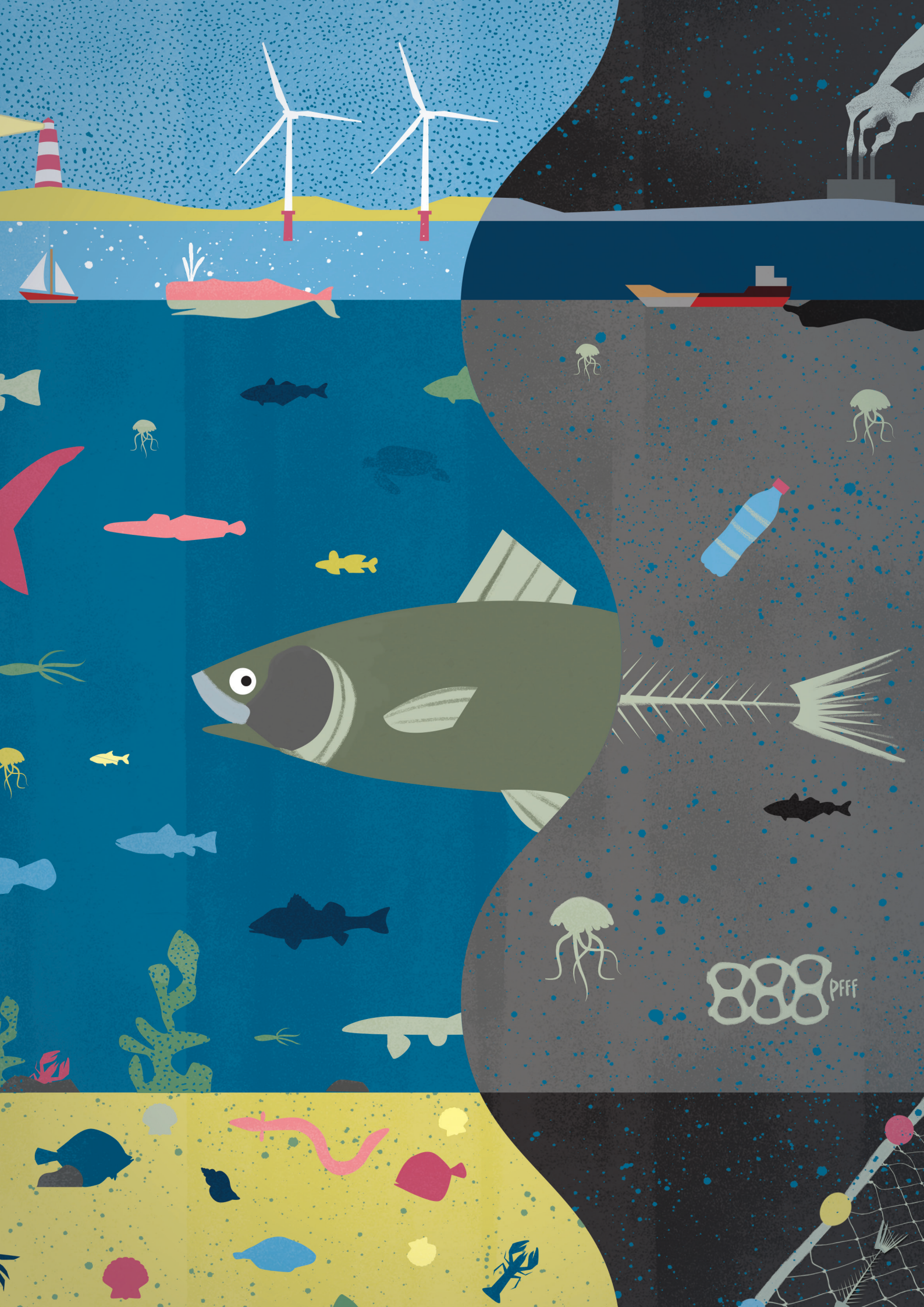
Marine messages

Our seas, our future — moving towards a new understanding

European Environment Agency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European seas — diverse in every way

Europe — a continent with a strong dependency on the sea

- Seas have provided Europeans with food, livelihoods and well-being for millennia. But these benefits are increasingly coming under threat from multiple pressures.
- European seas cover around 11 220 000 km² — an area larger than Europe's land territory.
- 23 out of 28 EU Member States have a coastline connecting Europeans to the sea.
- In 2011, 41 % of Europe's population — or 206 million people — lived in the 378 EU coastal regions.

The diverse regional seas

The regional seas surrounding Europe include the vastness of the open oceans as well as almost entirely land-locked seas (Table 1). Each sea is shared by a myriad of people, cultures, and activities. They are also the home to thousands of species of plants and animals, many of which are unique and fragile.

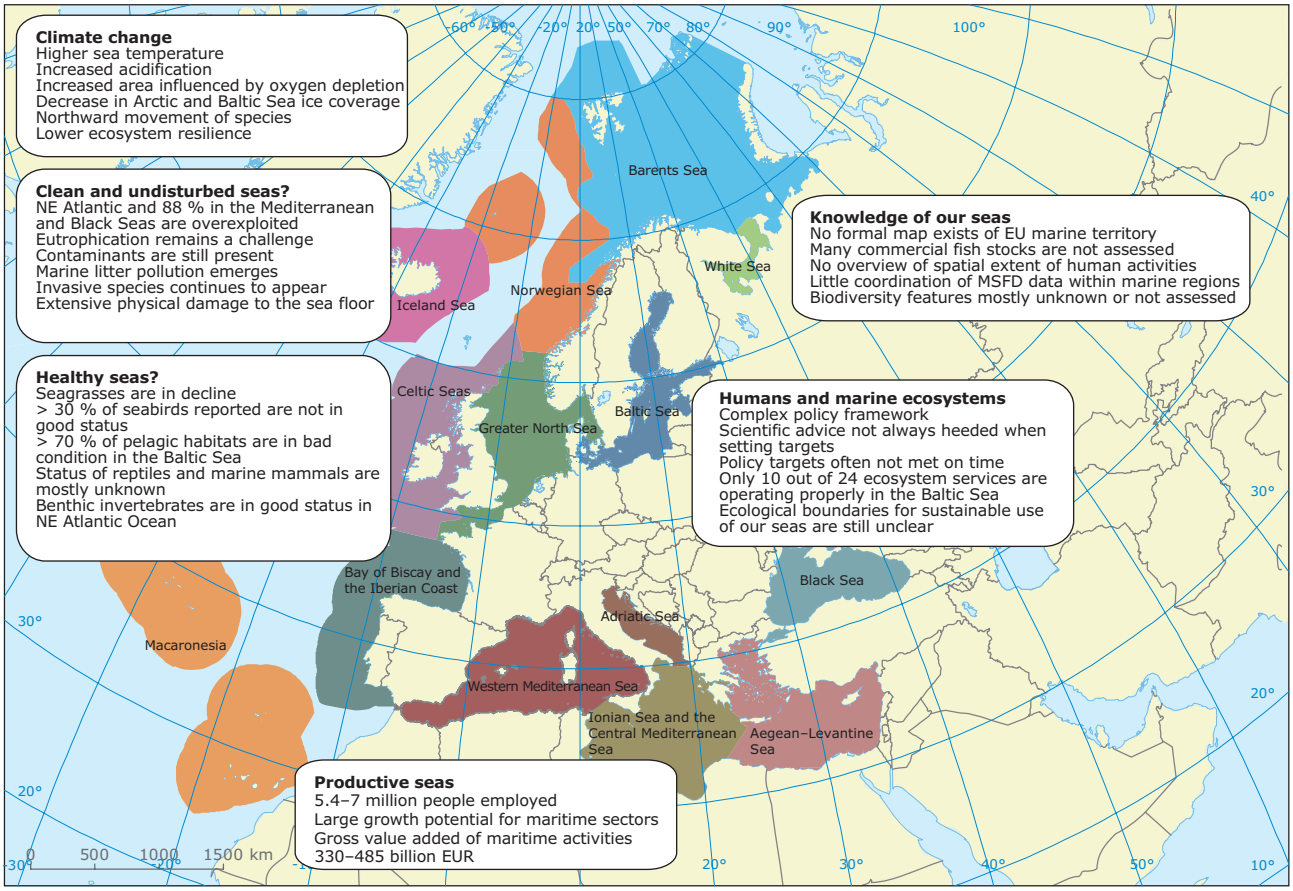
Together, all life interacts within the marine environment causing continuous change. If a change is adversely affecting the health of the seas, it exposes our societies and our way of life to major risks. Foremost among such adverse changes are those related to over-exploitation of natural resources, causing biodiversity loss, and climate change.

Table 1 Regional seas surrounding Europe — selected geographic characteristics

Regional seas surrounding Europe	Neighbouring EEA/collaborating countries	Regional sea surface area (km²)	EU Member State share of sea surface area (km²) and (%)	% of EU Member State sea surface area reported under the MSFD	Area of catchment (km²)	Population in catchment
Baltic Sea	SE, FI, EE, LT, LV, PL, DE, DK	394 000	370 000 (93.9)	92	1 653 000	77 019 000
North East Atlantic Ocean	UK, NO, DK, DE, NL, BE, SE, IE, FR, PT, ES	7 835 000	4 076 000 (52.0)	58	2 721 000	260 192 000
Barents Sea	NO, RU	1 944 000	0 (0)	–	706 000	1 401 000
Norwegian Sea	NO	888 000	0 (0)	–	89 300	824 000
Iceland Sea	IS	756 000	0 (0)	–	103 000	283 000
Celtic Sea	UK, IE	920 000	916 000 (99.6)	–	185 000	23 135 000
Greater North Sea	DK, SE, NO, DE, BE, NL, FR, UK	670 000	503 000 (75.1)	–	966 000	183 889 000
Bay of Biscay and the Iberian Coast	FR, PT, ES	804 000	804 000 (100)	–	661 000	48 500 000
Macaronesia	ES, PT	1 853 000	1 853 000 (100)	–	10 300	2 160 000
Mediterranean	ES, FR, IT, SI, MT, HR, BA, ME, AL, EL, CY, TR	2 517 000	1 210 000 (48.1)	86	1 121 000	133 334 000
Western Mediterranean	FR, IT, ES	846 000	660 000 (78.0)	–	429 000	53 852 000
Ionian Sea and Central Mediterranean Sea	IT, MT, EL	773 000	240 000 (31.0)	–	76 300	8 295 000
Adriatic Sea	SI, IT, ME, AL, HR	140 000	120 000 (87.7)	–	242 000	37 327 000
Aegean-Levantine Sea	EL, CY, TR	758 000	190 000 (25.1)	–	374 000	33 860 000
Black Sea	BG, RO, TR	474 000	64 000 (13.5)	46	2 414 000	191 994 000
Sea of Marmara	TR	11 700	0 (0)	–	39 290	No data
Total	**–**	**11 220 000**	**5 720 000 (51.0)**	**66**	**7 909 000**	**662 538 000**

Note: AL: Albania; BA: Bosnia and Herzegovina; BE: Belgium; BG Bulgaria; CY: Cyprus; DK: Denmark; DE: Germany; EE: Estonia; EL: Greece; ES: Spain; FI: Finland; FR: France; HR: Croatia; IE: Ireland; IT: Italy; LT: Lithuania; LV: Latvia; ME: Montenegro; MT: Malta; NO: Norway; NL: Netherlands; PL: Poland; PT: Portugal; RO: Romania; SE: Sweden; SI: Slovenia; TR: Turkey; UK: United Kingdom.

Map 1 **Regional seas surrounding Europe and the main sustainability challenges they face**



These changes can ultimately lead to an irreversible degradation of marine ecosystems and the services and benefits provided by them. This creates a challenge for policy and society: how best to steer these changes so that they ensure ecosystem resilience, while at the same time allowing for the sustainable use of healthy European seas?

Europe — and the EU in particular — have a responsibility to face these challenges. Member States in the EU have direct responsibility for more than half of the Regional Seas surrounding the European continent and outermost regions, an area more than 5 700 000 km^2. In 2011, 206 million people, or 41 % of the EU population, lived in Europe's coastal regions.

EU Member States cover more than 56 % of the up-stream catchments, an area more than 4 450 000 km^2. These catchment areas provide a home for more than 660 million people in EU and non-EU countries indirectly affecting the health of our seas. Similarly, the European Union also includes 25 overseas countries and territories associated with France, the United Kingdom, Denmark and the Netherlands; a sea area of similar size as that of the European seas.

Part of the solution to addressing the sustainability challenges (Map 1) of Europe's seas is to improve the effectiveness of policies and ensure that they are better implemented. Truly implementing them will be essential for steering the current chaotic pattern of change into a controlled transition towards sustainable use of our seas.

The present 'Marine messages' provides an overview of the many challenges and needs we face on the course towards the sustainable use of our seas and their bountiful, though not unlimited, natural resources. These messages are based partly upon the recent reporting under the EU Marine Strategy Framework Directive. It will be followed by a comprehensive EEA report on the state of the marine environment, which will be published later in 2014. This report will also act as a marine contribution to the 2015 EEA 'State and outlook of the environment' report.

EU policy visions for our seas

Integrated ecosystem-based management: the policy framework for the sustainable use of our seas

- There is a multitude of EU policy visions, ambitions and targets for the intertwined management of maritime activities and marine ecosystems.
- Enhanced understanding of socio-economic and ecological interactions has led to increased policy complexity.
- The EU is increasingly formulating its environmental policies in a three-step timeframe to cover a mixture of short-term targets, mid-term ambitions and long-term visions.

Increased policy complexity

Our understanding of the cumulative pressures and impacts affecting the marine environment has increased over the past 30 years. This knowledge recognises that the large-scale over-exploitation of resources, climate change and loss of biodiversity remain persistent issues of concern.

At the same time there is an enhanced appreciation of the interconnectedness between different societal and environmental problems. This awareness has led to a realisation among policymakers and public authorities that the marine environment is facing increasingly complex policy challenges. Successful solutions to these challenges require a change from the traditional approaches used to deal with them in regard to problem definition, analysis and response.

As a direct response, the EU is increasingly formulating its policies in a three-step timeframe. Step one includes short-term targets for individual sectoral policies for the period 2012–2018. Step two includes mid-term goals linking policy ambitions in more comprehensive policies e.g. the 7th Environment Action Programme (7th EAP) with 2020–2030 objectives for the environment and climate. Lastly, the EU is working towards a 2050 vision of societal transition, informed by the concepts of planetary boundaries, green economy, and resilience of society and ecosystems.

The integrated policy approach

The concrete policy measures that make up these three steps include a range of policy initiatives introduced by the EU. These aim at improving sustainability through the implementation of an integrated ecosystem-based approach to management (Table 2). In the marine and maritime domain these initiatives include the 7th EAP, the 2020 Biodiversity Strategy, the Integrated Maritime Policy (IMP) and the Common Fisheries Policy (CFP). All these initiatives include elements on data collection and information sharing in order to provide a sound knowledge base for policy development and decision-making.

The 7th EAP sets out a strategic overarching framework for the environment for achieving a 2050 vision for a Europe including a green, competitive economy, while safeguarding the environment and health of future generations. For marine ecosystems it focuses on sustainable fisheries and on reducing marine litter.

The EU Biodiversity Strategy aims to halt the loss of biodiversity and degradation of ecosystem services in the EU by 2020 (Box 1). A key element is the full implementation of EU nature legislation to better protect biodiversity and ecosystems, and to enable more use of green infrastructure. It includes better management of fish stocks and tighter control of invasive species. It provides a policy umbrella for objectives of the Habitats Directive, Birds Directive, Water Framework Directive, and the Marine Strategy Framework Directive (MSFD).

The IMP aims to provide a coherent approach to maritime issues and increase co-ordination between different policy areas. It includes elements, such as 'Blue Growth' and 'Maritime Spatial Planning'. The CFP lays down rules to ensure fisheries do not damage the marine environment

Box 1 Vision and headline targets for biodiversity in the EU's 2020 Biodiversity Strategy

By 2050: European Union biodiversity and the ecosystem services it provides — its natural capital — are protected, valued and appropriately restored for biodiversity's intrinsic value, and for their essential contributions to human well-being and economic prosperity, and so that catastrophic changes caused by the loss of biodiversity are avoided.

By 2020: Halting the loss of biodiversity and the degradation of ecosystem services in the EU, and restoring them in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss.

and are sustainable. The MSFD adopted in 2008 is the environmental component of the IMP. It aims to maintain biodiversity and provide diverse and dynamic oceans and seas that are healthy, clean and productive.

Table 2 Timeline for selected policy objectives and targets for achieving healthy, clean and productive European seas

Objectives	Sources	Deadline for implementation
		2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2030 2050
Healthy seas		
Halt the loss of biodiversity and the degradation of ecosystem services	EU Biodiversity Strategy to 2020	→ 20
To fully implement the Birds and Habitats Directive	EU Biodiversity Strategy to 2020	→ 20
Halt the loss of biodiversity	Seventh Environment Action Programme	→ 20
To establish an ecologically coherent network of protected areas under the title of Natura 2000	Directive 92/43/EEC	1998
Achieve Good Ecological Status in coastal waters	Directive 2000/60/EC	→ 15
Include spatial protection measures contributing to a coherent and representative network of MPAs	Directive 2008/56/EC	→ 16
Achieve Good Environmental Status in marine waters	Directive 2008/56/EC	→ 20
Marine biodiversity is restored or maintained	Directive 2008/56/EC	→ 20
Clean and undisturbed seas		
Establish EU-wide quantitative reduction target for marine litter	Seventh Environment Action Programme	→ 15
Tighter control of invasive alien species	EU Biodiversity Strategy to 2020	→ 20
43 % reduction in areas or ecosystems exposed to eutrophication	Thematic Strategy on Air Pollution	→ 30
Reduce carbon emissions from shipping by 40 % compared to 2005 levels	Roadmap to a single European Transport Area	→ 50
All bathing waters achieve a classification of at least 'sufficient' quality	Directive 2006/7/EC	→ 15
Achieve good chemical status in coastal and territorial waters	Directive 2000/60/EC	→ 15
Reduce maximum sulphur content of marine fuels from 3.5 % to 0.5 %	Directive 2012/33/EC	→ 20
All fish stocks exploited at MSY rates	Regulation (EU) No 1380/2013	→ 20
Productive seas		
Fishing at Maximum Sustainable Yield or below in all fisheries	Roadmap to a resource efficient Europe	→ 15
Phase out environmental harmful subsidies	Roadmap to a resource efficient Europe	→ 20
Renewable energy should account for 20 % of final energy consumption (land and sea)	Directive 2009/28/EC	→ 20
Marine knowledge		
Reducing uncertainty in knowledge of the seas and provide sounder basis for marine management	Marine Knowledge 2020	→ 20
Analysis of marine waters for assessment of environmental status	Directive 2008/56/EC (6 years-cycle)	→ 12 → 18
Member States shall cooperate on the different elements of marine strategies	Directive 2008/56/EC (6 years-cycle)	→ 12 → 18
Collect, manage and provide access to high quality fisheries data	Data Collection Framework 2008	→ 13
Reporting of conservation status of habitats & species based on established surveillance	Directive 92/43/EEC (6 years-cycle)	→ 13 → 19
Share data sets and services between public authorities for purposes of public tasks	Directive 2007/2/EC	→ 20

Note: Orange = legally binding obligations, blue = non-binding obligations.

The Marine Strategy Framework Directive

The EU and its Member States have taken an important step towards achieving healthy seas, but further effort is needed

- Implementation of the MSFD to date shows that the ecosystem-based approach to management of human activities in the marine environment is still in its infancy.
- More efforts are needed to meet the 2020 objective of reaching Good Environmental Status as part of a complete, adequate, consistent and coherent MFSD implementation.
- Only 66 % of the EU sea area was covered by the 1st MSFD reporting cycle, and more than 70 % of maritime boundaries between EU Member States are still not fully agreed upon.

MSFD — the EU's marine environmental policy pillar

Our seas and their ecosystems are facing many challenges caused by, in particular, over-exploitation. Addressing these challenges is recognised as being both an ecologic, economic and social imperative for Europe if we are to continue to reap the services and benefits that healthy oceans can provide. The Marine Strategy Framework Directive (MSFD) is a key component of the EU's policy response to these challenges.

The MSFD entered into force in June 2008 with the objective of achieving Good Environmental Status (GES) of our seas by 2020. It aims to maintain biodiversity and provide diverse and dynamic oceans and seas that are healthy, clean and productive, now as well as for the future. At its core is the concept of implementing an ecosystem-based approach to the management of human activities in the sea (Box 2).

Box 2 Ecosystem-based management

Ecosystem-based management is an integrated approach to management that considers the entire ecosystem including humans. The goal is to maintain ecosystems in a healthy, clean, productive and resilient condition, so that they can provide humans with the services and benefits upon which we depend.

It is 1) a spatial approach that builds around 2) acknowledging connections, 3) cumulative impacts and 4) multiple objectives. In this way, it differs from traditional approaches that address single concerns e.g. species, sectors or activities.

Source: Modified from McLeod & Leslie, 2009.

Implementing the MSFD

EU Member States have spent the first five years of MSFD implementation on data collection and analysis of the environmental state of their seas. The outcomes show that ecosystem-based management of human activities in the marine environment and what it means in practice is still poorly understood in Europe.

Recognising the spatial dimension

There is a need for further understanding of the MSFD's 'spatial dimension'. So far, there is no commonly accepted European map, which delineates the area where the MSFD is being or should be implemented. Disputes, gaps or overlaps on the position of maritime boundaries between countries exist for more than 70 % of maritime boundaries within the EU (minor and major issues). Member States have reported 280 assessment units from across the 5.7 million km^2 sea area under the jurisdiction of EU Member States. One Member State is responsible for 132 units alone. The assessment units reported range in size from 162 km^2 to 488 763 km^2. Many of these units overlap with each other, and combined only cover 66 % of the MSFD area. Such challenges make the establishment of a quantitative, spatially explicit baseline covering all of the marine regions for almost any feature (i.e. species, habitats and ecosystems) and activities difficult. This is clear for almost every parameter reported on under the MSFD Initial Assessment. Without a spatial baseline it will also be difficult to measure progress.

There is no correct spatial scale at which an ecosystem-based approach should be implemented. The appropriate scale should be determined by the connections between ecosystem features and human activities (and their related pressures). The marine regional and sub-regional scale is a pragmatic 'upper scale boundary' for MSFD implementation. Defining these scales and their boundaries is an imperative for any ecosystem-based approach to management.

Acknowledging connections

A similar lack of coherence is seen on acknowledging connections. This includes connections within marine ecosystems, within the associated socio-technical systems and between them. At the basic level is a need to further

improve the actual cooperation and coordination between Member States sharing a marine region. For example, while Member States have in general defined what 'Good Environmental Status' means, none have done it in the same way or even similarly for most of the MSFD descriptors. Likewise, a large part of the EU maritime economy is not consistently reported on.

In regard to acknowledging the linkages between marine ecosystems and socio-technical systems this appears even more difficult. How will we actually link our knowledge of individual human activities and ecosystem features? How will we embed the MSFD implementation within our societal and governance structures? Such questions have not been addressed adequately within or across the marine regions. In general, there seems to be a need to further discuss what 'acknowledging connections' actually means in the context of European marine ecosystem-based approach to management.

Assessing cumulative impacts on a regional scale

Another core component of an ecosystem-based approach is the assessment of cumulative pressures and impacts. HELCOM, the Regional Sea Convention in the Baltic Sea, has shown that it is possible to make a spatial description of the relative impacts on a regional scale. HELCOM managed to combine ecosystem features with pressures resulting from human activities in a spatial analysis.

Few harmonised spatial layers of ecosystem features or human activity layers have been reported for any regions. This approach could be further developed by EU Member States as part of their future marine assessments, as done for the eastern North Sea (Figure 1). However, to implement such an approach across the marine regions, Member States have to consider ways of pooling efforts. A joint approach of this nature would help to develop common methodologies and identify, share and harmonise the relevant national data sets.

Handling multiple objectives

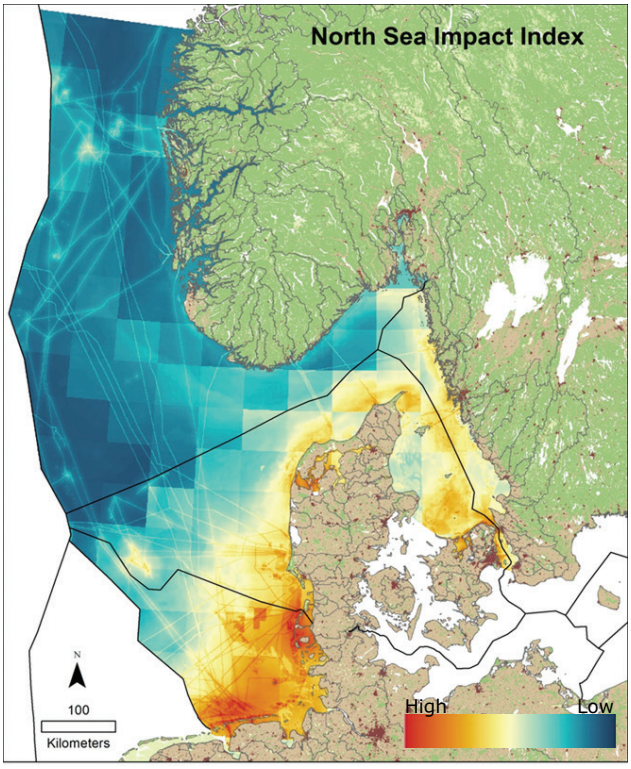
The ecosystem-based approach is about the sum of services and benefits we want to achieve from the marine environment rather than the focus on a single service or activity. Any number of activities can occur at a single location, whether it is an offshore wind farm, a fishery or a leisure activity. The MSFD recognises that in order to reap the services and benefits of our seas we need to understand the connections not only within the ecosystem or the socio-technical system, but also between them. How do human activities affect the delivery of the services upon which we depend, and how do we maintain a balance between short-term gains and long-term sustainability?

In order to address this, ecosystem-based management has to be explicit on the trade-offs between multiple objectives. These trade-offs cannot be handled through the more traditional 'sector-by-sector' or 'policy-by-policy' approach that still characterises much European marine and maritime management. The EU Commission has shown that Member States often do not take into account even their existing obligations when outlining the path by which they intend to reach Good Environmental Status. This lack of coherence, both across the EU and within marine regions shows the difficulty in considering multiple objectives.

Towards Good Environmental Status by 2020

Despite the current lack of coherence, EU and its Member States have taken an important step towards sustainable use of our seas. The process of producing the Initial Assessments is in itself of high value. The dialogue has been intense in the MSFD community, in the Regional Sea Conventions and between Member States sharing the marine regions. Innovative methodologies such as the use of spatial assessment tools are also appearing. The process has also enlightened the MSFD community as to where we have to focus its future efforts in terms of improving connections, creating agreed spatial boundaries, and handling multiple objectives. These improvements will assist progress towards the 2018 objective of a comprehensive and adequately revised approach to the Initial Assessment.

Figure 1 **Cumulative environmental impacts in the eastern North Sea**



Note: Colour grading shows impact magnitude.

Source: From Andersen & Stock, 2013.

Healthy seas?

Marine biodiversity remains in jeopardy. This may cause irreversible loss of ecosystem resilience and services

- Marine ecosystems are under pressure throughout Europe, threatening marine biodiversity.
- It is possible to halt the loss of European marine biodiversity and restore marine ecosystems through targeted policy actions and committed management efforts.
- Significant efforts are needed to enhance coordination of marine biodiversity information across all regions in order to improve our knowledge base.

Biodiversity is the variability among all living organisms: this includes diversity within species, between species and of ecosystems. It is the 'fabric of life' on which we depend: from the smallest bacteria in the sediment to the largest whale in the ocean. More than 36 000 species (excluding bacteria) have been identified in European seas, although up to 48 000 may exist. This 'fabric of life' is under threat of losing its very integrity due to historical and on-going over-exploitation of marine resources and changes in marine conditions.

Loss of biodiversity leads to loss of resilience

Such loss of integrity is closely linked to how individual species experience a decrease of population size, loss of distribution range and loss of habitat due to exploitation or invasive species. These patterns are now being observed for many European marine species such as the Blue Fin tuna, the Angel shark, and the European eel. The eel population is now approximately 1 % of its size 20 years ago. The low number of species in favourable conservation status is another clear indication that our seas are not as healthy as they could be.

Larger-bodied animals and top predators are particularly impacted by these pressures, and are disappearing throughout Europe's marine regions. The consequences of removing top predators from the marine ecosystem are significant. This leads to disturbances in the food-web (trophic downgrading), and affects ecological processes such as disease control, spread of invasive species and biogeochemical exchanges.

At the same time, the food-web is also being affected by other pressures such as climate change and other human activities. Such impacts are of the most insidious kind as they slowly but pervasively break ecological interactions. These impacts act first locally and then at a larger scale, potentially leading to ecological tipping points from which there are little or no return. Ultimately, this can lead to the extinction of species and the loss of ecosystem resilience (Box 3). Despite these trends, only a few marine species have to our knowledge so far become extinct in European seas. Among them are the Baltic Sturgeon and the Great Auk.

Are European seas healthy?

At the European scale, it remains difficult to analyse the rate at which the loss of biodiversity and the related resilience of marine ecosystems occurs. This is mainly because of the lack of adequate available data. However, information reported by EU Member States under the MSFD indicates that local biodiversity loss could be considerable (Figure 2). Whether looking at species (fish, mammals, birds, invertebrates or reptiles) or marine habitats (water column, seabed), less than 20 % (often much lower) of all biodiversity features (i.e. species, habitats and ecosystems) are considered as being in Good Environmental Status. This pattern is consistent throughout all the marine regions. In marine regions except for the Black Sea. Here the status of all biodiversity features are reported as 'unknown'.

The same pattern has been observed for vulnerable marine species and habitats protected by the Habitats Directive. From 2001 to 2006, only 10 % of the marine habitats assessments were considered at favourable conservation status. All of these were within the Macaronesian region. The assessments also stated that conservation status was inadequate or bad for 50 % of the marine habitats. Marine species fared even worse with only 3 % of the assessments being favourable and more than 70 % being categorised as unknown. Hopefully, the conservation status will have improved across Europe when the latest Habitats Directive reporting is made

Box 3 Ecosystem resilience

Ecosystem resilience can be defined as the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state. It is the ability to withstand shocks or adapt when necessary. Resilience thus relates to characteristics that underpin the capacity of ecosystems to provide ecosystem services and benefits.

available in 2014, although this might not be the case. Early results from the United Kingdom show that the number of all habitats on Annex I of the Habitats Directive in favourable conservation status has declined from 5 % to 3 % in the period from 2007 to 2013.

Signs that marine ecosystems, their biodiversity features, and related ecosystem services are under pressure are also emerging from reporting conducted by Regional Sea Conventions (Box 4).

Available information thus indicates that biodiversity remains under pressure in European seas in spite of on-going efforts to reverse current trends. It is the result of the cumulative impacts caused by multiple pressures. These include global climate change, overfishing, and pollution by contaminants and nutrients. The combined effects jeopardise the long-term services and benefits our seas are able to deliver and, as such, the European seas cannot be considered to be in a 'healthy' state.

Targeted management efforts produce results

In spite of these observations on the state of marine ecosystems, there is also the evidence that targeted policy actions and committed management efforts can protect species and habitats.

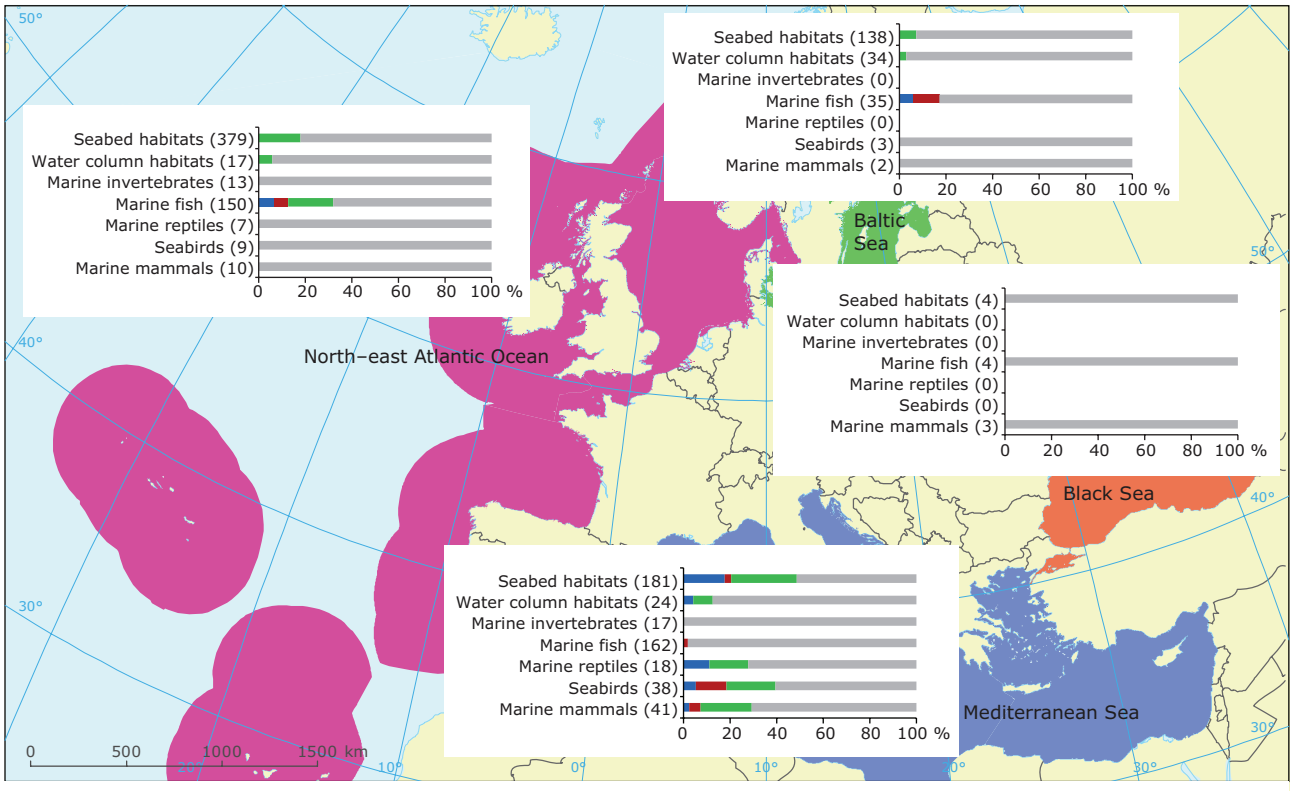
Box 4 Regional views on the loss of biodiversity

In 2010 OSPAR concluded '...on the basis of the current evidence, that the UN target of reducing the loss of biodiversity by 2010 is far from being achieved in the North-East Atlantic Ocean'.

For the Baltic Sea, HELCOM concluded in 2010 that 'the status of biodiversity appears to be unsatisfactory in most parts of the Baltic Sea'. HELCOM also concluded that out of 24 marine ecosystem services identified in the Baltic Sea, only ten are operating properly with seven being under severe threat.

Some achievements in this regard include Natura 2000 efforts that have increased marine protected areas over the last two decades. Likewise, the number of European fish stocks being exploited at sustainable levels has been increasing since 2007. In the Baltic Sea, the status of top predators such as grey seals and white-tailed sea eagles has been improving over recent decades. In parts of the Northeast Atlantic Ocean, encouraging trends are observed for estuarine fish diversity as well health of seabird colonies in areas with control of invasive species. Such evidence shows us that it is still within our reach to halt the loss of marine biodiversity and restore our seas.

Figure 2 Status assessment of natural features reported by EU Member States under the MSFD



Note: Blue = good, red = not good, green = other and grey = unknown). The figures in parenthesis are the number of reported features. The associated confidence rating of the information is rarely high.

Source: ETC/ICM, 2014.

Marine climate change impacts

Climate change impacts in European marine ecosystems are happening at accelerating rates causing a loss of resilience

- Climate change is being observed in European seas. It leads to a wide range of impacts on marine ecosystems and on dependent communities.
- Sea surface temperature is increasing more rapidly in European seas than in the global oceans, causing a northward shift in species distribution.
- In recent decades, ocean acidification has occurred a hundred times faster than during past natural events over the previous 55 million years. This acidification has the potential to adversely impact all marine life.

Climate change covers the headlines of today as a major global policy challenge. It impacts the health and resilience of natural systems, increasing existing vulnerabilities and social imbalances. Together with the loss of biodiversity, climate change is one of the key policy challenges of our age.

The three major effects of climate change

The three primary physical effects of climate change on our seas are increased sea surface temperature, oxygen depletion (hypoxia) and acidification (Box 5). The combined effects of these phenomena decrease the overall resilience of marine ecosystems and make them even more vulnerable to other pressures. This includes the cumulative impacts of human exploitation.

Box 5 Climate change and loss of biodiversity

Increased sea surface temperature, acidification and hypoxia are all associated with the majority of mass extinction events over the last 540 million years. These phenomena are now occurring at an accelerated rate.

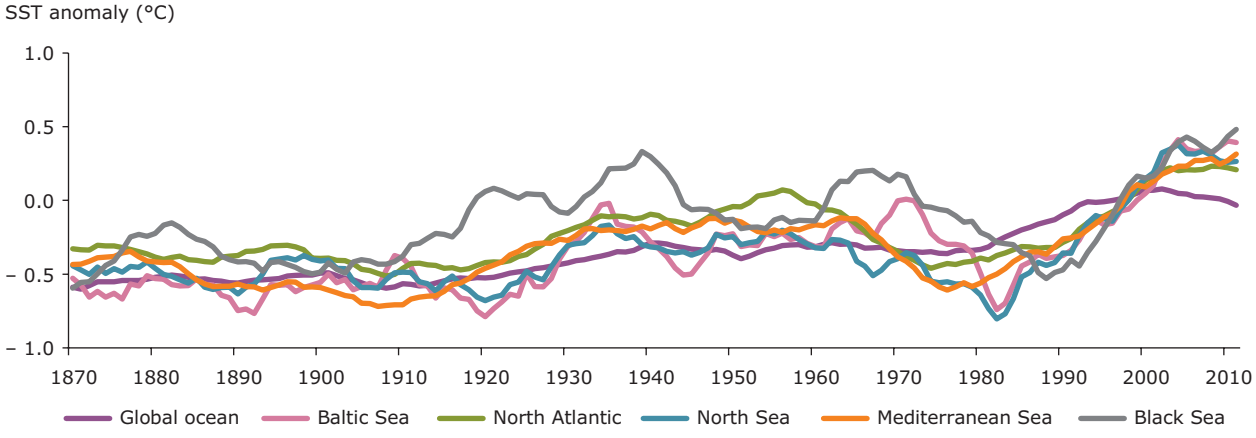
Climate change is expected to impact the physical conditions differently in each European regional sea. Consequently, biological impacts vary depending on the region.

Temperature is increasing

The rate of increase in sea surface temperature in all European seas during the past 25 years is the largest ever measured in any 25-year period. It has been about 10 times faster than the average rate of increase during the past century and before (Figure 3).

The life cycles of marine organisms are adapted to a certain temperature range, so they respond to changes in temperature. When temperatures change, organisms either live under sub-optimal conditions, or they move elsewhere. In the sea, these adjustments are happening much faster than on land, but the speed at which they happen differs depending on the species in question.

Figure 3 Annual average sea surface temperature anomaly in different European seas (1871–2011)



Source: EEA, 2012a.

In European seas with an increased surface temperature, there has been a trend of northward movement of species such as the Grey triggerfish and the Pipefish. Similar northward expansion can be seen in warmer water plankton (*Calanus helgolandicus*) in the North-east Atlantic Ocean, with a northward retreat of colder-water plankton (*Calanus finmarchicus*). This northerly movement is about 1 100 km and appears to have accelerated since 2000.

Such behavioural responses cascade through the marine ecosystem, altering biogeochemical pathways and food-webs. This in turn changes the overall productivity of marine ecosystems. For example, plankton such *C. helgolandicus* has lower nutritional value than *C. finmarchicus.* Such decline in productivity has potential consequences for both marine life and for humans.

These changes also create political challenges important for local communities. One such example is how the northward movement of mackerel stocks has led to tension between the EU, the Faroe Islands, Norway, and Iceland on the distribution of the quota available for mackerel. At the moment, the Faroe Islands are not permitted to land or export fish to the EU because of this disagreement.

Oxygen depletion is exacerbated by climate change

Increase in sea temperature raises the metabolism of organisms. Climate change also increases the water run-off from land, especially in northern countries. The combination of these effects can further increase the effects of eutrophication and potentially the areas influenced by oxygen depletion.

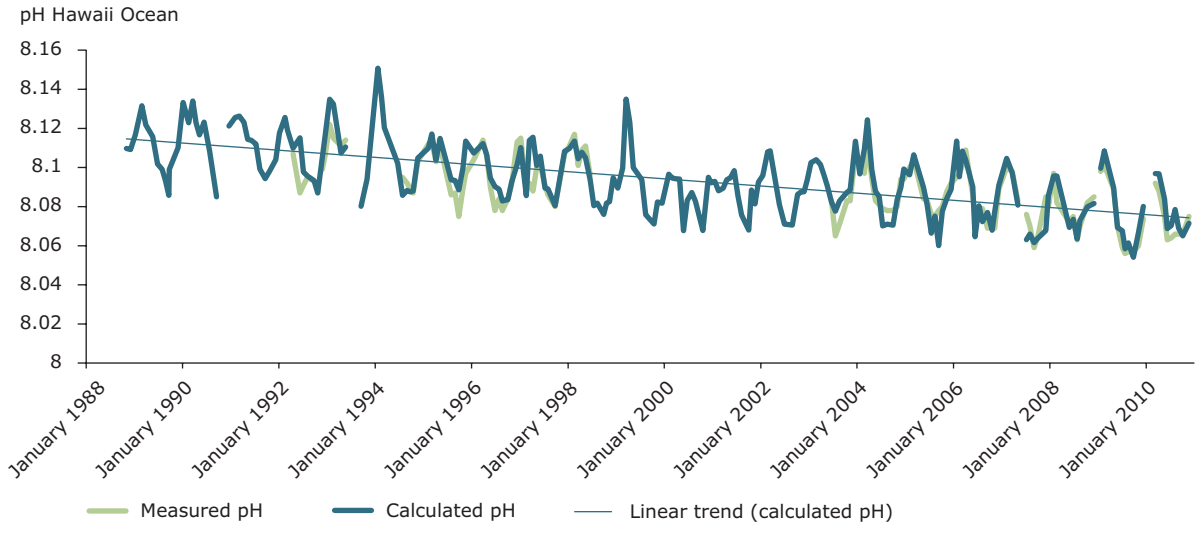
Acidification could alter marine ecosystems

In recent decades, ocean acidification has been occurring a hundred times faster than during previous natural events over the last 55 million years. Global surface ocean pH has declined from 8.2 to 8.1 over the industrial era due to the growth of atmospheric CO_2 concentrations. This equals a 26 % lowering in ocean acidity (Figure 4). Average surface-water pH is projected to decline further to 7.8 by 2100 depending on future CO_2 emissions. The largest projected decline represents more than a doubling of acidity on today's levels.

When CO_2 is absorbed by the ocean it reacts with water producing carbonic acid. It has been shown that corals, mussels, oysters and other marine calcifiers have difficulties constructing their calcareous shell or skeletal material as the concentration of carbonate ions decreases. Most marine calcifying organisms exhibit the same difficulty. Acidification also affects other biological molecules and processes, including enzyme activities, calcification and photosynthesis. Most importantly, it affects primary producers (such as phytoplankton) at the very bottom of the marine food-web. Reductions in seawater pH due to human activities could therefore affect entire marine ecosystems.

The effects of climate change combined with the cumulative pressure of human activities leads to overall loss of resilience in marine ecosystems. This loss of resilience is intricately linked with the loss of biodiversity and the ecosystem services healthy seas could provide us with. Ultimately it could have a significant effect on human well-being. For example, our seas would produce less fish and shellfish even if the resources were exploited sustainably.

Figure 4 Decline in pH measured at the Aloha station as part of the Hawaii Ocean time-series



Source: EEA, 2012a.

Clean and undisturbed seas?

Multiple pressures continue to be a significant presence in our seas and their combined effect is of growing concern

- Fishing pressure is reducing, but decades of overfishing have affected ecosystem integrity.
- Damage to seafloor habitats is likely to increase with growth in maritime activities.
- Pollution by nutrient enrichment and contaminants remains an environmental challenge.
- Non-indigenous species are spreading, and their impacts are not fully assessed.
- Marine litter and underwater noise are adding pressures, but are still poorly understood.

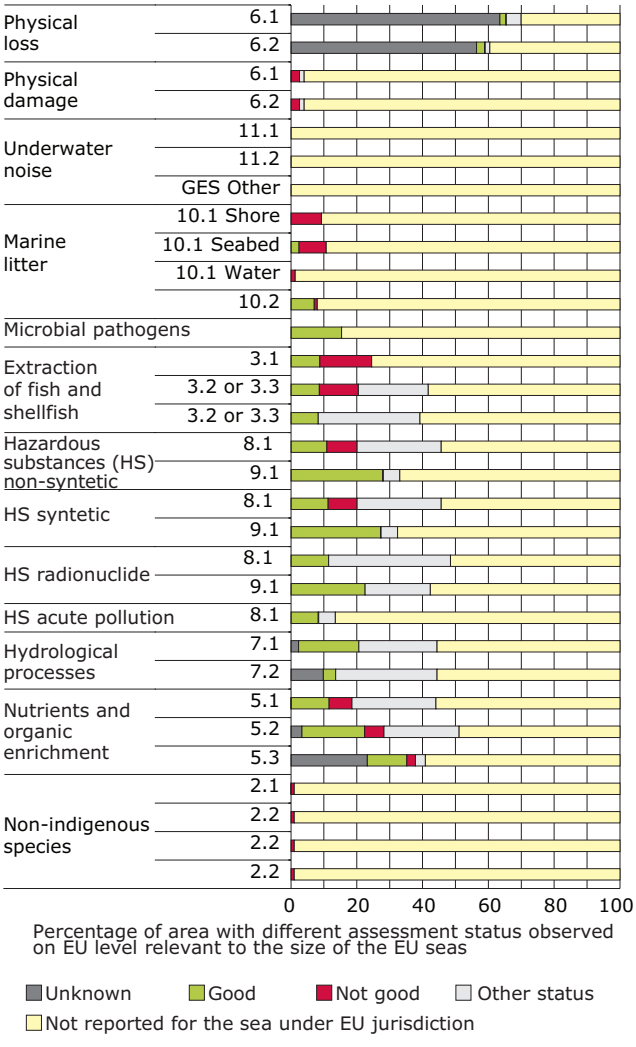
Climate change is the major indirect pressure on the marine environment. It makes our marine ecosystem more sensitive to other pressures coming from human activities at sea or on land. Although it is difficult to determine or predict the cause-and-effect relationships of the interactions between all these pressures, evidence shows that they are inducing large-scale changes such as hypoxia zones and the collapse of fish populations.

While climate change mitigation requires regional action and global cooperation, many of the remaining, more direct pressures can be addressed directly by the EU and its Member States. However, there is a need for clinical tools to better understand the complexity of the marine ecosystem and allow more accurate diagnoses. Combined with adequate and innovative management measures, these can support sustainable maritime activities. While we gradually progress on this complex pathway, reducing pressures based on the knowledge we have today and the adoption of the precautionary approach remains crucial to improve the current state of the marine environment and restoring its resilience to change.

A multitude of pressures affects our seas

The main pressures affecting European seas result from: fishing, seafloor damage, pollution by nutrient enrichment and contaminants, and the spreading of non-indigenous species. Marine litter and underwater noise are also of growing concern. These pressures are at the core of the MSFD but some have also been targeted by other dedicated EU policies (the Water Framework Directive and related directives, the Habitat and Bird Directives, and the Common Fisheries Policy). The information reported under the MSFD, although incomplete, shows a low percentage of our seas where pressures are considered to be at an acceptable (good) level (Figure 5).

Figure 5 **Status assessment of pressures reported by EU Member States under the MSFD**



Note: Numbers refer to criteria under the Commission Decision 2010/477/EU.

Source: ETC/ICM, 2014.

Fishing pressure affects ecosystem integrity

Fishing is one of the greatest pressures in the marine environment. It reduces biodiversity by targeting commercial fish and shellfish and accidentally killing invertebrates, mammals, seabirds and turtles. It also modifies the structure and functioning of the ecosystems in which fisheries are embedded. Unsustainable fishing levels and practices have greatly damaged European fish stocks. In 2013, the 88 % of the assessed stocks in the Mediterranean and Black Seas were overfished.

As a result of better implementation of management measures, fishing pressure has been decreasing since 2007 in EU Atlantic and Baltic waters. The number of assessed stocks fished above their maximum sustainable yield (MSY) has fallen from 94 % in 2007 to 39 % in 2013. This has in turn led to important signs of recovery in stocks over the past years. In 2013, 59 % of those assessed stocks had climbed back to safe biological limits.

Although crucial, this improvement on the status of stocks is still only relevant for a fraction of the exploited stocks. Currently, approximately 50 % of all landings from stocks in the EU Atlantic and Baltic waters, and 80 % of landings in the Mediterranean and Black Sea come from data-poor stocks. This means that we still know little about most of the stocks and how much their future reproductive capacity is being threatened.

Fishing also affects the wider ecosystem. The continued use of unsustainable fishing practices, in particular bottom-trawling and the use of other high-impact gear, have destroyed seafloor habitats and compromised its biodiversity. This has induced high-levels of accidental mortality not only in fish, but also among seabirds. Recent estimates report by-catch by the EU fishing fleet in EU waters at about 200 000 seabirds annually.

Fishing thus affects species interactions and decreases the productivity of ecosystems, bringing them to states that are often less predictable and more unstable. These make ecosystems less resilient to change. These systemic changes are still complex and to a large extent poorly understood, but there is already enough evidence to show that fishing can push ecosystems beyond their tipping points, from which recovery is unlikely. This affects not only the natural system, but also the livelihoods that depend on it. The collapse of cod stocks in the Canadian North Atlantic are a good example of this, where these triggered or contributed to large-scale reorganisations of ecosystems with enduring environmental and socio-economic impacts.

Multiple activities threaten seafloor integrity

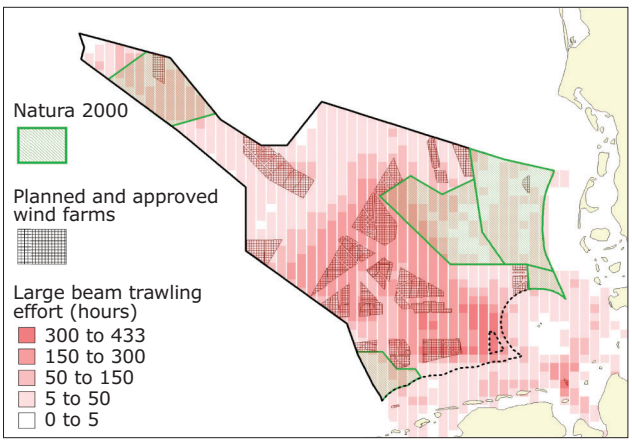
Seafloor damage mainly refers to changes in the structure and function in seabed habitats and their communities, therefore affecting seafloor integrity. It is caused by harvesting natural resources, which can be either biological (e.g. bottom-trawling) or physical (e.g. aggregates). To a lesser extent, it is also caused by energy production (e.g. oil and gas structures), coastal and port infrastructure (e.g. dredging), or telecommunication (sub-sea cables). Because these activities differ in terms of their extent, degree of impact, or affected habitat types and associated communities, the overall magnitude of their impact differs.

The extent of seafloor pressure in some parts of Europe's seas shows that managing it will become a major challenge. For example, in the German North Sea, some areas (3 x 3 nautical miles) have been annually fished up to 433 hours of large-beam trawling, even inside marine protected areas (Figure 6). The recovery time for seabed communities affected by bottom-trawling has been estimated to be between 7.5 and 15 years after one single pass of a beam trawl. With the expected growth in maritime activities, the impact on the seafloor and its cumulative effects are likely to increase. In this respect, the development of seabed mining, a novel but strategic area for the EU's Blue Growth strategy, will be of importance for seafloor integrity, especially in the deep-sea due to the vulnerability of those ecosystems.

Non-indigenous species are spreading

The introduction of non-indigenous species is closely linked to the increasing globalisation of trade and travel. While many of these species become part of the ecosystem they are introduced into, only a few actually become invasive and end up generating negative impacts (Box 6). When this happens, major ecological, economic, or social effects threaten biodiversity and ecosystem services. Moreover,

Figure 6 **Seafloor pressure in the German North Sea exclusive economic zone by beam trawl fishing (annual effort)**



Source: Pedersen et al., 2009.

Box 6 A definition of non-indigenous species

Non-indigenous species (NIS), also known as alien, are species introduced outside their natural environment. They are referred to as 'invasive alien species' (IAS) if they find adequate conditions to survive, reproduce, spread, and cause widespread harm.

even when introduced locally, the impacts of marine invasions are generally widespread and irreversible.

Records show that more than 1 350 marine alien species have been introduced in European seas since the 1950s. These introductions are happening at an accelerating rate with almost 300 new species observed since 2000. Introduction pathways are often uncertain, but available data shows a majority of species invaded through shipping and via marine and inland canals. Introductions to the Aegean-Levantine Sea are of particular concern due to the Suez Canal. Less important pathways for alien invasive species include aquaculture-related activities, and, to a much lesser extent, the aquarium trade.

Impacts on local ecosystems are still poorly assessed, but enough examples exist to show how alien species can significantly alter the ecosystems and the communities that depend on them. The population outbreak of the jellyfish *Mnemiopsis leidyi* in the enclosed Black, Azov and Caspian Seas in the 1980s and early 1990s is a paradigmatic case of the potential harm caused by the introduction of alien species. As it spread and out-competed local fish populations, it eventually led to a collapse in fisheries and in turn the livelihoods that depended on them.

Contaminants in the marine environment

Contaminants are widespread in the marine environment, and can be dissolved in water, stored in sediments or ingested by animals. Some of these substances are naturally occurring in low concentrations, and others are introduced by man. Contaminants toxic to plants and animals are liable to accumulate through the food-web. Substances with endocrine-disrupting properties can impair reproduction in fish and shellfish. Evidence shows that regulatory levels for certain contaminants in seafood have been exceeded in European seas exposing humans to contaminants through consumption.

Contaminants can be spread over large distances through repeated deposition and evaporation. The main sources for this dispersal are treated and untreated waste water, agriculture, shipping, port activities, aquaculture, offshore oil exploration, consumption of fossil fuels, and industrial activities.

Under the Water Framework Directive, more than 90 % of transitional and coastal water bodies in Sweden, Denmark, Netherlands, Belgium and northern France were classified as having poor chemical status, while good status was achieved in the eastern Baltic and western United Kingdom. EEA indicator MAR 001 addresses concentrations and trends of seven hazardous substances found in marine organisms: mercury, lead, cadmium, HCB, lindane, PCB, and DDT. All these substances have been banned from use, but are still found in the environment. Concentrations of HCB and lindane are generally classed as being Low or Moderate, concentrations of cadmium, mercury and lead are classed as being Moderate, and concentrations of PCB and DDT are classed as being Moderate or High.

Between 1998 and 2010, concentrations of lead, lindane, PCB, and DDT were on a decreasing trend in the Northeast Atlantic Ocean. In the Mediterranean Sea, more than a third of stations show High concentrations of lead, lindane, DDT and PCB. A general upward trend was found for mercury and lead. In addition to such legacy substances there are many other substances emitted into the seas, but it varies widely among Member States which substances are considered problematic. For some pollutants, awareness of potential effects has only just emerged. These 'emerging pollutants' include substances that have existed for some time, such as pharmaceuticals, but also relatively new ones such as nano-materials.

Pollution with nutrients — eutrophication

The marine regions of Europe have different sensitivities to eutrophication, determined by their physical characteristics. The Baltic and Black Seas have high sensitivity to eutrophication due to limited water exchange with connecting seas. There are several definitions of eutrophication (Box 7).

Coastal eutrophication contributes to ecosystem degradation. It leads to increased growth of algae (increased biomass), changes in the balance of organisms, and degradation of water quality. For

Box 7 A definition of eutrophication

Eutrophication is a process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of organisms; and water quality degradation. The consequences of eutrophication are undesirable if they appreciably degrade ecosystem health and/or the sustainable provision of goods and services.

Source: Ferreira et al., 2010.

example, increased growth of phytoplankton can lead to blooms of noxious and opportunistic algae. As the plant material decays, increased oxygen consumption in bottom waters is promoted, potentially leading to hypoxia with lethal effects on bottom fauna. Even a short-time event of hypoxia will kill most invertebrates living on or within the seabed, creating 'dead zones'. Dead zones in marine ecosystems due to hypoxic conditions have doubled in size globally every decade since the 1960s.

Nutrients in marine waters derive from artificial fertilisers and manure used in agriculture, urban wastewater, aquaculture, and shipping. Member State reporting confirms these pathways. Whatever their origin, nutrients often cross national boundaries. Finding the right solutions requires continued regional cooperation.

The information made available under the Initial Assessment indicates that eutrophication remains a cause of concern in the Baltic Sea and parts of the North Sea. Mediterranean countries reported good or mostly 'not detected' status for their Mediterranean Sea territories. In the North Sea, Germany and Denmark are reporting 'not good' status whereas other countries are reporting 'not detected' status. The status of the Black Sea cannot be assessed from reported information.

In addition, EEA indicator CSI 021 shows that between 1985 and 2010 overall nutrient (nitrates and phosphates) concentrations across European seas have been either unchanging or decreasing in stations reported to the EEA. EEA indicator CSI 023 shows that between 1985 and 2010 chlorophyll-a concentrations (which reflect the amount of biomass in the water) remained unchanged at 87 % of stations.

Significant efforts have been made to reduce nutrient inputs. In the Baltic Sea, nutrient loads to the sea have decreased by between 16 % and 18 % over the past 20 years. OSPAR reports for the Northeast Atlantic that a 50 % reduction target for inputs has mostly been met in the case of phosphorous. However, this target has not been met for nitrogen in the same region. Nutrient concentrations in marine ecosystems have not reduced equivalently due to recirculation of nutrients.

Marine litter is accumulating, in particular plastic

Marine litter is a problem rooted in unsustainable consumption patterns and behaviours. Increasing amounts of litter, mostly coming from land-based sources, are ending up in the oceans, making this an emergent global problem. Plastic is the most abundant material in this waste, although the amount and type of litter varies regionally.

This pattern is also seen in European seas. Recent information shows plastic is the most abundant material in all regions, and that more than half of this plastic is formed by plastic packaging waste (e.g. bottles and plastic bags). The other main types of materials in marine litter include sanitary waste, smoking-related material, and fishing-related material. While land-based activities generate most of the marine litter in the Mediterranean, Baltic Sea, and Black Sea, maritime activities are an almost equally important contributor in the North Sea. Inappropriate waste management and infrastructure together with individual behaviour and attitudes towards littering are amongst the main factors causing marine litter to end up in our seas.

Marine litter can cause many environmental and socio-economic impacts. It causes injuries and death to a range of marine wildlife, mainly through ingestion and entanglement. In the North Sea alone, over 90 % of the Northern Fulmar sea birds washed ashore dead contained plastic in their stomach. It also serves to transport potentially harmful chemicals and invasive species, and it affects activities such as fisheries and tourism, reducing the recreational value of beaches.

Micro-plastics are of particular concern due to their potential toxicity and size. Used directly in products (such as exfoliants or industrial abrasives) or resulting from the fragmentation of larger pieces, micro-plastics are widespread in the marine environment and increasingly ingested by animals. The consequences of plastic build-up in the food chain are still largely unknown, but they are beginning to raise human-health concerns.

Human activities are generating underwater noise

Underwater noise has become an emerging environmental issue in light of growing transport and industrial activities at sea. Whether emitted deliberately (e.g. military sonar) or as a by-product of other actions (e.g. shipping), manmade sound induces a range of behavioural reactions, and can even cause death. Sound can reach very far underwater, and its impacts can be felt at large distances.

Short-term impulsive sounds from seismic surveys, impact pile-driving, or military sonar have the greatest potential to affect marine mammals and fish. These can lead to changes in their distribution, which in turn could affect life functions such as mating and migration, and thus species populations.

There is also evidence that ambient sound has increased in some marine areas due to the intensification of ship traffic. Prolonged exposure can lead to physiological and behavioural stress, affecting in particular communication in whales and fish.

Productive seas

Human activities and exploitation of marine resources continue to increase, and are likely to do so in the future

- The EU maritime economy is a thriving economic engine and job creator.
- Adequate planning and management are needed to ensure the health of the seas and to maximise the sustainable socioeconomic benefits they provide.
- Continued environmental degradation poses a significant risk to marine resources and the activities and communities that depend on them.

Seas and coasts — EU resources worth preserving

Marine and coastal areas have long been drivers of economic growth, providing Europeans with natural resources as well as access to trade and transport. Today, marine and coastal activities remain essential to the European economy and society. They have an estimated Gross Value Added of 330–485 billion EUR and employ approximately 5.4–7 million people (Table 3).

Expansion, growth and competition

The use of European oceans, seas, and coasts has increased as traditional industries grow and as emerging industries seek access to marine resources. These on-going developments are highly relevant for the coastal communities and the marine environment in the regions where they occur.

A number of maritime activities are in the early stages of growth and are expected to increase significantly in the future. These include offshore renewable energy production (output increased by 21.7 % (MW) between 2003–2008), algae production, mineral mining, the extraction of genetic resources and biotechnology, coastal protection, and surveying and monitoring (expected to grow by between 14 % and 20 % in allocated funding in coming years). These activities are driven by several factors, such as the increased demand for marine biological resources for medical and cosmetic products, or the drive to combat climate change, a drive that has led to the construction of renewable energy installations at sea. Another factor is the construction and high-tech industries' need for minerals.

Many traditional maritime activities are also experiencing growth. Maritime transport of freight has remained relatively constant over recent decades. Despite a recent and slight decline caused by the global financial crisis, maritime transport of freight is expected to grow by between 3 % and 4 % goods handled per annum over the next decade. Similarly, the shipbuilding and repair industry is also expected to grow in coming years, driven by a demand for new technologies to reduce the environmental impact of the shipping industry. After setbacks stemming from the global financial crisis, port operations have returned to previous levels of activity and are also expected to continue growing.

Tourism and recreation are an important motor of the European blue economy, with significant added value and employment. Tourism grew by 3 % between 2003 and 2008. Both tourism and recreation are expected to increase in coming years as marine and coastal areas remain top touristic destinations in Europe. Cruise tourism is also highly successful and predicted to continue to grow in the near future. Similarly, the yachting and marina industry has been steadily growing (5 % GVA in Europe over five years) and this growth is set to continue. A key challenge in the coming decade will be to steer such expectations for growth in the maritime economy towards the policy visions of establishing a green economy (Box 8) and within the ecological limits of our seas.

In spite of this overall picture of continued growth, several maritime activities are experiencing stagnation or decline. However, they remain important for the value and jobs they provide to the European economy. Fishing, a traditional European industry, has been in steady decline over the last decade as the size of EU total catches in all fishing regions has decreased. Aquaculture accounts for a significant portion of seafood supply in the EU, and although EU aquaculture production is stagnating in Europe it is steadily

Box 8 Towards a green economy

A green economy recognises that ecosystems, the economy and human well-being and their related types of capital are intrinsically linked.

At the core of these links is the dual challenge of ensuring ecosystem resilience and improving resource efficiency.

increasing worldwide. Marine oil and gas extraction is declining in the North Sea, but the sector remains a vital part of the maritime economy, as new fields are discovered in regions such as the Barents Sea and Eastern Mediterranean Sea (decreased by 4.8 % GVA in the period 2003–2008 in Europe). Passenger ferry services have seen a slight decline in passengers in recent years (falling by 2 % between 2009 and 2010). However, the sector remains highly significant for some Member States in terms of numbers of passengers.

Maritime activities and sustainability challenges

The pressures and impacts arising from the growth of maritime industries present a number of sustainability challenges. For example: invasive alien species must be contained to avoid disruption of food webs, contaminants must be managed to avoid their building-up to dangerous levels in organisms, fisheries must reduce their impact on the seafloor, and waste recycling incentives should be put in place to reduce marine litter. Challenges like these will continue to appear unless smart and innovative solutions, such as integrated maritime spatial planning or a circular green economy, are developed and implemented at the same rate as our exploitation of the seas increases.

This challenge of sustainably using our marine resources is compounded by a further problem: information. The recent MSFD reporting showed significant information gaps and lack of coordination across all marine regions on maritime information including on economic data, employment, and spatial distribution of activities. Such information is essential for providing a knowledge base that can inform the analysis, policy development, and measures needed to achieve sustainable development.

Table 3 European maritime activities, their estimated economic value, people employed and expected future trends

Category	Human activities	GVA (million EUR)	Employment	Turnover (million EUR)	Expected future trend
1: Land-based activities/ industries	Industrial discharges and emissions	–	–	–	–
	Agricultural and forestry run-off and emissions	175 289	11 935 000	–	–
	Municipal waste water discharge	–	600 000	72	–
2: Extraction of living resources	Fisheries incl. recreational fishing (fish and shellfish)	3 400	127 686	–	↘
	Seaweed and other sea-based food harvesting (bird eggs, shellfish, etc.)	–	–	–	–
	Extraction of genetic resources/bio-prospecting/maerl (blue technology)	–	–	–	↗
3: Production of living resources	Aquaculture (fin-fish and shellfish)	270	30 000	–	→
	Marine aquatic products (e.g. growing algae)	–	80 000	–	↗
4: Extraction of non-living resources and disposal	Marine mineral and aggregates mining (sand and gravel, rock)	600	4 300	25	↗
	Dredging	558	25 000	–	↗
	Desalination/water abstraction	–	25 000	6 800	↗
	Extraction of salt	–	7 325	–	↗
	Solid waste disposal incl. dredge material	–	–	–	–
	Storage of gasses (carbon capture and storage)	–	–	–	–
5: Transport and shipbuilding	Freight shipping	57 000	700 000	–	↗
	Passenger ferry services	–	250 000	–	↘
	Shipbuilding and ship repair	–	500 000	30 000	↗
6: Tourism and recreation	Marine and coastal tourism	121 000	2 350 000	–	↗
	Recreational activities (e.g. bathing)	–	–	–	↗
	Yachting and marinas	–	–	–	↗
	Cruise tourism	14 100	153 012	–	↗
7: Man-made structures (incl. construction phase)	Land claim, coastal defence & flood and saltwater protection	–	–	–	↗
	Port operations	–	1 500 000	–	→
	Placement and operation of offshore structures (other than for energy production)	–	–	–	↗
	Submarine cable and pipeline operations	–	–	–	–
	Protection of habitats	–	–	–	–
8: Energy production	Marine-based renewable energy generation (wind, wave and tidal power)	2 650	36 000	–	↗
	Marine hydrocarbon (oil and gas) extraction	130 000	50 000	–	↘
9: Research and survey	Marine research	–	–	–	↗
	Survey and monitoring	–	–	–	↗
10: Military	Defence operations	–	–	–	–
	Dumping of unwanted munitions	–	–	–	↘

Source: Modified from the EU Blue Growth initiative.

Marine knowledge — towards a baseline

Improving and recognising our knowledge base in decision-making is essential to achieve sustainable development

- Our current knowledge base is fragmented: the information reported by EU Member States under the 2012 Initial Assessment cannot be considered a comprehensive representation of the marine and maritime knowledge base existing in Europe.
- Important initiatives are underway to improve the exchange of data and information. These initiatives will allow us to make better informed decisions on the sustainable use of our seas.
- More research is needed to improve understanding of the interactions between species, habitats and cumulative impacts. We also need to improve our understanding of how Europe's different environmental policy objectives can best fit together.

At present, a fragmented knowledge base

The information reported under the MSFD gives an incomplete overview of the state of the marine environment, offering low confidence and comparability to establish a baseline of the state of Europe's seas (Figure 7).

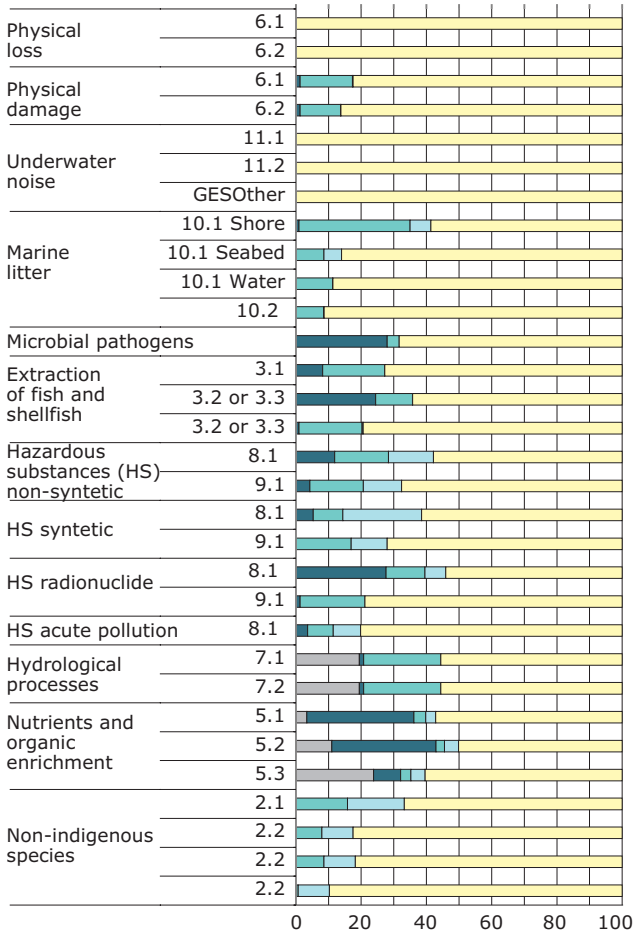
The scope of the assessments required by the MSFD is very comprehensive, and knowledge gaps are therefore inevitable as many elements are still largely unknown or poorly understood. Moreover, different Member States have different traditions with regards to how they collect and share marine data. These differences have resulted in fragmented European marine and maritime knowledge-base.

In addition there is also a problem of data availability. The MSFD-reported information does not always reflect all the available data and information at the national or regional level, nor does it adequately show the existing wealth of marine data and information held inside public, research and private organisations throughout Europe.

This situation hampers consistent and regionally coherent assessments of the marine environment, core elements of the MSFD. The MSFD is the environmental pillar of the Integrated Maritime Policy. As a result, the whole blue economy is operating without the proper knowledge-base it needs if it is to grow within the sea's ecological limits.

In spite of the shortcomings of the information reported under the MSFD, it nevertheless provides a basis for a discussion across Europe about how to create this more comprehensive common knowledge base. This knowledge base can help protect European seas, while allowing for the sustainable development of maritime activities that are part of the Blue Growth strategy. It will also support the achievement of Europe's policy visions for our seas.

Figure 7 **Confidence level of EU Member States status assessments of pressures reported under the MSFD**



Note: Numbers refer to criteria under the Commission Decision 2010/477/EU.

Source: ETC/ICM, 2014.

Bridging the gap between science and management

Marine policy implementation is also struggling with more qualitative problems concerning the relationship between marine science and marine management. We still need to improve our understanding of the interactions between habitats, species, ecosystems and humans. This means answering a number of questions such as: how and what can we learn from history on ecosystem response to human exploitation? How can we translate regional research and local experiences into a European perspective? To what extent can we address the trade-off between marine ecosystems and resource exploitation? And lastly, but perhaps most importantly, how do we learn from previous management efforts to better evaluate progress and effectiveness of new ecosystem-based management initiatives?

To better answer such questions the EU needs to continue strengthening the linkages between policy initiatives and research-funding streams.

Unlocking the power of future interconnected information systems for the benefit of all

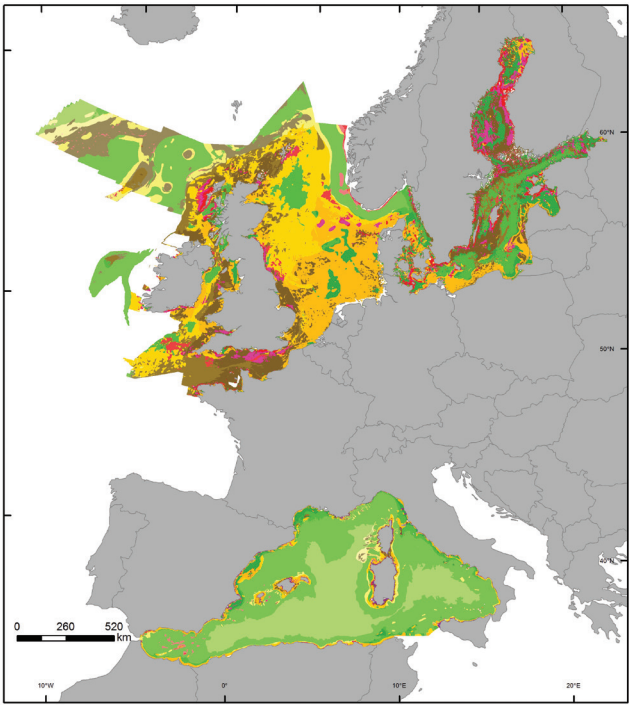
Already, the EU is working together with Member States and other stakeholders under the umbrella of the Marine Knowledge 2020 initiative or the marine research programme under Horizon 2020 to address these problems. Marine Knowledge 2020 in particular brings together available resources and mechanisms to deliver the knowledge needed to support ecosystem-based management. These initiatives aim to benefit industry, public authorities, researchers and society at large. They should also help to strengthen implementation of the MSFD.

A crucial component for this programme is the objective to deliver a seamless high-resolution digital seabed map of European waters by 2020. This map will be created by integrating environmental information from a wide range of sources, covering topography, geology, habitats and ecosystems as part of the European Marine Observation and Data Network (EMODnet) initiative. As a result of EMODnet, crucial information on parts of our seas is already available in the form of maps such as broad-scale modelled seabed habitat maps (Figure 8). It should also improve our knowledge of human activity in Europe's seas. Such initiatives have many potential benefits, including making fisheries data more widely available and making it easier to assess the impacts of management measures.

Further opportunities to increase our knowledge base are also coming from satellite observations, such as those gathered by the operational marine service of the Copernicus programme.

At the same time, as part of the implementation process of the MSFD, the EU Commission and the EEA, together with

Figure 8 **EUSeaMap is a broad-scale modelled habitat map of over 2 million km² of seabed**



Note: Colours illustrate different broad-scale seabed habitats.

Source: EUSeaMap Consortium WebGIS, 2014.

the Regional Sea Conventions and EU Member States are putting in place a streamlined and efficient management system of data, information and knowledge. This public system will be called WISE-Marine and will be shared between all stakeholders. The INSPIRE Directive will deliver an infrastructure for spatial information in Europe. This infrastructure will be crucial for supporting environmental policy and management, including of our seas.

These European initiatives and processes are extremely important in supporting Member State efforts to perform better and more integrated assessments of their national waters. These initiatives will also help to place those assessments into an international context of shared approaches and targets. The problems facing the marine environment transcend national boundaries, and properly assessing the cumulative impact of activities in a region is critical if Good Environmental Status is to be reached by 2020.

A window of opportunity is now open to ensure a more coherent and consistent approach for future assessments as part of the MSFD implementation cycle. This can also inform the process toward the next state of the marine environment assessment, due in 2019. The challenge now is integrating all these initiatives and processes in order to deliver a solid, common knowledge base for the benefit of all.

Reaching our policy objectives?

Implementation of EU policies and legislation needed to achieve healthy seas is lagging behind policy visions

- In 2012, 5.9 % of the seas under EU jurisdiction were designated as part of a network of marine protected areas. The target is to reach 10 % coverage by MPAs by 2020.
- Sustainable use of fish stocks has been a goal of the EU Common Fisheries Policies since 1983, but is only now showing progress. The target is that all stocks should be exploited at sustainable levels (Maximum Sustainable Yield) by 2020 at the latest.
- The MSFD provides an opportunity to fully implement existing EU marine-related policies and legislation in order to achieve Good Environmental Status by 2020.

Meeting our policy targets?

The European community has been formulating sound and ambitious policies. Moving from policy visions to timely action appears to be more of an issue. The result is that environmental targets are often not met on time and have to be readdressed in a new policy wrapping. This can be demonstrated by nature conservation and fisheries management efforts.

Protected areas should cover 10 % of our seas

In 2002, the Johannesburg World Summit set the goal of creating a representative, global network of MPAs by 2012 (Box 9). In Nagoya in 2010, this target was postponed to 2020. The goal now includes a quantitative target that the MPA network must cover 10 % of the world's oceans. In 2012, the MPA network in European seas covered more than 338 000 km^2, or 5.9 % of EU marine areas within 200 nautical miles (nm) from the coast. Significant differences in terms of MPA coverage remain throughout the regional seas (Table 4). In coastal waters (until 12 nm from the shore), MPA coverage is relatively good in Europe, with more than 16 % of these marine areas inside an MPA. However, in the offshore area between 12 nm from the shore and 200 nm from the shore, only 3 % of Europe's marine areas are within an MPA. This zone covers 4.7 million km^2, representing more than 80 % of EU waters.

Box 9 Marine protected areas

Marine protected areas (MPAs) are geographically distinct zones for which protection objectives are set.

They often aim at striking a balance between ecological constraints and economic activity, so that our seas may continue to deliver goods and services.

The Natura 2000 network of sites designated under the Habitats Directive and Bird Directive accounts for 229 000 km^2 alone or 4 % of the EU marine areas within 200 nm of the coast. It has been a major driver and success for the designation of sites for vulnerable habitats in coastal waters in particular. However, since Natura 2000 network only covers 8 marine habitats it is less suited for establishing a representative and coherent network. Especially in offshore areas, it can thus be supplemented by measures identified under the MSFD.

Despite its success in designating Natura 2000 sites, Europe faces a large challenge if it is to meet its policy targets for MPAs. In less than seven years, EU Member States have to designate the same area of MPAs as has

Table 4 Percentage cover of marine protected area networks in European regional seas

MPA assessment area regions and subregions	Area covered by MPAs, km^2	% covered by MPAs	Total no. of sites
Baltic Sea	50 105	13.5	3 050
North East Atlantic Ocean	171 174	4.2	3 203
Celtic Sea	40 457	4.4	1 194
Greater North Sea incl. Kattegat & English Channel	90 257	17.9	1 534
Bay of Biscay and the Iberian Coast	25 930	3.2	334
Macaronesia	14 530	0.8	163
Mediterranean	114 461	9.5	1 410
Western Mediterranean	103 196	15.6	724
Ionian Sea and Central Mediterranean Sea	3 875	1.6	274
Adriatic Sea	2 441	2.0	199
Aegean-Levantine Sea	4 949	2.6	221
Black Sea	2 883	4.5	62
Total	**338 623**	**5.9**	**7 725**

Source: ETC/ICM 2013.

been designated under the marine Natura 2000 network over the last 20 years. Even then it is not certain that meeting the 10 % coverage target is sufficient to create a coherent and representative network of MPAs.

Related to the coverage issue is the equally pressing issue of the effectiveness of MPAs. It has been estimated that less than 1 % of EU MPAs can be considered as being marine reserves, which provide a high level of protection for species and habitats. Marine reserves show an increase in diversity, biomass, size of individuals and healthy age structures. No European overview exists of the management effectiveness of our networks of MPAs.

Fisheries remain a sustainability challenge

Sustainability has been a goal of the Common Fisheries Policy (CFP) ever since its adoption in 1983. However, overfishing has been a chronic problem in European seas. Only now, after 30 years of CFP implementation, has the first evidence emerged of a positive change, with the visible improvement of the status of assessed fish stocks (Figure 9).

The reasons for the failure to meet sustainability objectives are complex, but widely documented and well-known (Box 10). These structural failings therefore led to a third major reform of the CFP, adopted in January 2014.

It remains to be seen whether this reform will be successful in reversing the long-term trends of deterioration in fish stocks, instability in the fishing industry and fishing communities, and damage to the broader marine environment. But as we set out into a new cycle of policy implementation and target setting, one should also consider the knowledge baseline and the challenges it represents for the new CFP.

Stock assessment is a crucial component of fisheries management, as it allows for informed and evidence-based decisions. However, the current level of knowledge about our fish stocks is still far from ideal. The reasons for the lack of information include limited available biological data, limited resources to develop and apply appropriate assessment models, as well as limited data collection and reporting from EU Member States. This latter problem is particularly important, as data collection and reporting is an obligation under the requirements of the European fisheries Data Collection Framework. However, it is a requirement with which no Member State is entirely compliant to date.

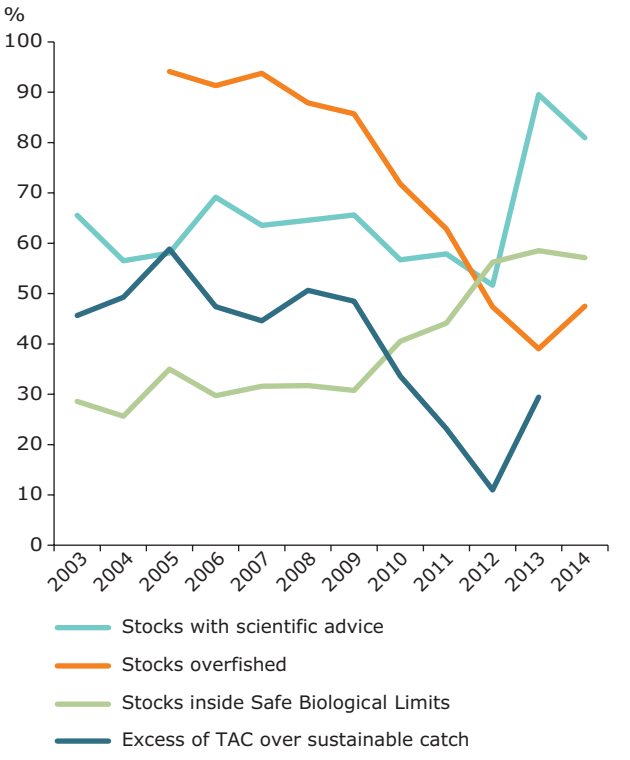
Data-poor fisheries present a challenge to managers, as there is more uncertainty associated with any assessment of such fisheries, and in many cases they cannot be directly evaluated in relation to the policy objectives of Maximum Sustainable Yield (MSY). This inevitably raises the question of how well will we be able to monitor progress towards the new CFP objective of fish stocks exploited at MSY rates by 2015 where possible and by 2020 at the latest for all stocks.

Furthermore, long-term overfishing coupled with other pressures exerted on the marine environment have affected ecosystem structure and functioning. Together with the lack of knowledge, this poses an additional challenge to ecosystem-based management. Fisheries science is therefore being challenged to provide advice from a fundamentally different perspective, one that minimizes impact in the marine environment rather than maximizing catch.

Box 10 Main issues with CFP implementation

The structural failures of the CFP are mainly due to fleet overcapacity, lack of political will to follow through with implementation, continuous disregard of scientific advice and early warnings, an absence of clear objectives, and a decision-making system geared towards short-term gains.

Figure 9 **Better implementation of CFP measures and respect for scientific advice have contributed to improvement in status of Northeast EU Atlantic and Baltic fish stocks**



Source: EC, 2013.

At a time when progress is finally being seen in the state of EU fish stocks, a question arises: how much disturbance have we already introduced in the ecosystem and how fit are we to deal with the consequences? Thus knowledge on the boundaries of ecosystems and managing fisheries accordingly (i.e. following the precautionary approach) in an ecosystem approach remains ever more crucial. These are among the core challenges that the new CFP will have to fully embrace if it is to deliver the long-standing target of sustainable exploitation of fisheries resources. Moreover it now also has to support the MSFD objective of reaching Good Environment Status of our seas by 2020.

The MSFD: a platform to integrate and implement multiple policy objectives

These examples show that two of our biggest challenges are the full implementation of existing policy, and the full use of the knowledge and information that already exists in Europe. A related problem is integrating the multiple policy objectives existing for European seas into a coherent whole (Table 5).

We need to understand how different targets relate to each other, from a science, policy, and management point of view. We also need to understand how these targets relate to industry's ambitions to make greater use of the sea. For example, this means figuring out how an ecologically coherent and well-managed network of MPAs could support fisheries targets, or how the Common Fisheries Policy could support Natura 2000 conservation targets.

On a broader level, we also need to better understand the interactions between Good Environmental Status (MSFD), Good Ecological Status (Water Framework Directive), Favourable Conservation Status (Habitats Directive), and fishing at Maximum Sustainable Yield (CFP). Meeting one target might not automatically deliver the others.

The ecosystem-based approach and adaptive process to management introduced by the MSFD therefore provides a platform and opportunity for the marine and maritime communities to bridge the gaps between these increasingly complex challenges by 2020.

Table 5 Summary of progress towards selected policy objectives and targets for achieving healthy, clean and productive European seas (2010–2020)

Objective	Sources for target	Target	What is happening?	EU trend
Healthy seas				
Halt the loss of biodiversity	EU Biodiversity Strategy to 2020	Compared to 2008 assessments 50 % more species assessments should show favourable conservation status in 2020	3 % of marine species assessments were favourable in 2008.	↗
Halt the loss of biodiversity	EU Biodiversity Strategy to 2020	Compared to 2008 assessments 100 % more habitats assessments should show favourable conservation status in 2020	7 % of marine habitat assessments were favourable in 2008.	↗
Productive seas				
Fishing at MSY (Maximum Sustainable Yield) or below in all fisheries	EU biodiversity Strategy to 2020, CFP, 2014	All fish stocks should be fished at MSY rates by 2020 at the latest.	In 2013, 39 % of European Atlantic fish stocks were fished at MSY compared to 6 % in 2005.	↗
Offshore wind	EWEA, 2013	Member States indicate that they will deploy 43.3 GW of offshore wind capacity to meet the EU's commitments to achieve 20 % of its energy consumption through renewable energy by 2020	Despite significant growth across Europe, only 6 GW was installed by June 2013 compared to the expected 9 GW	↗
Marine knowledge				
Collect, manage and provide access to high-quality fisheries data	Data Collection Framework, 2008	No formal target exists but CFP aim at fishing at MSY rates for all stocks by 2020 at the latest.	In 2013, 50 % of all landings from stocks in the European Atlantic and Baltic waters, and 80 % of landings in the Mediterranean and Black Sea come from data-poor stocks.	→
Member States shall cooperate on marine strategies	Directive 2008/56/EC (6 year-cycle)	The different elements of marine strategies are coherent and coordinated across marine regions and sub-regions	In 2012, > 70 % of the reported maritime boundaries between EU Member States had either overlaps or gaps.	→
Reporting of conservation status of species and habitats	Directive 92/43/EEC (6 year-cycle)	In order to monitor progress towards favourable conservation status, assessments of status are necessary	70 % of the marine species assessments and 40 % of the marine habitats assessments were considered unknown in 2008.	↗
Management measures				
Establish an ecologically coherent network of marine protected areas	CBD, 2004	10 % of European waters should be covered by networks of marine protected areas by 2012.	In 2012, 5.9 % of European waters were covered by marine protected area networks.	↗

Note: ↗ Positive trend compared to target; → Stable trend compared to target.

Towards a new understanding

Use of our seas must respect ecological boundaries to protect and value its potential for present and future generations

- Policy ambitions for economic growth of maritime activities must be aligned with policy targets for securing healthy, clean and productive seas.
- Healthy oceans and productive ecosystems will also require fundamental shifts in the systems that fulfil our societal needs and in the way we use ecosystem services.
- True cooperation among all stakeholders and wider societal engagement will be crucial to support this transition.

Our seas are rapidly changing while our dependence on them is growing. We do not fully understand the complex interactions of natural and human-driven changes. But we do know that we are not yet on the path to achieving healthy, clean and productive seas. As the EU sets out to expand the blue economy in this context, it is therefore imperative that we approach the marine environment with a new understanding. One that uses it within its natural boundaries and the limits of our knowledge, manages it to provide societal well-being and takes responsibility for its future today.

The MSFD is a crucial tool in this respect, as it sets out a framework that puts the ecosystem approach at its heart, while promoting an integrated and adaptive management system to human activities affecting the marine environment. Although implementation of the MSFD has not been flawless, it has shed light onto the main missing elements that are needed to achieve Good Environmental Status for our seas by 2020. As a result, the MSFD has set in motion a reorganisation of governance structures and processes at several scales to improve monitoring, knowledge-sharing and decision-making. It has also triggered policy integration between different sectoral areas. This has revealed knowledge gaps and exposed the need for more robust and integrated assessment tools.

In addition, the EU has been putting in place a holistic framework with a set of long-term policies and legislation. Such framework will support a transition towards a low-carbon and resource-efficient society with resilient ecosystems by 2050. Europe's seas play a critical part in achieving this vision. Recognised in the Blue Growth strategy as drivers of innovation and growth, they will provide benefits such as clean energy, high-quality food supply, raw materials, and green jobs. If properly integrated into all sectoral policies, the MSFD could inform on the ecological boundaries for the use of our seas. Knowledge of these limits will support a pathway towards thriving ecosystems, sustainable Blue Growth and a green economy.

Nevertheless, our environmental challenges are of an increasingly systemic nature and the MSFD will not be the panacea for all issues. How we explore the marine fabric of life and the ecosystem services it provides goes beyond the MSFD remit. Persistent problems such as loss of biodiversity, loss of ecosystem resilience, pollution, overexploitation of resources, and climate change are deeply embedded in our 21st century societal structures, cultures, values and practices. Therefore obtaining Good Environmental Status for our seas will also depend on fundamental shifts in the systems that fulfill our societal needs, coupled with a wider re-evaluation of our values, and how we interact with nature and its resources.

Although no blueprint will exist to support this transition, the stewardship of the marine environment needs more than a sound policy framework and knowledge-base. It also needs improved cooperation among stakeholders across marine regions and Europe as a whole. This stakeholder cooperation includes broader societal engagement, examples of which already exist. One example is participatory policy development, such as the massive, organised citizen engagement involved in reforming the Common Fisheries Policy (CFP). This citizen engagement proved critical for the outcome of the new CFP. Other examples of societal engagement include the co-management of marine protected areas with local communities, and 'citizen science' initiatives that inform environmental policy, such as those related to surveying beach litter or the coastal environment.

We therefore have the opportunity to rewrite the narrative with which we use and live our seas. We can do so in a way that offers hope to future generations but one that can also deliver HOPE — Healthy Oceans, Productive Ecosystems — to the present one.

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An EEA report on the state of the marine environment due later in 2014 with full list of references will also be subject to Eionet consultation.

List of abbreviations and acronyms

CFP	Common Fisheries Policy
CSI	European Environment Agency Core Set Indicator
DDT	Dichlordiphenyltrichlorethan
EAP	Environment Action Programme
EEA	European Environment Agency
EU	European Union
GES	Good Environmental Status sensu Marine Strategy Framework Directive
GVA	Gross value added
HCB	Hexachlorbenzene
HELCOM	Baltic Marine Environment Protection Commission — Helsinki Commission
IMP	Integrated Maritime Policy
INSPIRE	Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community
MAR	European Environment Agency Marine Indicator
MPA	Marine protected area
MSFD	Marine Strategy Framework Directive
MSY	Maximum Sustainable Yield
MW	Mega Watt
PCB	Polychlorinated biphenyl
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
TAC	Total Allowable Catch

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