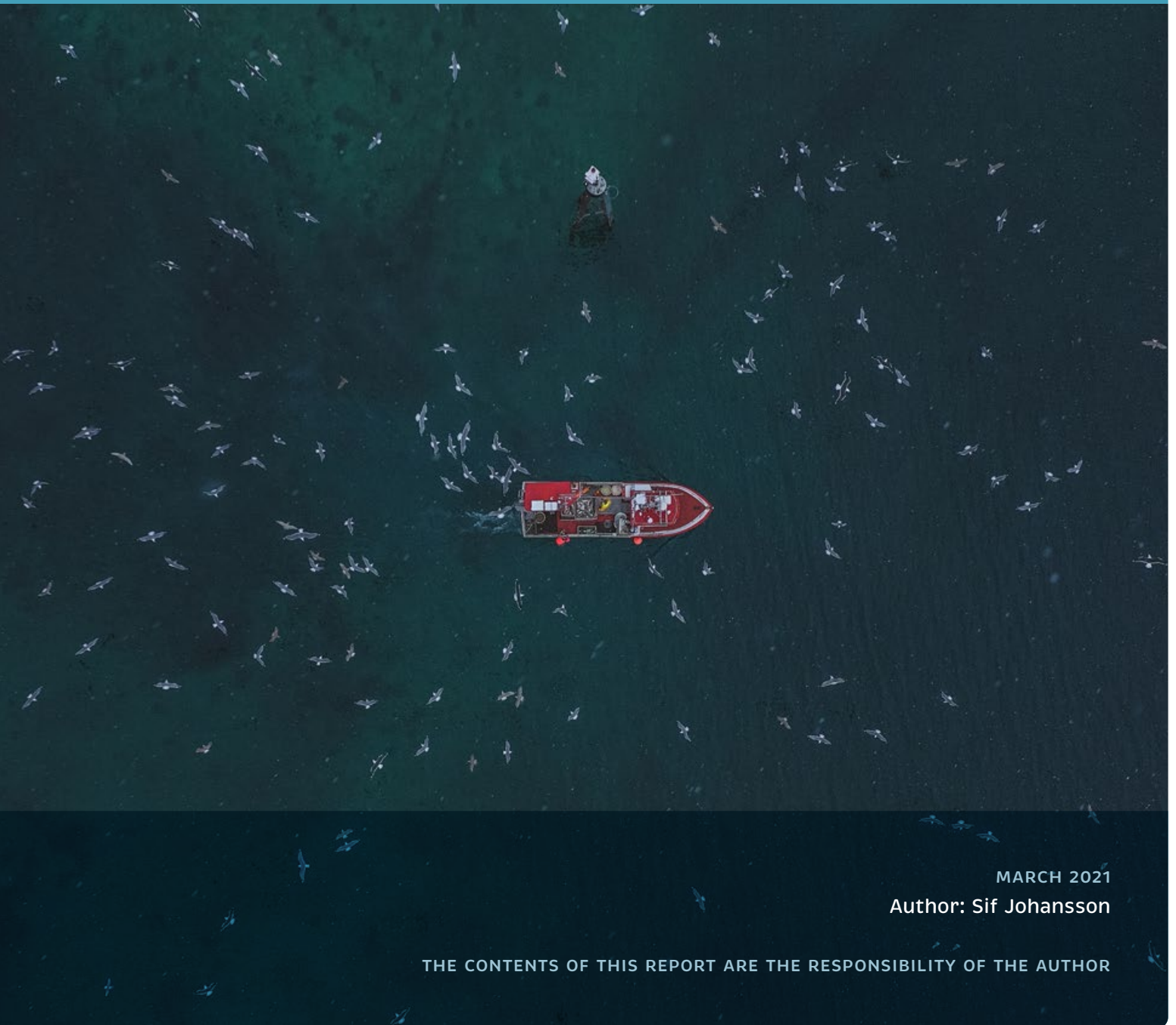


SCOPING STUDY

# On Research in Swedish Offshore Marine Areas

This report forms part of Mistra's preparations for a call on blue economy, and was commissioned to provide an overview of the challenges in the marine environment and the research needed to meet these challenges



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THE CONTENTS OF THIS REPORT ARE THE RESPONSIBILITY OF THE AUTHOR



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# Research in Swedish Offshore Marine Areas

Blue growth is a key concept and a long-term strategy to support sustainable growth in the marine and maritime sectors. To succeed, it must be based on the ecosystem approach, which entails an ecosystem-based management of the marine environment. And this requires a solid knowledge base about the structure and function of ecosystems, how they are affected by environmental change, and how we can reduce pressures on the environment.

Marine research has long been devoted mostly to studies of coastal waters, which is an understandable priority, as that part of the sea is strongly affected by human activities both on land and in the coastal waters. The coastal zone is also the part of the sea that we first encounter.

The environment of offshore marine areas is more foreign to us. The pictures that we usually see are satellite images of cyanobacteria blooms in the summer and underwater photos of starving cod from the Baltic Sea. At the same time, we know that climate change also affects open-sea ecosystems, among other things by changes to species habitats and the establishment of new species. We also know that fish communities have changed drastically, as in the Baltic Sea where there has been a shift in species dominance from cod to sprat. There is also increasing pressure from more intensive shipping activities.

To achieve Blue growth, we need to gain an overall understanding of how marine ecosystems are affected by environmental impacts and how we can reduce these impacts. In Swedish marine areas, it is fundamental to improve knowledge about the structure and function of ecosystems, especially in view of the large differences between the nearly freshwater environment in the Gulf of Bothnia and the fully marine areas of the Skagerrak. This document provides an overview of current gaps in knowledge with regard to ecosystem-based management of Swedish offshore marine areas.

The two sectors that particularly affect Swedish offshore marine ecosystems are shipping and fisheries. They affect the offshore environment in completely different ways, and we need to know more about both their individual environmental effects and their combined environmental effects. There is also increasing interest in developing and establishing wind energy and wind farms in offshore marine areas. Several marine areas are currently under discussion, and Poland has plans for an offshore wind farm in the Baltic Sea<sup>1</sup>. The Swedish plans for wind-energy projects have so far concentrated on shallow coastal areas. The ongoing Vindval research program includes research on marine wind energy<sup>2</sup>, and their synthesis report 2012 report “The effect of wind power on marine life” is currently being updated<sup>3</sup>. The review “Offshore Wind Power for Marine Conservation” (2016)<sup>4</sup> has

1 *EMODnet – Human activities* ([emodnet-humanactivities.eu](http://emodnet-humanactivities.eu))

2 *Vindval – Kunskap om vindkraft* ([naturvardsverket.se](http://naturvardsverket.se)) – in Swedish

3 *The effect of wind power on marine life – Naturvårdsverket* ([su.se](http://su.se)) (pdf)

4 *Offshore Wind Power for Marine Conservation* ([scirp.org](http://scirp.org)) (pdf)

further assessed offshore wind farms effects on marine biodiversity.

Finally, it is important to emphasize that the environmental status of offshore marine areas can only be improved through successful international cooperation and joint commitments. It is well known that it is often difficult and time consuming to reach common agreements, and the question is if this process can be improved and made more efficient. There may be lessons to be learned from other international collaborations in which organisations cooperate to improve the management of offshore marine areas.

## To summarize

The concept of Blue growth presupposes a holistic view of the marine environment and the application of ecosystem-based management. This requires greater knowledge about the function and structure of marine ecosystems and about how human activities affect them. In addition, international cooperation needs to be facilitated and become more effective.

With regard to Swedish offshore marine areas, the following aspects must therefore be considered:

- ▶ Increased understanding of offshore marine ecosystems, including biodiversity, processes and flows, and how they are affected by human activities such as climate change.
- ▶ Involvement of the main sectors, e.g. shipping and fisheries, in developing sustainable use of marine resources.
- ▶ Awareness of plans to establish offshore wind energy and wind farms.
- ▶ Development of cost-effective and smart environmental monitoring (measurements and analysis) of long-term changes in marine ecosystems.
- ▶ Improving international cooperation with regard to management of offshore marine areas.

# Aim of the research program

The aim of the proposed research program is to apply an ecosystem approach to the management of Swedish offshore marine areas. There is a need for better understanding of the biodiversity and functions of the offshore marine ecosystems and how they are affected by sectors such as shipping, fisheries, and energy production. The knowledge is needed to improve the ecosystem-based management of these offshore marine areas.

To delimit the offshore marine area, we start with the definition for the coastal zone, which is the marine area that stretches from land to one nautical mile off the shoreline. The offshore marine area is consequently the area outside the coastal zone. Naturally, this is not a sharp border, as both physical and biological exchange between the open sea and the coastal waters must be considered, but the focus will be on the open sea.

No country can alone manage and protect the sea. International cooperation and well-established international agreements are essential for the successful management of offshore marine areas. However, it can sometimes be a cumbersome process to achieve common results and there is a need to develop knowledge about how this process can be conducted more efficiently.

The Baltic Sea, including the Kattegat, is covered by the regional Convention on the Protection of the Marine Environment of the Baltic Sea Area (the Helsinki Convention, HELCOM). The Skagerrak is part of the Greater North Sea, which is covered by the regional Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention). Most member countries are also members of the European Union (EU) and must follow EU directives such as the Marine Strategy Framework Directive (MSFD), the Maritime Spatial Planning Directive (MSP) and the EU Biodiversity Strategy. These organisations and directives have in common that they have adopted an ecosystem approach and the use of ecosystem-based management to achieve a healthy and sustainable sea, and that their recommendations and decisions are based on the best available knowledge. Other EU directives relevant are the EU Regulation on Invasive Alien Species (IAS), the EU Strategy for the Baltic Sea Region (EUSBSR) and the EU Green Deal.

These conventions have also identified several knowledge gaps (see Appendix 2) of importance for further research. It is for example urgent to gain a better understanding of the diversity of pelagic and benthic ecosystems, the functions and flows between the ecosystems and the interactions between sediments and the water, considering the big differences in the ecosystems along the salinity gradient from the Gulf of Bothnia to the Skagerrak. Moreover, ongoing climate change will affect the marine ecosystems though for example increased temperature, decreased salinity and acidification (decreased buffer capacity).

The main direct impacts on Swedish offshore marine areas come from shipping and fisheries, and there is also an increasing interest from the energy sector to establish offshore wind farms. Most activities are regulated through interna-

tional organisations. The International Maritime Organisation (IMO) is responsible for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. Fisheries are managed according to the EU Common Fishery Policy (CFP). The European Commission suggests limits for fisheries on different fish stocks (total allowable catches, TAC) to be decided by the European Parliament. The European Commission suggests TACs on the basis of scientific advice from The International Council for the Exploration of the Sea (ICES) and also on consultations with fishermen and other stakeholders through the Regional Advisory Councils. Finally, offshore wind farms are regulated by the United Nations Convention on the Law of the Sea (UNCLOS).

The use of the ecosystem approach for management of human activities in the sea means an adaptive management. Monitoring of changes in the marine ecosystem identifies knowledge gaps, which leads to research and the implementation of new knowledge in improved management. This process requires close interactions between monitoring, research and management.



# The marine ecosystem

## Ecosystem approach

The ecosystem approach is the basis for sustainable management of the seas and also for international agreements in organisations such as HELCOM, OSPAR and ICES. It is a principle for management of natural resources that originates from the UN Convention on Biological Diversity (CBD)<sup>5</sup> and is specified in 12 principles (see Appendix 3). The two cornerstones of ecosystem-based management are specified in a document from the UN Environment Program (UNEP) 2011: *Taking Steps toward Marine and Coastal Ecosystem-based Management* (see Appendix 4): “(1) each human activity is managed in the context of ALL the ways it interacts with marine and coastal ecosystems, and (2) multiple activities are being managed for a common outcome.”

The ecosystem approach is based on what the ecosystems can sustainably withstand. It is the basis for environmental management and the social and economic dimensions must be considered within these limits. It stresses that management should be based on scientific methods focused on structures, processes, and functions. It presupposes adaptive management that deals with the complex and dynamic nature of ecosystems in the absence of complete knowledge or understanding about how they function. New knowledge constantly improves adaptive management.

There is no single way to implement the ecosystem approach, as it depends on local, provincial, national, regional or global conditions. An example of how the ecosystem approach has been used in Sweden is in Maritime Spatial Planning (MSP). This is illustrated by a report published in 2017 by the Swedish Agency for Marine and Water Management (SwAM): *The Ecosystem Approach in Maritime Spatial Planning*<sup>6</sup> where an ecosystem-based view was applied both on sectors (shipping, fisheries, energy production) and on the environment. There is also a more detailed description of how the ecosystem approach can be used in maritime spatial planning in the document *Tillämpning av ekosystemansatsen i havsplaneringen*<sup>7</sup> (SwAM, 2012). A more general guide on the ecosystem approach was published in 2007 by the Swedish Environmental Protection Agency (in Swedish)<sup>8</sup>.

Ecosystem-based management is constantly in need of better knowledge. We need better understanding of the biodiversity and food-web functions of Swedish marine offshore areas and how they are affected by climate change, impacts from shipping, fisheries, and other human pressures.

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<sup>5</sup> COP Decision ([cbd.int](http://cbd.int))

<sup>6</sup> *The Ecosystem Approach in Maritime Spatial Planning* ([havochvatten.se](http://havochvatten.se)) (pdf)

<sup>7</sup> *Tillämpning av ekosystemansatsen i havsplaneringen* ([havochvatten.se](http://havochvatten.se)) – in Swedish (pdf)

<sup>8</sup> *Ekosystemansatsen – en väg mot bevarande och hållbart nyttjande av naturresurser* ([naturvardsverket.se](http://naturvardsverket.se)) – in Swedish (pdf)

### The Aichi Biodiversity Target 11 (CBD 10, 2010)

By 2020, at least 17 per cent of terrestrial and inland water, and at least 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes

## Marine Protected Areas

Marine Protected Areas (MPAs) can be an effective tool for the management of marine areas. In 2010 the Convention on Biological Diversity (CBD) set a goal that at least 10% of coastal and marine areas should be protected (see text in the box). In the preparations for the post-2020 biodiversity framework CBD has 20 action-oriented targets for 2030<sup>9</sup>. Target 2 specifically aims to increase protected areas important for biodiversity: “By 2030, protect and conserve through well connected and effective system of protected areas and other effective area-based conservation measures at least 30 per cent of the planet with the focus on areas particularly important for biodiversity”. In the EU Biodiversity Strategy for 2030<sup>10</sup> a similar minimum of 30% of the EU’s sea areas should be legally protected.

The Aichi target was reached both the Baltic Sea and in the Greater North Sea in 2016, and the Greater North Sea is even closer to the goal of 30% MPAs according to the EU Biodiversity Strategy<sup>11</sup>. If the MPAs are registered according to their distance from land, the percentage that cover near-shore areas (from land to 1 nautical mile offshore) is 36.9 % in the Baltic Sea and 63.8 % in the Greater North Sea. In the zone between 1 and 12 NM from land, the MPAs cover 17.8 % in the Baltic Sea and 36.2 % in the Greater North Sea. In offshore areas (beyond 12 NM from land) MPAs cover 9.1 % in the Baltic Sea and 22.7 % in the Greater North Sea (see maps in Appendix 5).

Not only the percentage of MPAs is important, but also their location. The goal is to have a network of coherent MPAs, i.e. the protected areas should be ecologically coherent and integrated with the rest of the sea by means of corridors that promote connectivity. (see Appendix 6). However, more studies are needed to identify measures that enable the dispersal of individual species, especially invertebrates and non-commercial species of fish. There is also a need for comprehensive maps of species distributions, which can be used for spatially high-resolution analyses of connectivity, both by means of larval dispersal models and active migration analyses. There is also a need for knowledge about the changing distribution of species and habitats in a changing climate.

Moreover, the percentage of marine protected areas does not say anything of the efficacy of the protection. All MPA’s must have management plans to prevent conflicts of interest and to ensure that specific nature conservation goals are reached. The degree of protection in MPAs varies widely, and less than 1% of the EU’s marine areas are strictly protected (EU Biodiversity Strategy 2030). We also lack knowledge about the effects of different restrictions. In some areas, strict fisheries bans within MPAs have increased fish stocks outside the protected areas. In these cases, strict fisheries management measures have benefited not only the local ecosystem but also commercial fisheries, but more knowledge is needed to understand the effects of different regulations in MPAs. In the Baltic Sea, HELCOM has initiated a project (BALTFIMPA)<sup>12</sup> that aims to improve fisheries management in marine protected areas.

The European Environmental Agency (EEA) has summarised their view on future needs to improve knowledge about MPAs and their role in ecosystem-based management (see box).

<sup>9</sup> [Update of the zero draft of the post-2020 global biodiversity framework \(cbd.int\)](#) (pdf)

<sup>10</sup> [EUR-Lex – 52020DC0380 \(eur-lex.europa.eu\)](#)

<sup>11</sup> [Marine protected areas \(eea.europa.eu\)](#) (pdf)

<sup>12</sup> [BALTFIMPA – HELCOM \(helcom.fi\)](#)

## Reflections for the future

With entire networks of MPAs across Europe's seas designated, the next steps to ensure they deliver the best possible benefits for marine biodiversity are as follows;

- ▶ better capture the biodiversity components protected within MPAs;
- ▶ improve our understanding of how marine systems are interconnected to better designate and plan MPAs across Europe, and improve the connectivity and representativity of MPA networks;
- ▶ better manage MPAs and consider how to yield the greatest conservation benefits from individual MPA designations;
- ▶ improve reporting mechanisms and data flows across Europe, particularly in the areas with protected species and habitats of protected features and ecosystem components;
- ▶ share knowledge and experience of the response of European marine life to pressures, and the results of management regimes intended to protect it.
- ▶ accurately measure the degree to which MPAs and the network as a whole are achieving their intended purpose.

# Environmental monitoring

The aim of environmental monitoring is to describe the state of the environment, follow trends, detect changes, assess threats, and provide a basis for action. The Swedish Agency for Marine and Water Management (SwAM) is responsible for monitoring of groundwater, lakes, watercourses, coastal waters, and the open sea. Environmental monitoring programmes are designed to contribute to the Swedish environmental quality objectives, the requirements of environmental legislation and Sweden's commitments to report to international directives and conventions. EU environmental policy in particular places great demands on international reporting and has broadened the concept of environmental monitoring to cover everything from the monitoring of human activities that give rise to adverse effects to the monitoring of the positive effects of measures.<sup>13</sup>

There is ongoing work to improve marine monitoring and to link monitoring and research. For example, the report *Sweden's environment monitoring (SOU 2019:22)* underlined the need for research to support environmental monitoring. The report points out that research and development of new technology can lead to smart and more cost-effective methods for monitoring. The report calls for more research with a focus on the analysis and evaluation of environmental monitoring, in order to gain in-depth knowledge of trends and risks as a basis for program design. A closer link between research and monitoring will also detect knowledge gaps in the programmes and identify new areas for monitoring.

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<sup>13</sup> *Miljöövervakning i kust och hav – Övervakning i marin miljö (havochvatten.se)* – in Swedish

# Fish communities and fisheries

To promote sustainable and healthy fish stocks in the Baltic Sea, the Kattegat and the Skagerrak we need more knowledge about how fish are affected by environmental change. Fishing impacts commercially important species, and further knowledge is needed to develop environmentally sustainable fisheries. It is important to maintain or reduce fishing mortality at or under the level of the Maximum Sustainable Yield (MSY). This will help achieve healthy populations, age distributions and size distributions in fish stocks.

The impact of fishing on marine ecosystems concerns not only the commercially important fish stocks but also direct effects on the sea floor (benthic invertebrates) and effects due to by-catches (the incidental capture of non-target species). In addition, fisheries remove apex predators such as cod, which leads to changes in the entire ecosystem (cascade effects). The Swedish Environmental Objectives Committee has emphasised the lack of knowledge about the role of the fish in the marine ecosystem<sup>14</sup>. The Committee called for more studies on how different fishing pressures and fishing methods affect not only the status of different fish stocks, but also ecosystem functions. The Committee concluded that better knowledge of interactions between species and ecosystem effects was a priority issue for sustainable fisheries. The Committee also emphasised the need to include socioeconomic knowledge in ecosystem-based fisheries management. All decisions about the management of fisheries and their environmental impact need to be assessed according to the ecosystem approach and based on all three dimensions of sustainable development.

Here we focus on offshore fisheries and primarily the effects on the open sea ecosystems. However, the migration of fish between the open sea and coastal waters means that we must consider effects in the coastal zone.

## EU Common Fisheries Policy

European fisheries are regulated by the EU Common Fisheries Policy (CFP). The EU decides on the total allowable catches (TACs<sup>15</sup>) for each member state. These TACs are based on scientific advice from ICES, i.e. the best available scientific knowledge, from the European Commission's Scientific Technical and Economic Committee for Fisheries (STECF) and from the stakeholder-led Regional Advisory Councils, like the Baltic Sea Advisory Council (BSAC)<sup>16</sup> and the North Sea Advisory Council (NSAC)<sup>17</sup> which represent stakeholders in the fisheries sector. Finally, before a decision is reached negotiations take place in the European Parliament.

<sup>14</sup> *Havet och människan, volym 2, SOU 2020:83 (sou.gov.se)* – in Swedish (pdf)

<sup>15</sup> Total allowable catches (TACs) or fishing opportunities, are catch limits (expressed in tonnes or numbers) that are set for most commercial fish stocks.

<sup>16</sup> *BSAC (bsac.dk)*

<sup>17</sup> *North Sea Advisory Council (nsrac.org)*

## What are the aims of the Common Fisheries Policy?

The CFP aims to ensure that fishing and aquaculture are environmentally, economically and socially sustainable and that they provide a source of healthy food for EU citizens. Its goal is to foster a dynamic fishing industry and ensure a fair standard of living for fishing communities.

Although it is important to maximise catches, there must be limits. We need to make sure that fishing practices do not harm the ability of fish populations to reproduce. The current policy stipulates that between 2015 and 2020

catch limits should be set that are sustainable and maintain fish stocks in the long term.

To this day, the impact of fishing on the fragile marine environment is not fully understood. For this reason, the CFP adopts a cautious approach which recognises the impact of human activity on all components of the ecosystem. It seeks to make fishing fleets more selective in what they catch, and to phase out the practice of discarding unwanted fish.

[The Common Fisheries Policy \(CFP\) | Fisheries \(europa.eu\)](#)

ICES has stressed the need for further knowledge and development of methods to calculate sustainable TACs, not only for single species but also for multiple species. The ICES Science Plan<sup>18</sup> calls for further research (see also Appendix 2). Some of the knowledge gaps are listed below:

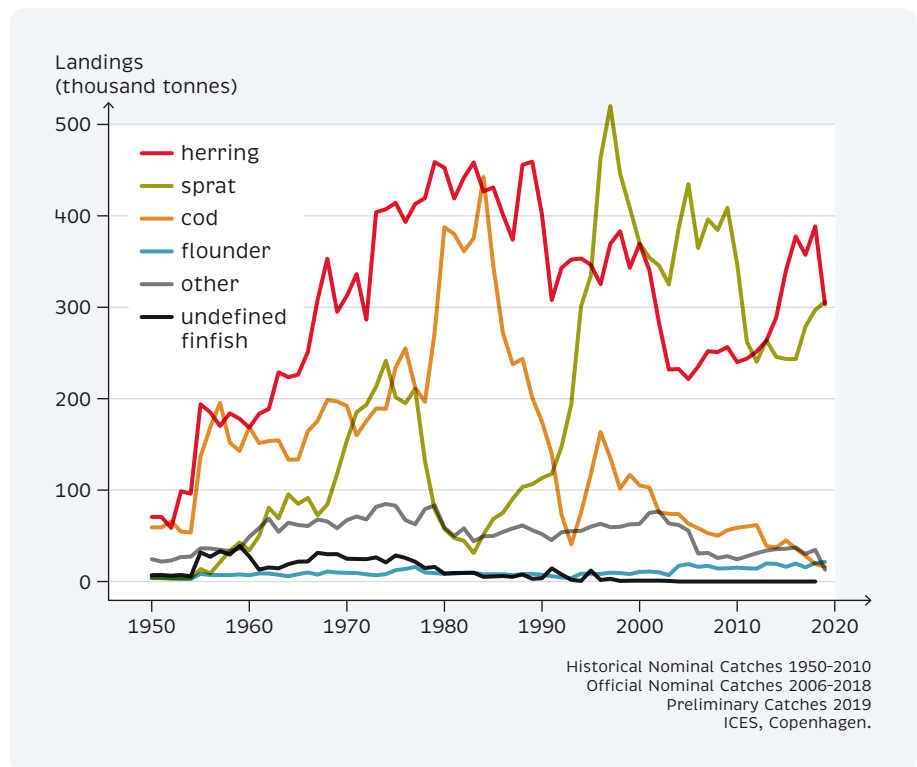
- ▶ Improve methods of single-species and multispecies stock assessment, including data-limited methods. Develop and conduct management strategy evaluations, address uncertainty, and improve the transparency, robustness, efficiency, and repeatability of stock assessment.
- ▶ Increase understanding of stock structures, migrations, life histories, natural mortality, climate, and food web impacts on marine and diadromous species, as well as multispecies interactions and the consequences of stock recovery; to strengthen the inputs and evidence base for assessment and advice.
- ▶ Further understanding and operationalization of ecosystem-based fishery management and MSY concepts and their application in mixed, multispecies, and emerging (e.g. mesopelagic) fisheries.
- ▶ Examine fisheries spatial dynamics, performance and impact of gear, links between catch and effort, mixed fishery interactions, role and impacts of recreational and small-scale fisheries, and the consequences of responses to management measures.
- ▶ Assess aquaculture production potential and carrying capacity, development scenarios, and methods of risk and benefits assessment; for rearing or full production systems including low trophic level and seaweed aquaculture, integrated multi-trophic aquaculture, and offshore production facilities.

## The Baltic Sea ecoregion

The fish communities that inhabit the Baltic Sea are a mixture of marine and freshwater species adapted to brackish water conditions. Approximately 100 fish species live in the Baltic sea, of which about 70 marine species dominate the Baltic Proper, while some 30–40 freshwater species occur in the coastal and the innermost areas. The composition and diversity of the open-sea fish community is structured along the salinity gradient, with a higher diversity in the western part of the Baltic compared to the eastern and northern parts. The HELCOM Baltic Sea Action Plan states that the Baltic Sea shall become a model of good management of human

<sup>18</sup> [ICES Science Plan \(issuu.com\)](#)

**FIGURE 1. ICES Baltic Sea Region – Fisheries Overview<sup>18</sup>. Landings (thousand tonnes) from the Baltic Sea in 1950–2019, by species. The five species with the highest landings are displayed separately; the remaining species are aggregated and labelled as “other”. The “undefined finfish” category is due to inadequate reporting in early years.**



activities, and that all fisheries management will be developed and implemented based on the ecosystem approach in order to enhance the balance between sustainable use and protection of marine natural resources.

Fishing contributes substantially to the economy and is central to the cultural heritage of the Baltic Sea. The ICES Fishery Overviews describe the fisheries in different ecoregions. In the Baltic Sea<sup>20</sup> three species (cod, herring and sprat) constitute about 95% of the total catch, while other species can be of local economic importance. Temporal trends show that the two Baltic cod stocks have decreased and that sprat is now a dominant species.

With regard to ecosystem effects, the ICES Fisheries Overview for the Baltic Sea Ecoregion specifically mentions the risk of bycatch (seals, birds, and porpoises) and the amount of lost or discarded fishing gear in the Baltic Sea. ICES concludes that fisheries have a large impact on the upper trophic levels in the Baltic ecosystem, and that this impact has cascaded down the food web and indirectly affected lower trophic levels.

## Greater North Sea Region

The Skagerrak and the Kattegat are part of the Greater North Sea Region and are not treated separately by OSPAR and ICES. (The Kattegat is thus part of both HELCOM and OSPAR.)

The fish community is more diverse in the North Sea compared to the Baltic Sea. The most common commercial species in the Skagerrak include herring, sprat, cod, mackerel, haddock, whiting, saithe and different flatfish species.

The ICES Ecosystem Overview of the Greater North Sea<sup>21</sup> concludes that fishing has reduced the number of large fish in the North Sea ecosystem (mostly cod, saithe, ling, sturgeon, and some elasmobranchs). In historical times, the large whale populations of the North Sea were depleted or extirpated by hunting. Whilst

<sup>19</sup> [Fish Communities – HELCOM \(helcom.fi\)](#)

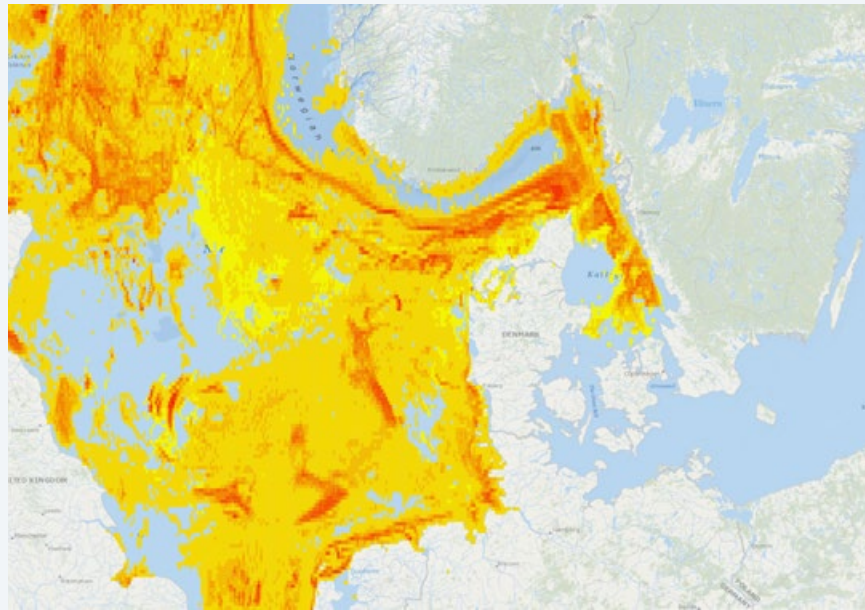
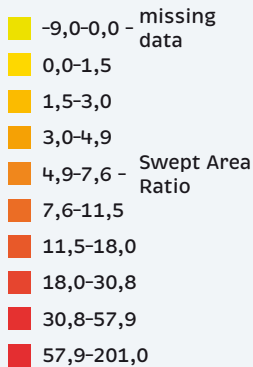
<sup>20</sup> [Baltic Sea ecoregion – Fisheries overview \(ices.dk\)](#) (pdf)

<sup>21</sup> [Greater North Sea ecoregion – Fisheries overview, including mixed-fisheries considerations \(ices.dk\)](#) (pdf)



**FIGURE 2. Bottom fishing intensity 2017.**

MAP: ODIMS<sup>22</sup>



the impact of these removals on the ecosystem functioning is not clearly understood, it should be assumed that the North Sea ecosystem is currently in a perturbed state. Several of species of elasmobranch (sharks and rays) are now considered threatened or endangered by OSPAR and IUCN and are still caught as bycatch in fisheries.

Fishing efforts have, however declined in the North Sea since the reform of the CFP in 2002. This is shown by a reduction in fishing mortality in most assessed fish stocks and an increase in the amount of larger fish present. The majority of assessed fish stocks are now fished at or below maximum sustainable yield, (MSY<sup>23</sup>).

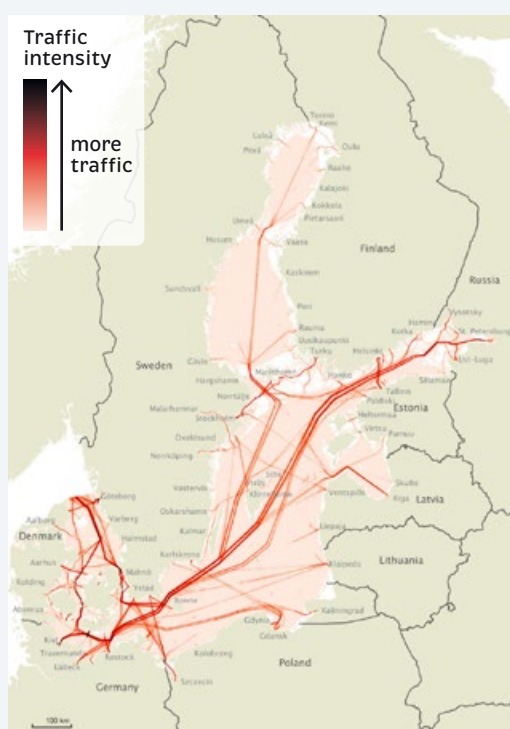
According to ICES there are reports of a shift from pelagic to benthic production. The plaice stock in the North Sea has increased almost fourfold in the last 15 years and is now larger than when monitoring began in the 1950s. Flatfish are not included in the current multispecies models for the North Sea. The ecosystem consequences of this large increase in the stock of plaice are unknown.

<sup>22</sup> OSPAR Bottom Fishing Intensity – Surface 2017 ([odims.ospar.org](http://odims.ospar.org))

<sup>23</sup> The maximum sustainable yield (MSY) for a given fish stock means the highest possible annual catch that can be sustained over time, by keeping the stock at the level producing maximum growth. The MSY refers to a hypothetical equilibrium state between the exploited population and the fishing activity.



# Shipping



**FIGURE 3.** Traffic intensity in the Baltic Sea Region in 2018.

SOURCE: HELCOM AIS DATA

Shipping is one of the main sectors that use the open sea. The Baltic Sea and the Skagerrak are heavily trafficked. More than 10 200 different vessels<sup>24</sup> fishing vessels excluded, trafficked the region in 2013<sup>25</sup>. Data from 2015 registered about 7 900 ships operating in the Baltic Sea<sup>26</sup> and during the last decades the number of ships has continued to increase.

HELCOM publishes a yearly report on ship accidents, and a map from the 2018 report<sup>27</sup> shows the main shipping routes<sup>28</sup>. Since 2004 the number of shipping accidents has been around 150 per year, but in 2018 about 250 accidents were reported, nearly 40% of which occurred in the open sea. HELCOM also compiles data over discharges (spills of oil and other harmful substances) observed by aerial surveillance<sup>29</sup>. These data are confirmed by the HELCOM countries, but the real number of discharges is presumably larger.

The emissions from ships affect the marine ecosystem in different ways. The figure below from the BONUS research program SHIBA<sup>30</sup> (2015- 2018) shows how different systems onboard ships affect different components of the marine ecosystem. However, to make an overall assessment of the environmental impact of emissions, it is important to understand both that the impacts vary between different types of ships and that different types of impact have effects on different temporal and spatial scales.

We know for example that shipping is the largest vector for transfer of invasive species in the marine environment, and they are transferred both via ships ballast water and as marine growth (biofouling) on ship hulls. Ballast water is mainly discharged in ports from which the organisms spread further.

Ballast water typically contains a diverse assemblage of phytoplankton, zooplankton, invertebrates, fish and bacteria. Transfer of invasive species with ships ballast water is controlled under International Maritime Organization by the

<sup>24</sup> Registered by AIS (Automatic Identification System)

<sup>25</sup> *Mapping shipping intensity and routes in the Baltic Sea* ([havsmiljoinstitutet.se](http://havsmiljoinstitutet.se)) (pdf)

<sup>26</sup> *HELCOM Assessment on maritime activities in the Baltic Sea 2018* ([helcom.fi](http://helcom.fi)) (pdf)

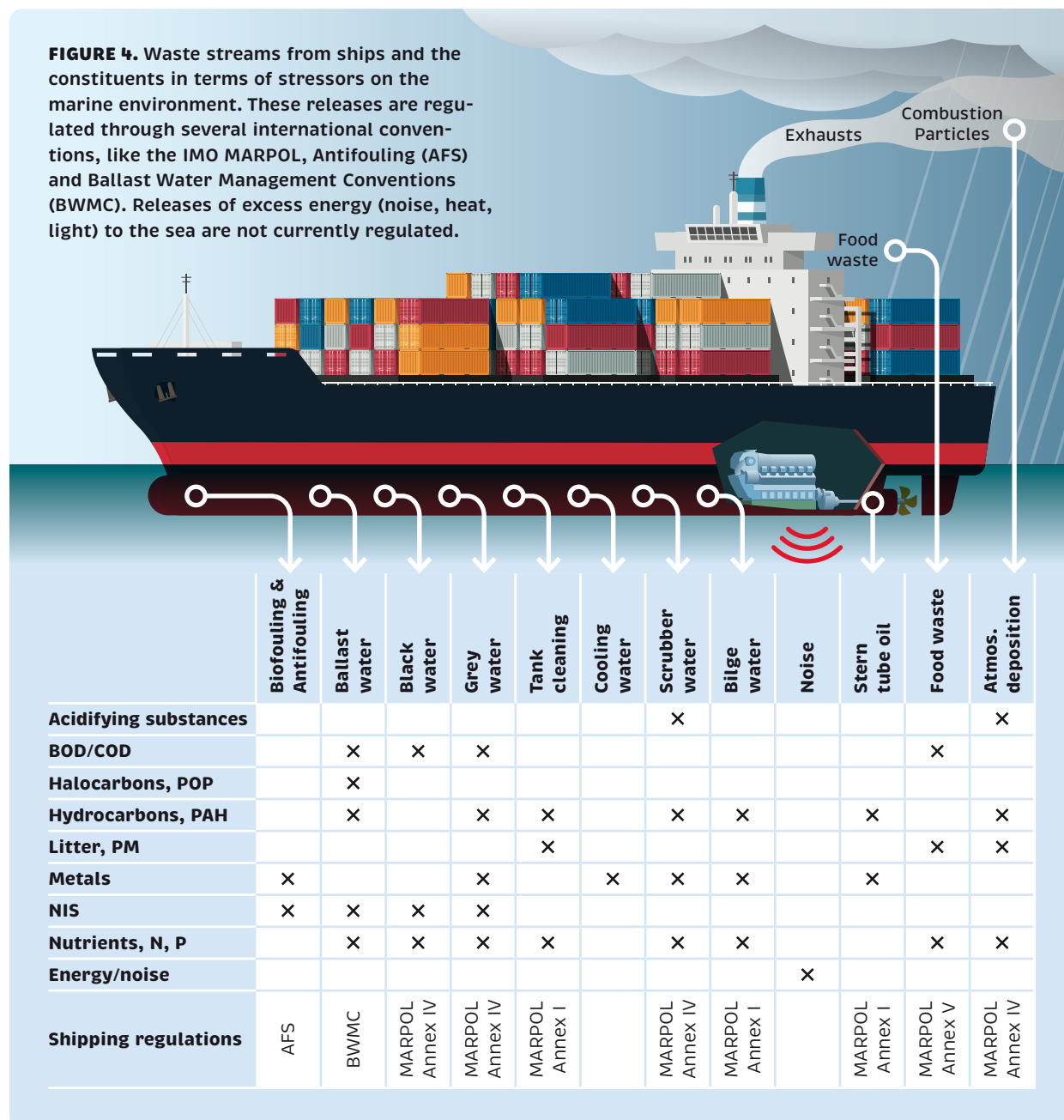
<sup>27</sup> *Shipping accidents in the Baltic Sea 2018* ([helcom.fi](http://helcom.fi)) (pdf)

<sup>28</sup> IMO regulations (i.e. SOLAS) require Automatic Identification System (AIS) transponders to be fitted on board all ships of 300 GT and above engaged in international voyages, cargo ships of 500 GT and above not engaged in international voyages, as well as all IMO registered passenger ships irrespective of size.

<sup>29</sup> *Annual report on discharges observed during aerial surveillance in the Baltic Sea 2019* ([helcom.fi](http://helcom.fi)) (pdf)

<sup>30</sup> *BONUS SHEBA – Sustainable Shipping and Environment of the Baltic Sea region* ([sheba-project.eu](http://sheba-project.eu)), Moldanova, J. et al 2018. (pdf)

**FIGURE 4.** Waste streams from ships and the constituents in terms of stressors on the marine environment. These releases are regulated through several international conventions, like the IMO MARPOL, Antifouling (AFS) and Ballast Water Management Conventions (BWMC). Releases of excess energy (noise, heat, light) to the sea are not currently regulated.

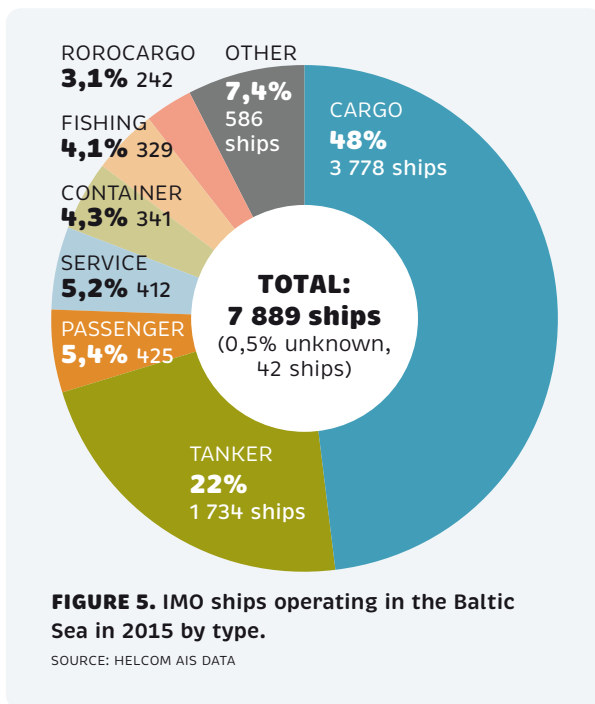


Ballast Water Management Convention (BWMC)<sup>31</sup>, which entered into force 2017. From the Baltic Sea perspective this means that traffic coming to the Baltic Sea need to treat the ballast water before discharge. It should be noted though, that BWMC applies immediately to new built ships, while start-date for when older ships need to follow the convention is dependent on the planned intermediate service of each ship. Ballast water are mainly discharged in ports. However, ship hull fouling will not be regulated. Formas, The Swedish Transport Administration and the Swedish Environmental Protection agency have decided to finance 9 research projects on alien species 2021-2024<sup>32</sup>. Of relevance for the marine environment is one project aimed to assess the viability in resistant life stages of invertebrates in ballast water and projects about the invasive species Pacific oyster (*Magallana gigas*) and Round goby (*Neogobius melanostomus*) respectively.

The goal of BONUS SHIBA was to develop a holistic assessment of ecological, economic, and societal impacts of operational shipping on the environment of the

<sup>31</sup> IMO Ballast Water Management Convention / BIO SEA ([ballast-water-treatment.com](http://ballast-water-treatment.com))

<sup>32</sup> Forskningsprojekt om invasiva arter finansieras ([formas.se](http://formas.se)) – in Swedish



Baltic Sea region. The SHIBA project has produced scenarios for emissions to air and water as well as underwater noise from shipping in the Baltic Sea for the present, 2030 and 2040. The scenarios were also used to identify the gaps between what is expected from shipping in the future and what is needed for shipping to become sustainable. When the scenarios were analysed in relation to two EU Directives, the Marine Strategy.

Framework Directive (MSFD) and the Water Framework Directive (WFD), the analyses showed that some of the descriptors and quality elements in these directives were negatively affected by future shipping in the Baltic Sea.

Shipping is an international sector, regulated by international conventions and agreements. The UN agency IMO (International Maritime Organization) 26 has responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. Swedish participation in the IMO is coordinated by the Swedish Transport Agency

(Transportstyrelsen). IMO has classified the Baltic Sea, including the Kattegat, except for Russian waters, as Particularly Sensitive Sea Area (PSSA). The Baltic Sea is also classified as a special area where stricter rules for discharges from ships apply.

A recent report from the Swedish Environmental Objectives Committee<sup>33</sup> concluded that much knowledge is lacking regarding the impact of shipping on the marine environment and its ecosystems, but even our current limited knowledge shows that the impact is extensive. The committee stressed the need for additional knowledge on the overall impact of shipping on the marine environment and its ecosystems, and pointed out that these questions tend to “fall in between the cracks” in management and decision-making.

The Environmental Objectives Committee<sup>34</sup> also noted that the impact of shipping on the marine environment and its ecosystems has not received sufficient attention in the context of long-term research. They emphasised the need for further research on the impact of shipping, which will require deep knowledge and understanding of the shipping industry, ship operations, and the marine environment. They further noted that the Swedish Maritime Administration (Sjöfartsverket), which is responsible for achieving the transport policy objectives, does not currently conduct any research on the impact of shipping on the marine environment.

The Environmental Objectives Committee specifically pointed out the need for research on the effects of underwater noise on the marine environment. This is a relatively new marine environmental issue that needs skills from several disciplines such as biology, ecology, ethology and population analyses to gain a broader understanding.

33 *Particularly Sensitive Sea Areas* (imo.org)

34 *Havet och människan, volym 2, SOU 2020:83* (sou.gov.se) – in Swedish (pdf)

# International cooperation

An incredible number of international organizations work for a healthy and sustainable marine environment. Some work to implement international conventions, while others promote different sectoral interests. Cooperation is necessary, but it is often difficult and time-consuming to achieve results. What makes some collaborations easier than others and what can international organizations learn from each other? Some important organisations are presented below. The offshore marine environment is managed by international agreements. The most important regional platform for the Baltic Sea (including the Kattegat) is the Helsinki Convention, HELCOM<sup>35</sup>, which has been signed by all nine countries that border the Baltic Sea. The European Union is also one of the contracting parties and all of the HELCOM member countries except Russia are members of the EU.

The OSPAR Convention<sup>36</sup> covers the entire North-east Atlantic but has divided it into five marine regions. Region II: Greater North Sea includes the English Channel, the North Sea, the Skagerrak and the Kattegat. The three countries around the Kattegat and the Skagerrak all follow the directives from the EU, even though Norway is not a member of the EU.

The International Council for the Exploration of the Sea (ICES)<sup>37</sup> is also of special interest with regard to international cooperation for protection and sustainable use of the sea. In the beginning the focus was on fish and fisheries and ICES still provides advice to the EU on fish quotas and fisheries. However today, ICES also provides scientific advice on marine ecosystem issues.

All of these international organisations underline that their agreements and advice are, or should be, based on science although a lack of knowledge should not be a hinder for actions to improve the marine environment. Similarly, they all have identified knowledge gaps (see Appendix 2).



<sup>35</sup> HELCOM – the Helsinki Commission ([helcom.fi](http://helcom.fi))

<sup>36</sup> OSPAR Commission ([ospar.org](http://ospar.org))

<sup>37</sup> ICES – The International Council for the Exploration of the Sea ([ices.dk](http://ices.dk))

Equally important is the international cooperation that regulates the shipping industry. Shipping is regulated worldwide by the International Maritime Organization (IMO)<sup>38</sup> which currently has 174 member states. Swedish participation in the IMO is coordinated by the Transport Agency (Transportstyrelsen). The Swedish Shipowners' Association (Svensk Sjöfart) is a member of the European Community Shipowners' Associations (ECSA)<sup>39</sup> and the International Chamber of Shipping (ICS).



Fisheries in the Baltic Sea and North Sea are regulated by the EU Common Fisheries Policy (CFP). The European Commission's Directorate-General for Maritime Affairs and Fisheries (DG MARE) is responsible for implementation of the CFP, and they are advised by ICES, by the Scientific Technical and Economic Committee for Fisheries (STECF) and by the Advisory Councils. The Advisory Councils are regional bodies that consist of representatives from the fishing industry and from other interest groups. In addition, fishermen and other stakeholders are organized in different associations, for example the Swedish Pelagic Federation<sup>40</sup> (SPF), Sveriges Fiskares Producentorganisation<sup>41</sup> (SFPO), The Fisheries Secretariat<sup>42</sup> (FishSec) and the Marine Stewardship Council<sup>43</sup> (MSC).



<sup>38</sup> IMO – International Maritime Organization ([imo.org](http://imo.org))

<sup>39</sup> ECSA – European Community Shipowners' Associations ([ecsa.eu](http://ecsa.eu))

<sup>40</sup> SPF – Swedish Pelagic Federation ([pelagic.se](http://pelagic.se))

<sup>41</sup> SFPO – Sveriges Fiskares Producentorganisation ([sfpo.se](http://sfpo.se))

<sup>42</sup> FishSec – The Fisheries Secretariat ([fishsec.org](http://fishsec.org))

<sup>43</sup> MSC – the Marine Stewardship Council ([msc.org](http://msc.org))

# Research program initiatives

## The Formas National Research program for marine and freshwater research

Formas proposed a *national research program*<sup>44</sup> for fresh and marine waters as part of the Swedish government's research bill. The program aims to support and provide scientific knowledge for national and international commitments such as the Swedish Environmental Objectives, relevant EU directives, and the United Nations Decade of Ocean Science for Sustainable Development. The program was developed in broad cooperation between stakeholders and scientists from agencies, institutes, universities, and companies.

The proposal *Forskning och innovation för en livskraftig vattenmiljö* (in Swedish)<sup>45</sup> identifies three areas where further knowledge is needed:

Research area	1. Research on biodiversity, processes, interactions, and effects	2. Innovations for a viable aquatic environment	3. Development of instruments, implementation, and financial aspects
Subareas	Biodiversity and impact on the ecosystems	Water use and control of flows in industrial processes	
	Groundwater formation	Groundwater levels and use	
	Toxic substances	Monitoring status and changes	
	Eutrophication		
	Under water noise		
	Environmental effects of shipping		

Formas requested a budget of 40/80/120/120 million SEK/year for the period 2021-2024. In the research bill the government proposed to support the research program with 10/60/70/70 million SEK/year for the first 4 years, including activities related to the UN Ocean Decade. In 2021, Formas will appoint a program board and continue work on developing the program.

<sup>44</sup> Uppdrag att inrätta nationella forskningsprogram ([regeringen.se](https://regeringen.se)) – in Swedish

<sup>45</sup> *Forskning och innovation för en livskraftig vattenmiljö* ([formas.se](https://formas.se)) – in Swedish



From the research bill:

### Formas program for research and innovation for a viable aquatic environment

In the research bill (2020/21:60) Research, freedom, future – knowledge and innovation for Sweden was assigned in total 210 million SEK for the first four years of a 10-year national research program on marine and freshwater according to their proposal to the government<sup>46</sup>. The program will cover both fresh water and marine waters and will be a complement to the three present national programs at Formas: Climate, Sustainable spatial planning and Food.

The water program will now be further developed from the document *Forskning och innovation för en livskraftig vattenmiljö* (in Swedish). It is suggested that the program should focus on three areas. The area Knowledge of biodiversity, process, interactions and

effects aims for a better understanding of processes in the aquatic ecosystems and the causal relationships from the impact of land and human activities. The area Innovations for a viable environment aim for the development of innovative and more efficient use of water status and changing status over time.

Research in the last area Instruments, implementation, and economic effects aims contribute to the transformation of new knowledge into action through political instruments, voluntary commitments and behaviours etc., but also support integrated planning and ecosystem management.

The money should also cover the Swedish input to the UN Decade of Ocean Science for Sustainable Development.

#### Decade outcomes 'The ocean we want'

1. A **clean ocean** where sources of pollution are identified and reduced or removed.
2. A **healthy and resilient ocean** where marine ecosystems are understood, protected, restored and managed.
3. A **productive ocean** supporting sustainable food supply and a sustainable ocean economy.
4. A **predicted ocean** where society understands and can respond to changing ocean conditions.
5. A **safe ocean** where life and livelihoods are protected from ocean-related hazards.
6. An **accessible ocean** with open and equitable access to data, information and technology and innovation.
7. An **inspiring and engaging ocean** where society understands and values the ocean in relation to human well-being and sustainable development.

## UN Decade of Ocean Science for Sustainable Development

UN declared 2021 – 2031 as the Decade of the Oceans<sup>47</sup> and the vision for the Ocean Decade is *The Science We Need for The Ocean We Want*. The Ocean Decade will build scientific capacity and generate knowledge that will directly contribute to the goals of the 2030 Agenda for Sustainable Development and other relevant global legal and policy frameworks. The last few years have been a preparatory phase during which the Intergovernmental Oceanographic Commission of UNESCO (IOC) has engaged nations and stakeholders to develop an implementation plan<sup>48</sup>.

The implementation plan identifies seven Decade outcomes for the transformation from 'The ocean we have' to 'The ocean we want' (see box).

At the request of the Swedish government, Formas, the Swedish Agency for Marine and Water Management (SwAM) and the Swedish Meteorological and Hydrological Institute (SMHI) developed suggestions for national activities during the Ocean Decade. The report was presented to the government in October 2020<sup>49</sup> and proposed to focus on four areas in line with the Ocean Decade implementation plan:

1. Ecosystem based management.
2. Innovation and digitalisation.

<sup>46</sup> 2021: 10 million SEK, 2022: 60 million SEK, 2023: 70 million SEK and 2024: 70 million SEK

<sup>47</sup> *The Decade of Ocean Science for Sustainable Development* ([oceandecade.org](https://oceandecade.org))

<sup>48</sup> *Ocean Decade | IOC UNESCO* ([ioc.unesco.org](https://ioc.unesco.org))

<sup>49</sup> *Ett svenskt bidrag till FN:s årtionde för havsforskning för hållbar utveckling 2021–2030* ([formas.se](https://formas.se)) – in Swedish

### 3. Data and modelling.

### 4. Ocean literacy

The wide focus areas include suggestions for demonstration projects, citizen science projects, monitoring, mapping as well as basic science. Research suggestions include the proposed national research program at Formas, long-term investment in marine modelling by SMHI, including models of climate effects on the sea, and extra investments in marine innovation by Formas and Vinnova.

Neither the Ocean Decade nor the national water research program were explicitly addressed in the Swedish government's appropriation directions (regleringsbrev) to Formas, but an additional 140 million SEK was added to the budget for 2021, to be spent after consultation with the government.

#### What are mission and mission areas?

EU missions are commitments to solve major societal challenges like fighting cancer, adapting to climate change, protecting our oceans, living in greener cities and ensuring soil health and food.

As integral part of the Horizon Europe framework programme beginning in 2021, they are a new way to deliver on these commitments.

Each mission will operate as a portfolio of actions - such as research projects, policy measures or even legislative initiatives - to achieve a measurable goal that could not be achieved through individual actions. The missions will contribute to the goals of the European Green Deal, Europe's Beating Cancer Plan as well as the Sustainable Development Goals.

## EU research

### EU Horizon Europe

Horizon Europe is the EU research and innovation framework programme for 2021-2027. The EU institutions reached a political agreement on 11 December 2020 and the first Horizon Europe Strategic Plan (2021-2024) is expected to be adopted in February 2021.

Five mission areas have been identified in Horizon Europe: Adaptation to climate change including societal transformation

1. Cancer
2. Climate-neutral and smart cities
3. Healthy oceans, seas, coastal and inland waters
4. Soil health and food

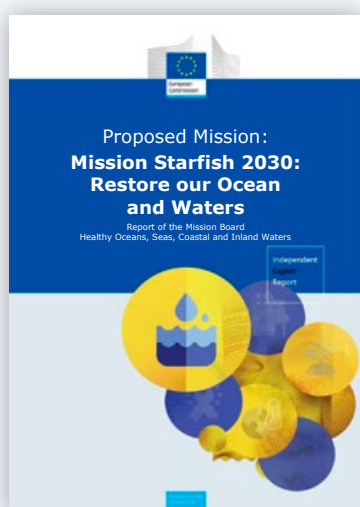
Marine research is found in the mission *Healthy oceans, seas, coastal and inland waters*<sup>50</sup>. In this area the EU mission board has presently (one proposed mission: Starfish 2030: *Restore our Oceans and Waters*).

### EU Mission Starfish 2030: Restore our Oceans and Waters.

Inspired by the shape of the starfish, the Mission will address the four interdependent challenges – unsustainable footprint, climate change, lack of understanding, connection and investment, inadequate governance - by proposing five overarching objectives for 2030:

1. Filling the knowledge and emotional gap,
2. Regenerating marine and freshwater ecosystems,
3. Zero pollution,
4. Decarbonising our ocean, and waters
5. Revamping governance.

The Mission is presented by the Mission Board in an Independent Expert Report<sup>51</sup>.



<sup>50</sup> [Healthy oceans, seas, coastal and inland waters](#) / European Commission ([ec.europa.eu](#))

<sup>51</sup> [Mission Starfish 2030](#) ([op.europa.eu](#))



## European partnership for Blue Economy

In autumn 2019 the Commission services asked potential partners to further elaborate proposals for the candidate European Partnerships identified during the strategic planning of Horizon Europe. These are presented in the *Draft proposal for a European Partnership under Horizon Europe – A climate neutral, sustainable and productive Blue Economy*<sup>52</sup>.

The document contains an overview of R&D initiatives. Among them are the now completed program *BONUS*<sup>53</sup> – *Science for a better future of the Baltic Sea region* and *BANOS CSA*<sup>54</sup> – *Baltic and North Sea Coordination and Support Action* (see boxes below)



**BONUS** has evolved since 2004: in the beginning as an ERA-Net involving the key research funders of all coastal states including Russia, then as an ERA-Net Plus, and finally, as TFEU Art. 185 action. Its SRIA is being systematically updated based on policy landscape analysis, and thoroughly consulted on with stakeholders through repeated strategic orientation workshops. BONUS has implemented 64 co-funded transnational multidisciplinary R&I projects and multitude of impact enabling and stakeholder engaging activities. The dedicated legal entity implementing BONUS EEIG is the coordinator of BANOS CSA.



**BANOS** building a SRIA, implementation mechanisms and the impact enabling strategies for the future joint Baltic Sea and North Sea R&I programme that will involve all countries surrounding the two “sister seas”. The three BANOS strategic objectives, including (1) Healthy Seas and Coast, (2) Sustainable Blue Economy, and (3) Human Wellbeing, all have strong emphasis on the integral long-term sustainability and resilience of the marine ecosystem and its biodiversity, including the development of ecosystem-based management approaches. The programme intends to contribute to all components of the European Blue Growth Strategy (BGS), i.e. high-potential sectors such as aquaculture, coastal tourism, biotechnology and ocean energy; essential components such as marine knowledge, maritime spatial planning and sea basin strategies in two out of seven listed maritime areas. The programme will also commit to combatting climate change, new circular solutions, climate change threats to human wellbeing such as sea level rise and securing safe food and feed supply. The BANOS CSA1 (2018-2021) prepares a framework for launching a joint Baltic Sea and North Sea Research and Innovation Programme (BANOS) from 2021 onwards. The consortium consists of twelve states surrounding the Baltic and North Sea and is coordinated by the BONUS secretariat.

<sup>52</sup> *Draft proposal for a European Partnership under Horizon Europe – A climate neutral, sustainable and productive Blue Economy, version 27.07.2020 (ec.europa.eu) (pdf)*

<sup>53</sup> *BONUS – the joint Baltic Sea research and development programme (bonusportal.org)*

<sup>54</sup> *BANOS CSA – the Baltic and North Sea Coordination and Support Action (banoscса.org)*



# Appendices

# 1. Stakeholders

The list shows examples of stakeholders. Others may become relevant depending on how the program is designed.

## Swedish agencies

- ▶ Swedish Agency for Marine and Water Management (Havs- och Vattenmyndigheten) Swedish Environmental Protection Agency (Naturvårdsverket)
- ▶ Swedish Meteorological and Hydrological Institute (SMHI) Geological Survey of Sweden (SGU)
- ▶ Swedish Transport Agency (Transportstyrelsen)
- ▶ Swedish Maritime Administration (Sjöfartsverket) Swedish Transport Administration (Trafikverket) Swedish Energy Agency (Energimyndigheten)

## Environment

- ▶ International Council for Exploration of the Sea (ICES)
- ▶ The Baltic Marine Environmental Protection Commission (HELCOM)
- ▶ The Oslo and Paris Commissions (OSPAR) Swedish Institute for the Marine Environment (Havsmiljöinstitutet)
- ▶ World Wide Fund for Nature (WWF)
- ▶ Swedish Society for Nature Conservation (SSNC) The Baltic Sea Action Group (BSAG)
- ▶ Coalition Clean Baltic (CCB)

## Shipping

- ▶ International Maritime Organisation (IMO) Swedish Shipowner's Association (Svensk sjöfart)
- ▶ Cruise Lines International Association Europe (CLIA Europe) Interferry

## Fisheries

- ▶ Swedish Pelagic Federations (SPF)
- ▶ Sveriges fiskares producentorganisation (SFPO) The Fisheries Secretariat (FishSec)
- ▶ Marine Stewardship Council (MSC) Baltic Sea Advisory Council (BSAC)
- ▶ Baltic Sea Regional Advisory Council (BS RAC) North Sea Advisory Council (NSAC)
- ▶ North Sea Regional Advisory Council (NS RAC) Sea Fisheries Forum (BALTFISH)

## 2. International Science Plans

### ICES Science Plan<sup>55</sup>

Our Science Plan highlights seven interrelated science priorities for our organization. The knowledge we generate when tackling these priorities will support advice on the state of the seas and on meeting conservation, management, and sustainability goals.

More about the objects are found in their Science Plan.<sup>56</sup>

#### **Ecosystem science**

Advance and shape understanding of the structure, function, and dynamics of marine ecosystems – to develop and vitalize marine science and underpin its applications.

#### **Impacts of human activities.**

Measure and project the effects of human activities on ecosystems and ecosystem services — to elucidate present and future states of natural and social systems.

#### **Observation and exploration**

Monitor and explore the seas and oceans — to track changes in the environment and ecosystems and to identify resources for sustainable use and protection.

#### **Emerging techniques and technologies**

Develop, evaluate, and harness new techniques and technologies — to advance knowledge of marine systems, inform management and increase the scope and efficiency of monitoring.

#### **Seafood production**

Generate evidence and advice for management of wild-capture fisheries and aquaculture — to help sustain safe and sufficient seafood supplies.

#### **Conservation and management science**

Develop tools, knowledge, and evidence for conservation and management — to provide more and better options to help managers set and meet objectives.

#### **Sea and society**

Evaluate contributions of the sea to livelihoods, cultural identities, and recreation — to inform ecosystem status assessments, policy development, and management.

### OSPAR Science Agenda

The OSPAR Science Agenda<sup>57</sup> was first published in 2015 and revised in 2017. The current Science Agenda contains a prioritised list of 44 knowledge gaps, aiming at improving future OSPAR assessments, notably the OSPAR's next Quality

<sup>55</sup> *ICES Science priorities* ([ices.dk](https://www.ices.dk))

<sup>56</sup> *ICES Science Plan* ([issuu.com](https://www.ices.dk))

<sup>57</sup> *OSPAR Science Agenda* ([ospar.org](https://www.ospar.org))

Status Report (QSR) due in 2023, and contains suggestions for increasing OSPAR's knowledge base. Whilst OSPAR recognises there are gaps in knowledge in many strands of work, this update is based on knowledge gaps identified in OSPAR's 2017 Intermediate Assessment (IA2017).

A summarised list of prioritised knowledge gaps:

1. Further development of (common and candidate) indicators to fulfil the requirements of the (primary) criteria of the revised EU MSFD Commission Decision 2017, and to allow increased coverage of existing common indicators. Highest priorities are for pelagic and benthic habitats, seabirds and food webs (biodiversity); and marine litter, noise, eutrophication, non-indigenous species and the oil and gas industry (pressures);
2. Thresholds and reference values for common indicators. Highest priorities are for fish communities, marine mammals and food webs (biodiversity); and for contaminants (including in dredged material) and radioactive substances, as well as eutrophication and marine litter (pressure);
3. Ecologically meaningful assessment areas. Highest priority is for eutrophication, to solve incoherent assessment outcomes (pressure);
4. Cumulative effects and integration of indicators. Highest priorities are for integrated ecosystem assessments in general and eutrophication, and cumulative impacts of human activities on marine mammals and food webs;
5. Effectiveness of measures to reduce pressures. This is an overarching priority, including socio-economic assessments, and for the management of Marine Protected Areas

## HELCOM Science agenda

BSAP was originally published in 2007, and the latest update was adopted by the contracting parties in December 2020. They also approved a draft HELCOM Science Agenda<sup>58</sup>.

The HELCOM Science Agenda has been prepared to support the implementation of the BSAP and other HELCOM agreements. It highlights knowledge needs that are seen as essential within the upcoming 10 years. The Science Agenda aims at communicating HELCOM science needs to funding agencies, to inform and inspire scientists to direct their interest towards meeting the knowledge needs in HELCOM, and to increase the interaction between science and policy.

The Science Agenda has been developed based on the following principles:

- it should focus on the knowledge needed to implement HELCOM agreements, i.e. it should be oriented towards applied knowledge needs;
- it should focus on topics of major importance for HELCOM work and be relevant from a regional perspective;
- it should have a relatively long shelf-time (about 10 years), and as a consequence the highlighted science needs have been formulated relatively broadly, while more specific knowledge needs are included in a separate file as received from HELCOM subsidiary bodies (labelled 'Comprehensive inventory of HELCOM knowledge and science needs');
- the highlighted science needs should be complementary to the BSAP actions, i.e. by providing knowledge that will support the implementation of BSAP actions, but they should not duplicate each other;

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58 [Provisional approval of the HELCOM Science Agenda \(portal.helcom.fi\)](https://portal.helcom.fi/) (pdf)

- the annexes provide information on how the highlighted science needs are linked to HELCOM agreements and other relevant policies (e.g. UN SDGs, UN Decade of Ocean Science). It should be noted that annexes will be updated and completed once the actions for the updated BSAP have been agreed.

The Science agenda Chapters 1-3 highlights principal HELCOM knowledge and research needs that are required to support the implementation of the updated BSAP by 2030, as well as and other HELCOM agreements, and is structured around priority topics for HELCOM work.

**Chapter 1**, which focuses on the theme ‘Biodiversity’, presents the knowledge needed to better understand and develop methods to assess the status of and impacts on the Baltic Sea species and habitats and the development of direct measures used to improve their status.

## **1. Biodiversity**

- 1.1 Species
- 1.2 Habitats
- 1.3 Food webs
- 1.4 Marine Protected Areas

**Chapter 2** on ‘Human dimension’ describes science needs related to human activities and the resulting pressures on the Baltic Sea ecosystem and the development of measures to reduce their impact.

## **2. Human dimension**

- 2.1 Climate change
- 2.2 Eutrophication
- 2.3 Hazardous substances
- 2.4 Marine litter
- 2.5 Underwater noise
- 2.6 Non-indigenous species
- 2.7 Shipping
- 2.8 Fishery

**Chapter 3** on ‘Holistic approaches’ addresses overarching approaches that can support the goal of reaching a good environmental status, such as the Ecosystem Approach.

## **3. Holistic approaches**

- 3.1 Ecosystem approach
- 3.2 Maritime Spatial Planning
- 3.3 Spatial pressure and impact assessments
- 3.4 Economic and social analyses

### 3. Ecosystem approach

CBD COP 5 Decision V/6 Ecosystem approach, article 6<sup>59</sup>

#### A. Description of the ecosystem approach

1. The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Thus, the application of the ecosystem approach will help to reach a balance of the three objectives of the Convention: conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.
2. An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.
3. This focus on structure, processes, functions and interactions is consistent with the definition of “ecosystem” provided in Article 2 of the Convention on Biological Diversity: “Ecosystem” means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.” This definition does not specify any particular spatial unit or scale, in contrast to the Convention definition of “habitat”. Thus, the term “ecosystem” does not, necessarily, correspond to the terms “biome” or “ecological zone”, but can refer to any functioning unit at any scale. Indeed, the scale of analysis and action should be determined by the problem being addressed. It could, for example, be a grain of soil, a pond, a forest, a biome or the entire biosphere.
4. The ecosystem approach requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. Ecosystem processes are often non-linear, and the outcome of such processes often shows time-lags. The result is discontinuities, leading to surprise and uncertainty. Management must be adaptive in order to be able to respond to such uncertainties and contain elements of “learning-by-doing” or research feedback. Measures may need to be taken even when some cause-and-effect relationships are not yet fully established scientifically.
5. The ecosystem approach does not preclude other management and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programmes, as well as other approaches carried out under existing national policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations. There is no single way to implement the ecosystem approach, as it depends on local, provincial, national, regional or global conditions. Indeed, there are many ways in which ecosystem approaches may be used as the framework for delivering the objectives of the Convention in practice.

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59 COP Decision (cbd.int)



## B. Principles of the ecosystem approach

6. The following 12 principles are complementary and interlinked:

**Principle 1:** The objectives of management of land, water and living resources are a matter of societal choice. *Rationale:* Different sectors of society view ecosystems in terms of their own economic, cultural and societal needs. Indigenous peoples and other local communities living on the land are important stakeholders and their rights and interests should be recognized. Both cultural and biological diversity are central components of the ecosystem approach, and management should take this into account. Societal choices should be expressed as clearly as possible. Ecosystems should be managed for their intrinsic values and for the tangible or intangible benefits for humans, in a fair and equitable way.

**Principle 2:** Management should be decentralized to the lowest appropriate level. *Rationale:* Decentralized systems may lead to greater efficiency, effectiveness and equity. Management should involve all stakeholders and balance local interests with the wider public interest. The closer management is to the ecosystem, the greater the responsibility, ownership, accountability, participation, and use of local knowledge.

**Principle 3:** Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.

*Rationale:* Management interventions in ecosystems often have unknown or unpredictable effects on other ecosystems; therefore, possible impacts need careful consideration and analysis. This may require new arrangements or ways of organization for institutions involved in decision-making to make, if necessary, appropriate compromises.

**Principle 4:** Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should:

- ▶ Reduce those market distortions that adversely affect biological diversity;
- ▶ Align incentives to promote biodiversity conservation and sustainable use;
- ▶ Internalize costs and benefits in the given ecosystem to the extent feasible.

*Rationale:* The greatest threat to biological diversity lies in its replacement by alternative systems of land use. This often arises through market distortions, which undervalue natural systems and populations and provide perverse incentives and subsidies to favour the conversion of land to less diverse systems.

Often those who benefit from conservation do not pay the costs associated with conservation and, similarly, those who generate environmental costs (e.g. pollution) escape responsibility. Alignment of incentives allows those who control the resource to benefit and ensures that those who generate environmental costs will pay.

**Principle 5:** Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.

*Rationale:* Ecosystem functioning and resilience depends on a dynamic relationship within species, among species and between species and their abiotic environment, as well as the physical and chemical interactions within the environment. The conservation and, where appropriate, restoration of these interactions and processes is of greater significance for the long-term maintenance of biological diversity than simply protection of species.

**Principle 6:** Ecosystems must be managed within the limits of their functioning.

*Rationale:* In considering the likelihood or ease of attaining the management objectives, attention should be given to the environmental conditions that limit

natural productivity, ecosystem structure, functioning and diversity. The limits to ecosystem functioning may be affected to different degrees by temporary, unpredictable or artificially maintained conditions and, accordingly, management should be appropriately cautious.

**Principle 7:** The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.

*Rationale:* The approach should be bounded by spatial and temporal scales that are appropriate to the objectives. Boundaries for management will be defined operationally by users, managers, scientists and indigenous and local peoples. Connectivity between areas should be promoted where necessary. The ecosystem approach is based upon the hierarchical nature of biological diversity characterized by the interaction and integration of genes, species and ecosystems.

**Principle 8:** Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term. *Rationale:* Ecosystem processes are characterized by varying temporal scales and lag-effects. This inherently conflicts with the tendency of humans to favour short-term gains and immediate benefits over future ones.

**Principle 9:** Management must recognize that change is inevitable. *Rationale:* Ecosystems change, including species composition and population abundance. Hence, management should adapt to the changes. Apart from their inherent dynamics of change, ecosystems are beset by a complex of uncertainties and potential “surprises” in the human, biological and environmental realms.

Traditional disturbance regimes may be important for ecosystem structure and functioning, and may need to be maintained or restored. The ecosystem approach must utilize adaptive management in order to anticipate and cater for such changes and events and should be cautious in making any decision that may foreclose options, but, at the same time, consider mitigating actions to cope with long-term changes such as climate change

**Principle 10:** The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.

*Rationale:* Biological diversity is critical both for its intrinsic value and because of the key role it plays in providing the ecosystem and other services upon which we all ultimately depend. There has been a tendency in the past to manage components of biological diversity either as protected or non-protected. There is a need for a shift to more flexible situations, where conservation and use are seen in context and the full range of measures is applied in a continuum from strictly protected to human-made ecosystems.

**Principle 11:** The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.

*Rationale:* Information from all sources is critical to arriving at effective ecosystem management strategies. A much better knowledge of ecosystem functions and the impact of human use is desirable. All relevant information from any concerned area should be shared with all stakeholders and actors, taking into account, inter alia, any decision to be taken under Article 8(j) of the Convention on Biological Diversity. Assumptions behind proposed management decisions should be made explicit and checked against available knowledge and views of stakeholders.

**Principle 12:** The ecosystem approach should involve all relevant sectors of society and scientific disciplines. *Rationale:* Most problems of biological-diversity management are complex, with many interactions, side-effects and implications, and therefore should involve the necessary expertise and stakeholders at the local, national, regional and international level, as appropriate.

## C. Operational guidance for application of the ecosystem approach

7. In applying the 12 principles of the ecosystem approach, the following five points are proposed as operational guidance.
  1. Focus on the functional relationships and processes within ecosystems
8. The many components of biodiversity control the stores and flows of energy, water and nutrients within ecosystems, and provide resistance to major perturbations. A much better knowledge of ecosystem functions and structure, and the roles of the components of biological diversity in ecosystems, is required, especially to understand: (i) ecosystem resilience and the effects of biodiversity loss (species and genetic levels) and habitat fragmentation; (ii) underlying causes of biodiversity loss; and (iii) determinants of local biological diversity in management decisions. Functional biodiversity in ecosystems provides many goods and services of economic and social importance. While there is a need to accelerate efforts to gain new knowledge about functional biodiversity, ecosystem management has to be carried out even in the absence of such knowledge. The ecosystem approach can facilitate practical management by ecosystem managers (whether local communities or national policy makers).
  2. Enhance benefit-sharing.
9. Benefits that flow from the array of functions provided by biological diversity at the ecosystem level provide the basis of human environmental security and sustainability. The ecosystem approach seeks that the benefits derived from these functions are maintained or restored. In particular, these functions should benefit the stakeholders responsible for their production and management. This requires, inter alia: capacity-building, especially at the level of local communities managing biological diversity in ecosystems; the proper valuation of ecosystem goods and services; the removal of perverse incentives that devalue ecosystem goods and services; and, consistent with the provisions of the Convention on Biological Diversity, where appropriate, their replacement with local incentives for good management practices.
  3. Use adaptive management practices
10. Ecosystem processes and functions are complex and variable. Their level of uncertainty is increased by the interaction with social constructs, which need to be better understood. Therefore, ecosystem management must involve a learning process, which helps to adapt methodologies and practices to the ways in which these systems are being managed and monitored. Implementation programmes should be designed to adjust to the unexpected, rather than to act on the basis of a belief in certainties. Ecosystem management needs to recognize the diversity of social and cultural factors affecting natural-resource use. Similarly, there is a need for flexibility in policy-making and implementation. Long-term, inflexible decisions are likely to be inadequate or even destructive. Ecosystem management should be envisaged as a long-term experiment that builds on its results as it progresses. This “learning-by-doing” will also serve as an important source of information to gain knowledge of how best to monitor the results of management and evaluate whether established goals are being attained. In this respect, it would be desirable to establish or strengthen capacities of Parties for monitoring.
  4. Carry out management actions at the scale appropriate for the issue being addressed, with decentralization to lowest level, as appropriate
11. As noted in section A above, an ecosystem is a functioning unit that can operate at any scale, depending upon the problem or issue being addressed. This

understanding should define the appropriate level for management decisions and actions. Often, this approach will imply decentralization to the level of local communities. Effective decentralization requires proper empowerment, which implies that the stakeholder both has the opportunity to assume responsibility and the capacity to carry out the appropriate action, and needs to be supported by enabling policy and legislative frameworks. Where common property resources are involved, the most appropriate scale for management decisions and actions would necessarily be large enough to encompass the effects of practices by all the relevant stakeholders. Appropriate institutions would be required for such decision-making and, where necessary, for conflict resolution. Some problems and issues may require action at still higher levels, through, for example, transboundary cooperation, or even cooperation at global levels.

#### 5. Ensure intersectoral cooperation

12. As the primary framework of action to be taken under the Convention, the ecosystem approach should be fully taken into account in developing and reviewing national biodiversity strategies and action plans. There is also a need to integrate the ecosystem approach into agriculture, fisheries, forestry and other production systems that have an effect on biodiversity. Management of natural resources, according to the ecosystem approach, calls for increased intersectoral communication and cooperation at a range of levels (government ministries, management agencies, etc.). This might be promoted through, for example, the formation of inter-ministerial bodies within the Government or the creation of networks for sharing information and experience.

## The Malawi Principles for the Ecosystem Approach

In a Workshop on the Ecosystem Approach (Lilongwe, Malawi, 26-28 January 1998), whose report was presented at the Fourth Meeting of the Conference of the Parties to the Convention on Biological Diversity (Bratislava, Slovakia, 4-15 May 1998, UNEP/CBD/ COP/4/Inf.9), twelve principles/characteristics of the ecosystem approach to biodiversity management were identified:

1. Management objectives are a matter of societal choice.
2. Management should be decentralized to the lowest appropriate level.
3. Ecosystem managers should consider the effects of their activities on adjacent and other ecosystems.
4. Recognizing potential gains from management there is a need to understand the ecosystem in an economic context, considering e.g. mitigating market distortions, aligning incentives to promote sustainable use, and internalizing costs and benefits.
5. A key feature of the ecosystem approach includes conservation of ecosystem structure and functioning.
6. Ecosystems must be managed within the limits to their functioning.
7. The ecosystem approach should be undertaken at the appropriate scale.
8. Recognizing the varying temporal scales and lag effects which characterize ecosystem processes, objectives for ecosystem management should be set for the long term.
9. Management must recognize that change is inevitable.
10. The ecosystem approach should seek the appropriate balance between conservation and use of biodiversity.

- 11.** The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
- 12.** The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

## 4. Defining Ecosystem-based management (EMB)

UNEP (2011): Taking Steps toward Marine and Coastal Ecosystem-Based Management - An Introductory Guid.

Ecosystem-based management, or EBM, is an approach that goes beyond examining single issues, species, or ecosystem functions in isolation. Instead it recognizes ecological systems for what they are: a rich mix of elements that interact with each other in important ways. This is particularly important for oceans and coasts. A single commercially valuable fish species, for example, may depend on a range of widely separated habitats over its life, depending on whether it is young or adult, feeding, spawning, or migrating. It needs access to each habitat at the right time, as well as ample food, clean water, and shelter.

Because humans depend on an array of ocean and coastal functions for our well-being — including fish as food, for example — EBM recognizes that our welfare and the health of the environment are linked. Put another way, marine and coastal systems provide valuable natural services, or “ecosystem services”, for human communities. Therefore, to protect our long-term wellbeing, we need to make sure marine and coastal ecosystem functions and productivity are managed sustainably. This means managing them in a way that acknowledges the complexity of marine and coastal ecosystems, the connections among them, their links with land and freshwater, and how people interact with them.

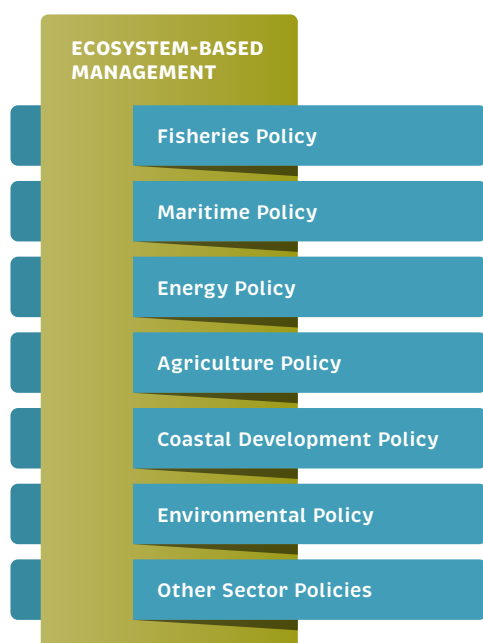
Management must be integrated, just as ecosystems are interconnected. One of the most important aspects of EBM is that it is **fundamentally a place-based approach**, where an ecosystem represents the place. Across an entire “place”, EBM

aims to manage each of the human uses at a scale that encompasses its impacts on marine and coastal ecosystem function, rather than scales defined by jurisdictional boundaries. Regional-scale management is an important practice in a range of places, including within the framework provided by regional governance mechanisms, such as the Regional Seas Conventions and Action Plans and other regional frameworks.

To summarize the above, EBM involves two changes in how management is practiced: (1) each human activity is managed in the context of ALL the ways it interacts with marine and coastal ecosystems, and (2) multiple activities are being managed for a common outcome. To describe this, the terms **ecosystem-based management** and **ecosystem approach** (EA) are often used interchangeably, and they mean generally the same thing.

There is, on the other hand, an important distinction between fully cross- sectoral EBM (or fully cross-sectoral EA) and applying ecosystem-based policies within an individual sector. Some fisheries management agencies, for example, have adopted “ecosystem-based fisheries management” or EBFM (often referred to as an “ecosystem approach to fisheries”, EAF), which considers the status of commercial fish stocks and ecosystem components that interact with

### EBM promotes inter-sectoral coordination





*“Ecosystem-based management cannot be implemented through single-sector policy alone.*

*Different sector policies must all contribute to a cross- sectoral approach. In the case of fisheries, for example, EBM addresses both the impacts OF fisheries on marine ecosystems and the impact ON fisheries from other sectors, such as coastal development, offshore energy, and so forth. In this way, crosssector integration and within-sector contributions are both needed.”*

POUL DEGNBOL, HEAD OF ADVISORY PROGRAMME, ICES

those stocks: predators, prey, habitats, etc. In doing so, fisheries management has made progress in maintaining or even enhancing fisheries productivity for many stocks. But adopting environmentally-oriented management measures in just one sector falls short of the integrated goal- setting and management that full EBM entails, and which is needed to ensure the sustainability of a complete range of ecosystem services. As such, although EBFM may be an important component of successful EBM, it does not equal EBM in itself. Rather, full EBM may serve as a cross-sectoral

mechanism to facilitate overall planning and coordination of individual sector policies, such as fisheries, shipping, energy, tourism, and so forth — through which each sector can apply sector policies to implement EBM (see figure above).

Ecosystem-based management of terrestrial systems began in the 1950s. But its application in the marine and coastal environment is relatively new, developed in response to the declining state of coastal and marine ecosystems. Although the term “ecosystem-based management” has been defined in numerous ways, the core elements of it include:

- ▶ Recognizing connections among marine, coastal, and terrestrial systems, as well as between ecosystems and human societies.
- ▶ Using an ecosystem services perspective, where ecosystems are valued not only for the basic goods they generate (such as food or raw materials) but also for the important services they provide (such as clean water and protection from extreme weather).
- ▶ Addressing the cumulative impacts of various activities affecting an ecosystem.
- ▶ Managing for and balancing multiple and sometimes conflicting objectives that are related to different benefits and ecosystem services.
- ▶ Embracing change, learning from experience, and adapting policies throughout the management process.

Each of these core elements is examined in more detail in Section II of this introductory guide.

It is important to recognize **there are multiple paths to implementing EBM**. Ecosystembased management is being put into practice in different ways in different places, and across different scales. Often it combines and improves management practices that are already in place. The intent of this guide is to draw on a variety of experiences of marine and coastal EBM practitioners to describe how EBM is envisioned, how it is put into practice, and how its success can be measured around the world.

*“Ecosystem-based management builds on existing knowledge and management structures and develops these further. It is not about throwing out what we have and replacing it with something else.”*

ALF HÅKON HOEL, EDITOR OF BEST PRACTICES IN ECOSYSTEMS BASED OCEANS MANAGEMENT IN THE ARCTIC

In addition, **EBM is as much a process as an end point**. It does not require a single giant leap from traditional, sectoral management to fully integrated, comprehensive management. Instead, EBM can be achieved in a step-by- step, incremental, and adaptive process. This guide will show what such a process can look like.

Finally, **EBM does not require managing all aspects of a system at once**. Instead, an EBM initia-

tive founded on good knowledge and understanding of ecological and social systems can allow for thoughtful prioritization of the most important management actions and activities. It is better to manage the most critical elements effectively than to become paralyzed by trying to manage everything else at the same time.

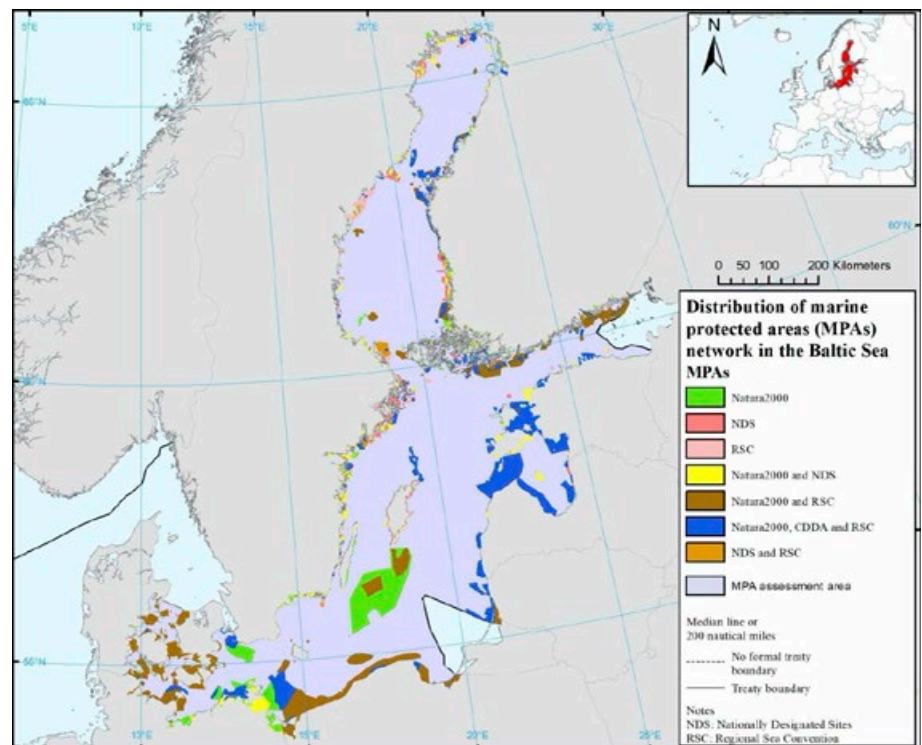
EBM is aimed at conserving and sustaining ecosystem services to benefit current and future human generations.” -Michael Sissenwine, former Chief Science Advisor, National Marine Fisheries Service, USA Marine and coastal ecosystems are the focus of EBM. They cover land, sea, and air, and include a variety of interconnected habitats and species. Humans are fully part of ecosystems, too. As such, urban and transformed landscapes must also be considered in ecosystem-based management.



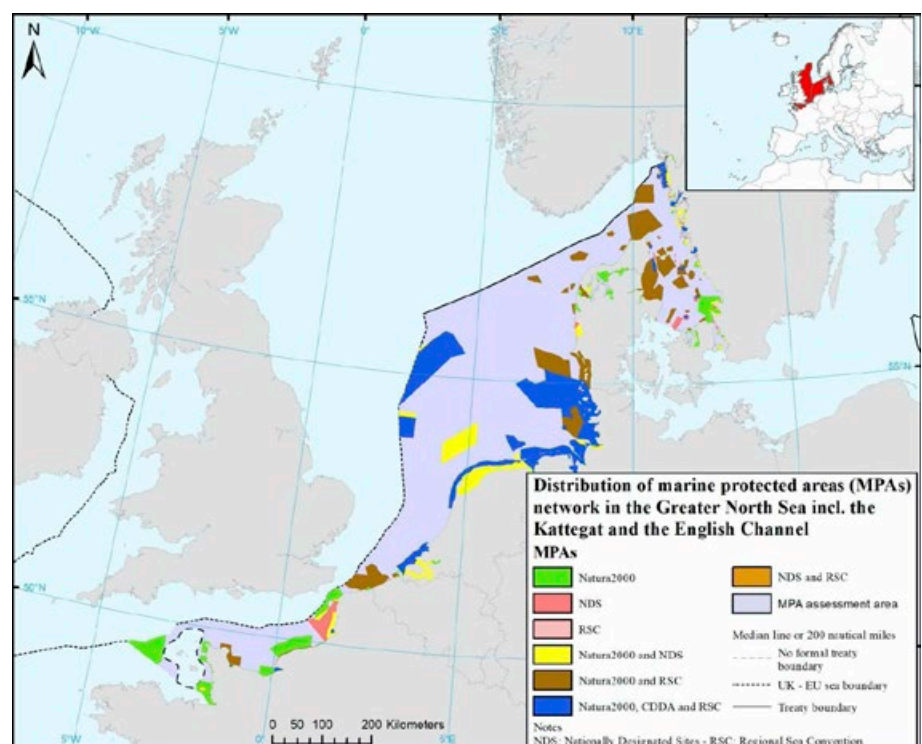
## 5. Maps of Marine Protected Areas

Map showing the marine protected areas (MPA) in EU waters in the Greater North Sea and Baltic Sea regions. In contrast to the regional sea conventions OSPAR and HELCOM EU include Kattegat in the Greater North Sea Area.

**DISTRIBUTION OF** Marine Protected Area (MPA) networks in the Baltic Sea marine region



**DISTRIBUTION OF** Marine Protected Area (MPA) networks in the Greater North Sea including the Kattegat and English Channel marine sub-region.



## 6. EU Modern MPA network design principles

From European Environmental protection Agency 2015<sup>60</sup>:

### Modern MPA network design principles

**Representativity:** To be representative, an MPA network must protect the range of marine biodiversity found in the seas. This includes protecting those features of conservation importance known to be rare, threatened or declining.

**Adequacy:** Refers to both the overall size of an MPA network and the proportion of each feature protected within the MPA network.

**Viability:** For an individual MPA to be viable, it must be able to maintain the integrity of its features (population of species, or condition and extent of the habitat) and to be self-sustaining throughout natural cycles of variation. Viability is determined by the size and shape of individual MPAs in conjunction with their effective management. Viability of the network as a whole should also be considered, as MPAs contribute differently to networks.

**Connectivity:** Connectivity is the extent to which populations in different parts of a species range are linked by the movement of eggs, larvae or other propagules, juveniles or adults (Palumbi, 2003) but slight differentiation could also be due to sampling error. Examination of genetic isolation by distance, in which close populations are more similar than distant ones, has the potential to increase confidence in the significance of slight genetic differentiation. Simulations of one-dimensional stepping stone populations with particular larval dispersal regimes shows that isolation by distance is most obvious when comparing populations separated by 2-5 times the mean larval dispersal distance. Available data on fish and invertebrates can be calibrated with this simulation approach and suggest mean dispersal distances of 25-150 km. Design of marine reserve

systems requires an understanding of larval transport in and out of reserves, whether reserves will be self-seeding, whether they will accumulate recruits from surrounding exploited areas, and whether reserve networks can exchange recruits. Direct measurements of mean larval dispersal are needed to understand connectivity in a reserve system, but such measurements are extremely difficult. Genetic patterns of isolation by distance have the potential to add to direct measurement of larval dispersal distance and can help set the appropriate geographic scales on which marine reserve systems will function well. The MSFD does not define 'network', but dictionary definitions consider 'interconnectedness' to be a key characteristic of the term.

**Replication:** Replication is protection of the same feature across multiple sites within the MPA network, taking biogeographic variation into account. All features should be replicated, and replicates should be spatially separated.

**Protection level:** No current European overview exists of the broad range of protection levels: their scope includes reserves and multiple use areas.

**Best available science:** A vital element of assessing an ecologically coherent MPA network is ensuring that the best available science is used. Uncertainties and knowledge gaps should be recognised and taken into account throughout the process. However, decisions will need to be taken based on this science, and lack of full scientific certainty should not justify postponing proportionate decisions on site selection (Defra, 2010).

NOTE: MODIFIED FROM DEFRA, 2010.

<sup>60</sup> *Marine protected areas in Europe's seas – An overview and perspectives for the future* (eea.europa.eu)



