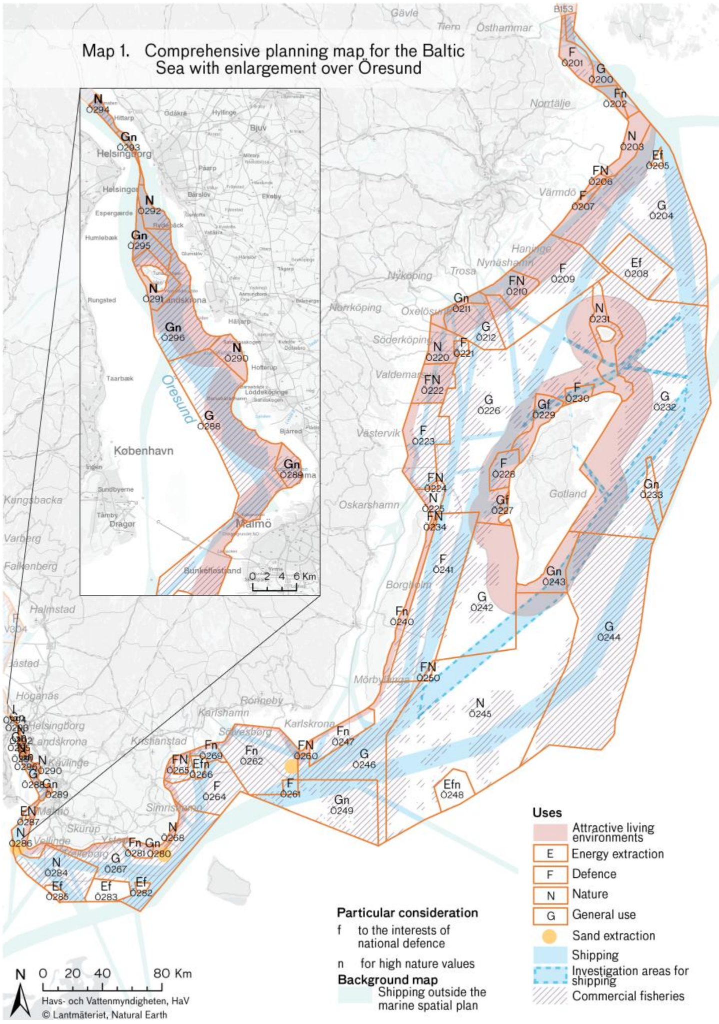
MARINE SPATIAL PLAN PROPOSAL

EARLY STAGE — **CONSULTATION** — REVIEW — FINAL PROPOSAL — GOVERNMENT DECISION

Swedish Agency for Marine and Water Management

Strategic Environmental Assessment of the Marine Spatial Plan proposal for the Baltic Sea



Swedish Agency for Marine and Water Management 2018

Swedish Agency for Marine and Water Management

Date: 10/04/2018

Publisher: Björn Sjöberg

Contact person environmental assessment and SEA: Jan Schmidtbauer Crona

Swedish Agency for Marine and Water Management

Box 11 930, SE-404 39 Gothenburg, Sweden

www.havochvatten.se

Photos, illustrations, etc.: Source Swedish Agency for Marine and Water Management unless otherwise stated.

This strategic environmental assessment (SEA) was prepared by the consulting firm COWI AB on behalf of the Swedish Agency for Marine and Water Management (SwAM).

Consultant:
Mats Ivarsson, Assignment Manager, COWI
Kristina Bernstén, Assignment Manager, SEA
Selma Pacariz, Administrator, Environment
Ulrika Roupé, Administrator, Environment
Emelie von Bahr, Administrator, Environment
Marian Ramos Garcia, Administrator, GIS
Morten Hjorth and others

Strategic Environmental Assessment

Marine Spatial Plan – Baltic Sea

Preface

In the Marine Spatial Planning Ordinance, the Swedish Agency for Marine and Water Management (SwAM) is given the responsibility for preparing proposals on three marine spatial plans (MSPs) with associated strategic environmental assessments (SEA) in broad collaboration. The MSPs shall provide guidance to public authorities and municipalities in the planning and review of claims for the use of the marine spatial planning area. The plans shall contribute to sustainable development and shall be consistent with the objective of a good environmental status in the sea.

In the work on marine spatial planning, SwAM prepared a current status report (SwAM report 2015:2) and a roadmap (SwAM 2016-21), which included the scope of the SEA. On 15 February 2018, the Agency published three MSP drafts for the Gulf of Bothnia, the Baltic Sea, and Skagerrak and Kattegat. The associated SEAs and sustainability assessments were published on 10 April 2018.

The SEA for the MSP draft for the Baltic Sea in the dialogue phase was prepared by the consulting firm WSP Sverige AB. Comments submitted during the dialogue phase were worked into the MSP proposals prior to the consultation phase between 15 February and 15 August 2018. A revised SEA for the three revised MSPs was prepared by the consulting firm COWI AB. Together with new documentation from the environmental assessment tool Symphony, analysed by the consultants Medins Havs- och Vattenkonsulter, comments submitted during the dialogue phase were worked into the SEA. Symphony contributes to a more detailed spatial analysis of the nature values, their sensitivity, and the impact from the plan proposals. The revision was done in collaboration with SwAM, where COWI AB provided the assessment of environmental effects and consequences along with comparisons with environmental objectives.

The results from the SEA will be included in the continued planning work and will constitute input for revision of the plan proposal prior to the review phase in the spring of 2019.

Gothenburg, 10 April 2018

Björn Sjöberg, Director,
Department for Marine and Water Management

CONTENTS

1 SUMMARY 7

2 INTRODUCTION 16
2.1 Background: National marine spatial planning with associated environmental assessment 16
2.2 MSP's purpose and objective 17
2.3 The MSPs' relations to other plans and programmes 18
2.4 Strategic environmental assessment 20
2.5 Guiding objectives 20
2.6 Sustainability assessment 21

3 MARINE SPATIAL PLAN - BALTIC SEA 22
3.1 Summary of the Baltic Sea MSP 23
3.2 Northern Baltic Sea and Södra Kvarken 24
3.3 Central Baltic Sea 25
3.4 South-eastern Baltic Sea 26
3.5 Southern Baltic Sea 28
3.6 South-western Baltic Sea and Öresund 29

4 ENVIRONMENTAL ASSESSMENT METHOD 31
4.1 Purpose of the environmental assessment 31
4.2 Scope 31
4.3 Symphony 33
4.4 Environmental assessment method 35

5 BASIC CONDITIONS 39
5.1 General 39
5.2 Physical and chemical conditions 39
5.3 Biological conditions 43
5.4 Protected areas 53

6 CURRENT SITUATION 64
6.1 Sectors and themes 64
6.2 Cumulative effects - present situation 73

7 ZERO ALTERNATIVE 88
7.1 Sectors and themes 88
7.2 Outlook towards 2050 94
7.3 Cumulative effects - zero alternative 97

8 PLAN ALTERNATIVE 113
8.1 Sectors and themes 113
8.2 Outlook towards 2050 118
8.3 Cumulative effects - plan alternative 118

9 COLLECTIVE ASSESSMENT 140
9.1 Environmental impact 140
9.2 Evaluation of the plan – sustainability and goal attainment 149

10 MONITORING AND AUDIT 162
10.1 Continued planning process and environmental assessment 162
10.2 Evaluation and follow-up 162

11 REFERENCES 163

12 APPENDICES 168
12.1 Glossary 168

1 Summary

Background, objectives and purpose
The Swedish Agency for Marine and Water Management (SwAM) was assigned by the Swedish Government to prepare marine spatial plans (MSPs) for the Gulf of Bothnia, the Baltic Sea, and Skagerrak and Kattegat.

For each MSP, an environmental assessment and associated environmental impact assessment, the strategic environmental assessment (SEA), are also being done. This report is the SEA for the Baltic Sea marine spatial planning area. It constitutes a consultation document together with the proposals on the MSP that were prepared by SwAM for consultation in the spring and summer of 2018. In this SEA, the MSP's five marine sub-regions have been analysed – the Northern Baltic Sea and Södra Kvarken, the Central Baltic Sea, the South-eastern Baltic Sea, the Southern Baltic Sea, and the South-western Baltic Sea and Öresund.

The objective of the SEA is to integrate environmental aspects in the planning and decision-making so that sustainable development is promoted (Chapter 6 Section 1 of the Environmental Code). With the help of the planning method Symphony, the cumulative environmental impact within the marine spatial planning area has been estimated and analysed with the aim of assessing the result of the MSP in relation to the zero alternative for 2030. Symphony is presented in the SwAM report 2018:1.

In parallel with the SEA, a sustainability assessment was also done. The sustainability assessment is based on the three sustainability dimensions: *Economy*, *Ecology*, and *Social aspects*. Through the sustainability assessment, an expanded perspective is added to the SEA by also covering the plan's socio-economic and social impact. The sustainability assessment is presented in a separate report.

Most sectors' operations and development entail an impact on the environment and biological diversity. The results from Symphony indicate that the majority of the environmental impact can be traced to land-based or historical emissions. However, the present MSP proposal entails no or very small changes in the spread of most sectors. The MSP entails a change from the current situation only for energy extraction and sand extraction and, to some extent, commercial fisheries. It is therefore primarily these sectors' environmental impact that gives rise to environmental consequences that can be traced to the MSP even if they contribute relatively small environmental effects according to the analyses in Symphony. Below is a summary of the SEA's collective assessment, Chapter 9.

Environmental impact
The analysis identifies and describes the direct and indirect effects that the MSP might entail for people and the environment, both to the management of

water and the physical environment in general and to other management of materials, raw materials, and energy.

Table 1 Summary of the environmental impacts of the MSP on environmental aspects as per the Environmental Code, compared with the zero alternative. Scale: positive, none, small negative, moderate negative, and large negative impact.

ENVIRONMENTAL ASPECTS ENVIRONMENTAL CODE / MSP'S THEME	POPULATION AND PEOPLE'S HEALTH	ANIMAL OR PLANT SPECIES AND BIODIVERSITY OTHERWISE	LAND, SOIL, AND WATER	AIR AND CLIMATE	LANDSCAPE, BUILT ENVIRONMENT, AND CULTURAL ENVIRONMENT	MANAGEMENT OF LAND, WATER, AND THE PHYSICAL ENVIRONMENT, AS WELL AS MATERIALS, RAW MATERIALS, AND ENERGY
ATTRACTIVE LIVING ENVIRONMENTS	Positive	None	None	None	None	None
ENERGY	None	Small negative	Small negative	Positive	Small negative	Positive
DEFENCE	None	None	None	None	None	Positive
STORAGE AND EXTRACTION OF MATERIALS	None	Small negative	Small negative	None	Small negative	Positive
NATURE	Positive	Positive	Positive	None	None	Positive
TRANSPORTATION AND COMMUNICATIONS	None	None	None	None	None	None
AQUACULTURE AND BLUE BIOTECHNOLOGY	-	-	-	-	-	-
COMMERCIAL FISHERIES	None	Positive	None	None	None	Positive

Population and people's health

One of several conditions for retained and increased outdoor recreation is that important nature values are preserved, which the MSP's guidance of areas with *particular consideration to high nature values (n)* is intended to do. Establishment of wind power according to planned use in the Baltic Sea's marine spatial planning area might entail negative effects on multiple ecosystem services that are of significance to the sector Attractive living environments. However, in the operating phase, the environmental pressure is assessed to decrease because the effect from *physical loss* of seabed is assumed to decrease when foundations, etc., are colonised by bottom-dwelling animals and plants and when the underwater noise is limited to the actual operation. Fishing can be impacted in the areas with *particular consideration to high nature values (n)*. A positive effect with limitations of fishing in the areas is an increased recruitment or survival of certain species that can thereby have a positive economic effect for the sector through increased catch possibilities. The MSP is deemed to provide a positive impact on the environmental aspect *Population and people's health*.

Animals, plants, and biological diversity

The MSP is deemed to provide a local negative effect in some of the areas where sand extraction and energy extraction are given priority, and thus a small negative consequence can be expected for the environmental aspect *Animal, plants, and biological diversity*. At the same time, use of the areas where *particular consideration to high nature values (n)* is to be taken is deemed to provide a positive effect through regulation of Commercial fisheries as well as shipping. In a collective assessment of the whole, the MSP is deemed to not entail any substantial consequence on the environmental aspect *Animals, plants, and biological diversity*, but extensive consideration needs to be taken to nature values in the area in the planning, permit review, establishment, and operation of various activities.

With planned area protection, 17.3% of the Baltic Sea is expected to be covered by area protection by 2020. The marine area protection in the Baltic Sea is currently 16%. In the Baltic Sea, the areas that can be possible climate refuges were identified for several species, which is a part of the particular consideration taken to the nature values. This does not entail a direct increase in the marine area protection, but it is expected to benefit biological diversity in several areas.

Sea-based wind power has an impact through *underwater noise* and *physical disturbance* during construction of the facilities, which is a short-term disturbance that is not handled in the Symphony planning method. *Underwater noise* in the operating phase is deemed to constitute a small share compared with shipping noise, but *underwater noise* is a pressure the cumulative effects of which must be taken into consideration. Use of the seabed entails some *physical disturbance* and *physical loss*, i.e. habitat loss as a result of such use. Energy extraction's use of seabed habitats for wind turbine foundations might create artificial reefs that can benefit biodiversity in general, at the same time that wind power limits access for fishing, shipping, and recreational activities within these areas. There are habitats within these areas (Ö248 and Ö266) with the use Energy that are very valuable for fish stocks, as well as other parts of the ecosystem, and the establishment of wind power can thereby also have an effect outside these areas. In the MSP, an assessment is made that coexistence can be achieved through the energy extraction areas being provided with a designation for *particular consideration to high nature values (n)* and also *national defence (f),* which means that future energy facilities need to make special adaptations. The MSP entails a small local negative cumulative environmental effect in the Baltic Sea as a result of energy extraction.

The MSP indicates two new areas for sand extraction in the Baltic Sea's marine spatial planning area (in addition to Sandhammar bank with existing permits). It can also entail a negative environmental effect with water clouding and loss of valuable habitats unless sand extraction takes place with mild methods and within less sensitive parts of the areas, which have been proposed in earlier studies. Here, the MSP entails a small negative environmental effect for marine life (*physical loss* and *physical disturbance*) compared with the zero alternative (without sand extraction except for Sandhammar bank with existing permits), but the effect is deemed to be of relative local significance. The guiding suggestion of *particular consideration to high nature values (n)* within the same areas is deemed to limit the negative effects from sand extraction. With regard to all environmental impacts from the plan's indications regarding sand extraction, the SEA is based on no new sand extraction coming about without the MSP.

Commercial fisheries will be limited within the MSP's areas for energy extraction, and this entails locally reduced pressures from the fishing; however, such fishing can be assumed to be moved to nearby areas. Through the plan's indications of *particular consideration to high nature values (n)*, the plan's guidance is expected to result in further regulation of Commercial fisheries, for example, through equipment limitations or protective measures such as pingers to avoid by-catch of porpoises. In the MSP, there are three areas of investigation for shipping lanes, which go through areas with very high nature values and with the red-listed species porpoise and long-tailed duck. From a nature conservation perspective, adjusted routes would be important, and how this can be resolved in terms of planning must be investigated further.

Alternative for Storage and extraction of materials
The difference in the cumulative environmental effect between the zero and plan alternatives is comprised of the assumption of no sand extraction by 2030 and that the MSP could accelerate sand extraction before 2030 through guiding proposals in the plan, i.e. Sandhammar bank, Sandflyttan, and Klippbanken. Even if the future for sand extraction is uncertain, it is advantageous to have identified suitable locations once extraction of marine sand begins. Sand extraction at Sandflyttan stands for 0.2% of the cumulative environmental effect within the marine area of South-western Baltic Sea and Öresund and around 65% locally in the sand extraction area. Within the marine area, there are several other sectors that contribute to the environmental effect. Sand extraction at Klippbanken stands for 0.33% of the cumulative environmental effect within the marine area Southern Baltic Sea and around 46% locally in the sand extraction area. Sand extraction has a local effect through *increased turbidity*, *physical disturbance*, *habitat loss*, and *physical loss* within the sand extraction area consisting of high nature values that include seals, spawning fish, and in Sandflyttan also sea birds. Extraction of sand in Klippbanken only takes place below the photic zone on transport bottoms, while in Sandflyttan

the sand extraction area is only partly below the photic zone. In summary, Sandflyttan is assessed as a less suitable alternative. The alternative MSP without sand extraction in Sandflyttan will thereby entail a lower environmental effect within the marine area South-western Baltic Sea and Öresund.

Land, soil, water, air, climate, landscape, built environment, and cultural environment

For the environmental aspects *Land, soil, water, air, climate, landscape, built environment, and cultural environment*, the MSP is deemed to mainly entail local negative environmental effects in the areas in which a new establishment is introduced, such as sand extraction or wind power facilities. The negative effects that sea-based wind power entail are deemed to not exceed the positive effect on *climate* and the environmental improvement measures that are expected to come about as a result of *particular consideration to high nature values (n)* being taken. The MSP entails a small negative consequence to the part of the environmental aspect that affects *landscape, built environment, and cultural environment*. Altogether, the MSP is deemed to entail a small negative consequence to the components *Land, water, and cultural environment* of this environmental aspect, a positive consequence on *climate,* and no negative consequence for the other parts of the environmental aspect *Land, soil, water, air, climate, landscape, built environment, and cultural environment*.

Until 2030, shipping is predicted to increase by 50% in the Baltic Sea, and existing areas for shipping lanes are deemed to be adequate for handling this expected increase. By 2030, the impact of defence activities is expected to increase proportionally with the development of the sector. The interests of the Defence are expected to have good possibilities for coexistence with Commercial fisheries, outdoor recreation, and shipping. In the MSP, reference is made to which areas in the Baltic Sea that particular consideration to national defence interests shall be taken in wind power establishment. This might entail limitations in the scope of the wind power expansion. Altogether, the MSP is not deemed to entail any change for emissions to air and sea from the sectors shipping and defence compared with the zero alternative. Emission estimates for the adjustments to shipping routes that are under investigation indicate that potential adjustments will not lead to any significant emission increases. The plan entails a potential emission reduction of carbon dioxide in an establishment of renewable energy extraction and is thereby deemed to have a positive effect (COWI, 2018b).

Cultural heritage remains, such as shipwrecks, may be affected in the establishment of permanent constructions for wind power, which must be taken into account in a permit process, and the construction must be adapted to minimise the impact on possible permanent remains.

Management of land, water, and the physical environment otherwise and *Other management of materials, raw materials, and energy*.

Altogether, the MSP is deemed to entail a positive consequence for the environmental aspects *Management of land, water, and the physical environmental otherwise* and *Other management of materials, raw materials, and energy* because the plan works for the coexistence between various uses and because sand extraction replaces extraction of natural gravel on land and because energy extraction contributes energy from a renewable source.

Both sand extraction and energy extraction are preceded by an environmental permit process in which local impacts and effects are analysed and assessed with the aim of minimising the environmental impact. In the MSP, some sectors are deemed to be able to coexist, and areas with *particular consideration to high nature values (n)* have been pointed out in co-existence with one or more uses. Adaptations will need to be made to minimise the impact and effects in these areas worth protecting in order to achieve the aim of appointing these areas as such.

The MSP provides guidance regarding suitable uses in a number of areas where *particular consideration to high nature values (n)* is to be taken. In most cases, these areas are important spawning grounds and recruiting areas for fish, which means that the MSP through these areas can have a positive effect on the fish stocks as a resource. This might also entail a geographically large effect. It is therefore important in the establishment of other activities that this is taken into consideration and that possible regulation of Commercial fisheries is discussed.

Goal attainment and sustainability

Plan proposal and the Swedish environmental objectives
The total assessment when it comes to the plan's effects in relation to *A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos* is difficult to judge. The results indicate that the plan might potentially entail a positive effect as a result of guidance on *particular consideration to high nature values* and reduced pressure from Commercial fisheries in the energy areas. At the same time, the plan's guidance on energy extraction entails a potential increase in the environmental pressure and visual impact, both with potentially negative effects for cultural ecosystem services. An overall assessment is that the plan proposal does not have any net effect on the possibility of achieving the objective.

Good environmental status according to the Marine Strategy Framework Directive
The overall effect when it comes to the plan's impact on the possibility of achieving the Environmental Quality Standard of *Good environmental status* in the Baltic Sea management area is difficult to assess because the plan proposal entails both negative and positive effects. Further analyses are required to determine with certainty the total effect of the plan proposal in terms of the possibility of achieving environmental quality standards within the Marine Strategy Framework Directive.

The sustainability assessment of the proposed MSP in the Baltic Sea indicates a generally positive result compared with the zero alternative (without an MSP) (COWI, 2018b):

Economic sustainability
Altogether, the analysis indicates a positive result for the economic sustainability dimension. This is primarily due to expected positive economic effects within energy extraction from wind power, sand extraction in the marine areas of the South-western Baltic Sea and Öresund and the Southern Baltic Sea and strengthened ecosystem services in the Baltic Sea planning area as a result of increased consideration of nature through guidance on *particular consideration to high nature values (n)*.

Ecological sustainability
The analysis of the Baltic Sea plan proposal also indicates a positive result within the sustainability dimension of Ecology. This is mainly due to reduced climate emissions as a result of the expansion of wind power according to the plan proposal's guidance on energy extraction. The plan proposal is deemed to entail positive environmental effects through guidance on *particular consideration to high nature values (n)* in areas with *general use*, *defence*, and *energy extraction*. The plan is also deemed to entail negative environmental effects, mainly as a result of disturbances in the construction phase in wind power establishment in the Baltic Sea planning area and as a result of guidance regarding sand extraction.

Social sustainability
A positive result is also obtained in social sustainability. Positive effects of the plan proposal are linked to *increased employment* from a potential expansion of sea-based wind power, increased possibilities of *identity-creating activities* such as *Commercial fisheries* and *recreation activities* through increased environmental consideration, and *decreased pressure on cultural environments* as bottom trawling is limited in some areas. However, an expansion of wind power according to the guidance in the plan proposal is considered to entail a deterioration in terms of *coexistence* between different sectors and interests in the Baltic Sea plan area.

Cross-border environmental impact
The cross-border impact that is considered to be caused by the MSP mainly takes place in areas close to the border with Denmark in the south-west, towards Poland in the south, and in the east towards Latvia, Lithuania, and Russia and consists of negative impacts from sand extraction, wind power, and shipping and positive environmental impacts from areas with *particular consideration to high nature values (n)*. Cross-border environmental effects from sand extraction are assessed to only arise at Sandflyttan on the border with Denmark. The analysis carried out with the help of Symphony shows that the areas where the MSP points out shipping and Commercial fisheries in the same areas generally indicate a burden on the environment, which might need

to be managed through cross-border cooperation because these sectors are mobile and their environmental impact is cross border. Mobility also provides opportunities for improvements, where in especially impacted areas limits can be set on fishing and shipping through cross-border cooperation, such as in the South-western Baltic Sea together with Denmark and Germany, or in the Southern and South-eastern Baltic Sea with Denmark and Poland. Another activity in the Baltic Sea that causes cross-border environmental impact is the establishment of wind farms, which provide a local negative effect in the MSP, mainly when *particular consideration to national defence interests (f)* and the area's high nature values needs to be taken. An example is an area in the South-eastern Baltic Sea bordering on Poland.

Conclusions and future outlook

The various marine areas in the Baltic Sea MSP demonstrate different results in the comparison between the plan alternative and the zero alternative. Within smaller areas, both increases and decreases arise in the cumulative environmental effect and the MSP thereby generally entails a redistribution of the environmental impact.

The expansion of sea-based wind power and added areas for sand extraction are the most significant differences in relation to the zero alternative. Within the entire Baltic Sea, major environmental effects are also seen from Transportation and communication (shipping), which can also be seen in the zero alternative in comparison with the present situation.

In general, it can be emphasised here that the areas with the indication of *particular consideration to high nature values (n)* provide a positive effect based on related assumptions, both environmentally and from a sustainability perspective.

Possibilities of an expanded use of the indication *particular consideration to high nature values (n)* combined with General use and Energy could potentially strengthen access to the ecosystem services that Commercial fisheries and a significant part of Tourism and recreation are dependent on.

The good effect of the consideration recommendations for these areas is weighed up to some extent by the impact from wind power establishment and sand extraction in an analysis of the cumulative environmental effect with the help of the Symphony planning method. One recommendation is, however, that more areas be identified where some form of special environmental consideration should be taken and to find possible instances of coexistence with various sectors within these areas.

Proposed areas in Hanöbukten for climate refuges for certain species are a step towards more protection for animals and plant species exposed to impacts from climate change, and these areas might be of great value for future nature conservation.

Another recommendation is to also identify areas worthy of protection with high and important environmental values with clear decisions that nature values in these areas receive marine protection, which provides a stronger protection than the aforementioned areas with environmental consideration.

SwAM can propose regulations for areas if they are considered necessary to achieve the objective of the MSP. These can contain binding limits and could be a stronger alternative to areas with *particular consideration to high nature values (n)*.

Because shipping has a tangible environmental impact in the ecologically valuable marine area of the South-western Baltic Sea and Öresund, the possibility of rerouting or concentrating shipping routes should be investigated. Because the plan cannot affect shipping’s pressures more than pointing out shipping lanes in the area, the plan within the marine area of the South-western Baltic Sea and Öresund should also be investigated further. Promoting a further pressure (sand extraction) in this area in the planning needs to be further investigated and assessed. The actual impact and geographic spread as a result of extraction activities also needs to be analysed further in Symphony.

A possible future adjustment of shipping movements needs to be rooted and negotiated internationally, which sets high standards on documentation. At the same time, it is possible to find ways to effectively allow and stimulate the development of shipping, energy extraction, and sustainable resource management.

2 Introduction

2.1 Background: National marine spatial planning with associated environmental assessment

On 1 September 2014, a new regulation was introduced in the Environmental Code (Chapter 4 Section 10) regarding national marine spatial planning in Sweden. According to this regulation, there shall be an MSP for each of the marine spatial planning areas of the Gulf of Bothnia, the Baltic Sea and Skagerrak and Kattegat that provides guidance to authorities and municipalities in the planning and review of claims. The Marine Spatial Planning Ordinance (2015:400) regulates the implementation of the marine spatial planning. It contains provisions on geographic boundaries, the content of the marine spatial plans, the responsibility for preparation, consultation and cooperation in the proposal process, and monitoring and review.

According to the Ordinance, SwAM shall develop proposals for MSPs with the help of relevant county administrative boards and with support from national authorities, which will assist with supporting data for the planning. The municipalities, regional planning bodies, regional coordination bodies and county councils that might be affected must be given the opportunity to participate in the proposal process so that consideration can be given to local and regional conditions and needs. The Agency shall promote cooperation with other countries and the coordination of the Swedish marine spatial plans with those of other countries. Each MSP shall be environmentally assessed, and a strategic environmental assessment (SEA) shall be prepared.

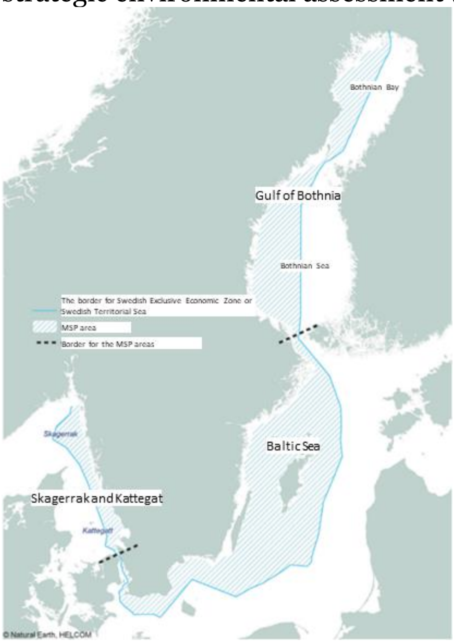


Figure 1. The three marine spatial planning areas. The municipal boundary between Östhammar and Norrtjälje forms the boundary between the Gulf of Bothnia's and the Baltic Sea's marine spatial planning areas. The municipal boundary between Helsingborg and Höganäs represents the boundary between the Baltic Sea and the Skagerrak/Kattegat marine spatial planning areas.

The MSPs cover Sweden's exclusive economic zone and Swedish territorial sea from one nautical mile (1,852 metres) outside the Swedish baseline. Privately owned water is excluded. The MSPs accordingly do not comprise the coastal area, which is within one nautical mile from the baseline.

The municipalities have planning responsibilities for the part of the sea that is within the municipal boundaries, meaning internal waters and the territorial sea. The municipalities' and the state's planning responsibilities thereby overlap in most of the territorial sea since 2015 in connection with the Marine Spatial Planning Ordinance. The overlap means that municipal and national planning meet within a geographic zone in the territorial sea. Within this zone, differences in planning interests might exist and entail a challenge regarding collaboration and dialogue in future planning. Through good collaboration between the state and municipality, possible future conflicting objectives between the planning levels can be minimised.

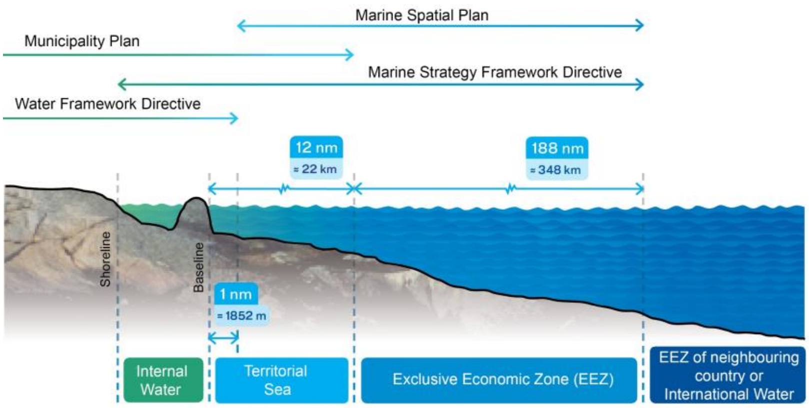


Figure 2. Illustration of the MSP's physical scope. This figure also indicates planning responsibility and environmental legislation for the sea.

2.2 MSP's purpose and objective

Planning of the sea comprises the areas in the water, on and above the surface, and on and in the seabed. The purpose of the MSPs is to integrate economic policy objectives, social objectives, and environmental objectives. The MSP shall contribute to:

- achieving and maintaining good environmental status
- the resources of the sea being used sustainably so that maritime industries can develop
- promoting coexistence between various activities and areas of use

A marine spatial plan should also provide the guidance necessary to be able to use the marine areas for the purposes that they are best suited to considering their character, situation, and needs[1]. The MSPs shall provide guidance to public authorities and municipalities in the planning and review of claims for the use of the area. This includes a presentation of which areas are of national interest according to Chapter 3 of the Environmental Code and other public interests of material significance. When necessary, the plan shall provide proposals on considerations between interests with claims in the same geographic area through standpoints. A point of departure for the marine spatial planning is consideration of the conditions of the ecosystems in order to secure the values that form the basis of industries such as tourism and Commercial fisheries. SwAM therefore applies an ecosystem approach in marine spatial planning. Marine spatial planning is a process that is carried out over several years and can be described as cycles where one goes from information gathering and present situation analysis where the MSPs are the results of the planning processes. The plans are subsequently implemented and continuously monitored.

2.3 The MSPs' relations to other plans and programmes

The MSPs are not legally binding, but serve as guides. The planning should interact with both the international planning perspective, as well as the regional and municipal perspectives, which is why the MSPs must relate to both a large geographic area and a small one. The reasoning and analysis behind the plans' standpoints will therefore be larger, both internally and externally, than the actual marine spatial planning areas. The planning of the Skagerrak and Kattegat, Baltic Sea and Gulf of Bothnia also needs to be coordinated with each other (SwAM, 2015b).

The planning of the marine areas must relate to the Law of the Sea, other international law, and EU law, and this provides both opportunities and limitations in planning. An MSP cannot restrict an activity or an interest beyond what is made possible by the Law of the Sea, for example (SwAM, 2018b).

2.3.1 International plans

From the international perspective, common solutions must be sought with neighbouring countries, and efforts should be made to establish coordinated forms of presentation of the MSPs. An effort must also be made for all neighbouring countries to have a common view of the current situation and to share a future vision as the starting point for the planning. On the offshore banks of Södra Midsjöbanken and Kriegers flak, coordination with Poland and with Germany and Denmark, respectively, is strived for.

In July 2014, the EU adopted the Framework Directive on Maritime Spatial Planning. The official name is Directive 2014/89/EU of the European Parliament and the Council of 23 July 2014, establishing a framework for maritime spatial planning. Within the Baltic Marine Environment Protection

[1] Section 4 of the Marine Spatial Planning Ordinance (2015:400).

Commission (HELCOM), there is a joint roadmap in the Baltic Sea region with the goal of MSPs functioning together across borders and applying an ecosystem approach to 2020. The Marine Spatial Planning Directive indicates March 2021 as the time when national MSPs are to be adopted.

2.3.2 National plans

The MSPs cover Sweden's exclusive economic zone and Swedish territorial seas, but not the coastal area, which extends from the baseline out to one nautical mile.

The MSPs shall provide guidance to public authorities and municipalities in the planning and review of claims for the use of the marine spatial planning area. The MSP shall also serve as a complement to the existing national sector planning and shall contribute to a holistic perspective there.

2.3.3 Municipality plans

In accordance with the Planning and Building Act, the planning of the municipalities extends out over all the territorial waters, i.e. 12 nautical miles from the baseline. Through the introduction of the marine spatial planning in Sweden, there are 65 municipalities where the planning responsibility overlaps between the municipality and the state in the territorial sea. Some 20 additional municipalities border the sea, but not waters that are included in the national marine spatial plan areas. (SwAM, 2018b)

As long as the purpose of the marine spatial planning is fulfilled, the marine spatial planning needs to take into account the existing municipal comprehensive plans where they present planning issues and development intentions in the national marine spatial planning area. Data produced during the planning process that might facilitate municipal comprehensive planning should be made available to the municipalities. The three national MSPs shall support municipal planning of the coastal zone and territorial sea.

2.3.4 Interaction between land and sea

Developments in the sea are dependent on and governed by activities on land, and the marine spatial plans must therefore be placed in this context in the MSP proposal, the SEA, and the sustainability assessment. Population and industry on the coast, transportation systems and ports, etc., are important reference points for marine spatial planning. Urban and rural development is another important factor as well as regional development strategies linked to the land. Emission sources on land also impact the sea to a large degree, and this is an additional factor that the marine spatial planning needs to relate to. The Symphony method that was used in this report also provides analysis results that include land-based emission sources. The municipalities are responsible for the spatial coastal zone management and like the state have planning responsibility in the territorial sea. Good collaboration between the state, regions, and municipalities is necessary in order to coordinate local and regional conditions and perspectives with the national issues in the national planning.

2.4 Strategic environmental assessment

At present, the marine spatial planning is in the consultation phase as per Figure 2. Comments submitted during the dialogue phase (2017) have generated the MSP proposal for the Baltic Sea, the environmental impact of which is being assessed in this SEA. The objective of the SEA is to integrate environmental aspects in the planning and decision-making so that sustainable development is promoted[2]. With regard to the preparation of plans and programmes, the environmental assessment process is called an SEA. An SEA shall be carried out when implementation of a plan is assumed to entail a significant environmental impact, which is the assumption for the preparation of an MSP in accordance with the Marine Spatial Planning Ordinance[3]. The work on the strategic environmental assessment is compiled in an SEA-document, the contents of which are listed in Chapter 6 paragraph 11 of the Environmental Code. One of the main tasks for the environmental assessment of the MSPs is to indicate the marine spatial planning's possibilities of contributing to a good environmental status and to assess what significant impacts different uses of the sea might entail.

The proposal on the MSP for the Baltic Sea (plan map and plan description) will be out for consultation between 15 February and 15 August 2018. The associated SEA and sustainability assessment wereadded to the consultation as of 10 April 2018. The consultation will take place with concerned authorities, organisations, etc., at the national, regional, and municipal level. During this period, consultation will also be carried out with Sweden's neighbouring countries for the SEA, which is required in a cross-border context within the scope of the Espoo Convention.

2.5 Guiding objectives

SwAM has prepared a *Marine Spatial Planning Roadmap* with the aim of supporting and guiding the work of developing the MSPs and to create clarity and support for the continued planning process (SwAM, 2016b). The Roadmap establishes the planning objectives and planning strategies that shall serve as guides in the work of developing the MSPs. This also includes a scope for the environmental assessment and the focus in the SEA. Marine spatial planning can briefly be described as a process of analysing and organising activities in marine areas in order to achieve environmental, social, and economic policy objectives.

In the Road Map, ten planning objectives are presented, see Figure 3. The overall objective for marine spatial planning is Good marine environment and sustainable growth. The other nine planning objectives support this overall objective. Towards the end of this SEA, the plan will be evaluated with regard to the fulfilment of these environmental objectives.

[2]Act (2017:955).

[3] Marine Spatial Planning Ordinance (2015:400)

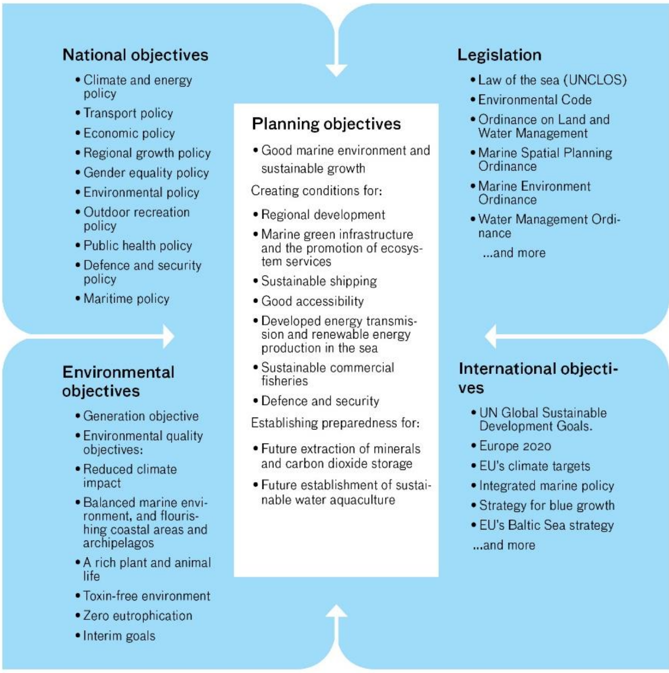


Figure 3 Identified planning objectives for the marine spatial planning, Marine Spatial Planning Roadmap, SwAM report 2016:21.

2.6 Sustainability assessment

In parallel with the SEA, a sustainability assessment is being done of the MSP for the Baltic Sea. The sustainability assessment is based on the three sustainability dimensions of Economy, Ecology, and Social aspects. Through the sustainability assessment, an expanded perspective on the ecological sustainability dimension is added to the SEA by also covering the plan's socio-economic and social impact.

- Economy – within the economic dimension, the MSP's socio-economic impact is investigated for the maritime sectors the conditions of which are affected by the planning.
- Ecology takes into account the plan's impact on nature and environmental aspects that cover both the marine environment and the relationship to climate change in general. Marine ecosystem services and their fundamental role for the ecosystem's function are important points of departure because these are prerequisites for several maritime industries.
- The Social aspect investigates the plan's consequences with regard to employment and gender equality, as well as public access in the marine spatial planning area. Within this aspect, possibilities for coexistence are also investigated between various interests and the areas' natural and cultural values.

The sustainability assessment is coordinated with the environmental assessment under Chapter 9 Collective assessment.

3 Marine Spatial Plan - Baltic Sea

The Marine Spatial Plan – Baltic Sea (SwAM, 2018b) contains guidance and a plan map that shows the most suitable use of the marine spatial planning area, such as conducting Commercial fisheries or shipping, extracting energy, or managing and protecting nature.

The MSP also indicates areas where *particular consideration to high nature values (n)* and to *national defence interests (f)* is to be shown, which are marked in the plan map by "n" and "f", respectively. *Particular consideration to high nature values (n)* can, for example, be areas that have valuable or sensitive nature values, or animal and plant species worthy of protection, but which today do not have statutory protection, and where particular consideration shall be shown by all use of the area. *Particular consideration to high nature values (n)* is not a use in the plan, but instead is a guide regarding consideration. *Particular consideration to national defence interests (f)* means that particular consideration shall be shown in all use of the area.

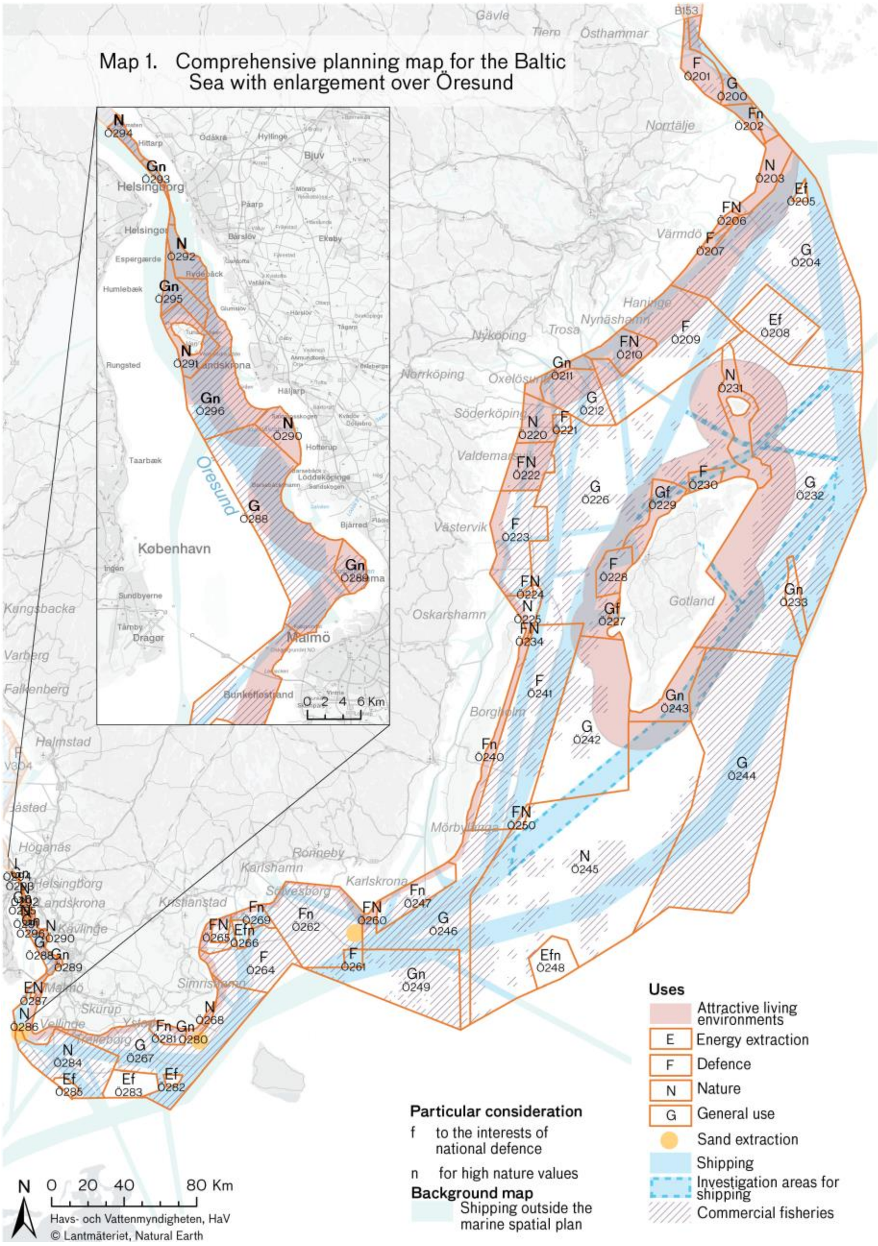


Figure 4 Planning map for the Baltic Sea (SwAM, 2018b)

3.1 Summary of the Baltic Sea MSP

There are high nature values in the marine spatial planning area, including important habitats for threatened species and attractive living environments for people. Commercial fisheries is extensive and is conducted on both a small and a large scale. The Baltic Sea is of major significance to international trade and is therefore one of the most intensively trafficked marine areas in the world. Sweden's national defence has extensive interests in the marine spatial planning area, including marine training areas among other things. In the marine spatial planning area, there are several areas that might have a potential for the extraction of sand, and there are good conditions for renewable energy extraction through sea-based wind farming.

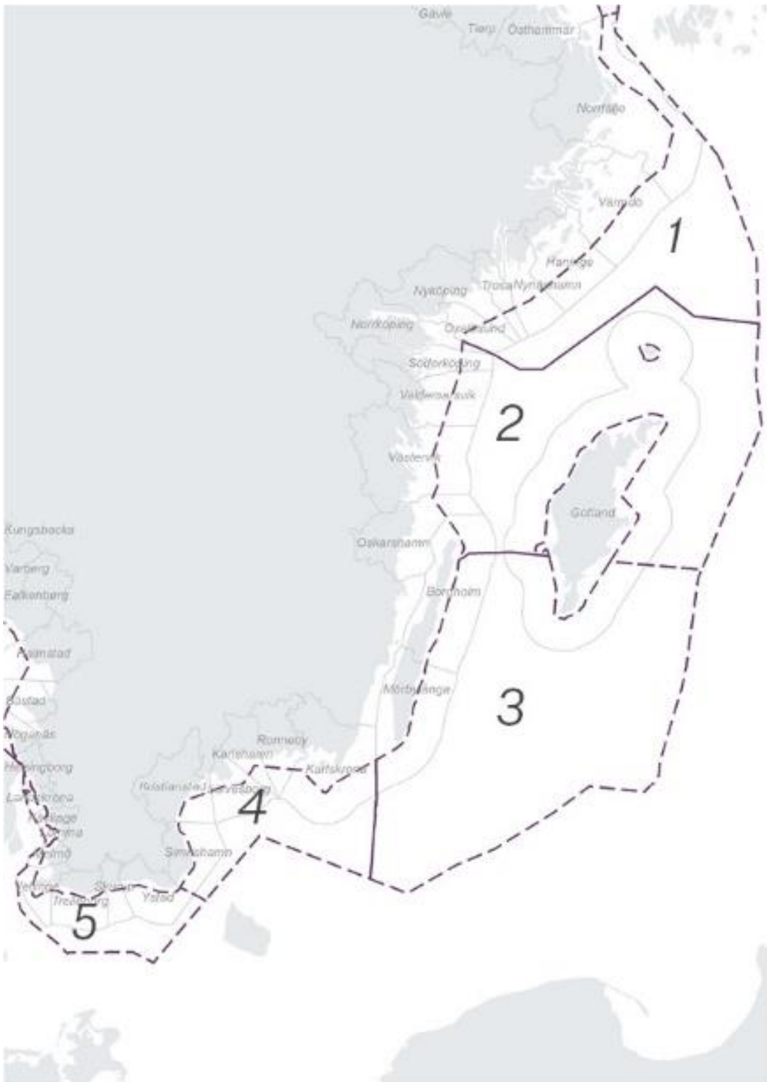


Figure 5 Comprehensive map over the five marine sub-regions in the Baltic Sea: 1. Northern Baltic and South Kvarken, 2. Central Baltic Sea, 3. South-eastern Baltic Sea, 4. Southern Baltic Sea and 5. South-western Baltic Sea and Öresund.

3.2 Northern Baltic Sea and Södra Kvarken

This marine sub-region constitutes an important shipping link to inland areas and the Gulf of Bothnia.

There are several national interest claims for defence in the Northern Baltic Sea and Södra Kvarken. In the Northern Baltic Sea, there are good conditions for energy extraction, and the need is great due to the electricity consumption in the Mälardalen region. There are both good wind conditions and suitable depths for sea-based wind power plants, but the national interest claims for wind power that exist in the marine area are not considered to be compatible with national defence interests, which is why the MSP points out additional areas for energy extraction outside of today’s national interest claims.

Significant areas with valuable coastal and archipelago landscapes extend along the entire coast, and there are many sunken wrecks in the marine area. Outdoor recreation and recreational boating are extensive in the Northern Baltic Sea and Södra Kvarken.

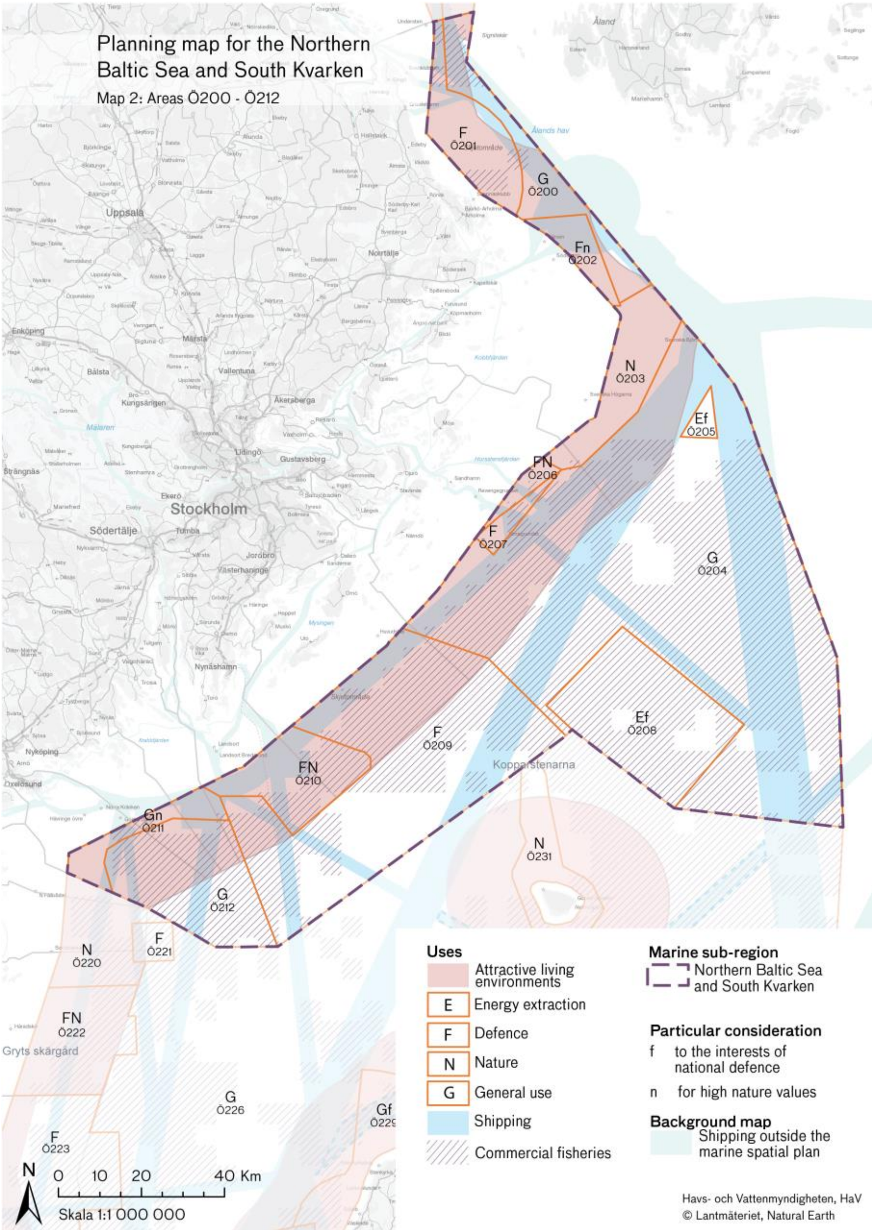


Figure 6 Planning map of the Northern Baltic Sea and Södra Kvarken marine sub-region. Area numbers are on the map, and areas with *particular consideration to high nature values* are marked with an "n". (SwAM, 2018b)

3.3 Central Baltic Sea

Several important ports are located along the coast in the Central Baltic Sea, and shipping traffic is important in towards the mainland coast, to Gotland, and further north or south. Significant areas with valuable coastal and archipelago landscapes extend along the coasts in the Central Baltic Sea. Outdoor recreation and recreational boating are extensive. There are several defence areas in the marine area, which in the MSP are indicated with the use Defence. Commercial fisheries is widespread in the Central Baltic Sea. The vast majority of fishing (sparse fishing with passive equipment) is pelagic and is conducted in the entire offshore area, while cod fishing mostly takes place towards the coast.

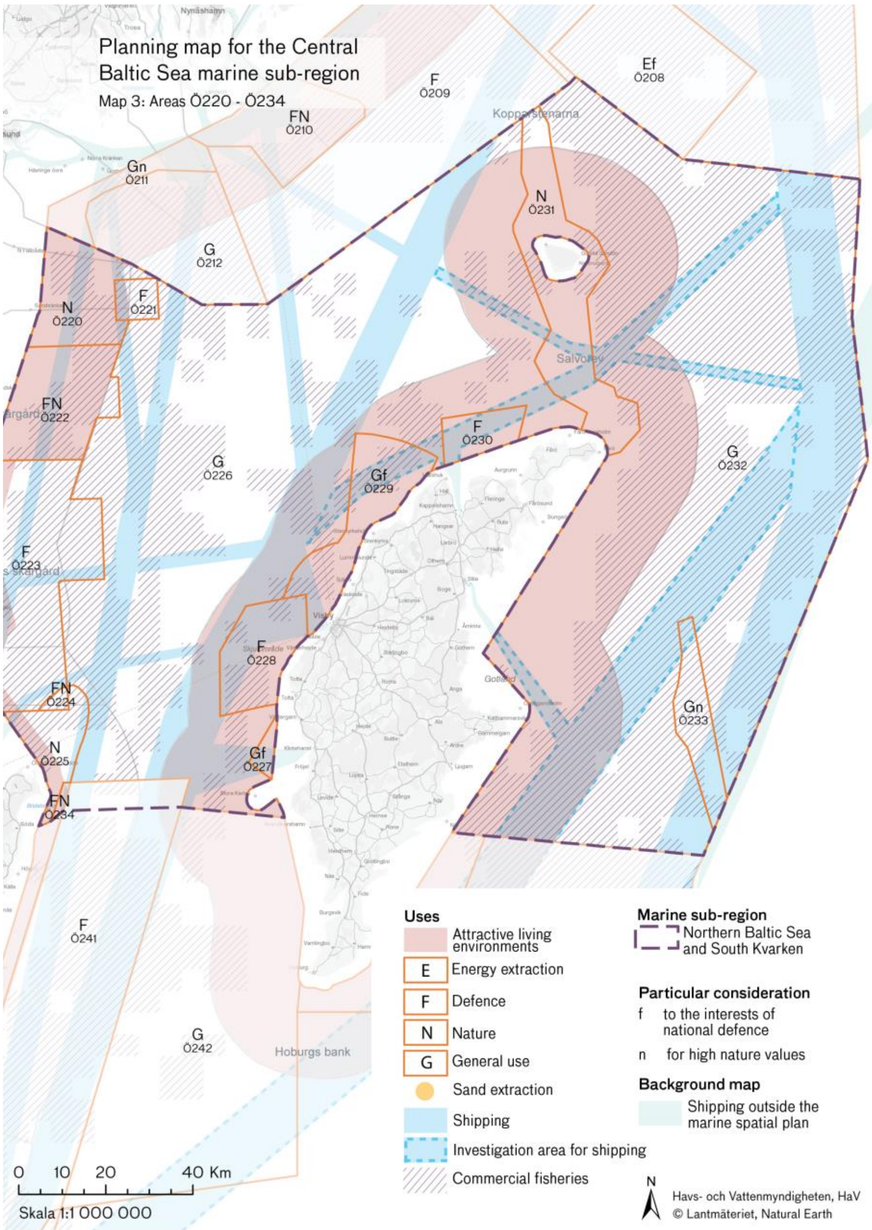


Figure 7 Planning map for the Central Baltic Sea marine sub-region. Area numbers are on the map, and areas with particular consideration to high nature values are marked with an "n". (SwAM, 2018b)

3.4 South-eastern Baltic Sea

In the South-eastern Baltic, maritime traffic is important with extensive traffic to both foreign and Swedish ports. A large amount of traffic moves towards the mainland coast and to Gotland and further northwards or southwards.

A very large area with valuable nature extends from Gotland's southern cape at Hoburg through Hoburgs bank to Norra and Södra Midsjöbanks. In large parts of this area, the environmental impact is low and the marine environment can be seen as relatively original. In the South-eastern Baltic Sea, there are good conditions for energy extraction and the need is extensive due to the energy consumption in southern Sweden. The offshore banks have both good wind conditions and suitable depths for sea-based wind power stations.

Commercial fisheries is widespread in the South-eastern Baltic Sea, but is rarely conducted on the offshore banks. Fishing for cod is mostly conducted in the south-western parts of the marine area with trawler fishing offshore and passive fishing closer to the coast. Pelagic fishing is conducted in the entire offshore area except on the banks.

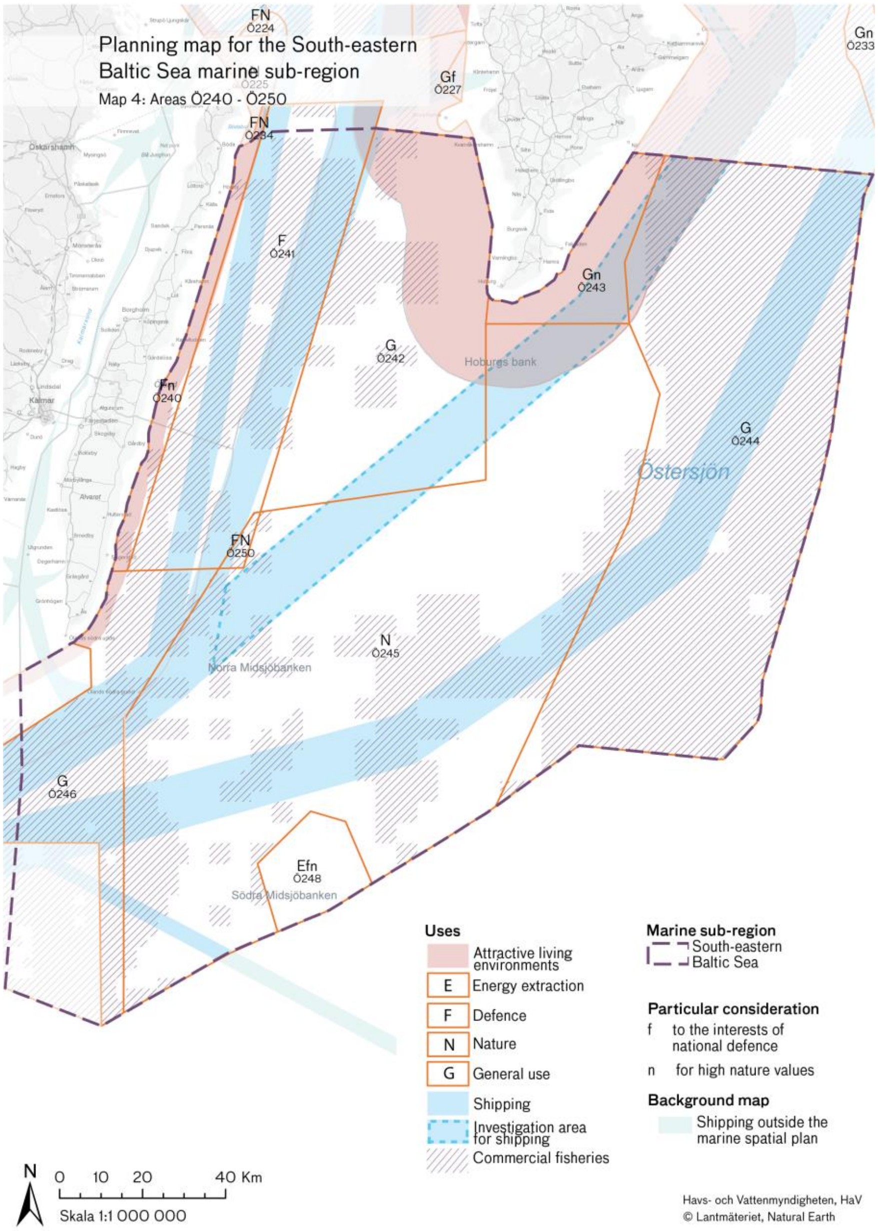


Figure 8 Planning map for the South-eastern Baltic Sea marine sub-region. Area numbers are on the map, and areas with particular consideration to high nature values are marked with an "n". (SwAM, 2018b)

3.5 Southern Baltic Sea

The most trafficked shipping lane in the Baltic Sea runs through the Southern Baltic Sea along Sweden's southern coast in traffic separation systems from Öresund or Gedser between Denmark and Germany, through Bornholmsgattet, and towards southern Öland.

The uses Defence and Commercial fisheries are presented as the most suitable uses in large parts of the marine area. In several cases, the areas are also indicated for *particular consideration to high nature values (n)*, but the operations also need to be able to coexist with shipping. Outdoor recreation and recreational boating are important in the Southern Baltic Sea, and the use Attractive living environments exists along the entire coast in the marine area. Areas with valuable coastal and archipelago landscapes extend along the coast in Simrishamn municipality and at Listerlandet and in Blekinge archipelago.

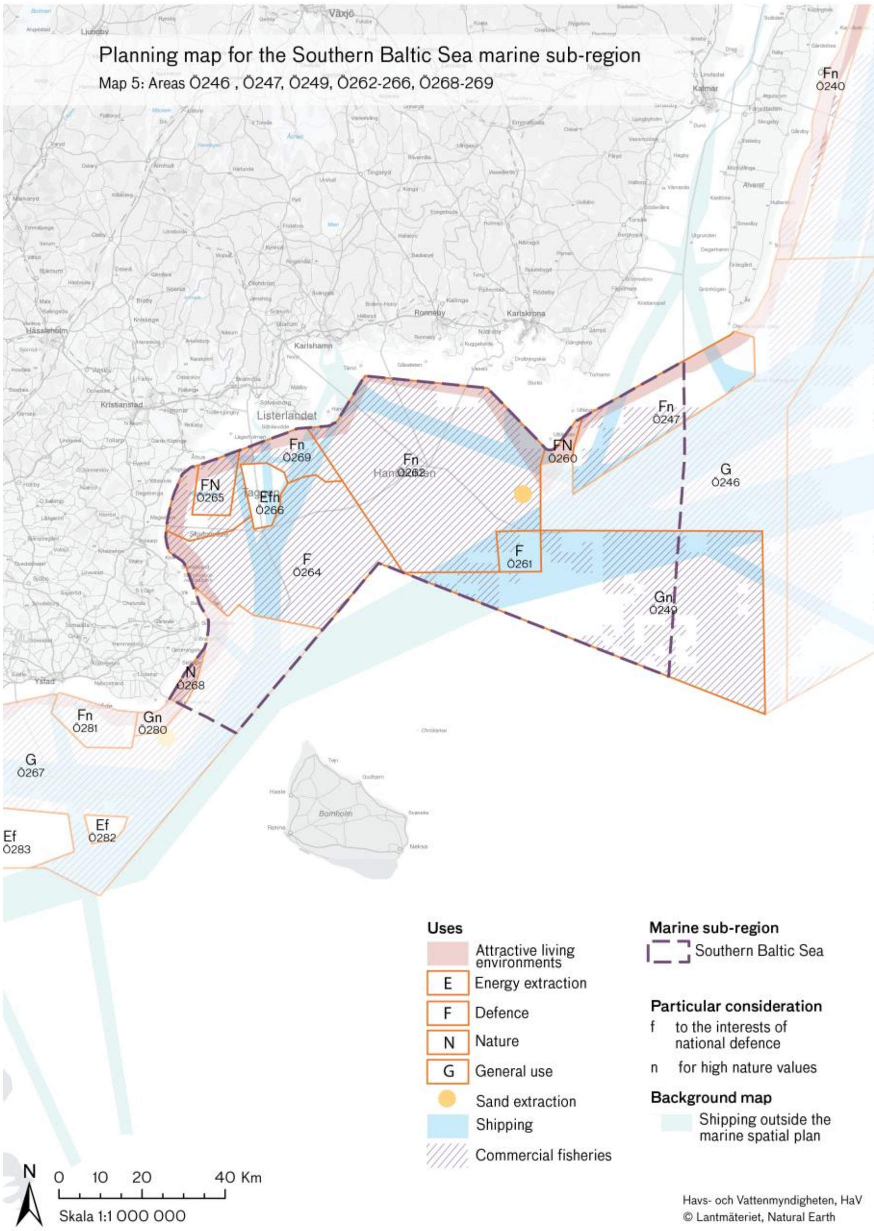


Figure 9 Planning map for the Southern Baltic Sea marine sub-region. Area numbers are on the map, and areas with particular consideration to high nature values are marked with an "n". (SwAM, 2018b)

3.6 South-western Baltic Sea and Öresund

The most trafficked shipping lane in the Baltic Sea runs through the South-western Baltic Sea along Sweden's southern coast. Commercial fisheries is widespread in the South-western Baltic Sea and Öresund.

There are good conditions for energy extraction in the marine area, with good wind conditions and coasts and offshore banks with good depth conditions for bottom-based wind power in proximity to areas with large electricity consumption in southern Sweden. There are high nature values in the marine area, and several nature reserves and Natura 2000 areas have been established.

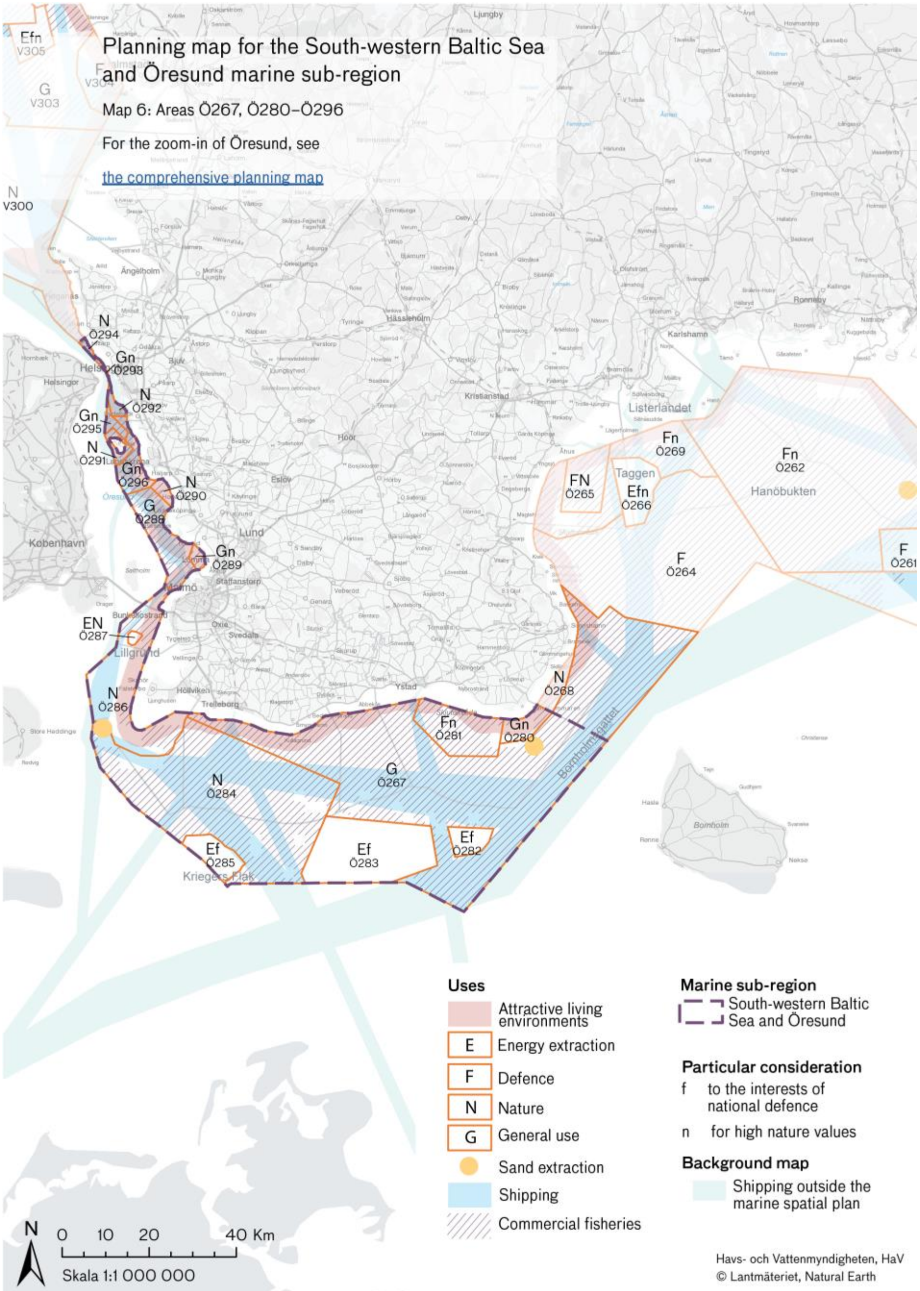


Figure 10 Planning map for the South-western Baltic Sea and Öresund marine sub-region. Area numbers are on the map, and areas with particular consideration to high nature values are marked with an "n". (SwAM, 2018b)

4 Environmental assessment method

4.1 Purpose of the environmental assessment

The environmental assessment of plans and programmes is regulated according to Chapter 6 of the Environmental Code. The objective of the environmental assessment is to integrate environmental aspects into the plan or programme so that sustainable development is promoted. This means that the environmental assessment needs to be an integrated part of the planning process so that the environmental impact of the plan has an adequate treatment in the planning work and is allowed to influence the plan's direction and standpoints.

An SEA is the written account that an environmental assessment leads to. The purpose of an SEA is to identify and describe a plan or activity's significant effects and consequences on human health and the environment and on the management of the physical environment and natural resources. The significant environmental effects that the implementation of the plan, the programme, or the change can be assumed to entail shall be identified, described, and assessed. Reasonable alternatives with regard to the plan or programme's purpose and geographic range shall also be identified, described, and assessed.

4.2 Scope

Geographic scope
The environmental assessment shall describe the significant environmental impact that might arise as a result of the MSPs. The line between the marine areas and the coastal zone is important from an environmental perspective. In addition, the cross-border environmental impact in relation to neighbouring countries will be especially investigated. This SEA primarily comprises the marine spatial planning area even if the influence area for certain environmental aspects (Chapter 6 of the Environmental Code) is larger. The marine spatial planning area has been divided into marine sub-regions, which in turn are divided into areas. The environmental assessment is carried out for every marine sub-region. When the analysis shows major changes in the cumulative effect as a result of the application of the MSP, a more detailed assessment is done at the area level. A collective assessment is then done for the marine spatial planning area. This means that the environmental assessment's smallest geographic unit is on an area level.

Time perspective
In the environmental assessment, the zero alternative (development without the plan) and the MSP alternative are primarily assessed for the reference year 2030. To some extent, this is also related to the planning's horizon year of 2050.

The planning's horizon contributes to capturing ecosystems' large-scale processes that require a long-term perspective in directions and measures. In addition, it is important to try to include a generation perspective in planning and environmental assessment. Another factor regarding the chosen scope is the UN's new global sustainable development goals with the target year of 2030 (UN, 2015). Good environmental status in the seas shall be achieved by 2020 according to the Marine Strategy Framework Directive. Several of the Environmental Quality Standards for good environmental status in the seas are considered to be difficult to achieve by then and are therefore also relevant as points of departure for the marine spatial planning with the time perspective 2030/2050.

Actual scope

In the SEA, the long-term sustainability and environmental effects are the main focus. The MSPs will be assessed according to Chapter 6 of the Environmental Code with regard to the following environmental aspects.

1. population and people's health
2. animal or plant species that are protected under the Environmental Code Chapter 8, and biological diversity otherwise
3. land, soil, water, air, climate, landscape, built environment, and cultural environment
4. management of land, water, and the physical environment otherwise
5. other management of materials, raw materials, and energy
6. other parts of the environment

The environmental assessment aims to identify and assess the MSPs overall environmental impact compared with the zero alternative in 2030, i.e. if the plan is not applied. The environmental assessment has been based on Symphony and expert investigations. Symphony is described in the following section. The effects of the plan have been assessed for the following themes defined in the MSP:

- attractive living environments (cultural environment, tourism, outdoor recreation, angling)
- energy
- defence
- storage and extraction of materials (carbon dioxide, sand)
- nature
- transportation and communications (shipping, communication cables)
- aquaculture and blue biotechnology
- Commercial fisheries

The methodology for this SEA is presented in further detail in Section 4.4.

Terms used in this environmental assessment:

Themes are defined in the MSP, e.g. attractive living environments, nature, transportation and communications, Commercial fisheries, etc.

Sectors describe actors that can directly affect the environment with their activities, i.e. tourism, transportation and communications, Commercial fisheries, defence, energy, aquaculture and blue biotechnology, and storage and extraction of materials.

Environmental aspects are the aspects described in Chapter 6 of the Environmental Code with regard to which the environmental assessment is done.

Impact is the change in physical conditions that the plan's implementation entails (e.g. that an area is claimed, water clouding, noise). (Pressure in Symphony = environmental impact in the SEA).

Effect is the change in the environment that the impact entails on an ecosystem component (ecosystems or individual flora and fauna). Effects can be direct or indirect, cumulative, positive or negative, or long or short term (in Symphony, the collective cumulative environmental effect is given when the ecosystem components' sensitivity is linked to the pressure). Ecosystem components in Symphony are living environments, species, or groups of animals and plants that constitute a part of the marine ecosystems.

Consequence is the impact that the effects have on the environmental aspects.

4.3 Symphony

Symphony is an assessment method that has been developed as an aid for national marine spatial planning and is based on the ecosystem approach. The objective is to show on a general level how environmental effects differ between different areas and how the planning affects this distribution.
Symphony calculates the cumulative environmental effect from a spatial perspective, which means that every area in the sea (spatial resolution: 250 m × 250 m) is given a value that describes how much we humans affect a representation of the marine environment. The value is based on the current knowledge, and uncertainty is large in many cases. The value is provided to be compared between areas rather than to be related to absolute limits. Symphony consists of the following three main components: maps of pressures, maps of ecosystem components, and a matrix that shows how sensitive every ecosystem component is to every pressure. The result is illustrated through a map of the environmental effects (SwAM, 2018a). Pressures are things that we humans cause that can affect and harm the marine environment. Ecosystem components are living environments, species, or groups of species that constitute parts of the marine ecosystems. To calculate the environmental

effect, the values for ecosystem components are multiplied by the values for the pressures and the values for the sensitivities in each area (pixel). The result is an estimate of the combined environmental impact (here called the cumulative environmental effect).
In this way, Symphony contributes a quantitative input to the environmental assessment. The cumulative environmental effect is calculated among other things for a description of the present situation, the zero alternative for 2030, and the MSP for 2030 (SwAM, 2018a).

1. The present situation is an assessment of the effect of individual pressures on the marine environment at present. Input for this is prepared in different ways for pressures and ecosystem components. The resulting data show the cumulative effect of the sectors' impact on the environment as it looks today.
2. The zero alternative 2030 is an extension of the present situation where the results from a sector analysis until the reference year 2030 are added to the present situation. The results show the cumulative effect in 2030 without the MSP.
3. MSP 2030 provides a further development where, besides results from sector analysis to the reference year 2030, changes regarding use of the marine area according to the MSP have also been added. The results show the cumulative effect in 2030 with the application of the MSP.

The planning support Symphony includes a large amount of information where all components contain uncertainties. The results are a comprehensive aggregation of uncertainties where certain geographic areas have a higher uncertainty than others, see Figure 11. The areas in red are areas where knowledge of nature values is low. The number of measurements in the offshore areas is much lower than closer to the coast where a greater amount of data is available. In the South-western Baltic Sea, there is very good knowledge of ecosystem components (SwAM, 2018a). Otherwise, the yellow marked areas in the marine spatial planning area are most often offshore banks that are already protected areas and where the knowledge of nature values is therefore high.

Interpretation of the results from Symphony must generally be made with caution because the results are a gross assessment of a complex reality. Within Symphony, consideration is not taken to interactions between parts of the ecosystem, i.e. if an ecosystem component is affected what effects this entails on other directly related ecosystem components. Symphony provides an illustration of the long-term environmental impact, and individual short-term disruptive elements are not included because they would have an overrepresented impact on the results. The geographic resolution in Symphony is high, but measurement data do not exist for all pixels and the result is therefore closer to the truth on a rough geographic scale compared with a detailed scale. The uncertainties in Symphony also indicate the need for an overall qualitative analysis and supplementation of environmental aspects that are not found within Symphony.

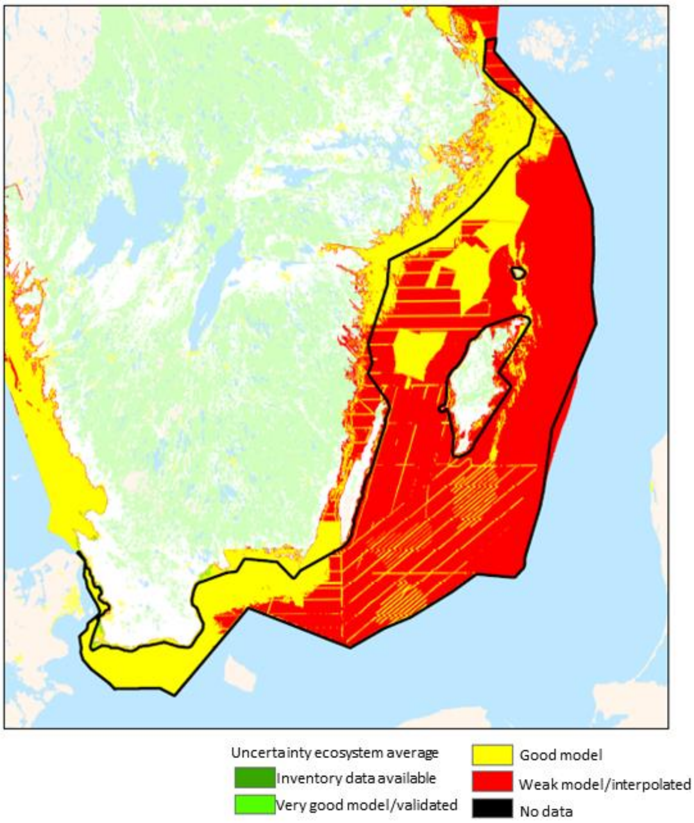


Figure 11 Aggregated uncertainty for the Baltic Sea based on data on ecosystem components. In the red areas, knowledge of nature values is low and the model is thereby weaker compared with, e.g. coastal areas.

Further information on the planning support Symphony can be read in the SwAM report 2018:1.

4.4 Environmental assessment method

Environmental assessment of the plan proposal in 2030 is made against the zero alternative in 2030. This way, the MSP's environmental effect and benefit is estimated and put in relation to the environmental conditions without implementation of the MSP. The environmental assessment is done according to three steps.

Step 1. Identification of the connection between sectors and pressures

The environmental assessment is based on the sectors defined in the MSPs within the themes. The sectors' impact is linked to the type of potential impact (pressures) as defined in the Marine Strategy Framework Directive. The purpose of this is to achieve a suitable structure in the environmental assessment.

The environmental assessment is largely based on an analysis of data from Symphony, which provides a quantitative assessment of the cumulative environmental effect. The type of impact as defined in Symphony is linked to the impact according to the Marine Strategy Framework Directive, see Table 2. Today, some of the Marine Strategy Framework Directive's pressures are not handled in Symphony, and for these pressures input has been used from the environmental assessment in the discussion phase (WSP Sverige AB, 2017), and the environmental effect has been assessed qualitatively.

Table 2 Connection between Themes/Sectors and the Marine Strategy Framework Directive.

MSP (Theme/Sectors)		Marine Strategy Framework Directive (Pressures)	Input data
Attractive living environments	**Recreation and tourism** Angling Recreational craft Cruise ship service Ferry traffic	*Selective withdrawal of species* *Physical disruption* *Underwater noise* *Introduction of pollutants* *Introduction of nutrients and organic material* *Introduction of microbial pathogens* *Introduction and relocation of invasive species* *Marine litter*	***Symphony*** *Recreational craft noise* *Recreational craft pollution* *Bird hunting* *Infrastructure in the sea* *Coastal development* *Water treatment plant pollution* ***Environmental assessment discussion phase*** *Air quality* *Greenhouse gases* *Marine litter* *Invasive species*
Energy	Wind power Power from: waves, currents, tides, and salinity gradients	*Biological disruption of species* *Physical loss* *Physical disruption* *Underwater noise*	***Symphony*** *Electromagnetic fields* *Wind power noise 125 Hz* *Wind power bird impact*
Defenc e	Artillery range/training areas Dumped ammunition (existing)	*Underwater noise* *Introduction of pollutants*	***Symphony*** *Explosions overpressure* *Explosions sound pressure* *Artillery ranges pollution*
Storage and extraction of materials	**Extraction** Sand, gravel, shells **Storage** CO_2	*Physical loss* *Physical disruption*	***Symphony*** *Sand extraction water clouding* *Sand extraction habitat loss*
Transportation and communications	**Shipping** Maritime transports Dredging and dumping dredged materials **Linear infrastructure** Pipelines Cables	*Biological disruption* *Physical disruption* *Underwater noise* *Introduction of pollutants* *Introduction of nutrients and organic material* *Introduction of other forms of energy* *Introduction and relocation of invasive species* *Marine litter*	***Symphony*** *Shipping noise 125 Hz* *Shipping noise 2000 Hz* *Shipping oil spills* *Shipping erosion* *Dredging water clouding* *Dredging habitat loss* ***Environmental assessment discussion phase*** *Air quality* *Greenhouse gases* *Marine litter* *Invasive species*

Aquaculture and blue biotechnolo	Fish farming Mussel farming	*Introduction of pollutants* *Introduction of nutrients and organic material* *Introduction and relocation of invasive species*	***Symphony*** *Fish farming nutrient emissions* *Fish farming habitat loss* *Mussel farming habitat loss*
Commercial fisheries	Bottom trawling Pelagic trawling Other fishing	*Selective withdrawal of species* *Physical disruption* *Underwater noise* *Introduction of pollutants* *Introduction of nutrients and organic material* *Marine litter*	***Symphony*** *Net-fishing catch* *Pelagic trawling catch* *Bottom trawling catch* *Bottom trawling habitat loss* *Bottom trawling water clouding* ***Environmental assessment discussion phase*** *Air quality* *Greenhouse gases* *Marine litter*

Neither Symphony nor data from the environmental assessment in the discussion phase provide a complete basis to fully cover all of the pressures of the Marine Strategy Framework Directive. Accessibility to input is, however, considered to be so comprehensive that a good general illustration of the MSP's effects and environmental impact can be provided.

Step 2. Description of the values, environmental impacts, and environmental effects

The MSP proposal is set up based on various themes that describe marine sectors for which the plan states conditions for future development. It is thereby mainly activities in these sectors that entail an impact that is to be assessed in this SEA. In this step, the sectors' environmental impact and environmental effects are identified. Basic conditions in the marine spatial planning area are described in this step. Symphony is used to describe the present situation, the zero alternative in 2030, and the MSP proposal in 2030. Each sector's contribution to the environmental impact in Symphony and to the total cumulative environmental effect will be stated as a percentage.

In addition, the areas are identified in the marine sub-regions in which the plan entails significant change in the cumulative environmental effect compared with the zero alternative. These areas are described in more detail with regard to changes in activities from the sectors in question and the impacts they entail. The sectors also entail some impact, the environmental effect of which is not calculated in Symphony. For these, qualitative assessments will be done based on the SEA from the discussion phase. The assessments are relative and are based on the affected aspect's or the affected object's value and on the size of the impact/pressure as per Table 3.

Table 3 Assessment of effects for pressures not handled in Symphony.

OBJECT'S VALUE/SENSITIVITY	PRESSURE/IMPACT **Large pressure**	**Moderate pressure**	**Small pressure**
HIGH VALUE	Large effects	Moderate-large effects	Moderate effects
MODERATE VALUE	Moderate-large effects	Moderate effects	Small-moderate effects
LOW VALUE	Moderate effects	Small-moderate effects	Small effects

Step 3 Assessment of environmental consequences

In this step, the scope is assessed of the environmental effects that arise as a result of the marine sector's impact.

The following scale has been applied in the impact assessment:

- Positive consequences
- Small negative consequences
- Moderate negative consequences
- Large negative consequences

5 Basic conditions

5.1 General

The Baltic Sea's marine spatial planning area is the largest of the three marine spatial planning areas and extends from the Åland Sea in the north, around Skåne's coast in the south, and up through Öresund to the municipal boundary between Helsingborg and Höganäs. It encompasses the metropolitan regions of Stockholm and Malmö, Sweden's largest islands Gotland and Öland, unique cross-border archipelago environments, and areas of great importance for holiday homes and outdoor recreation (SwAM, 2016b).

5.2 Physical and chemical conditions

5.2.1 Hydrographic conditions

The Baltic Sea has estuary circulation due to the large amounts of fresh water that runs out into the Baltic Sea area and constitutes surface water layers. The salinity is low in the Baltic Sea, and large fresh-water inflows from the north, together with salt-water inflow from the southern areas, means that each marine area has unique characteristics. The difference in salinity between the surface water and bottom water creates a layer, a halocline (due to the difference in density/salinity), that impedes mixture between the different layers. The layer's depth and strength affects the mixture between the layers. Within the marine spatial planning area, there are many thresholds that impede the inflow of salt water through Skagerrak and Kattegat and on up into the Baltic Sea.

The turnover period for the water in the Baltic Sea is estimated at 30 years due to the special conditions required for an inflow through Kattegat to reach the deep depressions. The circulation affects the sea's temperature, salinity, and oxygen conditions, which in turn also affect pH. The inflow is seasonally dependent and requires optimal conditions of both water level and meteorological conditions, which means that the entire Baltic Sea is sensitive to impacts that can change these conditions. If inflows from Skagerrak and Kattegat during an extended period cannot replace the deep water in the Baltic Sea, this results in a stagnation period (SwAM, 2009) that affects the marine life both locally and on a larger scale. Together, these changes increase the stress on plant and animal life (SwAM, 2015c).

In all areas, the warmer winters in recent years have meant higher temperatures of the surface water, which reduces the possibility for the vertical mix between cold bottom water and warm surface water. The latest mixture occurred in 1986/1987 when the winter was long and cold enough for an adequately good mixture. The temperature of the surface water and the southern parts' deep water has increased since the 1990s, and the salinity has decreased (Swedish Institute for the Marine Environment, 2016a). The spread of ice shows the same trend; since measurements began in 1957, the ice has not had such a small spread as in 2014/2015, and in the Baltic Sea marine spatial planning area the spread of ice was entirely non-existent (Swedish Institute for the Marine Environment, 2016a).

There is a close connection between the circulation and the physiochemical conditions. The general trend in the entire marine spatial planning area is a deteriorated vertical circulation as a result of higher temperatures. All areas are negatively affected by these changes even if they lead to larger effects in some areas and for some species. For cod, the central, south-eastern, and southern Baltic Sea are especially important spawning and nursery areas, and in these areas it thereby becomes especially important to have good hydrographic conditions. Both in the Northern and Central Baltic Sea, the salinity has decreased in the deeper areas since the 1970s, while the salinity in the surface water is unchanged. Oxygen conditions have improved somewhat in the Central Baltic Sea. In the South-eastern Baltic Sea, the oxygen conditions are unchanged. The Southern Baltic Sea and Öresund have a shallower halocline and oxygen levels and salinity are affected by sporadic salt-water inflows from Skagerrak and Kattegat (Swedish Institute for the Marine Environment, 2016a).

5.2.2 Physiochemical composition

Besides the inflow to the Baltic Sea, climate change is one of the largest impact factors for the physiochemical composition of the water. These problems are visible in the Baltic Sea where the greenhouse effect from the elevated carbon dioxide level has caused the water temperature to increase since the beginning of the 1990s. An elevated carbon dioxide level also entails the addition of carbon dioxide to water, which reduces its pH. The reduction of pH in the Baltic Sea has also taken place as a result of sulphur dioxide emissions, even if the impact of the sulphur is greater in lakes than in the sea. In the Southern and South-eastern Baltic Sea, increased acidification has been measured in recent years, which especially affects organism groups that build up their bones from calcium oxide (Swedish Species Information Centre, 2015).

The water temperatures vary with year and season, which also affects pH. At higher temperatures, primary production that consumes carbon dioxide increases, thereby raising pH. The temperature itself also affects pH because carbon dioxide is less soluble in warmer water and is emitted to the air. During the spring, a thermocline is created in the Baltic Sea at around 20–30 m depth, which is later broken down by cooling and remixing in the autumn. The wind also affects the water temperature. When the wind is blowing towards land, the warm surface water is pushed inwards and downwards. When the wind is blowing away from land, the warm surface water is forced out and cold water rises from below. This is called upwelling and is common especially in Hanöbukten and around Gotland. In upwelling, water with higher nutrient salt contents is pushed up to the surface (SwAM, 2015c).

The salinity varies sharply along Sweden's coast, from around 30–33 psu (practical salinity unit) in eastern Skagerrak to 2-4 psu in the Bothnian Bay.

The sea's salinity sets limits on the ecosystems and affects species' ranges in the Baltic Sea. The larger number of plant and animal species goes from around 1,500 species in Skagerrak and around 800 species in Kattegat to around 70 species in the Baltic Sea south of Gotland. With the change in salinity, there is a transition from salt-water species in Skagerrak to a predominance of freshwater species in the Gulf of Bothnia. The salinity also varies locally from lower levels at the coastline, especially at the mouths of rivers, to higher levels in the open sea. An important factor that affects the conditions for life in the sea is also the halocline, which is typical for the South-eastern, Northern, and Central Baltic Sea (SwAM, 2015c). A stable halocline at 40–80 m depth delimits the surface water towards the deeper and saltier water volume. The halocline prevents remixing of the entire water mass and thereby oxygen transport down to the bottom (Swedish National Environmental Protection Agency, 2013).

5.2.3 Nutrient levels and microbiological water quality

The amount of nutrients in the sea water controls biological life in the seas because the nutrients are the main food for primary producers that build up the entire sea's food chain. When the nutrient level increases, the production of the primary producers also increases, which in a naturally nutrient-poor sea can be positive, but in an already nutrient-rich sea can lead to eutrophication and cause problems such as algae blooms.

HELCOM (2010a) has classified the eutrophication situation in the Baltic Sea on the scale of good, moderate, poor, and substandard. The Northern Baltic Sea is the marine area where the eutrophication level is the lowest, and the area is classified mostly as substandard except in the northernmost area. East of Gotland in the Central Baltic Sea, the eutrophication level is also counted as substandard, while it is classified as poor west of Gotland. In the South-eastern Baltic Sea, the classification varies between poor and substandard, and in the Southern Baltic Sea it varies between moderate and substandard. Öresund has somewhat better levels and is on a moderate to poor eutrophication level.

In this environmental assessment, microbiological water quality is related mainly to the occurrence of algal blooms, which can be considered to be harmful to the ecosystem and to humans. The occurrence of algae blooms is mainly a result of a surplus of nutrients, but it is also affected by the water's physiochemical composition and the occurrence of predatory fish and animal plankton. This is explained by animal plankton placing grazing pressure on primary producers and thereby being partly able to regulate their levels. Animal plankton is in turn eaten by smaller fish (such as herring in the Baltic Sea), which are prey for the larger predatory fish. Overfishing of predatory fish thereby entails reduced regulation of the primary production from animal plankton. In the Baltic Sea, algal blooms can be explained by the combination of overfishing of predatory fish and a high nutrient input. Algal blooms are in turn a contributing factor to the low salinity levels that occur in the Baltic Sea's waters and bottoms (SMHI, 2013) because they are benefited by and amplify the eutrophication (Swedish Institute for the Marine Environment, 2014a).

Algal blooms occur mostly in the South-eastern Baltic Sea, and some 20 algal blooms occurred in the area south of Gotland in 2016. The algal blooms vary every year and are weather dependent, but the occurrence of algal blooms in the South-eastern Baltic Sea has not been observed to this extent since 2010 (HELCOM, 2016).

5.2.4 Pollution level in the sea

The first monitoring of environmental toxins in Swedish marine areas began in the late 1960s, and several measurement series have been conducted since. Since the first measurements, the levels of early environmental toxins, such as the poorly biodegradable chlorinated substances polychlorinated biphenyl (PCB) and dichlorodiphenyltrichloroethane (DDT), as well as lead, have decreased in organisms in the marine environment thanks to successful remediation measures. This has contributed to a significant recovery of several marine species, such as the sea eagle and seal. Even if we succeed in reducing the levels of most classical environmental toxins, some are still too high, such as dioxins, mercury, and lead. Moreover, the concentrations of a number of environmental toxins are high in the sediments, such as PCB and DDT. Levels of mercury, which originate from old emissions and natural leaching, have decreased in guillemot eggs, but at the same time increased in cod from both the Baltic Sea and Skagerrak and Kattegat (Swedish Environmental Protection Agency, 2014). The level of dioxin (tetrachlorodibenzo-p-dioxin equivalents) in the fish-eating guillemot in the Baltic Sea has decreased since the beginning of testing in 1969, but the Swedish National Food Agency still recommends children and women of fertile age to eat fatty fish from the Baltic Sea a maximum of three times a year due to dioxins and other environmental toxins in this fish. The amount of oil released from ships illegally is greatest in the Southern and South-eastern Baltic Sea. These oil emissions are mostly unmonitored, and the oil from propeller shafts is believed to contribute to even higher percentages of the total oil emissions in the Baltic Sea than the illegal emissions (Swedish Institute for the Marine Environment, 2014b).

Altogether, the results from the environmental control show that we are still far from the goal of a toxin-free environment. Lead, cadmium, mercury, and organic tin compounds have been pointed out as especially dangerous because they can cause illness in humans by affecting the nervous system, reproduction, kidneys, and bones.

The sea’s ecosystem is also affected by several new foreign substances that are increasing in the marine environment. For example, perfluorinated substances have increased substantially since the 1980s. These substances can disrupt hormones and have proven to negatively impact human and animal reproduction. Pesticides from agriculture also make their way to the sea, which can mainly affect important underwater plants and microorganisms.

The preliminary assessments done by the county administrative boards for all offshore areas (1–12 nautical miles from land) within the marine spatial planning area (and also for all marine spatial planning areas) is that all areas achieve good chemical status “without pervasively exceeding substances” (mercury and brominated flame retardants), but that none of the marine areas achieves a good status if pervasively exceeding substances are included in the assessment (County Administrative Board VISS, 2016c). HELCOM (2010b) classifies the pollution situation in the water in the Baltic Sea on the scale of high, good, moderate, poor, and substandard. The situation is the worst in the Northern and Central Baltic Sea in terms of the level of harmful substances in the water where the water quality has been assessed as poor or substandard. The South-eastern Baltic Sea has been classed as moderate and poor in the area closest to Gotland, but the number of measurement points is limited for this area. The water quality in the Southern Baltic Sea’s offshore areas is classified as moderate, which also applies for Öresund.

With regard to the pollution situation in the sediments, there is some variation between the areas (HELCOM, 2010b). Öresund has a higher share of mercury in the surface sediments than the other areas. In Öresund, as well as the Central Baltic Sea, high levels of hexachlorocyclohexane (HCH) have been measured. The Central and Northern Baltic Sea show very high levels of cadmium and tributeltin (TBT) in sediment, but also moderately high levels of dichlorodiphenyldichloroethylene (DDE) in almost all sediment sampling points where continuous monitoring takes place. Also in the area east of Gotland at the border between the South-eastern and Central Baltic Sea, high levels of DDE have been measured (HELCOM, 2010b).

5.3 Biological conditions

5.3.1 Biodiversity and green infrastructure

The situation for marine diversity in the Baltic Sea is serious. Biodiversity is vital to be able to preserve the ecosystem services people depend on and to retain the unique population composition that exists. The Swedish Species Information Centre Red List (2010) clarifies that the percentage of red-listed species was higher in the marine environment than in any other habitat, and 318 of the species that are on the 2015 red list are marine species (Sandström, 2015). The red list also shows that many species that were previously regularly encountered have become very uncommon or have entirely disappeared from coastal environments. In many cases, the species continue to exist farther out to sea where eutrophication is not as tangible. Many other species can currently be found only in small, isolated areas that have escaped trawling due to their inaccessibility (SwAM, 2015c).

In the Baltic Sea, marine and fresh-water species live in the same habitat and have often adapted genetically to the brackish water environment. Compared with many other seas, biodiversity is low and there are only a few key species that build up the foundation of the food webs, which makes them especially sensitive to anthropogenic pressure.

Öresund is the area that is the absolute smallest in the Baltic Sea’s marine spatial planning area, with only 4 km width at some places. It is also the shallowest area with plant and animal life that is a mix between the coastal environments of the Baltic Sea and Skagerrak and Kattegat. Bottom life is dominated by marine species where the salinity is high, while more brackish water species typical to the Baltic Sea area are dominant above the thermocline (at 10–12 m depth). The strong surface stream and the rapid and large variation in salinity add a major stress to the variable animal life and mean that fewer species are able to live in Öresund than in, e.g. Kattegat. In HELCOM's (2010a) evaluation, the status for biodiversity in Öresund is considered to be moderate.

A decrease in the local biodiversity can contribute to invasive species taking over the ecosystem and changing it forever. In recent decades, large-scale fluctuations in climate have affected the Baltic Sea, which makes it difficult to distinguish between the impact from natural causes and anthropogenic causes to changes in biodiversity. At the lower trophic levels, the composition of phytoplankton has changed, which in turn has entailed an impact on the stock of zooplankton and copepods, which are the main food for fish. At the same time, many macrophytes have disappeared in exploited and polluted areas, especially in the Southern Baltic Sea. The stock of invertebrates has decreased both in number and in abundance at the same time that the fish stock has undergone a regime change. The earlier dominance of cod has been replaced with sprat. In mammals and bird species dependent on Baltic Sea fish, many populations have continued to decline (HELCOM, 2010a).

Among the marine species are the most red-listed species in the hard and soft seabeds in deep-bottom areas (Swedish Species Information Centre, 2015). In the Southern Baltic Sea, the status of diversity varies from moderate to poor and substandard according to HELCOM's report. In the same report, the Central and Northern Baltic Sea are classified mostly as substandard, which is the lowest assessment class (HELCOM, 2010a).

The knowledge status in terms of marine species occurrence and range is generally much worse than for other environments. The large changes that have occurred in the marine environment can thereby affect far more species than what the red list reflects (SwAM, 2015c).

The sea mussel is one of the most important biotope-forming species in the Baltic Sea regions, the others being bladder wrack and eel grass. Other species that have proven essential are small grazers, such as amphipods, which with a high diversity can hold down the growth of periphyton on eelgrass, which contributes to preserving eelgrass beds. It is thus of major importance to preserve and try to benefit these key species.

The significance of the various key species varies in the Baltic Sea's different marine areas. Because the Baltic Sea area contains much lower biological diversity than, e.g. Skagerrak and Kattegat, the system can be assumed to be more sensitive to external disturbances (to have lower resilience). However, the Baltic Sea region has shown extensive resilience, and several endangered species have recovered after measures were implemented, e.g. predatory birds and harbour seal populations, which suffered extensive damage from PCB, but have now successfully recovered.

5.3.2 Natural bottom environments

The Baltic Sea's offshore banks provide a very unique species composition of a few plants and animals as a result of the special soil type geology and the distribution of the surface sediment along with the Baltic Sea's naturally low salinity. In addition to this, one of the purest waters is found in the Baltic Sea, and this contributes to the occurrence of species at a depth of 30 m in some places whereas such species usually disappear at a depth of 15 m in the outer archipelago. The environment is characterised by perennial, attached plant species that can sit at depths down to 33 m and with a good occurrence of flatfish and sea mussels. Offshore banks are especially important for sea birds that live on mussels because the offshore banks' more visible bottom makes it easier for fishing for these species (Swedish Environmental Protection Agency, 2006).

In the Northern Baltic Sea, there is the offshore area Knolls Grund, and in the South-eastern Baltic Sea there are Södra Midsjöbanken, Norra Midsjöbanken, Hoburgs Bank, and Ölands Södra Grund. In the Southern Baltic Sea, there are Kriegers Flak and Hanöbukten (SwAM, 2015c).

The Northern Baltic Sea is the marine area with the deepest sections (≥10 m), and this also contains Landsortsdjupet, which has the Baltic Sea's maximal depth of 457 m. This marine area's dominant bottom type is soft seabeds made up of fine clay particles. Several areas have loose clays, but there are also sections with hard-paced clay. The loose soft seabeds are encountered in the deepest areas and are typical accumulation bottoms with high water contents. The bottom type that occurs most in the marine area is soft accumulation seabeds and transport bottoms. Hard bottoms occur in patches within the entire marine area and at different depths. In the northern coastal areas, there are rocky sections with many islands and shallower sea areas that constitute a very important migration path for birds. Large possibilities for sea mussels are found in these areas, and the fauna varies widely (Swedish Environmental Protection Agency, 2006). Within this marine area, there are only small areas where sunlight reaches the bottom environment, and this is primarily the shallower hard seabeds in the northern part of the marine area.

The Central Baltic Sea also has large, deep areas (≥100 m) with a predominance of soft seabeds that correspond to soft accumulation seabeds and transport bottoms. The soft bottoms consist of fine clay with both loose and hard clays, and the loose soft seabeds are encountered in the deepest areas. Hard bottoms also occur in patches within the entire marine area and at different depths. Bottoms with coarser sand only exist in occasional places north of Gotland towards Gotska sandön, and there several of the important offshore banks are found. These areas are erosion bottoms and consist of coarser materials that have been exposed to natural waves and water currents, which are good substrates for sea mussels (SwAM, 2015c). On the offshore banks, there are zones that can maintain a rich animal and plant life, and because the offshore banks have varying bottom substrates, the fauna becomes very diverse (Swedish Environmental Protection Agency, 2006).

5.3.3 Pelagic habitats

Pelagic habitats refer to the part of the marine habitat that is above the seabed or is not mainly affected by the bottom environment. It is in the pelagic zone that the majority of the sea's primary production takes place. This habitat is strongly affected by the photic (actually *euphotic*)[4] zone's extent, i.e. the upper sunlit part of a body of water in which photosynthesis can occur. The photic zone is affected by the water's turbidity, but also by access to nutrients. Emissions of nutrients increase the production of plant plankton and filamentous algae, which has a negative impact on the pelagic photic zone. The supply of nutrients (total nitrogen and total phosphorous) has decreased since 1995, while the supply of inorganic phosphorous and loose organic materials has increased in all marine areas since 1995.

Plankton, especially plant plankton, are a good indicator of changed water quality because they quickly react when nutrient salt concentration and light availability change. The composition and change in the amount of plankton also extensively affects the rest of the water environment through changed visual depth and food supply for animals that live in the body of water or on the bottom (SwAM, 2016a). The amount of cyclops has decreased in all marine areas, and this affects the composition of animal plankton communities because they account for a large share of grazing on plant plankton, even if the total biomass of animal plankton is unchanged (Swedish Institute for the Marine Environment, 2016a).

The chlorophyll content that plant plankton contains is an indication of the supply of light that is available for photosynthesis. If the visual depth decreases, the chlorophyll concentration increases in the plant plankton and in the water. In the coastal areas in the northern and central parts of the marine spatial planning area, the chlorophyll levels have increased, which indicates that the visual depth has decreased. In the offshore areas in the northern part of the marine spatial planning area, the chlorophyll levels have not changed, but the biomass of plant plankton has increased somewhat, which indicates that the supply of nutrients has increased. The occurrence of plankton is the greatest in the Northern Baltic Sea, but it is also high in the South-eastern Baltic Sea marine area. The occurrence of plankton decreases in the Southern Baltic Sea and is much lower in the Öresund area and decreases somewhat in all marine areas during the summer months. The ecological status for plant plankton is moderate in the Northern and Central Baltic, good in the South-eastern and Southern Baltic, and the status for Öresund is unavailable (Swedish Institute for the Marine Environment, 2016a). The supply of

[4] For the sake of simplicity, "photic zone" is used synonymously with "euphotic" zone in this environmental assessment.

nutrients from bodies of water varies over the marine area, but is generally a little lower for the Northern Baltic Sea and Central Baltic Sea than in the other marine areas. The total amount of nitrogen and phosphorous has decreased while inorganic phosphorous and organic materials have increased in the past 20 years (Swedish Institute for the Marine Environment, 2016a) in all marine areas except Öresund where the supply of nutrients generally increased from bodies of water from intensive farming on land (Swedish Institute for the Marine Environment, 2016a).

5.3.4 Oxygen-free bottoms

Oxygen deficit leads to reduced biodiversity and altered species composition, and thereby has a negative impact on ecosystems. Oxygen deficit refers to oxygen levels below 2 ml/l, which entails levels that make it difficult for most animals to survive (SwAM, 2015c). Oxygen deficit is defined on two levels: *hypoxia* entails levels of 2 mg/l, and *anoxia* means a total absence of oxygen.

Oxygen-free bottoms is a condition that can last for decades or centuries, and there have periodically been cycles with severe oxygen deficit in several areas in the Baltic Sea. Introduction of fresh salt water from the Atlantic can restore oxygen conditions in the Baltic Sea with recolonisation of bottom-dwelling animals (Swedish Environmental Protection Agency, 2013).

When all oxygen is consumed by various bottom processes, hydrogen sulphide (H_2S) is formed and is toxic to marine life. Under oxygen-free conditions, nutrients are also released, such as phosphate and silicate, from the sediment to the water, which upon vertical mixing can reach the surface layer and the photic zone and thereby contribute to the eutrophication problem. High levels of phosphate benefit the growth of plant plankton, especially cyanobacteria in the summer in the Baltic Sea, which can further increase the oxygen deficit because plankton ultimately sink to the bottom and require more oxygen to be broken down (SMHI, 2015). A greater spread of oxygen-free seabeds also contributes to a higher production and emission of methane gas, which is a greenhouse gas. The methane emissions are also affected by climate change because an increase in primary production resulting from a temperature increase can increase the production of methane gas. With warmer winters, the natural methane gas emissions can occur for longer periods every year. It is thereby of utmost importance to place focus on reducing the oxygen-free seabeds, not only from a plant and animal life perspective, but also so as not to increase methane emissions from the seabed.

In the Baltic Sea's marine spatial planning area, a large part of the deeper seabeds are entirely or occasionally without oxygen. The area and volume spread of hypoxia and anoxia continues to be at an elevated level in the Baltic Sea even after the large inflows of oxygen-rich salt water in 2014 and 2015 (Swedish Institute for the Marine Environment, 2016a). The only areas where the number of cases of hypoxia decreased as a result of these inflows are the Eastern Gotland Basins in the Central and South-eastern Baltic Sea (Swedish Institute for the Marine Environment, 2016a; SMHI, 2015). With deteriorated oxygen conditions, the conditions for bottom-dwelling animals and the Bottom Quality Index (BQI) decrease.

5.3.5 Marine plants

On soft seabeds in the Northern Baltic Sea and South-eastern Baltic Sea, eel grass, sago pondweed, etc., are commonly occurring and are significant species. In the area south of Öland, large, dense seaweed belts mainly of toothed wrack have been documented. In the Southern Baltic Sea, bladder wrack and toothed wrack dominate the hard bottom, and there are around 100 species of macro algae there, but a majority of them are very uncommon (SwAM, 2015c). On Öresund's soft seabeds, eel grass is dominant. On hard bottoms, there are often brown algae, such as bladder wrack, that form seaweed belts that also serve the key species function for the Baltic Sea because they create one of the Baltic Sea's most species-rich biotopes. Another brown algae is the toothed wrack that occurs in all marine areas except the Northern and Central Baltic Sea and that forms important habitats for bryozoans and hydroids.

Red-listed sea-dwelling water plants are difficult to map because they are difficult to discover, but some species should be taken into account in marine spatial planning. In Öresund, the red-listed red algae *Acrochaetium dumontiae* has been registered, but few finds have been made since the 1960s. Similar conditions apply for the brown algae *Acrochaetium stilophorae* and *Microspongium stilophorae*, and all three form wire-like bushes/pillows of corresponding marine brown/red algae. Most red-listed marine plant species occur in the coastal areas, but it is possible that many move towards deeper water when the conditions allow.

In the Baltic Sea, a large supply of nutrients has entailed major changes along the coast. There have been long-term changes in seaweed communities, and these changes vary along Sweden's coast. In the northernmost part of the Southern Baltic Sea, a decrease in seaweed communities has long been under way. The deep spread of seaweed in the Stockholm area has recovered in the Northern Baltic Sea, and in some areas the spread depth is at the same level as in the 1940s (SwAM, 2015c), but it is still low because it lacks many species such as toothed wrack. The bladder wrack has had less depth spread since 2007 in the Central Baltic Sea in the area around Gotland, but in the southern part of the Southern Baltic Sea the ecological status of the vegetation-covered seabeds has remained high. However, the amount of *Polysiphonia fucoides* and toothed wrack decreased somewhat while *Furcellaria lumbricalis* demonstrates increased depth spread there instead. Continuous seaweed belts are harder to find, and the bottom flora is increasingly dominated by red algae in this marine area. The red algae generally grow at significantly deeper depths than the boundary for high status, while the seaweed only grows at a depth that corresponds to moderate to good status (Swedish Institute for the Marine Environment, 2016a).

5.3.6 Marine animals

Marine mammals

All marine mammals that usually occur in Swedish waters are encountered in the Baltic Sea and include the species grey seal, harbour seals, ringed seals, and porpoises. Status for the seal species varies, and the harbour seal is classified as *vulnerable* according to the red list, while the ringed seal is *near threatened*. The grey seal is classed as *viable*. The situation for all three seal species has improved since the 1970s when they were severely threatened due to hunting and low fertility. But since 1988, a number of disease epidemics have occurred that reduced the seal populations. Despite this, the grey seal population in the Baltic Sea is reported to have a good rate of growth (SwAM, 2015c), and the species' ranges are counted as satisfactory.

Our three seal species are geographically separated during the reproduction period, and the grey seal exists further south and west, while the harbour seal is south of Gotland's southern tip. The ringed seal is dependent on the spread of the sea ice because it gives birth to its pup on the ice, which means that it exists mainly in the Bothnian Bay in the winter and is also very much affected by global warming. The harbour seal's permanent habitat corresponds to the South-eastern Baltic Sea and Southern Baltic Sea area, and in recent years it has disappeared from the area around Gotland (Swedish Species Information Centre, 2015).

The *critically endangered* harbour porpoise is the only whale species that regularly occurs in Swedish waters, and it is encountered in all marine areas in the marine spatial planning area. A distinction is made between two populations of porpoise in the Baltic Sea, which are called the *Baltic Sea population* and *the Danish Straits population*. Today, the porpoise population is mainly affected by injuries caused by fishing, underwater noise, ecosystem changes, and environmental toxins. There is today a strong protection system for the species because only a few of the marine protected areas are specifically designed to protect the porpoise. This entails a major risk to mainly the Baltic Sea population's continued existence because Swedish waters encompass its main range (AquaBiota, 2015). In December 2016, the Government decided to create a large Natura 2000 area comprising Hoburgsbank and Norra Midsjöbanken in order to expand the protection of the Baltic Sea porpoise.

The Baltic Sea porpoise has its largest continuous core area in the Southern Baltic Sea, which also extends beyond the marine spatial planning area (Wijkmark & Enhus, 2015). Virtually all reproduction areas for the Baltic Sea population are covered by the marine spatial planning area, except for some smaller areas on Jutland's and Funen's eastern coast (Wijkmark & Enhus, 2015). The Baltic Sea population's areas worth protecting are Hanöbukten in the Southern Baltic Sea, south of Öland, the Midsjöbanks and Hoburgs bank in the South-eastern Baltic Sea, and the area north of Öland in the Central Baltic Sea (AquaBiota, 2015). The areas that are mainly used by the Danish Straits population (at least during the summer) are Öresund and parts of the Southern Baltic Sea.

Invertebrates

Marine invertebrates represent a large part of the ocean's biodiversity, while a limited number of species predominate over larger areas. Of the red-listed species from the 2015 list (Swedish Species Information Centre, 2015), 70 per cent are invertebrates, but many species are probably missing from the list because there is a significant lack of knowledge about this particular group.

Blue (common) mussel banks constitute a substrate for other organisms and therefore indicate high biodiversity. These mussel banks also contribute a regulating ecosystem service in the form of filtration of particles in the water, which contributes to lower turbidity in the water column. The banks are therefore of high protective value. Soft seabeds that are relatively unaffected by trawling can also have a high protective value because they are often home to digging organisms and various species of sea pen. Live sponges are also effective filterers and can take up plankton and other organic materials and mainly exist on hard moraine bottoms.

The distribution and composition of invertebrate bottom dwellers has undergone a considerable change over the last hundred years. Today, the occurrence of the largest mussel communities in the deep-water areas is limited to the South-eastern Baltic, where Hoburgs bank and Norra and Södra Midsjöbanken are the largest continuous areas, but also south of Gotland and Öland. The Northern Baltic Sea is believed to contain few mussel beds in the deep sea, but some smaller areas exist in Stockholm's outer archipelago. In the Central Baltic Sea, the mussel stocks are believed to be limited to areas north of Gotland and Öland, while in the Southern Baltic Sea and Öresund there are mussel stocks along the entire coastal area to a varying degree.

Many invertebrates are bottom-dwelling organisms and have therefore been affected to a high degree by bottom trawling. Trawler fishing is most intensive in the Southern Baltic Sea marine area, and we can thereby also assume that the invertebrates in this marine area are the most vulnerable.

Many annelid worms, marine snails, and mussels live in the marine spatial planning area, and many of them are currently red listed and occur in all marine sub-regions (Swedish Species Information Centre, 2015). Three foreign species of annelid worms *Marenzellaria* occur in the Baltic Sea (as well as the Bothnian Bay), with the largest concentration in the Northern and Central Baltic Sea, but they have also been encountered in the Southern Baltic Sea and Öresund (no individuals have been encountered in the South-eastern Baltic Sea). Their impact on the environment is not unambiguous because they oxygenate oxygen-poor sediment, but thereby contribute to the sediments releasing stored environmental toxins (SwAM, 2016a).

Fish

The fish fauna's composition in the Baltic Sea is lower than in Skagerrak and Kattegat due to the lower salinity that provides a unique, but more difficult to access, living environment where around 50 fish species occur. The most frequently occurring species in the offshore areas are cod, herring, and sprat, while the more coastal areas in the Baltic Sea are dominated by fresh water species such as perch and roach as well as flatfish. Eels occur along the coastal areas with the greatest numbers in the southern marine areas. The stock of salmon, salmon trout, eel, and to some extent also whitefish is a mix of natural and planted fish (SwAM, 2015c). The fishing pressure has historically had a major impact on species in the Baltic Sea. Examples of species that have been seriously affected by fishing are cod, haddock, sole, plaice, and pollack. The recovery is progressing slowly even though the trawling boundary has been moved out and other preservation measures have been implemented. In the Öresund area, where trawler fishing has been prohibited since the 1930s, the situation is considerably better. But here too the proportion of large fish has decreased in recent years (SwAM, 2015c). This can very likely be due to the large withdrawals through net fishing that occurs year-round in Öresund (Wijkmark & Enhus, 2015). However, the Swedish cod population with the greatest abundance is in Öresund.

The stock of cod in the Northern, Central, and South-eastern Baltic Sea decreased drastically at the end of the 1980s, which had its roots in high fishing pressure and impacts from seals and cormorants. This cod stock saw some increase from 2005, but decreased abruptly between 2011 and 2014 and is still low except in the southernmost parts of the South-eastern Baltic Sea.

The cod stock is still somewhat small and concentrated to the Southern Baltic Sea where the Bornholm Basin is its only spawning area in the Baltic Sea today. Sprat also decreased abruptly between 2011 and 2014 and has moved more north, while the herring stock is increasing in the entire Baltic Sea. The stocks of whitefish are at a stable level while the situation for wild salmon in the Baltic Sea is worrying, and the situation for eel is critical. More coastal fish, such as eelpout, carp fish, and pike have seen a continued decrease, while perch and pike-perch have generally been stable (SwAM, 2015c).

The main human impact on the fish population is of course fishing, but the population is also affected by the supply of nutrients, exploitation, and the physical impact on habitats, such as salinity and environmental toxins. Large-scale sea fishing is the cause of more than 20 species of fish being red listed in 2015. Among other things, Swedish stocks of cod, haddock, ling, and halibut are still threatened. As of 2015, hake and starry ray have also been red listed, where the latter is endangered (Swedish Institute for the Marine Environment, 2016a). An uncertainty factor is how climate change and the growing spread of seabeds with oxygen shortages in the Baltic Sea affect the fish's habitat and food base. Further studies of how pH affects the fish stock are needed, but an effect in, among others, cod and herring larvae has been documented. Regulation of rivers and clean-ups in both large and small bodies of water affect fish stocks and fishing by limiting the access to suitable spawning areas for marine fish (SwAM, 2015c). The fish resource is affected by a number of physical disruptions in the ecosystem, which might be due to dredging, installations, lost fishing equipment, and noise. An important impact factor is also coastal development, which might mean that fish spawning habitat is destroyed in coastal areas (SwAM, 2015c).

Birds

In 2015, 157 bird species were registered in the Baltic Sea on various sea bird assessment routes for the Swedish Environmental Protection Agency (Green, 2016). Predominant breeding birds in the Baltic Sea's archipelagos are eider, black-headed gulls, and cormorant, but in addition to this there are large stocks of several other diving ducks and gulls. On the Karlsöarna Islands at the southern boundary of the Central Baltic Sea, there are colonies of razorbills and guillemots. Razorbills, guillemots, and black guillemots are also found farther north in the Baltic Sea. There are many wintering stocks of sea birds in the Baltic Sea, and they are dominated by diving ducks such as tufted ducks and long-tailed ducks. Auks also winter in the Baltic Sea together with various species of gulls (SwAM, 2015c).

Many marine bird species, such as long-tailed ducks, eider, and velvet scoters, are decreasing drastically in the Baltic Sea. A decrease for the velvet scoter began as early as the 1950s, and the eider has decreased drastically since the mid-1990s. At the same time, the pressure on the birds' habitat has increased, in part due to the many wind farms being planned mainly in German, Danish, Polish, and Swedish waters in the southern Baltic Sea. A species that overwinters, such as the long-tailed duck, is entirely dependent on shallow offshore banks with a rich occurrence of sea mussels. Research indicates that some species, including long-tailed duck, often do not return to an area that has been developed (SwAM, 2015c).

The sea eagle is a typical species for the Baltic Sea and has become a representative for the environmental problems (SwAM, 2015c). One sees some increase in the population compared with previous years, and its activity has increased in the milder winters of recent years (Green, 2016). It is estimated that there are more than 700 sea eagles in Sweden, which is the same number as in the 1950s, and it is thereby assessed that the species has generally recovered from poisoning by the environmental toxins DDE and PCB, which obstructed reproduction and nearly led to the species' extinction. Damage to eggs from these environmental toxins is still occasionally found, as well as elevated levels of lead in tissue samples. The sea eagle thereby needs continuous monitoring as new threats constantly arise for this perhaps recovered, but at the same time genetically limited species.

Bats

There are 18 bat species in Sweden, and 16 of them occur in the marine spatial planning area for the Baltic Sea (Swedish Species Information Centre, 2004). The extent to which the bats move over the sea was previously unclear even though bat populations are often found in coastal areas. Studies from recent years have shown that bats not only migrate along the coasts, but can also go farther out to sea hunting insects. This hunting is seasonally restricted to summer and late summer and is dependent on good weather. Systematic mapping of bats in coastal and marine areas has yet to be conducted (SwAM, 2015c).

5.4 Protected areas

Establishment of marine protection areas in the form of Natura 2000 areas, nature reserves, biotope protection, and national parks is one way of pointing out and protecting valuable areas. Within the Convention on Biological Diversity, there is a target that 10% of coastal and marine areas shall be covered by marine area protection by 2020. Existing nature reserves, Natura 2000 areas, and marine national parks today comprise 13.6% of Swedish internal waters, territorial waters, and the exclusive economic zone. Sweden's interim target in the environmental targets was to increase this share to at least 10% by 2020, which was achieved in December 2016. However, much of the area protection is coastal and is outside the marine spatial planning areas.

The protected areas should at the same time be geographically representative and ecologically connected, which they currently are not. Bird and seal protection areas, Natura 2000 sites under the EU Birds Directive, and some other categories of areas are not included in the area target but are still important in marine spatial planning.

The marine areas that are protected constitute a part of the green infrastructure in the marine areas that are currently only partly protected (SwAM, 2015c). Many offshore banks in the Baltic Sea are of protection interest, and some are reported to be included in the international networks of marine protection areas that are under construction. The Swedish Environmental Protection Agency previously pointed out four offshore areas that from a nature conservation perspective are especially valuable and important to protect from all forms of development. In the Baltic Sea, these are Hoburgs bank and Norra Midsjöbanken. Hoburgs bank is also pointed out as a Natura 2000 area according to the EU Habitats Directive and is included together with the Norra Midsjöbanken in HELCOM's network of Marine Protected Areas (MPAs).

The offshore bank areas are highly protected compared with deep offshore areas (SwAM, 2015c), and the variation in percentage protection per marine area is extensive.

5.4.1 Northern Baltic Sea and Södra Kvarken

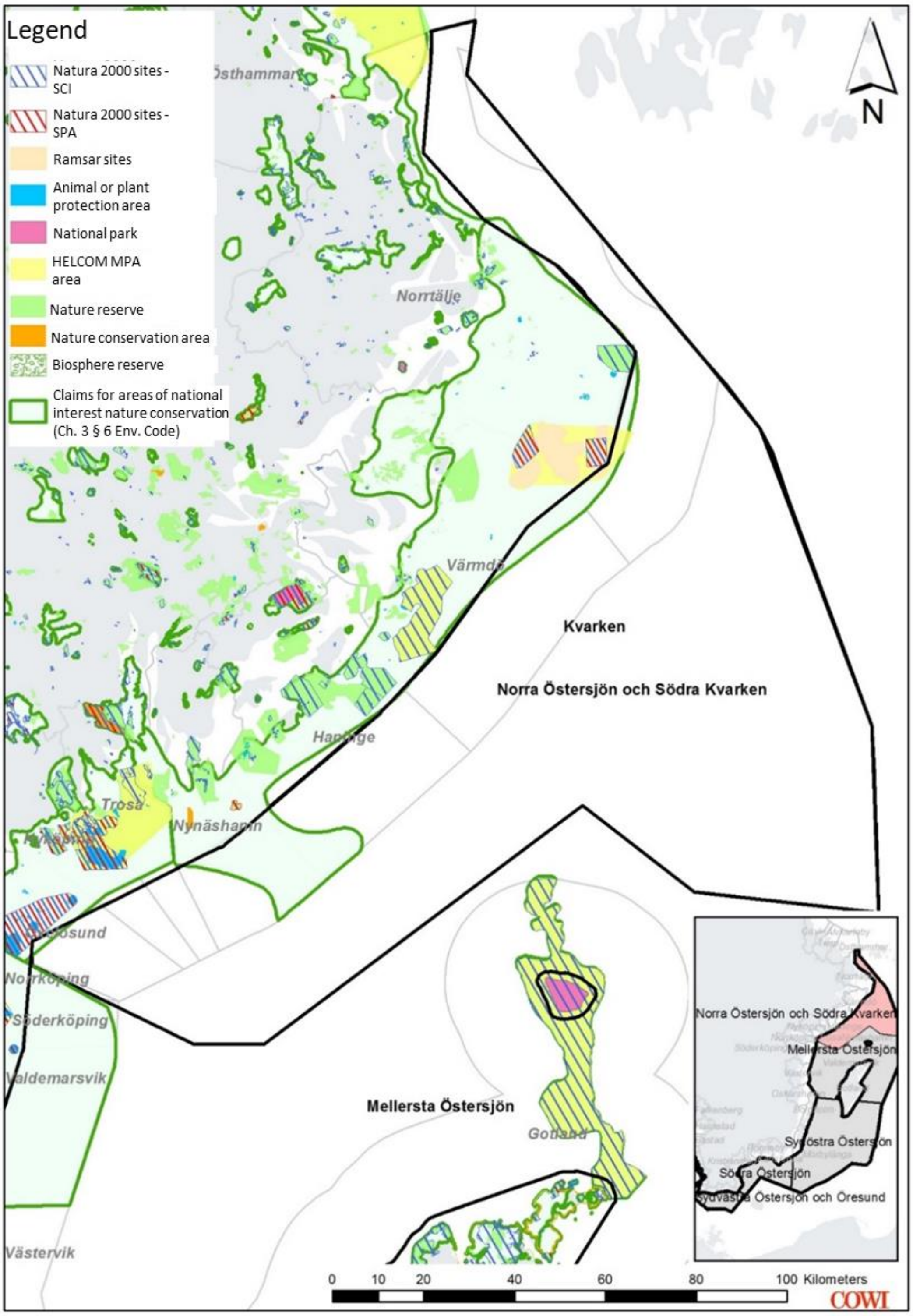


Figure 12 Natura 2000 areas, national interests for nature conservation, and other potential protected areas for the Northern Baltic Sea and Södra Kvarken.

5.4.2 Central Baltic Sea

Salvorev-Kopparstenarna is a shallow area north of Gotland and is a marine reserve and Natura 2000 area. The area forms a habitat for grey seal and is an important reproduction area for fish, including turbot. The area is also an important food-seeking area for several different sea bird species. This area is a part of the national park of Gotska sandön (County Administrative Board of Gotland, 2016a).

Hoburgs bank is a Natura 2000 area located south of Gotland, which is protected due to the offshore bank's unique substrate composition, which is very uncommon and is home to unique plant and animal life. The seabed is dominated by large brown and red algae with a spread down to a depth of at least 25 m because the water is clear and its biomass is generally much higher than other offshore banks in the Baltic Sea. The area is an important spawning ground for fish and is a known reproduction area for turbot, which is an important commercial species for the area. During the winter, bird life is dominated by long-tailed duck, but also many other overwintering birds. The long-tailed duck feeds mainly on sea mussels, which have a wide range in the area, even if the sea mussel banks in recent years have been slightly over fished by birds. Otherwise, the bank is of major significance to the black guillemot, the eider, and the velvet scoter, as well as the guillemot and the razorbill. This nature conservation area overlaps geographically with the national interest for shipping as a deep shipping lane passes through the eastern part of the area with more than 50,000 ship passages per year, and there is also a shipping lane in the northern part of the area (County Administrative Board, 2005).

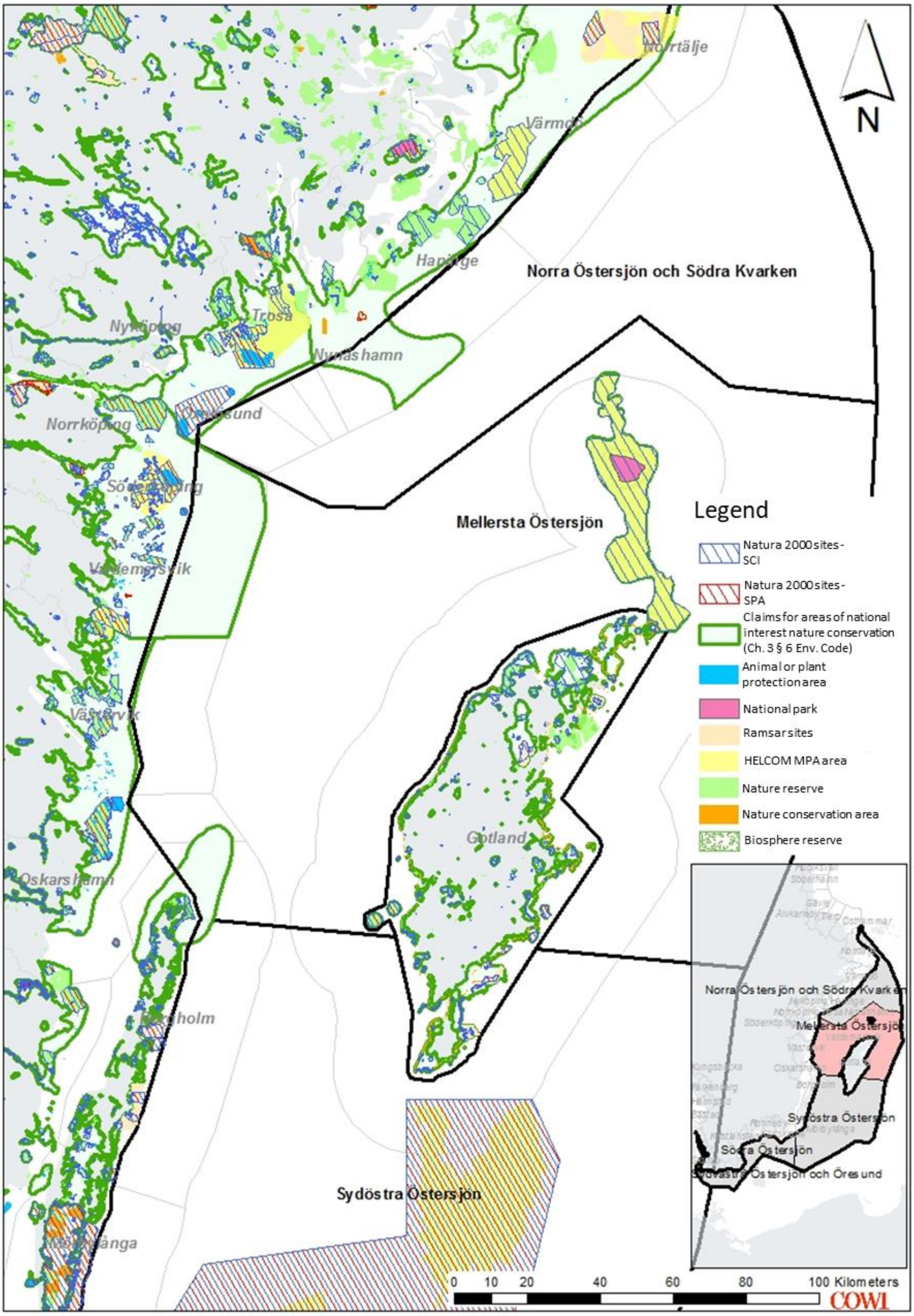


Figure 13 Natura 2000 areas, national interests (for nature conservation), and other potential protected areas for the Central Baltic Sea.

5.4.3 South-eastern Baltic Sea

Norra Midsjöbanken is an offshore bank around 50 km east of Öland's southern tip with the highest biomasses and average numbers of sea mussels in the Baltic Sea marine spatial planning area. The sea mussels cover up to 75% of the bottom, which consists of sand, reef, and stone. On larger stones and boulders, there is attached algae at a greater depth including the perennial attached red algae, which indicates the occurrence of fresh water. Norra Midsjöbanken and Hoburgs bank are the most important areas for the red-listed long-tailed duck that feeds on the mussel banks. This is one of the reasons that the Norra Midsjöbanken is covered by the Natura 2000 protection. Many red-listed fish species are also found here, and the area is important for the turbot's life cycle and is a spawning ground for herring. The area is also located within the largest continuous reproduction area (Swedish Environmental Protection Agency, 2006) (AquaBiota, 2015).

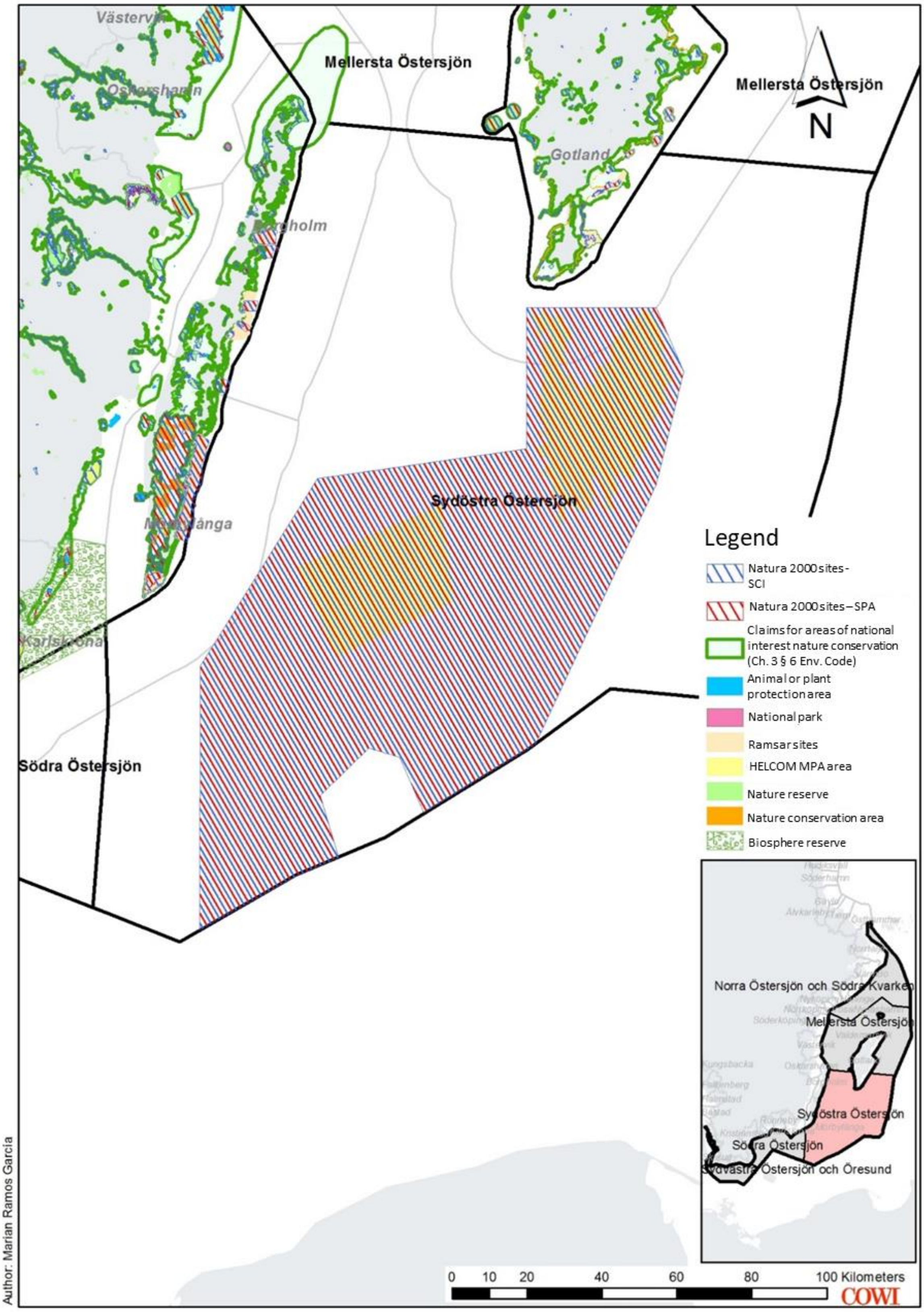


Figure 14 Natura 2000 areas, national interests for nature conservation, and other potential protected areas for the South-eastern Baltic Sea.

5.4.4 Southern Baltic Sea

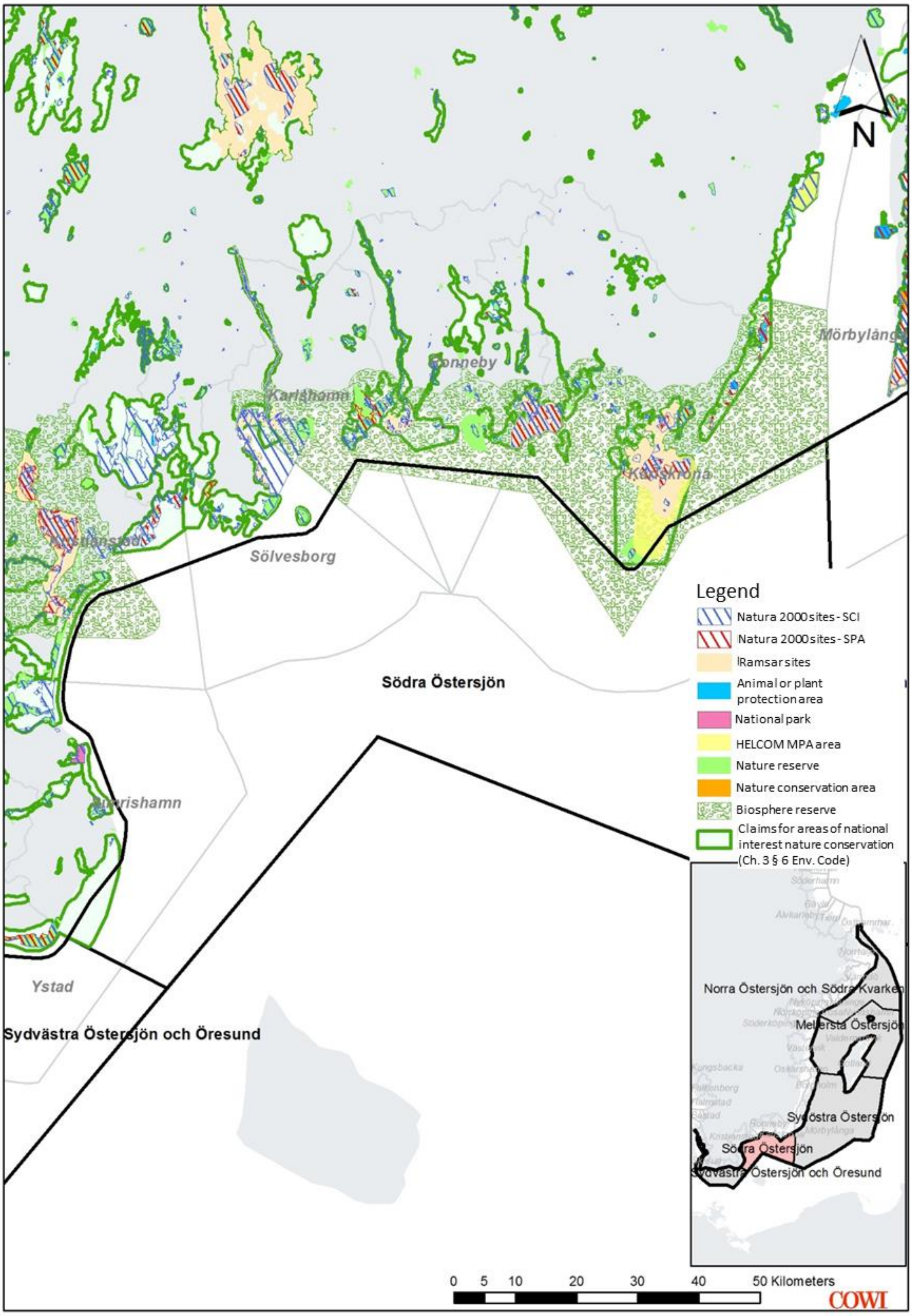


Figure 15 Natura 2000 areas, national interests for nature conservation, and other potential protected areas for the Southern Baltic Sea.

5.4.5 South-western Baltic Sea and Öresund

The Falsterbo Peninsula's marine area is a nature reserve around the south-western tip of Skåne, which is on the boundary between the Öresund and South-western Baltic Sea areas. The area constitutes a sand migration area and the bottom thereby consists of fine-grained sand and the water is almost always clear due to strong currents. It forms a reproduction area for the turbot and an important nursery place for cod, flatfish, eel, lumpfish, and garpike. It is the grey seal's only habitat in the South-western Baltic Sea/Öresund and the harbour seal's largest habitat for the entire Baltic Sea region. The most important plant life in the nature reserve is the eel grass beds where a lot of small shrimp, molluscs, mussels, and annelid worms live. These eel grass beds are important for reproduction, protection, and young fish for cod, herring, eel and garpike. The vegetation-free sand bottoms are also important as food-seeking areas for, among others, flatfish despite its lower species diversity. The Falsterbo Peninsula is an internationally well-known location for bird watching because there is an extremely large diversity of species during the autumn migration period. The area is protected under the Habitats Directive (County Administrative Board of Skåne, 2016b).

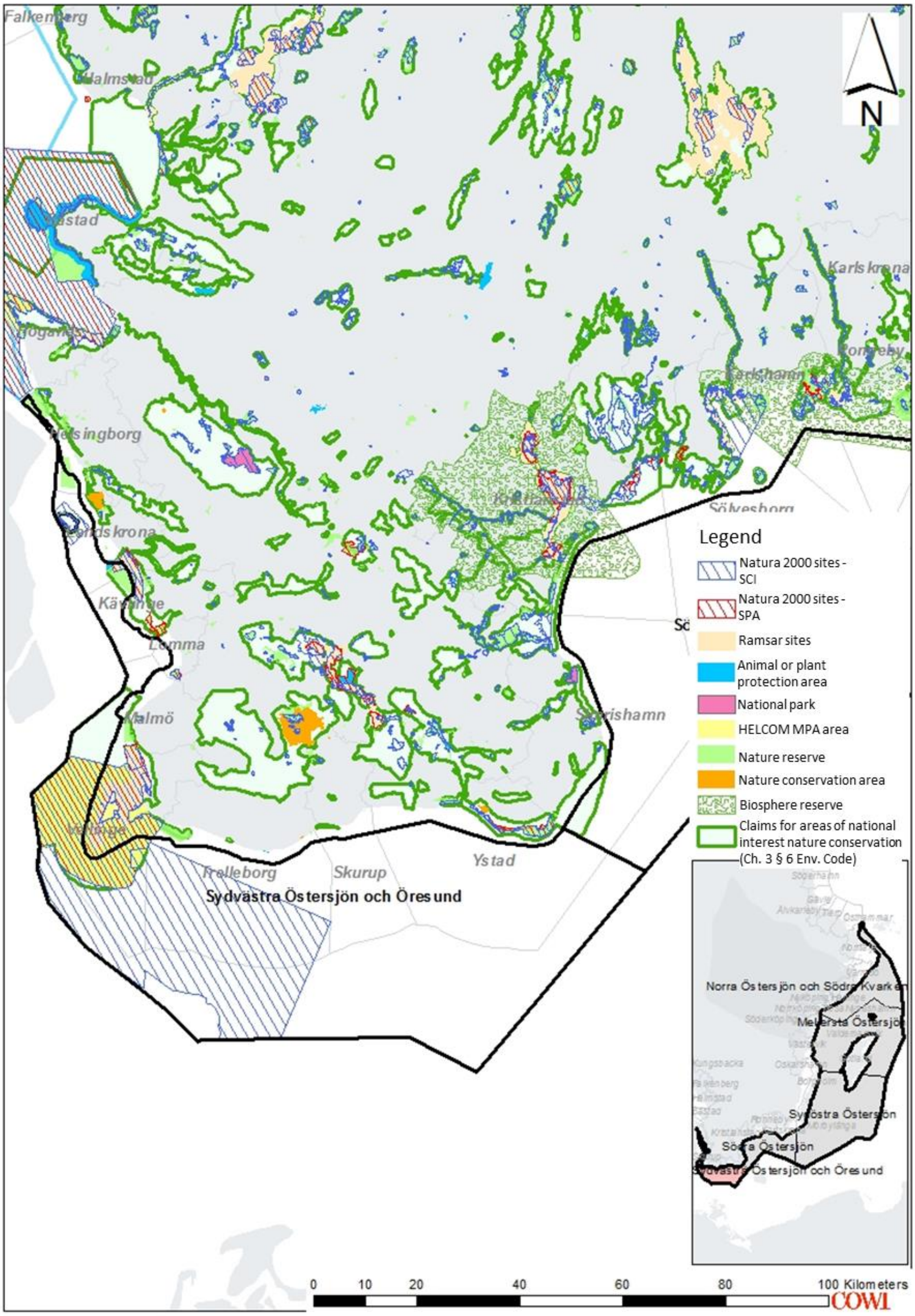


Figure 16 Natura 2000 areas, national interests for nature conservation, and other potential protected areas for the South-western Baltic Sea and Öresund.

5.4.6 Green Map

In addition to analyses of cumulative environmental effects, SwAM has prepared a map within the work on the planning support Symphony that describes aggregated ecological values. This product is called the *Green Map (3)*, and it shows which areas are valuable for many ecosystem components (SwAM, 2018a). If an area is of major significance for many different ecosystem components, the area receives a high value in the Green Map.

In the Green Map, a normalisation has been done with the aim of creating comparability and representativeness. In the version of the Green Map that is mainly used in marine spatial planning, normalisation has been done based on both the MSP and components (Figure 17). Normalisation according to the MSPs means that the areas in the Gulf of Bothnia do not automatically receive lower values than areas in Skagerrak and Kattegat only because there are fewer species in the Gulf of Bothnia. Instead, the analysis is based on the regional conditions, and areas that for the Gulf of Bothnia have uncommonly high nature values receive the same value in the Green Map as an especially rich area in Skagerrak and Kattegat. The aggregated ecological values for the Baltic Sea are presented in Figure 18.

Together with other input on nature values, the Green Map is used in the marine spatial planning work to identify areas where *particular consideration to high nature values (n)* might need to be observed (see Chapter 3 and the MSP).

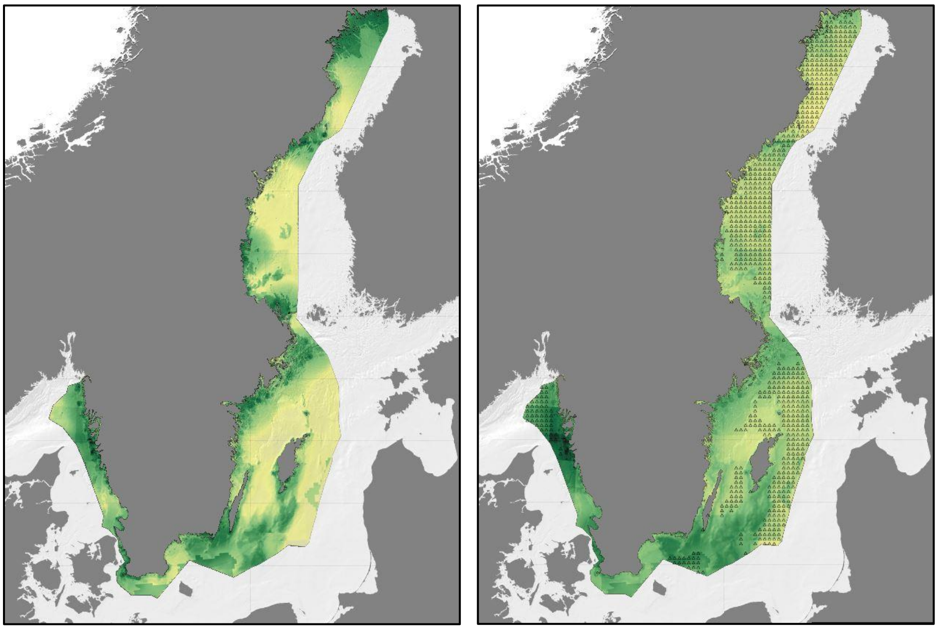


Figure 17 The Green Map. The picture on the left shows the version of the Green Map used in the marine spatial planning, where normalisation has been done both according to the MSP and according to groups of ecosystem components (habitats, fish, mammals, and sea birds). The picture on the right shows a simple aggregation of ecosystem components without normalisation or weighting; this version represents what is included in the calculations of the cumulative environmental impact within Symphony. The grid that is visible on top of the map in the picture on the right shows areas with especially high uncertainty in the data. Here, the knowledge of the nature values is low.

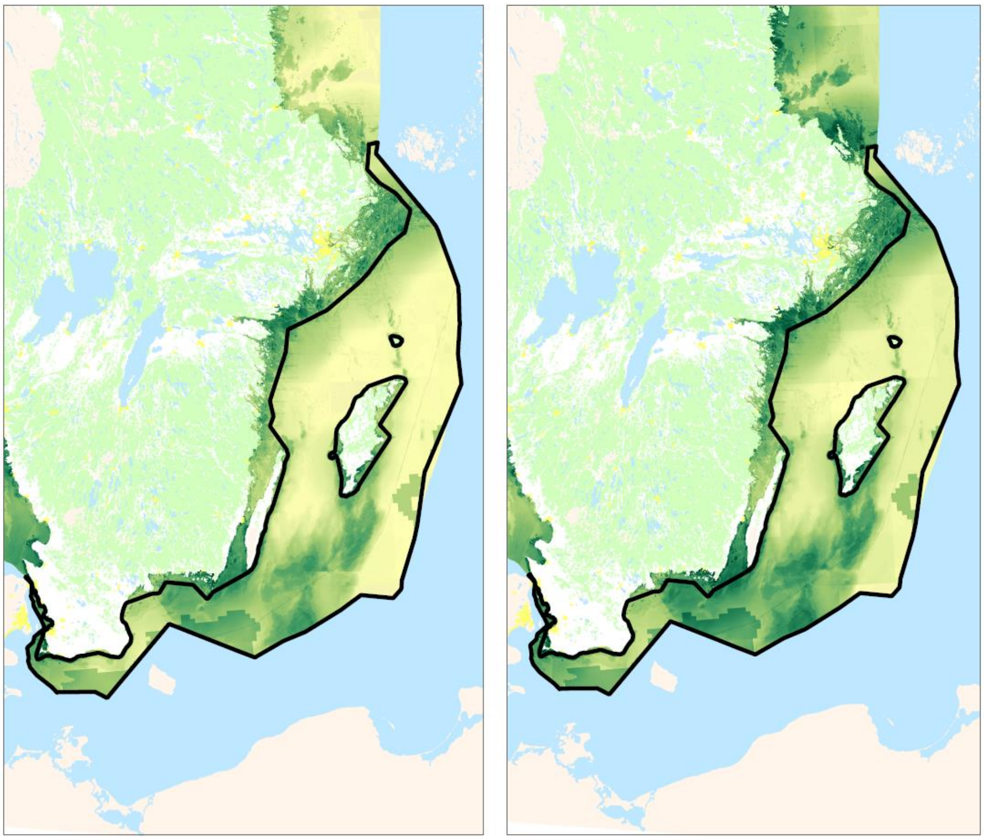


Figure 18 Aggregated ecological values for the Baltic Sea. The picture on the left shows averages without weighting, and the picture on the right shows four equally weighted groups (bottom environment, fish, mammals, and birds) of ecosystem components and normalisation of the values. Dark green – high value, light green – low value).

6 Current situation

6.1 Sectors and themes

6.1.1 General

The Baltic Sea is today an inland sea with heavy pressures from many stakeholders, both nationally and internationally. The coast around the Baltic Sea has a high development pressure. The expected development is that the degree of use will increase further within both existing and new areas of activity and interest. Shipping is intensive and is expected to increase strongly, and the interest in extraction of various kinds of sea-based energy, especially wind power, is growing with technical development, changes in energy prices, and adaptation to climate change. More shipping means that accident risks can be expected to increase, and this entails negative effects on the environment. In the Baltic Sea area, there is today a number of nuclear power reactors and there are transports of radioactive material that in connection with Finland’s nuclear power plans in the Gulf of Bothnia can be expected to increase as a whole in the area. Extraction of natural resources, such as oil and sand, is under way and is planned in and nearby the Swedish marine spatial planning area.

Within the marine spatial planning area, there is today physical infrastructure that in several cases ties Sweden with individual neighbouring countries, such as cables, pipelines, and the Öresund Bridge. The fixed infrastructure is expected to increase within the planning horizon’s time frame. With its low salinity, the Baltic Sea has a unique ability to conserve shipwrecks, and with a rising sea level, the Baltic Sea is a well-preserved cultural treasure to explore and manage. Within the marine spatial planning area, there are many unique environments and nature values that provide good possibilities to conduct active outdoor recreation in close connection to the population concentrations in the area’s northern and southern sections. Tourism is already an important industry in the municipalities that border on the marine spatial planning area, and the industry is expected to grow further. The possibility of outdoor recreation and access to attractive natural environments are important prerequisites for the development of local business at the same time that the ecosystems in the marine spatial planning area are heavily burdened by, e.g. weak salt-water intrusion, seasonal algal blooms and dead seabeds. These environmental problems also account for growing strains from climate change effects, which also increases the interest in adaptation measures in the coastal zone. Greater interest in climate adaptation in the coastal zone might entail a greater interest in sand extraction farther out to sea.

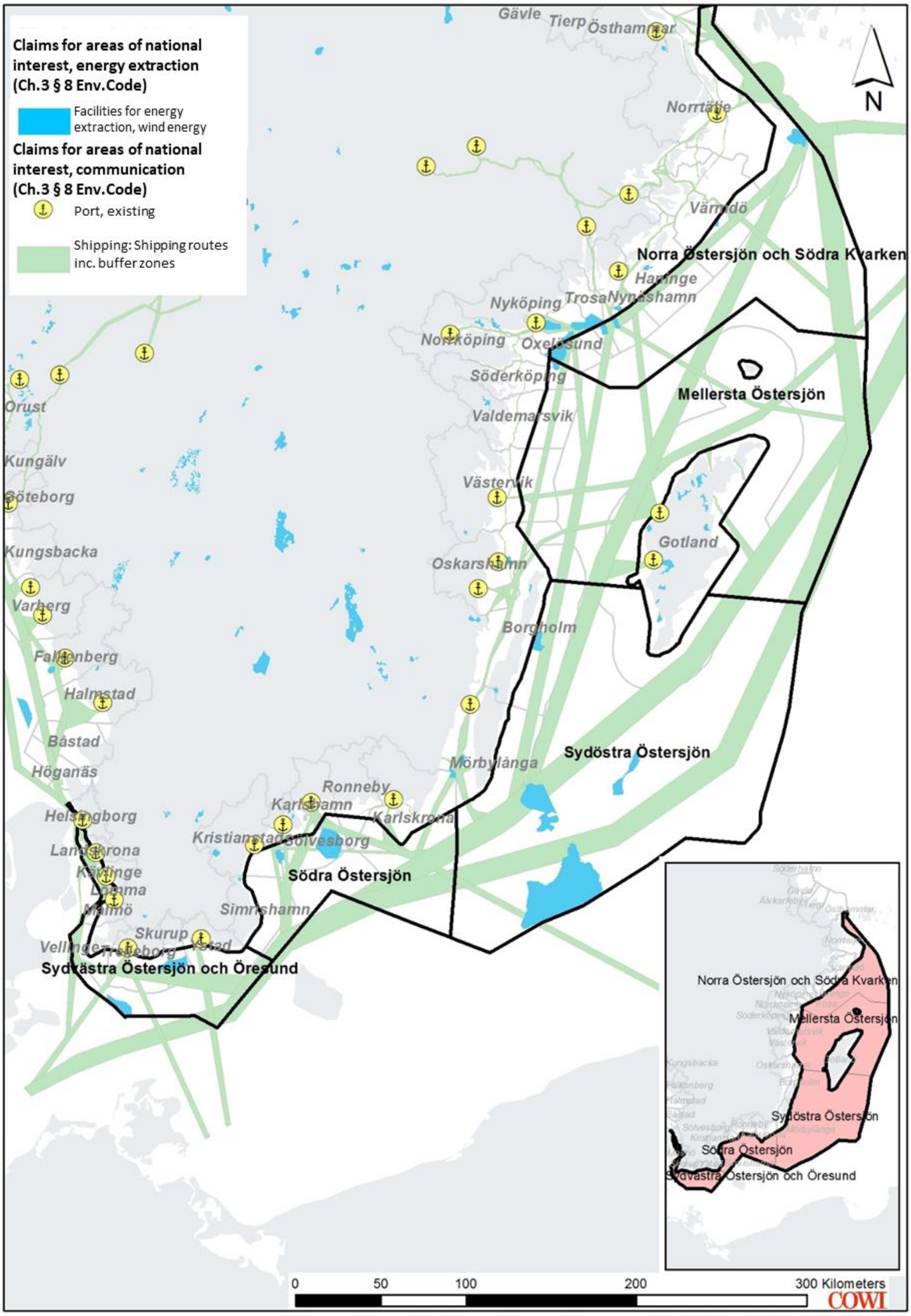


Figure 19 National interests for transportation and communications and energy in the Baltic Sea.

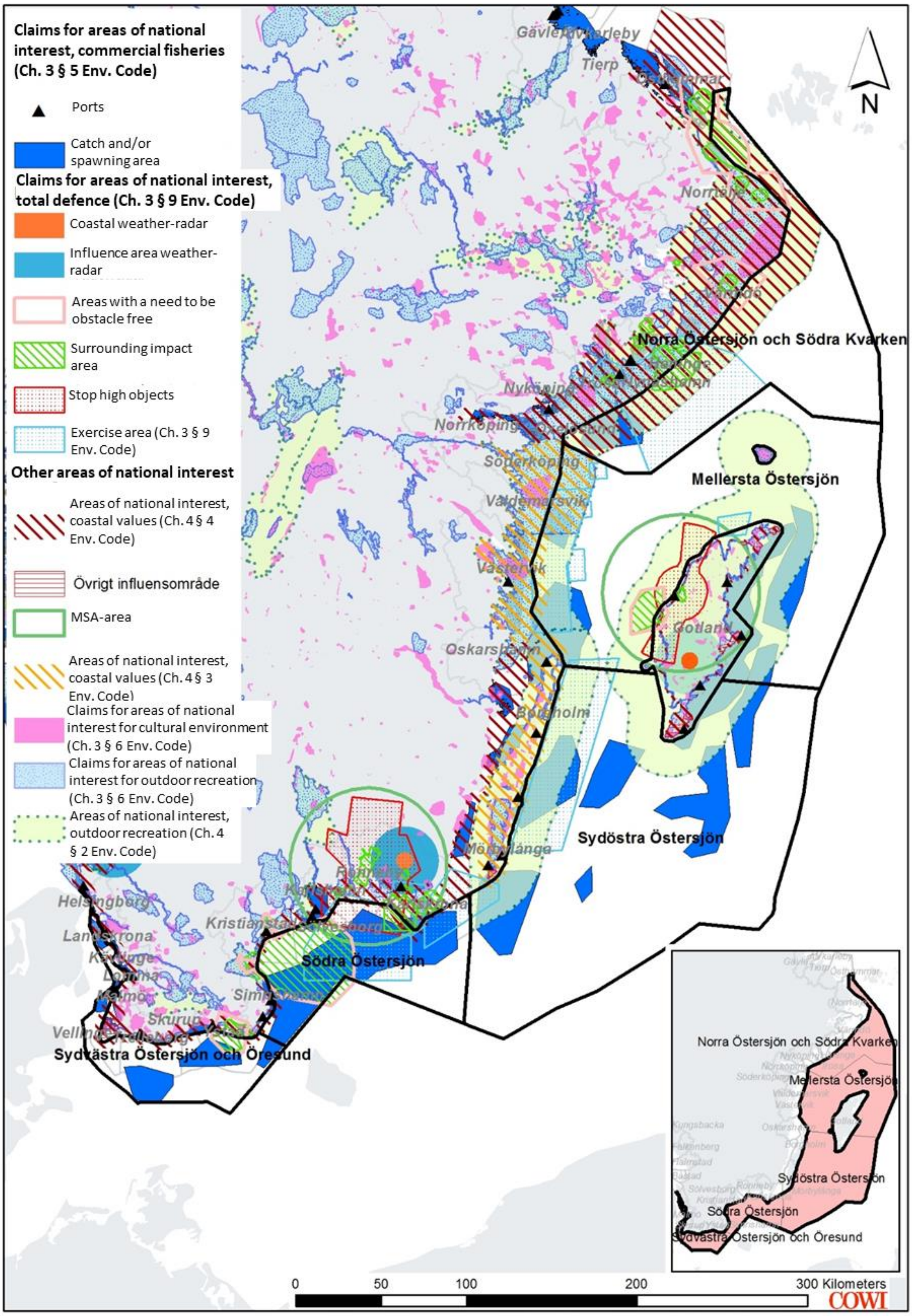


Figure 20 National interests for Commercial fisheries, defence, and other potential protected areas in the Baltic Sea.

6.1.2 Attractive living environments

Outdoor recreation that depends on waters in the marine spatial planning areas mainly comprises recreational boating traffic and angling, but also cruise ships and ferry traffic, safaris, etc. Marine tourism in Sweden is estimated to have an extensive economic value of up to 50,000 employees and net sales of around SEK 70 billion (SwAM, 2017c). Aforementioned information also comprises coastal tourism, including food, lodging, wholesale trade, etc., that to a limited extent can be linked to marine tourism in the marine spatial planning areas. Angling is conducted in the sea by nearly 700,000 people annually with an estimated 3.4 million fishing days (Statistics Sweden, 2017). Statistics on recreational boating show that in 2015 there were around 200,000 recreational craft with their home port in Skagerrak and Kattegat (Swedish Transport Agency, 2016). In the Baltic Sea marine spatial planning area, there are several areas pointed out for the outdoor recreation national interest.

Outdoor recreation and tourism contribute to environmental impacts through multiple pressures, such as selective withdrawal of species, underwater noise, air pollution, and littering. Effects of the pressures vary with both time and geography.

One of several drivers for marine tourism is access to cultural environments along the coast. The cultural environments directly impacted by the plans are mainly sunken ships, stone age settlements, and other remains that are now below sea level (SwAM, 2017a). The knowledge of remains on the seabed is insufficient. In the marine spatial planning areas, there are no appointed national interests for cultural environments. At the Swedish National Heritage Board, work is under way to identify guidelines for the appointing of national interests for cultural heritage preservation in the sea. Cultural environments outside the marine spatial planning areas in the archipelago landscape are affected indirectly by the plans, for example, through changes in the landscape or changed accessibility. Cultural environments underwater can be threatened by other interests making claims on, or otherwise affecting, the physical environment. With increasingly tough competition for the sea’s resources, such a threat is expected to increase over time. The sea’s chemical and organic composition can affect cultural environments negatively (SwAM, 2017a).

6.1.3 Energy

With regard to the sea-based energy production touched upon in the plans, wind power is the absolutely largest part while production from other sources, such as waves, currents, tides, and salinity gradients, only constitutes a limited component. Sea-based wind power has been in Sweden since the 1990s (Swedish Energy Agency, 2015). Today, there are four wind farms at sea and seven more have approved permits to be built (WSP Sverige AB, 2016). Wind power from the sea has a marginal role in the energy system. The collective wind power in Sweden accounts for around 9% of the total energy production with an annual production of 15.5 TWh (Swedish Energy Agency, 2017b). In 2016, energy from sea-based wind power amounted to 0.6 TWh or 3% of produced wind power. Today, there are three smaller wind farms in operation

– Bockstigen outside of Gotland, Utgrunden I and Kårehamn off of Öland, and a larger farm in Öresund, Lillgrund. Lillgrund and Kårehamn are in the Baltic Sea marine spatial planning area. Also within the marine spatial planning area are a number of farms with permits where production has not started and additional areas where the permit process has begun (SwAM, 2015a).

Energy production at sea other than wind power is mainly comprised of wave power in Sweden. Several operations for research and development are being conducted, but the scope of commercial production is limited. According to the Swedish Energy Agency (2017c), there is major potential for wave power in Sweden, but technologies need to be developed for lower costs and greater commercialisation.

The following numbers of national interest areas for wind farms are within the respective marine areas:

- **Northern Baltic Sea** – 5.
- **Central Baltic Sea –** 1, but it is located partly within the Northern Baltic Sea's marine spatial planning area.
- **South-eastern Baltic Sea –** 4, of which one is already developed at present.
- **Southern Baltic Sea –** 2, of which one (Taggen) has a permit, but is not developed.
- **South-western Baltic Sea and Öresund –** 2, of which one (Kriegers Flak) has a permit, but is not developed.

6.1.4 Defence

Defence activities in the marine spatial planning area mainly involve conducting signal surveillance and monitoring and training activities (Swedish Armed Forces, 2017). Artillery exercises are conducted below, on, and above the water in especially appointed training areas throughout Sweden's coast. Military activities are conducted in all marine spatial planning areas. However, there is a concentration in the Baltic Sea, between Helsingborg and Stockholm, due to the geographic location in relation to other countries in the Baltic Sea. In the marine spatial planning area, there are among other things five large and a few smaller artillery and training ranges. The sea around Gotland and Blekinge archipelago is affected by military activity in the form of the training areas, prohibitions against tall objects, a special need for obstacle clearance, and an airspace influence area (SwAM, 2015a).

The interests of the Defence have good conditions for coexistence with Commercial fisheries, outdoor recreation, and shipping. Permanent installations for energy production at sea can, however, constitute physical obstacles and cause technical disruptions that compete with the interests of national defence (SwAM, 2016c).

Military exercises add metals to the sea from the use of ammunition, which can cause high concentrations locally with effects on biological activity. In addition to physical impacts, artillery and blasting exercises cause underwater noise. Effects on marine life from noise vary to some extent with the time of the year due to the ecosystems' varying sensitivity to disturbances. Consideration to seasonal variations in sensitivity is taken in the Swedish Armed Forces' exercises (SwAM, 2016a).

6.1.5 Storage and extraction of materials

Marine sand and gravel can constitute replacement materials for natural gravel from the land, which is used today as material in concrete production (Geological Survey of Sweden, 2017). Today, there is only one permit for the extraction of marine sand and gravel in Swedish waters, Sandhammar bank south of Ystad, in the Baltic Sea marine spatial planning area. The Geological Survey of Sweden (SGU, 2017) assesses that in the long term an annual extraction of marine sand and gravel of 1–2.5 million tonnes would be involved. Extraction is mainly relevant in areas with an extensive need for natural gravel and where there is limited natural gravel on land at the same time. Four areas have been pointed out by the Geological Survey of Sweden (SGU) as most suitable for extraction on a smaller scale, of which three are located in the Baltic Sea (Sandhammar bank, Sandflyttan, and Klippbanken) and one in the Gulf of Bothnia (Svalans and Falkens grund) (SGU, 2017).

No carbon dioxide storage takes place today in Sweden. Environmental effects of carbon dioxide storage are mainly associated with risks of leakage from the storage site and potential effects of acidification of the water, in addition to pressures in connection with the works, construction, etc., during the extraction process.

6.1.6 Nature

Various geographic conditions contribute to the ecosystems and nature values varying widely between the coastal and marine areas in Skagerrak and Kattegat, the Baltic Sea, and the Gulf of Bothnia. Compared with Skagerrak and Kattegat, the Baltic Sea has a low salinity, which means that relatively few species thrive in the environment. A relatively low biodiversity makes the Baltic Sea's ecosystems sensitive to disturbances.

Marine environments are currently affected by historical and contemporary pressures, mainly from emissions of nutrients from activities on land and sea, from selective withdrawals of species through fishing, and from other human activities. In the Baltic Sea, the introduction of nutrients has contributed to major eutrophication problems where algal blooms are common and large parts of the Baltic's seabeds suffer from hypoxia. The status of the cod and sprat stocks in the Baltic Sea has deteriorated in recent years. However, in Öresund, where there is a total trawling ban, there is the only thriving cod population in Swedish waters (Swedish Institute for the Marine Environment, 2016b).

The impact of climate change on marine environments is, among other things, through the acidification that takes place through carbon dioxide dissolving in the water. Acidified water dissolves calcium oxide, which affects marine organisms and ecosystems. Risks of an elevated water temperature caused by climate change are also that invasive species can more easily establish themselves in Swedish waters and that salinities will be affected by changes in precipitation.

6.1.7 Transportation and communications

Shipping
The Baltic Sea is one of the world's most trafficked seas, due largely to the transport of goods to and from Russia and the other countries around the Baltic Sea (SwAM, 2016e). Passages and cruise traffic have increased sharply since the beginning of the 2000s and are conducted today to a large extent (Swedish Institute for the Marine Environment, 2017). Shipping contributes to environmental problems in several different ways.

In addition to emissions of carbon dioxide that contribute to climate change, combustion of fuels also results in the air pollutants sulphur oxides (SO_X), nitrogen oxides (NO_X), and particulates that among other things contribute to acidification and eutrophication problems. Shipping constitutes a large emission source of air pollution. Of the total marine emissions in the entire Baltic Sea area, Swedish shipping accounts for 15–25% of the emissions. In addition to this, there is a significant contribution from international shipping in the marine spatial planning area. Specifically for nanoparticles, half of the emissions into the Baltic Sea come from the boat traffic's fuel combustion.

Emissions of NO_X gases from shipping have gradually increased in the Baltic Sea (Swedish Institute for the Marine Environment, 2016b), while emissions of sulphur dioxide are decreasing (Swedish Environmental Protection Agency, 2016). From 1 January 2015, new rules limit sulphur dioxide emissions from shipping, which will hopefully reduce these emissions even further (Swedish Institute for the Marine Environment, 2016b). Within the marine spatial planning area, the amount of NO_X gases is the highest in Öresund and the Southern and the Northern Baltic Sea, where shipping is most extensive (SMHI, 2016). The particle content has in general decreased in the Baltic Sea area in recent years, but is highest in the Northern Baltic Sea marine area (Swedish Environmental Protection Agency, 2016). In a comparative perspective between the MSPs, the sulphur emissions from shipping are higher in the Baltic Sea than in Skagerrak and Kattegat, while the conditions for NO_X gases are the opposite (SMHI, 2016). The environmental quality objective of "Fresh Air" has an interim goal specified as "emissions of sulphur dioxide, nitrogen oxides, and particulates shall have begun decreasing from shipping traffic in the Baltic Sea and the North Sea no later than 2016" (Swedish Environmental Protection Agency, 2016). The interim goal was considered to have been achieved on time, while there is a way to go to achieve the environmental quality objective for 2020.

Emissions of greenhouse gases from shipping are still increasing (Swedish Environmental Protection Agency, 2016) despite an on-going decrease in Sweden's emissions of greenhouse gases in total. In the environmental assessment context, the emissions of the greenhouse gases carbon dioxide (CO_2) and carbon monoxide from shipping are especially relevant. Methane gas

(CH_4) is another greenhouse gas that is relevant because it, among other things, is present in certain sea and lake beds and can thereby be freed upon activities such as resource extraction. Today, CO_2 accounts for 65% of the global greenhouse gas emissions, and Sweden's emissions totalled 54.4 megatons of CO_2 (ppmv) per year in 2015. This amount can be compared with 15.9 megatons in total that were released from all shipping in the entire Baltic Sea that same year (including international emissions), which corresponded to an increase of 5.6% compared with 2014. In the Baltic Sea, boat traffic thereby accounts for a large part of the emissions of greenhouse gases, although aviation is also a significant contributing factor. Baltic Sea ferries are currently the vessel type that emits the most CO_2, followed by tank vessels. Tank vessels and freight ships accounted for the largest part of the increase between 2014 and 2015.

Underwater noise is caused by engines, propellers, sonar, etc., and can, among other things, disturb the communication of marine organisms. Through the emptying of ballast water, there is a risk that the ships will spread invasive species that become established in Swedish waters and outcompete native species with potentially major consequences for the ecosystems. Other consequences from shipping are systematic releases of oil and other chemicals and a risk of major spills upon running aground or colliding.

According to the Swedish Institute for the Marine Environment (2016a), shipping's emissions of both greenhouse gases and other air pollutants would be easy to reduce by reducing speeds at sea.

Pipelines and cables

Society's dependence on the Internet is constantly growing, as is the need for communication between Sweden and other countries. The majority of this communication with other countries takes place over cables in the sea. Even if the transmission capacity in the cables is growing, more cables are needed to create space and security in the networks.

The Swedish electrical system is characterised by high production in the north and large consumption in the south, and the imbalance is expected to increase in pace with the closure of nuclear power plants. This increases the demand for cables and other resources in the transmission system that enables transport of electricity from the hydroelectric power stations in the north to the consumers in the south. The system is largely land-based, but the expanded planning scope for wind power at sea places new demands on a flexible transmission system that will be able to handle a large share of variable energy from wind power.

Two parallel lines for the transport of natural gas extend between Russia and Germany and pass through Sweden's exclusive economic zone (the Nord Stream line). There are plans for further lines along essentially the same route. Another natural gas pipeline extends between Denmark and Sweden in Öresund, and a new one is planned between Poland and Denmark, possibly through Sweden's exclusive economic zone.

6.1.8 Aquaculture and blue biotechnology

Aquaculture in the sea is almost exclusively conducted as coastal activities and not in the marine spatial planning area. In Sweden, aquaculture is comprised of the farming of fish, shellfish, and algae. The farming of edible fish has increased sharply from 2007, when around 5,000 tonnes were produced in Sweden, to 2016 when around 11,400 tonnes were produced (Statistics Sweden, 2017). The largest percentage is produced in fresh water. Farming of edible fish in the sea mainly pertains to rainbow trout and mainly takes place close to the coast and to the greatest extent on the north-eastern coast (Statistics Sweden, 2017). Mussel farming in the sea mostly takes place in Skagerrak and Kattegat with a few exceptions. Pressures on marine ecosystems from aquaculture can look different depending on what is farmed, where farming of edible fish is associated with additions of nutrients that contribute to eutrophication, while farming of, for example, mussels and algae results in a net uptake of nutrients that contributes to a reduced nutrient pressure in the sea. Other consequences are seabed losses and the impact on the physical environment. In the Baltic Sea marine spatial planning area, there is no existing facility for aquaculture, and at present no such activities are planned. There is also no survey of areas with good conditions for aquaculture, which is planned for in the scope of the municipalities' comprehensive planning.

6.1.9 Commercial fisheries

Swedish Commercial fisheries is varied, with large boats that most often fish with trawlers and smaller boats with cages, traps, and nets. Trends in Commercial fisheries are among other things that it is shifting from small scale and coastal fishing to fishing with larger boats (SwAM, 2016d). A strong negative trend for the number of commercial fishermen has been under way since the mid-1990s. Intensive Commercial fisheries has led to strained stocks, and overfishing of predatory fish has affected the food chain with consequences for other parts of the ecosystem. Fishing is a contributing cause to the status for half of the 300 marine species on the Swedish Species Information Centre Red List (Swedish Institute for the Marine Environment, 2016a).

Bottom trawling is the method that causes the greatest damage to the marine environment, mainly in the form of withdrawals of species including by-catch, physical damage to the bottom environment from abrasion, and increased turbidity from disturbed sediments. Underwater noise and the introduction of organic materials are also among the consequences from fishing. Consequences from pelagic trawling are associated with the same types of pressure as bottom trawling except for the physical impact on the bottom environment (SwAM, 2016d).

In the Baltic Sea, it is fishing for cod, herring, and sprat that dominates what comprises both trawling in the water column (so-called pelagic trawling) and at the bottom. Bottom trawling takes place south of Gotland (SwAM, 2016e).

6.2 Cumulative effects - present situation

The cumulative effect for the marine spatial planning area of the Baltic Sea and included marine areas has mainly been identified using Symphony. For each marine area, the cumulative effect is described and illustrated based on the sectors that have the main pressure on the environment. Background pressure that cannot be specifically tied to a sector has been identified and included in the cumulative effect. The sectors also entail pressures, such as air emissions, marine litter, invasive species, and cultural environments that are not currently addressed in Symphony. These are described after the analysis of the Symphony results. The environmental effects are described based on the Marine Strategy Framework Directive's pressures, which are described in Chapter 4.

6.2.1 Baltic Sea

The areas within the Baltic Sea that show the greatest cumulative environmental effect are northern Öresund around Ven and along the coast in the Stockholm archipelago (SwAM, 2018a). Here, there are sensitive ecosystems and many different pressures. Farther out to sea, the environmental effects are extensive in the southern Baltic Sea around Bornholm and in the central Baltic Sea south-east of Gotland (approx. 30% of the highest value in the Baltic Sea), see Figure .

In these areas, there is a lack of oxygen and there are pollutants of various kinds in the sediments. Especially low environmental effects can be seen at Listerland in Hanöbukten, off of Stockholm archipelago, and in large areas south of Gotland that form Natura 2000 areas (Hoburgs bank and the Midsjöbanks). The environmental effect is also low in south-western Skåne, off of Västervik's archipelago and around Salvorev and Gotska Sandön.

The sectors that contribute to the cumulative effect are Transportation and communication, Defence, and Commercial fisheries. Transportation and communication contribute around 7% and consist mainly of *underwater noise* and a smaller portion of *introduction of pollutants* (oil spills). Shipping also entails emissions to air and the spread of invasive species. Defence contributes by around 2% and consists of some *introduction of pollutants* and *underwater noise* from explosions. Commercial fisheries has a share in the effects of around 3% through impact of bottom trawling and pelagic fishing, including *selective withdrawals of species*, and *physical disturbance*. The largest share of the environmental effect in the Baltic Sea comes from the background pressure, around 88%, of which eutrophication is the largest cause (60%). The single largest pressure is oxygen-free bottoms (around 36%), which are also a source of phosphorous, which accounts for around 8%. Also contributing to the cumulative environmental effect are pollutants in sediments from historical emissions (synthetics approx. 16%, heavy metals approx. 10%) and nitrogen (approx. 14%) and a small share from pollutants from military activity from World War II (organic/inorganic approx. 3%, heavy metals from mines < 1%).

The cumulative effects in the Baltic Sea are mainly visible in the deep soft seabeds, and also on herring, plankton, and sprat. There is also some impact on deep transport bottoms, spawning fish, cod, porpoises, and aphotic soft and transport bottoms.

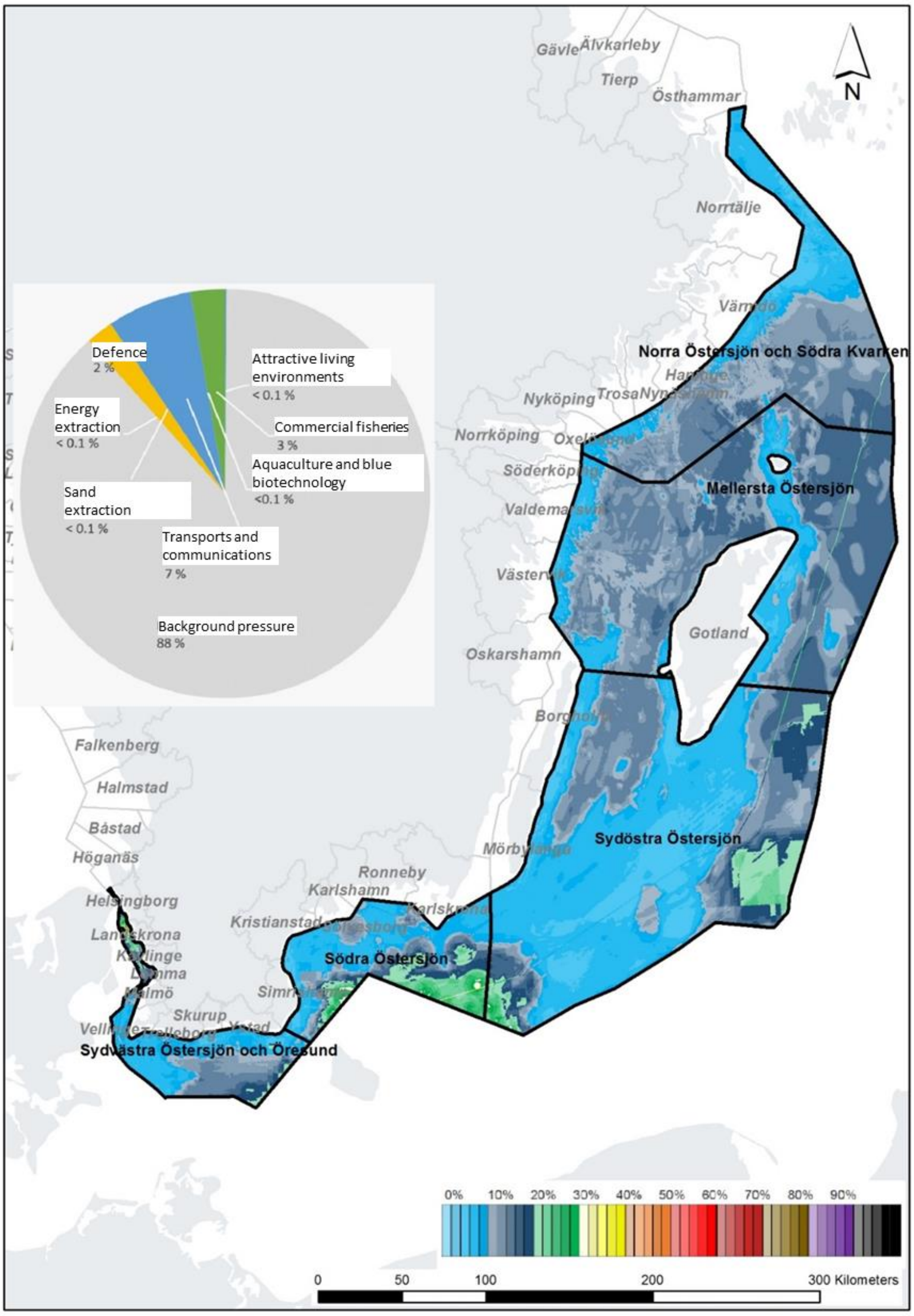


Figure 21. The total cumulative environmental effect in the Baltic Sea marine spatial planning area for the present situation. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea including coastal areas. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect at present. The colours in the pie chart indicate sectors.

Other pressures that are not analysed in Symphony

Besides the above-listed pressures, the Transportation and communications sector contributes to the cumulative environmental effect with, among other things, air emissions (*introduction of pollutants*), *introduction and relocation of invasive species*, and *marine litter*. The sectors of Commercial fisheries and Attractive living environments also contribute air emissions (*introduction of pollutants*) and *marine litter*. Today, these pressures are not included in Symphony. Below is a brief description of these pressures based on an assessment of how sensitive the marine areas are to these pressures, and in Chapters 7 and 8 the environmental effects are assessed based on the areas' sensitivities.

Air quality

The environmental objective of "Fresh Air" that is to be achieved by 2020 has an interim goal specified as "emissions of sulphur dioxide, nitrogen oxides, and particulates shall have begun decreasing from shipping traffic in the Baltic Sea and the North Sea no later than 2016" (Swedish Environmental Protection Agency, 2016). The interim goal was considered to have been achieved on time, while there is still a way to go to achieve the environmental quality objective for 2020.

Emissions of NO_X gases from shipping have gradually increased in the Baltic Sea (Swedish Institute for the Marine Environment, 2016b), while emissions of sulphur dioxide are decreasing (Swedish Environmental Protection Agency, 2016). From 1 January 2015, new rules limit sulphur dioxide emissions from shipping, and this will reduce these emissions further (Swedish Institute for the Marine Environment, 2016b). Within the marine spatial planning area, the amount of NO_X gases is the highest in Öresund and the Southern and the Northern Baltic Sea where shipping is most extensive (SMHI, 2016). The particle content has in general decreased in the Baltic Sea's area in recent years, but is highest in the Northern Baltic Sea marine area (Swedish Environmental Protection Agency, 2016). In a comparative perspective between the MSPs, the sulphur emission from shipping are higher in the Baltic Sea than in Skagerrak and Kattegat, while the conditions for NO_X gases are the opposite (SMHI, 2016).

The air quality generally appears to be on the way to improving, but the levels of NO_X gases are still increasing. Because air quality continues to be sensitive to further impact from emissions to air, all marine areas are given a moderate value (2), although the Northern Baltic Sea and Södra Kvarken receive a high value (3) because the particle content and amount of NO_X gases there are higher and thus there is a higher priority to address these within this marine area, see Table 4.

Greenhouse gases

The environmental quality objective "Limited quality impact" specifies that the concentration of greenhouse gases shall be stabilised at 400 ppmv. The objective is considered to be able to be achieved by 2020. Even if the emissions of greenhouse gases from the marine sector are small in relation to total emissions in Sweden, they correspond to a significant factor and are especially relevant at present because the emissions from shipping are increasing year by year. These emissions must, however, be put into the perspective that shipping entails comparatively lower greenhouse gas emissions than most other means of transport. As a result of the environmental quality objective and the prevailing awareness of the significance of greenhouse gases to the future climate, the interest is set at high (3) for all of the marine sub-regions, see Table 4.

Invasive species

In the environmental objective “A rich plant and animal life”, there is the specification that invasive species and genotypes shall not threaten biodiversity. In the areas where invasive species are not present or are few in number, or do not have an impact on biodiversity, the assessment is that the sensitivity value is high (3).

Invasive polychaetes, plant plankton, and diatom species occur in all marine areas in the Baltic Sea. The Chinese mitten crab has also been encountered in the Southern Baltic Sea’s coastal area, while the round goby has been encountered in the Central, South-eastern, and Southern Baltic Sea and the warty comb jelly has been encountered in Öresund and the Northern and Central Baltic Sea. The value of the interest is considered to not be high for these marine areas. The value for invasive species is considered to be moderate (2) in all marine areas because it generally appears to be a distributed occurrence of invasive flora and fauna (WSP Sverige AB, 2017). Many animal species have difficulties with establishment, but the area’s conditions mean that extensive damage could occur upon establishment and the area thereby has a high degree of sensitivity. Uncertainty regarding this interest is high because the knowledge situation is low.

Marine litter

Littering negatively affects the value for outdoor recreation because the sea landscape’s attractiveness decreases. Benefits from reducing marine littering include higher aesthetic values and improved possibilities for recreation and tourism (SwAM, 2012b). (Havs- och vattenmyndigheten, 2012b)

There is currently limited data on marine litter in the open sea. Compared with litter on beaches, the litter at sea is spread over a wider area, which makes it harder to collect and measure. Lost and forgotten equipment and nets, such as cages and traps, are left in the sea and animals and objects get stuck in them. So-called ghost nets kill fish, birds, and marine mammals in our seas every year. Ghost nets affect people when they are visible on the surface, but otherwise mostly only affect the marine bottom dwellers (SwAM, 2015c). (Havs- och vattenmyndigheten, 2015c) The large-scale surface currents are on average directed out from the Baltic Sea, and floating litter is transported away from the Baltic Sea (SwAM, 2012b). Large plastic particles occur to the greatest extent in coastal areas in the Northern and Southern Baltic Sea (outside the marine spatial planning area), but the occurrence is also high in Öresund. In the Northern Baltic Sea, the amount of macroplastic varies from low to relatively high, and the marine area has a low occurrence of ghost nets. The situation for the Central Baltic Sea is similar to the Northern Baltic Sea, but the amount of macroplastic occurs to a greater extent around Gotland, and the occurrence of ghost nets north of Öland and east of Gotland is also higher. In the South-eastern Baltic Sea, the occurrence of macroplastic is moderate to high in all areas except in connection with the large offshore banks where the occurrence is low. Ghost nets occur to a greater extent in the northern part (east of Gotland) and in the southernmost part of the marine area. The occurrence of macroplastic is high in the Southern Baltic Sea in general, and the occurrence of ghost nets is very high in almost the entire marine area, but lower at the edges of the area. In Öresund, the occurrence of plastic is moderate to high, and the amount of ghost nets varies from a low degree to a very high degree in some locations (Wijkmark, N. & Enhus, C., 2015).

The environmental objective "Sea in balance and living coasts and archipelagos" specifies the preservation of the values of outdoor recreation where marine litter is viewed as a reduction in the recreation values at sea. Outdoor recreation is considered to not be especially impacted by marine litter in the offshore areas, but at the same time, all marine areas have a high occurrence of marine litter. All marine areas are therefore given a low value (1) except the South-eastern and Central Baltic Sea where the value is considered to be moderate (2) because the quality is somewhat higher (WSP Sverige AB, 2017), see Table 4.

Table 4 Assessed sensitivity for the respective marine areas to the pressures *air emissions* (air quality, greenhouse gases), *invasive species*, *marine litter*, and cultural environments. The respective interest is assessed regarding its value and sensitivity according to a three-degree scale – low (1), moderate (2), and high (3).

Assessed value[5] by marine area	**Air quality** (NOx or particles)	**Greenhouse gases** (CO_2 or other greenhouse gases)	**Invasive species** (extensive uncertainty - lack of knowledge)	**Littering** (litter from fishing, shipping, and tourism)
Northern Baltic Sea and Södra Kvarken	3	3	2	1
Central Baltic Sea	2	3	2	2
South-eastern Baltic Sea	2	3	2	2
Southern Baltic Sea	2	3	2	1
South-western Baltic Sea and Öresund	2	3	2	1

6.2.2 Northern Baltic Sea and Södra Kvarken

The cumulative effects in the Northern Baltic Sea and Södra Kvarken mainly come from the sectors Defence (approx. 4%) and Transportation and communication (approx. 5%) through *underwater noise* and *introduction of*

[5] Assessed sensitivity value in accordance with the SEA in the discussion phase (WSP Sverige AB, 2017)

pollutants. Effects from defence activities come from the spread of heavy metals and noise from explosions. In the Transportation and communication sector, shipping contributes *underwater noise* and *oil spills*. The largest share of the cumulative effects comes from the background pressure, approx. 91%, which is caused by oxygen-free seabeds (approx. 44%) and the eutrophication-related nutrients nitrogen (approx. 11%) and phosphorous (approx. 8%) and other pollutants in sediments (synthetics approx. 15%, heavy metals approx. 12%). A very small part (<1%) of the environmental effect can be related to heavy metals from mines from World War II. Attractive living environments and Commercial fisheries have a small contribution to the cumulative effect. The environmental effect is highest (16-20% of the highest value in Baltic Sea) in the deep areas in the eastern parts of the marine area. The cumulative effects in the Northern Baltic Sea and Södra Kvarken are seen mainly on deep soft seabeds, but also on herring, plankton, and sprat. A smaller effect can also be seen on deep transport bottoms, aphotic hard and transport bottoms, and on grey seals and spawning fish.

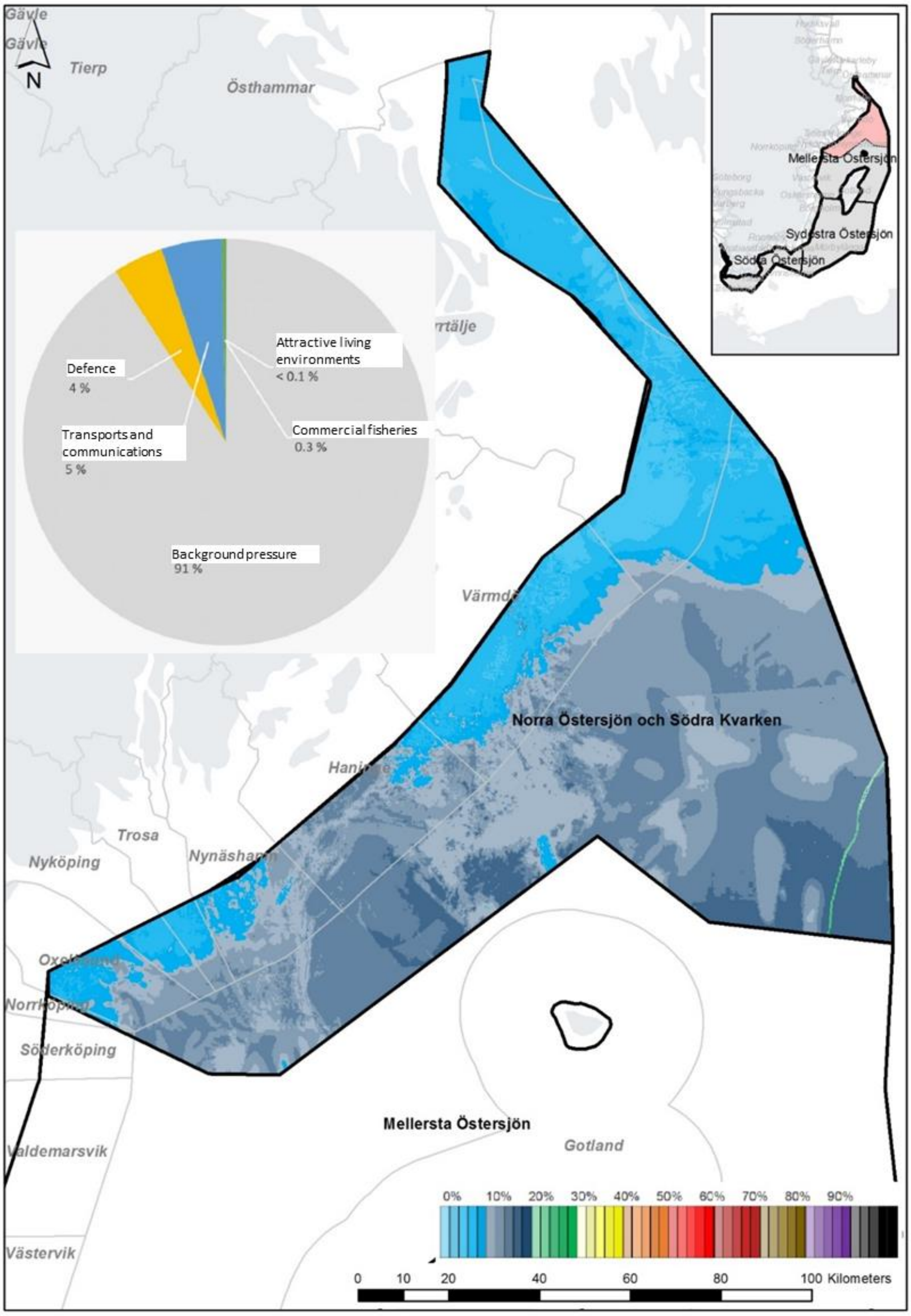


Figure 21 The total cumulative environmental effect in the Northern Baltic Sea and Södra Kvarken in the current situation. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect at present. The colours in the pie chart indicate sectors.

6.2.3 Central Baltic Sea

The cumulative effects in the Central Baltic Sea come mainly from the Transportation and communication sector, which contributes around 4%, mainly *underwater noise* and *introduction of pollutants* (oil spills), see Figure 22. Defence activities also contribute with *introduction of pollutants* (heavy metals) and *underwater noise* from explosions, around 1% in total. Commercial fisheries, Attractive living environments, and Aquaculture and blue biotechnology contribute a very small percentage, less than 1%. The largest part of the cumulative effects comes from background pressure, around 94%. These largely consist of oxygen-free bottoms (approx. 43%), nitrogen (approx. 11%), and phosphorous (approx. 7%), which can be related to eutrophication, and other pollutants in sediment (synthetics approx. 17%, heavy metals approx. 16%). A very small part (<1%) of the environmental effect can be related to heavy metals from mines from World War II. The cumulative effects in the Central Baltic Sea are mainly seen on deep anoxic soft seabeds, which are represented by the dark colours in the eastern parts of the marine area (16–25% of the highest value in the Baltic Sea). The environmental effect is also noticeable on herring, plankton, sprat, and spawning fish. Some effect can also be seen on deep transport bottoms and aphotic hard, soft, and transport bottoms.

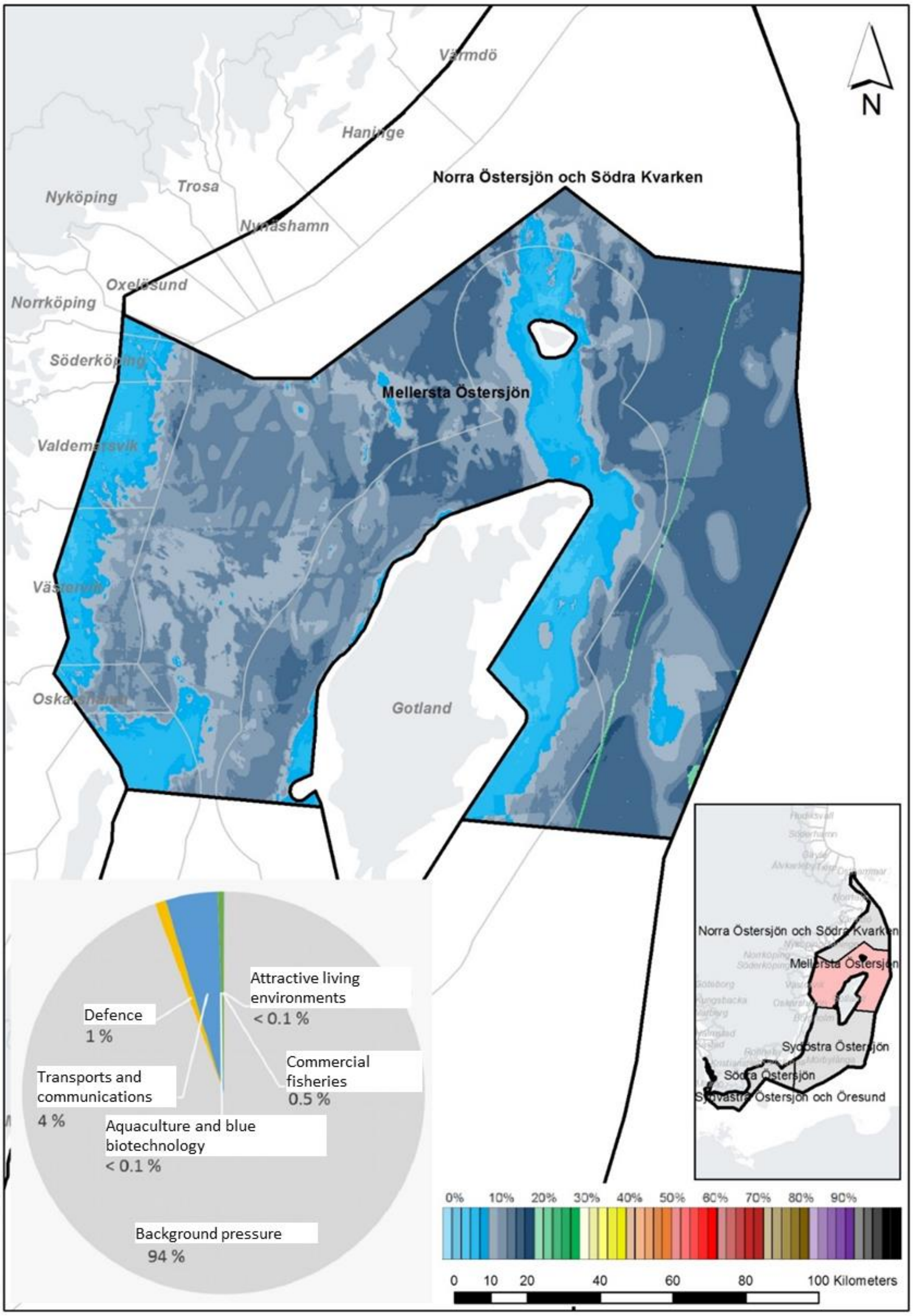


Figure 22 The total cumulative environmental effect in the Central Baltic Sea in the present situation. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect at present. The colours in the pie chart indicate sectors.

6.2.4 South-eastern Baltic Sea

In the south-eastern parts of this marine area, there are two of the areas that have the highest environmental impact in the Baltic Sea marine spatial planning area (up to 30% of the maximum effect). The largest cumulative effect comes from background pressure, around 90%. This largely consists of oxygen-poor bottoms (approx. 34%), nitrogen (approx. 17%) and phosphorous (approx. 10%), and pollutants in sediment (synthetics approx. 17%, heavy metals approx. 7%). A smaller share from pollutants from military activity from World War II (organic/inorganic approx. 5%, heavy metals from mines <1%). The sectors' contribution to the cumulative effects in the South-eastern Baltic Sea comes mainly from Transportation and communication, which contributes around 8% consisting of *underwater noise* and *introduction of pollutants* (oil spills), and a small share, around 2%, comes from Commercial fisheries and is linked to effects from pelagic and bottom trawling, i.e. *selective withdrawals of species* and *physical disturbance*, see Figure 23. Attractive living environments and Energy contribute a very small share. The effects are mainly seen on deep soft seabed, but also on plankton and herring and sprat, cod, spawning fish, porpoises, and aphotic and deep transport bottoms.

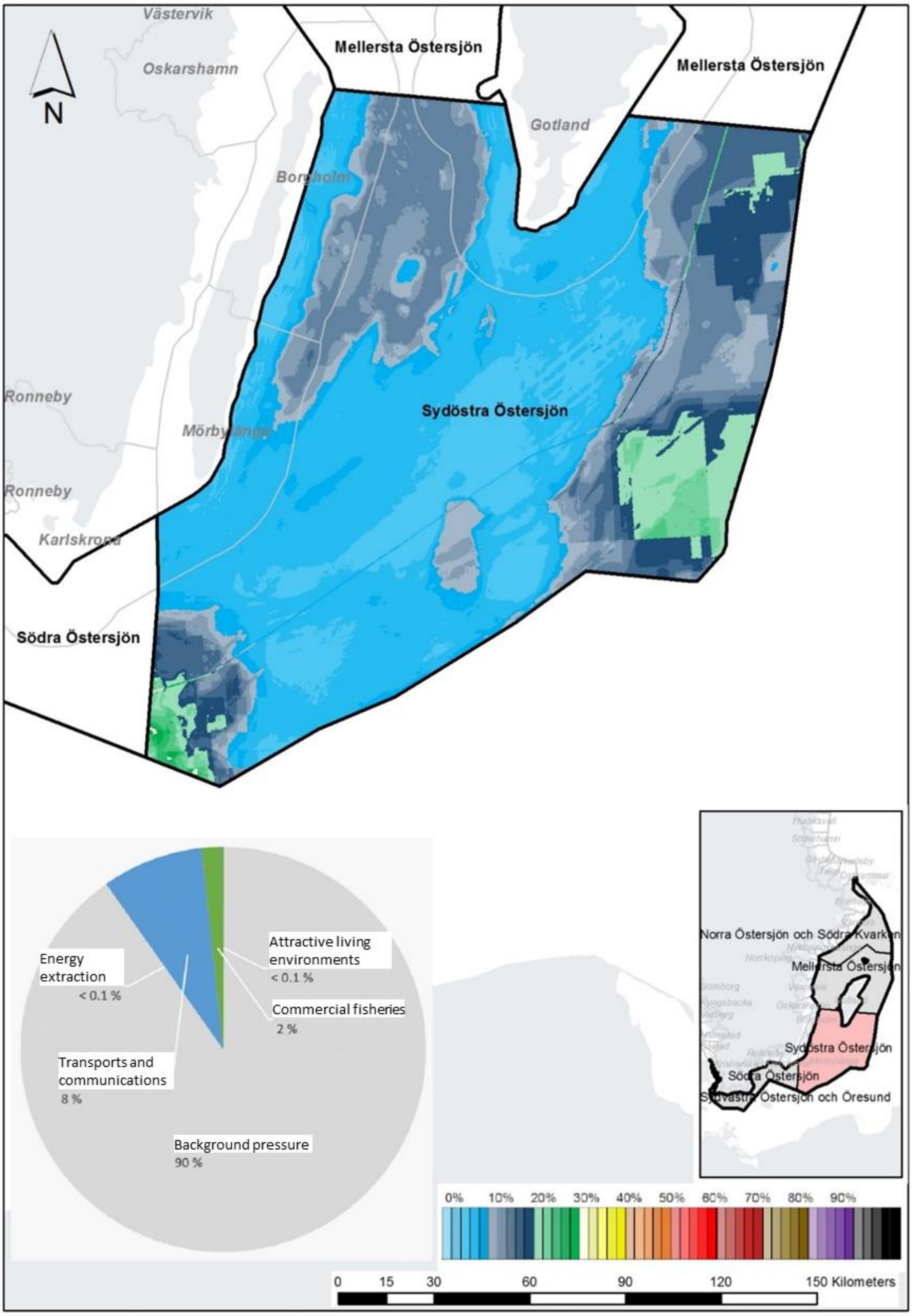


Figure 23 The total cumulative environmental effect in the South-eastern Baltic Sea in the present situation. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect at present. The colours in the pie chart indicate sectors.

6.2.5 Southern Baltic Sea

The sectors that contribute to the cumulative effect in the Southern Baltic Sea are Commercial fisheries, Transportation and communication, and a small share from Defence, see Figure 24. Commercial fisheries contributes around 10% and includes effects from bottom trawling and to some extent pelagic trawling, including *selective withdrawal of species* and *physical disturbance*. Transportation and communications account for around 8% of the cumulative effect and includes *underwater noise* and *introduction of pollutants* (oil spills from shipping). Defence activities contribute with around 2% and include *introduction of pollutants* (heavy metals) and *underwater noise* from explosions. The background pressure accounts for around 80% of the cumulative effect mainly in the form of oxygen-free bottoms (approx. 21%), nitrogen (approx. 19%), and phosphorous (approx. 8%). A large share of the background pressure also constitutes pollutants in sediments (synthetics approx. 14%, heavy metals approx. 5%) and pollutants from military remains (organic/inorganic approx. 13%). Attractive living environments contribute marginally to the effect. In the north-western part of the marine area, the cumulative environmental effect is the lowest (approx. 5%), and in the south-eastern part the cumulative environmental effect the highest (approx. 30%) in the Baltic Sea marine spatial planning area.

The cumulative effect is seen mainly in deep soft seabeds, cod, and herring, but also plankton, spawning fish, aphotic transport and soft seabeds, porpoises, and sprat.

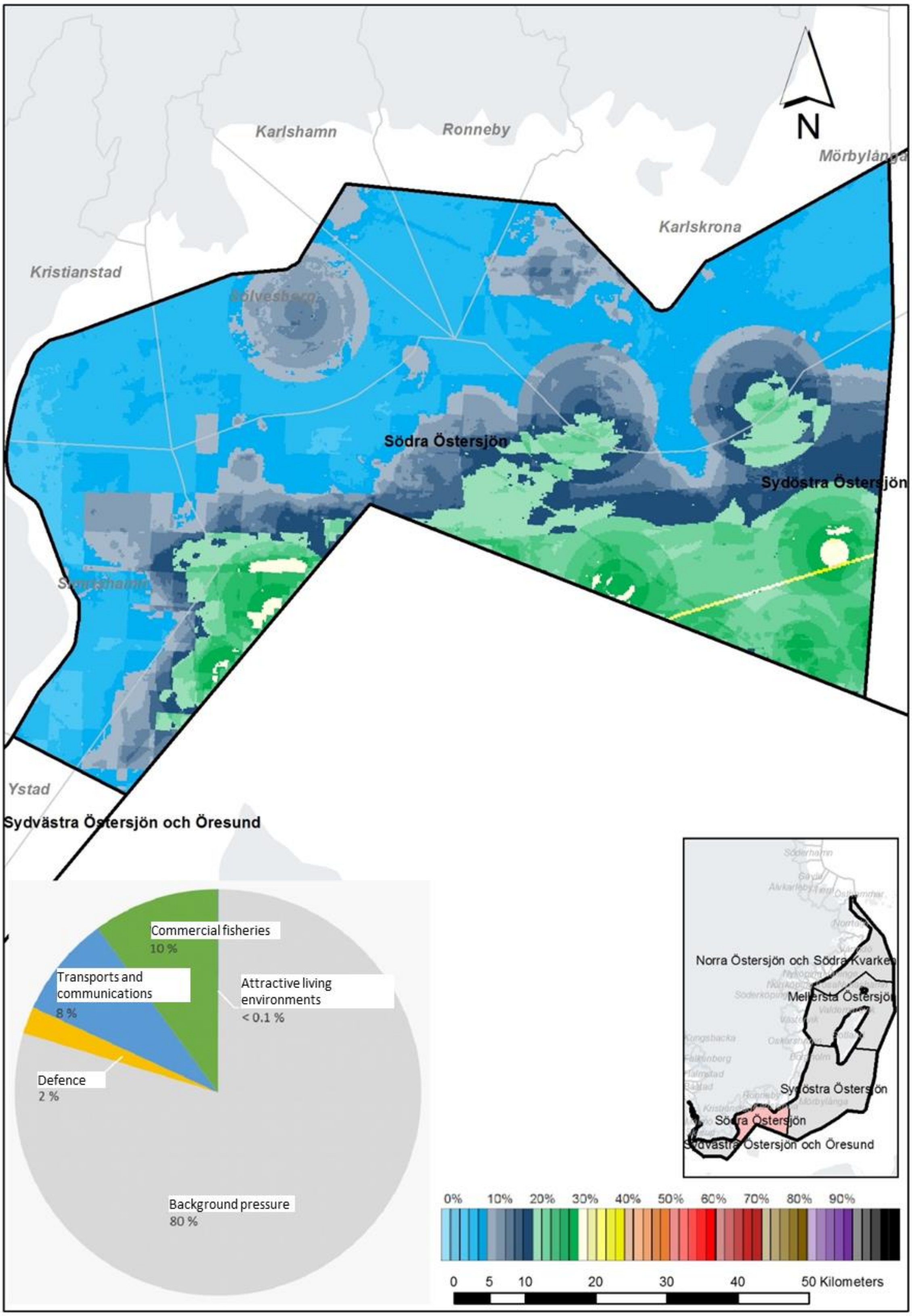


Figure 24 The total cumulative environmental effect in the Southern Baltic Sea in the present situation. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect at present. The colours in the pie chart indicate sectors.

6.2.6 South-western Baltic Sea and Öresund

The cumulative effect in the South-western Baltic Sea and Öresund are relatively evenly distributed between the sectors Defence, Commercial fisheries, and Transportation and communication, see Figure 25. Defence contributes around 14% and consists mainly of *underwater noise* from explosions, and to a small extent *introduction of pollutants* (spread of heavy metals). Commercial fisheries contributes around 15% with *selective withdrawals of species* through catches of all types of fishing and *physical disturbance* through bottom trawling. Transportation and communications account for around 16% and consists mainly of *underwater noise* and also to a certain extent *introduction of pollutants* (oil spills) and *physical disturbance* from increased turbidity. Here, Attractive living environments, Storage and extraction of material, and Energy also contribute with less than 1%. Compared with the other parts of the marine spatial planning area, the background pressure constitutes a smaller share of around 54% of the cumulative effect in the marine area. The background pressure includes nitrogen (approx. 19%), oxygen-free seabeds (approx. 12%), pollutants in sediment (synthetics approx. 12%, heavy metals approx. 3%), and phosphorous (approx. 7%). A very small part (<1%) of the environmental effect can be related to heavy metals from mines from World War II.

The cumulative effect is seen mainly in cod and spawning fish, as well as plankton, herring, sprat, porpoises, offshore sea birds, coastal birds, and mussel banks. Besides the marine flora and fauna, pressures are noticed from sectors on mainly aphotic and photic soft seabeds and aphotic and photic transport bottoms.

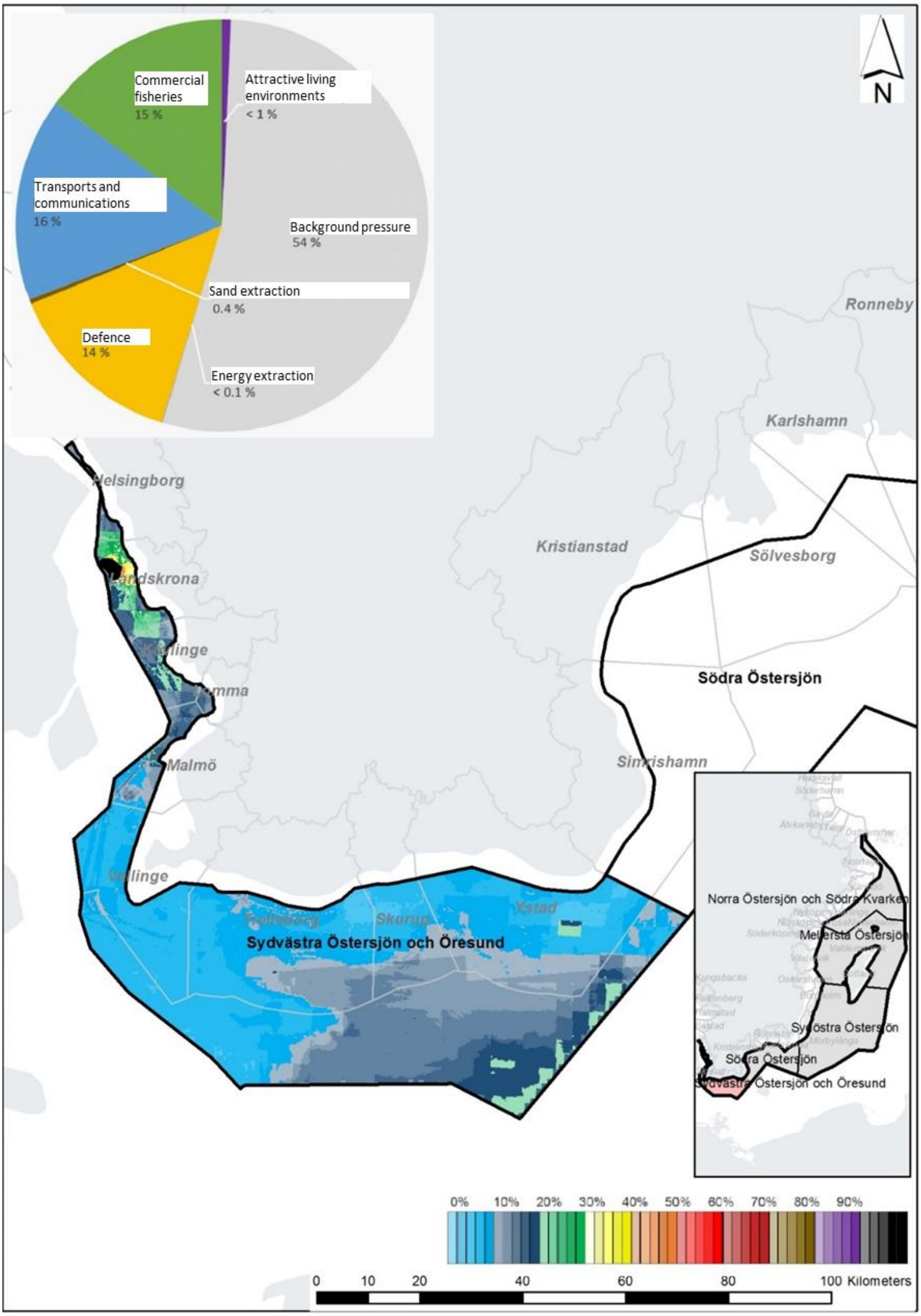


Figure 25 The total cumulative environmental effect in the South-western Baltic Sea and Öresund in the present situation. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect at present. The colours in the pie chart indicate sectors.

7 Zero alternative

This chapter describes the zero alternative as a trend projection for the plan's sectors until 2030 with a prospective view towards 2050. The cumulative environmental effect for the zero alternative I 2030 (based on the Symphony planning method) is also described. The analysis for the sectors is completed with tables that illustrate the predicted change in pressure. An upwards mark in the table means an increased pressure and thereby a negative effect.

7.1 Sectors and themes

7.1.1 Attractive living environments

Marine tourism consists of various components that can be expected to develop differently over time. A number of trends of significance to the development of tourism are identified in WSP Sverige AB 2016, including a generally increasing tourism, a broader spread of niched tourism and ecotourism, and active holidays. The development of tourism and outdoor recreation is assumed to follow the population growth otherwise.
Marine tourism is expected to continue an upward trend (SwAM, 2017c), and an annual growth of recreational boats by several percentage points can be expected (WWF, 2010). In this analysis, a more cautious assessment is made of an increase by 5% by 2030 with reference to uncertainty in the estimates and a lack of a clear trend in actual statistics (SwAM, 2017d). However, recreational fishing is assessed to be relatively constant in scope until 2030 (SwAM, 2017d). With regard to tours with ferry and cruise traffic, an increase is expected to take place over time in the Baltic Sea (WWF 2010, SwAM 2015).

Underwater noise is expected to increase as a result of more cruise and ferry traffic. In SwAM's action programme for the marine environment, no proposals are made on measures to reduce underwater noise, which is why the pressure is expected to increase in proportion to the sector's development (SwAM, 2017d). Air pollution can also be expected to increase with the development of the activities, but to a somewhat lesser extent because regulations can be expected to be strengthened and complied with to a greater extent over time. With proposed measures in SwAM (2015d) regarding the collection of litter and lost fishing equipment, along with prevention measures, littering is expected to decrease (SwAM, 2017d).

Table 5 Attractive living environments (Recreation, tourism, cultural environments) – sector development and development of pressures until the reference year 2030.

	SECTOR DEVELOPMENT	PRESSURE DEVELOPMENT			
	*	Withdrawal of species	Underwater noise	Air pollution	Littering
ANGLING	→	→	→	→	↘
RECREATIONAL CRAFT	↗	-	↗	↗	↘
CRUISE SHIP SERVICE	↗	-	↗	↗	↘
FERRY TRAFFIC	↗	-	↗	↗	↘

* ↑ sharp increase (+10%), ↗ moderate increase (+5%), → unchanged situation, ↘ moderate decrease (-5%), ↓ sharp decrease (-10%)

7.1.2 Energy

With the current political objectives in the energy and climate area (e.g. a target of 100% renewable energy production by 2040 (Energy Commission, 2017)), there is pressure on the expansion of renewable energy, where wind power is expected to play an important role. According to the Swedish Energy Agency, sea-based wind power has extensive potential, but the expansion of wind power on land is currently relatively competitive, which inhibits the development at sea (Swedish Energy Agency, 2017a). Current support for sea-based wind power through the electricity certificate system is assessed to be inadequate to make the alternative competitive. On behalf of the Government, the Swedish Energy Agency has prepared a proposal on systems for the repeal of connection charges for sea-based wind power. Repealed connection charges entail a significant reduction in cost[6] (Swedish Energy Agency, 2018). If the connection charge is repealed, it can have a significant positive impact on the establishment of wind power at sea.

Development for wind power in the marine spatial planning area until 2030 depends on multiple factors, such as the development of technology, costs, electricity prices, and political action in the form of implementation of incentive funding. The Swedish Energy Agency (2017a) assesses that a limited establishment will take place by 2030 and that the development will not gain speed until after 2030.

In the marine spatial planning area, there are two current permits, Kriegers flak with a permit to build 120 turbines with an installed power of 640 MW, and Taggen, located in Hanöbukten, with permits to construct 60 turbines with 415 MW of installed power. Trends identified for technical development are that the turbines are becoming taller and the rotor blades longer, and that the foundation technology is developing (WSP Sverige AB 2016, the Swedish Energy Agency 2017a, SwAM 2017d). The development towards larger rotor blades is going quickly (SwAM, 2017d), and it is having an impact on the number of turbines that are suitable to build per area and their distance in

[6] Personal contact with Maria Stenkvist, Swedish Energy Agency, 12 December 2017.

relation to each other. Expected development of floating power stations will make it possible to place wind farms at a deeper depth than today and with potentially lower conflict with other interests. Establishment of floating power stations is not expected until after 2030 (Swedish Energy Agency 2017a, SwAM 2017d).

Referring to a strong political desire to speed the transition to renewable energy production and on-going investigations in the area, some establishment of wind power can take place in the marine spatial planning area, and the permitted establishments are likely to become a reality. In the zero alternative and associated estimates in Symphony, the assumption is therefore made that wind power will be conducted in the areas that currently have permits and in the areas with existing production.

Potential exists for the development of wave power in Sweden, but development is not expected until possibly after 2030. In light of the activities not being expected to increase in scope by 2030, no change is expected in the activities' pressures on the environment.

Table 6. Energy - sector development and development of pressures until the reference year 2030. Assessment of the pressure is based on the development increasing significantly, but mainly after 2030.

	SECTOR DEVELOPMENT	PRESSURE DEVELOPMENT			
	*	Physical loss	Biological disruption	Underwater noise	Physical disruption
WIND POWER	↗	↗	↗	↗	↗
POWER FROM WAVES, CURRENTS, TIDES, AND SALINITY GRADIENTS	→	→	→	→	→

* ↑ sharp increase, ↗ moderate increase, → unchanged situation, ↘ moderate decrease, ↓ sharp decrease

7.1.3 Defence

The Government bill on the defence policy direction (Government bill 2014/15:109) describes a changed defence policy situation that motivates increases in the Swedish Armed Forces' activities. A parliamentary decision from 2015 on increased investments in military capacity is expected among other things to mean that training activities and signal surveillance will increase in the marine areas (Government bill 2014/15:109). A likely development in signal surveillance is that permanent facilities are replaced by mobile facilities, and today no fixed installations are expected to be established. A likely development is the expanded use of virtual exercises that to some extent can replace the need for physical artillery exercises, but effects can be expected only after 2030 (WSP Sverige AB 2016, SwAM 2016c). Military activities' pressures can be expected to increase proportionately with the sector's development by 2030.

Table 7. Defence - sector development and development of pressures until the reference year 2030.

	SECTOR DEVELOPMENT	PRESSURE DEVELOPMENT	
	*	Underwater noise	Introduction of hazardous substances
ARTILLERY RANGE/TRAINING AREA	↗	↗	↗
DUMPED AMMUNITION	↗	↗	↗

* ↑ sharp increase (+10%), ↗ moderate increase (+5%), → unchanged situation, ↘ moderate decrease (-5%), ↓ sharp decrease (-10%)

7.1.4 Storage and extraction of materials

In the marine spatial planning area for the Baltic Sea, there are a few deposits with sand and gravel with geological conditions for extraction (SGU, 2017). In the Stockholm region, major investments in urban development are under way and are being planned, which entails large demands for building materials. Today, a relatively large share of natural gravel is used in aggregate production in the region, which might entail an increased demand for marine sand and gravel as replacement material in the long term (SGU, 2017). This is on the condition that it is financially advantageous, which depends on several different factors, such as the supply of natural gravel on land, prices for the production of replacement material from crushed rock, and a political will that, among other things, is shown through incentives for the respective form of extraction. The increased demand can be expected to lead to sand being extracted in the Baltic Sea after 2030 to a greater extent than today. In the zero alternative, extraction is assumed to only take place in the existing area at Sandhammar bank with no new establishment for extraction of marine sand and gravel in the current marine spatial planning area.

A study done in 2016 on behalf of SGU shows that there is extensive potential for carbon dioxide storage in Sweden (SGU, 2016). Because carbon dioxide storage is a technology that has potential to contribute to achieving set climate objectives, demand can be expected to increase in the long term (WSP Sverige AB, 2016). A relatively slow development of the method and a potentially large opposition due to uncertainty regarding risks with the technology contribute to the assessment that some development of carbon dioxide storage in the Baltic Sea can take place, but only after 2030 (SGU, 2016).

Table 8. Extraction and storage of materials - sector development and development of pressures by the reference year 2030.

	SECTOR DEVELOPMENT	PRESSURE DEVELOPMENT	
	*	Physical disruption	Physical loss
CARBON DIOXIDE STORAGE	→	→	→
SAND EXTRACTION	→	→	→

* ↑ sharp increase (+10%), ↗ moderate increase (+5%), → unchanged situation, ↘ moderate decrease (-5%), ↓ sharp decrease (-10%)

7.1.5 Nature

The assessment is that several interests that affect and make claims on the physical environment will increase by 2030, including shipping, defence activities, and aquaculture. Other interests such as Commercial fisheries and energy production are not expected to decrease from today's levels. Introduction of nutrients to the Baltic Sea has decreased since the 1980s (Swedish Institute for the Marine Environment, 2016a), and a trend for reduced introduction of nutrients from agricultural and water treatment plants is expected to continue (SwAM, 2017b). Among other things, due to the low inflow of oxygen-rich water into the Baltic Sea, the recovery from eutrophication problems is estimated to take a very long time, even though the pressures appear to decrease over time. Effects from climate change are also expected to increase by 2030 and taken together are expected to entail further stress on the marine ecosystems from, among other things, acidification, change of the water's salinity, and a greater risk for the spread of invasive species.

The objective for expanded introduction of marine area protection will probably lead to more protected areas in 2030 (SwAM 2016d). In the zero alternative, it is therefore assumed that by 2030 area protection will be introduced in areas where the introduction of protection is planned today.

7.1.6 Transportation and communications

According to forecasts by the Swedish Transport Administration (2016), considering among other things population growth, economic development, surrounding world factors, and some regulation of shipping (IMO's Sulphur Convention and the EU Sulphur Directive), the transport of goods at sea in Sweden is expected to increase by a maximum annual growth of 2.3% (Swedish Transport Administration, 2016). From today to 2030, this entails an increase of around 30% of transport work (tonne kilometres) in Swedish waters. WWF (2010) describes a higher growth rate, with a doubling of the number of vessels from 2010 to 2030. Based on these two sources, the zero alternative is expected to provide an increase in the pressure from the sector of 50% until 2030.

Existing areas for shipping lanes are considered to be adequate for handling an expected increase. A general trend that is expected to continue is that the ships will become larger. However, the bridge height in the Great Belt and the water depth in Öresund limit the size of ships in the Baltic Sea. The on-going trend of increasing cruise and ferry traffic can also be expected to continue. Assumptions are made that dredging of existing shipping lanes might need to increase to enable passage of deeper-running vessels.

With more activity in existing shipping lanes, the risk of collision increases, as well as the risk of running aground, with associated risks to people and the environment (WSP Sverige AB, 2016). Shipping emissions to the air are regulated by several national and international regulations, such as the EU Sulphur Directive and IMO's Sulphur Convention. Regulations and provisions can affect the supporting infrastructure and the possibilities of bunkering as ships transition to alternative fuels, which might in turn affect the routes and movement patterns of shipping. Through the implementation of the Ballast Water Convention in the autumn of 2017, where ballast water must be cleaned before release, effects in connection with the spread of invasive species are expected to decrease by 2030.

Table 9. Defence - sector development and development of pressures until the reference year 2030.

	SECTOR DEVELOPMENT	PRESSURE DEVELOPMENT				
	*	Physical disturbance (impact on the seabed)	Under water noise	Emission of oil and hazardous substances	Emission of air pollutants	Introduction and spread of invasive species
MARITIME TRANSPORTS	↑	↑	↑	↑	↑	↘
DUMPING OF DREDGED AMOUNTS	↗	↗	-	-	-	-

* ↑ sharp increase, ↗ moderate increase, → unchanged situation, ↘ moderate decrease, ↓ sharp decrease

7.1.7 Aquaculture and blue biotechnology

Technical and knowledge development can provide better conditions for farming in the sea farther from the coast and might potentially become relevant in the marine areas by 2030. Considering uncertainty in development, however, it is assumed that aquaculture will not be conducted in the marine areas in the assessment's zero alternative in 2030.

Table 10. Aquaculture and blue biotechnology - sector development and development of pressures by the reference year 2030.

	SECTOR DEVELOPMENT	PRESSURE DEVELOPMENT	
	*	Introduction of nutrients	Physical loss
AQUACULTURE	↗	→	→

* ↑ sharp increase (+10%), ↗ moderate increase (+5%), → unchanged situation, ↘ moderate decrease (-5%), ↓ sharp decrease (-10%)

7.1.8 Commercial fisheries

Demand for fish as food is extensive and is expected to grow (WSP Sverige AB, 2016). The structural conversion of Commercial fisheries already under way from smaller boats and one-man companies being replaced by larger units with higher capacity is expected to continue (SwAM, 2016d). The trend of a lower number of active fishermen is expected to be a part of this development.

Management, including regulations of fishing, is expected to lead to more possibilities of catches in the long term (SwAM, 2017d). However, fishing is expected to be stable until 2030. One of many uncertainties for the future is how climate change with a higher water temperature and expected lower pH in the seas will affect marine environments and fishing.

Establishment of marine area protection with fully or partly regulated fishing are measures that can be expected to lead to the protection of sensitive bottom environments and nursery areas for fish and other marine organisms. The on-going development of fishing equipment and methodology to reduce impact on the environment from fishing is expected to continue. Examples are the development of selective equipment for the reduction of by-catch and techniques for minimising damage to bottom environments (SwAM, 2016d). The withdrawal limits for commercial species that are set at a supranational level through the Common Fisheries Policy play an important role for the withdrawal of catches and thereby also for the consequences linked to the pressure *selective withdrawal of species*. Altogether, pressures from Commercial fisheries through physical disturbance and withdrawal of fish are expected to decrease by 2030.

Table 11. Commercial fisheries - sector development and development of pressures until the reference year 2030.

	SECTOR DEVELOPMENT	PRESSURE DEVELOPMENT	
	*	Selective withdrawal of species	Physical disturbance (from trawling)
BENTIC TRAWLING	→	↘	↘
PELAGIC TRAWLING	→	↘	↘
OTHER FISHING	→	↘	↘

* ↑ sharp increase (+10%), ↗ moderate increase (+5%), → unchanged situation, ↘ moderate decrease (-5%), ↓ sharp decrease (-10%)

7.2 Outlook towards 2050

7.2.1 Attractive living environments

In the maritime strategy prepared by the Ministry of Enterprise and Industry that points out the vision and strategy for maritime industries by 2050 (Ministry of Enterprise and Industry, 2015), the development potential for marine tourism is described as good. Demand from national and international tourism to participate in archipelago life and to use the sea for recreation is expected to increase. One of several conditions is that important natural and cultural values are preserved. Identified trends towards more active holidays, niched tourism, and ecotourism can also lead to other uses of the sea than today with a potential increased pressure on sensitive environments. With increased use of the sea for recreation, the activities' pressures can also be expected to increase even if they to some extent can change over time with other and different types of activities and pressures.

7.2.2 Energy

Political objectives regarding renewable energy production and technical development have will probably lead to it becoming more economically advantageous to build and operate wind turbines at sea in 2050 and that development will have gained speed. By 2050, development of floating wind turbines might also make it a commonly applied technology that also enables placement of wind turbines at a greater depth and at locations different from today. Regarding sea-based energy in the form of wave power and currents, development can be expected to take place until 2050, and investments from the Swedish Energy Agency are being made to increase the possibility of commercialisation (Swedish Energy Agency, 2017c). With expected strong development of sea-based wind power and some development of other types of energy at sea, pressures in the form of noise, light pollution, and physical loss and disturbance are expected to increase. An expected use of floating wind turbines might contribute to physical disturbances increasing to a lesser extent than the actual sector.

7.2.3 Defence

Technical development and changes in the defence policy situation make it very difficult to assess the total defence outlook for 2050 (WSP Sverige AB 2016). Described trends for scenario 2030 can be expected to also continue to 2050. Technical development is expected to enable virtual training, and this might reduce the sector’s pressures from artillery exercises in the long term (WSP Sverige AB 2016).

7.2.4 Storage and extraction of materials

It is likely that extraction of sand from the seabed will become increasingly important over time considering natural gravel resources on land being a finite resource that at the same time is important to preserve. By 2050, it is expected that demand and technology will have developed so that the conditions for carbon dioxide storage are good. Assumptions are made on the increase in carbon dioxide storage mainly in the Baltic Sea where the conditions according to studies are considered the best (SGU 2016).

7.2.5 Nature

By 2050, an even harder pressure on the marine environment is expected than 2030. A probable development is that energy production at sea will have become more profitable and that the establishment of wind farms will have gained speed along with the development of other energy sources at sea. Sand extraction, aquaculture, defence activities, and shipping can be expected to be conducted to a greater extent in the marine areas. It is also probable that political incentives and technical development will drive reduced pressures from these activities. For example, floating wind turbines might be common with reduced pressure on the physical environment and with potentially less conflict with other interests such as nature conservation.

A continued downward trend of nutrients to the Baltic Sea probably will probably have positive effects on eutrophication problems. But recovery of the ecosystems is a complex process and takes place slowly, and the status of the Baltic Sea in 2050 is uncertain. Regulation of withdrawals of marine species is still important for the status of the ecosystems' status and should take place adaptively according to the status of the stocks. In 2050, effects from climate change can be expected to be more extensive with potentially larger effects from acidification, warmer water temperatures, changed salinity levels, and the spread of invasive species.

7.2.6 Transportation and communications

Shipping in the marine areas is predicted to continue to increase until 2050. A potential scenario is that it in 2050 it will be common to have automatically controlled and unmanned vessels that might lead to a more efficient use of shipping lanes (SwAM, 2016d). A possible development is that regulation of shipping fuels will become more stringent over time to reduce environmental effects from air pollution and climate emissions. Such a development can lead to reduced emissions for individual transports, but it can be considered less likely that it will compensate for the greater amount of shipping, and the total pressure can therefore be expected to increase.

7.2.7 Aquaculture and blue biotechnology

The demand for seafood can be expected to continue to be extensive in 2050. It is possible that there will be other areas of use, for example, algae for the production of food, feed, and biogas. It is likely that an increased demand will contribute to a higher use of aquaculture in 2050. Technical development might make it possible for farming farther out at sea, and it is possible that co-existence will take place with permanent installations from, for example, energy production. To reduce nutrient leakage into surrounding environments from the farming of edible fish, farming in closed systems will probably take place in closed systems to a greater extent than today.

7.2.8 Commercial fisheries

The expected increased demand for fish and other seafood can potentially be partly met by production from aquaculture in the sea and on land. In addition to the activities' pressures on the marine environment and the fishing stocks, the possibilities of future withdrawals are also affected by other pressures and the seas' environmental status. The Baltic Sea and the Gulf of Bothnia are especially sensitive to disruptions that can affect fishing because the ecosystems are heavily burdened from eutrophication, pollution, overfishing, etc. The ecosystems' health, effects from climate change, etc., are uncertainties that make it difficult to forecast Commercial fisheries in 2050. Fisheries management is under constant development, and technical developments to minimise the environmental impact of fishing are expected to continue (SwAM, 2016e).

7.3 Cumulative effects - zero alternative

The cumulative effect for every marine area in the Baltic Sea for the zero alternative has been identified using Symphony. For the MSP and each marine area, the cumulative effect is described and illustrated based on the sectors that have the main pressure on the environment. Background pressures that cannot be specifically tied to a sector have been identified and included in the cumulative effect. The type of impact that the sectors contribute is linked to the pressures of the Marine Strategy Framework Directive.

7.3.1 Baltic Sea

The cumulative effect in the entire Baltic Sea marine spatial planning area comes from the sectors Transport and communication, and a small share from Commercial fisheries and Defence. The geographic spread of the environmental effect seen in Figure 27 differs only marginally from the present situation, but an increased environmental effect is seen in the South-western Baltic Sea and Öresund. In comparison with the present situation, the total environmental effect in the marine spatial planning area will increase by around 3%, but in the South-western Baltic Sea and Öresund the increase will be around 8%. The increase in the zero alternative compared with the present situation is illustrated in Figure 26, and this depends mainly on an increased pressure from shipping due to the development that the Transportation and communication sector will undergo until 2030.

The background pressure will still account for the largest share of the cumulative effect even in the zero alternative in the entire marine spatial planning area, around 87%, see Figure 27. Most of the background pressure consists of oxygen-free seabeds (36%), and also pollutants in sediment (heavy metals approx. 10%, synthetics approx. 16%), nitrogen (approx. 14%) and phosphorous (approx. 8%), and heavy metals from mines from World War II (approx. 3%). The Transportation and communication sector contributes around 10% to the total environmental effect and largely consists of *underwater noise* and some oil spills from shipping. Commercial fisheries contributes around 3% and consists of effects from trawling, including *physical disturbance* and *selective withdrawal of species*. Defence contributes around 1%, which consists of *introduction of pollutants*, i.e. spread of heavy metals, and effects from explosions. Attractive living environments, Energy, Storage and extraction of materials, and Aquaculture and blue biotechnology contribute extremely little.

The cumulative effects are seen mainly on deep and aphotic soft seabeds and aphotic and deep transport bottoms and on herring, plankton, sprat, spawning fish, and cod.

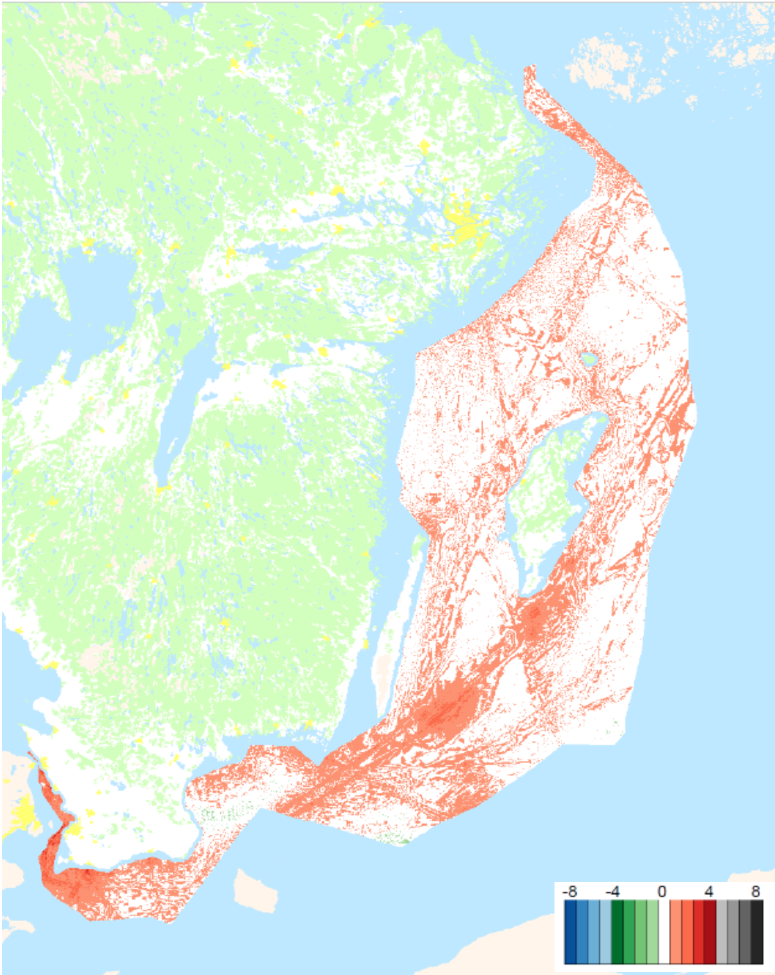


Figure 26 Change in cumulative environmental effect in per cent in the Baltic Sea in the zero alternative compared with the present situation. Positive values, in red and grey, result in a larger cumulative environmental effect compared with the present situation.

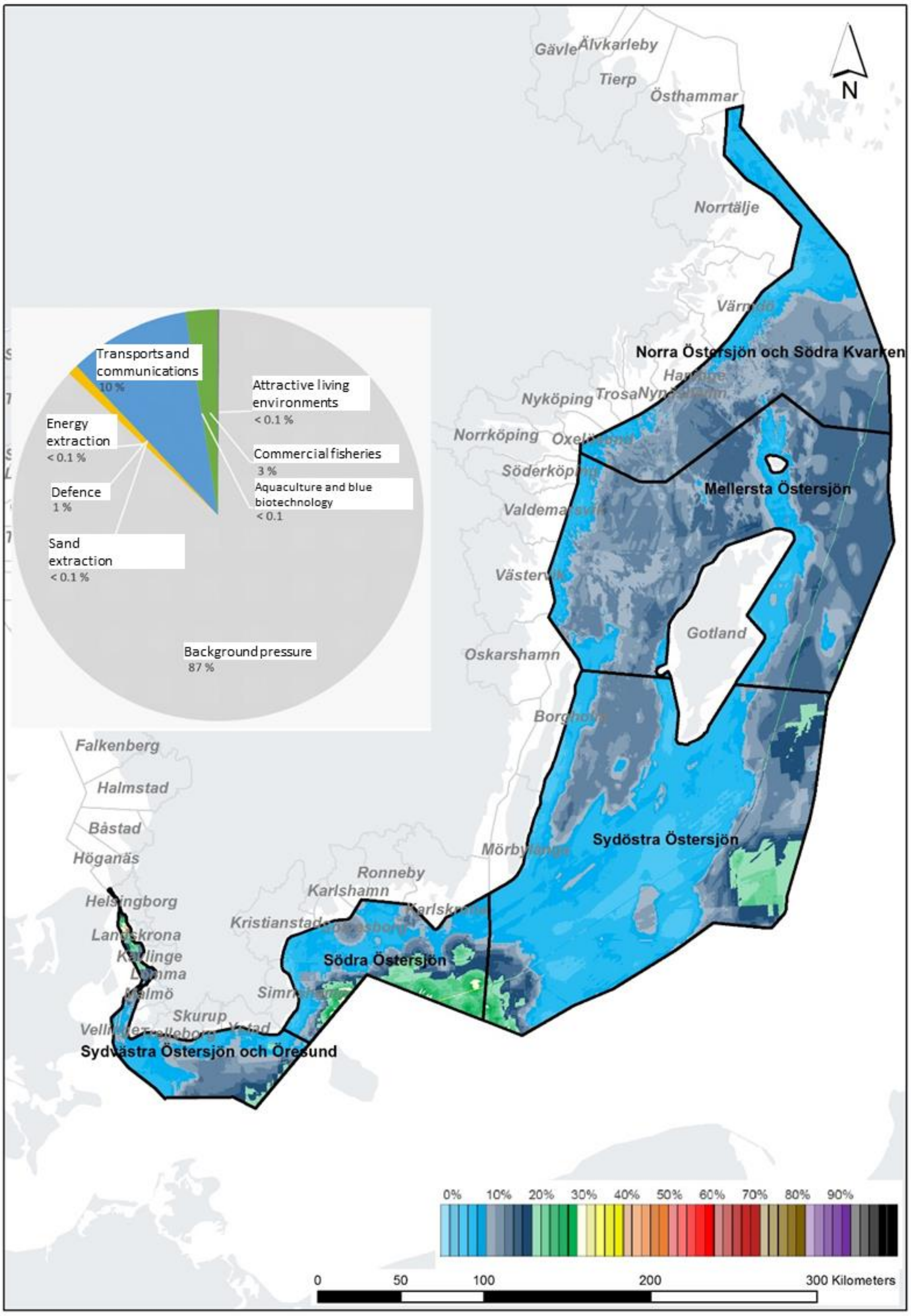


Figure 27 The total cumulative environmental effect in the Baltic Sea marine spatial planning area. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect for the zero alternative. The colours in the pie chart indicate sectors.

Other pressures that are not analysed in Symphony

Tourism and recreation are expected to increase in the Baltic Sea, which entails among other things more ferry and cruise traffic, which will result in greater pressures from emissions to air and a risk of greater spread of invasive species.

Littering is, however, expected to decrease as a result of collection of litter and lost fishing equipment and the enacting of preventive measures. Commercial fisheries is expected to be stable up to 2030 and is not expected to entail any change in the pressures compared with the current situation. Shipping is expected to increase by 50% until 2030 and to entail an increase in pressures. Shipping emissions to the air are regulated by several national and international regulations such as the EU Sulphur Directive and IMO's Sulphur Convention. Through the implementation of the IMO Ballast Water Convention, where ballast water must be cleaned before release, effects in connection with the spread of invasive species are expected to decrease by 2030.

Altogether, the environmental effect of emissions of greenhouse gases to the Baltic Sea is expected to have moderate to large effects based on the marine areas' sensitivity assessment and the sector analysis until 2030, see Table 12. Air quality and the spread of invasive species are to have small to moderate effects, and the effects of marine litter will be small.

Table 12 Assessed environmental effects in the respective marine area for the pressures air emissions, invasive species, and marine litter based on the sector analysis until 2030. The scale is as per Table 3.

ASSESSED ENVIRONMENTAL EFFECT	**AIR QUALITY** (NO_X OR PARTICLES)	**GREENHOUSE GASES** (CO_2 OR OTHER GREENHOUSE GASES)	**INVASIVE SPECIES** (EXTENSIVE UNCERTAINTY - LACK OF KNOWLEDGE)	**MARINE LITTER** (LITTER FROM FISHING, SHIPPING, AND TOURISM)
NORTHERN BALTIC SEA AND SÖDRA KVARKEN	moderate-large effects	moderate-large effects	small-moderate effects	small effects
CENTRAL BALTIC SEA	moderate effects	moderate-large effects	small-moderate effects	small-moderate effects
SOUTH-EASTERN BALTIC SEA	moderate effects	moderate-large effects	small-moderate effects	small-moderate effects
SOUTHERN BALTIC SEA	moderate effects	moderate-large effects	small-moderate effects	small effects
SOUTH-WESTERN BALTIC SEA AND ÖRESUND	moderate effects	moderate-large effects	small-moderate effects	small effects

7.3.2 Northern Baltic Sea and Södra Kvarken

Similar to the analysis for the entire marine spatial planning area, the background pressure contributes the largest share to the cumulative environmental effect, around 91%, within the marine area of the Northern Baltic Sea and Södra Kvarken. The background pressure consists mainly of oxygen-free seabeds (approx. 44%), and also effects from pollutants in sediment (synthetics approx. 15%, heavy metals approx. 12%), nitrogen (approx. 11%), and phosphorous (approx. 8%). The Transportation and communication sector contributes around 7% mainly through *underwater noise* and some oil spills from shipping. Defence also contributes with *underwater noise* and *introduction of pollutants* with around 1%, and these consist of noise from explosions and the spread of heavy metals, respectively. The distribution is seen in Figure 28. Commercial fisheries and Attractive living environments have a small share in the effect.

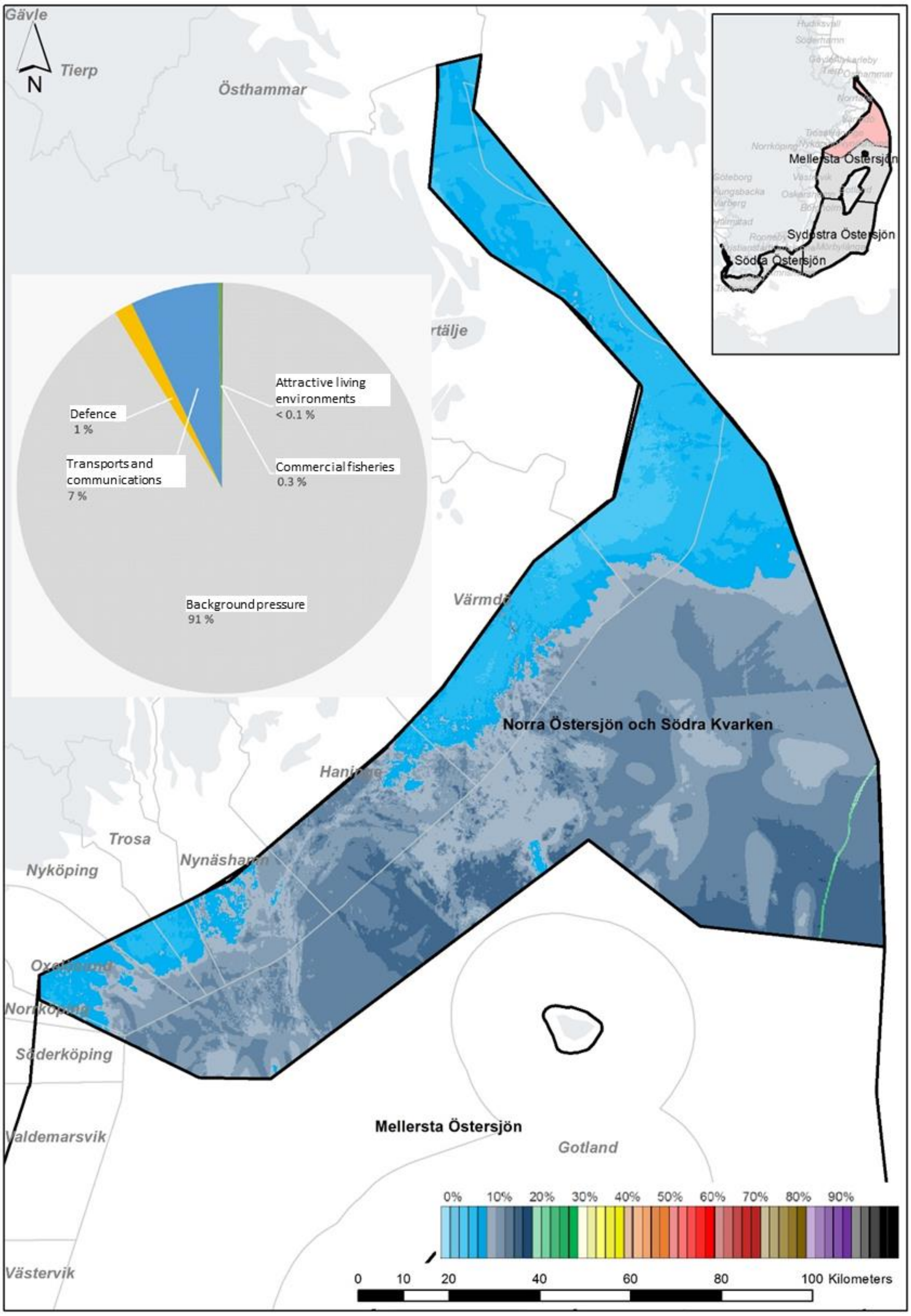


Figure 28 The total cumulative environmental effect in the Northern Baltic Sea and Södra Kvarken. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect for the zero alternative. The colours in the pie chart indicate sectors.

The cumulative effects are seen mainly on herring, plankton, sprat, grey seal, and spawning fish, as well as various types of seabeds, including deep soft seabeds, deep transport bottoms, aphotic hard seabeds, and aphotic soft and transport seabeds.

In a comparison between the zero alternative and the current situation, the zero alternative provides a generally higher environmental effect in the marine area of the Northern Baltic Sea and Södra Kvarken, around 2% more than in the present situation. The additional increase in environmental effect in the zero alternative can be seen in Figure , which shows the change between the zero alternative and the present situation. The difference shows an increase in shipping, but also includes a small increase in the total defence activities.

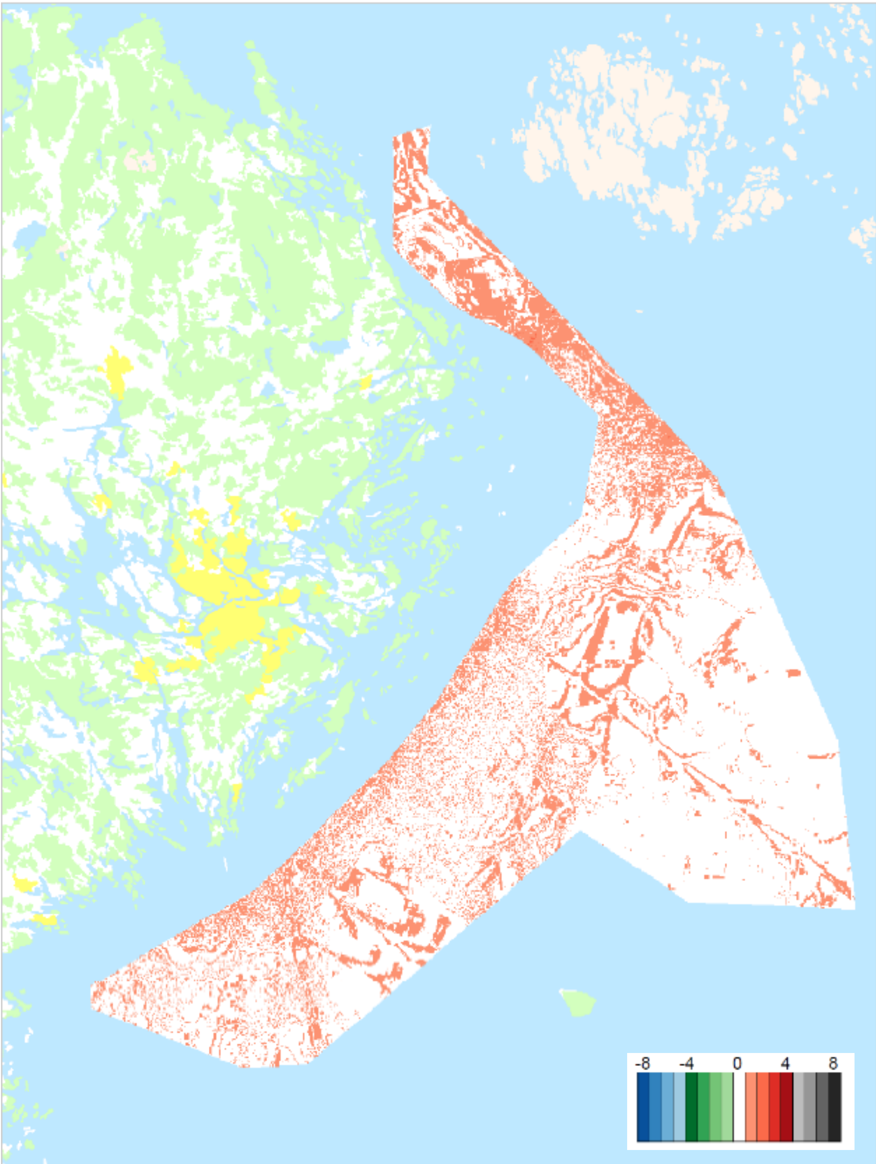


Figure 30 Change in cumulative environmental effect in per cent in the Northern Baltic Sea and Södra Kvarken in the zero alternative compared with the present situation. Positive values, in red and grey, result in a larger cumulative environmental effect compared with the present situation.

7.3.3 Central Baltic Sea

Also in this marine area, the background pressure contributes an overwhelming share to the total cumulative environmental effect at around 93%, see Figure 29. Nearly half can be attributed to oxygen-free seabeds (approx. 43%), while the rest comes from pollutants in sediment (synthetics approx. 17%, heavy metals approx. 15%), nitrogen (approx. 11%), and phosphorous (approx. 7%). The cumulative effects from sectors in the Central Baltic Sea come from Transportation and communication, with around 6%, and Defence, with around 1%. Commercial fisheries and other sectors contribute less than 1%. Transportation and communication consists of *underwater noise* and *introduction of pollutants* from oil spills from shipping, and Defence consists of *underwater noise* from explosions, and also the spread of heavy metals, *introduction of pollutants*. Commercial fisheries consists of effects from trawling, including *physical disturbance* and *selective withdrawal of species*. Attractive living environments and Aquaculture and blue biotechnology contribute marginally through *introduction of pollutants* from recreational boats and bird hunting, respectively, *physical loss*, and *introduction of nutrients and organic materials*.

The cumulative effects are mainly seen on herring, plankton, sprat, spawning fish, and deep soft seabeds, deep transport bottoms, and aphotic hard, soft, and transport bottoms.

The change in the cumulative environmental effect is seen in Figure 30 and shows a general increase in the environmental pressure compared with the current situation, around 2% of the present situation. Also in this marine area, it is shipping and national defence activities that will increase in the zero alternative.

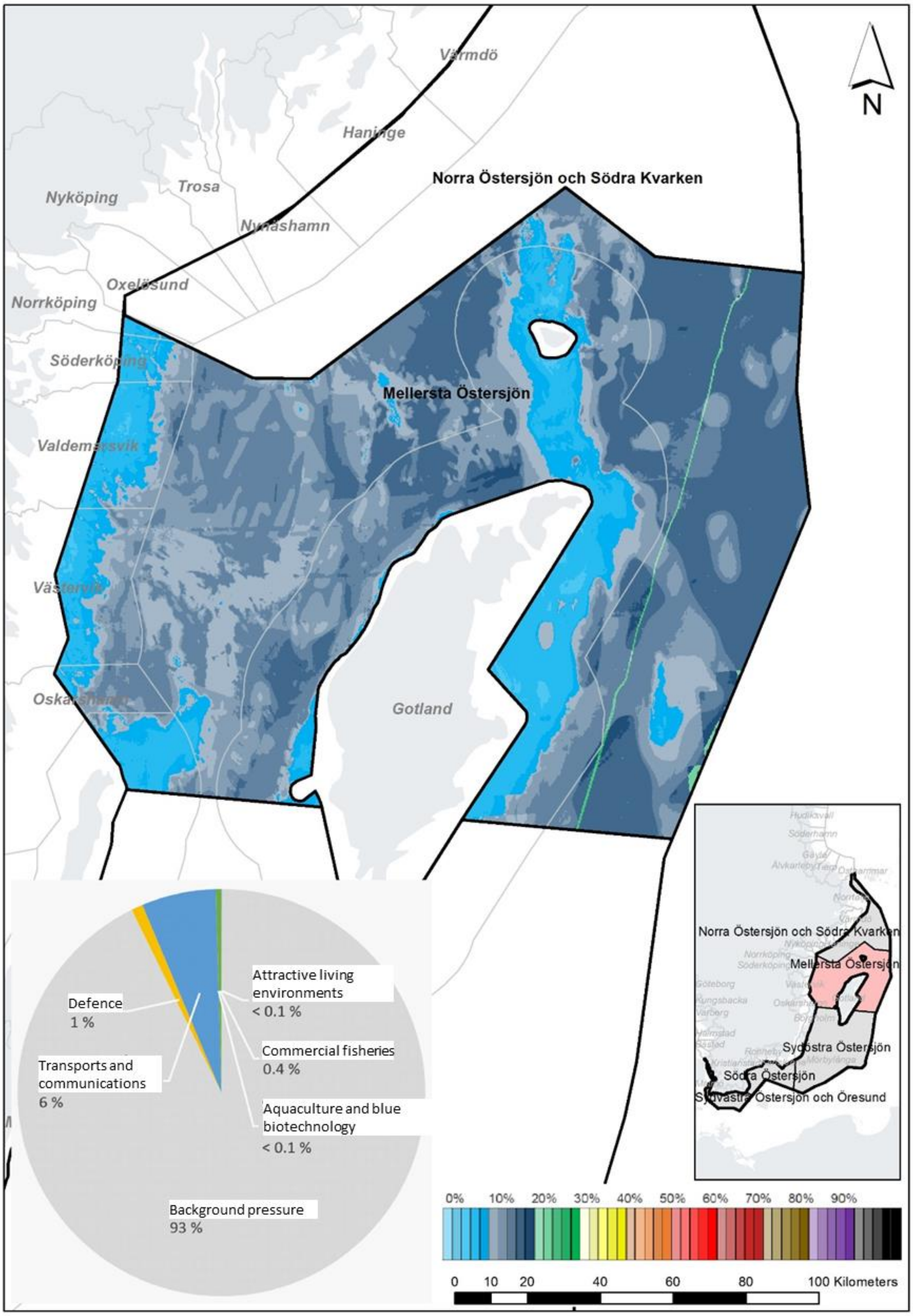


Figure 29 The total cumulative environmental effect in the Central Baltic Sea. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect for the zero alternative. The colours in the pie chart indicate sectors.

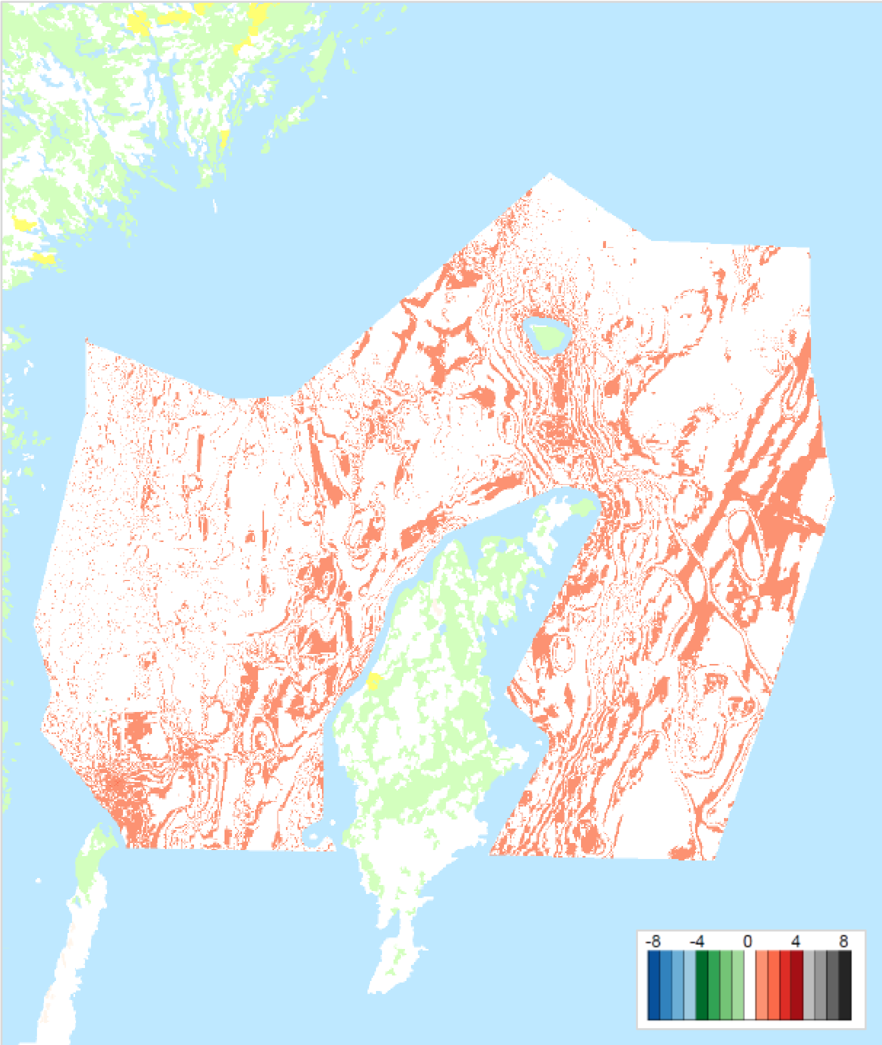


Figure 30 Change in cumulative environmental effect in per cent in the Central Baltic Sea in the zero alternative compared with the present situation. Positive values, in red and grey, result in a larger cumulative environmental effect compared with the zero alternative.

7.3.4 South-eastern Baltic Sea

The background pressure's contribution (around 87%) to the cumulative environmental effect is also dominant in this marine area. The background pressure consists mainly of oxygen-free seabeds (33%), but also pollutants in sediment (synthetics approx. 16%, heavy metals approx. 7%), nitrogen (16%), phosphorous (9%), and heavy metals and chemical pollutants from World War II (approx. 5% and 1%, respectively). The sectors that contribute to the cumulative effects are Transportation and communication and Commercial fisheries, see Figure 31. Transportation and communications account for around 11%, and here as well the effect is from *underwater noise* and to a lesser extent *introduction of pollutants* (oil spills) from shipping. Commercial fisheries contributes around 2% and consists of *selective withdrawals of species* from pelagic trawling and a smaller share from *physical disturbance* from bottom trawling. The themes Attractive living environments and Energy contribute less than 1% to the cumulative effect.

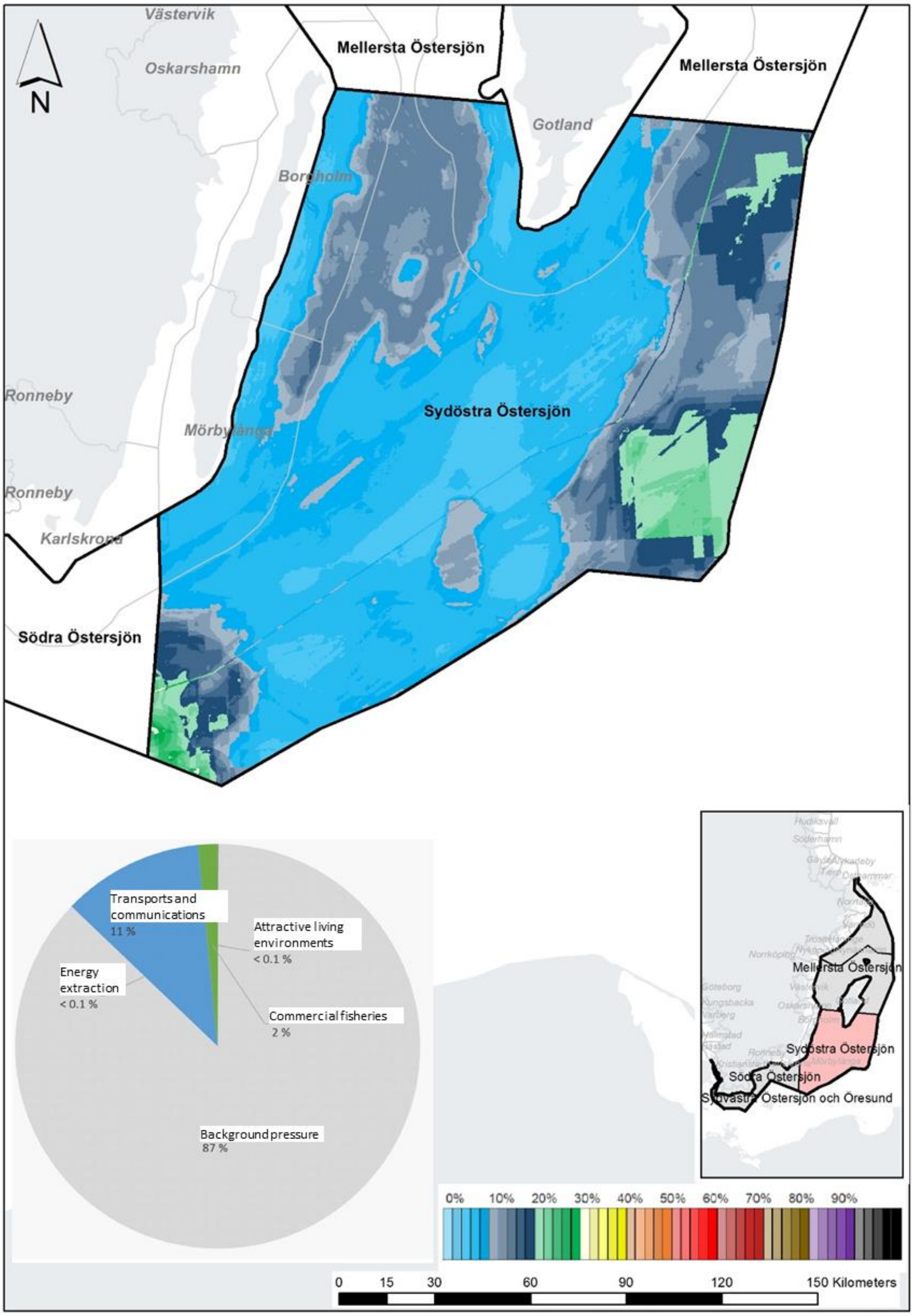


Figure 31 The total cumulative environmental effect in the South-eastern Baltic Sea. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect for the zero alternative. The colours in the pie chart indicate sectors.

The cumulative effects are seen mainly on deep soft seabeds, but also on aphotic transport bottoms, deep transport bottoms, and aphotic soft seabeds. The effect is also relatively large on herring, plankton, and sprat, but also on cod, spawning fish, porpoises, and offshore sea birds in winter.

Compared with the present situation, the total environmental effect within this marine area is expected to increase by around 3% due to the sector development that is assumed for shipping. The change between the zero alternative and the present situation is seen in Figure 32.

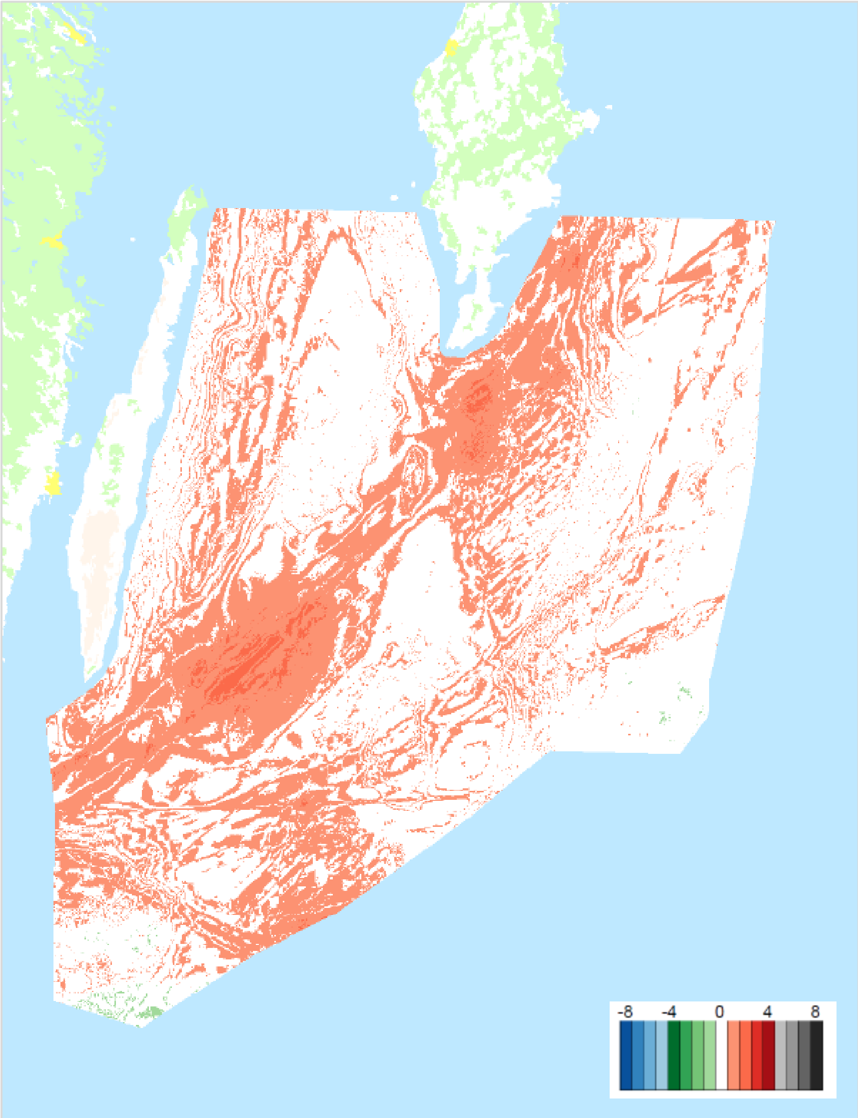


Figure 32 Change in cumulative environmental effect in per cent in the South-eastern Baltic Sea in the zero alternative compared with the present situation. Positive values, in red and grey, result in a larger cumulative environmental effect compared with the present situation. Negative values, in blue and green, result in a smaller cumulative environmental effect compared with the present situation.

7.3.5 Southern Baltic Sea

Within the marine areas of the Southern Baltic Sea and South-western Baltic Sea and Öresund, the sectors' contributions to the total environmental effect (relative to the background pressure) are expected to increase compared with the other marine areas in the MSP. Within the Southern Baltic Sea marine area, the sectors Transportation and communication, Commercial fisheries, and Defence contribute to the cumulative environmental effect, see Figure 33. Transportation and communications account for around 11%, which consist of *underwater noise* and to a lesser extent *introduction of pollutants* (oil spills) from shipping. Commercial fisheries contributes around 9% and consists of *selective withdrawals of species* from bottom trawling and net fishing and a smaller share from *physical disturbance* from abrasion and increased turbidity from bottom trawling. Defence accounts for around 2% of the cumulative effect and consists of *introduction of pollutants* through the spread of heavy metals and *underwater noise* from explosions. Attractive living environments and Energy constitute an extremely small share of the effect. The background pressure is expected to decrease here in comparison with the northern parts of the Baltic Sea marine spatial planning area, but it still constitutes the largest share with around 77% of the total cumulative effect. Here, a large share of oxygen-free seabeds contribute 20% and nitrogen 18%, but also smaller shares come from pollutants in sediment (synthetics approx. 13%, heavy metals approx. 5%), heavy metals from mines from World War II (approx. 12%), and phosphorous (8%).

The cumulative effects are noticed mainly on deep soft seabeds, and to a lesser extent on aphotic transport bottoms and soft seabeds. The effect is also relatively large on cod, herring, plankton, spawning fish, porpoises, sprat, and somewhat less on grey seals.

In a comparison with the present situation, the zero alternative entails an increase in the environmental pressure from shipping (*underwater noise*), and the environmental effect is thus expected to increase by around 3%. The change is illustrated in Figure 34.

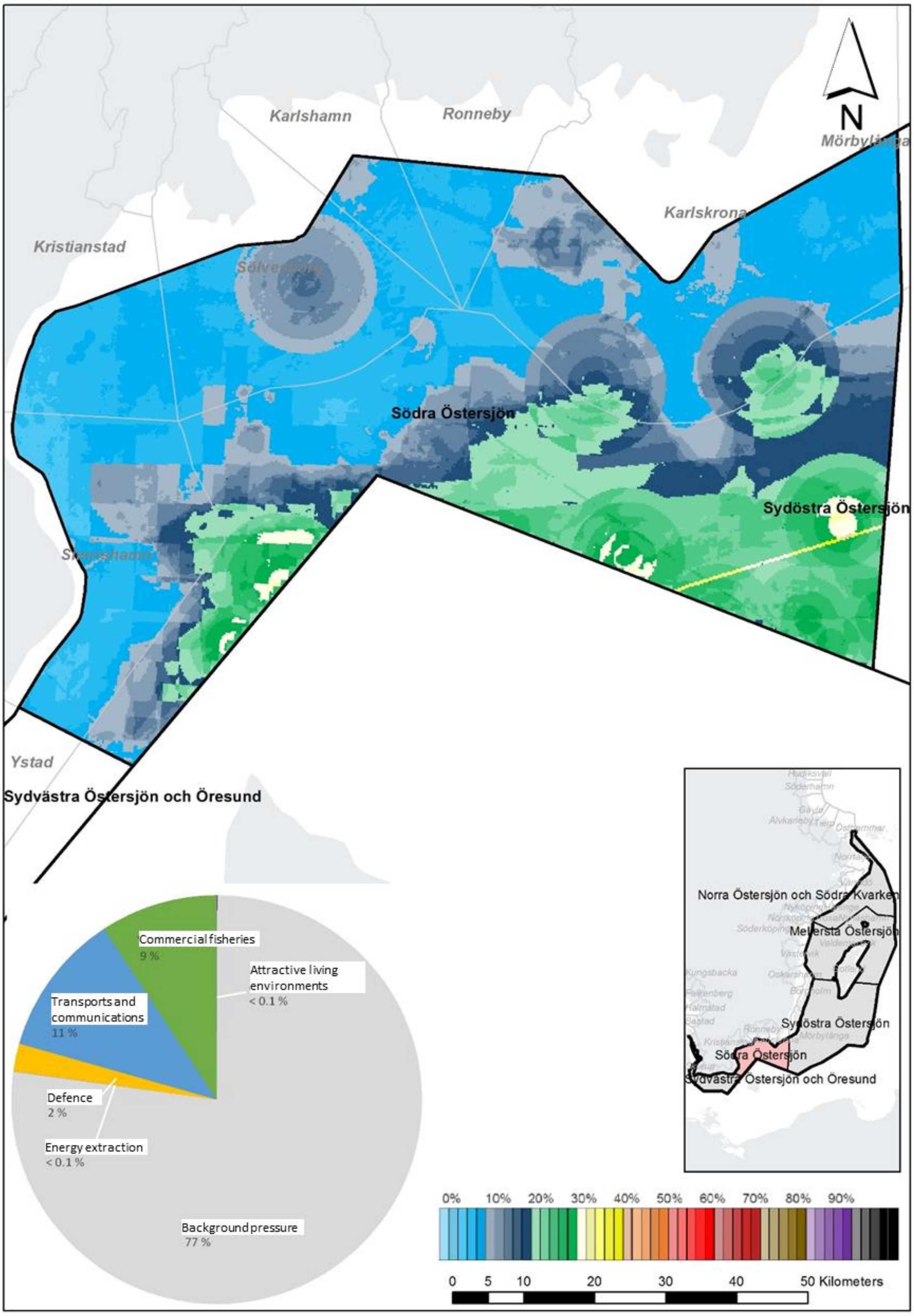


Figure 33 The total cumulative environmental effect in the Southern Baltic Sea. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect for the zero alternative. The colours in the pie chart indicate sectors.

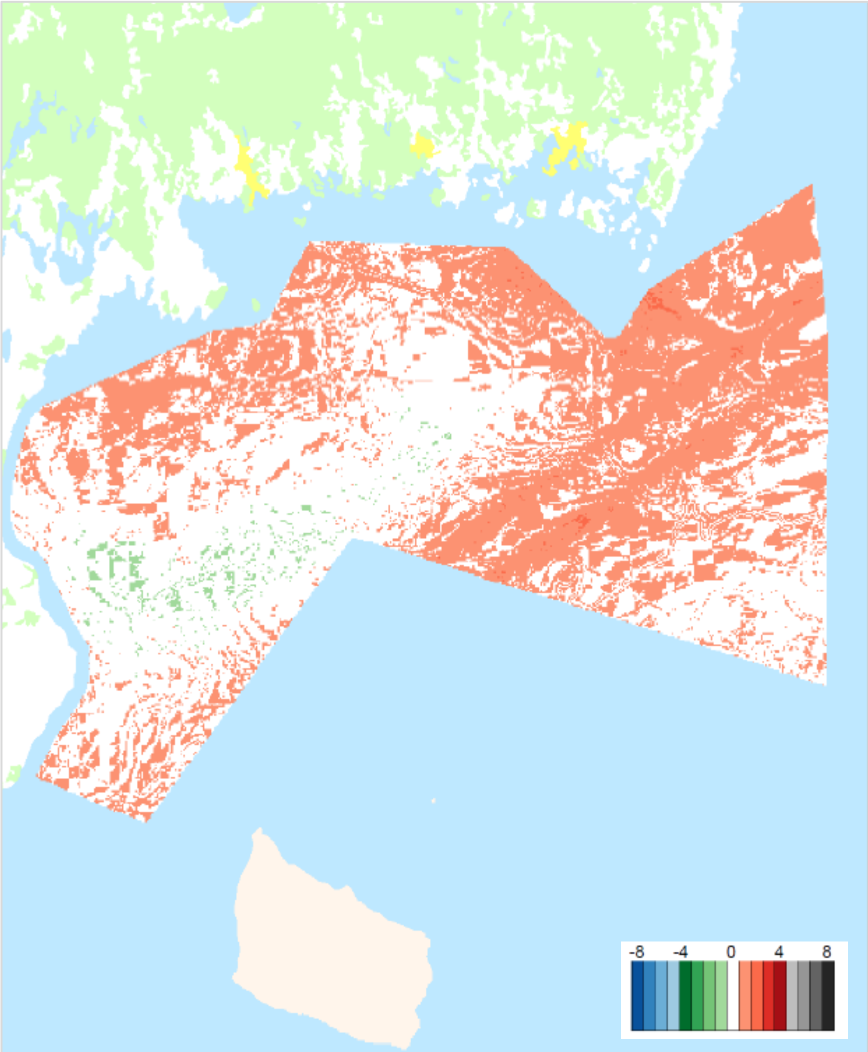


Figure 34 Change in cumulative environmental effect in per cent in the Southern Baltic Sea in the zero alternative compared with the present situation. Positive values, in red and grey, result in a larger cumulative environmental effect compared with the present situation. Negative values, in blue and green, result in a smaller cumulative environmental effect compared with the present situation.

7.3.6 South-western Baltic Sea and Öresund

The sectors that are found among the cumulative effects for the South-western Baltic Sea and Öresund are Transportation and communication, Commercial fisheries, and a small share of Defence, Attractive living environments, and Storage and extraction of materials, see Figure 35. Transportation and communications, which account for around 25%, consist mainly of *underwater noise* and also some *introduction of pollutants* (oil spills) from shipping. Commercial fisheries, which contributes around 15%, includes *selective withdrawals of species* from bottom trawling and net fishing and a smaller share from *physical disturbance* from abrasion and increased turbidity from bottom trawling. Attractive living environments, around 1%, includes *underwater noise*, and also some *introduction of pollutants* from recreational boats and bird hunting. Storage and extraction of materials, less than 1%, includes effects from sand extraction and mining, including *physical loss* and *disturbance*. With less than 1%, the sector Defence contributes *introduction of* *pollutants*, and Energy contributes *underwater noise* and *biological and physical disturbance*.

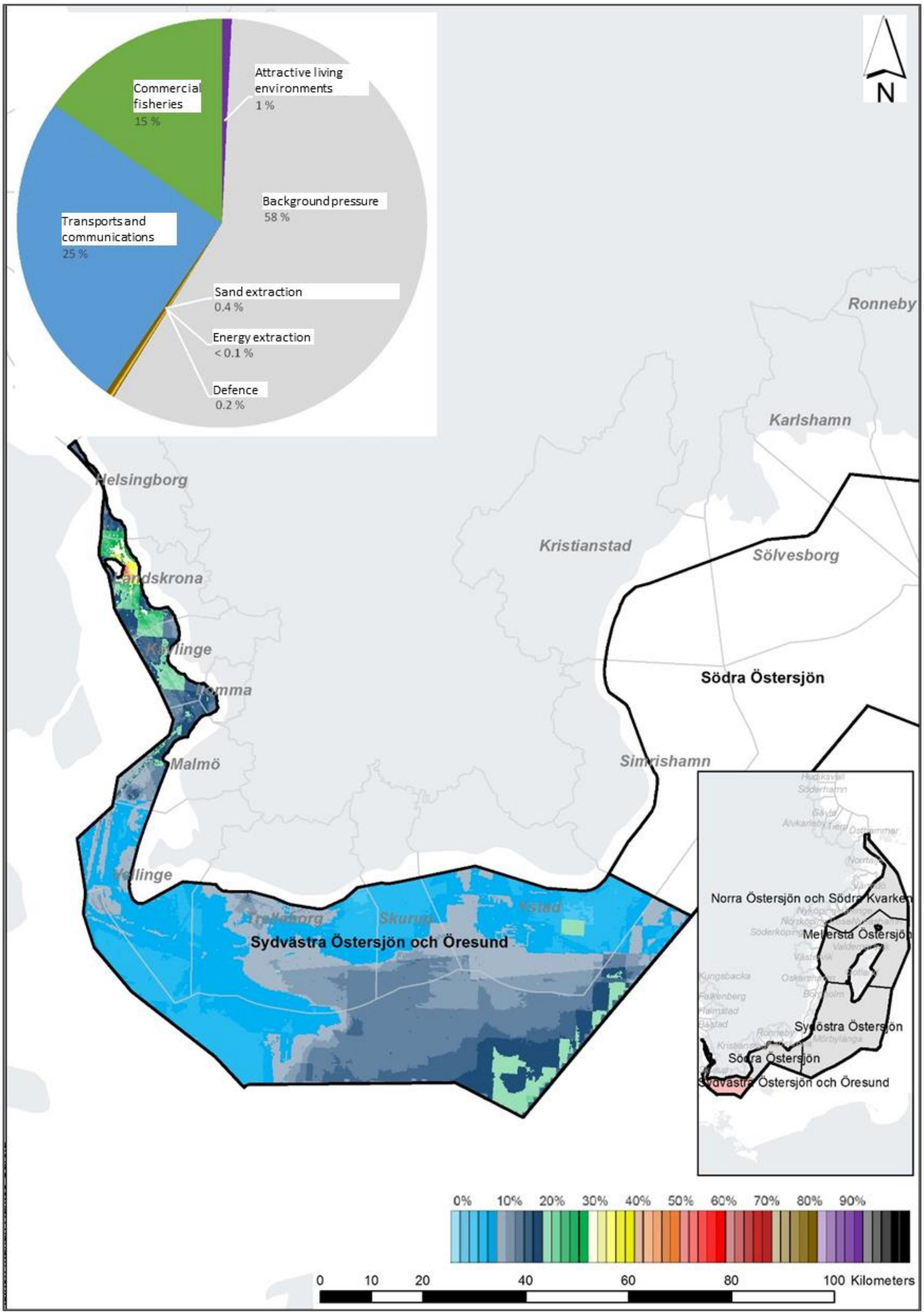


Figure 35 The total cumulative environmental effect in the South-western Baltic Sea and Öresund. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect for the zero alternative. The colours in the pie chart indicate sectors.

Because use from the theme in the marine area is expected to increase, the background pressure share decreases to around 58% of the cumulative effect. The effects are from nitrogen (around 20%), oxygen-free seabeds (around 13%), phosphorous (around 8%), and pollutants in sediment (synthetics around 13%, heavy metals around 3%), and other pollutants contribute with a very small share (<1%). The cumulative effects are seen mainly on cod and spawning fish, as well as plankton, herring, sprat, porpoises, grey seals, and offshore sea birds in winter. Seabeds that are mainly affected are aphotic soft seabeds, as well as aphotic and photic transport bottoms and photic soft seabeds.

Compared with the present situation, the environmental pressure and environmental effect in the marine area are expected to increase by around 8% as a result of increased shipping, and the increase is expected to be most intensive in the western part of the marine area and in Öresund. The change between the zero alternative and the present situation is seen in Figure .

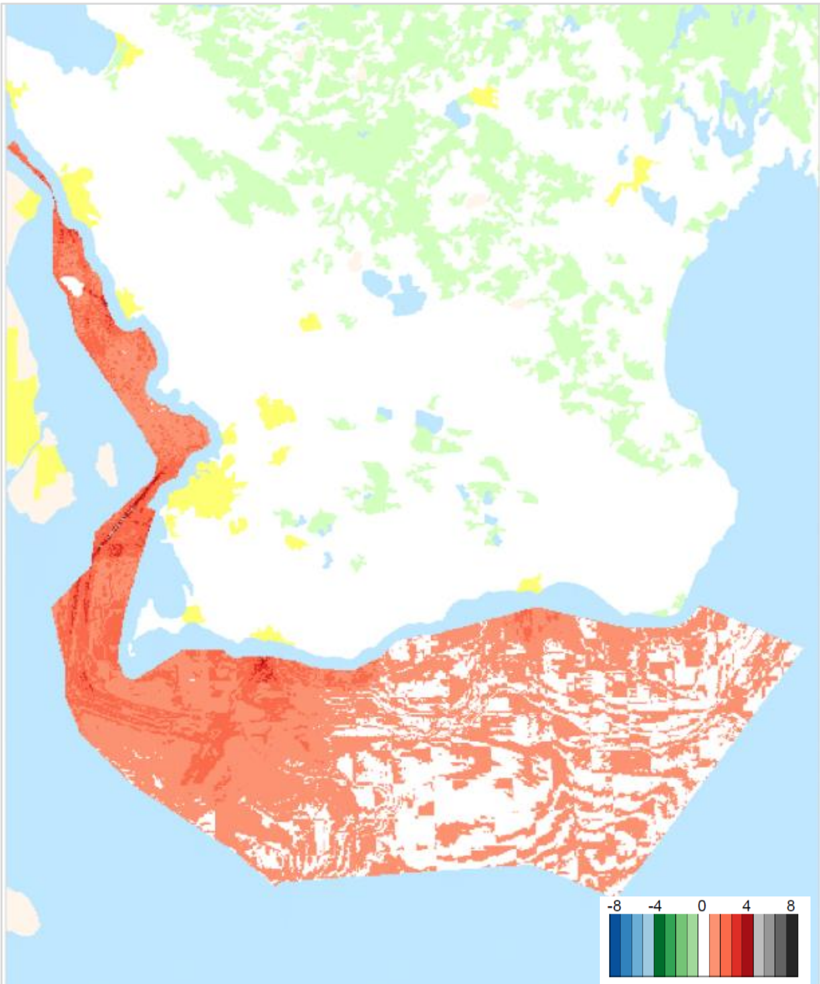


Figure 38 Change in cumulative environmental effect in per cent in the South-western Baltic Sea and Öresund in the zero alternative compared with the present situation. Positive values, in red and grey, result in a larger cumulative environmental effect compared with the zero alternative.

8 Plan alternative

8.1 Sectors and themes

This chapter describes the plan alternative based on the plan's sectors and themes. Differences from the zero alternative are emphasised in particular. In the subsequent assessments of the cumulative effect, the Symphony planning method and its included values were used as a base.

8.1.1 Attractive living environments

Attractive living environments are based on the national interest areas in the sea for active outdoor recreation, unbroken coastline, and a highly developed coast, as well as national interest claims for cultural environments and recreation where angling is included along with UNESCO's world heritage sites.

Significant areas with valuable coastal and archipelago landscapes extend along the entire coast, and there are many sunken ships in the marine spatial planning area. Outdoor recreation and recreational boating are extensive, and the use Attractive living environments is stated in the plan along the entire coast.

8.1.2 Energy

There are good conditions for energy extraction in the Baltic Sea, and the need is great due to the electricity consumption in the area. There are both good wind conditions and suitable depths for sea-based wind turbines.

The offshore banks have both good wind conditions and suitable depths for sea-based wind turbines. All three banks are covered by national interest claims for wind power. Of the banks in the South-eastern Baltic Sea, Hoburgs bank and Norra Midsjöbanken are pointed out as particularly important to not use for purposes other than nature conservation. Södra Midsjöbanken is more suited to energy extraction than the other banks. Today, wind power project engineering is under way there and a facility is under review by the Government. The area at Södra Midsjöbanken has been withheld from development in the Government's decision on the introduction of Natura 2000 areas. The MSP indicates the use of energy extraction with *particular consideration to high nature values (n)* on Södra Midsjöbanken. The use Energy is indicated in the Southern Baltic Sea in an area closer to land in Hanöbukten in Kristianstad and Sölvesborg municipalities where the Taggen wind power project has already received a permit.

There are good conditions for wind power in the marine spatial planning area, with good wind conditions and coasts and offshore banks with good depth conditions for bottom-based wind turbines in close proximity to areas with large electricity consumption in southern Sweden. In Öresund, there is Sweden's largest already built sea-based wind farm, namely Lillgrund next to the Öresund Bridge. The use Energy is indicated in the South-western Baltic

Sea at Kriegers Flak next to Germany and Denmark's exclusive economic zones. In the area, there is a wind power project that has permits. Denmark and Germany have also planned for wind power at Kriegers Flak in the respective country's exclusive economic zone. In the marine area farther east in the offshore area towards Germany and Denmark's economic zones, there are another two areas with the use of Energy. In all three areas, wind power is given priority over Commercial fisheries. The fishing interests might be negatively affected if wind power is built in these areas, but these fishing interests constitute a small part of the fishing in the marine spatial planning area, and energy extraction has been considered to be a more suitable use.

The zero alternative estimates of the cumulative effect, based on the Symphony planning method, include existing establishments (Lillgrund) and permitted wind power establishments (Kriegers flak and Taggen).

8.1.3 Defence

There are several national interest claims for national defence in the Northern Baltic Sea and Södra Kvarken. The national interest claims for wind power that are in the marine area are not considered to be compatible with the national defence interests.
There are several defence areas in the Central Baltic Sea, which in the MSP are indicated with the use Defence. Off of Öland are the Hanö nord and Martin marine training areas. They extend from the coast through the territorial sea out into the Swedish exclusive economic zone off of the municipalities of Bornholm and Mörbylånga. One of Sweden's largest and most important marine bases is the Karlskrona navy port. The Hanö marine training area extends from the coast through the territorial sea out into the Swedish exclusive economic zone from Simrishamn municipality to Mörbylånga municipality. In the Southern Baltic Sea, there is the Kabusa artillery range in Ystad Municipality. In the area, *particular consideration of high nature values (n)* is to be taken. In all Swedish areas for the use Energy, *particular consideration to national defence interests (f)* shall be taken. All of these areas are shown as the use Defence.

8.1.4 Storage and extraction of materials

Today, no carbon dioxide storage is done in Sweden, but the potential for future storage is being investigated. In the south-western part of the marine spatial planning area and in Öresund, there are potential areas for carbon dioxide storage (SGU, 2016).

Sand extraction only takes place to a limited extent. The potential for future sustainable extraction of marine sand and gravel has been investigated, and a number of interesting areas are presented as the most suitable use. There are three areas with the use of Storage and extraction of materials – off of Falsterbo, in Hanöbukten, and at Sandhammaren south of Ystad. At Sandhammaren, there is a permit for sand extraction. The sand is used for coastal nourishment measures.

In the zero alternative's estimates of the cumulative effect, based on the Symphony planning method, existing room for sand extraction is included, which in the Baltic Sea's marine spatial planning area comprises extraction at Sandhammar bank.

8.1.5 Nature

Along the entire marine spatial planning area's coast, Stockholm's outer archipelago, and the Södermanland coast and archipelago, there are large areas with valuable nature that are safeguarded in the plan by the use Nature. At Svenska Högarna outside the Stockholm archipelago, there is a potential climate refuge for sea mussels. Klints bank is a deep offshore bank east of Gotland with indications of high biological values and also a possible climate refuge for sea mussels, which is safeguarded through *particular consideration of high nature values (n)*. A very large area with valuable nature extends from Gotland's southern cape at Hoburg through Hoburgs bank to Norra and Södra Midsjöbanks. In large parts of this area, the environmental impact is low and the marine environment can be seen as relatively original. The high nature values that exist here comprise valuable bottom environments, reproduction areas for the threatened Baltic Sea porpoise, and the most important wintering areas for the red-listed long-tailed duck. There are also food-gathering areas for common eider and black guillemot, as well as spawning areas for fish in the area. The marine area's banks have been pointed out as possible climate refuges for several species – areas set aside for the protection of future nature considering climate change – which indicates that the area's ecological significance will be very high in the future[7]. These environments and the species are protected by an extensive Natura 2000 area and are safeguarded in the MSP through the use Nature. There are relatively few areas with protected nature in the Southern Baltic Sea. To ensure green infrastructure, *particular consideration to high nature values (n)* is indicated for several areas. In Hanöbukten, there is, among other things, the red-listed porpoise of the strongly endangered Baltic Sea population, even in the Swedish Armed Forces' marine training areas. Particular consideration must be given to porpoises there. In Hanöbukten's north-western corner, there is an important climate refuge that is safeguarded through *particular consideration to high nature values (n)*. At Utklippan, there are high nature values that require particular consideration, as well as a possibility for sand extraction in deeper parts of the area.

There are high nature values in the marine area, and several nature reserves and Natura 2000 areas have been established. Around Ven in Öresund, there is a Natura 2000 area with important eel grass beds and porpoises. All national interest claims for nature conservation are met in the marine area.

[7] Report 2017:37. Swedish Agency for Marine and Water Management

The following areas have been classified with *particular consideration to high natural values (n)*; the designation Öxxx is the designation for the area in the MSP:

- Ö202 – Bottom environments, reef environments, and especially important mammal areas and climate refuges
- Ö211 – Reef environments and spawning and mammal areas
- Ö233 – Bottom environments and climate refuges for sea mussels
- Ö240 – Fishing recruitment areas, reef environments, and spawning, mammal, and bird areas with especially low environmental impact
- Ö243 – Bird and mammal areas, reef environments, and spawning, mammal, and bird areas with especially low environmental impact
- Ö247 – Fishing recruitment and mammal areas with valuable bottom environments, reef environments, and spawning areas
- Ö248 – Fish recruiting, bird, and mammal areas with valuable bottom environments, climate refuges for sea mussel, and reef environments
- Ö249 – Spawning and mammal areas with especially high environmental impact
- Ö247 – Fishing recruitment and mammal areas with valuable bottom environments, reef environments, and spawning areas
- Ö249 – Spawning and mammal areas with especially high environmental impact
- Ö261 – Fish recruiting areas and spawning and mammal areas
- Ö262 – Fishing recruitment and mammal areas with valuable bottom environments, reef environments, and climate refuges
- Ö266 – Fish recruiting areas with valuable bottom environments, reef environments, spawning grounds, and climate refuges
- Ö269 – Reef and soft bottom environments, spawning and bird areas, and climate refuges for sea mussels, seaweed, and herring
- Ö280 – Low-impacted fish recruitment and bird areas with valuable bottom environments
- Ö281 – Fish recruitment and bird areas with valuable bottom environments
- Ö289 – Reef and soft bottom environments and spawning, mammal, and bird areas with especially high environmental impact
- Ö293 – Spawning and mammal areas

8.1.6 Transportation and communications

Several important ports are along the coast in the Central Baltic Sea. Shipping traffic is important with traffic both to the mainland coast, to Gotland, and farther north or south. In the South-eastern Baltic, maritime traffic is important with extensive traffic to both foreign and Swedish ports. In the Southern Baltic Sea, the deep lane is pointed out for some ships in a passage to the east through the Baltic Sea. Shipping goes both in to the coast, but mainly onwards towards both Swedish and foreign ports.

The most-trafficked shipping lanes in the Baltic Sea go through the South-western Baltic Sea along Sweden’s coast in a traffic separation system from

Öresund via Falsterbo in Vellinge Municipality or Gedser, between Denmark and Germany, to Bornholmsgattet. Shipping continues towards both Swedish and foreign ports.

The use Shipping is therefore indicated in several shipping lanes in the Baltic Sea.

Investigation areas
Across Salvorev, between Fårö and Gotska Sandön, there is today a passage for maritime traffic through an area with a great deal of high nature values, and, among other things, the red-listed species long-tailed duck is present here[8]. The study shows that the long-tailed duck is negatively impacted by oil spills from ships. The effect of this needs to be investigated further, and for the shipping lanes across Salvorev the plan therefore indicates *investigation area shipping*. Shipping lanes east of Gotland and the lane in to Slite are also part of the *investigation area shipping* that can affect shipping in the Central Baltic Sea.
Between Hoburgen and Hoburgs bank, shipping traffic today goes through a shallow area with very high nature values for the red-listed species porpoises and long-tailed ducks. From a nature conservation perspective, there is reason to move maritime traffic from this area. Secondary effects of a potential relocation of the shipping have also been studied in terms of emission increases, travel times, and accident risks[9]. The problems must be studied further, and the shipping lane at Hoburgs bank is therefore pointed out as an *investigation area shipping*. A possible future adjustment of shipping movements through the area needs to be rooted and negotiated internationally, which sets high standards on documentation.

8.1.7 Aquaculture and blue biotechnology

In the MSP, no areas have been pointed out for use by the theme aquaculture and blue biotechnology, and the plans are not expected to affect the conditions for the development of the theme otherwise. Consequently, no assessment is made in this investigation regarding aquaculture and blue biotechnology.

8.1.8 Commercial fisheries

Fishing in the Baltic Sea marine spatial planning area has a long tradition and is a large part of the Swedish Commercial fisheries industry both in terms of value and catch amounts. Commercial fisheries is widespread in the Baltic Sea. Pelagic fishing is mainly conducted in offshore areas. Some sparse fishing with passive equipment mostly takes place in towards the coast in the Northern Baltic Sea.
The most important species economically and in terms of quantity in the Baltic Sea are sprat, herring, and cod. Fishing for herring and sprat is conducted in

---

[8] Shipping burden on Salvorev north of Gotland. Report 2017:28. Swedish Agency for Marine and Water Management

[9] Rerouting analysis of shipping around Hoburgs bank and the Midsjöbanks. Report 2017:11. Swedish Agency for Marine and Water Management

the offshore areas in the Central Baltic Sea south of Gotland. Fishing for cod is conducted with trawler fishing in offshore areas in the South-eastern Baltic Sea, mainly in Hanöbukten, and with passive fishing closer to the coast. Sparse other fishing with passive equipment is conducted along the coast in the Southern Baltic Sea and in Öresund where bottom trawling is not permitted, but rather the Commercial fisheries takes place with passive equipment for cod among other species. The use Commercial fisheries therefore exists to varying extents in all areas except for the areas pointed out for energy extraction.

8.2 Outlook towards 2050

At present, there is no set development of the plan until 2050. The MSP will be revised at least once every eight years in order to be adapted to new knowledge, new needs, and sector development.

8.3 Cumulative effects - plan alternative

The cumulative effect for every marine area in the Baltic Sea for the MSP alternative has been identified using Symphony. For the MSP and its marine areas, the cumulative effect and the sectors that have the main impact on the environment are described and illustrated. Background pressures that cannot be specifically tied to a sector have been identified and included in the cumulative effect. The type of impact that the sectors contribute is linked to the pressures of the Marine Strategy Framework Directive.

8.3.1 Baltic Sea

The MSP for the Baltic Sea largely entails no change in terms of the cumulative environmental effect in comparison with the zero alternative. An increased environmental pressure and environmental effect can, however, be seen mainly in the marine areas of the Southern Baltic Sea and the South-western Baltic Sea and Öresund, see Figure 36. In the MSP, there is sand extraction here in three areas, which entails an increased environmental effect.

The environmental effect of the MSP’s planning of energy use differs from area to area in the Baltic Sea. South of Skåne, the local effect of energy use is less compared with the zero alternative as a result of trawler fishing being moved out from the area. On Södra Midsjöbanken, energy use entails a higher environmental effect because this area is relatively unaffected and has high valued for sea birds. Within the Baltic Sea MSP, the effect of the use of areas in which *particular consideration of high nature values (n)* is to be taken is not as positive as, for example, in Skagerrak and Kattegat. This is due to the Baltic Sea to a higher degree being affected by pressures that are not governed by the marine spatial planning, such as eutrophication and pollution from historical emissions. In Öresund, there are, however, areas in which the introduction of *particular consideration to high nature values (n)* entails major environmental improvements.

The cumulative effects in the Baltic Sea in the plan alternative mainly come from the background pressure (approx. 87%). The background pressure consists of oxygen-free seabeds (approx. 36%), but also nitrogen (approx. 14%), pollutants in sediment (synthetics approx. 16%, heavy metals approx. 10%), phosphorous (approx. 8%), and heavy metals and chemical pollutants from World War II (approx. 3% and less than 1%, respectively). Of the sectors, it is mainly Transportation and communication, and to a lesser extent Commercial fisheries and Defence, that contributes to the cumulative environmental effect, see Figure 37. Attractive living environments, Energy, Storage and extraction of materials, and Aquaculture and blue biotechnology contribute marginally to the total cumulative effect at <1% each.

Figure 36 Change in the cumulative environmental effect in per cent in the Baltic Sea marine spatial planning area compared with the zero alternative. Positive values, in red and grey, result in a larger cumulative environmental effect compared with the zero alternative. Negative values, in blue and green, result in a smaller cumulative environmental effect compared with the zero alternative.

Transportation and communications, which account for around 10%, consist of *underwater noise* and *introduction of pollutants* (oil spills) from shipping. Defence contributes around 1% and consists mainly of *introduction of pollutants*, through the spread of heavy metals, and the spread of *underwater* *noise* from explosions. Commercial fisheries contributes around 2% and consists mainly of effects from bottom trawling and a smaller share of net fishing and pelagic trawling, *selective withdrawals of species,* and a smaller share from *physical disturbance* from abrasion and increased turbidity from bottom trawling. Attractive living environments consist of bird hunting and *underwater noise* and *introduction of pollutants* from recreational boats. Energy contributes *underwater noise* and effects from the rotor blades of wind turbines. Storage and extraction of materials contribute with *physical loss* (habitat loss) in sand extraction and *physical disturbance* in sediment spread in *mining*. Aquaculture and blue biotechnology contributes with *physical loss (*habitat loss*)* and *introduction of nutrients and organic material*. The cumulative effects are mainly seen on deep soft seabeds, as well as herring, plankton, sprat, spawning fish, cod, deep transport bottoms, aphotic soft and transport bottoms, and Baltic porpoises.

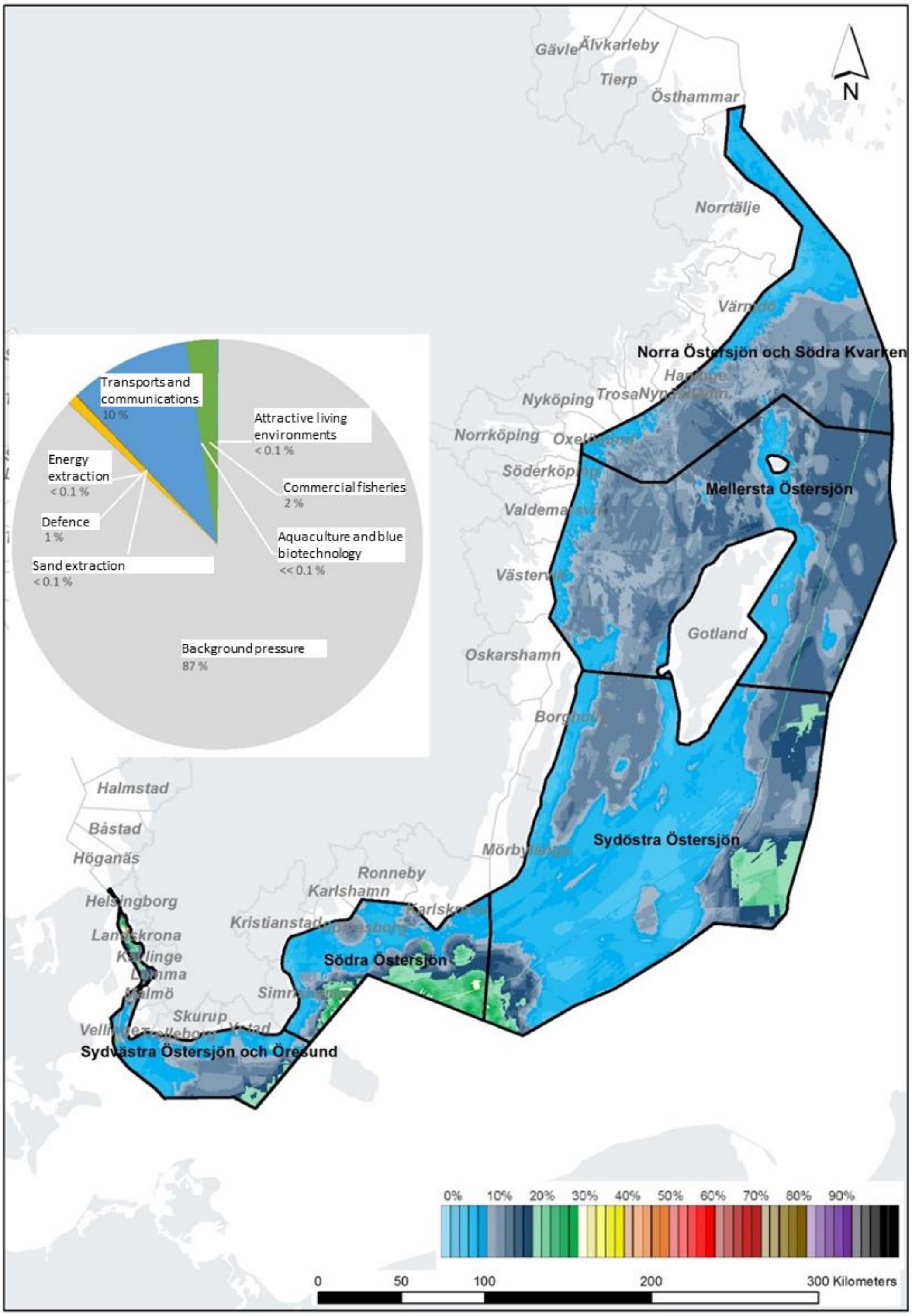


Figure 37 The total cumulative environmental effect in the Baltic Sea marine spatial planning area. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect. The colours in the pie chart indicate sectors.

Besides the environmental effects analysed above, the MSP's planning of the sectors Energy and Storage and extraction of materials also entails *physical* *disturbance* and *biological disturbance* as an addition to the total cumulative environmental effect that is shown in Figure 37. These new uses might also affect Attractive living environments (cultural environments and landscape appearance). The environmental objective of “A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos” specifies that the natural and cultural values of the marine, coastal, and archipelago landscapes shall be preserved and that conditions shall exist for continued preservation and development of these values. A further specification is that the status remains unchanged for cultural heritage remains under the water. Due to the prevailing lack of knowledge regarding cultural heritage environments under the water, the assessed cultural heritage value for the sea areas is only an estimate of the likelihood that there are cultural heritage values in the marine areas.

In the Baltic Sea, the submarine cultural values are often well-preserved due to the unique natural geography conditions. The low salt content and low water temperature mean that there are no organisms to break down wooden objects (SwAM, 2015c). According to the Heritage Conservation Act, a shipwreck shall be considered as ancient remains if it is from before 1850. However, the county administrative board has the possibility of declaring vessel remains from 1850 or later as ancient remains if there are special reasons considering their cultural and historical value (SwAM, 2015c). Also, younger wrecks can have both a large cultural history and scientific value, such as ships sunk in the world wars. The overwhelming part of these shipwrecks is in the Baltic Sea and Öresund, from Kullen to the boundary between Stockholm and Uppsala counties. The actual number of culturally and historically valuable shipwrecks and other remains, such as Stone Age settlements, might be far more numerous than is known today (SwAM, 2015c).

Known cultural heritage remains underwater are seen in Figure 38 (showing data on underwater remains from the Swedish National Heritage Board’s database for archaeological sites and monuments (FMIS)). In the areas that are planned for Energy and Storage and extraction of material, there might be a conflict with cultural heritage remains. In detailed development plans of the wind power farms in these areas, a study of marine archaeology needs to be carried out to minimise the impact on the cultural environment.

Construction of wind farms might also affect the landscape appearance. The landscape appearance’s value at the sea consists, among other things, of a horizon free from anthropogenic pressure. This value exists for an observer both on land and at sea. Here, anthropogenic pressure refers to the construction of wind turbines. Today, there are no wind power establishments, and the impact on the landscape appearance is therefore not currently relevant, but in the plan alternative, the landscape appearance will be affected by the plan pointing out areas for Energy. Overall, the use of, in particular, areas for Energy is expected to have moderate environmental impact on the cultural environment and landscape appearance.

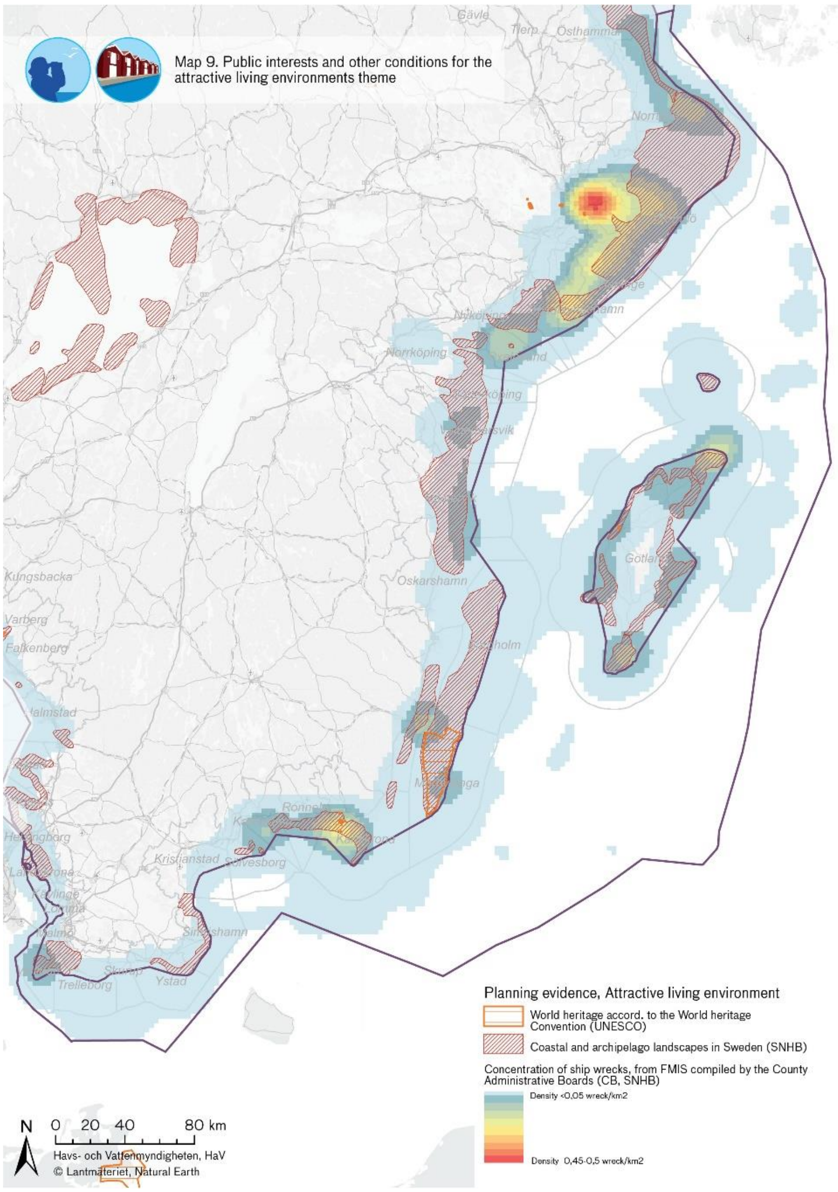


Figure 38 Public interests and other prerequisites for the theme Attractive living environments in the marine spatial planning area (SwAM, 2018b).

For every marine area in the Baltic Sea marine spatial planning area, the environmental effects for the pressures of air emissions, invasive species, and marine litter were assessed. The MSP in 2030 entails only a small increase in the pressures air quality and greenhouse gases in the South-western Baltic Sea and Öresund. It is changes in the theme Transportation and communication (shipping) in the South-western Baltic Sea and Öresund that contribute these pressures. This entails further small environmental effects that are added with the MSP 2030 guidance compared with the effects that the zero alternative 2030 entail (text in light grey in Table 13).

Table 13 Assessed environmental effects in the respective marine area for the pressures air emissions, invasive species, and marine litter with the MSP in 2030 compared with the zero alternative for 2030. The scale is according to Table 3, and "-" indicates that the plan entails no change in pressure.

ASSESSED ENVIRONMENTAL EFFECT	**AIR QUALITY** (NOx OR PARTICLES)	**GREENHOUSE GASES** (CO_2 OR OTHER GREENHOUSE GASES)	**INVASIVE SPECIES** (EXTENSIVE UNCERTAINTY - LACK OF KNOWLEDGE)	**MARINE LITTER** (LITTER FROM FISHING, SHIPPING, AND TOURISM)
NORTHERN BALTIC SEA AND SÖDRA KVARKEN	Plan alternative: - Zero alternative: Moderate-large effects	Plan alternative: - Zero alternative: Moderate-large effects	Plan alternative: - Zero alternative: Small-moderate effects	Plan alternative: - Zero alternative: Small effects
CENTRAL BALTIC SEA	Plan alternative: - Zero alternative: Moderate effects	Plan alternative: - Zero alternative: Moderate-large effects	Plan alternative: - Zero alternative: Small-moderate effects	Plan alternative: - Zero alternative: Small-moderate effects
SOUTH-EASTERN BALTIC SEA	Plan alternative: - Zero alternative: Moderate effects	Plan alternative: - Zero alternative: Moderate-large effects	Plan alternative: - Zero alternative: Small-moderate effects	Plan alternative: - Zero alternative: Small-moderate effects
SOUTHERN BALTIC SEA	Plan alternative: - Zero alternative: Moderate effects	Plan alternative: - Zero alternative: Moderate-large effects	Plan alternative: - Zero alternative: Small-moderate effects	Plan alternative: - Zero alternative: Small effects
SOUTH-WESTERN BALTIC SEA AND ÖRESUND	Plan alternative: Small effects Zero alternative: Moderate effects	Plan alternative: Small effects Zero alternative: Moderate-large effects	Plan alternative: - Zero alternative: Small-moderate effects	Plan alternative: - Zero alternative: Small effects

8.3.2 Northern Baltic Sea and Södra Kvarken

For the marine areas Northern Baltic Sea and Södra Kvarken, the marine spatial planning entails no or a little change compared with the zero alternative, which is illustrated in Figure 39. The increased pressure within the western parts of the area comes from planned energy establishment. In the southern part, a small positive effect is also seen by Commercial fisheries being limited. Establishment of wind power entails some pressures, but at the same time it can create positive effects similar to reef environments and protection as marine nature reserves. These effects are not included in Symphony.
Several areas are introduced where *particular consideration to high nature values (n)* is to be taken, which also entails a reduced environmental effect (green areas).

The cumulative effects in the Northern Baltic Sea and Södra Kvarken in the plan alternative come from the background pressure (approx. 91%) that consists mainly of oxygen-free seabeds (approx. 44%) and pollutants in sediment (synthetics approx. 15%, heavy metals approx. 12%), but also nitrogen (approx. 11%) and phosphorous (approx. 8%). Chemical pollutants from World War II also contribute a very small part to the cumulative effect. For the sectors of Transportation and communication and a small part of Defence, see Figure 40.

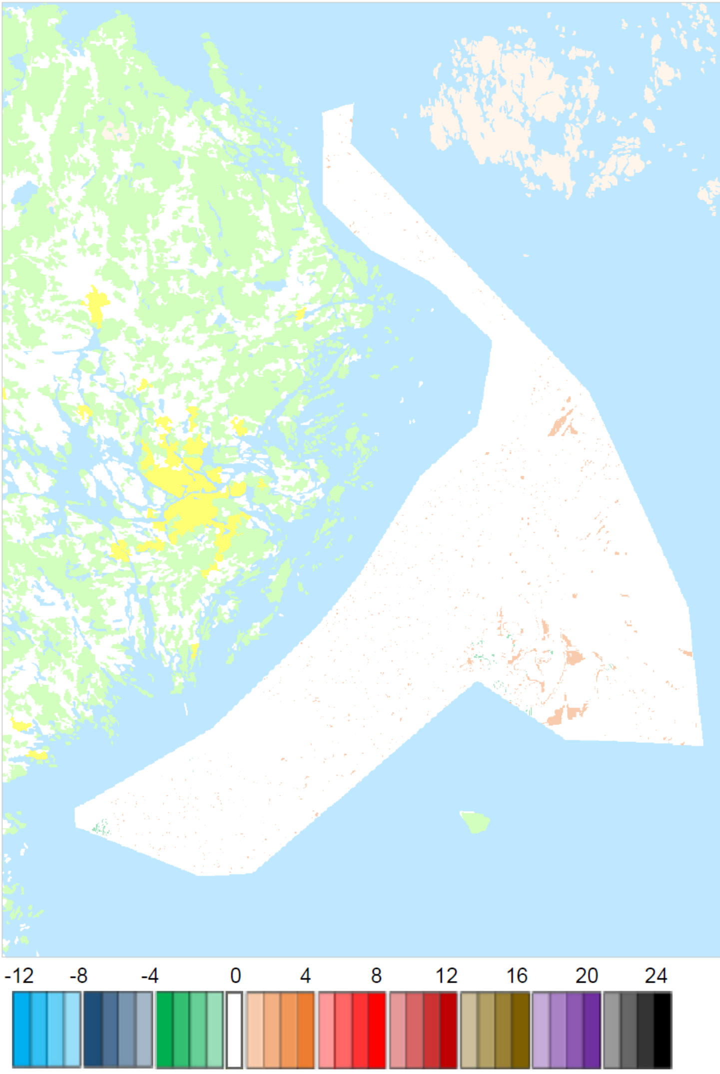


Figure 39 Change in the cumulative environmental effect in per cent in the Northern Baltic Sea and Södra Kvarken compared with the zero alternative. Positive values, in red and grey, result in a larger cumulative environmental effect compared with the zero alternative. Negative values, in blue and green, result in a smaller cumulative environmental effect compared with the zero alternative.

Transportation and communications account for around 7% and consist of *underwater noise* and *introduction of pollutants* (oil spills) from shipping. Defence contributes around 1% and consists of effects from *underwater noise* from explosions and also *introduction of pollutants* from the spread of heavy metals. Commercial fisheries contributes less than 1% and consists of *selective withdrawals of species* from pelagic fishing. Attractive living environments consists of bird hunting and *underwater noise* and *introduction of pollutants* from recreational boats. Energy consists of *underwater noise* and effects from the rotor blades of wind turbines. The cumulative effects are seen mainly on deep soft seabeds, but also on herring, plankton, sprat, deep transport bottoms, aphotic hard seabeds, grey seals, and spawning fish.

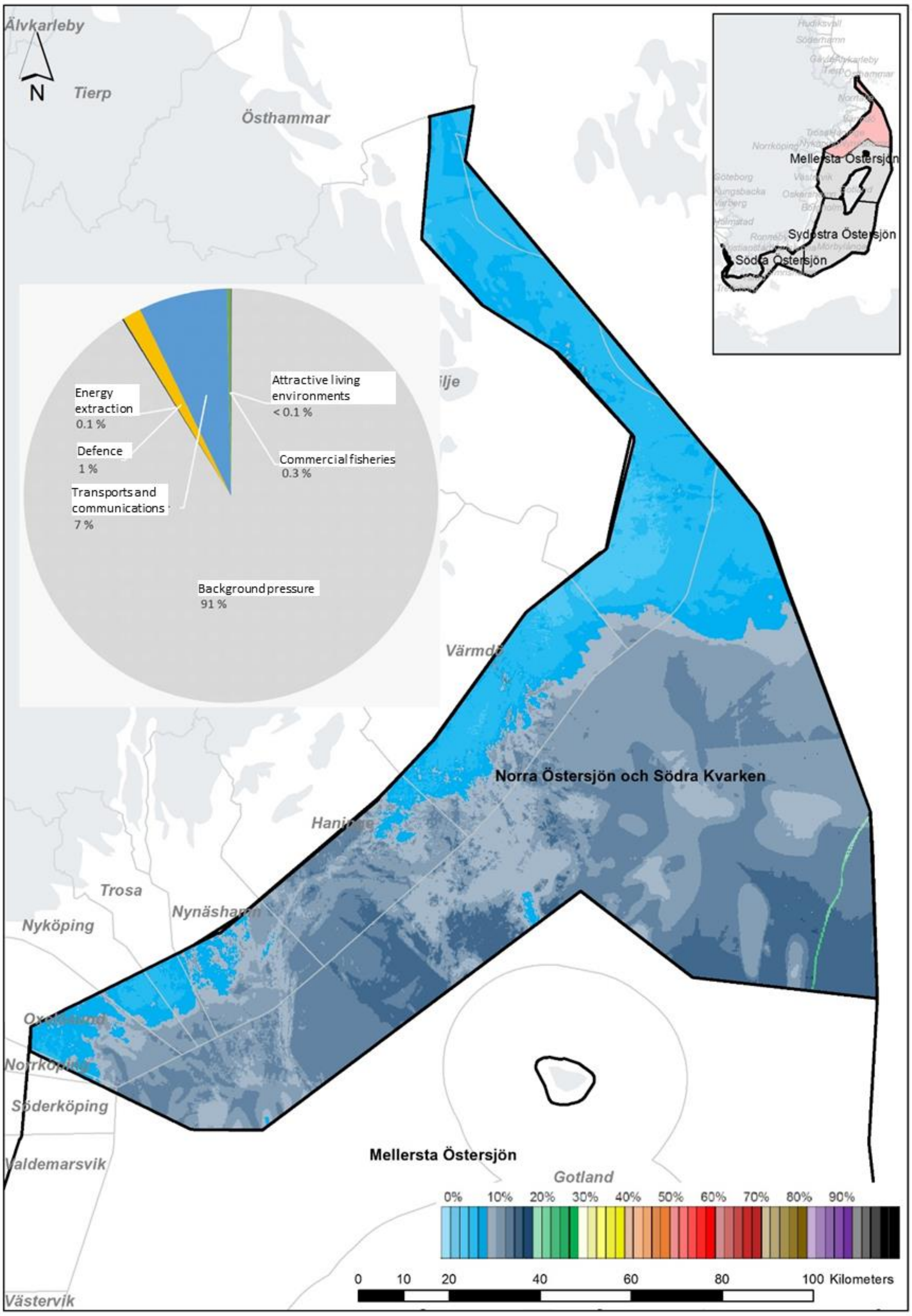


Figure 40 The total cumulative environmental effect in the Northern Baltic Sea and Södra Kvarken. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect. The colours in the pie chart indicate sectors.

8.3.3 Central Baltic Sea

For the Central Baltic Sea marine area, the marine spatial planning entails no change to the cumulative environmental effect compared with the zero alternative, see Figure 41. There is only one area in the south-eastern part that has the designation of *particular consideration to high nature values (n).*

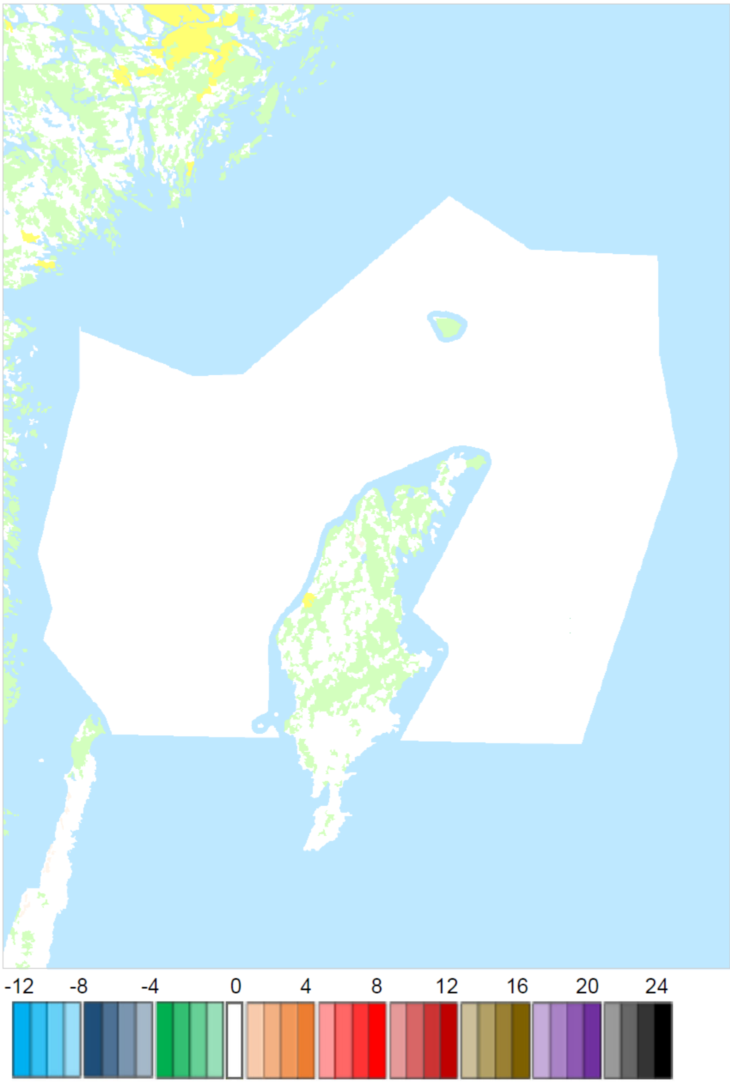


Figure 41 Change in the cumulative environmental effect in per cent in the Central Baltic Sea compared with the zero alternative. Positive values, in red and grey, result in a larger cumulative environmental effect compared with the zero alternative. Negative values, in blue and green, result in a smaller cumulative environmental effect compared with the zero alternative.

The cumulative effects in the Central Baltic Sea in the plan alternative come mainly from the background pressure (approx. 93%) and consist mainly of oxygen-free seabeds (approx. 43%) and pollutants in sediment (synthetics approx. 17 %, heavy metals approx. 15%). Nitrogen (approx. 11%), phosphorous (approx. 7%). and a very small share of chemical compounds from World War II also contribute to the cumulative effect. The sectors Transportation and communication and to a smaller extent Defence also contribute to the total environmental effect, see Figure 42. Transportation and communications account for around 6% and consist of effects from *underwater noise* and *introduction of pollutants* (oil spills) from shipping. Defence accounts for around 1% and consists of effects from *underwater noise* (explosions) and *introduction of pollutants* (heavy metals). Commercial fisheries contributes less than 1% and consists of *selective withdrawals of species* from pelagic trawling and *physical disturbance* from bottom trawling. Attractive living environments (less than 1%) consist of bird hunting and *underwater noise* and *introduction of pollutants* from recreational boats.

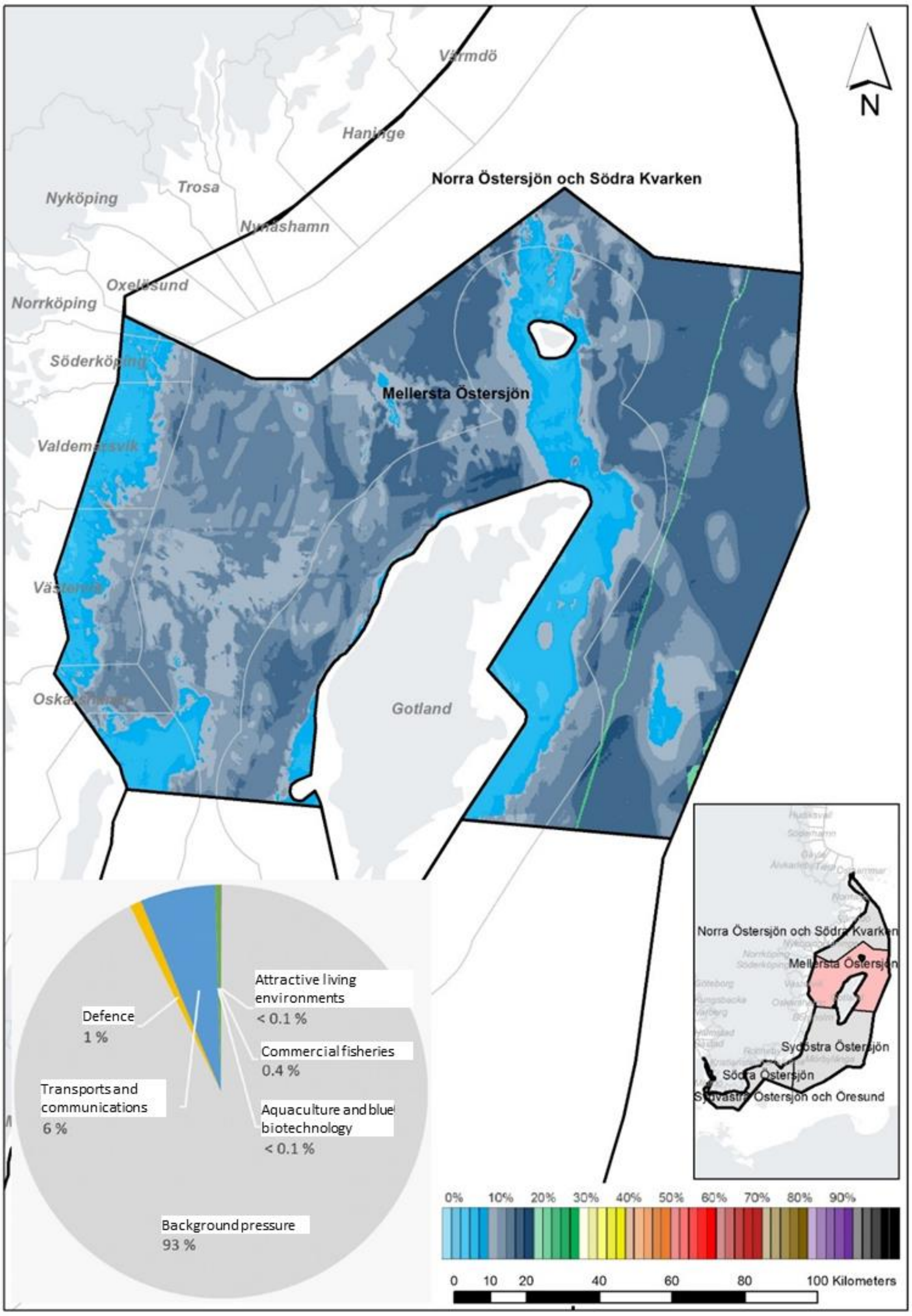


Figure 42 The total cumulative environmental effect in the Central Baltic Sea. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors’

contributions to the cumulative effect. The colours in the pie chart indicate sectors.

The cumulative effects are seen mainly on deep soft seabeds, but also on herring, plankton, sprat, spawning fish, aphotic and deep transport bottoms, and aphotic soft and hard seabeds.

8.3.4 South-eastern Baltic Sea

Within the marine area of the South-eastern Baltic Sea, the wind power establishment at the Södra Midsjöbanken entails a negative change in the environmental effect compared with the zero alternative (approx. 10% higher than the zero alternative), see Figure 43. Södra Midsjöbanken is currently a relatively unaffected area with high values for sea birds. Establishment of wind power entails some pressures, but at the same time it can create positive effects similar to reef environments and marine nature reserves where fish can seek protection. These effects are not included in Symphony.

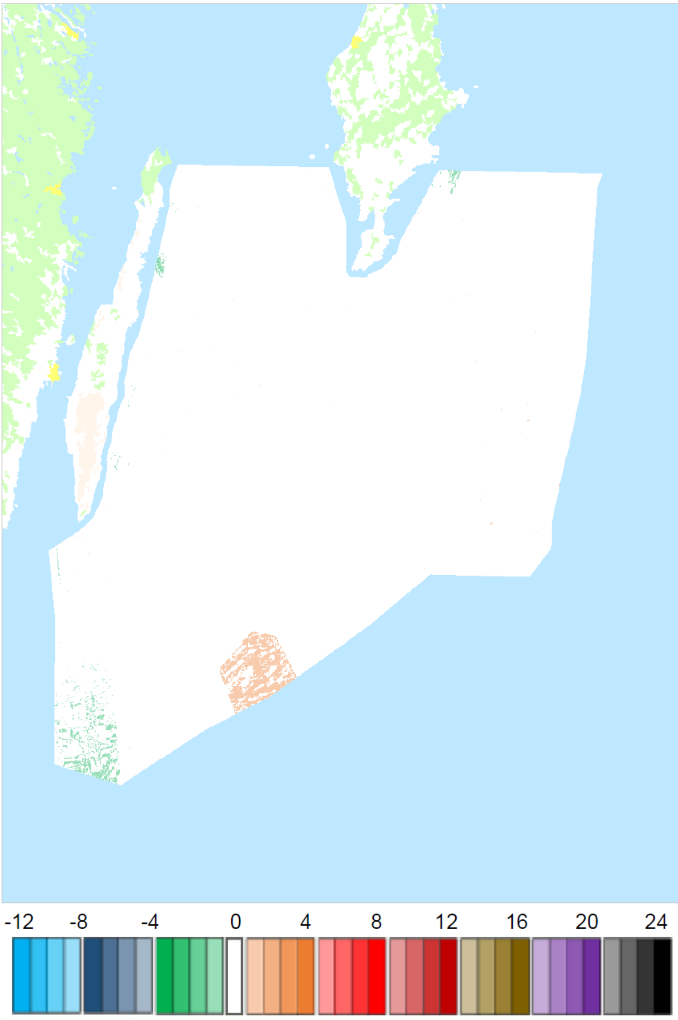


Figure 43 Change in the cumulative environmental effect in per cent in the South-eastern Baltic Sea compared with the zero alternative. Positive values, in red and grey, result in a larger cumulative environmental effect compared with the zero alternative. Negative values, in blue and green, result in a smaller cumulative environmental effect compared with the zero alternative.

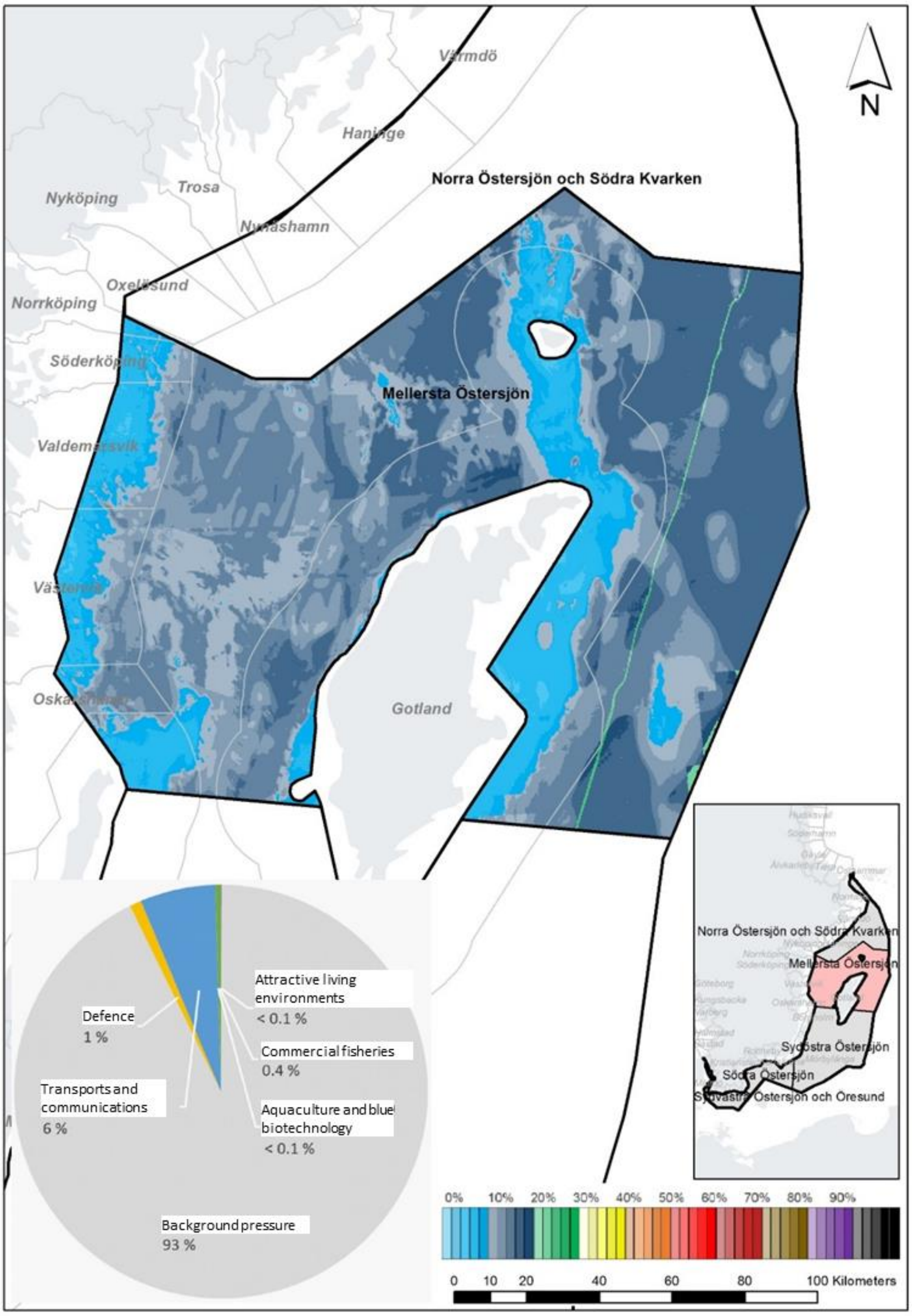


Figure 44 The total cumulative environmental effect in the South-eastern Baltic Sea. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect. The colours in the pie chart indicate sectors.

In the other areas, the marine spatial planning entails no change compared with the zero alternative except in some local areas where the marine spatial planning entails a positive change resulting from areas in which *particular consideration to high nature values (n)* is to be taken. The major environmental improvement is mainly in fishing being limited within these areas, which has a positive effect on the cumulative environmental effect. In total, the MSP entails no change to the environmental effect compared with the zero alternative.

The cumulative effects in the South-eastern Baltic Sea in the plan alternative mainly come from the background pressure (approx. 87%), which mainly consists of oxygen-free seabeds (approx. 33%), but also nitrogen (approx. 16%), pollutants in sediment (synthetics approx. 16%, heavy metals approx. 7%), phosphorous (approx. 9%), and heavy metals and chemical pollutants from World War II (approx. 5% and 1%, respectively). The sectors Transportation and communication and Commercial fisheries also contribute to the total environmental effect, see Figure 44. Transportation and communications account for around 11% of the effects and consist mainly of *underwater noise* and *introduction of pollutants* (oil spills) from shipping. Commercial fisheries contributes around 2% and consists of *selective withdrawals of species* from bottom trawling and pelagic fishing and a smaller share from *physical disturbance* from abrasion and increased turbidity from bottom trawling. The cumulative effects are mainly seen on deep soft seabeds, as well as herring, plankton, sprat, aphotic transport bottoms, cod, spawning fish, Baltic porpoises, deep transport bottoms, aphotic soft bottoms, and sea birds offshore in winter.

8.3.5 Southern Baltic Sea

Within the marine area of the Southern Baltic Sea, the areas within which *particular consideration to high nature values (n)* is to be taken entail a positive change to the cumulative environmental effect in comparison with the zero alternative. This is mainly due to Commercial fisheries being limited in these areas through regulations of equipment and seasons. National defence's impact is also limited in an area with high nature values in the north-eastern part of the marine area, which leads to an environmental improvement.

A limitation to the impact from Commercial fisheries through local regulation of equipment and season in areas with *particular consideration to high nature values (n)* entails, however, that the fishing increases in other areas, which can have a negative environmental effect compared with the zero alternative. One such effect can be seen in the marine area's south-western part, see Figure 45.

In the marine area's central part, sand extraction entails a new use, which has a higher cumulative environmental effect compared with the zero alternative where no sand extraction occurs before 2030. The establishment of wind power also has a negative change even if consideration is taken to national defence interests and areas of high nature values. What is not shown in the cumulative effect is that wind power can also have positive effects such as protective environments for fish and that artificial reefs are created with a high biodiversity.

In total, the plan alternative entails a greater environmental effect compared with the zero alternative (1%, higher than the zero alternative).

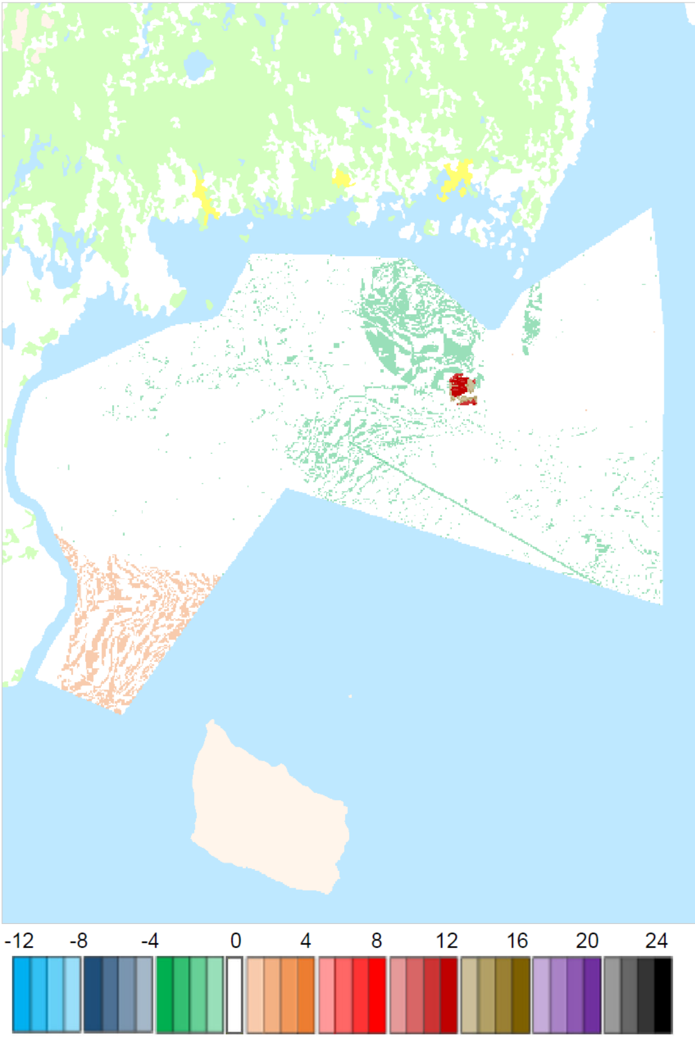


Figure 45 Change in the cumulative environmental effect in the South Baltic Sea compared with the zero alternative. Positive values, in red and grey, result in a larger cumulative environmental effect compared with the zero alternative. Negative values, in blue and green, result in a smaller cumulative environmental effect compared with the zero alternative.

The cumulative effects in the Southern Baltic Sea in the plan alternative come from the sectors Transportation and communication, Commercial fisheries, Defence, and Storage and extraction of material. Transportation and communications account for around 11%, which mainly consist of *underwater noise* and *introduction of pollutants* (oil spills) from shipping. Commercial fisheries contributes around 9% and consists mainly of *selective withdrawals of species* from bottom trawling and pelagic trawling and a smaller share from *physical disturbance* from abrasion and increased turbidity from bottom trawling. Defence contributes around 2% and consists mainly of *introduction of pollutants* (the spread of heavy metals) and *underwater noise* from explosions. Storage and extraction of materials, around 1%, includes *physical loss* and *disturbance* from sand extraction and mining. The background pressure contributes around 76%, which consists of oxygen-free bottoms (approx. 20%), nitrogen (approx. 18%), pollutants in sediment (synthetics approx. 13%, heavy metals approx. 5%), chemical compounds from dumping during World War II (approx. 12%), and phosphorous (approx. 8%).

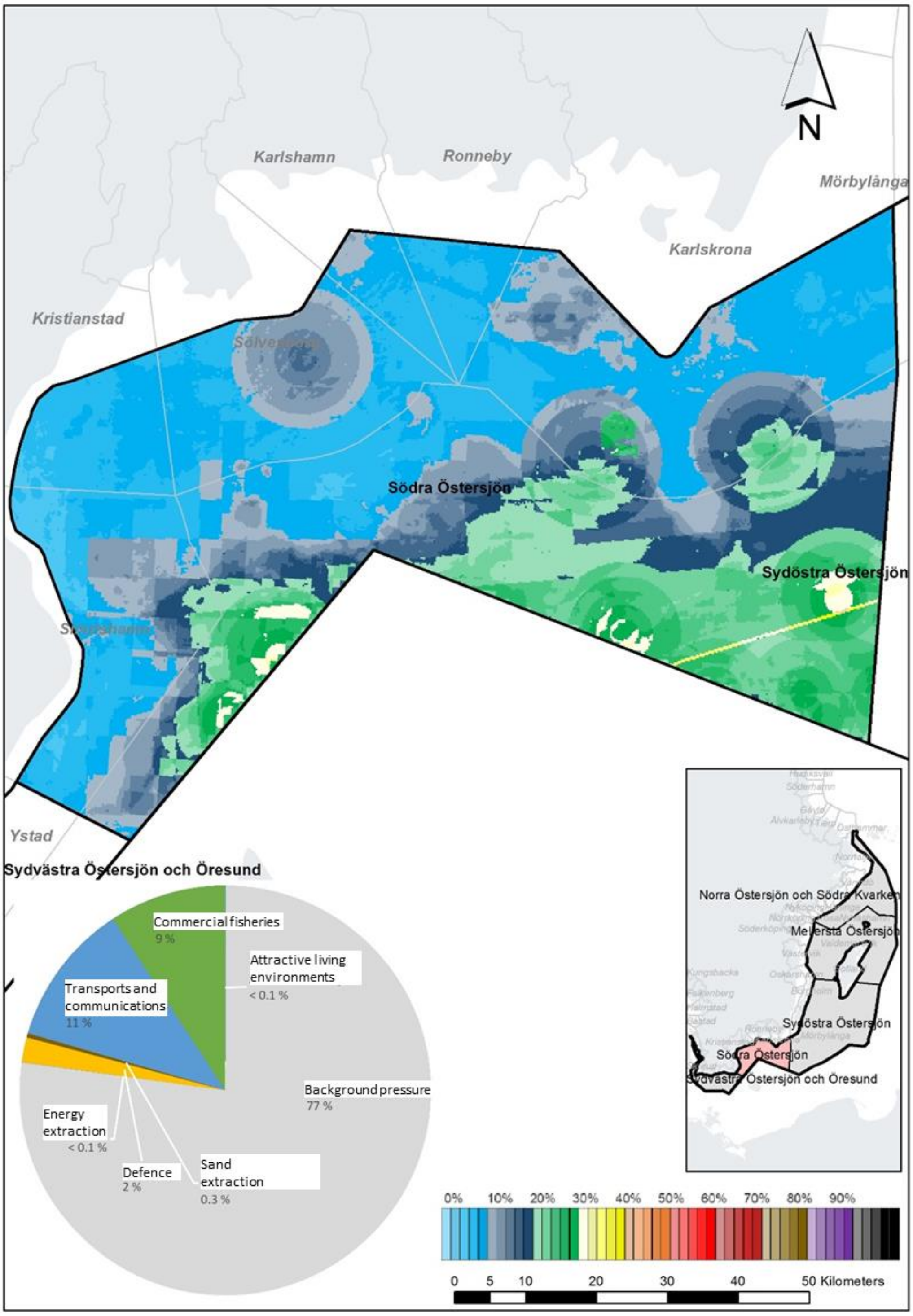


Figure 46 The total cumulative environmental effect in the Southern Baltic Sea. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contributions to the cumulative effect. The colours in the pie chart indicate sectors.

The cumulative effects are seen mainly in deep soft seabeds, cod, and herring, but also in plankton, spawning fish, aphotic transport bottoms, Baltic porpoises, sprat, aphotic soft seabeds, and grey seals.

8.3.6 South-western Baltic Sea and Öresund

The South-western Baltic Sea and Öresund shows no change compared with the zero alternative, see Figure 47. At the area level, the planning entails no major differences.

In Öresund, the areas in which *particular consideration of high nature values (n)* is to be taken provide a clear environmental improvement. An environmental improvement can also be seen in an offshore area south of Karlshamn. The improvement in these areas depends on reduced pressures from Commercial fisheries.

Sand extraction exists according to the MSP in two areas within the marine area, south of Karlskrona (Sandhammar bank) and off of Falsterbo in Skåne (Sandflyttan). Environmental effect from the existing sand extraction area at Sandhammar bank is nearly the same as the zero alternative except in the western edge where a sand extraction area has increased somewhat in the plan alternative. In Sandflyttan, which is an area pointed out in the plan for a new establishment of extraction of marine sand, the sand extraction entails a negative change and larger environmental effect compared with the zero alternative (up to 65% higher than the zero alternative locally for the area off of Falsterbo).

The MSP entails no environmental improvement in the protected nature areas in the southern and south-western parts of the marine area, and the negative environmental effect is largely due to sand extraction. In the MSP, no special measures are introduced in the protected nature areas; rather, these are managed through existing legislation and the national interests' indications.

In the southern part of the marine area, wind establishment is described in two areas, and these provide a positive change compared with the zero alternative. The environmental improvement is due mainly to limitations of trawler fishing in these areas (87% of the zero alternative).

The cumulative effects in the South-western Baltic Sea and Öresund in the plan alternative come from the sectors of Transportation and communication, Commercial fisheries, Storage and extraction of materials, Attractive living environments, Energy, and Defence. Transportation and communications, which account for around 25%, consist of *underwater noise* and *introduction of pollutants* (oil spills) from shipping. Commercial fisheries accounts for around 14% and consists of *selective withdrawals of species* from bottom trawling and net fishing and a smaller share from *physical disturbance* from abrasion and increased turbidity from bottom trawling. Storage and extraction of materials contribute around 1% and consist of *physical loss* (habitat) and *disturbance* (increased turbidity) from sand extraction and mining.

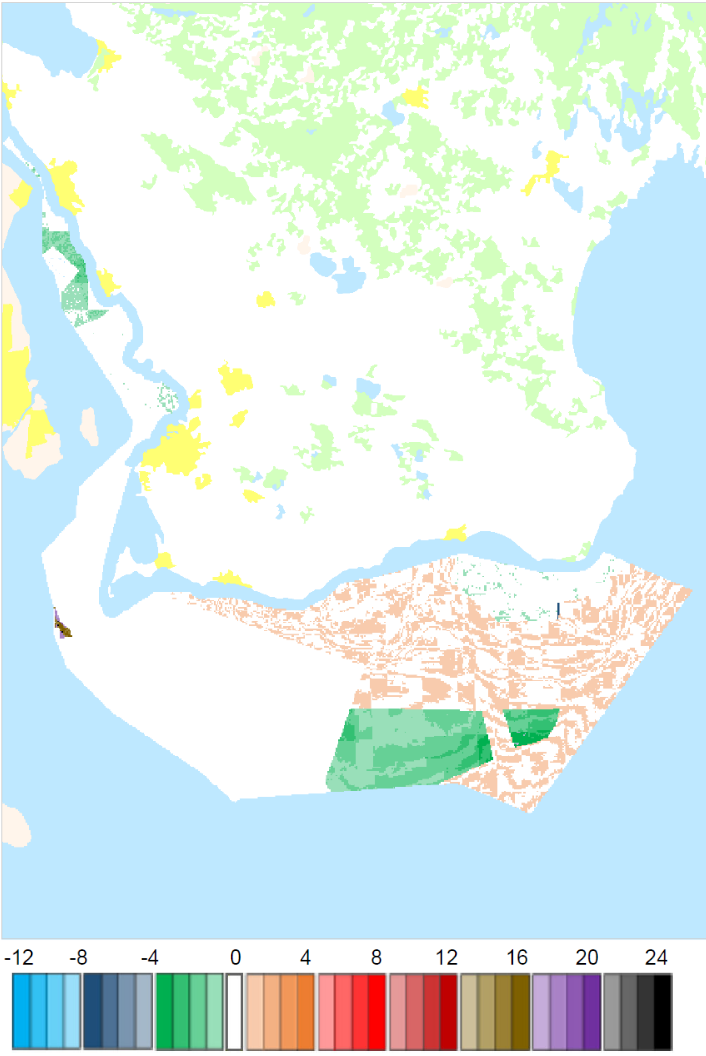


Figure 47 Change in the cumulative environmental effect in per cent in the South-western Baltic Sea and Öresund compared with the zero alternative. Positive values, in red and grey, result in a larger cumulative environmental effect compared with the zero alternative. Negative values, in blue and green, result in a smaller cumulative environmental effect compared with the zero alternative.

Attractive living environments consist of bird hunting and *underwater noise* and *introduction of pollutants* from recreational boats and contribute around 1%. Energy consists of *underwater noise* and effects from rotor blades in wind power and contributes less than 1%. Defence contributes less than 1% and consists of *introduction of pollutants* through the spread of heavy metals. The background pressure accounts for around 57% and mainly consists of nitrogen (approx. 21%), oxygen-free seabeds (approx. 13%), pollutants in sediment (synthetics approx. 13%, heavy metals approx. 3%), phosphorous (approx. 8%), and heavy metals from World War II (less than 1%).

The cumulative effects are mainly noticed on aphotic soft seabeds, cod, and spawning fish, as well as plankton, herring, aphotic transport bottoms, sprat, photic transport seabeds, Danish Strait porpoises, grey seals, photic soft seabeds, and sea birds offshore in winter.

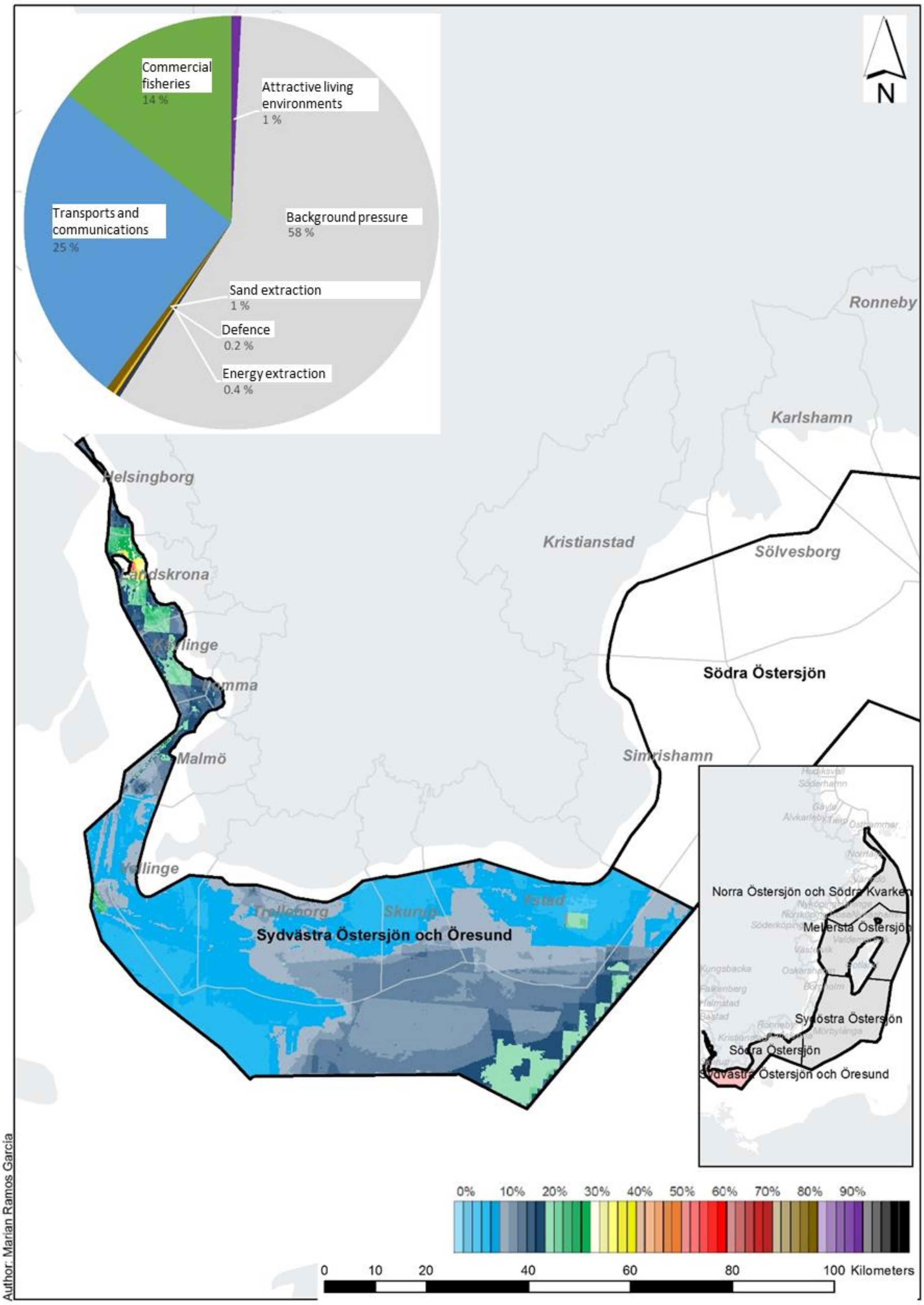


Figure 48 The total cumulative environmental effect in the South-western Baltic Sea and Öresund. The colour scale in the map applies to all of the Baltic Sea, including coastal areas, and shows the percentage of the maximal cumulative effect in the Baltic Sea. The pie chart shows the relative percentage distribution of the sectors' contribution to the cumulative effect. The colours in the pie chart indicate sectors.

8.3.7 Alternative for Storage and extraction of materials

In the zero alternative, an assumption is made that no sand extraction takes place until 2030, in addition to the existing operations in South-western Baltic Sea. Thereafter and during the period until 2050, it is assumed that some extraction of marine sand can take place in all areas identified by SGU. In the study done by SGU, nine places were pointed out as suitable for extraction activities.

Both the zero alternative and the plan alternative build on the same sector analysis, i.e. that no sand extraction probably takes place before 2030. With regard to the MSP's long-term perspective and for the purpose of serving as a guide, three locations in the Baltic Sea (including the existing one in the South-western Baltic Sea) and one in the Gulf of Bothnia have been identified as best suited for sand extraction based on a study done by SGU. Through the guiding proposals on areas for sand extraction, the MSP is assumed to be able to stimulate sand extraction before 2030. Because sand extraction is included in the planning proposal, the environmental effects of such activity become clear when the plan is compared with the zero alternative.

The future for sand extraction with or without the plan is uncertain, but it is likely that when extraction of marine sand begins, it will be advantageous to have the most suitable places with the least environmental impact already pointed out compared with the zero alternative where extraction is assumed to be able to take place at all locations pointed out in earlier studies by SGU.

Through an analysis of the areas that in the planning proposals are indicated for the use of sand extraction, alternatives have been prepared for the Gulf of Bothnia and the Baltic Sea planning areas. The three relevant extraction areas have been analysed individually without mutual comparisons based, among other things, on Symphony data. Based on the analysis, an alternative MSP is proposed for sand extraction where the least-suited extraction locations, i.e. those with greatest environmental impact, have been removed.

Table 14 shows the appointed areas for sand extraction based, among other things, on the photic zone, nature protection areas, what ecosystem components are affected by pressures, and the cumulative environmental effect as estimated in Symphony. The relative contribution to the cumulative environmental effect within the respective extraction area and marine area shows how large a share of the pressures are accounted for by the actual sand extraction or the relative pressures from the other sectors in the area.

Sandflyttan

Sandflyttan accounts for around 0.2% of the cumulative environmental effect in the South-western Baltic Sea and Öresund marine area. Parts of the Sandflyttan area are located below the photic zone and have a strong sediment dynamic. The area at Sandflyttan is included in an N area (Ö284 and Ö286), which is a national interest for nature conservation and Natura 2000 areas (the Birds Directive and the Habitat Directive), and it borders on a nature reserve.

The high nature values and existing nature protection in the area are also reflected in a higher number of ecocomponents being affected by the sand extraction.

Table 14 Compilation of environmental effects of appointed locations for sand extraction in the Baltic Sea and the Gulf of Bothnia.

Location / **Assessment grounds**	Svalans and Falkens grund	Klippbanken	Sandflyttan
Below the photic zone	YES	YES	PARTLY
Nature protection area, N or n area	n	n	N
Pressure on ecocomponents, number	8 (plankton, fish, seals)	6 (plankton, fish, seals)	13 (plankton, fish, seals, birds)
Relative contribution in the extraction area	87%	47%	65%
Relative contribution in the marine area	5.29%	0.33%	0.2%

The sand extraction accounts for a relatively high share (around 65%) of the cumulative environmental effect in the sand extraction area. For the area, there are also other sectors (e.g. shipping around 18%, Commercial fisheries around 4%) that contribute to the cumulative environmental effect. A detailed study should be done to find optimal areas, and times for possible extraction should be chosen with care because the area is highly productive for fish.

Klippbanken

Klippbanken accounts for around 0.33% of the cumulative environmental effect in the Southern Baltic Sea marine area. Klippbanken contains large volumes of sand and gravel and has a substrate consisting of moveable sand over large areas. Up on the bank, however, it is not likely that removed volumes will be replaced naturally through sediment dynamics. The sand extraction area is located below the photic zone and outside areas of national interest for nature conservation and Natura 2000. The high nature values within the area have received attention in the MSP through coverage by *particular consideration to high nature values (n).*

The sand extraction accounts for a relatively high share (around 47%) of the cumulative environmental effect in the sand extraction area. Otherwise, it is only Transportation and communication that contributes by around 7%, and the remaining 46% comes from background pressures. A detailed study should be done to find optimal areas, and times for possible extraction should be chosen with care because the area is highly productive for fish.

In summary, Sandflyttan is considered to be a less suitable alternative mainly due to the site being within an area with high nature values with area protection (N in the plan). In addition, the area is only partly below the photic zone, which might entail a larger environmental effect. The marine area is already strongly affected by several other sectors that are active in the area. The alternative without *Storage and extraction of material* within the marine area South-western Baltic Sea and Öresund reduces the environmental effect.

9 Collective assessment

9.1 Environmental impact

The objective of the SEA is to integrate environmental aspects in the planning and decision-making so that a sustainable development is promoted (Chapter 6 Section 1 of the Environmental Code). With the help of mainly the planning method Symphony, the collective cumulative environment impact within the marine spatial planning area has been estimated and analysed with the aim of assessing the result of the MSP in relation to the zero alternative for 2030.

Table 15 Summary of environmental impact of the MSP on environmental aspects as per the Environmental Code, compared with the zero alternative. Scale: positive, none, small negative, moderate negative, large negative impact.

ENVIRONMENTAL ASPECTS ENVIRONMENTAL CODE / MSP'S THEME	POPULATION AND PEOPLE'S HEALTH	ANIMAL OR PLANT SPECIES AND BIODIVERSITY OTHERWISE	LAND, SOIL, AND WATER	AIR AND CLIMATE	LANDSCAPE, BUILT ENVIRONMENT, AND CULTURAL ENVIRONMENT	MANAGEMENT OF LAND, WATER, AND THE PHYSICAL ENVIRONMENT, AS WELL AS MATERIALS, RAW MATERIALS, AND ENERGY
ATTRACTIVE LIVING ENVIRONMENTS	Positive	None	None	None	None	None
ENERGY	None	Small negative	Small negative	Positive	Small negative	Positive
DEFENCE	None	None	None	None	None	Positive
STORAGE AND EXTRACTION OF MATERIALS	None	Small negative	Small negative	None	Small negative	Positive
NATURE	Positive	Positive	Positive	None	None	Positive
TRANSPORTATION AND COMMUNICATION	None	None	None	None	None	None
AQUACULTURE AND BLUE BIOTECHNOLOGY	-	-	-	-	-	-
COMMERCIAL FISHERIES	None	Positive	None	None	None	Positive

This chapter summarises the cumulative environmental effect for the respective environmental aspect that is taken up in Chapter 6 of the environmental code. In parallel with the environmental assessment of the MSP for the Baltic Sea, a sustainability assessment was done, which is summarised below in the following section.

Most sectors' operations and development entail an impact on the environment and biological diversity. The results from Symphony indicate that the majority of the environmental impact can be traced to land-based or historical emissions. However, the present MSP proposal entails no or very small changes in the spread of most sectors. The MSP entails a change from the current situation only for energy extraction and sand extraction and, to some extent, Commercial fisheries. It is therefore primarily these sectors' environmental impacts that gives rise to environmental consequences that can be traced to the MSP even if they contribute relatively small environmental effects according to the analyses in Symphony.

9.1.1 Population and people's health

Our seas contribute in various ways to our welfare and our well-being from food to various conditions for recreation activities. Through trade and fishing, the seas have also played a crucial historical role for Sweden's development and are thereby also important from a cultural heritage perspective. A concept that is used to describe the benefits of the sea is ecosystem services. The services, often exemplified as fish, crops, or timber, are benefits that contribute to society's well-being or that bear financial or other value for people.

In the sustainability assessment for the Baltic Sea (COWI, 2018b), marine ecosystem services are used to take into account the socioeconomic values that are created or threatened as a result of the proposed MSP. Through their pressures, all marine sectors in some way affect the marine environment and thereby also the marine ecosystem services. Among the sectors covered by the sustainability assessment, there are two that are also directly dependent on the marine ecosystem services for their activities – Commercial fisheries and Attractive living environments (tourism and recreation).

Within the marine spatial planning of the Baltic Sea, outdoor recreation is mainly comprised of recreational boat traffic and angling, but also cruise ships and ferry traffic, hunting, safaris, etc. In the future, demand to partake in archipelago life and the use of the sea for recreation are expected to increase in terms of both national and international tourism. One of several conditions is that important natural and cultural values are preserved, which the MSP's guidance on suitable use of the areas with *particular consideration to high nature values (n)* is intended to do. The MSP entails certain restrictions on outdoor recreation in the areas where energy extraction is pointed out as the most suitable use, which also means that the landscape appearance changes in these areas. Otherwise, the outdoor recreation is not affected in the marine spatial planning area more than marginally.

Establishment of wind power according to planned use in the Baltic Sea's marine spatial planning area might entail negative effects on multiple ecosystem services that are of significance to the sector Attractive living environments. Through wind power's visual impact on the landscape, the cultural ecosystem services and some relocation of tourism might take place between the areas. The use of seabeds for wind power establishment that are of significance to the recruitment of commercial (and other) species is expected to have a negative impact mainly during the construction phase. However, in the operating phase, the environmental pressure likely to decrease because the effect from *physical loss* of seabed is assumed to decrease when foundations, etc., are colonised by bottom-dwelling animals and plants and when the underwater noise is limited to the actual operation.

Establishment of wind power and sand extraction affects the ecosystem services both negatively and positively as seen from the Commercial fisheries sector. Within areas planned for wind power and sand extraction, Commercial fisheries is limited because trawler fishing cannot take place in a wind farm and no fishing can take place at the same time as sand extraction. Fishing can also be impacted in the areas with *particular consideration to high nature values (n)*. The MSP does not specify any regulation, but the implementation of the consideration of the plan indicates, for example, that there might be future regulations of equipment or requirements for protective measures. A positive effect with limitations of Commercial fisheries in the areas is the increased recruitment or survival of certain species that can thereby have a positive economic effect for the sector through increased catch possibilities.

Human health is impacted by the emissions and the littering that takes place in the air and sea. The spatial changes that an adopted MSP has on the Baltic Sea are not expected to change these pressures in any significant way. It is rather the sectors' development that has an impact along with environmental effects that the plan has no control over, for example, the development of shipping and tourism.

The collective assessment is that the MSP has a positive impact on the environmental aspect *Population and people's health*.

9.1.2 Animal or plant species that are protected under Chapter 8 of the Environmental Code, and biological diversity otherwise

Pressures on the marine environment are expected to increase until 2030 along with the effects of climate changes. Work is under way to expand the marine area protection in the Baltic Sea, and with planned area protection 17.3% of the Baltic Sea is expected to be covered by area protection in 2020. In the plan, areas are pointed out in which *particular consideration of high nature values (n)* is to be taken. This means that consideration is to be taken in new establishments, but this also entails restrictions on Commercial fisheries and activities within outdoor life and recreation. In several areas in the Baltic Sea, consideration to nature values entails a reduced pressure from Commercial fisheries and shipping and limitations in recreation activities, such as bird hunting, which means that the cumulative effect in the area decreases relative to the zero alternative. At the same time, some of these areas, which are important habitats where *particular consideration to high nature values (n)* is to be taken, are of interest for energy extraction and/or the interests of national defence. Consideration designations set extensive requirements on adaptations within these areas in order for this coexistence to not counteract the positive effect that the plan seeks.

SwAM's work (2017) on proposals on climate refuges for a number of selected species indicates the possibilities of creating space for especially vulnerable species to survive future climate change. In the Baltic Sea, the areas identified as possible climate refuges include several species, such as eel grass in the Southern and South-western Baltic Sea, sea mussels in the South-eastern and Southern Baltic Sea, Baltic herring in the Northern and Southern Baltic Sea, cod in the Southern Baltic Sea, and *Fucus* ssp in the Southern and Central Baltic Sea. This is further reason that extensive consideration is taken to nature values. This does not entail a direct increase in the marine area protection, but it is expected to benefit biological diversity in several areas.

With the prevailing political objectives in the energy and climate area, there is a pressure on the expansion of renewable energy in which sea-based wind power plays a significant role. Sea-based wind power has an impact through *underwater noise* and *physical disturbance* during construction of the facilities, which is a short-term disturbance that is not handled in the Symphony planning method. *Underwater noise* in the operating phase constitutes a small share compared with shipping noise, but *underwater noise* is a pressure which cumulative effects must be taken into consideration. Use of the seabed entails some *physical disturbance* and *physical loss*, i.e. habitat loss, as a result. Energy extraction's use of seabed habitats for wind turbine foundations might create artificial reefs that can benefit biodiversity in general, at the same time that wind power limits access for fishing, shipping, and recreational activities within these areas. There are habitats within these areas that are very valuable for fish stocks, as well as other parts of the ecosystem, and establishment of wind power can thereby also have an effect outside these areas. In some areas (such as Södra Midsjöbanken) where there are sea birds, *physical disturbance* might mean that sea birds avoid wind power areas to some extent, which can affect the population especially if it suffers from habitat limitations. In the MSP, an assessment is made that co-existence can be achieved through the energy extraction areas being provided with a designation for *particular consideration to high nature values (n)* and also *national defence* (*f)*, which entails extensive requirements on adaptations for wind power establishment. In future permit processes regarding wind power establishment in the plan's areas for energy extraction, the negative environmental effect should be taken into account and managed to minimise the cumulative effect and to meet the plan's recommendation regarding *particular consideration to high nature values (n)*. Altogether, the MSP entails a small local negative cumulative environmental effect in the Baltic Sea as a result of energy extraction.

In the MSP, sand extraction is present as the most suitable use in three areas in the Baltic Sea, which are three of four that the SGU has identified as most suitable for extraction of marine sand and gravel. In the central part of the Southern Baltic Sea, possible sand extraction is located in an area with high nature values (fish recruiting and mammal areas with valuable bottom environments), which means a negative environmental effect with increased turbidity and loss of valuable habitat if the sand extraction takes place with mild methods within less sensitive parts of the area, which has been proposed in earlier studies. In the South-western Baltic Sea and Öresund, two establishments of sand extraction are pointed out, south of Karlskrona and off of Falsterbo in Skåne. The MSP entails a negative environmental effect in the nature protection areas in the southern and south-western parts of the marine area where the sand extraction is planned. In the MSP, no special measures are introduced in the protected nature areas; rather, these are managed through existing legislation and the national interests' indications. Demand for natural gravel is expected to remain high in the future and in pace with the depletion of finite deposits on land, and thus extraction of marine sand and gravel will increase. Extraction of sand only takes place, however, on transport bottoms below the photic zone, and replacement of sand takes place continuously in the area (SwAM, 2018b). Here, the MSP entails a small negative environmental effect on the marine life (*physical loss* and *physical disturbance*), but the effect is considered to be of relative local significance. *Particular consideration to high nature values (n)* within the same areas will limit the negative effect from sand extraction. With regard to all environmental impacts from the plan's indications regarding sand extraction, the SEA is based on no new sand extraction coming about without the MSP.

The relatively large difference in the cumulative environmental effect between the zero and plan alternative is comprised of the assumption of no sand extraction by 2030 and that the MSP could enable sand extraction before 2030 through guiding proposals in the plan. Even if the future for sand extraction with or without the MSP is uncertain, it is probable that when extraction of marine sand begins, it will be advantageous to have the most suitable locations with the least environmental impact already pointed out as in the MSP.

Fishing in the Baltic Sea planning area has a long tradition and is a large part of the Swedish Commercial fisheries industry both in terms of value and catch amounts. Commercial fisheries is widespread in the Baltic Sea. Pelagic fishing is mainly conducted in offshore areas. Sparse fishing with passive equipment is conducted mostly towards the coast in the Baltic Sea and in Öresund where bottom trawling is not permitted, but rather the Commercial fisheries takes place with passive equipment, for cod among others. The marine life is sensitive to over-withdrawal of fish, but other pressures, such as eutrophication and pollutants, also affect the ecosystems. Fishing is expected to be stable until 2030 at the same time that there is continuous development of fishing equipment and methodology to reduce the impact from fishing. Within the MSP's areas for energy extraction, Commercial fisheries will be limited, which entails locally less pressure from the fishing. However, such fishing can be assumed to be moved to nearby areas. Through the plan's indications of *particular consideration to high nature values (n)*, the plan's guidance is expected to result in further regulation of Commercial fisheries by the competent administrative authority, for example, through equipment limitations or protective measures such as pingers to avoid by-catch of porpoises.

In the MSP, there are three *investigation areas for shipping*, including shipping lanes over Salvorev, a shipping lane east of Gotland and the lane in to Slite, and the lanes between Hoburgen and Hoburgs bank. Today, these shipping lanes go through the areas with very high nature values with the red-listed species of ringed seal and long-tailed duck. From a nature conservation perspective, adjusted routes would be important, and how this can be resolved in terms of planning must be investigated further. A possible future adjustment of shipping movements through the area needs to be rooted and negotiated internationally, which sets high standards on documentation.

Altogether, the MSP is expected to provide a local negative effect in some of the areas where sand extraction and energy extraction are given priority, and thereby a small negative consequence can be expected for the environmental aspect *Animals, plants, and biological diversity*. At the same time, use of the areas where *particular consideration to high nature values (n)* is to be taken is expected to provide a positive effect through regulation of Commercial fisheries as well as shipping. In the overall assessment, the MSP is considered to have no significant consequence regarding the environmental aspect Animal, Plants and Biodiversity, but major consideration of the nature values in the area is required when planning, licensing, establishing and conducting various activities.

Alternative for Storage and extraction of materials
The relatively large difference in the cumulative environmental effect between the zero and plan alternative is comprised of the assumption of no sand extraction by 2030 and that the MSP could accelerate sand extraction before 2030 through guiding proposals in the plan, i.e. Sandhammar bank, Sandflyttan, and Klippbanken. Even if the future for sand extraction is uncertain, it is advantageous to have identified suitable locations once extraction of marine sand begins. Sand extraction at Sandflyttan stands for 0.2% of the cumulative environmental effect within the marine area of South-western Baltic Sea and Öresund and locally around 65% in the sand extraction area. Within the marine area, there are several other sectors that contribute to the environmental effect. Sand extraction at Klippbanken stands for 0.33% of the cumulative environmental effect within the marine area Southern Baltic Sea and locally around 46% in the sand extraction area. Sand extraction has a local effect through *increased turbidity*, *physical disturbance*, and *physical loss*, and within the sand extraction area there are high nature values that

include seals, spawning fish, and in Sandflyttan also sea birds. Extraction of sand in Klippbanken only takes place below the photic zone on transport bottoms while in Sandflyttan the sand extraction area is only partly below the photic zone. In summary, Sandflyttan is assessed as a less suitable alternative. The alternative MSP without sand extraction in Sandflyttan will thereby entail a lower environmental effect within the South-western Baltic Sea and Öresund marine area.

9.1.3 Land, soil, water, air, climate, landscape, built environment, and cultural environment

The Baltic Sea is one of the world's most trafficked seas, due largely to transports of goods to and from Sweden and the other countries around the Baltic Sea. Combustion of fuel results in emissions to the air that contribute to climate changes and acidification and eutrophication problems, and shipping is a major source of emissions of air pollution. Shipping also affects the environment through several other emissions that are regulated with multiple national and international regulations. Until 2030, shipping is predicted to increase by 50% in the Baltic Sea, and existing areas for shipping lanes are expected to be adequate for handling this expected increase. The MSP entails a minor relocation of shipping lanes in several areas in the Baltic Sea. In the Southern Baltic Sea and in the Northern Baltic Sea and Södra Kvarken, the plan does not confirm a shipping lane in areas where *particular consideration to high nature values (n)* shall be taken and where there is nature protection.

Within the Baltic Sea, the Swedish Armed Forces have a number of artillery and training ranges, which affect the marine environment through emissions of metals from ammunition. Locally, this can cause large concentrations with effects on the marine environment. The Swedish Armed Forces' activities in the area also generate underwater noise. A possible development according to the SwAM thematic work is that national defence might increase the use of virtual methods to reduce the need for physical artillery exercises. An effect of this can probably be expected only after 2030. By 2030, the impact of defence activities is expected to increase proportionally with the development of the sector. The interests of the Defence are expected to have good possibilities for coexistence with Commercial fisheries, outdoor recreation, and shipping. Permanent installations for wind power (or other energy production) can entail physical obstacles and cause technical disruptions that compete with the interests of defence. In the MSP, guidance is provided on which areas in the Baltic Sea that particular consideration to national defence interests shall be taken in wind power establishment. This might entail limitations to the scope of wind power expansion.

Altogether, the MSP is not expected to entail any change for emissions to air and sea from the sectors shipping and defence compared with the zero alternative. Emission estimates for the adjustments to shipping routes that are under investigation indicate that potential adjustments will not lead to any significant emission increases.

The plan entails a potential emission reduction of carbon dioxide in the establishment of renewable energy extraction and is thereby considered to have a positive effect (COWI, 2018b). Besides a local impact on the seabed and the marine flora and fauna, the establishment of wind power also entails a change in the landscape appearance, which is addressed in Section 9.1.1.

Cultural heritage remains, such as shipwrecks, might be affected in the establishment of permanent constructions for wind power, which must be taken into account in the permit process, and the construction must be adapted to minimise the impact on possible permanent remains. Extraction activities can potentially cause major damage and loss of cultural environments on the seabed through the extensive impact on bottom environments that extraction entails. According to information on known cultural history remains, there is some concentration of wrecks at both locations that are deemed to be suitable for sand extraction, i.e. Sandflyttan and Klippbanken. To minimise the impact on the cultural environment, detailed investigations and studies need to be done prior to an application for extraction activities in these areas. The total cumulative environmental effect in the marine area of the South-western Baltic Sea and Öresund is strained in the zero alternative, and the plan's introduction of sand extraction increases this environmental effect.

For the environmental aspects *Land, soil, water, air, climate, landscape, built environment, and cultural environment*, the MSP is expected to mainly entail local negative environmental effects in the areas in which a new establishment is introduced, such as sand extraction and wind power establishment. The negative effects of offshore wind power are not expected to exceed the positive impact on climate and the environmental enhancement measures expected to occur due to *particular consideration of high natural values (n).* The MSP entails a small negative consequence to the part of the environmental aspect that affects *landscape, built environment, and cultural environment*.

Altogether, the MSP is expected to have a small negative consequence to the *Land, water, and cultural environment* components of this environmental aspect, a positive consequence on *climate,* and no negative consequence for the other parts of the environmental aspect *Land, soil, water, air, climate, landscape, built environment, and cultural environment*.

9.1.4 Management of land, water, and the physical environment otherwise, and Other management of materials, raw materials, and energy.

The objective of the MSP is to plan the marine spatial planning area to be able to use the areas for the purposes that they are best suited for considering their character, situation, and needs. The areas where a difference between the MSP and the zero alternative entails a change in the cumulative environmental effect and accordingly can have an effect on this environmental aspect are the areas where new use is introduced, i.e. sand extraction and energy extraction, but also where *particular consideration to high nature values (n)* and *national defence (f)* are introduced.

At present, there is only limited need for sand extraction at sea within the Baltic Sea, but within the MSP's horizon year the need is expected to increase and SGU has therefore prepared a few areas, of which three are within the Baltic Sea, that may be suitable for sand extraction. With regard to energy extraction at sea, interest in renewable energy is also expected to increase in pace with technical development, which means that sea-base wind power will become more competitive. Both sand extraction and energy extraction are preceded by an environmental permit process in which local impact and effects are analysed and assessed with the aim of minimising the environmental impact. In the MSP, some sectors are expected to be able to coexist, and areas with *particular consideration to high nature values (n)* have been pointed out in co-existence with one or more uses. Adaptations will need to be made to minimise the impact and effects in these areas worth protecting in order to achieve the aim in having appointing these areas as such.

The MSP provides guidance regarding suitable uses in a number of areas where *particular consideration to high nature values (n)* is to be taken. In most cases, these areas are important spawning grounds and recruiting areas for fish, which means that the MSP through these areas can have a positive effect on the fish stocks as a resource. This might also entail a geographically large effect. It is therefore important in the establishment of other activities to take this into consideration and to discuss possible regulation of Commercial fisheries.

Altogether, the MSP is considered to entail a positive consequence for the environmental aspects *Management of land, water, and the physical environmental otherwise* and *Other management of materials, raw materials, and energy* because the plan works for the coexistence between various uses and because sand extraction replaces extraction of natural gravel on land and energy extraction contributes energy from a renewable source.

9.1.5 Other parts of the environment. Act (2017:955).

No other areas have been identified in the impact assessment of the MSP than the environmental aspects assessed above.

9.1.6 Impact of climate change on sectors

The changes in the environment predicted from climate change will in the long term affect water temperature, ice cover in winter, length of the seasons, length of the growing seasons, and the ranges and survival of species. The sectors that are generally affected primarily by climate change are Transportation and communications, Commercial fisheries, Energy, and Nature (COWI, 2018a).

The largest effect of climate change in the Baltic Sea's marine spatial planning area will take place in habitats and ecosystems. A number of climate refuges have been pointed out (SwAM, 2017b), which are areas where the effect of climate change is small in relation to the surrounding living environment and where specific species have a possibility to be preserved. Climate refuges thereby contribute to preserving species and biological diversity and thereby also increasing the surrounding areas' resilience. The impact of climate change in the Baltic Sea is mainly assessed to be seen in eel grass, bladder wrack, sea mussels, and cod.

The effects of climate change in the Baltic Sea will also arise in the sectors Storage and extraction of material and Energy. Increased storms and floods might lead to more erosion and thereby greater demand for marine sand and gravel, and an increased desire for development of wind power might benefit the establishment of sea-based wind power.

9.2 Evaluation of the plan – sustainability and goal attainment

The ecosystem approach is a starting point in the EU Directive on maritime spatial planning, and the Swedish Marine Spatial Planning Ordinance (2015:400) states that SwAM shall apply an ecosystem approach in the work of drafting MSPs. The ecosystem approach is an international strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way. The goal is to ensure that ecosystems are used without compromising their long-term survival in terms of their structure, dynamics, and function.

Application of the ecosystem approach in Swedish marine spatial planning involves, among other things, regularly referring back to the environmental strategic objective of good environmental status, as provided within the framework for the Marine Environment Ordinance (2010:1341). According to the Swedish Marine Spatial Planning Ordinance, the marine spatial planning should contribute to achieving and maintaining good environmental status in Sweden's marine areas. Marine spatial planning therefore needs to take into account aspects that are required so that the environmental quality standards can be met. In the marine spatial planning process, it must be concretised what good environmental status means in a spatial perspective, and the ways in which various activities can affect the marine environment must be analysed.

According to the Environmental Code, an environmental impact assessment shall contain a description of how relevant environmental quality objectives and other environmental considerations are taken into account in the plan. In the environmental impact assessment, the Marine Strategy Framework Directive and fulfilment of environmental quality standards have also been included in the assessment.

9.2.1 Plan guidance towards guiding objectives

The MSP shall aim for good environmental status in the marine environment to be achieved and maintained, for the sea's resources to be used sustainably so that sea-related industries can develop, and for the promotion of co-existence between different activities and areas of use.

The proposed MSP for the Baltic Sea has been reconciled with objectives in the Marine Strategy Framework Directive against the plan's effects with regard to the Swedish environmental objective work, and the maritime strategy for people, jobs, and the environment has been evaluated in general, which is compiled below.

Marine Strategy Framework Directive

Good environmental status (GES) is the desired status in the environment where the use of the marine environment is at a level that is sustainable. Marine spatial planning is a tool for adapting the utilisation of the sea so that development needs are met at the same time as environmental objectives and good environmental status are achieved and maintained. The Marine Strategy Framework Directive (2008/56/EC), implemented in Sweden through the Marine Spatial Planning Ordinance, aims to achieve or maintain good environmental status in the EU's marine areas by 2020. This shall be achieved through adaptive management and shall be based on the ecosystem approach (SwAM, 2015b).

As a guide for achieving good environmental status, Sweden has chosen to use so-called environmental quality standards. These shall among other things be based on the definition of good environmental status provided in the Marine Strategy Framework Directive and shall take into account both impacts and pressures. Environmental quality standards with indicators constitute an important part in the assessment and monitoring of the sea. The environmental quality standards shall not be violated, which is why the marine environmental management needs to take into account aspects and formulate action programmes so that environmental quality standards are met and so that good environmental status is achieved. It is the authorities and municipalities that are responsible for compliance to the standards.

Through Regulation HVMFS 2012:18, SwAM has determined what characterises good environmental status for Sweden's marine areas and has set environmental quality standards with 11 associated indicators (SwAM, 2012a). These standards are structured in consideration of pressures and impacts as described in Table 2 in the Directive's Annex III. Environmental status is described using 11 descriptors.

Table 16. Marine Strategy Framework Directive's descriptors (HVMFS 2012:18, Appendix 2).

D1	Biodiversity
D2	Invasive species
D3	Commercial use of fish and shellfish
D4	Marine food webs
D5	Eutrophication
D6	Sea-floor integrity
D7	Lasting changes in hydrographical conditions
D8	Concentrations of hazardous substances

D9	Hazardous substances in fish and shellfish
D10	Characteristics and amounts of marine litter
D11	Introduction of energy, including underwater noise

The environmental quality standard *Good environmental status for the North Sea and the Baltic Sea* (including Kattegat, Skagerrak, and the Gulf of Bothnia) is evaluated using all 11 descriptors and the conditions that shall be achieved in the marine environment in order for the standard to be viewed as fulfilled (HVMFS 2012:18). The standard is evaluated on a management area level, meaning partly for the *North Sea* (all Swedish waters from the baseline to the boundary of the Swedish exclusive economic zone north of the Öresund bridge) and partly for the *Baltic Sea* (all Swedish waters from the baseline to the boundary of the Swedish exclusive economic zone south of the Öresund bridge).

Environmental quality standards with indicators are evaluated on a finer geographic scale and applied in internal and external coastal waters and offshore waters in all Swedish marine areas. In contrast to the standard for *Good environmental status for the North Sea and the Baltic Sea,* these standards focus on specific environmental pressures and are divided into four groups:

A. Introduction of nutrients and organic material (one norm: A1)
B. Introduction of hazardous substances (two standards: B1 and B2)
C. Biological disturbances (four standards: C1 -C4)
D. Physical disturbances (four standards: D1 – D4)

The evaluation of the plan proposal's contribution to achieving good environmental status according to the Marine Strategy Framework Directive builds on the connection between the plan's assessed environmental effects and the 11 descriptors, see Table 16. For example, an increase in the environmental pressure from a maritime sector would entail a negative effect on the possibility of achieving the relevant environmental quality standard.

The results from the evaluation of the plan's consequences in the Baltic Sea in terms of environmental effects show that the sectors Energy and Storage and extraction material and the interest Nature are of significance. For the energy sector, it is the potentially comprehensive expansion of wind power that may increase the environmental pressure, mainly through *physical loss* and *physical impact* on the bottoms that are claimed for use, but also through *underwater noise*. The environmental pressure from energy extraction is expected to increase in the marine areas of the Northern Baltic Sea and Södra Kvarken, the South-eastern Baltic Sea, and the South-western Baltic Sea and Öresund where the planning proposal's use of energy extraction exceeds the energy extraction assumed in the zero alternative.

An overall assessment of potential environmental effects as a result of the MSP in the Baltic Sea for the Energy sector is a moderately increased pressure. The cause is mainly the pressure associated with the construction phase when areas of seabed with high nature values are claimed for use. The construction phase also entails underwater noise and increased turbidity from the actual construction work, which contributes further to the cumulative environmental pressure. In the operating phase, the environmental pressure from *physical loss of seabed* is expected to decrease when foundations, etc., are colonised by bottom-dwelling animals and plants and when *underwater noise* during the operating phase is significantly lower than during the construction phase. At the same time, the pressure from Commercial fisheries in affected energy areas mainly in the South-western Baltic Sea and Öresund's marine area where fishing with certain equipment is excluded is expected to move to surrounding areas where the pressure is expected to increase.

The environmental pressure from Storage and extraction of materials as a result of the planning proposal comprises *physical loss* (of seabed) and *physical disturbance* (as a result of increased turbidity). Sandflyttan off of Falsterbo is located in a Natura 2000 area with high nature values. This location is of significance as wintering and rest areas for sea birds and for porpoises, grey seals, and fish. It is primarily central parts of the area, with large sea mussel occurrences, that are of significance, and extraction is deemed by SGU (2017) to be able to be conducted on the edges (east and west) of the area. Assessments of the cumulative environmental effect show that extraction from Sandflyttan contributes to 2.8% of the total environmental effect in the South-eastern Baltic Sea and Öresund marine area. However, on a local scale (Ö284, Ö286), corresponding calculations show a pressure of around 7–8% as a result of the extraction.

When it concerns the plan proposal's guidance on the use Nature, the Symphony calculations show small positive effects in the Baltic Sea's plan area as a result of *particular consideration to high nature values (n)*. For Commercial fisheries, the n-areas are expected to give a positive effect in combination with guidance on *General use* (Gn). The effect arises as a result of reduced by-catches through the use of trawlers with high catch selectivity in pelagic fishing, porpoise-deterring pingers, by-catch minimisation panels for net fishing, etc. (SwAM, 2018a). A small pressure decrease from (n) can also be linked to *Defence* in the planning area. At the same time, the pressure from a sand extraction location in the southern part of the plan area (Klippbanken) may increase the pressure, despite guidance of *particular consideration to high nature values (n)*. For energy extraction, *particular consideration to high nature values (n)* is not deemed to have any positive effect. In the relevant areas (Ö248 and Ö266), the pressure is estimated to increase by around 8% and around 5%, respectively, as a result of a potential expansion of wind power.

The plan's consequences on Good Environmental Status in the Baltic Sea are difficult to assess due to both positive and negative consequences. The following environmental quality standards are expected to be affected:

- *Environmental quality standard: Good environmental status for the North Sea and the Baltic Sea*

> Environmental pressures from the plan proposal's guidance on sand and energy extraction entail a negative impact in all Baltic Sea marine areas except the Central Baltic Sea. The descriptors to be negatively affected are *D1 – Biological diversity, D6 – Seabed integrity*, and *D11 - Addition of energy including underwater noise*, which potentially contribute negatively to achieving *Good environmental status* in the Baltic Sea.
>
> In terms of pressures linked to energy extraction, the negative effects are to be mostly linked to the construction phase and to then decrease substantially in the operating phase. The exception is *Physical loss* and parts of *D11 - Supply of energy including underwater noise* and impact on sea birds (descriptor D1), the effects of which remain during the operating phase.
>
> Energy extraction according to the plan proposal in the Baltic Sea entails the exclusion of some kinds of Commercial fisheries from areas with guidance on energy extraction, which leads to locally reduced environmental pressures with a connection to the descriptor *D6 – Seabed integrity*. At the same time, the on-going fishing in affected energy areas is moved to surrounding areas where the pressure on the seabed increases instead, and thus the net effect with regard to norm fulfilment is uncertain.
>
> The proposed plan's expected positive effect from the guidance on *particular consideration to high nature values (n)* through measures in Commercial fisheries is deemed to lead to reduced pressure (biological disturbance of species) and thereby a positive effect on the descriptors D1, D3, and D4. Correspondingly, the consideration designation (n) is assessed to entail positive environmental effects within an area with guidance on sand extraction (Klippbanken, Ö262). In the areas with the guidance on energy extraction with *particular consideration to high nature values (n)* (Ö248), detailed project planning of wind power stations is expected to take place to minimise the impact on sea birds (descriptor D1). This way, the plan entails a positive contribution to the possibility of achieving *Good environmental status* in the Baltic Sea management area.

The overall effect when it comes to the plan's impact on the possibility of achieving the Environmental Quality Standard of *Good environmental status* in the Baltic Sea management area is difficult to assess because the plan proposal entails both negative and positive effects. Further analyses are required to determine with any certainty the total effect of the plan proposal in terms of the possibility of achieving environmental quality standards within the Marine Strategy Framework Directive.

Sweden's environmental quality objectives

For the evaluation of the Swedish national environmental quality objectives, both the environmental assessment and the sustainability assessment focused on the environmental objective of *A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos*. The proposed MSP also concerns other environmental objectives, but the aforementioned environmental objective is considered to be of greatest significance to the marine spatial planning. The Government has established 11 specifications of the environmental objective, and of them the following were evaluated:

- **Good environmental status**
  Coastal and sea waters have a good environmental status with regard to physical, chemical, and biological conditions in accordance with the Marine Environment Ordinance (2010:1341).
- **Favourable conservation status and genetic variation**
  Habitat types and indigenous species linked to the coast and sea have favourable conservation status and sufficient genetic variation within and between populations, and naturally occurring fish species and other marine species thrive in viable populations.
- **Threatened species and restored habitats**
  Threatened species have recovered and habitats have been restored in valuable coastal and marine waters.
- **Preserved natural and cultural heritage values**
  The natural and cultural values of the marine, coastal, and archipelago landscape are preserved, and conditions exist for the continued preservation and development of these values.
- **Cultural heritage remains under the water**
  The condition is unchanged for cultural heritage remains under the water.
- **Outdoor recreation and noise**
  The marine, coastal, and archipelago landscape values for recreational fishing, bathing, boating, and other outdoor activities are safeguarded and preserved, and the impact from noise is minimised.
- **Ecosystem services**
  The coasts' and the seas' important ecosystem services are maintained.

For this environmental quality objective, the MSP entails positive conditions for several of the specifications as a result of the areas where *particular consideration to high nature values (n)* is to be shown. Introduction of areas with *particular consideration to high nature values (n)* are also expected to entail positive secondary effects for outdoor recreation, but at the same time the establishment of wind farms can entail negative effects for outdoor recreation (limited accessibility) and landscape appearance (visual impact). Similar reasoning applies to the ecosystem services. The plan is expected entail both negative and positive effects for the marine ecosystem services in the area. The positive effect reaches the areas through limitations of effects from Commercial fisheries through, among other things, the regulation of equipment and from *particular consideration to high nature values (n)*, and the negative effect is mainly tied to the expansion of sea-based wind power and sand extraction. The positive effects are potentially larger than the negative effects because the effect from the protection of Commercial fisheries in referred energy areas is considered to be relatively large at the local level and because a significant area is pointed out with *particular consideration of high nature values (n)*. A positive effect with more recruitment to Commercial fisheries areas can thereby have a positive economic effect for the sector through greater catch possibilities. At the same time, catch possibilities are limited as a result of exclusion from referred energy areas.

The total assessment when it comes to the plan's effects in relation to *A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos* is difficult to judge. The results indicate that the plan might entail a positive effect as a result of guidance on *particular consideration to high nature values* and reduced pressure from Commercial fisheries in the energy areas. At the same time, the plan's guidance on energy extraction entails a potential increase in the environmental pressure and visual impact, both with potentially negative effects on cultural ecosystem services. An overall assessment is that the plan proposal does not have any net effect on the possibility of achieving the objective.

9.2.2 MSP from a sustainability perspective

The sustainability assessment is intended to analyse the proposed plan's impact from a sustainability perspective. Among other things, this means identifying the geographic or thematic areas where the proposed MSPs are at risk of leading to conflicts of interest or priorities that put at risk society's overall objective of a good environmental status and sustainable growth. The result from the assessment shall thereby be a basis for considerations in the continued planning work, which shall lead to sustainable management of the marine environment.

The sustainability assessment is based on the three sustainability dimensions of *economy*, *ecology*, and *social aspects*. The sustainability assessment of the proposed MSP in the Baltic Sea indicates a generally positive result compared with the zero alternative when no plan is applied (COWI, 2018b).

Economic sustainability
Altogether, the analysis indicates a positive result for the economic sustainability dimension. This is primarily due to expected positive economic effects within energy extraction from wind power, sand extraction in the marine areas of the South-western Baltic Sea and Öresund and the Southern Baltic Sea, and strengthened ecosystem services in the Baltic Sea planning area as a result of increased consideration of nature through guidance on *particular consideration to high nature values*.

Ecological sustainability
The analysis of the Baltic Sea plan proposal also indicates a positive result within the sustainability dimension of Ecology. This is mainly due to reduced climate emissions as a result of the expansion of wind power according to the plan proposal's guidance on energy extraction. The plan proposal is expected to entail positive environmental effects through guidance on *particular consideration to high nature values* in areas with *general use*, *defence*, and *energy extraction*. The plan is also expected to entail negative environmental effects, mainly as a result of disturbances in the construction phase in wind power establishment in the Baltic Sea planning area and as a result of guidance regarding sand extraction.

Social sustainability
A positive result is also obtained in social sustainability. Positive effects of the plan proposal are linked to *increased employment* from a potential expansion of sea-based wind power, increased possibilities of *identity-creating activities* such as *Commercial fisheries* and *recreation activities* through increased environmental consideration, and *decreased pressure on cultural environments* as bottom trawling is limited in some areas. However, an expansion of wind power according to the guidance in the plan proposal is deemed to entail a deterioration in terms of *coexistence* between different sectors and interests in the Baltic Sea plan area.

9.2.3 Cross-border environmental impact

For the Baltic Sea, the cross-border environmental impact is mainly about the effects from the sectors of Transportation and communications, Commercial fisheries, Storage and extraction of materials, and Energy. The cross-border impact that is deemed to be caused by the MSP mainly takes place in the areas close to the border with Denmark to the south-west, with Poland to the south, and with Lithuania, Latvia, and Russia to the east.

The analysis carried out with the help of Symphony shows that the areas where the MSP points out shipping and Commercial fisheries in the same areas generally suffer a burden on the environment that might need to be managed through cross-border cooperation because these sectors are mobile and their environmental impacts are cross border. Mobility also provides opportunities for improvements, and limits can be set on fishing and shipping in some especially impacted areas through cross-border cooperation, such as in the South-western Baltic Sea together with Denmark and Germany or in the Southern and South-eastern Baltic Sea together with Denmark and Poland.

Another activity in the Baltic Sea that causes cross-border environmental impact is the establishment of wind farms, which provide a local negative effect in the MSP, mainly when *particular consideration to national defence interests* and the area's nature values needs to be taken. An example is an area in the South-eastern Baltic Sea bordering Poland, where the area is classified as "Efn: Energy with *particular consideration to national defence interests* and *particular consideration to high nature values (n)*". Local positive effects can also arise around wind farms because they have a reduced withdrawal of fish due to reduced Commercial fisheries and because shipping and other activities decrease. This leads to positive effects in the MSP, such as in areas appointed for Energy extraction in the South-western Baltic Sea, something that needs to be coordinated with Denmark in order to be maintained long term. This can also lead to long-term positive effects in the form of new protected spawning grounds for fish.

Wind power that is placed in the areas bordering neighbouring countries will have an effect outside Sweden's borders, which is why cooperation with neighbouring countries is needed, mainly when it concerns coexistence with areas with *particular consideration to high nature values (n).* Here, cooperation across borders is needed for establishment, implementation, and maintenance of the area's protection.

Sand extraction that takes place in the border areas potentially has a limited local environmental impact outside Sweden's borders, and the MSP points out some areas in the South-eastern Baltic Sea, and an area located near Denmark in the South-western Baltic Sea and Öresund, that might require cooperation with Denmark.

The environmental impact that extends over national borders requires cooperation and dialogue between the countries. SwAM (2014) initiated a dialogue with all nine neighbouring countries that Sweden shares a marine border with. The discussions indicate shared problems and a good cooperation climate.

The dialogue arrived at the following conclusions regarding these problems (SwAM, 2014):

- A shared and collective illustration of the present situation as a starting point for the planning is desirable and should also include planned, but not yet implemented, projects.
- Regarding the method for the ecosystem approach, there are partly different perspectives.
- Linear objects must be coordinated between the countries, such as power lines, bridges, shipping routes, and pipelines.
- Common guidelines for safety distances for wind power facilities in relation to shipping are desirable.
- Both early and on-going cooperation and exchange of planning documentation throughout the planning process and not just in connection with the Espoo consultation are important.
- Exchange of data and planning information between countries is necessary if it is to be possible to make plans that are coordinated with each other, but this is difficult because one often ends up with secrecy issues.
- Integration of the Marine Strategy Framework Directive and the Maritime Spatial Planning Directive is a challenge, not least because there are different administrations in several countries that are responsible for the implementation of the respective directives. The marine spatial planning is not seen as a distinct tool for the implementation of the Marine Strategy Framework Directive, and the connections to the spatial perspective are perceived to be weak, except for protected areas.
- Wind power, tourism, shipping, and aquaculture are the thematic sectors that the majority of countries see as possible growth sectors. However, although there is much planning and discussion about wind

power and to some extent aquaculture at sea, implementation of concrete projects is progressing slowly.

- The interaction between the work on blue growth and an improved environment and how these different perspectives should be combined is highlighted as a challenge.

There is a need to handle chemical weapons and leftover munitions in some parts of the marine spatial planning areas, which primarily affects the Baltic Sea in particular (SwAM, 2014).

Other common cross-border issues concern wind farms in shallow areas and other energy production, sand extraction, cables and power lines, trawler areas, and cooperation between authorities and follow-up and monitoring.

The report (SwAM, 2014) also confirmed that there are good conditions for coordinated marine spatial planning because the majority of the neighbouring countries will be closely in phase with each other in terms of marine spatial planning.
Marine spatial planning in the Baltic Sea has elements of issues of an inter-state nature that might require political negotiations and agreements, e.g. secrecy issues regarding the exchange of data between states or unresolved border issues.

The EU-funded cooperation within the Baltic SCOPE project indicated the advantages of cooperation between countries that are preparing MSPs and how method development can be done jointly. Among other things, the importance of cooperation between relevant authorities and of paying attention to bilateral and cross-border environmental issues. There is also an opinion that the planning authorities should create good and continuous cooperation with the authorities that have sector responsibility and that they should be permitted to influence the marine spatial planning. The process should map common conflicts and synergy effects, and it should apply knowledge in methodology for risk assessment and conflict management in the work. The importance is also pointed out of using the ecosystem approach and its checklists in the work.

The MSP for the Baltic Sea needs to be coordinated with all neighbouring countries from Finland in the north to Denmark in the west. Cooperation across the borders is dependent on how far the countries have come in their marine spatial planning process, but several of the neighbouring countries have opened up for cooperation and have the possibility to exchanging experiences with the Swedish process (European Union 2017, SwAM 2014).

9.2.4 Alternative formulations

Within the scope of this SEA, alternatives for *Storage and extraction of material* were analysed (also refer to Section 8.3.7 and 9.1.2). In summary, it can be said that an alternative MSP without the use of sand extraction in Sandflyttan entails a reduced local environmental effect. This is because sand extraction accounts for a relatively large share of the cumulative environmental effect in the sand extraction area (around 65%).

Within the Baltic Sea's marine spatial planning area, there is an investigation area within which alternative formulations would be possible, for example, for shipping. These are not possible to evaluate within this environmental assessment because the alternatives are not chosen or specified.

9.2.5 Proposed revisions to the plan

Plan alternative compared with the zero alternative

The various marine areas in the Baltic Sea MSP demonstrate different results in the comparison between the plan alternative and the zero alternative. Within smaller areas, both increases and decreases arise in the cumulative environmental effect, and the MSP thereby generally entails a redistribution of the environmental impact.

The expansion of sea-based wind power and added areas for sand extraction are the most significant differences in relation to the zero alternative. Within the entire Baltic Sea, major environmental effects are also seen from Transportation and communication (shipping), which can also be seen in the zero alternative in comparison with the present situation.

In the South-western Baltic Sea and Öresund as well as the Southern Baltic Sea, an increased cumulative environmental effect arises in the plan alternative. Here, it can be added that the environmental effect in these marine areas increases markedly in the zero alternative compared with the current situation. The plan adds further environmental impact to parts of these marine areas mainly through planning for sand extraction, relocated Commercial fisheries, and wind power establishment. In an area off of Falsterbo, the increase is distinct as a result of the plan's indication of suitable sand extraction in a nature protection area. The effect of wind power establishment differs within the marine areas. In the areas where trawler fishing cannot coexist with energy extraction, the effect is positive compared with the zero alternative. In other areas, the environmental effect is greater as a result of improved conditions for wind power establishment in comparison to the zero alternative.

The interest Nature is benefited by the plan as a result of the indication *particular consideration to high nature values (n)* primarily in combination with General use and Defence. These areas are assessed to provide local positive effects that can also provide positive environmental effects to surrounding areas. Effects of *particular consideration to high nature values (n)* are mainly seen in Öresund where the environmental effect decreases compared with the zero alternative. In the other areas within the Baltic Sea, the effect of *particular consideration to high nature values (n)* is not as large.

The plan is assessed to contribute positively to goal attainment of set targets, which is largely due to the good effect the areas with *particular consideration to high nature values (n)* are deemed to provide. However, the plan is deemed to contribute negatively to the possibility of achieving the Environmental Quality Standard of Good environmental status in the Baltic Sea.

The sustainability assessment done in parallel with the environmental assessment indicates an overwhelmingly positive effect for the plan alternative with regard to financial, ecological, and social sustainability.

Proposed revisions

Proposed revisions to the plan proposal are formulated in consideration of the overall and strategic level at which the plan works. The revision proposals therefore primarily aim to influence the plan's overall formulation in a direction that to the greatest possible extent enables fulfilment of the plan's guiding environmental and sustainability objectives.

In general, the positive effect can be emphasised here that the areas with the indication of *particular consideration to high nature values (n)* provide such effects based on related assumptions, both environmentally and from a sustainability perspective.

Possibilities of an expanded use of the indication *particular consideration to high nature values (n)* combined with General use and Energy could potentially strengthen access to the ecosystem services that Commercial fisheries and a significant part of Tourism and recreation are dependent on. The good effect of consideration recommendations for these areas is weighed up to some extent by the impact from wind power establishment and sand extraction in an analysis of the cumulative environmental effect with the help of the Symphony planning method. One recommendation is, however, that more areas be identified where some form of special environmental consideration should be taken and to find possible coexistence with various sectors within these areas.

Proposed areas in Hanöbukten for climate refuges for certain species are a step towards more protection for animals and plant species exposed to impact from climate change, which might be of great value for future nature conservation.

Another recommendation is to also identify areas worthy of protection with high and important environmental values with clear decisions that nature values in these areas receive marine protection, which provides a stronger protection than the aforementioned areas with environmental consideration.

SwAM can propose regulations for areas if it is considered necessary to achieve the objective of the MSP. These can contain binding limits and could be a stronger alternative to areas with *particular consideration to high nature values (n)*.

Because shipping has a tangible environmental impact in the ecologically valuable marine area of the South-western Baltic Sea and Öresund, the possibility of rerouting or concentrating shipping routes should be investigated. Because the plan cannot affect shipping's pressures more than pointing out shipping lanes in the area, the plan within the marine area of the South-western Baltic Sea and Öresund should also be investigated further.

Promoting a further pressure (sand extraction) in this area in the planning needs to be further investigated and assessed. The actual impact and geographic spread as a result of extraction activities also needs to be analysed further in Symphony.

Areas around Gotland (three investigation areas for shipping, including shipping lanes over Salvorev, a shipping lane east of Gotland and the shipping lane in to Slite ,and the lane between Hoburgen and Hoburgs bank) are of interest to finding possibilities to strengthen the protection of the sensitive environments and their high natural value. Today, the shipping lanes go through areas with very high natural value with the red-listed species of porpoise and long-tailed duck. In the MSP, a new shipping lane is proposed through a nature area in the South-western Baltic Sea. Even if this only entails a relocation of shipping locally, the environmental effects on marine life will increase.

From a nature conservation perspective, this is an important change that the MSP can work further on. A possible future adjustment of shipping movements through the area needs to be rooted and negotiated internationally, which sets high standards on documentation. At the same time, it is a possibility to find ways to effectively be able to allow and stimulate the development of shipping, energy extraction, and sustainable resource management.

If areas can be identified that should be entirely protected from both shipping and other uses in order to strengthen the use Nature, this can reduce the environmental impact and effects within parts of the marine area. Partially strengthening the interest Nature as a prerequisite and management sector will thereby reduce the environmental impact and effects in certain parts of the marine spatial planning area.

The MSP could work further to identify areas that are suitable for energy extraction at a greater depth and thereby reduce the impact on the shallow banks, and this would indicate long-term planning for technical development.

10 Monitoring and audit

10.1 Continued planning process and environmental assessment

The marine spatial planning process comprises the phases of discussion, consultation, review, and adoption. After the initial informal discussion phase, where drafts of proposed plans and SEAs were discussed, the planning process has continued with this formal consultation.

Consultation document
Consultation on the MSPs is held for six months beginning on 15 February 2018. The Espoo consultation with neighbouring countries is being held for three months during this period.

Review document
Review of plan proposals, SEAs, and sustainability assessments is planned to begin in the early spring of 2019. This is the last phase to obtain opinions before the proposals are submitted to the Government.

Assumptions
SwAM's aim is for the MSP proposals to be submitted to the Government in December 2019. The Government will prepare the issue internally based on the proposed plan and other decision documentation. To fulfil the EU Maritime Spatial Planning Directive, Sweden should have adopted national MSPs before March 2021.

After the plans have been adopted and begun to be applied, a follow-up of the plans will be done continuously.

10.2 Evaluation and follow-up

Once the MSPs have been adopted, SwAM is responsible for follow-up of the environmental impact the plans actually entail. This will be done to obtain knowledge early on of significant environmental impacts that were not previously identified in the process. The follow-up also aims to monitor the expected environmental impact that this environmental assessment describes. A control programme will therefore be prepared that describes how the follow-up will be done and what parameters will be followed up. The control programme will be coordinated with other existing environmental follow-ups to ensure effective implementation.

11 References

In Swedish except those marked “ENGLISH”

AquaBiota. (2015). Areas worthy of protection for porpoise in Swedish waters.

Swedish Species Information Centre. (2004). Bat fauna in Sweden. Species range and status. State of knowledge in 2004. Swedish Species Information Centre.

Swedish Species Information Centre. (2015). Red-listed species in Sweden. Uppsala: Swedish Species Information Centre, Swedish University of Agricultural Sciences (SLU).

COWI. (2018a). Impacts of climate change on marine spatial plans of Swedish marine waters.

COWI. (2018b). Sustainability Assessment of the Baltic Sea MSP, Consultation document.

Swedish Energy Agency. (2015). Sea-based wind power Government assignment 2015:12.

Swedish Energy Agency. (2017a). Havsbaserad vindkraft - En analys av samhällsekonomi och marknadspotential. [Sea-based wind power - An analysis of societal economy and market potential].

Swedish Energy Agency. (2017b). Wind power statistics 2016 ES2017:2.

Swedish Energy Agency. (2017c). Marine energy. Downloadedon 23 March 2018: http://www.energimyndigheten.se/forskning-och-innovation/forskning/fornybar-el/havsenergi/

Swedish Energy Agency (2018). Repealed connection charges for sea-based wind power. Report 2018:6 Swedish Energy Agency, Eskilstuna.

European Union. (2017). Recommendations on Marine Spatial Planning Across Borders, Baltic Scope. ENGLISH

Swedish Armed Forces (2017). Report on national interests in Västra Götaland County (2017). Report FM2017-3631:2, Annex 21.

UN. (2015). Transforming our world: The 2030 agenda for sustainable development. ENGLISH

Green, M. H. (2016). Monitoring bird population development. Annual report for 2015. Swedish Environmental Protection Agency.

Swedish Agency for Marine and Water Management. (2009). What determines the salt water break-in to the Baltic Sea? The Sea in 2009. Life and movement in the open water.

Swedish Agency for Marine and Water Management. (2012a). Good marine environment 2020 Marine strategy for the North Sea and the Baltic Sea. Part 2: Good environmental status and environmental quality standards.

Swedish Agency for Marine and Water Management. (2012b). Marine litter in Sweden. Björn Risinger.

Swedish Agency for Marine and Water Management. (2014). Marine spatial planning, Dialogue with our neighbouring countries, Report 2014:23.

Swedish Agency for Marine and Water Management. (2015a). Ecosystem services from Swedish seas – Status and impact factors. Gothenburg: Björn Risinger.

Swedish Agency for Marine and Water Management. (2015b). Proposal for the direction of the marine spatial planning and the scope of the environmental assessment. Gothenburg.

Swedish Agency for Marine and Water Management. (2015c). Marine Spatial Planning – Current Status 2014. Gothenburg: Björn Risinger. Report 2015:2.

Swedish Agency for Marine and Water Management. (2016a). Fiske & Fritid. Downloadedfrom SwAM: https://www.havochvatten.se/hav/fiske--fritid/arter/lista-over-vanliga-arter-i-svenska-vatten/arter/nordamerikanska-havsborstmaskar.html

Swedish Agency for Marine and Water Management. (2016b). Färdplan havsplanering. [Marine Spatial Planning Roadmap.] Gothenburg: Jakob Granit.

Swedish Agency for Marine and Water Management. (2016c). Littering in sea and water. Downloadedfrom SwAM: https://www.havochvatten.se/hav/fiske--fritid/miljopaverkan/marint-skrap.html

Swedish Agency for Marine and Water Management. (2016d). Fishing – Report from marine spatial planning thematic work from October 2015 to March 2016. Swedish Agency for Marine and Water Management, Gothenburg.

Swedish Agency for Marine and Water Management. (2016e) Sjöfart – rapport från havsplaneringens tematiska arbete från oktober 2015 till mars 2016. [Shipping – report from marine spatial planning thematic work from October 2015 to March 2016.] Swedish Agency for Marine and Water Management, Gothenburg.

Swedish Agency for Marine and Water Management. (2017a). Marine Spatial Plan for the Baltic Sea, Consultation Document 2017.

Swedish Agency for Marine and Water Management. (2017b). Possible climate refuges in the Baltic Sea based on two different scenarios, Knowledge documentation for marine spatial planning, report 2017:37.

SwAM (2017c). *Economic statistics on sectors that are dependent on the sea.* Documentation on the initial assessment in 2018 in the Marine Environment

Ordinance. Report 2017:16. Swedish Agency for Marine and Water Management, Gothenburg.

Swedish Agency for Marine and Water Management. (2017d). Consultation on initial assessment 2018, Circulation version, SwAM

Swedish Agency for Marine and Water Management. (2018a). Symphony - Integrated planning support for national marine spatial planning based on an ecosystem approach

Swedish Agency for Marine and Water Management. (2018b). Consultation Document, Proposed Marine Spatial Plan for the Baltic Sea, 15/02/2018.

Swedish Institute for the Marine Environment. (2014a). The Sea in 2013/2014.

Swedish Institute for the Marine Environment. (2014b). Shipping around Sweden and its impact on the marine environment Gothenburg: Swedish Institute for the Marine Environment report 2014:4.

Swedish Institute for the Marine Environment. (2016a). The Sea 2015/2016 - on the environmental status of Swedish marine areas. Swedish Agency for Marine and Water Management and the Swedish Environmental Protection Agency.

Swedish Institute for the Marine Environment. (2016b). Shipping affects Sweden's marine environment. Downloadedfrom Swedish Institute for the Marine Environment: http://havsmiljoinstitutet.se/hav-och-samhalle/sjofart on 10 10 2016

Swedish Institute for the Marine Environment. (2017). Measures to reduce shipping's impact on the marine environment, Swedish Institute for the Marine Environment report 2017:2

HELCOM. (2010a). Ecosystem Health of the Baltic Sea 2003–2007: HELCOM Initial Holistic Assessment. Balt. Sea Environ. Proc. No. 122. ENGLISH

HELCOM. (2010b). Hazardous substances in the Baltic Sea - An integrated thematic assessment of hazardous substances in the Baltic Sea. Balt. Sea Environ. Proc. No. 120B. ENGLISH

HELCOM. (2016). Cyanobacterial blooms in the Baltic Sea in 2016. Downloadedfrom http://helcom.fi/baltic-sea-trends/environment-fact-sheets/eutrophication/cyanobacterial-blooms-in-the-baltic-sea/: ENGLISH http://helcom.fi/baltic-sea-trends/environment-fact-sheets/eutrophication/cyanobacterial-blooms-in-the-baltic-sea/

County Administrative Board. (2005). Conservation plan for Natura 2000 areas. County Administrative Board of Gotland.

County Administrative Board of Gotland. (2016a). Conservation plan for Natura 2000 area (Gotska Sandön-) Salvorev SE0340097. Downloadedfrom the County Administrative Board: http://www.lansstyrelsen.se/gotland/SiteCollectionDocuments/sv/djur-och-natur/skyddad-natur/natura-2000/natura-2000-pa-gotland/salvorev.pdf

County Administrative Board of Skåne. (2016b). Falsterbo Peninsula's marine area. Downloadedfrom the County Administrative Board of Skåne: http://www.lansstyrelsen.se/skane/Sv/djur-och-natur/skyddad-natur/skydd-skansk-natur/naturreservat/vellinge/falsterbohalvons-havsomrade/Pages/_index.aspx

County Administrative Board VISS. (2016c). Water Map. Downloadedfrom the County Administrative Board Water Information System Sweden: http://viss.lansstyrelsen.se/MapPage.aspx

Swedish Environmental Protection Agency. (2006). Inventory of marine nature types on offshore banks.

Swedish Environmental Protection Agency. (2013). Characterisation of PCB and PCDD/F in the Baltic Sea's surface sediment. Stockholm.

Swedish Environmental Protection Agency. (2014). Toxins & Environment 2014. On the impact to the outdoor environment and humans. Swedish Environmental Protection Agency.

Swedish Environmental Protection Agency. (2016). Follow-up of interim objectives. Environmental objectives - annual follow-up of Sweden's environmental quality objectives and interim objectives 2016, 299-382.

Government bill on Defence policy direction - Sweden's defence 2016-2020 (Government bill 2014/15:109) Stockholm: Ministry of Defence.

Sandström, J. B. (2015). Status and trends for species and their habitats. Swedish Species Information Centre Reports 17. Uppsala: Swedish Species Information Centre, Swedish University of Agricultural Sciences (SLU).

SGU. (2016). Carbon dioxide storage in Sweden. Report 2016:20. Geological Survey of Sweden, Uppsala.

SGU. (2017). Förutsättningar för utvinning av marin sand och grus i Sverige. [Conditions for extraction of marine sand and gravel in Sweden.]

SMHI. (2013). Oxygen Survey in the Baltic Sea 2012 - Extent of Anoxia and Hypoxia, 1960-2012. Gothenburg: REPORT OCEANOGRAPHY No. 46, SMHI. ENGLISH

SMHI. (2015). Oxygen Survey in the Baltic Sea 2015. Gothenburg. ENGLISH

SMHI. (2016). Documentation of estimation of marginal costs for Swedish shipping - Modelling of ozone, secondary particles and deposition of sulphur and nitrogen. Report 2016/30. SMHI.

Swedish Transport Administration. (2016). Forecast for freight transports 2040, Swedish Transport Administration base forecasts 2016, Swedish Transport Administration report 2016:062.

Swedish Transport Agency. (2016). Boating life study 2015.

Wijkmark, N. & Enhus, C. (2015). Method description for preparation of GIS map for a nationally comprehensive view of marine green infrastructure. AquaBiota Water Research AB.

WSP Sverige AB. (2016). Our future seas – A report on future opportunities and challenges in Swedish marine spatial planning.

WSP Sverige AB. (2017). SEA draft in the discussion phase of marine spatial planning.

WWF. (2010). Counter currents - Scenarios for the Baltic sea towards 2030. ENGLISH

12 Appendices

12.1 Glossary

Term	Explanation
Abrasion	Abrasion of the seabed through, e.g. trawling.
Accumulation bottom	Seabed where sediment materials (particles that sink to the bottom) remain.
DDT	Dichlorodiphenyltrichloroethane (DDT) is an insecticide that was introduced in 1942.
DDE	Dichlorodiphenyldichloroethylene
Ecosystem service	A concept used to describe the sea's benefits, from food to recreation activities at, on, or in the sea.
Erosion bottom	Seabeds where sediment can easily erode, be dispersed, and carried away.
Green infrastructure	Green infrastructure is defined as how important marine habitats and processes are linked in time and space. Diversity and fragmentation of ecosystems are assessed in this environmental assessment within green infrastructure. Green infrastructure also refers to the ecological functional network of structures and habitats that contribute to the preservation of the biological diversity with a focus on their functionality and the connectivity between them. The sea's green infrastructure is thereby comprised of habitats for various species, spreading routes, migration routes for birds, fish, and other animal species, and this infrastructure is vital to be able to preserve the entire ecosystem.
Angiosperms	Plants characterised by having seeds enclosed in fruit (in contrast to gymnosperms).
HCH	Hexachlorocyclohexane (HCH)
HELCOM MPA	Marine Protected Areas, a marine protected area in the Baltic Sea established by HELCOM to protect marine ecosystems and habitats.
Hard seabeds	On hard seabeds, there are habitats such as mussel beds and seaweed forests.
Soft seabeds	The most commonly occurring type of seabed in Sweden's marine areas. Soft and shallow soft seabeds provide a good substrate for seaweed beds and for seed plants and charophyte green algae. These are also characterised in contrast to hard seabeds of digging animals, such as annelid worms, molluscs, crustaceans, and echinoderms.
MSFD	Marine Strategy Framework Directive, an EU initiative
PCB	Polychlorinated biphenyl (PCB) is a group of environmentally and health hazardous industrial chemicals.

Pelagic habitats	Pelagic habitats refer to the part of the marine habitat that is above the seabed or is not mainly affected by the bottom environment. It is in the pelagic zone that the majority of the sea's primary production takes place. This habitat is strongly affected by the photic (actually euphotic) zone's extent, i.e. the upper sunlit part of a body of water in which photosynthesis can occur.
Plankton	Plankton is a collective name for organisms that live in the pelagic zone, and these are an important part of the food chain because they are the main food for, among others, the endangered porpoise. Plankton consist of viruses, bacteria, protists, plants, and animals and are also food for seals and fish. They are a good indicator of changed water quality because they quickly react when nutrient salt concentrations and light availability change, especially plant plankton. The composition and amount of plankton also strongly affect the rest of the water environment through changed visual depth and food supply for animals that live in the water column or on the bottom.
Oxygen-free bottoms	Oxygen deficit leads to reduced biodiversity and altered species composition, and thereby has a negative impact on the ecosystems. Oxygen deficit refers to oxygen levels below 2 ml/l, which entails levels that make it difficult for most animals to survive (SwAM, 2015c). Oxygen deficit is defined on two levels: hypoxia entails levels of 2 mg/l, and anoxia means a total absence of oxygen. When all oxygen is consumed by various bottom processes, hydrogen sulphide (H2S) is formed and is toxic to marine life. Under oxygen-free conditions, nutrients are also released, such as phosphate and silicate, from the sediment to the water, which upon vertical mixing can reach the surface layer and the photic zone and thereby contribute to the eutrophication problem. High levels of phosphate benefit the growth of plant plankton, especially cyanobacteria in the summer in the Baltic Sea, which can further increase the oxygen deficit because plankton ultimately sink to the bottom and require more oxygen to be broken down (SMHI, 2015). A higher spread of oxygen-free seabeds also contributes to a higher production and emission of methane gas, which is a greenhouse gas. The methane emissions are also affected by climate change because an increase in primary production resulting from a temperature increase can increase the production of methane gas. With warmer winters, the natural methane gas emissions can occur during longer periods every year. It is thereby of utmost importance to place focus on reducing the oxygen-free seabeds, not only from a plant and animal life perspective, but also to not increase the methane emissions from the seabed.
Transport seabeds	Seabeds where sediment material is temporarily deposited until it is moved to accumulation bottoms.
Offshore banks	Offshore banks are elevations from the bedrock that differ from shallower coastal areas in that they are surrounded by deeper water. They are generally home to species and habitats that are characteristic for more unaffected marine environments. The offshore banks thereby often have high ecological and biological values because organisms that previously occurred in shallow coastal areas, but disappeared or decreased as a result of increased disturbances and pollution, often still exist. At the same time that offshore banks are home to high

	nature values, they are also attractive areas for installations of wind power due to their shallower conditions.