# Impact assessment of the proposals for amended marine spatial plans for the Gulf of Bothnia, the Baltic Sea and Skagerrak/Kattegat

Final version (ref. 00764–2022)

2025-01-20

Swedish Agency for Marine and Water Management

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# Preface

On 10 February 2022, the Government adopted Sweden's first marine spatial plans for the Gulf of Bothnia, the Baltic Sea and Skagerrak/Kattegat. The marine spatial plans are the state's comprehensive guidance to state authorities, regions and municipalities when planning and examining claims for the use of areas in the sea. The considerations in the marine spatial plans are strategic and long-term. In connection with the decision on the marine spatial plans in 2022, the Government also decided on a new assignment focusing on new areas for energy extraction in the marine spatial plans. This is to enable offshore energy extraction with an additional 90 terawatt hours of annual electricity production in addition to the areas included in the agreed marine spatial plans (M2022/00276).

The Swedish Agency for Marine and Water Management has drawn up proposals for amended marine spatial plans for the Gulf of Bothnia, the Baltic Sea and Skagerrak/Kattegat, together with an impact assessment, through broad dialogue and collaboration with many different stakeholders. Marine spatial planning is an important tool for achieving long-term sustainable development and management in Sweden's marine areas.

The function of the impact assessment is to provide a broad picture of the potential effects and consequences of the plan proposal, with an emphasis on effects from offshore wind power. The impact assessment complies with the standard for the environmental impact assessment required within the framework of strategic environmental assessment pursuant to Chapter 6, Sections 1–19 of the Environmental Code.

Two formal dialogues have been carried out, consultations in autumn 2023 and a review in spring-summer 2024. In addition to the national consultation, the Swedish Agency for Marine and Water Management has also held an international Espoo consultation through the Swedish Environmental Protection Agency to gather the views of neighbouring countries. Comments have formed the basis for the development of both the plan proposal and the impact assessment.

Gothenburg, January 2025

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# Summary

The impact assessment describes the impact of the proposed marine spatial plan on environmental, social and economic aspects linked to the state of the sea, maritime industries and marine interests. The assessments are carried out at an overall level in accordance with the Environmental Code’s rules on strategic environmental assessment. The focus is on assessing direct and indirect effects and impacts in the short and long term linked to the plan’s guidance on the most suitable use and particular consideration. Assessments are made for each marine spatial plan; the Gulf of Bothnia, the Baltic Sea and Skagerrak/Kattegat. An overall assessment is also carried out jointly for the three marine spatial planning areas and an assessment of the significance of the plan in relation to relevant plans, programmes and strategies.

In the impact assessment, there is a strong focus on assessing the impact from the proposed energy areas. New proposals for energy areas are the main difference from the agreed marine spatial plans. It is also the focus of the government assignment from 2022 to expand the area for offshore energy production in order to achieve an objective of enabling an annual electricity production of 120 TWh in the territorial sea and exclusive economic zone.

## Overall assessment of the impact of offshore wind energy

### Transboundary and cumulative impacts

In the territorial seas and exclusive economic zones of Sweden and neighbouring countries, human activity is continuously increasing. Planned offshore wind power is expected to account for a sharp increase in the short and medium term, in Sweden and in neighbouring countries. Therefore, consideration needs to be given to the risk of cumulative effects of mainly offshore wind power, but also other activities. The energy areas in the plan proposals can contribute to cumulative effects in the Gulf of Bothnia and Skagerrak/Kattegat. No new energy areas are proposed in the Baltic Sea, and therefore no new contributions to cumulative effects in the marine spatial plan area follows.

The risk of cumulative effects is particularly high in areas with a high concentration of energy areas where there are high nature values and ecological links of international importance, such as migratory birds and harbour porpoises. The impact on the cultural environment and landscape is also important in cases where energy expansion is visible from neighbouring countries' coastlines. Cumulative effects may also occur in relation to shipping where energy expansion can increase the risk of incidents and reduce maritime safety. When it comes to fishing, there is extensive foreign fishing in all Swedish marine areas and offshore wind power can affect the conditions for several fleets. Offshore wind power in Swedish sea areas can also affect other countries' defence-related activities and vice versa. Cross-border interactions on cumulative effects are necessary to assess cumulative impacts from a sea basin perspective.

### Gulf of Bothnia

The marine spatial plan’s guidance in the Gulf of Bothnia has implications for the marine environment and biodiversity. Ecological aspects that risk being negatively affected by proposed energy areas include the ringed seal, which is dependent on ice in order to reproduce and rear its pups. There are uncertainties regarding the effect of offshore wind power on the conditions for ice formation. The risk of impact on migrating salmon is considered to be limited if energy establishment in shallow coastal areas is avoided. The impact on the benthic habitat is expected to be small, as well as the impact on fish and spawning grounds. For migratory birds in particular, the plan proposal entails potentially major negative effects in connection with proposed energy areas at Finngrunden. Also wintering birds can be negatively affected in this area. The area for areas with particular consideration to high nature values has been expanded in the plan proposal, with a special focus on birds, seals and bottom habitats. This is expected to have positive effects on the protection of biodiversity and contribute to a network of green infrastructure.

For impacts related to climate, water and air, the assessment is that the marine spatial plan guidance has a major positive effect in that it guides increased opportunities for renewable energy production that can replace energy types that generate greenhouse gas emissions. However, the expansion of energy areas may mean changes in the steaming distances for shipping and commercial fishing. The effect of increased mileage is difficult to assess on the basis of available information. Both offshore wind energy construction and sand extraction can lead to local impacts in the form of turbidity and dispersal of sediments, but the assessment is that this does not affect the marine environment in the long term.

In terms of impact on landscapes, cultural environments and recreation, several energy areas risk visually affecting national interests, world heritage sites and coastal areas with landscape protection, such as Haparanda Archipelago, the High Coast and Hornslandet. Energy areas within a distance of less than 35 kilometres from cultural sites have been designated ‘k’ for particular consideration of high cultural heritage values, which indicates that particular consideration should be given to visual impact when establishing energy in these areas.

The plan proposal for the Gulf of Bothnia has the potential to provide energy production of approximately 130 TWh per year. The Gulf of Bothnia is expected to connect mainly to bidding zones 1 and 2 and the supply of electricity production is needed for energy transition, primarily for industry. Energy establishment also leads to positive indirect employment effects. However, the proposed energy expansion affects other interests in the marine area. In the Gulf of Bothnia, there are both Swedish and Finnish commercial fishing whose access to fishing areas can be affected. The impact on commercial fishing is negligible in the Bothnian Bay and North Kvarken, and medium-sized in the Southern Bothnian Sea. Indirect effects may occur in value chains linked to the fisheries processing industry and landing ports. Shipping is affected partly by a slightly longer mileage in the changed fairway in the Southern Bothnian Sea, and partly by the potential impact on navigation and maritime safety of the increased presence of fixed installations that offshore wind farms would entail. The plan indicates that safety distances should be established when designing and permitting energy areas in order to minimise collision risks. The potential impact on ice formation is an uncertainty factor for winter navigation in the Gulf of Bothnia.

### Baltic Sea

The plan does not provide guidance on more energy areas in the Baltic Sea than the existing or already licensed wind farms. This means that the plan's guidance on energy extraction does not contribute to negative effects on the natural environment, cultural environment, outdoor activities, tourism, shipping, fish and commercial fishing in the plan area.

At the same time, this means that a large potential for energy extraction is not exploited. A large contribution to renewable and fossil-free energy in southern Sweden is lacking, as well as the potential climate benefit an establishment would have provided space for. Limited guidance on energy extraction and energy areas in the plan area is negative for the wind industry, including wind power project companies and affected sectors. New electricity production in the Baltic Sea is expected to connect mainly to bidding zones 3 and 4. In order to achieve this goal, Sweden's offshore wind power must be realised with a higher concentration in other marine spatial planning areas.

Investigation areas for shipping around Gotland as well as sand extraction areas remain from the adopted marine spatial plan.

### Skagerrak/Kattegat

The plan proposal for Skagerrak/Kattegat contains energy areas in important migratory routes for birds and bats. This poses a high risk of negative impacts. The risk of cumulative effects is high as several of the energy areas with projects that have received permits are assessed to have a negative effect on birds. Realisation of the energy areas would have a cumulative negative effect on harbour porpoises in both the northern and southern parts of Skagerrak/Kattegat. Negative effects on the benthic habitats are considered to be limited if nature values are taken into account in the design. A potential positive local net effect may arise if energy use replaces bottom trawling in areas especially in Skagerrak. However, the impact on commercial fishing may mean an intensification of fishing in adjacent accessible areas with increased pressure in them.

For impacts related to climate, water and air, the assessment is that the marine spatial plan guidance has a great positive effect in that it guides on increased opportunities for renewable energy production that can replace fossil fuels and also fuels in the long term, which would lead to lower levels of air emissions. However, the expansion of energy areas may mean changes in driving distances for commercial fishing, with the risk of some increase in emissions as a result. The construction of offshore wind power can lead to local impacts in the form of turbidity and dispersal of sediments, but the assessment is that this does not affect the marine environment in the long term.

The west coast has high values from a cultural environment and recreation point of view. A large number of areas of national interest and national interest claims for the cultural environment and recreation can be found along the coast. The plan's proposals for energy areas, particularly in Halland, are expected to have a major negative effect on these interests, with a risk of impact on the tourism industry. In Skagerrak, the energy areas are located further out from the coast but, on the other hand, include large areas in the marine area.

The marine spatial plan for Skagerrak/Kattegat guides potential energy extraction of about 20 TWh per year, which would constitute an important addition of fossil-free electricity to parts of western Sweden. Electricity production is expected to be able to connect to bidding zones 3 and 4. The potential impact on shipping in Skagerrak/Kattegat is assessed to be relatively small, both for Swedish and international shipping, provided that permits for the establishment of wind farms take into account existing recommendations. The plan indicates that safety distances should be established when designing and permitting energy areas in order to minimise collision risks.

Energy areas were adjusted according to the planning consultation taking into account national interest claims for commercial fishing and fishing operations. Overall, the impact on commercial fishing of the energy areas in the marine spatial plan for Skagerrak/Kattegat is considered to have a potential major impact on commercial fishing in the plan area, primarily in the case of the northern shrimp fishing, as well as bottom trawling for Norway lobster and fish. This includes the effects of areas with licensed wind farms. The impact on commercial fishing can also have second-round effects on value chains, self-processing, the processing industry, affected landing ports and municipal interests.

### Environmental objectives and the EU Marine Strategy for the Marine Environment Directive

The marine spatial plans' guidance is considered to make both positive and negative contributions to Sweden's national environmental objectives. The environmental quality objectives where the plan has the greatest positive effect are *"Limited climate impact".* By creating the conditions for an increased establishment of offshore wind power in the Swedish territorial sea and Swedish exclusive economic zone, there is potential to replace fossil energy production and, in the long term, fossil fuels with an alternative that does not generate greenhouse gases. The environmental quality objectives where the plan has the greatest negative effect are *Sea in balance and living coast and archipelago, A rich plant and animal life,* and *Good built environment.* Offshore wind affects marine environments both during construction and the operational phase, which risks negatively affecting ecosystems and threatening biodiversity, such as birds and marine mammals. The landscape is also affected by offshore wind power, as well as cultural environments and areas that are important for recreation. For the environmental quality objectives *Fresh air and Non-toxic environment,* marine spatial plans have a marginal effect in that guidance on energy use can affect local emissions, both positively and possibly negatively as driving distances change. The marine spatial plans' guidance on sand extraction can lead to local impacts on the marine environment, and lead to the dispersion of pollutants from sediments.

The marine spatial plans are assessed in relation to the Swedish Marine Environment Regulation and the EU Marine Strategy Framework Directive to be able to affect the descriptors for biodiversity (seabirds, marine mammals), alien species, seabed integrity, hydrographic conditions and underwater noise. It is possible to limit the impact on the marine environment by introducing conditions and consideration measures, but there are several uncertainties linked to the extensive deployment of offshore wind power. Uncertainties include potential risks of hydrographical changes and consequential effects, effects on ice formation, outcomes of consideration measures and opportunities for coexistence.

### Relation of the marine spatial plans to the National Strategy for Sustainable Regional Development throughout the country 2021 – 2030 and its priorities:

*Equal opportunities for housing, work and welfare throughout the country:*

- *High quality of life with good and attractive habitats* - By guiding about areas for use recreation and cultural environment, as well as consideration and adaptation for natural and cultural landscapes, the marine spatial plan affects the strategy's priority related to promoting natural and cultural landscapes, visits in nature, the right of public access and recreation.
- *Good spatial planning* - Through the plan's guidance on the most appropriate use and particular consideration, marine spatial plans contribute to a long-term and balanced

trade-off between different societal interests. Thus, the marine spatial plans contribute to the strategy's priority of promoting a sustainable social structure, reduced climate impact, conservation of biodiversity and ecosystem services in a changing climate, and that the interests of defence are taken into account.

*Innovation and renewal as well as entrepreneurship and entrepreneurship across the country:*

- *A competitive, circular and bio-based, climate and environmental sustainable economy -* The plan's guidance on energy in two of the marine spatial plans contributes to the strategy's priority on the deployment, production and use of renewable energy that is important for regional energy supply and sustainable regional development.
- The plan’s guidance on the use of commercial fishing contributes to the same priority by taking into account the conditions for commercial fishing.

*Accessibility throughout the country through digital communication and the transport system*

- *Accessibility through sustainable transport systems* - The plan's guidance on shipping and other uses contributes to the priority through maritime transport supply that is significant for people and businesses across the country. The priority also highlights the importance of coordination between activities and transport infrastructure at local, regional and national level.

# Content

# 1. Introduction

## 1.1. Marine spatial planning and objectives of the marine spatial plans

The marine spatial plans shall show the most appropriate use of the sea. It is about providing spatial conditions for different types of activities or protection in the sea in marine spatial planning, from a holistic perspective. Marine spatial planning is the process by which marine spatial plans are developed. It organises current and future activities in the sea basins in order to achieve environmental, economic and social objectives. The adopted marine spatial plans guide authorities and municipalities in the planning and examination of claims to use the area. Marine spatial planning is one of several tools for the state to control and influence activities and the environmental status of the sea.

In July 2014, the EU adopted a directive on marine spatial planning (2014/89/EU). The Directive requires marine spatial planning to promote the sustainable development of offshore energy, maritime transport, fisheries, aquaculture and the conservation, protection and improvement of the quality of the environment. The ecosystem approach shall be applied in planning so that the pressure of maritime activities on the environment is compatible with good environmental status in accordance with the EU Marine Environment Directive, which is implemented in Sweden through, among other things, the Marine Environment Ordinance.

The EU Marine Spatial Planning Directive was incorporated into Swedish national law in September 2014 by a provision in the Environmental Code (Chapter 4, Section 10) on state-owned marine spatial planning in Sweden, and in 2015 by the Marine Spatial Planning Ordinance (2015:400), which regulates the implementation of marine spatial planning. The Environmental Code states that the purpose of marine spatial plans shall be to contribute to long-term sustainable development.

The Marine Spatial Planning Regulation clarifies that the design of marine spatial plans shall contribute to good environmental status and that marine resources shall be used sustainably in order to develop marine industries. The co-existence of different activities is an explicit goal. The integration of industrial policy objectives, social objectives and environmental objectives aims to provide a holistic perspective in planning. Based on this aspect, 10 planning objectives have been developed during the previous planning process (see **Fel! Hittar inte referenskälla.**). The overall objective of marine spatial planning is *Good Marine Environment and Sustainable Development*, which is then supported by the other nine marine spatial planning objectives. The planning objectives also take into account various international objectives, policy orientations, legislation and environmental objectives.

New objectives in the planning process launched in 2022 mainly relate to increased ambition regarding offshore areas of energy extraction. In addition to these, the marine spatial plans have been updated on the basis of new conditions for area protection and other interests.

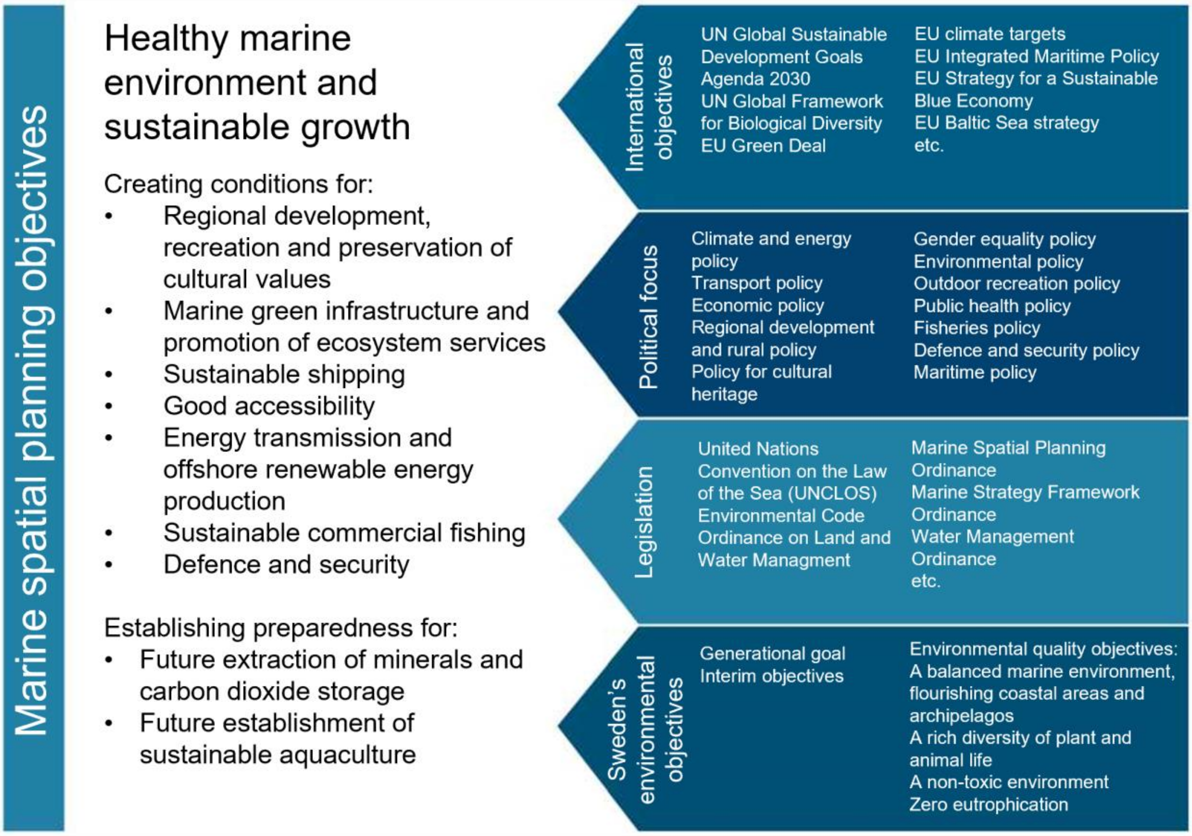


Figure 1. The planning objectives and some of the overarching objectives and conditions that have formed the basis for the formulation of the planning objectives (Swedish Agency for Marine and Water Management, 2024b).

## 1.2. Strategic environmental assessment of marine spatial plans

### 1.2.1. Formal requirements for strategic environmental assessment of marine spatial plans

Strategic Environmental Assessment (SEA) is a process aimed at integrating environmental aspects into plans or programmes in order to promote sustainable development. The fact that a marine spatial plan is subject to the requirement to carry out a strategic environmental assessment pursuant to Chapter 6, Sections 1–19 of the Environmental Code derives from the Environmental Assessment Ordinance. The work on strategic environmental assessment is documented in an impact assessment in the form of a single document for the three marine spatial plans.

The requirements for environmental assessment of marine spatial plans are also based on the portal section of the Environmental Code, according to which the Code shall be applied in such a way that:

1. protection of human health and the environment from damage and nuisance, whether caused by pollution or other influences;

2. valuable natural and cultural environments are protected and nurtured;

3. preserving biodiversity;
4. land, water and the physical environment are otherwise used in such a way as to ensure good long-term management from an ecological, social, cultural and socio-economic point of view, and
5. re-use and recycling, as well as other management of materials, raw materials and energy, are promoted in order to achieve a circular economy.

This means that social and economic aspects also need to be included in a broad impact assessment. This document has therefore been titled Impact Assessment, while the requirements for Strategic Environmental Assessment have guided the work and drafting of the document.

### 1.2.2. Scope of the impact assessment

The impact assessment takes the form of a single document for the three marine spatial plans, the effects of which are presented separately and together. The assessment of the impact of marine spatial plans guidance is at an overall strategic level. The focus is on impacts linked to offshore wind as the main difference from already adopted marine spatial plans in 2022 is new proposed energy areas. Concretely, the analysis and assessment of the plan proposal has been based on an estimate of potential impacts, second-round effects and finally the consequences that a proposed energy area could generate in relation to other aspects and interests. According to the requirements for a strategic environmental assessment, positive, negative, direct, indirect, temporary, long-term and cumulative impacts that could arise from the implementation of marine spatial plans are reasonably accounted for. The effects are described as potential as there are uncertainties surrounding all assessments (see also Chapter 8. Methodology). The uncertainties may be linked to evidence used in the assessment or uncertainty about the actual extent of an effect, as well as possible second-round effects. The description of impacts, if not specifically mentioned, does not take into account conditions and consideration measures that could limit negative impacts when establishing offshore wind energy.

### 1.2.3. International consultation and cooperation

According to Chapter 6, Section 10 of the Environmental Code, the authority drawing up or amending a plan must consult on the scope and level of detail of the impact assessment. A delimitation consultation was held with a consultation period from 8 July to 10 October 2022.

Both the Espoo Convention and its Protocols and the Strategic Environmental Assessment Directive (2001/42/EC) regulate consultation in case of transboundary significant environmental impacts. These have been transposed into Swedish law through transposition into Chapter 6 of the Environmental Code and the Environmental AssessmentOrdinance (2017:966). The general requirements are to inform the countries concerned of current planning and carry out consultations when planning proposals and environmental impact assessments have been prepared.

Since the responsibility for consultation vis-à-vis other countries currently lies with the Swedish Environmental Protection Agency, the Swedish Agency for Marine and Water Management has informed the Swedish Environmental Protection Agency that marine spatial planning is considered to give rise to significant transboundary impacts. Neighbouring countries Norway, Denmark, Germany, Poland, Lithuania, Latvia, Estonia, Finland and Åland have therefore had the opportunity to comment through a consultation process that ran from 28 November 2023 to 20 February 2024.

## 1.3. Current situation, zero alternative and assessment scenarios

### 1.3.1. Current situation and zero alternative

The impact assessment examines the environmental effects of marine spatial plans with the main focus on the plan proposals' guidance on the use of energy extraction. The consequences of offshore wind power being established in the energy areas according to the marine spatial plans can be seen in relation to the current situation and the zero alternative. The zero alternative shall represent how the environment would evolve into a given year if the current plan or programme is not implemented.

There are currently two offshore wind farms located within Sweden's marine spatial plans. The Lillgrund wind farm in Öresund, which has been in operation since 2007, and Kårehamn off the coast of Öland, which has been in operation since 2013.

The impact assessment is based on an assessment of the impact of marine spatial plans when fully implemented. This means that the guidance on different uses in marine spatial plans has been applied and put into practice. This can be considered an unreasonable assumption, but at the same time it is relevant for decision-makers to get an overview of the overall impact and consequences of the marine spatial plans.

The environmental effects and consequences shall be investigated in relation to a zero alternative in accordance with Chapter 16, Section 4 of the Environmental Code. For marine spatial planning, this applies both in terms of offshore wind power and other parameters. Seven wind power projects within the marine spatial plans have been granted permits: Kriegers Flak (2022) south of Skåne, Kattegatt Syd and Galene (both 2023) in Kattegat and Poseidon (2024) west off Stenungssund in Skagerrak/Kattegat. The Storgrundet and Falkenberg wind farms have older permits that have made changes to the application recently. The Swedish Agency for Marine and Water Management has made the assessment that it is a reasonable assumption that both existing and licensed offshore wind farms are included in the zero alternative. Furthermore, the zero alternative is described in Chapter 2 under the heading conditions, current situation and development for each assessment aspect.

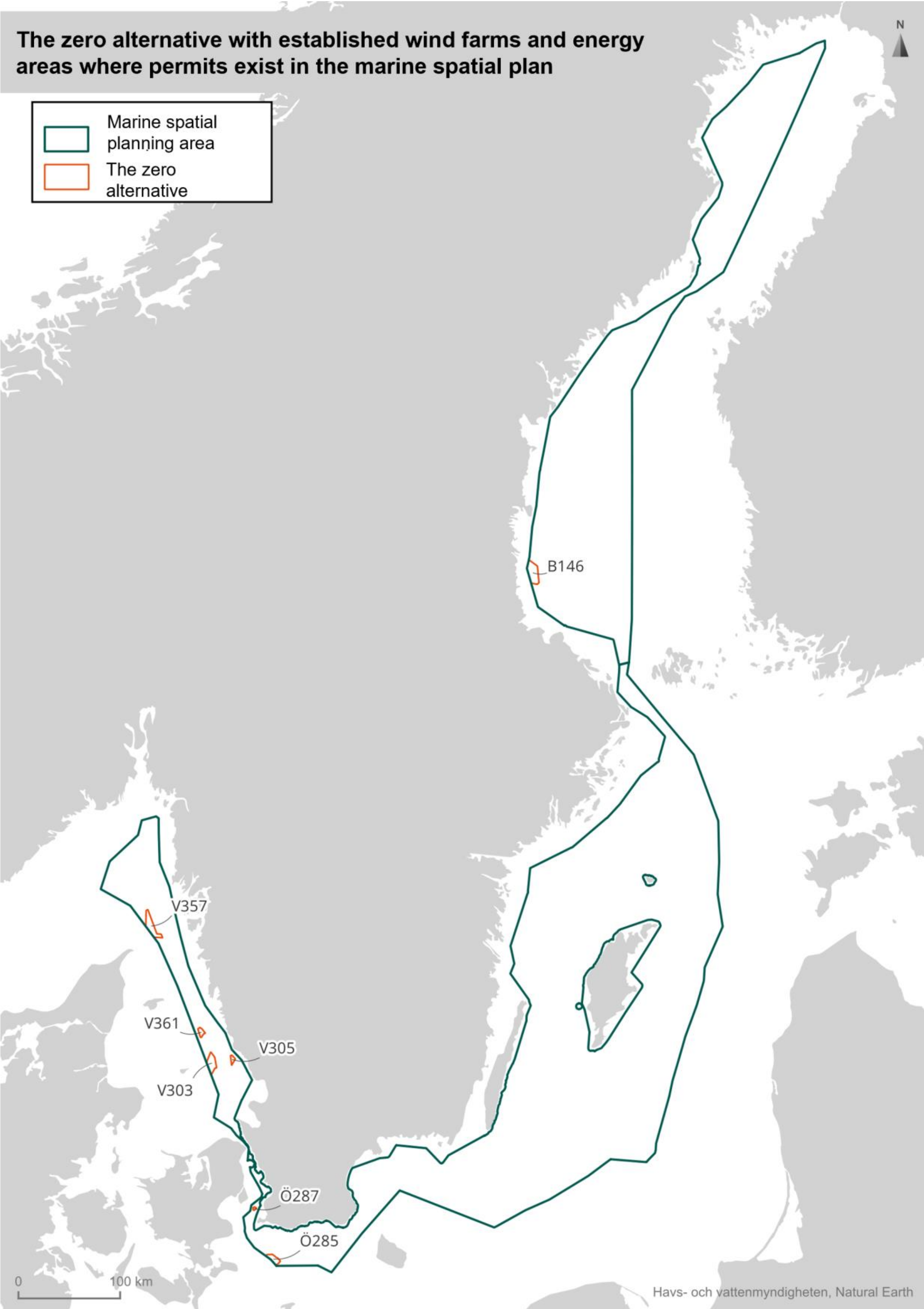


Figure 2. Shows the zero alternative in the impact assessment consisting of energy areas where there are permits to establish offshore wind power, including the already existing wind farm Lillgrund (Ö287).

### 1.3.2. The meaning and guidance of the marine spatial plans - Level of exploitation and realisation

Within the current planning system for offshore wind power, there are a number of uncertainties regarding which energy areas can be realized in accordance with the plan proposal. The uncertainties are due to several factors, worth mentioning are the secret interests of the defence, the assessment of site-specific needs for nature protection, as well as other issues that are dealt with in future permit applications and whether the state or the contractors should bear the cost of cabling (see also section 6.1 of the proposed marine spatial plan). Responsible authorities concluded early in the planning process that, within the current system, there is a need for 'overplanning' to enable energy extraction equivalent to 120 TWh. The plan proposals to the Government include approximately 150 TWh of annual energy production. In the case of energy establishment, some area and hence potential amount of energy would be lost due to safety zones against shipping. Uncertainties also remain in relation to, among other things, defence interests and nature considerations. Full deployment as planned is therefore relatively unlikely. In the impact assessment, it is the full expansion that is assessed as it is in accordance with the guidance of the marine spatial plan and in line with the target of 120 TWh of annual energy production.

### 1.3.3. Assessment scenarios

According to the Environmental Code, a strategic environmental assessment must contain reasonable alternatives taking into account; the geographical scope and purpose of the plan. During the various stages of the planning process, the Swedish Agency for Marine and Water Management has assessed reasonable alternatives in the planning. Prior to the consultation, the proposals for the marine spatial plan included alternative energy areas. The impact assessment presented the effects of energy areas and alternative energy areas. The aim was to show different possibilities in planning when it comes to choosing energy areas in the different marine spatial plans.

At the review stage, most of the consultation's alternative energy areas had become energy areas in the plan. In the impact assessment, alternative plan proposals were developed to show different potential outcomes within the target of 120 TWh based on different aspects.

Prior to submission to the Government, the Swedish Agency for Marine and Water Management has developed scenarios to discuss potential cumulative consequences that may arise from the application of the marine spatial plan. The scenarios do not correspond to planning choices, but show the energy areas that have the least negative impact on the respective interests. The energy areas that have the greatest negative impact on commercial fishing and shipping have been removed in the scenario “Fishing and Shipping” and the energy areas that have the greatest negative impact on cultural environments, recreation and ecological aspects have been removed in the scenario “Culture and Nature”, and in the scenario “Energy” all energy areas are included.

There is no assessment of how likely an individual scenario is, but the function of the scenarios is to illustrate how the marine spatial plans *could potentially be* applied, with a particular focus on consequences for different interests. The purpose of the scenarios is to be able to reason in the impact assessment about the potential distribution of cumulative effects in relation to different outcomes, and compare with both the baseline option and the marine spatial plan proposal as a whole. They also show what an application of the marine spatial plans could have looked like taking into account different interests.

## 1.4. The marine spatial plans’ relation to other plans and programmes

Under Chapter 6, Section 11 of the Environmental Code, an environmental impact assessment must contain a summary of the main purpose of the plan and its relationship with other relevant plans and programmes. Marine spatial plans shall aim at sustainable development and shall be based on objectives and strategies at local, regional, national and international level. The selection of plans, programmes and other processes presented in this section is mainly based on their relevance for marine spatial planning, with a focus on new areas for offshore energy production.

### 1.4.1. National interests, policy documents and spatial planning

#### *1.4.1.1. National interests*

National interests are geographical areas that have been identified as nationally significant. The marine spatial plan proposal shall comply with the provisions for the management of land and water areas as set out below:

National interest claims under Chapter 3 of the Environmental Code (to be reported by national interest authorities)

- Includes, among other things, national interest claims for commercial fishing, nature conservation and outdoor activities, cultural environment conservation, facilities for energy production and electricity distribution, facilities for communications, and defence facilities. Authorities that provide information on the respective national interest claims are listed in Section 2 of the Ordinance on Land and Water Management.

National interests under Chapter 4 of the Environmental Code (listed directly in the Act)

- Applies to larger areas with great natural and cultural values as well as values for recreation that are in their entirety nationally significant. This includes coastal areas and Natura 2000 sites (listed in a specific order).

Marine spatial plans shall guide uses of the sea. The guidance is based on an assessment of the most appropriate use taking into account the nature, location and needs of the sites and the overall purpose of the plans. Assessment is made on the basis of national interests, national interest claims and other public interests of substantial importance.

#### *1.4.1.2. Connection to the transmission network*

Svenska Kraftnät is currently working on developing the process for actors who want to connect offshore wind power to the onshore transmission grid. In these zones, Svenska Kraftnät will prepare one or more connection points, the positioning and capacity of which will then be communicated to all stakeholders via stakeholder pools. An offer of connection is made to the operator(s) who first obtains the necessary permits for the construction and operation of a wind farm in the respective zone (Svenska Kraftnät, 2024a).

#### *1.4.1.3. Strategy for sustainable development,maritime strategy and EU strategies*

According to the Marine Spatial Planning Regulation, proposals for marine spatial plans must be designed in such a way that the plan integrates industrial policy objectives, social objectives and environmental objectives. The *National Strategy for Regional Sustainable Development 2021-2030* sets out a number of strategic areas and priorities in terms of industrial policy objectives, social objectives and environmental objectives. The national strategy guides the direction of regional development strategies and directs state funds for regional development work. The major societal challenges that permeate the national strategy for sustainable regional development are: environmental problems and climate change, demographic change, and widening gaps nationally and within the EU. The strategic area considered most relevant for marine spatial planning is *Equal opportunities for housing, work and welfare in the entire country*, which includes ‘good spatial planning’. Urban planning shall promote a social structure that contributes to sustainable habitats, reduced climate impact, as well as the preservation of biodiversity and ecosystem services in a changing climate. Another strategic area of relevance for marine spatial planning is *Accessibility throughout the country through digital communication and the transport system* (Government, 2021b).

In 2015, the Government adopted a national maritime strategy for Sweden. The strategy aims to achieve the government’s vision of *‘Competitive, innovative and sustainable maritime industries that can contribute to increased employment, reduced environmental impact and an attractive living environment’.* The strategy touches upon a number of policy areas related to the sea, regional development, business and the environment, thereby contributing to the implementation of a Swedish integrated maritime policy. The strategy highlights marine spatial plans as an important instrument for steering development in Swedish waters. For example, by indicating the most appropriate use for different sea basins, marine spatial plans and environmental assessment promote safety at sea in line with the strategy, so as to minimise risks to humans, fauna and flora from accidents. A number of indicators have been developed for follow-up and a number of follow-ups have been carried out (the Swedish Agency for Marine and Water Management, 2023). Work is currently underway to update the maritime strategy.

For Sweden, the EU Strategy for the Baltic Sea Region is relevant, which aims to strengthen cooperation to jointly address challenges and opportunities. The three overarching objectives of the strategy are: Save the marine environment, Connect the region, and Increase prosperity. The strategy includes an action plan, which includes the policy areas of spatial and maritime spatial planning (PA Planning), and energy (PA Energy). The Baltic Sea Strategy contributes to the implementation of the 2030 Agenda, but also of the EU's so-called Green Deal. The Green Deal aims at a transition to a modern, resource-efficient and competitive economy, and together with other wills includes an industrial transition for a climate-neutral EU by 2050. According to the Baltic Sea Strategy, alignment with the Green Deal requires integrating climate action and the promotion of sustainable development into all policy areas of the Strategy. Swedish marine spatial planning is closely integrated with neighbouring countries' work in this area and its actions under the action plan.

In addition, at EU level, there are a number of sectoral policies relevant to marine spatial planning in the policy areas of climate and energy, transport, fisheries, outdoor activities, and security and defence. Both the EU Blue Economy Strategy and the Offshore Renewable Energy Strategy and the European Wind Power Action Plan are working towards the implementation of the EU Green Deal (European Commission, 2021 and 2023; European Parliament, 2022). In addition, there is also the REPowerEU plan, which aims to reduce the use of fossil energy, diversify energy use and produce more fossil-free energy within the EU. The EU has agreed on new additions to the Renewable Energy Directive (EU/2018/2001) that will change the planning conditions for renewable energy. The Swedish Energy Agency has been commissioned to map areas suitable for fossil-free electricity production. The amendment includes systems for the designation of land and sea areas for energy production (including environmental assessment), and that installations for the production of renewable energy shall be considered to be of overriding public interest. The implementation of the proposal could have an impact on both marine spatial planning and environmental assessment processes. Earlier planning will be the basis for a mapping of possible sites for renewable energy, and some sites will also be identified as acceleration zones where the requirements for environmental impact assessment are lowered. According to the directive, the marine spatial plan should serve as a basis for the national mapping.

#### *1.4.1.4. Regional development strategies*

According to Ordinance (2017:583) on regional development, each region must prepare so-called regional development strategies (RUS). According to the regulation, the *national strategy for sustainable regional development throughout the country 2021-2030* (Regeringen, 2021b) should guide regional development work. Regional development strategies shall be well-anchored locally and regionally, and shall be developed in collaboration with the municipalities, regions, county administrative boards and other relevant state authorities. These strategies contain visions, goals and long-term priorities for development in each county, and provide a comprehensive picture of the region's perspective on sustainable development. Taking into account sectoral claims and assets, these strategies are relevant for marine spatial planning. Regional development strategies also guide inter-municipal planning and municipal comprehensive plans.

#### *1.4.1.5. Municipal and regional planning*

According to the Planning and Building Act (2010:900), each municipality must have an up-to-date master plan covering the entire municipality, including the sea area (inland waters and territorial sea) within the municipality's boundaries. Through the Marine Spatial Planning Ordinance, municipalities and the state have geographically overlapping planning responsibilities in most of the territorial sea. This means that differences between municipal and state planning interests in the overlapping zone may arise, which is a challenge for state and municipal planning to manage through collaboration and dialogue. Through good collaboration, future conflicts between the planning levels can be minimized. State marine spatial plans can also help to develop and strengthen the planning of coastal zones and territorial seas by municipalities.

A municipality can also control the supply, distribution and use of energy. According to the Act (1977:439) on municipal energy planning, each municipality must have an up-to-date plan for the supply, distribution and use of energy in the municipality. In its planning, the municipality shall promote energy management and promote a safe and sufficient supply of energy.

For the management of cross-municipal issues such as infrastructure, climate and housing supply, spatial planning also takes place at regional level. A regional plan should provide the basic features for the use of land and water areas, and aims to facilitate municipal and other planning. The regional plan is not binding, but must be indicative of comprehensive and detailed plans and area regulations. According to the Planning and Building Act (PBL), regional planning is to be carried out in the counties of Stockholm and Skåne, while in the other counties it is voluntary. The regional plan is relevant to marine spatial planning based on its spatial planning and the link between sea and land, for example in terms of infrastructure and climate.

### 1.4.2. Environmental and climate objectives

#### *1.4.2.1. National environmental objectives*

Sweden's environmental goals system includes a generational goal, 16 environmental quality goals, and 16 milestones. The generational goal is overarching for Swedish environmental policy, which in turn should guide environmental work at all levels of society. To the generational goal there are a number of so-called indents that clarify the meaning of the goal and what environmental policy should focus on. The indents that are particularly relevant for marine spatial planning are:

- Ecosystems have recovered, or are recovering, and their ability to generate long-term ecosystem services is secured.
- Biodiversity and the natural and cultural environment are preserved, promoted and used sustainably.
- Human health is exposed to minimal negative environmental impacts while the positive impact of the environment on human health is promoted.
- The share of renewable energy is increasing and energy use is efficient with minimal impact on the environment.

Of the 16 Swedish environmental quality objectives, the following are most central to marine spatial planning: Sea in balance and living coast and archipelago, Limited climate impact, Non-toxic environment, No eutrophication, A rich plant and animal life, and A good built environment. The environmental quality objectives are described in a number of specifications, some of which are particularly relevant for marine spatial planning. This applies, for example, to ecosystem services, favourable conservation status, endangered species, green infrastructure, the protection of recreation and the preservation of cultural and nature values. Clarifications on good environmental status under the Marine Environment Ordinance (2010:1341) and good chemical and ecological status under the Water Management Ordinance (2004:660) are also important for marine spatial planning.

#### *1.4.2.2. Climate policy at national and EU level*

In 2017, Sweden adopted a climate policy framework consisting of a Climate Act (2017:720), climate objectives and a climate policy council. The Climate Act requires the Government to conduct a policy based on the climate objectives and to report regularly on developments. Sweden has a long-term climate target of zero net emissions of greenhouse gases by 2045, before achieving negative emissions thereafter. The target means that greenhouse gas emissions from Swedish territory will be at least 85 per cent lower by 2045 than emissions in 1990. The remaining emissions (down to zero) are achieved through so-called accompanying measures. In order to reach the target, the capture and storage of carbon dioxide of fossil origin may also be counted as a measure where reasonable alternatives are lacking (Swedish Environmental Protection Agency, 2024c). The Government has also adopted an action plan containing concrete measures for how Sweden can achieve both national and international climate targets (Government letter, 2023/24:59). Climate adaptation work relates to marine spatial planning through work on increased preparedness and risk and vulnerability analyses in accordance with Ordinance (2018:1428) on authorities' climate adaptation work, but also on the basis of the national climate adaptation strategy (Government Bill 2017/18:163) with the priority biological and ecological effects.

The EU’s 2050 climate neutrality objective is in line with international commitments under the Paris Agreement. Through the Regulation on a European Climate Law, the political ambition to achieve the climate targets by 2050 becomes a legal obligation for the EU and through its adoption, Member States commit to reducing net greenhouse gas emissions by 55% by 2030 (European Council, 2021a). The EU strategy to achieve these objectives is the Green Deal (see section 1.3.1.3) and the so-called Fit for 55 package is expected to put this into practice. The package includes a set of proposals for the revision of climate, energy and transport-related legislation and new legislative initiatives to align Union law with the EU’s climate objectives. The EU Strategy on Adaptation to Climate Change (European Council, 2021b) and its actions, such as the collection and sharing of data and knowledge, as well as objectives to promote nature-based solutions to strengthen climate resilience and ecosystems are also relevant for marine spatial planning.

#### *1.4.2.3. EU directive for the marine and aquatic environment*

The EU Marine Strategy Framework Directive (2008/56/EC) aims to achieve good environmental status in the EU's marine areas and is implemented in Swedish legislation through the Marine Environment Ordinance (2010:1341). For Swedish sea areas, the Swedish Agency for Marine and Water Management has decided in regulations (HVMFS 2012:18) on what characterises good environmental status and established environmental quality standards with indicators. The Agency has also established an environmental monitoring programme and an action programme. Marine spatial planning supports the implementation of marine environmental management primarily through spatial planning that promotes good environmental status. The work in marine management also takes place through regional agreements such as HELCOM (Helsinki Convention) with an action plan for the Baltic Sea, and its counterpart in the North-East Atlantic, OSPAR (Convention for the Protection of the Marine Environment of the North-East Atlantic).

The EU Water Framework Directive (2000/60/EC) also has some links to marine spatial planning based on land-based activities, water resources and potential indirect well-to-sea pressures and uses. The Directive is implemented in Sweden through the Water Management Ordinance (2004:660) and has correspondingly objectives for the environmental status of freshwater and coastal areas. Sweden's five water authorities decide on management plans, environmental quality standards and programmes of measures.

#### *1.4.2.4. Biodiversity work*

The Swedish work to strengthen biodiversity, combat climate change and promote sustainable use includes a number of tools. Some of these are marine area protection, regional action plans for green infrastructure, counteracting physical impacts on the aquatic environment, restoration, measures for endangered species, counteracting invasive alien species, and regulations in fisheries. The national work is mainly based on the implementation of the EU Birds and Habitats Directives (2006/147/EC and 92/43/EEC respectively), the EU Biodiversity Strategy for 2030 and the EU's Common Fisheries and Agricultural Policy. The role of marine spatial planning in this is about spatial guidance and trade-offs regarding, for example, commercial fishing and the protection of nature values.

The EU Biodiversity Strategy (European Commission, 2020) includes a long-term plan for the protection and restoration of nature and ecosystems, including a target of protecting at least 30% of the marine area by 2030. Of this 30%, 10 percentage points shall be strictly protected. The strategy also includes measures for invasive alien species and endangered species, as well as requirements for Member States to develop national commitments for protection and restoration. As part of the strategy work, the European Commission presented a proposal for a Nature Restoration Regulation in June 2022, which entails, among other things, the restoration of 20% of the sea by 2030, the European Parliament adopted the Restoration Regulation in February 2024 and it is now up to subsequent instances to take the regulation further.

Furthermore, the strategy requires Member States to ensure that at least 30% of all species and habitats that are currently not in favourable status fall into that category or show strong positive trends. The Commission will also request Member States to ensure by 2030 that there is no deterioration in the conservation trends and status of any of the habitats and species protected under the Birds and Habitats Directives (for marine environments also EUNIS). Marine spatial planning supports the implementation of these directives and strategies through the spatial guidance provided by marine spatial plans on the use of the sea.

## 1.5. Terminology and definitions

**Use** is a term for the types of activities or interests categorised in marine spatial plans: electricity transmission, energy extraction, investigation area energy extraction, recreation, defence, general use, cultural environment, nature, sand extraction, investigation area sand extraction, shipping, investigation area shipping and commercial fishing.

**Pressure is** the change in physical conditions resulting from the implementation of the plan (e.g. use of an area, turbidity or noise).

**Effect** or **impact** is the change in the environment caused by a pressure on an ecosystem component (habitat or individual flora and fauna). Impacts can be direct or indirect, cumulative, positive or negative, long or short term and give rise to consequences (see below).

**The ecosystem approach** is a strategy for the conservation of nature values, sustainable use and equitable distribution of natural resources. It aims to take into account both environmental, social and economic contexts and a more integrated management methodology. The approach includes a number of guiding principles (the Malawi principles), including the principle of ensuring that the use of ecosystems takes place within their boundaries (Convention on biological diversity, 2007). The implementation of strategic environmental assessment and the integration of environmental considerations into marine spatial planning is part of the application of the ecosystem approach.

**Ecosystem components** in Symphony are habitats, species or groups of animals and plants that constitute a part of marine ecosystems.

**Ecosystem services** are the products and services of nature's ecosystems that contribute to human well-being and welfare. The concept helps to systematize the link between ecology and society and makes it clear that well-functioning ecosystems are important for society, health and welfare.

**Climate neutrality** means that greenhouse gas emissions are net zero.

**Consistency** is the importance of effects from an environmental and social perspective.

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

**An environmental impact assessment** is the written report that identifies, describes and assesses, among other things, the likely significant environmental effects of implementing the plan, programme or amendment.

**Strategic environmental assessment** of plans and programmes is the process underlying the environmental impact assessment. It contains certain elements that authorities and municipalities must implement when establishing or amending certain plans or programmes whose implementation is likely to have significant environmental effects (Chapter 6 of the Environmental Code).

## 1.6. Instructions for reading

This Impact Assessment is divided into eight chapters. After this introductory chapter, chapter two describes the current situation, conditions and environmental effects, as well as the impact linked to offshore wind power for all assessment criteria and interests. Chapters three, four and five follow with a description of the expected effects of the marine spatial plans for the Gulf of Bothnia, the Baltic Sea and Skagerrak/Kattegat, respectively. Chapter 6 compiles the assessments for each marine spatial plan in relation to the assessment criteria under the Marine Strategy Framework Directive and the Water Framework Directive. The chapter also contains analyses of the marine spatial plans' contribution to meeting Sweden's environmental quality objectives and targets in other policies, plans and strategies, and finally an analysis of the plan's impact on ecosystem services. Chapter 7 proposes measures to prevent, deter, offset or remedy the significant adverse environmental effects identified in the impact assessment. The last chapter presents the methods used in the impact assessment.

# 2. Conditions and environmental effects

## 2.1. Impact on population and health

### 2.1.1. Current situation, conditions and development

The sea and coastal areas are an important basis for the well-being and health of many people. The ocean generates a variety of ecosystem services such as climate regulation, food and attractive recreational environments that to varying degrees affect people's quality of life (see Section 6.4. Ecosystem services). The ability of the ocean to deliver ecosystem services that can directly benefit human health is highly dependent on how marine areas are used. Access to recreational areas in the sea, or in coastal environments, can contribute positively to public health and also have positive socio-economic effects.

All uses in marine spatial plans can generate effects that can affect human health, both directly and indirectly. Negative health impacts can be linked to uses such as shipping, sand extraction and defence activities that can generate noise and emissions affecting air and water quality. Protected nature areas contribute to positive health effects when the ability of ecosystems to generate ecosystem services is safeguarded. Fishing, both commercial and recreational, can contribute positively to people's access to nutritious food, but there is also a problem of chemical pollution in fish from certain areas. Risks related to the different uses can also pose health risks to humans, such as increased risk of collisions, accidents and incidents at sea.

Climate-related health impacts are one of the biggest challenges for human health in the coming decades (Public Health Agency of Sweden, 2024). Through regulating ecosystem services such as climate regulation, water purification, atmospheric purification and biological remediation, the ocean can contribute to improved conditions for tackling climate-related health effects such as increased air pollution, increased heat waves and the spread of microorganisms (Paulsson et al., 2024). The ocean is yet another relatively unexplored resource for health-promoting products, but marine organisms can be an important resource for researching and producing pharmaceuticals and other medical products.

### 2.1.2. Environmental impacts and impacts linked to offshore wind energy

Offshore wind energy deployment can affect human health in several ways, both directly and indirectly. Knowledge of the effects of offshore wind power on human health is to some extent limited as large-scale offshore wind power is relatively new. The health effects of onshore wind power have been studied to a greater extent. Some of the conclusions are relevant for offshore wind, although they are not always directly applicable given the differences between land and sea. Onshore wind power risks being built closer to homes and other environments where people live. Vindval's latest synthesis report on the impact of wind power on human interests includes a review of studies of effects on health (Bolin et al., 2021). The synthesis lifts noise, shadows and warning lights/obstacle lighting as the main possible influence factors. More indirect health effects from offshore wind power could result from changed opportunities for recreation and outdoor activities, as well as an increased risk of accidents. Reduced opportunities to perform activities that are important for both physical and mental health can lead to negative health effects (see also section 2.4.2 Recreation). Examples of activities that may not occur are that people no longer feel motivated to visit a coastal area that has been exploited with wind power, or that the offshore wind power prevents people from, for example, practicing recreational fishing, diving or canoeing in the area.

*Airborne noise and infrasound*

A wind farm generates several different types of noise, both low-frequency noise and infrasound that arise primarily from the rotation of the rotor blades, but also mechanical noise from the plant itself. Within a wind farm, the noise level can be up to 50 dBA in the air. How the sound spreads in the air from the parks depends, among other things, on the turbine's design and technical specifications, but is also affected by weather conditions and natural conditions. Generally speaking, sound spreads well over the sea, but there are limited studies on the noise impact of large offshore wind turbines. In Sweden, the guideline value for wind power noise is 40 dBA at homes, and 35 dBA in areas where the soundscape is particularly important and natural sounds dominate (Naturvårdsverket, 2020). The Swedish Environmental Protection Agency carried out an analysis of the sound environment in Sweden's nature areas, which shows that the existing offshore wind turbines are a source of noise, but the sound level decreases within a few kilometres of the parks and does not affect the soundscape on the coast (Swedish Environmental Protection Agency, 2024). The infrasound generated by wind turbines is considered to be very low in relation to other sources, and according to Bolin et al. (2021) there is currently no scientific evidence that infrasound from wind farms leads to direct or indirect health problems. However, the offshore wind farms planned today are larger than already existing, both in terms of the number and size of turbines, which means that studies on the spread and impact of noise are an important aspect of future environmental assessments for specific offshore wind projects.

*Shading and obstacle lighting*

Shadows from wind turbines can be perceived as disturbing (Bolin et al., 2021). Studies in this area focus mainly on onshore wind power and shading in the vicinity of residential areas, and the phenomenon is less relevant for offshore wind power as people rarely stay in offshore wind farms. When it comes to shading, the National Board of Housing, Building and Planning (2009) states that it is difficult to determine the limit for which distance shadows from wind turbines are perceivable. A study for the UK Department of Energy and Climate mentions a distance of ten rotor diameters as the limit beyond which shading is not perceived as problematic (Parsons and Brinckerhoff, 2011). For modern works with a total height of 350 m and a rotor diameter of 320-330 metres, this means a boundary distance of 3.2 to 3.3 kilometres.

Wind turbines shall be equipped with warning lights, known as obstacle lighting. The purpose of obstacle lighting is to avoid collisions with air and sea traffic. According to Transportstyreslen's regulations, turbines higher than 150 m must be equipped with a high-intensity white flashing light, and internal or lower wind turbines can be equipped with a medium-intensity red light (Transportstyrelsen, 2020:88). Obstacle lighting can be perceived as disturbing to people. However, research in the field has not yet clarified the relationship between exposure to obstacle lighting and possible health problems, such as sleep disturbances (Bolin et al. 2021). Obstacle lighting can be perceived as more disturbing in sparsely populated areas where other artificial light is rare, or absent altogether. The lights flash and shine relatively brightly (Odell et al., 2022). Wind turbines usually have synchronised lighting, which can amplify the perceived disturbance. Furthermore, the cumulative aspect of wind power installations can be assumed to affect people's experiences. For example, if wind turbines dominate a coastline and several parks are visible at the same time, the effect may be more noticeable. In other countries, regulations on obstacle lighting for wind power differ, and the lighting is adapted to avoid disturbing people (Odell et al., 2022).

*Distribution of health impacts – individual experience and generational aspect*

Effects of wind power on human health also have a psychological dimension that is influenced by individual differences such as attitude towards wind power, personality and age (Bolin et al.2021; Poulsen et al., 2019). Research has shown that individuals who experience an unfair establishment process of wind power, negative impact on landscapes or other disturbances can experience psychological discomfort from wind power establishments, which in the long term can lead to ill health. This negative effect from wind power is very subjective, and the opposite may also apply, that is, some individuals in the population experience positive health effects linked to the psychological dimension. The parts of the population that experience the effects of wind power installations are, on the one hand, the people who live or stay on the coast, as well as people who for various reasons are at sea, such as fishermen, sailors or recreationists (see section 2.4.2 Outdoor activities). A wind farm can be expected to operate between 25-30 years and an environmental permit can be valid for up to 40 years, therefore there is also a generational aspect to take into account as future generations will experience the consequences and effects of possible decommissioning.

*Indirect health effects due to changes in emissions*

As mentioned earlier, climate-related health impacts are one of the biggest challenges for human health in the coming decades (Public Health Agency of Sweden, 2024). In the longer term, wind power can also have positive effects on human health through the production of renewable energy and reduced net greenhouse gas emissions. Similarly, other positive indirect effects may also apply to the reduction of other air pollutants such as the amount of air particles and hydrocarbons in the urban environment, which affects air quality and health in the local and residential environment (Swedish Environmental Protection Agency, 2024b).

*Collisions and accidents*

Additional aspects related to the impact of offshore wind energy are a potential increased risk of collisions and accidents, which can affect the safety and security of people at sea. Fixed installations at sea mean that there is a risk of collision and allision. Accidents at wind farms with the risk of incremental spillage of fuel, oil and other chemicals can be difficult to manage (see also Section 2.4.4. Defence, and 2.4.5. Shipping). Currents can cause distressed people and ships to drift into the park, including breakdowns by aircraft. Wind turbines affect the ability of rescue resources to operate in and around the park area. The Swedish Transport Agency and the Swedish Maritime Administration have described the importance of carrying out a risk analysis as part of the licensing process to manage possible accident risks (Swedish Maritime Administration and Swedish Transport Agency, 2023).

*Impact during construction, operation and decommissioning*

Table 1. Shows the type of direct and local impact from offshore wind power in different phases in relation to the impact on population and health, as well as possible consideration measures.

| Phase | Type of impact | Possible consideration measure |
|---|---|---|
| **Facility** | Noise | |
| | Risk of spreading contaminants in sediments | Wind farm location |
| **Operation and maintenance** | Visual impact turbines | Location of wind turbines |
| | Visual impact obstacle lighting | Height of wind turbines |
| | Risk of collision | Clear safety distances |
| | Noise | |
| **Settlement** | Noise | No specific measure |
| | Increased traffic | |

## 2.2. Effects on protected animal or plant species and biodiversity

### 2.2.1. Birds

*Current situation, conditions and development*

Swedish sea areas are some of the most important areas for birds in the world. Many seabirds with breeding areas in northern Scandinavia and western Russia including the Arctic and northeast Atlantic have the Baltic Sea and Kattegat as some of the central wintering areas. For many more species, sea areas provide passages for further migration to resting and wintering areas along the coasts of Western Europe and further south to the Mediterranean and Africa. Also many terrestrial birds with large recruitment areas in northwestern Russia and northern Scandinavia follow the same routes. In total, the movements involve several hundred million birds annually and in a few places, so-called bottlenecks, where the distance over the open sea is small, particularly large numbers of birds are concentrated.

The most important places with very concentrated routes include the North Kvarken, the Åland Sea, an east-west route that passes Öland and Gotland, Öresund, the northern Jutland-Bohus coast and the Grenå-Anholt-Halland coast. The ranges at these sites differ somewhat in terms of the number of birds, how concentrated the routes are and which species have their main routes there.

Different species also have different migration processes and different migration biology where, for example, the time of passage varies, if the birds move during the day or night, if they move in flocks or single on a broad front, if they use thermals or fly actively, if they move at high altitude or low, etc. These different factors also affect how sensitive different species are to wind power.

The different sea areas differ with respect to the bird fauna and when in the year the birds stay there. In the Bothnian Bay and the Bothnian Sea there are coastal nesting birds that, to varying degrees, can also use water areas further out to sea, for example within designated energy areas. Characteristic species are common eider, velvet scoter, red-breasted merganser, black guillemot, razorbill, common guillemot, european herring gull, lesser black-backed gull, arctic tern, red-throated loon and white-tailed eagle. The Bothnian Bay is normally ice-covered in winter as well as large parts of the Bothnian Sea and therefore it is only in the southern areas that there are some wintering areas of importance, mainly Finngrunden. Migrating birds are believed to move throughout the sea area, but there are some places where higher concentrations occur. One is particularly extensive in the spring and takes place from the Dalälven water system where the birds move out over the southern Bothnian Sea, presumably quite wide in a northeasterly direction towards the mainland coast of Finland and continues further northeast. In relation to the energy areas, it is mainly those around Finngrunden that are supposed to be affected to a large extent by these stretch movements. The other known route follows the coast and is supposed to be extended by the furthest north and pass, among other things, Haparanda archipelago.

The proper Baltic Sea, with its very varied environments, is extremely important for both breeding, resting and wintering birds. Many coastal nesting birds can be found in the archipelagos where great cormorants, common eiders, gulls, terns, merguses, white-tailed eagle, and guillemots are distinctive. The shallow embankments are of international importance and for some species such as the long-tailed duck, significant parts of the global populations are found there. Karlsöarna islands are the only areas with rocky cliffs in the Baltic Sea where large parts of the Baltic Sea populations of common guillemot and razorbills breed. Since the guillemots regularly use a zone of 50 km or more around the colonies, this means that large areas between Öland and Gotland and north are sensitive to disturbance of various human activities. Extensive movements are also taking place in connection with the migration of the guillemots to wintering areas mainly in the southern Baltic Sea.

The most important migration routes in the Baltic Sea pass through the southern parts of Öland and Gotland and further along the coast of Blekinge and south where virtually the entire coast of Skåne is affected with the highest concentrations across the Sound.

At more coastal areas there are many important wintering areas that are mainly used by diving ducks, swimming ducks, great cormorants and seagulls.

Skagerrak/Kattegat has rich bird communities linked mainly to archipelagos in the north and islands further south. Diving ducks, swimming ducks, arctic skua, waders, terns and seagulls are typical in these areas. Out in the open sea in areas in and around the embankments Stora and Lilla Middelgrund and Fladen there are some of the most important wintering areas for razorbills in the world, but also of great importance for common guillemots and black-legged kittiwake. Several of the species exploit very large sea areas and originate from nesting stocks in large parts of the northeast Atlantic, including the British Isles and the Norwegian coast. In winter, there are large concentrations of seabirds along the coasts.

Variations in bird populations have several causes that are often different in the different habitats of the species. It is therefore generally difficult to identify the factor that is most important for the development of a particular stock. Among the uses that the marine spatial plan guides, it is primarily recreation, fishing, shipping and energy extraction that risk having a negative impact on bird populations.

*Environmental impacts and impacts linked to offshore wind energy*

Fact-based data on mortality, barrier effects or displacement effects caused by offshore wind power in Swedish waters is limited as only one of the existing wind power plants consists of a larger number of turbines. The large wind farms that are now being planned offshore therefore do not correspond in many respects to the small farms where some knowledge has been built up through multiannual studies. Studies in other countries and regions include both studies based on displacement observations but also modelling studies, many of which are from Skagerrak/Kattegat region. The studies have, among other things, generated knowledge about which species are sensitive to displacement. Empirically based knowledge of collision mortality appears to be lacking at present for offshore wind power and mortality assumptions are based entirely on mathematical modelling. There are many uncertain variables relating to collision mortality, which means that conclusions based on modelling are currently very uncertain. Barrier effects have been studied in isolated cases and in some cases indicate a strong reaction where, for example, birds of prey turn around when they reach the wind farm, but it is unclear whether the birds can pass through in another way. The overall state of knowledge indicates that offshore wind power can have significant negative effects on certain disturbance-sensitive species foraging or resting at sea and for the most sensitive species, the disturbance may cover significantly larger areas than the wind farm itself. For some other species the impact appears to be very low or none at all, and for some other species these may also be attracted by offshore wind farms, such as cormorants and seagulls that can use the foundations as resting places (Leemans & Collier, 2022; Bergström et al., 2021; Rydell et al., 2017). In addition, in order to draw conclusions about the effects of wind power on bird populations, much more knowledge is often required, which also includes other influence factors and how different dynamic effects act in time and space that can compensate or add to the impact of wind power. Uncertainties mean that power assessments are currently difficult to make and that the safest way to avoid negative effects is not to establish wind power in the most important and sensitive areas for birds (Rydell et al., 2017). In other areas where sensitivity is considered to be low or moderate, research suggests that various protective measures may possibly reduce the degree of impact to acceptable levels.

*Impact during construction, operation and decommissioning*

Table 2. Shows the type of impact from offshore wind power in different phases in relation to the impact on birds, as well as possible consideration measures.

| Phase | Type of impact | Possible consideration measure |
|---|---|---|
| **Facility** | Low risk of impact | No specific measure |
| **Operation** | Displacement | Avoidance of wind power in high risk areas. |
| | Collision | Stop control in high-risk situations. |
| **Settlement** | Low risk of impact | No specific measure |

### 2.2.2. Bats

*Current situation, conditions and development*

There are 19 bat species in Sweden, which makes up a quarter of all mammal species in Sweden. Bats are found almost all over the country, but the number of species and density is significantly higher in southern Sweden. According to the IUCN's criteria for redlisting, twelve bat species are redlisted in Sweden. Bats can be divided according to whether they are migratory or mainly stationary, which is an important factor in relation to offshore wind power. Bats move and hunt at night, mainly in warm and relatively still weather.

*Environmental impacts and impacts linked to offshore wind energy*

Risk of impact on bats linked to offshore wind power can occur primarily during migration but also during their foraging across the sea from the coast. Bats can be killed in collisions and by pressure changes caused by the rotor. Wind turbines can attract bats because insects can gather there.

*Relocation*

There are two long-distance species in Sweden: Large brown bats/common noctule (*Nyctalus noctula*) and nathusius's pipistrelle (*Pipistrellus nathusii*), which move south in the autumn and return in the spring. Migratory movements also occur in several other species, and may vary in length, including the part-coloured bat (*Vespertilio murinus*) and soprano pipistrelle (*Pipistrellus pygmaeus*) as well as the serotine bat (*Eptesicus serotinus*) and the lesser noctule (*Nyctalus leisleri*).

Knowledge of bat migration is limited, but some information is available. For example, it is known that, like many migratory birds, bats follow the coasts that form the guiding lines in the landscape, and even when crossing the sea, they choose routes where the distances between the land masses are as short as possible. Individual markings have shown, among other things, that northern populations of nauthusius's pipistrelle migrate from Finland to Sweden via North Kvarken and further south along the coast. In the central part of the Baltic Sea, data indicate that bats from Finland and the Baltic States either follow the coast south or fly over the open sea via Åland or Gotland to Sweden and then further south. In southern Sweden, bats have been observed stretching south or southwest from Gotland, Öland and Falsterbo. Migration takes place during specific periods in spring and autumn.

*Search for food*

Both migratory and more stationary bat species can feed across the ocean. They can hunt insects that are staying over water or that have drifted out of land with the winds. Hunting bats have been found up to about 15 kilometers, in some cases even further, from the coast.

*Impact during construction, operation and decommissioning*

Table 3. Shows the type of impact from offshore wind power in different phases in relation to the impact on bats, as well as possible consideration measures.

| Phase | Type of impact | Possible consideration measure |
|---|---|---|
| **Facility** | Low risk of impact | No action |
| **Operation** | Risk of collision and damage caused by pressure changes of the rotor | Stop regulation* for high activity of bats |
| **Settlement** | Low risk of impact | No action |

*Methods to reduce the risk of collisions and damage to bats can be achieved by shutting down wind turbines during critical periods when bat activity is high. Stop regulation needs to be adapted to the conditions prevailing in the marine environment and may differ from recommendations in the terrestrial environment.

### 2.2.3. Marine mammals

*Current situation, conditions and development*

An assessment of the status of the marine environment is made every six years in the Marine Strategy for Skagerrak/Kattegat and the Baltic Sea, based on the Marine Environment Ordinance. The latest status assessment is from 2024 (Swedish Agency for Marine and Water Management, 2024a).

According to the most recent assessment, none of the three seal species, harbour seal, grey seal and ringed seal or their populations reach a good status in their respective assessment areas. As a result, seals as a species group do not achieve good environmental status either. The reason for not achieving good status for seal species is, among other things, that population growth has slowed down. However, all populations, except the harbour seal in Kalmarsund, meet the requirement that the number of individuals must be above the population size that ensures a sufficiently high genetic variation within the population.

The distribution of the populations does not reach a good status for any of the seal species. This is mainly due to the fact that accessible or historical sites for reproduction, foraging and resting cannot be used by seals, for example due to reduced ice extent and the disappearance of sandbanks. The health status of the grey seal population, measured as gestation frequency and blubber thickness, also does not reach good status.

Grey seals in the Baltic Sea move throughout the Baltic Sea and Öresund and are therefore considered to be a population. Knubbsäl is mainly found along the west coast down to Skåne. Harbour seals are considered to be three distinct populations because only a few individuals are exchanged between them; one population in Skagerrak, one population in Kattegat, Öresund and the Arkona Basin (neither of these two stocks are limited to Swedish waters but also include seals in Danish and Norwegian areas) and a smaller population in Kalmarsund.

Ringed seal is found in the Gulf of Bothnia, the northern Baltic Sea, the Gulf of Finland and the Gulf of Riga. Swedish waters include an assessment of the population in the Gulf of Bothnia. Ringed seals occurs mainly in the Bothnian Bay with population concentration in the far north of the bay.

Sensitive times during the ringed seal's life cycle are February-May when mating, pupping, nursing and fur replacement takes place. Establishment of offshore wind farms during this period should therefore be avoided. There is a lack of knowledge about how areas with offshore wind power can affect the conditions for seals, e.g. by affecting ice formation and the presence of sea ice.

The environmental status of harbour porpoises is assessed for three different populations and is based for all populations on an assessment of abundance and trend as well as by-catch. An indicator reflecting distribution is also used for the Baltic Sea population. None of the three harbour porpoise populations reach good status in their respective assessment areas. As a result, harbour porpoises do not achieve good environmental status either. The reason for not achieving good status is, among other things, that by-catch exceeds the established thresholds for all populations. For the Belt Sea and Baltic Sea populations, good status of abundance and trends is also not achieved while Skagerrak/Kattegat population shows stable abundance over the period of data availability (1994-2016).

*Effects and impacts linked to offshore wind power*

The impact on marine mammals is mainly caused by the propagation of impulsive underwater noise and sediment dispersion in the offshore wind construction phase. It is not entirely clear whether the operating phase gives rise to negative effects, for example through continuous underwater noise. Harbour porpoises are particularly sensitive to impulsive underwater noise. Ringed seals are at risk of being affected by wind farms being able to disrupt the formation of ice, which is a prerequisite for their reproduction.

*Impact during construction, operation and decommissioning*

Table 4. Shows the type of impacts from offshore wind power in different phases in relation to the impact on mammals, as well as possible consideration measures.

| Phase | Type of impact | Possible consideration measure |
|---|---|---|
| **Facility** | Impulsive noise from piling.<br>Sediment dispersion;<br>Other disturbance from construction activities e.g. continuous noise. | Noise abatement protection measures at the installation; |
| **Operation** | Continuous noise<br>Impact on icing | No specific measures |
| **Settlement** | Continuous and possibly impulsive noise and sediment dispersion. | Noise abatement protection measures |

### 2.2.4. Benthic habitat

*Current situation, conditions and development*

The diversity of species along Sweden's coasts varies greatly, mainly due to the variation in salinity. The number of major plant and animal species ranges from about 1,500 species in the Skagerrak and about 800 species in the Kattegat to about 70 species in the Baltic Sea south of Gotland. Overgrown seabeds and biogenic reefs are among the most productive and species-rich environments. Bottoms with few but rare species can also have a high conservation value.

Biodiversity is vital for preserving the ecosystem services on which humans rely and for maintaining the natural population composition. Both the Gulf of Bothnia and the Baltic Sea area have significantly lower biodiversity than Skagerrak/Kattegat and are considered to be more sensitive to changes. In Skagerrak/Kattegat there are sediment-dwelling organisms that can increase the oxygenation of sediments and thus the binding of nitrogen, phosphorus and carbon. This process, which reduces the effects of acidification and eutrophication, is lacking in the Baltic Sea region. According to Artdatabanken's Red List in 2020 (Artdatabanken, u.å.), 237 marine species and 60 brackish water species in Swedish waters are red-listed. In general, few marine species are red-listed, which is considered to be due to a lack of knowledge about the status of the species. This means that several marine species cannot be assessed on the basis of the redlisting criteria. The changes that have taken place in the marine environment are therefore considered to affect far more species than the red list reflects (Swedish Agency for Marine and Water Management, 2015a). The knowledge gap is particularly high for invertebrates and algae, and many species in these groups fall under the ‘Knowledge gap’ category of the Red List. Generally speaking, the distribution of anoxic bottoms, large-scale climate change and the effects of fishing are the main threats to marine species. Other important factors are environmental toxins, exploitation of shallow areas, acidification, and predation from marine mammals and birds (Swedish Agency for Marine and Water Management, 2022b).

The Gulf of Bothnia does not contain as many species as the other Swedish marine areas, but most populations are prosperous. In the marine area there are both brackish and freshwater species, where a typical benthic fauna community consists of about 10 species (Havet.nu, 2023b). Future changes in salinity levels can have a major impact on the sensitive species composition. The stable winter ice in the outer lake forms a basis for photosynthesizing algae, and seals need the ice for the pups to survive. As climate change reduces the extent of stable ice, the northern parts of the Gulf of Bothnia become increasingly critical (Swedish Agency for Marine and Water Management, 2018a).

In the Baltic Sea, marine and freshwater species live in the same habitat and are often genetically adapted to the estuarine environment. Compared to many other seas, biodiversity in the Baltic Sea is low. Since only a few key species form the foundation of the food web, the Baltic Sea is particularly sensitive to human influence. Öresund is a shallow area, with flora and fauna that is a mixture between the coastal environments of the Baltic Sea and Skagerrak/Kattegat. Benthic habitats are dominated by marine species where salinity is high, while more brackish water species typical of the Baltic region dominate the shallower surface layer than 10-12 m water depth.

Large-scale climate fluctuations in recent decades have affected the Baltic Sea, making it difficult to distinguish between natural and human factors. At the lower trophic levels, the composition of phytoplankton has changed, which in turn has affected populations of zooplankton and copepods, which are the main food for fish. At the same time, many underwater plants have disappeared in exploited and polluted areas, especially in the Southern Baltic Sea. Stocks of invertebrates have decreased both in number and in individual density, while the Baltic Sea ecosystem is considered to have undergone a regime change, in particular regarding fish communities (Eklöf et al., 2020; Yletyinen et al., 2016), which are affecting species dependent on fish.

Blue mussel (Mytilus edulis) is one of the most important biotope-forming species in the Baltic Sea, as it is the dominant species on hard bottoms (Marbipp, 2018). Other particularly important biotope-forming species are bladderwrack (Fucus vesiculosus) and eelgrass (Zostera marina). It is of great importance to preserve and try to promote these key species. Blue mussel banks are substrates for other organisms and therefore indicate high biodiversity. These mussel banks also provide a regulatory ecosystem service in the form of filtration of particles in the water, which contributes to lower turbidity in the water column. Today, the largest mussel communities are limited to shallower bottoms and the banks are therefore of high protection value. The range of blue mussels is limited by salinity and therefore does not extend past the Bothnian Sea.

The importance of the different key species varies in the different sea areas of the Baltic Sea. On shallower soft bottoms in the Northern Baltic Sea and the South-Eastern Baltic Sea are eelgrass and sago pondweed (Stuckenia pectinata) common and important species. In the area south of Öland, large, dense seaweed belts of mainly toothed wrack (Fucus serratus) have been documented. In the Southern Baltic Sea, bladderwrack and toothed wrack dominate hard bottoms and there are also about 100 species of macroalgae, the majority of which are very rare (Swedish Agency for Marine and Water Management, 2015a). Eelgrass dominates the soft bottoms of Öresund. On hard bottoms there are often brown algae such as bladderwrack, which form seaweed belts.

Skagerrak/Kattegat, with its almost ocean-like conditions, has greater biodiversity compared to the Baltic Sea and the Gulf of Bothnia. The Skagerrak, which is deepest, has a more stable salinity and good oxygen supply, and almost twice as many major animal and plant species as the Kattegat. Of the macroalgae that occur in Skagerrak/Kattegat, as in the Baltic Sea, a majority are very rare. In Skagerrak/Kattegat, a large supply of anthropogenic nutrients has led to major changes along the coast, with sharp increases in the amount of phytoplankton and organic particles in the water. A larger amount of particles reduces the light supply for plants and an increased nutrient supply generally favors fast-growing algae. Long-term changes in seaweed communities vary along the Swedish coast and in Skagerrak a decline has been going on for a long time.

In Skagerrak/Kattegat, it is also important to preserve and promote the key species blue mussel and Lophelia (pertusa), which are two important biotope-building species for the survival of the ecosystems that still exist. Structure-forming species, such as Lophelia, often have a long lifespan and low reproduction, which makes them sensitive to changes.

Eelgrass is currently an endangered species. Along the coast of Bohuslän, the area spread has decreased by over 60% since the 1980s as a result of, among other things, eutrophication and overfishing, which corresponds to a loss of about 12 500 ha of eelgrass (Moksnes et al., 2016). Eelgrass grows in shallower areas and is therefore rarely found in the areas of the marine spatial plan.

Even soft bottoms that are relatively unaffected by humans can have high protection value as they often house endangered burrowing organisms and various species of sea pens. Sponges are also effective filter feeders that can absorb plankton and other organic matter, spreading mainly on hard substrates. Many invertebrates are soft-bottomed organisms and have therefore been significantly affected by bottom trawling. Trawling is most intensive in Skagerrak and Kattegat, followed by the Southern Baltic Sea area, making the invertebrates in these sea areas the most vulnerable. The long-lived tall sea pen, which were previously found in Skagerrak/Kattegat, are particularly affected by the intensive bottom trawl fishing and are currently under threat (Artdatabanken, u.å.; Shield et al., 2021). Skagerrak/Kattegat has the highest abundance of crustaceans, such as northern prawn, edible crab, european lobster and Norway lobster/langoustine. These species are of great economic importance but are currently suffering from high fishing pressure, mainly from commercial fishing (Sandström et al., 2019).

*Environmental impacts and impacts linked to offshore wind energy*

The bottom impact in energy areas depends on a number of factors. The type of installation used e.g. bottom-fixed foundations or floating foundations and also the level of bottom trawling in the area. Bottom-fixed foundations give a direct impact on the bottom covering the surface that the total foundation takes up. With modern wind turbines that can stand up to two kilometres apart, it is about 1-2% of the bottom of the park that is affected by physical loss from the plant itself. Floating foundations require anchoring at the bottom and it is these structures and possibly anchoring ropes/chains that can have a negative effect on benthic habitats. It is also these parts of the foundations that are underwater and involve the addition of new hardened surfaces.

In cases where wind power replaces bottom trawling as a use in sea areas, the local net effect can be positive through a reduced overall area-related negative disturbance/loss. The assessment per marine spatial plan therefore includes an analysis, supported by the cumulative impact assessment tool Symphony, of the areas in which such a positive effect is most likely to occur.

The pressure from offshore wind power on benthic habitats is proportional to the construction area or the size of the energy area. At the same time, the negative effect of the pressure is dependent on the sensitivity of the seabed and existing nature values. In Symphony, an analysis has been made of cumulative bottom effect per area in the energy areas. The results are presented in maps showing where it becomes clear that certain energy areas produce higher bottom pressures per area. In general, it is only when planning wind farms that a detailed location can be carried out that takes into account the presence of sensitive and endangered species and habitat types.

Bottom-fixed foundations and also anchorages to floating foundations mean new hardened surfaces on which marine life can grow. Here, so-called reef effects can occur that contribute to biodiversity and a positive effect, but they can also entail some increased risk of spreading unwanted alien species.

*Impact during construction, operation and decommissioning*

Table 5. Shows the type of impact from offshore wind power in different phases in relation to the impact on benthic habitats, as well as possible consideration measures.

| Phase | Type of impact | Possible consideration measure |
|---|---|---|
| **Facility** | Physical disturbance and loss of benthic habitats | Avoidance of impacts on sensitive or protective benthic habitats |
| **Operation** | Possibility of establishment of artificial reefs. Risk of spread of alien invasive species. | Adaptation of foundations/structures to provide conditions for biodiversity "nature inclusive design" |
| **Settlement** | Likely loss of established artificial reefs. | Avoidance of impacts on sensitive or protective benthic habitats |

### 2.2.5. Fish and spawning grounds

*Current situation, conditions and development*

The fish fauna in the Gulf of Bothnia consists mainly of cod, herring and european sprat, with freshwater species such as european perch and common roach closer to the coast. Salmon, trout and eel occur, but consist to some extent of implanted individuals. Stocks of lavaret are stable in the Bothnian Bay, but in the Bothnian Sea, among other things, the lack of older individuals and declining catches per effort in commercial fisheries indicate that the stock is outside biologically safe limits. The situation of Baltic herring has received a lot of attention in recent years in connection with several reports of declining supplies of herring along the Swedish coast, especially large individuals. The low average weight of herring over the past 15 years is estimated to be the result of, among other things, high fishing pressure, predation of the grey seal and changes in access to food. The low average weight is one of the reasons behind the declining spawning stock biomass. Catches of perch have been stable in exploratory fishing in most of the Gulf of Bothnia, except in North Kvarken, where trends have been negative, also for the number of large individuals. The situation for wild salmon in the Bothnian Bay has improved since a couple of decades, and today shows good status, while stocks further south generally become weaker. Reduced fishing and other measures have led to reduced mortality in recent years, but there are concerns about disease-related mortality in several rivers. The wild sea trout stocks have been negatively affected by a number of pressure factors such as eutrophication, channelling, migration barriers, hydropower utilization and too low water flow in the summer, as well as consequences of a warmer climate. The impact of fisheries on stocks is not known, which justifies a precautionary approach to all fisheries. The vendace, which is economically the most important species in the Bothnian Bay, has relatively stable populations despite annual variations, although knowledge of the stock structure is considered to be limited. Predation of the seal is estimated to be up to five times greater than the yield of the fishery (Fiskbarometern, 2022a).

The fish fauna in the Baltic Sea consists of about 50 species of fish. These are mainly saltwater species such as cod, herring and sprat, while the more coastal areas are dominated by freshwater species such as perch and roach, but also by flatfish. Eel occurs along the coastal areas with the largest distribution in the southern sea areas. The stocks of salmon, trout, eel and to some extent also lavaret, are a mixture of natural and planted fish. In the Baltic Sea, fishing pressure has historically had a major impact on several commercially interesting species such as cod, haddock, common sole, european plaice and pollack. The recovery is slow despite the cessation of fishing for certain species, the removal of the trawl limit and the implementation of other conservation measures. The status of cod is of particular concern, with recruitment of young cod at very low levels since 2017 (Fiskbarometern, 2022b). In the Öresund area, the situation is better, where trawl fishing has been prohibited since the 1930s, but here too the proportion of large fish has decreased in recent years (Swedish Agency for Marine and Water Management, 2015a).

The composition of the fish fauna in Skagerrak/Kattegat is approximately the same as in the rest of Skagerrak/Kattegat. About 80 marine fish species reproduce in Swedish waters and the number of fish species generally decreases from Skagerrak towards Öresund. Cod, herring, sprat and sandeel predominate, and on sandy and clay bottoms mostly flatfish. Eel occurs along the entire west coast of Sweden, but more generally in the southern parts (Swedish Agency for Marine and Water Management, 2015b). The largest eel stock in Sweden is located in the southern Skagerrak's inland coastal area, but the abundance is high throughout the marine spatial plan area of Skagerrak/Kattegat. The fishing community in Skagerrak/Kattegat has since the end of the 19th century changed with a reduction of large, adult predatory fish to an ecosystem where small and young individuals dominate. Examples of species strongly affected by fishing pressure are cod, haddock, common sole, plaice and pollack. Recovery is slow despite various conservation measures, and levels are not satisfactory. The cod stocks are still at such a low level that they are considered to have reduced reproductive capacity.

Fishing is the main human impact on fish stocks, but it also results from nutrient inputs and environmental toxins, as well as from exploitation and physical impact on habitats. Regulation of rivers and clearings in both large and small rivers affect fish stocks and fisheries by limiting access to suitable spawning grounds for marine fish (Swedish Agency for Marine and Water Management, 2015a). Other physical disturbances in the ecosystem may be due to dredging, facilities, lost fishing gear and noise. One factor of uncertainty is how the fish's habitat and food base are affected by climate change and the increased distribution of oxygen-poor seabeds in the Baltic Sea. More than 20 fish species are included in the Red List for endangered species, including cod, haddock, common ling and atlantic halibut, as well as hake and thorny skate (Swedish Institute for the Marine Environment, 2016).

*Environmental impacts and impacts linked to offshore wind energy*

According to the latest synthesis of the effects of offshore wind power on fish, there is much in the overall scientific evidence to suggest that the supply of offshore wind turbines does not pose a threat to fish species or populations (Öhman, 2023). However, the conclusion only applies if certain precautionary measures are introduced to minimise the pressures of offshore wind power, in particular impulsive underwater noise and sediment dispersion. However, like other studies, the synthesis highlights that the effects can differ significantly between different areas and that important knowledge gaps remain (see also Hogan et al., 2023). For these reasons, wind power establishment should be preceded by a local assessment of how fish including fish spawning may be affected.

The question of how offshore wind power can affect salmon was raised in the consultation for the marine spatial plans. The Swedish Agency for Marine and Water Management therefore tasked SLU Aqua with compiling the current state of knowledge based on available research on the risk of impacts from offshore wind power on migratory salmon (Koehler et al., 2024). The assessment is based on literature on the biology of salmon and on pressures from offshore wind power. There are currently no wind farms where salmon is present in Swedish seas in order to study actual effects, nor are there any studies from wind farms in other countries. According to the current state of knowledge, the risk that migrating salmon will be adversely affected is assessed if wind farms are built with bottom-fixed foundations with a long distance between the towers and located in the outer lake at a not too shallow water depth (more than about 30 meters).

The risk of negative impact on migratory salmon is considered to be low even when using floating foundations, but there the uncertainty is slightly higher. The cables that transport electricity from floating foundations will be in the water mass and would come closer to the salmon than when using bottom-fixed foundations. However, the magnetic field from the cables has a very limited spread, in the order of maximum single meters. Although the risk is considered low, it is important to conduct follow-up studies in and around the wind farms being built, with a focus on clarifying the salmon's behaviour at the plants. If several wind farms are built, coordinated monitoring is important in order to monitor possible cumulative effects. The purpose of the studies would be to clarify the state of knowledge and provide an opportunity to identify the need for adaptations to mitigate any unforeseen negative effects on a larger spatial scale, such as migration patterns.

The risks associated with sound at the installation can be reduced by means of protective measures that reduce the intensity of the sound pressure, the area of impact and the likelihood of fish being present in the area. There is reason to use these methods routinely and also monitor their actual effectiveness in practice. Conditions may be included in the permit, such as that works that cause high-intensity noise may not be carried out during certain biologically relevant periods of time.

*Impact during construction, operation and decommissioning*

Table 6. Shows the type of impacts from offshore wind power in different phases in relation to impacts on fish and spawning areas, as well as possible consideration measures that can reduce negative impacts and consequences.

| | **Type of impact** | **Possible consideration measure** |
|---|---|---|
| **Facility** | Noise and turbidity | Protection measures against noise; adjustment of planting time by season (avoidance of spawning periods); Choice of foundation type and cable recess method. |
| **Operation** | Noise<br>Possibility of establishing artificial reefs that benefit fish through food availability and protection.<br>Influence on natural magnetic field.<br>Electromagnetic fields. | Avoidance of shallow coastal areas. |
| **Settlement** | Loss of established artificial reefs.<br>Noise and turbidity | Adjustment of settlement time by season (avoidance of spawning periods); |

### 2.2.6. Proposals for new areas with particular consideration to high nature values

The plan includes a number of proposals for new areas for particular consideration of high nature values (so-called small n-areas). These have been developed in a process together with coastal county administrative boards and the Swedish Environmental Protection Agency. Areas with particular consideration to high nature values can be based on existing known nature values where the designation provides general guidance on particular consideration. They can also complement guidance on energy extraction, highlighting the need for particular consideration in energy realisation, e.g. in the form of protective measures for harbour porpoises or birds. The new proposals for n-areas in this planning round are described in the respective assessment chapters below.

## 2.3. Effects on ground, soil, water, air, climate, landscape, settlement and cultural environment

### 2.3.1. Water and air

*Current situation, conditions and development*

The chemical and physical properties of the sea are essential for marine life. Both water characteristics and water quality are crucial for marine species. The salinity varies greatly along the Swedish coast, from about 30-33 PSU (practical salinity unit, measured in g/l or g/kg) in Skagerrak to 2-4 psu in the Gulf of Bothnia. The variation in salinity means that each sea area has unique characteristics and sets boundaries for ecosystems by affecting the range of species. With the change in salinity comes a shift from saltwater species in Skagerrak to a dominance of freshwater species in the Gulf of Bothnia. The salinity also varies locally from lower levels at the shoreline, especially at river mouths, to higher levels in the open sea.

The chemical status of Sweden's marine areas is affected by both historical and contemporary uses, both from emission sources on land as well as emissions and activities in the sea. Environmental monitoring shows that Sweden is still far from the target of a non-toxic environment, although the supply of a number of environmental toxins has constantly decreased in recent decades and the conditions for achieving that target have improved in recent years (Swedish Agency for Marine and Water Management, 2018b; Swedish Chemicals Agency, 2022). Since the first measurements of environmental toxins in Swedish marine areas, the levels of early environmental toxins, such as the persistent PCBs and DDT, as well as lead, have decreased in marine organisms thanks to success in the action work. This has contributed to the significant recovery of several marine species such as white-tailed eagles and seals. Although the levels of most classical environmental toxins have decreased, the National Food Agency recommends that children, adolescents and women of childbearing age continue to eat fatty fish from the Baltic Sea no more than two to three times a year as a result of dioxins and other environmental toxins in this fish.

According to the latest initial assessment under the EU Marine Strategy Framework Directive, the concentrations of most hazardous substances remain higher than the thresholds defining good environmental status (Swedish Agency for Marine and Water Management, 2024a). Particularly worrying are the high levels of mercury and brominated diphenyl ethers, which are exceeded in fish in coastal waters throughout Sweden and where the trend points to no or slow improvement. Dioxins and dioxin-like contaminants remain problematic in the Baltic Sea. As the Baltic Sea ecosystem is relatively young and species-poor, it is particularly sensitive to hazardous substances, especially if they affect key species. Despite a downward trend in tin pollution, endocrine disrupting effects on snails continue to occur, particularly in coastal waters of Skagerrak/Kattegat and the Baltic Sea. Cadmium levels in embankment sediments in waters around Gotland are also too high, which can partly be explained by the high levels in the bedrock in the area. A growing problem globally is plastic pollution in the ocean, especially when it breaks down into microscopic particles that can be absorbed by organisms and cause poisoning.

Illegal oil spills from ships in the Baltic Sea and Skagerrak/Kattegat, oil leaks from propeller cores and wrecks in Skagerrak/Kattegat contribute to pollution of the Swedish sea (Swedish Marine Environment Institute, 2014). The long tradition of industries in the Gulf of Bothnia has resulted in many contaminated areas with high levels of environmental toxins along the coast. This has led to concrete environmental challenges in meeting future needs for maritime dredging, energy production and transmission. The presence of dumped weapons, wrecks or other types of dumped material can affect water quality locally and regionally.

Since water quality, and factors such as oxygenation, salinity and temperature are a prerequisite for life in the sea, this is an essential part of Swedish marine management. As described above, there are many remaining challenges with the chemical status and other climate-related factors linked to water quality in Swedish marine areas. Both water and air quality are affected by climate change, which is expected to intensify in the coming decade (IPCC, 2023). Both warming, acidification of seawater and increased precipitation and runoff are factors that are expected to have a significant negative impact on water quality. More complex climate effects linked to ocean circulation and hydrography are difficult to predict at present. In addition to climate change, it is pressures in the form of emissions from human activities that can be expected to have the greatest effect in the long term.

*Environmental impacts and impacts linked to offshore wind energy*

*Impact on hydrography*

Studies have shown that the establishment of offshore wind power has some impact on hydrography (Arneborg et al., 2024). SMHI was commissioned by the Swedish Agency for Marine and Water Management to study the hydrographic effects of large-scale deployment of offshore wind power. A modelling study was conducted in 2024 to investigate how offshore wind power deployment in the Baltic Sea and Skagerrak/Kattegat affects hydrographic factors such as temperature, salinity, currents and stratification. The results showed that an extensive expansion of offshore wind power in the Baltic Sea in particular could cause a shallower halocline, as well as increased salinity and temperatures in the deep water due to decreasing winds behind the wind farms leading to reduced vertical mixing (Arneborg et al., 2024). The modelling also showed that the wind power foundations cause a decrease in the salinity of the deep water in the Baltic Sea, probably due to increased friction and mixing in Öresund. All wind turbines were assumed to be bottom-fixed in the modelling, which does not correspond to what a realistic expansion would look like.

The results of the study are based on certain assumptions, including how wind affects the sea surface and also the extent of wind power expansion, both internationally and nationally. One of the conclusions of the study is that there is a sensitivity to these variables and more studies are needed to investigate how large the effects would be in terms of actual conditions for the wind wave effect throughout the season, as well as real expansion of offshore wind power in Sweden's neighboring areas. More studies are also needed to investigate possible second-round effects that changes in hydrography may lead to for biochemical variables and ultimately how marine organisms and habitats could be affected. SMHI's researchers also note in the study that changes that could occur from offshore wind power are smaller than expected effects of climate change, for example in terms of temperature.

The foundations could also affect waves and the movement of water downstream of the wind farm. This may be important if the wind farm is located in the vicinity of constantly changing sandy areas where waves and currents play a role in the design of the shoreline, which could lead to beach erosion (Swedish Environmental Protection Agency, 2008).

*Dispersion of sediments and pollutants*

Sediment dispersion can occur during the construction of the foundations of wind turbines and also during cable laying. The extent of sediment dispersion depends on several factors, including the characteristics of the bottom material, ocean currents and technical choices at the plant (Naturvårdsverket, 2008). In general, sediment suspension becomes more extensive in areas where the bottom and sediment are made up of more fine-grained material, and also in areas with more powerful currents. Sediment dispersal can lead to environmental effects such as turbidity, which can affect lighting conditions, fish spawning and biodiversity, see Table 7 below. Detailed modelling of expected sediment dispersion is done in the permit application for specific wind power projects, and in the planning of construction, maintenance and decommissioning can be taken into account to minimize negative environmental effects. The sensitivity of a species to turbidity varies, depending, among other things, on whether the species is fixed or not and whether it is accustomed to sedimentation (Bergström et al., 2022). Some species may also be more sensitive to impacts during specific phases, such as spawning time and the larval stage.

Another risk in sediment dispersion is if the sediment contains different types of contaminants, which then risk spreading into the water column and can be absorbed by marine organisms. SGU carries out marine environmental monitoring and mapping of the seabed within the Swedish continental shelf area. Information on bedrock material, different sediment strengths and formation modes, and content of organic matter and environmental toxins (Swedish Geological Survey, 2024). The spread of environmentally hazardous substances can be prevented by sampling and mapping of pollutants in the benthic habitat in connection with design. The presence of environmentally hazardous wrecks, dumping sites or dumped combat materials and ammunition in the vicinity of the site may increase the risk of spreading environmentally harmful substances.

Some sediment dispersal also occurs during the operational phase, around foundations. This can be prevented by laying different types of erosion protection around the foundations. Common erosion protection consists of a layer of large-grained gravel, pebbles or other material (Hammar, Andersson, Rosenberg, 2008).

*Erosion of foundations*

The spread of particles in the form of materials and chemicals from wind turbine structures both above and below the surface occurs gradually during the operational phase and depends on external influences from, for example, rain and wind (Pryor et al. 2022). Wind turbines consist mostly of iron and other metals, in addition there are electronic components and the rotor blades are made of fiberglass and plastic materials (Energy Agency 2021). It is important that the rotor blades retain the shape for optimal conditions for energy extraction, therefore they are treated with a protective coating. The studies carried out have not been able to demonstrate that wind turbines are a major source spreading environmentally hazardous chemicals, such as PFAS, Bisphenol A or microplastics (Swedish Environmental Protection Agency 2021, Wang et al., 2018). Research is ongoing to investigate this further, including the PREMISE project at the Technical University of Denmark (see, for example: Hasager et al.2022; Pryor and Others 2022).

The decommissioning of wind turbines is the responsibility of the companies and this is regulated in permits for each project (Energy Authority, 2021).

*Impact during construction, operation and decommissioning*

Table 7. Shows potential impacts during different phases of offshore wind on different aspects related to water, both in the short and long term, how these impacts may affect other assessment aspects, as well as possible consideration measures.

| Phase | Effects | Indirect effects | Long-term consequences | Link with other aspects | Possible consideration measures |
|---|---|---|---|---|---|
| **Facility** | Dispersion of pollutants and sediments on site | Increased turbidity and local concentration of pollutants | Increased levels of chemicals in marine organisms, impact on marine organisms and habitats | Professional fishing, health, fish and fish spawning | Studies of the benthic habitat and location, as well as planning of the plant with regard to current conditions |
| **Operation** | Impact on hydrographic conditions | Influence biochemical properties, such as salinity, halocline, currents | Algal blooms Altered oxygen conditions at the bottom, dispersal of larvae, altered species composition | Fish and fish spawning, Climate | Location of wind turbines |
| | Dispersion of substances during erosion of construction | Increased local concentration of certain substances | Increased levels of certain substances | Fish and fish spawning | Use of erosion protection, e.g. sacrificial anodes |
| | Dispersion of pollutants and oil in the event of a breakdown or accident | Increased local concentration of certain substances | Impact on marine organisms and impact on preparedness | Health, Shipping | Safeguards and monitoring |
| **Settlement** | Sediment dispersal | Increased turbidity and local concentration of pollutants | Impact on marine organisms and habitats | Professional fishing, fish and fish spawning | Studies of the benthic habitat and location, as well as planning of the plant with regard to current conditions |

## 2.3.2. Climate

*Current situation, conditions and development*

Climate change is expected to affect marine conditions in several ways and is relevant for all uses in marine spatial plans. Climate-related effects linked to the sea include changes in temperature, salinity, ocean acidification, altered and reduced ice formation, rising sea levels and changing weather patterns (Swedish Agency for Marine and Water Management, 2024d). These climate effects lead to indirect effects such as changes in species composition and ecosystems when marine species react to changes. In turn, climate impacts in the sea can also lead to societal impacts, such as changes in maritime and marine value chains and an increased risk of beach erosion. Figure 3 below illustrates climate effects in the marine environment, for more detailed information on the effects of climate change in the sea, see the Swedish Agency for Marine and Water Management's climate adaptation plan and the marine strategy (Swedish Agency for Marine and Water Management 2024d, Swedish Agency for Marine and Water Management 2024a).

Based on regional conditions, it differs how climate change will affect different sea areas in Sweden. In the Gulf of Bothnia, ice formation is a factor that can play a greater role than in other sea areas, and in the Baltic Sea changes in salinity and circulation can exacerbate problems with oxygen-free bottoms. Sea level rise also has a regional dimension as land rise is greater in northern Sweden (SMHI, 2023). Already today, marine environmental monitoring shows that the average temperature in Swedish sea areas has risen and more and more studies confirm that this affects the ranges of marine species (Sweden's aquatic environment, 2023).

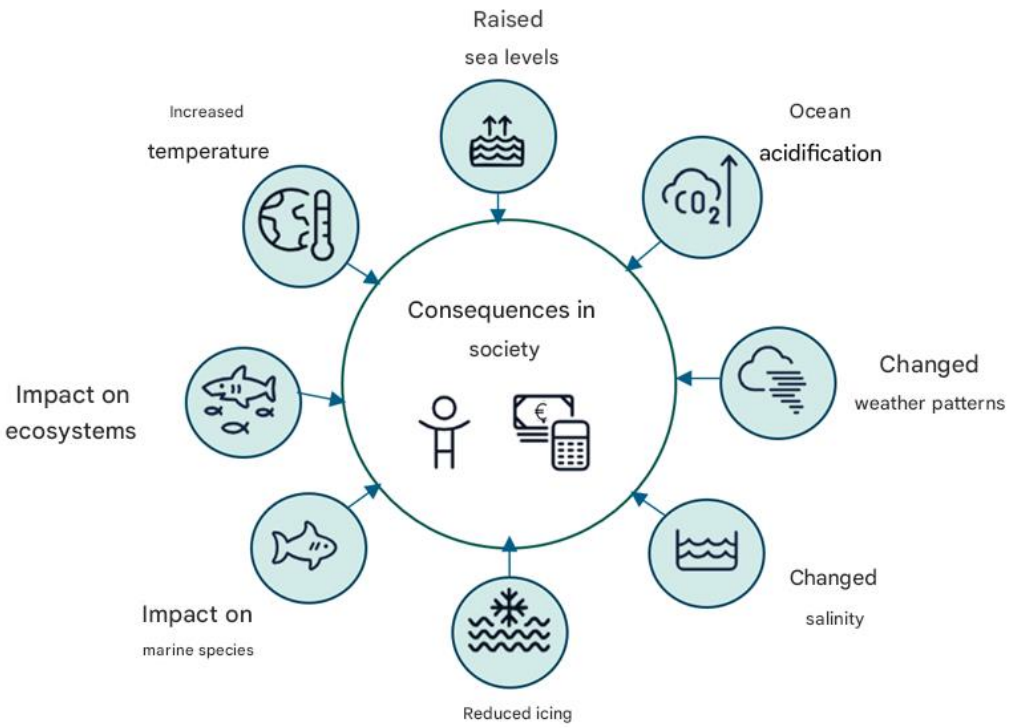


Figure 3. Shows an illustration of climate change in the ocean (Own illustration: Veronica Berntson).

*A changing climate in the future*

According to the Intergovernmental Panel on Climate Change (IPCC), the extent of climate problems depends, among other things, on how well society manages to switch to renewable energy production and thus reduce greenhouse gas emissions (IPCC, 2023). In order to be able to work proactively with the climate issue, the IPCC has developed climate scenarios that can give an indication of a possible development of the climate based on different levels of greenhouse gases in the atmosphere. The scenarios, also known as RCP (Representative Concentration Pathways), show what a possible future development could look like from a continuation of current emission trends (RCP 8.5), to a very large limitation of future emissions (RCP 2.6), see Figure 4.

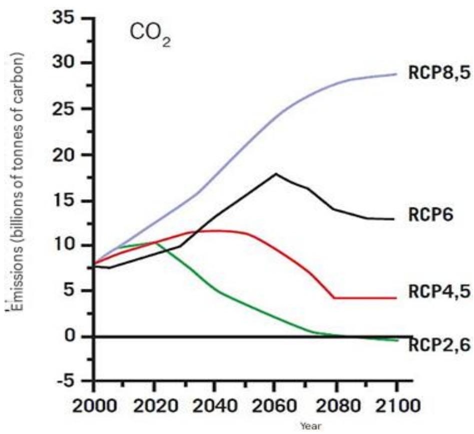


Figure 4. Examples of possible CO2 emission trajectories at different RCPs given as billion tonnes of carbon (van Vuuren et al., 2011).

Climate scenarios are also applicable in the sea, models show that all marine areas in Sweden risk facing major changes if emission levels are not reduced. Factors such as increased precipitation and increased temperature will have an impact on the marine environment. Figure 5 and 6 show projections for the oceanographic climate indicators surface temperature and surface salinity in Sweden's marine areas for RCP 4.5 and RCP 8.5 in 2040-2070 (SMHI, u.y.).

The trend for climate change is that there is an increased risk and likelihood that marine ecosystems will be increasingly negatively affected (IPCC, 2023), and marine spatial planning may need to take more parameters related to climate and climate adaptation into account. Climate change occurs in a context where marine ecosystems are also exposed to other pressures that stress marine organisms and ecosystems. The combined effects of climate change and other pressures such as eutrophication, selective fishing or marine pollution can lead to large-scale changes in marine ecosystems and loss of both habitats and biodiversity (Swedish Agency for Marine and Water Management, 2024a). Modelling studies using the cumulative impact assessment tool Symphony show that in the long term, pressures from climate change will have a greater impact than the combined impact of other pressures (Wåhlström et al., 2022).

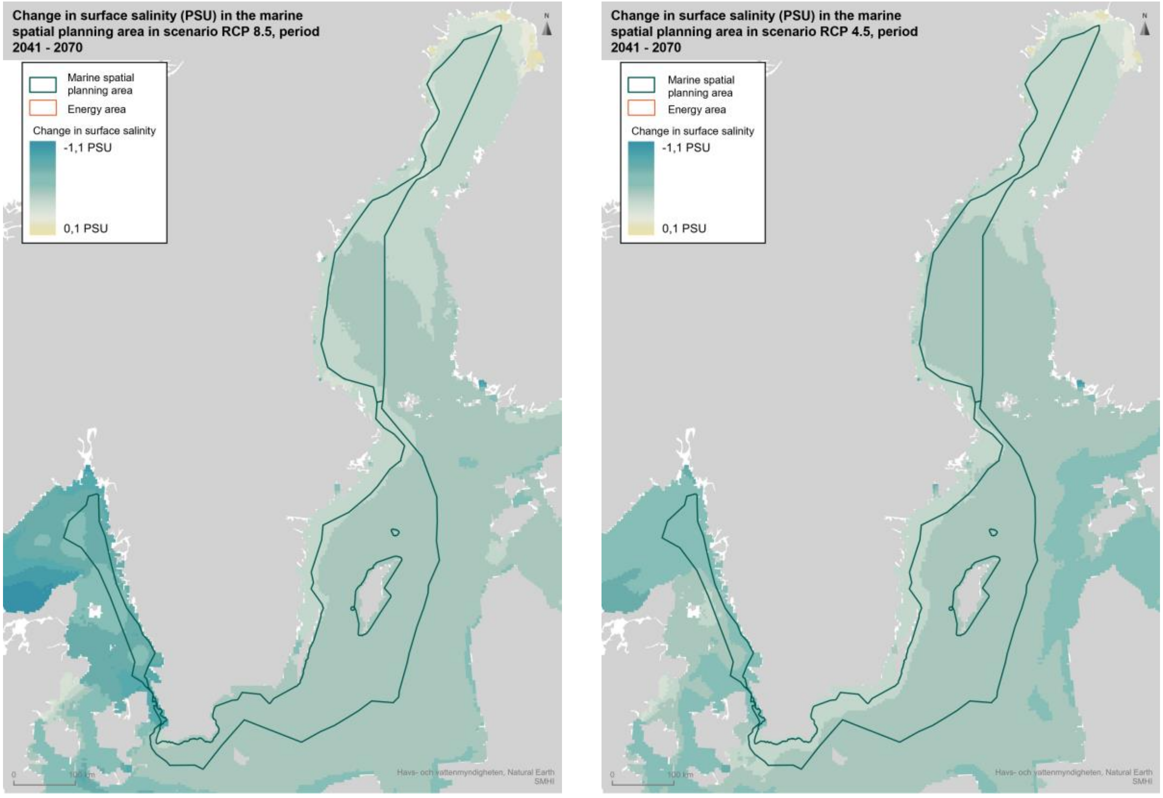


Figure 6. Displays the expected change in surface salt content (PSU) for RCP 4.5 (left) and 8.5 (right).

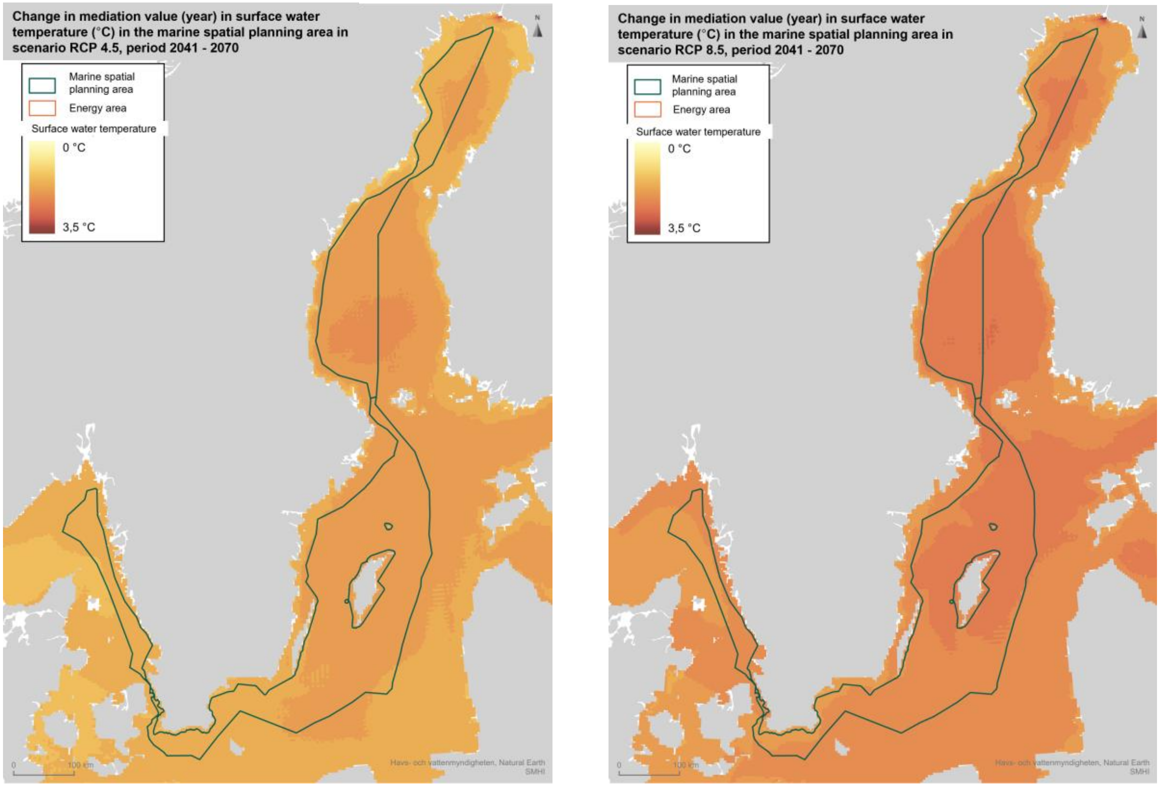


Figure 5. Displays the expected change in sea surface temperature in degrees Celcius for RCP 4.5 (left) and 8.5 (right).

*Environmental impacts linked to climate change*

Climate change is relevant to marine spatial planning from several perspectives, partly because of its impact on the sea and the interests that depend on the sea's ability to deliver ecosystem services, and partly because marine spatial plans can contribute to both reduced climate emissions and climate adaptation measures. Several uses and maritime activities also generate greenhouse gas emissions that in themselves contribute to climate change, such as shipping, commercial fishing, outdoor activities and the hospitality industry. The plan can also help strengthen the ocean's capacity to deal with climate change by providing guidance on the consideration and protection of marine environments. Strengthening the resilience of ecosystems through strategic area protection and coordination with marine spatial planning is part of the Swedish Agency for Marine and Water Management's climate adaptation plan (Swedish Agency for Marine and Water Management, 2024d). Guidance on nature use or particular consideration for high nature values (small-n) can, when applied, contribute to a positive climate effect as natural ecosystems protected from exploitation act as marine carbon sinks and store carbon dioxide in either biomass, or in sediment (Björk et al. 2021, Baltic Sea Centre 2021). Marine environments protected from pressures can also lead to ecosystems becoming more resilient, withstanding and recover from climate-related impacts, such as heat waves. Potential function as a climate refugia is a selection criterion for areas with particular consideration to high nature values that have been applied in marine spatial planning where data were available (Hammar & Mattsson, 2017). Climate refugias are areas that are considered to be highly likely to host biodiversity even in a changing climate.

*Impact on climate linked to offshore wind energy*

*Renewable energy production and national climate targets*

The addition of renewable energy production is a prerequisite for Sweden to achieve national and international climate goals (see paragraph 1.4.2 Environmental and climate objectives). In 2023, Sweden's emissions of carbon dioxide equivalent amounted to approximately 48 million tonnes (Swedish Environmental Protection Agency, 2024c). By 2030, national emissions are to be reduced by 20 million tonnes and down to 10 million tonnes by 2045 (Swedish Environmental Protection Agency, 2023a). It is the industrial and transport sectors that account for the largest emissions in Sweden (see Figure 7 below), and it is in these sectors that there is a great need to replace fossil-based energy sources as the majority of petroleum-based energy carriers are used here (Energy Agency, 2024). Demand for energy is expected to rise until 2050, which means that the supply of fossil-free energy will be particularly important for emissions to be reduced in accordance with climate targets (Energy Agency, 2023a). There are different projections and scenarios for estimating future energy needs, see section 2.4.1 Energy.


Figure 7. Shows Sweden's emissions of carbon dioxide equivalents broken down by different sectors. Note that the figures in the figure were preliminary, and differ from Statistics Sweden's figures. Image source: Swedish Environmental Protection Agency, 2024c.

*Climate impact and benefits*

Offshore wind energy has a positive climate effect as it does not contribute to greenhouse gas emissions. In addition, it is assessed to have low carbon dioxide emissions from a life cycle perspective (Energy Agency, 2023a). The climate benefits of offshore wind power are mainly due to the displacement of fossil fuels. It can be more direct, when electricity from fossil fuels is replaced by that from offshore wind, or more indirect, when electricity produced with low emissions replaces fossil fuels as energy carriers in other sectors. Direct compensation is when fossil fuels for electricity generation is replaced by offshore wind power, and CO2 emissions can be reduced by substituting electricity from offshore wind power for fossil electricity generation. Examples of indirect substitution are when fossil fuels for the transport sector and/or fossil raw materials in industrial processes such as the replacement of coal with hydrogen in steel production.

It is difficult to estimate exactly what climate benefit offshore wind power could have in the Swedish energy system, as there are several different factors that affect the outcome. One example for which electricity generation from offshore wind power could be substituted is the residual mix. Residual mix is an environmental value for the electricity that is not produced and sold with guarantees (Energy Market Inspectorate, u.y). It is this electricity that constitutes the electricity available on the market, there is a Nordic mix, and a European mix. In 2023, the Nordic residual mix had a climate impact of 524.10 g CO2eq/kWh or 524 100 tonnes CO2eq/TWh (Energy Markets Inspectorate, 2024). This value is due to a fossil share of 78.82 percent, while the renewable corresponds to 6.51 percent and nuclear 14.68%, see Figure 8 below. For its part, the European residual mix had a climate impact of 599.23 g CO2eq/kWh or 599 230 tCO2eq/TWh (AIB, 2024). This can be compared to a climate impact from offshore wind power that has a median of 11 g CO2e/kWh or 11 000 tonnes of CO2e/TWh (Energy Agency, 2021). With these assumptions, each TWh of offshore wind power would thus have a clear potential for reduced climate impact. The environmental and average climate impact from the residual mix varies from year to year depending on energy production, and as fossil-free energy production increases and replaces fossil production, the climate impact from the residual mix will decrease. The environmental value of the residual mix has changed from year to year (Energy Market Inspectorate, 2024).

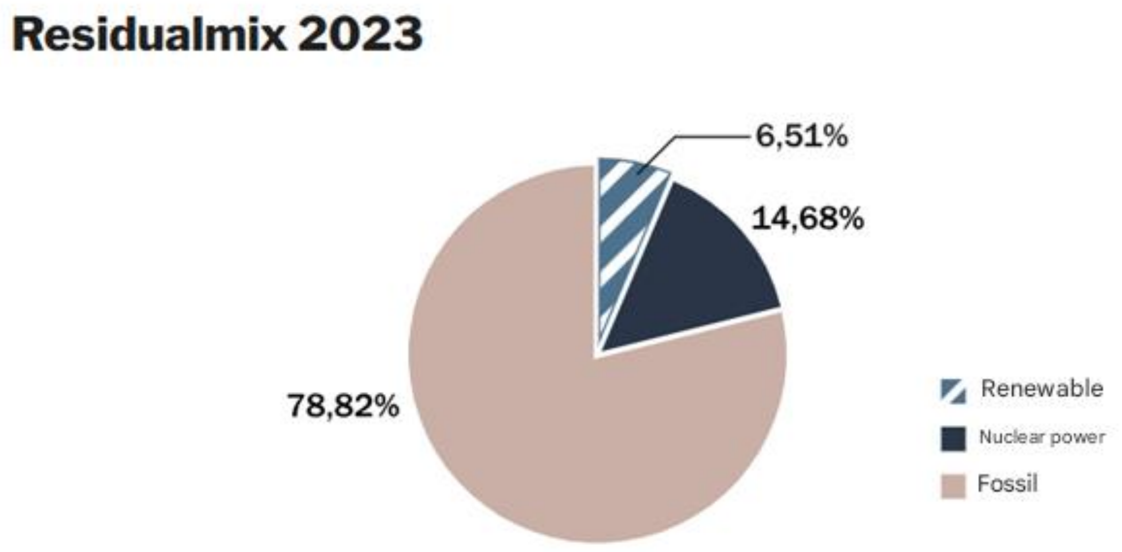


Figure 8. Shows the distribution of energy sources in the Nordic residual mix in 2023. Source Energy Market Inspectorate, 2024

### 2.3.3. Landscape

*Current situation, conditions and development*

The establishment of offshore wind power can mean large-scale changes in the landscape as the turbines have a considerable height and large sweeping area for the rotor blades. The rotation of the rotor blades contributes to landscape impact, as well as at night through the active obstacle lighting.

The current situation in Swedish sea areas is characterised by few and, where appropriate, more small-scale existing offshore wind farms. These include Lillgrund (Ö287) in Öresund, Kårehamn east of Öland, and Bockstigen 1 southwest of Gotland. Kårehamn is not an energy area for cartographic reasons and Bockstigen 1 is not included in the marine spatial planning area. In general, this means that there are currently few physical installations in Swedish waters, which means that knowledge of the impact on the landscape is limited. Offshore wind power affects the landscape in all directions from the plant, but primarily the impact on the coast and how the physical structure affects the existing coastal landscape is assessed. The location and design of wind farms can have a major impact on the landscape, where issues such as height, location and design, formation and lighting come into play. In some energy areas, the marine spatial plan gives particular consideration to high cultural heritage values, which means that consideration must be taken in the management, planning and licensing of energy areas, which can contribute to certain adaptations that can mitigate the impact on cultural environments, thereby reducing the impact on the landscape.

The landscape along Sweden's coasts is varied from both a natural and cultural environment perspective. The natural environments include forested and shrub-clad environments, open, stony and rocky coasts as well as finely topography-broken archipelagos and flat stretches of coastline. The cultural environments are characterized by human's historical use of the landscape in the form of, for example, fishing communities, but also modern occurences such as large-scale ports and urban environments.

National interests for, among other things, the cultural environment and recreation capture the landscape's values and contribute to consideration in planning and permit applications. This impact assessment includes assessments of the cultural environment and recreation as its own parts, but where relevant, also described areas of national interest unbroken coastline and high-exploited coastline under Chapter 4, Sections 3-4 of the Environmental Code. Landscape protection is also mentioned in the Nature Conservation Act (1964:822) where it risks being affected by the establishment of offshore wind power. The assessment of the impact on the landscape can be seen as a starting point for visual effects on cultural environment and recreation interests.

In an approach to a future outlook, the landscape is expected to be marginally affected along the Swedish coast. However, larger installations of industrial scale can contribute to a major change in the landscape, not least of offshore wind power.

*Impact linked to offshore wind energy*

The impact on the landscape depends on several factors. This analysis of landscape effects includes the proximity of the energy areas to land, the angle of view from land and from which points on land the wind turbines are visible. Proximity to land or distance from land is considered to be the most important impact factor because it largely determines the visual presence of the works and thus the degree of impact. Other possible impacts on the landscape that offshore wind power may have are not included in this analysis, such as related onshore infrastructure. Visual impact need not by definition be negative, as the perception of wind turbines is subjective. Although negative perceptions of the visual impact offshore wind power can have, there are also positive perceptions of it (Bolin et al., 2021).

To give an idea of the difference in impact on the landscape with different distances from land, photomontages has been developed for a hypothetical example park. The park is twenty kilometers long and ten kilometers wide with the long side towards the coast and the pictures show it 5, 12.5, 25, 35 and 50 kilometers from land.

The sample park has 72 wind turbines with a total height of 343 metres, a hub height of 200 metres and a rotor diameter of 286 metres. The distance between the turbines is 6 rotor diameters or about 1.7 kilometers.

The size of the sample park has been chosen to give examples of a medium-sized wind farm based on the size of the energy areas in the plan proposal. See Figure 7 for the layout of the sample park.

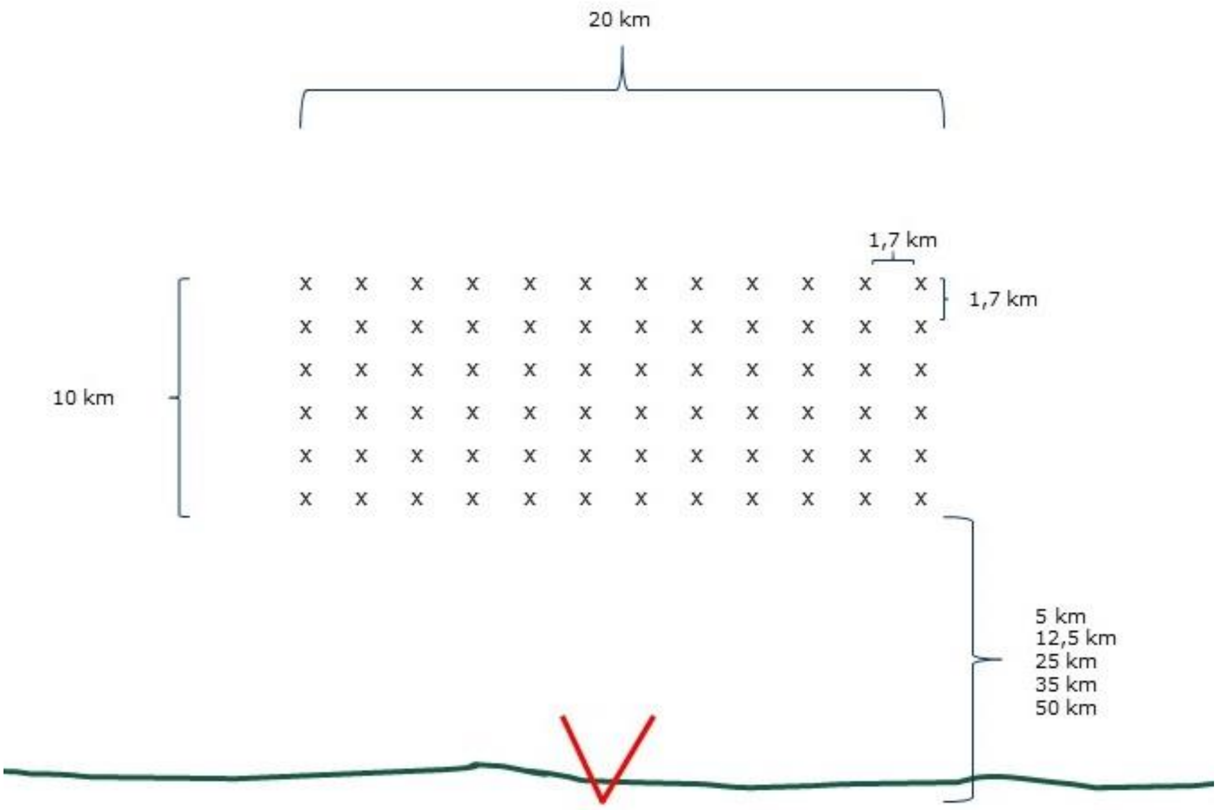


Figure 9. The layout of the sample park with 72 wind turbines placed in grids with 1.7 kilometers of distance between the turbines. The red angle shows the point of view from land.

Below are photomontages for the different distances from land. The Swedish Agency for Marine and Water Management's website contains these images, images with a marked sweep area and video animations for the sample park at night. With a larger screen, it is recommended to view the images with a height of 18 centimeters and a distance of 40 centimeters from the screen for the most realistic representation possible. In this document, they can be seen at a height of 9 centimeters at a distance of 20 centimeters. Below are the images cropped to fit into the document.

Figure 11. The example park with a 5 km distance from land to the nearest works.

Figure 10. The example park with a 12.5 km distance from land to the nearest works.

Figure 12. The example park with a 25 km distance from land to the nearest works.

Figure 13. The example park with a 35 km distance from land to the nearest works.

Figure 15. The example park with a 50 km distance from land to the nearest works.

For the images showing cumulative impacts from several parks, similar facilities have been added as explained below. For the night animations, all works have been provided with a flashing white light in accordance with the Transport Agency's instructions. Images and animations are made without weather filters.

Figure 14. Example of cumulative effect with the example park 12.5 km from land with a view to the right with another park 25 km from land.

*Impact during construction, operation and decommissioning*

Table 8. Shows the type of impact from offshore wind power in different phases in relation to the landscape, as well as possible consideration measures for planning and planning that can reduce negative effects and consequences.

| Phase | Type of impact | Possible consideration measure |
|---|---|---|
| **Facility** | Visual impact | Location and design of wind farm |
| **Operation** | Visual impact | Custom obstacle lighting |
| **Settlement** | Visual impact | No specific measure |

### 2.3.4. Cultural environment

*Current situation, conditions and development*

The cultural environment provides a picture of Sweden's history and people's livelihood. Cultural environments have arisen through various historical events, processes and activities, reflecting people's use of the landscape from ancient times to the present. The environments make it possible for present and future generations to take part in the landscape's historical dimension and thereby understand Sweden's development through the ages.

Cultural environments can also have significance for people in different ways, where it can be, for example, about identity and context in life or about well-being. Cultural environments are also important for economic development at local and regional level, as well as for recreation, tourism and science. How the environments are used varies from generation to generation. A basic condition, however, is that there must be a sufficient representation of preserved cultural environments to be able to understand how the country has formed and developed over time.

The cultural environment in the three marine spatial planning areas includes national interests, world heritage, regional value areas, marine archaeological sites and cultural reserves. The cultural heritage in and by the sea is characterised by the traditional industries of fishing, shipping, agriculture, industry and tourism. Valuable environments, landscapes and buildings are linked to archipelago agriculture, fishing villages, seaside resorts, harbours, fortifications, lighthouse and pilot sites and coastal industry, which in turn arose there because of the connection to the sea. For many of these cultural environments, a nearby coastal and archipelago landscape as well as free lines of sight towards the horizon are important to be able to understand the historical context and function linked to the sea. The intensive activities over the centuries have also resulted in a cultural landscape on the seabed. This includes, for example, shipwrecks, settlements, ship gates, port facilities and anchorages.

The National Heritage Board is responsible for identifying national interest claims for cultural heritage conservation under Chapter 3, Section 6 of the Environmental Code. Today, there are about 300 national interest claims for cultural conservation along the coast, but as yet none in the marine spatial planning areas. However, cultural environments outside the marine spatial planning areas may be indirectly affected by changes in landscape or accessibility within the marine spatial planning areas. In addition to the cultural heritage conservation claims, there are also national interests under Chapter 4 of the Environmental Code. These geographically defined areas of national interest are listed in the Environmental Code and have been decided by the Parliament. They are national interests for unbroken coasts under Chapter 4, Section 3 of the Environmental Code and high-exploited coasts under Chapter 4, Section 4 of the Environmental

Code. The areas are of national interest, taking into account natural and cultural values as a whole, and their use must not significantly harm the values of these areas. See Figure 16 below.

Furthermore, there is also a planning basis for marine cultural heritage values for the national marine spatial planning, which has been developed by all coastal county administrative boards according to a government letter of appropriation (RB2021:2B4). The purpose of the assignment were to clarify cultural heritage values along Sweden's coast that may be affected by the expansion of offshore wind power. The document presents cultural environments together with the County Administrative Board's recommendations on consideration needs for the designated so-called value areas (County Administrative Boards, 2024). In total, there are 96 value areas along the coast of Sweden. Most of these are located outside the marine spatial plan area, but with several consideration needs that extend within the marine spatial plan area. Several areas of value contain existing areas of national interest, but designations have also been based on other cultural heritage and/or formal protection. This includes cultural sites covered by international conventions such as the Council of Europe's Landscape Convention and UNESCO's World Heritage Convention, listed buildings under ordinance 2013:558 on state-owned listed buildings, cultural reserves (Chapter 7, Section 9 of the Environmental Code) and landscape protection in the Nature Conservation Act (1964:822), for example. World heritage in the vicinity of Sweden's marine spatial planning area are the High Coast, the Hanseatic City of Visby, the Naval City of Karlskrona, Southern Öland's agricultural landscape and Struve's meridian arch (Riksantikvarieämbetetet, u.å.a.).

The marine spatial plan states that particular consideration must be given to high cultural heritage values in the management, planning and permit procedures. Particular consideration for high cultural heritage values refers to the landscape's cultural-historical character and visual impact that changes the cultural-historical content, but also includes consideration for ancient and cultural-historical sites on the seabed. Particular consideration is given to high cultural heritage values for energy areas that are considered to be likely to visually affect cultural heritage areas expressed through national interest claims and value areas. Particular consideration for high cultural environments is given for all energy areas in the marine spatial plan except for four (B159, B160, B161, V360). The guidance is considered to be able to contribute to certain adaptations that can mitigate the impact on cultural environments from the energy areas (Swedish Agency for Marine and Water Management, 2025).

Measures that limit climate change, including achieving an energy transition, can have a positive impact on the long-term management of all of Sweden's cultural environments. Climate change, such as sea level rise and accompanying shore shift, can lead to damage to cultural environments both on land and in the sea. A rise in sea temperature may also involve the establishment of invasive species that damage wooden structures. Ship sites, older port facilities and cultural-historical industrial environments can in turn pose environmental threats if they contain heavy metals and other environmentally hazardous substances that are released into the sea.

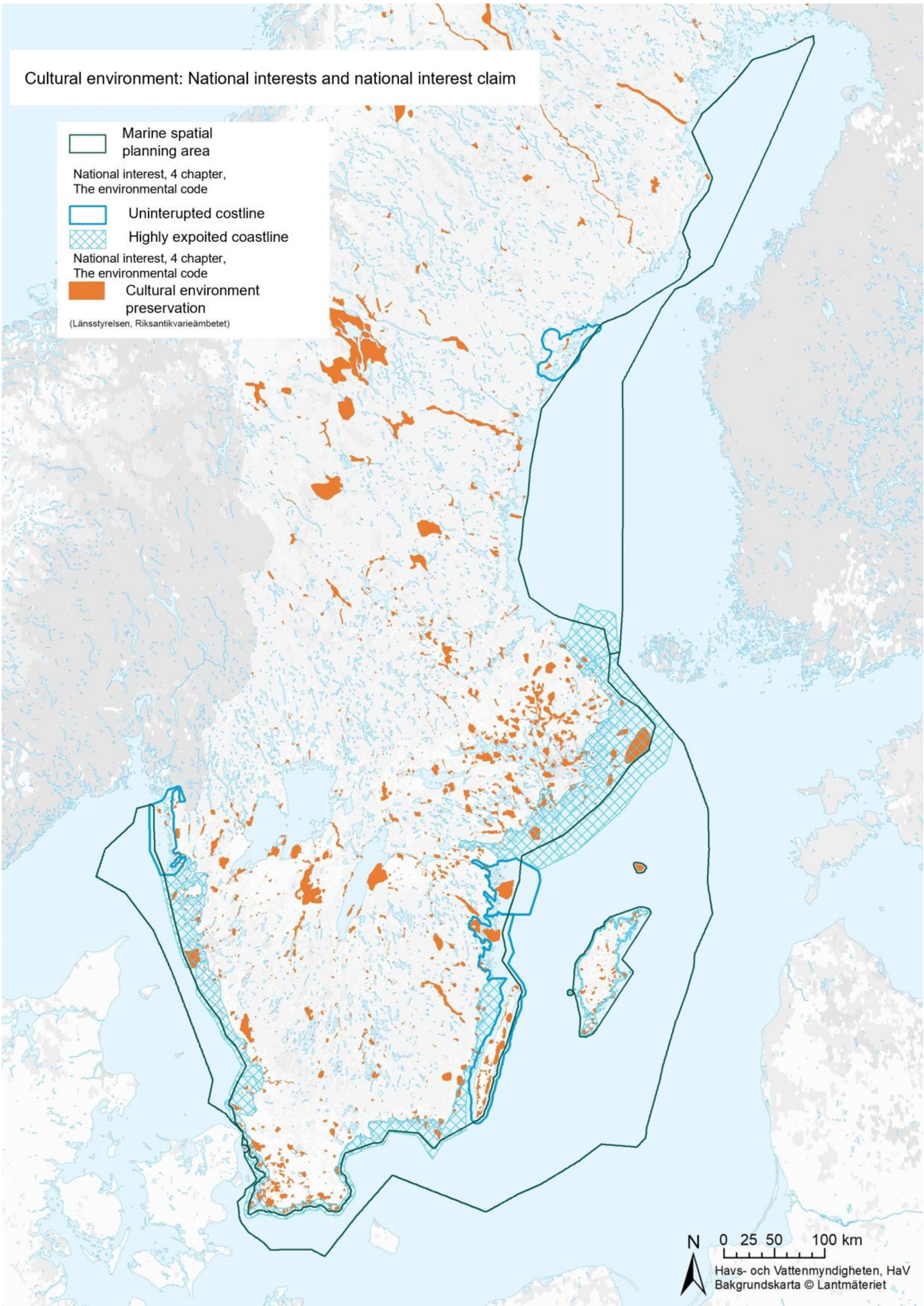


Figure 16. Map of national interest unbroken coast, high-exploited coast and national interest claims for cultural heritage conservation (Swedish Agency for Marine and Water Management, 2025).

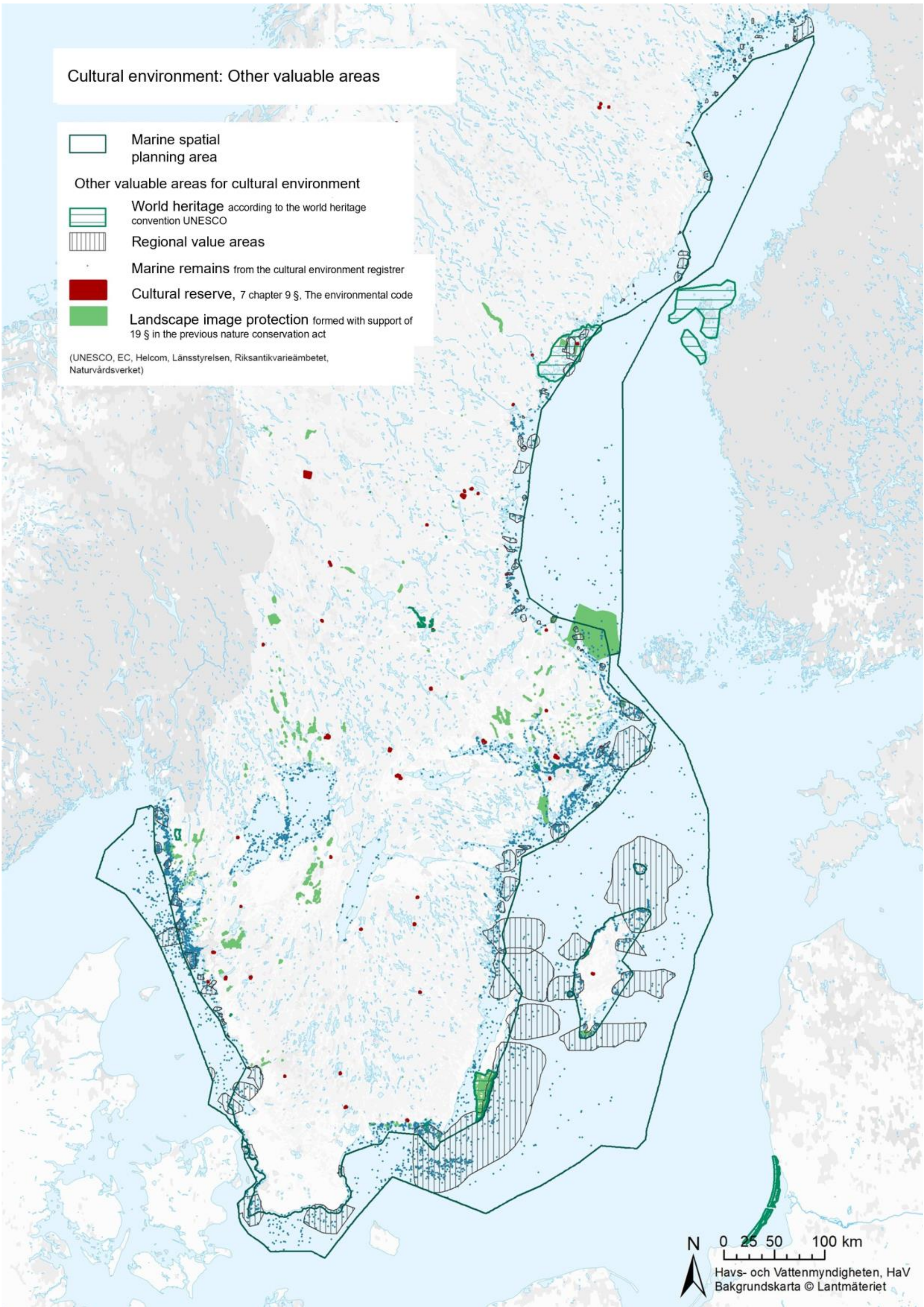


Figure 17. Map of other valuable areas for the cultural environment such as World Heritage Sites, regional value areas, marine archaeological sites, cultural reserves and landscape conservation (Swedish Agency for Marine and Water Management, 2025).

*Environmental effects and impacts linked to offshore wind power*

The establishment of offshore wind power can mainly affect cultural environments in two ways: a direct physical impact and an indirect visual impact. Direct impacts can occur, for example, through the interventions on the seabed that the establishment requires and which can thus affect marine cultural heritage, including marine archaeological sites. The impact area may be larger than the area occupied by foundations or anchorages, as connection also requires cabling and other infrastructure both in the sea and on land. There is generally high uncertainty about marine archaeological sites, and how they are affected by the establishment of offshore wind power. Lack of situational awareness, low information quality and antiquarian assessments risk causing damage to marine cultural environments. However, the risk that the establishment of offshore wind power would damage marine archaeological sites is considered low, as marine archaeological investigations and studies that should be done can contribute to an increased knowledge of marine cultural heritage, where more are often discovered and mapped.

The establishment of tall and large facilities can have an indirect, visual impact on a cultural environment and the historical function it is an expression of. In addition to the wind farm's dimensions, the complexity of the impact also lies in how the establishment is perceived and interpreted together with the cultural environment and its values. The conditions for assessing the impact on the cultural environment solely on the basis of proposed areas for wind power establishment are limited, as a complete assessment requires knowledge of the expression of each establishment (height, location, design, formation).

In the 2021 appropriation directions, the Government instructed the coastal county administrative boards to develop an appropriate planning basis for cultural environments in the national marine spatial planning (Regeringen, 2021a). In January 2024, the County Administrative Board of Västra Götaland presented the compilation of the appropriation directions assignment (RB2021:3B4, County Administrative Boards, 2024). The documentation clarifies which cultural values along Sweden's coastline may be affected by an expansion of offshore wind power. The document presents a selection of cultural environments along the Swedish coast in the form of so-called marine value areas, together with the county administrative board's recommendations on consideration needs for these. The value areas are based on national interests according to chapters 3 and 4 of the Environmental Code, World Heritage, municipally designated cultural environments, ancient and cultural historical sites on land and under the sea surface, landscape context, lines of sight, cultural and nature reserves, Natura 2000 areas, biosphere reserves and landscape image protection. At the same time, it should be noted that other cultural sites of regional and/or local interest may also need to be taken into account when planning an activity or establishment. Some county administrative boards have also chosen to update and assure the quality of the information on marine archaeological sites in the cultural environment register in connection with the assignment.

*Impact during construction, operation and decommissioning*

Table 9. Shows the type of impact from offshore wind power in relation to the cultural environment during different phases, as well as possible consideration measures for planning and planning that can reduce negative effects and consequences.

| Phase | Type of impact | Possible consideration measure |
|---|---|---|
| **Facility** | Physical impact on remnants | Location and design of the wind farm, as well as aspects such as height of the wind turbines. |
| **Operation** | Visual impact | Custom obstacle lighting |
| **Settlement** | Physical impact on remnants | No specific measure |

## 2.4. Management with water, land and the physical environment in general

### 2.4.1. Energy

*Government Mission on Revised Marine Spatial Plans and Energy Policy Objectives*

The starting point for proposals for amended marine spatial plans is Government mandate M2022/276 on expanded areas for electricity production from offshore wind power. Increased electricity production is needed to reach Sweden's climate and energy targets (see also Section 2.3.2, Climate), as well as to enable a green transition of industry and extensive electrification (Government 2022b).

The focus of energy policy means that planning for electricity use will be based on a need of at least 300 terawatt hours in 2045, which means approximately a doubling compared to the current situation. This, together with an energy policy goal that the composition of electricity production should be 100 percent fossil-free by 2040. The overall objective of energy policy is to create the conditions for efficient and sustainable energy use and a cost-effective energy supply with low impact on health, the environment and climate (Government 2024a).

Sweden is facing strong electrification, with an expected increase in electricity consumption from around 140 TWh to around 160-210 TWh by 2030 and in the longer term, by 2045 the electricity demand is expected to be in the range of 200-340 TWh. The range of future electricity needs depends on scenarios, high and low, and indicates uncertainties in forecasts for the pace of transition. The increase in electricity consumption is mainly due to the conversion of energy-intensive industries, new industries and electrification of the transport sector (Energy Agency 2023c).

The energy transition poses spatial challenges for the expansion of electricity production and grids to meet the increased demand. Offshore wind power also poses a challenge as power production is weather dependent and thus intermittent. The Government has given various authorities a number of government assignments in this regard. One assignment concerns developed regional and local energy planning for electrification, which has been submitted to the County Administrative Board of Västra Götaland and the Swedish Energy Agency (Regeringen, 2023a). In addition, two government assignments regarding intermittent power production were submitted to Svenska Kraftnät, the Swedish Energy Markets Inspectorate and the Swedish

Energy Agency. The assignments concern incentives for better power contribution, as well as the design and integration of intermittent power production (Government 2024b, Government 2024c).

In December 2024, the final report of the *inquiry Wind power in the sea - A transition to an auction system* was submitted. The inquiry's task was to analyse how the establishment of wind power can be improved and how the permit procedure for wind power in Sweden's economic zone can be more effective and clear. In addition, in a supplementary directive, the inquiry would also assess and take a position on whether Sweden should, in the long term, move to an instruction system for permitting offshore wind power and how it should be designed. The inquiry's conclusion and recommendation is that Sweden should switch to the allocation and auction system, rather than the current system. The inquiry justifies this on the basis that the current regulatory framework is not considered to be appropriate for the exploitation of the sea for offshore wind power (Government Official Reports, 2024).

*Current electricity use and production*

The development of the electricity system is central to achieving the green transition. Since the late 1980s, electricity consumption has remained relatively constant at around 140 TWh. Dominant end-uses of electricity in 2022 were residential and service sectors, as well as industry, see Figure 18 below.

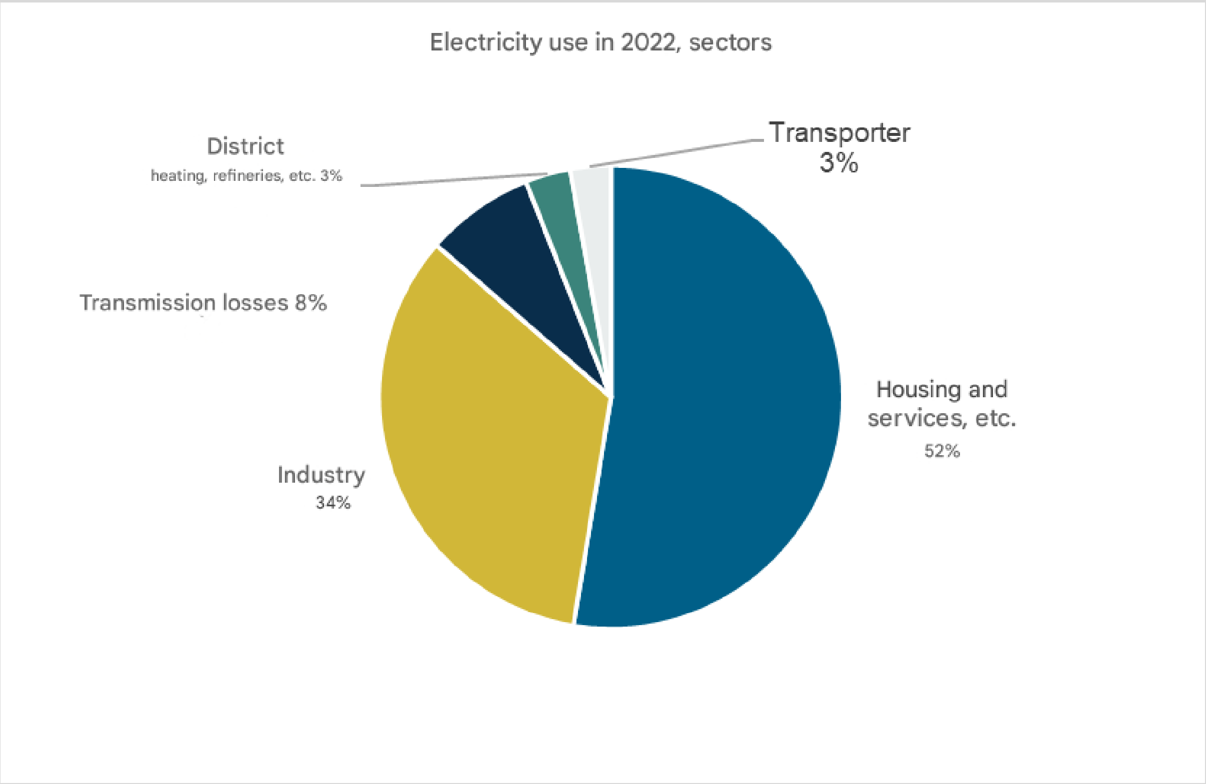


Figure 18. Electricity consumption by sector, 2022 share of TWh. Source Swedish Energy Agency, 2024.

Sectors where electricity use is expected to increase mainly due to the transition are the industrial and transport sectors. In terms of electricity use in industry in 2022, the main sectors were the paper and pulp industry, steel and metal works, followed by the chemical and engineering industries, see Figure 19 below.

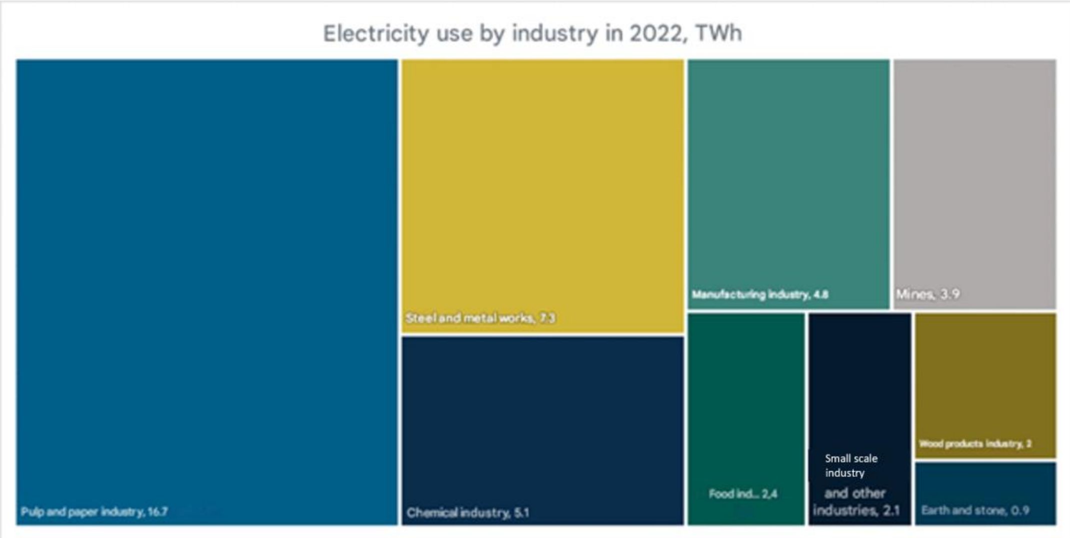


Figure 19. Industrial electricity use by industry, 2022 TWh. Source Swedish Energy Agency 2024.

As regards the transport sector and domestic electricity consumption, it remained relatively constant around 3 TWh, but slightly increased in 2022 to almost 4 TWh (Energy Agency, 2024). With targets for the transformation of the transport sector, it is assumed that the share of electricity as a fuel will increase in the future.

The government commission on offshore wind power mentions deficits in electricity production in southern Sweden, while electricity use in the area is relatively high. Where electricity is produced and consumed varies regionally. The highest electricity use occurs in the metropolitan regions, Stockholm County, Västra Götaland County, Skåne County, followed by Norrbotten County and Västernorrland County. In Västra Götaland, Norrbotten and Västernorrland counties end-users are mainly industrial and construction activities, in Stockholm and Skåne counties the predominant end-use is electricity use for other services - and single-family houses, see Figure 20 below.

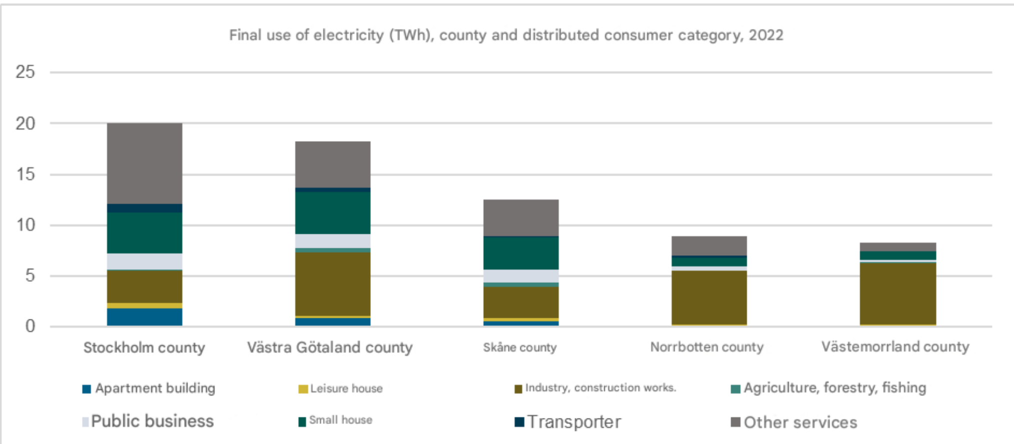


Figure 20. End-use electricity (TWh) for the counties of Stockholm, Västra Götaland, Skåne, Norrbotten, Västernorrland, distributed consumer category, 2022. Source SCB 2024.

The marine spatial plan describes the conditions for energy extraction in Sweden (part 6.1 *Prerequisites for energy extraction)* including the four bidding zones, from SE1 in the north to SE4 in the south. In northern Sweden there is currently a production surplus, and in southern Sweden a deficit. The bidding zones provide guidance on where more generation and electricity transmission is needed through different pricing. In 2024, a joint review of the zoning of EU bidding zones was ongoing. If the national decision-making body decides on a change, it can be implemented no earlier than 2027 (Svenska Kraftnät, 2024b).

Surpluses and deficits depend to some extent on the level of production. A larger share of electricity production takes place within bidding zone 2, followed by bidding zone 3, bidding zone 1 and bidding zone 4 (Energy Agency 2024, Electricity production per bidding zone). Electricityconsumption in each bidding zone is largely explained by consumption levels at regional level. Bidding zone 2 includes the metropolitan regions of Stockholm and Gothenburg. Electricity prices in all bidding zones, but mainly bidding zones 3 and 4, have been unusually high for a period due to, among other things, the geopolitical situation and high prices for fossil fuels, especially natural gas (the Swedish Agency for Marine and Water Management 2025).

*Offshore energy generation and transmission*

Offshore energy can be produced from wind, waves, currents, tides or a salinity gradient. In Sweden, offshore energy production is still carried out on a small scale and mainly as wind power. In 2022, Swedish wind power produced 33 TWh, of which the offshore turbines accounted for 0.6 TWh (Energy Agency, 2023d). There are currently three offshore wind farms adjacent to the marine spatial plans (Bockstigen (Gotland), Kårehamn (Öland) and Lillgrund), all located within the territorial sea. Kårehamn and Lillgrund are located in the marine spatial planning area. However, due to cartographic reasons, Kårehamn is not marked as an energy area in the plan map.

From an energy extraction perspective, there are several advantages of offshore wind power. Winds at sea are often both stronger and smoother than over land, making it possible to build efficient parks with a high production. Offshore wind power can provide electricity production in areas where there are restrictions on the establishment of other types of power such as onshore wind power. In this way, offshore wind power can provide a greater geographical spread of electricity production in Sweden. Higher costs for offshore wind compared to, for example, onshore wind make it difficult to achieve economic viability and may limit the deployment of offshore wind.

In the case of other offshore energy generation, the technology is new and largely under development. In Sweden, research, development and demonstration are carried out in wave power, as well as research in marine current power. Several private and public actors are preparing new experiments with ocean energy in Swedish waters (International Energy Agency, 2023). Today, there are several wind power projects that highlight the possibility of producing hydrogen with the electricity generated by wind power, either in the plant itself or on land. On-site production requires additional offshore infrastructure, either for ships to receive and load hydrogen, or gas pipelines to shore. There is currently no hydrogen production in the Swedish marine spatial planning area. With regard to natural gas, there is currently a pipeline between Malmö and Denmark that supplies the western Swedish natural gas network. Two parallel lines run between Russia and Germany through Sweden's economic zone (Nord Stream) and another line between Poland and Denmark (Baltic pipe) which may also affect the Swedish exclusive economic zone.

*Environmental impacts and impacts linked to offshore wind energy*

Environmental effects from offshore wind power, includes environmental effects in the form of the addition of fossil-free energy for electricity supply, as well as the impact on land and water where the wind farm is established. Land claims for wind power affect the surrounding environment and people. Energy extraction also indirectly affects land and water use in the sea and on land, relating to infrastructure for the construction, maintenance and decommissioning of wind turbines, as well as surfaces for electricity distribution, cables and transmission networks. The actual surface requirement for construction, for example, is difficult to assess as it depends on a number of different factors, such as the size of the project, technology choices, distance to land, use of ports nationally or abroad, and other factors. See section 6.1 on prerequisites for energy extraction in the planning document (Swedish Agency for Marine and Water Management 2025).

The impact varies between the construction phase, the operational phase and the decommissioning phase. The impact during the construction and decommissioning phase is temporary, and mainly concerns bottom impact and noise. The imprint is also of a different nature depending on the type of foundation.

Bottom-fixed foundations are anchored in place either by drilling, piling or suction cup anchors into the seabed, or by gravity foundations. Today, bottom-fixed foundations are used down to about 70 meters depth, but experiments occur in deeper waters. Floating foundations can be used in front of bottom-fixed at depths of at least around 50 meters, and anchored to the bottom with ropes or chains. The floating wind power has a significantly larger footprint in the water column compared to the bottom fixed, since cables and power cables need to be several times longer than the distance between the turbine and the bottom. The different types of foundations have approximately the same impact on the bottom (Energy Agency, 2023a). During the operation phase, some noise occurs, but the effects of this are not clear. Birds and bats are at risk of being affected by collisions, but some species may also suffer habitat loss as they avoid the wind farm and seek food elsewhere. The cable laying entails physical impact on the benthic habitat as well as turbidity and electromagnetic radiation. A potential positive effect of wind power is that the foundations can act as artificial reefs and attract different marine species, such as fish and marine mammals (Bergström et al., 2022). Wind power also affects the conditions for other industries such as commercial fishing, shipping and air traffic.

Which environmental effects and impacts actually occur depends on the possibility of coexistence and for adaptations, possible consideration measures of wind farms or activities. For more information see the respective sections in Chapter 2 Conditions and environmental effects.

*National interests and the marine spatial plan's guidance energy*

The Swedish Energy Agency decides on national interest claims for installations for energy production and distribution in accordance with Chapter 3, Section 8 of the Environmental Code. The Swedish Energy Agency has been tasked with updating its national interest claims (Regeringen, 2024e). Appropriate areas for energy extraction reported in 2023 are seen as a basis for the designation of new areas of national interest (Energy Agency 2023a).

The claims for energy production in the marine spatial plan area include wind farms and are based on criteria for annual average wind, depth and area size. National interest claims for energy production were developed in 2013, and technology development in wind power has been rapid since then. Technological development since 2013 means that today there are more areas that have suitable properties for wind power compared to when the national interest claims were decided.

The marine spatial plan's guidance of energy areas takes into account uncertainties regarding feasibility in time, economic and spatial conditions and with regard to various interests such as defence, culture and nature values and adaptations to shipping safety zones. The plan proposal does not, for example, provide guidance on specific safety distances to shipping routes and the realisation within each energy area thus needs to be spatially and surface-wise adapted to any surrounding shipping routes, as well as to other interests and guidance on particular consideration for defence, cultural environment and nature values. The planning takes into account different conditions regarding the realization of wind power based on depth, technology and economic conditions. In the latter case, economic conditions, it is mainly about the anchorage and foundation of the wind turbines, bottom-fixed and floating. In the short term, bottom-fixed foundations are expected to have greater feasability, in terms of forecasts for technology development and profitability for investment. While floating foundation wind turbines are likely to be realizable only in the slightly longer term.

Within the territorial sea, the marine spatial plan coincides with municipal planning. Municipalities point out areas of wind power in their comprehensive planning in accordance with the Planning and Building Act (2010:900).

*Achievement of objectives, national and municipal interests - energy*

The assignment to expand the areas for energy extraction in the marine spatial plans is based on the large electricity demand that the ongoing electrification and industrial transition entails, and that there is currently a shortage of electricity production in southern Sweden. The marine spatial plan's guidance is that it should be possible to use areas for energy production so that it corresponds to a total of 120 TWh of annual electricity production in the three marine spatial plans together. This means that the plan includes a certain margin based on adaptation needs during realisation, for example with regard to the safety distance to shipping to be taken into account.

According to the Marine Spatial Planning Regulation, marine spatial plans are to contribute to national environmental, industrial and social objectives, of which energy policy objectives form part. With the plan’s guidance and marine spatial planning objectives of creating the conditions for regional development, as well as creating the conditions for energy transmission and renewable energy extraction in the oceans, the plan’s guidance on energy contributes to the *national strategy for sustainable regional development* (Government, 2021b). The strategy includes a number of priorities and provides guidance for the implementation of the Ordinance on Regional Development Work (2017:583). Marine spatial planning contributes to the prioritisation of spatial planning, *for equal opportunities for housing, work and welfare throughout the country*, as well as to the prioritisation of the climate and environmentally sustainable economy, based on the plan’s guidance on offshore energy extraction. Through guidance on nature and particular consideration for high nature values, the marine spatial plan also contributes to the strategy’s priority of reducing climate impact, as well as preserving biodiversity and ecosystem services in a changing climate. The plan’s guidance on energy also contributes to the national strategy’s priority on the establishment, production and use of renewable energy. This is significant for households and the transformation of the industrial and transport sectors, important conditions for competitive industries and employment, both directly and indirectly. For more information on marine spatial planning objectives and national strategy for sustainable regional and its priorities, see section 1.1, marine spatial planning and objectives of the marine spatial plans and section 6.3 Assessment to other plans and programmes.

Employment linked to offshore wind energy means on the one hand direct jobs during the phases; the development, design and production of turbines and foundations, as well as the design, construction, operation, maintenance and decommissioning of wind turbines, and more indirectly through the supply of skills, as well as contributions to energy supply and other business development, industrial conversion, maintenance and job creation. The contribution of offshore wind to employment is difficult to quantify, but there are many links between offshore wind and other parts of society and industry. The wind power industry is international and employment is distributed internationally between countries, regionally and locally. The number of jobs varies during the different phases, more jobs during the construction phase, lower but higher proportion of regional jobs for operation and maintenance (Energy Agency 2024).

Energy supply is also classified by the Swedish Civil Contingencies Agency (MSB) as an important social function. The societal function refers to the ability to meet society's electricity supply needs. The function covers the production, transmission, distribution and trading of electricity and activities to maintain or ensure the important societal function are examples, control and monitoring as well as maintenance and repair of infrastructure. Important activities are significant activities for society's basic needs and security and constitute an important starting point in the work on accident protection, crisis preparedness and civil defence (MSB, 2021). There may also be a potential increased vulnerability under the current political security situation in the Baltic Sea, regarding the challenges of protecting and guarding infrastructure far out at sea, especially outside the Swedish territorial sea (Energy Agency, 2023a).

### 2.4.2. Recreation

*Current situation, conditions and development*

Recreation and tourism in and by the sea include nature, culture and landscape experiences and various outdoor activities. Recreation is dependent on several conditions. It is about having sufficient access to natural and cultural environment areas of good quality where it is possible to exercise recreation. The areas also need to be accessible, both physically and experientially, to the outdoor enthusiast who can be both local or out of town. The starting point for the use of recreation in the marine spatial plan is based on national interest claims for recreation in accordance with Chapter 3, Section 6 of the Environmental Code. National interest in mobile recreation, Chapter 4, Section 2 of the Environmental Code, which extends along the coast of Bohuslän, Halland, the archipelago of Östergötland, Gotland, Södermanland and Stockholm, the High Coast and Norrbotten, shall also be taken into account. In these areas, the interests of tourism and recreation, primarily mobile recreation, shall be particularly taken into account in development. National interest claims for recreation consist of areas that are considered to have particularly good conditions for people to have enriching experiences in the natural environment and areas used by many people. Other areas of national interest also have a bearing on recreation, especially the coastal areas and archipelagos referred to in Chapter 4, Sections 3-4 of the Environmental Code, but also areas related to cultural environments include values for recreation.

Outdoor activities and recreation occur to some extent in the marine spatial planning area, mainly at embankments, but to a greater extent along the coasts. Popular outdoor activities at sea and in coastal areas include boating, recreational fishing, coastal hiking, swimming, diving and paragliding. The waterborne recreation consists mainly of recreational boats and recreational fishing. Recreational craft are found in a total of 16 per cent of Swedish households and the total number amounts to approximately 865,000 recreational craft nationally (Transportstyrelsen, 2021). Recreational shipping moves mainly inshore or near the coast. Self-adapted routes outside fairways are common. Some pleasure boat traffic also occurs on the open sea, such as sailing routes to and from larger islands or in the waters outside archipelagos, major cities and pleasure boat ports (Sjöfartsverket & Transportstyrelsen, 2023). There are also important routes to Denmark, Åland and Finland. In 2021, recreational fishing was carried out by approximately 1.5 million Swedish citizens between the ages of 16 and 80, of whom approximately 30 per cent of the recreational fishing days took place in marine waters (Swedish Agency for Marine and Water Management & Statistics Sweden, 2022).

The land-based and coastal recreation can offer activities such as swimming, hiking and camping. Areas that are designated as national interest for recreation are areas that can offer qualities such as undisturbedness, low noise and views towards the horizon or interesting and unique landscape views. Interest in recreation gained a boost during the pandemic years and is expected to gain increased importance in the future. The tourism industry is also expected to continue to increase after a downturn during the pandemic, and domestic tourism is an increasing part of tourism in Sweden (Tillväxtverket, 2022). A healthy sea and functioning ecosystem services are a prerequisite for functioning recreation, while recreation and tourism can have a negative impact on the environment. Climate change can affect the conditions as a warmer climate can threaten icing in the Gulf of Bothnia and shorten the tourist season in winter, while a warmer climate can at the same time attract visitors. Either because it gets warmer in Sweden or because Sweden is a cooler alternative to holiday in when other parts of the world get warmer. Changes in sea temperature and salinity affect fish stocks and conditions for recreational fishing, and in Skåne, for example, land subsidence together with sea level rise can contribute to increased beach erosion. Extreme weather and the establishment of invasive species as a result of climate change can also have a negative impact on recreation.

*Environmental impacts and impacts linked to offshore wind energy*

Recreation is a use in the marine spatial plan that can generate environmental effects and also be affected by other uses. Outdoor activities need access to a healthy sea, but the activities can also have a negative impact on the environment. Motorised traffic at sea contributes to emissions and underwater noise, as well as various types of antifouling paint can contribute to pollution. The construction of docks and ports affects valuable shallow ecosystems, and coastal recreation causes littering. Further examples are the addition of nitrogen and phosphorus discharges from holiday homes' wastewater that contribute to eutrophication. The effects of pressures vary between both location and time (Moksnes et al., 2019; Törnqvist et al., 2020).

Coastal recreation and outdoor activities can be affected by marine spatial planning guidance on uses in various ways, for example directly by restricting access to areas for the benefit of other uses, such as shipping, defence or energy extraction, but also indirectly through visual impact and interference. For offshore wind turbines, the public is mainly concerned about the potential negative impact on outdoor activities on the coast, despite the fact that they would rather see offshore wind energy than on land (Prince et al., 2024). The distance between the coastline and wind turbines is of great importance. However, the perception of the visual impact of wind power is subjective and does not by definition have to be negative. Despite some negative perceptions of the visual impact of offshore wind power, there are also positive perceptions of development and contribution to sustainable development and energy independence. Research also suggests that tourists who engage more in outdoor activities tend to have more positive views about wind power (Prince et al., 2024, Bolin et al., 2021).

An energy area that overlaps with an recreation area risks restricting or displacing people from staying there. This applies mainly to recreational boating and recreational fishing. An energy area can be a real obstacle and increase the risk of recreational craft that, for example, need to enter land quickly in bad weather conditions or other emergency situations or are forced to take alternative routes. There are different rules for how close different boats may come to an offshore wind farm, and there are also uncertainties linked to insurance issues and rescue at sea that are relevant to consider in terms of consequences for recreational boat traffic. Indirect forms of impact can be that the energy area interferes with the experience itself, either through visual impact or interference from noise and increased traffic, but also linked more to direct impact in the form of navigational interference from light and reflections. The extent of the impact can primarily be influenced by the experiential values and natural conditions that exist in the area. Experiential values that risk being particularly affected by energy establishment are pristineness (absence of interventions in the landscape), stillness and silence, an appealing landscape image with a view of the landscape and water, and whether the landscape is varied or unique. The degree of impact may also vary depending on how exploited the landscape is in general. Most of the coastal nature areas are currently rated to have very good sound environment classes (Noise forecast, 2024). When offshore wind power is established, this classification can potentially be changed to an inferior sound environment classification for coastal natural areas.

### *Impact during construction, operation and decommissioning*

Table 10. Shows the type of impact from offshore wind power in relation to recreation during different phases, as well as possible consideration measures for planning and planning that can reduce negative effects and consequences.

| Phase | Type of impact | Possible consideration measure |
|---|---|---|
| **Facility** | Increased traffic<br>Noise | Location and design of the wind farm, as well as aspects such as height of the turbines.<br>Clear transit passages and safety distances |
| **Operation** | Visual impact of wind turbines<br>Visual impact of obstacle lighting<br>Limited availability for pleasure boats | Custom obstacle lighting. |
| **Settlement** | Increased traffic | No specific measures. |

### 2.4.3. Tourism

*Current situation, conditions and development*

The coastal tourism industry is a nationally significant industry and has enjoyed steady growth since the early 2000s. Tourism's contribution to Sweden's GDP has been around 2.5 per cent for a long period (Swedish Agency for Economic and Regional Growth, 2022). The pandemic years had a negative impact on the tourism industry, but according to accommodation statistics, they appear to have recovered to levels comparable to those in 2019 (Swedish Agency for Economic and Regional Growth, u.y.). For many municipalities, the tourism industry accounts for an important part of the local economy (Boverket, 2024). Compared to other industries, the tourism industry employs more women, young people, the low-educated, low-income earners and people with a foreign background (Sweco, 2023).

Marine tourism consists, for example, of trips by cruise ships or passenger ferries, overnight stays either in coastal hotels or in holiday homes, as well as activities such as recreational fishing, swimming, diving and boating (Söderquist et al., 2012). More than 50 per cent of the number of guest nights in Sweden were spent in the coastal area (the Swedish Agency for Marine and Water Management, 2023c), indicating that marine and coastal tourism is a significant part of the national tourism industry. The tourism industry is the maritime industry that grows the most in relation to other more industrially oriented maritime industries (Swedish Agency for Marine and Water Management, 2023c), and it is also the maritime industry that is the largest in terms of employment (Swedish Agency for Marine and Water Management, 2018b). The coastal and marine tourism industry is often linked to the natural environment, and is dependent on good environmental status of the marine environment and the production of cultural ecosystem services (Swedish Agency for Marine and Water Management, 2024a). Marine tourism is one of the economic activities affected by a deteriorating marine environment. Good environmental status in the sea is positive for the ocean's ability to deliver ecosystem services, which is a prerequisite for people's experiences at the sea. In the socio-economic impact assessment of the first action programme for the marine environment from 2015, an estimate was made showing potential incremental benefits to the marine tourism sector of SEK 4.9 billion per year for a scenario where good environmental status is achieved in the marine environment (Swedish Agency for Marine and Water Management, 2015c). The attractiveness of a coastal area for both residents and visiting tourists is also dependent on the experiences of individuals, such as the presence of cultural environments and visual aspects of nature and landscape (LTU, 2023).

Areas that in their entirety are of national interest are dealt with in Chapter 4 of the Environmental Code (1998:808). Through Chapter 4, Section 2 of the Environmental Code, large parts of the Swedish coast are of national interest for mobile recreation and tourism, meaning that these interests must be taken into account in particular when assessing the admissibility of development companies or other interventions in the environment. There are points of contact for aspects that are important for recreation and those that are important for the tourism, good accessibility, good water quality and a rich plant and animal life are a couple of examples. Values that form the basis of tourism are in many cases strongly linked to values for recreation but also the landscape and the natural and cultural environment values that exist there, which means that other national interests are also of importance to the tourism industry, such as Chapter 3, Section 6 of the Environmental Code concerning recreation, nature conservation and cultural environment conservation. National interest claims relating to commercial fishing may also have some significance for the tourism industry linked to recreational fishing. Areas that are attractive to visit are important for regional development through the tourism industry. In Sweden, there are recreation policy objectives whose purpose is to support people's opportunities to spend time in nature and exercise recreation. One of the ten objectives is of particular relevance to the tourism sector, *Sustainable regional growth and rural development*. The goal means that outdoor activities and tourism contribute to strengthening local and regional attractiveness and contribute to strong, sustainable development and regional growth (Naturvårdsverket, 2023b). Clarifications in the case concern, for example, an expanded market for nature and cultural experiences, improved infrastructure and accessibility, and the promotion of sustainable business.

The tourism industry is expected to continue to grow and develop. An increased amount of visitors can mean an increased pressure on the environment in the form of physical pressure, disturbance of plant and animal life, littering and emissions to water and air. Digital and technological development can both contribute to the pressure by increasing accessibility to different areas, but also contribute to a lower impact by, for example, offering simulated experiences that reduce the need for physical presence.

Climate change may affect the tourism industry. A warmer climate on the continent can increase interest in the relatively cooler climate that Sweden can offer and thus account for increased tourism (Tillväxtverket, 2024). While, for example, sea level rise and coastal erosion can generate a negative impact on the tourism industry (Boverket, 2024).

*Environmental effects and impacts linked to offshore wind power*

Tourism can, in different ways and to different degrees, have a negative environmental impact through activities that generate marine litter, physical loss, physical or biological disturbance, nutrient inputs and emissions to air and water.

Offshore wind power can affect the hospitality industry and tourism by creating a visual impact. This can be perceived as negative, especially in areas that are considered to be scenic, where free horizons and views towards the open sea are distinctive. Another visual aspect is light pollution, especially during the night. The extent of the visual impact depends to a large extent on the visibility of the wind turbines. According to a research review done by Luleå University of Technology to investigate the effects of offshore wind power on the tourism industry, it is concluded that a distance of 35 kilometers should be enough to minimize predominantly negative experiences from the visual impact of offshore wind power (LTU, 2023). Whether the impact is actually negative or possibly positive depends on the perception of individuals. According to a report from Vindval, which examined the impact of wind power on nature tourism and experience values, wind turbines generally do not deter tourists from visiting a destination (Prince et al., 2024). The results showed the importance of previous opinions about wind power and how it affects attitudes, feelings and behavioral intentions around areas with visible wind turbines. The study further suggests that tourists who engage in a physically demanding outdoor activity are less likely to notice the wind turbines. The results are based on studies on onshore wind power and a research project to better understand how offshore wind power affects tourism has begun and will be presented in early 2027.

Previous studies on offshore wind power show that some perceive wind turbines as elegant and as positive for sustainable development (LTU, 2023). Factors such as age, level of education and attitude towards offshore wind power can affect an individual's perception. Furthermore, those with previous experience of wind farms tend to be more positive. There are also examples of how wind power establishments have become part of the local tourism industry, with, for example, a tour boat out to the wind farm (Glasson et al. 2021). Studies have also shown that people who engage in recreational fishing have positive experiences of wind farms, the explanation for this is that they are displacing commercial fishing (LTU, 2023). Further studies conducted on offshore wind have shown that visual impacts from nearby wind power do not affect the choice of holiday location for a majority of respondents (Scottish government, 2022; Teisl et al., 2018). However, a few indicated that they would choose not to visit an area built with offshore wind power. Studies have also been able to show that a majority of those who respond that they would refrain from visiting one beach because of visible wind turbines would choose to visit another beach instead (LTU, 2023). From a national perspective, such relocation does not therefore constitute a negative impact on the tourism industry, but on the other hand there is a risk for individual businesses from a local perspective. At the same time, the establishment of offshore wind power is expected to lead to increased local and regional energy production, which is positive for the regional industry as a whole, but also for parts of the tourism industry.

The marine spatial plans do not directly guide the use of tourism, but there is guidance for outdoor activities and cultural environments, which also concern areas that are important for the tourism industry. Furthermore, there is a general analysis of the potential impact of the marine spatial plan on the tourism industry in each marine spatial plan area. Through an ecosystem services analysis, it is also made visible how the environmental effects highlighted in the assessment can in turn affect ecosystem services that are also of importance for economic and social interests. The tourism industry is an example of such an interest, in which cultural ecosystem services in particular are important.

### 2.4.4. Defence

Defence is activities that are needed to prepare Sweden for war. Defence consists of military activities (military defence) and civilian activities (civil defence). Civil and military defence are mutually reinforcing. Civil defence refers to the civilian activities that authorities, municipalities, regions, individuals, companies, voluntary defence organisations and civil society, among others, take to prepare Sweden for war. Military defence refers to the activities carried out by the Armed Forces with the support of defence authorities, parts of the voluntary defence organisations, as well as parts of the defence industry and other relevant parts of the business sector, in order to act as a deterrent to war and to prepare Sweden for war.

*State of play and environmental impact – military defence*

The Swedish Armed Forces is the sectoral authority for the military component of the defence in accordance with ordinance (1998:896) on land management and shall therefore appoint national interest claims for areas needed for the military installations of the defence (according to Chapter 3, Section 9 of the Environmental Code). These areas include shooting and training grounds, airports, marine exercise areas and technical systems and facilities that need to be protected from influences that may restrict the activities of the armed forces. The Swedish Armed Forces' claims also include the activities of the Swedish Defence Radio Establishment, the Swedish Defence Research Agency, the Swedish Defence Materiel Administration and the Swedish Fortifications Agency. There are also national interest claims that are covered by secrecy and are classified and therefore cannot be reported on an open map or in any other way. The Swedish Armed Forces' main task is to defend Sweden and allied states against armed attack on the basis of collective defence within NATO (Regulation 2007:1266). Furthermore, the Armed Forces shall promote national security, support civilian defence activities and identify external threats to Sweden.

The activities of the military defence can affect areas in the marine spatial plans, but it is also an interest that can be greatly affected by wind power installations. Military exercises conducted in designated areas, both below and above the water surface, cause pollution by the introduction of metals into the marine environment. In addition to physical impact, firing and explosive drills, as well as to some extent aircraft and ship drills, cause underwater noise. The impact on marine life varies; during spawning periods for fish and breeding and incubation periods for birds, the impact on wildlife may be more severe. However, the Swedish Armed Forces have a need to exercise even at these times and have therefore developed a marine biological calendar to be able to plan exercises with regard to marine life.

*Impact linked to offshore wind energy*

In terms of the impact of energy expansion, there are both positive and negative potential consequences. For the Armed Forces, security of energy supply is of great importance, and robust energy supply is also one of NATO's basic requirements. Energy supply is thus relevant for the defence, and even the military part of the defence is expected to electrify parts of its operations in the longer term (Nykvist & Mårtensson, 2021). The open national interest claims that are designated for the military part of the defence in marine areas can be, for example, marine shooting areas, blasting areas and marine exercise areas that are used to maintain and develop the capability for armed combat at sea. Marine exercise activities need to be able to be carried out in different sea areas with different hydrological and topographical qualities, such as varying depths, bottom formations, turbidity and salinity which can affect navigation, visibility and other aspects. There needs to be a variation in areas corresponding to different types of conditions in Sweden's territory, which also includes weather conditions and proximity to coast and land.

Each designated energy area constitutes a unique restriction on the military defence's ability to use both the situation and the natural conditions, which needs to be assessed by the responsible experts in a holistic perspective. Furthermore, large parts of the marine exercise areas are also used as air exercise areas, which means that freedom from obstacles is a prerequisite. Consequences for the military defence of wind power installations in sea areas also include a challenge regarding the safety of both own operations and civilians staying within or near the exercise area.

The national interests that are classified in accordance with Chapter 15, Section 2 of the Public Access to Information and Secrecy Act (SFS 2009:400) may include infrastructure relating to signals intelligence, telecommunications and surveillance of air and sea space. Wind power installations may affect technical systems such as reconnaissance radars, weather radars, radio communications, signal reconnaissance and underwater sensors (Odell et al., 2022). (The term "military part" also includes civilian authorities that support the Armed Forces, such as the Swedish Defence Research Agency (FOI), the Swedish Defence Radio Establishment (FRA), the Swedish Fortifications Agency and the Swedish Defence Materiel Administration (FMV)).

The consequences for the defence's operations of an individual energy area can vary between very serious damage to the fact that the consequences are so mild that coexistence is possible under specific conditions and with certain consideration measures. The Swedish Defence Research Agency (FOI) has, on behalf of the Swedish Armed Forces and the Swedish Energy Agency, proposed measures that could lead to increased coexistence between wind power and military defence activities; the measures fall within the categories of strategic planning and geographical location of wind power in areas that do not affect the military component of defence (Odell et al., 2022). The report presents international examples of consideration measures for coexistence that are not applicable in a Swedish context at present. The Armed Forces' assessment is that a developed planning process is the most appropriate option to support coexistence between the Armed Forces' interests and offshore wind energy development (Swedish Armed Forces, 2022).

*Impact during construction, operation and decommissioning*

Table 11. Shows the type of impact from offshore wind power in relation to defence during different phases, as well as possible consideration measures that can reduce negative effects and consequences.

| Phase | Type of impact | Possible consideration measure |
|---|---|---|
| **Facility** | Increased traffic | Adapt to the activities of the defence |
| **Operation** | Limits airspace and affects technical equipment | Possibility for air traffic controllers to regulate the operation of wind turbines<br><br>Development of technical solutions in the Armed Forces' systems, and wind turbines. |
| **Settlement** | Increased traffic | Adapt to the activities of the defence |

*Civil defence and the impact of offshore wind power*

Sweden's civil preparedness is about the ability to prevent and manage disasters, crisis situations, danger of and war. The capacity is created throughout society, by authorities, municipalities, regions, businesses and volunteers in the population. The Swedish Civil Contingencies Agency (MSB) is responsible for identifying claims of national interest. The national interests of the civil defence can complement other national interests where, for example, a port that is not particularly important in terms of, for example, commercial fishing, can have a strategic and important role in the event of war.

Offshore wind power can directly or indirectly affect the conditions of civil defence in various ways. Access to energy is a prerequisite for Sweden's preparedness. Offshore wind energy is an important component of the energy transition and has the potential, through its spread, to create a secure energy supply that contributes to a stronger civil defence.

The proposed energy expansion could also have an impact on the preparedness of the civil protection sector and on the protection of civilians, in particular at sea. The Swedish Civil Contingencies Agency is the sector responsible authority and the preparedness sector also includes the Coast Guard, the Swedish Maritime Administration, the Swedish Police Authority, SMHI, the Swedish Radiation Safety Authority and the county administrative boards. Offshore wind turbines and other fixed installations are physical barriers to shipping, which can increase the risk of accidents as well as possibly complicate rescue operations in the vicinity of the wind farms. At present, it has not been investigated how an individual park could affect the civil defence related to sea rescue operations. The design of the park, the height and distance between wind turbines are factors that affect the possibility of carrying out rescue operations.

Furthermore, there are uncertainties that large-scale wind farms are a new phenomenon in Swedish waters, knowledge, skills and experience regarding how the parks affect locally, how to navigate around them and where it is safe to anchor when needed.

The wind turbines may affect ocean currents (study on the hydrological impact of wind power is ongoing in collaboration with SMHI, delivered in autumn 2024), which in turn could affect how chemicals or oil spread in the event of an accident.

*Risks linked to offshore wind energy and the security situation*

The security situation is influenced by several different factors, of which energy is an integral part. The Swedish Armed Forces notes a complex external development and an uncertain threat picture in various domains. Russia’s full-scale invasion of Ukraine has affected the security situation and made events more unpredictable, including rapid technological developments and the cyber-information environment, which pose new security policy challenges.

Energy is an integral part of geopolitics and a shift from fossil to renewable energy provides in some respects more secure energy access, but also creates new dependencies and security risks. Just as fossil energy sources have been used as a tool for political pressure, offshore wind power can also create new dependencies that can affect the security situation and create corresponding geopolitical power struggles as those associated with fossil resources.

Sweden's entry into NATO places new demands on capacity expansion and capability development that could be affected by large-scale offshore energy expansion. The Armed Forces are facing the most extensive rehabilitation in 50 years, which means that access to a stable energy supply is essential, but also that security risks and obstacles to development are minimized. Large-scale offshore wind power can pose both obstacles and security risks, and the consequences of proposed energy areas from a security policy perspective need to be analysed and assessed by the Swedish Armed Forces and other relevant authorities.

In the construction of offshore wind turbines, exploitation of the seabed takes place, both when anchoring the turbines and when cabling to land. According to the Swedish Armed Forces, the exploitation of the seabed poses increased security risks as there are several types of critical infrastructure (Swedish Armed Forces, 2024). Digitalization has made society very vulnerable to disruptions in electricity and IT networks, sabotage of infrastructure such as power cables, fibre cables and underground pipelines can have serious consequences and also constitute strategic targets for attackers.

The Swedish Armed Forces sees risks that a significant part of Swedish energy production, with associated infrastructure and transmission capacity, may in the future take place outside Swedish territory (Swedish Armed Forces, 2024). Fourteen energy areas are listed in whole or in part in the territorial sea and ten areas in Sweden's exclusive economic zone. Areas in the territorial sea and the exclusive economic zone account for 20% and 80% respectively of the total area used for energy extraction in the proposal. The expansion of energy production in the Swedish exclusive economic zone poses challenges and difficulties, as well as for other critical infrastructure, when it comes to protecting and monitoring this infrastructure.

### 2.4.5. Shipping

*Current situation, conditions and development*

Shipping is an important part of Sweden's transport infrastructure and a significant engine for the country's industry and economy. For domestic freight transport, shipping accounts for about one third of transport measured in tonne-kilometres. The dominance of shipping is even more pronounced in foreign trade, where around 90 per cent of export goods are transported at least partly by ship (Swedish Agency for Marine and Water Management 2024). It plays a significant role in Sweden's trade and accounts for about 70 per cent of Sweden's foreign trade (Sjöfartsverket, u.å.). As an example, in 2023 160 million tonnes of cargo were handled over Swedish quays, 87 % of all cargo handling in Swedish ports concerned international cargo (Traffic Analysis 2024).

Passenger traffic is also significant. Annually, ships and ferries transport people to and from Swedish ports and in 2023 approximately 22 million passengers travelled from Sweden to a foreign port (Traffic Analysis 2024). Traffic is vital for both international connections and domestic transport between islands and the mainland.

Maritime transport has a broader meaning beyond transport, based on aspects such as:

- Security of supply; It is critical for the civilian defence’s supply chain needs and constitutes an important societal function in both everyday life and crisis (Swedish Civil Contingencies Agency 2021).
- Economic importance; The maritime industry has annual sales of approximately SEK 85 billion and accounts for approximately 1.7 per cent of total net sales in the Swedish business sector.
- Regional development and employment: Shipping is concentrated in the metropolitan regions of Gothenburg, Stockholm and Malmö/Helsingborg, where it serves as an important industry and employer. For coastal municipalities, ports and shipping are often a central part of the economy. This includes, among other things, cargo handling and supply chains, such as for raw material-intensive export industries.
- Regional development and accessibility. Shipping is also important in terms of accessibility, accommodation and service. For example, freight and passenger ferry services are important for tourism and commuting, within and between municipalities and in some cases also between countries.
- Shipping also has the potential to become an important part of a long-term sustainable transport system.

Shipping is thus of national interest and national interest claims for shipping are identified by the Swedish Transport Administration. National interest in shipping includes both ports and shipping lanes that are considered to be of national importance. The vessels operate mainly in an extensive network of shipping lanes and routes, as well as in adjacent areas based on suitability, for example, depending on weather conditions and destination.

*Gulf of Bothnia*

For the plan area, maritime traffic is slightly less intensive, compared to other plan areas, but still frequent and important traffic to ports and shipping routes takes place within the plan area and between Sweden and Finland. For example,Norrland's industries rely heavily on maritime transport to reach consumers in Sweden and abroad, with extensive traffic to both Swedish and Finnish ports. Maritime transport in the plan area, especially in the North Bothnian Sea and the North Kvarken, faces several challenges:

*Navigation conditions*
Limited manoeuvrability due to depth conditions and narrow passages. Multiple Traffic Separation Systems (TSS) to manage complex waters.

*Winter conditions and winter navigation*
During normal winters, the entire Bothnian Bay and large parts of the Bothnian Sea, including the North Kvarken, freeze. Ice formation does not usually extend to the entire southern part of the Gulf of Bothnia during normal winters. Winter conditions place high demands on the adaptability of shipping and icebreaking operations. Ice formation in the Gulf of Bothnia requires flexibility for shipping, with the need for large areas and alternative shipping routes. Extensive wind farms can pose a particular challenge for winter navigation, as they can limit the necessary flexibility. This is particularly relevant for freight volumes to and from ports in northern Sweden (Ringsberg et al., 2024).

There are uncertainties about how offshore wind farms can affect the nature of sea ice and ice formation, and potentially indirectly affect winter navigation and icebreaking. Indirect effects based on the impact on winter navigation, icebreaking and aggravating operations can lead to cost increases. These can affect both the shipping industry and related industries, as well as public activities including costs for maintaining shipping lanes and transport functions (Ringsberg et al., 2024).

*Baltic*

Shipping in the Baltic Sea is extensive, with several important ports along the coast but above all several international shipping routes. The ship traffic goes to the mainland coast, Gotland and further north, east and south, to both Swedish and foreign destinations. West of Gotland, traffic with Swedish destinations dominates, while international traffic to and from the Gulf of Finland and the Baltics, but which often does not dock in Sweden, is more prominent south and east of the island.

For vessel traffic in and out of the Baltic Sea, there are three alternative sea routes: Öresund, the Kiel Canal and the Great Belt. The busiest maritime route is the Öresund route, which runs through the southern Baltic Sea along the southern coast of Sweden in traffic separation systems. Traffic through Öresund is limited by Flintrännan's minimum depth of about 8 meters at mean water, with a maximum recommended draught of about 7 meters. The fairway is also limited by the height limit under the Öresund Bridge, which is 55 metres above Flintrännan. Larger and deeper vessels therefore mainly use the route through the Great Belt, which has a higher height limit of 65 metres.

*Skagerrak/Kattegat*

Maritime traffic in Skagerrak/Kattegat is of great importance for Swedish foreign trade, with two of the country's largest ports: Port of Gothenburg and Port of Brofjorden. The Port of Gothenburg handles almost 30 per cent of Sweden's foreign trade and accounts for half of the country's total container traffic (Port of Gothenburg, u.y.). The marine spatial planningarea is traversed by several shipping routes;

- From Oslo in the north to Kattegat in the south
- In to the coast and out past Skagen towards Skagerrak/Kattegat
- Through Kattegat and Öresundto and from the Baltic Sea

Kattegat is particularly important for maritime traffic as it is one of only two routes into the Baltic Sea for large vessels. However, this traffic does not go mainly to Swedish ports, but to other countries in the Baltic Sea. There are shipping routes throughout the sea area, both on the Swedish and Danish sides. In the southern part of the area, outside Stora and Lilla Middelgrund, ships must choose between Öresund and Great Belt. Both of these passages limit the height and draught of the ships, with the Great Belt Bridge as a special height limit.

To increase safety in the shallow waters of Kattegat, new traffic separation regulations were introduced in 2020 on both sides of the offshore banks, following a decision by the International Maritime Organization in 2018. (International Maritime Organization, 2018).

For further information on spatial analyses of shipping, see the Lighthouse report *Maritime Interest in Sea Space in the Light of Increased Wind Power Expansion* (Hjerpe Olausson, J. et al., 2024).

*Environmental and other impacts*

Maritime transport contributes to several environmental pressures affecting both the marine environment and the atmosphere:

- Emissions to air and water
    - Fuel combustion involves both emissions of pollutant gases such as sulphur dioxide, nitrogen oxides, particulate matter, as well as carbon dioxide and other greenhouse gases. International shipping is a rapidly growing source of emissions, and the need to reduce its climate and environmental impact is today the strongest driving force behind technological development in the sector (Maritime Administrations, u.y.)
    - Other consequences of the operation of shipping are operational oil spills, chemicals, as well as discharges from kitchens, toilets and cleaning of cargo tanks.
    - Ships that also use flue gas cleaners (so-called scrubbers) to reduce their emissions of sulphur oxides to air have been linked to water pollution and more and more countries have imposed restrictions on these in recent years (Lunde Hermansson et al., 2023).
- Noise
    - Marine life is affected by the underwater noise caused by ships' engines, propellers and sonar, as it interferes, among other things, with the communication between organisms.
- Spread of alien, including invasive species
    - Furthermore, there is a risk that ships spread alien species via ballast water and hull fouling, species that can establish themselves in Swedish waters and outcompete native species with potentially major consequences for ecosystems.
- Bottom impact

- Shipping also affects the seabed adjacent to shipping lanes and ports, where dredging and dumping of dredged materials is ongoing.

Maritime transport is an efficient mode of transport with lower CO2 emissions per unit transported compared to land transport. Despite this, it also poses significant environmental challenges. Transport policy objectives aimed at promoting energy-efficient transport can create conflicting objectives in terms of increased sea-based transport work and impact on the marine environment (Fridell, et al., 2024). To address these challenges, it is important to develop strategies that balance efficiency and sustainability in shipping, which may include investments in cleaner fuels and technologies to reduce the negative environmental impact.

*Marine spatial plan guidance on shipping*

The marine spatial plan's guidance for shipping is based on national interests and is largely in line with established shipping lanes and shipping routes. Guidance for other uses, such as energy extraction, can potentially affect and complicate shipping activities.

Although the marine spatial plan does not explicitly provide guidelines for safety zones, it stresses the importance of taking these into account on the basis of the specific conditions of each energy area. It is generally considered that shipping and offshore energy production can coexist, provided that the right conditions are created and that the safety of shipping is prioritised. This includes taking into account safety distances to maintain maritime safety as well as complying with both national and international regulations at sea.

Maritime safety is key to preventing accidents at sea and minimising the environmental impact on populations, animals and plant life. The need for safety zones and safety distances is specific to each location and depends on several factors, including spatial conditions, the nature of the fairway and its use. Factors such as traffic intensity, type and size of vessels and the direction of the fairway in relation to wind farms affect these needs. Establishing offshore activities, such as wind power, requires a thorough examination and permit decision that includes specifications for consideration and safety distances. This is necessary to enable safe coexistence with shipping. To this end, the Swedish Maritime Administration and the Swedish Transport Agency have developed specific recommendations (Sjöfartsverket & Transportstyrelsen, 2023). For more information on the legal conditions, see the Swedish Energy Agency’s report 2023:12 (Energy Agency, 2023a).

*National objectives, regional development and maritime transport*

The maritime spatial plans shall contribute to the achievement of national environmental objectives and integrate industrial policy and social objectives, of which transport policy objectives form part of the whole. By promoting the objective of marine spatial planning to create the conditions for regional development and sustainable shipping, the plans offer guidance for shipping and other uses, such as energy, which supports the National Strategy for Sustainable Regional Development (Government, 2021b). This strategy covers several priorities and is implemented in accordance with the Ordinance on Regional Development Work (2017:583).

In particular, the marine spatial planning contributes to the priority of ‘accessibility through sustainable transport systems’, where guidance on shipping and other uses has a direct impact on maritime transport supply. This is of great importance to both people and businesses throughout the country. The strategy stresses the importance of coordinating activities and transport infrastructure at local, regional and national level. For further information on marine spatial planning objectives and the national strategy for sustainable regional development and its priorities, see Section 6.3.

Maritime transport is also classified by the Swedish Civil Contingencies Agency (MSB) as an essential activity. These activities are essential to meet society's basic needs and security, which constitute an important basis for the work on accident protection, crisis preparedness and civil defence. Activities that maintain or ensure these vital societal functions include ships, ports, pilotage, icebreaking, ship brokerage, and the operation and planning of fairways (MSB, 2021).

Table 12. Shows the type of impacts from offshore wind in relation to shipping during different phases, as well as possible consideration measures that can reduce negative impacts and impacts.

| Phase | Type of impact | Possible consideration measure |
|---|---|---|
| **Facility** | Increased traffic | Clear security measures |
| **Operation** | May affect technical equipment<br>Increased collision risk | Clear security measures<br>Development of technical solutions, complementary equipment in wind farm |
| **Settlement** | Increased traffic | Clear security measures |

### 2.4.6. Commercial fishing

Swedish fishing is conducted in the Baltic Sea including the Gulf of Bothnia and Skagerrak/Kattegat, and periodically also in Skagerrak/Kattegat and the Norwegian Sea. In the Gulf of Bothnia, commercial fishing is seasonally characterised by ice-free periods. Both the Gulf of Bothnia, the Baltic Sea and Skagerrak/Kattegat have different physical and ecological conditions that affect the presence of marine animal species such as fish and shellfish, which in turn helps to influence how professional fishing looks in the areas. In the Gulf of Bothnia and the Baltic Sea, the composition of species changes from south to north as a result of decreasing salinity, which means that the proportion of marine species decreases. Several commercially important fish species, such as herring and sprat, are found in all three sea areas, while others, such as Northern prawn and Norway lobster, are only found in the marine spatial planning area of Skagerrak/Kattegat.

Fishing also varies over time depending on the species available. While cod was a common catch in the 1980s, stocks in the Baltic Sea and Kattegat are now at a very low level, which has affected the regulation of fisheries. For example, directed fishing for cod in the Baltic Sea has been temporarily closed for several years. Environmental impacts on fish stocks, such as oxygen-free bottoms in the Baltic Sea and climate change, also affect the opportunities for fishing today and in the future.

Swedish commercial fishing includes bottom trawling, pelagic trawling and passive fishing with nets and cages. Commercial fishing is varied, with larger vessels mostly fishing with trawls and smaller vessels with cages, traps and nets (see Figure 21). Fishing varies both geographically and over time. Small-scale fishing is normally carried out in more limited areas close to the coast, while larger vessels move over large areas in and beyond the Swedish territorial sea and economic zone. The conditions for fishing are affected by the season, but also by the development of fish stocks and fishing regulations. The total landing volumes and removals of fish and shellfish from commercial fisheries are governed by the EU's Common Fisheries Policy, decided fishing quotas and national regulations. National interest claims for commercial fishing include areas considered important for commercial fishing's access to catch areas, areas important for spawning and nursery areas, as well as ports for landing and service. In both the Swedish territorial sea and the exclusive economic zone, there is also extensive fishing from other EU countries' vessels.

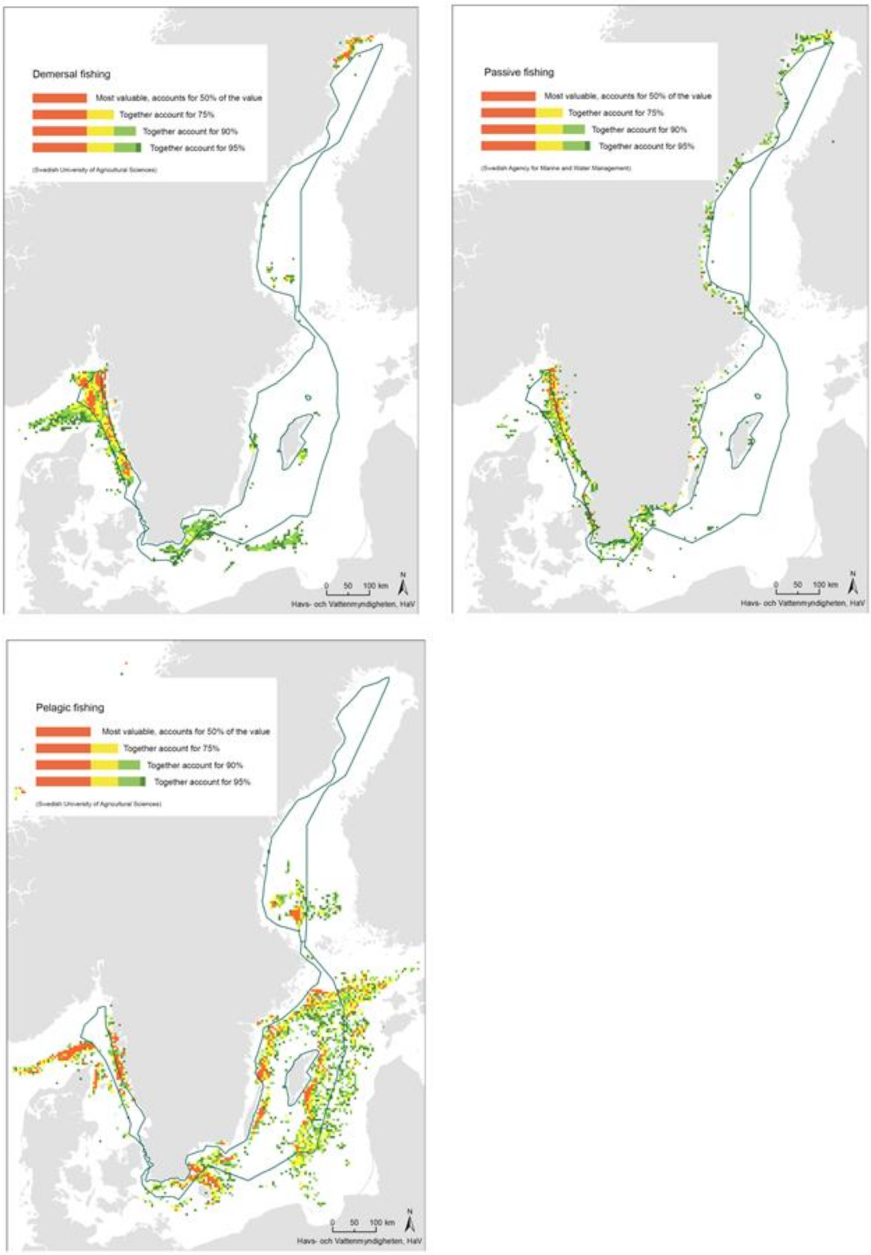


Figure 21. Professional fisheries 2012-2021: Compilation of annual economic landing values for Swedish fisheries for the period 2012-2021: Passive fishing (top left); Pelagic trawl fisheries (upper right); Demersal/bottom trawl fisheries (bottom trawl) (bottom left).

Commercial fishing in the Gulf of Bothnia is most concentrated near the coast outside the marine spatial planning area, and in the Southern Bothnian Sea. Fishing is clearly seasonal, as the area is ice-covered for parts of the year. Economically important species are vendace, herring and salmon, where fishing for vendace takes place closer to the coast (outside the marine spatial plan area). Finnish herring fishing is also taking place in the outer embankment areas (Swedish Agency for Marine and Water Management, 2025).

Fishing in the Baltic Sea's marine spatial plan area accounts for a large proportion of Swedish commercial fishing in terms of both value and quantity of catches. The main species (2018-2022) are sprat and herring, following the decline of the cod stock. The area uses both passive and active gear, with the exception of Öresund, where fishing is conducted exclusively with passive gear (Swedish Agency for Marine and Water Management, 2025).

In the marine spatial plan area of Skagerrak/Kattegat, commercial fishing is varied, with the economically most important species being Northern prawn and Norway lobster. There is also mixed fishing for species such as haddock and saithe (bottom living), mackerel, herring and sprat (pelagic).

*Environmental Impacts and Surface Claim*

Fishing affects the size and structure of fish populations, both for the species targeted and those caught unintentionally. Further other species and ecosystems are indirectly affected through interactions in the food chain. Fishing with passive fishing gear can affect birds and marine mammals trapped in nets, even gear lost in the sea creates problems as they continue to catch animals long after they are lost. Work is under way to prevent this, for example with regard to wire material in cages.

Bottom trawling affects the marine environment through species harvesting, by-catch, and physical damage to the benthic habitats. Pelagic trawling is associated with the same types of pressure as bottom trawling, with the exception of physical bottom impact. Emissions and underwater noise are also among the effects of fishing. Action to reduce physical disturbance is under way through the development of regulations and technical adaptations that reduce, for example, by-catch and physical disturbance from trawling. The establishment of marine protected areas with fully or partially regulated fisheries are measures that can be expected to lead to increased protection of vulnerable benthic habitats and nursery areas for fish and other marine organisms. Measures to meet environmental quality standards on biodiversity and physical disturbance of the seabed are a driver contributing to enhanced protection of specific species and benthic habitats. The ongoing development of fishing gear and methodology to reduce the environmental impact of fishing is expected to continue, such as the development of selective gear to reduce by-catch, as well as techniques to minimise damage to benthic habitats (Swedish Agency for Marine and Water Management 2016c).

Climate change is also expected to affect marine environments and commercial fish stocks and their distribution, and by extension fishing, through increased water temperature, altered wave, current and salinity conditions, reduced ice cover and reduced pH in the oceans by 2040 (the Swedish Agency for Marine and Water Management 2025).

*Achievement of objectives, national and municipal interests*

The marine spatial plan's guidance on the use of commercial fishing is largely based on national interest claims. According to the Marine Spatial Planning Ordinance, marine spatial plans are to contribute to national environmental, economic and social objectives, of which objectives related to commercial fishing form part of the marine spatial plan's guidance and the planning objective of *creating the conditions for regional development,* as well as *sustainable fishing*. The plan's guidance on commercial fishing should also relate to the national strategy for sustainable regional development (Government, 2021b). The strategy includes several priorities and the Ordinance on Regional Development Work (2017:583) contains provisions on regional development work and the involvement of state authorities in that work. The marine spatial plan's guidance on the use of commercial fishing relates to the priority '*Innovation and renewal as well as entrepreneurship and entrepreneurship across the country – A competitive, circular and bio-based and climate and environmental sustainable economy'.* Guidance on nature use and particular consideration for high nature values can have positive effects on the fish resource, thereby favouring sustainable fishing in the longer term, on the basis that the guidance can contribute to maintaining important ecosystem services on which commercial fishing depends, see Chapter 2.2.6. Proposal for new areas with particular consideration for high nature values. For more information on the national strategy for sustainable regional and its priorities, see Chapter 6.3 *Assessment against other plans and programmes.*

Food security is classified as an important social function by the Swedish Civil Contingencies Agency (MSB). Fishing is included as a function of primary production and refers to the ability to produce livestock and primary production of feed. Examples of essential activities include activities and facilities that are necessary to maintain the production of food-producing animals and fishing. Important activities are important activities for society's basic needs and security and constitute an important starting point in the work with protection against accidents, crisis preparedness and civil defence (MSB 2021).

Port activities are important for maintaining the activity of commercial fishing. Some ports are designated as national interest claims for commercial fishing. Port operations can also be a municipal interest. Commercial fishing is also important for other municipal interests such as employment, the opportunity to live and work in coastal communities, cultural and social values, local identity, tourism, and the preservation of fishing for the future (Waldo S. & Lovén I. 2019).

*Impact during construction, operation and decommissioning*

Table 13. Shows the type of impacts from offshore wind power in relation to commercial fishing during different phases, as well as possible consideration measures that can reduce negative impacts and impacts.

| Phase | Type of impact | Possible consideration measure |
|---|---|---|
| **Facility** | Increased traffic | Clear security measures<br>Keeping the areas not worked in open for fishing |
| **Operation** | Affects fishing opportunities | Location of turbines<br>Development of fishing gear or method depending on the type of fishery concerned |
| **Settlement** | Increased traffic | Clear security measures<br>Keeping the areas not worked in open for fishing |

# 3. Impact assessment of marine spatial plan for the Gulf of Bothnia

## 3.1. Impact on population and health

The most relevant aspects of the plan to consider when investigating effects on the population and human health are guidance on energy use, sand extraction and guidance on changing mileage for shipping. The new plan proposal has not changes in regards to sand extraction and maritime routes, and the assessment for these uses presented in the sustainability assessment of decided marine spatial plans in 2019 is still up to date (Swedish Agency for Marine and Water Management, 2019b). The conclusion of that assessment is that neither the proposed sand extraction in the Bothnian Bay nor the guidance on shipping posed any health risks to humans. When it comes to energy areas, the assessment is that the negative health effects that can arise from visual impact and noise are relatively small, with marginal negative effects on the health of the population. The potential for positive health effects from renewable energy production and thereby reduced emissions is also assessed as relatively small. This is because these effects are indirect and do not have a local effect in the same way as visual effects.

*Visual impact and noise*

Regarding guidance on energy production, and offshore wind establishment, there are various aspects that can have an impact on human health. There is only one permit for offshore wind power in the Gulf of Bothnia. The proposed marine spatial plan will guide a relatively large expansion of offshore wind power in the Gulf of Bothnia's marine spatial plan area, and several energy areas are located so close to the coast that they will be visible from land. Visual impact from both the wind turbines and associated obstacle lighting risks disturbing people both during the day and at night. However, it is not established to what extent this can lead to direct health problems, and there is also a subjective aspect where different individuals are disturbed to different degrees (see section 2.1 Impact on population and health). Effects and influences of obstacle lighting may need to be investigated especially in the Gulf of Bothnia in relation to the natural conditions, such as terrain and how light is reflected by ice and snow during the winter months. The effect of shading is not considered problematic due to the distance from land.

Offshore wind power generates noise, both audible noise and infrasound. Modelling for noise dispersion in various project applications shows that the overall noise level generally decreases to 35 dBA within 5 kilometres of the outer boundary of wind farms. Noise modelling is often based on a worst-case scenario for sound dispersion, where the calculations assume that there is no natural attenuation of the sound. In the Gulf of Bothnia, there is no proposed energy extraction area closer than 5 kilometres from coastal settlements (see Figure 22 below). People living in coastal areas are therefore not considered to be at risk of experiencing harmful or particularly disturbing noise levels when establishing offshore wind power in proposed energy areas. Just as for obstacle lighting, there is a need to examine in more detail how sound spreads in winter conditions in the Gulf of Bothnia.

In the Bay of Gävle there is a cluster of energy areas which means that the risk of cumulative impact increases. Visual influences, and effects such as noise and obstacle lighting, become more noticeable and intense. These effects may be limited to some extent by consideration measures. At the same time, it is not likely that all the energy areas in the marine spatial plan will be built on, but rather a number of energy areas and with a certain geographical spread. It would provide a distribution of negative impacts on population and health across the entire marine spatial planning area, see section 3.5 Overall assessment for reasoning on potential distribution of cumulative impacts.

*Maritime safety and risk*

The proposed energy areas may lead to reduced safety of navigation due to fixed installations adjacent to fairways. This can lead to an increased risk of shipping accidents, as well as possibly complicate remediation and rescue work that can indirectly pose a risk to human health.

*Reducing Health Hazardous Emissions*

There are potential indirect health benefits of offshore wind energy. This is especially true if the produced renewable energy replaces fossil energy use with health-damaging air emissions. As it is uncertain where the energy from proposed energy areas will be used, it is difficult to assess the magnitude of this effect. Effects on air emissions and climate benefits are indirect and long-term effects of marine spatial plans that in the long term are expected to contribute positively to human health. In a shorter time perspective, however, local emissions may increase with civil works and increased traffic, or diversion of ship traffic, this is transitory and the net effect of building wind power is positive in terms of the potential to replace fossil-based energy carriers, thereby leading to reduced emissions of greenhouse gases and other airborne pollutants.

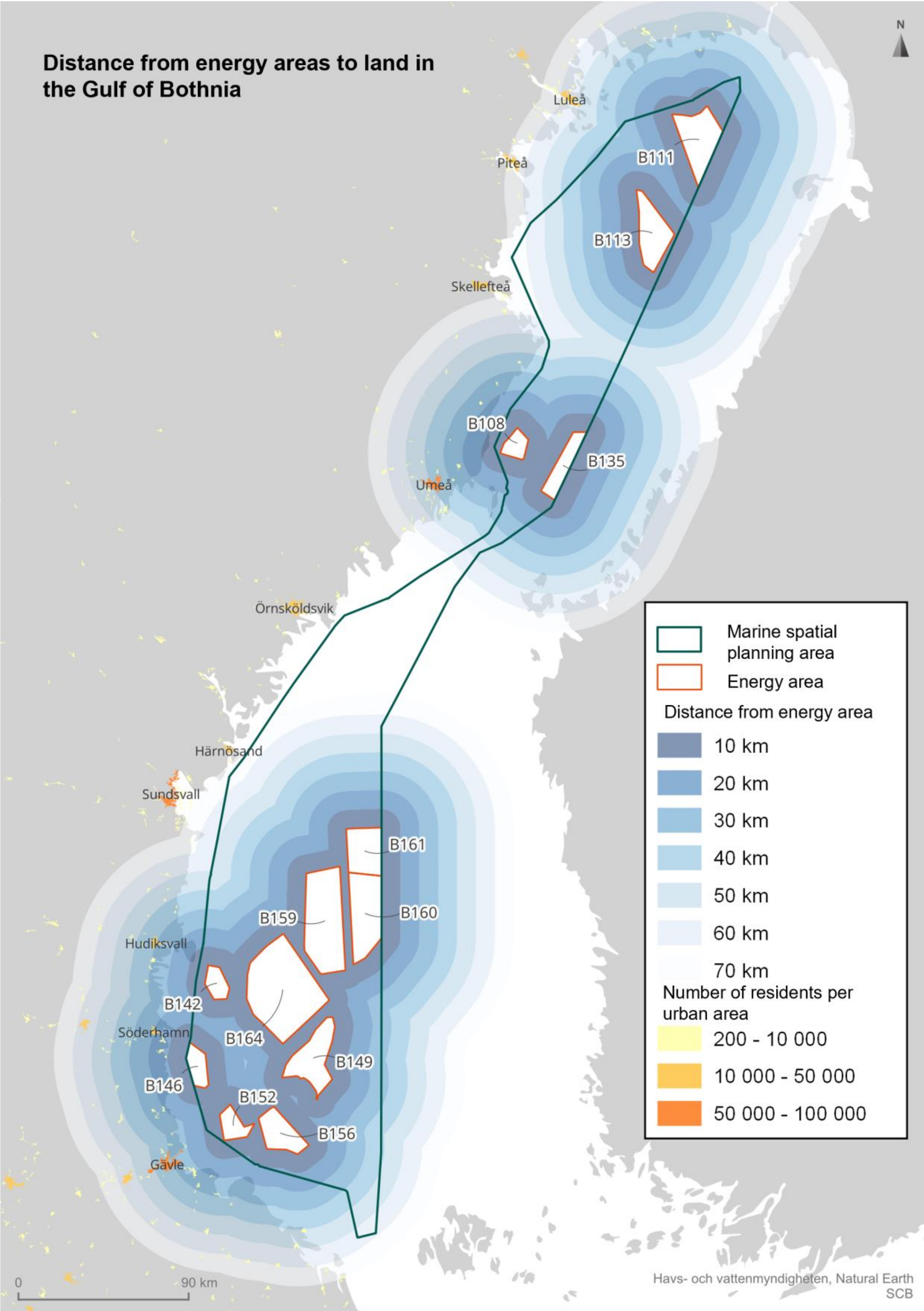


Figure 22. Shows the distance of energy areas to urban areas in the Gulf of Bothnia. Source: Statistics Sweden, 2020.

## 3.2. Effects on protected animal or plant species and biodiversity

### 3.2.1. Birds

In the marine spatial planning area of the Gulf of Bothnia, the greatest risks of impact on birds are linked to the areas around Finngrunden and North Kvarken. In both cases, the risk of impact on migratory birds is greatest.

Finngrunden is of great regional importance for resting and wintering seabirds, several of which are known to be very sensitive to disturbance. When it comes to migratory birds, the autumn migration past Finngrunden and the southern Bothnian Sea is particularly extensive, with over 100 species and one million individuals of larger birds. In comparison, studies show that the spring migration includes just under 70 species. Many migratory species are red-listed. In addition to the passage of larger birds, a presumed very large number of small birds migrate. For species such as the bean goose, whooper swan, black-throated loon and red-throated loon, a significant proportion of the populations are estimated to pass through the area from breeding areas in north-eastern Scandinavia and north-western Russia. For the subspecies taiga geese, the central migration route for the entire world population over this area is found.

Energy areas B152 and B156 in the Southern Bothnian Sea pose a high risk of impact on migratory birds and a medium risk of impact on wintering birds, mainly long-tailed ducks and red-throated loons. Area B149 is considered to have a medium risk of impact on migratory and wintering birds.

Energy areas B164 and B142 are considered to have a medium risk for migratory birds and a low risk for wintering birds.

The species red-throated loon and long-tailed duck are typical species of sublittoral sandbanks and reefs within the Natura 2000 site Finngrunden. The species shall be protected and allowed to remain in existing viable populations. The conservation of species within the Natura 2000 network must also be seen in a long-term perspective where the conditions must be in place for the range of different species to change over time. Ongoing climate change caused by human emissions of greenhouse gases will result in sharp shifts in ranges that are very difficult to predict more accurately.

Along the coast there are important breeding, resting and wintering areas for seabirds, which risk being negatively affected by wind power expansion in the proposed energy areas B152 and B156. Black guillemot, lesser black-backed gull and Caspian tern, and a high density of white-tailed eagle are some of the known breeding species in the area, where the lesser black-backed gull in particular uses the ground areas at Finngrunden for foraging. Particularly important areas are Lövstabukten and Björns archipelago and the nature reserve Gräsö eastern archipelago. The archipelago area west of B146 has a rich bird fauna and along the coast there are occurrences of seabirds. Several protected bird species breed in the area. The energy areas of North Kvarken are located just north of the very important migratory bird path that stretches northwest-southeast between Umeå-Holmön and the Vaasa region of Österbotten in Finland, where the crossing of the sea is the shortest. The migration route is used by several sensitive species of birds of prey (in particularly high numbers of rough-legged buzzards) as well as common crane, bean goose, wader, whooper swan and other fell and taiga species. The energy area B135 is considered to entail a risk of a medium negative effect, while B108 has a small negative effect on migratory birds.

On the coast there are to some extent nesting seabirds and birds that stretch along the coast. There is a risk of some negative impact from wind power establishment in the energy area B108, albeit small. With regard to the latter area, the proximity to the Holmöarna islands is also considered to pose some risk to the species that breed there, such as red-throated loons.

In the far north of the Gulf of Bothnia, the coastal area bordering the Haparanda Archipelago National Park is very sensitive. Several of the islands are bird protection areas, and the national park has been created partly because the area is relatively unaffected by humans. The area near the coast is very important for migratory, resting and nesting birds, several of which are susceptible to disturbance. The bird stretch is expected to occur on a broad front along the coast and partly over the open sea, and there is some risk that it will be negatively affected by wind power establishment. The risk is greater closer to the coast, which is why the potential negative impact is assessed as medium in energy area B111, and small in energy area B113.

*Cumulative and transboundary effects*

The greatest risk of cumulative effects on birds is in the southern Bothnian Sea, where several energy areas are located. This applies primarily to energy areas B152, B156 and B149 in the vicinity of Finngrunden.

Several wind farms are planned on the Finnish side of the Bothnian Bay, which increases the risk of cumulative effects in connection with the establishment of wind power on the Swedish side (see section 3.5 Overall assessment). Moderate risk of negative impact on migratory birds if establishments are established in the designated energy area west of Kokkola (southern part). If wind power is established in the Vaasa archipelago and surrounding areas, the risk of impact is considered to be high.

In the southern Bothnian Sea, on the Finnish side, there are several energy areas, all of which, if built, carry the risk of a major negative cumulative effect on migratory birds. The establishment of wind power in Åland's archipelagos entails a high risk of negative effects on both migratory, breeding and wintering stocks. Risks of negative cumulative effects should be taken into account in the future assessment of wind power projects on both sides of the border.

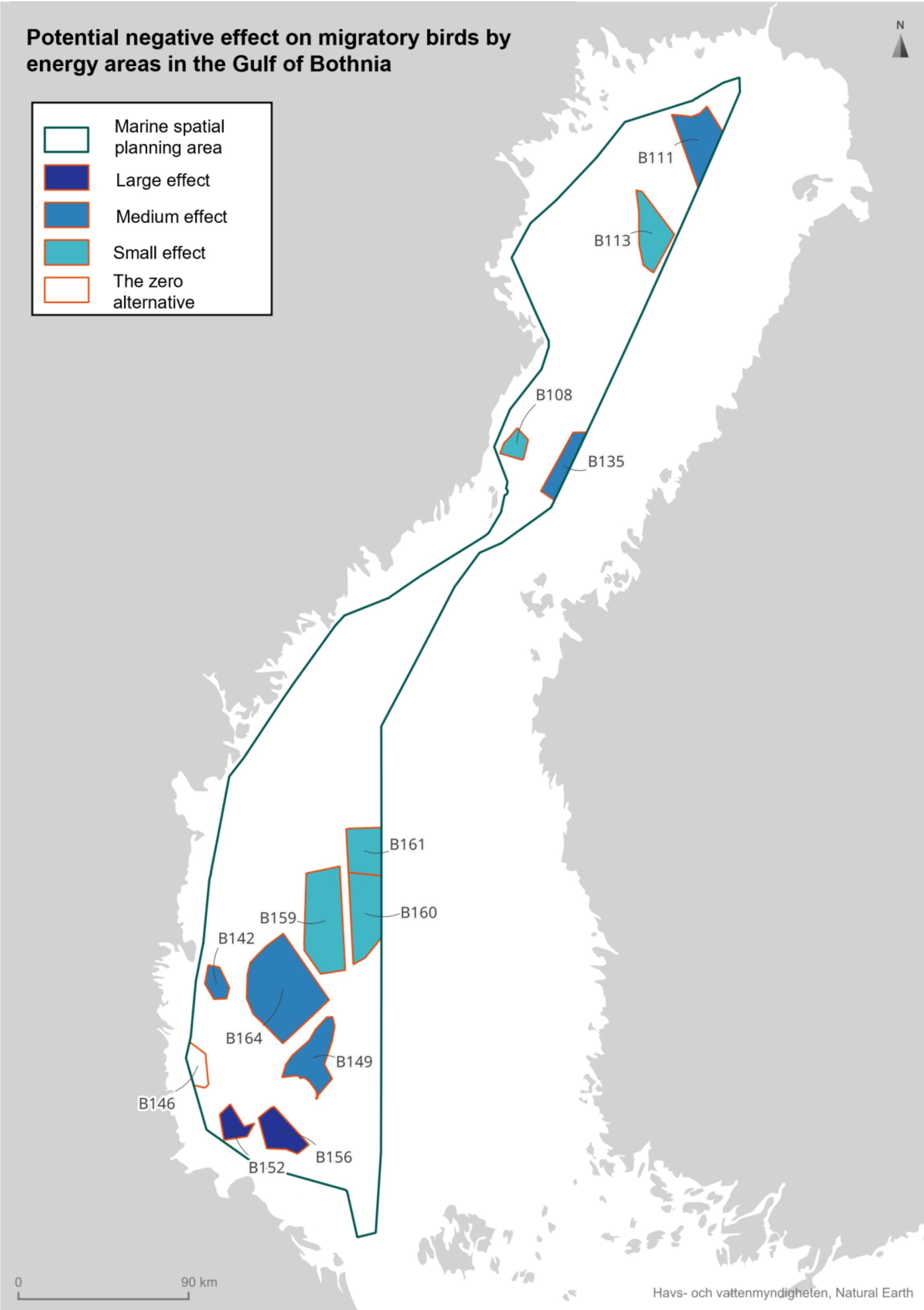


Figure 23. Risks of adverse effects on migratory birds in the Gulf of Bothnia. Dark color shows great effect and light color shows little effect.

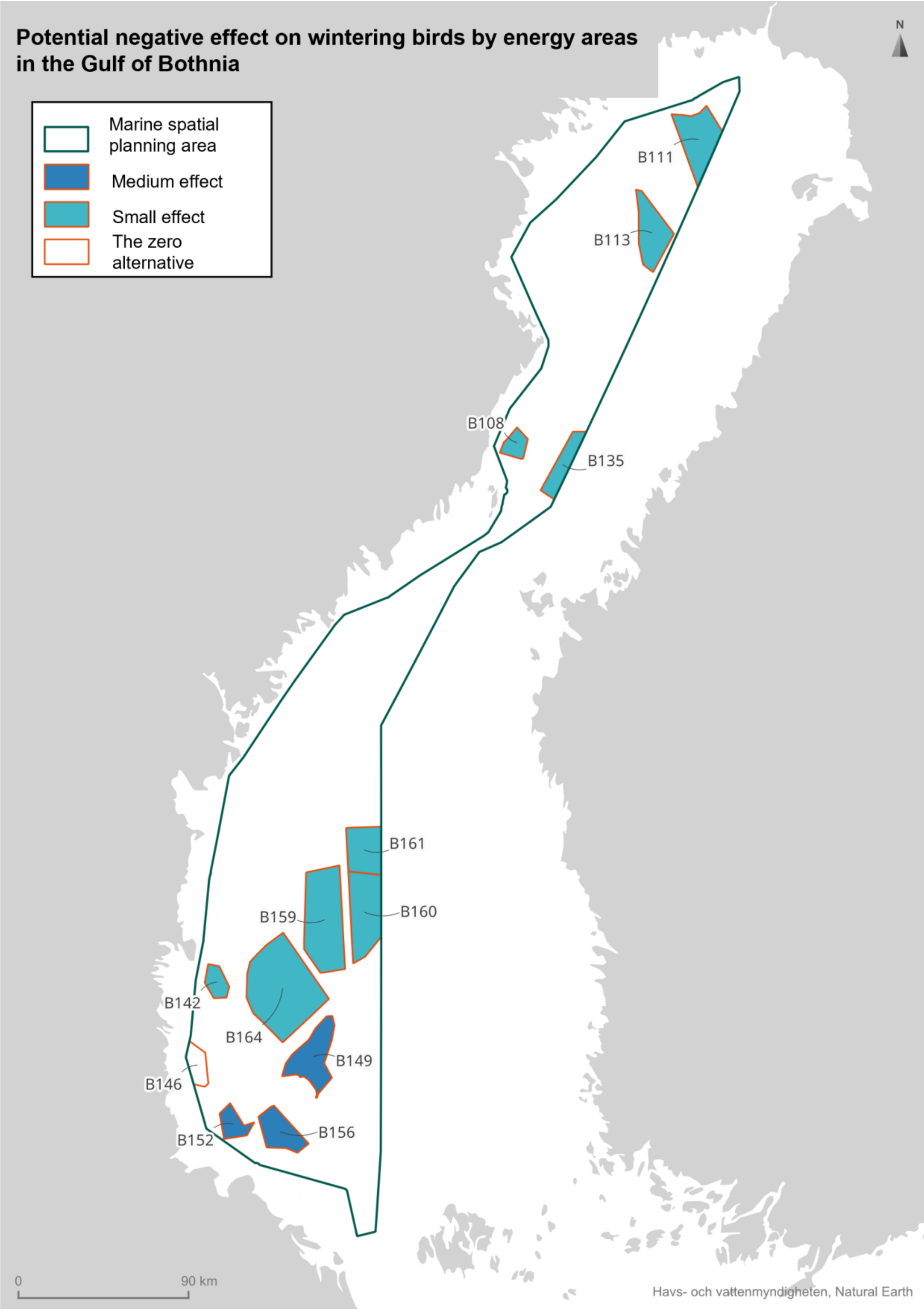


Figure 24. Potential negative effect on bird wintering areas of proposed energy extraction areas in the Gulf of Bothnia. Dark color shows great effect and light color shows little effect.

### 3.2.2. Bats

In the Gulf of Bothnia, it is primarily the migratory route at North Kvarken where the southern parts of the energy area B135, but to some extent also B108 can have a negative impact on migratory bats. Otherwise and generally, the risk of negative impact on bats depends on the distance from land where energy areas within 10 km of land are considered to be at higher risk. This provides an overall assessment of the low risk of impact on bats for the marine spatial plan.

*Cumulative and transboundary effects*

In the Gulf of Bothnia, the risk of cumulative effects on bats is relatively limited. It is in North Kvarken that there is some risk that B135 and B108, if both are established, may have a cumulative negative effect on bats.

In the agreed Finnish marine spatial plan, there is an area for energy use southeast of energy area B135 that is estimated to have a cumulative negative effect together with B135 and to some extent B108.

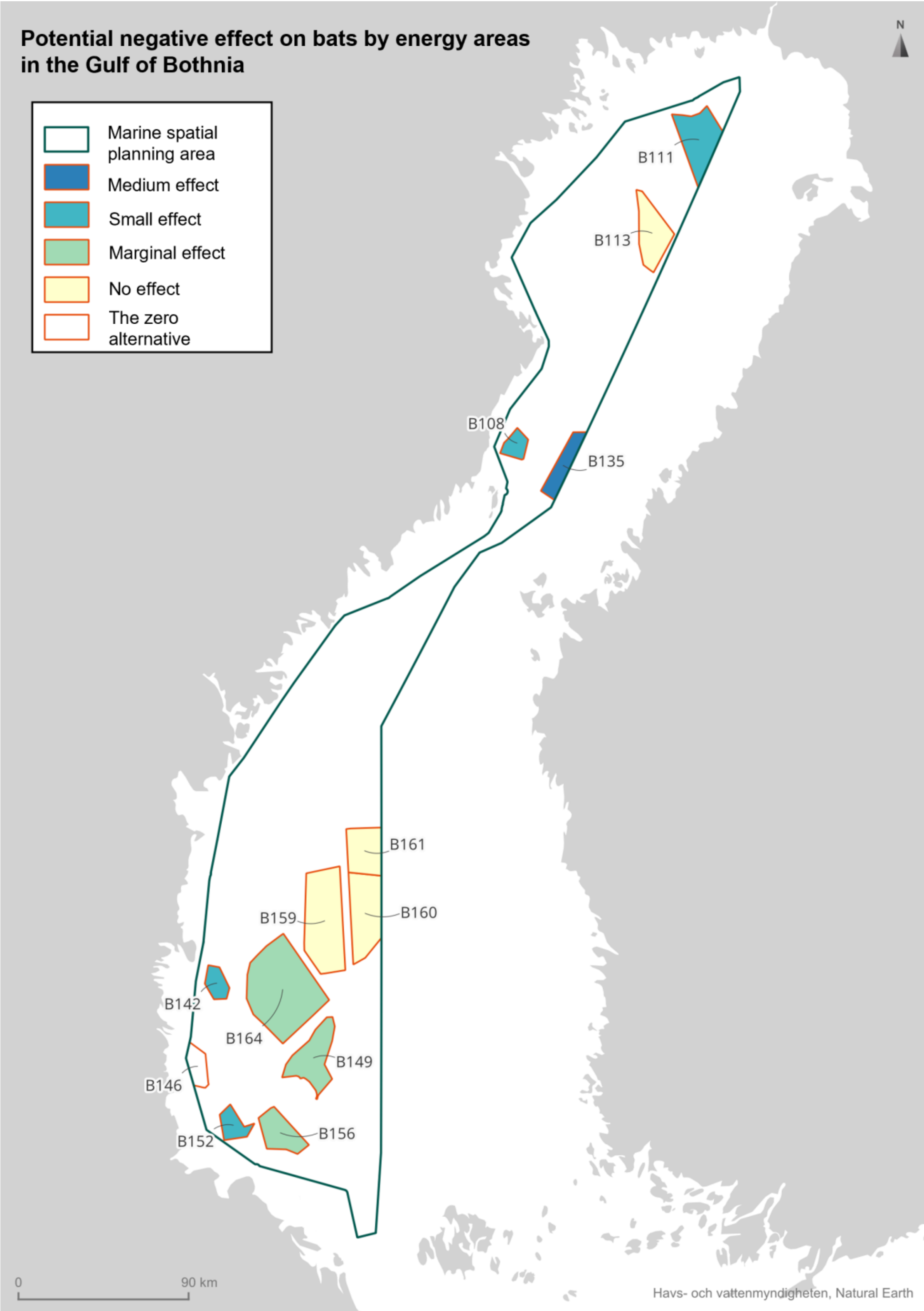


Figure 25. Potential negative effect on bats of proposed energy extraction areas in the Gulf of Bothnia. Dark color shows great effect and light color shows little effect.

### 3.2.3. Marine mammals

Occuring marine mammals in the Gulf of Bothnia include ringed seals and grey seals.

*Ringed seal*

In the Bothnian Bay there is a unique population of ringed seals where the population is stable, but the species has been exposed to environmental toxins and the reproduction rate is weakened. According to the latest status assessment in the Marine Strategy for the North Sea and the Baltic Sea 2024, good environmental status is not achieved for ringed seals or any of the other two seal species. This is partly due to the fact that population growth, one of the parameters included in the indicator ‘Abundance and trend of species’, has slowed down compared to the assessment period 2011-2016 (Swedish Agency for Marine and Water Management, 2024a). In addition, its long-term survival depends on the availability of sea ice whose distribution is threatened by climate change.

Based on current knowledge of the ringed seals reproductive area in the area, the energy areas B111 and B113 are in the middle of the most important area in the sea basin. The marine spatial plan is considered to potentially have a major negative effect on seals by affecting the presence of stable sea ice. The wind turbines themselves can affect the ice and maintenance traffic to and from the turbines may require ice-free passage.

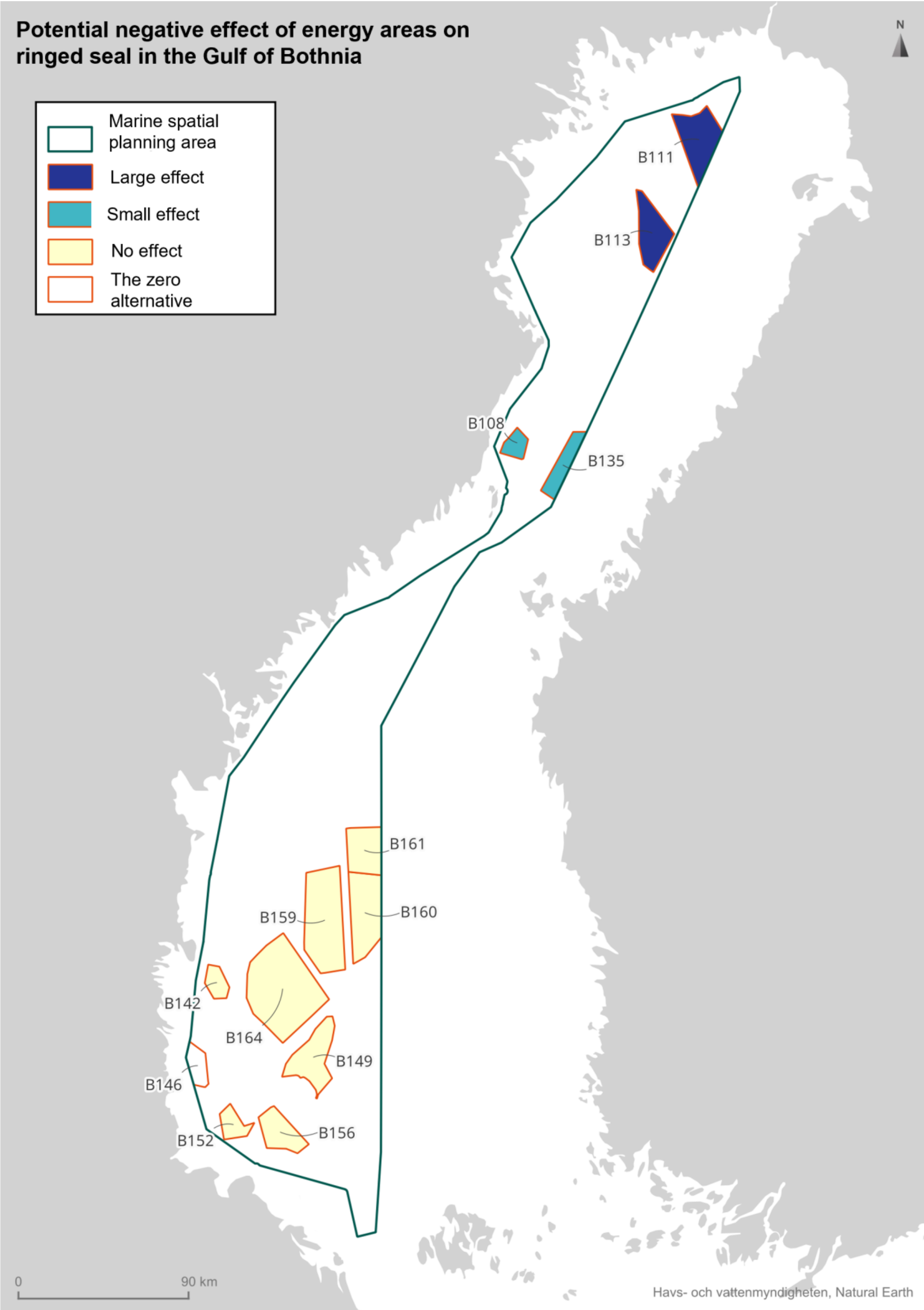


Figure 26. Potential negative impact of proposed energy extraction areas in the Gulf of Bothnia on ringed seals. Dark color shows great effect and light color shows little effect.

The energy areas B108 and B135 in North Kvarken are estimated to have little negative effect on ringed seals, as these parts of the Gulf of Bothnia are less important as reproductive areas.

Energy areas in the Bothnian Sea are not considered to have any effect on the ringed seal.

*Grey seal*

Grey seals are found in the Gulf of Bothnia, mainly in the North Kvarken and in the Southern Bothnian Sea. Like other seal species in Swedish waters, it does not achieve good environmental status.

Grey seals are considered to be sensitive to disturbance during February to June and to be more prevalent in coastal areas than out at sea. The more coastal energy area B142 is estimated to have a potential small negative effect on grey seals. However, effects from the construction phase are considered to be minimised to negligible levels if protective measures for underwater noise are taken.

*Cumulative and transboundary effects*

It is mainly the energy areas B111 and B113 that, if both are established, would have a cumulative negative effect on the ringed seal.

The Finnish marine spatial plan contains a number of energy areas in the northern Bothnian Bay, which together with areas B111 and B113 in the Swedish plan proposal are estimated to have a major negative impact on the population of ringed seals.

### 3.2.4. Benthic habitats

The benthic habitats in offshore areas and embankments in the Gulf of Bothnia consist of soft bottoms with clay, but also, especially in the southern Bothnian Sea, a lot of rocks and boulders. In soft-bottomed areas, bottom-fixed foundations will involve the introduction of a new hard substrate.

The Symphony results show a small negative bottom effect for the energy areas B107, B139 and B152. For other energy areas, the result is a marginal effect based on knowledge of existing nature values and that about 1-2 per cent of the bottom is affected when wind power is established.

If the bottom conditions are taken into account in the design and construction, it is considered that negative permanent effects on existing benthic habitats can be avoided for both bottom-fixed and floating foundations. Assessing the risk of negative effects from cabling is not possible as it is uncertain how cables would be constructed.

Bottom trawling is not very common in the Gulf of Bothnia. There are therefore no prerequisites to replace commercial fishing with wind power establishment for a positive local net effect on benthic habitats.

*Cumulative and transboundary effects*

The risk of cumulative negative effects on the benthic habitats is limited to ensuring that local natural values are avoided during planning. The effects on benthic habitats is considered to be local and temporary.

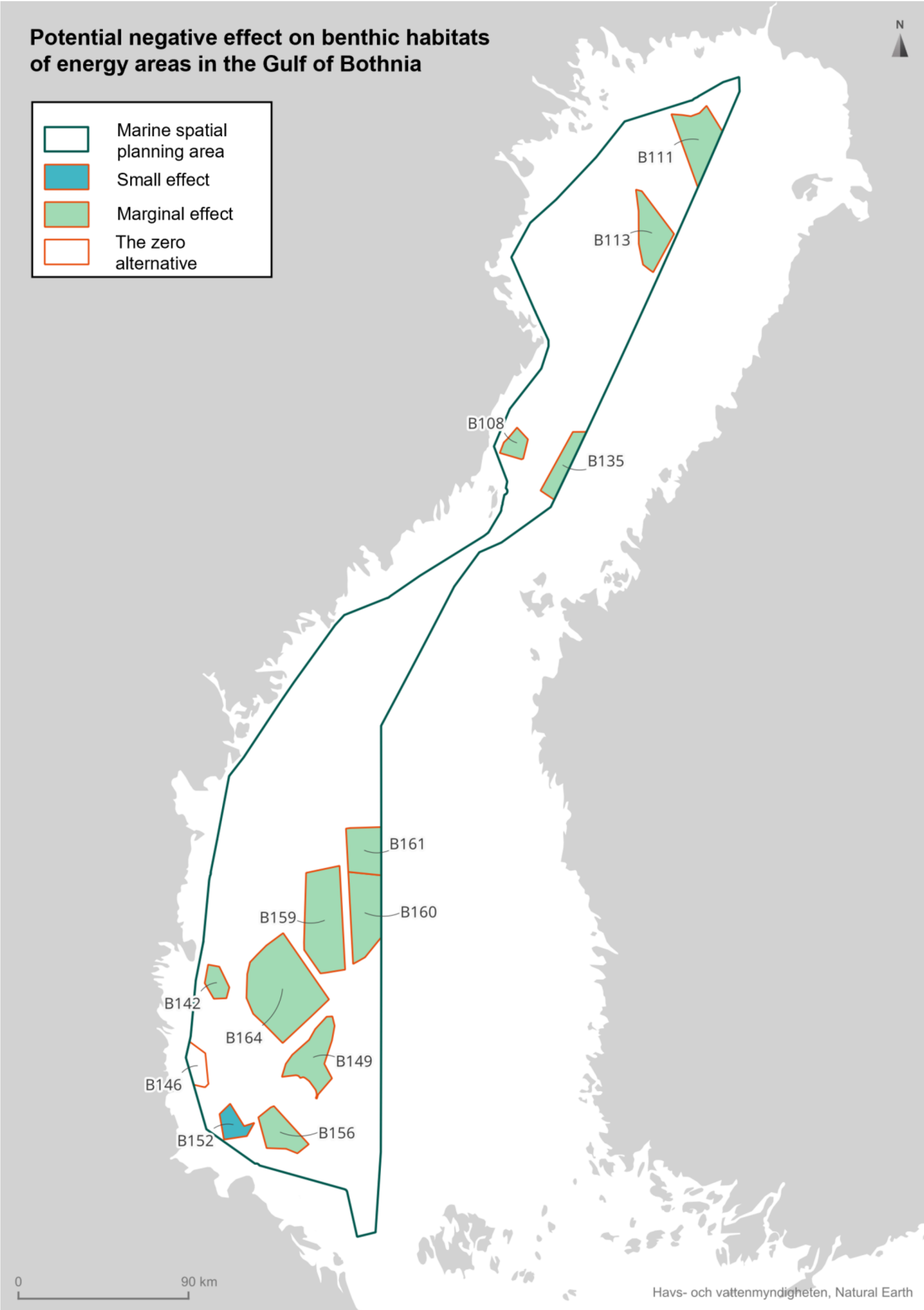


Figure 27. Potential negative effect of proposals for energy extraction areas in the Gulf of Bothnia on benthic habitats. Energy area B152 is expected to have a small negative effect, while other energy areas in the plan are expected to have a marginal effect on benthic habitats.

### 3.2.5. Fish and spawning grounds

In terms of effects on fish and fish spawning, the guidance on sand extraction at the shallow of Svalan and Falken in the Bothnian Bay is considered to have a small negative effect locally on fish, in particular spawning herring and vendace. The proposed extraction area partly coincides with shallower spawning grounds out at sea, but not with the species' most important spawning grounds. Since there are several spawning grounds in the Gulf of Bothnia, the most important of which are in the coastal zone, the negative effect is considered to be marginal in relation to the entire marine spatial plan area. It is important to adapt the extraction activities to important reproduction periods for the fish species in the area.

There is a risk of marginally increased pressure through underwater noise and operational emissions from shipping in connection with the marine spatial plan's guidance on slightly longer shipping routes after adaptation to proposed energy areas in the South Bothnian Sea. Given that the change in marine traffic is relatively small and that fish move in a very large area, the impact on fish is considered to be marginal.

In the Gulf of Bothnia, there is some overlap between energy areas and spawning grounds, mainly for herring. The exact extent of the spawning grounds is not always known, which is why more detailed assessments need to be made for any future wind power establishment. It is mainly the energy areas located near the coast or on shallower areas that are more likely to affect spawning areas for herring. In the Southern Bothnian Sea, the conducted Symphony analysis indicates that energy area B152 has a small risk of impact on spawning areas, while areas B143, B149, B159 and B160 have a marginal effect on spawning areas.

In North Kvarken, the coastal area B108 risks affecting spawning grounds, and in the Bothnian Bay the northernmost energy area B111. See Figure 28. As regards the risk of impact from the energy areas on migratory salmon, this is considered to be low and mainly affect the coastal energy areas, e.g. B146, B154 and B108. See also section 2.2.4 Benthic habitats.

*Cumulative and transboundary effects*

If wind farms are established in several of the more coastal energy areas, there is a risk of cumulative negative effects on both fish spawning and conditions for salmon migration.

The uncertainty surrounding the development of Finnish offshore wind power makes it difficult to assess the risk of cumulative effects, but in general there is a risk of impact mainly in shallower coastal waters. As far as migratory salmon stocks are concerned, marine areas in both Sweden and Finland are important.

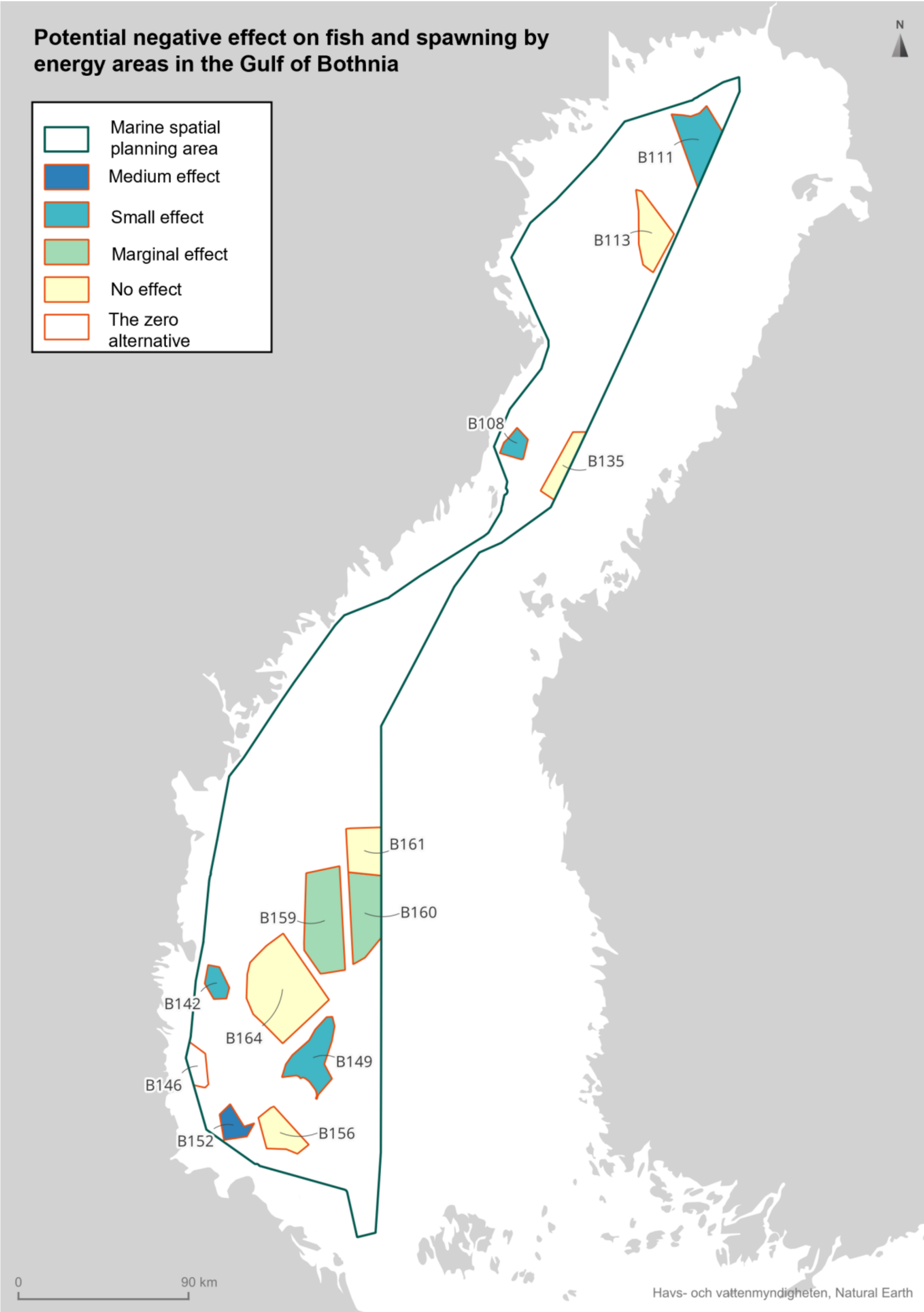


Figure 28. Potential negative effect on fish and spawning grounds of proposed energy extraction areas in the Gulf of Bothnia. Dark color shows more effect and light color shows less effect. White color shows energy area in the zero alternative.

### 3.2.6. Impact of proposals for new areas with particular consideration to high nature values

The plan includes a number of proposals for new areas for particular consideration of high nature values (so-called small n-areas). These have been developed in a process together with coastal county administrative boards and the Swedish Environmental Protection Agency. SwAM is responsible for the final proposals.

The Gulf of Bothnia plan area is generally characterised by a lower proportion of protected areas as well as fewer areas for particular consideration of high nature values than both the Baltic Sea and Skagerrak/Kattegat. However, the plan proposal includes a number of proposals for additional areas for particular consideration of high nature values. The energy areas are B152 west of western Finngrunden and B156 south of Finngrunden. Both areas are proposed for particular consideration of migratory and wintering birds. The energy area B149 with the designation small n has been extended to the north, which has expanded the area for particular consideration.

Ulvödjupet outside Härnösand and Örnsköldsvik is proposed as a new area for particular consideration of high nature values through areas B123 and B165. Deep soft bottoms and reef environments are characteristic of the area.

Furthermore, a larger expansion of the areas for particular consideration of high nature values for the areas has been proposed at and north of North Kvarken. It also confirms the EBSA area over the North Kvarken in the transboundary Swedish-Finnish waters (EBSA = Ecologically or Biologically Significant Marine Areas). Area B118 has also been extended to the southwest.

In the northern Gulf of Bothnia, the energy area B111 and the area B112 are proposed for general use as areas for particular consideration of high nature values. In these cases, especially for the ringed seal.

The proposals for additional areas for particular consideration of high nature values are considered to contribute to strengthened particular consideration for both areas with proposed use of energy extraction and other uses. Together with areas for particular consideration of high nature values in the adopted marine spatial plan, these are considered to provide a good complement to the area protection, contribute to green infrastructure and ecosystem services and sustainable use in the Gulf of Bothnia. Figure 29 shows the areas with nature use and particular consideration for high nature values within the marine spatial plan area of the Gulf of Bothnia.

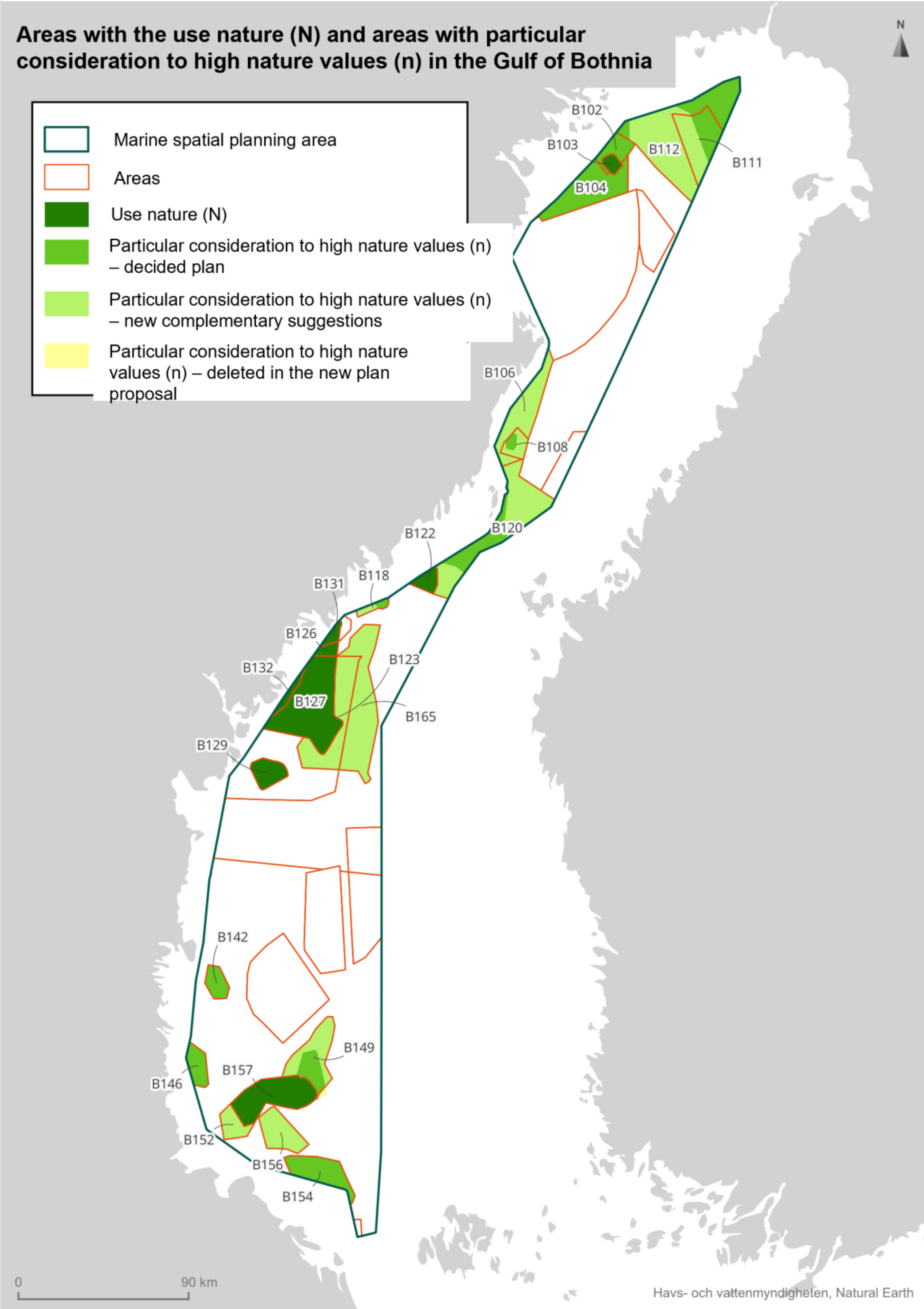


Figure 29. Areas using nature (N) and decided on the respective proposals for new areas with particular consideration to high nature values (n) in the Gulf of Bothnia.

## 3.3. Effects on land, soil, water, air, climate, landscape, settlement and cultural environment

### 3.3.1. Water and air

In terms of effects on air, the assessment refers to changes in emissions of airborne pollutants as a result of the marine spatial plan guidance. The uses relevant in this context are shipping, fishing, sand extraction and offshore wind. Wind power partly based on conversion to fossil-free energy and reduced air pollution related to this. Effects on water as a habitat refer to changes in the physical and chemical conditions of water as a result of the marine spatial plan guidance on the different uses.

*Turbidity and dispersal of sediments*

In the Gulf of Bothnia, sand extraction in the proposed quarrying operations at the shallow of Svalan and Falken is expected to have a negative effect on water quality locally, as a result of increased turbidity in the vicinity of the extraction area. The effect is considered to be short-term, and thus insignificant in terms of the marine spatial plan as a whole, in line with the conclusion in the environmental impact assessment of the adopted marine spatial plan (Swedish Agency for Marine and Water Management, 2019a).

Construction of offshore wind power and associated cabling are also activities that are expected to lead to increased local turbidity and negative local impact on water quality. The turbidity itself can lead to sequential effects on marine life and particular consideration needs to be given to benthic habitats and organisms that are sensitive to impacts (see sections 2.3.1 and 2.2.5).

*Dispersal of pollutants*

During the construction phase, it is important that sediments and surroundings are carefully examined to avoid the spread of contaminants. Sediments in the Gulf of Bothnia are characterised by elevated levels of arsenic, which is probably due to high levels in the bedrock within the catchment area and discharges from point sources (Josefsson, 2022). There are also other impurities, such as chlorinated paraffins and PFAS (ibid). Sampling and examinations need to be carried out to avoid stirring up particularly contaminated sediments during constructions works. Close proximity to environmentally hazardous wrecks and dumped warfare agents can also mean an increased risk of environmentally hazardous substances and pollutants spreading. In the Southern Bothnian Sea there are two wrecks that are classified as environmentally hazardous (Swedish Agency for Marine and Water Management Environmentally hazardous wrecks, retrieved 2024 – 12-20), these need to be taken into account in construction and cabling to avoid the spread of pollution.

There are four national monitoring stations in the Gulf of Bothnia, see Figure 30 below. Environmental monitoring has been carried out for 16 years. Offshore wind energy establishment in energy areas B111 and B146 (where permits exist) risks affecting sampling and stations may need to be relocated, or otherwise taken into account during construction, operation and decommissioning phases.

*Hydrographic effects*

Studies have shown that offshore wind power can affect hydrographic conditions during continuous operation, both at the surface and at the foundations (Arneborg et al., 2024). The effects on surface water occur when the wind behind the wind farms decreases, which in turn can affect currents and stratification in the surface water. The foundations have a small effect in that they slow ocean currents and create turbulence that mixes different water layers. The effects of offshore wind power can spread beyond the boundaries of the park and also lead to sequential and consequences for marine life (see also Section 2.3.1. Water and air). The marine spatial plan guides the large-scale deployment of offshore wind power in the Gulf of Bothnia, and cumulative hydrographic effects need to be further investigated, for example with a focus on how changes in hydrographic conditions can affect algal blooms, oxygen depletion and ice formation. Impacts of energy expansion in neighbouring countries also need to be considered in terms of cumulative and cross-border impacts on hydrography and potential second-round effects.

*Changes in emissions and air quality*

In terms of shipping, the Gulf of Bothnia marine spatial plan proposes an approximately five per cent longer shipping route through the Southern Bothnian Sea as a result of energy areas B149 and B164. According to the environmental impact assessment of adopted marine spatial plans (Swedish Agency for Marine and Water Management, 2019a), the consequences of the extended route are marginally increased emissions from shipping and thus marginally worsened air quality locally.

The establishment of wind power in the proposed energy areas may mean longer distances for fishing vessels as well, and increased service traffic. However, it is difficult to assess the magnitude of potential impacts on local air quality as a result of increased emissions. Sand extraction at the shallow of Svalan and Falken in the Bothnian Bay can also lead to an increase in air emissions from marine transport during sand extraction and between extraction area and port. This is expected to have a marginal negative impact on local air quality.

In a longer time perspective, it is possible to reason that offshore wind power has a positive effect on air quality as it has the potential to replace fossil-based energy sources, which in extraction, production and combustion worsen air quality.

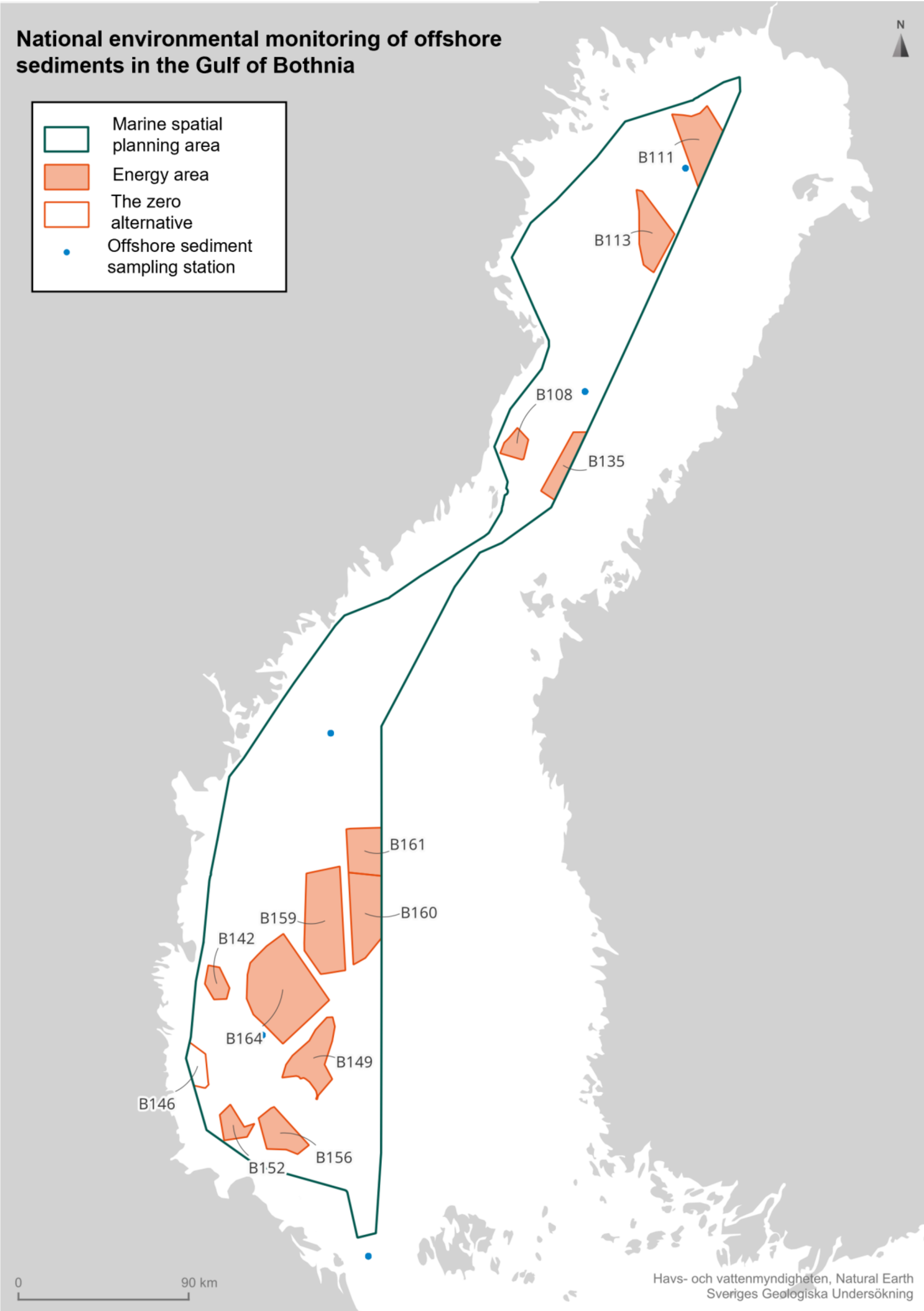


Figure 30. Displays marine sampling stations and proposed energy areas, including the zero alternative in the marine spatial plan area of the Gulf of Bothnia.

### 3.3.2. Climate

The marine spatial planning guidance on nature protection, particular consideration for high nature values and energy extraction are the most relevant aspects in terms of climate impact. The establishment of offshore wind power in energy use areas has the potential to provide society with renewable and fossil-free energy. The expected negative climate-related impacts of energy establishment are time-limited and small compared to the contribution of the marine spatial plan to renewable energy. With the marine spatial plan's guidance on 13 energy areas in the Gulf of Bothnia, the assessment is that there is great potential to contribute to Sweden's climate goals. There are both direct and indirect effects in terms of potential climate benefits. The marine spatial plan’s guidance on nature use and particular consideration for high nature values can indirectly lead to climate benefits if these areas are protected from interventions that negatively affect the marine environment, which in turn affects both ecosystem resilience and the ability to store organic carbon.

*Climate benefits linked to energy extraction through offshore wind power*

Fossil-free energy production is central to the climate transition by enabling the electrification of society (Swedish Environmental Protection Agency, 2023b, Government, 2021b). In the long term, there is a great need for energy supply in the Gulf of Bothnia, partly because of large energy establishments located in northern Sweden, and because the supply of renewable electricity is a prerequisite for society to cope with the transition and achieve Sweden's climate goals. Offshore wind power is a renewable energy that has low climate emissions from a life cycle perspective (Energy Agency 2023a). The direct climate benefit is that offshore wind power can replace energy production that has a higher climate impact. Great climate benefits could also be achieved by using energy as an energy carrier to electrify the industrial and transport sectors, which today account for a fair share of Sweden's greenhouse gas emissions (Energy Agency, 2024). Indirectly, climate benefits can also arise from the fact that the electricity produced is exported to other countries, thereby replacing other energy production with higher emissions (see Section 2.4.1. Energy).

There are several uncertainties and limitations to make a quantitative estimate and calculation of the climate benefit. Among other things, the final climate benefit depends on how many areas, and how much of individual areas are realized. It also depends on the method used to estimate potential energy production. Compared to what is generally used among wind power projectors, marine spatial planning uses a more conservative calculation of potential energy production. For the Gulf of Bothnia, the plan is estimated to enable approximately 130 TWh of annual energy production (see also section 3.4.1). There are several factors that can determine the actual climate benefit that could result from the plan’s guidance. This may include factors such as how much capacity there is in the electricity grid and infrastructure, how other energy production and associated climate emissions are changing and what the electricity demand will look like in the future.

Chapter 2 (Section 2.3.2. Climate) presents a reasoning to estimate potential climate benefits. This reasoning was also the basis for calculations made in the previous sustainability report (Swedish Agency for Marine and Water Management 2019b) and is based on comparing climate impact between offshore wind power and residual mix. The climate impact from offshore wind power is approximately 11 000 tonnes of carbon dioxide equivalent per TWh (Energy Authority, 2021) corresponding to 524 100 tonnes of carbon dioxide equivalent per TWh for the residual mix in 2023 (Energy Market Inspectorate, 2024). Calculations according to the same methodology for the proposal for a marine spatial plan for the Gulf of Bothnia show that the plan's guidance on energy extraction has great potential to contribute to climate benefits. The table also shows a comparison between potential CO2 emission reductions per TWh and Sweden's total emissions in 2023 (SCB, 2024). As mentioned above, this is only a calculation example and not an actual measure of climate benefit, as there are several limiting factors to achieve this climate benefit in reality. It is reasonable to assume that the climate benefit is initially greater, and decreases with time when the fossil energy sources have been replaced and phased out. The overall assessment of potential climate benefits in the Gulf of Bothnia is that the marine spatial plan's guidance contributes to creating good conditions for climate benefits.

Table 14. Shows results of calculation for potential climate benefit as offshore wind power according to the plan proposal, the zero alternative and the current situation in the Gulf of Bothnia would replace the Nordic residual mix.

| | **TWh** | **Climate impact Offshore wind energy (11 000 tonnes CO2-equivalent/TWh)** | **Nordic residual mix (524 100 tonnes CO2-equivalent/ TWh)** | **Potential CO2-equivalent reduction** | **Potential reduction in relation to Sweden's emissions in 2023** |
|---|---|---|---|---|---|
| Existing offshore wind power in the Gulf of Bothnia | 0 | 0 | 0 | 0 | 0% |
| Zero alternatives (permitted projects) | 3,8 | 44 000 | 2 096 400 | 2 052 400 | 4% |
| Proposal for a marine spatial plan | 127 | 1 397 000 | 66 560 700 | 65 163 700 | 135 % |

In a longer time perspective, and a larger geographical perspective, the establishment and expansion of offshore wind power also leads to positive effects for the marine environment in terms of reduced emissions and reduced climate impact.

*Changes in emissions*

The proposal for a marine spatial plan with energy areas may have an impact on other uses with a potential impact on greenhouse gas emissions. This applies, for example, to possible changes in the mileage of shipping and commercial fishing. For the Southern Bothnian Sea, the guidance on energy use in area B164 changes the fairway for shipping. The cluster of energy areas close to shipping lanes also means potentially extended mileage for shipping. However, the impact on greenhouse gas emissions is difficult to estimate, but it is estimated that a limited number of passages are affected. Extended itinerary has been estimated to a maximum of approximately 15 km based on the plan map and AIS data, which is considered to be of minor importance (Swedish Agency for Marine and Water Management, 2019b). The stretching of the fairway in the current marine spatial plan is no different from the decided marine spatial plan, where the fairway is moved and runs north-east of the proposed energy areas.

Installation and servicing of offshore wind power can also involve emissions that affect the climate, but in relation to the input of renewable energy, these emissions are considered to be insignificant.

*Guidance on nature conservation and particular consideration - carbon sequestration*

The marine spatial planning provides guidance on both nature use (N) and particular consideration for high nature values (n). Marine areas that are protected against disturbances and impacts can generally be assumed to have better conditions both to deal with climate change by conserving biodiversity, and better conditions to store carbon as they are to some extent protected from physical disturbances. There are no data or figures that describe the potential and ability for carbon sequestration in different benthic habitats and sediments in a Swedish national context. Norwegian researchers have mapped carbon sequestration in Norwegian marine areas, and concluded that benthic habitats of different nature have different abilities and conditions to contribute to carbon sequestration, both in shorter and longer time perspectives. An important conclusion of the study is that benthic habitats that are left undisturbed have greater potential to act as natural carbon sinks (Diesing et al., 2024).

In the Gulf of Bothnia there are several different types of benthic habitats, and the marine spatial plan guides the use of nature, and particular consideration is given to high nature values on a total area of approximately 38,500 square kilometres, which corresponds to just over 28 per cent of the Gulf of Bothnia's marine spatial plan area. The largest proportion is made up of areas with particular consideration to high nature values, and only 6% are protected areas. The proposal for the area of high nature value has also been extended in relation to adopted marine spatial plans (see section 3.2.6. Proposals for new areas with particular consideration to high nature values). Marine spatial planning as such is only a small part of, and has no decisive role in, the ocean management processes that decide on guidelines for human activities in protected areas. However, the guidance on particular consideration is considered to be able to contribute positively to the protection of marine environments to a greater extent than if the guidance had not been provided. As mentioned earlier, there is no nationwide data or an established method to calculate or quantify the extent and rate of carbon storage in the Gulf of Bothnia, to investigate this further can lead to a better understanding of the climate benefits of conserving and protecting marine ecosystems.

*Adaptation to climate change*

The guidance for particular consideration for high nature values has taken into account data for climate refugias for particularly important species such as ringed seals, mussels, eelgrass, herring and cod (Hammar & Mattsson, 2017). This is to avoid negative pressures on areas that may be of particular importance in a future climate. In the Gulf of Bothnia, there are climate refugias for ringed seals, but they are coastal in the Gulf of Bothnia and not within the marine spatial planning area.

For the Gulf of Bothnia, ice formation is a particularly important condition for many life forms, such as the ringed seal. Climate projections for the Gulf of Bothnia show that temperature rises and salinity changes, but also that ice formation and ice thickness will change (see Figure 29 below, which shows the expected change in the proportion of winters with ice cover and expected thickness of ice for RCP 4.5 and RCP 8.5).

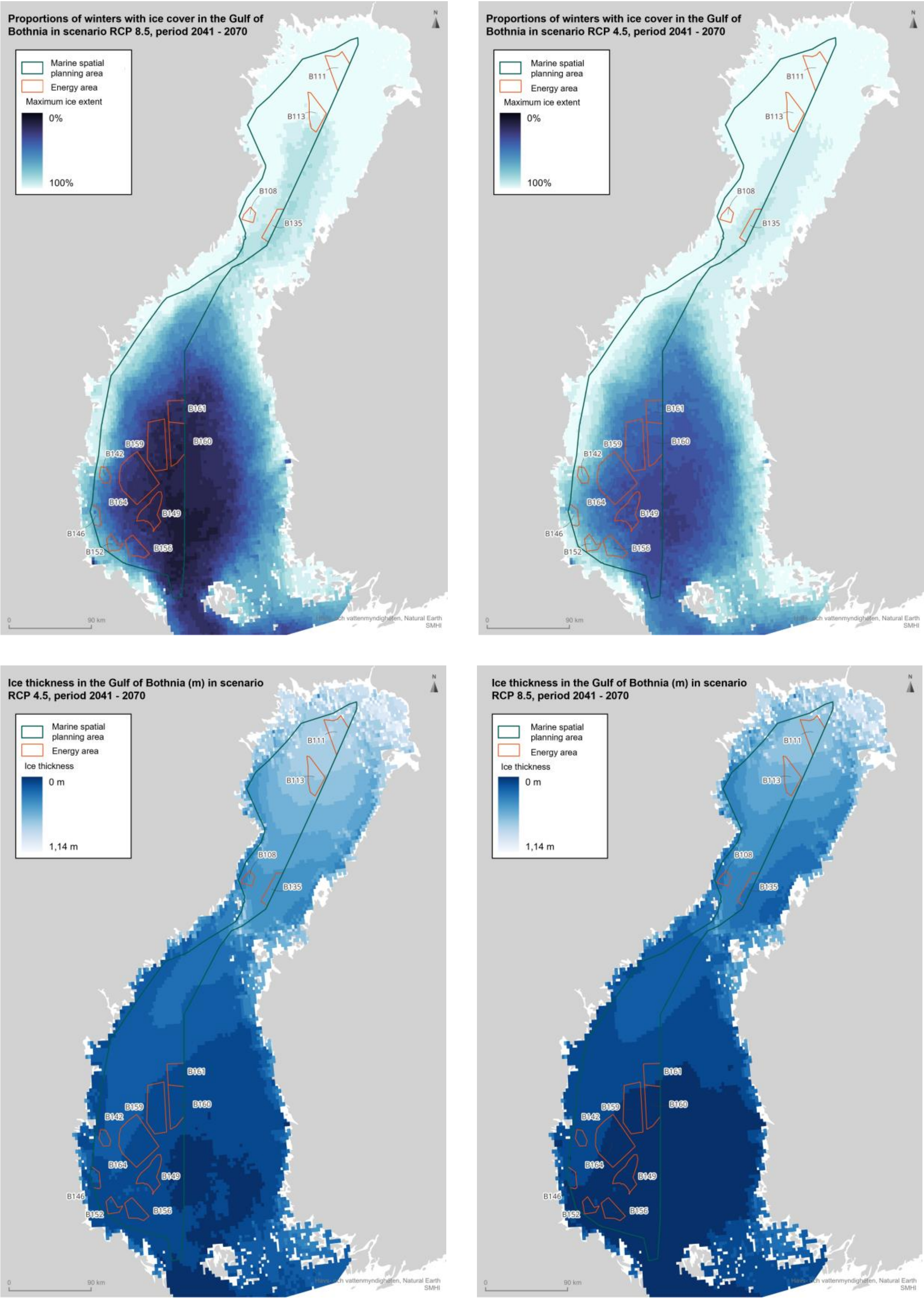


Figure 31. The two upper maps show the expected winter ice extent for RCP 4.5 and RCP 8.5 respectively. The two lower ones show the expected ice thickness according to RCP 4.8 and RCP 8.5.

### 3.3.3. Landscape

In the Gulf of Bothnia, impact on landscape is concentrated to certain areas. It is mainly about the southwestern part of the Southern Bothnian Sea and the southwestern part of the Bothnian Bay, but also the northern Bothnian Bay. In the marine spatial plan area, there are three energy areas that are considered to entail a risk of major negative impact on landscapes: B108 in North Kvarken and B152 and B156 east of Gävle. Furthermore, three additional energy areas are expected to have a medium negative effect on landscapes: B111, B135 and B142. These areas are wholly or partly within the territorial boundary and are therefore relatively close to the coast. In an energy area, the risk of negative effects on landscapes is assessed as low: B164. B113, B149 and B159 are considered to have marginal negative effects on landscapes and B160 and B161 are not considered to have any negative effect on landscapes. Figure 32below shows the estimated negative impact for each energy area in the Gulf of Bothnia.

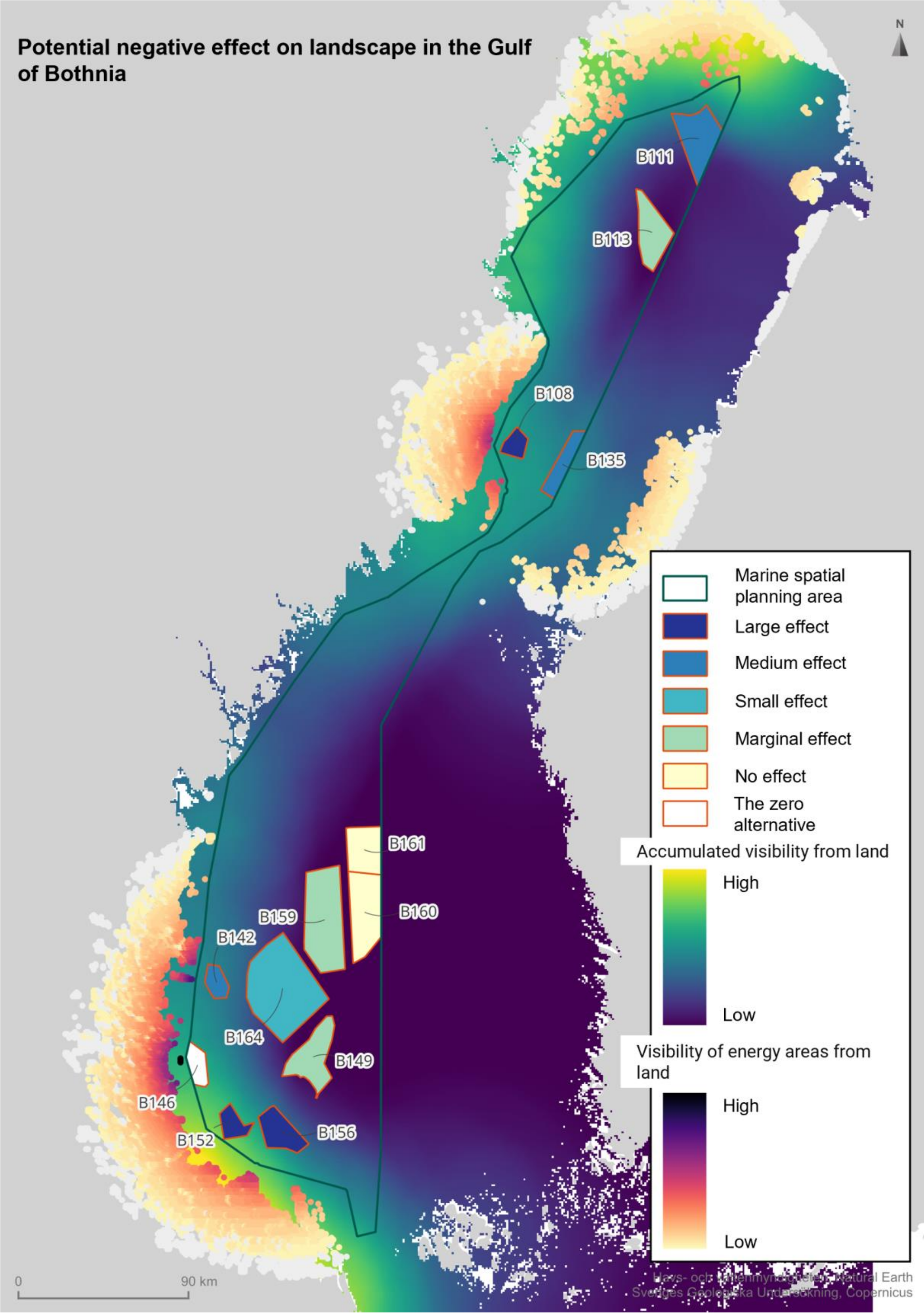


Figure 32. Potential negative effect on landscapes of proposed energy areas in the Gulf of Bothnia. In the energy areas, dark color shows great effect and light color shows little effect. Accumulated visibility from land is shown over the sea and visibility of energy areas is shown over land.

*Area-specific assessments*

*Gulf of Bothnia*

Energy area B111 can primarily have a visual impact on areas in the Haparanda Archipelago, including within the Haparanda Archipelago National Park and the island of Malören. From Sandskär in the national park it is about 10 kilometers to B111, while from Haparanda's mainland coast it is about 35 kilometers to the energy area.

Energy area B108 is located closest to about 7 kilometers from the coast and is expected to primarily have a visual impact on local coastal areas at Bygdeå, as well as the Holmöarna islands, not least towards the island of Stora Fjäderägg. The energy area B135 can also affect the Holmöarna islands, but more limited as it is about 22 kilometers away.

*Southern Bothnian Sea*

In the Southern Bothnian Sea, B142 is estimated to have the greatest impact on landscapes in the areas in the southern part of Hornslandet, as well as Agön. Despite its generally medium negative effect on landscapes, the energy area can have greater negative effects locally, not least on the mentioned areas around Hornslandet and Agön. From B142 to Hornslandet it is about 8 kilometers.

The energy area B152 has a landscape impact on the coast outside Gävle. Areas that are mainly affected are those around Fågelsundet and Björn, Billudden, as well as the islands Eggegrund-Gråsjälsbådan, Lövgrund, Vitgrund, Eskön and Iggön.

The energy area B156 has its greatest landscape impact in the areas of Fågelsundet and Björn, as well as Norrboda and Örskär on northern Gräsö. From the energy area to Örskär and Fågelsundet it is about 18 kilometers, while Gävle's coastal parts are about 25 kilometers away.

*Other impacts on landscapes*

In the Southern Bothnian Sea there is the landscape protection area *Öregrund and Östhammar,* which has a direct overlap with the south-eastern part of energy area B156. The same part of B156 is overlapped by the *Coastal Area from Arkösund to Forsmark*, which is a national interest for high-exploited coasts (Chapter 4, Section 4 of the Environmental Code). Along the Uppland coast there are also landscape protection areas *Björns skärgård*, *Bondskäret*, *Klubben* and *Ledskärsängna* which are relatively close to B152 and B156, which may negatively affect these protections.

*Cumulative and transboundary effects*

In the Gulf of Bothnia, Finnish areas can be affected by energy areas. In the Gulf of Bothnia, the B111 can have some negative landscape impact mainly on the islands of Karlö, Ulkokrunni and Maakrunni. The B135 energy area is estimated to have some negative landscape impact on Finnish areas in North Kvarken, from the islands west of Kokkola to Björkö northwest of Vaasa about 35 kilometers away. The marine spatial plan of Åland contains energy areas that may affect the landscape protection area at Öregrund and Östhammar, which is about 19 kilometres away.

Neighbouring energy areas will have a synergetic cumulative effect on the landscape of the coast of the south-west Bothnian Sea. From many outlook points along the coast, several wind farms can be visible in good weather. Based on the number of energy areas, their size, relatively coastal location and its location along the coast with relatively even distances, the cumulative impact in the Southern Bothnian Sea is estimated to be large. In the Gulf of Bothnia, the energy area B108 together with B135 together can produce cumulative effects. The cumulative effects from the northernmost energy areas are estimated to be small.

### 3.3.4. Cultural environment

*Indirect influence – National interest claims in cultural heritage conservation, Chapter 3, Section 6 of the Environmental Code*

In the Gulf of Bothnia's marine spatial plan area, there are five energy areas that are considered to entail a risk of large negative impact on national interest claims for cultural heritage conservation: B108 outside Bygdeå, B111 outside Haparanda archipelago, B142 outside Hudiksvall, and B152 and B156 outside Gävle. These areas are wholly or partly within the territorial sea boundary and are therefore relatively close to the coast. In another energy area, the risk of negative effects on cultural heritage management is considered to be medium: B135. Finally, there is an energy area that is considered to give rise to a risk of a small negative effect on cultural heritage conservation (B164), three energy areas with marginal negative effect (B113, B149, B159), and two energy areas with no effect (B160, B161). In addition to B159, B160 and B161, the marine spatial plan specifies other energy areas in the Gulf of Bothnia with particular consideration to high cultural heritage values (small-k). The guidance on particular consideration for high cultural heritage values is considered to entail adaptations of the location and design of wind farms regarding, for example, the location and height of wind turbines in order to reduce the impact on the specific cultural heritage sites concerned. **Fel! Hittar inte referenskälla.**below shows the estimated negative impact of the respective energy area.

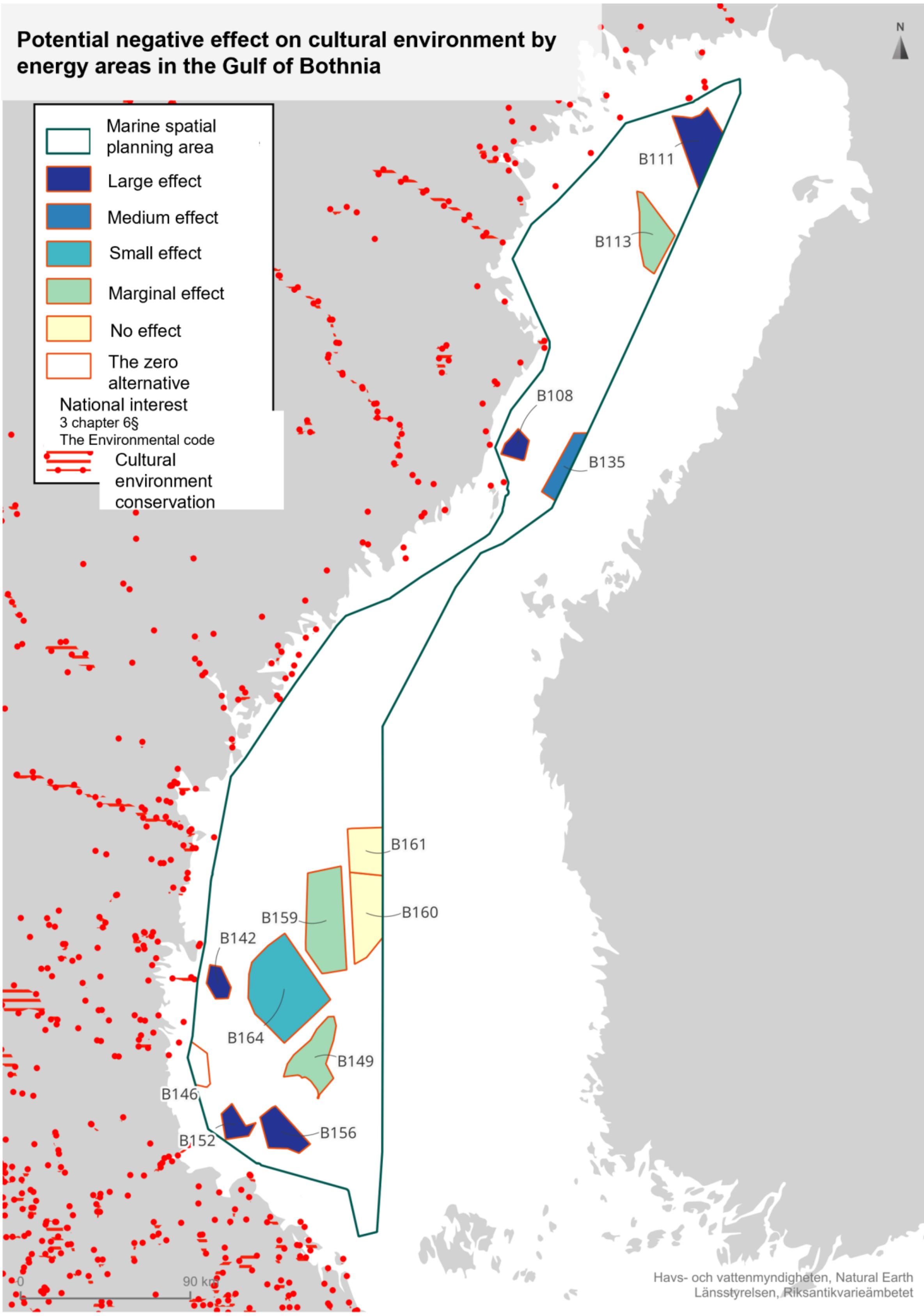


Figure 33. Potential indirect negative effect of energy areas on national interest claims for cultural environment in the Gulf of Bothnia. Dark color shows great effect and light color shows little effect.

*Gulf of Bothnia*

In the Bothnian Bay, B111 is considered to be able to cause a risk of negative impact primarily on *Malören* and *Sandskär*, which are covered by values such as fishing villages, seasonal fishing villages, communication environments and archaeological environments. Expressions of national interest claims include fishing villages, beacon grounds, labyrinths, wrecks, lighthouses, chapels, jetties and pilot station. In addition to the national interest claims being within the bounds of dominance/competition (see Chapter 8. Method) from B111, the energy area risks affecting communication environments where free views are an essential expression. It may also affect fishing villages where adjacent coastal and marine landscapes are an essential physical expression.

Energy area B108 is considered to be able to cause a risk of negative impact primarily on *Ratan*, *Stora Fjäderägg* and *Holmöns village*. These are covered by values such as a composite coastal and archipelago environment, seasonal fishing villages, ancient and medieval coastal environment, archipelago village and agricultural landscape. Expressions of national interest include, among other things, buildings linked to port operations, remnants of war, labyrinths, plots of land, lighthouses, and an unobstructed view of the sea out from Rataskär. In addition to the national interest claims being within the bounds of dominance/competition to B108, the energy area may affect communication environments where free outlooks are an essential expression. It may also affect the fishing village and coastal and archipelago environment where adjacent coastal and marine landscapes are an essential physical expression.

B135 is considered to be able to cause a risk of negative impact primarily on *Stora Fjäderägg*. The cultural environment includes seasonal fishing villages as well as ancient and medieval coastal environment. Expressions of national interest are covered by plots of land, a lighthouse, labyrinths and buildings linked to fishing activities. In addition to the national interest claims being within the bounds of dominance/competition to B135, the energy area may affect communication environments where free outlooks are an essential expression. It may also affect fishing villages and coastal and archipelago environments where adjacent coastal and marine landscapes are an essential physical expression.

*Southern Bothnian Sea*

In the Southern Bothnian Sea, B142 is considered to be able to cause a risk of negative impact primarily on the cultural environments *Agö, Drakö, Kråkö and Innerstön*, *Kuggörens*, *Bålsö and Prästgrundets fishing village*. The environments are covered by the coastal and archipelago environment, which through land uplift has different port locations from several centuries as well as representative 17$^{th}$, 18$^{th}$ and 19$^{th}$ century fishing harbor. Expressions of national interest include medieval archaeological environment, harbours, fishing communities, settlements, cemeteries and chapels. It also includes the maze in Bålsö, Prästgrundets, Kuggörens fishing village, as well as burial fields with cairns and stone settings in the latter two. In addition to the fact that these environments are within the bounds of dominance/competition to B142, the energy field may affect the archaeological environment where free views are an essential expression. It may also affect fishing villages and coastal and archipelago environments where adjacent coastal and marine landscapes are an essential physical expression.

B152 is considered to be capable of causing a risk of negative impact on national interest claims for cultural heritage conservation *in Norrlandet, Bönan and Utvalsnäs* and *Hållen and*

*Fågelsundet*. The national interest claims are described as recreational environments with parkland and large summer villas from the late 19th century, archaeological environment, fishing harbours, farmland and village environments with a cluster character. Expressions of national interest lie, among other things, in the fishing harbours, villas, viking burial fields, cultivation sites, as well as  medieval sites. In addition to these environments being within the boundary of dominance/competition to B152, the energy area may affect the communication environment and recreation environment where free views are an essential expression. It may also affect fishing villages and coastal and archipelago environments where adjacent coastal and marine landscapes are an essential physical expression.

B156 is considered to be capable of causing a risk of negative impact primarily on the national interest claim for cultural heritage conservation *Hållen and Fågelsundet*. The national interest claim environment is described as a farmed landscape, village environment with cluster character, fishing harbour and archaeological environment. Expressions of national interest are linked viking age burial fields, cultivation and medieval sites. In addition to the national interest being within the bounds of dominance/competition to B156, the energy area may affect the communication environment and recreational environment where free views are an essential expression. It may also affect the fishing village and coastal and archipelago environment where adjacent coastal and marine landscapes are an essential physical expression.

*Direct impact*

The marine spatial plan area of the Gulf of Bothnia contains a number of registered marine archaeological sites in both the proposed energy areas and those included in the zero alternative. Figure 34 shows recorded marine archaeological sites within and outside energy areas.

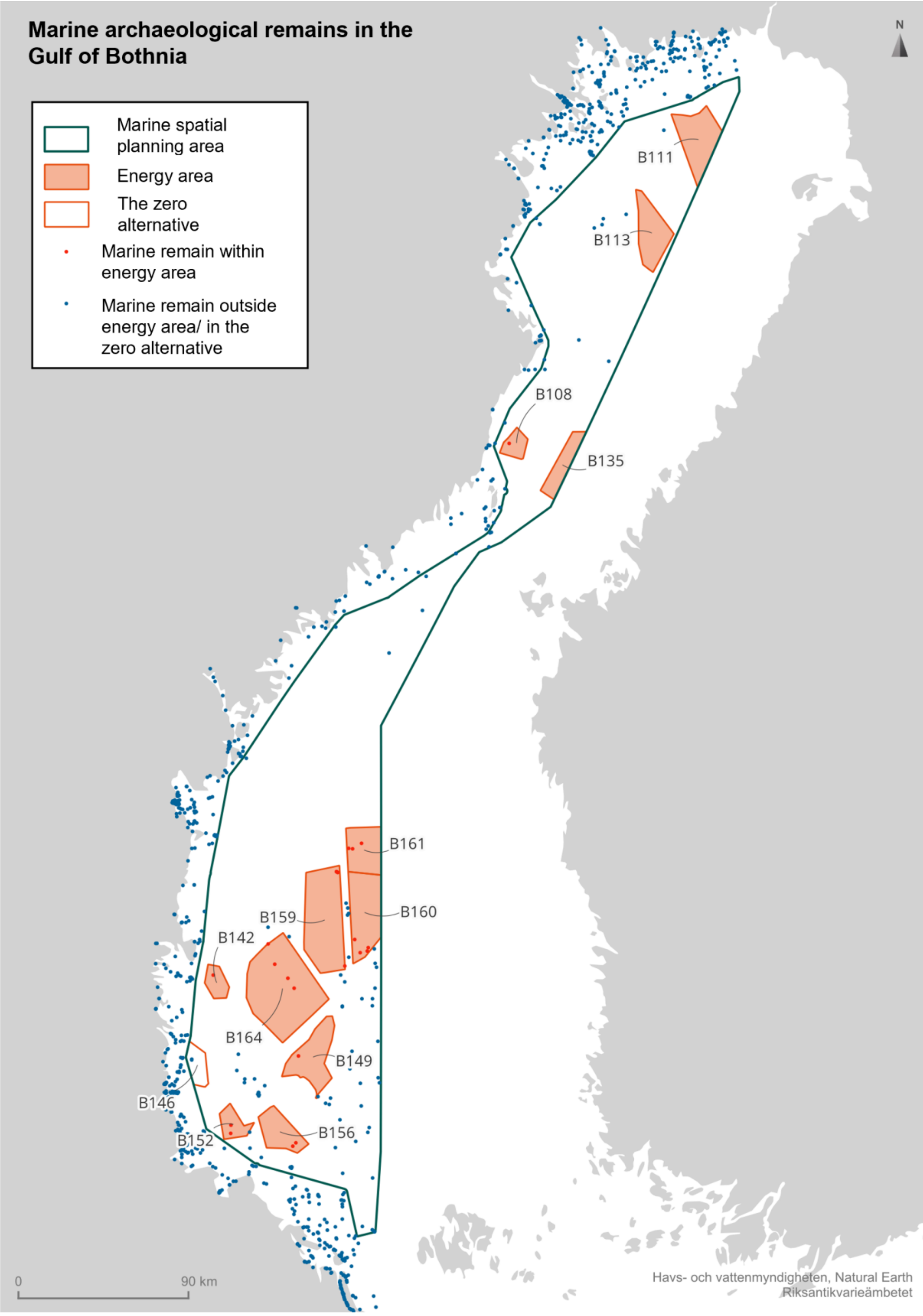


Figure 34. Risk of impact on marine archaeological sites.

Energy area B159 has the most registered marine archaeological sites in the area with five. B160 and B164 have four, B161 has three, B152 and B156 have two and B108, B142 and B149 have one each. B111, B113 and B135 have no recorded marine archaeological sites in the area. Table 15 provides an overview of the number of marine archaeological sites for individual proposed energy areas in the Gulf of Bothnia. Note that the compilation only refers to the sites that are registered in the Swedish National Heritage Board's Cultural Environment Register (Riksantikvarieämbetetet, u.y.). Since knowledge of the existence of marine archaeological sites in Swedish waters is not complete, the establishment of offshore wind power should be preceded by marine archaeological investigations where there may be marine archaeological sites (County Administrative Boards, 2024).

Table 15. Number of recorded marine archaeological sites per energy area in the Gulf of Bothnia. Source: The Swedish National Heritage Board's Cultural Environment Register (Riksantikvarieämbetetet, u.y.).

| Energy area | Number of marine archaeological sites |
|---|---|
| B108 | 1 |
| B111 | 0 |
| B113 | 0 |
| B135 | 0 |
| B142 | 1 |
| B149 | 1 |
| B152 | 2 |
| B156 | 2 |
| B159 | 5 |
| B160 | 4 |
| B161 | 3 |
| B164 | 4 |

*Indirect and direct impact – Regional value areas*

In the Gulf of Bothnia's marine spatial plan area, there are two energy areas that are expected to have a large negative effect on marine regional value areas: B108 and B142. These areas are wholly or partly within the territorial sea boundary and are therefore relatively close to the coast. Three energy areas are considered to have a medium negative impact on value areas: B111, B152 and B156. Two energy areas are considered to have little negative impact on value areas: B135 and B164, while three energy areas are estimated to have marginal negative effects on value areas: B113, B149 and B159. B160 and B161 are not considered to have any negative effect on value areas. Figure 35 below shows the estimated negative impact of each energy area on marine cultural heritage values based on the County Administrative Board's identification of regional value areas.

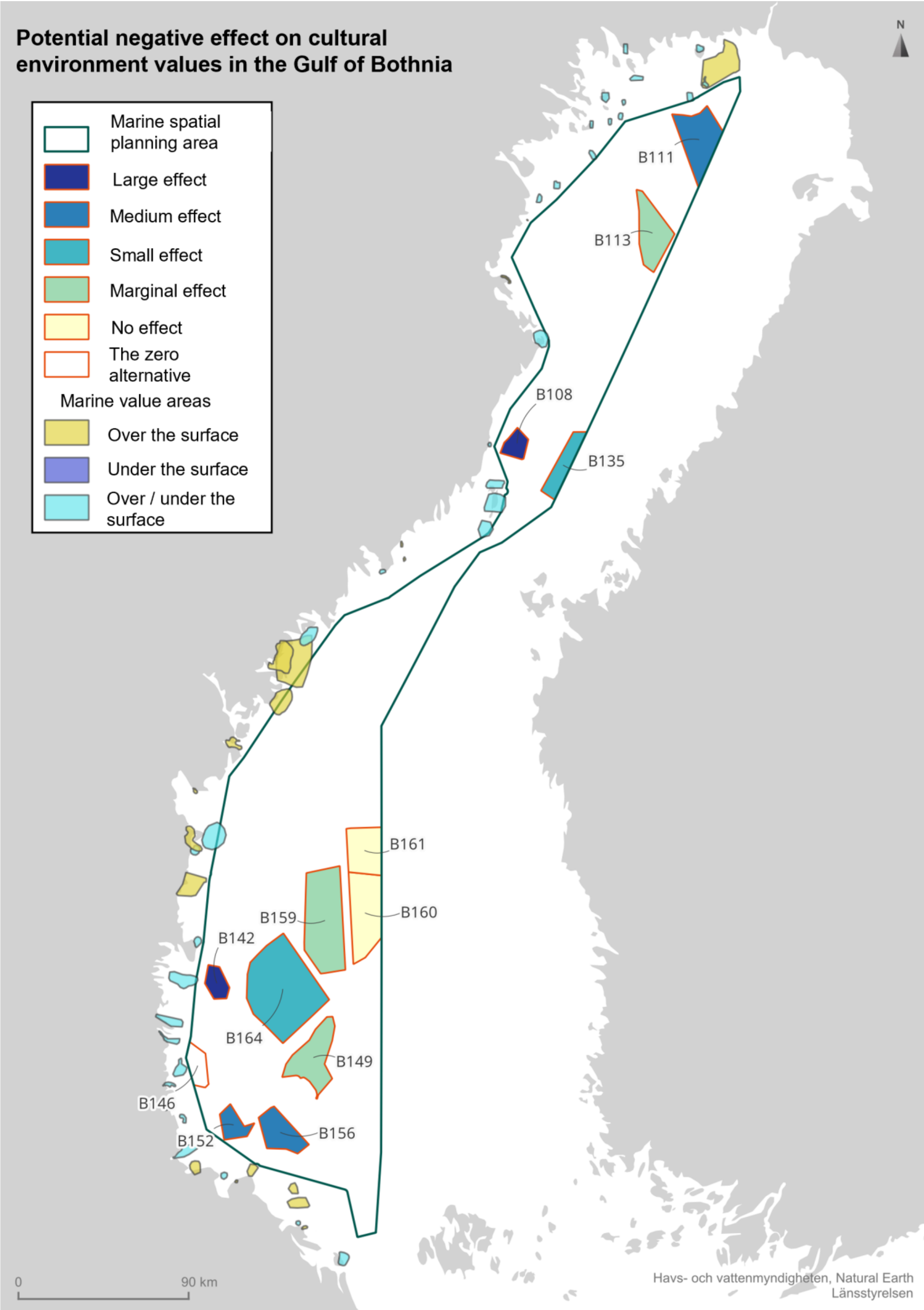


Figure 35. Indirect and direct negative impact on regional cultural heritage value areas.

*Gulf of Bothnia*

B111 is considered to be able to cause a risk of negative impact on the value areas *Malören*, *Sandskär*, *Haparanda archipelago* and *Likskär and Renskär*. All areas are sensitive to the establishment of tall facilities and other visually dominant features. Wreck sites that are sensitive to possible cabling are registered in close proximity to all value areas. Several value areas have expressed consideration needs that overlap with the energy area in the form of free lines of sight and outlooks (County Administrative Boards, 2024).

B108 is considered to pose a risk of impact on cultural environments within the *Ratan* value area. In the value area, the view from Rataskär's lighthouse, beacon and pilotage house towards the open sea is particularly sensitive to tall and large facilities. In the area there are a few registered wreck sites that require consideration when cabling. Furthermore, the expansion of wind power within B108 is expected to entail a risk of impact on the value areas *Holmön-Stora Fjäderägg* and *Ängesön*. Free views towards the open sea are important for the understanding of cultural environments in both areas of value. Registered wreck sites can be found in areas around both Stora Fjäderägg and Ängesön (Länsstyrelserna, 2024).

*Southern Bothnian Sea*

In the Southern Bothnian Sea there are a number of value areas that, to varying degrees, risk being affected by the establishment of wind power in areas B142, B152 and B156. B142 risks having a negative effect on cultural environments in the value areas *Agö-Kråköarkipelagen*, *Bålsö-Kuggörarna* and *Skärså-Prästgrundet*. For the value area Bålsö-Kuggörarna there are visual connections to the open sea. Wreckage sites are registered in and close to both value areas, which are at risk of being affected by cabling. Furthermore, B142 risks having a negative impact on the Skärså-Prästgrundet value area. The area is sensitive to the establishment of facilities that interfere with the experience of the fishing village. A few marine archaeological sites are registered in the waters off Prästgrundet (Länsstyrelserna, 2024).

B152 together with B156 has the risk of having a negative effect on cultural environments in the value areas *Fågelsundet and Björns lighthouse*, *Kniven* and *Sikhjälma*. Fågelsundet and Björn's lighthouse risk being visually affected, especially northeast from Fågelsundet and from Björn's lighthouse towards the open horizon. Kniven and Sikhjälma include both historical fishing villages, where the connection between the fishing village and the open sea is of great importance. Since relatively few marine archaeological sites are registered in these areas, they are not considered to be sensitive to cabling. B152 also risks affecting *the Iggö-Iggöhällan shipwreck area*. The shipwreck area has a dense presence of wrecks that make it sensitive to cabling and other installations on the seabed. Iggöhällen is sensitive to tall facilities to the east. The value area also includes the cultural environment type farmed landscape, which is unique within the marine spatial planning area. B152 also risks having a negative impact on cultural environments in the value area Norrlandet-Utvalsnäs-Lövgrund-Limön. The value area includes two types of cultural environment that are rare in the marine spatial planning area, namely summer entertainment environment and holiday home environment that may to some extent be sensitive to wind power exploitation. Finally, the B152 is also close to *Skutskär*, which has industrial environments and port facilities. However, the area is considered to be less sensitive to the establishment of taller objects due to its industrial character. In the value area, there are relatively few known shipwrecks and thus not sensitive to cabling (County Administrative Boards, 2024).

In addition to the impact on the former value areas in the previous paragraph, the B156 also risks visually affecting Örskär's lighthouse site to the north. The area has links to shipping as well as an open and barren archipelago landscape that allows for long lines of sight towards the horizon, making the area sensitive to facilities that interfere with that experience. Consideration is given to maintaining clear lines of sight northwards. Relatively few marine archaeological sites around Örskär and cabling is considered possible. Finally, B156 is close to the value area *Norrboda-Söderboda*. The area includes fishing villages and archipelago farming, where sight lines northeast from Gräsö's eastern side are to be protected. In the archipelago there are marine archaeological sites, which makes the area unsuitable for laying cables without careful mapping of the marine archaeological conditions (County Administrative Boards, 2024).

*Other impacts on cultural environment*

Energy areas in the Southern Bothnian Sea can cause negative effects on landscape protection areas off the northern coast of Uppland, see previous chapter 3.3.3. The Haparanda Archipelago National Park is located about 10 kilometres from energy area B111. The national park includes cultural-historical values to be protected, not least the buildings within the park.

*Cumulative and transboundary effects*

In the Gulf of Bothnia, Sweden's and Finland's offshore energy areas can influence each other's cultural environments. Despite the fact that all projects in Finland's exclusive economic zone have been rejected pending new legislation (Ministry of Economic Affairs and Employment, 2024), there may in the future be an offshore wind power area outside Ijo-Simo in the Gulf of Bothnia along Finland's marine spatial plan 2030 (Finnish marine spatial plan, 2021), which may have an indirect impact on the value area Haparanda archipelago (20 kilometres away) and the value area and the national interest Sandskär (26 kilometres away). Further south in the North Kvarken there is Kvarken's northern offshore wind power area which can have a negative effect mainly on the national interest claim Stora Fjäderägg and the value areas Holmön-Stora Fjäderägg (28 kilometers away) and Ängesön (23 kilometers away).

For the impact of Swedish energy areas on the Finnish cultural environment, B111 may risk indirectly affecting cultural environments in Finland, in particular the Bothnian Bay National Park and cultural environments in Kemi (25 kilometres away). The B135 risks having a visual impact on the UNESCO World Heritage site Kvarken Archipelago in Finland (22 kilometres away).

The cumulative effects of energy areas on the cultural environment of the Gulf of Bothnia vary, but are mainly concentrated in the Southern Bothnian Sea. However, the B111 in the Bothnian Bay can provide indirect cumulative effects for twelve national interest claims for cultural heritage conservation to a varied extent at a distance of up to 70 kilometers. It is also expected to have negative cumulative effects on 12 marine value areas. Further south, the cumulative effects from B108 are expected to affect up to six national interest claims for cultural heritage conservation and five marine value areas. In the Southern Bothnian Sea, the cumulative effects are expected to be large from B142, as it can have an indirect negative impact on up to 15 national interest claims for cultural heritage conservation and twelve marine value areas. The large cumulative impact is expected due to B142's number of affected cultural environments and its relative proximity. Furthermore, indirect cumulative impacts from B152 and B156 are expected to be large. B152 and B156 may have indirect effects for up to 14 and 15 national interest claims for cultural heritage conservation and up to 15 and 16 marine value areas respectively.

For cumulative effects on specific cultural environments, Ratan, Stora Fjäderägg and Holmöarna are expected to have greater negative cumulative consequences when establishing wind power in B108 and B135, based on its proximity. The cumulative effects, based on how many energy areas can have an indirect impact on cultural environments in the Bothnian Bay, are not expected to be as large when establishing wind power in B111 and B113. Many cultural environments along the Gulf of Gävle are expected to have greater cumulative effects when establishing most energy areas. B142 combined with B164 can be perceived as a larger contiguous area that covers a long stretch of coastline, which can have a negative indirect impact on cultural environments at Hornslandet, Agö and Skärså-Prästgrundet. B152 and B156 together give rise to indirect cumulative effects for a large number of cultural environments along the coasts of Gävle and Uppland, especially at Fågelsundet, Örskär and Norrlandet.

Below is table 16 showing the total sum of cumulative impacts from each energy area in the Gulf of Bothnia. The highest cumulative impact on national interest claims for cultural heritage conservation is B142 and B152 has the highest cumulative impact on marine value areas.

Table 16. Shows cumulative effects in the Gulf of Bothnia from energy areas on national interest claims for cultural environment conservation and marine value areas, based on the number of cultural environments affected, as well as its proximity. The higher the cumulative impact. The method is described in Chapter 8.

| Energy area | Cumulative impact on national interest claims for cultural heritage conservation | Cumulative impact on marine value areas |
|---|---|---|
| B108 | 50,5 | 30 |
| B111 | 76 | 71 |
| B113 | 24,5 | 27 |
| B135 | 32,5 | 27,5 |
| B142 | 128,5 | 45 |
| B149 | 10 | 19 |
| B152 | 67,5 | 75,5 |
| B156 | 60,5 | 63 |
| B159 | 8 | 7,5 |
| B160 | 0 | 1 |
| B161 | 0 | 3 |
| B164 | 47,5 | 27 |

## 3.4. Effects on the management of water, soil and the physical environment in general

### 3.4.1. Energy extraction

Offshore wind power has relatively good conditions in the marine spatial planning area of the Gulf of Bothnia. Wind conditions in the area are generally good, although slightly lower than the other plan areas. The plan area has an elongated coastline with relatively shallow water areas, and relatively lower levels of interest conflicts, compared to other marine spatial plan areas. However, conflicts of interest also exist to varying degrees within the planning area, such as defence and nature values. A wind power project in the Southern Bothnian Sea (part of B146) has been granted a permit, but no installations have yet been built.

Characteristic of the plan area is the ice formation in winter. Maritime authorities have raised the risk that offshore wind power can affect ice formation, which can make it more difficult for both shipping and icebreaking. During normal winters, the entire Bothnian Bay and large parts of the Bothnian Sea, including the Northern Quark, freeze. A particular challenge for the plan area is thus uncertainties regarding coexistence for energy production and winter navigation, based on the spatial flexibility considered necessary for accessibility and icebreaking (Ringsberg et al., 2024), see section 2.4.5 prerequisites and assessment Maritime transport.

The plan's guidance on energy extraction is based on the adopted marine spatial plan, national interest claims for wind power, planning documents *Proposals for suitable energy extraction areas for marine spatial plans* (Energy Agency 2023a), which is handled as a public interest of substantial importance. The adopted marine spatial plan, national interest claims for wind power and municipal comprehensive plans have also been taken into account.

The draft marine spatial plan includes 13 areas for energy extraction. Areas for energy production cover a total area of approximately 6,600 km2, approximately 17 per cent of the plan area and are estimated to generate an annual electricity production of approximately 130 TWh, based on assumptions of 5 MW/ km2 and 4000 full load hours per year, see plan document part 6.1 for further description (Swedish Agency for Marine and Water Management, 2025). The target for all marine spatial plans corresponds to a total of 120 TWh in annual production, which means that not all identified energy areas are assumed to be fully realized in the plan area.

Figure 36 below shows all energy areas in the marine spatial plan, as well as areas in the initial planning document, *Proposals for suitable energy extraction areas*, presented in 2023 (Energy Agency 2023a). The map in the figure also shows a grading of the conditions for energy extraction for each energy area based on wind and depth conditions. Note that the classification does not include other factors such as distance to the connection point or other conditions.

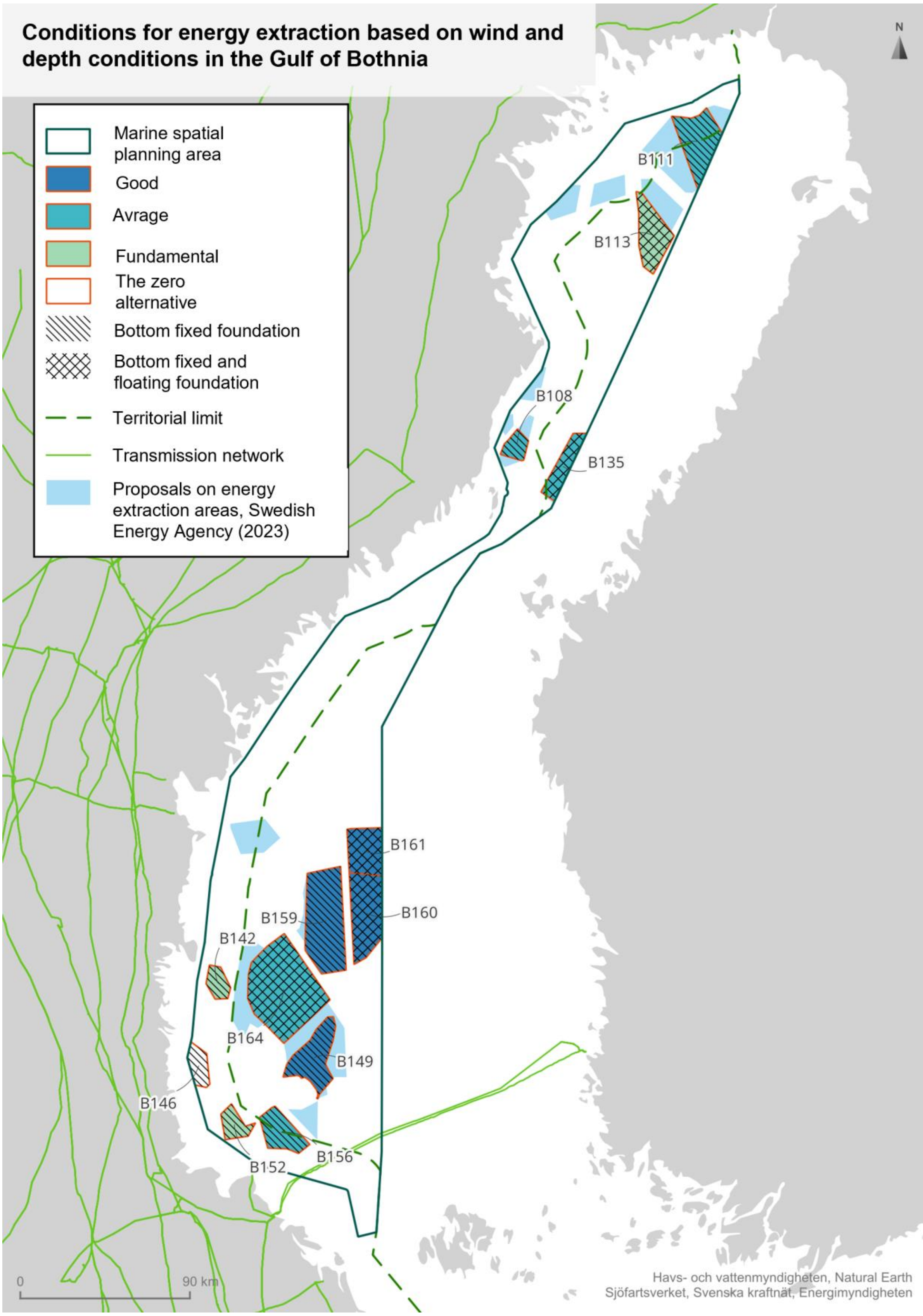


Figure 36. Map of energy areas in the plan proposal, zero alternatives, and initially identified suitable energy areas for energy extraction (Energimyndigheten.2023a), as well as conditions for energy extraction based on wind and depth conditions.

*Area-specific assessments, nature and conditions for energy extraction*

All energy areas in the marine spatial plan The Gulf of Bothnia are included in the documentation on suitable energy extraction areas for marine spatial plans presented in 2023 (Energy Agency, 2023a). The assessment of the respective energy areas and their conditions for energy extraction has been limited to the assessment of their nature in terms of wind and depth conditions. In a weight-of-evidence assessment, values for wind and depth are added to a total value on a four-point assessment scale. For more information see Chapter 8. Method.

Table 17. Grouping, for wind speed and depth indicators.

| Group/points | Wind speed, medium | Depth, medium |
|---|---|---|
| 1 | Less than 8,5 m/s | Depths exceeding -70 m |
| 2 | Between 8,5 and 9 m/s | Between -40 and -70 m |
| 3 | Greater than 9 m/s | Founder than -40 m |

The marine spatial plan consists of three sea basins and the assessment of energy areas is presented from north to south, see also Table 18 below.

*Gulf of Bothnia*

The plan provides guidance on four areas for energy extraction.

- In the far north are the two medium-sized areas B111 and B113, with wind conditions between 8.5 and 9 m/s and where B111 is estimated to have a depth between 40 and 70 meters, respectively B113 deeper than 70 meters.
- The energy area B111 is located partly in the territorial sea of the municipality of Kalix, partly in the exclusive economic zone. Establishment of wind power is assumed to consist of a mix of bottom-fixed and floating foundations. For the area, special needs for space and flexibility for winter navigation, icebreaking and ship traffic to Swedish and Finnish ports have been noted (Ringsberg et al., 2024). Area B113 is located in the outer sea area, partly in the territorial sea but mostly in the exclusive economic zone. For the area, wind farm with floating foundations is assumed.
- To the south of the sea area is the area B108, which is located in the territorial sea and Robertsfors municipality. Areas have been expanded compared to the adopted marine spatial plan (Government, 2022a), but are smaller than the area identified as a public interest of substantial importance (Energy Agency 2023a). The area is located relatively shallow and is assumed to consist of a wind farm with bottom-fixed foundations.
- At the level of B108, further out at sea and into the economic zone, is area B135 located. The area is considered to have good wind conditions and depth conditions with depths from 40 to 70 meters. Establishment of wind power is assumed to consist of a mix of bottom-fixed and floating foundations.

*Northern Bothnian Sea and North Kvarken*

In the sea area North Bothnian Sea and North Kvarken, the energy area B161 is located in an exclusive economic zone. Wind conditions are considered to be very good and the depth rangefrom 40 to 70 meters. Wind farms are assumed to consist of a mix of foundation types. Area B161 is located next to energy areas B160 and B159 in the South Bothnian Sea.

*Southern Bothnian Sea*

The plan provides guidance on eight energy extraction areas. The areas are relatively concentrated. They are considered to have relatively favourable conditions regarding wind and depth conditions. The relative coastal areas are estimated to have slightly lower wind conditions, compared to areas further out from the coast. All areas are estimated to be at depths between 40 to 70 meters.

- In the central Bothnian Sea, areas B159, B160 are adjacent to the EEZ, and adjacent to area B161. Wind farms are assumed to consist of a mix of foundation types.
- The relative coastal areas (B142, B152, B156) are wholly or partly located within the territorial sea and municipal plan areas. The municipalities concerned are Hudiksvall, Söderhamn, Gävle, Älvkarleby, Tierp and Östhammar.
- For the area Storgrundet B146 there is a licensed project for the establishment of wind power and national interest claims for wind power. The area is also listed as an energy extraction area in the previously adopted marine spatial plan for the Gulf of Bothnia 2022 (Regeringen, 2022a). The area is also specified in the plan as an investigation area regarding coexistence with shipping.
- In the marine area, two major energy areas are located, B159 and B164, corresponding to approximately 1,000 and 1,500 square kilometres, respectively.

The concentration of areas in the Southern Bothnian Sea may entail the possibility of synergies in terms of infrastructure and maintenance, but also the risk of an overall large cumulative impact in terms of other interests in the area, wind farms among themselves, and capacity for connection point to the transmission network. With regard to conflicts of interest, see the overall assessment, as well as the respective assessment aspects and the need for adjustments when establishing a wind farm.

In the Southern Bothnian Sea there are three investigation areas for energy extraction (B149, B152, B156). The distribution areas relate to the investigation of uncertainties regarding the potential impact of the areas on migratory birds. The plan also includes particular consideration for the interests of defence in all areas, as well as particular consideration for high nature and/or cultural environmental values for a number of areas.

In the Southern Bothnian Sea, the plan specifies the use of electricity transmission, which applies to transmission grid cables between Sweden and Finland.

Table 18. Plan proposal Gulf of Bothnia. Overview of guidance on energy extraction, location and conditions.

| **Gulf of Bothnia** ***Sea area; North to South*** | **Area** **Permits/ Zero-Option** | **Design ation** | **Km²** | **Of which km² in territorial sea ~22 km (12 NM)** | **Municipality** | **Estimated electricity production, TWh*** | **Adoption; Typ** | **wind, Group** | **Depth Group** |
|---|---|---|---|---|---|---|---|---|---|
| **Gulf of Bothnia** | B111 | Efkn | 570 | 280 | Kalix | 11,4 | Bottom-fixed | 2 | 2 |
| **Gulf of Bothnia** | B113 | Efk | 480 | 3 | Luleå | 9,6 | Mix | 2 | 1 |
| **Gulf of Bothnia** | B108 | Efkn | 150 | 150 | Robertsfors | 3,0 | Bottom-fixed | 1 | 3 |
| **Gulf of Bothnia** | B135 | Efk | 290 | 9 | Umeå | 5,7 | Mix | 2 | 2 |
| **Northern Bothnian Sea and North Kvarken** | B161 | EF | 440 | 0 | | 8,8 | Mix | 3 | 2 |
| **Southern Bothnian Sea** | B159 | EF | 1040 | 0 | | 20,7 | Bottom-fixed | 3 | 2 |
| **Southern Bothnian Sea** | B160 | EF | 690 | 0 | | 13,8 | Mix | 3 | 2 |
| **Southern Bothnian Sea** | B164 | Efk | 1480 | 0 | | 29,7 | Mix | 2 | 2 |
| **Southern Bothnian Sea** | B142 | Efkn | 165 | 165 | Hudiksvall | 3,3 | Bottom-fixed | 1 | 2 |
| **Southern Bothnian Sea** | B149 | E(utr) fn | 550 | 0 | | 11,0 | Bottom-fixed | 3 | 2 |
| **Southern Bothnian Sea** | B146 (Permits) | Efkn | 190 | 190 | Gävle, Söderhamn | 3,8 | Bottom-fixed | - | - |
| **Southern Bothnian Sea** | B152 | E(utr) fkn | 180 | 185 | Gävle, Älvkarlaby | 3,7 | Bottom-fixed | 1 | 2 |
| **Southern Bothnian Sea** | B156 | E(utr)f kn | 360 | 190 | Tierp, Älvkarleby Östhammar | 7,3 | Bottom-fixed | 2 | 2 |
| ***Total, approximatel y*** | | | *6 600* | *1 170* | | 130 | | | |

* Assumption according to marine spatial plan, 5MW/km², 4000 full load hours.

*Overall description*

The marine spatial plan generally has medium-quality conditions for energy extraction and wind power establishment. Conditions regarding wind are medium, but the areas are located in relatively shallow areas. A number of areas further out from the coast are considered to have very good conditions with regard to wind conditions. The coastal areas generally have slightly lower wind conditions. However, coastal areas are considered to be favourable in terms of distance to the connection point and transmission network.

The areas of size also have an impact on suitability and investment conditions. The energy areas vary in size, from around 150 km² to 1 500 km², with an average size of around 500 km², which is larger compared to other plan areas. The areas, B159 and B164, each cover an area of more than 1 000 km².

Depth conditions are important for the feasibility of wind power projects in terms of investment costs and technology choices. At depths down to about 70 meters, construction is assumed primarily with bottom-fixed foundations. At greater depths, mainly floating foundationsare assumed. Bottom-fixed foundations can also be assumed to be relatively more likely to be realised in the near future, compared to floating foundations, based on the degree of establishment of the technology and the cost of establishment (Energy Authority, 2023a). The variety of areas and a relatively high proportion of areas with average depths between 40 and 70 metres mean that the plan can be assessed as relatively favourable for energy establishment from both a short and a long perspective.

Figure 37 below shows the surface distribution of the areas in terms of depth and foundation depth. Depths vary within and between energy areas but about 90 percent are located at an average depth of 40 to 70 meters. Half of these surfaces are assumed to be built with a mix of foundations, suggesting that depth varies within these areas.

A smaller proportion, about 5 percent are located at the average depth shallower than 40 meters, remaining just over 5 percent are located at depths greater than 70 meters. Approximately half of the plan's energy extraction areas, approximately 3 200 km$^2$, are assumed to be suitable for wind farms with bottom-fixed foundations. The remaining areas are expected to have a mix of bottom-fixed and floating foundations.

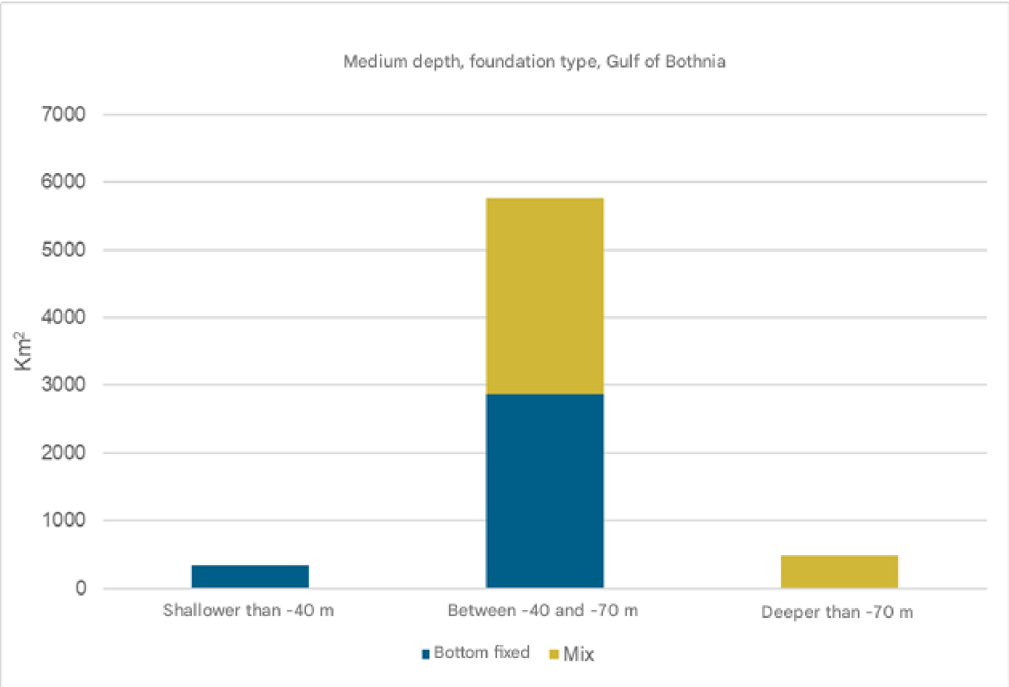


Figure 37. Distribution of areas for energy extraction (km2), average depth and foundation type.

The distance of the areas to the connection point for electricity distribution is also important in terms of investment costs. Where actual connection points may actually take place depends on a number of factors and involves relatively large uncertainties. The distance to the connection point depends, for example, on the location of the available connection point to the transmission network, the depth conditions, as well as on the choice of technology and on the design and possible location of storage and energy carriers, see also method section. Assessment of distance is not included in the criteria assessment but is shown to some extent taking into account whether the energy area is located within the territorial sea or not. If areas are located in the territorial sea is also relevant due to overlap with municipal planning, which can affect decision-making and permit processes. In the area of the territorial sea where national, regional and municipal plans overlap, all plans apply. More than 80 per cent of the area of energy areas is located in an economic zone, see Figure 38 below.

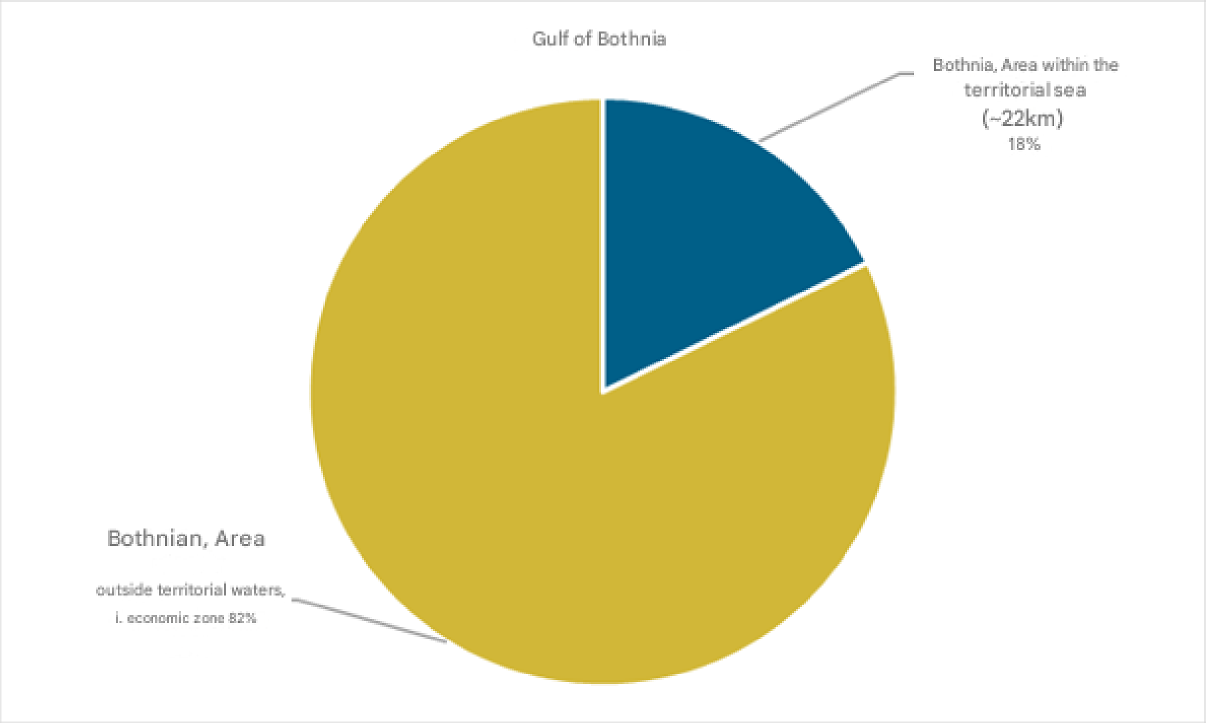


Figure 38. Distribution of energy extraction areas (km2), territorial sea and exclusive economic zone.

*Marine spatial plan, zero alternatives and guidance on energy extraction*

Potential electricity production is estimated on the basis of surfaces for energy extraction to be approximately 6,600 $km^2$ corresponding to approximately 130 TWh, based on assumptions of 5 $MW/km^2$ and 4,000 full load hours. The corresponding area for energy extraction in the baseline scenario (permitted) is approximately 190 $km^2$. A number of areas of national interest and public interest of substantial importance for wind farms have been considered incompatible with other uses. The original planning documents of substantial public interest identified 18 areas suitable for offshore wind power in the Gulf of Bothnia, with a total area of approximately 9,100 $km^2$. During the planning process, these areas have been adjusted and some have been excluded taking into account other interests such as commercial fishing, defence, recreation, cultural environment and shipping. Total areas for energy extraction in the draft marine spatial plan, zero alternatives, public interest of substantial importance, national interest claims, and adopted marine spatial plan, see Table 19 below.

Table 19. Estimated area for energy extraction in plan proposals, zero alternatives, public interest of substantial importance, national interest claims and adopted marine spatial plan (Government, 2022).

| Indicative basis for energy extraction | Gulf of Bothnia, approximate area ($km^2$) |
|---|---|
| **Plan proposal** | 6580 |
| **Zero alternatives (Permitted parks)** | 190 |
| **Public interest of substantial importance, Swedish Energy Agency (2023b)** | 9 080 |
| - **Of which surface in planes;** | 6 030 |
| **National interest claims** | 1 340 |
| - **Of which surface in level, approx. $km^2$** | 510 |
| **Plan adopted** | 1 520 |

The plan’s guidance on energy extraction, including consideration guidance, is considered to contribute to the achievement of objectives for offshore wind energy. The plan is also expected to contribute positively to increased predictability for the activities concerned, as well as as a knowledge base for permit processes, regional and municipal planning. The areas that were initially identified as suitable for energy extraction (the Swedish Energy Agency, 2023a) and which during the planning process were assessed as not being the most suitable use, mean that the total area for energy extraction has decreased, which can be assumed to potentially affect activities in offshore wind power and affect other sectors in plan areas negatively.

*Realisation, projects and bidding zones*

A prerequisite for realising the marine spatial plan's energy areas is investment interest in the construction and operation of wind farms. In principle, all energy areas in the plan area are undergoing permit processes for the establishment of wind power.

Assumptions about potential electricity production and distribution between Sweden's bidding zones can be made based on projectors applications and specified connection areas. According to project information and investment data from the County Administrative Boards' interactive map service *Vindbrukskollen* (Länsstyrelserna u.y.), approximately 80 percent of the potential electricity production in the plan area is expected to be connected to bidding zone 2, see Figure 39 below. For more detailed information on electricity consumption and related to bidding zones and users, see Section 2.4.1. Energy.

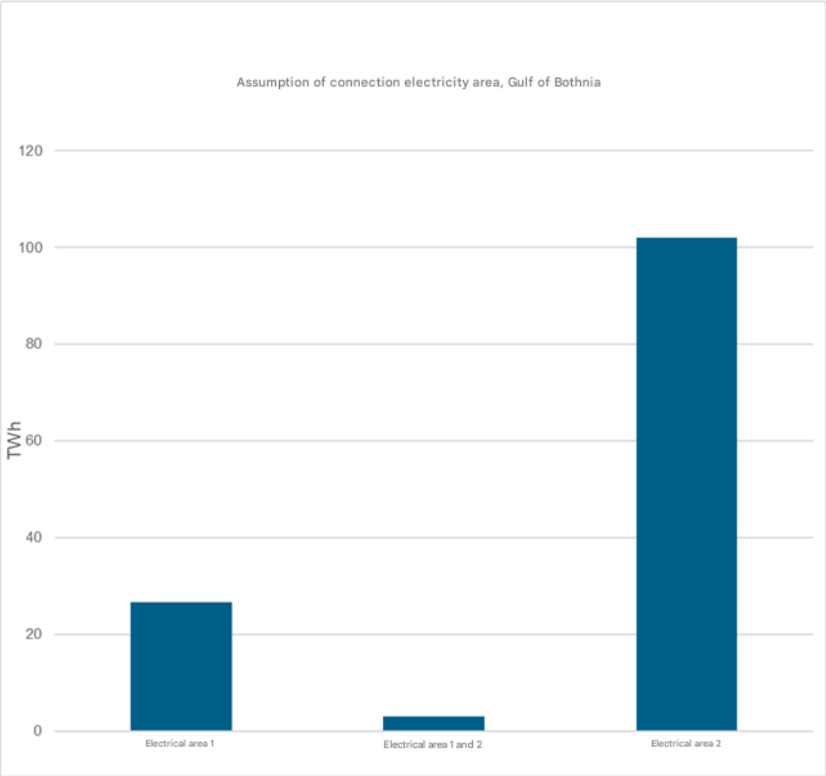


Figure 39. Assumptions on connection bidding zones.

*Indirect impact - energy*

Guidance on energy extraction in the marine spatial plan may involve indirect land claims for cabling and other electricity transmission infrastructure and/or various forms of energy storage, such as hydrogen. In turn, this may entail additional land and water claims and also potential indirect environmental impacts and additional risk management on shore and land, see section 2.4.1. Energy. The extent of land claims on coast and land, and where these land claims will take place, depends, among other things, on the type of technology and wind turbines, as well as connection points or storage forms for each wind farm.

*Achievement of objectives, national and municipal interests - energy*

The plan proposal for the Gulf of Bothnia contributes to the achievement of the objectives of the Government's current assignment to amend marine spatial plans for offshore wind power and national energy policy objectives, as well as national targets on climate and fossil-free electricity supply. It is also expected to contribute to the transformation of the industrial and transport sectors and to strengthening the conditions for employment at local and regional level, see Section 2.4.1. Energy.

With regard to essential functions and activities, according to national classification (MSB, 2021), the plan proposal is expected to contribute to the conditions for ensuring electricity supply in the country. However, there are some questions regarding the relatively large proportion of energy areas located outside the territorial boundary, in the Swedish exclusive economic zone, regarding potential risk and impact on the essential functions such as maintaining or ensuring, for example, control and monitoring, and maintenance and fault repair of infrastructure.

For territorial sea areas, the national marine spatial plan overlaps with regional and municipal plans. The plan's guidance on energy areas overlaps with municipal plans for the municipalities of Kalix, Robertsfors, Hudiksvall, Söderhamn, Gävle, Älvkarleby, Tierp and Östhammar.

*Cumulative and transboundary effects*

Cumulative effects on areas for energy extraction can mean impacts between the areas, both positive and negative. When establishing several areas nearby, there may be synergies in terms of infrastructure and maintenance. Negative cumulative impacts can occur based on limitations and scope of nearby wind farms, limitations in connection capacity, increased levels of conflicts of interest and possible impact on wind conditions between the farms. This may be relevant both nationally and in relation to the establishment of wind farms in neighbouring countries.

The plan’s guidance on energy extraction may also have an impact and have an impact on neighbouring countries, similar to those identified at national level, mainly in Finland. This applies cumulatively as individual impacts, such as impacts on shipping, especially with regard to winter navigation, as well as nature values such as migratory birds and migratory routes between countries. See the respective assessment for more information.

### 3.4.2. Recreation

The Gulf of Bothnia has a varied coastal landscape with high outdoor and nature values and great potential for the development of the tourism industry in both summer and winter. The Bothnian Bay archipelago with tour boat traffic and ice roads, the Haparanda Archipelago National Park and the High Coast World Heritage Site are significant attractions. Hornslandet and Gräsö archipelago are also popular areas for recreation.

In the Gulf of Bothnia's marine spatial plan area, there are two energy areas that are considered to entail a risk of large negative effects on recreation: B108 and B142. These areas are completely within the territorial boundary and are therefore relatively close to the coast. In additional energy areas, the risk of negative effects on recreationis considered to be medium: B111 and B156. Two energy areas are considered to give rise to a risk of a small negative effect: B113 and B164. Two energy areas are considered to entail a risk of marginal effects on recreation: B135 and B152. Four areas are not considered to have any effect on recreation values: B149, B159, B160 and B161. In area B146, there are permits, and the area is included in the zero alternative, therefore it is not subject to an impact assessment. Figure 40 below shows the estimated negative impact of the respective energy area.

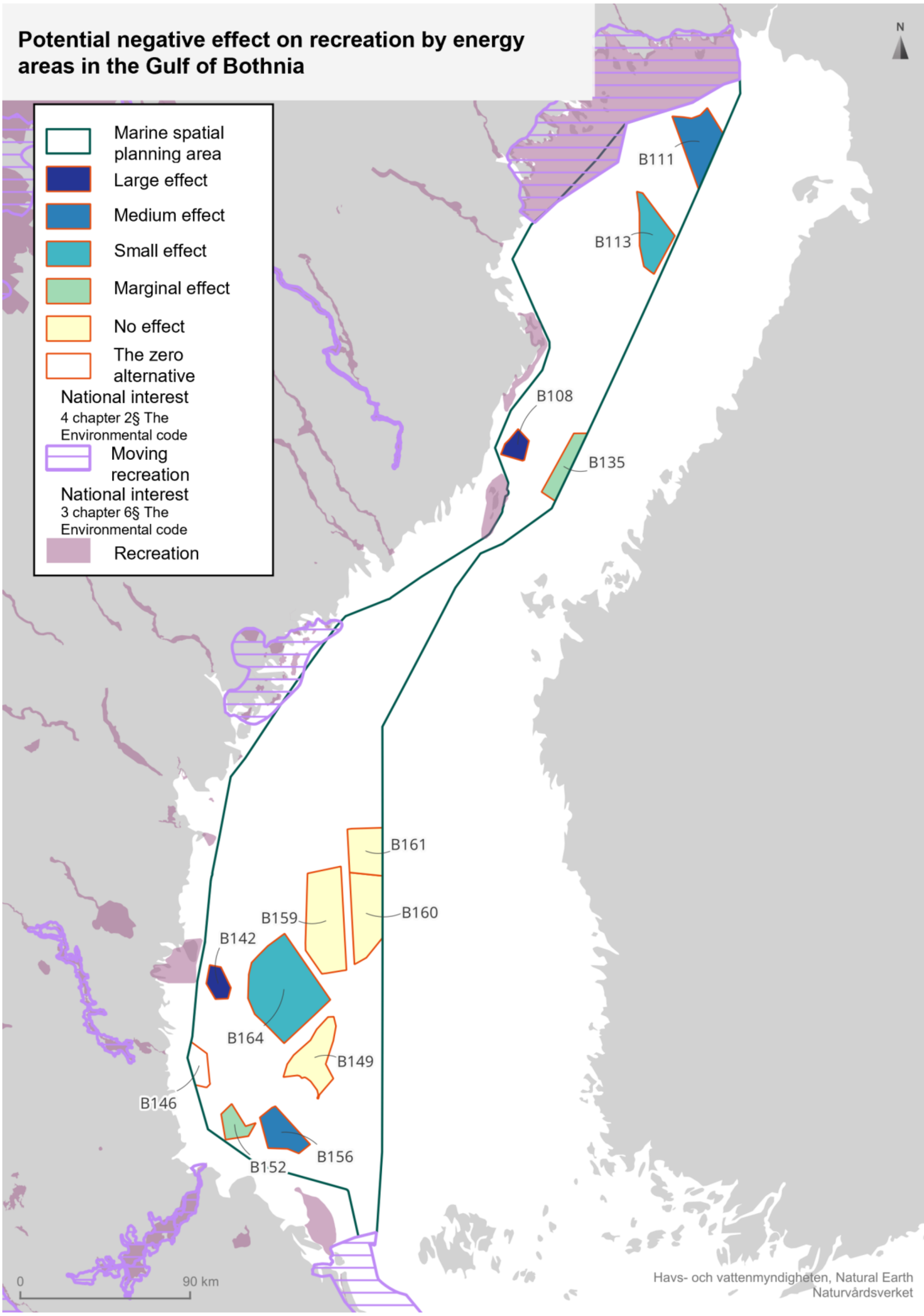


Figure 40. Potential negative effect on recreation of proposed energy extraction areas in the Gulf of Bothnia. Dark color shows great effect and light color shows little effect.

*Area-specific assessments*

*Gulf of Bothnia*

In the Gulf of Bothnia, B111 is considered to have a potential negative effect on national interest claims for recreation and national interest for mobile recreation. *Norrbotten's coast and archipelago* together with *Haparanda Archipelago National Park* north of the energy area have great values for recreation and outdoor activities in the area include nature and cultural experiences, swimming, canoeing, paragliding, recreational fishing and dog sledding. Values for the experiences include low noise levels and attractive landscapes and further out in the coastline there are values of stillness, silence and untouchedness. The B111 is located about 9.5 kilometres from the Haparanda Archipelago National Park and *Malören,* which are particularly designated as important areas for recreation in the outer archipelago. The distribution of B111 means that parts of the area of national interest and the values of untouchedness, stillness and landscape can be negatively affected. Cumulative impact on the experience values from wind power installations should be taken into account.

The national interest claims for recreation *Holmöarna* islandsand *Lövånger Coast* include activities such as boating, recreational fishing, bird watching, canoeing, skiing, ice skating and hiking. Both areas have experience values such as stillness, silence, low noise and attractive landscapes that may be affected by the establishment of wind power. B108 is located about 10.5 kilometers south and 9.5 kilometers north of the Lövånger coast and Holmöarna islands, respectively. The energy area is considered to have a potential negative effect on national interest claims for outdoor activities, as the proposed energy area is near the coast. For this area together with B135 cumulative impacts need to be considered. In addition to the removal of B107 and B139 as energy areas in marine spatial plans proposal, B108 has been adjusted in southern and northern parts of its extent.

*Southern Bothnian Sea*

In the Southern Bothnian Sea, B142 is expected to have a negative effect on national interest claims for recreation *Hudiksvall coast with Hornslandet* located about 5.5 kilometers from B142. In the area of national interest there are opportunities for various activities on land, including snowshoeing, bird watching and cave visits, where the area of national interest also includes the archipelago. Values that can be affected by the establishment of wind power are untouchedness, stillness, silence, low noise and attractive landscape. The value description shows that the Hudiksvall coast with Hornslandet is considered one of the most beautiful coastal sections in Gävleborg County and at the same time one of the most valuable areas for outdoor activities and recreation. The report *Proposals for suitable energy extraction areas for marine spatial plans (Energy* Agency, 2023a) also notes that the area is relatively untouched and unexploited and has a varied range of outdoor activities in a culturally, geologically and biologically interesting environment. Exploitation and various types of installations (e.g. industrial installations) and noise-generating activities (e.g. wind turbines) risk damaging these values. The area of national interest is part of a preparatory phase for the establishment of a new national park.

Further south west of B156 there are national interest claims for recreation *Nedre Dalälven and Billudden* with activities such as hiking, recreational fishing and running. The value description states that the landscape is important and in the northern sub-area the view of the sea is important. When exploiting or otherwise interfering with the environment, tourism and recreation, in particular the interests of mobile recreation, shall be taken into account. The southern part of the B156 overlaps with the landscape protection area Öregrund *and Östhammar*. South of the energy area there are national interest claims *Öregrund-Gräsö archipelago* with activities such as ice skating, recreational fishing and boating. According to previous assessments, developments within or in the immediate area in the form of infrastructure facilities and facilities could lead primarily to the archipelago being exposed to sound or light pollution, changed landscapes or other effects that could have negatively affected the perception of the national interest claim and thereby damage its values. Öregrund-Gräsö archipelago is covered by the values of untouchedness, stillness, silence, low noise and attractive landscape image.

*Accessibility*

Despite no direct overlap with energy areas and national interests for recreation in the Gulf of Bothnia, the activities and experiences described as parts of the values can be affected, especially the more sea-based, such as boating, recreational fishing and canoeing. In summary, it is the more coastal energy areas that can affect accessibility and perceived accessibility, especially B108 and B142.

Recreational shipping in the Gulf of Bothnia occurs mainly along the coastline, with most activity in the North Bothnian Sea and the North Kvarken and the Southern Bothnian Sea. Based on historical data on recreational boating activity, it is energy areas B152 and B156 that can affect recreational shipping in the Gulf of Bothnia (Emodnet, 2022). B152 has tendencies towards north-westerly – south-easterly routes that may affect accessibility and perceived accessibility in the maritime area. The activity of recreational shipping can be viewed in a general way using information from automatic identification systems (AIS data). Not all recreational craft use AIS, which means that the actual prevalence of recreational craft is more extensive. See Figure 41 and **Fel! Hittar inte referenskälla.** for recreational boating in the Gulf of Bothnia.

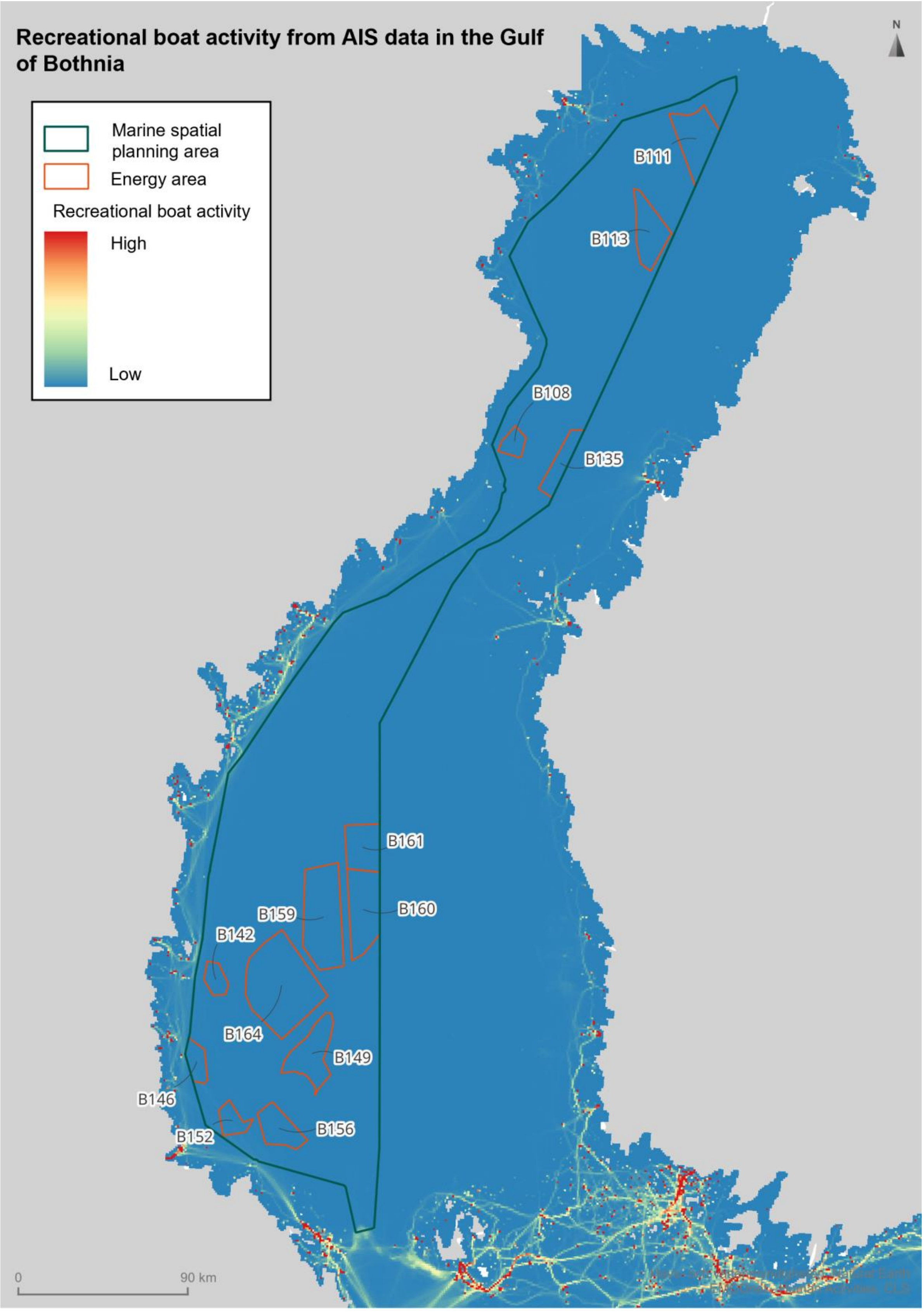


Figure 41. Prevalence of recreational boating activity in proposed energy areas in the Gulf of Bothnia based on an average of hours per month in the years 2017 – 2022 (Emodnet, 2022).

Table 20. Prevalence of recreational boating activity in proposed energy areas in the Gulf of Bothnia based on an average of hours per month in the years 2017 – 2022. The data is based on activity from at least one leisure boat in the energy field (Emodnet, 2022).

| Energy area | Recreational boat activity average hours/month 2017 - 2022 |
|---|---|
| **B108** | 0,2 |
| **B111** | 0,1 |
| **B113** | 0,1 |
| **B135** | 0,2 |
| **B142** | 0,6 |
| **B149** | 0,5 |
| **B152** | 2,2 |
| **B156** | 1,1 |
| **B159** | 0,9 |
| **B160** | 0,4 |
| **B161** | 0,3 |
| **B164** | 1,7 |

*Other impacts on recreation*

In the Gulf of Bothnia is the national park Haparanda archipelago with great values for recreation. The entire Norrbotten archipelago offers recreation unique experiences. Sandskär's nature and culture offer an attractive character, as well as good harbour and bathing places. Experiences within the national park may be affected by energy area B111, not least visually in view of its proximity of 10 kilometers. In the Southern Bothnian Sea there is a national interest for high-exploited coastline (Chapter 4, Section 4 of the Environmental Code) with direct overlap with the south-eastern part of energy area B156. The national interest Arkösund to Forsmark includes natural and cultural heritage values along the coastline and includes restrictions on industrial plants that are subject to the government's permit assessment under Chapter 17 of the Environmental Code. Within the area, the interests of recreation, primarily mobile recreation, must be taken into account when assessing the admissibility of development companies or other interventions in the environment.

*Cumulative and transboundary effects*

The cumulative effects of energy areas on recreation in the Gulf of Bothnia vary and are generally considered to be small. The effects are mainly visual and concentrate on certain areas. In the Bothnian Bay, the Norrbotten archipelago is expected to be affected cumulatively by B111 and B113, where the effects are expected to be greater at the construction of both areas. In North Kvarken, both B108 and B135 are expected to have cumulative effects on both the national interest claims Lövångerkusten and Holmöarna, where B108 has a greater impact based on its proximity to recreation areas. The Hudiksvall coastline with Hornslandet risks being affected cumulatively by the establishment of B142 and B164. For Nedre Dalälven and Billudden, together with the mobile recreation within Nedre Dalälven, it can be affected cumulatively by B152 together with B146, which is included in the zero alternative. B156 is expected to have cumulative effects primarily on the risk interest claim for recreation Öregrunds-Gräsö archipelago and Nedre Dalälven and Billudden.

For cumulative effects on specific national interests for recreationin the Gulf of Bothnia, the areas of Norrbotten coast and archipelago, Lövånger coast, Holmöarna islands and Hornslandet that could possibly have been affected by the establishment of energy areas are highlighted. To some extent, the national interest claims Nedre Dalälven and Billudden and Öregrund-Gräsö archipelago can also be affected by the establishment of wind power in B152 and B156.

Although all Finnish projects in Finland's exclusive economic zone have been rejected pending new legislation (Ministry of Economic Affairs and Employment, 2024), Finnish energy areas could potentially have some impact on recreation in Sweden, following their marine spatial plan 2030 (Marine spatial plan of Finland, 2021). The energy area outside Ijo-Simo in the northern Bothnian Bay can have visual effects on the Haparanda Archipelago National Park, as well as national interests in the Norrbotten Archipelago. Kvarken's northern offshore wind power area in North Kvarken is located 22.5 kilometers from the national interest claim Holmöarna Islands, which can have indirect effects on its values and experiences.

Energy areas in the Gulf of Bothnia are expected to have a primarily visual impact on recreation in Finland, not least *the Bothnian Bay National Park and the* Sea *Lapland tourism and recreation area, which* is about 24 kilometres from the B111. The B108 is located about 22 kilometers from the tourism and recreation area *of the Kvarken Archipelago* on the Finnish side, which can give some visual effects. Crossings for pleasure boats to and from Finland are generally assessed to be small throughout the marine spatial planning area, but with the highest concentration in North Kvarken to and from Finland. The energy areas on both sides are not expected to have any major consequences for recreational shipping to and from the countries.

### 3.4.3. Tourism

According to the coastal municipalities in the Gulf of Bothnia comprehensive plans, tourism is an industry that the municipalities invest in. The coast, the archipelago, the untouched nature and the open sea are seen as assets for the continued development of the tourism industry. Tourism is also seen as a potential way to attract more people to settle in the area (Region Västerbotten, u.y.). The conditions for the tourism industry are closely linked to qualities in the landscape, conditions for recreation and cultural environments with the indirect consequence that where there is a high risk of impact on these factors, there is also a risk of impact on the tourism industry. However, according to research, there are uncertainties about what the impact on the tourism industry might look like. One of the reasons is that people perceive wind power in different ways (LTU, 2023). Studies suggest that the majority do not allow elements of wind farms to influence the choice of destination. Some are attracted by wind turbines while others are discouraged, see Section 2.4.2 Recreation. Most of those who choose to refrain a destination because of visible wind turbines instead choose to visit a nearby destination. Furthermore, there is disagreement in research as to whether or not wind turbines have a negative impact on property prices (Bolin et al., 2021). There are studies that have been able to show reductions in prices of up to 15 percent. There are also studies that have not been able to find a statistically significant relationship between wind power establishment and property prices. A Danish study showed an impact linked to onshore wind power but not from offshore wind power (Jensen et al., 2018).

*Southern Bothnian Sea*

The tourism industry is a growing industry according to the comprehensive plans for the area's coastal municipalities. In the Gulf of Bothnia there are 13 energy areas, eight of which are located in the Southern Bothnian Sea. About half of them are relatively coastal, while the other areas, which are larger in area, are further out to sea. In one area (B146) there is a licensed wind farm. The area is located about 14 kilometer from the coast, to the island of Storjungfrun it is about 3 kilometer. Areas B142, B152, B156 are located between 8 and 25 kilometer from the coast. The impact on the tourism industry could consist of a redistributive effect where visitors opt out of locations with visible wind turbines such as in the area around the southern parts of the Southern Bothnian Sea and instead choose to locate their stay in another part of the Gulf of Bothnia or the Baltic Sea.

*Northern Bothnian Sea and North Kvarken*

In the area around the High Coast, the tourism industry is important for the municipalities concerned (Översiktsplan Kramfors kommun, 2013; Översiktsplan Örnsköldsvik Municipality, 2012). The area is covered by Chapter 4, Section 2 of the Environmental Code, which means that the interests of tourism and recreation must be taken into account in particular when assessing the admissibility of development companies or other interventions in the environment. See section 3.4.2 Recreation, for assessment outdoor activities. An energy area, B161 is located in the North Bothnian Sea. The area is located at a great distance from the coast and is not considered to have any impact on the landscape, recreation, cultural environment or shipping and should therefore not have any impact on the tourism industry.

*Gulf of Bothnia*

The tourism industry is an industry that the regions in the area see as important to strengthen (Swedish Lapland Visitors Board, 2024; Region Västerbotten Tourism, 2023). Activities linked to the tourism industry create jobs, especially for young people, women and people with a foreign background, groups that people are keen to choose to move to and stay in the region. In the Gulf of Bothnia there are four energy areas. Two of them are located in the southern parts, one of which, B108, is coastal and is located about 7 kilometers from the coast. There is a risk that there may be a redistribution effect at local level if visitors choose to spend their stay elsewhere because of the location of the wind turbines. The other two energy areas are higher up in the northern part of the Bothnian Bay. B111 is located about 10 kilometers from Sandskär and 35 kilometers from Haparanda. B113 is located about 30 kilometers from the coast. Where there is a negative impact on the landscape, recreation and cultural environment, there is also a risk of negative impact on the tourism industry.

The area is home to the Norrbotten archipelago, which is covered by Chapter 4, Section 2 of the Environmental Code. See section 3.4.2 for recreation assessment.

### 3.4.4. Defence

No assessment is made at marine spatial plan level for the interests of defence. See chapter 2.4.4 for general effects.

### 3.4.5. Shipping

Maritime traffic in the plan area is less intensive compared to other plan areas, but it is still frequent and of great importance. The traffic includes both routes to and from ports within the plan area and between Sweden and Finland. Norrland's industries rely heavily on maritime transport to reach consumers both within Sweden and internationally. This results in extensive traffic to both Swedish and Finnish ports. Maritime transport plays a crucial role for regional industry. It strengthens its accessibility and competitiveness and enables it to reach consumers in Sweden and abroad on whom it depends. Maritime transport in the plan area, especially in the North Bothnian Sea and the North Kvarken, faces several challenges:

- *Navigation conditions* - The level area has some limited manoeuvrability due to depth conditions and narrow passages within the level area. Through North Kvarken, shipping is conducted for safety reasons in a traffic separation system (TSS) because the passage is narrow and shallow.
- *Winter conditions* - In the Bothnian Bay there are special conditions in winter with thick and extensive sea ice. This affects the conditions for shipping, which needs large areas and access to alternative shipping routes to ensure accessibility in the event of icing.
- *Icebreaking* - For the Gulf of Bothnia plan area, there are particular challenges and uncertainties regarding winter navigation and icebreaking. Climate change is expected to bring milder winters, but may still mean more complex ice formation with severe ice conditions for icebreaking, for example through increased occurrence of ice embankments.

*Proposal for a marine spatial plan, energy extraction and shipping*

The plan proposal for the Gulf of Bothnia will provide guidance on 13 areas for energy production, corresponding to an area of approximately 6,600 km2, approximately 17 percent of the marine spatial plan area. Marine spatial plans do not provide guidance on specific safety distances to shipping, but these will be required for all areas using energy extraction. Safety distances shall be adapted to local conditions according to risk assessment (Swedish Maritime Administration, Swedish Transport Agency, 2023).

In the northern part of the plan area, the Bothnian Bay, two energy areas are guided, B111 and B113. These areas are potentially likely to affect winter navigation, limiting the flexibility and need for alternative routes needed by winter navigation and icebreaking. In a study conducted by Chalmers, the risk of impact on winter navigation has been analyzed. The result shows that the energy area B111 has a risk of relatively large impact while B113 has a risk of more limited impact. During ice winters, icebreaking is carried out and often other areas are used than the established fairways used during summer time, such as B111, B113, B135 (Ringsberg et al., 2024).

Over North Kvarken, between Umeå and Vaasa in Finland, European route 12 runs via ferry line and has shipping use in the plan. Umeå municipality's comprehensive plan points out a reserve for the future fixed connection between Umeå and Vaasa. The Finnish marine spatial plan identifies this route and Finland intends to investigate a functional connection.

Slightly further south, the energy areas B108 and B135 are located. All energy areas in the northern plan area are located between ship routes and with maritime traffic to and from ports in Finland, Haparanda and Luleå, Skellefteå, Umeå.

A larger spatial share of the marine spatial plan's proposed energy areas, approximately 4,660 km2, is distributed over eight energy areas in the Southern Bothnian Sea. There are several fairways in the area, which means that all energy areas are adjacent to a fairway of varying extent. A number of areas are located in clusters, which can have a multidimensional impact on maritime routes, i.e. wind farms on more sides of the fairway, this applies to areas B159, B160 and B164.

In the Southern Bothnian Sea, guidance is given on energy areas B149, B164 where the current fairway is located and classified as a national interest. The fairway runs for northbound traffic from South Kvarken, around eastern Finngrunden and up to Sundsvall harbour. The plan's guidance remains from the decided plan and means that shipping must instead take the turn at eastern Finngrunden and follow a northbound route and then turn off towards Sundsvall's port in the northwest. The effect on shipping will be a longer mileage. The extended itinerary is estimated to be around 15 kilometers. Traffic intensity in the fairway is estimated to be less extensive, but may nevertheless affect shipping in the area and activities at local level. The main maritime traffic is freight vessels, tankers and fishing vessels (EMODnet, 2022). Guidance on energy areas B164 and B149 and extended distance can affect accessibility and also mean indirect environmental impact and increased emissions.

Figure 42 below shows the potential effect of each energy sector on shipping in the Gulf of Bothnia.

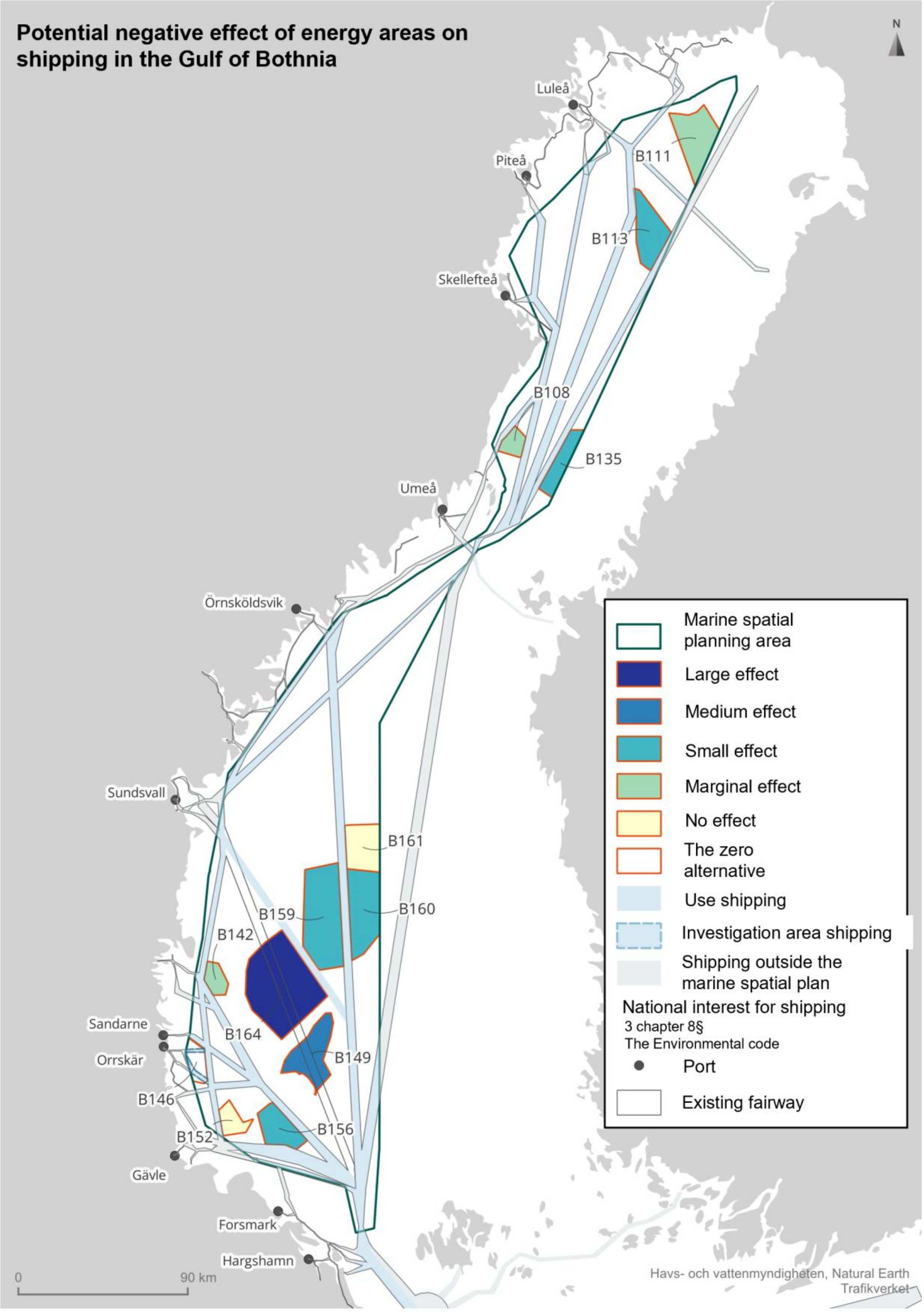


Figure 42. Relative potential negative effect of energy areas on shipping in the Gulf of Bothnia. Dark color shows great effect and light color shows little effect.

*Indirect impact*

A potential indirect impact may be an increased risk of allision, i.e. collision between ships and wind turbines. Allision can have environmental effects such as oil spills, etc. Other potential indirect impacts from guidance in areas of energy concern general accessibility for rescue and remediation work in maritime accidents at sea. For more information, see section 2.4.4 Defence and the Swedish Maritime Administration's and the Swedish Transport Agency's knowledge base on offshore wind power (Ahlström 2023, and the Swedish Maritime Administration and the Swedish Transport Agency 2023).

Further information on spatial analyses of shipping in the area can be found in the Lighthouse report *Maritime interest in sea space in light of an increased expansion of wind power (Hjerpe* Olausson, J. et al.,2024).

*Assessment Marine Spatial Plan*

The plan's guidance on energy areas is considered to constitute a potential impact on shipping, primarily with regard to energy areas B149 and B164, which are located in existing national interest claims for shipping. The plan's guidance with several energy areas in the southern Bothnian Sea also risks having a potential cumulative effect on shipping. If several nearby energy areas are realized, this may mean that areas adjoin fairways sideways in several directions, such as the B159 and B160.

Possible indirect effects and environmental effects are increased accident risk, taking into account the increased number of fixed installations at sea, the risk of collision during crowding, and the risk of impact on the availability and aggravation of rescue operations.

The challenge for shipping in the entire plan area is also uncertainties regarding the impact on winter navigation. This may be particularly relevant for the northern plan areas and energy areas B111, B113 and B135, which risks limiting shipping and the flexibility of icebreaking activities for alternative shipping routes and icebreaking.

In the marine spatial planning area there is uncertainty regarding the impact of wind power expansion on ice formation, which has consequences for both energy expansion and shipping. The use of shipping in the marine spatial plan is based on national interest claims for shipping that coincide in large parts with established shipping lanes and shipping routes, except in the South Bothnian Sea. It is estimated that the potential impact on shipping is medium. Assessment is made partly on the basis of the impact on national interest claims, energy areas B149 and B164, and taking into account uncertainties and potential impact of winter navigation especially areas in the northern planning area (B111, B113 and B135).

*Cumulative and transboundary effects*

Potential impact on Swedish and international shipping is assumed to be limited on the basis that the recommendation and permit for the establishment of wind farms take into account the required safety distances. However, uncertainties remain regarding winter navigation and further knowledge is needed to facilitate coexistence in the plan area. The same assessment also applies to shipping to and from neighbouring countries, mainly to and from Finland.

### 3.4.6. Commercial fishing

Swedish commercial fishing in the Gulf of Bothnia is sparse in the open sea, but more frequent in the coastal waters. The economically most important species are vendace, salmon and herring, where fishing for vendace and salmon takes place outside the marine spatial plan area closer to the coast. At times, pelagic fishing takes place in the Southern Bothnian Sea, mainly around the offshore banks and in the south-eastern parts of the sea area. There is also bottom trawling. Fishing is clearly seasonal, as the area is ice-covered for parts of the year. In addition to Swedish fishing for Baltic herring, there is also extensive Finnish Baltic herring fishing in the area (Swedish Agency for Marine and Water Management, 2025).

*Impact on commercial fisheries*

In the southern Bothnian Sea there are three areas of national interest for commercial fishing in the marine spatial plan area, see Figure 41. At Finngrunden there is a spawning and nursery area for fish. The area is partly covered by a Natura 2000 site and the entire area B157 is listed as use nature in the marine spatial plan. The other two areas of national interest are catch areas and are located west and east of Finngrunden. The marine spatial plan indicates the use of commercial fishing for these areas. With this national interest, the marine spatial plan meets the demand for commercial fishing.

The plan’s guidance on other uses, such as energy, affects the conduct of commercial fisheries outside identified risk interest claims. This is particularly true in the Southern Bothnian Sea, where several energy areas in the plan proposal are located. The actual impact depends on opportunities for coexistence and adaptations such as the design of wind farms or of commercial fishing, spatially or regarding fishing methods. The total landing value for Swedish trawl fisheries for pelagic species in Sweden’s territorial waters and exclusive economic zone was annually on average approximately SEK 36 million over the period 2013-2023 (Waldo S. & Blomquist J., 2024b).

In all energy areas of the Southern Bothnian Sea, pelagic fishing has taken place in the period 2013-2023, but to a very different extent. Based on the assumption that each trawl line passing through the proposed energy areas is affected by an establishment, the impacted landing value represents approximately 12 percent of the landing value from Sweden's territorial sea and exclusive economic zone in the Gulf of Bothnia. If Swedish fishing in the Finnish zone is included, the proportion decreases. This proportion should also be seen in the light of the fact that vessels fish pelagically both in the Gulf of Bothnia and in the Baltic Sea. Fishing in the Baltic Sea is not affected by the proposed marine spatial plan, as no new areas for energy extraction are proposed in the Baltic Sea. The total average annual landing value of catches from pelagic pelagic pelagic trawls in the Baltic Sea was about five times higher than in the Gulf of Bothnia during the period. The actual impact will depend on opportunities to continue fishing in the area and to move operations to other locations (Waldo S. & Blomquist J. 2024a).

The energy areas that could have the greatest impact on fisheries based on landing values in 2013-2023 are energy area B164, and area B149, where fishing with trawls for pelagic species is conducted. It is difficult to fish with pelagic pelagic trawls in a wind farm. The establishment of wind power is likely to exclude trawl fisheries for pelagic species in these energy areas (Waldo S. & Blomquist J. 2024a).

Table 21. Landing value from Swedish fisheries affected by energy areas in millions of SEK (mkr) and percentage (%) of total landing value, for the Gulf of Bothnia. Annual averages 2013-2023.

| Type of fishing | Landing value affected by energy areas (SEK million) | Landing value from Swedish territorial waters and exclusive economic zone (SEK million) | Share of landing value from Swedish territorial waters and exclusive economic zone affected by energy areas | Landing value including part of fishing in other countries' territorial sea and exclusive economic zone total (SEK million) | Share of landing value incl. share of fishing in other countries' territorial sea and economic zone affected by energy areas |
|---|---|---|---|---|---|
| **Trawl fishing pelagic species (floating trawl and bottom trawl) in the Gulf of Bothnia** | 4,5 | 36 | 12% | 45 | 10% |

Source: Waldo, S. & Blomquist, J., 2024b How is Swedish fishing affected by offshore wind power? Supplementary material (AgriFood Report, no. 2024:2). AgriFood Economics Centre.

The impact assessment is based on the landing value generated by the trawl lines that partially or fully pass through the energy area. The areas are not classified as national interests, but fishing with both pelagic trawls and bottom trawls for pelagic species is carried out in the areas.

The plan proposal includes an expansion of areas in the Gulf of Bothnia with particular consideration to high nature values with regard to migratory birds, soft bottom and reef environment. Areas with special nature considerations can in the long term, depending on the nature value the consideration refers to, benefit commercial fishing based on potentially enhanced ecosystem services.

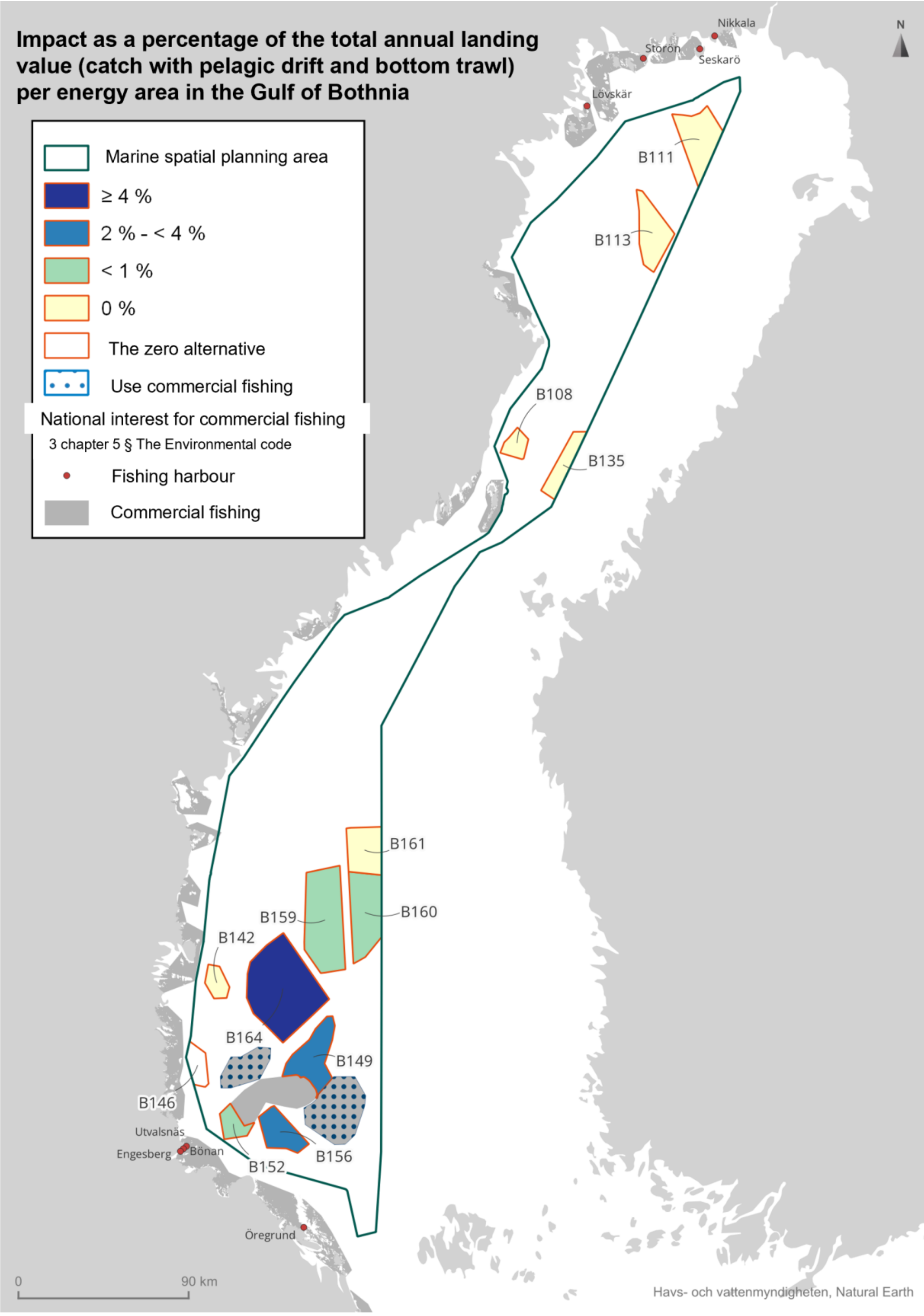


Figure 43. The map shows proposed energy areas, use of commercial fishing and national interest claims for commercial fishing in the Gulf of Bothnia. The figure also shows the impact as a percentage of the total annual landing value (pelagic floating or bottom trawl) per energy area.

*Indirect environmental impact of land and water use*

The guidance provided by the marine spatial plan and the potential impact on commercial fisheries may also have indirect environmental effects. Changes in the spatial and intensity of commercial fishing may involve a shift in fishing activity to other areas, possibly with longer driving distances and increased air emissions, such as greenhouse gases. It may affect the conditions for commercial fishing if operating costs increase due to longer distance and driving time and/or income decreases due to reduced catch. Actual outcomes and indirect environmental impact regarding the impact on mileage and air emissions are considered uncertain and also due to the development and conversion of the fleet to more energy efficient and fossil-free fuels.

The area is mainly fishing with pelagic trawls, but also some fishing with bottom trawls. Potentially, this may mean that the impact on benthic habitats is expected to decrease in the energy areas where bottom trawling no longer takes place. However, the gross effect is mainly local and the overall net effect of reduced impact on benthic habitats depends on whether and to which other areas a possible relocation of bottom trawling takes place.

*National, regional, municipal interests*

The plan's guidance on the use of commercial fishing confirms national interest claims for commercial fishing. However, guidance on the use of energy may to some extent affect the conduct of commercial fishing in the plan area. The impact on commercial fishing can also affect activities and value chains dependent on marine resources, as well as other activities and facilities for landing and processing fishery resources. This includes, for example, port activities of local and regional interest in the plan area, as well as essential functions related to food security and primary production (see section 2.4.6. Commercial fishing).

For the marine spatial planning area, it is primarily Gävle municipality and the landing port Norrsundet whose landings come from fishing that has been carried out in any of the proposed energy areas that are affected. This may indirectly affect other operations that depend on certain landing volumes. In Norrsundet, 17.9 percent of the landed value comes from fishing that has been conducted in energy areas (Waldo S. & Blomquist J., 2024a) The actual impact on landings depends on the ability of the fishery to conduct fishing in places other than the energy areas.

*Cumulative and transboundary effects*

In addition to Swedish fishing, extensive Finnish fishing is taking place throughout the Gulf of Bothnia. Fishing takes place mainly in the southern Bothnian Sea and is believed to be affected by guidance on energy extraction in the area. The extent of the impact is difficult to assess, but is assumed to be mainly affected by energy areas located in the exclusive economic zone, such as area B156 which is located in both the economic and territorial sea and area B161 in the exclusive economic zone. The total potential impact on commercial fishing is therefore significantly higher than if one only looks at Swedish commercial fishing in the plan area.

Limited Swedish commercial fishing is carried out in two energy areas in the Finnish marine spatial plan, Archipelago Sea and the Southern Bothnian Sea (Finnish Marine spatial plan, 2021).

The impact on commercial fishing of all energy areas in the marine spatial plan for the Gulf of Bothnia is assessed to have some impact on the conduct of commercial fishing in the plan area, mainly in the case of Swedish pelagic fishing for herring, However, not all areas of energy in the marine spatial plan are assumed to be realised, and the actual impact and aggravation on the conduct of commercial fishing depend on which areas of energy are actually realised, as well as on opportunities for coexistence. Examples of different types of adaptation are: the design of the wind farm, adaptations in fisheries, e.g. fishing methods, as well as possibilities for relocation of fisheries to other areas.

The total potential impact on landing values and related activities for all fisheries may be significantly higher due to the existence of extensive Finnish fisheries.

Potential impact on commercial fishing, is also considered to entail indirect effects in terms of fishing value chains, processing industry, affected landing ports and municipal interests. See chapter 2.4.6. about national and municipal interests.

In terms of effects on the profitability of fishing enterprises, these depend on the extent to which fishing can move, how landings are affected and whether the costs of fishing operations change. The impact on individual companies depends on how their fishing patterns may need to be changed.

### 3.4.7. Reindeer husbandry

In the Gulf of Bothnia, it is relevant to highlight potential consequences for reindeer husbandry because there are designated national interest claims under Chapter 3, Section 5, and large-scale establishment of offshore wind power can affect reindeer husbandry. The impact can be visual, both from the turbines and the obstacle lighting as well as noise from construction and maintenance. Increased expansion of infrastructure linked to energy transfer on land such as cables, wires, transformers, together with other exploitation can contribute to deteriorating conditions for reindeer husbandry. Reindeer tend to avoid areas with wind power exploitation on land (Naturvårdsverket 2018, Skarin A. 2018), and the same may apply if the exploitation in the sea affects areas where reindeer graze on the coast and in the archipelago. Coastal pastures and archipelago islands are particularly important winter pastures as the milder coastal climate offers better conditions than inland lands that may be covered by thick snow cover and ice that makes it difficult for reindeer to graze the ground lichen (Sametinget, 2024, personal communication).

The energy areas B111 and B113 in the Bothnian Bay are within 10 kilometers, respectively 50 kilometers distance to the coast and national interest for reindeer husbandry. Area B111 can have visual effects, and risks disturbing reindeer. Effects that could arise are displacement from important pastures and, in the long term, a change in the Sami cultural landscape and cultural heritage. B113 could be perceived, but the visual impact is estimated to be relatively small. Of the remaining energy areas in the North and South of the Gulf of Bothnia, the B107, B139 and B108 are located between 12 kilometres and 20 kilometres from the coast, but they have no direct visual impact as the landscape and terrain between the coast and areas of national interest are hilly. The southernmost energy areas of the Gulf of Bothnia are so far away from reindeer herding areas that they should not be affected. Infrastructure building in connection with these energy areas will probably also end up south of Sundsvall, and is therefore not expected to have any impact.

The consequences of establishing offshore wind farms in areas that affect reindeer husbandry mean that it may be more difficult to conduct reindeer husbandry. Reindeer herding is linked to several different values in society, both intangible such as cultural heritage, identity, landscape and also material such as employment and food production. There are several factors that affect reindeer husbandry, where climate change is a factor that leads to more uncertain conditions in the longer term. Reindeer herding has a strong connection to the natural landscape and risks being affected to a large extent by climate-related effects. Consequences of exploitation resulting from energy extraction should be seen in a holistic perspective, where cumulative consequences of exploitation need to be investigated.

*Impact during construction, operation and decommissioning*

Table 22. Impact on reindeer husbandry in different phases, as well as possible consideration measures.

| Phase | Type of impact | Possible consideration measure |
|---|---|---|
| **Facility** | Increased traffic<br>Noise | Time adjustment after reindeer husbandry |
| **Operation** | Visual impact of wind turbines<br>Visual impact obstacle lighting<br>Impact on ice conditions | Location of wind turbines<br>Wind farm design |
| **Settlement** | Increased traffic<br>Noise | Time adjustment after reindeer husbandry |

## 3.5. Overall assessment Gulf of Bothnia

### 3.5.1. Nature and ecological aspects

The biodiversity and species composition of the Gulf of Bothnia is unique in view of the specific conditions prevailing in terms of, for example, salinity and contact with a large number of freshwater bodies. Fish stocks are generally relatively weak, and migratory salmon need to be taken into account. In the Bothnian Bay there is a unique population of ringed seals where the population is stable, but the species has been exposed to environmental toxins and the reproduction rate is weakened. Ringed seals depend on a stable ice sheet for breeding and rearing young. There are several important areas for both migratory and wintering birds. In the proposed marine spatial plan, the area for areas with particular consideration to high nature values has been increased with a focus on birds, ringed seals, and bottom habitats at Ulvödjupet. Together with other consideration areas and areas with the use nature in the adopted marine spatial plan, these are considered to signal the need for special protection and consideration when planning and regulating human activities. The new proposed areas can be seen as a complement to area protection, contributing to green infrastructure and ecosystem services and sustainable use in the Gulf of Bothnia.

The marine spatial plan provides guidance for extensive energy expansion in the Gulf of Bothnia, and this may entail the risk of major negative effects for birds, especially in the southern part. Western and Eastern Finngrunden are important for both wintering and migratory bird populations. Wind power expansion in connection with Finngrunden risks displacing birds living in the area. There is also a risk of collision with migratory birds as the proposed areas are adjacent to a migratory route towards Finland. Large-scale energy expansion is also negative for the ringed seal, as there is a risk that wind farms in the Bothnian Bay will affect the sea ice on which it depends for its reproduction. For benthic habitats, larger surface claims generally mean greater negative impact, but overall, the assessment is that the plan proposal has a small negative effect on the benthic habitat and that local adaptation can be made when planning. Similarly, it is considered that the risk of negative impact on fish spawning can be minimised by adapting the construction time to the spawning period for herring and vendace for wind power projects in energy areas close to the coast.

### 3.5.2. Recreation, cultural environment and landscape

Norrbotten is home to the Haparanda Archipelago, an area with high values for recreation and the cultural environment, including the Haparanda Archipelago National Park. At the same level as Umeå, there is Lövångerkusten and the Holmöarna islands, which are national interests for recreation. Further south is the High Coast World Heritage Site, which possesses unique qualities that are essential for the national recreation, the regional tourism industry, where the area is also an important cultural environment. The southern Bothnian Sea is home to Hornslandet, which is in the process of becoming a new national park thanks to its high natural and cultural heritage values.

In the proposed plan for the Gulf of Bothnia, a number of proposed energy areas are located within 25 kilometers of the coast: one at Haparanda archipelago, one at Holmöarna islands and several in the southern Bothnian Sea. Energy areas that are well within sight of the coast have a risk of having a major impact on cultural environments and recreation values. Landscape impact is also considered to be greatest in the southern Bothnian Sea. This risk is particularly high if several energy areas are established. There is a small risk of impact on recreational boat traffic in the areas of North Kvarken and along the Gävle and northern Uppland coasts, as some energy areas are located near the coast and near routes for recreational boats.

### 3.5.3. Energy extraction, shipping and commercial fishing

The marine spatial plan for the Gulf of Bothnia will provide guidance on 13 areas for energy production, which corresponds to approximately 17 percent of the marine spatial plan area. Energy areas in the territorial sea are located in the municipalities of Kalix, Robertsfors, Hudiksvall, Söderhamn, Gävle, Älvkarleby, Tierp and Östhammar. In general, the energy areas in the Gulf of Bothnia have good conditions for energy extraction, however, relatively lower than other marine areas in terms of wind conditions, but a relatively large area in shallow areas and in the southern Bothnian Sea relatively close to the coast. In some areas suitable for energy, other uses have been given priority, which may negatively affect the industry, affected companies in wind power planning in the planning area.

In the Gulf of Bothnia, there is uncertainty regarding the impact of wind power expansion on ice formation, which can have consequences for both energy expansion and shipping. The use of shipping in the marine spatial plan is based on national interest claims for shipping that largely coincide with established shipping lanes and shipping routes. In two energy areas in the Southern Bothnian Sea, however, guidance on the use of energy is given priority over the national interest claim for shipping, which means a changed route for the shipping concerned. The overall assessment of the potential impact on shipping in the plan area is difficult to make based on uncertainties regarding the impact on winter navigation. In addition to this uncertainty, potential impacts are considered to be medium, both for Swedish and international shipping, based on uncertain cumulative impacts on shipping and uncertain conditions for winter navigation. The plan indicates that safety distances must be decided when designing and licensing the wind farms.

It is not expected that there will be any negative impact on Swedish commercial fishing in the Bothnian Bay or the North Bothnian Sea. In the Southern Bothnian Sea, however, the impact on commercial fishing is estimated to be medium for pelagic trawl fisheries and Finnish fisheries conducted in the area. Potential impact on commercial fishing is also considered to have indirect effects on fishing and its value chains, the processing industry, affected landing ports and municipal interests.

### 3.5.4. Aggregated assessment of energy areas

In the impact assessment, negative and positive impacts have been assessed on a scale from 0 to 4. The purpose is to show the risk of impact on the assessment aspect, such as bird or cultural environment. It is a complex task to make an overall assessment for an energy area in terms of the cumulative impact an energy area has on different assessment aspects and interests. This is due to several factors, including the degree of detail and quality of the knowledge base differing between different assessments, as well as the challenge of comparing widely different types of effects and consequences. At the same time, it is essential that the impact assessment provides an overall picture. Table 23 below shows all assessments by energy area in the marine spatial plan area of the Gulf of Bothnia. The table aims to give an overview and an indication that some energy areas have a greater risk of negative effects than others.

Table 23. The table shows, in colour scale, assessments for all assessment aspects that have potential adverse effects. The table also shows a column where the values have been summarised, both in total and by nature and ecological aspects, maritime transport and commercial fisheries.

| | Ecology | | | | | | Sectors | | Recreation, Cultural environment and Landscape | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Benthic habitats | Fish and fish spawning | Bats | Migratory bird | Bird, over-wintering | Marine mammals | Shipping | Professional fishing | Recreation | Cultural environment | Landscape |
| B108 | | | | | | | | | | | |
| B111 | | | | | | | | | | | |
| B113 | | | | | | | | | | | |
| B135 | | | | | | | | | | | |
| B142 | | | | | | | | | | | |
| B146 (permit) | | | | | | | | | | | |
| B149 | | | | | | | | | | | |
| B152 | | | | | | | | | | | |
| B156 | | | | | | | | | | | |
| B159 | | | | | | | | | | | |
| B160 | | | | | | | | | | | |
| B161 | | | | | | | | | | | |
| B164 | | | | | | | | | | | |

| | Min negative | | | | Max negative |
|---|---|---|---|---|---|
| Area | | | | | |

### 3.5.5. Assessment scenarios show potential distribution of cumulative effects

As it is unclear which energy areas are ultimately being built, it is difficult to draw conclusions on the actual distribution of impacts. Two different assessment scenarios have been developed showing potential deployment taking into account different interests (see section 1.3.3. Assessment scenarios). The 'Nature and Culture' scenario shows an expansion that has taken into account the values of nature and cultural environments. The expected energy production would be approximately 107 TWh, which is a large amount of potential energy production. At the same time, the most negative effects on, for example, the ringed seal in the north, migratory bird routes in the Southern Bothnian Sea and the impact on coastal cultural environments in the Haparanda Archipelago, the North Kvarken and the Gulf of Gävle are avoided. In the central parts of the Bothnian Sea is remains an extensive cluster of energy areas that are located far from the coast and have the potential to contrubute to the transition to more sustainable energy production.

The 'Maritime and Commercial Fishing' scenario shows an expansion that would generate about 102 TWh, i.e. a large amount of energy, while avoiding areas that are particularly important for commercial fishing. Expansion under the scenario "Shipping and Commercial fishing" would also mean that negative consequences for shipping are avoided as energy areas that could lead to increased mileage disappear. However, the risk of potential and uncertain impact on winter navigation remains with expansion in the northern parts.

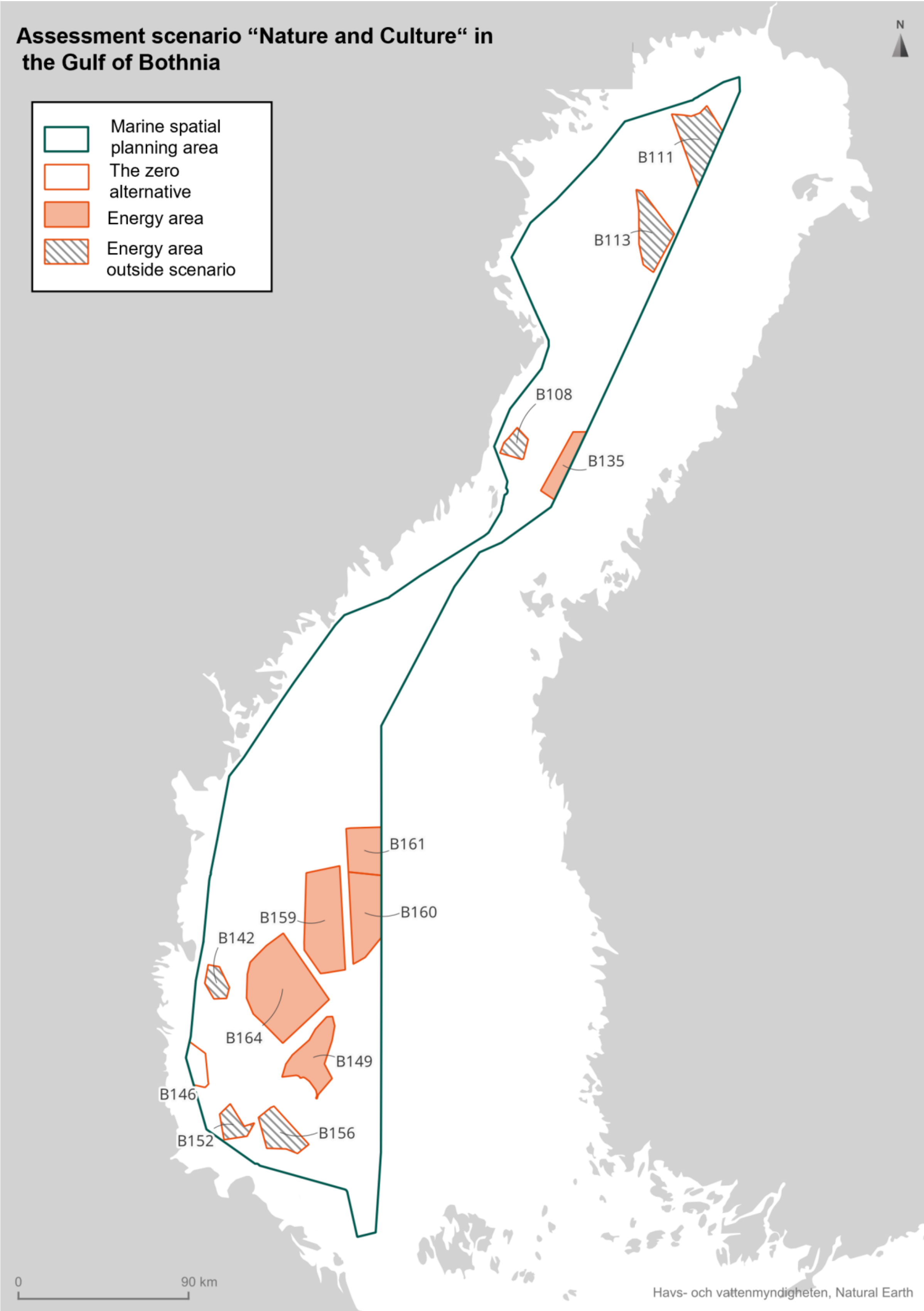


Figure 44. Demonstrates what an offshore wind development could look like in the Gulf of Bothnia if greater consideration were taken to avoid negative impacts on nature and culture values based on the impact assessment.

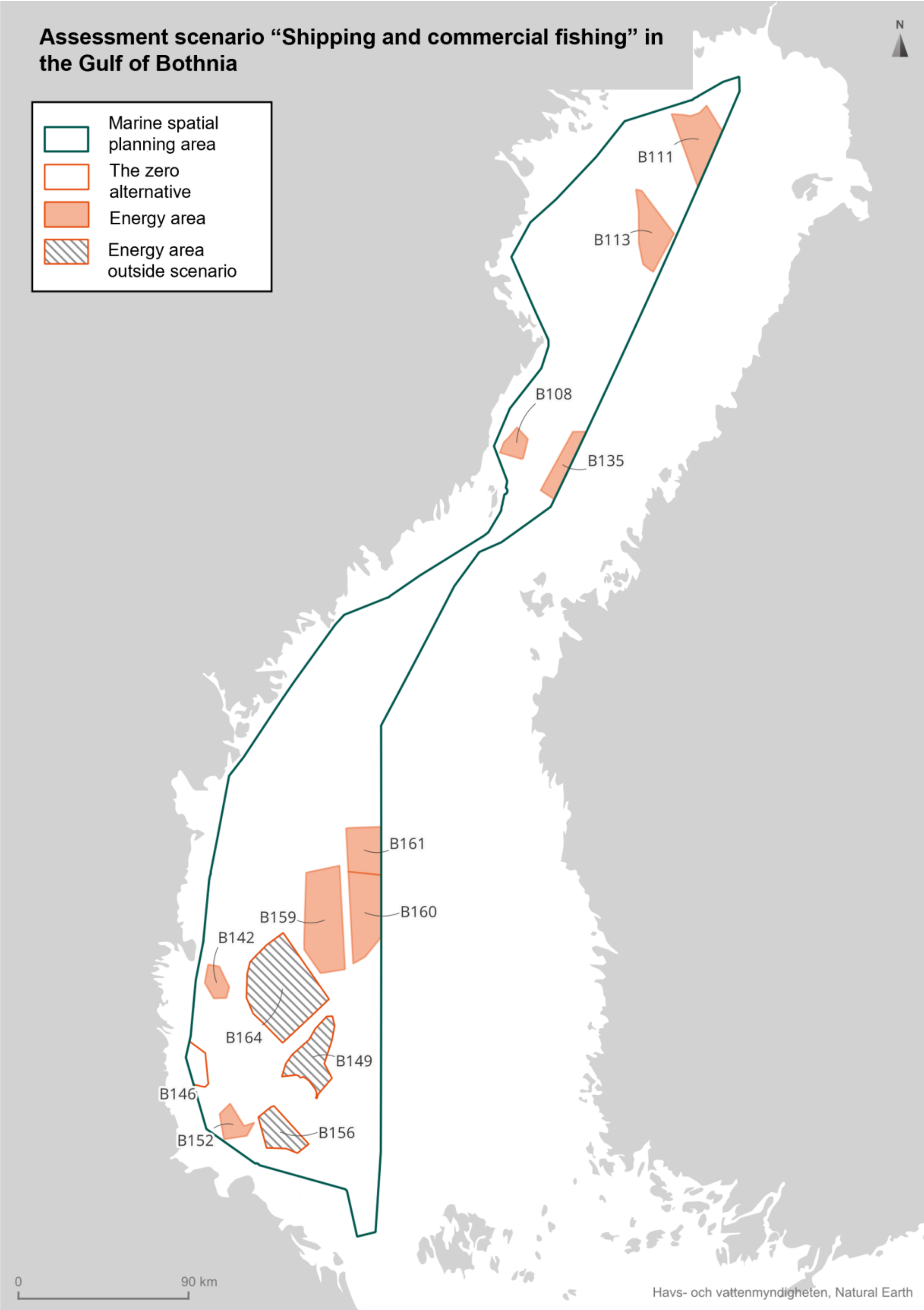


Figure 45. The map shows what an expansion of offshore wind power could look like in the Gulf of Bothnia if greater consideration were taken to avoid negative impacts on values for shipping and commercial fishing based on the impact assessment.

### 3.5.6. Cross-border cumulative effects

Cumulative effects in the Gulf of Bothnia can mainly occur in relation to the impact on birds, ringed seals, fish, landscapes, cultural environments, recreation, water (hydrography), commercial fishing and shipping.

The planned energy establishment of neighbouring countries can mainly contribute to cumulative impacts on birds, bats, ringed seals, fish, commercial fisheries, energy and shipping.

Continued co-operation and dialouge with neighbouring countries is necessary to assess cumulative impacts from a sea basin perspective.

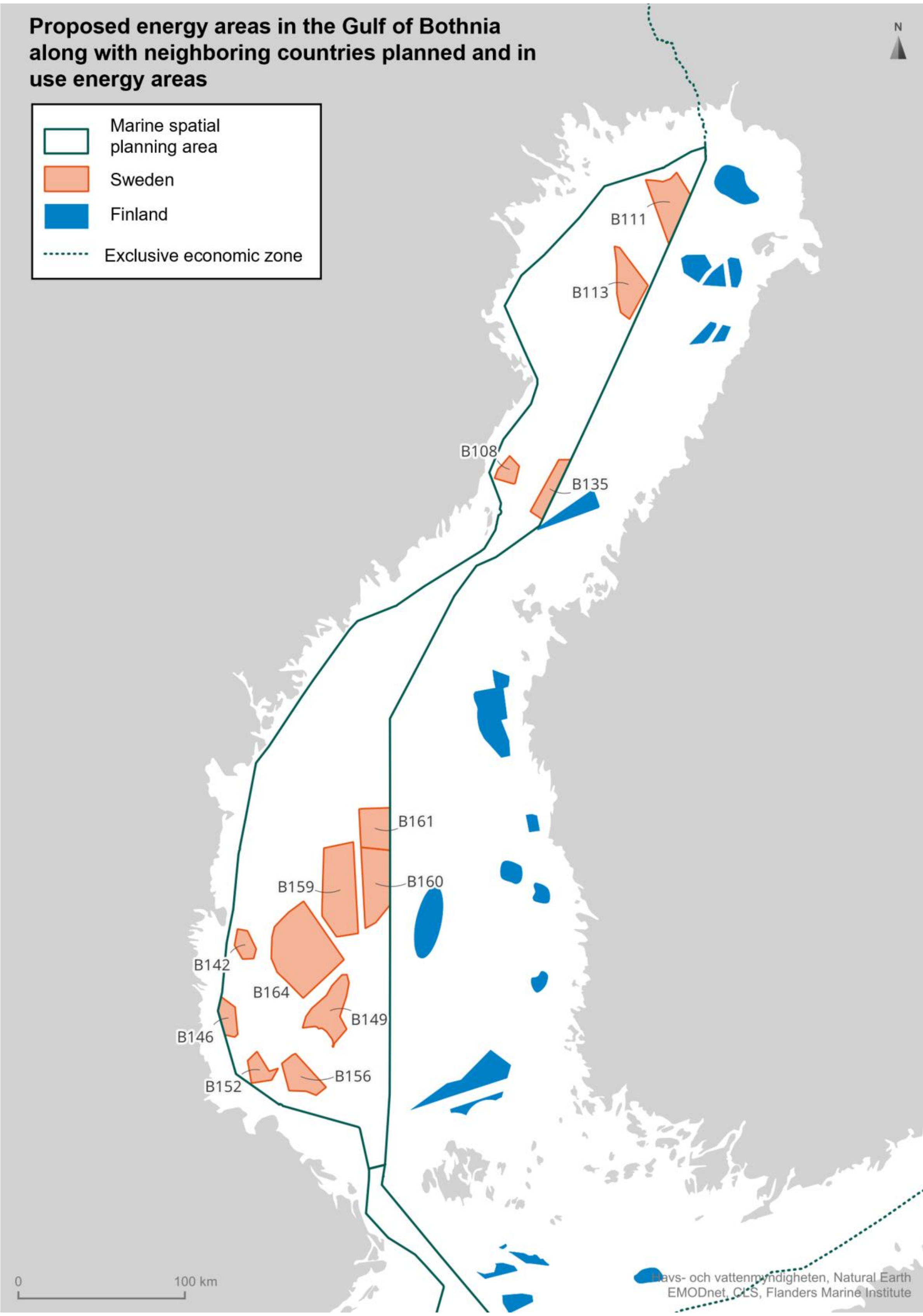


Figure 46. Map of proposed energy areas in the Gulf of Bothnia and energy expansion plans of neighbouring countries. Source: EMODnet, 2022, Flanders Marine Institute, 2023.

# 4. Impact assessment of marine spatial plan for the Baltic Sea

## 4.1. Impact on population and health

The uses that can have an impact on population and human health are guidance on energy use, sand extraction and guidance on changing mileage for shipping. The guidance on sand extraction and shipping lanes has not changed since the previous marine spatial plan, and the assessment presented in the sustainability assessment of decided marine spatial plans in 2019 is still up to date (Swedish Agency for Marine and Water Management, 2019b). The previous sustainability report assesses the risk of health effects from the guidance on shipping as insignificant taking into account negligible changes in emissions of airborne pollutants (Swedish Agency for Marine and Water Management, 2019b). Sand extraction activities at Utklippan, Sandhammar Bank and Sandflyttan according to the marine spatial plan's guidance on sand extraction are assessed to have a marginal negative impact on air quality locally (Swedish Agency for Marine and Water Management, 2019b), but this is a transitory effect and without a closer estimate of air emissions it is not possible to assess any risks to human health.

The Baltic Sea is the only marine spatial planning area in Sweden that has offshore wind power in operation, outside the city of Malmö and off the coast of Öland. The zero alternative also includes the energy area where the Kriegers Flak project has a permit to construct offshore wind power, see Figure 47 below. In the draft marine spatial plan for the Baltic Sea, only energy areas where there are permits for the establishment of offshore wind power remain. The background to the Government's decision to reject all applications for offshore wind farms in the sea area is the overall assessment that there are currently no conditions for using energy extraction in addition to existing permits in the Baltic Proper due to the interests of defence (Ministry of Climate and Industry 2024; Government 2024d).

The already adopted marine spatial plan for the Baltic Sea from 2022 included the energy area Södra Midsjöbanken, which in the current proposal is removed. It is not possible to derive any direct or indirect effects on population and health from this change in the marine spatial plan in the Baltic Sea.

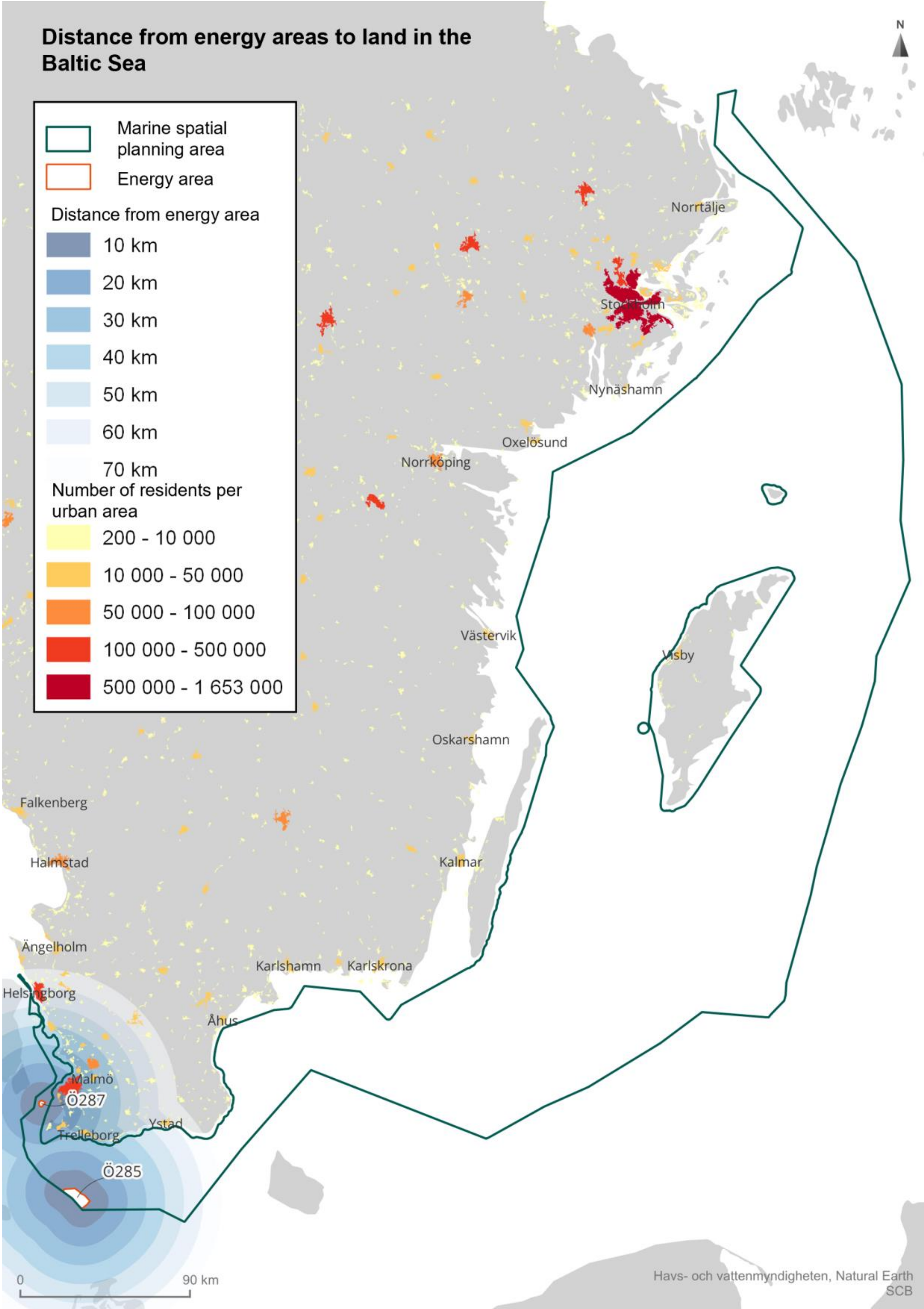


Figure 47. Map showing distances from energy areas to agglomerations in the Baltic Sea marine spatial plan area. Source: Statistics Sweden, 2020.

## 4.2. **Effects on protected animal or plant species and biodiversity**

### 4.2.1. Birds

Through large parts of the southern and central Baltic Sea, broad migratory bird paths run in a southwest-northeast direction from south of Skåne, through southern Hanö Bay, past Öland and Gotland, and further towards the Gulf of Finland and South Kvarken. The route covers several million individuals annually in both spring and autumn. In addition to this broad route, narrow passages over the sea, so-called bottlenecks, are particularly important migratory routes for terrestrial birds and bats that largely avoid flying over the open sea. Known bottlenecks in the Baltic Sea are Öresund, Kalmarsund-Öland-Gotland and Södra Kvarken. The establishment of offshore wind power in the proposed energy areas located within the broad strip and the known bottlenecks is therefore intended to entail a risk of high or medium impact on birds.

The potential positive environmental effects of moving the shipping currently operating through Hoburg Shoal and Midsjöbankarna to a deep water route south and east of the banks were reported in the environmental impact assessment of the adopted marine spatial plans (Swedish Agency for Marine and Water Management, 2019a). Based on conclusions from previous studies and results from Symphony, it was concluded that the transfer of shipping from the banks was the most favorable option for the protection of endangered species of birds and marine mammals and for reducing the cumulative environmental impact of shipping. As the guidance on the investigation area for shipping remains unchanged, the conclusions are considered to apply to the present proposal for a marine spatial plan for the Baltic Sea.

The long-tailed duck is one of the species with wintering areas of global importance in the Baltic Sea. The species is classified as highly endangered in its wintering areas. The Natura 2000 site Hoburg Shoal and Midsjöbankarna are one of the most important wintering areas for algae in the world (Larsson, 2018) with about 25 percent of the entire northern European and western Siberian population wintering at Hoburg’s Shoal (Skov et al., 2011). Long-tailed ducks migrates from its breeding areas to the embankments in the autumn and remains there until spring. There are also other wintering seabirds in the area, including black guillemot, common scoter, velvet scoter, common guillemot and razorbill.

*Cumulative and transboundary effects*

Since no wind power is proposed in the Swedish part of the marine spatial plan area, the neighbouring countries' planning for wind power constitutes the cumulative risk of impact. South of Skåne, there are established wind power on both the Danish and German sides as well as plans for further establishment. The cumulative effect on birds is expected to be smaller when no potential negative impact can occur on the Swedish side according to the plan proposal. There is still a risk of cumulative impact due to the fact that many other wind farms are currently being established and many energy areas are identified that concern the same migratory route, including Estonia, Denmark and Germany, but the birds are also affected much further south as many that pass are long-distance species.

A large energy area west of Saaremaa, Estonia, may to some extent affect the route that crosses the Baltic Sea towards Gotland. There are many designated energy areas in the southern Baltic Sea (Arkona Basin) that can pose a high risk of negative impact if all of them are built.

#### 4.2.2. Bats

In the Baltic Sea, the risk of impact on bats is greatest south of Skåne and between Öland and Gotland. As no energy areas are included in the Baltic Sea marine spatial plan, bats are not expected to be negatively affected by offshore wind power from the Swedish side.

#### 4.2.3. Marine mammals

Grey seals, harbour seals and Belt Sea and Baltic Sea harbour porpoises are found in the Baltic Sea.

*Common seal*

In Kalmarsund there is also a small isolated population with harbour seals that are red-listed in the vulnerable category. According to published studies (Stanley et al., 1996; Goodman, 1998) the Kalmar Strait stock is the genetically most deviant among European harbour seals. The stock has probably been isolated from other harbour seal populations for at least 6 000 years.

*Grey seal*

Grey seals are common in the Baltic Sea. It can be disturbed and intimidated by underwater noise but is not as noise sensitive as the harbour porpoise.

*Harbour porpoise*

According to the results of the SAMBAH project, harbour porpoises from the Baltic Sea population accumulate during the summer in the area on and between the banks of the central Baltic Sea (Hoburg’s Shoal, North Midsjöbank and South Midsjöbank). Summer is the time when the harbour porpoise is most susceptible to disturbance because it calves in June-July and mates in August. The porpoise suckles its calf for up to ten months and for at least the first six months from birth the calf is assumed to be so dependent on the female that any separation may be critical. For these reasons, the area is a very important area for the Baltic Sea's critically endangered harbour porpoise population.

*Cumulative and transboundary effects*

Negative cumulative effects on harbour porpoises may occur at the South Midsjöbank, where Poland has a larger number of energy areas in its marine spatial plan. The areas of the Slupsk embankment are not as significant during the summer reproduction period of the harbour porpoise.

Risk of negative cumulative effects on harbour porpoises from wind power in Danish and German waters. Most importantly, establishment does not take place at the same time because the construction phase has the greatest negative impact.

### 4.2.4. Benthic habitats

Some deeper parts of the Baltic Sea have for a long period been negatively affected by oxygen deficiency and are therefore considered to lack nature values. Natural bottom substrates in the Baltic Sea consist largely of soft bottoms with clay as well as sand, gravel and stone.

### 4.2.5. Fish and spawning grounds

In the current proposal for an amended marine spatial plan for the Baltic Sea, guidance on sand extraction is considered to entail a risk of impact on fish. The guidance is the same as in the adopted marine spatial plan, which is why the conclusions in the respective environmental impact assessment are considered to apply (Swedish Agency for Marine and Water Management, 2019a).

When sand is extracted at Utklippan, it is considered that increased turbidity can occur locally. The effect is considered to be short-lived as the sediment consists mainly of coarse-grained sand and gravel (Swedish Geological Survey, 2017). Even if the area is outside the cod spawning area, cod larvae can drift into the area (Swedish University of Agricultural Sciences, Department of Aquatic Resources, 2018). The larvae are sensitive to suspended sediment at higher concentrations, which is why extraction should preferably be paused during those times of the year when there are cod larvae in the water. The area is also part of an important growing area for cod, and the bottom is probably used by flatfish. Based on the uncertainty about the design of the activity and its specific effects on fish and fish habitats, and taking into account the precautionary principle, it is considered that the effect of proposed sand extraction activities in Utklippan could lead to moderately negative effects on fish. The effects are considered to be most local and reversible in the short term based on the geographical scope of the activity in relation to the marine spatial planning area and alternative spawning grounds for the affected species. Specific effects on fish and in particular fish spawning should be further investigated in the licensing process.

However, the proposed sand extraction at Sandhammar embankment, south of Ystad, is not expected to have any specific effects on fish. According to previous assessments, the area does not host any particularly valuable habitat types, but it is considered to be a foraging area for flatfish (Swedish Geological Survey, 2017). The area is characterised by high sediment mobility and sand extraction is estimated to be compensated by the accumulation of sand from the upper part of the bank. High substrate dynamics and large temporal variation in the bottom fauna make it difficult to assess the specific effects of quarrying on biodiversity.

Locally large negative environmental effects are expected to occur in connection with the proposed sand extraction at Sandflyttan southwest of Falsterbo. Disturbance to sensitive habitats for affected fish species such as cod and flatfish should be minimised by avoiding periods of sensitive life stages for the species, as well as by distributing sand extraction so that the risk of oxygen-poor pits does not arise (Swedish University of Agricultural Sciences, Department of Aquatic Resources, 2018). In view of the high nature values in the local area, sand extraction activities are considered to have moderate to large negative effects on fish, but specific effects need to be investigated within the framework of Natura 2000 permit assessment. Increased turbidity is expected to occur locally during sand extraction, but is not expected to be long-lasting given the grain size of the sediment, so the effect is considered to be local and small in relation to the marine spatial plan area as a whole.

Guidance on particular consideration for high nature values in the application of the plan may contribute to a small positive effect on the fish resource. Adaptations relate, for example, to reduced by-catch or reduced impact on the seabed during bottom trawling. However, whether and, if so, how such provisions could be introduced is impossible to predict at the current juncture, and thus also the potential positive effects on fish.

### 4.2.6. Impact of proposals for new areas with particular consideration to high nature values

For the Baltic Sea, the plan proposal includes a number of additional areas for particular consideration of high nature values (small n areas). The energy area Ö283 south of Skåne is proposed as an area for particular consideration for high nature values in order to strengthen particular consideration for migratory birds and meet up with the migratory bird path Rügen – Skåne, which is marked in the German marine spatial plan.

The areas for general use, shipping and commercial fishing (Ö258 and Ö259) between Hanöbukten and Midsjöbankarna have mainly been proposed as areas for particular consideration of high nature values with regard to the Baltic Sea population of harbour porpoises.

Södra Midsjöbanken (Ö248) is an area for particular consideration of high nature values in the adopted marine spatial plan, but is also proposed as a Natura 2000 area under the Birds Directive designated for seabirds, long-tailed ducks and black guillemot. Several areas around Gotland are included in proposals for new Natura 2000 areas under the Birds Directive. West of Gotland, this applies to parts of areas Ö291 and Ö500 around Stora Karlsö. East of Gotland it applies to the areas Ö500 and Ö296 along the east coast.

Northwest of Gotska Sandön, an area with use defence (Ö505) and one with general use (Ö506) has been supplemented as areas for particular consideration for high nature values with a focus on birds, and east of Muskö, an area with general use (Ö507) is proposed as an area for particular consideration for high nature values.

Application of particular consideration for high nature values is considered relevant for the new areas with the designation small n in the Baltic Sea as guidance for uses such as commercial fishing and shipping. In practice, it can contribute to better conditions for biodiversity conservation and green infrastructure as a basis for developed ecosystem services. Figure 48 shows the areas with nature use and particular consideration for high nature values within the marine spatial plan area of the Baltic Sea.

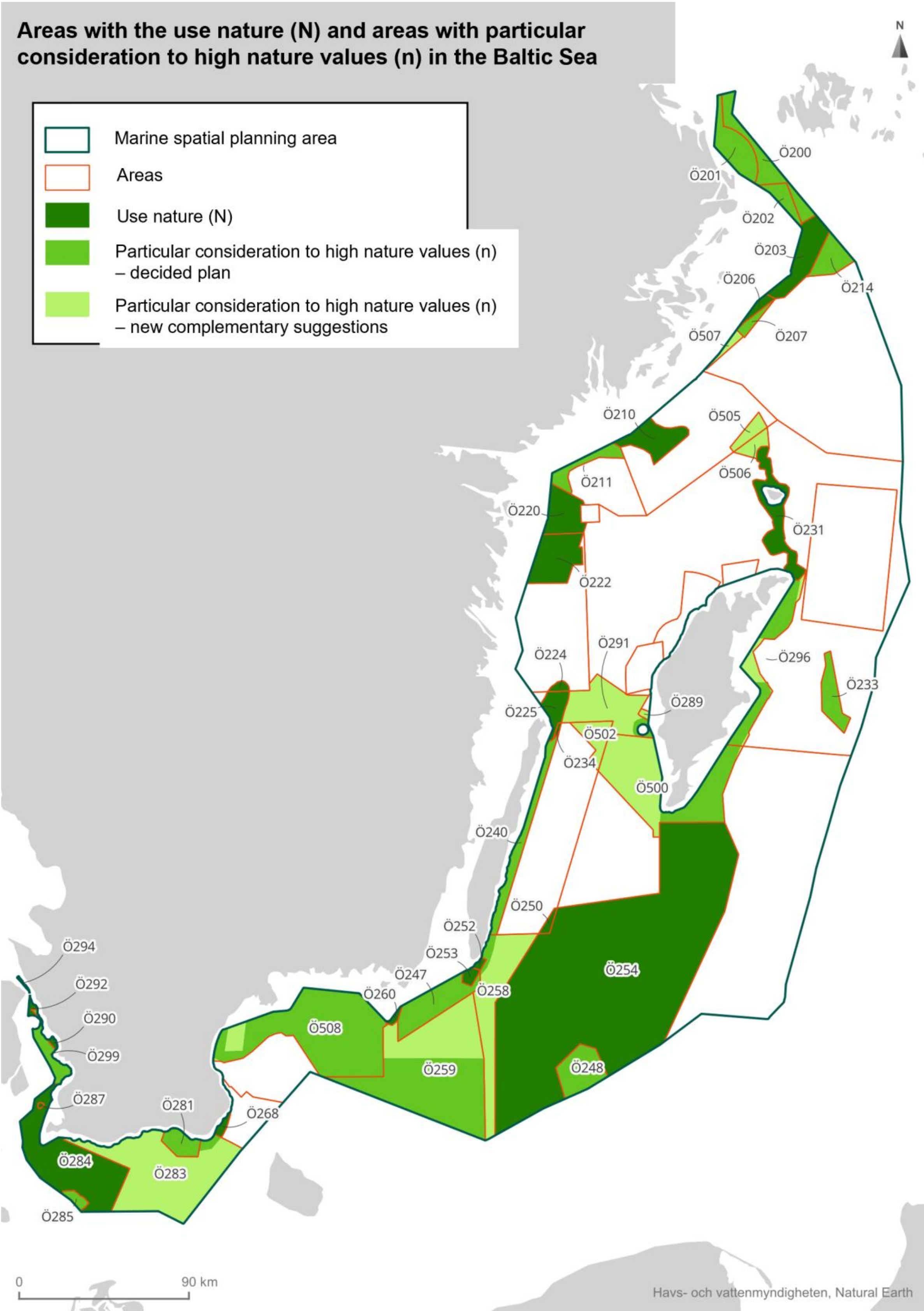


Figure 48. Areas using nature (N) and decided on the respective proposals for new areas with particular consideration to high nature values (n) in the Baltic Sea (Swedish Agency for Marine and Water Management 2024c).

## 4.3. **Effects on land, soil, water, air, climate, landscape, settlement and cultural environment**

### 4.3.1. Water and air

In the Baltic Sea marine spatial plan area, it is the marine spatial plan's guidance on energy extraction, sand extraction and investigation area for shipping that is considered to have effects on water and air. The guidance in these areas does not differ from the marine spatial plan already adopted, except that an energy area in the Southern Baltic Sea has been removed.

The proposed marine spatial plan for the Baltic Sea provides guidance on sand extraction activities in three areas: Utklippan within Ö508, Sandhammar embankment within Ö280 and Ö281, and the Sandflyttan investigation area within Ö284. Previous extraction operations at Sandhammar have ceased. According to the Geological Survey of Sweden, all three areas have geological, economic and environmental conditions for sand extraction (Swedish Geological Survey, 2017). Sand extraction is expected to lead to increased turbidity and reduced water quality locally. However, the effect is considered to be short-term, so no lasting effects on water quality are considered to occur (Swedish Agency for Marine and Water Management, 2019a).

*Impact on hydrography*

Studies have shown that offshore wind power can affect hydrographic conditions also during continuous operation, both at the surface and at the foundations (Arneborg et al., 2024). The effects on surface water occur when the wind behind the wind farms decreases, which in turn can affect currents and stratification in the surface water. The foundations have a small impact in that they slow sea currents and create turbulence that mixes different water layers. The effects of an offshore wind farm can spread beyond its boundaries and also lead to second-round effects and impacts on marine life (see also section 2.3.1). The marine spatial plan does not provide guidance on any additional area for offshore wind energy in the Baltic Sea. However, expected expansion in Skagerrak/Kattegat and Gulf of Bothnia may also be relevant in terms of impact on hydrographic conditions, as the effects may spread beyond the wind farm's boundaries. The Baltic Sea is a particularly vulnerable sea area in terms of the expansion of oxygen-free seabeds. Possible consequences and large-scale effects of energy development in other marine spatial planning areas also need to be investigated in terms of potential effects in the Baltic Sea.

*Changes in emissions and air quality*

Increased maritime transport in connection with sand extraction and transport between extraction sites is expected to lead to increased air emissions and a marginal deterioration of air quality locally. The proposal for a marine spatial plan for the Baltic Sea provides guidance on several investigation areas for shipping through the central Baltic Sea. These include the transfer of maritime traffic that today passes through Hoburgs bank and Norra Midsjöbanken to a deep water fairway south and east of the bank. The shift entails an approximately five percent longer journey distance and an approximately 2.6 percent higher fuel consumption at unchanged average speed, which means a small negative effect on air quality throughout the marine spatial planning area (Swedish Agency for Marine and Water Management, 2019b). In addition to investiongation areas for shipping, the marine spatial plan guidance does not entail any further changes for shipping.

### 4.3.2. Climate

In the Baltic Sea, only guidance on nature and particular consideration for nature protection is relevant from a climate perspective, as the marine spatial plan does not guide any increased energy extraction in relation to the zero alternative.

*Climate benefits linked to energy extraction through offshore wind power*

The potential climate benefit in the Baltic Sea is presented in a similar table as for other marine spatial planning areas, the existing offshore wind farm Lillgrund has an effect of 0.1 TWh, and Krieger's Flak, which is licensed, is estimated to have an effect of 1.5 TWh.

Table 24. Shows results of calculation for potential climate benefit when offshore wind power replaces the Nordic residual mix according to plan proposals, zero alternatives and the current situation in the Baltic Sea.

| | TWh | Climate impact Offshore wind energy (11 000 tonnes CO2-equivalent/TWh) | Nordic residual mix (524 100 tonnes CO2-equivalent/ TWh) | Potential CO2-equivalent reduction | Potential reduction in relation to Sweden's emissions in 2023 |
|---|---|---|---|---|---|
| **Existing offshore wind energy in the Baltic Sea** | 0,1 | 1 100 | 52 410 | 51 310 | 0.1% |
| **Zero alternatives (permitted projects)** | 1,5 | 16 500 | 786 150 | 769 650 | 1,6 % |
| **Proposal for a marine spatial plan** | 0 | 0 | 0 | 0 | 0 % |

*Guidance on nature protection and particular consideration Carbon sequestration and adaptation to climate change*

The marine spatial planning guides on both nature protection (N) and consideration of high values for nature protection (n), marine areas protected against disturbances and impacts can generally be assumed to have better conditions both to deal with climate change by conserving biodiversity, and better conditions to store carbon when they are to some extent protected from disturbances. There are no data or figures that describe the potential and ability for carbon sequestration in different benthic habitats and sediments in a Swedish national context. Norwegian researchers have mapped carbon sequestration in Norwegian marine areas, and concluded that benthic habitats of different character have different abilities and conditions to contribute to carbon sequestration, both in shorter and longer time perspectives. An important conclusion of the study is that benthic habitats that are left undisturbed have greater potential to act as natural carbon sinks (Diesing et al., 2024).

In the Baltic Sea, the total area for guidance on nature and particular consideration for high nature value amounts to 74,850 square kilometres, which makes up approximately 43% of the Baltic Sea's marine spatial plan area. It is evenly divided between guidance on nature (20.5%) and particular consideration for high nature values (22.5 %).

In the Baltic Sea, climate refugias for blue mussels, bladderwrack, herring and cod have been part of the basis for the guidance, which is positive in terms of the chances of ecosystems and particular species to survive in a changed climate (Hammar & Mattsson, 2017). The marine spatial plan guidance on nature and particular consideration for high nature values is assessed to promote and enhance important ecosystem services significant for adaptation to a changing climate.

In southern Sweden, coastal erosion is expected to become more common as a result of climate change and sea level rise (Malmberg et al. 2016). The marine spatial plan guides sand extraction in three areas of the Baltic Sea, which means that sand from the seabed can be used for beach nourishment and climate adaptation measures.

### 4.3.3. Landscape

In the Baltic Sea marine spatial plan area there are two energy areas (Ö285, Ö287). As the energy areas are built or licensed, they are included in the zero alternative and are therefore not subject to an impact assessment. Figure 49 below shows the energy areas and landscape impact in the Baltic Sea.

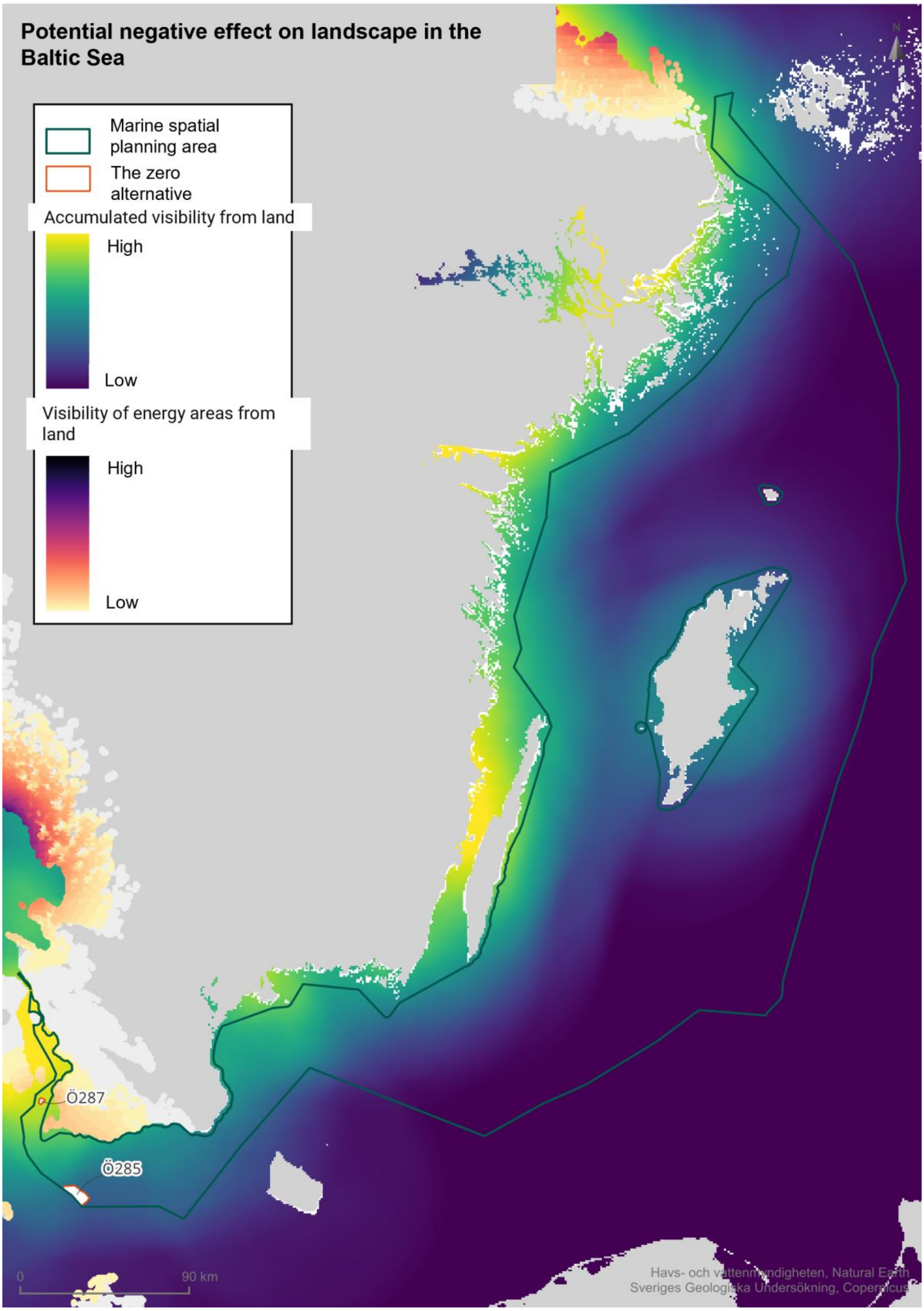


Figure 49. Potential negative effect on landscapes of proposed energy areas in the Baltic Sea. In the energy areas, dark color shows great effect and light color shows little effect. Accumulated visibility from land is shown over the sea and visibility of energy areas is shown over land.

*Other impacts on landscapes*

As energy areas in the Baltic Sea marine spatial plan area are built or have permits, no other impact on landscapes is assessed.

*Cumulative and transboundary effects*

Although no impact assessment is carried out for energy areas in the Baltic Sea, those energy areas in the zero alternative may have negative effects on landscapes in Denmark around Öresund, as well as the northern part of Rügen in Germany.

The cumulative impact of energy areas is mainly linked to areas around Skanör-Falsterbo in southwestern Skåne, where existing energy area Ö287 and permit-granted Ö285 can cause cumulative impact on landscapes. This impact may increase with energy areas in neighbouring countries.

### 4.3.4. Cultural environment

*Indirect influence – National interest in cultural heritage conservation, Chapter 3, Section 6 of the Environmental Code*

In the Baltic Sea marine spatial plan area there are two energy areas (Ö285, Ö287). As the energy areas are built or permit-granted, they are included in the zero alternative and are therefore not subject to an impact assessment. All energy areas in the Baltic Sea are listed with particular consideration to high cultural heritage values (small-k). The guidance on particular consideration for high cultural heritage values is considered to entail adaptations of the location and design of wind farms regarding, for example, the location and height of wind turbines in order to reduce the impact on the specific cultural heritage sites concerned. Figure 50 below shows the energy areas in the Baltic Sea.

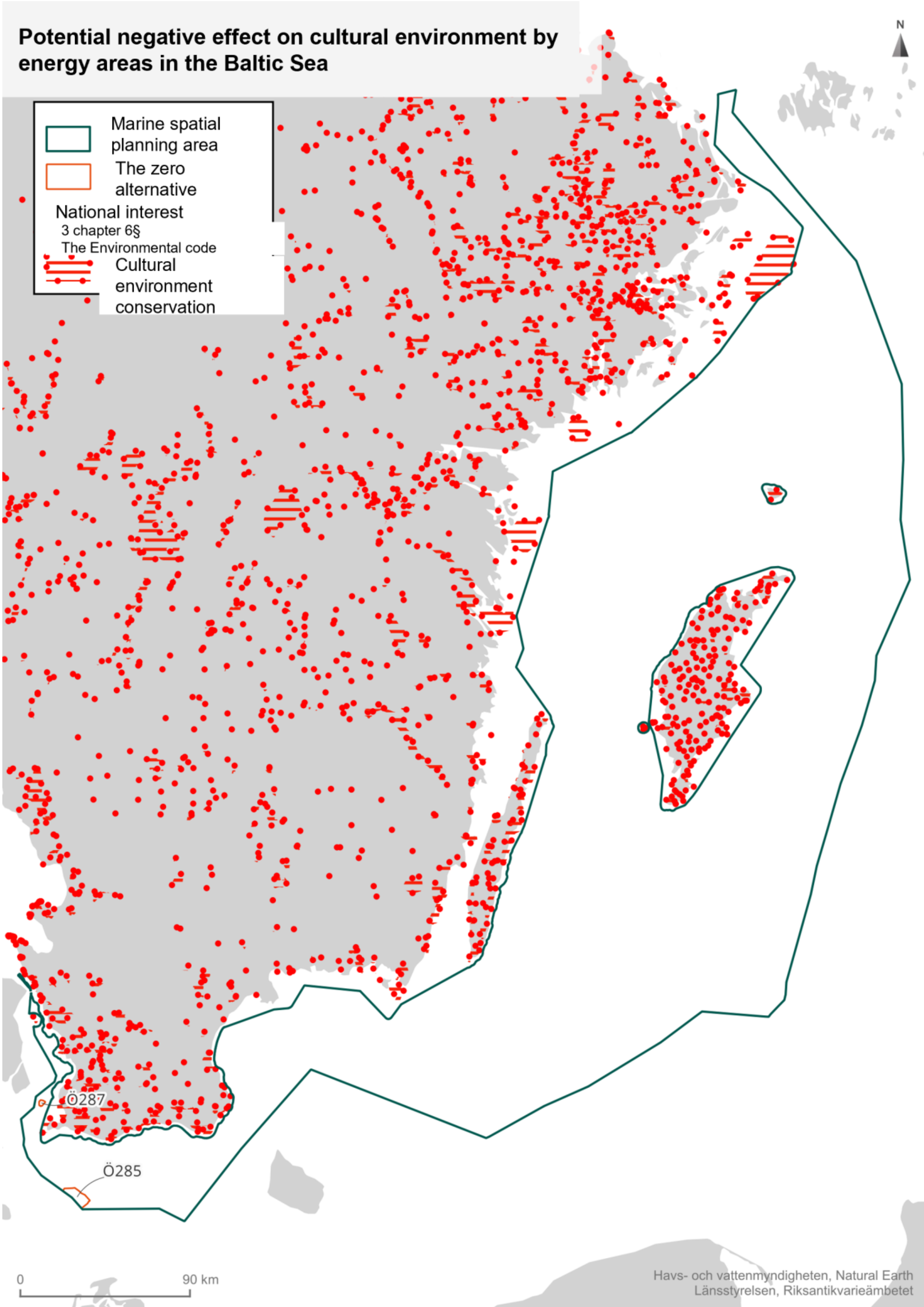


Figure 50. Potential indirect negative effect of energy areas on national interest claims for cultural environment in the Baltic Sea.

*Direct impact*

In the Baltic Sea marine spatial plan area, there are no energy areas that are impact assessed for the cultural environment, hence no marine archaeological sites within the proposed energy areas are assessed. However, there are a number of registered marine archaeological sites in energy areas in the zero alternative. Figure 51 presents marine archaeological sites outside energy areas and within energy areas included in the zero alternative.

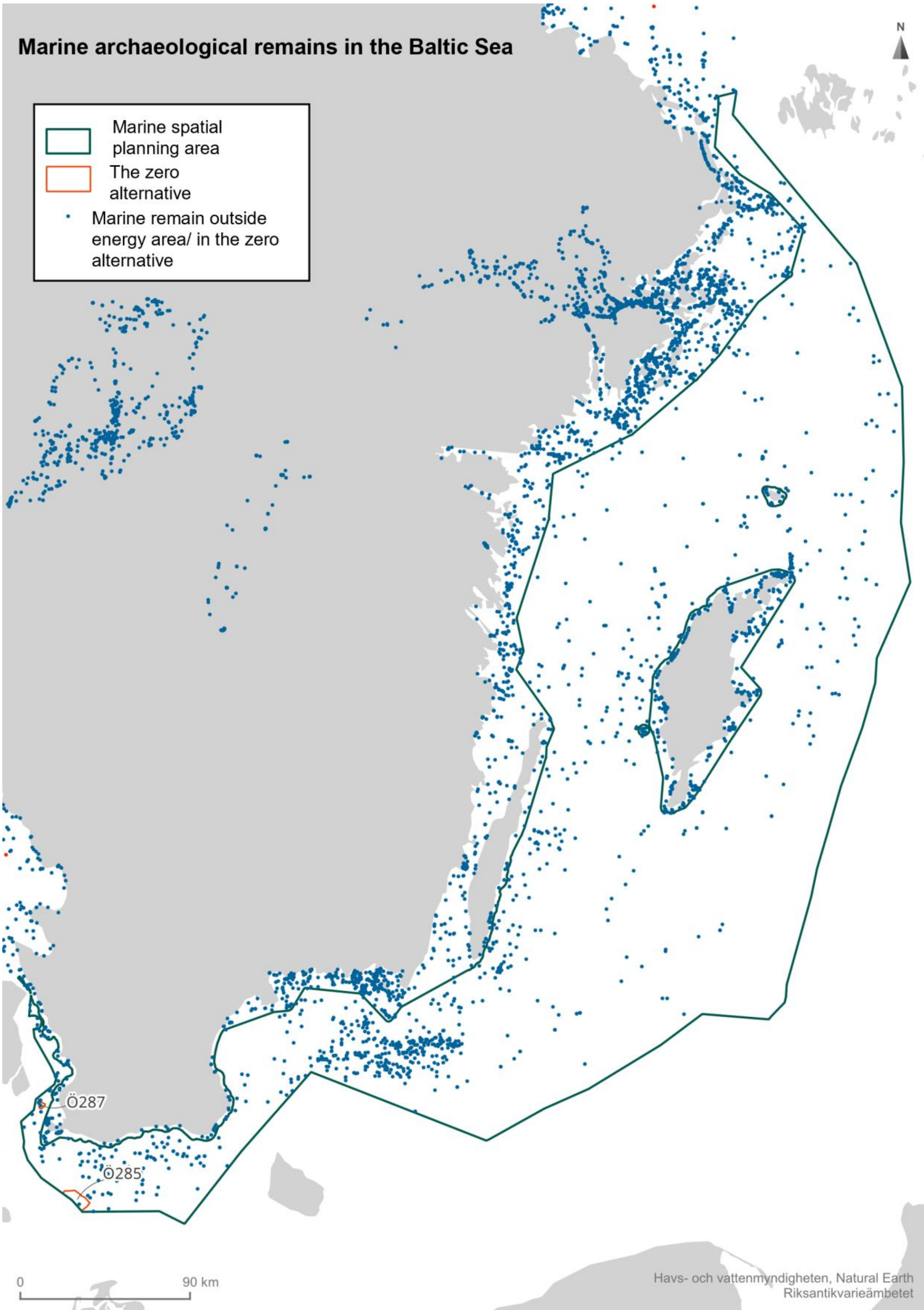


Figure 51. Risk of impact on marine archaeological sites.

Note that the compilation only refers to the sites that are registered in the Swedish National Heritage Board's Cultural Environment Register (Riksantikvarieämbetetet, u.y.). Since knowledge of the existence of marine archaeological sites in Swedish waters is not complete, the establishment of offshore wind power should be preceded by marine archaeological investigations where there may be marine archaeological sites (County Administrative Boards, 2024).

*Indirect and direct impact – Regional value areas*

In the Baltic Sea's marine spatial plan area there are only two energy areas, Ö285 with a permit for the establishment of offshore wind power, and Ö287 which is built. There is therefore no impact assessment of energy areas on marine cultural heritage values in the Baltic Sea. **Fel! Hittar inte referenskälla.** shows energy areas and marine cultural heritage values in the Baltic Sea.

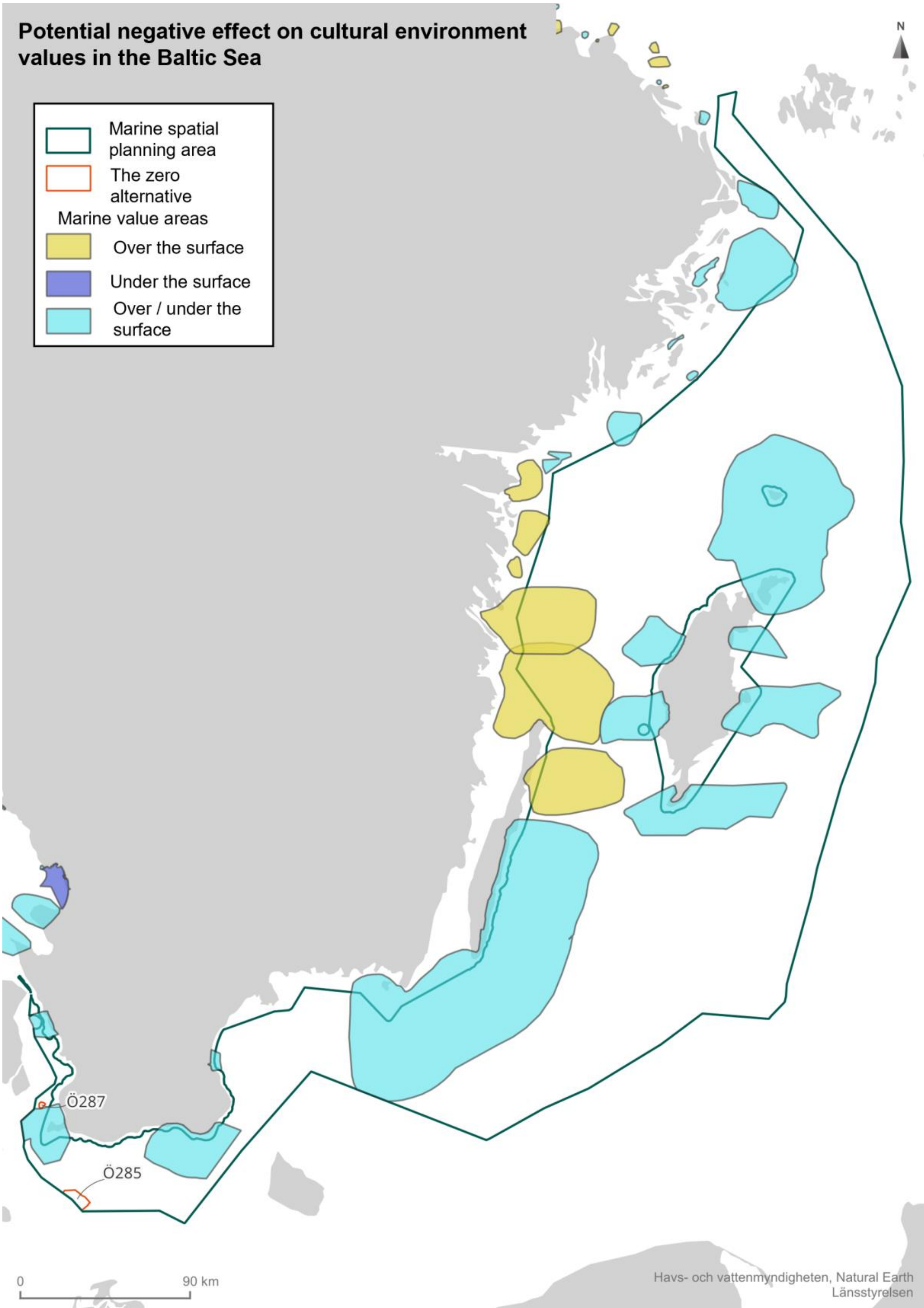


Figure 52. Indirect and direct negative impact on regional cultural heritage value areas.

*Other impacts on cultural environment*

The coastline of the Baltic Sea marine spatial plan area is entirely of national interest for unbroken coastline (Chapter 4, Section 3 of the Environmental Code) or high-exploited coastline (Chapter 4, Section 4 of the Environmental Code). As energy area Ö287 is already built, and there are permits in Ö285 it is included in the baseline option and is not subject to an impact assessment.

*Cumulative and transboundary effects*

Denmark's marine spatial plan (Denmark's marine spatial plan, 2024) contains energy areas that can affect cultural environments in Sweden. West of Bornholm there are two energy areas in the marine spatial plan that can affect the value area Kåseberga-Sandhammaren (16.5 kilometers away) and the national interest Sandhammaren (28 kilometers away). Furthermore, there are four Danish energy areas in Öresund that may indirectly affect cultural environments such as the value areas Falsterbo Peninsula and Landskrona-Pilhaken-Ven, as well as the national interest claims Skanörs ljung, Skanör and Falsterbo, Foteviken-Glostorp, Malmö, Alnarp, Barsebäck-Hofterup, Landskrona and Ven. The entire coast of Skåne is covered by the national interest of high-exploited coast (Chapter 4, Section 4 of the Environmental Code).

As only energy areas in the Baltic Sea are included in the zero alternative, the cumulative impact is not assessed. However, the energy areas in the Baltic Sea together with energy areas in neighbouring countries can give rise to indirectly negative cumulative effects on cultural environments in Sweden, especially along the coast of Skåne.

## 4.4. Effects on the management of water, soil and the physical environment in general

### 4.4.1. Energy extraction

The planning area has very good conditions for offshore wind power in terms of wind and depth conditions. However, the proposed marine spatial plan does not guide use for energy extraction in addition to existing wind farms, Kårehamn (not visible for cartographic reasons), Lillgrund, and the Krieger's Flak area, where a licensed project is located, see Figure 53 below.

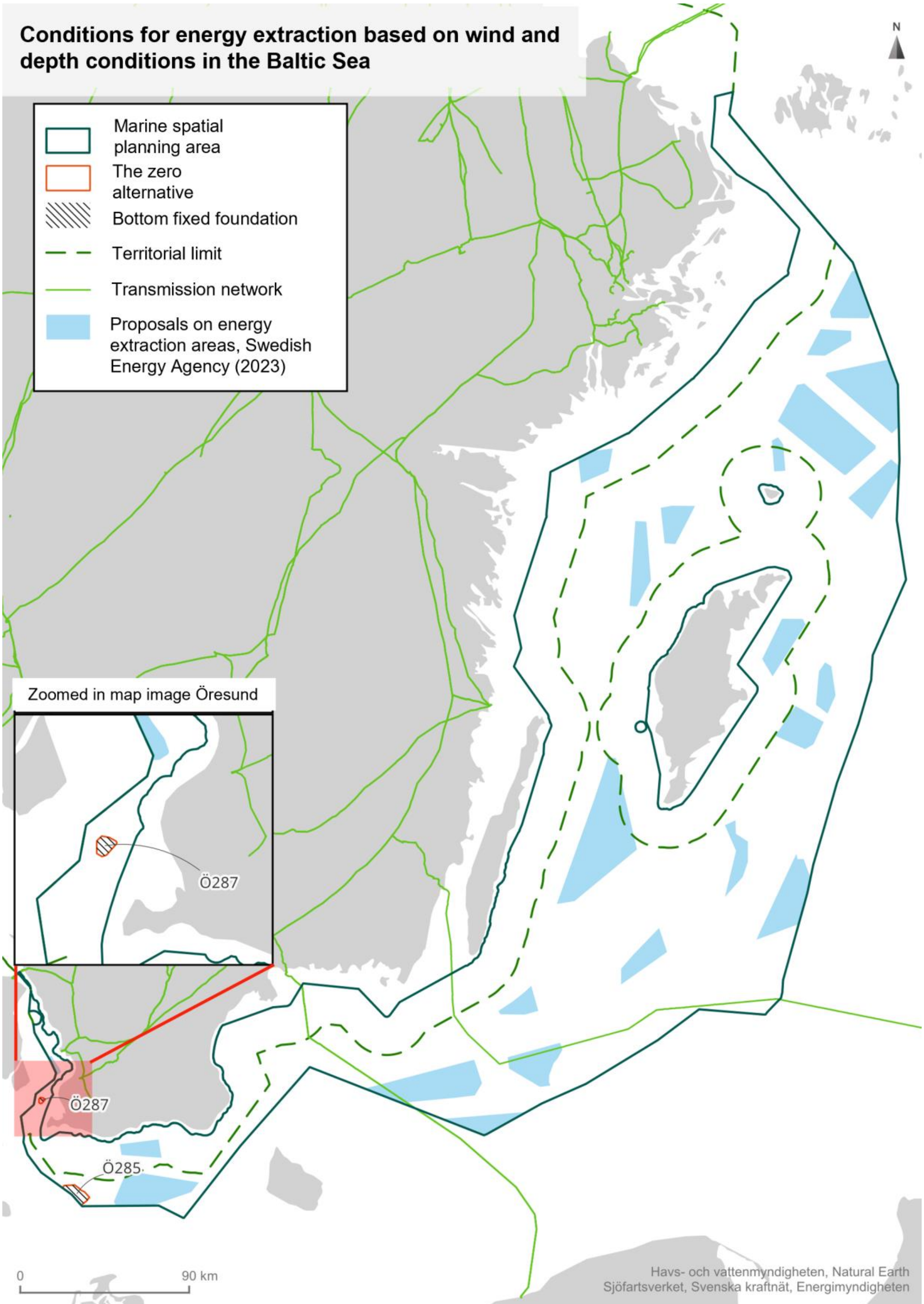


Figure 53. Map of energy areas in plan proposals, zero alternatives, and initial planning basis The Swedish Energy Agency 2023.

*Area-specific assessments, nature and conditions for energy extraction*

The proposed marine spatial plan does not provide guidance on additional areas for energy extraction other than the existing wind farm, Ö287 Lillgrund, and the area Ö285 Krieger's Flak, where a licensed project is located. Guidance on additional areas for energy extraction in addition to these two is not available in the plan with reference to government decisions and rejection of a number of project applications in plan areas with reference to defence interests. For more information see the marine spatial plan section 2.4.1.

The two energy areas that remain in the plan proposal since the review proposal are included in the impact assessment zero alternative and, in addition, no further areas are assessed. Potential for energy extraction and electricity production is estimated based on surfaces for energy extraction, for plan proposals corresponding to this approximately 1.6 TWh. The conditions for energy extraction based on the nature of wind and depth are considered to be very good, with relatively good wind conditions and located in relatively shallow areas.

The zero alternative for assessment is the existing wind farm, as well as a licensed project Krieger's Flak Ö265. Taken together, these two areas correspond to an area of approximately 80 km2, see Table 25 below.

Table 25.Guidance energy extraction, plan proposal Baltic Sea, total area, as well as area within territorial sea and foundations.

| Areas of energy; | Area | About $Km^2$ | Of which $km^2$ in territorial sea ~22km | Estimated TWh | Municipal planning area | Foundations |
|---|---|---|---|---|---|---|
| **Ö285** | Krieger's Flak | 70 | 0,0 | 1,4* | - | Bottom-fixed |
| **Ö287** | Lillgrund | 8 | 7,3 | 0,33 ** | Malmö | Bottom-fixed |
| **Total, approximately** | | | | About 1.6 | | |

* Assumption according to marine spatial plan, $5MW/Km^2$, 4000 full load hours

** according to project authorisation

*Marine spatial plan, zero alternatives and guidance on energy extraction*

The original planning documents of public interest of substantial importance identified 24 areas suitable for offshore wind power in the Baltic Sea, with a total area of approximately 9,640 km2. During the initial planning process, areas have been adjusted and some have been excluded with regard to other interests such as defence, recreation, cultural environment and shipping. Based on the Government's decision to reject all applications for offshore wind farms in the sea area, the overall assessment is that there are currently no conditions for using energy extraction in addition to existing permits in the Baltic Proper due to the interests of defence (Ministry of Climate and Industry 2024; Government 2024d).

Total areas for energy extraction in the draft marine spatial plan, zero alternatives, public interest of substantial importance, national interest claims, and adopted marine spatial plan, see Table 26 below.

Table 26. Guidance on energy extraction, estimation of production potential, based on marine spatial plans, zero alternatives, national interest claims and public interest of substantial importance.

| Indicative basis for energy extraction | Baltic Sea approximate area (km$^2$) |
|---|---|
| **Plan proposal** | 80 |
| **Zero alternative** | 80 |
| **General Interest of Significant Importance, Planning Basis Step1, EM** | 9 640 |
| - **Of which surface in planes;** | 70 |
| **National interest claims** | 2 020 |
| - **Of which surface area in level, approx. km2** | 60 |
| **Plan adopted** | 560 |

*Realisation, projects and bidding zones*

In the plan areas there is an existing wind farm, as well as a permit-granted one. Potential additional electricity production in the plan area is assumed to be connected to bidding zone 4. For more detailed information on electricity consumption and related bidding zones and users, please refer to chapter 2.4.1, *Energy* regarding electricity consumption and industry, the transport sector and households.

The plan's guidance on energy coincides with the plan areas for the existing wind farm, the City of Malmö.

*Indirect impact - energy*

Based on the fact that the plan does not guide on additional areas for energy extraction other than already existing and permit-granted, the indirect impact on land use and the impact of the proposed marine spatial plan is considered to be minor within the marine spatial plan area. However, exempted areas may possibly indirectly affect other plan areas in terms of establishing offshore wind power.

*Achievement of objectives, national and municipal interests - energy*

Plan proposal for the Baltic Sea contributes a limited part to the achievement of objectives regarding assignments for offshore wind power and national energy policy goals, climate goals and goals for fossil-free electricity supply. The objective of the assignment for all marine spatial plans corresponds to a total of 120TWh, which means that the relatively large marine spatial plan areas that are exempt may make it difficult to realise the objective and generate electricity. The Baltic Sea is the largest marine spatial plan area and represents approximately 60 percent of the total area of the marine spatial plans.

In the proposed marine spatial plan, the total area for energy extraction is approximately 80 square kilometres, corresponding to approximately 1.6 TWh, including the existing Lillgrund wind farm. Compared with previously decided marine spatial plan and initial planning basis for guidance on energy extraction, the space in the plan area has decreased significantly.

In the adopted marine spatial plan (Regeringen, 2022a) for the Baltic Sea, the corresponding total area for guidance on energy extraction is approximately 570 $km^2$. The total area for energy extraction in the initial planning basis (Energy Agency 2023) is equivalent to approximately 9,600 km2, where the national interest has also been taken into account. The proposal for a marine spatial plan for the Baltic Sea thus entails a marked reduction in the indicative use of energy in the plan area. This could also potentially affect electricity generation in bidding zones 3 and 4 and affected regions.

*Cumulative and transboundary effects*

The marine spatial plan does not provide guidance on areas for energy extraction other than those that have been granted a permit and those that already exist, which means that cumulative impacts, as well as impacts on neighbouring countries, are not considered within the marine spatial plan area. However, the exclusion of energy areas in the plan area in question may indirectly affect and entail an increased risk of cumulative effects in the other two plan areas and neighbouring countries, based on increased concentration and the need for realisation of areas for energy extraction in these two areas in order to achieve the target of 120TWh.

### 4.4.2. Recreation

The Baltic Sea includes high nature values, where coastal and archipelago landscapes offer good conditions for recreation. A large part of the coast is designated as an area of national interest for recreation under Chapter 4, Section 2 of the Environmental Code. Stockholm's outer archipelagos, which together with the Åland Archipelago and the west coast of Finland form a unique stretch of shallow archipelagos, in the Gotska Sandön National Park with its unique isolated location, the islands of Öland and Gotland and the coast of Skåne are some areas that attract many visitors. Recreational boat traffic is also an important part of recreation in the Baltic Sea, not least in the Stockholm archipelago and to and from Gotland. In the proposal for a marine spatial plan area, the Baltic Sea has two energy areas: Ö285 and Ö287. As the energy areas are built or permit-granted, they are included in the zero alternative and are therefore not subject to an impact assessment. Thus, no negative impact on recreation from these energy areas is assessed. Figure 53 below shows the energy areas in the Baltic Sea.

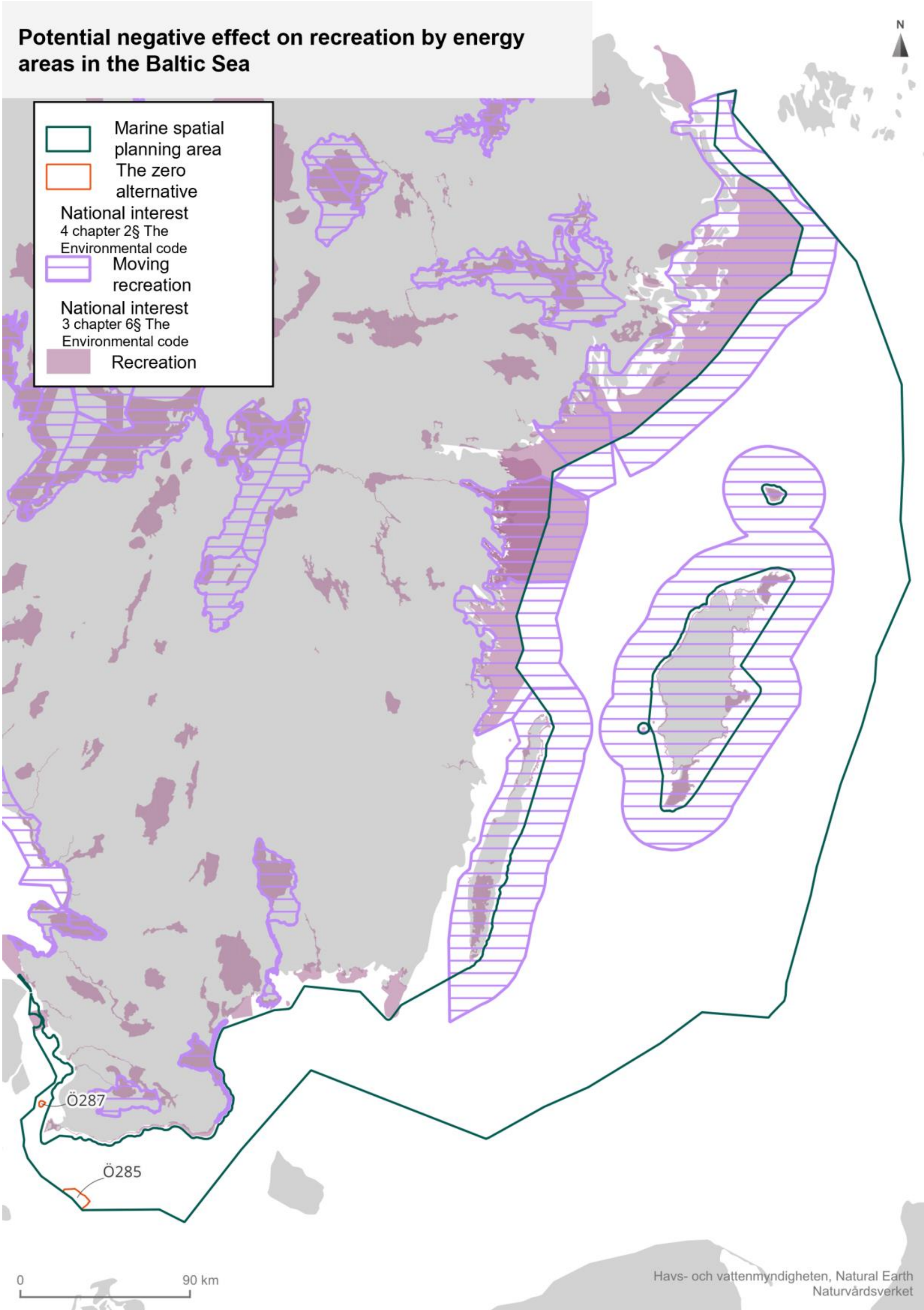


Figure 54. Potential negative effect on recreation of proposed energy extraction areas in the Gulf of Bothnia. Dark color shows great effect and light color shows little effect.

*Accessibility*

As the two energy areas Ö285 and Ö287 in the Baltic Sea marine spatial planning area are built or licensed and are included in the zero alternative, they are not subject to an impact assessment. Regardless, recreation along the coast and inside the marine spatial planning area is widespread with several different activities and experiences that may affect accessibility when establishing offshore wind power.

Leisure boating in the Baltic Sea occurs mainly along the coastline with the greatest activity in the Stockholm archipelago, around and to and from Gotland and Öland, as well as along the coasts of Småland, Skåne and Blekinge. There are major tendencies towards recreational shipping routes within the marine spatial planning area, but also within the marine spatial planning area, such as to and from Gotland and in the Hanö Bay, as well as to our neighbouring countries. The activity of recreational shipping can be viewed in a general way using information from automatic identification systems (AIS data). Not all recreational craft use AIS, which means that the actual prevalence of recreational craft is more extensive. See Figure 55 for recreational boating in the Baltic Sea.

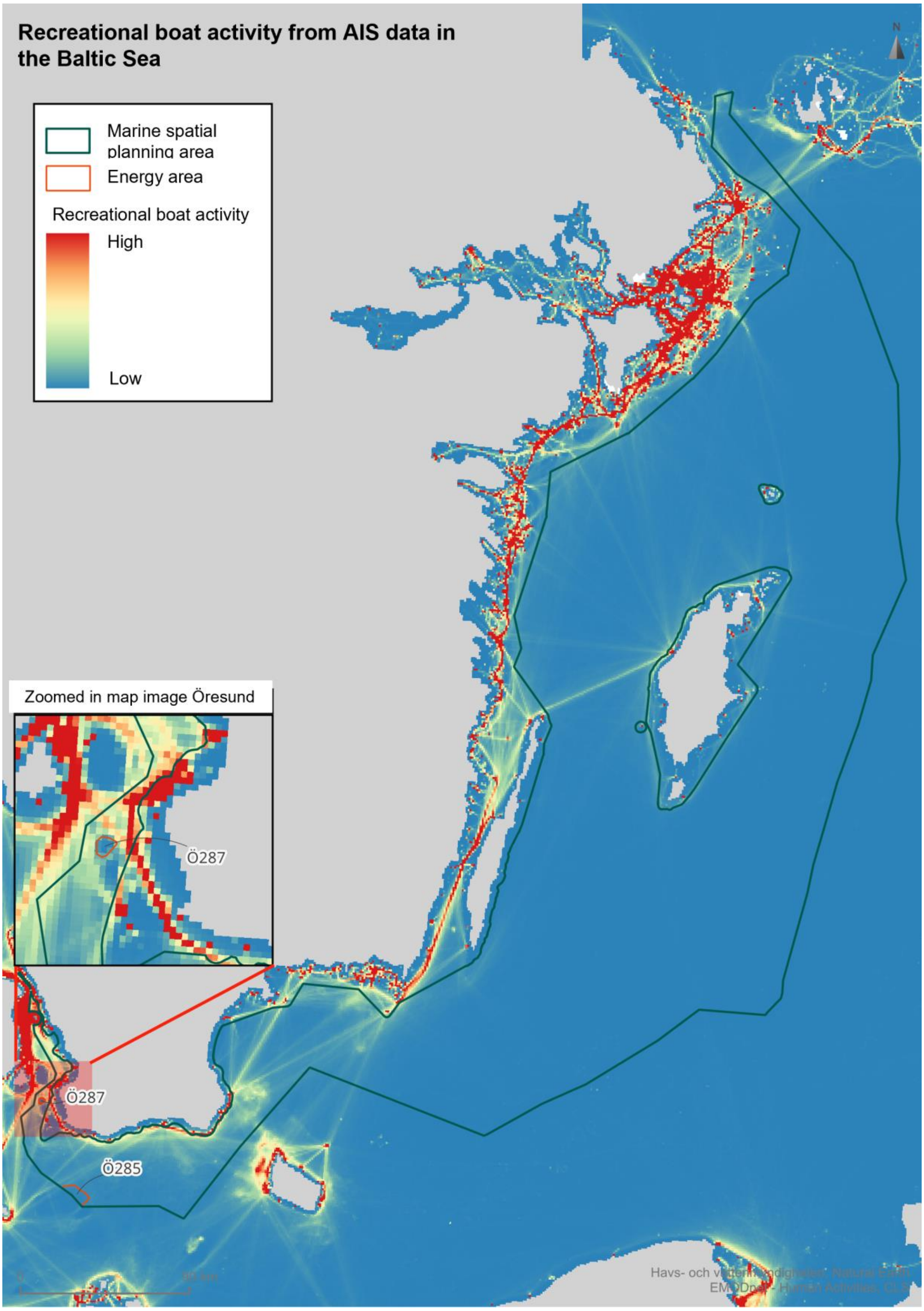


Figure 55. Prevalence of recreational boating activity within proposed energy areas in the Baltic Sea based on an average of hours per month in the years 2017 – 2022 (EMODnet, 2022).

*Other impacts on recreation*

The coastline of the Baltic Sea marine spatial plan area is entirely of national interest for unbroken coastline (Chapter 4, Section 3 of the Environmental Code) or high-exploited coastline (Chapter 4, Section 4 of the Environmental Code). As energy areas Ö285 and Ö287 are licensed and built, they are included in the zero alternative and are not subject to an impact assessment. However, the coastal zone in Skåne is of great importance for recreation along the beaches, not least around Skanör-Falsterbo.

*Cumulative and transboundary effects*

Denmark's marine spatial plan (2024) contains energy areas that can affect recreation in Sweden. Energy areas west of Bornholm that may affect the national interest claim *The coast stretch Trelleborg-Abbekås-Sandhammaren-Mälarhusen-Simrishamn* indirectly, which also German energy areas south of Skåne can potentially do. The *Skanör-Falsterbo peninsula with the coastline Höllviken-Trelleborg* can also be affected by German energy areas. Furthermore, there are primarily two Danish energy areas in Öresund that may indirectly affect recreation around Skanör-Falsterbo, which are located about 12.5 kilometers and 16 kilometers from the national interest claim. The Danish energy area Nordre Flint outside Malmö may have some indirect impact on recreation in the national interest claims *Höje å from Genarp to Lomma*, *Kävlingeån from Vombsjön to Bjärred* and *Ven*. The national interest claims include values of natural and cultural environment and have appealing landscape images, but the impact is considered to be marginal given the degree of exploitation in Öresund.

Due to the fact that the two energy areas in the Baltic Sea marine spatial plan area are built or licensed, its possible effects on recreation in neighbouring countries are not assessed. Crossings for pleasure boats to and from neighbouring countries are generally considered to be large throughout the marine spatial plan area, with the greatest concentration in South Kvarken and Åland, to and from the Danish islands Zealand, Mön, Falster and Bornholm, and northern parts of Germany, where energy areas in Sweden and its neighbouring countries can entail barrier effects.

As the energy areas Ö285 and Ö287 are included in the zero alternative for the Baltic Sea marine spatial plan area, the cumulative impact is also not assessed. However, the energy areas included in the zero alternative, together with energy areas in neighbouring countries, may constitute indirect effects that negatively affect recreation areas in Sweden. The coast of Skåne can potentially be most affected, especially the national interest for recreation Skanör-Falsterbo peninsula with the coastline Höllviken-Trelleborg and the coastline Trelleborg-Abbekås-Sandhammaren-Mälarhusen-Simrishamn.

### 4.4.3. Tourism

In the Baltic Sea there is a developed tourism industry, important for several of the coastal municipalities located in the area (Region Sörmland, 2024: County of Regio Kalmar, u.y.; Region Gotland, 2024) In the marine spatial planning area there are two energy areas, one built on and one with a permit. Since no new energy areas are involved, the assessment is that there is no risk of negative impact on the tourism industry in the area from offshore wind power.

### 4.4.4. Defence

No assessment is made at marine spatial planning level for the interests of defence. See chapter 2.4.4 for general effects.

### 4.4.5. Shipping

The Baltic marine spatial plan area is the plan area with the relatively highest maritime intensity. In the planning area, there is extensive maritime traffic, both national and international, to and from ports, with shipping routes to and from Sweden and the countries around the Baltic Sea and passages for transport to different parts of the world. Maritime transport includes freight vessels, tankers and also relatively high proportion of passenger vessels (EMODnet, 2022). The plan area also includes fairway and shipping lanes that are part of international IMO (International Maritime Organization) routing systems, including the Baltic Sea deep water route south of Gotland. The routing system is a vessel traffic control measure aimed at reducing the risk of accidents.

However, the proposed marine spatial plan does not guide use for energy extraction other than the existing wind farm, Lillgrund (Ö287), and the Kriegers flak area (Ö285), where a licensed project is located, see Figure 56.

Based on the Government’s decision to reject all applications for offshore wind farms in the area, the overall assessment is that there are currently no conditions for using energy extraction in addition to existing permits in the Baltic Proper due to the interests of defence (Ministry of Climate and Industry 2024; Government 2024d). The draft marine spatial plan does not therefore provide guidance on additional areas for use for energy production other than the existing wind farm, Lillgrund, and the Krieger’s Flak area, where a licensed project is located. For this reason, there is no further assessment of the impact on shipping for the current planning document related to energy extraction.

The marine spatial plan's guidance on the use of shipping is based on national interest claims for shipping and thus largely coincides with established shipping lanes and shipping routes. However, the marine spatial plan provides guidance on maritime investigation areas at Hoburg’s Shoal, Midsjöbankarna and Salvorev. Investigation areas are included in the adopted plan and mean that the plan proposes redirection of shipping, but more investigation is required to establish in the plan. The investigation option is described in the adopted marine spatial plan with environmental impact assessment and sustainability report, and includes diversion of shipping away from sensitive natural areas to protect birds and critically endangered marine mammals. However, changed extended mileage is assumed to lead to increased fuel consumption and increased emissions of airborne pollutants and greenhouse gases (Swedish Agency for Marine and Water Management, 2019a; 2019b). The long-term impact depends on the development of ships, energy efficiency and fuels in shipping, as well as other external factors. Re-routing is also likely to increase the intensity of shipping in the deep water route of the Baltic Sea, a route with very high traffic intensity, and with possible other indirect sequential effects.

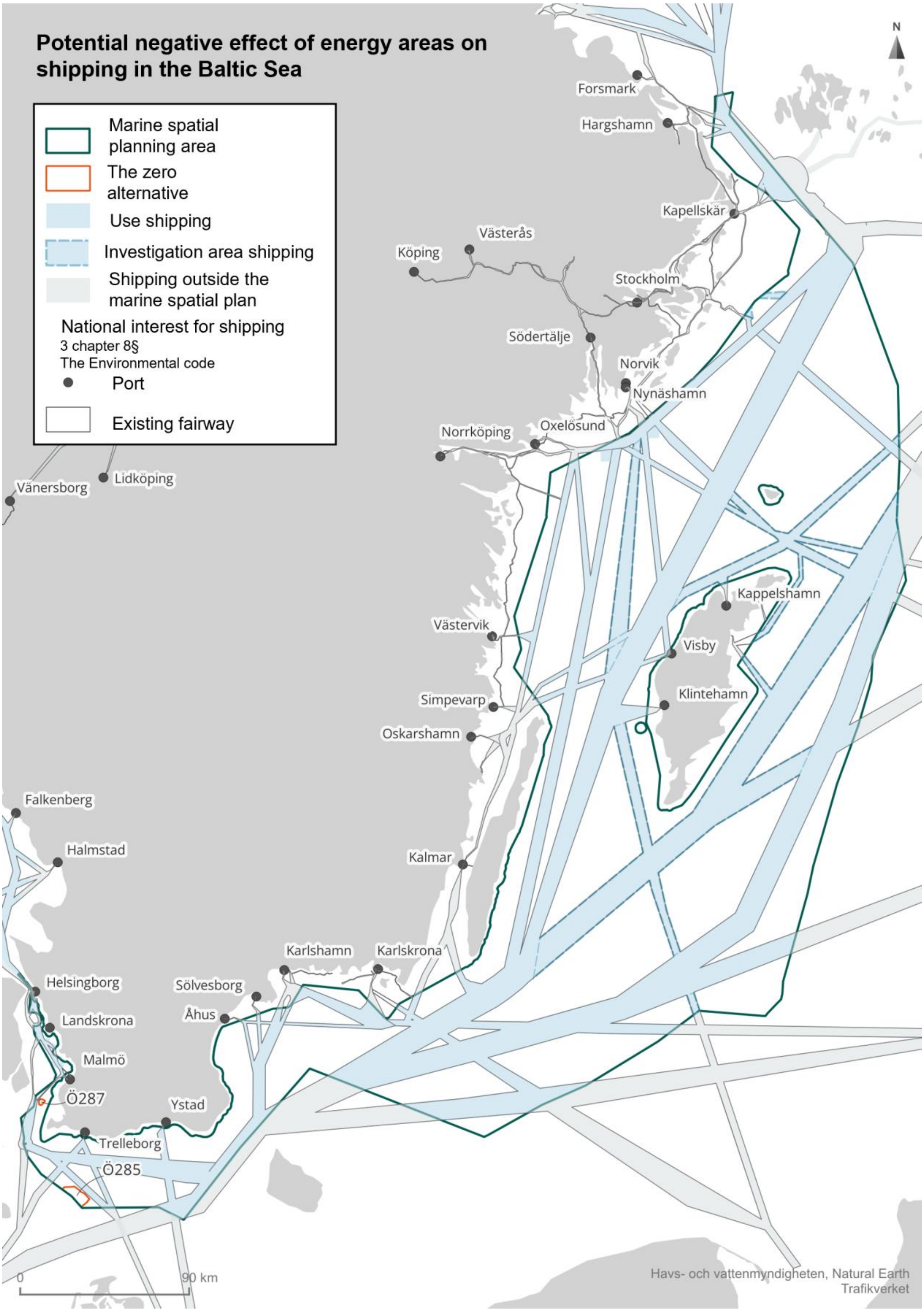


Figure 56. Relative potential negative effect of energy areas on shipping in the Baltic Sea. Dark color shows great effect and light color shows little effect.

As the plan does not guide on additional energy areas in the plan area, the assessment is that the potential impact on shipping of plan proposals is considered to be marginal, both for Swedish and international shipping, provided that recommendations and permits for the establishment of a licensed wind farm take into account existing recommendations (the Swedish Maritime Administration and the Swedish Transport Agency, 2023) regarding, among other things, requirements for safety distances. Safety distances and other adaptations of a wind farm are decided during the permit assessment of the park.

*Cumulative and transboundary effects*

The same assessment also applies to shipping to and from neighbouring countries and international traffic in the plan area.

### 4.4.6. Commercial fishing

Fishing in the Baltic Sea's marine spatial plan area accounts for a large proportion of Swedish commercial fishing in terms of both value and quantity of catches. The main species (period 2018-2022) are sprat and herring, following the decline of the cod stock. The area uses both passive and active gear, with the exception of Öresund, where fishing is conducted exclusively with passive gear. (Swedish Agency for Marine and Water Management, 2025).

Commercial fishing in the Baltic Sea is geographically widespread and the marine spatial plan states the use of commercial fishing in large parts of the plan area. Most fishing in the Baltic marine spatial plan area is pelagic fishing for herring and sprat, which is mainly carried out in the Baltic Sea area, based on nationally allocated quotas. Some fishing with passive gear takes place in front of the coast. Directed fishing for cod in the Baltic Sea has been temporarily closed for several years, but has historically mainly been conducted in the southwestern parts of the sea area, with trawlingin the outer sea and passive fishing closer to the coast. In the plan area, fishing is also carried out from fleets from other EU countries that have quotas in the area.

In the proposal, area Ö248 (E(utr)fn) in the agreed marine spatial plan 2022 has been removed. In and around the area, only limited Swedish fishing has been carried out. The removal of the area is not expected to affect commercial fishing. Otherwise, the proposed marine spatial plan does not guide the use of energy extraction except for areas with existing permits for the establishment of wind power.

There are proposals for expansion of areas with particular consideration to high nature values in the Baltic Sea with regard to migratory birds, harbour porpoises and reef habitats. Areas with special nature considerations can in the long term, depending on the nature value the consideration refers to, benefit commercial fishing from potentially strengthening ecosystem services.

*National, regional, municipal interests*

The plan's guidance on the use of commercial fishing in the Baltic Sea confirms the national interest in commercial fishing. Several municipalities have landing ports for fish (which also represent national interests), including the ports of Simrishamn, Nogersund in Sölvesborg municipality, Byxelkrok in Borgholm municipality, Ronehamn in Gotland and Västervik. See Figure 57 below.

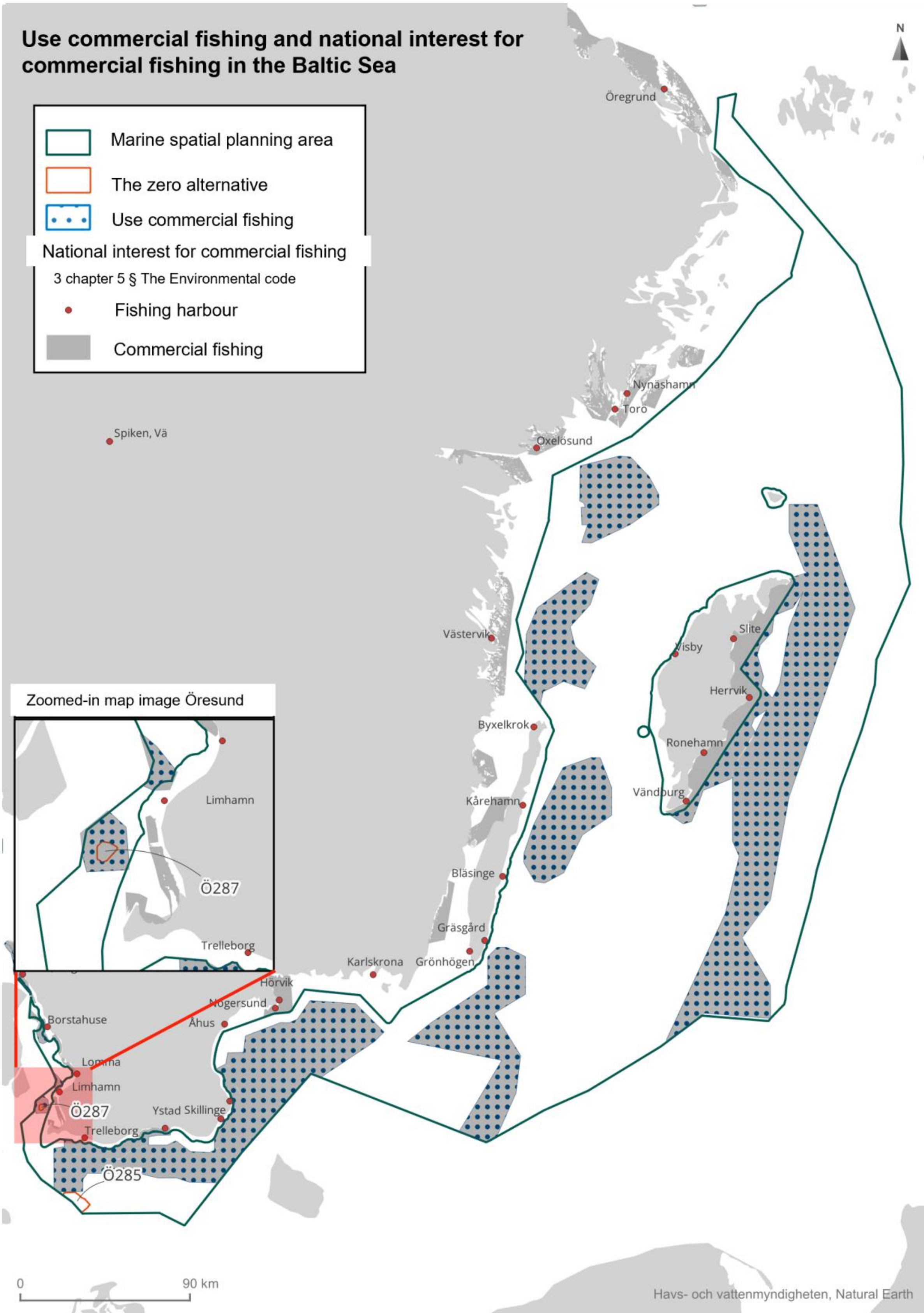


Figure 57. Map showing proposed areas for energy extraction, use of commercial fishing and national interest claims for commercial fishing in the Baltic Sea.

## 4.5. Overall assessment of the Baltic Sea

### 4.5.1. Nature and ecological aspects

The Baltic Sea, with its very varied natural environments, is of great importance for both breeding, resting and wintering birds. The most important migration routes in the Baltic Sea pass through the southern parts of Öland and Gotland and further along the coast of Blekinge and south where virtually the entire coast of Skåne is affected with the highest concentrations across Öresund. These passages are also considered important for migratory bats. The Baltic Sea is also home to the main distribution area of the critically endangered Baltic harbour porpoise at and around Midsjöbankarna and Hoburg’s Shoal. Endangered cod have important spawning grounds in the Baltic Sea south of Skåne and east of Bornholm. The Öresund, which is characterised by several marine saltwater species, intensive shipping and a trawling ban, completes the marine spatial plan area of the Baltic Sea towards Skagerrak/Kattegat. New areas for particular consideration of high nature values have been added to the plan. South of Skåne, a larger area has been designated small n with regard to the bird migration route Rügen-Skåne. Between Öland and southern Midsjöbanken, areas have been added with particular consideration to high nature values for the Baltic Sea harbour porpoise. Several areas around Gotland are included in proposals for new Natura 2000 areas under the Birds Directive and have therefore been given the designation "small n" pending a decision. An area with particular consideration to birds has also been added west of Gotska Sandön. The marine spatial planning guidance on sand extraction risks leading to temporary negative effects in the form of turbidity.

### 4.5.2. Recreation, cultural environment, landscape and tourism

In the northern parts of the Baltic Sea there is the Stockholm archipelago, of national importance for tourism. Along the mainland coast there are several national interests and national interest claims for recreation as well as national interests, national interest claims and value areas for the cultural environment. On Gotska Sandön there are both values for the cultural environment and recreation, where the national park offers privacy, tranquility and a view of the open horizon. Around Gotland and Öland there are several cultural environments both on land and below the surface. The Hanseatic city of Visby, the agricultural landscape of Southern Öland and the naval city of Karlskrona are world heritage sites with high cultural heritage values. National interest in the mobile recreation in the Baltic Sea is widespread, mainly around Öland, Gotland and along the counties of Stockholm, Östergötland and Småland. The coast along Skåne and Blekinge also has high values for recreation and cultural environment, including Ale Stenar, Hanöbukten and Falsterbohalvön.

### 4.5.3. Energy extraction, shipping and commercial fishing

In the Baltic Sea, only energy areas where there are permits for the establishment of offshore wind power remain. The background to the Government's decision to reject all applications for offshore wind farms in the sea area is the overall assessment that there are currently no conditions for using energy extraction in addition to existing permits in the Baltic Proper due to the interests of defence (Ministry of Climate and Industry 2024; Government 2024d). The conditions for energy extraction in the Baltic Sea are good in terms of wind conditions and depth, and there is also a great need for increased energy production to secure the electricity supply in southern and central Sweden.

The use of shipping in the marine spatial plan is based on national interest claims for shipping that largely coincide with established shipping lanes and shipping routes. The plan proposal also guides the investigation of shipping, re-routing of maritime transport in order to reduce the pressure on the marine environment. Investigation proposals are assumed to contribute to reduced environmental impact, but also involve an extended mileage, with potentially increased emissions. Long-term effects are dependent on the development of fuels in shipping. Re-routing would probably also mean an increased intensity of shipping in the deep water route of the Baltic Sea, a route with very high traffic intensity already today and with possible other indirect sequential effects.

The plan specifies the use of commercial fishing in large parts of the Baltic Sea, based on national interest claims for commercial fishing.

### 4.5.4. Cross-border cumulative effects

The low presence of energy areas in the Baltic Sea means that contributions to cumulative effects are very limited on the Swedish side. The cumulative effects are those from existing wind farms and licensed Krieger’s Flak together with energy areas in neighbouring countries. The risk of negative impact is estimated to be greatest in the area around the southern Midsjöbanken from energy areas in Polish waters.

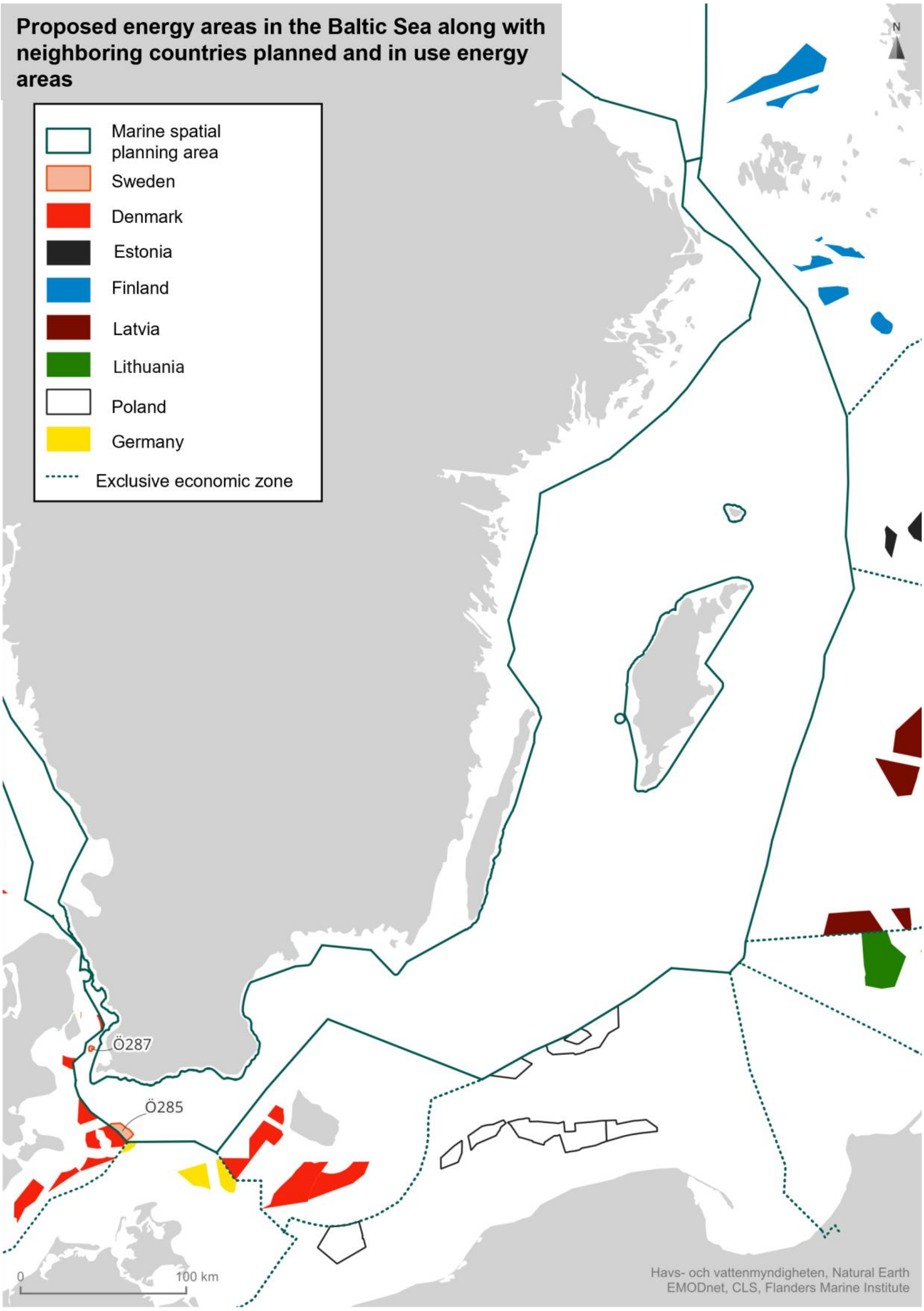


Figure 58. Shows proposed areas for energy expansion as well as already established wind farms in the Baltic Sea for neighbouring countries.

# 5. Impact assessment of marine spatial plan for Skagerrak/Kattegat

## 5.1. Impact on population and health

The marine spatial plan for Skagerrak/Kattegat does not provide guidance on either sand extraction or changing shipping routes. The guidance for energy extraction is therefore what differs from the already adopted marine spatial plan, and is particularly relevant to assess in relation to population and human health.

There is currently no established offshore wind power in Skagerrak/Kattegat, but there are a total of four permits for projects. Energy areas with licensed projects are included in the zero alternative in the impact assessment against which the plan proposals are compared.

*Visual impact and noise*

In Kattegat there is a cluster of energy areas, three of which are included in the zero alternative. The energy areas are located between 7 to 25 kilometers from the coast and will be visible from land. Visual influences from both the turbines and obstacle lighting can disturb people living in coastal areas (see Figure 59 below). However, it is individual and there is uncertainty about how visual disturbance can directly or indirectly affect human health (see section 2.1. Population and health). These energy areas are also in close proximity to areas of national interest for recreation, and there is a risk that some individuals feel less motivated to visit nature areas that are exploited. However, it is difficult to draw any direct conclusion regarding the effects of proposed energy expansion on public health.

Offshore wind generates noise, both audible and infrasound (see section 2.1 Population and health). Modelling for noise dispersion in various project applications shows that the overall noise level generally decreases to 35 dBA within 5 kilometres of the outer boundary of wind farms. Noise modelling is often based on a worst-case scenario for sound dispersion, where the calculations assume that there is no natural attenuation of the sound. In Skagerrak/Kattegat, proposed energy areas are located with sufficient distance from land to avoid health-damaging effects from noise.

The energy areas in Skagerrak are located at a longer distance from the coast, which reduces the visual impact, and the risk that people on the coast are disturbed by obstacle lighting and noise.

*Maritime safety and risk*

A number of proposed energy areas in Skagerrak/Kattegat are considered to pose an increased navigation safety risk due to proximity to shipping lanes and routes. Skagerrak/Kattegat is one of Sweden's busiest sea areas, both in terms of freight traffic and recreational boat traffic (see sections 5.4.2 and 5.4.5). Similar to the assessment of the marine spatial plan for the Gulf of Bothnia, there is a higher risk of marine accidents that indirectly entail a higher risk of adverse effects on human health.

*Reducing Health Hazardous Emissions*

There are also indirect health benefits from offshore wind power. The deployment of offshore wind energy in proposed energy areas can lead to a reduction in emissions, and be a mitigation measure to reduce the effects of climate change that threaten the welfare and security of that society (see Section 2.3.2). Effects on air emissions and climate benefits are indirect and long-term effects of marine spatial plans that in the long term are expected to contribute positively to human health. In a shorter time perspective, local emissions may increase due to construction works and increased traffic, or diversion of ship traffic. However, this is transitory and the net effect of building wind power is positive in terms of the potential to replace fossil-based energy carriers, thereby leading to reduced emissions of greenhouse gases and other airborne pollutants.

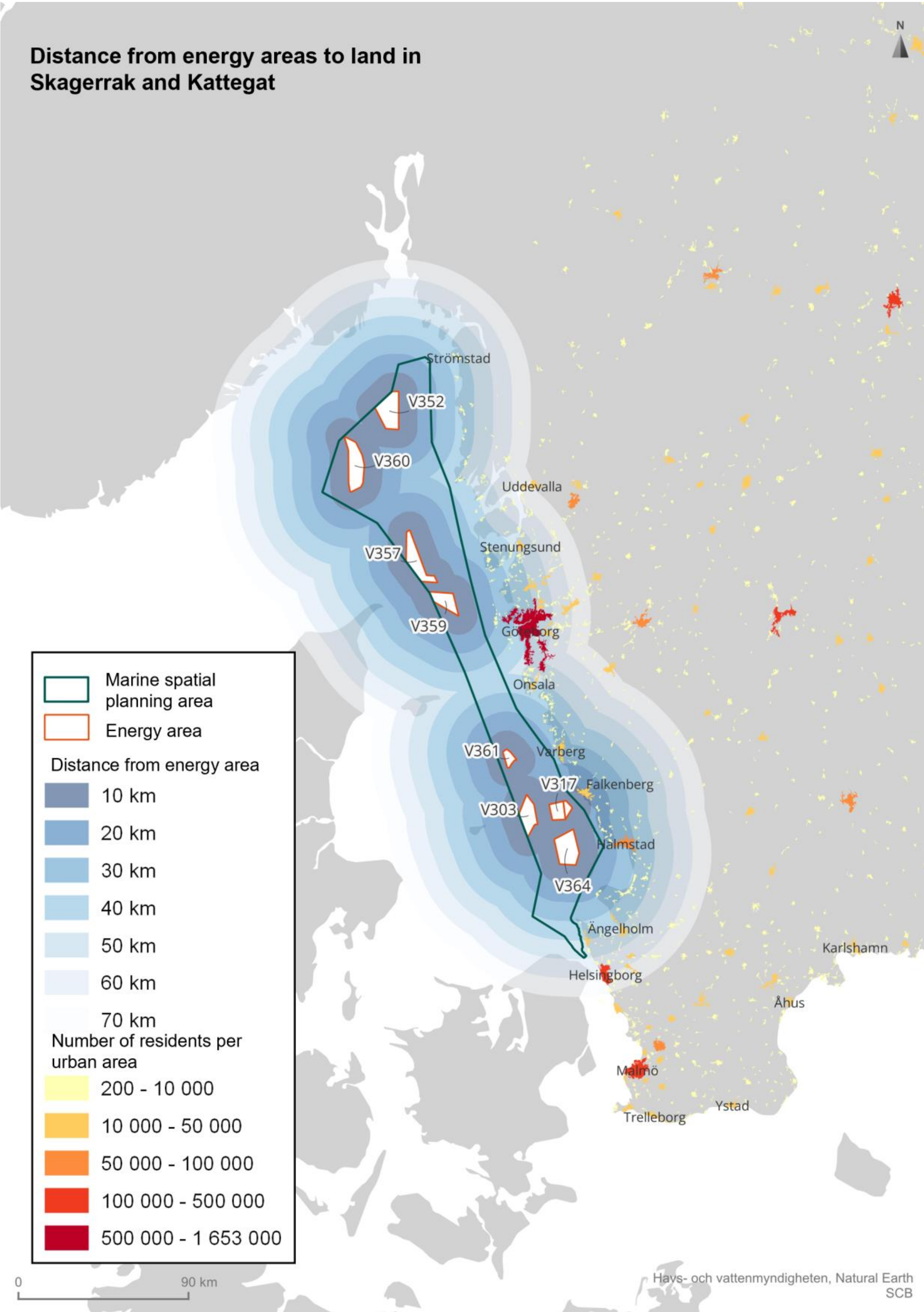


Figure 59. Map showing distances between energy areas and urban areas in the marine spatial plan area of Skagerrak/Kattegat. Source: Statistics Sweden, 2020.

## 5.2. Effects on protected animal or plant species and biodiversity

### 5.2.1. Birds

There are two main migratory bird paths over the marine spatial plan area of Skagerrak/Kattegat: in Skagerrak/Kattegat runs a route in a southwest-northeast direction between Skagen in Denmark to the archipelago area in Bohuslän between Tjörn in the south and Smögen in the north. In Kattegat, another southwest-northeast migration route extends from the Grenå area over Anholt in Danish waters to the Falkenberg-Varberg area. The proposed energy areas within these two migratory routes – V359 in the north and V317 and V364 in the south – are considered to entail a risk of large or medium impact on migrating birds. V359 risks affecting a migratory bird corridor used by birds of prey during the spring migration, many of which are red-listed. The Swedish Environmental Protection Agency considers that the risk of collisions and barrier effects is high as the area is located in the middle of a relatively narrow migration corridor (Energy Agency, 2023a). V359 may also pose a risk to bird species moving in a north-south direction between Skagerrak and Kattegat.

The migratory corridor in the south is also important for birds of prey. It is estimated that three to four thousand birds of prey follow this route during the spring route. Parts of V305 and V317 are at risk of negatively affecting the bird path. The more coastal energy zones V317 and V364 carry a certain risk of negative impacts on coastal species and coastal breeding species foraging in the sea. For these species, the establishment of wind power in the above-mentioned energy areas constitutes a possible barrier to the foraging areas further out to sea. V364 is bordered to the south by the Natura 2000 area Northwest Skåne Sea Area, which is designated, among other things, for the protection of wintering ducks and other seabirds.

*Cumulative and transboundary effects*

The energy area V357 is included in the baseline option and, together with area V359, would pose a cumulative risk of impact on birds.

The area in Kattegat bounded by Fladen in the north and Stora Middelgrund in the south as well as towards the coast is of international importance for several seabirds, including guillemot, razorbill and three-toed gulls. These species show varying degrees of sensitivity to offshore wind (Leemans & Collier, 2022). Although each proposed energy extraction area affects only a small part of the entire area used by the birds, there is a high risk that the habitats of the different species will be fragmented or parts of them will become inaccessible if all energy areas were to develop.

In Kattegat, energy areas V303, V305 and V361 are included in the zero alternative. Of these, special area V361 is considered to have a high risk of negative impact on birds. The cumulative picture for Kattegat is that establishing all energy areas in the plan together with those in the zero alternative would create a risk of major negative impact on birds.

On the Danish side, there are plans for the establishment of wind power in both Skagerrak and Kattegat which are considered to further contribute to the risk of negative impact on migratory birds. Norway currently has no plans to establish offshore wind power in eastern Skagerrak.

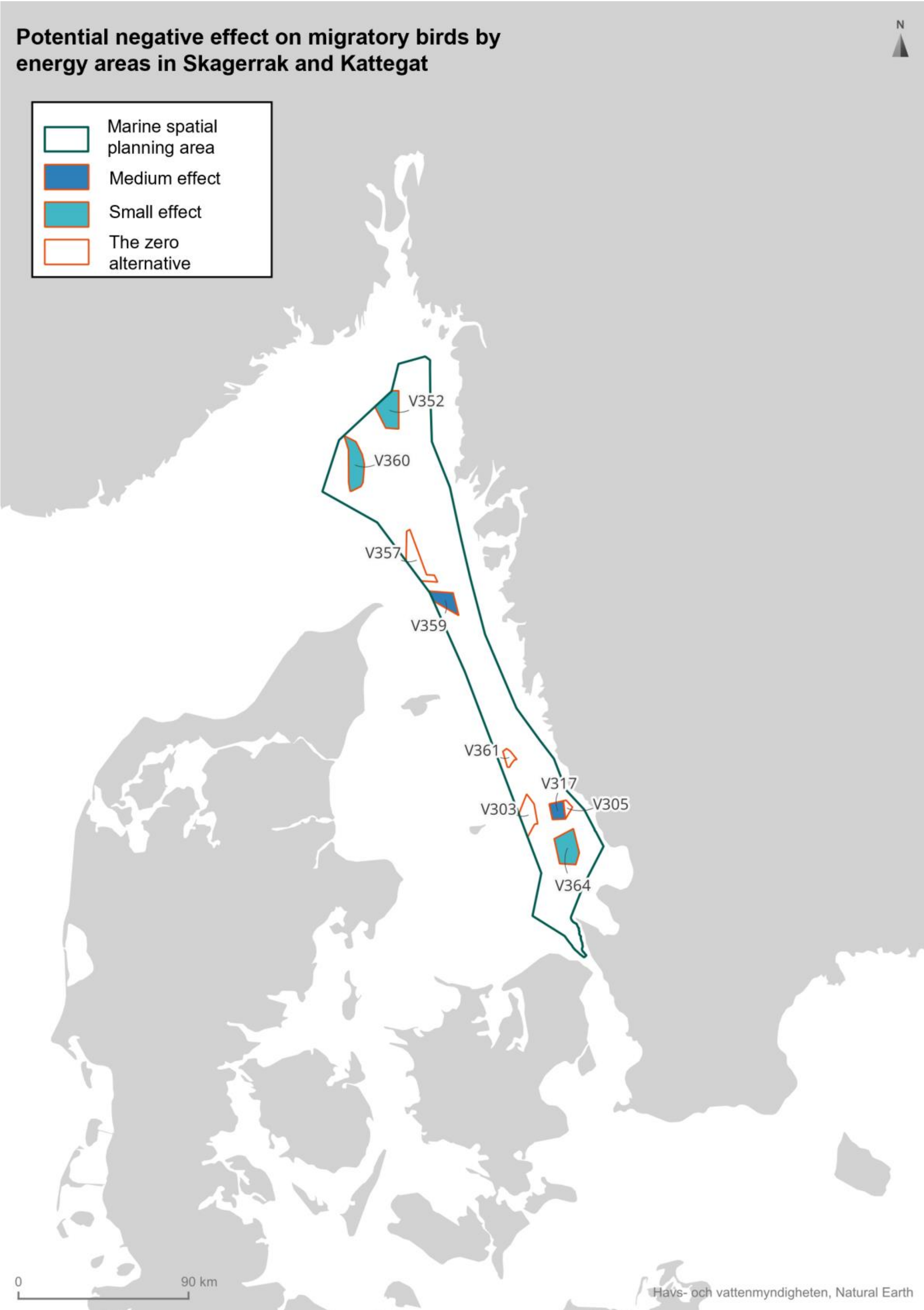


Figure 60. Potential negative effect on migratory birds of proposals for energy extraction areas in Skagerrak/Kattegat. Dark color shows great effect and light color shows little effect.

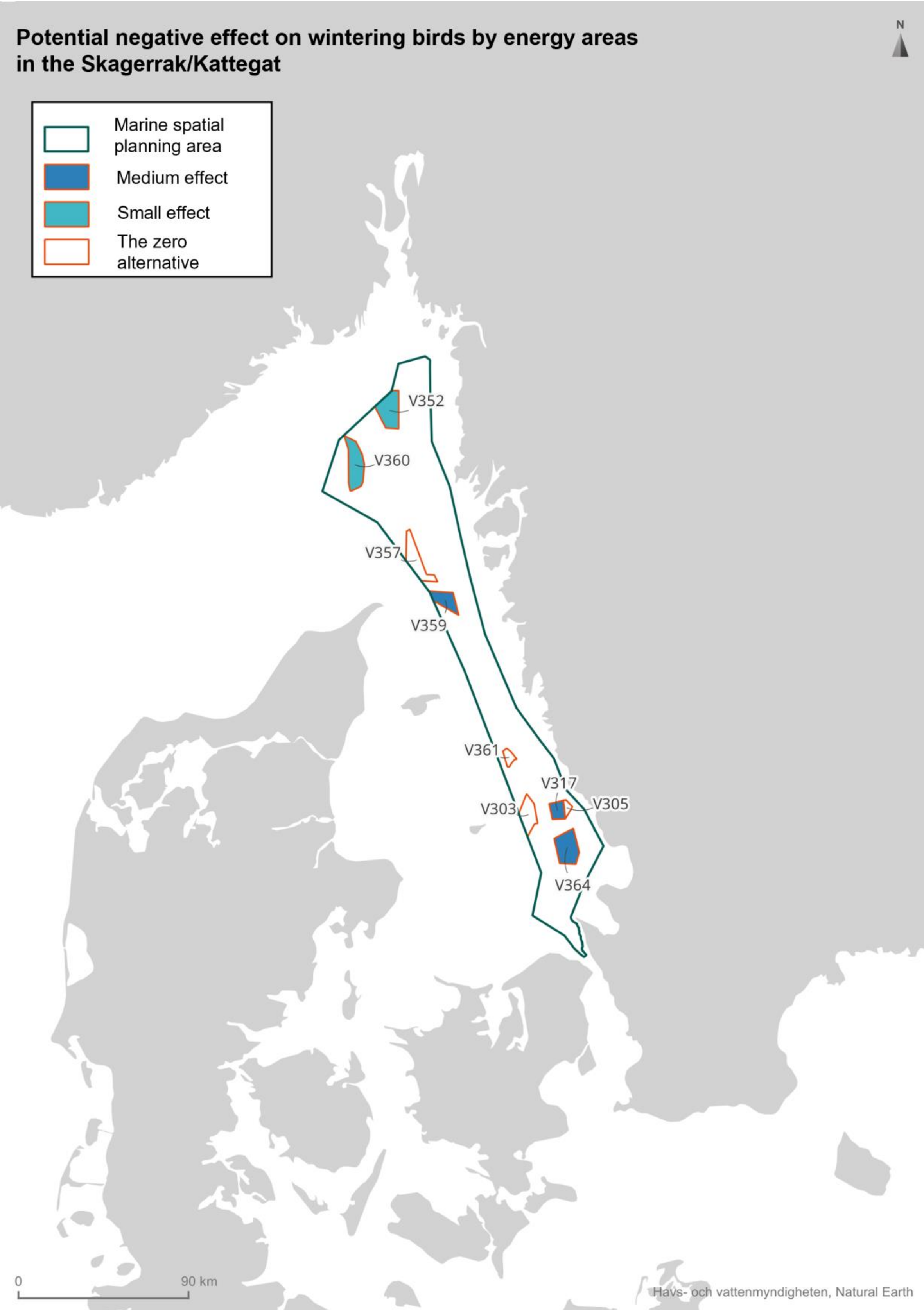


Figure 61. Potential negative effect on wintering areas for birds of proposals for energy extraction areas in Skagerrak/Kattegat. Dark color shows great effect and light color shows little effect.

### 5.2.2. Bats

In Skagerrak/Kattegat, the knowledge base on the presence and risk of impact on bats is particularly weak. There is a great need for additional analyses of migration routes and foraging areas.

There is a migration route in the spring from Skagen's cape in Denmark eastwards towards the Swedish coast. Otherwise, it is the coastal energy areas in Halland that can have a negative effect on foraging bats and a potential migration route via Anholt and over to the Halland coast. An overall assessment gives a medium risk of impact on bats in Skagerrak/Kattegat.

*Cumulative and transboundary effects*

It is especially the energy area V303 within the zero alternative that is considered to be able to contribute to cumulative effects on bats in the potential migration route from Denmark via Anholt.

Several energy areas in the Danish marine spatial plan are considered to have a risk of contributing to cumulative negative impacts on bats, but the state of knowledge is too uncertain for more precise assessments of the risk of impacts.

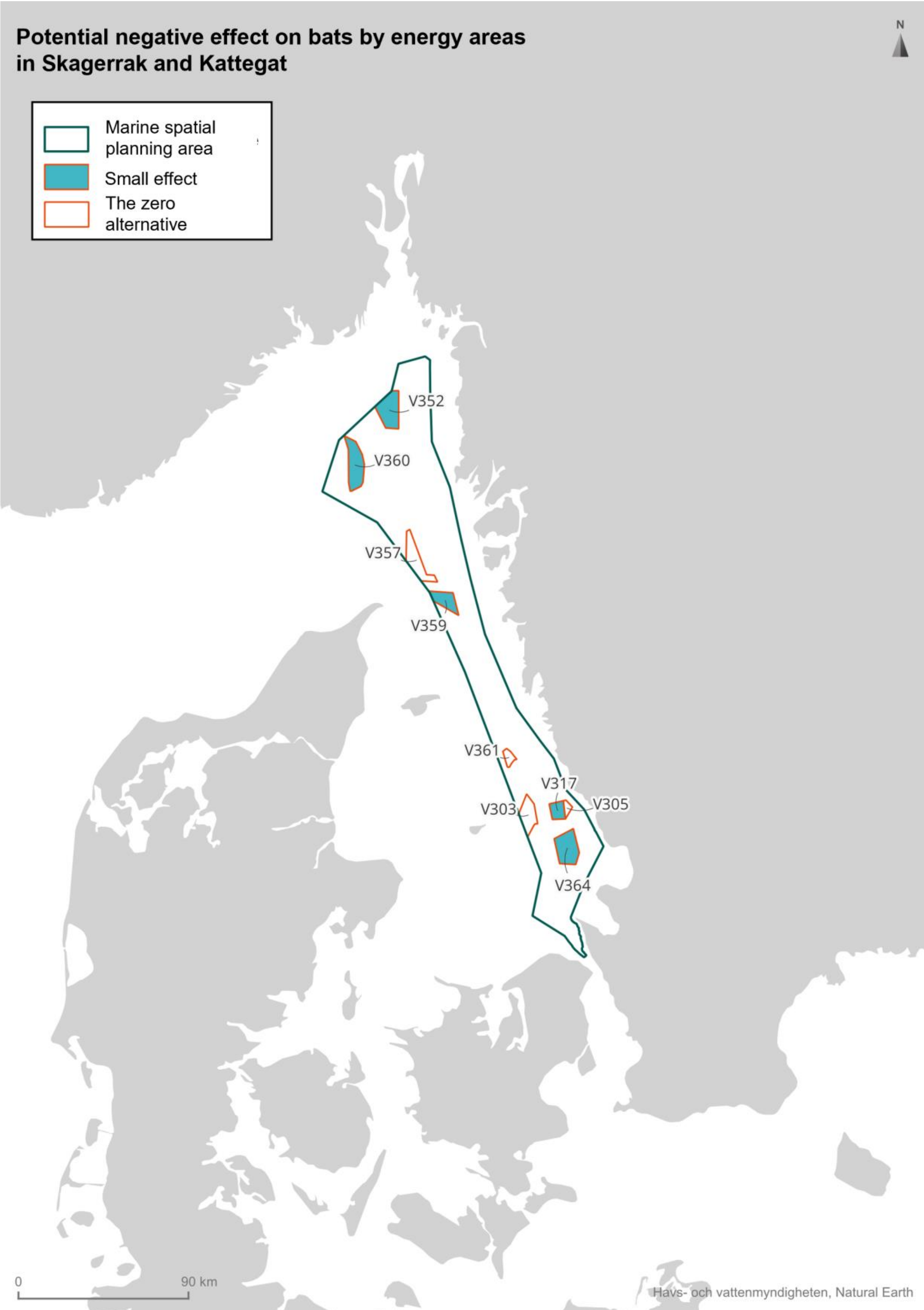


Figure 62. Potential negative effect on bats of proposed energy areas in Skagerrak/Kattegat. Dark color shows great effect and light color shows little effect.

### 5.2.3. Marine mammals

There are harbour seals, harbour porpoises and, to a limited extent, grey seals in Skagerrak/Kattegat.

*Harbour seal*

The harbour seal is close to the coast and rests on islets and skerries. The harbour seal, like other seals in Swedish waters, does not achieve good environmental status according to the latest assessment (Swedish Agency for Marine and Water Management, 2024a). The harbour seal is not as sensitive to impulsive underwater noise as the harbour porpoise. Effects from the construction phase are considered to be minimised to negligible levels if mitigation measures are taken in the construction phase.

*Harbour porpoise*

In Skagerrak/Kattegat, the Skagerrak/Kattegat population of harbour porpoises has one large and several small (but important) reproduction areas, mainly in Skagerrak (Wijkmark, 2015). Particularly worthy of protection for this population is the area at the northern tip of Jutland, which is part of a large reproduction area.

In Kattegat, Fladen and Lilla och Stora Middelgrund are the most important areas for the harbour porpoise. These are mainly used by the Belt Sea population. Neither the population in the Skagerrak nor the Belt Sea population is currently endangered, but is classified as of least concern in the Swedish Species List (Artdatabanken, u.y.), but in the latest status assessment under the Marine Environment Ordinance, the Belt Sea population is not considered to be in good status in any part of the Swedish assessment area.

The energy areas V303 and V361 near Fladen and Lilla Middelgrund as well as V317, V305 and V364 adjacent to Morup's embankment are estimated to have a potential medium negative effect on harbour porpoises.

If account is taken of when in the season construction works are carried out to avoid damage and mitigation measures are used, the effects on harbour porpoises are not considered to have a negative impact on populations in Skagerrak/Kattegat. There is a lack of knowledge about the long-term effects of continuous noise from wind farms on harbour porpoises. Further research and follow-up of actual impact is therefore important and that the conditions for decided parks include that the operator uses the best possible technology to minimize avoidance behaviour of harbour porpoises and ensured that during normal operation there are no noise levels that lead to harmful levels for harbour porpoises.

See Figure 63 for a map of impact assessment for harbour porpoises in Skagerrak/Kattegat.

*Grey seal*

A small number of grey seals are also found along the Swedish west coast. The consideration that will be taken to minimise disturbance of harbour porpoises in the construction of energy areas in Skagerrak/Kattegat will also indirectly exclude negative effects on grey seals.

*Cumulative and transboundary effects*

The energy area V357 included in the zero alternative is assessed to have a potential medium negative impact on harbour porpoises in the construction phase as the area overlaps with a harbour porpoise denser area extending into the Danish sea area.

In Danish waters there are several energy areas in Kattegat. Together with the proposed energy areas in the plan proposal, they are considered to have a medium negative cumulative impact on both Skagerrak/Kattegat and Belt Sea populations of harbour porpoises.

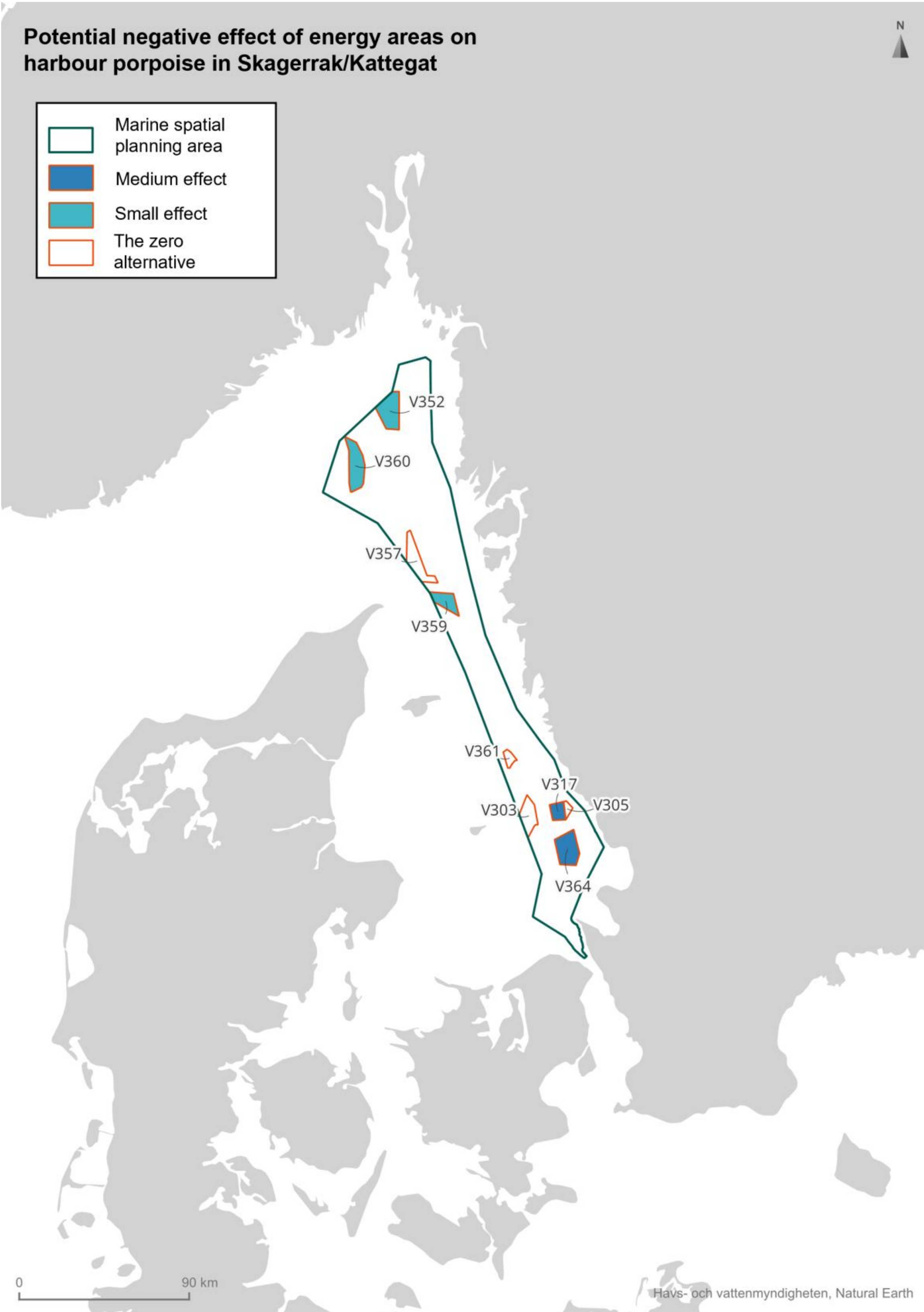


Figure 63. Potential negative effect of proposed energy areas on harbour porpoises in Skagerrak/Kattegat. Dark color shows great effect and light color shows little effect.

### 5.2.4. Benthic habitats

The generally greater biodiversity in Skagerrak/Kattegat compared to the Baltic Sea and the Gulf of Bothnia entails a greater risk of negative bottom impact from offshore wind power in this marine spatial planning area. An analysis of potential bottom impact made with Symphony gives a large negative effect on benthic habitats for the coastal energy area V305 and medium impact for V364, both in southern Kattegat. For both areas, the negative effect is primarily on the photic soft bottom, that is, sunlight-exposed soft bottom. In general, wind power installations should avoid disturbing or causing the loss of benthic habitats worthy of protection. One example of such is the so-called bubble reefs that occur in Kattegat. Known occurrences of bubble reefs do not exist within proposed energy areas in the marine spatial plan, but consideration should nevertheless be given to design to avoid damage to potential biotopes worthy of protection.

Other energy areas in Skagerrak/Kattegat have a small negative effect on benthic habitats in the analysis. See Figure 64 below.

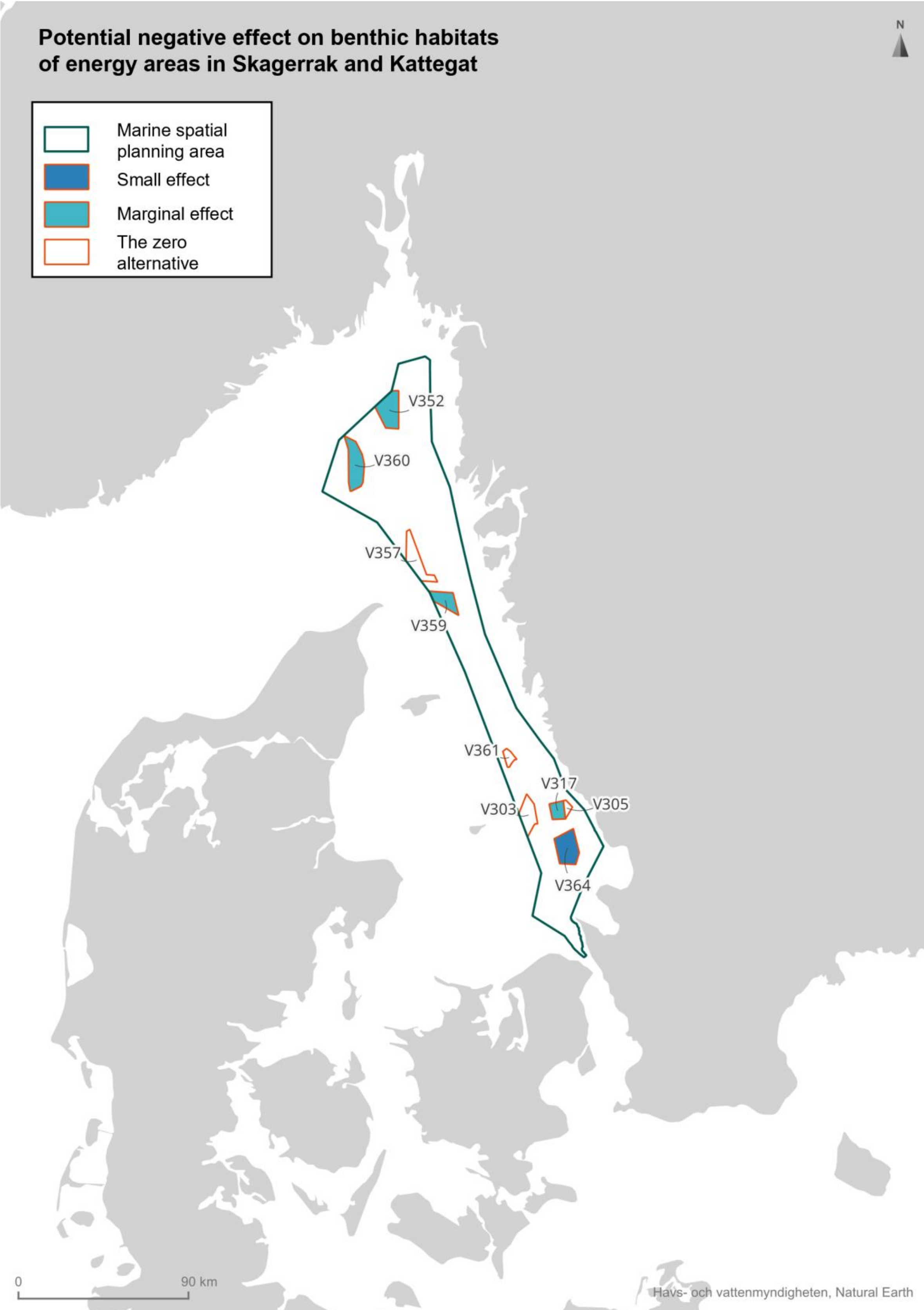


Figure 64. Potential negative effect of proposed energy areas on the benthic habitat in Skagerrak/Kattegat. Dark blue color shows medium effect and light green blue color shows little effect.

In Skagerrak/Kattegat, bottom trawling is conducted, which has negative effects on the benthic habitats. Bottom trawling is different in intensity in different areas. In the assessment of good environmental status made for Skagerrak/Kattegat, the limit value for physical disturbance and physical loss is considered to have been exceeded. This means that activities with physical impact must decrease in extent if there is to be room for new activities with physical impact. Since bottom trawling is one of the main pressures on the benthic habitat in Skagerrak/Kattegat and a dynamic one, it is relevant to see in which areas it contributes the most disturbance. In such areas, a wind power installation with about 1-2% bottom impact could have been an improvement from a bottom pressure perspective compared to bottom trawling that impacts a significantly larger part of the seabed. This can be seen as a positive net local impact.

In Symphony, this has been analysed with assumptions that trawling is not possible in energy areas with floating foundations and assumptions of a 50% reduction in trawling in energy areas with solid foundations. No assumptions have been made about the displacement of the fishing effort. Movement is likely because the fishing quota is likely to govern the effort, i.e. fishing is likely to take place elsewhere to fill the fishing quota. This would mean a concentration of the fishing pressure compared to the current situation. There are uncertainties in these assumptions and how bottom trawling will adapt.

According to the Symphony analysis, a medium positive local net effect from a bottom pressure perspective can be obtained for energy area V352, V359 and V361. A small positive local net effect can be obtained for V317 and V364 in the southern Kattegat and in area V360 in the Natura 2000 site Bratten. See Figure 63 below. These results naturally coincide with the areas that are important for commercial fishing. A balance must therefore be struck between energy use and commercial fishing. Two interests sharing a limited bottom pressure space.

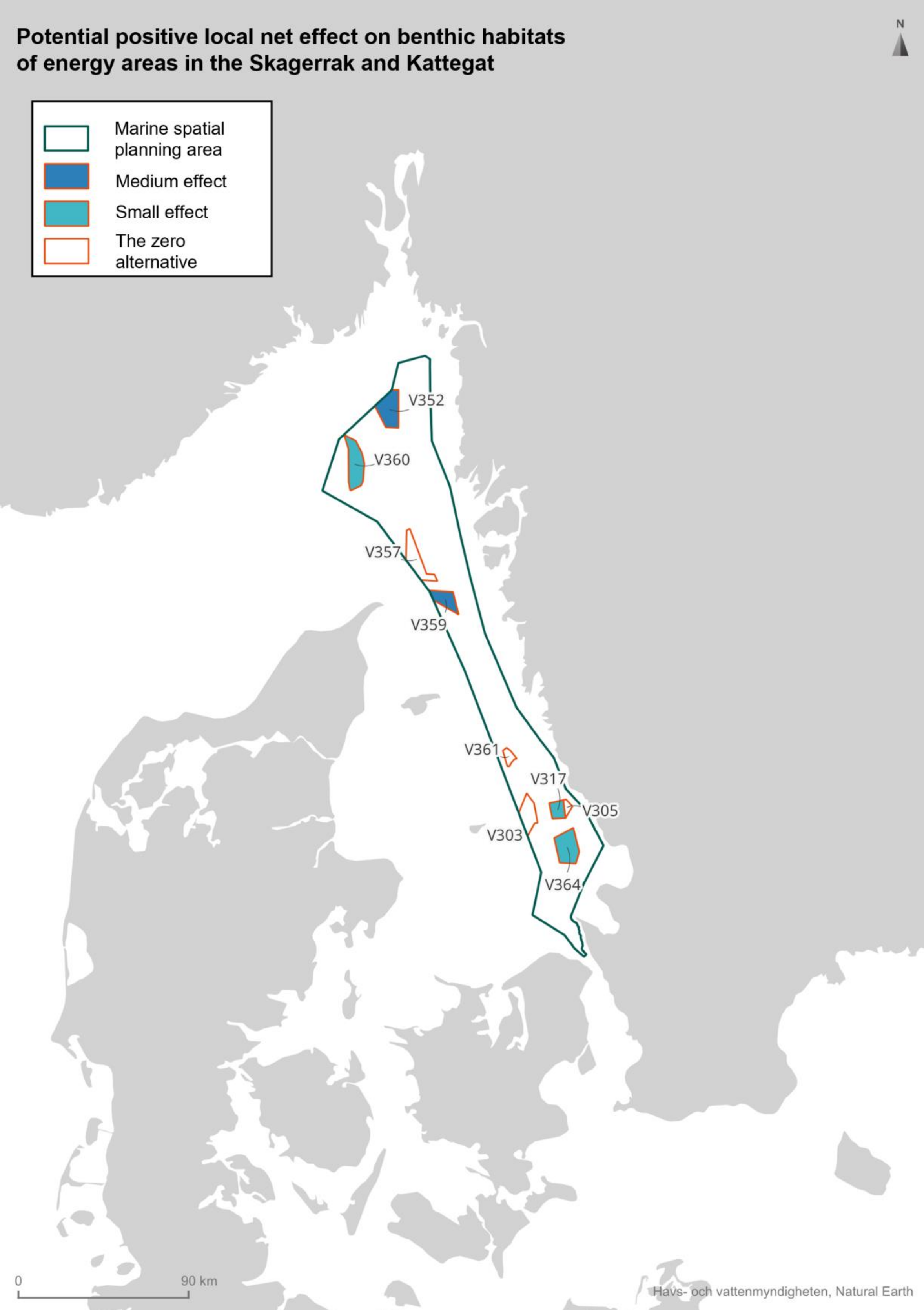


Figure 65. Potential positive local net effect of energy areas on the benthic habitat in Skagerrak/Kattegat if energy use replaces bottom trawling. Dark color shows great effect and light color shows little effect.

*Cumulative and transboundary effects*

The effects on benthic habitats are considered to be primarily local and temporary, in addition to the establishment of a new hard bottom substrate at a plant in the soft bottom. In Skagerrak/Kattegat, such substrates can act as artificial reefs and attract biodiversity, but they also risk being stepping stones for invasive alien species. Therefore, the assessment does not give any positive or negative effect to new hard bottom substrates. In energy area V303 there are several known occurrences of bubble reefs that need to be taken into account in particular.
The risk of cumulative bottom effects in relation to wind farms planned in Danish waters is considered to be mainly linked to potential reef effects and the risk of spreading alien species.

### 5.2.5. Fish and spawning grounds

The main parts of Skagerrak/Kattegat have the potential for fish spawning, but several species' primary spawning grounds are outside Skagerrak/Kattegat. This applies, for example, to saithe, whiting and mackerel spawning in the northern or central North Sea.

In Skagerrak/Kattegat, the conducted Symphony analysis results in that the energy areas V352 and V360 in the north may have a medium negative effect and the energy areas V317 and V364 in the south a small negative effect on spawning areas.

More detailed assessments need to be made prior to the possible establishment of wind power in these areas. Conditions differ between different areas, which requires area-specific surveys and adaptations (Öhman, 2023).

In Kattegat, the proposed energy area V317 overlaps with an area that is designated as a national interest due to its importance for cod play and upbringing. The area is therefore considered to have been able to have a major negative effect on spawning and nursery areas. The establishment of offshore wind power in accordance with the plan proposal entails a risk of impact, which requires consideration and adaptation, in particular during the construction phase.

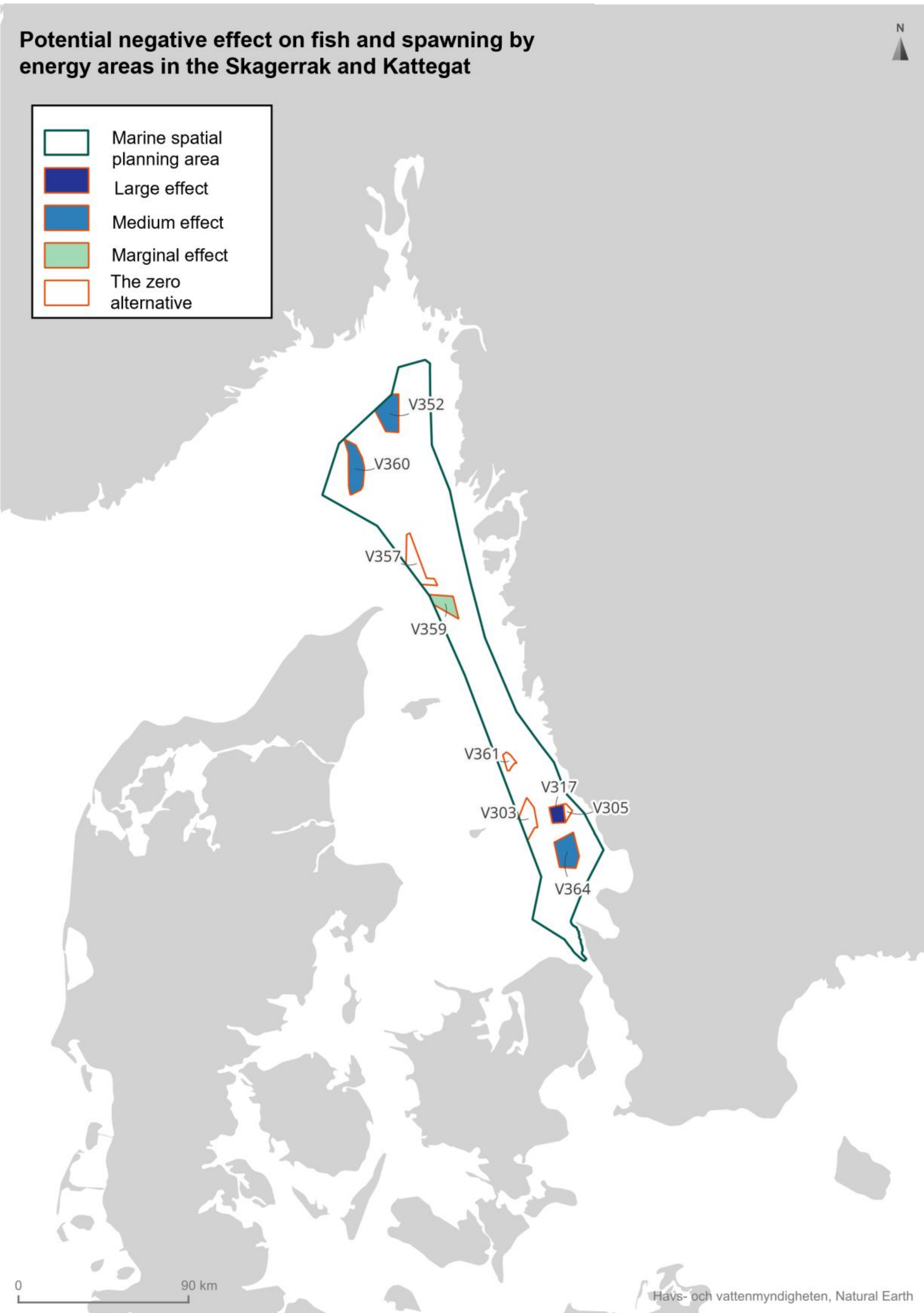


Figure 66. Potential negative effects on fish and fish spawning in Skagerrak/Kattegat. Dark color shows great effect and light color shows little effect.

A reduction in fishing activities may occur as a result of the establishment of offshore wind power according to the plan proposal. The reduction could lead to reduced fishing pressure on the fish resource and benefit the recovery of the resource. However, how fishing will be affected and adapted to possible wind power establishment cannot be predicted at present. It is therefore also not possible to assess how large such a positive effect could be. Similarly, the environmental impact assessment of the adopted marine spatial plan highlights that the marine spatial plan's guidance on particular consideration for high nature values can contribute to the introduction of provisions for more low-impact fishing, which is considered to have a small positive effect on the fish resource (Swedish Agency for Marine and Water Management, 2019a). Regulations may relate, for example, to adaptations for reduced by-catch or reduced impact on the seabed during bottom trawling. However, whether and, if so, how such adaptations could be introduced is not foreseeable at present, and thus also the potential positive effects on fish.

The overall assessment is that the plan proposal has a small negative effect on fish and fish spawning.

*Cumulative and transboundary effects*

The extent of energy establishment in Skagerrak/Kattegat affects the risk of negative effects on fish and fish spawning. The energy area V317 is considered to have the greatest negative effect and should therefore preferably be avoided.

Energy areas in Danish waters has similar conditions to negatively affect fish and fish spawning. Here too, spawning periods should be taken into account in order to minimise the risk of adverse effects.

### 5.2.6. Impact of proposals for new areas with particular consideration to high nature values

In Skagerrak/Kattegat, there are proposals for additional areas for particular consideration of high nature values in an area for general use (V308). The area is proposed by the Swedish Environmental Protection Agency as a new Natura 2000 area under the Birds Directive. It also has valuable occurrences of bubble reefs.

A supplement to areas for particular consideration of high nature values can be found in the proposed energy area (V357) as a bird area because it is located in a migratory bird path from Skagen to the Swedish west coast.

There are also proposals to supplement areas for particular consideration of high nature values in the northern Skagerrak within the marine protected area Bratten. The proposals are less extensive than those received from the County Administrative Board of Västra Götaland. SwAM has seen a value in prioritizing among areas. Examples of areas not included are those north and south of Bratten.

The defence area V319 is proposed for particular consideration of high nature values.

The areas for particular consideration for high nature values in Skagerrak/Kattegat complement the existing relatively extensive network of protected areas. The proposed new areas with the designation "small n" are considered to be able to provide guidance on particular consideration for sustainable use when establishing wind power and other uses such as commercial fishing. Together with agreed areas for particular consideration of high nature values, the proposals are considered to contribute to a preventive consideration that can contribute to green infrastructure and ecosystem services and to the achievement of conservation objectives for biodiversity. Figure 67 shows the areas with nature use and particular consideration for high nature values within the marine spatial planning area Skagerrak/Kattegat.

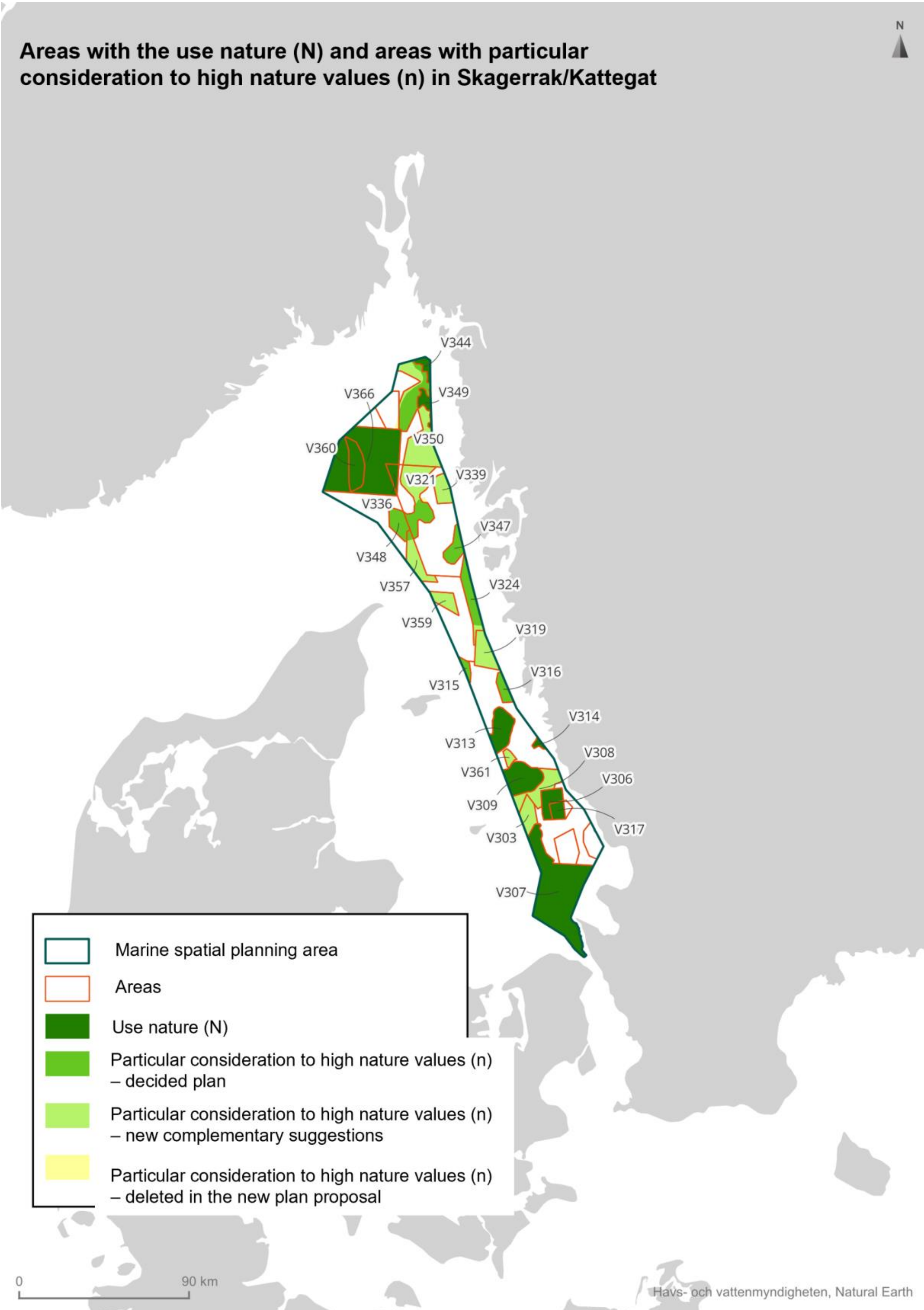


Figure 67. Areas using nature (N) and decided on the respective proposals for new areas with particular consideration to high nature values (n) in Skagerrak/Kattegat (Swedish Agency for Marine and Water Management 2024c).

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## 5.3. Effects on land, soil, water, air, climate, landscape, settlement and cultural environment

### 5.3.1. Water and air

In Skagerrak/Kattegat, it is the marine spatial plan's guidance on energy extraction that is assessed to affect air and water. For effects on air, the assessment refers to changes in emissions of airborne pollutants as a result of the marine spatial plan guidance. Effects on water as a habitat refer to changes in the physical and chemical conditions of water as a result of the marine spatial plan guidance on the different uses.

*Turbidity and dispersal of sediments*

Offshore wind power construction and associated cabling are activities that are expected to lead to increased local turbidity and negative local impact on water quality. The turbidity itself can lead to sequential effects on marine life and particular attention needs to be paid to benthic habitats and organisms that are sensitive to impacts (see also section 2.3.1). Turbidity can also occur during maintenance and decommissioning. The effects are generally considered to be transient and local, and thus insignificant in terms of the marine spatial planning area as a whole and the estimated lifespan of the wind farms.

*Dispersal of pollutants*

During the construction phase, it is important that sediments and benthic habitats are carefully examined to avoid the spread of contaminants. In Skagerrak/Kattegat plan area, there are a number of environmentally hazardous wrecks (the Swedish Agency for Marine and Water Management, Miljöfarliga Wrecks web map, u.y.) that, when affected, can spread pollution. There is also some increased risk of dumped ammunitions and mines in some areas (Swedish Agency for Marine and Water Management, 2025).

In Skagerrak/Kattegat there are three national environmental monitoring stations where the Swedish Geological Survey collects data to monitor the state and trends of environmental toxic pressures in marine sediments. The installation of offshore wind power in several energy areas may affect sampling and stations in the vicinity of energy areas may need to be moved, see Figure 68 below. Other marine environmental monitoring may also be affected by expansion in energy areas.

*Hydrographic effects*

Studies have shown that offshore wind power can affect hydrographic conditions during continuous operation, both at the surface and at the foundations (Arneborg et al., 2024). The effects in the surface water occur when the wind behind the wind farms decreases, which in turn can affect currents and stratification in the surface water. The foundations affect by slowing sea currents and creating turbulence that mixes different water layers. The effects of offshore wind energy can spread beyond the boundaries of the park and also lead to sequential effects and consequences for marine life (see section 2.2.1). Skagerrak/Kattegat with the Skagerrak in the north has a good water turnover through the direct connection with Skagerrak/Kattegat. Kattegat is a transitional zone to the Baltic Sea where water masses and streams with different salinity mix (Havet.nu, 2023a). The plan proposal indicate an extensive energy area expansion especially in combination with the zero alternative. It is therefore important to investigate the effects of changes in hydrographic conditions. Hydrographic changes in Kattegat may also have effects in the Baltic Sea. Consideration also needs to be given to the effects of energy expansion in neighbouring countries in terms of cumulative impacts on hydrography and potential sequential effects.

*Changes in emissions and air quality*

The establishment of offshore wind power can lead to increased maritime transport for the construction and servicing of the wind farms. This in turn can lead to higher air emissions to a limited extent. Shipping and commercial fishing may also need to adapt routes to avoid offshore wind power, which could potentially lead to shifts in mileage and changes in air emissions. However, these effects can be seen as marginal in relation to the total emissions of these sectors.

The expansion of offshore wind energy can also make a positive contribution to air quality by replacing other energy production that generates greenhouse gas emissions. This depends on the energy source being replaced, and the effects are regional and long-term. The overall assessment is that guidance on energy extraction has a positive effect on air quality.

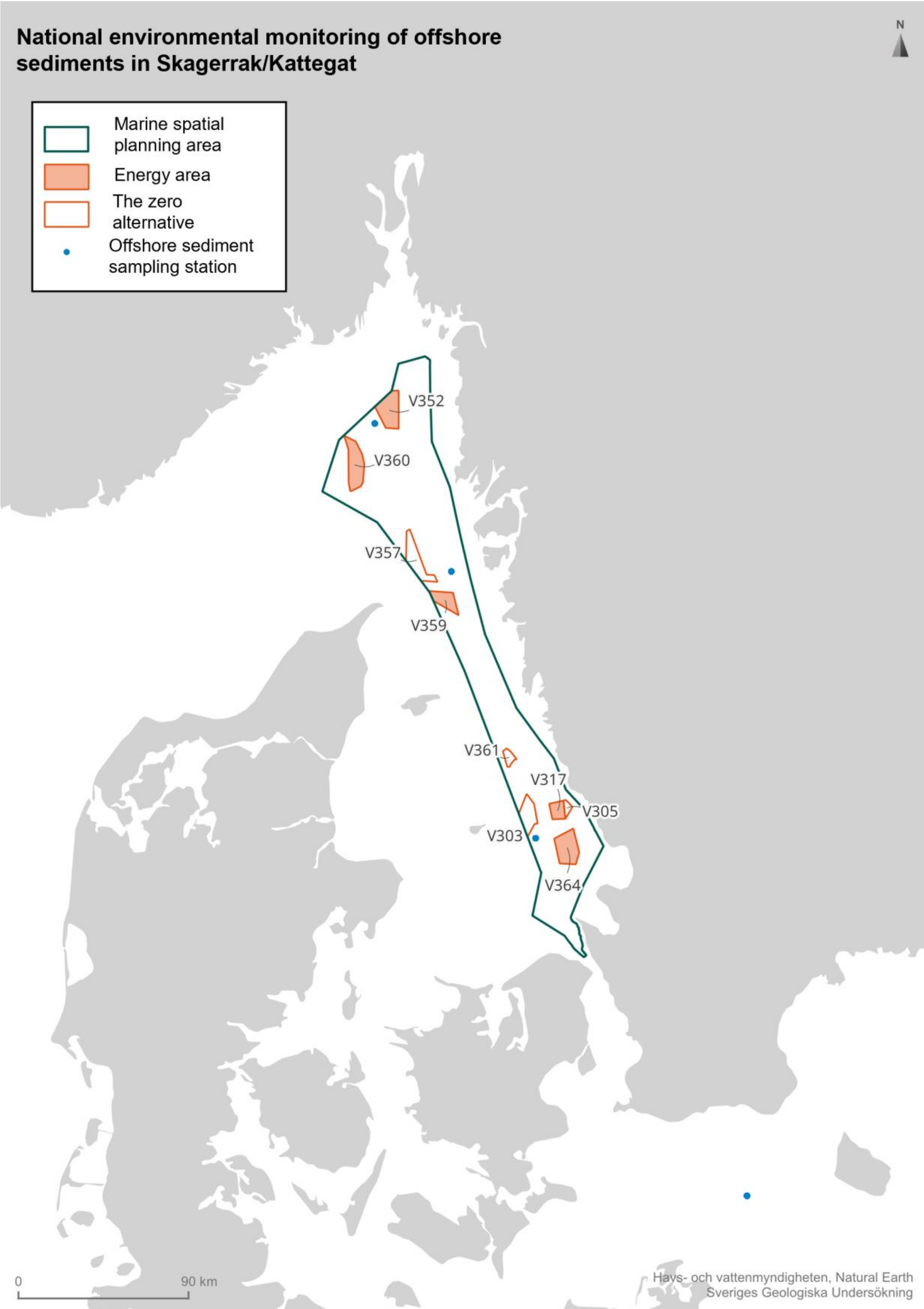


Figure 68. Displays sampling stations for marine environmental monitoring as well as proposed energy areas including the zero alternative.

### 5.3.2. Climate

The marine spatial plan's guidance on nature conservation, particular consideration for high nature values and energy extraction are the aspects that are most relevant in terms of climate impact in Skagerrak/Kattegat. The marine spatial plan provides guidance on five additional energy areas, in addition to the zero alternative, which in Skagerrak/Kattegat consists of the four energy areas where various projects have been granted permits for offshore wind power. The establishment of offshore wind power in energy use areas has the potential to provide society with renewable and fossil-free energy. The expected negative climate-related impacts of energy establishment are time-limited and small compared to the marine spatial plan’s contribution to renewable energy in the longer term. The marine spatial plan's guidance on energy areas in Skagerrak/Kattegat means that there is great potential to contribute to Sweden's climate goals. There are both direct and indirect effects in terms of potential climate benefits. Guidance on protected natural areas can indirectly lead to climate benefits as these areas are protected from interventions that negatively affect the marine environment, which in turn affects both ecosystem resilience and the ability to store organic carbon.

*Climate benefits linked to energy extraction through offshore wind power*

Fossil-free energy production is central to the climate transition by enabling the electrification of society (Swedish Environmental Protection Agency, 2023a, Government, 2021b). Southern Sweden generally has a large energy demand, and the metropolitan region in Västra Götaland County has the second highest electricity consumption in a comparison between counties (see section 2.4.1). Offshore wind power is a renewable energy that has low climate emissions from a life cycle perspective (Energy Authority 2021), and the direct climate benefit consists of the fact that offshore wind power can replace energy production that has a higher climate impact. Climate benefit could also be achieved by using energy as an energy carrier to electrify the industry and transport sector, which currently accounts for a fair share of Sweden's greenhouse gas emissions (Energy Authority, 2024). Indirectly, climate benefits can also arise from the fact that the electricity produced is exported to other countries, thereby replacing other energy production with higher emissions (see section 2.3.2).

There are several uncertainties and limitations to make a quantitative estimate and calculation of the climate benefit. Among other things, the final climate benefit depends on how many energy areas, and how much of individual areas are realized. It also depends on the method used to estimate potential energy production. The marine spatial planning uses a more conservative calculation for potential energy production, some designs indicate a higher power density, a reasonable range would be to assess that the areas in the proposed marine spatial plan allow between 21-30 TWh in Skagerrak/Kattegat (see also section 3.4.1). Furthermore, there are other factors that can determine the actual climate benefit. This may include factors such as how much capacity there is in the electricity grid and infrastructure, how other energy production and associated climate emissions are changing and what the electricity demand will look like in the future.

Chapter 2 (section 2.3.2) presents a reasoning to estimate potential climate benefits, this reasoning was also the basis for calculations made in the previous sustainability report (Swedish Agency for Marine and Water Management, 2019b) and is based on comparing the climate impact between offshore wind power and residual mix. The climate impact from offshore wind power is approximately 11 000 tonnes of carbon dioxide equivalent per TWh (Energy Authority,

2021) corresponding to 524 100 tonnes of carbon dioxide equivalent for the residual mix in 2024 (Energy Market Inspectorate, 2024). Calculations according to the same method for the proposal for a marine spatial plan for Skagerrak/Kattegat show that the plan's guidance on energy extraction has great potential to contribute to climate benefits. Table 27 below also shows a comparison between potential CO2 emission reductions per TWh and Sweden's total emissions in 2023 (SCB, 2024). As mentioned above, it is not possible to interpret the result as realistic, as several variables in the calculations are not definitive, but it gives an indication that there is a great potential for the supply of renewable and fossil-free energy production according to the marine spatial plan's guidance. In general, it is reasonable to assume that the climate benefit is initially greater, and decreases over time when the inferior energy sources are replaced.

Table 27. Shows results of calculation for potential climate benefit when offshore wind power replaces fossil in the Nordic residual mix according to plan proposals, zero alternatives and current situation in Skagerrak/Kattegat.

| | TWh | Climate impact Offshore wind energy (11 000 tonnes CO2-equivalent/TWh) | Nordic residual mix (524 100 tonnes CO2-equivalent/ TWh) | Potential CO2-equivalent reduction | Potential reduction in relation to Sweden's emissions in 2023 |
|---|---|---|---|---|---|
| **Existing offshore wind power in Skagerrak/Kattegat** | 0 | 0 | 0 | 0 | 0% |
| **Zero alternatives (permitted projects)** | 7 | 77 000 | 3 668 700 | 3 591 700 | 7% |
| **Proposal for a marine spatial plan** | 21 | 157 300 | 7 494 630 | 7 337 330 | 15% |

*Changes in greenhouse gas emissions*

Proposals for marine spatial plans with energy areas may have an impact on other uses with a potential impact on greenhouse gas emissions. This applies, for example, to possible changes in the mileage of shipping and commercial fishing. Skagerrak/Kattegat is one of Sweden's most well-trafficed seas, both in terms of freight traffic and pleasure boat traffic. Fixed installations at sea may be an obstacle to vessels, requiring certain routes to be changed. The assessment is that estimated second-round effects on the climate as a result of increased mileage and emissions are insignificant.

Installation and servicing of offshore wind power can also involve emissions that affect the climate, but in relation to the input of renewable energy, these emissions are considered to be insignificant.

*Guidance on nature conservation and particular consideration - carbon sequestration*

The marine spatial plan provides guidance on both nature conservation (N) and particular consideration for high nature values (n). Marine areas that are protected against disturbances and impacts can generally be assumed to have better conditions both to deal with climate change by conserving biodiversity, and better conditions to store carbon as they are to some extent protected from physical disturbances. There are no data or figures that describe the potential and ability for carbon sequestration in different benthic habitats and sediments. Norwegian researchers have mapped carbon sequestration in Norwegian marine areas, and concluded that benthic habitats of different character have different abilities and conditions to contribute to carbon sequestration, both in shorter and longer time perspectives, an important conclusion of the study is that benthic habitats that are left undisturbed have greater potential to act as natural carbon sinks (Diesing et al., 2024).

In Skagerrak/Kattegat there are unique benthic habitats, with great variation in biodiversity and also deep sea channels in the north. The marine spatial plan guides the use of nature, and particular consideration for high nature values on a total area of approximately 5 386 square kilometres, which corresponds to just over 56 percent of the marine spatial plan area of Skagerrak/Kattegat. The largest proportion, 33 percent, consists of large N, and 23 percent is particular consideration for high nature values (small-n). The proposal for the high nature value area has been extended by two areas compared to adopted marine spatial plans (see section 5.2.6). Marine spatial planning as such is only a small part of, and has no decisive role in, the ocean management processes that decide on guidelines for human activities in protected areas. However, the guidance on particular consideration is considered to be able to contribute positively to the conservation of marine environments to a greater extent than if the guidance had not been provided. As mentioned in previos assessments, there is neither data nor an established method to calculate or quantify the extent and rate of carbon storage in Skagerrak/Kattegat, to investigate this further can lead to a better understanding of the climate benefits of conserving and protecting marine ecosystems.

*Adaptation to climate change*

In the marine spatial plan area of Skagerrak/Kattegat, data for climate refugias have not been available as a basis for selection in areas with particular consideration to high nature values, which means that this perspective is lacking. More measures of the ability of ecosystems and marine species to adapt to climate change may also need to be taken into account in marine spatial planning, such as connectivity and genetic variation (Havenhand & Dahlgren, 2017).

### 5.3.3. Landscape

In Skagerrak/Kattegat, the greatest impact is on the landscape in southern Halland, but there are also effects in the northern Skagerrak/Kattegat, where several areas provide a cumulative effect. Energy area V364 west of Halmstad is expected to have a potential large negative effect on landscapes. The nearby energy area V317 is estimated to have a medium negative effect on the landscape. These areas are almost entirely within the territorial boundary and are therefore relatively close to the coast. For V352 and V359 the risk of negative effect is considered to be small and for V360 marginal as the area is far from land. Figure 69 below shows the estimated negative effect of the respective energy area in Skagerrak/Kattegat.

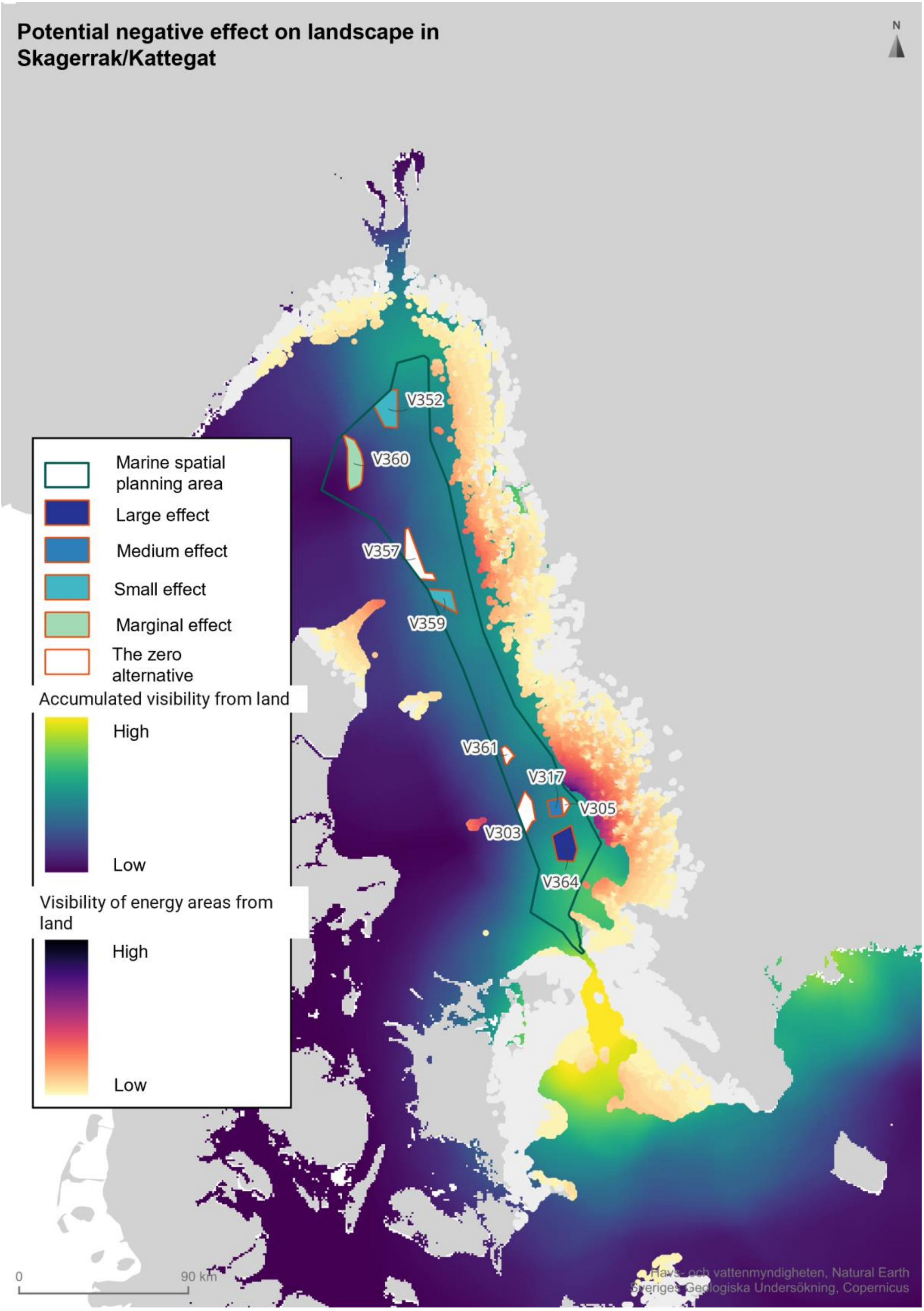


Figure 69. Potential negative effect on the landscape of proposed energy areas in Skagerrak/Kattegat. In the energy areas, dark color shows great effect and light color shows little effect. Accumulated visibility from land is shown over the sea and visibility of energy areas is shown over land.

*Area-specific assessments*

*Skagerrak*

In the northern part of Skagerrak/Kattegat, it is especially the energy areas V352 and V359 that are considered to cause some effect on the landscape. V352 tends to have the greatest negative effect on the northern Bohus coast, where the Kosteröarna islandsand its national park stand out along with the area west of Havstenssund, Grebbestad, Fjällbacka, and Väderöarna. The energy area is about 25 kilometer from the Kosteröarna islands and about 32 kilometer from Grebbestad.

Following the landscape analysis, V359 tends to have the greatest negative effect on landscapes around the areas around western Tjörn, Marstrand, Pater-Noster, and Gothenburg's northern archipelago, including the islands Rörö, Hälsö, Öckerö and Björkö. The distance from V359 to Gothenburg's northern archipelago is about 18 kilometer and to Marstrand about 20 kilometer.

In Skagerrak/Kattegat, the plan's energy areas are relatively far from land, but its size contributes to a relatively greater negative effect on the landscape. The report 'Storskalig vindkraft I Västerhavet – Landskapsbild 2023-11-30' (Ramböll, 2023) analyses the impact on the landscape in more detail, in particular the potential for reducing effects by dividing areas into smaller parts with open views between them.

*Kattegat*

In Kattegat, V317 is estimated to have the greatest landscape impact on the coastal areas around Morups tånge and Falkenberg down towards Steninge. The energy area is located about 10 kilometer from Falkenberg. Worth mentioning is that V317 is located in the shadow of sight from V305 (zero alternative) to the Halland coast, but when established together with V305 can be perceived as a larger contiguous area if the landscape is viewed southwards from the north of the energy areas, for example from Träslövsläge or Morups tånge.

For V364, the energy area is considered to have the greatest impact on the landscape in the areas around a larger part of the coast of Halland, as well as the Bjäre peninsula. This impact extends mainly from Falkenberg, along Halmstad and down towards Laholmsbukten. The northern and western parts of Bjärehalvön together with Hallands Väderö are affected. V364 is located about 16 kilometer from Tyludden and 13 kilometer from Hallands Väderö. V317 (and V305) have a distance of 6 kilometer to V364, which may contribute to them not being perceived as a coherent energy area.

*Other impacts on landscapes*

Energy area V352 is located about 27 kilometers from *Fjällbacka archipelago* landscape protection area that may be negatively affected by the establishment of offshore wind power. The entire coastline of Skagerrak/Kattegat is also covered by areas for unbroken coast or high-exploited coast (Chapter 4 of the Environmental Code). V352 is located about 12.5 kilometers from the coastal area and archipelago in Bohuslän. Values in this so-called national landscape include, among other things, the originality of the entire area, connected beautiful and original landscape sections and lookout points, and other values linked to the landscape image. The area includes values with areas of some originality and other environments linked to the landscape (Länsstyrelsen, 2000) that may be affected by the energy area. In the northern part of

Skagerrak/Kattegat there is also Kosterhavet National Park about 11.5 kilometers from energy area V352. In addition to high marine nature values, the national park also has a rich cultural and natural landscape. In Kattegat, the coast of Halland is covered by high-exploited coast of national interest. V317 is located less than a kilometre from the area and V364 about 5 kilometres from the area and Skåne's northern part of the national interest high-exploited coast. The landscape protection area *Vesslunda* about 16 kilometer from both energy areas and Strandområdet Påarp-Fylleån estuary about 27 kilometers from V364 is considered to be visually affected by the establishment of wind power.

*Cumulative and transboundary effects*

In Skagerrak/Kattegat, areas in Norway and Denmark can be affected by energy areas in the marine spatial planning area. For example, V352 in Skagerrak may have negative landscape effects on areas within the Norwegian national park Ytre Hvaler, as well as the coastal areas south of Sandefjord and Larvik. Further south, the V359 can have a negative landscape effect on Danish Skagen about 30 kilometer away, as well as marginal effects on the northern parts of Læsø over 40 kilometer away. In Kattegat, it is primarily the Danish island of Anholt that can be affected by energy areas in the plan area. Anholt is located approximately 34 kilometers and 36 kilometers from V317 and V364 respectively.

Neighbouring energy areas will have a synergetic cumulative effect on the landscape on the coast of Skagerrak/Kattegat, despite some gaps between energy areas. From many viewpoints along the coast, several wind farms can be visible in good weather conditions. Based on the number of energy areas, their size, relatively coastal location and its location along the coast with relatively even distances, the cumulative impact in Kattegat is estimated to be large. In Skagerrak, V359 together with the authorised V357 can entail cumulative effects alternating its specific assessed effects. The cumulative effects from the northernmost energy areas are estimated to be smaller as the V360 is located almost 50 kilometers from the mainland.

### 5.3.4. Cultural environment

*Indirect influence – National interest in cultural heritage conservation, Chapter 3, Section 6 of the Environmental Code*

In the marine spatial plan area of Skagerrak/Kattegat, there are three energy areas that are considered to entail a risk of large negative impact on national interest claims for cultural heritage conservation: V359 outside Öckerö, V317 outside Falkenberg and V364 outside Halmstad. These areas lie wholly or partly within the territorial sea boundary and are therefore relatively close to the coast. Another area is considered to have a risk of medium negative effect on cultural heritage conservation: V352 outside Koster. Finally, energy area V360 is considered to be able to give rise to a risk of marginal negative effect on cultural heritage management. The energy areas V303, V305, V357 and V361 are not subject to an impact assessment as there are permitted projects in the area and are therefore included in our zero alternative. In addition to V360, other energy areas in Skagerrak/Kattegat are listed with particular consideration to high cultural heritage values (little-k). The guidance on particular consideration for high cultural heritage values is considered to entail adaptations of the location and design of wind farms regarding, for example, the location and height of wind turbines in order to reduce the impact on the specific cultural heritage sites concerned. Figure 70 below shows the estimated negative impact of the respective energy area by colour code.

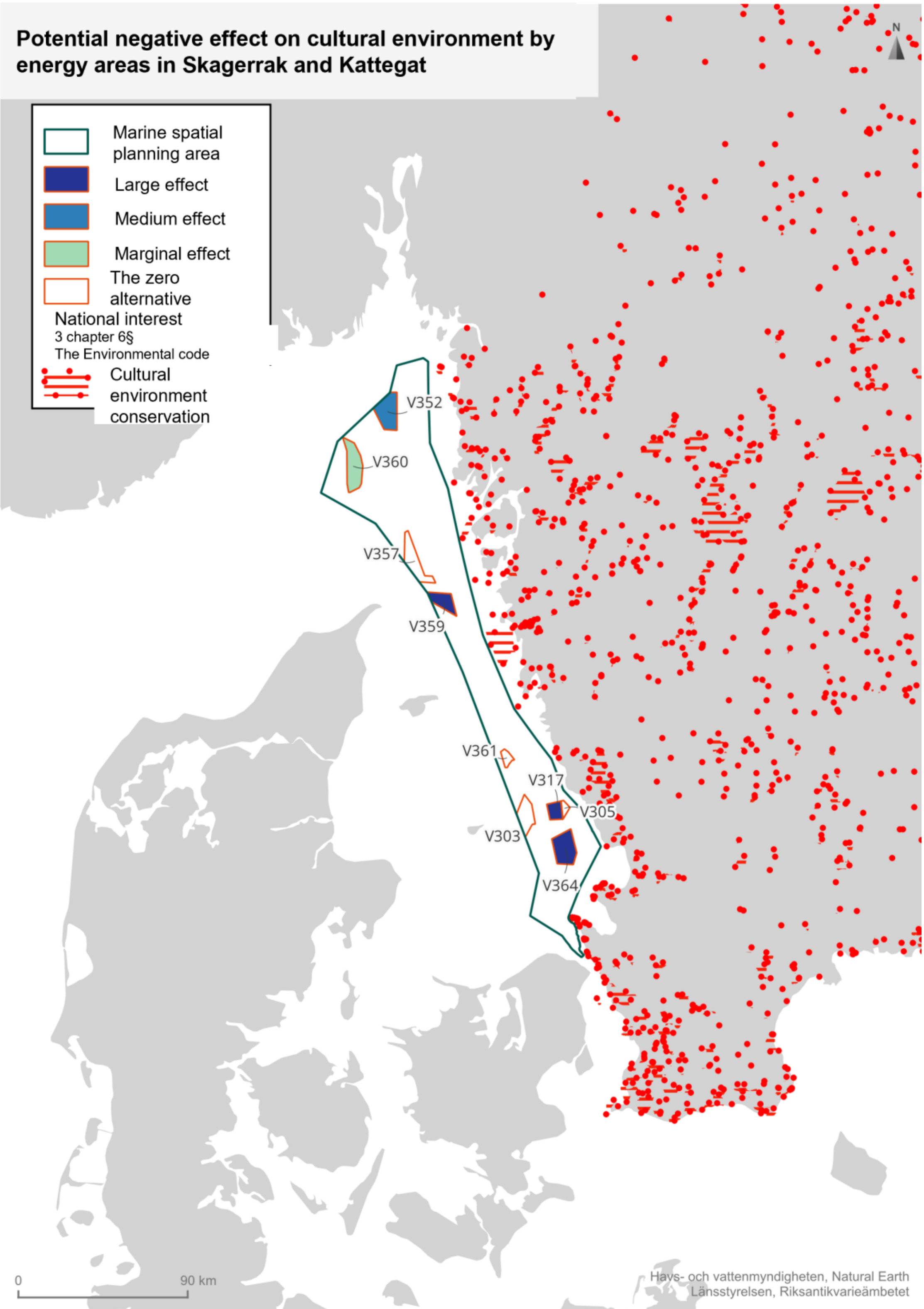


Figure 70. Potential indirect negative effect of energy areas on national interest claims for cultural environment in Skagerrak/Kattegat. Dark color shows great effect and light color shows little effect.

*Skagerrak*

V352 is considered to be likely to have a negative effect primarily on the national interest claim *Koster*. The cultural environment includes archipelago, agricultural and fishing villages with older cultural landscapes. Expressions of national interest are described to lie primarily in the environment linked to the structure of the landscape, agriculture, coastal settlements related to fishing, and beach resort life. In addition to the national interest being within the bounds of spatial dominance/competition to V352, the energy area may affect the communication and recreation environment where unobstructed views are an essential expression. It may also affect fishing villages, urban environments, coastal and archipelago environments, coastal and shippers' communities where adjacent coastal and marine landscapes are an essential physical expression.

V359 is expected to give rise to a risk of negative impact mainly on several national interest claims, mainly *Pater Noster*, *Marstrand*, *Burösund (Hällsö – Burö et al. islands)*, *Styrsö parish*, *Åstol* and *Tumlehed*. The national interest claims are covered by communication environment, small town environment, seaside resort, coastal and archipelago environment, ancient site environment, institutional environment, cognitive environment, fishing village and coastal communities. Expressions of national interest are described mainly in lighthouses and pilot sites, defence installations and the silhouette of Carlsten Fortress, churches, town halls and homes from the 17th century onwards, seaside resorts, port environments, plots, ancient sites in the form of communities from the Stone and Bronze Age, agricultural settlements, fishing activities, quarantine facility and rock paintings. In addition to the national interest claims being within the bounds of spatial dominance/competition to V359, the energy area may affect the archaeological environment, communication environment, recreation environment and defence environment where free views are an essential expression. It may also affect fishing villages, urban environments and coastal and shipping communities where adjacent coastal and marine landscapes are an essential physical expression.

*Kattegat*

V317 is considered to be likely to have a negative impact primarily on the national interest claims *Vastaddalen* and *Träslövsläge*. The national interest claims are covered by, among other things, agricultural landscapes with plains, ancient relics, church environment, mill environment, coastal environment and fishing village. Expressions of national interest are described to lie primarily in prehistoric sites, agricultural buildings from the 19th century, coastal cottages, fishing village with protected natural harbor, and unique mill facility at Berte. In addition to the national interest claims being within the bounds of spatial dominance/competition to V317, the energy area may affect the archaeological, communication, recreation and defense environment where unobstructed views are an essential expression. It may also affect fishing villages, the urban environment and the coastal and shipping community, where adjacent coastal and marine landscapes are an essential physical expression.

V364 is considered to be likely to have a negative impact primarily on the national interest claims *Vastaddalen*, *Gröthögarna*, *Segelstorp*, *Dagshög*, *Tyludden – Tylöns lighthouse site* and *Båstad – Norrviken gardens*. The national interest claims include small-scale cultural environments and agricultural landscapes with plains, ancient relics, church environment, mill environment, coastal landscape, village environment, ancient and medieval coastal environment, seaside resort, recreational environment, and garden. The claims of national interest express prehistoric sites, farm buildings from the 19th century, coastal cottages, medieval buildings, unique mill plant at Berte, burial cairns, line of sights along the beach and out to sea, 19th century farms, farmland, port, shipping and shipbuilding, the Bronze Age mound Dagshög, fishing villages, seaside resorts, and Båstad with its location and port. These cultural environments are sensitive to large-scale wind farms that can break historically functional links and complicate the understanding of the history that the cultural environments represent. In addition to these national interest claims being within the bounds of spatial dominance/competition to V364, the energy area may affect communication, archaeological, recreational and defence environments where unobstructed views are an essential expression. It may also affect fishing villages, urban environments, coastal and shipping communities where adjacent coastal and marine landscapes are an essential physical expression.

*Direct impact*

In the marine spatial plan area of Skagerrak/Kattegat there are a number of registered marine archaeological sites in both the proposed energy areas and the energy areas included in the zero alternative. Figure 71 shows marine archaeological sites within and outside energy areas.

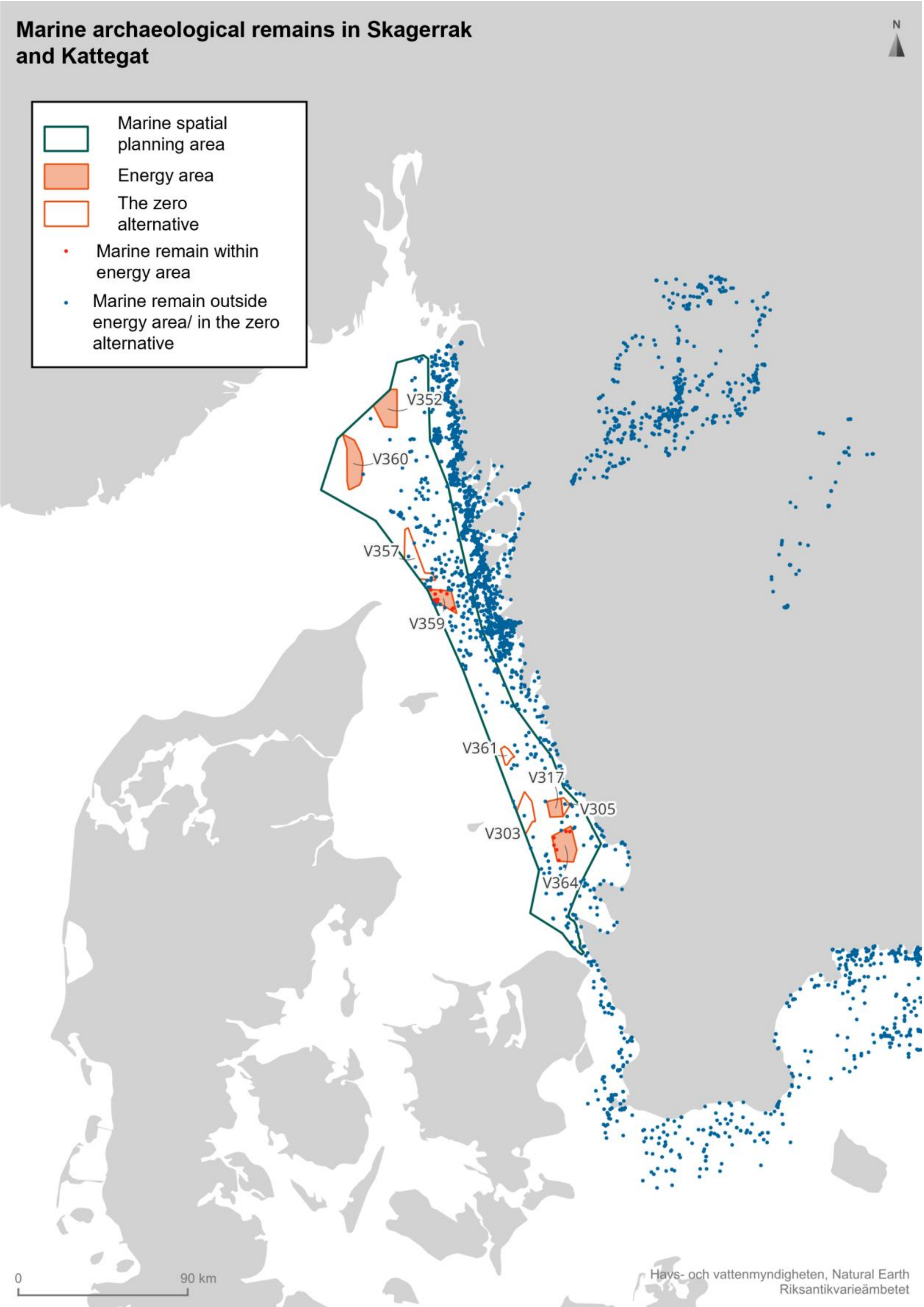


Figure 71. Risk of impact on marine archaeological sites.

V359 has the most registered marine archaeological sites in the area with 15. V364 has six registered sites. V317, V352 and V360 have no recorded marine archaeological sites in its area. Table 28 provides an overview of the number of marine archaeological sites for individual proposed energy areas in Skagerrak/Kattegat. Note that the compilation only refers to the sites that are registered in the Swedish National Heritage Board's Cultural Environment Register (Riksantikvarieämbetetet, u.y.). Since knowledge of the existence of marine archaeological sites in Swedish waters is not complete, the establishment of offshore wind power should be preceded by marine archaeological investigations where there may be marine archaeological sites (County Administrative Boards, 2024).

Table 28. Number of recorded marine archaeological sites per energy area in Skagerrak/Kattegat. Source: The Swedish National Heritage Board's Cultural Environment Register (Riksantikvarieämbetetet, u.y.).

| Energy area | Number of marine archaeological sites |
|---|---|
| V317 | 0 |
| V352 | 0 |
| V359 | 15 |
| V360 | 0 |
| V364 | 6 |

*Indirect and direct impact – Regional value areas*

In the marine spatial plan area of Skagerrak/Kattegat there are five energy areas that are subject to an impact assessment, the remaining areas have been granted a permit. Two areas are considered to have a risk of large negative impact on marine cultural heritage: V359 and V364. These areas are partly within the territorial sea boundary and are therefore relatively close to the coast. An energy area is considered to have a medium negative effect: V352. For V317 the risk of negative effects on the cultural environment is considered to be small and for V360 marginal. V303, V305, V357 and V361 are permitted and therefore not subject to impact assessment. In Figure 72 below, using a colour code, the estimated negative impact of each energy area on marine cultural heritage values is shown.

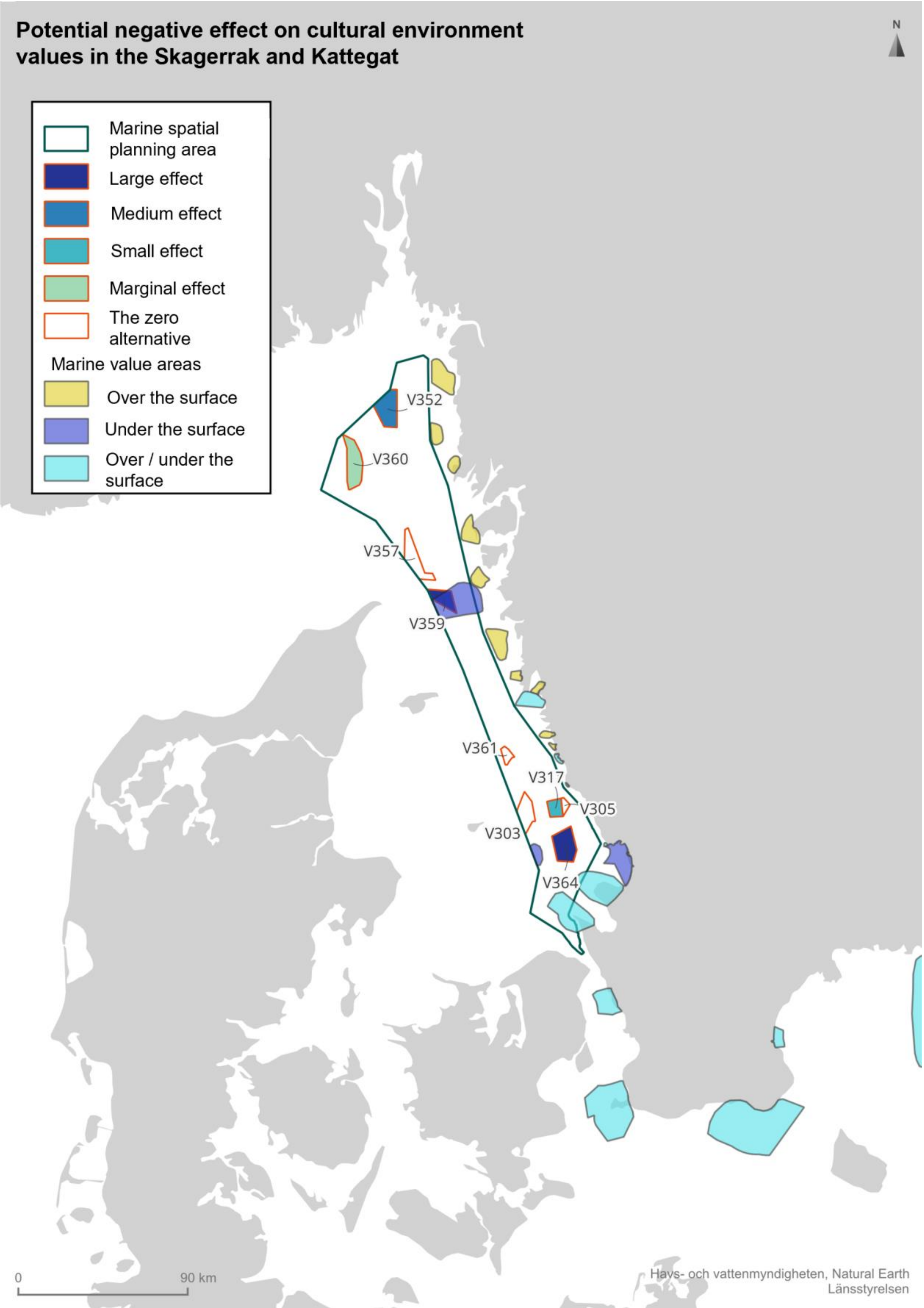


Figure 72. Indirect and direct negative impact on regional cultural heritage value areas.

*Skagerrak*

In the far north, energy area V352 is expected to have a negative effect on the marine cultural heritage values *Koster* and *Väderöarna*. The impact in this case is primarily visual, as visibility towards the free horizon from a number of viewpoints in the value areas is important for the understanding of their cultural environments. In Kosterhavet there are particularly important line of sights between Ursholmen and Väderöarna, Lindön, and Koster archipelago. In the Väderöarna islands value area, the view of the lighthouse environment at Väderöbod, between Storön and the Northern Väderöarna islands archipelago, as well as between Väderöarna and Fjällbacka archipelago is particularly sensitive to visual influences. Both Kosterhavet and Väderöarna include the marine spatial plan area rare cultural environment type communication environment, and are part of national interest unbroken coast.

V359 directly overlaps with the *North Kattegat ,* a value area below the surface with a large number of shipwrecks. Norra Kattegatt refers to values below the water surface, which is why the risk of negative impact primarily refers to physical impact in the construction and decommissioning of foundations, cables or other infrastructure. The value area includes a large number of sites from mine blasted and sunk ships from the two world wars and is considered an important educational testimony of the 20th century world wars. The North Kattegat also includes the sinking of the Swedish submarine Ulven. V359 has a direct overlap with about 28 percent of the value area. For energy area V359 there is a risk of direct impact on cultural heritage values through the cable laying or other infrastructure outside the energy area, both on the seabed and on land. However, this risk is difficult to estimate without information on the exact location of such infrastructure. Furthermore, V359 risks having an indirect impact on cultural environments in the value areas *Marstrand-Pater Noster* and *Känsö*. Visual connections between cultural heritage buildings and a view towards the horizon are essential for the understanding of these cultural environments, which should be taken into account when developing wind power in the area (County Administrative Boards, 2024).

*Kattegat*

V317 is expected to have a negative effect on the value areas *Morups tånge* and *Träslövsläge-Gamla Köpstad-Galtabäck*. For Morups tånge, the line of sight towards the horizon from the lighthouse site in the direction of Anholt is particularly important and the area around Korshamn, both on land and on the seabed, is considered sensitive to cabling regarding ancient relics. Within Träslövsläge-Gamla Köpstad-Galtabäck, the free lines of sight towards the horizon from the ports in Träslövsläge and Gamla Köpstad are particularly significant. The area around the bay of Lerjan is rich in marine archaeological sites, which are sensitive to interventions both on land and on the seabed (County Administrative Boards, 2024).

V364 is considered to entail a risk of indirect impact on the value areas *Tyludden-Tylön*, *Bjärehalvön* and *Kullahalvön*. All areas are sensitive to visual effects from the establishment of tall and area large facilities, but assessment of consideration distances needs to be based on site-specific conditions. Tyludden-Tylön, Bjärehalvön and Kullahalvön include all areas with high potential for marine archaeological sites that should be investigated before any cable laying. Like V317, V364 is considered to be likely to have a negative effect on Morups tånge (County Administrative Boards, 2024).

*Other impacts on cultural environment*

In Skagerrak/Kattegat, V352 is considered to have a negative effect on the national interest for unbroken coast (Chapter 4, Section 3 of the Environmental Code) *of Northern Bohuslän.* Within the national interest, no tall objects may occur, which means that higher objects within V352 about 12.5 kilometers away means that the visual effects are considered to be large. The area has, among other things, high-quality archaeological sites, older buildings and scientific cultural values that may be affected visually. The pristine nature and view of the untouched horizon are important experiences for the northern Bohuslän coast that risk being lost. The landscape protection area *Fjällbacka archipelago is* located about 27.5 kilometres from V352, which is considered to have indirect negative effects on the protection area. Kosterhavet National Park is located about 11.5 kilometers from energy area V352 and includes high cultural heritage values that may be affected by energy area V352. V359 is located about 7.5 kilometers from the national interest for high-exploited coast *Södra Bohuslän* (Chapter 4, Section 4 of the Environmental Code). However, the national interest is considered to have greater resilience for offshore wind power in V359 compared to V352. According to Västra Götaland County Administrative Board, the impact is not greater than allowed. However, cultural environments such as high-quality archaeological sites, older settlements and scientific cultural values (Länsstyrelsen, 2000) may be indirectly affected. In Kattegat there is a national interest for high-exploited coast along the entire coast of Halland and Skåne. Both V317 and V364 are expected to have indirect visual effects on national interests, but no large effects.

*Cumulative and transboundary effects*

In Kattegat, there is a risk that cultural environments are indirectly affected by Danish energy areas. The Kullahalvön peninsula value area is located 19.5 kilometres from an energy area in the Danish marine spatial plan. In Skagerrak there is a larger energy area east of Skagen located 25 kilometers from the value area Känsö and the national interest Styrsö parish.

The Swedish energy areas V303, V357 and V359 are close to the Danish zone and can affect cultural environments in Denmark, not least at Anholt and in Skagen.

In Skagerrak/Kattegat there are several cultural environments that may be affected cumulatively by the establishment of wind power in energy areas. However, the cumulative effects tend to concentrate in Kattegat, given the energy areas already included in the zero alternative. V352 is expected to give indirect negative cumulative effects for up to 13 national interest claims for cultural heritage conservation and four marine value areas to a varied extent at a distance of up to 70 kilometers. V359 is the energy area that is expected to affect the most national interest claims for cultural heritage conservation, up to 31. V359 is also expected to affect seven marine value areas indirectly, as well as the North Kattegat directly given its direct overlap with the value area. In Kattegat, V317 can entail indirect cumulative effects for up to 16 national interest claims for cultural heritage conservation and eleven marine value areas. V364 is reported to have indirect cumulative effects on 15 national interest claims for cultural heritage conservation and ten marine value areas.

For cumulative effects on specific cultural environments, it is expected that there will be less indirect cumulative effects in Skagerrak, given that the energy areas are further out into the sea compared to those in Kattegat. However, some cumulative effects may occur when establishing V352 and V360, mainly in the value area Väderöarna and Ramsvikslandet. When establishing the licensed V357 together with V359, the cumulative effects may be greater. Here, the greatest cumulative impact on cultural environments will be on Pater Noster, Marstrand and the western part of Orust. The combined direct and indirect effects of V359 on the North Kattegat value area and the previous mentioned areas are expected to entail relatively large cumulative effects. In Kattegat, V317 and V364, combined with energy areas in the zero alternative and its relative proximity, can have indirect cumulative effects on cultural environments along the coast of Halland and northwestern Skåne. Morups tånge, Träslövsläge and Vastaddalen are the cultural environments that are cumulatively primarily affected by the establishment of V317 in combination with energy areas in the zero alternative. V364 in combination with surrounding energy areas can give indirect cumulative effects mainly on Tyludden-Tylön.

Table 29 below shows the total sum of cumulative impacts from each energy area in Skagerrak/Kattegat. The highest cumulative impact on national interest claims for cultural heritage conservation and marine value areas is V364.

Table 29. Cumulative effects in Skagerrak/Kattegat from energy areas on national interest claims for cultural conservation and marine value areas, based on the number of cultural environments affected, as well as its proximity. The higher the value, the higher the cumulative impact. The method is described in the method section Chapter 8.

| Energy area | Cumulative impact on national interest claims for cultural heritage conservation | Cumulative impact on marine value areas |
|---|---|---|
| V317 | 64,5 | 47 |
| V352 | 60,5 | 21 |
| V359 | 95 | 43 |
| V360 | 16,5 | 7 |
| V364 | 104,5 | 49,5 |

## 5.4. Effects on the management of water, soil and the physical environment in general

### 5.4.1. Energy extraction

In the planning area Skagerrak/Kattegat there are good conditions for wind power with high wind speeds. In the northern part it is deep, which requires wind farms with floating foundations. From north of Gothenburg and south, it is shallower and possible with bottom-fixed foundations. The transmission network on land is well developed since the Ringhals nuclear power plant is located on the coast of Halland.

Despite good conditions, there are several challenges. The plan area is relatively small and with limited space. It is also relatively crowded with a lot of ongoing activities in the sea areas and along the coast with potential conflicts of interest. Coastal areas are also relatively densely populated. Extensive national interest claims exist in both coastal and marine areas including: recreation, cultural environment, nature values, shipping and ports, and commercial fishing.

The plan's guidance on energy extraction is based on a adopted marine spatial plan, a national interest in wind power, planning documents and *Proposals for suitable energy extraction areas in the marine spatial plan* (Energy Agency 2023a), which is handled as a public interest of substantial importance. The adopted marine spatial plan, national interest claims for wind power and municipal comprehensive plans have also been taken into account.

The draft marine spatial plan includes nine areas for energy extraction. Areas cover a total area of approximately 1,060 km2, corresponding to approximately 11 percent of the plan area and are estimated to generate an annual electricity production of approximately 20 TWh, based on assumptions of 5 MW/km2 and 4000 full load hours, see plan document part 6.1 for further description (the Swedish Agency for Marine and Water Management, 2025). There are four permitted parks within the marine spatial plan area (V303, V361, V305, V357).

The map below, Figure 73, shows all energy areas in the marine spatial plan, zero alternatives (permitted) and areas in the initial planning documentation, *Proposals for suitable energy extraction areas in the marine spatial plan* presented in 2023 (Energy Agency 2023a). The map also shows a grading of the conditions for energy extraction in each energy area, based on wind and depth conditions. Note that the classification is limited to these factors. Areas with a lower classification may have other advantages, such as proximity to connectivity or storage facilities, or may have conflicts of interest. Higher rated areas may in turn have disadvantages such as distance or limitations in connection or storage capacity or more or more severe conflicts of interest. With regard to conflicts of interest, see the overall assessment, as well as the respective assessment aspects and the need for adjustments when establishing a wind farm.

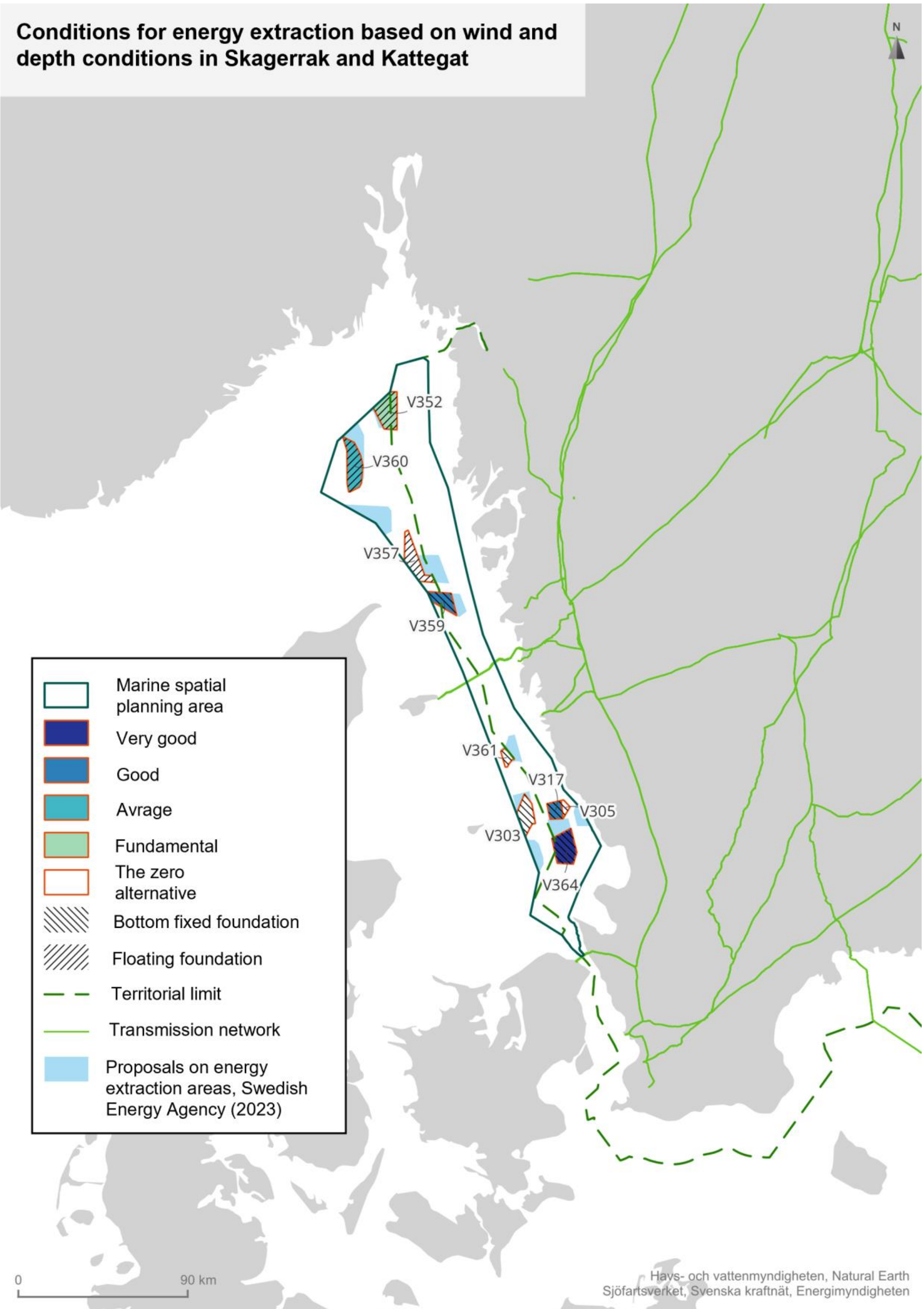


Figure 73. Map of energy areas in plan proposals, zero alternatives, initial planning basis, and conditions for energy extraction based on wind and depth conditions.

*Area-specific assessments, nature and conditions for energy extraction*

All energy areas in Skagerrak/Kattegat are included in the documentation on suitable energy extraction areas for marine spatial plans presented in 2023 (Energy Agency 2023a). The assessment of each energy area and its conditions for energy extraction has here been limited to assessment of the nature of wind and depth conditions and is made on the basis of a three-point scale as shown in Table 30 below. For more information see Section 8. Method.

Table 30. Grouping, for the wind speed and depth indicators.

| Group/points | Wind speed, medium | Depth, medium |
|---|---|---|
| 1 | Less than 8,5 m/s | Depths exceeding -70 m |
| 2 | Between 8,5 and 9 m/s | Between -40 and -70 m |
| 3 | Greater than 9 m/s | Founder than -40 m |

The marine spatial plan consists of two sea basins and the assessment of energy areas is presented from north to south below, see Table 31.

*Skagerrak*

The plan includes four areas using energy extraction V352, V357, V359, V360, of which one (V357) has a licensed project. Almost all energy areas are considered to have very good wind conditions.

- Most of the areas are assessed to be located in areas with average depths of more than 70 metres, where area V360 is located in a particularly deep area.
- Area V359 is estimated to be located on some shallower area, with an average depth of between 40 and 70 meters.
- The areas are assumed to be designed for wind farms with floating foundations, except for area V359, which has been assessed as sufficiently shallow for bottom-fixed foundations.
- All areas are fully or partially located in the exclusive economic zone. Area V359 is also partly located in the territorial sea, within the planned areas of Kungälv and Öckerö municipality.

*Kattegat*

The marine spatial plan guides on five areas using energy extraction, which also includes three areas with permit-granted parks. All energy areas are considered to have very good wind conditions, and are located in relatively shallower areas than in the northern plan area. In addition to the energy areas V303, V305, V361 with licensed wind farms, the plan provides guidance on additional areas for energy extraction in V317 and V364.

- Areas V317 is located alongside V305, where permits are available for the establishment of a wind farm. The average depth is estimated to be between 40 and 70 meters with the assumption of establishing a wind farm with bottom-fixed foundations. Both areas are located within the territorial sea and municipal plan area for Falkenberg municipality.
- Area V364 is shallower than 40 meters, mostly within the territorial sea and within Halmstad municipality's plan area. Wind farm is assumed to consist of bottom-fixed foundations.

The plan also guides on the use of electricity transmission. This includes the two parallel transmission network cables Konti-Skan 1 and Konti-Skan 2 which run between Lindome in Sweden and Vester Hassing in Jutland, Denmark. Two cable connections between Kristinelund in Sweden and Skibstrupgård in Denmark, the so-called Öresund cables, are located in the boundary between the marine spatial plan area Skagerrak/Kattegat and the Baltic Sea.

Table 31. Plan proposal Skagerrak/Kattegat. Overview of guidance on energy extraction, location and conditions.

| **Skagerrak/Kattegat** ***Sea area; North to South*** | **Area** ***(Permission=zero alternative)*** | **Designation** | **Km² Approx.** | **Of which km² in territorial sea ~22 km (12 NM)** | **Municipality** | **Estimated electricity production, TWh*** | **Adoption; Typ** | **wind, Group** | **Depth Group** |
|---|---|---|---|---|---|---|---|---|---|
| **Skagerrak** | V352 | E(utr)f | 180 | 70 | Tanum | 3,6 | Liquid | 2 | 1 |
| **Skagerrak** | V357 (Permit) | EFN | 160 | O | | 3,2 | Liquid | – | – |
| **Skagerrak** | V359 | E(utr)f | 100 | 65 | Kungälv, Öckerö | 2,0 | Bottom-fixed | 3 | 2 |
| **Skagerrak** | V360 | E(utr) Nf | 190 | | | 3,8 | Liquid | 3 | 1 |
| **Kattegat** | V303 (Permit) | EF | 120 | | | 2,4 | Bottom-fixed | – | – |
| **Kattegat** | V305 (Permission) | EF | 25 | 25 | Falkenberg | 0,5 | Bottom-fixed | – | – |
| **Kattegat** | V317 | EF | 65 | 65 | Falkenberg | 1,3 | Bottom-fixed | 3 | 2 |
| **Kattegat** | V361 (Permit) | Efk | 35 | 0 | | 0,7 | Bottom-fixed | – | – |
| **Kattegat** | V364 | Efkn | 180 | 170 | Halmstad | 3,6 | Bottom-fixed | 3 | 3 |
| ***Total, approximately*** | | | *1 060* | *395* | | *20* | | | |

* Assumption according to marine spatial plan, 5MW/km², 4000 full load hours.

*General description*

For the marine spatial plan, there are good conditions for energy extraction in terms of wind and depth conditions. Wind conditions are very good, however, with a relatively large proportion of the area with the energy areas located in relatively deep areas.

The size of the energy areas is also important for suitability and investment conditions. The energy areas in the marine spatial plan vary in size, from around 25 to 180 km$^2$, with an average size of around 120 km$^2$, which is smaller compared to the energy areas in the other plan areas.

Depth conditions are important for the feasibility of wind power projects in terms of investment costs and technology choices. At depths down to about 70 meters, construction is assumed primarily with bottom-fixed foundations, at greater depths, mainly floating foundations are assumed. Areas with conditions for bottom-fixed foundations are likely to be realised earlier than floating foundations due to their lower construction costs and more established technology (Energy Agency, 2023a). This allows the plan's guidance on energy extraction to be assessed as beneficial from both a short and a long-term perspective. The three northernmost energy areas are in relatively deep areas with average depths of less than 70 metres, where the wind farms are assumed to consist of floating foundations.

Surface distribution of the areas by depth and foundation type, see Figure 74 below. Depths vary within and between energy areas, but in terms of surface distribution, half of the areas have an average depth deeper than 70 meters, about 30 percent of the surface of the average depth shallower than 40 meters, the remaining area has an average depth of between 40 and 70 meters. Approximately half of the plan's energy areas, approximately 530 km2, are assumed to be suitable for wind farms with bottom-fixed foundations. The remaining areas are expected to consist of floating foundations.

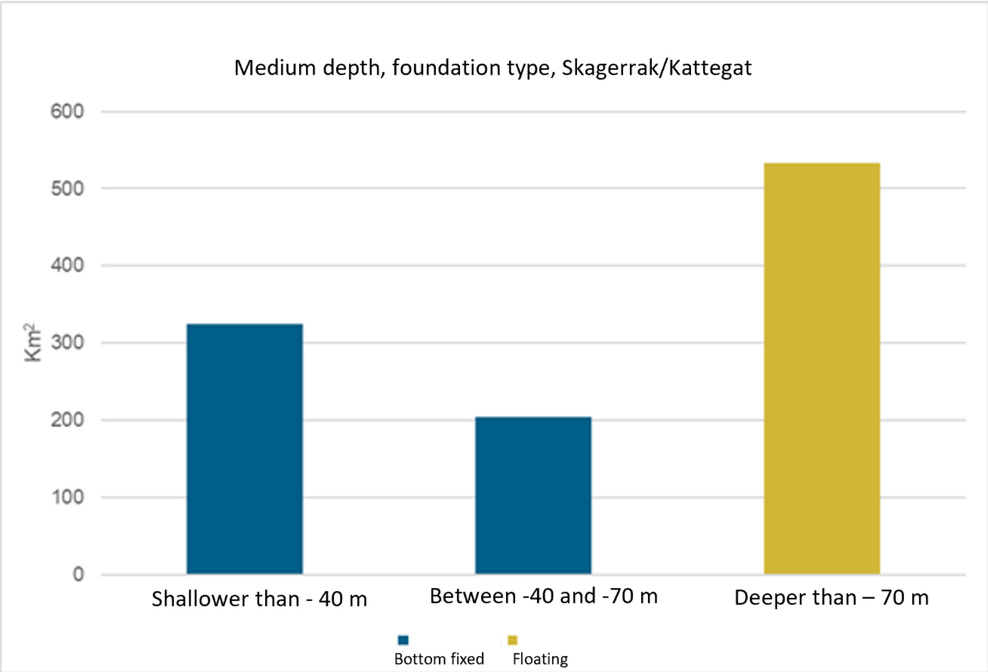


Figure 74. Distribution of areas for energy extraction (km2), average depth and foundation type.

The distance of the areas to the connection point for electricity distribution or storage is also important in terms of profitability and investment cost. Where actual access points actually end up depends on a number of factors and involves relatively large uncertainties. The distance to the connection point depends, for example, on the appropriate and possible connection point to the transmission network, depth conditions, as well as on the choice of technology and on the design and possible location of storage and energy carriers, see also method section. Assessment of distance is not included in the criteria assessment but is shown to some extent with regard to whether the energy area is located within the territorial sea or not. If areas are located in the territorial sea is also relevant because of overlaps with municipal planning, which, among other things, also affects the decision-making and permit process. A slightly larger proportion of the plan's surfaces for energy extraction, just over 60 percent, are located outside the territorial sea, about 22 kilometres from the baseline, see Figure 75 below. This can have a significant factor in connection costs and maintenance, as well as being relevant to the current permit process.

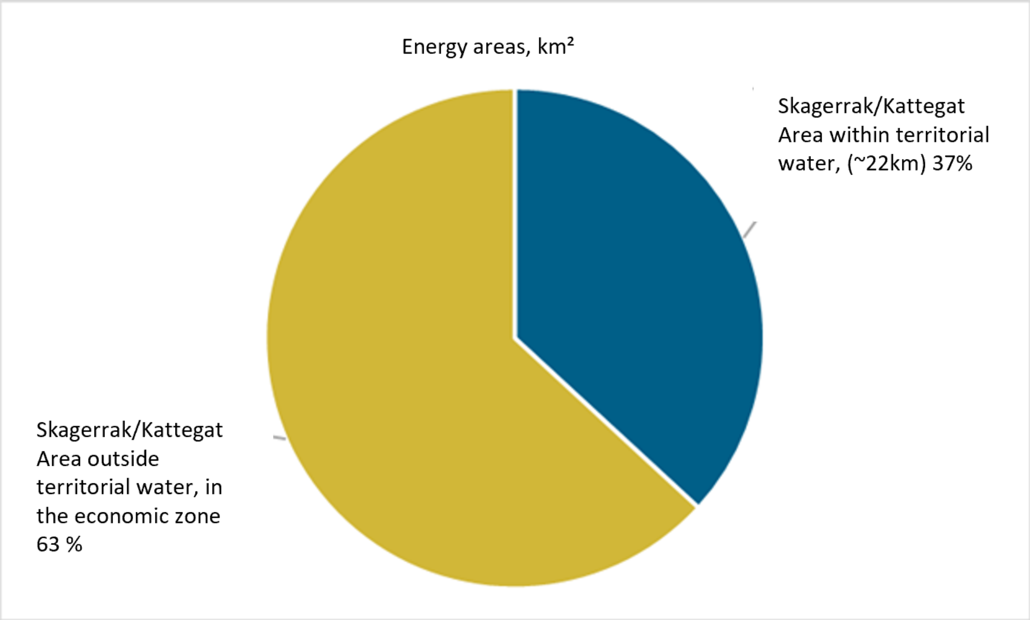


Figure 75. Distribution of energy extraction areas (km2), territorial sea and exclusive economic zone.

*Marine spatial plan, zero alternatives and guidance on energy extraction*

The potential for energy extraction and electricity production is estimated on the basis of the surfaces for energy extraction in the plan proposal to be approximately 20 TWh, calculated on the basis of approximately 1060 $km^2$ and assumptions of 5 MW/ km2 and 4000 full load hours. The corresponding area for energy extraction in the baseline scenario (permitted) is approximately 345 $km^2$, see Table 32 below.

Table 32. Energy extraction guidance, baseline/permitted.

| **Skagerrak/Kattegat Areas of energy;** *North to South* | **Area** | **Km², Approx.** | **Of which km² in territorial sea ~22km** | **Municipal planning area** | **Adoption; Typ** |
|---|---|---|---|---|---|
| **V357** | Southwest Sea Exercise Area Skagen | 160 | 0 | - | Floating |
| **V303** | North Red Bank | 120 | 0 | - | Bottom-fixed |
| **V305** | Southeast Morup Bank | 25 | 25 | Falkenberg | Bottom-fixed |
| **V361** | North Little Middelgrund | 35 | 0 | - | Bottom-fixed |
| **Total approximately** | | ***346*** | ***24*** | - | - |

Certain areas of national interest and public interest of substantial importance for wind farms have been considered incompatible with other uses. The original planning documents of public interest of substantial importance identified 11 areas suitable for offshore wind power in Skagerrak/Kattegat, with a total area of approximately 1,900 km2. During the planning process, these areas have been adjusted and some have been excluded taking into account other interests such as recreation, defence, shipping and commercial fishing. Total areas for energy extraction in the draft marine spatial plan, zero alternatives, public interest of substantial importance, national interest claims, and adopted marine spatial plan, see table below.

Table 33. Estimated area for energy extraction in plan proposals, zero alternatives, public interest of substantial importance, national interest claims and adopted marine spatial plan (Government, 2022).

| Indicative basis for energy extraction | Skagerrak/Kattegat, approximate area (km²) |
|---|---|
| **Plan proposal** | 1060 |
| **Zero alternative** | 345 |
| **Public interest of substantial importance, Swedish Energy Agency (2023b)** | 1875 |
| - **Of which surface in planes** | 995 |
| **National interest claims** | 320 |
| - **Of which surface in level, approx. km²** | 15 |
| **Plan adopted** | 155 |

The plan's guidance on energy extraction, including consideration guidance, is considered to contribute to the achievement of objectives for offshore wind energy. The plan is also expected to contribute positively to increased predictability for the activities concerned, as well as as a knowledge base for permit processes, regional and municipal planning. The areas that were initially identified as suitable for energy extraction (Energy Agency, 2023b) and that during the planning process were assessed as not being most suitable for use, mean that the total area for energy extraction has decreased, which can be assumed to affect offshore wind power activities and concerned sectors within the plan area.

*Realisation, projects and bidding zones*

Based on the target of a total of 120 TWh in annual electricity production for all plans, it is assumed that a large proportion of the energy areas in the proposal for amended marine spatial plans need to be realised. A prerequisite for realising the marine spatial plan's energy areas is investment interest in the construction and operation of wind farms. In principle, all energy areas in the plan area are undergoing permit processes for the establishment of wind power.

Assumptions about potential electricity generation and allocation between bidding zones can be made based on designers' applications and specified connection areas. According to project information and investment data from the County Administrative Boards' interactive map service Vindbrukskollen (County Administrative Boards u.y.), it can be assumed that approximately 75 percent of the potential electricity production in the plan area is connected to bidding zone 3, the remaining to bidding zone 4, see Figure 76 below.

For more detailed information on electricity consumption and related bidding zones and users, please refer to chapter 2.4.1 *Energy* regarding electricity consumption and industry, transport sector and households.

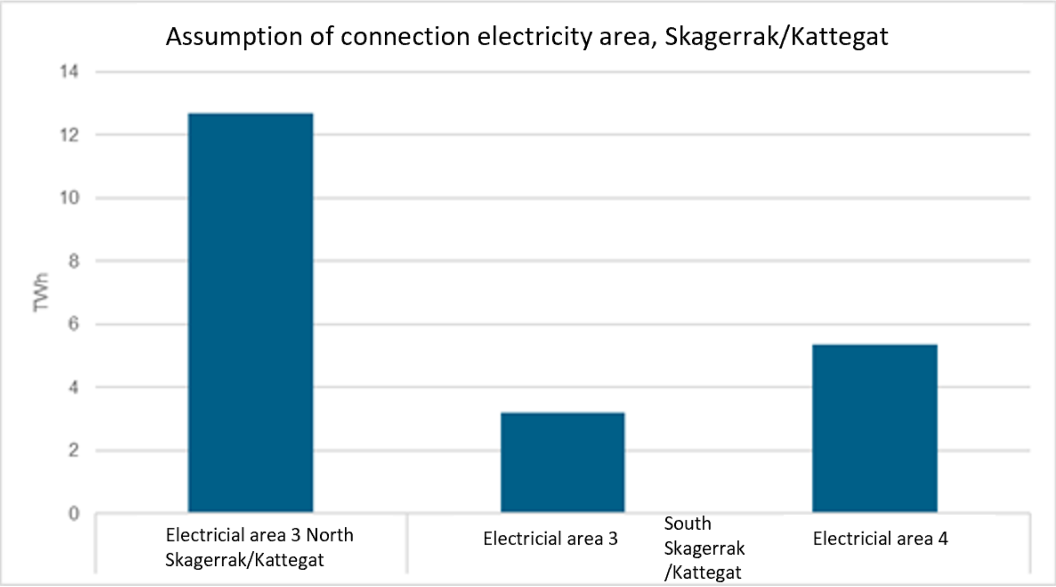


Figure 76. Assumptions on connection bidding zones.

*Indirect impact - energy*

Guidance on energy extraction in the marine spatial plan may involve indirect land claims for cabling and other electricity transmission infrastructure and/or various forms of energy storage, such as hydrogen. This in turn may imply additional land and water claims as well as potential indirect environmental impacts and additional coastal and terrestrial risk management (see section 2.4.1.). The extent of land claims on coast and land, and where these land claims will take place, depends, among other things, on the type of technology and wind turbines, as well as the connection point for each wind farm.

*Achievement of objectives, national and municipal interests - energy*

The plan proposal for Skagerrak/Kattegat contributes to the achievement of objectives regarding offshore wind power assignments and national energy policy objectives, as well as national targets on climate and fossil-free electricity supply, significant for the transformation of the industry and transport sector and employment at local and regional level, see section 2.4.1.

With regard to essential functions and activities, according to national classification (MSB, 2021), the plan proposal is expected to contribute to the conditions for ensuring electricity supply in the country. However, there are some questions regarding the relatively large proportion of energy areas located outside the territorial boundary, in the Swedish exclusive economic zone, regarding potential risk and impact on the essential functions such as maintaining or ensuring, for example, control and monitoring, and maintenance and fault repair of infrastructure.

For territorial sea areas, national marine spatial plans overlap with regional and municipal plans. The plan's guidance on energy areas overlaps with municipal plans for the municipalities of Kungälv, Öckerö, Falkenberg and Halmstad (Table 31).

*Cumulative and transboundary effects*

Cumulative effects on areas for energy extraction can mean impacts between the areas, both positive and negative. When establishing several areas nearby, there may be some synergies in terms of infrastructure and maintenance. Negative cumulative impacts can occur based on limitations and scope of nearby wind farms, limitations in connection capacity, increased levels of conflicts of interest and possible impact on wind conditions between the farms. This may be relevant both nationally and in relation to the establishment of wind farms in neighbouring countries.

The marine spatial plan's guidance on energy extraction can also have an impact on and have an impact on neighbouring countries, similar to those identified at national level. This applies, for example, to the impact on and possible coexistence with shipping, nature values such as bird paths, as well as recreation and cultural environments. There is extensive international maritime activity in the plan area, including passage to and from the Baltic Sea and out to Skagerrak/Kattegat. The impact on neighbouring countries may also include the impact on migratory routes for migratory birds to Denmark and other surrounding areas, as well as the impact on outdoor recreation and recreational boating activities that occur frequently between neighbouring countries Denmark and Norway. See the respective assessment for more information.

### 5.4.2. Recreation

Skagerrak/Kattegat has large areas of high nature value in the marine spatial planning area and many of them are nature reserves and Natura 2000 areas. In addition, there is the marine national park Kosterhavet National Park in Skagerrak/Kattegat. Recreation is extensive throughout the marine spatial planning area with significant tourism. Recreational fishing and boating are an important part of outdoor life in Skagerrak/Kattegat. In principle, the entire coastline of Skagerrak/Kattegat is covered by national interest claims for recreation or national interest for mobile recreation. Wind power installations can have a large impact on experience values and the effects will be greater if the areas are used by many people. In the proposal for a marine spatial plan, Skagerrak/Kattegat has a total of nine proposed energy areas, four of which are included in the zero alternative.

There are two energy areas in the marine spatial planning area of Skagerrak/Kattegat that are considered to entail a risk of large negative effects on recreation: V317 and V352. These areas are located within or partly within the territorial boundary and are all considered to be relatively coastal. For two additional energy areas, the risk of negative effects on recreation is considered to be medium: V359 and V364. One energy area, V360, is considered to entail a risk of marginal effects on outdoor activities. V303, V305, V357 and V361 are authorised and included in the zero alternative and are therefore not subject to an impact assessment. Figure 77 below shows the estimated negative effect of the respective energy area by colour code.

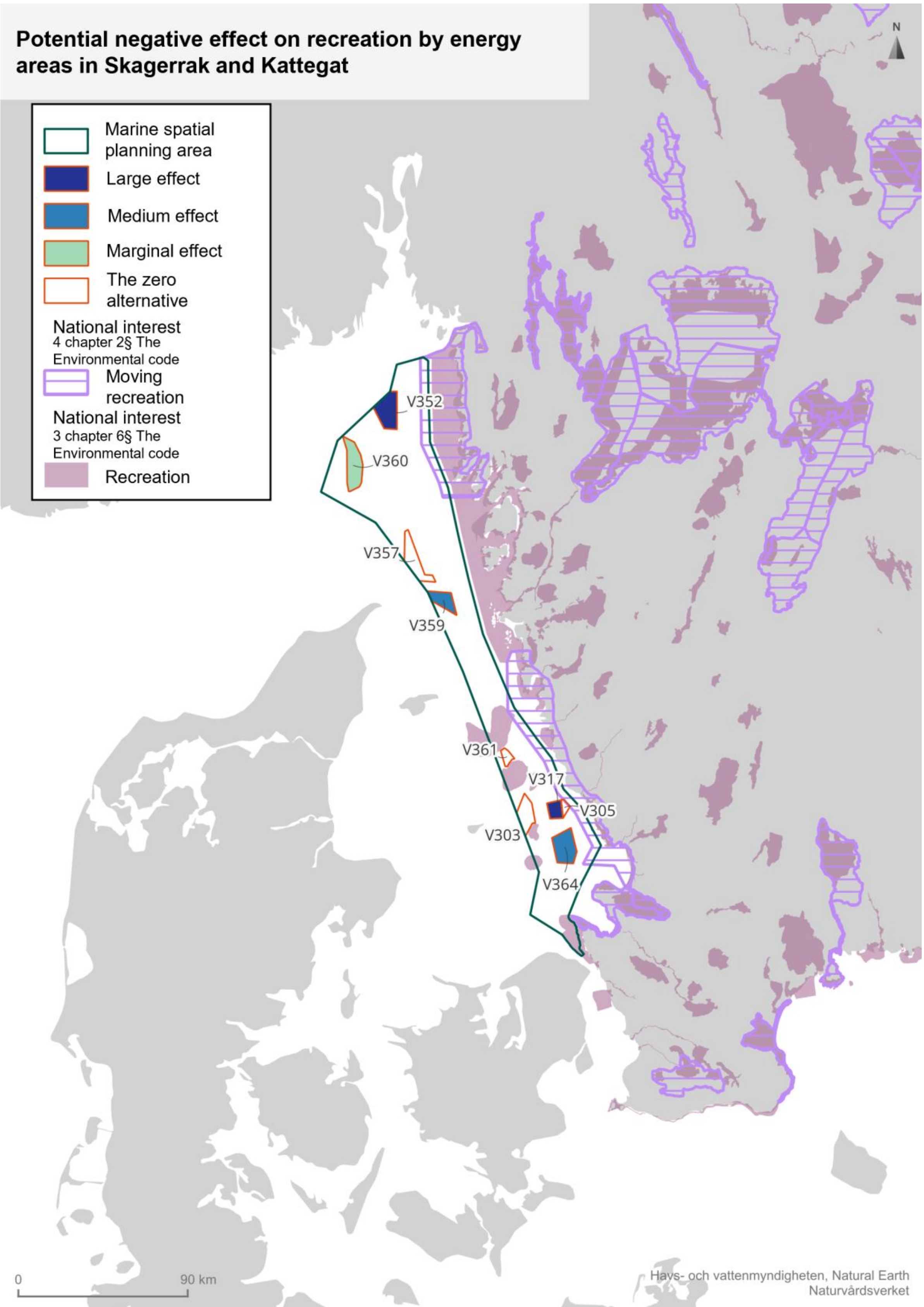


Figure 77. Potential negative effect on recreation of proposals for energy extraction areas in Skagerrak/Kattegat. Dark color shows great effect and light color shows little effect.

*Area-specific assessments*

*Skagerrak*

Four proposed energy areas (V352, V357, V359, V360) are located in Skagerrak/Kattegat. Energy area V352 is located approximately 30 kilometres from the mainland coast and approximately 11 kilometres from *Kosterhavet National Park*. V352 may affect the national interest in mobile recreation *Norra Bohuslän*, with conditions for bathing places, fishing places and opportunities for boating. The energy area may also affect national interest claims for recreation *Northern Bohuslän coast – outer coastal zone*, as well as Kosterhavet National Park, east of the area. In the national interest there are activities such as hiking, rock climbing and kiting/paragliding. Values shown in the value description are pristineness in the outermost coastline, appealing landscape with sensitivity to wind power exploitation. Visual impact from wind power on sensitive recreation values is considered to exist throughout the area (Energy Agency, 2023b), with a significant risk of negative impact to the east, which gradually decreases to the west. V352 has been adapted by removing the northern part of the area. Cumulative impacts need to be considered.

V359 is expected to have a negative effect on national interest claims for recreation *Southern Bohuslän coast* and *Gothenburg archipelago,* which is about 12.5 kilometers away, and the area *Göta älv – subarea Nordre älvs estuarium* about 20 kilometers away. The distance is considered to have a visual impact from V359 on the areas. Current activities according to the values of the recreation areas are cultural experiences, kiting/paragliding, diving, horseback riding and surfing. Eligibility criteria based on value descriptions are attractive landscapes. Energy areas in Skagerrak/Kattegat are considered to entail a risk of cumulative impact on experience values, as a result of exploitation in the landscape and disturbing obstacle lighting.

*Kattegat*

Five proposed energy areas (V303, V305, V317, V361, V364) are located in Kattegat. V317 is located near the mainland coast around 7 kilometers. The energy area is considered to have a potential negative impact on recreation. The national interest *Skrea strand-Tylösand* is close to the area with activities such as beach life, swimming and boating and the values of the view to the sea. *Morups* and *Röde bank* are also close to the energy area with values of untouchedness, stillness, silence, low noise level and attractive landscape that may be negatively affected by the establishment of wind power in V317. Finally, there is a national interest in mobile recreation in the *Halland coast* just under a kilometre from the V317, which can have a direct impact.

Energy area V364 is expected to have a potential negative effect on the mobile recreation on the *coast of Halland, Kullaberg and Hallandsåsen with adjacent coastal areas*. An indirect negative effect on national interest claims for recreation mainly in the areas *of Bjärekusten-Skälderviken*, *Skrea strand-Tylösand* and *Laholmsbukten* can also be given. The areas include activities such as boating, swimming and diving, with values such as view out over the sea. The nearby areas of *Röde Bank* and *Stora Middelgrund* in the sea area can also be affected by V364 as the areas include values of untouchedness, stillness, silence, low noise and attractive landscapes in the form of views of the sea. The establishment of wind power was considered in the Swedish Energy Agency's report (2023b) to have less visual impact on national interest claims. The cumulative effects in Skagerrak/Kattegat clusters are important to take into account, despite smaller values of stillness in this region that are more linked to activities such as beach life, but also the national areas of interest at sea that have activities such as recreational fishing and harbour porpoise safari.

*Accessibility*

Barrier effects are estimated to be greatest in Skagerrak/Kattegat compared to the other two marine spatial planning areas. Negative effects on the activities and experiences within the designated national interests for recreation can occur when establishing wind power. Despite no direct overlap, apart from permit-granted energy areas, of national interests for recreation in Skagerrak/Kattegat, activities and experiences can be affected, especially the more sea-based ones. Skagerrak/Kattegat has an extensive coastal recreation in the form of boating, recreational fishing, swimming, kiting/paragliding and diving. Recreational fishing and boating are considered to be most affected related to accessibility in Skagerrak/Kattegat, especially in the energy areas V352 and V359. Kattegat is unique with its sea-based national interest along the coast of Halland, situated on banks and foundations. The establishment of offshore wind power can create major barrier effects for these national interest claims. Apart from the energy areas included in the zero alternative, V317 and V364 are expected to create these effects on nearby national interests, including the mobile recreation along the coast of Halland a few kilometres from V317, as well as recreation, primarily at Morups and Röde bank, and Stora Middelgrund. The national interest claims are covered by activities such as recreational fishing, diving and harbour porpoise safaris that are considered to be affected. Recreational fishing has, however, been restricted by regulation.

Recreational boating in Skagerrak/Kattegat occurs mainly along the coastline, where the Bohuslän coast has the greatest activity of recreational boats. Also out at sea there is great activity and some major stretches of recreational boating. Apart from areas included in the zero alternative, V359 and V364 have the highest activity of recreational boating within the energy areas and are considered to have negative effects on recreation, along recreational boating activity and trends towards recreational boating routes (Emodnet, 2022). See Figure 78 and **Fel! Hittar inte referenskälla.** below. Sections of recreational boating to and from Öresund and between the coast of Halland and the Bjäre Peninsula have greater activity, where V317 and V364 are considered to be physical barriers to recreational boating. Many routes to and from Bohuslän and Denmark also pass through V359, which can have negative effects on recreational boating there.

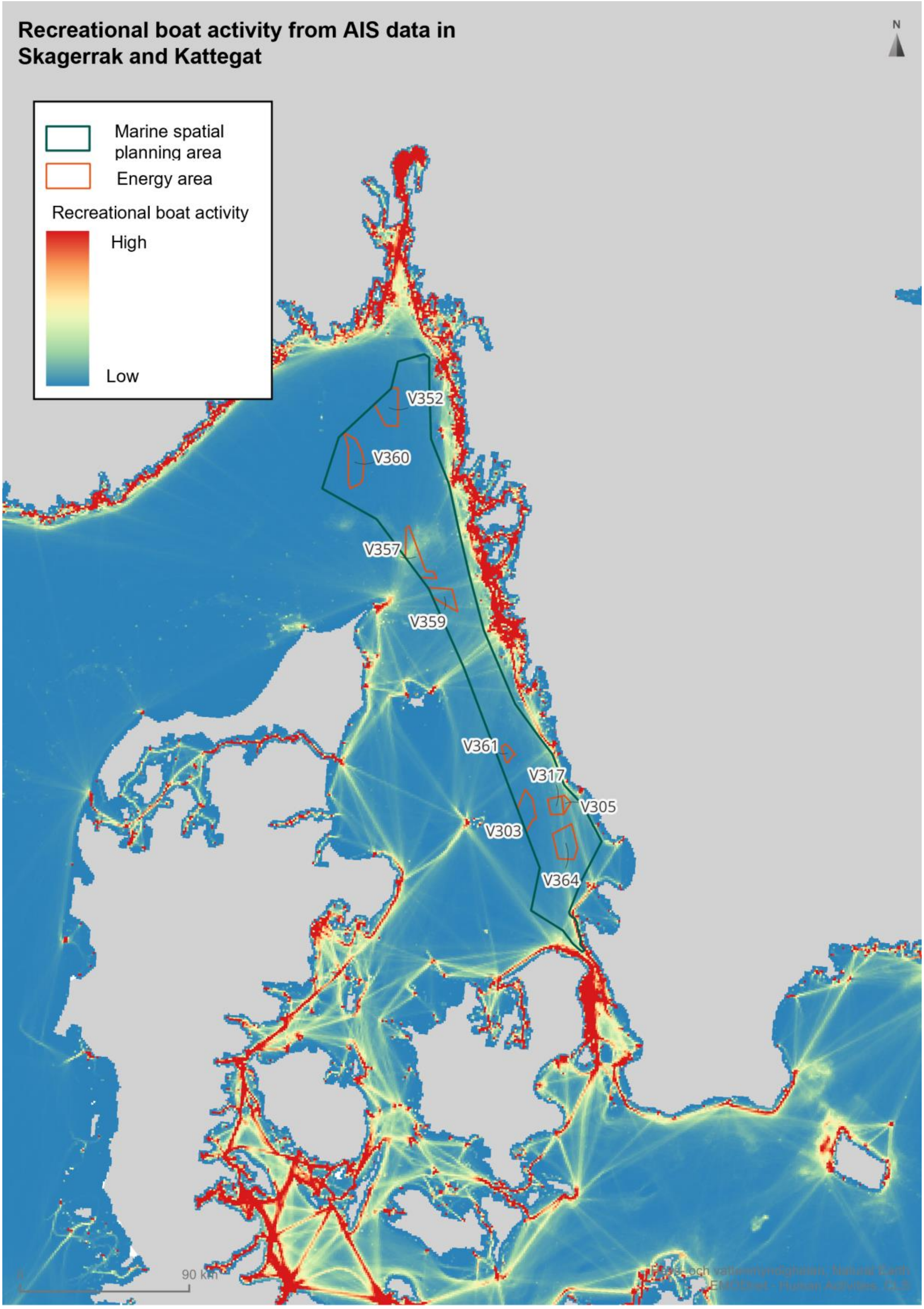


Figure 78. Prevalence of recreational boating activity within proposed energy areas in Skagerrak/Kattegat based on an average of hours per month in the years 2017 – 2022 (Emodnet, 2022).

Table 34. Prevalence of recreational boating activity in proposed energy areas in Skagerrak/Kattegat based on an average of hours per month in the years 2017 – 2022. The data is based on activity from at least one leisure boat in the energy field (Emodnet, 2022).

| Energy area | Recreational boat activity average hours/month 2017 - 2022 |
|---|---|
| **V317** | 8,9 |
| **V352** | 4,1 |
| **V359** | 10,6 |
| **V360** | 1,8 |
| **V364** | 23,2 |

*Other impacts on recreation*

In Skagerrak/Kattegat, V352 is considered to have a negative effect on the national interest for unbroken coast (Chapter 4, Section 3 of the Environmental Code) *Northern Bohuslän.* Within the national interest, no high objects may occur, which means that higher objects within V352 about 12.5 kilometers away means that the visual effects are considered to be large. The national interest includes values such as pristine coasts, conditions for recreation and tourism, as well as high values for nature, geology and culture (County Administrative Board, 2000), whereupon these may be indirectly affected by V352. V352 is also located about 11.5 kilometers from Kosterhavet National Park. The national park has high recreation values and is a popular tourist destination. Various activities and recreational boating are extensive in the area. The proximity of the V352 to the park can cause negative effects on recreation and its experiences, not least visually. V359 is located about 7.5 kilometers from the national interest for high-exploited coast *Södra Bohuslän* (Chapter 4, Section 4 of the Environmental Code). However, the national interest is considered to have greater resilience for offshore wind power in V359 compared to V352, despite the fact that it includes conditions for recreation with values of, among other things, silence. The national interest includes conditions for mobile recreation, recreational environments, accessible and attractive bathing, beach and archipelago areas, as well as other environments and values linked to recreation (Länsstyrelsen, 2000). These may be affected by energy area V359, mainly linked to the visual impact. In Kattegat there is a national interest for high-exploited coast along the entire coast of Halland and Skåne. Both V317 and V364 are expected to have indirect visual effects on national interests, but no major effects.

*Cumulative and transboundary effects*

In Skagerrak/Kattegat, some indirect effects can be given by Danish energy areas, especially one east of Skagen and three east of Grenå in Denmark. The Gothenburg archipelago is located about 25 kilometres from a Danish energy area, which together with the establishment of wind power in V359 can provide the experience of a large contiguous area and constitute greater cumulative effects on the values within the national interest claim. Röde Bank and Stora and Lilla Middelgrund's national interest claims for recreation can also be indirectly affected by the three Danish energy areas east of Grenå. Together with the establishment of wind power in Swedish energy areas off the coast of Halland, they can cause greater cumulative effects for values such as untouchedness, stillness, silence, low noise and attractive landscapes.

In the marine spatial plan area of Skagerrak/Kattegat, there are energy areas that can indirectly affect recreation values in Denmark and Norway. Areas V359 are particularly important due to its relative proximity to Skagen in Denmark about 24.5 kilometer away. The current impact on crossings for recreational boats to and from neighbouring countries is considered to be large for Skagerrak/Kattegat. Several routes to and from Denmark, but also to and from Norway, are in Skagerrak/Kattegat. V359 is expected to have the greatest impact on crossings of recreational boats, mainly linked to Danish Skagen.

The cumulative effects on recreation are estimated to be greater in Skagerrak/Kattegat than in other marine spatial planning areas. In Skagerrak/Kattegat, some cumulative impact is expected due to designated energy areas. The designated national interests for recreation are few, but large in area and cover the entire marine area's coastline. V352 is expected to give visual cumulative effects on the national interest for recreation Northern Bohuslän, as well as the national interest claims for recreation Northern Bohuslän's inner and outer coast. V359 is expected to indirectly give marginal cumulative impact on the mobile recreation in Northern Bohuslän and the Halland coast, but greater for the national interest claims for recreation. Nine areas may be indirectly affected, mainly the coast of Södra Bohuslän, the Gothenburg archipelago and the Göta älv – Nordre älvs estuarium sub-area. In Kattegat, V317 can provide indirect cumulative effects for the national interest for recreation on the coast of Halland, as well as Kullaberg and Hallandsåsen with adjacent coastal areas. Energy areas may also indirectly give rise to cumulative effects for twelve national interest claims for recreation, primarily for Morups and Röde bank, as well as Skrea strand-Tylösand. V364 can potentially provide indirect cumulative effects for the same national interests for mobile recreation as V317. V364 can potentially also give rise to indirect cumulative effects on eleven national interest claims for recreation, primarily on the nearby Röde bank, Stora Middelgrund, Skrea strand-Tylösand and Bjärekusten-Skälderviken.

For cumulative effects on specific national interests for recreation in Skagerrak/Kattegat, certain areas are identified that tend to be affected more cumulatively when establishing the energy areas. In Skagerrak, the mobile recreation in Northern Bohuslän can be affected cumulatively when establishing wind power in areas V352 and V360, which can be seen as a larger coherent area from within the national interest. Even the energy area V357, which is included in the zero alternative, can have some impact on the national interest. For national interest claims for recreation, it is primarily Northern Bohuslän's outer coast where visual cumulative impact from V352 and V360 is greatest. Further south, the V359 together with the V357 in the zero alternative may indirectly affect the coast of Södra Bohuslän, the Gothenburg archipelago and the Göta älv – Nordre älvs estuarium sub-area. In Kattegat, the national interest in mobile recreation on the Halland coast is expected to be affected by the establishment of most energy areas, especially considering the areas within the zero alternative. National interest claims for recreation at sea on embankments and shallows can be affected cumulatively when establishing in most energy areas and create barrier effects for those areas in addition to the indirect impact. Otherwise, it is primarily Skrea strand - Tylösand that is affected cumulatively.

### 5.4.3. Tourism

In Skagerrak/Kattegat, seven out of eight coastal municipalities write in their comprehensive plans that the tourism industry is an important industry (Båstad municipality, 2020; Municipality of Sotenäs, 2024). The accessibility to the sea and what it has to offer in the form of activities such as swimming, diving, surfing, boating and recreational fishing is important for the tourism conducted in the area. Furthermore, the open sea with beautiful views and a free horizon are factors that attract visitors. The conditions for the tourism industry are closely linked to qualities in landscapes, conditions for recreation and cultural environments with the indirect consequence that where there is a high risk of impact on these values, there is also a risk of impact on the tourism industry. However, according to research, there are uncertainties about what the impact on the tourism industry might look like. One of the reasons is that people perceive wind power in different ways (LTU, 2023). Studies suggest that the majority do not allow elements of wind farms to influence the choice of destination. There are also some that are attracted by wind turbines while others are discouraged, see Section 2.4.3. Recreation. Most of those who choose to forgo a destination because of visible wind turbines instead choose to visit a nearby destination.

*Kattegat*

According to the municipalities in the area's comprehensive plans, the tourism industry is an important part of the business sector. During the summer months of 2022, the population of Halland increased by about 60 000 inhabitants, which means that the region had the third largest increase in Sweden (Region Halland, 2024). The tourism industry makes a relatively large contribution to the gross regional product. Furthermore, there is value in the creation of employment. There are nine energy areas in Skagerrak/Kattegat, five of which are located in Kattegat off the coast of Halland. The areas are relatively coastal. In three areas there are licensed wind farms (V305, V361, V303) located at a distance between 8 and 24 kilometers from the coast. Energy area V317 is located about 11 kilometer from Falkenberg. V364 is located about 17 kilometer from Halmstad, about 14 kilometer from Haverdal and about 29 kilometer from Båstad and about 19 kilometer from Torekov. The impact on the tourism industry could possibly lead to a redistribution effect where visitors choose not to have places with visible wind turbines such as along the coast of Halland and instead choose to spend their stay, for example, in the southernmost parts of Kattegat or in Skagerrak.

The entire Kattegat is covered by Chapter 4, Section 2 of the Environmental Code, which means that the interests of tourism and recreation must be taken into account in particular when assessing the admissibility of development companies or other interventions in the environment. See Section 5.4.2 Recreation.

*Skagerrak*

In the Skagerrak there are four energy areas that, in an overall comparison with those in Kattegat, are located farther from the coast but are larger in area. In one area (V357) there is a licensed wind farm, located about 29 kilometer from the coast. Energy area V359 is most coastal and is located about 19 kilometer from Öckerö and about 20 kilometer from Marstrand. V352 is located about 25 kilometer from the Kosteröarna islands and about 32 kilometer from Grebbestad. V360 is located about 47 kilometer from Smögen. In Skagerrak, the tourism industry is important for several coastal municipalities (Blå översiktsplan för norra Bohuslän, 2018). In large parts of Bohuslän, the population more than doubles during the summer months (Statistics Sweden, 2023). In several places, it is the income from tourism during these months that allows a trader to keep the business going for the rest of the year (Gothenburg Region, 2019). At local level, therefore, a redistribution effect due to visitors opting out of locations with visible wind turbines could be noticeable.

The upper part of Skagerrak is also covered by Chapter 4, Section 2 of the Environmental Code. See Section 5.4.2 Recration.

### 5.4.4. Defence

No assessment is made at marine spatial planning level for the interests of defence. See chapter 2.4.4 for general effects.

### 5.4.5. Shipping

The planning area Skagerrak/Kattegat is considered to have relatively high maritime intensity, with extensive national and international maritime traffic to and from ports. Ship routes to and from Sweden and between neighbouring countries occur, such as Norway and Denmark, as well as maritime transport to Europe and other parts of the world. The plan area also has significant port operations, with about 20 percent of all Swedish foreign trade going through the Port of Gothenburg. Maritime transport includes freight vessels, as well as tankers and fishing vessels (EMODnet, 2022). In the planning area there are also shipping lanes that are part of the IMO's international routing system. The routing system is a vessel traffic control measure aimed at reducing the risk of accidents.

*Proposal for a marine spatial plan, energy extraction and shipping*

In the plan area there are four energy areas where there are permits for offshore wind power, V357 in the northern plan area and V303, V305 and V361 in the southern plan area.

Table 35. Energy areas with authorised wind farms.

| **Skagerrak/Kattegat Energy Areas, Permitted** *North to South* | **Area** | **Km² Approximately** | **Adoption; Typ** |
|---|---|---|---|
| **V357** | Southwest Sea Exercise Area Skagen | 160 | Liquid |
| **V303** | North Red Bank | 120 | Bottom-fixed |
| **V305** | Southeast Morup Bank | 25 | Bottom-fixed |
| **V361** | North Little Middelgrund | 35 | Bottom-fixed |
| ***Total, approximately*** | - | *345* | - |

The use of shipping in the marine spatial plan is based on national interest claims for shipping that coincide in large parts with established shipping lanes and shipping routes. Marine spatial plans do not provide guidance on specific safety distances to shipping, but distances will be required for all areas using energy extraction. The distance is adapted to local conditions according to risk assessment (Swedish Maritime Administration, Swedish Transport Agency, 2023).

In the proposal for a marine spatial plan, Skagerrak/Kattegat has nine proposed energy areas, of which four permit-granted are included in the zero alternative. All energy areas in the plan area, except V360 in the northern plan area, are adjacent to fairways with national interest for shipping and shipping routes.

The energy areas V357 (permitted/zero alternative) and V359 are adjacent to two national interest fairways, which include the main fairway from northern Skagen to Gothenburg, and north. With regard to the energy areas located on either side of the fairway, there is a risk of cumulative effects that need to be taken into account in further permit assessment, construction and operation. This also applies to the southern planning area, in particular the energy areas V303 (permitted/zero alternative) and the plan's energy area V317.

To the south is guided with energy areas V303, V305, V317, V361, V364 and all adjoining fairways with national interest, as well as IMO-classified routes. There are permits for wind farms for V303, V305 and V361 and safety distances from shipping are specified in the respective permits.

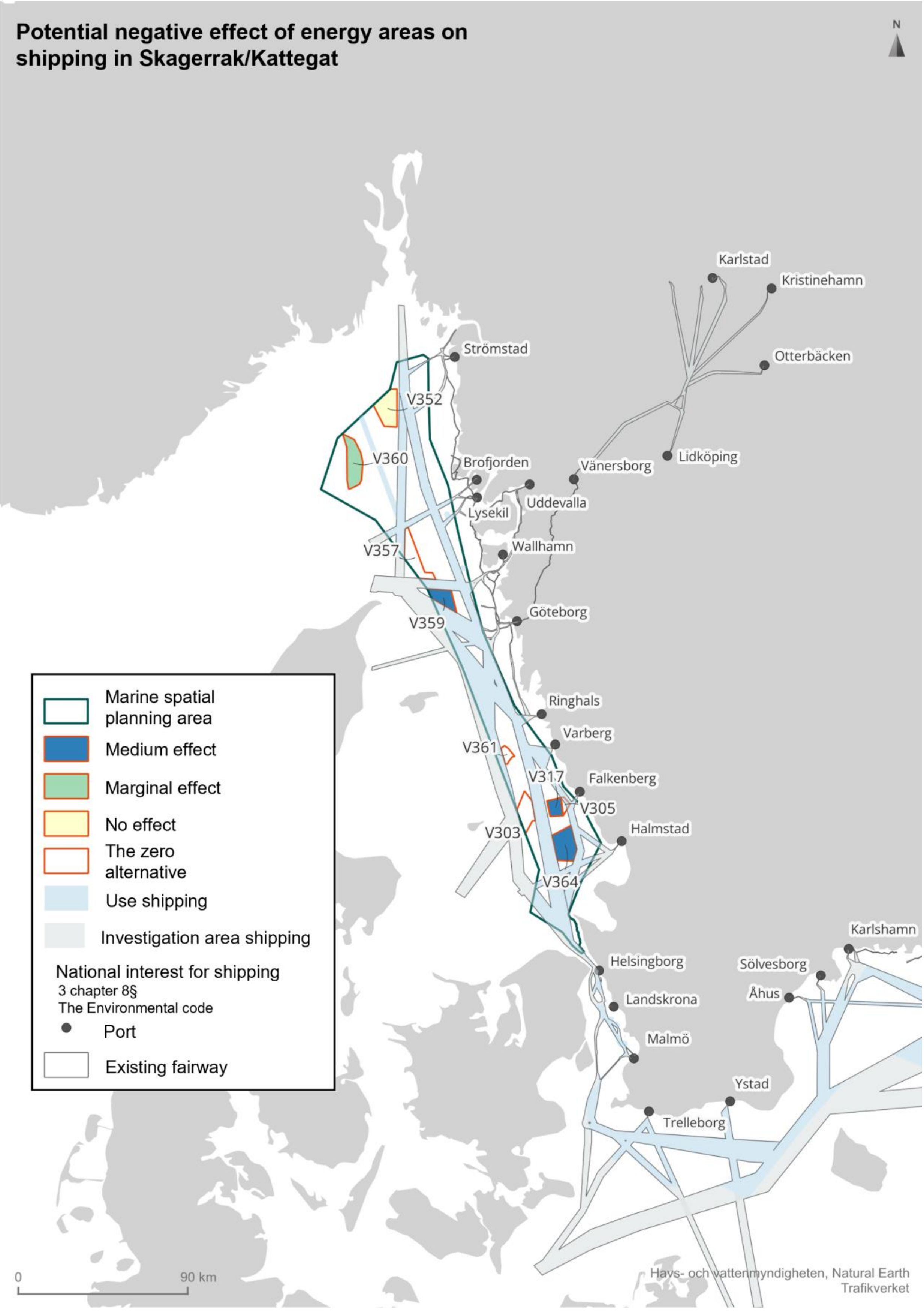


Figure 79. Relative potential negative effect of energy areas on shipping in Skagerrak/Kattegat. Dark color shows great effect and light color shows little effect.

*Indirect impact*

A potential indirect impact may be an increased risk of allision, i.e. collision between ships and wind turbines. Allision can have environmental effects such as oil spills, etc. Other potential indirect impacts from guidance in areas of energy concern general accessibility for rescue and remediation work in maritime accidents at sea. For more information, see the Swedish Maritime Administration's and the Swedish Transport Agency's knowledge base on offshore wind power (Ahlström 2023, the Swedish Maritime Administration and the Swedish Transport Agency 2023).

Further information regarding spatial analyses of shipping in the area can be found in the Lighthouse report *Maritime interest in sea space in light of an increased expansion of wind power (*Hjerpe Olausson, J. et al., 2024).

*Assessment Marine Spatial Plan*

Indicative use of shipping in the marine spatial plan is based on national interest claims for shipping that largely coincide with national interest claims, established shipping lanes and shipping routes. For the planning alterantive and including areas with licensed parks, all are located adjacent to one or more national interest-classified fairways, where some energy areas are also adjacent to the IMO route.

In addition to direct impact on shipping and navigation, the impact may thus include indirect sequential effects, with regard to increased collision risk and with fixed installations, as well as the risk of impact on accessibility in case of need for rescue operations.

In terms of zero alternatives and proposed marine spatial plans, the  assessment is that the potential impact on shipping is relatively small, both for Swedish and international shipping, provided that permits for the establishment of wind farms take into account existing recommendations (the Swedish Maritime Administration and the Swedish Transport Agency, 2023) and the need for safety distances.

Safety distances and other adaptations are handled and decided upon in the permit assessment for the wind farm.

*Cumulative and transboundary effects*

Nearby energy areas can have a cumulative impact through multidimensional effects on maritime routes, i.e. wind farms on several sides of the fairway. This also applies to areas with currently licensed wind farms, such as V317 and licensed parks in area V303.

The same assessment also applies to shipping to and from neighbouring countries and international traffic in the plan area.

In the planning area, there is extensive international traffic, both to and from Sweden, as well as maritime traffic to and from the Baltic Sea. Kattegat is particularly important for maritime traffic as it is one of only two routes into the Baltic Sea for large vessels.

### 5.4.6. Commercial fishing

Skagerrak/Kattegat stretches from north of Helsingborg in the south up to Strömstad in the north. Commercial fishing is widespread in the area and includes both fish and shellfish. Commercial fishing is geographically extensive and the surface area for commercial fishing is relatively large in the marine spatial plan. Trawl fisheries for Norway lobster and pelagic fisheries are carried out in large parts of the marine area. Trawl fishing for Northern prawn is carried out extensively in the northern part of the area. Even demersal fish are caught as by-catch, and a few vessels also conduct a directed fishery for demersal fish. Some creel fishing also takes place to a lesser extent in order to fish for Norway lobster and lobster closer to the coast. Fishing with other passive gear occurs to varying degrees throughout the area. Shellfish have relatively low geographical mobility, which means that fishing grounds are more stationary than for other fisheries. As in other offshore areas, foreign fleets are also being fished in the Skagerrak/Kattegat planning area, mainly by Danish and Norwegian vessels.

*Impact on commercial fisheries*

The marine spatial plan indicates the use of commercial fishing in large parts of both Skagerrak and Kattegat. There are extensive national interest claims for commercial fishing, catch area in the plan area. Commercial fishing is given priority over energy extraction in areas of national interest for commercial fishing in V348, V351, V356, V358 and V365. Area V366 also gives preference to commercial fishing, but on the basis of a general interest of vital importance for commercial fishing. In areas V303, V359, V361, the guidance means coexistence between commercial fishing (which corresponds to national interest claims) and energy extraction. In an area of national interest for commercial fishing in part of the area, V357, energy extraction is given priority over commercial fishing.

National interest claims for commercial fishing, cod spawning grounds and valuable fish habitat overlap with energy extraction in V317.

In addition to this, the conduct of commercial fishing outside identified risk claims and public interests is also significantly affected.

The conditions for coexistence with commercial fishing and thus the impact on commercial fishing depend on the design, adaptation of the wind farm, the type of foundation of the wind turbines, as well as on the type of fishing carried out and the adaptations that are possible of the fishing (Swedish Agency for Marine and Water Management and Swedish Energy Agency, 2023).

For energy areas V352, V357 and V360 in Skagerrak, energy areas are assumed to consist of parks with floating foundations. In these areas, bottom trawl fisheries are conducted primarily for shrimp, but also for Norway lobster, which is not considered to be compatible with this type of wind farm. Norway lobster and shrimp have relatively low geographical mobility, which is assumed to limit the possibility of trawl fisheries targeting these species to other areas. The plan's guidance on the use of energy thus means that priority is given to energy extraction over national interest claims and the interests of commercial fishing in these three areas. For area V359 bottom-fixed foundations are assumed to be relevant. The area is mainly bottom trawling for Norway lobster and fish, this fishery is considered to be able to coexist with an established energy area.

The energy areas V303, V305, V317, V361, V364 in Kattegat are assumed to consist of wind farms with bottom-fixed foundations. These areas are mainly bottom trawling for Norway lobster and fish. Trawl fishing for Norway lobster in combination with wind farms with fixed foundations is considered, after adaptation of the wind farm, to be able to coexist to some extent.

The annual average landing value during the period 2013-2023 for the pelagic trawl fishery, the trawl fishery for demersal species such as shrimp and Norway lobster and the creel fishery for Norway lobster was in Skagerrak/Kattegat SEK 490 million in total. Based on the assumption that each trawl line passing through proposed energy areas is affected by the establishment of an energy area, approximately 10 percent of the landing value is estimated to be affected if all energy areas in Skagerrak/Kattegat are built. In particular, commercial fishing using trawls for Norway lobster and trawls for shrimp is affected (Waldo S. & Blomquist J., 2024a). The actual impact on the landing value depends on the possibility of coexistence or relocation of fisheries to other areas.

In Skagerrak/Kattegat, there are already four energy areas that have been granted permits. It corresponds to areas V357, V305, V303 and V361. For V361, the Natura 2000 permit has not become final. Already licensed wind farms for the energy areas mean that the indicative use and impact of the marine spatial plan can be assessed to be lower in reality.

All nine areas for energy extraction in the proposal for a marine spatial plan in Skagerrak/Kattegat are considered to have a potential large impact on the commercial fishing. Based on landing values and share in the fisheries in question, the impact is considered to be relatively large, regarding trawl fishing for crayfish and fish, and shrimp fishing. Figures 80 and 81 below show the impact as a percentage of the total annual landing value per energy area. For areas with permits for the establishment of wind power, the share is not shown as they are included in the zero alternative of the impact assessment. The establishment of wind power in the licensed areas, together with the proposed areas, contributes to a potential cumulative impact. Table 36 below shows landing values for all areas. Please note that the reporting refers to averages for the whole period 2013-2023. In some cases, shifts between areas have occurred over time that do not show the average values. Among other things, such a shift has taken place from the V360 to the V352.

Table 36. Landing value from Swedish fisheries affected by energy areas in SEK million (SEK million) and percentage (%) of total landing value, for Skagerrak/Kattegat. Average per year 2013-2023. Rounding has taken place to the nearest integer.

| Type of fishing | Landing value affected by energy areas (SEK million) | Landing value from Swedish territorial waters and exclusive economic zone (SEK million) | Share of landing value from Swedish territorial waters and exclusive economic zone affected by energy areas | Landing value including part of fishing in other countries' territorial sea and exclusive economic zone total (SEK million) | Share of landing value including share of fishing in other countries' territorial sea and economic zone affected by energy zones |
|---|---|---|---|---|---|
| **Trawl fisheries Northern prawn (bottom trawl) in Skagerrak/Kattegat** | 12 | 103 | 12% | 148 | 8% |
| **Trawl fisheries Norway lobster and fish (bottom trawl) in Skagerrak/Kattegat** | 37 | 163 | 23% | 204 | 18% |

Source: Waldo, S. & Blomquist, J., 2024b How is Swedish fishing affected by offshore wind power? Supplementary material (AgriFood Report, no. 2024:2). AgriFood Economics Centre.

The plan proposal includes an expansion of areas in Skagerrak/Kattegat with particular consideration to high nature values with regard to birds and reef environments. Areas with special nature considerations can in the long term, depending on the nature value the consideration refers to, benefit commercial fishing from potentially strengthening ecosystem services.

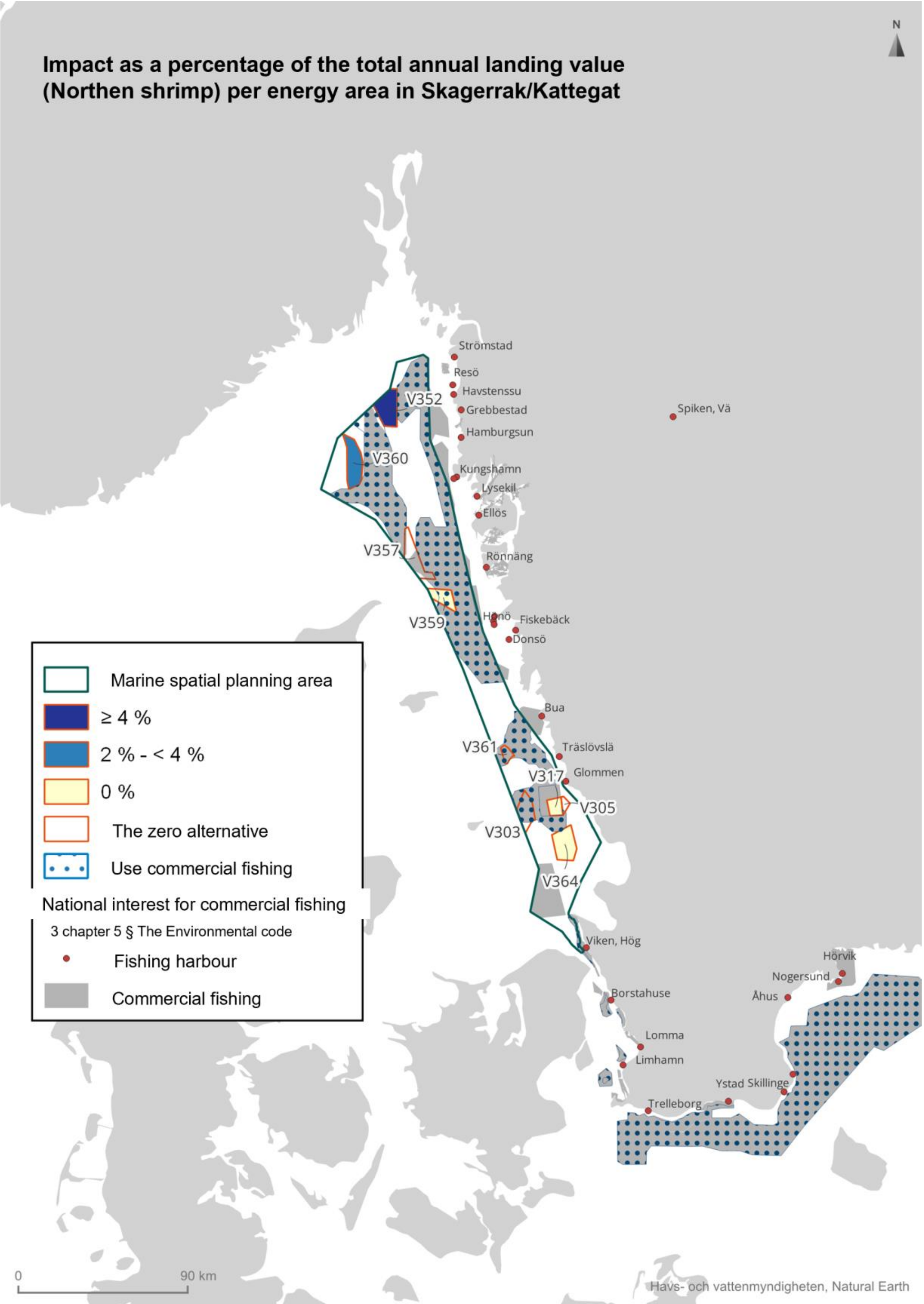


Figure 80. The map shows proposed energy areas, use of commercial fishing and national interest claims for commercial fishing in Skagerrak/Kattegat. The figure also shows the impact as a percentage of the total annual landing value (Northern shrimp) per energy area.

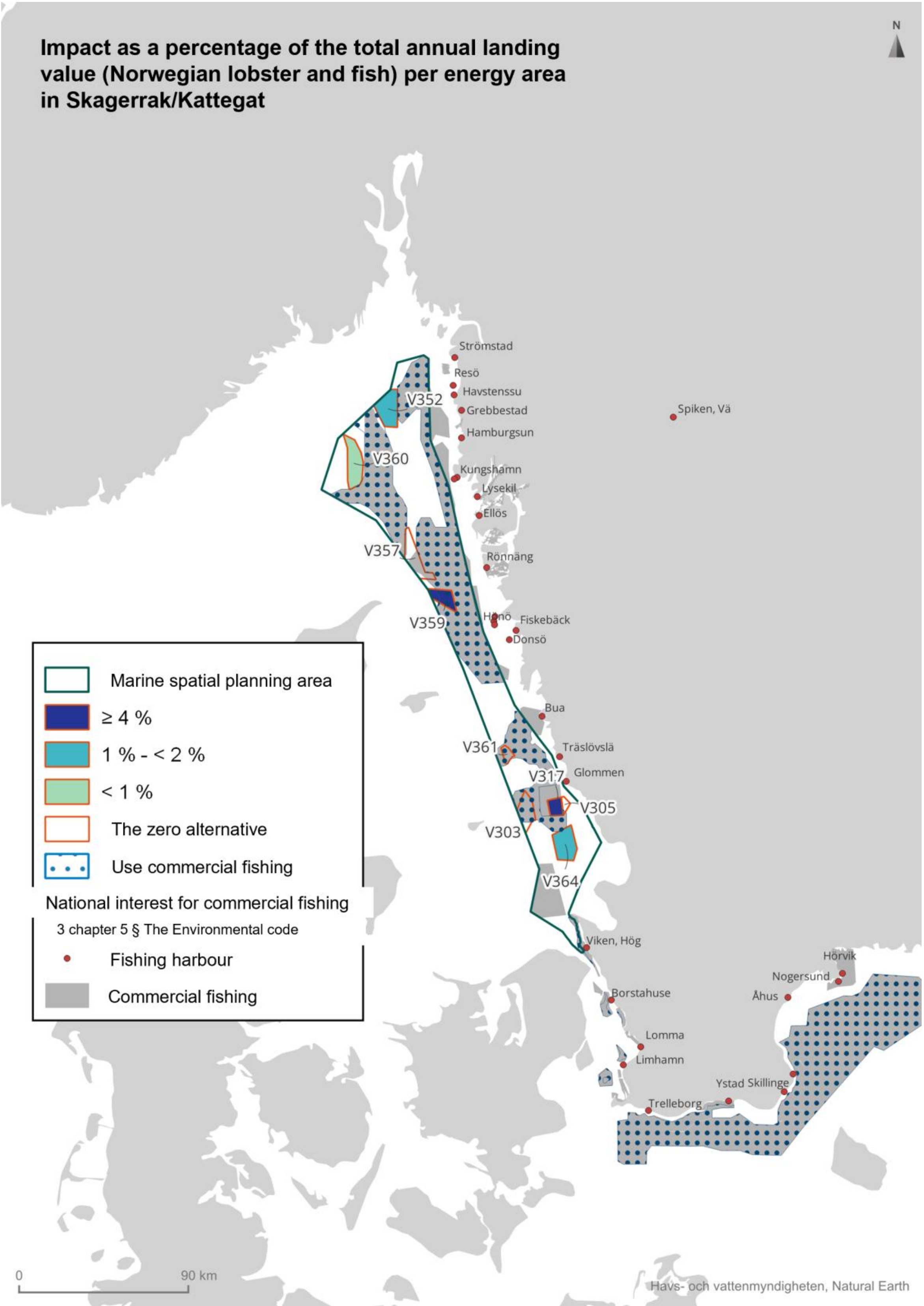


Figure 81. The map shows proposed energy areas, use of commercial fishing and national interest claims for commercial fishing in Skagerrak/Kattegat. The figure also shows the impact as a percentage of the total annual landing value (Norway lobster and fish) per energy area.

*Indirect environmental impact of land and water use*

The marine spatial plan's guidance and potential impact on commercial fishing can also have indirect environmental effects. Changes in the activity of commercial fishing, spatially and in intensity, may involve the movement of fishing activity to other areas, possibly with longer driving distances, which may lead to increased air emissions, such as greenhouse gases. It may affect the conditions for commercial fishing if operating costs rise due to longer distance and driving time and/or revenues fall due to reduced catch or catch of lesser quality. However, the actual outcome and indirect environmental impact regarding mileage impact is considered to be highly uncertain and in the long term also due to the development and conversion of the fleet to more energy-efficient, better and fossil-free fuels.

The area is used for bottom trawling and pelagic fishing. Potentially, this may mean that the impact on benthic habitats can be reduced in the energy areas where bottom trawling no longer takes place. However, the gross effect is mainly local, the total net effect on reduced impact of benthic habitats depends on, if and to which other areas a possible movement of bottom trawling takes place.

*National, regional, municipal interests*

The plan's guidance on the use of commercial fishing confirms, with one exception, national interest claims for commercial fishing. However, guidance on the use of energy extraction can to some extent affect the conduct of commercial fishing in the plan area's offshore areas. The impact on commercial fishing can also affect activities and value chains dependent on marine resources, as well as other activities and facilities for landing and processing fishery resources. This includes, for example, port operations of local and regional interest in the plan area, as well as essential functions related to food security and primary production, see section 2.4.6 on national and municipal interests.

Most ports in Halland and Västra Götaland have between 2019-2023 had landings from catches coming from one of the marine spatial plan's energy areas. In Träslövsläge harbour in Varberg municipality and Glommen harbour in Falkenberg municipality, a large proportion of catches caught in an energy area are landed. Should all energy areas be built on, 47 percent of the landing value in Träslövsläge and 49 percent of the landing value in Glommen would be affected based on an annual average landing value 2019-2023. As some trawl fisheries targeting Norway lobster and fish are considered to be able to coexist with wind farms, the actual impact depends on the extent to which coexistence can be achieved and on which energy areas are ultimately built.

*Cumulative and transboundary effects*

As in other offshore areas, in addition to Swedish fishing, extensive foreign fishing is taking place in Swedish waters in Skagerrak/Kattegat, mainly by Danish and Norwegian vessels. The total potential impact on landing values for all fleets can therefore be significantly higher, as foreign vessels are assumed to fish to a large extent in the same areas as Swedish vessels.

Denmark's marine spatial plan includes four energy extraction areas in Kattegat. Swedish fishing is mainly conducted in an energy area off Jutland's northernmost east coast, about 25 kilometers from Gothenburg's outer archipelago (Vinga) (Swedish Maritime Administration, 2025).

The impact on commercial fishing of all the energy areas in the marine spatial plan for Skagerrak/Kattegat is considered to have a potentially large impact on the operation of commercial fishing in the plan area, primarily in the case of shrimp fishing, as well as bottom trawling for crayfish and fish. This also includes areas with licensed wind farms (V303, V305, V357, V361), which are relatively significant for crayfish fishing, and are not considered to be directly affected on the basis of the draft marine spatial plan.

However, not all areas of energy in the marine spatial plan are assumed to be realised, and the actual impact and aggravation on the conduct of commercial fishing depend on which areas of energy are actually realised, as well as on opportunities for coexistence. Examples of different types of adaptation are: the design of the wind farm, adaptations in fisheries, e.g. fishing methods, as well as possibilities for relocation of fisheries to other areas. However, the possibility of fishing movements is assumed to depend on current target species, where some e.g. Norway lobster is more linked to specific locations/habitats.

The plan area also includes fishing from vessels registered in other countries, mainly Danish and Norwegian fishing vessels. The total potential impact on landing values and related activities for all fisheries can therefore be significantly higher.

Coastal fishing and creel fishing for Norway lobster, which are mainly conducted closer to the coast, are not considered to be directly affected by the plan's guidance of energy areas.

Opportunities for commercial fishing are also affected by fishing regulations as certain areas are limited for commercial fishing. This is partly about the Natura 2000 site Bratten (V366). An area completely and partially closed to both commercial and recreational fishing is located in the southern part of the area (large parts of V307). Fishing-free areas or areas limited to fishing thus affect the possibilities for movement of fishing.

Potential impact on commercial fishing, is also considered to entail indirect effects in terms of fishing value chains, processing industry, affected landing ports and municipal interests see 2.4.6 about national and municipal interests.

In terms of effects on the profitability of fishing enterprises, these depend on the extent to which fishing can move, how landings are affected and whether the costs of fishing operations change. The impact on individual companies depends on how their fishing patterns may need to be changed.

## 5.5. Overall assessment Skagerrak/Kattegat

### 5.5.1. Nature and ecological aspects

Skagerrak/Kattegat, with its almost ocean-like conditions, has greater biodiversity compared to the Baltic Sea and the Gulf of Bothnia. There are rich bird communities linked mainly to archipelagos in the north and islands further south. Offshore areas in and around the embankments Stora and Lilla Middelgrund and Fladen there are important wintering areas for birds, as well as important migratory routes north Jutland-Bohus coast and Grenå-Anholt-Halland coast. In Skagerrak/Kattegat, both the Belt Sea population and Skagerrak/Kattegat population of harbour porpoises occur.

Establishing energy areas in accordance with the proposed marine spatial plan for Skagerrak/Kattegat would entail a high risk of negative impact on important migratory routes for birds and a risk of impact on bats. In particular, the four permitted energy areas and included in the zero alternative contribute to this risk of impact on birds. The additional five energy areas included in the plan increase the cumulative pressure on birds. Underwater noise from the construction and operation of offshore wind power can lead to disturbance of marine mammals, the extent of the disturbance depends on adaptations and consideration measures during both construction and operation. In this area, there is a need to investigate potential effects and technologies for both construction, operation and decommissioning in order to minimize the risk of negative impact in particular on the harbour porpoise.

In Skagerrak/Kattegat there are important biotope-building species such as blue mussel and Lophelia corals in hard benthic habitats and important burrowing organisms and protected sea pens in soft bottoms. Trawling is the main pressure on the benthic habitats of Skagerrak/Kattegat. Here, fish spawning occurs in large parts of the sea area. Specific conditions need to be carefully investigated during the design process to avoid damaging or negatively affecting habitats rich in species and worthy of protection.

A potential positive net local impact on benthic habitats may arise if energy use replaces bottom trawling especially in Skagerrak. Fishing is likely to be partly relocated to adjacent accessible areas, which would result in the pressure on the benthic habitat being shifted and concentrated.

### 5.5.2. Recreation, cultural environment and landscape

In Skagerrak the Bohuslän coastline stretches, which in the north is of national interest for unbroken coastl There is also a marine national park - Kosterhavet. The entire coastline of Skagerrak/Kattegat is covered by national interest claims for recreation, and the northern parts also mobile recreation. In this region there is extensive recreational boat traffic, mainly in coastal areas, but also recreational boat routes offshore between southern Bohuslän and Skagen. Södra Bohuslän is of national interest for high-exploited coast with several cultural environments, such as lighthouses and fishing villages with strong links to the marine environment and qualities such as unobstructed horizon. Marine cultural heritage sites are mainly found along the coast, but also further out in southern Bohuslän with a particularly designated value area below the surface.

Along the coast of Halland there are values for the moving recreation. Claims of national interest for recreation are also found in the marine spatial planning area at embankments that offer good opportunities for activities such as recreational fishing and nature experiences. There are wrecks, marine archaeological sites and two value areas below the surface with the likely presence of sunken settlements and islands. The coast of Halland is also of national interest for high-exploited coast

The marine spatial plan's guidance on energy extraction may entail a risk of negative impact on cultural heritage, recreation and landscapes, with possible sequential effects on the tourism industry. In the northern marine spatial planning area, it is mainly about visual impact. Energy area V359 overlaps with a marine value area for cultural environment and is also close to the cultural environments on Marstrand with Pater Noster. Energy areas overlap with recreational boat routes in both Halland and Bohuslän. Offshore wind power can affect the availability and maritime safety of recreational craft in, for example, energy areas V364 in southern Kattegat and energy area V359 as well as area V357 that has a permit for a project. The cluster of energy areas in the southern parts of Skagerrak/Kattegat affects areas of national interest for recreation. The energy areas that are close to the coast also have a visual impact from land, where people spend time on beaches, for example. Landscape effects in Skagerrak/Kattegat tend to have medium-sized effects from energy areas. The coastal areas in Halland are also the areas that have the greatest impact on recreational boat routes.

### 5.5.3. Energy extraction, shipping and commercial fishing

The plan proposal for Skagerrak/Kattegat will provide guidance on 9 areas for energy production, corresponding to an area of approximately 1 060 km2 and approximately 11 percent of the marine spatial planning area. Energy production is estimated to be approximately 20 TWh per year. For the marine spatial plan, there are good conditions for energy extraction in terms of wind and depth conditions. A relatively large proportion of the area consists of energy areas located in relatively deep areas. Compared to other marine spatial plans, a relatively large proportion of the energy areas are located within the territorial sea, about 40 percent. The plan's guidance on energy is available in the municipalities of Tanum, Öckerö, Falkenberg and Halmstad. In some areas suitable for energy, other uses have been given priority, which may affect energy supply, affected companies in wind power planning in the plan area negatively. According to the assignment, Skagerrak/Kattegat is a priority area for marine spatial planning for increased offshore wind power.

The potential impact on shipping in Skagerrak/Kattegat is assessed to be relatively small, both for Swedish and international shipping, provided that permits for the establishment of wind farms take into account existing recommendations and the need for safety distances. The same assessment also applies to shipping to and from neighbouring countries and international traffic in the plan area.

The design of energy areas in the plan proposal has to some extent been adapted to take account of the national interest in commercial fishing and the fishing activity after the consultation. Overall, the impact on commercial fishing for Skagerrak/Kattegat is considered to have a potential major impact on the conduct of commercial fishing in the plan area, primarily in the case of shrimp fishing, as well as bottom trawling for crayfish and fish. There is a high risk of cumulative effects if all energy areas are established.

Several energy areas with licensed projects have a potentially large negative effect on commercial fishing. These include, for example, V357 for shrimp fishing and V303, V361 and

V305 for crayfish fishing. There is considerable uncertainty regarding the impact and possible loss of landing values. The conditions for the movement of fisheries depend on the type of fishery and the target species concerned. Where fishing can be relocated, the effect is mainly an increase in the cost of fishing effort. Norway lobster is an example of a target species linked to specific sites and habitats, with limited possibilities for the movement of fisheries. Adapted park layout, buried cables and other solutions for coexistence between commercial fishing and offshore wind power can affect the conditions for continuing fishing in energy areas and adjacent areas. Vessels from other countries, mainly Danish and Norwegian, also fish in the plan area, which may also be affected by the establishment of offshore wind power. Coastal fishing and creel fishing for Norway lobster, which are mainly conducted closer to the coast, are not considered to be directly affected by the plan's guidance on energy areas. Potential impact on commercial fishing is considered to have indirect effects on fishing value chains, the processing industry, affected landing ports and municipal interests.

#### 5.5.4. Aggregated assessment of energy areas

In the impact assessment above, negative and positive impacts have been assessed on a scale from 0 to 4. The purpose is to show the risk of impact on the assessment aspect, e.g. birds or cultural environment. It is a complex task to make an overall assessment for an energy area in terms of the cumulative impact an energy area has on different assessment aspects and interests. This is due to several factors, including the degree of detail and quality of the knowledge base differing between different assessments, as well as the challenge of comparing widely different types of effects and consequences. At the same time, it is essential that the impact assessment provides an overall picture. The table below shows all assessments by energy area in the marine spatial plan area of Skagerrak/Kattegat. The table aims to give an overview and a feeling that some energy areas have a greater risk of negative effects than others.

Table 37. Shows all assessments for energy areas in Skagerrak/Kattegat, and how these can be aggregated and show the total negative effects of an energy area.

| | Ecology | | | | | | Sectors | | Recreation, Cultural environment and Landscape | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Area | Benthic habitats | Fish and fish spawning | Bats | Migratory bird | Bird, wintering | Marine mammals | Shipping | Commercial fishing | Outdoor activities | Cultural environ ment | Landscape |
| V303 | | | | | | | | | | | |
| V305 | | | | | | | | | | | |
| V317 | | | | | | | | | | | |
| V352 | | | | | | | | | | | |
| V357 | | | | | | | | | | | |
| V359 | | | | | | | | | | | |
| V360 | | | | | | | | | | | |
| V361 | | | | | | | | | | | |
| V364 | | | | | | | | | | | |
| Ö285 | | | | | | | | | | | |
| Ö287 | | | | | | | | | | | |

* Zero alternatives/Authorised.

| | Min negative | | | | Max negative |
|---|---|---|---|---|---|
| Area | | | | | |

### 5.5.5. Assessment scenarios show potential distribution of cumulative effects

In Skagerrak/Kattegat, there are permits to build offshore wind power in four energy areas, some permits are older, such as V305, and the rest have been awarded in recent times. The marine spatial plan for Skagerrak/Kattegat provides guidance on four additional energy areas. As mentioned earlier, there are several uncertainties linked to how the actual expansion will look like in Skagerrak/Kattegat. To illustrate what an expansion of energy areas could look like, two scenarios are used, showing potential expansion taking into account different interests. The ‘Nature and culture’ scenario shows a selection of the energy areas identified by the impact assessment as having the least overall negative impact on natural and cultural heritage values. The expected energy production would be around: 16 TWh.

In the ‘Nature and Culture’ scenario, only one energy area sites in Skagerrak/Kattegat, V360, which overlaps with the Natura 2000 Bratten site. All energy areas in Skagerrak/Kattegat generally have a major impact on both ecological aspects and cultural environments, and V360 is the area that archaeological sites in a weighted assessment of these aspects, despite overlapping with nature conservation. Natura 2000 requires specific permits to establish offshore wind energy, and it shall be possible to ensure that important nature values are not harmed. As the zero alternative in Skagerrak/Kattegat entails a relatively large area claim for energy extraction, the assessment is that further expansion beyond the zero alternative risks affecting bird migration routes between Denmark and Sweden. Along the Bohuslän and Halland coasts, there are plenty of national interest claims for both the cultural environment and recreation that risk being negatively affected by expansion in the more coastal energy areas, see Figure 82 below.

In the ‘Shipping and commercial fishing’ scenario, the energy areas with the greatest combined negative impact on fishing and shipping are removed, V359 which directly overlaps with national interest for commercial fishing and V317 which is in the same area as national interest for commercial fishing and spawning area. Consequences for shipping in Skagerrak/Kattegat are primarily about safety and navigation. Skagerrak/Kattegat is a well-trafficed area, and energy areas included in the zero alternative risk having a negative impact on shipping, see Figure 83 below.

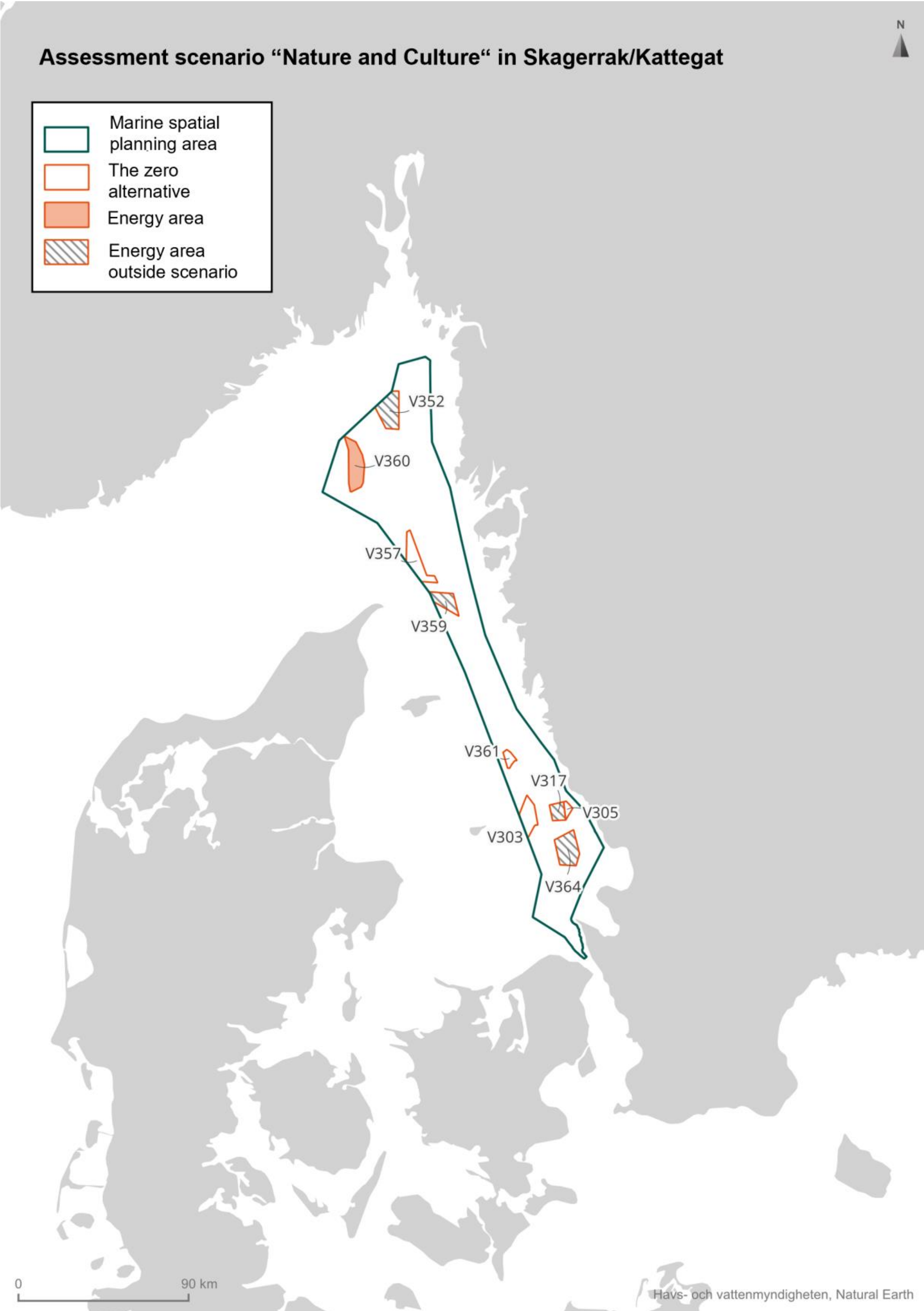


Figure 82. Displaying the "Nature and Culture" assessment scenario, in this case the energy areas identified by the impact assessment as having the greatest overall negative impact have been removed. The overall negative impact on the values of nature and culture will be low.

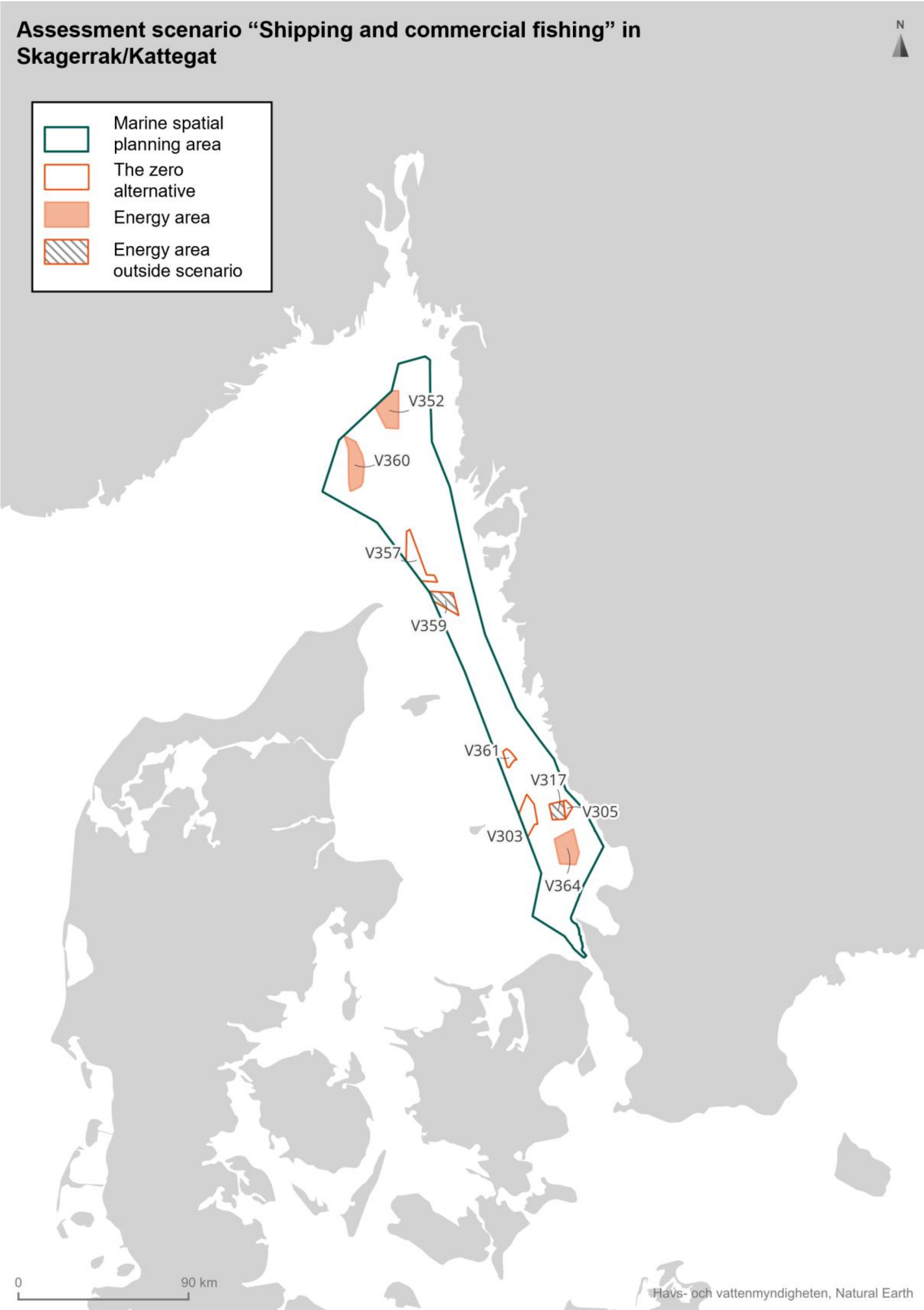


Figure 83. If the assessment scenario "Shipping and commercial fishing" is shown, in this case the energy areas identified by the impact assessment as having the greatest overall negative impact have been removed. The overall negative impact on values for shipping and fishing will be low.

### 5.5.6. *Cross-border cumulative effects*

Cumulative effects in Skagerrak/Kattegat could mainly occur in relation to the impact on birds, harbour porpoises, landscapes, cultural environments, recreation, water (hydrography), commercial fishing and shipping.

The planned energy establishment of neighbouring countries can mainly contribute to particularly cumulative impacts on birds, harbour porpoises, commercial fisheries, energy and shipping. Continued dialogue with neighbouring countries is necessary to assess cumulative impacts from a sea basin perspective.

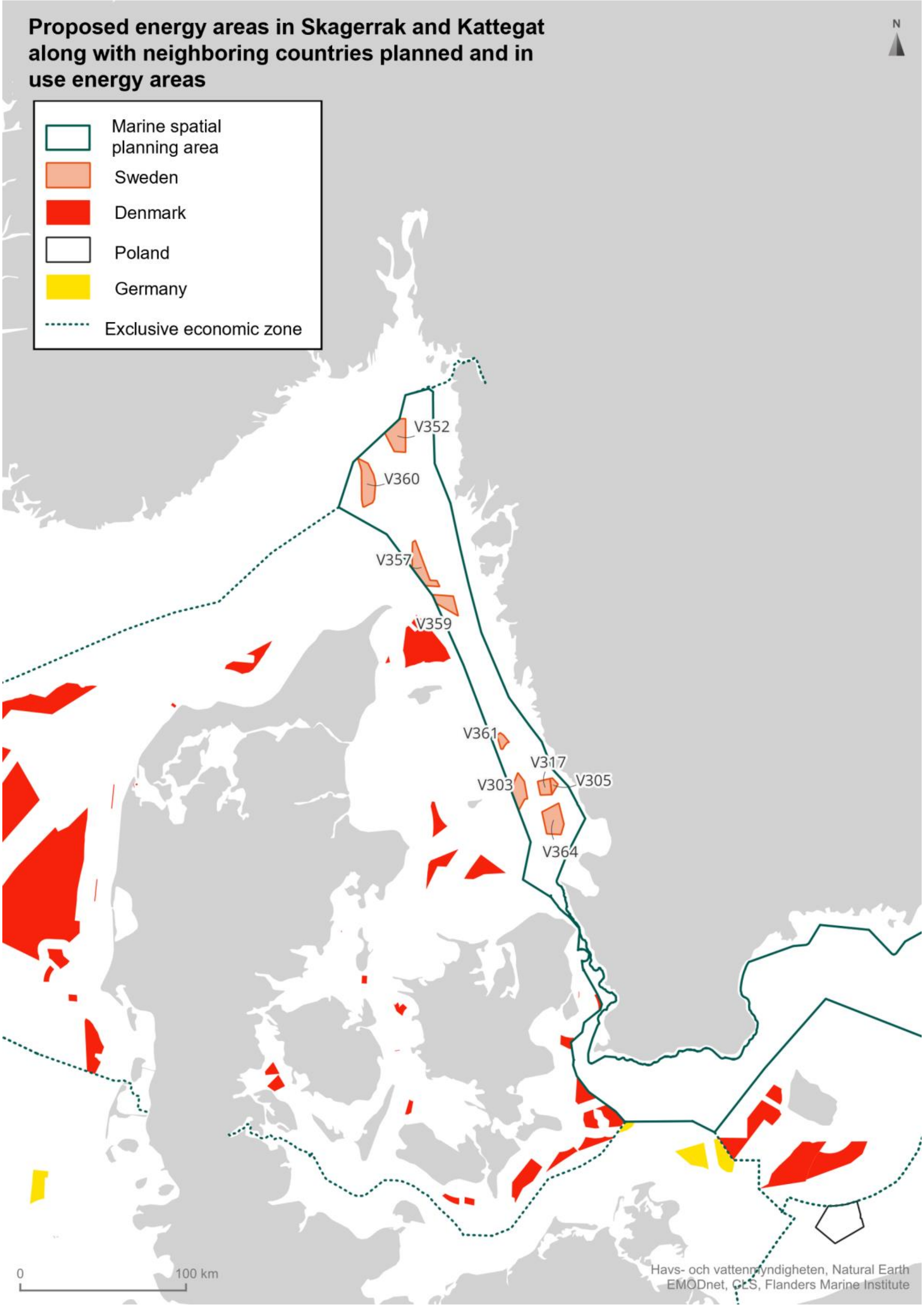


Figure 84. Map of proposed energy areas in Skagerrak/Kattegat and plans for energy expansion in neighbouring countries. Source: EMODnet, 2022, Flanders Marine Institute, 2023.

# 6. Results and conclusions

This chapter compiles the assessment of the expected environmental effects of the marine spatial plans for the three marine spatial planning areas of the Gulf of Bothnia, the Baltic Sea and Skagerrak/Kattegat based on the results reported in the previous chapters. The analyses in this part are carried out at national level and cover all three marine spatial plans.

Section 6.1 describes the contribution of marine spatial plans to achieving good environmental status in Swedish waters under the Marine Strategy Framework Directive and the criteria in the Water Framework Directive that are related to the marine environment. Section 6.2 includes an analysis of how the marine spatial plans jointly contribute to achieving Sweden's environmental quality objectives. The third section presents the implications of marine spatial plans for other relevant plans, policies and programmes. Apart from the use of energy extraction and the guidance on particular consideration for high nature values in a number of areas, the guidance in this proposal for revised marine spatial plans does not differ from agreed marine spatial plans.

## 6.1. Assessment against the Marine Strategy Framework Directive and the Water Framework Directive

### 6.1.1. Plankton communities and pelagic environments

*Current environmental status*

According to the latest assessment of the status of the marine environment (Swedish Agency for Marine and Water Management, 2023c), good status of pelagic habitats is not achieved in any of the assessment areas. The indicators for phytoplankton and zooplankton (D1C6, D4C1) meet their threshold values in individual marine areas, but the eutrophication problem has a negative impact on the status of plankton communities in the Baltic Sea. Phyto- and zooplankton have also shown a downward trend in Skagerrak/Kattegat.

*Effects of marine spatial plans*

In total, marine spatial plans are not considered to have a significant impact on plankton communities or on pelagic habitats. The overall assessment against relevant MSFD and WFD descriptors is shown in the table below.

Table 38. Overall assessment for plankton communities and pelagic habitats. HMD: Marine Environment Directive, RDV: Water Framework Directive.

| Plankton communities and pelagic habitats | | Gulf of Bothnia | Baltic Sea | Skagerrak/Kattegat |
|---|---|---|---|---|
| **HMD** | D1C6<br>*State of pelagic habitats* | No effect | No effect | No effect |
| **HMD** | D4C1<br>*Impact on the diversity of the trophic group* | No effect | No effect | No effect |
| **RDV** | Phytoplankton in coastal and transitional waters | No effect | No effect | No effect |

Increased turbidity is expected to occur as a result of sand extraction activities and in connection with the construction of offshore wind power in the areas where the marine spatial plans guide sand extraction and energy extraction. Although the pressure may be significant locally, it is generally short-term and geographically limited, and the impact on water quality and marine life is not significant. In areas where fish spawning occurs, it is important to adapt activities causing sediment dispersal after spawning periods, in order to minimise the risk of negative impacts on the pelagic life stages of fish.

The establishment of offshore wind power may impose restrictions on fishing, in particular fishing with active gear. Limiting bottom trawling can have a local positive effect in terms of reduced turbidity, especially in areas with bottoms of fine sediments. Similar effects may arise as a result of guidance from marine spatial plans on particular consideration for high nature values if this would lead to the introduction of management measures targeting bottom-contact fisheries. The actual extent of these two effects cannot be ascertained at present.

Model studies show that wind farms can cause changes in currents, stratification and mixing in the surface of the sea, (Arneborg et al. 2024) see also Section 2.2.1 Water and air. These are effects that can affect hydrography, biogeochemistry and pelagic ecosystems far beyond the boundaries of wind farms. One possible consequence of this could be the impact of wind farms on cyanobacterial blooms in the Baltic Sea. These blooms are an annual phenomenon, especially in the Baltic Proper, but also in the Bothnian Sea. The blooms are expected to be stronger if the water temperature rises and the water is stratified. Since these effects of wind farms in terms of reduced mixing, more stratification and changes in temperature and salinity are unknown, it is also not possible to fully estimate the effects on phytoplankton, zooplankton and cyanobacteria.

### 6.1.2. Fish

*Current environmental status*

Overall, fish descriptors do not reach good environmental status (D1C2, D3C1, D3C2, D4C1) according to the most recent assessment (Swedish Agency for Marine and Water Management, 2023c), although individual species perform well. Fishing pressure is the dominant pressure for all species groups, in addition, the state of fish in Skagerrak/Kattegat is affected by lost ghost fishing gear, while eutrophication has a negative impact on fish in the Baltic Sea. As regards hazardous substances in food (D9C1), good environmental status is achieved in Skagerrak/Kattegat but not in the Baltic Sea. This is due to elevated levels of dioxins and PCBs in fish in the Baltic Sea.

*Effects of marine spatial plans*

In total, the marine spatial plans are not considered to have a significant negative effect on fish within the marine spatial plans areas. However, the effects may vary slightly between different areas. The overall assessment against relevant MSFD and WFD descriptors is shown in the table below.

Table 39. Overall assessment for fish. HMD: Marine Environment Directive, RDV: Water Framework Directive. (*) Associated indicator refers to carp and predatory fish in coastal waters.

| **Fish** | | **Gulf of Bothnia** | **Baltic Sea** | **Skagerrak/Kattegat** |
|---|---|---|---|---|
| **HMD** | D1C2<br>*Abundance of species of birds, mammals and fish* | Marginal negative effect | No effect | Marginal negative effect |
| **HMD** | D3C1<br>*Fishing mortality of commercially exploited species* | No effect | No effect | No effect |
| **HMD** | D3C2<br>*Spawning stock biomass of commercially exploited species* | Marginal negative effect | No effect | Small negative impact |
| **HMD** | D4C1<br>*Impact on the diversity of trophic groups* | No effect | No effect | No effect |
| **HMD** | D4C2<br>*Impact on the balance of abundance between trophic groups* | No effect | No effect | No effect |
| **HMD** | D9C1<br>*Hazardous substances in marine food* | No effect | No effect | No effect |
| **RDV** | Hiking fish species | Small negative impact | No effect | No effect |
| **RDV** | Bottom fauna in coastal and transitional waters | No effect | No effect | No effect |

The establishment of offshore wind power can have an impact on fish through turbidity in spawning grounds and underwater noise. Based on the latest knowledge synthesis (Bergström et al., 2022), the risk of such negative effects is considered to be avoidable by taking into account spawning times. However, it is important that the risk of impact is examined in each area, taking into account the sensitivity of the fish species and other local conditions.

Increased turbidity in connection with sand extraction and the construction and decommissioning of offshore wind power may have a negative impact on fish spawning, but the risk of such impact is considered to be minimised to acceptable levels by taking into account measures for each activity, including adjusting the construction time if necessary to avoid spawning periods. The greatest overlap is found between energy area V317 in the national interest area professional fishing for spawning and nursery areas.

The risk of impact on migratory salmon is estimated to be greater in coastal shallower sea areas. Energy areas B108, B111, B142, B149 and B152 are considered to have little risk of negatively affecting the conditions for migratory salmon in the Gulf of Bothnia and energy area V303, V364 in Skagerrak/Kattegat.

The marine spatial plans' guidance on particular consideration for high nature values may lead to the introduction of adaptation measures for various human activities in order to reduce pressure on marine life. There is thus potential that the guidance indirectly contributes to increased protection of fish species. Similarly, the establishment of offshore wind power may impose restrictions on fishing activities, which may benefit fish stocks over time. The greatest prerequisites for such positive effects are found in Skagerrak/Kattegat, but the extent is not possible to estimate based on current knowledge.

The marginally longer mileage for shipping through the Southern Bothnian Sea as a result of the marine spatial plans' guidance on energy extraction is expected to lead to marginally increased underwater noise and marginally higher levels of pollutants from operational emissions. These pressures are considered to have a marginal negative effect on pelagic fish species. Adaptation of fisheries and also shipping to energy areas elsewhere may have similar effects, but these cannot be predicted at present.

On the other hand, re-routing of shipping in the two investigation areas Salvorev and Hoburg Bank in the northern and south-eastern Baltic Seas is considered to have little positive impact on marine life, including fish.

### 6.1.3. Seabirds

*Current environmental status*

The environmental status of nesting and wintering seabirds varies between both species groups and sea areas (D1C2, D4C1). For example, good environmental status is achieved for breeding birds in the species groups surface foraging and pelagic foraging, but not for benthic foraging. For the species group wintering birds, good environmental status is reached for benthic foraging in Skagerrak/Kattegat and for pelagic foraging in the Baltic Sea. The pressures affecting seabirds vary between species groups, but by-catch in fisheries, direct disturbance by human pressure, and hazardous substances are the pressures considered to have the greatest impact (Swedish Agency for Marine and Water Management, 2023c).

*Effects of marine spatial plans*

The plan proposal is considered to entail a medium risk of negative effects on birds. The overall assessment against the relevant MSFD descriptors is shown in the table below.

Table 40. Overall assessment for birds. HMD: Marine Environment Directive, RDV: Water Framework Directive.

| **Bird** | | **Gulf of Bothnia** | **Baltic Sea** | **Skagerrak/Kattegat** |
|---|---|---|---|---|
| **HMD** | D1C2<br>*Impact on population* | Medium negative impact | No effect | Medium negative impact |
| **HMD** | D4C1<br>*Impact on the diversity of the trophic group* | Medium negative impact | No effect | Medium negative impact |
| **RDV** | No relevant basis of assessment | No assessment | No assessment | No assessment |

Several energy areas are located in the vicinity of migratory corridors used by large numbers of individuals of different bird species. Several of these bird migration routes are of global importance. Energy areas in so-called bottlenecks pose particularly high risks, not only for seabirds, but also for land birds and bats seeking the shortest possible passage across the sea. The marine spatial plan also provides guidance on energy extraction in or adjacent to wintering areas for bird species worthy of protection, as is the case for the offshore embankments of the Southern Bothnian Sea and southern Kattegat. In addition to these, a few energy areas close to the coast are proposed, posing a particular risk to birds breeding, feeding or stretching along the coast.

In a number of other energy areas, the risk of impact on birds is considered to be low. Usually these are areas at greater depths further out to sea and at greater distances from migratory routes.

In some areas, it is considered that the risk of adverse effects on birds can be minimised by adapting the operation of wind farms to the wind and weather conditions or the presence of birds. Special risk of cumulative adverse effects on birds exists for areas B149, B152, B156, they have therefore been designated as investigation areas. The risk of impacts from offshore wind should be seen in the context of the downward trend of several seabird populations, as well as in the context of the surge of offshore wind energy in many areas and also many other countries that concern the same bird population.

### 6.1.4. Marine mammals

*Current environmental status*

None of the three harbour porpoise populations achieves good status according to the latest assessment (Swedish Agency for Marine and Water Management, 2023c). The main pressure on harbour porpoises is by-catch by fishing, mainly fishing with nets but also pelagic trawling. For the Belt Sea population, the annual by-catch exceeded the threshold for the indicator (D1C1) ten times and for Skagerrak/Kattegat population four times over the assessment period. As the Baltic Sea population is classified as endangered according to the Swedish Red List, the threshold for by-catch has been set at zero individuals, which has also been exceeded during the assessment period. Skagerrak/Kattegat population meets the population size threshold (D1C2), but neither the Baltic Sea population nor the Belt Sea population.

None of the three seal species or their populations achieve good status in their respective assessment areas. This is partly due to the fact that population growth, a parameter included in indicator D1C2, has slowed compared to the previous assessment period. Gestation frequency and thickness of blubber (included in indicator D1C3) are only assessed for grey seals, but do not meet their threshold values. In terms of distribution (D1C4), none of the seal species or populations achieve good status. The pressures that have the greatest direct impact on the condition of seals are the by-catch and hunting of fisheries.

*Effects of marine spatial plans*

In total, marine spatial plans are assessed to have mixed effects on marine mammals. Some negative effects mainly concern harbour porpoises in Skagerrak/Kattegat and seals in the Gulf of Bothnia. Guidance on particular consideration for high nature values can have a small positive effect. The impact on seals is not considered significant. The overall assessment against the relevant MSFD descriptors is shown in the table below.

Table 41. Overall assessment for marine mammals. HMD: Marine Environment Directive, RDV: Water Framework Directive. (*) Associated indicator concerns by-catch of harbour porpoises; (**) Related indicators relate to the gestation rate and the blubber thickness of grey seals; (***) Related indicators relate to the distribution of grey seals, harbour seals and ringed seals; (****) Associated indicators refer to abundance and trends of grey, harbour and ringed seals).

| **Marine mammals** | | **Gulf of Bothnia** | **Baltic Sea** | **Skagerrak/Kattegat** |
|---|---|---|---|---|
| **HMD** | D1C1*<br>*Mortality due to by-catch* | No effect | No effect | No effect |
| **HMD** | D1C2<br>*Impact on population* | Medium negative impact | No effect | Medium negative impact |
| **HMD** | D1C3**<br>*Demographic characteristics of the population* | No effect | No effect | No effect |
| **HMD** | D1C4***<br>*Species distribution* | No effect | No effect | No effect |
| **HMD** | D4C1****<br>*Impact on the diversity of the trophic group* | No effect | No effect | No effect |
| **RDV** | No relevant basis of assessment | No assessment | No assessment | No assessment |

The positive effects related to descriptor D1C1 are due to reduced mortality in by-catch or physical disturbance from fishing and defence activities in areas where the marine spatial plan gives particular consideration to high nature values. The effect is assumed to be slightly greater for harbour porpoises than for seals. Assumptions made for these areas concern the application of by-catch minimisation methods and gear in trawl and gillnet fisheries, as well as greater adaptation of defence exercises during biologically sensitive periods for mammals.

Consideration can also be given to establishing offshore wind power so that the risk of negative impact on most marine mammal populations can be kept within acceptable levels.

Furthermore, the guidance provided by the marine spatial plans is not considered to make any difference for factors affecting the abundance or distribution of seals.

### 6.1.5. Benthic habitats

*Current environmental status*

The integrity of the seabed in Swedish marine areas is not considered to achieve good environmental status in a number of assessment areas. The results vary between different habitat types, but generally it can be said that the status is better in the sea areas that are part of the Gulf of Bothnia (Åland Sea, Bothnian Sea, North Kvarken, Bothnian Bay), compared to the Baltic Sea and Skagerrak/Kattegat. The main contributing factor to physical disturbance in the lake is bottom trawling, but oxygen deficiency due to eutrophication also affects the status of benthic habitats (Swedish Agency for Marine and Water Management, 2024a).

*Effects of marine spatial plans*

The overall impact on benthic habitats is assessed as small positive. The overall assessment against the relevant MSFD descriptors is shown in the table below.

Table 42. Overall assessment for benthic habitats. HMD: Marine Environment Directive, RDV: Water Framework Directive. (*) Relevant indicators include bottom fauna in coastal waters (5.8A) and bottom fauna in offshore waters (5.8B).

| **Benthic habitats** | | **Gulf of Bothnia** | **Baltic Sea** | **Skagerrak/Kattegat** |
|---|---|---|---|---|
| **HMD** | D6C3<br>*Extent of physical disturbance in benthic habitats* | Marginal negative effect | No effect | Potential for both negative and positive local impacts |
| **HMD** | D6C5*<br>*Extent of adverse effects of human pressures* | Marginal negative effect | No effect | Potential for both negative and positive local impact |
| **RDV** | Morphological status of coastal and transitional waters | No effect | No effect | No effect |
| **RDV** | Macroalgae and angiosperms in coastal waters | No effect | No effect | No effect |

The establishment of wind power has a permanent local impact on the seabed. Wind energy foundations and erosion protection can at the same time contribute to new habitats for certain bottom-dwelling organisms. The seabed area covered by foundations and erosion protection generally amounts to less than one percent of the total area of a wind farm. In cases where energy areas in Skagerrak/Kattegat replace bottom trawling as a use, positive net local effects may arise from a bottom pressure perspective. The effect is positive if fishing is concentrated in areas outside the energy areas as the total bottom-pressured area is likely to decrease.

Moving the marine routes to deeper waters in the Southern Bothnian Sea and in connection with the distribution areas in the Baltic Sea may also lead to a slightly reduced impact on shallower benthic habitats according to the modelling in the Swedish Agency for Marine and Water Management (2019a).

Locally significant negative effects are expected to occur in the proposed sand extraction areas in the Bothnian Bay, as well as in the southwestern and southern Baltic Seas. The areas are located below the photic zone, and the extraction activity is not considered to have any negative effects on bottom-dwelling plants. The effects on benthic fauna, on the other hand, are considered to be very negative due to the withdrawal of large amounts of sediment and the re-sedimentation of stirred sediment in the immediate area. Despite large local negative effects on benthic habitats, the effects of sand extraction activities are geographically limited, and very small in relation to the area of sandbanks in the marine spatial planning areas. However, there is a risk of permanent physical disturbance, which could contravene EQS D.1 and D.3. The risk needs to be further investigated within the framework of permit procedures.

The impact on protected bottom types needs to be further investigated in the context of permit assessment processes in order to avoid harm.

### 6.1.6. Hydrographic conditions

*Current environmental status*

At present, there are no nationally agreed indicators with threshold values for assessing hydrographic conditions. However, a qualitative assessment indicates that current large-scale infrastructure does not result in any significant impact in Swedish offshore waters (Swedish Agency for Marine and Water Management, 2023).

*Effects of marine spatial plans*

In total, the marine spatial plans are expected to lead to an increased risk of some negative effect on hydrographic conditions within the plan area. The magnitude of the effect is uncertain. The overall assessment against the relevant MSFD descriptors is shown in the table below.

Table 43. Overall assessment for hydrographic conditions. HMD: Marine Environment Directive, RDV: Water Framework Directive.

| **Hydrographic conditions** | | **Gulf of Bothnia** | **Baltic Sea** | **Skagerrak/Kattegat** |
|---|---|---|---|---|
| **HMD** | D7<br>*Persistent changes in hydrographic conditions* | Risk of some negative impact | No effect | Risk of some negative impact |
| **RDV** | Hydromorphological quality elements in coastal and transitional waters<br>• Connectivity | Risk of some negative impact | No effect | Risk of some negative impact |

| | | | | |
|---|---|---|---|---|
| | • Hydrographic conditions | | | |
| **RDV** | Physicochemical quality elements in coastal and transitional waters<br>• Depth of vision<br>• Nutrients<br>• Oxygen balance<br>• Particularly polluting substances | Risk of some negative impact | No effect | Risk of some negative impact |

The establishment of offshore wind energy according to the marine spatial plans' guidance on energy extraction could entail the risk of regional changes in hydrographic conditions in all three marine spatial plans. Preliminary results of modelling studies in Swedish waters indicate possible changes in wind and current conditions, with consequences for stratification, temperature and salinity in the sea and coastal zone. The magnitude of this effect and consequential effects for physicochemical conditions are currently unclear. The Swedish Agency for Marine and Water Management has commissioned SMHI to study hydrographic effects linked to offshore wind power. The results show that large-scale expansion of offshore wind power can lead to sequential effects in the marine environment due to reduced winds behind the wind turbines, which in turn leads to reduced vertical mixing of the water. In the Baltic Sea, this could lead to a shallower halocline, as well as increased salinity and temperatures in the deep water (Arneborg et al., 2024). See Section 2.3.1.

### 6.1.7. Underwater noise

*Current environmental status*

Good environmental status is reached for impulsive underwater sounds in Skagerrak, Kattegat, the Bothnian Sea, North Kvarken and the Bothnian Bay. Impulsive sound sources include, for example, underwater explosions, construction works, sonars and sonars used by the military, as well as acoustic scares for seals used in commercial fishing. For continuous underwater noise, good environmental status is reached only in the Bothnian Sea, North Kvarken and Bothnian Bay. In these three sea basins, shipping is less intense than in other sea basins, which is the dominant source of continuous noise in Swedish sea areas (Swedish Agency for Marine and Water Management, 2023c).

*Effects of marine spatial plans*

In total, marine spatial plans are estimated to have a marginal negative effect on underwater noise within marine spatial plans. The overall assessment against the relevant MSFD descriptors is shown in the table below.

Table 44. Overall assessment for underwater noise. HMD: Marine Environment Directive, RDV: Water Framework Directive.

| **Underwater noise D11** | | **Gulf of Bothnia** | **Baltic** | **Skagerrak/Kattegat** |
|---|---|---|---|---|
| **HMD** | *Impulsive underwater noise D11C1* | Small negative impact | No effect | Small negative impact |

| | | | | |
|---|---|---|---|---|
| | Continuous underwater noise D11C2 | Small negative impact | No effect | Small negative impact |
| **RDV** | No relevant basis of assessment | No assessment | No assessment | No assessment |

Assumptions of reduced impact from fishing and defence activities in areas where marine spatial plans provide guidance on particular consideration for high nature values are considered to lead to reduced underwater noise in these areas. The possible transfer of the shipping route south of Gotland to deeper waters is also expected to reduce the noise level from shipping locally.

Wind power expansion is expected to increase underwater noise in a number of areas. Wind turbines generate both impulsive noise during the construction phase and continuous noise during the operation phase. There are currently uncertainties in estimating the impact of both impulsive noise and continuous noise, as there are no plants in operation in the size planned for. The basis that exists consists of sound modelling. Research projects are ongoing to investigate the noise impact of large offshore wind farms (Swedish Environmental Protection Agency, 2024). The effects of impulsive underwater noise are serious because high noise levels can damage marine organisms and lead to behavioural change, hearing damage and death as a result of excessive exposure. However, impulsive noise is transient and affects the marine environment for a limited time. The effects of continuous noise during the operational phase are less severe, although there are some uncertainties linked to cumulative pressures.

With noise abatement measures and other local consideration measures, it is possible to limit the input of impulsive noise during construction and decommissioning of wind farms. There are still uncertainties regarding direct applicability. Precise consideration measures and conditions need to be specified for each area within the framework of the permit assessment. The extensive deployment of offshore wind power according to the guidance provided by the marine spatial plans is considered to lead to a change in soundscape in several areas even during the operational phase, with an average higher noise level. Knowledge of long-term biological and ecological effects of an elevated noise level for marine ecosystems and organisms is currently inadequate, there are also no studies for cumulative noise effects from several wind farms.

### 6.1.8. Alien species

The environmental status of non-indigenous species is based on the number of registered new non-indigenous species, good environmental status is achieved neither in Skagerrak/Kattegat nor in the Baltic Sea as new species have been introduced in both sea basins during the 2016-2021 assessment period. Sources of dispersal of non-indigenous species are vessel traffic, either from ballast water or fouling on ship hulls, as well as through aquaculture and regional stock movements (Sea and Water Authority, 2023). Offshore wind energy has the potential to contribute to the spread of alien species by acting as ‘stepping stones’ (Bergström et al., 2022). This means that the hard substrates offer suitable habitats for alien organisms that can establish themselves more quickly with the help of the habitats.

Table 45. Overall assessment for non-indigenous species.

| Alien species D2 | | Gulf of Bothnia | Baltic | Skagerrak/Kattegat |
|---|---|---|---|---|
| **HMD** | *Introduction of alien species* D2C1 | No assessment | No effect | Risk of some negative impact |

### 6.1.9. Other effects

The marine spatial plans are not considered to have significant effects on MSFD descriptors, D5 – eutrophication, D8 – concentration and effects of hazardous substances and D10 – marine litter.

## 6.2. Fulfilment of Sweden's environmental quality objectives

This section presents the analysis of how the proposed revised marine spatial plans can contribute to the achievement of Sweden's environmental objectives. The results are summarised in the table below and described in text below for the five objectives to which the marine spatial plans are considered to contribute.

Table 46. Summary of the contribution of marine spatial plans to the achievement of Sweden's environmental objectives.

| Environmental objectives | The possibility for the marine spatial plan to have an impact |
|---|---|
| **Limited climate impact** | By guiding on suitable areas for the extraction of fossil-free energy. |
| **Fresh air** | By guiding on suitable areas for renewable energy extraction.<br>By guiding on the spatial distribution of boat and ship traffic and associated air emissions in relation to communities and nature. |
| **Only natural acidification** | No impact. |
| **Non-toxic environment** | By guiding on the spatial distribution of activities that affect the sea, for example when civil works risk releasing environmental toxins. |
| **Protective ozone layer** | No impact. |
| **Safe radiation environment** | No impact. |
| **No eutrophication** | No impact. |
| **Live lakes and streams** | No impact. |
| **Good quality groundwater** | No impact. |
| **Sea in balance and living coast and archipelago** | By guiding on the precedence and spatial distribution of activities affecting fish and shellfish stocks, and the general ecological status of coastal waters. |
| **Flooding wetlands** | No impact. |
| **Living forest** | No impact. |
| **A rich agricultural landscape** | No impact. |

| Environmental objectives | The possibility for the marine spatial plan to have an impact |
|---|---|
| **Magnificent mountain environment** | No impact. |
| **Good built environment** | Because the landscape can be affected by wind power installations. |
| **Rich plant and animal life** | By guiding on the primacy and spatial distribution of areas for nature conservation, and of activities that affect the conservation status of different habitat types and species, and the accessibility of man-made natural and cultural environments. |

With regard to the *'Limited climate impact'* objective, the contributions of marine spatial plans relate primarily to climate-impacting emissions. The marine spatial plans are expected to have a positive effect by creating better conditions for a significantly increased establishment of offshore wind power in the Swedish territorial sea and Swedish exclusive economic zone. The guidance on energy extraction is considered to be able to facilitate permit-granting processes and thereby increase the rate of offshore renewable energy extraction. To the extent that electricity production from offshore wind power replaces fossil-based energy sources, the marine spatial plans are considered to be able to contribute to reducing Sweden's greenhouse gas emissions.

By guiding on suitable areas for renewable energy extraction, marine spatial plans are assessed to contribute to fossil-free energy for the industrial and transport transition and the reduction of air pollution from these sectors. Marine spatial plans have a small or marginally negative contribution to the objective *of 'Fresh air',* mainly with regard to levels of harmful air pollutants. The marine spatial plans do not affect which fuels are used in maritime transport, which is the maritime industry that emits the most air pollutants. The guidance on sand extraction as the most appropriate use is considered to contribute to marginally increased emissions in the coastal areas concerned. A corresponding assessment is made of the effects of increased emissions from ship traffic in connection with the construction, operation and decommissioning of offshore wind power. The marine spatial plan is not expected to have a net effect on emissions from fishing boats, despite the fact that the establishment of wind power may lead to changes in fishing operations. At the same time, the establishment of wind power can contribute to less air emissions by replacing fossil-free energy with fossil-based energy, which makes a positive contribution to the target.

The environmental quality objective *Non-toxic environment* is affected by the fact that the marine spatial plans' guidance on the development of sand extraction activities can contribute to an increased risk that environmental toxins are released from the sediment and absorbed by marine organisms, the same applies to piling and construction work for offshore wind power. However, there is currently no evidence that the areas in question have elevated levels of environmental toxins, which is why the risk is considered marginal. Increased small and service boat traffic in connection with guidance on priority use recreation, energy extraction and sand extraction entails a higher risk of operational emissions that affect the environment locally. However, the extent of this effect is difficult to estimate.

The marine spatial plans' contribution to the objective *'Sea in balance and living coasts and archipelagos'* concerns the conservation of natural and cultural heritage values, the promotion of sustainable use and the protection of valuable areas. The proposed energy areas entail an increased risk of disturbance of valuable and in some cases endangered species and habitats in several areas.

At the same time, through guidance on particular consideration for high nature values, the marine spatial plan opens up the possibility of increased protection of habitats and species in significantly more and larger areas. Restrictions on fishing within wind farms, for example, may in some cases also cause less disturbance to marine species. It is also positive that nature use confirms all existing and planned protected areas, national interest claims for nature conservation and fish spawning areas. Guidance on particular consideration for high nature values draws attention to the importance of specific areas for biodiversity, ecosystem integrity and climate change adaptation, which may be the basis for future protection of habitats or species.

Some guidance in marine spatial plans may have an impact on the environmental quality objective '*Good built environment'*. Marine spatial plans provide guidance on the protection of valuable cultural and recreational environments at sea, promoting access to nature and culture. The proposal for a marine spatial plan is considered to entail a risk of negative effects in several coastal landscapes, areas for recreation and cultural environments.

Finally, the contribution of marine spatial plans to the environmental quality objective *A rich flora and fauna* refers to the conservation and use of biodiversity, the conservation of habitats and ecosystems, viable populations, and access to nature and cultural environments. The marine spatial plans guide the deployment of offshore wind energy and sand extraction activities, which pose both biodiversity risks of importance from the local to the international level. At the same time, the plans provide guidance on the protection of specific valuable areas as well as on adaptation needs for maritime activities aimed at preserving biodiversity and ecosystem integrity. Such adaptations may be important for the conservation and recovery of stocks of commercial fish and shellfish species, as well as species affected by by-catch or other disturbance.

## 6.3. **Assessment against other plans, policies and programmes**

According to the Marine Spatial Planning Regulation, proposals for marine spatial plans must be designed in such a way that the plan integrates industrial policy, social and environmental objectives. Within the framework of marine spatial planning, ten planning objectives have been developed to support this integration of policy areas. Overall objectives are good marine environment and sustainable development, as well as a number of thematic and sectoral sub-objectives. All targets relate differently to national policies and strategies. The starting point for the assessment of the plan proposal is therefore based on the planning objectives, set in relation to the *national strategy for sustainable regional development throughout the country 2021 - 2030* (Government, 2021b).

Regional development policy is part of Sweden's implementation of the Sustainable Development Goals Agenda 2030. The 2030 Agenda's goals and targets are integrated and indivisible and cover all three dimensions of sustainable development: economic, social and environmental. The goal of regional development policy is developmental power with strengthened local and regional competitiveness for sustainable development in all parts of the country. The strategy for regional development states that the policy should promote a better environment, reduce climate impact and promote energy transition. In addition, the policy will promote sustainable structural change and the development of the business sector. Regional development policy shall promote the conditions for conducting long-term sustainable development work and contribute to ensuring that Sweden has no net emissions of greenhouse gases by 2045. All policy areas are relevant for achieving the objectives set out in the strategy (Government, 2021b).

The table below shows how the marine spatial plans are considered to contribute to priorities in the national strategy for regional development. The table also analyses in an overall way how this relates to national interests and the impact of marine spatial plans on national interests and various types of policy documents.

National interests are geographical areas that have been identified as nationally significant. Proposals for marine spatial plans shall be compatible with provisions for the management of land and water areas and national interests under Chapters 3 and 4 of the Environmental Code. The marine spatial plan's guidance is based on planning data and various national interests and trade-offs between them. When balancing interests, coexistence shall be sought and in the event of conflicting interests, it shall be planned and ensured that national interests are not significantly impaired or harmed.

Table 47. The impact of marine spatial plans on national strategy priorities for regional development, related to marine spatial planning objectives and governance documents.

| National strategy for regional development – priority | Marine spatial planning objectives | The possibility for the marine spatial plan to influence and contribute to the strategy | National interests and policy documents | Marine spatial plans' guidance in relation to national interest claims |
|---|---|---|---|---|
| **Equal opportunities for housing, work and welfare throughout the country**<br>***- High quality of life with good and attractive habitats*** | *Create the conditions for:*<br>• Regional development, outdoor activities and preservation of cultural values<br>• Marine green infrastructure and promotion of ecosystem services | By guiding on areas of use nature, recreation and cultural environment, as well as consideration and adaptation for natural and cultural landscapes, the marine spatial plan affects the strategy's priority related to promoting natural and cultural landscapes, living in nature, the right of public access and recreation.<br><br>According to the strategy, green and blue surfaces also contribute to improved public health and quality of life. | National interests under Chapter 3 of the Environmental Code:<br>• Outdoor activities<br>• Conservation of cultural heritage<br>• Nature conservation<br><br>*Examples related policy documents*<br>Cultural policy objectives<br>- Recreational objectives<br>- Public health policy objectives<br>- Species and Habitats Directive<br>- Marine strategy (Follow-up, indicator 8, 9) | The marine spatial plans' guidance on the use of recreation and cultural environment and particular consideration for high cultural values promotes recreation and cultural environmental values along the coast, but also within the marine spatial plan areas. Values can be affected by marine uses, in particular energy extraction, to varying degrees depending on location and design. The impact and need for adaptation to promote coexistence need to be assessed from a regional and local perspective. |
| **Equal opportunities for housing, work and welfare throughout the country**<br>***- Good urban planning*** | *Create the conditions for:*<br>• Regional development, outdoor activities and preservation of cultural values<br>• Energy transmission and renewable energy extraction in the oceans | Through the plan's guidance on energy areas, as well as the use of nature and particular consideration for high nature values, the marine spatial plan affects the strategy's priority of promoting a social structure that contributes to sustainable habitats, | National interests under Chapter 3 of the Environmental Code:<br>• Installations for the production and distribution of electricity<br>• Nature conservation<br>*Examples of related policy documents:*<br>- Energy policy objectives | The marine spatial plans provide guidance on energy extraction for more extensive areas than today's national interest in energy production. The guidance on nature use and particular consideration for high nature values is more |

| National strategy for regional development – priority | Marine spatial planning objectives | The possibility for the marine spatial plan to influence and contribute to the strategy | National interests and policy documents | Marine spatial plans' guidance in relation to national interest claims |
|---|---|---|---|---|
| | • Marine green infrastructure and promotion of ecosystem services | reduced climate impact, as well as the conservation of biodiversity and ecosystem services in a changing climate. | - Biodiversity Strategy<br>- EU renewable energy strategy<br>- EU Blue Economy Strategy<br>- EU Strategy for the Baltic Sea Region<br>- Maritime strategy (Follow-up, indicator 3, 8, 9, 16) | extensive than areas of national interest for nature conservation.<br><br>The impact between these uses is described in the previous section and environmental description. |
| **Equal opportunities for housing, work and welfare throughout the country**<br>***- Good urban planning*** | *Create the conditions for:*<br>• Regional development, outdoor activities and preservation of cultural values<br>• Defence and security | Affects prioritization by ensuring that the interests of defence are taken into account. | National interests under Chapter 3 of the Environmental Code:<br>• Defence<br>*Examples related policy documents*<br>- Security policy objectives | Open national interest claims for defence are specified as use defence in marine spatial plans. Particular consideration shall be given to the interests of defence in certain areas of energy production. Further adjustments have also been made based on the interests of the defence. |
| **Innovation and renewal as well as entrepreneurship and entrepreneurship across the country**<br>***– A competitive, circular and bio-based, climate and environmental sustainable economy*** | *Create the conditions for:*<br>• Regional development, outdoor activities and preservation of cultural values<br>• Energy transmission and renewable energy extraction in the oceans<br>*Prepare for:*<br>• Mining and storage of carbon dioxide | The plan's guidance on energy contributes to the strategy's priority on the deployment, production and use of renewable energy, which is important for regional energy supply and sustainable regional development.<br><br>It is unclear how the plan's guidance on sand extraction affects the strategy's priorities. | National interests in accordance with Chapter 3, Section 4 of the Environmental Code:<br>• Installations for the production and distribution of electricity<br>*Related policy documents:*<br>- Energy policy objectives<br>- EU renewable energy strategy<br>- EU Blue Economy Strategy<br>- EU Strategy for the Baltic Sea Region<br>- Maritime strategy (Follow-up, indicator 16) | The marine spatial plans provide guidance on energy extraction for more extensive areas than today's national interest in energy production. However, several areas considered to be public interests of substantial importance for energy extraction are listed as any other use on the basis of incompatible interests. |
| **Innovation and renewal as well as entrepreneurship and entrepreneurship across the country**<br>***– A competitive, circular and bio-based, climate and environmental sustainable economy*** | *Create the conditions for:*<br>• Regional development, outdoor activities and preservation of cultural values<br>• Sustainable commercial fishing<br><br>*Prepare for:*<br>• Future establishment of sustainable aquaculture | Through the plan's guidance on the use of commercial fisheries, including consideration guidance, the plan also impacts prioritisation on a competitive, circular and bio-based, climate-sustainable economy. In the case of aquaculture, the plan does not yet provide guidance on this. | National interests in accordance with Chapter 3, Section 4 of the Environmental Code:<br>• Commercial fishing<br>*Related policy documents:*<br>- Fisheries of the future<br>- EU Common Fisheries Policy<br>- EU Blue Economy Strategy<br>- EU Strategy for the Baltic Sea Region<br>- Maritime strategy (Follow-up, indicator 3, 17, 18) | The marine spatial plans' guidance on energy extraction has a negative impact on commercial fishing by limiting fishing opportunities, including in areas of national interest. Guidance on nature use and particular consideration for high nature values, possibly including energy areas, can have positive effects on the fish resource, thereby favouring sustainable fishing in the longer term. |
| **Accessibility throughout the country through** | *Create the conditions for:* | The plan's guidance on shipping affects the prioritisation based on | National interests under Chapter 3 of the Environmental Code: | The marine spatial plans provide guidance on the use of |

| National strategy for regional development – priority | Marine spatial planning objectives | The possibility for the marine spatial plan to influence and contribute to the strategy | National interests and policy documents | Marine spatial plans' guidance in relation to national interest claims |
|---|---|---|---|---|
| **digital communication and the transport system – *Accessibility through sustainable transport systems*** | • Sustainable shipping<br>• Create conditions for good accessibility | maritime transport supply, significant for people and business across the country. Prioritisation also highlights the importance of coordination between activities and transport infrastructure at local, regional and national level. | • Shipping<br><br>*Related strategies:*<br>- Transport policy objectives<br>- Regional plans<br>- EU Strategy for the Baltic Sea Region<br>- Maritime strategy (Follow-up, indicator 10, 14, 15) | shipping for most areas of national interest for shipping, or that the function of the claim can be met in the immediate area. Areas with energy extraction have a potential impact of varying degrees on shipping. The need for site-specific adaptations to promote coexistence with shipping is assessed for each energy area in the permit process. |

## 6.4. Assessment of the impact of the marine spatial plan on ecosystem services

Ecosystem services are the functions and processes in nature that benefit human interests. These services are divided into supportive, regulatory, supportive and cultural. The following is based on data produced by WSP (Paulsson et al., 2024) on behalf of the Swedish Agency for Marine and Water Management. Assessment of the impact on ecosystem services is only done for the Gulf of Bothnia and Skagerrak/Kattegat, as the differences in the Baltic Sea are small compared to the already adopted marine spatial plan from 2022.

### 6.4.1. Supportive ecosystem services

Supportive ecosystem services are about the basic conditions for other ecosystem services to function and thus have an indirect function. Increased expansion of energy production can have both positive and negative impacts on supporting ecosystem services related to habitats, biodiversity and population regulation. Which ecosystem services are affected and to what extent depends on whether the wind turbines are built, operated or decommissioned, and whether protective measures are taken. Impacts can take the form of noise, turbidity, bottom impact and the creation of artificial reefs. Marine spatial planning areas have different conditions through which the impact level shifts. For example, the Gulf of Bothnia is more sensitive to changes as the area has a lower biodiversity than Skagerrak/Kattegat. The higher degree of biodiversity in Skagerrak/Kattegat entails a greater risk of negative bottom impact and where a higher degree of bottom trawling already constitutes an impact. Provided that fishing is not moved to new areas, the energy areas could thus have a positive effect on benthic habitats. The plan is indicative and areas where consideration is to be given to natural and cultural environments do not provide formal protection but can be assumed to have positive but small effects on habitats and diversity.

### 6.4.2. Regulating ecosystem services

Regulating ecosystem services regulate and maintain the functions of ecosystems. Offshore wind power can generate negative as well as positive effects. The impact occurs through the physical structure of the wind turbines and by contributing with renewable electricity production, where the size of the effect depends on which energy sources are replaced. Energy extraction has a positive effect by contributing to fossil-free electricity production and thereby reducing the pressure on the climate-regulating ecosystem services that absorb carbon dioxide through carbon sequestration. Furthermore, the physical structure of wind turbines can attract marine species that contribute to carbon sequestration. As there is a risk that these species may be invasive, it could also have a negative effect on the regulation of biological conditions. Negative impact could also come from the increased emissions that can be expected from the transport that construction and maintenance of the wind farms generate. However, this depends on how the development of fuel in this type of transport will look like. Areas where nature is to be taken into account are expected to have small but positive effects on regulatory ecosystem services.

### 6.4.3. Supplying ecosystem services

Sufficient ecosystem services provide human beings with food and materials. In Skagerrak/Kattegat, it is reasonable to assume that ecosystem services relevant for commercial and recreational fishing are adversely affected to a greater extent than in the Gulf of Bothnia. This is due to the fact that the fishing carried out in the area is more extensive and more difficult to coexist with the wind farms.

### 6.4.4. Cultural ecosystem services

Cultural ecosystem services are services that enable well-being. The ecosystem service can be different qualities in the environment that generate experience values, for example in the form of recreation, spirituality or knowledge building. When it comes to the effects of wind power on cultural ecosystem services, it is primarily the visual impression that affects. However, since the experience is subjective, it is difficult to assess whether it is a positive or negative effect because different people have different perceptions. The plan is indicative and areas where consideration is to be given to natural and cultural environments do not provide formal protection but can be assumed to have positive effects on cultural ecosystem services.

## 6.4.5. Gulf of Bothnia

Table 48. Shows an overview of how the guidance in the marine spatial plan affects ecosystem services.

| Ecosystem service | Impact on ecosystem services through the use of Energy | The benefits of the ecosystem service for human interests | Other uses/ particular consideration that may affect the ecosystem service | Interests Affected by Changing Ecosystem Services |
|---|---|---|---|---|
| ***Supporting***<br><br>Provision of habitats, species diversity and genetic diversity<br><br>Regulation of populations by predators or predators | ***Small positive***<br>Restricted fishing leads to stronger stocks in the long term<br><br>New habitats;<br><br>***Small negative***<br>Bottom impact, turbidity and noise<br><br>Impact on marine mammals, birds and bats | A prerequisite for the functioning of other ecosystem services | ***Positive***<br>Nature<br>n-areas<br>Cultural environment<br>K Areas<br><br>***Negative***<br>Sand extraction<br>Commercial fishing | Recreation<br><br>Commercial fishing |
| ***Regulatory***<br><br>Carbon sequestration<br><br>Regulation of Pests and Pest Plants<br><br>Maintenance of nurseries and nursery environments<br><br>Filtering of microorganisms, algae, plants and animals | ***Medium positive***<br>Reduced load on carbon sequestration<br><br>***Small positive***<br>New habitats<br><br>***Medium negative***<br>Bottom impact, turbidity and noise<br><br>***Small negative***<br>Risk of favouring invasive species | Reducing the impact of climate change.<br><br>Balanced ecosystems<br><br>Contribution to providing ecosystem services | ***Positive***<br>Nature<br>n-areas<br><br>***Negative***<br>Sand extraction<br>Commercial fishing | Recreation<br><br>Commercial fishing |
| ***Sufficient***<br><br>Food from wild animals<br><br>Wild animals for direct use or processing | ***Small negative***<br>Possibility of fishing restricted | Food for sale or household needs | ***Positive***<br>Recreation<br>Commercial fishing<br><br>***Negative***<br>Recreation<br>Commercial fishing | Recreation<br><br>Commercial fishing |
| ***Cultural***<br><br>provision of endangered species, habitats and ecosystem processes; attractive recreational environments; areas with varied wildlife and interesting vegetation; areas of scientific interest and learning | ***Small positive***<br>Recreational fishing<br><br>Wind turbines can be viewed positively.<br><br>Artificial reefs that create learning environments<br><br>***Medium negative***<br>Visual impact.<br><br>***Small negative***<br>Opportunities for recreation | Well-being<br><br>Knowledge building | ***Positive***<br>Nature<br>n-areas<br>Cultural environment<br>K Areas | Recreation |

### 6.4.6. Skagerrak/Kattegat

Table 49. Shows an overview of how the guidance in the marine spatial plan affects ecosystem services.

| Ecosystem service | Impact on ecosystem services through the use of Energy | The benefits of the ecosystem service for human interests | Other uses/ particular consideration that may affect the ecosystem service | Interests Affected by Changing Ecosystem Services |
|---|---|---|---|---|
| ***Supporting***<br><br>Provision of habitats, species diversity and genetic diversity<br><br>Regulation of populations by predators or predators | ***Medium positive***<br>New habitats;<br><br>***Small positive***<br>Restricted fishing leads to stronger stocks in the long term<br><br>***Medium negative***<br>Impact on marine mammals, birds and bats<br><br>Bottom impact, turbidity and noise | A prerequisite for other EST function | ***Positive***<br>Nature<br>n-areas<br>K Areas | Recreation<br><br>Commercial fishing |
| ***Regulatory***<br><br>Carbon sequestration<br><br>Regulation of<br>pests<br>and harmful plants<br><br>Maintenance of nurseries and nursery environments<br><br>Filtration of micro-organisms; algae, plants and animals | ***Small positive***<br>Reduced pressure on carbon sequestration<br><br>New habitats<br><br>***Medium negative***<br>Bottom impact, turbidity and noise<br><br>***Small negative***<br>Risk of favouring invasive species | Reducing the impact of climate change<br><br>Balanced ecosystems<br><br>Contribution to providing ecosystem services | ***Positive***<br>Nature<br>n-areas<br><br>***Negative***<br>Commercial fishing | Recreation<br><br>Commercial fishing |
| ***Sufficient***<br><br>Food from wild animals<br><br>Wild animals for direct use or processing | ***Medium negative***<br>Possibility of fishing restricted | Food for sale or household needs | ***Positive***<br>Recreation<br>Commercial fishing<br><br>***Negative***<br>Recreation<br>Commercial fishing | Recreation<br><br>Commercial fishing |
| ***Cultural***<br><br>provision of endangered species, habitats and ecosystem processes; attractive recreational environments; areas with varied wildlife and interesting vegetation; areas of scientific interest and learning | ***Small positive***<br>Recreational fishing<br><br>Wind turbines can be viewed positively.<br><br>Artificial reefs that create learning environments<br><br>***Medium negative***<br>Visual impact.<br><br>Opportunities for recreation | Well-being<br><br>Knowledge building | ***Positive***<br>Nature<br>n-areas<br>K Areas | Recreation |

# 7. Measures, follow-up and monitoring

Under Chapter 6, Section 11 (5 and 7) of the Environmental Code, an environmental impact assessment must contain information on the measures planned to prevent, deter, counteract or remedy significant adverse environmental effects, as well as an account of the measures planned to follow-up and monitor the significant environmental effects that the implementation of the plan or programme entails. This section presents proposals for both impact minimisation measures and follow-up and monitoring measures. Consideration proposals are also presented in chapter two linked to specific assessment criteria.

Within the framework of the environmental impact assessment of the adopted marine spatial plan, measures for the significant environmental effects that the marine spatial plan proposal was considered to give rise to were analysed and described in detail (Swedish Agency for Marine and Water Management, 2019a). The analysis was then synchronised with the development of a new programme of measures under the Marine Strategy Framework Directive and the implementation of the Marine Strategy Framework Regulation. As the guidance in the current proposal for amended marine spatial plans on most uses does not differ from the guidance in the agreed plans, that analysis and the description of measures made in 2019 are still valid today. These measures are reproduced in Annex A. During 2023 - 2024, work is underway at the Agency to update the action programme for the marine environment, and there is a need to continue to have more interaction between the marine spatial planning process and the results of the assessment of the marine environment and related action work.

The new proposal for amended marine spatial plans has a particular focus on the deployment of offshore wind energy. Thus, the main objective of the present review procedure is to identify the energy areas which, from an overall perspective, are most suitable to proceed to the final marine spatial plan. Against this background, it is appropriate in the present impact assessment to look more closely at measures that specifically address the effects of offshore wind energy on the environment and other human activities. The impact assessment is at a horizontal, strategic level and is therefore not suitable for identifying specific consideration measures for individual areas or projects. The analysis is therefore based on five main types of measures and draws on the results of the assessments in the previous chapter to illustrate which effects these types of measures are suitable for. Types of actions are 1. Location, 2. The boundaries of the energy sector, 3. Wind farm design, 4. Technology choices for construction, operation and decommissioning, and 5. improvement measures; As a rule, planning concerns only the first two types of measures, while types 1 to 4 are often subject to authorisation. Improving measures have so far been mostly developed by wind energy companies on a voluntary basis, but requirements for the introduction of such measures have started to be imposed by some countries.

## 7.1. Location

The choice of location is a first and in many cases crucial step in assessing the suitability of an energy area, both for its economic viability and for its environmental impact. Localisation is also a fundamental assessment factor in the admissibility assessment of water operations under the Environmental Code. Where assessment results show that a water operation poses too high a risk of unacceptable damage to parts of the marine environment or other human interests, the operation may be denied at the proposed location. Such assessment is currently very difficult to make at a strategic, overall level due to insufficiently detailed knowledge of environmental and socio-economic conditions in all proposed energy areas. Applications for offshore wind power establishment are currently made in accordance with the so-called box model, which means that the final location within a given area is determined later than at the time of the actual permit granting (Energy Authority, 2020). In the current system of indicative marine spatial plans and an “open door” offshore wind establishment system. It is currently not possible to decide on permissibility in a given area solely on the basis of the results of a strategic assessment. Despite these limitations, the results of the impact assessment are considered to provide a valuable indication of locations that are more or less problematic for a given use for further planning. The fact that strategic assessments take into account cumulative effects in a way that individual project assessments rarely do is particularly valuable. On the basis of the results of the present impact assessment, it may, for example, be necessary to exclude areas that are particularly riskful for birds or that threaten other marine life, or entail particularly high losses or risks for other human activities or interests in future planning.

## 7.2. Borders of energy areas

There may be cases where the location of an energy area is generally acceptable, but where some adjustments to its boundaries need to be made to minimise the risk of unacceptable impact on other interests. The location sites unchanged in its main features, but the size of the energy area is adjusted. Within the framework of the ongoing marine spatial planning, such adjustments were made to the energy areas included in the Swedish Energy Agency’s (2023a) stage 1 mandate. However, taking into account the findings of this impact assessment, adaptation of the boundaries of certain energy areas may be justified, inter alia, by the introduction of safety zones around fairways; avoidance of fish spawning areas or disturbance of valuable bottom habitats; reduced visual or physical disturbance of cultural and recreational environments; avoidance of particularly valuable areas for other marine industries, such as fishing.

## 7.3. Wind farm design

This type of measure concerns the internal design of a wind farm. For example, distance between wind turbines, arrangement of wind turbines or introduction of transit corridors. On a more detailed level, the location of each individual wind turbine, so-called “micrositing”, is also included in this type of measure. Micrositing is a permanent part of the wind farm design carried out by the designer and used for environmental protection purposes, among other things, to avoid damage to habitats worthy of protection. Measures of this kind generally aim to promote coexistence with both nature values and other interests. Transit corridors may be introduced, or be part of conditions to facilitate access by fishing vessels to fishing areas beyond the wind farm, or to create more space for staging birds. Disposition and distance between wind turbines play a role, among other things, for the ability to conduct fishing within a wind farm (Swedish Agency for Marine and Water Management & Swedish Energy Agency, 2023) and for the degree of visual impact from different points on the coast.

## 7.4. Technological choices for construction, operation and decommissioning

This type of measure includes many of the consideration measures provided for in permits for the construction of offshore wind energy. The measures are very varied and generally adapted to the specific conditions in the project area and the specific effects that the wind power project is expected to give rise to. The identification of measures of this type thus requires detailed impact assessments. Table 50 below summarises some of the most frequent technical measures regarding environmental impacts used during the different stages of a wind farm (based on the Swedish Agency for Marine and Water Management & Swedish Energy Agency, 2023). Corresponding technical measures may be required to reduce the risk of harm to other human interests. In most cases, the introduction of such measures is made a condition for reducing the impact on the environment and other human interests to acceptable levels in areas that would not otherwise be suitable for wind power. It is common for conditions to be imposed with regard to marine and aviation safety. The aim may also be to enable coexistence. In the case of fishing, for example, the cabling, adaptation of construction work to fishing operations, power plant foundations without protruding to avoid fishing gear can catch examples of other technology choices that can be made. Examples are the cable laying, adaptation of construction work to fishing operations, power plant foundations without protruding parts to avoid that fishing gear can get stuck (Swedish Agency for Marine and Water Management & Swedish Energy Agency, 2023). Coexistence with defence interests is another area where technical adaptation may be relevant.

Table 50. Consideration measures applied in the establishment of offshore wind energy. Based on a compilation prepared for the OSPAR group on offshore renewable energy development, ICG-ORED. Damage mitigation comprises the following four types of actions accordi

| Phase | Type of measure | Description and objectives |
|---|---|---|
| Research and project design | Location | Location and burial of cables in a way to avoid impact on sensitive benthic habitats or species. |
| Research and project design | Design | Selection of materials and equipment with the least possible impact on the environment, such as foundations that do not require piling or drilling or works with greater clearance between rotor blades and the water surface. |
| Research and project design | Scheduling | Conducting surveys outside sensitive periods for species worthy of protection, such as reproduction, foraging and migration periods; |
| Construction and maintenance | Scheduling | Carrying out construction and maintenance work outside sensitive periods for species worthy of protection, such as reproduction, foraging and migration periods; |
| Construction and maintenance | Operational management and control | Emission controls to prevent or reduce various emissions or pressures during civil engineering or maintenance work, such as noise-reducing protective measures when piling foundations. |
| Construction and maintenance | Restoration | Restoration of benthic habitats after completed construction and maintenance work, such as the burial of cables. |

| Phase | Type of measure | Description and objectives |
|---|---|---|
| Construction and operation | Operational management and control | Regulation of obstacle lighting or other lighting in areas where photosensitive species are present; However, there are limitations here in a Swedish context. |
| Construction and operation | Operational management and control | The use of acoustic intimidation techniques in connection with work that causes noise at a level that may be harmful to species worthy of protection; |
| Construction and operation | Operational management and control | Control of emissions of pollutants to water and air which may be harmful to the environment. |
| Construction and operation | Operational management and control | Regulation of boat traffic in connection with construction, servicing and maintenance in order to reduce the impact on species that are sensitive to noise or other human influences. |
| Operation | Operational management and control | Modifications to wind turbines or other parts of the wind farm in order to reduce the risk of collision for birds and bats, such as rotor blade colouring and stop regulation; |
| Operation and decommissioning | Operational management and control | Downtime in the event of unforeseen high environmental impacts in order to implement mitigation or environmental restoration measures; |
| Settlement | Scheduling | Adaptation of the time of decommission or *repowering* to sensitive periods for protected species present in the area, such as reproduction, foraging or migration periods |
| Settlement | Restoration | Restoration of benthic habitats during decommission. |

## 7.5. Improving and nature-based measures

This last type of measures includes measures developed so far mainly by wind energy operators with a view to achieving certain environmental improvements related to the construction of an offshore wind farm. The introduction of environmental improvement measures has mainly taken place on a voluntary basis by wind power operators, but in recent years countries such as the UK and the Netherlands have started to develop conditions for net positive environmental impact, so-called “marine net gain”, and the introduction of nature-inclusive design in offshore wind projects, respectively. Corresponding principles have been developed to create better conditions for other human activities to be carried out within wind farms, such as recreational fishing and other recreation or marine aquaculture. Improvement measures have so far been developed mainly in the framework of pilot projects, but their application is likely to become the standard in the future. As regards the environmental impacts identified in the context of this impact assessment, improvement measures may be appropriate to increase the diversity of demersal habitats and benefit demersal species.

Finally, it is appropriate to mention some areas where the need for new knowledge is intended to be great in order to achieve sustainable use of the marine spatial plans in line with the objectives of the marine spatial plans and Swedish marine governance. The environmental impact assessment of adopted marine spatial plans described five proposals for investigation and coordination areas (Swedish Agency for Marine and Water Management, 2019a): 1. cumulative impacts of offshore wind energy on seabirds; 2. bats and the impact of wind power; 3. area-specific measures in areas with particular consideration to high nature values; 4. diversion of shipping in the South Bothnian Sea; and 5. further development of spatial data on ecosystem services.

In the following paragraphs, three further areas in need of special investigation are discussed: 1. winter navigation and offshore wind power in the Gulf of Bothnia; 2. the impact of offshore wind power on outdoor activities, recreation and the tourism industry; and (3) an offshore wind monitoring programme.

### 7.5.1. Winter navigation and offshore wind power

The problems surrounding the impact of offshore wind power on winter navigation have been described by the Swedish Marine Administration in a memorandum in connection with the task of developing proposals for suitable energy extraction areas for marine spatial planning (Energy Agency, 2023a, Annex 5). In order to be able to assess the impact of marine spatial plans' guidance on energy extraction and for marine spatial planning to be able to guide future use of areas that are ice-covered parts of the year, the state of knowledge on the impact of wind power needs to be improved. There is currently no experience from other countries regarding the establishment of wind power and shipping in areas with similar conditions, which is why it is particularly important to clarify the issue in the Gulf of Bothnia. The large number of energy areas in the marine spatial plan for the Gulf of Bothnia is an important argument behind the investigation.

### 7.5.2. The impact of offshore wind power on outdoor activities, recreation and the tourism industry

Visual impact from offshore wind power is a common argument against wind power establishment. Visual impact can affect the experience of both natural and built environments, and affect the value of outdoor, recreational and cultural environments. However, knowledge of the actual extent of this effect is lacking, both from abroad and in particular from Sweden. At the beginning of 2024, the County Administrative Boards delivered a document identifying coastal cultural environments that are at risk of being affected by offshore wind power. There is currently no similar basis for recreation and outdoor activities. The importance of such an investigation is great given the extensive expansion of offshore wind power along Sweden's coasts that the marine spatial plans guide. Given the lack of knowledge about the actual effects on these two aspects and about sequential effects on the tourism industry, it is currently not possible to make a robust assessment of the effects of wind power establishment in different coastal areas. Within the programme Offshore wind power in coexistence with human environment, research projects are ongoing to investigate the effects of offshore wind power on tourism experiences (Swedish Environmental Protection Agency, 2024a).

### 7.5.3. Offshore wind monitoring programme

The extensive expansion of offshore wind power guided by the marine spatial plans constitutes a significant intervention in the Swedish marine environment. Although offshore wind farms have been in operation for over two decades, knowledge of biological and ecological impacts is still very limited. Within the same research programme mentioned above, a study is ongoing that focuses on the far-reaching effects of the Lillgrund offshore wind farm that has been in operation since 2007, with a particular focus on fisheries and nature conservation (Swedish Environmental Protection Agency, 2024). In the current state of knowledge, there is a particular lack of results on the effects in the long term and across larger geographical areas. Given the large-scale expansion not only in Sweden but also in neighbouring countries, it is precisely these large-scale effects that need to be investigated.

Sweden's marine monitoring programme is insufficient to follow up the various environmental effects of wind power in all areas where offshore wind power may be established. Already today, there are shortcomings in monitoring some of the marine species and habitats that are considered to be most affected by offshore wind power, such as the Baltic Sea harbour porpoise and most migrating bird species. Sweden is not alone in this deficiency, which means that there is relatively little knowledge of long-term, cumulative effects to be drawn from other countries. In addition, the conditions in Sweden's territorial sea and economic zone differ significantly from those in Skagerrak/Kattegat countries, where most of the knowledge about the effects of wind power has so far been produced.

Wind power designers today collect very large amounts of data about the marine environment. As a rule, this information sites private and only the part of the permit documents becomes public. When wind farms are built, the wind power operator is obliged to follow up the environmental effects in accordance with a control programme established by the State. Wind farms are fixed at the same point, and also have direct access to electricity, which means that they would be good measuring stations as a complement to buoys and other marine environmental monitoring. Against this background, the possibilities for cooperation between the State, private wind energy operators and other organisations, including the academia, should be analysed in the context of the design of a future national monitoring programme.

# 8. Methodology

The emphasis of the impact assessment is on estimating the differences in environmental, social and economic impacts between the plan options and the zero alternative (see section 7.1). The impact assessment has applied a mainly semi-quantitative approach, as described below. A quantitative approach is not considered applicable in terms of the overall level of marine spatial plans and the impossibility of setting numerical values for all the different aspects that the plans affect and the effects they entail. The impact of the marine spatial plans is described in relative terms from a change perspective in relation to the zero alternative. In particular, the impact assessment highlights the relative effects that the different energy areas in marine spatial plans can have.

The selection of assessment aspects included in the impact assessment was made on the basis of the requirements in Chapter 6, Section 2 of the Environmental Code for the environmental aspects. The selection of social and economic aspects was made on the basis of the criteria in the sustainability assessment of agreed marine spatial plans (Swedish Agency for Marine and Water Management, 2019b) taking into account the most likely impacts of offshore wind power. In the selection of assessment aspects, comments received by the Swedish Agency for Marine and Water Management during the delimitation consultation of the impact assessment were also taken into account. The table below shows the assessment aspects used in the impact assessment.

Table 51. Assessment aspects used in the impact assessment.

| **Assessment aspect** |
| --- |
| Population and human health |
| Protected animal and plant species and biodiversity: Birds, bats, marine mammals, bottom habitats, fish and spawning areas and high nature values |
| Water and air |
| Climate |
| Landscape |
| Cultural environment |
| Management with land, water and the physical environment, as well as with materials, raw materials and energy |
| Energy extraction – prerequisite, wind and depth conditions |
| Outdoor activities and recreation |
| Tourism industry |
| Defence |
| Maritime transport – accessibility and safety |
| Commercial fishing – landing value |

## 8.1. Population and health

The assessment of impacts on human health is based on aspects identified as relevant in relation to proposed uses in the marine spatial plan, with a focus on impacts and impacts related to offshore wind deployment.

- Noise disturbance – airborne noise emitted by offshore wind turbines.
- Visual disturbance – obstacle lighting, shading and the wind turbines themselves.
- Risk of accidents or accidents with an indirect effect on human health.
- Indirect effects on human health through changes in emissions, both positive and negative.

The Sustainability Impact Assessment carried out in 2019, a socio-economic impact assessment from WSP (Paulsson et al. 2024) as well as communication with experts have been the basis for the assessments.

## 8.2. Protected animal and plant species and biodiversity, bottom habitats

Assessment of the aspects *Protected animal and plant species and biodiversity and Benthic habitats* is based on the Swedish Agency for Marine and Water Management's Symphony method for assessing cumulative effects (for a detailed description of the Symphony method and its use in an impact assessment, see Swedish Agency for Marine and Water Management, 2019a; for Symphony metadata, see Annex 1 of the Swedish Agency for Marine and Water Management, 2018c. Analyses of the effects of changes in use, in this case energy use, have been made for all energy areas. The results of effects on ecosystem components marine mammals, wintering birds, coastal bird spawning areas and bottom habitats have then been used to show the potential effect of different areas on a scale from zero to four, with four indicating large negative effect. The overall Symphony results have formed the basis for an expert assessment of the risk of impact in each marine spatial plan area.

The method for assessing effects on birds is based on evidence from the Swedish Environmental Protection Agency and the Swedish Agency for Marine and Water Management, as well as expert assessment from Lund University and the Swedish Environmental Protection Agency.

The method for assessing effects on bats is based on a risk assessment dialogue between SwAM, SLU and the Swedish Environmental Protection Agency.

## 8.3. Water and air, and other elements of the environment

The assessment of effects on air refers to changes in emissions of airborne pollutants as a result of the marine spatial plan guidance. The uses relevant in this context are shipping, fishing, sand extraction and offshore wind. Wind power partly based on conversion to fossil-free energy and reduced air pollution related to this. Effects on water as a habitat refer to changes in the physical and chemical conditions of water as a result of the marine spatial plan guidance on the different uses. For the assessment aspects of water and air, it has not been relevant to assess the impact of individual energy areas, this is because effects are not local or permanent, but rather affect quality factors throughout the marine spatial planning area.

## 8.4. **Climate**

The climate aspect describes how the marine spatial plan guidance can contribute positively or negatively to greenhouse gas emissions. Potential climate benefits are illustrated by a calculation example. Nature conservation, as well as particular consideration for high nature values, is considered to be an indication of how marine spatial planning can contribute to increased resilience and climate adaptation by protecting ecosystems from disturbances.

## 8.5. **Landscape**

The method for assessing the effects of energy areas on landscapes has been divided into visualisations that are presented as a separate part in Chapter 2.3.3, as well as a visibility analysis that constitutes the assessment itself.

### 8.5.1. Visualizations

The general photo montages showing landscape effects at different distances from land have been produced by Ramboll at the request of the Swedish Agency for Marine and Water Management. Photo montage or visualizations tend to mitigate the experience compared to a real offshore wind farm. The visual influence is subjective in the viewer. Detailed visualisations for individual energy areas were not possible within the scope of the assignment, but the visualised sample parks are seen as a medium-sized offshore wind farm.

### 8.5.2. Visibility analysis

The method for assessing landscape impact is based on a so-called viewshed analysis in order to assess the effects from the energy areas. These are presented in the site-specific assessments. The visibility analysis has been done by a final summary of the impact that the individual energy areas give rise to following this analysis. The method is calculated based on views for approximately 50 000 land observation points and takes into account the topography of the landscape and altitude-blocked views, but not any vegetation. The Geological Survey of Sweden has conducted the viewshed analysis in ArcGIS Pro according to the method description below.

The analysis is based on elevation data from a so-called Digital Elevation Model (DEM) from Copernicus. The raster data has a resolution of 30 meters and is produced by the Copernicus programme of the European Space Agency (ESA). The vision analysis is then calculated according to the following detailed steps:

- Elevation data from Copernicus about 30 meters resolution is converted to a 1 kilometer resolution.
- The visibility analysis is in turn based on a data set called *offshore visibility dataset*.
- The vertical extent is based on an observation height of 1.7 metres on land and a maximum height of 300 metres from sea level.
- Observers are located at intervals of one kilometre in areas within 70 kilometres of Sweden's sea border. A maximum visibility distance of 70 kilometres has been adopted, representing an ideal and precautionary scenario to ensure that no potential visibility is overlooked. This relatively conservative approach takes into account the maximum extent of a theoretical viewing distance, even under optimal visibility conditions linked to atmosphere and light.

- The tool ArcGIS Viewshed2 was used to calculate visibility based on observer placement, altitude data and turbine heights. The final visibility dataset is in 1 kilometre resolution. Visibility values represent a theoretical line of sight from the observer points to the wind turbines, taking into account the terrain.
- The visual impact is in turn designed to show the visual impact of offshore wind turbines. The analysis includes buffering of energy areas, selection of observer points, calculation of line of sight and quantification of visual impact based on angle and distance.
- Energy areas were buffered with a 70 kilometer radius to define the area of potential visual impact, where all observer points within this 70 kilometer buffer were selected. This resulted in approximately 50 000 points that were used in the analysis. For each point, the same observer altitude of 1.7 metres was assumed, as well as 300 metres maximum altitude and 70 kilometer maximum visibility.
- The intersection between each sieve analysis and the energy area was calculated to define the visual impact.
- The visual impact for each observation point and energy area was calculated based on the angle at which the observer's view meets the energy area and the distance from the point to the energy area. The visual impact was measured with a combination of the visibility analysis and a customized effect evaluation based on the angle and distance overlap. Distance impact decreases linearly from 100 at 0 kilometers and 0 at 70 kilometers, reflecting the reduced visual impact at increased distance. The angular influence was based on the calculation of the apparent angular width from each energy area from the observation point, on a scale of 0 to 100. The minimum distance to the visible part of each energy area was used.
- The total impact was calculated by multiplying the distance impact by the angle impact, ensuring that both factors contributed proportionally to the overall visual impact level. This approach allows for a more nuanced assessment of visual impact, taking into account both the proximity and the extent of visibility from different angles.
- To make assessments for each energy area's impact on landscapes, a final analysis was made that summarizes the total potential visual impact for each energy area by aggregating individual impact values from land-based observation points. Consideration is given to the effect that nearby areas can hide the view from the underlying energy areas. The summary gives an overview of what the visual impact can be for each energy area and is presented on a scale from large to no effect.

### 8.5.3. Other impacts on landscapes

An account of the potential effects of energy areas on other areas related to landscape impact, such as landscape protection areas in the Nature Conservation Act (1964:822), areas of national interest (Chapter 4, Sections 3 - 4 of the Environmental Code) and national parks is also included in the assessment of the impact on landscapes.

### 8.5.4. Cumulative and transboundary effects

Potential cumulative and transboundary effects are presented qualitatively along the viewshed analysis and the other effects on landscapes, in terms of number, size, distance and design of energy areas. The cross-border effects are partly due to the potential impact of Swedish energy areas on the landscape in neighbouring countries. Also existing and planned energy areas in neighbouring countries that may have cumulative effects on landscapes in Sweden, not least cross-border cumulatively.

## 8.6. Cultural environment

The method for assessing the effects of energy areas on the cultural environment has been divided into different sections, which are presented in chapters 3.3.4, 4.3.4 and 5.3.4. The assessment of the effects on the cultural environment has been based on national interest claims for conservation of the cultural environment (Chapter 3, Section 6 of the Environmental Code). In addition, the County Administrative Boards' planning basis for marine cultural heritage (regional value areas) in the national marine spatial planning (County Administrative Boards, 2024) has been used in its own part. Direct effects have then been reported for marine archaeological sites, as well as assessment of other effects on the cultural environment and cumulative and transboundary effects. The results are shown in figures in chapters 3, 4 and 5. The Swedish Energy Agency (2023a), Annex 6, has been used for descriptions of the impact on cultural environment interests. These descriptions assess the extent to which the proposed energy areas risk affecting different known cultural environment types, creating dominance and/or competition against the cultural environments or affecting specifically designated cultural environment values as World Heritage Sites. These three aspects relate primarily to the visual (indirect) impact caused by the wind farms, which in turn can affect the experience of the different cultural heritage values.

### 8.6.1. Indirect impact – National interest in cultural heritage conservation (Chapter 3, Section 6 of the Environmental Code)

Indirect impact on national interest claims for cultural heritage conservation has been assessed on the basis of a geographical overlap analysis of national interest claims. Buffer zones of 12.5, 25, 35, 50 and 70 kilometres have been created around national interest claims. Different types of overlap have been given different weights in the assessment, with a closer overlap weighted higher than an overlap further away, and a 70 kilometer buffer weighted lowest. This is done to capture the impact of the energy areas on the cultural environment in terms of its proximity and the assessment is expected to capture the distance of the energy areas and the length parallel to the coast. Unlike the method for landscape impact, the assessment for the cultural environment does not take into account terrain, or vegetation on the coast. This can have a major impact on the visual impact from different areas on land. In addition to the quantitative analysis, the Swedish Agency for Marine and Water Management, together with the Swedish National Heritage Board, has anchored methods and assessments and the results have been reviewed and adjusted qualitatively if necessary. This is because there are shortcomings in a quantitative overlap analysis to assess the impact on national interest claims for cultural heritage conservation, where not all aspects can be captured. Impact refers to conditions for national interest claims for cultural heritage conservation and potential impact based on current value descriptions. Area-specific assessments have been limited to areas with high and medium impact, as well as national interest claims for cultural heritage conservation located within 25 kilometers of the energy areas that are considered to pose a risk of high or medium impact on cultural heritage conservation. The aim is to highlight areas where dominance and/or competition with cultural heritage values can occur, as well as the type of impact that is relevant based on the sensitivity of each cultural heritage. This is in line with the Swedish National Heritage Board's upcoming report, which outlines their development work on general consideration distance for dominance/competition regarding offshore wind power and cultural environments. The report on these development efforts in connection with the government assignment will be published in 2025.

### 8.6.2. Direct impact

As a complement to the assessment of the impact on the cultural environment, a geographical analysis of direct impact has been produced, which is mainly linked to marine archaeological sites such as wrecks. The result is reported by the number of registered marine archaeological sites from the Cultural Environment Register (Riksantikvarieämbetet, u.y.). The number of marine archaeological sites per energy area has been compiled in a table to show the potential direct impact on the cultural environment.

### 8.6.3. Indirect and direct impact – Regional value areas

Assessment for impact on the county administrative boards' developed regional value areas (County Administrative Boards, 2024) has a similar method as for assessment of impact on national interest claims for cultural heritage conservation, but has been divided to clarify the assessments. The assessment is based on a similar geographical overlap analysis of indirect impacts, but where there is direct overlap of regional value areas with energy areas, they have been weighted higher and then in decreasing longer weight along buffered distances. This is due to the fact that value ranges are above and/or below the surface. For the assessment, the County Administrative Boards' value descriptions and consideration recommendations for designated regional value areas have been used qualitatively. It should be noted that the descriptions are not exhaustive, but are based on the selection of cultural heritage values described in the planning documents. In addition, even energy areas with a lower impact assessment can create dominance and/or competition for cultural heritage values, especially for cultural heritage within 35 kilometres, a limit that has been used as a general distance of consideration for the regional value areas (County Administrative Boards, 2024), which marine spatial planning has taken as its starting point in connection with areas with high cultural heritage values (small-k). This limit differs from the limit of dominance/competition that the Swedish National Heritage Board invokes in their development work.

### 8.6.4. Other impacts on cultural environment

The potential effects of energy areas on other areas related to the impact on cultural environments, such as landscape protection areas in the Nature Conservation Act (1964:822), areas of national interest (Chapter 4, Sections 3 - 4 of the Environmental Code) and World Heritage sites, are then reported. Their values are described in a separate section where it is relevant for the assessments of the impact of energy areas on the cultural environment.

### 8.6.5. Cumulative and transboundary effects

Finally, it also describes the transboundary impact on the cultural environment, partly the potential impact of Swedish energy areas on cultural environments in neighbouring countries, but also the potential impact of neighbouring countries' planned energy areas on cultural environments in Sweden. A method for cumulative impact has also been developed. National interest claims for cultural heritage conservation and regional value areas have been dealt with separately, where overlaps from these areas with energy areas have been calculated in direct, 12.5, 25, 35, 50 and 70 kilometer buffering. The overlap has then been added together, based on the number of cultural environments affected, but also along its distance. A higher weighting has been made if a cultural environment area is close compared to further away. It is only the closest overlap that counts for each cultural heritage site. The weighted values have then been summed up to a total value that constitutes the cumulative assessment. See examples below.

Table 52. Example of the method for assessing cumulative effects of energy areas on cultural environments.

| Energy area | Direct overlap (1*15) | 12.5km (1*10) | 25km (1*7.5) | 35km (1*5) | 50km (1*2.5) | 70km (1*1) | Total |
|---|---|---|---|---|---|---|---|
| **X123** | 0 | 10 | 15 | 10 | 7,5 | 2 | 44,5 |
| **X456** | 15 | 0 | 7,5 | 5 | 5 | 4 | 36,5 |
| **X789** | 0 | 0 | 0 | 5 | 2,5 | 1 | 8,5 |

## 8.7. Management with land, water and the physical environment, as well as with materials, raw materials and energy

The assessment of *the management of land, water and the physical environment, as well as of materials, raw materials and energy,* is made on the basis of the Ordinance on Land and Water Management (SFS 1998:896) and the relevant national interest claims (the National Board of Housing, Building and Planning) and uses within the marine spatial plan areas, both as individual assessments (recreation, cultural environment, nature, shipping, commercial fishing), and gathered in the overall impact assessment in Chapter 6.

## 8.8. Energy extraction

The starting point for the method and assessment of the marine spatial plans' energy areas is the Swedish Energy Agency's interim report of the government assignment, *Proposals for suitable energy extraction areas for marine spatial plans* (Energy Agency 2023a). The Swedish Energy Agency is the national interest authority for national energy claims and existing national interest claims were also taken into account in the agency's interim reporting. All energy areas in the marine spatial plan consist of reported energy extraction areas and have initially been assessed as suitable by the Swedish Energy Agency.

Energy impact assessment consists of a descriptive overall analysis at marine spatial plan level including area, wind and depth ratio, distribution of foundation type and location, as well as a criteria assessment for each energy area.

For criteria assessment, a grading of the energy areas is carried out based on character and conditions. The approach is similar to that used by the Swedish Energy Agency (2023e), with some modification. The Swedish Energy Agency's method is based on a model with criteria wind speed, water depth and distance to land.

Current assessment of energy areas includes assessment of wind and depth conditions, but excludes criteria for distance to land. The criterion for wind conditions is based on the area's bearing capacity based on the potential for electricity produced, based on wind resource (wind strength), where the area size of the wind farm (area) is also relevant. In addition, assessment of depth conditions is included, based on the importance of investment costs for construction and choice of technology, bottom-fixed or floating foundations. The characteristics of the areas in terms of wind and depth ratio are spatial conditions, which are considered to be relatively constant and include a lower degree of uncertainty in order to assess the natural geographical conditions for construction and realisation.

With regard to distance to land and connection and maintenance costs depend on infrastructure conditions, such as distance to the appropriate connection point to the transmission point, possible storage solutions (e.g. hydrogen) and port operations for maintenance. Connection costs for electricity distribution and maintenance are essential, but involve relatively greater uncertainty as to where and in what form this will actually take place. Based on the assessment's time perspective to 2040 and uncertainties regarding future expansion of connection points and distribution networks, as well as storage forms, distance to land is therefore not included as a criterion for each energy area.

Criteria assessment for each energy area is limited to only spatial terrestrial conditions regarding wind and depth conditions. Prerequisites such as distance to land are, however, to some extent included in the descriptive analysis, in the aspect of whether the energy area is located within the territorial sea, 12 nautical miles (about 22 kilometers) from the baseline or not.

### 8.8.1. Wind and depth criteria

Method and starting point for criteria analysis are geographical analyses regarding wind and depth conditions, based on an average of the respective criteria for each energy area. Analyses are based on modelled breaks of depth data and wind data from the Baltic sea hydrographic commission (u.y.), respectively the New European wind atlas (u.y.). Both wind and depth conditions can vary within the energy area and the character of the areas refers to wind, and depth and is grouped into three different groups, with 1 - 3 points, as below. Justification for the choice of grouping is based on documentation from the Swedish Energy Agency (2023e)

Table 53. Grouping for wind speed and depth criteria.

| Group/points | Wind speed at 150 m hub height, medium | Depth, medium |
|---|---|---|
| 1 | Less than 8,5 m/s | Depths exceeding -70 m |
| 2 | Between 8,5 and 9 m/s | Between -40 and -70 m |
| 3 | Greater than 9 m/s | Founder than -40 m |

Based on, wind and depth ratio, points are summed per criterion for each energy area. Energy area are then grouped based on min and max values on a scale of 1-4, where measured min value 3 corresponds to 1 and max value 6 corresponds to 4, see example below.

Grouping and summation is a simplified and rough estimate for comparison and visualization of the nature and natural conditions of the areas, and overall per marine spatial plan. For the method, no weighting of the parameters beyond the score scale is used, but wind and depth conditions are considered equivalent.

Table 54. Examples of criteria assessment, summation and grouping.

| Energy area | Wind speed at 150 m hub height, medium | Depth, medium | Total | Relative scale 1 - 4 |
|---|---|---|---|---|
| X123 | 3 | 3 | 6 | 4 |
| X456 | 2 | 2 | 4 | 2 |
| X789 | 2 | 1 | 3 | 1 |

Conditions are also assessed overall at the marine spatial plan level, based on averages per energy area, relative to the size of the energy area, as shown below.

- $F_H$ = Total: $(Pe_v{*}e_y / Y_H) + (Pe_d * e_y / Y_H)$, where;
  $F_H$ = Conditions, nature of wind and depth, mean seaplane
  $Pe_v$ = energy area grouping wind, points
  $Pe_d$ = energy area grouping depth, points
  $e_y$ = area ($km^2$) energy area;
  $Y_H$ = total area ($km^2$) in marine spatial plan with guidance on energy extraction

The criteria method with regard to wind and depth conditions can be seen as a simplified version of the Swedish Energy Agency's initial for the selection of suitable energy areas. Analyses and methods regarding conditions for offshore wind power can also be found in the appendix to the report Wind power in the sea (Government's public investigations, 2024).

### 8.8.2. Uncertainties and limitations of the method

The analysis is thus based on modelled breaks of depth data and wind data from the Baltic sea hydrographic commission (u.y.) and the New European wind atlas (u.y.) respectively. The depth data is not comprehensive, and several data points are therefore interpolated. For those places where depth data is less reliable, the result is also less reliable. The method has nevertheless been considered reasonable as the greatest uncertainties are at greater depth and given that the ranges of depth used in the analysis are so large, the outcome is nevertheless considered reasonable. However, the result should not be read in too high resolution, but is intended to be used at a strategic level.

Since the energy areas are not homogeneous in terms of depth and wind speed, but in several cases include depth and/or wind from at least two categories, this means that some areas get a lower average in the analysis than more homogeneously cropped areas after depth curves would get. Nevertheless, the report at energy area level gives an indication of how the conditions for the areas can be assessed.

The methodology also does not take into account where appropriate connection points to the terrestrial transmission network would be, or potential storage possibilities (e.g. hydrogen), which limits the assessment of the economic conditions for investment and maintenance.

In addition, the methodology does not include potential price developments for electricity prices, revenues or price developments for inputs for construction and maintenance, cost side, which constitutes a significant part for the actual realisation of the plan's guidance on areas for energy extraction and wind farm construction. More information on this can be found in the appendix to the report Wind power in the sea (Government Official Reports, 2024).

## 8.9. Recreation

Methods for assessing the impact of energy areas on recreation are based on national interest for mobile recreation (Chapter 4, Section 2 of the Environmental Code), national interest claims for recreation (Chapter 3, Section 6 of the Environmental Code), and the Swedish Energy Agency (2023a), Annex 6. The results are presented in chapters 3.4.2, 4.4.2 and 5.4.2 with descriptions and figures. There is also an assessment linked to the impact on accessibility, primarily for recreational boating, as well as an assessment of other impacts on recreation and cumulative and cross-border effects.

### 8.9.1. Area-specific assessments – National interest for mobile recreation (Chapter 4, Section 2 of the Environmental Code) and national interest claims for recreation (Chapter 3, Section 6 of the Environmental Code)

Similar to the method for assessing the impact on the cultural environment, a geographical overlap analysis has been made based on areas of national interest and areas of national interest. However, the analysis was only used as a quantitative complement to roughly see potential impact linked to distance and proximity, but not all aspects. Together with the Swedish Environmental Protection Agency, a qualitative assessment of the impact on recreation from energy areas has been made based on the national interest for mobile recreation and national interest claims for recreation. The Swedish Energy Agency's (2023a) Annex 6 includes value descriptions and descriptions of the impact on orecreation that have also been used. The assessments are based on the marine spatial plans' energy areas and include potential indirect (visual) impact on coastal-based national interests and national interest claims. Impact refers to conditions for recreation and potential impact based on current value descriptions, such as visual impact, experience values and accessibility. The results are presented as area-specific assessments and are presented in figures together with descriptions.

### 8.9.2. Accessibility

The assessment of accessibility is linked to a more direct impact on recreation. This mainly relates to recreational boating in the marine spatial planning area, where barrier effects can occur for example recreational boating routes, but also linked to accessibility in areas of the sea linked to activities such as recreational fishing. This is particularly evident for the offshore national interest claims for recreation outside Halland. As a complement to the assessment, an overall geographical analysis has been made of recreational boating within the marine spatial planning area as part of the accessibility assessment. The basis for the assessment was the Automatic Identification System (AIS) data from EMODnet (2022). It used data on vessel density for pleasure craft and sailboats for the years 2017 to 2022. The data was merged into a layer calculated along the energy areas of the marine spatial plans, where a mean value within the energy area was summed up. The result was compiled in a table and shows a monthly average of the number of timber there is recreational boating activity in each energy area between the years 2017 – 2022. The base also shows figures. It should be mentioned that most recreational boats do not use AIS, as recreational shipping usually consists of smaller boats that move within the archipelago and not out in the marine spatial planning areas. This analysis therefore covers only a part of recreational boating.

### 8.9.3. Other impacts on recreation

The potential effects of energy areas on other areas related to the impact on recreation are then reported. The national interests of unbroken coasts (Chapter 4, Section 3 of the Environmental Code) and high-exploited coasts (Chapter 4, Section 4 of the Environmental Code), as well as national parks, have been dealt with separately as a complement to the assessment. Their values are described in a separate paragraph where it is relevant for the assessments of the impact of energy areas on recreation.

### 8.9.4. Cumulative and transboundary effects

Finally, an assessment is made of cumulative and transboundary impacts on recreation. The cumulative effects are accounted for in terms of the potential impact of energy areas on the number of areas linked to recreation, as well as linked to its proximity. The cumulative effects are also assessed on the basis of whether most wind farms would be realised. The cross-border effects describe the potential impact of Swedish energy areas on recreation areas in neighbouring countries, as well as the potential impact of neighbouring countries' planned energy areas on recreation areas in Sweden. This is mainly linked to indirect (visual) effects, but can also be direct, such as barrier effects or effects linked to accessibility.

## 8.10. **Shipping**

Assessment of the impact on shipping is based on national interest claims for communications under Chapter 3, Section 8 of the Environmental Code. The assessment of the effects on *accessibility and safety in shipping is based* on a relative comparison between energy areas regarding how shipping may be affected and what conditions exist for coexistence. The need for adaptation and safety distances are described in planning documents, as well as planning documents *Proposals for suitable energy extraction areas for marine spatial plans* The Swedish Energy Agency (2023a), Section 4, Annexes 5 and 6. Annex 6 describes the adaptations to shipping that are relevant for each energy area.

For the assessment of each energy area, a number of criteria are used, which are then weighed together. Assessment is initially based on geographical overlap analysis based on the national interest including safety distances, area and share of safety zone relative to the respective energy areas. Thereafter, an estimate is made of the need for a changed fairway, as well as visual analysis of the area within the marine spatial plan area relevant for winter navigation (icebreaking), if the energy area is adjacent to more than one fairway, if it is adjacent to a fairway in a neighbouring country and/or an IMO-classified route, and if special remark regarding unsuitability or safety zone is reported in the Swedish Energy Agency (2023a).

For comparison between energy area, the following summation and indexation are used:

Impact on shipping = $AZ_n + AA_n + JF + VS_n + FL + AN + GL$

$AZ_n$ = Area, potential area within safety zone, normalised
$AA_n$ = Percentage of energy area total area related to safety zone, normalized

JF = Adjusted fairway, increased mileage, percentage in decimal form.
$VS_n$ = Winter navigation, energy area as a proportion of plan area, normalised
FL = Multidimensional influence. Adjoining fairway, No, (0), adjoining 1- 2 fairways (0.5), Adjacent to more than two fairways or ‘‘crammed’ (1)
AN - Report Note (No (0) /Yes, Not Acceptable (1), Yes, Note Safety Distance Requirement (0.5))
GL = Borders with neighbouring fairway, and IMO-classified fairway (No (0) /Neighbouring country (0,5), IMO (1)

Total impact on shipping, indexed, normalized to 0-1, and then distributed based on the highest value.

The assessment is based on interim report The Swedish Energy Agency (2023a) and provides an overview of the conditions for coexistence with shipping. Further investigations regarding the conditions for winter navigation and area-specific adaptation for coexistence with shipping and wind power are required in permit decisions on wind power establishment.

## 8.11. **Commercial fishing**

The economic analysis is based on the report *How is Swedish commercial fishing of offshore wind power affected?* with complementary materials (Waldo S. & Blomquist J., 2024a and 2024b). The report contains a more detailed methodological description than the summary presented here.

The exposure of commercial fisheries to wind energy establishment in the proposed energy areas is measured using landing values over the period 2013-2023. The landing value is calculated by multiplying the reported catches (from the vessels’ logbooks) by a price by species (from the catch value statistics). By calculating landing values from catches inside and outside energy areas, a picture is obtained of how commercial fishing is affected by energy areas. A fishing activity is defined as affected by the energy area if all or part of the fishing activity has taken place within the area. For a trawl line, this means that it is sufficient that a small part has been inside the area for it to be defined as an affected fishing activity. This means that the values reported cannot be interpreted strictly as ‘catches within the energy zones’, as part of the catch may have taken place outside the zone. The definition corresponds to a situation where it is difficult or too costly to carry out parts of the trawl tow if it is not possible to trawl through the energy area. The economic analysis also assumes that commercial fishing will be completely excluded from energy areas, although trawl fishing for Norway lobster in combination with wind farms with fixed foundations is considered, however, after adaptation of the wind farm, to be able to coexist to some extent.

The analysis is based on logbook data and satellite-based monitoring through ‘Vessel Monitoring System’ (VMS) between 2013 and 2023, as well as the value of fished-in statistics reported by the HaV to EU economic statistics (European Commission, 2021). All prices are adjusted by the Consumer Price Index (CPI) to the 2023 value (established annual values according to Statistics Sweden). To calculate the landing value per fishing activity, the landing weights in the logbook are multiplied by a price by species. The price used is based on the value fished reported and corresponds to the average landing price per vessel, species, catch area and year.

The fish included in the analysis reported for Skagerrak/Kattegat and the Gulf of Bothnia:

- Gulf of Bothnia:
    - Bottom trawl fisheries for cod and demersal species
    - Pelagic trawl fisheries for cod
    - Bottom trawl fisheries for vendace
    - Bottom trawl fisheries targeting pelagic species, mainly herring, sprat and mackerel
    - Pelagic trawl fisheries, mainly herring, sprat and mackerel
    - Purse seine fisheries targeting pelagic species mainly herring and sprat
- Skagerrak/Kattegat:
    - Bottom trawl fisheries with shrimp trawls
    - Bottom trawl fisheries mainly targeting Norway lobster
    - Bottom trawl fisheries (including Danish seines) targeting mainly demersal fish
    - Bottom trawl fisheries targeting pelagic species, mainly herring, sprat and mackerel
    - Pelagic trawl fisheries, mainly herring, sprat and mackerel
    - Purse seine fisheries targeting pelagic species mainly herring and sprat

The relative impact on total landing values per energy area is shown in one map for the Gulf of Bothnia (pelagic trawling and bottom trawling) and two maps for Skagerrak/Kattegat (shrimp fishing and Norway lobster and fish fishing). 'Total landing value' means the average total landing value for Swedish fisheries over the period 2013-2023 for the specific fishery (e.g. Northern prawn) in Sweden's territorial waters and exclusive economic zone. The percentage has been divided into intervals from 0 percent to more than 4 percent. For areas included in the baseline, no impact is reported. The zero alternative covers areas where there are permits for the establishment of offshore wind energy.

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SFS 2017:720 *Climate Act*

SFS 2017:966 *Environmental Assessment Ordinance*

SFS 2018:1428 *Ordinance on authorities' climate adaptation work*

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# Annex A Summary of measures in the environmental impact assessment of the adopted marine spatial plan

| **Environmental impact** | **Habitat loss to marine mammals and seabirds due to disturbance in the construction and operation of offshore wind energy, respectively, and operation of sand extraction activities** |
|---|---|
| **Criteria and indicators concerned** | **Descriptor D1 – Biodiversity**<br>*Biodiversity is preserved. The quality and abundance of habitats and the distribution and abundance of species are consistent with prevailing geomorphological, geographical and climatic conditions.*<br>Criterion D1C2 - Abundance of species of birds, mammals and fish<br>Indicator 1.2A — *Seabird Breeding Abundance*<br>Indicator 1.2B — *Abundance of wintering seabirds*<br>Indicator 1.2C – Grey seal abundance and trends<br>Indicator 1.2D — Harbour seal abundance and trends<br>Indicator 1.2E – Ringed seal abundance and trends<br>Criterion D1C4 — Species distribution<br>Indicator 1.4A — Grey seal distribution<br>Indicator 1.4B — Harbour seal distribution<br>Indicator 1.4C — Prevalence of ringed seals<br>Lack of relevant indicators for harbour porpoises |
| **Measures to prevent, deter, counteract or remedy adverse environmental effects** | Relevant measures are primarily administrative instruments linked to the regulatory framework for the licensing of water operations under Chapters 9 and 11 of the Environmental Code. In connection with this, conditions for the reduction of disturbance to different species can be established. There is currently no guidance on how offshore wind and sand extraction should be designed to minimise the risk of disturbance, and how different solutions should be tested. Among other things, there are no limit values for what constitutes reasonable disturbance for different species or groups of species, both during construction, as well as during operation and felling. There is also disagreement about the ability of protective measures to minimise pressures to reasonable levels.<br>Knowledge-building measures under, inter alia, the Vindval Programme and Action 25 under the Marine Environment Action Programme are relevant in this context.<br><br>Other relevant existing measures include:<br>- The Species Protection Ordinance (2007:845), which implements Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, and Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds.<br>- Programme of Action for Endangered Species. There are currently no specific programmes for endangered seabird species. There is an action programme for harbour porpoises from 2013, which focuses on minimising by-catch, inventories and mapping of populations, the underwater noise problem and area protection. The program is under update. |

| Environmental impact | Habitat loss to marine mammals and seabirds due to disturbance in the construction and operation of offshore wind energy, respectively, and operation of sand extraction activities |
|---|---|
| | In the framework of the present environmental assessment, a measure was tested to minimise the risk of wind power establishment at Södra Midsjöbanken for benthic foraging seabirds, with a particular focus on alder birds. The measure involves the relocation of the wind farm to nearby areas deeper than 30m. Modelling in Symphony shows a significant reduction in the impact on seabirds. At the same time, the measure means that the wind farm is located within the boundaries of the Natura 2000 site. |
| **Monitoring and surveillance** | **Seabird monitoring programme**<br>Monitoring of breeding and wintering birds along the coast and offshoreaims to monitor stock trends over time, which can be affected by changing conditions in the food web but also by direct impacts arising from a variety of human activities. The data collected includes:<br>*Wintering seabirds (coastal and offshore)*<br>- Number of wintering seabirds within counting units along the coast or along air transects in the lake (see methods)<br>- Geographical distribution can be partly assessed on the basis of population size<br>*Breeding seabirds*<br>- Abundance and distribution of different seabird species along the Swedish coast<br>- Number and size of mainly Eider cubs (indirect measure of young age)<br>Details of the programme can be found at https://www.havochvatten.se/sea/coordination--facts/miljoovervakning/remissversion-for-overvakning-i-marin-miljo/marin-miljoovervakning/sjofaglar.html<br><br>**Seal monitoring programme**<br>The purpose of seal monitoring is to study long-term trends in the marine environment resulting from anthropogenic pressures by documenting the evolution of seal populations. The following data are collected via sample measurements:<br>- population growth rate (%)<br>- population size (number of seals)<br>- distribution of grey seals during the fur change period in May<br>- propagation of harbour seals during the fur change period in August<br>- the spread of ringed seals during ice-laying in the Gulf of Bothnia in April.<br>Details of the programme can be found at https://www.havochvatten.se/hav/coordination--facts/miljoovervakning/remissversion-for-overvakning-i-marin-miljo/marin-miljoovervakning/sal.html.<br><br>**Monitoring programme for harbour porpoises**<br>The purpose of the monitoring is to monitor trends in abundance and population growth of harbour porpoises in Swedish waters. Threats to harbour porpoises include, in particular, increased mortality through by-catches in fisheries, |

| Environmental impact | **Habitat loss to marine mammals and seabirds due to disturbance in the construction and operation of offshore wind energy, respectively, and operation of sand extraction activities** |
|---|---|
| | environmental toxins, reduced food availability due to overfishing, and habitat loss, mainly due to noise disturbance. The survey measures:<br>- Relative density and distribution of harbour porpoises in the surveyed area<br>- Population growth rate (%)<br>- Population size (number of harbour porpoises per square kilometre)<br>- Health and disease surveillance<br>Details of the programme can be found at https://www.havochvatten.se/sea/coordination--facts/miljoovervakning/remissversion-for-overvakning-i-marin-miljo/marin-miljoovervakning/tumlare.html |

| Environmental impact | **Physical damage to marine mammals caused by impulsive underwater noise** |
|---|---|
| **Criteria and indicators concerned** | **Environmental quality standard E.2**<br>*Human activities shall not cause harmful impulsive noise in the ranges of marine mammals during periods where animals are susceptible to disturbance.*<br><br>**Descriptor D1 – Biodiversity**<br>*Biodiversity is preserved. The quality and abundance of habitats and the distribution and abundance of species are consistent with prevailing geomorphological, geographical and climatic conditions.*<br>Criterion D1C4 — Species distribution<br>Indicator 1.4A — Grey seal distribution<br>Indicator 1.4B — Harbour seal distribution<br>Indicator 1.4C — Prevalence of ringed seals<br>Lack of relevant indicators for harbour porpoises |
| **Measures to prevent, deter, counteract or remedy adverse environmental effects** | The environmental impact is strongly associated with the risk of habitat loss for marine mammals described above. The effect is particularly significant for harbour porpoises due to their sensitivity to underwater noise and dependence on echolocation for survival. The effect is to some extent also relevant for seals. Activities in Swedish waters that primarily cause potentially harmful impulsive noise include:<br>- piling and blasting in offshore wind energy construction<br>- piling for transport infrastructure<br>- explosives in connection with military operations<br>- laying of electricity and communication lines<br>- seabed seismological surveys<br><br>Water operations that risk adversely affecting people or the environment require a permit under the Environmental Code and are subject to review by the Land and Environment Court. The main impact minimisation measures are set out in the authorisation procedure in the form of operational conditions, which usually include provisions on when and where activities may be carried out, and the application of protective measures. In this way, the risk of injury is minimized by scaring the animals away from the area, reducing the noise level or avoiding periods where the |

| Environmental impact | Physical damage to marine mammals caused by impulsive underwater noise |
|---|---|
| | animals are particularly sensitive to disturbance, e.g. the calving period. Examples of risk mitigation measures include: (Nordzell et al., 2019):<br>- choice of season for installation<br>- gradual increase in piling strength<br>- use of harbour porpoises and seal frights<br>- the use of noise abatement methods, namely bubble curtains, various forms of protective jackets, caisson techniques or screens of gas-filled balloons.<br><br>The effects of the application of noise minimisation measures in the construction of wind farms in Germany have recently been published and constitute an important basis for installations in Swedish waters, where similar studies do not exist (Brandt et al., 2018; Rose et al., 2019).<br>Within the framework of the Vindval programme, documentation and guidance were produced on the regulation of underwater noise during piling (Andersson et al., 2016), which among other things indicates proposals for noise levels that can cause hearing damage in harbour porpoises. At the Swedish Agency for Marine and Water Management, work is underway to develop uniform guidance for underwater noise that covers activities other than wind power alone.<br>Relevant policy actions include the work of thematic expert groups at EU level, or under OSPAR and HELCOM for Skagerrak/Kattegat and the Baltic Sea respectively[1]. In Sweden, a national reference group for underwater noise was initiated in 2015 with the task of developing national limit values for the impact of human-induced underwater noise. The aim is for these limit values to be used in permit applications and impact assessments. |
| **Monitoring and surveillance** | **Impulsive underwater noise monitoring programme**<br>The purpose of the program is to map the extent of noisy activities in time and space to get a picture of the accumulated sound environment in the sea and be able to prevent too many high impulsive sounds from occurring simultaneously in one area.<br>Information reported within the programme includes:<br>- Type of activity<br>- Position (coordinates or *ICES statistical subrectangles)*<br>- Proxy for source strength (noise level)<br>- Start and end dates<br>- Existence of noise abatement measure<br>Details of the programme can be found at https://www.havochvatten.se/sea/coordination--facts/miljoovervakning/remissversion-for-surveillance-in-marine-miljo/marine-miljoovervakning/impulsive-underwater noise.html.<br><br>**Seal monitoring programme**<br>*See above*<br><br>**Monitoring programme for harbour porpoises** |

[1] MSFD Common Implementation Strategy Technical Group on Underwater Noise (TG-NOISE); OSPAR Intersessional Correspondence Group on Underwater Noise (ICG Noise); HELCOM Expert Network on Underwater Noise (EN-Noise).

| Environmental impact | Physical damage to marine mammals caused by impulsive underwater noise |
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| | *See above* |

| Environmental impact | Habitat loss and reduced reproductive capacity of fish due to physical disturbance in the operation of sand extraction activities |
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| **Criteria and indicators concerned** | **Environmental quality standard D.3**<br>*Permanent changes in hydrographical conditions due to large-scale activities, individual or cooperative, shall not adversely affect biodiversity and ecosystems*.<br><br>**Descriptor D6 - Seabed integrity**<br>*The integrity of the seabed is maintained at a level that ensures that the structure and functions of ecosystems are safeguarded and that benthic ecosystems in particular are not adversely affected.*<br>Criterion D6C3 – Extent of physical disturbance of benthic habitats<br>Indicator 6.3A – Extent of physical disturbance in benthic habitats<br>Criterion D6C5 — Extent of adverse effects of human pressures<br>Indicator 5.8B – Bottom fauna in effluent waters<br><br>**Descriptor D7 - Permanent changes in hydrographic conditions**<br>*The descriptor currently lacks specific criteria and indicators.*<br><br>**Environmental quality standard C.3**<br>*Populations of all naturally occurring fish species and shellfish affected by fishing have an age and size structure as well as stock size that ensures their long-term sustainability.*<br><br>**Descriptor D1 – Biodiversity**<br>*Biodiversity is preserved. The quality and abundance of habitats and the distribution and abundance of species are consistent with prevailing geomorphological, geographical and climatic conditions.*<br>Criterion D1C2 — Abundance of species of birds, mammals and fish<br>Indicator 1.2H — Spawning biomass of pelagic and demersal fish species<br>**Descriptor D3 – Commercially exploited fish and shellfish**<br>*Populations of all commercially exploited fish and shellfish are within safe biological limits and show an age and size distribution that indicates a healthy stock.*<br>Criterion D3C2 — Spawning stock biomass of commercially exploited species<br>Indicator 3.2A — Spawning stock biomass for commercially exploited populations |
| **Measures to prevent, deter, counteract or remedy adverse environmental effects** | The environmental impact is mainly caused by increased sediment dispersion and changes in bottom conditions within and in the vicinity of the areas where marine spatial plans indicate the use of sand extraction. Hydrographic conditions that are assumed to change are turbidity and depth conditions, as well as possible currents in the immediate area. The risk of such changes may be high during sand extraction, depending on the sediment type and dynamics, as well as on the extent and duration of the activity. These aspects determine whether the changes will be permanent or not. In the case of offshore wind energy, the risk of significant and |

| Environmental impact | Habitat loss and reduced reproductive capacity of fish due to physical disturbance in the operation of sand extraction activities |
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| | long-term impacts on biodiversity and ecosystems is usually assessed as negligible. However, the risk and possible harm minimisation measures still need to be investigated and tested. Changes that occur only during the construction or harvesting phases are usually not counted as permanent, which is however the case for the changes caused by the wind turbine foundations themselves during the operation phase.<br>The risk of loss of fish habitats is similar to that of other marine species, namely harbour porpoises and seals, as described above. Changes in bottom structure and dynamics can make habitats unsuitable for certain species, while greater human presence can scare away animals. Sediment extraction can be directly detrimental to species laying eggs on bottom substrates, while increased sediment dispersion can interfere with reproductive capacity of species with pelagic egg and larval stages.<br><br>Measures to maintain good environmental status with regard to hydrographic conditions fall mainly within the scope of the permit assessment. These are administrative instruments linked to various laws and the Ordinance, namely the Environmental Code. It is important that the basis for decisions is available for the assessment of activities and measures. There is usually a requirement for an environmental impact assessment, which should account for the activity's impact on hydrographic conditions. Environmental impact assessment in permit assessment under Chapter 9 and Chapter 11 of the Environmental Code is considered to be the main instrument for ensuring that infrastructure or other activities offshore do not deteriorate the status of environmental quality standard D.3 (Swedish Agency for Marine and Water Management, 2015c).<br>Under the Marine Environment Action Programme 2016-2021, a measure (ÅPH 13) was proposed to develop guidance to strengthen descriptions of hydrographical changes and how these affect marine ecosystems. Within the same programme of measures, there are a number of other measures to develop guidance or policies on various aspects related to the integrity and restoration of benthic habitats that are relevant for compliance with EQS D.3.<br><br>Measures against adverse effects on fish in terms of habitat loss caused by physical disturbance are largely of the same nature as for habitat loss for marine mammals and birds, as described above. It is primarily about administrative instruments that are determined within the framework of the permit assessment process.<br>Most existing measures related specifically to fish are targeted at fisheries, which are considered to be the main cause of changes in fish stocks and communities, despite several other pressures in the marine environment (Swedish Agency for Marine and Water Management, 2015c). Such measures fall within the scope of the EU Common Fisheries Policy and national fisheries regulations, respectively, and are not directly relevant to disturbance caused by new constructions or activities. In comparison, measures related to conditions for construction in the water or planning and operation of water operations are generally considered to have significantly lower potential impact to achieve good environmental status (Swedish Agency for Marine and Water Management, 2015c). However, in the |

| Environmental impact | Habitat loss and reduced reproductive capacity of fish due to physical disturbance in the operation of sand extraction activities |
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| | context of specific projects, such measures can be instrumental in minimising the risk of harm, by, for example, avoiding disruption during biologically sensitive periods. |
| **Monitoring and surveillance** | **Monitoring of hydrographic conditions**<br>Monitoring of hydrographic conditions is part of five different monitoring programmes, two of which measure hydrographic characteristics (physical characteristics such as temperature and salt, and hydrological characteristics such as currents, waves and water levels), and three monitor human pressures and their effects, namely:<br>- effects of cooling water;<br>- physical impact<br>- benthic habitats.<br>The latter two programmes are relevant to the effects described above, which are expected to result from the application of the marine spatial plans. These two programmes are currently under development. Data from both programs need to be combined to assess the possible impact of physical disturbance on habitats. It is anticipated that the following data will need to be collected under these two programmes:<br><br>*Physical impact:*<br>- bottom trawling data<br>- data from environmental impact assessments;<br>- aerial imagery and satellite data<br>For each activity or design, the following data are collected:<br>- timing<br>- geographical location<br>- area/length<br>- relative impact in terms of hydrological quality elements<br>- general wave regime around the phenomenon and how it is affected<br>- bottom substrates affected and affecting the surrounding area<br>- depth effect<br>- zoning of intensity<br>- intensity of pressure<br>Details of the programme can be found at https://www.havochvatten.se/sea/coordination--facts/miljoovervakning/marin-miljoovervakning/physical-paverkan.html.<br><br>*Benthic environments*<br>Geographical distribution of habitat types and habitats and areas of occurrence:<br>- Distribution area and area covered by habitat types and habitats<br>- Structures (of habitat types and habitats) that can be defined spatially<br>Quality of habitat types and habitats:<br>- biotic and abiotic structures (e.g. presence of vegetation)<br>- ecological functions (e.g. typical species composition, species size and/or age structure, etc.) |

| Environmental impact | Habitat loss and reduced reproductive capacity of fish due to physical disturbance in the operation of sand extraction activities |
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| | Details of the programme can be found athttps://www.havochvatten.se/sea/coordination--facts/miljoovervakning/marin-miljoovervakning/bentiska-livsmiljoer.html<br><br>**Monitoring programme for inshore and offshore fish**<br>The main purpose of these two programmes is to follow up changes in the number and size structure of the most common species commercially exploited. The programmes thus have a significant focus on fisheries and their impact on stocks. Data collected within the programmes is also used to assess the status of the ecosystem. Data from the offshore fish monitoring are coordinated between different countries and are used in the work to produce data for fishing quotas. The programmes have no particular focus on how fish stocks, fish reproductive capacity or spawning stocks are affected by physical disturbance. Nevertheless, monitoring data form the basis for permit assessments, including spawning stock assessments, which in turn are necessary to estimate and compare the effects of new constructions or activities. Where a certain water activity is considered to have negative effects on fish, spawning habitats and reproductive capacity, a control programme shall be developed to monitor these aspects. |

| Environmental impact | Loss of benthic habitats in the construction and operation of offshore wind energy, as well as operation of sand extraction activities |
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| **Criteria and indicators concerned** | **Environmental quality standard D.1**<br>*The area of the seabed unaffected by human activity must be large enough to maintain the structure and function of the seabed for each habitat type.*<br><br>**Environmental quality standard D.2**<br>*The area of biogenic substrates shall be maintained or increased.*<br><br>**Descriptor D6 - Seabed integrity**<br>*The integrity of the seabed is maintained at a level that ensures that the structure and functions of ecosystems are safeguarded and that benthic ecosystems in particular are not adversely affected.*<br>Criterion D6C3 – Extent of physical disturbance of benthic habitats<br>Indicator 6.3A – Extent of physical disturbance in benthic habitats<br>Criterion D6C5 — Extent of adverse effects of human pressures<br>Indicator 5.8B – Bottom fauna in effluent waters |
| **Measures to prevent, deter, counteract or remedy adverse environmental effects** | Most existing seabed integrity measures address the impact of bottom trawling on benthic habitats. Despite numerous other pressures affecting the seabed, bottom trawling for fish is considered to be the predominant activity in the seabed causing negative physical impacts on the seabed. This is particularly true in Skagerrak/Kattegat, while in the Baltic the impact of trawl fishing on the integrity of the seabed is less extensive (Swedish Agency for Marine and Water Management, 2015c). Existing measures include area-specific regulations to reduce the impact of trawl fishing within existing protected areas, the relocation of the trawl border on the west coast, fishing regulations to protect the integrity of the seabed under the |

| Environmental impact | Loss of benthic habitats in the construction and operation of offshore wind energy, as well as operation of sand extraction activities |
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| | Fisheries Act and Fisheries Ordinance, and the establishment of protected areas, including biotope protection areas.<br>The establishment of protected areas may also be relevant as a preventive measure for protection against other pressures likely to affect the seabed, including wind energy installation and material extraction. In this context, the measure can be used to prohibit or limit anthropogenic pressures in order to preserve the seabed, and opens up the possibility of requiring restoration and compensation measures within protection plans for certain types of protected areas.<br><br>For specific water operations such as offshore wind power and material extraction, the conditions determined in the framework of permit procedures under the Environmental Code are most important in order to minimise the risk of negative impacts on the integrity of the seabed (see above). An important aspect is the threshold for what is considered to be acceptable disturbance or damage to the integrity of the seabed, which is currently undetermined. This relates to knowledge about the distribution of the different habitat types and what different degrees and types of human influence mean for the structure and function of benthic ecosystems. Such knowledge is also necessary to be able to assess the form and extent of possible future restoration and compensation in the event of loss of natural bottom habitat. Such measures are currently not applied in the sea. Within the action programme for the marine environment 2016-2020, action ÅPH 25 was developed, aimed at, among other things, building up knowledge about mussel banks in the Baltic Sea, physical impact on deep soft bottoms, reef environments and shallow gravel bottoms in Skagerrak/Kattegat (Swedish Agency for Marine and Water Management, 2015c). |
| **Monitoring and surveillance** | **Physical impact monitoring programme**<br>See above, under Monitoring programme for hydrographic conditions.<br>Today, different types of data are collected that could be used for estimating the physical impact of different human activities. However, there is a lack of an overall strategy for the use of data in assessments. Methods for both monitoring and assessment are under development. In the case of individual projects, such methods are usually developed within the framework of the project's control programme.<br><br>**Monitoring programme for benthic habitats**<br>The monitoring is part of the following six different monitoring programmes, the first two of which are relevant to the environmental impact in question, while they are currently under development.<br>- benthic habitats<br>- physical impact (see above)<br>- larger animals on the seabed<br>- sediment-dwelling macrofauna<br>- vegetation-covered bottoms<br>- chemical properties of water (oxygen and pH)<br>For benthic habitats see above under *Monitoring programme for hydrographic conditions.* |

| Environmental impact | Loss of benthic habitats in the construction and operation of offshore wind energy, as well as operation of sand extraction activities |
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| | Large-scale national marine mappings of Sweden's marine areas have been carried out since 2016, with the aim of improving knowledge of benthic marine habitats. Monitoring is also being developed to monitor the condition of benthic habitats on an ongoing basis, as well as the extent of human activities and their adverse effects on habitats. Innovative monitoring methods are now being developed, where shallow ground environments will be monitored by satellite and validated with adapted monitoring locally. However, reliable comprehensive monitoring of benthic habitats in deeper areas continues to require a comprehensive mapping effort, in particular to generate sufficiently accurate data on depth and substrates. In parallel, there is also the development of physical impact monitoring, using aerial image interpretation and impact models. |

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