

BIODIVERSITY AND ECOSYSTEM SERVICES IN NORDIC COASTAL ECOSYSTEMS

AN IPBES-LIKE ASSESSMENT



SUMMARY FOR POLICY MAKERS

BIODIVERSITY AND ECOSYSTEM SERVICES IN NORDIC COASTAL ECOSYSTEMS – AN IPBES-LIKE ASSESSMENT SUMMARY FOR POLICY MAKERS

The Summary for policy makers is based on two volumes, 1) the general overview (Chapters) and 2) the geographical case studies, from the report “Biodiversity and ecosystem services in Nordic coastal ecosystems – an IPBES-like assessment”. The report is a result of Nordic cooperation among Denmark, Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland and the Åland Islands.

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Biodiversity and Ecosystem Services in Nordic Coastal Ecosystems – an IPBES-like assessment Summary for Policy Makers

FOREWORD

This study has been inspired by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). IPBES was established in 2012 to provide policy makers with adequate knowledge and tools for decisions by bringing them together with scientists and other knowledge holders. At IPBES-2 in Antalya, 2013, Nordic representatives decided to work together along the lines set out by IPBES to explore the possibilities for this approach on a Nordic scale. Initially the project was led by Norway, then by Sweden, and it was financially supported by the Nordic Council of Ministers. This cooperation led to a scoping study of options for a Nordic report, and to the current study, of which this is the summary for policy makers.

This Nordic study is built as closely as possible according to the framework for the regional assessments currently being finalized within IPBES. The aim is to describe status and trends for biodiversity and ecosystems in the Nordic region, the drivers and pressures affecting these, effects on people and society, and options for governance. For practical reasons it has not been possible to cover all Nordic ecosystems. The study therefore focuses on the Nordic coastal areas, since these represent an important ecosystem common to all Nordic countries.

Also in procedural matters we have tried to follow IPBES guidelines. However, since we did not have access to a plenary or a Multidisciplinary Expert Panel, the project and especially this summary for policy makers was directed by a Steering Committee consisting of management officers from the various competent authorities. The summary for policy makers was composed based on the chapters and case studies in the main study, and then the Steering Committee decided on the final wording for the key findings and options.

Stockholm, March 2018
Mark Marissink
Chairman of the Steering Committee, Swedish EPA

Black legged kittiwake. Photo: Mark Marissink

Key messages

A THE NORDIC COASTAL REGION HAS MANY NATURAL ASSETS AND PROVIDES NUMEROUS ECOSYSTEM SERVICES.

A1. **The Nordic coastal region is unique due to the variability in nature types and biodiversity.** Its coastal areas support examples of many different habitats spanning the temperate to the Arctic zone. This diversity supports considerable biodiversity and people depend on it for their livelihoods.

A2. **The Nordic coastal region contains several globally important species and habitats.** These include the wintering bird assemblages in the shallow seas around Denmark, the unique habitats of the Baltic Sea (the largest brackish water area in the world), the kelp forests and breeding seabird colonies on offshore islands and cliffs in northern regions along the Norwegian coast, the recovering populations of whales in the North Atlantic Ocean, the assemblages of Arctic species and the recovering stocks of cod and other species in the North Sea and further north.

A3. **Most of the region's biological value is in the form of large concentrations of fairly common species.** The region houses habitats and assemblages of species that are typical of temperate seas warmed by the Gulf Stream, along with the Arctic and the Baltic Seas, parts of which are seasonally frozen. The strong seasonality also results in long and short distance migration of many fish, birds and mammals using the coastal and marine systems in the region. These include globally important winter concentrations of migrant seabirds and shorebirds in the southern part of the region and similarly important summer concentrations in the northern and Arctic regions.

A4. **The Ecological status in the North-East Atlantic and Bothnian Sea is good.** The status is moderate in the Arkona Basin and the Sound, but poor in the Baltic Proper and Gulf of Finland.

A5. **Many biological values of the region are slowly recovering from very low values following past overexploitation.** These biological values include populations of fish-eating sea birds and white-tailed eagle, grey heron, crane and several geese species in the Baltic Sea. It also includes cod, herring and mackerel, ringed seals, and grey and harbour seal, the hooded seal, North Atlantic fin whale, and bowhead whale along the Norwegian coast and wintering and breeding populations of geese and swans in Danish coastal areas. In the Baltic Sea, and particularly in the Bothnian Bay, there is a slow recovery from DDT and PCB pollution events. However, pollution from heavy metals and contamination from persistent toxic chemical and radiation events, remains a challenge.

A6. **The network of marine and coastal protected areas is important for preserving biodiversity and ecosystem services in the Nordic region.** Regulations to accomplish sustainable use of these areas are under development.

A7. **The coastal natural resources of the region have provided food for**



Puffin. Photo: Mark Marissink

people living in the Nordic region for thousands of years. They continue to provide this today, especially from fisheries in the shallow seas, but also from animals feeding on the coastal habitats, and birds breeding on the coastal cliffs. These resources are under various management regimes, some traditional going back at least 100s of years, and others with a more recent natural science basis.

A8. **The diversity of Nordic coastal and marine ecosystems continues to deliver goods and services that are vital to the livelihoods of many people in the region.** Beaches and other coastal areas are important leisure resources for tourists from other countries and, especially, holidaymakers and weekend visitors from within the Nordic countries, particularly in the southern parts of the region. There are also continuing traditions and systems of using coastal and marine resources across the Nordic region, which are integrated into the modern lives of people living both in the rural areas and, increasingly, in cities throughout the region.

A9. **The Nordic coastal regions support communities with traditional and strong ties to nature which provides opportunities for natural resource conservation based on these traditional uses and traditional natural resource management and governance regimes.** These communities include both Inuit/Greenlandic and Saami peoples in the north, coastal communities along the seaboard of Norway, Sweden, Finland and Denmark, as well as populations on the Faroe Islands and Iceland.

A10. **The coastal natural resources of the region provide inspiration for the people living in the Nordic countries.** Some are strongly embedded in cultural identities and ways of living. These cultural values provide a powerful bond between people and nature and are a major reason for the persistence, and in some cases recovery of natural resources in these coastal regions.

THE COASTAL NORDIC REGION IS UNDER PRESSURE

B B1. **Some species are still in decline in the region despite conservation actions aiming to assist their recovery.** This includes the globally important populations of breeding auks (puffin, razorbill, common guillemot, Brünnich's guillemot) and some breeding seabirds (e.g. kittiwake). There has been a considerable decline in sea grass meadows, and kelp forests and furoid algae/or brown seaweeds in different parts of the region. Due to population crashes in the past century species like sturgeon and lamprey in the Baltic Sea remain at very low populations.

B2. **The Arctic – also the parts within the Nordic region – is the part of the planet most heavily affected by climate change and is warming at a far higher rate than any other region of earth.** This is having and will continue to have dramatic impacts on ecosystems and their services, including through ocean acidification. Throughout the region there are emerging impacts of climate change. Northern species of birds, fish and bivalves cease to breed in southern countries like Denmark, migrating northward and expanding their breeding grounds along the coasts of Norway, Sweden and Finland. Fish e.g. mackerel, herring and tuna, are moving to more northern waters



Whimbrel. Photo: Mark Marissink

around Iceland and Greenland. There are changes in the coastal food web, potentially impacting food sources for some of the largest marine creatures in the region, e.g. humpback whale. Ocean warming is having negative impacts on the extensive kelp forests in the western oceans off Norway.

B3. Chemical pollutants, eutrophication and plastics are affecting the coastal waters of the region. The historical heavy industrial and nuclear radiation pollution is still affecting parts of the Baltic Sea. The situation has greatly improved from over the past 30 years. In other parts of the region there is considerable run-off of agricultural fertilizers and pesticides, although the amount has been reduced from past levels. Eutrophication of the coastal waters remains a problem, evidenced by impacts to species composition in many areas. In recent years, fears have emerged on what consequences the high quantities of plastics and nanoparticles in the oceans lead to. It will take many centuries for these particles to degrade in the regions' colder northern waters, and their impact on marine life is negative.

B4. Invasive species pose serious challenges to parts of the Nordic coastal ecosystems. Significant challenges arise from the Japanese rose (*Rosa rugosa*) on coastal foreshores and sand dune areas in Denmark and southern Sweden. Challenges also arise as a result of a variety of invasive marine animals and plants, including the round goby in the Baltic Sea and in the North Sea, and king crab in the Bering Sea. Measures against alien invasive species may mitigate the effects of these species. Such measures may include the implementation of legislation and/or physical measures to remove already established species.

B5. Infrastructure development in marine and coastal areas poses challenges. The Nordic region is a global frontrunner in near- and offshore wind turbine technological development and installation. However, wind power plants have impacts on e.g. migratory birds and bats. In addition, there are impacts associated with the construction of the large bridges between Denmark – Sweden and Denmark – Germany. The trend to set aside coastal or near-coastal areas for building summer cottages, brings challenges of reduced access, increased disturbance and the need for water treatment. There is oil and gas exploration, and mining industry in the northern seas that has potential to impact these areas. Of particular concern is the slow breakdown of pollutants in cold waters of low biological capacity.

BUILDING RESILIENT FUTURES IN THE NORDIC COASTAL REGION



C1. The political and governance systems of the Nordic region are transparent and fair. There is a broad interest within the Nordic countries to pursue development pathways to reduce local and global impacts. There is good access to coastal areas and strong emphasis on the use of nature and natural areas for livelihoods and recreation. These values and traditions need to be maintained to continue to provide space for nature, and to allow people to benefit from natural coastal areas. Nordic countries are able to implement and maintain systems for improved coastal management and sustainable harvesting of species, habitats and resources.



Fish. Photo: Mats Blomqvist, Hafok

C2. **There are good examples of indigenous and local peoples participating in coastal nature management in the northern regions.** This is critically important for subsistence use and for maintaining ecosystem services in the north. Better integration and support of indigenous and local knowledge within conservation management and in governance of resource use in the region would be beneficial.

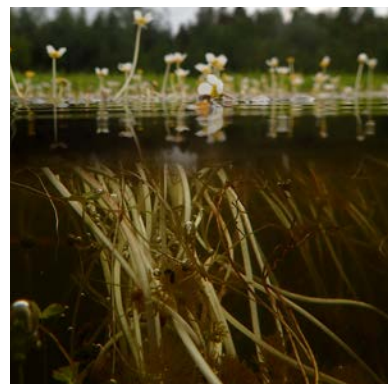
C3. **Ongoing progress to clean up pollution and reduce eutrophication in rivers, lakes, coastal areas and open seas needs to be continued.** This relates to all the countries in the Nordic region, and is equally important on national, regional and international scales. This can be achieved through catchment-based management approaches, as eutrophication is mainly caused by runoff from land. There have been intensive efforts to reduce the secondary environmental impacts from the large marine aquaculture industries (e.g. salmon farmed in the Norwegian fjords), shell fish farming (e.g. blue mussels on poles and other structures in Danish and Swedish seas), and the emerging seaweed farming industries.

C4. **Some fish stocks and populations of marine mammals are recovering in the region.** Further recovery can be accomplished through careful review and changes to policies as required. However, some populations have recovered to the point where they are causing problems. For those fisheries and populations of marine mammals that are still in decline, more efforts are required to help return populations to a healthy state.

C5. **Co-operation among the Nordic countries is needed to improve coastal zone planning and management.** Policies and their implementation need to balance the needs of the natural system and human development in coastal areas (e.g. summer houses, urban areas, industry). Examples can be drawn from ongoing marine spatial planning initiatives.

C6. **Coastal resilience to rising seas needs to be enhanced, e.g. through nature-based solutions offered by natural or moderately modified ecosystems.** Changes in the coastal regions may be dramatic in the future due to climate change and related sea level rise, flooding, extreme weather events, and increased run off from inland water bodies and melting ice.

C7. **The legal frameworks in most Nordic countries have national laws, EU directives and regulations and follow regional marine conventions including HELCOM and OSPAR.** These are often developed from agreed targets of international non-binding agreements, such as those under the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change. This legislative framework is strong, but can always be improved to enhance the outcomes for nature and people in the coastal regions.



Pond water-crowfoot Photo: Linnea Bergdahl

Options for Policy Makers

POLICIES

- Evaluate the costs and benefits of existing environmental policies, prioritise and streamline them to help overcome the high density of policies.
- Where possible, coordinate the implementation of policies across the Nordic region to reduce policy conflicts.
- Identify and adjust policies that counteract incentives for conservation and the sustainable use of biodiversity in coastal areas.
- Increase political focus on the status of marine biodiversity and the influence of human activities on species and habitat diversity. This would be closely related to work with the UN Sustainable Development Goals (SDGs).
- Involve science-based assessments and priorities in policymaking in terms of identifying most needed conservation and management policy initiatives.
- Safeguard the right to public access of coastal areas as access to nature maintains access to a number of non-material nature's contributions to people, such as identity, physical and psychological experiences, knowledge and inspiration, as well as material benefits such as food and ornaments. This collectively helps maintain society's sense of duty to protect the environment.
- Implement ecosystem-based adaptation to increase the coastal region's resilience to climate change.
- Draw benefits from technological developments that reduce the region's ecological footprint.
- Identify pathways to achieve the 2050 vision of the Strategic Plan for Biodiversity and implement the Sustainable Development Goals and their targets.



KNOWLEDGE

- Address knowledge gaps to understand the impacts of climate change, pollution, land use change, invasive species and infrastructure development on biodiversity and ecosystem services.
- Develop standardised assessment tools for assessing status and trends in biodiversity and how ecosystem services are affected by these changes. Tools should use indicators that allow for cross-regional comparative analyses and allow for application in monitoring programmes.
- Develop (new monitoring and research) programs with focus on multi-stressor impacts of human activities in the coastal zone, to quantify and understand the combined impact of climate change (warming, elevated precipitation, ocean acidification), eutrophication and human resource harvesting (e.g. fisheries).

DIALOGUE WITH STAKEHOLDERS AND INDIGENOUS AND LOCAL KNOWLEDGE HOLDERS

- Assess and value ecosystem services, recognising both monetary and non-monetary values, and include all relevant stakeholders, including the perspectives of indigenous and local knowledge holders.
- Further improve and apply indigenous and local knowledge in monitoring and management programmes. Seek inspiration from pre-existing co-management schemes, such as the Laponia or Näätämö cases.
- Open a dialogue and mutual exchange of multidisciplinary data and information between indigenous and local knowledge holders, the scientific community, NGOs, decision-makers and other stakeholders.
- Recognise the link between biodiversity, ecosystem services and cultural identity by integrating indigenous and local knowledge as well as knowledge held by other stakeholders in a better way into decision-making and thus improve transparency.

Photo: Ysign, Shutterstock



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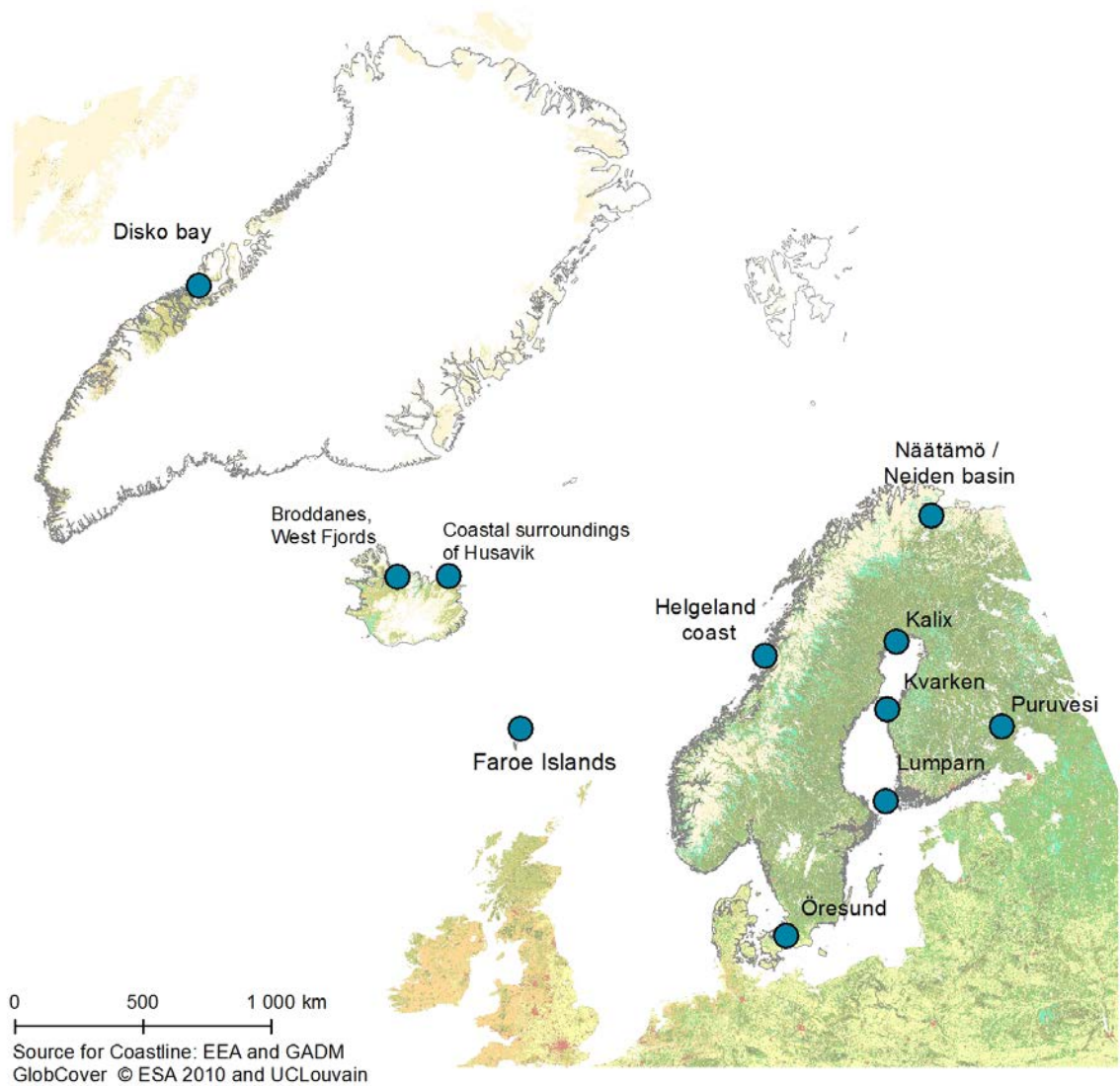


Figure 1. Map prepared by Minna Kallio

Introduction

Biodiversity and Ecosystem Services in Nordic Coastal Ecosystems – an IPBES-like assessment highlights the importance of biodiversity and ecosystem services in the Nordic region, with a focus on coastal ecosystems.

The coastal focus was selected due to the significance of coastal ecosystems for the historical and economic development of the Nordic region. Much of the Nordic population and economic activities are located in the coastal zone, resulting in high environmental pressures and changes to coastal ecosystems in the Nordic region.

Coastal areas highlight the important linkages between the

countries, but also the interactions between land and sea, which are key in this region. The assessment covers some coastal areas in the Nordic countries: Denmark, Finland, Iceland, Norway, Sweden, the Åland Islands, the Faroe Islands and Greenland, based on selected case studies from across the region. The report consists of two volumes: I) a general overview and II) geographical case studies. The ten case

studies (see Figure 1) were selected to illustrate different aspects of the key Nordic coastal ecosystems, along with their influence, relationship and coherence with society. These are presented in volume II.

This Summary for Policy Makers (SPM) is based on the assessment described above. It highlights the policy-relevant points from the assessment report and incorporates examples from the abovementioned

Nordic case studies to illustrate key messages.

The SPM aims to strengthen the science-policy interface for biodiversity and ecosystem services or nature's contributions to people (NCP)¹, as well as the conservation and sustainable use of nature for long-term human well-being. Key findings are presented to demonstrate challenges for maintaining biodiversity and NCP in the Nordic region. The SPM also proposes options for incorporating results and overcoming challenges through sound knowledge-based decision-making.

Following the introductory section, this summary describes NCP and a good quality of life (based on chapter 2 in the full report), the status and trends in biodiversity and NCP in the Nordic coastal region (chapter 3), the drivers of change (chapter 4), and closes with challenges and opportunities for policy and management (chapter 5 and 6). Case studies illustrate key points on the wealth of available knowledge and may help to provide inspiration for further studies.

The Nordic countries are surrounded by water, which around Scandinavia includes the North-Eastern Atlantic Ocean, the North Sea, the Norwegian Sea, the Barents Sea, the Skagerrak and Kattegat, and the Baltic Sea. Further to the northwest, the Icelandic Sea and the Greenland Sea meets the shorelines of Iceland and the east coast of Greenland, along with the Norwegian Sea to the east and the Arctic Ocean to the north. Physical (e.g. depth, temperature, water currents,

tidal range, and wave impacts) and chemical (e.g. salinity, nutrients, and organic matter) features are the main factors affecting the structure and function of the various aquatic ecosystems. There are freshwater conditions in Näättämö and Puruvesi, with increasing salinity across Kalix, Kvarken, Lumparn and the Sound, with true oceanic conditions in the Atlantic coastal areas. The Baltic Sea is the world's largest brackish water area, with almost freshwater conditions in the northernmost part and an increasing salinity towards the south and the Kattegat.

The Nordic region is inhabited by circa 27.9 million people. The majority of the population live in the coastal regions. The political systems in all the Nordic countries are democracies and most citizens enjoy a high standard of living within some of the most equitable societies on earth. A number of indigenous and traditional communities live in the region, including the indigenous Saami and Kalaallit (Inuit Greenlandic people).

The Nordic countries share a long history of political, economic and social interactions connected by the surrounding seas, including fishing, transport and exploration. Today, coastal regions are very important marine traffic routes, and are crucial for a number of economic sectors, including fisheries, agriculture, aquaculture, tourism, energy (e.g. wind turbines, nuclear power plants), natural resources (e.g. sand and gravel, and oil and gas fields for instance around Norwegian and Greenlandic coasts)

and industrial processes. Marine traffic routes place pressure on ecosystems, for instance around the Sound and the Gulf of Finland. Diffuse nutrient loading from intense agriculture still affects water quality in more vulnerable and enclosed coastal areas, particularly at the Baltic Sea.

There is a comprehensive, but complex system of legislation in the Nordic countries (see chapter 6 in full report). It is comprised of a combination of local and traditional, national, international (Convention on Biological Diversity CBD, Convention on the International Trade in Endangered Species CITES, UN Framework Convention on Climate Change UNFCCC etc.) and regional (e.g. EU Habitat Directive, Marine Strategy Framework Directive, Water Framework Directive, Marine Spatial Planning Directive, Common Fisheries Policy, Common Agricultural Policy, Floods Directive, Drinking Water Directive, Nitrates Directive, and Emission Ceilings Directive) legislation. These different levels govern the management and protection of nature and natural resources, along with the benefits derived by people.

Accessibility to nature is an important value for the Nordic people. In contrast to most parts of the world, the coastal regions outside settled areas are accessible, with rights to public access granted to citizens to use most coastal areas. Thus, people do not rely as heavily on protected areas for outdoor recreation as they do in many other countries.

¹ The development in concepts and terminology around nature's contributions to people has been very rapid. The term ecosystem services was formally established with the Millennium Assessment 2005. The Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES) has developed the conceptual framework and terminology to furthermore explicitly include "other knowledge systems" specifically Indigenous and Local Knowledge (ILK) and also to recognizing "the central and pervasive role that culture plays in defining all links between people and nature". The overarching term changed from "nature's benefits to people" (NBP) to "nature's contributions to people" (NCP) in 2018 and this is the terminology now used by IPBES. Since much of the discussions took place at the same time the current report was written, the use of these terms throughout the report (both this SPM and the underlying volumes) may not be consistent. For the key messages we have kept the more familiar "ecosystem services".

The many stakeholders found along Nordic coastlines, including indigenous and local knowledge (ILK) holders, have rights regarding environmental decision-making. Procedures for stakeholder consultations are laid down in the Aarhus convention and in national legislation, but further development is needed to ensure implementation of participatory mechanisms.

The Nordic region also supports a number of indigenous peoples and local communities living relatively traditional lifestyles, such as the Saami people and the Inuit, along with local communities in Iceland, on the Faroe Islands and in the Bothnian Bay. With their unique biocultural aspects and knowledge systems these form an essential part of the Nordic societies, but indigenous and local knowledge, along with associated monitoring systems have been poorly integrated in common environmental monitoring schemes and decision making. Indigenous and local knowledge systems based on customary use of coastal and marine resources have high potential value for development of policies for long term sustainable use of coastal ecosystems, especially in the northern parts of the Nordic region.

SETTING THE SCENE

Biogeographically the Nordic region is part of the Palearctic region, with climatic conditions spanning the Atlantic to Continental and Arctic climatic systems. The Nordic coastline is about 150,000 km long with large geomorphological variation from ancient, nutrient-poor and very hard basement rocks to more recent and much softer sediments with higher nutrient content. Nature in the Nordic region is represented by a variety of aquatic

and terrestrial habitats including marine, brackish water, freshwater, wetlands, forests and agriculture landscapes. The coastal zone, including seashore habitats and connecting wetlands acts as a “filter” between land and open sea. Nutrients, organic matter and anthropogenic substances are transformed and retained along the land – sea continuum.

The post-glacial natural land cover in the Nordic countries varies from broad-leaved forests in the south of the region to Arctic tundra and polar deserts in the north, and from boreal forests adapted to continental climate in the east to the high slopes of the fjords in the west characterised by high annual precipitation of the Atlantic climate system. Greenland is dominated by glaciers, but also has tundra and marine ecosystems with diverse fauna and flora. There are unique archipelago areas in Greenland, Norway, and along the Swedish west coast, along with the Archipelago Sea in the central Baltic between Sweden, Åland and Finland.

Over the past several thousand years, land use has been changed dramatically by people in the Nordic

countries, significantly affecting biodiversity and ecosystem services. This change has also occurred in most coastal areas, where grazing, deforestation and afforestation have been, and continue to be, the main drivers of changes to vegetation. Minor drivers of change include sand extraction, for example in the Faroe Islands. Overfishing is a region-wide threat to biodiversity and ecosystem services, with implications for traditional lifestyles and human well-being. Pollution in coastal areas poses health hazards, again with particular implications on customary use of natural resources. Other drivers include ongoing urbanisation, coastal development, eutrophication, acidification of seawater and climate change. There is also an increasing number of people accessing the coast, especially in the southern regions, for recreational and tourism reasons. This can put increasing pressure on these areas. Many impacts can be mitigated by implementing effective and participatory governance, but efforts to mainstream, develop, and reduce the density of policies are needed.

Sheep. Photo: Mark Marissink



Nature's contributions to people and human well-being in a Nordic coastal context

Ecosystem services are usually categorised into four categories: provisioning services such as food and water; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as photosynthesis, and nutrient cycling.

IPBES now defines three broad and partly overlapping categories of nature's contributions to people: regulating contributions, material contributions and non-material contributions: The regulating group includes such categories as regulations of climate, freshwater and coastal water quality, the material group includes categories such as food and genetic resources and the non-material group provide for example learning and inspirational benefits and physical and psychological experiences. The following NCPs are of particular relevance in the Nordic coastal region:

- Biological resources including fish, marine invertebrates, algae, mushrooms, berries, birds and mammals. Harvesting these resources for the provisioning of food is a prerequisite for many recreational activities, an intergenerational transfer of knowledge and a part of cultural behaviour
- Energy production from the coast by wind, wave, algae and the use of seawater for heat storage are increasingly important aspects of coastal NCPs
- Mediation of waste and toxins by biota and ecosystems such as mussel beds, kelp

forests and eelgrass or Chara meadows

- Physical, spiritual, symbolic, aesthetic and intellectual interaction with biota, ecosystems and landscape is important in Nordic cultural heritage.

FOOD AND HEALTH SECURITY (MATERIAL CONTRIBUTION)

Currently, food supplies in the Nordic countries are secured through domestic production and import. However, the depletion of fish stocks is a matter of concern, and a potential indicator of the integrity of this NCP. Evidence includes overfishing of the large spring spawning of the Norwegian herring stock and the low-productive states of cod, perch and eel in the Baltic Sea. Further evidence includes reduced stocks of predatory fish, including cod, haddock, pollack, halibut and ling, along the Swedish west coast in the late 20th century that have yet to recover.

Livelihood security, in a broad sense, is a significant driver behind the current trends in urbanisation and depopulation of remote areas in the Nordic countries. As the lives of people in the Nordic region are increasingly decoupled from local NCP, economic and social constraints may lead to an abandonment of remote settle-

ments. Indigenous peoples and local communities with traditional lifestyles are heavily dependent on local biological resources, e.g. through fishing, hunting and harvesting of wild plants and berries, and thus more likely to be affected by declining populations of important species – one example is the displacement of small-scale and subsistence fisheries due to professional large-scale practices. In modern societies such as those in Nordic countries, the concept of traditional lifestyles becomes a gradient from customary to a modern small-scale use of local resources; yet, the good status of local ecosystem functioning and local biological resources is essential. Rural people might be more or less dependent on the local biological resources for their subsistence, while the urban population to a large extent is detached from local dependencies and relies on the global market for everyday living. Consequently, the issue of dependence on local NCPs can be seen as a question dividing rural and urban lifestyles.

SOCIAL RELATIONS, SPIRITUALLY AND CULTURAL IDENTITY (NON-MATERIAL CONTRIBUTIONS)

For many people, the recreational use of coastal environments is crucial for their health and well-being. Thus, exploitation of the



Seining in Puruvesi. Photo: Tero Mustonen

coast for housing and infrastructure may severely limit open-air coastal recreational activities. Coastal exploitation and closure through private purchase of coastal lands also poses a problem for reindeer herding and local fishermen. Therefore, public access to coastal areas and the seashore should be high on the political agenda. In Sweden, Norway and Denmark, people have the right to public access to beaches. In Sweden and Norway, 100 metre zones are protected from exploitation by law. In Sweden this zone has been extended to 300 metres in some areas, whereas in others, exemptions from the law have been given. Similarly, enforcement of the law has, to some degree, varied between municipalities in Norway. Finnish authorities provide information and recommendations on what the right of public access covers, but these have no legal significance, and in Åland similar rules are applied.

Biological diversity plays a major role in shaping the cultural history of local communities and

customary practices. Fishing methods, hunting techniques and other practices, which used to ensure the daily subsistence for the local community, have been developed in relation to the local landscape and its biodiversity. This has contributed to form local cultural heritage and identity, both material and spiritual. The yearly cycle of physical and biological phenomena has developed a local calendar of customary practices, depending on resource availability and weather conditions. Consequently, there are cultural values closely linked to the harvest of biological resources. Today, where they still exist, such events are mostly of social and cultural importance, but they are also essential for the quality of life and for upholding a sense of identity in the local communities. Therefore, many animals and plants have high symbolic significance to the local communities, such as vendace, eel, pilot whale and eider (see Box 1). Harvesting of more common aquatic species such as salmon, cod, herring, perch and

pike, along with terrestrial species along the coast such as, mushrooms, cloudberries, blueberries and lingonberries, also plays a significant role in Nordic culture.

Factors important for maintaining biological and cultural diversity are affected by economic, social and technological changes. The consequences are most observable in the societies most dependant and closest to natural and semi-natural ecosystems. As an example, in the Kalix area of the Bothnian Bay, local fishermen and reindeer herders emphasize that their quality of life, sense of place and deep connection with the land is intimately linked to their possibilities to continue traditional, customary practices. In Northern Iceland, local women describe the importance of protecting mountain areas from human disturbance in order to respect and maintain their sacredness. They also talk about “the hidden people”, the non-human entities and beings of these sacred mountains. In the Faroe Islands, some inhabitants describe that to feel

Faroese, one has to be brought up on the islands, or have adapted to them, and to feel the influence of the rough and changeable nature, the unpredictability of the weather, the beauty of the local nature, the possibility to wander freely and continue customary use of biodiversity in a sustainable way. As cultural identity and spirituality often are closely tied to traditional ways of living, local and customary economic activities are encouraged and supported in some areas. For example, fishing of the vendace at Kalix in the Bothnian Bay and the traditional communal seining in the Puruvesi area has been successfully maintained as a local commerce, as has seal hunting in Iceland, the pilot whale hunt on the Faroe Islands and eel fishing in eastern Scania (see Box 1).

Recognising the variety of nonmaterial contributions to

people in political decision-making is an important step toward improving stakeholder dialogue. Involving all stakeholders, including indigenous and local knowledge holders, in documenting and identifying key areas, biodiversity hotspots and sacred sites can provide insights overlooked by the scientific community. Their involvement helps to improve transparency and contribute to regional progress toward the CBD's Aichi target 18 and the UN's Sustainable Development Goal 3 and 16. Better insight can improve conservation interventions, thus also helping to implement Aichi target 11 and 12 and SDG 14 and 15.

VALUATING NATURE'S CONTRIBUTIONS TO PEOPLE

Economic valuation of NCPs can determine whether a project, a plan or a policy leads to socio-

economic profitability or loss.

Such analyses may enable us to prioritise between different outcomes, investigate conflicts of interest and create balance between various aspirations and goals. Economic valuation may provide a common currency to communicate the value of provisioning and most cultural ecosystem services.

However, it needs to be recognised that not all NCPs can be valued in monetary terms. For instance, spiritual values, like sacredness of a mountain, are priceless to the holders of those values. Values are subjective and therefore each NCP may be valued in a large number of ways. It is important to develop language and practices in strategies and policy-making that fully incorporate these value perspectives in the final project assessment.

Box 1. Supported local and customary economic activities and the symbolic value of animals

Löjrom, vendace caviar: The vendace (*Coregonus albula*) is a small salmonid fish, whose roe is very esteemed and marketed as caviar (löjrom). Vendace is common in the brackish Bothnian Bay, where local roe fisheries have existed for generations. The vendace roe from the Kalix archipelago, the "Kalix löjrom", has been cherished for a long time and received a protected designation of origin by the EU in 2010. Vendace is also the iconic fish of the Puruvesi winter seiners on the large Saimaa lake system. The vendace of Puruvesi is an EU Geographical Indicator for the traditional harvest, which is a seal-friendly, as well as for its particular biological qualities. The oral culture of the Puruvesi winter seiners is currently being considered and was included in the national registry of intangible culture of Finland in November 2017 and is now up for nomination in the intangible cultural heritage of UNESCO.

Ålagillen, the 'eel feast': At the 'eel coast' at the Hanö Bay in eastern Scania in Southern Sweden, the traditional fishing and eating of eel has taken spectacular forms with 'eel feasts' (ålagillen), where a variety of eel dishes are prepared and ceremonies take place during the autumn. The eel culture in the area has been proposed as a cultural heritage to be listed nationally within the UNESCO Convention for the safeguarding of intangible cultural heritage. While eel fishing could easily sustain the cultural traditions in eastern Scania, the present eel fishing intensity is not sustainable. Although eel fishing occurs all over Europe, the Nordic impact on the eel stock is likely to be significant, as both Sweden and Denmark are two major European eel fishing nations.

Whale hunting: Pilot whale hunting (Grindadráp) on the Faroe Islands, the traditional harvesting of long-finned pilot whales (*Globicephala melas*) and occasional dolphins, takes place at irregular intervals. This traditional hunt is passive in the sense that the hunters wait until a shoal of whales is approaching. It has been ongoing for at least the past thousand years. Whale still constitutes a fair share of the meat consumption, but problems with contamination of hazardous pollutants have led to discussions regarding local health issues.

Eider hunting: In the old fisher-farmer communities, spring seabird hunting was a matter of survival. Today the hunt, while no longer crucial for survival, is still an important part of life and culture. In the Vega archipelago in Norway, local people tend the female eiders and protect them against predators to ensure a viable population for harvesting of eider down. This relationship between the birds and the bird tenders is of unique character, and preserving this socio-cultural interdependence was one core reason for the approval of a UNESCO world heritage site.

Status and Trends of Biodiversity and Ecosystem Function

Status and trends have been assessed using the information gathered within the case study areas (see Volume 2 of the full report), which are included to represent regional status and trends in biodiversity and ecosystem function.

For the Baltic Sea, recent assessments compiled by HELCOM and others are included. For the North-East Atlantic, the assessment by OSPAR has been used. By developing and improving standardised cross-regional indicators to monitor biodiversity and NCP, the impacts of threats to their integrity can be mitigated through improved managements taking consideration of the biodiversity. Policy aimed at improving our understanding of NCPs is an important first step in this direction and in line with Aichi target 19 of the Convention on Biological Diversity (CBD). Increased knowledge on the status and trends of biodiversity and ecosystem function across the region, can help to prioritise decision-making.

REGIONAL TRENDS

Biodiversity across the Nordic coastal region is reflected by the region's physical characteristics. Marine biodiversity is relatively high in the North East Atlantic region, and relatively low in the inner Baltic Sea. On land the coastal margins have higher biodiversity in the southern parts of the region when compared with the northern coastal land areas, which are often rocky.

In the Atlantic coastal marine region, kelp forest are key habitats, in addition to smaller seaweed

species, seagrass meadows, blue mussel beds, and soft and sandy sediments. Entering the brackish Baltic Sea, the large kelp species disappear due to low salinity, leaving selected seaweed species, seagrass meadows, blue mussel beds, and soft and sandy sediments as the most important habitats, with decreasing diversity along a decreasing salinity gradient. Declines in sea grass have occurred across the region since the 1970's, most likely due to eutrophication. Seabird populations have declined significantly during the last decades, reaching historical lows.

An overview of the ecological status of the Nordic region based on status in case studies, indicates good status in North-East Atlantic and Bothnian Sea, moderate status in the Arkona Basin and the Baltic Sea between Denmark and Sweden, and poor status in the Baltic Proper and Gulf of Finland (Figure 2). These results are based on a compilation of information from the Norwegian Nature Index and HELCOM. The development of common Nordic assessment tools and indicators, such as those currently under development at HELCOM and OSPAR, is recommended to aid future monitoring of the status and trends in biodiversity and NCP and function across the region. Such indicators

can help to expand the scholarly pool of knowledge, potentially allowing for links to be made between biodiversity and ecosystem function, with NCP and their valuation.

Application of indigenous and local knowledge in assessments and monitoring of biodiversity and NCPs, such as those described in Box 2, could help to improve scientific estimates of status and trends. Furthermore, such initiatives would be in line with global targets including the CBD's Aichi target 18 and the UN's SDG 16.

Case study site	Status	Index
Norwegian Sea / Helgeland coast	Good (Green)	NI
NE Atlantic / Faroe Islands **	Good (Green)	**
Bothnian Bay / Kvarken, Kalix coast	Good (Green)	HELCOM
Bothnian Sea / Kvarken	Good (Green)	HELCOM
Gulf of Finland	Moderate (Red)	HELCOM
Baltic Proper	Moderate (Red)	HELCOM
Bornholm Basin	Poor (Yellow)	HELCOM
Arkona Basin	Poor (Yellow)	HELCOM
Kattegat	Poor (Yellow)	HELCOM

Figure 2. Biodiversity status assessment of selected Nordic coastal regions. The colors green, yellow, red indicate status classes: Good, moderate and poor biodiversity respectively, referring to the definitions of ecological status used in HELCOM (2010).

*Assessment status for the Norwegian Sea/Helgeland coast is from the Nature index of Norway. Status for the Baltic Sea is integrated from values of biodiversity status and are means of normalized values assessment for habitats, communities, species and supporting services based on the HELCOM (2010) classification system, and derived by Andersen et al. (2015).

**No index exists for the Faroe Islands. Assessed as good quality (Jan Sørensen, Natural History Museum, Faroe Islands, Pers Comm.)

HELGELAND: THE NORTH-EAST ATLANTIC

The Nature Index of Norway describes the state and development of biodiversity in Norway, and gives an overview of the status of the environment for selected species groups and ecosystems. The index shows that there has been a slight improvement in the biodiversity of the coastal zone of Mid-Norway during the last 25 years (Figure 3). The slightly improved condition towards 2010 is due to improved phytoplankton biomass and numbers of harbor seal, while the weak decline since 2010 is due to a small decline in the stocks of herring, cod, crab, sand eel, and some seabird species along the coast. The estimated populations of cod are considered close to a critical limit, and their decline seems linked to poor recruitment.

A recent assessment of the status of kelp forests in European waters concluded that a general decrease in their abundance is apparent. This decrease has been linked to eutrophication and warming of the coastal water in some areas - partly in areas considered

as southern distribution limits. In more northern areas such as Helgeland, a regrowth of kelp forests on barren grounds has occurred. The reforestation of Mid-Norway kelp forests is also linked to climate changes and warming, but here due to the negative impacts on sea urchins who graze on kelp, thus improving conditions for reforestation.

There are 56 red-listed marine species in Norway. These are threatened at various levels, from critical to vulnerable. Of these, nine species are considered critically endangered, including spiny dogfish, European eel, common guillemot, and bowhead whale. Another 23 species are categorized as strongly threatened, including black legged kittiwake, blue ling, hooded seal, and narwhale.

According to the Water Framework Directive, the ecological status of Helgeland is generally good. Of the more than 200 water bodies in the marine environment, which includes kelp forest, seagrass meadows and the pelagic environment, 88 % are classified as 'Good', whereas 99 % of the total area is classified as 'Very good'.

Currently, no ecological or biodiversity status index exists for the Faroe Islands, however the overall status is evaluated as good, according to local authorities. Local knowledge holders have reported decreases in seabird populations during the last decade and noted a gradual replacement of small-scale professional fishing with larger industrial practices.

THE BALTIC SEA. KALIX, KVARKEN, LUMPARN AND THE SOUND

Approximately 85 million people live in the catchment area of the Baltic Sea. Land use change due to agriculture, urban development and industry, along with maritime traffic, has resulted in large environmental changes during the last 100 years despite ambitious and effective policy-making, particularly in the Sound. Pressures include eutrophication, overfishing, pollution and changed hydrodynamic conditions, which have had heavy impact on coastal waters and the open Baltic Sea. These pressures have resulted in changes in the distribution of fish, vegetation and benthic fauna, and also caused regime shifts from an oligotrophic to eutrophic state, with resultant changes in dominant species. A shift from dominance of demersal

Box 2. Use of indigenous and local knowledge to monitor biodiversity

Throughout the Nordic region, indigenous and local knowledge holders monitor biodiversity, providing valuable knowledge on status and trends.

- The Näätämö river watershed is home for the Skolt Saami indigenous community. Following the extreme heat waves and torrential rain in 2010, which affected water levels and access to upstream spawning grounds for Atlantic salmon, the first official collaborative management project was established in Finland. A database monitoring salmon populations and water quality has been produced. Lost salmon spawning areas have been identified and are now subjects of major restoration projects.
- Since 1584, local Faroese communities have tracked the annual harvest of pilot whales. This is probably the longest running community based monitoring initiative in the world. A more modern approach using Facebook, now also allows Faroese hunters to register the number of hares hunted, while researchers at the University of the Faroe Islands process the data.
- In the Kalix archipelago of the Bothnian Bay, local communities have mapped the abundance of fish stocks over the past three decades. Local community members and reindeer herders make regular observations of changes in abundance of fish, birds, seals and other mammals. In addition, observations of changing weather patterns and changing ice cover are made. Special focus has been on mapping areas of presence and absence of brown trout. Local fishing communities hope that collaborative monitoring and co-management of fishing can sustain increased trout populations, as well as the local fishing culture.

fish to a dominance of pelagic clupeid fish occurred, where the abundance of cod decreased and abundance of sprat increased, suggestively due to climate variation and overfishing.

Up to 60-100 % of seagrass meadows have been lost over the last century in some areas, e.g. along the northern part of the Swedish west coast. Bladder wrack has suffered similar declines, but is currently under recovery in some areas of the Baltic Sea. The decline has had negative effects on the biomass of fish and the sequestration of nutrients. Along with eutrophication, stressors include sediment runoff, dredging, and coastal development.

Oxygen deficiency has greatly reduced the benthic biodiversity in deep water areas of the Baltic Proper. One consequence is an increase in hypoxia-tolerant species has been observed, most notably a dramatic increase in the abundance of the invasive species *Marenzelleria* spp. The species may or may not outcompete other species, it may help aerate and decompose sediment layers, it may increase the load of previously bound harmful chemicals in the food chains, and it may increase the nutrient contents of the sea and result in increased algal/cyanobacterial blooms. Its potential impact in the Bothnian Bay remains largely unknown. One study indicates a potential cost of *Marenzelleria* in the Baltic Sea that ranges from 167 billion SEK to 732 billion SEK, depending on the effect of *Marenzelleria* on sequestration of phosphorus.

Common eider, common scoter, velvet scoter and long tailed duck populations have severely decreased in the Baltic sea region during the last 20 years, the latter two are now considered 'endangered' and 'vulnerable' on the global IUCN Red List. The reasons are partly unknown, but the impacts of climate change on nesting sites,

along with increased hunting by white-tailed eagle on common eider is thought to contribute to population changes. The total number of over-wintering sea ducks decreased from approximately 7 million individuals in the beginning of the 1990's to about 3 million birds in 2007–2009. Conversely, the abundance of many fish-eating sea birds such as sandwich tern, common guillemot and great cormorant have increased during recent years, presumably due to improved prey quality of common guillemot and declined concentrations of hazardous substances in prey and sea water. Indigenous and local knowledge holders have pointed to increases in numbers of white-tailed eagle, grey heron, crane and several geese species. Protection schemes have helped conserve viable populations, providing incentive for decision-makers to develop similar schemes in the future.

Local knowledge holders report enormous increases in seal populations in the Baltic Sea following the decimation of populations in the past. In the Bothnian Bay, a tenfold increase in ringed seal has also been observed by HELCOM. However, in the Gulf of Finland ringed seal has not increased, whereas population sizes of grey seal and harbour seal have grown. Local communities, and increasingly also scientists, are concerned about the strong negative impact of seals on fishing practices, with implications including damage to catch, equipment, fish stocks and the dispersal of parasites. Efforts to develop seal-proof equipment are met with concern, as prices are too high for small scale fishing families, and protection schemes.

About 130 non-indigenous species have entered the Baltic Sea since the 18th century, mainly



Kayaking in Helgeland. Photo: KelpScotland.com
Copenhagen in The Sound. Photo: Håkan Tunón

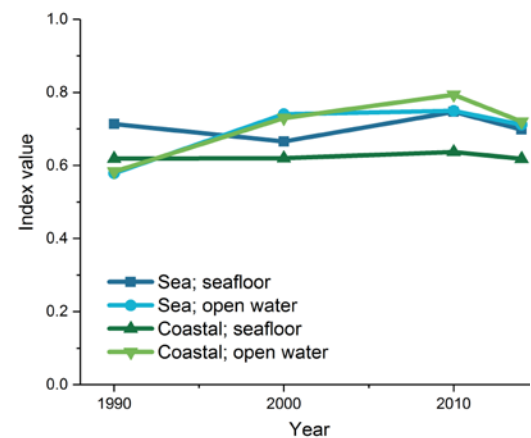


Figure 3. Overall trend in biodiversity in the coastal regions of Mid-Norway. Data are from the Nature Index of Norway and show an overall slight improvement in the biodiversity of the coastal region in Mid-Norway, during the last 25 years. The index includes the off-shore sea-floor (dark blue), open waters (light blue), the coastal specific seafloor (dark green) and waters (light green). The index is compiled to represent the biodiversity of the represented habitats, by compiling indicator values of relevant indigenous species on a scale between 0 and 1, where 1 describes an unaffected status with close to intact biodiversity. Both common and rare species are included in the indicator. Indicator values are based on data from monitoring, model estimates and expert assessments. Source: <http://www.naturindeks.no> (Gundersen et al., 2015).



as an effect of human activities. Invasive species in the Baltic Sea include round goby (*Neogobius melanostomus*), red gilled mud worm (*Marenzelleria* spp.) and American comb jelly (*Mnemiopsis leidyi*). For a young sea like the Baltic Sea, from which all ice disappeared 9000–8000 years ago, the establishment of non-indigenous species is, to some extent, also a natural on-going process of succession. So far, no non-indigenous species have resulted in the extinction of native species. However, the low species diversity in the Baltic Sea makes the Baltic Sea especially vulnerable, as the loss of one species may have a large effect on other parts of the ecosystem, as there may not be other species to occupy its niche. Invasive species, such as the Damask rose, also pose a threat to the integrity of ecosystem on coastal shores and sand dunes in Denmark and southern Sweden.

HELCOM assessments of the Baltic Sea based on biodiversity (see Figure 4), eutrophication and

the presence of hazardous substances, found it to be in a 'non-acceptable' state. The HELCOM Red List reports have categorized at least 60 marine species and 16 marine biotopes in the Baltic Sea as threatened and/ or declining. This leaves the Baltic Sea as one of the most threatened marine ecosystems worldwide.

DISCO BAY, WEST GREENLAND: THE ARCTIC

The anthropogenic drivers most relevant for changes in biodiversity are climate change and exploitation of wild species. The number of fish species known from northwest Greenland is increasing due to the northward migration of species – a result of warming seas. The northern shrimp population has been declining in recent years, while there is an ongoing recovery of Atlantic cod. Trends may be related to positive correlations between cod biomass and ocean temperature, along with strong negative correlations between shrimp and cod biomass. Among

the bird species, especially common eider and thick-billed murre have suffered large population declines, which has been linked to hunting and egg collection. Eider populations have responded positively as restrictions have been enforced, while murrens have kept declining.

The ecosystems of west Greenland are still considered to be healthy, and lakes, rivers and marine waters are presumed to be of good or very good ecological status. Habitat degradation is not regarded as a major issue in Greenland, except for that related to climate change. Climate driven changes in physical properties might alter the biological balance and regional biodiversity. For instance, northwards retreat of the sea ice edge has been linked to an increase in the distribution of kelp beds and increase in seasonal productivity of seaweeds along the Greenland west coast. Exploitation of wild species, and to some degree pollution and invasive species, may threaten the present good status in Greenland.

STATUS OF BIODIVERSITY CORE INDICATORS IN THE SUB-BASINS OF THE BALTIC SEA



* Core indicator agreed to be tested in this assessment

** Pre-core indicator agreed to be tested in this assessment

*** The indicator 'Zooplankton size and stock' is under testing for the Gdansk Basin



Making an inventory of under water vegetation with snorkel in Kalix. Photo: Petra Welander

Direct and Indirect Drivers of Change

Direct and indirect drivers of change have impacts on biodiversity and NCPs. Understanding how drivers work and what impacts they have on ecosystems is an important step towards mitigating any detrimental effects.

Direct drivers of change are natural (i.e. not a result of human activities and therefore beyond human control, e.g. weather or extreme events) or anthropogenic (a direct result of human activities and actions e.g. land use change and pollution) and have direct impacts on biodiversity and NCPs. Indirect drivers are the underlying causes of change generated outside the ecosystem. They are central as they influence all aspects of relationships between people and nature. These might include legislation, the organisation of societal institutions and the demand for food. In a comparison of the direct and indirect drivers in the different case study areas referred to in the Indigenous and local knowledge Biodiversity and Nature's Contributions to People in Coastal Ecosystems, the following have a widespread influence on NCPs: population dynamics, climate change, pollution, fishing and habitat degradation. All indirect drivers were found to have major impacts on ecosystems in the case study areas.

DIRECT DRIVERS

Population dynamics are natural fluctuations that occur in the numbers of individuals in populations and the factors that control these fluctuations. Gaining an understanding of how the drivers that impact population dynamics, and how these drivers are interlinked,

is necessary to be able to decide how to balance between different interests. One example in the Nordic context that is of relevance in policy-making, is the predator-prey relationship between vendace and seal in the Bothnian Bay. Seal populations have recovered following past reproductive failure induced by hazardous substances, thus their consumption of vendace has reduced the viable stock. Local fishermen call for a culling of seals, giving rise to conflicts and a need for policy-making that can balance livelihood and conservation requirements. In this example, the impact of fishing on vendace populations (1400 tons fished) and conservation of seal are anthropogenic direct drivers with impacts on population dynamics.

Overfishing has led to depleted fish stocks throughout the Nordic seas and has direct implications for food and livelihood security (see "Food and health security" and "Livelihood security"). Impacts include reductions in the large spring spawning of Norwegian herring, the low productive status of cod, perch and eel in the Baltic Sea, fewer and smaller haddock and pollack in Skagerrak and Kattegat and no recovery of predatory fish populations along the Swedish west coast since their decline in the late 20th century.

Human-induced climate change is an anthropogenic direct driver of change of global relevance. In the ocean-connected and sea-like

ecosystems of Lake Puruvesi and Nääntämö River in Finland, the latter of which is a crucial ecosystem for both Skolt Saami and Atlantic salmon, climate change will most likely increase water temperatures and cause changes in ice cover thickness and duration. Also, extreme heat waves and changes in precipitation can be foreseen to lead to population declines of species such as Atlantic salmon, vendace, trout, grayling, Saimaa ringed seal and other cold-dependent species. In the Kalix archipelago and other parts of the Bothnian Bay, climate change may cause both increases and declines in fish populations. In this area, there is also a risk of highly increased levels of methylmercury through expected biogeochemical and ecological changes from climate change.

Habitat degradation, such as exploitation, dredging and bottom trawling, have direct impacts on ecosystems and are significant anthropogenic direct drivers. In addition, drainage for agriculture or forestry, grazing and the use of artificial fertilisers are common drivers of land-use change and habitat degradation in the Nordic region. Drainage of the land can lead to accelerated acidification in surrounding seas, with implications on the coastal environment, as has occurred in the Quark area. Recirculating nutrients by employing green infrastructure initiatives, e.g. through the restoration



Faroe Islands. Photo: Håkan Tunón

Box 3: Competition for space in the Sound

Competition for space on land and at sea is a critical issue in densely populated areas. The Sound region is the most densely populated area in Scandinavia with about two million inhabitants, who with their modern lifestyles and high demand for various resources, potentially could affect ecosystems and biodiversity in a multitude of ways. There is an urgent need for regulating the use of marine and coastal space in the region, due to impacts from shipping, fishing, recreation and tourism, housing, infrastructure development projects such as a bridge and tunnel across the Sound, new harbours and offshore wind turbine parks. The extraction of sand and other materials also put strain on the benthic habitats in the Sound. Policy instruments aiming to deal with spatial planning can help to clarify which interests take priority. Examples include Marine Spatial Planning using an ecosystem – approach, the introduction of exclusive economic zones and Integrated Coastal Zone Management.

or construction of wetlands, is now rather wide-spread in Nordic countries. Such initiatives can also contribute to restoring and conserving biodiversity and help increase resilience to climate change.

In the Faroe Islands, sand extraction occurs within fjords and along the coastline with potential impacts on sandeel, which has a preference for specific sand quality and grain size. Potential negative impacts on sandeel populations can have implications for its viability as a commercial fish species and also reduces prey numbers for the puffin. Policy needs include balancing conservation interests with sand extraction industries. Similar conflicts arise through the competition for space in the most densely populated areas in the Nordic region (Box 3).

Pollution is a significant anthropogenic direct driver in the Nordic region. For example, in the Faroese and Greenlandic waters, albeit far from the industrial or urban areas of Europe, the level of mercury in sea mammals may be at high levels. Top predators such as seabirds and whales are exposed to high levels of industrial chemicals, heavy metals and PCBs through bioaccumulation. Environmental toxins like mercury,

and to a minor extent arsenic, cadmium, zinc, lead, copper and selenium, occur in pilot whale meat, whereas significant amounts of organochlorine compounds such as PCBs are found in blubber. Effects of a mixture of chemicals, the “cocktail effect”, must be considered. Whilst the concentration of each substance in most tissues may be below safe toxicological limits, the total effect may be substantial and impacts on human health is plausible. The use of fauna to remove pollutants from ecosystems, such as harvesting fish to remove PCBs from the Baltic Sea, may help to minimise impacts of this driver.

The spread of hazardous substances in the marine environment remains a matter of concern for health reasons. For example, the consumption of pilot whales, fatty fish and sea birds in the Faroe Islands, along with Inuit game hunting, poses health risks due to the storage of lipophilic pollutants in fatty tissue. The Arctic Monitoring and Assessment Programme, as well as the Inuit Circumpolar Council demonstrate the need for safe foods and maintaining traditional practices. Other pollutants including mercury, polychlorinated biphenyls

(PCBs) and heavy metals, many of which originate from the heavily industrial countries of Europe, can lead to impaired immune systems, hormone disorders and fertility problems. Plastics, which are picked from the sea surface by birds such as fulmars, along with microplastics in the food web, also have implications on food and health. The accumulation of toxins in plastics further exacerbates health risks. Risks need to be balanced with the nutritional value of seafood by minimising consumption of fish species with high methylmercury content or organic compounds such as PCBs and dioxins.

Radioactivity has also been traced in marine flora as far away as western Greenland. The Baltic Sea is considered as one of the most radioactively contaminated seas in the world. The largest source of radioactivity in fish, bladderwrack and aquatic organisms in the Baltic Sea is the aftermath of the Chernobyl nuclear accident in 1986. Remnants from the Soviet Union, including pollutants trapped in sediments, dumped chemicals and nuclear-powered lighthouses also pollute the Baltic Sea. The concentrations of radionuclides such as Cesium-137 in fish, have declined

considerably since early 1990's and continue to decline. It is expected that adequately low concentrations of radioactive substances in biota and water may be achieved in all of the Baltic Sea by 2020 (HELCOM 2017).

INDIRECT DRIVERS

Legislation is the regulation of interactions between socioeconomic and ecological interactions. For example, fishing policies, nature conservation measures such as the development of marine protected areas and laws. Legislation needs to balance the interests of different groups to reduce conflicts.

Economic development is a major driver of environmental change. The economically advanced welfare societies in the Nordic region results in a heavy ecological footprint – the impacts of which can be reduced through continued sustainable development, environmental awareness and measures to protect and conserve nature. The mainstreaming of sustainability into all levels of decision-making and society, in line with Aichi Strategic Goal A and SDG 8, 9 and 11, needs to be highly prioritised by decision-makers.

Alongside economic development, people are migrating from rural areas towards bigger towns and cities (i.e. urbanisation). Generally, competition for space is thus declining in rural areas and increasing in urban areas. Rural areas along the coast where agricultural and fisheries cease, traditional cultural landscapes will change. In coastal areas, the urban lifestyle manifests through the conversion of many farmhouses into secondary homes/summerhouses, and local communities turn into seasonal living communities, and local inhabitants

commute instead of engaging in the local economy. Local fishermen and local farmers disappear, as does grazing of coastal seminatural grasslands with implications for biodiversity and NCPs. Depopulation of rural areas in the Faroe Island, such as smaller islands without road connections to the capital on the Faroe Islands, may change the general attitude towards traditional activities such as the egg-harvest and hunting of some bird species. Thorough assessments of the consequences resulting from urbanisation, urban development and the associated pressures on biodiversity and NCP, are important for reducing the impacts on biodiversity of this indirect driver.

Technical development oriented toward less-energy dependent societies that promote decoupling of economic development from expanding resource utilisation can reduce environmental trade-offs. Prioritising sustainable technical advancement in decision-making is high on international agendas.

Aesthetic and ethical perspectives on nature and the use of NCPs

are important for how governance is developed. Where cultural ecosystem services are part of the classification of MA 2005, IPBES has established culture as a mediator in the relationship between people and all NCP. The precautionary approach adopted during the construction of the Sound bridge between Denmark and Sweden, as to avoid any large-scale effects on the ecosystem in the short- and long-term, was on one hand part of the mainstream environmental project implementation but also a cultural expression of caring for nature. The right of public access to the shoreline in most Nordic countries is another expression of the value Nordic societies place on the right to be close to nature. Safeguarding this right, along with maintaining the beach protection law, helps to protect coastal environments from further exploitation. Culture is thus generally a positive indirect driver of environmental change in the region, providing potential for sustainable policy-making.

Oqaatsut, small village on an island in Disko Bay.
Photo: Silje Bergum Kinsten/norden.org





Grazing landscape in the Faroe Islands. Photo: Håkan Tunón



Bomarsund ruins at Lumparn. Photo: Åland local government

Challenges and Opportunities for Policy and Management

High density of policies. Environmental governance in the Nordic region is oriented towards polycentric and participatory governance, which means that many different stakeholders are involved in the policy making process in more or less formal ways.

Currently, a shift toward multi-level governance is observed, where power previously held by the nation state is shifting both upwards (to the supranational level), downwards (to the local level) and sideways (to involvement of both private and public stakeholders in policymaking). These trends have implications for policy coherence. As policy density is high, there are many different political goals to be achieved simultaneously, which increases the risk for policy conflicts. For example, biodiversity and water quality goals can conflict with other targets influencing the aquatic environment, such as aquaculture, industrial development, flood risk

management, climate change mitigation and adaptation, tourism, infrastructure development and agriculture (Box 4). Such policy conflicts are often related to the difficulty in balancing ecological, economic and social sustainability, as well as to the difficulty in weighing different societal and ecological goals. Even though policy makers weigh the costs and benefits of the alternative policy decisions – the high policy density makes it challenging to evaluate the complete picture and develop cohesive policy in this area. Options to overcome these challenges include research targeted at informing the political process, as well as legal and institutional

innovations to overcome unintentional policy outcomes and conflicts.

A major challenge is how to align different international policies and EU-directives in national policy – and how to coordinate this across policy sectors, policy levels and national borders, while inviting all relevant stakeholders into the process. For example, the EU Water Framework Directive (WFD), which is relevant for all EU member states, along with Norway and Iceland which are connected to the EU through the Agreement on the European Economic Area (the EEA agreement), follows an ecosystem approach. This means

that waters should be managed according to hydrological boundaries in larger River Basin Districts (RBDs), redrawing the administrative map of water institutions in Europe. In the Nordic region, all countries except for Iceland, share one or more RBD with another country. Implementation of the WFD thus implies new demands on institutional arrangements at local, national and international levels, and transnational cooperation is important.

A multi-scales approach is necessary to incorporate a ‘landscape’ vision that goes beyond the current coastal environment definition, but includes the entire watershed and eco-regional boundaries that connect the sea/coast/land interface. The EU Commission’s Framework for Marine Spatial Planning (MSP) aims to identify the different uses of the marine space and facilitate a coherent and sustainable implementation of various initiatives for

the marine environment. For example, the Swedish Agency for Marine and Water Management has divided their waters in to three areas with distinctive features (the Gulf of Bothnia, the Baltic Sea and Skagerrak and Kattegat) and implemented MSP initiatives in each. The Integrated Coastal Zone Management (ICZM) tool includes all political processes that affect the coastal zone with the goal of achieving sustainable development in the interaction between land and sea. The connections between MSP and ICZM place new demands on transnational cooperation. Implementation of these types of approaches can help to assess trade-offs and the coupling between biodiversity, NCP and governance in coastal areas.

There is a common Nordic culture of well-developed information-systems, equity, trust in the State and compliance to regulations, as well as a long-standing corporate governance tradition,

where participatory governance structures and extensive cross-border cooperation has a long history. This culture provides ample opportunity for co-management, transnational cooperation and landscape approaches.

INCREASE KNOWLEDGE BASE

Assessments of threats to NCP, along with determining their vulnerability, especially in relation to changes in supply and demand in a climate change context, will help to provide important insight. The categorization of threats linked to NCP will provide information on the thresholds associated with each service in relation to drivers, the scales at which management actions are required, and help prioritise goals.

There is a need for better data, as well as a compilation of existing knowledge on biodiversity, ecosystem function and their services. In particular, there is a need to investigate how changes in

Box 4: Policy incoherence in the Nordic region

The Sound, Denmark, Sweden: Despite good cross-border cooperation, high policy density in the Sound has led to incoherence. Streamlining and developing holistic strategies is needed:

- The Swedish part of the Sound is managed under the EU Water Framework Directive (WFD), while the Danish part is managed under a combination of the WFD and the EU Marine Strategy Framework Directive (MSFD)
- Different authorities handle different regulations that affect water quality work, each with different perceptions of how efforts should be balanced between e.g. water quality and water use.
- Marine managers identify the Sound as part of the Greater North Sea, due to its marine nature and the presence of the shallow sill at its southern end. River basin managers identify the Sound as part of the Baltic, due to the watershed at its northern end. Even smaller catchments, used to group measures on land, do not match the marine underwater topography. These mismatches can cause difficulties when evaluating work at a regional level.

Kalix, Sweden: An extensive network of authorities create, implement and oversee compliance of regulations relating to fishing in the coastal waters of the Bothnian Bay. The new fishing regulations have meant that local community members no longer can catch their own fish or sell any surplus as previous generations did, despite the area regularly being put forward as a successful example of participatory governance or co-management.



Näätämsö/Neiden basin

biodiversity at multiple trophic levels are related to ecosystem function, and how this is linked to NCP. Monitoring programs that allow for comparative analyses across national borders, and that are adapted to policy priorities and trade-offs, need to be designed. The development and use of standardised assessment tools and ecological indicators across the Nordic region can provide information on status and trends and be applied in cross-regional monitoring programmes. Inspiration can be drawn from monitoring programs developed in regional conventions including HELCOM and OSPAR.

The inclusion of ILK in monitoring programs can help to provide important insights (Box 5). The region has excellent and credible community-based monitoring examples, as illustrated e.g. in the Disko Bay, Kalix and Näätämö River cases studies, that can provide on the ground knowledge to detect changes in species abundance and the quality of NCPs.

MAINSTREAM BIODIVERSITY AND ECOSYSTEM SERVICES IN TO ALL POLICY SECTORS

In the Nordic region, there is political will to ensure that environmental management, protection and conservation are integrated in to sustainable development, by mainstreaming sustainability in to society. For instance, Åland Islands aims to mainstream sustainability into their daily life and management of the environment and natural resources. Building on this will, the importance of NCP for society can be highlighted. Not only as provider of food and goods, but also to secure and value social and

cultural wellbeing for future generations. By mainstreaming the concept of NCP in to all policies (e.g. health, education, transport, land-use, environment and so on), considerations of sustainability across sectors can be enhanced. The integration of environmental policy in to all policy areas is a requirement for all EU member states and in accordance with the SDGs and Aichi targets (Strategic Goal E).

To maintain the strong cultural, physical and psychological link to nature, along with a sense of duty to protect it, safeguarding the right to public access of coastal areas is key. This works to maintain the “naturalness” of landscapes, improving the potential for NCP and promoting outdoor recreation.

INVOLVE ALL STAKEHOLDERS

A strong – but often forgotten – link exists between biodiversity, NCP and Nordic cultural identity. We need to elaborate on how to govern and harvest NCP in a way that makes the most common good today and for the future. Collaborative management and joint governance can help to highlight non-monetary values of biodiversity and NCPs and conserve

cultural values. Successful approaches that result in better compliance in decision-making, are thought to be constructed from a dual-approach: 1) Joint knowledge flows from ILK and science to inform decision-makers of the situation, baselines and changes in a given context; 2) joint decisions (usually consensus or 50-50) on the uses and governance of natural resources and territories

Changes in the customary use of NCP are often inflicted by external drivers, like regulations regarding resource management or competing resource use. Within ILK systems there are processes of, for example, limiting self-harvest of Atlantic salmon in years of low stocks, and ILK discussions regarding local governance of subsistence fishing in the Northern Gulf of Bothnia. It implies systems of endemic or place-based resource management, which is closely linked with customary uses.

CLIMATE CHANGE

Climate change will affect Nordic marine and coastal biodiversity profoundly in the future by changes, for example, in biogeochemical cycles and in the distribution of species with influence on

Box 5: Inclusion of indigenous local knowledge in environmental monitoring

Since 2008, the Ministry of Fisheries and Hunting (APN), Qaasuitsup Municipality and the Association of Fishers and Hunters in Greenland (KNAPK), have been testing the use of locally-based monitoring of living resources in communities in Disko Bay and other places in Qaasuitsup Municipality in North West Greenland under the PISUNA program. In the program, village councils appoint 5-12 members of local Natural Resource Councils, comprising experienced fishermen, hunters and other environmentally interested people. They observe the living resources and the marine and coastal environment whenever they are travelling, fishing and hunting. Every three months they summarize, discuss and interpret their observations. They propose management recommendations to the municipal government through submission of a standardized report. At first, PISUNA was met with considerable skepticism from both scientists and the local hunters and fishermen. Most of this skepticism has since been overcome as the program has addressed challenges, tested solutions and adapted as required. The program therefore now provides a great example of how local people can participate in environmental monitoring in Greenland and elsewhere.

the biodiversity. The northward migration of fish including mackerel and cod, along with the occasional records of tuna in the seas of the region are evidence of changes in the distribution of biodiversity. Dramatic changes in the Arctic, including loss of permanent ice cover, the northward migration of species, and the greening of northern regions, can lead to changes cascading effects through the ecosystems. For instance, changes in coastal food webs have resulted in impacts on humpback whale populations. Moreover, the abovementioned examples can lead to changes in trophic structure, the spread of pathogens, the leakage of nutrients and increased oxygen depletion in many areas. It is therefore of paramount importance that effective governance is developed to mitigate impacts on NCPs and to build strategies for sustainability.

To help build a resilient future for the Nordic region, adapting to

the effects of climate change is necessary. Ecosystem-based adaptation is a relevant and applicable mechanism in the Nordic coastal region, due to the value placed on open and accessible coastlines. In addition to their recreational value, these coastlines provide a natural buffer to the impacts from sea level rise and increased frequency of storms that are expected in changing Nordic climate. The establishment and conservation of wetlands, such as those in northern Funen in Denmark, reduce the vulnerability of coastal towns and cities, have positive impacts on coastal biodiversity including birds and fish, and provide opportunities for recreation and learning.

While fossil fuels still are vital to the economies and welfare of the Nordic countries, it is crucial to mitigate the climatic consequences of exploiting fossil carbon reserves by eliminating CO₂ emissions where possible. While

the development of coastal wind power, wave and tidal energy can reduce dependence on fossil fuels, negative consequences include reductions in aesthetic values and habitat modification with impacts on biodiversity and ecosystem function. For example, offshore wind parks have been seen to have negative impacts on migrating fish and sea birds. Conversely, wind parks in the Sound have proven to enhance fish stocks due to the creation of new habitats and marine protected areas due to fishing restrictions near windmills. The production of alternative energy sources is ingrained with costs, benefits, difficult trade-offs and conflicts, but help to reduce the region's ecological footprint. Carbon capturing and/or techniques, such as the use of carbon fixing ecosystems like kelp forests, and zero emissions targets provide similar opportunities.

Kvarken. Photo: Vincent Westberg



Biodiversity and Ecosystem Services in Nordic Coastal Ecosystems – an IPBES-like assessment

Summary for Policy Makers



The report focuses on the Nordic coast since the Nordic countries have this environment in common and it is significant for the historical and economic development of coastal areas.

The aim is to highlight the Nordic coastal biodiversity and ecosystem services, as well as drivers affecting them and policy options for their conservation and sustainable use. The report brings together a wide variety of knowledge from science, humanities and other knowledge systems such as traditional knowledge.

The report is a result from Nordic co-operation among Denmark, Finland, the Faroe Islands, Iceland, Greenland, Norway, Sweden and the Åland Islands.

It is based on a process developed within the framework of the Intergovernmental Platform on Biodiversity and Ecosystem Services IPBES, where it is used to guide regional and subregional assessments of biodiversity and ecosystem services.