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1. Setting the scene

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Box 1: Summary

Biodiversity loss can degrade ecosystems and impact the ability of ecosystems to contribute to people. The last 20 years of ecosystem service research has increased society's interest in fighting the consequences of ecosystem degradation. During the last decades, attitudes towards conservation have been shaped in many ways. According to Mace (2014), "nature for itself" was a key principle during 1960s–1970s supporting concepts such as protected and wilderness areas. Human pressures on nature during the 1980s and early 1990s resulted in extinctions, habitat loss, and pollution, which made it urgent to act for "nature despite of people". That period was followed by a "nature for people" period, in which biodiversity challenges were mainstreamed via concepts such as ecosystem approach, ecosystem services and economic values. The latest paradigm, which was developed by Mace (2014) is called "people and nature". Key concepts in conservation circles include environmental change, resilience, adaptability and socio-ecological systems.

Several assessments of the state and trends of biodiversity, ecosystems and ecosystem services have been carried out via various initiatives, such as Millennium Ecosystem Assessment (MA, 2005), followed by the Economics of Ecosystems and Biodiversity (TEEB) assessments and the Aichi biodiversity targets of the Convention on Biological Diversity (CBD). In Europe, Mapping and Assessment of Ecosystems and their Services (MAES) has generated a lot of new knowledge on the quantification of ecosystem services and use of this information in decision-making. Today, more and more open data is available through research infrastructures, for example, remote sensing data through the Copernicus programme of the European Union and European Space Agency. Nature-based solutions and green and blue infrastructure are becoming popular in landscape planning and highlight different aspects of the socio-ecological (synon. coupled human-environment) systems and their sustainable management.

The most significant attempt to highlight the importance of biodiversity and ecosystem services globally, has been the establishment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). IPBES has launched a series of thematic and geographical assessments. The European and Central Asian regional assessment has been ongoing parallel to this Nordic IPBES-like assessment that has focused on coastal ecosystems and their services. This assessment covers the Nordic countries, i.e. Denmark, Finland, Iceland, Norway and Sweden, and autonomous areas such as Åland, Faroe Islands and Greenland, which are a unique "biocultural" piece of Earth with unique nature values and well-established societies. This report consists of two volumes: I) a general overview and II) case studies (Tunón (Ed.), 2018). The chapters of volume I include: Setting the scene and describing the methods used in the report (Ch. 1), the significance and development of NCP (Ch. 2), biodiversity and ecosystems (Ch. 3), drivers and pressures (Ch. 4) and the integrative synthesis of them (Ch. 5), as well as governance and policy analysis (Ch. 6). In volume II, ten case studies illustrating different aspects of the Nordic key ecosystems and their influence onthe society are presented. Drivers and pressures that human activities cause to nature are also demonstrated. Each case has been analyzed using the IPBES approach, and where possible, Indigenous and Local Knowledge (ILK) aspects are emphasized. We

have followed the IPBES methodology already described in the scoping study for the Nordic region (Schultz *et al.*, 2016). The coastal focus was selected because of its significance to the history and development of the Nordic countries. Coastal areas also highlight the important linkages between the regions, but also interactions of land and sea. The first chapter introduces the assessment, data sets and methods, along with the important role of ILK data alongside novel data sources such as Earth Observations in comprehensive socio-ecological systems analysis.

1.1 Context of the Nordic coastal zone assessment

This Nordic IPBES-like assessment of Nordic coastal ecosystems and their services analyses the relationship between nature and people. It aims to strengthen the science-policy interface for biodiversity and ecosystem services, as well as the conservation and sustainable use of biodiversity and long-term human well-being. Governance aspects are assessed in the Nordic region, e.g. fiscal issues and how governance systems in one country might affect the whole region, or governance structures that need to be better linked due to the governance of commons in the Nordic region. Nordic coastal ecosystems have a very important role for all Nordic countries, while there are also great differences between the areas depending on abiotic, biotic and social circumstances and histories. This aim of this first chapter is threefold: 1) to introduce the Nordic environment and its major characteristics, 2) to introduce the reasons for this IPBES-like assessment and 3) to introduce the structure of the report, including some methods used in various chapters and the synthesis of results in Chapter 5.

1.1.1 Why is this assessment important?

Biodiversity loss is one of the biggest challenges threatening the future of mankind and may even be more serious than climate change (e.g. Rockström *et al.* 2009, 2016). The gradual loss of biological functions is difficult to observe, but changes may lead systems to tipping points, after which ecosystem changes may be irreversible and the delivery of ecosystem services altered dramatically. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) was established in 2012 to support the conservation and sustainable use of biodiversity and ecosystem services, and it is administrated by the United Nations Environment Programme (UN Environment). The aim of this platform is to gather relevant knowledge on the status and trends of ecosystems and their services, in order to change the direction of unwanted development in nature e.g. the loss of biodiversity and degradation of ecosystem services.[1]

The serious loss of biodiversity and degradation of ecosystem services has been observed globally (MA, 2005) and economic impacts have been partly quantified (e.g. via TEEB[2]). Regionally, some positive trends in the environment have occurred (see

[1] https://www.ipbes.net/
[2] http://www.teebweb.org/

e.g. EEA ,2015), but in general, habitat loss, climate change, pollution and the unsustainable use of natural resources are the key drivers for negative trends in biota, which often leads to a decrease in human well-being (MA, 2005). However, there are some positive initiatives in society, such as mainstreaming of the protection of ecosystem services to several new sectors and policies. However, better knowledge and new governance tools are needed to improve the sustainability of our societies under current drivers of change.

The first step toward changing the direction of unwanted development for the future is to gain accurate knowledge on the status and trends of ecosystems and their services. Currently, IPBES is developing regional assessments of the four UN regions (Europe and Central Asia, Africa, the Americas, and Asia-Pacific), and a global assessment of ecosystems and their services. In addition, thematic assessments on pollination and land degradation have been completed and there are plans for further thematic assessments on valuation, invasive species and sustainable use.

The IPBES work inspired the Nordic countries to start planning for this "Nordic IPBES-like assessment" in early 2015, when the Nordic Council of Ministers founded a pilot study for scoping the Nordic IPBES contribution (Schultz *et al.* 2016). Based on that study, a mutual interest to specify assessment toward coastal areas was identified. The three-year ecosystem assessment took a coastal focus, including considerations of land-sea interactions. *Coastal* is defined very flexibly and more detailed descriptions are given in chapters or case studies. In this assessment, *coast* includes both the terrestrial part of the shoreline and the shallow near-shore aquatic parts. The open sea area is not included in this assessment.

1.2 Previous assessments and the conceptual "IPBES" framework

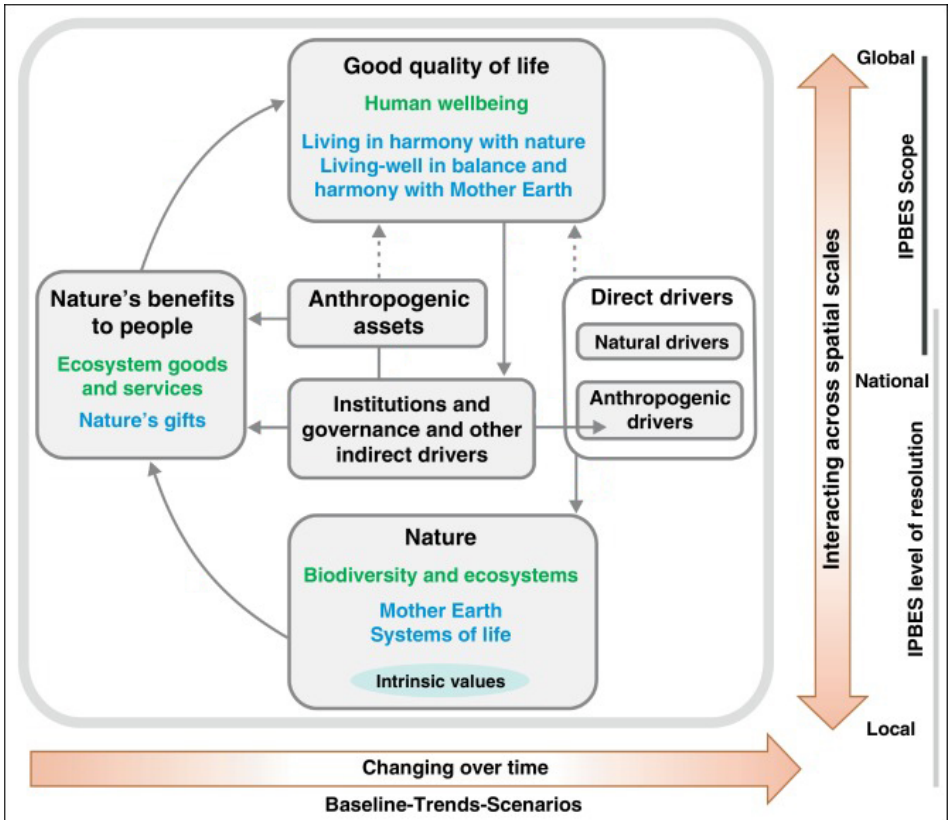
European ecosystem assessment work, such as Mapping and Assessment of Ecosystems and their Services (MAES) of the European Commission's Biodiversity Strategy, has focused mainly on terrestrial ecosystems. However, coastal and marine ecosystems and their services have been explored recently in two publications: *Marine ecosystem services in Nordic marine waters and the Baltic Sea – possibilities for valuation* (Hassler *et al.*, 2016), and *Ecosystem Services in the Coastal Zone of the Nordic Countries* (Gundersen *et al.*, 2016). These publications, together with some earlier reports including the TEEB Nordic evaluation on the socio-economic importance of ecosystem services in the Nordic Countries (Kettunen *et al.* 2012), gave a good starting point for this Nordic coastal IPBES-like assessment. In addition to these previous ecosystem service studies, there are plenty of marine studies published by, for instance HELCOM.[3]

IPBES Plenary 2013 adopted a conceptual framework for the Platform (Fig. 1). The "nature's benefits to people" were set out with a classification of those benefits, renamed "nature's contributions to people" (NCP) (Díaz *et al.*, 2015, Pascual *et al.*, 2017,

[3] http://www.helcom.fi/

Díaz *et al.* 2018). The concept of NCP is proposed to increase inclusiveness and to facilitate reporting. It is considered to reflect key improvements to the original Millennium Ecosystem Assessment classification (2005), based on more than a decade of scientific progress in interdisciplinary thinking, with increasing involvement from the social sciences. NCP is fully consistent with the IPBES conceptual framework and it is recommended for use in IPBES regional assessments and in the global assessment.

Figure 1: The conceptual model for the IPBES approach



Note: During the assessment, nature's benefits to people were changed to "nature's contributions to people". This definition allows pluralistic views such as ecosystem goods and services, nature's gifts etc.

The Nordic assessment follows the IPBES conceptual framework that includes six interlinked elements constituting a socio-ecological system operating at various scales in time and space: nature, nature's contributions to people, anthropogenic assets, institutions and governance systems, along with other indirect drivers of change, direct drivers of change and good quality of life (Fig. 1). In this report, we have followed the IPBES recommendation and taken NCP as a general term that includes definitions for different worldviews and interpretations, such as western thinking "ecosystem services (ES)" and nature's gifts of indigenous people, for instance. The Multidisciplinary Expert Panel of IPBES also proposes that the term Nature's Contributions to People can be used when referring to "Ecosystem Services" (ES). Both concepts are used throughout the report.

1.3 The Nordic model for ecosystem assessment

1.3.1 Characteristics of the Nordic region

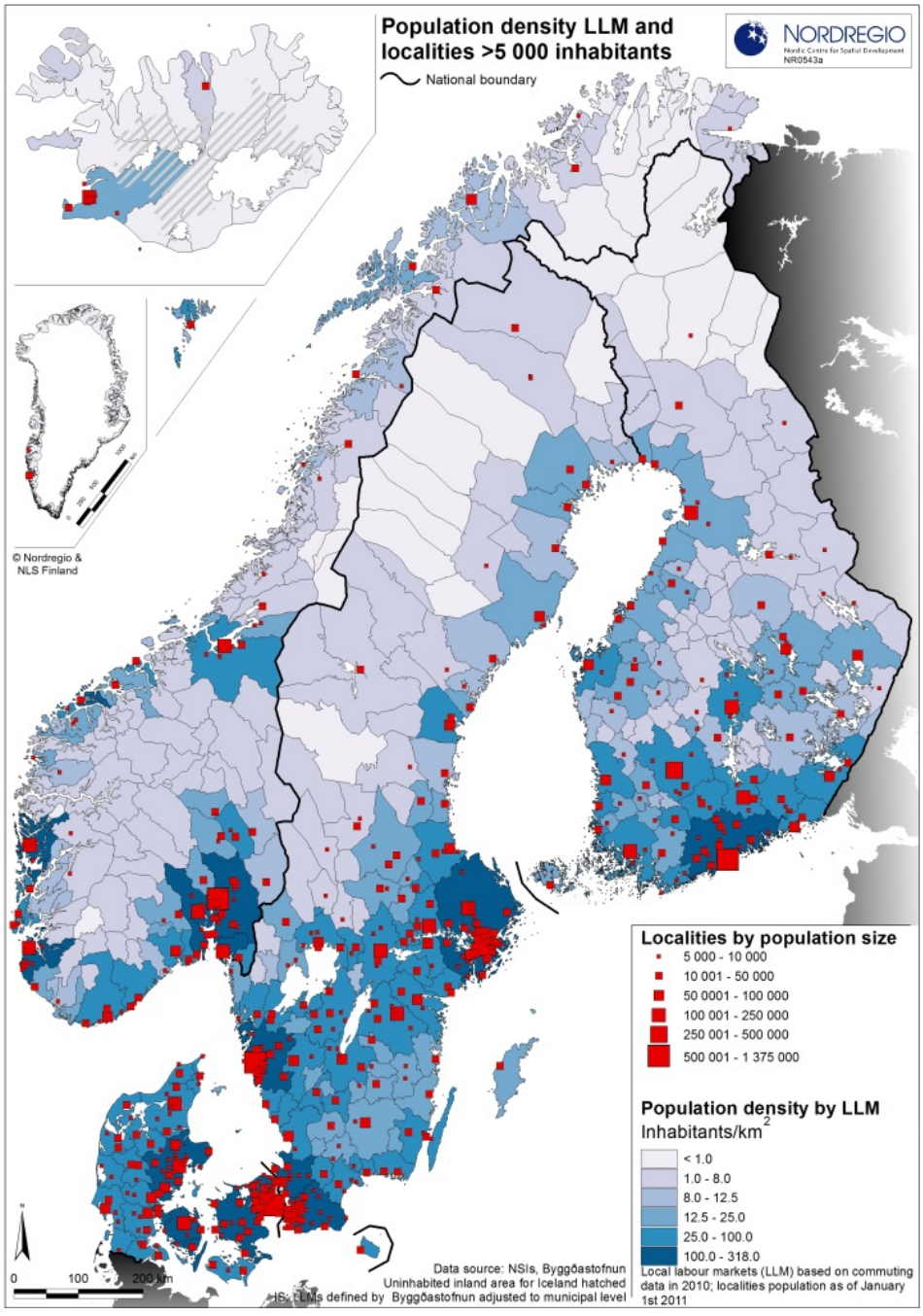
Figure 2: Study area of the Nordic IPBES-like assessment (yellow regions)

Source: DeLorme, Lat Long: ESRI 2013.

The Nordic region includes Denmark, Finland, Faroe Islands, Greenland, Iceland, Norway, Sweden and Åland (Fig. 2). Unique characteristics of the region are a result of the continuum of human influence – from hunters and gatherers of the ice-age, towards wealthier modern times and increasing urbanization during which land use has changed remarkably. Forests of southern areas such as Denmark and southern Sweden have overturned to agricultural areas. Mires and peatlands have been heavily ditched to support forestry, but have affected run-off to adjacent waters. Fishing technologies and governance systems have changed drastically. During the last hundreds of years, the Nordic societies have become prosperous and stable democracies in a global comparison. Throughout history, coastal areas have played a special role for societies

in the Nordic region: they have been used as transport and exchange routes of ideas and natural resources, and as a source of basic human needs. Today, the area is inhabited by ca. 26.9 million people and also includes the indigenous people of the Saami and Kalaallit (Inuit Greenlandic), as well as several national minorities. There are densely populated areas as well as areas with few inhabitants (Fig. 3).

Figure 3: Population density in the Nordic countries in 2011



Source: Nordregio. (Available at: archive.nordregio.se)

Nature

Biogeographically the Nordic countries are part of the Palearctic region, with conditions spanning from Atlantic to continental (see below). The Nordic area supports a variety of aquatic and terrestrial habitats including e.g. marine, brackish water, freshwater, wetlands, forests and agricultural landscapes. The Nordic coastline is about 150,000 km long with large geomorphological and climatological variation. 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.[4]

Nordic countries belong to five biogeographical zones:

- Arctic (Norway, Iceland, Greenland);
- Alpine (Finland, Sweden, Norway);
- Boreal (Finland, Sweden, Norway);
- Atlantic (Norway, Denmark);
- Continental-nemoral (Sweden, Denmark).

In addition, there is a transition zone between the temperate deciduous forests of the nemoral zone and the coniferous forests of the boreal zone, the boreo-nemoral zone (or hemiboreal vegetation zone) (Kettunen *et al.*, 2012; Fig. 4).

The Nordic region can be divided in to marine biogeographical regions according to EEA:[5]

The two EEA marine biogeographical regions[6] are:

- Marine Atlantic;
- Marine Baltic.

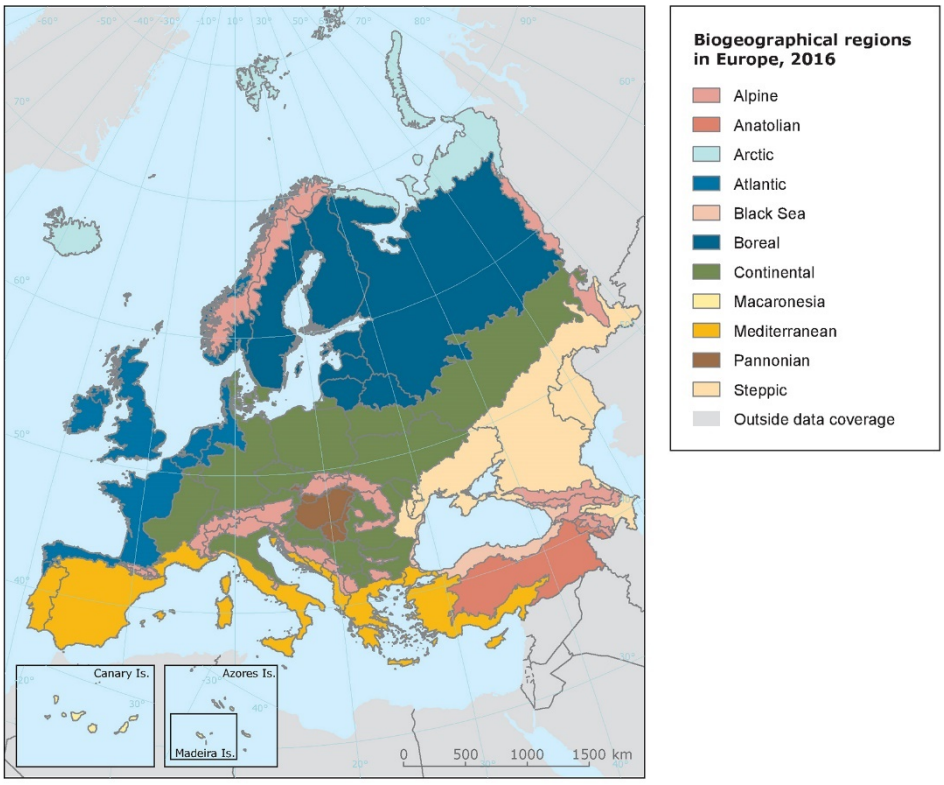
Baltic Sea data and management of it is hosted by the regional agreement of HELCOM, while the North Sea and Norwegian Sea are hosted by the regional agreement of OSPAR.

[4] See e.g. https://www.bonusportal.org/projects/viable_ecosystem_2014-2018/cocoa

[5] https://bd.eionet.europa.eu/activities/Natura_2000/chapter1

[6] https://bd.eionet.europa.eu/activities/Natura_2000/chapter1

Figure 4: Biogeographical regions in Europe



Note: Nordic bio-geographical regions have unique characters and they differ significantly from the southern regions of Europe. This influences also the composition of available ecosystem services.

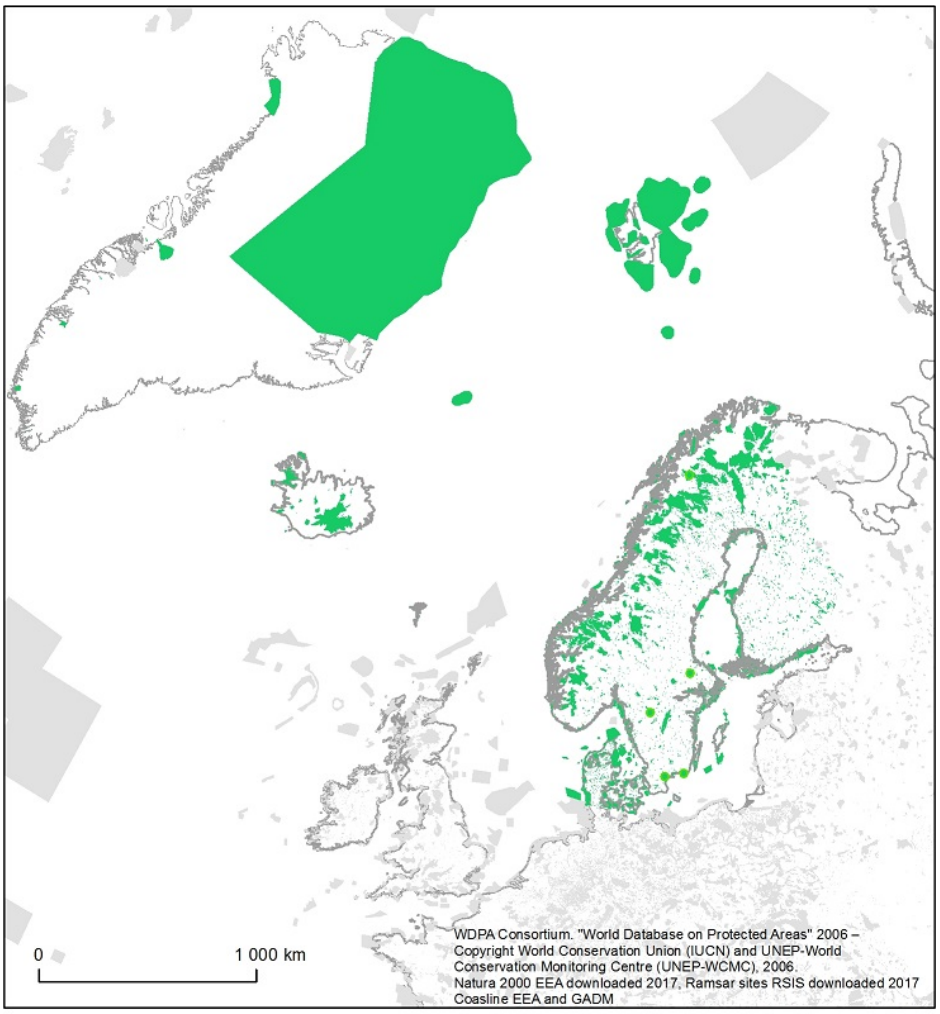
Source: EEA, Copenhagen, 2016.

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 characterized by high annual precipitation. Greenland is dominated by glaciers, but also has tundra and marine ecosystems with diverse fauna and flora. There are unique archipelago areas typical for the Swedish west coast and the archipelago sea in the central Baltic between Sweden, Åland and Finland. Waters are typically brackish and the mosaic landscapes on thousands of islands have a variety of terrestrial habitats (NMR 2001).

The Nordic countries are surrounded by marine waters of North-eastern Atlantic Ocean origin i.e. the Baltic, Barents, Greenland, Iceland, North and Norwegian Seas, the Skagerrak and Kattegat, and the Arctic Ocean. Salinity together with morphological (such as depth) and physical features (such as currents, tidal range and wave impacts) are the main factors affecting the structure of the various aquatic ecosystems. The Baltic Sea is one of the world's largest brackish water areas. It is a shallow inland sea with almost freshwater conditions in the northernmost part and an increasing salinity towards the south and the Kattegat. True oceanic conditions prevail in the Atlantic coastal areas.

In a study by Gundersen *et al*. (2016), four key ecosystems were selected to be examined for their services. These were kelp forests, eelgrass meadows, blue mussel beds and shallow bays and inlets. These ecosystems have also been included in this assessment because they provide important nursery habitats for many fish species, along with several key processes and functions that regulate e.g. coastal erosion, nutrient cycling, carbon sequestration and water purification. Some of these ecosystems and other valuable habitats are protected by conservation areas, forming important networks of valuable ecosystems. Protected areas in the Nordic countries consist of areas of different conservation categories, from Natura 2000 sites to national parks and marine protected areas (see HELCOM; Fig. 5).

Figure 5: Coverage of the protected areas (green) in the Nordic region



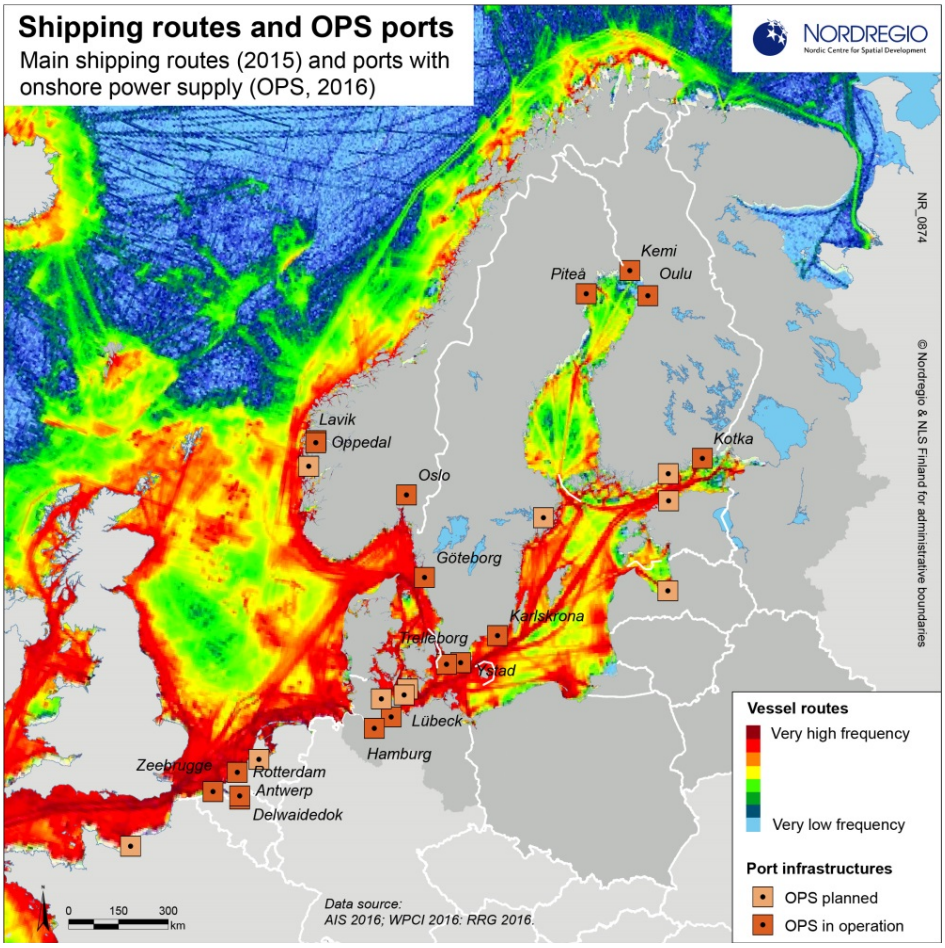
Source: World Conservation Union (IUCN) and UNEP World Conservation Monitoring Centre (UNEP WCMC), 2016.

Drivers and pressures

The Nordic countries share a long history, with their socio-ecological systems connected to one another via the sea. Today, coastal regions are still very important traffic routes, which affects pressures on ecosystems, for instance around the Sound and Gulf of Finland (Fig. 6). Coastal regions are crucial for many economic sectors such as fisheries, aquaculture, tourism, energy (e.g. wind turbines), natural resources (e.g. sand and gravel, oil and gas fields, particularly around Norwegian and Greenlandic coasts, see Fig. 7) and industrial processes. Agriculture is also adjacent to many coastal

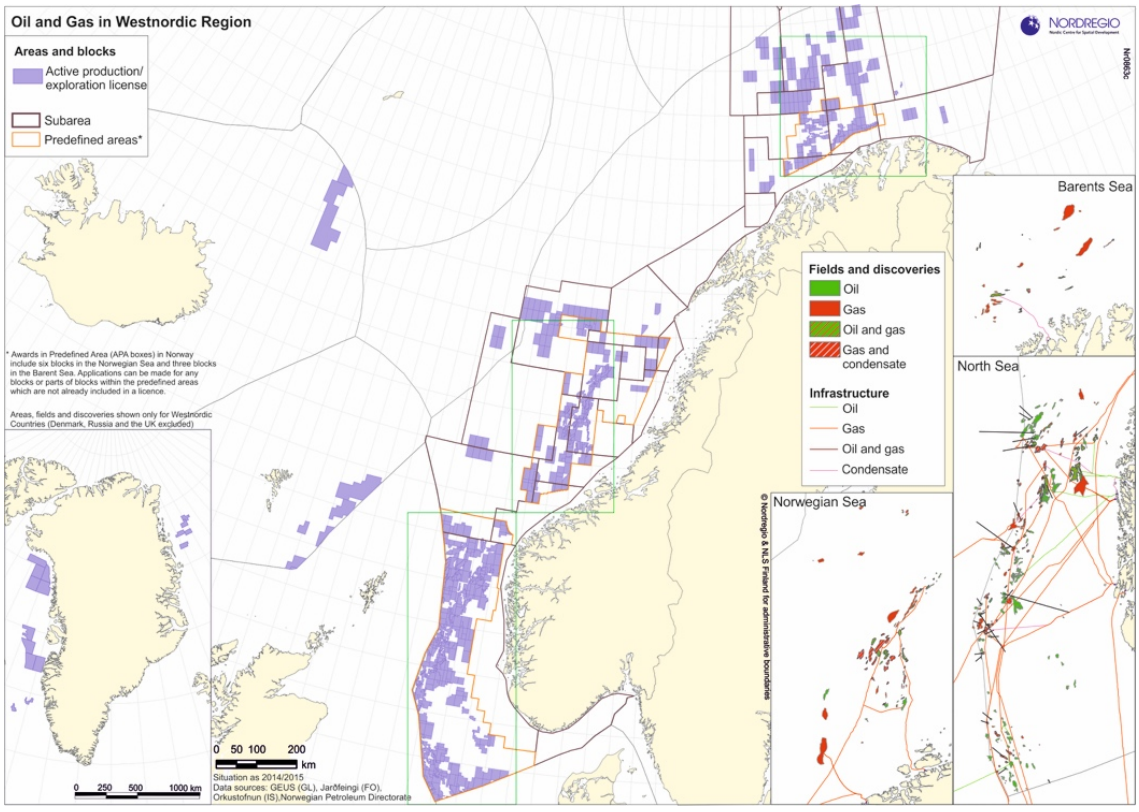
catchments affecting the water quality in shallow waters with restricted water exchange, such as the Baltic Sea (see Fig. 8). Drivers and pressures are discussed comprehensively in Chapter 4. The importance of regulating services has increased significantly. For instance due to climate change, effective carbon sequestration is necessary to consider for sustainable management of landscapes and seascapes.

Figure 6: Shipping routes as an example of pressure to coastal and marine areas 2015



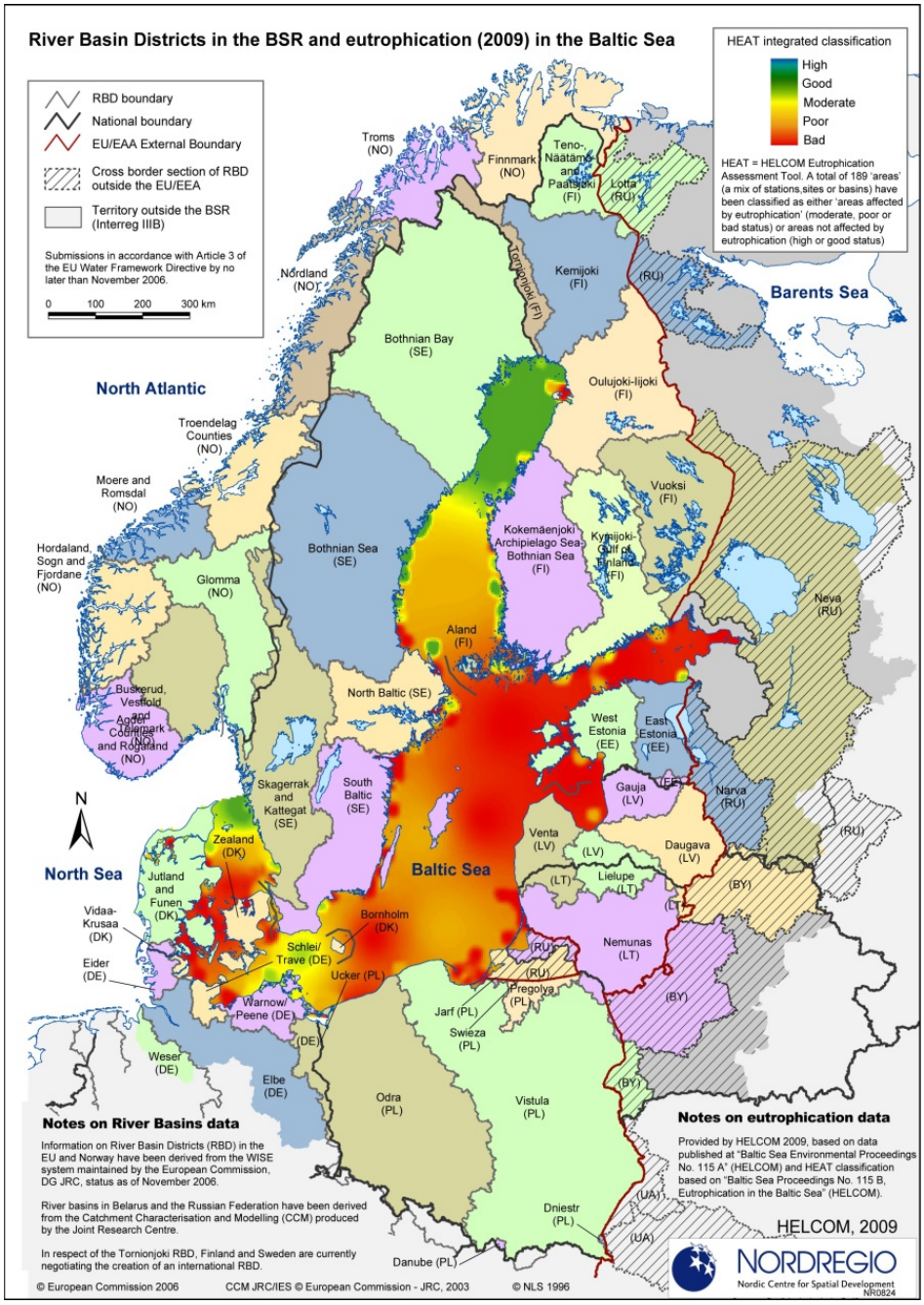
Source: Nordregio. (archive.nordregio.se)

Figure 7: Oil and gas fields in the Nordic region showing possible risks and pressures to the sea ecosystems



Source: Nordregio, 2016. (archive.nordregio.se)

Figure 8: River Basin Districts in the Baltic Sea region and eutrophication (2009) in the Baltic Sea



Source: Nordregio. (archive.nordregio.se)

People and governance

Societies in the Nordic countries are well established. People give high value for nature and rights of public access. The majority of the population live in the coastal regions (cf. Fig. 3). The political systems are quite similar in all the countries. National, regional, international and EU legislation (e.g. Habitat Directive, Water Framework Directive, Marine Spatial Planning Directive, Common Fisheries Policy) is implemented to govern nature and natural resources. These and other examples of governance aspects are described comprehensively in Chapter 6.

Accessibility to nature is an important value for the Nordic people and everyman's rights are a unique part of the Nordic outdoor culture. The extent of the right to public access varies among countries and in certain regions within a country, there are different public access rights, such as between Åland and Finland. In contrast to most parts of the world, the landscape outside settled areas is accessible and people do not rely as heavily on protected areas for outdoor recreation. However, discussions on ecosystem services and for instance, nature-based tourism, has highlighted the need for assessing and updating rules on how to balance different demands and needs that stakeholders and citizens have for nature.

Along the Nordic coasts there are many different stakeholders, some of them indigenous peoples or local communities. The Nordic countries and the EU have procedures for stakeholder consultations in decision-making and certain rights of the public (individuals and their associations) with regard to the environment. Some of these are laid down in the Aarhus convention (EU, 2017) and in national legislations. However, further development is needed to ensure implementation of participatory mechanisms. This Nordic IPBES-like assessment intends to take a step forward toward various information sources describing human-environment relationships.

Best practice can be learned from the ILK systems. For instance, the indigenous peoples such as the Saami people and the Inuit (Greenlanders), form a crucial part of the Nordic societies with their unique biocultural aspects and knowledge systems, which so far have been poorly integrated in standard environmental monitoring schemes and decision making today. Local communities along the Nordic coasts have local knowledge systems and their customary use of coastal and marine resources has high potential value for the development of policies for long-term sustainable use of coastal ecosystems. When it comes to the local use of biological resources, the concept of "tragedy of the commons" is often referred to, but in local use, there is or has been traditional governing systems in order to ensure the common good. One example in the Nordic context is the often-overlooked Saami siida system that covered approximately half of present day Scandinavia. This was a system of self-regulated fisheries, hunting and reindeer pastures within the Saami society. It contained limitations to prevent overharvesting. Today, the only surviving siida system is preserved amongst the Skolt Saami (Mustonen & Mustonen, 2013).

1.3.2 *Data sources – a focus on GIS and Earth Observation data*

Various spatial and statistical data sets were used in this assessment. The overall assessment is based on scientific literature and expert knowledge. Furthermore, we tried to highlight the importance of GIS, Earth Observation (EO) and ILK, and test and demonstrate their use in ecosystem assessments. National, regional and European Union data (e.g. INSPIRE Geoportal[7] and Copernicus services[8]) have been used. Improved technological solutions are needed for spatially-explicit monitoring of ecosystems and NCP (cf. Holmberg *et al.*, 2016; Vihervaara *et al.*, 2017). This is of particular relevance in the Nordic countries, with their low population density, high social costs and rapid environmental changes due to, for instance, climate change. Many resources are allocated toward producing high quality and harmonized datasets, but further application is still somewhat rare. Especially the full potential of the use of EO data, such as remote sensing data, is not harvested today in ecosystem monitoring and assessments (see also Tolvanen *et al.*, 2016).

Examples of data and their limitations

There are plenty of data sources available that could be used in IPBES-like assessments, for instance:

- Official data for multilateral environmental agreement such as the CBD are available in the most of the countries;
- Some EU policy tools, such as status reports under the Habitats, Birds, Water Framework and Marine Strategy Framework Directives;
- The marine status reports of the HELCOM (Baltic Marine Environment Protection Commission – Helsinki Commission) and OSPAR;
- Assessments and reports that have a more general focus, such as the EU MAES work and ESMERALDA project, Global Biodiversity Outlook and the Nordic countries' own assessments and reports, such as reports by the Arctic Council (e.g. Protection of the Arctic Marine Environment (PAME) working group[9]), and national TEEB studies[10];
- Nordregio[11] has collected and shared numerous maps of the Nordic countries, which are used to illustrate the general features of the study area.

Data sets are not always consistent across data providers. For example, the distribution of common eider (*Somateria mollissima*), which was reviewed in Chapter 3, differs between HELCOM map services, EMODnet biology, IUCN Red List species range and EEA Bird Directive data.

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[7] https://inspire.ec.europa.eu/
[8] http://www.copernicus.eu/
[9] https://pame.is/index.php/document-library/pame-reports
[10] http://www.teebweb.org/
[11] http://www.nordregio.se/en/Maps/

The development of spatial data-sharing infrastructure enables the exchange of information, also outside the governmental public organizations. Marine data is dispersed in different services, both in collections of GIS data and EO products. For all the Nordic countries, data was drawn from multiple sources. HELCOM[12] and OSPAR[13] complete national datasets for their assessment products. The OSPAR Convention members cooperate to protect the North-East Atlantic marine environment. The data collected contains various environmental monitoring themes. The physical features of the sea, such as salinity and sea floor temperature, were drawn from The Operational Mercator global ocean analysis for Chapter 3. Most of the data is grouped, covering the globe and the Arctic Ocean, Baltic sea and European North-West Shelf Sea regions.

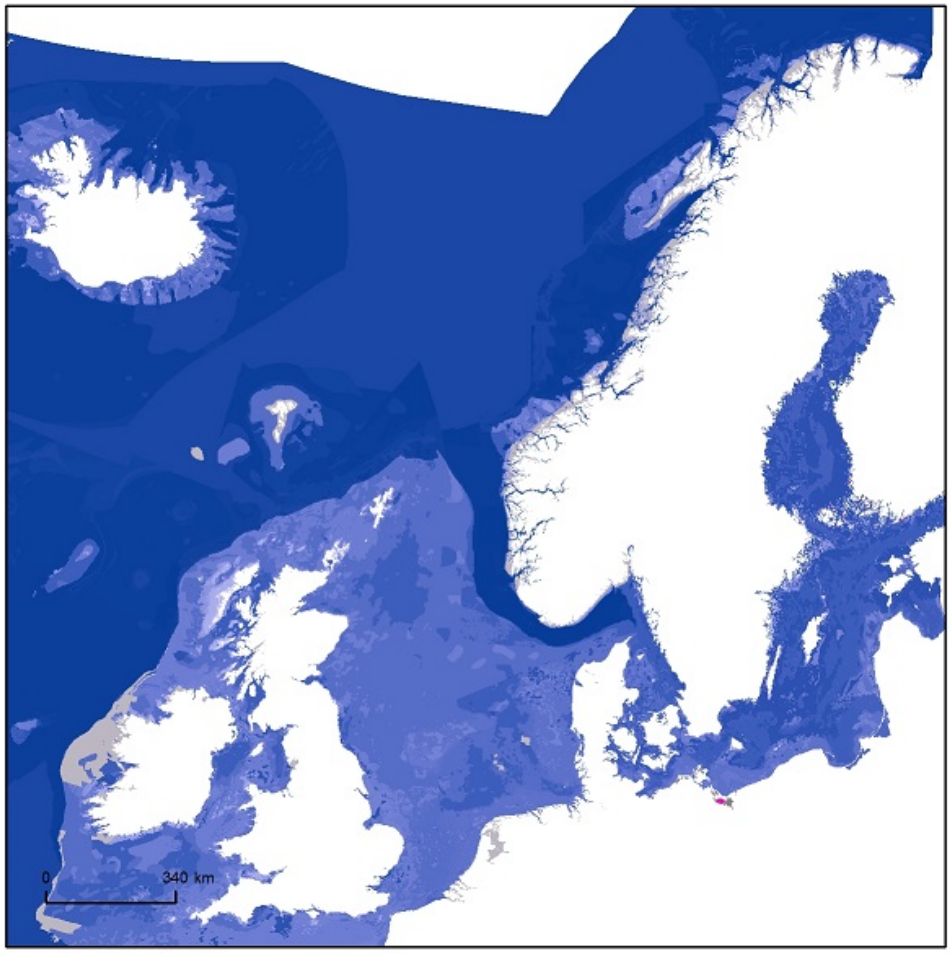
Copernicus services provide increasing amounts of data that can be used in environmental assessments. However, applicability is limited. For instance, data from the Copernicus Marine Environment Monitoring Service is at a global scale, but lacks details. Similarly, European Space Agency's (ESA) GlobCover[14] data is outdated and coarse.

Spatial land and sea cover information

Spatial land and sea cover information on European ecosystem types are available at EEA,[15] EMODnet Seabed Habitats[16] and in regional seas data and map services[17] (Fig. 9). The EEA data on MAES ecosystem types is produced by combining the Corine Land Cover 2000 raster data with EUNIS habitat classification. That data aims to represent probabilities of EUNIS habitat presence in ecosystem types. The extent of the data in this study area covers Finland, Sweden, Denmark, Iceland and Norway. MAES data has many classes for shore types, but limited information on sea habitats. The applicability of MAES datasets in this Nordic IPBES-like assessment is evaluated in subchapter 1.6 and the findings are presented in Chapter 5. Conservation status of habitat types and species (Article 17, Habitats Directive 92/43/EEC) was also used.

[12] http://www.helcom.fi/
[13] https://www.ospar.org/
[14] http://due.esrin.esa.int/page_globcover.php
[15] https://www.eea.europa.eu/data-and-maps/data/ecosystem-types-of-europe
[16] http://www.emodnet.eu/seabed-habitats
[17] http://www.helcom.fi/

Figure 9: Emodnet Seabed Habitats dataset uses the same EUNIS classification, but is also combined with several environmental variables



Note: According to the confidence maps, the data quality varies in different parts of the dataset. For example, there are data gaps near the Norway coastline. The dataset covers the marine areas except western Greenland (Disko bay).

1.3.3 Highlighting ILK in the Nordic circumstances

General introduction – what is ILK?

ILK helps to frame an IPBES-like assessment. Local communities possess knowledge about the functioning of complex ecosystems, which they apply in their daily lives (Berkes, 2012). Indigenous knowledge has been referred to as a "knowledge tradition of its own" (Helander, 1999), which highlights its internal context, connection to a place and relevance in a socio-ecological matrix. In the IPBES context, the most frequent description of ILK or actually *traditional ecological knowledge* is that of Berkes and colleagues:

> "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (e.g. Berkes *et al*., 1995, 2000; Gadgil *et al*., 1993; Berkes, 2012)

This kind of knowledge is most often attributed to communities with historical continuity in resource use in an area, often described as "non-industrial or less technologically advanced societies, many but not all of them indigenous and tribal" (Berkes *et al*. 2000). In IPBES terms, ILK has come to describe traditional knowledge within indigenous peoples as well as within local communities. ILK includes "knowledge of social institutions and governance systems as well as environmental observations, interpretations and practices" (Tunón *et al*., 2015b; Berkes & Turner, 2006; Gómez-Baggethun *et al*., 2013; IPBES, 2017).

The CBD has developed general characteristics to describe "local communities", the most common of which was self-identification of one's characterisation. Some of the characteristics regarding ILK communities are also described in the IPBES assessment on pollinators (IPBES 2016, Box 5.1):

> "Local communities are groups of people living together in a common territory, where they are likely to have face-to-face encounters and/or mutual influences in their daily lives. These interactions usually involve aspects of livelihoods – such as managing natural resources held as 'commons', sharing knowledge, practices and culture. Local communities may be settled together or they may be mobile according to seasons and customary practices. Self-identification is also the key determinant of whether people consider themselves to be local communities."

What characterise indigenous and local knowledge communities?

In this Nordic study, ILK communities can be characterised by having:

- Local knowledge gathered through own observations and experiences over long time periods, usually combined with knowledge transferred from earlier generations, providing a long term view of place-based status and changes over time;
- Exchanges of place-based knowledge with neighbours, relatives and other local knowledge holders in the community, but also exchanges of knowledge with other local communities in the Nordic countries and in the EU (e.g. exchange with other coastal and island residents in the EU);
- A place-based identity, where one's quality of life is linked to the status of the local ecosystems and the possibilities for own agency to influence this status;
- Knowledge of changes both in biodiversity and biotic factors along the coast and in governance structures driven by local, national and EU directives and how these affect local life.[18]

[18] Tunón *et al.*, 2015b; Kvarnström & Tunón, 2018.

According to IPBES, ILK communities are knowledge holders, experts and stakeholders and there is no clear boundary between local knowledge holders and other stakeholder groups. In our study however, we have not focused on the knowledge and actions of larger NGOs or associations like farmer or fisher associations, but on knowledge of local, place-based communities and knowledge holders. As the IPBES Multidisciplinary Expert Panel states, "knowledge systems of many indigenous peoples and local communities, as well as relational approaches in environmental-social sciences and humanities, conceive the linkages between nature and people without strict boundaries between them and in relations based on reciprocity, with human obligations towards the non-human parts of the world." This is also true for the ILK communities in the Nordic region, which means that the different categories of NCP or ecosystem services are usually interlinked for the local communities. Local fishing, for example, is both a material contribution (food) and a non-material contribution, in that fishing defines local identities by providing "a sense of place, purpose, belonging, rootedness or connectedness, associated with different entities of the living world" (IPBES-5-inf-24).

The question of validation

Within the CBD and in IPBES, it is stated that academic knowledge and ILK should be considered as equally valid and valuable. In an ILK community, ILK is validated in a similar way as in the scientific community, with a continuous "peer review process". Statements and practices are continuously validated by, for instance other farmers, fishers, and hunters. The most suitable validation method when evaluating ILK is a broad participation process in which many practitioners can give a combined view on the matter discussed.

In the Arctic Climate Impact Assessment (Arctic Council, 2005), the Finnish Saami reindeer herders worked together with scientists to convey observations of weather change, the arrival of new species, rain-on-ice events and other impacts of northern change. This major assessment reflected that scientific findings were much in line with the Saami indigenous knowledge. Saami knowledge on climate change has also been validated in a cooperative project between researchers and reindeer herders (Riseth *et al.*, 2011) and compared regarding land use and biological diversity (Blind *et al.*, 2015).

There is an increasing number of community based monitoring system projects (CBMS) around the world, which could be applied as ILK data sources. CBMS can be compared to citizen science projects, in that the non-scientific community reports observations that scientists can analyze and present. These data types are included in this assessment. The ILK aspects are described in more detail throughout the other chapters and case studies (see Tunón (Ed.), 2018) of this assessment.

Recent reviews of climate change impacts and biodiversity assessments (Arctic Council, 2005; IPBES, 2016) point to the undisputed value of having more dialogue between ILK and science. A new emerging trend is also the capacity of ILK to provide ecological baseline information in the context of ecological restoration (Mustonen 2013). Sites of change, the extent and scope of damage from negative land uses, along with good practice methods for restoring habitats can be found in ILK.

1.4 Stakeholders in the Nordic context

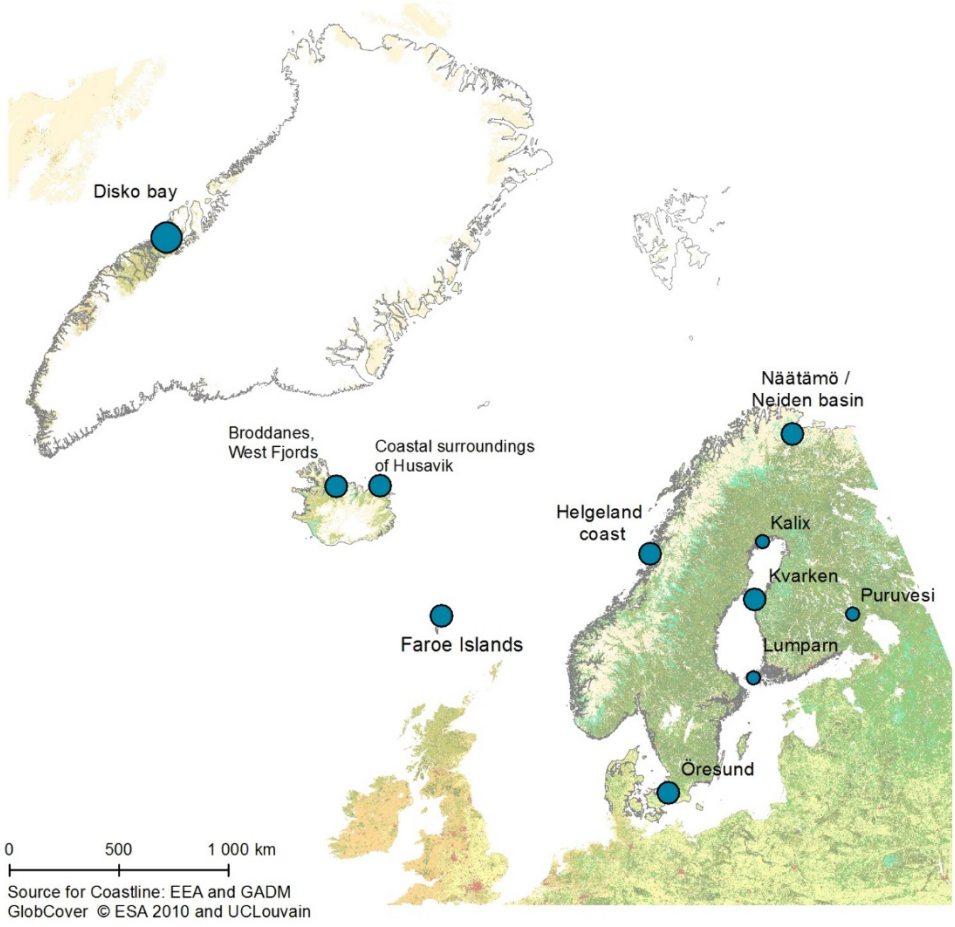
Stakeholders can be classified in two categories: 1. *contributors*, such as scientists, practitioners and ILK holders and 2. *(end-)users*, such as national administrators, governments, reporteurs to environmental agreements (e.g. CBD), research institutes, NGOs, businesses, the general public, along with the European Commission, United Nations and other international organisations.

The local and indigeneous peoples are both extractors and beneficiaries, but in many cases they are "affectees", while their role as influencers is increasing (Newton & Ellliot, 2017). The messages in this report aim to target all of them. Besides indigenous peoples, other rural groups (e.g., farmers, fishers, hunters) constitute important holders of traditional knowledge about the environment (Hernandéz-Morcillo *et al.*, 2014; Tunón *et al.*, 2015a; Prop. 2004). In the present Nordic IPBES-like assessment, we argue for a wide and inclusive definition (cp. Tunón *et al.*, 2015b), which is in line with the conclusions made in the IPBES Assessment report on Pollinators, Pollination and Food Production (2016): *Our treatment of ILK systems here is guided by definitions that recognize the complexity, diversity and dynamism of human communities, and that self-identification, rather than formal definition, is the key* (IPBES, 2016).

1.5 Introduction to Nordic case studies where the IPBES approach is tested

The core material for this Nordic IPBES-like assessment is derived from ten case studies located all over the Nordic region (Fig. 10) (Tunón (Ed.), 2018). Case studies listed from east to west are 1) Neiden/ Näätämö (Finland-Norway, ILK), 2) Kalix archipelago (Sweden, ILK), 3) The Quark/ Kvarken (Finland-Sweden), 4) Puruvesi (Finland, ILK), 5) Lumparn area (Åland), 6) The Sound/ Öresund (Denmark-Sweden), 7) Helgeland, an Atlantic archipelago (Norway), 8) Faroe Islands, 9) Iceland: a) Gendered Landscapes of Northern Icelandic Coasts and Rural Areas, b) "We're not the enemies of the seal": Seal hunters of Iceland, and 10) Disko Bay (Greenland). Some of these cases, such as Kvarken, Sound, Helgeland and Lumparn cover all aspects of IPBES-like assessments, i.e. ecosystem services, biodiversity, drivers and pressures, while others such as Näätämö, Puruvesi, Kalix and Iceland have a stronger focus on ILK aspects. Disko Bay and Faroe Islands have strong ILK components, but also include general land cover based assessments. The two Iceland case studies focus solely on ILK issues.

Figure 10: Ten case studies describing various socio-ecological systems and environmental conditions were conducted



Note: The size of the circle reflects the size of the case study area: Disko bay is the largest, while Kalix, Puruvesi and Lumparn are the smallest.

Source: EEA and GADM. GlobCover, ESA 2010 and UCLouvain.

1.6 Methods and approaches

1.6.1 The assessment procedure

A team of over 35 experts were selected following IPBES procedures to a certain extent. Invitations to join the assessment were advertised in each Nordic country, with the aim of covering different disciplines during the nomination process. The data sources of this Nordic assessment include academic and grey literature, as well as ILK insights.

1.6.2 Case studies

The main part of the assessment material comes from case studies that are summarized in the findings of this report. A full description of the case studies is found in the Case areas report(Tunón (Ed.), 2018). They are presented following the overall structure of the report's chapters 2–4 and 6, i.e. ecosystem services, biodiversity, drivers and pressures, and governance and policy issues. In addition, a matrix approach (see Burkhard *et al.* 2014) was tested in some cases. The MAES ecosystem classes that occurred inside the case study areas were listed based on the land and sea cover data, and their role in ecosystem service delivery were evaluated by local experts. In addition, the condition of these ecosystem classes were assessed to a certain degree. Outcomes are synthesized in Chapter 5. A more general view of different chapter topics was compiled based on a Delphi survey and MAES ecosystem type matrix assessment, in addition to the bottom-up approach of comparative integration of findings from case studies.

1.6.3 Delphi survey

A qualitative comparative analysis based on experts' judgements was carried out using a Delphi Analysis approach. This provided the following information on NCP across the case studies:

- Criteria selection for ranking NCP;
- How well are NCP connected to human well-being and good quality of life, data availability/coverage (temporal and spatial) for NCP indicators;
- How functional changes in ecosystem components affect NCP;
- Impacts of drivers of change on NCP;
- How changes in governance and programme of measures affect NCP, including trade-offs.

The information provided by ILK was also integrated in this synthesis.

1.6.4 MAES matrix approach

Literature surveys and case studies form the basis of this assessment. In addition, "the MAES approach" (Mapping and Assessment of Ecosystems and their Services) was tested by:

1. Listing land cover types for all case study areas using MAES (including EU's harmonized EUNIS habitat categories) land cover classes and EMODnet seabed data;
2. Expert assessments of how habitats affect the delivery of ecosystem services, following the marine-adjusted ecosystem service classification specifically compiled for this study, that is modified and combined from CICES (Common

International Classification of Ecosystem Services), TEEB (The Economics of Ecosystems and Biodiversity) and MA (The Millennium Ecosystem Assessment) (Liquete *et al.*, 2013; Garpe, 2008). A three-step classification was used: 0 = MAES class with no/very little functions of which this ES is dependent (Negligble importance), 1 = MAES class with little/some functions of which this ES is dependent (Low importance), 3 = MAES class with many functions of which this ES is dependent (High importance) (Galparsoro *et al.*, 2014).

1.6.5 Ecosystem condition

It is important to use harmonized measures to assess ecosystem condition and its effect on the ecosystems' capacity to deliver NCP (EU, 2016). Thus, in addition to the MAES matrix assessment, the case study experts were invited to fill in an ecosystem condition assessment table using red (i.e. poor condition)-yellow-green (i.e. good condition) colour codes. Information was also added on the structure of, functions by, trophic levels of biota in, and pressures to particular habitat types (Fig. 40; Ch. 5). The spatio-temporal framings of how the condition assessment was evaluated were flexible, as this is a pilot study defined by case study experts. These are described in more detail in the case study descriptions.

Table 1: Examples of four selected condition categories for different ecosystem types

MAES ecosystem	Structure of	Functions by	Trophic levels of biota in	Pressures to
Deciduous woodland	Age structure, coverage	Nutrient uptake, carbon sequestration	Information about number of red list fungi species related to this ecosystem, changes in population trends	Logging, urban sprawl along coastlines
Mesic grasslands	Temporal landcover change	Sea bird feeding grounds (e.g. Geese)	Shore bird data	Reduced grazing
Infralitoral seabed	Oxygen levels of seabed	Fish feeding and spawning	Number of seabed invertebrate species and their abundances	Eutrophication, ocean darkening, building

Note: Illustration of possible measures do not mean that such data was implicitly used in the assessment, but rather depends on experts' knowledge on the topic. There was not enough knowledge available for all ecosystem types (marked as "not assessed").

1.6.6 Methodologies regarding ILK-inclusion in the assessment

The empirical material on ILK-perspectives in this assessment is mainly secondary to academic-based knowledge, due to limits in time and economy. For full and effective participation of indigenous peoples and local communities in the coastal areas of the Nordic region, continuous participatory workshops, field visits, discussions and collaborations would have been required (as suggested in Tunón *et al.*, 2015b). An important issue when it comes to ILK is the question of free prior informed consent

(FPIC), where indigenous peoples and local communities are able to give their consent to the interpretation and use of the information provided by them. For the present assessment, it has only been partly possible to fulfill the requirements for FPIC. This work thus relies on:

- Empirical data from the scoping study phase 2015 (Tunón *et al.*, 2015b);
- The assessment phase 2016–2017 (Kvarnström & Tunón, 2018);
- ILK-case studies;
- Previous experience from the Swedish work in the National Programme of Local and Traditional Knowledge related to Conservation and Sustainable Use of Biodiversity (NAPTEK, 2006– 2014);
- Knowledge and experience from the Snowchange Co-op (2000-on-going) that has a geographical focus oriented toward Finland, Sápmi and other parts of the Arctic (e.g. Siberia, Alaska, Canada);
- Nordeco, a Nordic NGO that has been collaborating with the local communities on Greenland/Kalaallit Nunaat.

Many of the ILK and CBMS projects across the Arctic are reviewed in Johnson *et al.* (2015).

One joint Nordic ILK-workshop was held in Uppsala 1–2 June 2015 and local ones in Sweden and Finland, as well as many parallel consultative processes in during 2016–17. The scoping phase had a broad approach regarding ILK in all different ecosystems, while the assessment phase focused on ILK in coastal and archipelago ecosystems (Tunón *et al.*, 2015b). A joint Swedish and Finnish workshop was held in Uppsala 23–24 November 2016. Several more informal contacts and field visits to different areas have also been made during the assessment in order to enhance participatory mechanisms (Kvarnström & Tunón, 2018). Three different questionnaires were sent out to relevant people and organizations in order to get the diversity of inputs necessary for the ILK-analysis: one broad questionnaire in 2015 and more ecosystem-focused ones in 2016.

In order to bring in the ILK-perspective in to the subregional assessment, certain case studies have particular emphasis on ILK, i.e. Näätämö and Puruvesi in Finland, Kalix in Sweden, Húsavík on Iceland, as well as Faroe Islands and Disko Bay in Greenland/Kalaallit Nunaat with self-government arrangements under the Danish Realm. Also, several of the other case studies in the assessment contain ILK issues (Tunón (Ed.), 2018).

1.7 The structure of the Nordic assessment and the core questions

This report follows the overall structure of regional IPBES assessments and aims to answer the core questions presented below. The assessment is divided in two parts, 1) Analysis – describes general issues across the region, 2) Case-studies – ten case studies from Nordic countries (Tunón (Ed.), 2018).

The general and Nordic specific questions to be answered by this assessment:

1. How do biodiversity and ecosystem function and services affect Nature's Contributions to People (NPC) in the Nordic region, especially in coastal areas? (Ch. 2);
2. What are the status, trends and potential future dynamics of biodiversity and ecosystem function, specifically in coastal ecosystems? (Ch. 3);
3. What are the drivers and pressures creating changes in biodiversity, ecosystems and their function and services? (Ch. 4);
4. What are the actual and potential impacts of various policies and policy instruments on biodiversity and ecosystem services? What potential is there in policy-making? How do these impact human well-being in the Nordic region? (Ch. 6);
5. How could ILK and data sources, such as Earth Observation and GIS data, be used in assessments and to support decision-making? (All chapters);
6. What are the perspectives for future sustainability and nature-dependent human well-being in Nordic societies? (Ch. 5, all chapters);
7. What are the major gaps in data, knowledge, management and decision-making systems, and how can they be reduced? (Ch. 5, summary);
8. What are the key messages to various stakeholders based on the findings of this assessment? (Summary).

The structure of the Nordic report follows IPBES assessment chapter division and consists of the following six chapters:

- Chapter 1) (this chapter) Setting the scene – introduces the assessment and the themes;
- Chapter 2) Nature's contributions to people and human well-being in a Nordic coastal context – describes the role of ecosystem services to human well-being;
- Chapter 3) Status and trends of biodiversity and ecosystem function – describes the key issues of biodiversity change in the past and present and its influence on ecosystem function;
- Chapter 4) Direct and indirect drivers of change in the context of different perspectives of human well-being (quality of life) – gives an overview of direct and indirect drivers and pressures to Nordic coastal ecosystems and their services;

- Chapter 5) Analysis of interactions between nature and human societies – synthesizes the findings of previous chapters and case studies, resulting in an region-wide Nordic assessment. This includes the outcomes of the Delphi questionnaire;
- Chapter 6) Options for governance – institutional arrangements and private and public decision-making across scales and sectors – embeds the findings of earlier chapters into the policy-framework, including analysis of relevant governance tools used today in the Nordic countries.

Further, knowledge from the Nordic case studies along with ILK is included in the chapters. Recommendation for decision-makers, other stakeholders and the wider public are suggested based on the chapters.

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Biodiversity and ecosystem services in Nordic coastal ecosystems: an IPBES-like assessment. Volume 1. The general overview

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Abstract [en]
This report describes the status and trends of biodiversity and ecosystem services in the Nordic region, the drivers and pressures affecting them, interactions and effects on people and society, and options for governance. The main report consists of two volumes. Volume 1 The general overview (this report) and Volume 2 The geographical case studies. This study has been inspired by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems Services (IPBES). It departs from case studies (Volume 2, the geographical case studies) from ten geographical areas in the Nordic countries (Denmark, Finland, Iceland, Norway, Sweden) and the autonomous areas of Faroe Islands, Greenland, and Åland. The aim was to describe status and trends of biodiversity and ecosystem services in the Nordic region, including the drivers and pressures affecting these ecosystems, the effects on people and society and options for governance. The Nordic study is structured as closely as possible to the framework for the regional assessments currently being finalized within IPBES. The report highlights environmental differences and similarities in the Nordic coastal areas, like the inhabitants´ relation to nature and the environment as well as similarities in social and policy instruments between the Nordic countries. This study provides background material for decision-making and it is shown that Nordic cooperation is of great importance for sustainable coastal management and should be strengthened in future work.

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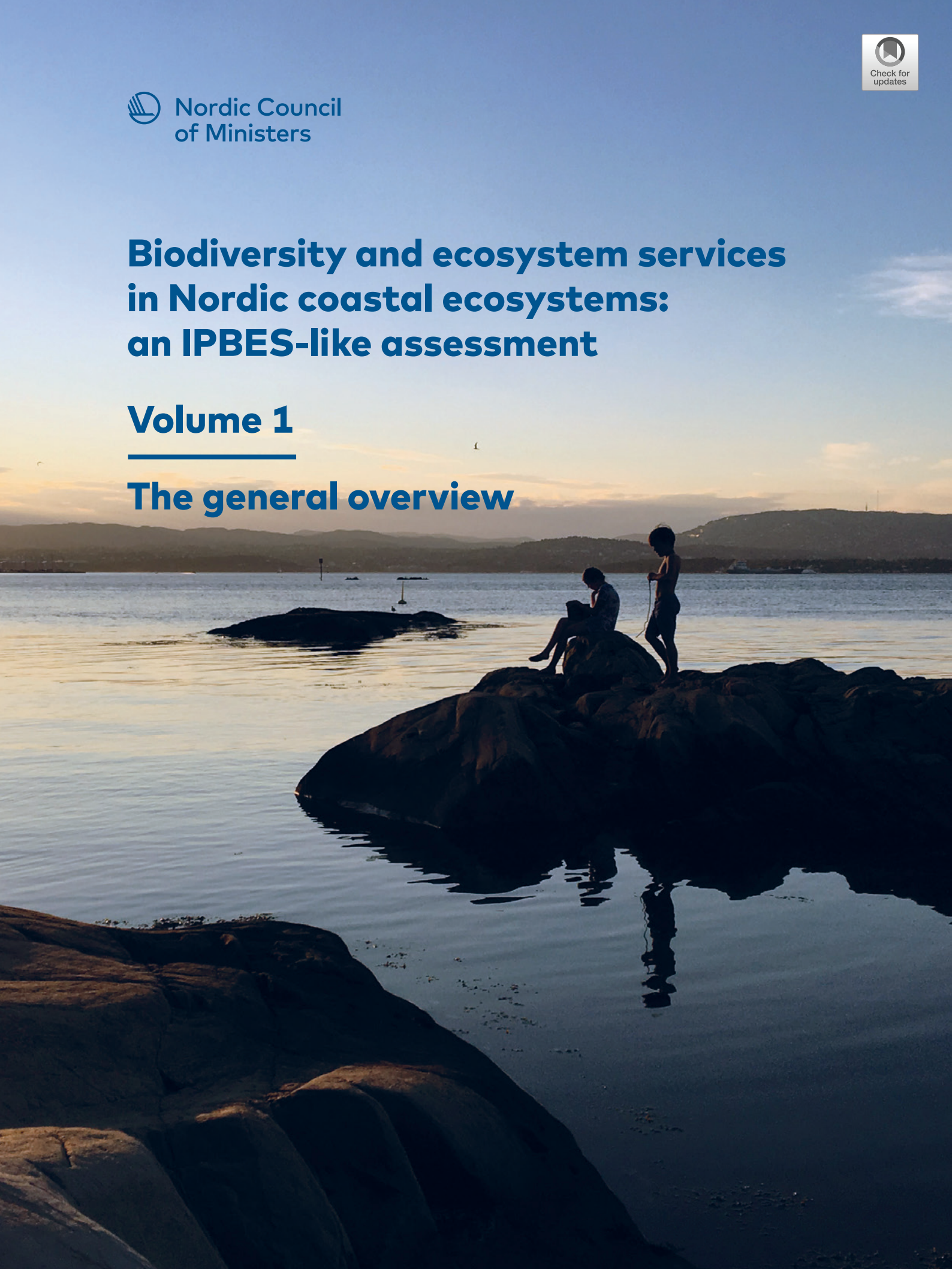
Biodiversity and ecosystem services in Nordic coastal ecosystems: an IPBES-like assessment

Volume 1

The general overview



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Contents

Summary

This study has been inspired by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems Services (IPBES). The aim of the assessment was to describe the status and trends of biodiversity and ecosystems in the Nordic region, including the drivers and pressures affecting these ecosystem components, as well as the effects on people and society and options for governance. Ultimately, this study provided an opportunity to aid the process of utilizing scientific results in the policy and decision-making realm, thus forwarding the science-policy interphase. The Nordic study is structured as closely as possible to the framework for the regional assessments currently being finalized within IPBES. This assessment has been based on information provided by the following case study areas in the Nordic countries: Näätämö/ Neiden basin, Kalix Archipelago, Kvarken/the Quark, Puruvesi Lake in North Karelia, the Lumparn area, Öresund, Helgeland coast, Faroe Islands (Føroyar), Broddanes West Fjords and the coastal areas of Húsavík (Iceland) and Disko Bay (Greenland).

The objectives of the assessment were to address the following questions:

- What are the main drivers and pressures affecting biodiversity, ecosystem services and ecosystem function?
- How does global, regional and national policy influence biodiversity, ecosystem services and human well-being in the Nordic region? What opportunities exist in policy-making?
- How can we better integrate indigenous and local knowledge (ILK) perspectives on biodiversity, ecosystem services and nature's contributions to people (NCP) in decision-making? How can we apply their culture and traditional management methods to support decision-making?
- What opportunities exist for sustainability and nature-dependent human well-being in Nordic societies?
- What biodiversity and ecosystem values define NCP in the Nordic coastal region?
- How can data sources such as Earth Observation and GIS spatial data be used in assessments to support decision-making?
- What are the major gaps in data, knowledge, management and decision-making systems? How can these gaps be minimized?

The outcomes from the assessment has been summarized in the following 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 that people depend on 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, mackerel, ringed seal, grey seal, harbor seal, hooded seal, North Atlantic fin whale and bowhead whale along the Norwegian coast, along with 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 in the region have provided food for 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 hundreds 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. Particularly holidaymakers and weekend visitors from within the Nordic countries frequent the southern parts of the region. There are also continuing traditions and systems of using coastal and marine resources across the Nordic region. These 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 strong traditional ties to nature, which provides opportunities for resource management based on traditional use, 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 in 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.

- B. The coastal Nordic region is under pressure:
  - 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, kelp forests and fucoid 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 on 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 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 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 may 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 and Sweden, and Denmark and 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 break-down of pollutants in cold waters of low biological capacity.

- C. 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 on natural resources. 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;

- C2. *There are good examples of indigenous and local peoples participating in coastal nature management in the northern regions.* This is critically important for continued 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 run-off 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), along with 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 (e.g. seals) have recovered to the point where they are causing problems. For those fisheries and populations of marine mammals that are still in decline, further efforts are required to help return populations to a healthy state;
- C5. *Cooperation 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

further developed to enhance the outcomes for nature and people in the coastal regions.

The following options for policy makers have been proposed:

- 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 is 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; and
- Identify pathways to achieve the 2050 vision of the Strategic Plan for Biodiversity and implement the Sustainable Development Goals and their targets.

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Biodiversity and ecosystem services in Nordic coastal ecosystems: an IPBES-like assessment Volume 1. The general overview

This report describes the status and trends of biodiversity and ecosystem services in the Nordic region, the drivers and pressures affecting them, interactions and effects on people and society, and options for governance. The main report consists of two volumes. Volume 1 The general overview (this report) and Volume 2 The geographical case studies. This study has been inspired by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems Services (IPBES). It departs from case studies (Volume 2, the geographical case studies) from ten geographical areas in the Nordic countries (Denmark, Finland, Iceland, Norway, Sweden) and the autonomous areas of Faroe Islands, Greenland, and Åland. The aim was to describe status and trends of biodiversity and ecosystem services in the Nordic region, including the drivers and pressures affecting these ecosystems, the effects on people and society and options for governance. The Nordic study is structured as closely as possible to the framework for the regional assessments currently being finalized within IPBES. The report highlights environmental differences and similarities in the Nordic coastal areas, like the inhabitants´ relation to nature and the environment as well as similarities in social and policy instruments between the Nordic countries. This study provides background material for decision-making and it is shown that Nordic cooperation is of great importance for sustainable coastal management and should be strengthened in future work.

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