FORUM FOR INTEGRATED OCEAN MANAGEMENT

M-2552 | 2023

Summary of the scientific basis for Norway's integrated ocean management plans 2019–2023

Referred as:
Summary of the scientific basis for Norway's integrated ocean management plans 2019-2023
M-2552 | 2023
Design: Pitch Studio AS

Trykksak
2041 0731

Preface

The Norwegian Government presents a white paper on integrated management plans for Norwegian ocean areas for the parliament (Stortinget) every 4th year.

The purpose of the management plans is to provide a framework for value creation through the sustainable use of marine natural resources and ecosystem services and at the same time maintain the structure, functioning, productivity and diversity of the ecosystems. The management plans are thus tools both for facilitating value creation and food security, and for maintaining the high environmental value of the Norwegian oceans: The Barents sea-Lofoten area, The Norwegian Sea and the North Sea-Skagerrak (figure 1).

The management plans are knowledge-based. The scientific basis for the plans is drawn up by two advisory groups: the Forum for Integrated Ocean Management and the Advisory Group on Monitoring. The Forum for Integrated Ocean Management is headed by the Norwegian Environment Agency, and is responsible for drawing up an overall scientific basis for updating the management plans in cooperation with the Advisory Group on Monitoring. The Advisory Group on Monitoring is headed by the Institute of Marine Research and coordinates monitoring programmes for marine ecosystems and reports on environmental status in the management plan areas.

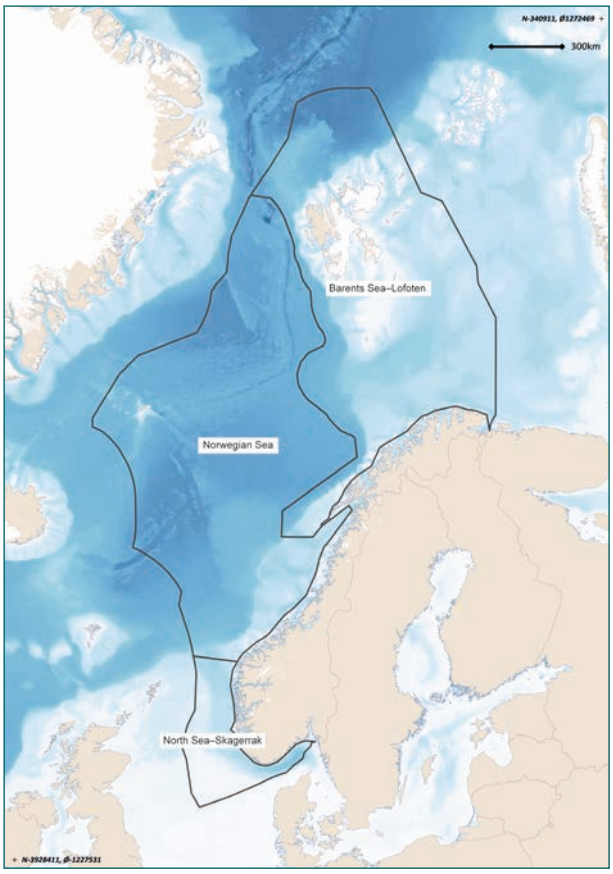


Figure 1 Map of the three management plan areas: the Barents Sea–Lofoten area, the Norwegian Sea and the North Sea and Skagerrak.
Source: Norwegian Environment Agency

The work on the management plans is coordinated by the interministerial Steering Committee for integrated ocean management, which consists of ten ministries and is headed by the Ministry of Climate and Environment. Figure 2 shows the organisation of the work and the member institutions. Figure 3 presents the process for integrated ocean management plans in Norway.

The main scientific basis from the Forum for Integrated Ocean Management is presented in the report "Faggrunnlag for helhetlige forvaltningsplaner for norske havområder – Hovedrapport 2019-2023" which is published with a summary in English. This publication is a reprint of the English summary.

In addition, three supporting reports have been published by the Forum for Integrated Ocean Management and five scientific reports have been published by the research institutes on behalf of the Forum. All these reports are presented in Norwegian at the website havforum.no. Some of them includes an English summary.

The Forum for Integrated Ocean Management
April 2023

Figure 2 Organisation of the management plan work..

Source: Forum for Integrated Ocean Manaagement/havforum.no

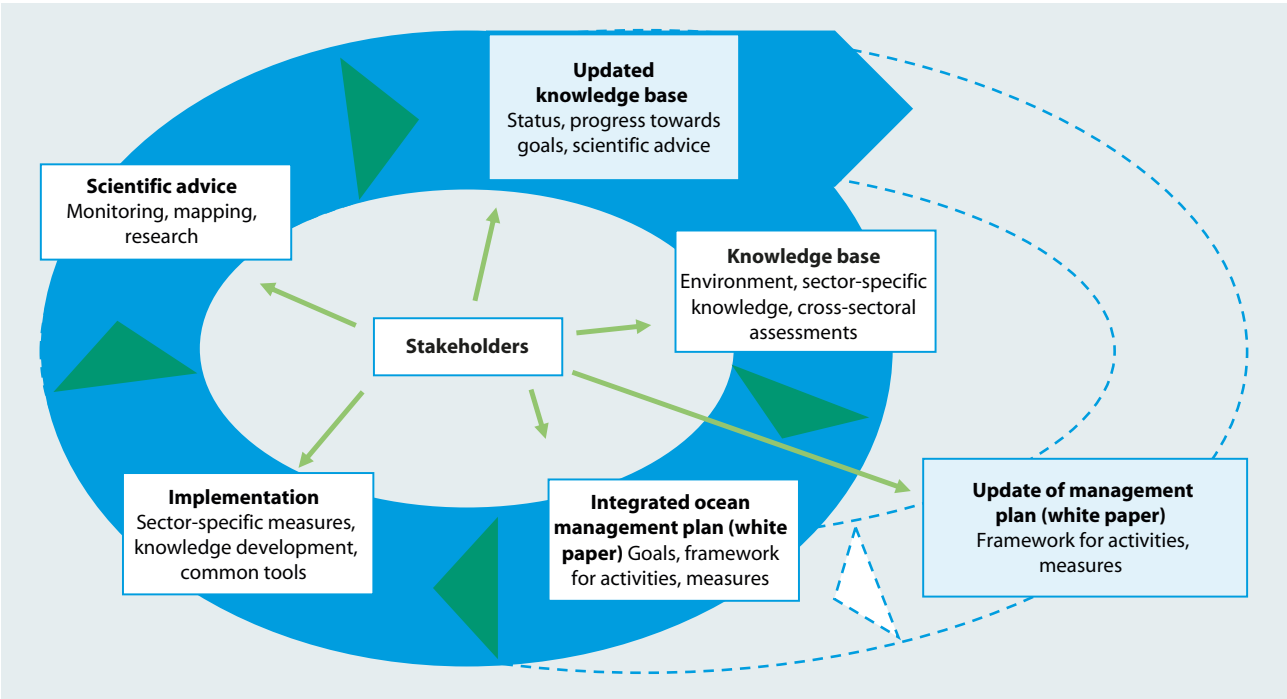


Figure 3 Ecosystem-based ocean management.

Source: Forum for Integrated Ocean Manaagement/havforum.no

Contents

Summary

Ecosystem states and trends in all ocean regions

Assessments of ecosystem state are based on a defined reference state (intact nature) and the extent of deviation observed from this reference state. "Intact nature" is defined as an ecosystem which is little impacted by modern industrial activities, including human-induced climate change. The assessments have been made for the Norwegian parts of the Arctic and the sub-Arctic Barents Sea, respectively, the pelagic ecosystem in the Norwegian Sea and the Norwegian part of the North Sea and Skagerrak, excluding the deeper parts of the Norwegian Trench. Climate and other components of the abiotic environment are considered as parts of the ecosystem in the assessments. Climate impacts all components of the ecosystem, while other human activities such as fisheries tend to impact locally. However, the degree of impacts from the different drivers relative to each other is not assessed in the ecosystem state report, which is aimed at presenting states and trends in the ecosystems.

Based on long time series (50-70 years), anthropogenic climate change is detected in all three areas. This is reflected in increasing sea temperatures, decreasing sea ice (Barents Sea), ocean acidification, and darkening of the water (North Sea and Skagerrak). In the assessments of the Barents Sea regions (Arctic and sub-Arctic), it is concluded that although there is limited evidence for human impact, there is no evidence that the ecosystem as a whole is impacted. In the Arctic Barents Sea, the observed changes are weak tendencies of increased primary production and earlier phytoplankton spring blooms, as well as changes in food webs with negative impacts on top predators. No evidence for human-induced changes apart from those from climate change, were found in the sub-Arctic Barents Sea. In the pelagic ecosystem of the Norwegian Sea, human-induced changes include reduced stocks of mackerel and Norwegian spring-spawning herring caused by fishing above the recommended quotas for several years, and a dramatic decline in sea bird populations. The North Sea ecosystem is extensively impacted by climate change and fisheries, including changes in zooplankton dynamics, trophic structure and functionally important species, and declines in seabird populations.

However, for both the Barents Sea and the Norwegian Sea there is considerable uncertainty regarding impact from climate change. It is an open question whether the impacts are limited, or potentially substantial but not detected because of too short time series (<20 years). In particular, we lack indicators for assessing ecosystem responses to periods of rapid warming prior to year 2000. For the Norwegian Sea, also indicators for key parts of the ecosystem are lacking. If climate emissions continue at the present rate, climate change is expected to continue in the future and the ecosystems of the Barents Sea and the Norwegian Sea are expected to respond with substantial changes. The fishing fleet in the Barents Sea is reduced by number of vessels in the last decades, which is expected to ease the impacts from bottom-trawling. Regulations have been made to avoid unwanted impact in previously ice-covered areas.

The large fish stocks are central parts of the ecosystem dynamics and also economically important. The condition of these is overall good in the Barents Sea, whereas the fisheries for stocks of mackerel and herring in the Norwegian Sea have been above the advised quota levels for several years. In the North Sea and Skagerrak, fisheries landings were substantially above the advised level for several years before 2000. Important stocks of cod and autumn-spawning herring have not recovered partly due to negative effects of climate change on recruitment, and the deep-sea shrimp stocks are also at a low level due to weak recruitments. Furthermore, data that have recently been assembled show that the populations of seabird species breeding along the North Sea and Skagerrak coasts are dramatically reduced over the last decades. For most seabird species, the decline is linked to reduced food availability combined with climate change. For several endangered species, including seabirds of significance to the management of biological diversity, the situation has deteriorated from 2015 to 2021. There were also some improvements, but for a much lower number of species. Non-indigenous species may have strong impacts on marine ecosystems and in Norwegian waters they are mainly observed along the coast. The number of non-indigenous species registered is highest in Southern Norway and has increased during the last ten years.

Inputs of pollutants measured in air decreased since the 1990s when the monitoring started but to some extent

it has levelled off in the last few years. The decline is only partly reflected in the levels measured in sediments and biota. There is still radioactive pollution in the oceans, caused by the Chernobyl accident, but at low levels and decreasing from the south and northwards. Seafood from the Norwegian seas in general is found to have pollutant levels well below the maximum levels for food safety. In cases where the maximum levels have been exceeded, measures have been taken to prevent the fish from reaching the market. Of the three studied sea areas, the Barents Sea generally has the lowest level of pollution, except for a few pollutants including the chlorinated pesticide HCB. Even so, monitoring of polar bears and seabirds in the Barents Sea shows that the contaminants accumulate towards the top of the food chain and may affect top predators. In the Norwegian Sea, concentrations of most monitored pollutants are at similar levels as in the North Sea, the Barents Sea or intermediate, but a direct comparison is difficult. Killer whales, a top predator, in the Norwegian Sea have been shown to have high levels of contaminants that can reduce both their health and reproductive capacity. A few seafood species harvested in limited areas of the Norwegian Sea contained unusually high levels of contaminants and sometimes above maximum levels for food safety. The reason is not known. The North Sea and Skagerrak is generally more polluted than the other sea areas, yet levels of contaminants in seafood species from the management plan area are below maximum levels for food safety. Monitored fish near oil and gas installations in the North Sea show some pollution by poly-aromatic hydrocarbons (PAH). From this area, there are no indicators and little knowledge about the levels and effects of contaminants in seabirds and marine mammals and there is no monitoring of metals in sediments.

Economic value and employment

Norwegian oceans and coastal areas contribute significantly to the Norwegian economy. In 2019 the oceans and coastal areas accounted for around 22 % of the Norwegian gross domestic product (GDP), or NOK 680 billion. The petroleum sector has the largest contribution to GDP within the ocean sectors, followed by fisheries and aquaculture, maritime transportation, other ocean-related production, and tourism. These sectors employed around 9 % of the total number of employees in Norway in 2019. The petroleum sector was the largest ocean sector employer in the period 2016-2019.

The petroleum sector is Norway's largest sector in terms of GDP. It accounted for 81 % of the GDP from ocean sectors and has been stable throughout the period 2016-2019. Employment was also high and stable, with nearly 100 000 employees. Future expectations are linked to increased development of the petroleum activity in the Barents Sea, which is the least developed area today.

Fisheries and aquaculture contributed to 8 % of GDP in ocean sectors in 2019 and was the second largest sector after the petroleum sector. The aquaculture industry accounted for approximately half of this value. The fishing industry and processing and preservation industry combined, contributed to the other half. Within the fisheries and aquaculture sector, the number of employees increased from 2016-2019, and it is the processing and preservation industries that had the highest number og employees throughout the period.

The maritime transportation sector has a long tradition in Norway and is also an important industry today. The sector accounted for 6 % of total GDP in the ocean sectors in 2019. GDP from maritime transportation sector increased with 9 % in the period 2016-2019. The foreign shipping industry accounts for the largest part of the GDP within maritime transportation, with 63 %. The number of people employed in the sector also increased by 3 % during the period. Also here, foreign shipping accounted for the largest share, with around half of the employed. The outlook for ship traffic and port calls is uncertain, especially in the short term due to the effects after the pandemics.

Ocean-based tourism makes up about 1 % of the GDP in the ocean sectors. It is challenging to link economic values in the tourism sector to the ocean, and valuation of ocean-based tourism is here limited to hotel accommodation and restaurants located by the coast and within 100 meters from the coastline. Like the national tourism sector, there has been a small increase in the GDP and employment in ocean-based tourism. There are also several other ocean-based tourism industries that contribute to the Norwegian economy, including the cruise industry, tourist fishing and whale- and bird safaris.

The category "other ocean-related production" is a collection of various industries that supply ocean-related products and services to the ocean sectors. Here we find, among others, equipment suppliers and repair and construction activities. The main users of this kind of

products and services are, in order, petroleum, maritime transportation and fisheries and aquaculture. Other ocean-related production industries contributed to 4 % of the GDP in ocean sectors in 2019. There are also a high number of people employed within the various industries and together they constitute the second largest share of ocean-based employment, after the petroleum sector.

Environmental effects from industrial activities

Fisheries

Fisheries management have developed from single-species stock management to ecosystem-based management, to ensure sustainable harvesting of renewable marine resources in a long-term perspective. Catches by Norwegian fishing vessels in 2021 were 2.6 million metric tons, an increase compared to the previous reporting period. The Norwegian fisheries fleet has seen a significant structurisation over several decades, and today the fleet consists of fewer and larger ships with more engine power and improved harvesting technology. The catch per individual fisherman is 30 times higher than in 1945.

Environmental impacts from fisheries consist of extraction of specific age classes from the commercial fish stocks every year, and bycatch of other than the target species. Fishing also impacts bottom habitats, and benthic species like corals and sponges as well as seabirds and mammals may be lost as bycatch. The major commercial fish stocks are in good conditions, while smaller stocks of the Norwegian coastal cod and catfish are in a poor condition. Vulnerable ecosystems in extensive areas have been protected by fisheries regulations, such as the fisheries zones at Spitsbergen and Jan Mayen. Other impacts from fisheries are pollution, plastic littering, and ghost fishing by lost gear. There is an action plan to prevent littering, and the Fisheries directorate is running yearly cruises to remove abandoned, lost, or otherwise discarded fishing gear (ALDFG) from the coastal areas and offshore. Research and development of new materials, tools and technology to reduce the environmental impacts, is supported as well.

Barentshavet and Lofoten

Stocks of Northeast Arctic (NEA) cod, haddock and saithe are in good or very good condition, while recruitment of Norwegian spring spawning (NVG) herring is varying. Shrimps are in proper conditions, and the capelin stock is fluctuating due to strong grazing pressure from the NEA cod and sometimes poor recruitment to the capelin stock. The NEA cod is moving north and eastwards in recent years, and spawning is observed in areas north of the traditional spawning areas by Lofoten/Vesterålen. NVG herring is not coming into the Vestfjorden area to the same extent as in previous years, but some spawning occurs outside the coast of Nordland and Lofoten/Vesterålen. Snow crab is a new commercial species from the Barents Sea, and knowledge about the stock is improving.

Catches by Norwegian vessels increased from 746 000 metric tons in 2016 to 1 102 000 tons in 2021, mainly due to increased catches of herring.

The Norwegian Sea

Conditions are good regarding the most important commercial stocks (NVG herring, blue whiting, mackerel and NEA saithe) with some irregularities in the recruitment of NVG herring. Mackerel is multilaterally managed, but agreements have not been reached in recent years. The coastal cod is in poor condition, and the Golden redfish is listed as critically endangered in the Norwegian Red list.

Catches varied from 481 000 tons in 2016 to 581 000 tons in 2021, and the increase is mainly due to higher catches of mackerel.

The North Sea and Skagerrak

Conditions of the important commercial species of mackerel, North Sea herring, shrimp, Norway pout and sandeel are good. The coastal cod is in poor condition, yet there has been some improvement in spawning biomass and reduced mortality. The sandeel stock varies from year to year because of varying recruitment in this shortlived species. Due to its homebound way of living, the sandeel is managed by an adapted area model. The North Sea herring is managed bilaterally by fisheries agreement between Norway and the European union. The quota recommendations were decreasing in 2021.

Catches varied from 150 000 tons in 2016 to 95 000 tons in 2021. There was an increase in catches of sand eel from 41 000 tons in 2016 to 146 000 tons in 2021.

Aquaculture

Aquaculture production is secured through ecosystem-based management, with implementation of a "traffic light system" to reduce the damaging effects of sea lice on wild salmon and on the aquaculture production. As with fisheries, marine food production is not possible without any impact on the environment, but the industry is continually working to ensure optimal conditions and monitor the environmental conditions. The report on environmental risks from aquaculture from the Institute of Marine Research is an important source of knowledge for management of the aquaculture industry, supporting development towards increased sustainability in the production. Aquaculture is also a source of plastic littering and pollution, and the sector is actively working to collect and recirculate materials to prevent environmental impacts. Industrial actors are encouraged to work on solving major environmental challenges through a system of development licenses. Several licenses have been granted to projects looking to move aquaculture further offshore, where technology development and dimensioning of equipment to withstand the forces from waves and wind is crucial.

The future and new industries

Exploitation of living marine resources is expected to increase, and management strategies for the exploited stocks must follow the development. Area management is affected by climate changes, and some species may move north and eastwards. If this tendency continues, we will see that the Barents Sea becomes an important living ground for species which mainly live in the Norwegian Sea today. Area management with trawling bans to protect ecosystems has been used by the fisheries sector for several decades.

The aquaculture industry is expected to move further offshore, and new areas may be opened after impact assessments have been performed. We also expect to see increasing harvesting of lower trophic resources such as mesopelagic fish and *Calanus*, but challenges such as overexploitation and bycatch of other species must be considered closely.

Shipping

Marine traffic is regulated by international conventions, and Norwegian vessels and traffic in Norwegian maritime areas follow the rules set by the UN International Maritime Organization (IMO) in the MARPOL convention, and the EU regulations on fuels and energy. MARPOL regulations encompass challenges such as sewage, littering, plastic pollution, hazardous chemicals and oil, and air pollution. Ballast water is a major source for spreading of alien species, and the international ballast water convention was implemented in 2017.

Litter is treated onboard and handed in using the reporting system SafeSeaNet to inform about deliveries. A regional arrangement to handle litter from ships going through the Arctic region is also considered through the PAME group of the Arctic council. Climate changes in the northern areas and decreasing ice covers is expected to promote increasing ship traffic in new areas. The international Polar code is developed to ensure safety for humans and prevent pollution by prohibiting release of oil-containing water, chemicals in the cargo, extra protection of fuel tanks and more restricted handling of sewage and litter than what is given by MARPOL. A general ban on residual fuel oil is in place for Svalbard waters, while the sewage regulations given in MARPOL are not implemented along the Norwegian coast north of Lindesnes. Work is ongoing to consider a low release area in the Skagerrak, and the need for stronger regulations along the coast.

A large fraction of ship traffic in Norwegian waters occurs inside the baseline and therefore included in the descriptions of traffic in the Norwegian economic zone. Changes in marine traffic has been predictable over the years, and about 7 000 ships go into Norwegian harbours in a normal year. The years 2020-21 were affected by the pandemic situation, and in 2017 (which was a more representative year) the main activity was related to passenger ships, general cargo transport and fishing vessels. Ship mile distance (in total 45.5 million nautical miles in Norwegian oceans in 2021) was largest in the North Sea and least in the Barents Sea, with most ship miles (62 %) performed by passenger and general cargo ships together with fishing vessels. The main activities differ, with passenger ships dominating in the Norwegian Sea, cargo vessels in the North Sea and fishing vessels in the Barents Sea. Larger ships are usually in transit through Norwegian ocean areas, while smaller fishing vessels dominate activities and visit harbours along the coast.

Increasing traffic in the northernmost areas is expected with climate changes and reduced ice cover, as this will reduce traffic time and transport costs between Europe and Asia. However, ship traffic through these areas will

also be of high risk and this is a focus area in the work of the Arctic council. The council is not a jurisdictional collaboration, but member states collaborate around search and rescue. Safety at sea is strengthened with the development of a reporting system (Barents SRS) in 2013 together with Russian authorities. Low ice coverage in 2020 opened the Northern Sea Route also for vessels of low ice class, and export of natural gas (LNG), oil and minerals will increase in the future. Norway is focusing on risk transport by vessels larger than 5 000 BT with dangerous and/or polluting cargo, and transport of petroleum products increased in later years with the Goliat field in production and LNG production in Sabetta (Russia).

Ship traffic also impact the environment through releases to air of e.g., NOx and CO_2, and releases are estimated using the information system Havbase. Shipping is considered as energy efficient transport but releases from operational activities can be extensive, especially in highly trafficked areas. Measures to reduce releases to meet the climate targets have, to some extent been counteracted by increasing traffic. The Parliament determined that cruise ships, tourist boats and ferries must be equipped with zero release-technology within 2026, to be allowed into the UNESCO world heritage-areas. More than 9 150 000 tons of CO_2 were released from ships in Norwegian ocean areas in 2021, and almost 50% was released in the North Sea and Skagerrak. The release of SO_2 was reduced by almost 50 % in the years 2017-21 because of regulations on the sulphur content in fuels. Passenger ships release most of the CO_2/CO, while gas tankers release most of the NOx. Larger and heavier vessels display the largest release per ship miles, however, if measured as release volume per ton kilometre they are lower because of the high carrying load capacities. Large ships (above 100 000 BT) only performed 1.4 % of ship miles in Norwegian oceans in 2021. At the same time, they generated 10 % of CO_2-releases, 11 % of CO-releases, 15 % of NOx- and 23 % of sulphur-releases, and 24 % of PM releases.

Underwater noise

Ship traffic is the main source to underwater noise from human activities, and the noise is disturbing or harmful to marine organisms. Noise from human activities is regulated in the MSFD, and ICES ranged noise as the 3. strongest impact factor after biomass harvesting and pollution. Although there is some focus on monitoring underwater noise, there is no consensus around how to achieve good environmental status regarding noise and ecosystem impacts. IMO-regulations do not cover underwater noise and marine life at present, but guidance on how to reduce noise from commercial vessels is being developed. Noise reducing technology is used in military and research vessels, and in some fishing vessels. The ocean management plans describe measures to strengthen the knowledge about impact and effects of underwater noise on fish and mammals and recommend that indicators are established in accordance with the OSPAR work.

The future

The Coastal Authorities forecast a growth of approx. 19 % in traffic and arrivals to Norwegian harbours towards 2050, with growth in dry load markets and cargo vessel transport and reduction in offshore supply vessels. A reduction is also forecasted for raw oil/petroleum products, while for fishing vessels a steady increase is expected together with a shift towards fewer but larger vessels. Because of restrictions, the numbers of cruise vessels that will arrive at world heritage fiords is expected to decrease initially and then increase again towards 2050 when they will be back at 2019-levels. For oil-related shipping, we expect a steady decrease through the period until 2050.

Petroleum industry

The petroleum industry includes value chain from seismic surveys, exploration drilling, discovery of oil or gas, followed by development of the field, production and product sales, and decommissioning. All these steps are dynamic, as the access to resources changes over time.

Only the southern part of the Barents Sea is opened for petroleum activity, and although there has been exploration activity for more than 30 years, it is still the least explored and developed area of the petroleum provinces in Norwegian waters. The Norwegian Sea contains large gas reserves and is more explored, and oil and gas have been produced on the Haltenbanken for more than 20 years. The smallest ocean area is in the North Sea, yet it has the largest amount of petroleum resources found and produced throughout the years. At the beginning of 2022, Norway had 94 producing fields, 71 in the North Sea, 21 in the Norwegian Sea and two in the Barents Sea. At present, it is estimated that about half of the expected resources on Norwegian shelf have been produced. Approx. 4 million barrels are produced each day, and most of it is exported. The Johan Sverdrup

field is relatively new, and when fully operating it is expected to produce around 35 % of the Norwegian oil production. The number of exploration wells has been relatively stable since 2005. Development wells can be of different types: production, injection or observation wells. The total number of new wells have varied around 200 each year since 2013.

Environmental effects

The environmental effects from petroleum activity relate to discharges of chemicals, oil and naturally occurring compounds to the sea and emissions to air. Activities are also physically interacting with the seafloor, and there is noise from e.g., seismic surveys. There are emissions to air of CO_2, NOx, methane and NMVOC from energy production on the installations, flaring, storage and loading of crude oil, cold ventilation and diffuse releases. Historically, emissions levels follow the energy need on the installations. Electrification is expected to reduce the emissions, and this is implemented on some fields in recent years. New methodology for measuring methane and NMVOC has also influenced emission numbers. In the Barents Sea, the main emissions of CO_2 and NOx is from the LNG production at Melkøya, and increased emissions are expected when the Johan Castberg field comes into production. Emissions of CO_2 and NOx have been relatively stable in the Norwegian Sea, while in the North Sea there was a decrease in the last years due to power from shore.

Exploration drilling is also contributing with some releases to air from energy production and flaring of hydrocarbons during well tests. Produced water is a major source of discharges to sea from production of oil and gas and it contains a range of different substances from the reservoirs including dispersed oil, BTEXs, phenols, organic acids, PAHs and heavy metals in addition to water soluble production chemicals. The amounts of produced water discharged to sea, depends on factors such as the age of the fields, production strategies, possibilities for reinjection and implementation of cleaning technology. The numbers of operating fields are highest in the North Sea, where the number of mature fields are high and thus the discharges of produced water are also highest here. In the Norwegian Sea, the discharges of produced water have been relatively stable since 2016 but an increase is expected when the Njord field comes into operation again. Only 0.02 % of the total volumes on the Norwegian shelf, are discharges in the Barents Sea. This is due to limited activity and a high degree of reinjection in the Goliat field. Smaller sources of oil releases are draining water and released amounts of drill cuttings is proportional to the numbers of drilled wells and their length.

Drilling and production involve use of chemicals, and the total discharges of chemicals increased in all regions during the revision period. Most chemicals are used in drilling operations. Discharge volumes of drilling chemicals and drill cuttings correlates to the number and the length of wells. The main volumes of discharged chemicals consist of chemicals on OSPARs PLONOR-list (green category). Discharges are highest in the North Sea because of the higher activity levels. .

The future

Petroleum production and incomes from the Norwegian shelf in the future is unknown, and scenario analyses are used to evaluate the possibilities. Technology development and financial investments together with successful searching, may keep production and incomes high also in the future. Analyses from the Petroleum directorate indicates that Norwegian oceans still contain significant amounts of petroleum resources, and about half of the total resources have been produced since the beginning in 1971.

The Norwegian Defence and activities in exercise fields

The Norwegian Defence recently revised the regulatory framework for firing and exercise fields at sea, and establishment of permanent or temporary installations within the fields is not allowed. Traffic and activity are allowed, unless it comes into conflict with ongoing exercises. The fields which are situated near bases are used the most, while other fields are being used only a few times per year.

Environmental impacts are Cu-containing disposals or explosives from shooting exercises on land and in the sea, and potentially resuspension of polluted sediments. The Defence has evaluated a set of environmental values against their use and exercise scenarios, such as 1) protected areas (planned and existing), 2) particularly valuable and vulnerable areas as described in the ocean management plans, 3) bottom habitats with corals, soft- or hard-bottom sponges, sea pens or mearl beds, 4) marine mammals, 5) fish, 6) seabirds, 7) species of particular interest to management, and 8) underwater cultural remains. All areas needed for the animals

throughout their life cycle have been evaluated, as well as areas where ammunition etc. is discarded. Risk reducing measures are described for each environmental value, such as instructions to keep the distance (both in time and space) or clean up and removal of litter or material which may impose a danger to species, ecology or cultural heritage.

A set of shooting field instructions will ensure that the use of exercise areas is environmentally sustainable, and regulate other sectors such as fisheries, shipping, aquaculture, or petroleum and gas production or cabled transport. The Defence may regulate activity to avoid conflicts with temporary activities from the other sectors, while permanent installations of windmills on the sea surface is not compatible with shooting activities

New industries

Deep sea mining

Sulphides and manganese crusts can be found in deep regions of the Norwegian continental shelf. There has been some activity related to seafloor mapping and mineral sampling in search for important mineral or metals in these areas. The law of mineral activity on the Norwegian continental shelf was set into force in 2019. The Government started an opening process which includes an environmental impact assessment (EIA). The aim of the EIA is to describe the impact of deep-sea mining on the environment and whether it is possible to perform mineral extraction responsibly, and to evaluate economic and social issues and other users of the sea. Investigations and data collection have been performed by several research institutes and agencies, and the EIA has been out for public consultancy. A White paper is announced for the spring 2023.

CCS

Carbon capture and storage (CCS) is considered an important measure to reduce global carbon emissions. Norwegian authorities actively support the development of socioeconomically sustainable CO_2 storage on the Norwegian shelf, and the government decided to initiate a project for large scale CO_2 handling in 2021; the Langskip project. Another three licenses have been issued for carbon storage in the North Sea and the Barents Sea. CO_2 has been reinjected and stored in relation to gas production since 1996 and up to 1 million tons of CO_2 are stored yearly in the Utsira-formation where gas from the Sleipner field is processed. CO_2 has also been stored at the Snøhvit field since 2007.

Hydrogen

The Norwegian government has decided that hydrogen should be developed as a "green alternative" in the industrial sector, and that it should be a complete value chain from production to use with low or no emissions. Hydrogen is considered an energy carrier of great potential when other power sources such as electricity or batteries are unsuited, as in transport or industry. It is not clear, however, if or when the market for hydrogen will become significant or to which sectors it will become important. Technology development and cost reduction for both hydrogen and competing technologies will determine the future markets.

Renewable energy

Renewable energy production at sea is area demanding, and the Ocean Energy Act defines the frames for areas to be used for energy production in the future. The areas Utsira North and Southern Nort Sea II were opened by Royal resolution in 2020, and together they cover 3 600 km^2. When finished, Hywind Tampen will be the largest floating wind farm in the world, producing electricity to the Gullfaks and Snorre field, and the permission is granted pursuant to the Petroleum Act.

Seaweed cultivation

Seaweed cultivation is a growing industry, and production is expected to increase in the coastal areas. The numbers of licenses increased from 47 in 2017 to 114 in 2021, and there is great interest in projects where seaweed cultivation is integrated with aquaculture to make use of nutrients released from salmon production.

Bioprospecting

Marine bioprospecting has become a commercial industry, and there are ongoing searches for bio-molecules for use in food and health products. Harvesting of marine biomass for bioprospecting is considered sustainable because only small quantities need to be removed in e search for genetic information or active compounds to be tested. The path from searching for compounds to market ready product is, however, long and expensive especially in medical or pharmaceutical settings.

Cumulative impacts

In holistic and ecosystem-based management it is a central principle to assess the effects on ecosystems based on cumulative impacts (as expressed in the Norwegian Biodiversity Act § 10).

Previously, The Forum for Integrated Ocean Management (FF) assessed cumulative impacts and effects on the environmental values, separately for of the three management areas (the North Sea and Skagerrak, the Norwegian Sea, and the Barents Sea and the area outside Lofoten and Vesterålen). FF saw the need for a general way to make cross-regional assessments, with harmonized scales for impacts linked to different management sectors. Commissioned by FF, the Institute of Marine Research suggested to deploy a new framework (Options for Delivering Ecosystem-Based Marine Management/ODEMM) to analyse cumulative impacts. In collaboration with other scientific research institutes, a report on the analyses and experiences was delivered to FF.

FF will continue to contribute with further development on analyses of cumulative impacts and adaption of the framework for future application in collaboration with the scientists.

Particularly valuable and vulnerable areas (SVO)

SVOs are ocean areas of particularly significant importance for biodiversity and biological production. The SVOs status signals a need for particular caution, and industrial activities shall be performed without posing any threats to the biodiversity or ecological functions within the SVO area. Otherwise, the SVO status does not automatically impose any restrictions on industrial activity.

Commissioned by The Forum for Integrated Ocean Management, an interdisciplinary expert group has identified proposals for amended and new SVOs. The expert group has taken as its starting point the existing SVOs, candidate areas for seabirds, previous environmental value assessments and new knowledge, and conducted new environmental value assessments in accordance with the "Ecologically or Biologically Significant Marine Areas" (EBSA) criteria defined in the UN Convention on Biological Diversity (CBD). The particularly valuable environmental values that were identified through this work and the geographical distribution of these formed the basis for delimiting the proposals for SVOs.

Seven ecosystem components were assessed with regards to the EBSA criteria: ice biota, plankton (phytoplankton and zooplankton), fish, mesopelagic fauna, benthic fauna, seabirds and marine mammals. Abiotic conditions that affect ecological processes and living conditions are also described, and the areas where environmental values were identified are assessed based on the degree of relevance for the given environmental value. The scientific expert group suggests a list of 19 SVOs, seven in the Barents Sea, eight in the Norwegian Sea, and four in the North Sea/Skagerrak. Two SVOs are suggested continued with no changes: SVO Sea ice Framstredet (NH1) and SVO The West Ice (NH2). Four new SVOs are suggested for the open ocean areas and deep seas: SVO The Central Barents Sea (BH7), SVO The Mid-Atlantic Ridge (NH4) SVO Deep sea basins of the Norwegian Sea (NH8), and SVO The Norwegian Trench (NS3) The changes include revision of 13 existing SVOs: SVO Listas beaches and Siragrunnen to be included in SVO The Norwegian Trench (NS3), SVO Karmøy field included in SVO The Boknafjorden and Jærstrendene (NS1), and seven smaller SVOs (fish "banks", very local spawning grounds) along the coast from Stad to Nordland are included in the suggested SVOs Coastal Zone Norwegian Sea North (NH6) and Coastal Zone Norwegian Sea South (NH7). Three SVOs are suggested removed, after finding that none of the EBSA criteria were fulfilled (SVO The Arctic Front and SVO Mackerel Spawning field) or lack of influence on the open sea ecosystems (SVO The Kors fjord).

Within each SVO, the inherent vulnerability of the identified valuable ecosystem components was further assessed, but this is work in progress. Inherent vulnerability is defined as the response of living ecosystem components to pressures, regardless of whether the pressure is present or not. The experts have taken into account where and when the environmental values are present, and how vulnerability varies with life history stages such as spawning and breeding periods. For each of the 19 SVOs the vulnerability is assessed for 21 separate ecosystem components representing the original categories (ice biota, phyto- and zooplankton, kelp, seaweed and eelgrass, mesopelagic fauna, fish, benthic fauna, seabirds and marine mammals) split into several sub-groups. In addition, a general assessment for food webs was made, to assess vulnerability of the

linkages between the components. All the 21 ecosystem components were assessed according to 17 different pressures: barriers to species movement, bycatch, electromagnetic fields, species extraction, marine littering, contaminants, petroleum-related contaminants, abrasion, non-indigenous species, organic matter/NP, siltation/smothering, sealing, extraction of non-living resources, underwater noise, incidental loss, climate change, and impact by human activities that are not included in the other categories (e.g., disturbance). The score for vulnerability is ranked in five categories: Positive impact, No or ignorable impact, Low, Medium or High impact. Confidence was assessed based on the quality and degree of uncertainty of the documentation found in scientific publications.

Most ecosystem components display high inherent vulnerability to at least one impact. Benthic fauna, seabirds and food webs were found to have the highest frequency of high vulnerability scores. Benthic fauna is particularly vulnerable to fishing activities such as bottom trawling and bycatch. Seabirds are particularly vulnerable to disturbances while nesting, and towards petroleum-related contamination, plastic littering and pollution, as well as climate change. The most widely detected pressure among the ecosystem components, are related to climate change and bycatch, followed by pollution. The documentation for impacts by electromagnetic fields, extraction of non-living resources and presence of non-indigenous species is sparse, and these are examples where the vulnerability of the environmental values is categorized with a high degree of uncertainty (or low confidence level) because the knowledge base is insufficient. The only pressure shown to have a positive impact for some ecosystem components, is climate change.

The Forum for Integrated Ocean Management consider that the EBSA criteria can be used to describe environmental values and assess the extent of SVOs. There is disagreement in the forum about what is sufficient knowledge to designate areas as SVO. New knowledge will be integrated in the work on environmental values and vulnerability, and the boundaries of a SVO can be proposed to be changed if the new knowledge warrants it. The forum will continue this work in the next management plan period.

Ecosystem services

Marine ecosystems contribute with great values to the society, including food, regulation of the environment and recreational opportunities. In order to ensure continued welfare and value creation, we must ensure well-functioning ecosystems.

In contrast to the national accounts, which provide an overview of the state and development in the Norwegian economy, there are no systems for collecting data on ecosystem services in Norway. The SVO Coastal Zone Lofoten has been selected as a pilot area to test how far it is possible to describe ecosystem services, given the existing data and knowledge. This is an area where we have a lot of data and knowledge about the ecosystems and environmental values.

In this work, the basis for ecosystem services is characterized by the environmental values found in the area. Knowledge of which environmental values contribute to which ecosystem services, is important to capture changes in the ecosystems' capacity to deliver ecosystem services over time. The environmental values are categorized into ecosystem components. The results show that the different groups of ecosystem components contribute directly or indirectly to most groups of ecosystem services. Ecosystem components at a lower trophic level, such as phytoplankton and zooplankton, mainly contribute to basic and regulatory services, while ecosystem components at a higher trophic level, such as fish, seabirds and marine mammals, mainly contribute to provisioning and cultural services. The organisms at a lower trophic level, however, have a large indirect effect on the flow of provisional and cultural services, through their role as the basis for all biomass production in the sea. Benthic habitats are composed of many groups of organisms and contributes to all groups of ecosystem services.

We have also searched for data to quantify the physical and monetary values for a few ecosystem services in the area. Based on existing data, we managed to describe physical and monetary values related to seafood, and for a few nature-based tourism activities. For climate regulation, we only found estimates for carbon uptake in kelp forests nationally, while for recreational services, we found no relevant data sources, neither at local nor national scale.

The results shows that there is still a significant knowledge gap about marine ecosystem services in Norway. Furthermore, we see that even when data exists and are available, it still requires some resources to obtain and adjust the data.

Risk of acute pollution and preparedness

Risk development in activities

Risk of environmental damage follows from activities which may lead to acute pollution, and the highest environmental risk in the Norwegian waters is connected to oil- and radioactive pollution in relation to petroleum activity and ship traffic. The main goal is to minimize the risk of damage to the environment and marine resources. This is achieved through monitoring and control of accidental risks and associated environmental risks, as well as ensuring the necessary emergency preparedness against acute pollution. Keeping the environmental risk at a low level requires keeping the accidental risks low. Thus, the risk of accidents must be handled jointly with environmental risk, to ensure taking the environmental vulnerability into account.

Petroleum activities

Safety and protection of the environment are recognised as closely connected in the petroleum industry, and activities are subject to integrated regulatory and auditing frameworks. This has been a stable framework condition for the petroleum industry for a long time, and it is important that it remains so. Descriptions of accident risk in the petroleum industry are adapted to the ocean management plans, and the descriptions aim at identifying where the authorities may need to adjust frameworks to prevent accidents also in the future. Efficient prevention of accidents – in accordance with the management goals – is achieved based on statistics combined with information from audits, investigations and research and technology development.

The Petroleum Safety Authority reports yearly about the development in the Norwegian petroleum industry regarding incidents and accidents, resulting in a time series of nearly 20 years of historic information. Knowledge about failures to barriers and consequences may be used to prevent accidents in the future. From 2005 and onwards, incidents of acute oil release on the Norwegian continental shelf have been fewer and most releases were small (0-0.1 metric tons). Acute releases of chemicals are dominating, especially in the Norwegian sea and the North Sea where there have been some major releases. Because these incidents happen far out at sea and with local impacts, it is difficult to quantify the environmental impacts. It is, however, important to maintain the attention on preventive measures to avoid major incidents in the future and to reduce the numbers of acute releases.

Near misses are events which could have resulted in discharges of crude oil, e.g., from leakages following damages, collisions with ships or floating objects, or deviations in well control. A clear decrease in near misses was seen in the years 2005-13 and this is explained mainly by a reduction in incidents with ship collisions. After 2013 there was a slight increase in near misses particularly connected to well control incidents in the North Sea. Accident risks have been assessed for the immediate past and the next management plan period, with focus on measures to prevent events of acute pollution and reduce the volume of accidental releases. No safety challenges were identified, which cannot be handled within the present regulations and development and improvement processes.

Environmental risk

Seabirds are generally considered to have the highest environmental risk from potential acute oil spills in Norwegian waters. Valuable ecosystem components in the water column (e.g., marine mammals) also pose environmental risk from acute oil spills, as well as vulnerable habitats, the ice edge, coast and beach areas. The high densities of seabirds in the Barents Sea and their vulnerability to oil spills underlines the importance of considering all relevant measures to reduce the environmental risk to seabirds during petroleum activities. Petroleum activities which have the potential for environmental risk in the Barents Sea, for shoreline and coastal areas, and along the marginal ice zone, also demands additional attention and regulations.

Activity levels are high in the North Sea and the Norwegian Sea, near the coast and further out to sea. As in the previous planning period, the environmental risk associated with most field and drilling activity in the North Sea and the Norwegian Sea is within what can be expected for this type of activity in the management plan area. However, there have been some activities with high environmental risk in the areas. The highest environmental risks stem from production and exploration wells with high blowout rates, waxy oils and/or wells close to the coast with high risk of large

amounts of stranded oil along the shore and important areas for seabirds.

Shipping

The Coastal Administration uses digital tools to estimate risks of accidents or releases and environmental risks from shipping. In recent years, there has been a slight increase in ship traffic, except for cruise and passenger traffic which was affected by the corona pandemic. Acute releases varied in volumes, and a single incident with two colliding ships in 2018 stands out as a year of high release.

A regulatory change in accepted fuels was made valid from January 2020, and low-sulphur fuel oils (LSFO) are now mandatory. The LSFO behaves differently at low temperatures, and wax or other lubricants are added when used in ship engines. The fact that LSFO solidifies at surface temperatures commonly found in Norwegian waters makes it difficult to collect oil spills, and the regulatory implementation of these oils seems to increase the environmental risk. There is a lack of knowledge around new fuels and environmental risk. We also lack experience from actions involving acute pollution from LSFO on cold sea surface.

The main reason for shipping accidents along the Norwegian coast is grounding due to faulty navigation or obstructions such as islets or skerries close to shore. The probability of acute events and releases increased in 2015-21, and most of the accidents happened to vessels smaller than 5 000 gross tonnages (GT) with releases mainly less than 0.9 tonnes. Numbers of accidents resulting in acute release of more than 0.9 tonnes of fuel also increased from 2015 to 2021, mostly related to fishing vessels, general cargo vessels and passenger boats. An increase in numbers of accidents involving transportation of chemicals is also registered, and this is related to a higher demand for chemicals in industry and society in general.

Environmental risk related to shipping accidents is an expression of how nature is affected from releases. Environmental risk values were going down in most areas from 2017 to 2019 due to lower risk of release. From 2019 to 2020 there was a clear difference in environmental risk values, but the short time and too many uncertainties make it difficult to conclude whether the risk increased in 2020. The Coastal Administration publishes environmental risk assessments for selected regions along the Norwegian coast, and in the 2021-22 assessment presented high environmental risk connected to significant ship traffic, high frequencies of oil impact, in combination with a potential for harming environmental values and areas of high vulnerability. Estimated environmental risk values for Spitsbergen, Bear Island and Jan Mayen are relatively low, as a consequence of low activity and low frequencies of accidents. For parts of the year, however, the estimated environmental risk values are very high and environmental consequences are more important than risk values when planning preparedness against acute pollution in these areas.

Environmental risk related to shipping accidents, is an expression of how nature is affected from releases. Environmental risk values were going down in most areas from 2017 to 2019 due to lower risk of release. From 2019 to 2020 there was a clear difference in environmental risk values, the short time and too many uncertainties make it difficult to conclude that the risk increased. The Coastal Administration publishes environmental risk assessments for selected regions along the Norwegian coast, and in the 2021-22 assessment presented high environmental risk connected to significant ship traffic, high frequencies of oil impact, in combination with a potential for harming environmental values and areas of high vulnerability. Estimated environmental risk values for Spitsbergen, Bear Island and Jan Mayen are relatively low, as a consequence of low activity and low frequencies of accidents. For parts of the year, however, the estimated environmental risk values are very high and environmental consequences are more important than risk values when considering preparedness against acute pollution in these areas.

Oil spill emergency preparedness

There are no considerable changes in the national oil spill emergency preparedness since the last management plan revision, either in private or public sectors. The Coastal Administration has performed an emergency preparedness analysis which is relevant to all parts of the national emergency preparedness response system. The analysis emphasizes the lack of oceangoing resources, especially in the outer regions, and the high cost of additional ocean-going resources. The petroleum industry has made similar assessments for development of petroleum activities in the Barents Sea, concluding that more emergency preparedness resources are needed to fulfil recommendations for the planned development

projects. Long distances and harsh weather in the Barents Sea make year-round activity and emergency preparedness difficult, and especially challenging during the winter months. The private capacity in ocean going resources is considered better in the North Sea and the Norwegian Sea, due to more resources connected to the petroleum fields and emergency preparedness bases and depots there.

According to the latest assessments, both coastal and shoreline emergency response systems are lacking. In the event of shipping accidents or major oil blowouts closer to the coast, it will be virtually impossible to prevent oil from hitting the shore and shoreline clean-up actions are difficult especially in remote areas with limited infrastructure and in winter. Another key factor in the national emergency response system is endurance or having enough resources to continue an operation as long as necessary. The existing resources are primarily set to handle the initial and acute phase of oil release events, and long-term shoreline clean-up is especially challenging from near-shore accidents or larger blowouts.

Documentation of the emergency response efficiency is limited, making it difficult to assess whether the oil spill emergency response system is of adequate and appropriate scope to achieve its purpose. Since the previous management plan revision, there has been an increased focus on the challenges of recovering hi-wax oil types, both from shipping and petroleum sectors.

Radioactivity

Traffic of reactor-driven vessels is increasing along the Norwegian coast and two ports (outside Bergen and Tromsø) are regularly visited by nuclear submarines. Old nuclear power plants in Europe and increasing probability of terrorist actions is also increasing the risk of accidents involving radioactivity and posing a threat to Norway.

The Crisis Committee for Nuclear Preparedness are responsible and authorized for the effectuation of measures to reduce the consequences of accidents involving nuclear power. The Government has established a scenario analysis with six scenarios around different events, in order to prioritise needs and plan for the best possible nuclear preparedness and response system. A seventh scenario about the effects of nuclear weapon use is under investigation. An emergency and preparedness exercise to test international response in events of an accident involving a nuclear vessel in Arctic conditions is planned for the spring of 2023.

In general, the level of radioactive pollution is low in the water. It is important, however, to continue monitoring of radioactive substances in the marine environment and seafood, to ensure proper documentation of background levels.

Climate changes and adaptations

Climate change is affecting the marine environment and ocean management must be adapted accordingly. Climate changes are a global challenge and key reports with a global or regional perspective contributes with knowledge. According to the 6th IPCC report the global average temperature has already increased by 1.1 °C because of human activities and emissions, and further increase is expected during the next 20 years unless emissions are haltered. Irreversible effects are expected, such as more extreme weather, heating and ice melting in the polar regions, rising sea levels, ocean acidification and deepwater warming. On land, melting glaciers and permafrost will lead to increasing carbon emissions, and in turn enhance the effects. Further heating of the Norwegian seas is expected as well as more marine heatwaves and negative impacts on the marine ecosystems. Species and habitats will suffer the pressure of seawater acidification and less oxygen and either they move to new areas, or they go extinct.

From climate projections, we expect air temperatures to increase 3.3-10 °C above the average temperature in the Arctic region during the years 1985-2014 within 2100. Emission scenarios indicate that the Arctic sea-ice will be gone by 2050. This will affect the indigenous people and their possibilities to hunt and fish, and also commercial fishing, aquaculture and tourism. Model studies indicate that marine mammals like the beluga and the bowhead whale will experience changes to their key habitats and their present distribution will change. Measurements using light loggers on seabirds to track their movements is used to investigate energy demand and feeding. The analyses indicate that winter habitat size will be reduced for seabirds such as the Little Auk, kittiwakes, and puffins. For the Common Guillemot and Brünnich's Guillemot, winter habitats will probably increase in all the scenarios except for the most extreme temperature increase (RCP8.5). The Barents Sea may become less important for the seabirds from the North

Atlantic Ocean and a main challenge will be a mismatch between food availability and the bird breeding season.

Risk analyses, coastal zones and ocean

During the period 2011-20, there was an average increase in ocean surface temperature of 0.88 °C compared to the years 1850-1900. Three global climate scenarios were scaled down to study physics and biology along the Norwegian coast during climate changes, and the scenarios span from low emission (SSP1-2.6), medium emission (SSP2-4.5) to very high emission (SSP5-8.5). Parameters such as temperature, oxygen, salinity and pH were used to model future habitats. The model results indicate heating and acidification of the seawater both at the surface and bottom. Oxygen levels will decrease; however, oxygen limitation is not expected in Norwegian oceans during the period until 2100. Low pH levels will follow from the highest emissions and especially in the southern areas, and this will be harmful to early life stages of some species. A gradual decline in habitat quality is foreseen along the coast, but conditions will remain within tolerance limits for the considered species in some parts of the coastal areas. Species distribution changes may occur, and e.g., the coastal cod can be moving northwards. Robust species like the sea urchin *Strongylocentrotus droebachiensis* and the seaweed *Laminaria hyperborea* can become extinct in the SPP5-8.5-scenario. The habitat assessments are based on long-term and expected climate trends, and do not consider stochastic events like marine heatwaves, ocean acidification events and varying oxygen levels, or coastal floods.

Model analyses were also performed for the Norwegian ocean management areas, using ecosystem models and selected key species of plankton, fish and crustaceans in combination with a down-scaled climate model. The results were used together with expert assessments to describe how climate changes will affect marine populations. Regional ocean models such as the NEMO-NAA10km take into account the "atlantification of the Barents Sea", a process where the seasonal layering is increasingly driven by temperature changes. Species sensitivity to changes are based on knowledge from a large range of sources from laboratory studies through estimates based on the distribution area characteristics. The outcome from the three model scenarios differs in terms of sea surface temperature, and some of the observed trends are due to natural variations which cause stronger effects on a regional scale compared to the global scale. In the North Sea, the changes following from increasing emissions may be positive for temperate species such as the Northern hake while North Sea herring, North Sea cod and *Calanus* are negatively affected. Coastal hake, Northeastern mackerel and the Norwegian Spring spawning herring in the Norwegian Sea may be positively affected by increasing temperatures, and the same is seen for Northeastern cod and *Calanus* in the Barents Sea. Increasing temperatures in the north will affect the ice cover distribution and negatively affect the species which are closely associated with sea ice, such as capelin and polar cod. Other effects of reduced sea ice can be higher plankton production, followed by increasing food availability and larger grazing areas. Higher water temperatures in the future may increase the migration of southernly distributed species into the norther oceans.

Measures

The Norwegian Ocean management plan presents a list of measures to support the goals which are set to manage our oceans and maintain healthy ecosystems. Some of the measures are specific in time and place, such as beach litter removal or limitations in activities which interact with spawning grounds in the spawning period. Other measures are long-term actions such as building a strong knowledge basis around climate changes and cumulative effects, were we lack data to evaluate the impacts and knowledge about the effects of measures.

The measures are sorted in six categories: Ocean and climate, sustainable use and area management, good environmental status and ecosystem conservation, strengthened knowledge basis, international collaboration, and development of the management plan system. In the first category we find measures which focus on industrial activities and sustainability including green transition to lower emission from ships and petroleum activity. All measures in this category are implemented. Sustainable use and area management is built around e.g., regulatory framework to prevent negative effects from industrial activities in valuable and vulnerable areas. Measures to reduce pollution and contamination in seafood is also important here.

Conservation of ecosystems is maintained through measures around particularly valuable and vulnerable areas (SVOs) or marine protected areas (MPAs), improvement of the situation for seabirds, protection of

threatened or vulnerable species or habitats, measures to prevent spreading of alien species, pollution and littering, including microplastics. Large mapping and monitoring programs such as Mareano and SEAPOP/SEATRACK contribute to increase our knowledge about marine habitats and seabirds and try to reverse the negative trends in seabird populations along the Norwegian coast. International collaboration is important in sectorial management and Norway is participating in international work such as OSPAR, NEAFC and in working groups under the Arctic council.

There is also a set of measures to develop the management plans and ensure that updates and revisions are performed regularly, as described in the mandates to the Forum for Integrated Ocean Management and the Advisory Group on Monitoring. A process to make the management plan work more efficient is initiated, including development of a digital presentation format and strengthened data dissemination through the Marine spatial planning tool. A process to make the management plan work more efficient is initiated, including development of a digital presentation format and strengthened data dissemination through the Marine spatial planning tool.

Goal achievements

The Norwegian Ocean Management Plans lists 38 goals and objectives to support the main vision that the cumulative effects from human activities shall be below the critical limits of ecosystem functions. The objectives to support value creation, industry and society are considered as reached, while several of the objectives to support biodiversity, ecosystems and sustainable populations are not reached. Objectives to reduce and prevent pollution are also not fulfilled. The goal on sustainable management of living marine resources is considered achieved, based on the Ocean Resource Act and the obligation to perform ecosystem-based management of the oceans. Goals for long-term value creation in the Petroleum industry are reached, and for renewable energies the development is positive with e.g., increasing numbers of low or zero emission vessels in the shipping sector.

Goals for maintaining biodiversity and ecosystems emphasize the importance of exercising caution in SVOs, but it is unclear how caution is practiced. Species and habitats are managed to maintain viable populations, and the goals are reached for zooplankton, large fish stocks and mammals, and partly achieved for benthic fauna and some of the smaller fish stocks. For some species, however, the situation is more critical in 2021 than in 2015 and the goal to conserve threatened and vulnerable species is not achieved. The seabirds are critically threatened in many parts of the management plan areas, and among the threatened species or habitats listed, only coral reefs are registered as protected from damage due to the ban on trawling. The list of protected areas is longer than before, but the goal of providing ecologically functioning networks across protected areas is not reached because many of the areas defined as MPAs are small or too far apart.

We have not managed to reduce the levels of hazardous compounds or prevent input of hazardous and radio-active compounds. Seafood safety is evaluated based on levels of contaminants in consumed species. The goals for seafood safety are met in the Barents Sea, while in the North Sea and the Norwegian Sea the goal is only partially achieved. Operational discharges from the petroleum industry are small in the Barents Sea because of a low activity level, higher in the Norwegian Sea and significantly higher in the North Sea due to extensive activity. We still lack knowledge about the effects of discharges to the environment, in particular long-term effects of pollutants in produced water and potential effects on bottom habitats. Operational discharge of contaminated drainage water in shipping is reduced, and ballast water releases are regulated by the Ballast water convention. Despite yearly rounds of plastic litter removal in some of the affected areas, there is no decrease in the amounts of plastics which end up on beaches. Lack of knowledge and monitoring of the effects of underwater noise and seismic activity on organisms in the underwater environment, makes it difficult to evaluate if there are negative impacts to the environment and organisms from underwater noise.

Any activity with a potential for acute oil spills has an inherent risk of damaging the environment and valuable ecosystem components. The goal is to reduce the risk of acute pollution, but it is difficult to determine if the goal is achieved, as risk concerns the future and depends on many different variables. Risks of major accidents happening in the petroleum industry is considered low, while in shipping there is a negative trend regarding the number of events and the risk of unwanted incidents since the previous management plan assessment. New

regulations and implementation of low-sulphur fuels has led to an increase in environmental risk in shipping. Also, traffic by nuclear powered vessels increases in all ocean areas, and the goal of reducing the environmental risk is considered as not achieved.

Environmental risk comprises the probability of damaging the environment and the potential consequences, and the goal is to minimize the risk of environmental damage from acute oil spills/discharges. We have no basis to conclude that this goal is achieved for the Barents Sea and must continue working towards reducing risk and implementing further measures. The environmental risk associated with most field and drilling activity in the North Sea and the Norwegian Sea is within what can be expected for this type of activity in the management plan area, but there have been some operations with high environmental risk due to high blowout rates, wax-rich oils and wells close to shore. The goal is therefore considered as partially achieved.

The national emergency preparedness towards acute pollution is considered partially achieved regarding capacity and endurance among the involved resources, while there is some uncertainty regarding the efficiency and preparedness to handle oil in ice-covered waters. It is difficult to assess the potential of reducing the consequences by the established preparedness system in the petroleum sector, and goal achievement is considered as uncertain. The goal is partially reached for shipping in those areas where measures are implemented along the Norwegian coast and Svalbard and Jan Mayen. Lack of resources to measure effects and lack of preventive efforts towards the casualty in case of an accident happening, results in negative goal achievement regarding nuclear preparedness in the management plan areas.

In general, evaluation of goals and achievements is challenging because we lack data and knowledge about cumulative impacts on ecosystem services, indirect effects on value chains, and we also lack relevant indicators and threshold values in the management. There are also some weaknesses in goal formulations and the method of evaluation, further described in the report on goal evaluation by the Forum for Integrated Ocean Management.

Knowledge needs

The decade 2021-2030 is the UN Ocean Science decade, and the goal is to strengthen ocean knowledge and protect marine ecosystem services. The Norwegian Research Council promotes topics such as ocean and climate interactions, environmentally friendly transport and renewable energy, and the research shall be useful to decision makers and in policy making.

We have gained more knowledge about particularly valuable and vulnerable areas, climate changes, plastic pollution and spreading of microplastics, in the last revision period for the ocean management plans. It is recommended to prioritize work to increase knowledge and understanding of ecological status, changes and causal relations, and effects of human impacts.

More knowledge is needed about sectorial activities and impacts, both from established and new industries, technology development for careful harvest and environmentally friendly activities as well as area usage and ecosystem impact. There is also a need to increase mapping and surveillance of open ocean areas and areas which may be developed for new industries. Long-term surveillance of the already known areas is needed to understand fluctuations and observe effects of regulatory measures.

There is still a need for more knowledge about threatened species and habitats, effects of management measures in particularly valuable and vulnerable areas and increasing impacts from alien species in some areas. Knowledge about ecosystem effects and climate impacts is important, together with increased understanding of the connections between ecosystem services, tipping points and consequences for value creation. Increased ocean littering and pollution of sediments and food webs leads to increased need for knowledge about effects on environmental values and whole ecosystems. Increasing activity also means increasing noise pollution, and there is a lack of knowledge about the impacts of underwater noise on ecosystems and vulnerable species.

The knowledge must be made available and operational for ocean management through data access and sharing, and development of analytics and modelling tools. Data collection through mapping and surveillance is very expensive and can be made more effective through collaboration and coordination of data collection across sectors. Model tool improvements may reduce

the numbers of data collection points and increase our understanding of large-scale processes and connections which cannot be seen from individual observations or data points.

Ocean accounts

The High-Level Panel for a Sustainable Ocean Economy has set several goals for 2030, where one of the goals is that all decision-making affecting the ocean should reflect the value of and impacts on the ocean's natural capital. Developing complete sets of national ocean accounts is one of their priority actions to achieve this. The Forum for Integrated Ocean Management has therefore evaluated how ocean accounting can contribute to Norway's management of the ocean.

Ocean accounts compiles information about the environment, economy, and society. The values from economic activities are presented in the national accounts today, but it is not specified which activities are connected to the ocean or how economic activities affect the ocean. It is therefore necessary to look at additional indicators to assess whether the use of the ocean is sustainable. The Ocean Panel recommends that comprehensive ocean accounts be based on three internationally determined and accepted accounting frameworks: (1) the System of National Accounts (SNA), (2) The Central Framework for Environmental Economic Accounts (SEEA CF) and (3) The SEEA Ecosystem Accounting (SEEA EA). These frameworks are compatible and complementary:

1) The national accounts (SNA) provide an overview of the state and development in the Norwegian economy. Marine economic activities must be extracted from the national accounts to create a so-called satellite ocean account.

2) The central framework for environmental economic accounting (SEEA CF) provide information about connections between economics and the environment in a holistic system.

3) The ecosystem accounts (SEEA EA) provide information about the extent and condition of ecosystems, and the use and supply of ecosystem services measured in physical and monetary quantities. The information can also be presented in maps to show geographical location and distribution.

The framework of environmental economic accounting has, to a large degree, been adapted to terrestrial and freshwater ecosystems. It is therefore necessary to further develop the framework to make it relevant for marine ecosystems. Adapting the framework to marine ecosystems raises several issues such as how to handle the water column and volume, migratory species and setting a reference condition. The idea of collecting information from the three different accounting frameworks into thematic ocean accounts is still relatively new, and the UN is currently working on this (SEEA Ocean).

A first version of a satellite account for Norwegian oceans was published by Statistics Norway in 2022. However, the development of a Norwegian marine ecosystem account and the thematic ocean account, have yet to be started. Given the recommendations from the Ocean Panel, there is no longer a question whether to develop ocean accounts, but rather when and how. Within internationally frameworks and standards, there is room to develop national ocean accounts that meets national needs and issues. Based on this, The Forum for Integrated Ocean Management has presented four recommendations for further work on ocean accounting in Norway, which are:

1) Use the results from Statistics Norway's satellite accounts when presenting values from economic activities in the ocean.
2) Create a pilot for marine ecosystem accounting.
3) Consider alternative concepts for establishing the Norwegian ocean accounts.
4) Prioritize research and development.

The marine spatial management tool

The marine spatial management tool is contributing to updates and revisions of the Norwegian ocean management plans, enabling collaboration with stakeholders. Development is ongoing, including standardized symbols and presentations of regulations, restrictions or area use measures (e.g., fisheries or petroleum regulations). Maps display activity, area use, species and habitat distribution, and particularly valuable and vulnerable areas (SVOs) with environmental values. The maps can be adapted to meet requirements of user such as case managers or NGOs.

Target groups are also politicians and departments, public administration, organisations and the general public. Registered users come from management, industry, financial sector, NGOs, research institutions, media and the advisory sector. The next step is to make the Marine spatial management tool known to new marine industries. Integration with other data resources and development of analytical tools will be of use, and also implementation of coastal zone information.

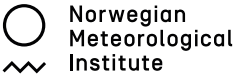

DSA
Norwegian Radiation
and Nuclear Safety Authority


DIRECTORATE OF FISHERIES


INSTITUTE OF
MARINE RESEARCH


Kartverket


KYSTVERKET
NORWEGIAN COASTAL ADMINISTRATION


Norwegian
Meteorological
Institute


Norwegian
Environment
Agency


NORWEGIAN POLAR INSTITUTE


NVE


NORWEGIAN PETROLEUM
DIRECTORATE


PETROLEUM SAFETY AUTHORITY
NORWAY


Sjøfartsdirektoratet
Norwegian Maritime Authority