



Norwegian
Polar Institute

Programme plans

Antarctic Programme

Arctic Ocean Programme

Svalbard Programme



Programme plan - Antarctic Programme

Introduction

Antarctica is changing. Climate change, ocean acidification, changes in land and sea ice cover and increasing human activity both on the continent and in the surrounding ocean areas contribute to these changes. Better knowledge of ongoing changes and the mechanisms that cause these is necessary to be able to predict what nature and society will face in the years ahead.

The purpose of the Antarctic programme is to provide the Norwegian Polar Institute with a basis to deliver relevant research and advice of high professional quality at the right time, and in line with management signals (cf. chapter 2) and allocated financial frameworks. Through monitoring and research, the programme will produce data and knowledge as a basis for advice to management about the geology, climate, nature, ecosystems, and environmental change in Antarctica. Through the programme, we will obtain evidence-based knowledge about the changing Antarctica and use this knowledge as a basis for advice to the authorities for use in national governance and international negotiations, as well as contribute to the dissemination of the knowledge to the science community and to the public. All data will be shared openly through the institute's data centre and other channels. The geographically most important areas for the Antarctic programme are Dronning Maud Land, Kong Håkon VII Hav (Sea) and Bouvetøya and its surrounding oceans. It is also both relevant and desirable to implement efforts in other parts of Antarctica when it is relevant to support the Norwegian authorities' concrete needs, for example on the Antarctic Peninsula where there is a need for knowledge that supports the management and regulation of the significant Norwegian activity in the area, both with respect to krill fisheries and cruise tourism. Through collaboration with other nations, it may be appropriate to contribute to scientific activity outside these areas.

This programme plan has a time horizon of ten years. It will be updated on need, at least every second years. Rolling (annual) action plans with specific prioritized objectives will be drawn up. Larger investments will as far as possible be coordinated timewise with the other NP programmes so that all of them are enabled to carry out larger investments during the planning period.

Everything we do and produce within the Antarctic programme must be anchored in the Norwegian Polar Institute's values: **credibility, targeted, quality-conscious** and **future-oriented**.

Framework

The most important strategic documents that govern the prioritization of the programme's resources are:

- NP's strategy 2019 – 2024 and the four overall strategic goals it sets out
- Annual award letters and guidance in instructions from the Ministry of Climate and Environment (KLD)

- National guidelines relevant to the Antarctic programme's efforts (Parliament White Paper, Norwegian Research Council (NRC))
- International guidelines relevant to the Antarctic Programme's efforts (UN climate panel (IPCC), ATCM and CCAMLR recommendations, CEP's science needs, etc.)

A more complete list and details are given in Appendix 1.

The Norwegian authorities (primarily NP itself, KLD and the Ministry of Foreign Affairs (UD)), CCAMLR, ATCM/CEP and IPCC are the most important target groups (knowledge users) for the Antarctic programme.

Needs identified by the target groups can be roughly divided into the following categories (a more detailed list is provided in Appendix 2).

- Changing environment
 - Knowledge to maintain protection of unique values
 - Knowledge of sustainable and environmentally adapted economic activity
- Changing climate
 - Knowledge of how climate change affects Antarctica
 - Knowledge of how climate-related changes in Antarctica affect the world and global systems
- Effects of human presence
- Mapping and monitoring
- Dissemination and use of knowledge

In setting up a research and monitoring portfolio that meets these needs, it is also necessary to look at research priorities that have been made in a national and international context.

The strategy document Norwegian polar research: The Research Council's policy for 2014–2023 and SCAR's Horizon Scan from 2014 are particularly important to look at, as well as, for example, strategies, priorities and initiatives within SCAR's working groups, as well as strategies and initiatives within the framework of SOOS.

Long time-series and monitoring

Long-term, quality-assured data series are important for being able to observe ongoing changes in nature caused by, among other things, climate change and human activity. Such data is also indispensable for understanding the mechanisms of change as a basis for modelling future change. Long-term time series are an important resource in many research programs and are the basic element in all environmental monitoring. The Antarctic programme will identify key time series that can help shed light on environmental changes in Antarctica and which can simultaneously strengthen the research results in the programme's focus areas. Identified, central time series will be prioritized within the programme's financial resources.

Thematic directions

Three main areas of effort have been identified for the Antarctic programme, and each of these have been narrowed down to a few thematic directions. These are designed to respond to the framework conditions (chapter 2). Throughout, there is a need for knowledge about **status, trends** and **future prospects**. Action plans will be prepared which will provide a

detailed description of the desired research and development activity for each of these areas.

1. How does Antarctica affect the future global climate and sea level: Climate processes and changes

Climate processes in Antarctica significantly influence global climate processes. Several of the latest reports from the IPCC have identified critical knowledge gaps when it comes to understanding the extent of how the Antarctic ice sheet and the ocean around Antarctica affect global climate change and sea level rise.

Climate change and its consequences are among the biggest challenges facing global society today. Sea level, biodiversity, living conditions, and more are key aspects of people's welfare and the maintenance of social structures. Knowledge of how these conditions can change as a result of ongoing climate and process changes is fundamental to being able to make the right choices/measures and adaptations to face the new future. Knowledge from and about Antarctica is of decisive importance in building this foundation. The Antarctic programme will help to fill key knowledge gaps in this area.

Thematic directions:

- a. **Sea and ice-shelf interaction:** *understand the extent of large-scale physical changes in the interaction between sea and land and how this can affect mass loss from the ice sheet.* Key question: How and to what extent does the sea (circulation, ice, etc.) off the coast of Dronning Maud Land (DML) affect the Antarctic ice sheet's contribution to global sea level rise? How are the ice barriers along the DML affected by ongoing changes and what are the long-term consequences of these changes.
- b. **Ice sheet dynamics:** improve estimates of the mass balance on the Antarctic ice sheet as a basis for future sea level forecasts. Key question: What is the possible and likely contribution of DML to global sea level rise in the next century and centuries?
- c. **Climate:** improve understanding of the link between the past climate in Antarctica, the current climate in Antarctica and changes in the global climate system, in order to contribute to the improvement of future-oriented modelling. Key question: Are there conditions in/outside DML in terms of past climate and climate development that are particularly suitable for elucidating current and future global climate change. How are the atmospheric climate processes in Antarctica changing, and what does this mean for future climate development? To what extent is the carbon absorption capacity in the sea areas outside the DML changing, and how does this affect climate change processes?

By focusing on these thematic directions, the Antarctic programme should be able to contribute constructively to the global effort to identify and explain change processes in the Antarctic climate and through this contribute to the further development of global climate models with improved representation of central processes and dynamics in Antarctica. Furthermore, the Antarctic programme will help to reduce uncertainty related to future sea level rise caused by change processes in Antarctica.

2. Knowledge to ensure protection while allowing for sustainable exploitation: Changing marine and marine-associated ecosystems

Current climate changes, and the changes expected in the future, are expected to have major consequences for Antarctica. The consequences in and around Antarctica will be many and complex and will affect both the marine and terrestrial ecosystems. Lack of knowledge about species in the ecosystems, processes that govern the ecosystems and changes in these is a fundamental obstacle to ensuring a robust, future-oriented and sustainable protection and management of the unique environmental values and the available natural resources in the area.

As a Party to the Environmental Protocol under the Antarctic Treaty, Norway has committed to a comprehensive protection of the environment in Antarctica, while at the same time it is an overarching aim to enable an ecosystem-based, comprehensive management of the environment in the marine areas (within the framework of CCAMLR) and on land (within the framework of the Antarctic Treaty) in the Treaty area, with a particular focus on the protection of vulnerable and valuable areas and species. The Antarctic programme will contribute to providing knowledge that gives Norway a basis for management that safeguards the high conservation objectives set for the area and that can contribute to the knowledge needed for sustainable harvesting where there is room for it within the international agreements.

Thematic directions

- a. **Process and change understanding:** identify, track, explain and predict changes in the marine-associated ecosystems (incl. associated/dependent ecosystems) as a basis for vulnerability assessments and adaptive management. Key question: What are the most critical changes that we can expect in light of ongoing global environmental change?
- b. **Vulnerable and valuable areas and species:** Obtain the scientific basis for area- or species-based conservation and management that encompasses the peculiarities linked to marine and terrestrial natural diversity, landscape and ecosystem processes. Key question: Which key processes, landscape elements, species, etc. can be considered particularly vulnerable or valuable as a basis for special management measures?
- c. **Human impact:** Exploring the scientific basis for being able to develop and establish national and international regulations, technologies and environmental guidelines that aim to reduce environmental impact from activity in Antarctica. Key question: What are the risks associated with the various current and expected impact factors (to which Norway contributes) for the environment in Antarctica, e.g. resource extraction, traffic, pollution, alien species, etc.) and what would be effective measures to limit and mitigate such threats?

By focusing on these thematic directions, the Antarctic programme will be able to contribute constructively to understanding the consequences of environmental changes caused by local and global processes, on key Antarctic and sub-Antarctic ecosystems and provide a strengthened scientific basis for implementing management measures that contribute to protection or sustainable use. These thematic directions are of particular importance in being

able to support ongoing work within the Antarctic Treaty (and the Environment Committee) and CCAMLR.

3. Dronning Maud Land and Bouvetøya: Knowledge about Norway's outer edge Dronning Maud Land is approximately 2.7 million km² in size, almost seven times larger than Norway, and covers approximately one sixth of the Antarctic continent. Since the early exploration in the 1920s and 30s (which was the basis for Norway claiming the area), Norway has relatively limited research and exploration activity in the area, and the detailed knowledge of the area is relatively low, even if the knowledge base is also strengthened by the fact that eight other countries have established stations and activities in the area in addition to Norway itself. The sovereignty claims in Antarctica stand firm, even if they lie dormant while the Antarctic Treaty is in force. Thus, Norway has a particular responsibility for and interest in holding knowledge about this area. The Antarctic programme must contribute to a sufficient knowledge base to safeguard Norway's responsibilities. To the extent that opportunities arise, it will be relevant and desirable to increase the overall knowledge of Peter I Øy, although this does not constitute a main priority and area of effort in the current programme period.

Bouvetøya lies north of the Antarctic Treaty's scope and is undisputed Norwegian territory. The authorities have expressed a clear desire to facilitate predictable and consistent management on the island, with an emphasis on taking care of the unique environmental values on the island and in the surrounding sea areas, knowledge acquisition and environmental monitoring. The Antarctic programme will facilitate the continuation of central monitoring activity and other management-relevant knowledge acquisition on and around the island.

Thematic directions

- a. **Nature and environmental mapping:** provide an overview and knowledge of species, habitat types and geology in DML and on Bouvetøya, as well as assess whether there are values that are particularly vulnerable to ongoing changes or that for other reasons must be given special consideration in future management. Key question: What and where are the distinctive biological, geological and physical natural and environmental values in these areas? How do they differ from and how do they relate to surrounding areas.
- b. **Changes in natural and environmental values:** seek to understand if and how the natural and environmental values in and near DML and on Bouvetøya are changing as a result of global influences. Key question: Are any of the particularly valuable and/or vulnerable natural and environmental values in these areas exposed to special pressure?

By focusing on these thematic directions, the Antarctic programme should be able to contribute constructively to the knowledge base for a robust, clear and future-oriented management of the Norwegian areas of interest in the south.

Methods and tools

The Antarctic programme will strategically utilize (and contribute to developing) available **infrastructure** as platforms for its operations, including F/F "Kronprins Haakon", Troll, cargo vessels, and in collaboration with other national Antarctic programs also their vessels and stations. As far as possible, **cruise and fieldwork** will be designed and used for studies that cut across areas of effort, so that we can produce holistic knowledge. This will provide added value for all subject areas, and increase the opportunity to provide comprehensive management advice. Efforts will be made to facilitate regular cruises. It is also relevant to develop cooperation with other national programs and actors with respect to vessel and station based activities.

In the Antarctic programme, active phasing in of **new technology** for monitoring (autonomous vehicles, new sensors) and data collection is encouraged.

Emphasis is placed on long-term and holistic thinking and as such develop or actively contribute to **modelling initiatives** (process, regional, climate downscaling).

In line with the Antarctic Treaty's Article III (c), all **data** and **scientific results** will be made available for sharing. The same requirement is laid down in the Ministry of Education's national strategy for making available and sharing research data. All projects in the Antarctic programme are obliged to submit a data plan according to the data centre's template before implementation and ensure that data is made available through NP's data centre. The programme will also seek to ensure the storage and availability of data obtained in previously completed projects in Antarctica for the best possible utilization of these.

National and international **cooperation** is of crucial importance in order to get the most possible return for efforts in Antarctica. Emphasis is placed on being visible and participating in the Antarctic Science Committee (SCAR). The programme will also prioritize cooperation with NP's identified key countries for cooperation in Antarctica.

The Antarctic programme will develop and utilize appropriate meeting points and products to **convey knowledge** obtained within the programme to the user groups.

Financial framework

Parts of NP's budget from KLD are channelled to projects through the programmes. This will mainly go towards financing prioritized time series relevant to environmental management. Internal funds are also used to respond to specific assignments in the ministerial award letter. Other research initiatives will primarily be financed through external funds, with the main emphasis on NRC and various EU programmes. NP will take a leading role in the development of large research projects on topics that are central to the programme's strategy.



Programme plan - Arctic Ocean Programme

Introduction

The Arctic is undergoing rapid changes, with increasing temperatures in the ocean and atmosphere, and a shrinking sea ice cover. Ecosystems and human activities in this area are therefore also changing. Improved knowledge about the ongoing changes and the mechanisms governing them, are thus needed to enable predictions of the changes nature and society are facing when we are approaching a time when most of the Arctic Ocean is likely to be ice free for long periods every year.

The Arctic Ocean Programme will enable the Norwegian Polar Institute's delivery of timely, relevant, high-quality science and management advice, in accordance with guidelines and allotted financial resources. Through long-term monitoring and research, we will produce data and knowledge to advice management about the **status, variability and trends of the environment and ecosystems** of the Arctic Ocean, and about the drivers of the ongoing changes. Through programme activities we will produce science-based knowledge about the **future development of the Arctic Ocean** and use this knowledge as basis for advice to the government for use in national management processes as well as for international agreements and disseminate the knowledge in scientific fora and to the public. All data are to be shared openly through the institute's data centre and other channels.

The geographically most important areas for the Arctic Ocean programme are the northern ocean areas where Norway has a particular responsibility for management; we will carry out relevant monitoring and research in the northern Barents Sea, the Fram Strait, and the Nansen Basin. The programme will also facilitate studies of the interactions between the ocean and Svalbard's coastal areas. Collaborative projects in other parts of the Arctic Ocean (The Amundsen Basin, the Canadian Basin, the Arctic shelf seas) and in the North Atlantic may also be considered when there are evident and important connections with the core working areas.

This programme plan has a time horizon of ten years. It will be updated as needed, and at least every two years. Based on the plan, action plans (projects) will be developed for specific prioritized goals. Larger undertakings must be temporally co-ordinated with the other programmes at the institute such that all programmes can carry out selected, more demanding actions during a five-year period.

Work in the Arctic Ocean programme will build on the values of the Norwegian Polar Institute; credible, targeted, quality-conscious, and forward-looking.

Framework

Important strategic documents governing the prioritization of the programme's resources are

- The Norwegian Polar Institute's strategy 2019 – 2024 and the overall strategic goals set there

- Annual letters of allocation and guidelines in instructions from the Ministry of Climate and Environment (KLD)
- National guidelines relevant to the Arctic Ocean programme (Parliament, Research Council, etc.)
- International guidelines and recommendations relevant to the Arctic Ocean programme (EU Polar policy, IASC, AMAP, CAFF, PAME, IPCC, etc.)

The most important target groups (knowledge users) for the Arctic Ocean Programme are Norwegian authorities, primarily the Ministry of Climate and Environment and the Norwegian Environment Agency, but also international bodies such as the IPCC, the working groups under the Arctic Council, etc. Important processes we will actively contribute to include integrated ocean management, assessments of ecological status and bilateral Norway-Russia cooperation.

From "[The Ministry of Climate and Environment's priority research needs \(2016-2021\), chapter 4.8 The Polar and High North](#)":

There is increasing pressure on the environment in the northern and polar regions from climate change, pollution, increased availability and economic activity. Alien species are also thought to pose a significant threat to native biota. Sea ice is a habitat for a number of polar species, and reduced sea ice could have major consequences for individual species and ecosystems. The changes in the sea ice also have an impact on the dynamics of the ice and how this is represented in operational forecast models.

The IPCC emphasizes that the risk of biodiversity loss increases drastically when the climate changes, especially when this interacts with other stressors, such as changes in habitats and pollution.

These challenges create a need for new research-based knowledge in the management sphere. Priority topics are the effects of climate change, short-lived climate drivers, ocean acidification, environmental toxins and increasing human activity on ecosystems and biodiversity in the polar regions. Furthermore, more knowledge is needed about the role of polar processes in the global climate system, and global ripple effects of climate change in the polar regions. Research data from the polar regions may also play a key role in the development of new and established global environmental agreements.

Key knowledge needs:

1. Effects of climate change, ocean acidification, pollution, commercial activity on habitats, ecosystems, and key species (especially ice-dependent species) in ecosystems
2. Habitat selection throughout the year, important breeding or nesting areas, key biotopes, key challenges and significance of environmental impacts in winter areas for migratory species
3. Interactions in ecosystems - ecological relationships between predators and prey and how this varies throughout the year and between years

Economic framework conditions

Parts of the Norwegian Polar Institute's budget from the Ministry of Climate and Environment are channelled to projects through the programs. This will mainly go to funding work related to the collection and processing of datasets – primarily time series – that are directly relevant for management advice, and for projects/tasks that otherwise contribute to

management advice. Internal funds are also used to respond to specific assignments in the letter of allocation. Process studies and other research initiatives will primarily be financed through external funding, with emphasis on RCN and various EU programs. The Norwegian Polar Institute will take a leading role in the development of large-scale research projects on topics that are central to the work programme.

Long time-series and monitoring

Long, quality-controlled time series are of fundamental importance to enable assessment of long-term change in nature. Such time series are an importance asset in many science projects and a fundamental part of all environmental monitoring. Through projects, the Arctic Ocean programme will establish new and maintain and further develop existing time series that allow us to assess variability and change in the Arctic marine environment. At the same time, the time series will support science-based knowledge building within the topical focal areas of the programme. Selection of variables to be covered will, when relevant, be done in accordance with selection of Essential Climate Variables (se e.g. <https://public.wmo.int/en/programmes/global-climate-observing-system/essential-climate-variables>). We will also rely on information from projections from Earth System Models to design time series that cover areas, variables, and time intervals to ensure that the resulting observational data will capture the most important changes within different possible development scenarios for the climate and ecosystem. Central time series will be identified in the programme, and these will be prioritized with respect to the programmes financial resources. The Arctic Ocean programme will contribute actively to international processes to strengthen development o holistic pan-arctic observational systems (e.g. through SAON).

Targeted science topics

Two overarching priority areas have been identified for the Arctic Ocean Programme, and thematic targets have been identified for each of these. These are designed to correspond with the framework conditions (Section 2). The focus areas and associated thematic priorities generally require knowledge about **status**, **trends**, and **future scenarios**.

1. Climate processes and climate change

In recent years, climate has changed faster in the Arctic has than in other areas, and climate processes in the Arctic Ocean affect the global climate. Knowledge of these processes is crucial for development of projections (and quantifying associated uncertainties) of future development in the Arctic Ocean, and for understanding how changes in the Arctic and the global climate system affect each other. Climate change and its consequences are among the greatest challenges facing the global community today. Sea level, extreme events, biodiversity, living conditions (climate, environment, etc.), and more are key aspects of human welfare and the maintenance of social structures.

The Arctic Ocean Programme aims to increase knowledge about how the Arctic Ocean – the sea ice, the ocean, the atmosphere and the biogeochemical system – reacts to variations and changes in the global climate system, and how feedback processes between the different

parts of the Arctic Ocean work. The programme will also study how changes in the Arctic Ocean affect adjacent areas (especially Svalbard and the North Atlantic) through the export of sea ice and transport by ocean currents. Knowledge about how these conditions may change because of ongoing climate and process changes is necessary in order to provide knowledge-based advice that can form the basis for the right measures and adaptations to meet the future. The Arctic Ocean programme aims to fill key knowledge gaps, including those identified by the IPCC, in this area.

Thematic objectives:

- **Sea ice and snow** – The programme will strengthen the **monitoring** of sea ice in the Arctic Ocean as well as carry out **process studies** and validation campaigns. Data coverage on sea ice and snow must be improved in the Nansen Basin and in the northern Barents Sea.
- **Ocean** – continue and strengthen **monitoring** of outflows through the Fram Strait and inflows north of Svalbard. New time series will be established in deeper parts of the Eurasian Basin and in the northern Barents Sea. The latter will be done in line with recommendations for future monitoring that will be given towards the end of the Nansen Legacy project. **Process studies** will improve our knowledge about e.g. links between ocean, sea ice and atmosphere.
- **Biogeochemistry** – Existing monitoring series will be strengthened, and new time series established to include key parameters on **carbon chemistry and nutrients**, among other things.
- **Paleoclimate** – Historical climate development will be studied further, with special focus on the deep Arctic Ocean.
- Numerical **modelling** tools will be used both as a supplement to monitoring and process understanding and as tools for creating independent **future scenarios**.

Data collection (both monitoring series and process studies) should be arranged so that data can also be of use for model validation and improvement, both at the Norwegian Polar Institute and by others.

2. Changing marine ecosystems

Today's climate change, and the changes expected in the future, have major consequences for the ecosystems in the Arctic Ocean. Knowledge about individual species and interactions between species in ecosystems, and processes that control ecosystems and changes in these, is fundamental to facilitating forward-looking and sustainable management of the distinctive environmental values and available natural resources in the area.

The Arctic Ocean Programme aims to increase knowledge about how ecosystems in the Arctic Ocean respond to variations and changes in climate and the natural environment, and to develop realistic scenarios for future developments. The purpose is to strengthen the knowledge base for balanced, sustainable ecosystem-based management of the systems in the Arctic Ocean. Among other things, we will be prepared to contribute to the Joint Programme of Scientific Research and Monitoring for the CAOF agreement (Agreement to prevent unregulated high seas Fisheries in the Central Arctic Ocean). In addition to knowledge about ecosystems as a whole, the Norwegian Polar Institute will have a special

focus on ice-related species, from phytoplankton through zooplankton to seabirds and marine mammals.

Thematic objectives:

- Obtain data and knowledge about **key species/functional groups** and entire **ecosystems** to provide management advice. This includes mapping of species occurrences (including new/invasive species) and biomass (including seasonal cycles and other variability) in selected geographical areas.
- **Adaptability of species** to climate change – developing quantitative models for species' life cycles to assess their response to environmental change. Understand how species adapt through genetic, physiological, and ecological changes. Including studies of historical adaptability to predict future tolerance limits. Focus on lower trophic levels (phytoplankton, zooplankton; ice-related species) and higher trophic levels (marine mammals and seabirds).
- **Pollution and pollutants** – mapping the occurrence of pollutants and plastics in the marine environment. Increased knowledge about transport, turnover and degradation at different scales and in light of changes in the ocean, sea ice and precipitation. Effect studies on selected key species including multi-stressor assessments.
- **Ocean acidification** – The Arctic Ocean Programme will further develop time series on key parameters in the marine carbon system, and study effects at species and ecosystem level.
- Numerical **modelling** tools will be used both as a supplement to monitoring and process understanding and as tools for creating independent **future scenarios**.

Data collection (both monitoring series and process studies) should be arranged so that data can also be of use for model validation and improvement, both at the Norwegian Polar Institute and by others.

Methods and tools

Several expeditions with RV Kronprins Haakon will be carried out by the Norwegian Polar Institute every year, and we will facilitate participation from other institutions that complement our efforts. Researchers at the Norwegian Polar Institute can also participate on other vessels and platforms when relevant. As far as possible, expeditions and fieldwork will be designed and used for studies that cut across the focus areas so that we can produce comprehensive and cross-cutting knowledge. This applies to both monitoring projects and process studies. Interdisciplinary efforts will provide added value for the various disciplines and increase opportunities for providing pervasive management advice.

The Arctic Ocean Programme calls for active phasing-in of new **technology** for monitoring and other data collection (autonomous vessels and platforms, new sensors, remote sensing) and new analytical methods. We will also engage in planned development and the use of **numerical** models: process modelling, coupled regional models, downscaling of future scenarios from global climate models.

In line with the Norwegian Polar Institute's data policy, **data** and **scientific results** shall be made **available** for sharing. All projects in the Arctic Ocean Programme must submit a data plan in accordance with the data centre's template before implementation and ensure that data is secured and made available through the Data Centre of the Norwegian Polar Institute. National and international **cooperation** is of crucial importance to achieve the greatest possible return on efforts in the Arctic Ocean. The programme will give priority to cooperation with certain institutions and partner countries.

The programme will host annual internal information meetings as well as thematic workshops for the development of initiatives for the action plans.

Management advice is also based on knowledge from other institutions. The Arctic Ocean Programme will develop and utilize good meeting points and products to communicate relevant knowledge to user groups.



Programme plan - Svalbard Programme

Introduction

Impacts of climate change are already very visible in the Svalbard Archipelago, and it is expected that change will continue, perhaps at accelerating rates. The West Spitsbergen Current is becoming warmer and warmer, and it is bringing with it species that are normally found at much more southerly latitudes – a process that has become known as «Atlantification» of European Arctic ecosystems. Glaciers are melting rapidly and sea ice in fjords has declined markedly over the last two decades. Many Arctic endemic species are tightly ice affiliated. For example, Arctic seals depend on sea ice as a birthing platform and for resting and foraging. They are experiencing reproductive failure and animals that undertake foraging migrations to the summer Arctic pack-ice must travel further north or eastward to find summer feeding areas. Species that do not have sufficient behavioural plasticity are likely to decline or even be regionally extirpated. There are more mild-weather periods in the winter that result in precipitation falling as rain rather than snow. This causes ground-icing, which makes winter foraging by herbivorous animals very challenging. The lack of insulating snow also exposes plants to harsh winter conditions. Some plants are not tolerant of icing, which is resulting in change at the level of whole plant communities. Significant changes in economic activities are also underway within the archipelago, among them a strong increase in tourism. Svalbard is already threatened by both direct and indirect aspects of climate change. The Svalbard Programme at the Norwegian Polar Institute is designed to assess threats (and their drivers) to contribute to the maintenance of the distinctive wilderness character of Svalbard, despite climate change.

The Svalbard programme facilitates timely delivery of relevant research, of high professional standard, in line with steering signals provided by management authorities (see below), within budget frames provided. Our monitoring and research must produce data and knowledge on status, variability, and trends in ecosystems as well as contaminant levels across the whole of Svalbard, including coastal waters.

The knowledge created in the Svalbard Programme is used directly as a basis for advice to management authorities. But publication in scientific journals of high standing, is also a target for our scientific production. Considerable effort is also made to reach the Norwegian public with our findings via net-pages, the Norwegian media, national bibliographic databases such as Cristin and other outlets. Our data is made available through the Norwegian Polar Institutes datacentre as well as other relevant, open scientific sources such as Pangea or AniBOS; NPI practises the FAIR principles for data sharing.

To provide advice on status of the environment and expected changes, NPI engages with predictive models and adaptive monitoring systems that allow for evaluation of the system but also identification of the drivers and effects of change. The Svalbard Programme includes research and monitoring activities across the whole archipelago, including Jan Mayen and Bjørnøya. The biological work in the Programme is organised into three principal areas 1)

terrestrial systems 2) coastal and fjordic systems and 3) glaciers (and snow); tidewater glacier fronts are key habitats for many organisms and snow cover is important to plants. Contaminants research is not identified as an independent theme, but rather is a component part of all of the subject areas. The programme also facilitates the study of interactions between Svalbard's coastal areas and the Arctic Ocean, with the Marginal Ice Zone (MIZ) being a major biological focal point.

The current programme plan has a time-horizon of 10 years. However, it will be updated as needed, and is reviewed at least every other year. Annual action plans guide the work within the programme, with concrete, prioritized goals.

All activity undertaken in the Svalbard Programme will be anchored in the Norwegian Polar Institute's values: credible, targeted, quality-conscious, and forward-looking.

Framework

Important strategic documents that help guide the prioritization of the programme's resources are:

- NPI's strategy (2019 – 2024) and the overall strategic goals set out there
- Annual instructions from the Ministry of Climate and Environment (KLD)
- National guidelines relevant for the Svalbard Programme (such as Norwegian Research Council Strategic documents and Parliamentary White Papers)
- International guidelines and processes relevant to the Svalbard Programme (e.g. EU Polar Policy, IASC, IPCC, Arctic Council and its working groups – (CAFF, PAME, AMAP) etc.)

Another important document guiding our research is the Climate and Environment Department's «KLD's priorities for research 2016-2021, specifically, Section 4.8 Polar and Northern Regions».

There is increasing pressure on the environment in the north and in polar regions from climate change, pollution, and increased accessibility for economic activity. Introduced species are also believed to be a serious threat to resident biota. Sea ice is a habitat for many polar species and reduced sea ice will have large consequences for some species as well as ecosystems. Changes in sea ice also has implications for ice dynamics and how these are represented in models that are used for forecasting and safety and security of ship traffic.

The United Nations Climate Panel warns that the risk of biodiversity losses has increased dramatically due to climate change, especially when it is considered in combination with other stress factors (cumulative impacts) that are changing habitats such as contaminants. These challenges create management needs for new research-based knowledge. Specially prioritized themes at NPI thus include effects of climate change on ecosystems, short-term climate drivers, ocean acidification, contaminants, and the impacts of increasing human activities on ecosystems and biodiversity in Polar Regions. Additionally, there is a need for increased knowledge on the role polar processes play in the global climate system and global

ripple-effects of climate change in polar areas. Research data from polar areas will also have a central role in development of new and established environmental agreements. Knowledge is also needed on the effects of melting of permafrost and coastal erosion impacts on cultural heritage sites (as well as knowledge on preservation strategies), along with the self-reinforcing impact of release of methane and carbon dioxide previously frozen in the ground. Identification of knowledge needs for Svalbard and ocean areas around Svalbard and Jan Mayen as well as in Norwegian focal areas in the Antarctic are key to designing NPI scientific studies.

Central research needs include:

1. Effects of climate change, ocean acidification, pollution, industrial activity impacts on nature-types, ecosystems, and key species (especially ice-associated species) in ecosystems.
2. Habitat choices by Arctic animals throughout the year, identification of important birthing/nursery and hatching areas, key biotopes, key sites, and the environmental impacts on wintering areas for migratory species.
3. Interactions in ecosystems – ecological relationships between predators and prey and how these vary across seasons and between years.
4. The most important target group (users of knowledge generated or compiled by NPI) for the scientists working within the Svalbard Programme is Norwegian management authorities, primarily the Ministry of Climate and Environment, the office of the Governor of Svalbard (Sysselimester) and the Environmental Directorate. However, international bodies such as IPCC, Working Groups with the Arctic Council etc. also help set priorities for our work.

Long time-series and monitoring

Long, quality-secured, monitoring data series are essential to document ecosystem change, determine drivers and predict future changes. Time-series are an important resource in many research programmes and are a basic element in the programme Monitoring Svalbard and Jan Mayen (MOSJ). NPI is the secretarial home for MOSJ, which was established to determine whether national environmental goals are being met in the Norwegian Arctic. Although MOSJ dominates our monitoring activities, NPI also prioritizes, and undertakes where possible, other national and international monitoring goals (such as those established by CAFF or the International Polar Bear Agreement).

All existing monitoring programmes are intermittently evaluated and where necessary adaptive changes are implemented. The data collected must deliver information relevant to administrative authorities, such that it can be used for testing/validation of probabilities for future trends. All monitoring must be clearly justified and harmonized with the MOSJ framework.

Focal areas

NPI will continue to organise monitoring and research in accordance with the Ministry of Environment's prioritized research needs (2016-2021) – Chapter 4.8 Polar and Northern Areas. Relevant research needs are identified in the knowledge gaps section of this document. Based on the scenarios outlined in "Climate in Svalbard 2100 – a knowledge base for climate adaptation", we shall identify the expected changes both in the short and longer term within each focal area – land, coastal marine systems and glaciers. The research and monitoring done by NPI builds knowledge about the future developments within ecosystems, environmental toxins and on the glaciers in Svalbard. The knowledge produced will be the basis for our advice to management authorities. Inputs to management plans promoting good conservation values are key targets. Hence, our studies will support the establishment of important protected areas and conservation processes.

The Svalbard Programme, through its projects, will identify changes that should be followed by monitoring, and thereby ensure that the monitoring programmes conducted reflect the actual needs for management. In cases where individual species are mentioned, it is because these species have been identified as "key" species that are currently selected for monitoring.

Special focus areas on land include:

- Monitoring the occurrence of introduced or invasive species and contributing to the current governmental strategies for dealing with these organisms (e.g. sibling voles and introduced plant species (in settlements) on Svalbard)
- Maintain geological mapping of Svalbard
- Increase monitoring activities in eastern and northern parts of Svalbard
- Remain updated regarding the effect of thawing permafrost and a thickening active soil layer

Special focus areas for coastal and fjord areas include:

- Monitoring the status of populations (and drivers of demography) of Brunnich's guillemot, common guillemot, kittiwakes, glaucous gulls, ivory gulls and common eiders on Svalbard
- Monitoring the population status (and drivers of demography) of polar bears, walrus and other ice-dependent marine mammals in Svalbard
- Monitoring the marine ecosystem, and drivers of primary and secondary production in Kongsfjorden
- Acquire knowledge regarding the effects of glacial fronts and fjord circulation on the Kongsfjorden ecosystem
- Monitor the effects of contaminants (including plastics) on the ecosystem (trends levels in key species – ringed seals, harbour seals, Brunnich's guillemots, glaucous gulls, ivory gulls, and fulmars)

- Monitor wader species (initially - in the Ny-Ålesund area)
- Remain updated regarding the effects of permafrost and thickening of the active layer, and resulting drainage/erosion
- Monitoring the occurrence of introduced (or invasive) species
- Monitoring annual land-fast ice thickness at key sites (east and west coasts)

Special focus areas for glaciers (snow and atmospheric interactions) include:

- Detailed monitoring of selected reference glaciers
- Monitoring of impacts of climate change on glacier mass-balance (driven by atmosphere, snow, precipitation, calving and melting)
- Acquire knowledge on the «reservoir» status of glaciers for contaminants (including plastics) and nutrients.
- Monitoring black carbon deposits on glacier and on snow at key sites
- Providing knowledge regarding atmosphere, land, and sea interactions

All data are stored and made available via the Norwegian Polar Institute's data centre in keeping with NPI's data policy, the National Education Ministry's, and the Norwegian Research Council's national strategy for sharing/availability of research data.

Methods and tools

NPI aims to be a visionary, flexible creator/supplier of scientifically based knowledge and advice regarding trends in Arctic ecosystems (both biological and physical components). We will work to develop our monitoring portfolio such that it is adaptive; targeted, improved data capture will increase the trustworthiness of our future scenarios modelling. With a background in "climate in Svalbard 2100 – a knowledge base for climate adaptation" we will create predictive models of ecosystem change. Given that there will always be uncertainties in models describing ecological systems components, we will create future scenarios for a variety of time scales. We will use the products of these scenarios to adjust our portfolio to continue to produce the most appropriate and best advice to managers. The Svalbard Programme shall consequently have an active, hypothesis-driven monitoring portfolio that at all times aligns the programme's monitoring and research portfolio with future trends.

Data collection in the field is undertaken using many different methods according to the discipline and available technological solutions. Despite these differences NPI strives to work together across disciplines as much as is possible. We routinely have x-disciplinary meeting to ensure maximum synergies among projects and programmes.

In the Svalbard Programme introduction of new technologies to extend our observation capacity or improve efficiency is strongly encouraged (i.e., including autonomous vehicles or

sampling devices, new sensors, use of satellite observation systems, eDNA and other genetic technologies/methods). Cost efficiencies are one motivation for this, but also reduction of our environmental footprint is an ongoing objective. Svalbard Programme will also systematically employ future scenario modelling as both a predictive tool and project assessment tool.

In keeping with NPI's data policy, all scientific data, results, and products should be made available to the community as quickly as possible. All projects with the programme must create a data plan and ensure that data is properly stored and that it makes its way to NPI's data centre in a timely fashion.

National and international collaboration is of crucial importance to get the greatest possible return for efforts in the programme. Hence, co-operation is prioritized, both generally and specifically with selected institutes and partner counties (often defined by the Norwegian Research Councils specified bi-lateral programmes).

The programme holds monthly internal NPI meetings to achieve information dissemination and communication. Intermittently, the focus of such meetings includes gap analyses, budget discussions, regional x-disciplinary findings, and development of action plans.

Advice developed by NPI often includes knowledge generated from other institutions. This requires good communication with the scientific community working in Svalbard, and good community relationships. The Svalbard Programme also prioritizes sharing of knowledge, both directions, with user groups (tourist organizations, miners, hunters, and fishermen – as well as management systems personnel). It is, at least in part, the responsibility of the programme to find meeting platforms for such exchanges of knowledge.

Attachments:

List of some of the most relevant strategic documents

- Annual letter of instructions to NPI from the Ministry of Climate and Environment (In Norwegian - [Tildelingsbrev til Norsk Polarinstitutt](#))
- General instructions for business and financial management Ministry of Climate and Environment (In Norwegian [Instruks for virksomhets- og økonomistyringen i Norsk Polarinstitutt](#))
- Strategy for research and higher education on Svalbard – Svalbard on top of the world for knowledge of global importance (Ministry of Education 2018 – In Norwegian - [Strategi for forskning og høyere utdanning på Svalbard, Svalbard på verdenstoppen for kunnskap med global betydning.](#)
- Norwegian Research Council 2019 - [Ny-Ålesund Research Station, Research Strategy](#)
- Norwegian Research Council 2014. Norwegian Polar Research: 2014-2023 In Norwegian [Norsk polarforskning: Forskningsrådets policy for 2014–2023](#)
- Norwegian Polar Institute Strategy 2019-2024 (In Norwegian - [Norsk Polarinstitutt, strategi 2019 - 2024](#)
- Ministry of Education (2017) A national strategy for disclosure and sharing of research data (In Norwegian [Nasjonal strategi for tilgjengeliggjøring og deling av data](#))
- Parliamentary White Paper - 32 (2015-2016). (In Norwegian [Svalbardmeldingen](#))