

# The UN Decade of Ocean Science

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Proposed priority areas



## About The Research Councils Ocean Secretariat

The purpose of the Ocean Secretariat is to strengthen Norway's work related to important ocean initiatives nationally and internationally, where research is a central part. The Ocean Secretariat is responsible for a national coordination and follow-up of the Decade of Ocean Science.



Photo: Christian Morel, The Nansen Legacy

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## ***The science we need for the ocean we want.***

The vision of the Ocean Decade

## Preface

A healthy and productive ocean is crucial to achieving a good future for all. To secure sustainable use and good governance of the ocean, research-based knowledge is needed. The Prime Minister of Norway has taken the initiative to establish, and chair, the international High Level Panel for a Sustainable Ocean Economy. Their recommendations to achieve the 2030 agenda was launched late 2020.

Norway conducts high-level Ocean Science, both nationally and in international collaborations, and the Government has prioritised ocean science in its Long-term plan for research and higher education 2019–2028. The Decade of Ocean Science provides a unique opportunity for Norway to continue its efforts and commitment to the ocean.

The Research Council's ocean secretariat established an expert group in 2019 to propose and ensure national commitments to the Decade of Ocean Science. The expert group was asked to propose priority areas where Norwegian efforts can have the greatest possible significance for this initiative. I would like to thank the expert group for their work and also express thanks for the many constructive contributions made during the process.

The Research Council will use the proposal as the basis for prioritising research efforts and we hope ministries and administrative authorities, research environments, business and industry, non-profit organisations and others who are interested in the ocean will do the same.

We endorse the vision of the Decade of Ocean Science – The Science We Need for the Ocean We Want – and it will guide our work the next ten years. We are making ocean science a priority to secure a healthy ocean!

John-Arne Røttingen  
The Research Council of Norway, August 2020

# Background

## About the expert group

The Research Council's Ocean Secretariat is responsible for coordinating and following up Norwegian efforts related to the Decade of Ocean Science. The Ocean Secretariat established an expert group in 2019 tasked with proposing priority areas in which Norwegian efforts could have the greatest possible impact in relation to the Decade of Ocean Science, and with planning Norwegian contributions, goals and priority areas linked to the initiative.

This document constitutes the expert group's proposal. Input from research institutions, the public administration, non-profit organisations and private individuals has been considered and incorporated during the work.

The expert group comprised:

- Peter Haugan (chair), Institute of Marine Research and the University of Bergen
- Arne Fredheim, SINTEF Ocean and the Norwegian University of Science and Technology (NTNU)
- Stål Heggelund, Federation of Norwegian Industries
- Fredrik Myhre, World Wide Fund for Nature
- Linda Nøstbakken, NHH Norwegian School of Economics
- Magnar Pedersen, Nofima
- Marit Reigstad, UiT The Arctic University of Norway and principal investigator of the Nansen Legacy
- Elana Wilson Rowe, the Norwegian Institute of International Affairs and Nord University

## Science to change society

The UN General Assembly has decided that the decade 2021 to 2030 will be the *UN Decade of Ocean Science for Sustainable Development*. The 17 Sustainable Development Goals adopted by the UN General Assembly in 2015 are the most important driving force behind the initiative. The Sustainable Development Goals (SDGs) aim to facilitate sustainable growth for all up to 2030. The decade will stimulate and coordinate national and global research efforts, such that the goals, and goal number 14 – Life below water – in particular, can be achieved.

The vision of the Decade is to develop scientific knowledge, build infrastructure and foster relationships for a sustainable and healthy ocean. The Decade will harness, stimulate and coordinate research efforts at all levels, in order to support delivery of the information, action and solutions needed to achieve the 2030 Agenda for Sustainable Development. The positive impacts for society can be summarised in the following seven outcomes:

1. A Clean Ocean
2. A Healthy and Resilient Ocean
3. A Productive Ocean
4. A Predicted Ocean
5. A Safe Ocean
6. An Accessible Ocean
7. An Inspiring and Engaging Ocean

The notion of transformation is central to the Decade initiative, and transformative ocean science has been identified as a key way of achieving the goals for this period.

UNESCO's Intergovernmental Oceanographic Commission (IOC) is responsible for organising the Decade initiative.

## Terms and definitions

### *The ocean and ocean science*

In this document, ocean covers both open ocean waters and coastal waters. Ocean science covers all disciplines and activities, including data collection and monitoring, competence-raising, knowledge exchange and education. A knowledge-based approach is a fundamental element in the proposal and is the premise for the rest of the text.

### *Sustainability*

The foundation of the *Decade of Ocean Science* is sustainable development, and sustainability is therefore fundamental in this proposal. The Brundtland Commission's definition of sustainability is applied, which includes social, economic and environmental sustainability.

In this document, we use the SDG icons to show which of the goals the different priority areas target.

**Transformative ocean science solutions for sustainable development, connecting people and our ocean.**

The mission of the Ocean Decade

# The UN Decade of Ocean Science – Proposed priority areas

**The Sustainable Development Goals (SDGs) invite politics, business and industry and civil society to help transform society. The Decade of Ocean Science was initiated because the ocean is a key element in the SDGs and because more and better knowledge is needed about protecting the ocean and ecosystem services and about achieving better use of the ocean.**

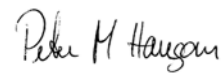
We propose ten priority areas for Norway's efforts in the Decade of Ocean Science:

Climate change (1) is the paramount challenge of our time. Understanding marine ecosystems is challenging, but it is vital that we establish how they respond to warming and ocean acidification and that climate adaptation and countermeasures are developed and implemented. Holistic ocean management (2) must take climate change and other stress factors for biological diversity into account when regulating human activity in order to secure a clean and healthy ocean. Ocean management that is underpinned by high professional quality is key to developing new ocean industries and our ocean economy in a sustainable manner. Food production from the ocean (3) offers huge national and international opportunities. Ocean-based renewable energy (4) is a minor industry in Norway today, but is deemed to have major potential. Maritime transport (5) is undergoing a challenging transformation to make it more environmentally friendly. Food, energy and transport provide exciting opportunities for innovation in the interplay between science and technology, policy development and business.

Observations, data and information about the state of the ocean (6) and human use of the ocean must be made readily available to decision-makers and the general public in order to develop

ocean management and industries. A key question of increasing relevance in local, national and international ocean policy and management is the access to and ownership (7) of resources and ocean areas. Access to data and distribution issues are also relevant to the Arctic (8), whose unique climate, political situation and international science collaboration require a special focus. Good global ocean management and development of ocean industries in developing countries (9) are important to Norway's development and foreign policy and can benefit from knowledge development under all the other topics. Although Norway is considered an ocean nation, there is an under-developed understanding of the ocean among people of all ages and occupations. Communication and ocean understanding (10) efforts are therefore defined as a separate priority area.

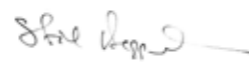
The Decade of Ocean Science does not cover all ocean science. Basic and curiosity-driven ocean science fall outside its scope. This is also the case for topics where ocean science makes a limited contribution to a broader issue, for example carbon capture and storage. The Decade of Ocean Science addresses important societal goals where ocean industries and targeted ocean science can play a decisive role in sustainable development. Open sharing of data and information are key in this respect. Education is envisaged as an integral part of all the priority areas.



Peter Haugan (chair), Institute of Marine Research and the University of Bergen



Arne Fredheim, SINTEF Ocean and the Norwegian University of Science and Technology (NTNU)



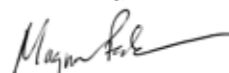
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Elana Wilson Rowe, the Norwegian Institute of International Affairs and Nord University

**1**

Climate and environment interactions

**Goal:** The role of the ocean for the climate is well understood, and we have a cleaner ocean with healthy ecosystems.

**2**

Holistic ocean governance

**Goal:** The world has a holistic understanding of how the ocean should be managed.

**3**

Healthy and safe seafood for all

**Goal:** Food from the ocean constitutes more and more of what we eat.

**4**

Renewable energy from the ocean

**Goal:** The ocean is a significant supplier of renewable energy.

**5**

Environmentally friendly maritime transport

**Goal:** New transport and technology solutions have made maritime transport environmentally friendly.

**6**

An ocean of data

**Goal:** Cooperation on the collection, storage, analysis and sharing of data is the norm.

**7**

Who owns the ocean?

**Goal:** The ocean and ocean-based value creation benefit all.

**8**

Keeping the Arctic as one

**Goal:** An Arctic ocean that is understood and managed holistically.

**9**

Global ocean economy and development aid

**Goal:** Norwegian ocean science and management gives increased access to, and fair distribution of, marine resources across the world.

**10**

Everyone understands the ocean!

**Goal:** Everyone understands the importance of the ocean and the possibilities that sustainable use and protection of the ocean offers.



# 1 Climate and environment interactions

## Goal:

**The role of the ocean for the climate is well understood, and we have a cleaner ocean with healthy ecosystems.**

### WHY:

Ocean currents function as global blood vessels, playing a key role for climatic heat transport and act as a buffer against increasing CO<sub>2</sub> emissions. Together with the atmosphere, they form part of the closely interrelated earth system. How do regional seas affect each other locally and globally, how are physical processes, biogeochemistry and ecosystem functions connected to land, sea ice, the ocean and seabed and to the atmosphere? It is important to understand how the climate and ecosystems are interrelated and affect each other. Ocean changes impact geographic distribution, biology and the life cycle of different species. Norwegian ocean waters including the Arctic and Southern Oceans are important for observing and understanding such connections.

### HOW:

A holistic understanding of the ocean's role in the climate and ecosystem is contingent on studies of connecting processes between the ocean, ice, atmosphere, land, coast and open sea. We must develop methods and increase our understanding of biology, life cycles and the traits of different species to understand the interplay between species, between species and habitats and species' ability to adapt. Knowledge of the total environmental- and climatic footprint, species and ecosystem responses, and how human activity impacts biogeochemical cycling must form the basis for limiting negative impacts and encouraging positive impacts. We must understand the human dimension as the driving force behind climate and environmental change, and how people and society are affected by and adapt to change. There is a need for both disciplinary and interdisciplinary research, and a further development of functional observational systems and tools.



Researchers from the Nansen Legacy collect samples of zooplankton and algae beneath the ice to better understand the consequences of reduced sea ice in the Arctic.  
Photo: Christian Morel, the Nansen Legacy

## TO ACHIEVE THIS GOAL, WE MUST:

### Know how climate change impacts the environment through:

- the effect on ocean currents and transport of heat, CO<sub>2</sub>, fresh water, nutrients and plankton
- the effect of runoff, melting ice, sea ice distribution and precipitation patterns on salinity, temperature, circulation systems and sea levels
- changed distribution, migration patterns and living conditions of large fish stocks and other species
- access to and use of observations for understanding processes, monitoring trends and changes as climatic year-on-year variations and decadal fluctuations
- developing, using and combining modelling tools and future scenarios

### Understand climate and ecosystem interactions through greater knowledge of:

- connections between the ocean and the atmosphere and their impact on weather systems
- the connection between coastal and ocean waters and how they are affected by increased human activities
- how melting permafrost, methane- and groundwater leakages, ocean acidification, melting glaciers and changed runoff conditions impact the climate and marine environment
- teleconnections in the climate system
- CO<sub>2</sub> fluxes and other biogeochemical connections to the seabed and atmosphere
- how long-range transport of nutrients and contaminants impact the ecosystems

### Understand the function of and response to species experiencing habitat changes by:

- mapping and developing knowledge about life in the deep sea, during the polar night, in the Southern Ocean and the Arctic Ocean
- understanding genetic diversity and adaptation, cascade effects in the ecosystem, and the overall impact of ocean acidification, environmental toxins, increasing temperatures, oxygen reduction, diseases, new species, food access etc. on different species and life stages
- studying how the 'blue forest' is impacted by, and impacts the ecosystems, carbon budgets and human activities
- acquiring greater knowledge of the safety margins for harvesting biological resources
- studying how industries and local communities linked to ocean industries impact and respond to the effects of climate change

### Develop the tools we need to give us:

- time and cost-efficient observations of the marine environment, ecosystems and relevant processes
- autonomous technology that can perform complex sampling and observations
- better digital interfaces between technology, ocean science and modelling for good system understanding
- increased interdisciplinary knowledge about natural assets (ecosystem services/natural services) of financial and non-financial benefit
- alert methods and decision-making tools that improve impact assessments and enable assessment of the overall impact of different stress factors
- critical analyses of societal conditions
- funding models that stimulate international and interdisciplinary research collaborations for holistic ocean- and system understanding

Kelp forest off the coast of Svalbard.  
Photo: Geir Johnsen (NTNU/UNIS), from the book Polar Night Marine Ecology



## 2 Holistic ocean governance

### Goal:

The world has a holistic understanding of how the ocean should be managed.

#### WHY:

There is sufficient knowledge of good ocean management in many areas, but this baseline of knowledge has not been translated to a sufficient degree into policy action. Many countries do not comply with norms and rules linked to management of the ocean. There are also emerging questions tied to implementation/effectiveness and our changing use of the ocean: Norwegian ocean management is often described as exemplary, but how effective is it really? How can the ocean best be managed, and biodiversity preserved, given the problems created by climate change, environmental toxins and marine litter? Marine biotechnology, deep sea mining, new technologies for monitoring ocean waters and ocean-based renewable energy present opportunities, but they also entail a greater impact on life in the ocean and new governance challenges. Increasing use of the ocean means that different sectors cannot manage the ocean independently of each other.

#### HOW:

Research is needed on the overall impact on the marine environment to support comprehensive ocean governance. New research and cross-sectoral management, as well as existing knowledge and sector-based management, will enable us to meet these challenges. Together with competence transfer and new forms of collaboration, this can lead to concrete political action. A better interface between research and politics can result in the best knowledge being used in all decisions, nationally, regionally and globally. Studying ocean 'success stories' and identifying more specifically how capacity challenges manifest would provide knowledge about how to increase implementation of existing ocean governance agreements and meet new challenges.



Capelin captured in a cruise by the Centre for Research-based Innovation in Sustainable fish capture and Processing. Photo: Maria Tenningen, Institute of Marine Research

### TO ACHIEVE THIS GOAL, WE MUST:

#### Based on rapid technological development and a changing ocean economy, focus on:

- methods for improving the science-policy interface
- inclusion of knowledge and perspectives of communities who use and rely on the ocean in research and policymaking
- an interdisciplinary and intersectoral approach to what constitutes good governance
- interdisciplinary models for ecosystem-based management
- models on how human activity impacts life in the ocean, for example deep sea mining, mining waste deposits, plastic pollution and increased runoff of nutrients
- models for good dialogue, rights-based management and handling of conflicts

#### Support further research on:

- measures that increase implementation capability
- how business and industry can contribute to implementing measures that lead to holistic ocean governance
- values and conduct; how societies use and cooperate on marine resources, and respond to climate, market, technological and political changes
- how citizens' interest in the ocean can lead to a demand for political action



Interdisciplinary models for ecosystem-based management are needed. Photo: Fredrik Myhre, World Wide Fund for Nature



Citizens' interest in the ocean can lead to a demand for political action. Here cleaning beaches at Svalbard. Photo: Margrete Keyser



# 3 Healthy and safe seafood for all

Photo: Jonas Berdtsen

## Goal:

Food from the ocean constitutes more and more of what we eat.

### WHY:

The world's population is growing, and we thus need more food. Food from the ocean is favourable from a climate and health perspective. However, we must overcome a number of challenges to achieve sustainable food production and secure safe, healthy products. These challenges require new knowledge, and new innovations and management regimes to be established that ensure optimal utilisation of the resources. The nutrient resources from fisheries and fish farming must be used optimally, and fisheries and aquaculture must operate within the bounds of what the ecosystem can tolerate.

### HOW:

It is important to minimise the climate and environmental footprint of fishing and aquaculture by, among other things, developing new vessel and gear technologies and optimising use of resources. Processing, preservation, transport and consumer behaviour must be climate and environmentally friendly in economically efficient value chains and with a greater emphasis on local sources and local processing. Given the climatic and environmental problems facing the world, Norway's most important contribution will be developing knowledge-based management, by employing a holistic combination of new technologies, expertise and socioeconomic understanding. Collaboration between research environments, public management and business and industry will be pivotal.



Photo: Nofima



## TO ACHIEVE THIS GOAL, WE MUST:

### Increase knowledge of harvesting, aquaculture, processing, preservation and transport, and utilisation and development of:

- how seafood value chains impact our climate and environmental footprint
- aquaculture production regimes that enable production growth
- new feed resources for the aquaculture industry
- healthy and safe products from less utilised species
- monitoring and detecting toxic algae, environmental toxins and marine waste, and technologies to remove them from food and feed
- nutrients from species that are not suitable for direct consumption
- healthy and safe side products from harvesting, aquaculture and the production of raw materials from the sea
- good fish welfare and robust fish with high survival rates
- processing and preservation methods to gain healthy products with a long shelf-life
- consumer behaviour and the consequences of consumers' habits and preferences on value chains
- digitalisation, decision support systems and automation and robotisation of operations

### Improve management of food resources from the sea by increasing knowledge of:

- ecosystem-based management, including multi-stock models
- harvesting and cultivating at different trophic levels to ensure that the highest possible level of nutrients is available
- optimisation of food production in co-existence with other ocean-based industries
- regulations and management models for aquaculture
- economic efficiency and consequences of resource distribution
- development of methods to prevent fisheries crime, illegal, unreported and unregistered fisheries and dumping of fish
- technology that prevents unwanted by-catches and damage to vulnerable habitats
- the catch potential of Norwegian fisheries under different climate scenarios



## 4 Renewable energy from the ocean

### Goal:

**The ocean is a significant supplier of renewable energy.**

#### WHY:

The world urgently needs more renewable energy, and thus new sources of energy. Large areas of the ocean can be utilised for harvesting energy through the use of floating and fixed wind turbines, floating solar cells, wave-energy plants, tidal power plants, bioenergy, ocean and geothermal energy. To make offshore wind energy more competitive, the costs need to be reduced and the production chain more effective. Floating wind turbines in particular have major development potential, and we have a strong Norwegian supplier industry. Energy from floating solar cells may be an interesting option in other parts of the world. Good communication must be established between actors, as well as good management regimes that take into account the diversity of actors, which ensures sustainable use of common resources. The interplay between the authorities, producers, suppliers, research, capital and other stakeholders will be important to provide good sustainable solutions and creating growth.

#### HOW:

Efforts should be made to develop floating offshore wind installations and other new sources of energy from the ocean, improving methods and processes, and generating knowledge about the environmental impact and interplay between actors and society. The strong Norwegian ocean industry sector, with in particular its experience from offshore oil and gas, can provide viable new energy solutions. Research-based knowledge about society, the economy and politics is an important basis for the authorities' and the business sector's long-term strategies in the area of energy.



### TO ACHIEVE THIS GOAL, WE MUST:

#### Increase knowledge about and development of:

- load-bearing structures, installation methods, offshore electric grids, operation and maintenance, marine operations, maritime logistics, and solutions for storage
- turbines and control systems
- digitalisation and new methods related to design and analyses
- facilitation and risk reduction for demonstrating technical solutions in an authentic environment
- environmental consequences of offshore renewable energy

#### Develop new sources of energy and monitor the environmental impacts of energy production by investing in:

- mapping of energy resources and suitable locations for development
- new sustainable solutions for harvesting energy
- concepts for preparing good, but immature, ideas for further development
- methods to account for nature's intrinsic value, good environmental assessments and mitigation measures
- systems and solutions for potential co-existence and co-use of areas, based on holistic assessments and utilisation of ocean resources
- methods for involving all types of stakeholders in planning and facilitation

Floating wind turbines have major development potential.  
Photo: Øyvind Gravås, Woldcam – Equinor





# 5 Environmentally friendly maritime transport

**Goal:**  
**New transport and technology solutions have made maritime transport environmentally friendly.**

**WHY:**  
The maritime industry needs new technology, digitalisation, new operating solutions and improvements to existing systems to achieve the International Maritime Organization's (IMO) goal of a 50 per cent cut in CO<sub>2</sub> emissions by 2050, based on the 2008 level. Propulsion systems based on zero or low-emission solutions for greenhouse gas emissions, technical infrastructure that supports the shift in energy carriers and protection of the natural environment, are required to make maritime transport environmentally friendly.

**HOW:**  
New ship design and new concepts, new fuels (hydrogen, ammonia, biofuels), new energy solutions (battery, fuel cells, hybrid), digitalisation and forms of operation will enable the maritime industry to achieve the IMO's goal of reducing greenhouse gas emissions. Cleansing ballast water and environmentally friendly anti-fouling systems are needed to prevent the spread of invasive species and toxic substances and to protect life in the ocean.



**TO ACHIEVE THIS GOAL, WE MUST:**

- Focus on increased knowledge and development of:**
- new ship models and standardised technical solutions for zero or low emissions of greenhouse gases, polluting chemicals and noise
  - new energy-efficient propulsion systems based on energy from batteries, hydrogen, ammonia and natural gas (LNG) and hybrid energy solutions
  - technical infrastructure and bunkering solutions for secure delivery of new forms of energy
  - networks of energy storages and cost-efficient terminals
  - new intelligent transport systems, management systems and technical-operational measures
  - intelligent digital systems that optimise and monitor ships' operation plans
  - international guidelines and technical requirements for alternative energy carriers
  - international conventions on protection of the marine environment
  - new environmentally friendly methods and means of preventing fouling on ship hulls



Yara Birkeland the world's first autonomous and zero-emission container vessel. Photo: Kongsberggruppen, Yara



## 6 An ocean of data

### Goal:

Cooperation on the collection, storage, analysis and sharing of data is the norm.

#### WHY:

In order to take better care of the ocean, we must increase our knowledge about what constitutes the largest habitat on the planet. The increasing pressure on the ocean implies an increasing need for data to be collected, interpreted, understood and made available. Open and transparent global data as a standard will lead to more and better use of data across sectors and user groups and will support all the other goals in this priority area.

#### HOW:

This requires thorough mapping, monitoring, improved analysis tools, holistic ecosystem mapping based on standardised methods and readily available data. It also requires the development of a data policy that promotes fair access, data sharing and reuse.



Akvaplan-niva launches a sailbuoy to collect ocean data off the coast of Svalbard.  
Photo: UNIS

#### TO ACHIEVE THIS GOAL, WE MUST:

##### Have knowledge about and conduct research on how to:

- coordinate the collection of data across disciplines
- verify and validate data
- handle large data sets from different observation platforms and time series
- share data across users and secure easy and fair access to data at a national and global level
- prevent the abuse of data for activities to the detriment of the ocean and society

##### Develop:

- observation systems for human use of the ocean and the state of the atmosphere, land, ice, freshwater, ocean and seabed, biological and physical parameters
- sensors and platforms for better observations
- complementary modelling and decision support systems that can be connected to remote sensing and direct measurement data and statistical analyses
- internationally coordinated standards, formats and data processing procedures, based on the FAIR principles (Findable, Accessible, Interoperable, Reusable)
- data collection and analysis methods that make it easier to compile data for use in research, management and in different industries

##### Increase use of data by:

- establishing global standards and formats for databases
- securing access to collected data for all
- ensuring that data is readily available and verifiable
- encouraging more cooperation on collecting, analysing and storing data

The western coast of Norway seen from a drone to map habitat types and prevalence of seaweed and kelp in the coastal zone. The drone is part of the research infrastructure SeaBee.  
Photo: Robert Poulsen, NIVA



# 7 Who owns the ocean?

Photo: Institute of Marine Research

## Goal:

**The ocean and ocean-based value creation benefit all.**

### WHY:

Resource distribution is important in the governance context, and particularly in managing common property resources. This applies to most ocean resources linked to biodiversity, the ocean and the seabed, such as carbon storage, fish stocks, the coastal zone and seabed minerals. Distribution considerations must be an important factor in achieving the best possible management of the ocean, particularly when new technology and the need for more climate- and environmentally-friendly energy and food production are putting pressure on increasing the use of the ocean's resources. Distribution considerations can be vital to determining whether different forms of regulation have legitimacy and thus for resource management in both developed and developing countries. Conflicts linked to distribution prevent good management solutions. Resource distribution can also directly impact the efficiency of industries and how much value a given resource base creates. Changes in management regimes will have consequences for distribution.

Distribution considerations play a key role in the management context for understanding which instruments that are used, and which distribution considerations must be taken into account to achieve more efficient management.

### HOW:

Social science, economics, humanities and legal research have increasingly examined distribution issues linked to the ocean at a national, regional and international level. This research must be developed even further to understand the effect of distribution considerations and to establish management regimes that are better at striking a balance between distribution and efficiency considerations.



How long it takes to rebuild the fish stock depends on the efficiency of the implemented management regime. Photo: Shutterstock

### TO ACHIEVE THIS GOAL, WE MUST:

#### Identify principles for how the ocean's resources should be distributed by:

- increasing understanding of the distribution consequences of different types of ocean management, across countries, regions, industries and actors
- developing instruments that take account of distribution considerations in combination with efficient management
- considering taxes linked to the use of ocean resources
- ensuring good area-use planning for the coast and ocean with respect to conservation, consideration of ecosystem services and holistic management
- developing methods and tools to handle conflicts over areas and facilitate co-existence in coastal zones and ocean waters in Norway and internationally
- researching and improving management models and how they are implemented
- researching how lobbying and special interests affect politics, twist politics, welfare implications and how political processes can be strengthened to prevent this

### REBUILDING FISH STOCKS

One example of the importance of resource distribution is illustrated by the work on rebuilding overfished fish stocks. The biological goal is to rebuild the fish stock, but the rebuilding itself is a financial process in which distribution is a key element. How long it takes to rebuild the stock depends on the efficiency of the implemented management regime, and distribution issues have a major impact on the management regime. This may concern the distribution between different fishers, types of vessels, regions, nations and other stakeholders both in and outside the fisheries industry. In the same way as distribution considerations impact the management decisions that lead to overfishing, they also shape the instruments intended to rebuild the stocks.



## 8 Keeping the Arctic as one

### Goal:

**An Arctic ocean that is understood and managed holistically.**

#### WHY:

The Arctic Ocean is surrounded by different nations and connected by ocean currents. The region is important geopolitically, for maritime transport and potential new resources, but it is also exposed to environmental toxins, ocean acidification, rising temperature and a strengthened climate response. Knowledge about the Arctic Ocean and pertaining coasts is more uncertain than for waters further south. The decreasing sea ice heralds the increasing availability of and opportunities for activities in new areas that may in turn impact the ecosystems. The biogeographical distribution of different species are changing, and there is a growing interest in exploiting new resources, such as catching snow crabs, extracting minerals or bioprospecting. Sound safety margins and minimal environmental and climate footprints are required of activity in new areas. The increasing interest in the resources in the Arctic may challenge international cooperation. It is therefore important to have an international as well as national perspective on issues concerning the Arctic and ensure good collaboration on science, development and management.

#### HOW:

Research on holistic solutions should be based on an understanding of what sustainable development entails. This includes knowledge about protection as a tool for sustainable use. Knowledge about what can resolve offshore conflicts of interest and contribute to ecosystem-based management, about management and diplomacy instruments, about how indigenous peoples' rights are safeguarded and how the coastal population's knowledge can be used, will be important, as will a legal foundation for safeguarding Norwegian and Arctic interests. Increased knowledge about different Arctic actors, their challenges and expert communities are needed, as well as better tools to improve collaboration among these. Facilitation and meeting places must be established to involve natural science, technology, social science and humanities, business and industry, the public administration, non-profit organisations, indigenous peoples and decision-makers in the development of knowledge, frameworks and tools.

Photo: Geir Johnsen, from the book Polar Night Marine Ecology/Ecology



There is a lot of information in the sea ice for biologists, physicists and chemists. Ice cores contain animal and plant life, as well as physical and chemical signatures about origin and sea climate. Photo: Christian Morel, The Nansen Legacy

#### TO ACHIEVE THIS GOAL, WE MUST:

##### Focus on institutional instruments:

- increase interdisciplinary research collaboration in the Arctic including the coastal populations' local knowledge
- study how the precautionary principle to Arctic management, by sector and overall, can be achieved
- further develop good expert communities and organisations, such as the scientific and political collaboration in the Arctic Council, and use them as models for other areas
- develop better tools to be used by the different Arctic actors and expert communities to solve challenges, and establish new forms of collaboration between them
- develop methodologies to improve cooperation between research and politics

##### Ensure healthy Arctic waters and ecosystems by:

- increasing knowledge of how physical processes, hydrological and biogeochemical cycles and ecosystems respond to changes in the Arctic across regions (see the section 'Interplay between the climate and environment' for details)
- increasing knowledge of the effects of long-range transported environmental toxins and the consequences for different species
- increasing knowledge about local pollution sources resulting from increased local activity and business development
- increasing knowledge about the overall impact of multiple factors such as climate change, environmental toxins, plastic pollution, ocean acidification, and any commercial activity relating to marine species and ecosystems
- further developing research on sustainable management and the use of new resources, such as harvestable species or bioprospecting finds
- further developing good tools for making interdisciplinary holistic assessments of ecosystems and total human impact, including connections across regions

- developing a knowledge base for assessing marine protected areas in the Arctic
- increasing understanding of how climate change and use of Arctic waters impact and are impacted by local communities

##### Develop and use technology to:

- improve communication systems for observatories, field research and security and emergency response
- improve modelling tools, observations including sensor technology, and the predictability of forecasts of weather, ocean temperature, sea ice conditions and ecosystems
- ensuring the lowest possible risk in the design and operation of infrastructure and ships in Arctic areas
- strengthening and connecting time series and observation systems across regions
- identify development opportunities in the Arctic, but emphasise minimal climate- and environmental footprints
- improve emergency response in the event of accidents, oil spills, search and rescue by means of real-time monitoring and alerts





# 9 Global ocean economy and development aid

**Goal:**

**Norwegian ocean science and management gives increased access to, and fair distribution of, marine resources across the world.**

**WHY:**

Fishery resources in developing countries are subject to overexploitation while at the same time, many countries also have a huge potential for more aquaculture and other ocean industries. A number of developing countries also struggle with plastic litter along their coasts and in their waters. Norwegian expertise in the areas of ocean management and open data and information sharing should be used to raise competence.

**HOW:**

A long-term focus on management, science and education together with relevant partner countries, with the active support of regional intergovernmental organisations and processes at UN level.



The Research Wessel Dr. Fridtjof Nansen in Cape Town. The vessel operates mostly along the west coast of Africa. Photo: Magne Nordvald Olsen, Institute of Marine Research

**TO ACHIEVE THIS GOAL, WE MUST:**

**Focus on:**

- building competence and institutions in partner countries, including technology and observation capacity
- cooperation on developing ocean management plans and ocean economy plans, which include holistic ecosystem assessment
- dialogue for handling conflicts, nationally and internationally
- regional centres of expertise with capacity to offer higher degree education in selected topics
- continuing education of public administrators in partner countries
- low trophic aquaculture and sustainable fisheries management
- mapping and monitoring of global pollution and litter in the ocean
- developing knowledge-informed policies nationally and for intergovernmental bodies (covering law of the sea, biological diversity, regional fisheries and marine environment organisations) by actively drawing on Norwegian and international expertise

**Generate knowledge and research on:**

- mapping resources and dynamics in large marine ecosystems and coastal ecosystems
- mapping deep sea ecology and international resources such as krill and new species
- planning of renewable energy in national and international waters
- legal and regulatory factors

**Ensure good ocean management by increasing knowledge of:**

- regional scientific collaboration (such as through ICES) and management models and methods that are used in well managed ocean waters and that may be relevant for other areas
- barriers that prevent integrated ocean management
- models for local ocean management, including experiments
- how holistic ocean management and rights-based governance approaches can be adapted to sociocultural conditions

The Kenyan coast is one of the project areas in a project mapping marine resource conflicts across sub-Saharan Africa to find patterns, drivers and solutions for coastal communities. Photo: Wildlife Conservation Society, Mombasa



# 10 Everyone understands the ocean!

**Goal:**  
**Everyone understands the importance of the ocean and the possibilities that sustainable use and protection of the ocean offers.**

**WHY:**  
 Despite the cultural significance of the ocean for Norwegians and the importance of ocean industries for Norway's national economy, the general public and decision-makers have little understanding of the ocean. Ocean literacy in all parts of society is vital to secure support for investing in knowledge about the ocean and achieving a healthy and productive ocean.

**HOW:**  
 A wide range of communication tools is needed to reach different groups in society. We must invest in the next generation through education. We need research and development to increase understanding of the relationship between people and the ocean and which communication tools that actually work. Cooperation is needed between scientists, ocean industries, communication experts, the arts and culture sector and the school sector. International cooperation is also needed to provide inspiration and to boost international understanding of the ocean.



Float Your Boat is an educational outreach program that provides young people the unique opportunity to participate in an Arctic research project. Photo: Espen Storheim, Nansen International Environmental and Remote Sensing Center

**TO ACHIEVE THIS GOAL, WE MUST:**

**Strengthen communication and dissemination efforts:**

- create readily available and stimulating tools that inform about human impact on the ocean, resources in the ocean economy and biological diversity
- establish easy access to real-time data from satellites, deep-ocean observatories and ocean forecasting
- strengthen measures to engage school pupils and the general public in simple ocean observation
- hold writing competitions, art exhibitions and festivals on the ocean
- increase contact between scientists and knowledge users to better connect different types of expertise and needs
- communicate the Decade of Ocean Science and develop tools and instruments to increase understanding of the ocean among the general public

**Improve communication methods:**

- study how dissemination and communication tools work
- identify and develop targeted methods of communication
- use citizen panels and citizen science to obtain knowledge and increase ocean literacy

**Strengthen ocean education:**

- develop teaching materials for all levels from kindergarten to university
- develop an education system that includes critical perspectives and expertise in dissemination of the nature and culture of the ocean

Researchers from UiT The Arctic University of Norway doing outreach in a kindergarten. Photo: Tusseladden friluftsbarnhage



**Key literature:**

- [Decade of Ocean Science website](#)
- [The UN Sustainable Development Goals](#)
- [Revised Roadmap for the UN Decade of Ocean Science for Sustainable Development](#)
- [Version 2.0 of the Ocean Decade Implementation Plan](#)

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