



# MARINFORSK Work-programme

Applicable from 2018

Programme  
Marine Resources and the Environment – MARINFORSK

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# 1 Summary

The Research Programme on Marine Resources and the Environment (MARINFORSK) is the Research Council of Norway's most important thematic initiative in the field of marine research. The programme encompasses research on ocean and coastal areas, the impact of pressures from human activity, and the entire value chain from the harvesting of marine resources to processing to markets. Programme activities will enhance the knowledge base for sustainable management and for innovation, value creation and profitability in the marine value chains. The programme will also be a key instrument for implementing the Research Council's main strategy *Research for Innovation and Sustainability* and its *Research Strategy for the Arctic and Northern Areas*.

The MARINFORSK work programme is divided into four areas which comprise the programme's thematic priority areas:

- The thematic priority area *Marine ecosystems* is targeted towards increasing knowledge about the ecosystems' structure, function, variation and change.
- *Pollution and other effects on ecosystems* is aimed at generating knowledge about the extent and effects of pollution and other anthropogenic factors on the marine environment.
- *Sustainable harvesting and value creation* focuses on strengthening the knowledge base for sustainable, ecosystem-based management of fisheries, including the value chain from the harvesting of marine resources to processing to markets.
- *Management and societal perspectives* will enhance understanding of which factors serve to facilitate or impede the knowledge- and ecosystem-based management of marine resources.

The MARINFORSK programme will collaborate with other programmes and funding instruments at the Research Council to increase the impact and scope of activities. Promoting multi- and interdisciplinary cooperation and network-building is a key task for the programme as well.

The programme targets the Norwegian research community in addition to users in the public and private sectors and civil society. Programme activities will encompass the entire spectrum from curiosity-driven basic research to applied research for management and industry.

## 2 Background and challenges

The Research Programme on Marine Resources and the Environment (MARINFORSK) is the Research Council's primary initiative for research on marine ecosystems and wild living marine resources. The programme seeks to generate basic knowledge about marine ecosystems and how they are being affected, and to enhance the knowledge base for the public sector and trade and industry. This includes knowledge for increased marine value creation and profitability through the entire value chain based on wild living marine resources. The aim is to help Norway to maintain its position at the international forefront in basic as well as applied marine research.

As a marine nation and a marine knowledge nation, Norway has a special responsibility for developing knowledge about marine ecosystems and how they are being affected, and for exploiting the potential inherent in the oceans through sustainable harvesting of resources. This is reflected in the Government's *Long-term Plan for Research and Higher Education (2015–2024)*, which identifies *the seas and oceans* as a long-term priority area where Norway will increase research activities.

Integrated, future-oriented management of Norway's marine areas must employ an ecosystem-based approach and apply knowledge about ecosystems, effects on ecosystems and related societal

perspectives. Ensuring the sustainable management of wild living marine resources will require strengthening the knowledge base about marine ecosystems, and how these are changed as a result of human activities, climate change, and pollution. Changes in the ecosystems will affect the types of organisms dominating the coastal and marine environment, which will in turn affect the structure of the ecosystems and the potential for harvesting and utilising marine bioresources. This presents management challenges within and between sectors and industries. Comprehensive research activities of consistently high quality are essential to generating relevant, up-to-date knowledge about the marine environment, the marine ecosystems, and the effects of resource harvesting and other human activities. Knowledge is also critical for promoting sustainability and more efficient resource utilisation and thus enhancing marine value creation throughout the entire value chain all the way to market.

There are complicated and at times overlapping legislation and regulatory systems relating to the coastal zone. More knowledge is needed to deal with conflicting interests and ensure more integrated and effective management. As the use of coastal and marine areas and resources increases, so does the complexity of questions relating to their use and conservation. Global change processes, both climate- and population-related, make national and international marine and coastal management a challenge. Climate change is having the most marked impact in the Arctic and northern areas, resulting in changes in the functioning and productivity of Arctic marine ecosystems. The Arctic sea ice is receding, leading to growing global interest in the Arctic region, with its petroleum, mineral and recreational resources and potential for seasonal shipping activity. Increased human activity in the polar regions, combined with other pressures, will affect the total load on the ecosystems.

Meeting tomorrow's challenges will require investment in education, training and recruitment of a new generation of marine researchers. The MARINFORSK programme will contribute significantly here by funding positions for doctoral students, post-doctoral research fellows and researchers. Norwegian marine research must be international in terms of its approach, quality and ambitions, as the fundamental processes that explain and regulate marine ecosystems are universal. In addition, many marine ecosystems extend into waters under the jurisdiction of several countries and/or areas beyond national jurisdiction. Norwegian marine research must therefore be further developed in an international context, and, not least, coordinated with the EU's research systems. Norway participates actively in the European Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans), whose purpose is to coordinate the national research activities of the participating countries in the marine sector. The MARINFORSK programme will contribute actively to setting the agenda for JPI Oceans and will take part in joint activities.

The MARINFORSK work programme plan follows up priorities set out in key documents such as the Norwegian Government's Ocean Strategy; Meld. St. 10 (2015–2016), white paper on a competitive seafood industry, Ministry of Trade, Industry and Fisheries; the HAV21 national marine R&D strategy; the Miljø21 national strategy on environmental R&D; the Research Council's *Research Strategy for the Arctic and Northern Areas*; and the Research Council's main strategy *Research for Innovation and Sustainability* (2017–2020).

# 3 Objectives for the programme

## Primary objective

- The MARINFORSK programme works to generate knowledge about marine ecosystems and the impact of anthropogenic pressures.
- With cutting-edge knowledge, the programme will strengthen the basis for sound, effective management processes and sustainable value creation based on marine resources.

## Secondary objectives

### *Scientific secondary objectives*

The MARINFORSK programme will:

- increase understanding of the structure and function of and variation and change in marine ecosystems;
- generate knowledge about the extent and effects of pollution and other pressures on marine ecosystems;
- expand the knowledge base for sustainable value creation based on marine resources throughout the entire value chain from harvesting to processing to markets;
- expand insight into ecosystem-based management of marine resources.

### *Structural secondary objectives*

The MARINFORSK programme will:

- provide funding for basic and applied research of high scientific quality;
- further develop outstanding research groups and foster the development of a new generation of marine researchers;
- encourage cooperation with other programmes and activities;
- encourage national and international collaboration on projects;
- draw international attention to Norwegian research groups and their contributions;
- work to ensure that research results are applied by making data and research findings accessible.

## Target groups and approach

The MARINFORSK programme targets Norwegian research institutes, universities, university colleges and other research environments, in addition to the public administration, trade and industry, and society at large. The programme will encompass basic research, applied research and innovation activities of relevance to the ocean and coastal areas, including curiosity-driven and problem-based research. Researchers, the public administration, trade and industry, and the general public will all be key users of the programme's research findings. One of the programme's aims is therefore to generate relevant, applicable knowledge.

## 4 Thematic and scientific priority areas

The MARINFORSK work programme is divided into four areas which comprise the programme's thematic priority areas. The overview below shows these with their respective priority focus areas.

### 4.1 Marine ecosystems (ØKOSYTEM)

- Structure
- Function
- Variation and change

### 4.2 Pollution and other effects on ecosystems (PÅVIRKNING)

- Hazardous substances/environmental pollutants and litter
- Petroleum activities
- The mineral industry
- Aquaculture
- Other pressures
- Combined environmental effects

### 4.3 Sustainable harvesting and value creation (VERDISKAPING)

- Harvesting levels
- Environmental effects of harvesting, harvesting patterns and catch technology
- Monitoring methodologies and resource control
- Ethical capture and killing methods
- Processing and production
- Consumers and markets

### 4.4 Management and societal perspectives (SAMFUNN)

- Marine ecosystem services
- Management of marine and coastal waters
- Management challenges in light of climate and other environmental changes
- Ecosystem-based management
- Food safety and nutrition

The following section describes the four thematic priority areas, in light of research needs and areas in which the MARINFORSK programme will give priority to seeking new knowledge. Sustainability is a key element in all research activities funded under the MARINFORSK programme, and the programme will actively follow up the Research Council's main strategy Research for Innovation and Sustainability (2017–2020).

### 4.1 Marine ecosystems (ØKOSYSTEM)

Norway's marine areas range from coastal ecosystems to ecosystems far out at sea, from the temperate ecosystems along the southern coasts of Norway to ice-covered Arctic areas. They encompass ecosystems in the seawater and on the seabed, and in shallow and deep waters.

Good information about the structure, function, variation and changes occurring in ecosystems is critical for knowledge-based management, and is fundamental for all activities taking place in the ocean and along the coast – including utilisation of resources, innovation and industrial

development. Long-term basic and management-oriented research is also essential to safeguarding national interests and contributing to the global knowledge pool.

Marine research is dependent on infrastructure for data collection to gain insight into and monitor the ecosystems. It is this data that forms the basis for modelling and predicting ecosystem dynamics. Marine infrastructure and data collection and management are costly, and new and more efficient solutions must be sought to cut costs and improve quality.

The thematic priority area *Marine ecosystems* is targeted towards increasing understanding of the structure and function of and variation and change in these ecosystems to facilitate long-term, sustainable management of Norway's ocean and coastal areas.

## Focus areas for research

### a) Structure

Marine ecosystems encompass organisms and their abiotic environment. Organisms range from microorganisms to whales, so a wide range of methodical approaches is needed to map and understand the diversity of nature types, species diversity and intra-species variability. Knowledge about the species and their biology and distribution, from the shoreline to deep waters, is essential to solving a number of challenges relating to Norway's management of marine ecosystems. Our understanding of the structure of marine ecosystems remains severely limited by observation methods, and it is necessary to take part in technological development to make progress in this field.

*Research is needed on:*

- knowledge about the biology, ecology and distribution of species and functional groups;
- knowledge about the existence of different habitats and nature types, and how they affect the distribution of organisms;
- development and use of new methods and technologies to generate more knowledge about the structure of the ecosystems, ranging from genetic to biological diversity.

### b) Function

The marine food web is complex, and more concerted effort is needed to understand the relationships between ecosystem components. The fundamental processes that explain and regulate marine ecosystems are the same around the world, even though there are major regional differences in the response and dynamics of the ecosystems. More research is needed to identify, understand and quantify processes in the respective ecosystems by combining field data, experimentation and modelling.

*Research is needed on:*

- knowledge about mechanisms that regulate dynamics of species, and knowledge about how species affect one another;
- core processes within marine ecosystems related to functional groups of organisms, the food web and biogeochemical cycling of substances in and between trophic levels, ocean circulation, spatial distribution, and different transition zones (e.g. pelagic-benthic, ice edge-open waters, land-water);
- mapping and understanding the processes in marine ecosystems.

### c) Variation and change

Marine ecosystems are dynamic and constantly changing due to natural and anthropogenic factors. Research is essential to understanding the driving forces of change, for instance in order



to distinguish between natural fluctuations and pressures from human activity as well as gain insight into impacts. Long time series in Norwegian waters should be used as a basis for better understanding ocean climate variations and their effects. The coastal and marine environment may be affected by global environmental changes such as ocean warming and ocean acidification, and inter-annual atmospheric and oceanic variability. This has an impact on hydrography, biological production and distribution of organisms at all trophic levels as well as freshwater runoff from land which influence the nutrient input, organic load and murkier coastal water. Global warming could cause changes in species abundance and distribution patterns, while increased oceanic transport around the world can facilitate the spread of alien species into Norwegian ocean and coastal areas. Changes in one or more ecosystem components may have major impacts on other parts of the food web.

For more on the effects of human activity on marine ecosystems, see also the thematic areas *Pollution and other effects on ecosystems* and *Sustainable harvesting and value creation*.

*Research is needed on:*

- the drivers and impacts of variation and changes in ecosystems' structure and functioning;
- potential impacts of altered species distribution patterns and increased occurrence of alien species;
- how changes in ecosystem components may escalate into trophic cascades;
- impacts of climate change and ocean acidification on individual organisms and marine ecosystems.

## **4.2 Pollution and other effects on ecosystems (PÅVIRKNING)**

Proper management of ocean and coastal areas depends on knowledge about the extent and impact of pressures from human activity, and how to safeguard environmental quality and food safety. The objective is to prevent pollution and other pressures from causing damage to health, reducing quality of life or weakening the natural environment's capacity for production and self-renewal.

Research under this thematic priority area is aimed at generating knowledge about the extent and effects of pollution and other anthropogenic factors on the marine environment, including the environmental impacts of petroleum activities, mineral extraction and aquaculture. Ecological impacts of fisheries are encompassed under the thematic priority area *Sustainable harvesting and value creation* and the impacts of climate change are under the thematic priority area *Marine ecosystems*.

### **Focus areas for research**

#### **a) Hazardous substances and litter**

Although levels of hazardous substances remain high and are increasing in certain ecosystems, the levels of several hazardous substances have declined as a result of international agreements and regulations. New chemicals are being continually introduced, however, and many of these may prove to have unintended properties. Society needs to know more about the sources, spread, extent and impacts of hazardous substances in marine ecosystems, and how the extent and effects of hazardous substances are affected by other natural and anthropogenic factors. Hazardous substances are a global problem, and Norway and the Arctic receive long-range transboundary pollution transported by air and ocean currents. Norwegian conditions such as low temperatures and large seasonal variations affect uptake, transport and effects in marine food webs.

*Research is needed on:*

- identifying and collecting evidence of uptake, accumulation and effects of hazardous substances, and their degradation products on their own and in combination (cocktail effect) in the marine environment;
- local vs. long-range transported emissions, and transport of pollution to fjords and from fjords and coastal waters to the open sea;
- the ecological relevance of pollution studies;
- long-term effects of pollution;
- the amount, origins, composition, accumulation and effects of marine litter.

#### **b) Petroleum activities**

The petroleum industry can affect marine ecosystems through operational discharges, acute spills, phasing out of petroleum fields, waste treatment and seismic surveys. These pose the risk of discharging heavy metals and other hazardous substances and constitute a threat to ecosystems, fisheries, the aquaculture industry and other nature-based industrial activities (for research needs related to seismic surveys, please see 4.2 e). In general, it is important to study effects at the individual, population and ecosystem levels alike.

*Research is needed on:*

- identifying the composition and long-term effects of unknown groups of substances in produced water, incompletely characterised components in discharges and process chemicals. More insight is needed into possible long-term effects on both pelagic and benthic organisms.
- the effects of accidental discharges into the open sea and coastal waters, particularly in the Arctic;
- how response and sensitivity to pollutants from petroleum activities vary among species and life stages.

#### **c) The mineral industry**

Mineral extraction both offshore and onshore can lead to occupation of areas and deposition of large quantities of fine minerals processing waste and various chemicals into the marine environment. More knowledge is needed about the spread of minerals processing waste and associated chemicals, and their impact on ecosystems as a whole and on individual species and populations.

*Research needed:*

- Research is needed on how mineral extraction in coastal areas and at sea and any associated minerals processing waste deposits affect the marine ecosystem.
- Empirical data and reliable models are needed for calculating chemical, physical and biological processes related to minerals processing waste deposits in both the operational and clean-up phases, and for calculating the spread of mining waste/tailings and contaminants.

#### **d) Aquaculture**

Research is needed to expand basic knowledge of the impact of aquaculture on marine ecosystems. Intensive cultivation and selective breeding of species for aquaculture change the genetic makeup of production populations. Aquaculture may lead to undesirable ecological interactions with other organisms in the ecosystem in various ways, for example through the spread to the natural environment of organic matter or escaped production organisms. In

addition, residual medicines and antifouling substances for net-cages can also affect the ecosystem. Aquaculture also poses risks of spreading disease and parasites to wild stocks.

Research related to wild salmon, including the marine stage of the wild salmon life cycle, lies within the scope of the Programme for Environmental Research for a Green Transition (MILJØFORSK). Thus this type of research will not be funded by the MARINFORSK programme on its own.

*Research is needed on:*

- discharges of organic matter and nutrient waste from aquaculture activities and their environmental impact on pelagic and benthic ecosystems;
- discharges of medicines and antifouling substances and their effects on the marine environment;
- effects of aquaculture activities on wild living marine species.

#### **e) Other pressures**

Stressors beyond those outlined in the above points include pressures such as inputs of nutrient waste and organic carbon, changes in salinity, oxygen depletion, exposure to radiation, noise, hydropower development and changed land/sea use by humans. We need to know more about how the different drivers of change function individually and in combination. (See below under f) Combined environmental effects.) Ecological impacts of fisheries are encompassed under the thematic priority area *Sustainable harvesting and value creation* and the impacts of climate change are under *Marine ecosystems*.

*Research is needed on:*

- the qualitative and quantitative effects of eutrophication on marine ecosystem structure and functioning;
- the effects of inputs of nutrient waste and organic matter in coastal waters, and models for their transport and dispersion in coastal waters;
- the effects of noise, e.g. seismic surveys, offshore wind farms and ship traffic, on marine organisms, particularly on fish migration and reproduction;
- how hydropower developments in river systems affect the ecology of fjords.

#### **f) Combined environmental effects**

The different anthropogenic drivers of change most often involve complex interactions, known as multistressor impacts. The response to a driver of change may depend on the extent of other drivers of change such as pollution, climate change, acidification, fisheries activity, natural stressors, increased human activity and more. Understanding how these drivers interact with one another requires targeted studies and multidisciplinary approaches.

*Research is needed on:*

- the extent to which the response to a stressor of individuals, populations and ecosystems depends on the level of other drivers of change;
- how the combined interactions between multiple drivers of change – such as climate change, pollution, fisheries, aquaculture and other drivers – affect marine ecosystems.

## 4.3 Sustainable harvesting and value creation (VERDISKAPING)

It is important to strengthen the knowledge base for ecosystem-based management of fisheries and sustainable value creation from the harvesting of marine resources. Throughout Norway's history, its fisheries have played a critical role in the development and settlement of the coastal areas, and remain a cornerstone of the country's economy, social development and food security. The fisheries rely on renewable biological production and are thus fundamentally dependent on clean and healthy oceans and coastal areas. Enhancing sustainable value creation in the marine value chain will require more insight into the ramifications of different framework conditions, both formal and informal, under which the industry operates. In this context, knowledge about life-cycle approaches in the bioeconomy will be essential for fully utilising harvested marine resources.

The harvesting of marine resources affects marine ecosystems beyond the stocks of fish targeted. In the context of ecosystem-based fisheries management, socially optimal utilisation of joint marine resources will not necessarily coincide with economic profitability in the short term. Activities under the MARINFORSK programme in this area will be targeted towards research that can mitigate the harmful environmental impact of harvesting in addition to research on the scope and effects of such activities.

### Focus areas for research

#### a) Harvesting levels

Many of Norway's marine resources are well on their way to being fully exploited. It is still possible to increase value creation based on sustainable harvesting, however, by considering the development of the various stocks in connection with one another to harvest optimal quantities of each stock based on biological and socio-economic factors. To this end, continual monitoring of marine resources in the ocean and coastal zone is essential to provide a basis for estimating stocks and offering guidelines. At the same time, socioeconomic models need to be developed.

*Research is needed on:*

- cost-effective methods for mapping and monitoring marine resources, both commercially important stocks and resources with limited potential economic returns;
- further development of management strategies and rules for harvesting commercial stocks, in order to adapt fisheries to changes in climate and the marine environment, among other things. This necessitates research related to effects on multiple stocks and development of models based on socio-economic principles.
- the potential for and impact of harvesting species at lower trophic levels (such as copepods) and harvesting other, little-utilised species.

#### b) Environmental effects of harvesting, harvesting patterns and catch technology

It is possible to enhance value creation and reduce the negative ecological impacts of harvesting by improving the harvesting levels of individual stocks. Bioeconomic multistock modelling will be an important tool for clarifying whether harvesting will be profitable on the basis of the resource base, environmental considerations, catch costs and market conditions. Relevant observations and data from the fishing fleet should be applied as a supplement to conventional research.

*Research is needed on:*

- the impact of fisheries activities on marine ecosystems, habitats, species and stocks;

- how to refine technologies and methods to improve both product quality and species/size selectivity as well as reduce discards, unwanted bycatches, bycatch mortality rates and negative impacts on vulnerable benthic habitats;
- how to refine existing catch technologies and initiate future-oriented research on new, more environment-friendly catch technology. These technologies must also fulfil requirements relating to profitability, including catch- and energy-efficiency;
- the relationship between resource bases, regulations, harvesting methods and patterns, reception, industry, logistics, markets and overall value creation;
- possible negative impacts on the genetic makeup of fish stocks, and how this may affect optimal catch levels;
- development of methods for collecting, treating and distributing environmental and catch data from the fishing fleet.

**c) Monitoring methodologies and resource control**

Norway's status today as a global leader in segments of the marine and maritime sectors could not have been achieved without cooperation and knowledge transfer between fishermen, equipment suppliers and R&D institutions. The goal of developing ecosystem-based fisheries management brings a new and greater demand for data and information for the fisheries industry, the research community and management authorities. This information must be collected in the most efficient way possible.

*Research is needed on:*

- knowledge, technology and instruments for identifying species, quantities and size of individuals before and during catch operations;
- how to improve technology and methods for determining actual catch levels, measuring both quantity and species composition;
- technology and methods to facilitate more effective, risk-based resource control.

**d) Ethical capture and killing methods**

Thus far, limited focus has been placed on fish welfare and other ethical aspects of catching and killing processes in fisheries. More knowledge is needed about the relationship between harvesting and fish welfare from an ethical perspective and in terms of sustainable value creation. Ethical capture and killing methods must also be considered in connection to new catch technologies.

*Research is needed on:*

- the relationship between harvesting and fish welfare both from an ethical perspective and from the perspective of quality and value creation;
- knowledge, technology and methods for preventing the loss of nets and other fishing gear, which can continue killing fish long after being lost (a problem known as ghost fishing).

**e) Processing and production**

Utilising marine resources sustainably and optimally requires that the raw materials are handled with care and efficiency to safeguard their quality and shelf life throughout the value chain. There is untapped potential in e.g. automating labour-intensive processes. Wider use of temporary storage of live fish may help to make deliveries less seasonally dependent while enhancing product quality and increasing product differentiation. There is also major potential for enhanced value creation by developing products, marine ingredients and feed ingredients from species that have not traditionally had a high commercial value, such as macro- and microalgae, krill, zooplankton and molluscs.

To increase profitability in the marine value chain and ensure the greatest possible utilisation of raw materials, it is essential that the supplier industry cooperates closely with R&D groups and the seafood industry.

*Research is needed on:*

- how to promote innovation, value creation and higher profitability in the marine value chain by focusing on optimal, efficient resource utilisation that safeguards quality and shelf life;
- enabling full utilisation of harvested marine resources using a bioeconomy-based life-cycle approach.

**f) Consumers and markets**

Products based on marine raw materials compete in extremely dynamic global markets with high demands for volume, continuity, quality and cost-effectiveness. Thus more knowledge is needed about how these conditions affect the industry actors, including interactions between actors and social structures such as rules, regulatory frameworks and other formal or informal framework conditions and market requirements that industry actors must adhere to. Research-based knowledge related to market access is vital in this context.

There is a need for research on consumers' choices and consumption of products. In this context it is important to focus on the supply side and analyse the interaction between consumers, retailers and producers. The interaction between consumers and informal structures such as social context and norms is also of relevance. This is a very broad area, since seafood encompasses many species, products and quality levels and is sold in a variety of global markets.

*Research is needed on:*

- the markets for marine raw materials, with a focus on how social structures affect the industry actors, and on the interaction between social structures and industry actors;
- consumers' purchasing choices and consumption of products based on marine resources;
- the interaction between consumers, retailers and seafood producers.

## **4.4 Management and societal perspectives (SAMFUNN)**

Achieving sustainable utilisation of marine resources requires knowledge- and ecosystem-based management with an integrated approach. Research activities within this thematic priority area should enhance understanding of which factors serve to facilitate or impede the management of marine resources. This may encompass studies of policy, national and international legislation, strategies, policy instruments, agreements, barriers and opportunities, attitudes and behaviour, gender perspectives and the capacity of society to design and implement change. One central issue is global change processes, e.g. changes in climate and population that lead to changes in demand for biological, chemical and geological resources. These pose challenges to effective management within and between sectors, both nationally and internationally. A better understanding of these issues is critical for sustainable blue growth. These are multi- and interdisciplinary challenges that require insight from the natural sciences and social sciences alike.

### **Focus areas for research**

**a) Marine ecosystem services**

Marine environments contribute a wide range of ecosystem services, but currently there is only a limited overview of what these comprise. Mapping of ecosystem services in the ocean and coastal zone as well as estimates of their scope and value are important for understanding connections and finding a balance between different activities in the marine environment. It will

be important to take this knowledge into consideration in the management of coastal areas and in management plans for marine areas. These efforts require knowledge from both the natural and social sciences, in addition to local ecological expertise.

For resources near the coast, sport fishing comprises a large and growing proportion of catch levels. In this context knowledge is needed to support development of ecosystem-based fisheries management and to help in mapping important marine ecosystem services.

*Research is needed on:*

- the scope and value of marine ecosystem services;
- how to balance different ecosystem services and the management-relevant knowledge needed to do this;
- the extent and development of recreational and tourism fishing.

#### **b) Management of marine and coastal waters**

The coastal zone is the part of the marine environment most exposed to human pressure, subject among others things to increasing competition. While the management plans for the ocean areas (Barents Sea, Norwegian Sea and North Sea) are by far ecosystem-based with an integrated approach, the challenges in the coastal zone are more complex and planning systems more fragmented. This complicates coastal zone management and increases the potential for both commercial and management-related conflict. In addition, legislation is complicated and fragmented across sectors and geographical scope. It is important to develop effective and practical systems for weighing these interests. These systems must pay due regard to the wide range of interests and perspectives – including gender perspectives, the dynamics (rapid changes in the ecosystem itself and in society) as well as the need for democratic processes and transparency. Comparative studies of spatial management, nationally and internationally, will be valuable. There is also a need to examine legal aspects relating to an integrated and more coordinated approach to marine value in the coastal areas, including research questions addressing rights to and ownership of marine resources.

*Research is needed on:*

- mechanisms and obstacles for integrated use of land and sea area and other resources under management today;
- interactions between and impact of various interest groups;
- development of models to resolve disputes about use of coastal land and sea area.

#### **c) Management challenges in light of climate and environmental change**

Changed environmental conditions present management challenges and require the revision of legal and management tools. Climate change affects the established distribution of natural resources and areas among various national and international interests, which leads to social and economic consequences. For example, melting ice and ocean warming will cause sea levels to rise, causing problems for coastal communities. Research targeting adaptive management in light of environmental changes is essential for tackling these kinds of social and ecological upheavals. There is also a major need for research on the Law of the Sea regarding, for instance, issues of safeguarding national rights associated with changes in migration patterns in fish stocks. Issues involving the Law of the Sea also extend to other environmental changes and new challenges relating to e.g. mineral extraction and production of renewable energy.

*Research is needed on:*

- societal processes that have an impact on the design of management tools, including knowledge about the relationship between research and policy design;

- existing management tools, including whether they function as intended;
- the Law of the Sea with respect to safeguarding national rights in an international perspective.

**d) Ecosystem-based management**

Ecosystem-based management is a broad concept, and good management models need to be developed. Given Norway's long coastline and vast ocean areas, there is a need for more cost-effective resource mapping and monitoring and for design of indicators.

*Research is needed on:*

- development of robust, sustainable, productive strategies for management of marine ecosystems, including strategies that take into account that marine systems are in a state of flux and are changing.
- further development of indicators along with associated threshold limits and reference values.
- development of methods for expressing combined environmental effects in ocean and coastal areas.
- development of new, cost-effective methods for mapping and monitoring marine biodiversity.

**e) Food safety and nutrition**

More knowledge is necessary to meet the need for better safeguarding and documenting of food safety and the nutritional effects of seafood and other marine raw materials. There is also a need to better understand relationships between research and policy development in the field of food safety and nutrition. This includes the interaction between various relevant stakeholders and social structures, both formal and informal, such as regulatory frameworks, attitudes, standards and more.

*Research is needed on:*

- food safety and correlations between human health and the consumption of seafood and other marine raw ingredients;
- societal processes that have an impact on the design of management tools related to food safety and nutrition, including knowledge about the relationship between research and policy design.

## 5 Priorities for structuring the research effort

Research within the thematic priority areas of the MARINFORSK programme will develop knowledge and help to ensure sound management processes and sustainable value creation based on Norway's marine bioresources.

### *Funding instruments*

Researcher projects will be the key funding instrument employed by the programme. In addition, the programme will announce funding for Innovation Projects for the Industrial Sector on research topics addressing the entire value chain from catch handling to markets for wild living marine resources. To promote recruitment and network-building, the programme may issue funding announcements for establishment of national-level graduate researcher schools, establishment of networks or mobility grants, and the programme will also fund a significant number of doctoral candidates, post-doctoral research fellows and researcher positions.



### *Gender balance and gender perspectives*

The MARINFORSK programme will follow up the Research Council's policy on gender balance and gender perspectives in research and innovation. Gender as a perspective implies that biological and social gender is reflected in research content. A growing number of studies show that diversity, including gender balance and gender perspectives, helps to enhance the scientific quality and social relevance of research. The incorporation of gender perspectives in research activities is a mandatory criterion when reviewing grant applications. The programme will take steps to strengthen gender perspectives in marine research, when this is relevant. The programme will also attach importance to achieving a good gender balance among project managers as well as encouraging younger researchers to take on project management responsibilities.

### *The research forefront*

The MARINFORSK programme will strengthen Norwegian research groups, and work to take advantage of opportunities in areas where Norway has competitive advantages and can contribute significantly to advancing the international knowledge front in the field of marine research. At the same time, the programme will attach importance to increasing international cooperation, both via the EU system and through bilateral cooperation with other countries when this is relevant to achieving the programme's strategic objectives (see also Chapter 6).

The Research Council is seeking to fund more projects based on bold, innovative ideas. In certain cases funding announcements will be open to high-risk projects.

### *Social dialogue and meeting places*

Communication activities under the MARINFORSK programme are to draw attention to the Research Council's marine research initiatives. The researchers are responsible for publication and dissemination of research results, and the programme will facilitate communication from the projects by encouraging the researchers to take part in the public debate. The programme's calls for proposals will stipulate requirements for scholarly publication and the dissemination of research results to users and the general public.

The MARINFORSK programme will further develop the Research Council's role as a meeting place. It also aspires to cooperate with related programmes to create arenas for discussion, not least of topics that may be divisive or where there is major disagreement among scientists. The programme will also facilitate dialogue between groups whose paths traditionally do not cross.

### *Access to research data*

The Research Council has implemented a policy on open access to research data. Better access to research data will enhance the quality of research in that results can be validated and verified in a more effective manner and datasets can be used in new ways and in combination with other datasets. The MARINFORSK programme will follow up the open access policy, and this may entail measures such as requiring projects to draw up a data management plan.

## **6 Cooperation with related instruments**

The Research Council works to promote integration and effective coordination between its thematic research programmes. Thus the MARINFORSK programme will seek binding cooperation with other Research Council programmes. The programme will also serve as a hub for research on the ocean and coastal areas at the Council and will be an important driving force for this type of research.

There is widespread interest in expanding cooperation between research programmes at the Research Council in line with growing recognition that knowledge needs may extend across multiple programmes and some extend beyond the framework of the programmes themselves. The programmes will employ a flexible structure that is open to different forms of cooperation on funding, advisory activities and expanding international research cooperation. Broader communication activities and meeting places will promote more unified, synthesised and targeted communication with user groups.

#### *Related instruments*

The MARINFORSK programme shares an interface and areas of overlap with a number of other programmes, centre schemes, open competitive arenas, infrastructure initiatives and other Research Council instruments (see the fact box). The most important partners for cooperation are the MAROFF, PETROMAKS 2, POLARPROG, KLIMAFORSK, HAVBRUK2, MILJØFORSK and BIONAER programmes.

The MARINFORSK programme also cooperates with the Norwegian Seafood Research Fund (FHF).

## **6.1 International cooperation**

The Research Council encourages the use of international cooperation to the greatest possible extent when this is expedient for achieving programme objectives. Opportunities for cooperation under the EU framework programmes must be explored each time international cooperation is relevant. Other forms of international cooperation must also be assessed in keeping with the Research Council of Norway's strategy on international cooperation.

Extensive international research cooperation is essential for achieving the objectives of the MARINFORSK programme. The programme will assess the need to develop incentive measures to encourage active participation of Norwegian research groups in international arenas for cooperation

### **Relevant partners and related activities**

- BIA – Programme for User-driven Research-based Innovation
- BIONÆR – Research Programme on Sustainable Innovation in Food and Bio-based Industries
- BIOTEK2021 – Research Programme on Biotechnology for Innovation
- ENERGIX – Large-Scale Programme for Energy Research
- HAVBRUK2 – Large-scale Programme on Aquaculture Research
- KLIMAFORSK – Large-scale Programme on Climate Research
- MAROFF – Innovation Programme for Maritime Activities and Offshore Operations
- MILJØFORSK – Programme for Environmental Research for a Green Transition
- MILPAAHEL – Research Programme on Environmental Exposures and Health Outcomes
- NANO2021 – Research Programme on Nanotechnology, Microtechnology and Advanced Materials
- PETROMAKS 2 – Large-scale Programme for Petroleum Research
- POLARPROG – Polar Research Programme
- INFRASTRUKTUR – National Financing Initiative for Research Infrastructure
- JPI Oceans – Joint Programming Initiative for Healthy and Productive Seas and Oceans
- SFF – Norwegian Centres of Excellence Scheme
- SFI – Centres for Research-based Innovation Scheme
- PROFORSK – Programme for the profiling of research
- FHF – Norwegian Seafood Research Fund

and competition. This applies to research cooperation at the Nordic, European and global level, as well as bilateral cooperation with selected countries.

The framework for international research cooperation will be established in keeping with the Research Council of Norway's strategy on international cooperation. The MARINFORSK programme will promote international marine research by means of joint funding announcements with relevant national and international programmes.

Key arenas for research cooperation include Horizon 2020, the Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans) and other European cooperation platforms (particularly the ERA-NET scheme), as well as large-scale global programmes such as Future Earth under the International Council for Science (ICSU) and the Belmont Forum.

Experience has shown that international cooperation promotes quality in research while strengthening the economic muscle needed to carry out the projects. International cooperation in the field of marine research must be continued and further developed. A bibliometric analysis<sup>1</sup> commissioned by the Research Council showed that Norwegian marine research is in the international forefront. The MARINFORSK programme will work to maintain this position.

The MARINFORSK programme will help to maintain and further develop marine research groups that measure up to international standards and are viewed as attractive partners for cooperation with the capacity to take on leadership roles in international research activities. This will require publication in international peer-review journals, high citation frequency and a visible presence in international research arenas (e.g. active participation in international conferences, EU-funded projects, recruitment and network-building activities).

## 7 Anticipated results, impacts and societal outcomes

The primary objective for the MARINFORSK is to *generate knowledge about marine ecosystems and the impact of anthropogenic pressures. With cutting-edge knowledge, the programme will strengthen the basis for sound, effective management processes and sustainable value creation based on marine resources.* With the primary objective as a starting point, the programme will see better, more effective management of marine resources as a societal outcome. Relevant results and impacts in this context may be e.g. that the MARINFORSK programme initiates research activities to generate new knowledge towards more reliable stock assessment for commercially harvested species, or insight into new, improved routines for management of the ocean and coastal zone. Another desired societal outcome is that the programme helps to enhance sustainable value creation and profitability in the marine industries. A relevant impact here may be that the programme contributes to innovation that increases profitability in the marine value chain, such as improved utilisation of marine raw materials. Other results, in addition to the research results produced, may be research collaboration or patents, for instance. To ensure satisfactory performance achievement through its activities, the programme aims to identify indicators that wherever possible can measure the MARINFORSK programme results. These will be included in the programme's annual report.

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<sup>1</sup> Science-metrix, 2014: Positional analysis of selected countries in Fisheries & Aquaculture with the mapping of their collaboration with Norway, 2003–2012, and with figures updated from 2017.

The knowledge base that will help to realise the desired societal outcomes is defined in the four scientific secondary objectives. It is these four objectives that form the basis for the programme's four main thematic priority areas: Marine ecosystems, Pollution and other effects on ecosystems, Sustainable harvesting and value creation, and Management and societal perspectives.

Strengthening the knowledge base within the programme's sphere of responsibility will require both basic and applied research. Furthermore, the project portfolio relating to each of the thematic priorities will be weighted differently in terms of type of research and whether funding will be made available for Innovation Projects. The thematic priority area *Marine ecosystems*, whose objective is to increase understanding of the structure and function of and variation and change in marine ecosystems, will incorporate a greater proportion of basic research than, for instance, the thematic priority area *Sustainable harvesting and value creation*, where the objective is to expand the knowledge base for sustainable harvesting and value creation, profitability, processing and marketing of marine raw materials and products. Furthermore, the weighting of the different activities funded in each thematic priority area will be reflected in the results, impacts and societal outcomes to be achieved. Thus it will be a good indicator for the programme that its calls for proposals result in a project portfolio that helps to realise both the scientific and the more general, structural objectives.

Figure 1 is a diagram showing the relationship between the primary objective, structural secondary objectives, activities, anticipated results, impacts and societal outcomes (programme logic model).

It is important to note that a research programme such as the MARINFORSK programme is but one of several contributors towards desired societal outcomes in the marine sphere. In 2015 institutions in Norway used a total of NOK 4.7 billion on marine research and development (NIFU report 2017:3, in Norwegian only), while the MARINFORSK programme budget for 2015 totalled roughly NOK 100 million. It is also important to be aware that it is very difficult to measure the societal outcomes of basic research in the long term, and virtually impossible in the short term. Thus caution must be taken when attempting to measure the societal outcomes of individual programmes.

This work programme may be revised at regular intervals to ensure that the programme has the most appropriate scientific and operational focus at all times and promotes the greatest possible scientific and societal relevance.

*The diagram (next page) is showing the links between the primary objective, structural secondary objectives, activities, anticipated results, impacts and societal outcomes (programme logic model). The diagram is intended to illustrate the various categories and does not represent an exhaustive list.*

Primary objective	Structural secondary objectives	Aktivities	Resultes (3-5 years)	Impacts (4-7 years)	Societal outcomes (7-15 years)
<p><b>The MARINFORSK programme works to generate knowledge about marine ecosystems and the impact of anthropogenic pressures.</b></p> <p><b>With cutting-edge knowledge, the programme will strengthen the basis for sound, effective management processes and sustainable value creation based on marine resources.</b></p>	<p>Provide funding for basic and applied research of high scientific quality.</p> <p>Further develop outstanding research groups and foster the development of a new generation of marine researchers.</p> <p>Encourage cooperation with other programmes and activities.</p> <p>Encourage national and international collaboration on projects.</p> <p>Draw international attention to Norwegian research groups and their contributions.</p> <p>Work to ensure that research results are applied by making data and research findings accessible.</p>	<p>Invest in outstanding research of thematic relevance.</p> <p>Organise researcher conferences.</p> <p>Provide funding for doctoral and post-doctoral positions.</p> <p>Organise gatherings for doctoral students.</p> <p>Encourage boldness in scientific thinking and scientific innovation.</p> <p>Promote gender balance among doctoral/post-doctoral positions and project managers.</p> <p>Issue and participate in joint funding announcements with other thematically related programmes.</p> <p>Establish arenas to promote interdisciplinarity and cooperation.</p> <p>Conduct dialogue meetings with relevant research groups.</p> <p>Facilitate Norwegian participation in international research arenas, including activities under JPI Oceans.</p> <p>Evaluate and compile impact analyses of implemented or completed research initiatives.</p> <p>Facilitate user-oriented dissemination activities.</p>	<p>Scientific publications in Level-2 journals with high impact factor.</p> <p>Completed doctoral degrees.</p> <p>Adequate gender balance among doctoral/post-doctoral positions and project managers.</p> <p>Scholarly publications with interdisciplinary focus.</p> <p>Expanded collaboration between different research groups.</p> <p>Participation of Norwegian researchers in international research projects under e.g. Horizon 2020 or JPI Oceans.</p> <p>Help to generate knowledge for policy development.</p>	<p>Research-based, applicable knowledge is available to public authorities.</p> <p>Norway's marine management is based on knowledge.</p> <p>All relevant sectors take responsibility for marine research within their respective areas.</p> <p>Research-based, applicable knowledge resulting from expanded collaboration between research groups is available to public authorities, trade and industry.</p> <p>Research-based, applicable knowledge is available to the international community.</p> <p>Research-based, applicable knowledge is available to public authorities and trade and industry.</p>	<p>Norway has achieved enhanced sustainable value creation and profitability in the marine industries.</p> <p>Norway maintains its leading position in publishing marine scientific articles.</p> <p>Researchers from Norway are contributing knowledge and new perspectives that are needed to ensure sustainable management of marine resources and the environment.</p> <p>Norway takes active part in the global knowledge effort and helps to realise UN Sustainable Development Goals.</p>

## 8 Resources and budget

The MARINFORSK programme is funded by allocations from the Ministry of Trade, Industry and Fisheries, the Ministry of Climate and Environment, the Ministry of Petroleum and Energy, the Ministry of Education and Research, and the Norwegian Oil and Gas Association. Total allocations for 2017 were approximately NOK 140 million.

The programme has identified research needs in existing areas that should be continued as well as research needs in new areas. The funding required to address all of these needs greatly exceeds the programme's budget framework in a zero-growth budget; thus, a substantial budget increase is called for. Identified needs should be followed up and incorporated into the Research Council's annual budget recommendation in keeping with the priorities set out in the Long-term plan for research and higher education 2015–2024.

The programme's long-term budget will incorporate funding set aside for the following:

- cooperation with other programmes and activities at the Research Council, roughly 10–15 per cent;
- international cooperation, roughly 10 per cent.

## 9 Governance and organisation

The MARINFORSK programme board is appointed by and reports to the Research Board of the Division for Energy, Resources and the Environment. The programme board is responsible for achieving the programme's objectives as set out in this work programme, using the specific instruments available. Activities are to be carried out in accordance with the Research Council's strategies and guidelines, and reflect the guidelines from the Council's Executive Board, the division research board, the funding ministries and other funding sources.

The programme board acts on behalf of the Research Council and reports to the research board via the executive director. A list of programme board members may be found on the programme's webpages: [www.forskningsradet.no/marinforsk](http://www.forskningsradet.no/marinforsk) (choose English version).

### Programme administration

The MARINFORSK programme administration is responsible for carrying out the day-to-day tasks of the programme, performing the administrative functions of the programme and the programme board, and facilitating the implementation of the programme board's decisions.



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