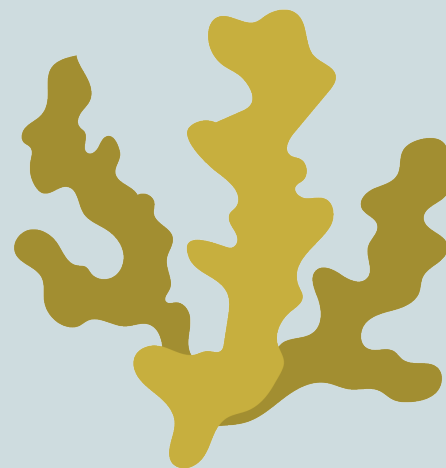




# Swedish efforts concerning science and technology

## **SUSTAINABLE DEVELOPMENT GOALS, TARGET 14.A:**

Increase scientific knowledge, develop research capacity and transfer marine technology, considering the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries.



## Executive summary

- › Sweden has a well-developed institutional infrastructure for research and technology development, and the tradition of advanced industry related to the maritime sector is strong. Sweden has developed marine policies and a maritime strategy, both of which encompass marine science and technology strategies to build the required human and technical capacities for increased and improved research and development of the blue economic sector.
- › The Swedish government's primary actions for research are through grants given to national research bodies. Support for research, technology development, and know-how transfer are also part of the national agencies' responsibilities. Regional bodies are financing and stimulating research as well as giving support to transferring research to commercialisation. Co-funding from national agencies is an approach used to stimulate collaboration and gear up grants from other financial sources. In the Triple Helix model, science and technology meet society in collaborative activities, together with the development of platforms such as test beds and incubators. These approaches help with integrating research into society. For knowledge transfer and capacity building, Swedish society is involved at all levels including the civil and private sectors.
- › Technological developments are taking place in parallel with research to improve existing technologies. New technologies currently being developed in Sweden include mobile wind turbines, wave power, energy extraction from ocean currents, and growing biomass at sea for energy production. Maritime informatics is one of the fastest growing branches in maritime science.
- › Areas of research with major data knowledge gaps exist from the cumulative effects of additional stressors, such as fishing, eutrophication, hazardous substances, and climate change impacts. Moreover, tools for the economic valuation of ecosystem services, couplings between social behaviours and their effects on the environment, and the economic consequences of ocean acidification are all examples of identified research needs within socio-economics.
- › Swedish universities, and most parts of society, are in one way or another involved in regional and/or international collaborations, research programs, twinning projects, and bilateral cooperation. All of these efforts contribute to the development of new knowledge, capacity development, technology, and knowledge transfer.

**Publisher:** Swedish Agency for Marine and Water Management (SwAM)  
**Date:** 2020-05-30

This report is based on the report from 2017 and has been updated by the Swedish Institute for the Marine environment together with researchers and experts from universities, organisations and agencies including the Swedish Agency for Marine and Water Management.

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**Graphic Design and Illustrations:** Where is my pony

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## Introduction

Scientific understanding is essential to forecasting, mitigating, and guiding the adaptation of societies to the ways oceans affect human lives and infrastructures at different spatial and temporal scales. Sweden, like many other countries, has established institutional infrastructures to carry out specific activities or programs related to marine science and technology development.

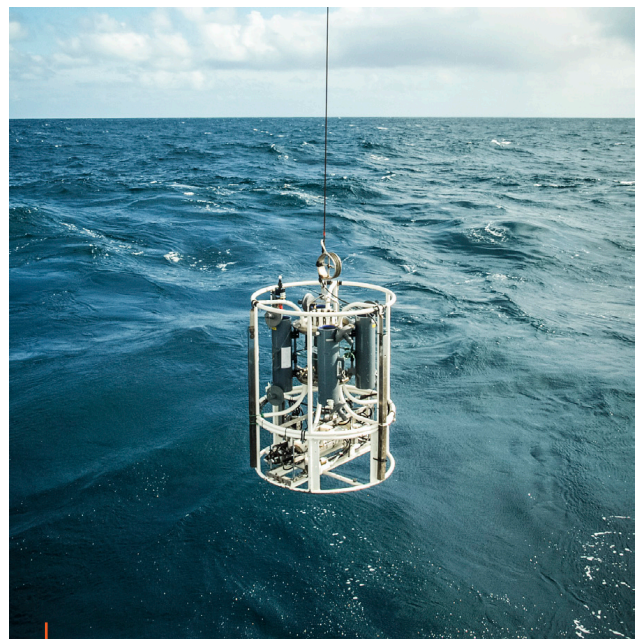
In spite of these efforts, the current processes are not keeping up with the pace of changes in the oceans. There is a need to better understand ecosystem processes and functions and their implications for ecosystem conservation and restoration, ecological limits, tipping points, socio-ecological resilience, and ecosystem services. There is also a need to further develop and make use of existing technologies as well as those under development. Know-how transfer and financial support are essential for meeting the challenges.

There is also an urgent need to invest in applied research and innovation in order to actually implement gained knowledge into action fields. In other words, in parallel with more basic understanding about ecosystem processes, the restoration of marine ecosystems cannot be on hold waiting for more knowledge. The threats, for example climate change and losses in biodiversity, are so severe that action is needed now.

### SWEDISH SCIENCE AND TECHNOLOGY INFRASTRUCTURE

Sweden is a leading nation in the amount of money (in relation to GDP) that it devotes to research and development. The country has a well-developed institutional infrastructure for research through research councils and national agencies, including specific programs related to marine and maritime science. Sweden also has a tradition of advanced industry related to the maritime sector. Sweden has developed marine policies and a maritime strategy, both of which encompass marine science and technology strategies to build the required human and technical capacities for increased and improved research and development of the blue economy sector.

The Swedish government's primary actions for research are through grants given to national research bodies, such as the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, or Formas. Research related to the marine and maritime fields are carried out in natural science as well as in social science and technology development. The Triple Helix is a model in which science and technology meet society in collaborative activities, together with the development of platforms such as test beds and incubators. These approaches help with integrating research into society. Collaborations between technical universities and private industries play an important role in technology development.



*In Sweden, well-designed monitoring programs have been in place for decades and are under development to better suite new management conditions.*

Responsibilities for the financial support of research, technology development, and know-how transfer also fall to national agencies, such as the Swedish Agency for Marine and Water Management (SwAM), Vinnova, the Swedish Agency for Economic and Regional Growth, the Swedish Energy Agency, the Swedish Maritime Administration, and the Swedish Meteorological and Hydrological Institute (SMHI). Regional bodies, such as Region Västra Götaland, are also financing and stimulating research as well as transferring research to commercialisation. Co-funding from national agencies is an approach used to stimulate collaboration, provide ownership of projects, gear up grants from other financial sources in projects, and provide more action on a local level.

In addition to classical and technical universities, Sweden is also home to a number of collective action research centres such as the Swedish Environmental Research Institute, the Swedish Institute for the Marine Environment, the Stockholm Resilience Centre, and the Stockholm Environment Institute. The newly established Kristineberg Marine Research and Innovation Centre is a centre for promotion of marine research and innovation for blue growth/economy including universities and research institutes like Chalmers, KTH, University of Gothenburg, RISE and IVL. For knowledge transfer and capacity building, Swedish society is involved at all levels including the civil and private sectors.



*Technologies in the maritime sector currently being developed in Sweden include wind turbines, wave power, energy extraction from ocean currents, and growing biomass at sea for energy production.*

## National efforts

In Sweden, well-designed monitoring programs have been in place for decades and are continuously under development to better suite new management conditions. Moreover, data from the monitoring programs can also provide a platform for further research.

Research needs identified by SwAM and the Swedish Environmental Protection Agency are funded by environmental research grants. Research projects that develop methods to value marine ecosystem services and indicators for the Marine Strategy Framework Directive is one example.

Technologies in the maritime sector currently being developed in Sweden include mobile wind turbines, wave power, energy extraction from ocean currents, and growing biomass at sea for energy production. Maritime informatics is one of the fastest growing branches in maritime science. In one of Sweden's regions (Västra Götaland) exists a cluster area with around 800 companies within marine technology and shipping. Products include everything from material development, design, and consultancy to traditional manufacturing industry and maritime informatics.

Ocean waves have potential to contribute significantly to a future sustainable global electricity production. Uppsala University is at the forefront of wave energy research. In a wave power park on the Swedish west coast different technological solutions are tested and the environmental impact on the marine environment is studied. The research site is one of the few off-shore test sites for full-scale wave energy converters in the world. Another example of sustainable energy production at sea is the development of a floating wind turbine made for the ocean.

Authorities and industries in Sweden have cooperated in devising tools, such as the Clean Shipping Index and the Zero Vision Tool, to make shipping more environmentally friendly, safer, and energy efficient. Ships fuelled by LNG, methanol, and electricity already exist even if the numbers still are few.

Sweden is also the initiator of the Sea Traffic Management project. The project aims to provide information sharing tools which will assist both people on board and ashore in their decision-making process. This is envisaged to increase efficiency, improve safety, and enhance the protection of the marine environment. Other examples of measures undertaken by Sweden to facilitate technology development are international efforts to gain acceptance to build ships in fibre reinforced plastic.

Sweden has also taken measures on a national level to reduce the discharge of sewage. Since the 1990s, ships have been prohibited from discharging sewage in Swedish waters. Pleasure crafts have also been prohibited to release sewage into the water. The development of selective fishing methods and gears to reduce environmental impacts and by-catch are taking place. For example, the

Scandinavian grid, a selective fishing gear that significantly decreases by-catch, has been developed. Moreover, methods to trace back where the fish has been caught has been development and implemented, in line with the landing obligation program.

The Swedish Algae Factory is an example of a circular business model, based on microalgae's natural cycle, in which aqua culture is combined with the production of a number of products such as energy, oil, and fertilisers. Marin Biogas AB cultivates and harvests ascidians from the sea where the process gives several environmental and economic benefits as well as products feed, ecological fertilisers, and biogas. KosterAlg AB is a new company starting to cultivate seaweeds on the Swedish west coast in order to provide biomass for biorefineries that may produce food, feed and bio based materials and in the same way providing a better environmental situation in the open sea where the seaweeds are cultivated.

*Sweden is engaged in several European and Nordic initiatives to strengthen marine research and innovations, for example the Joint Programming Initiative Healthy and Productive Oceans, The Joint Baltic Sea Research and Development Programme, Copernicus and the EU Strategy for the Baltic Sea Region.*

## Regional efforts

Sweden is engaged in several European and Nordic initiatives to strengthen marine research and innovation. Some examples are given below:

- › The Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans). Sweden and France are lead-ing a JPI-Oceans initiative to establish a research network and an agenda for marine ecosystem services-based assessments for marine spatial planning (MSP) and the MSFD. JPI Oceans has, for example, also funded projects that inves-tigate the concentration and effects of microplastics in the marine environment.
- › The Joint Baltic Sea Research and Development Programme (BONUS) will soon develop into the new program BANOS that will include both the Baltic Sea and the North Sea.
- › The Nordic Council of Ministers has funded marine research projects that investigate ecosystem services and their value, as well as a tool to incorporate the ecosystem services approach into MSP.
- › At the EU level, cooperation is ongoing to compile joint databases for the marine environment and monitoring. Copernicus, for example, provides extensive amounts of open near real time and archived data from a series of earth observation satellites. The EU Strategy for the Baltic Sea Region aims to deepen cooperation between the countries around the Baltic Sea in order to meet the common chal-lenges the region is facing today.



- › The HELCOM Baltic Sea Action Plan (BSAP) is an ambitious programme to restore the good ecological status of the Baltic marine environment by 2021.
- › SUBMARINER is a EU flagship network devoted to apply for and initiate sustainable projects for the blue growth/economy agenda, with many Swedish partners both regions, universities and research institutes. The network has a very good track record and runs several large projects.
- › The WATERBORNE Technology Platform is one of roughly 30 technology platforms in the EU. Where appropriate, possibilities for exchanges or other ways of cooperation are investigated. The Waterborne community has issued the Waterborne Declaration in which it commits to helping to achieve the “Europe 2020” objective of smart, sustainable, and inclusive growth.
- › MareFrame is a European Commission-funded research and technological development project which seeks to move barriers that prevent a more widespread use of the ecosystem-based approach to fisheries management.
- › The European Project on Ocean Acidification (EPOCA) is an example of a regional research project with relevance to ocean acidification and resilient ecosystems. The overall goal for the project is to further our understanding of the biological, ecological, biogeochemical, and societal implications of ocean acidification.
- › Many regional projects are done in close collaboration with HELCOM and OSPAR, the Regional Sea Conventions for the Baltic Sea and the North-East Atlantic respectively.

## International efforts

Sweden is a well-regarded and respected country in multi-lateral cooperation. Our long-standing role as a credible donor and important policy actor has resulted in many opportunities to influence developments that are far greater than our country’s size would merit. Sweden works in several international and regional organisations, such as UNDP, ICES, FAO, and IMO, in order to, among other things, strengthen the protection of marine environments, promote an ecosystem-based approach in marine spatial planning, reduce marine litter and pollutants, develop more environmentally friendly and safer shipping traffic, and implement research and new technology.

The Swedish International Development Cooperation Agency (Sida) plays an important role, giving support to national research programs in developing countries and regional development organisations as well as financing international training programs for professionals. An important focus is on increasing capacity for coastal communities’ involvement in establishing sustainable livelihoods and building improved resilience, as well as mainstreaming gender and equality perspectives in supplementary livelihood frameworks.

National research bodies, such as the Swedish Research Council, together with sector agencies, such as SwAM, the Swedish Energy Agency, and SMHI, and Swedish universities, both classical and technical, contribute to know-how transfer worldwide through bilateral collaboration, twinning projects, and joint research projects and programs. The Swedish Research Council is, for example, working through the global Belmont Forum.

Sweden supports research on ocean acidification both nationally and through international research cooperation. Sweden has worked internationally to amend the legal framework in order to facilitate the use of alternative fuel for shipping. In addition, the Swedish Transport Agency has worked closely with Swedish ship owners who have expressed a will to convert their existing vessels.

Sweden is a member of the International Council for the Exploration of the Sea (ICES). Sweden participates in many ICES working groups addressing ecosystem-based management. Through our engagement in ICES, we are involved in the work of the North Pacific Marine Science Organisation (PICES) and the Northern Atlantic alliance.

The UNDP Water and Ocean Governance Programme (WOGP) helps countries achieve integrated, climate-resilient, sustainable and equitable management of water and ocean resources, and universal access to safe water supply and sanitation. Focusing on governance, WOGP supports partnerships for a sustainable use and protection of freshwater and marine resources.

Sweden is involved in work considering the protection of marine areas in the Arctic and in Antarctica.



## Challenges and Gaps

- › In order to foster innovation and promote the use of new and innovative technologies, regulatory framework should, where possible, be function based. Goal-based rules need to be developed to create better conditions for innovation and the use of new technologies. Creating the right incentives for industry will be a key to the sustainable use of the oceans and, in the long term, determine the value of the potential of the ocean economy as such.
- › Maritime informatics is one of the fastest growing branches in maritime science. It constitutes an area that might help improve safety, reduce impacts on the marine environment, and grow into an emerging industry in itself, if we can efficiently make use of it.
- › Ocean management should be based on sound scientific research and knowledge. There is a need to strengthen international cooperation on ocean research and data exchange. Increased coordination or the integration of research programs is needed to tackle common problems on regional and global levels.
- › Marine and maritime science need to find ways of applying a holistic approach toward understanding and addressing the cumulative impacts of various threats such as climate change, pollution, coastal erosion, and over-fishing.
- › Data and knowledge gaps exist with respect to pollution, including all aspects of the life cycle of marine debris, plastics and microplastics, heavy metals, and other hazardous substances.
- › The precise scope of the impacts of acidification on the marine environment remains unclear and more research is needed.
- › There is a need to promote and build capacity for better ocean governance, conservation and restoration of marine ecosystems and biodiversity, and the sustainable use of marine resources (blue economics).
- › Mariculture, and especially cultivation on low trophic level organisms such as mussels and algae/seaweeds, and Ocean Literacy has been identified as important topics that needs to have a focus during the UN Decade of ocean science for sustainable development (2021-2030). There is also need for more social science to complement the natural sciences.

## **Compilations made by SwAM for SDG 14, Life below water**

This document represents one out of nine compilations made by the Swedish Agency for Marine and Water Management (SwAM) to highlight Sweden's key efforts and initiatives for Sustainable Development Goal 14 of the 2030 Agenda for Sustainable Development. This report has been developed as a part of Sweden's work in support of The Ocean Conference in Lisbon 2020. It is based on the report developed for The Oceans Conference in New York 2017 and has been updated by the Swedish Institute for the Marine environment together with researchers and experts from universities, organisations and agencies including the Swedish Agency for Marine and Water Management.

The documentation focuses on a situation assessment and does not constitute a complete picture of Sweden's initiatives being carried out in order to achieve the goal and targets. A starting point for the content is operational areas within national authorities, but the content has also been expanded to include other significant aspects based upon existing contacts and knowledge.