

Swedish efforts concerning science and technology

SUSTAINABLE DEVELOPMENT GOALS, TARGET 14.A:

Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account 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. There is a specific interest in which stressors amplify – and reduce – the detrimental effects of ocean acidification. 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.

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Introduction

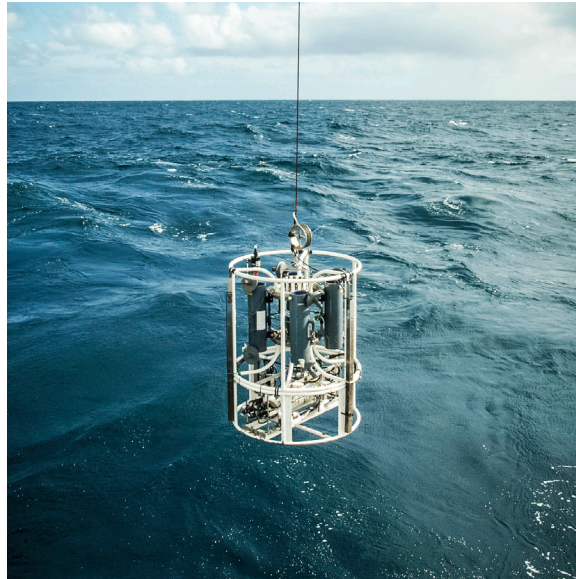
Scientific understanding is essential to forecasting, mitigating, and guiding the adaptation of societies to the ways oceans affect human lives and infrastructures at different spatial and temporal scales. Sweden, like many other countries, has established institutional infrastructures to carry out specific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

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 universities and technical high schools, Sweden is also home to a number of collective action research centers such as the Swedish Environmental Research Institute, the Swedish Institute for the Marine Environment, the Stockholm Resilience Centre, and the Stockholm Environment Institute. 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 valuate marine ecosystem services and indicators for the Marine Strategy Framework Directive are 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 1,000 companies within marine technology and shipping. Products include everything from material development, design, and consultancy to traditional manufacturing industry and maritime informatics.

In close cooperation with Uppsala University, wave energy solutions are being developed. Seabased Industry provides complete wave park solutions for renewable electricity generation. Seabased's technology is functionality verified with the connection of the Sotenäs Wave Power Plant, located on Sweden's west coast, to the Nordic Electricity Grid, which is the world's first multi-generator wave park. Another example is SeaTwirl which is developing 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 Management Traffic 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 fiber 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. Since 2015, pleasure crafts have also been prohibited. 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 are also under development and are, to some extent, linked to the new landing obligation program that is under implementation.

The Swedish Algae Factory is an example of a circular business model, based on algae'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 including fodder, ecological fertilisers, and biogas.

The Centre for Collective Action Research at Gothenburg University is a new initiative focusing on large-scale collective action and governance issues, among other things.

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 leading 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 investigate the concentration and effects of microplastics in the marine environment.
- The Joint Baltic Sea Research and Development Programme (BONUS).
- 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 challenges the region is facing today.
- The Baltic Sea Action Plan is one of the major programs improving the marine environment.
- 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 project produced the Guide to Best Practices for Ocean Acidification Research, BALTIC-C, which investigated the fate of CO₂ and organic carbon in the Baltic Sea.
- 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.

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.



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 and technical high schools 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. The Baltic Sea was designated by the International Maritime Organisation (IMO) as a particularly sensitive sea area in 2006, after lengthy discussions.

Sweden is a member of the International Council for the Exploration of the Sea (ICES), the body that provides scientific advice to EU members on total allowable catches for EU fisheries. Sweden participates in many ICES working groups addressing ecosystem-based management. Through our engagement in ICES, Sweden is involved in the work of the North Pacific Marine Science Organisation and the Northern Atlantic alliance.

The UNDP Water and Ocean Governance Programme (WOGP) 2014–2017 supports sustainable marine resource management in 10 of the world's most important large marine ecosystems. The program also promotes integrated land, water, biodiversity, and coastal area management in all 33 of the world's small island developing states in the Caribbean and Pacific, and around the African continent.

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

In the preparation of positions within the EU for the review conference of the Fish Stocks Agreement in 2016, Sweden focused especially on Chapter VII which covers Articles 24–26 regarding specific conditions and needs for developing countries.

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).

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. It has been developed as a part of Sweden's work in support of The Ocean Conference in New York, June 5–9, 2017.
- Several other Swedish agencies and institutions have contributed to the content in these compilations: the Swedish Environmental Protection Agency, the Swedish International Development Cooperation Agency (Sida), the Swedish Meteorological and Hydrological Institute (SMHI), the Swedish Board of Agriculture, the Swedish Chemicals Agency, the Swedish Transport Agency, and the Swedish Institute for the Marine Environment (SIME).
- 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.
- Furthermore, the Swedish Environmental Research Institute (IVL) has been commissioned by SwAM to compile initiatives and examples from Sweden's industry and blue growth sector. The Sustainable Development Solutions Network (SDSN) Northern Europe has also composed a complementary compilation of efforts from innovative blue growth initiatives. The result of this work is presented in separate reports.
- The Swedish Institute for the Marine Environment has been commissioned by SwAM to produce two syntheses in support of the conference. One concerns mitigating marine eutrophication in the presence of strong societal driving forces, with a focus on impacts and measures, and the other concerns impacts and measures regarding marine litter in small island developing states.

