

# BALTIC RIM ECONOMIES

## SPECIAL ISSUE ON THE BALTIC SEA PROTECTION

**KRISTA MIKKONEN**

State of the Baltic  
Sea is a priority  
to the Finnish  
government



**MINNA ARVE**

Sustainability  
as the policy  
framework



**LIENE GAUJENIETE**

Maritime  
spatial planning  
for improved  
environment in  
the Baltic Sea



**KIRSI AHLMAN**

Protection  
Fund for the  
Archipelago Sea  
finances concrete  
water protection  
actions





# BALTIC RIM ECONOMIES

The Pan-European Institute publishes the Baltic Rim Economies (BRE) review which deals with the development of the Baltic Sea region. In the BRE review, public and corporate decision makers, representatives of Academia, as well as several other experts contribute to the discussion.

## Pan-European Institute

ISSN 1459-9759

Editor-in-Chief | Kari Liuhto  
(responsible for writer invitations)

Technical Editor | Elias Kallio

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KRISTA MIKKONEN

# State of the Baltic Sea is a priority to the Finnish government

Expert article • 2855

**T**he Baltic Sea continues to suffer from eutrophication, plastic litter accumulates to the sea and underwater noise is a risk to marine mammals and fish. The Baltic is also warming much faster than many other sea areas.

Climate change affects marine life and increases nutrient loss from the catchment area. Although work to improve the state of the Baltic Sea has been carried out for several decades, much still needs to be done.

The Finnish Government considers the protection of the Baltic Sea of importance and has agreed on numerous measures to improve the state of the sea. The government decided to continue a programme of enhancing the effectiveness of water protection, with altogether 69 million euros reserved for its implementation between 2019 and 2023. Already over 100 water restoration projects have been initiated and water protection within the agricultural sector is enhanced by spreading gypsum, structural lime and fiber sludge to agricultural fields to reduce loss of phosphorus into waterways.

Longer-term work to protect the marine environment and surface waters has been organised with Finland's River Basin Management Plans and the national Marine Strategy. The goal is to achieve and maintain a good status of surface waters and the marine environment. A multitude of actors in the society participate in the implementation of the measures contained in the River Basin Management Plans and the Marine Strategy. The Plans and the Strategy will be updated for years 2022 – 2027.

Archipelago Sea in the South-West of Finland has been in special focus during recent years. The program of enhancing the effectiveness of water protection aims to spread gypsum to over 60000 hectares of agricultural land in the catchment of the Archipelago Sea, in order to reduce the level of annual loading of phosphorus by 44 tons from the current loading of about 480 tons. The effect of gypsum lasts for about five years.

In 2021, the Ministry of the Environment will initiate an assessment of the possibility to remediate Finland's only remaining HELCOM hotspot on the agricultural diffuse loading from the catchment of the Archipelago Sea. The objective is to evaluate whether existing measures and actions are sufficient to reduce nutrient loading to the sea, improving the state of the marine waters as defined in HELCOM's criteria for hot spots, or whether more measures are needed. Depending on the results of the analysis, measures will be planned to fulfil potential gaps.

To improve the state of the whole Baltic Sea, action by all coastal countries and cross-border collaboration is crucial. The Finnish Government strives for stronger international environmental cooperation in the Baltic Sea region. For Finland, central forms of environmental cooperation include HELCOM and cooperation within the framework of the EU Strategy for the Baltic Sea region.

The update of HELCOM the Baltic Sea Action Plan was initiated under the Finnish Chairmanship of HELCOM in 2018 – 2020. The

updated Plan is to be adopted by the HELCOM Ministerial Meeting in October 2021, with a view to containing measures that will enable achieving and maintaining a good status of the Baltic Sea.

Cooperation between EU Member States in the Baltic Sea region to implement the Marine Strategy Framework Directive and Maritime Spatial Planning Directive is an important contribution to enhancing action to protect the Baltic.

I want to stress the need for cooperation and dialogue between different economic sectors affecting the sea. The EU Ministers of environment, agriculture and fisheries met in September 2020 to discuss joint action to improve the state of the Baltic Sea. The particular topics discussed by this Conference were eutrophication, marine litter and impact of fisheries. At the Conference, Ministers signed a declaration, pledging to take further action on EU level and strengthen their commitment to the present measures on the EU level that aim at improving the state of the Baltic Sea.

Protection of the Baltic Sea is long-term work and climate change poses an extra challenge. There are, nevertheless, sparks of hope at sight. Since the beginning of the 1990's, the trend of the total nutrient load to the Baltic has been declining. The status of many species, such as the grey seal and the white-tailed eagle, has improved notably due to protection measures. Situation in the eastern Gulf of Finland is now much brighter due to improved wastewater treatment in Saint Petersburg. We need to continue cooperation across national borders and economic sectors to achieve more successes like these!



KRISTA MIKKONEN

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MINNA ARVE

# Sustainability as the policy framework

Expert article • 2856

**W**e have truly lived through extraordinary times for over a year now. Although practically the whole world has had to concentrate on fighting the pandemic, the fundamental challenge of the whole humankind has not changed: climate change and the sustainability of our planet.

In 2018, the City Council of Turku decided that the city will be carbon neutral by year 2029, when Turku will celebrate its 800th anniversary. By now we have already halved our emissions from the level of 1990, despite rapid economic growth and population increase. Successful climate action has increased our confidence that we can do even much more and we have actively widened our perspective to full-scale sustainable development.

Last year the City of Turku conducted a Voluntary Local Review of the UN Sustainable Development Goals. We have worked hard to engage the citizens, the companies and local communities in finding positive, effective solutions as well long term as in common choices made in everyday life. Through SDG's we can communicate with citizens and companies and give them answers to their questions. We can offer them accountability and possibilities to take part.

People long for a sign of a brighter future around the corner. All glimpses of good, of progression, of growth, jobs and stability are welcomed.

We can make good of these times by bringing forward actions of new innovations and promises of a more sustainable future. We can make the most of it by engaging as many citizens as possible so that they are aware that positive things are happening all the time, and the more they are supported, the faster they become part of our everyday life.

It is clear that strategies and roadmaps alone are not enough. We need legislation and we need resources.

Above all, we need implementation. The burning need for implementation is why cities and local authorities are so important in fighting climate change. At the end of the day, it is in cities where people live their lives and make their choices, it is in cities where the consequences of political decisions, or lack of decisions, is seen.

The need for good and skillful implementation is growing ever more important, because as we move along, the low-hanging fruits, the easy decisions are starting to become scarce. Ahead we have the decisions that affect the everyday life of all citizens and can also be decisions which divide the public opinion.

It is important to build a bridge between action and consequence. The justification for effective sustainability policy comes from the good consequences people see around them. On the other hand, the consequences of inaction are as visible.

The Archipelago Sea in front of Turku is a unique area on a global scale. The sea is characterized by 40 000 islands, sharing an extremely vulnerable nature. It is difficult to accept, that the state of the Archipelago Sea has plummeted during the last 50 years, because of human action.

The Archipelago Sea is the only HELCOM hotspot left in Finland. In the whole Baltic Sea region 75 % of hotspots have been cleaned up since 1992. In 2010 the Finnish government set a goal to remove the Archipelago Sea from the hotspot list by 2020. We did not succeed. In fact, the state of the sea has deteriorated.

Minister of the Environment and Climate Change Krista Mikkonen renewed this goal a few months ago, of which I am very pleased. The Archipelago Sea has not got time to wait for better times, but action must be taken immediately. The sea will survive, if we work decisively, consistently, and tirelessly in broad co-operation.

Deeper co-operation between cities and national governments is needed in sustainable development altogether. As more and more cities raise the level of ambition in sustainability and for instance go through the process of Voluntary Local Review we start to have a common framework, a common language.

At the local level we need the help of national actors to achieve our goals, and the government needs the cities to achieve theirs. After all, the goals are common. Through a common framework and common objectives we can dramatically raise the effectiveness of our policy.

At the end of the day, we are working for the good of our planet and the future generations. Rejecting sustainable development as a framework is not a viable option. Instead, sustainable development offers countless business opportunities, increasing standard of living, scientific progress and enjoyable surroundings.

Sustainability will be the guiding framework for policy at local, national and international level for years to come. Pace of different actors may differ, but the direction is same. ■

**MINNA ARVE**Mayor  
City of Turku  
Finland

BRITA BOHMAN

# Updating the Baltic Sea Action Plan

Expert article • 2857

In 2021 the Baltic Sea Action Plan will be updated. The Action Plan is a legal instrument under the Helsinki Convention for the environmental protection of the Baltic Sea. It was developed by the Helsinki Commission (HELCOM) and adopted in 2007 by all Baltic Sea coastal States to speed up the recovery of the Baltic Sea. The Action Plan takes a holistic ecosystem approach, based on ecological indicators and adaptive evaluations, it focuses on the core environmental problems of the Baltic Sea. The most severe problem is eutrophication. The Action Plan was developed in parallel to the EU Marine Strategy Framework Directive, which takes a similar approach to the EU regional seas.

The aim of the Action Plan is to reach good environmental status by 2021. However, as it turns out this goal has not been achieved for any of the problem areas addressed and instead the Action Plan is to be updated for continued work. The update is an opportunity to take stock, evaluate the effectiveness of the current Plan and adjust it accordingly. So, what has the Baltic Sea Action Plan meant for the problem of eutrophication and what must be in focus of the update?

The fact that the goal, good environmental status, has not been achieved for eutrophication is, as such, not surprising. The eutrophic state of the Baltic Sea has gone so far so that it will take several decades for the environmental status to change even if all eutrophic pollution would stop. This is acknowledged in the Action Plan, which instead focuses on reducing the pollution to levels that will enable good environmental status in the future. The approach taken has led to important progress, however, even in this regard there is still some way to go to reach the goal. The new Plan would gain from increased pressure on the States to take a more ambitious approaches to implementation.

Eutrophication is caused by nitrogen and phosphorus from a range of sources, of which many have been successfully controlled. Most remaining sources are diffuse, over time effective pollution reduction has become increasingly difficult to achieve and to control with legal measures. In addition, pollution must be reduced in all States to achieve the goal.

One purpose of the Baltic Sea Action Plan was to identify and visualize, through modelling, how much pollution each State must reduce and from which sources. This was done by targets for 'maximum allowable input'. Based on the targets, the Action Plan identified effective reduction measures despite the scientific complexity of the situation. The suggested measures are not binding but the Helsinki Convention obligates all States to take '*...appropriate measures...to prevent and eliminate pollution in order to promote the ecological restoration of the Baltic Sea Area*', and the States have agreed to reach the goal itself. Hence, the Action Plan defines what States must do to comply with the Convention and with the goal of the Plan.

The operationalization of the Baltic Sea Action Plan has to a large extent focused on reducing pollution from agriculture. Agriculture is the most urgent and most difficult source of eutrophic pollution that remains. However, it is also complex to regulate with traditional legal command- and control measures. Moreover, requirements on reductions related to agricultural activities often meet a political resistance. However, some of this resistance has been overcome

thanks to the design of the Action Plan and the adaptive approach leading to many small steps taken accordingly. Scientists and stakeholders at all levels, including NGOs and farmers organizations, are also invited to contribute to identifying measures and to the general implementation of the Action Plan.

The only control measure available under the Helsinki Convention is self-reporting. Still, in relation to the operationalization of the Baltic Sea Action Plan, State implementation has been evaluated regularly through meetings and digital tools and here progress has been monitored. HELCOM has also regularly analyzed the state of the Baltic Sea. Both the data and the legal monitoring of action taken shows that important progress has been made thanks to the Baltic Sea Action Plan. Not least in relation to eutrophication, an area characterized by regulatory and scientific complexity, as well as by political resistance to legal requirements. Against this background, the Baltic Sea Action Plan is well-suited to address the environmental challenges of the Baltic Sea.

In general, the essence of the original Plan will remain. Adjustments planned so far are e.g. to address increased integration of cross-cutting issues and global goals, such as climate change and targets for biodiversity. It remains to be seen what new measures or actions that will be added in relation to eutrophication. However, whatever measures chosen, success in achieving good environmental status depends on increased focus on the range of measures taken and on the States raising their ambitions. ■



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ANNA TÖRNROOS

# The Decade for oceans and humanity

Expert article • 2858

1st of January 2021 marks the start of a crucial 10-year period for oceans and humanity. It is *The Decade* for several reasons. Most importantly because the end of it, 2030, has been identified by scientists as a timeline for preventing catastrophic climate change. The same period is also identified as critical for stopping the rapid destruction of biodiversity by humans, that is, the sixth mass destruction of life on earth. An Earth that is blue, its surface covered to 71 percent of water, about 97 percent of which is in the oceans, seas and bays. Bodies of water harbouring the largest ecosystems on the planet that we humans live off and around, but that we do not safeguard enough for our future existence. 2021 also marks the Year of Science and communication of it to the surrounding society, which is important in an era of false and fake news.

These are also the reasons why the United Nations (UN) have decided to proclaim The Decade of Ocean Science for Sustainable Development and The Decade on Ecosystem Restoration. The goal is to strengthen management, restoration and protection of our oceans and coasts for the benefit of humanity and nature. These profoundly important recognitions by the UN comes at a time when scientific facts are clear on the impacts of climate change on the physical changes of the oceans featuring for instance unprecedented declines in sea ice, warming of the oceans, sea-level rise and decline in oxygen as well as profound but context-dependent impacts on the marine ecosystem and its services, stated by the Intergovernmental Panel on Climate Change (IPCC). Likewise, the Intergovernmental Science- Policy Platform on Biodiversity and Ecosystem Services (IPBES) outlines the deterioration of nature and its impacts on people and societies. These global proclamations and scientific statements recognise the cross-cutting role that ocean science, spanning e.g. marine biology, physical-geological- and chemical oceanography, has for reaching and implementing the UN Sustainable Development Goals, as well as the Aichi targets on biodiversity post 2020 that are the foundations of The Decade.

For the Baltic Sea and its protection, it is not only these actions and goals that signifies the recently started Decade. The deadlines set by the EU Water Framework and the Marine Strategy Framework directive to achieve good status of the marine environment passed without satisfactory results. The coming decade includes the absolute deadline in 2027 and, thus, a need to be even more ambitious in respect to reaching the target. The flagship that can make this happen and that is navigating the science-policy actions in our region, the Baltic Marine Environment Protection Commission (HELCOM), is also updating the Baltic Sea Action Plan (BSAP) this year. The plan will need to tackle the "old" and still existing wicked problems related to eutrophication, overexploitation and chemical pollution, but also new ones such as climate change, acidification as well as plastic and noise pollution and their interlinkages and effects on the old ones.

A key question and challenge that remains though, is how to downscale and implement the goals and activities of The Decade of the Oceans to the regional level of The Baltic Sea, and the national coastal waters. The refined BSAP and the ecosystem-based management approach, which recognises humans as an intrinsic part of the ecosystem, are both important pieces, but are they enough?

An answer can be found in the reviews and constructive critiques of e.g. IPBES as well as HELCOM, but also calls within the scientific community that emphasise the need to develop a clear approach to stakeholder engagement and co-design and co-production of assessments and implementation plans to ensure inclusion of a diversity of socio-ecological data and local knowledge. These needs can only be fulfilled if also ocean science and scientists progress towards greater inter- and transdisciplinary joint collaborations, *working with* the social sciences, humanities, engineering sciences as well as the private business sector, the public sector, NGOs and citizens. This requires and entails a level of common language in terms of terminology and concepts, and methodologies for working together. Encompassing and developing this type expertise and knowledge is the core vision within the strategic research profile *The Sea* at Åbo Akademi University, which aims to find solutions to so called wicked problems of the oceans, and particularly in and around the Baltic and Nordic Seas. ■



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MATI KAHRU

# The changing Baltic Sea

Expert article • 2859

**T**he Baltic Sea has always been changing - from its beginning as the Baltic Ice Lake and Yoldia Sea over 10 thousand years ago to its present brackish water state. Therefore, it is difficult to separate its natural evolution from the changes caused by the human-induced climate change. However, it is likely that the changes in the past took hundreds or thousands of years whereas now we can detect significant changes over a couple of decades. Our ability to detect these changes has also increased tremendously, particularly due to the development of satellite oceanography that started about 40 years ago. Suddenly, we were able to make millions of measurements per day from those "eyes in the sky".

It is important to differentiate between global climate change and regional environment change. Both are important but we need to separate them as accurately as we can to plan our actions and policies. Politicians and regional administrators love to combine them in order to use the excuse of global climate change as a scapegoat for their own shortcomings in regional management. The devastation caused by forest fires in California is a good example for that. Media, too, tends to bombard us with news clips about climate change that are distorted and seem to be designed to act as click magnets. "The Arctic Ocean is dying" is an example of these inaccurate messages. No, it's not dying, just transforming. A few years ago I completed an analysis of satellite data that showed that over the last 2 decades, primary production in the Arctic Ocean had increased by about 50%. Note – it has increased by a significant amount, not decreased. More primary production (due to the shrinking ice cover) means that there is more life and not less life in the Arctic Ocean. Of course, with the changing environment the properties of that "life" are also changing.

Science makes most sense when it touches our everyday lives. For example, climate change becomes real to middle-aged and older persons as they can compare conditions "now" with those some decades ago, e.g. "when the grass was greener and the sky was bluer". For example, I remember that during a research cruise to the Baltic Sea about 40 years ago, we once stopped the ship in the middle of the Baltic and jumped off the ship for a swim. It was a bit scary swimming in the open ocean but the water temperature was a soothing 25 °C. Surprisingly, events of 25 °C water in the middle of the Baltic have not become commonplace in spite of the general warming trend. What has actually happened is that the length of the period with the "barely swimmable" 16-17 °C waters has increased dramatically. The calendar day when the average surface water temperature of the Baltic Sea reaches at least 16°C has become progressively earlier and the calendar day until which it stays at least 16 °C has become progressively later. As a result, the overall length of this "at least lukewarm" water period has increased by about 33 days during the last 2 decades.

The Baltic Sea waters are not famous for being crystal clear and highly transparent – that is due to the high load of light absorbing and light scattering substances that they contain. While this is primarily a regional problem affected by abundant nutrients, pollution from runoff and eutrophication, it is also exacerbated by climate change. The offshore Baltic Sea waters tended to be decently transparent most of the year and were very turbid only during the relatively short periods

of plankton blooms. We can now estimate water clarity from satellite sensors and it appears that the turbid periods that used to last for about 50 days per year about 25 years ago, are now lasting for about 240 days per year. That is an increase in the length of the turbid period by almost 5 times. Toxic cyanobacteria blooms now start earlier - in the beginning of June instead of July - and end later - in September. It means that most of the year the Baltic Sea is now very turbid and even offshore waters have low transparency most of the year. What this means to fish, zooplankton and other animals who need water transparency for survival is not clear.

In conclusion, the effects of environmental change that the Baltic Sea is experiencing are not primarily in the absolute values of some indicators such as temperature (although trends are certainly present) but rather in the timing of seasonal events. The spring is arriving progressively earlier and the winter is being delayed and the real winter never arrives. Figuratively speaking, it looks as if during the last few decades, the Baltic Sea has moved from Finland to Germany and there is no easy way back. ■



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KAROLIINA A. KOHO

# Towards a “green” future of the Baltic Sea

Expert article • 2860

**A**lthough the COVID-19 pandemic is eminently going to leave a mark on the world's economy, it also provides us with an opportunity: a “clean slate”, to do better and change our approach towards the management of the environment and preserving global biodiversity. Here, Europe is intending to set a positive example to the world and lead the way towards healthier and more resilient ecosystems, while minimizing the impacts of climate change and decarbonizing our societies by 2050. The new policy initiative, European Green Deal, is aimed at all sectors alike, with no person or place left behind, and everyone's efforts are needed to achieve a sustainable tomorrow.

Many solutions for the greener future have a high affinity to the growing sector of Blue Economy, which in the Baltic Sea alone has increased in value from 29.7 billion euro to 34.1 billion euro in less than a decade. In future, this sector is likely to expand further. However, to ensure Blue Economy is truly developed with sustainability of marine ecosystem goods and services in mind, major research and innovation breakthroughs are needed.

During the last decade, the joint Baltic Sea Research and Development Programme known as BONUS (Treaty on the Functioning of the European Union Article 185 activity) has invested over 100M euros to support the development of ecosystem-based management of the Baltic Sea region, providing policy relevant solutions to current issues facing the marine environment. Now, a new Baltic and North Sea Research and Innovation Programme (BANOS), coordinated by the BONUS Secretariat, is being developed by means of an EU funded Coordination and Support Action, BANOS CSA. In future, BANOS aims to build on the BONUS legacy and success, unlocking the development of sustainable Blue Economy in northern European marine areas. The two ‘sister seas’, the Baltic Sea and the North Sea, have much in common and constitute a key macroregion of the European marine environment – making this an opportunity too good to miss. Many of the sustainability and climate related challenges are shared, plus the geopolitical and cultural setting is ripe for collaboration, hence pooling of resources and research and innovation capacities for the added benefit of both regions is considered highly desirable.

To support the ambitious goals of the European Green Deal, the next European Framework Programme Horizon Europe (2021-2027) is also aiming to deliver high impact solutions in research and innovation. A new element in Horizon Europe is the European Partnerships, bringing together the European Commission, private and/or public partners to address some of Europe's most pressing challenges through concerted research and innovation initiatives. For the Blue Economy sector, the partnership candidate Climate neutral sustainable blue economy is the most relevant, however others focusing on preserving biodiversity, decarbonizing waterborne transport, developing the energy sector and protecting freshwater environment are also highly topical.

During the last year BANOS CSA has been closely following and contributing to the development of the sustainable blue economy partnership. The BANOS Strategic Research and Innovation Agenda (SRIA), due to be launched in May 2021, together with SRIAs developed in other European regional sea areas, are laying the solid foundations for the agenda of the partnership. As the emerging joint SRIA indicates, many of the sustainability challenges facing the Blue Economy sector can be considered Pan-European, or even global in nature, however, the solutions for the problems are likely to be more localized, taking into account the nature of marine ecosystems, the people who depend upon them, and the local climate. In this respect, macroregionalized actions such as BANOS deliver appropriate solutions for the Baltic Sea and its unique ecosystems and biodiversity, which remain highly vulnerable to environmental stressors. Hence, the macroregional level should not be overlooked in the implementation of the Pan-European research and innovation agendas. Indeed, many marine governance issues continue to be better resolved through existing macroregional structures, with HELCOM being the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area.

The implementation of the sustainable blue economy partnership and BANOS agendas and priorities of research and innovation topics are still largely open. To ensure that the priorities of a “green” Baltic Sea are comprehensively addressed, a macroregional focused research and innovation programme is likely to be necessary to complement the Pan-European activities. Such a programme in the form of BANOS, following the footsteps of BONUS, would deliver high level sustainable Blue Economy solutions in the best interests of the Baltic region. ■

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MACIEJ ZALEWSKI

# Green Deal - Ecohydrological nature-based solutions for improvement of Baltic ecological status

Expert article • 2861

**T**he Sustainable Development Goals of the UN and the European Commission's Green Deal Strategy, have to be achieved through harmonization of societies needs with the improvement of the biosphere vital resources: clean water, biodiversity, fertile soils and air.

Baltic Sea ecological status has recently become one of important sustainability challenges for Europe, because of the increasing cumulative impact, however it is also a potential generator of opportunities for Green Deal success stories if innovative solutions will be implemented. In case of the Baltic Sea major components of cumulative impact are pollutions from point and non-point source which generate eutrophication, toxic algal blooms and anoxic zones. Due to its complexity, the reduction and compensation of increasing cumulative pollution impact, has to be solved by a new way of thinking e.g. enhancing the role of sewage treatment plants by ecohydrological Nature-Based Solutions.

Ecohydrology as a transdisciplinary scientific paradigm, is based on the assumption that water, and the hydrological cycle is the common denominator and regulator of fundamental ecological processes such as nutrient cycle and energy flow, which in turn determine biodiversity, bioproductivity, ecosystem services available for society and resilience to climate change. Biological structure of ecosystems in turn modify the hydrological cycle to a great extent. According the UNESCO World Water Assessment Program, the terrestrial ecosystems are responsible for more than 60% for stabilization hydrological cycle (Van der Ent et al. 2014). In turn the non-point source pollution and urban stormwater, may generate up to 50% of nutrients load to Baltic from some catchments (Kiedrzyńska et al. 2014). That is why the profound understanding the key ecohydrological process and the two-way water/biota interaction serves as a background to use ecosystem processes as a management tool to reduce impact, increase absorbing capacity of ecosystems and enhance catchment sustainability potential, described in Ecohydrological framework by five essential parameters: Water, Biodiversity, Ecosystem Services for Society, Resilience, Cultural Heritage and Education – WBSRCE (Zalewski 2014, 2016). The consciousness of this multidimensional goal for catchment management is a fundamental for transition from a exploitative to sustainable use of resources, including the incorporation of the innovative tools such as Ecohydrological Biotechnologies, known also as "Nature Based-Solutions" (NBS).

Water acts as the mechanism driving the circulation and accumulation of carbon, phosphorus, nitrogen, and other nutrients and pollutants in the catchment (Figure. 1).

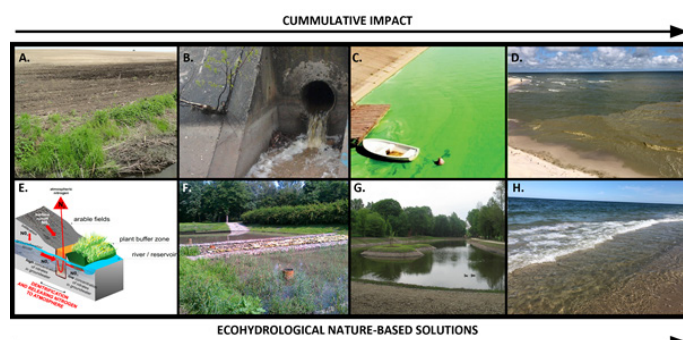


Figure 1. An example of cumulative impact: a reduction of a natural land/water ecotone (A) increases the surface flow, especially in periods of heavy rainfall, causing an increase in nutrient load washed up from urban (B.) and agricultural landscape and increasing the risk of toxic algal blooms (C., photo of toxic bloom M. Tarczyńska). The risk can be amplified by unforeseen factors( e.g failure caused by overloaded by stormwater sewage pumping station in Gdańsk (D., Jurata, 25 July 2019, 11:57 am photo: M. Zalewski). An example of Ecohydrological Nature-Based Solutions: a highly effective ecotone zones in agricultural landscape (E.), a Sequential Sedimentation Biofiltration System on the Sokołówka River in Łódź, Poland (F.), for purification of urban stormwater from: roads, parking lots and walkways, adapted for improvement water in urban reservoirs (G.), water retention, ground water recharge, adaptation of the city to climate change (Zalewski et al. 2012, Jurczak et al. 2018) and in catchment scale reducing the risk of toxic algal blooms (H.).

Currently the degradation of terrestrial and water ecosystems is amplified by ongoing climate change. For the involvement of society in actions towards enhancement of catchment ecological status it is necessary to rise society's consciousness and awareness of the basic processes in the ecosystems. Therefore for achieving sustainable future by Green Deal Strategy the transition from the current sociocentric/mechanistic paradigm, formulated at the beginning of the industrial age to the evolutionary-ecosystemic. According to the sociocentric-mechanistic approach, the biosphere is a "black box", a system which gives unlimited resources and receives and absorbs all generated pollutions and waste. The energy and matter is gained through unrennewable resources - fossil fuels. On the contrary, in the new evolutionary-ecosystemic approach, more emphasis is put on the sustainable usage of renewable resources by Circular Economy.

Expert article • 2861

The word “evolutionary” expresses the understanding that the biosphere and the ecosystems are constantly changing and with the severe modification to the natural processes which occur in the Anthropocene, each and everyone of us to various extent decides, whether we will use the Earth’s resources like it’s a “black box” providing unlimited resources and absorbing every dose of pollutants, this will be leading to an inevitable catastrophe, or will we be a disciplined crew, rationally using the potential of the magnificent Space Ship “EARTH”.

The urgent necessity for the transition from sociocentric-mechanistic paradigm to evolutionary-ecosystem has been noticed the European Commission’s Committee of Regions (COR) in a strategic document “Fitness check of the Water Framework Directive, Groundwater Directive, Environmental Quality Standards Directive and Floods Directive” (<https://cor.europa.eu/en/our-work/Pages/OpinionTimeline.aspx?opId=CDR-541-2020>). ■

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Pan-European Institute

**BALTIC RIM  
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AIJA CAUNE, MIKHAIL DURKIN &amp; NILS HÖGLUND

# Hope, stability and protection

Expert article • 2862

**A**nother HELCOM<sup>1</sup> meeting has passed... again frustrating and full of disappointments. Not because of not being able to meet physically and travel – we have all learnt in 2020 the value of working from home and spending more time with our families. Not because of tiring negotiations – we have also adapted to this new normal and possibly the online mode has even driven us to be more active in defending our positions. No, the reason for the frustration is that the countries so clearly show that national interests have nothing to do with the protection of the Baltic Sea. The countries don't understand that they create risk and uncertainty, the opposite of what people and markets want, and nature needs. Nothing has changed since Baltic environmental NGOs appeal in [BRE](#) – on contrary, it turned towards the worse.

In 2007<sup>2</sup> we aspired to reach a healthy state for our common blue pearl, the Baltic Sea, by 2021. A sea with "...diverse biological components functioning in balance, resulting in good environmental/ecological status and supporting a wide range of sustainable human economic and social activities." And instead – we have lost the main Baltic cod stock, almost wiping out the European eel and our only whale, harbour porpoise, from the Baltic species list. We have reached the point when almost the entire Baltic is suffocating of eutrophication and we have destroyed several unique nature amenities at the coast and inland. *In memoriam* can be continued for the only reason to prove that each of those losses is a result of economic activity that have never been aligned with what nature needs. Fishing to the last drop, farming to the last crop, shipping cargo like the sea and rivers are no-speed-limit highways, cutting nature apart by roads, pipes and canals like a piece of cake. This explains why countries around the Baltic Sea are so keen on discussing actions for the sake of actions, actions with no deadlines and targets, actions that are not even foreseeing implementation...

We keep on forgetting that people's need for connection to the sea and nature is the need for stability and calm. It is not only markets and investors that need stability and predictability. Our sea and environment also need stability and protection to heal. And that in turn is of vital importance for our own existence as just one of the fragile species on this planet. The year 2020 has proven it with scaring evidence.

The need and sense of urgency is very clear. Our sea is failing and fish stocks collapsing. We can make a change and we must make a change but it must start from the same place. Any plan must start with a common understanding that the functioning of the ecosystem must come first. Always first, because everything else is short sighted and unstable, creates unpredictability and worry. All the world's investors, banks etc. work all day to avoid risk and instead our policy-makers seem to create it by sharpening an axe to cut off the branch we are all sitting on, not knowing how hard the fall will be or when it will come.

We do need a strong, predictable and serious strategy to align people's expectations. A plan that encompass what most people already understand: one thing is connected to the other in a system, an ecosystem. The ecosystem approach may be theoretical to most of us but to people, teachers, nurses, farmers or fishermen it just means to understand the full picture. We, citizens of the Baltic Sea countries, have jointly offered such a [Plan](#) to the Baltic politicians and countries to implement.

If we keep on thinking that we can degrade the environment piece by piece, continue to overfertilize our fields, pollute our waters and fish out stock by stock without it having consequences for our own lives, then we are nowhere closer to stability and calm we all wish and hope for. Neither in 2021, nor in 2030... and a life of our [Baltic vaquita](#)<sup>3</sup> costs less than reducing soundwave produced by a commercial ship by e.g. lowering her speed, if we claim all the Baltic salmon and cod were eaten by seals, if we believe cheaper fertilizers will boost sustainable farming, we are nowhere closer to stability and protection we all hope for. Neither in 2021, nor in 2030... ■

1 Baltic Marine Environment Protection Commission – Helsinki Commission ([HELCOM](#))

2 HELCOM [Baltic Sea Action Plan](#) was adopted in 2007 to reach the Baltic in Good Environmental Status by 2021

3 Vaquita – the small cetacean that is almost extinct

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HANNU KLEMOLA

# Vulnerable sea needs voluntary work to support common vision

Expert article • 2863

**O**ur fragile and beautiful Baltic Sea has degraded dramatically over the past decades. It has special hydrographical and climatic conditions. The sea has been pressured by human activities, eutrophication, overfishing, marine litter, pollution, effects of climate change and decreasing of biodiversity. We have jeopardised ecological balance of the Baltic Sea beyond its biological limits. People living around the Baltic Sea and NGOs have been worried about the future of our common sea. In recent years also new partners have joined the work for marine ecosystem.

Besides The Baltic Sea Programme we need areal programmes, as for example for the Archipelago Sea. Programme should promote a holistic and integrated approach to the conservation and sustainable management of the Sea for the revision of the programme of measures of the marine strategy. We should welcome everybody to share a vision of a healthier, diverse and resilient Baltic Sea. Input of volunteers can vary from expertise to activism in projects, theme days, steering groups, working groups, nature management labour camps. Gladly we have already learned some good news and achievements from saved species and reduced plastic to better wastewater treatment.

Volunteers, members and employees of Finnish Association for Nature Conservation welcome deeper co-operation and a holistic approach to environmental issues of the Baltic Sea. We are the largest non-governmental organization for environmental protection and nature conservation in Finland. The purpose of our organization is to protect the natural environment, promote nature conservation, preserve cultural heritage and spark up active citizenship and strong environmental awareness. Most of the work in the local associations and district organizations is voluntary work in nature, training, environmental education and publishing. We also put forward motions and initiatives and issue statements on affairs associated with our field. Independence from party politics and interest groups ensures that nature is always our number one priority. The commitment and motivation of our volunteers is realised by participating in field courses, events, seminars, awareness campaigns, collecting litter, summer camps or just taking part to a guided daytrip – having a good time together.

Voluntary work for the Baltic Sea consists of and requires commitment for long time cooperation. It also demands monitoring species, news releases, blogs, vlogs, photogalleries, even film-makers. Local knowledge of marine ecosystem and species also needs to be respected. In addition the work demand paid staff and funding. On a national, regional and European Union level voluntary work must be appreciated. The economic support from different programmes, and foundations is vitally important. Enterprises and private sector are also welcomed to participate in cooperation. There is an increasing need to work both on the field and in politics, combining scientific knowledge and expertise with creative innovation,

political determination and cooperation with local communities and stakeholders—such as farmers, fishers, scientists, local industries and markets, and other conservation groups. We need open and longstanding environmental cooperation in and between the each country bordering The Baltic Sea, not to forget press, social media and social networks. We must work together to identify solutions to restore the Baltic Sea to a healthy state for the benefit of people and nature of the region. By working together it is easier to address the problem by promoting policy reform and more sustainable spatial planning, marine transport, farming, land management practices, fishing and management of biotopes and species. A key solution to the problem of eutrophication lies in addressing land-based measures through policy reform, and the promotion of more sustainable farming and land management practices. We should also identify marine biodiversity hotspots.

We have to increase co-operation to build up greener agricultural methods based on the eco-system between farmers, universities and other research, governments, regions, the Baltic Marine Environment Protection Commission HELCOM, foundations, Coalition Clean Baltic, other NGO's to implement methods that keep nutrients and water on land, utilize fertilizers more efficiently, restore habitats, improve soil health and protect watersheds. Agricultural policy reform at EU level is necessary in stopping harmful practices on a large scale. Financial support for the agricultural sector accounts for great deal of the EU budget.

So, what should we do next? The status of the sea is still poor but there are signs of improvement. At first we should find opportunities to continue and deepen dialogue with different stakeholders and support the public and private investment to flow to support. Sustainable bio gas, biocide free boating and blue tourism are good examples. It is important to influence spatial planning and reforms of policies and governance in all and sector-crossed levels. The final aim is to achieve good status of the marine environment by the realisation of sustainable Blue Economy and eco-system based resource management of the Baltic Sea and its marine and coastal resources. Let's find the spirit to work together for the Baltic Sea and its rich biodiversity. ■

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LIENE GAUJENIETE

# Maritime spatial planning for improved environment in the Baltic Sea

Expert article • 2864

The recently published EU Strategy on Offshore Renewable Energy has put Maritime Spatial Planning (MSP) in the spotlight as one of the focus areas in order to achieve the set targets for renewable energy production. MSP is a tool and an instrument to balance various interests in the Baltic Sea. Furthermore, the MSP process is an enabler for blue growth, increasing competitiveness and achieving European climate targets, while still ensuring environmental protection of the marine areas. MSP is supported by European and pan-Baltic frameworks that serve to improve environmental status of the Baltic Sea.

2021 marks a year when the EU member states shall transit from the initial planning process to implementation of maritime spatial plans as defined by the EU Directive for establishing a framework for MSP. The directive clearly emphasizes the application of ecosystem-based approach and considering the environmental interests. The Baltic Sea Broad-scale MSP Principles are outlining the same values for the Baltic Sea – ecosystem approach shall be an overarching principle, ensuring sustainable and cross-sectoral management of human activities. The MSP Principles were adopted in 2010, the MSP Directive was issued in 2014. Last year, the EU Green Deal and the EU Strategy on Offshore Renewable Energy have been added to overarching framework and are delivering the same message – development in the sea are to contribute to climate neutrality of the EU and help recover from the pandemics while protecting the environment and biodiversity.

In the Baltic Sea Region (BSR), there are well-established traditions in cooperating across the borders in spatial planning. Since the early nineties VASAB (Vision and Strategies around the Baltic Sea) has served as a platform for know-how exchange and networking also being among the front-runners on expanding spatial planning offshore. Since 2010 the HELCOM-VASAB MSP Working Group is working towards implementing the EU MSP Directive, ensuring coherent MSP across the national borders in Baltic Sea and applying the ecosystem-based approach. In addition, the EU Strategy for the BSR, the oldest macro-regional strategy in the EU has the objective “Save the Sea” and a Policy Area Spatial Planning that contributes to the achievement of this objective. The cross-border cooperation and jointly agreed pan-Baltic frameworks have allowed countries around the Baltic Sea a mutual learning and growing their capacities to elaborate MSP that contributes to the environmental protection. Finland has recently approved its maritime spatial plan that was elaborated based on three scenarios that would clearly show the various interests and interdependencies in the sea and allowed stakeholders to seek for compromises in balancing environmental and business interests.

MSP undoubtedly is among the most influential tools to manage the various marine activities while ensuring that the economic interests are balanced with environmental protection measures

crucial to maintain and wishfully to improve the environmental quality of the Baltic Sea. Still a narrow interpretation and application of MSP might be insufficient. Therefore, integrated approach to maritime and terrestrial planning has to be implemented in order to reach towards more sustainable solutions in the future. At this point, Lithuania is elaborating a new comprehensive plan for land and sea territories utilizing integrated approach. The concept of land-sea interactions has to be more broadly addressed to emphasize the impacts of terrestrial activities on the marine environments. In addition, thorough analysis of land-sea interactions allows enhancing the coastal communities and economies, which contribute to sustainable and balanced use of marine resources, improves climate change resilience as well as supports maintenance of coastal employment, cultural and social values. In addition, the concept of blue growth allows developing comprehensive approach for sustainable use of marine resources and MSP is a crucial component for the management of various activities.

The competition for the sea space is increasing, especially by the pressures made by the climate neutrality targets set on global and pan-European scale. As a negative side effect, the climate policies aiming for reduction of greenhouse emissions are set on contrary to environmental protection. Unwittingly, choices like deciding whether to build an appealing and climate neutral railway line or keeping the nature reserve for endangered birds, or increasing the offshore wind capacity to align with targets versus maintaining the precious fish habitats are set in the public scene, giving the impression for compromises to be impossible. Spatial planning both on land and in the sea, can serve successfully to facilitate the dialogue among all the involved parties and mitigate the conflicts in order to achieve the most favourable resolutions on both sides and the current policy framework is supportive to enhancing these benefits. ■

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KALERVO VÄÄNÄNEN

# Recycling is a key to the sustainable marine ecology and economy

Expert article • 2865

Throughout the ages, man has been thinking of the seas to be so great, that his actions does not affect them. All pollution that enters the sea, be it toxins, sewage, nutrients or plastic waste, is thought to dissolve and mysteriously disappear into the oceans and to their an almost infinite amount of water without being able to affect marine life.

Now, this fundamentally the same line of thought is in our approach to cleaning up polluted seas. All too easily, we think the seas are too big to clean, and we push the whole thing into the background of our thinking.

However, when we stop to think, every responsible person understands that both ideas are absolutely wrong. The seas are not too large to be damaged by human activities. Nor are they so large that we could once cleanse the damaged sea and restore its original vitality. The question is how strong our common will is on this issue.

Now, at the latest, it is time to embark on determined measures to improve the state of the seas, both through global joint efforts and through regional efforts that go as far as one individual. Each of us can do something to ensure the viability of the seas for future generations as well.

Climate change is the biggest threat to marine health. This does not mean that, under its guise, we can abandon local measures to reduce the burden on the various sea areas. Healing the seas requires both mitigating climate change and reducing local nutrient emissions, toxic emissions and littering, especially plastic littering.

The importance of climate change for marine health comes through a number of different mechanisms. The sea is the largest single carbon sink. The seas sequester more than a third of the excess carbon dioxide in the atmosphere. This has had a clear impact on the state of both the seas and their organisms. Increased dissolution of carbon dioxide acidifies the sea. This, in turn, has major implications for marine animal and plant health. Perhaps most clearly this is evident in the dying corals. The shell of corals is mainly calcium carbonate, the solubility of which is strongly dependent on pH.

In the case of the Baltic Sea, the effects of climate change are increasing rainfall in the catchment area. This will further dilute the low salinity, which in turn will have a major impact on the current viability of fish in the Baltic Sea, as well as other species.

In the Baltic Sea region, both public and cross-border actions by private organizations have been quite effective in reducing the burden on the sea. However, it is good to remember that Europe's largest desert is at the bottom of the Baltic Sea. Once dead, the seabed takes a long time to recover. If recovering at all.

There are areas in every sea that are more sensitive to external stress, such as nutrient loads, than others are. In the Baltic Sea, such an area is, for example, the Archipelago Sea between Finland and Sweden. The archipelago sea is very shallow on the Finnish side. The average depth is only 23 meters. Thousands of small islands affect water flows and nutrient loads brought by rivers in the catchment area

dissolve in a relatively small amount of water. This had caused the eutrophication of the Archipelago Sea, although stricter agricultural regulations have reduced the amount of nutrients used already for a couple of decades. Over the last hundred years, more than 40 million tons of mineral phosphate have been imported from outside to the Baltic Sea catchment area. We know now that it takes decades to drain from the fields into the sea.

With the eutrophication of the sea, both natural values and business opportunities are lost.

The widespread application of the principles of the circular economy in the marine environment would be the key to improving marine health\*. It would also provide much greater opportunities for the use of the goods provided by the seas. For the most part, for example, the technology for making recycled fertilizers already exists. It is an utmost importance that we apply immediately all possible means to reduce nutrient flow into Archipelago Sea and develop rapidly new technology to remove excess of nutrients both from the catchment area and directly from the sea. Removal of nutrients, especially phosphorus and nitrogen, in large scale from the ecosystem formed by the catchment area of Archipelago Sea and the sea itself is urgently needed to save this unique ecological entity with tens of thousands of small islands and characteristic fauna and flora.

\*This has been discussed in details in our recent book entitled "Saaristomeren Sininen kirja" in Finnish and "Skärgårdshavets Blåa Bok" in Swedish (ISBN 978-952-69442-3-4 (PDF)).

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# Blue bioeconomy – a sustainable path for resource utilisation

Expert article • 2866

A sustainable blue bioeconomy means business activities based on the sustainable use of renewable aquatic resources and expertise based on them. Blue bioeconomy is a relatively new concept, and a clear common understanding of the sectors and operations to be included is still lacking. However, in many studies a blue bioeconomy is understood as a set of economic activities that are either directly or indirectly linked to the aquatic environment or benefit from being located close to the coast or shore. These activities explore, develop, and use renewable aquatic resources, produce inputs for other activities, use the aquatic space, or protect the aquatic environment.

In the context of a blue bioeconomy sustainability is often defined through three pillars, i.e. ecological, economic and social sustainability. However, all too often their exact meanings and the relationships between the pillars remain obscure. The model of Doughnut Economics developed by economist Kate Raworth provides a new framework for assessing sustainability. It is a visual framework for sustainable development – shaped like a doughnut – combining the concept of planetary boundaries with the complementary concept of social boundaries. We must not overshoot the ecological ceiling of our planet if we wish to maintain the conditions for human life. However, we should also not fall short of the basic living conditions because this would erode the social foundation.

## Good ecological status of waters and the sea is the foundation of a sustainable blue bioeconomy

A good ecological status of waters and aquatic ecosystems enables to develop and diversify products and services. To create responsible growth, renewable aquatic resources must be used in a way that is wiser and more sustainable than at present. The less we use the natural resources to produce added value, the more sustainable is our path towards promoting a blue bioeconomy. Healthy aquatic ecosystems contain significant production potential. The weakening of the status of waters puts many economic activities at risk. The solutions required for improving the status of waters also help to create new business opportunities.

## Sustainable and profitable activities without harm to the environment

The possibilities to increase the fish catches of the world are very limited. According to FAO statistics, aquaculture already produces more food protein than fishing or beef production. New aquaculture establishments must be based on low-emission solutions such as recirculating technology, or they must be located in open sea where environmental impacts are easier to control. Circular economy solutions are being created through industrial symbioses that aim for a closed cycle of the water, nutrient and energy economy. In the Finnish experimental plant for a closed cycle, the recirculating aquaculture establishment has been connected to a greenhouse, biogas plant and

biofuel production plant. The nutrient-rich discharge water from the recirculating plant is conducted to the greenhouse as plant nutrient for vegetable production. The side streams from the aquaculture plant and greenhouse are delivered to the biogas plant. Gas is used to generate electricity and heat. The greenhouse warms, oxygenates and purifies the water, while nutrients from fish farming serve as fertiliser for plant growth. The digestion residue left at the biogas plant is used as nutrient in arable farming. In accordance with the principle of a circular economy, what is waste for one is a resource for another.

The production of algal biomass and the development of associated technologies are making fast progress. Algae are effective producers of bio raw materials. Algae can also be used for binding nutrients or carbon dioxide from industrial emissions and utilised in biotechnology products. Studies are being made on the economic utilisation of the vast amounts of excess nutrients and harmful biomasses such as blue-green algae in the eutrophic Baltic Sea. Algae and mussels can help us find biological methods for making use of the nutrients already present in the sea and water bodies, thus improving the status of waters.

## Aquatic environments are important for human health and wellbeing

For a long time we have been well aware of the aesthetic and recreational value of the aquatic environment for the people. This is why coastal areas and spas in different parts of Europe have been popular destinations for centuries. Aquatic environment provides an attractive setting for tourism, recreation and wellness services. Aquatic environments and their amenities have great potential for developing 'blue care' activities, i.e. new kinds of wellness services that may include physical exercise, rehabilitation and various kinds of treatments and care. ■



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# Offsetting - new possibilities for sustainable economic growth?

Expert article • 2867

**D**espite all measures taken to protect species and habitats, biodiversity is declining at an alarming rate worldwide. Functional ecosystems are built on diversity of species and the interactions they have with each other and with their environment. We humans are also dependent on the ecosystems and the services they provide. Thus, biodiversity loss is a serious threat also to human well-being. Measures to halt the deterioration of the nature are needed urgently. One option not yet fully implemented is to start offsetting the human inflicted damages on nature. In this article we discuss biodiversity and nutrient offsets.

Before jumping into the offsetting, it is highly recommended to minimize the harm as the loss is certain but the success of producing the offset is not. This stepwise approach where environmental harm is first avoided and mitigated and thereafter the unavoidable loss offset is called mitigation hierarchy. Although offsetting concepts have been considered worldwide, within the European Union the need for compensating environmental harm can be drawn from Habitats Directive (biodiversity offsets) or Water Framework Directive (nutrient offsets) which both require that certain environmental parameters cannot be degraded.

Common and fair rules and guideline and open procedures increase the reliability and acceptability of offsetting (Primmer et al. 2019). One option is to define in legislation the rights and responsibilities of both the one causing ecological damage and the offset producer. Alternatively, offsetting can be done voluntarily f.ex. as a part of the corporate responsibility actions. Whether the nudge to offset comes from legislation or is voluntary, transparency and integrity in setting the offsetting targets, measures taken, and the evaluation of success are needed. They are the key factors in increasing the social acceptance of offsetting. For business sector a license to operate can be a key motivation to do voluntary offsetting and openness may increase general acceptance.

Offsetting follows the polluter pays principle: the costs should be paid for by the one causing the harm, such as a company, a municipality, or the state. This encourages to look for solutions that minimize the ecological harm. Eventually the offsetting costs can partly or fully be passed onto the prices of products and services.

## Biodiversity offsetting

In biodiversity offsetting (also called ecological compensation) biodiversity loss is compensated by producing biodiversity gain somewhere else. Compensation is implemented by restoring, managing, or protecting habitats. In practice, biodiversity gain can be achieved, for example, by improving the state of coastal underwater meadows or bird nesting habitats. However, in the Baltic Sea region, successful restoration of the offset sites may require measures also in the watershed to improve water quality. Interest in biodiversity

offsetting has increased especially among companies whose operations alter the use of coastal and sea space and which need environmental permits to operate.

## Nutrient offsetting

EU Water Framework Directive and Marine Strategy Framework Directive both require that the state of the marine environment is improved. This means that currently no activities causing, e.g. excess release of nutrients into the seawater can be permitted in the marine areas. The central idea of nutrient offsetting is that the quality of water within a water body is not deteriorated due to human activities. This means that if human activities cause additional nutrient releases into a waterbody, it needs to be offset by removing nutrients from the same marine ecosystem. Potential tools for nutrient offsetting are e.g. growing and removing mussel, reed or macroalgal biomass or by binding nutrients into the sea bottom. The execution of offsetting measures requires extensive knowledge of the marine area and its ecosystem, as well as well-planned utilization of the removed biomasses or used chemicals.

## Novel business possibilities?

Along with environmental benefits, developing operational offsetting system can provide opportunities for new business development. Planning, executing and dealing offsets can provide opportunities for companies involved in environmental consulting. Producing offsets can provide an additional source of income for agriculture and aquaculture sectors when novel land use and aquaculture practices are taken into use. For example, culturing bladder wrack (*Fucus vesiculosus*) for extracting alginate and other economically valuable chemical components would not only provide the possibility to remove nutrients from the marine ecosystem, but also develop new circular economy approaches to agricultural and fish farming practices.

## Conclusions

Avoiding and reducing biodiversity loss and negative impacts on the marine ecosystem should always be the priority in project planning. If harm inflicted on nature by human activity cannot be completely avoided or alleviated, offsetting measures should be considered. However, developing an operational offsetting system requires common rules to consolidate the roles of the various parties involved to render the activity as transparent as possible. Among fair policies, this requires a science-based tool for comparing the ecological loss and gain in the offsetting procedure. The practical implementation of offsetting needs also development, such as a registration system for keeping track on the offsets, agreements and monitoring. Finally, it also should be recognized that some nature values, e.g. rare or endangered populations cannot be offset. Active national and

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international discussion and development of sound practices are needed within the Baltic Sea region to guarantee that the potential environmental benefits of offsetting are truly met. ■

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STAFFAN LUND

# Reaching further for cleaner water and rural development

Expert article • 2868

**B**elow I will share some pathways coming out of the work done by the partners in the WATERDRIVE project funded by the EU Baltic Sea Region Program. I will discuss two pathways to reach further and achieve better results in terms of water management and rural development.

Rural areas and agriculture are significant sources of eutrophication of Baltic waters. Progress is happening for example with legislation for better manure management and the introduction of agri-environmental programs for farmers investing in agri-environment measures like protective zones etc. Those are all good things with impact on the field scale. However, the up-take of such measures among farmers in high-risk intensive agricultural areas are still low. Moreover, despite the very good things done it is hard to see the positive trends in water quality measurements on the landscape- and or drainage basin level. The two pathways discussed below aims at strengthening voluntary actions on top of the existing regulation. The aim is to un-lock unused potential and reach further. One of the cornerstones is to initiate a transition in support programs from control and administration to management and results. It is a question of balance and a shift in priority. Governments can make that shift in programs.

The landowners have a key role in building the sustainable, secure and inclusive society. Their management of lands and waters is key to many of the challenges society is facing. Therefore, their willingness to join in and potentially drive the development is essential for success. Further, things like innovation in water management is more likely to happen from cross-sector cooperation than in single sector implementation. Keeping in mind the need to increase farmer's willingness to participate, introducing more local management and stimulating cross-sector cooperation, two parallel pathways can potentially reach further. They are mutually dependent of each other and it is more a question of taking advantage of different opportunities at hand. In the longer perspective it is likely we will see a shift towards the second pathway.

The first pathway includes the following: Up-date of the agri-environmental support programs to become more flexible with a stronger acceptance among landowners and especially landowners in the high-risk areas. Their concern is not only about financing but also about the level of paperwork, difficulties with long-term contracts and challenges with the general farm operations. The recommendations so-far from Waterdrive is to (1) increase the programs flexibility, (2) introduce more of result-based payment schemes, (3) increasingly support measures with multiple ecosystem benefits, (4) make sure the programs are motivating enough for farmers in high-risk areas. Doing that we will have more farmers engaged in programs, better results for the same money and cleaner water. Although, this is a very good step forward it will not be enough.

The second pathway includes the following: Significant increase and support to un-lock the capacities for water management on a

broader local community level. This includes changing management perspective from individual fields to the landscape level. This type of action called holistic water management can include larger investments for reducing risks with drought and flooding, large-scale smart drainage projects, larger wetland and water reservoir investments, restoration of streams and lakes, securing increased natural water purification in the landscape. Additionally, combined urban and rural water projects. Holistic water management will support commitments towards several international directives and national sustainability targets combined with local priorities, which is important. It will increase the attractiveness and value of local resources and landscapes while increasing ecosystem services in a cost-efficient way. The recommendation from Waterdrive is to prepare national frameworks and make financing available for holistic water management programs either as part of the EU CAP system or from other national development programs. Such combined water and rural development projects are on-going in the Baltic Sea Region and in some of the case areas of Waterdrive.

The results so-far are promising. However, holistic water management needs to be set in an appropriate governmental or regional framework. Important issues concerns how (1) platforms for cooperation and management on the local level are established, (2) the leadership issues, (2) the financial mechanisms for support, (3) access to qualified advisory services and appropriate decision support for strategic planning and implementation on the local level.

Water management is a societal challenge for the Baltic Sea Region becoming even more crucial when the climate is changing. Solutions to reach further includes supporting a transition from control and administration to management and results. The farmers and local municipalities will have key roles in this transition.

It is not a straightforward process, and we welcome any comments and insights from the reader's side. Please visit [www.water-drive.eu](http://www.water-drive.eu), where you will find contacts for further discussion and dialogue. ■

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LIISA PIETOLA

# Climate change challenges water protection in agriculture

Expert article • 2869

**F**armers and forest owners around the Baltic Sea experience climate change in their livelihoods. In Nordic conditions, the warming climate causes delayed winters and frosty days. Milder winters increase precipitation and discharge of nutrients from soils. Without climate change, the soil would be frozen for longer time, and excess runoff would be less frequent. Similarly, frosty days would be needed for restoring aggregated soil structure of erosion sensitive fine-textured farmlands, which can be compacted after field traffic of cultivation. Consequently, frosty winters are crucial for maintaining soil fertility, and keeping soil particles and nutrients on the ground, thus controlling eutrophication.

## Erosion sensitive clay soils on focus

In Finland, over 90 % of the phosphorus and nitrogen load occurs outside the growing season. Due to the increase of heavy rains and water saturated soil conditions this number is even higher. Particularly in the erosion sensitive clayey area in South-Western Finland, close to the Archipelago Sea, climate change complicates farming, agricultural water management, and water protection.

The primary cause of erosion is degradation of aggregate structure of clays, after prolonged water saturated conditions. Tiny soil particles disperse, and the crumbed structure is lost. Soil particles are transported by soil surface runoffs to rivers, and to the sea. Soil freezing would be essential, as it causes drying and strengthens stability of soil aggregates. Good soil aggregate structure, in turn, promotes good soil aeration and water availability, thus enhancing plant growth and nutrient uptake.

Thus, due to the climate warming, clay soils need special care and management for erosion and nutrient leakage control. The crop monoculture, and intensive tillage with bare soil conditions, cannot continue like past decades. Instead, we need to keep soil covered by crops all year round. Catch crops should be utilized together with spring-sown crops, or winter crops sown after harvested crop. Today, the minimum tillage is common, and many fields are left untilled before spring sowing. This may, however, challenge seedbed conditions for successful plant emergence and growth in the following season, thus risking nutrient uptake by crops.

## Grasses role increasing

35 years ago, my professor in soil science, late Dr. Reijo Heinonen ([www.slu.se](http://www.slu.se)) predicted that if climate warming eliminates frozen soil profiles, cultivated clay soils need to be transformed to grasslands. Otherwise the aggregated soil structure will not be maintained. In grasslands, the root growth would substitute the positive effect of freezing on soil aggregates, and the crop cover would control erosion, like on mountainous regions.

We have witnessed his prediction. Fortunately, the modern technology allows us to continue cropping along with additional soil improver crops, like deep rooting catch crops. To adapt climate

change, crop rotation by perennial grasses seems to be, however, an additional requirement.

The essential part of water protection and nutrient discharge control is biomass harvest, i.e., nutrient uptake from soil reservoirs, mobilized by microbes, or by fertilizers. The yield needs to be harvested and taken away. Otherwise we cause leakage of dissolved nutrients from decaying plants on the ground. Perennial grasslands take phosphorus up deeper from the soils by their roots. Thus, if above-ground biomass is not harvested, algae available dissolved phosphorus accumulates on soil surface, and risk of nutrient runoff is obvious.

## Markets for grass biomass needed

Harvested biomass needs markets. A big question of water protection is how to find those markets. Two options are animal feeds or biogas production. In the costal clayey area, there is not enough cattle to utilize grasses for valuable protein production. The sensible mix of cropping and livestock would be most beneficial for water protection.

Similarly, high yielding grasses are essential for carbon sequestration by soils, while thriving for climate neutral future and food. We need to diversify cropping and land use, but also utilize the potential of grass-based cattle farming, as described by [MTK-SLC Climate Roadmap for Agriculture](#).

## Willingness to act

Farmers and forest owners have strong a will to protect waters. This was well documented by the inquiry for MTK members, carried out in 2018 and 2020. These results, and all the efforts, challenges and opportunities are described in the new [MTK-SLC Water program](#): Towards a good status of waters - through 1) agricultural and forestry practices that reduce loads; 2) using cost-effective and well-targeted water protection solutions; 3) through catchment area-specific planning; 4) by applying more precise research data and by increasing know-how. ■



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KATARZYNA FIDLER

# Is Estonia's timber industry barking up the wrong tree?

Expert article • 2870

**T**he Siberian flying squirrel hardly ever touches the ground. Instead, these shy, wide-eyed rodents jump powerfully and glide up to 80 meters through the air from one tree to another. In this way they are able to cover fairly large ranges of territory. However, the fragmented forest landscape restricts their movements. Roads or larger clearances in the forest isolate the populations, pushing the European branch of this species towards extinction. Like many other Red-List species such as the black stork, the lesser spotted eagle, the honey buzzard or the grey-headed woodpecker, the flying squirrels require deciduous or mixed forests with trees over 65 years old, which provide more lodging and feeding opportunities than monoculture pine tree plantations. There are hundreds of endangered species living exclusively in old-growth forests, including many species listed in national and global Red Lists, and the annexes of the EU Birds and Habitat Directives.

The woodland key habitat (WKH) concept was designed in Sweden in the 1980s as a legal instrument for preserving old-growth forests and their biodiversity. The philosophy behind it is to conserve particularly valuable habitat patches amidst commercial forests according to legally predefined criteria. The concept has since been successfully exported to other northern Europe countries including Denmark, Norway, Finland, Latvia, Estonia and Lithuania. In Estonia, large-scale inventories of key woodland habitats were carried out during 1999-2002 and 2018-2020. In January 2021, the Environmental Register EELIS counted over 12.700 WKHs with a total area of 31.520 ha. In total, the area of old-growth forests in Estonia, which meet the WKH-criteria is estimated by experts at about 40.000 ha.

What is the price tag on these vulnerable animals and plants? Environmental economists demonstrate significant global and local economic benefits and human welfare impacts of natural ecosystems - and even larger damages due to their loss. For instance, the monetary value of the carbon capture in wood is 4,5 times larger than the monetary value of the wood itself (1.473 versus 323 Euros/ha respectively, as established by researchers from the Environmental Agency, University of Life Sciences and Tallinn University). However, since the methods used for monetizing even this one very tangible ecosystem service are not uniform, the common basis for decision-making remains the very matter-of-fact and quickly established price of a cubic meter of timber.

The forest harvesting pressure in Estonia, driven by the high demand for low-cost wood products for the Scandinavian market, has been rising steadily since 2007. Annual timber harvest has increased from 4,2 million cubic meters in 2006 up to 12,7 million in 2018. Although woodland key habitats constitute less than 2% of the Estonian forest area, the harvesting pressure does not make hold before their precious wildlife and recreational values. All cut areas are being reforested - argues the industry - however, the bark beetle susceptible pine trees will not replace the diversity and habitats lost

through cutting away an old-growth forest ecosystem.

The debate over the new Forestry Development Strategy 2020-2030, which attempted to further raise the target timber yields by means of less sustainable and outdated methods such as clear cuts, has polarized Estonian society. Fierce articles in major national newspapers were targeted at ecologists protecting old-growth forests and at environmental NGOs in general. The message: every hectare of forest under protection brings economic damage to Estonia.

As co-funder of the Estonian Woodland Key Habitats inventory project, the Baltic Sea Conservation Foundation has also been under attack from biased and badly researched journalism. These went as far as accusing the Foundation of representing the interests of the fossil energy giant Gazprom and therefore protecting forests to damage the, opposed as clean, timber industry. This odd conspiracy theory has gained some echo, for the hidden Russian agenda is an evergreen hotline in this part of Europe. Clarifying statements and articles followed, and their reception on social media showed that the popular opinion is predominantly on the side of nature protection. According to a recent study on environmental awareness conducted by the Ministry of Environment, 77% of Estonians are in favor of reduction of the current deforestation pace.

## For the record

The Baltic Sea Conservation Foundation (BaltCF) was created in 2014 as result of an out-of-court settlement between large German environmental NGOs and the Nord Stream AG to compensate adverse effects of the construction of the Nord Stream natural gas pipeline on the Baltic Sea ecosystem. Based on German charitable law, its starting capital of 25 million euros constituted a one-time non-refundable donation, which is since under the control of the Foundation. Not enough to produce an average Hollywood movie, but enough to work towards sustainably protecting natural coastal landscapes, boosting the quality of the region's rivers and wetlands and improving living conditions for endangered species such as the wild salmon, the harbor porpoise, the Baltic seals, many migrating birds and also the Siberian flying squirrel. ■



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MIKKO JOKINEN

# Is COVID-19 driven shutdown of Danish fur industries alarming signal for the Baltic Sea eutrophication?

Expert article • 2871

**N**utrient load into the Baltic Sea has slowly turned to decrease, thanks to many political and practical measures taken by EU and Baltic Sea states during the last three decades.

Despite of this positive development the state of the sea is still alarming. Annually more than 30 000 tons of anthropogenic phosphorus ends into the sea, increasing eutrophication and the risk of harmful algae blooming. Sustainable phosphorus inflow level into the Baltic sea is estimated to be at least 10 000 tons less than it receives today. Consequently, we have still a lot of work to do.

Beside the high phosphorus load the Sea faces another increasing problem: A strong decline in randomly incoming water pulses from the North Sea through the Danish straits into the Baltic Sea. During the last two decades pulses have strongly weakened and they are bringing less salted and oxygen rich water into the Baltic Sea compared to the time before 1990's. Reason for this is not yet fully understood. Present trend started soon after the construction of new bridges and other structures in the Danish straits were completed, which, together with the several consequences of the climate change, may (partly) explain the phenomenon.

Anyway, it is clear, that the biological productivity of the sea has increased due to the rising nutrient levels. This has led e.g., to growth of Baltic fish populations, and also such bird and mammal populations, who use fish stocks as a main food source.

## Commercial fishing removes nutrients from the sea

Main, and practically the only notable way to remove nutrients nowadays from the Baltic ecosystem is commercial fishing of cod, herring, and sprat. In some coastal areas seals and a few fish-eating seabirds play an important role as fish stock utilizers, but they do not remove phosphorus and nitrogen from the sea. Great cormorant is the only exception. It breeds in big colonies and when they locate on non-rocky islands, main part of the nutrients in their excrement will storage into the soil of island. Big breeding colony can remove hundreds of kilos of phosphorus and nitrogen from the water ecosystem every year. This positive effect is not normally recognized, because extra nitrogen is at the same time killing nesting trees and making the colony islands appear unaesthetic.

Commercial catch of herring and sprat has been at high level during the latest years compared to time in the beginning of the millennium. Cod populations have been reverted. They are suffering of heavy fishing pressure and poor reproduction mainly due to lower salinity in the Baltic Proper. Sprat is the main food for cod in the pelagic Baltic ecosystem, so decreasing cod numbers have allowed sprat populations to grow.

Total Baltic Sea fish catch was 760 000 tons in 2018. Among the fish some 3 500 tons of the phosphorus was removed from the sea. This is remarkable amount and important for the nutrient cycling in the Baltic ecosystem. However, it corresponds only some 10 % of the annual inflow of phosphorus into the sea, so we are still far from the sustainable nutrient balance of the Baltic Sea ecosystem.

Most of the commercial catch is used as animal food. Fur industries is the main end user, fish farming the second. For instance, in Finland annual catch of 2018 was 138 000 tons, mainly herring and sprat. 95 % out of that was used as forage in fur farms, only 3% was used as human food. Part of the catch was taken to Denmark for mink food there.

Denmark has been the most important fur industry country at the Baltic Sea Region (BSR) with more than 17 million minks (compared to 1 million in Finland) still in 2020. One mink use some 60 kg of forage during its lifespan. This means that Danish minks alone eat annually more forage than the whole Baltic Sea commercial fish catch at the same time. Herring and sprat are important part of mink food and Danes have been biggest utilizer of fish forage in the BSR area, even though main part of their mink food is coming from the North Sea or Atlantic. There is a small scale fur industry also in other Baltic states, and the industry has even been growing in Poland, when Dutch and Danish companies have moved their production to Poland.

When a new form of COVID19 was found at Danish mink farms last autumn, Danish government took a quick decision to kill all minks and close all the mink farms immediately. Forage consumption of those animals has been at the level of 1 million ton a year. This means, that there will be big changes in feed fish demand in the BSR from 2021 onwards.

This rises a serious question. What will happen to the Baltic fishing and fish industry? If mink farms in Finland, Poland and other Baltic countries will share the destiny of Denmark, there will be a remarkable crash in the demand of Baltic herring and sprat. Unfortunately COVID19 is not the only threat for fur industry. Public opinion in many countries is increasingly against fur farming. This may already in near future lead to a total ban of fur farms with heavy consequences for the Baltic fishing industry as well.

Is the fish industry prepared for that kind of challenges? Can they find alternative ways to utilize sprat and herring? It is obvious, that when the demand of fish will decline also the price of the fish will decline. Consequently, it is challenging to find alternatives. Fish oil and fish flour industries are still small at BSR, they might have possibility to increase their capacity, but is it economically feasible?

Already 10 % decrease in fishing intensity would mean 350 tons more phosphorus staying in the Baltic ecosystem. Much effort is

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needed elsewhere to replace this cap and keep BSR on right track in nutrient management.

**Epilogue**

A full-length mink coat contains 40 mink pelts and represents 2,5 tons of fed, including at least 10 kg of phosphorus. It is a bit confusing to think, that mink coat wearing ladies in Asia and elsewhere are important end users in the Baltic Sea nutrient cycle. Nowadays some 5 million minks used for the women's clothing annually are fed by the Baltic fish and remove more than 1000 tons of phosphorus from the Baltic Sea. ■

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JUKKA MEHTONEN

# Better management of hazardous chemicals

Expert article • 2872

Society benefits from using chemicals while aiming to minimize risks to the environment and human health. Chemicals are widely used in everyday life and many economic sectors such as agriculture, manufacture of consumer products and energy production depend on chemicals.

The EU has advanced but complex chemicals legislation, which has generated the most comprehensive knowledge base on chemicals in the world. The EU has approximately 40 legislative instruments addressing amongst all the safety of toys, cosmetics, biocides, plant protection products, food, carcinogens in the workplace as well as environmental protection. The EU has also managed to reduce the risks to humans and environment for certain hazardous chemicals like carcinogens.

One of the main legislations on chemicals is the **Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)**, which aims at the safe use and handling of substances and mixtures on the European market. After a rather slow beginning, REACH has speeded up the assessment and restrictions of the hazardous chemicals in the EU. **Water Framework Directive (WFD)** was established to protect inland surface waters, coastal waters and groundwater. The Fitness Check published in December 2019 concluded that WFD is broadly fit for purpose, but problems related to e.g. very slow process of revision of the list of WFD priority substances must be solved.

The production and use of chemicals are expected to increase in the future. Consequently, the total chemical burden on humans and to environment is likely to increase. The current single substance approach is not fit for assessing and managing the risks of the large number of chemicals on the European market. A shift towards tackling chemical groups rather than single substances would accelerate the risk management. Thus, EU's chemicals policy needs to be further strengthened.

The European Commission adopted the **EU Chemicals Strategy for Sustainability (CSS)** in October 2020. It is part of the **EU's zero pollution ambition**, which is a key chemical commitment of the **European Green Deal**. The Strategy will boost innovation for safe and sustainable use of chemicals and increase protection of human health and environment against hazardous chemicals. This includes for instance prohibiting the use of the most harmful chemicals in consumer products as well as managing risks of chemical mixtures and groups. The Strategy also draws the attention of Member States to the possibilities of the Recovery and Resilience Facility to invest in the green transition of EU industries, including the chemical sector.

On the EU level the main instrument to control industrial releases is the **Industrial Emissions Directive (IED)**, particularly through the sector specific BAT Reference documents (BREFs) and their key chapter "BAT conclusions". The BAT conclusions are the reference and legally binding for setting the environment permit conditions

for industry in all EU member states. However, BAT conclusions in most cases do not address hazardous substances comprehensively. HAZBREF project has developed a systematic approach that will help to utilize the existing information on chemicals between different regulatory frameworks such as IED, REACH and WFD in the preparation of BREFs.

The HAZBREF proposes not only general measures for improvement of information exchange but also to focus on what is to be improved, by which means and how in practice hazardous chemicals should be addressed in BREFs. In order to improve consideration of chemicals in BREFs and respectively in industrial environment permits it is crucially important to break down the silos between environmental and chemical authorities both at national and EU level. Additionally, we have to change work practices and co-operate more with each other. These changes are absolutely needed, and it is very delightful that the first positive signs for improved cooperation on EU level are already seen. The overall aim is to streamline and rationalize the work under the complex EU chemicals legislation both at national and EU administrative level. The intention is not to increase EU legislation but to enhance the implementation of current legislation.

The ongoing IED review provides a possibility to strengthen the BREFs with the proposals by HAZBREF concerning chemical management. The recent positive initiatives on EU level for better management of chemicals, such as the CSS and Zero pollution ambition can be seen as an opportunity for the EU to be a forerunner and a competitive player on global level in the production and use of safe and sustainable chemicals.

More information is available from reports of **HAZBREF project (Hazardous industrial chemicals in the IED BREFs)**; funded by EU Interreg BSR Programme 2014-20) found on project website. ■

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NOORA PERKOLA

# Reducing pharmaceutical emissions to Baltic Sea

Expert article • 2873

**P**harmaceutical residues are a risk to the environment and the need to manage their emissions is evident. At the same time, ageing population and medicalisation increase the consumption and consequently the emissions of pharmaceuticals. The European Union has recognized the situation in its Pharmaceutical Strategy and the Strategic Approach to Pharmaceuticals in the Environment.

The active ingredients of pharmaceuticals are a wide and complex group of substances. Decreasing their emissions requires a combination of different measures. As pharmaceuticals are vital to human health, their prescriptions are rarely, if ever, driven by environmental aspects. Unlike many other chemicals, we cannot ban the use of pharmaceuticals based on their toxicity to the environment – in contrary, toxicity is what makes many pharmaceuticals like antibiotics and cytostatic drugs effective. However, we can affect the spreading of pharmaceuticals in the environment.

Since 2017 we – researchers in 15 organizations from seven countries around the Baltic Sea – have worked together to identify the most problematic pharmaceutical compounds and the best ways to decrease their emissions to the environment. Our common project CWPPharma was funded by the EU's Interreg Baltic Sea Region Programme.

Before our project, pharmaceutical residues had been detected in wastewaters and surface waters in the Baltic Sea region, an opioid codeine even in fish. Still, there were many data gaps. For example, no data was available on some highly consumed pharmaceuticals and veterinary medicines. In CWPPharma, we filled in many of the data gaps by compiling consumption data and analysing up to 75 pharmaceuticals in six case study areas. Twelve were identified as risk substances as their environmental concentrations in the environment exceeded what is considered safe. The most efficient ways to decrease their emissions are improvements in wastewater treatment and waste management, and more prudent use of pharmaceuticals.

One of the most effective ways to decrease the emissions is enhancing wastewater treatment. From human consumption, pharmaceutical residues end up to sewers and wastewater treatment plants. The same plants also collect sewage from emission hot spots like hospitals and other healthcare facilities. Typical wastewater treatment works well for some pharmaceuticals, but others are not removed sufficiently to avoid risks to the environment. For instance, the emissions of environmentally problematic painkiller diclofenac could be decreased by up to 71%, if ozonation or activated carbon were applied in every large and medium size wastewater treatment plant. It is noteworthy that while advanced treatment processes increase the costs and greenhouse gas emissions of wastewater management, the very same techniques remove numerous other contaminants in addition to pharmaceuticals.

On the other hand, as conventional wastewater treatment can remove certain pharmaceuticals, their emissions could be decreased

by expanding the sewage network coverage and implementing the requirements of the EU's Urban Wastewater Treatment Plant Directive. In the Baltic Sea catchment area, expanding the sewage network would be an especially effective measure in countries like Russia and Ukraine where its coverage is still low.

Minimizing pharmaceutical waste and proper treatment of the waste are considered low-hanging fruits in decreasing emissions. Handling of pharmaceutical waste differs greatly in the Baltic Sea coastal countries, and some countries still lack proper collection and disposal practices. One of the main reasons for improper disposal of medicine waste is simply the lack of knowledge. Some people flush medicines down the toilet as they do not know how pharmaceutical waste should be disposed of. Even less they know about the consequences of improper disposal. To avoid pharmaceutical waste ending up in the environment, not only better practices but also information campaigns are needed.

An environmentally and economically beneficial development would be decreasing the consumption of pharmaceuticals as it directly decreases the emissions. It is obvious that illnesses must be treated. But some of the environmentally troublesome pharmaceuticals can be replaced with pharmacologically similar but less problematic ones, and unnecessary medication can and should be avoided. With these two changes the emissions of certain pharmaceuticals could be decreased as much as with improved wastewater treatment.

End-of-pipe measures like advanced wastewater treatment are sometimes criticised, but in this case, they are highly justified. However, end-of-pipe measures alone cannot solve this problem. Pharmaceutical emissions must be managed throughout the pharmaceutical lifecycle, from design and production to waste management. ■

*Information about efficient actions targeting various stages of the pharmaceutical lifecycle can be found on the project website ([cwpharma.fi/en-US](http://cwpharma.fi/en-US)).*

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JORMA KÄMÄRÄINEN

# IMO regulations and winter navigation

Expert article • 2874

IMO – the International Maritime Organization – is the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. The most important IMO convention related to prevention of pollution of the marine environment by ships is the MARPOL Convention, which contains regulations for the control of pollution by oil, noxious liquid substances, sewage, garbage and emissions to the air. In order to improve the energy efficiency of ships and stimulate innovation in energy efficiency, the regulations based on the Energy Efficiency Design Index (EEDI) for new ships adopted by IMO as part of MARPOL Annex VI in 2011 entered into force on 1 January 2013. The EEDI value for a ship (the 'attained EEDI') is defined as an efficiency index, i.e. the ratio of the amount of CO<sub>2</sub> emitted per unit of work done for the society. The work done is defined for cargo ships as the ship deadweight times the ship speed.

Currently, IMO is planning to have new regulations for energy efficiency of existing ships in order to further reduce CO<sub>2</sub> emissions from shipping. IMO has agreed to impose regulations similar to the EEDI regulations to existing ships (Energy Efficiency Existing Ship Index, EEXI) and, in addition, new regulations on operational energy efficiency would also be applied to ships in order to reduce the carbon intensity of international shipping.

The most important short-term measure to reduce CO<sub>2</sub> emissions and energy efficiency from new and existing ships is to reduce their speed, which will require reduction of their maximum engine power. When new regulations are developed, it is important that certain minimum engine power level is maintained in order to secure safe operation of ships in adverse weather conditions. This is taken into account by developing guidelines for minimum engine power for ships for EEDI and EEXI regulations.

In addition to safety issues, it is important to guarantee level playing field in shipping, when new regulations for shipping are developed. In EEDI and EEXI regulations this is taken into account by adopting ship type and size specific regulations for ships, because different ship types have their specific design requirements and, generally, big ships have better attained EEDI and EEXI values than small ships. It is also important that specific design requirements of ships designed to carry special cargoes or operating in special environmental conditions are taken into account. Ships designed to sail safely in ice conditions, i.e. ice-classed ships, is a good example of the latter case. Many ports in the northern Baltic Sea area are ice covered in winter and therefore ships sailing regularly in this area have an ice class. Fuel consumption and CO<sub>2</sub> emissions of ice-classed ships are higher than those of ships designed for sailing in open water only. The main reason for the higher fuel consumption is that the hull form and the propeller of ice-classed ships are less optimal for the operation in open water, as they must be strengthened for the operation in ice conditions. In addition to the increased fuel consumption in open water, ice-classed ships consume also much more fuel when sailing in ice covered waters

compared to sailing in the same area in open water conditions. Due to higher lightweight caused by ice strengthening of the hull of the ship, ice-classed ships have a smaller deadweight, compared to their displacement than ships of a similar displacement designed for sailing in open water only, which has an impact on the attained EEDI and EEXI.

In order to ensure a level playing field between ice-classed ships and ships designed to sail only in open water conditions, the higher fuel consumption and the special technical design requirements for ice-classed ships have been compensated in the EEDI regulations by adopting three correction factors for ice-class ships for calculation of the attained EEDI. These correction factors allow installation of more engine power for ships belonging to certain ship types than for ships without an ice class and they also take into account the special design requirements of ice-classed ships. It is anticipated that the special design requirements of ice-classed ships and higher fuel consumption when sailing in ice conditions would also be taken into account for calculation of the attained EEXI and in the new regulations on operational energy efficiency in order to ensure the level playing field between ice-classed ships and ships not having an ice class.

More and more regulations are adopted for international shipping by IMO. It is very important that the balance between safety of shipping and environmental regulations is maintained as well as the level playing field between ice-classed ships and ships designed to sail only in open water conditions, when new regulations are developed.

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JOACIM JOHANNESSON

# Baltic Sea regional cooperation for better maritime spatial planning

Expert article • 2875

All EU member countries in the Baltic Sea region are expected to have maritime spatial plans in place later this year. For most countries it will be for the first time. In Russia preparatory work for the introduction of maritime spatial planning, is being carried out. Apart from huge national efforts to achieve this, there has been extensive Baltic Sea regional cooperation in the last ten years to support the introduction of maritime spatial planning, MSP.

MSP is a national responsibility, but countries in the Baltic Sea region have jointly developed guidelines, methods and planning evidence to support the development of MSP and plans in the region. This has been done with guidance from a regional roadmap on establishing maritime spatial planning in the Baltic Sea region and an EU MSP-directive.

MSP is a fairly recent addition in the marine governance framework around the world. Legislation differs between countries due to different planning traditions and systems. Some countries' maritime spatial planning is detailed and binding in nature, while others' are more at a strategic and guiding level. In general, the introduction of MSP means a shift from traditional sector planning to a more holistic and cross-sectoral planning and management approach. MSP is about thinking ahead, having a coordinated perspective and deciding how to use the sea space sustainably to reach societal goals. With support from MSP we want to generate economic and social development while at the same time protect and restore the marine ecosystems. The EU MSP-directive specifically requires that the EU countries shall consider economic, social and environmental aspects to support sustainable development and growth in the maritime sector, applying an ecosystem-based approach, and to promote the coexistence of relevant activities and uses.

The Baltic Sea, shared by nine countries, is a sea of vast economic and social opportunities, but also a number of environmental challenges. The Baltic Sea produces valuable ecosystem services such as fish and recreational experiences. It is also very important for trade, accounting for about 15 percent of the world's sea transport of goods. However, the environmental pressure is high and the biodiversity is still threatened.

At the same time there are shared goals for the Baltic Sea region. For the EU countries specifically, there is the EU Baltic Sea Region Strategy with the three overarching objectives to save the sea, connect regions and increase prosperity. In addition, there are number of sectoral objectives to be supported by MSP. One example is achieving good environmental status. In September 2020 the EU-countries also agreed on a joint declaration for the development of off-shore wind in the Baltic Sea.

The Baltic Sea region has been a frontrunner in regional transboundary cooperation on MSP. A regional framework for MSP have been developed. Already in 2010 a joint co-chaired Working Group on Maritime Spatial Planning was launched by HELCOM

and the Vision and Strategies around the Baltic Sea (VASAB). The Working Group was established to ensure cooperation among the Baltic Sea Region countries for coherent regional MSP-processes in the Baltic Sea. In 2010 both organisations also adopted the Baltic Sea broad scale maritime spatial planning principles and in 2013/2014 they adopted a roadmap for MSP in the Baltic Sea region (2013-2020) with the aim to draw up and apply maritime spatial plans throughout the region. As part of the roadmap, regional guidance have been developed and adopted on the application of the ecosystem approach in MSP as well as on transboundary consultation and participation. A new roadmap is currently being developed as part of the process of updating of the HELCOM Baltic Sea Action Plan.

In parallel, a number of regional MSP-projects co-financed by the EU, have been implemented. The projects have supported transboundary cooperation, development of planning methodology and tools as well as of joint planning evidence. Most MSP planning authorities around the Baltic Sea have participated. Many of the project recommendations have been taken up by the HELCOM-VASAB MSP working group and have in that way reached the more formal cooperation within the Baltic Sea region.

In this decade-long process we have experienced the benefits of joint-learning in developing maritime spatial planning in the Baltic Sea region. Our extensive cooperation have led to better understanding of each other's planning and circumstances. Our methods and planning evidence have been refined. Also, there is now more likelihood for functional coherence between the countries' maritime spatial plans. The cooperation has in the end helped us to get better planning and better plans. MSP has in turn contributed to advancing the marine management by providing new ways of thinking and methods on how to address marine and maritime challenges now and in the future. And strengthened and broadened the regional cooperation. ■

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# Maritime governance and shipping

Expert article • 2876

Leading several projects on maritime governance and clean shipping for more than ten years has given me a wide peek on how tightening environmental regulation shapes the future of the maritime sector as an integral part of the maritime governance. Much has happened during that time in the attitudes of shipping sector towards environmental regulation. It is an excellent example of a case showing that when there is a will there is a way. Sometimes the will has to come from above in the form of a regulation, however. In early days, attitudes in the shipping sector towards environmental protection was that it was something extra, not our business and something that simply can never be afforded as it does not directly pay off. Now many have realized that environmental investments indeed are in the core of the business. How the turntables, currently we are in the situation that most of the forthcoming regulation on shipping is coming from environmental side.

Recently maritime governance has been gaining more weight and visibility in the public eye. Both maritime spatial planning process and launching the term blue growth for maritime businesses have contributed to this. The future of us all depends on successful maritime governance because seas and oceans provide so much for the humankind. We cannot lose their ecosystem services without endangering our own survival. One definition for the maritime governance is that it is a dynamic process consisting of interdependent areas of legal regulations, blue economy, security and environmental elements. From this definition, I would raise the word dynamic as being of key importance. For decisions to be knowledge-based, we need to be able to act and adapt the regulations in accordance with new knowledge on their effects.

Nowadays shipping and maritime industry are more integrated in the general maritime governance than earlier when they were seen more as an entity of their own, at least mentally. This is true especially here in the Baltic Sea Region where we have environmentally aware maritime sector and high technological and management skills. We can safely say that Baltic Sea Region is a forerunner in clean shipping, however including Norway in the Baltic Sea Region is wise as Norway is investing heavily in it. Luckily we can continue the existing good collaboration with Norway and other countries in the Baltic Sea Region.

The Sulphur regulation has been a test bed and a game changer in the environmental attitudes of the shipping sector, and many of us have learned a lot during the process. Sulphur regulation was criticized heavily before coming into force especially from the economic point of view. There were also some scary views on paper and metal industries leaving for instance Finland due to elevated freight rates. However, after it came into force its effects of the logistics costs on Finnish firms have been calculated to be very small and not a cause to relocate industries. The paper industries are in problems due to many other reasons, though. It was a success in improving our air quality and thus saving lives and decreasing the number of sick days. The effects on environment, namely acidification are also relevant, although the regulation is mainly targeting human health.

Complying with Sulphur regulations has induced several innovations and BSR have been successful in offering solutions. What is worrisome, though, are that some of the solutions provided to

tackle Sulphur regulations do not perform well in other respects. The information of the effects of the so called "Frankenstein-fuel" (i.e. Very Low Sulphur Fuel Oil, VLSFO) is still scarce but it may be destroying the ship engines and be very toxic to nature if leaked. Open-loop scrubbers transform the air emissions to water emissions and this is very problematic. Using Liquefied Natural Gas (methane) as fuel has many benefits but methane slip is a serious problem as it is a powerful greenhouse gas. Fixing these kind of unprecedented problems with novel regulation is an example where adaptive governance is part of the answer. Currently the process is very slow.

Adaptive maritime governance is also of essence when larger and larger sea areas are taken in human use. It is possible that building large facilities in the sea, i.e. wind parks, fish farms and platforms start to have cascading effects on the ecosystem by changing it in profound ways. The long-term environmental data sets of the Baltic Sea can reveal unprecedented effects and help in predicting the future. Not all effects are negative; however, for instance offshore structures will provide marine organisms with new hard substrate for colonization, thus acting as artificial reefs. The attitude towards environmental incentives are changing; the forward-looking people see welfare effects, business-opportunities and humans as part of the natural environment. ■

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VALTTERI LAINE &amp; JOUNI LAPPALAINEN

# Risk management in maritime transport in the Baltic Sea demands committed regional cooperation

Expert article • 2877

**M**aritime transport services are essential for the Baltic Sea region, but they are also a source of risk to human life, the marine environment and coastal ecosystem services. Almost 300 accidents occur in this sea area per year, ranging from ship-to-ship collisions to machinery damage incidents. Some four per cent of these accidents have had serious consequences, including loss of human life, environmental damage or total loss of the ships involved. Among such severe events, the most well-known is the sinking of the passenger ship Estonia in 1994, which led to 852 casualties. Continuous risk management efforts and cooperation are thus required in order to prevent future maritime accidents and minimize their consequences.

Risk management in maritime transport is a complex and dynamic area involving a vast number of different tasks and organizations. The International Maritime Organization (IMO) defines the general legal requirements for this framework. This includes tasks focusing on maritime accident prevention, onboard damage control, and different types of response operations, as well as the definition of responsibilities for public and private organizations to perform these tasks. Since many of the risk management tasks can be difficult to carry out in various scenarios, public and private organizations have established national and international cooperation agreements and procedures to develop their execution. However, there is still room for improvement in this field, including in the Baltic Sea region. This fact is evident in light of the associated accident, Port State Control and near-miss statistics.

To support maritime risk management and the technological development of the shipping industry in the countries bordering this sea area, the European Council decided to include maritime safety and security policy (PA Safe) into the EU Strategy for the Baltic Sea Region (EUSBSR). Following discussions with the European Commission, it was considered necessary to address these topics in order to achieve the overall objectives of the strategy, namely "save the sea", "connect the region" and "increase prosperity". As a result, the PA Safe was established in 2009, and has since become one of the key policy areas of the EUSBSR. Throughout its history, the policy area has been very active and contributed to the key objectives of this EU strategy.

The actual work in the PA Safe is mainly carried out through a project-based policy dialogue. In other words, the Steering Committee of the policy area holds regular meetings across the EU countries of the Baltic Sea region. The aim of these meetings is to identify gaps in the PA Safe work and to set up new project initiatives to close them. In addition, they are used to facilitate discussions, disseminate project results and streamline the work to better meet the objectives of the EUSBSR. The Policy Area Coordinators from the Danish Maritime Authority (DMA) and Finnish Transport and Communications Agency (Traficom) are responsible for organizing the meetings and support the everyday work of the PA Safe. The practical work on this policy

area has been ongoing for more than a decade, during which time it has reached a high degree of maturity.

The main tools used in the context of the PA Safe work are flagship projects and other projects pertaining to maritime safety and security issues. In the Baltic Sea region the projects have, for example, provided real-world tests for e-navigation services and resurveys of the major shipping routes and ports as well as helped reinforce emergency preparedness. Project results are often used to support the activities of various public and private maritime organizations or as the basis for high-level policy recommendations. In financial terms, PA Safe-based projects are typically carried out through the EU funding instruments and project partner investments. While this process has thus far been relatively smooth, many stakeholders have become concerned about the future in light of Covid-19 and Brexit.

To face the current challenges, support the implementation of the EU Baltic Sea Strategy and boost the work done in the various policy areas, the European Commission will adopt a new EUSBSR action plan in the beginning of 2021. The purpose of this revised version is to engage the Member States and the private sector more closely in the implementation of the strategy, while stressing the global challenges, namely climate change, pandemics, demographic changes and migration. In the context of the PA Safe, the revised action plan focuses particularly on improving the safety of open sea and winter navigation, developing maritime digitalization and automation, and enhancing preparedness and response activities. To promote these action items and the EUSBSR as a whole, new innovative projects and cooperation are needed across the Baltic Sea countries. This cooperation should involve both public and private organizations with a strong common will to contribute to the safety, security and environmental sustainability of our unique sea area. ■



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*Valtteri Laine on the right and Jouni Lappalainen on the left in the photo.*

RAMI METSÄPELTO

# Safe and smoothly running maritime transport requires a shared digital situational awareness

Expert article • 2878

Shipping is undergoing a major change where megatrends, particularly those related to climate change and digitalisation, are becoming intertwined and fuelling developments in the sector. Finland's shipping and the entire surrounding logistics system are now facing the substantial challenge of finding more comprehensive and more effective solutions for finding a balance between sustainable development on the one hand and financial viability and competitiveness on the other. One avenue being explored for answers is digitalisation and the creating of a shared situational awareness. The volume of data in this area is expected to escalate sharply in the near future.

Through international collaboration and constant advancements in digitalisation and automation, our sector is making significant progress in attaining environmental goals and also in making maritime transport safer and smoother.

## International collaboration towards shared goals

The Baltic Sea is one of the busiest sea areas in the world, with an average of 2,000 commercial vessels either en route or in port at any given time. Maritime traffic in the Baltic Sea requires increasingly close cooperation in order to run smoothly. Indeed, international collaboration around the Baltic Sea is crucial for ensuring safer and smoother passage for shipping. Close international collaboration leveraging high-quality, innovative maritime expertise can enhance the competitiveness of the sector and contribute to smoother, safer and more environmentally friendly shipping.

Finland is actively involved in developing digitalisation and automation in the shipping industry through the International Maritime Organization (IMO) and several EU forums, which aim to boost the competitiveness of shipping through various technological solutions. Risks in shipping have been systematically reduced through regional cooperation, international action being an efficient means of supervising safety at sea. A case in point is the mandatory ship reporting system in the Gulf of Finland (GOFREP) jointly set up by Finland, Estonia and Russia.

## Shipping automation requires enhanced information exchange

New technological solutions for shipping, such as functions for the remote control of vessels and testing of autonomous ships, are examples of the opportunities that emerging technologies bring for securing the competitiveness of the maritime industry. New types of information exchange and information needs, which maritime machine learning and, ultimately, artificial intelligence will need to function, also call for new common practices for the flow and transmission of information.

Fintraffic VTS is responsible for facilitating navigation in Finland's coastal waters. This involves the efficient use of automation, digitalisation and data. The role of Fintraffic VTS as a national provider

of vessel traffic services and situational awareness at sea, and in ensuring the safety of shipping, has come to include the providing of digital information services.

Fintraffic VTS has started to build a new digital situational awareness and information exchange service for maritime traffic with the eVäylä development project. The purpose of eVäylä is to develop a more comprehensive situational awareness to meet the needs of maritime transport arising from increased automation. The project objective is to enable effective, real-time flow of data between vessels, ports and port operators in order to improve the safety, flow and efficiency of maritime traffic in the coming years, as well as creating a link between maritime transport and other modes of transport.

eVäylä is one of the major digitalisation projects that will ensure efficient and secure electronic exchange of information between the various maritime transport operators. Real-time confirmed situational awareness at sea and information from sensors support operators of remote control and automation, and the distribution service for the arrival and departure times of vessels supports port operators. Essentially, the reform concerns information exchange among port operators as a whole, the aim being to create a platform for the digital management of evolving vessel traffic while creating the required information exchange interfaces between the Vessel Traffic Service and shore-based pilotage.

Digitalisation and various degrees of automation are strongly making their way into maritime traffic in Finland. Increased vessel automation will require increasingly comprehensive capabilities for monitoring the environment. Keeping shipping safe and smooth requires continuous exchange of information and consistent situational awareness. Ultimately, the aim of all this is to help the Baltic Sea retain its status as one of the most competitive regions in the world where transport is safe and smooth. ■

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IDA-MAJA HASSELLÖV

# Increased environmental pressure from ships

Expert article • 2879

In the transition to sustainable transport, following the EU white paper (2011), the ambition is to reduce climate impact by 60% by 2050 and at the same time cope with increasing transport demands. One cornerstone of the proposed solutions is to encourage a shift from road-based transport to rail and, in further extent, shipping. However, the assumptions that shipping is always a climate and environmental friendlier mode of transport is not correct. If the environmental impact from shipping on the marine environment is also taken into account, there is an obvious, but overlooked, goal conflict between transport strategies and environmental consideration. This is particularly pronounced in the Baltic Sea, where the HELCOM Second Holistic Assessment of the Ecosystem Health of the Baltic Sea concludes that Good Environmental Status with respect to eutrophication and hazardous substances respectively, are not in sight in most parts of the Baltic Sea. Hence, any additional ship operating in the Baltic Sea, or any additional distance travelled by the existing fleet, will actually be a step in the wrong direction, increasing the environmental pressure from ships on the vulnerable marine environment.

Ships can be compared with floating industries that during operation are giving rise to several different sources of stressors identified in the EU Marine Strategy Framework Directive (MSFD); e.g. contaminants, nutrients, acidifying substances, non-indigenous species, energy pollution including noise. If briefly going through the different on-board systems that contributes to the pressure on the marine environment, most ships are painted with toxic antifouling paints to prevent marine growth on the hull and minimize the ships resistance when moving through water. Thereby the fuel consumption is reduced, which of course is also good for the environment, but in the Baltic Sea the leakage of copper from anti-fouling paints is estimated to be more than 280 tons annually. This can be compared to all other natural and anthropogenic waterborne inputs of 890 tons. Still clean ship hulls are also important from another perspective; spreading of non-indigenous species transported on hulls, and ballast water make shipping a major vector for this severe threat to marine ecosystems and the natural biodiversity. Black water or sewage, and grey water from sinks, shower, laundry and kitchen are mixtures of organic matter, nutrients and cleaning agents. Tank water may contain residuals of whatever has been transported in the tanks, however there are some required prewash for the most toxic substances, which are left in port. Analogously to the strive to reduce hull growth it is important to eliminate growth inside the cooling system, why often toxic metals are released in the cooling water. Bilge water is also a mixture, primarily condense water from the engine room, with cleaning agents and residuals of fuel oil and lubricants. Most ships use oil for propeller shaft lubrication, which can imply a constant leakage of these oils that often are more toxic than fuel oils. From the atmosphere, we also have indirect deposition of especially nitrogen and sulphur oxides, along with particulate matter. Following the stricter regulation of maximum allowed sulphur content in marine fuels, an increasing number of ships have installed an exhaust gas cleaning system, also know a scrubber. In the scrubber the ship exhausts are led through a fine spray of water that reduce the emissions of acidifying sulphur oxides to the atmosphere. Unfortunately, also other pollutants are washed

out and the scrubber water is a potent mixture and in the simplest form, open-loop scrubbers, large volumes (typically 500m<sup>3</sup>h<sup>-1</sup>) of heavily polluted water are immediately discharged back to the sea. In 2018 there were 99 ships equipped with scrubbers operating in the Baltic Sea. These ships constituted less than 2% of the total number of ships operating in the area during that year, yet the ships with scrubbers caused 10-100 fold the loads of metals and polycyclic aromatic hydrocarbons to the Baltic Sea, compared with the load from all other onboard liquid waste streams from all other ships. Still it is allowed to run open-loop scrubbers in this sensitive brackish inland sea.

Most of these onboard systems are regulated individually, primarily through the International Convention for the Prevention of Pollution from Ships (MARPOL) by the International Maritime Organization. However, from an environmental management perspective, many of the subsystems contain the same sort of stressors included in the MSFD descriptors, but they are not assessed in a holistic way by the shipping regulations. The ships' compliance to the regulatory frameworks is assessed within the Port State Control system, in Europe through the Paris Memorandum of understanding that produce black-, grey- and white listing of ships and flag states depending on the ships' performance. If looking at the number of reported deficiencies as a proxy for potential environmental pressure, the ships on the black lists certainly pose a risk to the marine environment, having the highest average number of reported deficiencies per ship. However, if looking at the total number of reported deficiencies among ships operating in the Baltic Sea it is the much larger number of ships from white listed countries that together pose the potential highest pressure on the marine environment.

To conclude, if fulfilling the shift from land-based transport to shipping, it is important to realize that the pressure on the marine environment will increase if more ships operates, or the existing fleet travels additional distances, in the Baltic Sea. It is essential to make a holistic review of the impact of shipping on the marine environment to prevent further deterioration of the Baltic Sea due to uninformed decisions. ■

This article is based on the author's findings published in the following fora:

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HENRIK RINGBOM

# Why are we so timid on ship-source pollution?

Expert article • 2880

One of the most often repeated mantras in shipping is that a global industry needs global rules. But is it really true? Is there some sort of natural law making global rules always more effective in shipping, just because ships move from one area to another? Could it not be that regional requirements would sometimes be more effective to deal with regional problems in specific areas, such as the Baltic Sea?

Of course, global rules of worldwide applicability is usually the ideal solution for ensuring both awareness and implementation of maritime requirements. The International Maritime Organization (IMO) has mostly provided appropriate regulatory responses to key environmental threats posed by ships (the most notable exception, so far, being greenhouse gases, but that is a different matter). IMO pollution rules at times acknowledge regional differences and the main global environmental convention for shipping (the MARPOL Convention) accepts tighter requirements in 'special areas', such as the Baltic Sea, in several instances, including oil discharges and air emissions (emission control areas).

But what if that does not work? If the global reaction is lacking or entirely insufficient in terms of the protection needs of a given region, should one still insist on the need for global rules and refrain from implementing any requirements until a global consensus is reached?

A good example could be eutrophication, which is commonly regarded as the main environmental threat to the Baltic Sea. Yet it is not a big threat to the marine environment worldwide, or even in the EU, and the problems may therefore not be well understood, neither by mariners nor by regulators. Despite decades of activities at IMO by the Baltic Sea states, global shipping rules contain few standards aimed at curbing eutrophication. The original MARPOL Annex IV on sewage discharges took several decades to enter into force; the revised one in force now permits discharges of sewage if done slowly and at some distance from shore. The stricter standards for the Baltic Sea agreed in 2011 are only now becoming applicable, but only for passenger ships. Rules for grey water, which includes significant amounts of nutrients, do not exist at all, while food waste is permissible to discharge, if comminuted or ground, 12 nautical miles from nearest land.

Yet, the Baltic Sea states have not decided to take the matter in their own hands by introducing supplementary national or regional rules to stop this kind of additional nutrition load from being introduced in the Baltic Sea from ships. The question is why?

There are some objections that are commonly raised when "unilateral" rules in shipping are discussed. A first one is that regional rules will negatively affect the competitiveness of the region's own shipping operators. However, that is only true if the rule targets the nationality, or flag, of ships. As far as environmental (or safety) rules are concerned, there is normally no reason to target certain flags only, as flag changes are notoriously easy to make in shipping. Such rules, therefore, should apply to all ships operating in the region, irrespective of flag.

Second, it is a common objection, and misunderstanding, that international law prevents states or regions from imposing their own environmental requirements rules on international shipping. To begin with, express law of the sea limitations in this regard only concern national rules targeting ships that are merely passing through the coastal waters of the regulating state (without stopping in one of its ports). In the case of pollution standards, not even that is entirely true, given that all states have a right to implement their national pollution and discharge requirements in their territorial sea, as long as those requirements do not have the practical effect of denying ships their right of (innocent) passage. More importantly, there are no corresponding limitations for states to impose requirements on ships that enter their internal waters or ports. In the absence of rules to the contrary, port states can thus make compliance with their own environmental standards a condition for ships to access their ports. If states in the region adopt such rules in concert, the practical effect will be a regional rule covering all shipping in the region. This is particularly so in the Baltic Sea, where there is no through traffic and all ships in the region thus is bound for one of the region's ports.

A third common objection is that regulation of shipping requires global rules from a practical point of view. Chaos would reign, it is said, if the rules and standards would be different in each region or state, in view of the global nature of the business. Apart from the fact that very many ships in the Baltic Sea are not in global trade at all, but exclusively operate in the region, the argument is only relevant for issues that cannot be affected operationally during a voyage, such as typically how the ship is constructed, designed, manned or equipped. For the rest, national rules would not give rise to chaos, just another thing that the ship's crew has to comply with. There is no serious practical difficulty involved in demanding that ships do not release their wastes into the sea, and that they can demonstrate that in the port, even if such requirements extend beyond what is internationally regulated.

Nor is it an infringement of any navigational right to apply proper sanctions to any violation of such rules. Even for violations of existing IMO requirements there is a tendency to be very cautious with sanctions for pollution, to the extent that violation is noticed and brought to justice at all. It is not clear who is served by light sanctions for violations of - national or international - pollution rules.

Choosing between global or regional rules to protect the Baltic Sea is not an either-or question. Both types of rules may be perfectly justifiable and may indeed support each other. The experience by the EU over the past decades illustrates that unilateral standards may in effect also serve to encourage the global regulator to adopt corresponding standards.

Such standards could be introduced at national, HELCOM or EU-level, as appropriate. In the end, it is a matter of policy whether such complementary standards are desirable. The point of this text is to highlight just that. While it may be convenient to explain the absence of Baltic Sea-wide rule on ship-source pollution by referring to legal

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obstacles, it does not suffice as an explanation. The law of the sea includes no freedom for ships to pollute, even in the absence of IMO prohibitions. In view of that, could it not be expected that a regional sea, the uniqueness of which is so often emphasized, should be protected by some unique legal measures too? ■

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DANI LINDBERG

# Tackling food waste, a shipping company's perspective

Expert article • 2881

The creation of a sustainable food system capable of providing sufficient nourishment to a rapidly growing global population is arguably one of the most pressing challenges of our time. Agriculture is one of the most notable anthropogenic contributors to climate change, accounting for nearly a third of global GHG emissions. Moreover, the agriculture sector strongly impacts many of the Earth's systems, such as the nitrogen and phosphorous cycles, and growing food requires copious amounts of fresh water, land, and energy. Consequently, attaining sustainable production and consumption patterns while also battling an unprecedented climate crisis is no small matter. Solutions will no doubt require a multi-stakeholder approach throughout the entire food system, as well as keen regulatory foresight.

When considering the cost of food in terms of both natural and man-made capital, it becomes apparent that efforts need to be undertaken to avoid both food loss and waste at every level of the food chain. However, as it is inevitable that some food waste will be generated within the food cycle, the question of how to best deal with it becomes a pertinent one.

These were some of the considerations present at the outset of a sustainability project undertaken by Viking Line, a Finnish shipping company operating a fleet of ferries on the Northern Baltic Sea. [Contextual:] Viking Line transports some 6.5 million passengers annually between Finland, Sweden, Estonia and the Åland Islands. Dining is considered one of the cornerstones of the onboard experience, with a selection of several restaurants on each vessel catering to different tastes. The buffet restaurants have been a passenger favorite for decades, and well over a million dinner guests dine at the shipping company's buffets annually.

The aim of the Viking Line project was to reduce the amount of food waste produced onboard one of its ferries, M/S Mariella. The project was to be undertaken without compromises to the quality, freshness or the availability of the food served. The project was scheduled to run over a four-month period in 2019 and, as a matter of course, any garnered insights would become standard company policy. Moreover, the remaining food waste would be transported to a land-based plant to be used as feedstock to make biogas. The project called for negligible investments, which kept expectations modest. However, the results would prove a surprise for many.

Typically, food waste generation onboard a ferry occurs as customer plate waste, kitchen waste, and as waste borne of overproduction. Counteracting the generation of waste at each level was the project's main goal. The generated waste would have to be measured and categorized to allow for proper reporting and follow-up. Therefore, an external partner was invited to equip the kitchen waste bins with scales and supply the appropriate software for the categorization and logging of waste types and amounts.

Counteracting plate waste at a buffet can be a notoriously difficult task, as many restaurant owners will attest. There is a psychological element present in the dining experience which tends to cause the dinner guest to overestimate their appetite and thus generate plate

waste. The dinner guest cannot be faulted for this either, as a lot of meticulous work goes into presenting the dishes in as delicious a way as possible. And after all, the restaurant promises an all you can eat experience.

What Viking Line kitchen staff have found, though, is that a smarter presentation of dishes can indeed reduce plate waste. Pre-portioning and reducing the serving sizes of dishes seems to cause dinner guests to plate less food, thereby generating less waste per plate. Even small reductions account for big savings due to the considerable volume of food served in the buffets.

During the course of the project, waste borne from kitchen activities such as the overproduction of food was found to be a major cause of food waste. Marked savings were achieved by increasing the efficiency of kitchen procedures, such as tweaking the amount of food prepared per pre-booked dinner guest. The kitchen staff also found that some of the more resilient food items left over from lunch could be prepared as side dishes for dinner and ingredients were generally utilized more comprehensively. Furthermore, through diligent monitoring of waste logs, it was found that some dishes tended to end up as waste more readily than others. The issue was quickly addressed through adjustments in kitchen preparation.

Despite the modest budget and expectations, the project's results were a resounding success. During the four-month duration, food waste generation onboard the vessel was reduced by 40 % per passenger. The amount of food waste generated fell by 27 metric tons, equal to approximately 70,000 servings. Moreover, as an unforeseen bonus, the meticulous sorting allowed for less food waste to be lost as unsorted landfill-bound waste, increasing the amount available for biogas production. Viking Line has since been working on scaling up the project activities to cover its entire fleet.

It was found that the act of breaking previous behavioral patterns and mindsets was the key factor in the project's success. Assisted by digitalization, the kitchen staff of M/S Mariella were handed new tools to monitor their activities and could see the results of their efforts in real time. The staff became personally invested in the project, and new ways of thinking emerged. The value of food gained the attention it rightfully deserved, and maximizing that value became a leading thought in the minds of the staff. The project well illustrates how the act of valuing the resources we have can bring about considerable changes in the way we operate and how we set our goals for the future. ■



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# Sustainable shipping in the Baltic Sea Region

Expert article • 2882

**T**he Baltic Sea is a special place. A sea stretching from the north tip of Denmark to the Gulf of Bothnia, with decreasing water exchange as the Baltic Sea goes towards Poland, Russia and Finland, makes for a unique marine environment. The Baltic Sea has always been rich in natural resources and culture. Today, the Baltic Sea is also a hotbed for trade and tourism.

This is not a new trend, albeit the nature of the trade has changed. Vessels and distance travelled have become larger, leading to more concentrated environmental and climate impacts of shipping. Cruise ships discharging sewage negatively affects marine life due to eutrophication. Further, the exchange of ballast water brought microorganisms from other regions into the Baltic Sea.

These adverse effects on the Baltic Sea are a result of human activity. As such, humans can reverse course and remove the factors that have deteriorated the health and resilience of the Baltic Sea. With concerted efforts by Baltic Sea coastal states and the EU, with support from Flagship projects under the EUSBSR Policy Area on Clean shipping (PA Ship), we can now see a path towards sustainable shipping in the Baltic Sea.

## Climate change – short term measures serve a valuable purpose

Shipping is a major emitter of GHG. Studies show that upwards of 3 % of global CO<sub>2</sub> emissions comes from maritime transport. Further, the Fourth IMO GHG study show that emissions from shipping are projected to be 90-130 % of 2008 emissions if no actions are taken. Comparing this to the EU Green Deal, which seeks a 90 % reduction in transport emissions in 2050, or the IMO Initial GHG Strategy of minimum 50 % reduction in 2050 shows, that business as usual is not an option for shipping.

The global shipping community has acknowledged and mostly embraced this, and is working to reduce their GHG emissions. In the Baltic Sea, the PA Ship flagship ECOPRODIGI found, that by utilising existing data, ships can reduce their carbon emissions. The flagship showed that smaller ferries can reduce their bunkers consumption by 10-20 %, whilst larger ships can reduce their bunkers consumption by 2-4 %.

This shows that while we wait for long term solutions being developed for shipping, incl. battery technology and Power-to-X, there are measures to be taken in the short term so that we prevent harmful emissions from building up in the atmosphere.

Land-based power generation in ports serves as a short term measure to reduce carbon emissions. It allows ships, such as e.g. cruise ships, to switch their power supply from a fossil one to renewable energy. This reduces GHG emissions as well as emission of harmful substances in densely populated urban cruise ports. Several Baltic Sea ports have already installed shore power facilities, and more will follow soon. Whilst no panacea, it serves as a valuable tool to reduce emissions in the short term.

## Life below water in dire straits

The oceans have saved humanity from the earliest effects of GHG emissions due to their capacity to absorb CO<sub>2</sub>. However, oceans are

now at capacity and life below water is feeling the effects. But CO<sub>2</sub> is not all that goes into the seas.

Historically, vessels have dumped their sewage into the sea. However, with the onset of large cruise vessels, the issue of dumping sewage became apparent. Introducing massive amounts of Phosphorous and Nitrogen leads to eutrophication. This is especially harmful in a semi-enclosed sea such as the Baltic Sea.

The Baltic Sea coastal states and the EU in cooperation with HELCOM Maritime Group introduced a proposal in 2010 to the IMO to stop vessels from discharging sewage in the Baltic Sea. This ban goes into effect in 2021, although some areas are exempt until 2023. Reducing organic matter in the Baltic Sea will greatly benefit life below water.

Ballast water is an essential safety feature on vessels. However, one side effect of this has been the introduction of new species to our marine environments. As a response, the IMO adopted the Ballast Water Management Convention. Whilst a big step in the right direction, we must ensure that the regulation works. One important piece of work on this topic is the PA Ship flagship project COMPLETE, which is working on a regionally harmonised structure for ships' ballast water management in the Baltic Sea Region.

## All is not well, but road ahead is clear

As outlined, challenges are abound, and most have not been covered here. However, what has also been presented is that by way of multilateral and macro regional cooperation, the challenges are now being addressed.

The Baltic Sea is special - more special than most realise: due to a unique geography, Baltic Sea coastal states have the opportunity to introduce the Baltic Sea as a hotbed for testing new technologies and regulation; by setting the standards high and enforcing the rules. This will allow us to not only save the Baltic Sea, but also put the region on the map as a global leader in sustainable shipping. ■



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# Future path for shipping freight with peril?

Expert article • 2883

Shipping will be irrevocably changed in the future and the driver will be environmental pressures. The detrimental impacts of air pollutants, NO<sub>x</sub>, SO<sub>x</sub> and Particulate Matter (PM) have led to regulatory changes at all levels, from local to global. In the Baltic Sea region (BSR), reductions of Nitrogen and Sulphur have been agreed at the International Maritime Organization (IMO), but the compliance options were left for ship owners to choose. Some of these may lead to unexpected side effects.

The global switch to low Sulphur fuel in 2020 was easier than expected, probably because lot of experience had been gained. Low Sulphur fuel could be a costly option if the annual fuel consumption and the price difference between low- and high Sulphur fuels is high.

Alternative option is the use of Sulphur abatement techniques (affects also PM and Black Carbon (BC)) from ship exhaust. In its simplest form, open loop scrubbers, seawater spraying cleans the exhaust gas and the effluent is released back to the sea. Other scrubber options also exist, but these are more expensive than the open loop system. Air pollution is decreased but the effluent creates a new water pollution stream, the impacts of which are not known well. The risk of open loop scrubbers creating a new problem lies on those who have chosen to adopt this path. Most of the scrubbers in the global fleet are of open loop type, which means that this is a global issue in areas with low water volume or limited water exchange.

The use of scrubbers has increased sharply, first in the Baltic Sea area but also globally since the introduction of global Sulphur cap in 2020. There were 95 scrubber ships in the BSR in 2019 and the effluent release of the fleet was the second largest release (by volume) of water pollution from ships after the ballast water discharge. The release of heavy metals, polyaromatic hydrocarbons and other components from ships to the sea has led to local bans of open loop scrubbing in some port areas or close to the shoreline, even if limit values for scrubbers have not been exceeded. The precautionary principle prohibits releasing anything potentially harmful to the sea.

These options are not enough when other air pollutants are considered. From 2021 onwards, also 80% NO<sub>x</sub> reduction is required from new ships in the BSR. This will gradually reduce the NO<sub>x</sub> emissions, but its full effect will only be seen once the fleet has gone through one renewal cycle, which can take 25-30 years.

Since the two options mentioned above can be used to cope with SO<sub>x</sub> regulation but not NO<sub>x</sub>, it is tempting to switch to gaseous fuel like LNG (liquid natural gas), which is basically methane, and solve both problems simultaneously. LNG engines emit very little Sulphur or particles, which means that BC or scrubber effluent problems are avoided. Depending on the type of LNG engine, it may offer also significant NO<sub>x</sub> reduction. It can increase the emissions of unburnt methane to the atmosphere, known as methane slip. There are three types of LNG engines, two of which have low NO<sub>x</sub> emissions but high methane slip and one type with high NO<sub>x</sub> emissions and low methane

slip. With a correct choice of engine, both SO<sub>x</sub> and NO<sub>x</sub> requirements can be met with a gas engine.

This brings us to the problem of LNG. First, methane regulation is very likely since methane is a strong greenhouse gas and this increasing emissions source cannot be overlooked by the IMO. Second problem arises from the fact that LNG of today is a fossil fuel and its burning increases CO<sub>2</sub> in the atmosphere. Considering the investments made to gas pipelines, terminals, storages and shipping fleet, it would be logical to make best use of existing infrastructure as far as possible. Methane can be produced synthetically, which involves breaking H<sub>2</sub>O molecule to hydrogen and oxygen with electricity and combining the hydrogen with carbon taken from CO<sub>2</sub>. Similar processes are involved in manufacturing of methanol and ammonia, which are considered as potential future fuels for ships.

These three fuels have significant benefits. They can be used in internal combustion engines (ICE) and fuel cells, which are considered as a future of shipping. This provides an opportunity to shift the fossil-powered fleet towards greener fuels. All three fuels are hydrogen carriers and have intermediate hydrogen step in their production process. If the electricity needed by this process is taken from wind or the sun, then the need to use fossil energy is removed. All three fuels can be mixed with their fossil counterparts and this can be used to gradually increase the share of non-fossil fuel. It could be said that these fuels buy time for ICEs when moving towards ships operated with fuel cells.

The next 10-20 years will be critical. One significant challenge is to ensure that the shift from fossil to synthetic fuels really occurs. We cannot afford to get stuck with fossil fuels and lose the flexibility ICEs provide in decarbonizing shipping. ■



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NERIJUS BLAŽAUSKAS

# Marine research boosts the marine economy in Lithuania

Expert article • 2884

I find it very fascinating how science may influence and even shape the future of the strongly established maritime business. This has happen here in small European newcomer – Lithuania. Small in area, but rather ambitious and active in strategic planning. If we try to summarize what is on the Agenda during the recent few years, the list is colourful: offshore LNG terminal development; reconstruction of Šventoji and capital development of the Klaipėda sea port; NORDBALT and HARMONY LINK offshore HVDC energy links between Sweden-Lithuania and Poland-Lithuania; new projects related to expansion of marine Natura 2000 sites and recently started process for 700 MW wind energy park developments offshore the Lithuanian Baltic Sea. The latest is something that research has influenced the most. Estimations of the wind resource potential, recognition of environmental concerns, established principles for spatial allocation and possible conflict management at the sea, - those are the critical aspects that couldn't be elaborated without proper marine research and input of marine environment focused scientists. "Marine focused" is a key element here. Especially for the country, where marine business opportunities are well recognized and were limited to fishing, beach tourism and port related activities (ship repair and building, cargo handling and passenger transfers) mainly.

Situation has changed when being member of European Union has opened the door for extremely rapid experience exchange and growth for maritime science and research. Klaipėda, small port city in the western part of Lithuania, became the true centre of marine research with experienced and dedicated scientists and developed modern infrastructure - established Marine Research Institute. Team of dedicated and science-for-business oriented people have managed to concentrate the most valuable skills, develop modern, well-equipped labs and even building the multipurpose LT-made research vessel - the first offshore business servicing focused platform in and for Lithuania. Recognizing, that along with rapid growth of the maritime activities (especially offshore wind energy) on a European and national scale, the fragile Baltic Sea ecosystem needs to be regarded and managed as single entity, planning principles of the marine space became the first task to be established. Moreover, this started much before European Parliament endorsed the new Framework Directive for Maritime Spatial Planning (endorsed in April 2014). The planning of Lithuanian maritime space was the first attempt to integrate the environmental, economic and social needs into one comprehensive plan. The main objective of the maritime spatial plan is sustainable development of marine activities. Plan is the horizontal measure allowing controlling the potential conflicts on the very early stage. Therefore, the potential conflicts can be easier managed and allows avoiding the negative sequences for socio-economic as well as natural environment. Plan creates conditions for development of existing activities and also fostering development of new ones. Prepared spatial solutions require new quality of the scientific research while investigating the marine resources and evaluating the

economic effect as well as environmental consequences. Although existing environmental conditions and existing uses are influencing the development of the future economic activities at the sea, spatial planning facilitate the developments of future uses as well as optimize existing ones.

The prioritisation of potential areas for future uses and especially for wind energy utilizations is the output of complex marine research. Again, - OWE related feasibility studies have been developed during the number of international EU funded initiatives. Almost 10 years have passed since first elaborations have been ready. Today, Lithuania has adopted Maritime Spatial Plan with clearly identified areas for OWE development, infrastructure corridors for electricity transmission systems. This has been followed by legal acts prepared by the Ministry of Energy. Furthermore – tenders for different pre-development stage services have already been started. Special plan for 700 MW OWE park is in preparation, SEA and EIA to follow. Auction for the first OWE project in Lithuania to be launched in 2023. This is the basic achievement in order to foster the new marine business developments, or rather to say, entire economic branch, and to provide the essential GDP growth in the coming few years. ■

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MARKO TAKALA

# CoastNET LIFE offers cost-effectiveness in nature management

Expert article • 2885

The CoastNET LIFE project is funded by the European Union's LIFE programme. The primary goal of the project is to create a coherent and well-managed biotope network by upgrading 44 Natura2000 areas on Finland's west coast and Estonia's north coast. The efforts primarily focus on biotopes in the habitat directive (Council Directive 92/43/EEC) whose conditions currently range from unfavourable to bad (U2) or unfavourable to inadequate (U1).

A better quality of biotope networks and a more wide-ranging surface area helps several species grow their population size and offers new areas to colonize. Together these help species to fight against habitat fragmentation and isolation of populations, while improving the resilience of populations against the effects of climate change. The effects of climate change are becoming more clearly visible in Baltic Sea ecosystems, and the rate of the change exceeds that of the ability of species to adapt to the situation.

The overall budget of the CoastNET LIFE project is EUR 8.7 million and the project will continue until March 2025. Project targets cost-effectiveness by careful and mutual planning of actions on every step at the target Natura2000 areas, the implementation of inventories, restoration activities of different habitats, and monitoring. All-inclusive planning also involves the evaluation of logistics and travel expenses, the possibilities of utilising volunteer work, and the use of outside labour.

Especially when working at sea, it is important to minimise costs of logistics and travel, which can form a significant part of overall expenses. This means that efforts are made to encourage travel sharing whenever there are activities in a target area, or when travelling to other target areas located nearby. One part of improving cost-effectiveness involves greater utilisation of citizen involvement. A concept of citizen involvement will be developed in the project that includes aspects such as a day dedicated to well-being at work for companies as well as volunteer work contracts. In the project 28 volunteer work camps are to be organised in Finland and Estonia, which will be responsible for a total of 3,085 volunteer work days. Improved cost-effectiveness makes it possible to handle a maximum number of areas, which also helps achieve the best final result both with respect to quality and surface area from the point of view of nature protection as well.

Natura2000 areas that need restoration will be analysed in the project using several different methods before restoration plans are made. In addition to GIS-based analyses, terrestrial and underwater biotope inventories, archaeological inventories, and inventories of several different groups of species will be conducted. The resulting information will be used for restoration plans in the project's different Natura2000 areas. The restoration plans cover a total of 2,881 hectares. Their focus is on care for semi-natural habitats, large coastal meadows, mosaics of herb-rich forests and broad-leaved forests,

primary succession forests habitats, sun-lit habitats, and Boreal Baltic Islets and small-sized open habitats.

A comprehensive restoration plan for the long term ensures that measures taken on the target Natura2000 area will be correctly proportioned and targeted, thereby reducing the risk of doing unnecessary or inappropriate work. Analyses conducted in the regions and restoration plans can be utilised in broader plans such as producing the Management Plan. Management plans in Finland include those in the Bay of Bothnia and the Archipelago Sea, which together cover more than 69,000 hectares, while the Estonian management plans cover more than 3,000 hectares. The restoration actions include clearing of overgrown habitats by manual labour, machinery, controlled burnings, and volunteer work. Semi-natural habitats will be taken under continuing management by grazing and invasive alien species will be removed. Well-planned restoration actions are needed in the target area over a period of several years because the recovery of nature is often very slow. For this reason, the effects of upgrading measures are systematically followed through the entire duration of the project and thereafter.

In the implementation of the CoastNet LIFE project, the importance of a methodical approach, perseverance, and cost-effectiveness for the achievement of a good outcome have often been raised. Measures used and developed in the project can be utilised generally in the future in care for coastal nature, as the project material is freely available. Experiences and information are also shared in seminars involving the various projects. This is important because the need for the development, quality, and cost-effectiveness of measures for caring for nature are emerging especially now that the need for nature protection is great in light of climate change and the growing wave of extinction. Funds used for nature protection and nature management are usually quite limited, which means that every euro must be spent carefully and methodically, which can succeed only through the help of carefully honed procedures and processes. ■

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JAAKKO RUOLA &amp; KARI VEIJONEN

# Finland's national treasure the Archipelago Sea is in danger

Expert article • 2886

**T**he globally unique Archipelago Sea is in great danger due to eutrophication which has lasted for several decades.

It is the reason why Operation Archipelago Sea has been founded. By means of communications and marketing, we aim to enhance awareness and appreciation of the region both in Finland and elsewhere in the world.

Our goal is to influence political decision-makers and ordinary citizens in Finland and at the EU level in order to save a natural and cultural entity that is unique even on a global scale.

As part of the Operation, Professor and Rector Emeritus of the University of Turku Kalervo Väänänen has drawn up a three-part action plan, based on circular economy solutions, for starting the purification of the waters.

In our view, the nutrient recycling model presented in the action plan by Professor Väänänen offers a feasible concept that can be implemented also globally in other marine regions suffering from eutrophication.

## What makes nature in the Archipelago Sea so unique, and why is it important to save it for future generations?

The Archipelago Sea is situated in the northern part of the Baltic Sea in Southwest Finland, stretching out in front of the City of Turku. Many areas of the Archipelago Sea belong to the World Network of UNESCO Biosphere Reserves.

## The world's largest archipelago measured by the number of islands

The Archipelago Sea is a unique natural formation by any standards. It is the largest archipelago in the Baltic Sea consisting of as many as 41,255 islands and countless islets, tiny skerries and reefs.

Some of the islands are tightly clustered, some stand alone in the open sea. The fragmented topography has resulted in various kinds of marine areas: narrow gulfs, different types of bays and vast open seas.

## The Archipelago Sea has the highest biodiversity in Finland

The diversity of nature in the Archipelago Sea is one of its kind in Finland.

It is where the north, south and southwest meet. It is home to an exceptionally large number of endangered species and biotopes.

There are over 40 biotopes in the Archipelago Sea that are particularly valuable for the biodiversity in the region, and significant in the whole of Europe. Underwater rocky reefs, sandbanks and sand-based ridges as well as the islands and islets of the outer archipelago are among the most valuable biotopes. Fragmented topography, various archipelago zones and variability of the soil and the seabed further increase the biodiversity in the region.

## Bedrock of almost 2 billion years of age

The Archipelago Sea is a peculiar formation on the Fennoscandian Shield. It belongs to the oldest and most stable bedrock in Europe. The whalebacks of the open seas and the massive rocks of the archipelago are the steadfast roots of the Svecofennian mountain belt that was created about 1,900 million years ago.

About 200 million years later rapakivi granites were formed in the depth of several kilometres, and they became the bedrock of the Åland Islands and the north-western part of the Archipelago Sea. What is extraordinary on a global scale is that the surface of the bedrock is widely visible around the region.

## Signs of the latest Ice Age are visible everywhere

While the bedrock is ancient, the Archipelago Sea of today is young when measured by a geologic time scale. The series of Ice Ages that began more than two million years ago swiped off practically all signs of life from the area which is now Finland. As the ice spread, it pushed aside any loose soil and organic material.

At its most wide-spread stage, the glacier was 5.6 million square kilometres in size, which is seventeen times bigger than the area of Finland today. In some parts, the ice was three kilometres thick.

The pressure of the ice sheet created depressions on the ground that still exist. As it moved, the massive glacier dislodged pieces of the eroded land, even huge rocks. The hard pieces of material mixed inside the spreading ice scoured the bedrock which lay beneath the ice sheet. It became round in shape, and glacial grooves were formed on its surface, indicating the direction of ice movement.

## The Archipelago Sea and its brackish water

As a living environment, brackish water is physiologically very challenging for aquatic animals. While for the marine species the major cause of stress is the low salinity level, for the freshwater species it is the too high level of salinity.

The Baltic Sea is a young sea, and all its species were spread out in the region after the last Ice Age. For example, there are only about 60 species of bottom fauna visibly detectable in the Archipelago Sea, while in the North Sea there are over 1,500 species.

The Archipelago Sea has plenty of shoreline – more than any other region of equivalent size – and many shallow, biologically productive water areas. Even though there are not many species, there is an abundance of individuals.

In addition to the long shoreline, another typical feature of the Archipelago Sea is strong deviations in the shapes of the seabed. That is why different organisms may live side by side, even mixed together – just another example of the exceptional character of the Archipelago Sea.

**The Archipelago Sea is home for several hundreds of endangered plant species and invertebrate animals**

The tidal zones in the shorelines of large seas offer a highly productive habitat for many different species. The Archipelago Sea is productive in a different way: there are few species, but many individuals.

The high level of basic production creates and maintains huge amounts of biomass. The biological productivity of the Archipelago Sea is the result of the long shoreline and vast shallow water areas.

The number of biotopes and level of biodiversity vary greatly from area to area: from the coastline to the outer archipelago, from rocky islands to shingles, from soft seabed to rocky seabed, from shallow waters to deep basins.

There are many species in the Archipelago Sea that exist nowhere else in Finland's coastline. Large eelgrass meadows in the sandy seafloor in the outer archipelago and algae growing in various depths under water form together stunning communities that are hard to find in other parts of the country.

**One can experience the changing of the seasons in the Archipelago Sea**

The climate of the Archipelago Sea is mild and marine compared to mainland Finland. The Gulf Stream warms up Northwest Europe and has a dominant effect on the climate of the whole Baltic Sea region.

Daily temperature variation in the Archipelago Sea is smaller than in the mainland. The water masses of the sea have a strong influence also on the changing of the seasons. Winter in the Archipelago Sea is short. In the outer archipelago, for example, it is often not until late February that the sea freezes, and the ice season lasts around twenty days on average. In the inner archipelago the ice season is usually about one and a half months, but in some winters the sea does not freeze at all. Yet there are winters when fast ice stretches far out to the open sea, covering it for several months. ■

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MAIJA MUSSAARI

# Building up biodiversity capital

Expert article • 2887

**H**abitat loss and fragmentation are the main reasons for species decline worldwide. However, there are also increasing amount of different environmental changes affecting species and habitats assemblage. The eutrophication of the sea, deposition, climate change, invasive alien species and their multiplier effects change the structure and function of habitats. Efficient nature conservation and management is a demanding task at fragmented and changing environment. New practical solutions are needed to secure the biodiversity in these settings. To build up biodiversity capital strong enough to face the ongoing and coming changes at Archipelago Sea, new nature management concept has been under development. This networking concept acknowledges national priorities and regional responsibilities and works them through regional targets to site specific management guidelines. Cost-efficiency is relevant on every step.

Nature conservation areas are the backbone of biodiversity. However, in the static landscape structure and in the cross-pressure of different types of stresses, they can't preserve their diversity without nature management. Nature management targets different parts of biodiversity, dependent on the purpose. In nature conservation areas main targets are to restore and maintain both diversity in general and the endangered nature.

Archipelago has a unique character as a Finnish landscape. Outer archipelago is dominated by open and semi-open habitats such as heaths, rocky outcrops, deciduous forests and different kind of meadows. This environment is at a cross-pressure between strong and numerous environmental stresses and changes which threaten the species and habitats of open sites. In addition to these, ending of traditional ways of life cause increasing growth of forests. On the other hand nature management has a long tradition and its good results are widely known. Nature management in the Archipelago National Park has shown that the surface area of endangered habitats and the population of endangered species can be increased through high-quality nature management planning and local cooperation.

Future will bring new pressures and environmental changes. In 2018, different parts of the Archipelago Sea meadows experienced an exceptional drying. The long-term drought burned the vegetation on dry meadows and their honeydew plants as early as at the end of June and continued far into July. Climate change not only increases growth. It also makes the weather extremes more extreme, and rising temperatures have already reduced the ice cover, and in the future the water level will rise. In order to preserve biodiversity, efforts must be made to anticipate these changes. The slow response of nature and the multifaceted, partly unknown interaction networks make the situation even more challenging. Habitats of the Archipelago Sea are still adapting to the changes that have been taking place over the past 100 years. As a result, effects of the new changes are hard to filter.

Maintaining individual sites is not enough to preserve biodiversity in a changing landscape. Outside the restored sites, habitats have continued to overgrow, and hundreds of species are still threatened. A strong ecological network has long been identified as a key factor in preserving biodiversity. In a high-quality, habitat network, species have all the resources they need available near vicinity, they can move from unfavourable sites and areas to others, and within the site on the moisture and shade gradient.

Since 2015 Archipelago habitat networks have been strengthened by systematic targeting of actions, optimisation and predictions. Archipelago Sea networking concept concentrates management to specific areas where endangered species amounts are high, but occurrence sites or network need significant amount of restoration. Concept creates win-win management solutions between crossing networks of threatened species on each management area. Populations will be strengthened by increasing the surface area of desired habitats and improving the quality of actions. Preparations for climate change include restoring new sites to favourable places, targeting the restoration measures to a large humidity gradient, continuous landscape cover and a wide variation in management intensity. Networking concept used, shall be published in February 2021. Despite publishing, the plan continues being adaptive, it is constantly updated as climate change scenarios become more specific, information is accumulated, experience gained and new projects applied.

By managing networks, we achieve both ecologically and economically functional entities. In logistically challenging archipelago environment significant amount of resources are saved especially in working hours and logistics. With this concept for example planning, contract work and grazing management are cost-effective to arrange.

Coast net LIFE- project implements the networking concept at Archipelago Sea. This issue describes the CoastNET LIFE project in more detail. ■



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# Sustainable tourism requires cooperation

Expert article • 2888

The wind playfully flutters the hair whilst shades of blue dance across the eyes as you stare out to the horizon. From the deck of a cruise ship the power of the impressive seascape is breathtakingly beautiful. The Baltic Sea is a marvel of nature but the truth lying beneath the surface weighs on us like the heaviest of anchors: our wonderful sea is one of the most sensitive and polluted in the world.

Cruise shipping and other tourism companies in the Baltic Sea region operate in a natural environment that is simultaneously attractive and vulnerable. Therefore, sustainable tourism and its development in the Baltic Sea region is essential. Concern and responsibility for the Baltic Sea is also a strong indicator as to how tourism in the region should function in the future.

When it comes to responsible tourism in the Baltic Sea region, a focus is often placed on cruise tourism and the shipping companies, but we must also take care to understand the importance of smaller tourism operators. The tourism industry has a major role to play in promoting sustainable solutions as well as bringing commitment from public institutions, companies and individuals to foster sustainability. At its best, tourism actually increases the value we place on nature and directs both funds and attention toward environmental protection.

It is worth remembering that sustainable tourism is not just about ecological choices. In addition to the environment, sustainable tourism also takes into account the economic and social impact – now and in the future. For a sensitive environment, the sustainable actions of tourism can create a positive cycle in which sustainable principles are strongly incorporated.

Without question, truly ecologically sustainable tourism is that which causes the least possible harm to the environment, taking into account the numbers and levels of consumption of tourists when designing the destination. This means having a plan for waste management, energy production and the effects of tourism on the area's nature and ecosystem, for example. Economically sustainable tourism contributes to the well-being of the region by engaging in long-term action and choosing environmentally important investments instead of quick economic benefits. By supporting local service providers and valuing cultural diversity, companies will remain vibrant and have a better chance of adapting their services and making them environmentally friendly.

However, no tourism actor alone can manage the impact of tourism in its area of operation. Regional, national and international cooperation is needed, with a vision, goals and commitments to achieve common objectives. The development of sustainable tourism requires the conscious involvement of all relevant stakeholders. The Baltic Sea region, Finland or Turku cannot declare themselves a sustainable tourist destination unless local actors take the responsibility as a shared goal.

To support the Finnish tourism industry, Visit Finland has created the Sustainable Travel Finland programme, which provides support

and guidance to regional actors and companies on the path to sustainability. Visit Turku also plays an important role in tourism in Southwest Finland because we work closely with local tourism providers. We are involved in creating a regional programme that coaches and motivates companies to become increasingly sustainable. There are already encouraging pioneers in our region, such as Aavameri and Herrankukkarö, both of which have received the Sustainable Tourism Award. Both companies operate in the Turku Archipelago, fully embracing the ideals of sustainable tourism.

Sustainability plays a significant role in the image of an enterprise, granting them a competitive advantage as a travel destination or a player in the industry, as well as bringing great opportunity to create new services and generate new business. In the future, only sustainable tourism companies will remain competitive, as tourists and partners favour responsible destinations. Of course, it's essential for competitiveness that a tourism operator also remembers to communicate this message of responsibility to its customers and tourists. Tourists need all possible practical tips on how they can act more sustainably and, instead of becoming a burden, actively promote the conservation of nature. Tips on how to look after the Baltic Sea can concern anything from the reduction of food waste, for example, to how a boater might manage their waste whilst moving around the archipelago.

The principles of responsibility and sustainable tourism have become more prominent during the Covid-19 pandemic. The pandemic is a big crisis for tourism, but on the other hand, it has made tourists and tourism operators pay even more attention to sustainability, from the perspectives of nature, people and the regions. While the pandemic limits our daily lives, it must not be an obstacle to national and international cooperation. Sharing sustainable ideas and solutions is now more important than ever.

I would like to see more exchanges of views and cooperation in the field of tourism in the Baltic Sea region. What can we learn from each other about sustainability? ■

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JUULIA RÄIKKÖNEN &amp; ILARI E. SÄÄKSJÄRVI

# Biodiversity research and science tourism

Expert article • 2889

In the coming decades, we will see the consequences of an ecological crisis caused by accelerating global climate change and biodiversity loss. Recent estimates suggest that up to a million species are facing extinction (IPBES, 2019). As our current lifestyles and global business structures are among the root causes, reversing the biodiversity crisis requires a system-wide reorganisation at the business, institutional and consumer levels. Biodiversity and conservation education will be important but, besides traditional environmental education, we must create effective tools to highlight emotional and experiential aspects of scientific interpretation and engage actors to work for a common goal. Here, we address the potential of science tourism in advancing biodiversity conservation in the Archipelago Sea region.

Earth's basic feature – biodiversity – has evolved over hundreds of millions of years. Biodiversity refers to all manifestations of life; during life's long evolutionary history, it has sometimes flourished and sometimes withered in times of mass extinction. Biodiversity has various levels. Species diversity refers to each different species; genetic diversity means genetic differences between individual species and populations. Finally, different species living in the same area form biological communities (ecosystems) together with the physical environment.

The importance of biodiversity and healthy ecosystems boils down to this: life sustains life. Life's spectrum consists of species, each with a role to play (e.g. as food, predators, herbivores, nutrient recyclers, and pollinators). In naturally functioning ecosystems, a diverse range of life balances the species so that no single species gains dominance. Diverse nature also has a better chance of adapting to ecological changes, such as climate change.

Since 1964, the University of Turku has operated the Archipelago Research Institute on Seili Island to monitor the marine environment long-term. The Archipelago Sea region – part of the Baltic Sea between the Gulf of Bothnia, the Gulf of Finland and the Sea of Åland – uniquely consists of coastline, brackish water and thousands of small islands, forming ecosystems where biodiversity can flourish. Human activity, however, has upset the balance of life, and the consequences are visible in the Archipelago Sea. According to the 2019 Red List of Finnish Species, every ninth species is threatened (Hyvärinen et al., 2019). Many of these species live in aquatic habitats, herb-rich grasslands or forests of the Archipelago Sea region. Besides the well-acknowledged eutrophication of the Baltic Sea, the overgrowth of traditional landscapes is also threatening the region's species.

The University of Turku began developing Seili Island in close cooperation with a local tourism company to enhance biodiversity conservation and science popularisation. This includes the development of science tourism, referring to leisure tourism experiences based on science, scientific knowledge, or participation in scientific research (Räikkönen et al., 2019). Science tourism stems from educational tourism, thus combining learning and enjoyment.

Seili has been permanently inhabited since the Middle Ages and has had a long history of housing patients with leprosy and mental disorders. Due to its versatile natural and cultural resources, it slowly developed into an attractive tourism destination, with nearly 10,000 annual tourists. Since 2016, that number has risen to nearly 25,000 due to investments in tourism and hospitality services, such as accommodation and restaurant services, meetings and events, a guest marina, a sauna, guided tours and art exhibitions.

For years, the university has organized various scientific seminars, field courses, science camps and other science-related activities. This foundation has been further developed through an exhibition that introduces tourists to the island's history and the research conducted there. Furthermore, a virtual reality application was designed to enable remote visits to Seili, and a science nature trail will be built to mediate scientific research for tourists. In these actions, we aim to highlight the roles of scientific research and scientists as active mediators, conservation professionals, and enablers of nature-based tourism experiences. ■

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# Sustainable tourism in archipelagos

Expert article • 2890

**T**ourism promotes a balanced regional structure and has a positive impact on regional development and economy. The role of tourism is emphasised locally, especially in connection with tourism centres located in rural and archipelago areas. The importance of tourism is increased by the sector's location-specific nature; most tourism jobs and locally performed development work cannot be relocated to other countries or localities. Tourism will remain labour-intensive also when the use of technology and service accessibility increase.

Nowadays the objective of sustainable tourism is widely recognized. Sustainable tourism is the objective, while responsibility is the mode of operation for achieving sustainability. Responsibility is a common interest for both the tourism sector and tourists. Tourism needs to be developed through responsible choices that ensure sustainable growth and steer the industry towards minimising the negative impacts of tourism.

Sustainable tourism takes full account of its current and future economic, social, cultural and environmental impacts, addressing the needs of tourists, enterprises, the environment and host communities. Considering sustainability increases the profitability and qualitative growth of the sector and the positive impact of the sector on society.

Archipelagos are vulnerable environments where all aspects of sustainable tourism need to be considered carefully. Both environmental and socio-cultural aspects are significant. These include activities that do not damage the destination's societal structures, promoting the development of the host society based on its own values and needs, conserving and strengthening culture and cultural heritage, and taking responsibility for the enterprise's own personnel. Economic aspects are also important, including sourcing services locally, employing host populations, developing infrastructure, cash flows remaining in the destination, and operating lawfully and responsibly.

Improving the sustainability of tourism is a key issue for the societal acceptability and future of the sector. Tourism actors must invest in the development of sustainable and responsible tourism. The requirement to develop sustainable tourism has an emphasis on a low-carbon and resource-efficient global economy, for example in terms of food production, water consumption and waste minimisation. It also generates pressure to reduce tourism and transportation emissions and to take into account the wellbeing of host residents.

Sustainable tourism in archipelagos requires cooperation at different levels. The EU Strategy for the Baltic Sea Region connects eight EU member states and four neighboring countries around the Baltic Sea. It has three main objectives: save the sea, connect the region and increase prosperity. According to the strategy's action plan, policy area of tourism provides "a strong platform to reinforce sustainable tourism development in the Baltic Sea Region."

At a national level, Visit Finland has a cooperation model for greater tourism regions. Coast and archipelago is one of the four tourism regions. Its attractions include nature, sea, archipelago, calmness and cleanness. Common objectives in the region are sustainable tourism, more even and longer tourism seasons, as well as fostering cooperation. The cooperation model makes it possible to create more coherent messages, increase overall investment, strengthen the

supply of tourism services and products and create attractive sub-brands to the region.

Finland's Tourism Strategy 2019–2028 defines targets for the development of tourism. One of the main themes of the strategy is "Turning sustainability into a competitive asset for Finland's tourism". A key measure in increasing the sustainability of the Finnish tourism industry is the introduction of the Sustainable Travel Finland label created by Visit Finland. The label encourages tourism enterprises and areas to take environmental, cultural, social and economic sustainability into account in their own activities, product development and marketing. Sustainable choices should be profitable for enterprises from the business perspective. Responsible practices can also attract new employees: a company that shares the same sustainable values as its employees is an attractive employer.

The transition towards sustainable tourism industry is a long and challenging process. It requires commitment of different actors at all levels and is not possible to achieve without cooperation. Archipelagos are unique and vulnerable environments, so sustainable tourism from environmental, cultural, social and economic perspective is essential for the future. ■



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TIINA RINNE-KYLÄNPÄÄ

# Naantali – a gateway to the archipelago

Expert article • 2891

**N**aantali is a town located on the southwestern coast of Finland and a part of the greater Turku area. The history of the town dates back to the 15th century when a Bridgettine convent was founded in the area. Shortly after that, the town itself started growing around the convent. Naantali is best known as a tourist destination, with Moominworld as the main attraction. In addition, it is an important site of industry and the third-largest cargo port in Finland.

Naantali became a town rich in islands in 2009 through a municipal merger that changed the structure of the town considerably. An archipelago area of more than 4,000 inhabitants, consisting of three previously independent island municipalities, was incorporated into the town that before the merger had approximately 13,000 inhabitants.

The added island regions increased the town's surface area nearly sevenfold. Thanks to the many islands, the water area in Naantali, now totalling 372 km<sup>2</sup>, is larger than the land area, 311 km<sup>2</sup>. With its more than 1,000 islands and a coastline of 1,000 kilometres, the town has a maritime touch to it.

According to its strategy, Naantali wants to be a vibrant archipelago town that is building its future boldly and sees the island areas as an important resource. Naantali is a growing and attractive town. In 2018, in a survey assessing the attraction of municipalities and the willingness of people to move there, Naantali was estimated to be the second best place to live in Finland. In a recent study by the Association of Finnish Municipalities, Naantali was given best scores for its services.

Now, a good 10 years after the municipal merger, it can be noted that the union of archipelago and town has proven to be a successful one.

## Islands under development

A vision extending to the year 2070 and utilising the methods of futurology and ecosystems thinking has been drawn up for Luonnonmaa, the island nearest to the centre of Naantali. The first step towards the vision is the 2022 Housing Fair to be arranged in Naantali – a major effort for a small town. A community and learning centre will be built in connection with the residential homes in the fair area, collecting a school, day-care centre and other services aimed at families under the same roof. In the Housing Fair area, effort is put into creating an atmosphere of archipelago and implementing principles of sustainable development. The primary theme in all construction is nature in the archipelago, and emphasis is given to preserving it as well as possible. The construction rules for the area recommend using local plant species in garden designing. Innovative energy solutions, such as those to do with solar energy, are created for the area. The city of Naantali will be doing a pilot project on managing run-off rainwater during the construction of the Housing Fair area.

The city wants to invest in preserving local services in the archipelago. Furthermore, undertakings with regard to promoting remote services and remote work are under way.

Several village schools have been closed down in Finland in the past few years but Naantali swims against the tide here. The city believes in the future of the archipelago and is in the process of building a new village school in Velkua, on Palva island.

Also, alternative options for housing in the archipelago are being investigated. Livonsaari community village and Merimasku archipelago village are good examples of forms of housing that are well suited for the archipelago areas.

## The future of the archipelago

Development in archipelago areas has been studied in Finland. Population has declined almost everywhere. The same trend can be seen in the outer areas of the Naantali archipelago, but a maritime way of living on the islands nearest to the town centre attracts those moving to Naantali.

The COVID-19 virus has brought about significant losses in many respects: health-wise, economically and emotionally. Increase in the popularity of the countryside and archipelago as well as the booming remote working are surprising positive phenomena associated with it. The number of seasonal inhabitants in the archipelago has never been as high as it is now. Sales of secondary residences has been record-breaking also in Naantali.

Now, many of those who have a second residence have the opportunity to work in the midst of the archipelago, living in their holiday home. New phenomena that are currently gaining ground in the archipelago are multi-local working and location-independent work, which appear to be among the new ways of living. Secondary residences are no longer used in summer only. Instead, they are often well-equipped houses that enable all-year living. This may prove to be a new opportunity for the archipelago. Inhabitants, even part-time ones, bring much needed life and activity to the archipelago. A dynamic archipelago creates well-being for the entire society. The new multi-local approach challenges municipalities and other actors to develop new services and to acknowledge these people also in decision-making. In order to lead a good life in the archipelago we need appealing places of residence and ways of living. This is something that municipalities should consider when zoning new maritime areas for housing.

## Well-being of the Archipelago Sea is of key importance

The future of Naantali and its archipelago is in many respects dependent of the condition of the Archipelago Sea. For tourism and fishing as well as other forms of livelihood, the well-being of the sea is of key importance. Living by a sea that is in poor condition is not very appealing, either. Naantali has drawn up an environment action programme that focuses on improving the condition of the Archipelago Sea. Furthermore, Naantali is participating in the Baltic Sea Challenge. Concrete measures include investigation of pollution sources that have an impact on the condition of local water areas as well as finding out about the practicality of seabins that are used

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to remove floating rubbish from the water. The number of septic tank emptying points has been increased in the archipelago. Also, more effective wastewater treatment in the archipelago is being investigated. We are all responsible for ensuring the well-being of the Baltic Sea. Every concrete deed for the good of the sea – no matter how small – is important. The future of the archipelago is essentially dependent on the condition of the sea. ■

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KATRIINA SIIVONEN

# Cultural sustainability in the archipelago

Expert article • 2892

**S**outhwest Finland has a wide and idyllic archipelago, which covers 10,000 km<sup>2</sup> of water and includes over 22,000 islands. There are large and fertile islands in the inner archipelago, and, mostly in the outer archipelago, very small and barren islands, which cover 75 % of the area. The population on the islands is c. 17,600.

The living conditions in the Southwest Finland archipelago have changed in the course of the modernisation process. The former sources of livelihood, mainly agriculture and fishing, are no longer as profitable for the inhabitants. As a result, during the 20th century, the population fell steadily. Nevertheless, since the 1970s, the size of the population has remained relatively stable. The most extensive branch of industry is currently the services. Although living conditions have been changing rapidly, many old cultural traits are still practiced in some form.

In the everyday archipelago culture, nature is the element which ties people most strongly to their own archipelago area. All in all, identification with the archipelago is based on practices related to nature and the community. As in culture always, these operate as tacit knowledge, which are sometimes difficult to grasp and describe in words. However, in some contexts tacit knowledge is elevated to conscious symbols. They are at the same time the beautiful and violent nature of the archipelago, the shores of islands forming borders, the freedom to work and define one's own way of life inside these borders, and the skills and knowledge learned on the islands, which are able to conquer the administrative and literal knowledge defined outside of them. Culture and identities are always in constant motion, also in the archipelago. Moreover, a very prevalent element in these identities is the will of the archipelago people to define changes themselves within the shores of the islands. Only nature is an acceptable and strong definer of actions and identities.

To a degree, actions in local development work, and for instance in development of tourism, emphasize essential traits taken from everyday life identities in the archipelago. These are, for instance, the value of the former way of life, and the archipelago skills and knowledge that were part of it. They have deep meaning for local people, although they do not wish to limit the development of the archipelago only to protect and preserve a past way of life. In some respects, the aims of the development projects can be consciously opposed to the local archipelago identities. This is the case, for instance, when the goal is to create new forms of cooperation in the area. Then, for many people, these activities begin to overstep important island boundaries where a will exist to define life forms inside of these boundaries without the impact of the outside authorities. However, novel practices and relations in cooperation are established, if people working with the development processes are aware of these traits of the archipelago culture.

In the regional development, the best results will be reached if the local culture is not only used as an instrument in development

work but also as a basic understanding of local ways of act in the environment and among people. Knowledge and understanding of important traits in local culture should primarily be a part of the mode of activities of the development work. Then the essential power of culture will be used in development processes.

To better reach ecological sustainability, the relationship between humanity and nature needs to be uniformly redefined. We need cultural change to reach ecological sustainability, and thus we need changing and creative culture. The direction of cultural change everywhere, especially in our technologized world, is not necessarily towards a more ecologically sustainable world. There are tendencies towards the overuse of natural resources, even in areas where human beings have a strong commitment to nature. What we must do is guide this change, and apply the understanding that nature exerts power over human systems to all aspects of our future development.

In particular, if the sustainability of culture is seen only as the protection of the continuity of cultural heritage, there is a risk of stagnation of a living culture and ultimately the development of something that, whilst once ensuring sustainability, simply ceases to do so. Cultural change is necessary to ensure both cultural and ecological sustainability.

Therefore, it can also be argued that culture should not be seen as a dimension of sustainability, but rather as a platform for all dimensions of sustainability. This platform is a process that involves the development of all human activities; economic activities, social structures, human-nature relationships, and the instrumental use of cultural heritage are all defined and redefined through this process. ■



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JAMES SIMPSON

# St. Olav Waterway – A European cultural route through the Archipelago

Expert article • 2893

Standing before Turku Cathedral one will see several historic statues and monuments that hint at Turku's proud history. You may even notice a new milestone in front of the cathedral proclaiming Nidaros 1200km.

Nidaros Cathedral in Trondheim is the destination of all St. Olav pilgrimage routes; indeed, it was as important for pilgrims in northern Europe during Middle Ages as Santiago de Compostela or Rome.

St. Olav Waterway was officially opened on the 25th of May 2019 when over forty walkers left Turku Cathedral with a parchment. The message contained within was a message of friendship from Finland's Archbishop Tapio Luoma to the bishop of Trondheim and the people of Norway. It was carried by foot and over sea for two months by a rotating band of pilgrims, read out every day in small villages until it reached Nidaros Cathedral on 29.7, St. Olav's Day. This was the start of a new long-distance hiking route, but one steeped in a common Nordic cultural heritage that connects communities and illuminates trading and pilgrimage routes of the past.

Every long journey starts with a small step and all great endeavours start with a dream. The path is 1200km long and the dream was almost as long. A small group of enthusiasts from the small village of Nagu in the Finnish Archipelago dreamt of re-establishing an old heritage route and a historical connection over 3 Nordic countries to Trondheim. Through perseverance, a three-year Central Baltic Interreg project with partners from Turku and the Turku archipelago, Åland Islands and Sweden created an extension of the St. Olav pilgrimage routes to Finland.

The Cultural Routes of the Council of Europe were launched in 1987 to promote pan-European cultural heritage in a qualitative and accessible form to a wider public. There are currently 40 routes which undergo a strict evaluation ever four years, The Routes of Saint Olav Ways were accredited in 2010.

Pilgrimage is experiencing a modern resurgence, an interest that has not been seen since the Middle Ages and whilst modern pilgrimage is a reflection of past traditions, the renaissance has also created new traditions that connect communities and travellers through a common theme. We see the route not as a product but rather as a destination that spans borders of many regions and countries. This imposes challenges as well as opportunities as marketing budgets and tourist information are traditionally focussed on regional areas.

Whilst developing the trail focus was placed on creating services for long-distance hikers and pilgrims who are a new target group for the area. This in turn gives scope for new business models and opportunity for small local business. Over 50 workshops and training events were held for both the local population, SMEs, and potential new businesses in the archipelago. Most visitors have been domestic but international interest has been good from individual travellers and tour operators.

In addition to tourism development, cultural routes need to involve young people in both the development and activities along the route. There are a series of activities and a pilgrim's passport for children developed in cooperation with local school children and available free for visitors. The activities encourage families to visit churches and other historic sights along the route and complete small walks and challenges.

The route brought new tech to the archipelago in the form of an online platform and map database. This gives a seamless information channel to visitors in four languages and a selling platform for packages and individual experiential products.

St. Olav Waterway was awarded best product development in the 2020 Scandinavian outdoor travel awards and was accepted into Ruritage, a research and best practice sharing project run by UNESCO and The University of Bologna.

Tourism is a fast-changing industry, even more so under the Covid-19 pandemic. Travellers are increasingly searching for genuine experiences in safe, rural landscapes. They are looking for meaning in their holidays which has seen a boom in transformational travel of which pilgrimage is a part. Also, visitors wish to get a deeper contact to both the local culture and heritage of the area they visit.

We are thankful to a two-year grant from Finnish Ministry of Education and Culture. This enabled us to reach a broad audience during the pandemic, virtually through livestreams, 360 videos of the churches along the route and a walking app. And, future exhibitions, art projects and collaboration with youth groups for 2021 and 2022.

The journey does not end here. St. Olav Waterway is a step towards recreating Olav Haraldsson's last journey from Novgorod to Stiklestad in Norway where he died in 1030. A dream that will be realised in time for the St. Olav anniversary in 2030. ■



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HEIDI ARPONEN

# Mapping the underwater nature provides tools for the marine conservation and management of marine protected areas

Expert article • 2894

**M**arine biodiversity is threatened worldwide, due to human activities, and the Baltic Sea is no exception. The effective marine conservation and management of marine protected areas (MPAs) require extensive data concerning underwater species and habitats.

Historically, the knowledge of underwater nature in Finnish coastal seas has been scarce and fragmentary. To remedy emerging needs to know more about marine biodiversity, a Finnish Inventory Programme for the Underwater Marine Environment (VELMU), was launched in 2004, funded by the Ministry of Environment. VELMU is one of the largest, if not the most extensive, seabed mapping efforts in the Baltic Sea with over 140,000 observations made using scuba diving, underwater video filming and seabed acoustic scanning, as well as various benthic sampling methods. A large portion of the biological inventory work was conducted by the mapping teams of Metsähallitus Parks & Wildlife Finland. In addition to the VELMU programme, there have been several smaller EU-funded projects undertaking underwater inventories under the umbrella of national marine mapping effort. Metsähallitus Parks & Wildlife has conducted its yearly underwater inventories inside the conservation areas.

During the period from 2004 to 2017, VELMU-inventories produced a large amount of new information about the geology and biology of the coastal seabed for use in inter al. science, nature conservation and marine spatial planning. Gradually, the emphasis has moved from the extensive mapping of biodiversity towards more targeted species and habitat inventories, as well as further processing of the underwater data. Various computer software programmes enable the analysis of the collected georeferenced data, to produce advanced models of species and habitat distributions or the responses to environmental changes.

In marine areas, various socioeconomic interests meet and overlap. To enhance the sustainable use of the sea, effective marine spatial planning (MSP) requires knowledge of underwater nature values. In 2018, sites of high biodiversity in Finnish coastal areas were identified, when researchers from the Finnish Environment Institute combined VELMU-data with spatial conservation prioritization method Zonation.

The novel information of marine biodiversity hotspots was utilized when, in collaboration with numerous experts, 87 ecologically significant underwater marine areas (known in Finnish as EMMAs) were identified from the Finnish coast. EMMAs were used in national Marine Spatial Planning processes, to consider underwater nature values along with marine protected areas.

Marine inventories have generated more tools for species-specific conservation. For the first time, underwater data enabled thorough inclusion of marine underwater species in the assessment process of the IUCN Red List of Species in 2019. According to estimations, a proportion of marine underwater fauna and flora is endangered due to e.g., eutrophication, habitat degradation, and human-induced pressures. In the 2018 Red List assessment of marine ecosystems, several endangered habitat types were identified, including eelgrass meadows and sea bottoms covered with red algae or bladderwrack. Despite these mapping efforts, the need for even more accurate information still prevails and continues to emerge, since many species and habitat types were assessed as data deficient.

An ecologically effective and spatially comprehensive network of marine protected areas is essential in maintaining marine biodiversity. In Finland, although the network of protected areas is traditionally well developed, it is scattered spatially. The Finnish MPAs consist of Natura 2000 sites, HELCOM MPAs, Ramsar sites, national parks, private MPAs and Nature Reserves. These various types of MPAs largely overlap and differ in their legislative background. Natura 2000 sites form the core of Finnish MPAs. The EU Habitats Directive aims to maintain an adequate conservation status for habitats and species, protected by the Natura 2000 network. The condition of Natura 2000 sites is assessed periodically, and inventory data has brought new tools for evaluating underwater nature types, e.g., reefs, sandbanks, and coastal lagoons.

At present, 11% of Finnish sea areas, including its exclusive economic zones (EEZs) are under protection. According to Zonation analysis mentioned above, less than 30% of marine biodiversity features are covered with current MPAs. This is understandable since little information about marine species and habitats was available at the time most of the conservation areas were established. With enhanced data, conservation efforts can be targeted to better cover the underwater biodiversity, thus improving the functionality and representativeness of the MPA network. Knowledge of underwater nature can be utilised in enlarging existing MPAs or establishing new conservation areas. For example, in the Archipelago Sea, the current Natura 2000 site was enlarged to cover representative underwater reefs, while ecologically valuable eelgrass bottoms were purchased and added to the Archipelago National Park. Inventory data also enables underwater nature values to be included in MPA management strategies, e.g., the management plans of marine national parks.

Through various international and regional agreements, it is required that proportion of protected areas in our seas increases. The

Expert article • 2894

EU Biodiversity Strategy (2020) aims to halt biodiversity loss by 2030. In the marine realm, the target is to protect 30% of European sea areas, of which 10% would be protected by strict regulations. Through the comprehensive knowledge of benthic biodiversity gained through extensive marine mapping, Finland is prepared to meet both national and international requirements and to target conservation efforts in areas of valuable marine nature. ■

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MIKAEL WESTERLUND

# Towards a natural balance of ocean life, with innovation and eco-system partners

Expert article • 2895

**H**ow could we start a company, establish a business with a clear target to address the Sustainable Development Goal (SDG) 14? How can we positively impact the environment we live in and yet create economic growth? What businesses are successful fifty years from now? Is it possible to build a successful and sustainable business around and based upon these types of questions?

We, the founders of Origin by Ocean, are placing our bets on creating a company built from the start on sustainable, circular economy and circular nutrient principles and values. We extract and create value in our marine biomass refinery process.

Because of the enormous human population and our huge impact on our planet, we keep the future of our existence in our own hands. By changing our ways of using natural resources and with new behavior we can achieve the targets set in the United Nations SDG frameworks. This forced transition provides great opportunities for a new generation of companies and bold entrepreneurs fearless of the new and unknown. New companies with sustainability goals and values as a normal part of their operations are the winners of the future.

Origin by Ocean was born with sustainable principles and values at its core. Encouraged by this opportunity and powered by real Finnish "sisu", we are set to pursue our vision of a better planet for all of us, through sustainable use of cultivated and harvested marine biomass from our oceans. Our mission is cleaner water, cleaner oceans, cleaner life. We provide a strongly positive impact to our planet Earth, create new income opportunities in remote coastal and archipelago areas, alleviate the eutrophication problem of our oceans, boost biodiversity and provide sustainable ingredients for fast-moving consumables and applications. The UNOPS Global Innovation Challenge award we received in December 2020 is a great recognition of this fact. The European Union is making big bets on the Green Deal with 1 trillion Euros investments. This great initiative is a step in the right direction. It is clear that this new type of green or even blue sustainable businesses can and will provide a source for economic development in the long term, not only in the EU but globally.

Considering SDG 14, Life below water, and relating this to our local environment in the Baltic Sea, we see that Finland as a nation and part of the HELCOM agreement, still has to implement both nutrient reduction and removal actions to achieve the set targets. We apply the rules and power(s) of capitalism to solve this problem, turning it into an opportunity. Our business idea and commercial model enables a complete business ecosystem. By combining forces, we create a new value chain together to address this vast eutrophication problem of our oceans. Value can be created by solving this problem using the latest innovations in marine biomass refinery technologies, seaweed cultivation methods and blue green algae harvesting. The traditional

ideas and concepts of utilization of marine biomass typically suffer from low product and process yields, which both lead to relatively low value creation capacity. Overall value creation from the biorefinery is paramount to the birth of a sustainable business ecosystem. On the other hand, the ecosystem is key to drive this sustainable industry forward towards a global scale implementation and impact.

Our focus is on resolving the biomass processing pain-points and the building of a business ecosystem. Our biorefinery allows us to create new interesting business opportunities across the whole value chain. The business ecosystem is not limited to seaweed farmers and blue green algae harvesters but also includes enterprises involved in the manufacturing of different cultivation and harvesting equipment's and logistics services companies. Our global business is based on this model. Still, science and industrialization/commercialization of both seaweed cultivation and blue green algae harvesting is needed for us to reach the high impact we are in pursuit of. We aim at a similar industrial scale as for example that of forest industry. However, our case is built from the start on a sustainable business model, principle and foundation. In our work, we connect to the SDGs relevant to us: 1- No Poverty, 2-Zero Hunger, 8- Decent work & economic growth, 9-Industry, Innovation & Infrastructure, 12- Responsible Consumption and Production, 13- Climate Action, 14-Life below water, 17-Partnerships for the Goals. By connecting our business to these goals and by applying relevant metrics, we are monitoring our impact.

How to make a global impact? Finding constantly growing global markets and applications has been key to us. We are building our future on consumer market trends such as vegetarian diets, biobased ingredients for industrial applications, biobased packaging, biobased cosmetics and lab grown meat, amongst others.

Can Origin by Ocean make it? The future will tell, but one thing is clear; we need more initiatives like Origin by Ocean to reach our common interest of securing a livable habitat for our grandchildren. ■



MIKAEL WESTERLUND

Chief Business Activist  
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SANDER LOITE &amp; JONNE KOTTA

# Profitable mussel farms can clean up the Baltic Sea - just a dream or the real deal?

Expert article • 2896

**W**hat is suffocating the Baltic Sea  
Eutrophication — caused by excessive amount of nitrogen and phosphorus deposited into waterbodies — is the biggest environmental threat in the Baltic Sea. These nutrients literally over-fertilize the water body, resulting in massive algal blooms, reduced biodiversity, increased dead zones, and impeded ecosystem functions and services. Over 40 years of international efforts to reduce external nutrient loads have failed to solve the eutrophication problem. Despite significant reduction in external loads, the total phosphorus concentration in Baltic Sea waters continues to increase due to legacy phosphorus, which is previously deposited phosphorus released from seabed sediments. Future climate change is expected to enhance this nutrient release.

## There is still hope

The failure to control Baltic Sea eutrophication through external measures has called for supplementary in-situ (internal) methods to lower nutrient concentrations in the water column. Farming native blue mussel represents a vast yet untapped potential for eutrophication mitigation. Farmed blue mussels need no additional nutrients for effective growth. Instead, they feed on water microalgae and the positive effect of filtration by mussels on water quality is immediate. Importantly, subsequent harvesting of farmed mussels removes a significant amount of nutrients from the marine environment and thereby constitutes a sustainable, low-impact, circular and potentially cost-effective measure for eutrophication control. In addition to reducing eutrophication, mussel shells consist of mineralized carbon and mussel farming is a means to permanently removing carbon dioxide from the air, thus helping us to reach greenhouse gas targets. Preliminary research has shown that the predicted total area of farms needed to achieve nutrient reduction targets is attainable under the current maritime spatial planning environment in the Baltic Sea. Nonetheless, the actual sea space for mussel farms should be allocated carefully to avoid unacceptable environmental impacts or conflicts with other uses. The use of appropriate farming technology and harvesting, which is designed for the smaller and slower growing Baltic Sea mussels, provides remarkable production rates, cost-effectiveness, and also better nutrient content in the yield.

## Benefits

Applying relevant farming methods for the blue mussel is a profitable and sustainable way to remove nitrogen and phosphorus from the Baltic Sea and to capture excess atmospheric carbon. Mussel farming not only provides a tool for nutrient mitigation, but also contributes to the social and economic sustainability of rural areas. Furthermore, farms are seen as a restoration measure to supplement natural mussel reefs lost to anthropogenic impacts.

When available in a sufficiently large amount, mussels can provide a new sustainable protein resource for animal feed and the

food industry or serve as a biological alternative to chemical fertilizers. Mussel meal is a good raw material and feed ingredient with no detriment to the growth and health of chickens. Sustainably produced blue mussels have a growing market because of their expanding field of application in different industries. In addition to animal feed and human consumption, a range of valorization options exist for mussel meat and shells. Mussels are known to be a reserve of valuable compounds such as bioactive proteins, minerals, pigments, enzymes etc. This leads to a solid potential to use these components to produce high value food supplements, biocosmetics, and so on.

## Next steps

We need more data on the large-scale ecosystem effects of mussel farming as well as advances in the technical aspects of mussel farming and use. While additional research is desirable and is likely to take place, particularly if there are further innovation calls or programmes at the EU level, other factors, such as regulation, play a role in how fast these developments can proceed. We still lack appropriate support to cover for the ecosystem services provided by mussel farms. This means that mussel farming should be legally accepted as an important nutrient mitigation measure in the Baltic Sea region as soon as possible. Along with this acceptance, there is a need to develop and agree on a certification scheme using indicators based on standardized monitoring data. A system in which mussels are produced, converted into a value-added product, and sold profitably on the market, will attract the interest of investors, contribute to innovative blue growth, and promote the reduction of nutrients in the Baltic Sea. ■



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MARKKU SAIHA

# Herring with driftnets

Expert article • 2897

**H**ere in Finland, we have long talked about local food, sustainable food production and the carbon footprint. This year, the security of supply also became part of the debate. As usual, it's a long journey from conversation to decisions.

Where the improvement of the state of the Baltic Sea is concerned, these topics have rarely been present. It is well known that fishing is the cheapest way to improve the quality of water as it removes nutrients, while at the same time providing healthy food in a sustainable fashion. Here in Finland we have not yet turned our food situation into a problem, but the changes caused by the pandemic showed, however, that we should prepare ourselves. History can teach us and provide solutions in this regard as well.

Before the time of independence, more than a century and a half ago, there was no national plan in Finland to make ends meet in food production. The problem with agriculture was the dependence on bread grain, and the sowing area for rye accounted for almost half of it, while the rest was barley and oats. The reason for the popularity of rye was its suitability for the harsh farming environment, it had to withstand cold and give a reasonably good harvest.

The signs of danger were in the air in the autumn of 1866, when the rainy autumn slowed down the sowing of rye. The following winter was exceptionally cold and the Baltic Sea, for example, froze in its entirety. In the spring of 1867, many farmers were faced with a desolate sight: most of the rye shoots had been destroyed. Barley was now expected to ease the situation, but this hope also withered with the late arrival of the summer. During the hunger years of 1867–1868 mortality became exceptionally high.

## The first EU-project?

Something had to be done, and we began a rapid reform in agricultural production. The time of cold and long winters had also been tough in the coastal areas, but fishing had already been developed before, and the harsh times somewhat easier than inland.

The development was considerably accelerated by a new project. In the summer of 1864, a Gotland fisherman was hired to train herring fishing, and he brought his boat and fishing gear over the sea to Kökar in the Åland Islands. For the next summer, three fishermen were already hired, and in the third summer many of the archipelago villages had fishermen learning the new skills and driftnet fishing quickly spread to the Åland Islands and the counties of Turunmaa, Ostrobothnia and Uusimaa as well.

The training of fishermen was inspired by an organisation whose mission was to compensate for the devastation of the Crimean War (1854–1855). In 1861, H.J. Holmberg, a state fisheries inspector, was sent to the Netherlands to investigate why there was such good herring on the market. The survey was supposed to cover the methods of preparing the fish. However, Holmberg concluded that the reason for the good fish at the market was not in the preparation methods but in the fact that herring was caught out in the open sea. This resulted in the idea of using the expertise of the Gotland people, and through a local priest and the Russian consul of Visby, the fishermen were contacted.

At the same time, local fishing practises were developed elsewhere. Of necessity. In Satakunta home region studies from

1911, S. Linnainmaa writes about fishing on the coast of North Satakunta, and states that "in 1862 then begins the fishing method that is most common today, viz. driftnet fishing in the high seas, that is going to "rääki". It is invented in the islets of Ahlainen. The inventor is Kustaa Vesterlund, the host of Talloora island, who is locally well remembered for his many ingenious initiatives."

Tradition has it that Vesterlund had heard from Swedish fish buyers that somewhere in the south abundant herring had been caught using a new catching method. Once the idea was clear, the host of Talloora started weaving the nets and went out fishing. New fishing method was quickly adopted. Driftnet fishing was an important part of fishing culture on the coast of Satakunta and it played a key role in alleviating the food crisis in the years of food shortage.

The diverse fishing method, which began on Talloora island and spread to the entire Finnish sea area at the end of the 19th century, produced new innovations in boats and fishing gear as well as in the operating models of the coastal communities. The changes were reflected in various changes in the landscape and in the population of the archipelago as well and helped start a period of prosperous industrialization.

The 145-year history of driftnet fishing ended in 2007 with a European Union decision banning all driftnet fishing in the Baltic Sea.

Fish was caught and there was enough of it as far as the herring could be transported to the province. For a long time, the fisherman was a valuable part of food supply in our country and he put his two cents in the production of sustainable, low-carbon local food. ■



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MARKKU LAPPALAINEN

# Eagles and seals are back, but the sea is still feeling bad

Expert article • 2898

I sit on the outer islet, with only waterstones and small tree-free islets in the view. In the north, there are larger islands, far behind them the city of Turku and mainland Finland. In between the labyrinth of the Archipelago Sea.

On an islet nearby stands a familiar figure, a brave hookbeak – a White-tailed Eagle. In fact, there are several eagles in the landscape. Tops of islets and beacons assisting navigation of ships are for eagles the vantage points where they stay seemingly lazy days for long.

The morning is calm and peaceful. Since night, there has been mysterious sound in my ears – like howls of wolves – hear from the group of outer islets. With binoculars, a confusing sight emerges in the eyes: the islets are from shore to top full of large, magnificent creatures. Like sacks, gray, brownish.

Grey Seals are resting on islets. Most of them are intensely sleeping, a few howl with their mouths wide open, some have an ongoing showdown. At first glance, there seem to be dozens of them. More specifically: hundreds and hundreds more. The final calculation is a four-digit number.

When I moved to Turku more than 40 years ago to start my job, I started to get acquainted with the Archipelago Sea. The White-tailed Eagle and Grey Seal were almost mythical creatures at that time. A hard-working wanderer saw eagle every now and then. Seals hit the front even less frequently, once or a couple of times a summer. The top predators of the marine food-chain had declined to the brink of extinction due to biocides.

Over decades, a miracle has happened: the White-tailed Eagle and the Grey Seal have returned and are doing well nowadays. Now you can see more eagles in one place from one seat than there were them four decades ago in the whole archipelago. From one location can be counted more seals than at that time was the estimated population in the entire Baltic Sea.

As the largest unified archipelago in the Baltic Sea, the Archipelago Sea is unique as a natural formation. It contains more than 40 000 islands and islets with a wide range of different waters between them.

Measured by biodiversity, in Finland there is no other as valuable area as the Archipelago Sea. Here meet north, south and southwest surrounded brackish water. This archipelago is an environment for an exceptionally large number of endangered species and habitats.

There are dozens of in European scale especially valuable habitats in the Archipelago Sea. Fragmentary landscape, zonality, variability of soil and seabed increase the biodiversity. The spectrum of habitats and species changes when moving from the mainland to the outer archipelago, from rocky islands to gravel islands, from soft seabeds to rocky bottoms, from shallows to grooves.

Many of the valuable terrestrial environments in the Archipelago Sea have developed as a result of long term human impact. Such are various pastures, leaf-meadows and moors have overgrown as a result of uninhabitation and decline of local living. Species specialized

in them are threatened without support. Before the landscape was cared for by cattle and man, now traditional landscapes are taken care of by voluntary conservationists.

A calm mature summer day on outer islets is completely different from the day a couple of months ago. Gone are seals that rested on islets in a thousand-headed flock. Eagles are not visible, either. A few terns are speeding in the air, a wagtail bobs on a cliff. The view is confusing: open water is covered with green mash. Blue-green algae “bloom”.

The blue-green algae masses that boundlessly covers the open water reflects the biggest concern of the sea: eutrophication. Worrying times are being lived underwater. In spring, rockweed boldly swaying on rocky bottoms and eelgrass on sandy environment – suffer from nutrients. Nausea of these key species strains the entire brackish water ecosystem.

The effects of climate change also extend under the waves of the Archipelago Sea. The shallow and Baltic Sea is the fastest warming sea in the world due to low quantity of water. Increased precipitation in the catchment area has reduced the salinity of seawater so that originally marine species like rockweed and eelgrass are queasy. Precipitation and especially strong winter condensation have increased nutrient leaching from mainland.

Eutrophication is a result of decades of nutrient loading. Old sins feed the sea, although many sources of emission – such as municipal wastewater – have been significantly reduced. In addition to the internal load, agricultural nutrients all the time increase nutrification of the sea.

Small nutrient brooks eventually form larger streams, controlling them is the key challenge for marine conservation in the Archipelago Sea. The nutrients belong to fields, not to the sea. It is also economically and ethically sustainable to use nutrients for growing crops. ■



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# Ecological compensations as an emerging protection tool

Expert article • 2899

**W**e humans like thriving societies and economies. So far this has meant pollution, conversion of land cover for human needs and intensive use of natural resources, all of which is intensifying climate change and biodiversity loss. Meanwhile, it is evident that humans are dependent on healthy ecosystems and services they provide us.

We have learnt to curb pollution, but biodiversity loss is said to be the most serious problem facing humanity. Traditional nature conservation areas protect some parts of nature, but in spite of them and other conservation activities, biodiversity is declining. Ecological compensations are said to be part of the solution.

EU biodiversity strategies have emphasized no net loss (NNL) of biodiversity as an EU level aim and many national biodiversity strategies have the same aim. Achieving NNL requires that all biodiversity losses that cannot be prevented – prevention must always be the first step – are compensated i.e. offset. Ecological compensation can mean e.g. restoration of degraded habitats, creation of new wetlands or managed relocation of species. There are many ways to implement compensations in practice: developers can complete offsetting themselves, or buy offsetting services from private companies ('habitat banks'). Sometimes the developer pays the state for offset activities.

Biodiversity offsetting was introduced already in the 1970s in the US and Germany. Now about forty countries have mandatory compensation policies concerning at least some species or habitats. Legal requirements for ecological compensations are different in Finland and Sweden.

## Sweden

The Environmental Code and the underlying regulations have general requirements for precautions, requirements for environmental impact assessments of the extent to which it is possible to remedy likely environmental effects and offer an opportunity to impose compensatory measures in the event of infringement of public interests. The latter rule applies when assessing permits and dispensations (e.g. biotope protection). Compensation may mean replacing environmental values in an area with similar values in a corresponding area or of other conservation benefits being created elsewhere.

The Environmental Code contains rules on the protection of endangered species and habitats, on Natura 2000 sites, and on area protection (nature reserves), etc. In connection with species protection issues, dispensation is often subject to various compensatory measures. In addition, ecological compensation is required in the event of intrusion or damage in nature reserves and Natura 2000 sites.

There is nothing specific about biodiversity being protected in the Planning and Building Act and the question of how to compensate for biodiversity losses in relation to exploitation is predominantly unregulated. Nevertheless, and in terms of detailed development planning or other exploitation, a municipality can regulate how exploitation is to be carried out in order to ensure that no net loss of

natural and recreational values (as well as other ecosystem services) occurs. This can be done in development agreements or other agreements.

## Finland

In Finland there is also a legal obligation to offset biodiversity losses, but only in the case of deterioration of Natura 2000 conservation sites and there have not been any such cases yet. Nevertheless, in some infrastructure projects (e.g. building tramlines and roads), ecological compensations have been voluntarily used to protect endangered species.

The recent environmental impact assessment (EIA) of the faster train connection between Helsinki and Turku provides an example of voluntary compensations. In the EIA report offsetting suggested related to certain critically endangered species, whose habitat is going to be destroyed; new habitats for these species would be created. A new habitat for a frog species will also be created. Two nature conservation areas and habitats of other protected species will also be partially ravaged by the railroad. As for these areas, there are no plans to compensate.

## Future challenges

In either of the countries, legislation does not provide general, direct and clear protection of biodiversity when planning for construction and other land use or in the establishment of activities in individual cases.

Finnish Nature Conservation Act is currently being reformed and ecological compensations are most likely going to be part of the new act, probably related to a limited number of endangered species or habitats. Based on research, it is clear that this is not enough. Achieving no net loss of biodiversity requires a wider approach and biodiversity should be considered on a larger scale in e.g. land use planning and infrastructure and other projects. Otherwise 'the death by a thousand cuts' continue. As the awareness of biodiversity decline is growing, also the willingness to act – and even to compensate – is slowly increasing. ■

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MINNA SARVI

# Towards sustainability in manure and nutrient use

Expert article • 2900

**M**anure, a valuable source for nutrients and organic matter, is currently an undervalued resource in agriculture. In the Baltic Sea Region (BSR), and at the EU level in general, manure represents the largest source for recyclable nitrogen (N) and phosphorus (P) and, if used efficiently, it could replace much of the current mineral fertilizer use.

However, manure is not regionally evenly distributed. In the BSR countries, there are both intensive livestock production areas where manure is produced over the regional P fertilization need, and crop production areas in need of P. The situation hinders efficient use of manure nutrients and causes increased risk for nutrient losses in areas of surplus nutrients. Losses happen also at farm level, if manure is not managed properly during housing, storage and spreading.

Currently, according to Helsinki Commission (HELCOM) about 47% of the total N load and 36% of the total P load to the Baltic Sea originate from diffuse sources, mainly from agriculture. To decrease the losses, measures for more sustainable manure and nutrient use in the BSR are needed both at farm and regional levels. Policy recommendations for such measures are drafted in SuMaNu project. SuMaNu is a project platform of four agro-environmental projects funded by Interreg Baltic Sea Region Programme and coordinated by Natural Resources Institute Finland (Luke). SuMaNu supports the development of a transnational Regional Nutrient Recycling Strategy and the update of the Baltic Sea Action Plan as part of HELCOM actions.

At the farm level, fertilization on field plots should be based on national crop-specific guidelines for economically and environmentally optimal fertilization rates. The guidelines should take account crop-specific N and P needs, nutrient status in soil and plant availability of P in the fertilizing product.

Currently, all coastal BSR countries as Contracting Parties in HELCOM have agreed to set maximal manure P use to 25 kg P/ha. However, not all countries have implemented the limit and there may not be any regulation at all for manure P use. Instead, manure is often applied according to its N content, leading to overfertilization with P.

Sufficient manure storage capacity should also be guaranteed to enable fertilization with manure only during spring and summer when crops take up nutrient efficiently. Autumn spreading should be allowed only for the establishment of winter crops. In addition, best available techniques both in manure storage and spreading should be put into practice.

Knowing the nutrient flows in a farm would help the farm to improve its nutrient use efficiency (e.g. fertilization). One tool for this could be annual calculation of farm-gate nutrient balance including e.g. sold and bought animals, bought feeds, crops, sold products (e.g. milk, eggs), purchased seeds and mineral fertilizers. Results would indicate potential needs for enhancing the nutrient use efficiency and possible nutrient surpluses to be exported to other farms or, in the case of regional P surplus, to other regions. Manure processing might be needed to reallocate manure P especially in the latter case.

A prerequisite for sustainable reallocation of manure nutrients between regions is information on regional nutrient needs of crops and the available biomass quantities and their characteristics. Again, reallocated nutrients should be applied to fields according to the crop need to avoid overfertilization and thus decrease nutrient losses to waterways. Thus, not only manure processing is needed, but also markets for manure-based recycled fertilizers should be created. Incentives both to produce and to use these products should be available, new practices should be demonstrated and knowledge transferred across the sectors.

Manure and manure-based fertilizers should also be hygienic and concentrations of contaminants must be on adequate level. To minimize the risks, co-processing of manure with sewage sludge is not advisable as sewage sludges contain more often and more diverse contaminants than manure. Unnecessary use of especially antibiotics in animal rearing, but also trace elements (e.g. copper, zinc, arsenic) in feeds, should be avoided to minimize the risk for antibiotic resistance and trace element accumulation to the soil. To ensure high quality manure-based fertilizers, EU regulation on fertilizing products (EU 2019/1009) should be obeyed throughout the EU as a minimum requirement for all manure-based fertilizers regardless whether or not they are intended to internal EU markets. It should also be investigated if the unnecessary use of pharmaceuticals, especially antibiotics, in animal rearing, could be regulated at the EU level.

All these measures together could decrease agricultural nutrient losses to the environment, maximize the fertilizer value of manure and help the agriculture in the BSR take an essential step towards improved sustainability and resource efficiency. ■



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# VELMU data have many uses

Expert article • 2901

**S**olutions and decisions based on information are generally the easiest to accept, the most sustainable, and more transparent. In addition, the accuracy and reliability of the information are important aspects, especially in areas where few people are able to check things for themselves. This is the case with regard to seas. Looking at the map and the sea from the shore, the area seems to be one and the same blue entity, so one could assume that the same monotony would continue below the surface as well. But a peek below the surface gives a very different picture. The subsurface world is as diverse as the area above the surface, with its valleys, depressions and hills. In order to plan activities sustainably or protect important natural values underwater, we need knowledge of their location in the sea. Up to the year 2000, data on the underwater nature of the sea were scarce. At the same time, however, pressures on the use of sea areas began to rise and the need for protection began to extend below the water level, along with the Natura 2000 network.

In 2004, under the leadership of the Ministry of the Environment, it was decided to launch the Finnish Inventory Programme for the Underwater Marine Environment (VELMU). The aim was to get an overview of the distribution and volume of underwater species and habitats. Simultaneously, a data management system and a map template had to be developed to visualise the collected data and make them available to everyone.

The aim was to involve as many maritime actors as possible, not only those who produce data but also those who use the data collected. The goal of the broad-based structure was to be transparent in all operations. VELMU's progress is monitored by a steering group consisting of representatives of eight ministries and the bodies appointed by them. Planning and implementation of practical work is the responsibility of the project group, which comprises representatives of bodies that carry out mapping work at sea, such as Parks & Wildlife Finland, the Natural Resources Institute Finland and the Geological Survey of Finland, Åbo Akademi and some ELY-centres. The Finnish Environment Institute, processes the collected data and serves as the coordinator of the programme.

## Collection and processing of data

Mapping the seabed is slow and expensive; it's like trying to outline the landscape from above a cloud cover. Many types of tools are available, but none of them can work alone. Diving and sampling provide accurate data from a small area, while video recordings or a remote-controlled underwater robot can provide an overview of the area. In addition, data are collected on the depth and composition of the seabed, for example by side-scan sonar imaging. Because not every square metre can be studied, the nature and background data collected provide probabilistic models of the occurrence of species and habitats. The functionality of the models varies, but some have been so good that new occurrences have been detected in new areas. Other methods include remote sensing methods, such as the utilisation of satellite images. The data collected can be found in the VELMU Map Service, available to everyone.

## Data use

So far the VELMU programme has collected observations from more than 160,000 points. These data have been used very widely. When assessing the endangerment of habitats (2018) and species (2019), it was possible for the first time to include, for example, algae species widely in the assessment. Despite this, however, we still have many species and habitats for which data are incomplete, for which reason data collection continues.

At present, the Finnish network of protected areas covers about 11% of the marine area. However, the Zonation analysis, which utilised VELMU data, has been able to show that the current network of protected areas does not adequately cover underwater conservation values. At the same time, the European Union's recently adopted Biodiversity Strategy for 2030 aims to protect 30% of Europe's marine area, and 10% of this must be strictly protected by 2030. VELMU data are in demand.

In support of Finnish marine area planning, 87 ecologically significant Finnish underwater marine nature areas (EMMA) were described by utilising, among others, VELMU data. In addition, the data have been used, for instance, in some regional land use plans, in spatial planning of wind power and in EIA processes. With systematically and scientifically collected data, we can protect nature, but also enable activities that do not harm nature while creating a basis, among others, for blue growth. Climate change and its impact on marine nature also bring new challenges that we must prepare for.

In 2020 the European Commission granted VELMU the Natura 2000 Award in recognition of VELMU's successful in promoting biodiversity in the Finnish marine area. ■

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SARI LUOSTARINEN

# Manure data as a prerequisite to its sustainable use

Expert article • 2902

**M**anure is a natural by-product of animal production. It is meant to be recycled back into the field soil to provide crops with nutrients for higher yields and soil with organic matter for maintaining its good condition.

Manure cannot be spread on fields in any quantities or it may cause adverse environmental effects due to nutrient losses into air and waters. In the Baltic Sea region, eutrophication is one of the main concerns threatening the good status of the sea. Manure is one factor posing a risk to nitrogen and phosphorus leakage from agricultural areas.

In the Baltic Sea region, the amount of manure spread is limited by its nutrient content, the characteristics of the soil and the needs of the crop produced. However, the regulation varies between the countries and may not be sufficient to ensuring sustainable manure use. It may still allow e.g. too high doses of manure phosphorus if only nitrogen is used as the limiting nutrient. The regulation may also allow spreading without subsequent sowing due to too low manure storage capacity required. Also, the segregation of animal and crop production causes regional concentration of manure resulting in surplus manure phosphorus and ineffective use of manure nutrients.

To enable more efficient manure use, one vital factor is information on its quantity and composition. Fertilization planning on farm and regional scale is dependent on knowing the nutrient content of manure. Also, data on manure quantity is important as it determines e.g. the manure storage capacity needed to spread the manure only during the growing season.

The excreta from different animals (cattle, pigs, poultry etc.), age groups (e.g. heifer, calf, bull, cow) and production levels (e.g. milk yield, slaughter weight) varies in quantity and composition due to differences in feeding and animal metabolism. Furthermore, the technology choices in animal houses affect the quantity and composition of resulting manure. Manure types to be produced vary from dilute slurry to deep litter with high dry matter content. To know the quantity and composition of these manures is no easy task and they also need to be known on different levels from individual farms to regional and national level. While a farm needs the data for planning and implementing proper manure management and use, on regional and national levels the data is needed to assist in directing animal production and nutrient recycling into more sustainable solutions.

The alternative methods for generating manure data are either manure sampling and chemical analysis or mass balance calculation of which only the calculation enables estimation of manure quantity. Sampling and analysis may work for farm scale; provided that the sample is representative and the analysis methods are suitable for a heterogeneous matrix such as manure. To use this method for a national average of different manure types ('table values'), a large dataset of analyzed manure samples is needed.

Mass balance calculation can be used on farm, regional and national scale, but it requires detailed background data to provide

high-quality results. The calculation proceeds in three steps: the excreted feces and urine are calculated as the balance between animal uptake of feed and intake as growth, reproduction and product yield (milk, meat, eggs). The excreta are then calculated further as part of manure management in the animal house depending on the technology used, i.e. additions (water, bedding) and gaseous losses are accounted for to provide manure removed from housing. The third step calculates the changes during manure storage, i.e. additions (rain water) and losses (gaseous) to provide manure to be spread on fields.

At the moment, the Baltic Sea countries use different methods for determining manure data. The data is also updated variably, with some countries updating annually and some operating with old information, not comparable to current animal production. The precision of manure management and use as a fertilizer may thus be unequal starting already from the data on manure quantity and nutrient content.

Recommendations for more harmonized and regularly updated generation of manure data were made during the project Manure Standards (19 partners in all Baltic Sea coastal countries, coordination: Natural Resources Institute Finland, main funding: Interreg Baltic Sea Region Programme). The recommendations include specific tools for generating proper manure data (instructions for taking representative manure samples and using proper analysis methods, mass balance calculation tools for farm and regional level) and a vast amount of information on the importance of updated, precise manure data for effective manure use and reduced emissions to air and waters.

The recommendations have also been implemented by Helsinki Commission (HELCOM) as a policy tool to improve the precision and harmonization of manure data in the Baltic Sea region. The ultimate aim is to improve nutrient recycling and reduce emissions.

The use of manure as a fertilizer is important for recycling nutrients already present in the food system. To enable it with efficiency, many changes are needed. The first one in the chain is proper and updated knowledge on manure quantity and composition as the basis of manure use. ■



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# Protection Fund for the Archipelago Sea finances concrete water protection actions

Expert article • 2903

The Archipelago Sea located in Southwest Finland consists of thousands of islands and is a unique place in many ways. No wonder that the Archipelago is one of the most popular places to spend summers, both inland and on the sea. It is also a place many people call their home. But unfortunately not all news is good: the shallow Archipelago Sea has become one of the most polluted part of the Baltic Sea, and is the last HELCOM Hotspot in Finland.

The current state of the Archipelago Sea is a sum of many factors. The biggest threat for the Archipelago Sea is eutrophication. In addition, hazardous substances and human activity threat the Sea.

## Protection Fund for the Archipelago Sea

Despite the current challenges, change is possible. In Centrum Balticum Foundation, we envision a Sea that is healthy and an Archipelago that is a good place to live, work and relax.

In 2007 words were put into action: Protection Fund for the Archipelago Sea was founded under Centrum Balticum Foundation. The target area of the Fund is the Finnish Archipelago and its catchment area.

The Fund aims at reducing nutrient burden running into the Sea, raising awareness and promoting civil activity. To reach the goals, it finances concrete water protection projects with donations received from individuals, companies and associations.

Through diverse partnerships ranging from local music festivals to boat expos the Fund reaches out to a vast audience and calls for action to save the sea.

The Fund has also cooperated with a Finnish artist Stefan Lindfors who created a sculpture Symbiosis that is located by the river bank in Turku, Finland. The sculpture is covered with donated nameplates by individuals and companies who want to support the protection of the sea.

The Fund is proud to have support to its work even from presidential level. The President of Finland Sauli Niinistö and the spouse of the president Jenni Haukio were the first to accept the nomination "Conservationist of the Archipelago Sea". The Conservationists are advocates for the Sea, and commit to improve its well-being in their own actions and to raise awareness of the matter.

## Concrete actions to help the Archipelago Sea

Concrete water conservation projects are in core of the Protection Fund. Through the project funding, the Fund supports diverse actors in the region and offers an important platform for citizens to realise their own ideas to improve the state of the Sea. For many of those working in the projects, the actions even have a very personal impact: the work is carried out in areas where project implementers live and spend their free time.

The projects focus mainly on reducing the nutrient load to the Archipelago Sea and raising awareness on water protection. The Fund can also award grants for thesis that align with the Fund's principles.

To reduce nutrient load, we need innovative solutions that deal with, for example, agriculture, waste water management and sailing. The Protection Fund has addressed this by funding activities that include building of buffer zones, placing septic tanks in harbours, boat bottom scrubbing and developing waste management.

We also believe that education is the basis of sustainable solutions. For this reason, the Protection Fund grants funding for awareness raising, environmental education and civil society involvement in. As a result, the projects have produced informational material, monitored the water quality, shared best practices in local communities and piloted new ways of working.

It used to be possible to see deep down below the surface in the Archipelago Sea, but not anymore. However, with committed actions, we can help the Sea to slowly heal. Our mission is that our grandchildren have a clearer future ahead – they will see to the bottom again. ■



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Co-funded by  
the Centrum Balticum Foundation,  
the City of Turku, the John Nurminen Foundation,  
and the Turku Chamber of Commerce