A BLUE NEW DEAL FOR THE OCEAN AND HUMANS

For thriving Coastal Communities through a resilient Baltic Sea

A policy report for Rasmus Andresen
Member of the European Parliament (MEP) /
THE GREENS / EFA in the European Parliament

Regional focus: Baltic Sea

Thematic focus: Eutrophication, Aquaculture and Fisheries considering Social Justice and Sustainability Criteria

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1. Ocean and humans

"I am thinking of a summer on the Baltic when I was a child: how talkative I was to sea and forest; how, filled with unaccustomed exuberance, I tried to leap over all limits with the hasty excitement of my words. And how, as I had to take my leave on a morning in September, I saw that we never give utterance to what is final and most blessed, and that all my rhapsodic Table d'hote conversations did not approach either my inchoate feelings or the ocean's eternal self-revelation" (Rainer Maria Rilke)

Source: https://visibleearth.nasa.gov/images/53983/baltic-sea

We humans love our ocean as it gives us so much. We sail and surf across it. We swim and dive in it. Or we walk along its coastline and listen to the sound of the waves to relax and recover. Especially during the Covid-19 pandemic, many of us have felt the benefits of being able to get outside near the ocean and coastline for our health and wellbeing very clearly. The ocean has provided people with food, goods and ecosystem benefits for centuries. Besides providing livelihoods to millions of people and sources of revenue for governments and industries, the ocean has also brought many more non-physical elements into our lives. Many people have a special and more emotional connection to the ocean where it provides a space for inspiration, creativity and imagination for innovators, creators of new ideas, writers, singers and artists. From a very young age, we may have encountered or even empathised with the marine species that inhabit the ocean as unique and essential beings in our world.

Yet, despite these important roles through which the ocean touches everyone's lives, what do we humans give back to the ocean? We use the ocean as a dumping place for what is no longer needed: For decades, human activities such as intense agriculture have led to excess nutrients entering the ocean resulting in toxic algal blooms and oxygen depleted dead zones. The North and the Baltic Seas have been used to dispose of war bombs and nuclear waste. Drilling activities have resulted in oil pollution, and plastic is entering our ocean in drastic amounts with devastating effects on marine life. Our increasing wish to ship ourselves and all kinds of goods back and forth across the ocean often comes along with noise levels and ship strikes which seriously harm marine mammals and other aquatic species. We have caught so many fish that many species have disappeared or their populations are on the verge of collapsing. And often, we capture those fish in ways that rip up the seafloor, destroying their habitats and severely harming local marine biodiversity. And although this is already a lot for the ocean to cope with, it does the humans even more favours. So far, the ocean has taken up more than 90% of the heat related to global warming[1]. Additionally, 25% of anthropogenic CO_2 emissions have been taken up directly by the ocean, further mitigating climate change. But both oceanic warming and direct CO_2 uptake have devastating effects on marine life through deadly heat waves, ocean

[1] The Ocean has warmed unabated since 2005 and its rate has more than doubled since 1993. Ocean warming dominates the increase in energy in the climate system, accounting for more than 90% of excess heat between 1970 and 2017: PCC, 2019: Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, M. Nicolai, A. Okem, J. Petzold, B. Rama, N. Weyer (eds.)]. Available online: https://www.ipcc.ch/srocc/chapter/summary-for-policymakers

acidification and deoxygenation[2]. Unabated, climate change impacts will severely impact the lives of future generations of marine wildlife and us humans living on land.

In short: Our ocean has done a lot for us. It is time for a new deal between the ocean and humans: A Blue New Deal! A deal that leads to a healthy ocean to also allow future generations to connect with the ocean and enjoy its full potential while protecting marine life.

The importance of our ocean for Europe can hardly be overstated. Besides the ocean's key role in regulating both local and global climate, our ocean is also pivotal for the European economy, which continues to grow with increasing interest in the blue economy. In 2017 for example, economic activities related to our ocean produced a gross profit of EUR 74.3 billion employing around 4 million people, which shows an increase of half a million since 2011[3]. Additionally, the economic assets within 500 m of the sea around Europe have an estimated value of EUR 500 billion to 1000 billion[4]. Simply thinking about the sheer size of the European marine areas can be hard to grasp with our often "landlocked" perspective, as the area of sea controlled by EU Member States is actually larger than the total land area of the EU. In fact, when including outlying regions, European marine areas constitute the world's largest maritime territory. Even thinking about our ocean from a purely human perspective with regards to our daily lives, 41% or almost half of the EU population live less than 50 km from the sea[4]. Despite the core role of the ocean for climate change mitigation and adaptation, the ocean is only an instrument of the transformation set out in the **European Green Deal** through the prism of the blue economy.. Therefore, the establishment of a **Blue New Deal** for people and the sea in Europe is crucial.

Despite the importance of the ocean for the EU[5], major EU policy instruments are not aligned with ocean protection. While a framework is in place to protect the marine environment, the EU's

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[2] IPCC, 2019

[3] https://ec.europa.eu/jrc/en/news/how-big-eus-blue-economy-eu-report-potential-coasts-and-oceans-provide-sustainable-economic-growth

[4] https://www.eea.europa.eu/themes/water/europes-seas-and-coasts

[5] The European Union (EU) is committed to promote the sustainable use of the oceans and protect marine ecosystems. The Treaty on the Functioning of the European Union (TFEU) requires the EU to integrate environmental protection and sustainable development into its policies (Art. 7 and 11 TFEU). By virtue of the Treaty on the Functioning of the European Union, the EU has an exclusive competence in the conservation of marine biological resources under the Common Fisheries Policy (Article 3), while its competence is shared with Member States for fisheries (excluding the conservation of marine biological resources) and environment (Article 4), the most relevant of which for the ocean are set out in the Marine Strategy Framework Directive (MSFD) and the Birds and Habitats Directives (BHDs).

actions have not restored seas to good environmental status by 2020 as was aimed for, nor fishing to sustainable levels in all EU seas.[6] The protection of the marine environment of the Baltic sea is at a 'correct' level with regard to political ambitions, but 'poor' or 'bad' in terms of overall marine biodiversity condition. Identifying the regulatory and administrative changes necessary to protect sensitive species and habitats, strengthening the interactions between EU policy areas and relevant institutions beyond fragmentation, as well as increasing the potential of EU funding is crucial to close this big action gap. For example eutrophication driven by intensive agriculture and the associated fertiliser use is one of the key issues in the Baltic Sea. However, the Common Agricultural Policy (CAP), which accounts for a 33.1 % of the EU budget (55.71 billion in 2021) does not direct **any spending towards the Ocean**'s United Nations Sustainable Development Goal (SDG 14)[7]. Thus A **Blue New Deal "cross check" of all EU legislations** congruent with marine and coastal policy, taking into account the complexity and interlinkages between humans and the ocean is needed.

The regional focus of this policy report, as a **starting point for an European Blue New Deal**, is the Baltic Sea, as there is a **window of opportunity through the HELCOM ministerial meeting in Lübeck, Germany on October 20, 2021**,[8] to take political action. The Baltic Sea is one of the world's most polluted seas. HELCOM is the Baltic Marine Environment Protection Commission established through the 1974 Helsinki Convention, which was updated in 1992 and as such, entered into force in 2000. The EU as a body and its eight EU member states surrounding the Baltic Sea (Germany, Denmark, Sweden, Finnland, Estonia, Lithuania, Latvia and Poland) plus Russia are the contracting parties to this convention. Germany holds the HELCOM presidency from July 1, 2020 until June 30, 2022 and thus is in the unique position to show true leadership in protecting our ocean.

The future we envision is that of a thriving Baltic Sea region with healthy marine ecosystems, high employment and resilient coastal communities that are able to connect with the Baltic Sea and enjoy the many recreational opportunities it provides sustainably. Our vision for the future is a holistic one based on co-benefits for people and the environment where no one gets left behind. We imagine cities with many new green and blue spaces, like parks and ponds, that not

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6 https://www.eca.europa.eu/Lists/ECADocuments/SR20_26/SR_Marine_environment_EN.pdf

7 Scown, M.W., Brady, M.V., and Nicholas, K.A. (2020). Billions in misspent EU agricultural subsidies could support the Sustainable Development Goals. One Earth 3, 237–250, https://doi.org/10.1016/j.oneear.2020.07.011.

8 https://helcom.fi/helcom-at-work/ministerial-meetings/2021-lubeck

only combat eutrophication, but also improve people's wellbeing by bringing some nature closer into their daily lives. We hope to see significant growth and job creation in the community-based zero input shellfish aquaculture sector that generates high economic value with minimal environmental impact and alleviates pressure from land-based protein creation. In particular, we hope to see a continued resurgence and interest in sustainable historic aquaculture practices, like the blue mussel farming done centuries ago in the Kieler Fjord. We want to build this future together with all stakeholders involved, inspired by participatory approaches like the "Eckernförder Bucht 2030" project, that brings together the tourism industry, fishers and other stakeholders. We see those fishers engaging in fishing practices that allows them to harvest from the sea and meet their livelihood alongside strict marine protected areas that allow fish stocks to recover and replenish to ensure the fishing will also be able to sustain future generations. In this future, we imagine children excitedly telling their parents about growing numbers of harbour porpoises, their local Baltic Sea 'whale'!

Now is the lifetime opportunity for the EU and all member states to raise their ambition to protect our Baltic Sea collectively via a joined European **Blue New Deal.**

2. Eutrophication, Aquaculture and Fisheries

The thematic focus of this policy report lies on eutrophication, aquaculture and fisheries within the Baltic Sea as the problems, solutions and potentials related to these three topics are highly intertwined. Additional regional action embedded within the EU legislative framework is possible towards an ecological and solidarity transition with thriving coastal communities surrounding the Baltic Sea. Section 2 starts by outlining these problems from an environmental, social and legal perspective before exploring future potentials and proposing holistic solutions including concrete policy recommendations relevant for the Baltic Sea in Section 3.

2.1.1 Eutrophication of the Baltic Sea: An ongoing issue for decades amplified by climate change

In simple terms, eutrophication means increasing the nutrient supply into a water body. The main sources of nutrient loads are agriculture, urban waste waters and direct air input of nitrogen due to combustion processes. In the Baltic Sea, this is one of the most pressing issues as at least 97 percent of the Baltic Sea is impacted by eutrophication[9] (Fig. 1). Eutrophication can set off a chain reaction as some plants and algae are able to use those excess nutrients and become overabundant. Their growth causes an imbalance in the functioning of the aquatic ecosystem. For example, intense algal growth and the subsequent decomposition of their dead biomass near the seafloor requires high amounts of oxygen that is taken up from the water. This has contributed to the depletion of oxygen in particular near the bottom of the sea in many parts of the Baltic Sea[10]. These areas are also called 'dead zones', where the level of dissolved oxygen in the water is too low for most species to survive. In the Baltic Sea, one of the species most severely affected by this process is the Baltic Sea cod, which is also one of the economically most valuable fish in the Baltic Sea[11]. Hypoxic conditions decrease the potential for cod eggs to survive as well as decrease fish growth[12]. The impacts of ocean warming and acidification have further exacerbated

[9] HELCOM (2018): HELCOM Thematic assessment of eutrophication 2011–2016. Baltic Sea Environment Proceedings No. 156, https://helcom.fi/baltic-sea-trends/holistic-assessments/state-of-the-baltic-sea-2018/%20reports-and-materials

[10] BSAP draft, p. 19; Baltic Marine Environment Protection Commission

[11] https://www.ft.dk/samling/20081/almdel/MPU/bilag/7/596240.pdf or https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2019/2019/BalticSeaEcoregion_FisheriesOverviews. pdf

[12] Limburg KE and Casini M (2018) Effect of Marine Hypoxia on Baltic Sea Cod Gadus morhua: Evidence From Otolith Chemical Proxies. Front. Mar. Sci. 5:482. doi: 10.3389/fmars.2018.00482 https://www.frontiersin.org/articles/10.3389/fmars.2018.00482/full

those impacts and current predictions state a high risk for cod stock collapse under mid-term climate change[13].

The main nutrients responsible for eutrophication in the Baltic Sea are nitrogen and phosphorus. In general, they enter the Baltic Sea through point source pollution like cities, rivers, diffusive (or nonpoint source) pathways (e.g., agriculture) and through the air. However, nitrogen and phosphorus have very different properties and partly different pathways. In the case of nitrogen, 70% of it enters the Baltic sea through land pathways (i.e., diffuse sources, rivers or point sources) and 27% via the air. Phosphorus primarily enters the ocean through land-based pathways. Additionally, there is natural loss of nitrogen out of the Batlic Sea system, but phosphorus is much harder to remove once it has entered the marine environment. Thus, both nutrient types require different targeted mitigation actions, which we will describe in section 3.1. Below, we quickly outline the differences between nitrogen and phosphorus both in production and impact.

The so-called Haber-Bosch process takes nitrogen gas out of the air to produce synthetic ammonia-based fertilizers for agriculture use at industrial scale. As this process occurs under very high pressure and high temperatures, it requires a lot of energy and is responsible for 1.2% of the global CO_2 emissions[14]. The large amount of fertilizer production enabled population growth during the last century, but is also the ultimate driver of nitrogen input into soils, rivers and finally, the ocean. Notably we have already exceeded the planetary boundaries of the natural nitrogen cycle multiple times[15]. Additionally, combustion processes from cars and ships result in nitrogen oxides emissions, which further fertilize the Baltic Sea via air-input. In this context, shipping within the Baltic Sea is also an important source of airborne nitrogen input[16].

13 R. Voss, M.F. Quaas, M.H. Stiasny, M. Hänsel, G.A. Stecher Justiniano Pinto, A. Lehmann, T.B.H. Reusch, J.O. Schmidt Ecological-economic sustainability of the Baltic cod fisheries under ocean warming and acidification J. Environ. Manag., 238 (2019), pp. 110–118, 10.1016/j.jenvman.2019.02.105

14 Smith C., Hill A. K., and Torrente-Murciano L. (2020) Current and future role of Haber–Bosch ammonia in a carbon-free energy landscape, Energy Environ. Sci., 2020,13, 331–344, https://pubs.rsc.org/en/content/articlelanding/2020/ee/c9ee02873k#!divAbstract

15 https://www.stockholmresilience.org/research/researchnews/tippingtowardstheunknown/thenineplanetaryboundaries.4.1fe8f33123572b59ab80007039.html

16 https://helcom.fi/wp-content/uploads/2019/08/Contributions-of-emissions-from-different-countries-and-sectors-to-atmospheric-nitrogen-input-to-the-Baltic-Sea.pdf

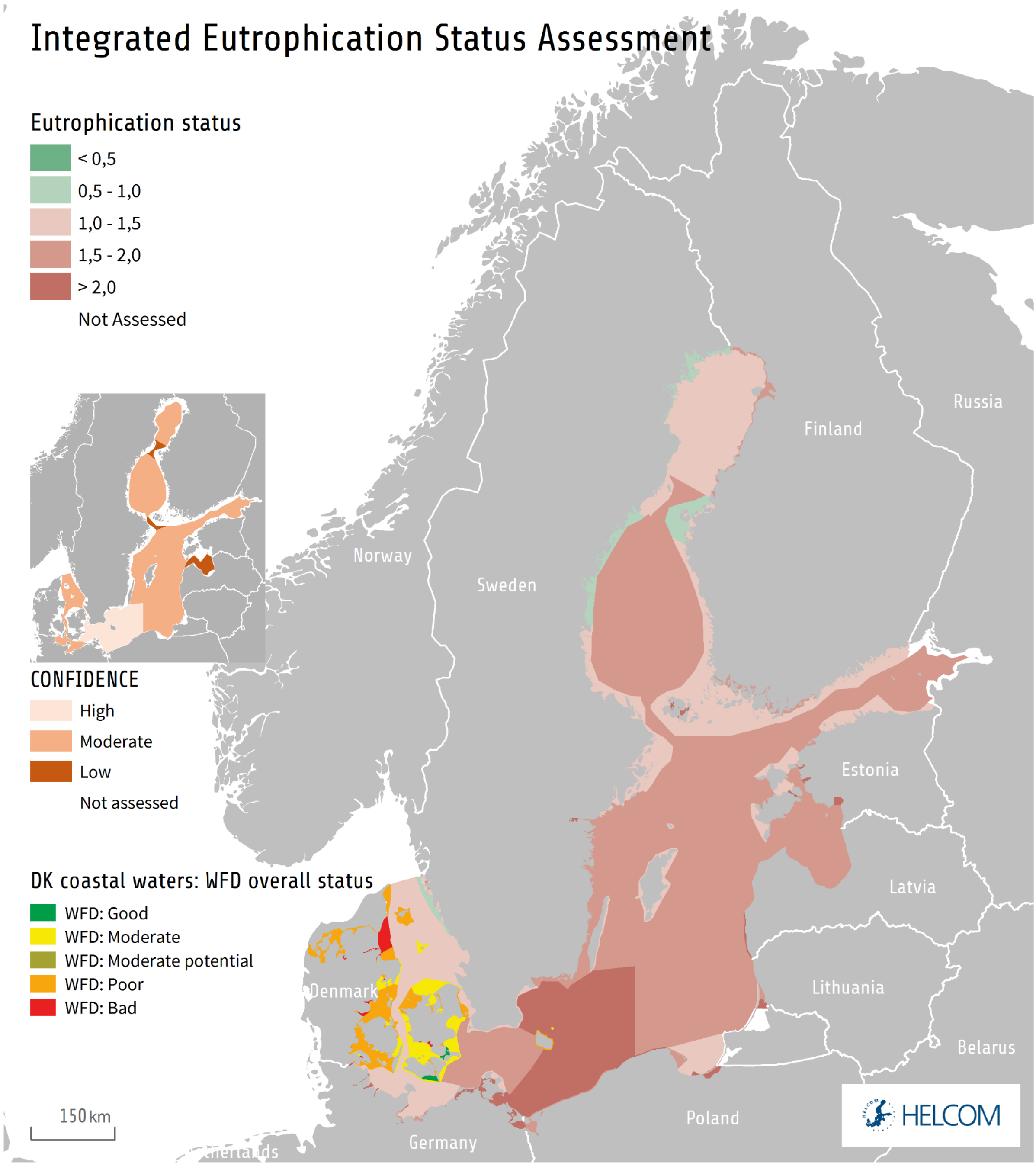

Figure 1 Integrated status of eutrophication in the Baltic Sea 2011–2016. In coastal areas HELCOM utilises national indicators used in the Water Framework Directive to arrive at an assessment of eutrophication status in eight countries. White areas denote that data has not been available for the integrated assessment. The map in the lower corner shows the confidence assessment result, with darker colors indicating lower confidence. http://stateofthebalticsea.helcom.fi/pressures-and-their-status/eutrophication

Unlike nitrogen, phosphorus cannot be made out of air. Instead, most phosphorus comes from phosphate rock, which is a finite geopolitically significant resource as 90% of phosphate rock reserves are located in just five countries (Morocco, China, South Africa, Jordan and the United

States)[17]. Phosphorus is a critical resource for food security and the current strong EU dependency on imports highlights the need to establish closed nutrient loops and recycle phosphorus due to reasons other than just environmental considerations.

Previous and current phosphorus pollution has resulted in particularly severe issues in the Baltic Sea and needs special emphasis and strong political action[18]. High phosphorus abundance supports cyanobacterial Harmful Algal Blooms, also known as “blue-green algae”, which are toxic for humans and marine life. These blooms amplify eutrophication by taking additional nitrogen out of the unlimited atmospheric nitrogen pool, thereby further increasing the “natural” nitrogen uptake by the Baltic Sea. Additionally, anoxic conditions such as the resulting dead zones due to eutrophication, can trigger the release of phosphorus stored in sediments back into the water column creating a positive feedback loop[19].

In short, if humans put phosphorus into the Baltic Sea, more nitrogen is added via cyanobacterial air uptake into the ocean itself. Recycling phosphorus within the food production systems is crucial as agriculture is the main contributor to diffuse nutrient pollution into the Baltic Sea. However, the agricultural sector has also been identified to have the highest reduction potential[20]. Additionally, avoiding phosphorus leakage into the ocean is also crucial for ensuring long term food security as phosphorus is a critical resource necessary for food production and the EU currently depends on phosphorus imports from overseas.

Future nutrient loads into the Baltic Sea will be impacted by various factors including global trade and food demand, societal changes related to urbanisation trends, population growth and diet shifts, which also directly relate to agriculture. Additionally, climate change will increase nutrient runoff due to changing precipitation patterns over the catchment area of the Baltic Sea[21]. This future increase in nutrient leakage forces us to enhance our mitigation efforts to reach a “good environmental status” in particular on phosphorus loads into the Baltic Sea (Fig. 2). The

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17 https://news.climate.columbia.edu/2013/04/01/phosphorus-essential-to-life-are-we-running-out

18 https://balticeye.org/en/eutrophication/policy-brief-phosphorus-in-the-catchment

19 McCrackin, M. L., Muller-Karulis, B., Gustafsson, B. G., Howarth, R. W., Humborg, C., Svanbäck, A., & Swaney, D. P. (2018). A century of legacy phosphorus dynamics in a large drainage basin. Global Biogeochemical Cycles, 32, 1107–1122.

20 BSAP draft, p. 20: https://portal.helcom.fi/meetings/HELCOM%2042-2021-746/MeetingDocuments/4-3%20Draft%20updated%20Baltic%20Sea%20Action%20Plan.pdf

21 Pihlainen et al. (2020) Impacts of changing society and climate on nutrient loading to the Baltic Sea., Sci. Total Environ., 731

green symbols in Figure 2 show the predicted future nutrient loads into the Baltic Sea under a scenario of ambitious climate change mitigation in combination with a socio-economic pathway (Shared Socioeconomic Pathways, SSP1). Here, economic growth is more defined through human well-being, respecting environmental boundaries and consumption and life-styles that are oriented towards low material, energy and resource demand. The red symbols refer to predictions under a high CO_2 emission scenario in combination with a socio-economic pathway (SPP5) that is dominated by high energy demands and resource intensive lifestyles. This pathway also goes along with the "faith in the ability to effectively manage social and ecological systems, including by geo-engineering if necessary."[22] The grey symbols show nutrient loads under current conditions, which are far outside of the target loads of the HELCOM Baltic Sea Action Plan (BASP), especially with regards to phosphorus.

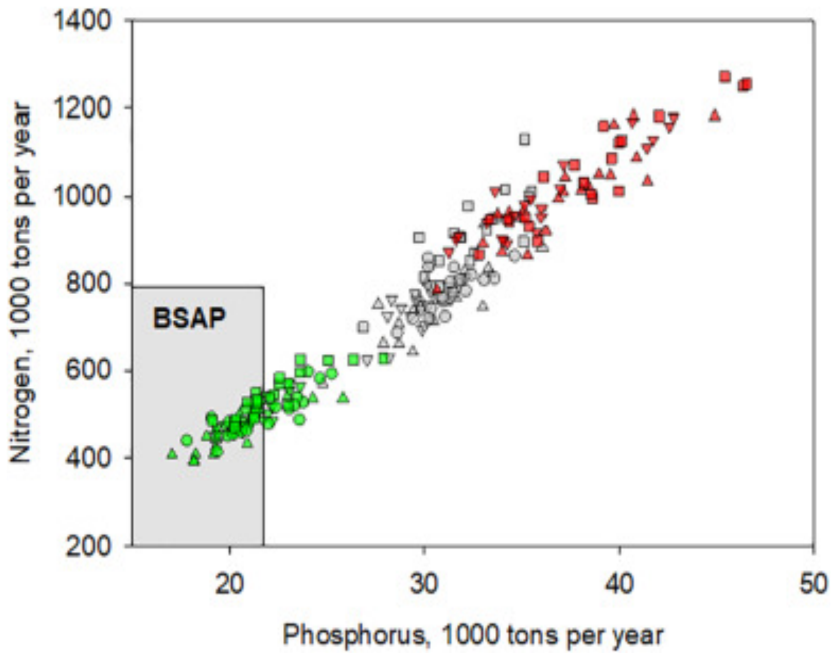

Figure 2 Future prediction of nitrogen and phosphorus loads into "the Baltic Sea under current conditions (grey symbols), 2010–2030) and by the end of the century (2080–2100) for two extreme combinations of climate and socioeconomic scenarios: SSP1 & RCP4.5 (green symbols), and SSP5 & RCP8.5 (red symbols). The shaded area in the figure shows the target area of total loading as specified in the Baltic Sea Action Plan (BSAP)." Figure taken from Pihlainen S. et al. (2020).

[22] Riahi et al. (2017) The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview, Global Environmental Change Volume 42, January 2017, Pages 153–168, https://www.sciencedirect.com/science/article/pii/S0959378016300681

Climate change also impacts deoxygenation directly by increasing stratification and reducing the oxygen solubility of seawater[23]. Ocean warming due to climate change in combination with high phosphorus loads might increase the occurrence of Harmful Algal Blooms in the future[24]. In practice, this could result for example in increasing beach closures due to the hazards of these Harmful Algal Blooms, with associated drastic impacts on tourism and the local economy. Thus, human recreational activities as well as our health will be directly impacted by this combined effect of eutrophication and climate change.

Climate change is also expected to severely impact coastal communities and the state of the Baltic Sea ecosystem via flooding and coastal erosion. Sea level rise driven by climate change in combination with extreme weather events can for example result in major flooding events in coastal cities. If coastal cities like Flensburg do not adapt to rising sea levels, various impacts like erosion of sandy beaches, temporary risk of energy supply and flooding of key traffic areas within the city center are to be expected in the upcoming decades[25]. Additionally, these flooding events especially when combined with heavy rain events can flood wastewater systems resulting in direct leakage of various other pollutants beside nutrients into the Baltic Sea further putting pressure on the marine environment.

Our ambition in nutrient input mitigation efforts has to increase significantly to allow the Baltic Sea to recover and cope with the upcoming stress due to climate change. This is especially crucial for phosphorus loads into the Baltic Sea which have already **exceeded the HELCOM target in 2015 by 44 %**[26]. This points to the urgency of needing to take action to drastically reduce phosphorus inputs. But if we humans decide to act on climate change and rigorously implement

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[23] Kiel Declaration on Ocean Deoxygenation: The ocean is losing its breath, Participants of the international conference "Ocean Deoxygenation: Drivers and Consequences – Past – Present – Future", 3 – 7 September 2018 in Kiel, Germany organized by: Kiel Collaborative Research Center SFB 754 and Global Ocean Oxygen Network (GO2NE – IOC-UNESCO), https://www.ocean-oxygen.org/documents/1222546/1237497/oceanoxygen_declaration_E_web.pdf

[24] Paerl H. W. And Barnard M. A. (2020) Mitigating the global expansion of harmful cyanobacterial blooms: Moving targets in a human- and climatically-altered world, Harmful Algae Volume 96, 101845, https://www.sciencedirect.com/science/article/abs/pii/S1568988320301244

[25] http://meeresspiegelanstieg-in-flensburg.info

[26] HELCOM 2018. Inputs of nutrients to the sub basins HELCOM core indicator 2018. https://helcom.fi/baltic-sea-trends/holistic-assessments/state-of-the-baltic-sea-2018/reports-and-materials

the Baltic Sea Action Plan, we will benefit from a drastic reduction of Harmful Algal Blooms in the future[27].

2.1.2 Legal framework and issues related to eutrophication

Although still insufficient in light of the urgency and magnitude of the problem of eutrophication, significant efforts have been made at the EU level to reduce nutrient inputs via, in particular:

- The 2000 Water Framework Directive which provides a framework for inland, transitional and coastal water protection, aims to ensure the good status of surface water and groundwater by 2015 or, in certain exceptional cases, by 2021 or 2027[28]. This programme aims at the preservation of water quality and other measures made compulsory by the Water Framework Directive, in particular measures to control diffuse sources of pollution (Art. 11.3(h)). All Baltic Sea Member States rely on the programme of measures in their river basin, management plans required by the directive as the main planning instrument to achieve the HELCOM nutrient reduction targets.
- The 2008 Marine Strategy Framework Directive aims to ensure that the EU's marine waters reach a good environmental status by 2020[29] and;
- The EU Strategy for the Baltic Sea region (EUSBSR), approved by the European Council in 2009, adopts the targets set out in the HELCOM BSAP as regards the reduction of nutrient loads[30], by promoting increased cooperation between neighbouring countries (both EU member States and non-EU countries) and innovative solutions.

The other EU legislatives acts instrumental in achieving a 'cleaner and healthier' Baltic Sea are:

- The 1991 Nitrates Directive concerning the adoption of measures to ensure that farmers in agricultural areas which cause or are at risk of causing nitrate pollution in water (referred to as 'nitrate vulnerable zones') respect minimum requirements concerning the

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27 Meier et al. (2019) Future projections of record-breaking sea surface temperature and cyanobacteria bloom events in the Baltic Sea. Ambio 48, 1362–1376 . https://doi.org/10.1007/s13280-019-01235-5

28 Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060

29 Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for Community action in the field of marine environmental policy: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0056

30 https://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/110889.pdf

use of nitrogen fertilisers[31]. The Directive imposes a precise limit on the application of nitrogen from manure, but not on the application of nitrogen from mineral fertilisers.

- The 1991 Urban Waste Water Treatment Directive (amended in 1998) regarding the collection and treatment of waste water from agglomerations[32] (another potential revision is currently assessed by the Commission on the basis of new issues such as including storm water overflows or the pollution of water bodies by pharmaceutical residues and microplastics)[33] and;
- The 2010 Industrial Emissions Directive regulating pollutant emissions from industrial installations to achieve a high level of protection of human health and the environment taken as a whole by reducing harmful industrial emissions across the EU, in particular through better application of Best Available Techniques (BAT)[34].
- The 2019 Regulation laying down rules on the making available on the market of EU fertilising products which guarantees the functioning of the internal market while ensuring that EU fertilising products on the market fulfil the requirements providing for a high level of protection of human, animal, and plant health, of safety and of the environment[35] and;
- The Common Agriculture Policy (CAP), and its future reform, due to be implemented from 1 January 2023, pending final agreement between the European Parliament and the Council of the EU[36].

EU funds that can be used to support policy actions against eutrophication are:

[31] Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A31991L0676

[32] Council Directive 91/271/EEC of 21 May 1991 concerning urban waste water treatment (amended in 1998): https://ec.europa.eu/environment/water/water-urbanwaste/legislation/directive_en.htm

[33] for more information, see https://ec.europa.eu/environment/water/water-urbanwaste/evaluation/index_en.htm

[34] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075

[35] Regulation (EU) 2019/1009 of the European Parliament and of the Council of 5 June 2019laying down rules on the making available on the market of EU fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 and repealing Regulation (EC) No 2003/2003: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R1009&rid=2

[36] https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-glance_en

- The European Regional Developments Fund and the Cohesion Fund to support infrastructure projects in the field of waste water treatment as part of the Member States' operational programmes[37];
- The European Agricultural Fund for Rural Development to finance rural development programme measures which may have either a direct or an indirect impact on water quality (mainly measures related to 'improving the environment and countryside')[38].

Legal and policy instruments to combat eutrophisation under the HELCOM are:

- The 2007 HELCOM Baltic Sea action plan (BSAP) (revised in 2013) to restore the Baltic Sea to a good environmental status by 2021[39]. This goal was not reached. The BSAP will be updated by the end of 2021, a momentum for congruency[40]. The BSAP includes a nutrient reduction scheme which allocates nutrient and phosphorus reduction targets to each country, defined at sub–basin level in relation to their average inputs in the 1997-2003 reference period[41].
- The HELCOM recommendations for protecting waters against pollution from various activities, including the collection and treatment of waste water, the use of phosphates in detergents and the use of fertilisers in agriculture[42].

Beyond the complex normative landscape to address the multifactorial and multiscale issue of eutrophication, several problems have been identified in terms of political coherence, as well as implementation by member States (or HELCOM contracting Parties), amongst which:

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37 According to a report of the European Court of Auditors of 2016, the total EU contribution to waste water collection and treatment projects in the Member States bordering the Baltic Sea was 4.6 billion euro in the 2007-2013 period (Poland, 3.4 billion euro; Latvia, 0.6 billion euro; Lithuania, 0.4 billion euro; Estonia, 0.2 billion euro and Germany, 0.04 billion euro: https://www.eca.europa.eu/Lists/ECADocuments/SR16_03/SR_BALTIC_EN.pdf

38 According to the same study of the European Court of Auditors, an amount of 9.9 billion euro was allocated to all eight Baltic Sea coastal Member States in the 2007-2013 period but the amount that was specifically dedicated to address water protection is not available (Poland (4.4 billion euro), Finland (1.5 billion euro), Sweden (1.3 billion euro), Germany (1.1 billion euro), Lithuania (0.6 billion euro), Latvia (0.4 billion euro), Denmark (0.3 billion euro) and Estonia (0.3 billion euro)): https://www.eca.europa.eu/Lists/ECADocuments/SR16_03/SR_BALTIC_EN.pdf

39 https://helcom.fi/baltic-sea-action-plan

40 https://helcom.fi/baltic-sea-action-plan/bsap-update-2021

41 The remaining necessary reductions are from shipping and non-signatories countries (mainly Belarus, the Czech Republic and Ukraine) under the 1999 Gothenburg Protocol under the 1979 UN Economic Commission for Europe (UNECE Convention on Long-Range Transboundary Air Pollution.

42 For a detailed view of HELCOM's recommendations, see https://helcom.fi/helcom-at-work/recommendations

- the lack of quantified targets established by EU member States as regards nutrient loads[43];
- The insufficient progress by HELCOM contracting parties in reducing annual input of nitrogen (7 % above maximum allowable input in 2015) and **phosphorus (44 % above** maximum allowable input in 2015) to the sea under the BSAP;
- The lack of commonly agreed assessment criteria for some substances and matrices restricting the number of classified substances and the subsequent identification problem areas (EEA, 2019);
- The lack of ambition and appropriate indicators (e.g. identification of pollution sources and classification of the water status) in EU members' nutrient reduction plans (e.g. river basin management plans) in application of the Water Framework Directive[44];
- the lack of effective implementation of the Nitrates Directive, i.e. shortcomings in the designation of vulnerable zones or variations in the content of the nitrate action programmes[45];
- There is no european directive or regulation concerning phosphorus application in agriculture. Some EU member States accommodate the restriction of phosphorus fertilisation under the Nitrates Directive, the Water Framework Directive and the regulation on Fertilizing products but in a partial or diverse manner[46];
- The lack of effectiveness of the cross-compliance mechanism through which farmers are expected to comply with EU standards for environmental, public, animal and plant health, animal welfare or land management, otherwise their EU support is reduced and they may face penalties[47];
- The subordination of the the objective of the conservation of the marine environment to the new common Agricultural Policy (the CAP aggravating the Eutrophication in the

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[43] In the absence of such targets, the EU commission considers the use of HELCOM BSAP targets to be good practice: SWD(2014) 49 final of 20 February 2014 accompanying the Commission report to the Council and the European Parliament entitled 'The first phase of implementation of the marine strategy framework directive (2008/56/ EC) -—The European Commission's assessment and guidance'.

[44] Furthermore, achieving a good environmental status under the Water Framework Directive is not sufficient to achieve the HELCOM targets for Phosphorus.

[45] https://www.eca.europa.eu/Lists/ECADocuments/SR16_03/SR_BALTIC_EN.pdf

[46] For more information, see: https://edepot.wur.nl/300160

[47] For more information, see: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/income-support/cross-compliance_en.

Baltic Sea)[48], as well as the latter and the Green New Deal with the coastal and marine policy;

- The non-alignment of agricultural subsidies with the Sustainable Development Goal 14 "Conserve and sustainably use the oceans, seas and marine resources"[49].

2.2.1 Aquaculture problem or solution? What, how (much) and where we farm matters

Aquaculture is the fastest growing food-production sector in the world and currently contributes 46% to global fish production[50]. This trend is expected to increase as it is unlikely that wild capture fisheries will be able to produce higher yields in the future to meet the growing seafood demand. In Europe, this dependency is also strong as one in four of every consumed seafood product comes from aquaculture. However, only 10% of seafood consumed in Europe comes from European aquaculture contributing less than 2% of global production in 2018 as Europe is currently importing more than 60% of its supply of fishery products. Despite this economic potential to increase European aquaculture production, growth has been slow, only showing a 6% increase since 2007 and yet reaching a EUR 4.1 billion turnover in 2018[51]. To address this issue among others, the EU has recently established The European Maritime, Fisheries and Aquaculture Fund (EMFAF) to enable sustainable use of marine biological resources in Europe, contribute to food security and the growth of a sustainable blue economy[52].

Increasing aquaculture production has a range of potential benefits for coastal communities, including local value and employment generation, establishment of regional markets and strengthening cultural identities and promoting community-based solutions, which will be outlined in detail in section 3.2. However, the sustainability of aquaculture highly depends on the way it is done and investment in unsustainable aquaculture systems can lead to severe negative environmental and social consequences. Similarly to agriculture on land, the impact of aquaculture strongly depends on where, how (much) and what is being farmed. For example,

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48 For more information, see https://balticeye.org/en/eutrophication/cap-analysis/ and https://ideas.repec.org/p/ags/eaa172/289745.html

49 Scown, M.W., Brady, M.V., and Nicholas, K.A. (2020). Billions in misspent EU agricultural subsidies could support the Sustainable Development Goals. One Earth 3, 237–250, https://doi.org/10.1016/j.oneear.2020.07.011

50 FAO (2020) State of the world fisheries and aquaculture: http://www.fao.org/3/ca9229en/ca9229en.pdf

51 https://ec.europa.eu/commission/presscorner/detail/en/ip_21_1554

52 https://www.europarl.europa.eu/meetdocs/2014_2019/plmrep/COMMITTEES/PECH/DV/2021/02-22/EMFAF_consolidated_clean_EN.pdf

mussel aquaculture has the potential to produce valuable proteins without any nutrient input, but instead removing excess nutrients from the surrounding ecosystem. In contrast, forms of aquaculture that depend on intensive food input, like salmon farming, can further amplify eutrophication. Other potential risks from aquaculture are the spread of disease or parasites from farmed to wild populations, introduction of invasive species or genetic changes in local populations through escaped farmed individuals.

One of the main elements that determines the sustainability of an aquaculture set-up is the trophic level of the farmed species. The trophic level describes the position of an organism in the food web. So, for example seaweed or algae are primary producers and represent the lowest trophic level as they get all of their energy directly from the sun. Shellfish species like blue mussels are primary consumers also representing a low trophic level and also require no additional food input. Instead they get all their required food and nutrients from the surrounding sea water. However, when farming finfish species with a high trophic level, meaning predatory fish on top of the food chain, such as salmon, high amounts of food input are required to farm them. Often, these come in the form of fishmeal/-oil that is produced by wild capture fisheries elsewhere and is thereby exacerbating the environmental impact of those fisheries. Even though recent improvements have been made to optimise the use of alternative feed sources[53], many salmon aquaculture set-ups still require more sea-based protein than they provide. Additionally, consumption of such predatory finfish species like salmon is often seen as a luxury good rather than a key source of protein. This highlights the importance of viewing seafood production also with regards to equity considerations as sea-based protein has high potential to meet nutrient needs and associated health benefits[54].

Depending on the origin of this fishmeal, this can also perpetuate fisheries that impact negatively on lives and socio-economic survival of people. Besides Europe relying on West Africa for fishmeal/-oil products, several European firms have some considerable investment in production factories in The Gambia, Senegal and Mauritania[55]. Meanwhile, fishmeal/-oil

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[53] Clarkson et al. Early nutritional intervention can improve utilisation of vegetable-based diets in diploid and triploid Atlantic salmon (Salmo salar L.) British Journal of Nutrition (2017), 118, 17–29, doi:10.1017/S0007114517001842

[54] Hicks, C.C., Cohen, P.J., Graham, N.A.J. et al. Harnessing global fisheries to tackle micronutrient deficiencies. Nature 574, 95–98 (2019). https://doi.org/10.1038/s41586-019-1592-6

[55] https://www.greenpeace.org/international/publication/22489/waste-of-fish-report-west-africa

products from these countries have been termed “dirty”[56] because their continued production has severe consequences on the health, livelihood, human rights[57], and food security at national and regional level[58]. As the EU largely depends on imports of fish feed for aquaculture farms as well as for seafood and fish products for consumption, it is key that strong regulations are put in place to ensure that the aquaculture sector is fully decoupled from wild fish catch[59]. Thus the whole supply chain has to be included in regulations so that any externalization of the environmental and socio-economic issues to non-EU countries as outlined above stops.

Depending on the species of fish that is farmed and its place in the food chain, you can calculate the conversion ratio that describes how much of the food and energy required for the fish production is actually available for human consumption. Because of this conversion ratio, similarly to other farm animals, eating fish with a high trophic level is an inefficient way of gaining protein. For example, on average, only 28g of every 100g of protein contained in salmon feed is available for human consumption[60]. In general, the higher up in the food chain you go, the more resources, energy and space are required to farm this species.

In the Baltic Sea input aquaculture is also a source of eutrophication both due to nitrogen and phosphorus input[61]. This points to the importance of establishing closed-nutrient loops and avoiding any pesticide use in the aquaculture systems, in particular if the sector aims to grow in the future. Thus, ensuring rigorous conduction of environmental impact assessments will be crucial for the establishment of new aquaculture farms. The impacts of zero input low trophic farms are in general much lower compared to input high-trophic level farming and can even improve local ocean health. It is important that locations for new mussel farms are well ventilated with oxygen throughout the whole year, in particular within the near bottom waters.

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56 https://ejatlas.org/conflict/dirty-fishmeal-production-in-nouadhibou-mauritania

57 http://www.fao.org/3/ca4536en/ca4536en.pdf

58 https://chinadialogueocean.net/11980-fishmeal-factories-threaten-food-security-in-the-gambia

59 https://www.duh.de/fileadmin/user_upload/download/Projektinformation/Naturschutz/Fischereipolitik/Bericht_Futter_bei_die_Fische_Screen_RZ.pdf

60 Fry J, Mailloux N, Love D., Milli M and Cao L (2018) Feed conversion efficiency in aquaculture: do we measure it correctly? Environ. Res. Lett. 13, 024017

61 https://helcom.fi/media/publications/BSEP153.pdf, Fig. 66 and 67

Note that this is also the case for well established and economic viable blue mussel farms[62]. Combining mussel farming with algal farming is strongly suggested to improve oxygen conditions locally[63].

Section 3.2 provides a detailed description of sustainable aquaculture practices that could be implemented in the Baltic Sea. In a nutshell, the key elements for such practices are focusing on low trophic level species and setting up multiple small-scale community based aquaculture systems with closed nutrient loops.

2.2.2 Legal framework and issues related to aquaculture

Unlike the conservation of marine biological resources under the Common Fisheries Policy (CFP), the EU has no exclusive competence in the area of aquaculture. EU legislation together with implementing national legislation set the regulatory framework for EU aquaculture. Each member State has its own licensing system, which leads to a complex regulatory framework with multiple competent authorities and as a result, a lack of predictability of the timeline and outcome of licensing procedures for the sector. Furthermore, concerns about the impact of aquaculture on the environment or on other economic sectors activities often lead to appeal procedures, further delaying the obtention or renewal of licenses[64].

Due to the cross-cutting and economic nature of aquaculture, a large body of EU rules applies to it, such as those ensuring environmental protection or human and animal health or regarding organic production. For environmental matters, the EU legislation ensures the mitigation of the impact that aquaculture activities may have on the environment (e.g. carbon footprint, waste,

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[62] J. Kotta et al. 2020, Cleaning up seas using blue growth initiatives: mussel farming for eutrophication control in the Baltic Sea Sci. Total Environ., 709 (2020), 10.1016/j.scitotenv.2019.136144

[63] Buck H. B., Nevejan N. And Wille M., Offshore and Multi-Use Aquaculture with Extractive Species: Seaweeds and Bivalves, Aquaculture Perspective of Multi-Use Sites in the Open Ocean, 2017, ISBN : 978-3-319-51157-3, https://link.springer.com/chapter/10.1007/978-3-319-51159-7_2

[64] Communication from the Commission to the European Parliament, the Council, the Economic and social Committee and the Committee of the regions (COM/2021/236 final): Strategic guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:236:FIN.

effluents, etc.) and that those activities do not significantly harm ecosystems or biodiversity[65]. Commission guidance documents and the jurisprudence of the European Court of Justice clarify the application of this legislation to the aquaculture sector[66]. However, the interpretation of EU law on aquaculture by member States is not uniform and coherent and often arduous to grasp for the sector's actors. In particular, the complexity of the 2017 Official controls Regulation[67] and the Water Framework Directive that ensure good water quality for bivalve molluscs creates confusion[68].

In 2013 and 2021, the Commission adopted non-binding strategic guidelines for the sustainable development of EU aquaculture, which serve as the basis for the development and revision by EU countries of specific national strategic plans for aquaculture[69]. Through the new strategic guidelines for 'a more sustainable and competitive EU aquaculture for the period 2021–2030'[70], the Commission provides a common vision for EU member States, the aquaculture sector and other stakeholders to develop the sector in a way that contributes directly to the 2021 European

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65 In particular, the following legislation applies to aquaculture, among other activities: the Water Framework Directive (Directive 2000/60/EC); the Marine Strategy Framework Directive (Directive 2008/56/EC); the Decision on Good Environmental Status (Decision 2017/848/EC); the River Basin Management Plans; the Birds and Habitats Directives (Directive 2009/147/EC and Directive 92/43/EEC); the Industrial Emissions Directive (Directive 2010/75/EU); the Regulation concerning the use of alien and locally absent species in aquaculture (Regulation (EC) No 708/2007) and the Regulation on invasive species (Regulation (EU) 1143/2014); the Environmental Assessment Directive (Directive 2011/92/EU); and the Strategic Impact Assessment Directive (Directive 2001/42/EC).

66 See for e.g., Weser Case (Case C-461/13 Bund v Germany [2015] ECR I-433) on the interpretation of the Water Framework Directive: https://curia.europa.eu/juris/liste.jsf?oqp=&for=&mat=or&lgrec=fr&jge=&td=%3BALL&jur=C%2CT%2CF&num=C-461%252F13&page=1&dates=&pcs=Oor&lg=&pro=&nat=or&cit=none%252CC%252CCJ%252CR%252C2008E%252C%252C%252C%252C%252C%252C%252C%252C%252C%252Ctrue%252Cfalse%252Cfalse&language=en&avg=&cid=7443929

67 Regulation (EU) 2017/625 of the European Parliament and of the Council of 15 March 2017 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32017R0625

68 Communication from the Commission to the European Parliament, the Council, the Economic and social Committee and the Committee of the regions (COM/2021/236 final): Strategic guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:236:FIN.

69 See also, Art. 34 CFP

70 Communication from the Commission to the European Parliament, the Council, the Economic and social Committee and the Committee of the regions (COM/2021/236 final): Strategic guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:236:FIN.

Green Deal[71] and the Farm to Fork Strategy[72]. It proposes general guidelines on addressing challenges and opportunities of the EU aquacultures sector (building resilience and competitiveness, participating in the green transition, ensuring social acceptance and consumer information and, increasing knowledge and innovation), as well as specific actions by the Commission, the EU member States and the Aquaculture Advisory Council[73].

The European Maritime, Fisheries and Aquaculture Fund (2021-2027) provides specific funding to support the sustainable development of aquaculture that each member State decides how to spend, provided that this is consistent with its national sectoral strategic plan. In addition to the significant support by the next European Maritime and Fisheries Fund for sustainable seafood farming, the Commission envisages adopting EU guidelines for Member States' sustainable aquaculture development plans and promote the right kind of expenditure under the Fund[74].

2.3.1 Fisheries and its impacts on marine biodiversity

Global fish consumption has been increasing at an annual rate of 3.1% since 1961, a rate that is almost twice of the global annual population growth. The rate of global fish consumption is also higher than that of all other animal proteins showing the pivotal importance of this field for food security and its economic potential. However, currently 34.2% of global fish stocks are overfished and 59.6% of stocks are fished at maximum capacity[75]. This has important consequences for being able to ensure fish supply in the future as well as economic consequences for fishers and people whose livelihood is derived from fishery-related activities. Additionally, in many coastal communities fisheries are an integral part of people's cultural identity and its importance goes much beyond simply the monetary value associated with it.

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71 A European Green Deal, European Commission: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

72 The 2020 Farm to Fork Strategy sets specific targets for aquaculture, in particular the reduction of sales of antimicrobials (reduction of the overall EU sales of antimicrobials in aquaculture by 50% by 2030) and a significant increase in organic aquaculture. See Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions (COM/2020/381 final):A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0381. For more information, see: https://ec.europa.eu/food/farm2fork_en

73 The Aquaculture Advisory Council (AAC) is a balanced stakeholder representative organisation created for consultation on elements of EU policies which could affect aquaculture under Articles 34 and 44 of Regulation (EU) No 1380/2013 of the European Parliament and of the Council on the Common Fisheries Policy https://aac-europe.org/en/about-us

74 https://eur-lex.europa.eu/resource.html?uri=cellar:ea0f9f73-9ab2-11ea-9d2d-01aa75ed71a1.0001.02/DOC_1&format=PDF

75 FAO, State of the World Fisheries and Aquaculture (2020) http://www.fao.org/3/ca9229en/ca9229en.pdf

The European Environment Agency reported in 2020 that fishing activities were responsible for some of the main pressures on ecosystems in Europe's seas[76]. From an environmental perspective, besides removing the target species from the sea, fisheries also have many other impacts on marine biodiversity. Destructive fishing practices can cause severe degradation of marine habitats and many non-selective fisheries have high rates of bycatch of non-targeted species, such as seabirds or marine mammals. One example of such destructive fishing practices is bottom trawling or dredging, which involves dragging heavy gear across the ocean floor which 'plough through' the seafloor thereby drastically reducing the complexity, productivity and biodiversity of those habitats and severely altering their morphology[77].

In terms of incidental bycatch, a crucial example here is the Baltic Sea harbour porpoise. The harbour porpoise is culturally highly significant as it is the only cetacean found in the Baltic Sea. It classified as critically endangered by the IUCN with one of the three populations only consisting of a few hundred animals[78]. The main threat for harbour porpoises comes from set-gillnets and entangling nets. In Germany, for example, around 70 animals per year are estimated to die because of gillnets[79]. The Federal State considers taking or has introduced measures such as the exclusion of specific gears from fisheries management areas within German Natura 2000 areas depending on the protected features (mobile bottom contacting gears/benthic habitats, set gillnets and entangling nets/harbour porpoise and sea birds), no-take zones, limitation of fishing effort[80]. The Land Schleswig Holstein (within the territorial Sea) has decided on the exclusion of fisheries with trawls and Danish seines within the 3 nm-zone, voluntary agreement with fishermen to protect harbour porpoises by reducing the length of their set gillnets that remain still allowed in Natura 2000 areas and, seabirds against bycatch in set gillnet and trammel net fisheries. Other promising solutions to reduce these risks are the use of jiggers or fish traps, which will be described in more detail in section 3.3[81].

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76 EEA: Marine messages II, Box 3.2, 2020: https://www.eea.europa.eu/publications/marine-messages-2/file

77 https://www.nature.com/articles/nature11410 and National Research Council. 2002. Effects of Trawling and Dredging on Seafloor Habitat. Washington, DC: The National Academies Press. https://doi.org/10.17226/10323.

78 https://www.iucnredlist.org/species/17031/98831650

79 http://schleswig-holstein.nabu.de/natur-und-landschaft/aktionen-und-projekte/stellnetzfischerei/12625.html

80 https://ec.europa.eu/environment/nature/natura2000/marine/docs/Review%20of%20fisheries%20management%20measures%20in%20Natura%202000%20sites.pdf

81 https://schleswig-holstein.nabu.de/natur-und-landschaft/aktionen-und-projekte/stellnetzfischerei/index.html and, https://webgate.ec.europa.eu/fpfis/cms/farnet2/on-the-ground/good-practice/short-stories/fish-traps-alternative-gillnet-fishing-german-baltic-sea_en

The overall status of marine biodiversity in the Baltic Sea is also severe. The 2018 Thematic assessment of biodiversity (2011–2016) of the Baltic Marine Environment Protection Commission shows that many species of fish (demersal, pelagic, migratory or widely distributed), water birds and mammals are vulnerable, near threatened or endangered[82]. This also applies to most habitats in the water column and on the seafloor as many ecosystems and food webs showed signs of deterioration and contamination. Additionally, about 100 species are currently at danger of becoming regionally extinct[83].

In terms of specifically commercially relevant species, four important commercial stocks (Eastern Baltic cod, Western Baltic cod, herring, European Eel) are in a bad condition, 12 others could not be assessed and only 2 (European sprat, European plaice) are in a good state[84]. Taking these developments into account it is particularly severe that the European Fisheries Council has repeatedly set catch limits that exceeded scientific advice. This is especially severe in the case of cod stocks, which are crucial for maintaining ecosystem function and diversity and to generate employment and provide food for local human consumption[85]. Apart from the size of the stocks, fishing pressure can also affect fish in other ways. For example, cod can live for up to 25 years and grow up to 1.5 m in length. However, cod longer than 45 cm have virtually disappeared from the Baltic Sea and currently most cod measure only around 30 cm[86].

When thinking about biodiversity in the Baltic Sea also including non-commercially relevant species, the situation shows similar worrying trends. Out of the 22 fish species found in the Baltic Sea, only six are considered to be in a good state. Migratory species that depend on both freshwater and marine habitats for part of their life cycle, namely sturgeon, European eel and salmon, were also found to be in particularly bad states. This is especially key as these iconic species all have been of major cultural and economic importance in Europe and used to be a major contributor to rural employment, but their wild populations are severely threatened now[87].

[82] Supplementary report to the second HELCOM 'State of the Baltic Sea' report: file:///C:/Users/bleue/AppData/Local/Temp/BSEP158-Biodiversity.pdf

[83] HELCOM 42-2021, 4-3, Baltic Sea Action Plan, p. 13, Baltic Marine Environment Protection Commission

[84] Status Report Baltic Sea 2018, Bund Länder Arbeitsgemeinschaft Nord – und Ostsee (BLANO)

[85] https://www.fishsec.org/baltic/state-of-the-stocks

[86] https://balticeye.org/en/fisheries/fewer-large-cod/ and https://www.fishsec.org/baltic/state-of-the-stocks

[87] https://www.arcgis.com/apps/Cascade/index.html?appid=71e693e10142417291c9abf579c209ef

Besides habitat destruction and fish/food depletion, migration barriers, eutrophication, chemical pollution, underwater noise and climate change are the main pressures on those species. Considering these impacts together is crucial as the predicted impacts of climate change are likely to exacerbate and accelerate the impacts of fisheries pressure. For example, climate change is expected to drive the species composition of Baltic Sea ecosystems. In the Central Baltic Sea and Gulf of Finland this will likely mean an ecosystem that is dominated by sprat at the top of the food chain, instead of herring and cod[88]. Through changed precipitation patterns and global warming, climate change is expected to increase Baltic Sea temperature and lower salinity. Current key commercial species are mainly marine-tolerant ones, such as cod, herring, sprat, plaice and sole, which are likely to have restricted habitats in the Baltic Sea in the future and associated fishing fleets might be forced to relocate as well. The change in salinity is also likely to lead to an increased range for freshwater species[89].

Incidental bycatch of water birds and mammals in fishing gear is also highly concerning. Drowning in fishing gear is believed to be the greatest source of mortality for harbour porpoise populations in the Baltic Sea, a strong pressure on populations of waterbirds (e.g. divers, grebes, cormorants), and is also a concern for seals. The risk of incidental bycatch is highest in various types of gillnets but other stationary fishing gear, such as fyke nets and push-up traps also have incidental bycatch[90]. A HELCOM core indicator to assess the number of drowned mammals and waterbirds caught in fishing gear is currently undergoing further development[91]. At EU level, an action plan is being developed (Commission adoption planned for second quarter 2021) to identify where action is needed to address bycatch of sensitive species and adverse impacts on sensitive habitats through technical measures such as area closures, gear changes and mitigation measures for sensitive species[92].

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88 https://oxfordre.com/climatescience/view/10.1093/acrefore/9780190228620.001.0001/acrefore-9780190228620-e-692

89 https://www.ices.dk/sites/pub/CM%20Doccuments/CM-2007/E/E1107.pdf

90 Baltic Marine Environment Protection Commission,Thematic assessment of biodiversity 2011–2016, Supplementary report to the second HELCOM 'State of the Baltic Sea' report: file:///C:/Users/bleue/AppData/Local/Temp/BSEP158-Biodiversity.pdf

91 HELCOM (2018) Number of drowned mammals and waterbirds in fishing gear. HELCOM core indicator report: https://helcom.fi/media/core%20indicators/Number-of-drowned-mammals-and-waterbirds-HELCOM-core-indicator-2018.pdf

92 https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12953-Action-plan-to-conserve-fisheries-resources-and-protect-marine-ecosystems_en

All the impacts described so far happen as part of the fishing process. However, lost fishing gear also places additional pressures on marine biodiversity and are important to consider in this context. When fishing gear, and especially fishing nets, are lost or abandoned they turn into so-called "ghost gear". As they don't readily degrade, usually being made of nylon, polyester or polyethylene, they continue to capture, trap and kill marine life including marine mammals, seabirds and fish. It can take up to hundreds of years for such nets to decompose. However, even when they have degraded, they can continue harming marine life as their degradation produces microplastics, which can accumulate especially in higher trophic levels of the food chain. In 2011, it was estimated that around 10 000 nets are lost or abandoned annually[93]. Since then, progress has been made to address this issue with, among others, the creation of the MARELITT project in 2016, which has produced an action plan for governments and organisations to combat marine litter in the form of derelict fishing gear in the Baltic Sea[94].

2.3.2 Legal framework and issues related to fisheries

In accordance with the Treaty on the Functioning of the European Union (TFEU)[95], the last common fisheries policy (CFP) adopted in 2013 aims to ensure that fisheries are environmentally, economically and socially sustainable in the long-term, and that they provide a source of healthy food for EU citizens[96]. It also aims to ensure that by 2020, the rate of fishing will not exceed "maximum sustainable yield" by applying the precautionary and ecosystem-based approaches, having healthy fish stocks form the guiding principles of the CFP (Art. 2). Guided by principles of good governance (Art. 3), the CFP focuses on the management of fisheries (whereas earlier CFP regulations focused only on stock conservation) and it includes aquaculture. The CFP considers inter alia, the gradual elimination of discards through the introduction of a landing obligation

93 http://www.balticsea2020.org/english/images/Bilagor/Ghost_net_EN_final.pdf

94 https://www.marelittbaltic.eu

95 Article 39(1)(d) and (2)(c) TFEU

96 Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy. This regulation adopted in December 2013 and applicable as 1st January 2014 is the basic act of the CFP, complemented by many other legal acts such the Council Regulation (EC) No 1005/2008 of 29 September 2008 establishing a Community system to prevent, deter and eliminate illegal, unreported and unregulated fishing (last amendment in 2018: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32008R1005), the Council Regulation (EC) No 1224/2009 establishing a community control system for ensuring compliance with the rules of the common fisheries policy (last amendment in 2018: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:343:0001:0050:EN:PDF) and, the Regulation (EU) 2019/473 on the European Fisheries Control Agency: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32019R0473

(Art. 15)[97], the best use of unwanted catches see (Art. 14), measures to adjust the capacity of EU fishing fleets (Art. 22 to 24) and, the promotion of sustainable Union aquaculture activities (Art. 34).

Subject to the rules of the CFP, EU fishing vessels can fish in all Union waters. Member States manage access under a temporary exception that has been successively renewed since the first CFP of 1983 (Art. 5 CFP). To ensure that fisheries management decisions are based on the best available scientific advice to bring exploitation to the levels that maximise yields within the boundaries of sustainability, they are required to collect data through the Data Collection Framework.[98] This data is then used by scientific advisory bodies, including the Baltic Sea Advisory Council (BSAC)[99] and the International Council for the Exploration of the Sea (ICES)[100], to issue scientific advice on which the Commission bases its proposals, including for setting the annual fishing opportunities.

The European Fisheries control Agency (EFCA) coordinates the implementation of the specific control and inspection programme established for certain pelagic and demersal fisheries in the Baltic Sea, in particular cod (including recreational fisheries in the Western Baltic), herring, salmon, sprat and European eel, as well as species under the landing obligation[101]. Its 2020 reports (participants: Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Sweden) highlight that the main type of infringements detected during the joint control operations is the non fulfillment of obligations to record and report catch or catch related data, including data to be transmitted by satellite vessel monitoring system[102].

The CFP also features regionalisation to allow the EU member States with a management interest to propose detailed measures, which the Commission can then adopt as delegated or

97 An evaluation of compliance with the landing obligation in selected fisheries in the Baltic Sea carried out in 2017 and 2018 by the European Fisheries control Agency shows an overall good level of compliance with the landing obligation in pelagic gear herring and sprat fisheries. The trend in other demersal segments in the Baltic Sea is concerning, with a lower level of compliance with the landing obligation in the fixed and towed gears catching plaice, as well as towed gear fleet segments targeting cod. An updated evaluation covering the period 2019–2020 is in progress: https://www.efca.europa.eu/fr/content/pressroom/efca-has-carried-out-evaluation-compliance-landing-obligation-selected-fisheries

98 https://datacollection.jrc.ec.europa.eu

99 http://www.bsac.dk

100 https://www.ices.dk/Pages/default.aspx

101 https://www.efca.europa.eu/en/content/baltic-sea

102 https://www.efca.europa.eu/en/content/reports-2020

implementing acts and transpose into EU law (Art. 18). In that context, BALTFISH, the Baltic Sea regional fisheries body with the primary goal to improve coordination and cooperation among Baltic Sea Member States, provides recommendations to the European Commission and the Council on EU fisheries conservation measures, multiannual plans, discard plans, and other regional fishery specific issues under the CFP[103].

Based on scientific, technological and economic advice, multiannual plans are adopted to manage fisheries in different sea basins to conserve and sustainably exploit marine biological resources (Art. 9 and 10). With a view of simplifying and clarifying the annual total allowable catch and quota decisions, fishing opportunities in the Baltic Sea have been fixed by a separate Regulation since 2006. A 2016 Regulation of the European Parliament and of the Council establishes a multiannual plan for the stocks of cod, herring and sprat in the Baltic Sea and the fisheries exploiting those stocks[104]. Its objective is to fix, for the most important fish stocks in the Baltic Sea, the fishing opportunities for 2021. In 2020, the Commission adopted a report on the multiannual plan[105].

As the pressures on Baltic fish stocks cannot be addressed through fisheries policy alone, Virginijus Sinkevičius, Commissioner for Environment, Oceans and Fisheries, took the initiative to convene a Ministerial Conference of all EU Baltic states to address all factors comprehensively to ensure a long term future for the Baltic. The Our Baltic Conference, originally to be taking place in Palanga (Lithuania) on 27-28 September 2020, was held online on 28 September 2020 in the context of the Covid-19 pandemic.

Specific actions to implement the Ministerial Declaration were identified on Eutrophication contaminants of emerging concern, marine litter as well as fisheries and biodiversity. Regarding this last focus area, the main specific actions are to:

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103 https://www.fishsec.org/baltic/baltfish

104 Regulation (EU) 2016/1139 of the European Parliament and of the Council of 6 July 2016 establishing a multi-annual plan for the stocks of cod, herring and sprat in the Baltic Sea and the fisheries exploiting those stocks:https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32016R1139

105 Proposal for a COUNCIL REGULATION fixing for 2021 the fishing opportunities for certain fish stocks and groups of fish stocks applicable in the Baltic Sea, and amending Regulation (EU) 2020/123 as regards certain fishing opportunities in other water (COM/2020/436 final): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020PC0436

- Introduce selective gears in demersal fisheries to reduce by-catch, especially of eastern Balticcod, and protect the harbour porpoise using mitigation measures such as acoustic deterrents;
- Ensure full implementation of by-catch limitation and promote the use of remote electronic monitoring as a method to tackle illegal discarding;
- Intensify efforts to collect accurate data on landings, discards and fishing effort, and to take measures to increase Baltic Sea fish stocks;
- Develop a coherent marine protected areas network with effective management plans, including strictly-protected areas based on scientifically-documented information, the designation of marine Natura 2000 sites, the protection of species and habitats, the development of maritime spatial planning with an ecosystem approach that ensures the coexistence of socio-economic activities and biodiversity, and the planning of protected areas and conservation measures in a transparent process involving stakeholders[106].

By the next **HELCOM meeting in October 2021**, ensuring the concretization and the follow-up of the **implementation by the HELCOM and the Baltic EU member States of these specific actions is key.**

Finally, EU law for both marine biodiversity and the CFP contains provisions to link the protection of the marine environment (where Member States are mainly responsible, for e.g. in creating marine protected areas for complying with conservation commitments under the Birds and Habitats directive) with fisheries conservation measures (of exclusive EU competence). With the EU Green Deal policy framework[107] and the EU Biodiversity Strategy to 2030[108], the European Union is taking an ambitious step towards halting the loss of marine biodiversity and securing healthy, thriving seas for the future. The congruence between the objectives set and their effective implementation will need to be closely monitored in the coming years.

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106 DG Env, Our Baltic, conference Report, 28 September 2020: https://op.europa.eu/en/publication-detail/-/publication/2fb104ea-383e-11eb-b27b-01aa75ed71a1

107 https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

108 https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030_fr

For now, these provisions to coordinate fisheries policy with environmental policy have not worked as intended[109] in practice and, the species and habitats protected by birds and habitats directives are based on outdated threat assessments[110].

- For example, the nature directives (birds and habitats directives) "exclude significant aspects of the marine ecosystem from formal protection schemes", in particular marine fish (e.g. commercially exploited species), invertebrate species (e.g. mussels) and marine offshore habitats (e.g. sandbanks below 20 m or soft-bottom habitats) and their associated communities of fauna and flora[111].
- Furthermore, less than 1 % of European marine protected areas could be considered marine reserves with full protection (e.g. through fishing bans), and that management of marine protected areas needed to be strengthened[112].
- Finally, fishing vessels, especially under-equipped small vessels (e.g. satellite monitoring systems), do not always comply with the obligations to record and report catch or catch related data, including data to be transmitted by satellite vessel monitoring systems. Besides legal infringement, these illegal practices are an impediment to the establishment of 'well informed" management plans and environmental impacts assessments.

109 For example, Article 11 of the CFP which allows Member States, when seeking to limit the impacts from fishing vessels from other Member States or to submit joint recommendations to enable the Commission to take measures, is little or not implemented. The Commission thus acknowledged that joint recommendations under Article 11 of the CFP "have taken longer to materialise and only cover certain areas in the North Sea and the Baltic Sea": COM(2019) 274 final of 7 June 2019: Communication from the Commission to the European Parliament and the Council on the State of Play of the Common Fisheries Policy and Consultation on the Fishing Opportunities for 2020: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019DC0274&from=EN

110 https://www.eca.europa.eu/Lists/ECADocuments/SR20_26/SR_Marine_environment_EN.pdf

111 https://www.eea.europa.eu/data-and-maps/indicators/marine-protected-area-mpa-network-coverage/eea-report-no-3-2015

112 EEA: Marine messages II, Box 3.2, 2020: https://www.eea.europa.eu/publications/marine-messages-2/file

3. Solutions, potentials and policy recommendations

This chapter provides details on our proposed solutions and specific policy recommendations. Each sub-chapter starts with a brief general description of the proposed solution highlighting the need for holistic and integrated approaches that take environmental, social and economic elements into consideration. Afterwards, policy recommendations are presented as bullet points that are grouped into relevant categories, based on the type and proposed mechanism of the recommendations.

A key focus lies on supporting rural areas due to their key responsibility in conserving public goods and environmental quality through their influence on water catchments, for example. Another focus point is the striving towards holistic solutions that recognise key leverage points in urban and rural systems that are likely to lead to an improved future for the Baltic Sea.

When suggesting solutions and providing policy recommendations, we recognise the tension between focusing on systemic or more collective actions and promoting individual behavioural and life-style change. We aim to balance those approaches as they are in the end intimately interlinked and both are required to create a positive future for the Baltic Sea and its coastal communities. For example, when we talk about behaviour change, each individual holds different potential and responsibility for sparking change on various scales within their means and communities. Beyond merely the focus on consumers, we see great potential for the impacts of behaviour change from a great diversity of actors in this context[113]. These include farmers, fishers, investors, chefs, managers or CEOs of businesses in relevant supply chains and many more. Adjustments and changing practices on each of those scales and different contexts can contribute to a positive future for the Baltic Sea in a different way. Of course, developing policies that consider and support individuals in these life-style changes as consumers is crucial too.

We all love our ocean! Many of us are willing to engage in more ocean-friendly lifestyles needed for a real **Blue New Deal, between humans and the ocean**. However, systemic support for following through with our intentions is often still missing. Therefore, setting up systems that support humans in their choice of more ocean-friendly modes of transport, food production and consumption or others is pivotal to mainstream such sustainable life-style changes. For instance,

[113] Nielsen, K.S., Marteau, T.M., Bauer, J.M. et al. Biodiversity conservation as a promising frontier for behavioural science. Nat Hum Behav 5, 550–556 (2021). https://doi.org/10.1038/s41562-021-01109-5

many people are interested in biking more to reduce the carbon emissions of their daily commute or transport in general. However, in many cities safe spaces for cycling or fast bike lanes that enable commuting between cities and associated suburbs are still missing. This makes it more difficult for those citizens to transition towards a green-blue lifestyle even though their personal motivation is often high.

Additionally, due to the complex linkages between the problems we have described in section 2, it is necessary to address them in a similar holistic way that acknowledges this complexity. Creating a more positive future for the Baltic Sea depends on addressing the environmental, economic and social dimensions in a way that creates synergies between solutions, instead of repeating the conflicts of the past. Besides the following sectoral measures and moving beyond legal and policy fragmentation, EU relevant policies regarding water quality, nitrates, urban waste water treatment, industrial emissions, agriculture, fisheries and aquaculture should be aligned with the EU Marine Strategy Framework Directive, the Green Deal, the Climate action and the Biodiversity Strategy for 2030. By doing so only, the transfer in space and time of socio-ecological problems (socio-ecological problem shifting) from one policy framework to another, ultimately impacting the marine environment and burdening future generations, will be reduced or even prevented.

3.1.1 Let’s close the nutrient tap into the Baltic Sea together

The key element necessary to address eutrophication in the Baltic Sea is to establish closed nutrient loops in our food production and waste management systems. This means designing systems where nutrients can be recycled, that only rely on minimal new nutrient input and where no nutrients leak into the environment. While nitrogen and phosphorus both contribute to eutrophication, phosphorus needs particular focus as it can trigger positive feedback loops that further amplify natural nitrogen take up and eutrophication. Additionally, combating eutrophication is not only an environmental imperative, but also economically promising. According to the most recent ‘State of the Baltic Sea’ report, about EUR 1-2 billion are lost annually in recreational value due to the deterioration of the marine environment. Similarly, reducing the level of eutrophication of the Baltic Sea is estimated to produce annual economic benefits of around EUR 4 billion across multiple economic sectors[114].

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[114] http://stateofthebalticsea.helcom.fi/humans-and-the-ecosystem/use-of-baltic-marine-waters

The most important sectors to address eutrophication are agriculture, and urban and rural planning. In practice, urban and rural planning means improving for example transportation systems towards more active and public transport and improving the water and flood management in cities to ensure nutrients are captured and recycled. Specific recommendations for each sector are listed below. In general in terms of agriculture, however, practices that rely on closed nutrient loops and nutrient recycling with reduced animal stock are the most promising pathways for reducing eutrophication. Reducing animal stock and focusing more on plant-based alternatives would also lead to increased space availability. For example, the land required to produce a kilocalories of beef or lamb is about one hundred times as much as the land needed to produce plant-based alternatives[115]. This space availability is also necessary to allow re-naturalisation of waterways and creation of buffer zones. These actions also help to protect biodiversity by not only improving water quality, but also creating new habitats.

Furthermore, it is important that soil management techniques take the magnitude of phosphorus already stored within agricultural soils due to intense use of mineral phosphorus fertilisers between the 1960 and 1990 into account[116]. This legacy phosphorus that has accumulated on agricultural lands in the Baltic Sea region would be enough to meet the nutrient needs for three decades of crop production[117]. Therefore, making these pools available to plants through improved soil management harbours huge potentials for farmers to save costs on fertilizers. The necessary soil monitoring could occur in collaboration with local universities to improve the mapping of nutrient storages and flows. Processing and managing manure is also a key action to close nutrient loops in agriculture. Transport costs are a challenges here, but regional biogas production can be a promising solution[118].

Buffer zones are also crucial in terms of urban and rural planning, as there is a need to invest significantly into improved watershed and wastewater treatment technologies that can provide adequate nutrient recycling infrastructure. In cities, this includes creating buffer zones that can store water or slow down its flow to avoid having only concrete surfaces that collect pollutants

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[115] https://ourworldindata.org/land-use-diets

[116] McCrackin, M. L., B. Muller-Karulus, B. Gustafsson, R. W. Howarth, C. Humborg, A. Svanbäck, D. P. Swaney. 2018.A Century of Legacy Phosphorus Dynamics in a Large Drainage Basin. Global Biogeochemical Cycles.https://doi.org/10.1029/2018GB005914

[117] https://balticeye.org/en/eutrophication/policy-brief-phosphorus-in-the-catchment

[118] Metson G. S. et al. (2020), Optimizing transport to maximize nutrient recycling and green energy recovery, Resources, Conservation & Recycling: X, Volumes 9–10, https://doi.org/10.1016/j.rcrx.2021.100049

which run-off directly into the catchment area that eventually leads to the sea. Instead, nutrients can be trapped and stored in those buffer zones, which reduces nutrient loading on the marine ecosystem. These buffer zones are also commonly called green and blue spaces and can be installed in a variety of different forms, such as roadside plantings, planter boxes, water retention ponds or fountains[119]. These infrastructures are also especially important to prepare for extreme precipitation events, which can lead to flooding and fast runoff into the aquatic system. Preparing wastewater infrastructure for extreme rain events in cities and rural areas comes with significant investment costs and the EU could play a key role here to support member states to speed up this process in particular in rural areas while providing future jobs.

Alternative sanitary systems, like dry closets, which don't depend on water as a transporter have a huge potential to reduce the pressure on existing wastewater systems, both in rural and urban space. These systems make the recycling of nutrients much easier and are thus a crucial contribution to close nutrient loops and reduce our dependence on nutrient imports from overseas, such as in the case of phosphorus. Various existing approaches have already been deployed during large public events[120], but also within public spaces such as in the city of Zurich[121]. Beside reducing the pressure on clean fresh water demand, a larger scale deployment of dry closets systems both in rural and urban space could reduce the nutrient loads into the Baltic Sea drastically[122].

The structural change necessary to address eutrophication also harbours great potential to act as a catalyst for developing more sustainable and holistic approaches in general that can be co-designed with local stakeholders. For instance, establishing green and blue spaces in cities also has many other advantages and has been shown to produce a range of positive benefits for people's psycho-social well-being[123]. Initiatives that help to spread awareness on how those land-based activities impact the marine environment can also help to promote such holistic

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119 https://e360.yale.edu/features/to_tackle_runoff_cities_turn_to_green_initiatives

120 https://www.goldeimer.de

121 https://www.kompotoi.ch

122 S. Pihlainen, M. Zandersen, K. Hyytiäinen, H.E. Andersen, A. Bartosova, B. Gustafsson, M. Jabloun, M. McCrackin, H.E.M. Meier, J.E. Olesen, S. Saraiva, D. Swaney, H. Thodsen, Impacts of changing society and climate on nutrient loading to the Baltic Sea., Sci. Total Environ., 731 (2020)

123 White, M.P., Elliott, L.R., Grellier, J. et al. Associations between green/blue spaces and mental health across 18 countries. Sci Rep 11, 8903 (2021). https://doi.org/10.1038/s41598-021-87675-0

approaches and to facilitate broader public engagement. One example of this is the 'Ocean Family' movement in Kiel that facilitates knowledge exchange on environmental issues related to the Baltic Sea to generate more public awareness, engagement and action[124]. We know that recovery of coastal ecosystems from eutrophication is possible. Examples from Danish coastal ecosystems show that after 25 years of mitigation measures and significant reductions in nutrient inputs, those ecosystems have partially recovered. This can be seen, for example, in improvements in water clarity through reduced algal blooms and the associated expansion of seagrass meadows. Seagrass meadows are important as they act as a nursery habitat and feeding ground for many fish and invertebrates that form the basis of marine food webs[125]. While this hopeful example shows that change is possible, it also stresses that significant long-term reductions in nutrient input are necessary to achieve this.

3.1.2 Policy recommendations related to Eutrophication and Agriculture

Reduction of industrial animal agriculture and closed nutrient loops are key to reduce nutrient river runoff into the Baltic Sea.

Part of the CAP reform currently under negotiations, eco-schemes are payment schemes in agriculture, embedded in the direct payments granted under CAP pillar 1, designed to reward farmers that choose to go one step further in terms of environmental care, land management and climate action with the objective to maintain public good[126]. The participation of farmers is voluntary. While member States are obliged to include one or more eco-schemes in their CAP Strategic Plans (CSPs), they are free to set the scheme's content and budget according to their environmental and climate needs on a national and regional level.

Fiscal solutions

- Strengthen financial support for the implementation of water pollution control in rural areas (i.e. via CAP eco schemes, support rural municipalities in repurchasing and

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124 https://www.bund-sh.de/der-bund-sh/arbeitskreise/ocean-family

125 Riemann et al. (2015). Recovery of Danish Coastal Ecosystems After Reductions in Nutrient Loading: A Holistic Ecosystem Approach. Estuaries and Coasts 1–16., https://www.fairspildevand.dk/wp-content/uploads/Recovery-of-Danish-Coastal-Ecosystems-kopi.pdf

126 See see Article 28 of the proposed Regulation of the European Parliament and of the Council (Com 2018/2018/392 final- 2018/0216 (COD): https://eur-lex.europa.eu/TodayOJ/

naturalization of land around aquatic systems, and strengthening contractual nature conservation)[127].

- Move from a subsidizing system towards a payment system for public goods (i.e. for protecting waterways and biodiversity).
- Create incentives for farmers to reduce livestock and afforestation of farmland in particular around aquatic systems like lakes, rivers, close to the coast, to provide new income for farmers via forestry.
- Stop subsidizing overproduction of meat products in Europe for export.
- Support the development and use of recycled fertilizers in particular for phosphorus.
- Provide financial incentives to farmers for the construction of wetlands in catchment areas (move general payment from CAP pillar 1 to specific payments related to pillar 2).
- Provide opportunities for farmers to test the nutrient content of their soils through collaborations with universities with mutual benefits: Farmers can send their soils samples and get a free analysis and fertilizing suggestion back from the student research programs e.g. with an estimate of existing phosphorus content to develop optimal soil management plans.
- Create market incentives and trade systems for recycled fertilizers to reduce the demand for importing mineral phosphorus fertilizers.
- Use european funds to help farmers to invest in improved manure storage structures that can help to facilitate further processing and avoid the risk of spills and water contamination.
- Provide funding for hackathons within university students as well as grants for private sectors to develop technological tools and models capable of diagnosing, tracking and identifying the presence, rate, and spread of excess Nitrogen and Phosphorus from agricultural lands.
- States should develop implementation plans for nitrogen and phosphorus reduction and ensure that funding for programmes and incentives is included in annual budgets.

[127] https://www.schleswig-holstein.de/DE/Fachinhalte/W/wasserrahmenrichtlinie/Downloads/Bewirtschaftungszeitraum3/e06_prio_seen.pdf

Management / Spatial solutions

- Adopt a phosphorus Directive aligned with other EU legislative frameworks which regulates in particular the use by farmers of phosphorus, mobilizing phosphorus stored in soil related to historical phosphorus fertilizer use for regenerative agriculture[128] .
- Ensure implementation of the Common Agricultural Policy (CAP) to contribute to the good status under the Water Framework Directive and to explore the possibility of result-based payments to reduce nutrient losses to water[129];
- Revise the Nitrates Directive's designation of Nitrates Vulnerable Zones and adopt the whole territory approach for areas of the Baltic Sea catchment basin most affected by nutrient flows from agriculture129[129];
- Promote ecologically sustainable sea-based measures with potential for eutrophication abatement, such as mussel cultivation129[129];
- Contribute through better nutrient management to reduce nutrient losses in the environment, to implement Farm-to-Fork and Biodiversity strategy objectives, by reducing nutrient losses at EU level by 50%[129];
- Ensure the implementation of the National Emission reduction Commitments, particularly for ammonia[129];
- Set livestock density limits to areas that are sensitive to nutrient losses into the aquatic environments, e.g., near rivers and coastal areas.
- Develop and implement manure management plans to prevent agricultural pollution and to increase soil productivity in the long run.
- Take the current phosphorus status of soils due to historic fertilizer use into account, mobilize it to be available for crops and take measures to reduce the fast runoff from these legacy phosphorus pools[130].
- Set standard and permissible application rates for agricultural lands, since the amount of nitrogen and phosphorus loss in agricultural land is tied to fertiliser;

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128 https://balticeye.org/en/eutrophication/policy-brief-phosphorus-in-the-catchment

129 DG Env, Our Baltic, conference Report, 28 September 2020: https://op.europa.eu/en/publication-detail/-/publication/2fb104ea-383e-11eb-b27b-01aa75ed71a1

130 McCrackin, M. L. et al. (2018). A century of legacy phosphorus dynamics in a large drainage basin. Global Biogeochemical Cycles, 32, 1107–1122. https://doi.org/10.1029/2018GB005914

- Develop a fertiliser action plan and fertilizer partnership to encourage improved fertiliser efficiency while maintaining productivity on agricultural properties through reducing the applications of highly water soluble phosphorus in bulk fertiliser.
- Reduce nutrient loadings that drain from agricultural fields by developing and implementing a drainage water management plan which helps prevent degradation of the water in local streams and lakes.
- Implementing nutrient management techniques that ensure fertiliser application in the right amount, at the right time of the year, using the correct method and in the right spot.

Social solutions

- Provide platforms to encourage watershed efforts and collaboration between a wide range of people, stakeholders and organisations across an entire watershed (Example project: Eckernförder Bucht 2030).
- Increase acceptance of recycled fertilisers.
- Support dietary shifts away from emission-intensive land-based protein sources (e.g. red meat) towards low carbon ocean-based protein and other plant-based sources of nutrition.
- Ensure all schools and other public canteens offer at least one plant-based meal option each day and highlight the human health co-benefits of plant-based diets.
- Set up participatory processes, such as soft systems methodology[131], to improve management of the Baltic Sea catchment area in collaboration with states, local partners and farmers across the Baltic Sea focused on developing local and regional strategies for preventing and managing the risks of eutrophication in rivers and the ocean.
- It is important to link the promotion of more environmentally friendly farming methods to economic benefits such as improvements in yield and savings in the cost of agrochemical inputs. The development of appropriate and well written agricultural advisory messages is therefore essential, as are demonstration plots/farms, training for advisors and other capacity building measures for agricultural extension services.
- Develop channels of communication and platforms where consumers can demand more transparency from their food producers about for example their use of fertiliser.

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[131] Bunch M. Soft Systems Methodology and the Ecosystem Approach: A System Study of the Cooum River and Environs in Chennai, India. Environmental Management 31, 0182–0197 (2003). https://doi.org/10.1007/s00267-002-2721-8

Natural solutions

- Re-naturalisation of lakes, rivers and peatlands to create buffer zones (increase nutrient retention) between agricultural land and water pathways into the Baltic Sea.
- Planting trees, shrubs and grasses along the edges of agriculture fields to add as a conservation buffer can help prevent nutrient runoff (Example project: "FGG Elbe – Ten Different Federal States – One Joint River Basin"[132].
- Ensuring year-round ground cover by planting cover crops or perennial species to prevent periods of bare ground on farm fields when the soil (and the soil and nutrients it contains) are most susceptible to erosion and loss into waterways.

Technological solutions

- Support regional manure transport systems and processing facilities for nutrient recycling and biogas / energy production.
- Further develop and implement technologies to reduce ammonia emissions from livestock houses and manure storages.

3.1.3 Policy recommendation related to Eutrophication, Urban and Rural Planning

- "All countries around the Baltic Sea should urgently comply with the EU Urban Waste Water Directive. The directive needs to be reviewed and sharpened."[133]

Fiscal solutions

- Apply the Do Not Harm Principle for any public spending. Remove any subsidies related to fossil fuels. Further increase the price of fossil fuels through more ambitious higher carbon prices (ETS). Use the proceeds to provide incentives for switching to public or active transportation modes.
- Invest into safe space for active transport in cities (car free zones) and rural areas (e.g. fast commuting bike lanes with safe e-bike / cargo bike charging / storage spots, good public transport connections) for all age groups (e.g. clear separation of bike lanes from motorized traffic to ensure small kids can bike safely and get used to bike at early age).

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[132] https://www.fgg-elbe.de/fgg-news/news-details/naehrstoffminderung.html

[133] https://balticeye.org/en/eutrophication/policy-brief-phosphorus-in-the-catchment

- Increase investment in on-site treatment and extending sewer networks also in rural areas.
- Financial aid from the EU to member states (i.e. support Poland, Lithuania, Latvia and Estonia)[134] to speed up technology transfer of wastewater treatment facilities (including nutrients removal and recycling) to further reduce point source pollution and prepare for extreme precipitation events.
- Refund schemes to encourage pet-poo deposit and treatment in cities.
- Provide funding for hackathons within university students as well as grants for private sectors to develop technological tools and models capable of diagnosing, tracking and identifying the presence, rate, and spread of excess nitrogen and phosphorus from municipal wastes.

Management / Spatial solutions

- Reduce nitrogen oxide emissions by supporting public and active transport to reduce car-based individual transport. Important concepts are intermodale mobility hubs, with flexible bike sharing at key public transport points, which solve the last mile problems.
- Provide significant more safe space for active transport in cities for all age groups including small children.
- Use EU funds to implement conservative buffers to catch runoff by planting trees, shrubs, and grass around residential neighbourhoods, transportation routes and fields, especially those that border water bodies both in rural and urban space.

Natural solutions

- Create additional wet ponds ("constructed wetlands") like reed polders, which remove nitrate via denitrification and increase retention of phosphorus. These solutions are very cost effective approaches and can have many co-benefits for biodiversity and human well-being (Example project: Duemmer – Schilfpolder in Niedersachsen[135]).

[134] https://helcom.fi/media/publications/BSEP153.pdf, Fig. 64 and 65

[135] https://www.lgln.niedersachsen.de/startseite/wir_uber_uns_amp_organisation/organisation_amp_kontakt/rd_sulingen_verden/verschiedenes/dummer_faq/faq-zum-duemmer---schlamm-107415.html

- Renaturalize water ways to mitigate flooding events such as the devastating Elbe flooding event in 2013 and increase natural nutrient removal (Example project: International Building Exhibition (IBA) in Hamburg[136]).
- Promoting the development of organic aquaculture and other aquaculture systems with lower environmental impact, such as integrated multi-trophic aquaculture systems (IMTA), energy-efficient recirculating aquaculture systems, as well as the diversification to lower-trophic species (molluscs and other invertebrates and algae and herbivore fish)[137].

Social solutions

- Promoting and fostering public awareness of the linkages of land-based activities with degradation of the marine environment. This should focus on surfacing people's visions with regards to the future of the marine environment focusing especially on youth[138], but also include promoting alternatives like low intensity approaches for residential properties relating to garden fertiliser.
- Support lifestyle change towards active transport (e.g. e-/biking, e-bikes, cargo bikes, bike leasing) at different age levels, e.g. from biking lessons in schools towards older age groups, value health co-benefits.
- Reduce 'poo-lution' by establishing systems which ensure that pet waste ends up within the municipal waste management systems and requiring citizens to pick up after pets on walks and in the backyard.

Technological solutions

- Prepare cities for storms and extreme precipitation to avoid runoff into aquatic systems and the ocean during these events (example in Hamburg[139]).

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[136] https://www.internationale-bauausstellung-hamburg.de/en/projects/elbe-islands-dyke-park/pilot-project-kreetsand/projekt/pilot-project-kreetsand.html

[137] Communication from the Commission to the European Parliament, the Council, the Economic and social Committee and the Committee of the regions (COM/2021/236 final): Strategic guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:236:FIN.

[138] https://atlanticstrategy.eu/en/news-and-events/events/eu4ocean-workshop-designing-ocean-literacy-action-europe

[139] https://www.hamburgwasser.de/privatkunden/unser-wasser/umweltschutz/gewaesserschutz

- Install small scale filter bags in street drainages[140] as a cheap but effective measure to pre-filter nutrients in a decentralized way while also partially capturing other pollutants such as plastic.
- Invest into updates of treatment categories in all EU countries (from primary or secondary to tertiary, namely biological, treatment) and allow nutrient recycling.
- Connect more rural households to the sewage grids, updating the sewage system i.e. to seperate fast rain runoff from households waste in case it is not the case, add biological filtering including phosphorus recycling.
- Further the development and use of dry compost toilet systems and waste recycling techniques that are not dependent on water as transporter through a new amendment of the Urban Waste Water Directive[141].
- Consider dry closets as an alternative more sustainable way in particular in regions where major updates in sanitary systems are happening as well as in smaller cities or rural areas, which lack wastewater treatment facilities.

3.1.4 Policy recommendations related to shipping

In February 2019, the European Parliament approved draft legislation to include emissions from ships over 5,000 gross tonnes in the EU Emissions Trading System (ETS) from 1st January 2022[142]. The MEPs called, inter alia, for the alignment of reporting obligations by the EU and the International Maritime Organisation (IMO)[143], as well as for the creation of an "Ocean Fund" financed by revenues from auctioning allowances under the ETS from 2022 to 2030, to make ships more energy-efficient, to support investment in innovative technologies (e.g. alternative fuels) and infrastructure (e.g. green ports). Considering the IMO's regulations insufficient, the MEPs also asked the Commission to examine the overall environmental integrity of the measures decided by the IMO, including the targets under the Paris Agreement. The European

140 https://weischer-gmbh.de/filtersysteme

141 Dry compost closets have already been proven successful in different settings in supporting a circular soil management while reducing pressure on urban and rural wastewater treatment systems (i.e. during festival events).

142 Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) 2015/757 in order to take appropriate account of the global data collection system for ship fuel oil consumption data (COM/2019/38 final): https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2019:0038:FIN

143 See Marpol Annex V

Commission has completed the consultation period and is still finalizing its impact assessment with all options still on the table[144].

Besides or additionally to the legislative proposals under discussion, policy actions should:

- Reduce demand for international shipping by fostering regionalisation;
- Include emissions by shipping in the national limits for air pollution[145].
- Develop the installation of exhaust Gas Cleaning Systems (EGCS) (e.g., scrubbers) for ships over 5,000 gross tonnes;
- Slow down ship speed by 20% to reduce CO_2 and nitrogen oxygen emissions as well as noise.
- Electrify all European ports to reduce local air pollution in connection with renewable energy sources.

The final legislative proposal has been postponed to 14 July 2021. Besides including shipping in the ETS, the commission might propose to create a separate ETS system for the transport sector, taxing shipping emissions, creating an hybrid system of emissions trading and complementary measures. IMO disapproves of regional measures that could undermine the global approach.

3.2.1 Zero input low trophic level aquaculture for thriving coastal communities through a resilient Baltic Sea

The key elements necessary to build long-lasting and environment-friendly aquaculture practices are to focus on farming species with a low trophic level that don't rely on additional food input. When farming finfish, the most sustainable set-ups are those that farm herbivorous fish or low-trophic level carnivorous fish, so fish that don't eat other fish, but only zooplankton or algae, to decouple aquaculture from wild capture fisheries. Additionally, those fish should be farmed inland in systems with closed nutrient loops to avoid leakage of nutrients from the fish into the surrounding ecosystem that might further exacerbate eutrophication. Another promising area to improve the sustainability of aquaculture is the set-up of integrated multi-trophic aquaculture systems. This means culturing multiple species of different trophic levels together and re-using the emerging waste material for other purposes. For example, species like mussels and seaweed that take up nutrients from the water are cultured with finfish species that

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[144] https://www.hellenicshippingnews.com/all-options-still-on-table-for-cutting-shipping-co2-emissions-ec-official

[145] Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32001L0081

produce organic and inorganic waste. Their waste actually serves as feed for the extractive species reducing the environmental impact of the aquaculture farm[146].

However, the overall sustainability of such a setup strongly depends on the feed required for the cultured finfish species as fish like salmon would still require nutrient inputs from fishmeal or other sources that might rely on wild capture fisheries. This is especially due to the need to have feed that includes omega 3 sources, which provide important nutritional benefits for humans consuming the fish[147]. Promising advancements in this area have been made to replace their reliance on fishmeal with alternative protein sources, such as from farmed algae or insects[148]. But focusing on farming low trophic level species, such as shellfish, which don't require any input requires thus less resources and space making it more sustainable. In the Baltic Sea, it has been determined that there is a potential for developing integrated multi-trophic aquaculture and feasibility studies to determine this potential in practice are currently underway[149].

Growing the aquaculture sector with a focus on low-trophic level or integrated multi-trophic aquaculture systems harbours great potential to generate economic value and create employment opportunities with minimal environmental impact. This can also help to reduce the pressure on land-based protein production and alleviate its environmental impacts. In particular mussel farming has been identified as one of the least impactful methods of producing animal-sourced protein, especially within the EU when farming native species, such as blue mussels[150]. Mussels can also support efforts to mitigate eutrophication by taking up excess nutrients from the water which are removed as the mussels are harvested[151].

[146] Buck BH, Troell MF, Krause G, Angel DL, Grote B and Chopin T (2018) State of the Art and Challenges for Offshore Integrated Multi-Trophic Aquaculture (IMTA). Front. Mar. Sci. 5:165. doi: 10.3389/fmars.2018.00165

[147] https://www.duh.de/fileadmin/user_upload/download/Projektinformation/Naturschutz/Fischereipolitik/Bericht_Futter_bei_die_Fische_Screen_RZ.pdf

[148] https://www.fisheries.noaa.gov/noaa-usda-alternative-feeds-initiative

[149] https://www.gma-buesum.de/en/projects/completed-projects/feasibility-study-of-a-sustainable-marine-aquaculture-in-the-baltic-sea-schleswig-holstein.html

[150] http://aquaticcommons.org/5758/1/Blue_Frontiers_Report.pdf

[151] Kotta et al. (2020), Cleaning up seas using blue growth initiatives: Mussel farming for eutrophication control in the Baltic Sea. Sci. Total Environ. 709, 136144

The effectiveness of mussel farming for direct nutrient remediation strongly depends on the type of farm, its location and scale[152]. However, mussel farming can alleviate nutrient loading much more effectively through the indirect mechanism of replacing meat consumption. Zero input mussels farming can be an alternative protein source and therefore can lead to the reduction of fertilizer use related to land-based protein production. For example, to produce 1000 kg of beef in Finland, which contains about 250 kg of proteins, 1700 kg of nitrogen and 189 kg of phosphorus is required[153]. Even a small scale farm, which produces about 5 t mussel biomass per year, can easily produce similar quantities of proteins[154]. This indirect nutrient mitigation is actually more than 10 times as effective as the additional direct nutrient remediation effect. It is imperative that any such mussel protein needs to be directly used for human consumption instead of as animal feed to avoid any loss of energy and make full use of this additional mitigation potential. In addition to these environmental benefits, mussel consumption also has significant human health benefits. For example, mussels outperform other protein sources in many areas as they contain high-quality amino acids and key micronutrients, especially iron and Vitamin B-12. Additionally, they are easily digestible and can be a good source of omega-3 fatty acids[155]. These health benefits are of particular importance considering the growing awareness of the health risks associated with high red meat consumption[156].

Even though worldwide aquaculture production of mussels has been increasing, there has been a decrease in EU mussel aquaculture production over the last two decades and in 2016, EU mussel aquaculture was valued around EUR 328 million. However, many of the key issues that have been identified as contributing to the decline in European mussel aquaculture production can be alleviated through political action. They include improving the process of obtaining permits, creating laws regarding the supply chain of imported mussel products that take for example

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152 Kotta et al. (2020), Cleaning up seas using blue growth initiatives: Mussel farming for eutrophication control in the Baltic Sea. Sci. Total Environ. 709, 136144

153 Joensuu, K., Pulkkinen, H., Kurppa, S. et al. Applying the nutrient footprint method to the beef production and consumption chain. Int J Life Cycle Assess 24, 26–36 (2019). https://doi.org/10.1007/s11367-018-1511-3

154 We assume that 5 t mussel biomasses harvested (wet weight) consists of 1.5 t mussel shells and 3.5 t of mussel tissues following https://www.sciencedirect.com/science/article/abs/pii/S1385110116302702 and that uncooked mussels tissue contains 10 % proteins. This results in 350 kg of proteins harvested in this case. Note that even small scale farms can easily harvest mussel biomass of order 50 t and more per year.

155 Yaghubi, E. et al. Farmed Mussels: A Nutritive Protein Source, Rich in Omega-3 Fatty Acids, with a Low Environmental Footprint. Nutrients 2021, 13, 1124. https://doi.org/10.3390/nu13041124

156 Battaglia Richi E, Baumer B, Conrad B, Darioli R, Schmid A, Keller U. Health Risks Associated with Meat Consumption: A Review of Epidemiological Studies. Int J Vitam Nutr Res. 2015;85(1-2):70-8. doi: 10.1024/0300-9831/a000224. PMID: 26780279.

working conditions into consideration and providing subsidies to promote environmental sustainability.

There are also important opportunities in focusing on supplying existing strong EU markets in the Baltic Sea region, like in Germany, as well as emerging markets with a focus on more sustainable food systems and healthy diets. Mussel and algae farming is also especially economically beneficial for coastal communities. As it does not depend on food or fertiliser import, its market can be decoupled more easily from global trade thereby boosting regional value creation. This also leads to increased regional tax revenue through employment generation not only in the aquaculture industry itself, but also associated sectors like local markets, restaurants or tourism. Focusing on supporting the local or regional capacity to diversity the processing of mussels can further support this commercialisation by adding value and prolonging the conservation time. This might include frozen, canned, modified atmosphere and different available dishes. Pasteurising fresh mussels is especially promising as it allows them to be in excellent condition for human consumption for at least 60 days[157].

Also farming algae and seaweed has huge economic potential as they can be used as a raw material for a wide variety of uses. They can be used for fish food or human consumption, but also as fertilizers, bioremediators, nutraceuticals, cosmetics or drugs. For now, very few seaweed species are utilised commercially in the Baltic, and only the kelp *Saccharina* latissima is presently cultivated, although a common red algae, *Furcellaria lumbricalis*, has the longest harvesting history in the region[158]. Processing of seaweed and algae can result in quite high value creation for example in the medical sector. For example, besides nutritional and bioremediation qualities, the algae *Spirulina subsalsa* shows promising bioactive effects on breast cancer cells as protease inhibitor[159]. So far the potentials of seaweed and algae farming have just started to be explored in the Baltic Sea[160]. For example, the Finish start-up Origin by Ocean baltic Sea algae wants to transform the problem of eutrophication into a solution, by refining algae into bio-based raw

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[157] Avdelas et al (2021), The decline of mussel aquaculture in the European Union: causes, economic impacts and opportunities. Rev. Aquacult., 13: 91–118. https://doi.org/10.1111/raq.12465

[158] Kersen et al (2017), Biotechnological applications of the red alga Furcellaria lumbricalis and its cultivation potential in the Baltic Sea, Botanica Marina, vol. 60, no. 2, 2017, pp. 207–218. https://doi.org/10.1515/bot-2016-0062

[159] Szubert et al. (2018) Bioactive metabolites produced by Spirulina subsalsa from the Baltic Sea, Oceanologia Volume 60, Issue 3, Pages 245–255, https://www.sciencedirect.com/science/article/pii/S0078323417301033

[160] Weinberger F., T. Paalme, S.A. Wikström (2020) Seaweed resources of the Baltic Sea, Kattegat and German and Danish North Sea coasts. Botanica Marina 63:61–73. doi: 10.1515/bot-2019-0019

material for hygiene and cleaning products[161]. Such innovative and environmentally friendly potentials of algae and seaweed from the Baltic should be further explored alone and in combination with mussel farming.

Of course, deciding what we eat and how we farm are choices that are not just rational decisions taken on the basis of nutrient calculations. Those lifestyle choices are also strongly emotional and often deeply embedded in our culture and identity and respecting these dimensions is key. However, there is no need to choose between rational and emotional arguments as we make the best decisions when both of those elements are taken into consideration. Realising the impact of our lifestyle choices on our ocean and marine biodiversity is important so we can take this information into consideration and figure out ways that are not only systemically desirable, but also culturally feasible.

It is important to keep in mind that our cultural identity and associated practices are not stagnant or fixed, but constantly changing. They are influenced by our heritage, but also by new ideas and information and might change based on how this aligns with our internal value system. This is best illustrated by the example of mussel farming in the village of Ellerbeck on the east coast of the Kiel fjord. For centuries, mussel farming was practiced here and not only sold regionally, but also exported to distant markets such as Prague or Budapest. This practice stopped as Kiel became more industrial which led to deteriorating water quality making the mussels unfit for consumption and eventually the whole village of Ellerbeck was removed. However, there has been a resurgence of interest in this presumably historic practice with the establishment of the *Kieler Meeresfarm* in 2012, a commercially fully established blue mussel farm in the Kieler fjord[162]. The example of mussel aquaculture shows how rapid transformations could be achieved with significant co-benefits for humans and the ocean. If we combine traditional farming approaches with refined new techniques and change our food consumption, both nature and humans are benefiting.

3.2.2 Policy recommendations related to aquaculture

Fiscal solutions

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[161] https://originbyocean.com

[162] Krost P. And Staufenberg T. (2017) Back on track: Mussel farming in the Baltic Sea, The Grower January 2017, https://www.researchgate.net/publication/320905650_Back_on_track_Mussel_farming_in_the_Baltic_Sea

- Prioritize subsidies and financial support towards zero input algal and mussel farming and not to high trophic level fish farms i.e. salmon farms.
- Support new small / medium sized community-based zero-input aquaculture farms via start-up grants, which include covering initial investment costs (about 85000 Euro)[163], like licensing procedures, environmental assessment / monitoring costs and regular analytical costs for food security assessments (about 500 Euro per month)[164].
- Develop regional joint analytical solutions to have synergetic effects to make small-scale farms more profitable by sharing monitoring costs, which can create financial barriers at the initial phase.
- Simplify regulations and speed up implementation (at EU, member state and regional scale) for small-scale coastal zero input low trophic aquaculture farms to new sustainable ocean farmers planning security.
- Fund regional seafood processing facilities and market places that support diversification of the aquaculture industry through additional economic activities related for example to tourism or direct processing[165].
- Support diversification of the aquaculture industry to make it more resilient.
- Regulate the finfish aquaculture fish feed market to ensure it fully decouples from wild catch fishing.
- Stop subsidizing aquaculture farms that depend on imports of fishmeal/-oil based fish-food creating overfishing and food security issues i.e. in West Africa[166] and anywhere else as outlined in detail in chapter 2.2.
- Regulate and reduce imports of fishmeal/-oil based fish-food into the EU to ensure food insecurity in other regions of the world are reduced.

Management / Spatial solutions

- Reserve space for community-based zero input low trophic level farms in the Baltic Sea through holistic Marine Spatial Planning, which takes into account environmental

163 https://www.dbu.de/123artikel24819_2442.html

164 Krost P. And Staufenberg T. (2017) Back on track: Mussel farming in the Baltic Sea, The Grower January 2017, https://www.researchgate.net/publication/320905650_Back_on_track_Mussel_farming_in_the_Baltic_Sea

165 Avdelas, L. et al (2021), The decline of mussel aquaculture in the European Union: causes, economic impacts and opportunities. Rev. Aquacult., 13: 91–118. https://doi.org/10.1111/raq.12465

166 https://www.greenpeace.org/static/planet4-international-stateless/2019/06/5cfb1014-a-waste-of-fish-exec-summary-en-.pdf

conditions (i.e. good ventilation of water bodies, optimal growth conditions like food availability and salinity levels, easy access for farmers from land).

- Ensure selection of optimal locations in terms of environmental, economic and socio-cultural elements. For example, ensuring to avoid farming at anoxic seafloor and promoting co-use and synergies in space use with other activities[167].
- Address aquaculture through a dedicated adaptation strategy under the EU Climate Adaptation strategy (adopted in February 2021) to ensure the sector implement comprehensive and efficient climate-change adaptation measures;
- Quantify and reduce any potential negative contribution made by aquaculture to climate change (e.g. energy consumption and carbon emission from production, transport and processing);
- Support the proposal made by the Commission under a new Fisheries control regulation to extend the traceability obligations across the supply chain (from production to the retail sale, including transport) to all aquaculture products, including processed products and products imported from non-EU countries[168].
- Clarify the EU legislation (Official controls Regulation and Water Framework Directive) applicable to the aquaculture of bivalve molluscs in terms of environmental requirements (e.g. classification of harvesting areas, sanitary survey, registers of protected areas);
- Improve the circular economy approach in aquaculture (fish manure, use of fisheries by-catch, use of waste, etc)[169];
- Use life-cycle approaches in the assessment of the environmental impact of the EU aquaculture sector;
- Set up management practices including a risk strategy for mitigating environmental and climate impacts (including those related to any discharges of organic matter, nutrients, plastics, veterinary medicines, other pollutants, any form of waste and litter and,

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[167] Kotta et al. (2020), Cleaning up seas using blue growth initiatives: Mussel farming for eutrophication control in the Baltic Sea. Sci. Total Environ. 709, 136144 including Response to a letter to editor regarding Kotta et al. 2020, and Buck B.H., Nevejan N., Wille M., Chambers M.D., Chopin T. (2017) Offshore and Multi-Use Aquaculture with Extractive Species: Seaweeds and Bivalves. In: Buck B., Langan R. (eds) Aquaculture Perspective of Multi-Use Sites in the Open Ocean. Springer, Cham. https://doi.org/10.1007/978-3-319-51159-7_2

[168] COM/2018/368 final.

[169] AAC Recommendation on the climate footprint of the EU food system (24/03/2021): https://aac-europe.org/images/jdownloads/AAC_Recommendation_-_Climate_Footprint_2021_06.pdf

greenhouse gase emissions) with regard to their potential adverse impact on local species and biodiversity, water quality[170].

Social solutions

- Establish a systemic and participatory process with a long-term vision and financial support to explore the specific regional and local potential for sustainable aquaculture development by building meaningful partnerships between relevant stakeholders (academics, local communities, industry representatives and policy makers); similar to the US Sea Grant programme[171] to develop positive visions of the future collaboratively.
- Initiate European educational program on sustainable algal and mussel farming to train the future Baltic Sea ocean farmers and strengthen the European spirit (i.e. training of farming techniques adapted to regional settings) across the Baltic Sea basis. This effort should build on already existing education programs i.e. the Nordic Masters programme in sustainable production & utilization of marine bioresources[172].
- Building on the educational programs: Create well paid and secure jobs for coastal communities through regional markets, regional processing and supply chains and regional product labeling.
- Foster community-based zero input low trophic level algal and mussel farming key solution to provide humans with proteins.
- Support regional markets for local seafood products i.e. through local “mussel festivals” reconnecting coastal communities and actors from ocean algal and mussel farmers, cosmetic producers, chefs and restaurants and consumers.
- Organize regional information events highlighting co-benefits for regional development, human and ocean health, regional tourism and cultural identity.

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[170] For other recommended specific actions, see communication from the Commission to the European Parliament, the Council, the Economic and social Committee and the Committee of the regions (COM/2021/236 final): Strategic guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:236:FIN. See also: https://eur-lex.europa.eu/resource.html?uri=cellar:bab1f9a7-b30b-11eb-8aca-01aa75ed71a1.0022.02/DOC_2&format=PDF .

[171] https://seagrant.noaa.gov/About#:~:text=Sea%20Grant%20is%20a%20Federal,healthy%20coastal%20environment%20and%20economy.

[172] https://www.gu.se/en/study-gothenburg/nordic-masters-programme-in-sustainable-production-and-utilization-of-marine-bioresources-n2mab

- Promote and set-up participatory processes including art and visual explorations that allow local stakeholders to share, explore and develop their perspective to find specific local solutions that are culturally feasible.
- Ensure these programs improve the representation of women and other marginalised groups through the development of targeted educational and capacity-building activities done in collaboration with higher education institutes or the industry.
- Develop channels of communication and platforms where consumers can demand more transparency from their seafood producers including the whole supply chain (e.g. sources of fish food used within aquaculture[173]) and that can link producers directly with consumers to promote the consumption of locally sourced seafood[174].

Natural solutions

- Use aquatic biomass such as farmed algae or seaweed as human food or raw material for multiple products like alternative packaging[175], cosmetics[176] or pharmacy[177].
- Support innovation to use marine algae as fertilizers for agriculture or regional biogas production.

Technological solutions

- Support closed aquaculture systems to avoid the spread of diseases and nutrients into the ocean.
- Support innovation of finfish feed through algal and insects to fully decouple aquaculture from wild fish catch.

3.3.1 Reducing fishing pressure while implementing and enforcing strong marine protected areas for fish stock and marine biodiversity recovery

Imagining a positive future for fisheries in the Baltic Sea requires integrating the current needs of coastal communities with actions that prioritise marine biodiversity recovery and also

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173 https://www.duh.de/futter-bei-die-fische

174 https://www.thefishmarketapp.com

175 https://www.yooweedoo.org/de/projekt/rematter

176 http://crm-online.de/en/research/marine-natural-product/recal-neuroprotective-algae-extracts

177 http://crm-online.de/en/research/marine-natural-product/rea-redox-enzymes-from-algae-as-innovative-tools-in-the-bio-industry

consider the well-being of future generations. It is clear that to allow future generations to catch and eat fish from the Baltic Sea, fishing pressure has to be reduced drastically, and the remaining fishing has to be done with approaches with minimal impacts on marine habitats and biodiversity. This is necessary to allow fish stocks and marine life to recover and continue to provide long-term benefits to coastal communities to fishers. Reducing fishing pressure could be done through improved gear technology that is more selective, strict fisheries management, setting catch limits and quotas according to scientific advice and establishing no-take marine protected areas[178].

Marine protected areas (MPAs) are one of the most effective mechanisms that can help fish stocks and biodiversity recover while providing significant long-term benefits for fishers as well. MPAs are spatially delineated areas of the ocean with specific guidelines on what uses are permitted in those zones. In general, they aim to protect these areas, but they can be set up for a number of specific reasons including biodiversity conservation, protection of specific species or economic resources and to aid the recovery of fish stocks[179]. Some MPAs are permanent designations, others involve only temporary closures for certain activities, such as fishing during specific periods. The most effective MPAs are so-called “no-take” marine reserves with strong protection levels where extractive activities and fishing are prohibited. Establishing strong no-take MPAs is especially important to allow the habitats to recover and regenerate providing possible retreat areas for non-commercial species commonly impacted by fishing, such as seabirds or marine mammals[180]. However, MPAs actually support fisheries and can lead to improved fishing yields without disadvantaging fishers. In the protected areas, biodiversity and fish stocks can recover leading to increases in size, diversity, density and biomass within the MPAs[181]. Therefore, the fish populations within the MPAs will contain more and larger fish. Because larger fish can also produce more eggs, the populations within the MPA will be able to produce more offspring than exploited populations outside of the MPA. Through ocean currents,

178 Opitz S. And Froese R. (2019) Ecosystem Based Fisheries Management for the Western Baltic Sea. Extended Report, https://www.researchgate.net/publication/339237754_Ecosystem_Based_Fisheries_Management_for_the_Western_Baltic_Sea_Extended_Report

179 https://www.iucn.org/theme/marine-and-polar/our-work/marine-protected-areas

180 https://academic.oup.com/icesjms/article/75/3/1166/4098821

181 http://www.mpaaction.org/keywordstags/spillover-effects

adults, eggs and larvae from the MPA also spill over into adjacent fishing grounds and can thereby actually supply local fisheries[182].

In addition to the fisheries perspective of MPAs, setting up well-designed and ensuring the strict implementation of existing MPAs will also be crucial to protect the harbour porpoise from regional extinction in the Baltic Sea. Ensuring the strong implementation of the MPA „Pommersche Bucht – Rönnebank“, east of Ruegen within the Exclusive Economic Zone (EEZ) of Germany is especially important here. New MPAs should be designed based on the population distribution data established from the SAMBAH project[183]. As shown in Figure 3, current gillnet fisheries overlap drastically with the main areas for harbour porpoises especially in Germany, Denmark, Sweden and Poland.

In addition to establishing MPAs in those key regions and improving the protection level of existing MPAs, overall reductions of fishing effort and gear technology improvements are also likely to contribute to harbour porpoise protection. Recent promising improvements have for example been made by the Thünen Institute of Baltic Sea fisheries that are likely to reduce harbour porpoise bycatch rates through net modifications[184] and the development of devices that emit synthetic harbour porpoise communication signals alerting them to the presence of gillnets[185]. Having a solid scientific basis for the effectiveness of those proposed mechanisms as well as an awareness of the economic implications and cultural feasibility are key for their successful implementation. However, while those developments are highly promising and should be pursued, it is absolutely imperative not to use this as an excuse to postpone decisions on establishing harbour porpoise protection measures given the urgency of the population status. No-take zones in important regions, such as nursery and feeding habitats, are necessary protection measures and the scientific data necessary for their implementation has already been collected through the SAMBAH project.

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182 Roberts, C.M., Bohnsack, J.A., Gell, F.,Hawkins, J.P., and Goodridge, R. Effects of marine reserves on adjacent fisheries. Science, 294, 1920–1923 (2001)

183 https://www.sambah.org

184 Kratzer et al (2020) Determination of Optimal Acoustic Passive Reflectors to Reduce Bycatch of Odontocetes in Gillnets. Front. Mar. Sci. 7:539.doi: 10.3389/fmars.2020.00539

185 Chladek et al. (2020) Synthetic harbour porpoise (Phocoena phocoena) communication signals emitted by acoustic alerting device (Porpoise ALert, PAL) significantly reduce their bycatch in western Baltic gillnet fisheries, Fisheries Research, Volume 232, 105732, https://doi.org/10.1016/j.fishres.2020.105732

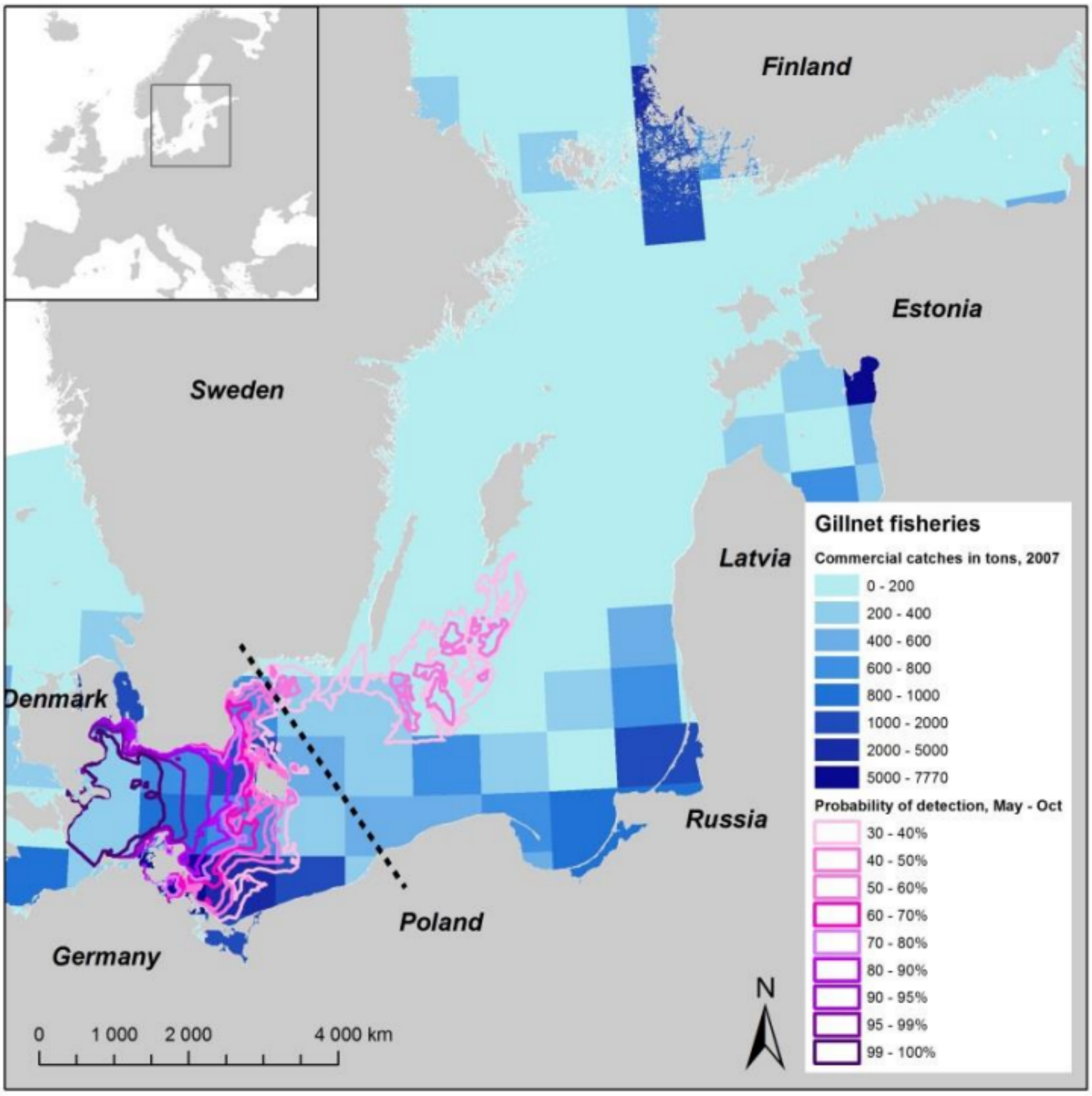

Figure 3: Catches in gillnet fisheries in 2007 together with important areas for harbour porpoises as the probability of detecting harbour porpoises. The dotted line indicates two distinct summer populations of harbour porpoise that were identified by the SAMBAH project[186].

Establishing effective MPAs is highly dependent on the local context. In general, to be effective MPAs need to be well designed according to scientific advice and need to be part of a larger integrated management or marine spatial plan. They also depend on effective enforcement and compliance with the established guidelines. Crucially, MPAs also need to be designed through engagement with local communities and take their needs and perspectives into consideration. When designed well, MPAs can enhance food security and empower local communities.

[186] https://www.sambah.org/SAMBAH-Final-Report-FINAL-for-website-April-2017.pdf (Fig 1b, page 6)

However, this depends on the process of establishment as MPAs don't inherently affect human well-being in a positive or negative way, but it entirely depends on the local context[187].

Moving towards a future that includes thriving coastal communities, economic opportunities and marine biodiversity recovery will require us to think creatively and to work together across scales and different stakeholders. We have to prioritise approaches that will allow the recovery of depleted stocks and degraded ecosystems over ones that promote the current extractive and unsustainable status quo. However, it is also absolutely crucial to make sure no one gets left behind and to take social justice and the realities of especially the most vulnerable and marginalised coastal communities into consideration. This will require participatory management approaches together with community members and other stakeholders based on co-design. Such processes are promising ways to identify and develop potential opportunities for alternative livelihoods and culturally feasible emerging economic opportunities, such as low trophic level aquaculture described in section 3.2. Using a holistic approach, such participatory processes can help to develop different scenarios for what the future of the Baltic Sea and its communities could look like and to start moving towards them in an inclusionary way.

3.3.2 Policy recommendations related to fisheries and biodiversity

- Add species to the annexes to the nature directives (birds and habitats directives) (e.g. commercially exploited marine fish, mussels, etc.) to make it easier to bring them under the protection of Common fisheries Policy (beyond the fact that the MSFD provisions enable member States to protect all marine species and habitats)[188];
- Set Total Allowable Catches (TACs) not exceeding scientifically advised levels based on the Maximum Sustainable Yield (MSY) Approach for all stocks for which MSY-based reference points are available and, where MSY-based reference points are not available, to not exceed the precautionary Approach catch limits advised by the ICES[189];
- "Set TACs at more precautionary levels and take additional spatial and temporal measures to accommodate stock-specific uncertainties (catch misreporting, discards, assessment bias etc.), interspecies stock dynamics (e.g. sprat-cod) and low recruitment trends of individual stocks, whilst also considering other pressures (pollution,

[187] MASCIA et al. (2010), Impacts of Marine Protected Areas on Fishing Communities, Conservation Biology Volume 24, Issue 5 p. 1424-1429, https://doi.org/10.1111/j.1523-1739.2010.01523.x

[188] https://www.eca.europa.eu/Lists/ECADocuments/SR20_26/SR_Marine_environment_EN.pdf

[189] https://our.fish/publications/joint-ngo-recommendations-on-eu-baltic-sea-fishing-opportunities-for-2021/

eutrophication, climate change) on the Baltic ecosystem that are likely to affect the abundance of fish stock biomass”[190];

- Take into account the lack of implementation of the Landing Obligation when setting TACs, and either require remote electronic monitoring (such as cameras) or onboard observers for all vessels above 12 m and for medium-high risk vessels below 12 m, or set TACs below ICES catch advice to ensure illegal, unreported discarding does not lead to actual catches exceeding ICES catch advice[190];
- Minimize incidental by-catches of harbour porpoise in fishing gear close to zero as already agreed in the BSAP;
- Support the development of the HELCOM core indicator to assess the number of drowned mammals and waterbirds caught in fishing gear;
- Support the development and the implementation of the future commission action plan to address by-catches of sensitive species and adverse impacts on sensitive habitats;

Fiscal solutions

- The EMFF should not be used to fund actions increasing the fishing capacity of a vessel.[191]
- As recommended by the European Court of auditors in 2020,[192] the Commission should, together with the Member States, in the context of the next EMFF programming exercise (by 2023), identify how to increase the contribution of EMFF funding to marine conservation objectives.
- Remove fisheries subsidies which result in overcapacity and overfishing.
- Provide financial support to fishers during the transition period until fish stocks have recovered.
- Foster sustainable coastal fisheries certifications, local products and distribution channels to strengthen regional value creation.

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190 https://our.fish/publications/joint-ngo-recommendations-on-eu-baltic-sea-fishing-opportunities-for-2021

191 See Article 1 of the EMFF Regulation (Regulation (EU) No 508/2014). It is important to note that it is, within the limits defined in the EMFF Regulation, a decision of the Member States how to use the funds available under their national envelope but the commission can encourage them to do so.

192 https://www.eca.europa.eu/Lists/ECADocuments/SR20_26/SR_Marine_environment_EN.pdf

- Allocate a substantial share of EU funding (for e.g. the European Maritime, Fisheries and Aquaculture Fund (2021-2027))[193] to the support of marine conservation under the Marine Strategy Framework Directive.

Management / Spatial solutions

- Set quotas / fishing limits according to scientific advice while supporting low-impact fishing approaches, which do not harm the overall habitat (i.e. like bottom trawling[194]). Set-up and enforce large trawl-free areas especially for important recruitment, spawning grounds or other sensitive habitats in coastal areas and promote the use of passive gears or trawls with less impact on the seabed[195].
- Implement management plans for strong no-take marine protected areas in member states and enforce these.
- EU member States should implement the EU Biodiversity strategy and protect 30 % of the ocean area, with 10 % strict protection[196].
- The quality and level of marine protected areas is key: Within these 10 % areas for strict marine protection, no fishing activities nor other extractive economic activities (i.e. sand extraction) should take place to ensure habits can recover.
- The marine protected areas have to be a real refuge for endangered species to allow their recovery.
- Marine protected areas require space and have to be considered and prioritized in ongoing integrated marine spatial planning efforts of all member states.
- Create networks of marine protected areas to allow species to migrate (i.e. due to expected climate change impacts).
- The EU must insist on rapid and strong implementation of the marine protected area „Pommersche Bucht – Rönnebank“, east of Ruegen within the Exclusive Economic Zone (EEZ) of Germany which plays a key role as a refuge for various endangered species such the harbour porpoise[197].

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193 https://ec.europa.eu/oceans-and-fisheries/funding/european-maritime-and-fisheries-fund-emff_fr

194 https://www.wwfbaltic.org/our-vision-for-the-baltic-sea/supporting-sustainable-fisheries/bottom-trawling-impacts

195 https://balticeye.org/en/policy-briefs/bottom-trawling-threatens-european-marine-ecosystems/

196 https://eur-lex.europa.eu/resource.html?uri=cellar:a3c806a6-9ab3-11ea-9d2d-01aa75ed71a1.0001.02/DOC_1&format=PDF

197 https://www.duh.de/projekte/pommersche-bucht

- Strengthen the implementation of the landing obligation, especially for the demersal fishing fleet of the Baltic sea.
- Foster the implementation of Natura 2000 areas as effective no-take zones.

Social solutions

- Explore future scenarios of sustainable fishing together with young fishers to establish working conditions and regulatory agreements that will improve the attractiveness of this sector and ensure attentiveness to their needs. This might also include financial support via educational diversification programs during the transition period until fish stock has recovered.
- Organise participatory processes based on existing successful systemic tools that focus on developing joint future visions between policy makers and other stakeholders. This can help to identify realistic and culturally feasible solutions to reduce the negative environmental impacts of the fishery sector as well as to improve job creation, sustenance and creations of alternative jobs (like the *Imagine* toolbox for sustainable marine spatial planning in the Mediterranean[198]).
- Provide secure grants for Small and Medium Scale Enterprises (whether through contracts or subsidies) to help them improve employment conditions for staff. The grants may also be extended to large scale enterprises that employ vulnerable or marginalised groups and should cover the extra costs associated with employing fishers enabling salaries to reach living wage level.
- Develop an ocean academy affiliated to a university or other institutions of higher learning to help fishers or those interested in sustainable ocean-based industries to develop the skills and behaviours employers are looking for in the new industries. This should build on existing initiatives for lifelong learning and vocational training in the blue economy[199].
- Flag a New Enterprise Allowance scheme, mentoring and financial support to help people to start restaurant businesses which are committed to offering certified regional seafood.
- Lobby the EU Directorate – General for Employment, Social Affairs and Inclusion to recognise employees and fishers that voluntarily agree to resign from companies whose

198 https://planbleu.org/en/imagine-method

199 https://www.marinetraining.eu/mates

fishing practices are considered destructive practices in the "vulnerable individuals" category for job seekers.

- Provide free centralised support and training to Small and Medium Scale Enterprises – e.g. through shared spaces for fledgling social enterprises to share administrative (and training) resources and to learn from each other's best practices.
- Develop future scenarios together with fishers to explore different potential futures and explore what's culturally feasible as well as meeting key ecological goals.
- Co-design Marine Protection Areas with fishers and key other stakeholders in coastal communities to ensure the needs of coastal communities are considered and the measures are also culturally feasible.
- Communicating the direct benefits to fisheries from Marine Protected Area (MPA) establishment; i.e. how the stock recovery inside MPAs leads to more and larger fish in the protected areas, which will lead to more eggs, larvae and adults also entering the surrounding exploited areas through currents. Therefore, the exploited areas surrounding the MPA will be replenished and will have more fish through input from the protected populations in the MPA aka the so-called spillover effect.

Natural solutions

- Establish ecological coherent networks of marine protected areas across the Baltic Sea applying the criteria of representativity, replication, connectivity and adequacy (i.e. via ECONET HELCOM[200])
- Protect whole ecosystems and habitats in combination with specific measures for particular endangered species.

Technological solutions

- Alternative fishing practices and stricter bycatch measures[201] are required to protect the Baltic Proper harbour porpoises ("Schweinswal") from extinction[202]

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[200] https://helcom.fi/helcom-at-work/projects/econet/

[201] https://ccb.se/2021/04/eu-scientific-body-confirms-stronger-bycatch-measures-are-needed-to-protect-bay-of-biscay-common-dolphins-and-baltic-proper-harbour-porpoises/

[202] https://www.duh.de/themen/natur/lebendige-meere/ and https://www.ndr.de/nachrichten/schleswig-holstein/Immer-weniger-Schweinswale-in-Nord-und-Ostsee,schweinswale170.html

- The use of PAL – Transmitters (Porpoise Alert) in the gillnet fisheries could be a way to reduce the bycatch of harbour porpoises[203].
- Avoid the use of pingers on gillnets to deter harbour porpoises from marine protected areas set up in key regions for harbour porpoises, such as nursery habitats.

[203] MASCIA et al. (2010), Impacts of Marine Protected Areas on Fishing Communities, Conservation Biology Volume 24, Issue 5 p. 1424–1429, https://doi.org/10.1111/j.1523-1739.2010.01523.x

Closing authors' statement

This policy report takes a holistic view of three topics in the Baltic Sea, including: eutrophication, aquaculture and fisheries. A wide range of experts' consultations also made this report possible and they are acknowledged below. The policy report highlights that many important solutions are found on land and are related to agriculture or city and rural planning. Therefore, improving the protection of our ocean from land and by adjusting land-based activities is crucial. However, of course there are a multitude of factors influencing our ocean or even just the Baltic Sea that are not covered in one document. Although aware of their threatening existence, this was not our ambition. Instead, we see this policy report as a starting point for the development of an ambitious **European Blue New Deal**, which has to be extended to other seas bordering the EU and the open ocean (Atlantic) as well as global thematic areas such as:

- **The climate crisis** is a major threat to our ocean primarily due to ocean warming and extreme heat waves, which can result in the collapse of whole marine ecosystems. In this report, climate change is mainly addressed due to its impacts on eutrophication via changing precipitation patterns.
- **The biodiversity crisis** threatens marine life in all European seas and in a very worrying way the Baltic sea, due to the combined impacts of anthropogenic activities on land, in the air and at sea, which are exacerbated by climate change. In this report, biodiversity considerations are raised through the focus on the impacts of fisheries stock depletion and associated habitat degradation and bycatch as well as eutrophication.
- **Human trafficking** continues to present a harrowing reality in the Baltic Sea region where women, men, girls and boys continue to be trafficked, with 4739 formally identified victims from 2016 to 2018. This number is likely to increase due to the linkage between climate change, poverty and the resulting vulnerability to human trafficking due to increasing societal instability. This is projected to be especially significant for already marginalised groups such as refugees, migrants, women and girls[204].
- **Sea-level rise** is posing significant challenges for coastal communities in combination with other human-induced processes such as coastal erosion and flooding.

[204] https://cbss.org/wp-content/uploads/2020/08/CBSS_Report_25.06.2020.pdf

- **Shipping** has a range of different direct and indirect impacts on marine biodiversity. In particular the impacts of numerous pollutants on marine life including significant greenhouse gas emissions[205] and noise pollution deserves detailed attention.
- **Plastic pollution** including abandoned, lost or disposed fishing gears **and toxic biochemical flows** (nitrogen, phosphorus, iron, etc.) are major threats to the marine ecosystems and oceanographic processes with significant impacts on present and future generations.

Finally, to reach a good environmental status for the Baltic Sea and beyond, a mobilisation across all actors in society and a strong governance including citizens is needed with all socio-economic activities considered in relation to their impact on the ocean. To achieve this, positive ambitious visions and holistic solutions that are being co-developed with local communities and all relevant stakeholders across scales (local, regional, national and international) in a long-term participatory and systemic process will be paramount. A **Blue New Deal "cross check" of all EU legislations** congruent with marine and coastal policy, taking into account the complexity and interlinkages between humans and the ocean is strongly recommended. For the Baltic Sea, the next **HELCOM ministerial meeting on October 20 in Luebeck, Germany** can be a momentum to raise this ambition collectively and spark ocean-climate-biodiversity action within all Europe.

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205 https://climateactiontracker.org/sectors/shipping/

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