Eutrophication in the Baltic Sea

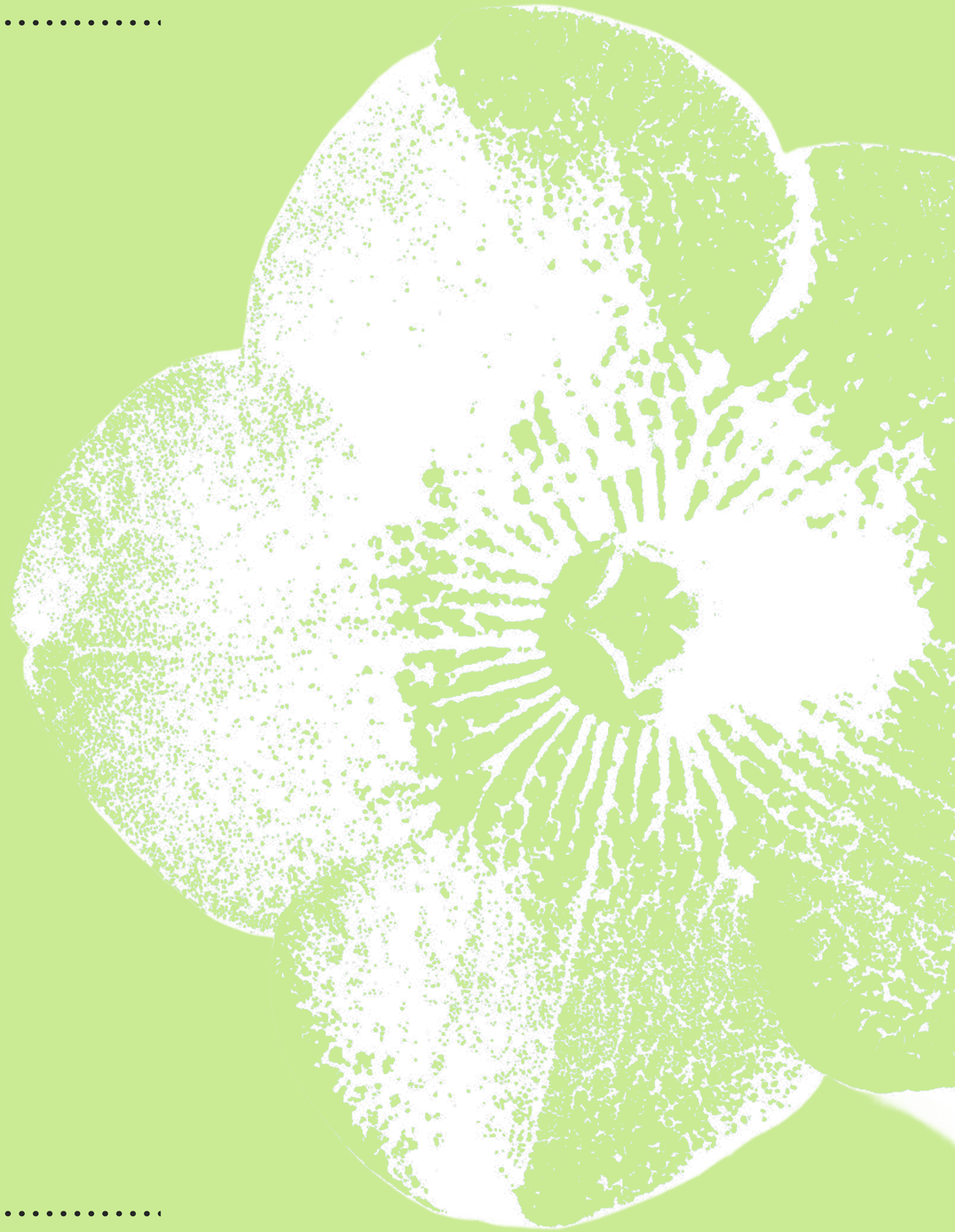
Effects on coastal communities and strategies for improvement

Emma Thorman, Erica Sima, Isadora Spoerer & Olympia Karlafti

January 14th, 2026

Table of contents

260114



Introduction

Problem outline & research question

The Baltic Sea remains in critical decline due to eutrophication, overfishing, habitat loss and pollution, leading to dead zones and algal blooms. Ecosystems and small-scale fishers are struggling, while poor governance and low public awareness prevent effective long-term restoration.

Method

- Literature review
- Semi-structured qualitative interviews (targeted sampling) (Bryman, 2018; Arsel, 2017)
- Thematic analysis (Braun & Clark, 2006), deductive with the use of the Framework for strategic sustainable development (FSSD) (Broman & Robèrt, 2017)
- FSSD Workshop (Broman & Robèrt, 2017)

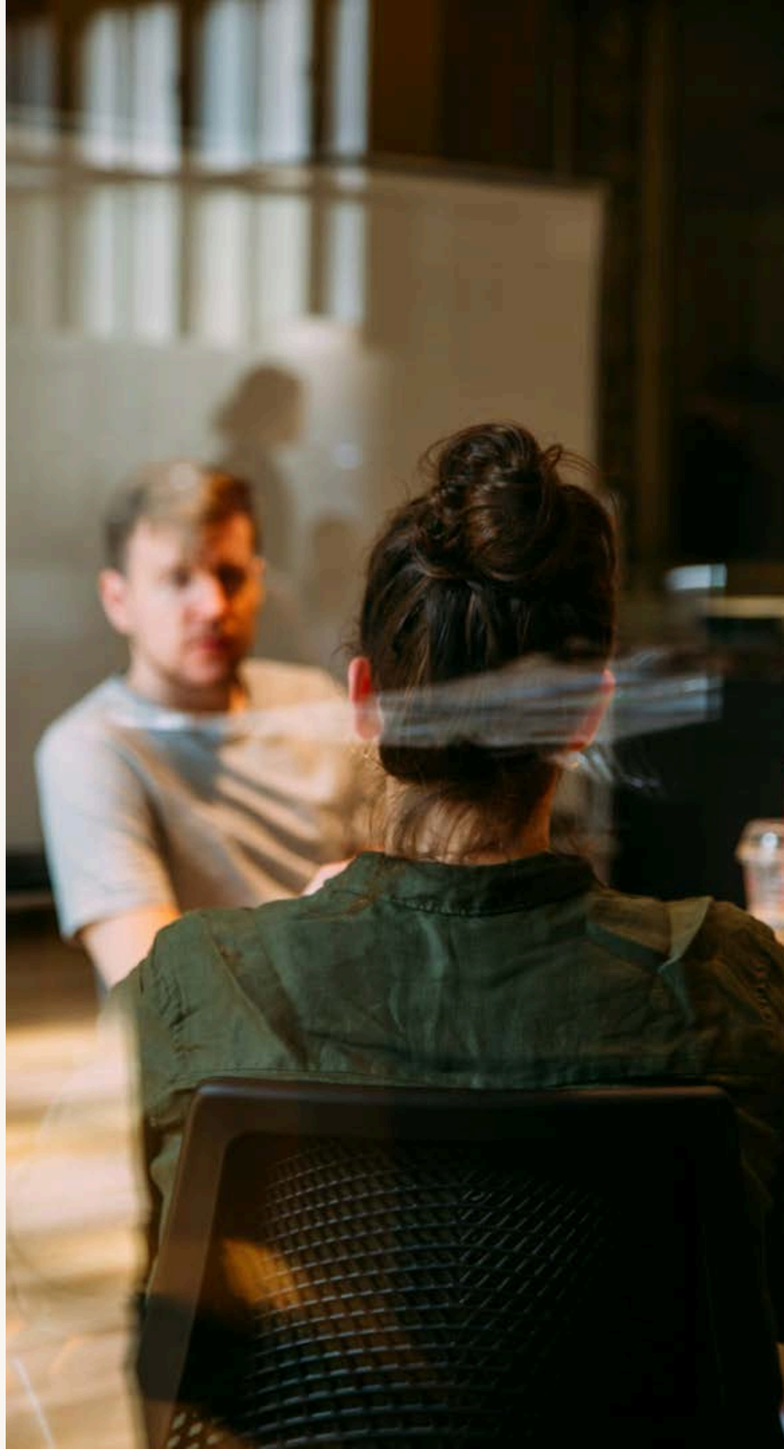
Method discussion

Weaknesses

- AI transcription and translation saved time but may have reduced analytical accuracy
- Limited number of interviews due to time constraints
- Targeted sampling increased risk of selection bias
- Lack of a non-fishing local citizen perspective
- Time pressure led to divided tasks, group coordination challenges, and language barriers in interviews

Strengths

- Pilot interviews improved the interview guide
- Systematic use of analytical frameworks integrating ecological and social principles (Clark & Braun, 2006; Broman & Robèrt, 2017)
- Strong focus on participant comfort and ethics (e.g., informed consent)
- Four interviews completed despite limited time
- Transparency about methodological limitations



260114

Research

Review of ongoing solutions and projects

Gypsum application on farmland

- Reduces phosphorus runoff, tested in Swedish and Baltic projects
- Improves soil structure
- Keeps phosphorus attached to soil particles (reduces leaching)

Constructed eco-wetlands

- Common in Sweden (e.g., Skåne)
- Trap nitrogen (N) and phosphorus (P) before reaching waters
- Mini-wetlands tailored to local farm conditions and specific runoff issues

Mussel cultivation for nutrient removal

- Researched in Sweden as a way to remove N and P from coastal waters
- Mussels absorb nutrients as they grow; harvesting removes them from the ecosystem

Review of ongoing solutions and projects

Oxygenation of anoxic waters

- Sweden is testing oxygenation in sheltered bays to improve habitats and reduce phosphorus release

Wastewater control

- Upgraded treatment and stricter EU rules aim to cut nutrient inputs to the Baltic Sea

Södertälje community system

- A shared sewage system replaces septic tanks
- Central treatment removes nutrients efficiently, and treated waste is reused as fertilizer, recycling phosphorus instead of releasing it

Literature review

Research gap (Ecosystems & health)

- More interdisciplinary research is needed to explicitly link Baltic Sea ecosystem services to health and well-being so that marine policies and the Baltic Sea Action Plan can better account for benefits and risks to people (Storie 2021)

Urgency of action

- Recovery will take decades; early and sustained interventions are critical to manage eutrophication (Ehrnsten et al., 2025)

Ocean literacy

- Understanding people’s relationship with the ocean (values, emotions, norms) builds support for sustainable governance and conservation (Kelly et al., 2022; Worm, 2021)

Interview respondents

HOBBY FISHERMAN

Recreational fisherman with local experience of Baltic Sea conditions.

SMALL-SCALE FISHERMAN

Co-founder of a local fishery at Norrland’s coast, Kvarken, producing surströmming and fishing since the 1970s.

CEO OF FOUNDATION

Leads long-term conservation, advocacy, and research initiatives to protect the Baltic Sea.

MEMBER OF SWEDISH PARLIAMENT

Works in the Environment and Agriculture Committee and represents Sweden in the Baltic Sea Parliamentary Conference.

Interview findings

Theme 1: What is the problem according to the stakeholders (part 1)

Overfishing and its cascading system impacts
The Baltic Sea is incredibly overfished. There are almost no predatory fish left. Fish eat algae, and algae eat plankton. The excess plankton causes eutrophication.
- Hobby fisherman

Physical degradation of the environment
Now, the dead zones in the Baltic Sea are the size of Iceland... a very large part of the Baltic Sea is actually uninhabitable.
- Member of Swedish Parliament

Chemical and nutrient pollution
We must reduce our nutrient load. Take care of the nutrients we have so that we do not add new ones.
- CEO of foundation

Interview findings

Theme 1: What is the problem according to the stakeholders (part 2)

Unequal enforcement and regulatory burden
The demands placed on us small-scale fishermen are the same as for the big trawlers. Our boat is 6.5 meters... - Small scale fisherman

Local fishing communities under pressure
It's almost impossible today [to make a living from small-scale coastal fishing].
- Small scale fisherman

Disconnect between public perception and marine realities
I think we should broaden the debate... Instead of always talking about eutrophication, we should focus on overfishing. - Hobby fisherman

Democratic imbalance
Public pressure actually helps... Persistence wins a little.
- Member of Swedish Parliament

Interview findings

Theme 2: Who is affected according to the stakeholders (part 1)

Across interviews, fishermen appear as one of the most directly affected groups. Declining stocks, regulatory barriers, and competition from industrial trawlers limit their livelihoods and future prospects.
These small-scale fishermen are quite hindered by the authorities... Our boat is 6.5 meters compared to those big trawlers.
- Small scale fisherman

People living near the coast experience environmental degradation most immediately: reduced water quality, decreased recreational value, and emotional stress.
Those who live in coastal communities notice it more... it affects employment... recreational fishing... health and recreational aspects.
- Member of Swedish Parliament

Interview findings

Theme 2: Who is affected according to the stakeholders (part 2)

Health warnings about Baltic Sea fish and reduced access to seafood affect public trust and consumption habits.

Sweden had a very strict recommendation... Finland said 'the benefits outweigh the risks'... the Baltic states said 'Toxic herring? We've never heard of that." - CEO of foundation

My daughter didn't want to eat it when she was pregnant. She's affected by it, of course.
- Small scale fisherman

Tourism, especially coastal tourism, depends heavily on the health and appearance of the sea.

If there's an algal bloom... it can be a problem [for camping site owners]
- Hobby fisherman

Society as a whole was also pointed out as affected

It's actually society as a whole that is affected... The Baltic Sea is the most polluted inland sea... one of the hotspots on the globe. - Member of Swedish Parliament

Interview findings

Theme 3: What could be the solutions according to the stakeholders (part 1)

Adopting a more flexible licensing system, similar to Finland's, where aspiring fishermen can try the profession before committing to strict requirements.

Maybe it's about loosening the rules a bit for small-scale fishing. Apparently, in Finland, anyone can start and get a license. And then after three years, they check: Can you make a living from this? If you can, you get to keep it; if you can't, you have to give it back. That sounded very reasonable to me. - Small scale fisherman

EU-level regulations should require fish caught by large trawlers to be used for human consumption rather than industrial purposes like pellet production.

If we take these trawlers, the big trawling boats that fish in the Gulf of Bothnia, almost everything they pull up goes to pellet production for salmon farming and chicken farming and all sorts of things. If you set the requirement that the fish you catch must go to human consumption, then they wouldn't be able to fish like that. - Small scale fisherman

Interview findings

Theme 3: What could be the solutions according to the stakeholders (part 2)

Economic instruments for sustainability
We must ensure that what is good costs less and that people actually pay for what they emit. - Member of Swedish Parliament

Stronger and better-resourced institutions
More resources are needed for the authorities. - Hobby fisherman

Promotion of circular nutrient flows
Great potential in nutrient recycling... 'This is bread grown on recycled phosphorus."
- CEO of foundation

Calls for systemic transformation
There is no silver bullet; we have to do everything... all these issues are interconnected.
- Member of Swedish Parliament

Key questions, problems, and impacts

Research question
Eutrophication of the Baltic Sea. Scope of Sweden: Who suffers? What can be done?

Core problems
Severe overfishing → Ecosystem imbalance & eutrophication
Environmental degradation → Dead zones, pollution
Governance failures → Unequal rules, weak enforcement, democratic imbalance

Who is affected
Small-scale fishermen → livelihoods threatened
Coastal communities & tourism → degraded environment
Consumers & society → health concerns, loss of trust, shared environmental risk

Summary of insights

Key proposed solutions
Strengthen institutions → Better enforcement & resources
Use economic incentives → Polluter pays, reward sustainability
Reduce nutrient loads → Recycling & circular systems
Reform fishing regulations → Protect small-scale fishing, restrict industrial trawling

The overall message
There is no single fix, but a coordinated, system-wide action is required

260114

Iteration

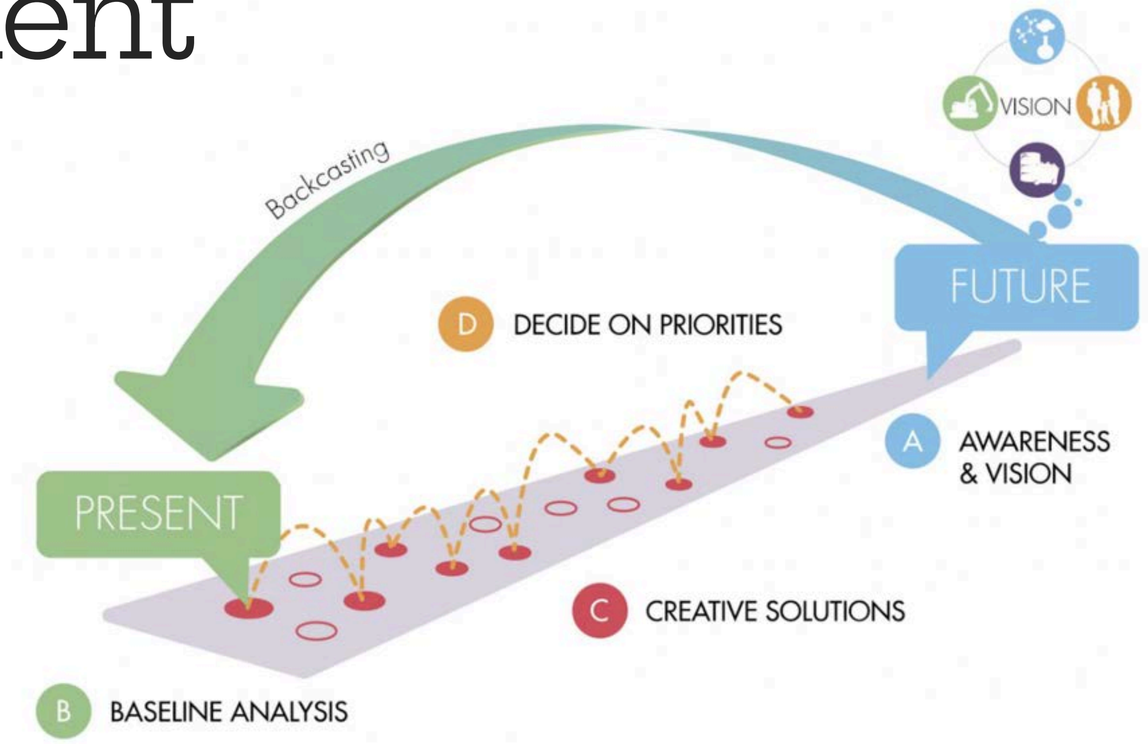
Framework for Strategic Sustainable Development

A. Creating a shared mental model by understanding the needs of coastal communities and setting a vision for the future

B. Compiling a baseline analysis based on data from literature review and interview study

C. Brainstorming possible solutions

D. Prioritising solutions and creating an action plan with solutions that most efficiently meet the needs of coastal communities and bring them towards their sustainability goals and visions



Creating a shared mental model (Step A)

What needs are we trying to meet

1. Change of mindset
2. Recreation
3. Food security
4. Hope of improvement
5. Health
6. Knowledge
7. Cultural belonging
8. Safe swimming and seafood
9. Understanding
10. Aesthetic value of the sea
11. Fair policies for all actors
12. Collaboration
13. Regulation for fisheries
14. Economic tools for sustainability
15. Systematic transformation
16. Meaningful ways to get involved
17. Safe environment for all
18. Economic capital to counter problems

Our vision for the future

A living, attractive, and healthy Baltic Sea that people are proud of, where local coastal communities collaborate, and practice responsible governance together with nature and society in order to thrive with the sea.

Baseline analysis (Step B)

Ecological sustainability principles	Alignments	Misalignments
 **SP1** Increased concentration of substances from the bedrock	▪ National climate and air-quality policies indirectly reduce NO_x emissions ▪ Recognition that emissions and resource extraction must be reduced ▪ Support for transitioning toward circular nutrient and material flows ▪ Awareness of the need to reduce reliance on fossil-fuel intensive industrial practices	▪ Air pollution from transport and industry deposit NOx in the Baltic Sea, increasing nutrient loads ▪ Fossil-fuel dependent agriculture and traffic intensify nutrient emissions ▪ High fossil-fuel dependence in fishing, shipping, and heavy industry ▪ Economic incentives still favor extraction of new resources over reuse or recycling
 **SP2** Increased concentration of substances from society's production	▪ Upgraded wastewater treatments and nutrient recycling projects aim to limit P and N discharge ▪ Calls for stricter regulation and elimination of harmful substances ▪ Experts highlight the need for improved wastewater treatment and monitoring	▪ Anthropogenic NO and P accumulate in the Baltic Sea due to agricultural runoff, wastewater, and industrial discharges ▪ Shipping introduces synthetic substances, including toxic antifouling residues ▪ Wastewater and stormwater systems unable to filter out many pollutants
 **SP3** Displacement or degradation by physical means	▪ Wetland restoration projects ▪ Shared recognition that marine ecosystems must be protected ▪ Support for habitat restoration, reduced trawling, and less physical interference ▪ Broad agreement on the need to rebuild fish stocks	▪ Oxygen-depleted “dead zones” result from eutrophication and destroy benthic habitats ▪ Algal blooms reduce light penetration, degrading seagrass and coastal ecosystems ▪ Interactions with overfishing and habitat loss further destabilize marine ecosystems ▪ Overfishing and trawling causing major ecosystem collapse

Baseline analysis (Step B)

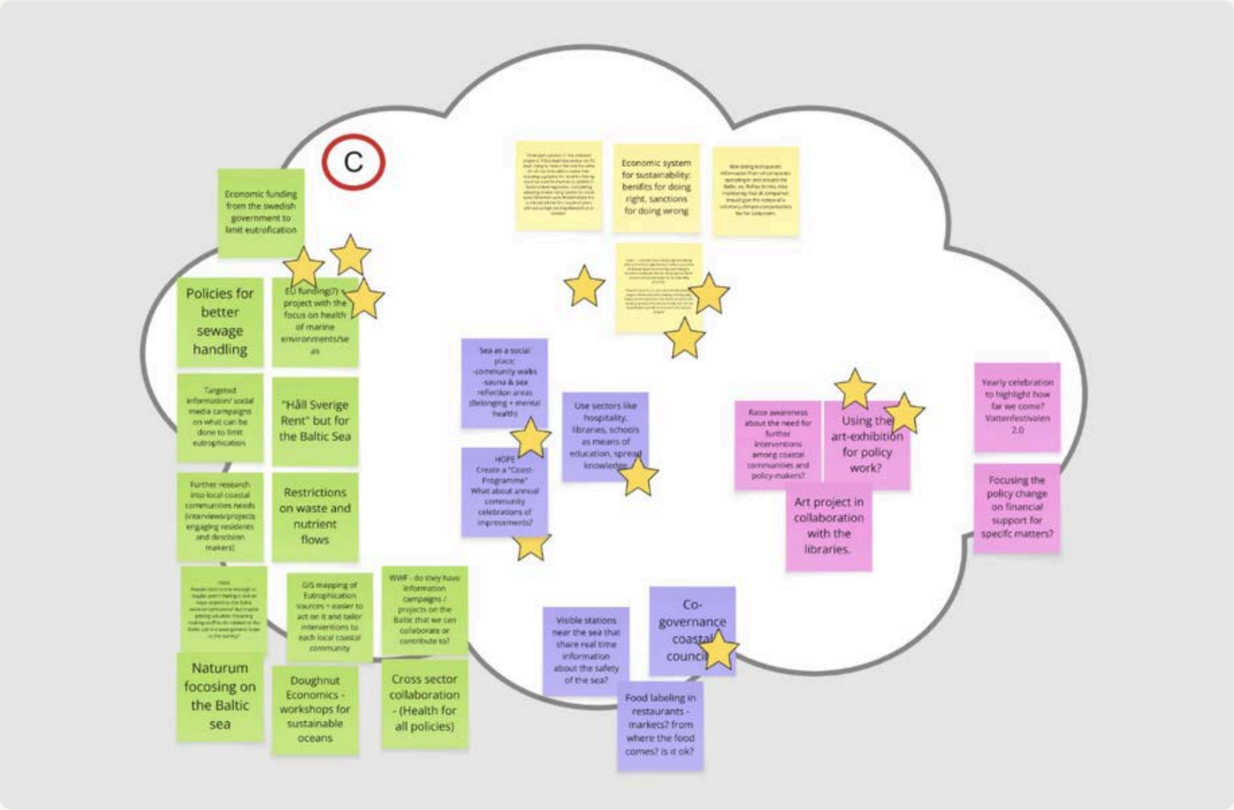
Social sustainability principles	Alignments	Misalignments
 **SP4** Health	▪ Regular monitoring and warning systems by HELCOM and national agencies provide health risk information ▪ Desire to protect cultural heritage and local livelihoods ▪ Recognition that a healthy Baltic Sea supports well-being, recreation, and local economies	▪ Toxic algal blooms caused by eutrophication pose health risks for swimmers and seafood consumers ▪ Algae-related toxins reduce access to safe beaches and coastal recreation. ▪ Small-scale fishers disproportionately harmed by current regulations. ▪ Emotional stress, declining well-being, and reduced access to clean nature
 **SP5** Influence	▪ The Baltic Sea Action Plan (BSAP) includes formal stakeholder consultation procedures ▪ Growing awareness of the need for renewable energy in marine sectors ▪ Support for reducing fossil-fuel dependency in fishing, transport, and industries	▪ Unequal influence, industries and large trawlers hold more power ▪ Local communities, small-scale fishers, and coastal residents have low influence on EU-level and regional nutrient governance ▪ Decision-making authority is concentrated in national agencies and international bodies
 **SP6** Competence	▪ Knowledge dissemination through universities such as SLU and Stockholm University, as well as the Baltic Sea Centre ▪ Enthusiasm for nutrient recycling ▪ Recognition that circularity is essential for long-term Baltic Sea recovery. ▪ Support for innovations in resource loops and local nutrient capture.	▪ Farmers and coastal communities often lack sufficient knowledge or resources to adopt nutrient-efficient practices ▪ Local fishers and residents have limited scientific understanding of eutrophication impacts due to complex ecological processes

Baseline analysis (Step B)

Social sustainability principles	Alignments	Misalignments
 **SP7** Impartiality	▪ EU regulations increasingly target agricultural runoff and maritime pollution to balance responsibility ▪ Shared understanding of the need for resilient fish stocks and ecosystems ▪ Calls for diversified local economies and more inclusive governance ▪ Recognition that democracy, participation, and cultural values strengthen resilience	▪ Environmental burdens (dead zones, toxic blooms, declining fisheries) disproportionately affect coastal communities, while major polluters, large-scale agriculture and shipping, retain economic benefits ▪ Policy incentives still favor nutrient-intensive farming systems ▪ Baltic Sea ecosystems losing biodiversity and functional resilience ▪ Dependence on large-scale, high-impact fishing reduces socio-ecological diversity ▪ Power asymmetries make systems less adaptive and inclusive
 **SP8** Meaning-making	▪ NGOs (WWF Sweden, BalticWaters, Naturskyddsföreningen) engage the public and empower community involvement in marine stewardship ▪ Calls for better coordination, shared responsibility, and long-term governance ▪ Support for financial incentives that reward sustainable behavior ▪ Recognition that cross-sector collaboration is essential	▪ Harmful algal blooms limit access to coastal areas used for recreation, tourism, and cultural practices (e.g., traditional fishing) ▪ Loss of fish affects cultural foods and traditions connected to the Baltic Sea ▪ Fragmented governance between EU, states, agencies, and industry ▪ Strong lobbying from large actors undermines equitable decision-making ▪ Authorities under-resourced to enforce sustainable policies ▪ Lack of integrated, systemic policy approaches

Brainstorming (Step C)

In Step C of the FSSD, brainstorming was used to develop innovative and creative actions that connected the current baseline (Step B) with the desired future vision (Step A). The process was conducted as an open and divergent exercise with several rounds of idea generation, where all proposed ideas were welcomed and explored. Next, the ideas was prioritised based on their ecological, social, and economic feasibility and sustainability.



Creation of action plan (Step D)

PILLAR 1

Art-based & cultural projects

Strengthens connection, pride, and community care for the sea

PILLAR 2

Policy intervention & co-governance

Builds trust, fairness, and sustainable fisheries management

PILLAR 3

Economic systems for sustainability

Supports local action, sustainable behavior, and long-term recovery

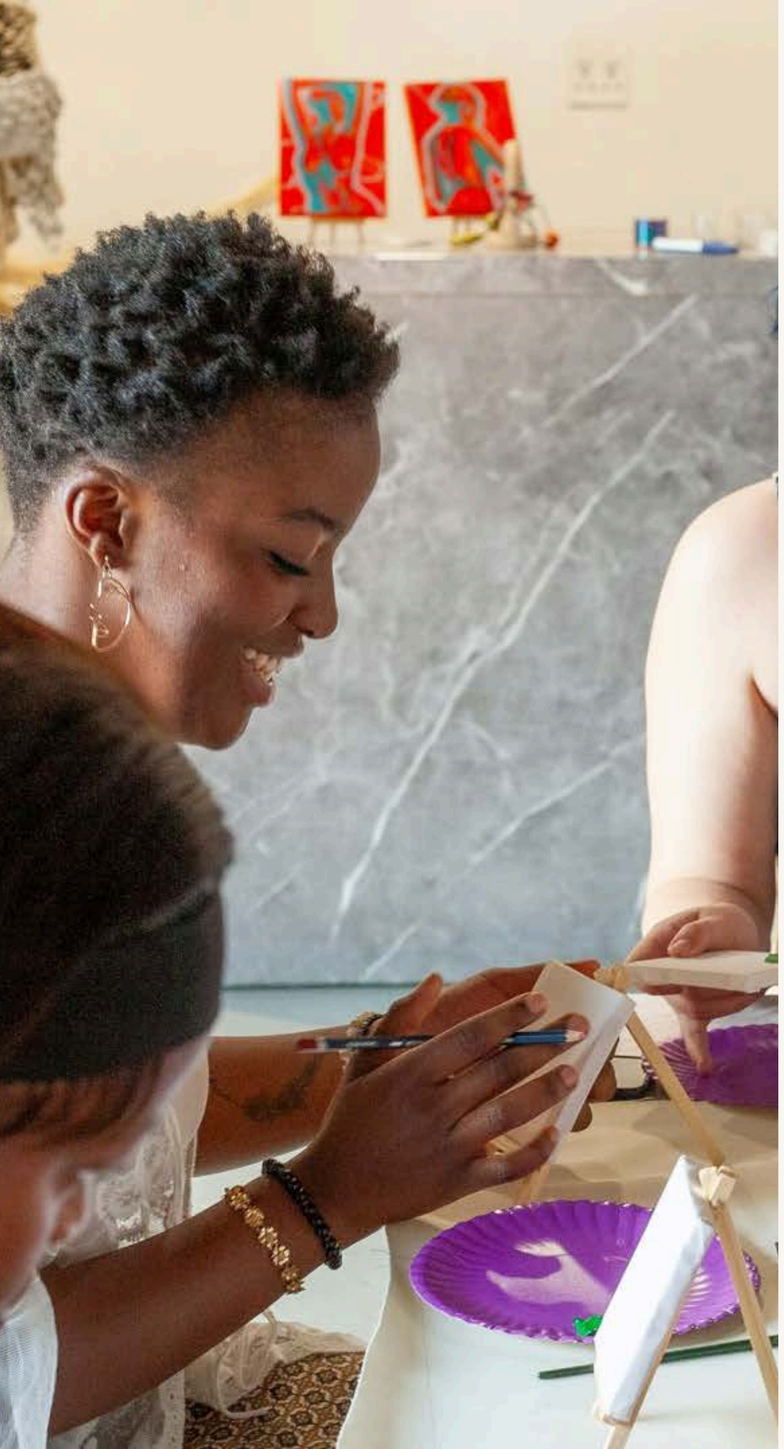
Solution

The Loop

A three-pillar coast programme

Vision
A living, attractive, and healthy Baltic Sea that people are proud of, where local coastal communities collaborate, and practice responsible governance together with nature and society in order to thrive with the sea

Content
A long-term, EU–national–local initiative built on three interconnected pillars; **art & culture programme, policy intervention and co-governance**, and **economic system for sustainability**. These operate in a continuous feedback loop, ensuring systemic transformation rather than isolated projects:
Art → Policy → Economy → Community → Art



Pillar 1: Art and culture programme

Baltic sea art & culture programme

Action: A national library-based art project, Havet & jag, invites coastal citizens to express their relationship with the Baltic Sea, with exhibitions in local libraries and a final museum showcase.

Purpose: Explore and strengthen the citizens connection to the Sea.

Reference projects: TBA21–Academy

Needs addressed: 1, 2, 3, 4, 5, 6, 7

SPs addressed: SP5, SP6, SP8

The sea as a social and healing place

Action: Coastal spaces are activated for reflection, wellbeing, and community life through walks, sauna–sea areas, and shared moments by the water. The sea becomes a place for belonging, mental health, and care.

Purpose: Strengthen mental health, emotional connection, and stewardship.

Reference projects: Kallbadhus tradition

Needs addressed: 2, 5, 7, 9, 10, 17

SPs addressed: SP3, SP4, SP8

Annual community celebrations

Action: Communities gather each year to celebrate visible improvements in the sea. Art, food, and shared stories make progress tangible and strengthen hope and pride.

Purpose: Make progress visible and emotionally tangible. Reinforce collective responsibility and pride.

Reference projects: Stockholm Water festival, Thames Festival

Needs addressed: 4, 7, 9, 16

SPs addressed: SP5, SP7, SP8

Pillar 2: Policy intervention and co-governance

Coastal co-governance councils

Action: Local councils bring together communities, fishers, scientists, and authorities to jointly shape decisions about the sea. Shared governance builds trust, fairness, and long-term responsibility.

Purpose: Shared ownership of regulation. Reduce conflict and increase legitimacy.

Reference projects: Swedish Water Councils (Vattenråd)

Needs addressed: 7, 9, 11, 12, 13, 15

SPs addressed: SP5, SP6, SP7

Art-informed national & EU-level policy labs

Action: Policy discussions take place within art exhibitions and public spaces. Visualised proposals and open dialogue make governance accessible and participatory.

Purpose: Democratize policy-making. Make governance accessible and transparent.

Reference projects: Artworks on View During the UN General Assembly Challenge Diplomats—and You—to Imagine a Better Future

Needs addressed: 1, 4, 6, 9, 11, 12, 15, 16

SPs addressed: SP5, SP6, SP7

Fair fisheries regulation

Action: Clear and equal fishing rules protect marine ecosystems while supporting small-scale livelihoods. Regulation ensures healthy fish stocks and safe seafood.

Purpose: Protect fish stocks and small-scale livelihoods.

Reference projects: SSF Guidelines in Europe

Needs addressed: 8, 11, 12, 13, 17

SPs addressed: SP1, SP2, SP3, SP4, SP7

Pillar 3: Economic system for sustainability

Baltic sea economic framework

Action: European and national funding is combined to support long-term marine recovery, rewarding sustainable practices and placing fees on activities that harm the sea.

Purpose: Provide long-term economic capital for transformation. Make sustainable behavior economically rational.

Reference projects: Ensuring that polluters pay - toolkit

Needs addressed: 3, 11, 14, 15, 17, 18

SPs addressed: SP1, SP2, SP3, SP4, SP7

Local action funds

Action: Small grants support community-led restoration, education, and innovation. Local actors are empowered to act for the sea.

Purpose: Empower small actors and local innovation.

Reference projects: Leader/ CLLD

Needs addressed: 6, 11, 16, 18

SPs addressed: SP5, SP6, SP7, SP8

Everyday learning spaces

Action: Schools, libraries, and public venues (i.e. local supermarket or the local beach) share stories and knowledge about the sea. Learning becomes part of daily life.

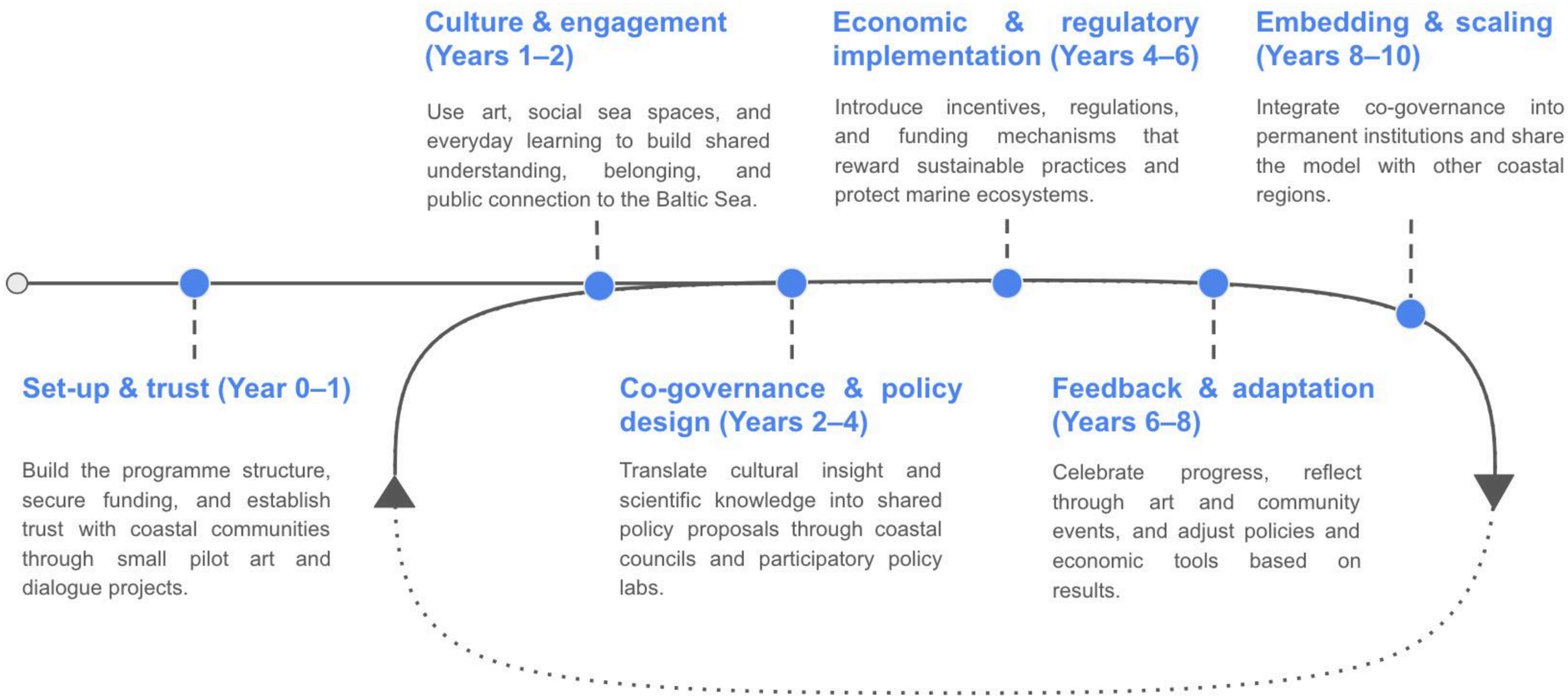
Purpose: Normalize sea stewardship in daily life.

Reference projects: "Can a "doughnut" economic framework be useful to monitor the blue economy success? A fisheries example"

Needs addressed: 1, 2, 3, 4, 6, 9

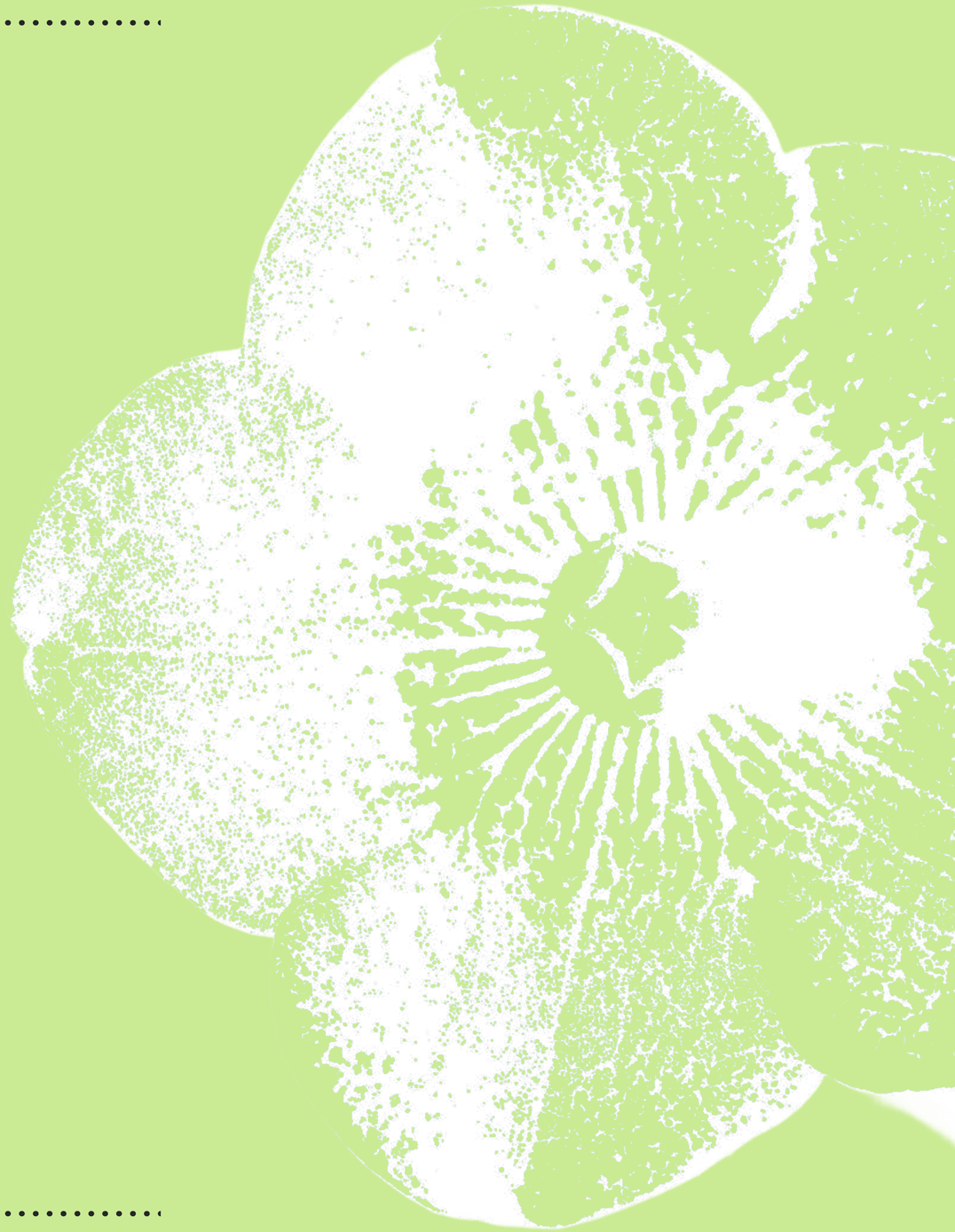
SPs addressed: SP4, SP6, SP8

Implementation plan



260114

Resources



Literature review

Almroth-Rosell, E., Eilola, K., Kuznetsov, I., Hall, P. O. J., & Meier, H. E. (2014). A new approach to model oxygen-dependent benthic phosphate release in the Baltic Sea. Journal of Marine Systems, 134, 35–46. https://doi.org/10.1016/j.jmarsys.2014.11.007

Arheimer, B., & Pers, B. C. (2017). Lessons learned? Effects of nutrient reductions from constructing wetlands in 1996–2006 across Sweden. Ecological Engineering, 103, 404–414. https://doi.org/10.1016/j.ecoleng.2016.01.088

Ehrnsten, E., Humborg, C., Gustafsson, E., & Gustafsson, B. G. (2025). Disaster avoided: Current state of the Baltic Sea without human intervention to reduce nutrient loads. Limnology and Oceanography Letters, 10, 318–328. https://doi.org/10.1002/lol2.10443

Horváth, S.-M., Payerhofer, U., Wals, A., et al. (2025). The art of arts-based interventions in transdisciplinary sustainability research. Sustainability Science, 20, 547–563. https://doi.org/10.1007/s11625-024-01614-2

Kaufmann, D. B., Palawat, K., Sandhaus, S., et al. (2023). Communicating environmental data through art: The role of emotion and memory in evoking environmental action. Humanities and Social Sciences Communications, 10, 940. https://doi.org/10.1057/s41599-023-02459-3

Rasmussen, M., Koskiaho, J., Tattari, S., Barquet, K., & Rosemarin, A. (2020). The role of gypsum soil amendments in reducing coastal nutrient run-off in Finland. Stockholm Environment Institute. https://www.sei.org/publications/role-of-gypsum-soil-amendments-in-reducing-nutrient-run-off-in-finland/

Literature review

Stadmark, J., & Conley, D. J. (2011). Mussel farming as a nutrient-reduction measure in the Baltic Sea: Consideration of nutrient biogeochemical cycles. Marine Pollution Bulletin, 62(6), 1385–1388. https://pubmed.ncbi.nlm.nih.gov/21620422

Stockholm Environment Institute. (2016). Sanitation, wastewater management and sustainability: From waste disposal to resource recovery — Reuse of household blackwater in agriculture, liquid composting technology, Hölö, Sweden. Stockholm Environment Institute. https://www.sei.org/wp-content/uploads/2020/08/sanitationwastewatersustainability.pdf

Zakopoulos, V., Makri, A., Ntanos, S., & Tampakis, S. (2023). Drama/theatre performance in education through the use of digital technologies for enhancing students' sustainability awareness: A literature review. Sustainability, 15(18), 13387. https://doi.org/10.3390/su151813387

Stoll-Kleemann, S. (2019). Feasible options for behavior change toward more effective ocean literacy: A systematic review. Frontiers in Marine Science, 6, Article 273. https://doi.org/10.3389/fmars.2019.00273

Storie, J., Suškevičs, M., Nevzati, F., Külvik, M., Kuhn, T., Burkhard, B., Vikström, S., Lehtoranta, V., Riikonen, S., & Oinonen, S. (2021). Evidence on the impact of Baltic Sea ecosystems on human health and well-being: A systematic map. Environmental Evidence, 10, Article 30. https://doi.org/10.1186/s13750-021-00244-w

Swedish Environmental Protection Agency. (2022). Wastewater treatment in Sweden 2020. https://www.naturvardsverket.se

Worm, B., Elliff, C., Graça Fonseca, J., Gell, F. R., Serra-Gonçalves, C., Helder, N. K., Murray, K., Peckham, H., Prelovec, L., & Sink, K. (2021). Making ocean literacy inclusive and accessible. Ethics in Science and Environmental Politics, 21, 1–9. https://doi.org/10.3354/esep00196

Tools and frameworks

Arsel, Z. (2017). Asking Questions with Reflexive Focus: A Tutorial on Designing and Conducting Interviews. Journal of Consumer Research 44(4): s. 939-948. https://doi.org/10.1093/jcr/ucx096

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Broman, G. I., & Robèrt, K.-H. (2017). A framework for strategic sustainable development. Journal of Cleaner Production, 140(Part 1), 17–31. https://doi.org/10.1016/j.jclepro.2015.10.121

Bryman, A. (2018). Samhällsvetenskapliga metoder [Social Research Methods] (3 uppl.). Liber.
Miro Board used for FSSD workshop: https://miro.com/app/board/uXjVJiADtHo=/?share_link_id=950644009589