ECOSYSTEM SERVICES AND THEIR SOCIOECONOMIC BENEFITS TO HUMANS

– improved understanding for sustainable management of the Baltic Sea

BONUS MARES - Policy Brief I • 2020

Why are ecosystem service evaluation studies important?

Continuous human population growth along with unsustainable socio-economic activities result in cumulative impacts of pollution, climate change and habitat fragmentation, threatening coastal ecosystems worldwide and degrading the services they provide to humans. But then, how can we sustain the benefits we derive from natural resources for us and future generations?

To identify which management practices can help us in this endeavor, we need to both trace socio-economic benefits back to the ecosystems that provide them and understand the interactions between environmental change and the capability of ecosystems in providing ecosystem services.

Sounds easy?

Based on Baltic Sea coastal ecosystems, a well-studied area at the border between the land and the sea, our ecosystem service evaluation has shown that these two links are missing. While a lot of research has been conducted within each step of the chain from natural resources to socio-economic benefits, the interface between them has been neglected. Moreover, for many ecosystem elements we still lack understanding on their generic roles.

Here we outline what we know, what we need to know more, and how to utilize this knowledge for sustainable management practices.

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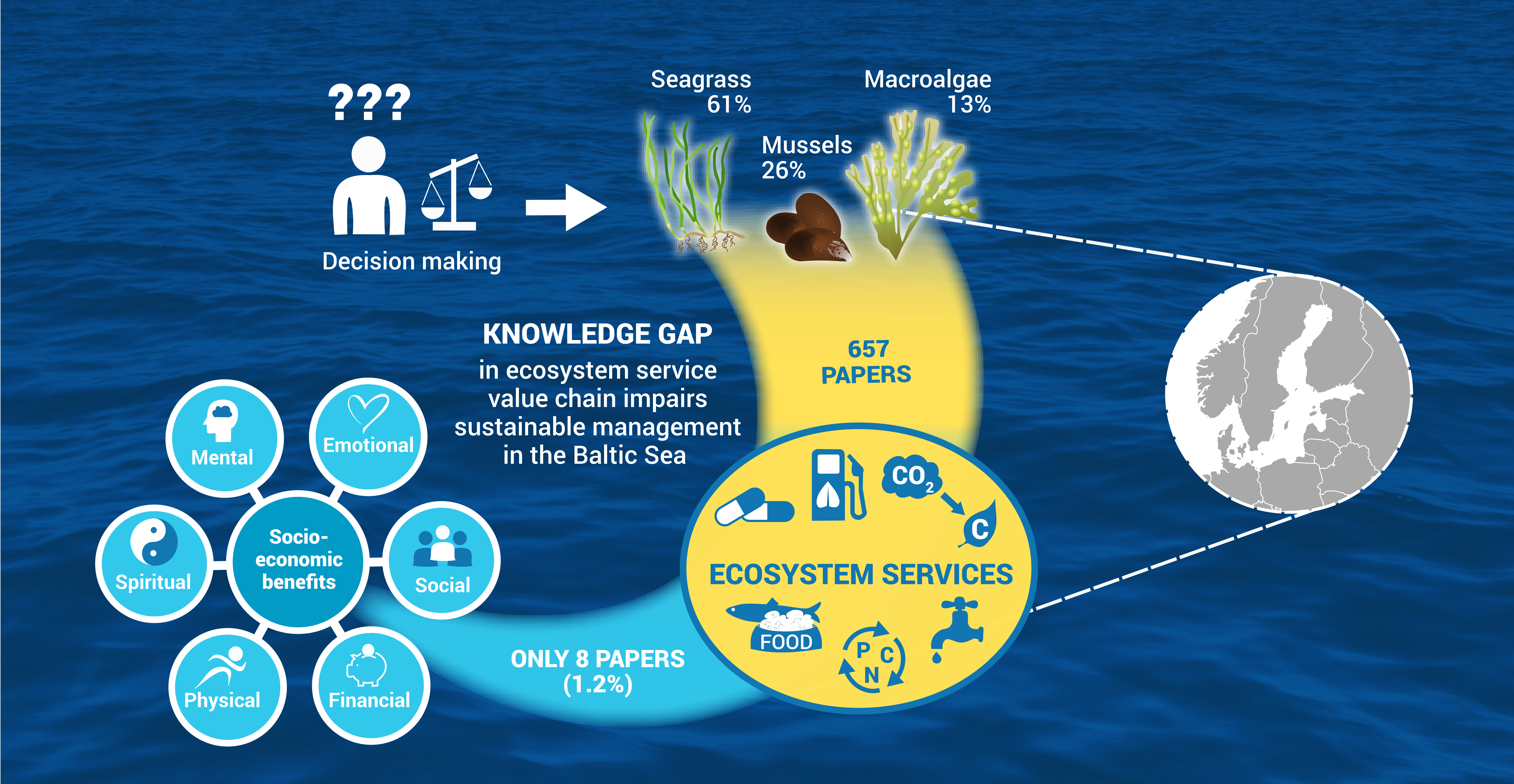
What are ecosystem services?

Ecosystem services describe the numerous benefits that humans derive from ecosystems and which can translate into socio-economic benefits. They fall into three categories:

1. **PROVISIONING SERVICES** – the provision of habitat, food or raw material
2. **REGULATING SERVICES** – the regulation of nutrient or carbon storage
3. **CULTURAL SERVICES** – recreational, aesthetic and intellectual values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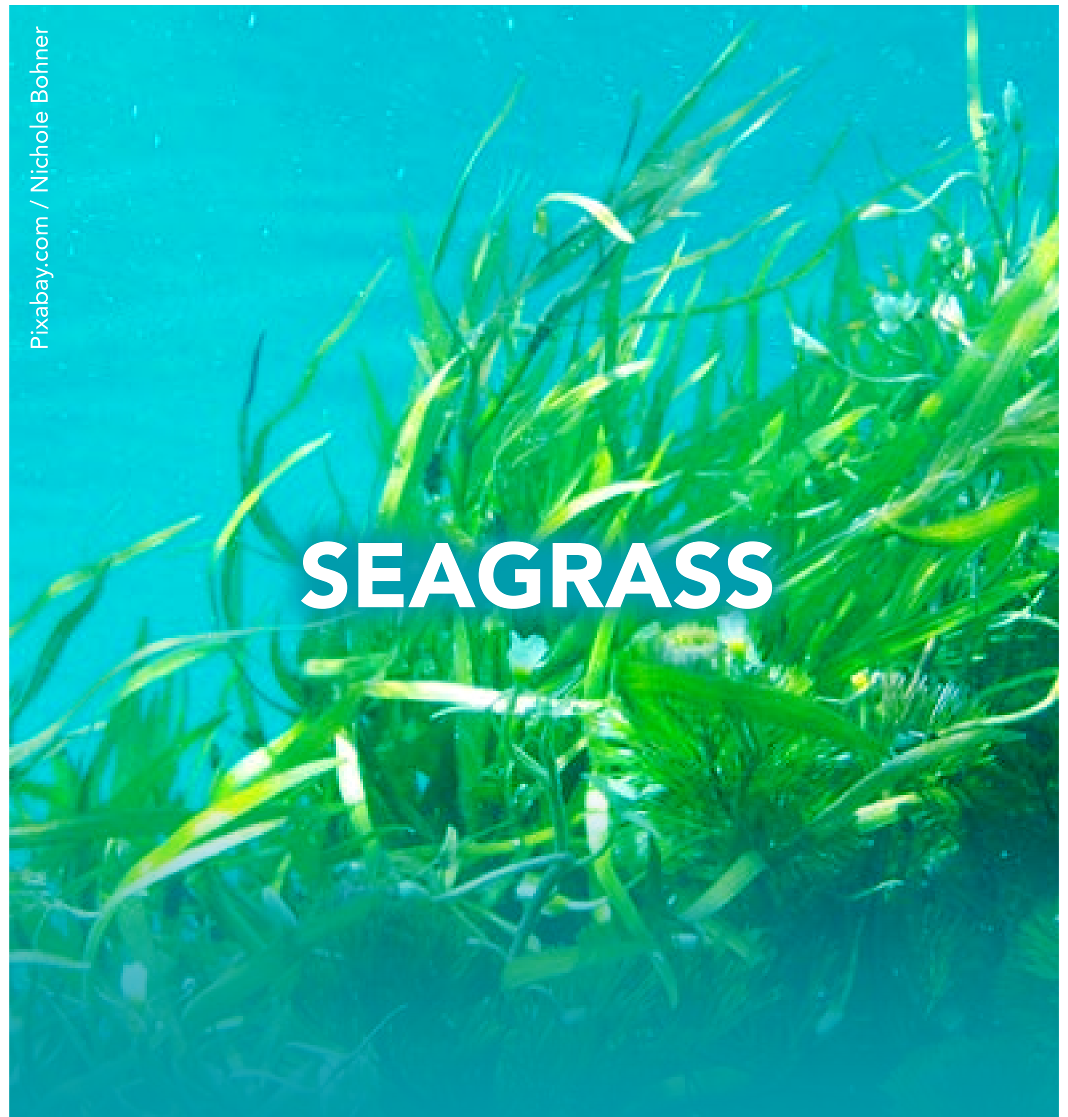
Decision making
Seagrass
61%
Mussels
26%
Macroalgae
13%
KNOWLEDGE GAP
in ecosystem service
value chain impairs
sustainable management
in the Baltic Sea
657
PAPERS
Mental
Emotional
Spiritual
Socio-
economic
benefits
Social
Physical
Financial
ONLY 8 PAPERS
(1.2%)
CO2
C
ECOSYSTEM SERVICES
FOOD
P
C
N

What we know now that we did not know before

By synthesizing information on ecosystem services provided by three key coastal Baltic Sea ecosystems, this study contributed greatly to the growing need for integrative data for sustainable marine resource management.

We identified 20 important ecosystem services that directly or indirectly support human needs and well-being:



SEAGRASS

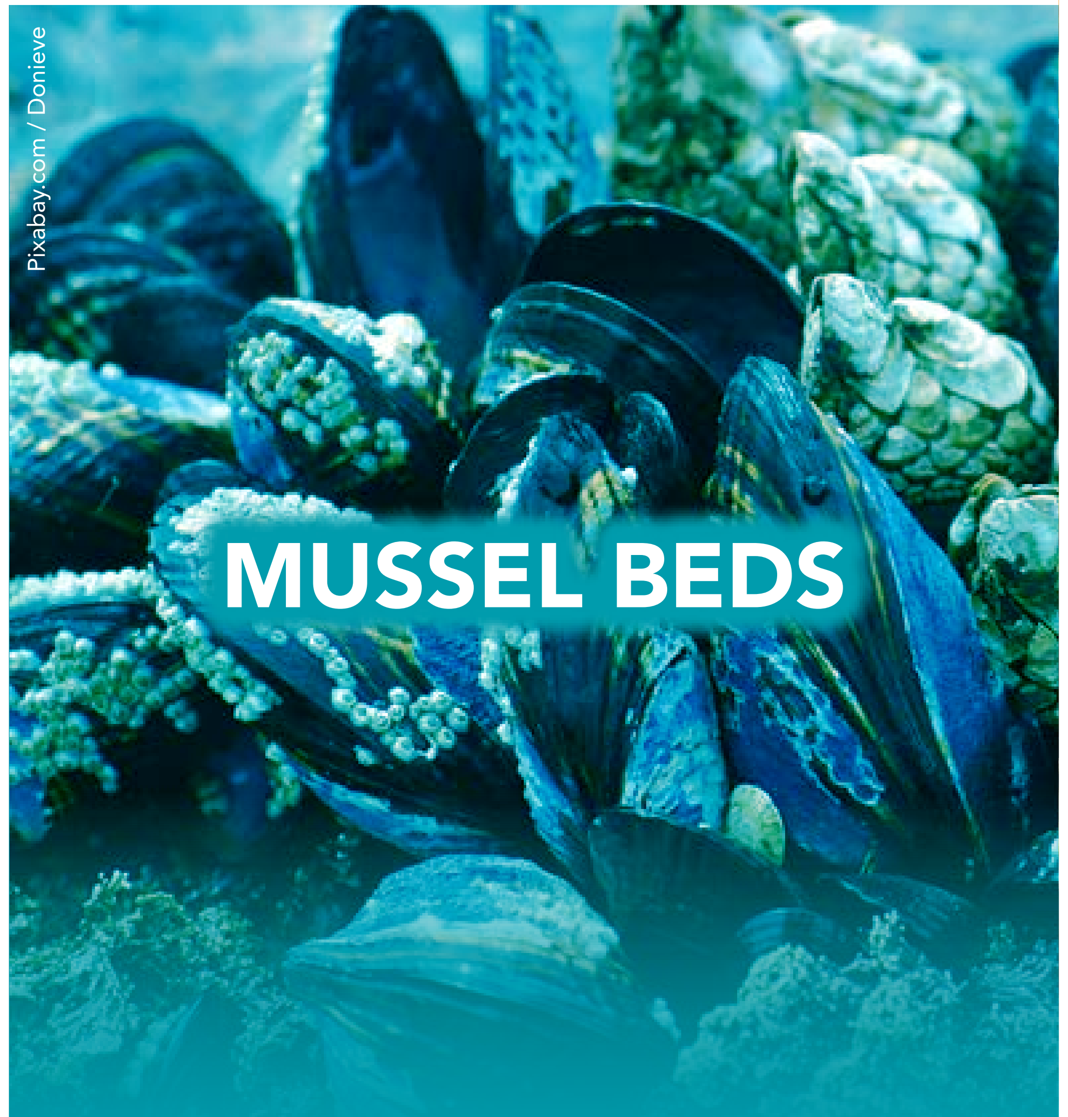
Proportion of results related to seagrass: 13%

No of unique ecosystem services: 15

Cultural ecosystem services:
Education and scientific information

Provisioning ecosystem services: Habitat provisioning, food for organisms, raw material (biomass, genetic or chemical material), promoting fisheries, resources for biotechnology

Regulating ecosystem services: Water quality enhancement, supporting diversity, nutrient cycling, maintanance of resilience, regulating food web dynamics, sediment retention through biodeposition and erosion control, carbon sequestration, pH regulation, primary production



MUSSEL BEDS

Proportion of results related to mussel beds: 26%

No of unique ecosystem services: 14

Cultural ecosystem services:
Education and scientific information

Provisioning ecosystem services: Habitat provisioning, food for organisms, raw material (biomass, genetic or chemical material), promoting fisheries, food production for humans, feed production in agriculture, resources for biotechnology

Regulating ecosystem services: Water quality enhancement, diversity, nutrient cycling, maintanance of resilience, regulating food web supporting dynamics, sediment retention through biodeposition and erosion control

MACROALGAE

Proportion of results related to macroalgae: 61%

No of unique ecosystem services: 19

Cultural ecosystem services:
Education and scientific information

Provisioning ecosystem services: Habitat provisioning, food for organisms, raw material (biomass, genetic or chemical material), promoting fisheries, food production for biotechnology, biomedical product, fertilizer humans, feed production in agriculture, resources for biotechnology, biomedical product, fertilizer

Regulating ecosystem services: Water quality enhancement, supporting diversity, nutrient cycling, maintanance of resilience, halocarbon retention, regulating food web dynamics, carbon sequestration, pH regulation, pH regulation, primary production

What knowledge gaps were identified?

Geographical knowledge gaps:

Knowledge on ecosystem services of coastal Baltic habitats is geographically unevenly distributed. Clear research hotspots were detected in the western and central Baltic Sea, close to research institutions. At the same time, only a few studies addressed the northern Baltic Sea. This could partially be explained by the lack of some of our target species in these regions (seagrass and mussels).

THE CHALLENGE: Since the Baltic Sea is characterized by steep environmental gradients, information from one study region is not expected to hold true for another. Therefore, if some areas are understudied we are not able to characterize Baltic Sea-wide ecosystem services and make scenario-specific predictions in those areas.

Interface knowledge gap:

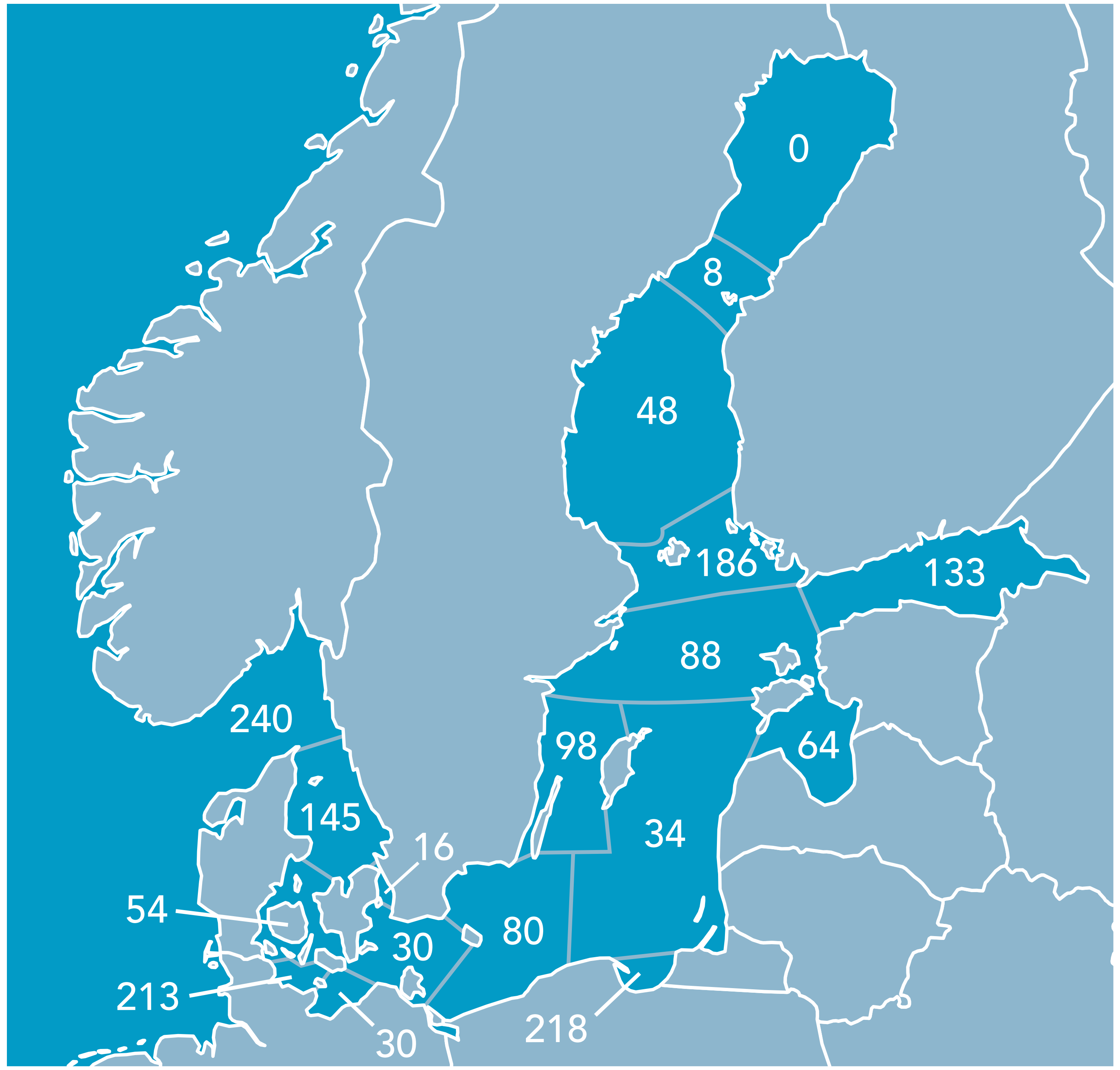
We identified two crucial knowledge gaps at the interface between disciplines and ecosystems: only 8 out of 657 studies (1.2%) provided insights into the links between ecosystem services and the derived socio-economic benefits. Further, most studies dealt with one or two species at a time, leaving important interactions within natural systems (e.g. food webs) understudied.

THE CHALLENGE: Since it is the ecosystem that is the target of management decisions and not the service or benefit, understanding how ecosystems and services are linked is vital for an informed decision process and sustaining socio-economic benefits. Additionally, understanding how different ecosystem elements are linked and how these links affect their ability to provide ecosystem services.

Anthropogenic pressure knowledge gap:

The most well-documented pressures to Baltic coastal ecosystems were pollution with toxins (356 results) and eutrophication (302 results). However, only 70 out of 1,740 ecosystem service indicators were assessed with multiple pressures at a time.

THE CHALLENGE: Understanding how the ongoing intensification and diversification of anthropogenic pressures cumulatively affect ecosystem structure, functioning and services they provide. Such analyses enable to assess the vulnerability of ecosystem services and foresee future damages.



Spatial distribution of ecosystem service indicators

HELCOM regions and the number of ecosystem service indicators per region are displayed in the map of the Baltic Sea area. 165 were Baltic Sea-wide and for ten indicators, the region was not specified. Some ecosystem service indicators spanned several regions and were thus counted multiple times.

Future directions: How would a unified framework look like and what should it do?

To provide knowledge for science-based decisions for the sustainable management of ecosystems and the services they provide, we need to close the geographical and interface knowledge gaps identified here. Future research should focus on collecting data under an interdisciplinary framework that considers the following aspects:

1. Systematic mapping of knowledge on ecosystem services in the baltic sea along ecological, economical, human and social dimensions (e.G. By using the Eco-GAME matrix)
2. Evaluation of the interdependencies of ecosystem elements in generating a service
3. Bridging of scientific fields to assess how ecosystems, via the services they provide, translate into socio-economic benefits
4. Assessment of the cumulative impact of anthropogenic pressures on ecosystem services in controlled experimental setups to establish cause-effect relationships.

These data need to be provided in an easy-to-use way to inform managers and policy-makers. Fortunately, such tools are now being developed, but often such web-based resources only focus on a limited geographical range or provide only part of functionality required. Thereby, implementing such a framework will be an important milestone in achieving the UN Sustainable Development Goals.

Example on Mapping Ocean Wealth in Australia

The information gathered and quantified about ecosystem services in the Baltic Sea should be combined with socio-economic measures for better interdisciplinary knowledge transfer.

For instance, a recent Mapping Ocean Wealth project in Australia provides a great example of how existing information about ecosystems and ecological processes was used to construct spatially explicit mathematical models with a capability of predicting the social and economic benefits provided by coastal ecosystems.

This model was then applied in the context of carbon sequestration and fisheries production.

Based on an Eco-GAME analysis matrix, that assesses the current state of knowledge and enhance communication between science-policy interactions, the Mapping Ocean Wealth project would have been the highest-scoring individual study effectively transferring knowledge between natural, economic, social and human dimensions.

As such it provides a robust framework that can be adapted not only for use in the Baltic Sea but also globally.

Steps to success from Mapping Ocean Wealth applicable world-wide

1 REVIEW	Detailed and systematic exploration of field data, literature and knowledge by experts from around the world.
2 MODEL	Develop models that demonstrate the value of ecosystem services under varying conditions. "Value" is not always a financial metric, but instead includes harder quantifying measures such as food security, risk reduction, job creation and seafood harvest among others.
3 MAP	Map important and valuable services to provide a continuous, geographically relevant tool for ecosystem services.

Outputs and results:

Mapping Ocean Wealth aggregates existing science and uses tools and maps to make science more accessible to audiences at all levels. Higher-resolution models illustrate the value of oceans at broad scales to inform decision-making at the national and international levels. The data become actionable and inform engineering, financial and policy language that lead to better planning, conservation and investment decisions.

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Policy Recommendations

Our ecosystem service evaluation study summarized scientific knowledge from over 1,000 researchers extracted from 657 publications. From this, we distilled policy recommendations addressed to the scientific community, funding agencies and decision makers:

1. **SCIENCE COMMUNITY:** close the information gap by explicitly considering ecosystem services in ecological assessments.

2. **FUNDING AGENCIES:** design research programmes specifically (I) addressing the link between environmental change and the capability of ecosystems in providing ecosystem services and (II) establishing the link between ecosystem functioning and socio-economic benefits.

3. **DECISION MAKERS:** demand spatially explicit ecosystem service information from marine ecology and environmental management studies to serve as a basis for policy making.

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Multi-method Assessment for Resilient Ecosystem Services and Human Nature System Integration

Policy recommendations based on the reserach by Heckwolf et al 2020 (manuscript submitted for publication) attached to research project Multi-method Assessment for Resilient Ecosystem Services and Human Nature System Integration (MARES).

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