Interreg Baltic Sea Region

Co-funded by the European Union

BLUE ECONOMY Baltic Sea2Land

5th BALTIC MSP FORUM

11-12 November 2025 Riga, Latvia

Implementation of the blue-green infrastructure concept for enhancing ecosystem based marine management in the Baltic Sea region

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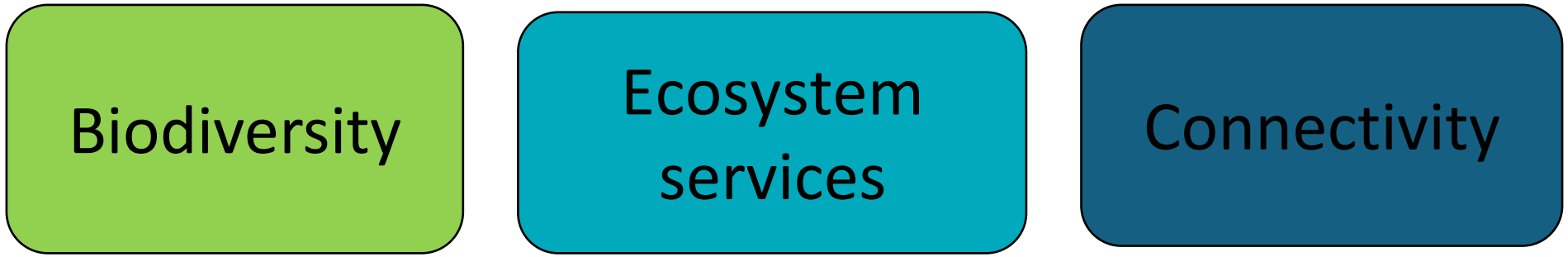
Green infrastructure – definition

GI is "strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas." (European Commission, 2013)

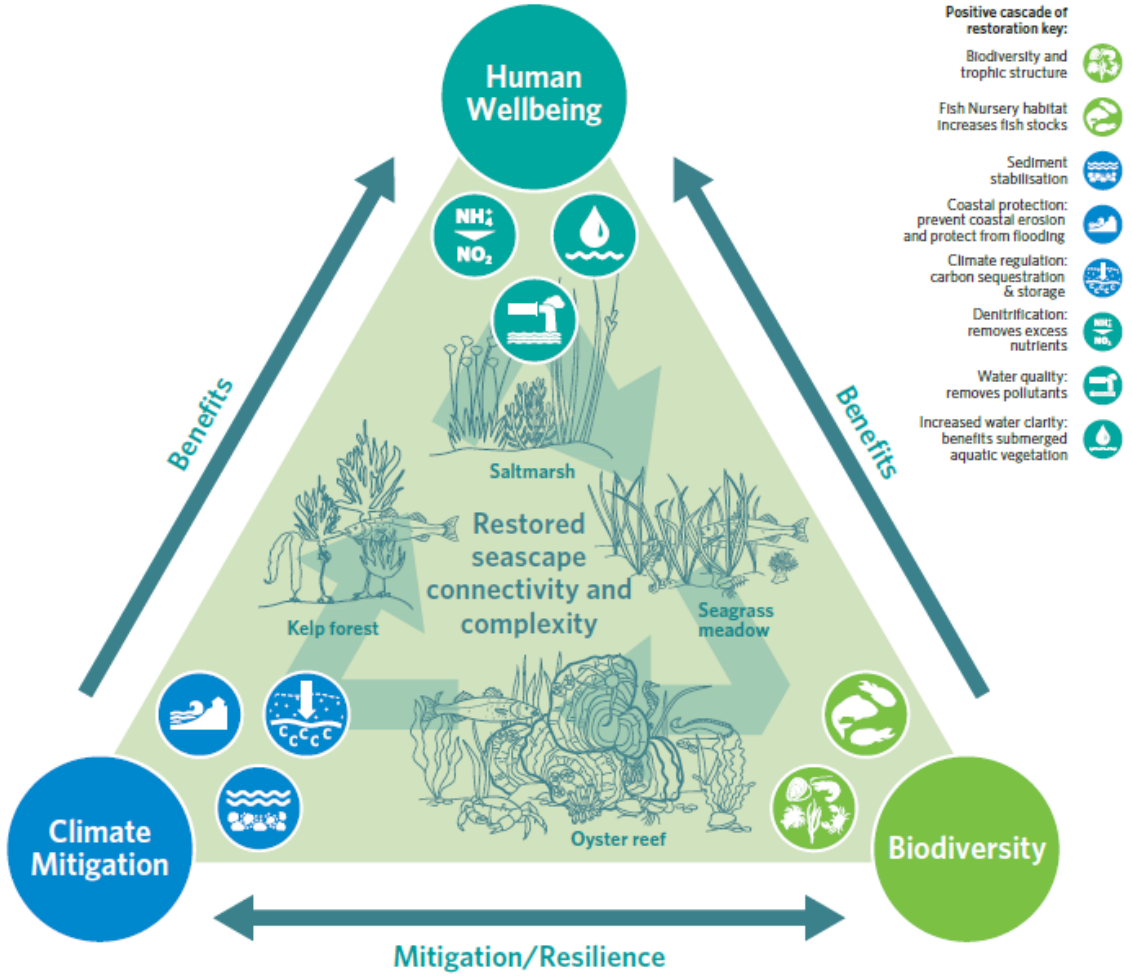
The functional GI network requires integration of the three main aspects or pillars (European Environment Agency, 2014):



There are significant knowledge gap in the use of GI in the marine environment, and it is not sufficiently used in maritime spatial plans (European Commission 2019; Joint Research Centre, 2019)

Importance of connectivity in marine ecosystems

- “Seascape ecology recognises oceans and coasts as spatially heterogeneous systems exhibiting complex dynamics and interconnections across multiple spatial and temporal scales”
- “Connectivity, highlighted as a critical factor for the success of nature recovery strategies in terrestrial systems, is also recognised as essential for delivery and quality of ecosystem services from marine restoration”
- “Enhanced ecological connectivity can increase functionality across interacting terrestrial and marine habitats that span the land-sea continuum”



Preston, J., Debney, A., Gamble, C. et al., 2025. Seascape connectivity: evidence, knowledge gaps and implications for temperate coastal ecosystem restoration practice and policy. npj Ocean Sustain 4, 33. https://doi.org/10.1038/s44183-025-00128-3

Pan Balic Scope approach
to mapping marine green infrastructure

Co-funded by the European Maritime and Fisheries Fund of the European Union

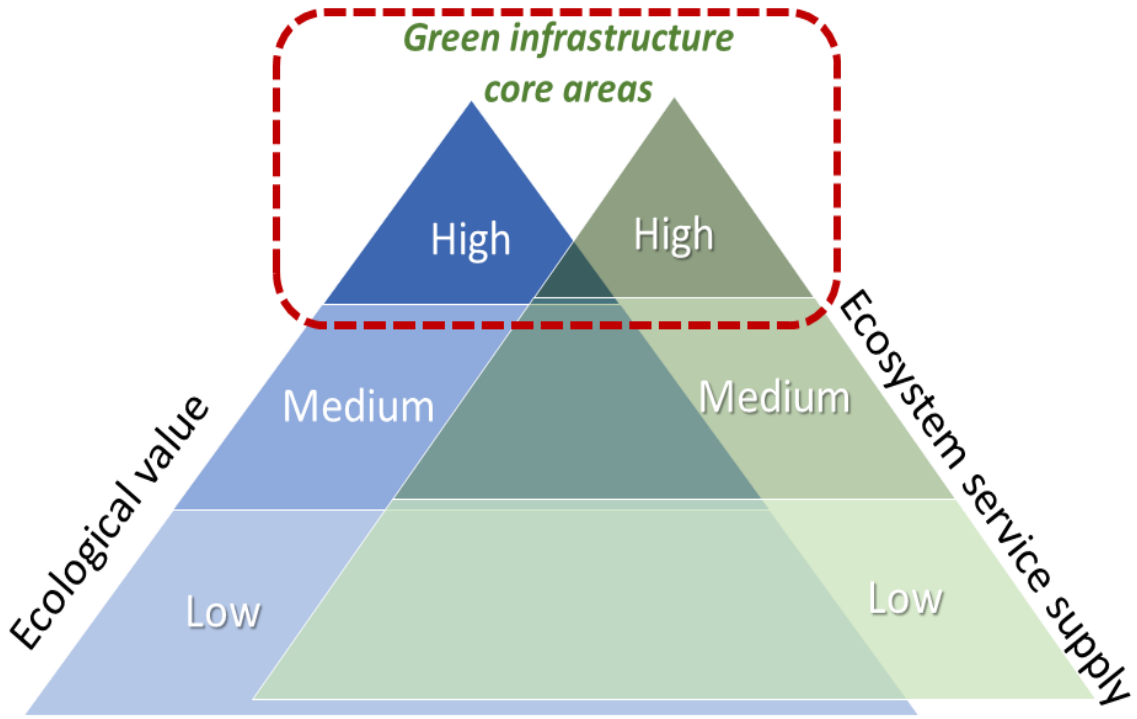
Project aimed:

- To outline a concept of marine “green infrastructure”
- To test the concept by utilizing available data

Definition of the concept:

Marine GI is formed by a spatial network of ecologically valuable areas significant for:

- ecosystems’ health and resilience,
- biodiversity conservation and,
- multiple delivery of ES essential for human well-being.



Read more in: *Ruskule A., Kotta J., Saha C.R, Arndt P., Ustups D., Strāķe S., Bergström L., 2023. Testing the concept of green infrastructure at the Baltic Sea scale to support an ecosystem-based approach to management of marine areas. Marine Policy, 147: 105374, https://doi.org/10.1016/j.marpol.2022.105374*

Pan Balic Scope approach

to mapping areas of high ecological value

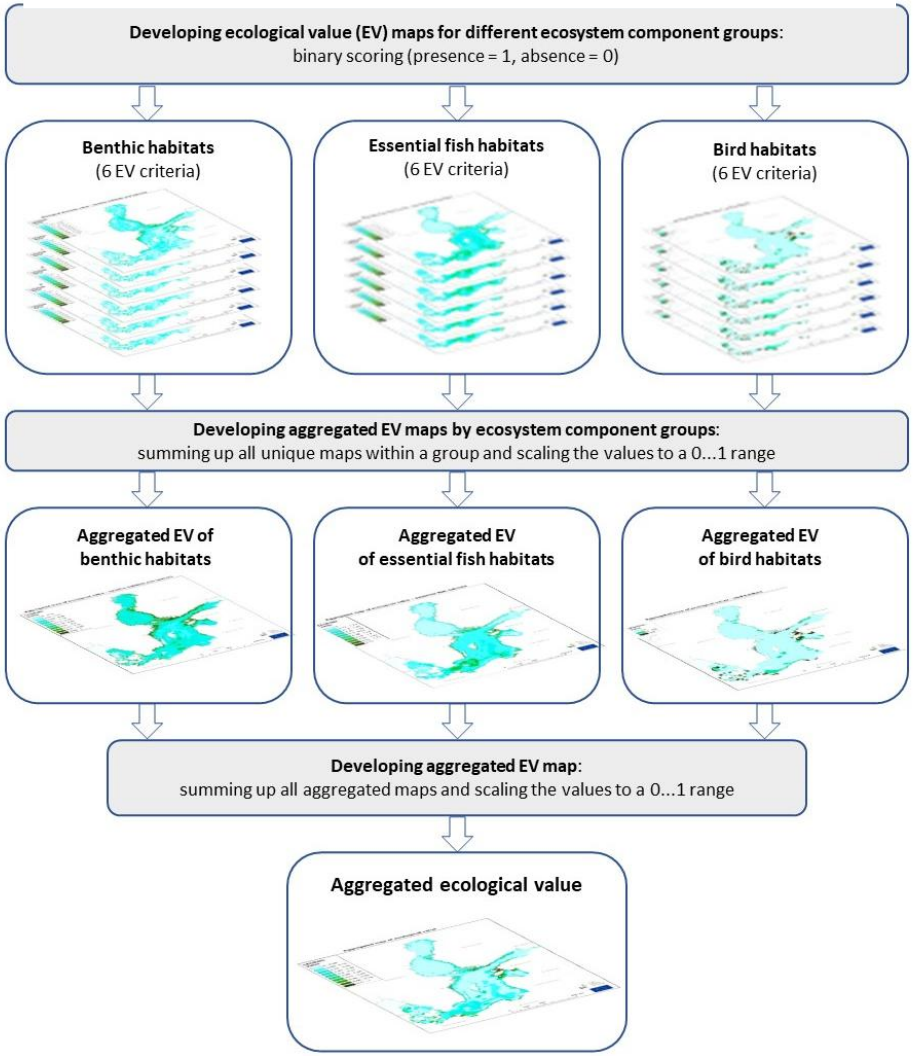
Co-funded by the European Maritime and Fisheries Fund of the European Union

Matrix: 30 components & 7 EV criteria

- biological diversity;
- rarity;
- importance for threatened, endangered or declining species and/or habitats;
- vulnerability, fragility, sensitivity, or slow recovery;
- special importance for life-history stages of species;
- biological productivity

HELCOM BSII Ecological Diversity Components	Biodiversity	Rarity	Importance for threatened, endangered or declining species and/or habitats	Vulnerability, fragility, sensitivity or slow recovery	Special importance for life-history stages of species	Biological productivity
Availability of deep water habitat, based on occurrence of H2S	0	1	0	0	0	0
Infralittoral hard bottom	0	1	0	0	0	0
Infralittoral sand	0	1	0	0	0	0
Infralittoral mud	0	1	0	0	0	0
Infralittoral mixed	0	1	0	0	0	0
Circalittoral hard bottom	1	1	1	1	1	1
Circalittoral sand	0	1	1	1	1	1
Circalittoral mud	0	1	1	1	1	1
Circalittoral mixed	1	1	1	1	1	1
Sandbanks which are slightly covered by sea water at all time (1110)	1	1	1	1	1	1
Estuaries (1130)	1	1	1	0	1	1
Mudflats and sandflats not covered by seawater at low tide (1140)	0	1	0	0	0	0
Coastal lagoons (1150)	1	1	1	0	1	1
Large shallow inlets and bays (1160)	1	1	1	1	1	1
Reefs (1170)	1	1	1	1	1	1
Submarine structures made by leaking gas (1180)	1	1	1	1	1	1
Baltic Esker Islands (UW parts, 1610)	1	1	1	1	1	1
Boreal Baltic islets and small islands (UW parts, 1620)	1	1	1	1	1	1
Furcellaria lumbricalis	1	1	1	1	1	1
Zostera marina	1	1	1	1	1	1
Charophytes	1	1	1	1	1	1
Mytilus sp.	1	1	1	1	1	1
Fucus sp.	1	1	1	1	1	1
Productive surface waters	1	1	1	0	1	1
Cod abundance	0	0	1	0	0	1
Cod spawning area	1	1	1	1	1	1
Herring abundance	0	0	0	0	0	1
Sprat abundance	0	0	0	0	0	1
Recruitment areas of perch	1	1	1	1	1	1
Recruitment areas of pikeperch	0	1	1	1	1	1
Wintering seabirds	1	1	1	1	1	0
Breeding seabird colonies	1	1	1	1	1	0
Grey seal distribution	0	0	0	0	0	0
Harbour seal distribution	0	0	0	0	0	0
Ringed seal distribution	1	1	1	1	0	0
Distribution of harbour porpoise	1	1	1	1	0	0

Hierarchical data aggregation method in GIS



Pan Balic Scope approach

to mapping areas of high ecosystem service potential

Pan Baltic Scope

Co-funded by the European Maritime and Fisheries Fund of the European Union

Matrix: 30 components & 10 ES:

- filtration of nutrients;
- storage of nutrients;
- storage of hazardous substances;
- erosion control;
- nursery habitats;
- pest control;
- climate control by biological fixation photosynthesis
- climate control by by sequestration in sediments;
- recreation through active & passive interactions

HELCOM BSII Ecological Diversity Components	Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals			Control of erosion rates	Maintaining nursery populations and habitats	Pest control (including invasive species)	Regulation of chemical composition of atmosphere and oceans (atmospheric CO^2 and other greenhouse gases):		Characteristics of living systems that that enable activities promoting health, recuperation or enjoyment	
	filtration of nutrients	storage of nutrients	storage of hazardous substances				by biological fixation in process of photosynthesis	by sequestration in sediments	through active or immersive interactions	through passive or observational interactions
Availability of deep water habitat, based on occurrence of H2S	0	1	1	0	0	0	0	1	0	0
Infralittoral hard bottom	1	1	1	1	1	0	1	0	1	1
Infralittoral sand	0	1	1	0	1	0	1	0	1	1
Infralittoral mud	0	1	1	0	1	0	1	1	0	0
Infralittoral mixed	1	1	1	1	1	0	1	0	0	0
Circalittoral hard bottom	1	1	1	0	0	0	0	0	0	0
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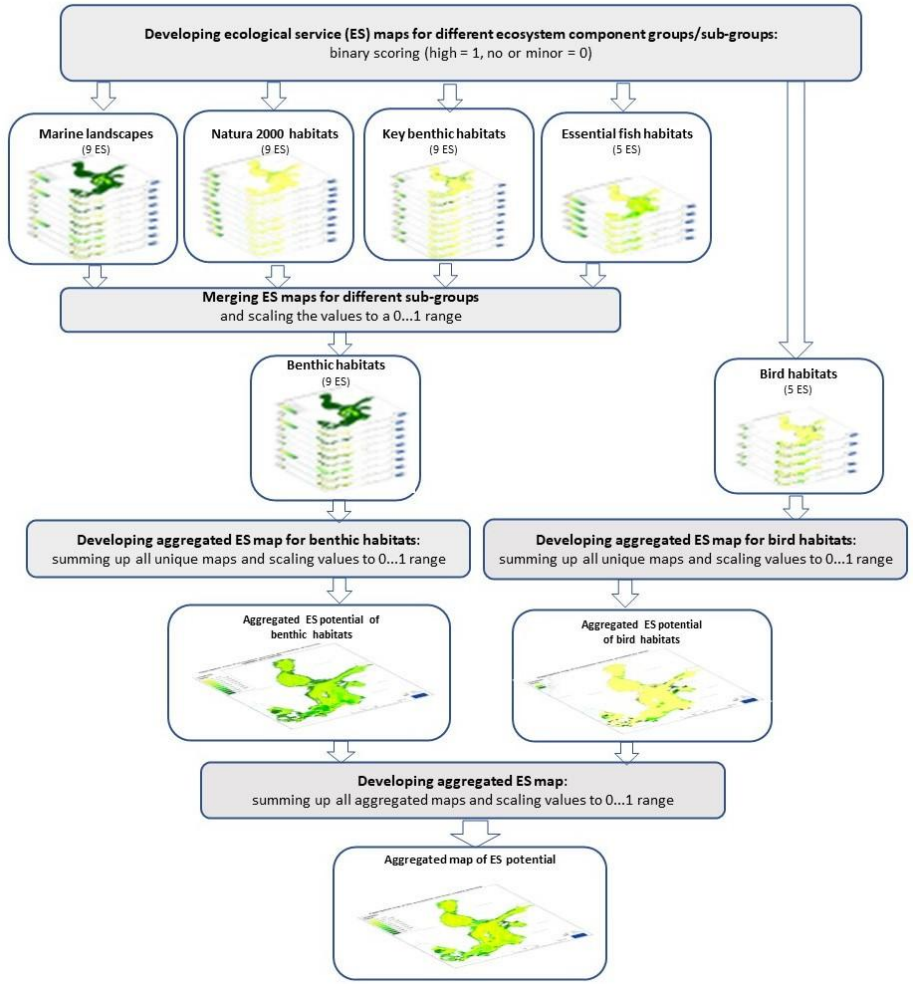
Distribution of harbour porpoise	0	0	0	0	0	0	0	0	1	1

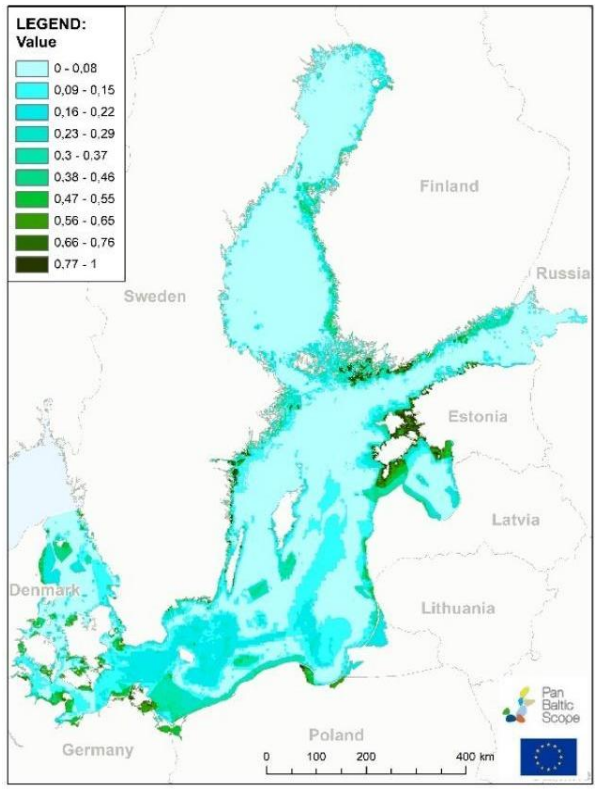
Hierarchical data aggregation method in GIS

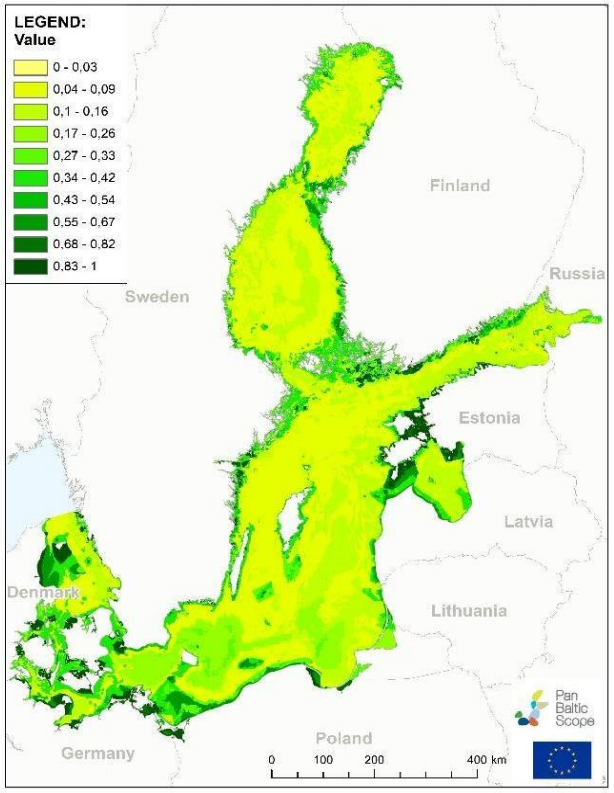


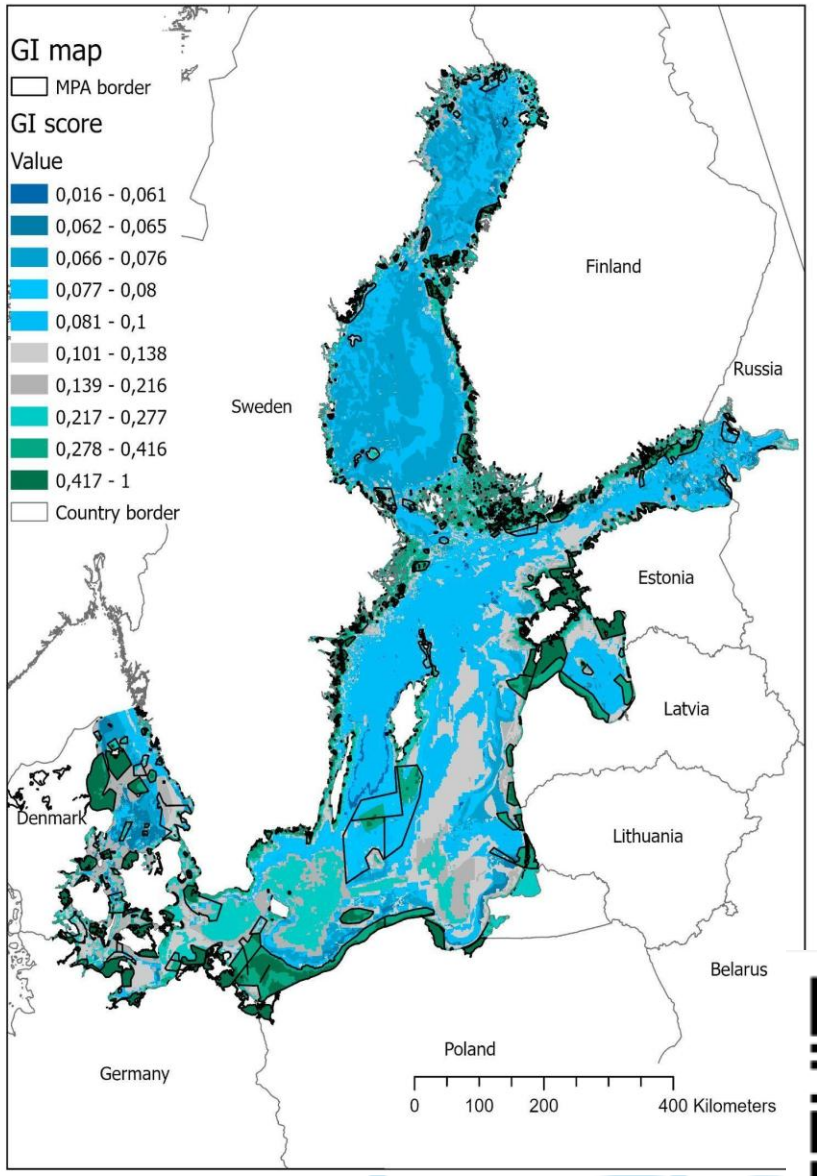
Pan Balic Scope MGI mapping results

Co-funded by the European Maritime and Fisheries Fund of the European Union

Aggregated maps of ecological value & ecosystem service potential, and **final aggregated map of marine green infrastructure**







Study on Integrating an Ecosystem-based Approach into MSP

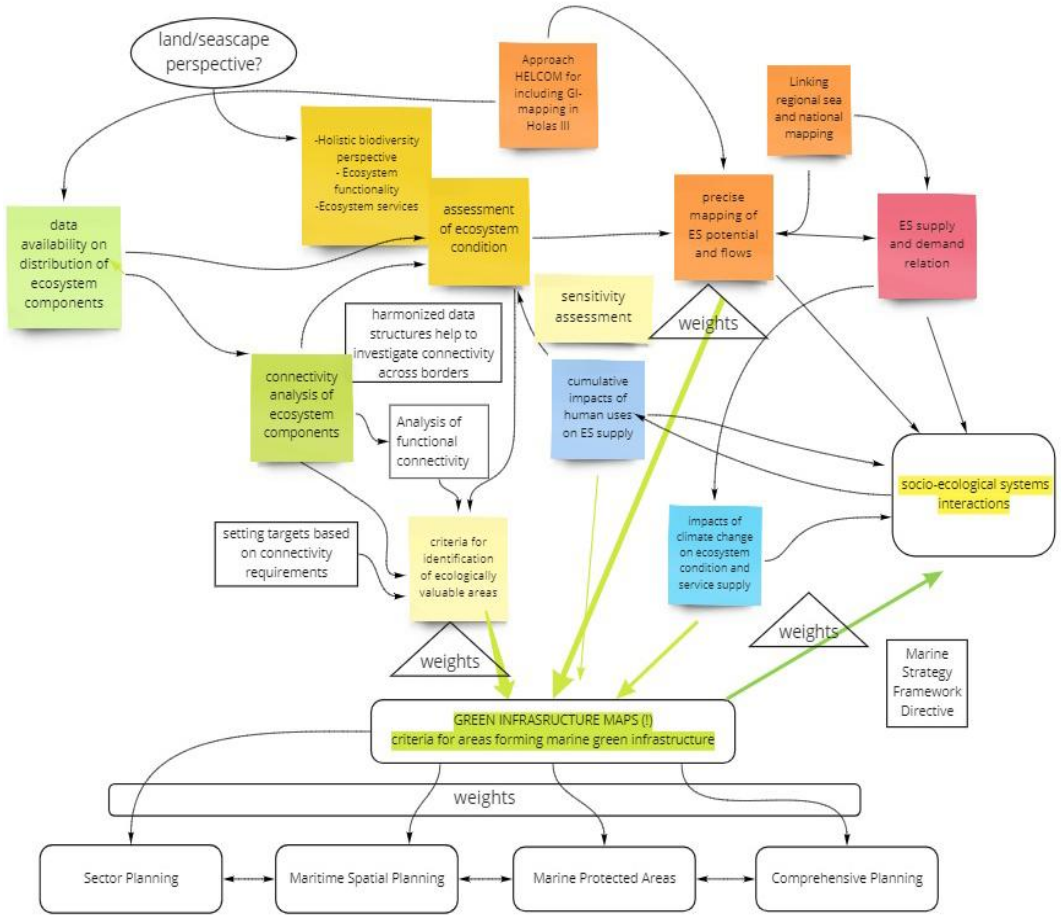
commissioned by the European Commission/DG MARE & EASME

The Baltic Case study:

- to examine the methods applied in the Baltic Sea region for marine GI mapping
- to explore opportunities for its further methodological development and operationalising in MSP

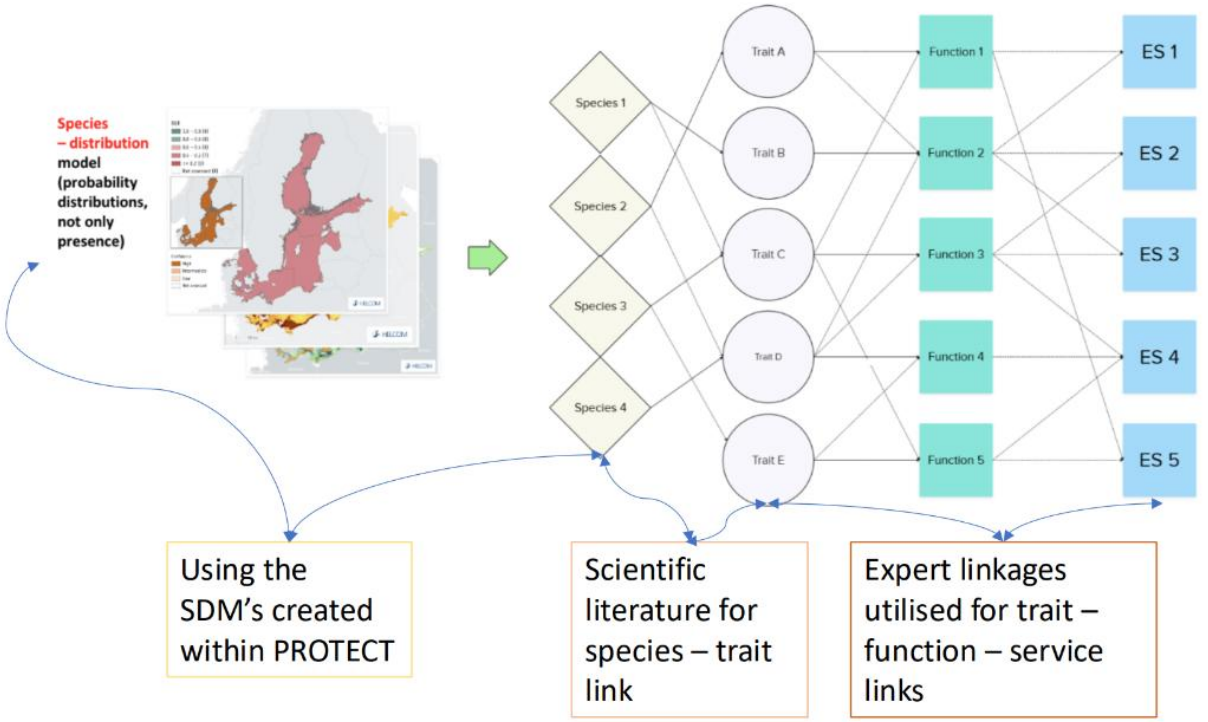
The study concluded on:

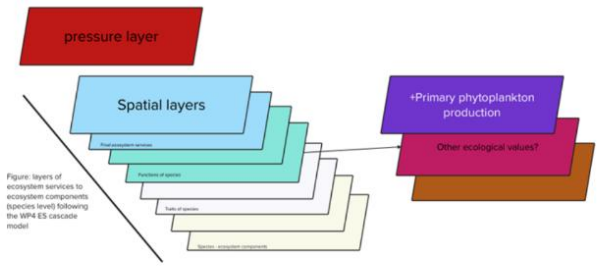
- **aspects to be considered in marine GI mapping**: ecosystem condition & connectivity , ecologically valuable areas, ecosystem services, sensitivity assessment, cumulative impact assessment, climate change impacts
- **data availability** - HELCOM support needed in development of new data sets
- **connectivity analysis** - the major focus for further development of GI mapping methodology

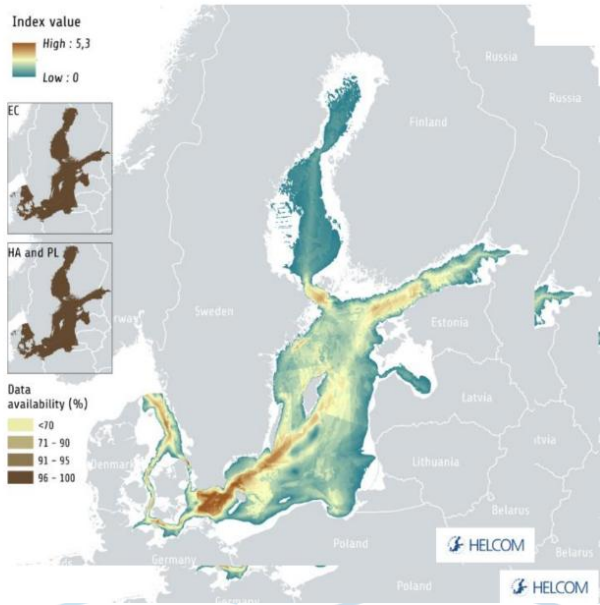


PROTECT BALTIC expected outputs

- Updated Biodiversity Database and Map & Data service
- Species distribution models (benthic invertebrates, plants, fish, and marine mammals)
- Spatial information on possible biodiversity hotspots
- The Baltic sea ecosystem service cascade model - integrates species traits
- ES maps revealing service supply, flows and how resilient they are to the loss of key species.
- Connectivity maps & matrices of key species
- Guidance for ecological coherence assessment
- Maps for optimizing the MPA network
- etc.

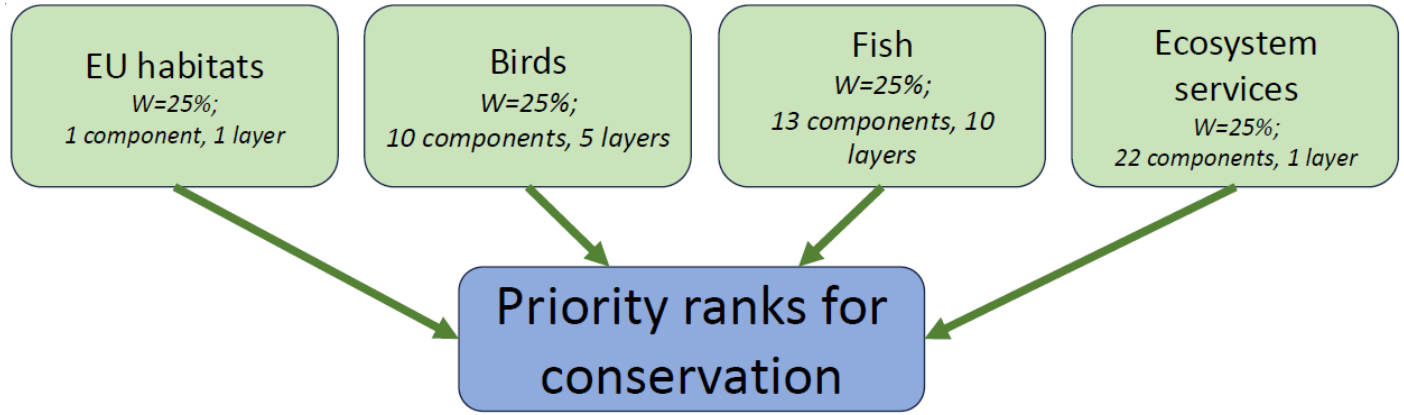




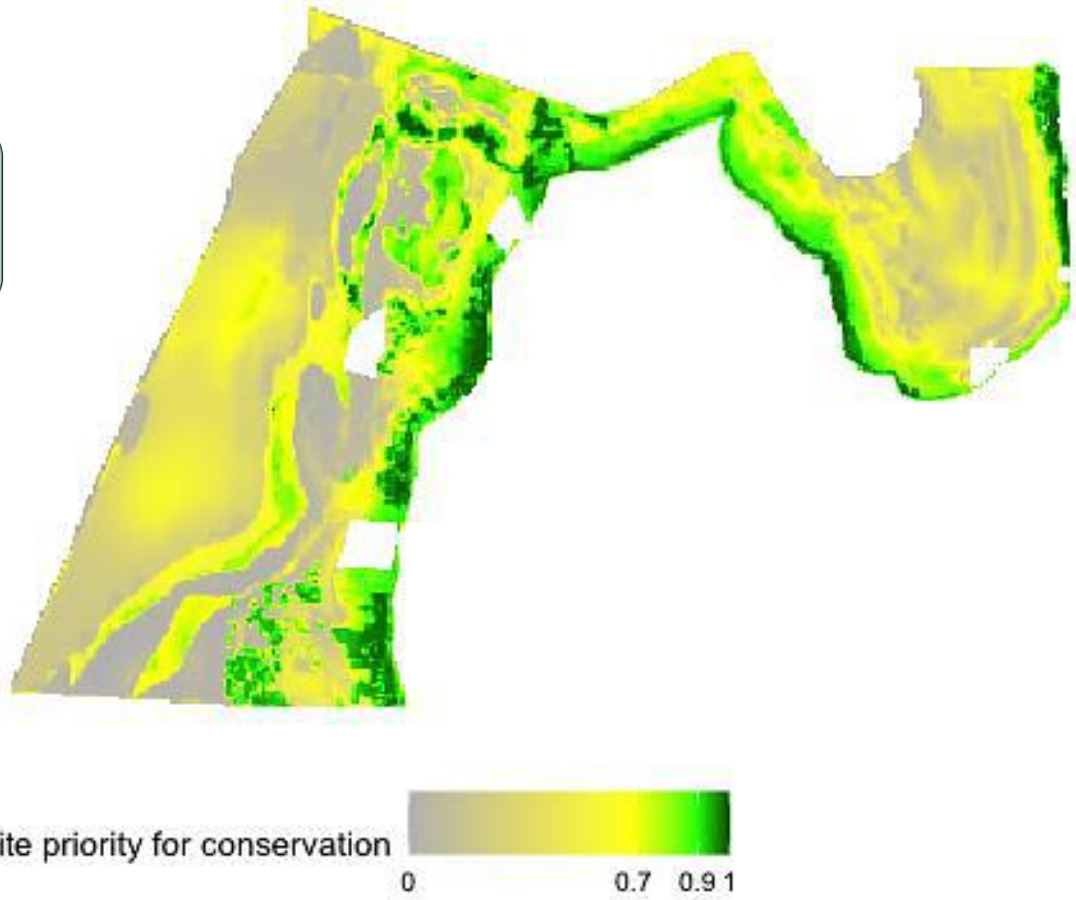


Life REEF approach - Latvia

- prioritization of sites for extension of MPA network by using Zonation software



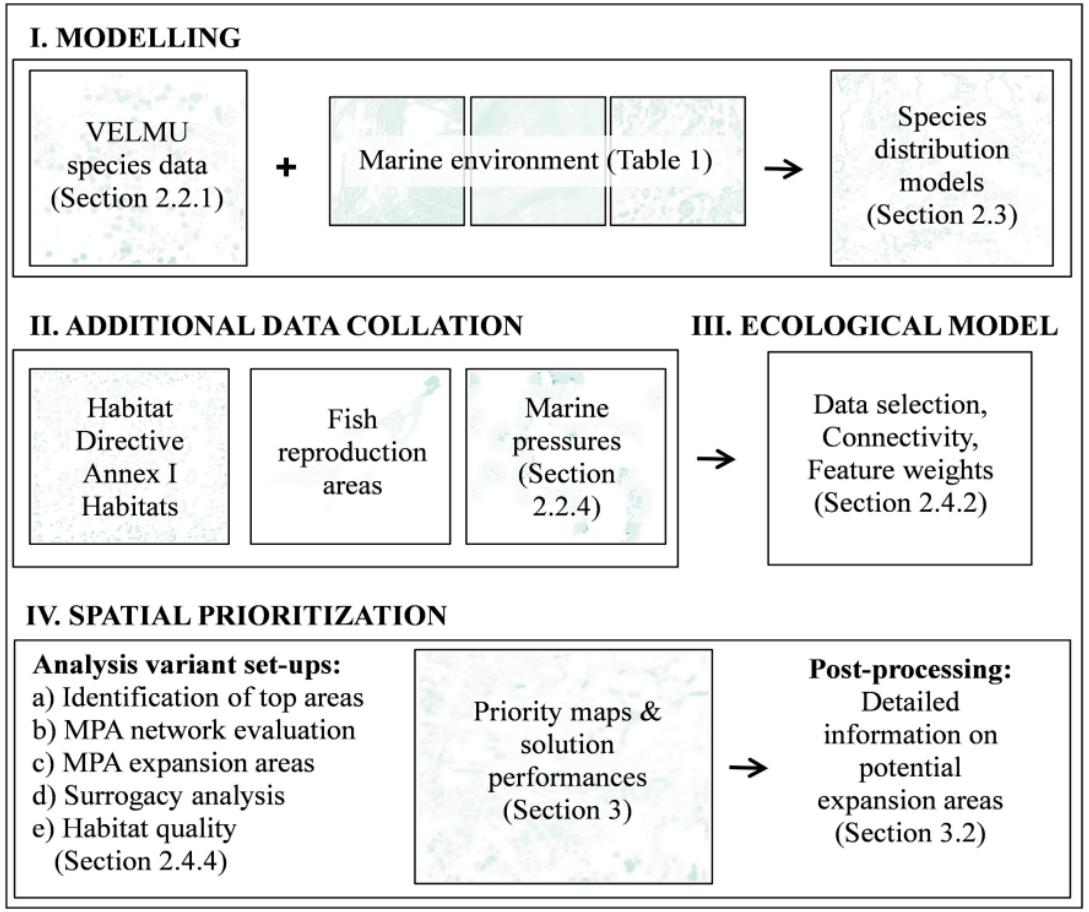
- Zonation 4
- Additive benefit function



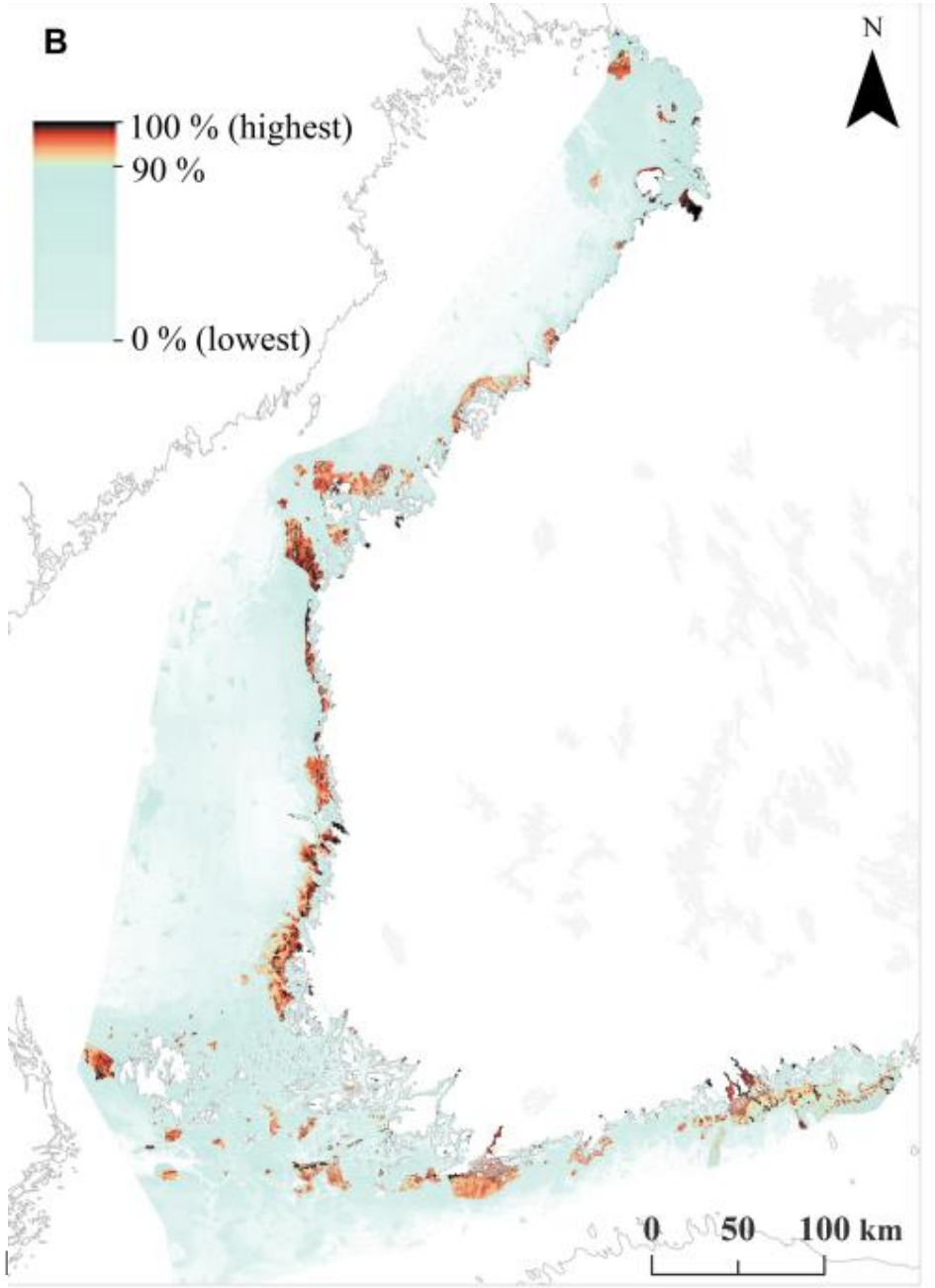
Source: *A. Avotiņš, J. Gruduls, L. Briekmane, I. Putnis, BIOR*

ZONATION
Conservation planning software

Prioritization of areas for expansion of Finnish MPA network by using Zonation



Hierarchical priority rank map



Virtanen EA, Viitasalo M, Lappalainen J and Moilanen A (2018) Evaluation, Gap Analysis, and Potential Expansion of the Finnish Marine Protected Area Network. Front. Mar. Sci. 5:402. https://doi.org/10.3389/fmars.2018.00402.

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THANK YOU!

Anda Ruskule

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