

# Spatial Pressure and Impact Assessment in HOLAS 3

Joint workshop of the Communities of Practice on Ecosystem Based Approach in MSP and on Sustainable Blue Economy of eMSP project.

Helsinki, Finland, 13 June 2023

# Presentation

- Terminology and definitions
- Spatial Pressure and Impact assessment (SPIA) methodology
- SPIA results
- How could SPIA contribute to MSP?

# Terminology

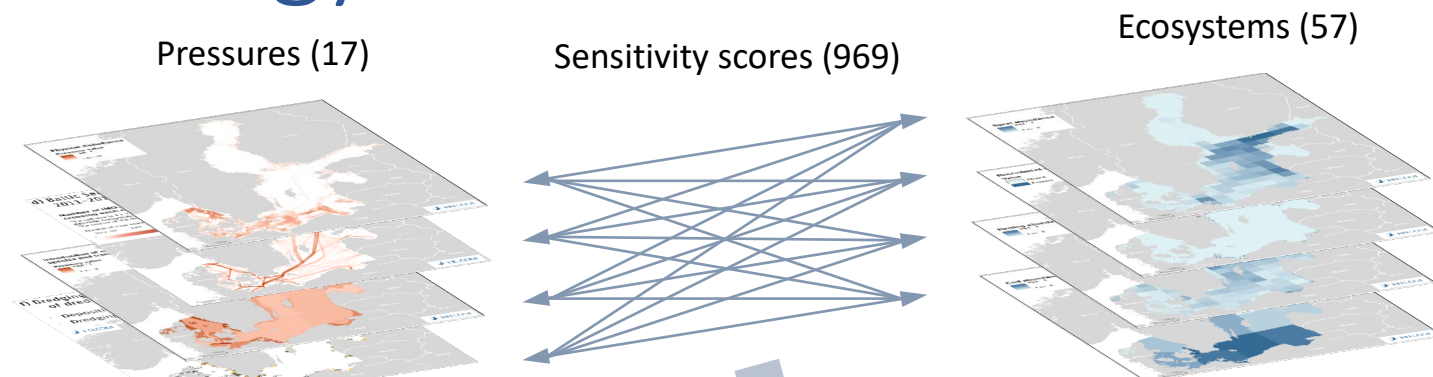
- CIA (Cumulative Impact Assessment) or CEA (Cumulative effect Assessment)
  - Umbrella term for assessment of cumulative impacts
  - *“The analysis of cumulative impacts aims at identifying areas in the sea where the environmental and ecological components are more exposed to anthropogenic pressures that negatively affect them.”*
- SPIA (Spatial Pressure and Impact Assessment)
  - The umbrella term for the assessment of pressures and impacts in HOLAS 3
  - The (cumulative) pressure or impact of any given combination of pressures and ecosystem components
  - Includes BSII and BSPI
- BSII (Baltic Sea Impact Index)
  - Assessment of cumulative impacts, all pressure and ecosystem layers included, index refers to the unitless output of the assessment
- BSPI (Baltic Sea Pressure Index)
  - Assessment of cumulative pressures, all pressure layers included, index refers to the unitless output of the assessment

# SPIA assessment in HOLAS 3

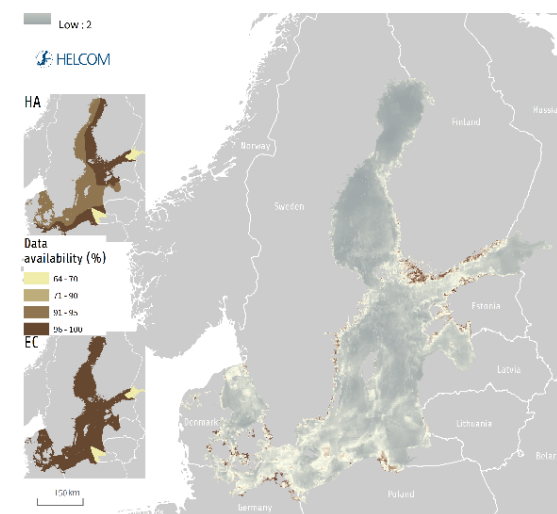
- SPIA is the cumulative impact assessment carried out in the HOLAS 3 assessment, based on methodology by Halpern et al. (2008)
- Differing from the sectoral approach of the indicators, the SPIA aims to identify the cumulative burden to the marine environment.
- Integral part of the assessment is also the "thematic analysis", where only a subset of layers are selected
- Outputs:
  - Thematic report on Spatial pressure and impact assessment (March 2023)
  - Summary report (main findings)
  - HOLAS 3 web page
  - 100 data sets published in HELCOM Map and Data Service (MADS)
  - Desktop and online tool

# Assessment methodology

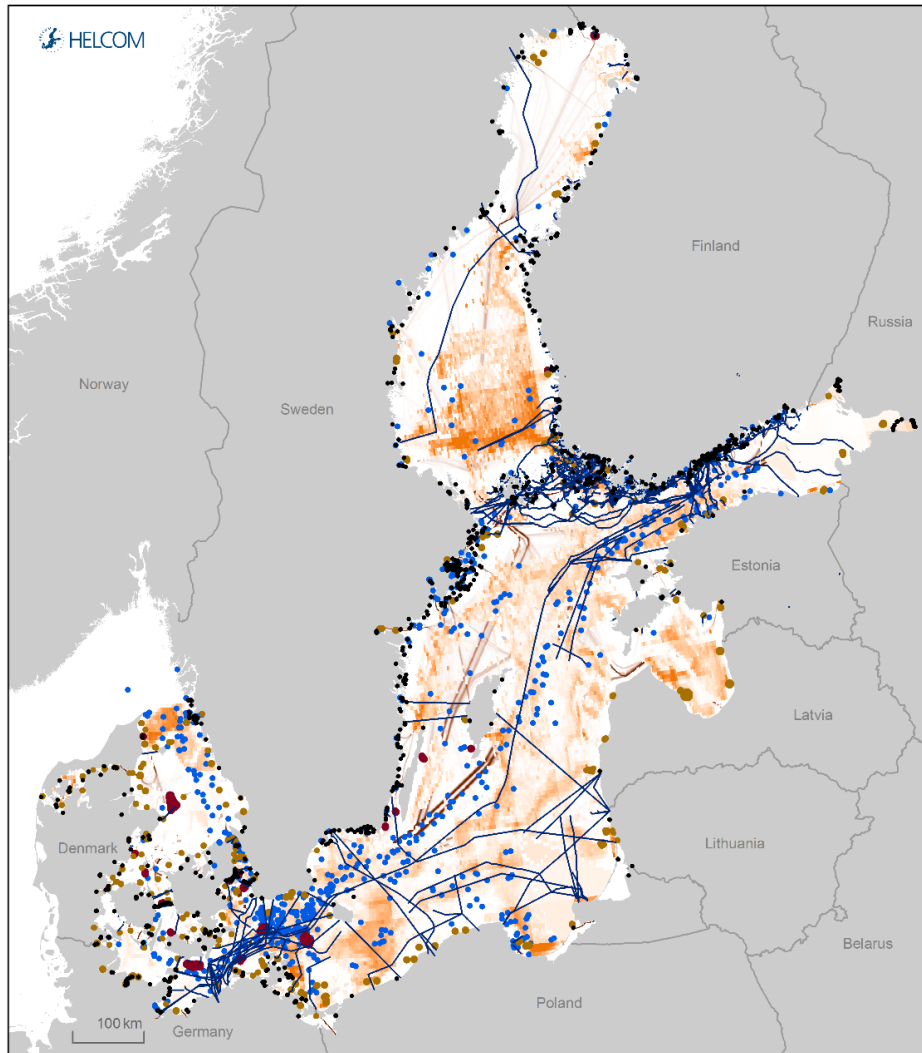
- Marine environments are facing multiple, simultaneous and overlapping pressures from human activities
- SPIA aims to reveal the combined spatial pattern and magnitude of pressure and impacts
- Uses human activities pressures, ecosystem components and sensitivity scores as input data



$$BSII(x, y) = \sum_{i=1}^n \sum_{j=1}^m PL_i(x, y) * EC_j(x, y) * SS_{i, j}$$



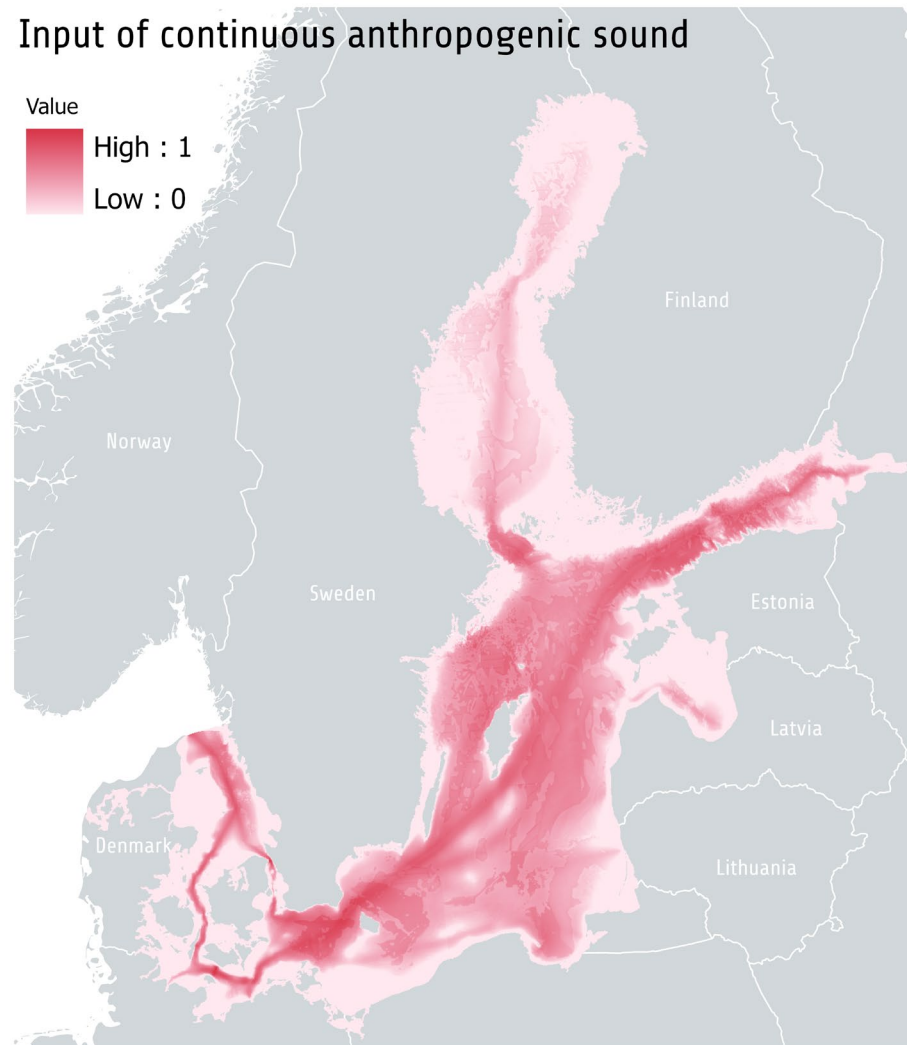
# Datasets on human activities



- Approximately 30 data sets
- Collected by
  - HELCOM annual reporting programmes
  - Open sources
  - Data requests to other organisations
  - National data calls
- Datasets include e.g.
  - Bridges and other constructions
  - Deposit of dredged material
  - Wind turbines
  - Cables
  - Illegal oil discharges
  - Shipping density
  - Fishing of herring

# Aggregated pressure layers

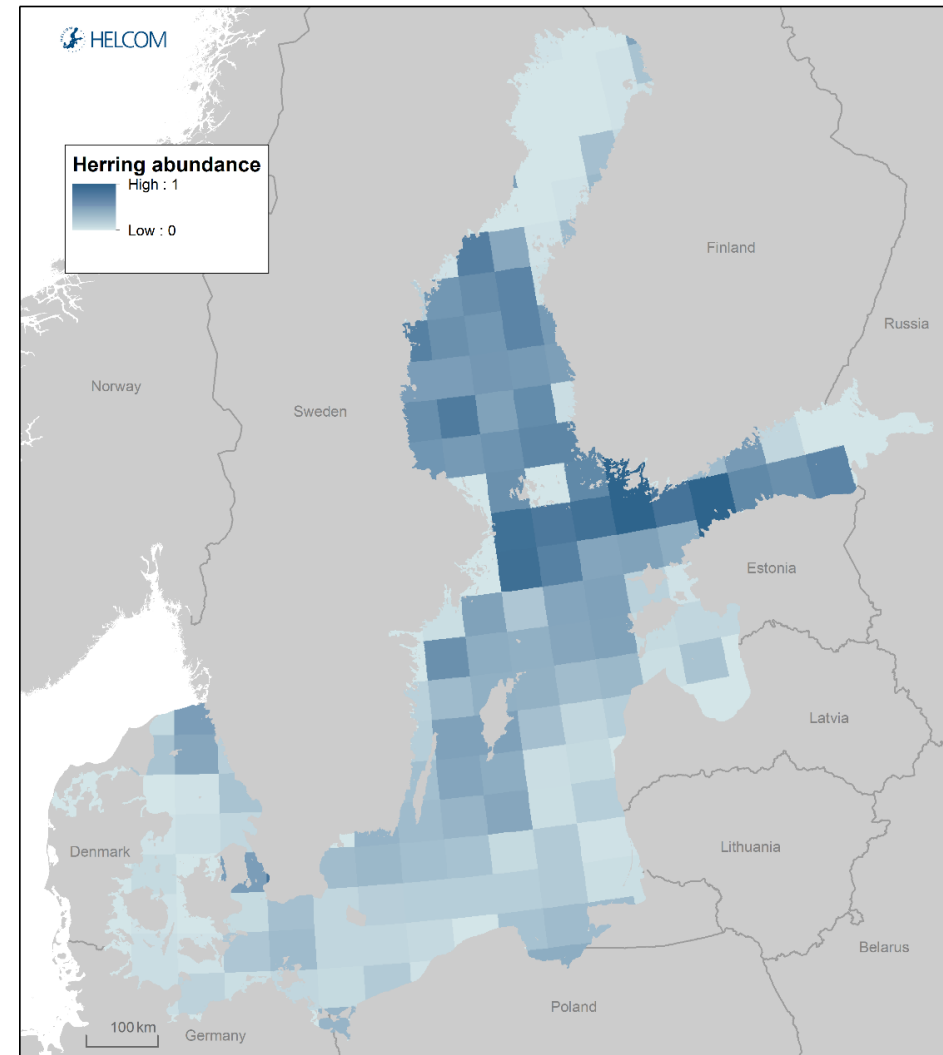
- Spatial distribution of pressures on the scale 0 to 1
- Some human activities effect the marine environment in similar ways
  - these activities are aggregated to one pressure layer
    - Physical disturbance
    - Physical loss
    - Disturbance to species due to human presence
- Some pressure layers are constructed from other HELCOM assessment products or modelled data
  - Hazardous substances (indicator)
  - Input of continuous anthropogenic sound (modelled noise data)





# Ecosystem components

- Showing the spatial distribution of ecosystem components on the scale 0 to 1
- Data collected by national data call, projects and HELCOM expert networks, datasets include e.g.:
  - Benthic habitats (presence/absence)
    - Species: Fucus
    - Large scale habitats: Infralittoral sand
  - Marine mammals (Classified distribution)
    - Harbour porpoise
  - Fish (Continuous data)
    - Herring abundance





# Results of the assessment

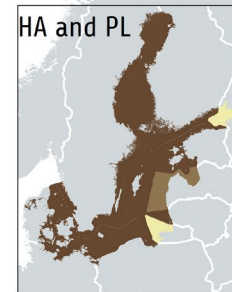
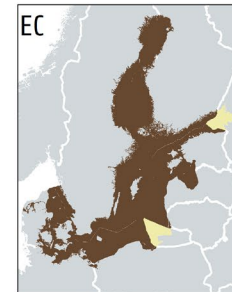
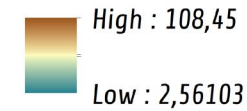
- The results are not to be considered as a status of the environment in absolute terms, but rather as a relative distribution of potential pressures and impacts, describing the pattern of most impacted areas
- The results provide a framework to communicate these patterns and to highlight hotspots and areas where further attention and studies might be needed
- As contrary to indicators, having a more sectoral approach, the SPIA draws attention to the cumulative burden of pressures across ecosystems on an accurate spatial scale
- Results consists of BSII, BSPI and thematic analyses

# Baltic Sea Impact Index (BSII)

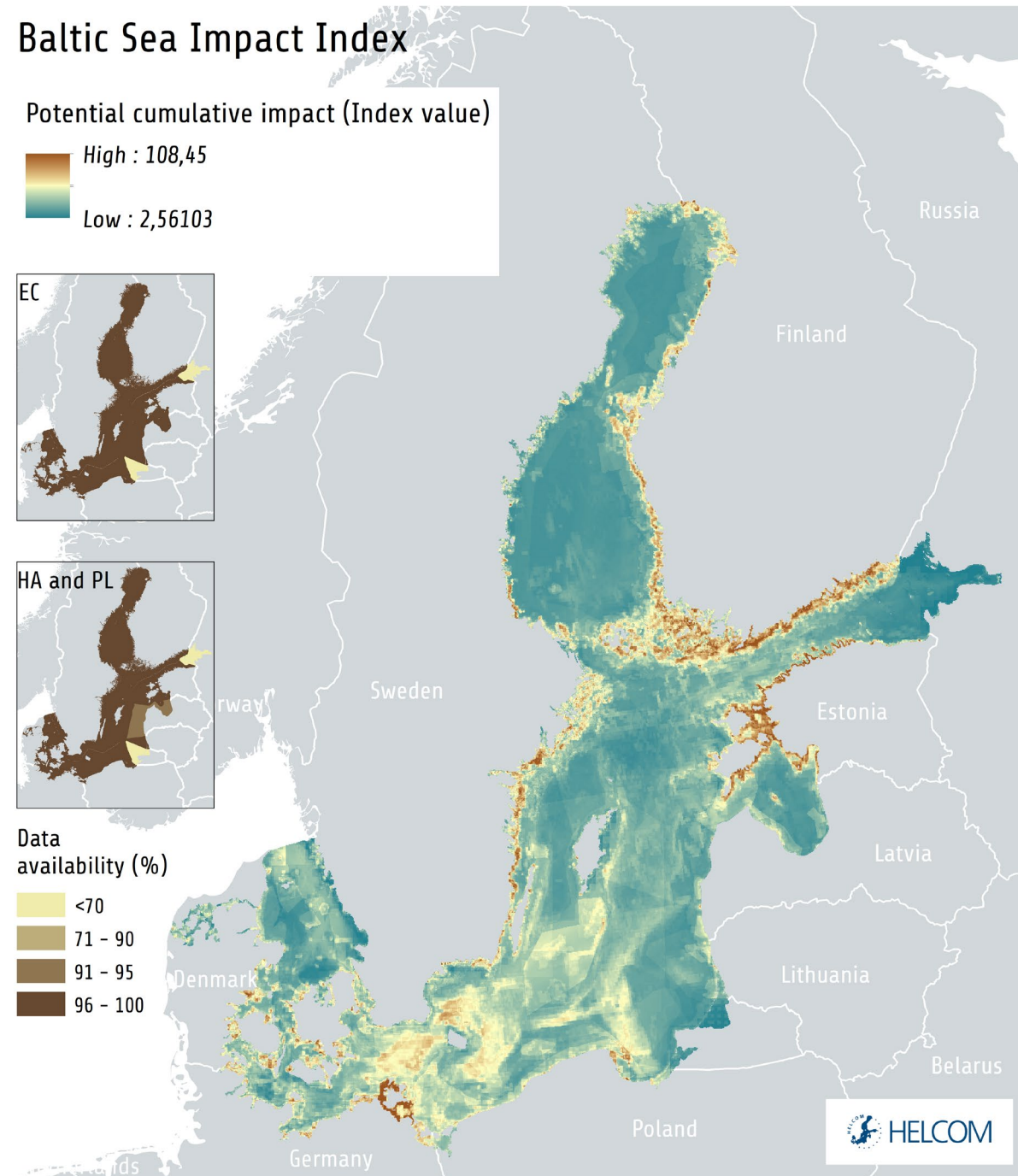
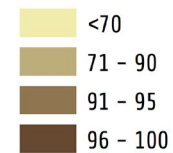
- Based on
  - 17 pressure layers
  - 57 Ecosystem components
  - Sensitivity scores
- All areas affected
- Shallow areas most impacted, most EC layers

## Baltic Sea Impact Index

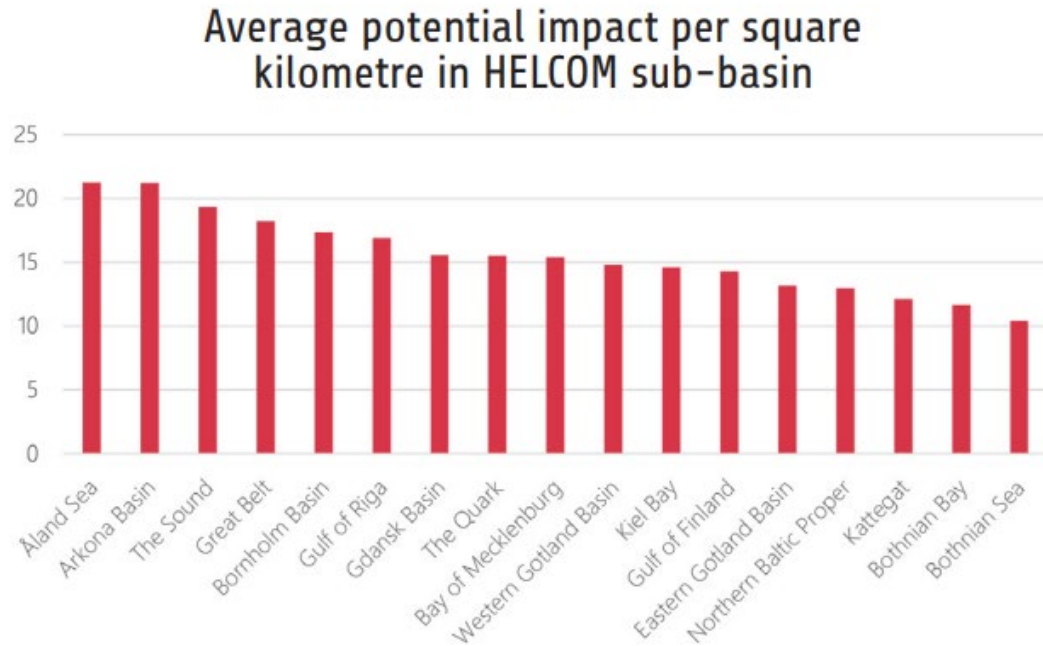
Potential cumulative impact (Index value)



Data availability (%)

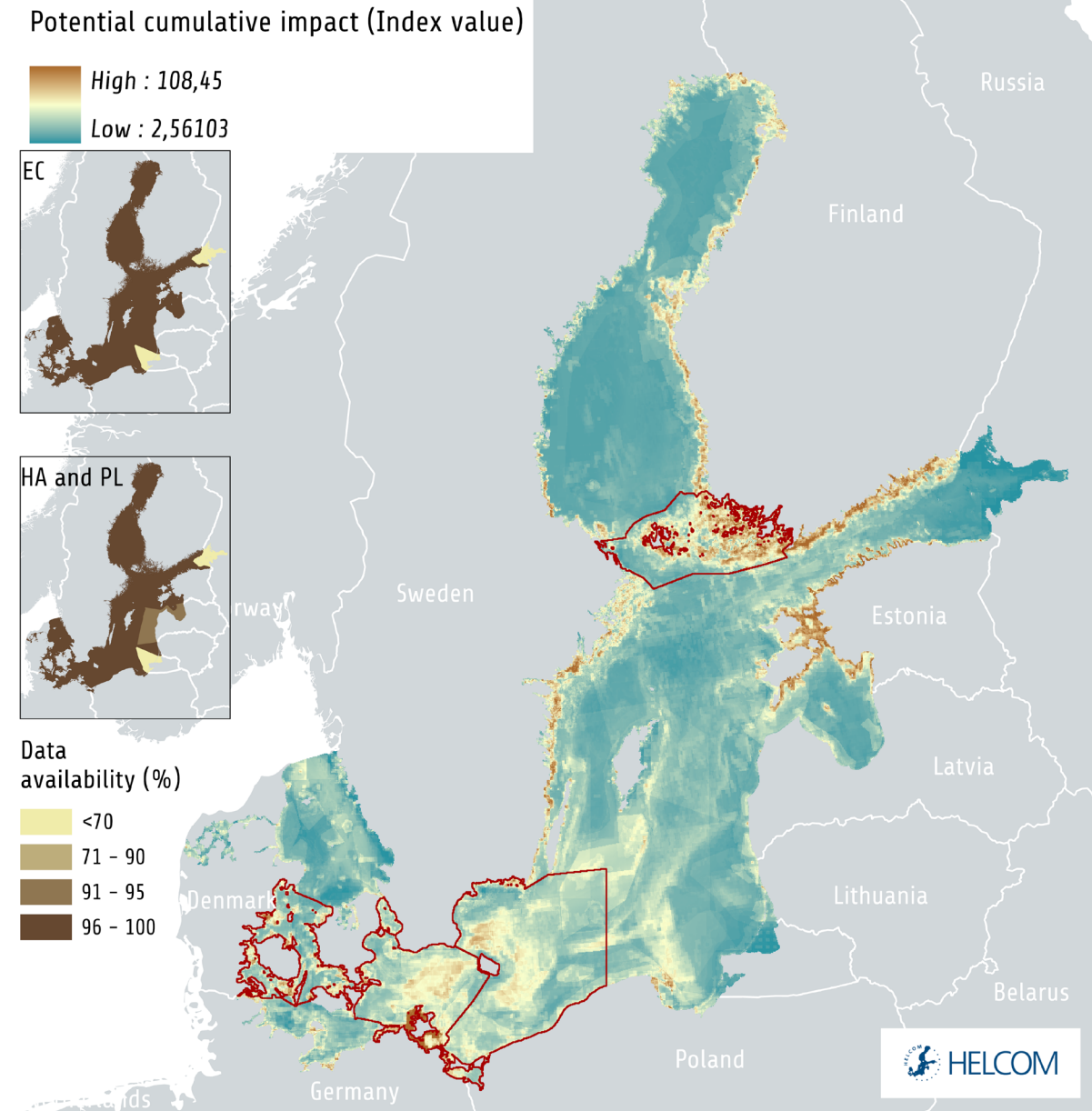


# Impact per sub-basin



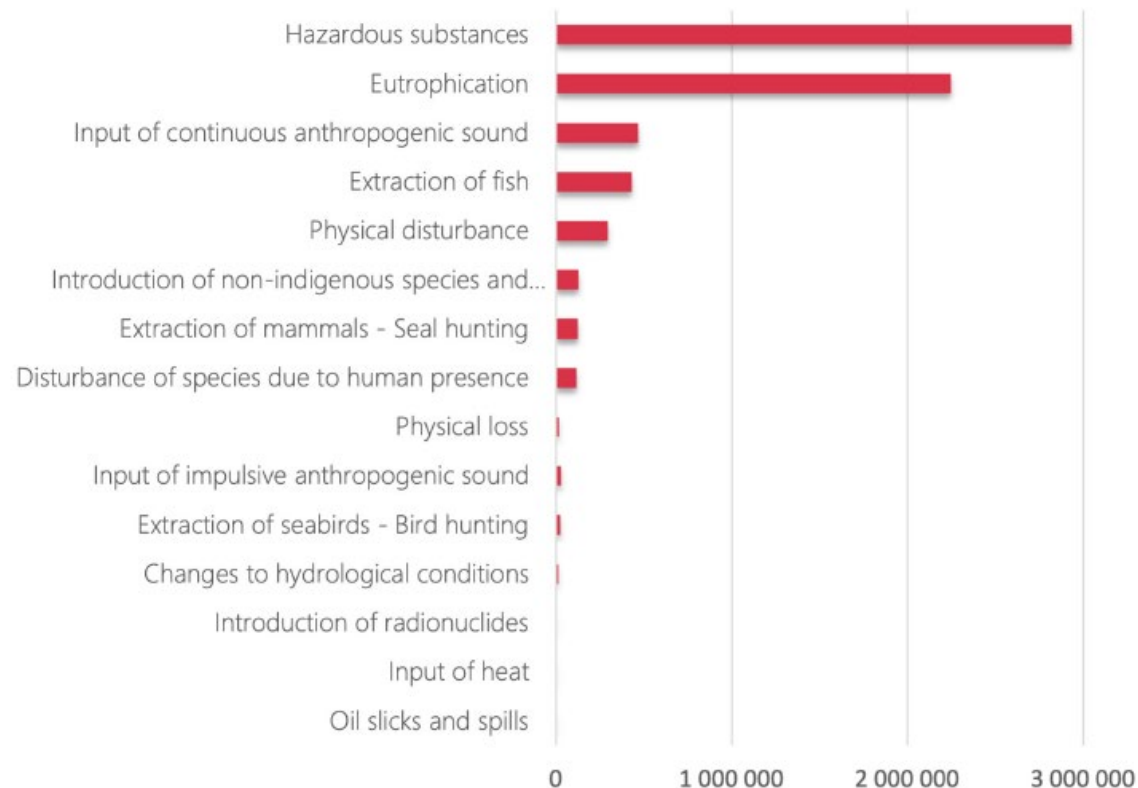
**Figure 21.** Average potential cumulative impact per square kilometre in HELCOM sub-basin in BSII.

## Baltic Sea Impact Index

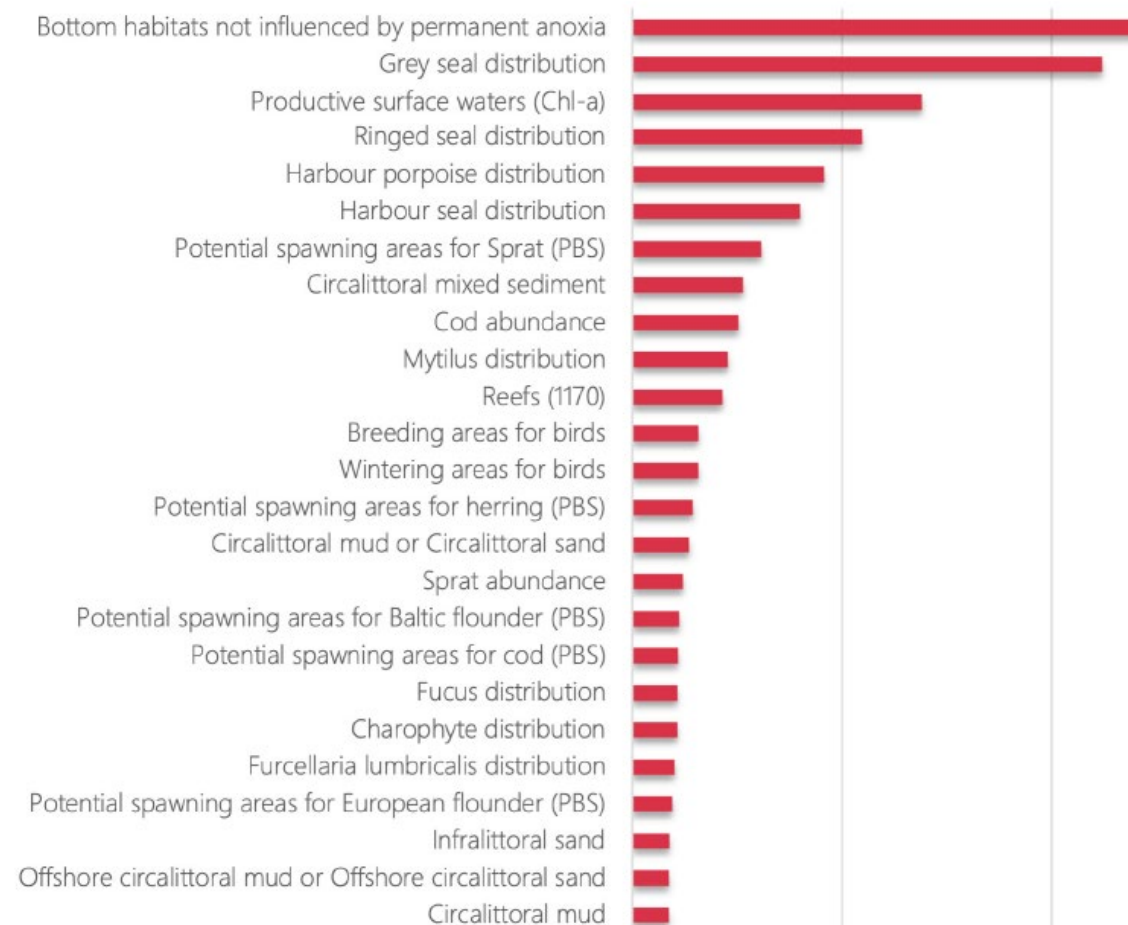


# BSII top pressures and most impacted ecosystem components

Cumulative impact per pressure category



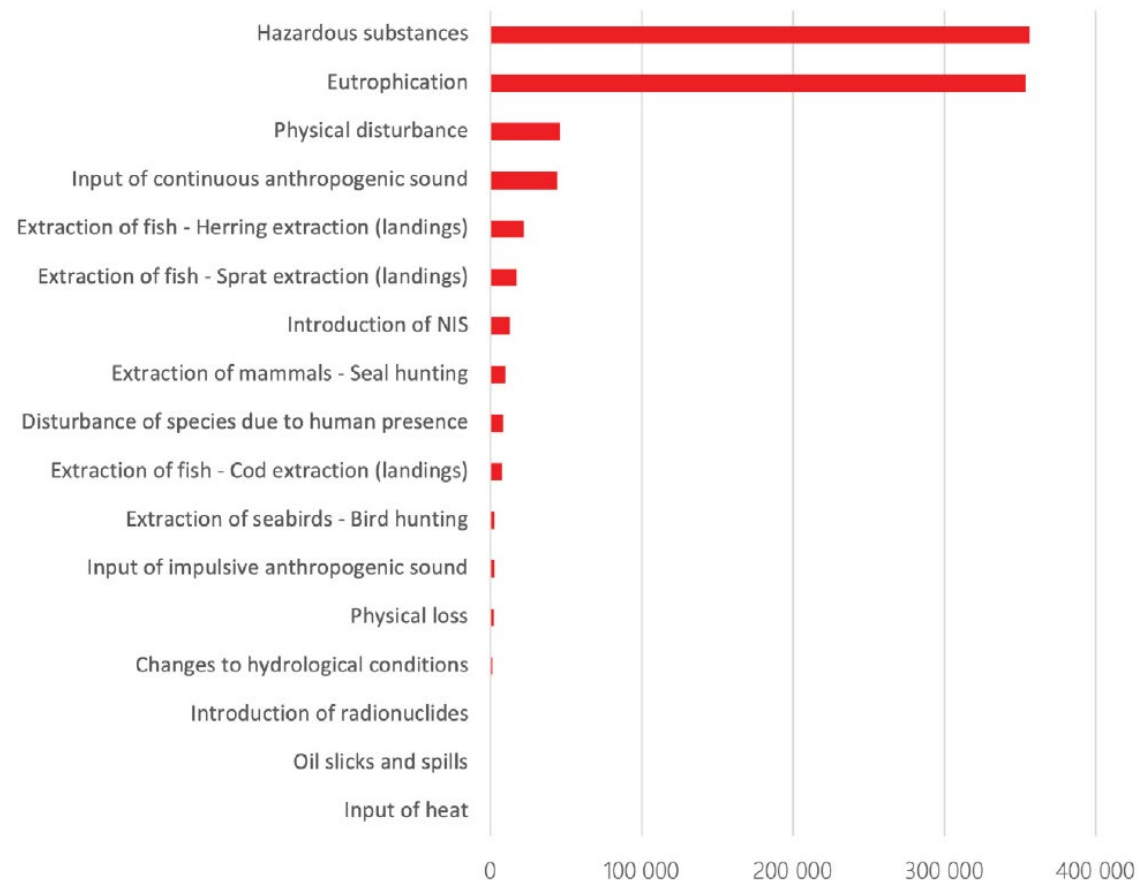
Potentially most impacted ecosystem components





# Baltic Sea Pressure Index (BSPI)

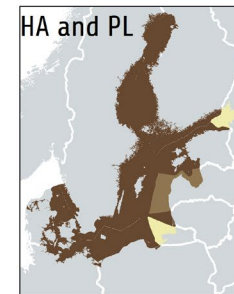
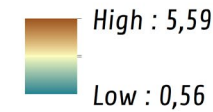
## Top pressures in BSPI



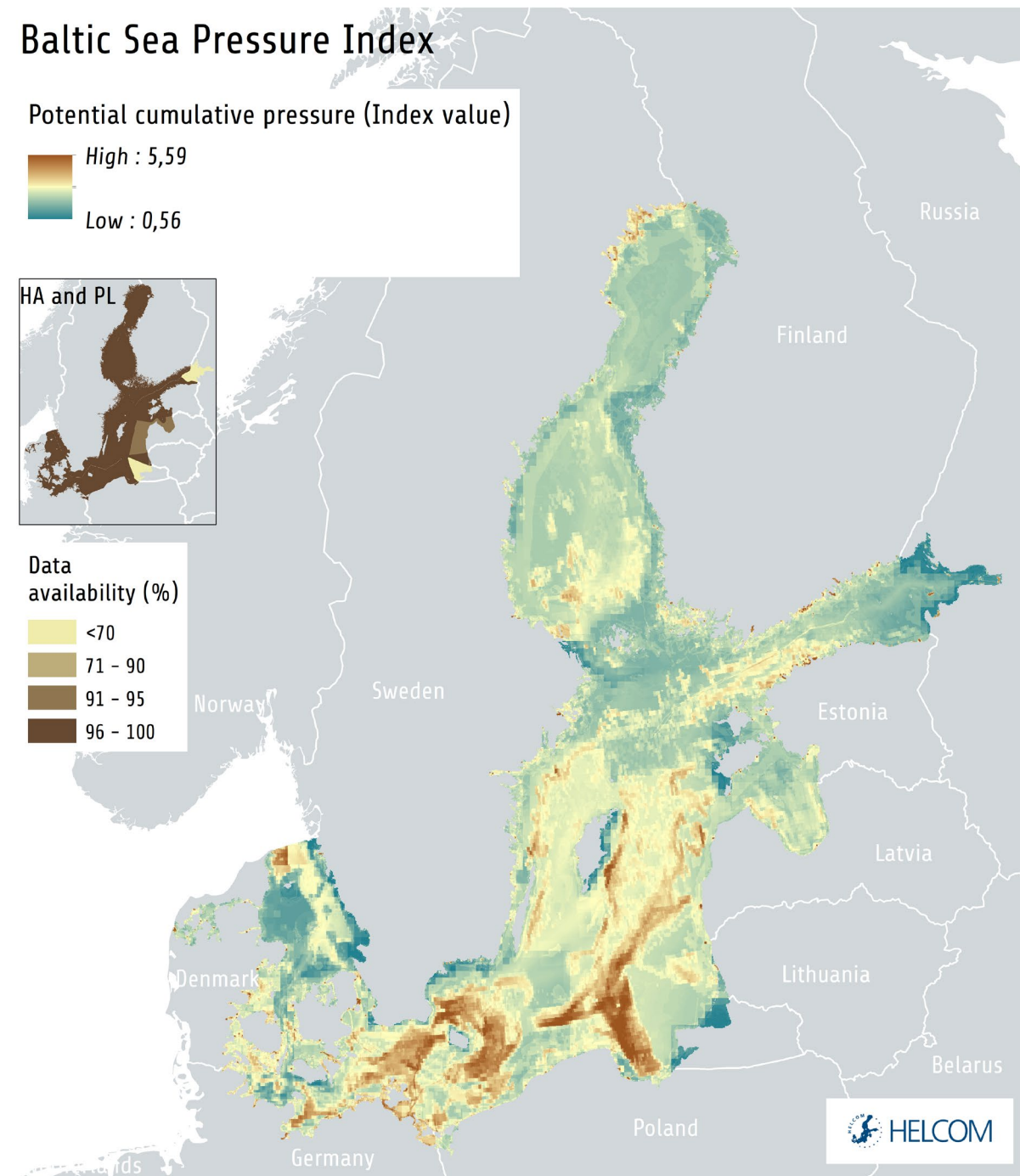
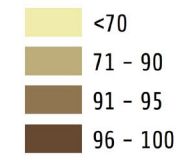
By HELCOM staff  
Friday, June 16, 2023

## Baltic Sea Pressure Index

Potential cumulative pressure (Index value)

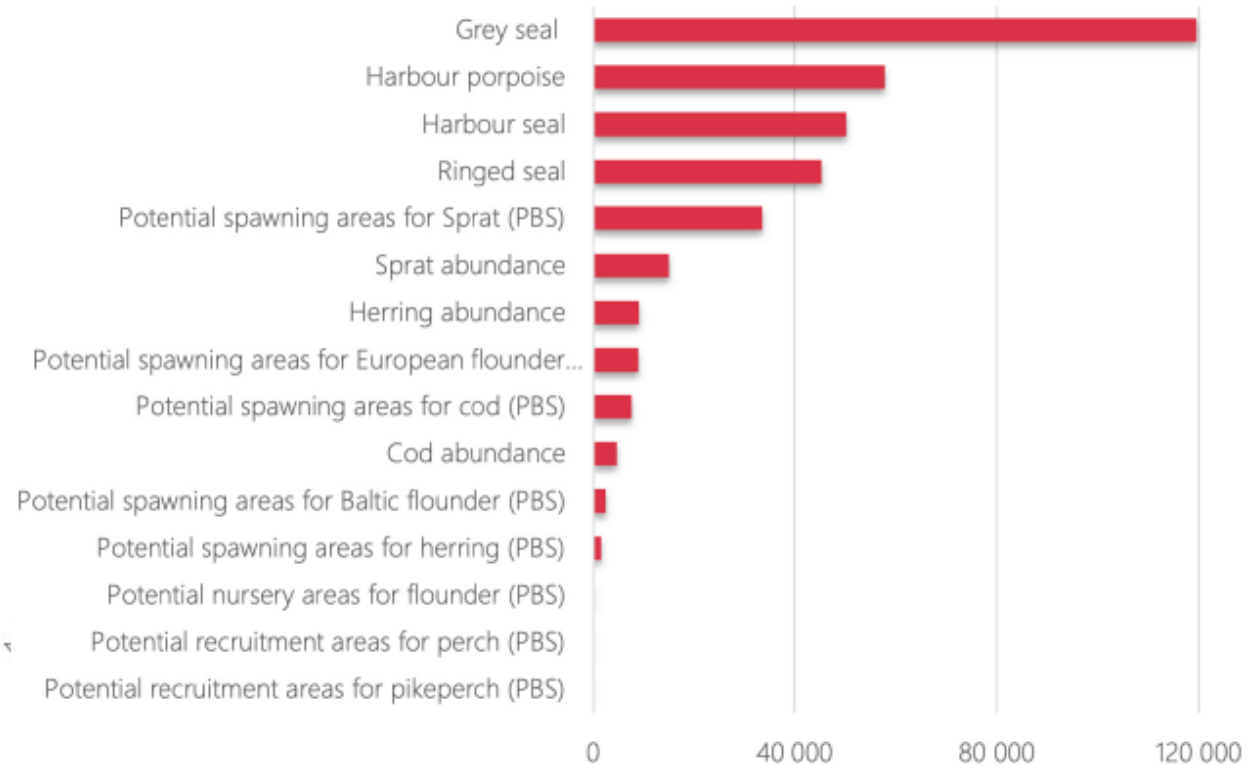


Data availability (%)



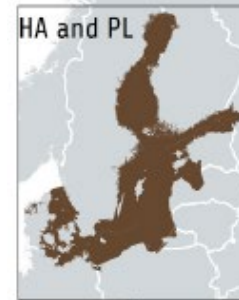
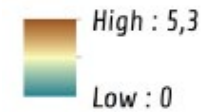
# Potential effect of continuous noise to mobile species

Species with the largest distribution range within areas where continuous noise is moderate to high

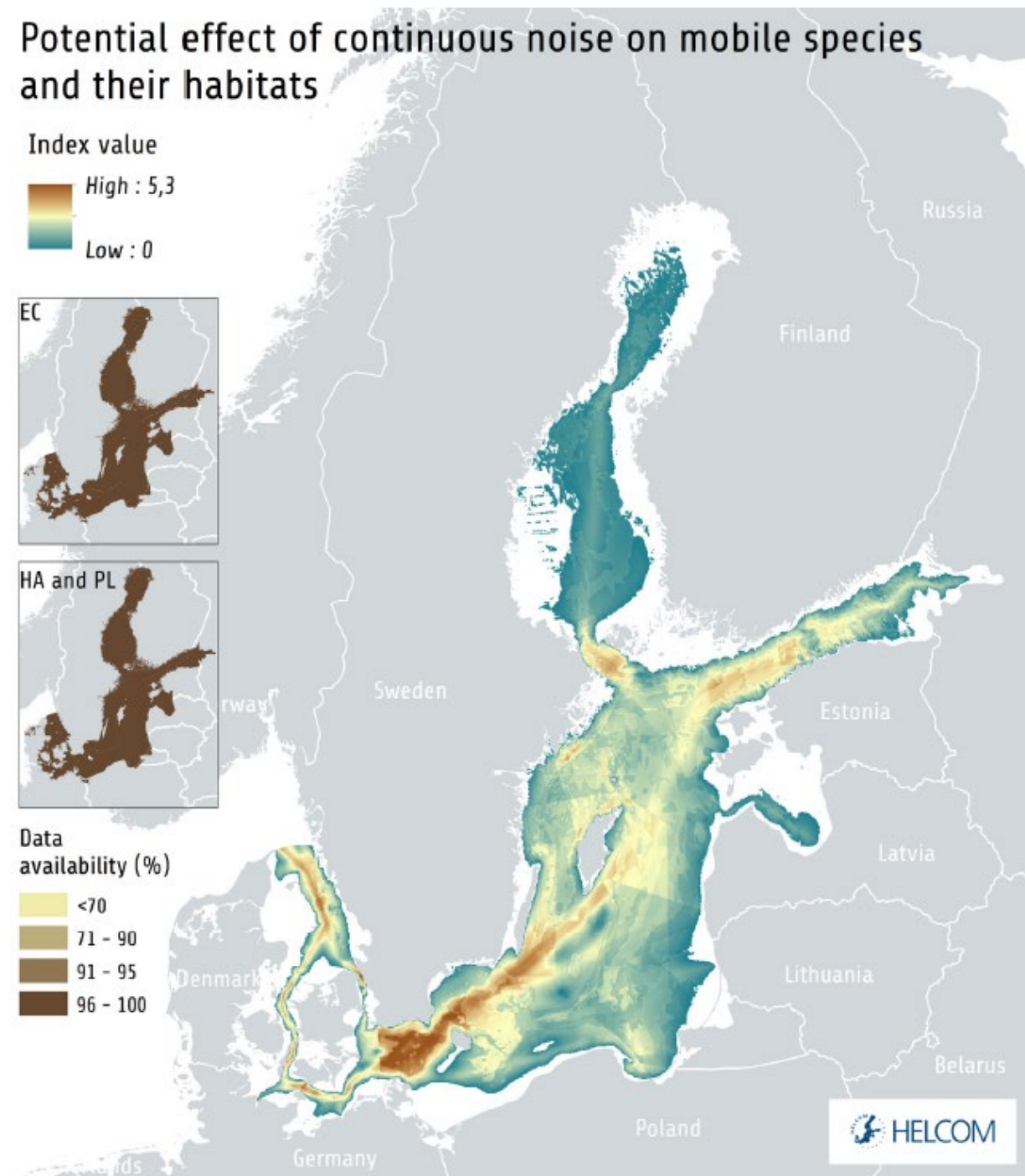
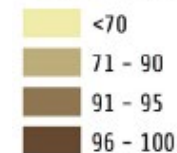


## Potential effect of continuous noise on mobile species and their habitats

Index value



Data availability (%)



# SPIA to support MSP and management

- The increasing use of sea areas leads to complex patterns and interactions between human activities, pressures and ecosystem components at sea.
  - > Tools to assess the spatial distribution of pressures and impacts are helpful to evaluate the combined and cumulative impact of human induced pressures on the environment, and to identify potential key areas of concern and enhanced management efforts.
- Outputs from the SPIA provide valuable information for marine spatial planning and marine management from various perspectives.



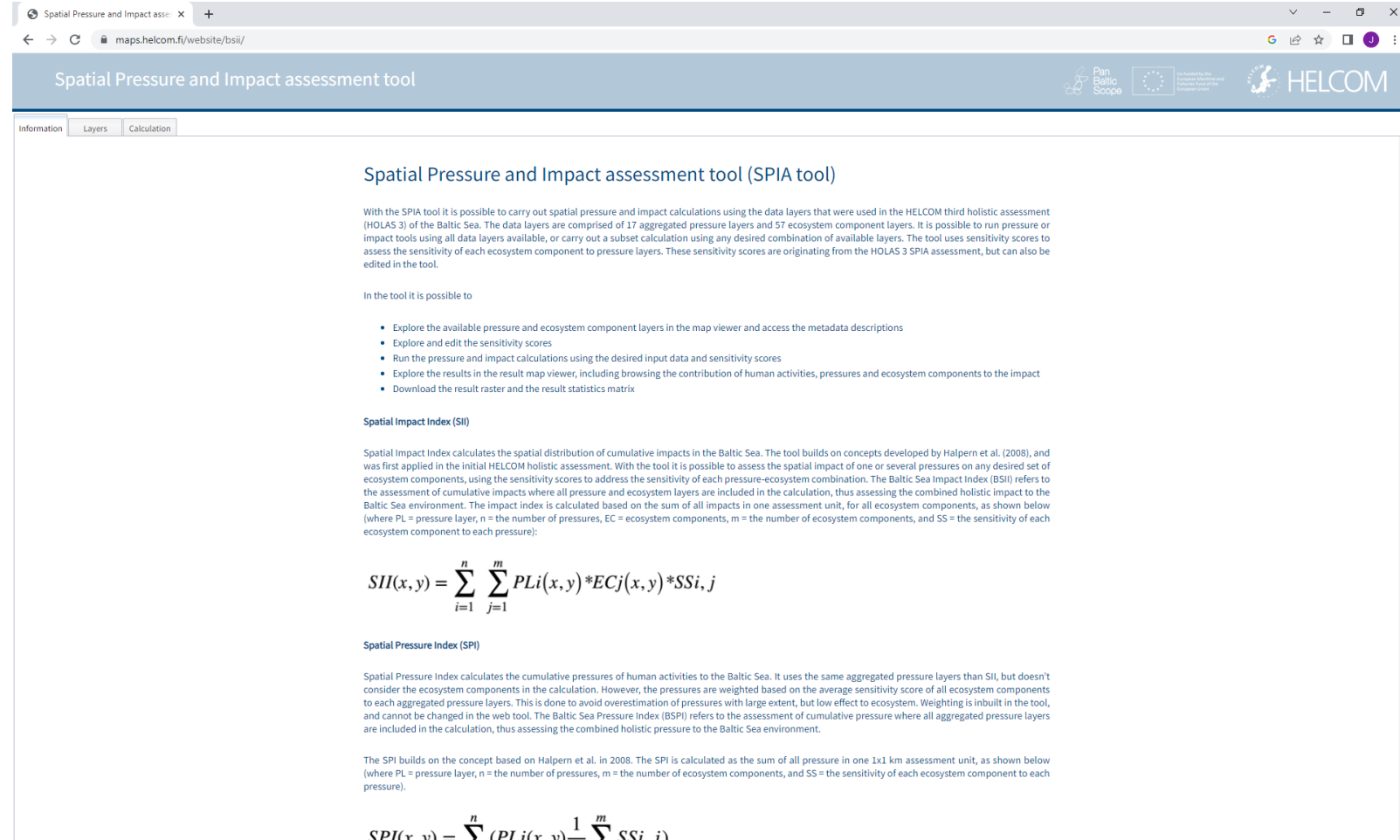
# SPIA to support MSP and management

- **Identifying key areas:** The assessment recognizes and displays the potentially most impacted areas in the region, making it possible to place any local impacts in a regional perspective, and identifying areas, activities, pressures and habitats which should be given special focus in management.
- **Data resource:** Substantial amounts of data on activities, pressures and ecosystem components (species and habitats) are needed to carry out the assessment, and the publication of these data sets provides a unique, region-wide and harmonized data resource to support management
- **Communication:** The cumulative impact assessment is an effective way to describe and visualize potential impacts of human activities on the Baltic Sea environment. This can help raise awareness of these impacts, and can also function as a platform to discuss the underlying causes and potential future solutions
- **Interactive tool:** The SPIA tool supports the written report, makes it possible to further explore the activities and pressures behind identified impacts, as well as the affected ecosystem components, and allows to run the assessment on any given combination of these layers
- **Scenario analyses:** Studying the impact of potential future sea uses

# SPIA online tool

In the tool it is possible to

- Explore the available pressure and ecosystem layers in the map viewer and access the metadata descriptions
- Explore and edit the sensitivity scores
- Run the pressure and impact calculations using the desired input data and sensitivity scores
- Explore the results in the result map viewer, including browsing the contribution of human activities, pressures and ecosystem components to the impact
- Download the result raster and the statistics matrix



The screenshot shows the web interface of the Spatial Pressure and Impact assessment tool (SPIA tool). The browser address bar shows the URL [maps.helcom.fi/website/bsii/](https://maps.helcom.fi/website/bsii/). The page title is "Spatial Pressure and Impact assessment tool". The interface includes a navigation bar with "Information", "Layers", and "Calculation" tabs. The main content area is titled "Spatial Pressure and Impact assessment tool (SPIA tool)" and contains the following text:

With the SPIA tool it is possible to carry out spatial pressure and impact calculations using the data layers that were used in the HELCOM third holistic assessment (HOLAS 3) of the Baltic Sea. The data layers are comprised of 17 aggregated pressure layers and 57 ecosystem component layers. It is possible to run pressure or impact tools using all data layers available, or carry out a subset calculation using any desired combination of available layers. The tool uses sensitivity scores to assess the sensitivity of each ecosystem component to pressure layers. These sensitivity scores are originating from the HOLAS 3 SPIA assessment, but can also be edited in the tool.

In the tool it is possible to

- Explore the available pressure and ecosystem component layers in the map viewer and access the metadata descriptions
- Explore and edit the sensitivity scores
- Run the pressure and impact calculations using the desired input data and sensitivity scores
- Explore the results in the result map viewer, including browsing the contribution of human activities, pressures and ecosystem components to the impact
- Download the result raster and the result statistics matrix

**Spatial Impact Index (SII)**

Spatial Impact Index calculates the spatial distribution of cumulative impacts in the Baltic Sea. The tool builds on concepts developed by Halpern et al. (2008), and was first applied in the initial HELCOM holistic assessment. With the tool it is possible to assess the spatial impact of one or several pressures on any desired set of ecosystem components, using the sensitivity scores to address the sensitivity of each pressure-ecosystem combination. The Baltic Sea Impact Index (BSII) refers to the assessment of cumulative impacts where all pressure and ecosystem layers are included in the calculation, thus assessing the combined holistic impact to the Baltic Sea environment. The impact index is calculated based on the sum of all impacts in one assessment unit, for all ecosystem components, as shown below (where PL = pressure layer, n = the number of pressures, EC = ecosystem components, m = the number of ecosystem components, and SS = the sensitivity of each ecosystem component to each pressure):

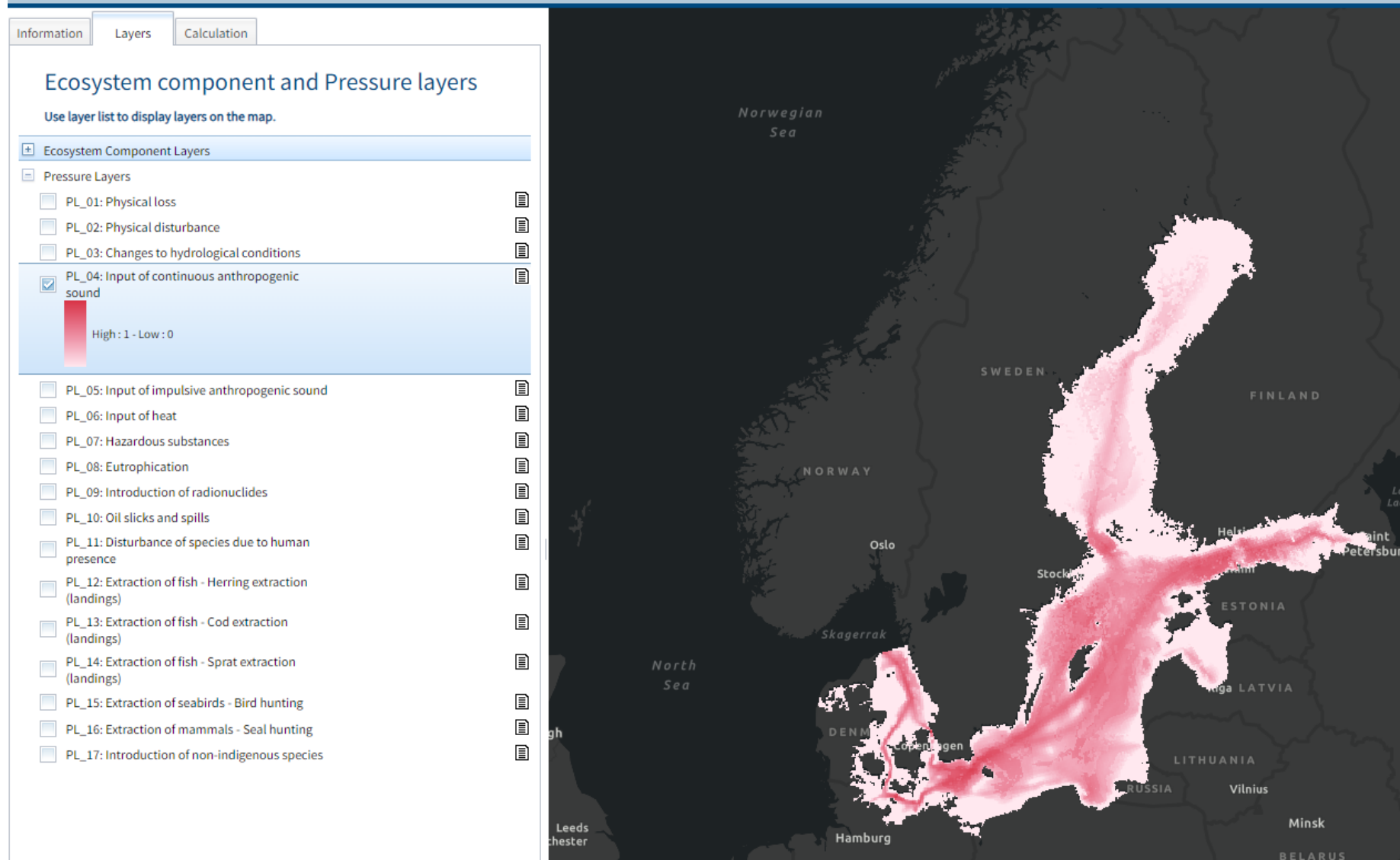
$$SII(x, y) = \sum_{i=1}^n \sum_{j=1}^m PLi(x, y) * ECj(x, y) * SSi, j$$

**Spatial Pressure Index (SPI)**

Spatial Pressure Index calculates the cumulative pressures of human activities to the Baltic Sea. It uses the same aggregated pressure layers than SII, but doesn't consider the ecosystem components in the calculation. However, the pressures are weighted based on the average sensitivity score of all ecosystem components to each aggregated pressure layers. This is done to avoid overestimation of pressures with large extent, but low effect to ecosystem. Weighting is inbuilt in the tool, and cannot be changed in the web tool. The Baltic Sea Pressure Index (BSPi) refers to the assessment of cumulative pressure where all aggregated pressure layers are included in the calculation, thus assessing the combined holistic pressure to the Baltic Sea environment.

The SPI builds on the concept based on Halpern et al. in 2008. The SPI is calculated as the sum of all pressure in one 1x1 km assessment unit, as shown below (where PL = pressure layer, n = the number of pressures, m = the number of ecosystem components, and SS = the sensitivity of each ecosystem component to each pressure):

$$SPI(x, y) = \sum_{i=1}^n (PLi(x, y) * \frac{1}{m} \sum_{j=1}^m SSi, j)$$



# Spatial Pressure and Impact assessment tool



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



HELCOM

Information Layers Calculation

## SII and SPI calculation

SII

SPI (sum)

SPI (weighted sum)

SII calculation

Select the area for which to perform calculation

Baltic Sea

Select Ecosystem component and Pressure layers to include in calculation

### ▼ Ecosystem component layers

- ☒ EC\_01: Productive surface waters (Chl-a)
- ☒ EC\_02: Bottom-water habitats not influenced by permanent anoxia
- ☒ EC\_03: Infralittoral coarse sediment
- ☒ EC\_04: Infralittoral mixed sediment
- ☒ EC\_05: Infralittoral mud
- ☒ EC\_06: Infralittoral mud or Infralittoral sand
- ☒ EC\_07: Infralittoral rock and biogenic reef
- ☒ EC\_08: Infralittoral sand

[Select all](#)

Get Sensitivity Scores

[Reset sensitivity scores](#)

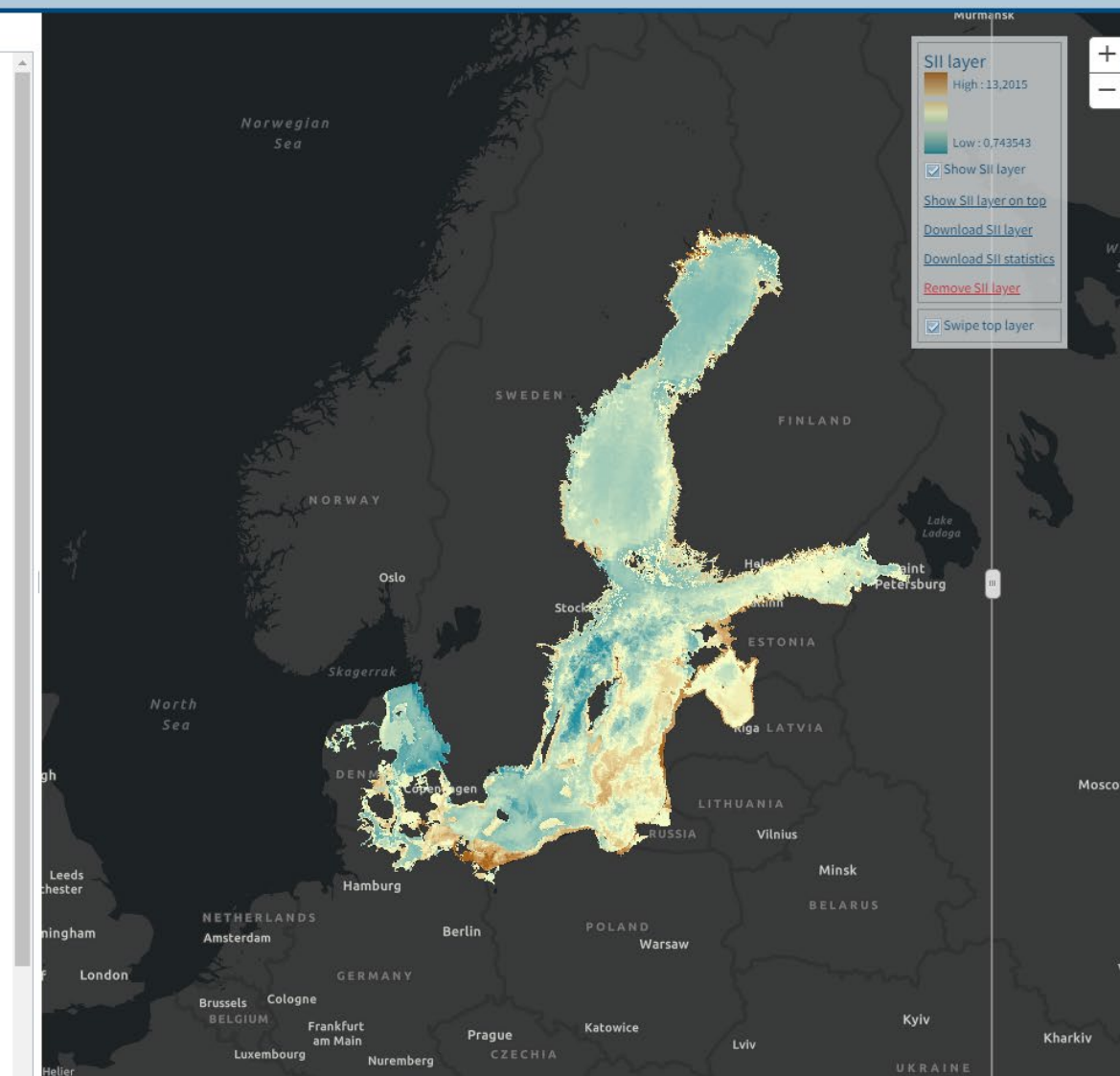
### ▼ Pressure layers

- ☒ PL\_01: Physical loss
- ☒ PL\_02: Physical disturbance
- ☒ PL\_03: Changes to hydrological conditions
- ☒ PL\_04: Input of continuous anthropogenic sound
- ☒ PL\_05: Input of impulsive anthropogenic sound
- ☒ PL\_06: Input of heat
- ☒ PL\_07: Hazardous substances
- ☒ PL\_08: Eutrophication
- ☐ PL\_09: Introduction of radionuclides

[Select all](#)

Default sensitivity scores for selected layers are displayed in the table below. Sensitivity scores can be edited directly in the table. Edited values will be used in SII calculation. Use **Calculate SII** button below to calculate SII.

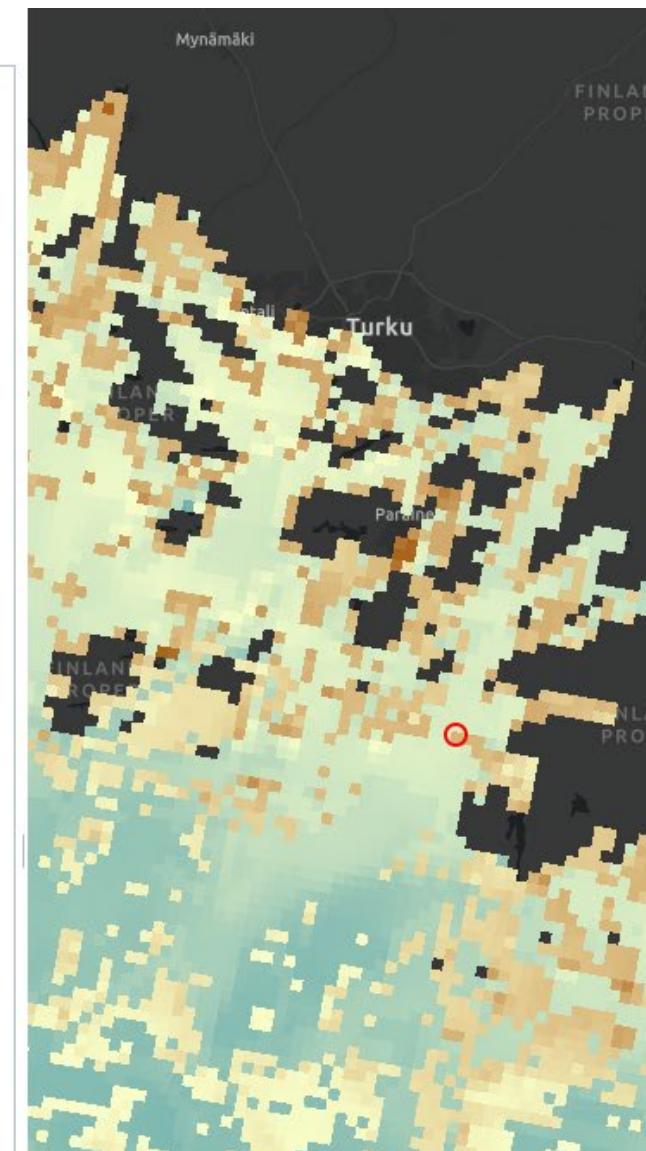
CODE	PL_01	PL_02	PL_03	PL_04	PL_05	PL_06	PL_07	PL_08
EC_01	0	1	0.8	0.6	0.2	1	1	1.8
EC_02	1.5	0.9	1.3	0.5	0.2	0.6	0.9	1.9
EC_03	1.9	1.3	1.2	0.2	0.2	1.3	1	1.3
EC_04	1.9	1.2	1.1	0.3	0.3	1.1	1	1.3
EC_05	1.9	1.1	1.1	0.3	0.3	1	1	1.3
EC_06	1.9	1.2	1	0.3	0.3	1	1	1.3
EC_07	1.9	1.3	1.2	0.2	0.2	1.3	1	1.3
EC_08	1.9	1.2	0.9	0.3	0.3	1	0.9	1.3



By HELCOM staff  
Friday, June 16, 2023

Baltic Marine Environment Protection Commission



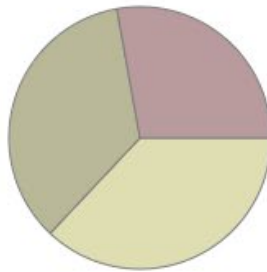


## Location information

[Back to calculation settings](#)

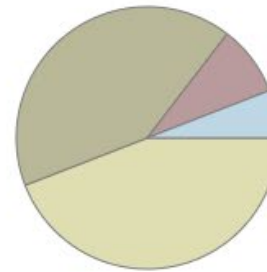
SII value: 6.1533

Ecosystem components contribution to SII

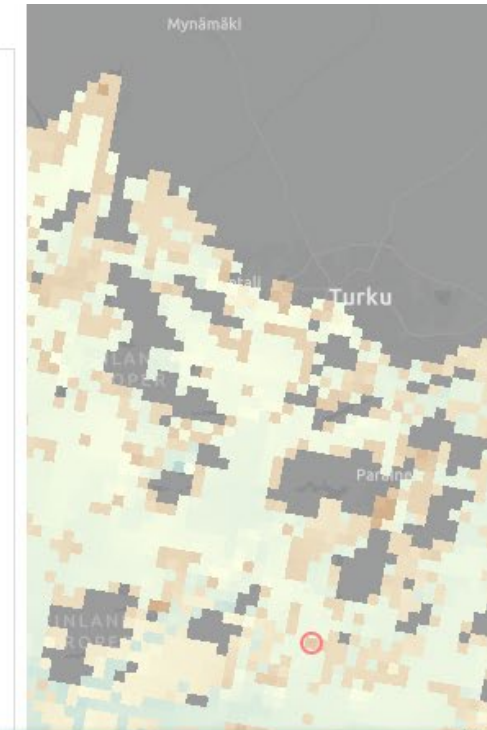


- Bottom-water habitats not influenced by permanent anoxia (37.03 %)
- Infralittoral rock and biogenic reef (35.15 %)
- Productive surface waters (Chl-a) (27.82 %)

Pressures contribution to SII



- Hazardous substances (44.12 %)
- Eutrophication (41.31 %)
- Physical loss (8.68 %) [Human activities](#)
- Physical disturbance (5.89 %) [Human activities](#)



Human activities contributions

Human activity	Contribution to Physical loss (%)	Contribution to SII (%)
Bridges and other constructions	0	0
Cables (operational)	1.5	0.13
Coastal defence and flood protection	0	0
Capital dredging	0	0
Extraction of sand and gravel	0	0
Finfish mariculture	0	0
Harbours	98.5	8.55
Land claim	0	0
Marinas and leisure harbours	0	0

# Conclusion

- The Spatial pressure and impact assessment is a powerful tool to assess and to communicate the relative pattern of activities, pressures and impacts in the Baltic Sea
- Potential pressures and impacts on the marine environment are widely distributed in the Baltic Sea and no area in the region is without human footprint
- Supports MSP by identifying key areas of interest, providing a data resource, acting as a mean of communication and by providing an interactive tool to explore the underlying data and results



# Thank you!