# HELCOM Cumulative impact assessment and human pressures mapping at Baltic wide scale

SEAmBOTH final seminar, Oulu 20 February 2020

HELCOM

# This presentation

- HELCOM
- State of the Baltic Sea report – HOLAS II
- HELCOM Cumulative effect Assessment
- Human pressures mapping
- Future work on Cumulative effect Assessment

# HELCOM structure

## The 10 Contracting Parties (CPs)

DK EE EU FI DE

LV LT PL RU SE

*Each Contracting Party designates its own Head of Delegation as well as members of the Working Groups and of the Expert Groups and Networks*

*The Contracting Parties have signed the first Helsinki Convention in 1974 and updated it in 1992. The current Convention was ratified in 2000.*

## Helsinki Convention

*The set of guiding principles and obligations signed by the Contracting Parties on the protection of the marine environment of the Baltic Sea*

## HELCOM Secretariat

*Coordinates the work and meetings of the Helsinki Commission and ensures CPs meet their obligations under the Helsinki Convention*

## Helsinki Commission (HELCOM)

*HELCOM chairmanship rotates every two years between the Contracting Parties (CPs)*

**Heads of Delegation**
*Permanently represent the CPs and are decision-makers*

**HELCOM Working Groups**
*Develop recommendations, policies & strategies*

**Expert Groups & Networks**
*Provide scientific and technical underpinnings*

**Decision making in HELCOM**

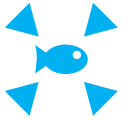
*The highest decision-making body in HELCOM is the Ministerial Meeting (the meeting of the HELCOM line ministers of each CP) that takes place every three years.*

*The Helsinki Commission meets annually (except when a Ministerial Meeting takes place) and is also entitled to make decisions. Its participants are designated by the CPs.*

*The Heads of Delegation meet twice per year and are also authorised to make decisions on behalf of the CPs.*

# HELCOM is...

an **environmental policy maker**
*e.g. BSAP*



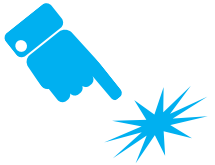
an **environmental focal point** *e.g. HOLAS II*

a **body for developing recommendations**
*e.g. HELCOM recommendations*

a **supervisory body**
*e.g. CART*

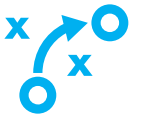
a **coordinating body**
*e.g. HELCOM Response & BALEX DELTA*

# Decision making process in HELCOM: a bottom-up, science-based approach

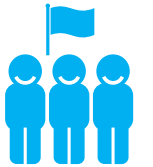


1) A **mandate or impulse** to look into a **specific issue** is usually given by the CPs

2) The **HELCOM Expert Groups** constituted of national experts provide the scientific or technical background



3) The **HELCOM Working Groups (WG)**, also constituted of national experts, translate the scientific findings into draft recommendations, strategies or actions



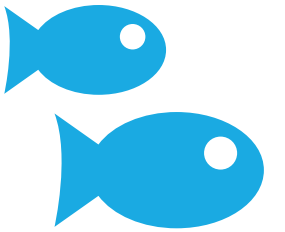
4) The **Heads of Delegation** formally approve the work of the Working Groups

5) Sometimes, decision are taken at **a higher level**: Annual Meeting of the Helsinki Commission, Ministerial Meeting (every three years)

HELCOM

# State of the Baltic Sea

## Second HELCOM holistic assessment of the environmental situation of the Baltic Sea 2011-2016

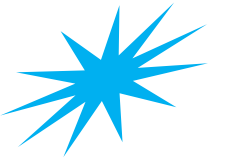


Baltic Marine Environment Protection Commission

# What data is it based on?

**30 HELCOM core indicators:**
Assess the status of selected elements of biodiversity and human-induced pressures on the Baltic Sea against regionally agreed threshold values

**Trend analyses**
Temporal developments have been included in order to understand long-term trends



**BSII – the Baltic Sea Impact Index:**

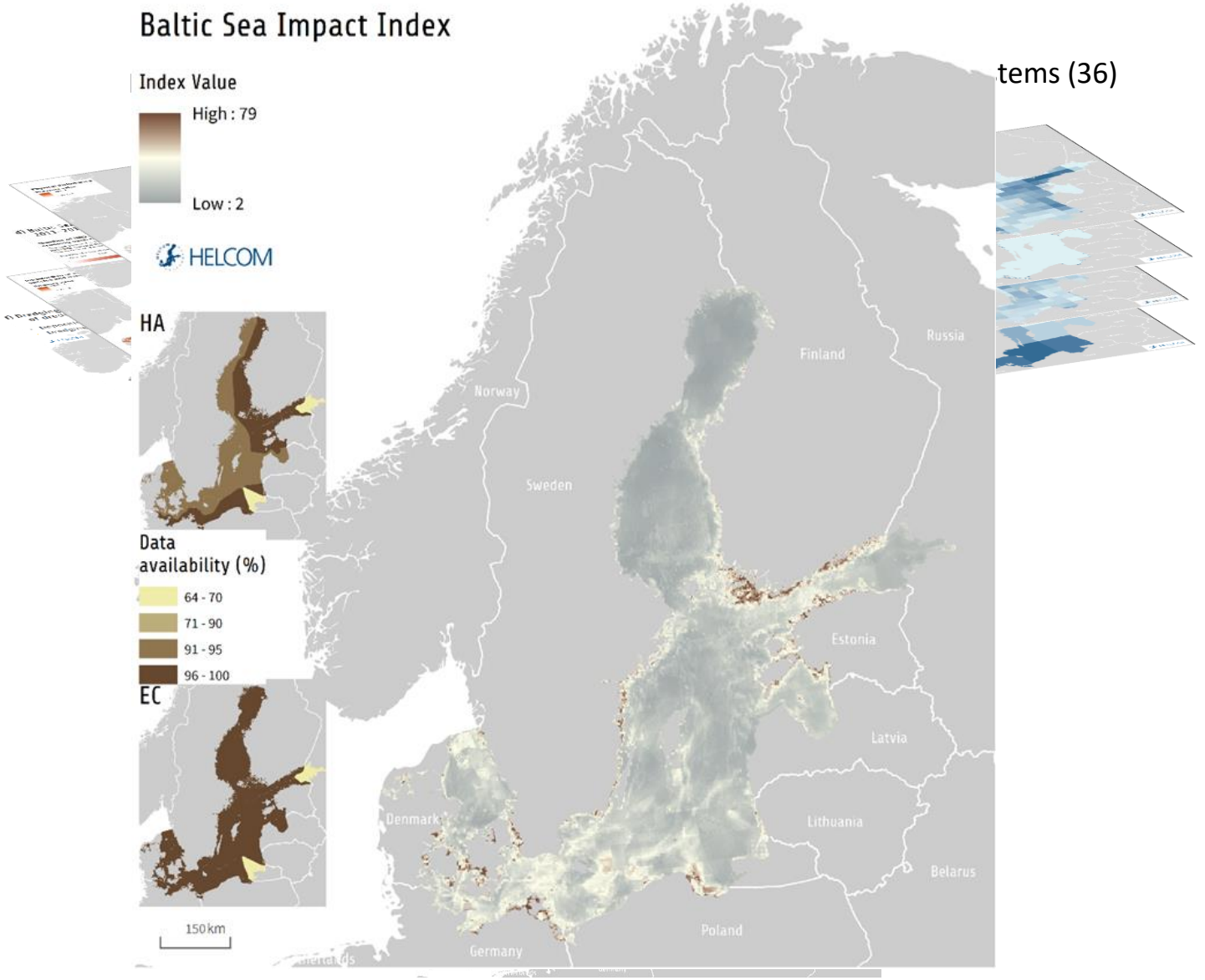
- 45 datasets on human activities or pressures (BSPI – Baltic Sea Pressure Index)
- 36 datasets on ecosystem components

# State of the Baltic Sea report

- Summary report: Environmental situation in the Baltic Sea for the period 2011-2016
- Thematic report on cumulative impacts: more detailed description of results and methodology
- State of the Baltic Sea website and HELCOM Map and Data Service

# Cumulative effects assessment

- Marine environments are facing multiple, simultaneous and overlapping pressures from human activities
- CEAs are assessing the **cumulative** burden of the human induced pressures to all ecosystem components
- Based on Halpern et al. (2008), First applied at HELCOM for HOLAS I (2010)



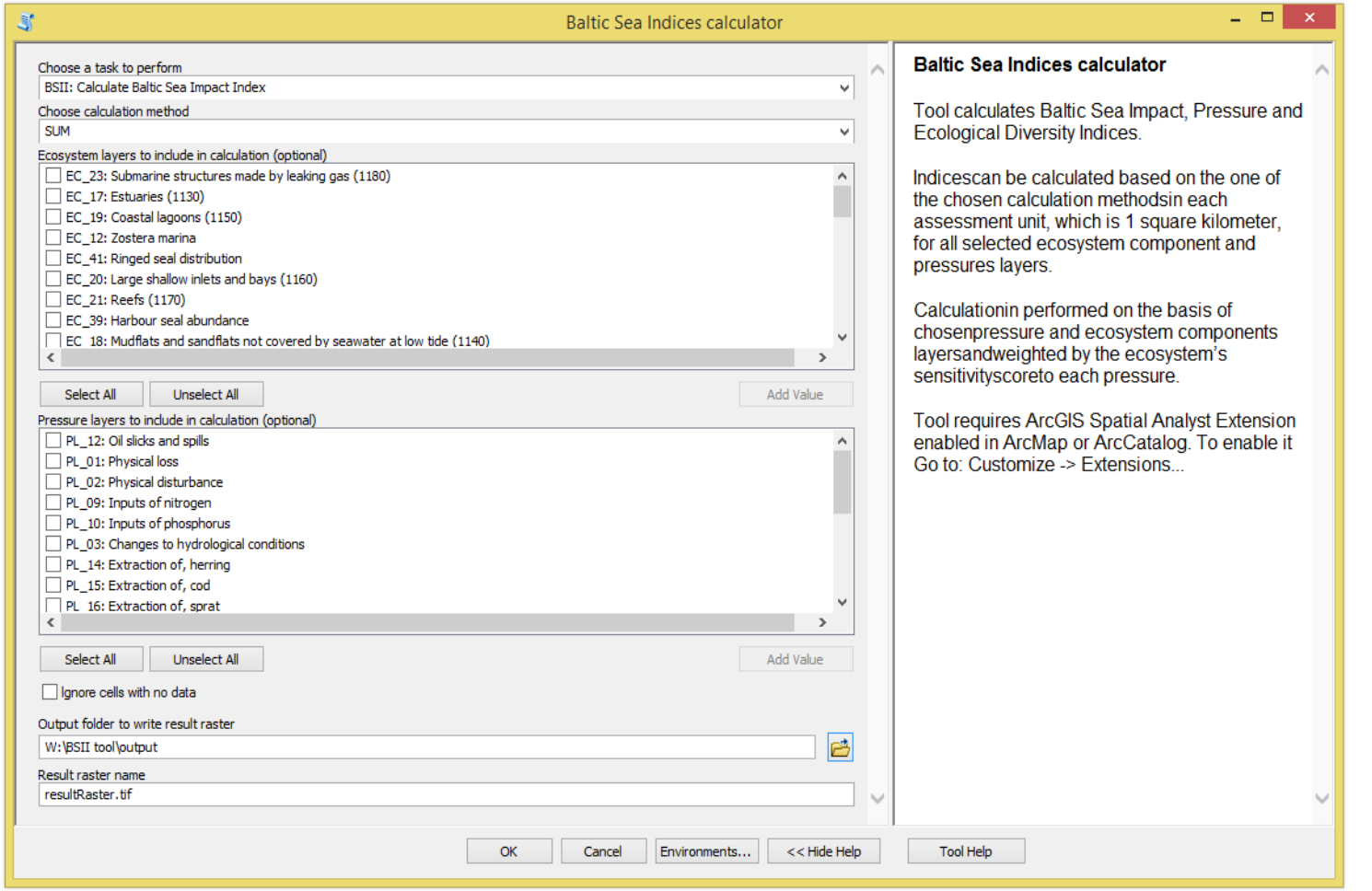
# Sensitivity score matrix

- Matrix based on responses to expert survey

| Sensitivity scores: mean | Oil slicks and spills | Physical loss | Physical disturbance | Inputs of nitrogen | Inputs of phosphorus | Changes to hydrological conditions | Extraction of, herring | Extraction of, cod | Extraction of, sprat | Inputs of hazardous substances | Introduction of non-indigenous species | Disturbance of species | Input of heat | Hunting of seabirds | Hunting of seals | Inputs of impulsive sound | Inputs of continuous sounds | Inputs of electromagnetic and seismic waves | Introduction of radionuclides |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Submarine structures made by leaking gas (1180) | 1.8 | 1.7 | 1.2 | 1.6 | 1.6 | 1.3 | 0.8 | 0.8 | 0.8 | 0.7 | 1.4 | 1.0 | 1.0 | 1.5 | 1.5 | 1.0 | 1.0 | 1.0 | 0.5 |
| Estuaries (1130) | 1.6 | 1.8 | 1.6 | 1.4 | 1.4 | 1.5 | 1.1 | 1.1 | 1.1 | 0.8 | 1.3 | 1.0 | 0.9 | 0.8 | 0.8 | 0.9 | 0.8 | 0.8 | 0.7 |
| Coastal lagoons (1150) | 1.7 | 1.9 | 1.7 | 1.5 | 1.5 | 1.6 | 1.1 | 1.1 | 1.1 | 1.0 | 1.4 | 1.0 | 1.3 | 0.6 | 0.6 | 0.8 | 0.7 | 0.6 | 0.2 |
| Zostera marina | 1.6 | 1.9 | 1.9 | 1.9 | 1.9 | 1.7 | 0.9 | 0.9 | 0.9 | 0.9 | 1.1 | 1.2 | 1.6 | 0.8 | 0.8 | 0.1 | 0.2 | 0.5 | 0.6 |
| Ringed seal distribution | 1.4 | 0.5 | 0.6 | 0.5 | 0.5 | 0.6 | 1.5 | 1.5 | 1.5 | 1.4 | 1.1 | 1.2 | 0.6 | 1.6 | 1.6 | 1.6 | 1.5 | 0.4 | 1.2 |
| Large shallow inlets and bays (1160) | 1.6 | 1.8 | 1.6 | 1.3 | 1.3 | 1.3 | 1.1 | 1.1 | 1.1 | 0.7 | 1.3 | 0.9 | 1.2 | 0.7 | 0.7 | 0.9 | 0.8 | 0.8 | 0.2 |
| Reefs (1170) | 1.9 | 2.0 | 1.6 | 1.3 | 1.3 | 1.4 | 0.9 | 0.9 | 0.9 | 1.2 | 1.2 | 0.8 | 1.0 | 1.1 | 1.1 | 0.3 | 0.3 | 0.6 | 0.6 |
| Harbour seal abundance | 1.6 | 0.6 | 0.7 | 0.3 | 0.3 | 0.7 | 1.2 | 1.2 | 1.2 | 1.5 | 0.8 | 1.3 | 0.3 | 1.9 | 1.9 | 1.6 | 1.5 | 0.6 | 1.0 |
| Mudflats and sandflats not covered by seawater at low tide (1140) | 1.8 | 1.9 | 1.7 | 1.5 | 1.5 | 1.8 | 0.9 | 0.9 | 0.9 | 0.6 | 0.9 | 1.0 | 1.7 | 0.8 | 0.8 | 0.2 | 0.2 | 0.5 | 0.3 |
| Recruitment areas of pikeperch | 1.7 | 1.6 | 1.1 | 0.7 | 0.7 | 1.2 | 2.0 | 2.0 | 2.0 | 0.6 | 0.9 | 1.0 | 0.3 | 0.5 | 0.5 | 1.1 | 0.6 | 0.7 | 0.5 |
| Sandbanks which are slightly covered by sea water at all time (1110) | 1.5 | 1.9 | 1.6 | 1.5 | 1.5 | 1.3 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 1.1 | 0.9 | 1.0 | 1.0 | 0.2 | 0.2 | 0.5 | 0.4 |
| Furcellaria lumbricalis | 1.5 | 1.9 | 1.7 | 1.5 | 1.5 | 1.7 | 0.7 | 0.7 | 0.7 | 0.9 | 1.2 | 0.6 | 1.5 | 0.7 | 0.7 | 0.3 | 0.2 | 0.6 | 0.5 |
| Recruitment areas of perch | 1.6 | 1.6 | 1.3 | 1.4 | 1.4 | 1.2 | 1.6 | 1.6 | 1.6 | 0.4 | 1.0 | 1.3 | 0.4 | 0.0 | 0.0 | 0.9 | 0.4 | 0.7 | 0.4 |
| Grey seal abundance | 1.3 | 0.6 | 0.7 | 0.3 | 0.3 | 0.7 | 1.2 | 1.2 | 1.2 | 1.4 | 0.8 | 1.0 | 0.3 | 1.6 | 1.6 | 1.6 | 1.4 | 0.6 | 1.0 |
| Charophytes | 1.5 | 1.9 | 1.9 | 1.7 | 1.7 | 1.4 | 0.8 | 0.8 | 0.8 | 0.8 | 1.4 | 0.7 | 0.9 | 0.7 | 0.7 | 0.0 | 0.0 | 0.6 | 0.4 |
| Circalittoral hard bottom | 1.3 | 1.9 | 1.3 | 1.3 | 1.3 | 1.4 | 0.8 | 0.8 | 0.8 | 1.2 | 1.2 | 0.4 | 1.2 | 1.0 | 1.0 | 0.3 | 0.3 | 0.6 | 0.5 |
| Wintering seabirds | 2.0 | 0.9 | 0.8 | 0.2 | 0.2 | 0.5 | 1.1 | 1.1 | 1.1 | 1.4 | 0.6 | 1.3 | 0.4 | 1.7 | 1.7 | 0.9 | 0.8 | 0.6 | 0.7 |
| Distribution of harbour porpoise | 1.6 | 1.2 | 1.3 | 0.2 | 0.2 | 0.4 | 1.5 | 1.5 | 1.5 | 1.6 | 0.4 | 1.2 | 0.5 | 0.0 | 0.0 | 1.9 | 1.7 | 0.3 | 1.0 |
| Baltic Esker Islands (UW parts, 1610) | 1.6 | 1.8 | 1.5 | 1.3 | 1.3 | 1.3 | 0.8 | 0.8 | 0.8 | 0.8 | 1.3 | 0.7 | 1.0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.1 |
| Boreal Baltic islets and small islands (UW parts, 1620) | 1.6 | 1.8 | 1.5 | 1.2 | 1.2 | 1.1 | 0.8 | 0.8 | 0.8 | 0.8 | 1.3 | 0.7 | 1.0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.1 |
| Breeding seabird colonies | 2.0 | 0.9 | 0.9 | 0.3 | 0.3 | 0.4 | 1.0 | 1.0 | 1.0 | 1.3 | 0.8 | 1.8 | 0.3 | 1.6 | 1.6 | 0.8 | 0.6 | 0.3 | 0.2 |
| Cod abundance | 0.5 | 1.0 | 0.7 | 1.5 | 1.5 | 0.4 | 1.6 | 1.6 | 1.6 | 0.8 | 0.6 | 0.9 | 0.7 | 0.7 | 0.7 | 0.9 | 0.2 | 0.5 | 0.6 |
| Infralittoral hard bottom | 1.7 | 1.8 | 1.3 | 1.3 | 1.3 | 1.2 | 0.6 | 0.6 | 0.6 | 1.0 | 1.1 | 0.3 | 1.3 | 0.7 | 0.7 | 0.2 | 0.2 | 0.6 | 0.4 |
| Fucus sp. | 1.4 | 1.8 | 1.7 | 1.3 | 1.3 | 1.3 | 0.5 | 0.5 | 0.5 | 0.9 | 1.2 | 0.6 | 1.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.5 |
| Cod spawning area | 1.0 | 0.7 | 0.8 | 1.7 | 1.7 | 0.9 | 1.3 | 1.3 | 1.3 | 0.9 | 0.4 | 0.6 | 0.6 | 0.2 | 0.2 | 1.0 | 0.6 | 0.5 | 0.5 |
| Productive surface waters | 1.4 | 0.4 | 1.0 | 1.5 | 1.5 | 0.6 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.8 | 1.0 | 0.5 | 0.5 | 0.6 | 0.6 | 0.4 | 0.0 |
| Circalittoral mixed | 1.1 | 1.8 | 1.1 | 1.2 | 1.2 | 1.3 | 0.6 | 0.6 | 0.6 | 1.0 | 1.0 | 0.4 | 0.9 | 0.7 | 0.7 | 0.3 | 0.3 | 0.6 | 0.4 |
| Infralittoral mixed | 1.5 | 1.8 | 1.2 | 1.3 | 1.3 | 1.1 | 0.4 | 0.4 | 0.4 | 1.0 | 1.0 | 0.3 | 1.1 | 0.7 | 0.7 | 0.3 | 0.3 | 0.6 | 0.3 |
| Circalittoral mud | 1.1 | 1.6 | 1.0 | 1.2 | 1.2 | 1.3 | 0.6 | 0.6 | 0.6 | 1.0 | 0.9 | 0.4 | 0.9 | 0.5 | 0.5 | 0.3 | 0.3 | 0.8 | 0.5 |
| Mytilus edulis | 1.6 | 1.8 | 1.6 | 0.9 | 0.9 | 1.6 | 0.4 | 0.4 | 0.4 | 1.1 | 1.4 | 0.4 | 1.0 | 0.2 | 0.2 | 0.1 | 0.2 | 0.5 | 0.5 |
| Infralittoral mud | 1.4 | 1.7 | 1.1 | 1.3 | 1.3 | 1.1 | 0.3 | 0.3 | 0.3 | 1.0 | 0.9 | 0.4 | 1.0 | 0.7 | 0.7 | 0.3 | 0.3 | 0.6 | 0.4 |
| Infralittoral sand | 1.4 | 1.8 | 1.2 | 1.3 | 1.3 | 0.9 | 0.3 | 0.3 | 0.3 | 0.9 | 0.9 | 0.3 | 1.0 | 0.7 | 0.7 | 0.3 | 0.3 | 0.5 | 0.2 |
| Oxygenated deep waters | 1.0 | 0.9 | 0.7 | 1.8 | 1.8 | 1.3 | 0.7 | 0.7 | 0.7 | 0.9 | 0.7 | 0.2 | 0.6 | 0.3 | 0.3 | 0.6 | 0.5 | 0.5 | 0.0 |
| Circalittoral sand | 0.9 | 1.8 | 1.1 | 1.2 | 1.2 | 1.1 | 0.3 | 0.3 | 0.3 | 0.9 | 1.0 | 0.3 | 0.7 | 0.7 | 0.7 | 0.3 | 0.2 | 0.5 | 0.2 |
| Herring abundance | 0.9 | 0.9 | 0.7 | 0.7 | 0.7 | 0.7 | 1.2 | 1.2 | 1.2 | 0.4 | 0.6 | 0.4 | 0.6 | 0.2 | 0.2 | 1.1 | 0.6 | 0.5 | 0.3 |
| Sprat abundance | 0.9 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 1.2 | 1.2 | 1.2 | 0.4 | 0.6 | 0.4 | 0.6 | 0.2 | 0.2 | 1.1 | 0.6 | 0.5 | 0.3 |
| **Scores for layers that were finally not included** | | | | | | | | | | | | | | | | | | | |
| Harbour seal haulouts | 1.6 | 0.8 | 0.9 | 0.3 | 0.3 | 0.6 | 1.0 | 1.0 | 1.0 | 1.6 | 0.5 | 1.6 | 0.2 | 2.0 | 2.0 | 1.5 | 1.5 | 0.3 | 0.3 |
| Grey seal haulouts | 1.4 | 0.8 | 0.9 | 0.3 | 0.3 | 0.6 | 1.0 | 1.0 | 1.0 | 1.6 | 0.5 | 1.4 | 0.2 | 2.0 | 2.0 | 1.5 | 1.5 | 0.3 | 0.3 |
| Recruitment areas of roach | 1.7 | 1.7 | 1.1 | 0.5 | 0.5 | 1.2 | 1.6 | 1.6 | 1.6 | 0.6 | 0.9 | 0.8 | 0.3 | 0.5 | 0.5 | 1.0 | 0.6 | 0.4 | 0.5 |
| Abundance of pelagic spawning flounder | 1.1 | 1.0 | 0.8 | 1.3 | 1.3 | 0.9 | 1.8 | 1.8 | 1.8 | 0.7 | 0.8 | 0.9 | 0.8 | 0.0 | 0.0 | 0.7 | 0.3 | 0.6 | 0.4 |
| Migration routes for birds | 1.9 | 0.8 | 0.5 | 0.2 | 0.2 | 0.4 | 0.7 | 0.7 | 0.7 | 1.2 | 0.3 | 1.4 | 0.6 | 1.8 | 1.8 | 0.8 | 0.7 | 0.0 | 0.0 |

# Calculation of indices

- ArcGIS toolbox, designed for this purpose
- Can be developed further with future needs
- Formulas based Halpern et al. (2008)




BSII

$$I_{\text{sum}}(x,y)=\sum_{i=1}^{n}\sum_{j=1}^{m}D_i(x,y)e_j(x,y)\mu_{i,j}$$

BSPI

$$S_{weighted}(x,y)=\sum_{l=1}^{n}\left(D_l(x,y)\frac{1}{m}\sum_{j=1}^{m}\mu_{l,j}\right)$$

# Mapping the human pressures

- Foundation of the work was built in several project

TAPAS
Co-funded by the European Union

SPICE
Co-funded by the European Union

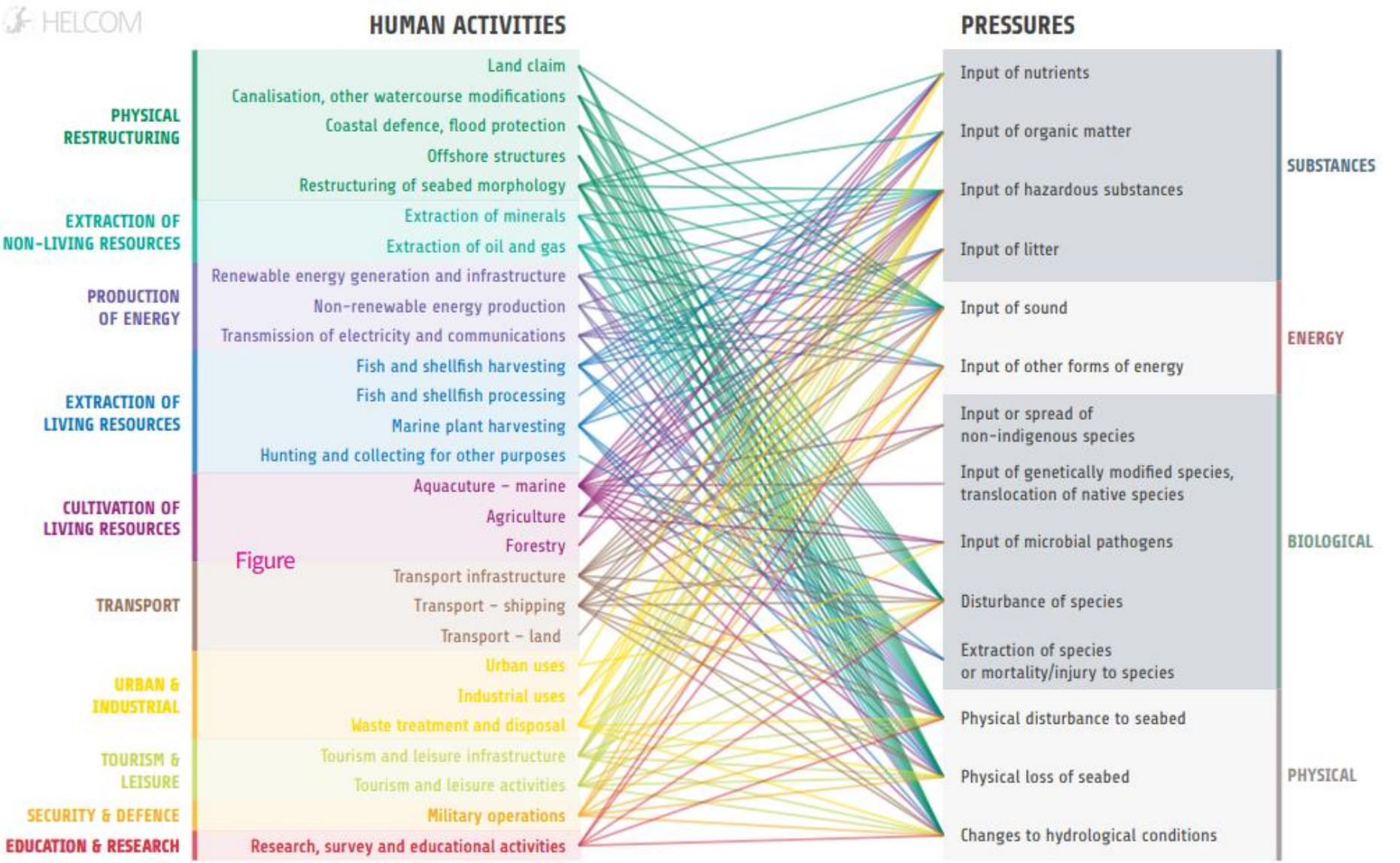
Baltic BOOST
Co-funded by the European Union

# HOLAS II

# Mapping the human pressures

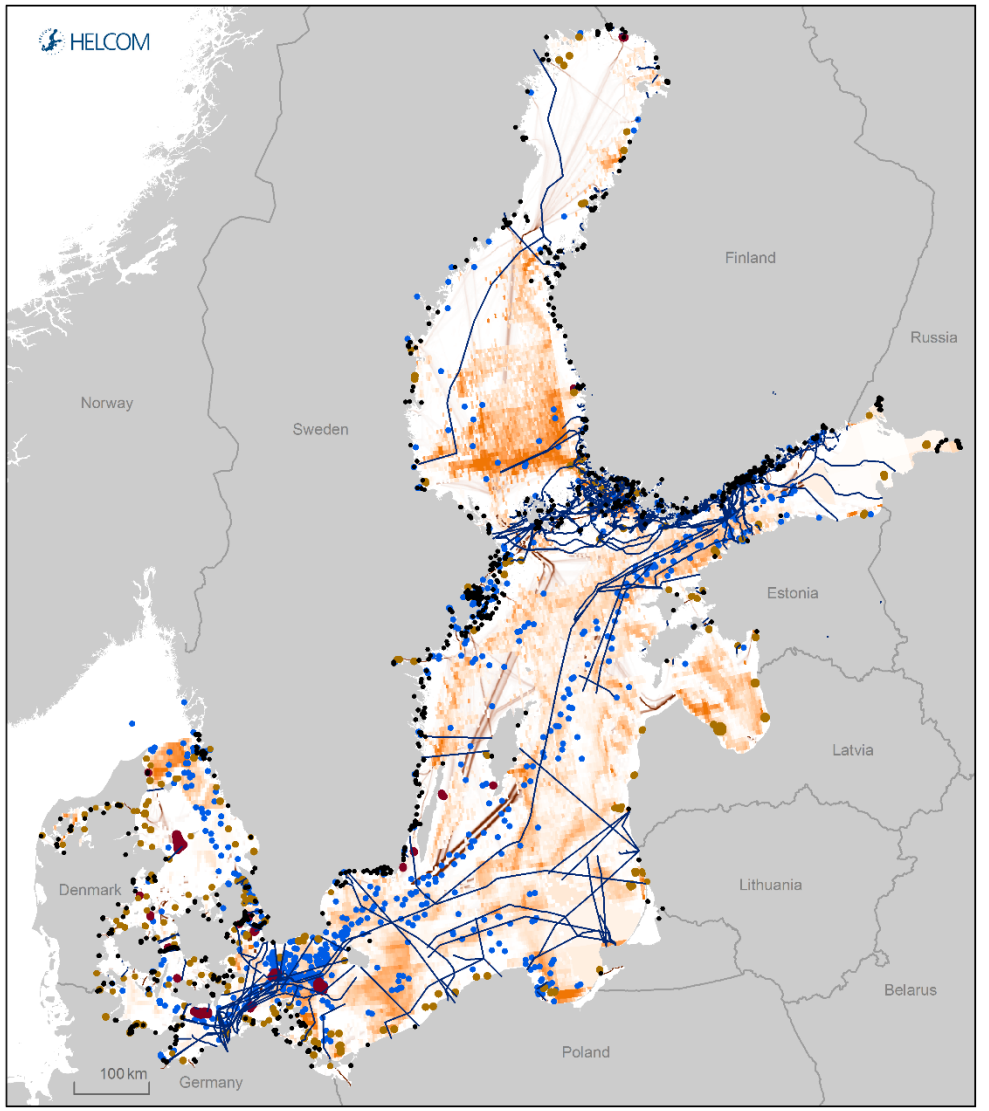
These projects contributed through various workshops, literature reviews and expert opinions

- What activities should be included and to what pressures they are linked to
- Aligned the pressures and activities with MSFD Annex III
- How human activities are transformed to pressures
- What metrices should be used when calculating the pressures
- How sensitive ecosystems are to these pressures
- Testing of approaches and methods


HELCOM
HUMAN ACTIVITIES
PRESSURES
PHYSICAL RESTRUCTURING
EXTRACTION OF NON-LIVING RESOURCES
PRODUCTION OF ENERGY
EXTRACTION OF LIVING RESOURCES
CULTIVATION OF LIVING RESOURCES
TRANSPORT
URBAN & INDUSTRIAL
TOURISM & LEISURE
SECURITY & DEFENCE
EDUCATION & RESEARCH
Land claim
Canalisation, other watercourse modifications
Coastal defence, flood protection
Offshore structures
Restructuring of seabed morphology
Extraction of minerals
Extraction of oil and gas
Renewable energy generation and infrastructure
Non-renewable energy production
Transmission of electricity and communications
Fish and shellfish harvesting
Fish and shellfish processing
Marine plant harvesting
Hunting and collecting for other purposes
Aquacuture – marine
Agriculture
Forestry
Transport infrastructure
Transport – shipping
Transport – land
Urban uses
Industrial uses
Waste treatment and disposal
Tourism and leisure infrastructure
Tourism and leisure activities
Military operations
Research, survey and educational activities
Input of nutrients
Input of organic matter
Input of hazardous substances
Input of litter
Input of sound
Input of other forms of energy
Input or spread of non-indigenous species
Input of genetically modified species, translocation of native species
Input of microbial pathogens
Disturbance of species
Extraction of species or mortality/injury to species
Physical disturbance to seabed
Physical loss of seabed
Changes to hydrological conditions
SUBSTANCES
ENERGY
BIOLOGICAL
PHYSICAL

Figure

# Datasets on human activities

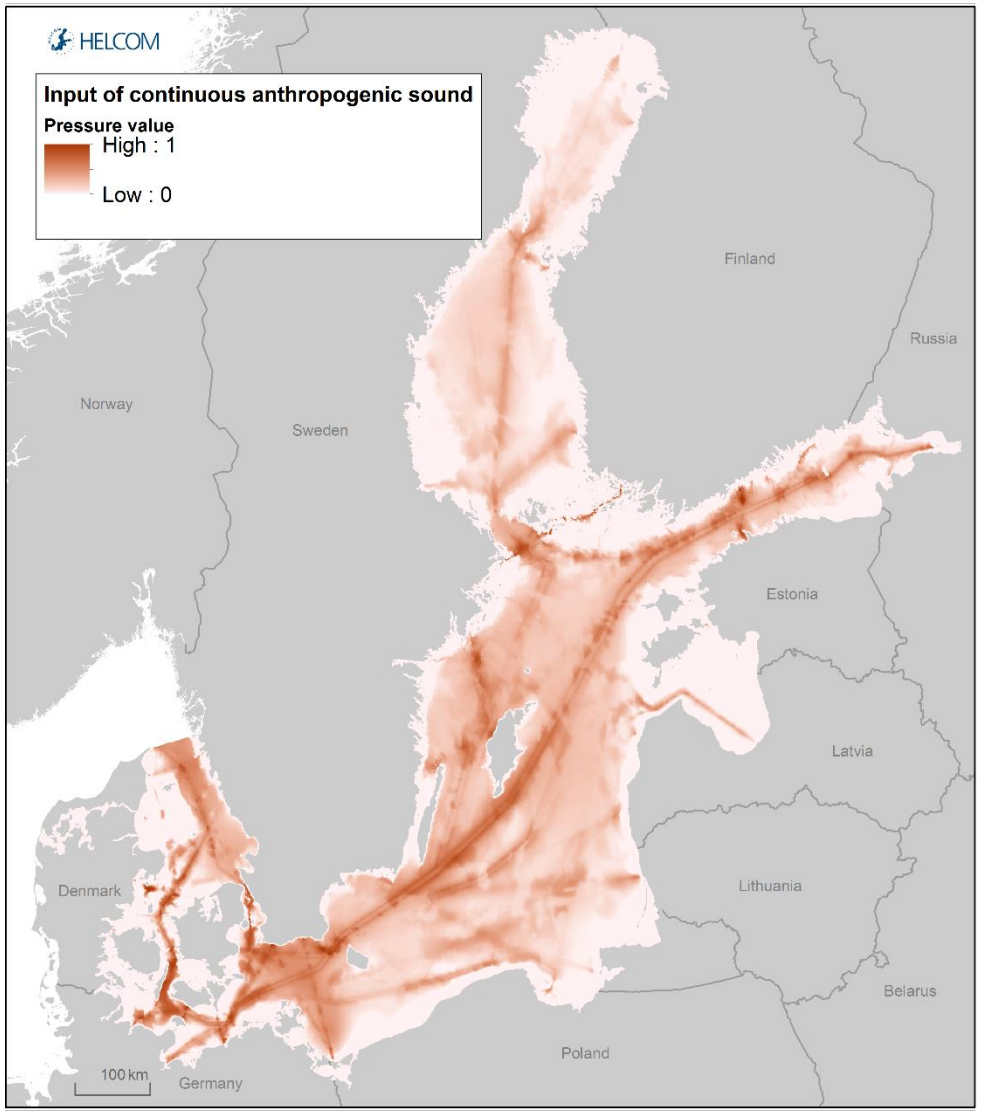



- 39 datasets
- Collected by
  - HELCOM annual reporting programmes
  - Open sources
  - Data requests to other organisations
  - National data calls

- Datasets include e.g.
  - Bridges and other constructions
  - Deposit of dredged material
  - Wind turbines
  - Cables
  - Illegal oil discharges
  - Shipping density
  - Fishing of herring

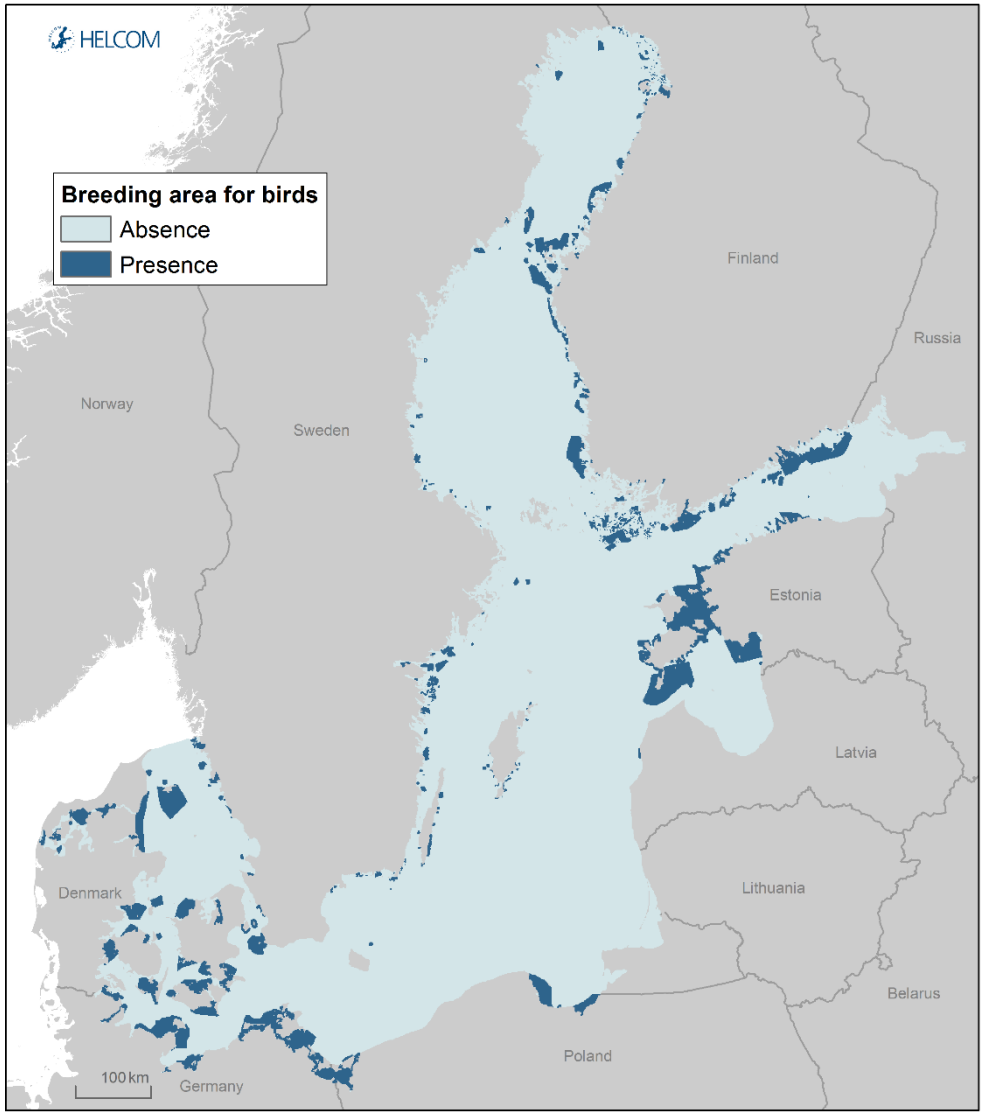
# Aggregated pressure layers

- 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 directly from observations or modelling
  - Concentration of nutrients (interpolation)
  - Input of continuous anthropogenic sound (using cut off values)

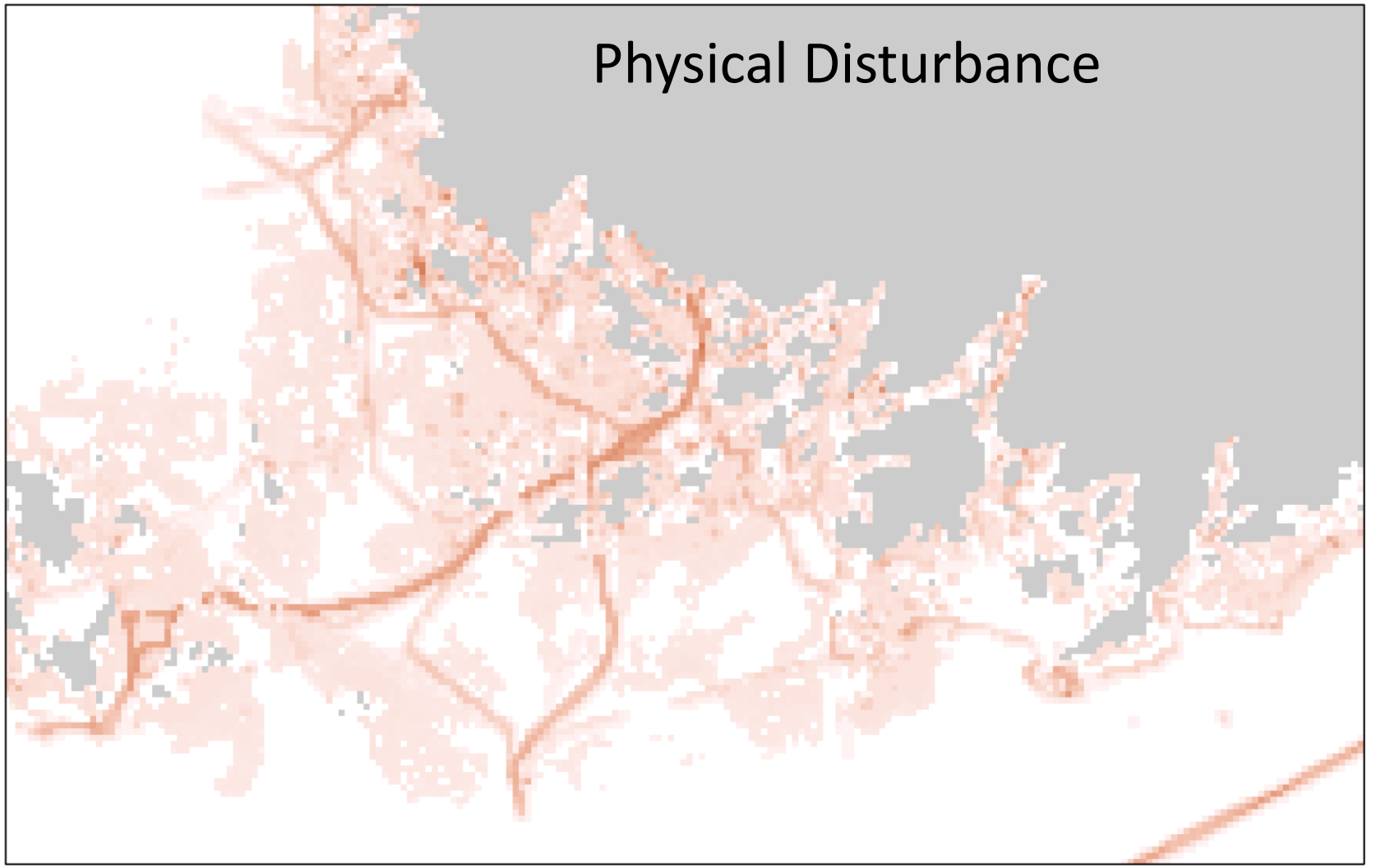


# Ecosystem components

- 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
  - Birds (Absence/presence)
    - Breeding area for birds



# From an activity to pressure: Dredging -> Physical disturbance and physical loss



# Further development of HELCOM BSII

- To fill spatial and temporal data gaps
- Regional sea -> Data coverage and quality varies between countries
- Better knowledge on linkages between pressures and ecosystems needed
- Temporal resolution consideration
- CP’s have different methods of defining some ecosystem components
- Benthic species data depended on national inventory programmes -> data gaps results in low impact
- Further improvements of the tool
  - The tool already available in GitHub
  - Online tool coming at the end of this month

# Thank you!