Environmental vulnerability and cumulative risk profiles

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KESKKONNAINVESTEERINGUTE KESKUS

PLAN4BLUE
MARITIME SPATIAL PLANNING FOR SUSTAINABLE BLUE ECONOMIES

Interreg Central Baltic

Introduction

- Human use of marine and coastal areas is increasing worldwide, resulting in conflicts between different interests for the space and resources and environmental sustainability

- To successfully support blue growth, while also preserving the capacity of ecosystems to provide valued services, marine spatial planning (MSP) processes are in a need of spatial data on nature values to minimize the potential harm on ecosystem

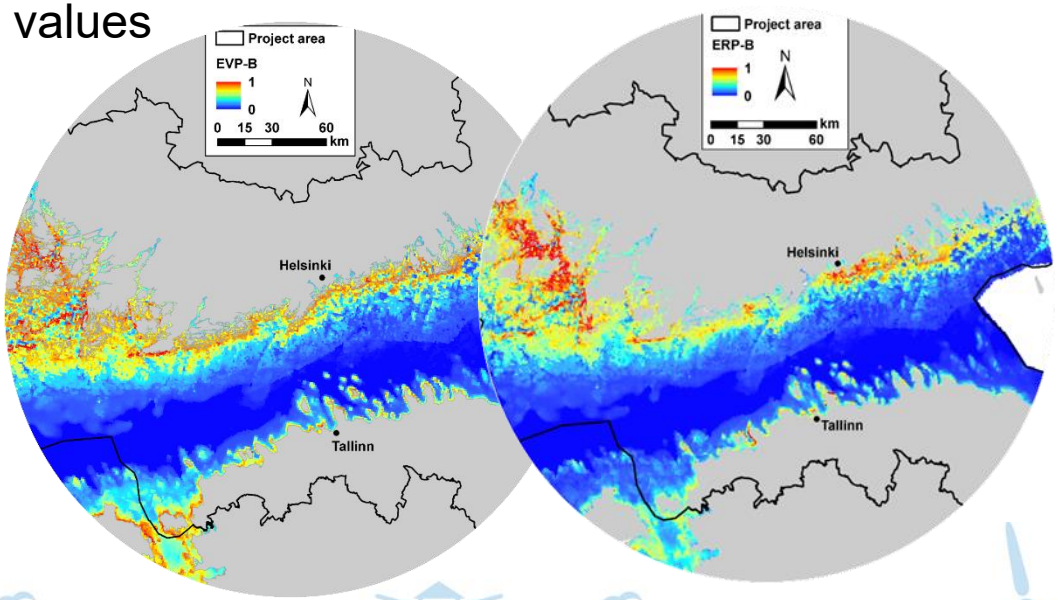
The aim of this study was to…

… develop cross-border environmental vulnerability profile (EVP) and environmental risk profile (ERP) of the Gulf of Finland, which can be used for ecosystem based MSP processes in Estonia and Finland, in order to find solutions that lead to sustainable use of resources and to improved planning and management of the marine and coastal areas

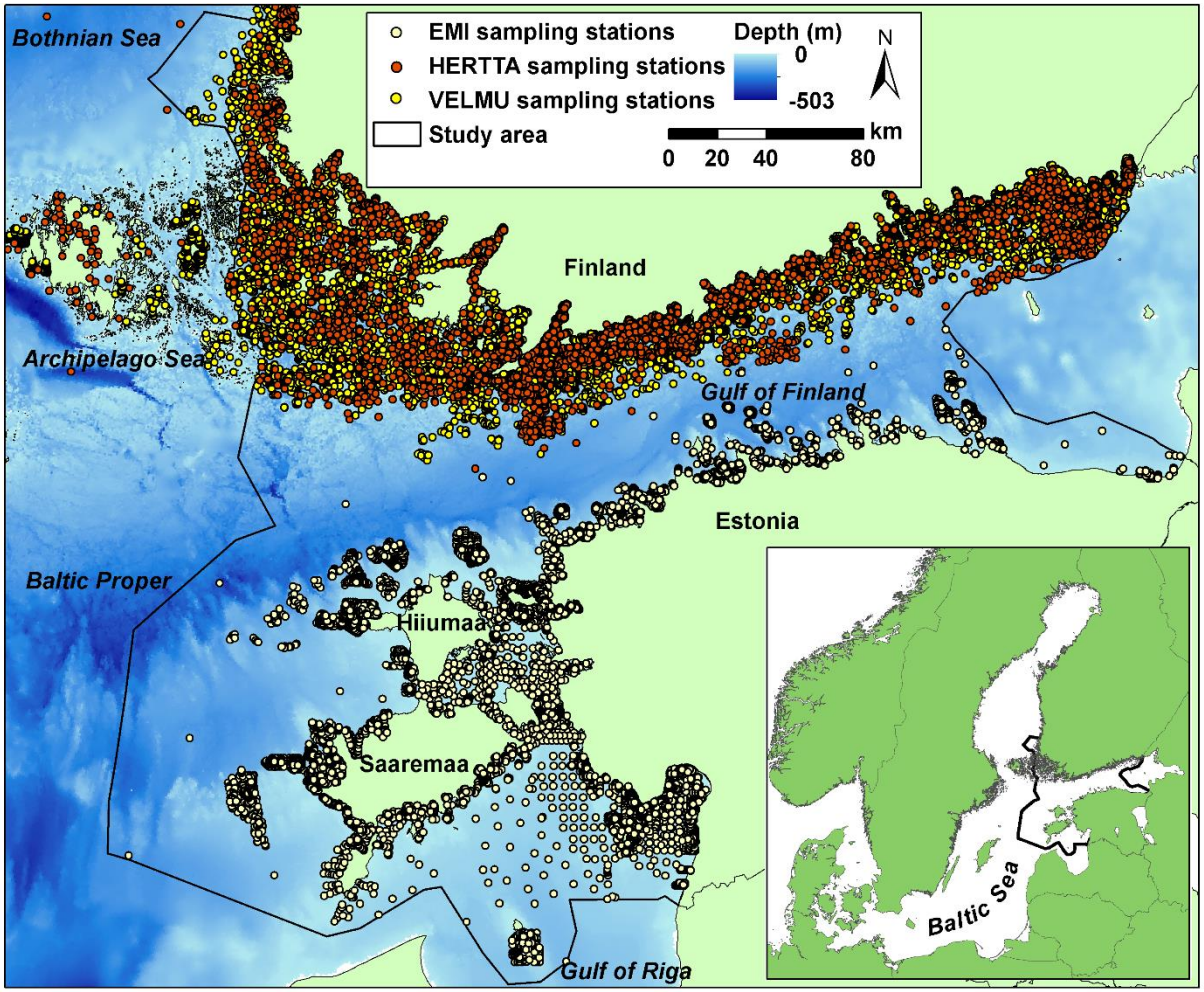
EVP and ERP

- Environmental vulnerability profile (EVP) – a spatial data layer that incorporates the distribution of nature values and their sensitivities to disturbances; higher value indicates a presence of more sensitive nature values

- Environmental risk profile (ERP) a spatial data layer that incorporates the EVP and cumulative human pressures - higher value indicates higher likelihood to damage nature values

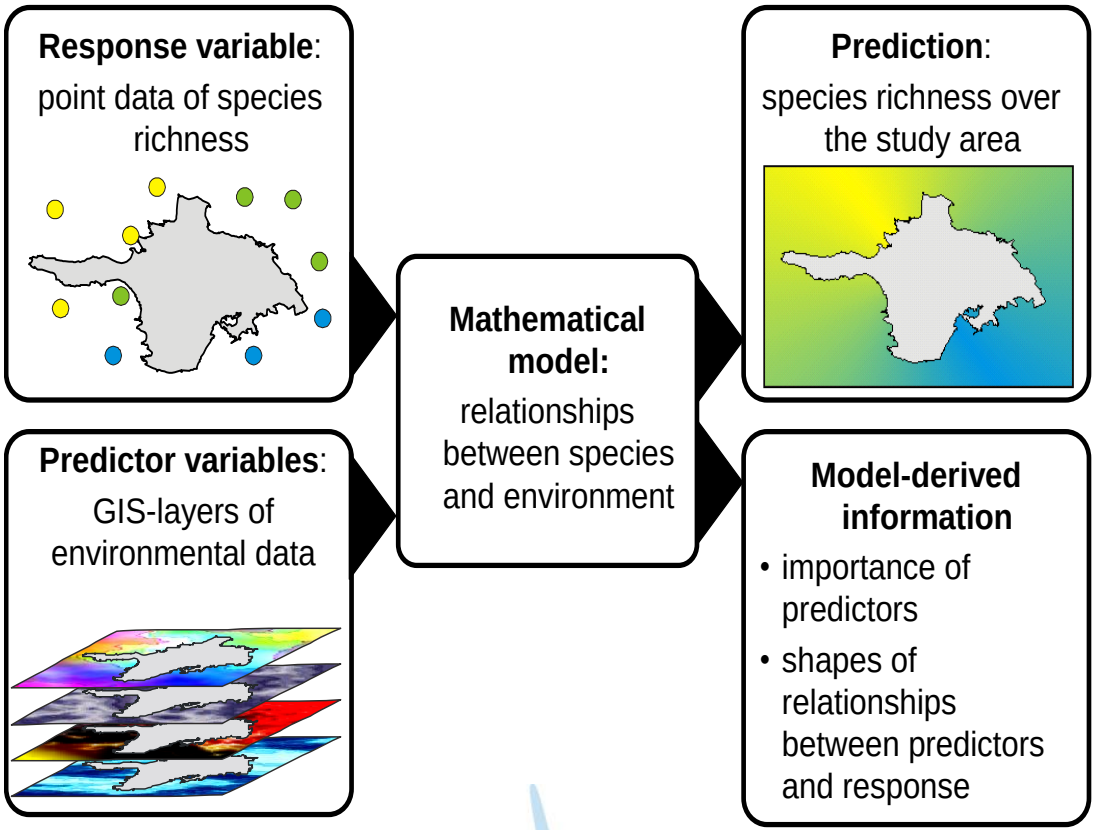


Study area


EMI sampling stations
HERTTA sampling stations
VELMU sampling stations
Study area
Depth (m)
0
-503
N
km
0 20 40 80
Bothnian Sea
Finland
Archipelago Sea
Gulf of Finland
Estonia
Baltic Proper
Hiiumaa
Saaremaa
Gulf of Riga
Baltic Sea

Modeling the distribution of nature values

- **18 Estonian and 23 Finnish environmental variables**



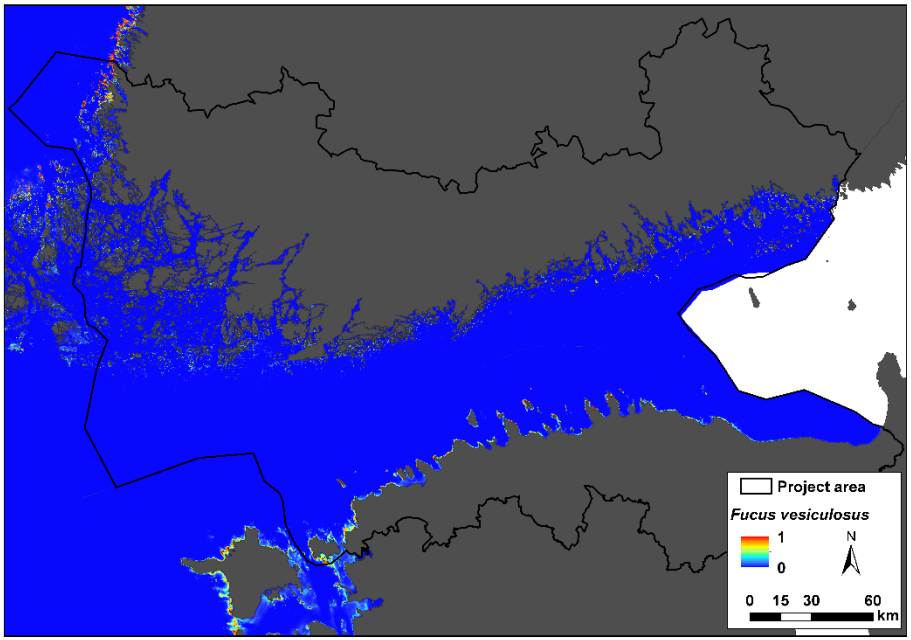
- **Nature values (NV):**
- *Fucus vesiculosus*
- *Furcellaria lumbricalis*
- Filamentous algae
- Epibenthic bivalves (*Mytilus trossulus*, *Dreissena polymorpha*)
- Vascular plants (excluding *Zostera marina*)
- *Zostera marina*
- Charophytes (*Chara* spp., *Tolypella nidifica*)
- Infaunal bivalves (*Limecola balthica*, *Cerastoderma glaucum*, *Mya areanaria*)
- Sea birds
- Seals
- Benthic biodiversity

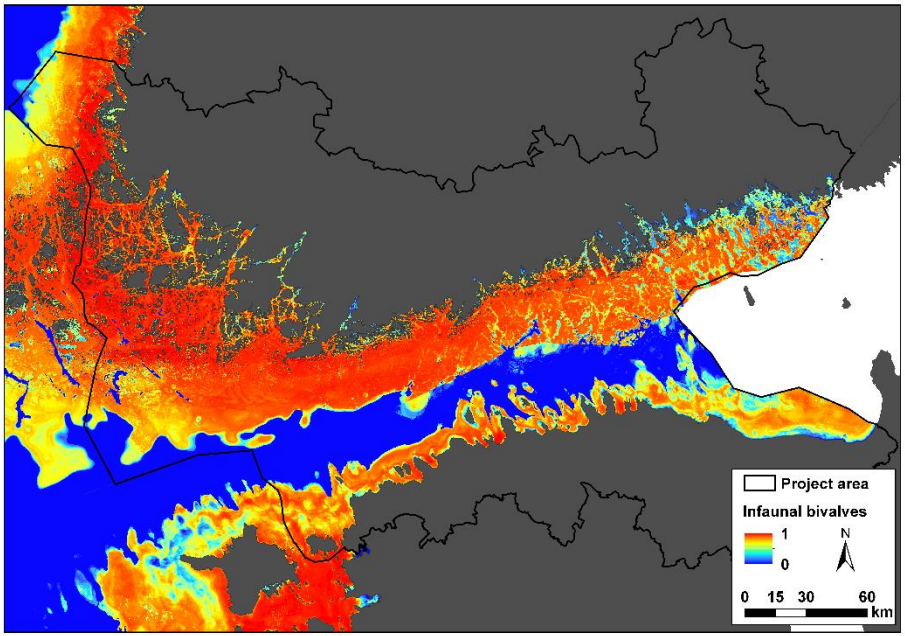
Environmental variables

Water depth
Average water depth in 2000 m radius
Slope of seabed
Slope of seabed in 2000 m radius
Salinity
Wave exposure based on simplified wave model
Chlorophyll a content of sea surface based on satellite imagery
Water transparency estimated as attenuation coefficient based on satellite imagery
Ice coverage
Water temperature in cold season
Water temperature in warm season
Current velocity
Orbital speed of water movement at seabed induced by wind waves
Proportion of soft sediment
Secchi depth
Concentration of ammonium
Concentration of nitrates
Concentration of phosphates

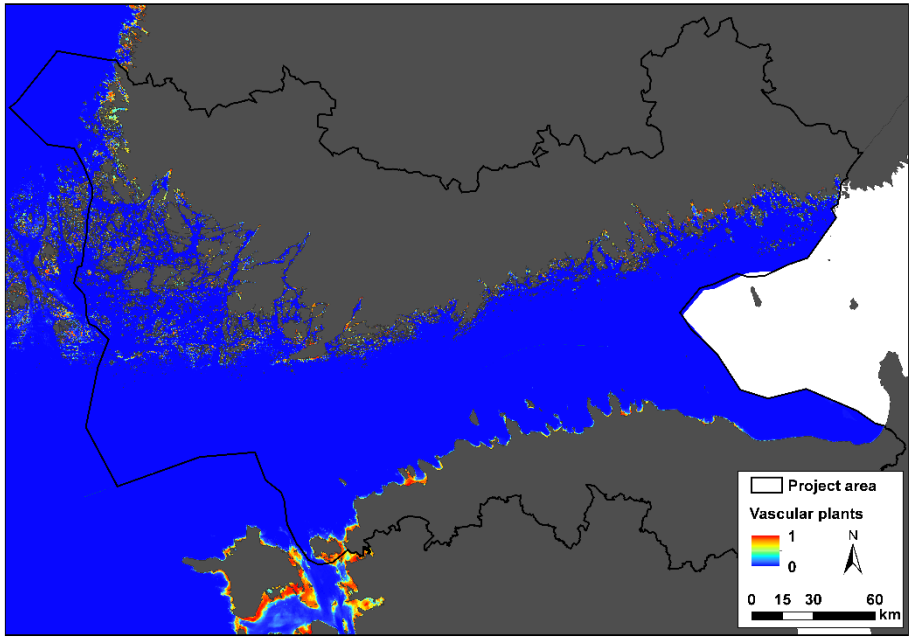
Bathymetric Position Index (BPI) 100x4000
Bathymetric Position Index (BPI) 1200x500
Bathymetric Position Index (BPI) 20x100
Bathymetric Position Index (BPI) 300x1000
Concentration of humic substances
Concentration of oxygen on the bottom
Concentration of phosporus on the bottom
Coverage of rock
Coverage of sand
Coverage of stones and boulders
Depth attenuated wave exposure
Distance to sandy shore
Euphotic depth
Maximum temperature on the bottom
Minimum temperature on the bottom
Natural habitats
Salinity on the bottom
Salinity on the surface
Share of the sea area (1 km radius)
Share of the sea area (10 km radius)
Share of the sea area (5 km radius)
Slope of seabed
Water depth

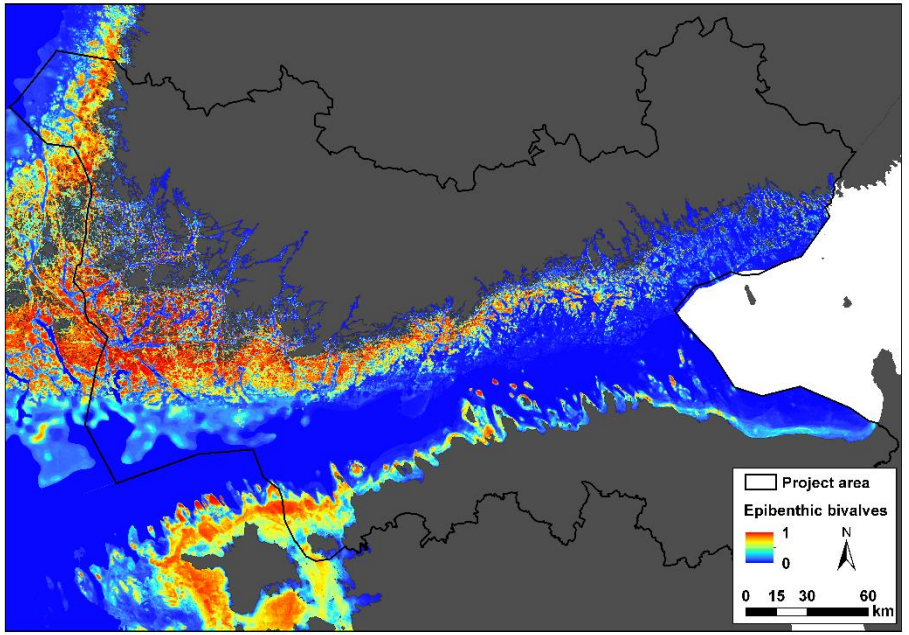
Distribution of nature values



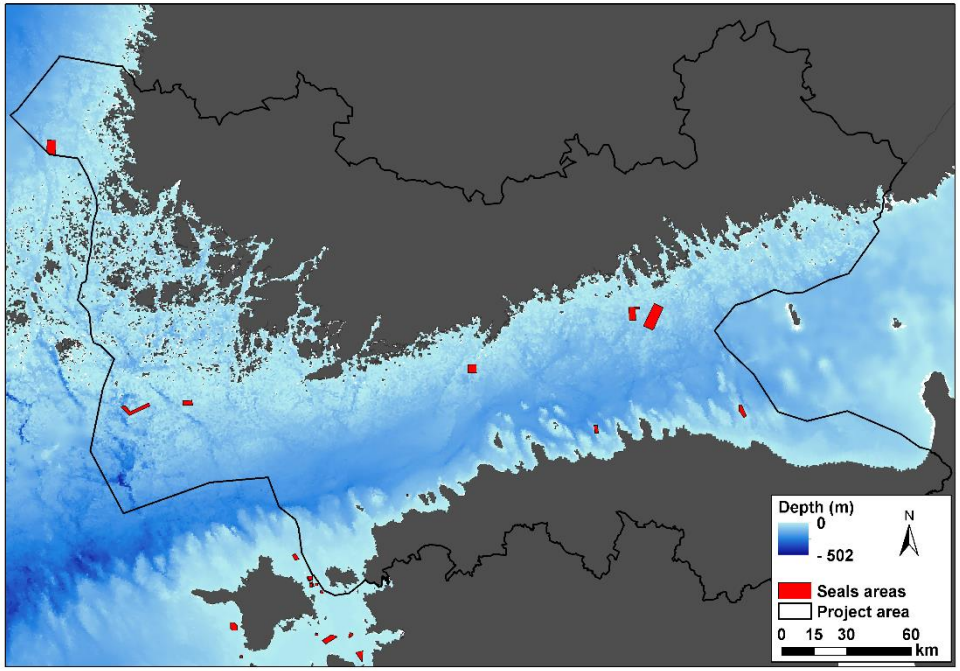


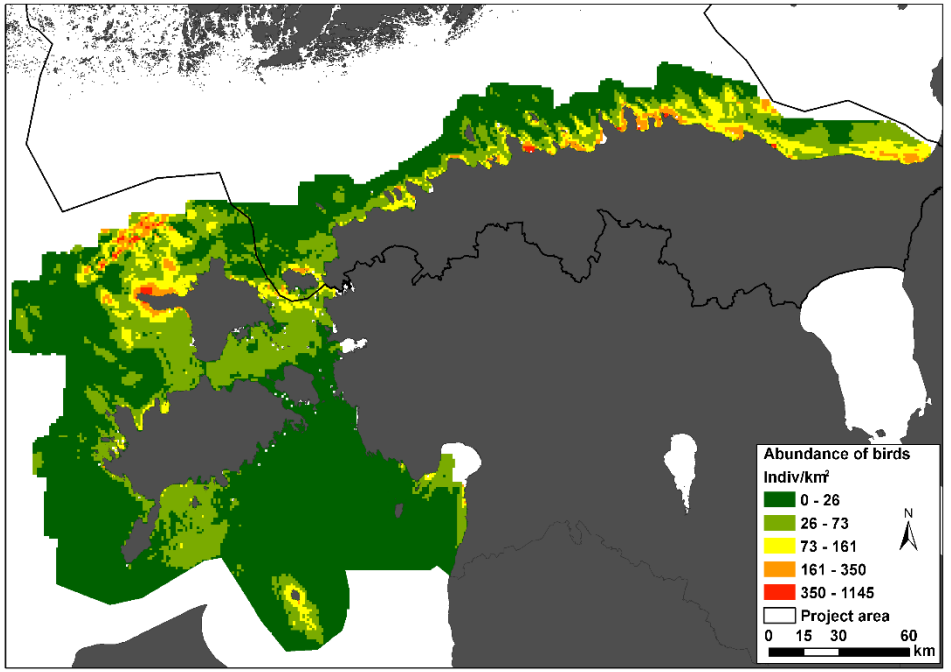
Distribution of nature values





Seals and sea birds data





Nationally protected moulting, resting, and breeding areas of seals.

Finnish seals data: originated from Parks & Wildlife Finland and was issued by the “Government Decree 736/2001”.

Estonian seals data: originated from EELIS (Estonian Natura Information System) – Estonian Environmental Register: Estonian Environment Agency.

Total abundance of wintering birds based on aerial survey and modeling study by Luigujõe and Auniņš (2016) that was used as an input in the current study.

Luigujõe L and Auniņš A (2016) Talvituvate lindude rahvusvaheline lennuloendus. Report. http://www.keskkonnaamet.ee/public/LuigujoeAunins_2016_talvituvate_veelindude-rahvusvaheline_lennuloendus_lopparuanne.pdf

Sensitivity of nature values (NV)

- There is a lack of empirical knowledge to quantitatively formalize species sensitivity as functions of environmental variables

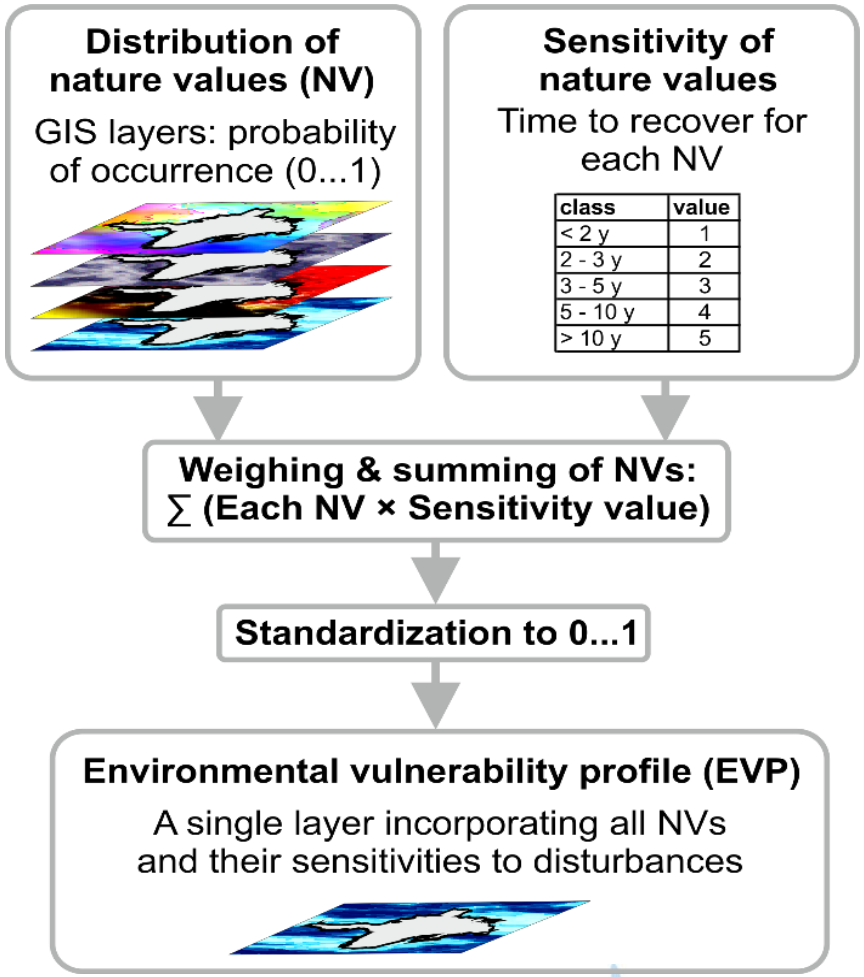
- A practical approach – recovery potential of an environmental value that is measured in time that is needed to recover from a destruction after an impact has ceased

- The recovery estimations were based on the earlier project results (*e.g.* Aps *et al.,* 2011), expert opinions and on the literature

NV	Recovery class	NV coefficient
filamentous algae	<2 years	1
Fucus vesiculosus, charophytes, infaunal bivalves	2-3 years	2
Vascular plants and epibenthic bivalves	3-5 years	3
Furcellaria lumbricalis	5-10 years	4
Zostera marina, birds, seals	>10 years	5

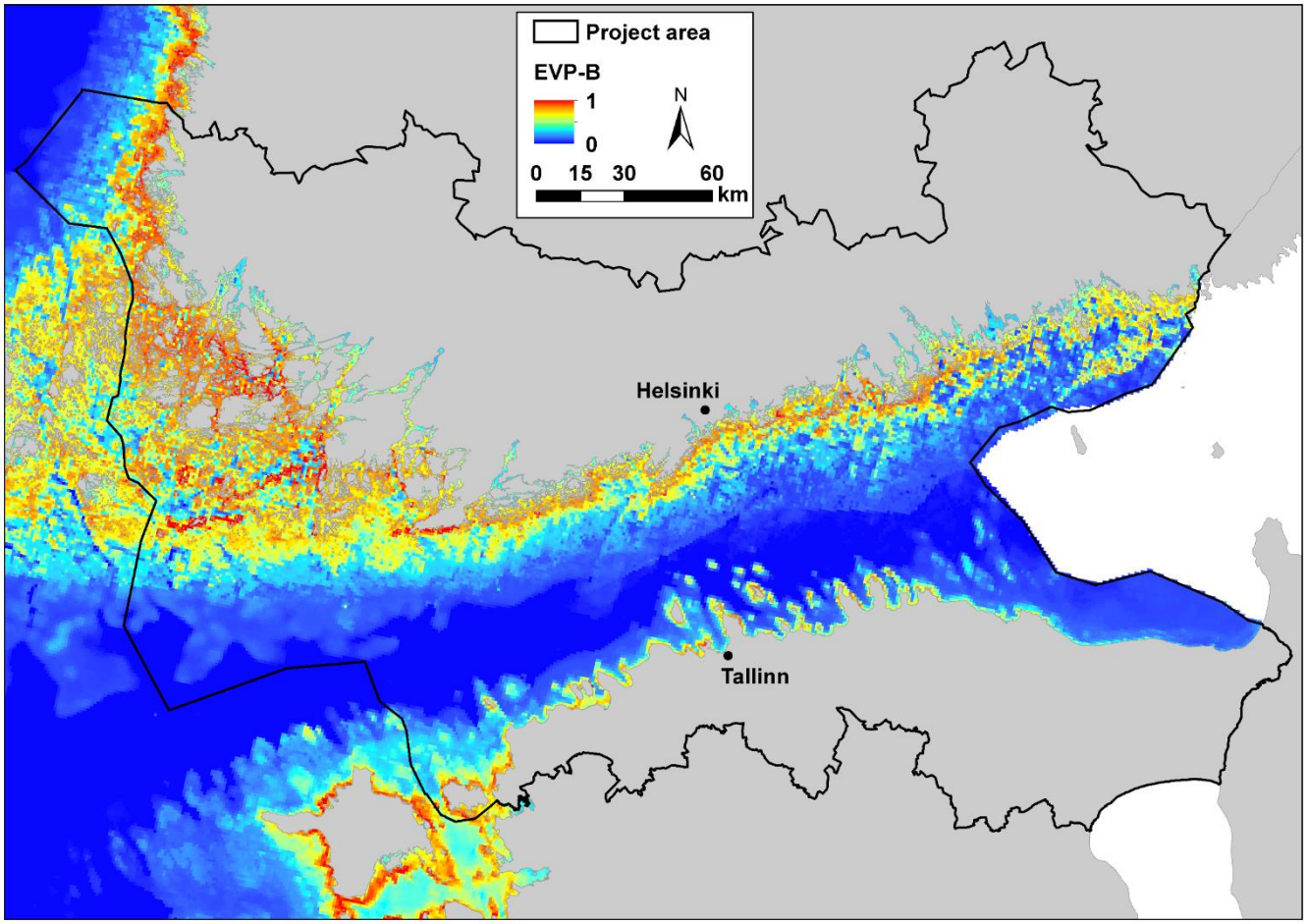
Aps, R., Ambjörn, C., Fetissov, M., Karjalainen, M., Kotta, J., and Kuikka, S. 2011. OILRISK web: advanced tool for enhancing spill response decision-making in the Baltic Sea. In Oil Spill Risk Management, pp. 109–117. Ed. by N. Bellefontaine and O. Linděn. The Proceedings of the International Conference on Oil Spill Risk Management, Mamlö, Sweden.

Calculation of EVP



- …calculated as a sum aggregation of all NVs that were first rescaled between 0 and 1 (by dividing with maximum value) and then weighed by NV-specific sensitivity coefficient

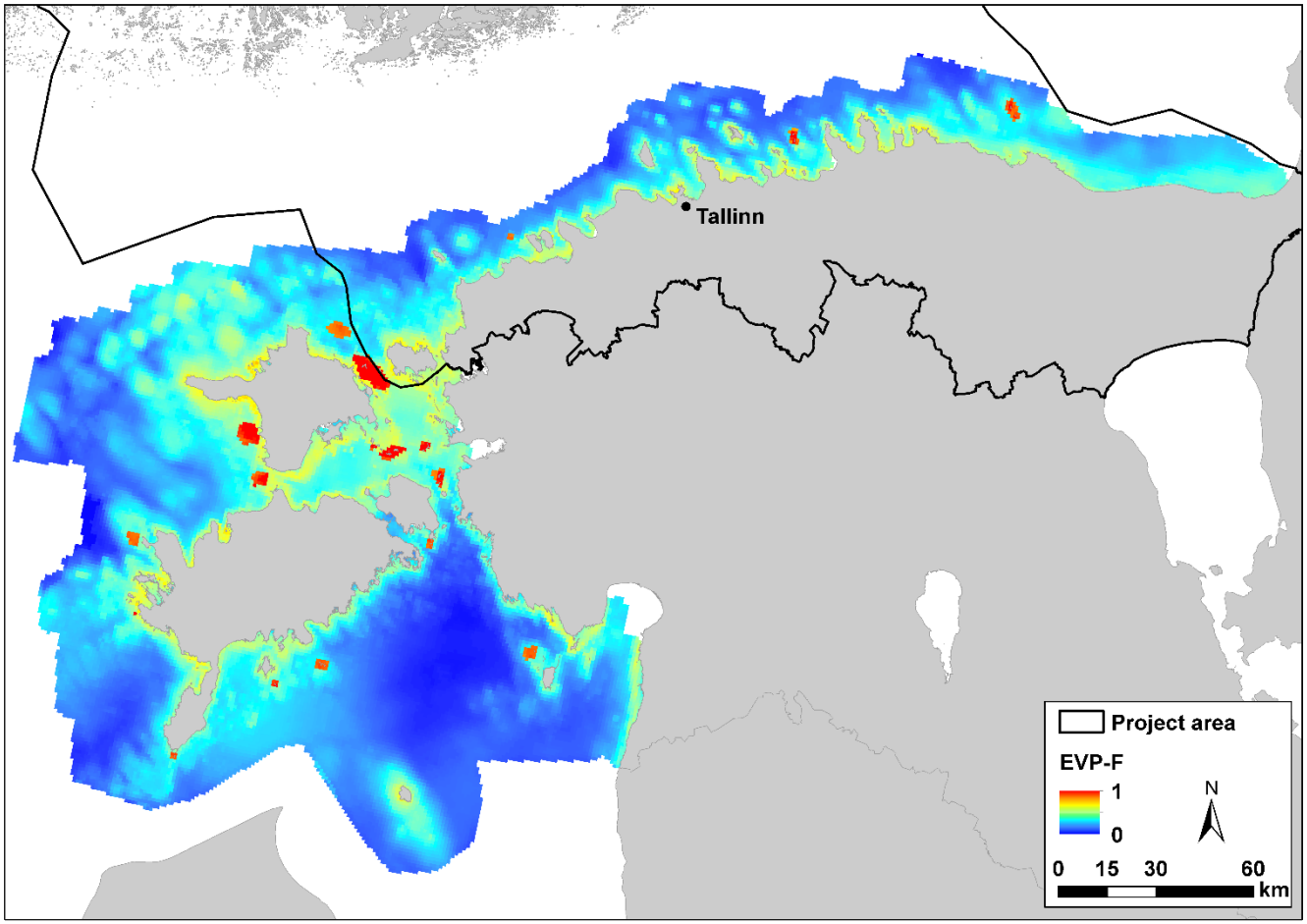
Results: EVP



Main products:

- <u>For the whole area:</u> EVP-B
- EVP-B: consists only benthic species

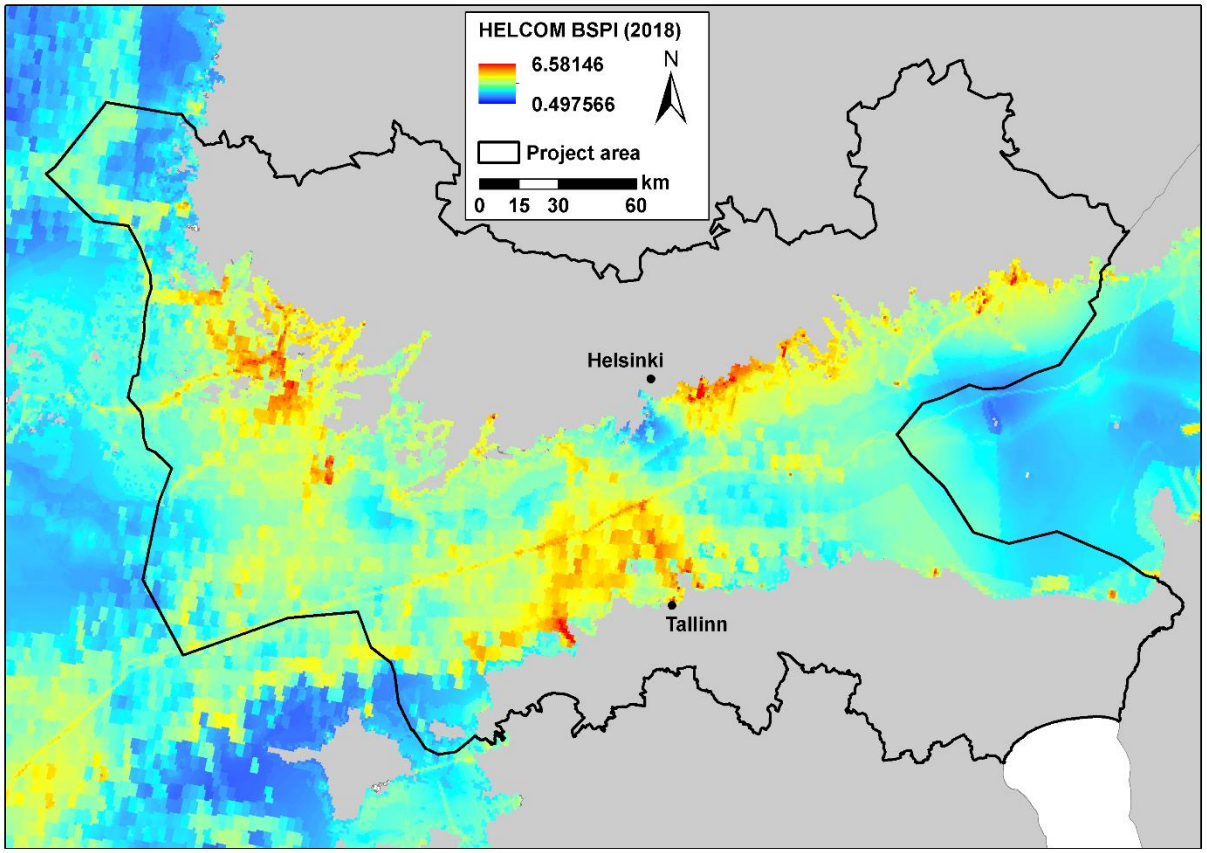
Results: EVP



Main products:

- Estonian area: EVP-F
  - EVP-F: consists of benthic, bird and seal data

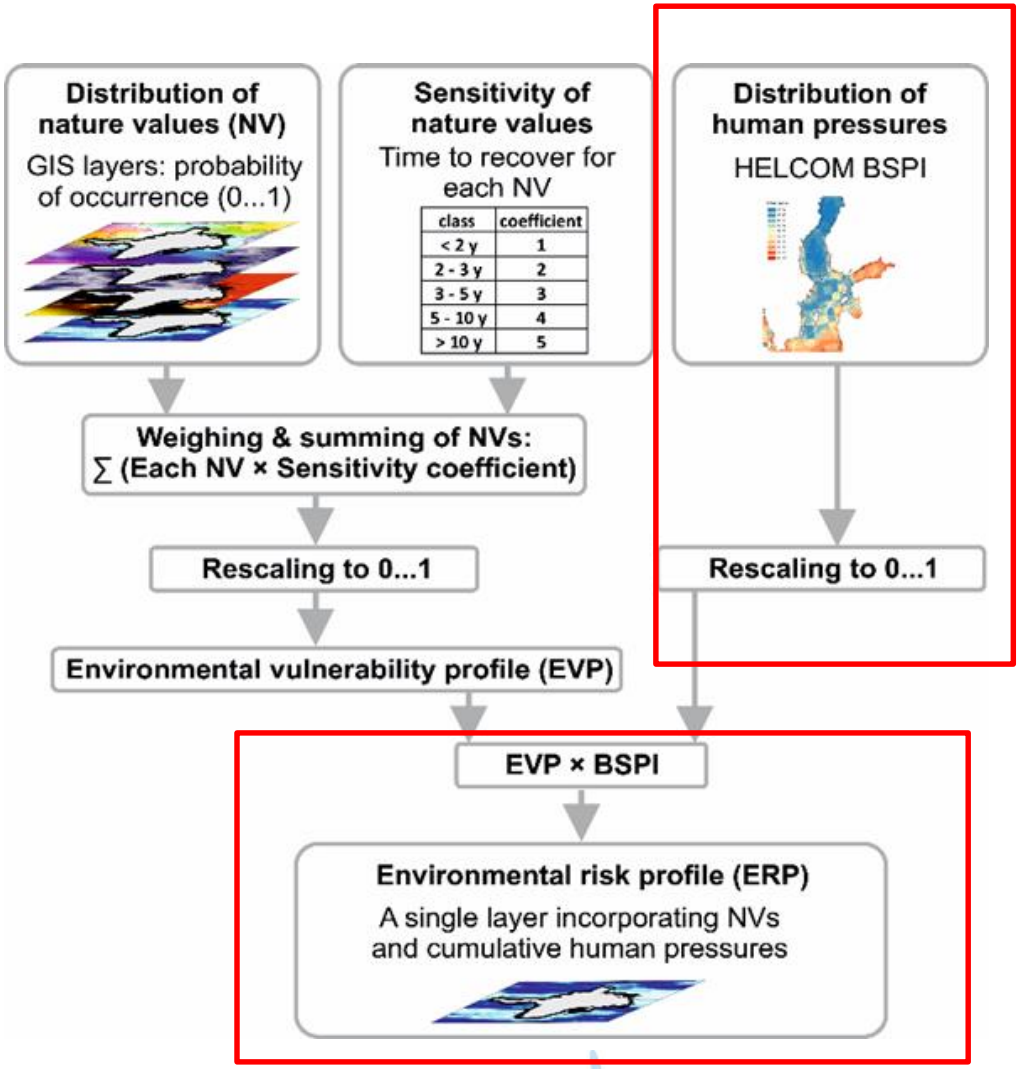
HELCOM Baltic Sea Pressure Index (BSPI)



- Map of the HELCOM BSPI (HELCOM, 2018) represents the intensity of cumulative anthropogenic pressures in a 1 km × 1 km grid in the study area
- BSPI is calculated based on multitude of human pressures weighed by their general potential impacts on ecosystem
- This dataset covers the time period 2011-2015

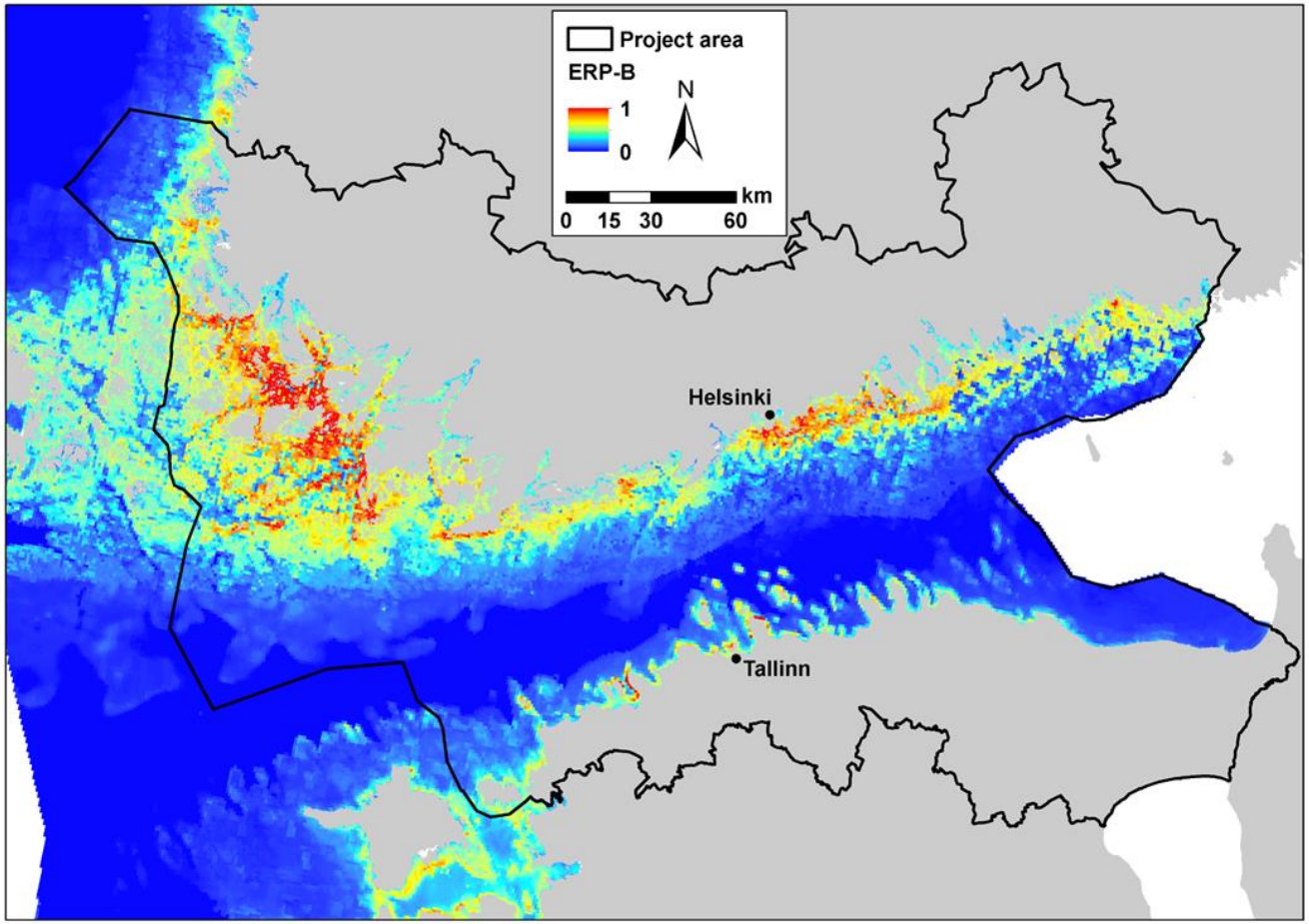
HELCOM (2018) Baltic Sea Pressure Index (BSPI). http://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/98cc1b96-3469-46e1-8247-7ff924a9ef27

Calculation of ERP



1. BSPI was divided by its maximum value over all cells to make the values vary between 0 and 1
2. Multiplication of EVP and BSPI
3. Product of the previous step was divided by its maximum value to make the values vary between 0 and 1

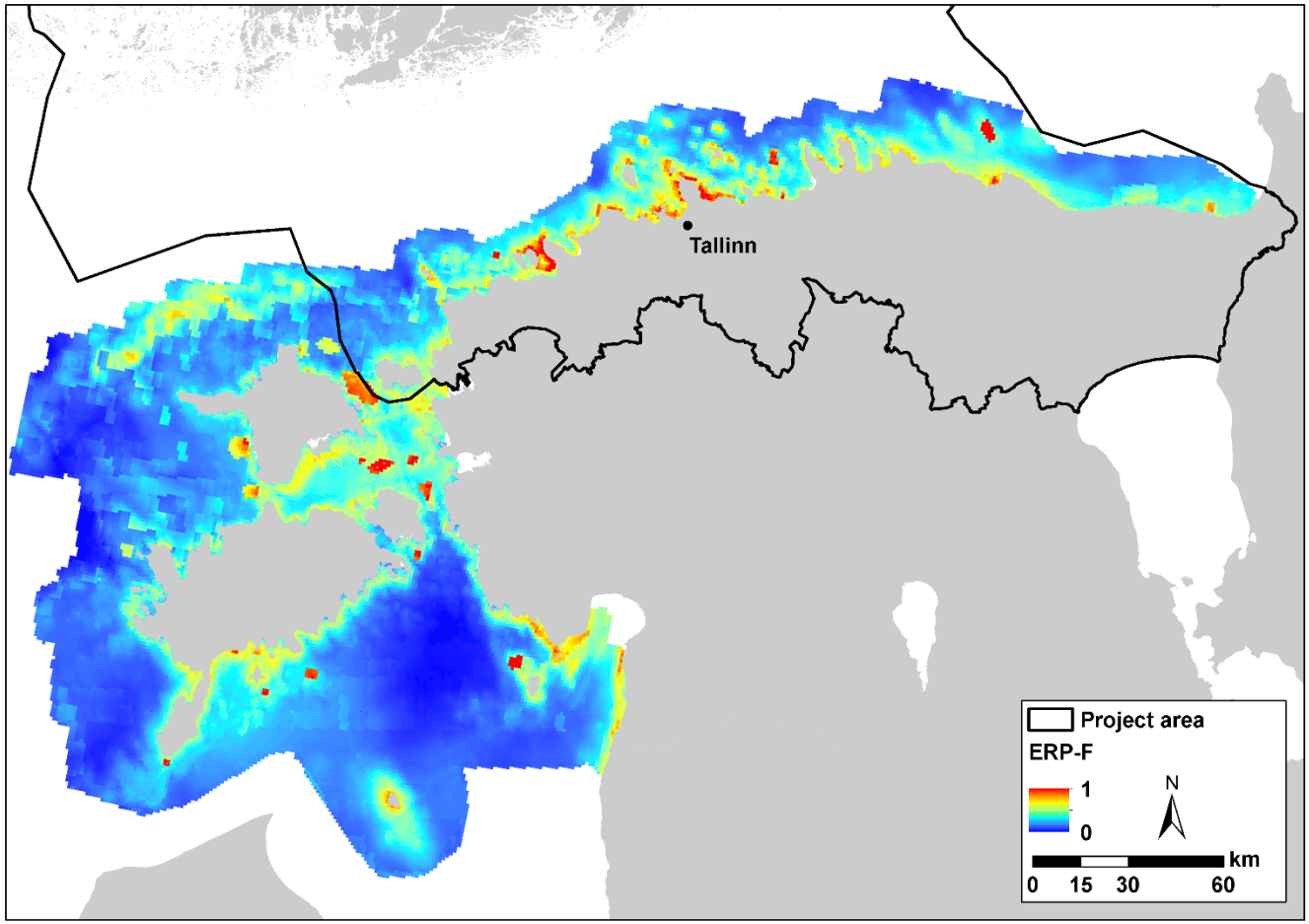
Results: ERP



Main products:

- <u>For the whole area:</u> ERP-B
- ERP-B: consists only benthic species

Results: ERP



Main products:

- Estonian area: ERP-F
  - ERP-F: consists of benthic, bird and seal data

Conclusions

- **EVP:** While it is impossible to include all the species and habitats to the assessment of ecosystem sensitivity, acknowledging what is valuable in the environment is undoubtedly important in environmental management planning
- **EVP** is not meant to reflect sensitivity to any specific pressures; it only sums up the spatial distribution of NVs for which we have the distribution data and knowledge on their recovery rates

- **ERP** identifies areas where environmental risks are the highest due to both long recoveries of the biota and high intensities of human pressures.
- **ERP** can be easily communicated to MSP experts and other interested stakeholders to jointly analyse and compare the potential environmental risk levels resulting from different planning solutions

ICES Journal of Marine Science

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

ICES Journal of Marine Science (2018), doi:10.1093/icesjms/fsy101

Contribution to the Symposium: '*Sustainable Use of Baltic Sea Resources*'

Marine environmental vulnerability and cumulative risk profiles to support ecosystem-based adaptive maritime spatial planning

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Thank you!

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