# The Gulf of Finland Science Days 2021

## “New start for the Gulf of Finland co-operation”

Estonian Academy of Sciences, Tallinn,
29–30 November 2021

Photo: City of Tallinn

Gulf of Finland
Co-operation

# PROGRAMME

## DAY 1: Monday 29th November

### PLENARY SESSION KEYNOTE

1 **Comprehensive monitoring of nutrients and their loads is essential for GOF state evaluations** Heikki Pitkänen, Seppo Knuuttila, Jouni Lehtoranta, Mika Raateoja, Finnish Environment Institute

2 **Gulf of Finland coastal systems: Holocene development and human impact**
Darya Ryabchuk, A.P.Karpinsky Russian Research Geological Institute

### SESSION 1 Marine spatial planning

3 **Russian MSP Roadmap as an instrument for enhancing participation of Russia in the Pan-Baltic MSP process** Larisa Danilova, Andrei Lappo, Institute of Maritime Spatial Planning Ermak NorthWest

4 **Finland's Maritime Spatial Plan 2030**
Riku Varjopuro, Finnish Environment Institute

5 **Estonian MSP – practical experiences from the process (title TBS),**
Eleri Kautlenbach, Estonian Ministry of Finance

6 **A geomorphic perspective on paradigms, history and coastal spatial planning in the Gulf of Finland,**
Kevin E. Parnell, Tarmo Soomere, Tallinn University of Technology

7 **Tools for the implementation of ecosystem-based approach in Maritime Spatial Planning in the eastern part of the Gulf of Finland,** Tatyana Eremina, Michael Shilin, Oksana Vladimirova, Vera Semeoshenkova, Alexandra Ershova, Russian State Hydrometeorological University

### SESSION 2 Marine litter

8 **The fate and effects of small plastic debris in the northern Baltic Sea seafloor**
Pinja Näkki, Aino Ahvo, Eeva Eronen-Rasimus, Samuel Hartikainen, Hermanni Kaartokallio, Harri Kankaanpää, Arto Koistinen, Kari Lehtonen, Emil Nyman, Janina Pažusienė, Sirpa Peräniemi, Erika Sainio, Milda Stankevičiūtė, Raisa Turja, Outi Setälä, Maiju Lehtiniemi

9 **Beached litter and microplastics in the coastal zone of the Russian part of the Gulf of Finland** Alexandra Ershova, Tatyana Eremina, Irina Makeeva, Anastassia Kuzmina, Natalya Loginova, Russian State Hydrometeorological University

10 **Marine litter in remote islands of Estonian coastal sea**
Tiia Möller-Raid, Maria Põldma, Estonian Marine Institute, University of Tartu

11 **Microplastics in urban stormwaters – designing a method to evaluate the microplastic discharges via stormwaters**
Julia Talvitie, Finnish Environment Institute

12 **Microplastics abundance and composition in fishes and macrozoobenthic organisms of the NE Baltic Sea – list of potential target species for microlitter contamination assessment**
Maria Põldma, Kaire Torn, Lauri Saks, Estonian Marine Institute, University of Tartu

### SESSION 3 Technics and physic

13 **FINMARI Research Infrastructure – an integrated platform for Baltic marine research and observation** Katri Kuuppo, Maiju Lehtiniemi, Jari Haapala, Aarno Kotilainen, Ari Leskelä, Joanna Norkko, Jari Hänninen, Martin Snickars, Finnish Environment Institute

14 **Exploring the potential of autonomous technologies for achieving sustainable Gulf of Finland** Victor Bolbot, Ahmad BahooToroody, Osiris V. Banda, Aalto University

15 **The stratification in winter and its consequences**
Taavi Liblik, Germo Väli, Inga Lips, Madis-Jaak Lilover, Villu Kikas, Jaan Laanemets, Tallinn University of Technology

16 **Climate impact on runoff and nutrient removal for the GoF tributaries (results of SEVIRA Project)** Ekaterina Ivanova, Sergey Kondratyev, Marina Shmakova, Institute of Limnology Russian Academy of Sciences

# DAY 2: Tuesday 30th November

## SESSION 4 Ecosystem studies

1 **The HAZLESS project: assessment of the transboundary issue of chemical pollution in the eastern Gulf of Finland**
Ivan Kuprijanov, Andrey Sharov, Nadezhda Berezina, Kari Lehtonen

2 **Seals in the Gulf of Finland – a status review and perspectives**
Mart Jüssi, ProMARE NGO, Mikhail Verevkin, University of St Petersburg

3 **Ecosystem services in the Gulf of Finland – the approach of MAREA project**
Susanna Jernberg, Finnish Environment Institute

4 **Linking marine natural values and underwater cultural heritage to promote sustainable blue eco-tourism in the Gulf of Finland (Baltic Sea)**
Robert Aps, Jonne Kotta, Mihhail Fetissov, Kristjan Herkül, Liisi Lees, Estonian Marine Institute, University of Tartu

5 **Perspectives for Integrated Multitrophic Aquaculture in the Gulf of Finland**
Georg Martin; Jonne Kotta; Jack Hall, Estonian Marine Institute, University of Tartu

## SESSION 5 Early Career Scientists

6 **Microplastics in the northern Baltic Sea bottom sediments: distribution and method development**
Jyri Tirroniemi, Outi Setälä, Maiju Lehtiniemi, Finnish Environment Institute

7 **Spatial and Temporal Distribution of Microplastics in the Gulf of Finland**
Arun Mishra, Natalja Buhhalko, Kati Lind, Inga Lips, Urmas Lips, Taavi Liblik, Germo Väli, Tallinn University of Technology

8 **In search of relations between factors of underwater landscapes in the Eastern Gulf of Finland (the Baltic Sea) using GIS and statistics**
Filipp Leontev, Marina Orlova, Daria Ryabchuk, Alexander Sergeev, A.P. Karpinsky Russian Geological Research Institute

9 **Methodological approaches to the establishment of regulations for the use of aquatorial zones of the maritime spatial plan in the Russian Federation**
Natalie Nosenko, Anastasia Anisimovets, Scientific and Research Institute of Maritime Spatial Planning Ermak NorthWest

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# Day 2: Tuesday 30th November

# The HAZLESS project: assessment of the transboundary issue of chemical pollution in the eastern Gulf of Finland

Ivan Kuprijanov[1*], Andrey Sharov[2], Nadezhda Berezina[3], Kari Lehtonen[4]

1 DEPARTMENT OF MARINE SYSTEMS TAL TECH
2 SRCES RAS
3 ЗООЛОГИЧЕСКИЙ ИНСТИТУТ РАН 1832
4 SYKE

e-mail:
ivan.kuprijanov@taltech.ee
hazless.msi.ttu.ee

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HAZLESS

# HAZardous chemicals in the eastern Gulf of Finland – concentrations and impact assessment

"HAZLESS" ER90

## BENEFICIARIES AND BUDGET

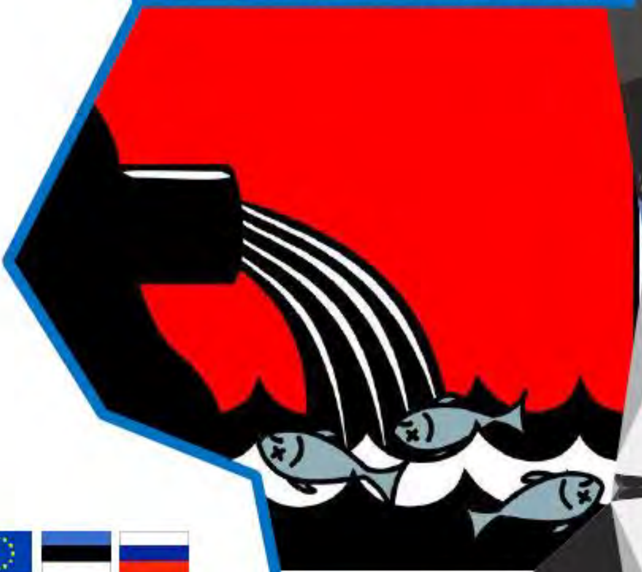
- **Tallinn University of Technology – 214 700,00 EUR**
- Institution of Russian Academy of Sciences Saint-Petersburg Scientific-Research Centre for Ecological Safety – 152 000,00 EUR
- Zoological Institute of the Russian Academy of Sciences – 102 600,00 EUR

## ASSOCIATE

- Finnish Environment Institute

## BUDGET

Total: 469.300,00 EUR
Programme co-finacing: 422.370,00 EUR



## DURATION

35 months
01.04.2019-28.02.2022

T06 Environmental protection, climate change mitigation and adaptation

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The Programme web-site: www.estoniarussia.eu

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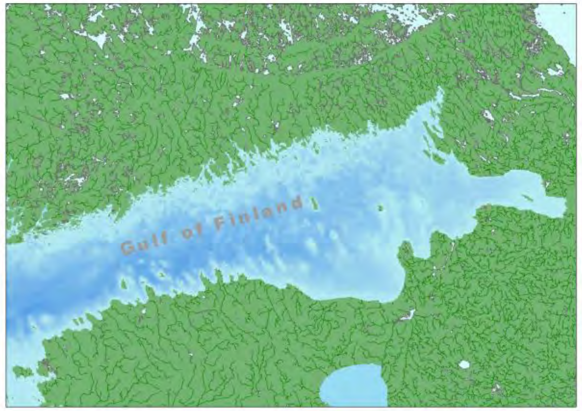
# BACKGROUND

Environmental problems related to ecological effects of **hazardous substances** (HS), including substances from the **HELCOM** Core Indicators list**:**

- **trace metals**
- **PAHs**
- **PCBs**
- **organotins**
- **phenols/alkylphenols**
- **pharmaceuticals**

produce a threat to the eastern GoF environment through accumulation in the various matrices and altering biological functions of aquatic organisms



Trilateral scientific communities from Estonia, Russia and Finland.

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# OBJECTIVES

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The overall objective:

- Adaptation and implementation of uniform biological indicators for assessment and control of environmental quality in the eastern GoF

The main outputs of the HAZLESS:

- The standard approach and strategies for transnational monitoring and assessment of emerging chemicals and harmful substances (HS) and their effects in the programme area and whole GoF

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# OBJECTIVES

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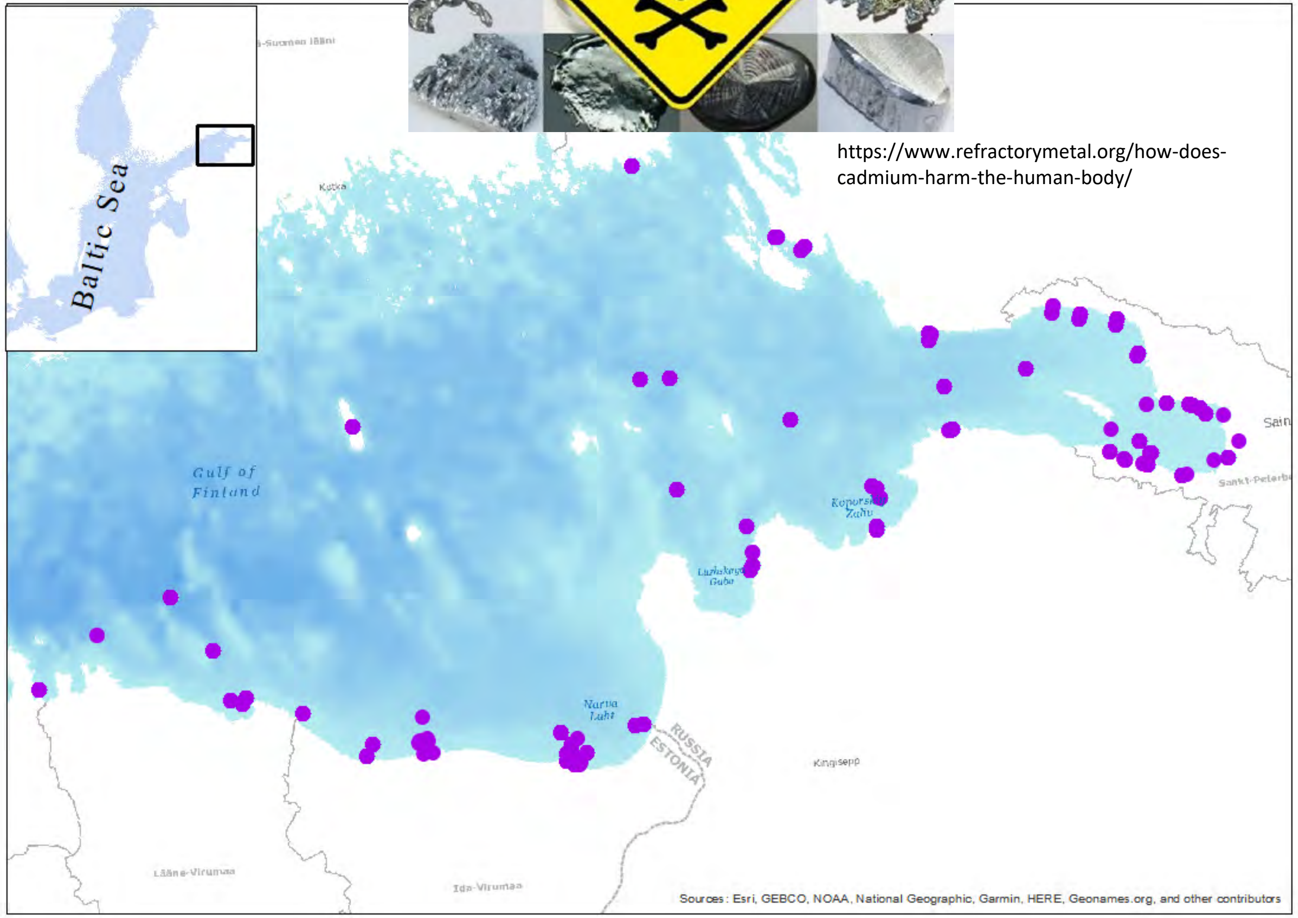
-Fulfill the existing gaps in the studies of priority substances along the eastern Gulf of Finland (GoF)

-The compilation of available data from neighboring countries (mainly Russia and Estonia) and collection of additional data from hotspot areas

-The numerical modelling of the spatial distribution of HS from different sources (mainly riverine/atmospheric origin)

-Implementation of assessment of toxicity to biota with a set of effect indices by conduction of exposure studies on substances of high environmental concern (e.g., TBT, diclofenac).

https://www.refractorymetal.org/how-does-cadmium-harm-the-human-body/

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# METHODS:
# DATA AND SAMPLES

New data collection

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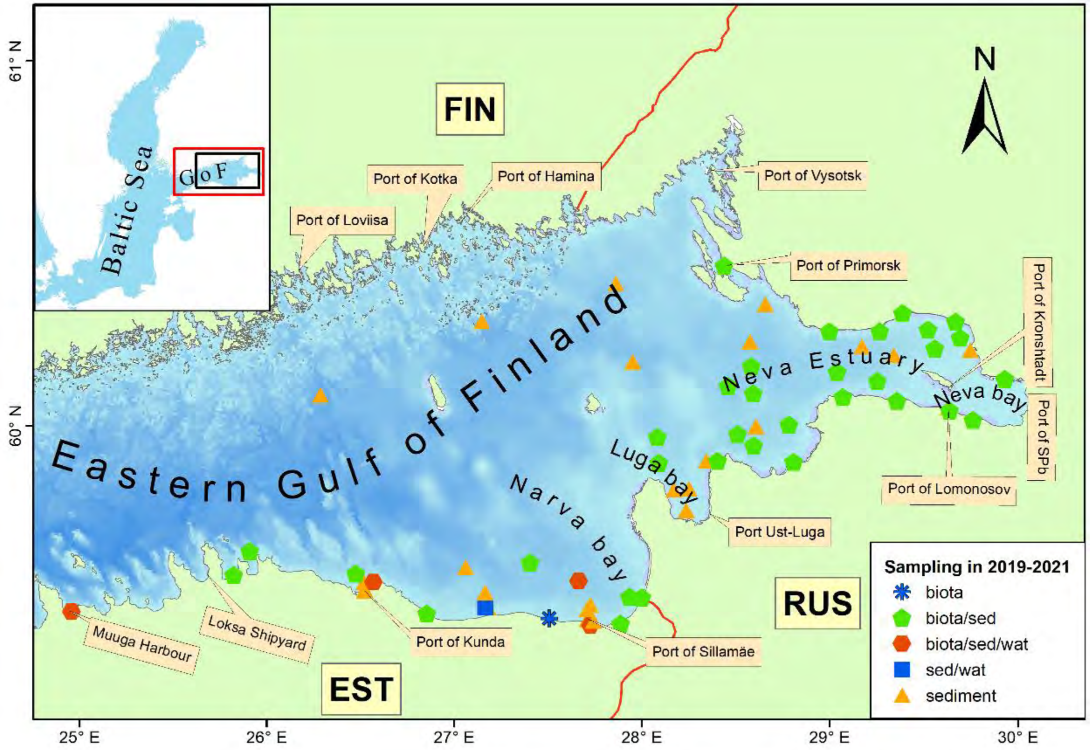
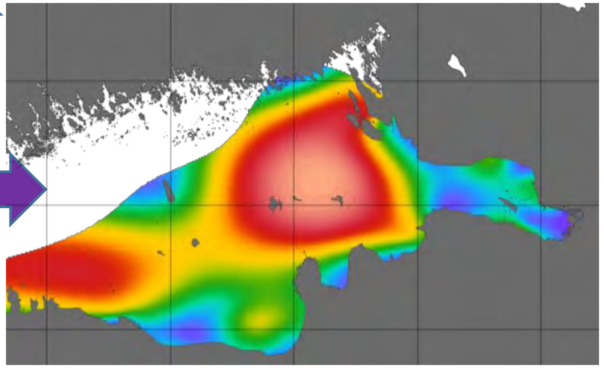



Data analyses



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# METHODS :
# *LABORATORY EXPOSURE STUDIES*

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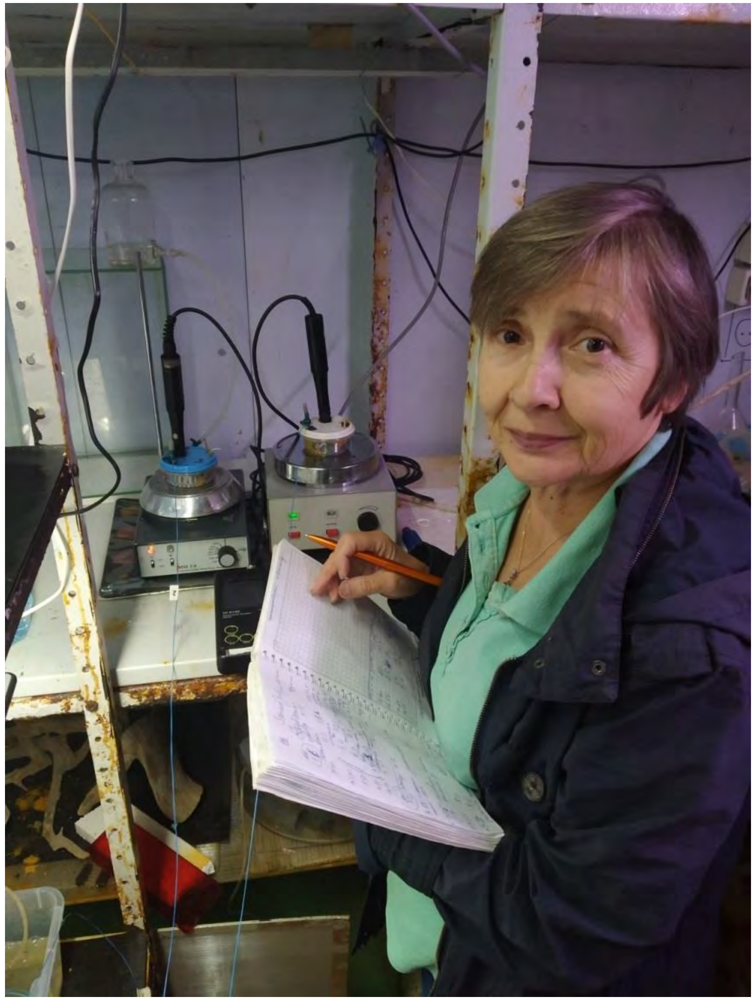
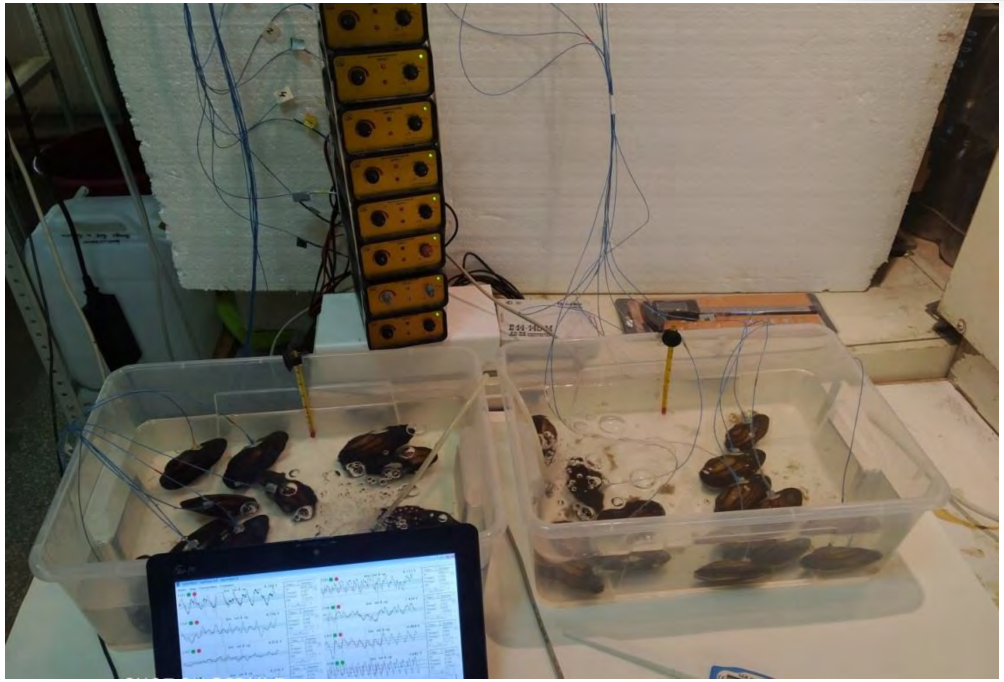


Determination of the respiratory activity



Analysis of the cardio activity of mollusks (e.g. *Limecola baltica, Anodonta anatina, Mytilus trossulus*)

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## METHODS:
## BIOASSAYS, CAGES

- Ecotoxicological tests of sediments
- Mortality/Reproductive disorders/Biomarkers

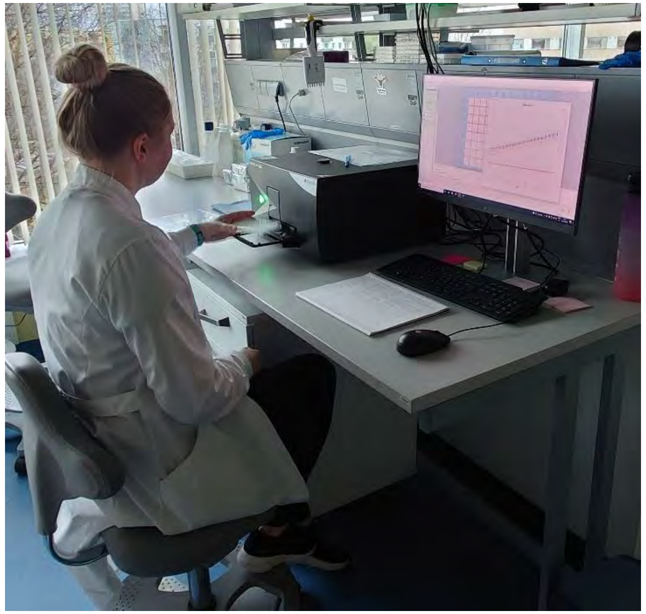
-Amphipodes: *Monoporeia affinis, Pontogammarus robustoides, Gmelinoides fasciatus, Gammarus tigrinus*

-Caged mussels: *Mytilus trossulus, Dreissena polymorpha, Unio pictorum*

Sediment biotest

Installation of the cage

Reproductive disorders in amphipods



Cage with mussels

Molecular biomarker analyses

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# RESULTS:
# POTENTIAL ACCUMULATION

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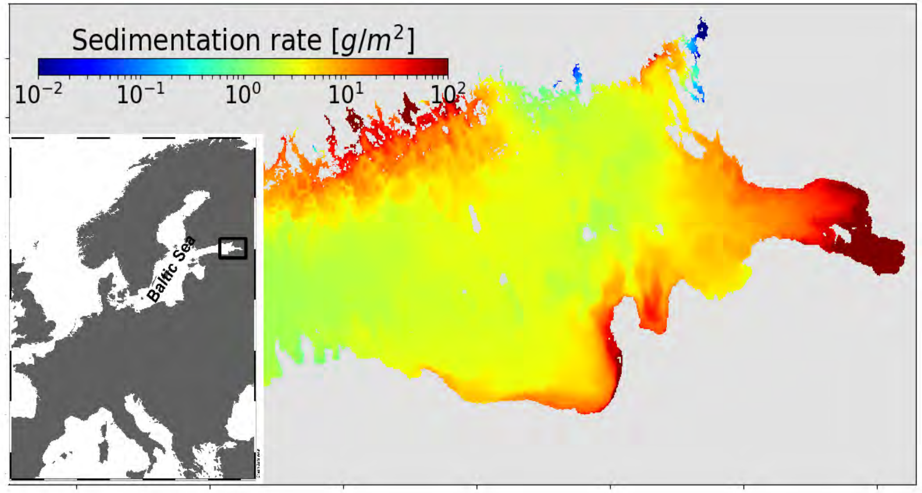


Simulated suspended particulate matter sedimentation from the main river basins across the eastern GoF


Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

ELSEVIER


## Hazardous substances in the sediments and their pathways from potential sources in the eastern Gulf of Finland


Ivan Kuprijanov [a,*], Germo Väli [a], Andrey Sharov [b], Nadezhda Berezina [c], Taavi Liblik [a], Urmas Lips [a], Natalja Kolesova [a], Jaakko Maanio [d], Ville Junttila [d], Inga Lips [a]

[a] *Department of Marine Systems, Tallinn University of Technology (TalTech), Tallinn, Estonia*
[b] *Scientific Research Centre for Ecological Safety of the Russian Academy of Sciences (SRCES RAS), Saint Petersburg, Russia*
[c] *Zoological Institute of the Russian Academy of Sciences (ZIN RAS), Saint-Petersburg, Russia*
[d] *Finnish Environment Institute (SYKE), Helsinki, Finland*



ARTICLE INFO

*Keywords:*
Organotins
PAHs
Heavy metals
Simulated accumulation
Baltic Sea



ABSTRACT

Contamination by hazardous substances is one of the main environmental problems in the eastern Gulf of Finland, Baltic Sea. A trilateral effort to sample and analyse heavy metals (HMs), polycyclic aromatic hydrocarbons (PAHs), and organotins from bottom sediments in 2019–2020 were conducted along with harvesting historical data in Russian, Estonian and Finnish waters. We suggest that the input of organotins still occurs along the ship traffic routes. The tributyltin content exceeded the established quality criteria up to more than 300 times. High contamination by PAHs found near the ports, most likely originate from incomplete fuel incineration processes. The Neva River Estuary and Luga Bay might potentially suffer from severe cadmium contamination. The high ecological risk attributed to the HMs was detected at deep offshore areas. The simulated accumulation pattern qualitatively agrees with field observations of HMs in sediments, demonstrating the potential of numerical tools to tackle the hazardous substances problems.


Kuprijanov, I., Väli, G., Sharov, A., Berezina, N., Liblik, T., Lips, U., Kolesova, N., Maanio, J., Junttila, V., Lips, I., 2021. **Hazardous substances in the sediments and their pathways from potential sources in the eastern Gulf of Finland.** *Mar. Pollut. Bull.* 170, 112642. https://doi.org/10.1016/j.marpolbul.2021.112642

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# RESULTS:
# HELCOM INDICATORS (SEDIMENTS)

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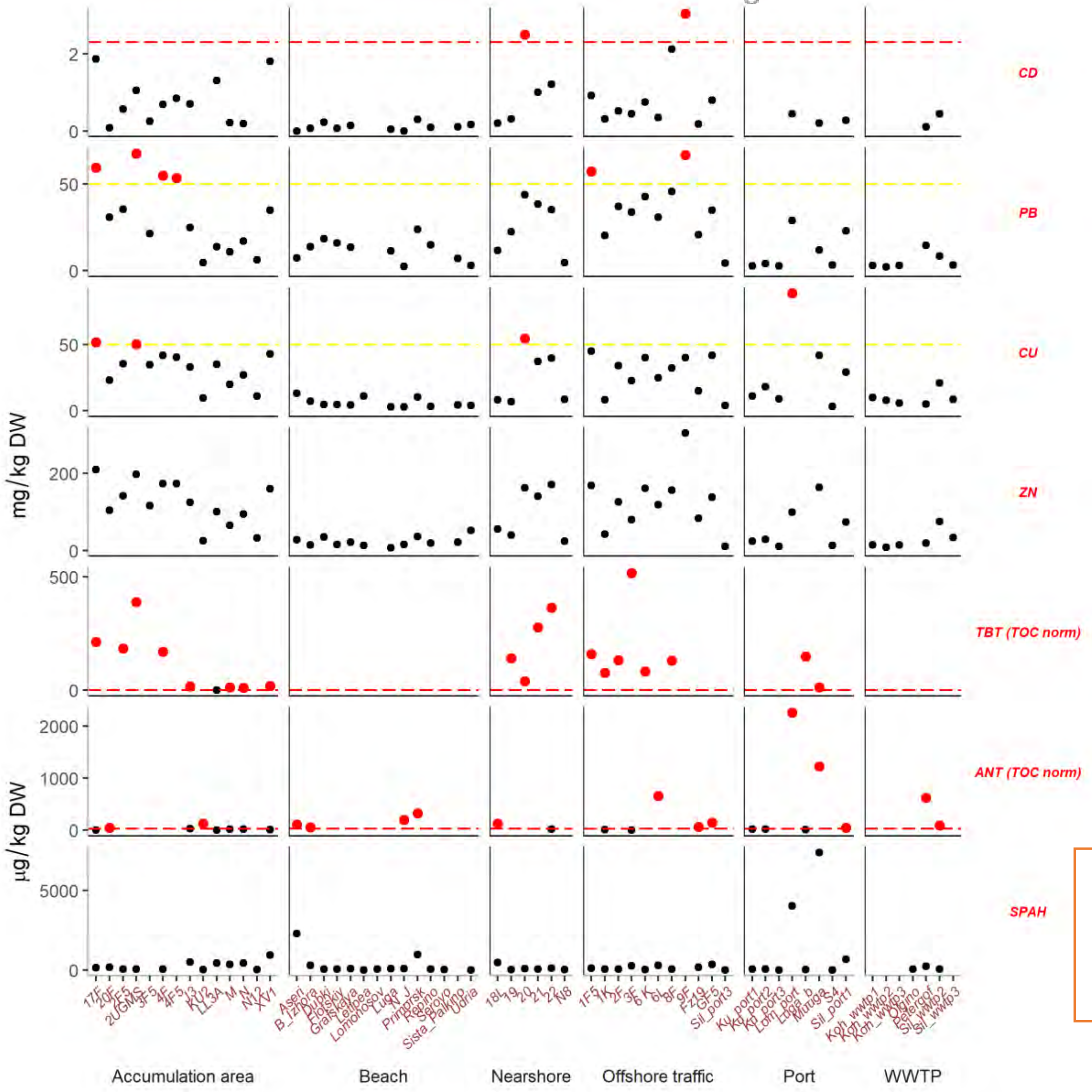


HELCOM threshold **(Cadmium)**: 2,3 mg/kg dw

HELCOM threshold **(Lead)**: 120 mg/kg dw

HELCOM threshold **(TBT)**: 1,6 µg /kg dw (5% TOC)

HELCOM threshold **(ANT)**: 24 µg /kg dw (5% TOC)

Kuprijanov, I., Väli, G., Sharov, A., Berezina, N., Liblik, T., Lips, U., Kolesova, N., Maanio, J., Junttila, V., Lips, I., 2021. **Hazardous substances in the sediments and their pathways from potential sources in the eastern Gulf of Finland.** *Mar. Pollut. Bull.* 170, 112642. https://doi.org/10.1016/j.marpolbul.2021.112642

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# RESULTS: PHARMACEUTICALS

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7 compounds were recorded in seawater samples in a range of measured concentrations from 0.1 to 4452 ng/L :

- caffeine [81% of samples]
- carbamazepine [81%]
- ketoprofen [60%]
- diclofenac [23 %]
- ciprofloxacin, trimethoprim, and clarithromycin)
- Antibiotics were presented in trace concentrations.
- In sediment samples, 6 pharmaceuticals (0.1–66.2 ng g−1) were detected. The most common was carbamazepine (80%)

Environmental Science and Pollution Research
https://doi.org/10.1007/s11356-021-15250-1

RESEARCH ARTICLE

## Occurrence of pharmaceuticals in the Eastern Gulf of Finland (Russia)

Ekaterina Chernova[1] · Zoya Zhakovskaya[1] · Nadezhda Berezina[2]

Received: 2 March 2021 / Accepted: 28 June 2021


**Abstract**
The presence of substances of emerging concern—pharmaceuticals—in marine environments has been studied to a lesser extent compared to fresh and wastewaters. This is the first study of pharmaceutical distribution in the Russian part of the Baltic Sea. Among 18 pharmaceuticals previously detected in influent waters of Saint-Petersburg WWTPs, 7 compounds (caffeine [81% of samples], carbamazepine [81%], ketoprofen [60%], diclofenac [23 %], ciprofloxacin, trimethoprim, and clarithromycin) were recorded in seawater samples in a range of measured concentrations from 0.1 to 4452 ng $L^{-1}$. Antibiotics were presented in trace concentrations. In sediment samples, 6 pharmaceuticals (0.1–66.2 ng $g^{-1}$) were detected. The most common was carbamazepine (80%). The remaining compounds were located in decreasing frequency as follows: ketoprofen, trimethoprim, drotaverine, tetracycline, and ciprofloxacin. Some specific features of the Gulf of Finland affecting the distribution of pharmaceutical concentrations were highlighted—among the most important, the megapolis of St. Petersburg with its population over 5 million and freshwater input by the Neva River (high urbanization of the territory with a potent dilution factor). We discussed the suitable set of anthropogenic markers for the Russian part of the Gulf of Finland.

**Keywords** Pharmaceuticals · Seawater · Mass-spectrometry · Gulf of Finland · The Baltic Sea · Russia

**Highlights**
•Pharmaceuticals were studied in the water and sediments of the Gulf of Finland (Russian part).
•Caffeine, carbamazepine, and ketoprofen were main pharmaceuticals in seawater.
•Diclofenac was detected in 23% of seawater samples, in a range of 0.9–4.5 ng $L^{-1}$.
•Six pharmaceuticals in a range of 0.1–66.2 ng $g^{-1}$ were established in sediments.
•The most common (80 %) was carbamazepine in sediments.
•Caffeine and carbamazepine are suitable anthropogenic markers for the Russian part of the Gulf of Finland.

### Introduction

Anthropogenic chemicals, including pharmaceuticals, represent a major cause of emerging concern. According to HELCOM (Baltic Marine Environment Protection Commission, The Helsinki Commission), the main sources of pharmaceuticals in the environment of the Baltic Sea are treated and untreated wastewaters (HELCOM 2018; Kolpin et al. 2002; Spongberg and Witter 2008). In this regard, information on the pharmaceuticals' release from WWTPs could help to predict the list of target compounds in the environment.

Pharmaceuticals are biologically active compounds; therefore, their presence in the environment, even in trace amounts, can negatively affect the state of the aquatic ecosystem

Chernova, E., Zhakovskaya, Z., Berezina, N., 2021. **Occurrence of pharmaceuticals in the Eastern Gulf of Finland (Russia).** *Environ. Sci. Pollut. Res.* https://doi.org/10.1007/s11356-021-15250-1

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# RESULTS:
# EXPOSURE STUDY (DCF)

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- Bivalve mollusks *Unio pictorum* exposed to **1 µg/L** DCF maintained the ionic balance between the organism and the diluted medium at a significantly higher level of Na, K, and Mg ions in water compared to the control and animals exposed to 0.1 µg/L DCF
- At **0.1 µg/L** DCF, the greater loss concerning the control ($p < 0.05$) was found only for Na ion.
- There were no differences in the dynamics of Ca ions between control and both treatments.

Comparative Biochemistry and Physiology, Part C 248 (2021) 109107

Contents lists available at ScienceDirect

Comparative Biochemistry and Physiology, Part C

journal homepage: www.elsevier.com/locate/cbpc

Shifted mineral ions transport in the mollusk *Unio pictorum* exposed to environmental concentrations of diclofenac

Vladimir I. Martemyanov[a], Nadezhda A. Berezina[b,*], Alexander S. Mavrin[a], Andrey N. Sharov[a]

[a] Papanin Institute for Biology of Inland Waters, Russian Academy of Sciences (RAS), 152742 Borok, Yaroslavl Province, Russia
[b] Zoological Institute, RAS, 199034 St. Petersburg, Universitetskaya embankment 1, Russia

ARTICLE INFO

Edited by Martin Grosell

*Keywords:*
Bivalve mollusks
Cations
Ion loss
Water mineralization
Pharmaceuticals

ABSTRACT

Previous studies showed that diclofenac (DCF), when released in the environment, can be toxic to aquatic animals (fish and mollusks), affecting gills, which are the main organ of ionic regulation. This study focuses on detecting the effects of relevant environmental concentrations of DCF (0.1–1 µg $L^{-1}$) on the transport of main mineral cations, i.e. sodium (Na), potassium (K), calcium (Ca), and magnesium (Mg), by widely distributed freshwater bivalve mollusks *Unio pictorum*. After 96-h exposure to river aerated water at 25 °C with DCF concentrations of 0 (control), 0.1 (treatment I), and 1 µg $L^{-1}$ (treatment II), the mollusks were transferred to deionized water, and daily (for 7 days) concentrations of these cations in the medium have been measured. Animals exposed to 1 µg $L^{-1}$ DCF maintained the ionic balance between the organism and the diluted medium at a significantly higher level of Na, K, and Mg ions in water compared to the control and animals exposed to 0.1 µg $L^{-1}$ DCF. At 0.1 µg $L^{-1}$ DCF, the greater loss concerning the control ($p < 0.05$) was found only for Na ion. There were no differences in the dynamics of Ca ions between control and both treatments. This study showed that detectable environmental concentrations of DCF in natural waters can influence the transport of main cations required by freshwater animals to maintain their ionic balance, and the observed effect (elevated ion loss) is ion-specific and also dose-dependent.

Martemyanov, V.I., Berezina, N.A., Mavrin, A.S., Sharov, A.N., 2021. **Shifted mineral ions transport in the mollusk Unio pictorum exposed to environmental concentrations of diclofenac.** *Comp. Biochem. Physiol. Part - C Toxicol. Pharmacol.* 248, 109107. https://doi.org/10.1016/j.cbpc.2021.109107

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# CONCLUSIONS ON OUTCOMES SO FAR:

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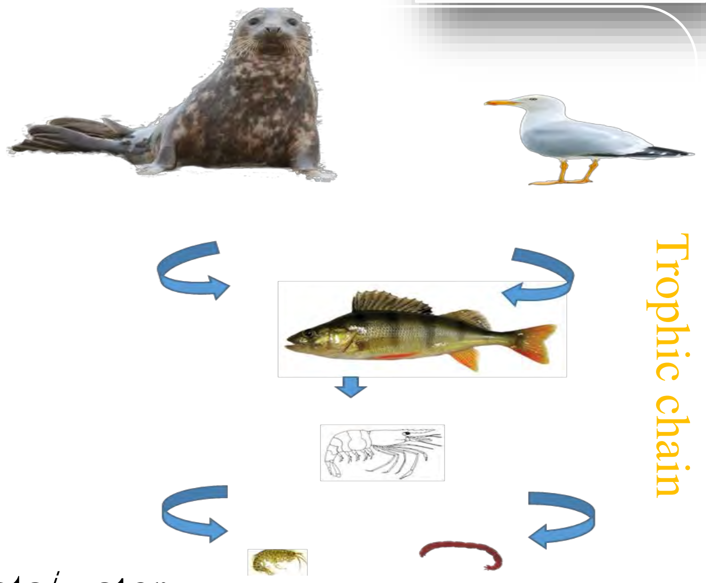
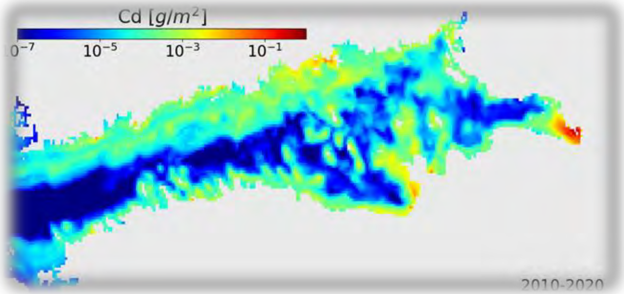
## Chemical residues continue to affect the state of the environment.

contaminated sediments → sediment dwelling biota →




Persistent organic pollutants and heavy metals in accumulation areas and around centers of the maritime activity revealed by the environmental surveys during the last decade:

- ➢ Closely approach in some matrixes (e.g. **Pb** in sediments)
- ➢ While more often exceed manifold (e.g. PAH **Anthracene**, **Hg** in biota, **Pb** in biota/water, **Cd** and **TBT** in biota/sediments) of good-quality threshold set for the Baltic Sea
- ✓ Depending on the rate of sedimentation, HS might disperse along the shoreline in the eastern GoF much further from the initial release within river estuary systems
- ✓ Important to take into account the gradient structure of possible dispersion when planning monitoring activities

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## FUTURE WAYS OF COLLABORATION – KEEPING THE HEALTH OF THE GULF IN CHECK:

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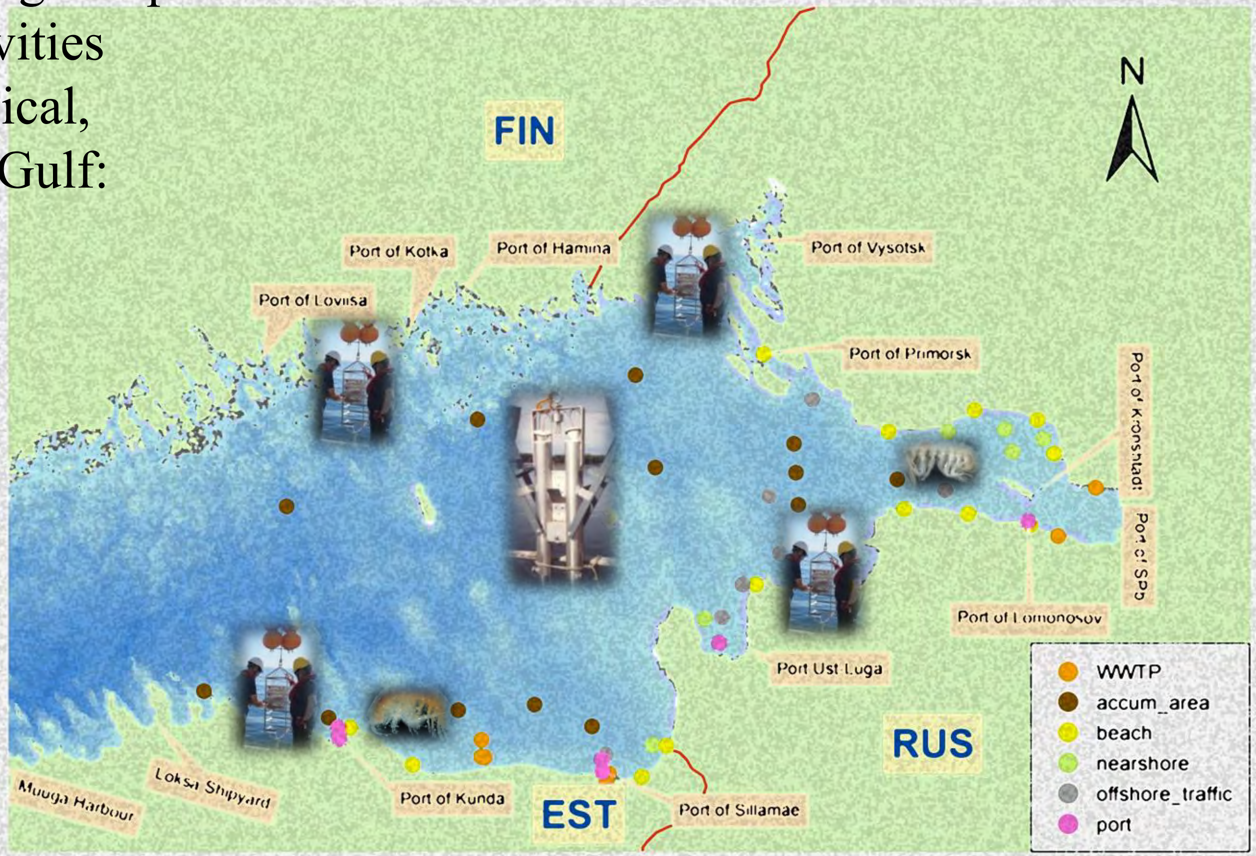
- ➢ **Joint screening campaigns** in established/emerging hotspots
- • Large ports, shipyards, centres of recreational activities
- ➢ **Combination of reliable approaches** in hydrological, chemical and biological effect monitoring across the Gulf:
- • Environmental background (e.g. oxygen conditions, nutrient levels)
- • Continuous survey of contaminants (e.g. in offshore accumulation areas)
- • Cost effective biological effect monitoring at shallow coastal areas (e.g. on subcellular, individual levels) with available local species or caging approach
- ➢ **Developing regionally optimized integrated approaches** for the monitoring and assessment of the health status of the GoF

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# SOME POSSIBLE FUNDING OPPORTUNITIES FOR CONTINUATION OF TRILATERAL COLLABORATION

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- **EU Horizon Europe calls**
  - special terms for involving Russian partners
- **EU INTERREG BSR**
  - targeted issues (e.g., pharmaceuticals, dumped munitions)
- **EU CROSS BORDER COOPERATION (CBC)**
  - Estonia – Russia
  - Southeast Finland – Russia (SEFR)
- **Other EU calls**
  - e.g., BIODIVERSA+ (project proposal preparation currently ongoing)
- **Bi/trilateral joint ventures** funded by national ministries, foundations and other research funding agencies


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# Thank you for attention!

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Get to know more about HAZLESS: hazless.msi.ttu.ee

Estonia-Russia Cross Border Cooperation Programme 2014-2020 aims to foster cross-border cooperation across the borders between the Republic of Estonia and the Russian Federation to promote socio-economic development in the regions on both sides of the common borders. The Programme web-site: www.estoniarussia.eu

*This study has been produced with the financial assistance of the Estonia – Russia Cross Border Cooperation Programme 2014-2020. The content of this publication is the sole responsibility of TalTech and can under no circumstances be regarded as reflecting the position of the Programme participating countries alongside with the European Union.*

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**“New start for the Gulf of Finland co-operation”**
**Estonian Academy of Sciences, Tallinn, 29-30 November 2021**

Saint Petersburg scientific center RAS

Gulf of Finland Co-operation

MERETÖÖD PROMARE SEAWORKS

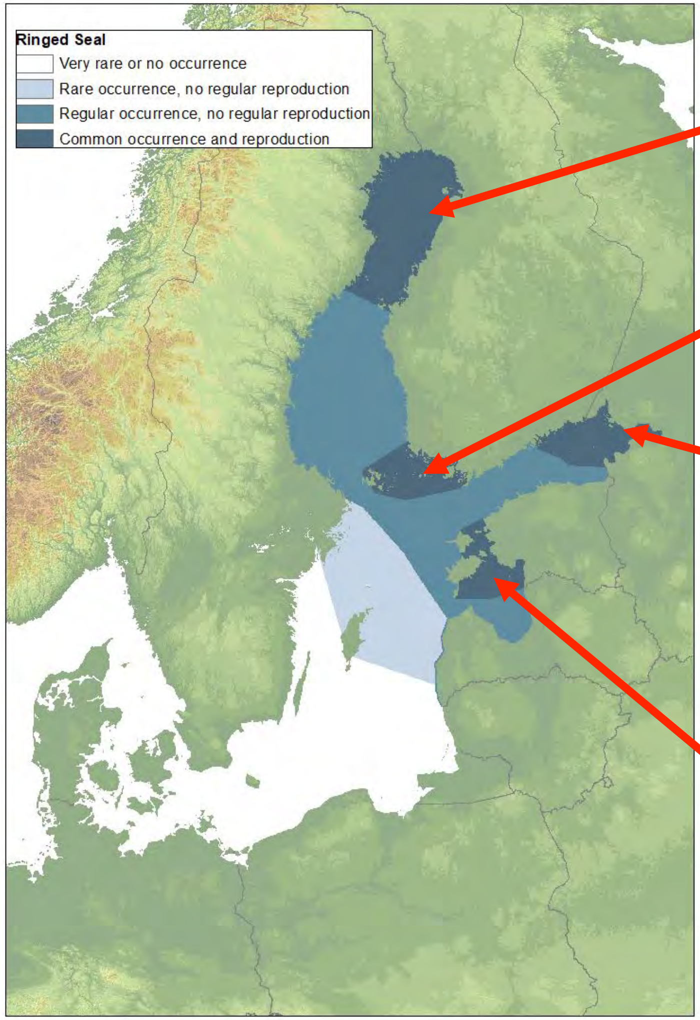
# Seals in the Gulf of Finland - a status review and perspectives

Mikhail Verevkin[1], Mart Jüssi[2]

[1] *Federal State budget Institution St. Petersburg Scientific Center of the Russian Academy of Sciences (SPbSC RAS), Russia*

[2] *Pro Mare MTÜ (non-profit consultancy), Estonia*

# Ringed seal sub-populations and abundance in the Baltic Sea




**The Gulf of Bothnia** > 10 000, slowly growing, but annual growth rate stays below the potential for healthy population.

**The Archipelago Sea** 200-300, data scarce.

**The Gulf of Finland** (Eastern part): 100+, no trends detectable, critically low population (less than Saimaa seal and Mediterranean monk seal) with high degree of isolation from the other sub-populations.

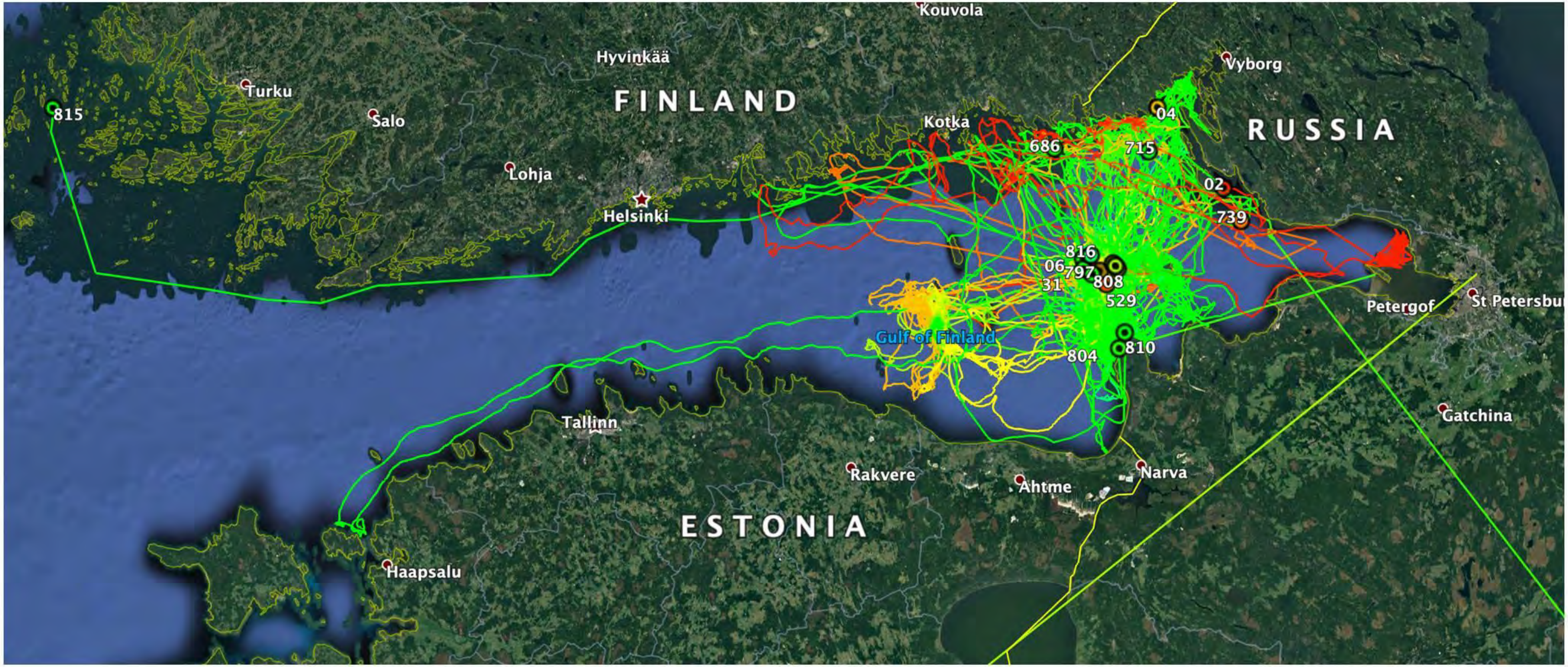
**The Gulf of Riga** > 1000, no trends over past 25 years

# Results of the ringed seal censuses in the Russian part of the Gulf of Finland in 2010-2021. Standard (HELCOM) method used.

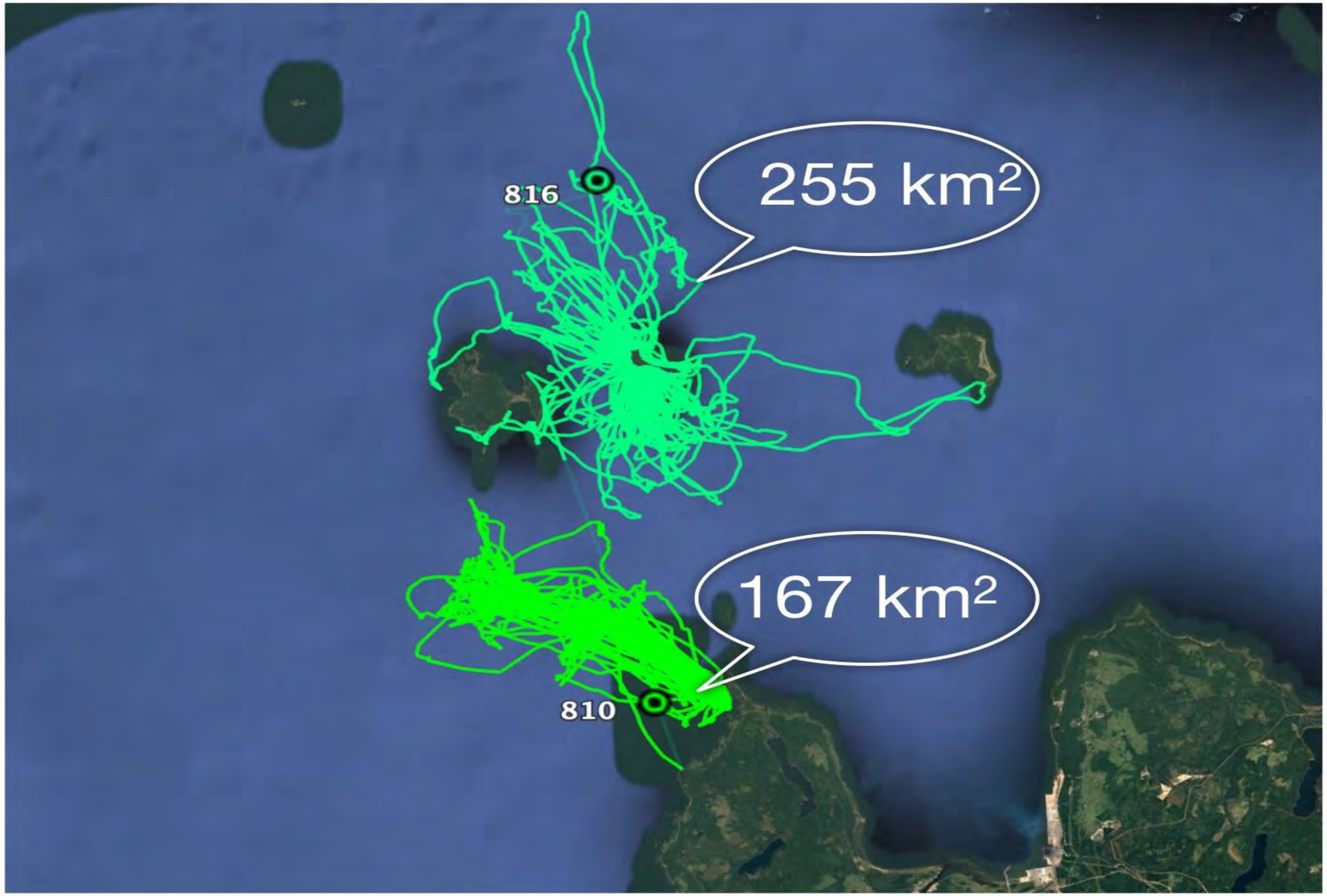
| Year | Survey length (km) | Area of survey sq.km | Ice area sq.km | %% of ice surveyed | Ringed seals | |
|---|---|---|---|---|---|---|
| | | | | | Seen | Absol. num.* |
| 2010 | 347,5 | 278 | 1193 | 23,3 | 6 | 26 |
| 2012 | 642,2 | 517 | 3916 | 13,2 | 12 | 90 |
| 2017 | 361,2 | 289 | 1640 | 17,7 | 9 | 51 |
| | 490,2 | 392 | 2451 | 16 | 13 | 81 |
| 2018 | 365,9 | 293 | 2081 | 14 | 10 | 71 |
| | 200 | 160 | 1191 | 13 | 13 | 100 (+13 FIN) |
| 2021 | 216 | 172,8 | 1218 | 14,1 | 19 | 135 |
| | 273 | 218,5 | 1300 | 16,7 | 16 | 96 |

# Telemetry data from 23 ringed seals in the Gulf of Finland.

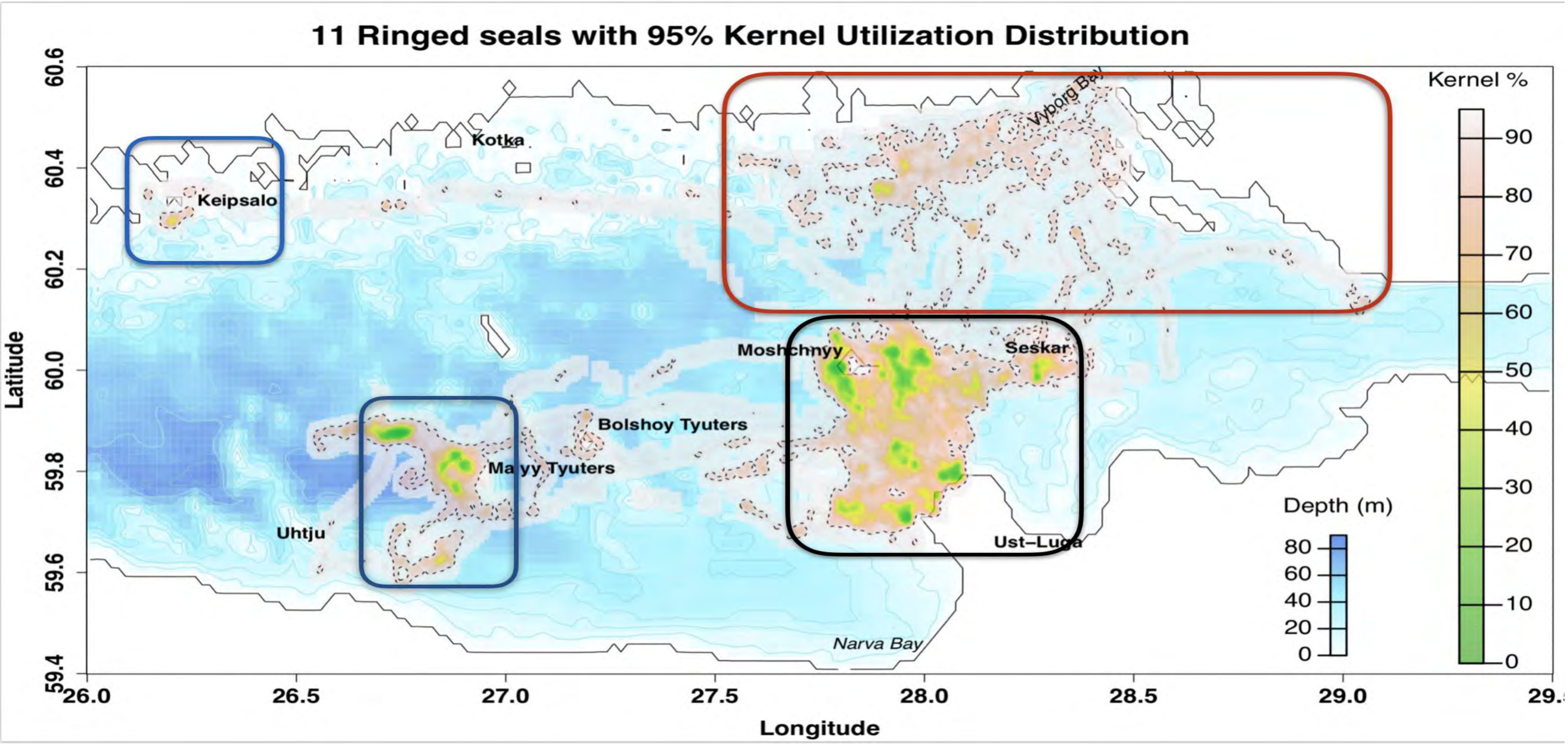
## The sample represents approximately 20 % of the population!



# Home ranges of two seals calculated from outermost registered locations on their tracks (September - February).



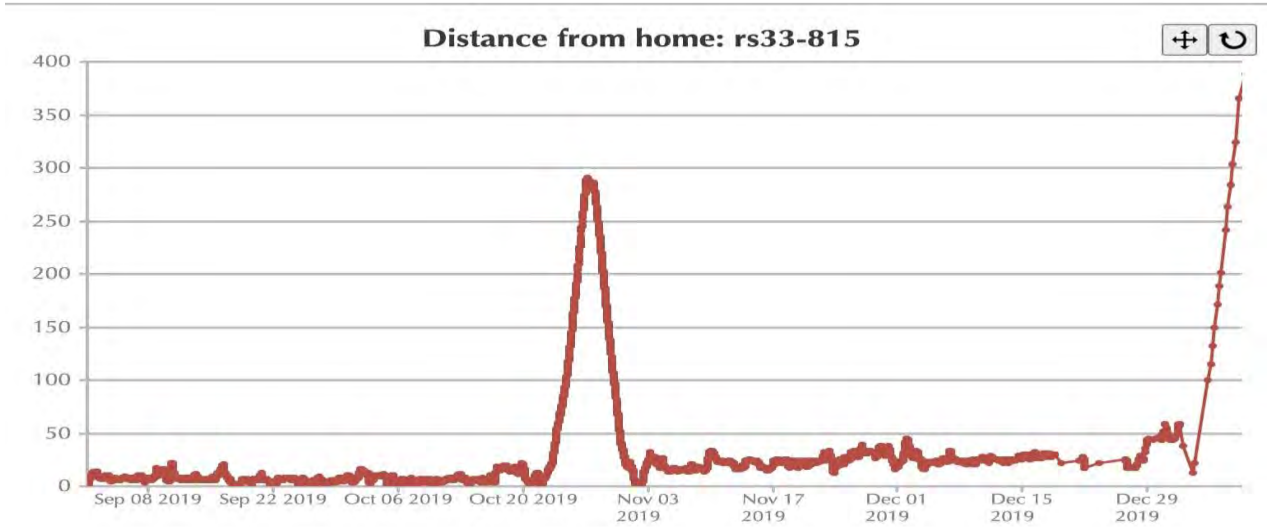
# Behaviour allows to detect key habitats




Core distribution area (**black**), all year, satellite distribution areas (**dark blue**) summer, reproduction (**red**), winter if/when the sea freezes.

**Truly international species requiring common research and conservation efforts !!!**

# Long range movements of seal rs33-815-18.

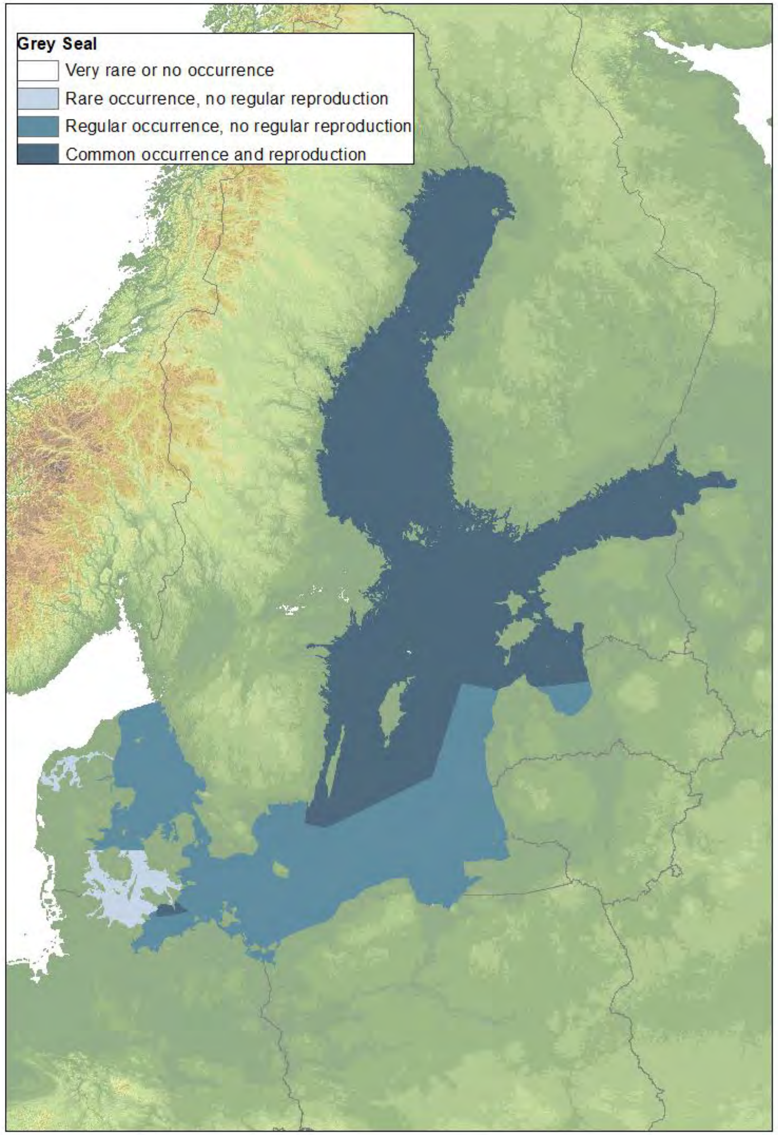




330 kilometres from Moshnyi to Vormsi (West Estonia) in just 106 hours and returned covering 345 kilometres in 101 hours.

Gulf of Finland to Åland sea later in the season covering 340 kilometres in 104.5 hours.

Constant average linear movement speed during these transfers 3.23 km/h.

# Grey seals in the Baltic Sea



# The abundance of the Grey Seal in the Baltic (HELCOM - coordinated surveys)

| Gray seal | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Part of the Gulf of Finland | | | | | | | | | | | |
| Russian | 390 | 326 | 331 | 400 | 168 | 446 | 305 | 1204 | No data | 1593 | 1638 |
| Finnish | 315 | 347 | 460 | 390 | 335 | 876 | 710 | No data | 685 | 663 | 1011 |
| Estonian | 51 | 130 | 174 | 250 | 112 | 95 | 178 | 164 | 323 | 134 | 419 |
| Total Gulf of Finland | 756 | 803 | 965 | 1040 | 615 | 1417 | 1193 | ? | ? | 2390 | 3068 |
| Total in the Baltic Sea | 20700 | 22000 | 22330 | 20395 | 23139 | 23941 | 28095 | ? | 38000 | 40075 | 41530 |

The grey seal abundance has grown 2X in the Baltic in past 15 years while in GoF it has grown 4X !

# Haul outs of Gray seals in the southeastern part of the Gulf of Finland

**Stony reef**

**Sandbank**

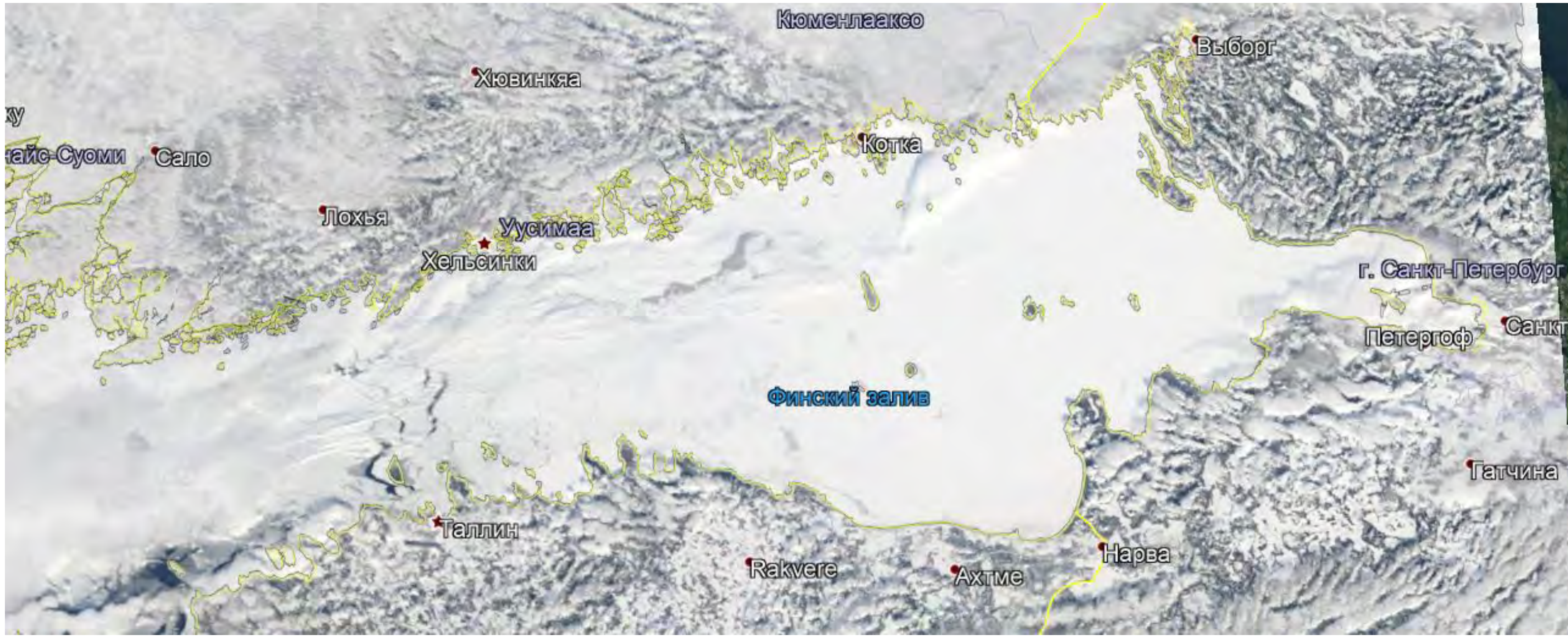
# Haul outs of Gray seals in the northeastern part of the Gulf of Finland

# Good ice winters of 21st Century

**Ice is key breeding habitat for seals**

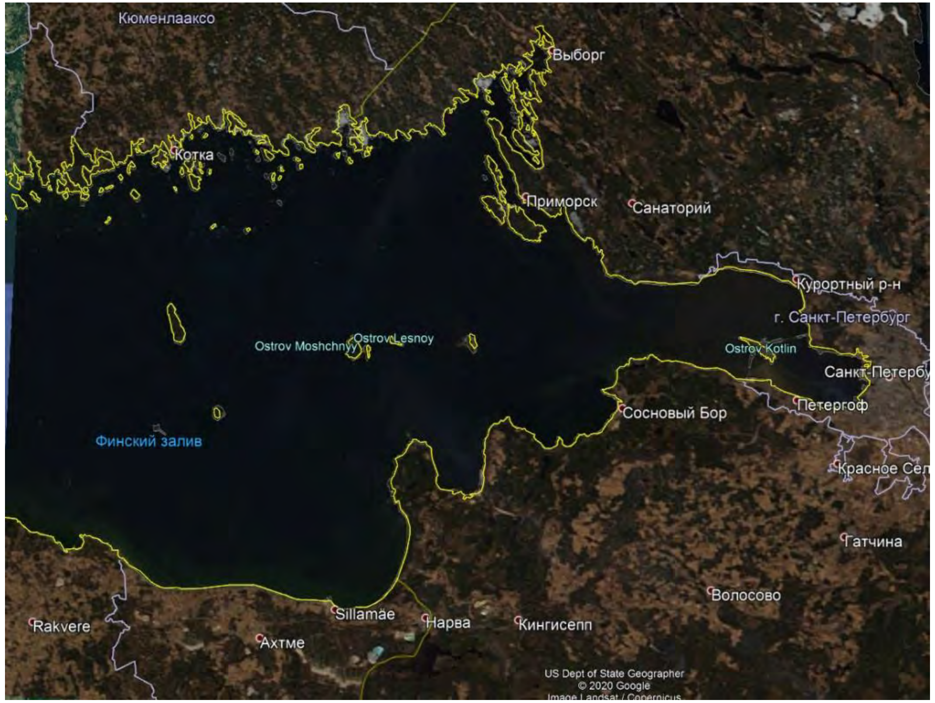
**and key work habitat for researchers**

After April 15, ice was present only in **2003, 2006, 2010, 2011 and 2012**.




March 1, 2003


April 19, 2003




April 10, 2014


April 11, 2015


April 15, 2016


April 12, 2019

# To sum up:

- The ringed seals in the Gulf of Finland are critically low in numbers and isolated to a very high degree This makes them vulnerable to local extinction. Ringed seal is a serious conservation concern.

- The numbers of grey seal in the gulf of are growing two times faster than the average for the Baltic sea. With increased numbers they challenge the seal-fisheries interactions and indirectly thus the status of the ringed seals too.

- The key breeding habitats of seals are found in the Eastern part of the gulf and the deteriorating ice conditions are bringing about critical (ringed seals) or unfavourable (grey seal) changes in breeding success.

- To maintain a good overview of the seals' status in this semi-closed sea are alternative survey methods are developed for ringed seals in the conditions of warm winters. The methods will be part of the HELCOM monitoring guideli

- Dense cooperation and international coordination are the preconditions for fruitful work with seals in the Gulf of Finland. Changing environment calls for full attention and involvement of the best available expertise to maintain the unique diversity and ecological balances of the gulf in close and far future.

Gulf of Finland
Co-operation

Nord Stream 2

ROSTERMINALUGOL
JOINT-STOCK COMPANY

MERETÖÖD
PROMARE
SEAWORKS

ENVIRONMENTAL INVESTMENT CENTRE

MAREA

From MARine Ecosystem Accounting to integrated governance for sustainable planning of marine and coastal areas

# Ecosystem services in the Gulf of Finland – the approach of MAREA project

Susanna Jernberg, Jonne Kotta, Maurizio Sajeva, Dace Strigune, Louise Forsblom, Tin-Yu Lai, Wilma Viljanmaa, Kristina Veidemane, Anda Ruskule, Agnese Reke, Liisa Saikkonen,Elina Virtanen, Ville Karvinen, Marco Nurmi, Francisco Barboza, Kirsi Kostamo, Liisi Lees, Robert Aps, Rovert Szava-Kovats, Harri Kuosa and others..

**Gulf of Finland Science days**
**30.11.2021**

Photo: Mats Westerbom

SYKE
Pellervo Economic Research
BEF LATVIA
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Interreg
Central Baltic

# Challenge: achieve sustainable use of natural resources

## Ecosystem approach

***Convention of Biological Diversity:***

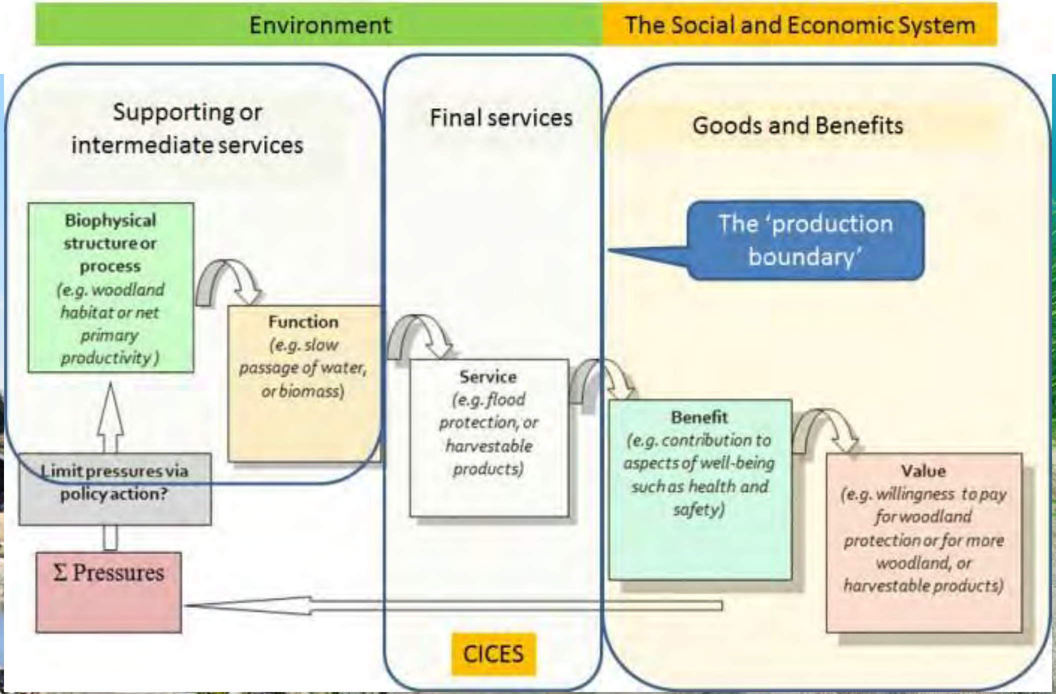
*"a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way "*

Information is required from

- ecosystem state,
- the supply and use of ecosystem services
- the links between human activities and their pressures
- Integration of this knowledge

# First aim: Developing ecosystem service mapping and modelling

Potschin, M. and R. Haines-Young (2011):





# Data and knowledge from previous projects

**MERIAVAIN project**

- Habitat
- Habitat
- Habitat
- Species
- Species

**Regulation and maintenance**
decomposing wastes, water flow regulation etc..

**Provisioning**
Food, materials etc.

**Cultural**
Recreation, Symbolic, sacred or religious meanings

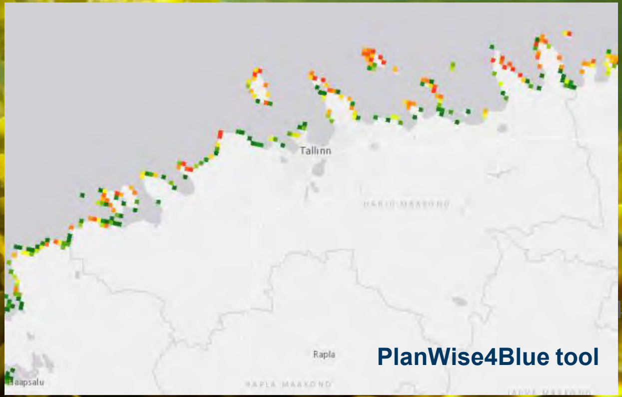




Photo: Juuso Haapaniemi, Metsähallitus

# Additional data is collected from

## Survey targeted to coastal visitors

- More information on recreational activities along coastal areas

## Social media platorms

Instagram

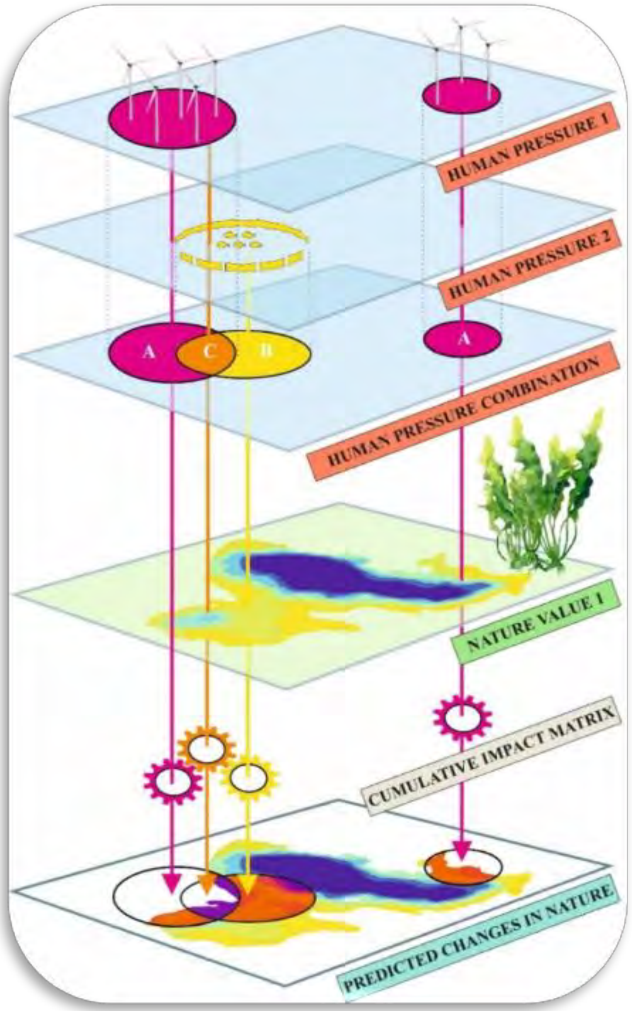
- Picture contents and places
- Under investigation, not sure if possible to utilize

## Satellite images

- Copernicus data to model common reed (Phragmites Australis) distribution

# Modelled services in the pilot areas (Gulf of Finland and Gulf of Riga) include for example:

- Regulating services
  - Blue carbon
  - Ferromanganese concretions
- Provisioning service
  - Common reed harvesting
  - Fucus compounds
- Cultural services services
  - Recreational opportunities
  - Aesthetic services




# Cumulative impacts are evaluated

Methodology based on Kotta et al. 2020 *Environemntal Advances*

# Second aim: Developing concepts of ecosystem accounting framework in the Baltic Sea environment

Test the Natural Capital Accounting concept in the pilot areas by linking the maps of ecosystem services developed with already existing data sources on relevant economic sectors


Ecosystem extent account

Ecosystem condition account

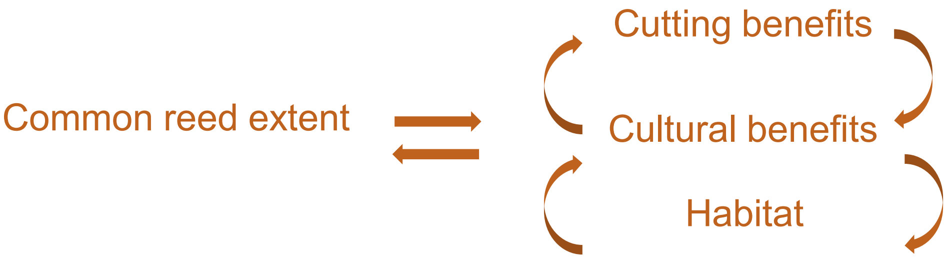
→ Service supply account → Monetary account

Photo: Mats Westerbom

Valuation of selected services: common reed use, blue carbon, cultural services etc.

Survey in preparation for valuing cultural services in all three countries

**Trade-off analysis example**



# Third aim: Creating sustainability compass towards sustainable development goals


Indicator-based assessment tool for evaluating the sustainability of different marine sectors

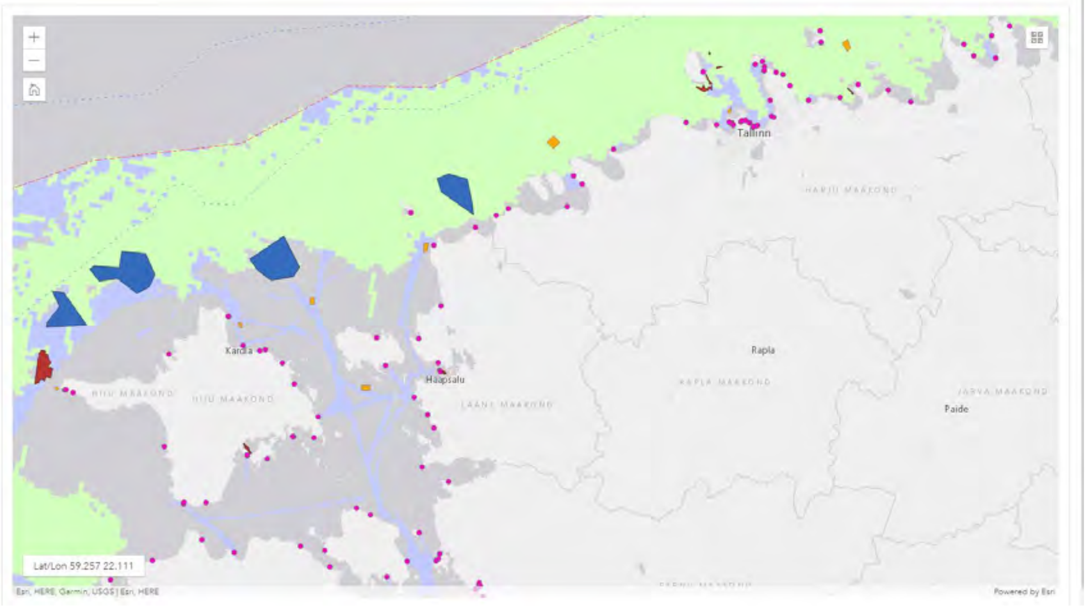
Photo: Hannu Vallas

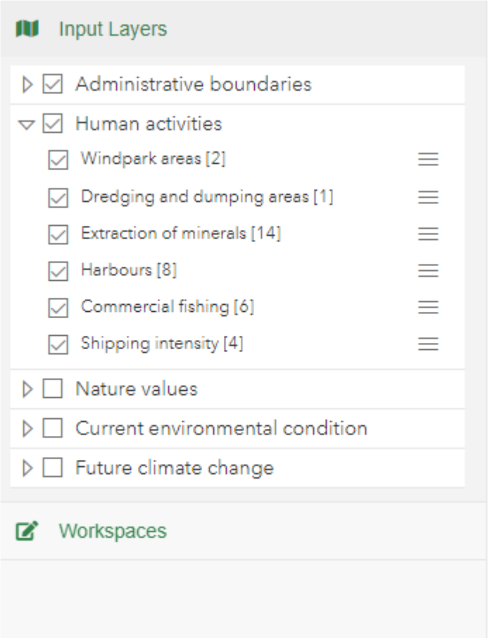
# Sustainability compass

- Targets different marine sectors such as windfarm and aquaculture
- Indicators are collected to represent human well-being, economy and ecosystem state
- A web-tool will be develop allowing easy use of the indicators
- Will be developed in collaboration with marine sectors

# Fourth aim: Building a synthetic decision-support geoportal for sustainable maritime planning in pilot areas

http://www.sea.ee/planwise4blue



# Thank you!

susanna.jernberberg@syke.fi

Twitter: @MAREA_CB

http://marea.balticseaportal.net/

MAREA

Photo: Juuso Haapaniemi / MH

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Central Baltic

The Gulf of Finland Science Days 2021
“New start for the Gulf of Finland co-operation”
Estonian Academy of Sciences, Tallinn, 29-30 November 2021

# Linking marine natural values and underwater cultural heritage to promote sustainable blue eco-tourism in the Gulf of Finland (Baltic Sea)

Robert Aps, Jonne Kotta, Mihhail Fetissov, Kristjan Herkül, Liisi Lees

Estonian Marine Institute, University of Tartu

BalticRIM
Interreg Baltic Sea Region
European Union European Regional Development Fund
2018 European Year of Cultural Heritage #EuropeForCulture
EUSBSR EU Strategy for the Baltic Sea Region
Policy Area 'Culture'
Flagship

# Ecotourism

**A sustainable blue economy is creating tangible opportunities for new jobs and businesses (COM/2021/240 final). Tourism is an important sector in blue economy.**

**Ecotourism is an emerging alternative to mass tourism, with reduced negative environmental impacts and higher benefits to local communities.**

# Ecotourism

The main characteristic of ecotourism is its objective to promote nature conservation through a principle of a ‘protection through usage’

In ecotourism activities the use of participatory tools such as citizen science is very useful to collect data at a low cost while involving local communities and educate visitors and industry value chain

# Sustainable blue ecotourism

**Sustainable blue ecotourism is contributing to creation of socio-economic benefits for the local community while preserving natural ecosystems**

https://www.resortsupportfiji.com/2019/07/blue-tourism-transition-sustainable-coastal-maritime-tourism-world-marine-regions/

# Participatory GIS - mch4blue

The INTERREG BSR Baltic RIM project has developed the user-friendly participatory GIS web portal

(http://www.sea.ee/mch4blue/Map/Content)

- The aim is to provide marine eco-divers with background information on sustainable marine eco-dive destinations connected to marine natural and cultural heritage assets

- Participatory GIS portal supports eco-divers and groups of other stakeholders in geographic problem-solving and decision-making

# mch4blue - ParticipatoryGIS

## INTERREG BSR BalticRIM project

Baltic Sea Region Integrated Maritime Cultural Heritage Management

TARTU ÜLIKOOL 1632 UNIVERSITY OF TARTU

MUINSUSKAITSEAMET

BalticRIM Baltic Sea Region Integrated Maritime Cultural Heritage Management

Interreg Baltic Sea Region

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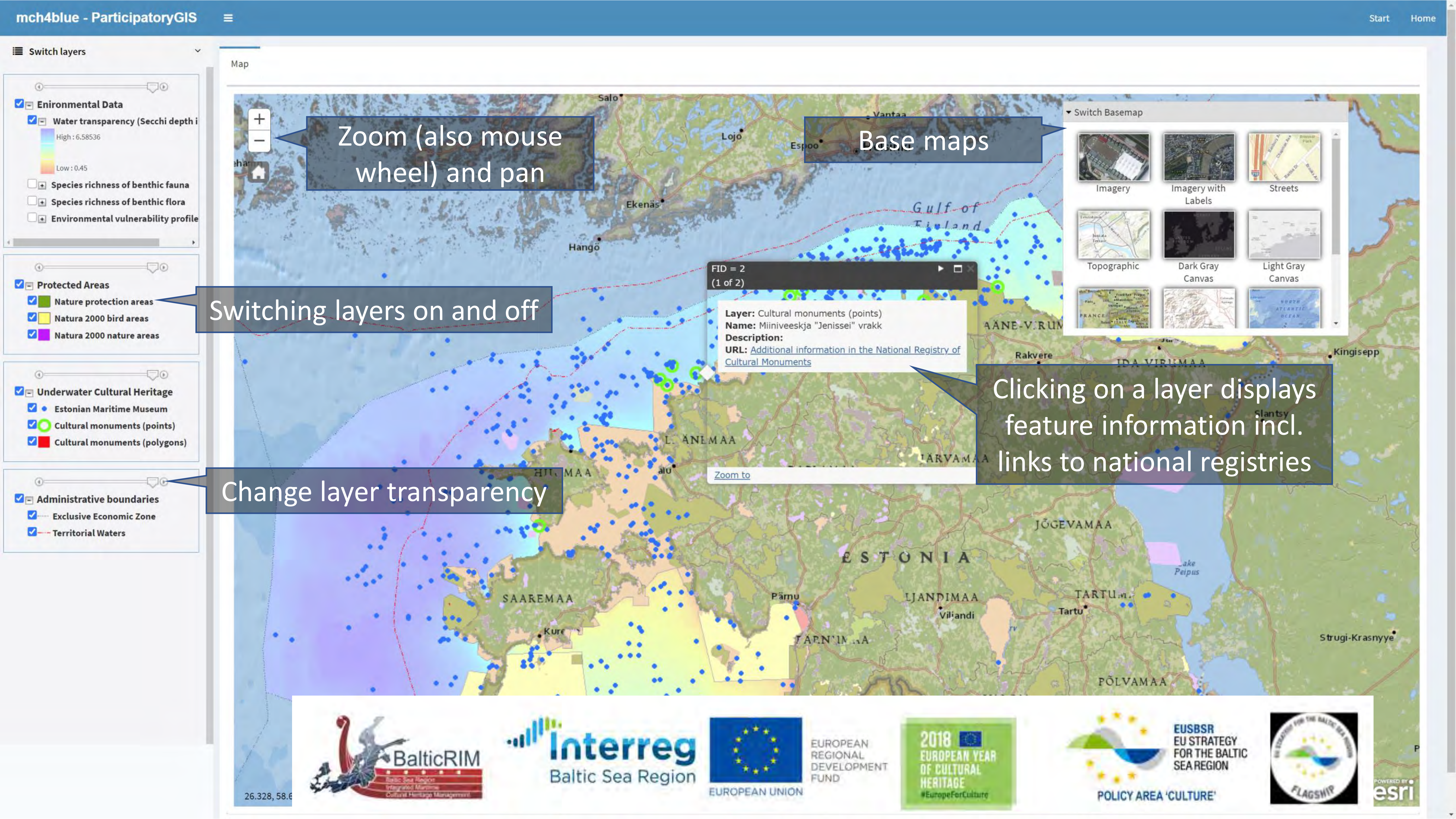
EUROPEAN REGIONAL DEVELOPMENT FUND

EU STRATEGY FOR THE BALTIC SEA REGION FLAGSHIP

2018 EUROPEAN YEAR OF CULTURAL HERITAGE #EuropeForCulture


mch4blue - ParticipatoryGIS
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Switch layers
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High : 6.58536
Low : 0.45
Species richness of benthic fauna
Species richness of benthic flora
Environmental vulnerability profile
Protected Areas
Nature protection areas
Natura 2000 bird areas
Natura 2000 nature areas
Underwater Cultural Heritage
Estonian Maritime Museum
Cultural monuments (points)
Cultural monuments (polygons)
Administrative boundaries
Exclusive Economic Zone
Territorial Waters
Zoom (also mouse wheel) and pan
Base maps
Switching layers on and off
Change layer transparency
Clicking on a layer displays feature information incl. links to national registries
Switch Basemap
Imagery
Imagery with Labels
Streets
Topographic
Dark Gray Canvas
Light Gray Canvas
FID = 2
(1 of 2)
Layer: Cultural monuments (points)
Name: Miiniveeskja "Jenissei" vrakk
Description:
URL: Additional information in the National Registry of Cultural Monuments
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Salo
Lojo
Espoo
Ekenäs
Hangö
Rakvere
Kingisepp
Pärnu
Viljandi
Tartu
Kure
JÕGEVAMAA
PÕLVAMAA
Lake Peipus
Strugi-Krasnyye
26.328, 58.6
BalticRIM
Interreg
Baltic Sea Region
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND
2018 EUROPEAN YEAR OF CULTURAL HERITAGE
#EuropeForCulture
EUSBSR
EU STRATEGY FOR THE BALTIC SEA REGION
POLICY AREA 'CULTURE'
FLAGSHIP
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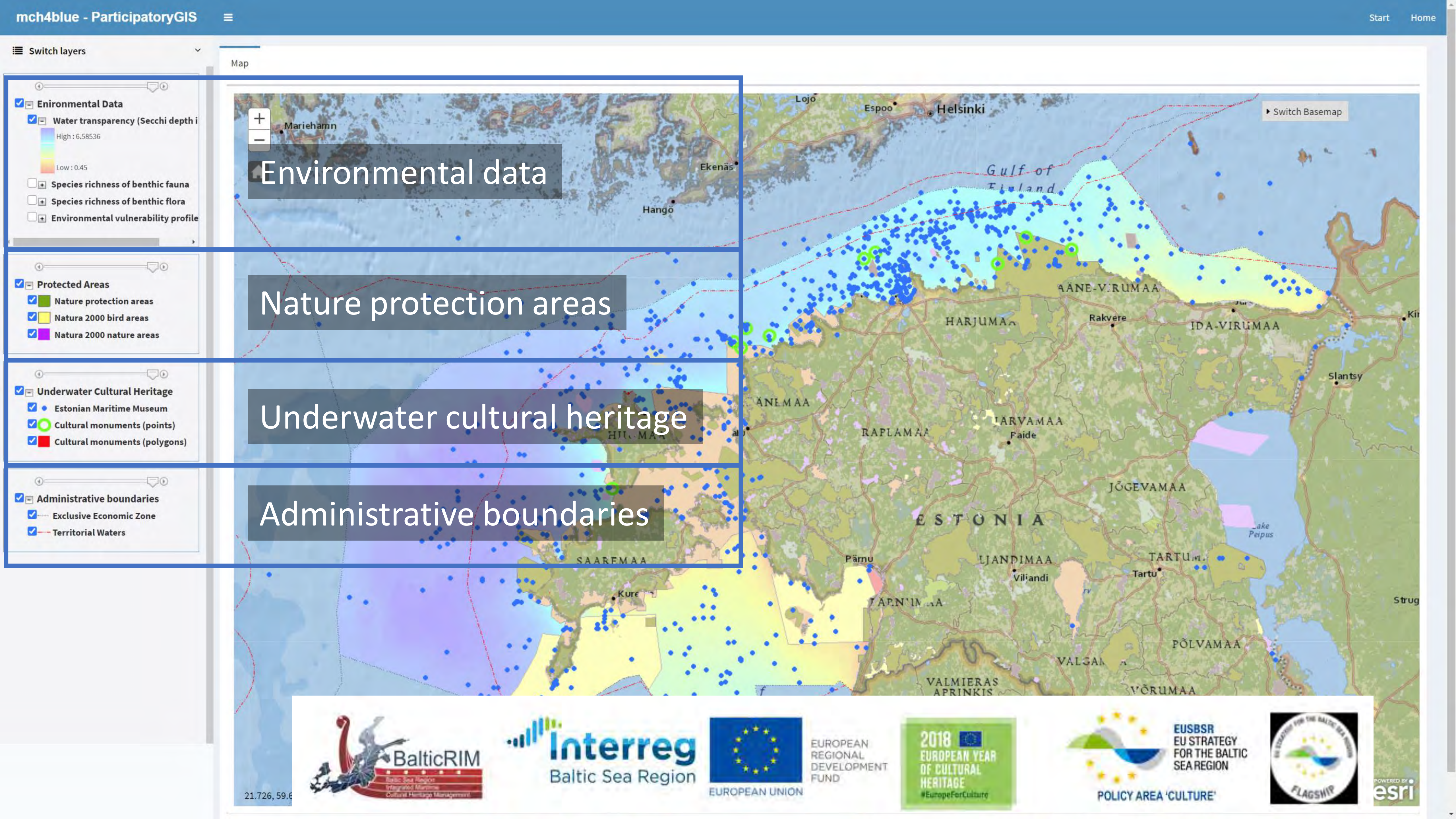
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Mariehamn
Ekenäs
Hangö
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HARJUMAA
Rakvere
IDA-VIRUMAA
Slantsy
RAPLAMAA
Paide
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ESTONIA
Pärnu
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Tartu
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VALMIERAS APRINKIS
SAAREMAA
Kure
Lake Peipus
Strug
21.726, 59.6
BalticRIM
Interreg
Baltic Sea Region
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND
2018 EUROPEAN YEAR OF CULTURAL HERITAGE
#EuropeForCulture
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EU STRATEGY FOR THE BALTIC SEA REGION
POLICY AREA 'CULTURE'
FLAGSHIP
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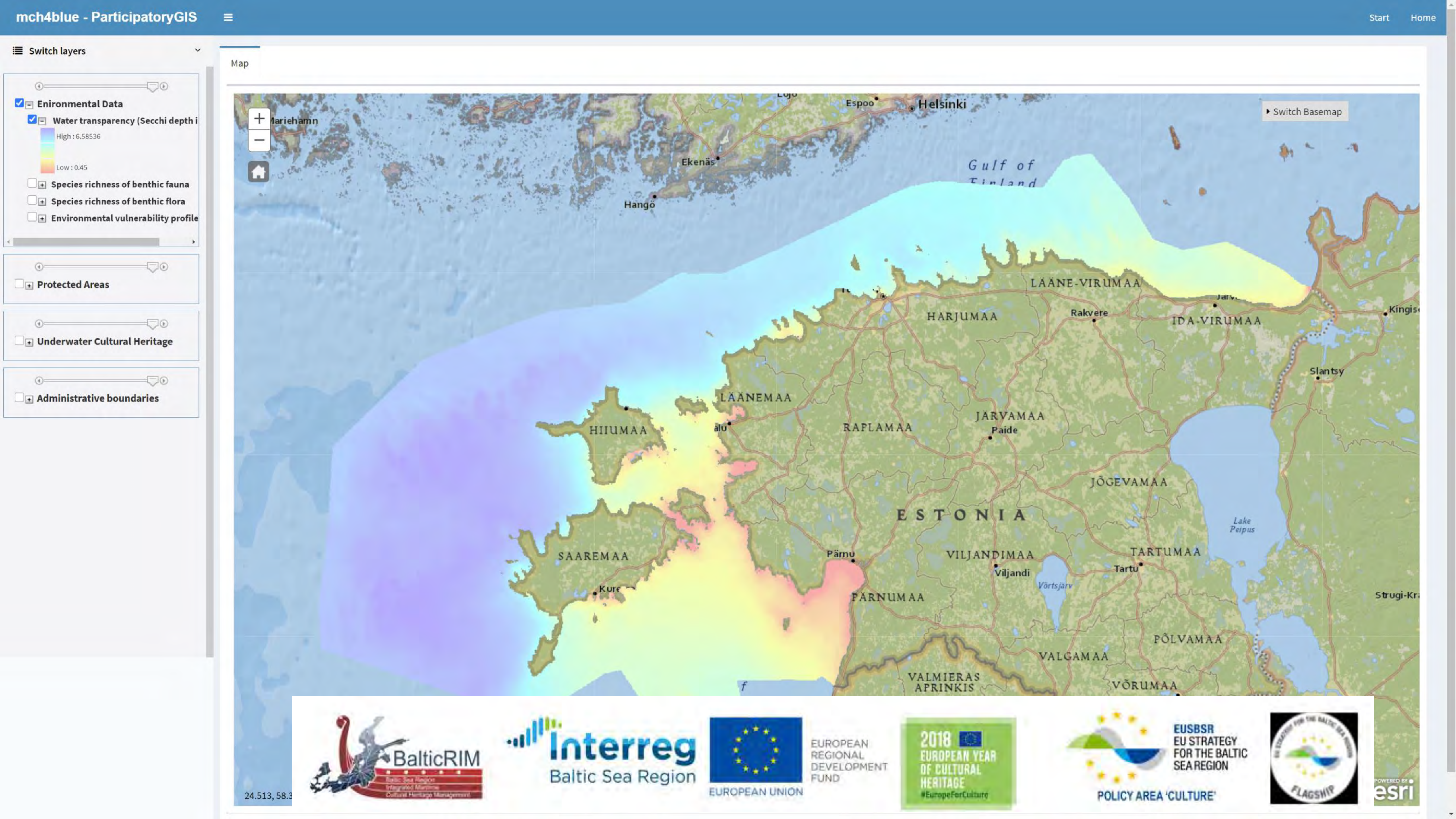
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VÕRUMAA
VALMIERAS APRINKIS
24.513, 58.3
BalticRIM
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Start Home

Switch layers

Enironmental Data

Water transparency (Secchi depth i

Species richness of benthic fauna

High : 22.7731

Low : 0.509197

Species richness of benthic flora

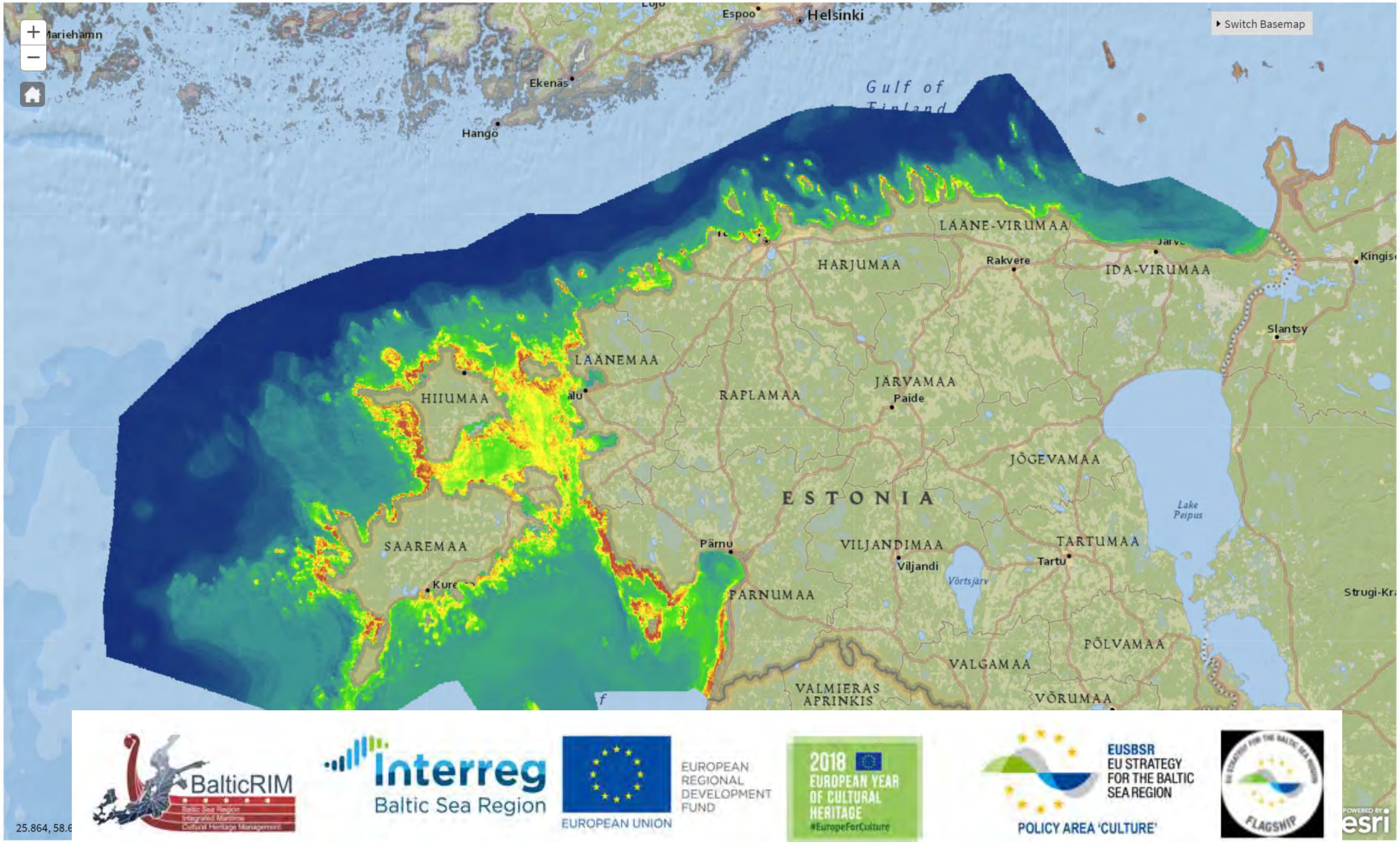
Environmental vulnerability profile

Protected Areas

Underwater Cultural Heritage

Administrative boundaries

Map



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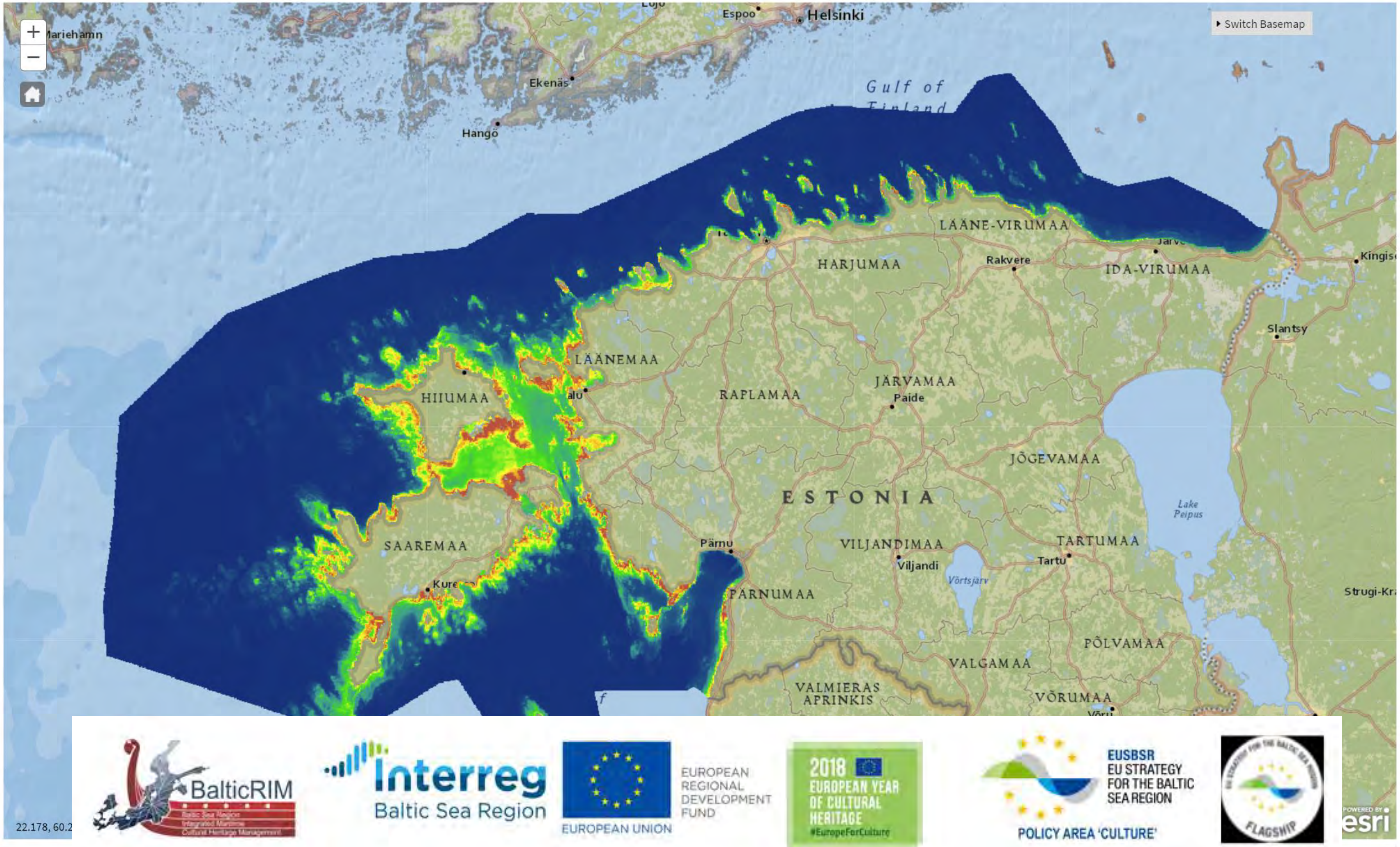
  - [ ] Species richness of benthic fauna
  - [x] Species richness of benthic flora
    - High : 16.6938
    - Low : 0.125415
  - [ ] Environmental vulnerability profile
- [ ] Protected Areas
- [ ] Underwater Cultural Heritage
- [ ] Administrative boundaries

Map




BalticRIM Baltic Sea Region Integrated Maritime Cultural Heritage Management

Interreg Baltic Sea Region

EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND

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  - [ ] Species richness of benthic fauna
  - [ ] Species richness of benthic flora
  - [x] Environmental vulnerability profile
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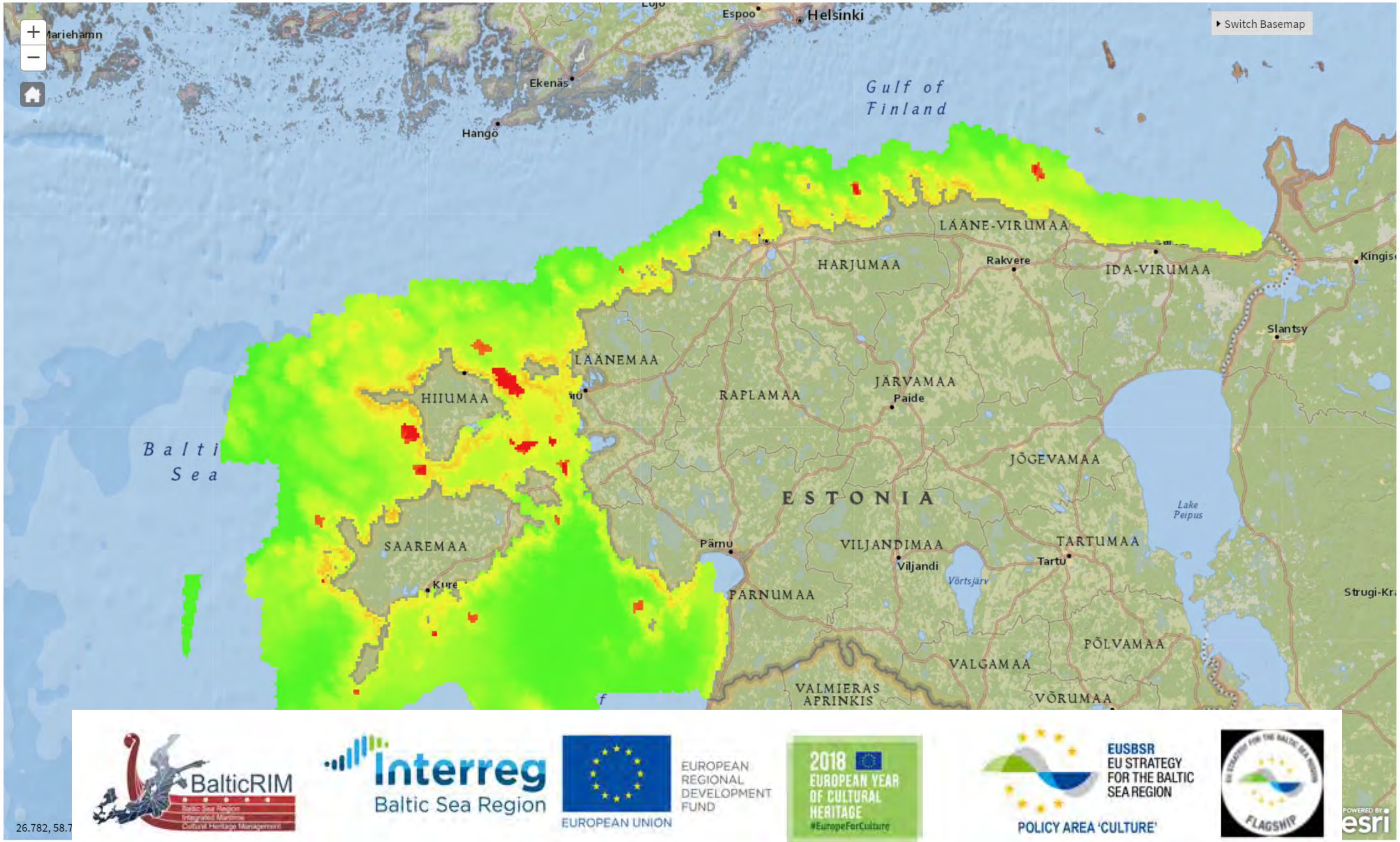
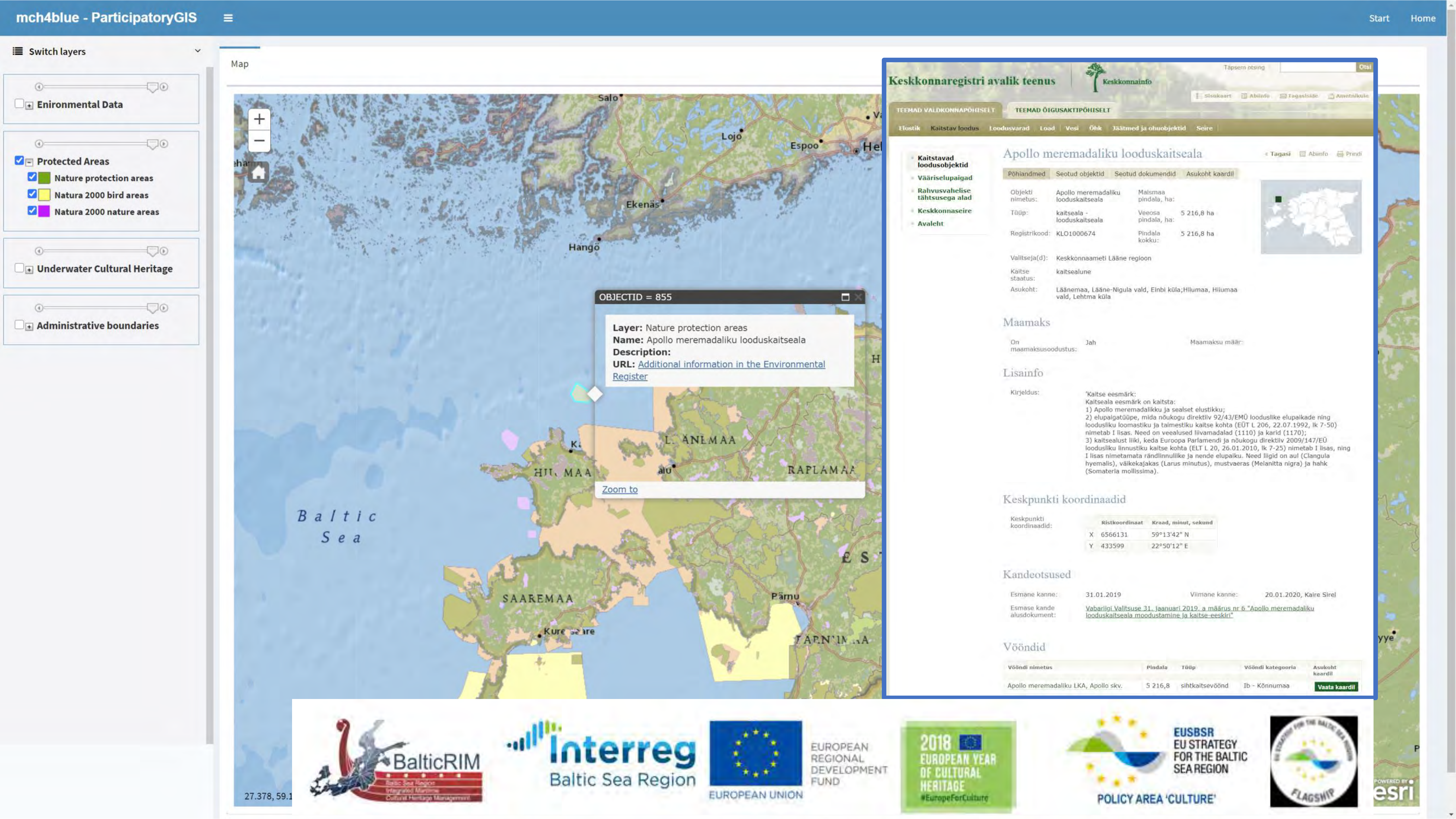
- [ ] Protected Areas
- [ ] Underwater Cultural Heritage
- [ ] Administrative boundaries

Map

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Nature protection areas
Natura 2000 bird areas
Natura 2000 nature areas
Underwater Cultural Heritage
Administrative boundaries
Salo
Lojo
Espoo
Ekenäs
Hangö
Baltic Sea
SAAREMAA
Pärnu
RAPLAMAA
OBJECTID = 855
Layer: Nature protection areas
Name: Apollo meremadaliku looduskaitseala
Description:
URL: Additional information in the Environmental Register
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Täpsem otsing
Otsi
Sisukaart
Abiinfo
Tagasiside
Ametnikule
TEEMAD VALDKONNAPÕHISELT
TEEMAD ÕIGUSAKTIPÕHISELT
Elustik
Kaitstav loodus
Loodusvarad
Load
Vesi
Õhk
Jäätmed ja ohuobjektid
Seire
Kaitstavad loodusobjektid
Vääriselupaigad
Rahvusvahelise tähtsusega alad
Keskkonnaseire
Avaleht
Apollo meremadaliku looduskaitseala
Tagasi
Abiinfo
Prindi
Põhiandmed
Seotud objektid
Seotud dokumendid
Asukoht kaardil
Objekti nimetus: Apollo meremadaliku looduskaitseala
Maismaa pindala, ha:
Tüüp: kaitseala - looduskaitseala
Veeosa pindala, ha: 5 216,8 ha
Registrikood: KLO1000674
Pindala kokku: 5 216,8 ha
Valitseja(d): Keskkonnaameti Lääne regioon
Kaitse staatus: kaitsealune
Asukoht: Läänemaa, Lääne-Nigula vald, Einbi küla;Hiiumaa, Hiiumaa vald, Lehtma küla
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Kaitseala eesmärk on kaitsta:
1) Apollo meremadalikku ja sealset elustikku;
2) elupaigatüüpe, mida nõukogu direktiiv 92/43/EMÜ looduslike elupaikade ning looduslikku loomastiku ja taimestiku kaitse kohta (EÜT L 206, 22.07.1992, lk 7-50) nimetab I lisas. Need on veealused liivamadalad (1110) ja karid (1170);
3) kaitsealust liiki, keda Euroopa Parlamendi ja nõukogu direktiiv 2009/147/EÜ looduslike linnustiku kaitse kohta (ELT L 20, 26.01.2010, lk 7-25) nimetab I lisas, ning I lisas nimetamata rändlinnuliike ja nende elupaiku. Need liigid on aul (Clangula hyemalis), väikekajakas (Larus minutus), mustvaeras (Melanitta nigra) ja hahk (Somateria mollissima).
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Y 433599 22°50'12" E
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Esmane kanne: 31.01.2019
Viimane kanne: 20.01.2020, Kaire Sirel
Esmase kande alusdokument: Vabariigi Valitsuse 31. jaanuari 2019. a määrus nr 6 "Apollo meremadaliku looduskaitseala moodustamine ja kaitse-eeskiri"
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Baltic Sea Region
Integrated Maritime
Cultural Heritage Management
Interreg
Baltic Sea Region
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND
2018 EUROPEAN YEAR OF CULTURAL HERITAGE
#EuropeForCulture
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POLICY AREA 'CULTURE'
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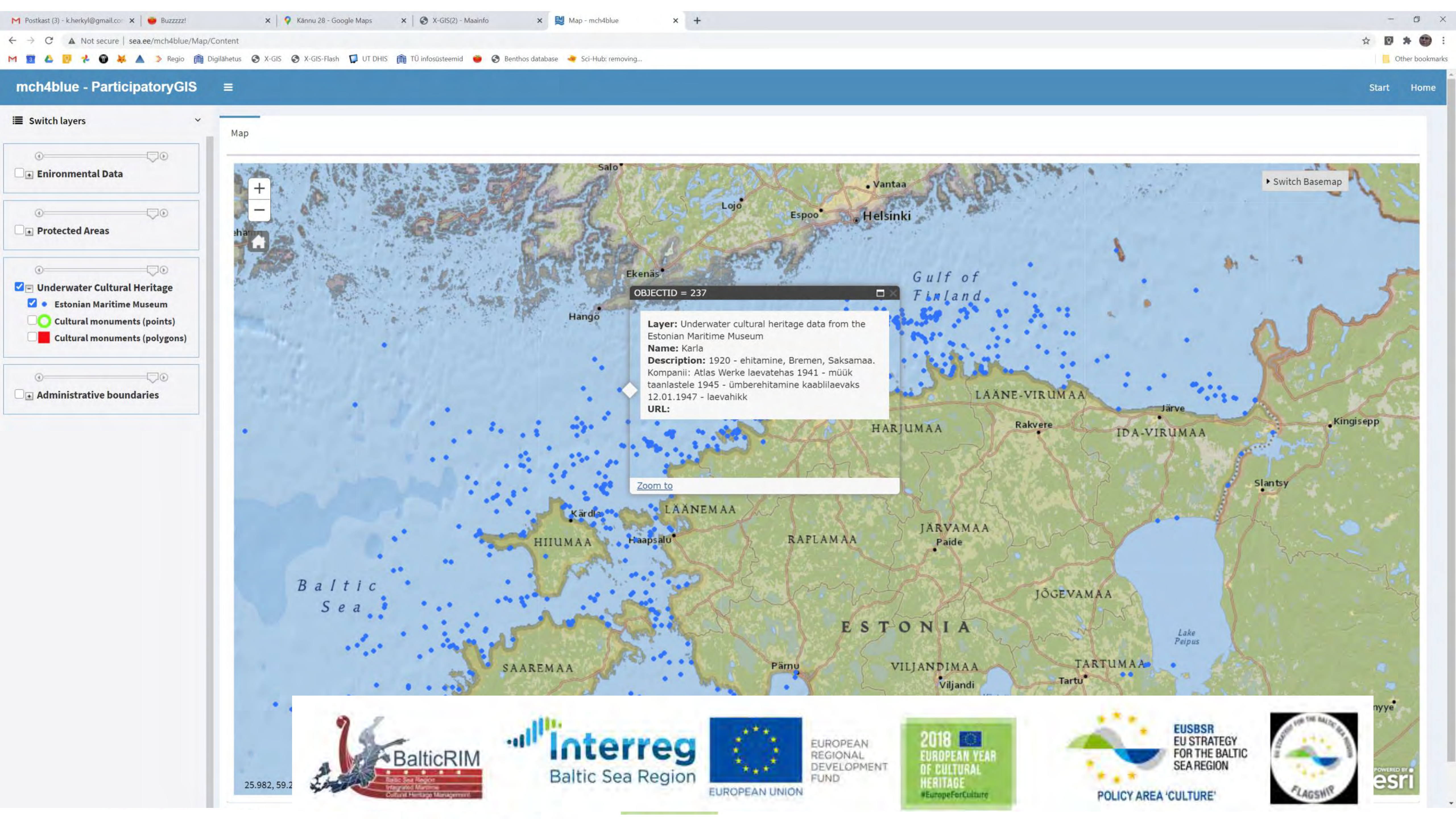
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Estonian Maritime Museum
Cultural monuments (points)
Cultural monuments (polygons)
Administrative boundaries
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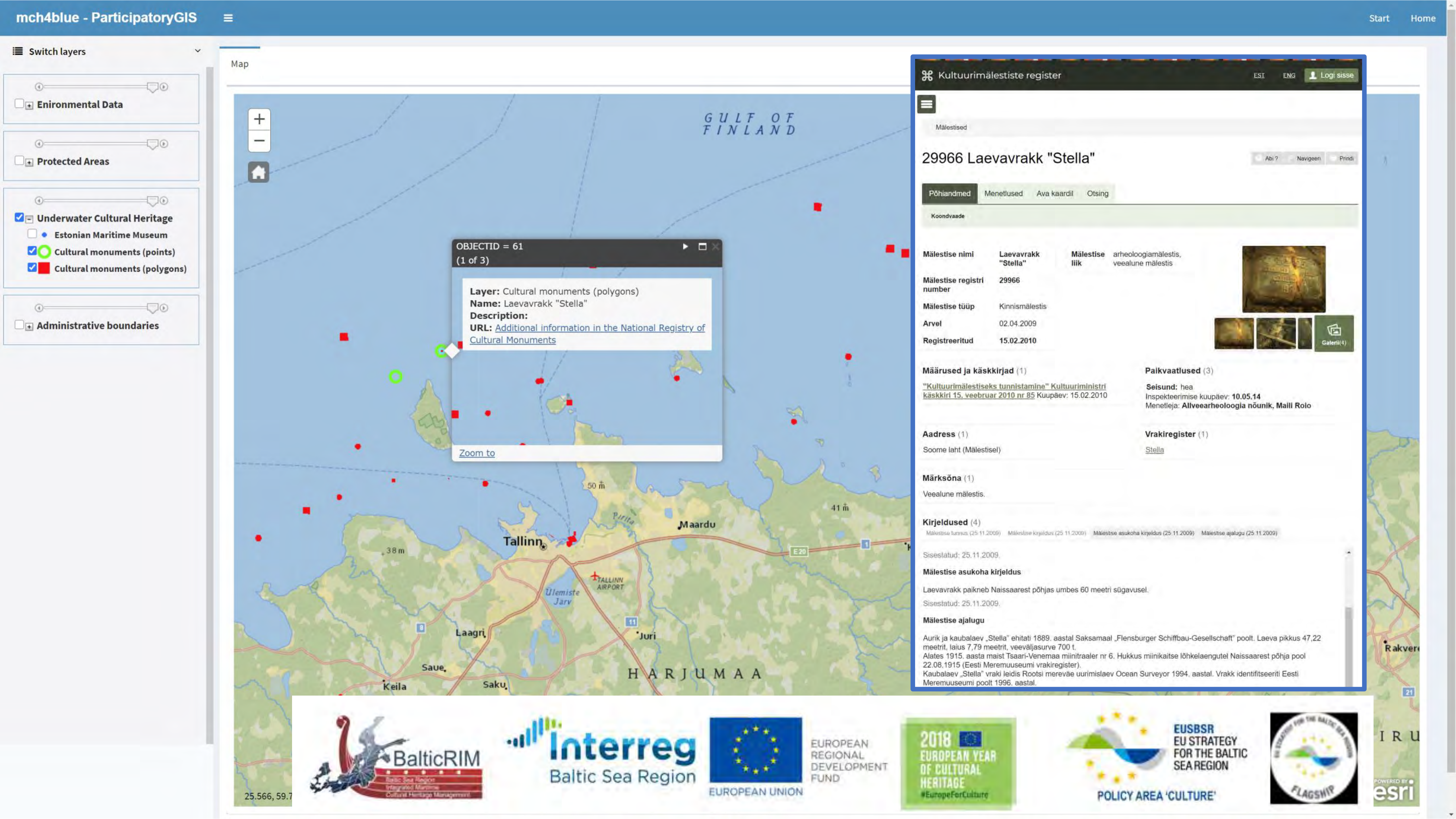

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Cultural monuments (polygons)
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Map
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Description:
URL: Additional information in the National Registry of Cultural Monuments
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Juri
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Navigeeri
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Mälestise liik
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Mälestise registri number
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Mälestise tüüp
Kinnismälestis
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Registreeritud
15.02.2010
Galerii(4)
Määrused ja käskkirjad (1)
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Paikvaatlused (3)
Seisund: hea
Inspekteerimise kuupäev: 10.05.14
Menetleja: Allveearheoloogia nõunik, Maili Roio
Aadress (1)
Soome laht (Mälestisel)
Vrakiregister (1)
Stella
Märksõna (1)
Veealune mälestis.
Kirjeldused (4)
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Mälestise asukoha kirjeldus
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Alates 1915. aasta maist Tsaari-Venemaa miinitraaler nr 6. Hukkus miinikaitse lõhkelaengutel Naissaarest põhja pool 22.08.1915 (Eesti Meremuuseumi vrakiregister).
Kaubalaev „Stella" vraki leidis Rootsi mereväe uurimislaev Ocean Surveyor 1994. aastal. Vrakk identifitseeriti Eesti Meremuuseumi poolt 1996. aastal.
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    - Low : 0.45
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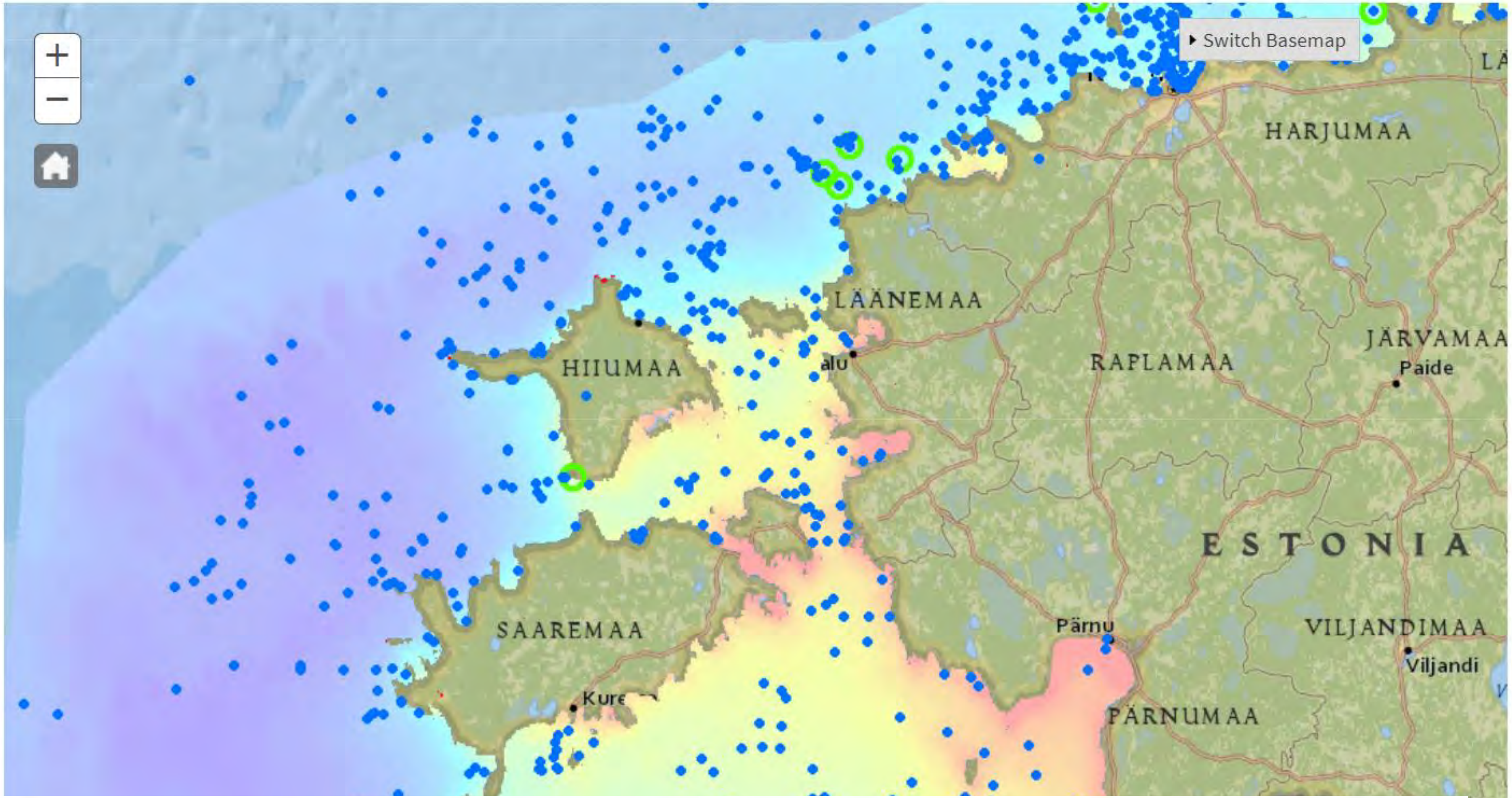
  - [ ] **Species richness of benthic flora**
  - [ ] **Environmental vulnerability profile**

- [ ] **Protected Areas**

- [x] **Underwater Cultural Heritage**
  - [x] **Estonian Maritime Museum**
  - [x] **Cultural monuments (points)**
  - [x] **Cultural monuments (polygons)**

- [ ] **Administrative boundaries**

Map




BalticRIM Baltic Sea Region Integrated Maritime Cultural Heritage Management

Interreg Baltic Sea Region

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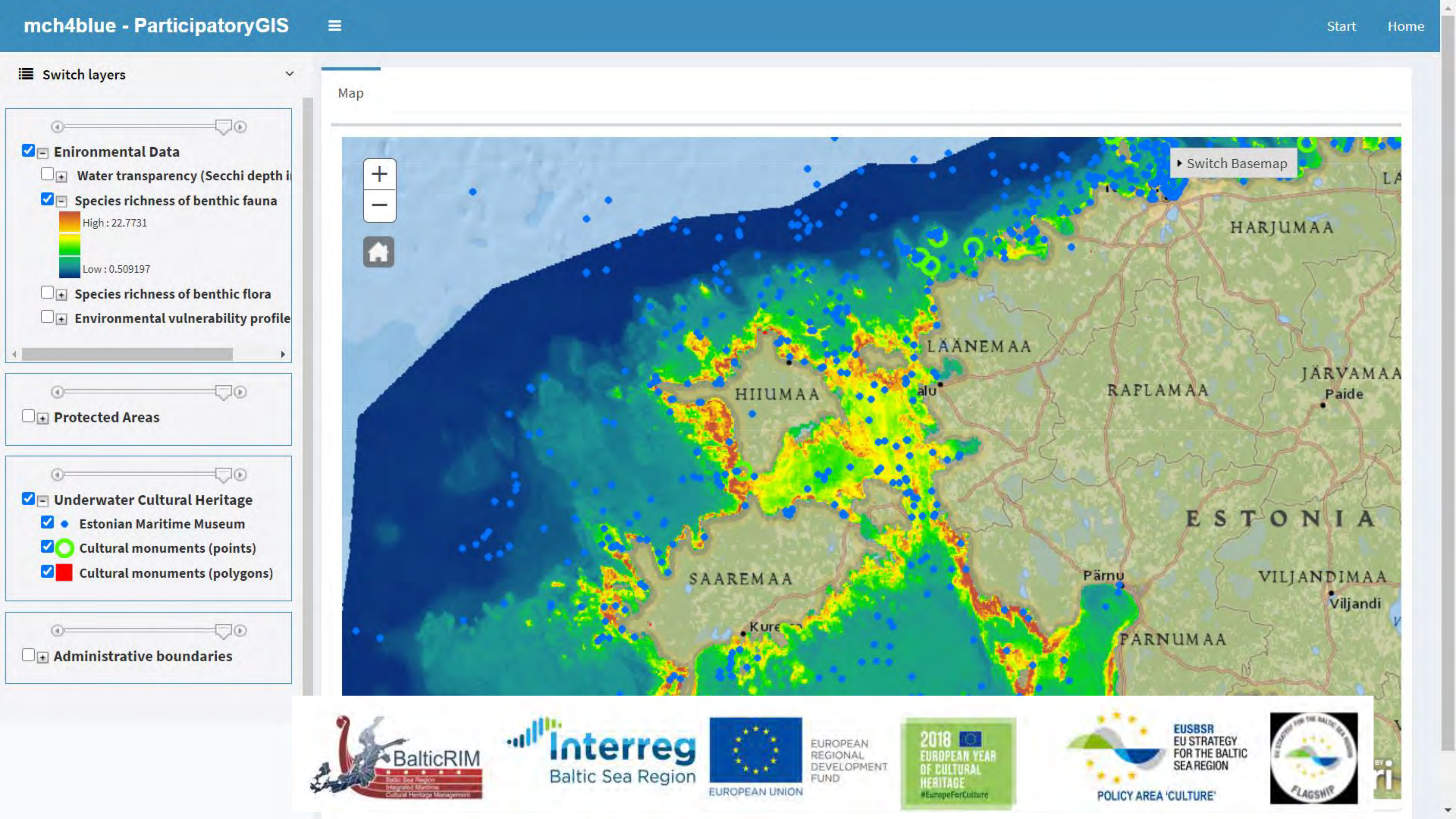
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Cultural monuments (polygons)
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# Conclusions

The mch4blue portal presents the data of marine natural values and maritime underwater cultural heritage that are publicly available for eco-divers and sustainable ecotourism in general

These data are publicly available also in support of the strategies of medium and long-term maritime sustainable ecotourism development to enhance its growth, consolidation, and sustainability at local, national, and regional level, based on the need of the local communities, through participative workshops, capacity building activities, and inclusive processes

BalticRIM Baltic Sea Region Integrated Maritime Cultural Heritage Management
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# Acknowledgements

This study was supported by European Regional Development Fund, INTERREG Baltic Sea Region project Baltic RIM "Baltic Sea Region Integrated Maritime Cultural Heritage Management"

# Thank you very much for your attention!

# Perspectives for Integrated Multitrophic Aquaculture in the Gulf of Finland

Georg Martin, Jonne Kotta, Jack Hall

*Estonian Martine Institute, University of Tartu*

The Gulf of Finland Science Days 2021
"New start for the Gulf of Finland co-operation"
Estonian Academy of Sciences, Tallinn, 29-30 November 2021

UNIVERSITY OF TARTU
Estonian Marine Institute

# Aquaculture in Estonia

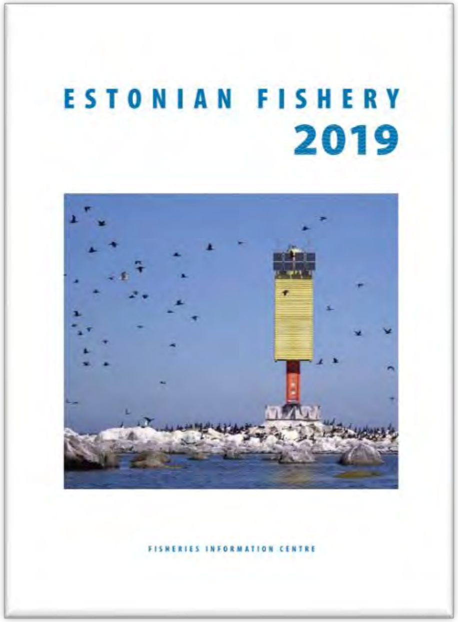




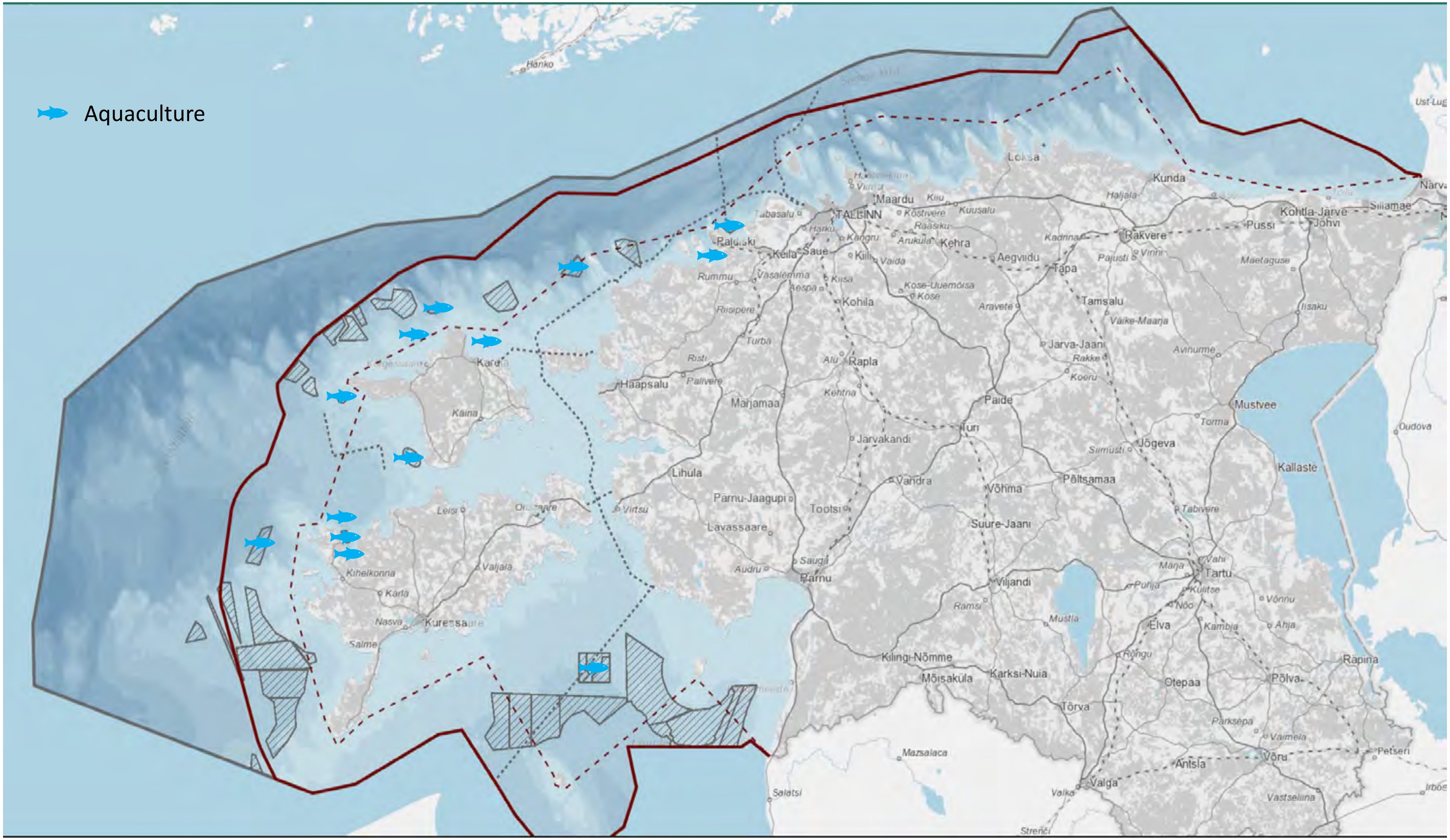
**Figure 50. Fish farms licensed by the Veterinary and Food Board and active in 2019**
Sources: Land Board, VFB.

| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eel | 46.0 | 30.0 | 20.3 | 2.0 | * | * | 127.0 | * | * | * | * | * |
| Crayfish | 0.7 | 2.0 | 0.4 | 0.6 | 0.1 | 0.4 | 0.2 | 0.6 | 0.7 | 0.8 | 0.6 | 0.9 |
| Carp | 52.3 | 45.4 | 39.4 | 37.5 | 38.2 | 43.7 | * | * | 33.8 | * | * | 29.8 |
| Rainbow trout | 333.8 | 549.0 | 487.5 | 333.8 | 455.3 | 465.5 | 569.6 | 559.0 | 680.4 | 702.2 | 804.1 | 927.0 |
| Other fish | 50.9 | 26.1 | 49.6 | 18.7 | 86.8 | 223.4 | 172.1 | 238.7 | 152.9 | 167.4 | 139.0 | 104.3 |
| **Total** | **483.7** | **652.5** | **597.2** | **392.6** | **580.4** | **733.0** | **868.9** | **798.3** | **867.8** | **870.5** | **944.0** | **1062.0** |
| Fish roe for human consumption | 6.7 | 7.4 | 4.5 | 0.1 | 4.1 | 5.0 | 3.1 | 7.3 | 4.9 | 3.8 | 3.2 | 6.3 |

* Data cannot be published due to data protection requirements.

Source: Statistics Estonia.

# Submitted applications for building permit in Estonian marine area. November, 2021




http://mereala.hendrikson.ee/kaardirakendus.html

# Land-based fish farms

Conventional tank

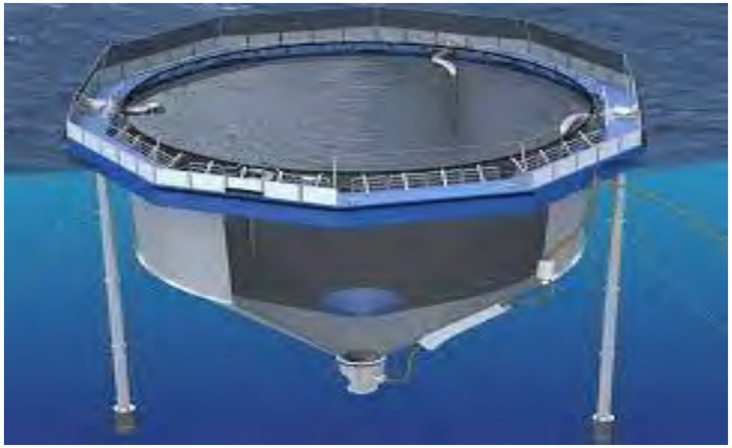
Conventional tank

Raceway trout Denmark

RAS - recirculation

# Open net farming

# Floating bag concept



Floating bags with dimension from 6 000 $m^3$ to 30 000 $m^3$. Pumping cost is 1 kwh per 1 kg fish produced, land-based farming is > 600%.

# Ship based concept

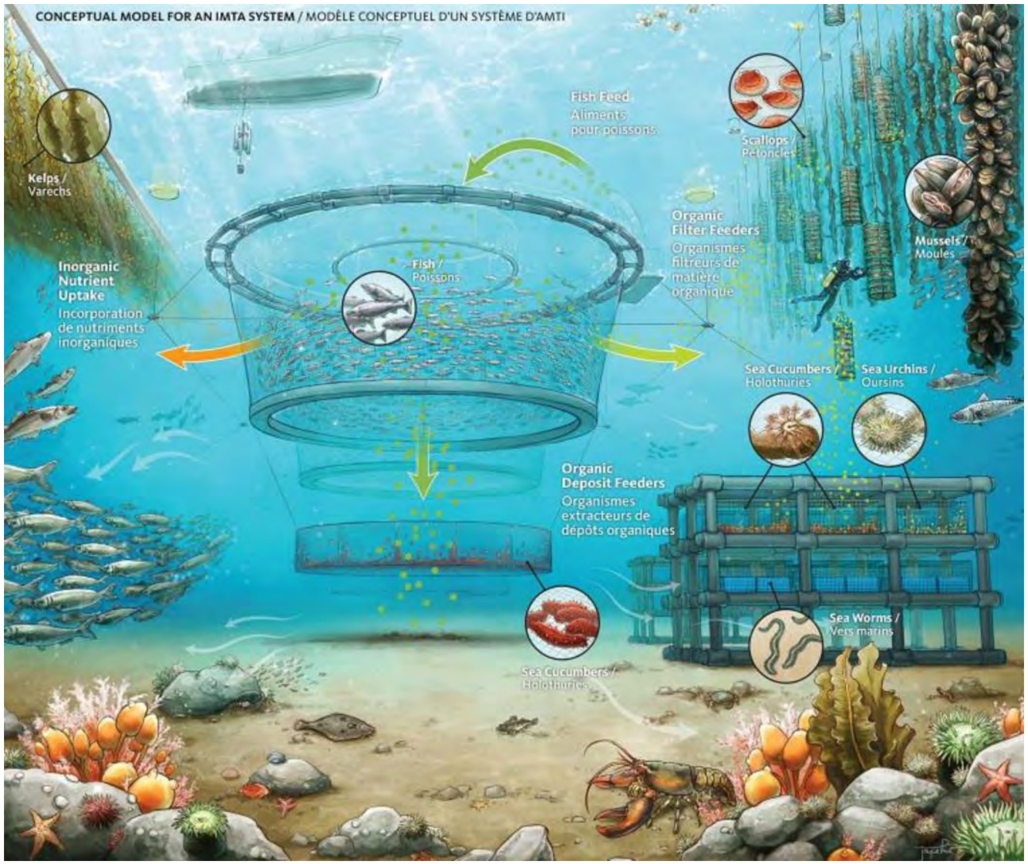

**Table 2a. Net nutrient input ceilings (NIC) of nitrogen** for the HELCOM countries, non-HELCOM countries in the Baltic Sea catchment area, other countries with airborne input, Baltic Sea shipping and North Sea shipping (in tonnes/year).

| | Bothnian Bay | Bothnian Sea | Baltic Proper | Gulf of Finland | Gulf of Riga | Danish Straits | Kattegat |
|---|---|---|---|---|---|---|---|
| Germany | 947 | 3,920 | 34,077 | 1,645 | 1,747 | 23,647 | 4,661 |
| Denmark | 280 | 1,148 | 9,025 | 421 | 462 | 28,067 | 28,538 |
| Estonia | 113 | 404 | 1,478 | 11,334 | 13,099 | 22 | 24 |
| Finland | 35,087 | 28,700 | 1,827 | 20,457 | 295 | 76 | 89 |
| Lithuania | 108 | 495 | 25,878 | 305 | 8,820 | 66 | 80 |
| Latvia | 73 | 330 | 6,457 | 246 | 43,074 | 31 | 34 |
| Poland | 668 | 3,125 | 151,997 | 1,407 | 1,596 | 1,480 | 1,443 |
| Russia | 839 | 1,993 | 10,317 | 61,503 | 3,296 | 238 | 245 |
| Sweden | 17,718 | 32,633 | 30,690 | 626 | 525 | 6,056 | 32,799 |
| Belarus | 1,375 | 5,008 | 26,947 | 2,986 | 2,188 | 4933 | 4,502 |
| Czech Republic | - | - | 13,456 | - | 12,820 | - | - |
| Ukraine | - | - | 3,551 | - | - | - | - |
| Other countries with airborne input | - | - | 1,693 | - | - | - | - |
| Baltic Sea shipping | 284 | 1,141 | 5,180 | 675 | 345 | 651 | 701 |
| North Sea shipping | 131 | 475 | 2,427 | 196 | 150 | 729 | 884 |

**Table 2b. Net nutrient input ceilings (NIC) of phosphorus** for the HELCOM countries, non-HELCOM countries in the Baltic Sea catchment area (in tonnes/year).

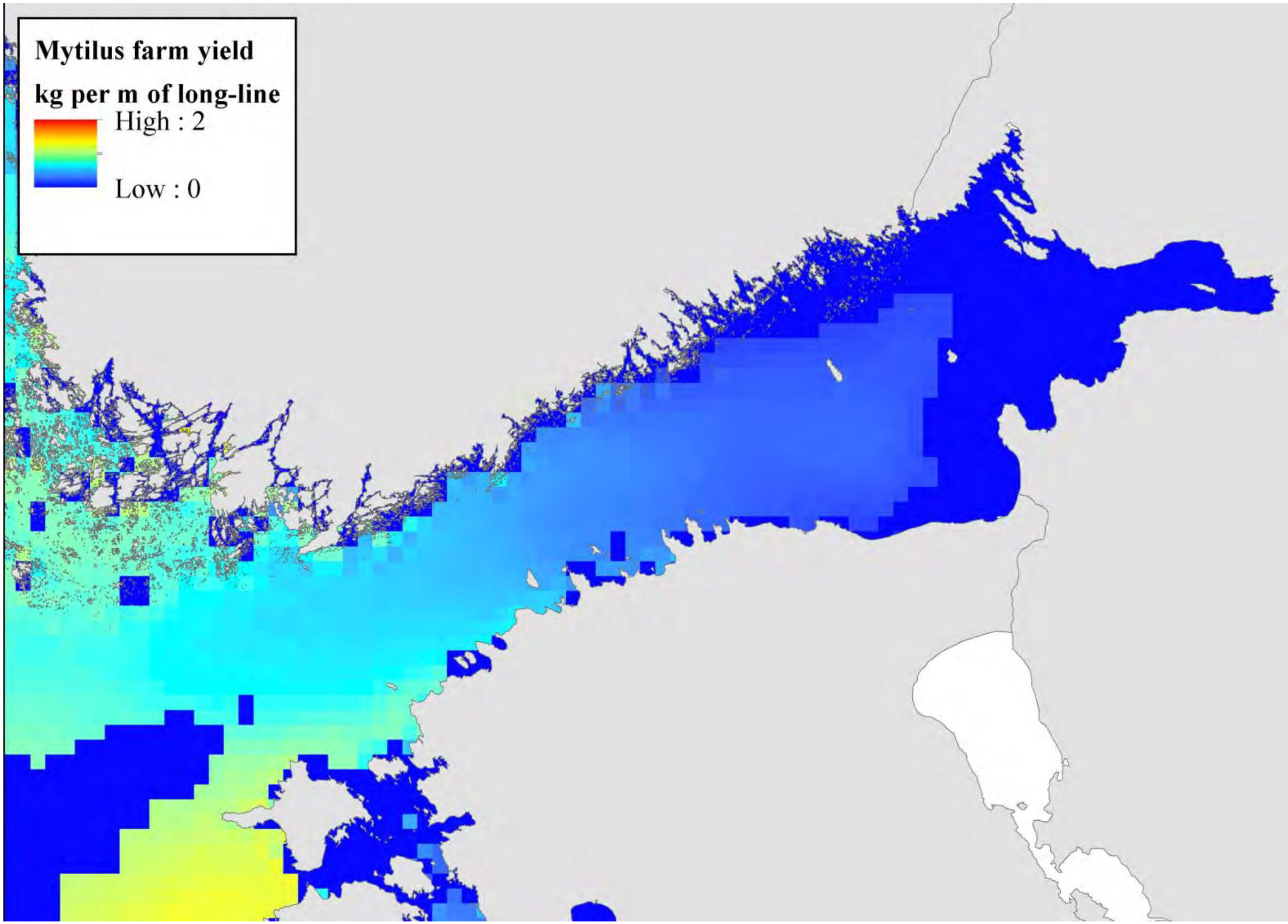
| | Bothnian Bay | Bothnian Sea | Baltic Proper | Gulf of Finland | Gulf of Riga | Danish Straits | Kattegat |
|---|---|---|---|---|---|---|---|
| Germany | - | - | 109 | - | - | 401 | - |
| Denmark | - | - | 21 | - | - | 979 | 815 |
| Estonia | - | - | 9 | 225 | 185 | - | - |
| Finland | 1,683 | 1,246 | - | 315 | - | - | - |
| Lithuania | - | - | 703 | - | 175 | - | - |
| Latvia | - | - | 167 | - | 1,061 | - | - |
| Poland | - | - | 4,291 | - | - | - | - |
| Russia | - | - | 242 | 2,909 | 99 | - | - |
| Sweden | 811 | 1,133 | 318 | - | - | 116 | 753 |
| Belarus | - | - | 349 | - | 407 | - | - |
| Czech Republic | - | - | 57 | - | - | - | - |
| Ukraine | - | - | 47 | - | - | - | - |

# What is IMTA system?

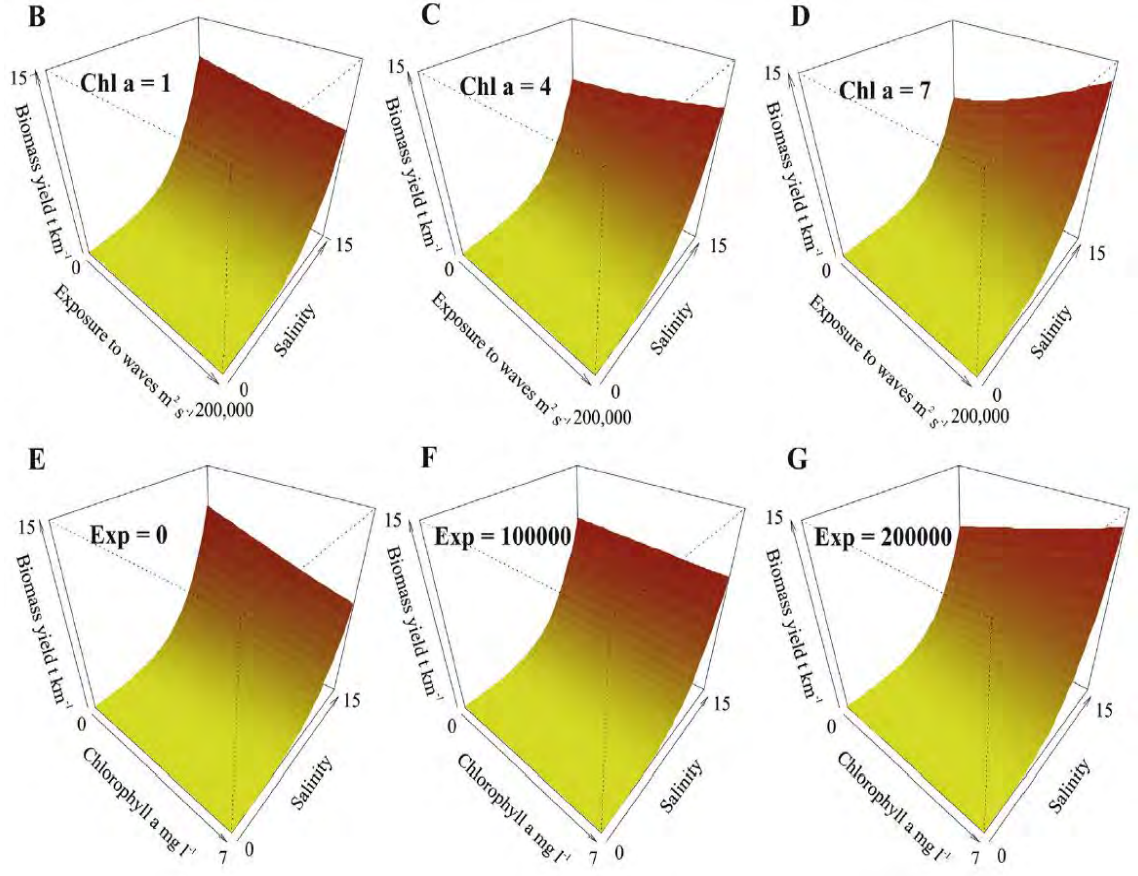



Integrated multi-trophic aquaculture (IMTA) provides the byproducts, including waste, from one aquatic species as inputs (fertilizers, food) for another. Farmers combine fed aquaculture (e.g., fish, shrimp) with inorganic extractive (e.g., seaweed) and organic extractive (e.g., shellfish) aquaculture to create balanced systems for environment remediation (biomitigation), economic stability (improved output, lower cost, product diversification and risk reduction) and social acceptability (better management practices).

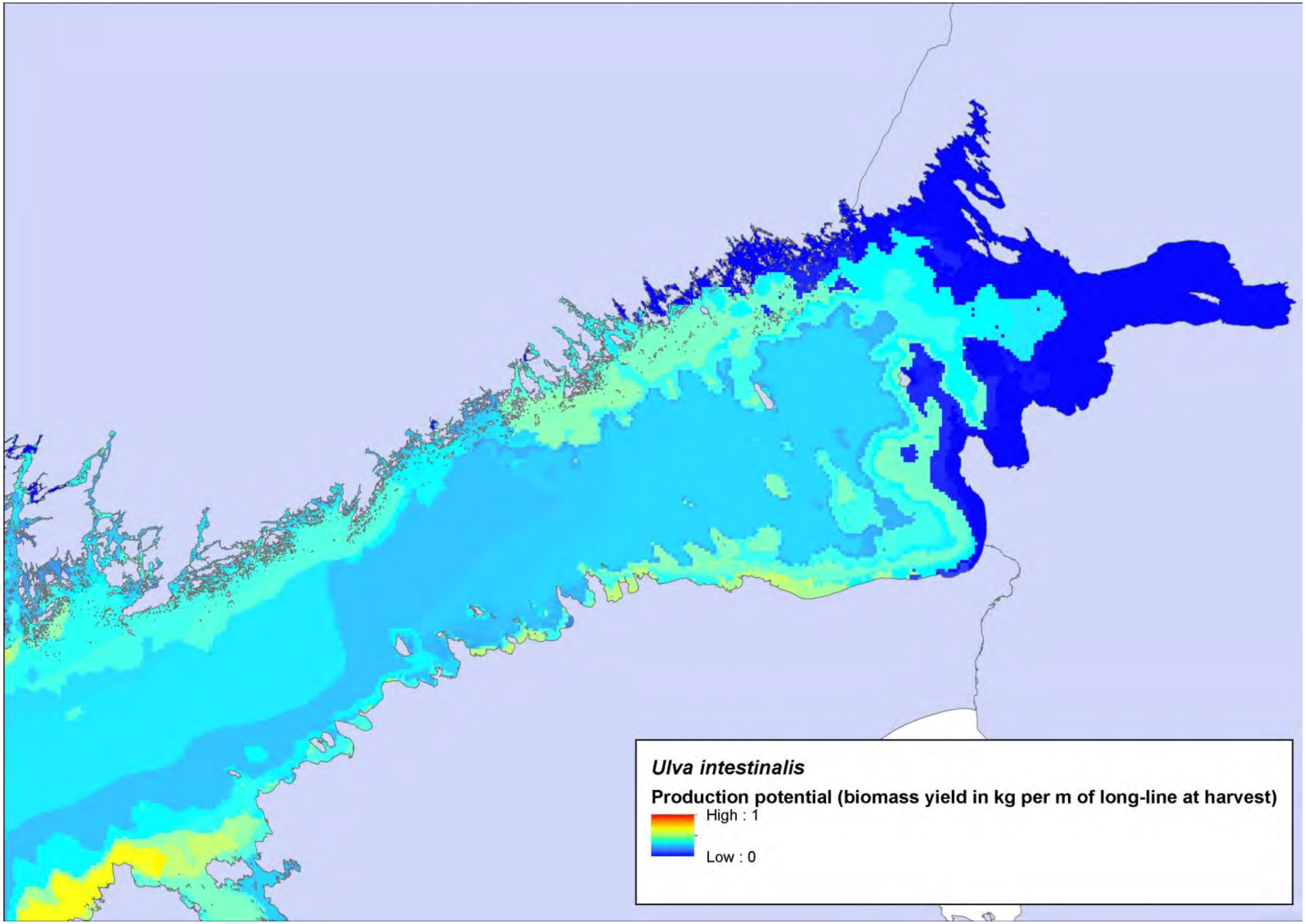
(Chopin *et al* 2001)



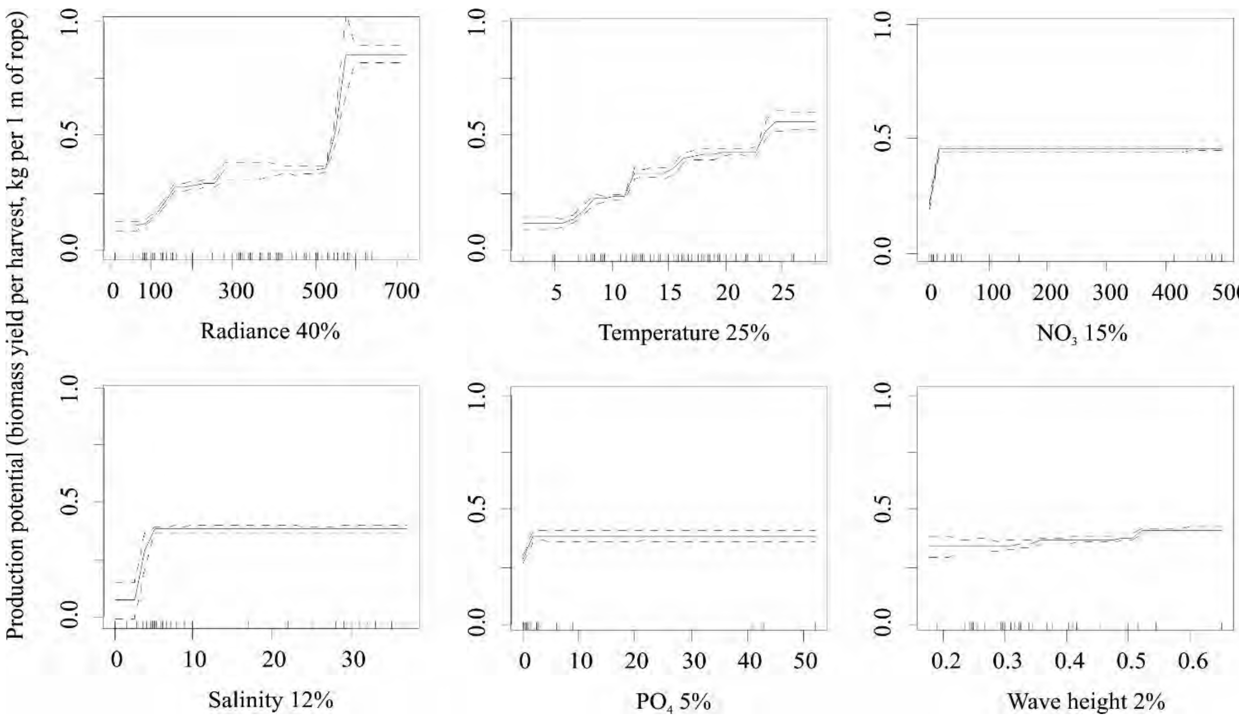

Kotta et al 2020




Kotta et al 2020




Kotta et al 2022


Kotta et al 2022

# Project (2017-2021): Treating of fish-farm effluents by cultivation of macroalagae.

EMKF RAKENDUSKAVA 2014-2020

Euroopa Liit
Euroopa Merendus- ja Kalandusfond

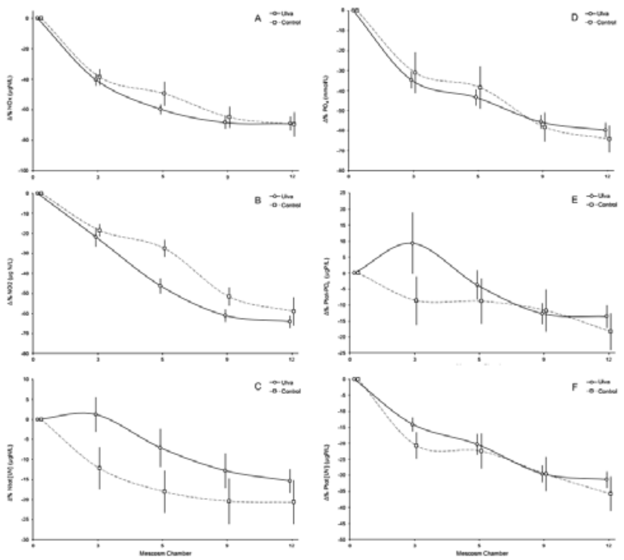


Figure 1: Change in the mean concentration of the nutrients (A = nitrite; B = nitrate; C = total nitrogen; D = phosphate; E = phosphorus; and F = total phosphorus) as a percentage relative to the initial trout stocked mesocosm across the mesocosm series. The mesocosms ranked four, five and six in the Ulva series were stocked with macroalgae. The control series contained no macroalgae. Error constructed as ±1 standard error.

TARTU ÜLIKOOL

EMKF RAKENDUSKAVA 2014-2020

**MEREVEEL PÕHINEVA KALAKASVATUSE HEITVEE PUHASTAMINE SUURVETIKATE KULTIVEERIMISE KAUDU**

Euroopa Merendus ja Kalandusfondi rakenduskava 2014-2020 meetme 2.1

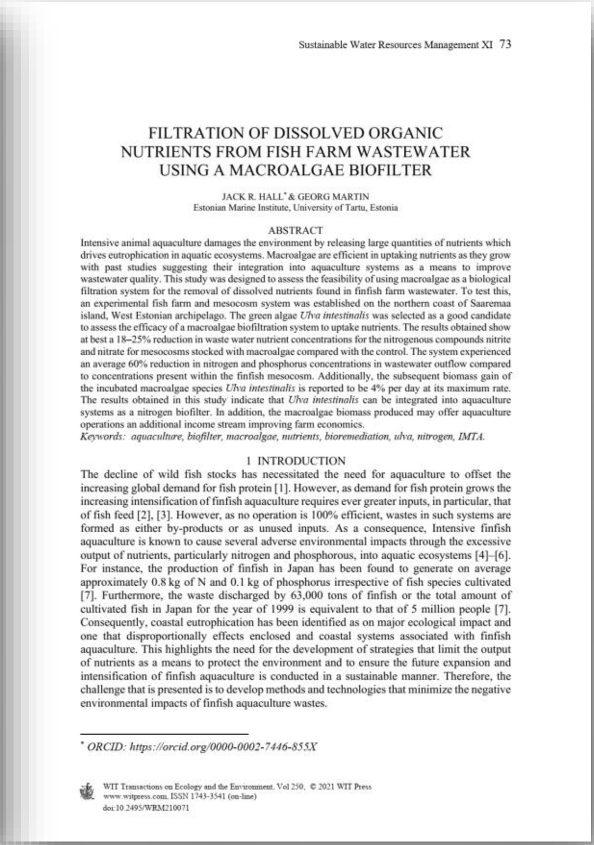
"Vesiviljeluse innovatsioonitoetus" projekti lõpparuanne

(projekti viitenumber 821017780003)

Toetuse saaja: Tartu Ülikool

Aruande koostaja: Georg Martin (TÜ Eesti mereinstituut)

2021





## FILTRATION OF DISSOLVED ORGANIC NUTRIENTS FROM FISH FARM WASTEWATER USING A MACROALGAE BIOFILTER


JACK R. HALL* & GEORG MARTIN
Estonian Marine Institute, University of Tartu, Estonia



ABSTRACT

Intensive animal aquaculture damages the environment by releasing large quantities of nutrients which drives eutrophication in aquatic ecosystems. Macroalgae are efficient in uptaking nutrients as they grow with past studies suggesting their integration into aquaculture systems as a means to improve wastewater quality. This study was designed to assess the feasibility of using macroalgae as a biological filtration system for the removal of dissolved nutrients found in finfish farm wastewater. To test this, an experimental fish farm and mesocosm system was established on the northern coast of Saaremaa island, West Estonian archipelago. The green algae *Ulva intestinalis* was selected as a good candidate to assess the efficacy of a macroalgae biofiltration system to uptake nutrients. The results obtained show at best a 18–25% reduction in waste water nutrient concentrations for the nitrogenous compounds nitrite and nitrate for mesocosms stocked with macroalgae compared with the control. The system experienced an average 60% reduction in nitrogen and phosphorus concentrations in wastewater outflow compared to concentrations present within the finfish mesocosm. Additionally, the subsequent biomass gain of the incubated macroalgae species *Ulva intestinalis* is reported to be 4% per day at its maximum rate. The results obtained in this study indicate that *Ulva intestinalis* can be integrated into aquaculture systems as a nitrogen biofilter. In addition, the macroalgae biomass produced may offer aquaculture operations an additional income stream improving farm economics.



*Keywords: aquaculture, biofilter, macroalgae, nutrients, bioremediation, ulva, nitrogen, IMTA.*

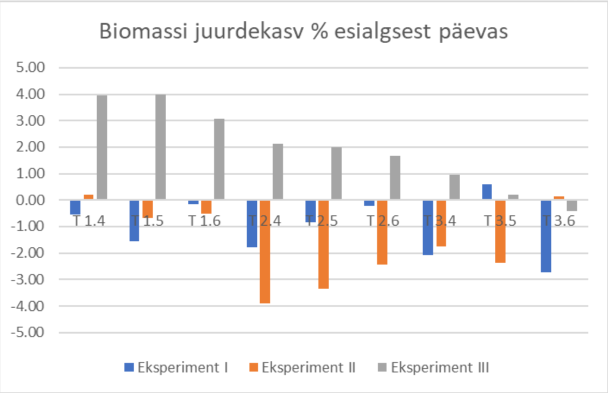

### 1 INTRODUCTION

The decline of wild fish stocks has necessitated the need for aquaculture to offset the increasing global demand for fish protein [1]. However, as demand for fish protein grows the increasing intensification of finfish aquaculture requires ever greater inputs, in particular, that of fish feed [2], [3]. However, as no operation is 100% efficient, wastes in such systems are formed as either by-products or as unused inputs. As a consequence, Intensive finfish aquaculture is known to cause several adverse environmental impacts through the excessive output of nutrients, particularly nitrogen and phosphorous, into aquatic ecosystems [4]–[6]. For instance, the production of finfish in Japan has been found to generate on average approximately 0.8 kg of N and 0.1 kg of phosphorus irrespective of fish species cultivated [7]. Furthermore, the waste discharged by 63,000 tons of finfish or the total amount of cultivated fish in Japan for the year of 1999 is equivalent to that of 5 million people [7]. Consequently, coastal eutrophication has been identified as on major ecological impact and one that disproportionally effects enclosed and coastal systems associated with finfish aquaculture. This highlights the need for the development of strategies that limit the output of nutrients as a means to protect the environment and to ensure the future expansion and intensification of finfish aquaculture is conducted in a sustainable manner. Therefore, the challenge that is presented is to develop methods and technologies that minimize the negative environmental impacts of finfish aquaculture wastes.


* ORCID: https://orcid.org/0000-0002-7446-855X



WIT Transactions on Ecology and the Environment, Vol 250, © 2021 WIT Press
www.witpress.com, ISSN 1743-3541 (on-line)
doi:10.2495/WRM210071


- 3 trials – 5 weeks in length / 2 seasons
- Fish tank stocked with rainbow trout
- Tanks stocked with 2kg macroalgae, different species tested
- Fourth series left as control

# Ulva as Biofilter

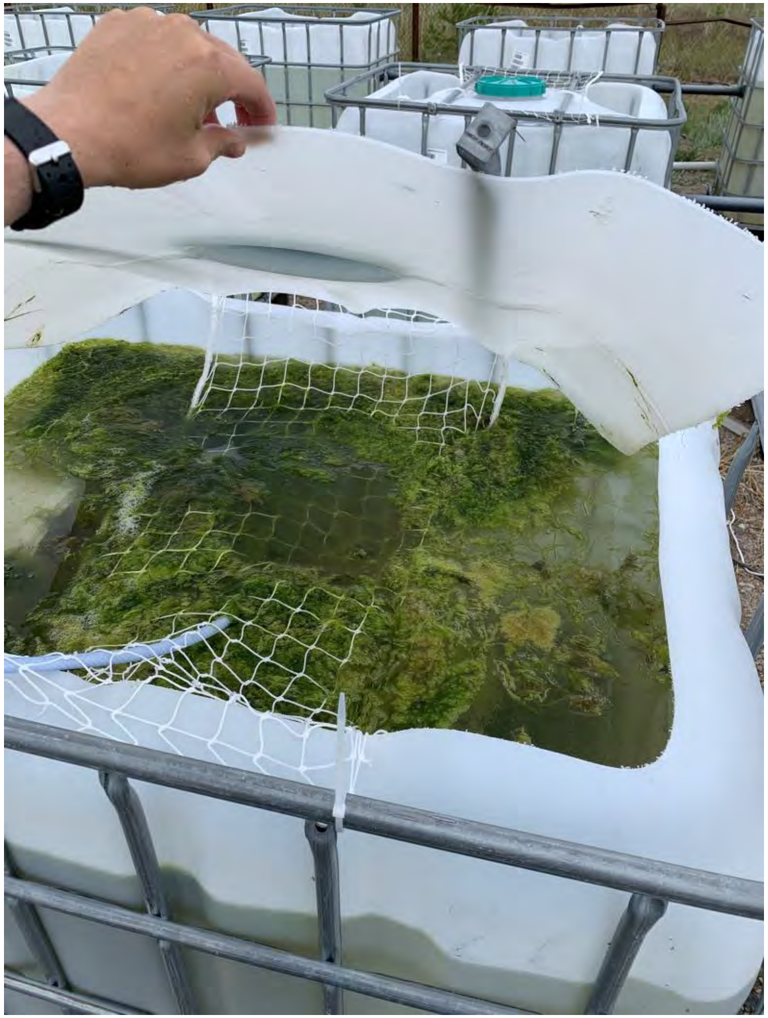
High nutrient uptake rates

Fast growing

Long vegetative period

Can grow unattached

Ulva widely distributed and easy to grow



# Growth Rate

Under peak conditions a 4% biomass growth/24 hour rate was achieved

However, growth was highly variable due to day time temperature spikes and other factors associated with outdoor cultivation

# Feasibility Study of West Estonia

# Aquaculture potential and circular economy 2020-30

The Report is structured according to guidelines stated in the public procurement reference number 232693

30 June 2021

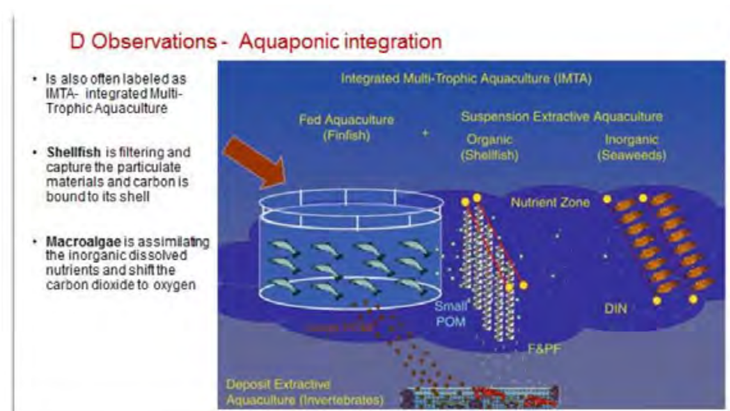

**Authors**

Knut Senstad, Aquaconsulting Senstad, senstadknut@gmail.com, phone + 47 95171617

Aquaponic analyses linked to the fish farming setup are provided from Prof. Jonne Kotta and Prof. Georg Martin, Estonian Marine Institute, University of Tartu, Estonia

Norway 30. June 2021

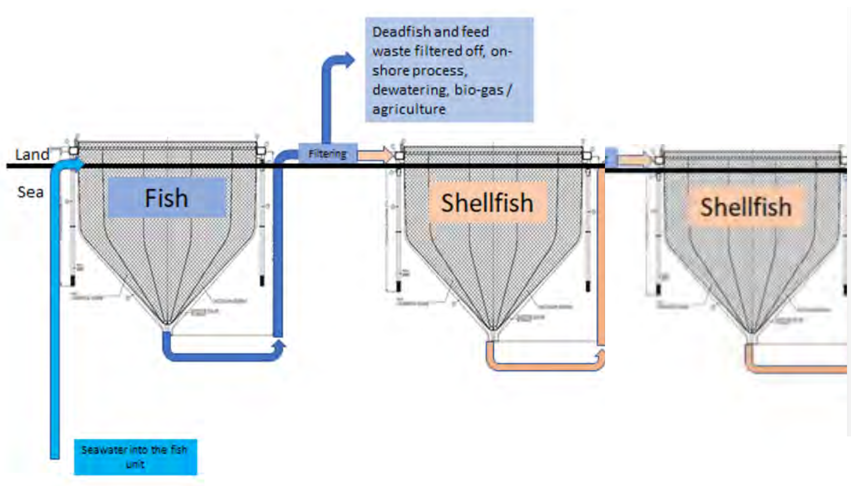


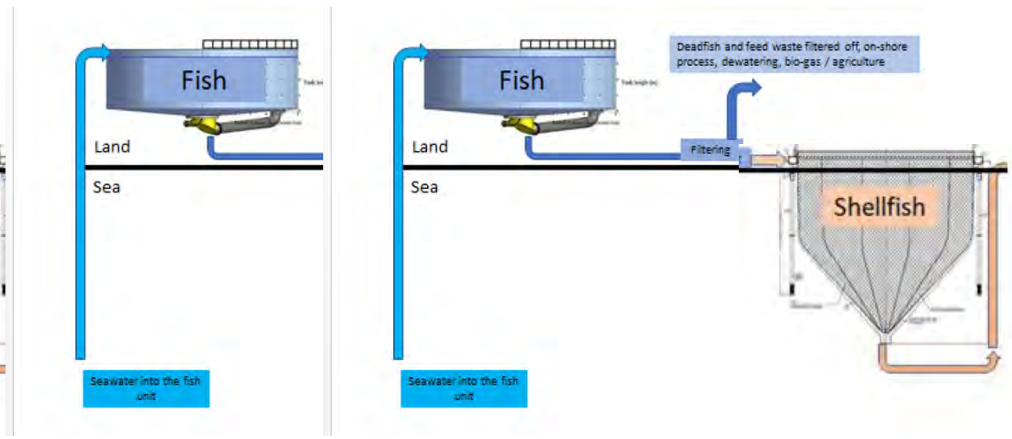



# Aquaponic mussel and organic waste

Aquaponic mussel integration to fish farming by use of land-based tanks or the floating bag concept; possibility to establish neutral organic waste flux to the sea

| Floating bag concept | Tanks on land |
|---|---|




2x fishbags per 1x mussel bag
400 tons fish - 24 tons mussel per year

4x fishtanks per 1x mussel bag
400 tons fish - 24 tons mussel per year

Senstad et al 2021

# Circular economy - mussel

**Aquaponic modeling mussel**

**Modeling –**
- Growth/filtering capacity
- concentration of suspended particles
- winter/summer
- mortality, predation

**Harvest planning-**

- optimum quality or alternative:
- Mussel populations can easy stay for a longer period
- => capturing suspended organic particles to avoid nutrient emissions to sea rather than optimize the mussel biomass
- Multiple choice

**Floating bags / fish tanks creates** a steady mussel food flow 24/7

Productivity is approx. 24 tons live weight per mussel bag per year (48 tons per 2 years) for every 400 tons live fish biomass

Senstad et al 2021

# Circular economy - mussel

**Circular economy Mussel**

**The starting point of the aquaponic integration** starts with a sea-based mussel seedling cultivation

- best location
- Planning time of year- spring
- cultivation techniques

**Advantages**

- avoid red tides
- reduce the contaminations of bio-accumulation
- 24/7 food supply will result in a good winter growth
- creates outfluxes of carbon and may eliminate total organic fluxes

**Risk factors**

- diseases/predation
- how to ensure that the food particles are suspended in the water column
- cultivation and harvest technique in the mussel bags must be investigated

**Circular economy**

- Employment
- harvesting and value-added processing line- not specified here
- 20 000 tons fish production may equal to 1 200 tons mussel biomass

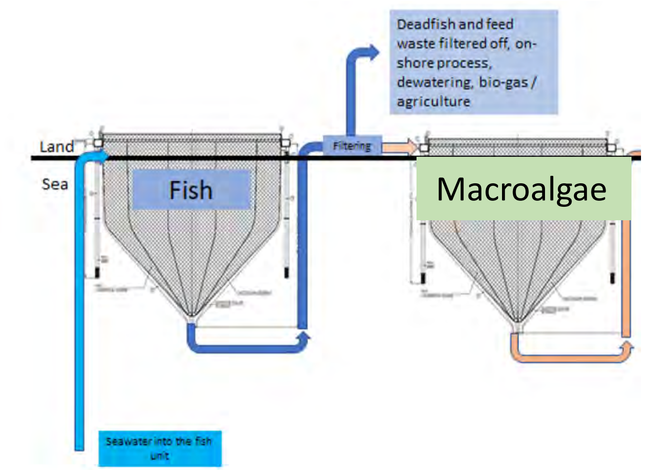
⇒ Mussel may act as feed ingredient for both land animal and for fish, as well as human food, or act just as a filter capturing organism

Senstad et al 2021

# Aquaponic macroalgae nutrient assimilation

Aquaponic macroalgae integration to fish farms by use of land-based tanks or the floating bag concept

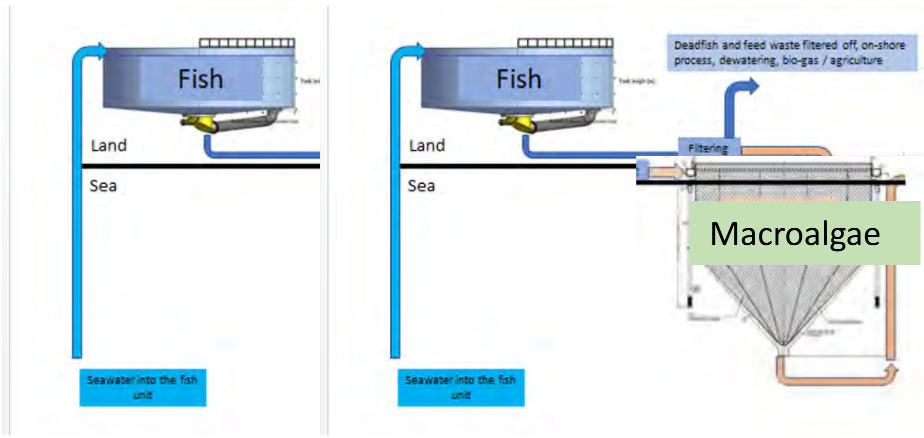
**Floating bag concept**




Best solution

4x fish bag for every 1x algae bag

**Tanks on land**




If good location is found- we predict that floating mussel bags represent a capex and cost advantage compare to land-based macroalgae cultivation

Senstad et al 2021

# Circular economy - macroalgae

**Circular economy Macroalgae**

**Best cultivation techniques for aquaponic**

- Sun light/ suspended in the water column
- Not attached to substrate nor bentic

**Final product**

- chemical content
- added value
- food/feed chain
- energy

**Productivity**

A large fish bag may produce

- 200 tons fish biomass per year
- 20 bags may represent 4 000 tons fish=> preliminary observations is that we here can integrate approx. 5x algae bags
- producing 5 x 1 620 tons wet weight algae per year (8 000 tons)- 200% more than fish biomass

**These estimates are based upon**

- our assumptions as of today
- The large waterflow from the fish tanks can disturb the assimilation efficiency
- should be verified under controlled cultivation

Senstad et al 2021

# Environmental impact

| | Nitrogen gram/kg fish | Phosphorus gram/kg fish |
|---|---|---|
| Current Water Act per 1kg fish produced | 50,0 | 7,0 |
| Latest Baltic fish feed Open nets | 44,4 | 5,1 |
| Tanks/ bags **excluding mechanical water filtration** | 37,6 | 4,0 |
| Tanks/bags **with water filtration 100 micro** | 35,5 | 2,7 |
| Tanks/bags with water filtration + **mussel** | 33,7 | 1,6 |
| Tanks/bags with water filtration + **mussel + algae** | **20,2 gram (-60%)** | **0,8 gram (-89%)** |

Physical integrated aquaponic algae and mussel to Open net farming is impossible

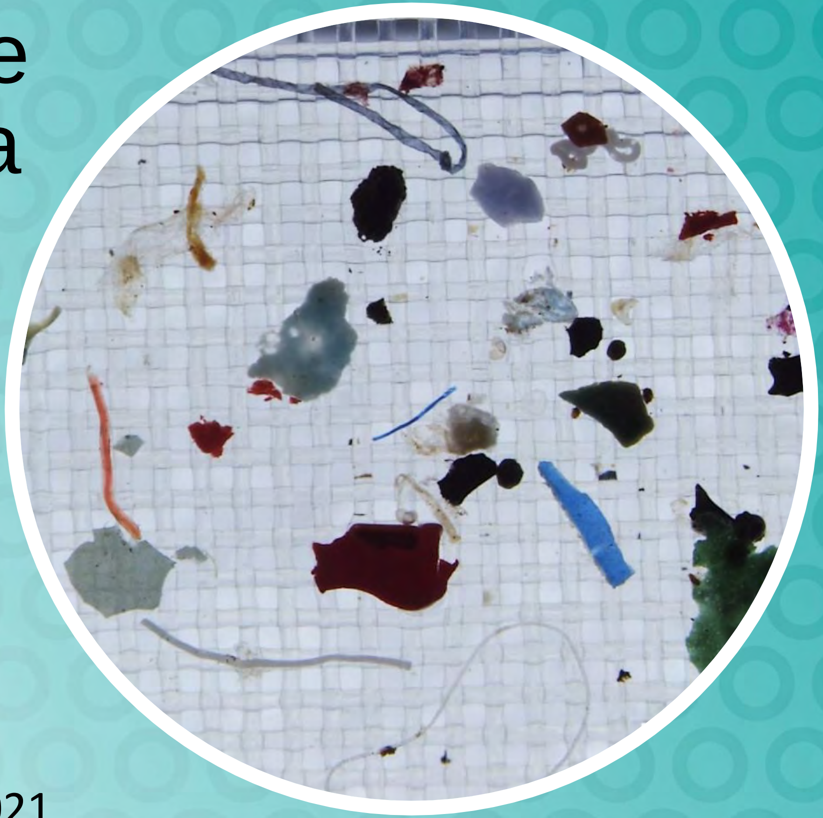
Organic waste can be fully captured by the filtering mussel for tanks on land and floating fish bags
Open sea cultivation of macroalgae *Ulva intestinalis* is difficult to setup, fragile, weather conditions - problematic economy platform?
Open sea cultivation of blue mussel is capable of capture waste volume of ambient natural suspended organic materials, that can counterbalance the fluxes from fish farming activity - however the cultivation dimensions are very very large

Senstad et al 2021

# Conclusions - Recommendations

- IMTA concept has great potential possibly enabling extensive marine based finfish aquaculture in nutrient enriched GoF environment
- IMTA approach can be applied in different setups utilising different finfish aquaculture technologies
- Experimental, near real size farm/station should be established to verify efficiency of removal of nutrients and particulate organic matter from fish-farm effluents by combining filtering thechnologies ant IMTA
- Efforts should be made to create a market based solutions for utilising the mussel and macroalgal biomass from IMTA setup

# Microplastics in the northern Baltic Sea bottom sediments



**Jyri Tirroniemi, Outi Setälä, Maiju Lehtiniemi**

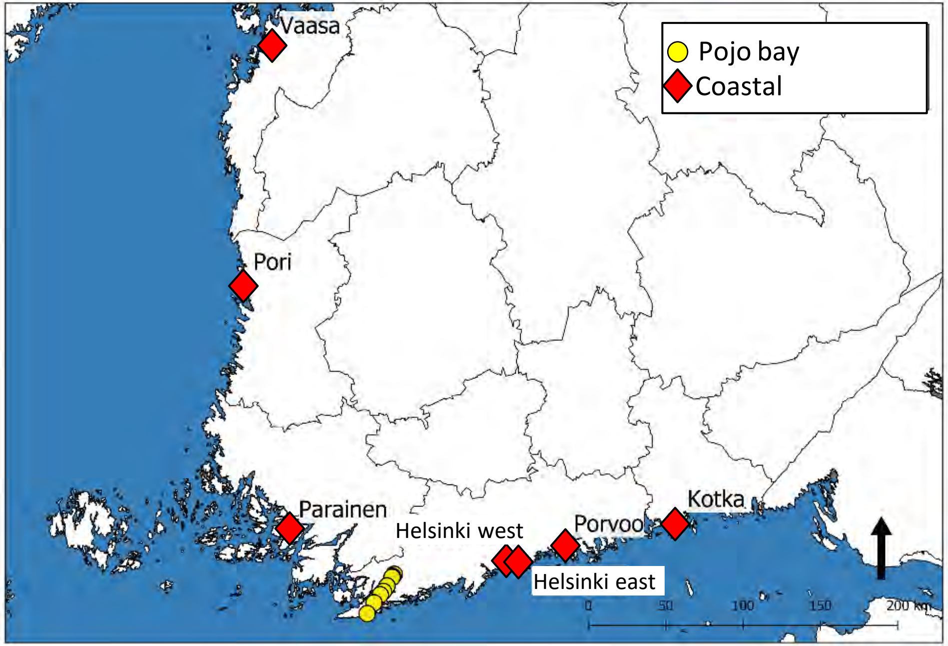
The Finnish Environment Institute

Gulf of Finland Science Days, 29-30.11.2021

SYKE

# Aims

- Microplastic (MP) concentration in coastal soft bottom sediments
- Testing and developing methods for monitoring
  - Sediment sampler
  - Extraction of microplastics
  - Filter mesh size
  - Detection, measuring and quantifying of MPs




SYKE

# Sediment sampling and pre-treatment

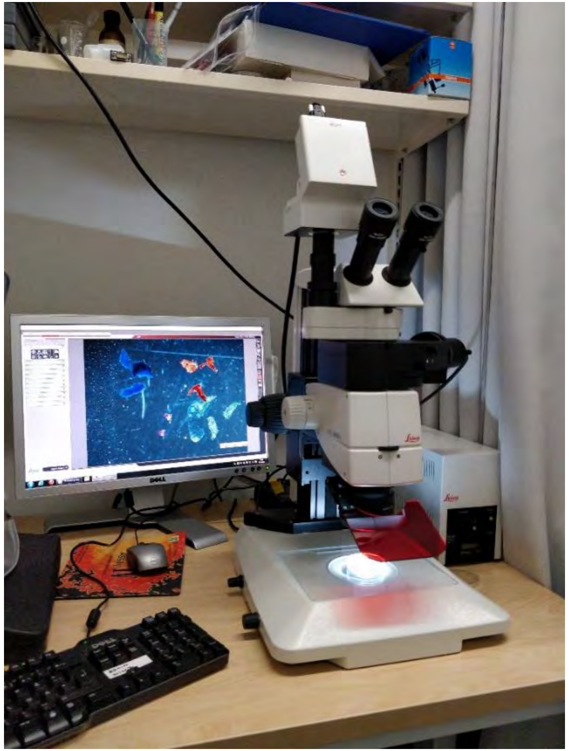
# Treatment and analyzes

- Density separation with Sediment-Microplastic Isolation (SMI) unit
  - Zinc chloride 1.5 g/cm3
- Treatment with cellulase, chitinase and hydrogen peroxide
- Second density separation

SYKE

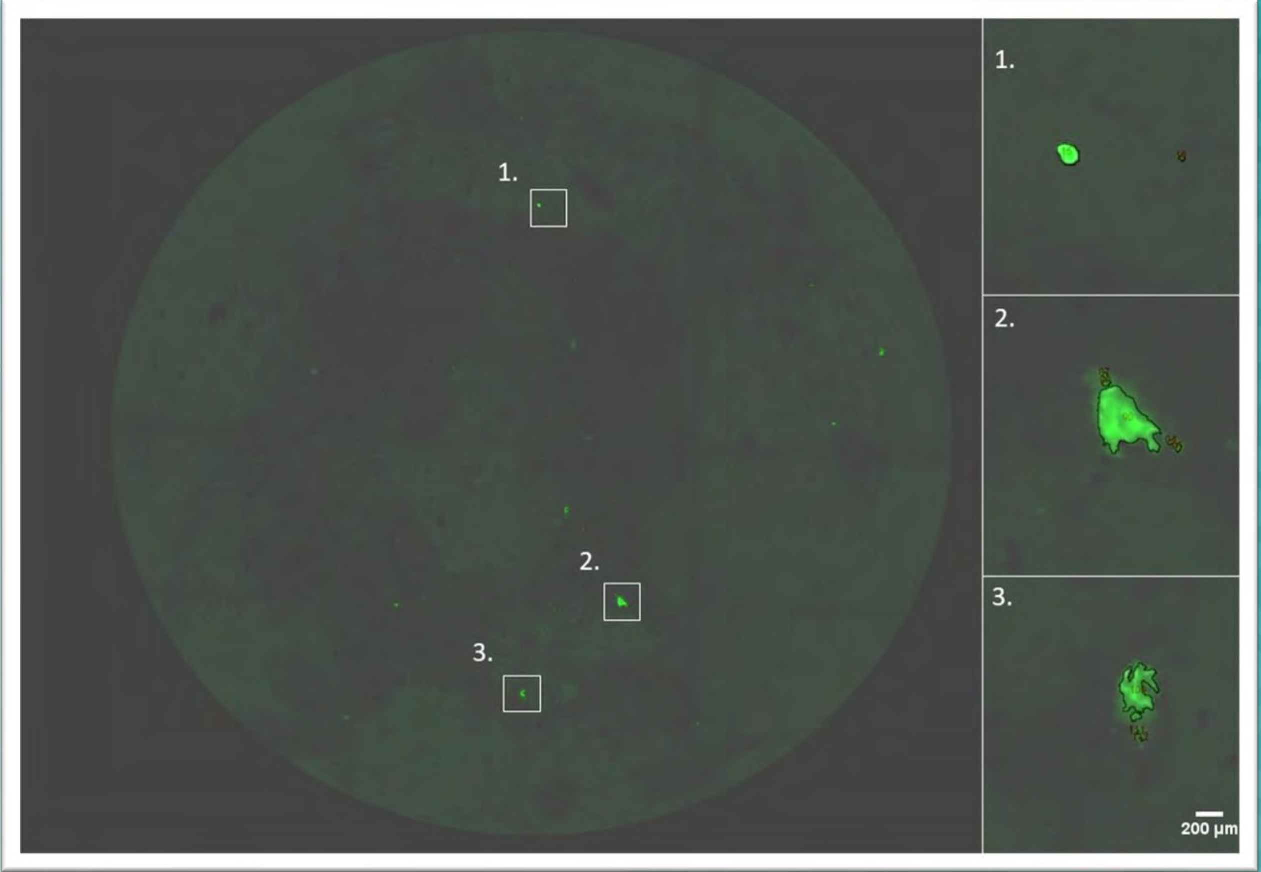
# Treatment and analyzes

- After extraction samples were stained with Nile red in acetone 0.1 mg/ml
- Photographed with Leica M 165 FC fluorescent microscope
- 9 separated pictures stitched together
- Analyzed with Fiji software
- Selection of particles analyzed with FTIR



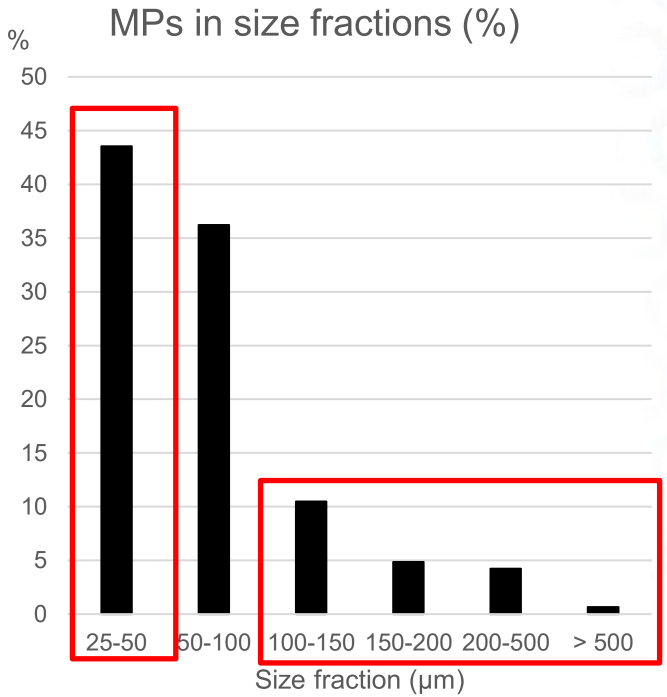
SYKE

# Results



# Result: smaller plastics are more abundant

- Smallest size fraction (25-50 µm) had significantly more MP particles than four biggest size fractions
- 80 % of particles found were under 100 µm in diameter

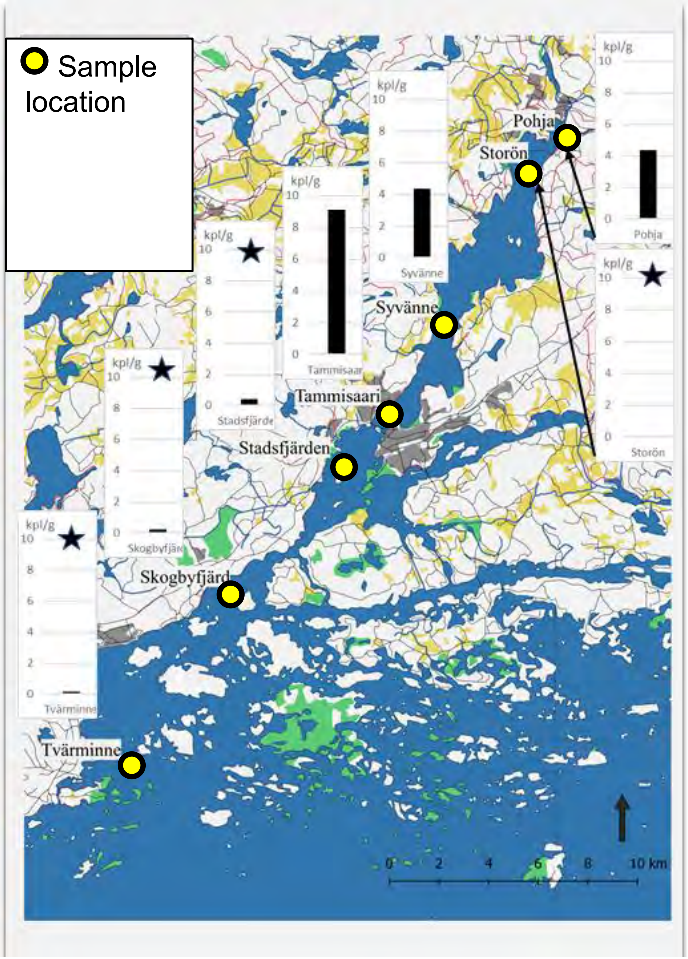




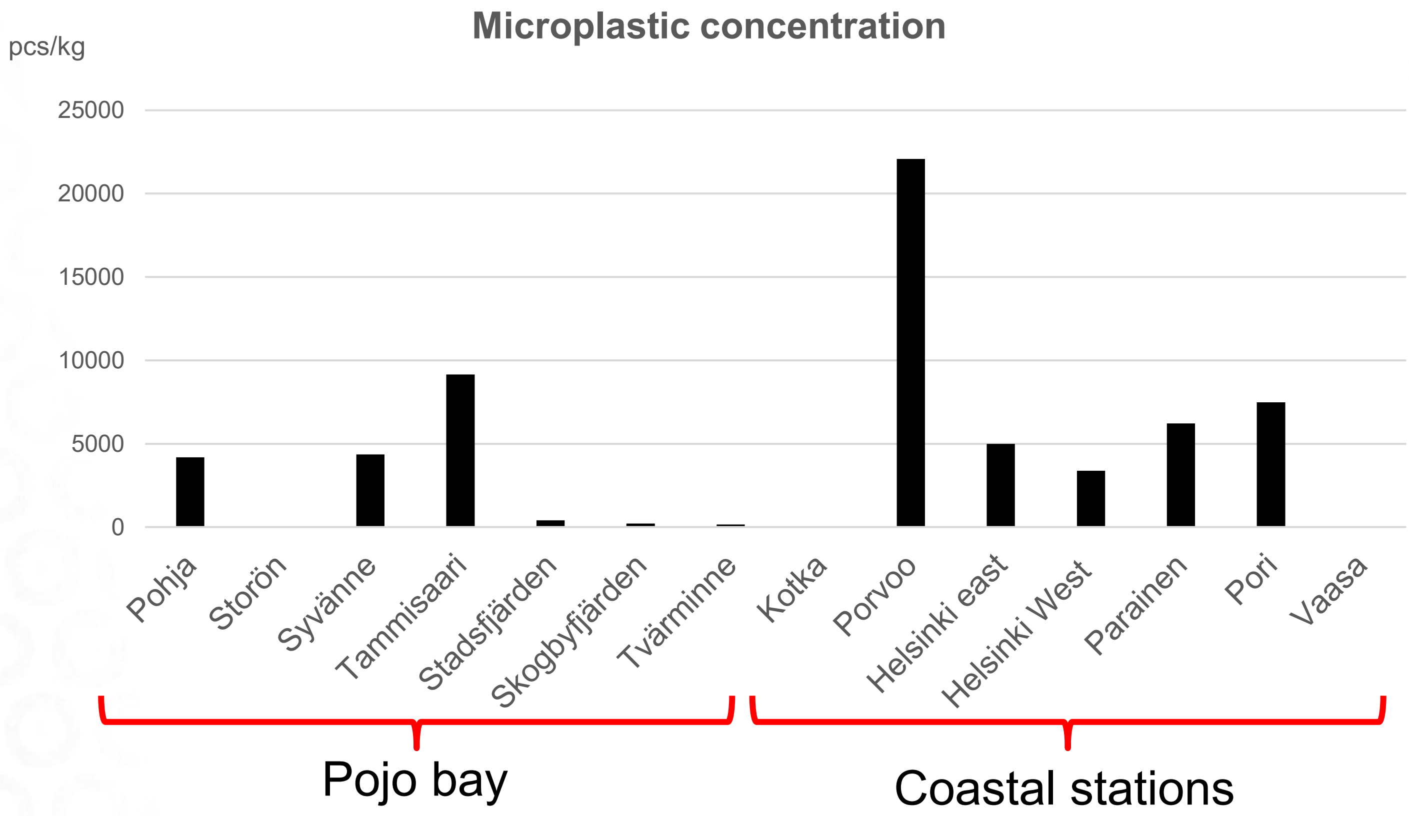

SYKE

# Results: High spatial variation (20-5000 µm)

- Tammisaari differed significantly from four location within Pojo bay (marked with ★)
- Other locations with higher concentrations were Pohja (river mouth) and Syvänne (deepest location in Pojo Bay)
- Strong variations in MP number within Pojo Bay



# Results: MPs (20-5000 µm) particles/ kg dry sediment




SYKE

# Summary

- Among the first sediment results from the northern Baltic Sea
- High MP concentrations
- Number of MPs varied greatly even within small area (few km)
- More samples needed for holistic assessment
- Smaller microplastics are more abundant than larger ones
- Results were used for developing monitoring

S Y K E

# Thank you for the attention!

Jyri Tirroniemi, researcher
Finnish Environment Institute SYKE
Contact: jyri.tirroniemi@syke.fi


SYKE

@roskasakki
@Jyri_Tirroniemi

POMERO PROJECT

PRO MARE BALTICUM
WALTER JA ANDRÉE DE NOTTBECKIN SÄÄTIÖ

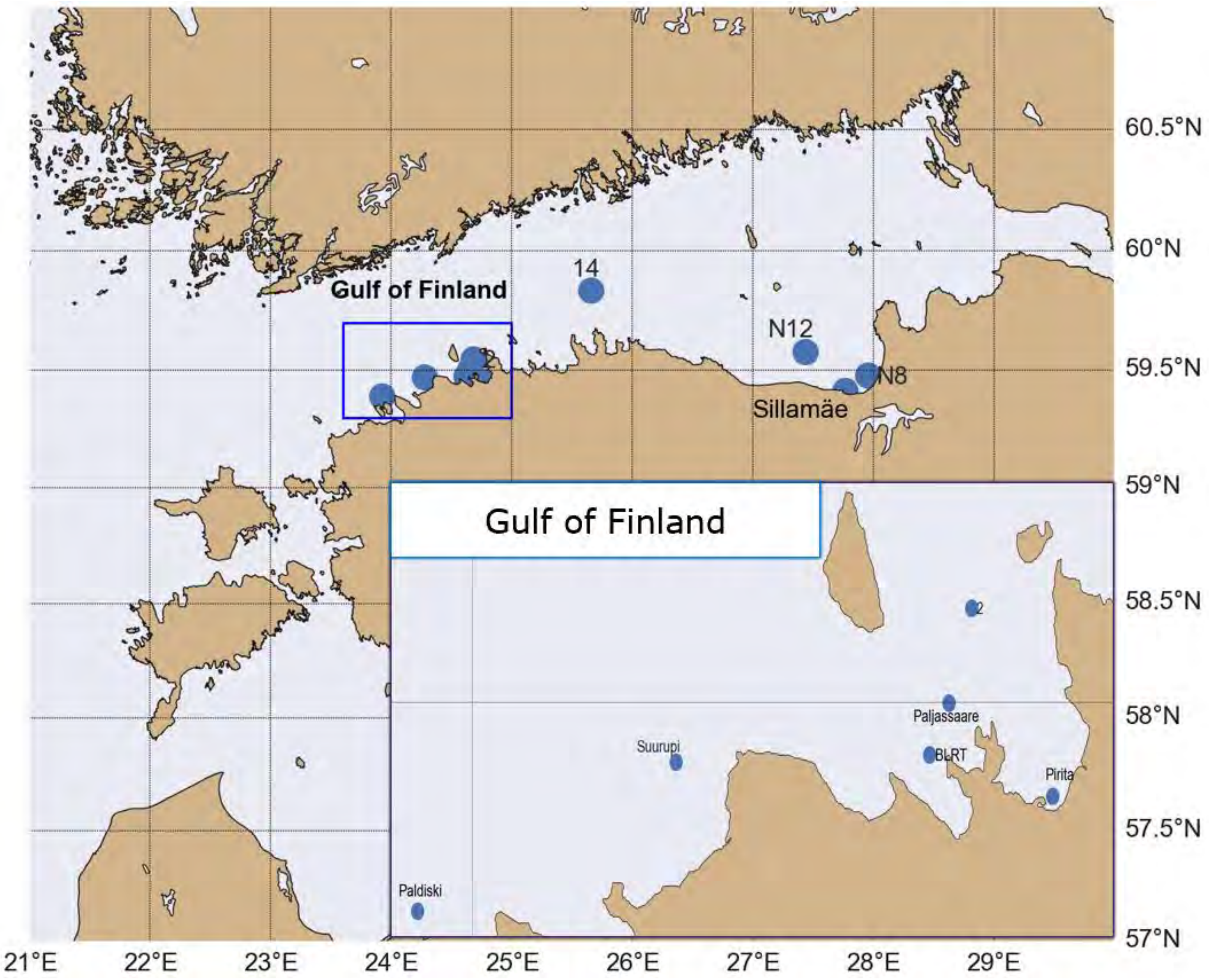
ACADEMY OF FINLAND

# SPATIAL AND TEMPORAL DISTRIBUTION OF MICROPLASTICS IN THE GULF OF FINLAND

Arun Mishra, Natalja Buhhalko, Kati Lind, Inga Lips, Urmas Lips, Taavi Liblik, Germo Väli
Department of Marine Systems
Tallinn University of Technology

# STUDY AREA

- In total 10 sampling stations were visited during the Monitoring Cruise from 2016-2020.
- The GOF was further divided into GOFW, GOFC and GOFE regions.
- Samples were collected from the sea surface using a manta trawl with a mesh size of 330 µm.




TAL TECH

# RESULTS

- In total, 6688 MP particles were extracted from 13902 $m^3$ of surface water samples.
- The In the regions of GOFW, GOFC and GOFE, mean MP concentration were 0.64, 0.58 & 0.46 counts/$m^3$
- 3031 MP-fibers were observed across all the 10 sampling stations with an average concentration of 0.27 counts/$m^3$ and 3657 MP-fragments with an average concentration of 0.28 counts/$m^3$.

| Year | Total MP | MP-fibers | MP-fragments |
|---|---|---|---|
| 2016 | 0.84 | 0.45 | 0.39 |
| 2017 | 0.56 | 0.26 | 0.3 |
| 2018 | 0.49 | 0.19 | 0.3 |
| 2019 | 0.26 | 0.13 | 0.14 |
| 2020 | 0.37 | 0.21 | 0.16 |
| 2016-2020 | 0.56 | 0.27 | 0.28 |

❖ The concentration values are in counts/$m^3$

TAL TECH

# RESULTS

| Station | MP | MP-Fibers | MP-Fragments | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|
| 2 | 0.75 | 0.34 | 0.41 | ✓ | ✓ | ✓ | ✓ | ✓ |
| 14 | 0.59 | 0.33 | 0.26 | ✓ | ✓ | ✓ | ✓ | ✓ |
| BLRT | 0.11 | 0.05 | 0.06 | | | ✓ | | |
| N12 | 0.76 | 0.38 | 0.38 | ✓ | | | | |
| N8 | 0.39 | 0.21 | 0.19 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Paldiski | 0.03 | 0.02 | 0.01 | | | | ✓ | |
| Paljassaare | 0.66 | 0.33 | 0.33 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Pirita | 0.68 | 0.09 | 0.59 | | | ✓ | | |
| Sillamäe | 0.46 | 0.23 | 0.23 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Suurupi | 0.37 | 0.2 | 0.17 | | | ✓ | | |

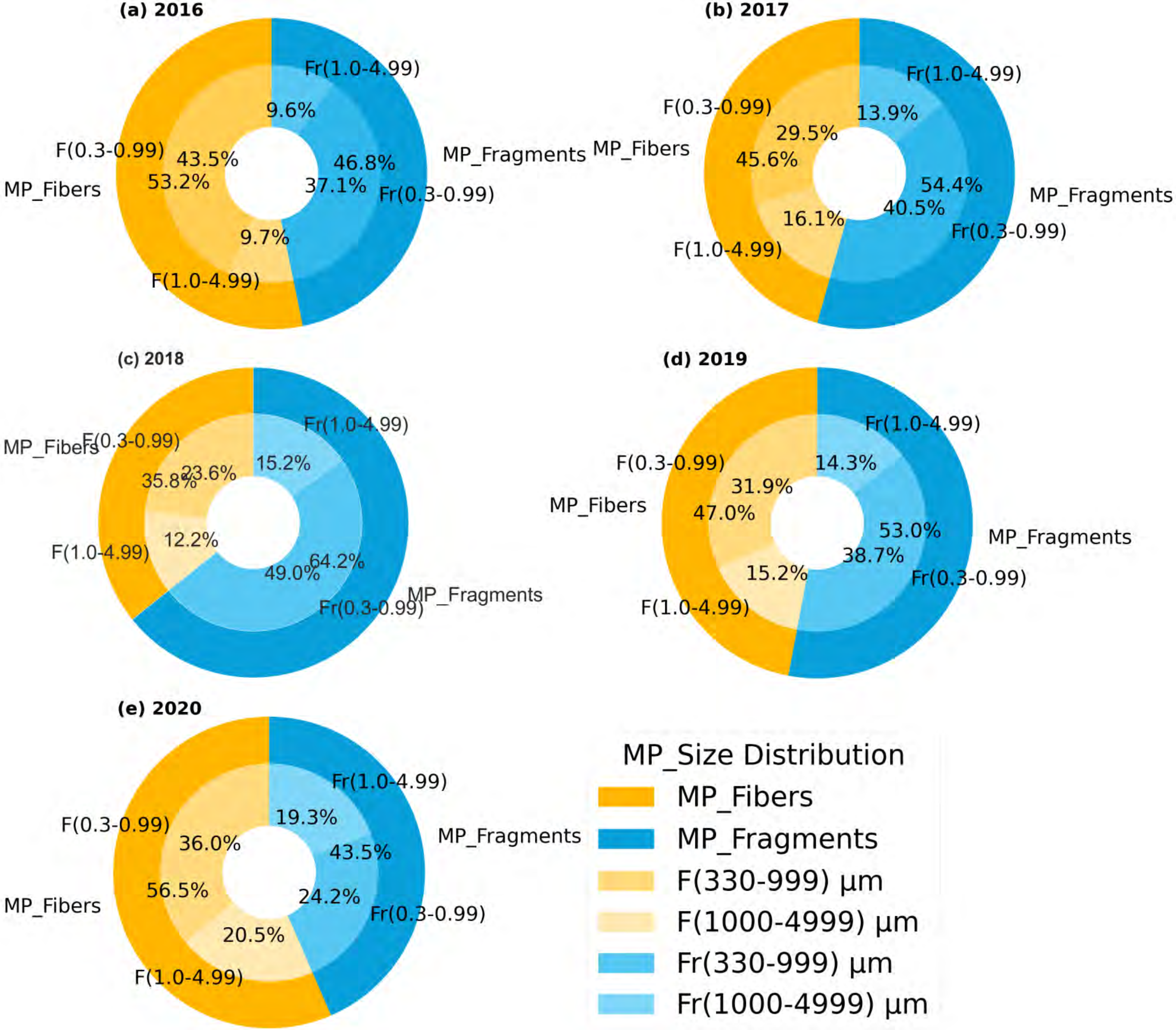
- The concentration values are in counts/$m^3$

TAL TECH

# MP MORPHOLOGY

- Two shape classes of MPs were distinguished during the monitoring Cruises: MP-fibers and all other non-Fiber MPs shapes in the likes of pellets, granules, film and spherical were categorized as MP-fragments.

- On average, 73% of detected MPs were in size range of 300-999 µm, and 27% contributed towards 1000-4999 µm.

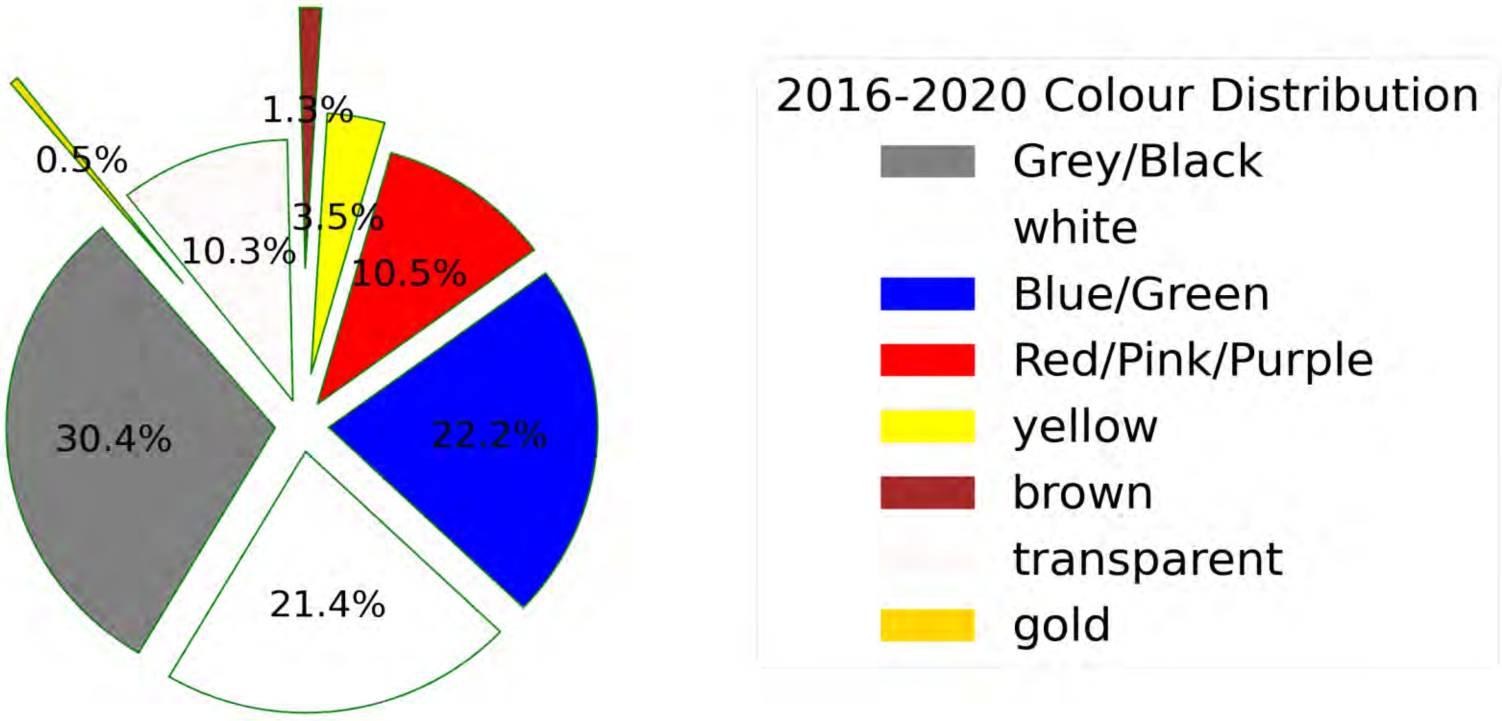



TAL TECH

# DISTRIBUTION OF MP BY COLOURS

- Most of the MPs found were Grey/Black (30.4%) followed by Blue/Green (22.2%) and white in colour.

- Dominant colour of MP-Fibers were Grey/Black & Blue/Green and for MP-Fragments, white & Blue/Green

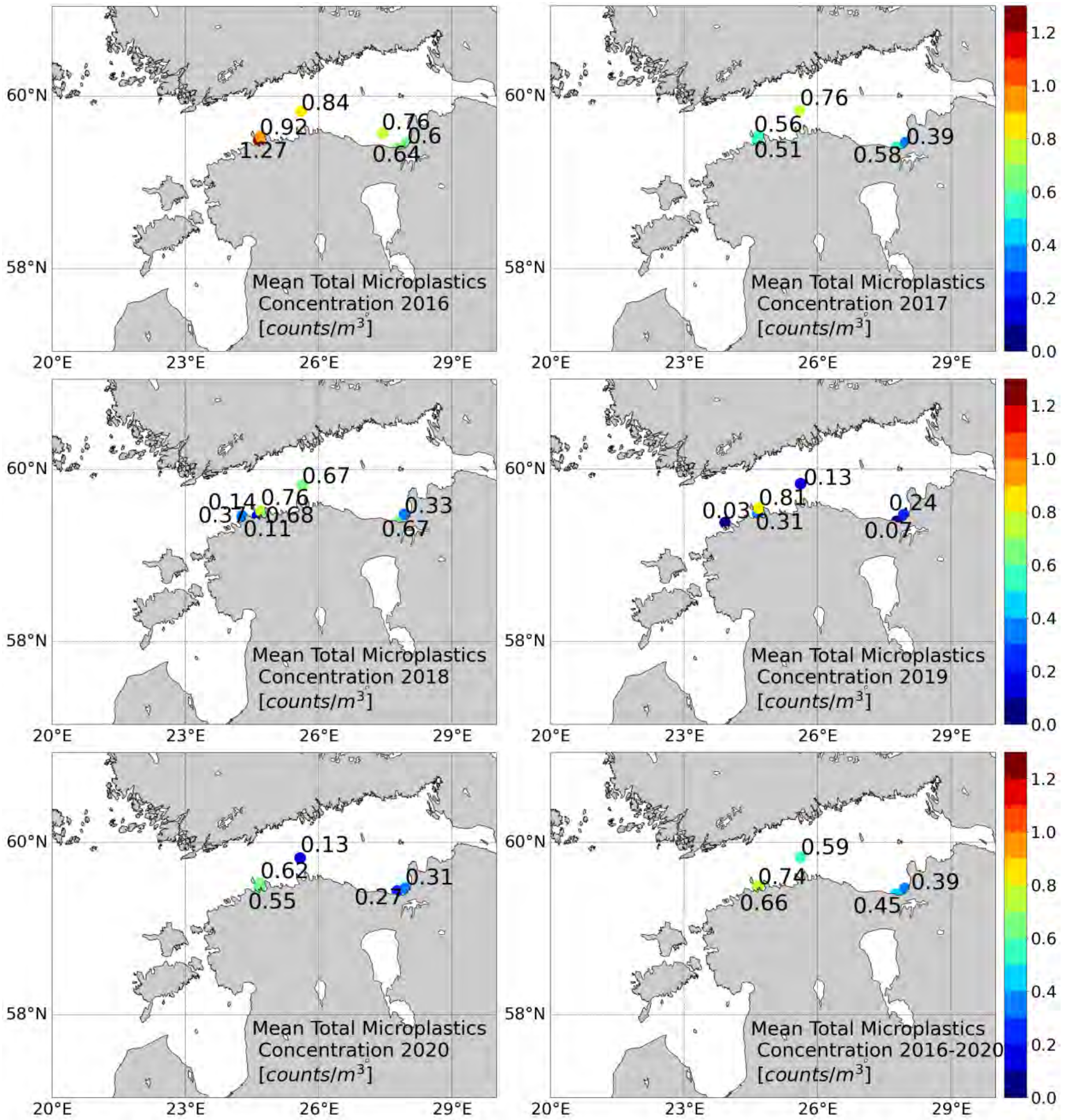



TAL TECH

# SPATIAL DISTRIBUTION OF MICROPLASTICS (MP)

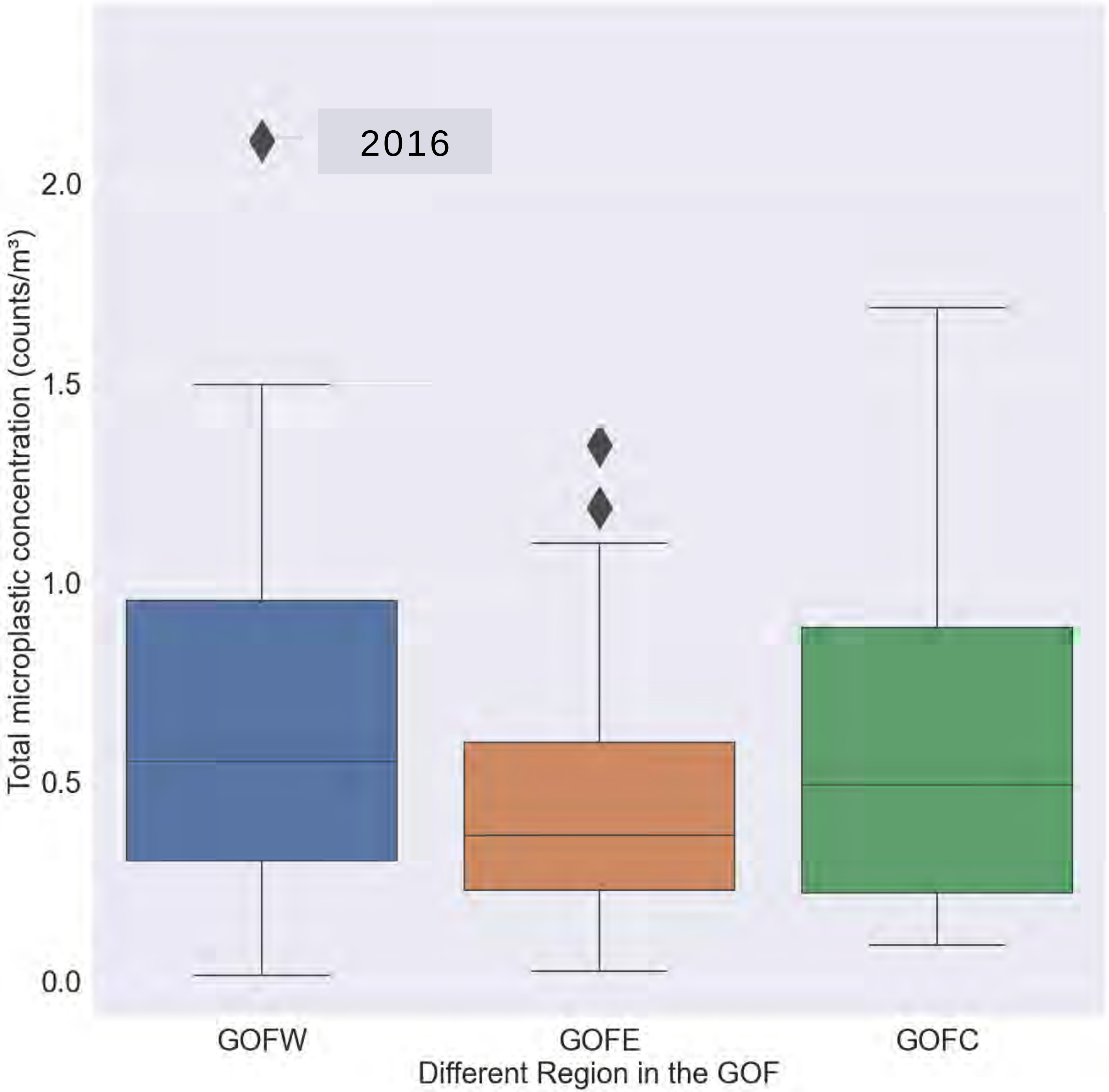
- Average MP counts/$m^3$ measured at each sampling station and the overall average for 2016-2020 was calculated as an airthmetic mean of all individual concentrations in the sampling location.

- There was significant difference in the temporal variation of MP concentrations in the GOF (ANOVA test, $F_{4,73} = 5.92$; $p = 0.0003$)



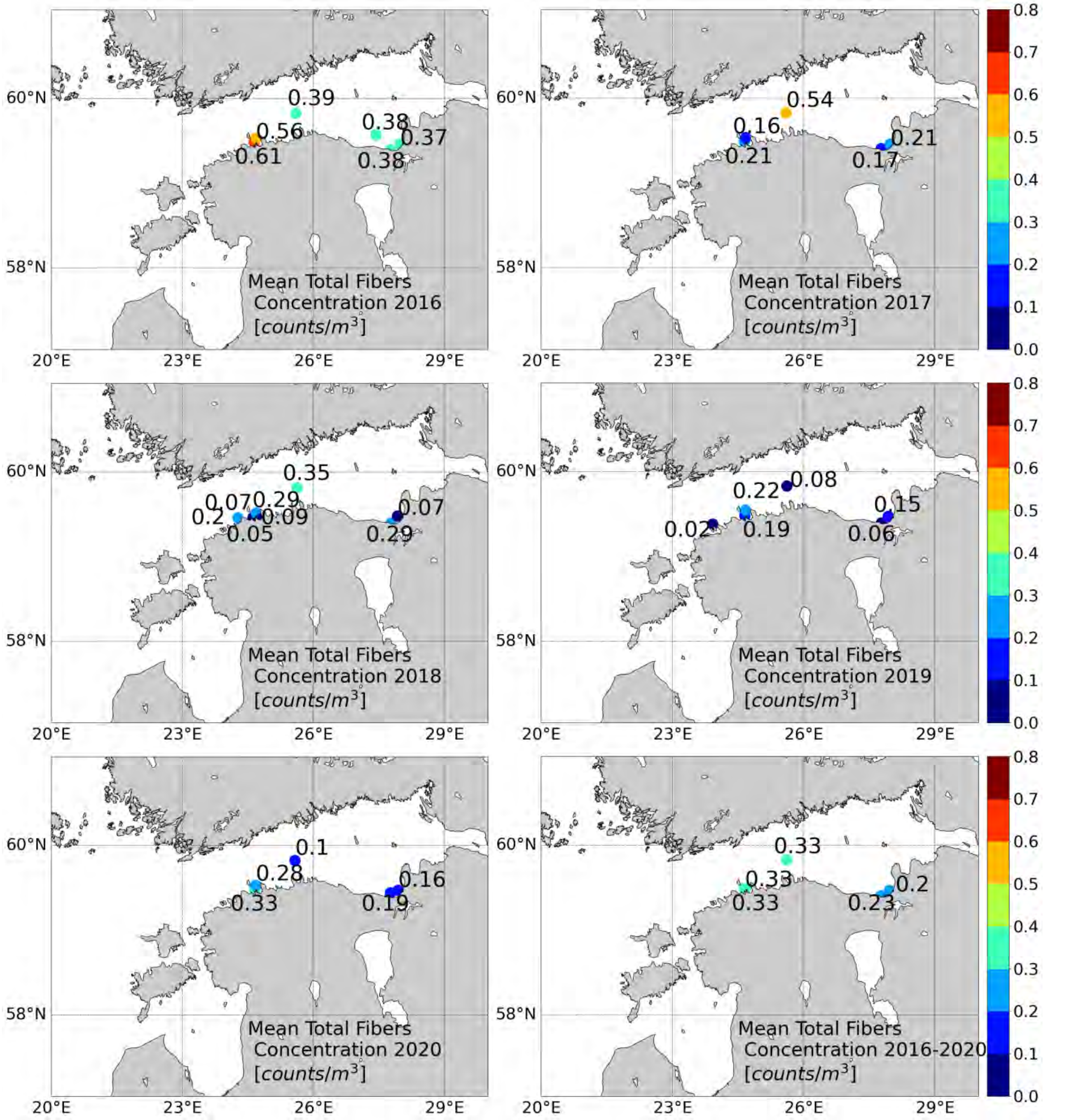
# MP VARIABILITY IN DIFFERENT REGIONS OF GOF

- When pooling together all data for selected regions, higher average MP abundances were found in the GOFW and GOFC than in the GOFE.



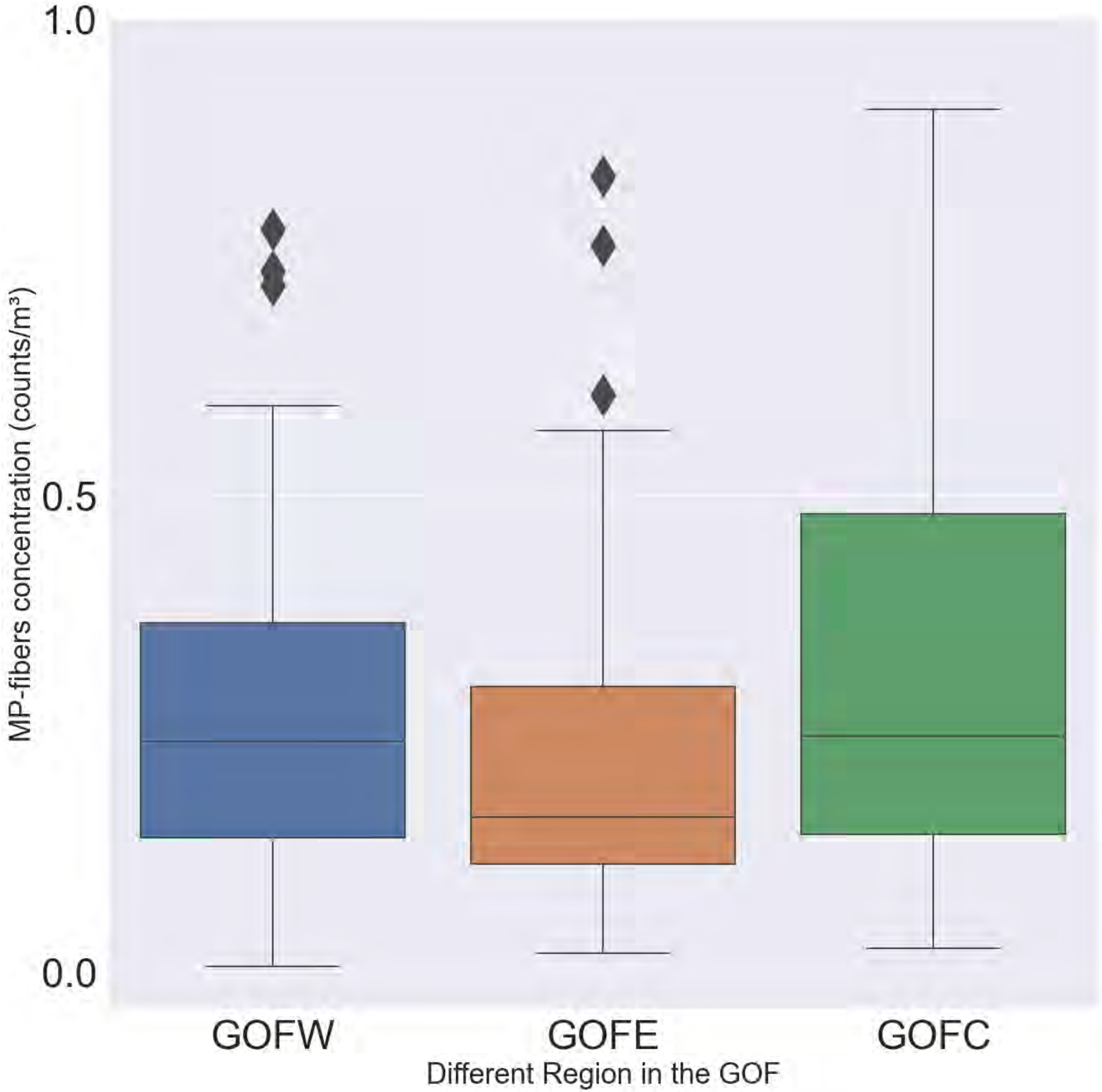
# SPATIAL DISTRIBUTION OF MP-FIBERS

- Average MP-Fibers counts/m$^3$ measured at each sampling station and the overall average for 2016-2020 was calculated as an airthmetic mean of all individual concentrations in the sampling location.



## MP-FIBERS VARIABILITY IN DIFFERENT REGIONS OF GOF

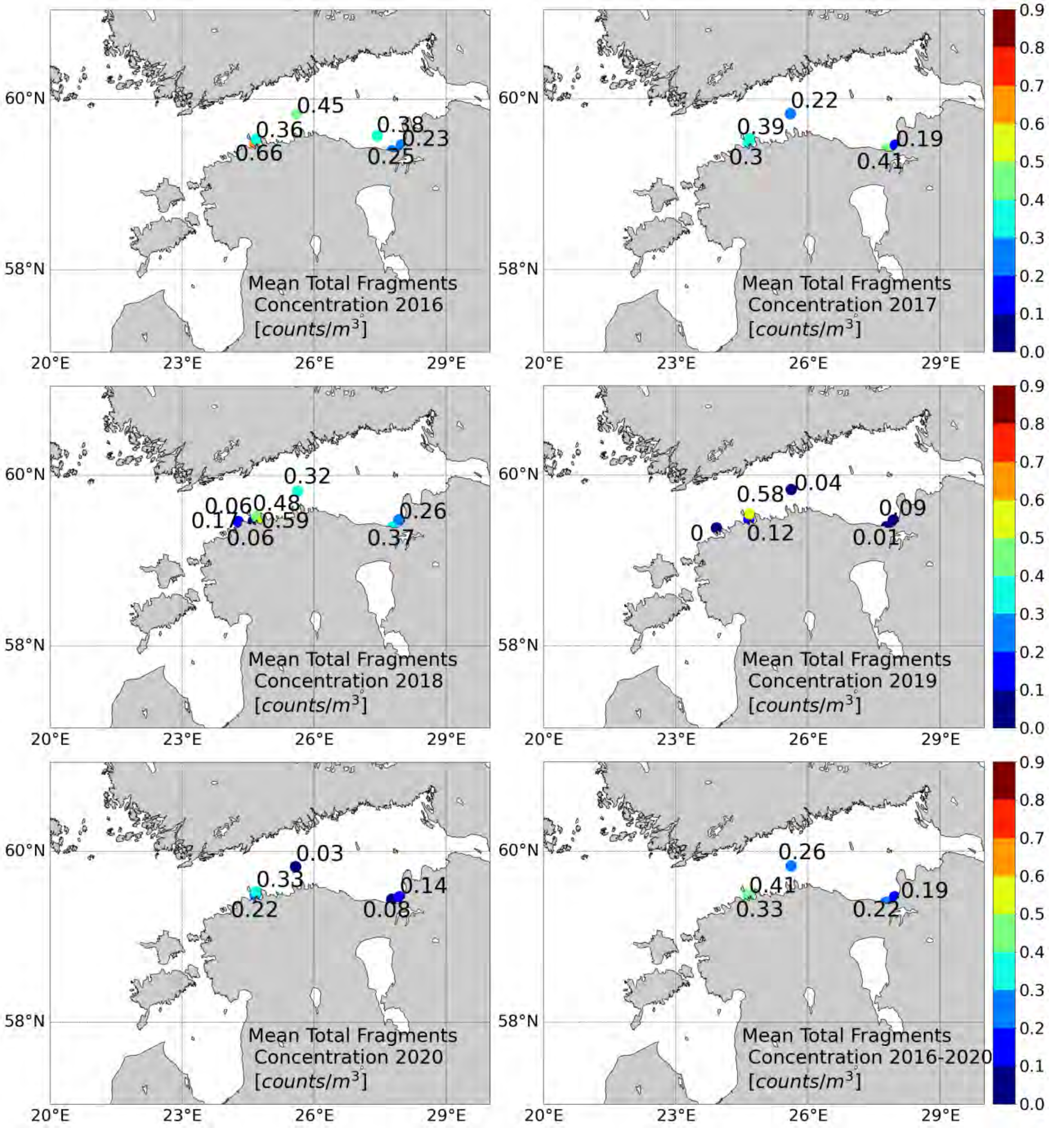
- It is quite clear that open sea region GOFC (0.02-0.9 counts/m$^3$) had maximum concentrations of MP-fibers.
- GOFW (0.005-0.77 counts/m$^3$) and GOFE (0.01-0.83 counts/m$^3$) had relatively lower fibers concentrations.




TAL TECH

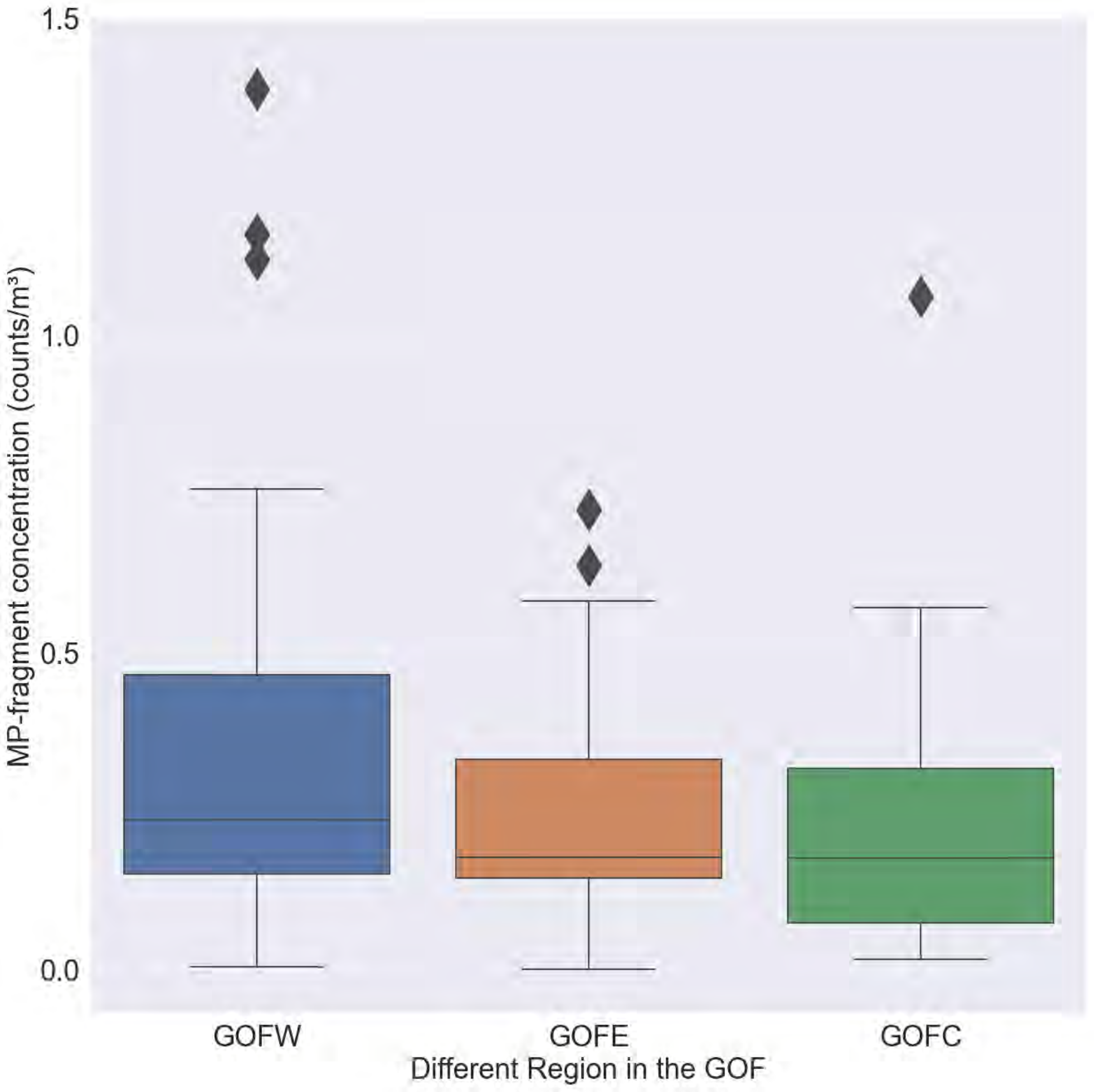
# SPATIAL DISTRIBUTION OF MP-FRAGMENTS

- Average MP-Fragments counts/m$^3$ measured at each sampling station and the overall average for 2016-2020 was calculated as an airthmetic mean of all individual concentrations in the sampling location.



# MP-FRAGMENTS VARIABILITY IN DIFFERENT REGIONS OF GOF

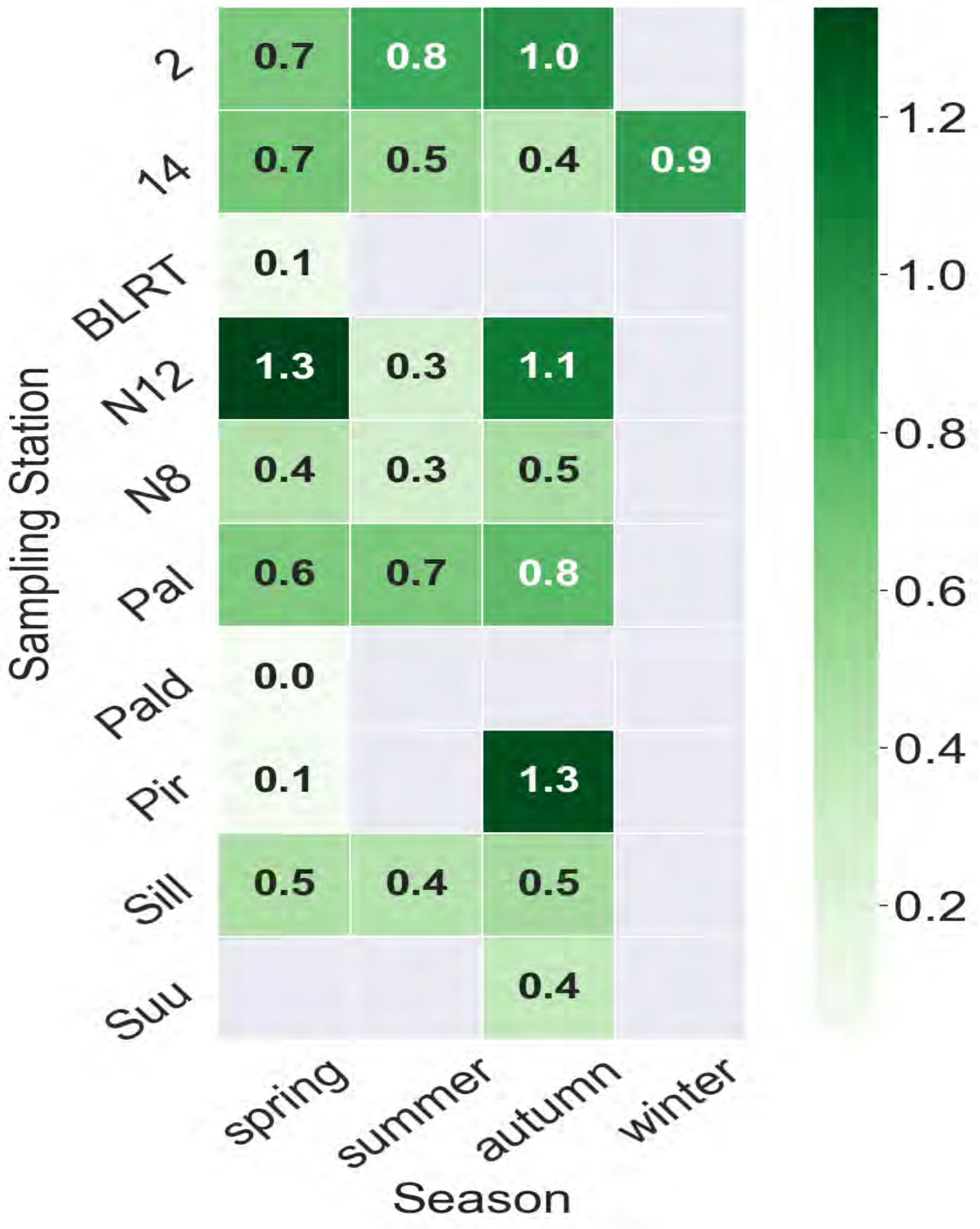
- MP-fragments concentrations were higher near the coastal stations than open sea areas.
- GOFW (0.004-1.38 counts/$m^3$) registered the highest fragments concentration.




TAL TECH

# SEASONAL VARIABILITY OF MEAN MP CONCENTRATION

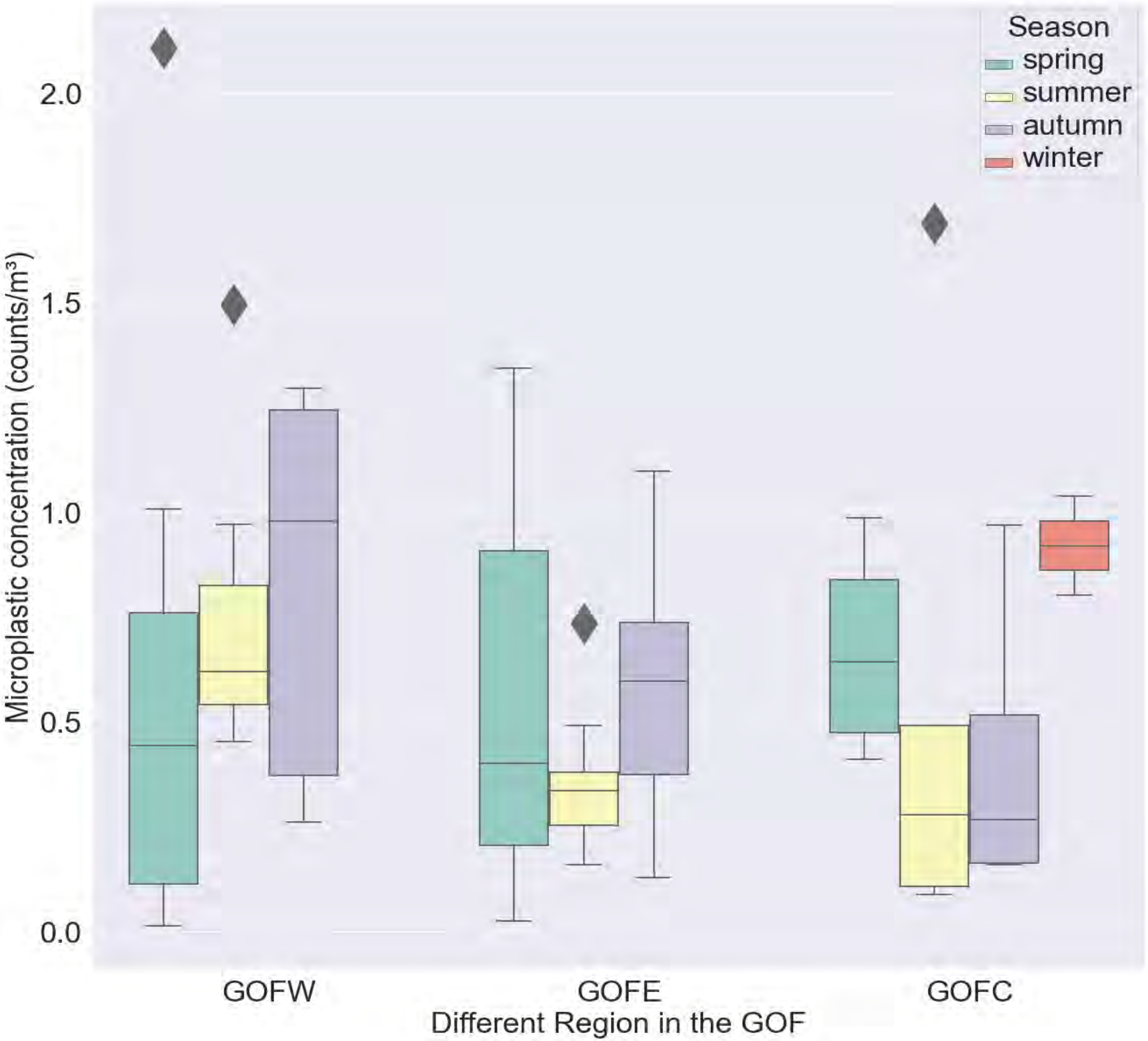
- Seasonal variation of mean MP was observed between the surveys in spring, summer, autumn and winter.
- The concentration values are in counts/$m^3$.
- The Spring month survey was from April-June, Summer from July-September, Autumn from October-November and winter from December-March.



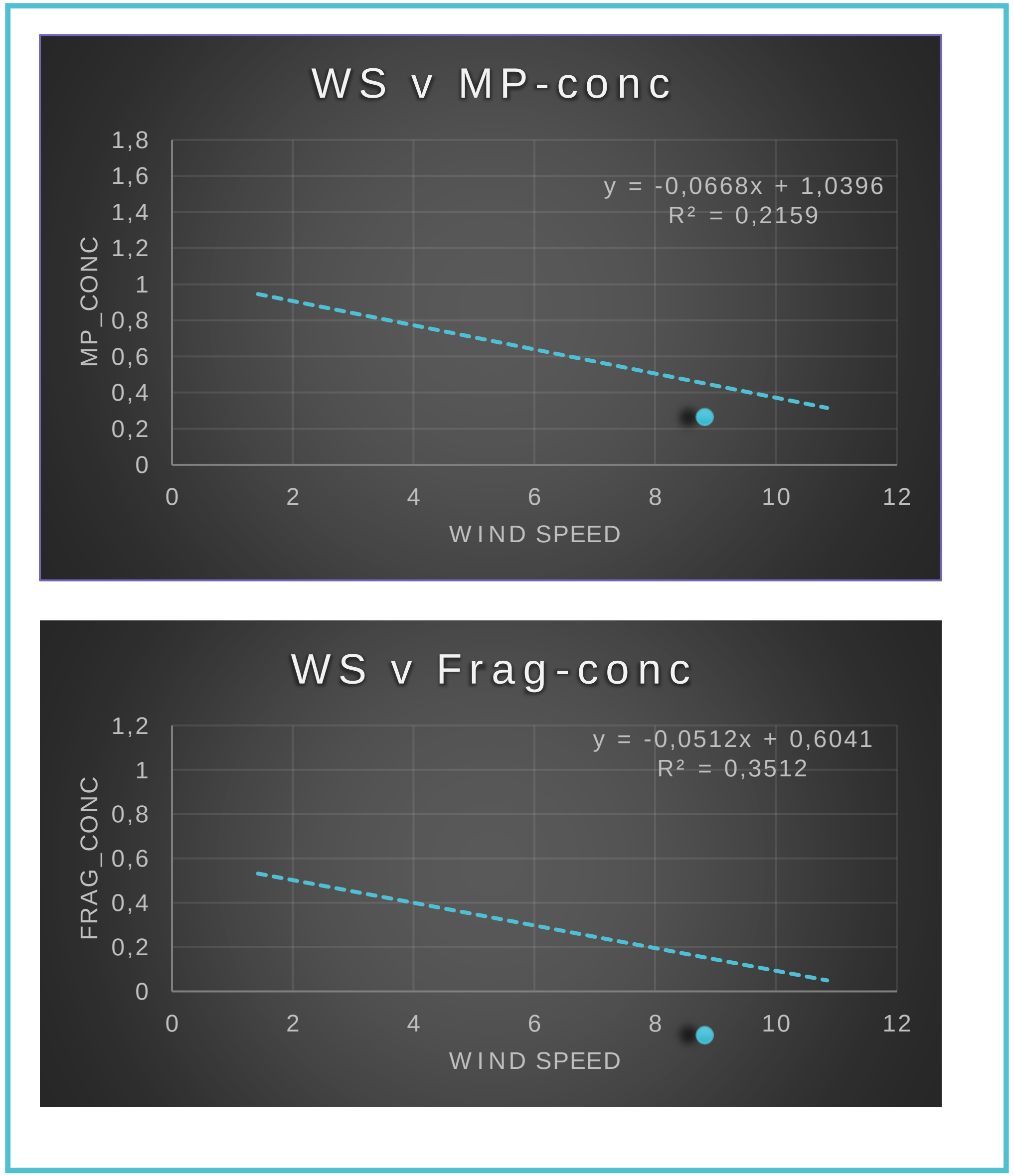

TAL TECH

# SEASONAL VARIABILITY OF MP CONCENTRATION ACROSS DIFFERENT REGIONS IN THE GOF

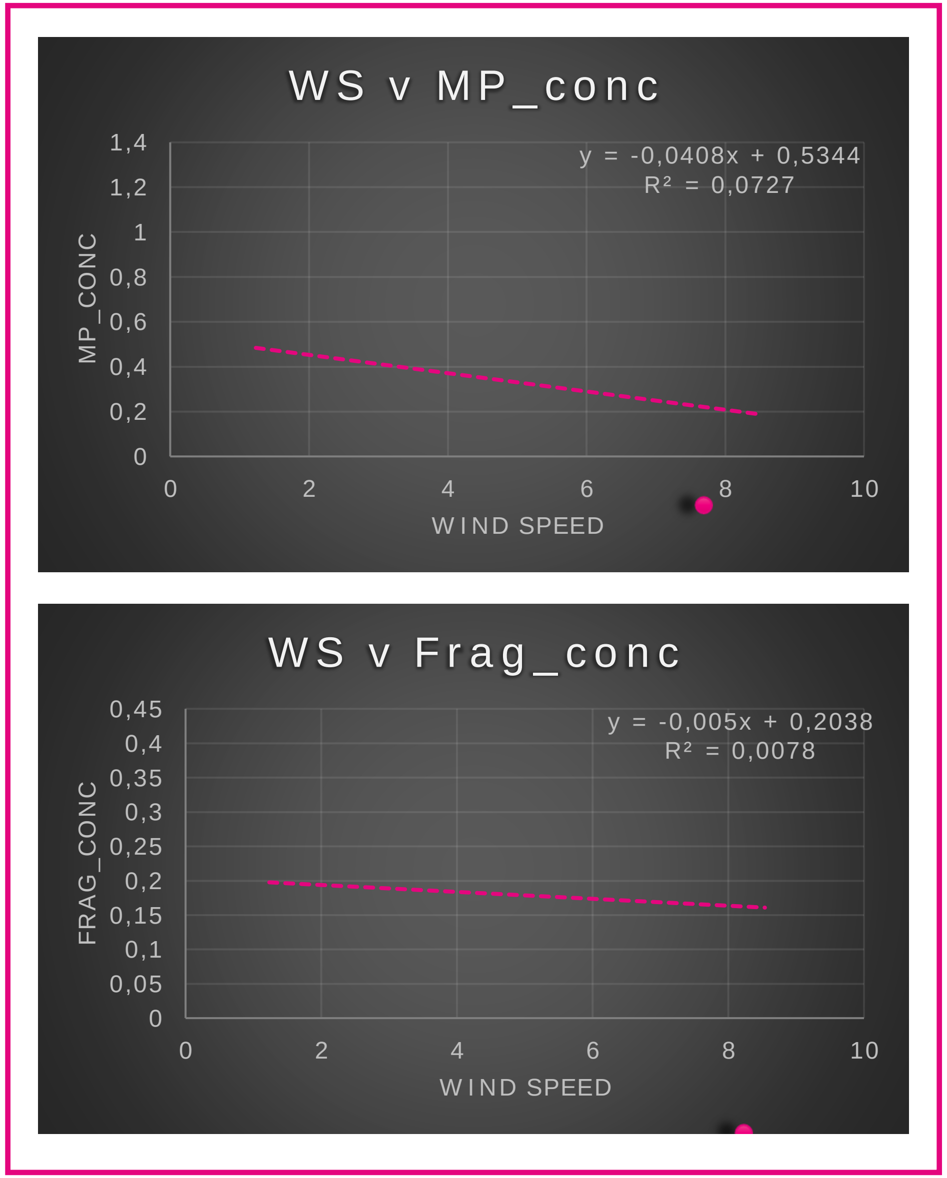
There was significant difference of MP concentration in the summer, autumn and winter surveys (ANOVA test, $F_{2,25} = 3.62$; $p = 0.04$).



# MP CORELATION WITH WINDSPEED




**Station 14**




**Station N8**

TAL TECH

# STATION N8 ANALYSIS WITH PHYSICAL FACTORS

When MP concentration are high.

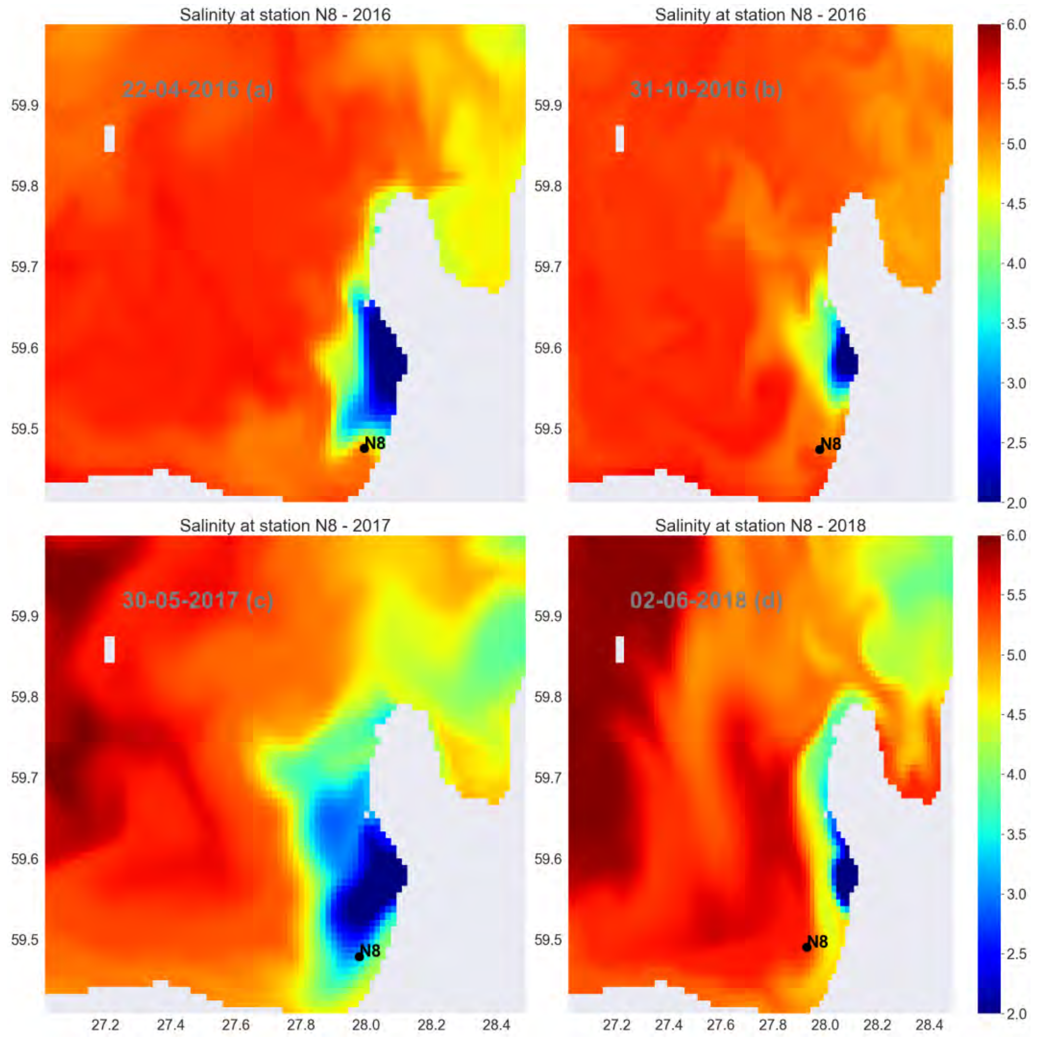
| Case | Date | MP-concentration |
| --- | --- | --- |
| A | 22-04-2016 | 1.18 |
| B | 31-10-2016 | 0.68 |
| C | 30-05-2017 | 0.52 |
| D | 02-06-2018 | 0.47 |

When MP concentration are low.

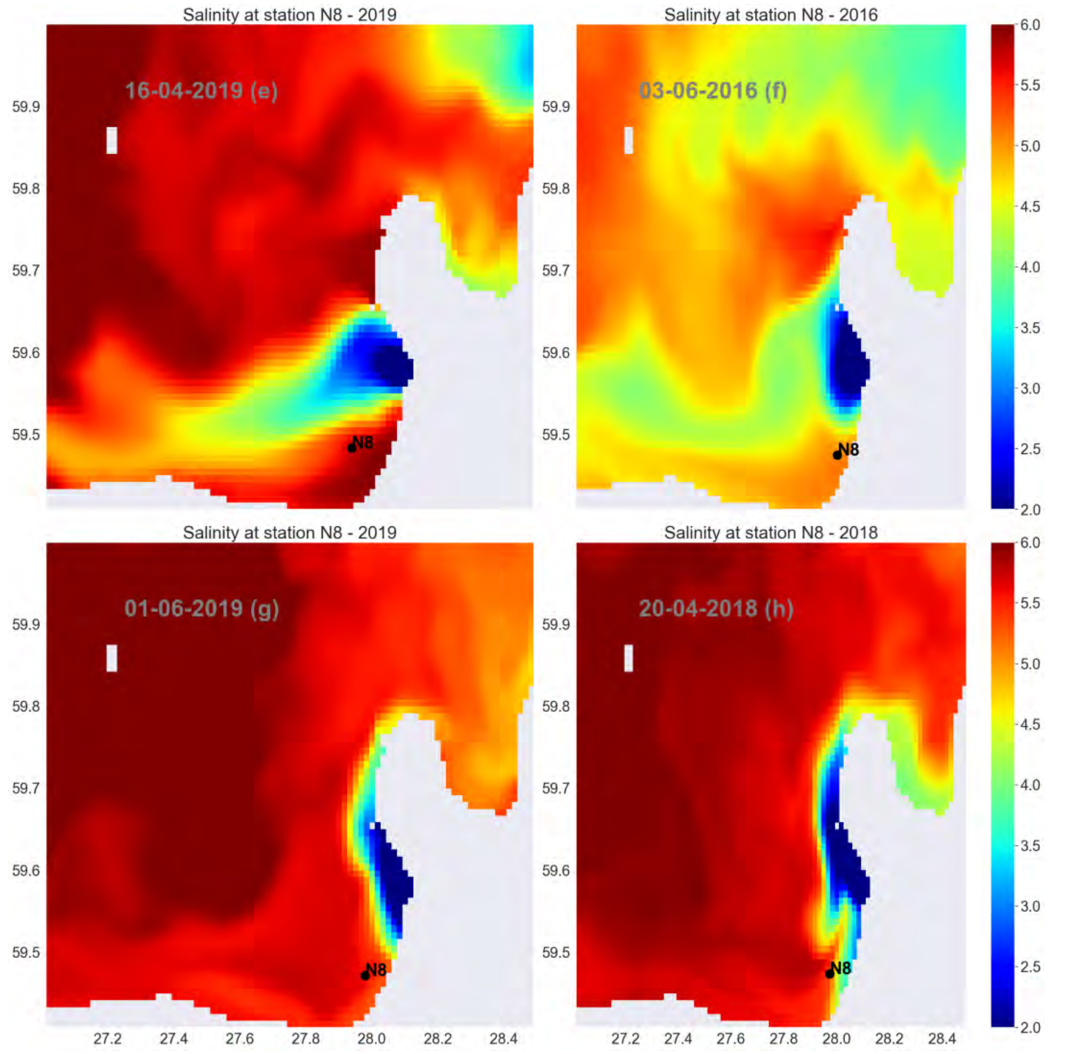
| Case | Date | MP-concentration |
| --- | --- | --- |
| D | 16-04-2019 | 0.02 |
| E | 03-06-2016 | 0.18 |
| F | 01-06-2019 | 0.21 |
| G | 20-04-2018 | 0.22 |

TAL TECH

# EFFECT OF SALINITY ON MP CONCENTRATION




Case – High concentration




Case – Low concentration

# STATION 14 ANALYSIS WITH PHYSICAL FACTORS

When MP concentration are high.

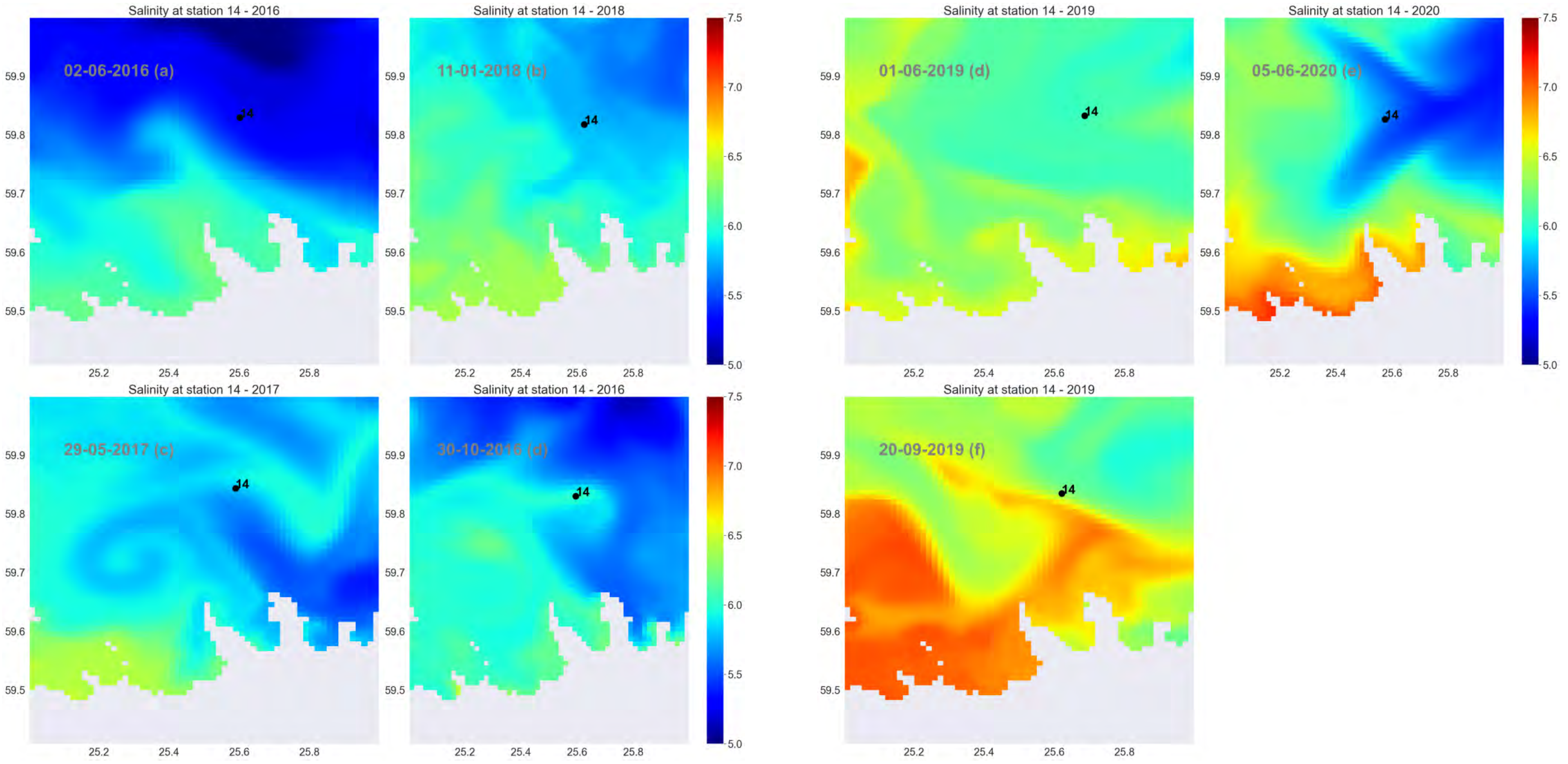
| Case | Date | MP-concentration |
|---|---|---|
| A | 02-06-2016 | 1.68 |
| B | 11-01-2018 | 1.03 |
| C | 29-05-2017 | 0.98 |
| D | 30-10-2016 | 0.96 |

When MP concentration are low.

| Case | Date | MP-concentration |
|---|---|---|
| D | 01-06-2019 | 0.08 |
| E | 05-06-2020 | 0.10 |
| F | 20-09-2019 | 0.16 |

TAL TECH

# EFFECT OF SALINITY ON MP CONCENTRATION




Case – High concentration

Case – Low concentration

# SUMMARY

- ❑ MP was present across all the sampling sites in the GOF.
- ❑ The mean share of MP-fibers and MP-fragments was nearly the same.
- ❑ High spatial and temporal variability revealed in the GOF.
- ❑ Western part had higher mean MP concentrations than the central and eastern part of the GOF.
- ❑ The main physical parameters affecting the MP are
  - ❑ the wind speed (offshore areas) and associated vertical mixing;
  - ❑ the riverine discharge and its advection.

TAL TECH

THANK YOU FOR YOUR ATTENTION!

QUESTIONS??

Estonia-Russia Cross Border
Cooperation Programme
2014-2020

# IN SEARCH OF RELATIONS BETWEEN FACTORS OF UNDERWATER LANDSCAPES IN THE EASTERN GULF OF FINLAND USING GIS AND STATISTICS

**Filipp Leontev[1,2], Marina Orlova[2], Daria Ryabchuk[1], Alexander Sergeev[1]**

VSEGEI[1], SPbRC RAS[2]

**The Gulf of Finland Science Days Conference**
**November 30, 2021**

ADRIENNE

EST | RUS
Cross Border Cooperation Programme

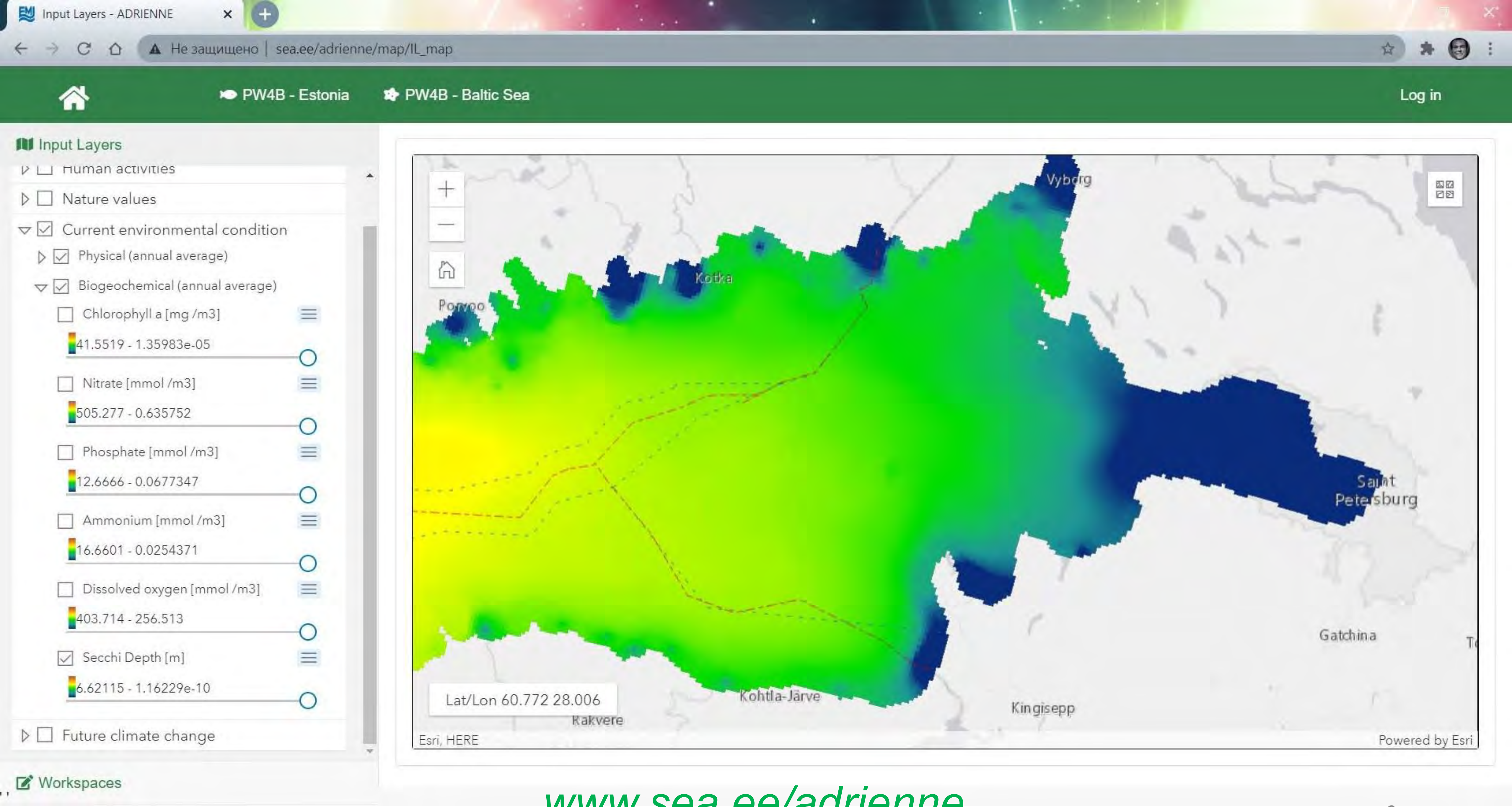
# Aim of the ADRIENNE Project

**Creation of a publicly accessible GIS portal** that will provide an opportunity to assess the consequences of anthropogenic impact on the underwater landscapes ecosystem of the Gulf of Finland under various scenarios (including climate change).

*Monitoring and modeling*

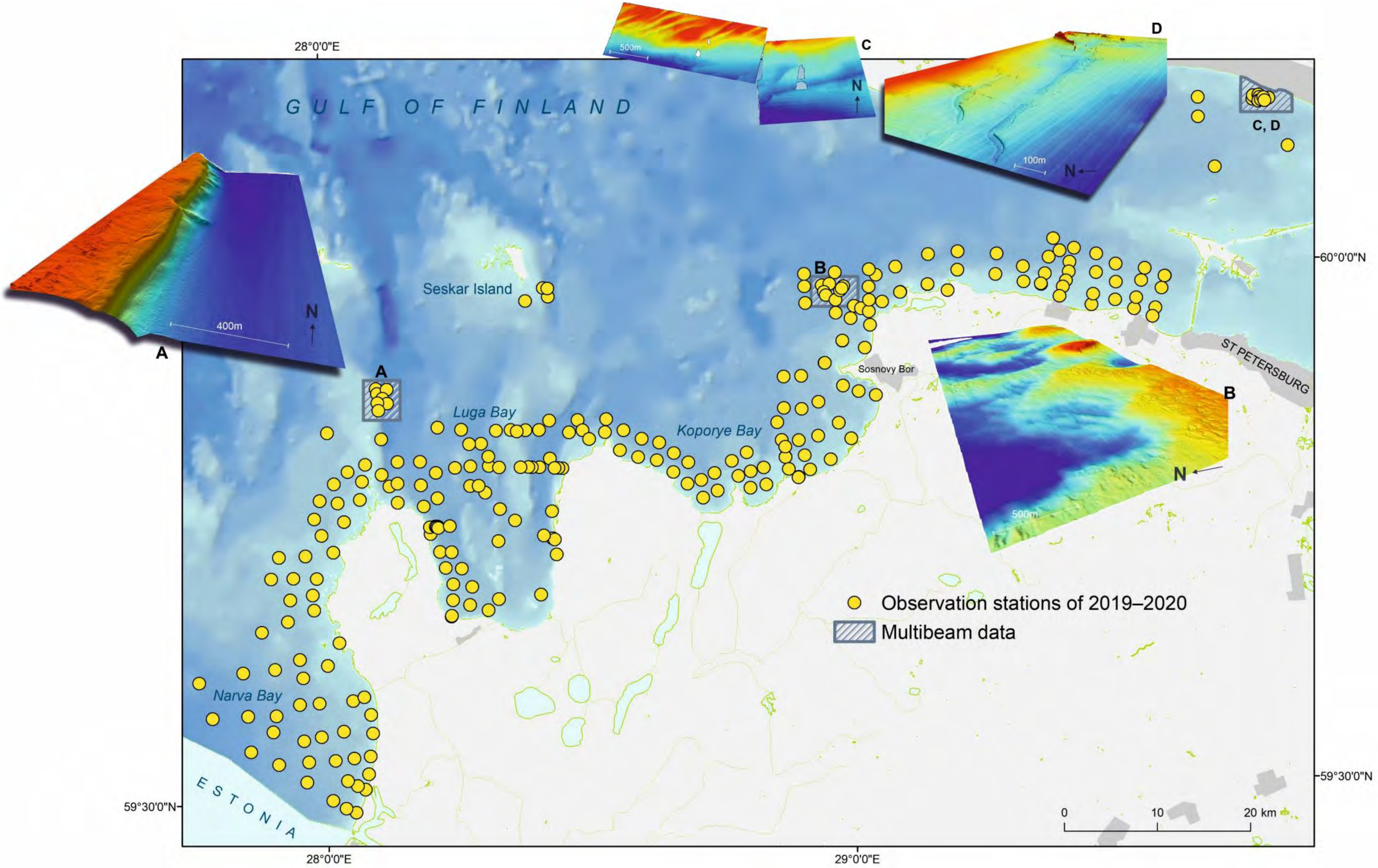
*Cooperation between Finland, Estonia and Russia*

**Search for new ways to reduce the risks of human activity negative effects on biogeocenoses of the Gulf of Finland**



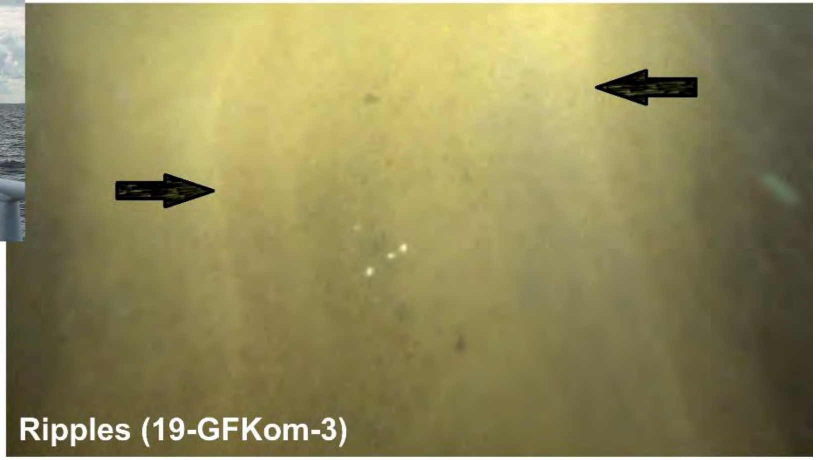

*www.sea.ee/adrienne*

# 2019–2020 Sampling

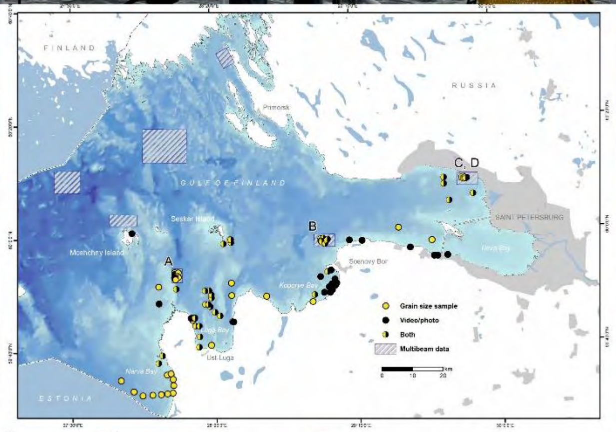


# Fieldwork Process





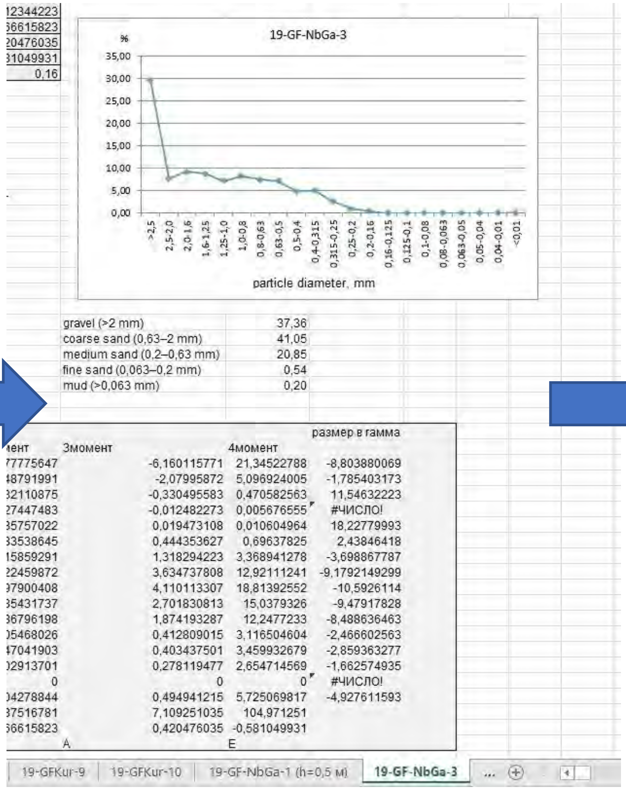




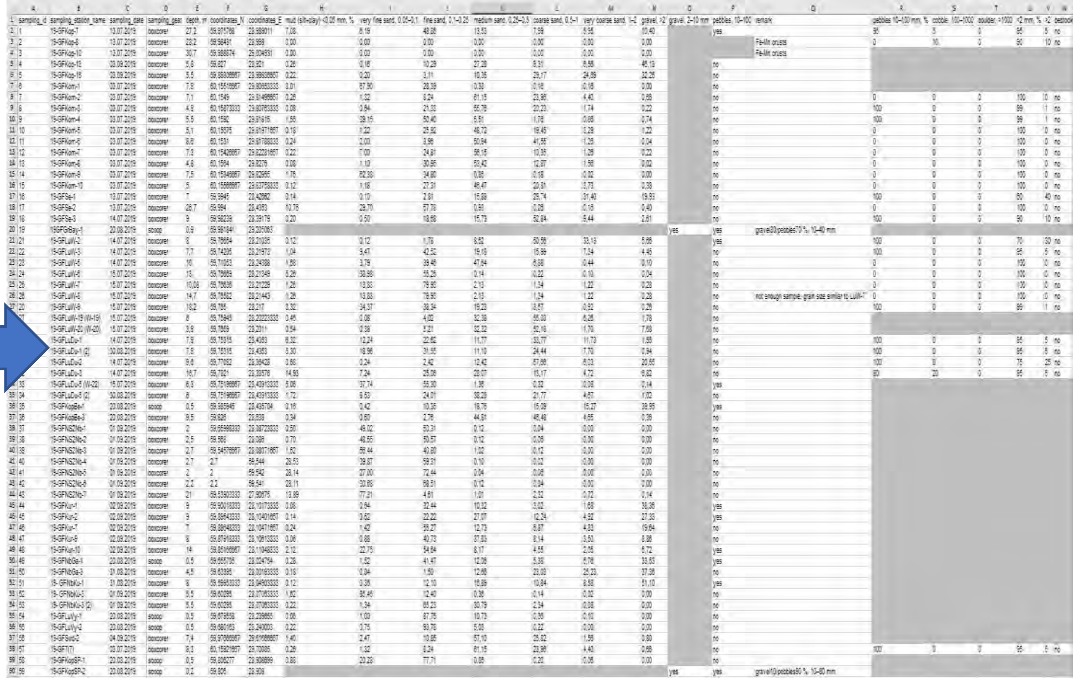


**Grain size analysis**

(sand and clay fractions)




**Result processing**



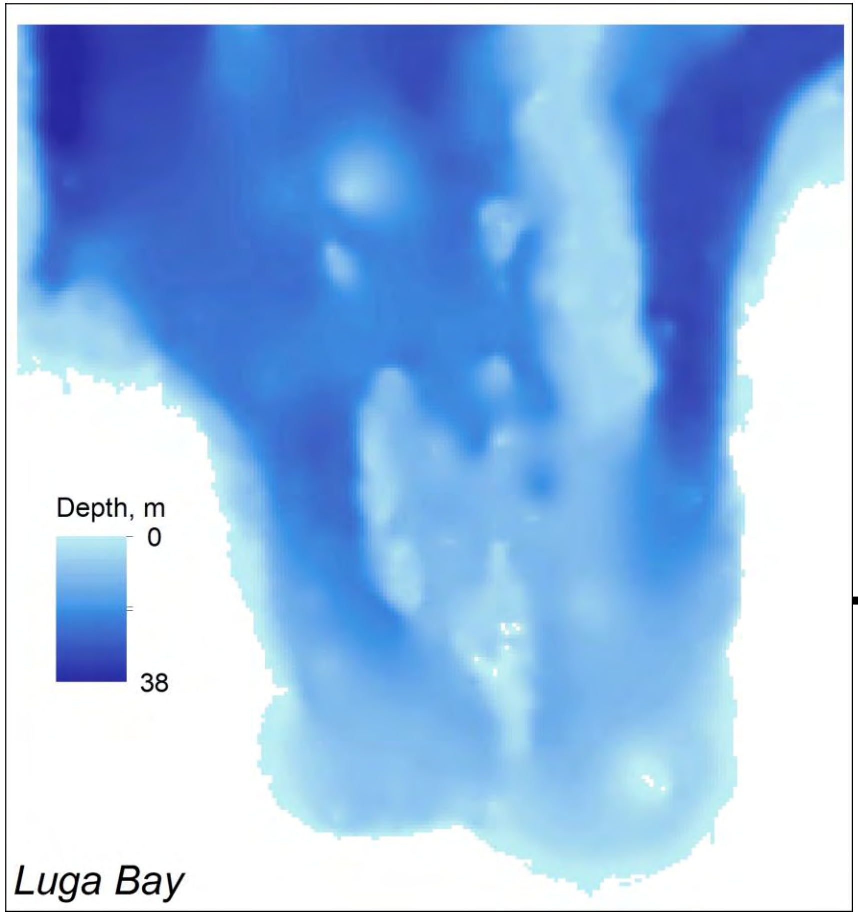
**Database for modeling**

(physicochemical properties of water and bottom sediments, characteristics of substrates and benthos)

**Expected outcome:**
The possibility of assessing and predicting the condition of underwater landscapes using the relationship between biotic and abiotic components of underwater landscapes under anthropogenic load (geo- and bioindication)

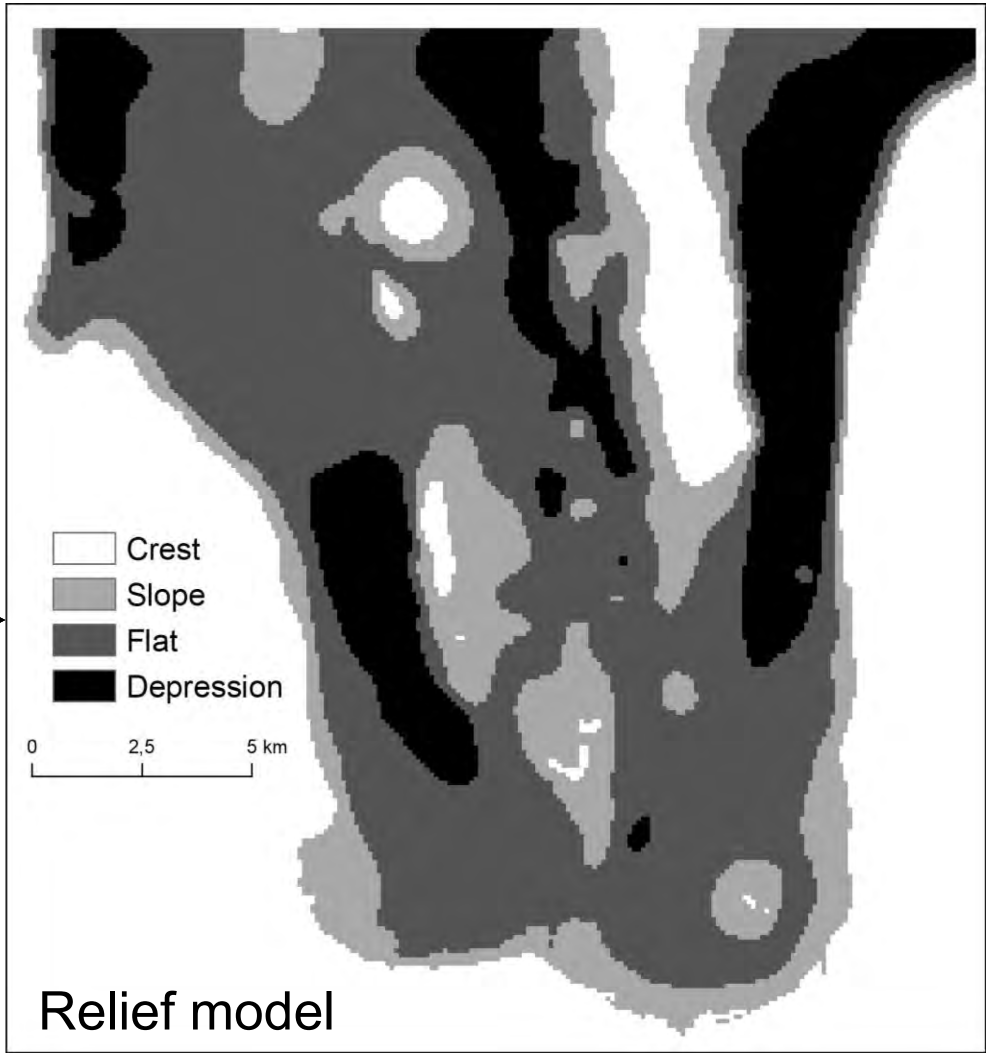
*«The dependence of the distribution of macrozoobenthos on the salinity and heterogeneity of the relief and bottom substrate was established, however, the relationship between the spatial distribution of certain types of bottom sediments and benthos at the level of mesohabitat was not revealed»* (Kaskela et al., 2017)

**Benthic Terrain Modeler (BTM)** – ArcGIS extension for identifying benthic zones and providing more detailed habitat maps

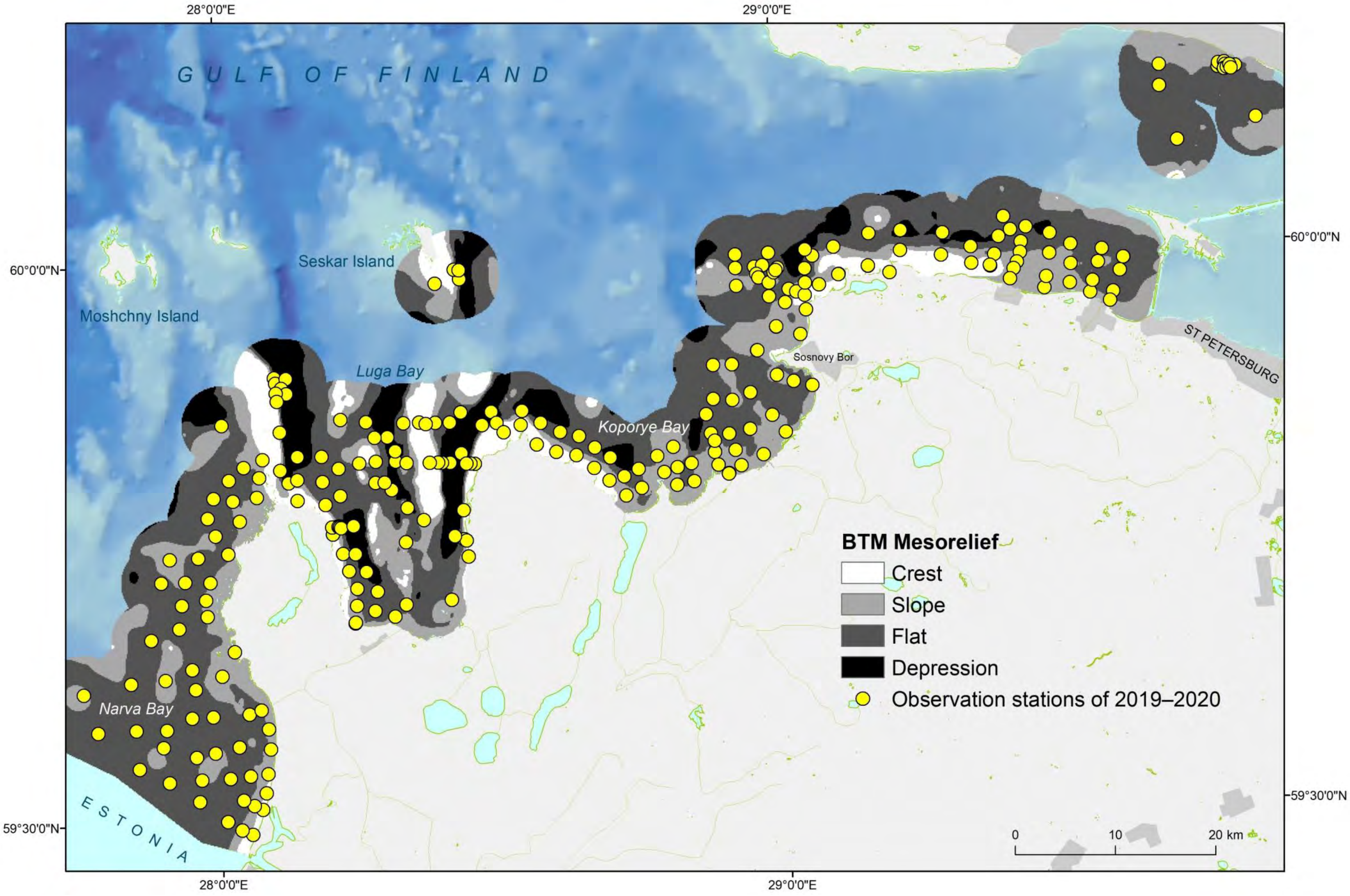



Bathymetry data

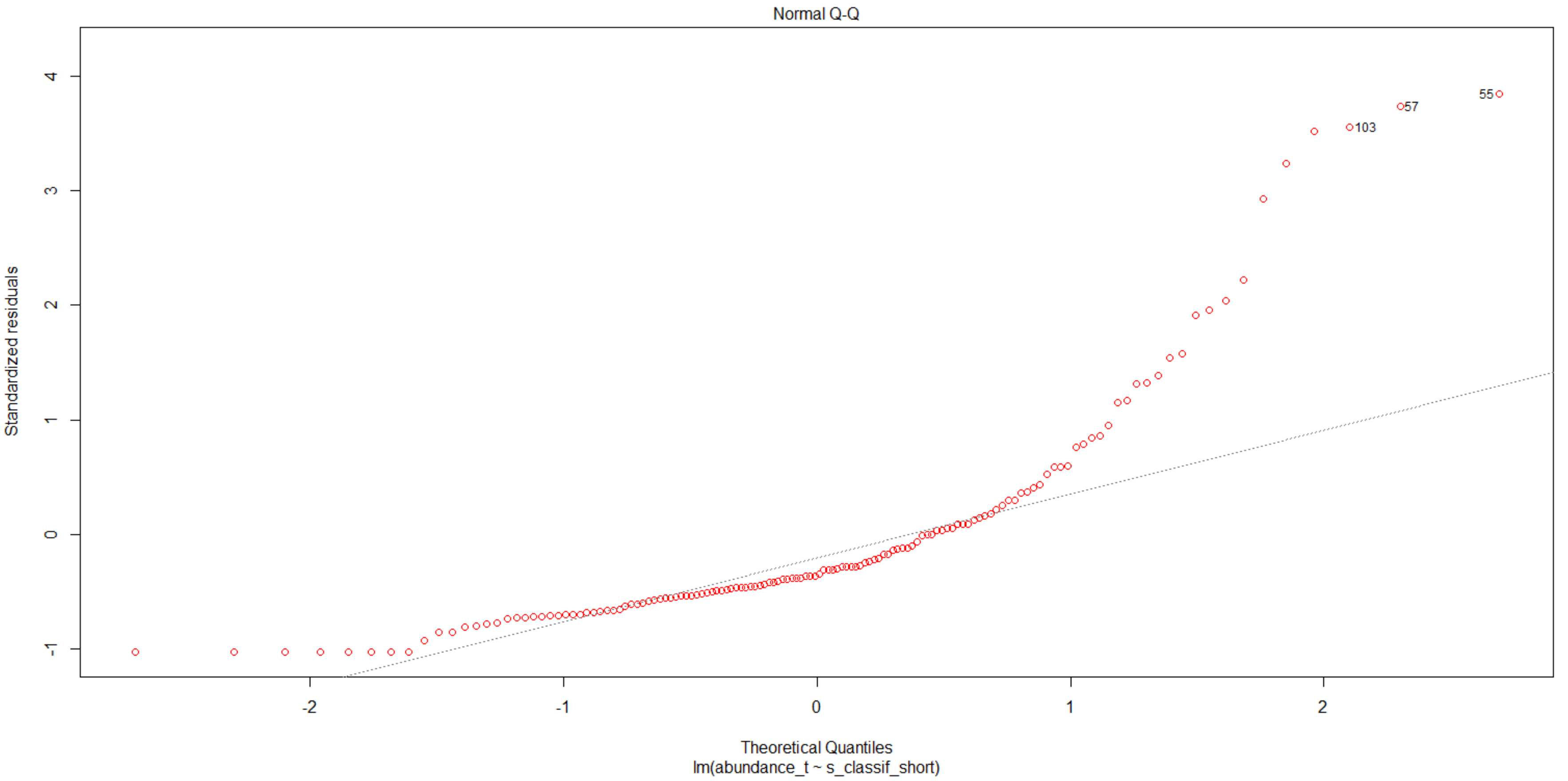
BTM




Relief model


28°0'0"E
29°0'0"E
G U L F O F F I N L A N D
Seskar Island
Moshchny Island
Luga Bay
Koporye Bay
Sosnovy Bor
ST PETERSBURG
Narva Bay
E S T O N I A
60°0'0"N
59°30'0"N
BTM Mesorelief
Crest
Slope
Flat
Depression
Observation stations of 2019–2020
0
10
20 km

Data preparation: abnormal va
FeMn concr




- <u>Pairwise Spearman correl</u>

**Strong relationships (ρ > 0.7**

Abundance of macrozoobenth

Biomass of macrozoobenthos-

**Moderate relationships (ρ ≥**

Abundance–surface water sali

Biomass–surface water salinit

**!Weak relationships (ρ < 0.5)**

- <u>Linear regression</u>

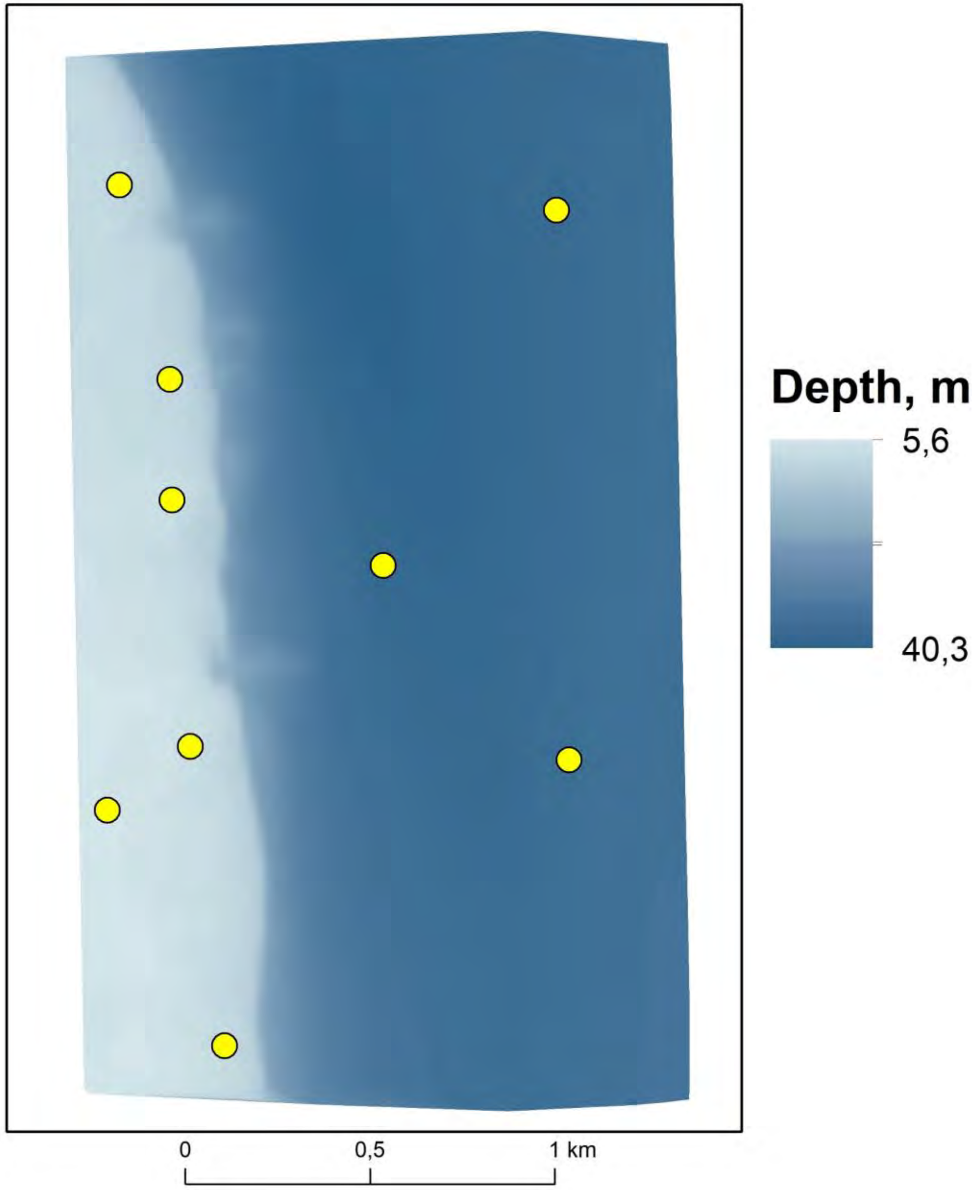
**Statistical significance:** abundance–sediments ($p < 0.05$)

**Multiple linear regression:** abundance–sediments*mesorelief types ($p = 0.07$)

# Future Plans and Questions

1. **Additional parameters:** wave exposure, currents, river runoffs
2. **2021 field season data:**
   a) Small-scale study (better bathymetry data?)
   b) Detailed investigations – Kurgalsky reef?

<u>Other methods of GIS and nonparametric statistics?</u>




- 3 m multibeam
- 9 stations already
- High depth difference – perfect for BTM

Estonia-Russia Cross Border
Cooperation Programme
2014-2020

# Thank you for your attention!

Filipp Leontev
(VSEGEI, SPbRC RAS)

*leontyevph@gmail.com*

The Gulf of Finland Science Days Conference
November 30, 2021

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# Methodological approaches to the establishment of regulations for the use of aquatorial zones of the Maritime Spatial Plan in the Russian Federation

Anisimovets Anastasiia, Nosenko Natalie

Scientific and Research Institute of Maritime Spatial Planning Ermak NorthWest (ErmakNW), Russia

VASAB Vision & Strategies around the Baltic Sea · Maritime Institute Gdynia Maritime University · Breaking New Ground Aalborg University · Swedish Agency for Marine and Water Management · HELCOM · Ministry of Environmental Protection and Regional Development Republic of Latvia · Ермакъ · RSHU · SUBMARINER NETWORK

# Introduction

What is Marine Functional Zoning (MFZ)?

Main goals and functions of MFZ

The principles of the use of marine areas

Types of usage of MFZ

Categories of functional areas of MFZ

# Background

- The proposed mechanisms for identifying water areas and establishing restrictions were developed in a study conducted by Ermak North-West. These mechanisms are formed on the basis of the current methodology of territorial planning and spatial zoning in Russia.
- The mechanisms take into account the changes dictated by the uniqueness of the environmental planning - the sea area – and target sustainable development and preservation of the unique ecosystems of Russian seas.
- The Marine Functional Zoning System is part of the Maritime Spatial Plan and defines the rules of the use of marine space. It is a method of rational organization of space.

# The main goals and principles of the national maritime policy of Russia:

- Ensuring sustainable economic and social development of the country
- Conservation of marine natural systems and rational use of their resources
- A holistic approach to maritime activities and its differentiation in certain areas, taking into account changes in their priority depending on the geopolitical situation
- Ecosystem-based management - consideration of the marine environment as a whole, and the processes in the marine environment in interrelation

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# Functional zoning approach

**Maritime functional zoning (MFZ) -** is a crucial **part of marine spatial planning (MSP).** It establishes the boundaries and functional purpose of aquatic areas in accordance with the preferred type of use. This approach allows to minimize or completely avoid conflicts between economic sectors, as well as reduce the negative impact on the environment.

**Marine functional zone -** a marine area within certain boundaries, with a homogeneous functional purpose and corresponding modes of use. The functional purpose is understood as the predominant type of activity for which this space is intended.

# Basic goals of MFZ:

- **Protecting marine ecosystems:** The MFZ should consider the protection of the marine environment and the conservation of the natural landscape. According to this clause, functional areas designated as nature conservation areas must be strictly protected.
- **Development of economic activities:** The development of the marine economy should not be achieved at the expense of the marine environment. It is essential to promote the harmonious use of marine resources.
- **Resolution of conflicts among industrial users -** maritime and non-maritime users.
- **Protection of the coastline:** The coastline is a valuable marine resource and must be strictly protected. This ensures common development of marine and coastal area.
- **Ensuring the security of national defense** and the requirements of the military use of maritime territories.

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# Main functions of MFZ :

- **Environmental protection**
- **Economic use -** construction of industrial plants, aquaculture, fisheries, and other ecosystems services
- **Reserve territories**

# The principles for the use of marine areas:

- Integrity of the ecosystem
- Rational use
- Minimization of conflicts

# The principles for the use of marine areas:

## Maintaining the integrity of the ecosystem:

- Ensuring the safety of marine areas which are crucial for the preservation of biodiversity
- Ensuring the functional interconnection of zones
- Perceiving the marine space as a single ecosystem

# The principles for the use of marine areas:

**Rational use:**

- Providing sufficient space for existing economic activities, while allocating space for new ones;
- Promoting synergy between different uses;
- Encouraging coexistence of complementary or interdependent uses of the sea;
- Maximum saving of the sea space allotted to certain economic activities. Maintaining the status of public marine areas in a significant part of marine areas as a reserve for future activities. For example, multiuse concept may be implemented.

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# The principles for the use of marine areas:

**Minimization of conflicts:**

- Possibly combining use of space by types of economic activities with similar requirements for environmental conditions and infrastructure;
- Determining priority type of use. In case of compatible uses of the sea, priority is given to existing or “fixed” economic activities in the area;
- Promoting collaboration between different economic activities;
- Encouraging the coexistence of complementary or interdependent uses of the sea;

# Activities considered in the development of Marine Spatial Plan:

- Environmental protection – nature protection areas (NPAs) and nature reserves
- Sites of underwater cultural heritage
- Aquaculture
- Fisheries
- Renewable energy - wind, wave and tidal energy
- Tourism and recreation
- Scientific research

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Baltic harbour porpoise

# Activities considered in the development of Marine Spatial Plan:

- Marine transport routes and traffic flows
- Submarine cables and pipeline routes
- Marine subsoil use - infrastructure for the exploration and extraction of oil and gas
- Military training areas
- Dumping of soil
- Other activities in the sea - artificial structures, islands, bridges, tunnels, etc.

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**The Main Function –** priority economic activity in the allocated area;

**Types of use:**

- **Permitted uses** – default activities that do not require prior approval;
- **Conditional permitted uses -** activities that require prior approval. In the event of a conflict with other activities identified as "permitted uses", preference is given to the latter.
- **Prohibited use -** activities prohibited in the allocated area.

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# Categories of functional zones:

- **Nature protection areas -** areas designated for the protection of marine ecosystems. They require minimization or complete elimination of the impact of economic activities in the area.
- **Zones with limited activities –** include areas with a minimum anthropogenic load and restrictions on certain types of use.
- **Zones of active maritime use -** include areas with moderate or significant anthropogenic pressure. Marine spaces belonging to these zones suggest the location of zones with economic activity in them. Often these zones have one lead function or share several equally important functions.

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# Nature protection areas:

- **Protected zones** – pieces of land and water that have air space above them where natural ecosystems and objects are located which:
  - have special environmental, scientific, cultural, aesthetic, and recreational value
  - have been withdrawn by the authorities fully or partially from economic use and have been granted special protection status.
- **Landscape protection zones** – aquatic areas, where economic activities are prohibited or restricted in order to preserve the natural landscape and allow it to regenerate.
- **Underwater Cultural Heritage (UCH) zones**– aquatic areas, where UCH sites are preserved and may be used with due precautions.

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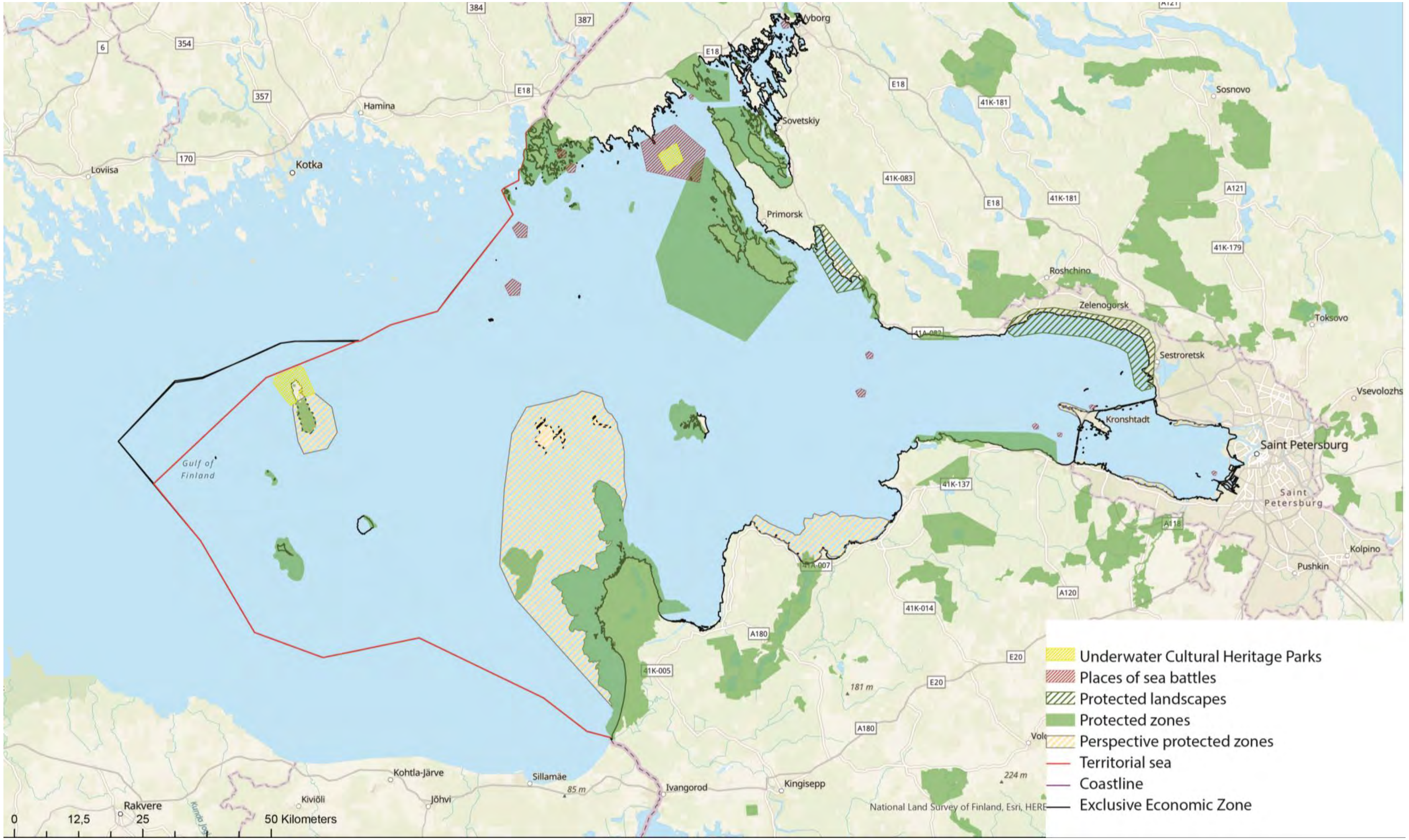
# Nature protection areas

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# Areas with limited activities:

- **Buffer zones** - are established around functional zones where economic activities can affect other activities in the immediate vicinity of the functional zones. The size of the buffer zones is established by the relevant regulatory documents and can be adjusted based on additional calculations.
- **Sanitary protection zones** – areas with special regimes of use. They are established around objects and enterprises that have an impact on the environment and human health. The size of the sanitary protection zone ensures the reduction of the impact of pollution (chemical, biological and physical) on marine space in accordance with sanitary norms. The zone is assigned based on additional calculations.
- **Restricted zones** – areas designated for protection of biological resources and especially vulnerable and productive areas with sensitive natural landscapes.

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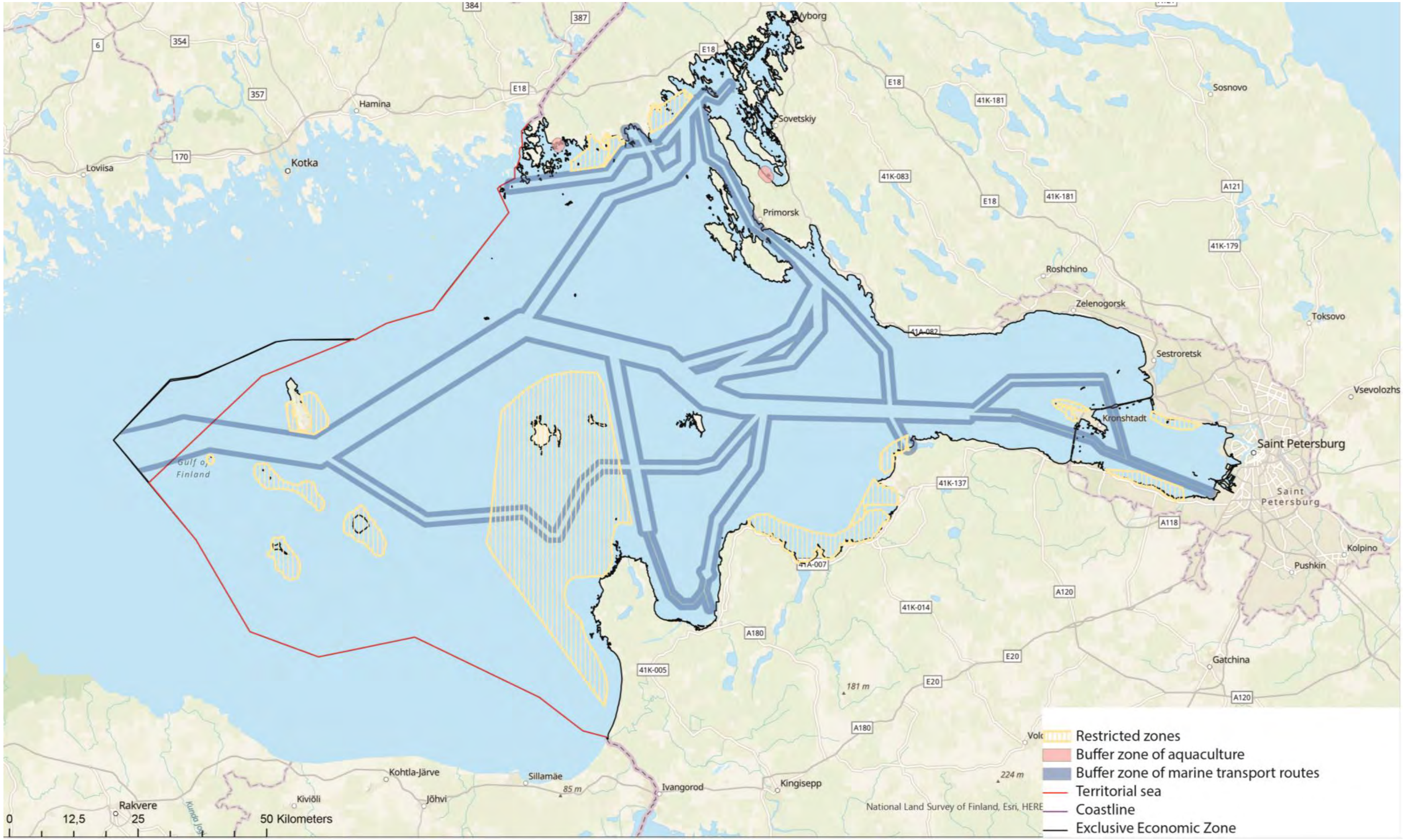
# Areas with limited activities

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# Zones of active maritime use:

- Zones of marine transport routes and traffic flows;
- Zones of submarine cable and pipeline routes;
- Zones of marine subsoil use (infrastructure for the exploration and extraction of oil, gas and other energy resources);
- Aquaculture zones;
- Fishing zones;
- Zones of offshore wind energy (as well as wave and tidal);
- Military training zones;
- Zones of tourism and recreation;
- Zones for dumping of soil (landfill and excavation);
- Scientific research;
- Other activities in the sea (including artificial structures, islands, bridges, tunnels, etc.).

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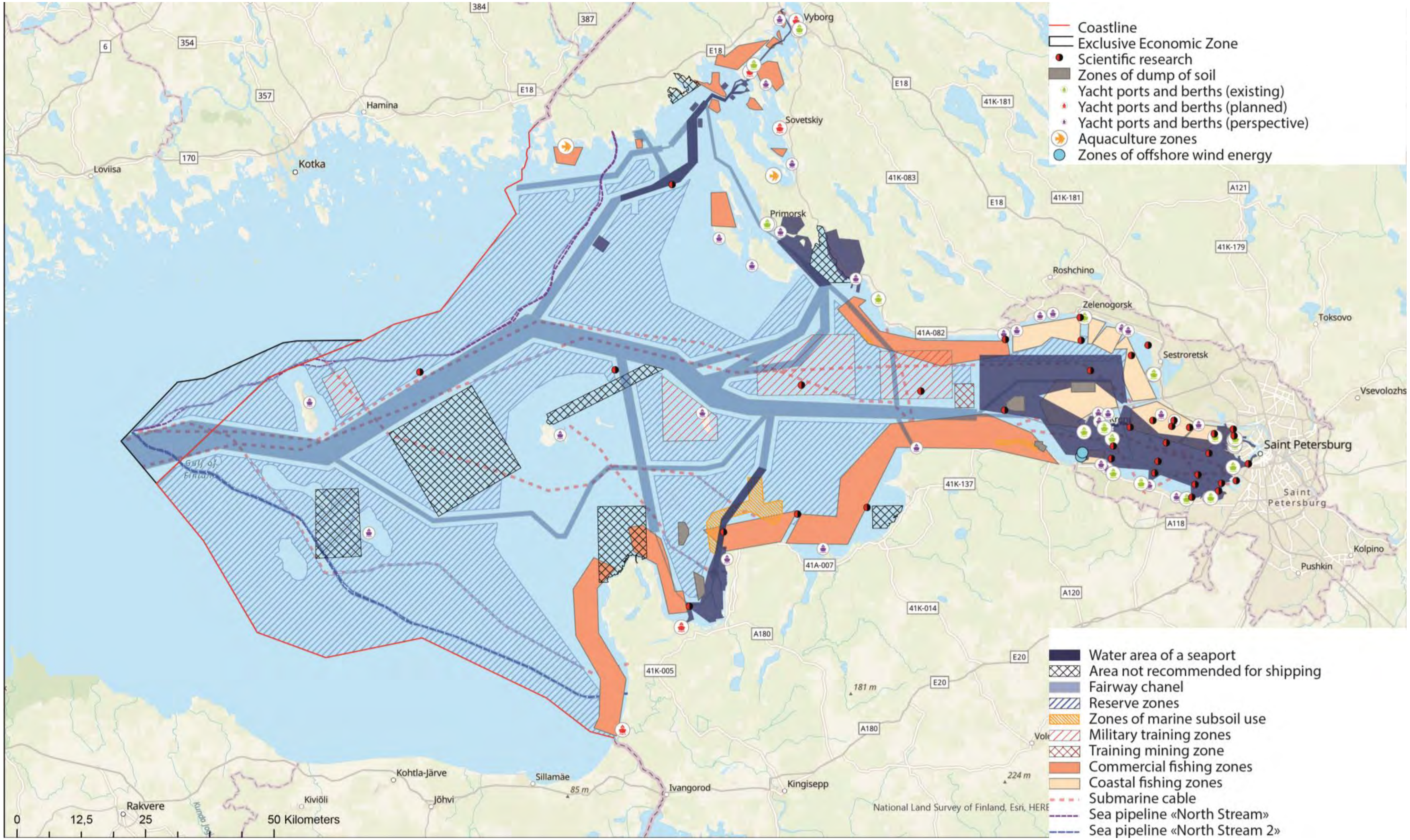
# Zones of active maritime use

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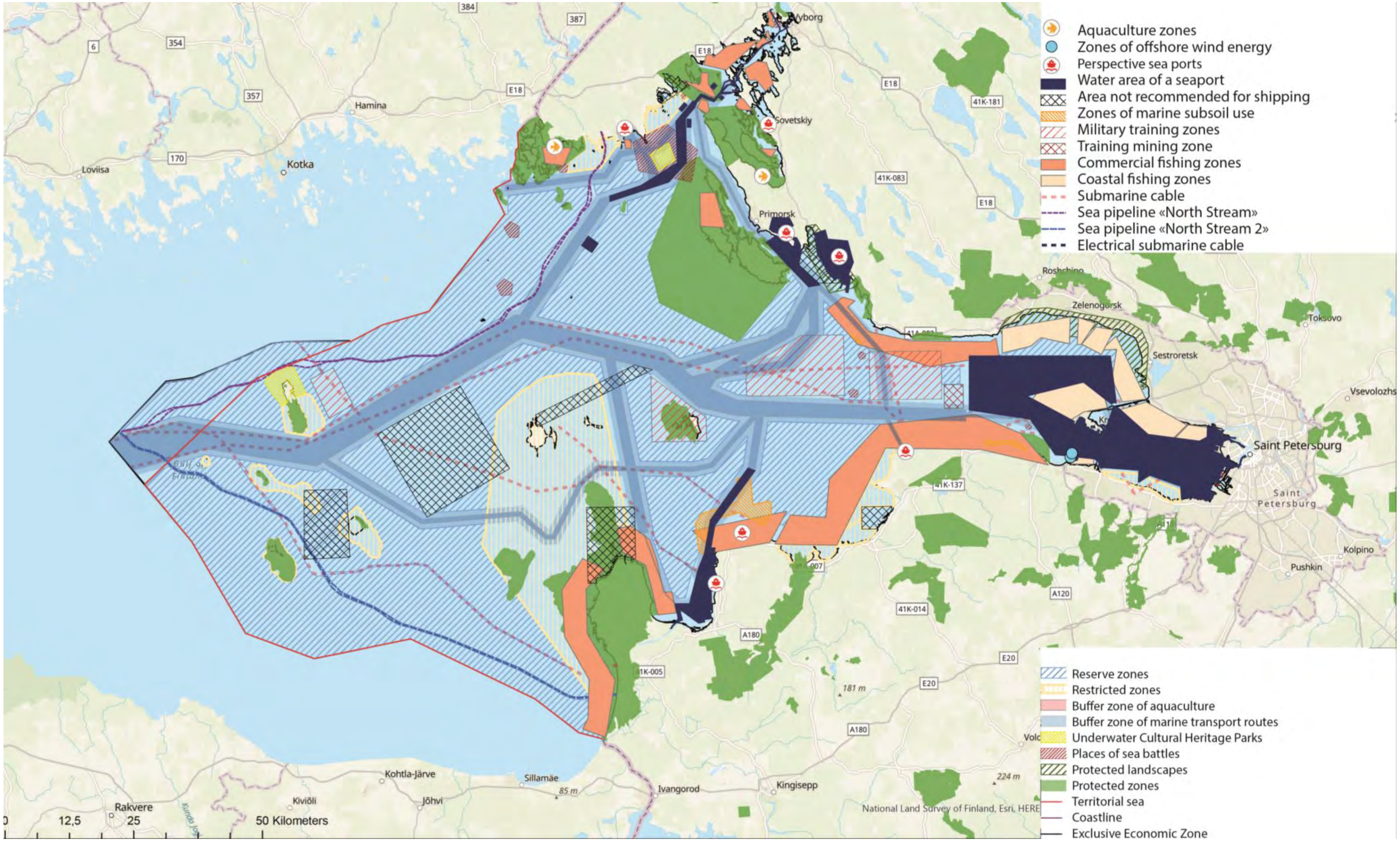
# Comprehensive plan until 2030

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# In the prospect, it is assumed there will be:

- improved coordination between maritime and land planning;

- distribution of responsibilities related to Maritime Spatial Planning and Zoning between public authorities at various levels;

- resolution of conflicts between industry users;

- development of the environmental monitoring in accordance with the data obtained by the MFZ;

- involvement of stakeholders and their more active participation in Marine Functional Zoning.

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# THANK YOU FOR YOUR ATTENTION

Anisimovets Anastasiia, Nosenko Natalie
info@ermaknw.ru

www.ermaknw.ru