Gulf of Finland Co-operation

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

PROGRAMME

Gulf of Finland
Co-operation

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

Gulf of Finland Co-operation

Day 1: Monday 29th November

The Gulf of Finland Science Days

"New start for the Gulf of Finland co-operation"

Tallinn, 29-30 November 2021

Comprehensive monitoring of nutrient concentrations and loads is essential for GOF state evaluations

Heikki Pitkänen, Seppo Knuuttila, Jouni Lehtoranta & Mika Raateoja
Finnish Environment Institute, SYKE

SYKE

Contents

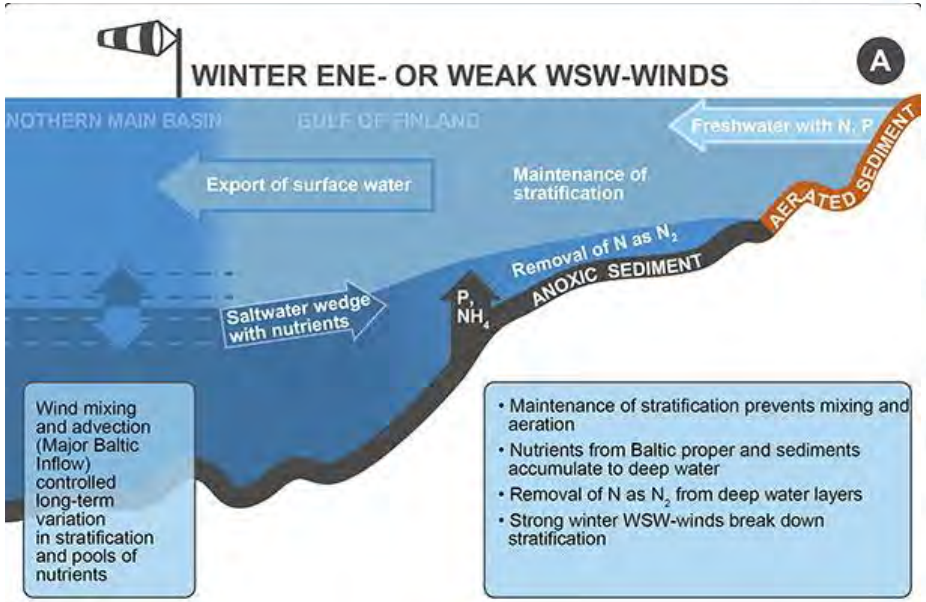
- Trophic status of GOF: internal processes vs. land-based loading
- Strong decreases in nutrient loads
- Long-term variations: is eutrophication continuing?
- The importance of quality assurance
- Proposals for future GOF co-operation

S Y K E

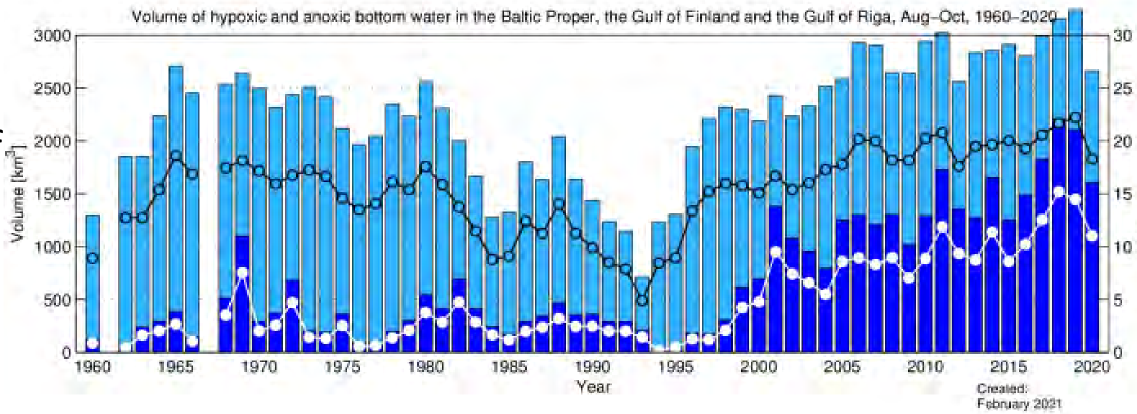
Internal processes vs. land-based loading

- The state of GOF is highly dependent on stratification conditions and sub-halocline imports of phosphorus from the Baltic Proper (BP)
- As land-based nutrient inputs have strongly decreased in recent decades, the relative role of internal nutrient sources have become more important, especially when hypoxic water volume in BP has increased, and halocline has risen
- The present annual land-based P load (3 000 - 4 000 t/a) corresponds roughly to about 10 % of the wintertime total P content of the GOF

=> decreases in external P loading affect trophic status of GOF only slowly, and responses to decreases are masked by internal processes induced by atmospheric forcing



Source: Lehtoranta et al. 2017. Atmospheric forcing controlling inter-annual nutrient dynamics in the open Gulf of Finland. Journal of Marine Systems 171:4-20.



Source: Hansson and Viktorsson 2020. Oxygen survey in the Baltic Sea – Extent of anoxia and hypoxia, 1960-2020. Swedish Meteorological and Hydrological Institute. Report Oceanography, no. 70. 88p.

S Y K E

Strong decreases in land-based nutrient loads

- After the 1970s/1980s P loading from the largest cities has deceased by about 4 000 t/y, and N loading by about 20 000 t/y
- Totally decreases up to 6 000-7 000 t/a of P and 70 000-80 000 t/a of N may have taken place during the past 40-50 years. However, these estimates include large uncertainties due to inconsistencies especially in loading data from rivers
- In 2008-2011 large P loading from the phosphogypsum stack of a fertilizer plant into the River Luga temporarily counteracted the decreasing trend in P loading

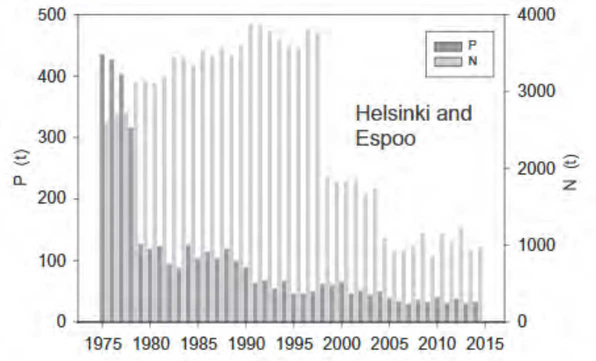


Fig. 3. Annual P and N load from the WWTPs of Helsinki and Espoo into the GOF from 1975 to 2014 (Helsinki Region Environmental Services Authority HSY).

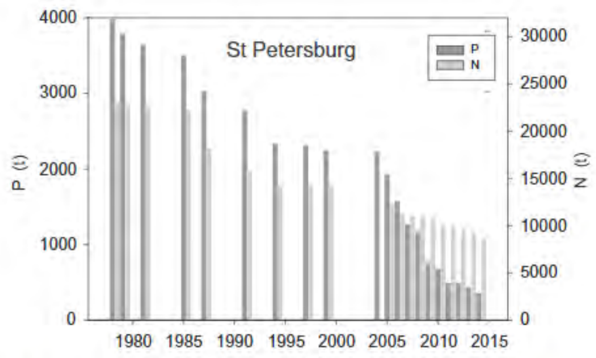


Fig. 2. Annual P and N load from the WWTPs of St. Petersburg into the GOF (Vodokanal, 2015).

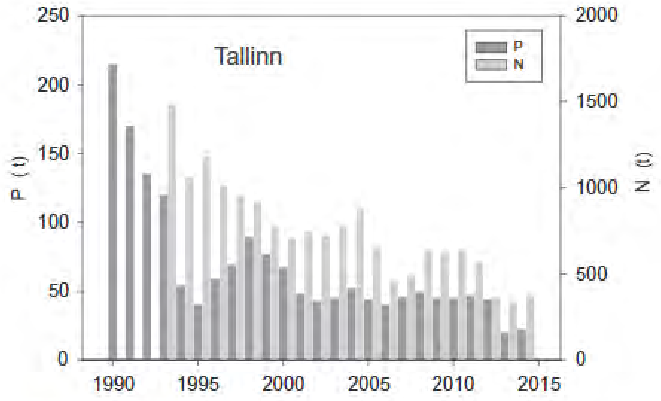


Fig. 4. Annual P and N load from the WWTP of Tallinn into the GOF from 1990 to 2014 (HELCOM, 2006; AS Tallinna Vesi, 2014).

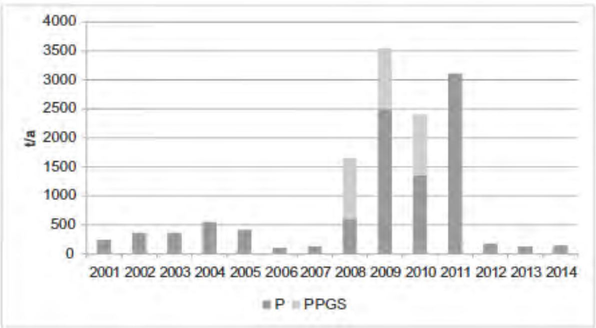


Fig. 8. P inputs transported via the River Luga into the GOF for the period 2001–2014. P = total P, P PGS = total P originated from the phosphogypsum stack. P inputs from the stack were covered by monitoring only in the year 2011. Therefore an estimate based on measurements in 2011 has been added to P discharges in the years 2008–2010.

Source: Knuuttila et al. 2017. Nutrient inputs into the Gulf of Finland: Trends and water protection targets. Journal of Marine Systems 171:54-64.

SYKE

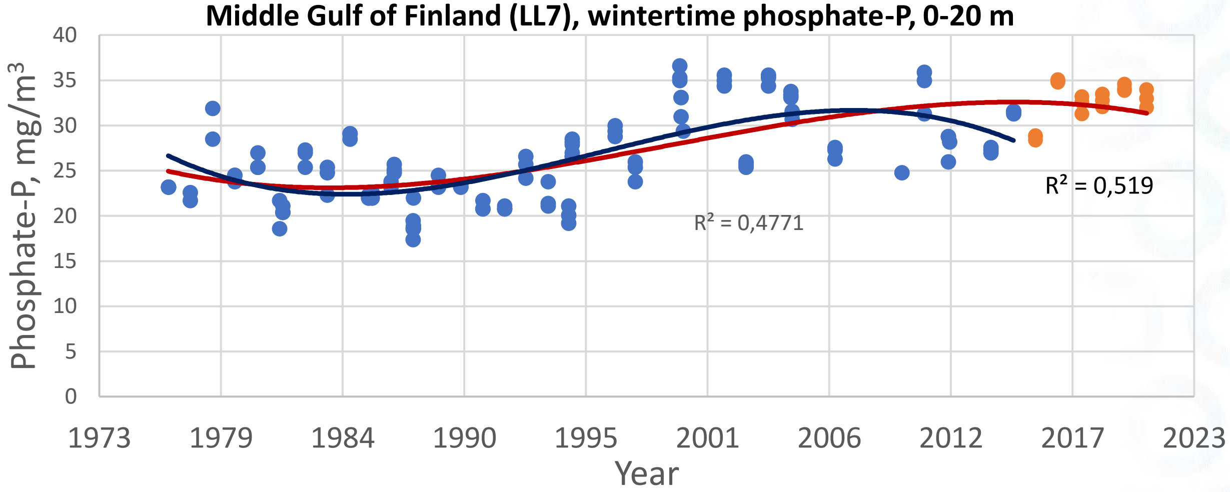
Long-term variations in wintertime phosphate and nitrate, middle GOF

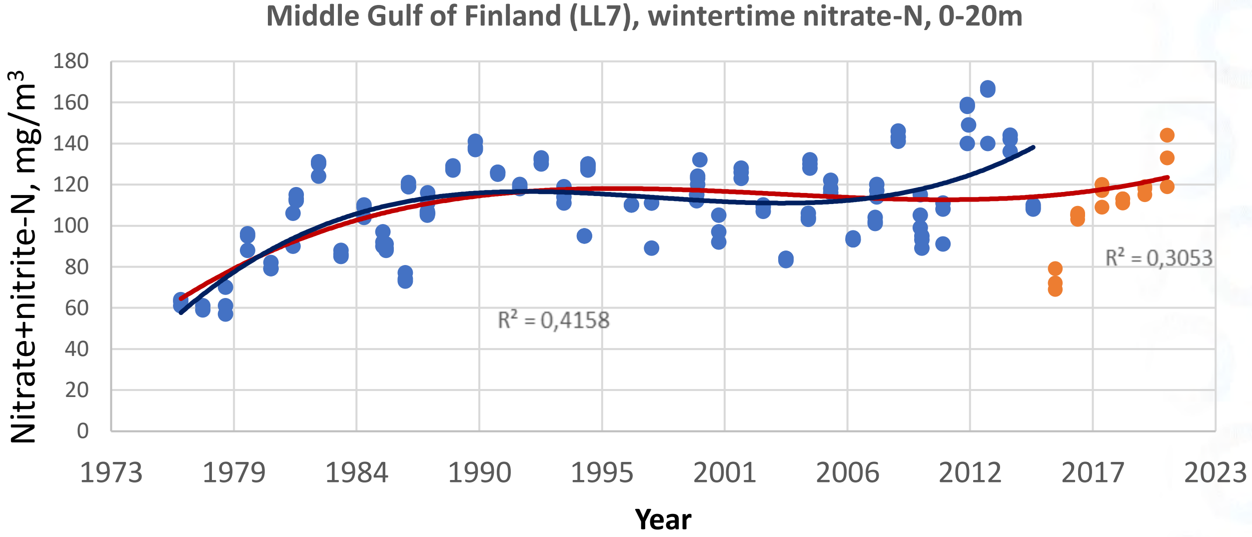
Phosphate

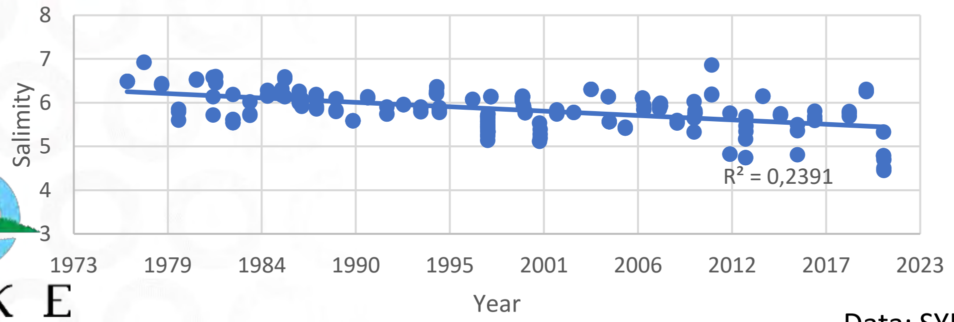
- Long-term increase in the open middle Gulf, no trend in the 2000s
- 2014-16 Major Baltic Inflows caused elevated concentrations after 2017
- The data of 2000-2014 has been carefully evaluated: values <0.7 µmol/l (22 µg/l) were assessed as uncertain, and can't be automatically downloaded from SYKE's data base anymore

Nitrate

- Eutrophication phase in the 1970s-1980s
- Slight decrease in the 1990s along with decreased land-based loading
- Increased impact of river waters (decreasing salinity) tend to elevate surface layer concentrations







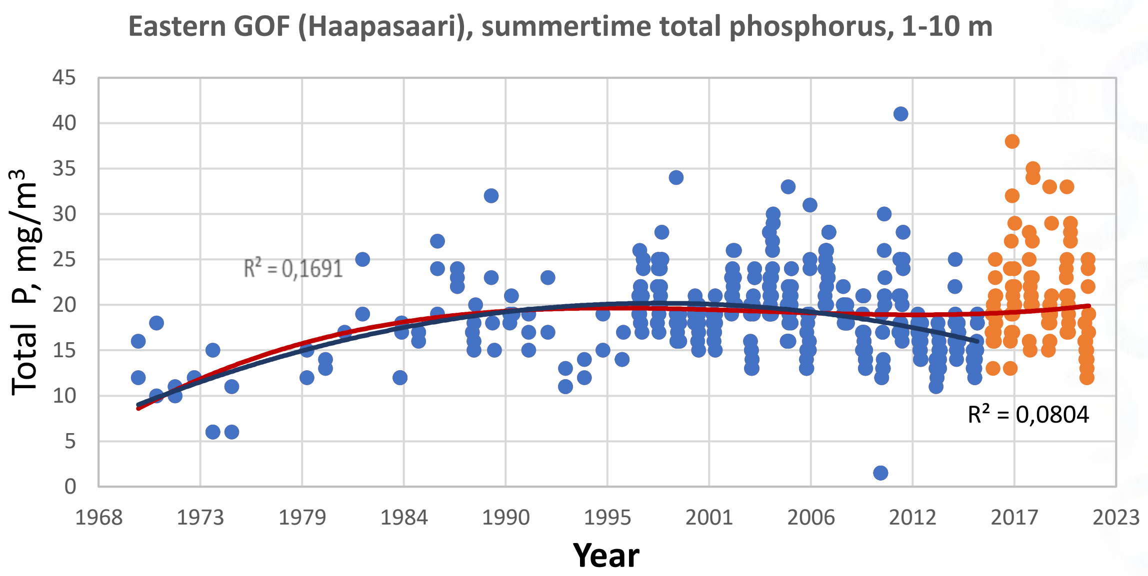
S Y K E

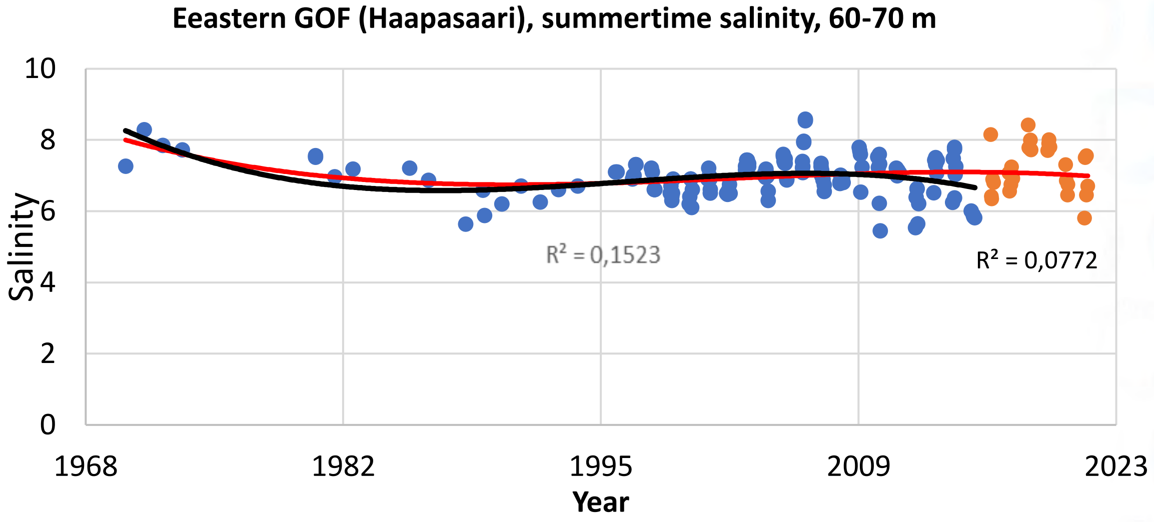
Data: SYKE, SYKE Data Base

Pitkänen et al., SYKE 10.12.2021

Long-term variations in summertime total P, eastern GULF

- Increase from the 1970s to the early 1980s, decrease from 2005 to 2015
- Indirect effects of the Major Baltic Inflows in 2014-16: an increase back to the level of the early 2000s
- Strong load reductions in 1985-1995 (when also halocline in BP was low), and in the 2000s coincide with decreased phases in P concentrations
- However, internal processes including deep water exchange between BP and GOF have been the main controlling factors (Lehtoranta et al. 2017)
  - This is once again demonstrated by the increase in concentrations after 2017 due to MBIs in 2014-16 which pushed old deep water from BP into GOF





Data: Southeast Finland ELY-Centre, SYKE Data Base

Pitkänen et al., SYKE 10.12.2021

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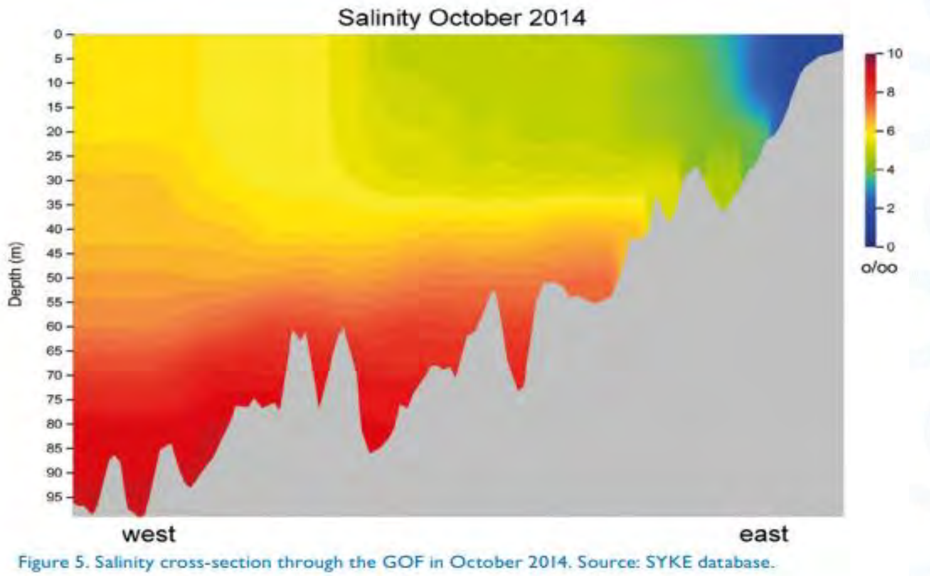
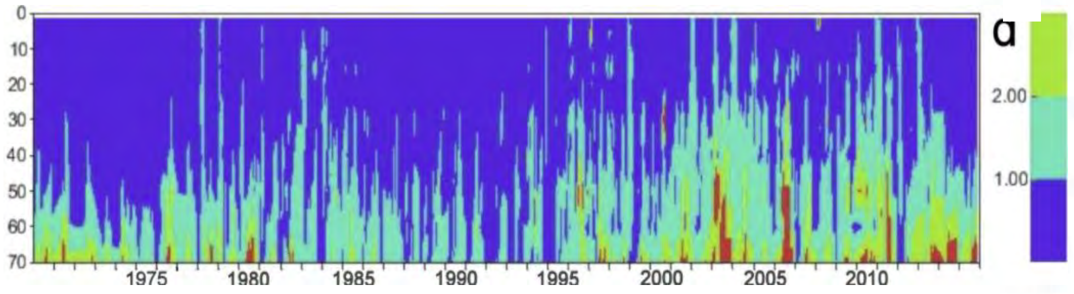
Challenges with pointing out effects of load reductions

- Concentrations of nutrients vary strongly due to physical and biogeochemical processes in the estuarine-like GOF
- Monitoring aims to follow, and analyse changes caused by anthropogenic loading to help to perform measures to reduce loading and improve state of the ecosystem
- Anthropogenic effects should be possible to separate from effects caused by natural processes
- => challenging especially in the open sea because changes in anthropogenic loading are much smaller than those caused by processes in the sea
    - Theoretically 1 000 tons of P corresponds roughly 1µg/l (0.03 µmol) of P in the whole water volume of GOF



Source: Alenius et al. 2016. Gulf of Finland physics. In: Raateoja and Setälä (eds.). The Gulf of Finland assessment. Reports of the Finnish Environment Institute no. 27. p. 42-57.



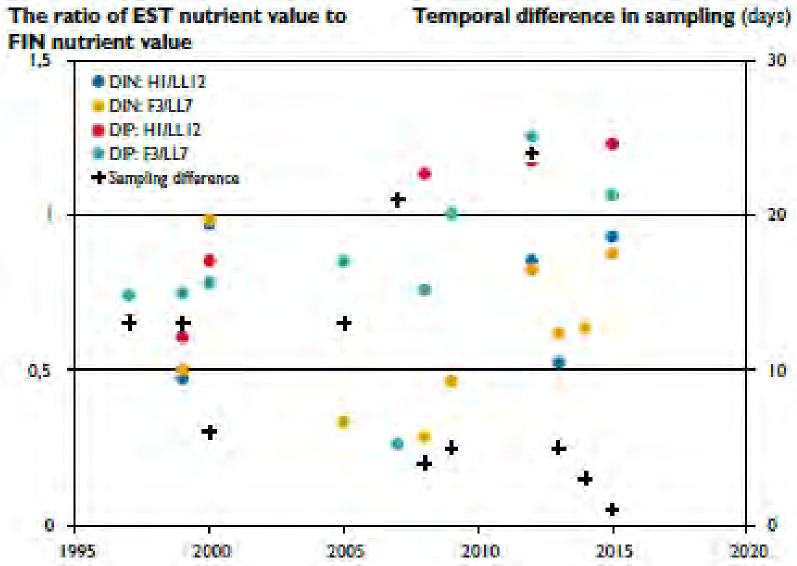
Long-term seasonal dynamics of phosphate (µmol) horizontally averaged over the whole GOF (Lehtoranta et al. 2017).

Pitkänen et al., SYKE 10.12.2021

S Y K E

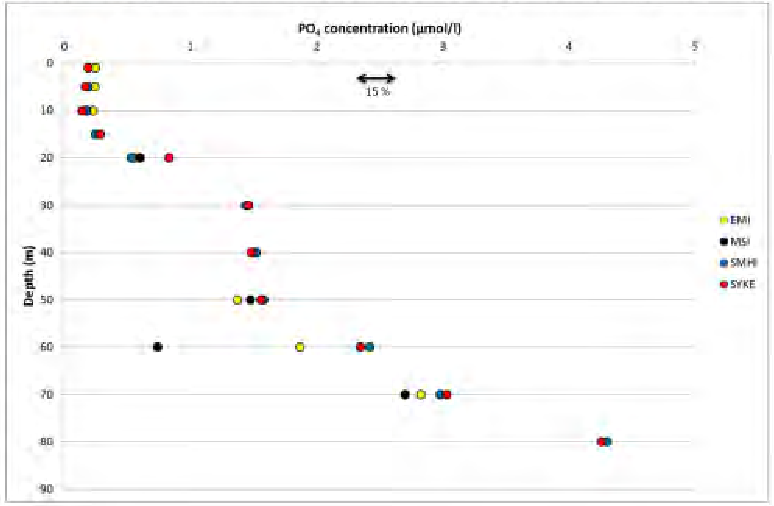
The importance of quality assurance

- The GOF2014 Year demonstrated inconsistencies in the monitoring data of both marine and river water concentrations and loads of nutrients
- Data from the same regions could produce different long-term trends depending on the data (Finnish or Estonian) used
- The NCM -funded MARICAL intercalibration exercise performed in September 2019 produced mostly acceptable differences in results



Source: Raateoja et al. 2016. Nutrients in the water. In: Raateoja and Setälä (eds.). The Gulf of Finland assessment. Reports of the Finnish Environment Institute no. 27. p. 94-113.

Figure A1.4. PO_4 concentration. Arrow shows the average measurement uncertainty



Source: Raateoja et al. 2020. MARICAL field inter-calibration exercise: Report of the field inter-calibration on sampling and analytical procedures for Estonian, Finnish and Swedish institutes carrying out HELCOM monitoring. Nordic Council of Ministers. TemaNord 2020:503. 27 p.

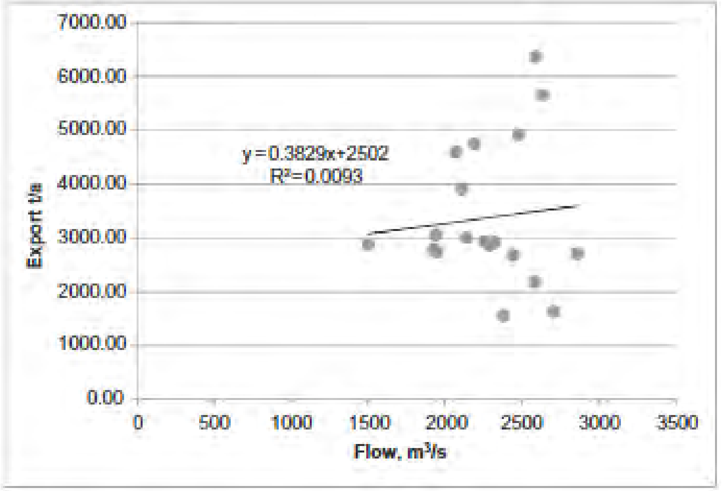


Fig. 7. P export and flow of the Neva based on data reported to HELCOM.

Source: Knuuttila et al. 2017

Proposals for future GOF-cooperation

- Regular monitoring based on research vessels and fully comparable chemical methodology either onboard or in land laboratories is presently the only way to reliably monitor nutrients in the whole Gulf in different seasons with necessary spatial coverage
- Additionally, development of continuous measurements (ferry-box, moored stations) are needed for high-frequency temporal coverage
- Regular intercalibrations are needed between the countries and within countries between the different institutes producing nutrient data
- Data exchange and annual reporting - as in connection with the GOF2014 Year - is suggested as a regular biennial process to follow the data quality and changes in the state of GOF. This applies to the monitoring of nutrients in both seawater and land-based sources

SYKE

Russian Geological Research Institute

Gulf of Finland Co-operation

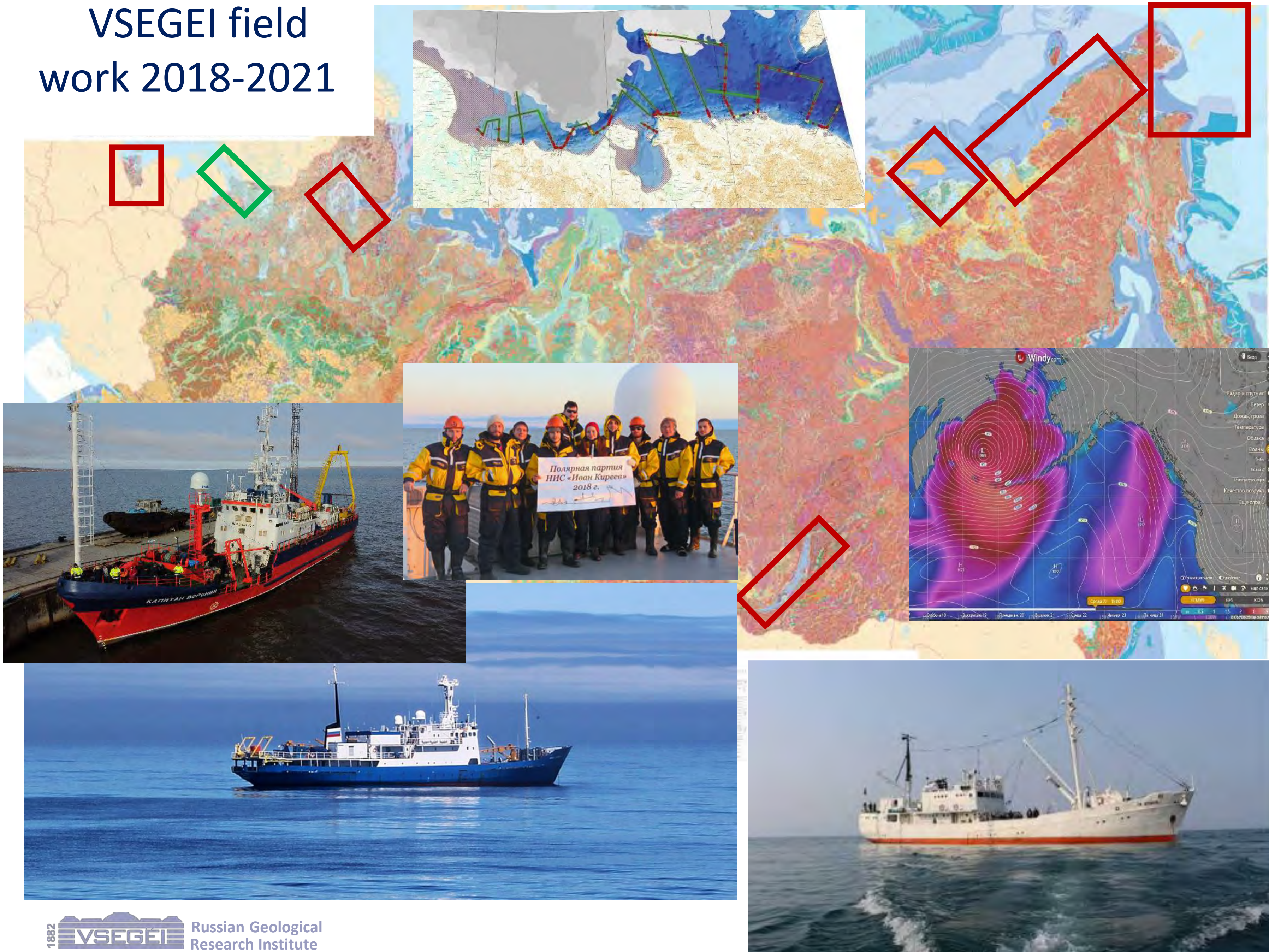
Gulf of Finland coastal systems: Holocene development and human impact

Daria Ryabchuk

Gulf of Finland Co-operation

Kaarel Orviku (15.07.1935 – 24.07.2021)

VSEGEI field work 2018-2021



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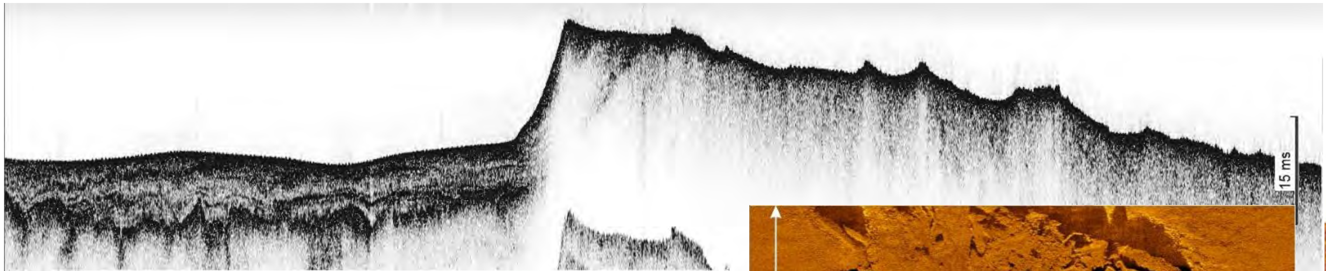
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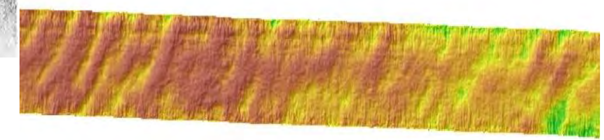

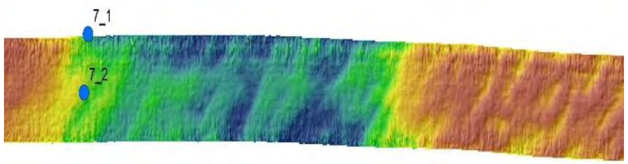
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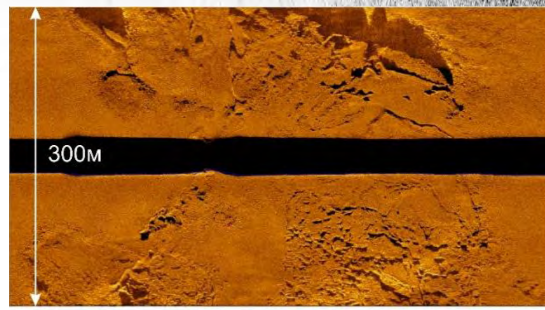
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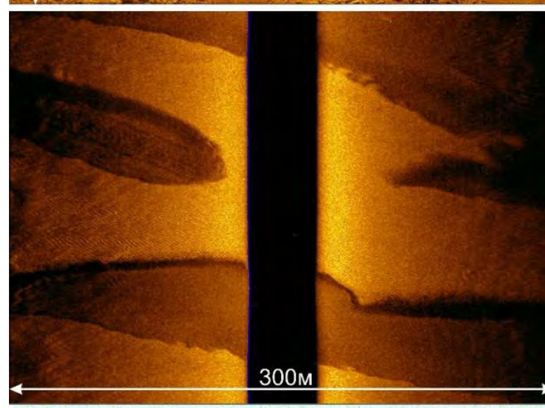
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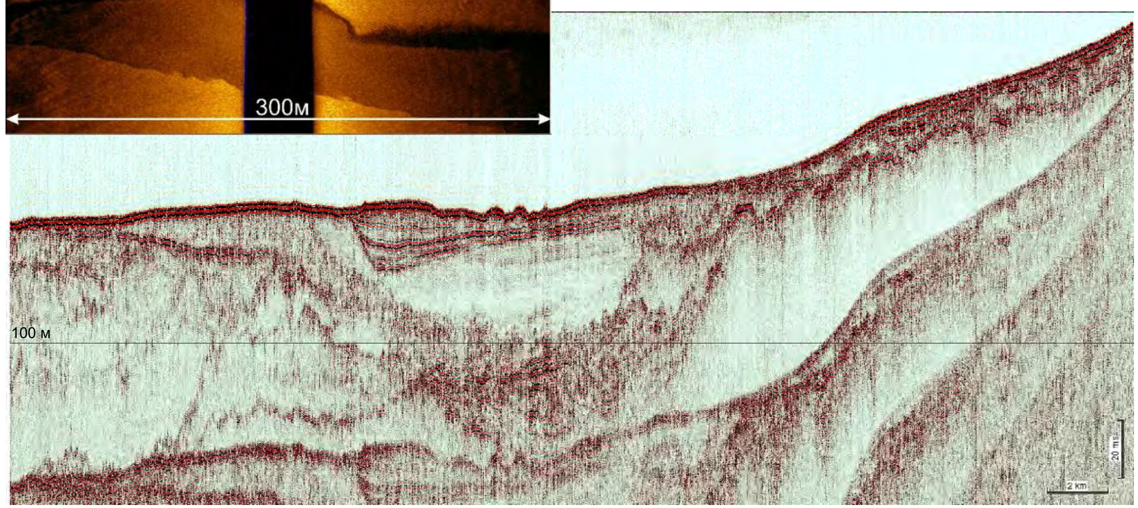
Берингово море


100 м
2 km

Gulf of Finland coastal systems: Holocene development and human impact

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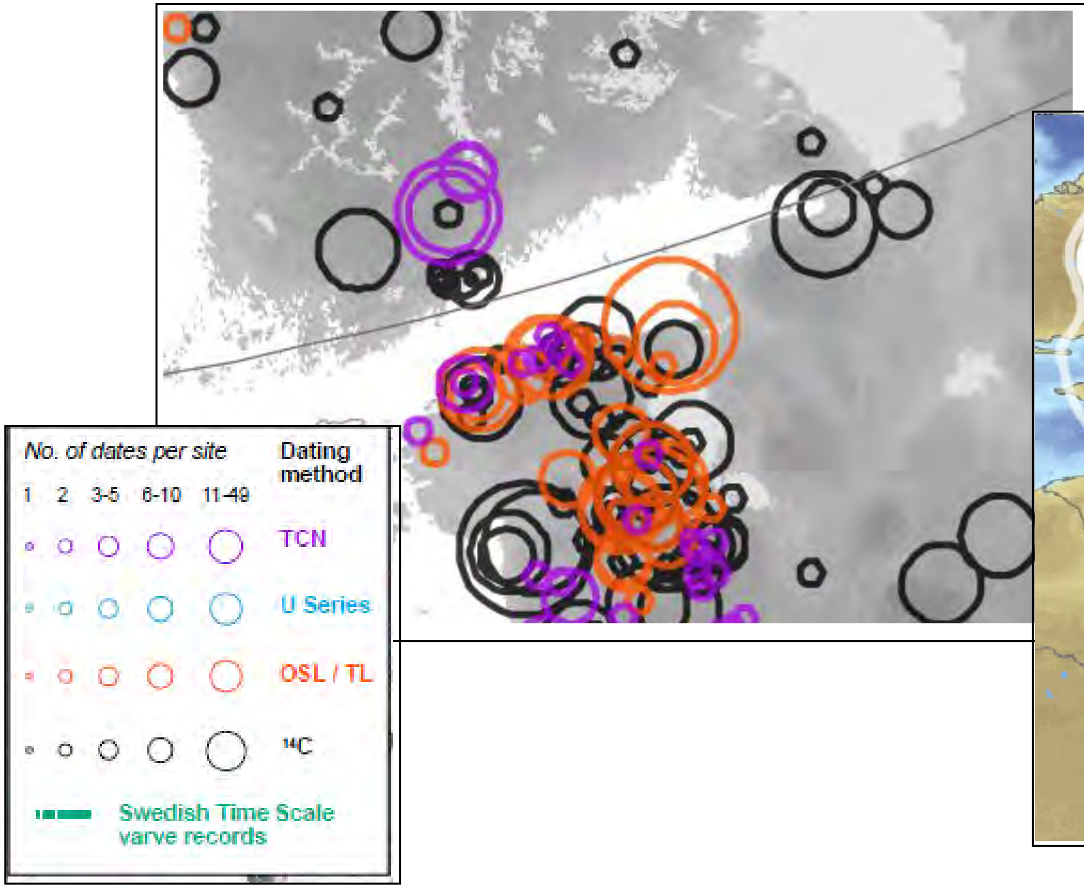
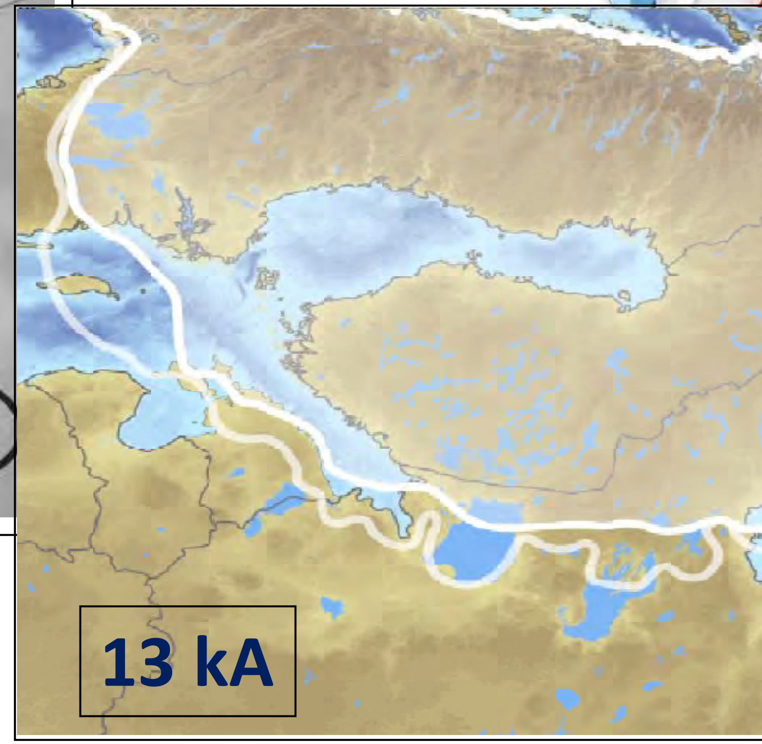
1. Investigation of coastal zone evolution in Holocene and revealing of main natural factors controlled long-term coastal development.

2. Study and monitoring of recent coastal processes (e.g. geological hazards) (dominated trends, intensity, natural and anthropogenic driving forces).

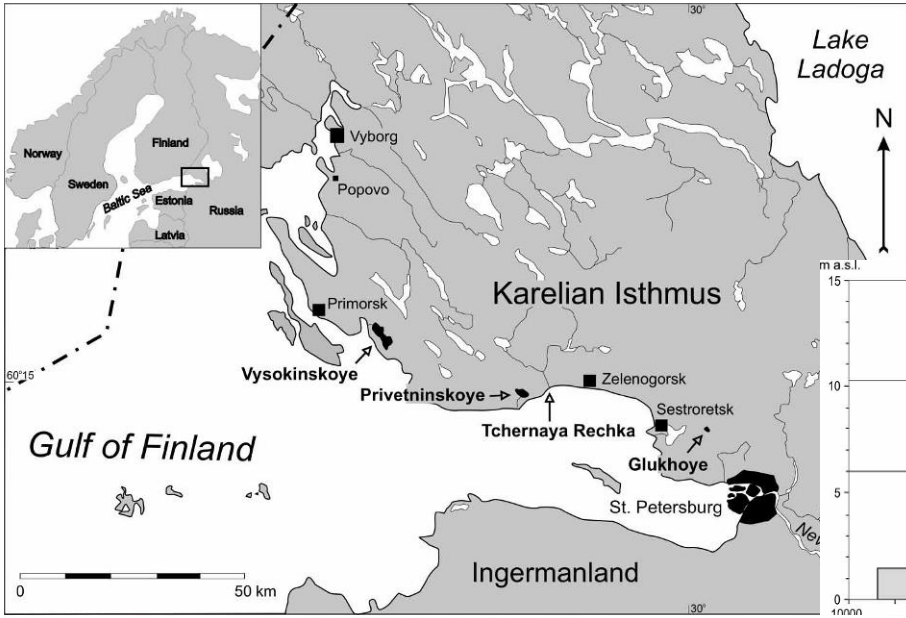
3. Prediction of future coastal development and recommendations for risk mitigation.



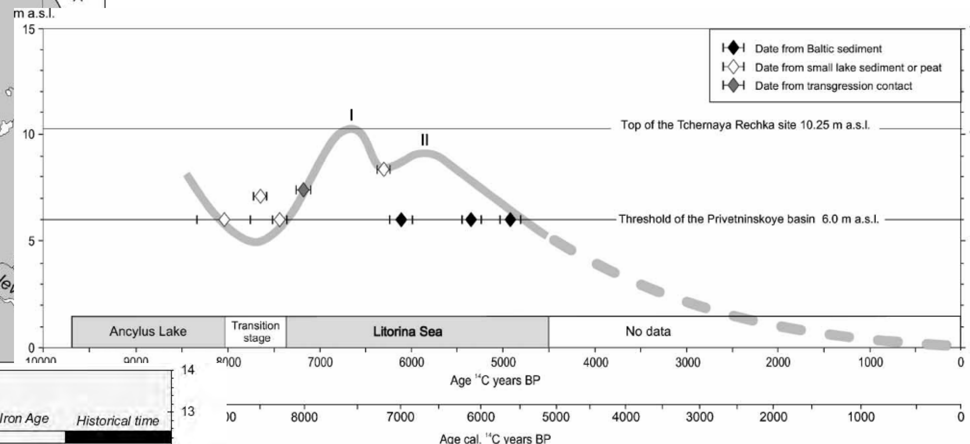


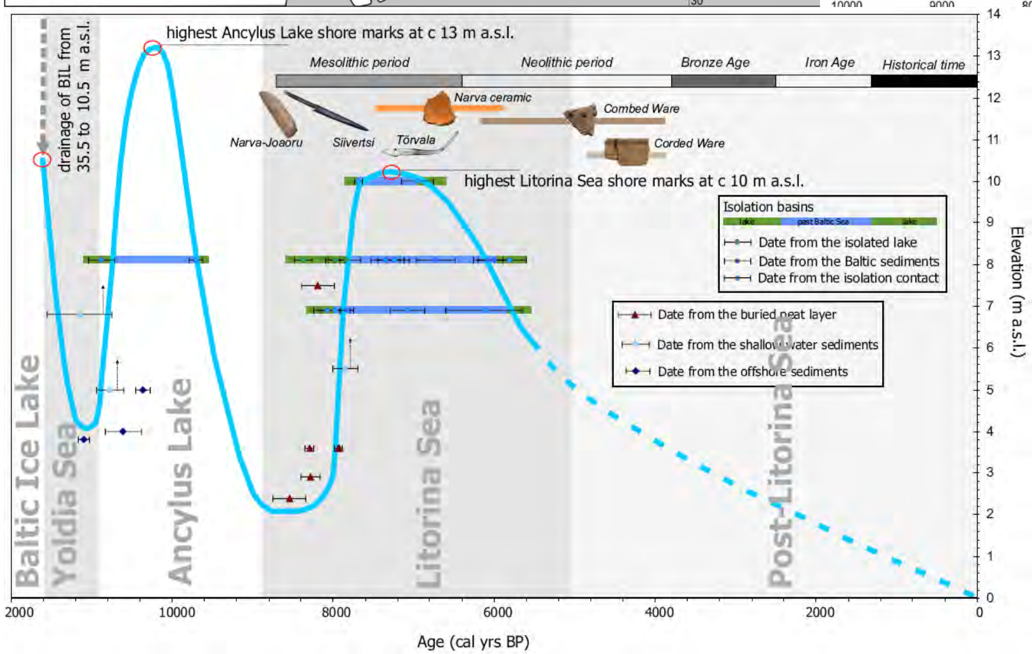
Spatial distribution of all dates within the DATED-1 database. Proportional circles and colours show the number of dates from each dating method at each site (as defined by unique geographic co-ordinates).. Note the low density of information for the Barents and Kara seas, Baltic and North seas, the Irish, Scottish and Norwegian continental shelves, and across Finland and the Russian Plain.

Hughes, A. L. C., Gyllencreutz, R., Lohne, Ø. S., Mangerud, J., Svendsen, J. I. 2016 (January): The last Eurasian ice sheets – a chronological database and time-slice reconstruction, DATED-1. Boreas, Vol. 45, pp. 1–45. 10.1111/ bor.12142. ISSN 0300-9483.



Miettinen, A., Savelieva, L., Subetto, D. A., Dzhinoridze, R., Arslanov, K. & Hyva.rinen, H. 2007 (October): Palaeoenvironment of the Karelian Isthmus, the easternmost part of the Gulf of Finland, during the Litorina Sea stage of the Baltic Sea history.





Rosentau, A., Subetto, D., Letjuka, N., Kriiska, A., Lisitsyn, S., Gerasimov, D., Nordqvist, K. Holocene water-level changes of the Baltic Sea in Narva-Luga klint bay area and its relations with stone age settlement pattern, 2010

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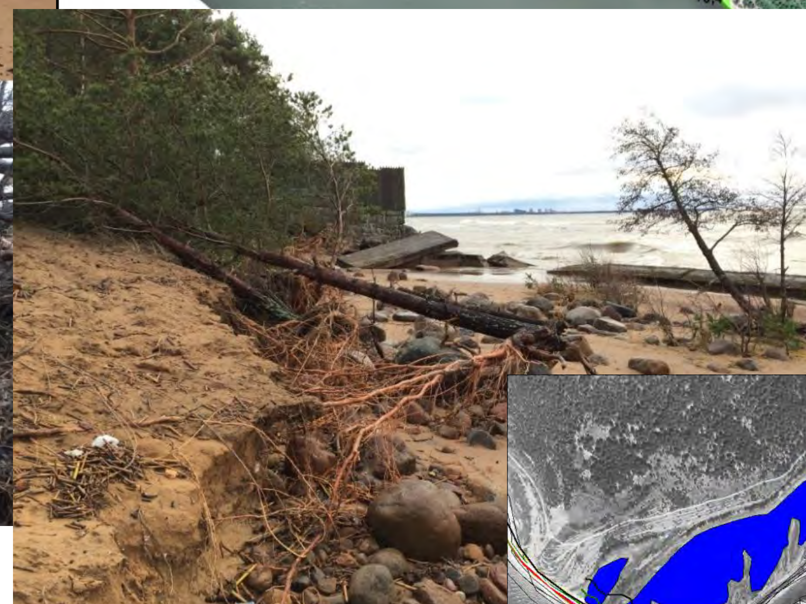

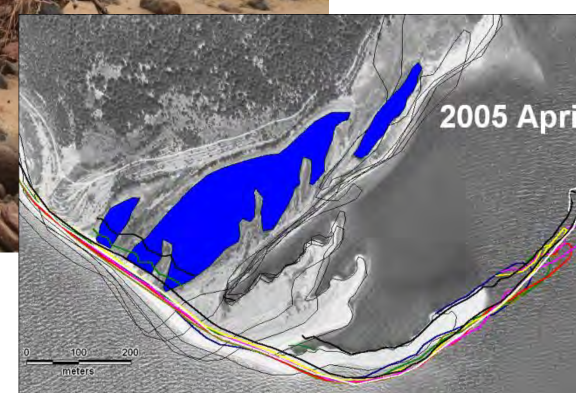

Kelba Spit, Kiipsaare island (Estonia)
Courtesy of K.Orviku and H.Tonisson

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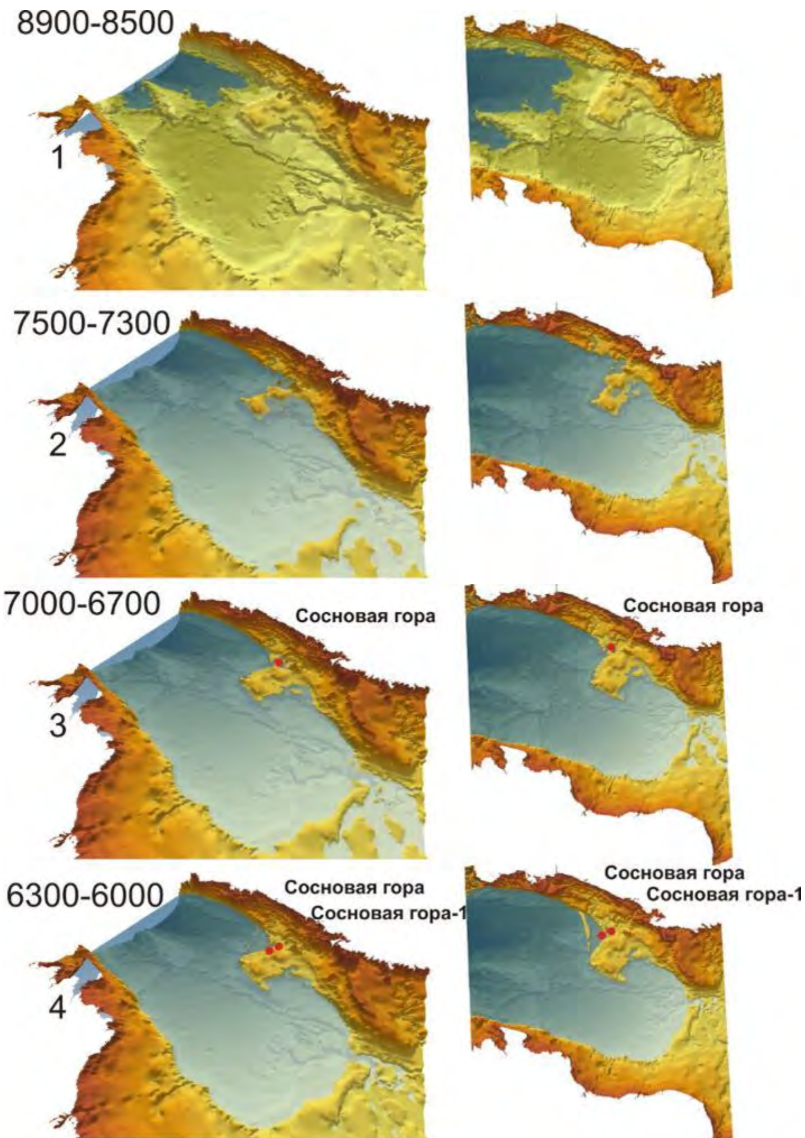
«Coastal zone – the space of interaction of lithosphere, hydrosphere, atmosphere and biosphere»

Nickolay Aibulatov



3D ⟶ 4D

Paleogeographic reconstructions of coastal zone development in Holocene (last 11.7 kA ago)

Prediction of future coastal zone development

Approximately 50% of the world's population lives within 100 km of the coastal line, two thirds of all cities with over 2.5 million inhabitants are located along the coasts

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«Coastal zones are among the most productive areas in the world, offering a wide variety of valuable habitats and ecosystems services that have always attracted humans and human activities. The beauty and richness of coastal zones have made them popular settlement areas and tourist destinations, important business zones and transit points».

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http://ec.europa.eu/

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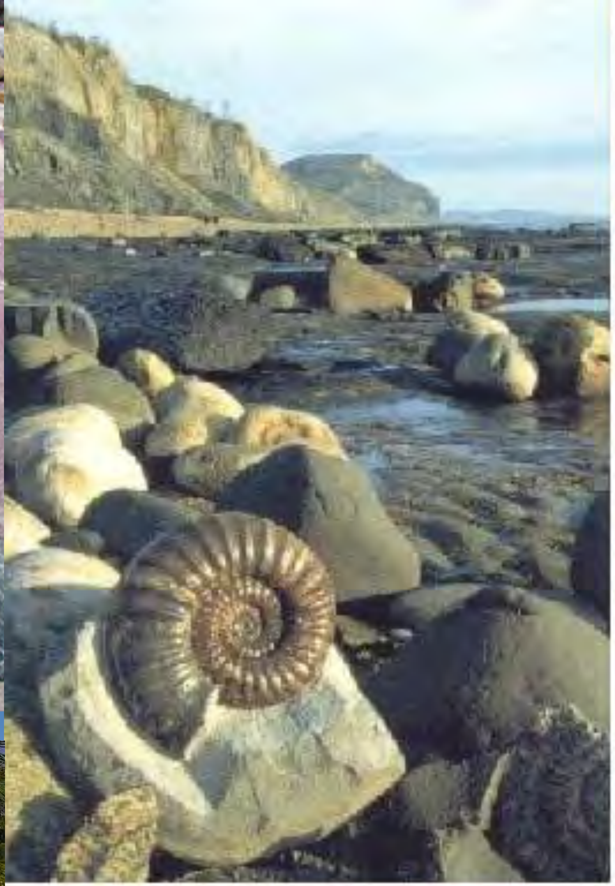
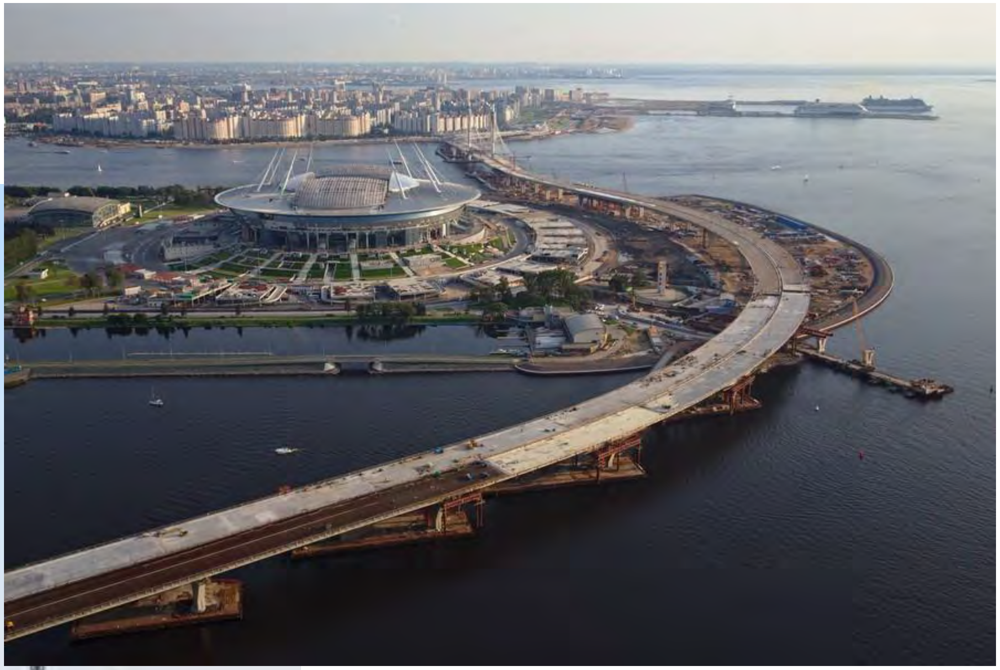
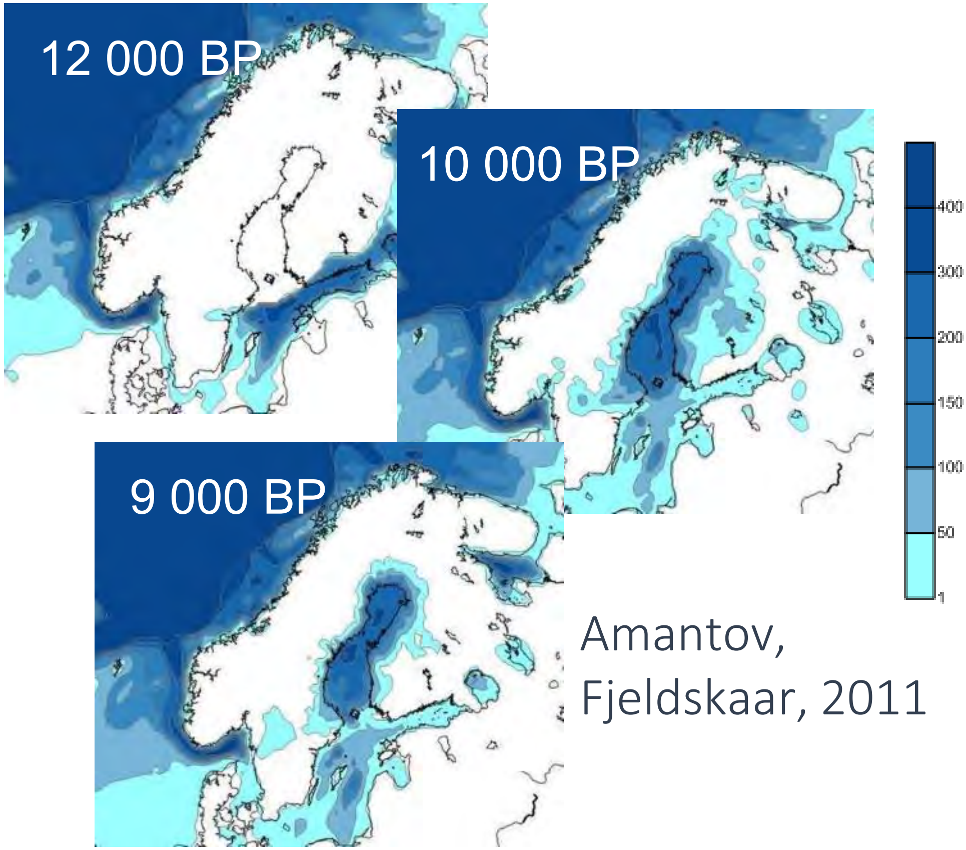



Natural coasts of Neva Bay

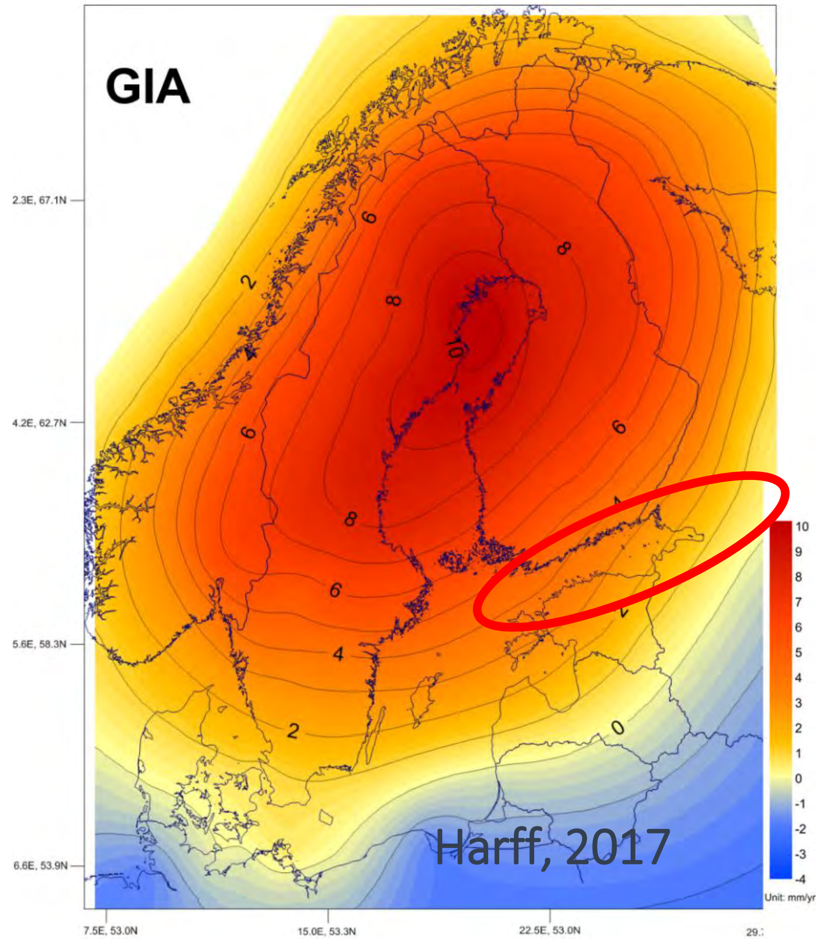




Russian Geological Research Institute

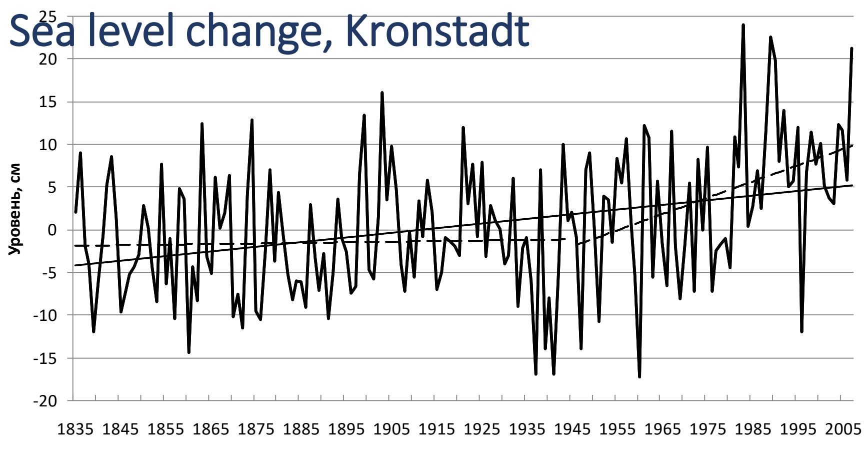


Amantov, Fjeldskaar, 2011

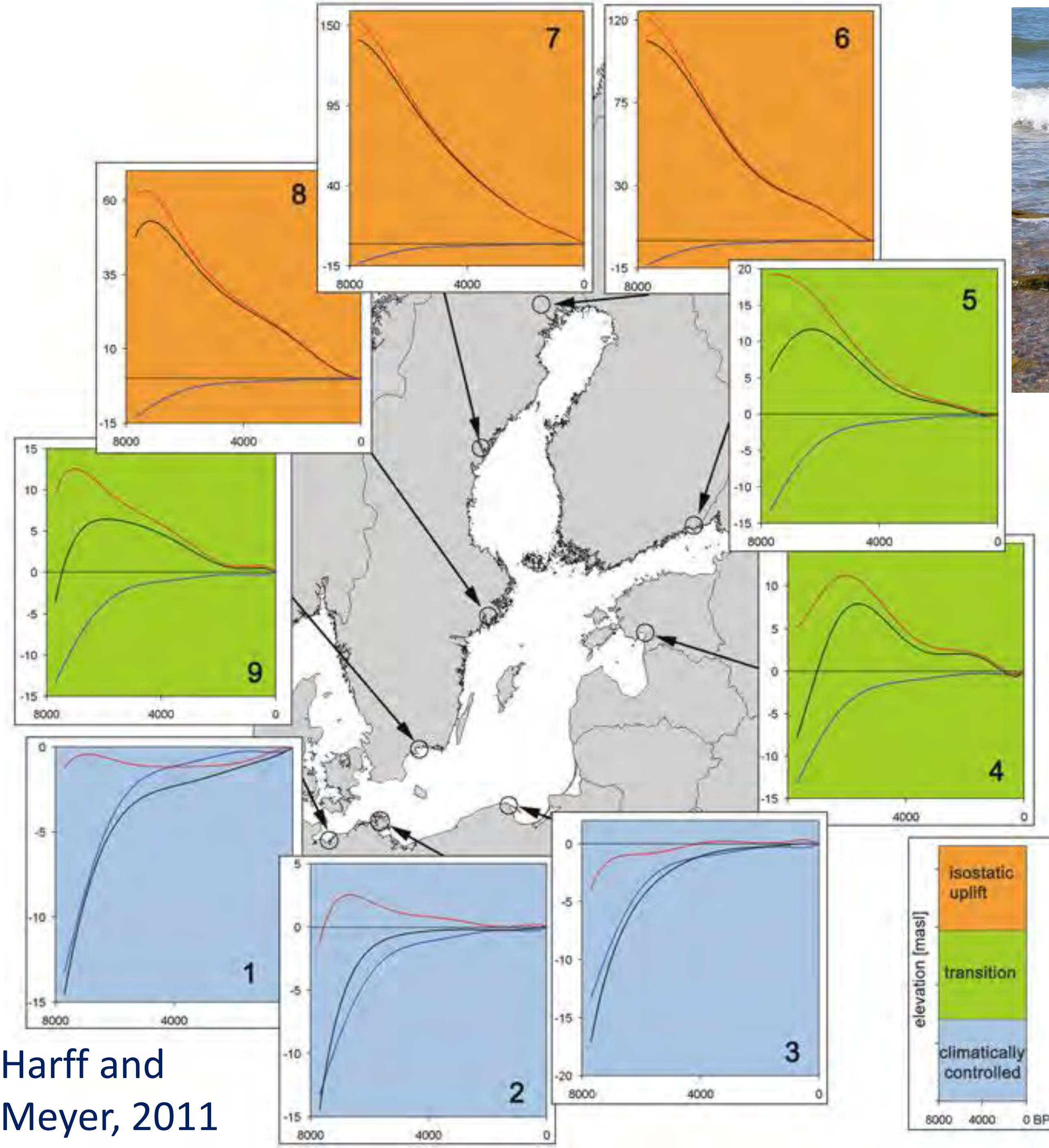


Rated of glacioisostatic rebound

Sea level change, Kronstadt



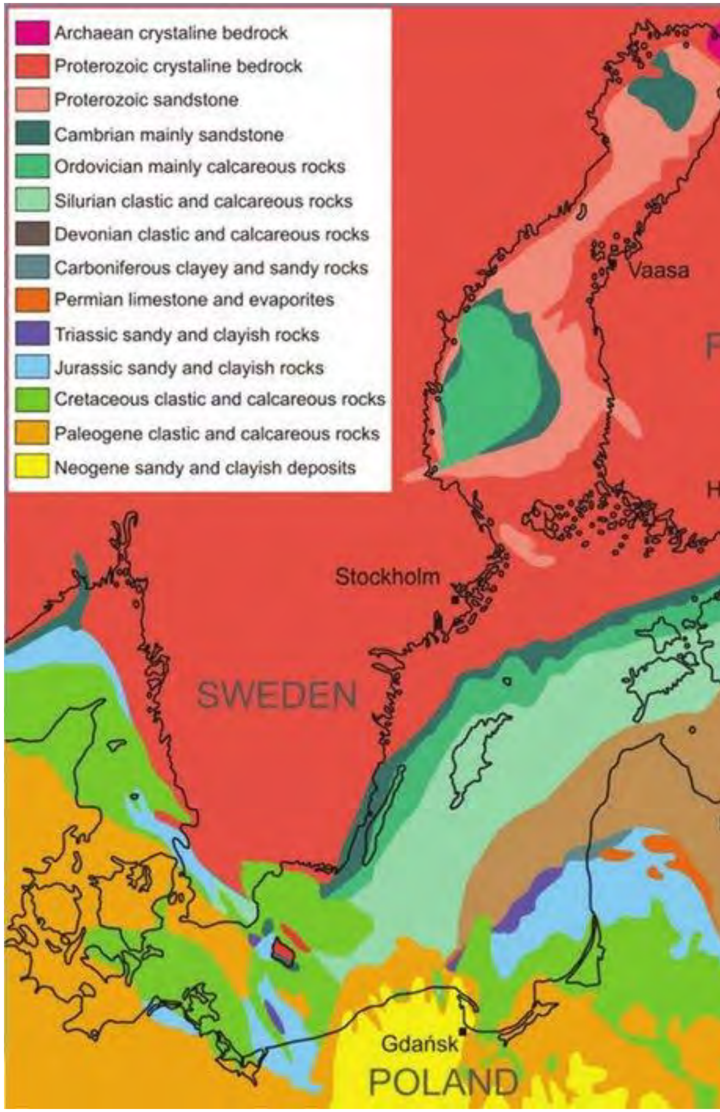
Gorgeeva, Malinin, 2016

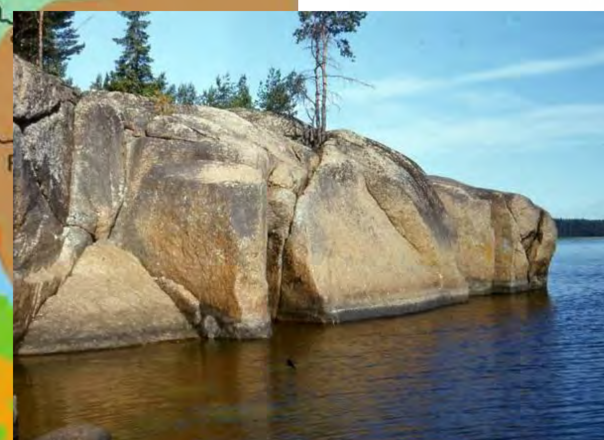


Harff and Meyer, 2011

Curonian spit

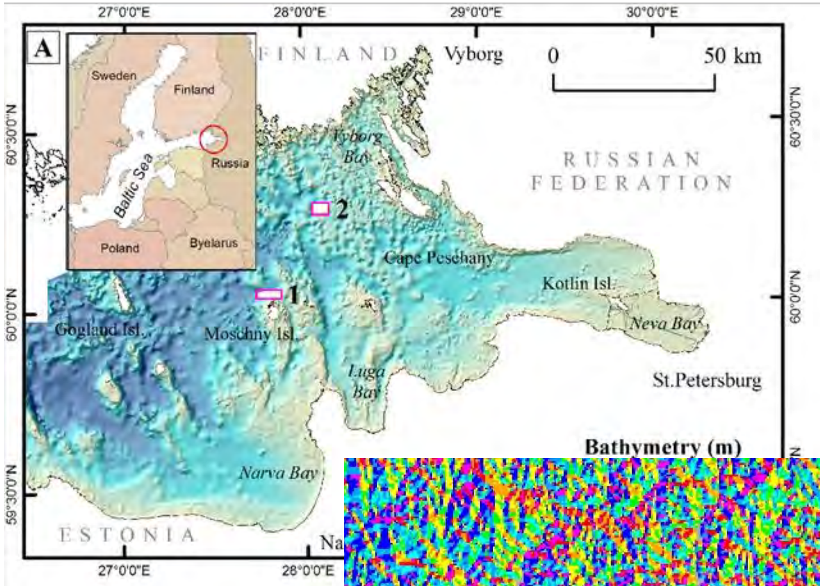
Wave-cut cliff, Saaremaa

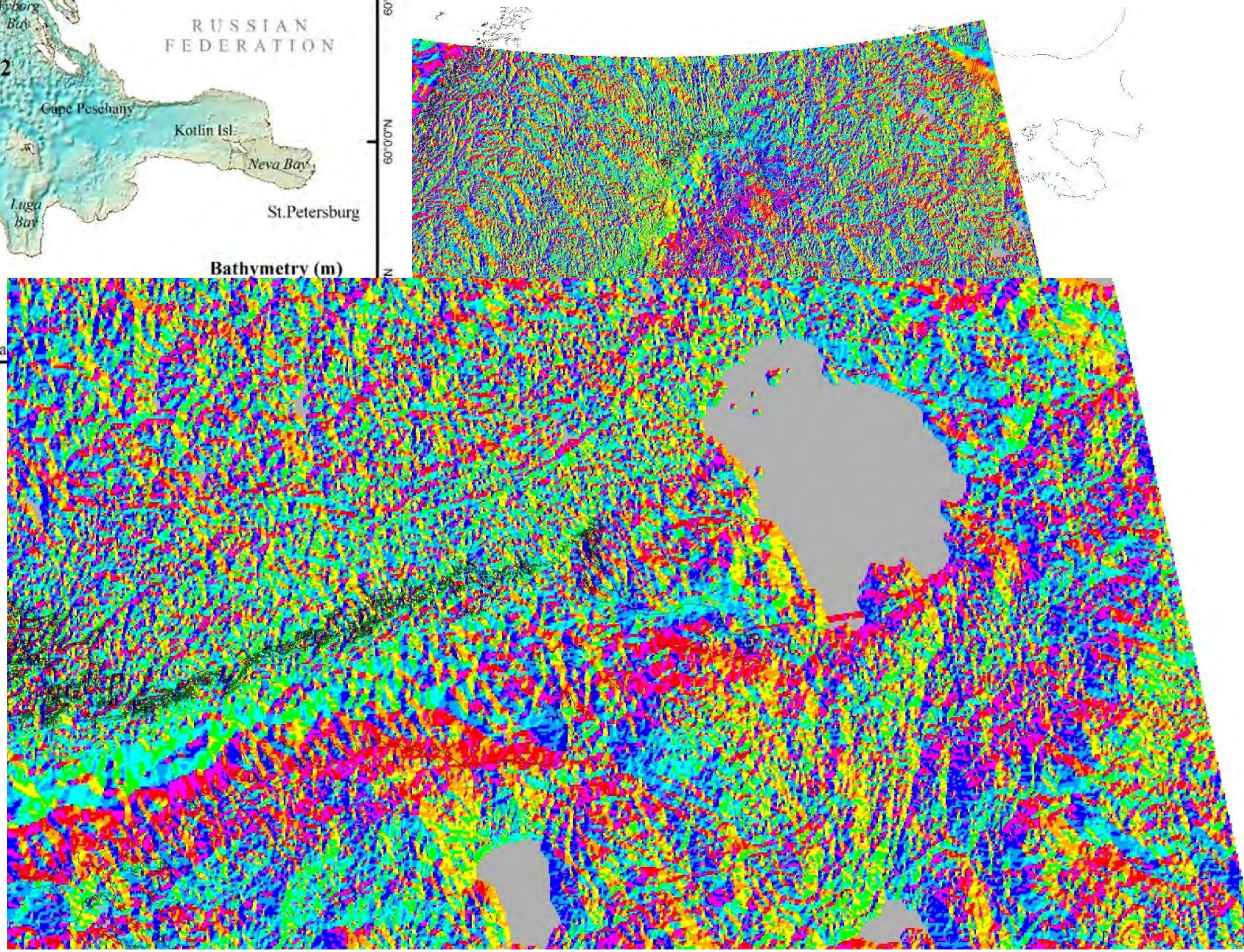




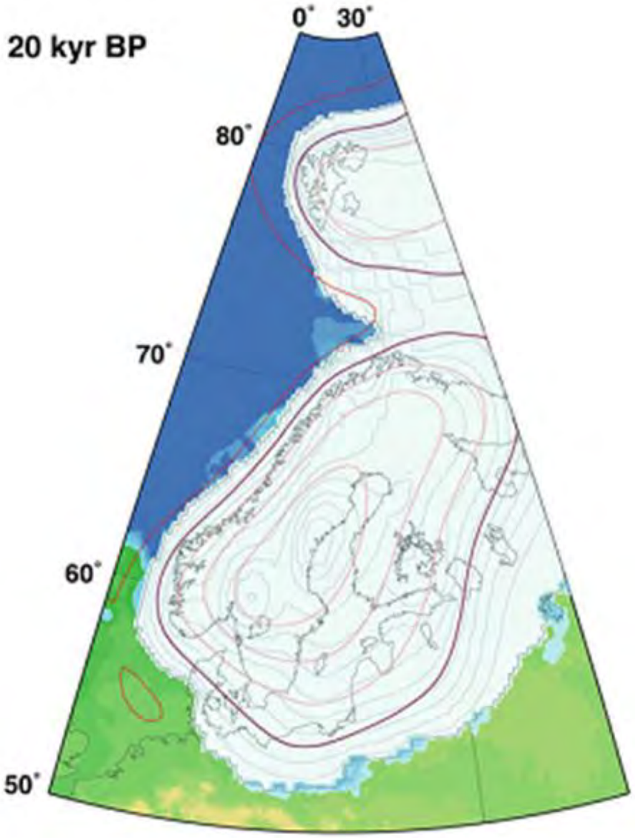
Rosentau et a. 2017. The Baltic Sea Basin, 2017. Pre-Quaternaary geology of the Baltic Sea region. Modified from Uscinowicz (2014).

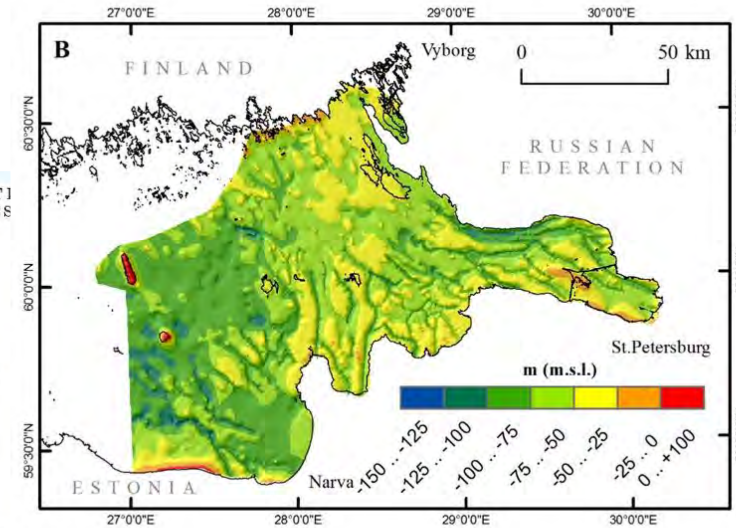
Aspect relief map of Baltics Region

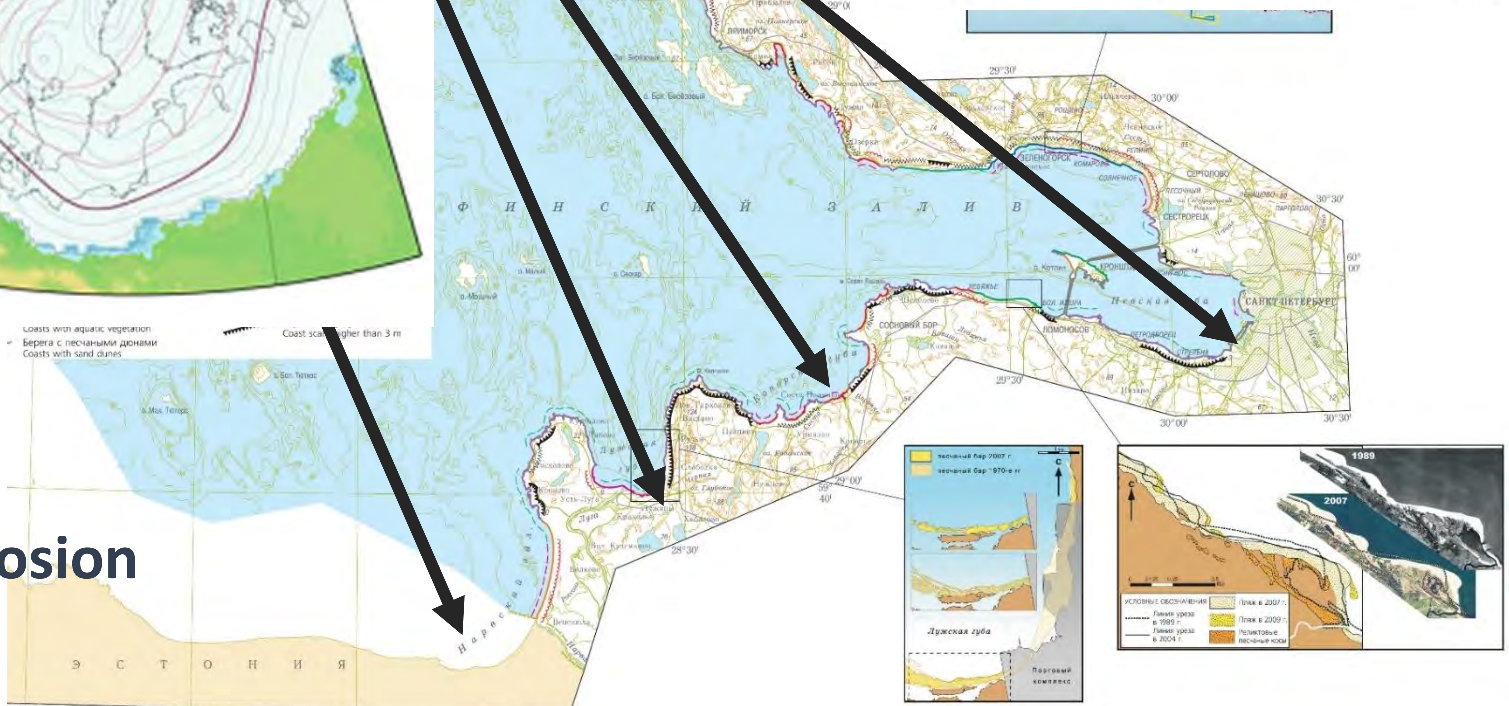




Lambeck et al. 2010



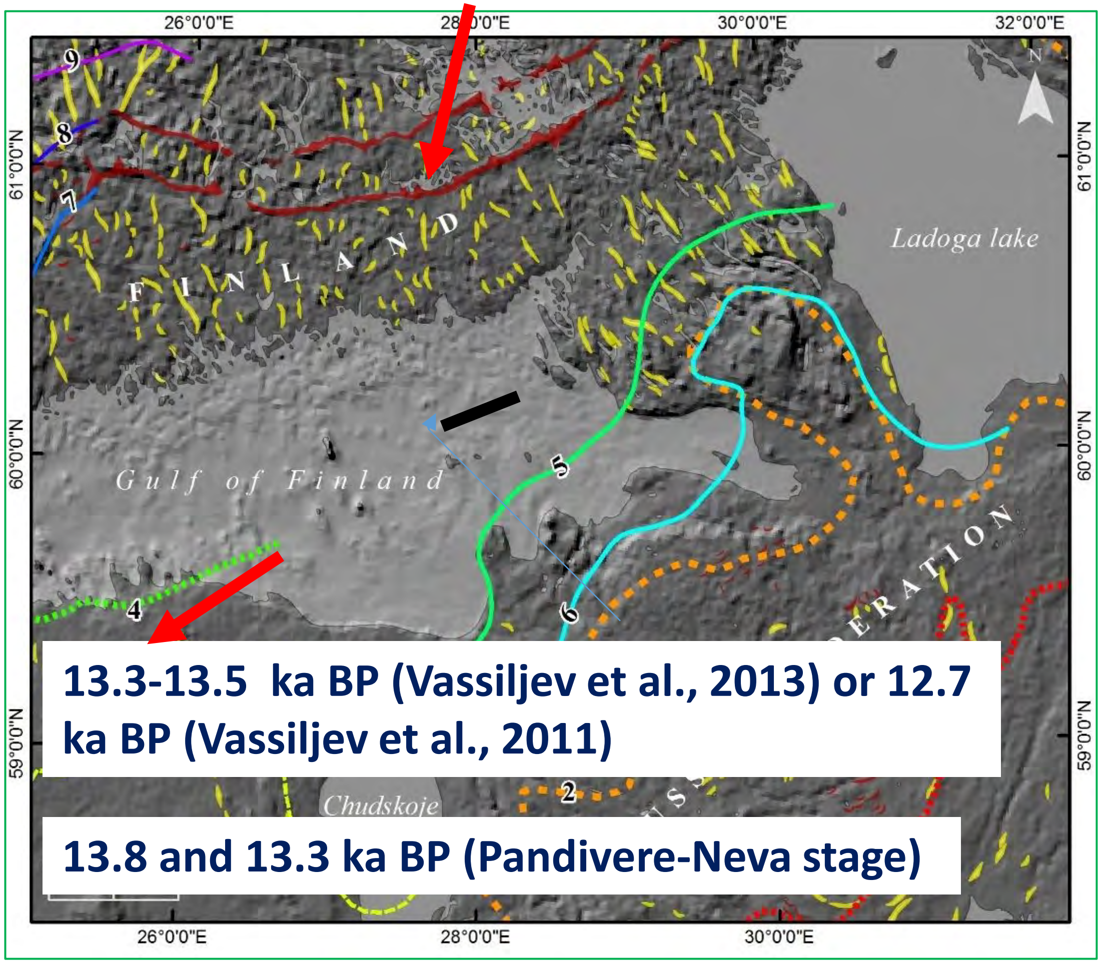


Glacial erosion

Glacial and fluvioglacial accumulation

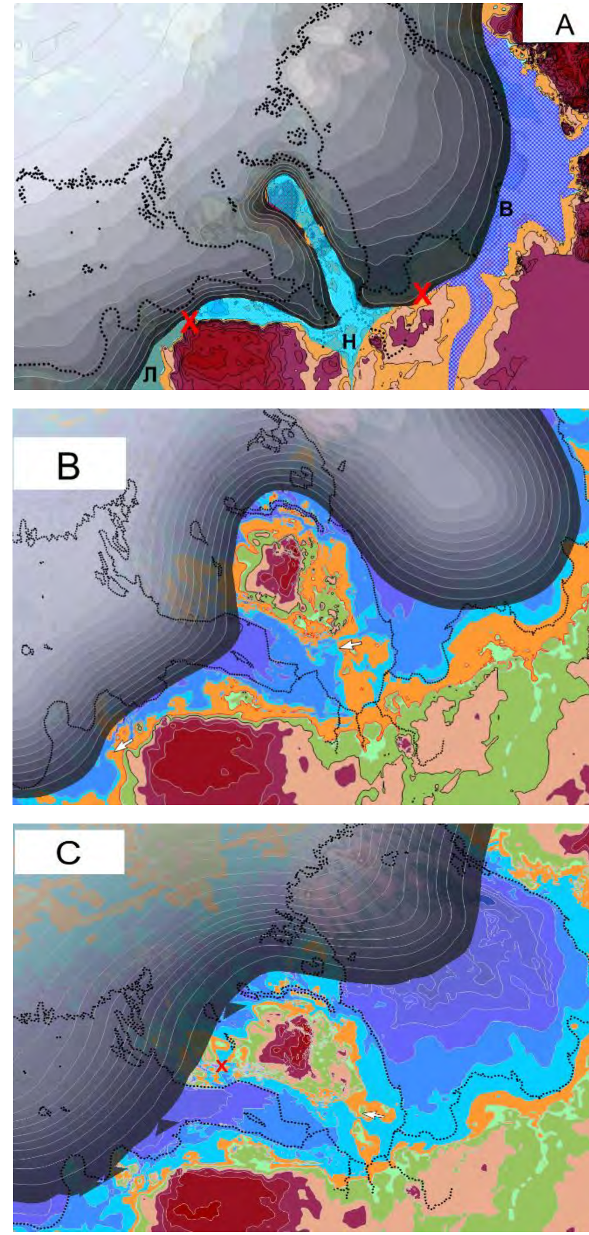
12.25 ka BP (Salpausselkä I stage)



13.3-13.5 ka BP (Vassiljev et al., 2013) or 12.7 ka BP (Vassiljev et al., 2011)

13.8 and 13.3 ka BP (Pandivere-Neva stage)

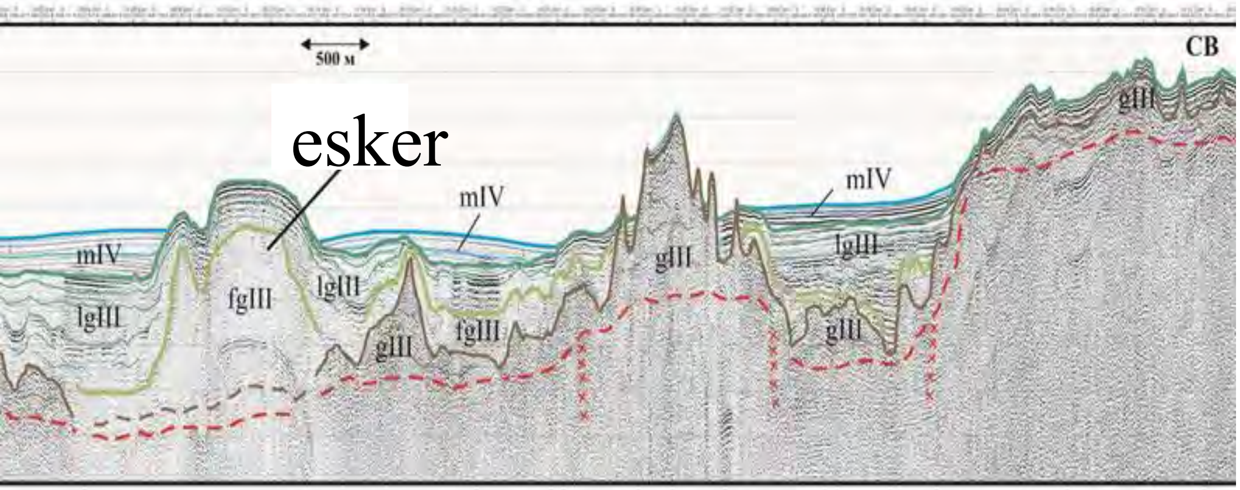
Vassiljev J. et al., 2011; 2013;
Saarnisto, M.; Saarinen, T., 2001

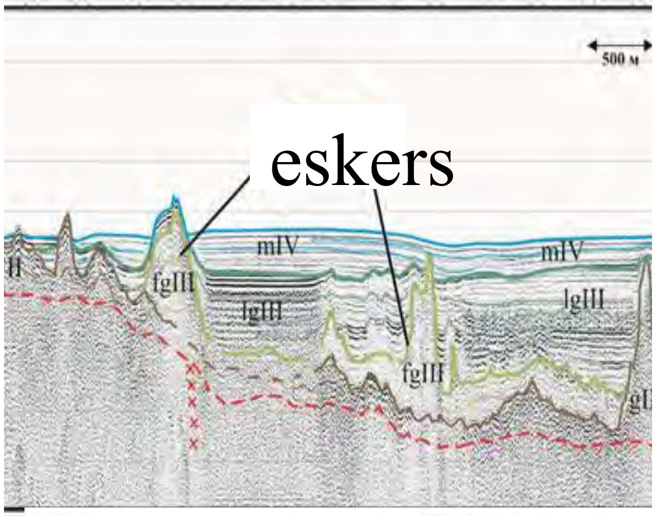


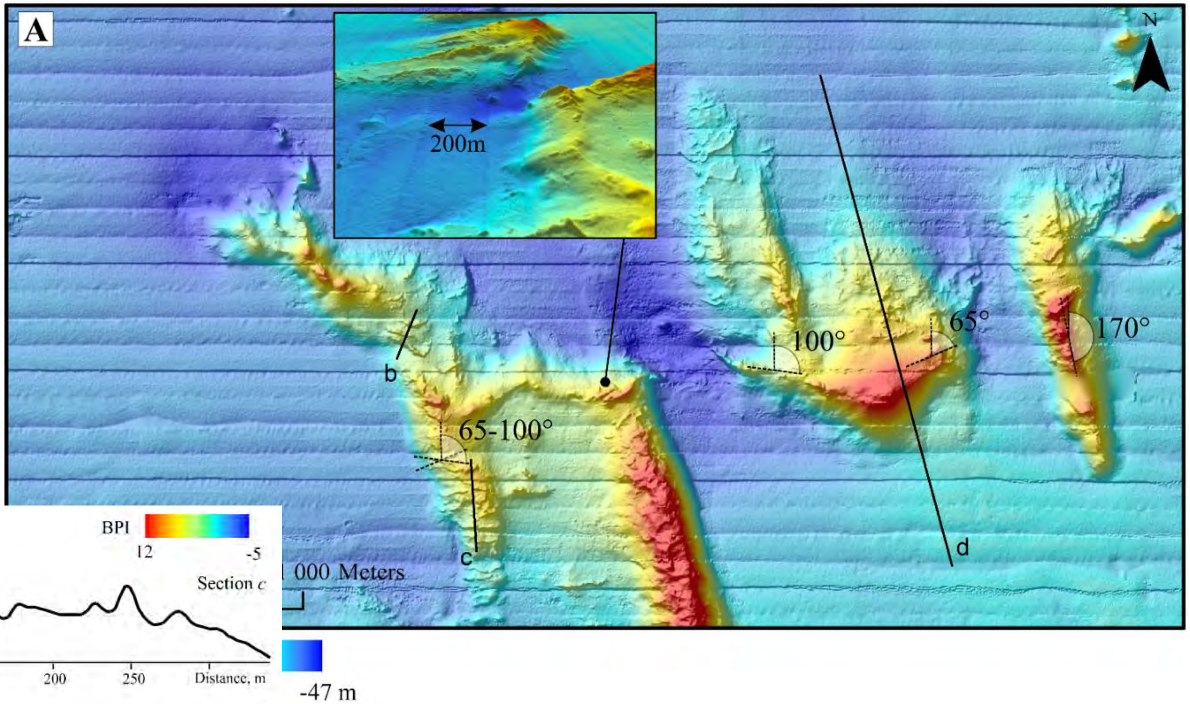
Amantov, Amantova, 2017

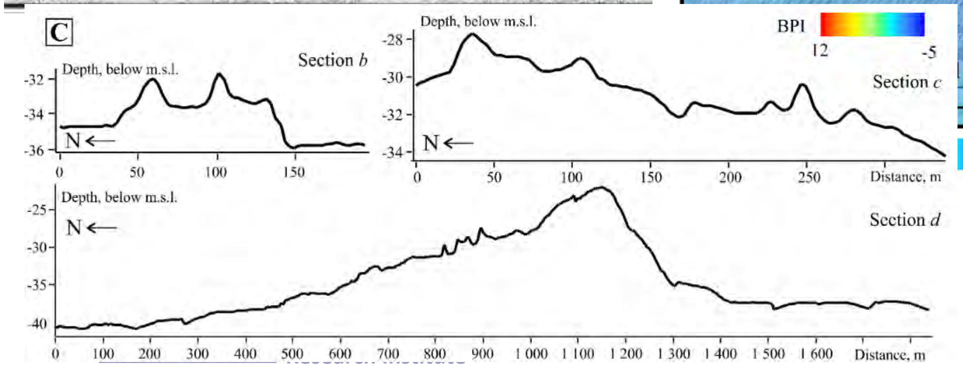
Russian Geological Research Institute

Glacial and glaciofluvial deposits



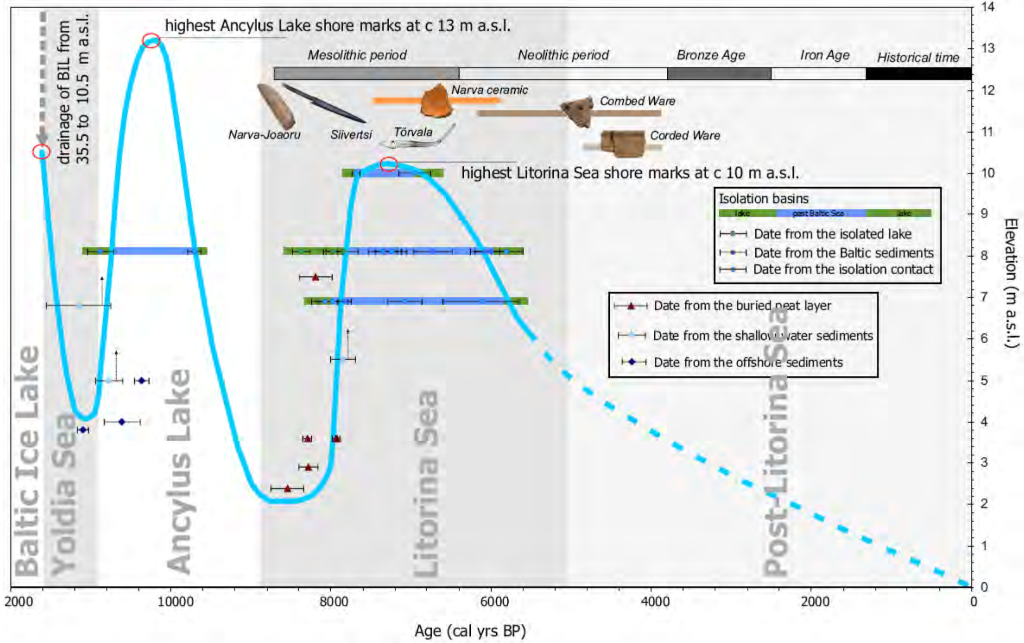






Narva-Luga Klint Bay

Gulf of Finland Co-operation

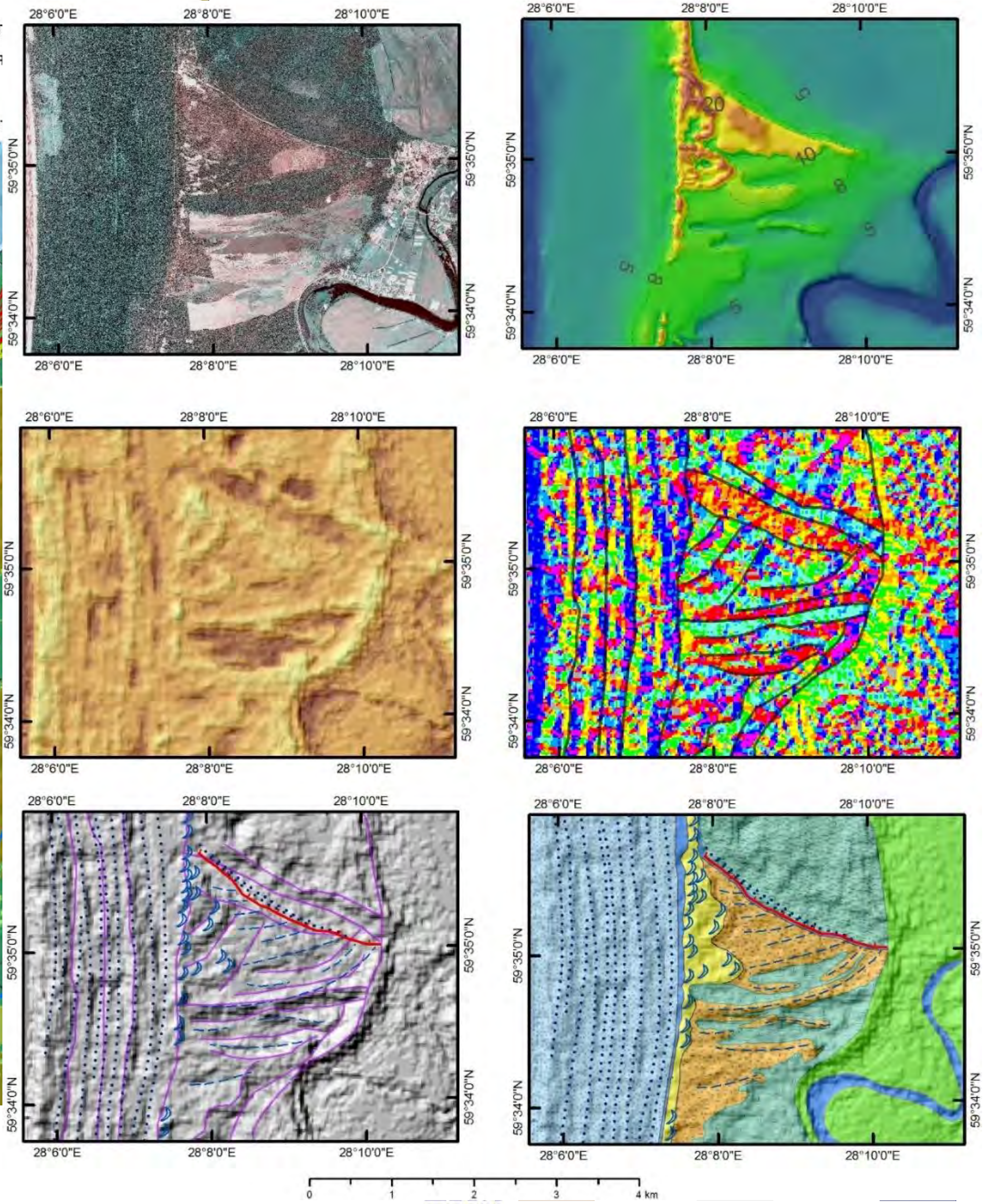


Rosentau A., Muru M., Kriiska A., Subetto D., Vassiljev J., Hang T., Gerasimov D., Nordqvist K., Ludikova A., Lõugas L., Raig H., Kihno K., Aunap R., Letyka N. (2013). Stone Age settlement and Holocene shore displacement in the Narva-Luga Klint Bay area, eastern Gulf of Finland. Boreas, 42(4), 912 - 931.

1882 VSEGEI Russian Geological Research Institute

Narva-Luga Klint Bay

Gulf of Finland



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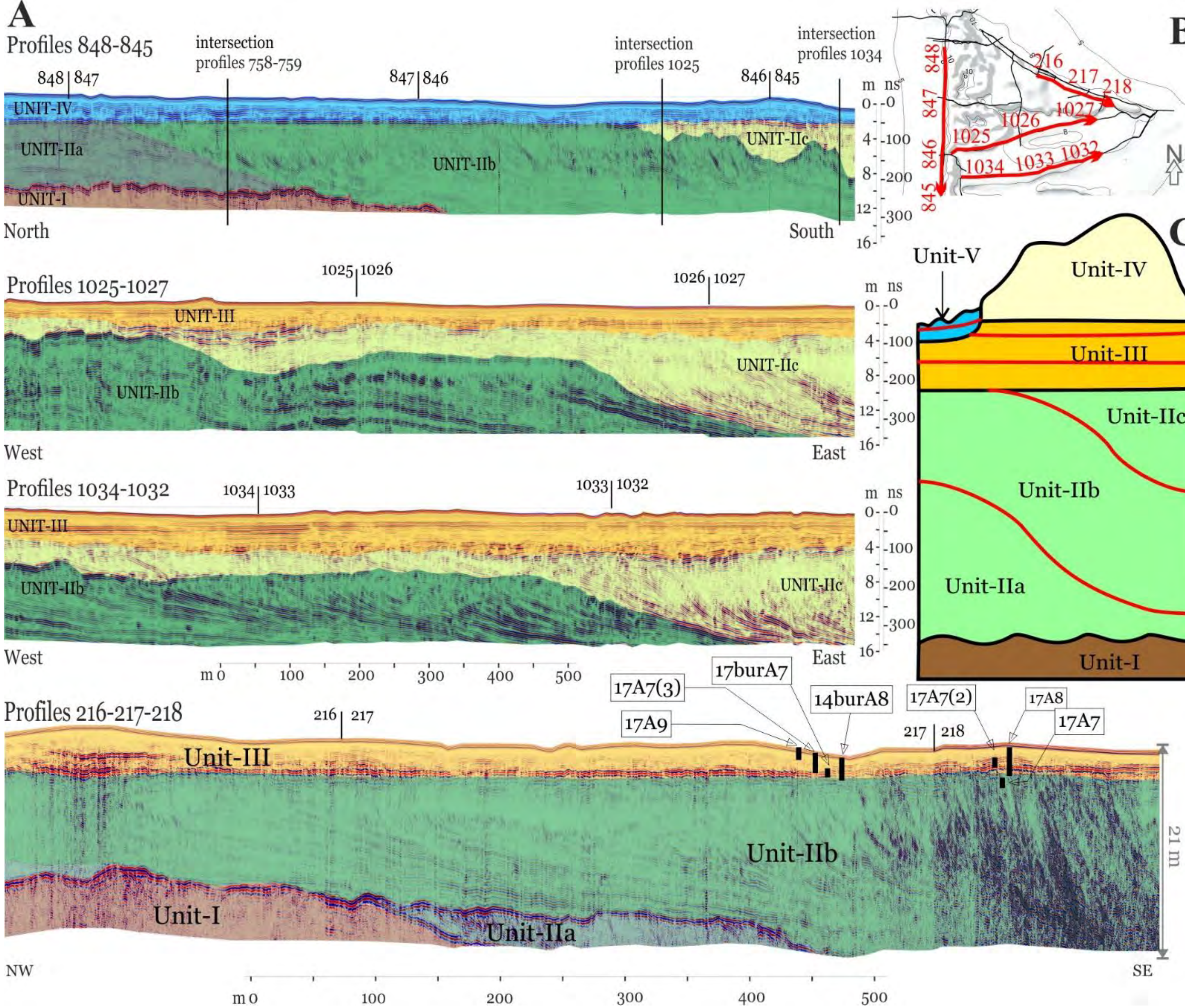
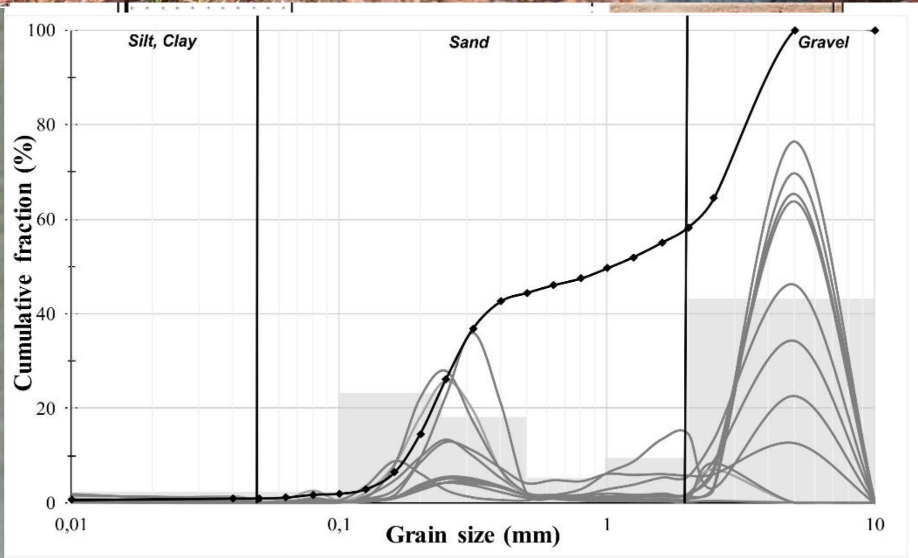
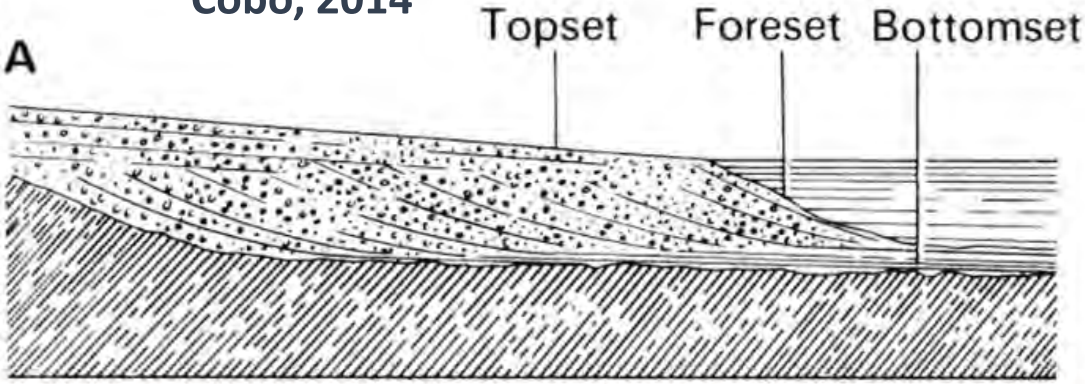


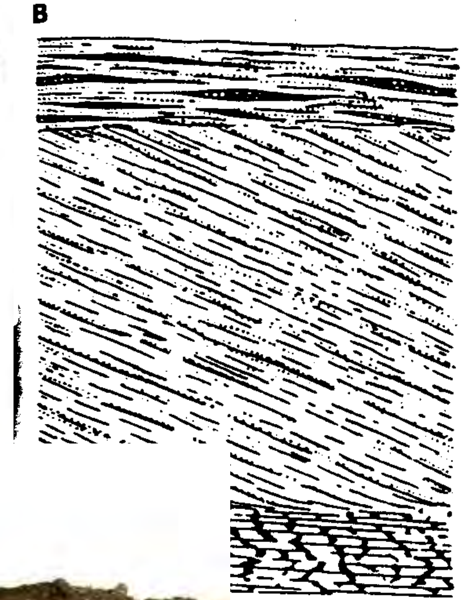
Sergeev et al., 2018



ion amplitudes zone (sandy crossbedded deposits with
s with gravel and pebbles); 4 – horizontally layered
vel; 7 – modern soil; 8 – sand; 9 – gravel; 10 – pebbles

Cobo, 2014

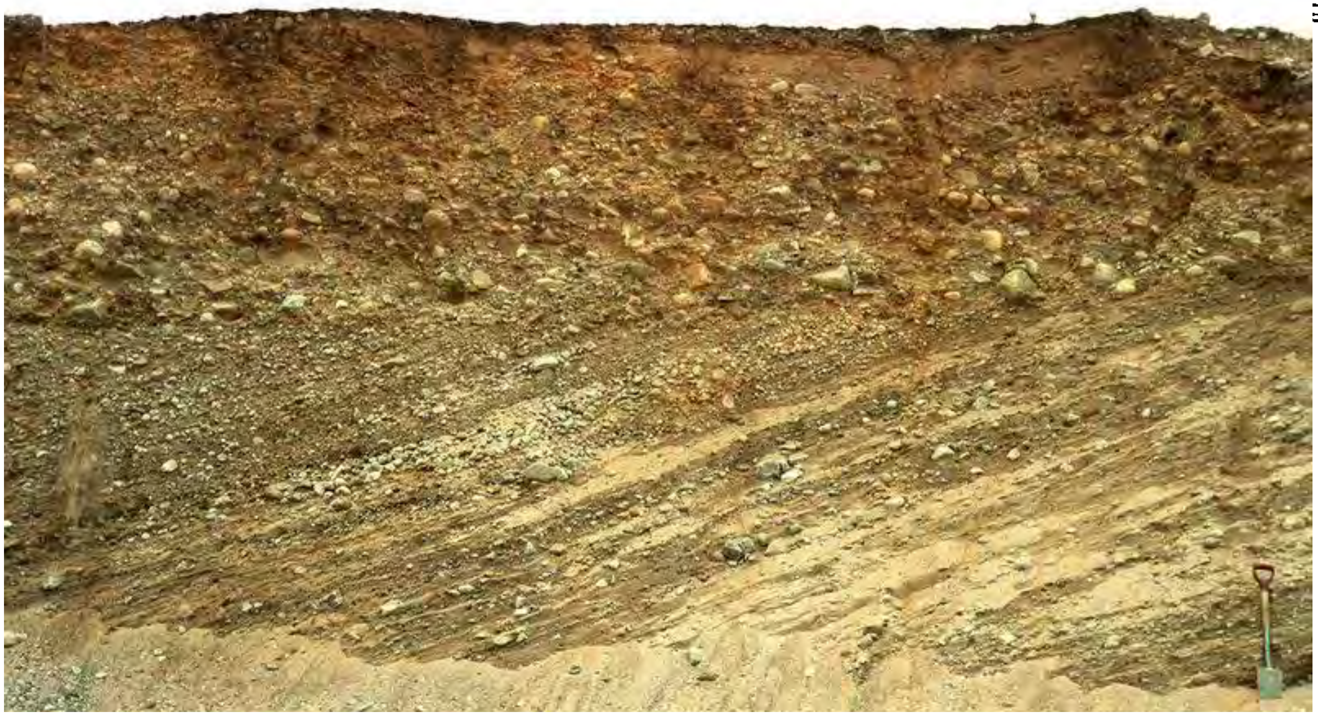




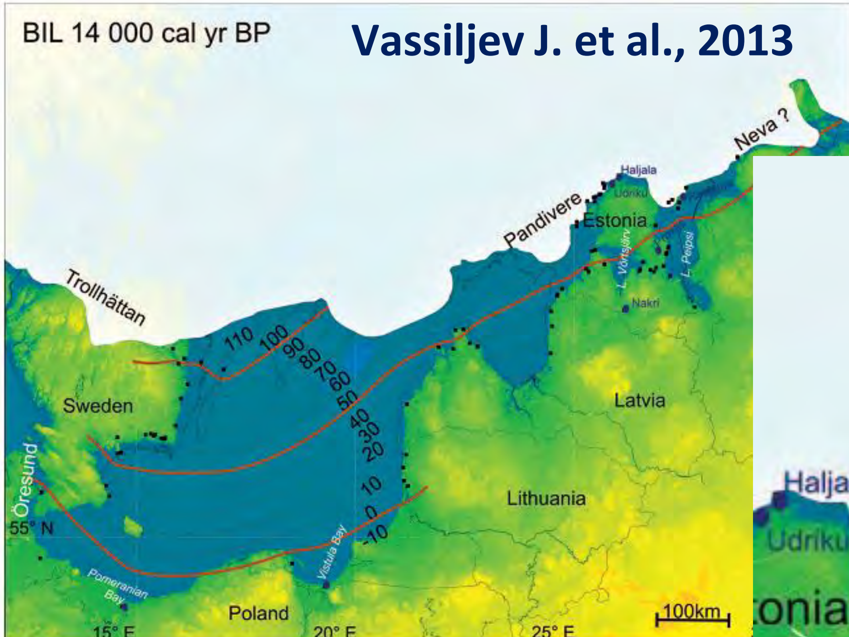
Topset - essentially flat-lying gravels

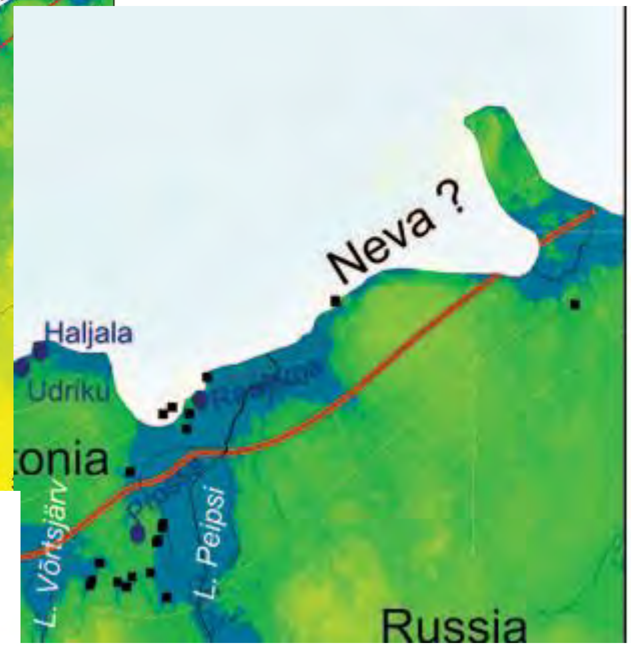
Foreset - beds of sand and gravel dipping at 10°-25°

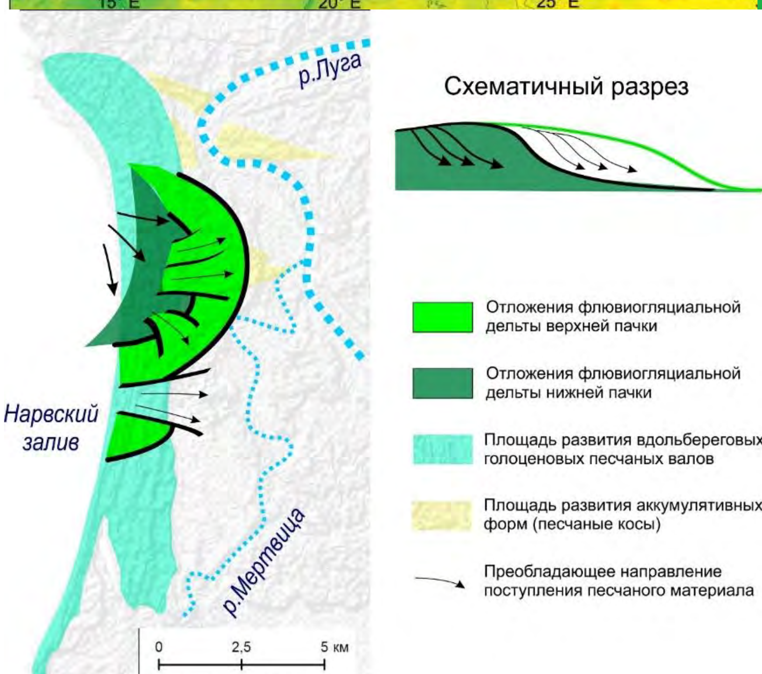
Bottomset - gently inclined fine-grained sediments

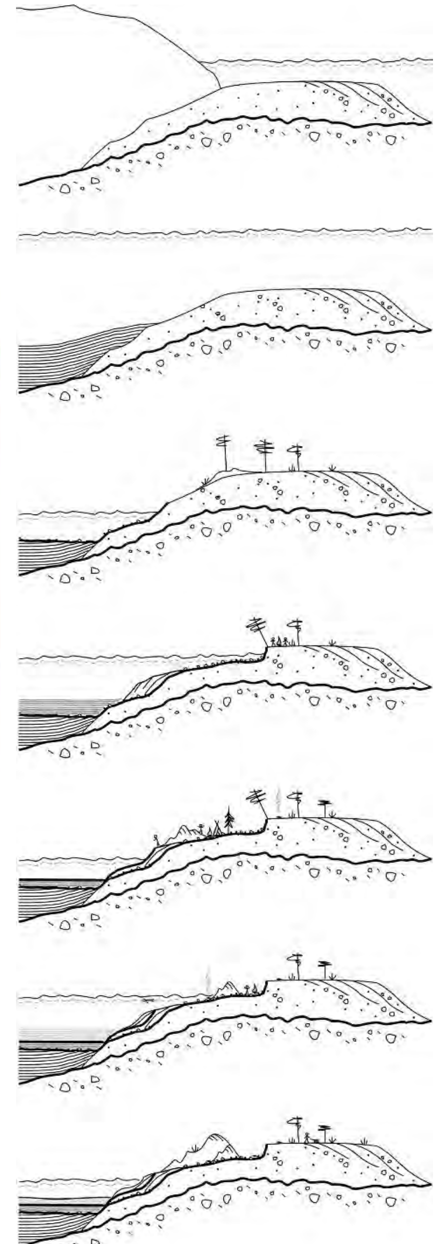


Vassiljev J. et al., 2013

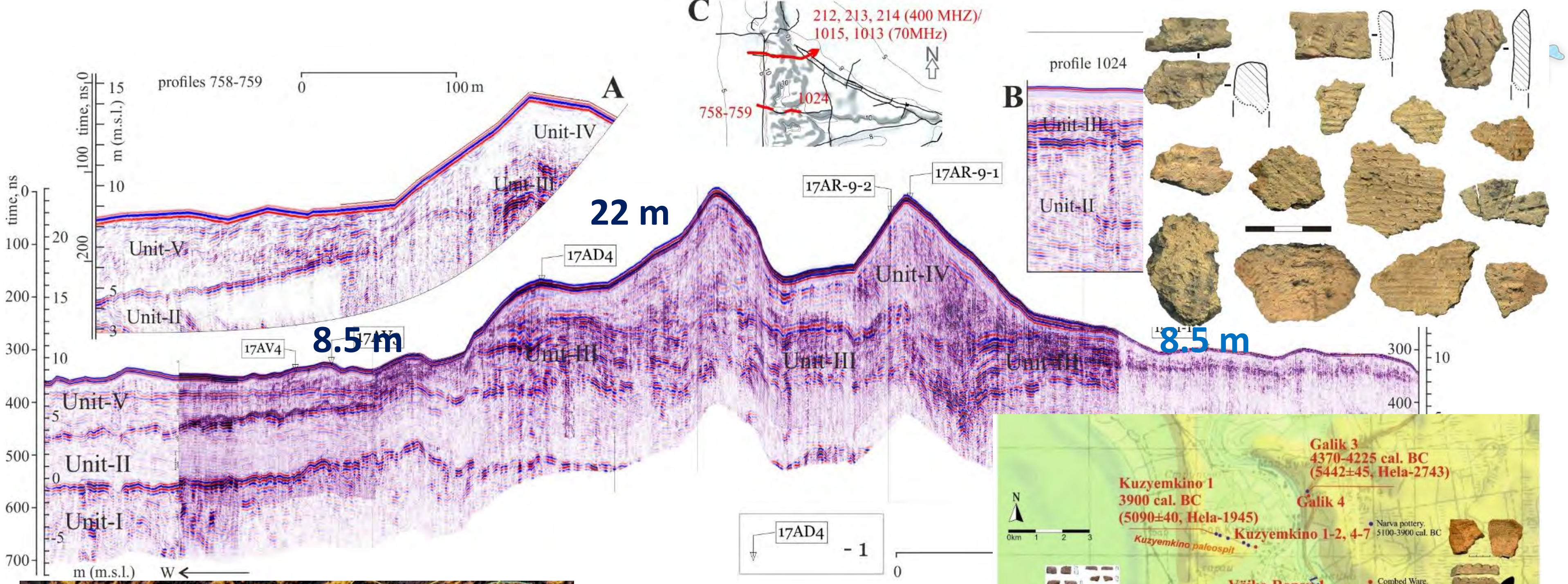


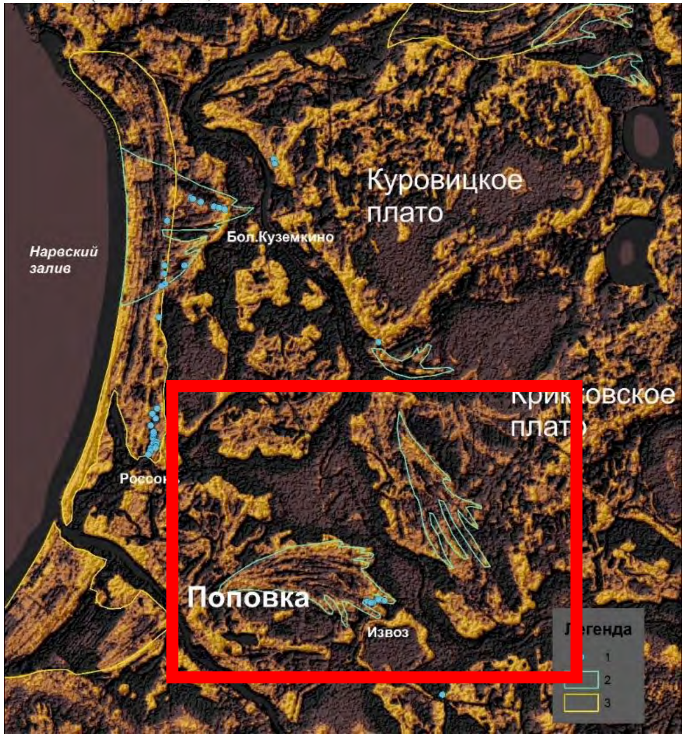




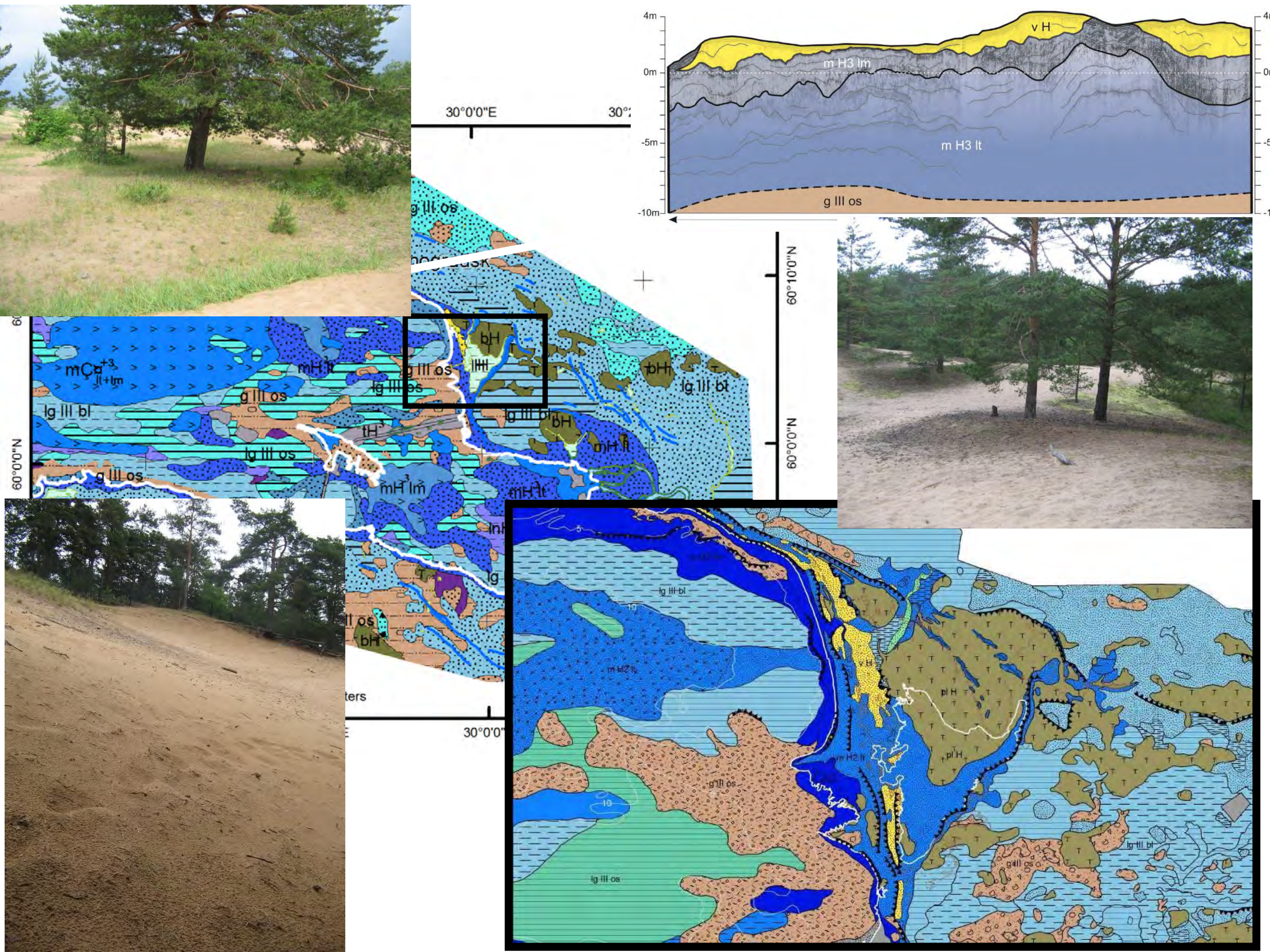


Segreev et al., 2018


C
212, 213, 214 (400 MHZ)/
1015, 1013 (70MHz)
N
758-759
1024
profile 1024
B
Unit-III
Unit-II
profiles 758-759
0
100 m
A
Unit-IV
Unit-III
Unit-V
Unit-II
time, ns
m (m.s.l.)
22 m
17AR-9-2
17AR-9-1
17AD4
17AV4
8.5 m
Unit-IV
Unit-III
Unit-V
Unit-II
Unit-I
m (m.s.l.)
W
17AD4
- 1
0

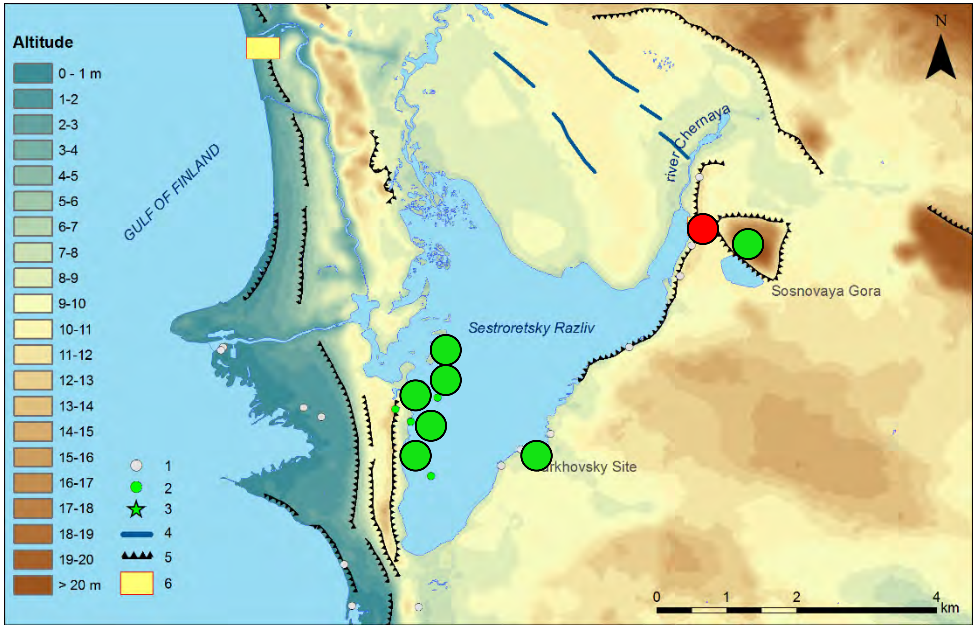

Куровицкое
плато
Нарвский
залив
Бол.Кузёмкино
Поповка
Извоз
Легенда
1
2
3


Galik 3
4370-4225 cal. BC
(5442±45, Hela-2743)
Galik 4
Kuzyemkino 1
3900 cal. BC
(5090±40, Hela-1945)
Kuzyemkino 1-2, 4-7
Kuzyemkino paleospit
Väike-Ropsu 1
1910 cal. BC
(3607±31, Hela-2516)
Väike-Ropsu 2-6
Narva pottery
(Kuzemkino site,
V mill. BC)
Kurovitzy 1
Corded ware pottery
(Kurovitsi-3 site,
III mill. BC)
Rosson 1-16
Kurovitzy 2-3, 5-6
Gulf
of Narva
Rosson 1:
2215-2020 cal. BC
(3725±40, Hela-2744)
Rosson river
Combed ware pottery
(Kurovitsi-2 site,
IV-III mill. BC)
RUSSIA
Narva-Jõesuu I-IV
Kudruküla
Izvoz 3-6
Izvoz 2
5305-5040 cal. BC
ESTONIA
Riigiküla I-XV
Lommi 1-3

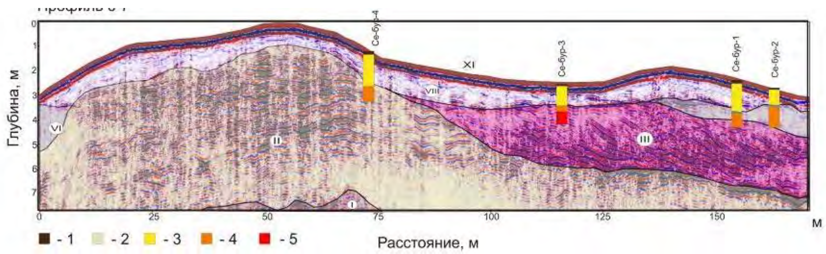


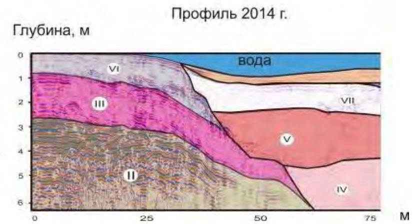
4m
0m
-5m
-10m
v H
m H3 lm
m H3 lt
g III os
30°0'0"E
60°10'0"N
60°0'0"N
bH
lg III os
lg III bl
mH lt
g III os
tH
lg III bl
v H
pl H
m H2 lt
lg III os

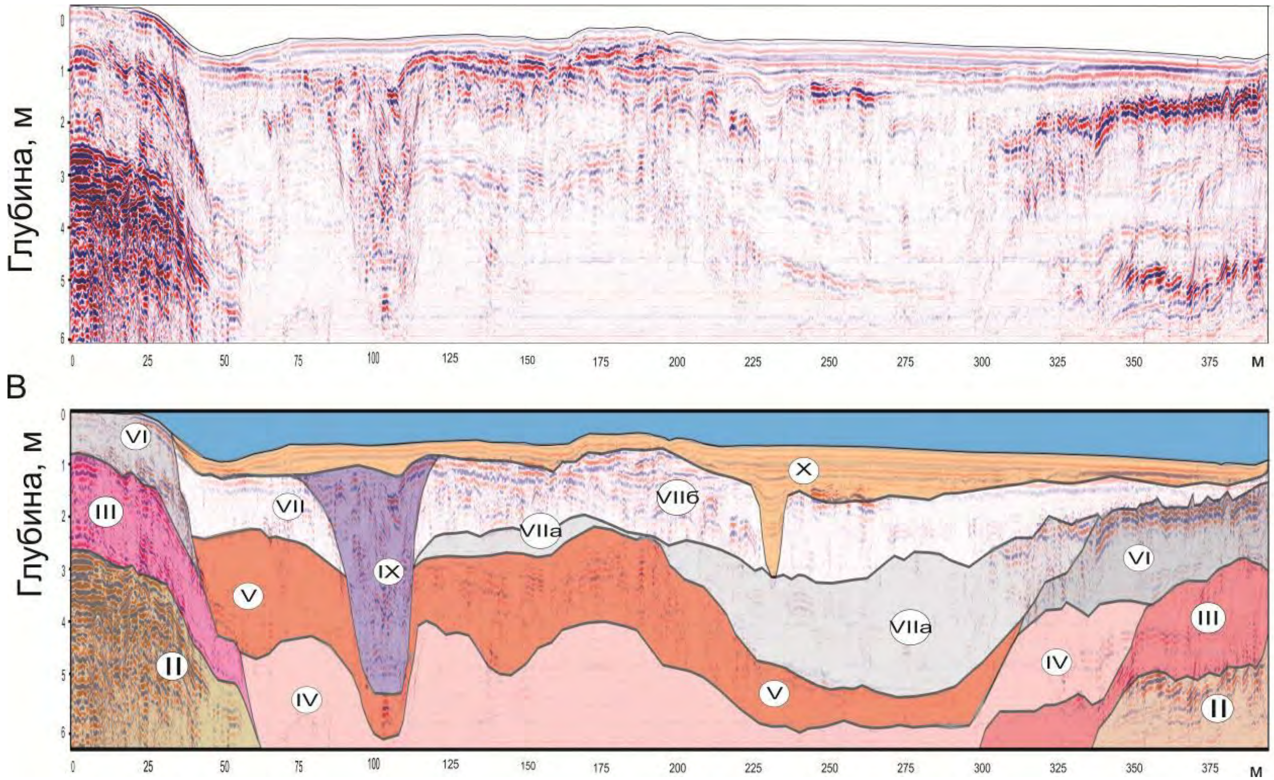
Sestroretskaya Lowland



Name of site	Period	Altitude, m	Source
Sosnovaya Gora	Early–Late Neolithic, Early Metal Epoch (V-III ka cal. BC)	20	S.A. Gamtchenko, 1907–08.
Tarkhovskaya	Late Neolithic, Typical Combed Ware (IV ka cal. BC)	9	M.Ya. Rudinsky, G.P. Sosnovsky, 1916; B.F. Zemlyakov, 1922–23.
Sestroretskiye sites	Late Neolithic–Early Metal Epoch (III ka cal. BC)	6	G.P. Sosnovsky, B.F .Zemlyakov, 1933
Razliv	Late Neolithic (not related to the shoreline)	20	A.P.Shtakelberg, 1913
Sosnovaya Gora 1	Late Neolithic - Early Metal Epoch (IV–III ka cal. BC)	8	T.M. Gusentsova, P.E. Sorokin, S.V. Lisitsyn, D.V. Gerasimov, 2012
Sosnovaya Gora 2	Early Neolithic (?)	11	S.V. Lisitsyn, 2012

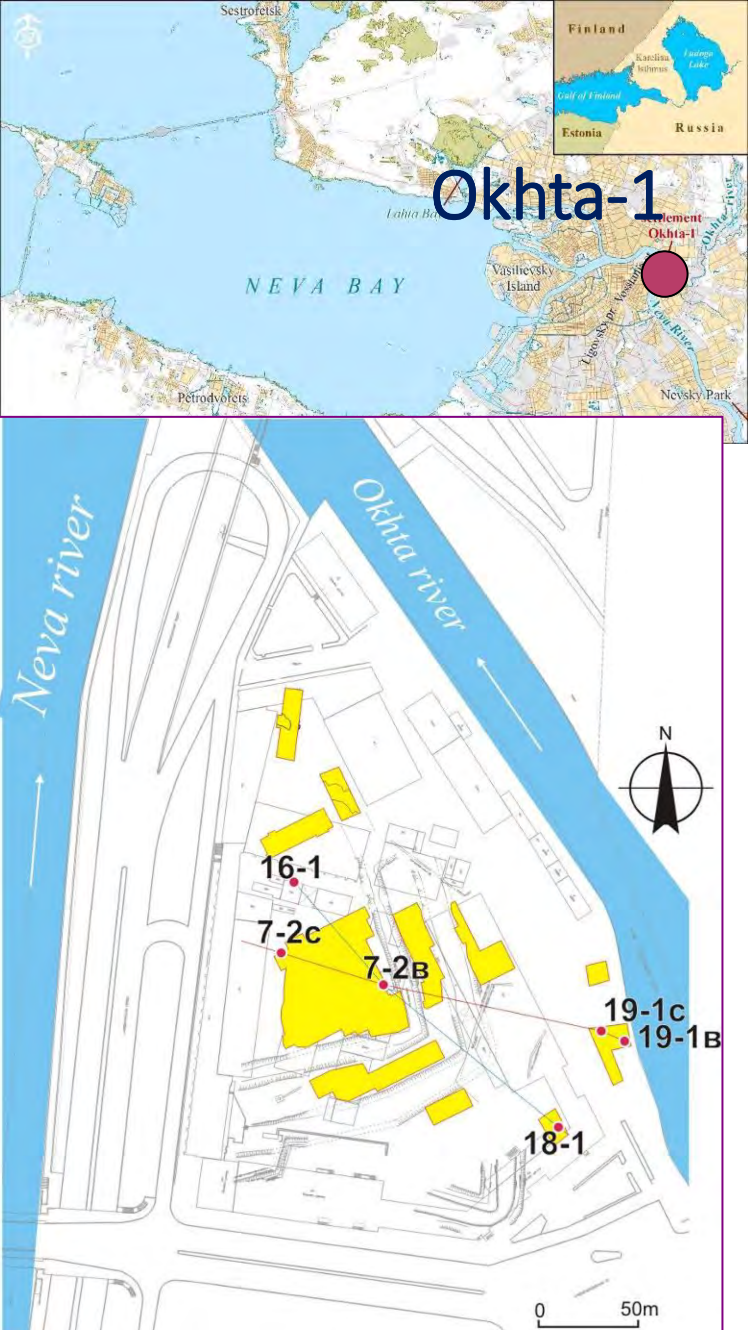






3

GPR profile within Sestroretsky Razliv



Inhabited between 6000 cal.BP and 3000 cal.BP

Gulf of Finland Co-operation

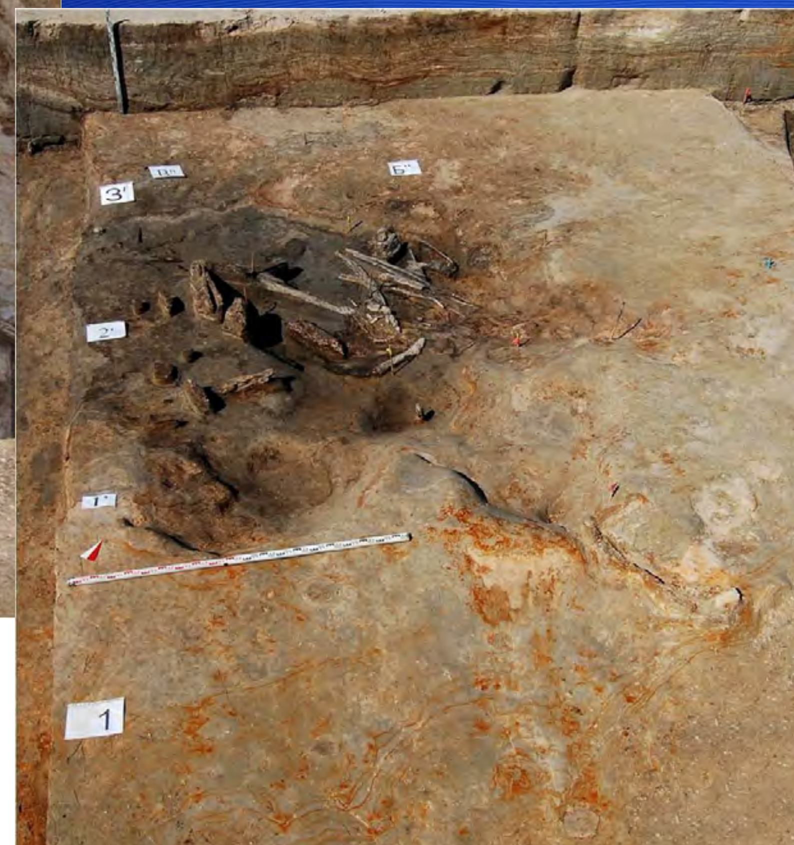
“Okhta Cape”

Sorokin , P.E. 2011. Archeological Sites of the Okhta Cape. *Science in Russia*. 3, 19–25.

Kulkova, M., Gusentsova, T., Nesterov, E., Sorokin, P., Sapelko, T. 2012. Chronology of Neolithic-Early Metal Age sites at the Okhta river mouth (Saint Petersburg, Russia). *Radiocarbon.* 54 (3-4), 1049-1063.

Russian Geological Research Institute


1
2
3
4
5
6
7



About 12,000 items

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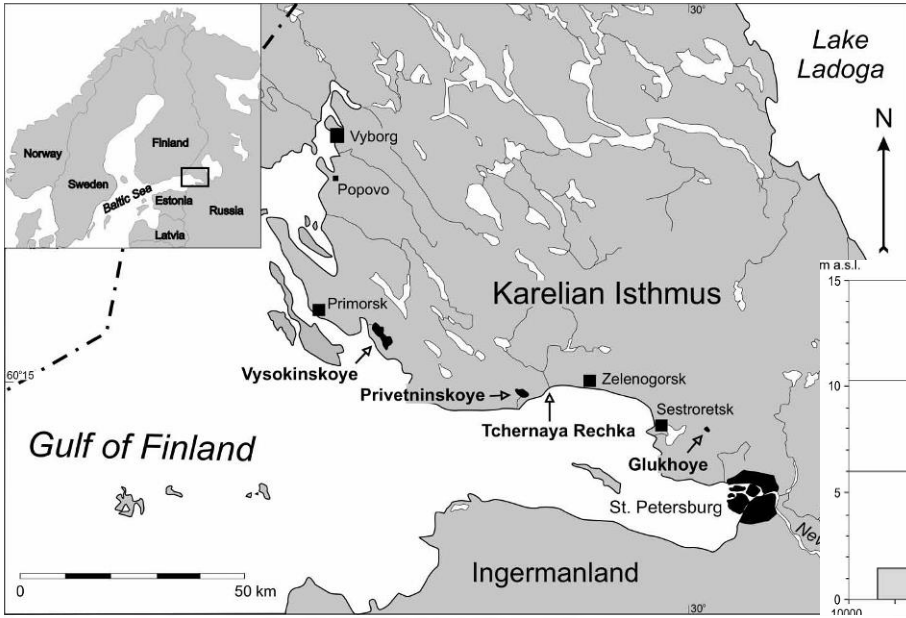
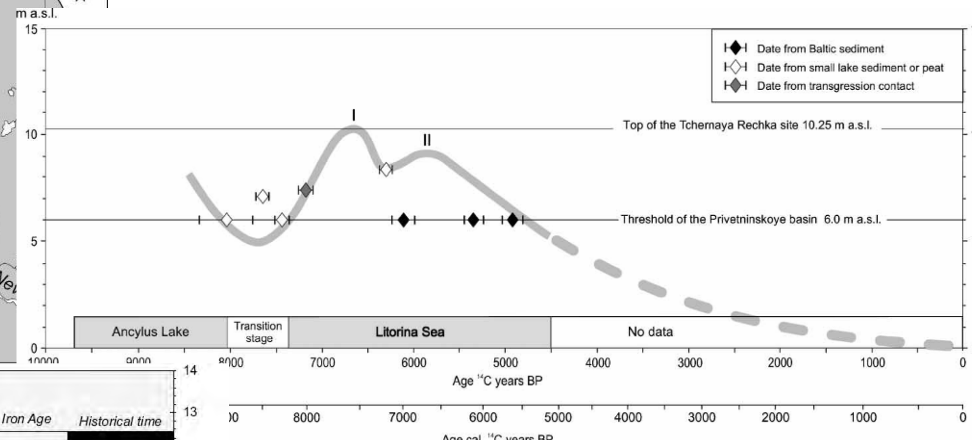
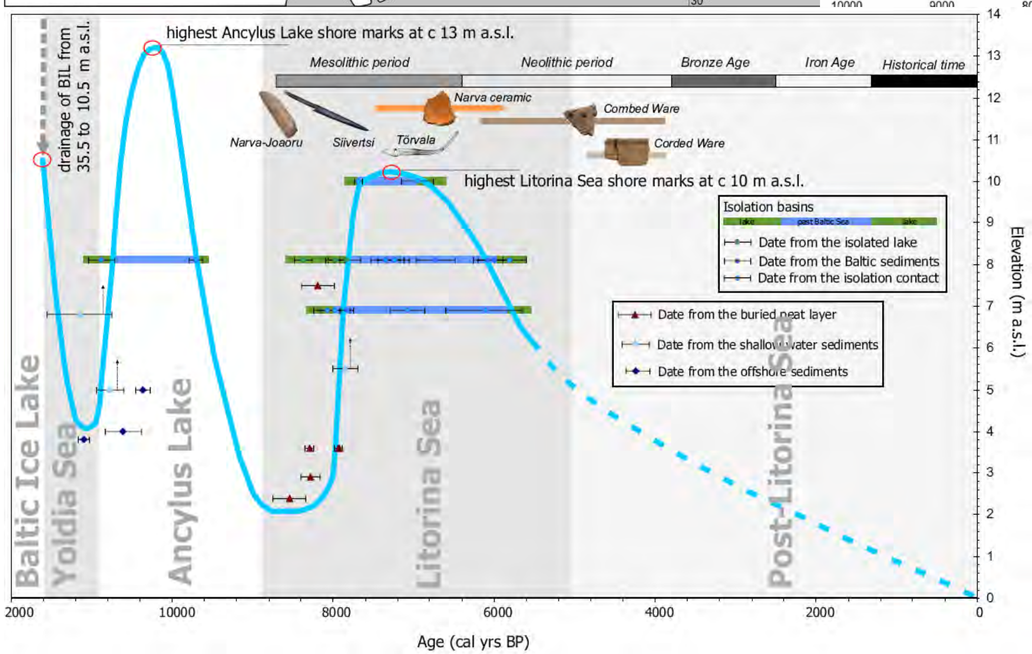
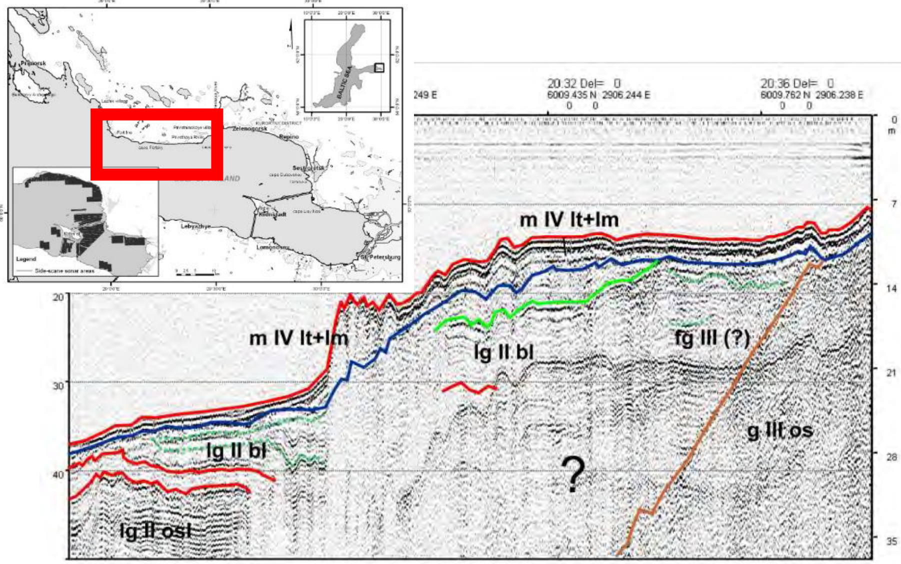


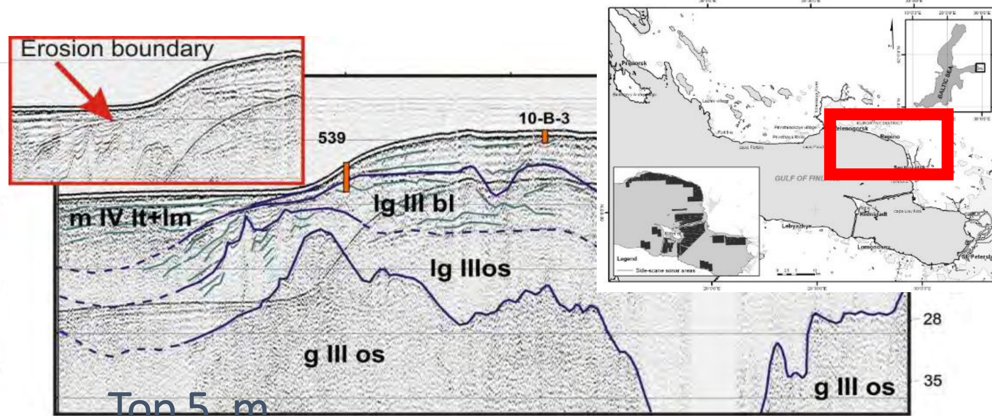
Miettinen, A., Savelieva, L., Subetto, D. A., Dzhinoridze, R., Arslanov, K. & Hyva.rinen, H. 2007 (October): Palaeoenvironment of the Karelian Isthmus, the easternmost part of the Gulf of Finland, during the Litorina Sea stage of the Baltic Sea history.



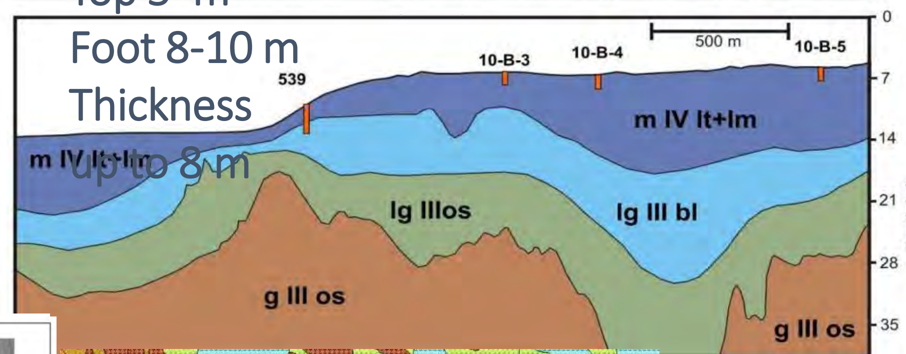


Rosentau, A., Subetto, D., Letjuka, N., Kriiska, A., Lisitsyn, S., Gerasimov, D., Nordqvist, K. Holocene water-level changes of the Baltic Sea in Narva-Luga klint bay area and its relations with stone age settlement pattern, 2010

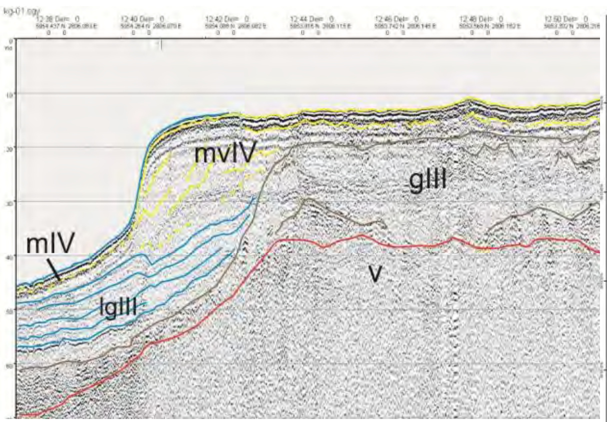


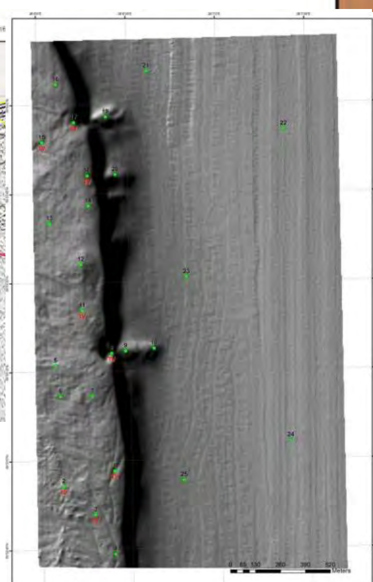


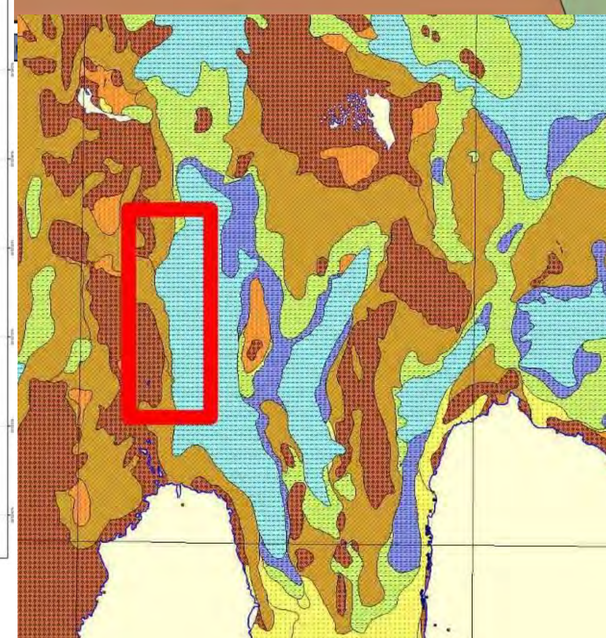
Top 5 m
Foot 8-10 m
Thickness
up to 8 m



Two terraces: tops 15 and 7 m
foots 30 and 15 m; thickness 10 m







Kurgalsky
peninsula

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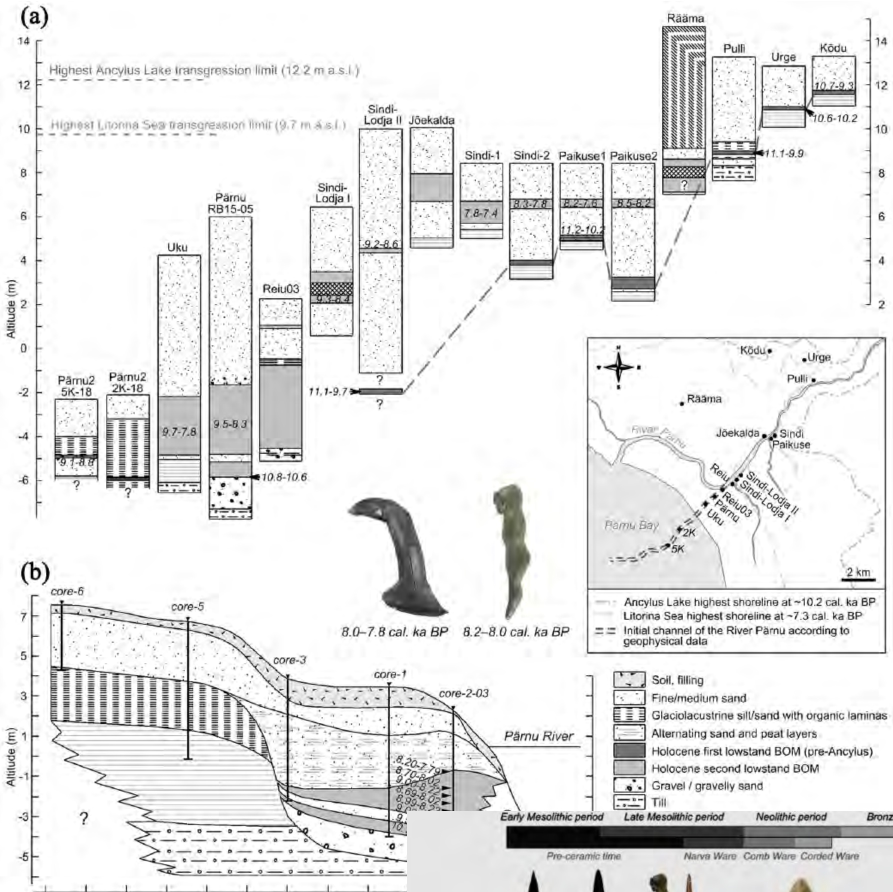
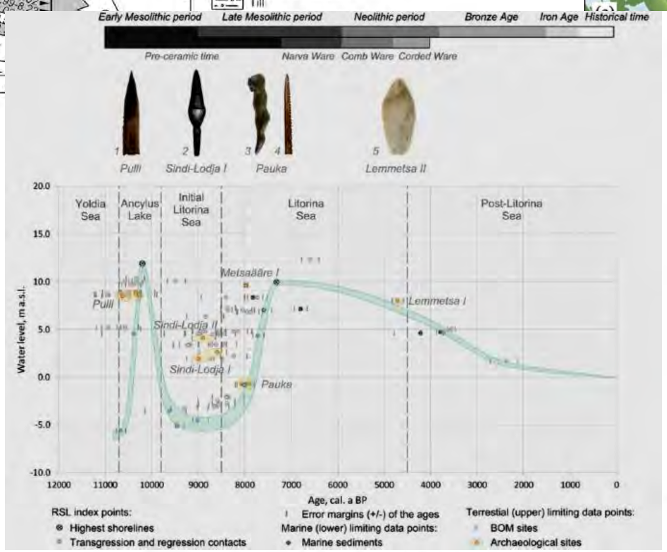
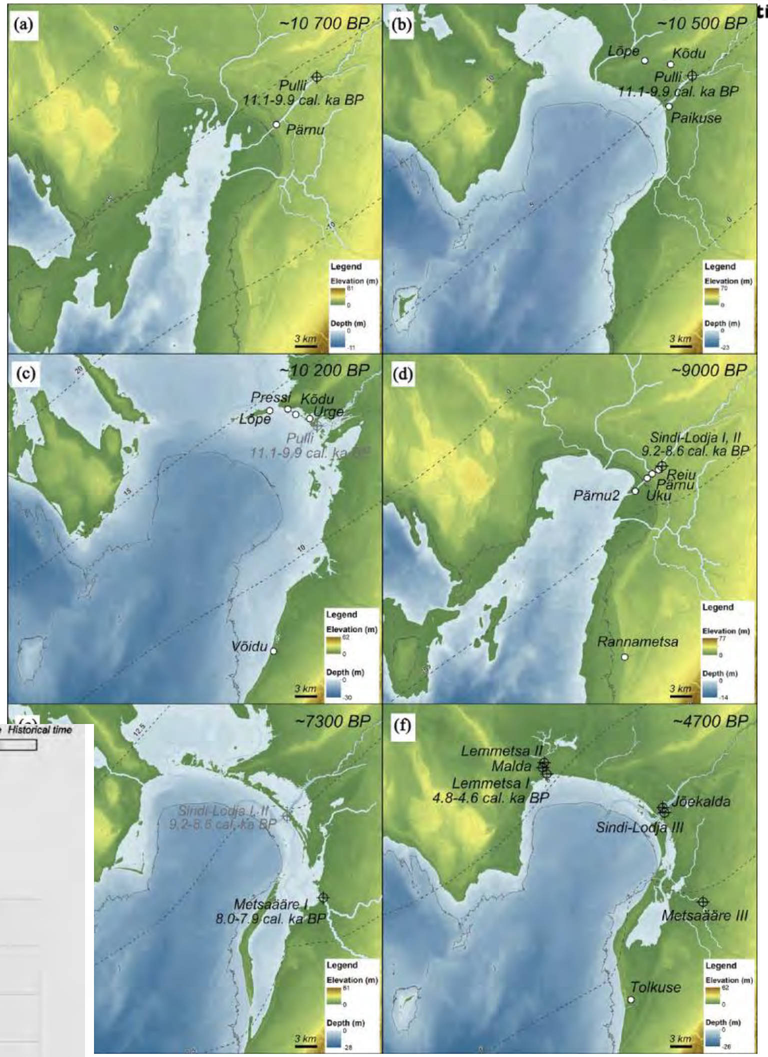




Nigri et al., 2020

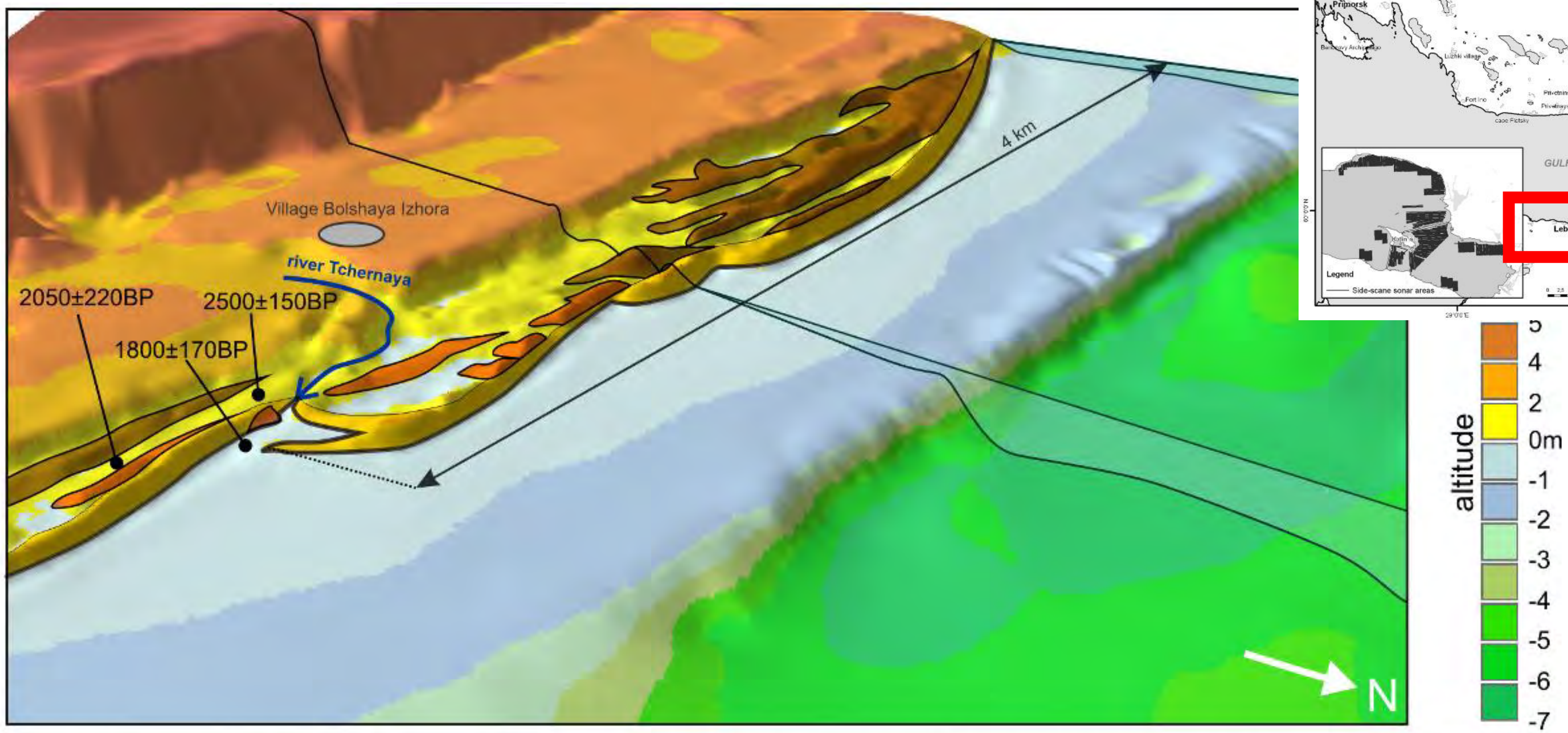


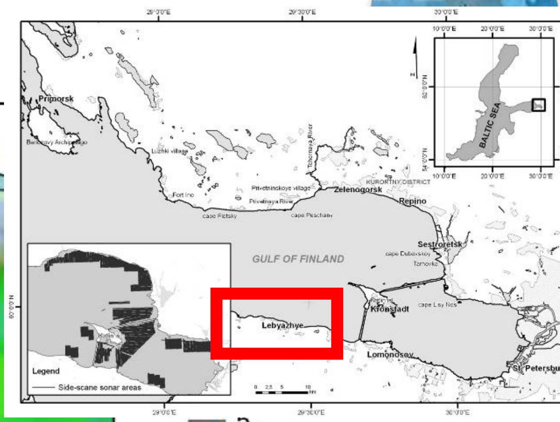
Kriiska et al., 2011

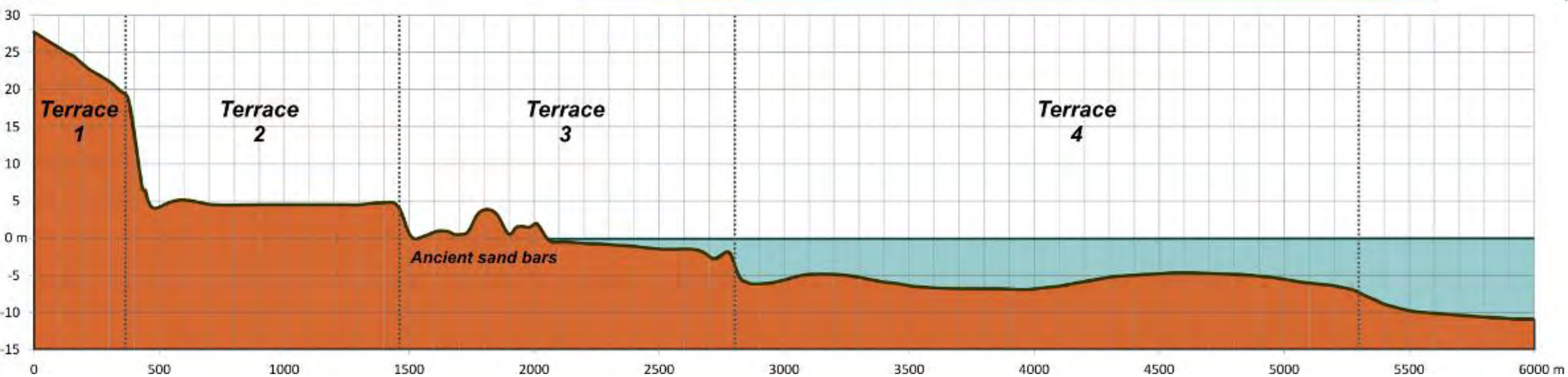
Gulf of Finland

Russian Geological Research Institute

Submarine terraces of the southern coast of the Gulf

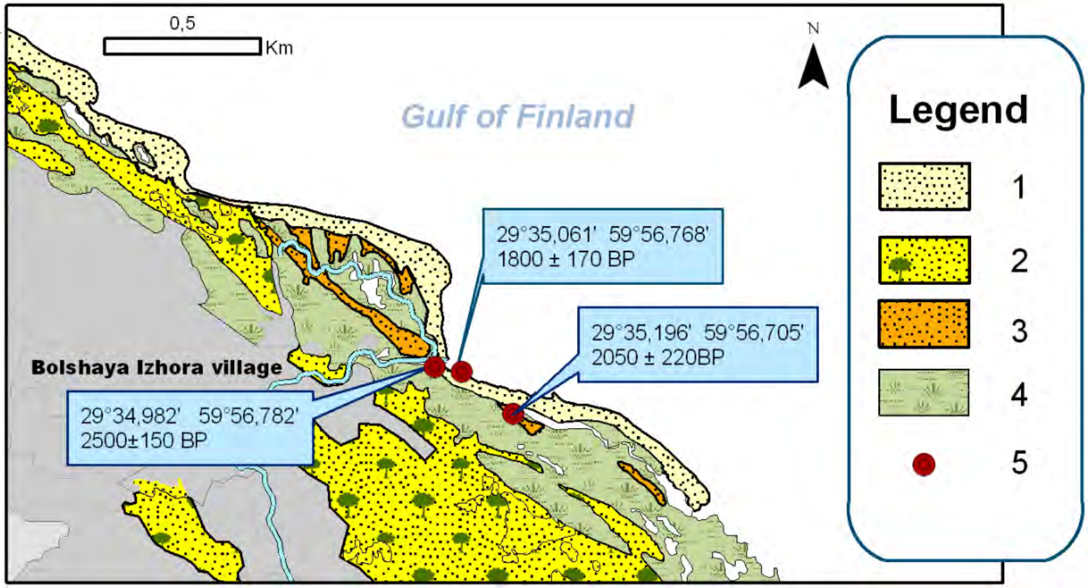






Top – 5 m
Foot – 10 m

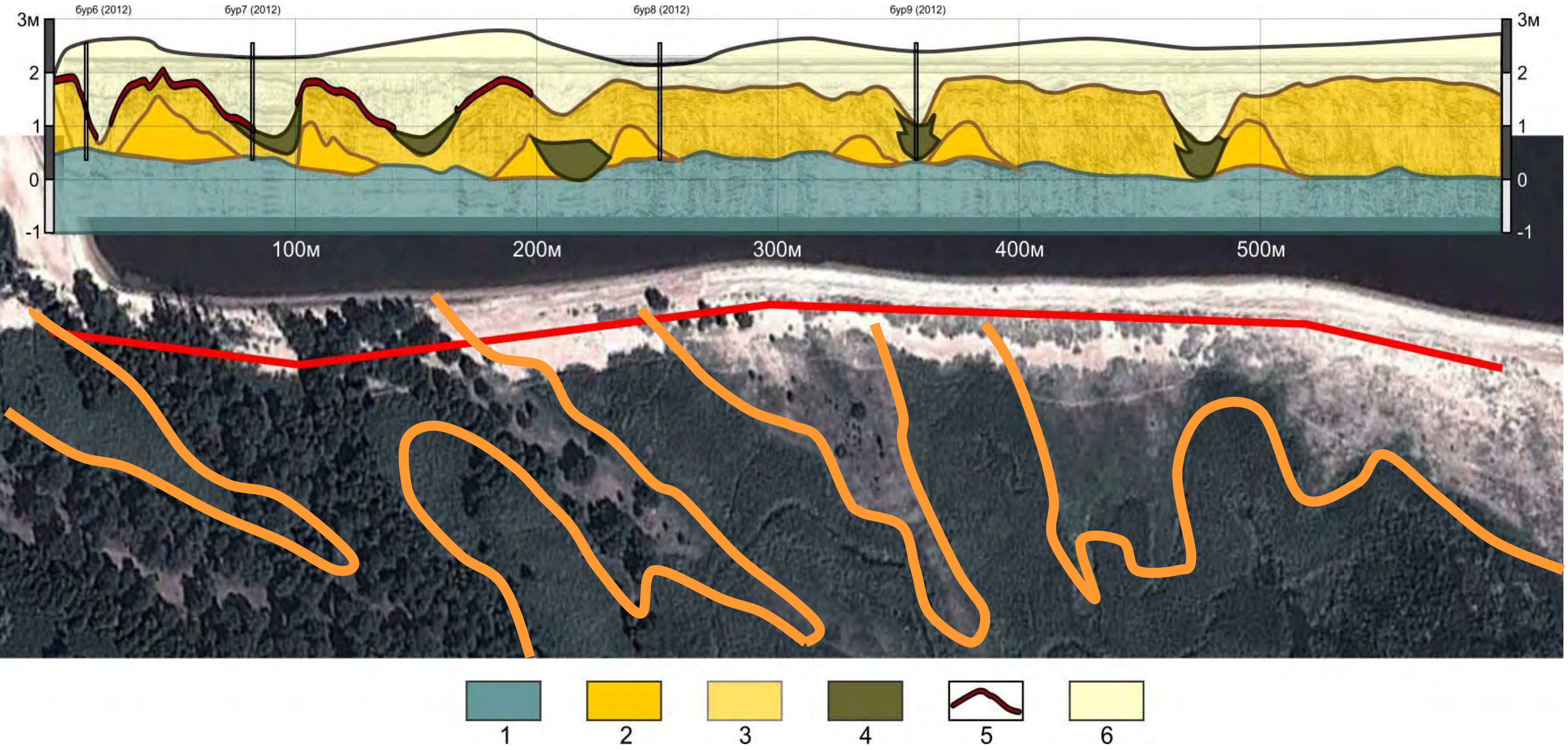
Gulf of Finland
Co-operation



1 – modern sand spits; 2 – ancient sand spits; 3 – relict sand spits; 4 – relict lagoons; 5 – sites of sampling for ^{14}C dating. Pictures of relict lagoon marl.

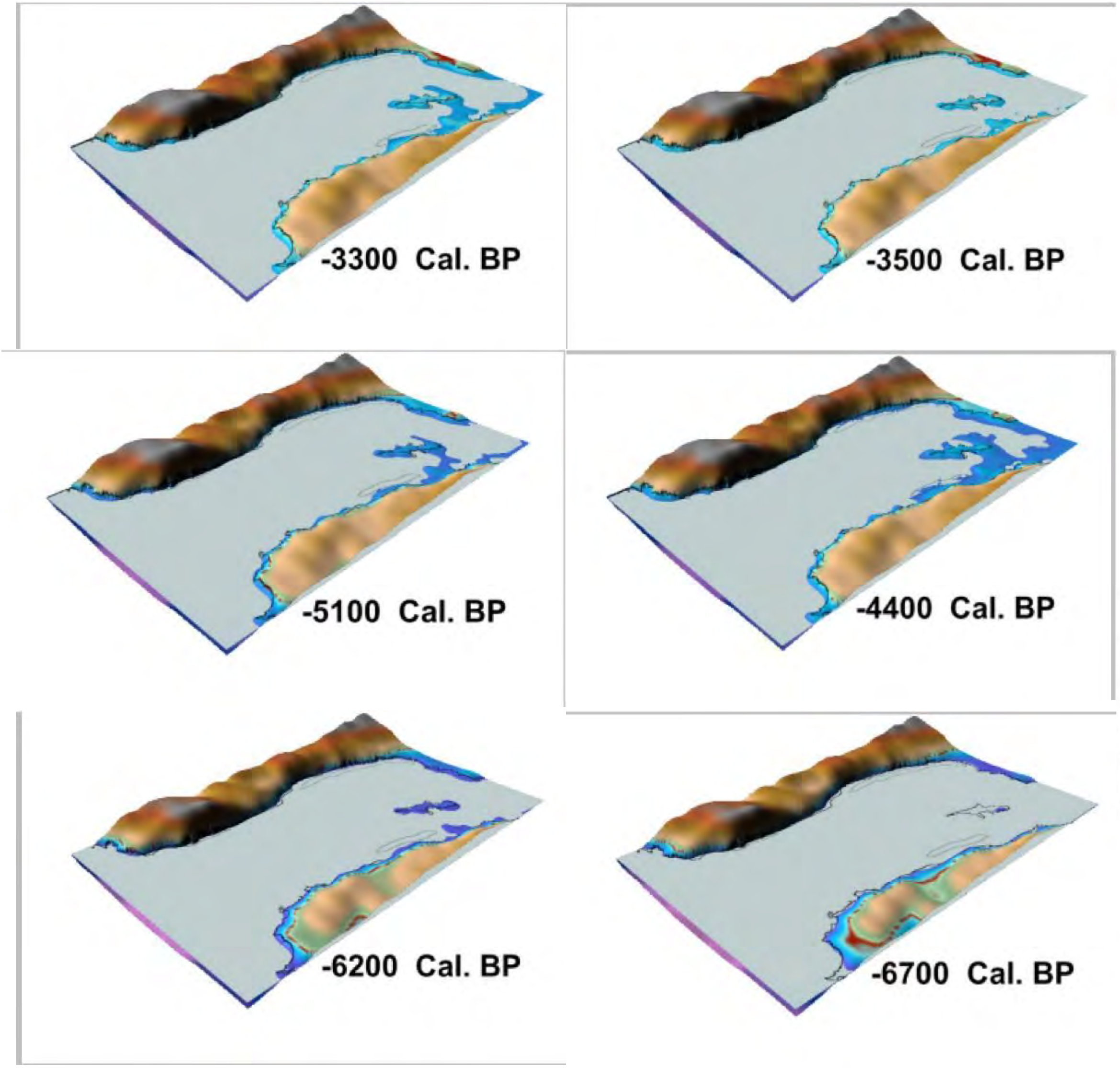
1882 VSEGEI Russian Geological Research Institute

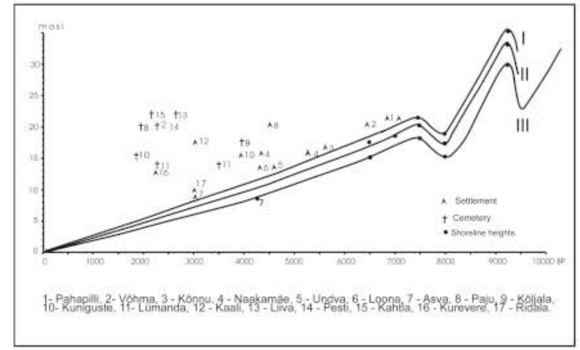
GPR-profile along the modern sand spit



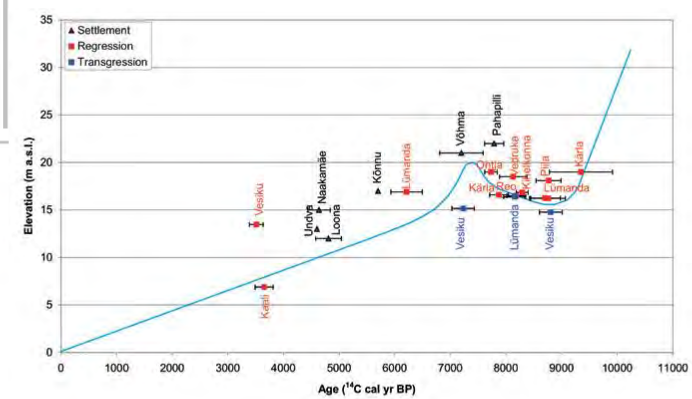
1 – erosion surface of relict coarse-grained sands; 2 - fine-grained sands; 3 – coarse-grained sands; 4 - relict lagoon mud; 5 – buried soils.

Gulf of Finland Co-operation





Saarse et al., 2007



Saarse et al., 2009

According to geological modeling (Amantov, 2012) possible periods of regressive fluctuations are 5600 –5100, 4600 – 4400, 3550 – 3000

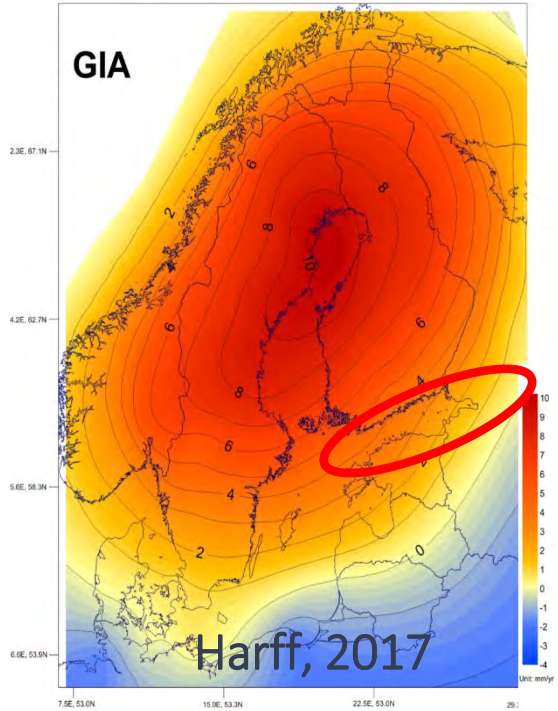
Gulf of Finland Co-operation

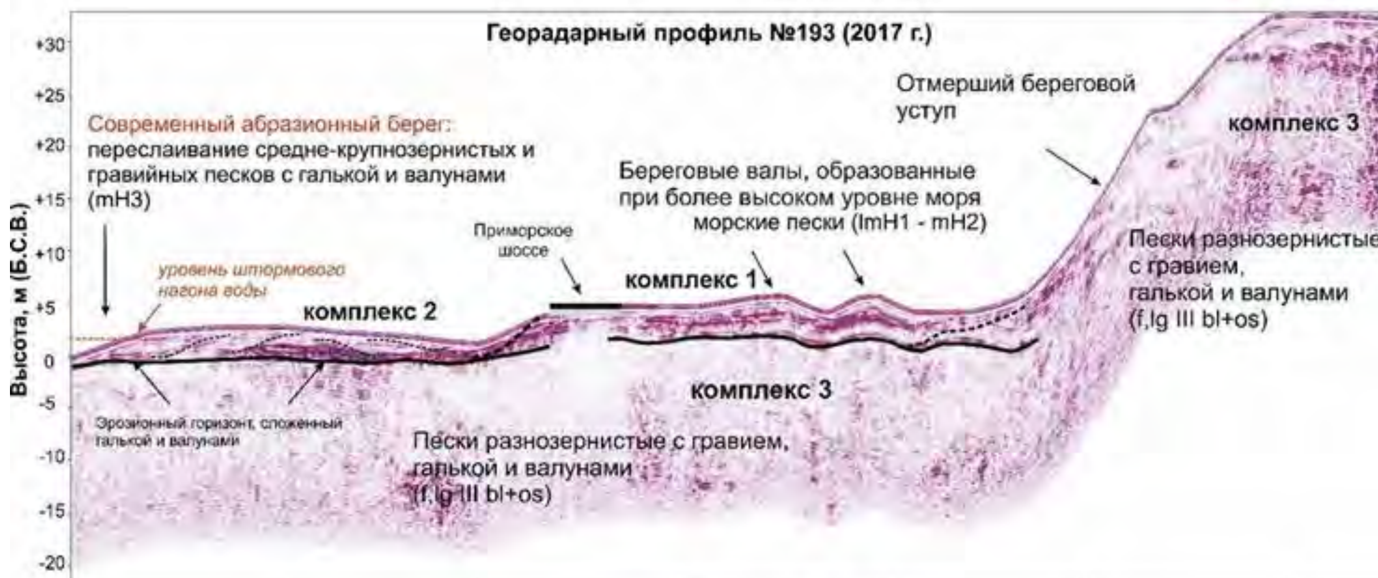
1. Glacial and glaciofluvial deposits are the main source of material for coastal zone development during Holocene

2. During the maximal stage of the Littorina transgression (7600–7200 cal. BP) several open bays connected with the Littorina Sea appeared in this area.

3. The lagoon systems and sand accretion bodies (spits and bars) were formed during the following decreasing of the sea level. Late Neolithic–Early Metal Epoch archaeological contexts of the end of the 6th to the beginning of the 5th ka BP mark the rate of regression.

4. An analysis of the submarine terraces morphology, geological structure of sediment basins, relict sand spits morphology, paleorivers' valleys and results of modeling shows that several relative sea level drops during the Holocene (including pre-Ancylus and pre-Littorina regressions) in the Eastern Gulf of Finland

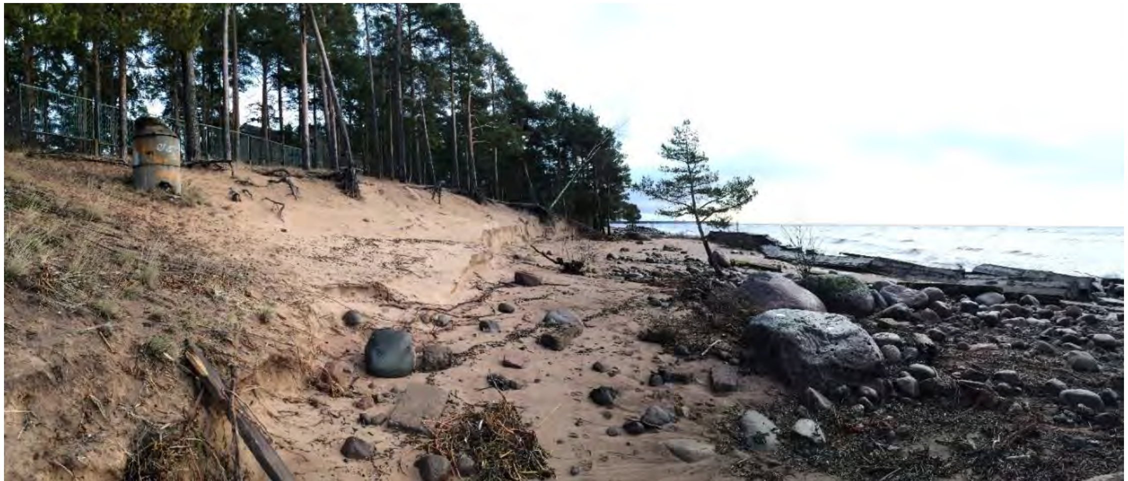

GIA
Harff, 2017
Unit: mm/yr

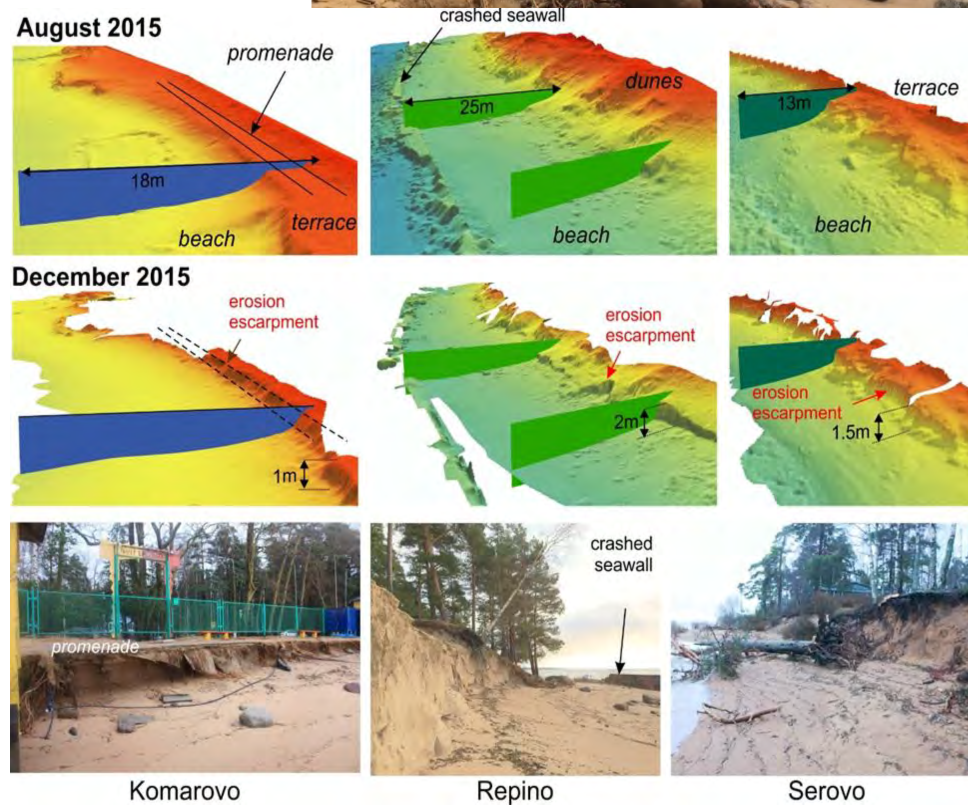

Георадарный профиль №193 (2017 г.)
Высота, м (Б.С.В.)
Современный абразионный берег:
переслаивание средне-крупнозернистых и гравийных песков с галькой и валунами (mH3)
уровень штормового нагона воды
комплекс 2
Приморское шоссе
комплекс 1
Береговые валы, образованные при более высоком уровне моря морские пески (lmH1 - mH2)
Отмерший береговой уступ
комплекс 3
Пески разнозернистые с гравием, галькой и валунами (f,lg III bl+os)
Эрозионный горизонт, сложенный галькой и валунами
комплекс 3
Пески разнозернистые с гравием, галькой и валунами (f,lg III bl+os)

Gulf of Finland Co-operation

Deficit of sand material after boulder bench forming in moraine erosion areas

Gulf of Finland Co-operation





1906

1940

2014

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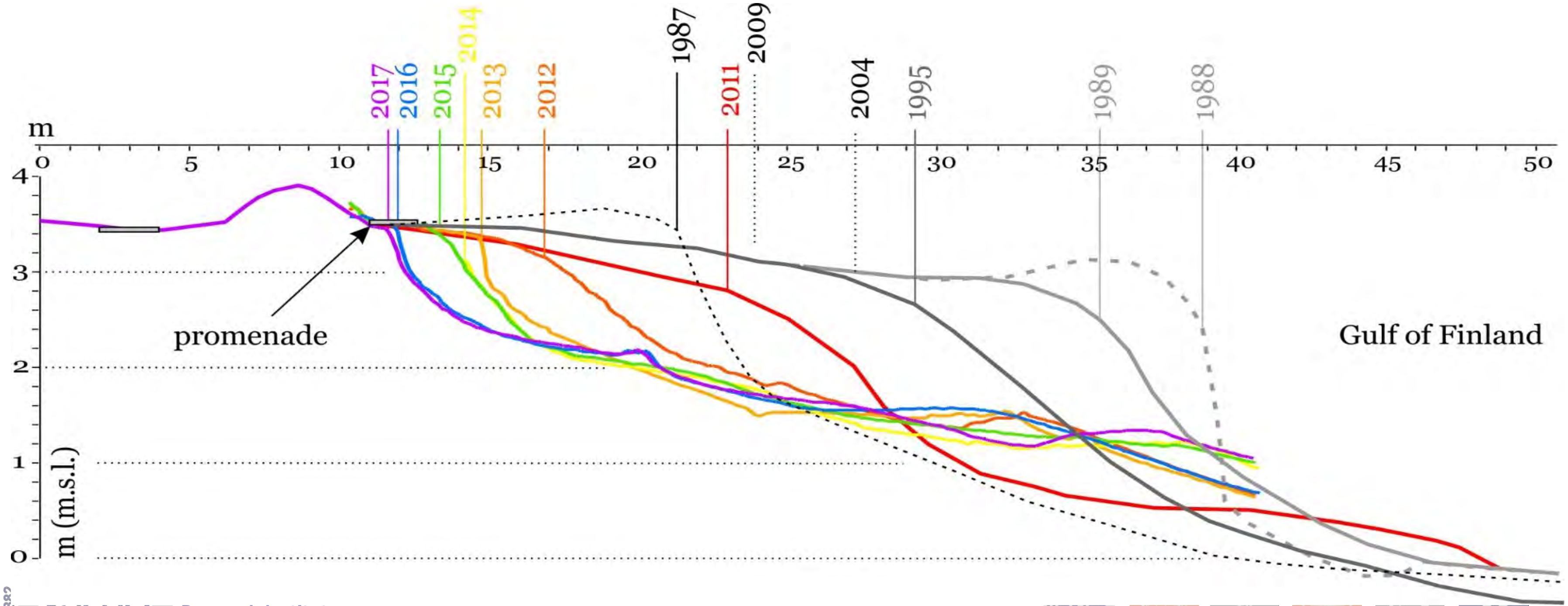
26.12.2011

28.12.2011

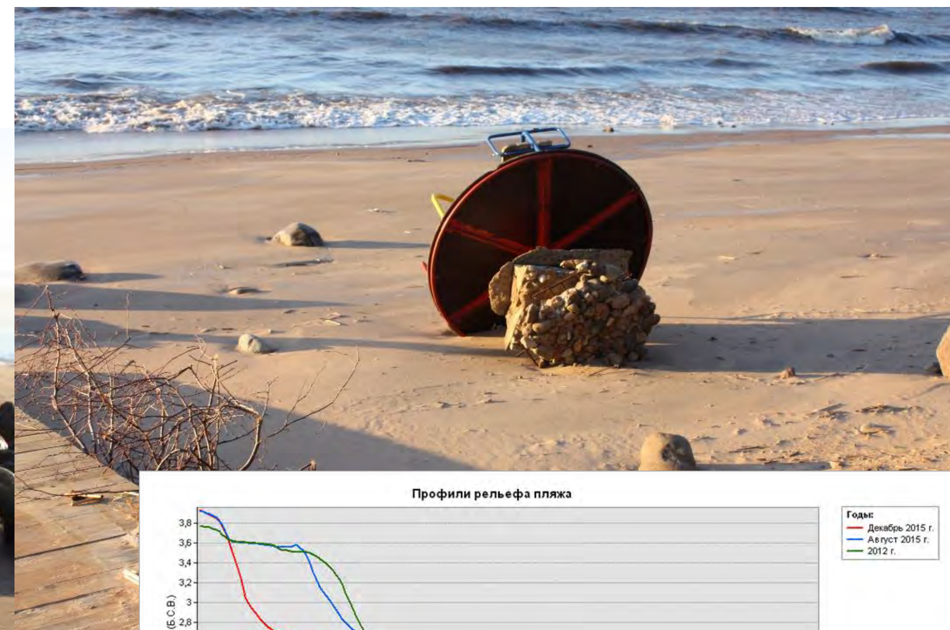
Artificial beach in Komarovo village (photos by K.Orviku)

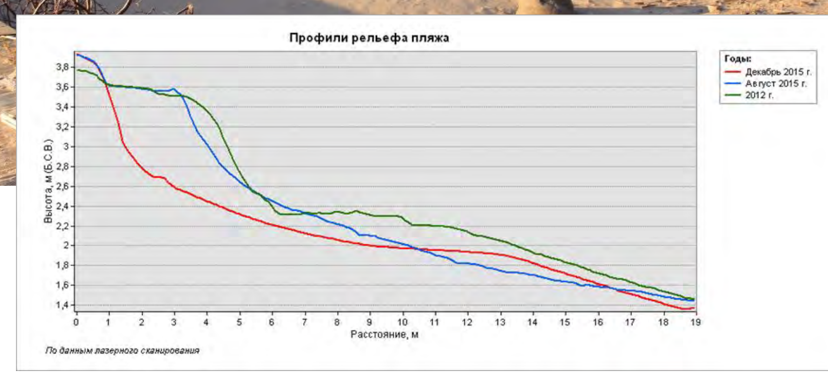


June 2011

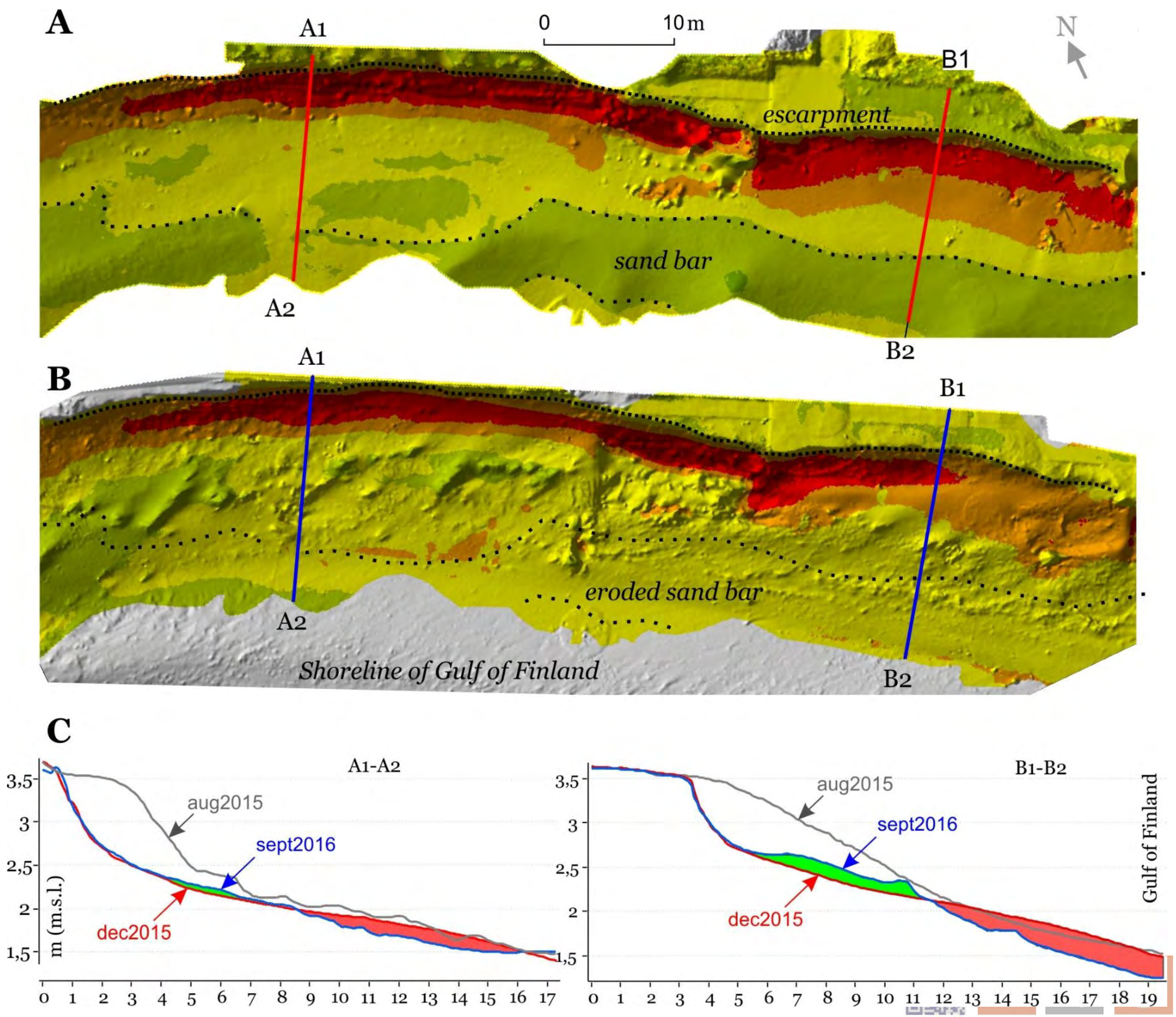
December 1, 2011

December 28, 2011

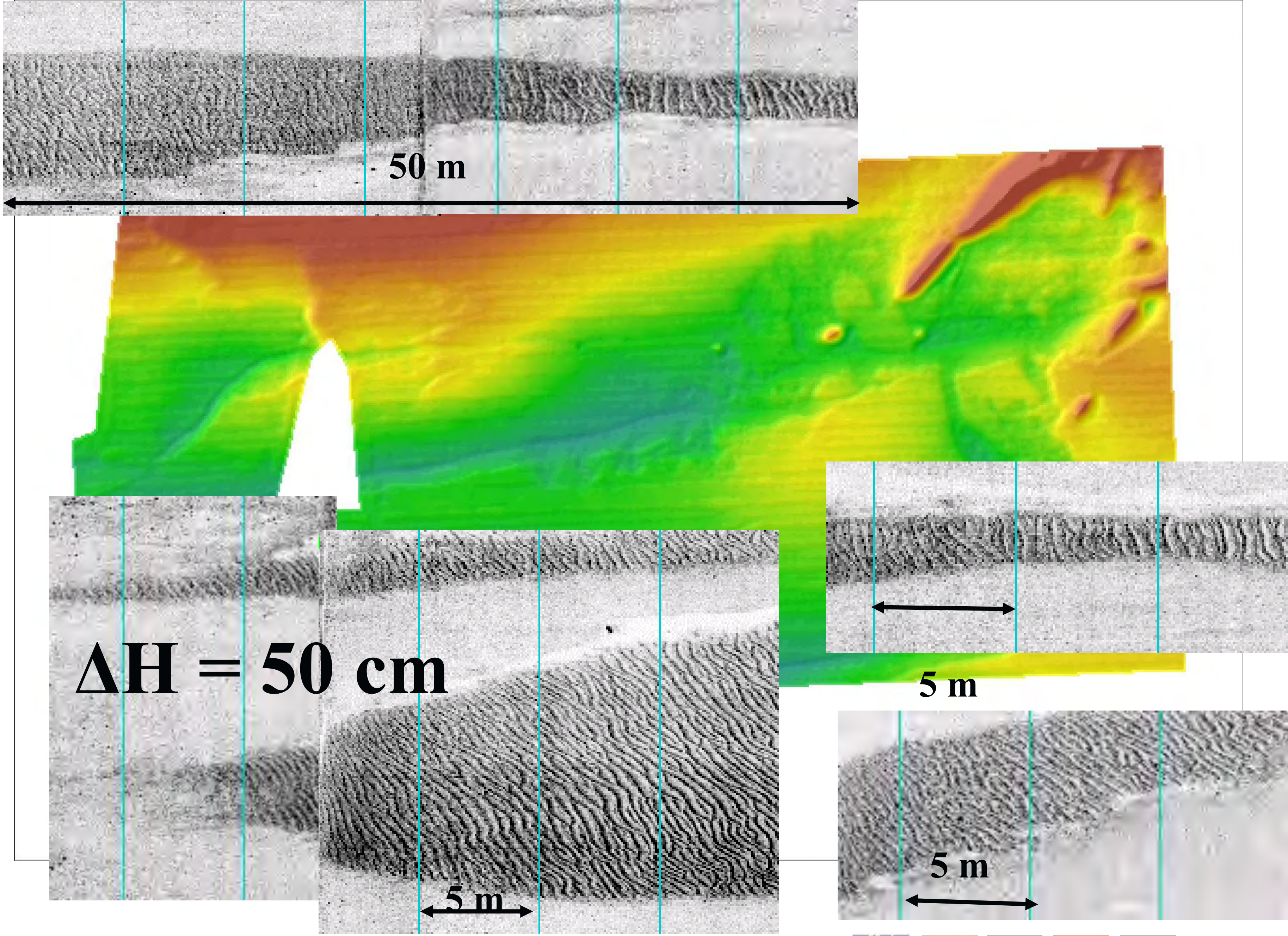


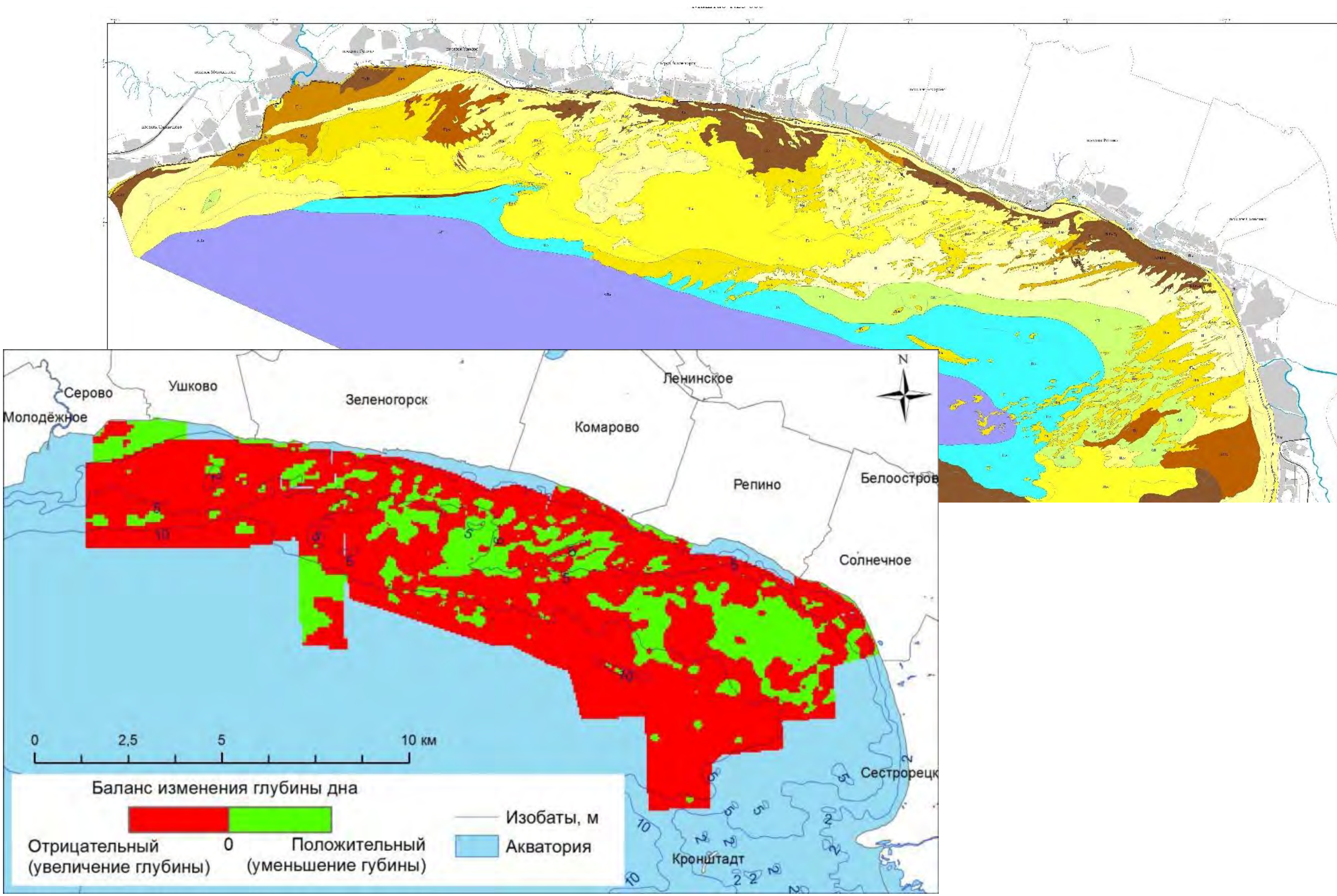


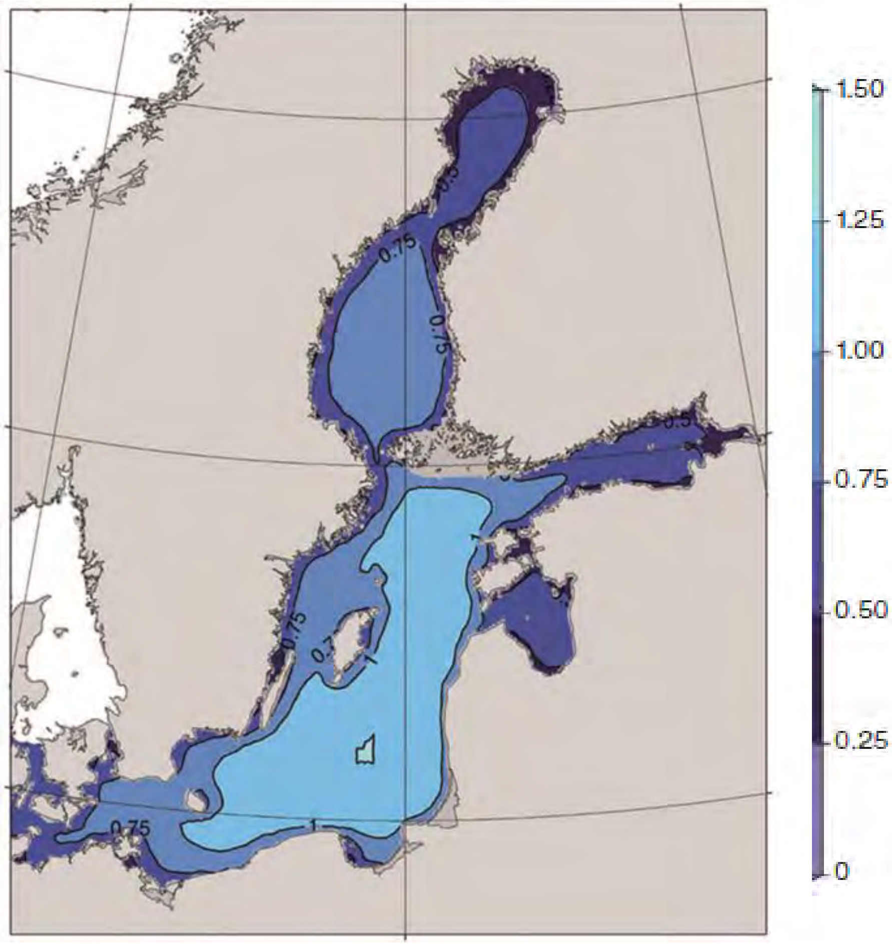
After storm (December 2013)



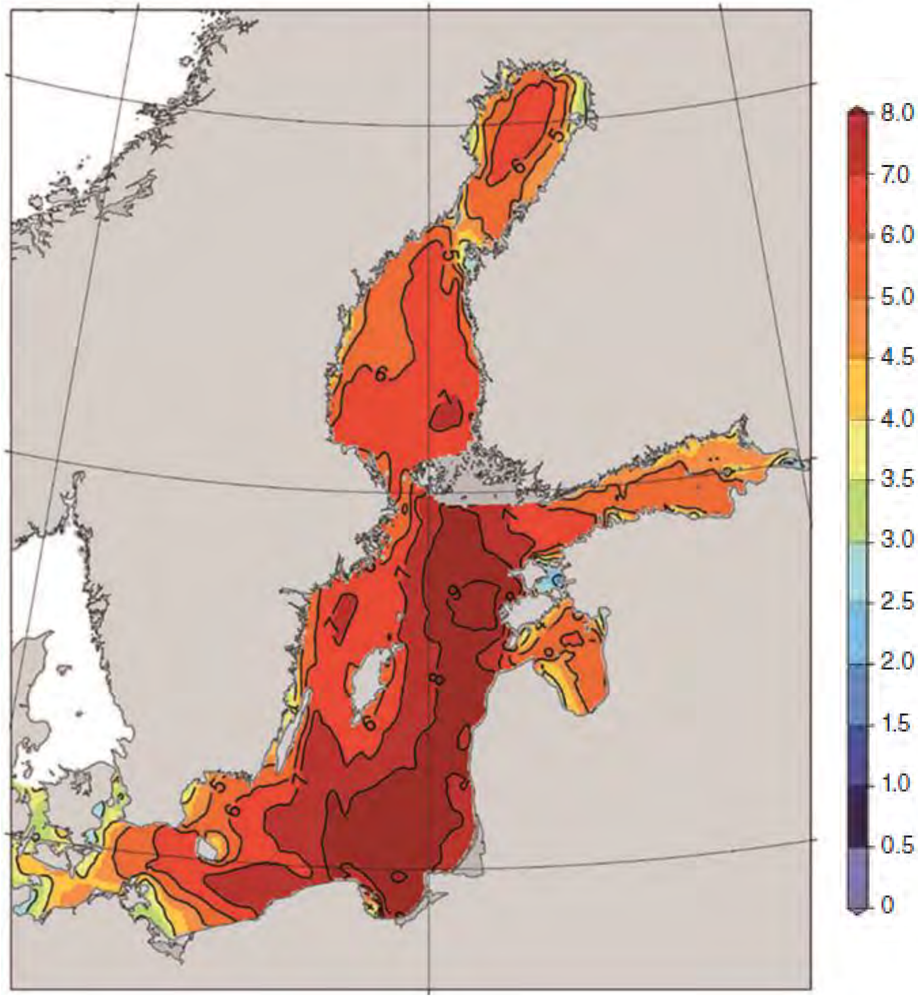
Gulf of Finland
Co-operation


50 m
ΔH = 50 cm
5 m
5 m
5 m


Серово
Ушково
Молодёжное
Зеленогорск
Ленинское
Комарово
Репино
Белоостров
Солнечное
Сестрорецк
Кронштадт
N
0
2,5
5
10 км
Баланс изменения глубины дна
Отрицательный
(увеличение глубины)
0
Положительный
(уменьшение губины)
Изобаты, м
Акватория



Numerically simulated mean values of significant wave height (m) in the Baltic Sea. Tuomi et al., 2011



Numerically simulated maximum values of significant wave height (m) showing areas with highest extreme waves. Tuomi *et al.* (2011).

Gulf of Finland Co-operation

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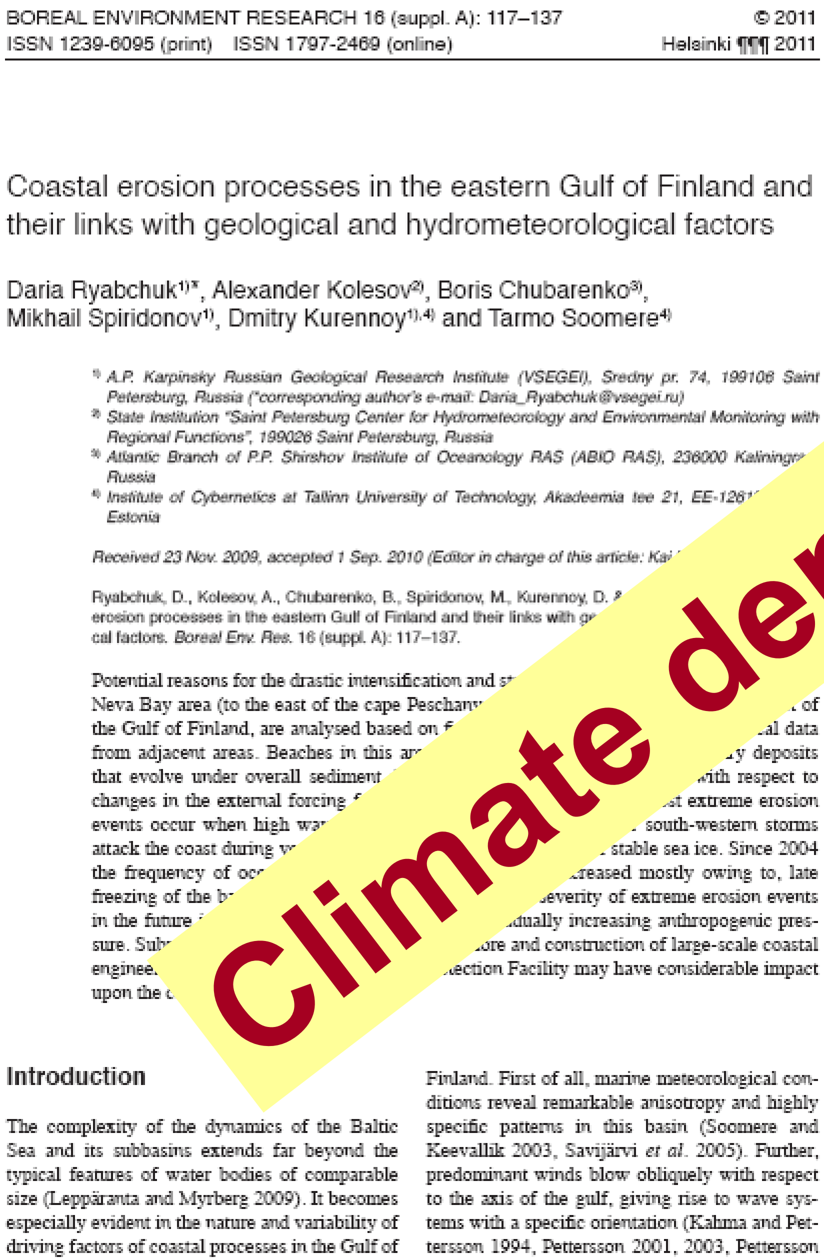
Gulf of Finland Co-operation


BOREAL ENVIRONMENT RESEARCH 16 (suppl. A): 117–137 © 2011
ISSN 1239-6095 (print) ISSN 1797-2469 (online) Helsinki ¶¶¶ 2011

Coastal erosion processes in the eastern Gulf of Finland and their links with geological and hydrometeorological factors

Daria Ryabchuk[1)*], Alexander Kolesov[2)], Boris Chubarenko[3)], Mikhail Spiridonov[1)], Dmitry Kurennoy[1),4)] and Tarmo Soomere[4)]

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Estonia

Received 23 Nov. 2009, accepted 1 Sep. 2010 (Editor in charge of this article: Kai

Ryabchuk, D., Kolesov, A., Chubarenko, B., Spiridonov, M., Kurennoy, D. &
erosion processes in the eastern Gulf of Finland and their links with ge
cal factors. Boreal Env. Res. 16 (suppl. A): 117–137.

Potential reasons for the drastic intensification and st
Neva Bay area (to the east of the cape Peschany … of
the Gulf of Finland, are analysed based on f … al data
from adjacent areas. Beaches in this ar … y deposits
that evolve under overall sediment … with respect to
changes in the external forcing … st extreme erosion
events occur when high wa … south-western storms
attack the coast during w … stable sea ice. Since 2004
the frequency of oc … creased mostly owing to, late
freezing of the b … severity of extreme erosion events
in the future … dually increasing anthropogenic pres-
sure. Sub … ore and construction of large-scale coastal
enginee … ection Facility may have considerable impact
upon the c

Introduction

The complexity of the dynamics of the Baltic Sea and its subbasins extends far beyond the typical features of water bodies of comparable size (Leppäranta and Myrberg 2009). It becomes especially evident in the nature and variability of driving factors of coastal processes in the Gulf of Finland. First of all, marine meteorological conditions reveal remarkable anisotropy and highly specific patterns in this basin (Soomere and Keevallik 2003, Savijärvi et al. 2005). Further, predominant winds blow obliquely with respect to the axis of the gulf, giving rise to wave systems with a specific orientation (Kahma and Pettersson 1994, Pettersson 2001, 2003, Pettersson

Climate dependant !

Severe coas … rosion
takes … case of
c … e of:
(i … ing western or
… n-western storms that
… ring high waves,
(ii) high water level (more than
2 m above the mean level
as measured by the Gorny
Institute water level
measurement post,
(iii) absence of stable sea

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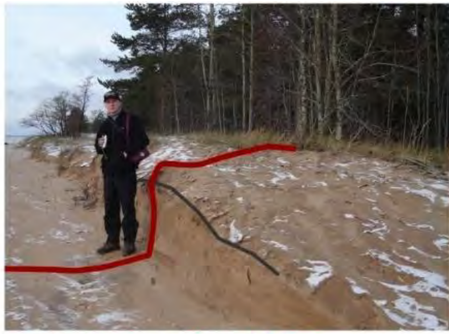
Extreme storms:

Autumn-winter:
2006-2007
2011-2012
2013
2015


October 2006, erosion


January 2007, erosion


June 2011, recovery


December 2011, erosion


July 2012, recovery


June 2013, recovery

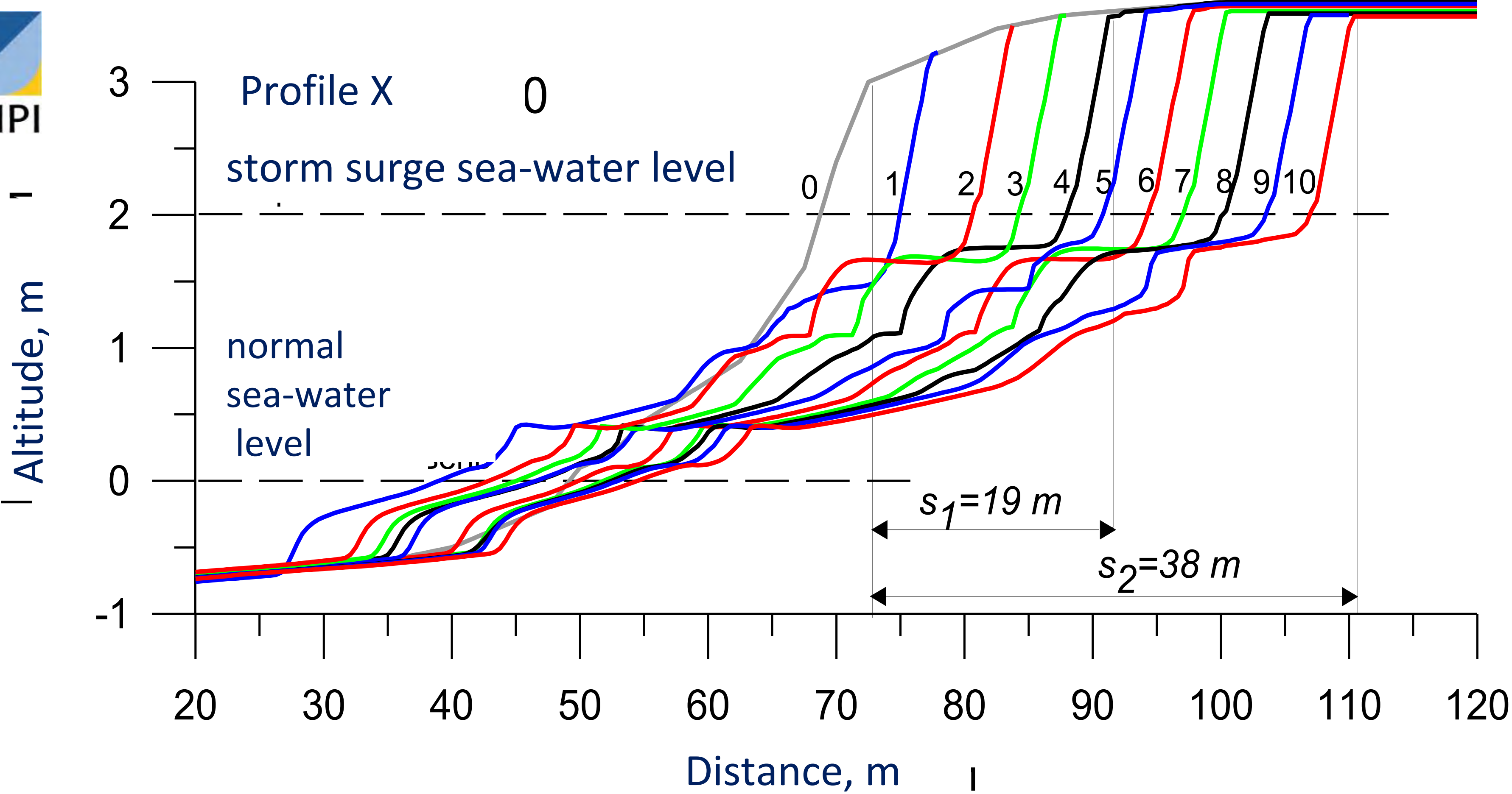

November 2013, erosior


December 2013, erosion


June 2014, recovery


December 2015, erosion

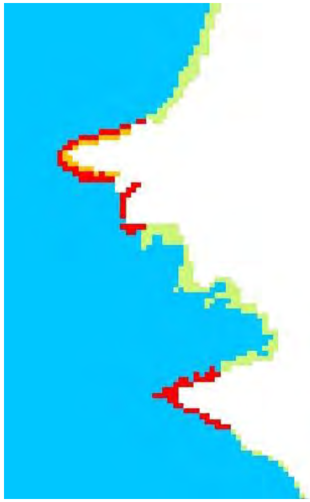
ENPI



Prediction of coast erosion rate depending on "erosion event" frequency (Leontiev, 2013)

Frequency of extreme storms (statistics of 1990-s) 1990-x – 1 per 25 years, rate of coastal erosion 0.25 m; frequency 1 per 10 years - 0.5 m/year

ENPI



Legend

- Stable
- Erosion 50
- Erosion 100
- Water area

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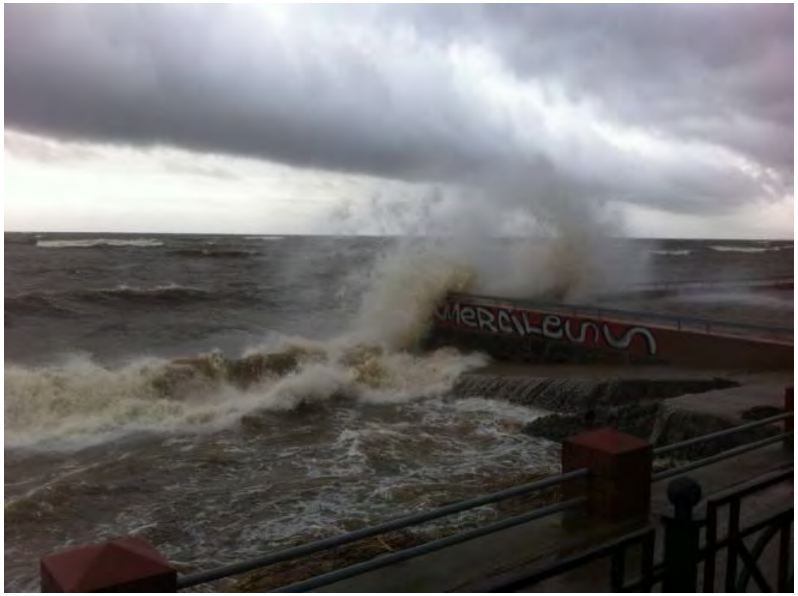
Technogenic processes

St. Petersburg Flood Protection Facility (FPF)

October 29, 2013

To the west from the FPF




2006


2013


2017


2019


2008


2008


2021


2021


2021

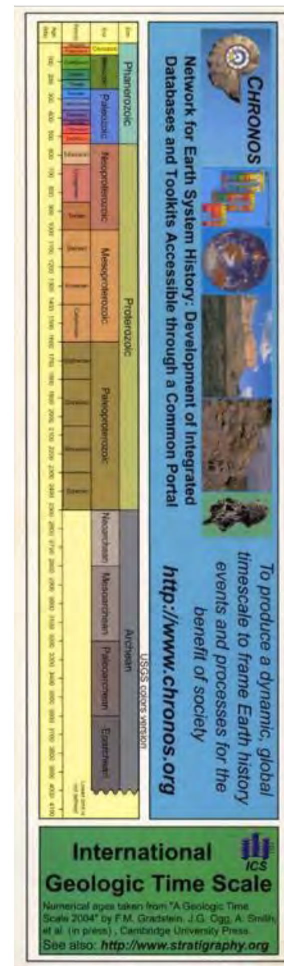

2021

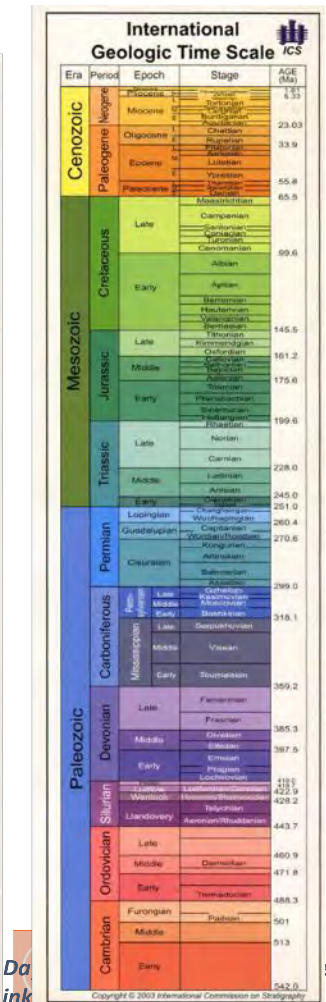
Photos by A.Lappo

Geological time
4 billion years of Earth history = 1 year

January 1, 00:00 – formation of Earth,
March 28 – first bacteria,
December 12 – golden age of dinosaurs,
December 26 – dinosaurs’ extinction,
December 31, 01:00 – first common ancestor of man and monkey;
December 31, 17:30 – first Australopithecus,
December 31, 23:56 – first Neanderthal,
December 31, 23:59:56 – Christmas

Prof. Sergey Romanovsky, VSEGEI





Russian Geological Research Institute

Contributors

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Igor Neevin

Vladimir Zhamoida

Leonid Budanov

Thank you for attention!

RUSSIAN MSP ROADMAP AS AN INSTRUMENT FOR ENHANCING PARTICIPATION OF RUSSIA IN THE PAN-BALTIC MSP PROCESS

First Draft of the Proposals for the action plan (“Roadmap”) for the promotion of Maritime Spatial Planning in the Russian Federation

Larisa Danilova, Andrei Lappo
Institute of Maritime Spatial Planning Ermak NorthWest
St. Petersburg, Russia

The Gulf of Finland Science Days 2021
New start for the Gulf of Finland co-operation

Tallinn
29-30 November 2021

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND
WITH FINANCIAL SUPPORT OF THE RUSSIAN FEDERATION

Baltic sea 2021. Introduction

- New HELCOM Baltic Sea Action Plan 2021-2030 is adopted
- New MSP Roadmap for the Baltic Sea Region 2021-2030
- Capacity4MSP project-platform with the aim to capitalize outcomes and findings of the previous MSP projects
- New VASAB LTE up to 2040 is being developed currently
- Russian MSP Roadmap is under finalization

The purpose of the Roadmap is to develop proposals for the action plan to ensure the MSP improvement and implementation in the Russian Federation. The cooperation of the Baltic Sea countries in the field of MSP, carried out within the framework of a joint horizontal action of the international regional organizations HELCOM and VASAB, has created the conditions for accelerating the process of MSP in the Russian Federation.

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Russian MSP Roadmap

Justification

International framework

- UNESCO guides on MSP
- BSAP
- Baltic Region MSP Roadmap
- Bilateral cooperation programs with Sweden, Finland, Estonia, Norway, etc. to ensure the ecological safety of marine economic activities
- New. Black Sea Strategic Research and Innovation Agenda

National strategies

- Maritime Doctrine of the Russian Federation until 2030
- Decree of the President of the Russian Federation "On the improvement of maritime activities"
- State Program "Environmental Protection 2012-2020"
- National project "Ecology"

Russian MSP Roadmap

Official support

- Ministry of Natural Resources and Ecology of the Russian Federation – supports the implementation of the ecosystem-based approach to marine and coastal management
- Ministry of Foreign Affairs of the Russian Federation – supports international cooperation in the field of Integrated marine management
- Marine Board under the Government of the Russian Federation – supports the development and Improvement of marine environmental management tools and education

Russia still don't have national authority responsible for MSP

Developers

- Institute of maritime spatial planning Ermak NorthWest (ErmakNW)
- Russian State Hydrometeorological University (RSHU)

Russian supporting platform developed by the Capacity4MSP project:

Leontiev Center (SPb), WWF-Russia (Arctic), Mineral (Baltic Sea), AO IO RAS (Kaliningrad), RTU MIREA (Moscow), FEFU, POI FE RAS (Far East), SSC RAS (Black Sea), IPA IC (Caspian Sea)

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How it was done. Parallel activities

1 Stakeholder involvement

Informing
Questionnaire

Round tables, forums, conferences, information seminars

2 Data collection and analysis

Stakeholder mapping and survey

More than 10 researches

3 Pilot Mapping and planning

Natural resource and vulnerability mapping.
Marine and coastal activities mapping

4 Outcome preparation

Draft action plan

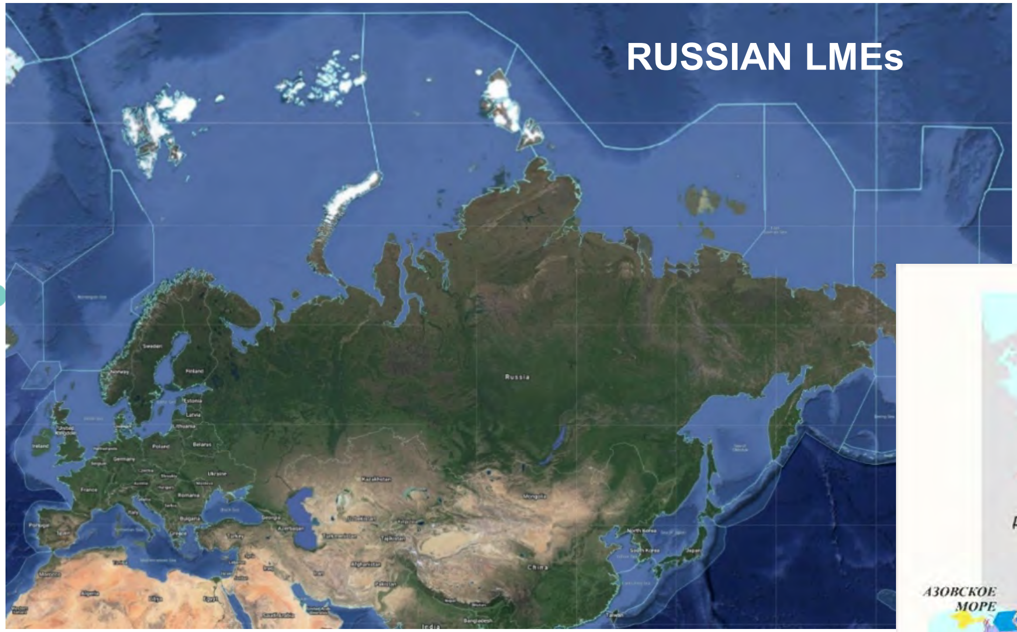
Explanatory note

Methodology of Marine Functional Zoning

…

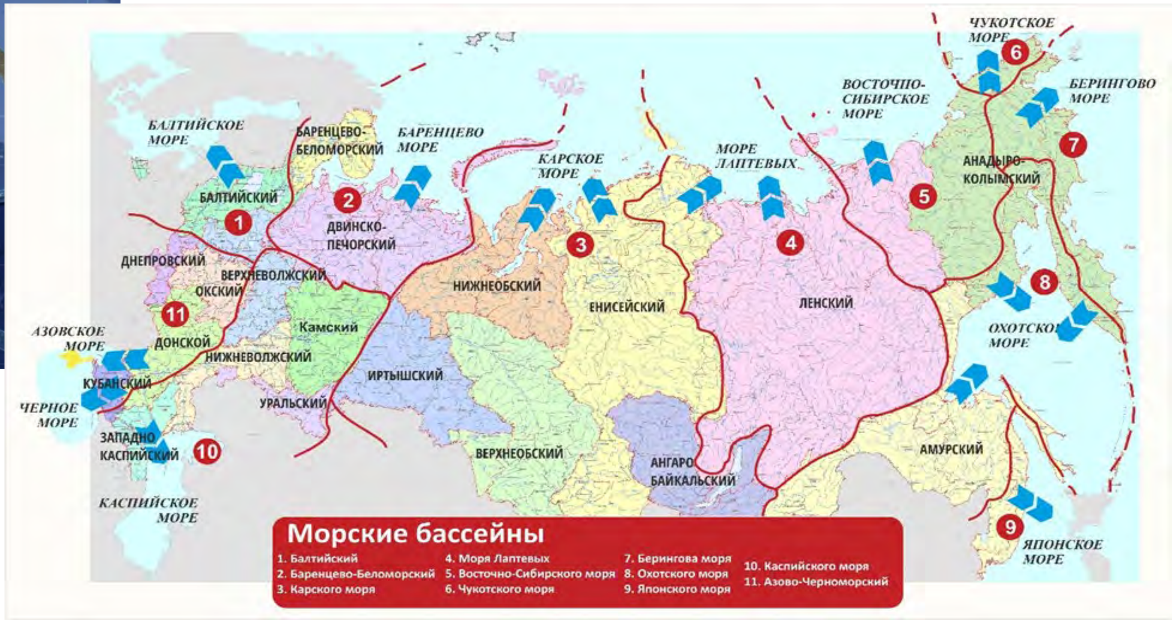
Specificity of the seas of the Russian Federation

- **Significant total area of marine areas (more than 8.6 million km2)**
- **The length of the coastline is 60,985 km**
- **Significantly different conditions (13 seas, 3 oceans + Caspian Sea)**



Challenge: the coastal regions borders don't match catchment areas

SEA BASINS AND CATCHMENT POOLS



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Stakeholder dialog

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Presentations on other events - 10

19-21 января 2021 г., Международная конференция MSP NATURE 2021 «Nature Conservation in Marine Spatial Planning: how to reconcile human activities with ecological functions» (онлайн)
18 мая 2021 г., Санкт-Петербург, Законодательное собрание Санкт-Петербурга;
27 мая 2021 г., Астрахань, Национальная научно-практическая конференция с международным участием «Каспий в цифровую эпоху»;
28 мая 2021 г., Санкт-Петербург, IX Невский международный экологический конгресс «Экология планеты – устойчивое развитие»;
02 июня 2021 г., Рига, Латвия, 4th Baltic MSP Forum;
09 июня 2021 г., Санкт-Петербург, в рамках обучающего тренинга «Управление водными ресурсами урбанизированных территорий» международного проекта «BSR WATER»;
21 августа 2021 г., Санкт-Петербург, Экологическая конференция в рамках XII международного экологического фестиваля искусств КРОНФЕСТ;
21 сентября 2021 г., Севастополь, Всероссийская научная конференция «Моря России: Год науки и технологий в РФ – Десятилетие наук об океане ООН»;
19 ноября 2021 года, Ростов-на-Дону, в рамках Международной конференции ITIBSM-2021 «Innovative Trends in International Business and Sustainable Management».

Conferences, sessions, workshops conducted - 13

Дата, регион	Название мероприятия	Организаторы
Сентябрь 2020 Краснодарский край, поселок Дюрсо (Новороссийск)	Круглый стол «УСТОЙЧИВОЕ РАЗВИТИЕ МОРСКОЙ/СИНЕЙ ЭКОНОМИКИ В АЗОВО-ЧЕРНОМОРСКОМ РЕГИОНЕ, ЗНАЧЕНИЕ МОРСКОГО ПРОСТРАНСТВЕННОГО ПЛАНИРОВАНИЯ - 2020» под эгидой Объединённой конференции «Экология. Экономика. Информатика»	ЮНЦ РАН, ИО им. П.П. Ширшова РАН, НИПИ АТП Ермак Северо-Запад
Сентябрь 2020 Москва	Информационный Семинар «МОРСКОЕ ПРОСТРАНСТВЕННОЕ ПЛАНИРОВАНИЕ В РОССИЙСКОЙ ФЕДЕРАЦИИ. ЗАЧЕМ ОНО НУЖНО РОССИИ?» для представителей федеральных и региональных органов власти	Институт Ермак Северо-Запад, РТУ МИРЭА, Морской университет в Гдыне
Октябрь 2020 Владивосток	Круглый стол «РАЗВИТИЕ СОТРУДНИЧЕСТВА В МОРСКОМ ПРОСТРАНСТВЕННОМ ПЛАНИРОВАНИИ ЧЕРЕЗ ОБЩИЕ ПРОЕКТЫ» в рамках международной научной конференции «FarEastCon»	ДВФУ, Институт Ермак Северо-Запад
Октябрь 2020 Санкт-Петербург	Круглый стол «МОРСКОЕ ПРОСТРАНСТВЕННОЕ ПЛАНИРОВАНИЕ – ДОРОЖНАЯ КАРТА РОССИЙСКОЙ ФЕДЕРАЦИИ» в рамках Международной научно-практической конференции «Современные проблемы гидрометеорологии и мониторинга окружающей среды на пространстве СНГ»	РГГМУ, МПА СНГ
Октябрь 2020 Мурманск	Круглый стол «Морское пространственное планирование как инструмент регулирования ЭКОСИСТЕМНОГО ПРИРОДОПОЛЬЗОВАНИЯ в арктических морях РОССИЙСКОЙ ФЕДЕРАЦИИ»	WWF-Россия, Институт Ермак Северо-Запад
Январь 2021 Калининград	Круглый стол «МОРСКОЕ ПРОСТРАНСТВЕННОЕ ПЛАНИРОВАНИЕ – ВЗГЛЯД ИЗ КАЛИНИНГРАДСКОЙ ОБЛАСТИ»	ГГМУ, АО ИО РАН
Март 2021 Санкт-Петербург	Круглый стол «МОРСКОЕ ПРОСТРАНСТВЕННОЕ ПЛАНИРОВАНИЕ» в рамках Международного форума День Балтийского Моря	Институт Ермак Северо-Запад, ГГУП СФ Минерал
Август 2021 Санкт-Петербург	Межрегиональный Круглый Стол Ленинградской Области И Санкт-Петербурга «КОМПЛЕКСНОЕ УПРАВЛЕНИЕ ПРИБРЕЖНЫМИ ТЕРРИТОРИЯМИ ФИНСКОГО ЗАЛИВА. СОВРЕМЕННЫЕ ВЫЗОВЫ И ВОЗМОЖНЫЕ РЕШЕНИЯ» в рамках XII международного экологического фестиваля искусств КРОНФЕСТ	Институт Ермак Северо-Запад, Общественный совет южного берега Финского залива
Октябрь 2021 Санкт-Петербург	Круглый стол «СИСТЕМА СТРАТЕГИЧЕСКОГО ПЛАНИРОВАНИЯ РАЗВИТИЯ МОРСКОЙ ДЕЯТЕЛЬНОСТИ РОССИЙСКОЙ ФЕДЕРАЦИИ И МОРСКОЕ ПРОСТРАНСТВЕННОЕ ПЛАНИРОВАНИЕ» в рамках XIX Общероссийского Форума «Стратегическое Планирование В Регионах И Городах России 2020-2021»	Институт Ермак Северо-Запад, МИД РФ, Леонтьевский центр, РТУ МИРЭА
Ноябрь 2021 Ростов-на-Дону	Круглый стол «ЧЕРНОЕ МОРЕ И СИНЯЯ ЭКОНОМИКА: ЭКОСИСТЕМНОЕ УПРАВЛЕНИЕ И МОРСКОЕ ПРОСТРАНСТВЕННОЕ ПЛАНИРОВАНИЕ» в рамках Международной конференции ITIBSM-2021 «Innovative Trends in International Business and Sustainable Management»	ЮФУ, РТУ МИРЭА, Институт Ермак Северо-Запад
Ноябрь 2021 Балтийское море	Балтийский Форум Планировщиков (онлайн), презентация предложений в ДК МПП и особенностей экосистемного подхода к планированию	Институт Ермак Северо-Запад, РГГМУ
Ноябрь 2021 Таллин	Сессия по предложениям в Российскую Дорожную карту МПП в рамках конференции «The Gulf of Finland Science Days 2021 “New start for the Gulf of Finland co-operation»	Институт ЕРМАК СЕВЕРО-ЗАПАД, SYKE, Финляндия, Академия наук Эстонии
Декабрь 2021 Санкт-Петербург	Международная научно-практическая конференция «ЭКОЛОГИЧЕСКИ-ДРУЖЕСТВЕННОЕ РАЗВИТИЕ ПРИБРЕЖНЫХ ЗОН И МОРСКИХ АКВАТОРИЙ»	РГГМУ, МПА СНГ

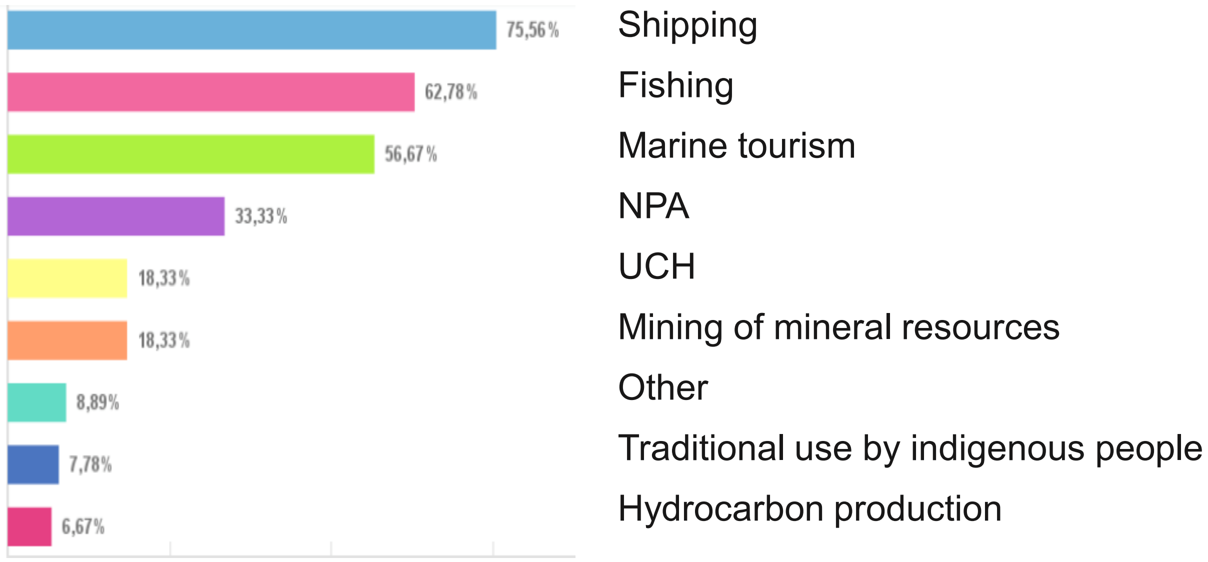
Russian MSP Roadmap

SURVEY FOR STAKEHOLDERS OF THE RUSSIAN COASTAL REGIONS

JULY-AUGUST 2020

CAPACITY4MSP

MAIN KINDS OF MARITIME ACTIVITIES IN RUSSIA



	TOTAL	BALTIC SEA	OTHER SEAS
INQUIRIES	450	210	230
ANSWERS RECEIVED	219	155	64
SUPPORTED MSP PROMOTION	149 (68%)	93 (60%)	56 (88%)
SUPPORTED THE DEVELOPMENT OF A PILOT MSP IN THEIR REGION	137 (63%)	116 (75%)	21 (33%)

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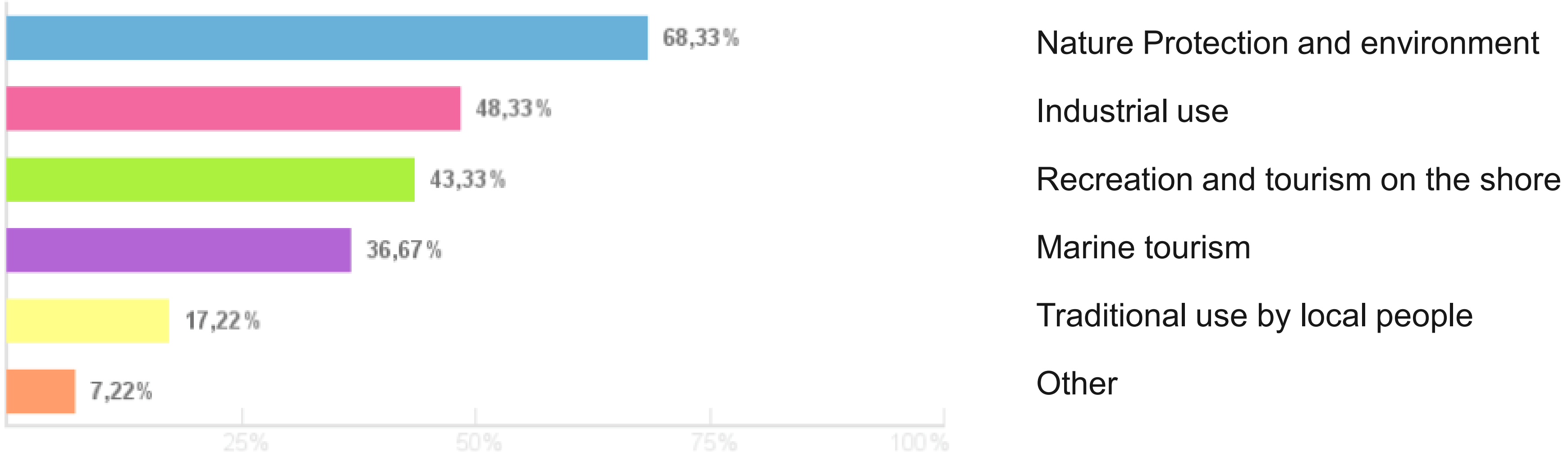
Russian MSP Roadmap

SURVEY FOR STAKEHOLDERS OF THE RUSSIAN COASTAL REGIONS.

JULY-AUGUST 2020

MARITIME ACTIVITIES THAT CAUSED PUBLIC CONCERNS



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RUSSIAN MSP ROADMAP PILLARS

1

Pillar 1
institutional arrangements

aimed at forming the institutional foundations of marine spatial planning in the Russian Federation

2

Pillar 2
Legislation arrangements

Inclusion of MSP in the system of strategic and territorial planning documents of the Russian Federation

3

Pillar 3
Scientific research

Creation of regulatory and legal methodological, organizational, administrative framework

4

Pillar 3
Education, skills and capacity building

Building human resources for the implementation of MSP in the practice of marine environmental management

5

Pillar 5
Maritime spatial plans development

Development of MSPs will expand spatial planning to the marine area of Russia

Russian MSP Roadmap

PILLAR 1. INSTITUTIONAL ARRANGEMENTS

Aimed at forming the institutional foundations of MSP in the Russian Federation.
They provide for the main actions that allow to form the structure of management bodies and launch the official process of introducing MSP into the regulatory framework of the Russian Federation and marine environmental management practical activities

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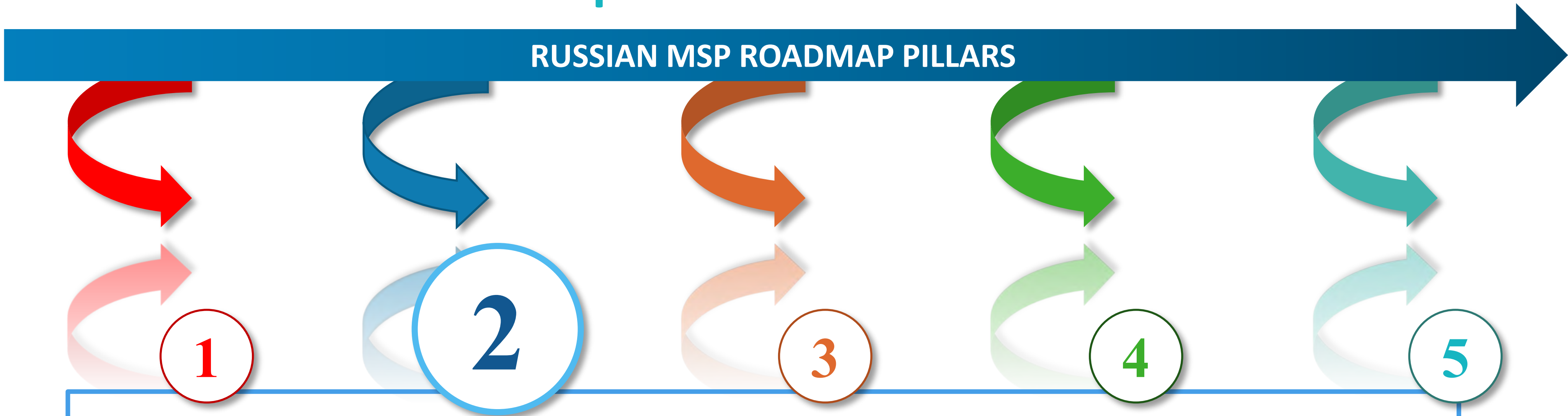

PILLAR 1. LEGISLATION ARRANGEMENTS

MSP is inextricably linked with the management of marine activities, state and regional legislation on the use of marine resources and nature conservation. The inclusion of MSP in the system of strategic and territorial planning documents of the Russian Federation is possible only if appropriate amendments are made to the legislative acts of the Russian Federation and the constituent entities of the Russian Federation. These changes should concern not only the MSP, but also related acts.

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PILLAR 3. SCIENTIFIC AND TECHNICAL MEASURES

The legal MSP framework planning should be supported by regulatory and legal documents of a methodological, organizational and administrative nature. Some of them can be developed only at the national level, others are of regional nature and should relate to the level of the coastal subject of the Russian Federation.

Of particular importance is analysis of the impact of external influences on marine ecosystems, the sensitivity of ecosystems to anthropogenic loads and the ability to restore them, interaction with neighboring countries on transnational issues.

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PILLAR 4. EDUCATION AND TRAINING

Education creates human resources and provides methodological support for the implementation of MSP tools in the practice of IMM. Staff training is carried out through academic training (master's level) and the additional education programs. Vocational educational programs for a master's degree can be carried out on the basis of existing enlarged groups of specialties and areas of training.

Roadmap propose to create three educational and research centers, in accordance with the three directions of the national maritime policy (Atlantic, Pacific and Arctic) on the basis of the regional Universities.

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Russian MSP Roadmap

PILLAR 5. MARINE SPATIAL PLANS

Development of plans for the sea areas of the Russian Federation will expand spatial planning to the entire territory and marine area of Russia, including EEZ and the continental shelf under Russia's jurisdiction, and create conditions for sustainable Blue economy, for increasing the welfare of coastal regions while maintaining the health of the ocean ecosystem.

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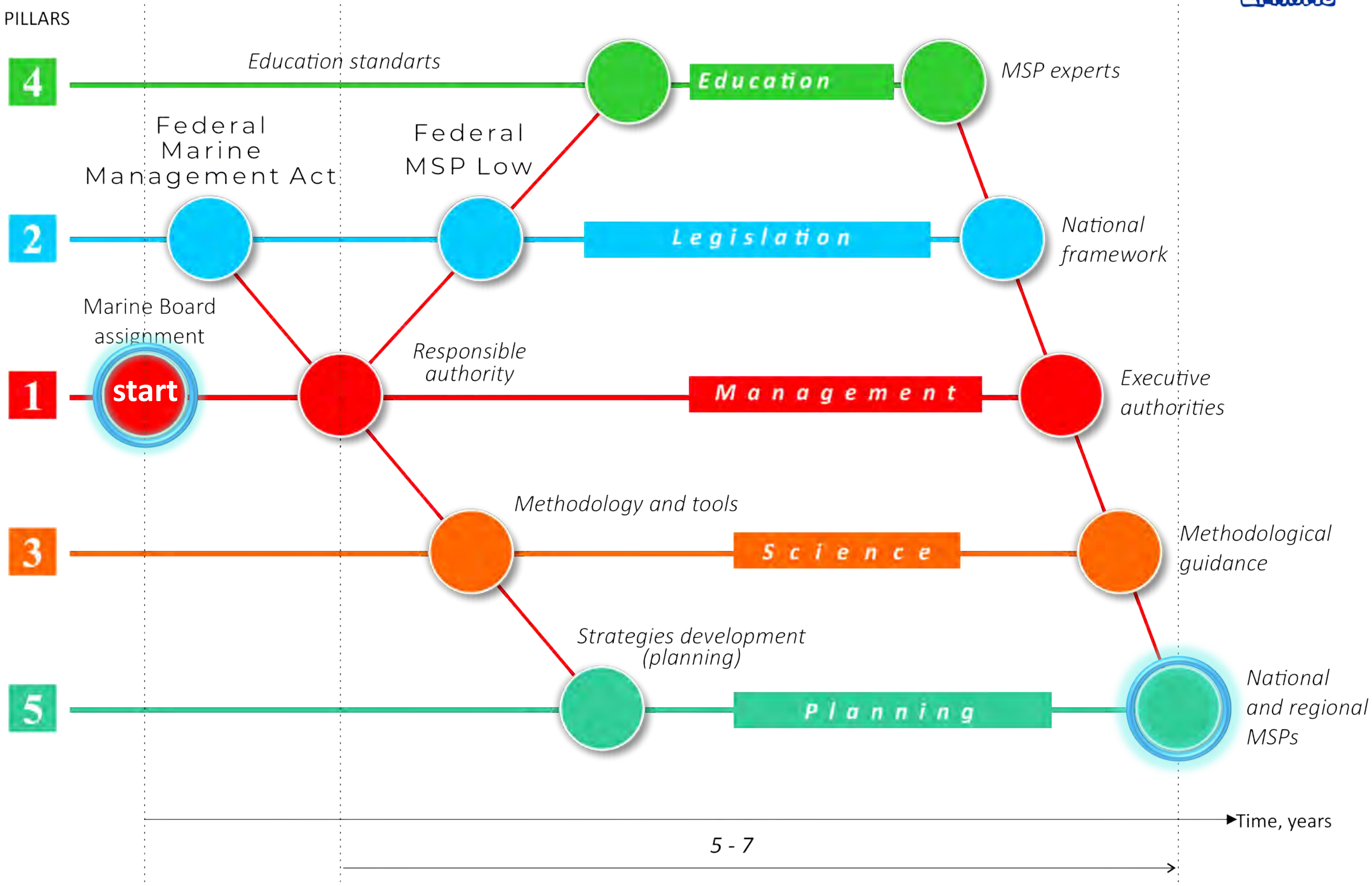
Russian MSP Roadmap Flowchart



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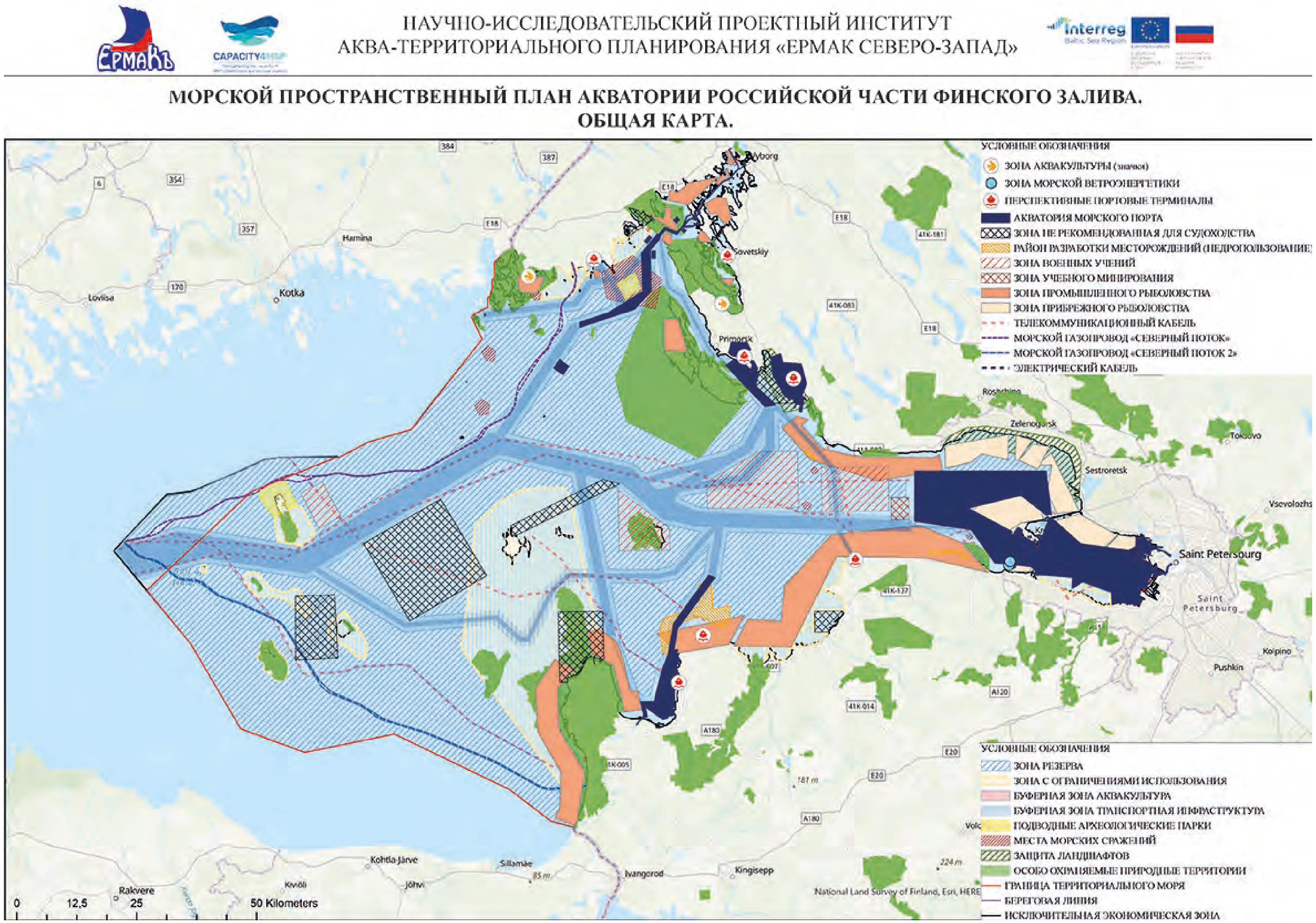
Pilot MSP of the Eastern part of the Gulf of Finland



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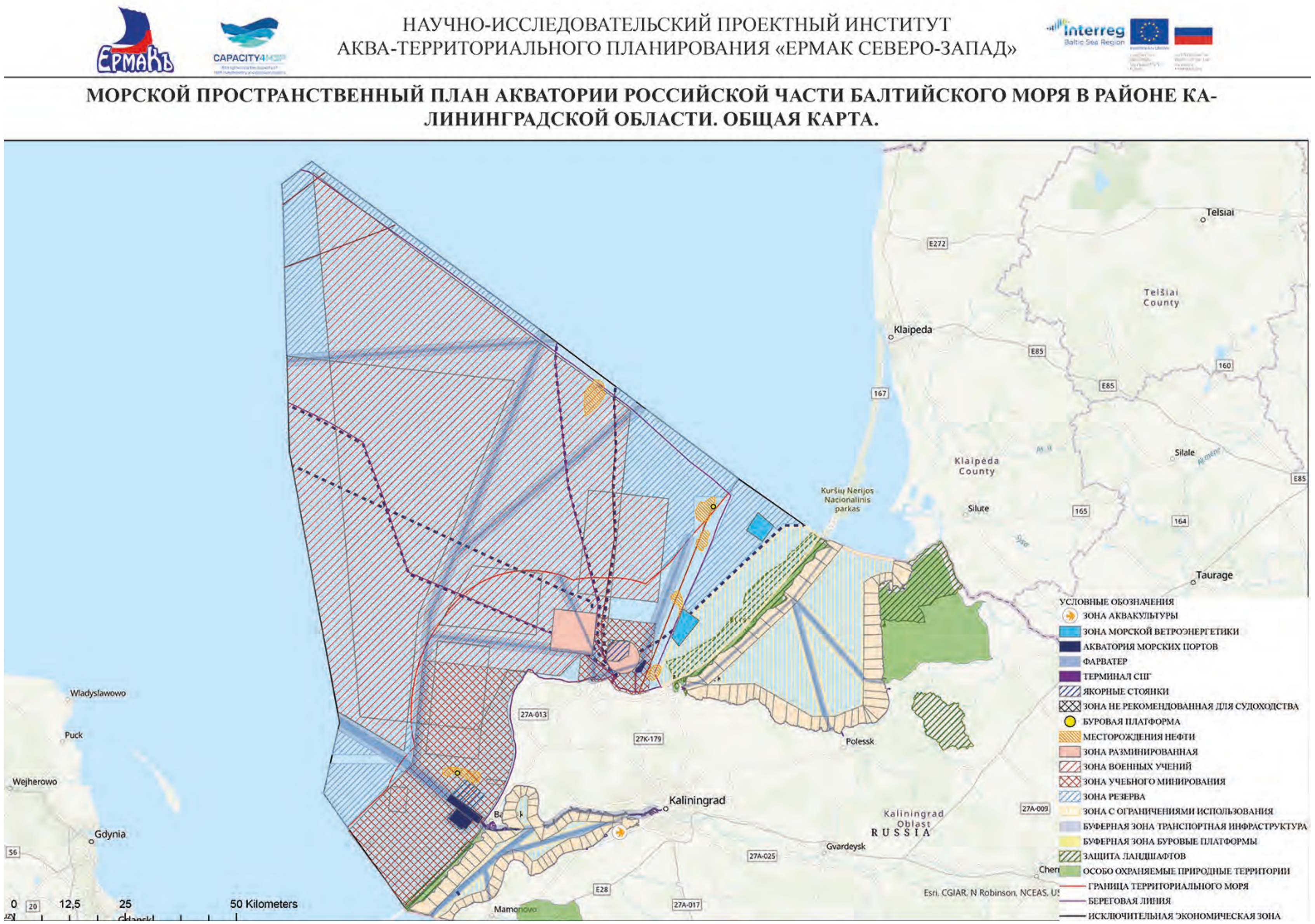
Pilot MSP of the South-East Baltic



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Explanatory note

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Content

MSP FAQ

- ✓ Why does Russia need MSP?
- ✓ Is MSP a self-sufficient tool?
- ✓ How are MSP and landscape planning related?
- ✓ What does the ecosystem approach to MSP mean?
- ✓ How MSP different from ICM and IMM?
- ✓ What are the benefits of MSP?
- ✓ Why do other countries have MSP, but Russia still does not have it?
- ✓ Wouldn't other countries dictate what Russia should do in its seas?
- ✓ What happens if there is no MSP in Russia?
- ✓ Will it turn out that we in the national MSP will disclose information containing commercial or military secrets?
- ✓ What is the threat to Russia of the MSP implementation in neighboring countries?
- ✓ Could it interfere with our interests?
- ✓ Can the Russian Marine Board assume the functions of an authorized MSP authority?

Explanatory note

Authors: Andrei Lappo, Larisa Danilova, Tatiana Eremina, Nikolai Plink

As one of the authors I am happy to express our gratitude to everyone who took part in the preparation and discussion of the Russian MSP Roadmap, as well as to those who contributed to the marine areas sections:

Baltic Sea:	M. Shilin, B. Chubarenko, D. Domnin, M. Vilner
Arctic seas:	E. Khmeleva
Far East:	Y. Blinovskaya
Black Sea:	E. Antonidze

Especially valuable is contribution of A. Anisimovets, who prepared Annex 1 “Pilot MSPs for the Baltic Sea”

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Next steps

- At the middle of November 2021 First Draft of the Proposals for the action plan ("Roadmap") for the promotion of Maritime Spatial Planning in the Russian Federation was submitted to the Expert Council of the Marine Board under the Government of the Russian Federation and sent to the spatial planners, MSP experts, environmentalists, representatives of public organizations who supports MSP for expert consultations and comments.
- After the first round of this discussion, the Draft would be amended and completed, then Russian MSP Roadmap would be translated into English and shared.
- Follow-up (outside the life of the Capacity4MSP project) depends on Maritime Board – do they support MSP or oppose it.
- The discussion is very heated, but it started and it's already a big success.
- The project allowed us to launch the discussion. Science people support MSP in all coastal regions. Regional administrations not ready to make a decision, they hesitate. Some sectors are opposed, for ex. shipping, military people. It is important now to keep the process alive and to continue contacts with the regions and coastal public.
- It is also important to bring together related processes and policies - Blue Growth and Blue economy, UN Ocean Decade, etc.

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THANK YOU FOR YOUR ATTENTION!
KIITOS HUOMIOSTA!
TÄNAN TÄHELEPANU EEST!

Larisa Danilova, Andrei Lappo

ErmakNW

info@ermaknw.ru

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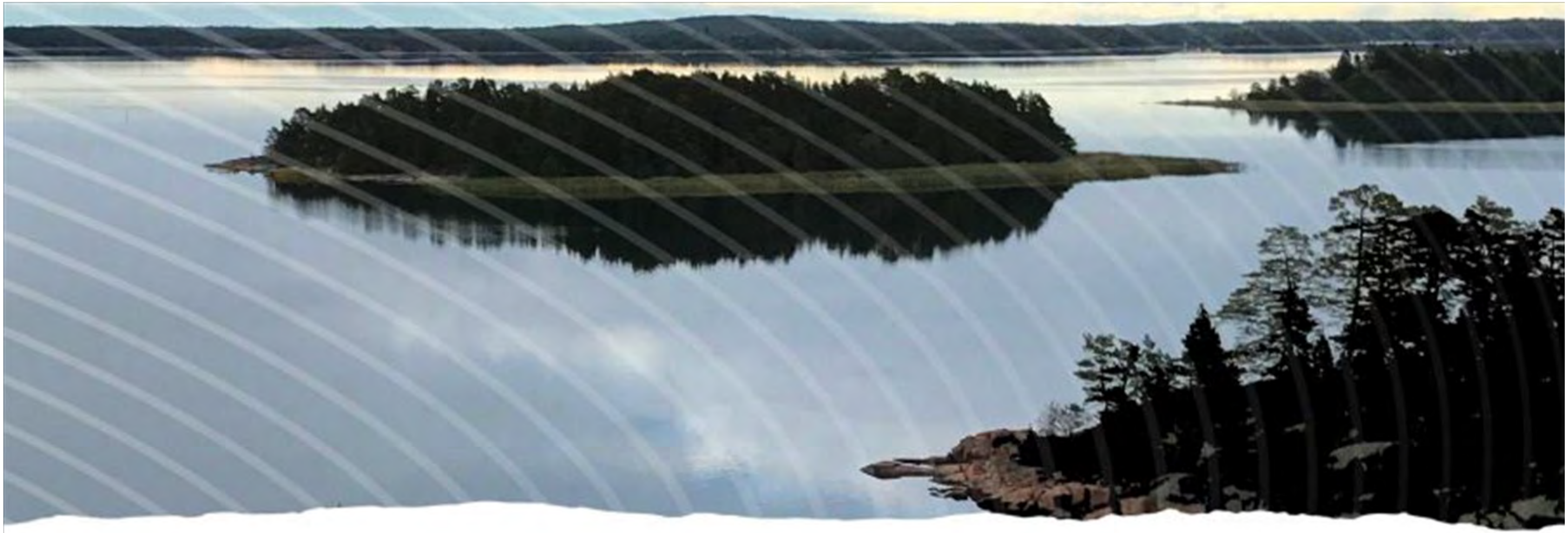


MARITIME SPATIAL PLANNING

Finland’s Maritime Spatial Plan 2030

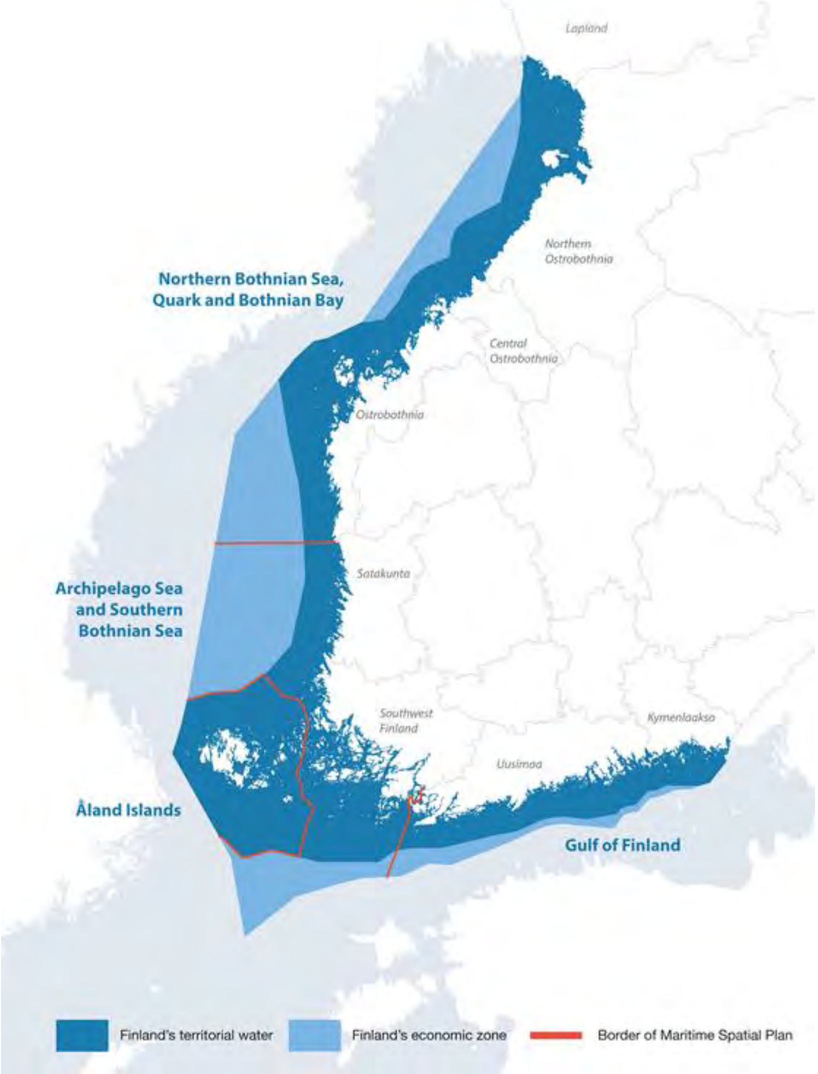
Riku Varjopuro
Finnish Environment Institute

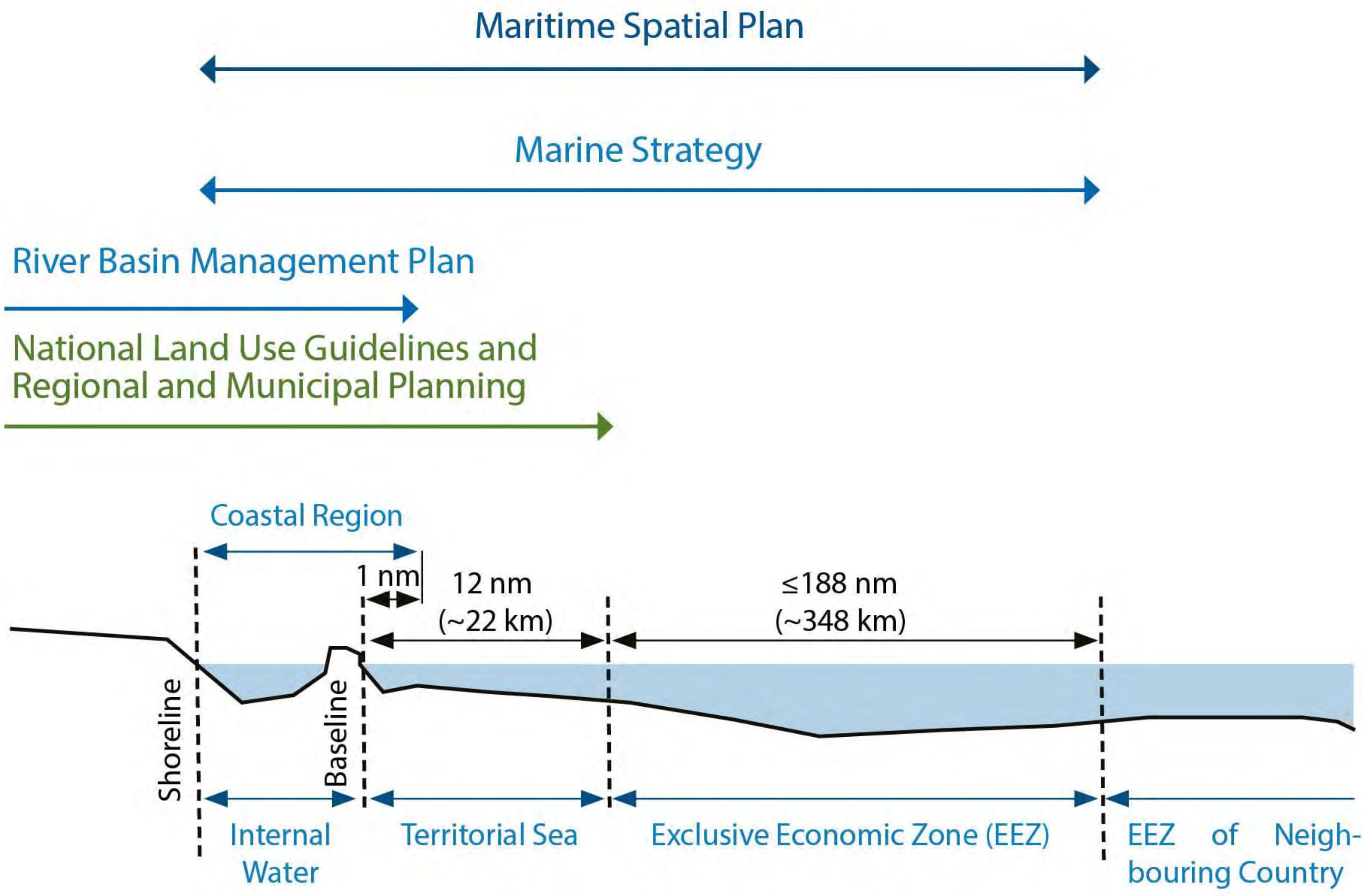
MARITIME SPATIAL PLANNING

(MSP DIRECTIVE 2014/89/EU; LAND USE AND BUILDING ACT 67a)

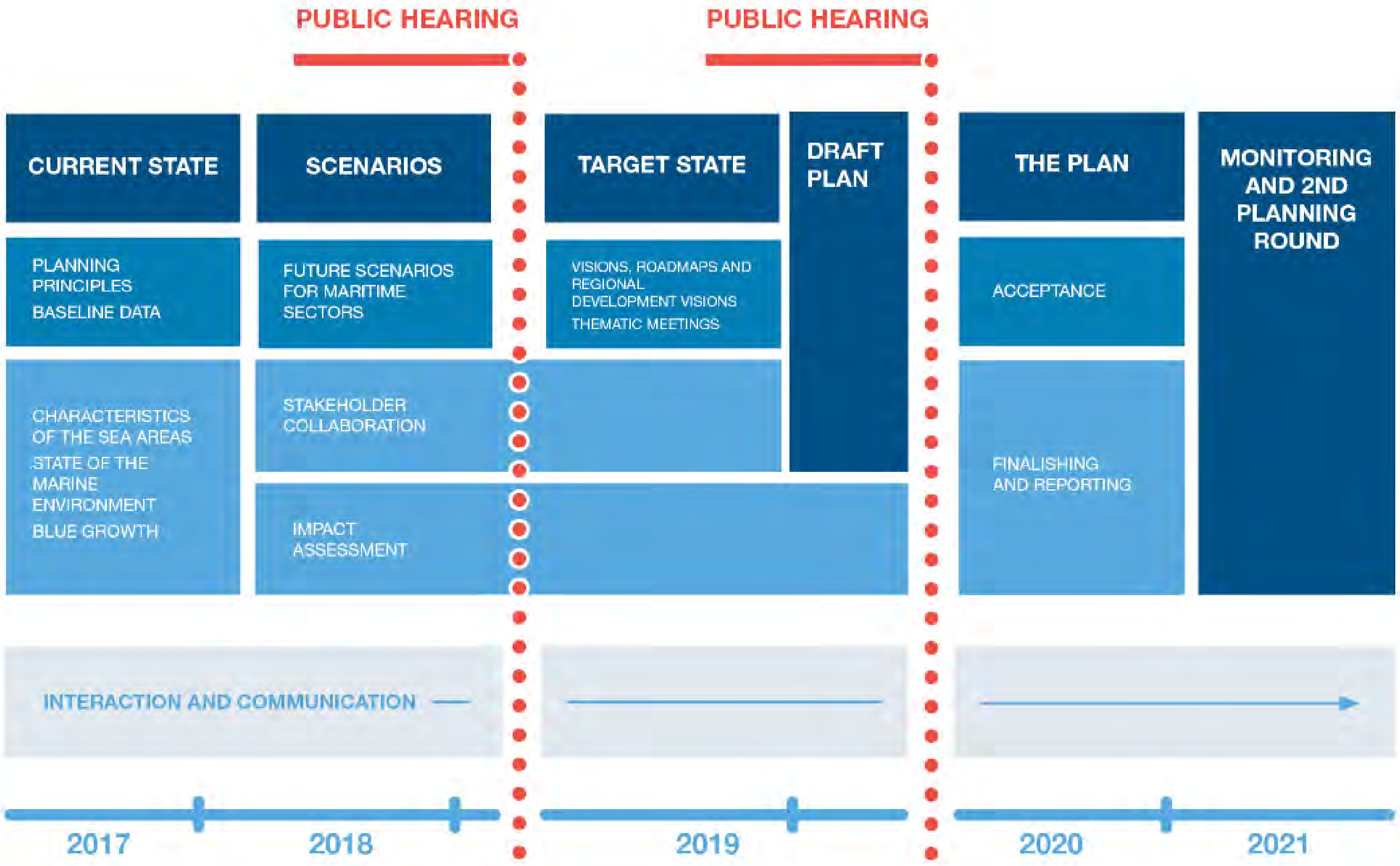
- The purpose of MSP is to promote
  - sustainble blue growth
  - sustainable use of natural resources, and
  - good status of the marine environment.
- The needs of the different maritime sectors are examined in order to coordinate them and find synergies.
  - natural values and cultural heritage
  - energy
  - maritime logistics
  - maritime industry and ports
  - fishing and aquaculture
  - tourism and recreation
  - (exstractive sector and blue biotechnology)
- Attention is paid to national defence needs.
- Ecosystem-Based Approach (EBA), Land-Sea Interactions (LSI), and characteristics of the marine areas are central elements in MSP

www.merialuesuunnittelu.fi/en



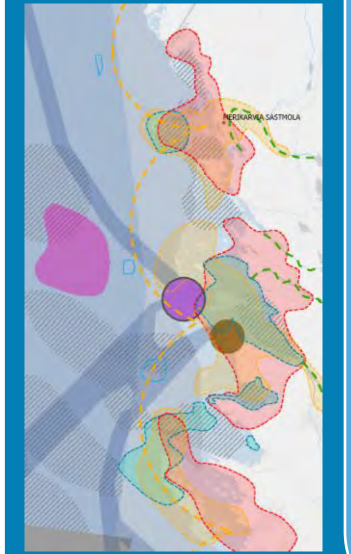

Maritime Spatial Plan
Marine Strategy
River Basin Management Plan
National Land Use Guidelines and Regional and Municipal Planning
Coastal Region
1 nm
12 nm (~22 km)
≤188 nm (~348 km)
Shoreline
Baseline
Internal Water
Territorial Sea
Exclusive Economic Zone (EEZ)
EEZ of Neighbouring Country

PLANNING PROCESS 2017–2021



MARITIME SPATIAL PLAN, territorial waters and EEZ, Responsible authority Regional Councils

Strategic



REGIONAL LAND USE PLAN, covers territorial waters, responsible authority Regional Councils

Legally guiding

LOCAL MASTER PLAN, covers territorial waters, responsible authority Municipalities

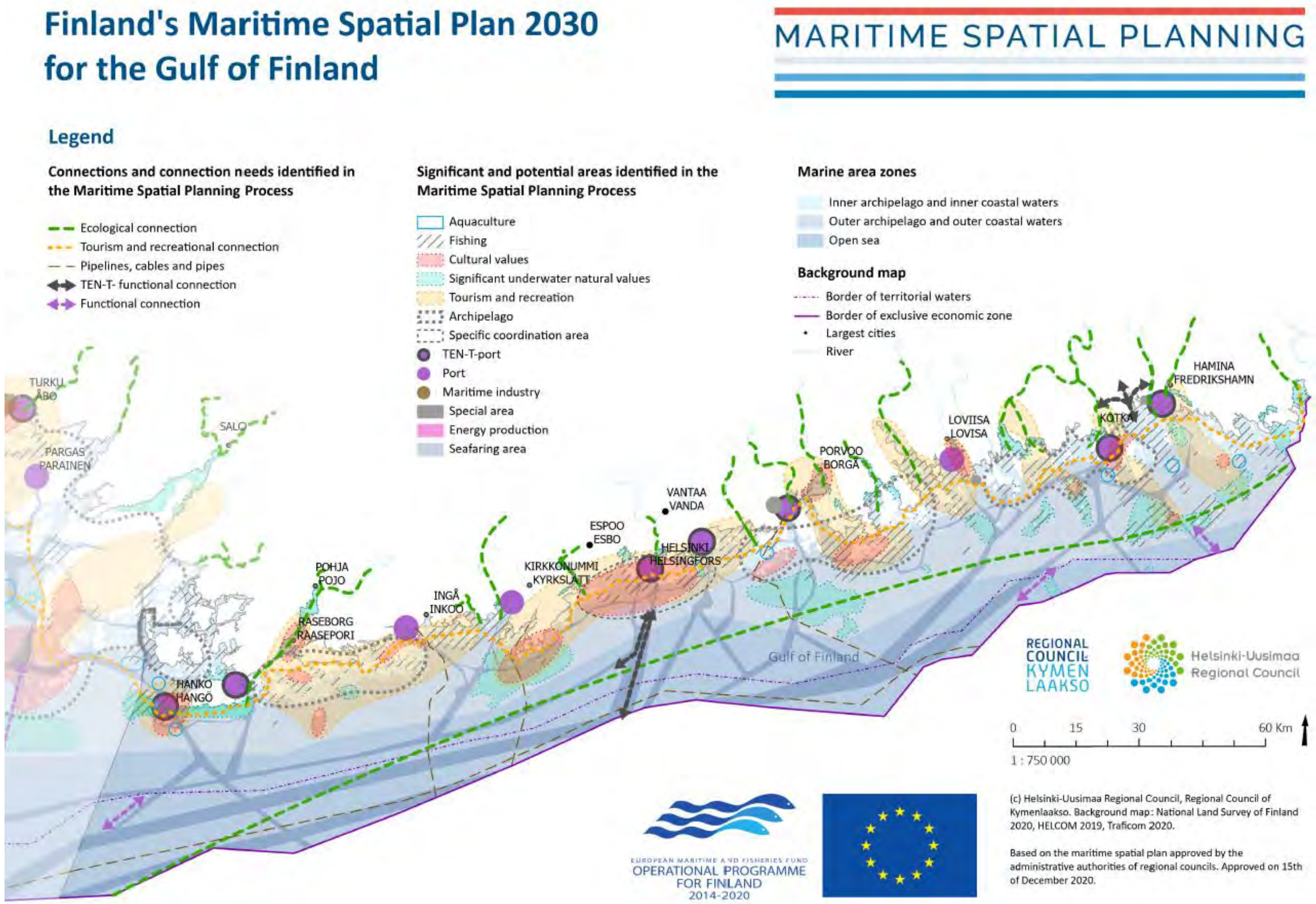
Legally guiding

MARITIME SPATIAL PLAN 2030 FOR FINLAND

The maritime spatial plan identifies the needs of the marine environment and the wellbeing of **maritime actors equally, without placing them in an order of importance**. The sectors examined have different societal and community values, which the plan seeks to foster.

The plan indicates areas and connections of significance and with potential.

The plan identifies the current and future potentials and synergies of maritime industries and the marine environment. **By its nature, the plan opens up opportunities rather than excluding them.**



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FRONT PAGE | MARITIME SPATIAL PLANNING | SCENARIOS | VISIONS | PLAN | IMPACT ASSESSMENT

This is the Maritime Spatial Plan for Finland 2030.
The maritime spatial plan consists of five parts, which you can read by following the links below.

MARITIME SPATIAL PLANNING

Legislative framework, planning principles and process description.

SCENARIOS

Potential and alternative scenarios for the future of marine areas up to 2050

VISIONS

Vision for the sustainable use of marine areas 2050, and sector-specific roadmaps 2030

MARITIME SPATIAL PLANS

Maritime spatial plans for Finland's three planning areas

IMPACT ASSESSMENT

Assessment of the indirect impacts of the maritime spatial plan

Thank you!

Riku.Varjopuro
@syke.fi

RUSSIAN MSP ROADMAP AS AN INSTRUMENT FOR ENHANCING PARTICIPATION OF RUSSIA IN THE PAN-BALTIC MSP PROCESS

First Draft of the Proposals for the action plan ("Roadmap") for the promotion of Maritime Spatial Planning in the Russian Federation

Larisa Danilova, Andrei Lappo
Institute of Maritime Spatial Planning Ermak NorthWest
St. Petersburg, Russia

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CAPACITY4MSP
Interreg Baltic Sea Region
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND
WITH FINANCIAL SUPPORT OF THE RUSSIAN FEDERATION
EU STRATEGY FOR THE BALTIC SEA REGION FLAGSHIP
VASAB Vision & Strategies Around the Baltic Sea
Maritime Institute Gdynia Maritime University
Aalborg University
Swedish Agency for Marine and Water Management
HELCOM
Ministry of Environmental Protection and Regional Development Republic of Latvia
Ермакъ
RSHU
SUBMARINER NETWORK

Baltic sea 2021. Introduction

- New HELCOM Baltic Sea Action Plan 2021-2030 is adopted
- New MSP Roadmap for the Baltic Sea Region 2021-2030
- Capacity4MSP project-platform with the aim to capitalize outcomes and findings of the previous MSP projects
- New VASAB LTE up to 2040 is being developed currently
- Russian MSP Roadmap is under finalization

The purpose of the Roadmap is to develop proposals for the action plan to ensure the MSP improvement and implementation in the Russian Federation. The cooperation of the Baltic Sea countries in the field of MSP, carried out within the framework of a joint horizontal action of the international regional organizations HELCOM and VASAB, has created the conditions for accelerating the process of MSP in the Russian Federation.

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Russian MSP Roadmap

Justification

International framework

- UNESCO guides on MSP
- BSAP
- Baltic Region MSP Roadmap
- Bilateral cooperation programs with Sweden, Finland, Estonia, Norway, etc. to ensure the ecological safety of marine economic activities
- New. Black Sea Strategic Research and Innovation Agenda

National strategies

- Maritime Doctrine of the Russian Federation until 2030
- Decree of the President of the Russian Federation "On the improvement of maritime activities"
- State Program "Environmental Protection 2012-2020"
- National project "Ecology"

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Russian MSP Roadmap

Official support

- Ministry of Natural Resources and Ecology of the Russian Federation – supports the implementation of the ecosystem-based approach to marine and coastal management
- Ministry of Foreign Affairs of the Russian Federation – supports international cooperation in the field of Integrated marine management
- Marine Board under the Government of the Russian Federation – supports the development and Improvement of marine environmental management tools and education

Russia still don't have national authority responsible for MSP

Developers

- Institute of maritime spatial planning Ermak NorthWest (ErmakNW)
- Russian State Hydrometeorological University (RSHU)

Russian supporting platform developed by the Capacity4MSP project:

Leontiev Center (SPb), WWF-Russia (Arctic), Mineral (Baltic Sea), AO IO RAS (Kaliningrad), RTU MIREA (Moscow), FEFU, POI FE RAS (Far East), SSC RAS (Black Sea), IPA IC (Caspian Sea)

Russian MSP Roadmap

How it was done. Parallel activities

1
Stakeholder involvement
- Informing
- Questionnaire
- Round tables, forums, conferences, information seminars

2
Data collection and analysis
- Stakeholder mapping and survey
- More than 10 researches

3
Pilot Mapping and planning
- Natural resource and vulnerability mapping.
- Marine and coastal activities mapping

4
Outcome preparation
- Draft action plan
- Explanatory note
- Methodology of Marine Functional Zoning
- …

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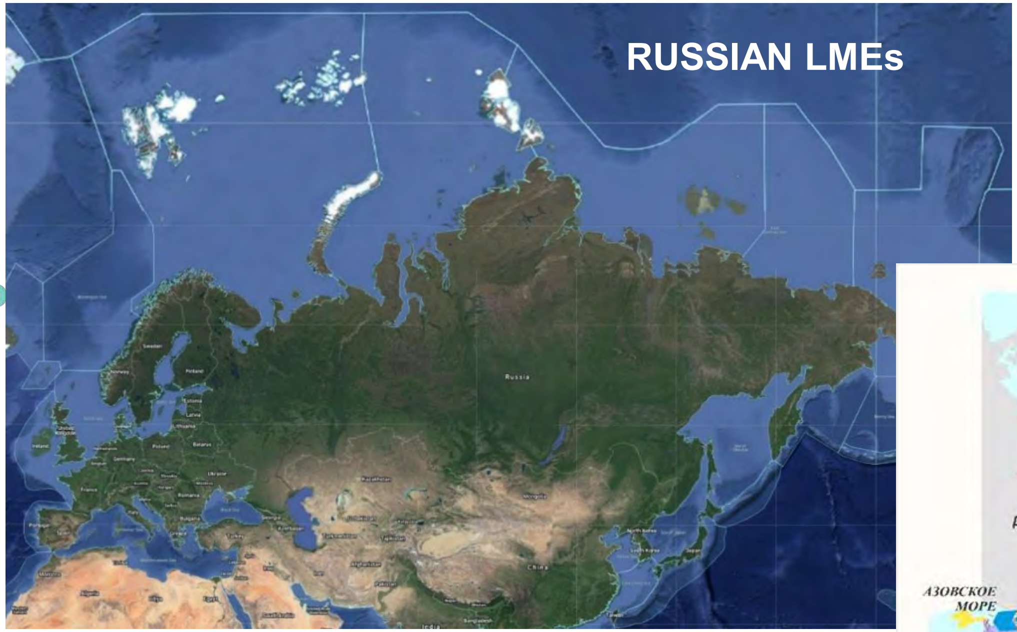
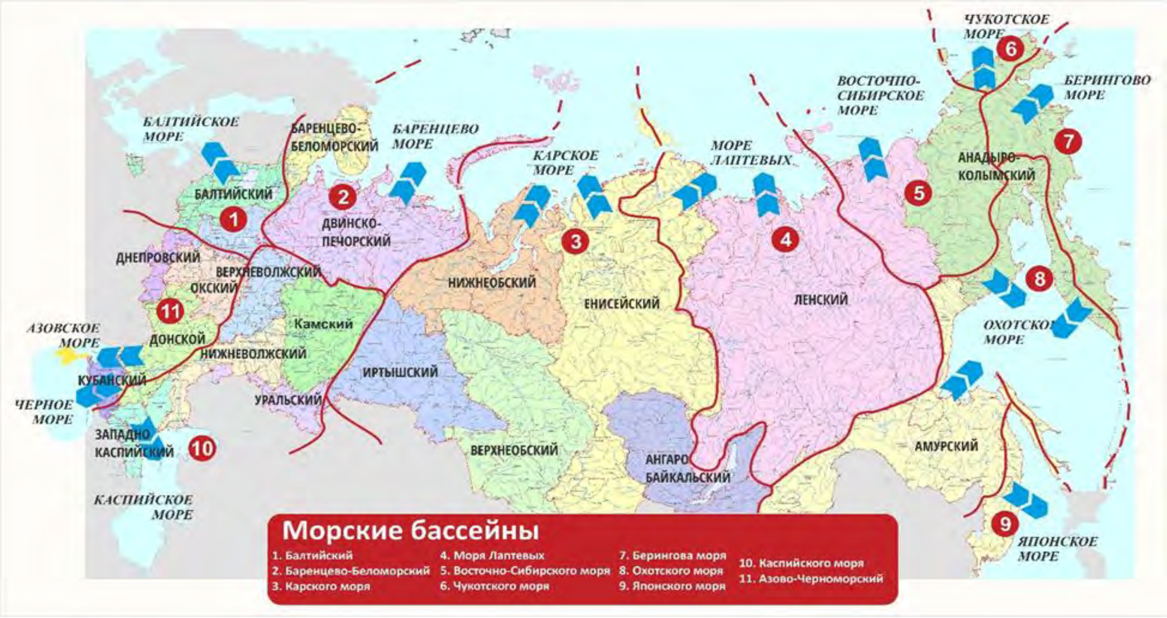
Specificity of the seas of the Russian Federation

- Significant total area of marine areas (more than 8.6 million km2)
- The length of the coastline is 60,985 km
- Significantly different conditions (13 seas, 3 oceans + Caspian Sea)



Challenge: the coastal regions borders don't match catchment areas

SEA BASINS AND CATCHMENT POOLS



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Russian MSP Roadmap

Stakeholder dialog

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Presentations on other events - 10

19-21 января 2021 г., Международная конференция MSP NATURE 2021 «Nature Conservation in Marine Spatial Planning: how to reconcile human activities with ecological functions» (онлайн)
18 мая 2021 г., Санкт-Петербург, Законодательное собрание Санкт-Петербурга;
27 мая 2021 г., Астрахань, Национальная научно-практическая конференция с международным участием «Каспий в цифровую эпоху»;
28 мая 2021 г., Санкт-Петербург, IX Невский международный экологический конгресс «Экология планеты – устойчивое развитие»;
02 июня 2021 г., Рига, Латвия, 4th Baltic MSP Forum;
09 июня 2021 г., Санкт-Петербург, в рамках обучающего тренинга «Управление водными ресурсами урбанизированных территорий» международного проекта «BSR WATER»;
21 августа 2021 г., Санкт-Петербург, Экологическая конференция в рамках XII международного экологического фестиваля искусств КРОНФЕСТ;
21 сентября 2021 г., Севастополь, Всероссийская научная конференция «Моря России: Год науки и технологий в РФ – Десятилетие наук об океане ООН»;
19 ноября 2021 года, Ростов-на-Дону, в рамках Международной конференции ITIBSM-2021 «Innovative Trends in International Business and Sustainable Management».

Conferences, sessions, workshops conducted - 13

Дата, регион	Название мероприятия	Организаторы
Сентябрь 2020 Краснодарский край, поселок Дюрсо (Новороссийск)	Круглый стол «УСТОЙЧИВОЕ РАЗВИТИЕ МОРСКОЙ/СИНЕЙ ЭКОНОМИКИ В АЗОВО-ЧЕРНОМОРСКОМ РЕГИОНЕ, ЗНАЧЕНИЕ МОРСКОГО ПРОСТРАНСТВЕННОГО ПЛАНИРОВАНИЯ - 2020» под эгидой Объединённой конференции «Экология. Экономика. Информатика»	ЮНЦ РАН, ИО им. П.П. Ширшова РАН, НИПИ АТП Ермак Северо-Запад
Сентябрь 2020 Москва	Информационный Семинар «МОРСКОЕ ПРОСТРАНСТВЕННОЕ ПЛАНИРОВАНИЕ В РОССИЙСКОЙ ФЕДЕРАЦИИ. ЗАЧЕМ ОНО НУЖНО РОССИИ?» для представителей федеральных и региональных органов власти	Институт Ермак Северо-Запад, РТУ МИРЭА, Морской университет в Гдыне
Октябрь 2020 Владивосток	Круглый стол «РАЗВИТИЕ СОТРУДНИЧЕСТВА В МОРСКОМ ПРОСТРАНСТВЕННОМ ПЛАНИРОВАНИИ ЧЕРЕЗ ОБЩИЕ ПРОЕКТЫ» в рамках международной научной конференции «FarEastCon»	ДВФУ, Институт Ермак Северо-Запад
Октябрь 2020 Санкт-Петербург	Круглый стол «МОРСКОЕ ПРОСТРАНСТВЕННОЕ ПЛАНИРОВАНИЕ – ДОРОЖНАЯ КАРТА РОССИЙСКОЙ ФЕДЕРАЦИИ» в рамках Международной научно-практической конференции «Современные проблемы гидрометеорологии и мониторинга окружающей среды на пространстве СНГ»	РГГМУ, МПА СНГ
Октябрь 2020 Мурманск	Круглый стол «Морское пространственное планирование как инструмент регулирования ЭКОСИСТЕМНОГО ПРИРОДОПОЛЬЗОВАНИЯ в арктических морях РОССИЙСКОЙ ФЕДЕРАЦИИ»	WWF-Россия, Институт Ермак Северо-Запад
Январь 2021 Калининград	Круглый стол «МОРСКОЕ ПРОСТРАНСТВЕННОЕ ПЛАНИРОВАНИЕ – ВЗГЛЯД ИЗ КАЛИНИНГРАДСКОЙ ОБЛАСТИ»	ГГМУ, АО ИО РАН
Март 2021 Санкт-Петербург	Круглый стол «МОРСКОЕ ПРОСТРАНСТВЕННОЕ ПЛАНИРОВАНИЕ» в рамках Международного форума День Балтийского Моря	Институт Ермак Северо-Запад, ГГУП СФ Минерал
Август 2021 Санкт-Петербург	Межрегиональный Круглый Стол Ленинградской Области И Санкт-Петербурга «КОМПЛЕКСНОЕ УПРАВЛЕНИЕ ПРИБРЕЖНЫМИ ТЕРРИТОРИЯМИ ФИНСКОГО ЗАЛИВА. СОВРЕМЕННЫЕ ВЫЗОВЫ И ВОЗМОЖНЫЕ РЕШЕНИЯ» в рамках XII международного экологического фестиваля искусств КРОНФЕСТ	Институт Ермак Северо-Запад, Общественный совет южного берега Финского залива
Октябрь 2021 Санкт-Петербург	Круглый стол «СИСТЕМА СТРАТЕГИЧЕСКОГО ПЛАНИРОВАНИЯ РАЗВИТИЯ МОРСКОЙ ДЕЯТЕЛЬНОСТИ РОССИЙСКОЙ ФЕДЕРАЦИИ И МОРСКОЕ ПРОСТРАНСТВЕННОЕ ПЛАНИРОВАНИЕ» в рамках XIX Общероссийского Форума «Стратегическое Планирование В Регионах И Городах России 2020-2021»	Институт Ермак Северо-Запад, МИД РФ, Леонтьевский центр, РТУ МИРЭА
Ноябрь 2021 Ростов-на-Дону	Круглый стол «ЧЕРНОЕ МОРЕ И СИНЯЯ ЭКОНОМИКА: ЭКОСИСТЕМНОЕ УПРАВЛЕНИЕ И МОРСКОЕ ПРОСТРАНСТВЕННОЕ ПЛАНИРОВАНИЕ» в рамках Международной конференции ITIBSM-2021 «Innovative Trends in International Business and Sustainable Management»	ЮФУ, РТУ МИРЭА, Институт Ермак Северо-Запад
Ноябрь 2021 Балтийское море	Балтийский Форум Планировщиков (онлайн), презентация предложений в ДК МПП и особенностей экосистемного подхода к планированию	Институт Ермак Северо-Запад, РГГМУ
Ноябрь 2021 Таллин	Сессия по предложениям в Российскую Дорожную карту МПП в рамках конференции «The Gulf of Finland Science Days 2021 "New start for the Gulf of Finland co-operation»	Институт ЕРМАК СЕВЕРО-ЗАПАД, SYKE, Финляндия, Академия наук Эстонии
Декабрь 2021 Санкт-Петербург	Международная научно-практическая конференция «ЭКОЛОГИЧЕСКИ-ДРУЖЕСТВЕННОЕ РАЗВИТИЕ ПРИБРЕЖНЫХ ЗОН И МОРСКИХ АКВАТОРИЙ»	РГГМУ, МПА СНГ

Russian MSP Roadmap

SURVEY FOR STAKEHOLDERS OF THE RUSSIAN COASTAL REGIONS

JULY-AUGUST 2020

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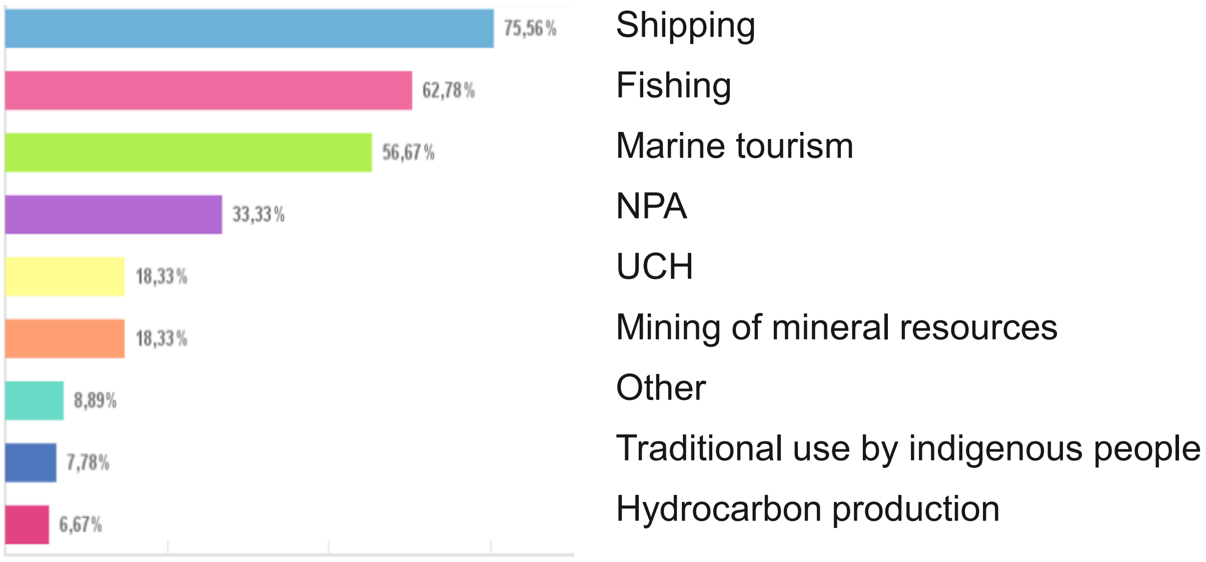
MAIN KINDS OF MARITIME ACTIVITIES IN RUSSIA



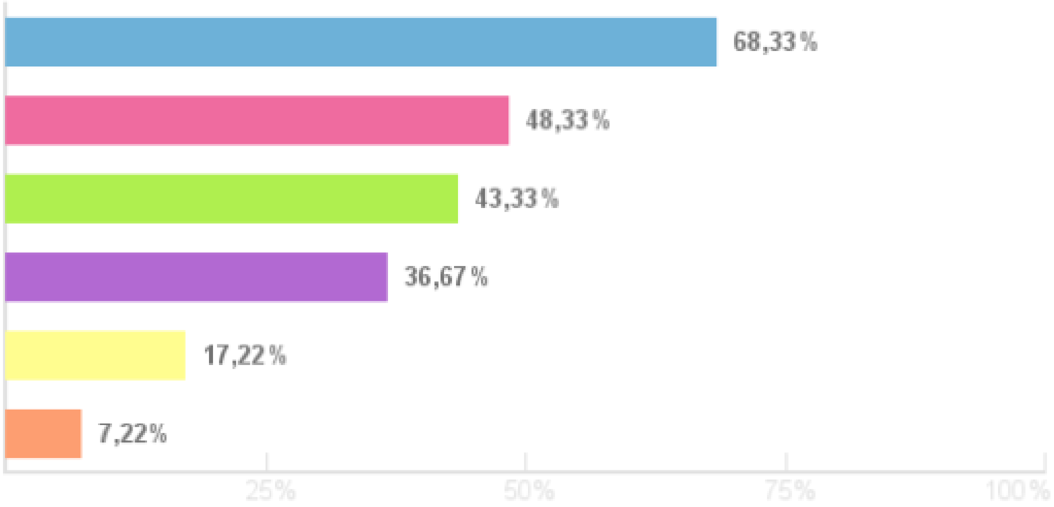
	TOTAL	BALTIC SEA	OTHER SEAS
INQUIRIES	450	210	230
ANSWERS RECEIVED	219	155	64
SUPPORTED MSP PROMOTION	149 (68%)	93 (60%)	56 (88%)
SUPPORTED THE DEVELOPMENT OF A PILOT MSP IN THEIR REGION	137 (63%)	116 (75%)	21 (33%)

Russian MSP Roadmap

SURVEY FOR STAKEHOLDERS OF THE RUSSIAN COASTAL REGIONS.

JULY-AUGUST 2020

MARITIME ACTIVITIES THAT CAUSED PUBLIC CONCERNS



Nature Protection and environment

Industrial use

Recreation and tourism on the shore

Marine tourism

Traditional use by local people

Other

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Russian MSP Roadmap

RUSSIAN MSP ROADMAP PILLARS

1

Pillar 1
institutional arrangements

aimed at forming the institutional foundations of marine spatial planning in the Russian Federation

2

Pillar 2
Legislation arrangements

Inclusion of MSP in the system of strategic and territorial planning documents of the Russian Federation

3

Pillar 3
Scientific research

Creation of regulatory and legal methodological, organizational, administrative framework

4

Pillar 3
Education, skills and capacity building

Building human resources for the implementation of MSP in the practice of marine environmental management

5

Pillar 5
Maritime spatial plans development

Development of MSPs will expand spatial planning to the marine area of Russia

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Russian MSP Roadmap

PILLAR 1. INSTITUTIONAL ARRANGEMENTS

Aimed at forming the institutional foundations of MSP in the Russian Federation.
They provide for the main actions that allow to form the structure of management bodies and launch the official process of introducing MSP into the regulatory framework of the Russian Federation and marine environmental management practical activities

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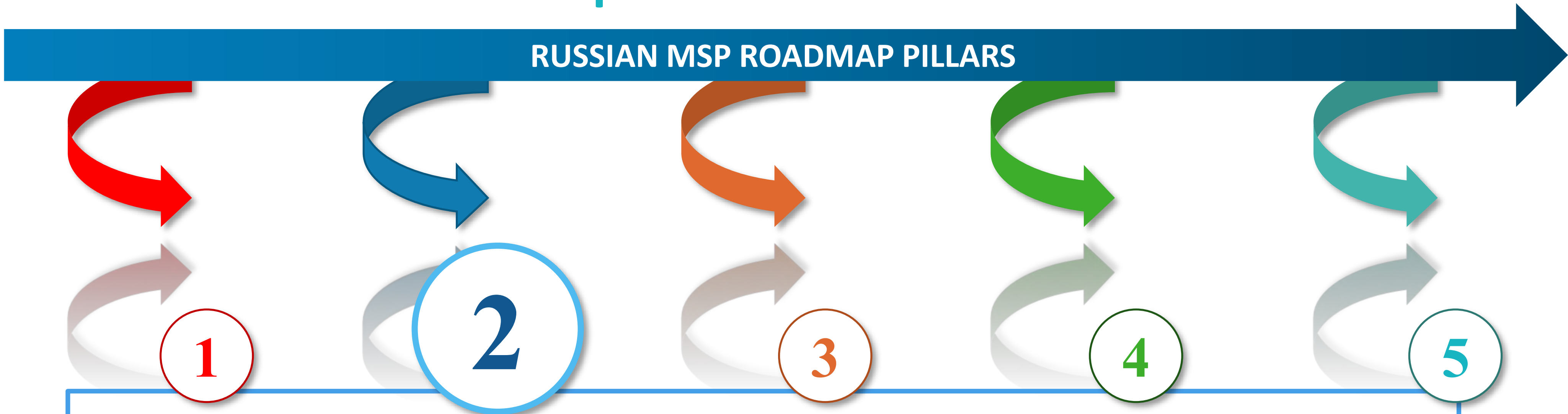
Russian MSP Roadmap



PILLAR 1. LEGISLATION ARRANGEMENTS

MSP is inextricably linked with the management of marine activities, state and regional legislation on the use of marine resources and nature conservation. The inclusion of MSP in the system of strategic and territorial planning documents of the Russian Federation is possible only if appropriate amendments are made to the legislative acts of the Russian Federation and the constituent entities of the Russian Federation. These changes should concern not only the MSP, but also related acts.

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PILLAR 3. SCIENTIFIC AND TECHNICAL MEASURES

The legal MSP framework planning should be supported by regulatory and legal documents of a methodological, organizational and administrative nature. Some of them can be developed only at the national level, others are of regional nature and should relate to the level of the coastal subject of the Russian Federation.

Of particular importance is analysis of the impact of external influences on marine ecosystems, the sensitivity of ecosystems to anthropogenic loads and the ability to restore them, interaction with neighboring countries on transnational issues.

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Russian MSP Roadmap

PILLAR 4. EDUCATION AND TRAINING

Education creates human resources and provides methodological support for the implementation of MSP tools in the practice of IMM. Staff training is carried out through academic training (master's level) and the additional education programs. Vocational educational programs for a master's degree can be carried out on the basis of existing enlarged groups of specialties and areas of training.

Roadmap propose to create three educational and research centers, in accordance with the three directions of the national maritime policy (Atlantic, Pacific and Arctic) on the basis of the regional Universities.

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Russian MSP Roadmap

PILLAR 5. MARINE SPATIAL PLANS

Development of plans for the sea areas of the Russian Federation will expand spatial planning to the entire territory and marine area of Russia, including EEZ and the continental shelf under Russia's jurisdiction, and create conditions for sustainable Blue economy, for increasing the welfare of coastal regions while maintaining the health of the ocean ecosystem.

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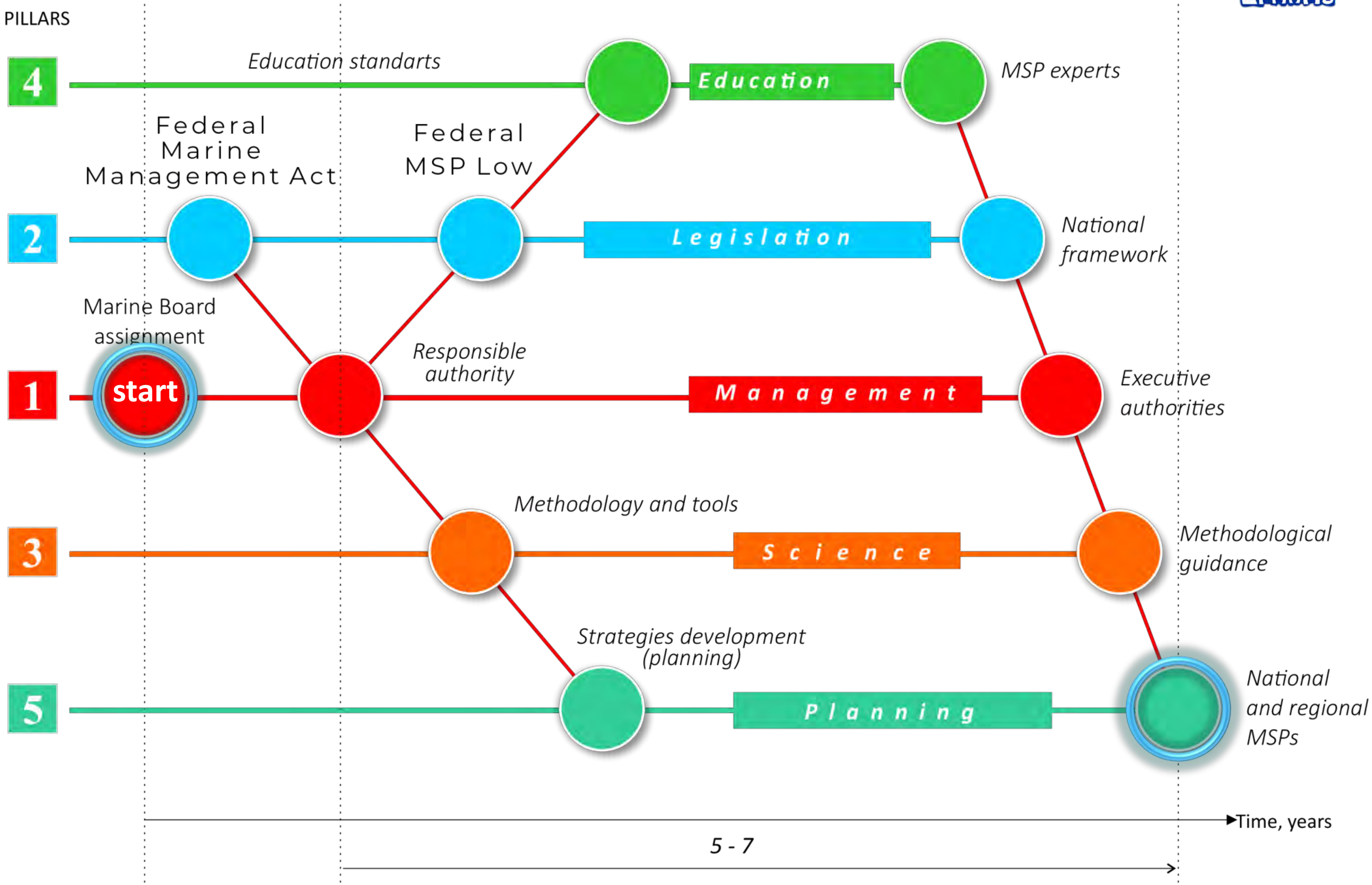
Russian MSP Roadmap Flowchart



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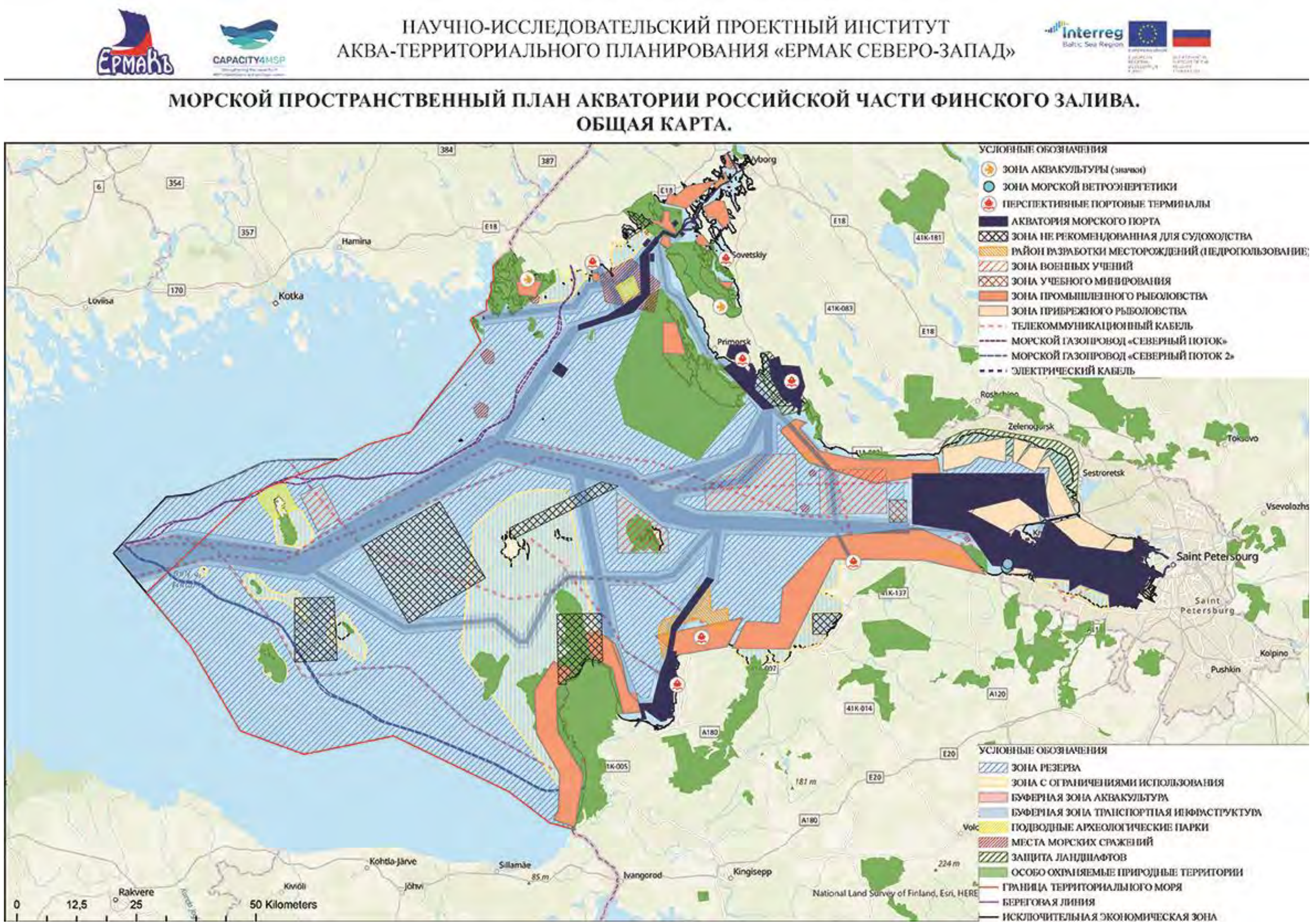
Pilot MSP of the Eastern part of the Gulf of Finland



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Science Days 2021
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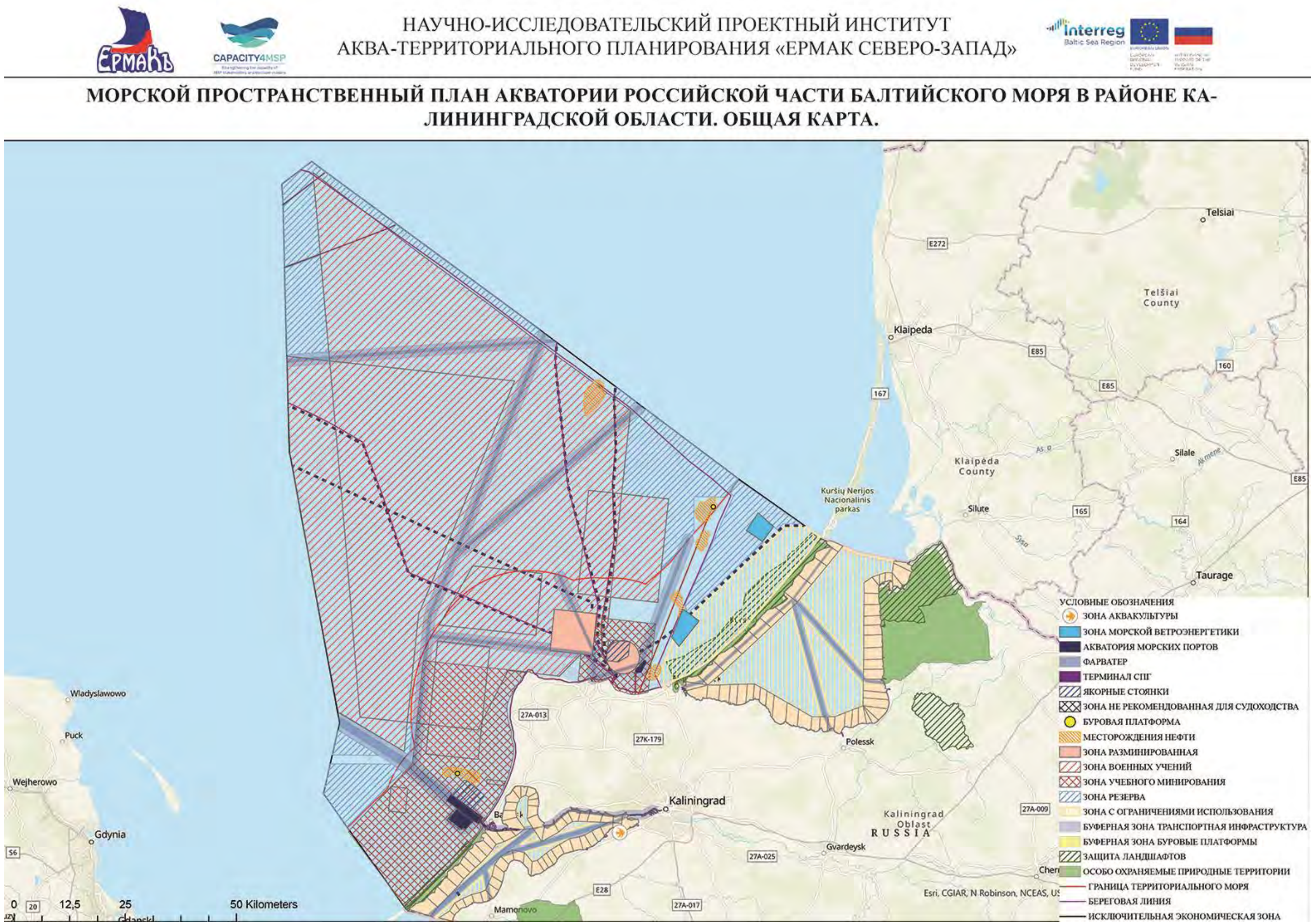
Pilot MSP of the South-East Baltic



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Explanatory note

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The Gulf of Finland
Science Days 2021
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Tallinn
29-30 November 2021

Content

MSP FAQ

- ✓ Why does Russia need MSP?
- ✓ Is MSP a self-sufficient tool?
- ✓ How are MSP and landscape planning related?
- ✓ What does the ecosystem approach to MSP mean?
- ✓ How MSP different from ICM and IMM?
- ✓ What are the benefits of MSP?
- ✓ Why do other countries have MSP, but Russia still does not have it?
- ✓ Wouldn't other countries dictate what Russia should do in its seas?
- ✓ What happens if there is no MSP in Russia?
- ✓ Will it turn out that we in the national MSP will disclose information containing commercial or military secrets?
- ✓ What is the threat to Russia of the MSP implementation in neighboring countries?
- ✓ Could it interfere with our interests?
- ✓ Can the Russian Marine Board assume the functions of an authorized MSP authority?

Explanatory note

Authors: Andrei Lappo, Larisa Danilova, Tatiana Eremina, Nikolai Plink

As one of the authors I am happy to express our gratitude to everyone who took part in the preparation and discussion of the Russian MSP Roadmap, as well as to those who contributed to the marine areas sections:

Baltic Sea: M. Shilin, B. Chubarenko, D. Domnin, M. Vilner
Arctic seas: E. Khmeleva
Far East: Y. Blinovskaya
Black Sea: E. Antonidze

Especially valuable is contribution of A. Anisimovets, who prepared Annex 1 “Pilot MSPs for the Baltic Sea”

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Tallinn
29-30 November 2021

Next steps

- At the middle of November 2021 First Draft of the Proposals for the action plan (“Roadmap”) for the promotion of Maritime Spatial Planning in the Russian Federation was submitted to the Expert Council of the Marine Board under the Government of the Russian Federation and sent to the spatial planners, MSP experts, environmentalists, representatives of public organizations who supports MSP for expert consultations and comments.
- After the first round of this discussion, the Draft would be amended and completed, then Russian MSP Roadmap would be translated into English and shared.
- Follow-up (outside the life of the Capacity4MSP project) depends on Maritime Board – do they support MSP or oppose it.
- The discussion is very heated, but it started and it’s already a big success.
- The project allowed us to launch the discussion. Science people support MSP in all coastal regions. Regional administrations not ready to make a decision, they hesitate. Some sectors are opposed, for ex. shipping, military people. It is important now to keep the process alive and to continue contacts with the regions and coastal public.
- It is also important to bring together related processes and policies - Blue Growth and Blue economy, UN Ocean Decade, etc.

CAPACITY4MSP

THANK YOU FOR YOUR ATTENTION!
KIITOS HUOMIOSTA!
TÄNAN TÄHELEPANU EEST!

Larisa Danilova, Andrei Lappo

ErmakNW

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Interreg Baltic Sea Region

EUROPEAN UNION

EUROPEAN REGIONAL DEVELOPMENT FUND

WITH FINANCIAL SUPPORT OF THE RUSSIAN FEDERATION

REPUBLIC OF ESTONIA
MINISTRY OF FINANCE

MSP in Estonia

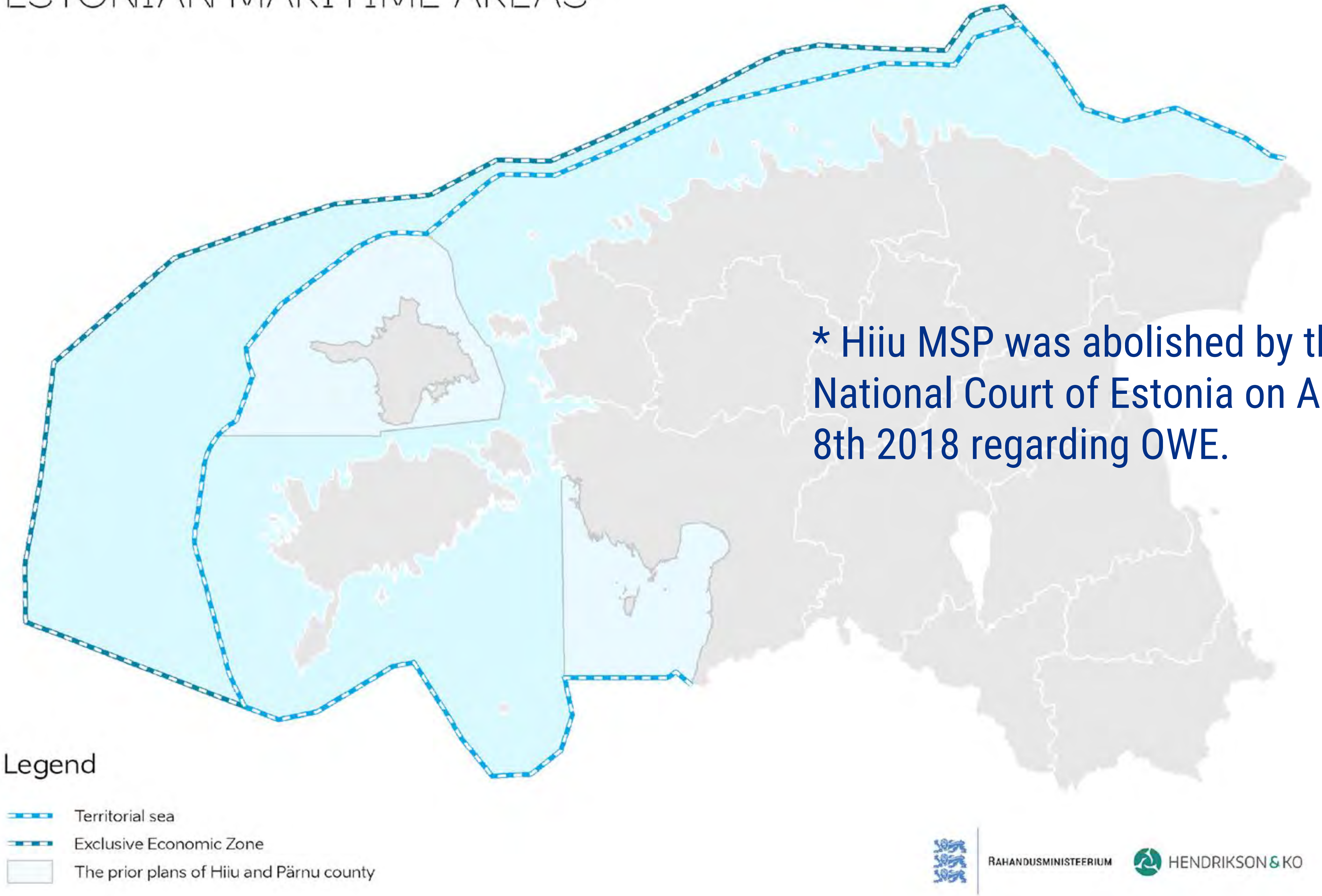
Practical experiences from the process

Eleri Kautlenbach

Adviser of Spatial Planning Department

29.11.2021

ESTONIAN MARITIME AREAS



* Hiiu MSP was abolished by the National Court of Estonia on August 8th 2018 regarding OWE.

RAHANDUSMINISTEERIUM HENDRIKSON&KO

Not Secure | mereala.hendrikson.ee/kaardirakendus-en.html

Legend | Layers

ESTONIAN MARITIME SPATIAL PLAN

Home Webmap

MSP OUTPUT DATA

- Preservation areas for archaeological finds
- Wind energy innovation area
- Wind energy development areas
- International water traffic area
- Safety margin
- Water traffic area
- Ship-to-ship areas
- Conceptual locations of cable corridors in MSP area

Natural growth potential of seashell

High : 100

Low : 0

Natural growth potential of algae

High : 100

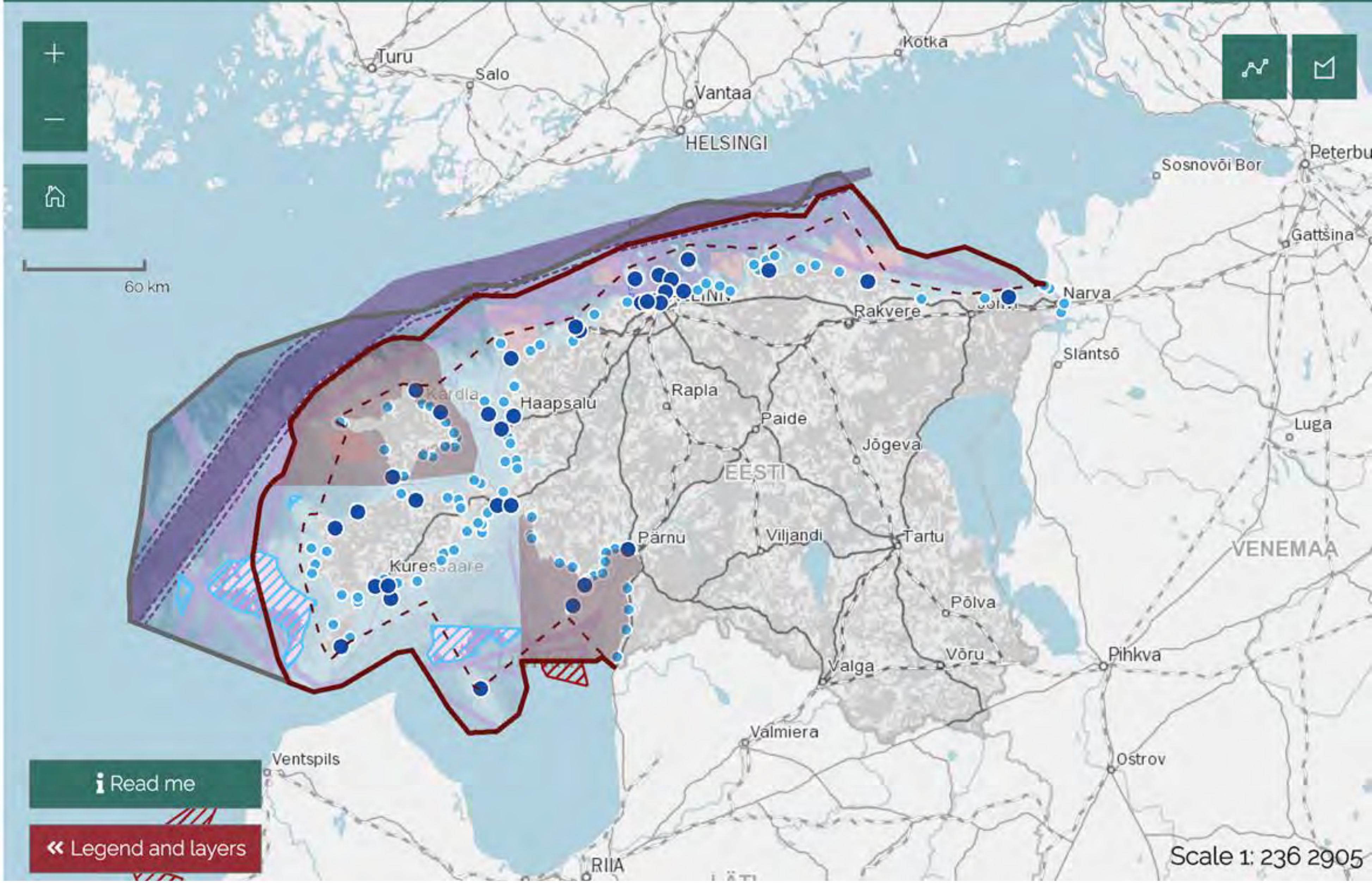
Low: 0

- Restricted areas for seashell and algae farming (02.2020)
- Restricted areas for fish farming (02.2020)

Spawning grounds

- Potential spawning grounds of freshwater and migratory species (depth < 5m)
- Potential spawning grounds of industrially important species (depth < 15m)
- Conceptual location of cable corridors outside MSP area
- Basic air traffic corridor
- Basic passage corridor for shipping

MSP INPUT DATA



Focus of the MSP

- Strategical spatial development document at the state level
- The primary focus - combined use and new uses
- Based of environmental considerations and the best available knowledge. Additional analyses:
  - Seals
  - Bird stopover locations
  - Economic model (added ecosystem service map layers) + cumulative impact model – PlanWise4Blue
  - Analysis of the visual impacts of wind farms
- Gives guidelines and conditions to next phases

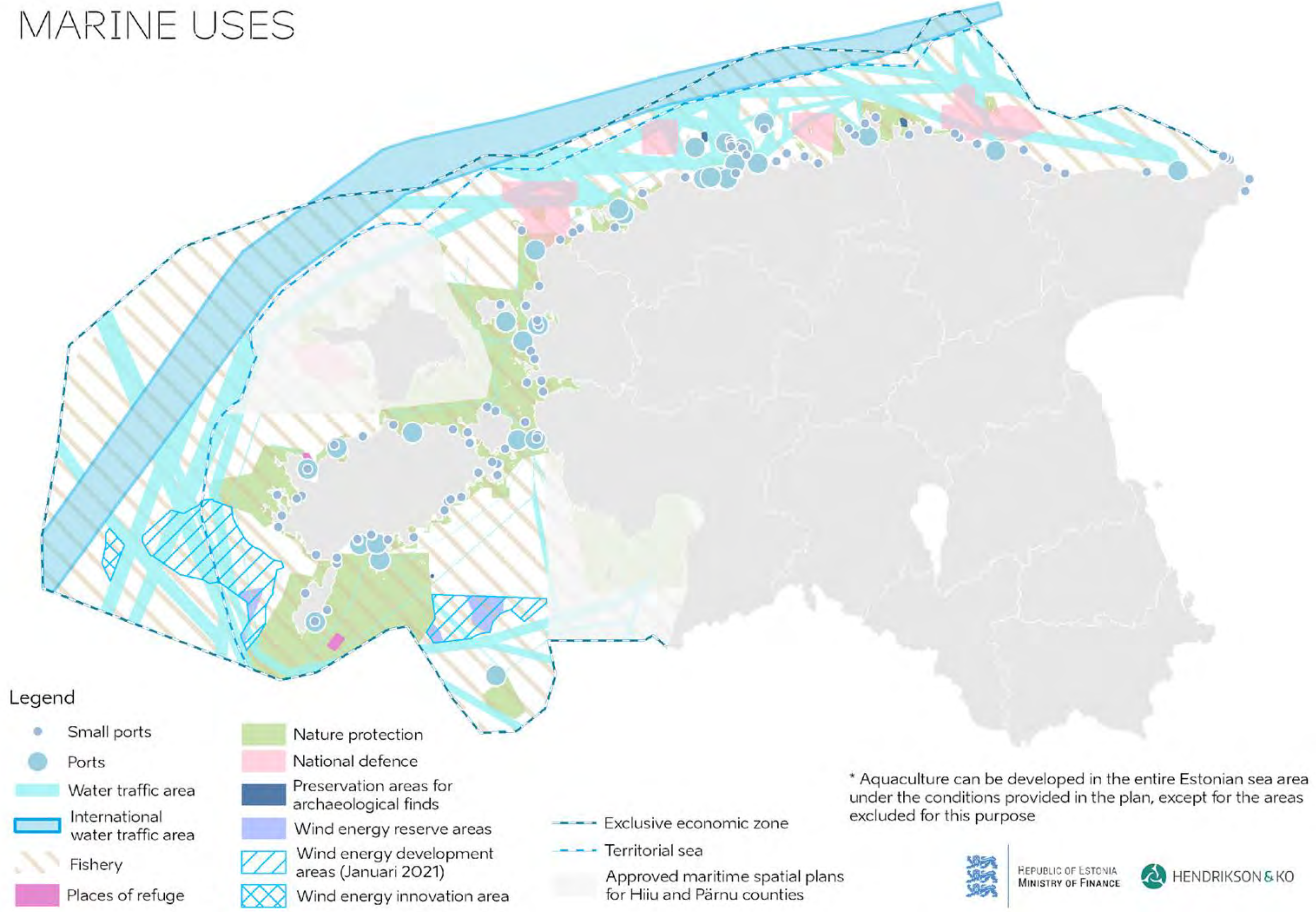
Eesti Vabariik

Marine uses in MSP

- Fishing
- Aquaculture (Fish farming, shellfish- and algae farming)
- Marine transport
- Maritime rescue, pollution response and guarding the state border
- Renewable energy
- Seabed infrastructure
- Marine tourism and recreation
- Protected natural objects
- Marine culture
- Cultural monuments
- National defence
- Mineral resources
- Dumping
- Permanent connections (Tallinn-Helsinki; Saaremaa)
- Land-sea interactions

Eesti Vabariik

MARINE USES



Legend
Small ports
Ports
Water traffic area
International water traffic area
Fishery
Places of refuge
Nature protection
National defence
Preservation areas for archaeological finds
Wind energy reserve areas
Wind energy development areas (Januari 2021)
Wind energy innovation area
Exclusive economic zone
Territorial sea
Approved maritime spatial plans for Hiiu and Pärnu counties
* Aquaculture can be developed in the entire Estonian sea area under the conditions provided in the plan, except for the areas excluded for this purpose
Republic of Estonia
Ministry of Finance
HENDRIKSON & KO

Impact assessment

Extended Impact Assessment - not a traditional, only natural environment-centered approach. MSP impact assessment process integrates the SEA with the assessment of the social (including health), cultural, and economic impacts.

Broad-based expertise - the IA is compiled by OÜ Hendrikson & Ko in cooperation with experts from the University of Tartu, the Estonian Marine Institute of the University of Tartu, the Center for Applied Research in Social Sciences, the University of Tallinn and OÜ Roheline Rada.

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In national process next steps:

- Adjusting the documents – march april 2021
- Coordination and public consultation period – may-june 2021
- Amendments – july-september 2021
- Coordination – october 2021
- Public display of the final solution – november 2021
- Distributing the plan to The Govenment for adoption

Adoption in January 2022

Eesti Vabariik

What to learn?

- Talk with people and give them opportunity to ask directly from you
- Covered topics usually needs clarifications
- Translations are necessary, summaries are not enough
- If you have a problem, ask your neighbours
- Extended Impact Assessment has helped to justify the solutions

Republic of Estonia
Ministry of Finance

Questions?

Eleri Kautlenbach

Adviser of Spatial Planning Department

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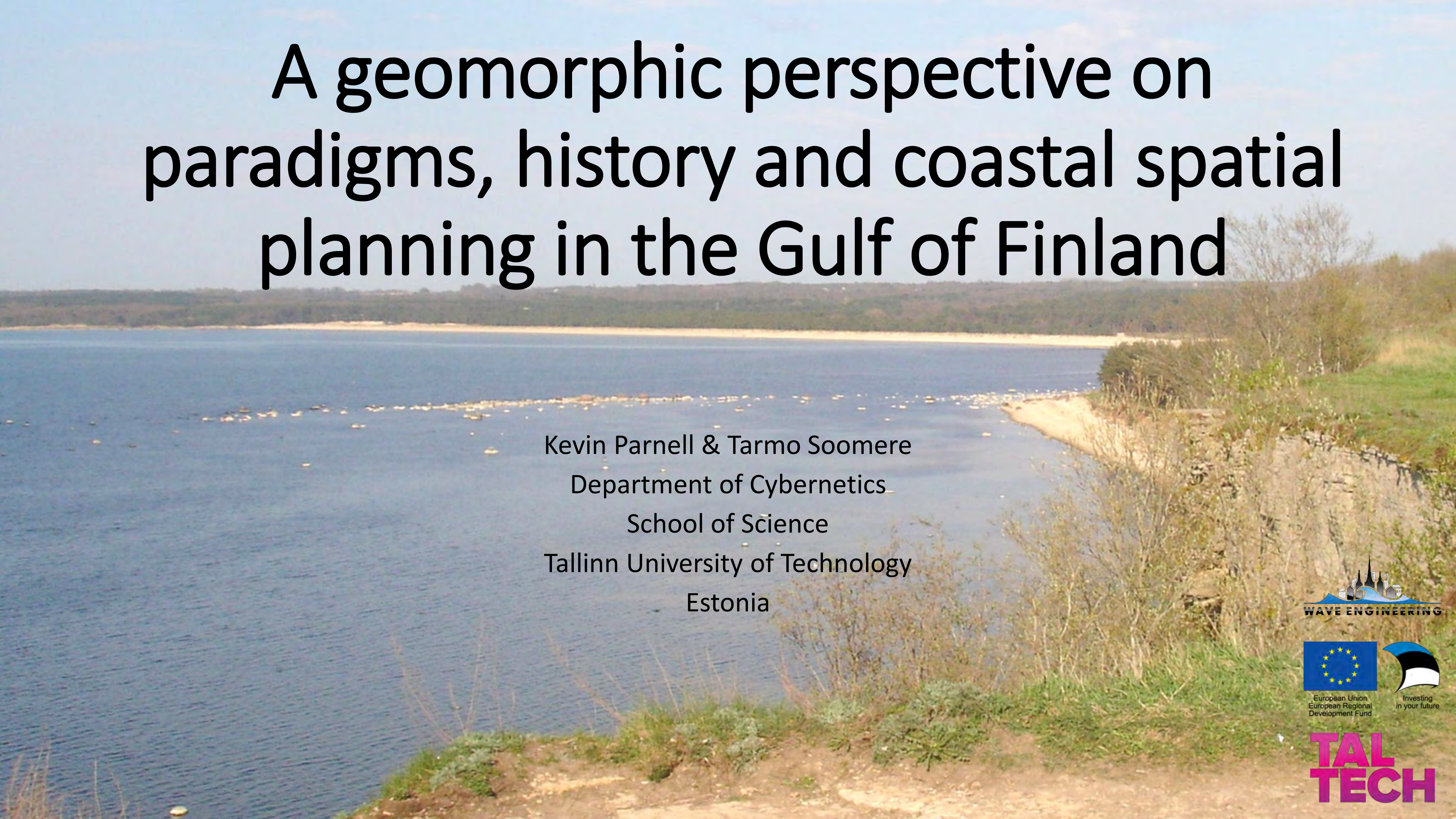
A geomorphic perspective on paradigms, history and coastal spatial planning in the Gulf of Finland



Kevin Parnell & Tarmo Soomere
Department of Cybernetics
School of Science
Tallinn University of Technology
Estonia

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Paradigm

- “A set of ideas that are used for understanding or explaining something, especially in a particular subject.”
- Paradigm shifts
- The prevailing paradigm can and does significantly influence environmental management practices.

Coastal management paradigms

- 1980s – 1990s Coastal Hazards

  - $CHZ = [(N x R) + C + S] x (1 + F)$

    CHZ = erosion prone area width (metres)
    N = planning period (years)
    R = rate of long-term erosion (metres per year)
    C = short-term erosion from the design storm or cyclone (metres)
    S = erosion due to sea level rise (metres)
    F = safety (or uncertainty) factor (typical range 0 – 1)

  - This approach has been used in many places.

Coastal management paradigms

- 1990s – 2010s Integrated Coastal Zone Management (ICZM)
  - An outcome of the 1992 Earth Summit of Rio de Janeiro, Agenda 21.
  - A resource management system following an integrative, holistic approach and an interactive planning process in addressing the complex management issues in the coastal area (Thia-Eng, 1993).
  - EU definition [COM(2000) 547 final]

    "A dynamic, multidisciplinary and iterative process to promote sustainable management of coastal zones. . . uses the informed participation and cooperation of all stakeholders . . . to take actions towards meeting objectives. . . . to balance environmental, economic, social, cultural and recreational objectives, within the limits set by natural dynamics. . . ."
  - A good idea but there are few examples of successful, long-term implementation (examples: Shipman B & Stojanovic T (2007) Facts, Fictions, and Failures of Integrated Coastal Zone Management in Europe, *Coastal Management*, 35:2-3, 375-398).
  - "The participative 'bottom-up' approaches of contemporary European ICZM are ineffectual and unsustainable" (McKenna and Cooper, 2006, *Area*, 28.4, 421-431).

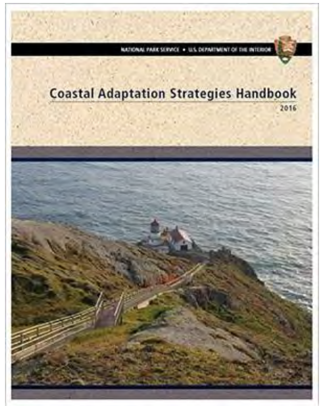
NCCARF_logo_rgb-320-1.webp

Coastal management paradigms

- 2000s – 2020s Adaptation
  - Increasing concern about the implications of climate change, particularly sea-level rise.
  - Acceptance that the impacts will be substantial for most coastal environments and communities.
  - e.g. National Climate Change Adaptation Facility (Australia)
  - Wide range of responses: hard and soft engineering, spatial planning, managed retreat etc.

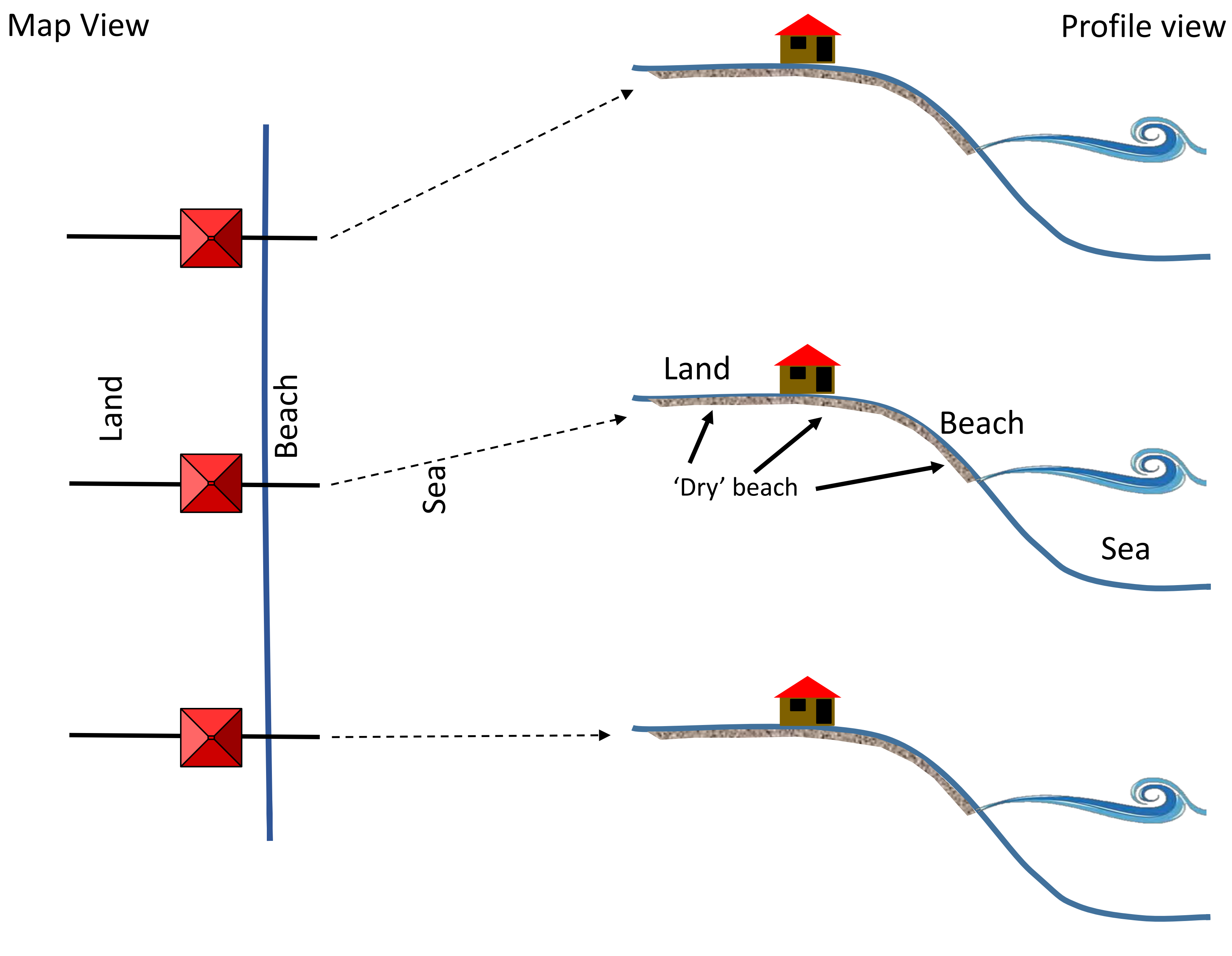
EPA United States Environmental Protection Agency

Coastal Adaptation Toolkit

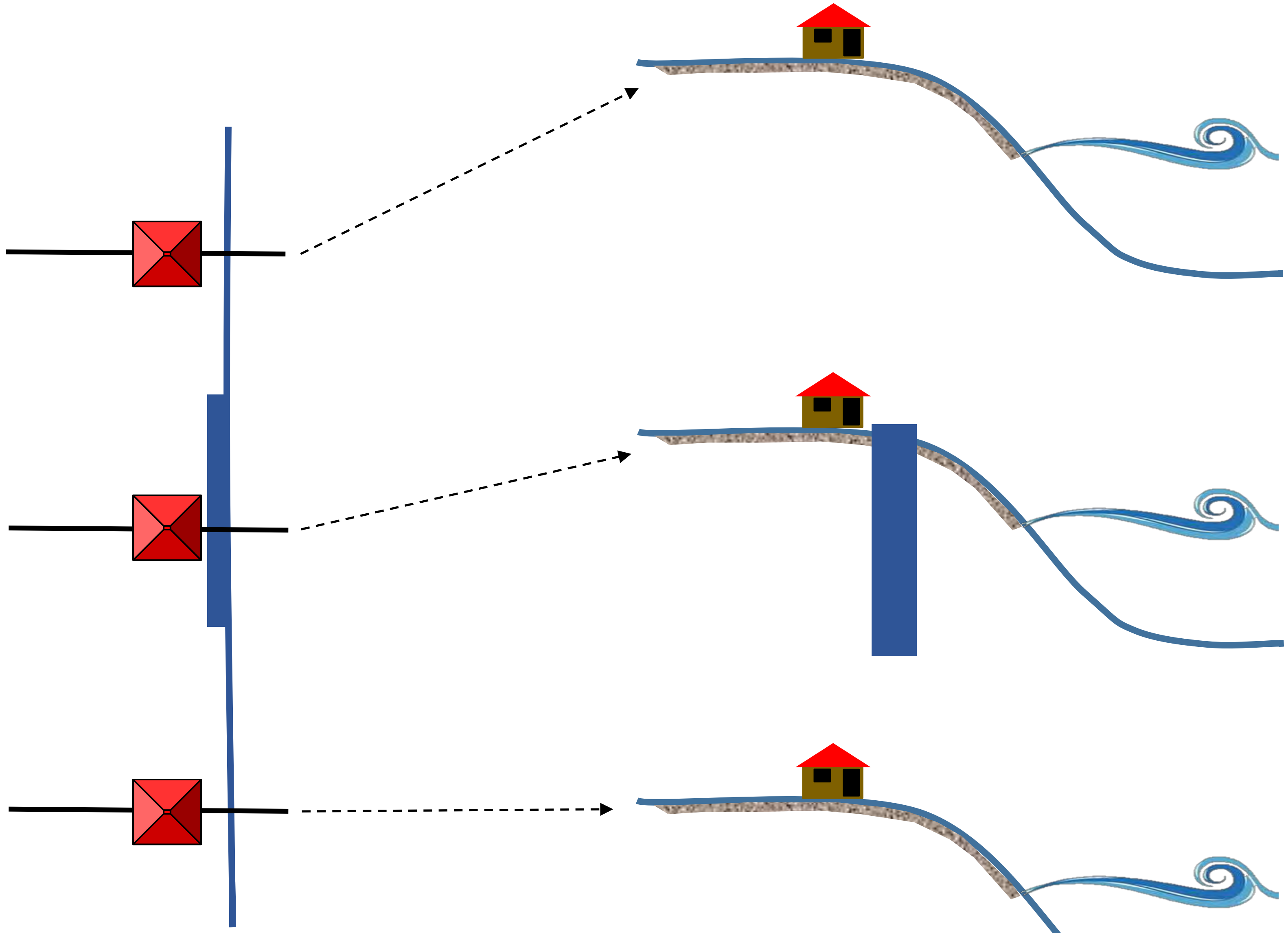


Property rights

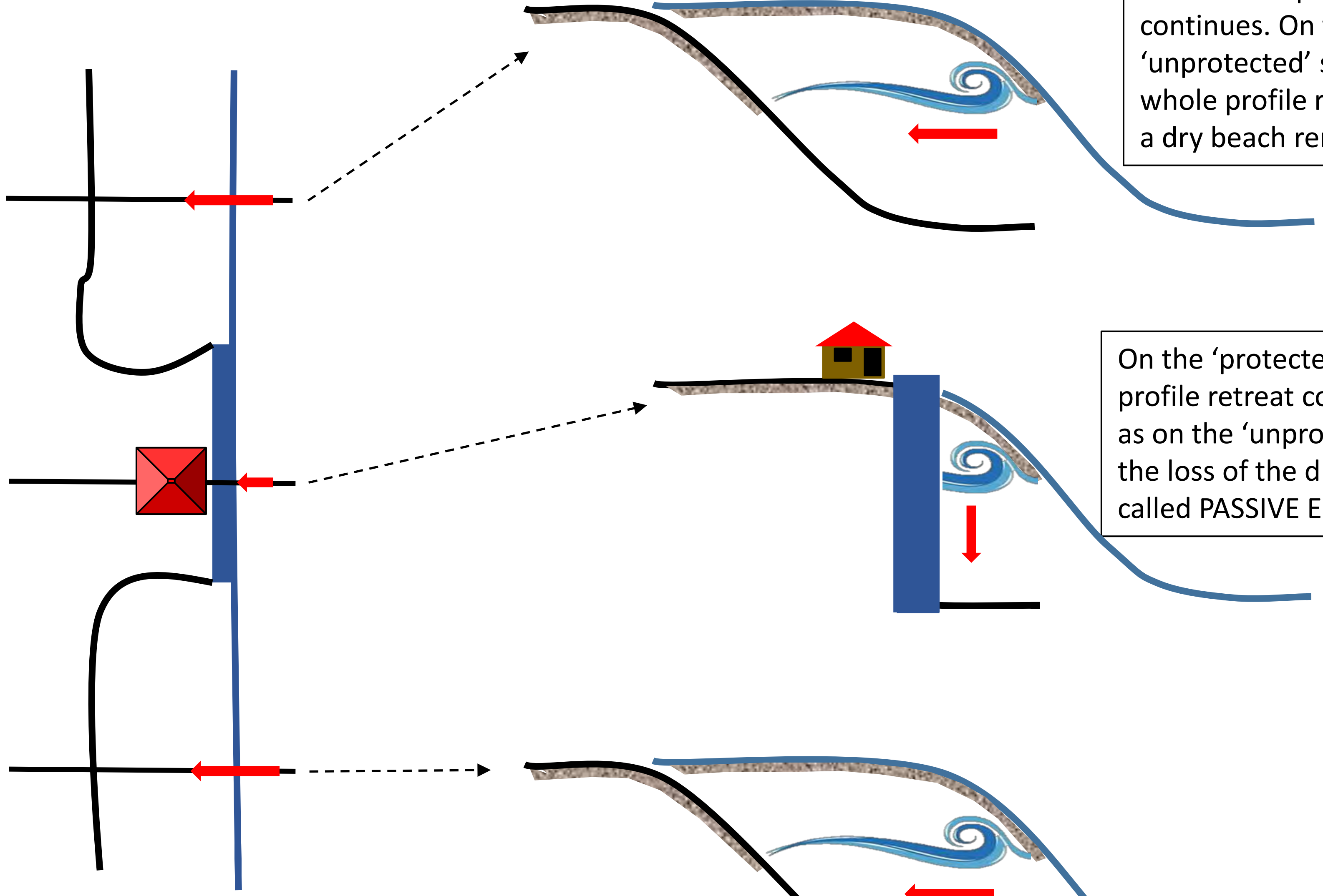
- Underlying all of these paradigms in many countries are issues relating to property rights.
  - The right to protect private property.
  - Private property rights vs public property rights.
- Who pays?
- An example: SEAWALLS
  - Many societies have entrenched private property rights including the right to protect private land from erosion, however . . . .
  - . . . most societies also assume the right of everybody to be able to enjoy beaches and coasts, and want the protection of coastal amenity.
  - When coasts are eroding, these two world views are incompatible.



Map View
Profile view
Land
Beach
Sea
Land
'Dry' beach
Beach
Sea

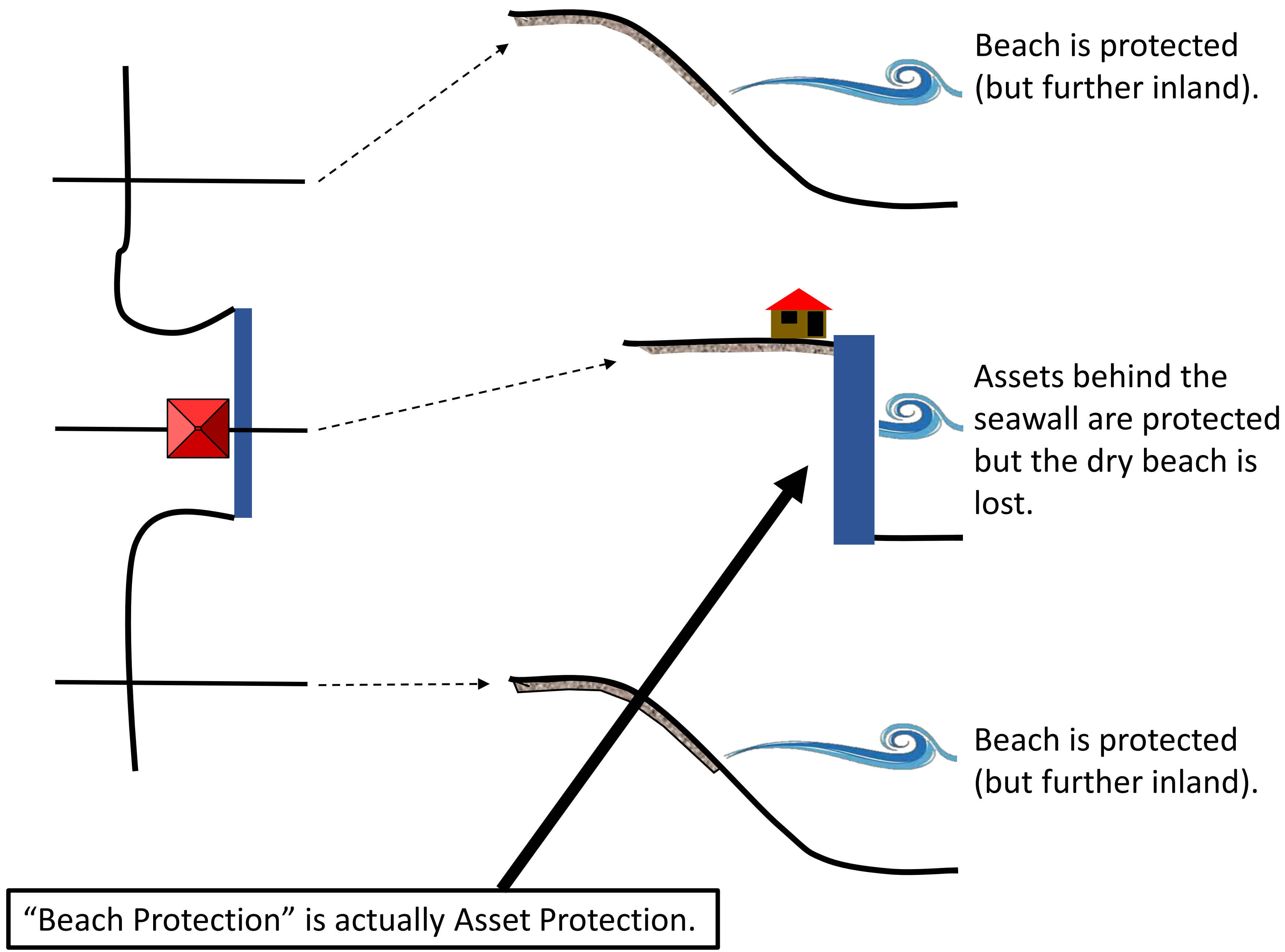


A seawall is built to protect a section of eroding coast



The erosion process continues. On the ‘unprotected’ sections the whole profile retreats, and a dry beach remains.

On the ‘protected’ section, the lower profile retreat continues at the same rate as on the ‘unprotected’ coast, resulting in the loss of the dry beach. This is a process called PASSIVE EROSION.


Beach is protected (but further inland).
Assets behind the seawall are protected but the dry beach is lost.
Beach is protected (but further inland).
“Beach Protection” is actually Asset Protection.

Kloogarand, Estonia

Property rights

- Most experts agree that:

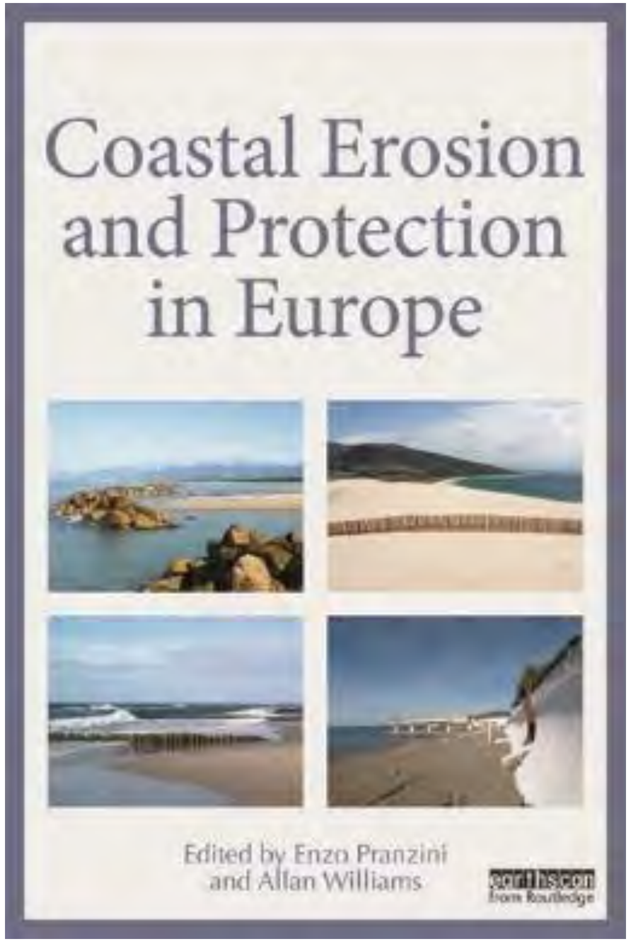
  - If a beach is eroding, a <u>properly built </u>seawall WILL protect assets and WILL result in the loss of the dry beach.

  - Few countries with sandy or soft-rock shorelines have the resources to maintain them in their current positions.

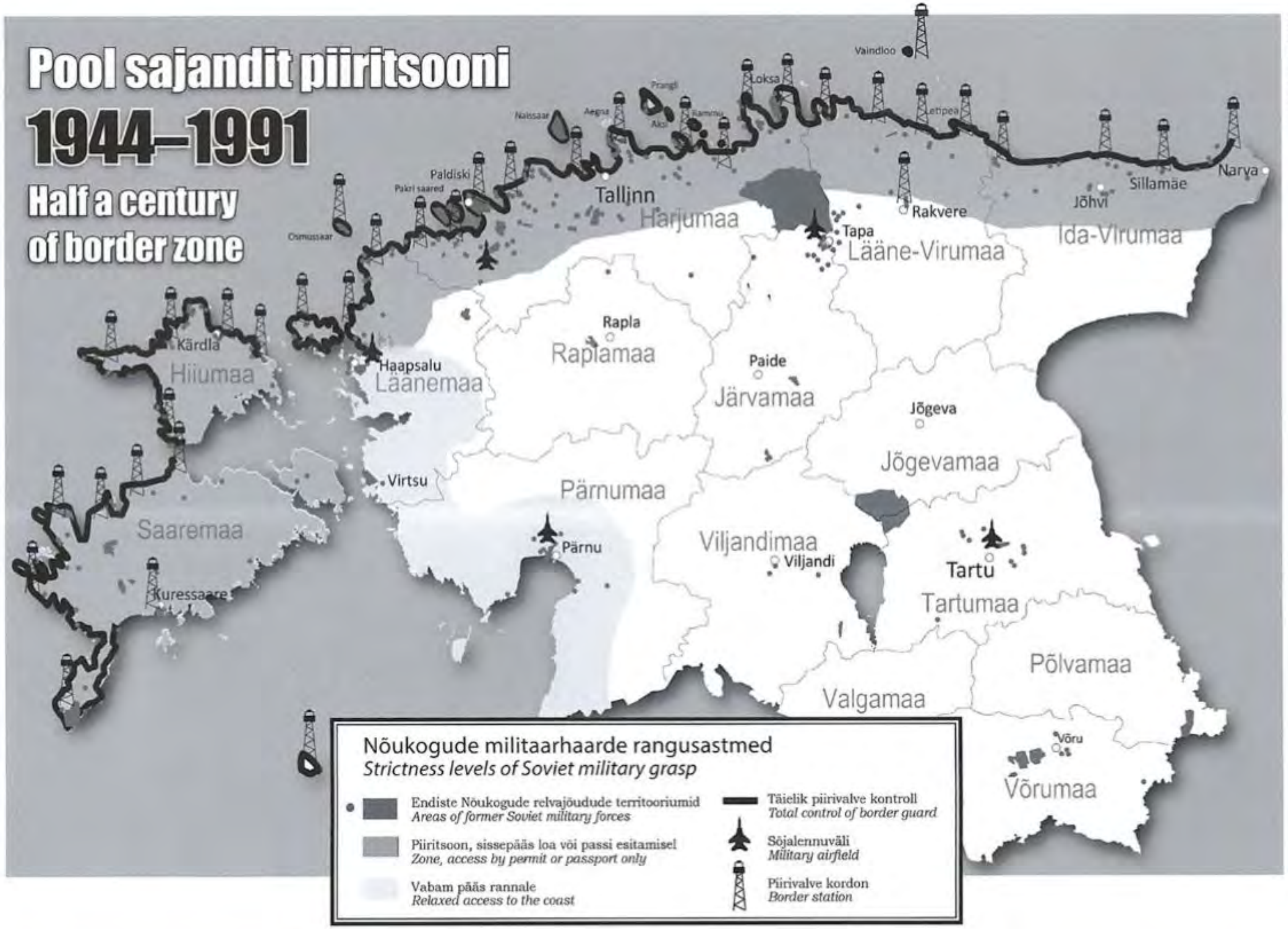
  - Beaches will remain healthy IF they can migrate (ambulatory).

The Gulf of Finland

- Finland: What problem? Hard coasts and isostatic uplift.
- Russia: Generally wide setback, but this may be changing, e.g. Druzhinin A.G. 2017. The coastalisation of population in today's Russia: A socio-geographical explication, *Baltic Region* 9(2) 19-30.
- Estonia: Either because of a tradition of not building near the coast, history, or the Nature Conservation Act (2004), coastal buffers (setbacks) are generally large, but this may be changing.



Estonia: Restricted areas 1944-1991



Miller A-LS. 2019. Keep out! No entry! Exploring the Soviet military landscape of the coast of Estonia
HS Web of Conferences 63, 11001

Narva-Jõesuu

Suurupi (near Tallinn)

The Gulf of Finland

- The Baltic Green Belt: A part of the European Green Belt, an initiative to save the natural assets that had grown alongside the iron curtain. There is not a lot of formal application into planning processes.
- Many countries look with envy at places that, for whatever reason, have a largely undeveloped coastal area with wide setbacks.
- However, there are concerning trends . . . .

^ https://www.err.ee/1608411410/riigikogu-liige-savisaar-lubanuks-majad-kallastele-lahemale

Recent developments in Estonia

- **English translation of an article in the newspaper Postimees 25 November 2021**

“On the initiative of Erki Savisaar, who has become Minister of the Environment, members of the Riigikogu [parliament] are forging a law that will allow buildings to be built almost on the water's edge and allow strangers to the beach less, claiming that natural values are not endangered. Conservationists disagree.

At present, according to the Nature Conservation Act, new buildings can generally be built at a distance of 200 meters from the shores of sea islands, 100 meters from the shores of the mainland and larger lakes, and 50 meters from the shores of lakes and rivers. The 50-meter construction exclusion zone also applies separately to densely populated areas.

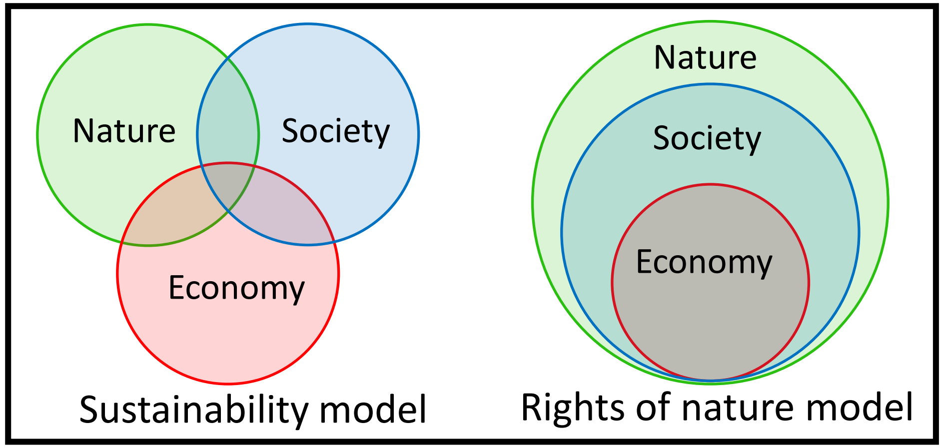
On November 8, [4 members of the Riigikogu] signed a bill that would leave only a 20-meter protection zone everywhere, which local governments could expand if desired.”

- This is not the time to be considering such a change.

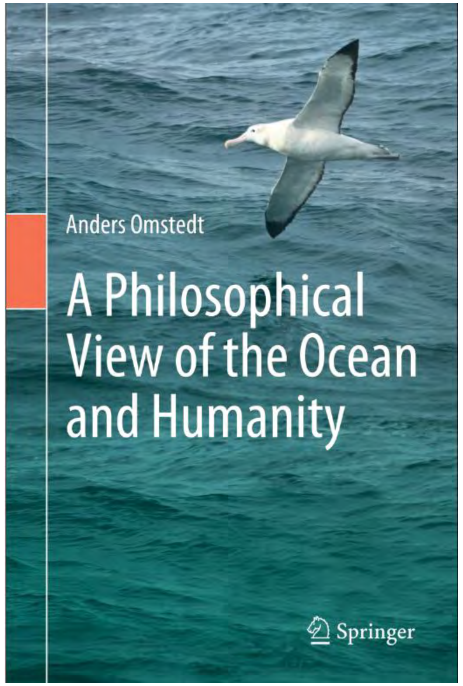
- We must encourage wise use of the historical advantage.

There have been successes, but do we keep trying to integrate, reconcile and adapt, or is it time for a paradigm shift?

- Earth Jurisprudence/Rights of Nature (2010s -)
  - ‘Rights of Nature’ is a legal and jurisprudential theory that describes inherent rights associated with ecosystems and species, similar to the concept of fundamental human rights.
  - It recognises nature as a legal stakeholder with inalienable rights in law.
  - It has common roots with indigenous worldviews, some world religions, and human rights (e.g. Universal Declaration of Human Rights (1948)).
  - It is not a new idea, often attributed to Thomas Berry (1914-2009), but also others, e.g. →
  - It is frequently regarded as an extreme viewpoint, however . . .
  - There are now examples where this principle has achieved some degree of legal status, in Ecuador, New Zealand, India, Bangladesh, Colombia, Uganda, Mexico, **Bolivia** and the USA (at local government level).
  - Bolivia: “Law of the Rights of Mother Earth” 2010.



Aldo Leopold (1887-1948) who wrote about “land as a community to which we belong” rather than “a commodity belonging to us.”



Earth Jurisprudence / Rights of Nature

Recognises nature as a legal stakeholder with inalienable rights in law.

e.g. New Zealand: In 2017, the Whanganui River was granted the status of legal personhood.

CNN World Africa Americas Asia Australia China Europe India Middle East United Kingdom Edition

This river in New Zealand is legally a person. Here's how it happened

By Julia Hollingsworth, CNN

Updated 0243 GMT (1043 HKT) December 12, 2020

A geomorphic perspective on the rights of the river in Aotearoa New Zealand

Gary Brierley[1] | Marc Tadaki[2] | Dan Hikuroa[3] | Brendon Blue[1] | Charlotte Šunde[4] | Jon Tunnicliffe[1] | Anne Salmond[3]

River Res. Applic. 2019. 35: 1640-1651. DOI: 10.1002/rra.3343

Crown and iwi appoint new 'face and voice' of Whanganui River

Moana Ellis Local Democracy Reporter · 16:47, Oct 28 2021

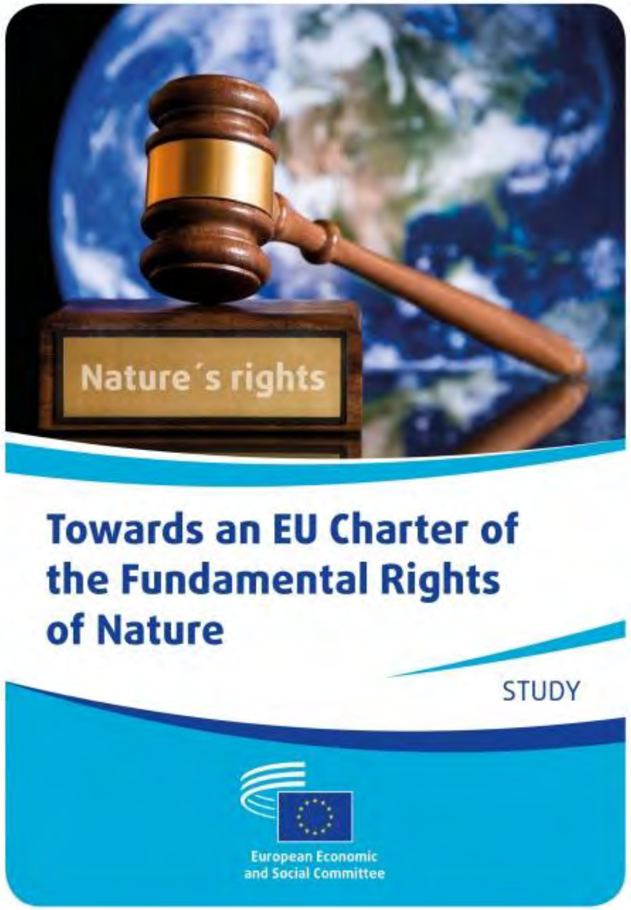
Keria Ponga is the new Pou Tupua for the Whanganui River.

The New Zealand case is fundamentally unique because the Parliament, in *The Te Awa Tupua Act (2017),* appointed two guardians of the river, one representing the Maori Indigenous people and one representing the government, arguably reconciling two different worldviews (Challe, 2021)

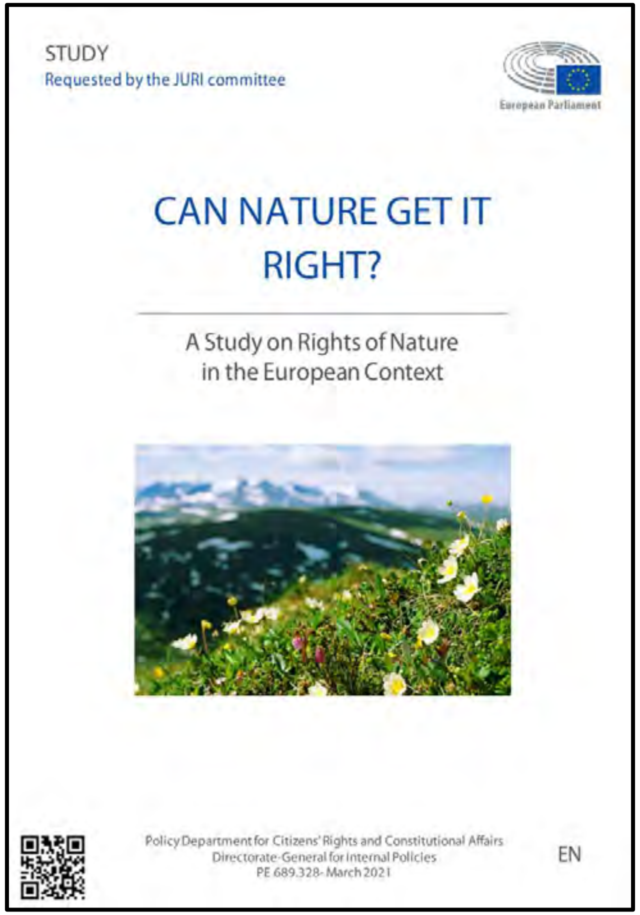
Rights of nature - Europe

Nov. 2020

Conference 2019



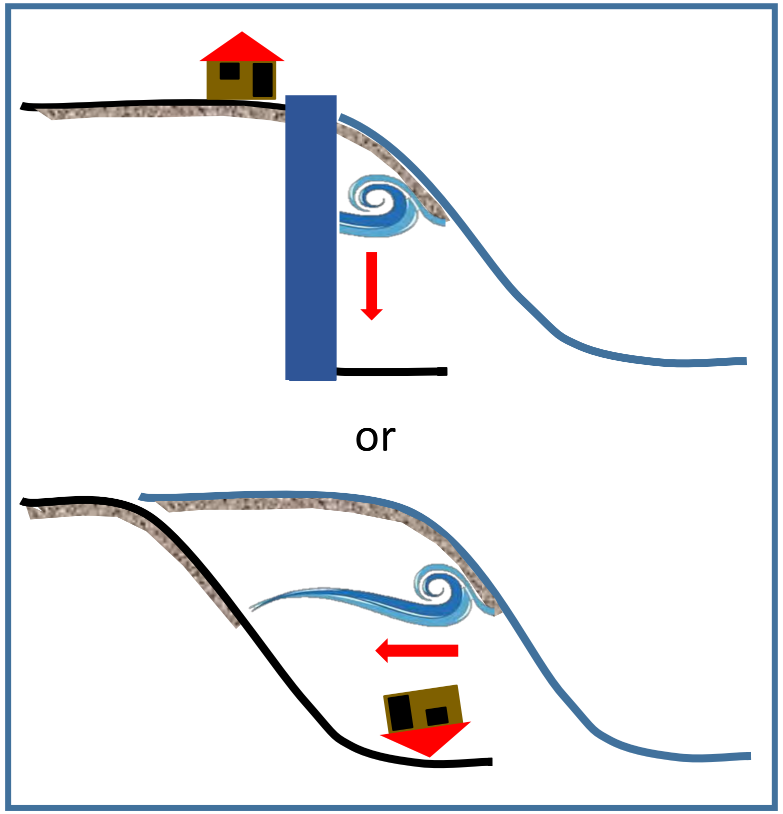
Published 2020



Published 2021

Summary questions

- Is the way forward for coastal spatial planning the integration of knowledge systems within a sustainability framework (where there has been some, but limited, success), or is a new paradigm required?
- How do we ensure the maintenance of historical and natural advantages where they exist?
- Should a beach have the legal right to exist, function and migrate, even when its functioning infringes on private property rights?
- Is a 'rights of nature' approach a possible way forward?



CAPACITY4MSP
Strengthening the capacity of MSP stakeholders and decision makers

Interreg
Baltic Sea Region

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

Tools for the implementation of the ecosystem-based approach into Maritime Spatial Planning of Russian coastal waters of the Baltic Sea

Tatyana Eremina, Michael Shilin, Oksana Vladimirova, Vera Semeoshenkova, Alexandra Ershova

Russian State Hydrometeorological University (RSHU)

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

To implement the ecosystem approach in marine spatial planning, which is being developed for the coastal Russian waters of the Baltic Sea within the framework of the Capacity4MSP project, scientific tools are needed to generalize, analyze and predict changes to ensure a good ecological state of the marine environment

Tools for the implementation of ecosystem-based approach

- indexing maps of biodiversity,
- maps of areas of the main techno sphere load on the ecosystems
- maps of high vulnerability of coastal ecosystems to anthropogenic impact
- 3D modeling of ecosystems for climate change scenario and nutrient load reduction according to BSAP

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Technosphere load on the GoF ecosystem

Kuvaa ei voi näyttää.

Areas of the main technosphere load on the ecosystem: 1 - Ust-Luga seaport complex, 2 - Vistino port, 3 - Bronka Outport, 4 - Big Port of St. Petersburg, 5 - Kronstadt port, 6 - Primorsk port, 7 - Lukoil port, 8 - Vysotsk port, 9 - Vyborg port, 10 - Gazprom port (orig.)

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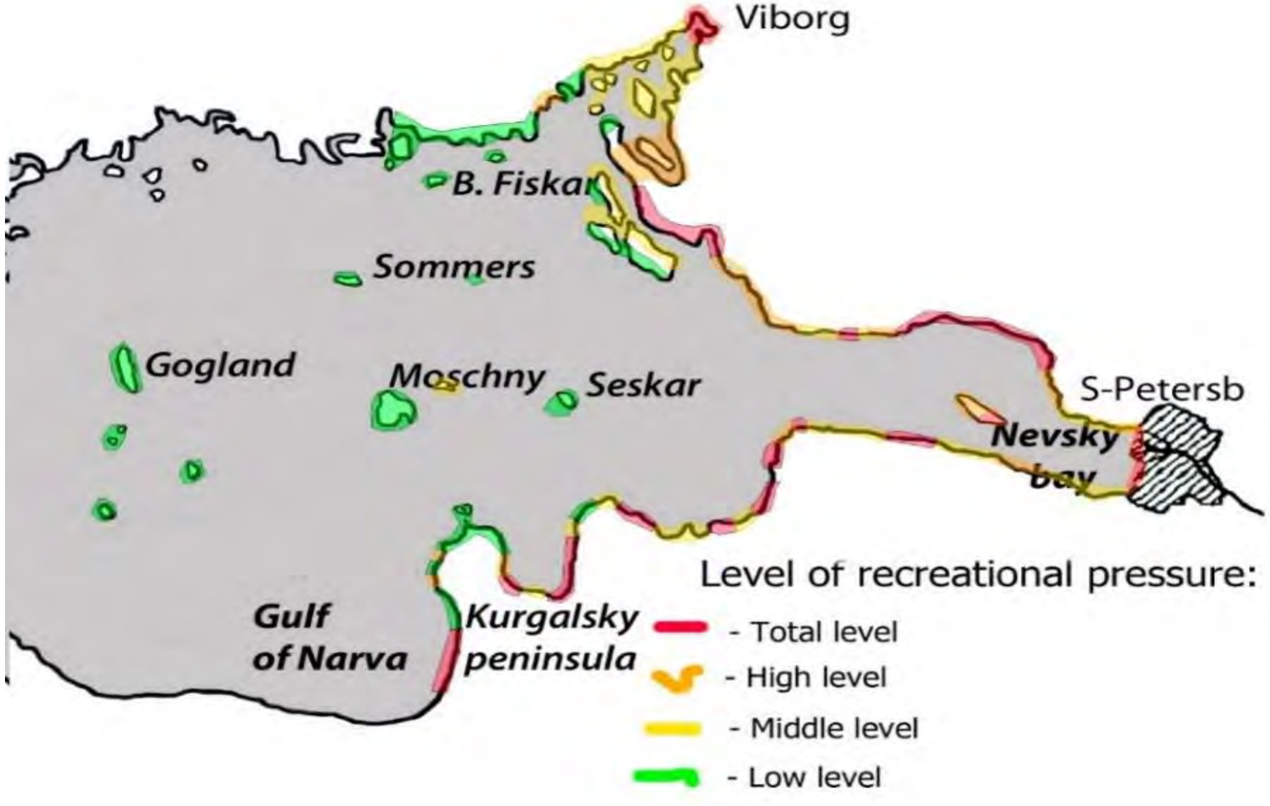
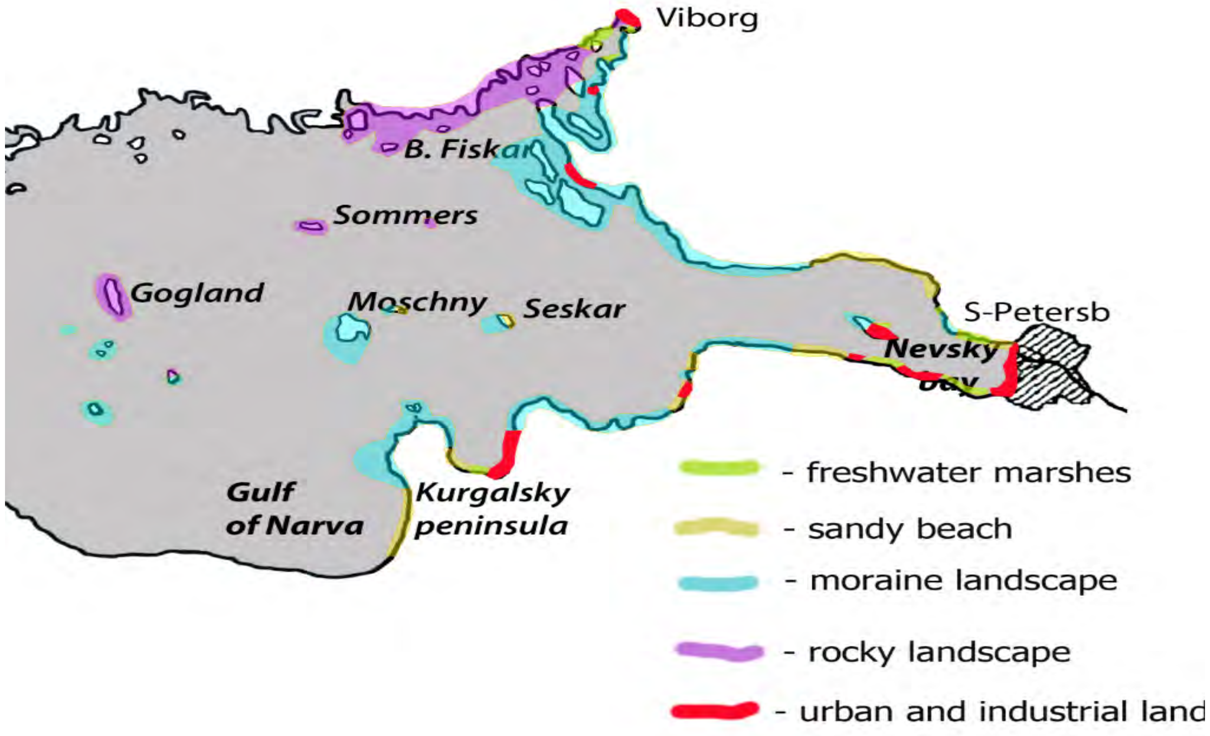
Recreational load



Zoning of the coastal zone of the Eastern part of the Gulf of Finland according to the level of recreational load Red color - overwhelming load, orange color - high load, yellow color - medium load, green color - low load

Diversity of coastal biotopes of the Eastern part of the Gulf of Finland



The coastal biotopes of the eastern part of the Gulf of Finland are diverse enough to support a large set of different biological communities.

Waterbird colonies (left) and stopping sites on the overflights (right) in the Eastern part of the Gulf of Finland (Kouzov)

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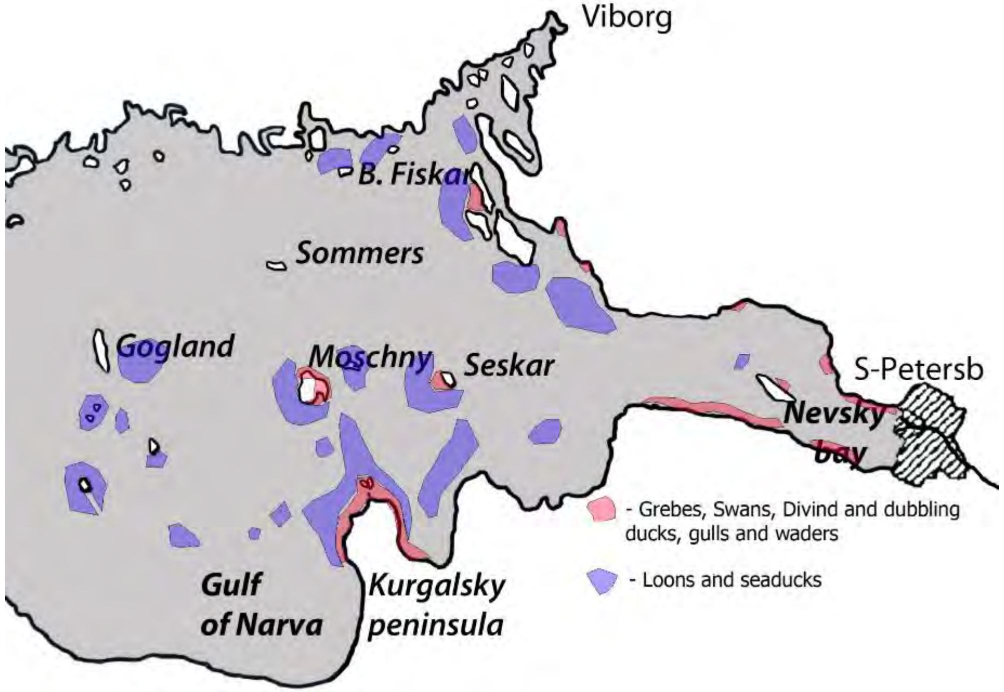
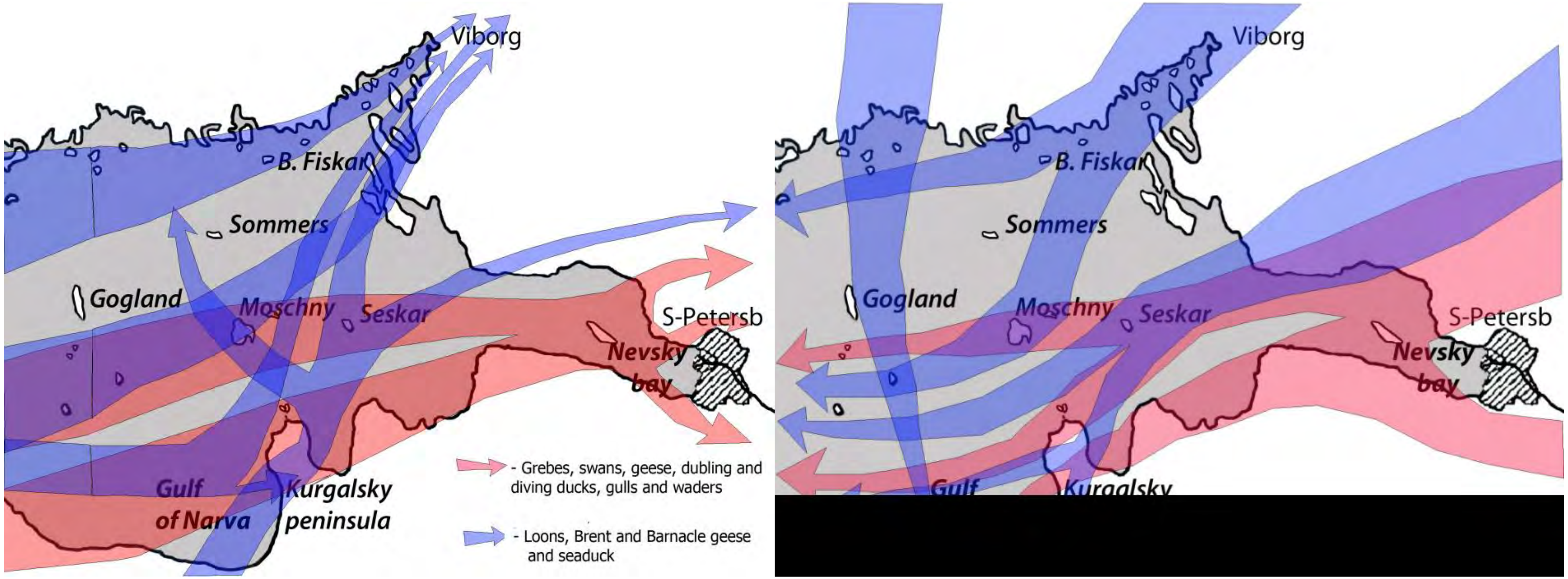


Routes of the spring (left) and autumn (right) flights of birds (Kouzov,2020)



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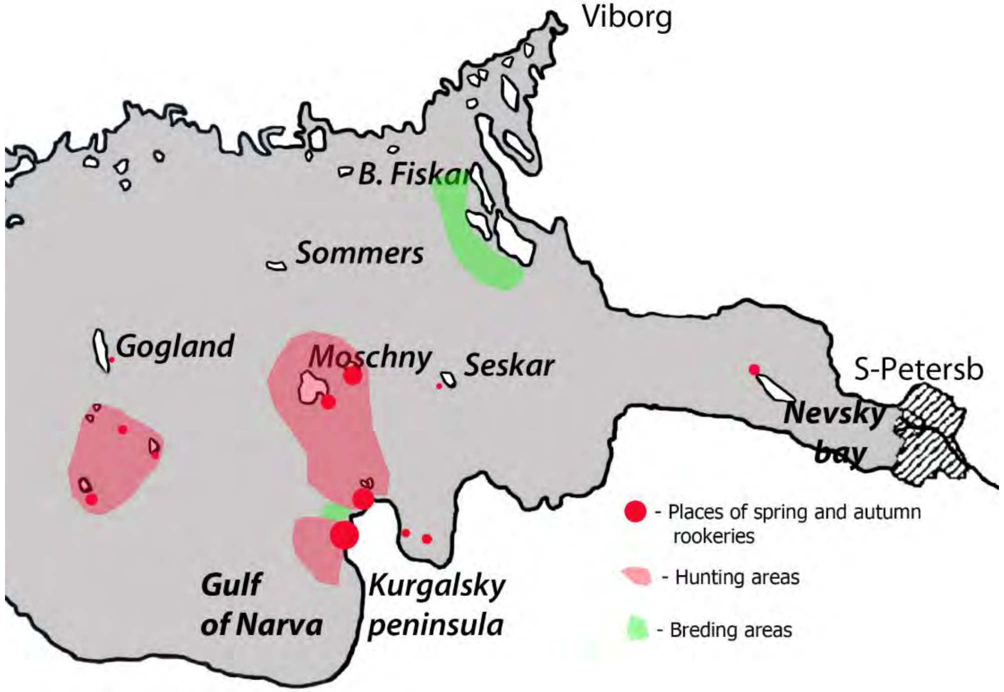
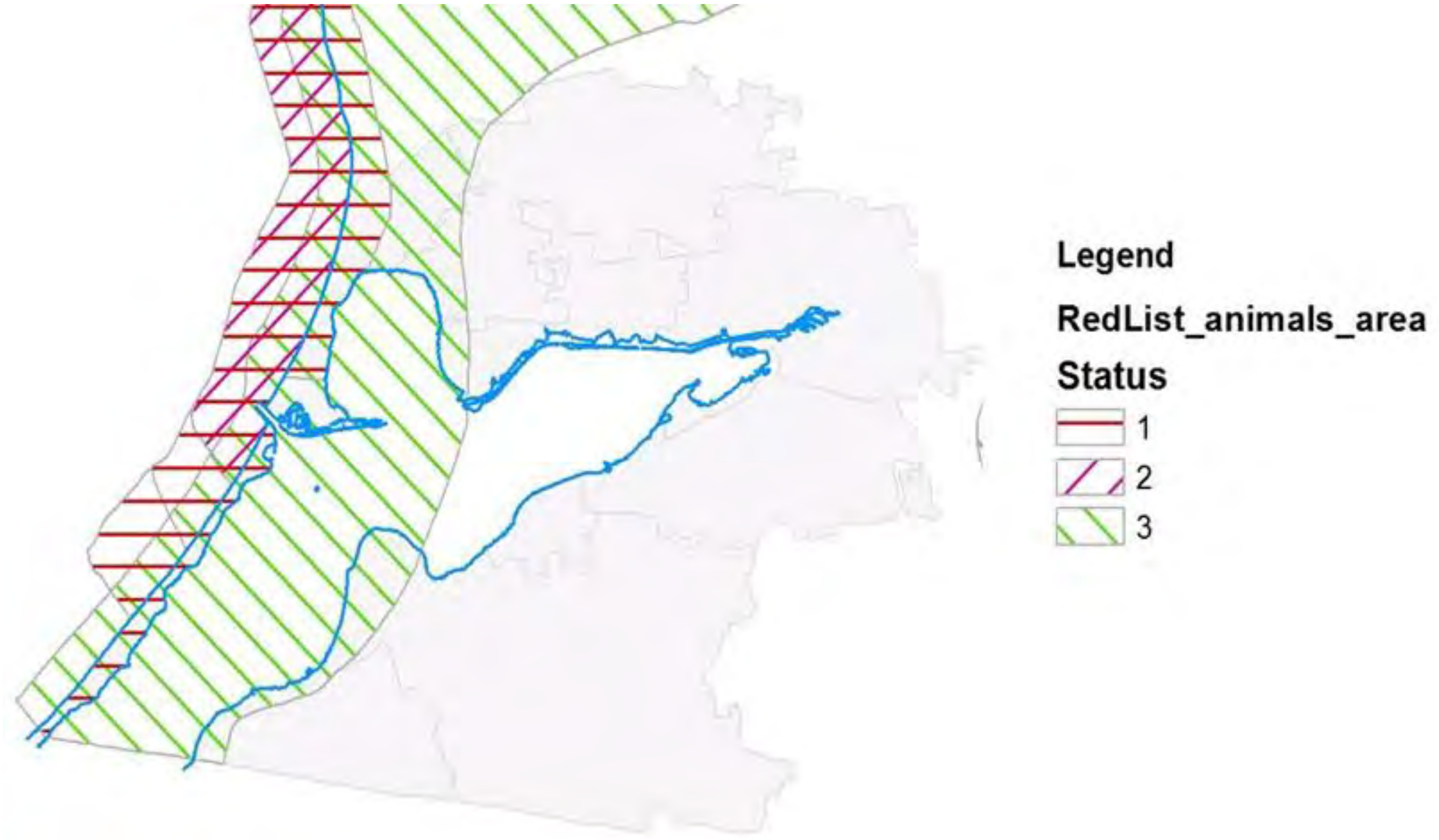
Key biotopes of the gray seal *Halichoerusgrypus and ringed seal Phoca hispida botnica*



Red color – areas of spring and autumn deposits; pink color - feeding areas; green color - breeding zones

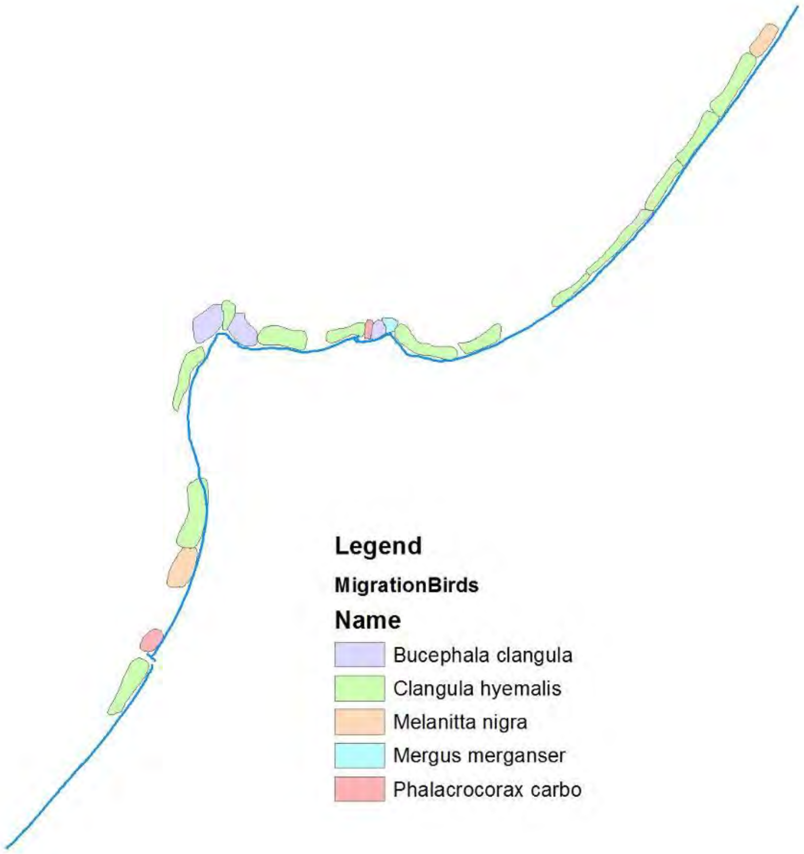
CAPACITY4MSP

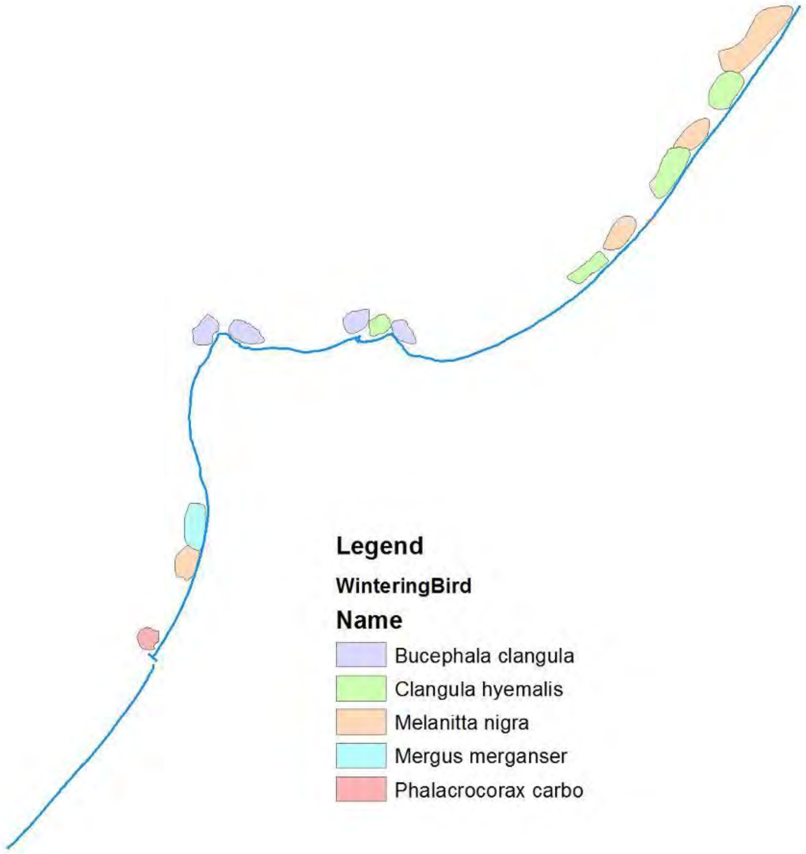
Distribution of animals listed in the Red Book of the Kaliningrad Region (redlist_animals_area) in the coastal zone of the Kaliningrad/Vislinsky Bay (Domnin,2021)



CAPACITY4MSP

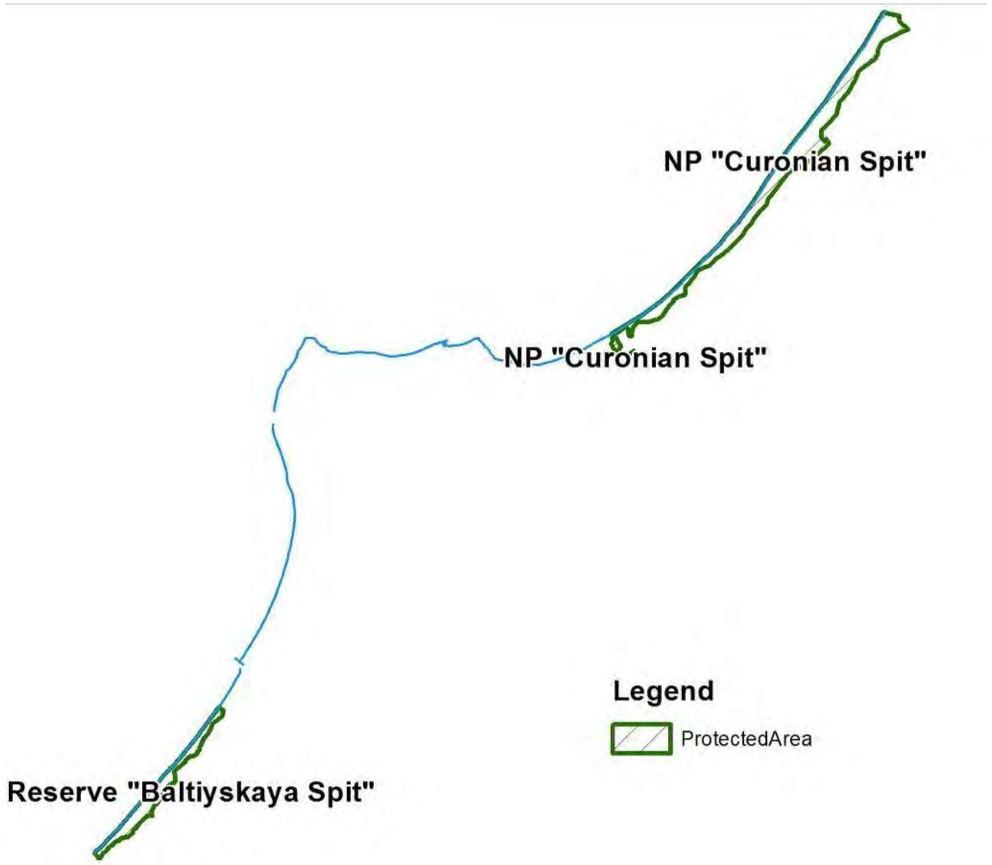
Habitats of Migration birds and Wintering birds in the coastal zone of the Russian sector of the South-Eastern part of the Baltic Sea

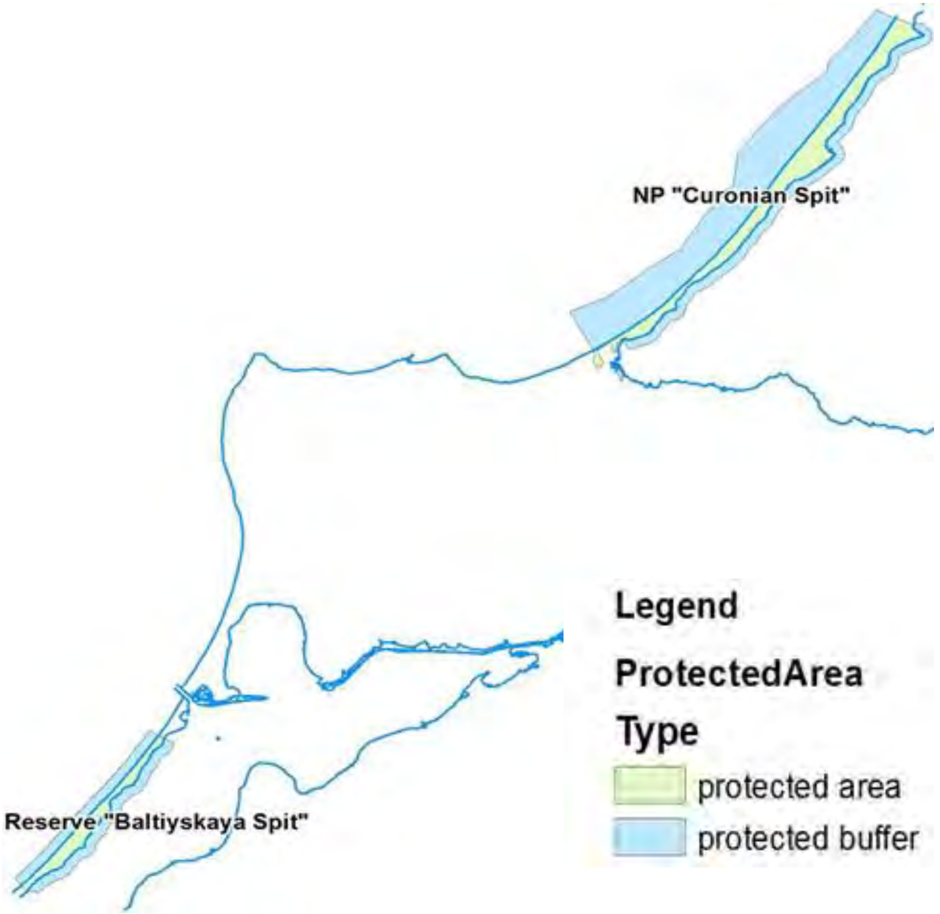




CAPACITY4MSP

Protected area (left) and possible marine protection zones (right) adjacent to specially protected natural territories (Protected Area) in the coastal zone of the Kaliningrad / Vislinsky Bay





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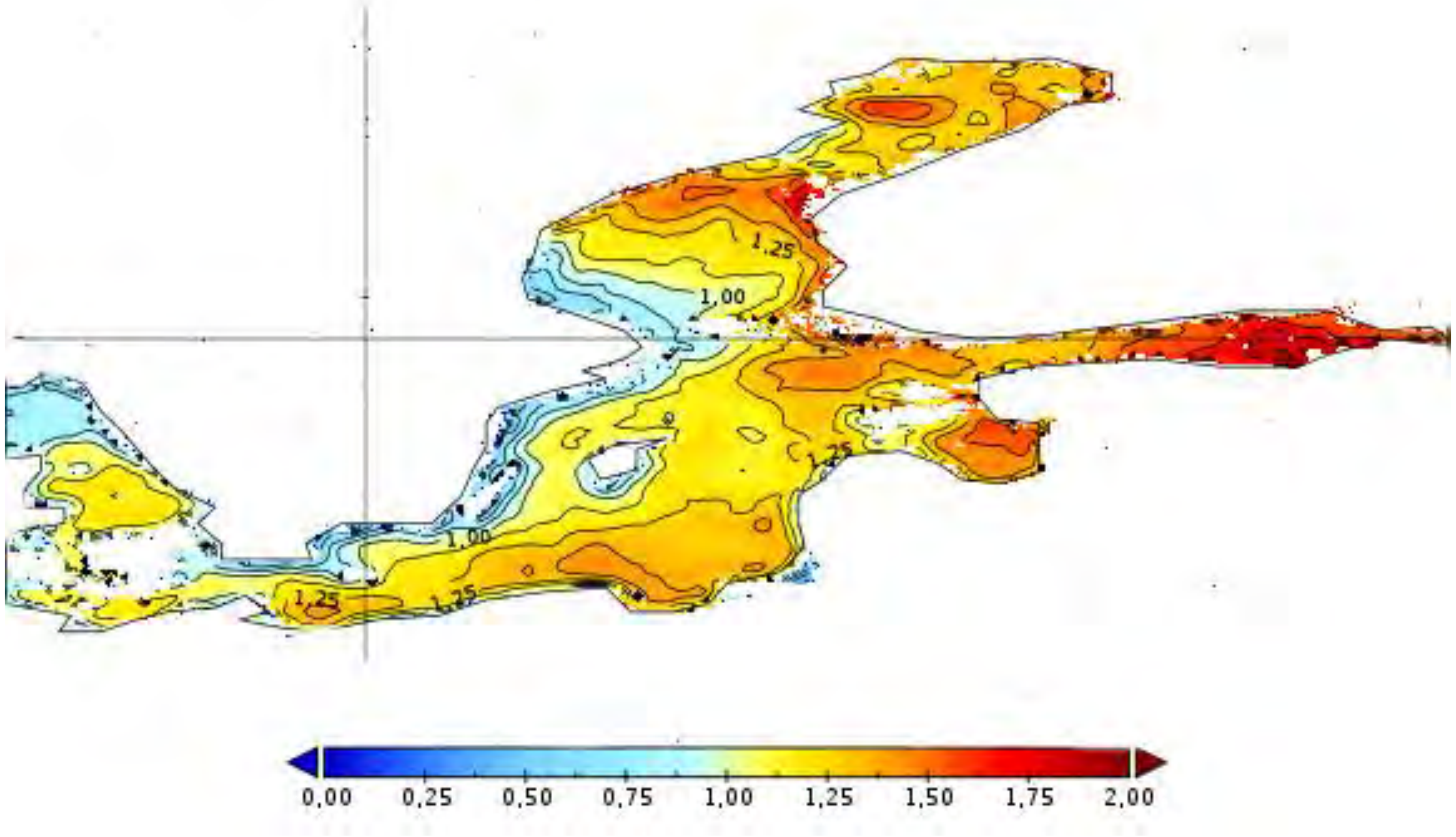
The SST trend of changes in the average annual surface temperature of the Baltic Sea according to satellite observations 1993-2017 [Mulet, S., et.al., 2018].



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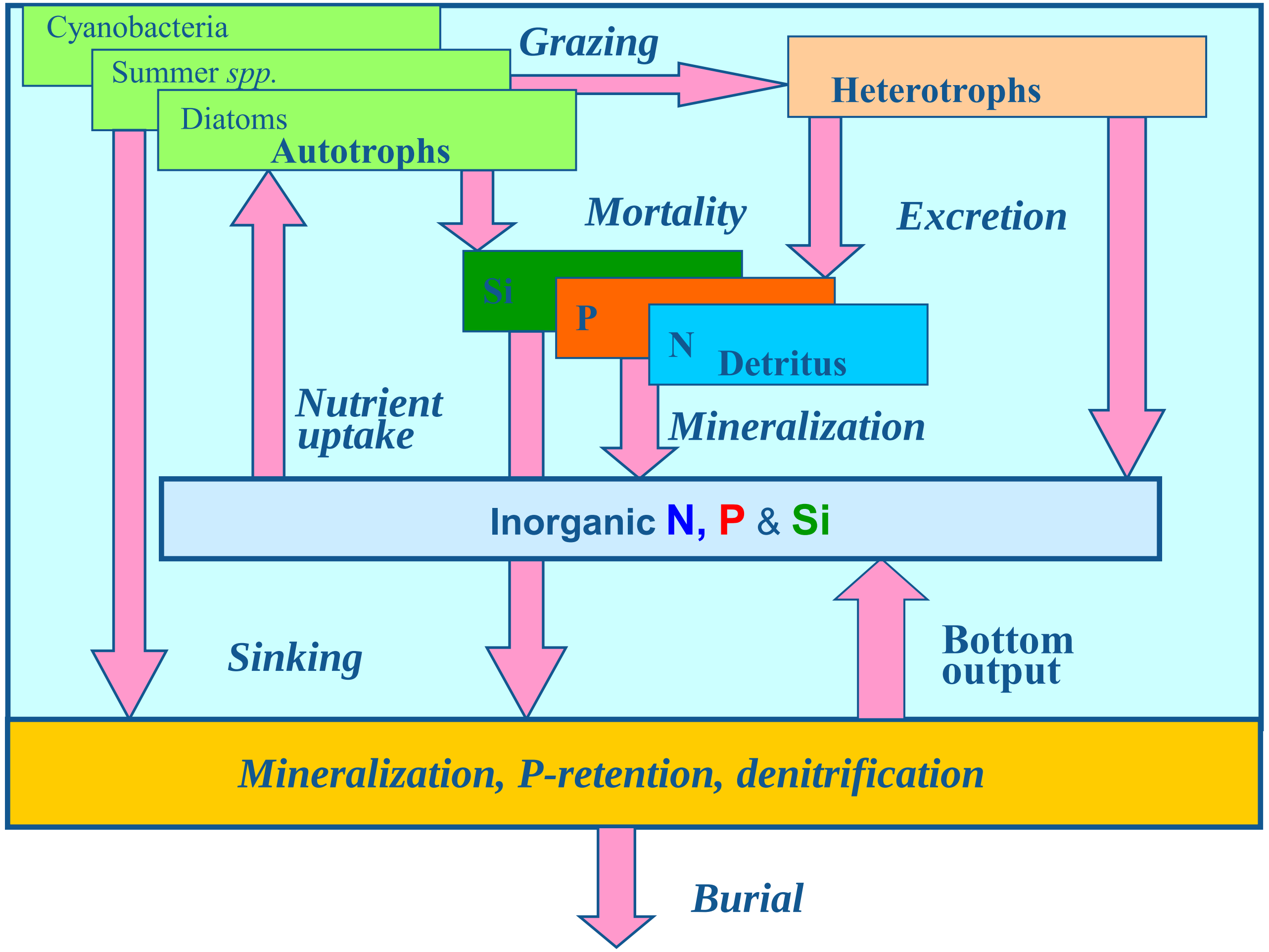
Climate change and nutrients reduction (BSAP) scenario modeling 3-d eco-hydrodynamic model SPBEM (St.-Petersburg Baltic sea Ecosystem Model)



Savchuk, 2002, Neelov et al., 2003, Skogen et al., 2014, Ryabchenko et al., 2016, Eremina et.al, 2017

Model describes N, P and Si cycling in the coupled pelagic and sediment sub-systems and has 12 pelagic & 3 sediment state variables

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Conditions of scenario simulations with SPBEM

- Period of calculation: January 1, 2008 – December 31, 2099
- Scenario of CO_2 emission: A1B
- Global climate model: ECHAM5
- Regional climate model: RCAO
- Phosphorus and nitrogen reduction according BSAP (eutrophication)

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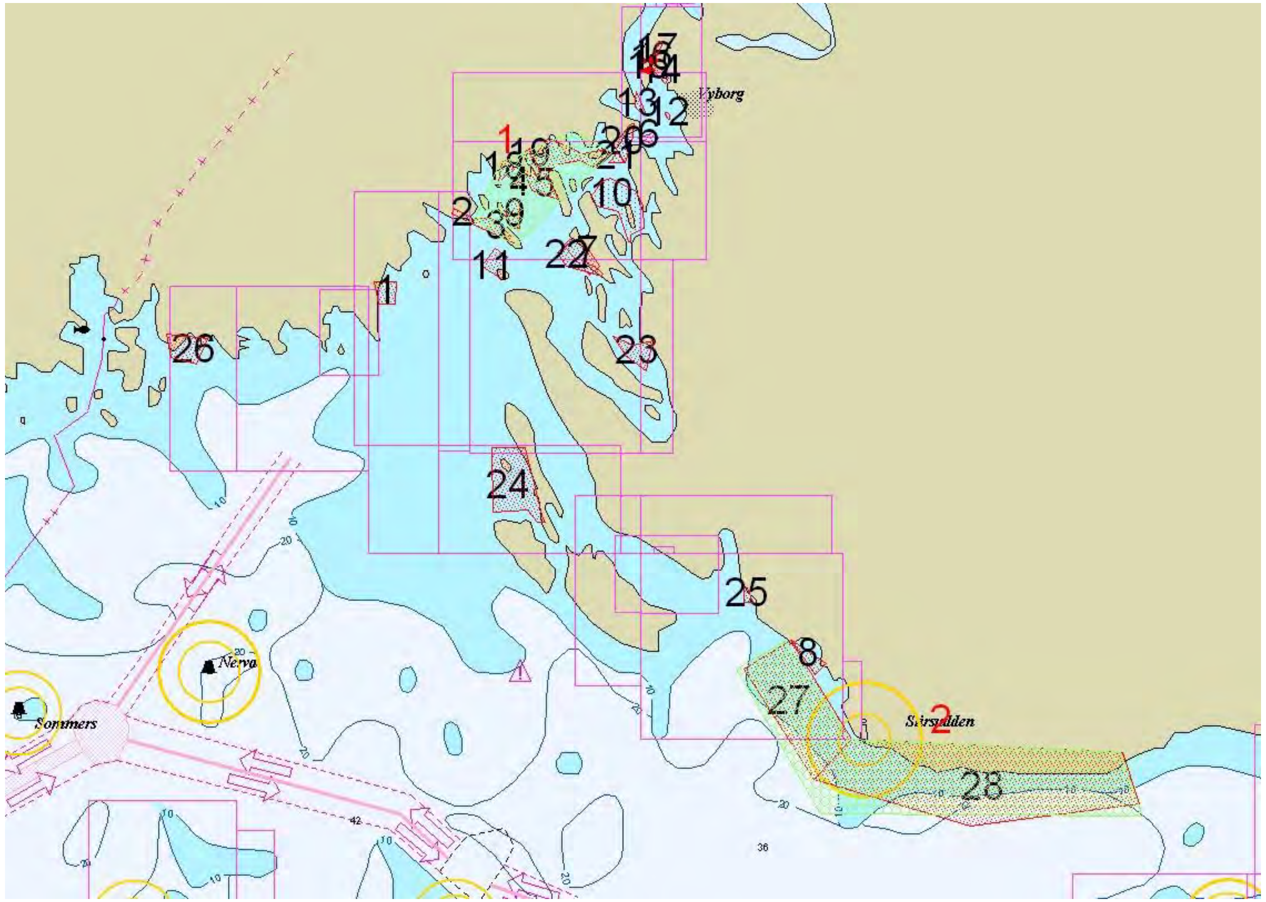
Annual average nutrients (t/y) in the Eastern part of the Gulf of Finland in the future climate under various external loads

AREA	Averaging period and scenario	
	2070-2100	2070-2100
	REF	**BSAP**
	Nitrates + nitrites	
Shallow	315,9	295,2
Transitional	219,5	197,2
Deep	200,5	170,4
	Phosphates	
Shallow	27,2	21,4
Transitional	40,3	32,1
Deep	54,8	44,8

CAPACITY4MSP

Location of fishing areas with indicator areas (1 and 2 red) near the northern coast of the Gulf of Finland (Bugrov et al., 2019)



Based on model assessments of changes in the state of the environment of the bay, fishing areas can be allocated for the purposes of industrial fishing (coastal fishing) and commercial fish farming (aquaculture).

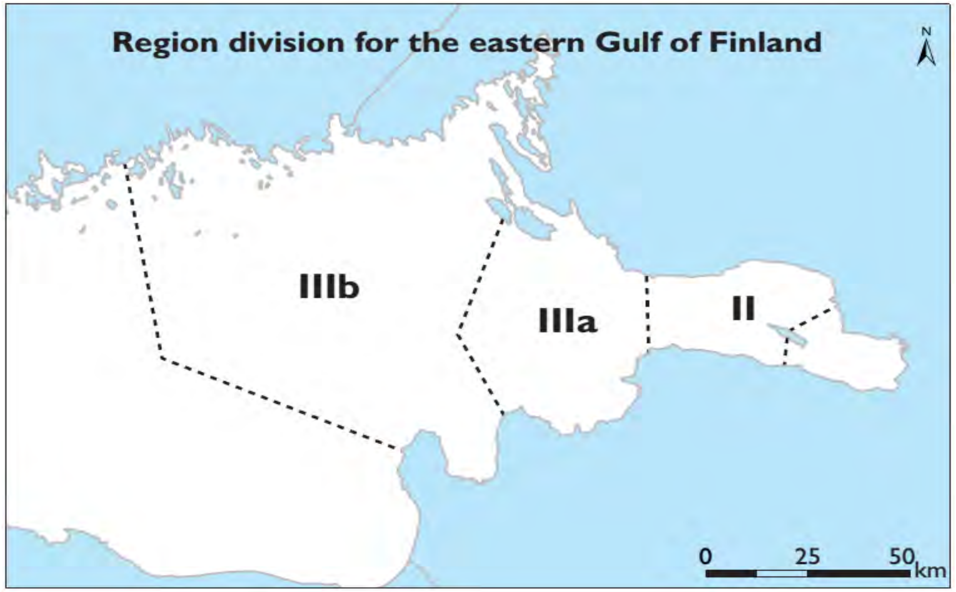
CONCLUSION

CAPACITY4MSP

1. Scientific tools for the implementation of the ecosystem approach in the MSP for the Russian coastal waters of the Baltic are quite well developed
2. A legislative framework is needed for the introduction of an ecosystem approach in the implementation of MSP

THANK YOU
FOR YOUR ATTENTION!

Assessment of the ecological status of ecosystem



Picture: Raateoja M., Pitkänen H., Eremina T., et al. Nutrients in the water. In: The Gulf of Finland Assessment. pp. 94-113 Ed. by: M.Raateoja and O.Setala. Reports of the Finnish Environment Institute 27 | 2016, 368 p.

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 K. Lehtonen, Emil Nyman, Janina Pažusienė, Sirpa Peräniemi, Erika Sainio, Milda Stankevičiūtė, Raisa Turja, Outi Setälä, Maiju Lehtiniemi

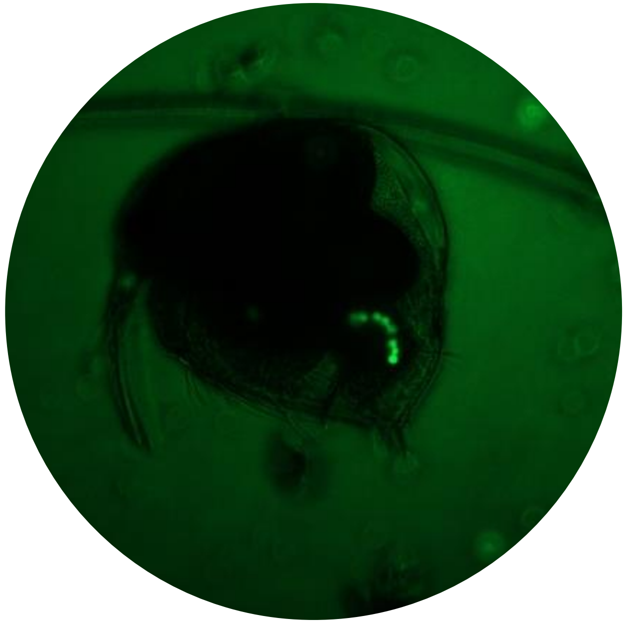
Finnish Environment Institute SYKE

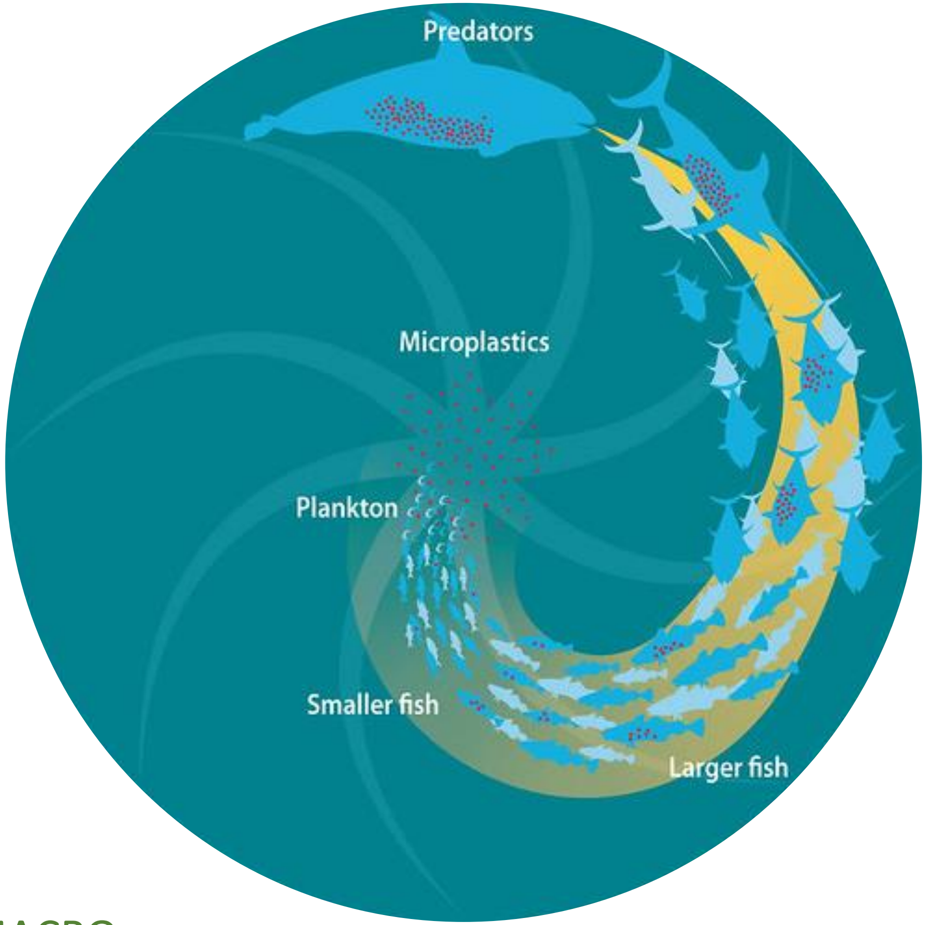
Gulf of Finland Science Days

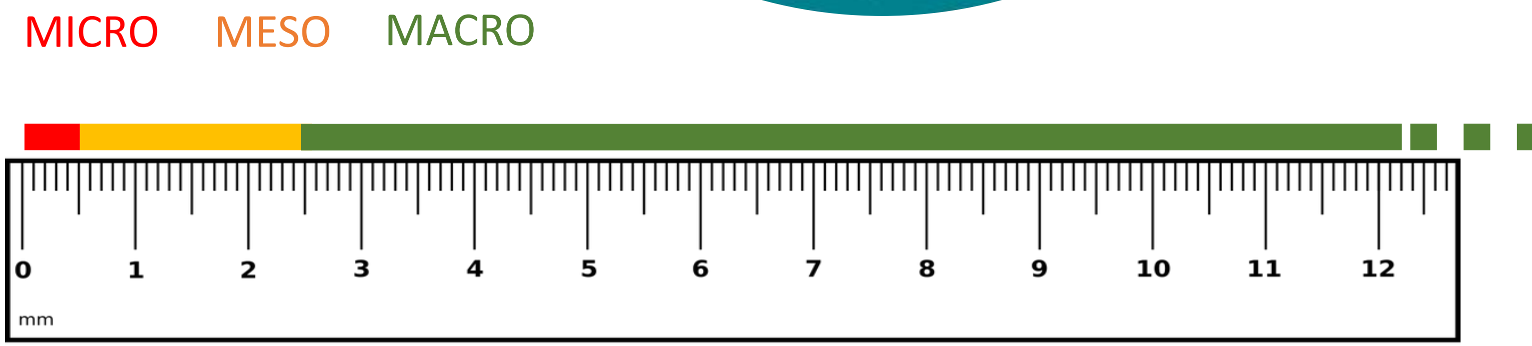
29 November 2021

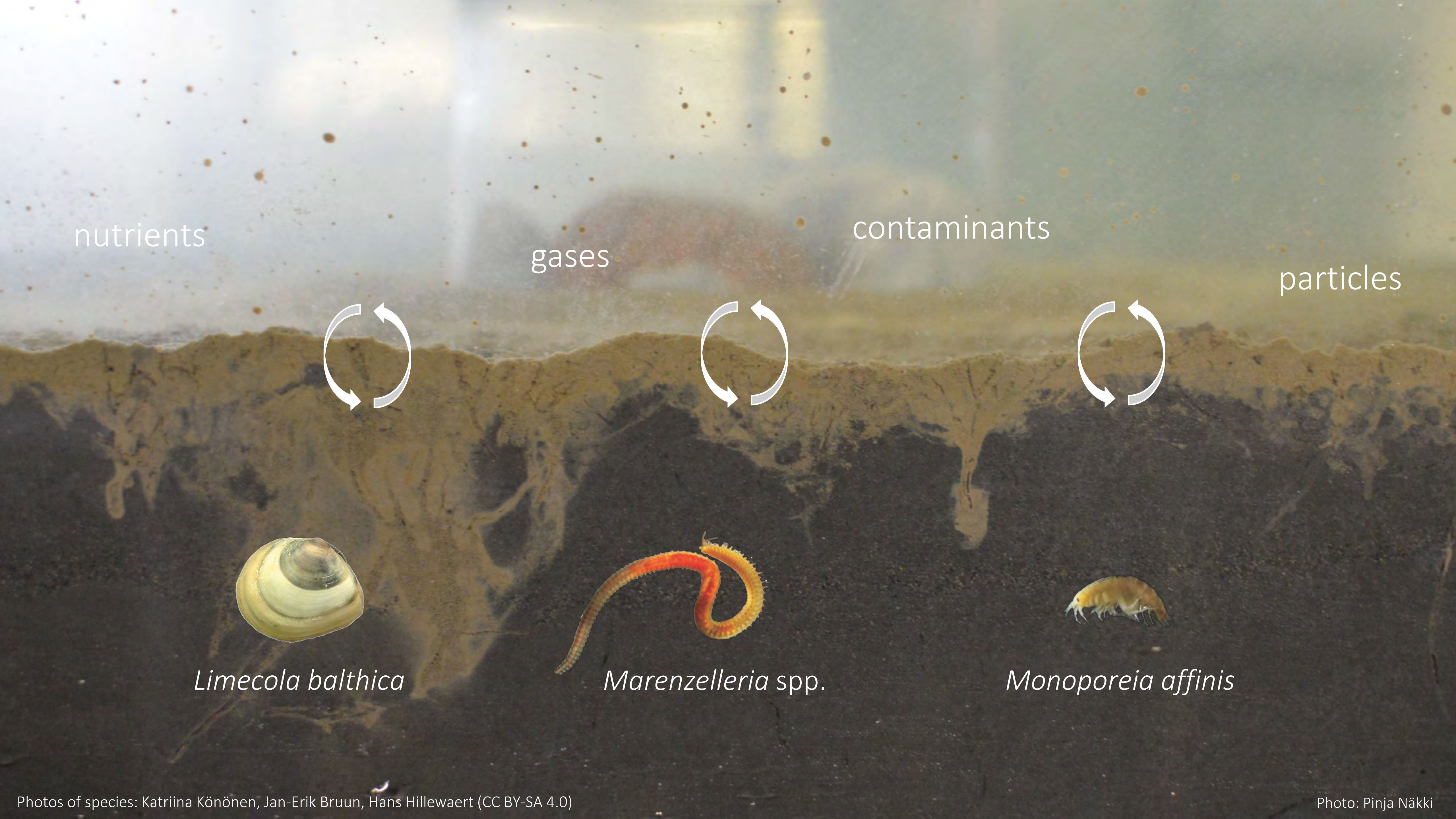
Illustration: Marine Litter Vital Graphics; UN-Environment, GRID-Arendal

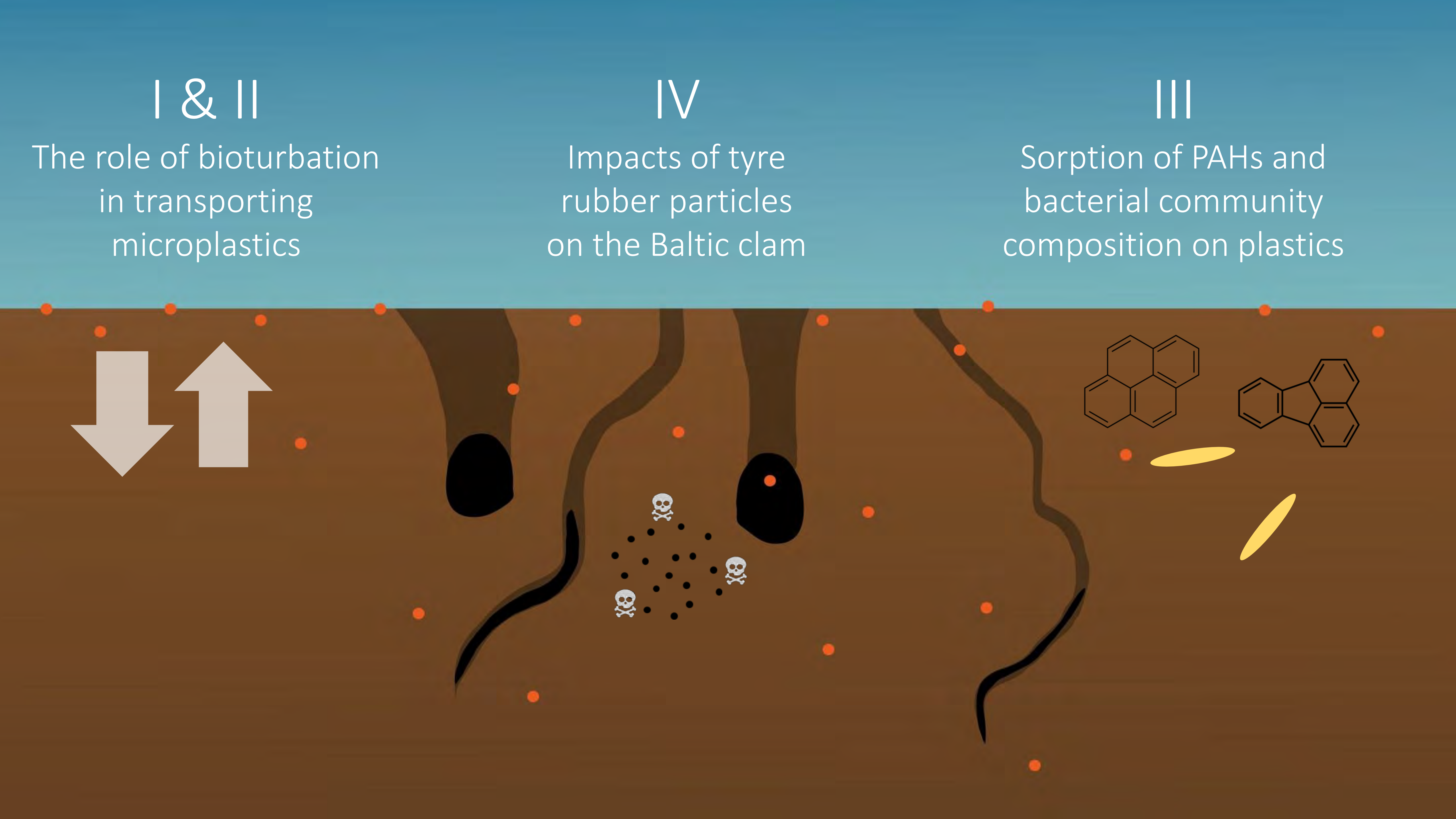
Photo: Outi Setälä

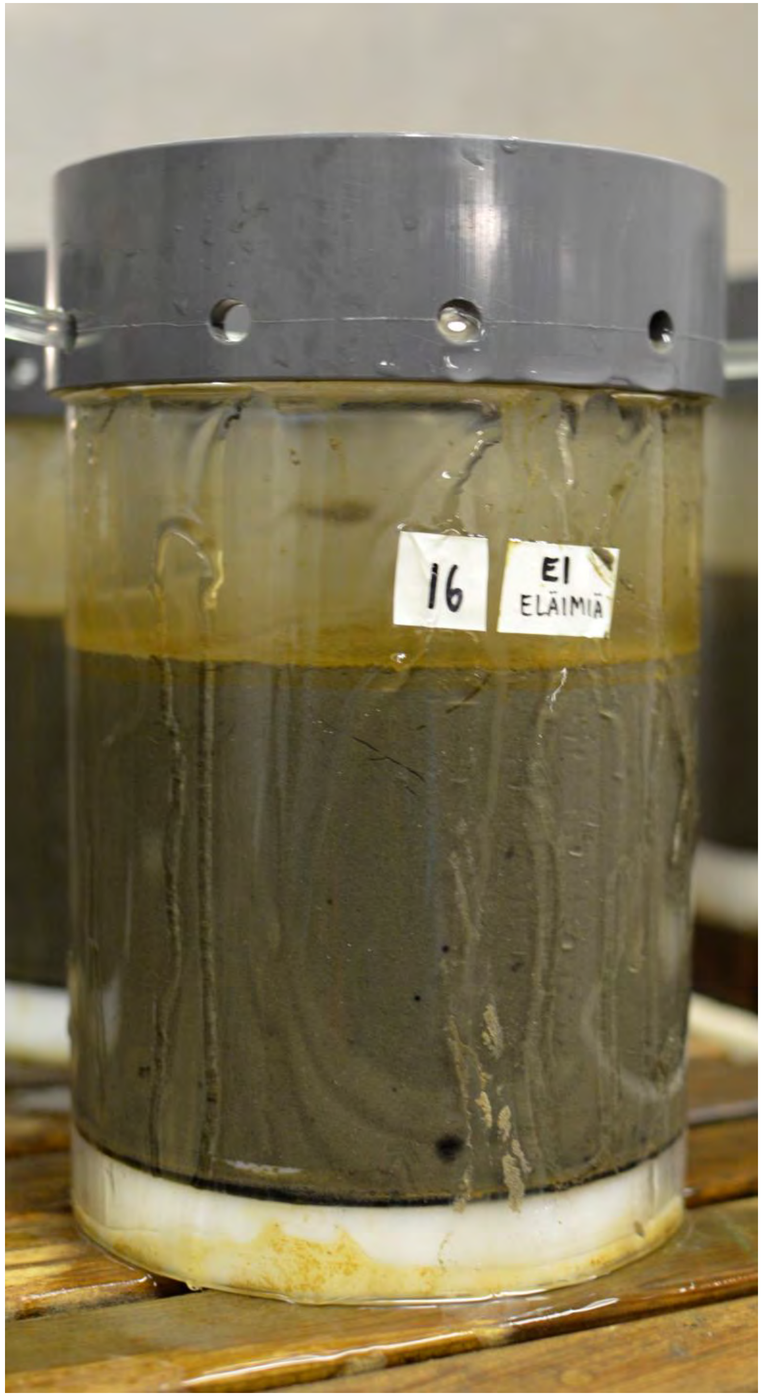


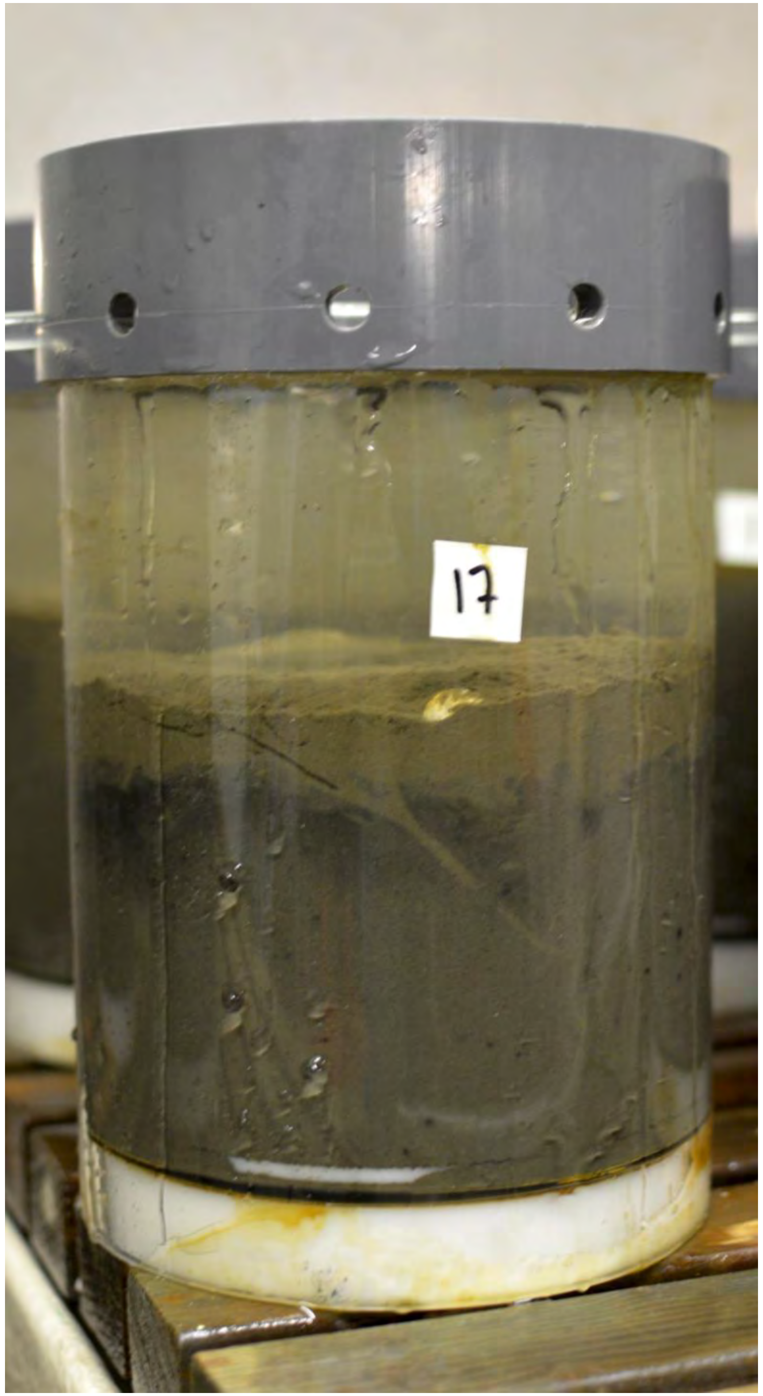





nutrients
gases
contaminants
particles
Limecola balthica
Marenzelleria spp.
Monoporeia affinis
Photos of species: Katriina Könönen, Jan-Erik Bruun, Hans Hillewaert (CC BY-SA 4.0)
Photo: Pinja Näkki

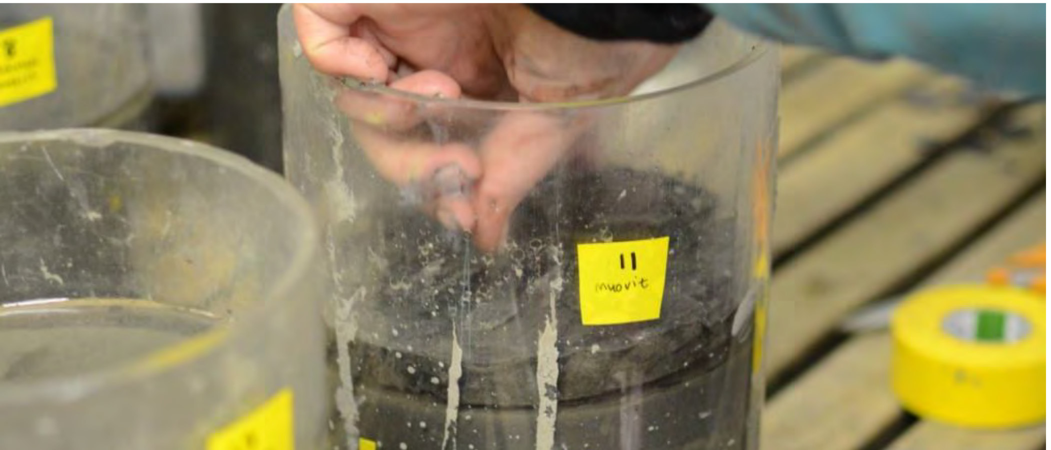

I & II
The role of bioturbation in transporting microplastics
IV
Impacts of tyre rubber particles on the Baltic clam
III
Sorption of PAHs and bacterial community composition on plastics





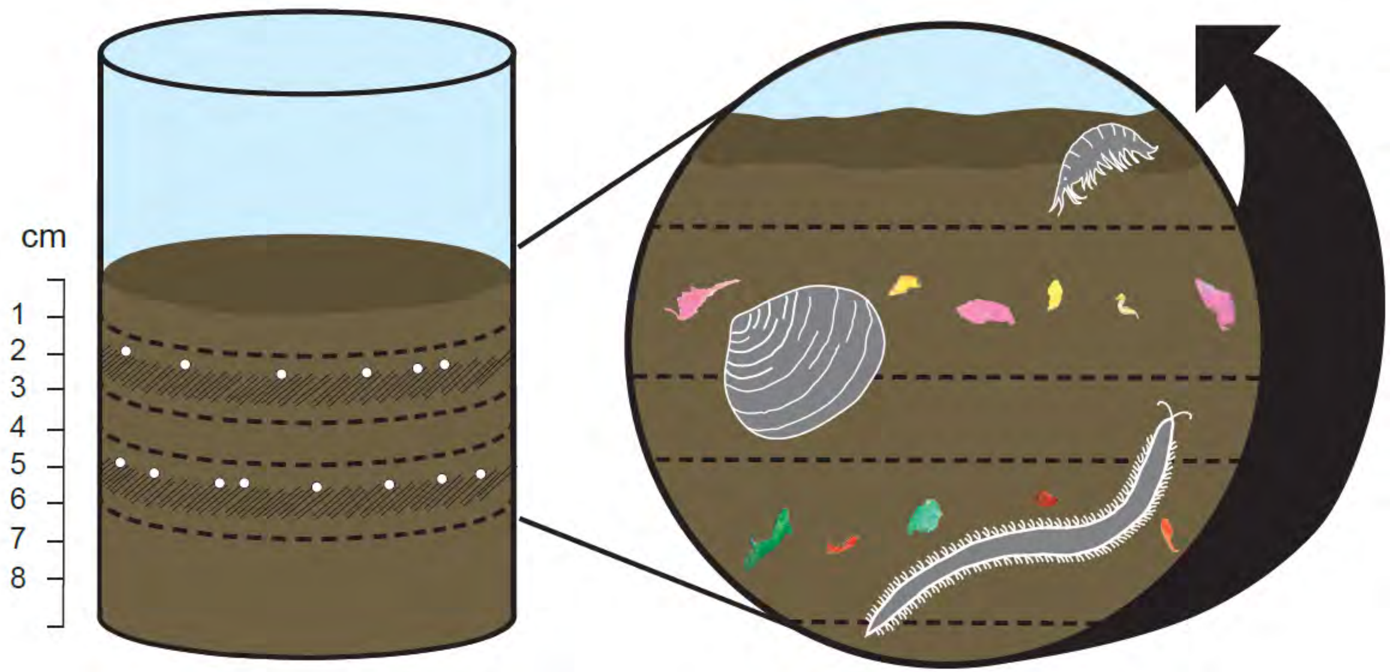
I

Is bioturbation by common benthic invertebrates burying microplastics deeper in the sediment?



II

Does bioturbation transport once buried microplastics back to the sediment surface?



Photos: Pinja Näkki & Tuomas Lahti

8%

OF MICROPLASTICS WERE BURIED BELOW THE SEDIMENT SURFACE

1%

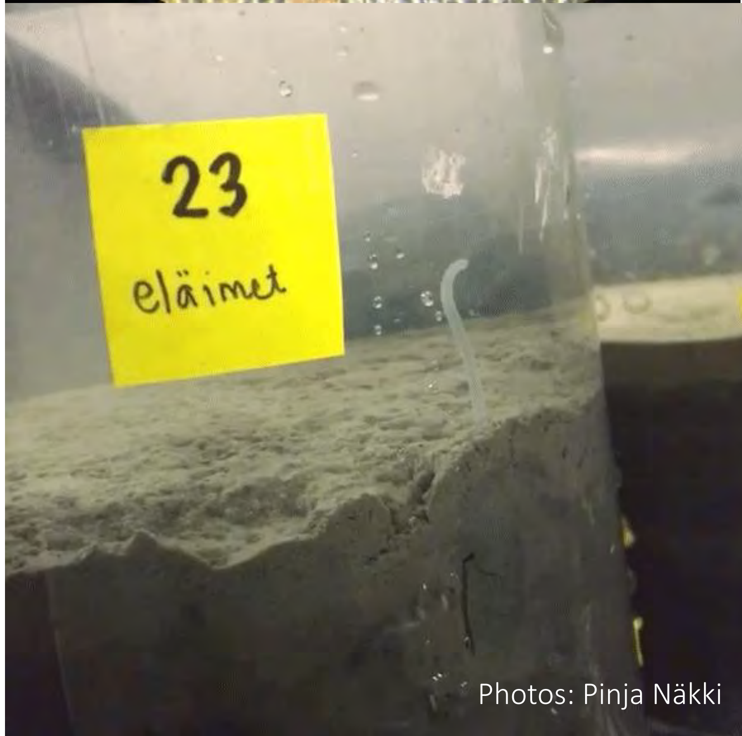
OF MICROPLASTICS RETURNED TO THE SEDIMENT SURFACE

I & II
Are benthic invertebrates ingesting microplastics?



	I	II
Monoporeia affinis	✗	✗
Marenzelleria spp.	✗	✗
Limecola balthica	✓ 25%	✓ 1%

Photos of species: Katriina Könönen, Jan-Erik Bruun, Hans Hillewaert (CC BY-SA 4.0)

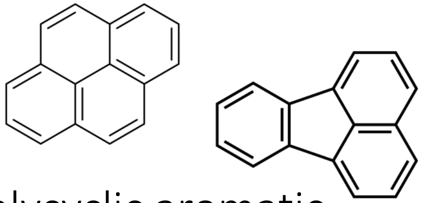



Photos: Pinja Näkki

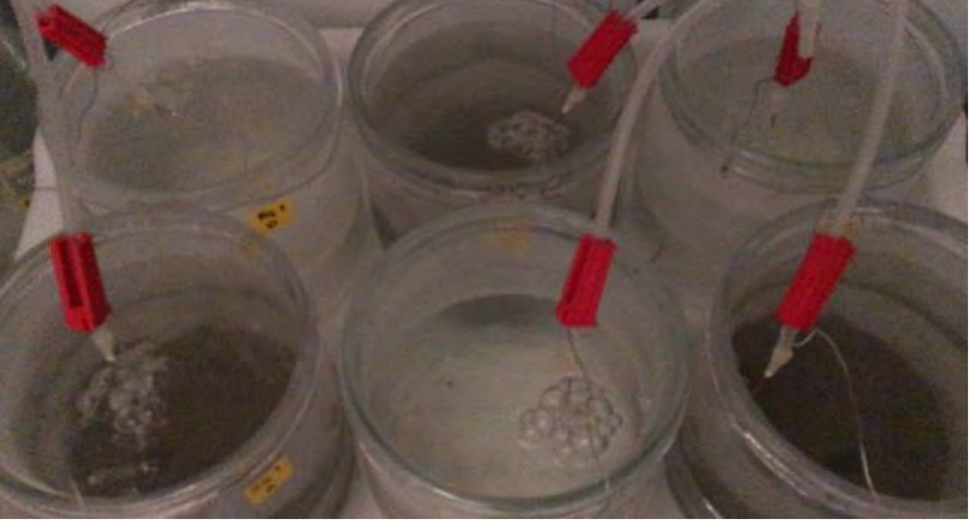
Photo: Ivan Radic (CC BY 2.0)

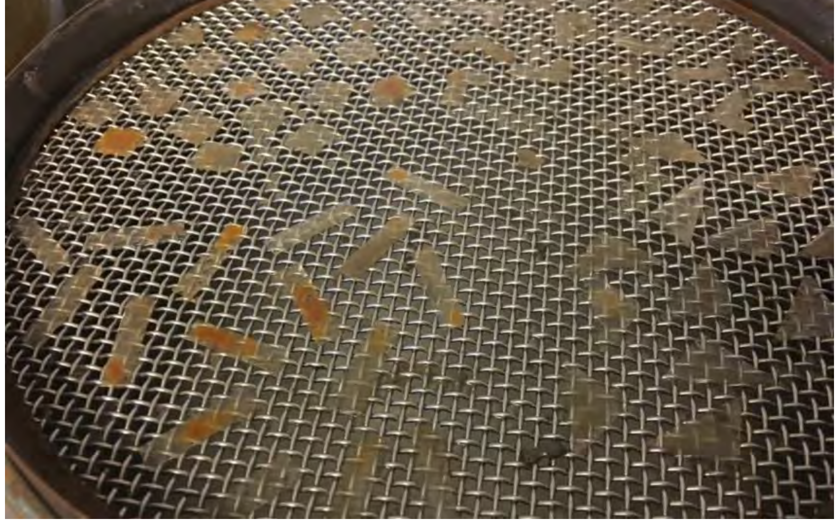
III
Does the PAH sorption capacity and bacterial community composition differ between conventional and biodegradable plastics?

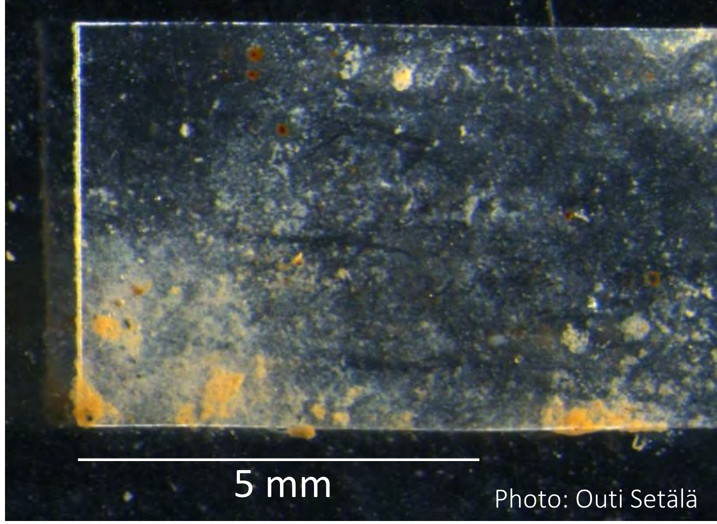
Photo: Pinja Näkki

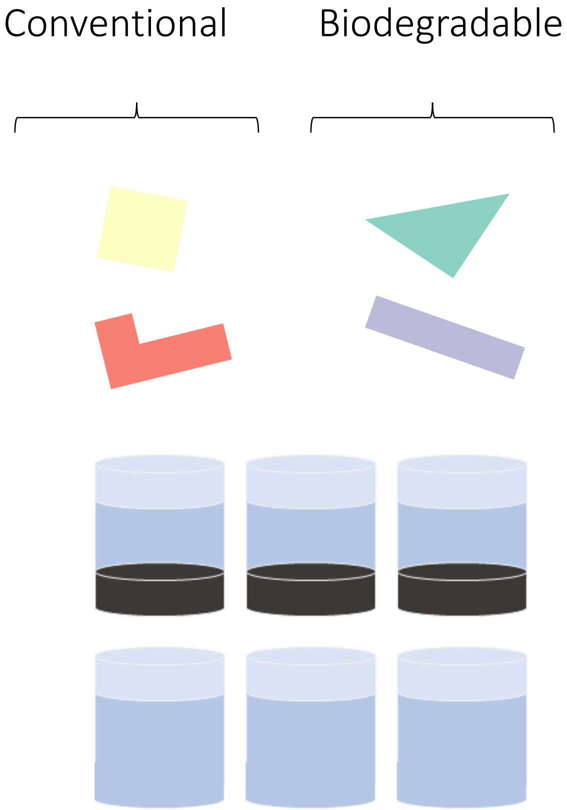


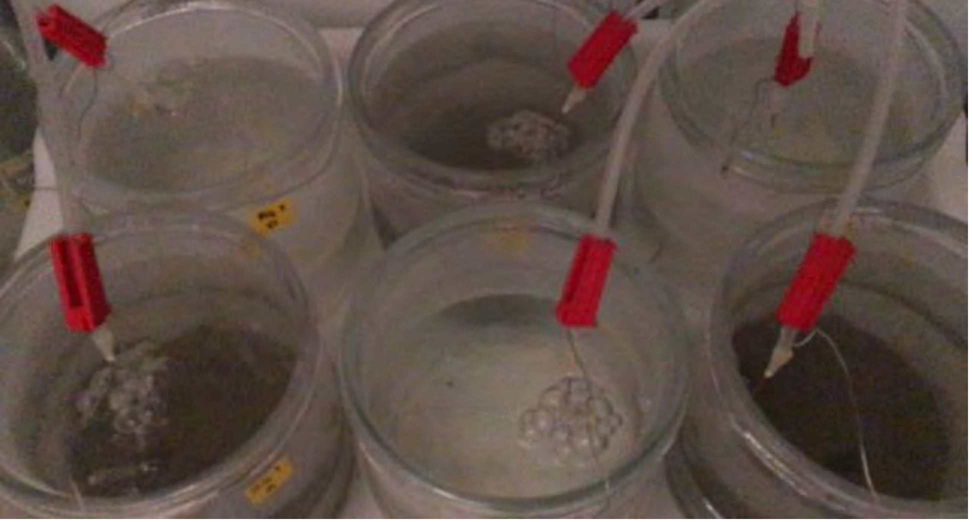
Polycyclic aromatic hydrocarbons (PAHs)

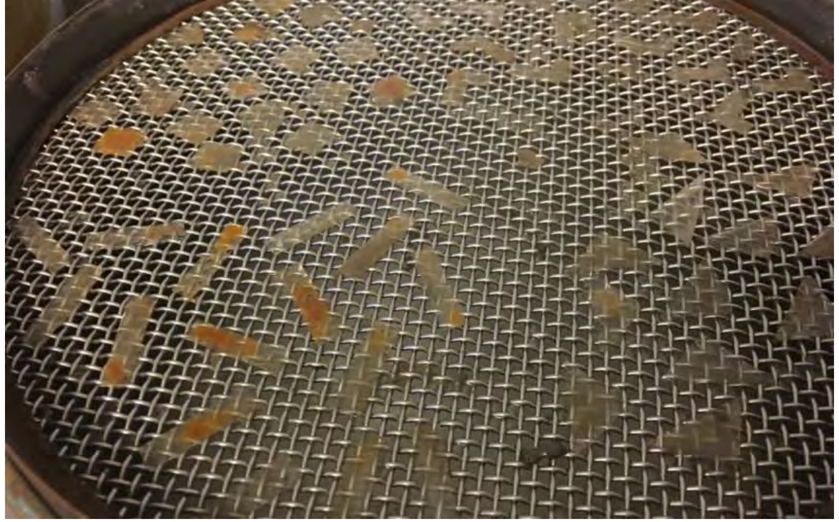


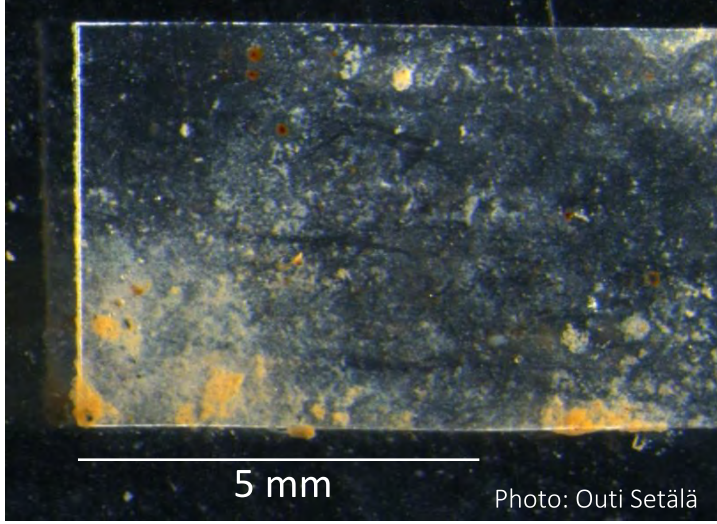


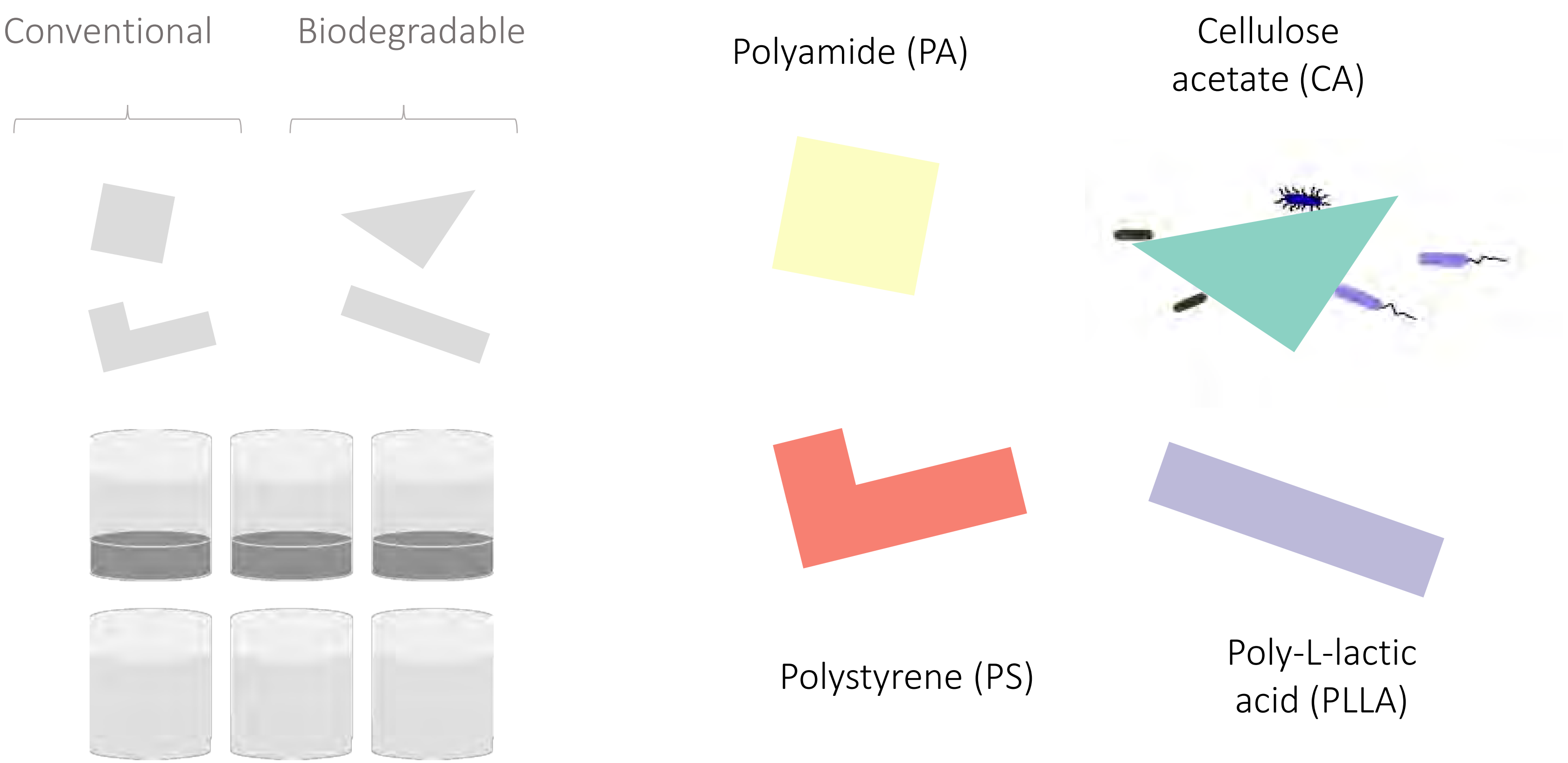

5 mm
Photo: Outi Setälä

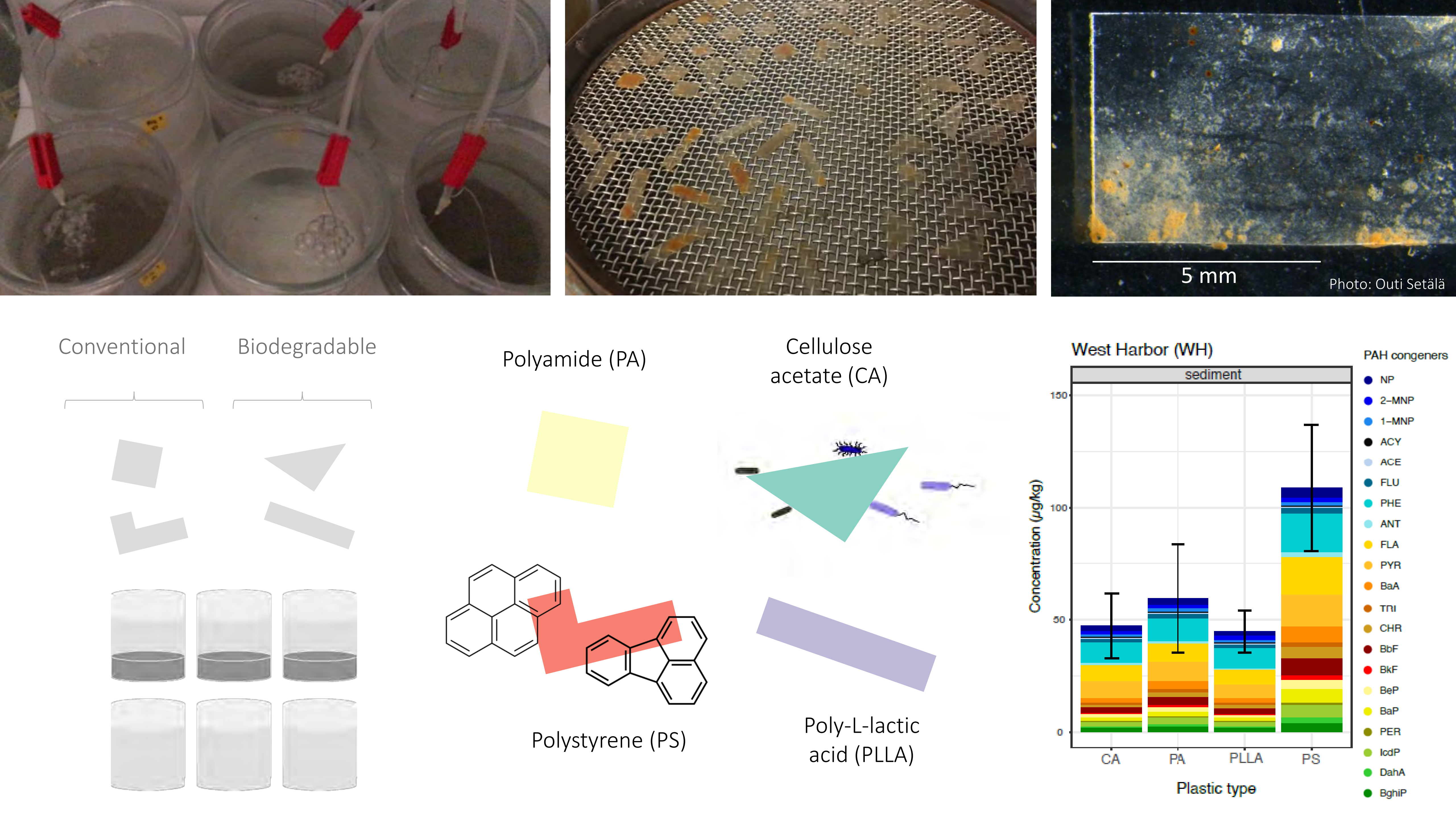

Conventional
Biodegradable



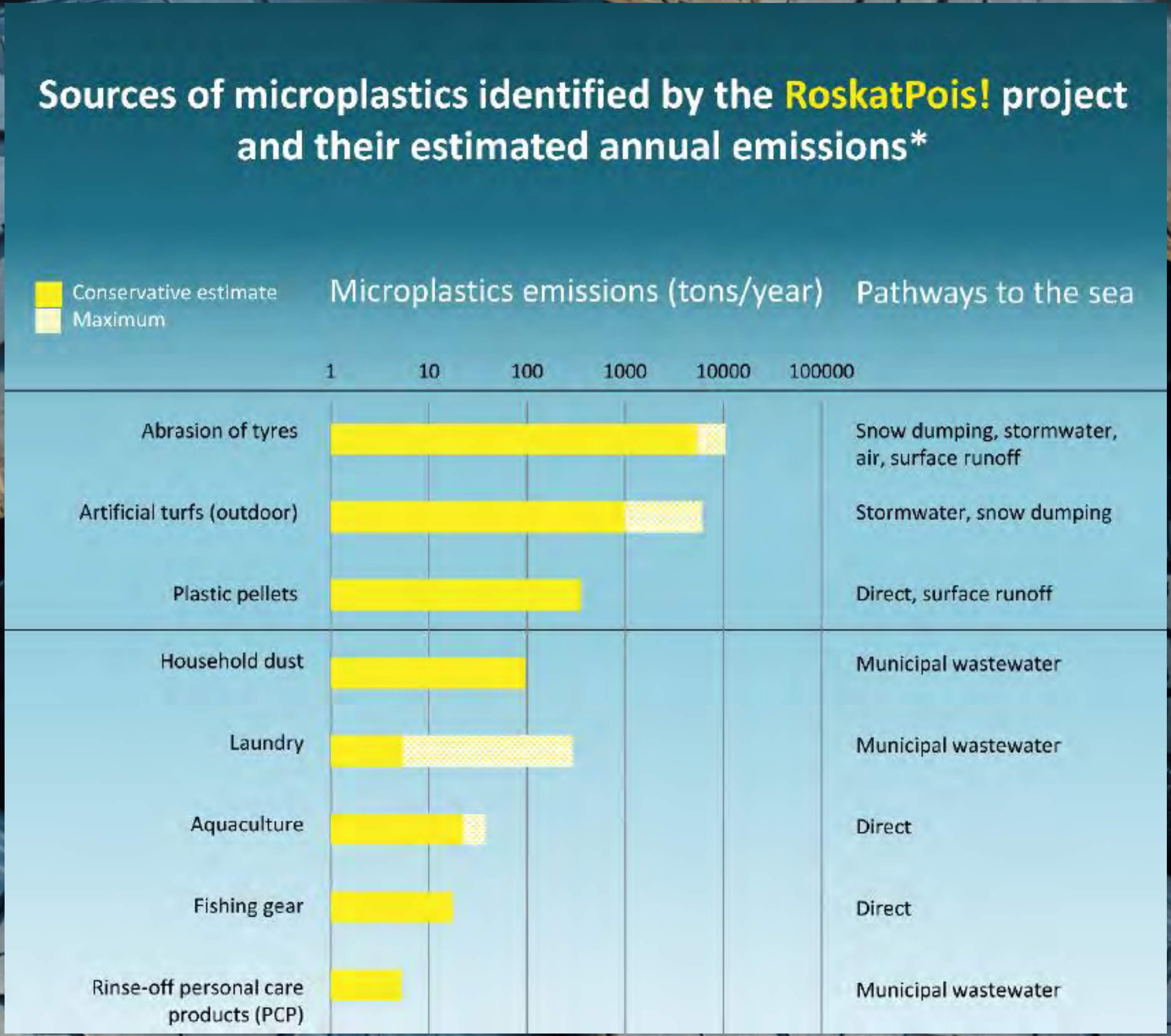



5 mm
Photo: Outi Setälä


Conventional
Biodegradable
Polyamide (PA)
Cellulose acetate (CA)
Polystyrene (PS)
Poly-L-lactic acid (PLLA)



5 mm
Photo: Outi Setälä
Conventional
Biodegradable
Polyamide (PA)
Cellulose
acetate (CA)
Polystyrene (PS)
Poly-L-lactic
acid (PLLA)
West Harbor (WH)
sediment
PAH congeners
NP
2–MNP
1–MNP
ACY
ACE
FLU
PHE
ANT
FLA
PYR
BaA
TRI
CHR
BbF
BkF
BeP
BaP
PER
IcdP
DahA
BghiP
Concentration (µg/kg)
150
100
50
0
CA
PA
PLLA
PS
Plastic type



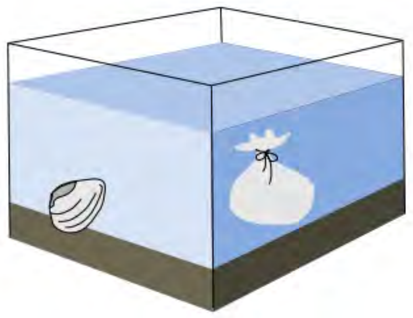
IV
Does exposure to tyre rubber fragments have negative impacts on the Baltic clam?

Illustration: ComiCONNMitch (CC BY-SA 3.0)

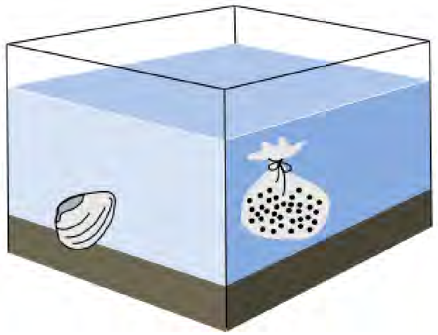
* The estimates represent total emissions of microplastics, and not the actual emissions to the sea. Source: Setälä & Suikkanen 2020

Photo: Goh Rhy Yan (Unsplash)

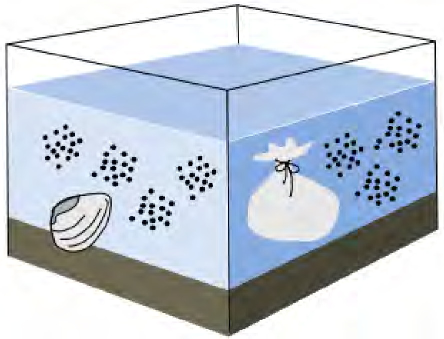
ACUTE (5 days) & **CHRONIC** (29 days) exposures



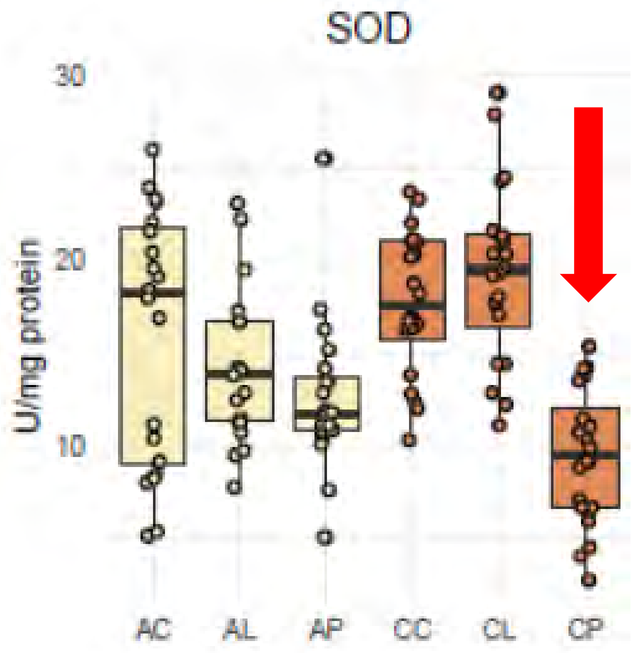
Control
empty mesh bag,
no rubber powder



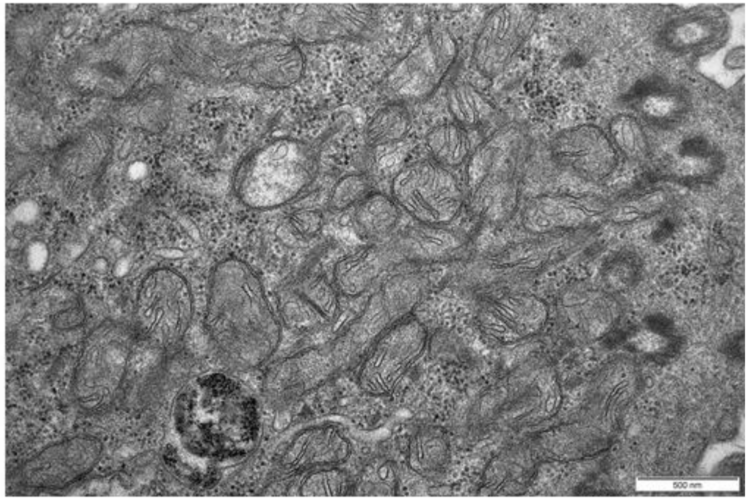
Leachate treatment
mesh bag containing
rubber powder



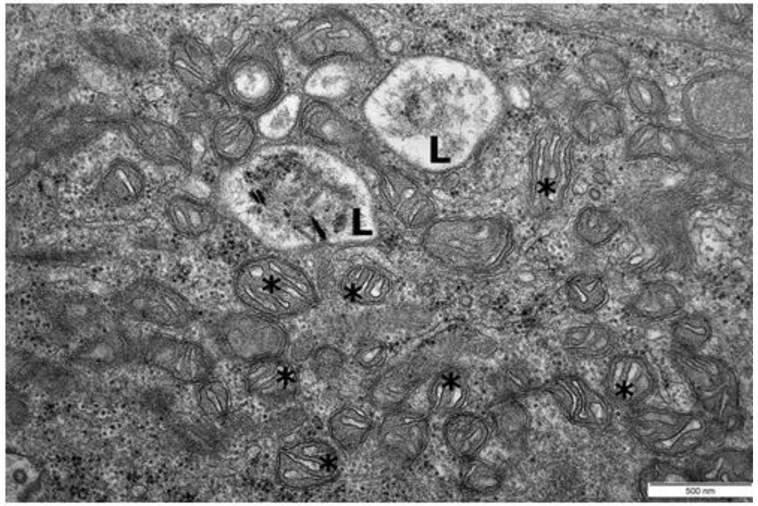
Particle treatment
empty mesh bag,
rubber powder freely in the
mesocosm



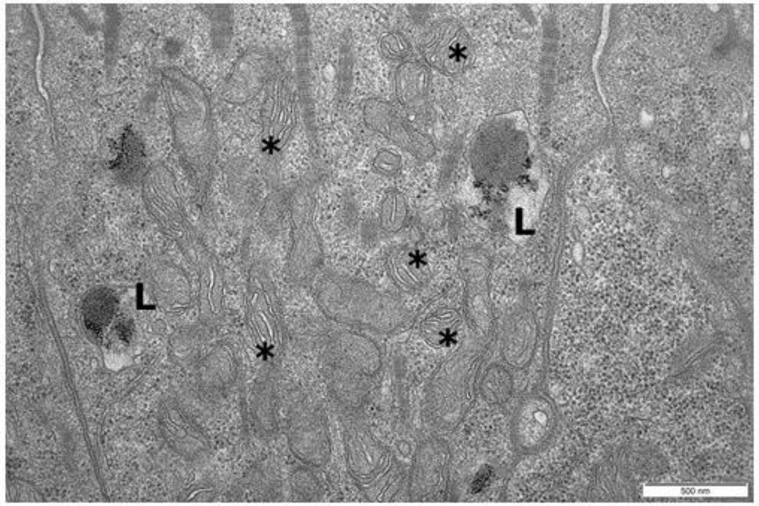
Chronic control

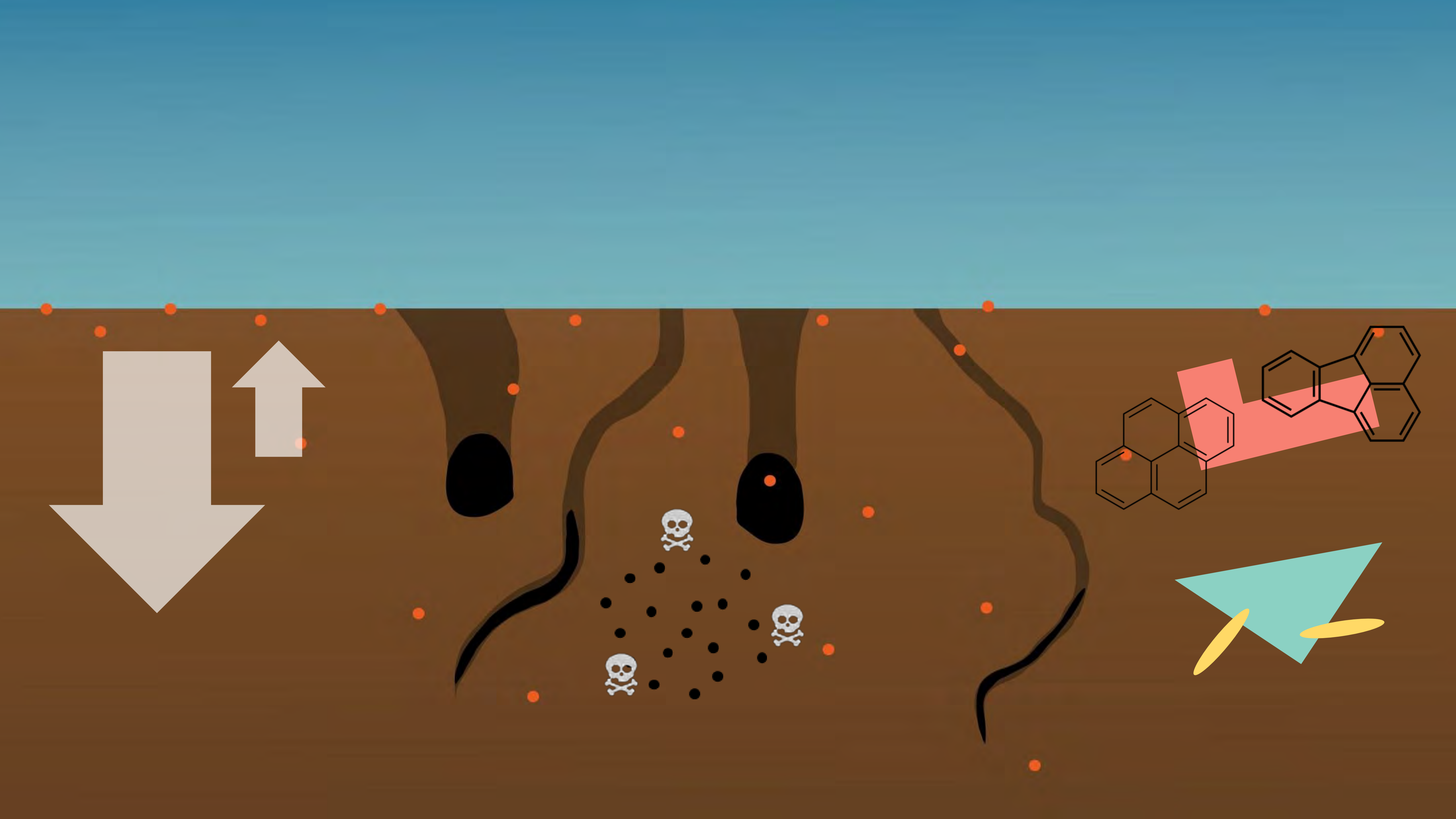


Chronic leachate



Chronic particle





Thank you!

SOLUTION TO MICROPLASTIC POLLUTION
ROSKASAKKI

Download the PhD thesis from here

I Näkki, P, Setälä O & Lehtiniemi, M. 2017. Bioturbation transports secondary microplastics to the deeper layers in soft marine sediments of the northern Baltic Sea. *Marine Pollution Bulletin* 119(1): 255–261.

II Näkki, P, Setälä O & Lehtiniemi, M. 2019. Seafloor sediments as microplastic sinks in the northern Baltic Sea – negligible upward transport of buried microplastics by bioturbation. *Environmental Pollution* 249: 74–81.

III Näkki, P, Eronen-Rasimus, E, Kaartokallio, H, Kankaanpää, H, Setälä, O, Vahtera, E & Lehtiniemi, M. 2021. Polycyclic aromatic hydrocarbon sorption and bacterial community composition of biodegradable and conventional plastics incubated in coastal sediments. *Science of the Total Environment* 755(Part 2): 143088.

IV Näkki, P, Ahvo, A, Turja, R, Sainio, E, Koistinen, A, Peräniemi, S, Hartikainen, S, Stankevičiūtė, M, Pažusienė, J, Lehtonen, KK, Setälä, O & Lehtiniemi, M. Tyre rubber exposure causes oxidative stress and intracellular damage in the Baltic clam (*Limecola balthica*) – *Manuscript*

UNIVERSITY OF HELSINKI
SYKE
PRO MARE BALTICUM WALTER AND ANDRÉE DE NOTTBECK FOUNDATION SR
TVÄRMINNE ELÄINTIETEELLINEN ASEMA ZOOLOGICAL STATION
Ympäristöministeriö
Miljöministeriet
Ministry of the Environment
ACADEMY OF FINLAND
UNIVERSITY OF EASTERN FINLAND

Beached litter and microplastics in the coastal zone of the Russian part of the Gulf of Finland

TATJANA EREMINA,
ALEXANDRA ERSHOVA,
IRINA MAKEEVA,
ANASTASSIA KUZMINA,
NATALYA LOGINOVA

ERSHOVA@RSHU.RU

PLASTICLAB
RUSSIAN STATE HYDROMETEOROLOGICAL UNIVERSITY (RSHU),
ST.PETERSBURG, RUSSIA

PLASTIC LAB
MICROPLASTIC RESEARCH LABORATORY

RSHU

Russian State Hydrometeorological University (RSHU) – *overview of past activities for future cooperation*

Conducts research on plastic pollution of the natural environment **since 2017**, with the support of the Russian Foundation for Basic Research 18-55-76001 ERA_a, *ERA-NET PLUS project "Litter rim along the coasts of the Baltic Sea: monitoring, impact, remediation"*

<u>1. Monitoring of the coasts and aquatic environment of the Neva Bay</u>

<u>2. Study of microplastic pollution in the Russian Arctic and the Far East</u>

Specialized Laboratory for Plastic Pollution Research – PlasticLab:

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- Development of observation techniques, development of methods and devices for sampling, adaptation of laboratory sample analysis techniques, adaptation of international experience to Russian conditions (freezing seas, eutrophied waters)

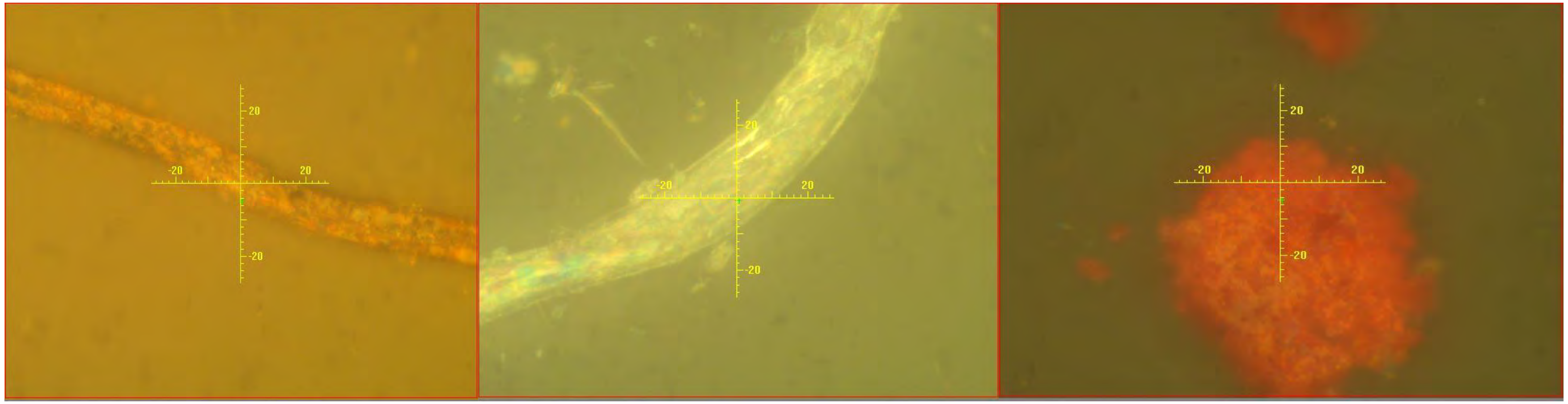
- Intercalibration of methods for monitoring microplastic pollution of the natural environment with leading Russian (IG RAS, TSU) and international (SYKE) scientific institutes to develop recommendations for a standardized method for monitoring plastic pollution of the natural environment for the Russian Federation

RSHU

Microplastics

Large MPs (1 - 5 mm) – visually detectable

MPs (less 1 mm) - requires special equipment for determination in the sample (IR spectrometry, Raman spectrometry, etc.)



Neva Bay and the Gulf Finland: monitoring overview of 2018-2021

<u>AIMS</u>:

1. Study of beached marine litter in the Neva estuary (enclosed bay, river Neva – the largest river in Europe):

Microlitter (**2-5 mm**), Mesolitter (5-25 mm), Macrolitter (>25 mm)

2. Study, testing and adaptation of different methods of litter sampling on the beach – urban beaches.

3. Identification of litter pollution “hotspots”

4. Define the basis of a mathematical model of litter distribution in the Neva estuary

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Monitoring methods

<u>METHODOLOGIES:</u>

ADAPTATION OF INTERNATIONAL METHODS FOR THE CONDITIONS OF THE NEVA BAY AND THE GULF OF FINLAND:

- ***2 METHODS FOR SANDY COASTS*** (SAND SCREENING, WRECK-LINE ZONE AND "DRY" BEACH AREA)
- ***METHOD OF WATER*** SAMPLING USING THE FILTER INSTRUMENT "HYDROPUMP - (HYDROPUMP FOR MICROPLASTICS)", (<u>PATENTED</u>) DEVELOPED BY PLASTICLAB

(A SPECIAL SAMPLER WITH REPLACEABLE FILTERS WITH VARIOUS MESH SIZES (50-100 MICRONS)

- ***METHOD FOR VESSELS***: FLOW-THROUGH SYSTEM OF MP SAMPLING

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ПОЛЕЗНУЮ МОДЕЛЬ

№ 206110

Пробоотборник для определения содержания микропластика в морской воде (HydroPuMP)

Патентообладатель: ***федеральное государственное бюджетное образовательное учреждение высшего образования "Российский государственный гидрометеорологический университет" (RU)***

Авторы: ***Ершова Александра Александровна (RU), Татаренко Юрий Алексеевич (RU)***

Заявка № **2020144043**
Приоритет полезной модели **28 декабря 2020 г.**
Дата государственной регистрации в Государственном реестре полезных моделей Российской Федерации **24 августа 2021 г.**
Срок действия исключительного права на полезную модель истекает **28 декабря 2030 г.**

Руководитель Федеральной службы по интеллектуальной собственности

Г.П. Ивлиев

Laboratory methods

Sample preparation (processing with chemical reagents to get rid of organic matter, separation, filtration, flotation, drying)

- **Microscopy**,
- UV microscopy
- IR spectrometry
- **Raman spectroscopy**
- **Pyrolysis-Gas Chromatography** / **Mass Spectrometry (Py-GC / MS)**

Unique spectral characteristics of various plastic polymers (polyethylene, polypropylene, polystyrene, etc.) in the range from near-infrared to short-wave infrared spectrum

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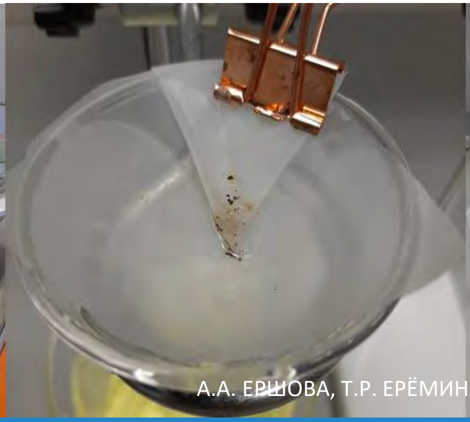
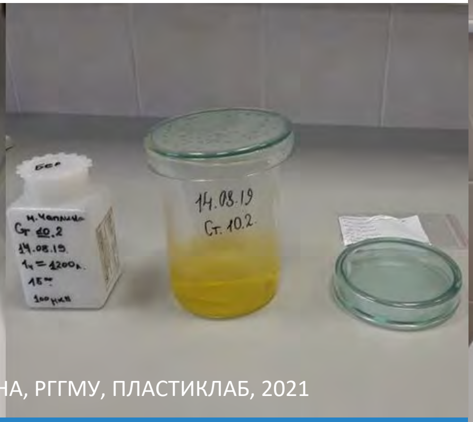
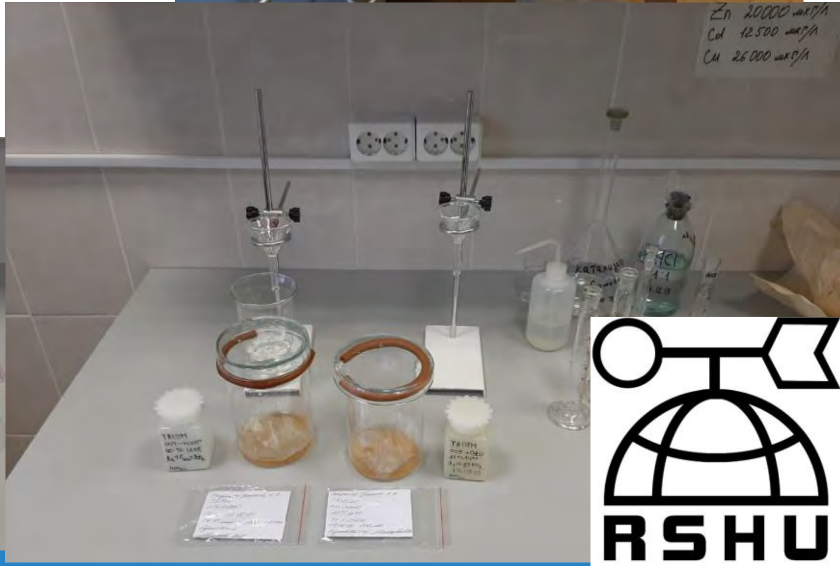






RSHU

Beach litter monitoring

Based on OSPAR, MSFD beach litter guidelines

Developed and adapted by Leibniz Institute for Baltic Sea Research (Leibniz-Institut für Ostseeforschung Warnemünde, IOW)

1. Sand Rake method – micro-and mesolitter at mini**mum** 50m^2 of beach surface between waterline and vegetation line

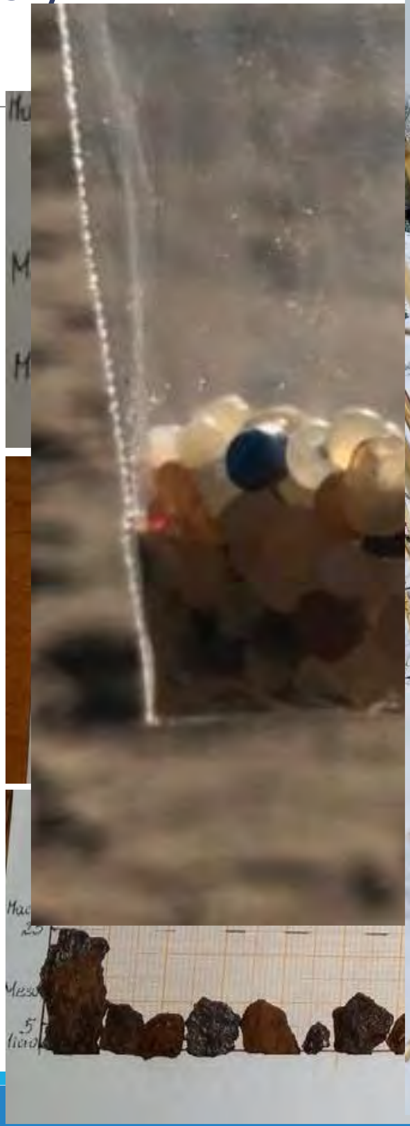
2. Frame-method – for local assessment of microliter accumulation in lagoon-type bays in the wreck-line zone

Focus: large micro-litter (2-5 mm) and **mesolitter** (5–25 mm) in upper layer of sand 30–50 mm for regularly cleaned beaches

Marine litter on the beaches of the Neva Bay

Top-litter items:

- plastic pellets
- glass
- cigarette butts
- metal
- cotton swabs
- synthetic napkins



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Types of litter in the Baltic region
(results from ERA-NET PLUS project “Litter rim along the coasts of the Baltic Sea: monitoring, impact, remediation“, 2018-2020)

Monitoring of large micro-, meso- and macro-litter at sandy beaches of Baltic lagoons and estuaries

Greta Gyraite[1,2*], Mirco Haseler[1,2], Arūnas Balčiūnas[1], Viktorija Sabaliauskaitė[1], Irina Chubarenko[3], Elena Esiukova[3], Liliya Khatmullina[3], Alexandra Ershova[4], Tatjana Eremina[4], Georg Martin[5], Greta Reisalu[5], Gerald Schernewski[1,2]

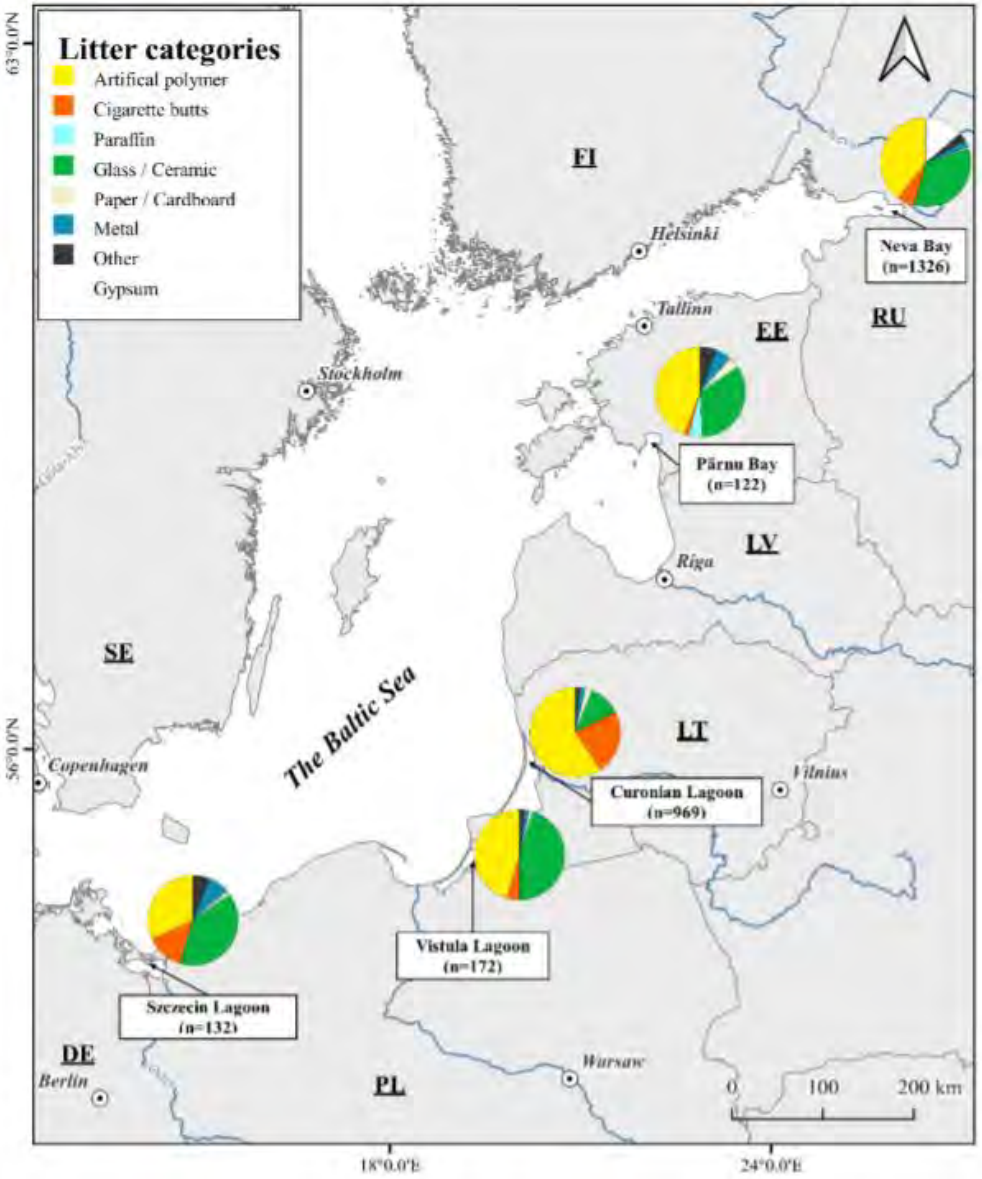
[1] *Marine Research Institute, Klaipeda University, Universiteto al. 17, 92295 Klaipeda, Lithuania*
[2] *Leibniz Institute for Baltic Sea Research Warnemuende, Seestraße 15, 18119 Rostock, Germany*
[3] *Shirshov Institute of Oceanology, Russian Academy of Sciences, Nakhimovski prospect 36, 117997, Moscow, Russia*
[4]*Russian State Hydrometeorological University, ul. Voronezhskaya 79, 192007, St. Petersburg, Russia.*
[5] *Estonian Marine Institute, University of Tartu, Mäealuse 14, 12618, Tartu, Estonia*

*Corresponding author: gyraite@io-warnemuende.de

<u>Submitted</u>

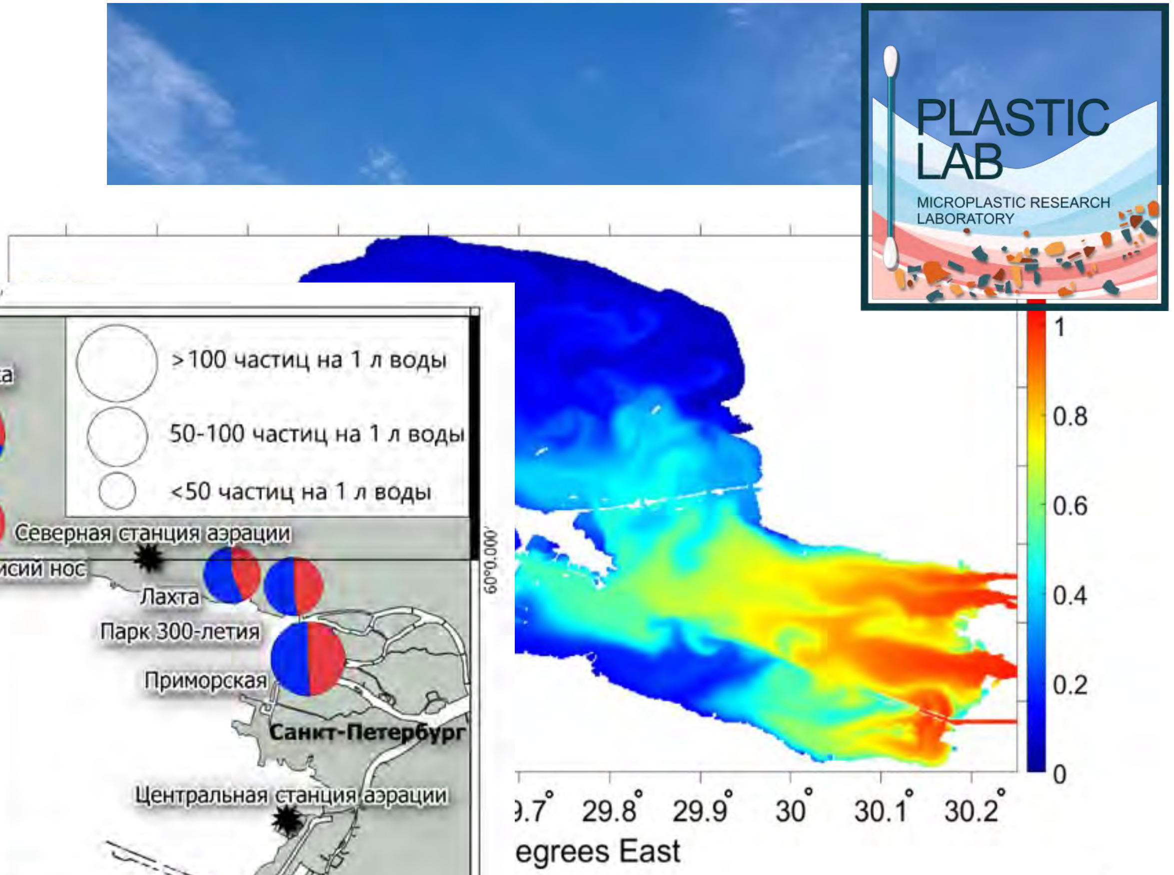
ABSTRACT

Coastal lagoons and estuaries are hot spots for the accumulation of river basin-related plastic leakage. However, no official methodology exists to investigate their relatively short, rich in organic matter beaches, and the knowledge of pollution of lagoons is scarce worldwide. This study aimed to develop a methodology suitable for large micro-, meso-, and macro-litter monitoring at sandy inner-coastal waters that would be applicable beyond the study region and would provide comparable results to the intensively used OSPAR 100 m method for coastal beaches. The method proposed in this study is based on two 40 m 2 rectangular polygons placed on the tidal accumulation zone for macro-plastic enumeration and two 1 m 2 squares for micro- and meso-plastics. This method has been applied in 48 beaches from five inner-coastal waters of the Baltic Sea. This study shows that the litter densities between

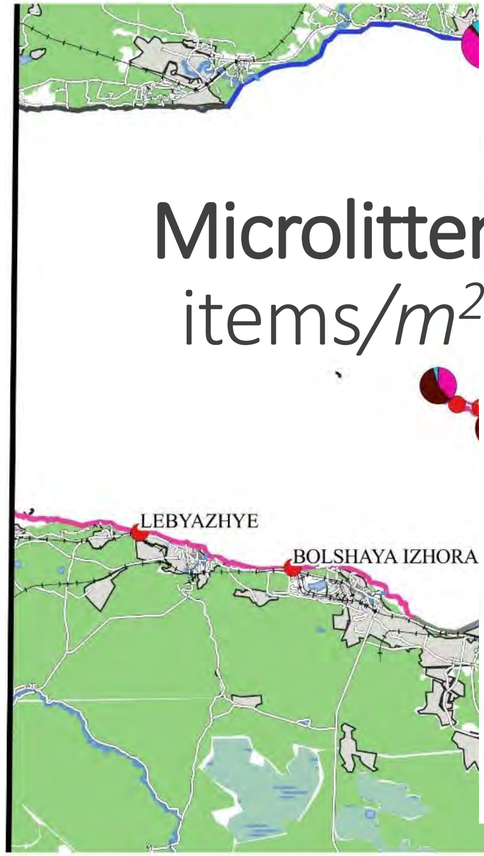


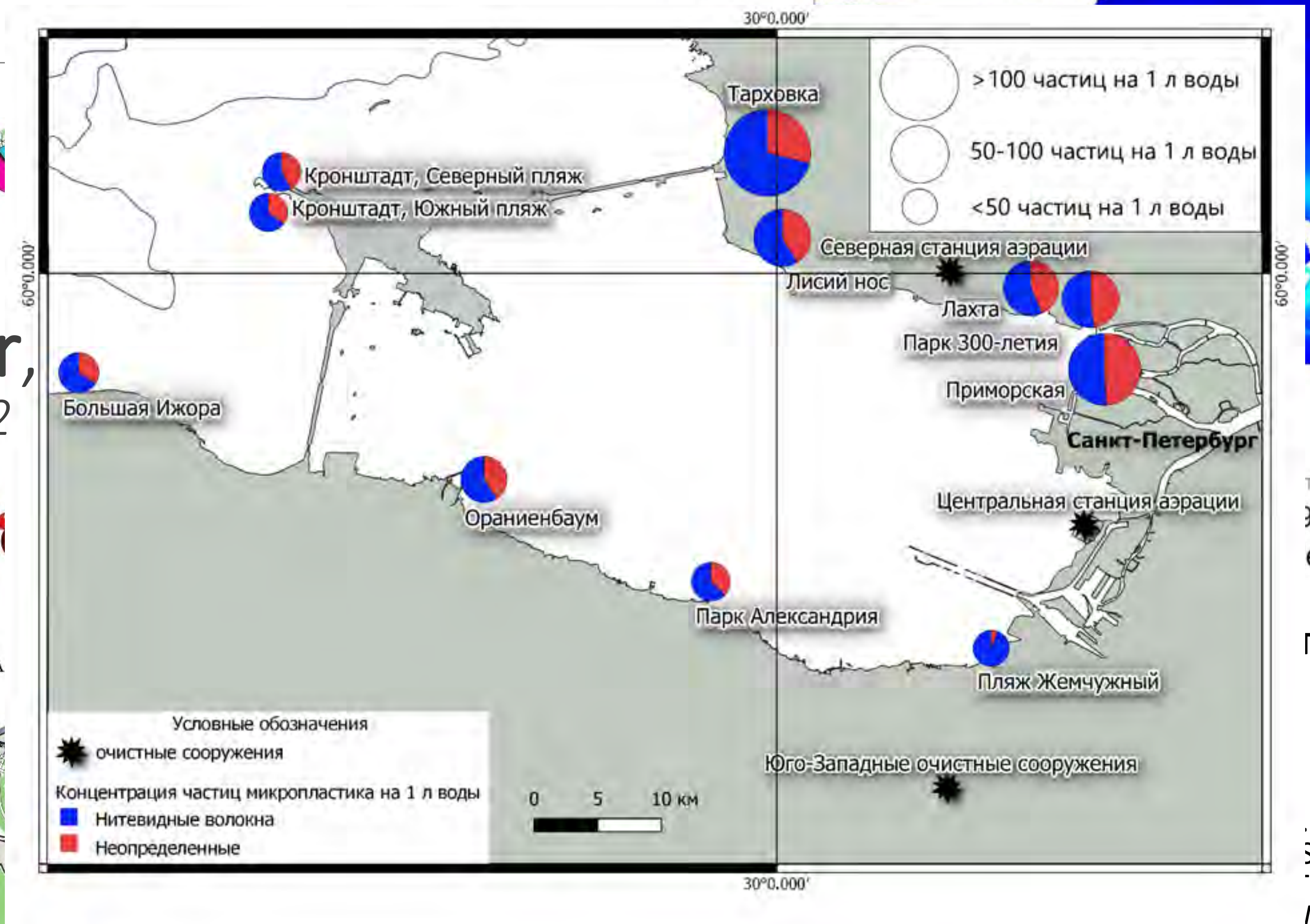
NEVA BAY and GULF OF FINLAND “HOTSPOTS”

(a)



Microlitter,
items/m^2





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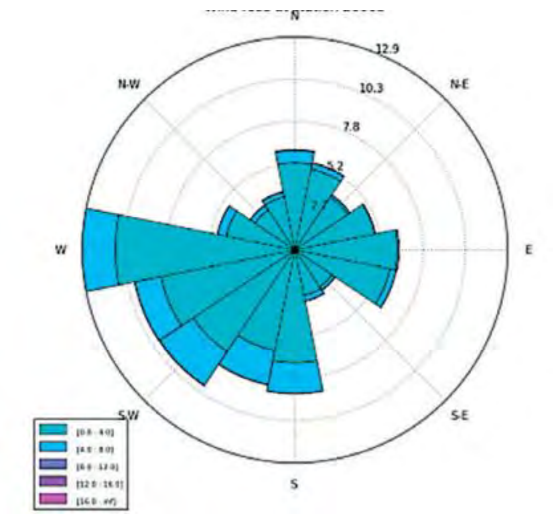
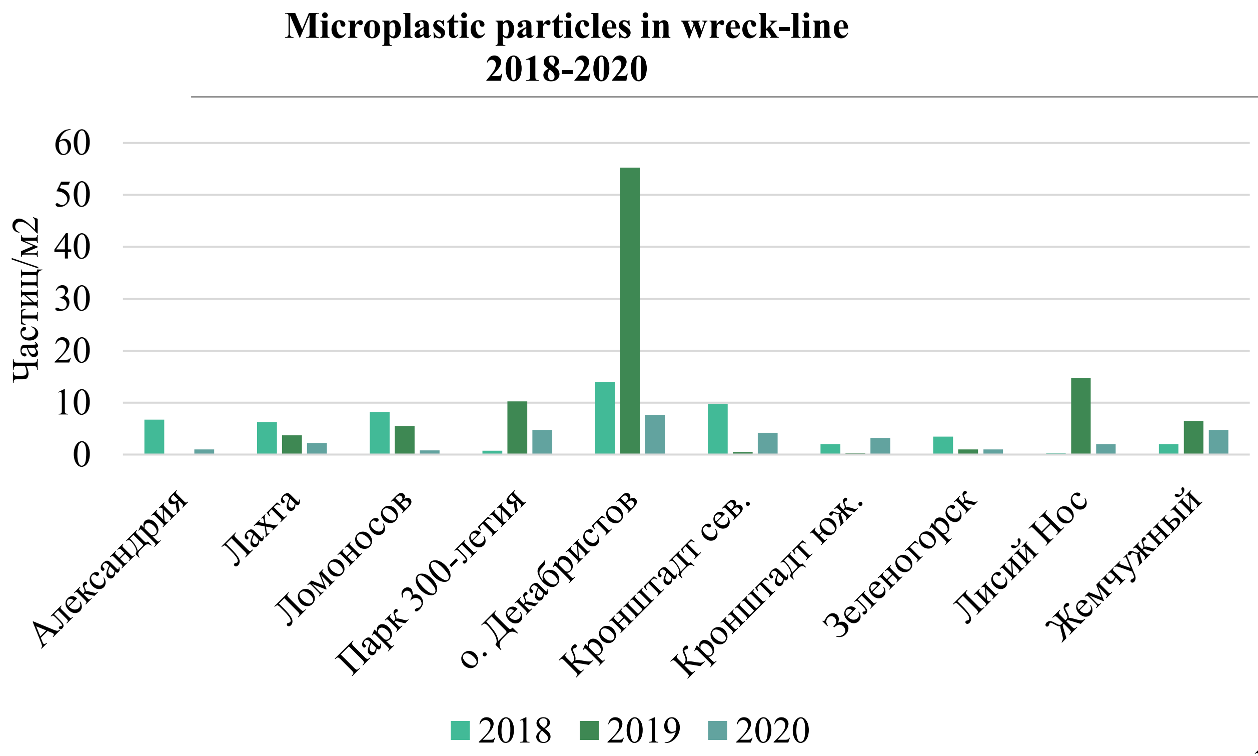
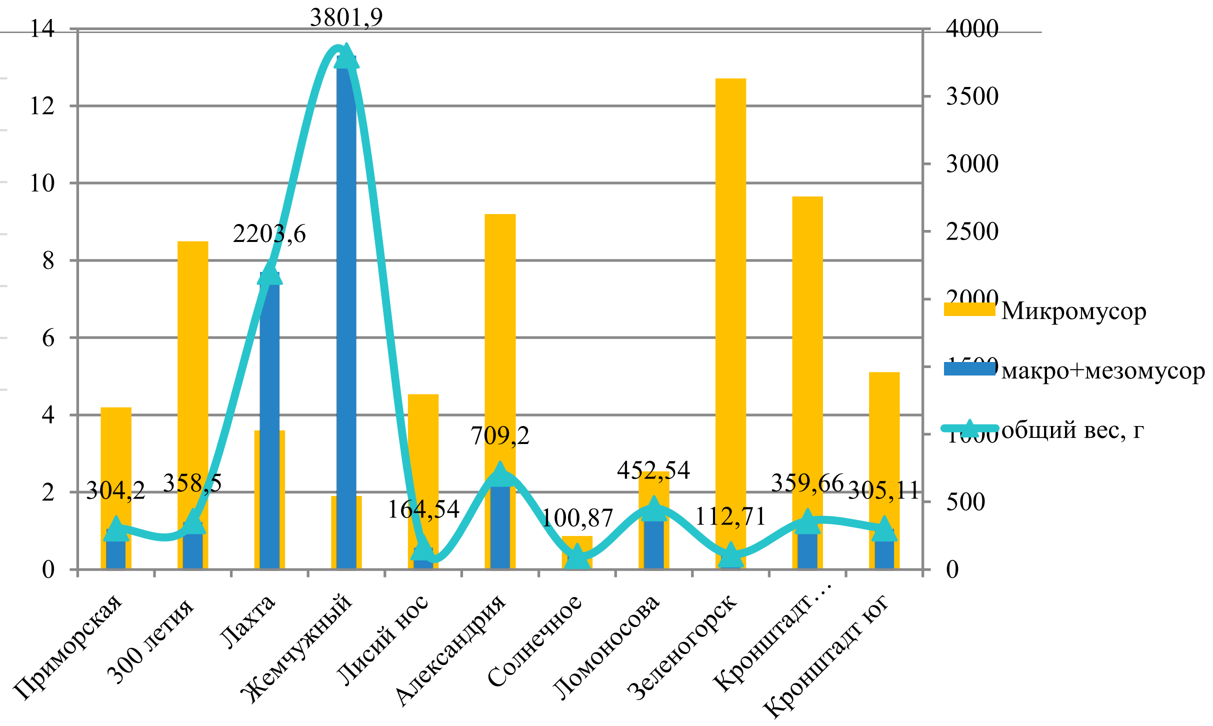
and Applied Hydrophysics, vol.3, **2019**



Neva Bay: microplastics in beach sand in 2018-2020



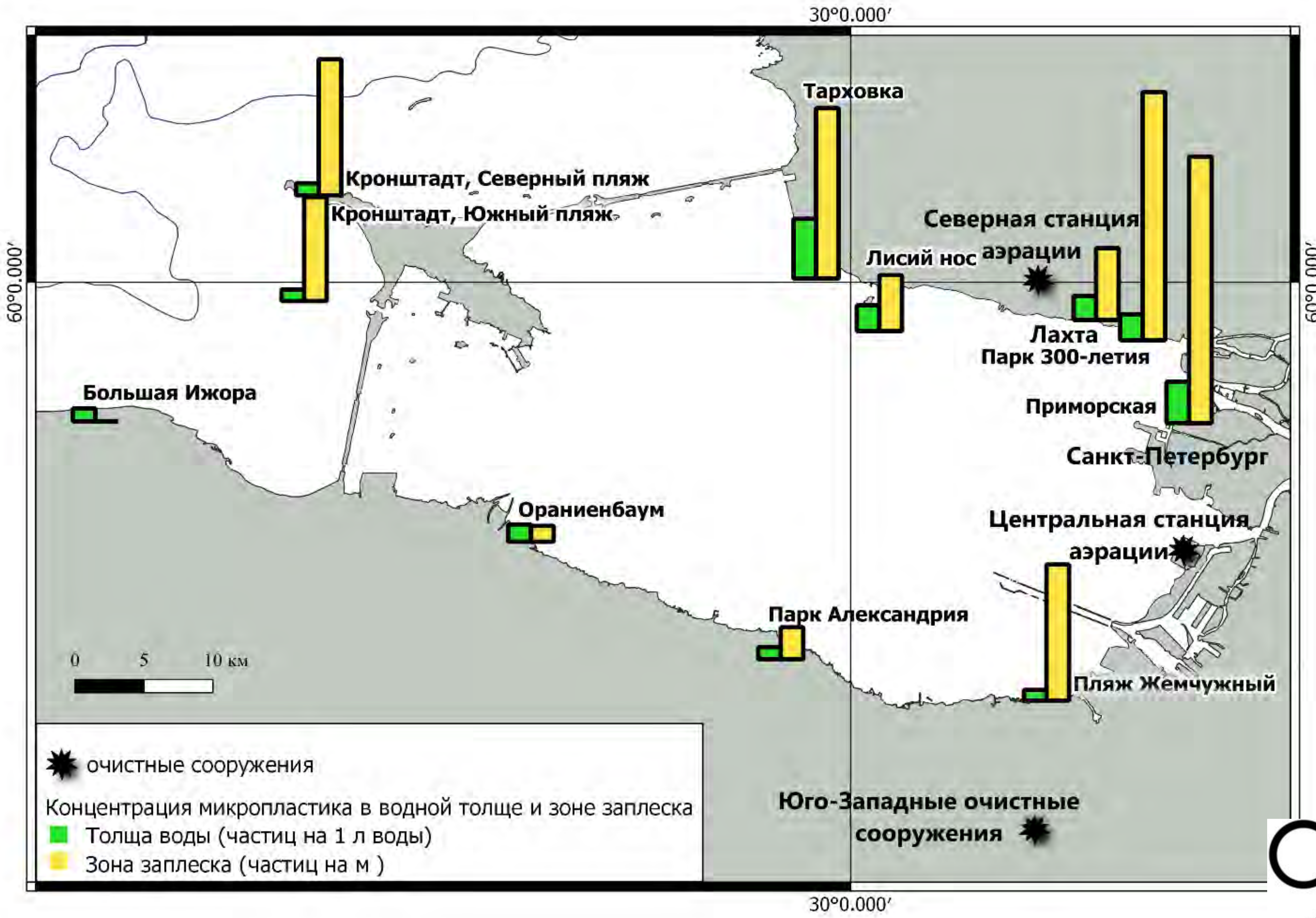


1. Sampling at least at 3 polygons to take account variability of litter accumulation.
2. Once a year sampling – not enough for such a dynamic system: need for seasonal monitoring (before and after storm events, storm surges, etc.).
3. Measuring units: amount in particles AND weight is necessary.

Microplastics in Neva Bay in 2020:
parallel measurements in water and beach sand

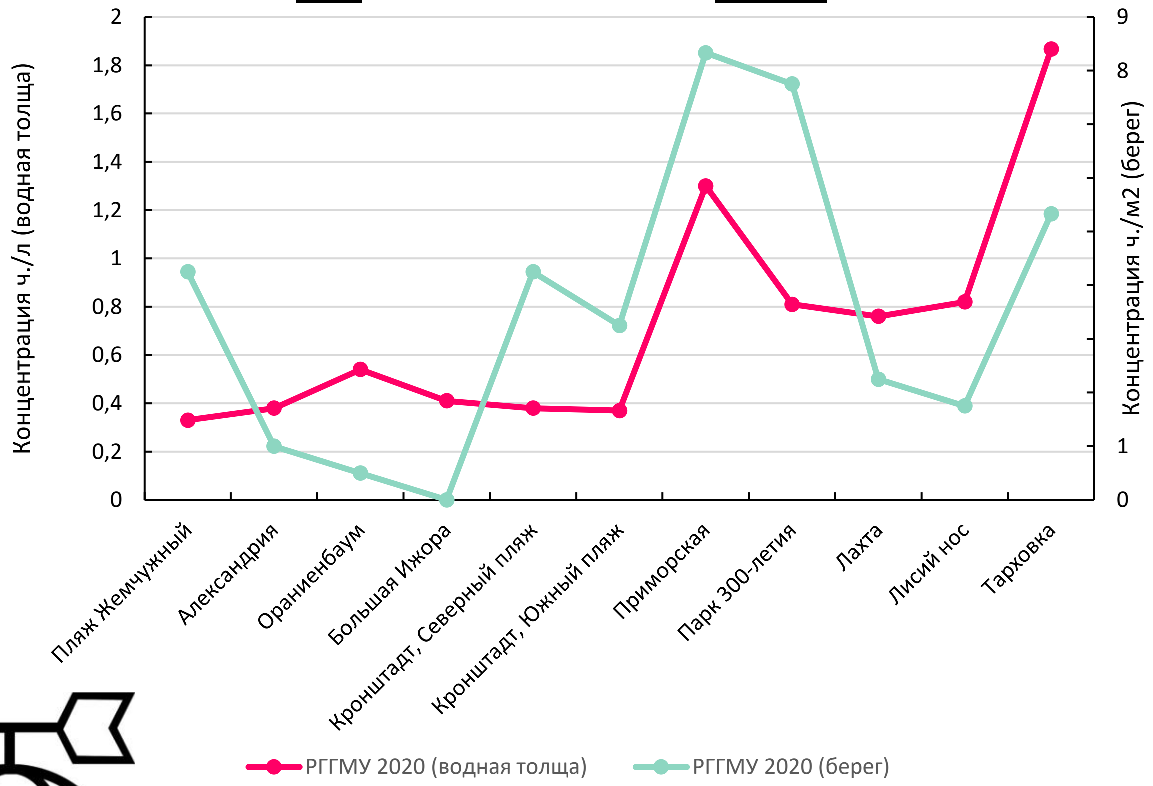
<u>Water (green)</u>:
0.33 – 1.3 particles/l
average 0.61 part/l
(130 μm - 6150 μm)

<u>Wreck-line (yellow)</u>:
0.5 – 8.3 part/m2
average 3.5 part/m2
(maximum in the Baltic Sea region)



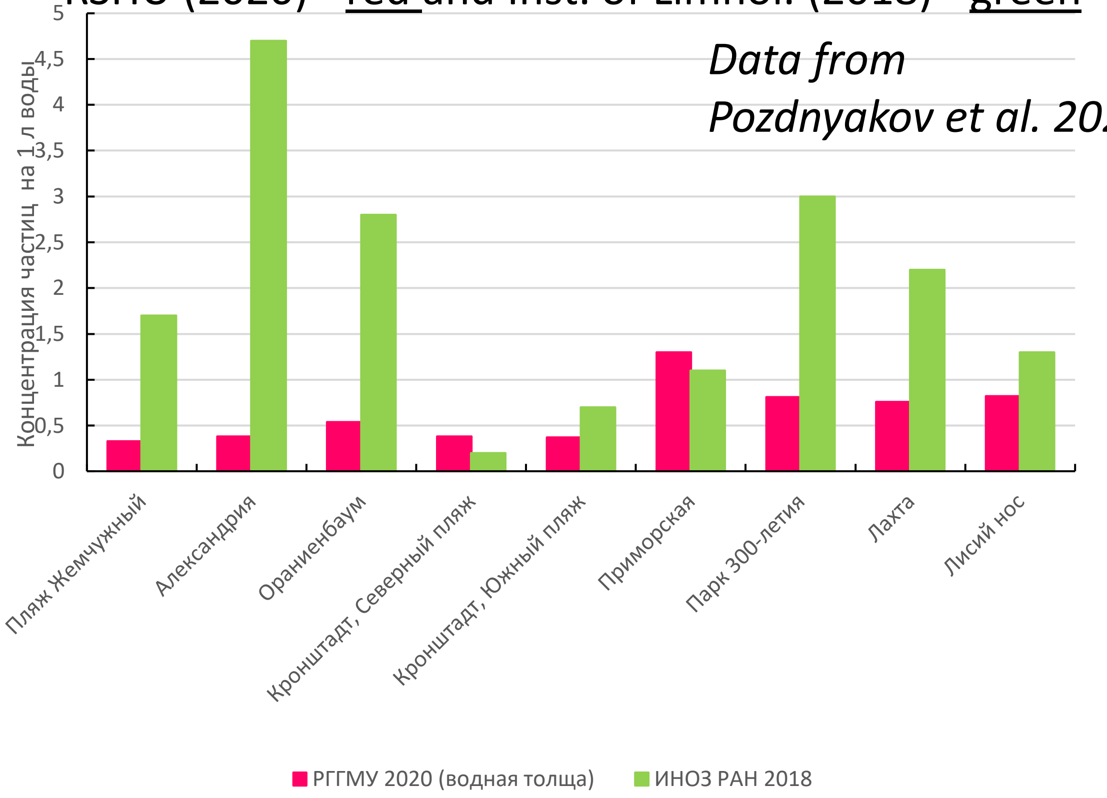
MPs in water and wreck-line zone of the beach: **Need for methods harmonization**

RSHU, 2020 parallel samplings:
water – red and beach sand - green



Microplastics in water:
RSHU (2020) - red and Inst. of Limnol. (2018) - green

Data from Pozdnyakov et al. 2020



Publications:

frontiers in Environmental Science

ORIGINAL RESEARCH
published: 26 November 2020
doi: 10.3389/fenvs.2020.599978

Check for updates

Marine Litter Pollution in Baltic Sea Beaches – Application of the Sand Rake Method

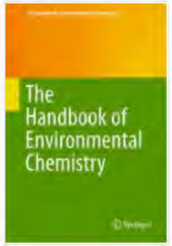
Mirco Haseler[1,2], Arunas Balciunas[2], Rah*
Irina Chubarenko[3], Alexandra Ershova[4] ar

[1] Leibniz Institute for Baltic Sea Research Warnemuende,
University, Klaipėda, Lithuania, [3] Atlantic Branch, Shirshov
Kalingrad, Russia, [4] Department of Geoecology, Environ
Hydrometeorological University, Saint-Petersburg, Russia

OPEN ACCESS

Most marine litter monitoring methods us
only and show shortcomings regarding
Baltic Sea beaches. Therefore, we used
(2–5 mm), and meso- (5–25 mm) litter to

Springer Link



pp 1-25 | Cite as

Marine Litter in the Russian Gulf of Finland and South-East Baltic: Application of Different Methods of Beach Sand Sampling

Authors | Authors and affiliations

Alexandra A. Ershova, Tatjana R. Eremina, Irina P. Chubarenko, Elena E. Esiukova

Chapter
First Online: 11 March 2021

Part of the The Handbook of Environmental Chemistry book series

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STUDY COURSE

(introduced in RSHU Curriculum)

"Plastic Pollution of the Environment"

and a **Text-Book** for Universities

(in Russian) *(in print)*

Authors: T.Eremina and A.Ershova

Russian State Hydrometeorological University (RSHU), St.Petersburg, Russia

PlasticLAB
https://vk.com/club171553796
WELCOME!

Monitoring of marine litter and microplastics in the Gulf of Finland and Neva Bay: conclusions and recommendations

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RSHU developed **harmonized methodological approaches** for different environments, worked out methods of sampling and laboratory analysis of water samples, developed sampling systems

Field observation data - 2018-2020: "**hot spots**" in the Neva Bay, accumulation trends (more questions than answers) and **a DATABASE** (over 1400 units for GoF area covering over 1400 m^2 of beaches)

SOURCES ??? Treatment facilities, untreated wastewater, leaching from underwater dumps, unauthorized landfills, construction sites, waste disposal, etc.

There is no information on the pollution of the Neva River tributaries, water intake points, the entire water column of the Gulf of Finland and bottom sediments

In order to develop **scientifically based measures** for the **management** of sources and recommendations for decision makers, it is necessary to comprehensively monitor the aquatic environment and the coasts of the Gulf of Finland, the Neva Bay and the river Neva, based on a **unified methodological approach**

Working with society (most of the plastic is household (hygienic) waste)

RSHU

Gulf of Finland future cooperation

1. Harmonization of sampling methods:
- manta nets, neuston nets, pumping filtering devices….
- micro-fraction – 100 mm and 330 mm or larger (visually-detectable)?
- beach monitoring methods: citizen science (volunteers) VS “true” science

2. Methods of lab analysis: what works for the Baltic (brackish sea) – does not work for the Arctic and the Pacific (phyto- and zooplankton digestion, etc. – need for method adaptation)

3. Joint intercalibration of monitoring methods (both beach sand and **water sampling**): DONE for water and sediments (*results presented by SYKE*), *beach monitoring remaining*

4. Modeling of microplastics in water: study of MPs properties’ changes under the influence of biogeochemical processes based on ecohydrodynamic models

5. Educational courses, programmes, field trainings – for students and young scientists

Dr Alexandra Ershova, Dr Tatjana Eremina

ershova@rshu.ru

PlasticLAB, Russian State Hydrometeorological University (RSHU), St.Petersburg, Russia

KKA joonistuskorkuss "Mina ja veekogu"
Niita Mohini Vool "Prügisaar" ("Trash Island")
Superviser Heidi Reisi, Kadrina Kunstidekool

Marine litter in the small islands of Estonia

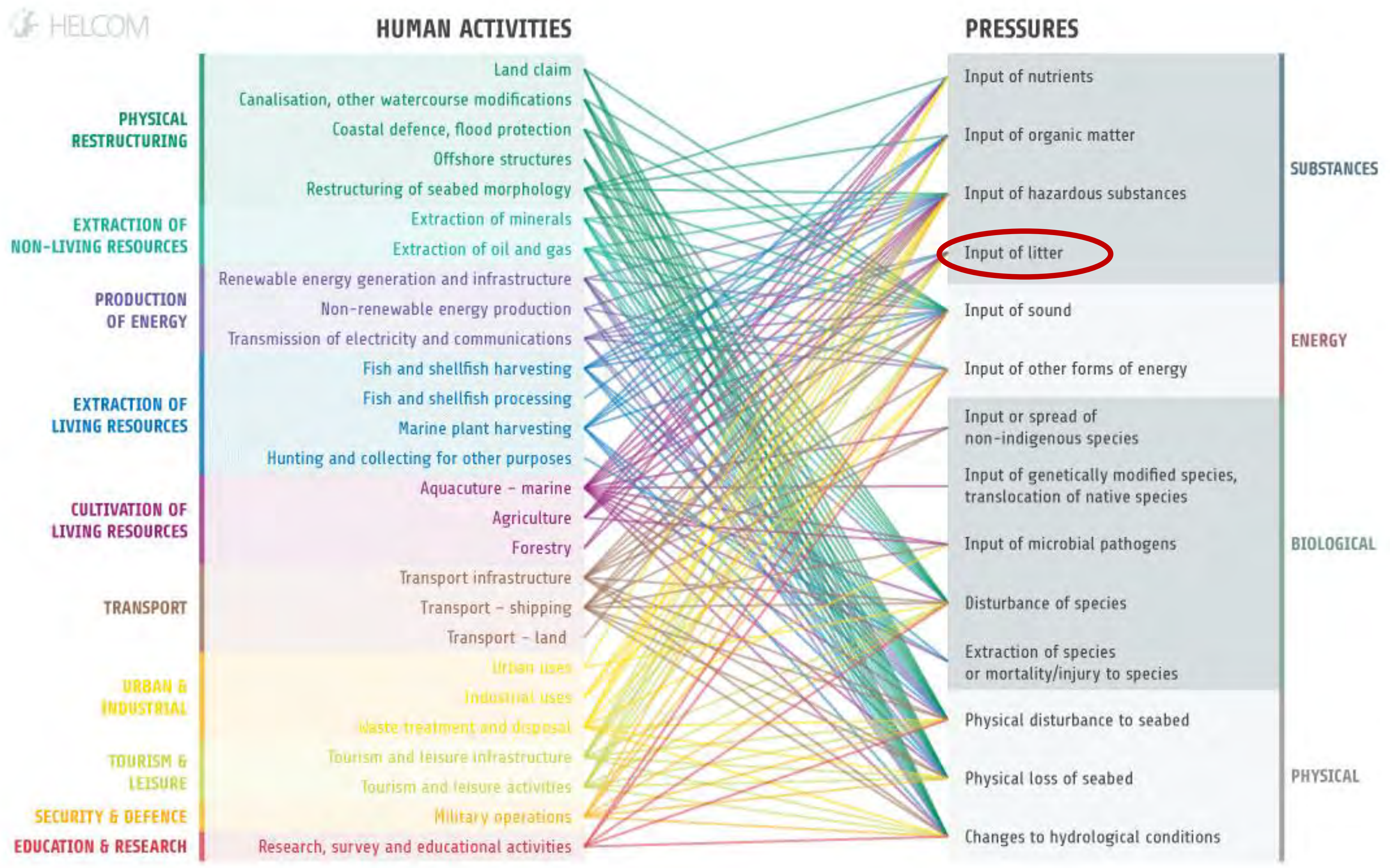
Estonian Environmental Centre project no. 15425

01.03.2019-10.12.2020

TARTU ÜLIKOOL · UNIVERSITAS TARTUENSIS · 1632

KIK KESKKONNAINVESTEERINGUTE KESKUS

Tiia Möller-Raid, Maria Põldma
University of Tartu, Estonian Marine Institute


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

Marine litter is defined as any persistent, manufactured, or processed solid material discarded, disposed of or abandoned in the marine and coastal environment.

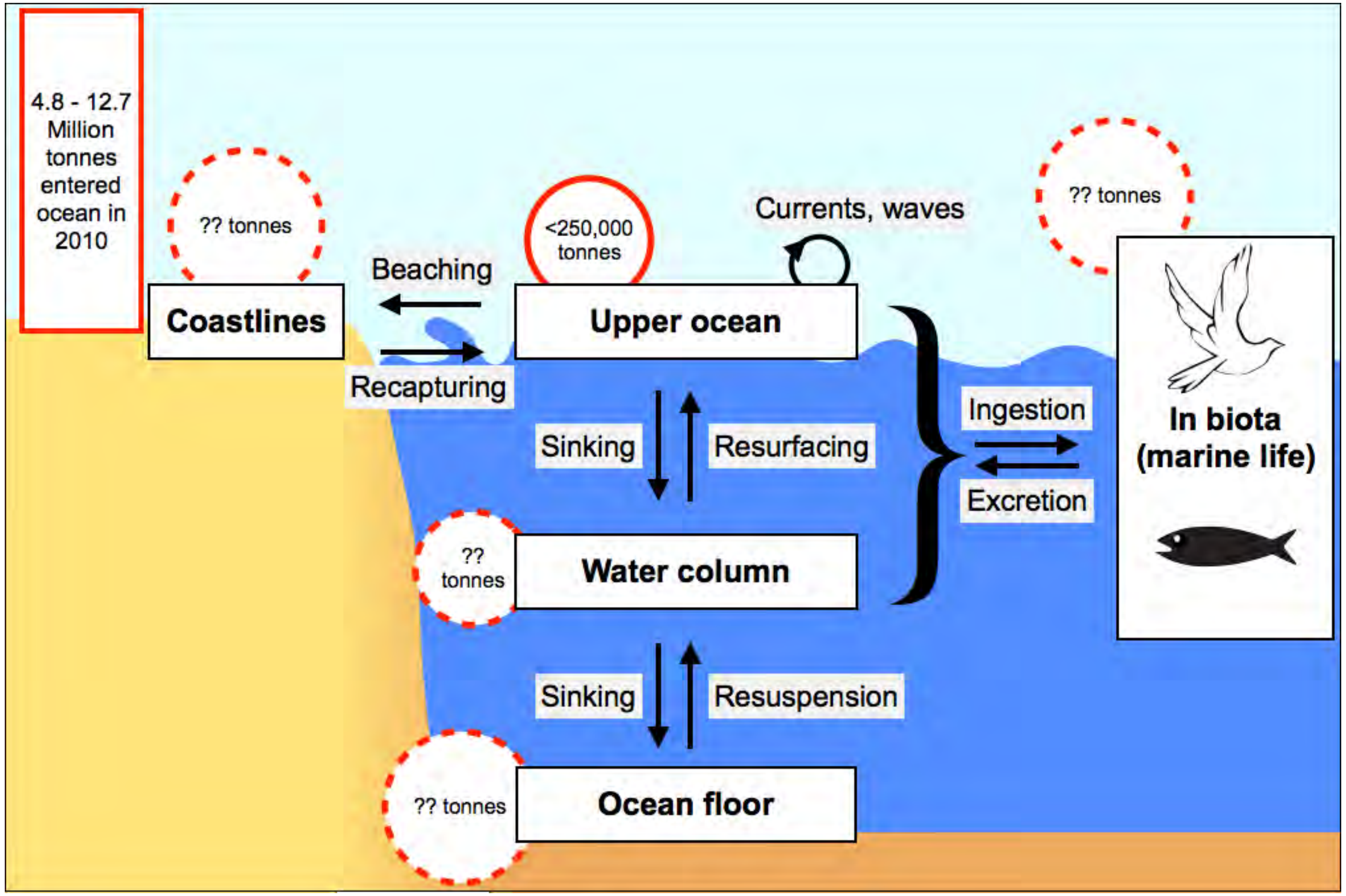
Megalitter

Macrolitter >2,5 cm

Mesolitter 0,5-2,5 cm

Microlitter <0,5 mm

Nanolitter



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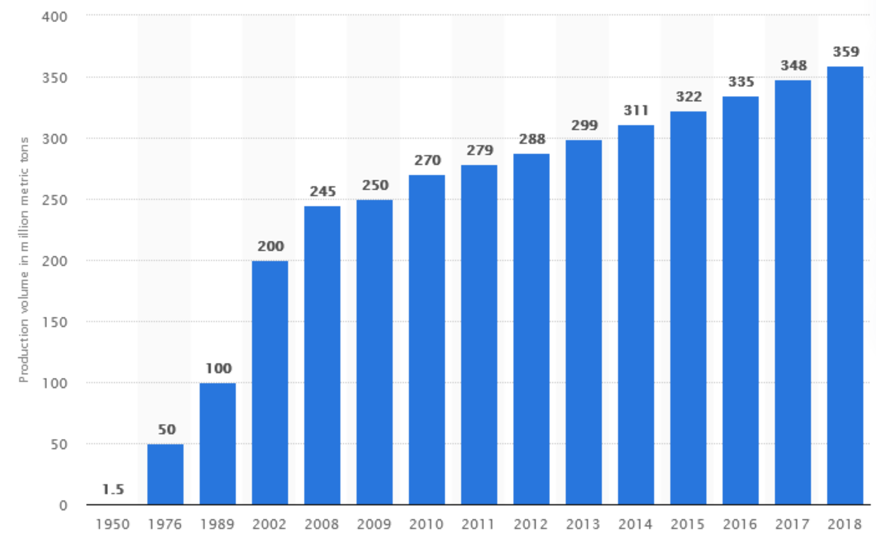

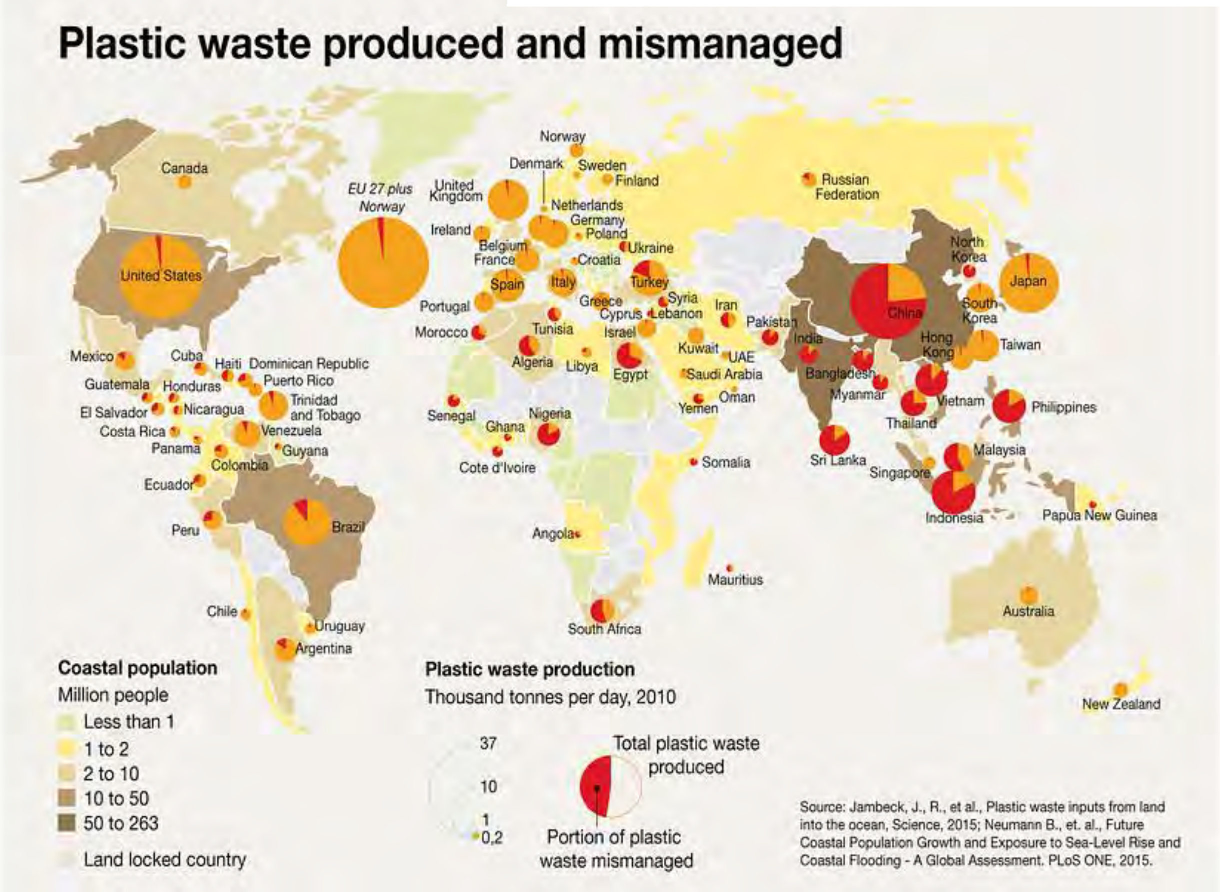

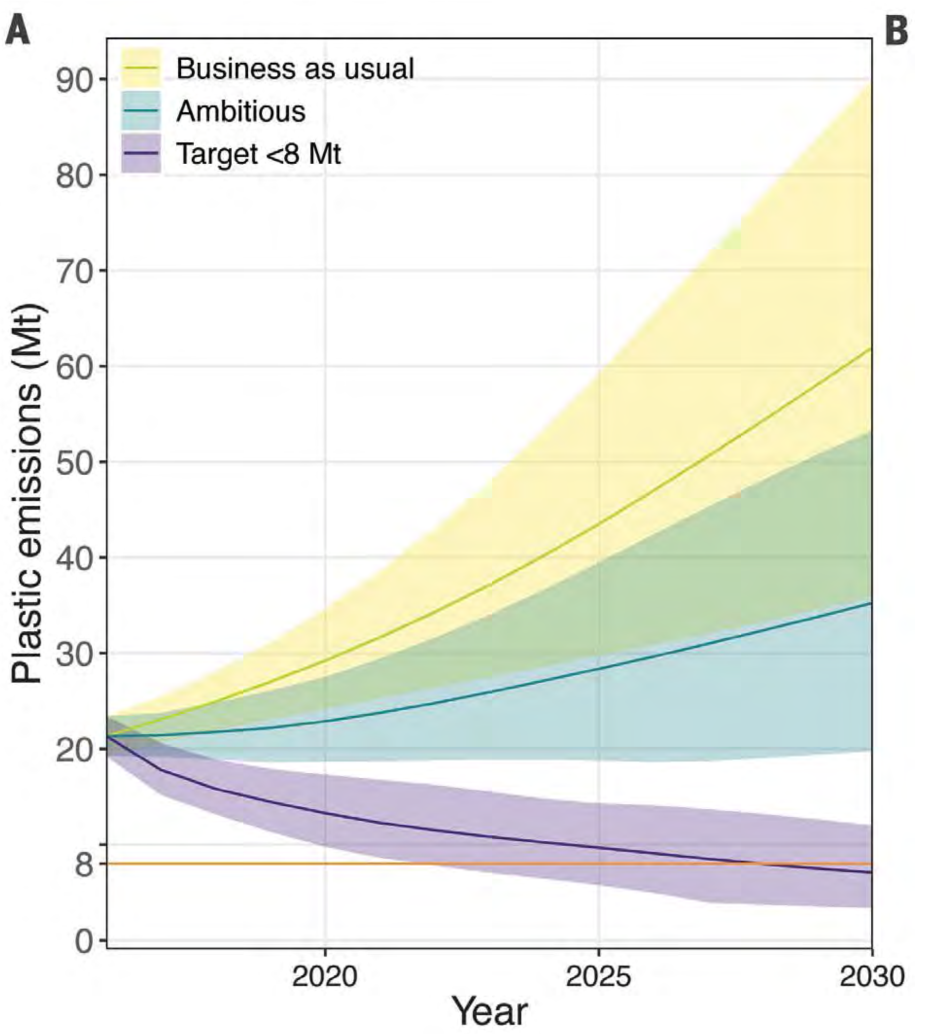

Borelle et al 2020

https://www.statista.com/statistics/282732/global-production-of-plastics-since-1950/

SEARCH Courthouse News Service LAW PUB

Paradise Buried: 414 Million Pieces of Plastic Litter Remote Australian Islands

CARSON McCULLOUGH May 16, 2019

Some 414 million pieces of plastic trash cover the white sands of Cocos (Keeling) Islands in the Indian Ocean. (Silke Stuckenbrock)

(CN) – A new study released Thursday reports that the beaches of Australian islands are littered with an alarming volume of plastic debris.

The report, published in the scientific journal *Scientific Reports*, surveyed the Cocos (Keeling) Islands and found roughly 414 million pieces of plastic waste have washed up unto the islands' beaches. Among this inventory includes an estimated 977,000 shoes, 373,000 toothbrushes, and millions of other various plastic-based items.

A Remote Pacific Island Awash in

The New York Times

ast Beach, Henderson Island, in the South Pacific Ocean. A new study estimated that the white sand beaches were littered ns of debris, deposited there by ocean currents. Jennifer Lavers/Institute for Marine and Antarctic Studies, via European Agency

By Austin Ramzy

May 16, 2017

Henderson Island ought to be one of the most pristine places on earth: an uninhabited South Pacific atoll so remote that the nearest human settlement is the small island 120 miles away where the Bounty mutineers hid out.

But the atoll's white sand beaches are littered with tons of multicolored plastic junk, deposited there by ocean currents.

GREEN JOURNAL

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Recycling · Sustainability

Remote Atlantic Island Becoming a Trash Island

July 26, 2019

Within below 10 years, plastic pollutants near St. Helena, Eastern Falkland, and Ascension Islands have multiplied 10 times and one hundred times within the past thirty years. Trash like fishermen nets, straws that get dumped and plenty of degenerated plastic have washed up at their shores.

From 2013 to 2019, research was carried out to check the extent of the trash in the ocean in South Atlantic. The researchers collected specimens of marine waste from the water, the seashores and the sea-bottom. Researchers additionally analysed trash ingestion in more than two thousand animals of twenty-six different species. The animals were found to have eaten a high amount of plastic.

Thirty years back, these remote places used to be clean. The plastic island Atlantic problem has gone up much during that time and it is currently very common. The beaches are the most affected.

+ Upcoming Events

Oman Energy & Water Conference & Exhibition
November 30 - December 2

European Electric Vehicle Batteries Summit 2020
December 9 - December 10

SPARK
June 22, 2021 - June 23, 2021

View All Events

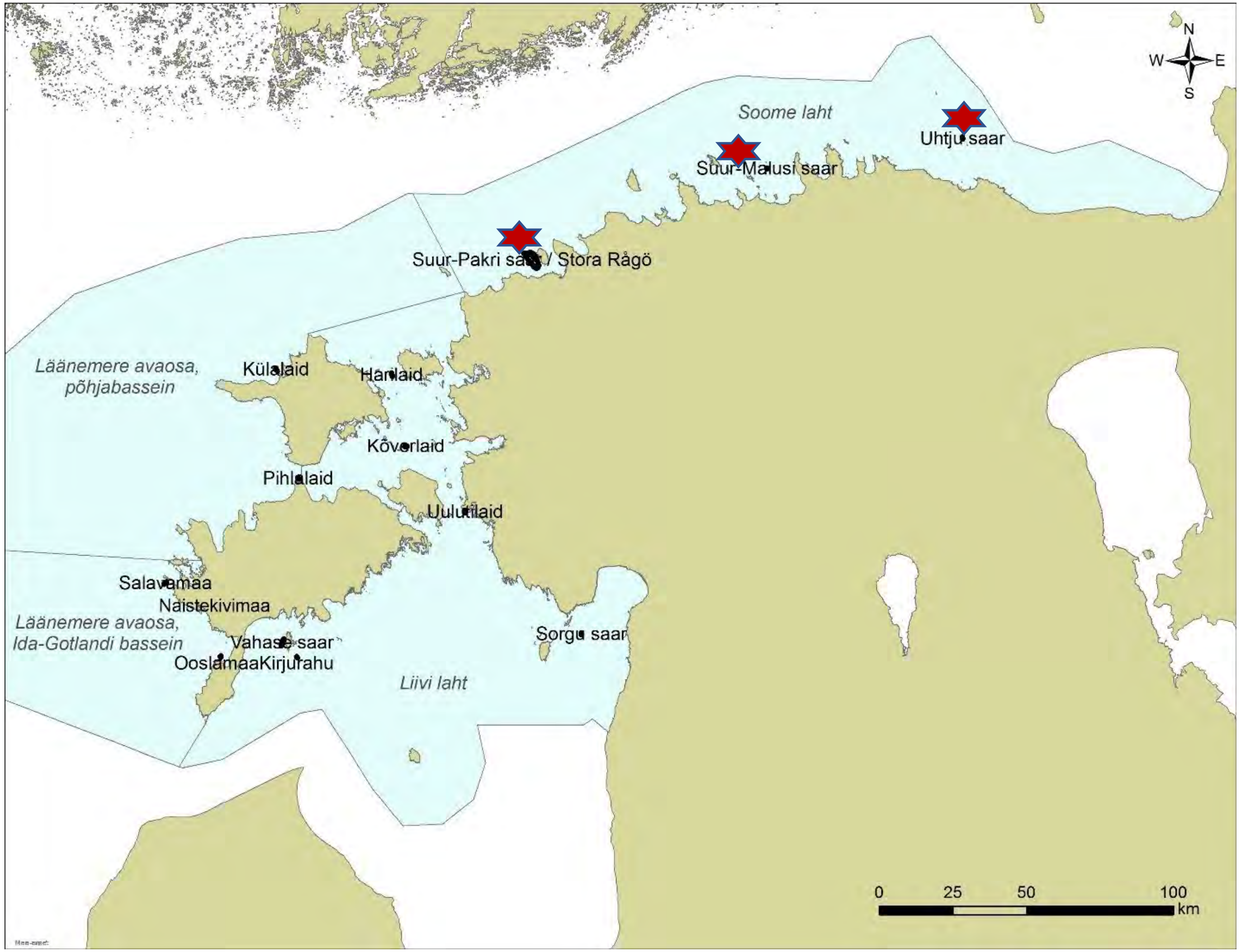
+ Recent Posts

- Snus vs Cigarettes vs e-Cigarettes: Which Is the Least Environmentally-Damaging?
- Why New Businesses Should Focus On Sustainability From The Start
- Five Environmentally-Aware Gardening Tips

What is the situation with marine litter on small & remote islands in Estonian coastal waters?

Commission decision (EU) 2017/848, 17. May 2017, D10 marine litter

Survey areas



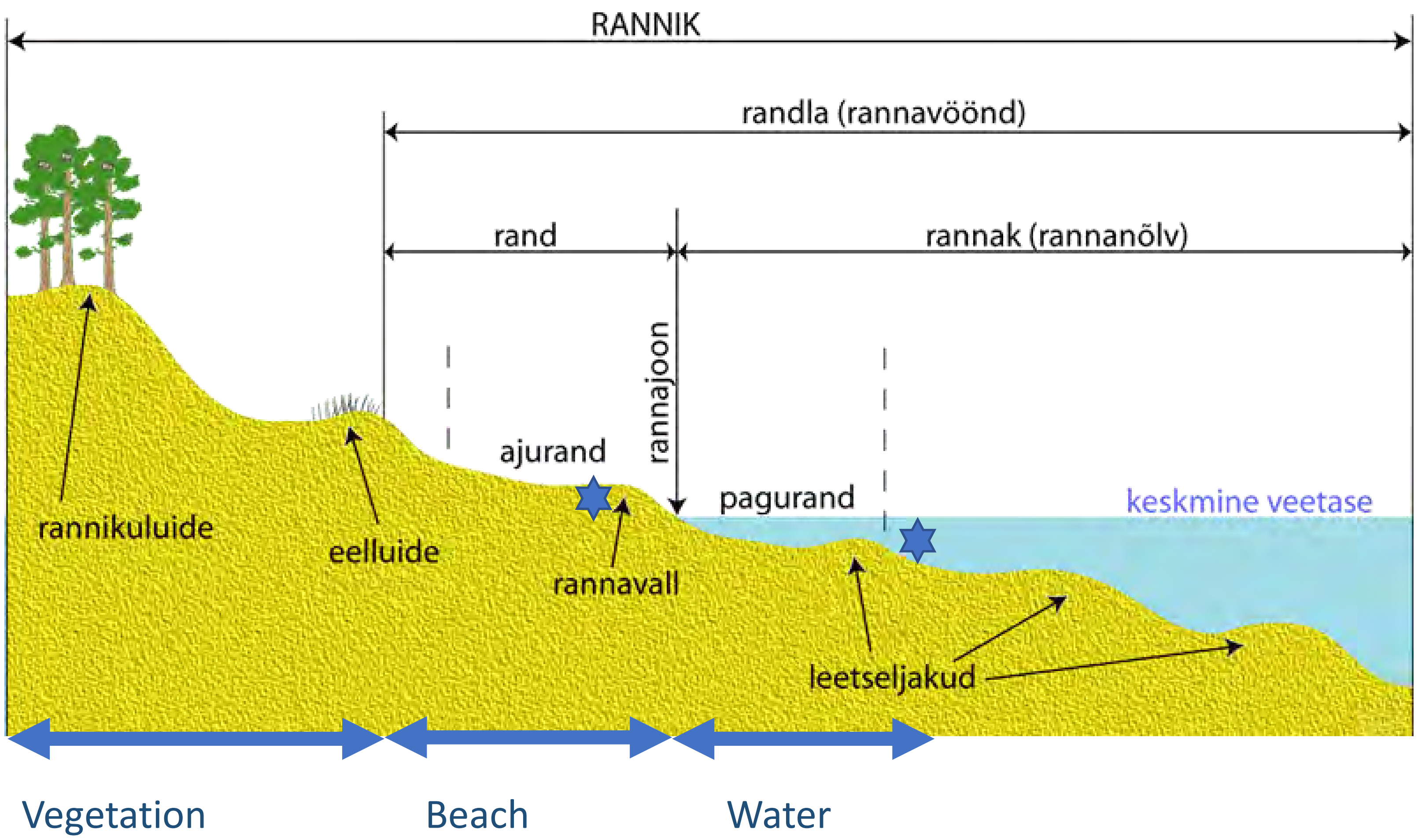
- In total 2222 islands in Estonia
- Minimal area 0.5 km^2
- Grass, bushes present
- Islands are located in different regions of Estonian coastal sea, 3 in the Gulf of Finland
- Islands lack human settlement

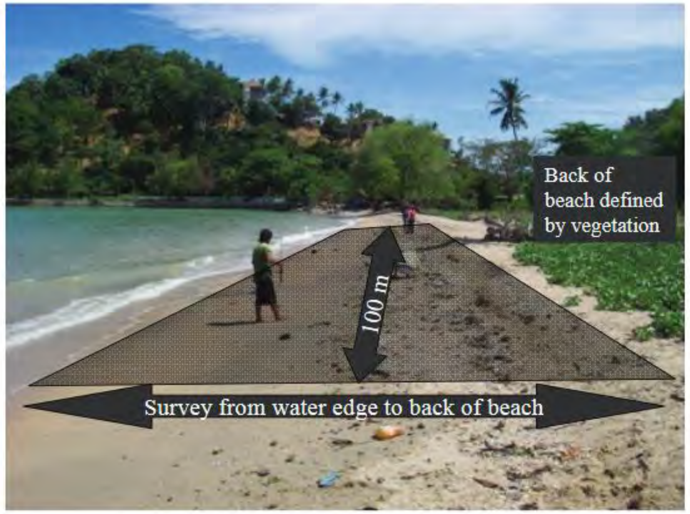
Methodology

Island	Summer 2019	Autumn 2019	Spring 2020	Summer 2020	Autumn 2020
Uhtju	01.08.2019	24.10.2019	23.03.2020	16.07.2020	x
Suur-Malusi	30.07.2019	21.10.2019	06.04.2020	26.07.2020	x
Suur-Pakri	20.06.2019	18.11.2019	08.04.2020	x	29.09.2020
Külalaid	06.07.2019	26.11.2019	x	12.08.2020	13.10.2020
Salavamaa	24.07.2019	20.11.2019	11.04.2020	17.07.2020	x
Ooslamaa	09.07.2019	30.10.2019	31.03.2020	18.07.2020	x
Naistekivimaa	x	x	x	17.07.2020	x
Pihlalaid	25.07.2019	21.11.2019	27.03.2020	17.07.2020	x
Harilaid	07.07.2019	23.10.2019	21.04.2020	20.07.2020	x
Kõverlaid	26.07.2019	31.10.2019	x	19.07.2020	11.10.2020
Vahase	08.07.2019	1.11.2019	20.04.2020	16.07.2020	x
Kirjurahu	25.07.2019	1.11.2019	x	16.07.2020	11.10.2020
Sorgu	27.07.2019	11.11.2019	31.03.2020	28.07.2020	x
Uulutilaid	26.07.2019	28.10.2019	13.03.2020	19.07.2020	x

- 13 islands – 4x, 1 island – 1x
- June 2019 – October 2020
- For most of the islands the movement was prohibited during bird breeding period (April-July)

Monitoring area



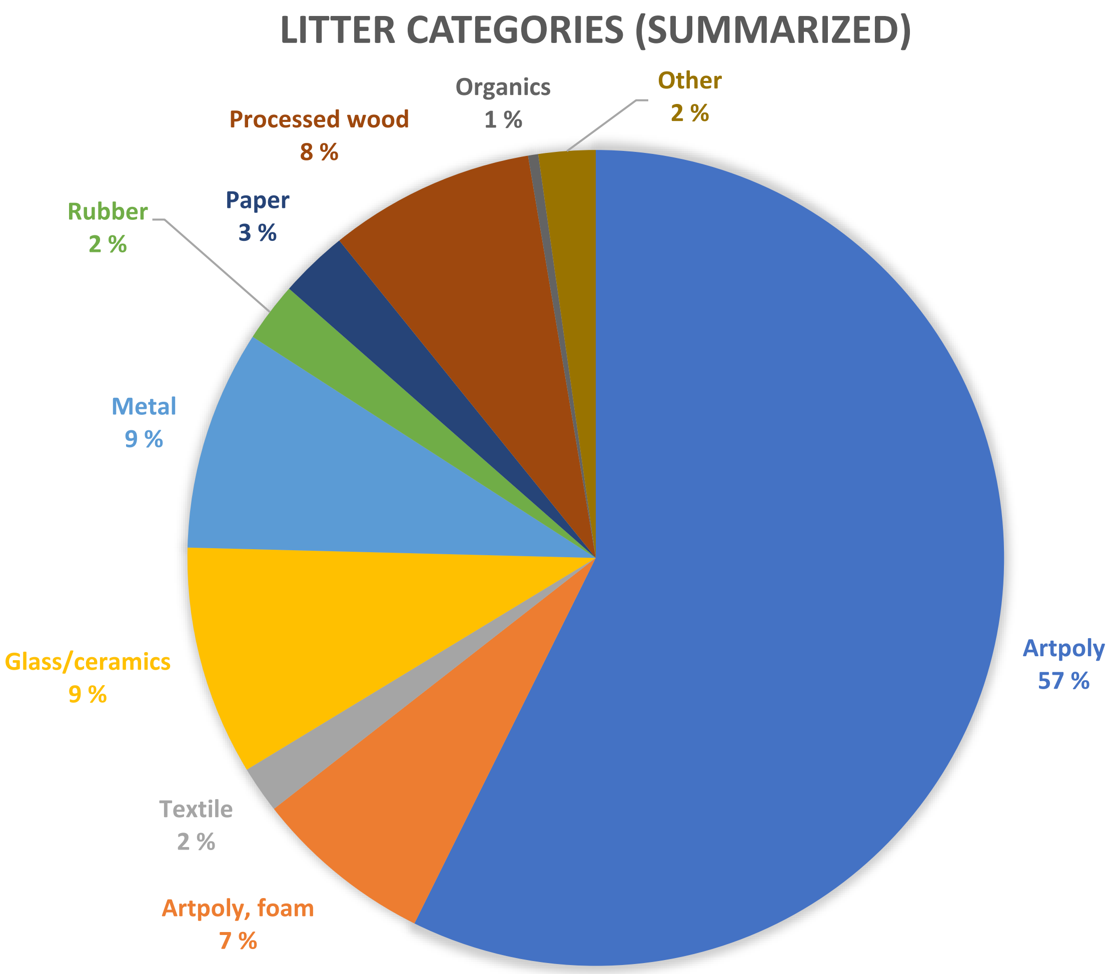


- Regular beach litter survey area – from water edge to back of beach
- Collected information on:
  - **D10C1 Litter**
  - **D10C2 Microlitter**
  - **D10C3 Litter ingested**
  - **D10C4 Litter entangled or other harmful effect**

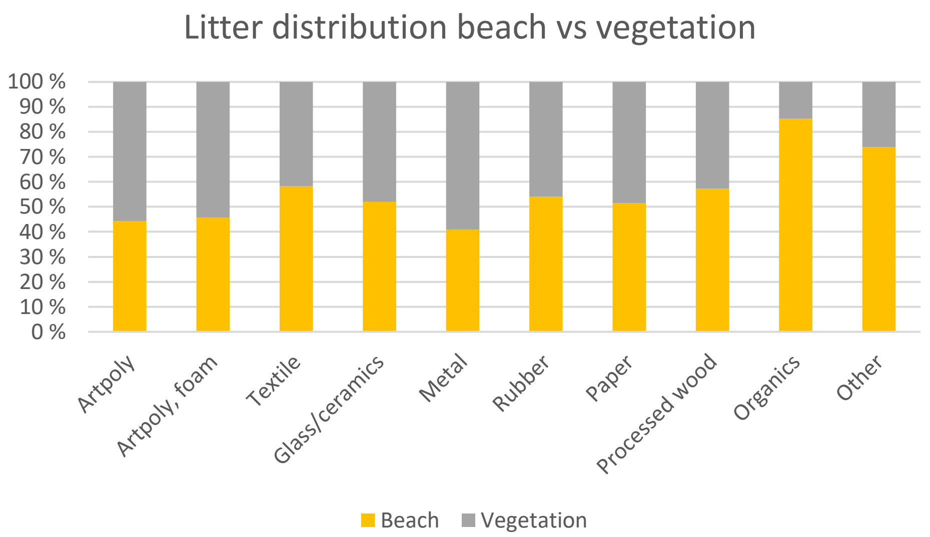
Monitoring area, beach

Monitoring area, vegetation

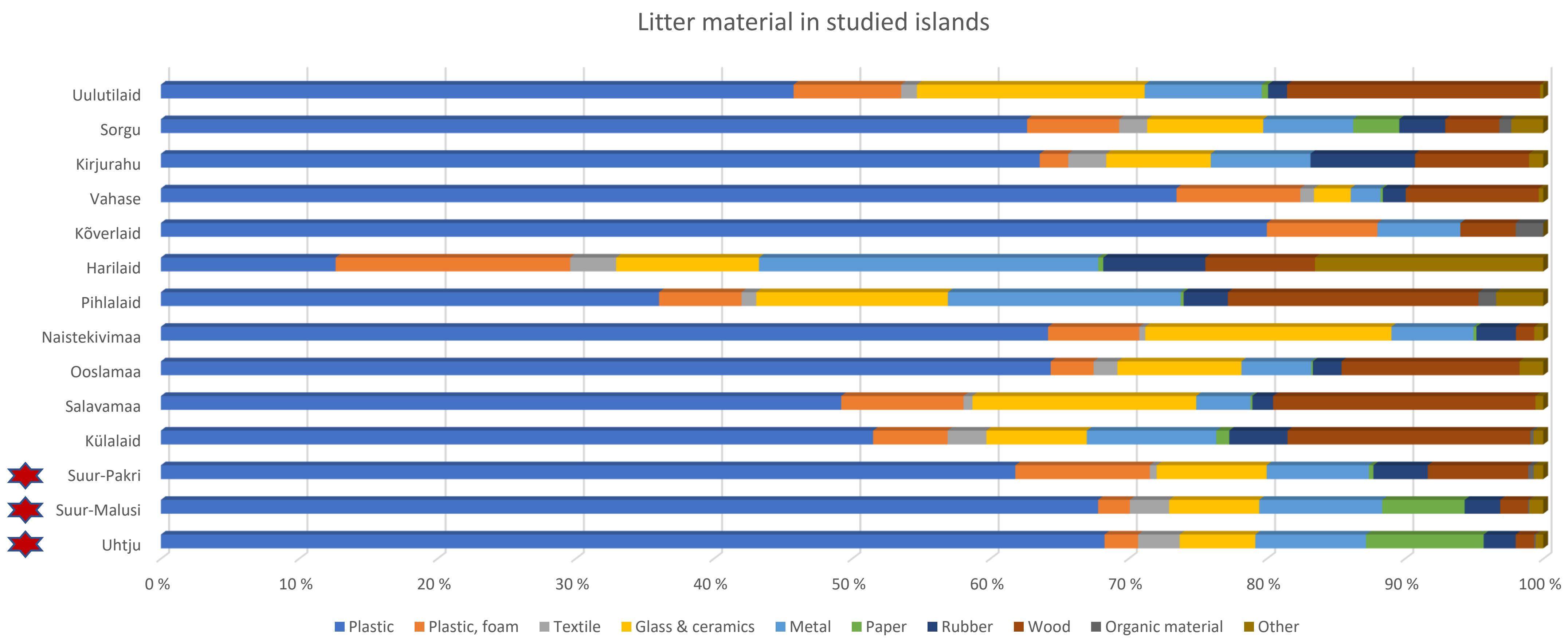
Results



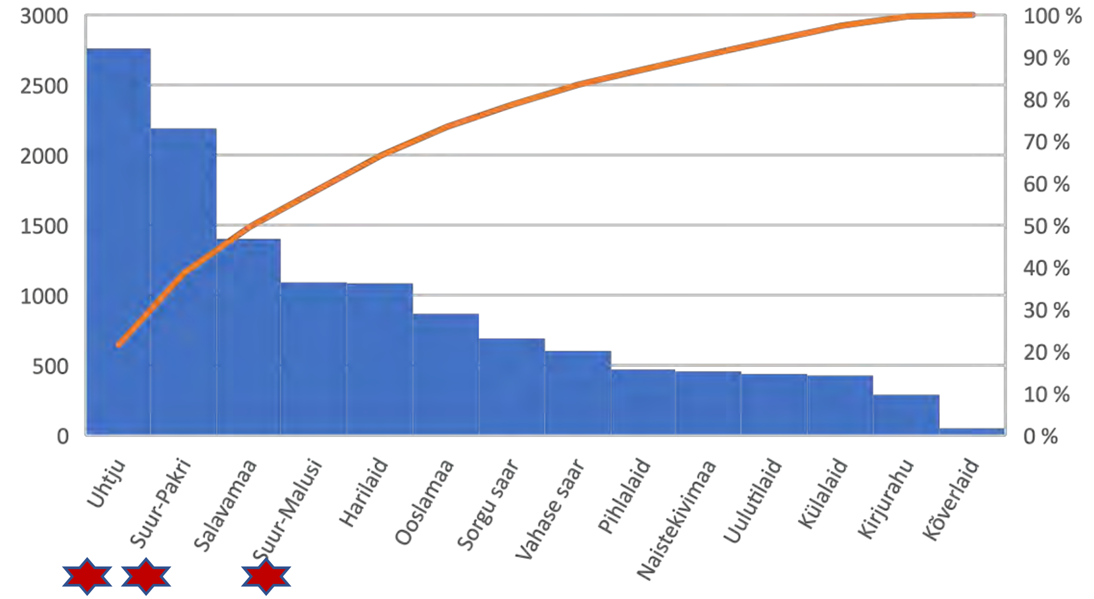
- Described: 12 818 litter items
- Removed: ca 12 000 litter items in total weight 854 kg
- Plastic was the dominant material (64%)
- Different materials were present both in beach and vegetation, except for organic waste



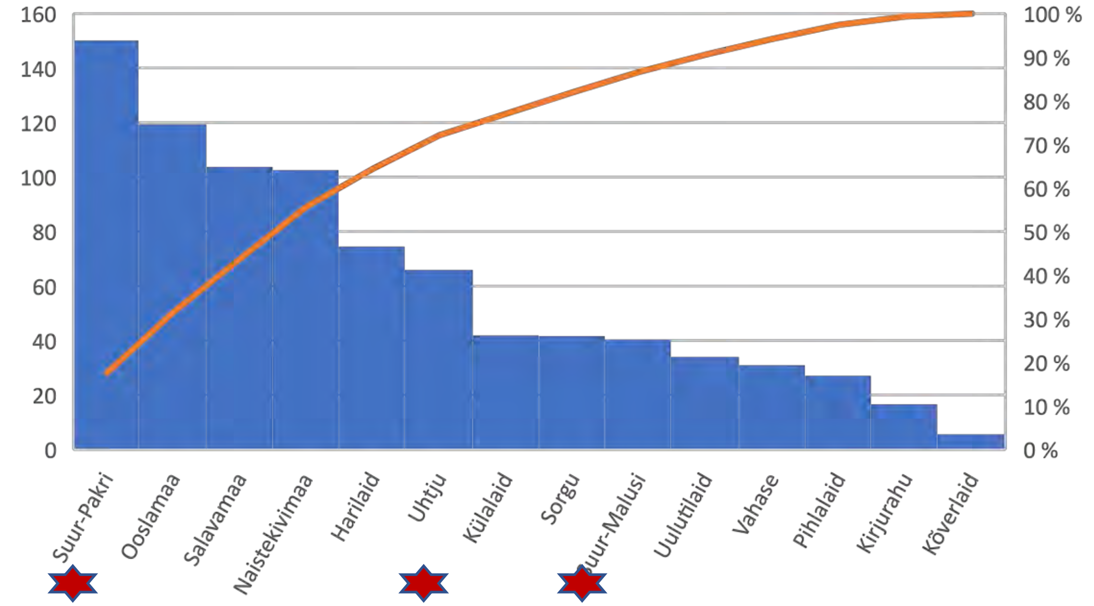
Litter material composition in studied islands

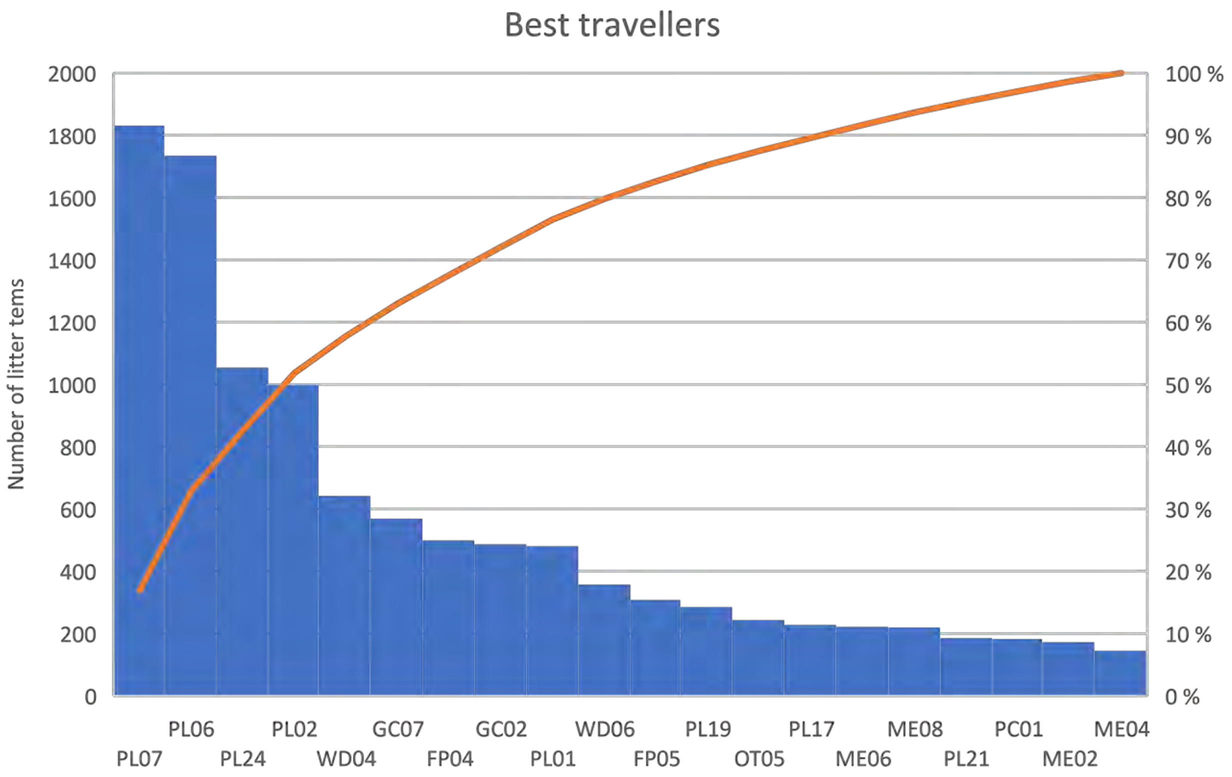


Number of litter items



Weight of litter, kg





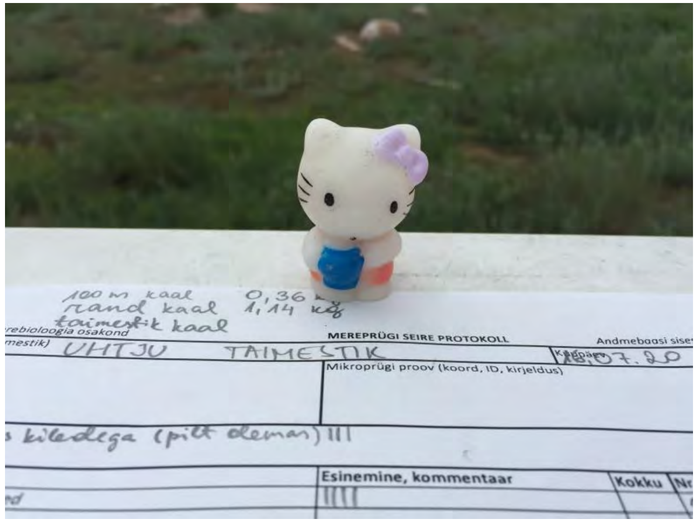
PL07	Plastic bags
PL06	Plastic food containers
PL24	Plastic, other
PL02	Plastic bottles, <2L
WD04	Processed wood
GC07	Glass, ceramic pieces
FP04	Foam – insulation & packaging
GC02	Glass bottles, jars
PL01	Plastic bottle caps
WD06	Wood, other
FP05	Foam, other
PL19	Plastic ropes
OT05	Other
PL17	Plastic fishing gear
ME06	Foil packaging
ME08	Metal pieces
PL21	Plastic ribbons
PC01	Paper (including newspapers etc)
ME02	Metal bottle caps etc
ME04	Metal jars <4L

- Plastic bags, plastic food containers, plastic pieces and plastic bottles formed 50% of all found litter
- Cigarette butts – altogether 25 found
- Balloons – ca 100 (RB01 ja PL08); shoes & boots – 71 (RB02)

Spring 2020 & lockdown due to COVID-19

- Single use mask did not yet reach the islands

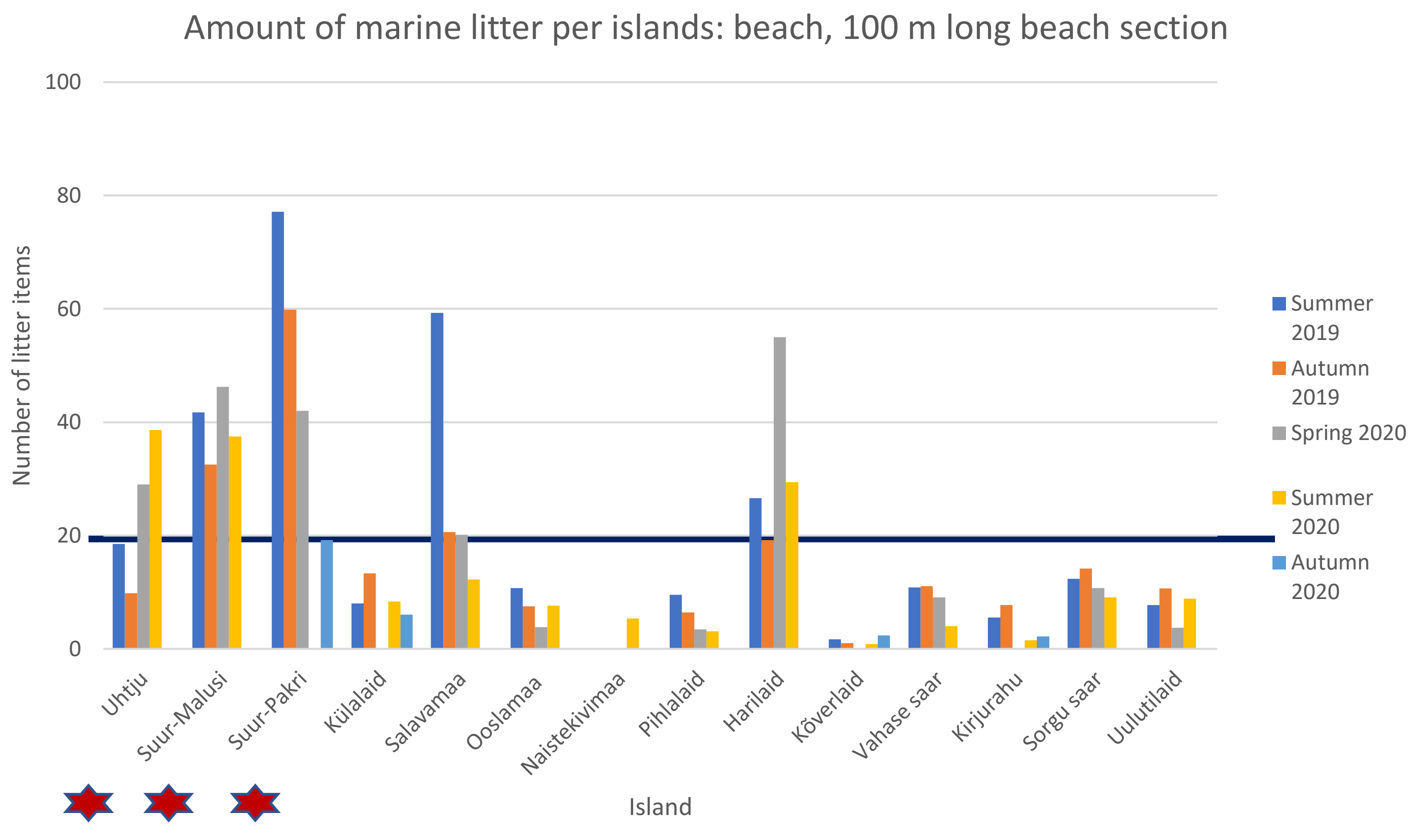
- Summer 2019 to autumn 2020:
  - Masks in total 5
  - Rubbergloves 17 (12 in the islands of GOF)



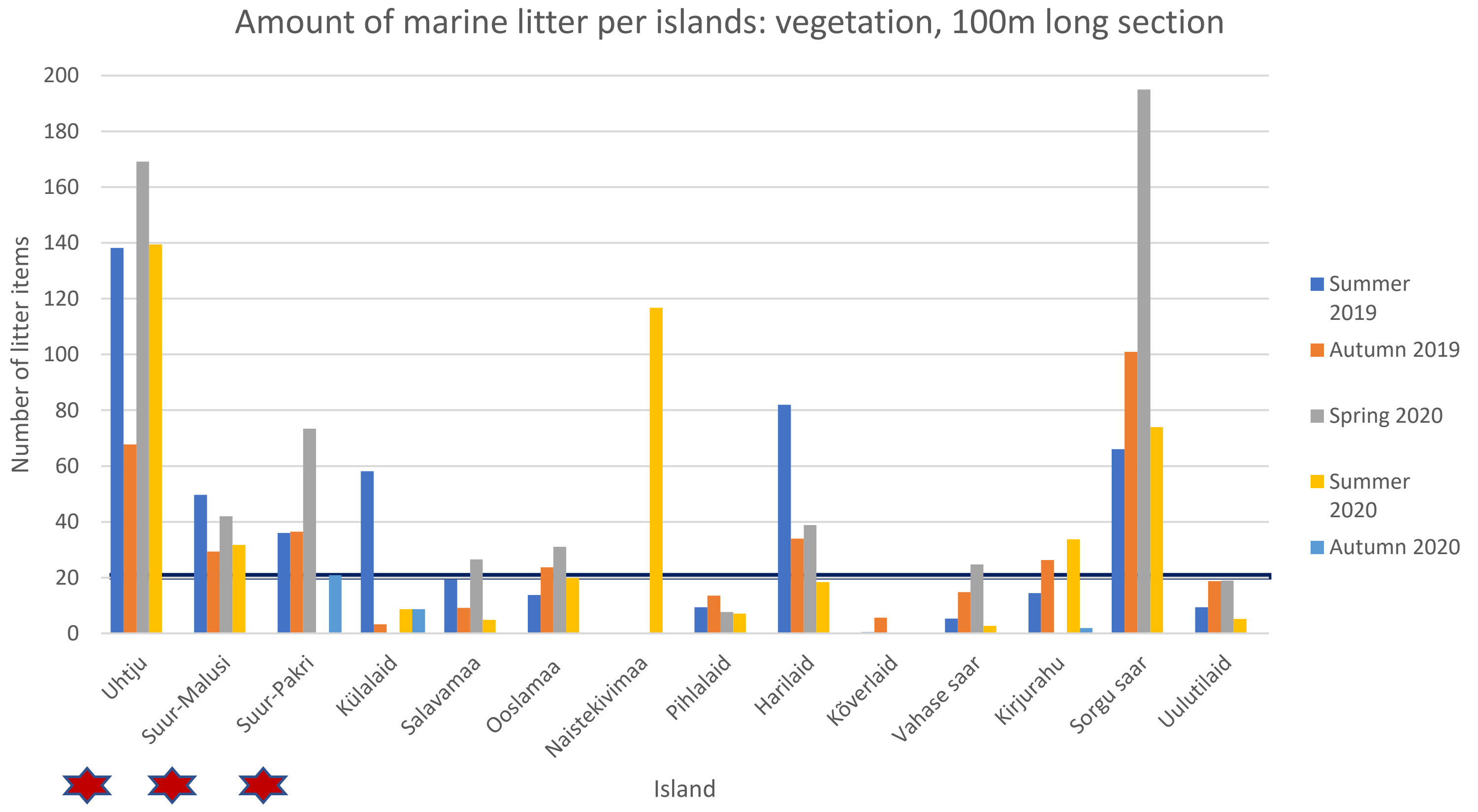
- However, since summer 2020 new type of litter emerged on Uhtju and Malusi:
  - Wet wipes
    - A **wet wipe** is a small to medium-sized moistened piece of plastic or cloth and is used for cleaning purposes like personal hygiene and household cleaning.
    - Invented in 1957, on the market since 1963.

Amount of litter per 100 m long beach section

The threshold value of 20 litter items per 100 m long beach section is agreed on to represent the good environmental status regarding beach litter (van Loon et al., 2020).



Amount of litter per 100 m long vegetation section



Marine litter vs biota

Dead birds and animals:

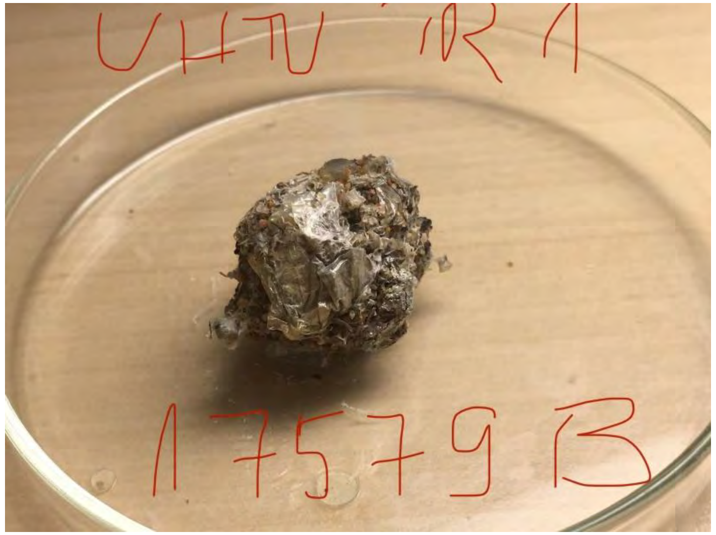
- 246 birds
- 22 seals
- 3 animals

Nest material

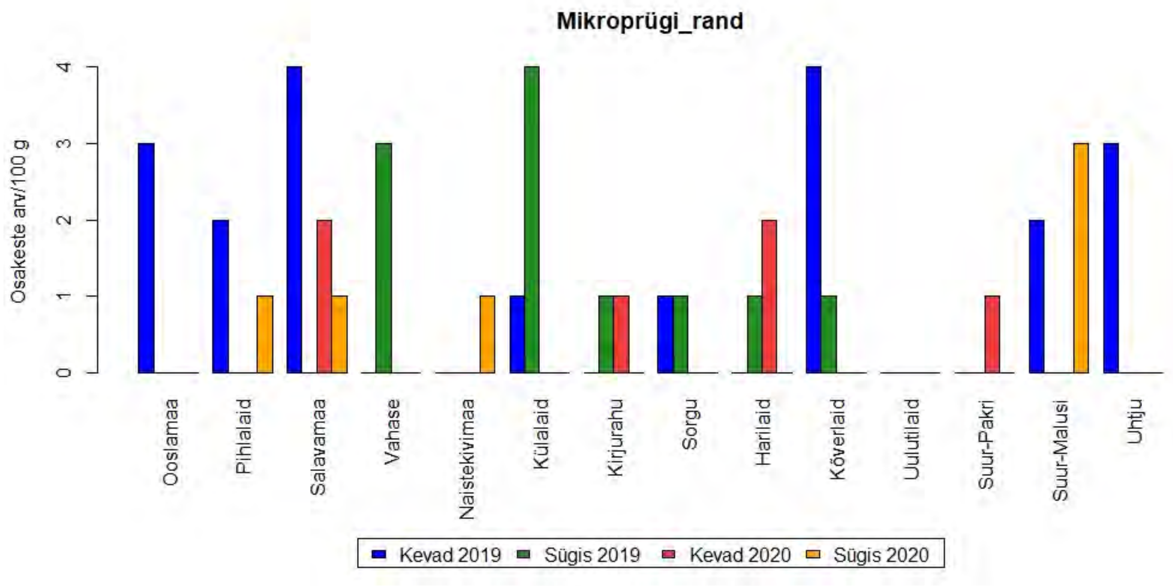
- Suur-Malusi
- Ooslamaa
- Kirjurahu
- Uhtju

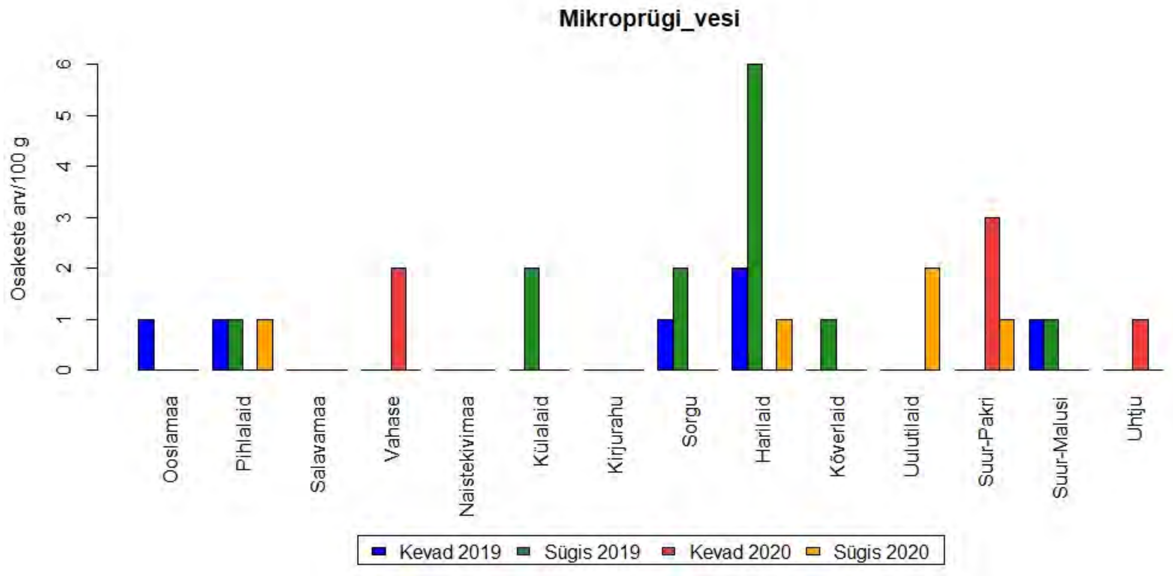
Bird pellets

- Uhtju



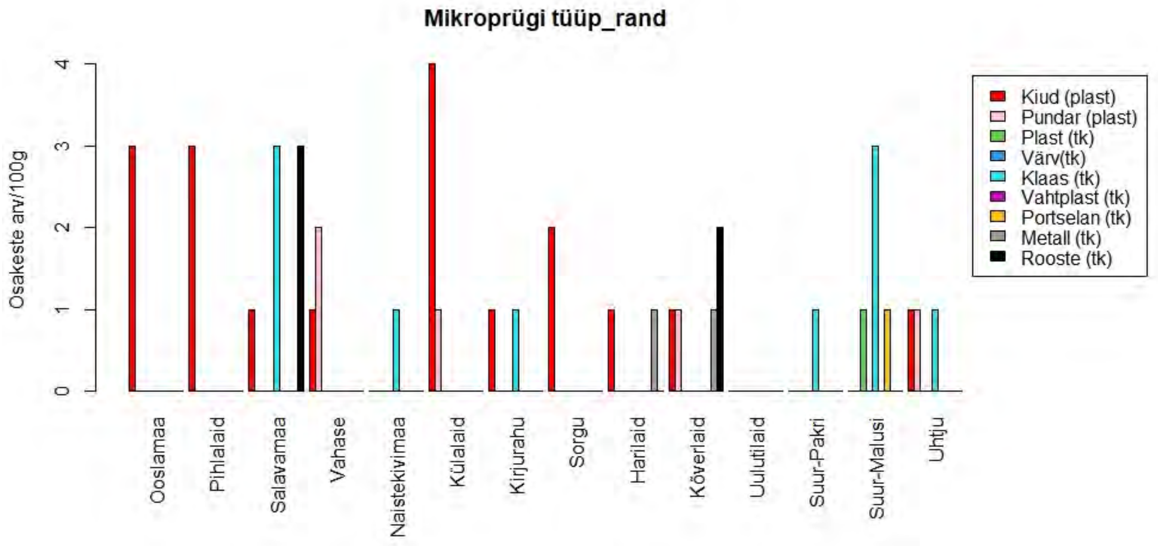
Microlitter in sediment I

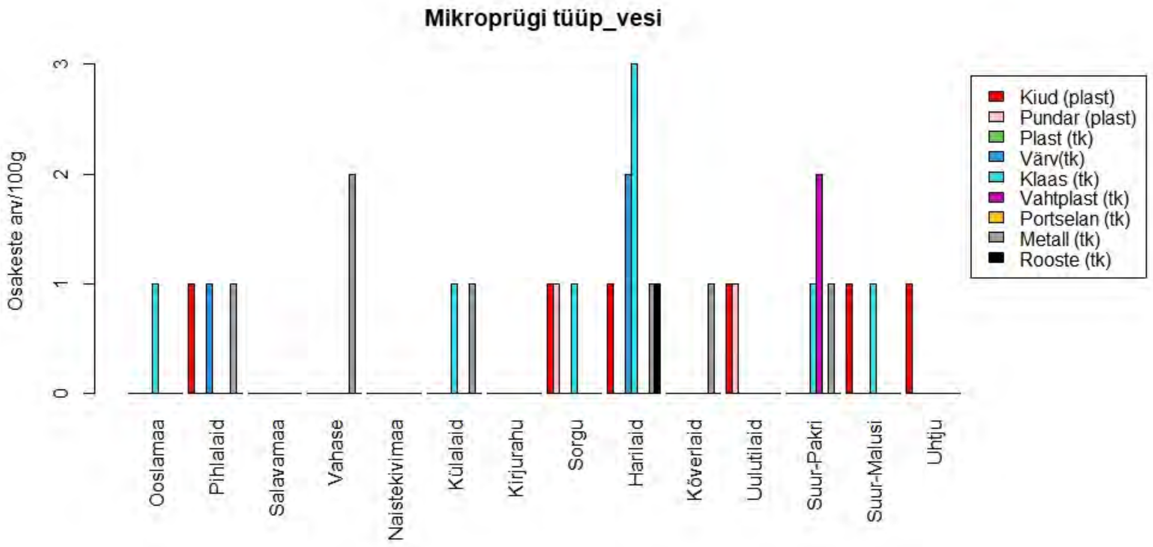


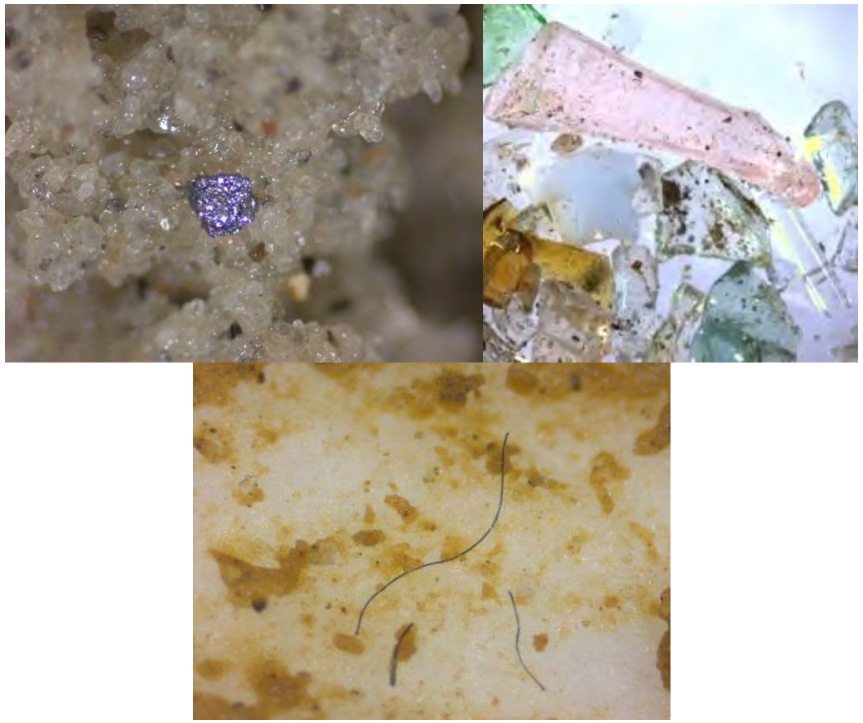


- Beach – 0-4 particles per 100 g of sediment
- Water– 0-6 particles per 100 g of sediment

Microlitter in sediment II







- Beach – plastic fibres and glass pieces dominated. Blue color fibre dominated.

- Water – equally plastic fibres, glass- and metal pieces.

To sum it up…

- Though we hardly see litter floating around in open sea areas, it is still reaching all coasts. Eg in Kirjurahu within 2 months time 8 plastic bottles turned up.
- GES = 20 litter items per 100 m long beach section. Can we truly agree to that also in our unhabited areas?
- In addition to beach litter surveys, we should look further into the vegetated area (where possible & without ruining the dunes). Water level change, storms and wind effect (aeolian transportation of litter) should be taken into consideration.
- Of all the marine litter beach litter is the easiest to remove. This should be done systematically, not just 1day campaigns or true enthusiasts.
- Nature protection areas that are prone to marine litter pollution need more attention.
- At least some of the visited islands should be monitored in the means of marine litter in a few years period.
- For remote areas there is no need for 4 visits per year. The litter surveys could be carried out 1-2 times per year but on a larger scale.
- It seems to be an endless fight, but there might also be some nice surprises…

Thank You!

Maria Põldma
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Keili Saava
Katerin Martin
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Kaire Torn
Alo Raid
Vanessa-Lotta Mäsak
Jessica Rodrigues de Pinho
Kristina Tiivel
Eda Andresmaa
Agni Kaldma

Estonian Environmental Investment Centre, project no. 15425

Microplastic pollution in urban stormwater runoffs

Julia Talvitie

Postdoc researcher

Finnish Environment Institute, Marine Research Center

”Garbage Group” (roskasakki)

Golf of Finland Science Days 2021, November 29-30, Tallinn

SYKE

@roskasakki, @Julia Talvitie

Sources and pathways of microplastics to the aquatic environment

Land-based sources

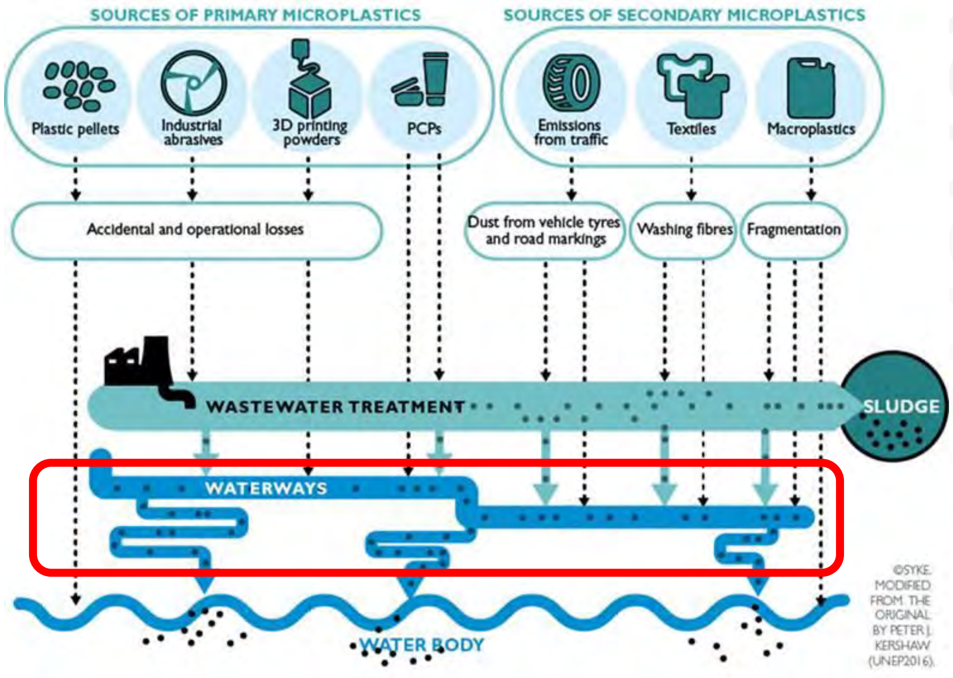
- Plastic industry and fabricators
- Personal care products
- Traffic
- Textiles
- Fragmentation of macroplastics

Aquatic-based sources

- Fisheries and shipping sectors
- Illegal dumping/littering

Pathways

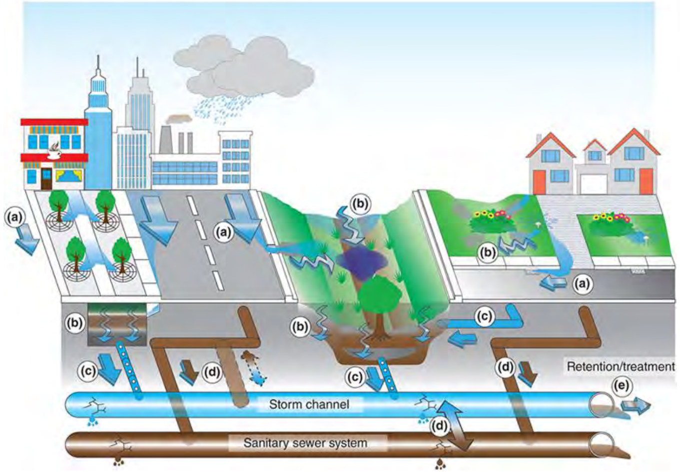
- Stormwaters
- WWTPs (wastewater & sludge)
- Atmospheric input



Stormwaters as pathways for microplastics to the aquatic environment

- **Urban stormwaters contains various pollutants and has the potential of deteriorating the quality of aquatic ecosystems**

- **Stormwaters contain microplastics**
  → Large amounts of untreated stormwaters are discharged into aquatic environments
  → climate change, urbanization
  → Role of stormwaters as a pathway of MPs to aquatic environments may be significant and grow in a future



Jiang et al. 2015

- **Stormwater management can offer solutions to reduce the MP discharges into the environment**

SYKE

The catchmen area

<u>Espoo, Vallikallio</u>

Urban suburb

- Area~ 10 hectare
- ~50% impervious surfaces
- impervious surfaces mainly asphalt (n. 30%) and roofs (n. 20%)

- Soil: sandy till and rock

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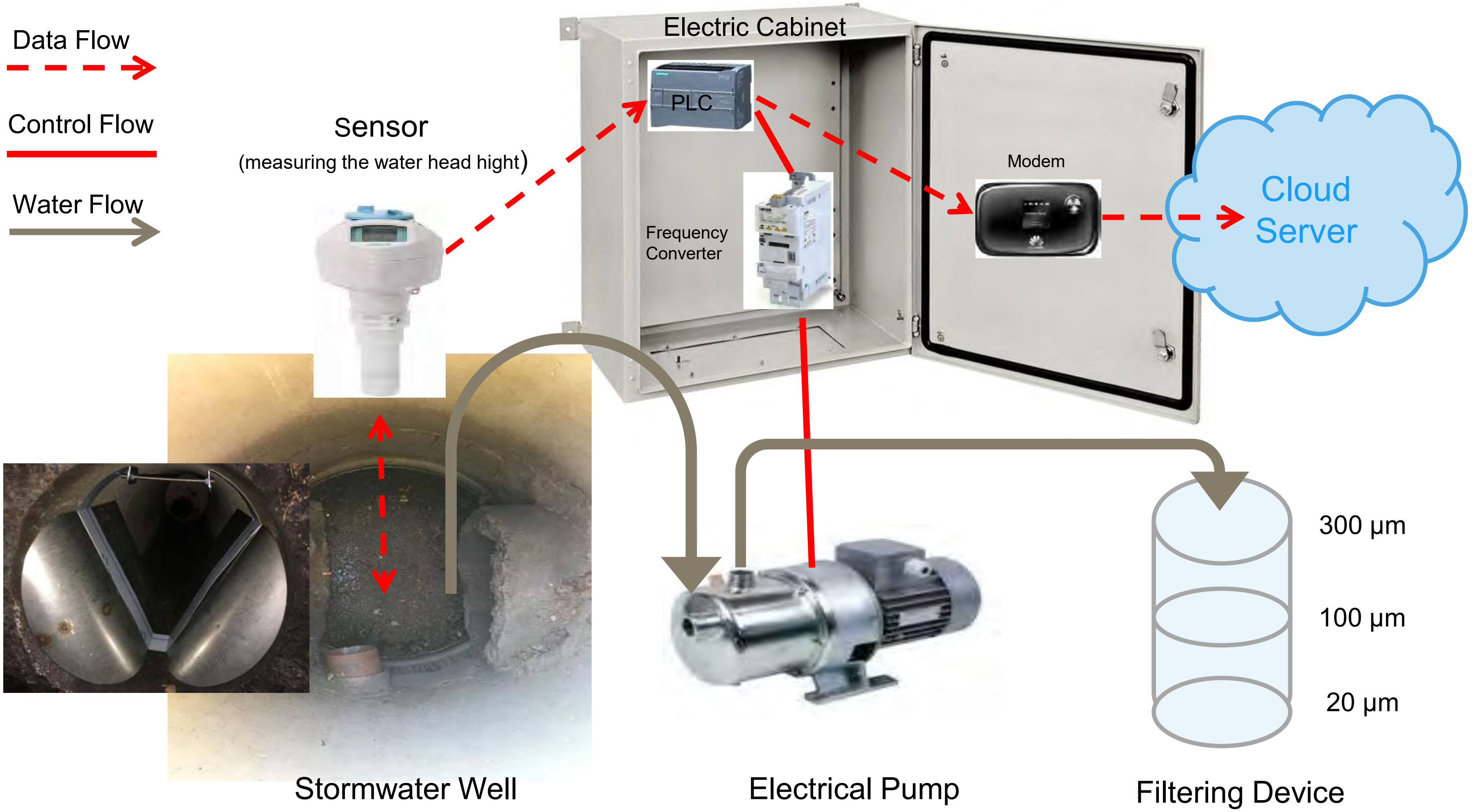
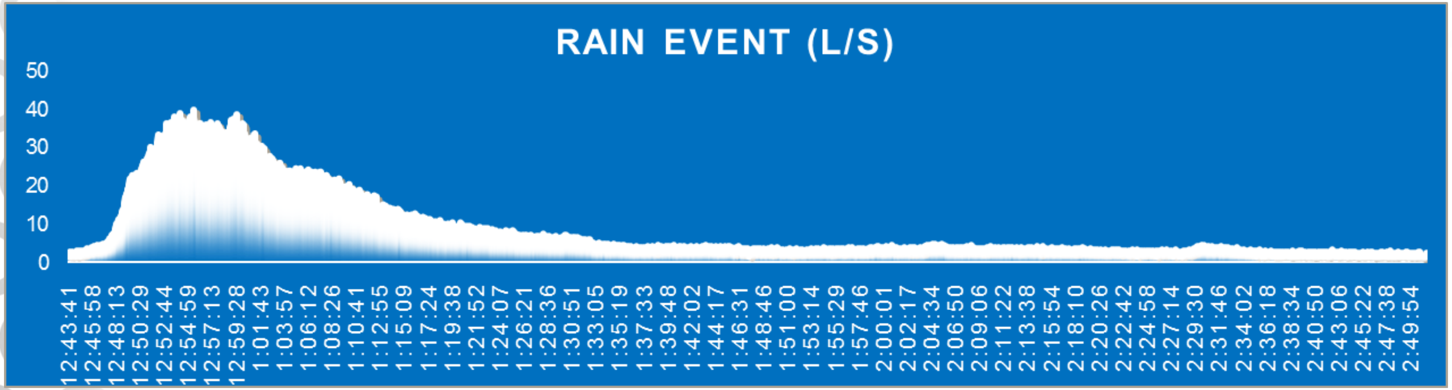
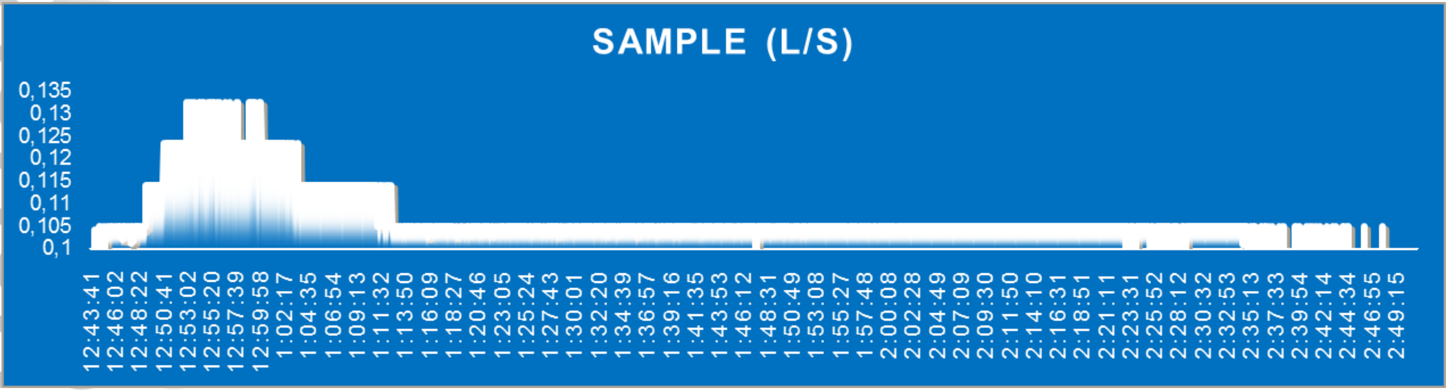
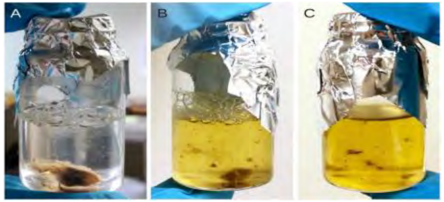

Data Flow
Control Flow
Water Flow
Sensor
(measuring the water head hight)
Electric Cabinet
PLC
Frequency Converter
Modem
Cloud Server
300 µm
100 µm
20 µm
Stormwater Well
Electrical Pump
Filtering Device

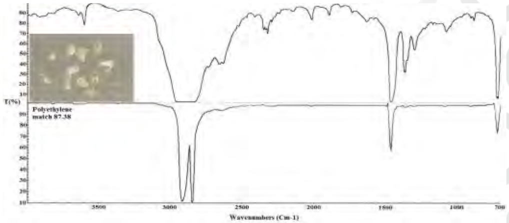
Rain event (2.11.2018): volume of the rain event ~ 65m³ liter, sample volume ~0,7m³ (~1%)





Methods for microplastic detection – how to find a needle in a haystack ?





Sampling → Extraction → FTIR-analyses → Spectrum-analyses

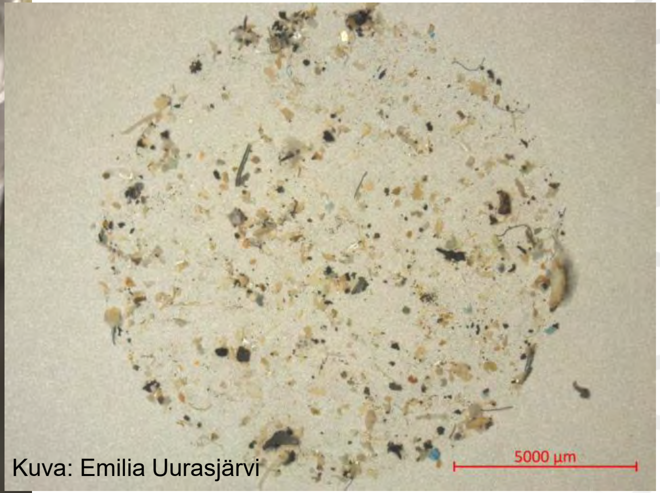
Sampling	Extraction	FTIR-analyses	Spectrum-analyses
months- years	**months**	**1 d/sample**	**1 d/sample**

- **You also need good quality control samples (incl. contamination and recovery)**

SYKE

Stormwater samples – how do they look like?


Kuva: Erika Sainio



Kuva: Emilia Uurasjärvi

Preliminary results

- These results include MPs 0,1mm – 5mm in size.

Sampling date	Rain event volume (L)	Sample volume (L)	Consentration (MP/L)	Discharge (MP/ Rain event
2.11.2018	64 928,2	729,6	7,0	455 340
12.11.2018	741 877,0	4360,8	2,1	1 551 316
13.11.2018	329 542,1	3349,9	0,8	252 329

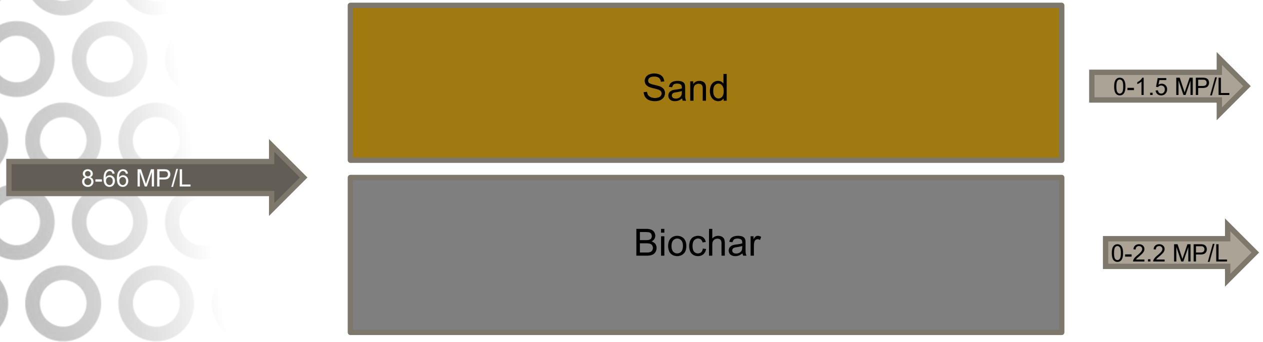
- Most common plastics found in a stormwater run off: polypropylene and polyethylene

SYKE

Preliminary results

(**Master's** Thesis: Pietu Pankkonen)

- The quality of the stormwater and the ability of **filtration system** to remove MPs from stormwater
- Study including MPs in size 90µm-5mm
- Catchment area: Töölö, Helsinki (70% impervious surfaces, high traffic road)



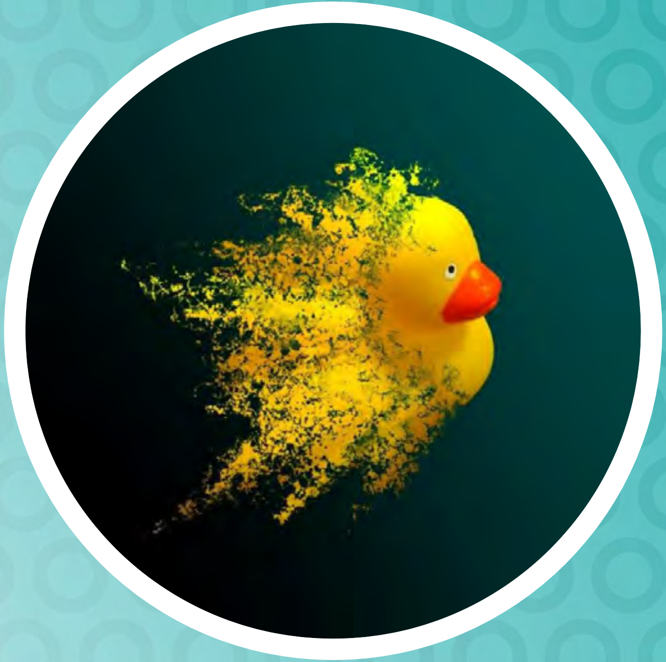
- More information: Olli Hakala, WSP Finland and Pietu Pankkonen, City of Sipoo

SYKE

Thank you so far;

- *Roskasakki* research group
  (Maiju Lehtiniemi, Outi Setälä)
- NouxNode Ltd.
  (Ossi Talvitie, Ville Strömberg, Jarno Sallila)
- Aalborg University
  (Jes Vollertsen and Urban Pollution Research Group)
- Sib-lab (University of Eastern Finland)
- Maj and Tor Nessling foundation
- Academy of Finland; MIF-project
  (Maiju Lehtiniemi)
- Maa- ja vesitekniikan tuki ry

- Academy of Finland; MIS-project



SYKE

Microlitter abundance and composition in fishes and macrozoobenthic organisms of the NE Baltic Sea – list of potential target species for microlitter contamination assessment

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***** ***e-mail of corresponding author: maria.poldma@ut.ee***

Project
'Litter ingested by marine animals – development of methodology and assessment for MSFD reporting

KIK
ENVIRONMENTAL INVESTMENT CENTRE

ERA.Net RUS Plus

UNIVERSITY OF TARTU
1632

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

Background

EU MSFD Descriptor 10 “Marine Litter” – aim to protect the marine environment against harm caused by marine litter.

Assessment criteria D10C3:

<u>requires that the amount of litter and microlitter ingested by marine animals is at a level that does not adversely affect the health of the species concerned (EC, 2017).</u>

- present knowledge gap about harm levels (chemical composition, particle shape and size) of litter
- it is suggested assessing the trends in the amount (%) and composition of microlitter ingested by marine biota.
- **need for baseline quantities (microlitter abundance, type, and composition)**

Objectives

- **To compile a basic data about microlitter ingested by fish and invertebrates**
- **Development of methodology**
- **Select indicator species**
- **Establish baseline quantities for future microlitter status and trends monitoring for MSFD reporting**

Microlitter

Microlitter – particles < 5 mm

Artificial polymer materials, rubber, textiles, processed/worked wood, metal, glass/ceramics, paint particles

Organisms mistake litter for food or ingest it unintentionally

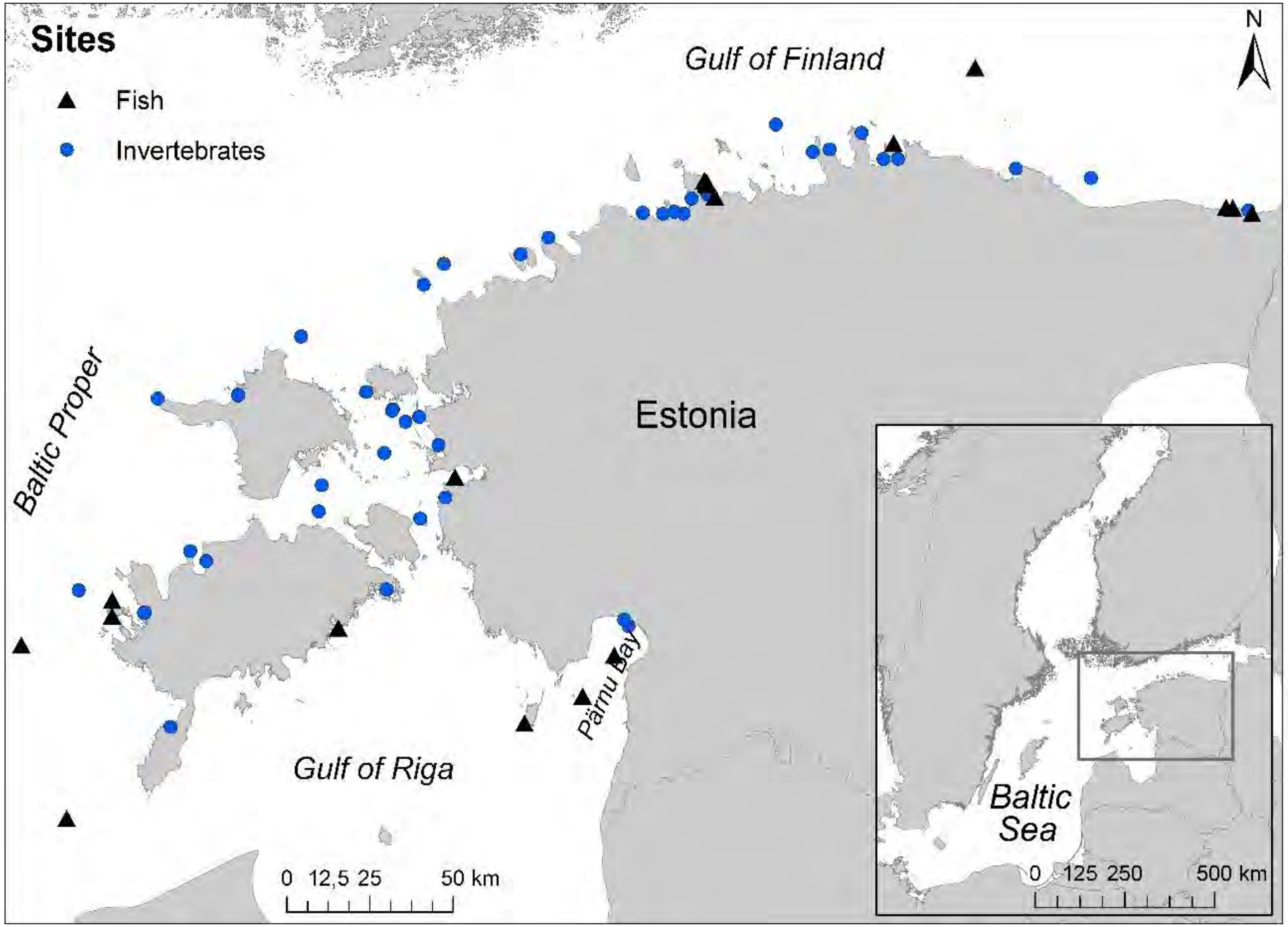
Microplastics provide a pathway facilitating the transport of harmful chemicals into marine organisms causing chemical toxicity

Studied species




Fish:

perch, pike-perch, flounder, round goby, bream, turbot, eelpout, cod, smelt, baltic herring, sprat.



Bivalves and crustaceans:

blue mussel, lagoon cockle, Baltic macoma, sand gaper.

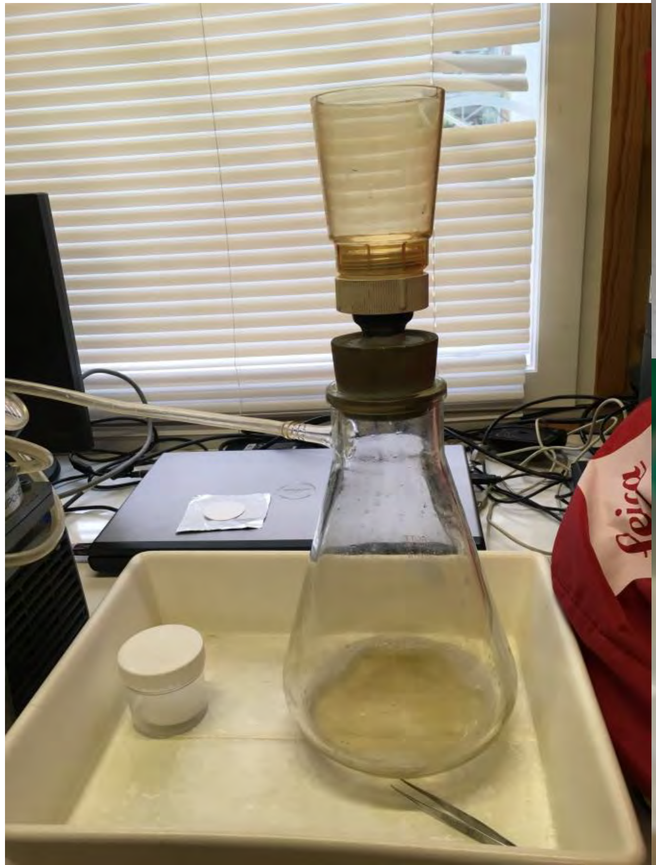
Harris mud crab, *Saduria entomon*

Altogether 1332 individuals (524 fish and 808 benthic invertebrates)

Methods

- Length and weight measured
- Gastrointestinal tract or soft tissue extracted
- 10% KOH solution 12-24 h
- Incubated 60°C, 15 min
- Shaked 12-24 h
- Filtrated
- Filters were examined visually under stereomicroscope

Blank control was performed regularly at every step to avoid contamination + several other procedures

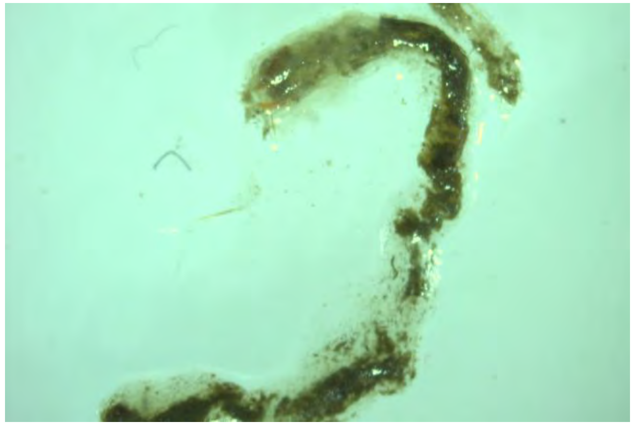


Methods

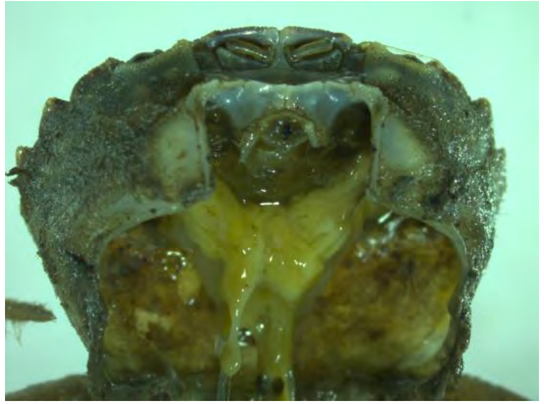
Crustaceans

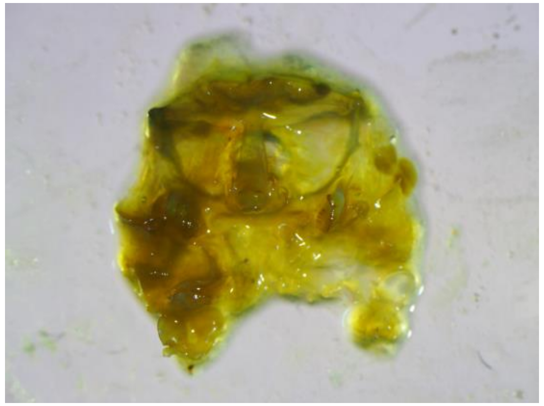
- Carapace was opened under the stereomicroscope
- All intestines extracted
- Placed on a Petri dish
- Examined visually under stereomicroscope
- Blank controls were used

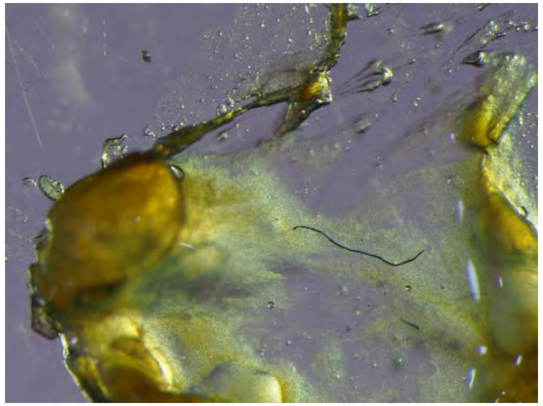
Saduria entomon



Harris mud crab







Methods

Microlitter

- abundance
- length (fibers) or diameter (fragments),
- color, transparent

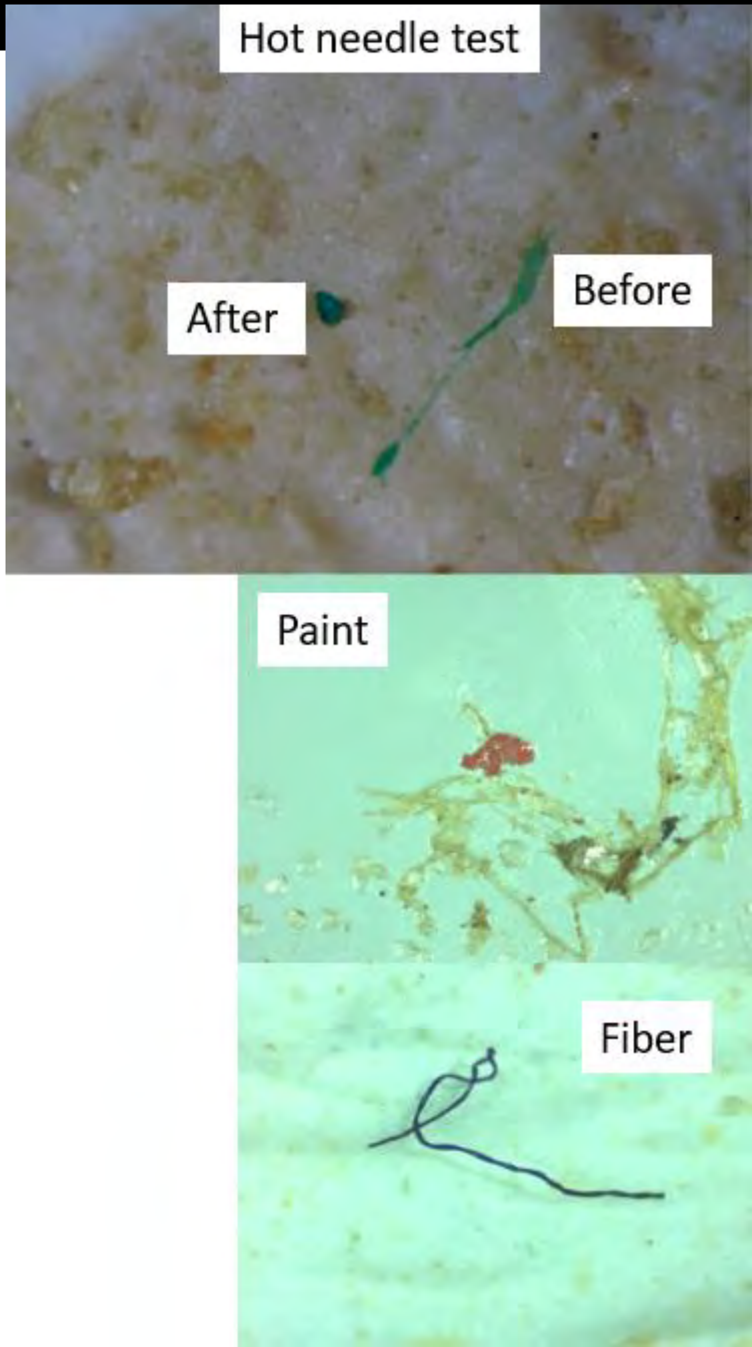
Material and shape category:

- fiber – straight, clump, flexibility, plastic or natural;
- fragment – plastic, pellet, granule, film, foam, paint, metal, glass, wood

Size classes:

1 mm< x <5 mm (1)
330 µm< x <1 mm (2)
100 µm< x < 330 µm (3)

To distinguish between plastic and organic material hot needle test was used.



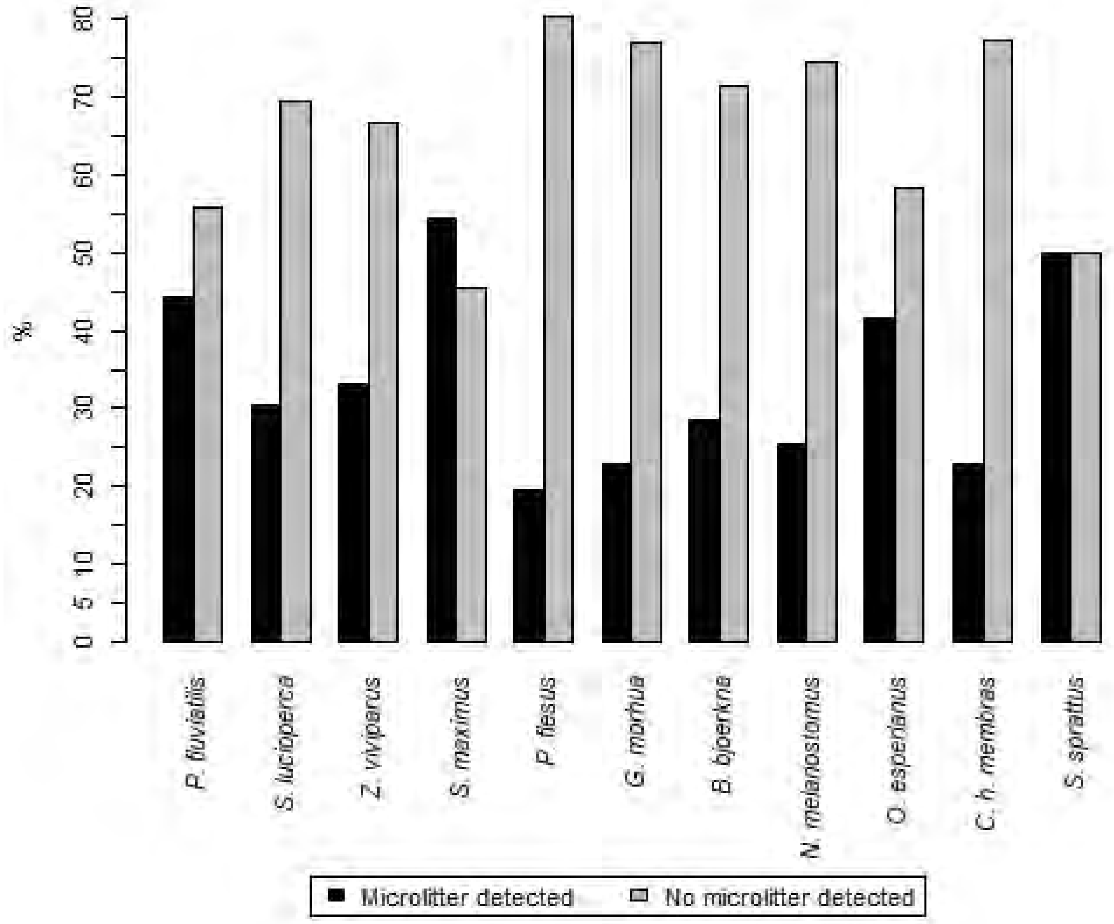
Microlitter in fish

Microlitter contamination in 30.5% (n=524) of all analysed fish

Over 40% contained microlitter:
Perch *P. fluviatilis* (n=106)
Turbot *S. maximus* (n=10)
Sprat *S. sprattus*
Smelt *O. esperlanus*

Less than 20% contained microlitter
Flounder *P. flesus* (n=51)

Majority contained 1 litter item
(occasionally 2 to 4 items)

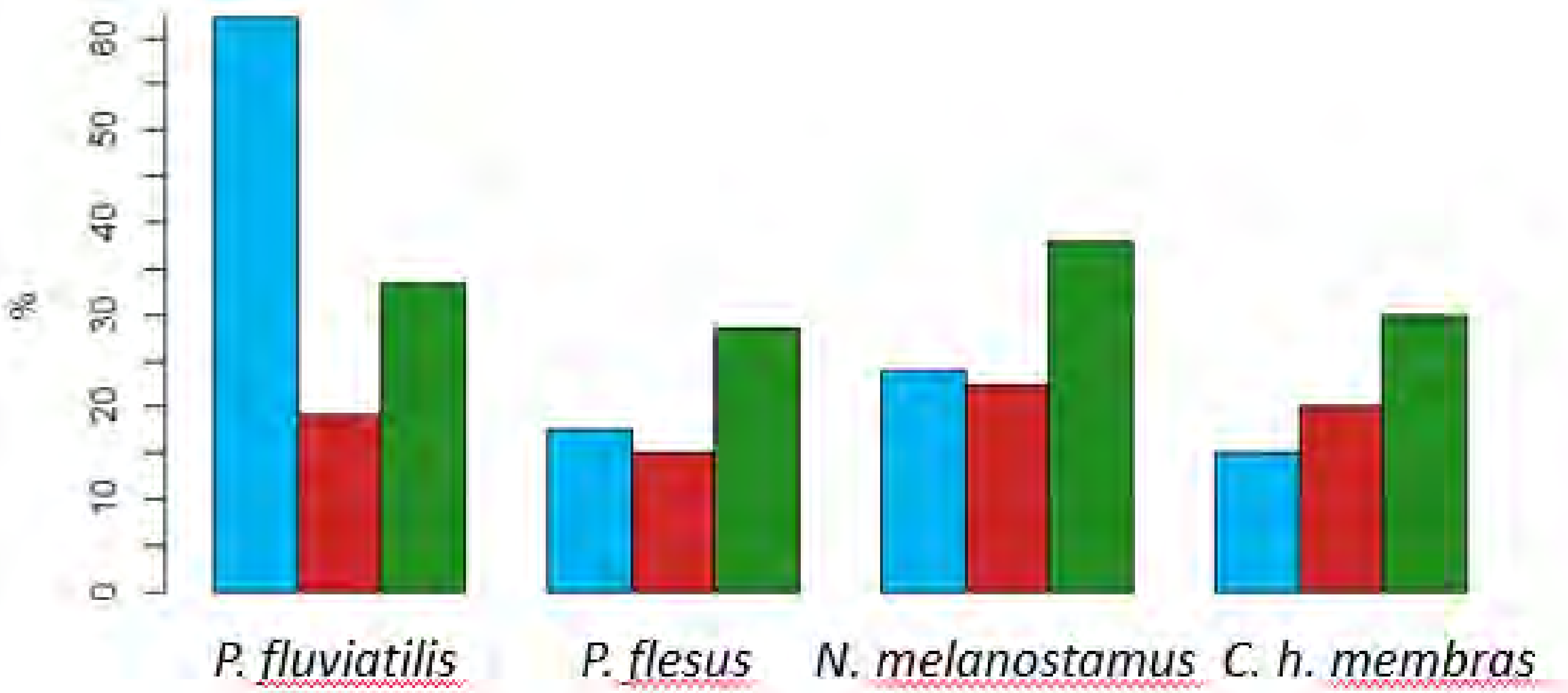


Microlitter in fish

Gulf of Riga
36.1% (n=144)

Western Estonia
33.1% (n=115)

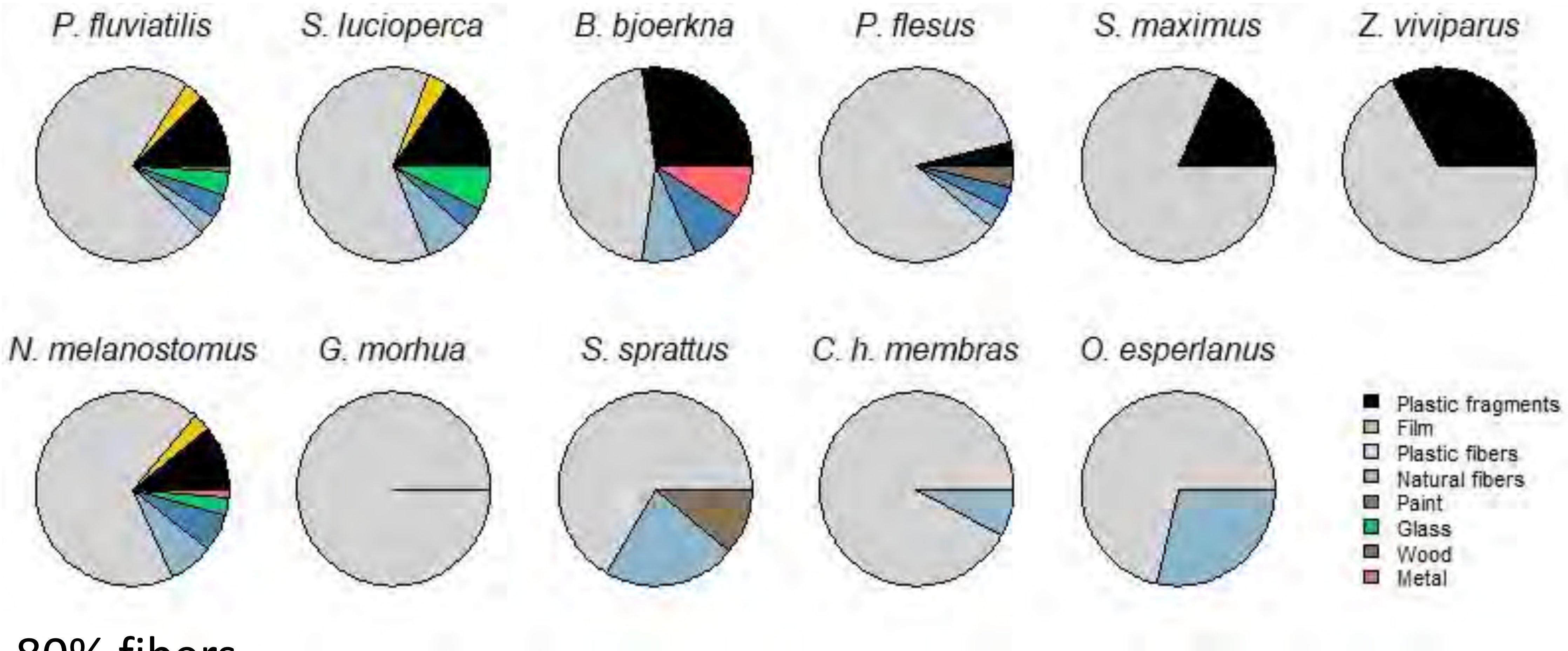
Gulf of Finland
22.7% (n=191)



Gulf of Riga, two methods:
gill nets 27%
trawl nets 37.8%

The number of ingested microlitter items was significantly different among Gulf of Finland and Gulf of Riga

Microlitter categories in fish



ca 80% fibers

52.6% blue

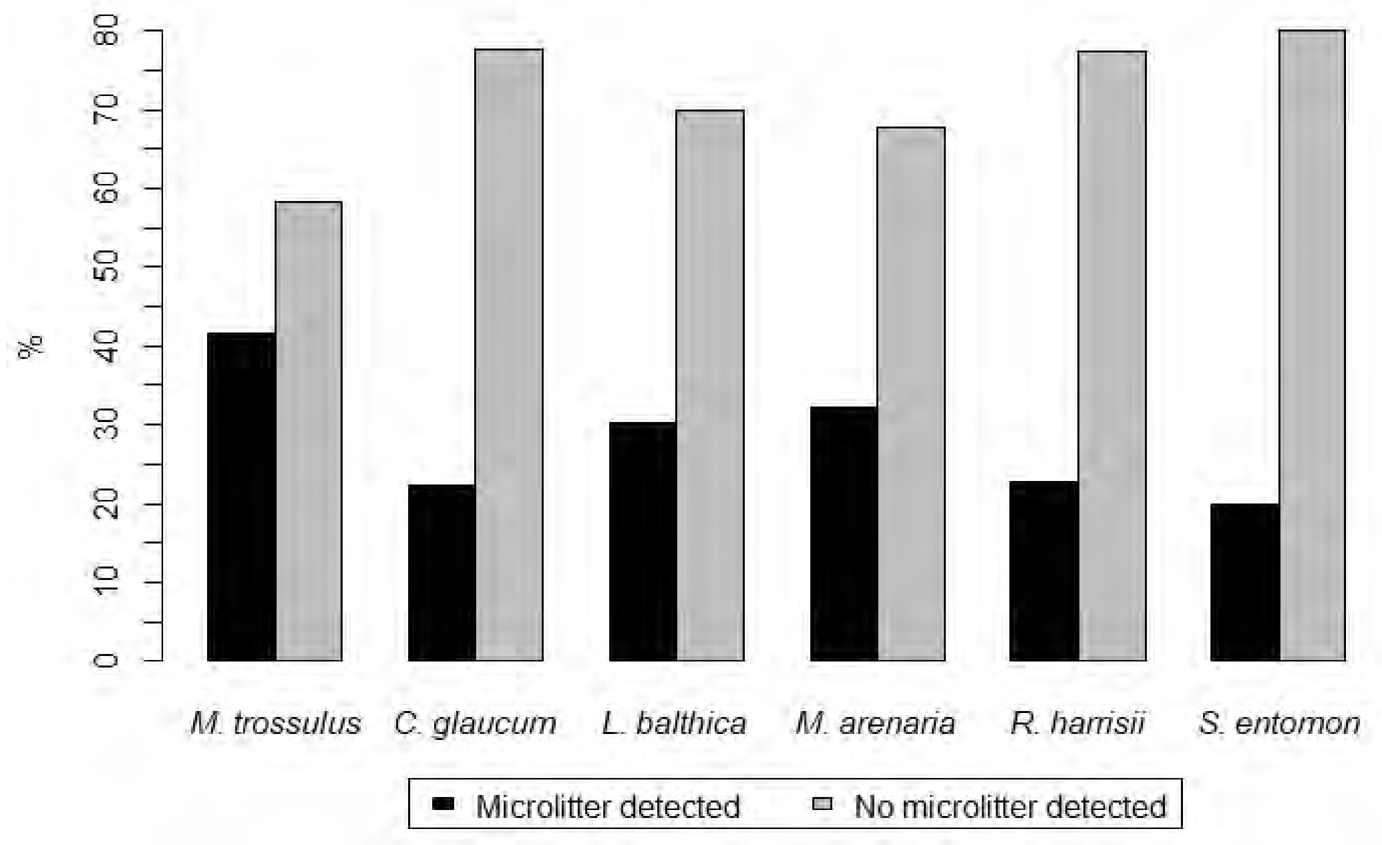
Microlitter in macrozoobenthic organisms

Litter were detected in 31.3%

No significant difference between marine areas or species was found

70% comprised one particle/ind,
18.6% comprised two particles/ind

Maximum - 10 particles/ind
(*M. trossulus,* eastern Baltic Proper).

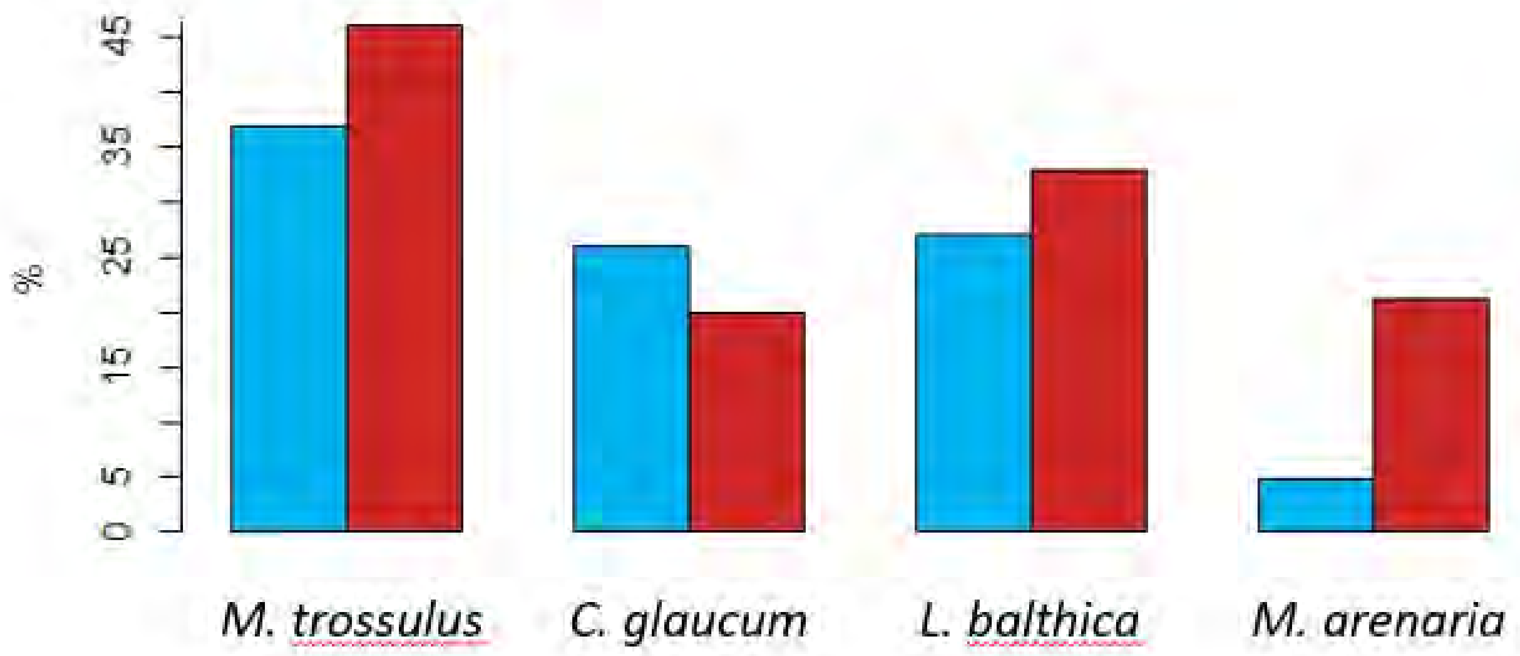


Microlitter in bivalves

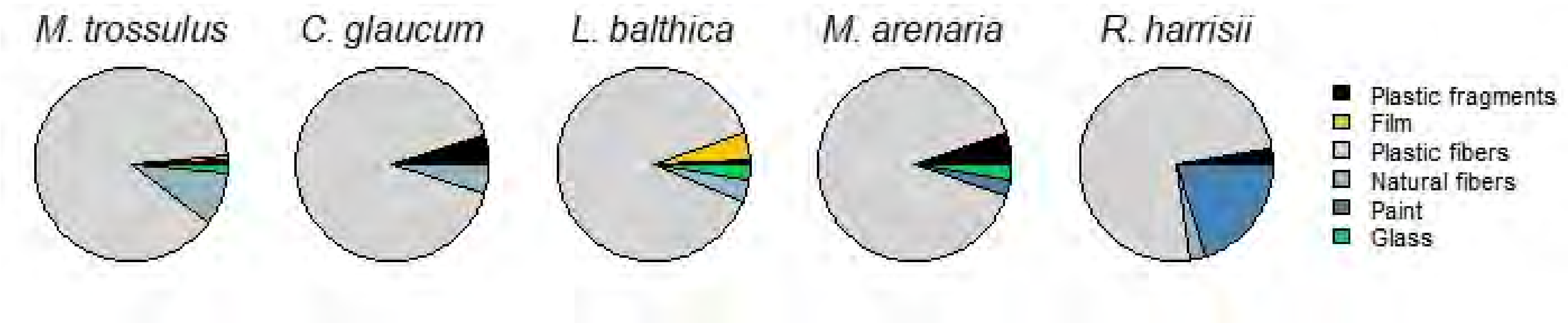
Gulf of Finland
32.3% (n = 321)

Western Estonia
33.6% (n = 354)

No significant difference in number of ingested micro-litter items between areas



Microlitter in macrozoobenthic organisms



ca 97% fibers (of which over 90% was plastic)

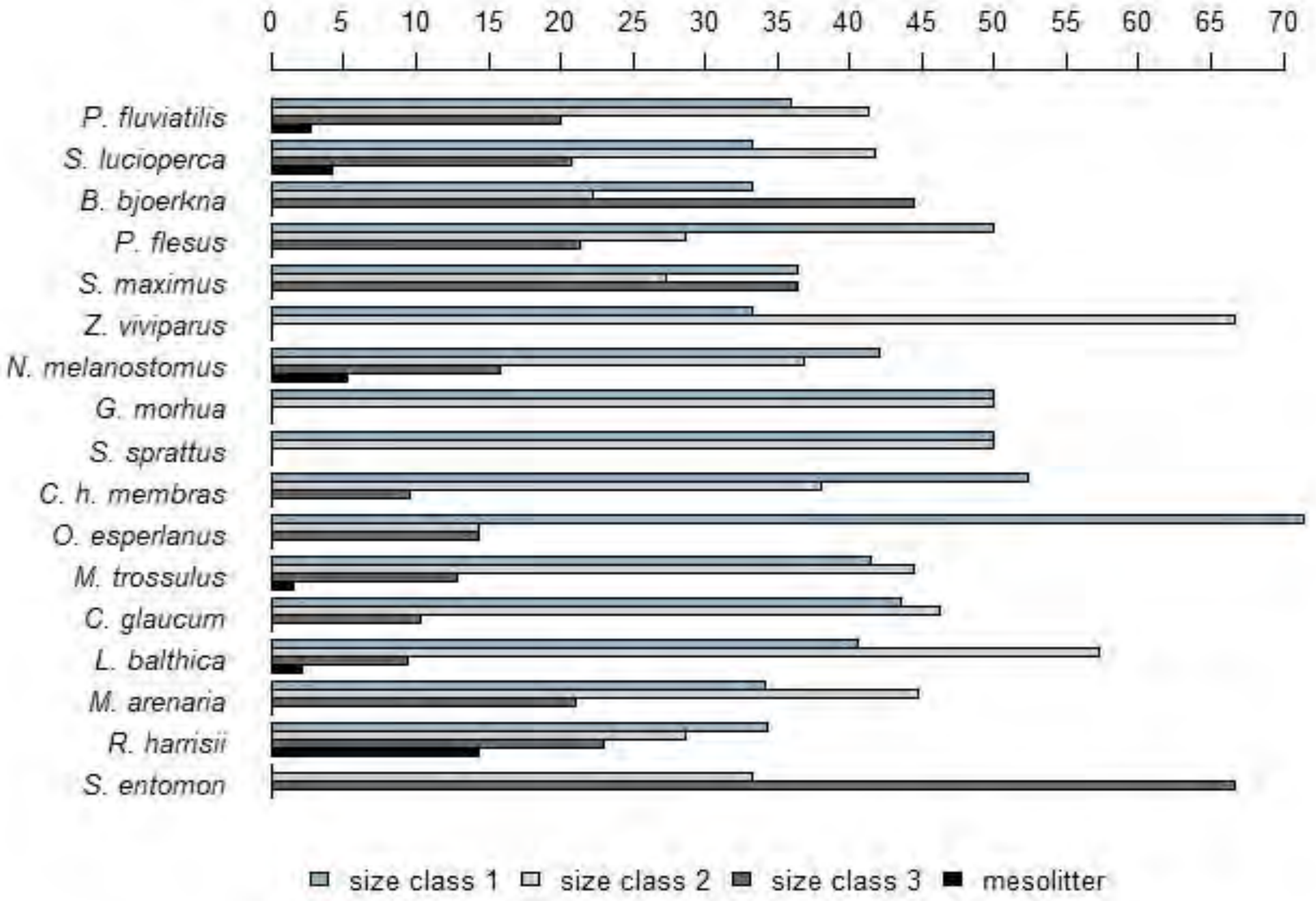
blue fibers – 60.9%

red fibers – 16.5%

10% of fibers found in the gut of Harris mud crab were clumped (the longest was 19 mm)

Size class 1:
1 mm< x <5 mm
Size class 2:
330 µm< x <1 mm
Size class 3:
100 µm< x < 330 µm
Mesolitter > 5 mm

Proportion of total litter items per size classes



Fish – mainly size class 1 or 2

2.7-5.3% – mesolitter

Bivalves – mainly size class 1 or 2

Smallest items mainly <15%

Harris mud crab – 15% mesolitter

Saduria entomon – 67% size class 3

Indicator species

a) be representative of specific environmental compartments;

b) have a wide distribution in the MSFD (and RSCs) areas;

c) have a commercial value;

d) already be described as regular litter consumers by different research studies;

Fish:

- **perch *P. fluviatilis***
- **flounder *P. flesus***
- **baltic herring *C. h. membras***
- **sprat *sprattus sprattus***

Macrozoobenthic organisms:

- **blue mussel *M. trossulus***
- **Baltic macoma *L. balthica***
- **Harris mud crab *R. harrisii***







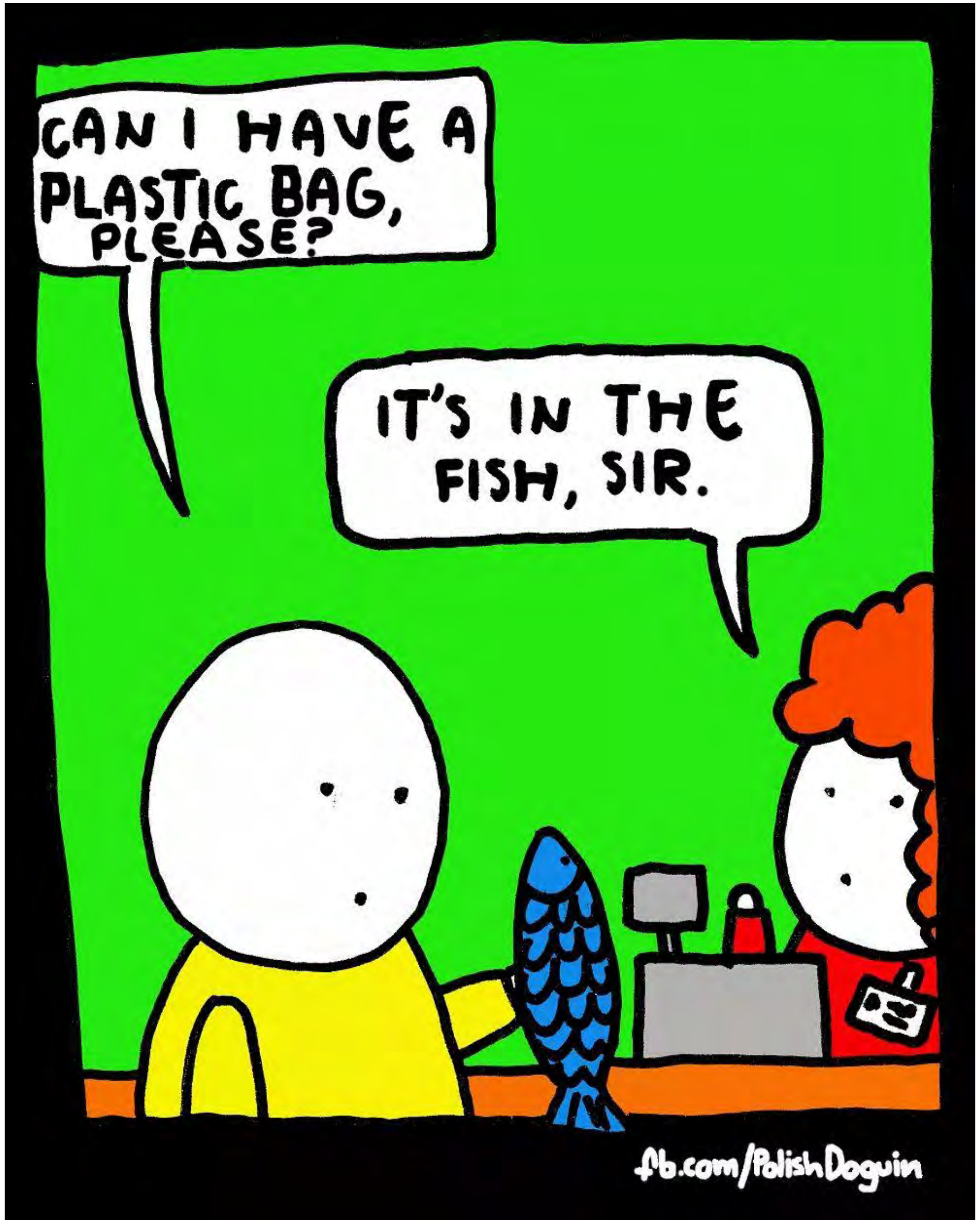
Fish photos: L. Saks

Conclusions

- Sampling from different sites of Estonian marine area
- At least 30 individuals of one species from one station
- Fish species: perch *P. fluviatilis*, flounder *P. flesus*, baltic herring *C. h. membras and* sprat *Sprattus sprattus*

Macrozoobenthic organisms: blue mussel *M. trossulus*, Baltic macoma *L. balthica*, Harris mud crab *R. harrisii*

We know the base values of an amount and composition of microlitter in selected species and from now on it enables to assess changes



Acknowledgements to:
the staff of Estonian Marine Institute
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Study is funded and supported by:
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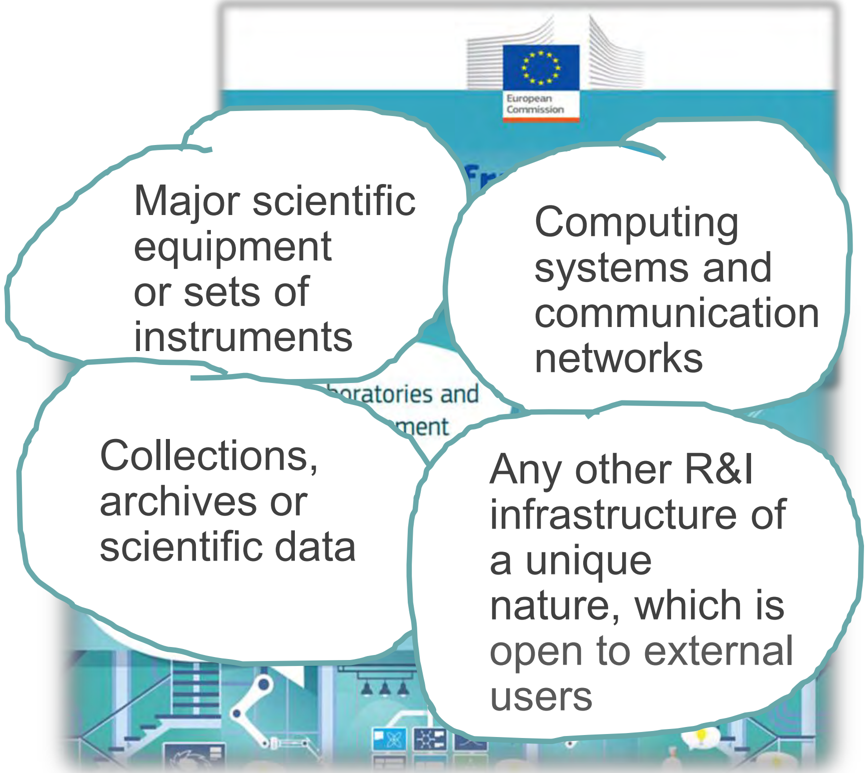
FINMARI Research Infrastructure – an integrated platform for Baltic marine research and observation

Maiju Lehtiniemi, Jari Haapala, Aarno Kotilainen, Ari Leskelä, Joanna Norkko, Jari Hänninen, Martin Snickars, Katri Kuuppo*

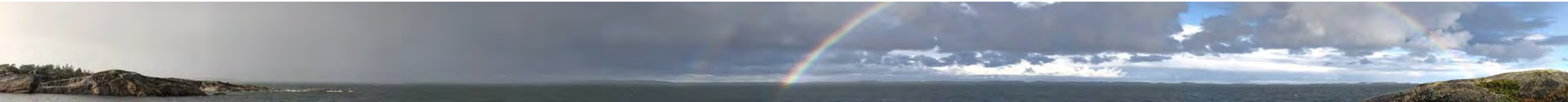
The Gulf of Finland
Science Days
Tallinn
29-30 November 2021

What are Research Infrastructures ?



- Facilities that provide resources and services for research communities to conduct research and foster innovation
- Single-sited, distributed, or virtual
- Can be used beyond research e.g., for education and public services such as monitoring

https://op.europa.eu/en/publication-detail/-/publication/6702e82f-e4c3-11e9-9c4e-01aa75ed71a1/language-en/format-PDF/source-106123556

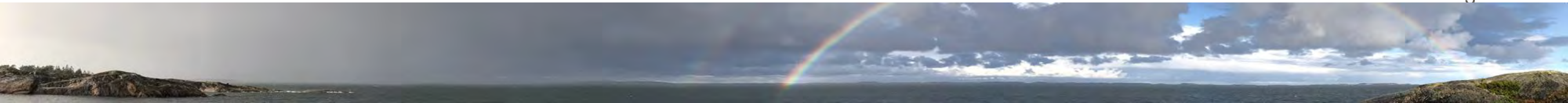


The Academy of Finland coordinates the roadmap of Finnish national Research Infrastructures (RI)

33 RI on the 2014-2020 FIRI roadmap

29 RI on the 2021-2024 FIRI roadmap

- The Accelerator Laboratory of the University of Jyväskylä (JYFL-ACCLAB)
- ALD center Finland - research infrastructure for atomic layer deposition and etching
- Biobanking and Biomolecular Resources Research Infrastructure of Finland (BBMRI.fi)
- Biocenter Finland (BF)
- Bioeconomy Infrastructure (BIOECONOMY RI)
- Common Language Resources and Technology Infrastructure (FIN-CLARIAH)
- CSC's Research Infrastructure Services
- Earth-space research ecosystem (E2S)
- Euro-BioImaging: Research Infrastructure for Imaging Technologies in Biological and Biomedical Sciences (EuBI-Fi)
- European Infrastructure of Screening Platforms for Chemical Biology (EU-OS FI)
- European Life-Science Infrastructure for Biological Information (ELIXIR)
- European Plate Observing System (FIN-EPOS)
- EuropeanSocial Survey (ESS)
- Finnish Biodiversity Information Facility (FinBIF)
- Finnish Computing Competence Infrastructure (FCCI)
- The Finnish Infrastructure for Public Opinion (FIRIPO)
- Finnish Marine Research Infrastructure (FINMARI)
- Finnish National Infrastructure for Light-Based Technologies (FinnLight)
- Finnish Research Infrastructure for Population Based Surveys (FIRI-PBS)
- Finnish Social Science Data Archive & CESSDA ERIC's Finnish Service Provider (FSD)
- FiQCI: Finnish Quantum Computing Infrastructure
- Integrated Atmospheric and Earth System Science Research Infrastructure (INAR RI)
- Integrated Structural Biology Infrastructure (FinStruct & Instruct-ERIC Centre FI)
- Measuring Spatiotemporal Changes in Forest Ecosystem (Scan4estEcosystem)
- Otaniemi Micro- and Nanotechnology Research Infrastructure (OtaNano)
- Partnership for Advanced Computing in Europe (EuroHPC)
- Printed Intelligence Infrastructure (PII)
- RawMatTERS Finland Infrastructure (RAMI RI)
- Research Infrastructure for Future Wireless Communication Networks (FUWIRI)



FINMARI is a multiplatform marine research infrastructure for research, observation and innovation, with the goal to “know, restore and protect” the Baltic Sea

Climate Change

CO_2 sinks/sources
Other greenhouse gases
Aerosols

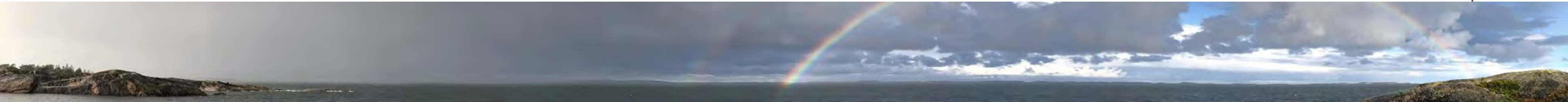
Direct anthropogenic pressures

Eutrophication
Overfishing
Habitat disturbances

Ecosystem services

Sustainable coastal marine systems
Blue growth

Marine populations and communities
Biodiversity and ecosystem functions
Impacts to and by the society



The FINMARI consortium includes 3 Finnish universities and 4 Governmental research institutes

Key fields of activity

Biological oceanography

Chemical oceanography

Physical oceanography

Marine geology

Fishery Sciences

Blue growth

Societal impacts

Key competences

Field observations

Experimental research

Modelling

Databases

Marine technology

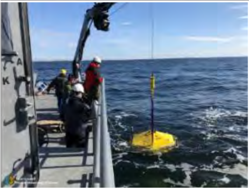
Education





Key infrastructures of FINMARI



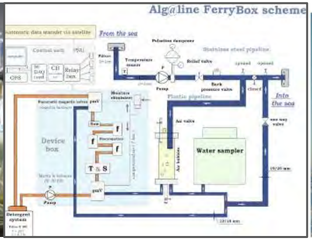



Research vessels
Alg@line FerryBox
Autonomous buoys and gliders
Field stations
Experimental facilities and laboratories
Automated real-time observations
Traditional research equipment









Field Stations are located along the Finnish Coast

Husö biological station of ÅAU

- Located in Finström on the Åland Islands
- Base for aquatic and other ecological research
- Monitoring especially shallow waters
- Laboratory & experimental facilities

Utö Atmospheric and Marine research Station of FMI

- Located on Utö Island at the edge of the Baltic proper
- Physical and biological real-time observations
- Part of the HELCOM network, EMEP and ICOS programs and JERICO-RI
- Observations are supported by Alg@line

Archipelago Research Institute of UTU

- Located on Seili Island, the Archipelago Sea
- Long-term monitoring
- Statistical time series modeling
- Experimental laboratory
- RV Aurelia
- Operates one of the profiling buoys of FINMARI network

Tvärminne Zoological Station of UHEL

- at the entrance to the Gulf of Finland
- Biological and ecological research
- Long-term environmental monitoring
- RV Augusta
- Large-scale field experiments
- Indoor experimental and laboratory facilities

Photo ÅAU /Husö Photo Lauri Laakso

Research vessels, varying in instrumentation and range of operation

Aranda

Owner **SYKE**
Length 59.20 m
Cruising speed 10.5 knots
Berths for scientists 25

Laboratory space 124 m²
Wet lab 9 m²
Acclimated rooms 16 m²
Computer lab and offices 32 m²
Workshop 7 m²
Sampling facility 132 m²
Helicopter deck
Research and storage container facilities

Augusta

Owner **Tvärminne Zoological Station**
Length 18.5 m
Cruising speed 18 knots
Range 20 h at cruising speed

2 x Volvo IPS 490 hp with skyhook
2 x Crane capacities of 300 and 1000/500 kg
Capstan and rope lock for buoy anchor

Aurelia

Owner **Archipelago Research Institute**
Length 18,1 m
Speed 15 knots
Passengers max 42 persons

Wet and dry laboratories
CTD, sediment corers, grabs ADCP-profiler, on-line chlorophyll fluorometer, digital sonar system, other sonars, weather station, differential GPS, Navi Fisher navigating system

Geomari

Owner **GTK and Finnish Navy**
Length 20.0 m
Cruising speed 20 knots
Berths for scientists 3, crew 3

Equipment for seafloor mapping and research: seismic signal equipment (250-1300 Hz), Sidescan Sonar (100/500 kHz), research echosounder (MD 28 kHz), Chirp sonar (3 – 9 kHz), multibeam sonar, seabed sediment sampling equipment
Wet laboratory


Photo Ilkka Lastumäki


Photo Jes er Häggblom


Photo UTU /Seili


Photo Juha Rahkonen

Autonomous platforms: cutting-edge technology

Argo Floats

Free drifting, profiling Argo float measures T°C, salinity, currents and bio-optical properties in the sea

Ice Buoys

An ice buoy measures sea ice drift and tracks its coordinates, air pressure and sea surface temperature

Profiling Buoys

Profiling buoys are automated devices for measuring salinity, T°C, O_2, turbidity, chl-α, and blue-green algae in the whole water column

FINMARI has a profiling buoy network at **Seili, Tvärminne, Husö and Utö** stations

Gliders

Autonomous underwater vehicle used for measuring e.g., T°C, salinity, chl-α, turbidity and CDOM

The glider regulates its buoyancy and diving to pre-set depth.

Data to European marine databases


Photo Petra Roiha


Photo Jari Haapala


Photo Lauri Laakso


Photo Lauri Laakso

Catalogue of facilities and instruments is building up on the FINMARI web page

FINMARI Gear Gallery: https://www.finmari-infrastructure.fi/gear-gallery/

FINMARI partnership represents the Baltic Sea in European RIs and delivers data to databases

ERICs
Euro Argo
EMBRC
(national process ongoing)
ICOS

ESFRI project
eLTER

H2020 *INFRAIA*
JERICO-S3
AQUACOSM-plus
ASSEMBLE plus
GROOM II
Eurofleets+
ARICE
MINKE

H2020 *INFRADEV*
Euro-Argo RISE
JERICO Design Study

Data & services RI
EMODnet
(several portals)
SeaDataNet
Copernicus Marine Service CMEMS

European components of global RI
EuroGOOS
ECORD

Multinational marine portals
ICES
HELCOM

EU R&D and data projects
NAUTILOS (H2020)
PHIDIAS (INEA/CEF)

The Gulf of Finland is a Pilot Supersite of the JERICO RI

One of four JERICO pilot supersites on European scale

Key objectives

- Multiplatform observational approach: spatial, temporal and extensive multidisciplinary coverage

  → Integration of long-term observation, process measurements, and experimentation
- Study how transnational/-institutional joint actions improve the data value chain and provide added value
- Improve understanding of interconnections of the climate change and other pressures, and their cascading effects in the marine ecosystem

Platforms in Gulf of Finland Pilot Supersite

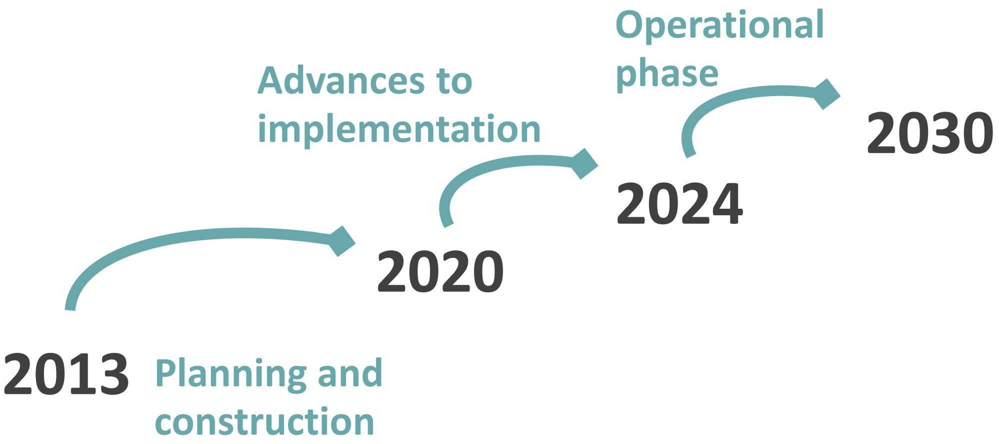
Operational observation systems & platforms in the region	Parameters
FerryBox: Silja Serenade and Finnmaid (SYKE, FMI, IOW), Silja Europa (TALTECH)	T, S, Chla-Fluo, CDOM-Fluo, Turbidity, Phycocyanin-Fluo, Phycoerythrin-Fluo, O2, pH, CO2, sampler
Utö Observatory (FMI, SYKE), Keri Observatory (TALTECH)	Utö: T, S, Chla-Fluo, CDOM-Fluo, Turbidity, Phycocyanin-Fluo, O2, pH, CO2, Meteorology, IFCB, Cytosense, FRRF, discrete samples Keri: T, S, Chla-Fluo, Turbidity, Phycocyanin-Fluo, O2, Meteorology
Gliders (FMI, TALTECH)	T, S, Chla-Fluo, CDOM-Fluo
Argo floats (FMI)	T, S, Chla-Fluo, O2
Profiling buoys (FMI, SYKE, TALTECH)	T, S, Chla-Fluo, CDOM-Fluo, O2, Phycocyanin-Fluo
Wave riders (TALTECH, FMI)	Wave height
Monitoring by R/V (All).	Annual program with several cruises & stations in the GoF area.
Experimental and calibration facilities (SYKE)	

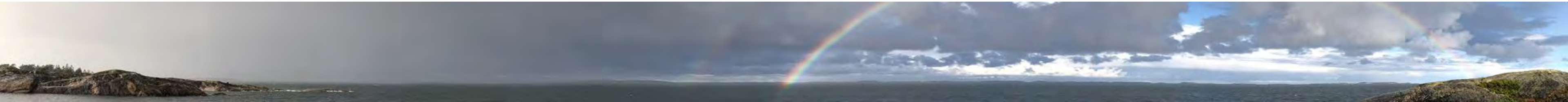
IOW Leibniz Institute for Baltic Sea Research Warnemünde · TAL TECH · FMI · SYKE · JERICO RI Science · Services · Sustainability

FINMARI is in the phase ‘Advances to implementation’

Focus area of FINMARI

- Develop open access protocols to the research facilities
- Data management to meet the FAIR principles





More information

https://www.finmari-infrastructure.fi/

FINMARI1

finmari_marineresearch


Photo Lauri Laakso

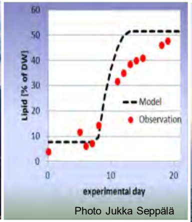


Photo Jukka Seppälä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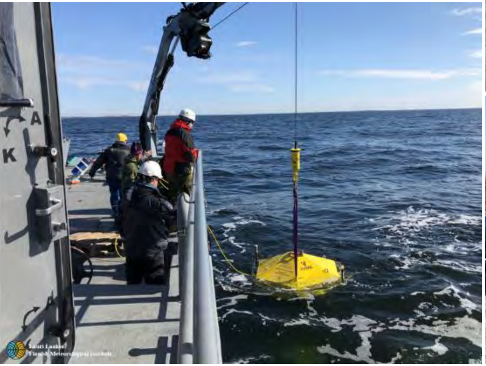



Photo Timo Tamminen

Aalto University
School of Engineering

Gulf of Finland Science Days

Exploring the potential of autonomous technologies for achieving sustainable Gulf of Finland

Dr Victor Bolbot
Dr Ahmad BahooToroody
PhD candidate Sunil Basnet
Professor Osiris Valdez Banda

Contents

- Introduction
- Autonomous ships projects at Aalto
- SWOT analysis of different autonomous solutions
- Conclusions

Introduction

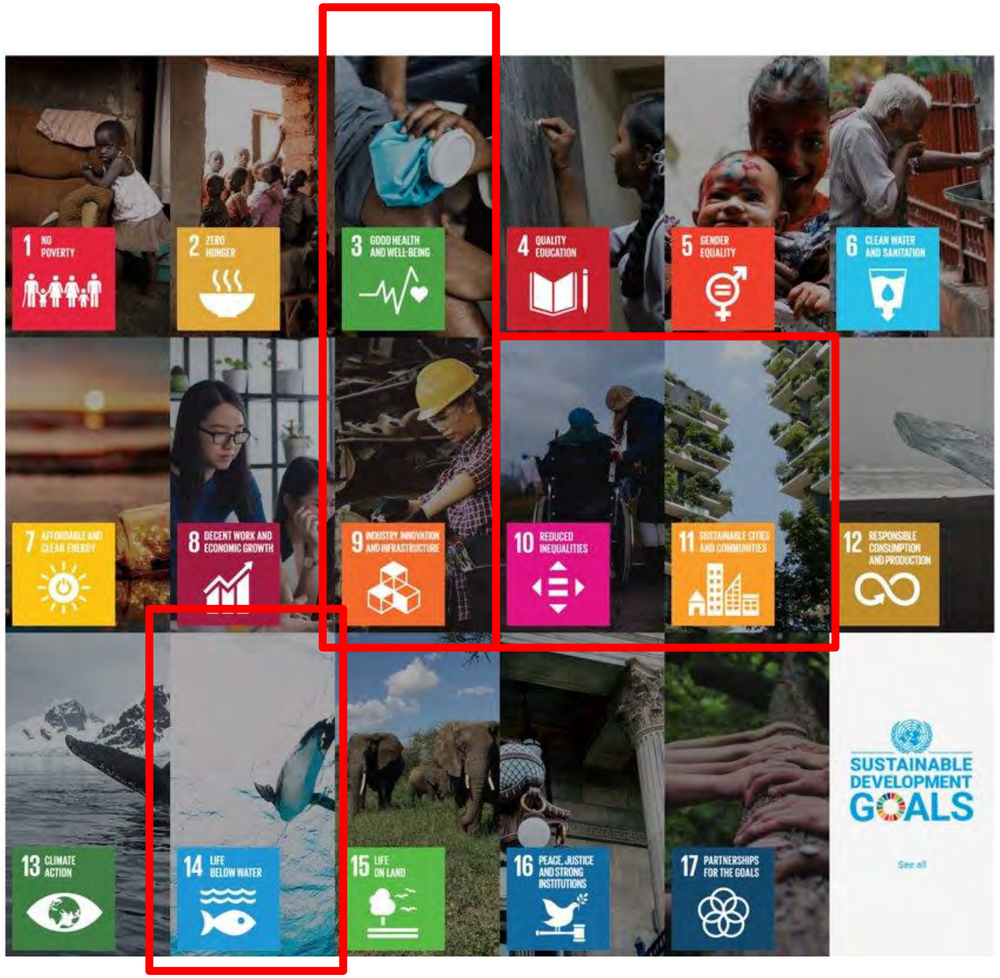
- **Autonomous shipping is becoming a tangible reality**
- **Roro ferries, Containership, inland waterway ships, fish feeding vessels, tugboats, cargo ships**
- **Finland, Norway, Denmark, United Kingdom, United States, China, Korea, Japan, Russia, Netherlands, etc.**

© https://www.ndtv.com/world-news/worlds-first-electric-autonomous-cargo-ship-launched-in-norway-2617903

Introduction

Expected benefits

- **Reduced operational costs – no crew costs**
- **Reduced CO2 emissions – redesign**
- **Improved safety – less human errors**
- **Increased jobs accessibility – more jobs on shore**
- **New markets – potential for exports**



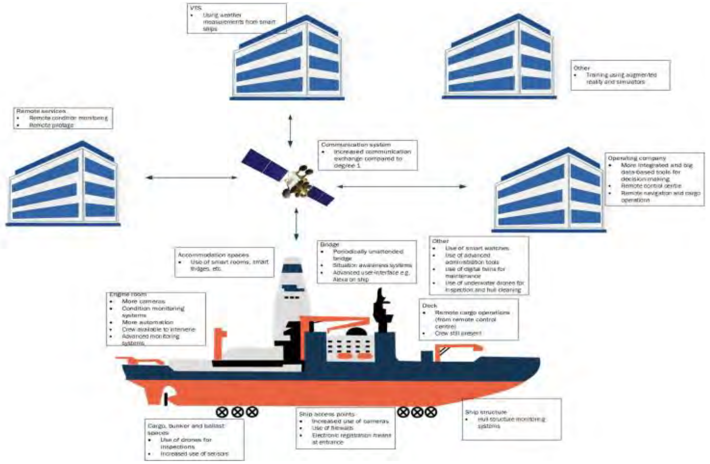
Autonomous ships projects

SMART CITY FERRIES

- **ÄlyVESI - Smart City Ferries (1.10.2016 – 31.5.2018)**
- **Solutions and concepts for unmanned city ferry**
- **Main Partners:**
  - Novia University of Applied Sciences
  - Turku University of Applied Sciences
  - Aalto University
  - the City of Turku
- **The financing is mainly based on European Regional Development Fund. Additional financiers are**
  - Finnish Transport Safety Agency
  - the cities of Helsinki and Espoo.
- **Topics covered**
  1. **Innovation Platform of Smart Urban Waterway Traffic**
  2. **Concepts and Services of Smart Urban Waterway Traffic**
  3. **The Safety of an Unmanned and Automated Ferry**
  4. **Environmentally Friendly Energy Solutions**
  5. **Research and Test Process of Remote Control and Remote Operation**
  6. **Smart Pier/Quayside**

Autonomous ships projects

- **AutoMARE – Multidisciplinary education network for autonomous shipping (1.1.2021 – 31.12.2022)**
- **Needs and solutions for educating next generation maritime experts**
- **Main Partners:**
  - Novia University of Applied Sciences
  - Turku University of Applied Sciences
  - Satakunta University of Applied Sciences
  - University of Turku
  - XAMK Open University of Applied Sciences
  - Abo Akademi University
  - Aalto University
- **The financing is offered by the Finnish Ministry of Education and Culture.**
- **Specific objectives**
  1. Identifying the technologies on autonomous ships
  2. The impact of technologies on the industry
  3. The arising educational needs identification
  4. Pedagogical methodology development
  5. Technical and technological solutions for education development



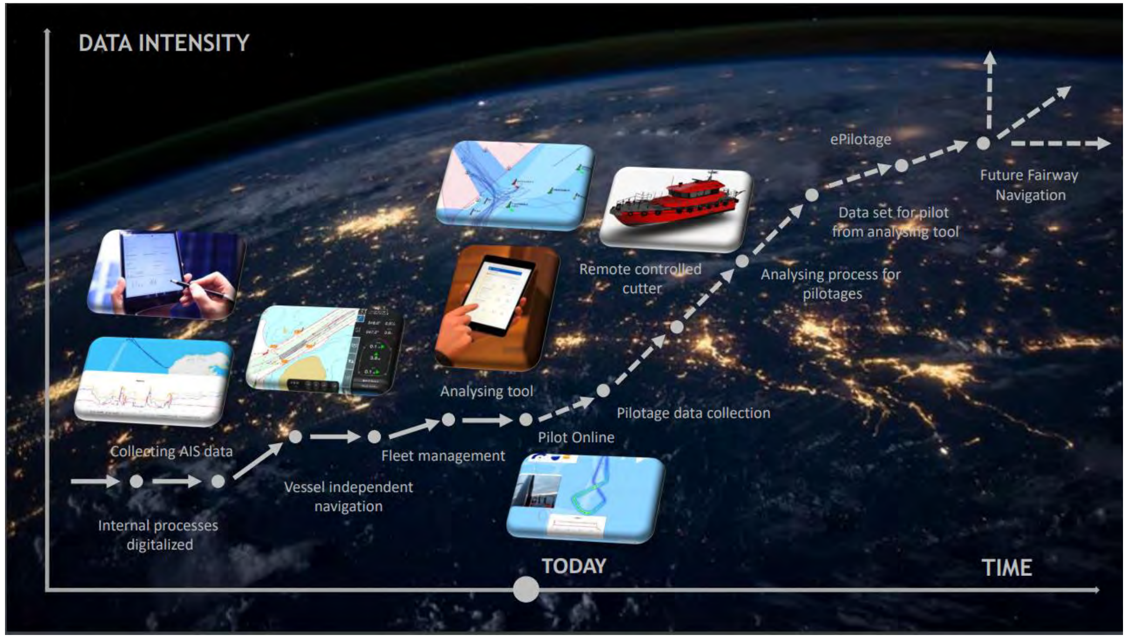
Autonomous ships projects

- **ECAMARIS – Enablers and Concepts for Automated Solutions (1.10.2021 – 31.9.2023)**
- **Investigation of key enabling technologies for MASS**
- **Main Partners:**
  - VVT
  - ABB
  - GIM robotics
  - AILiveSim
  - Aalto University
- **The financing is offered by the Business Finland.**
- **Investigated concepts**
  - Relocated bridge
  - Conditionally and periodically less-manned bridge
  - Conditionally and periodically unmanned bridge
- **Tasks related to safety**

Autonomous ships projects

DIMECC Program
SEA4VALUE – Fairway

- **Sea4Value– Providing blueprints towards digitalization, service innovation and information flows in maritime transport (01.04.2020 – 31.12.2022)**
- **A path towards development of an innovative smart shipping service, ”Remote pilotage”**
- **Main Partners:**
  - Dimecc
  - Finnpilot
  - Brighthouse
  - Awake.AI
  - Novia University of Applied Sciences
  - Aalto University
- **The financing is offered by the Business Finland.**
- **Investigated concepts**
  - Intelligent fairway
  - Remote pilotage
- **Tasks related to safety and security**



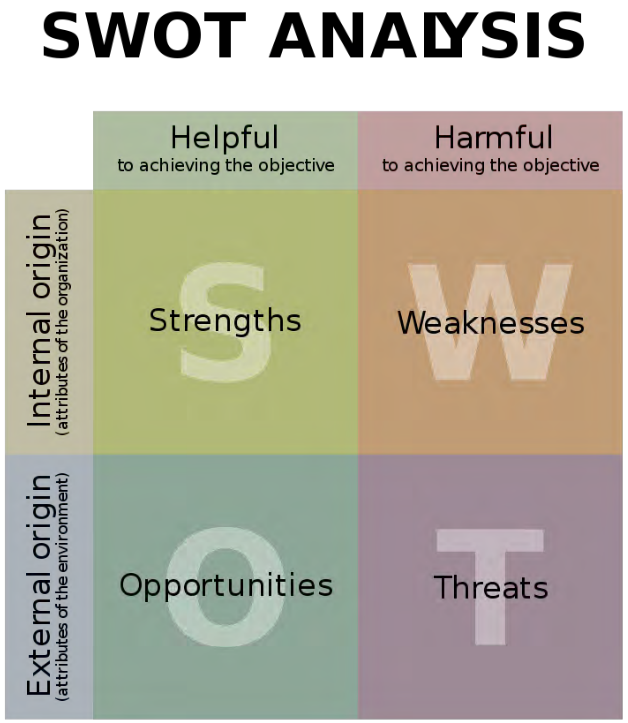
SWOT

Why SWOT (Strength, Weaknesses, Opportunities, Threats)?

- **Good for preliminary decision-making**
- **Efficient for initial planning**

Limitations

- **Only preliminary findings**



© Wiki

1st idea

Unmanned cargo ship between Tallin and Helsinki
- Idea similar to Yara Birkenland

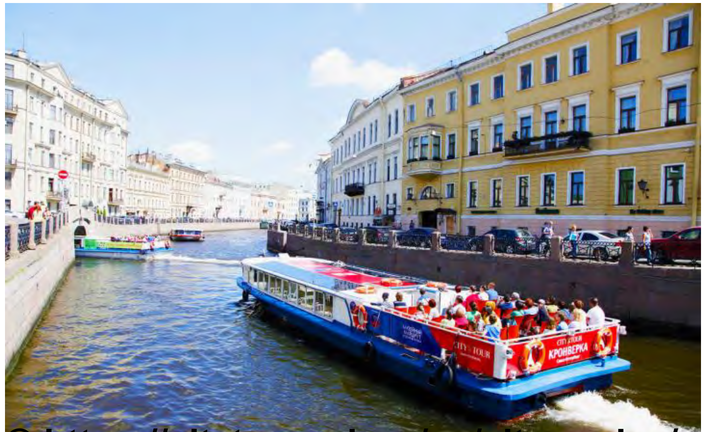
	Internal	External
	Strength	Opportunities
Helpful	- Reduced operational costs - Improved safety - Resilience - Can be a novel design - Improved emissions - Automatic mooring is available	- Completely novel design - Coupled with autonomous ports and trucks? - Operation during the night - Other shipping routes in the GoF
	Weaknesses	Threats
Harmful	- Battery capacity vs speed - No humans - Infrastructure update	- Economy of scale - Dense traffic - Difficult approaches - Big changes in logistics - Distance (80 km) (not 15-18km in Norwegian fjords) - 13-55km Yara Birkenland

2nd idea

Small urban ferries

- Similar to ÄlyVESI

© hel.fi



© https://citytourspb.ru/en/city-cruise/

	Internal	External
	Strength	Opportunities
Helpful	- Reduced operational costs - Improved safety - Can be a retrofit	- Small distance - Alternative propulsion solutions - Suitable for Suomenlinna, archipelago and lake route ferries
	Weaknesses	Threats
Harmful	- Battery capacity	- Dense traffic - Currents etc. - Managerial procedure for certification and acceptance to operate

3rd idea

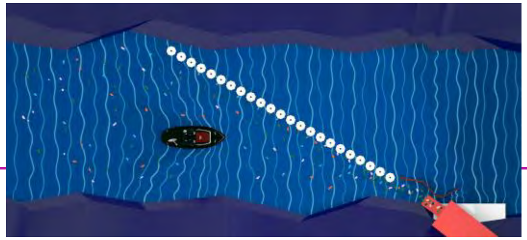
Plastic pollution cleaning vessels

- e.g. Waste Shark

© Disney plus

© https://www.dogonews.com/2019/4/8/trash-eating-sharks-are-taking-over-harbors-worldwide

	Internal	**External**
	Strength	Opportunities
Helpful	- Has been tested in a number of countries (Netherlands, South Africa, Singapore) - Easy to implement	- Small safety implications - Huge potential market - UAV for sediments cleaning - Oil pollution?
	Weaknesses	Threats
Harmful	- Innovation?	- Competition - Effectiveness? - Other systems of cleaning



© https://rivercleaning.com/river-cleaning-system/

© https://designedconscious.com/plastics-in-the-ocean/sustainability-news-stories/12-river-plastic-cleanup-projects/

4th idea

Rohi et al. 2020 Autonomous monitoring, analysis, and countering of air pollution using environmental drones Heliyon 6 (2020)

Drones for monitoring pollution

- Fan Zhou et al. 2019
- Monitoring of compliance with fuel sulfur content regulations through unmanned aerial vehicle (UAV) measurements of ship emissions

	Internal	**External**
	Strength	Opportunities
Helpful	- Easy to implement - Ship drones (larger operational time)	- Ships can be also used - Medium safety implications - Not only Sox emissions but also level of pollution, fish, temperature, weather, eutrophism
	Weaknesses	Threats
Harmful	- Aerial drones (limited operation) - Issues with accuracy	- Competition

Conclusions

- **Autonomous ships and technology becomes more and more tangible reality**
- **Aalto has experience in connection to autonomous ships projects**
- **Autonomous technologies can contribute to the GoF sustainability**
  - Novel greener supply chains
  - Reduced operational costs
  - Cleaning/mitigating activities
  - Monitoring activities

Aalto University
School of Engineering

Thank you for your attention
We are open to collaborative proposals

You can contact us at the following emails
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The stratification in winter and its consequences

Taavi Liblik, Germo Väli, Inga Lips, Madis-Jaak Lilover, Villu Kikas, and Jaan Laanemets

TAL TECH

Background

Pycnocline determines the vertical physical, biogeochemical fluxes.

Stable mixed layer shallower or comparable to euphotic zone is required for the primary production.

Annual cycle in stratification in most of the Baltic:

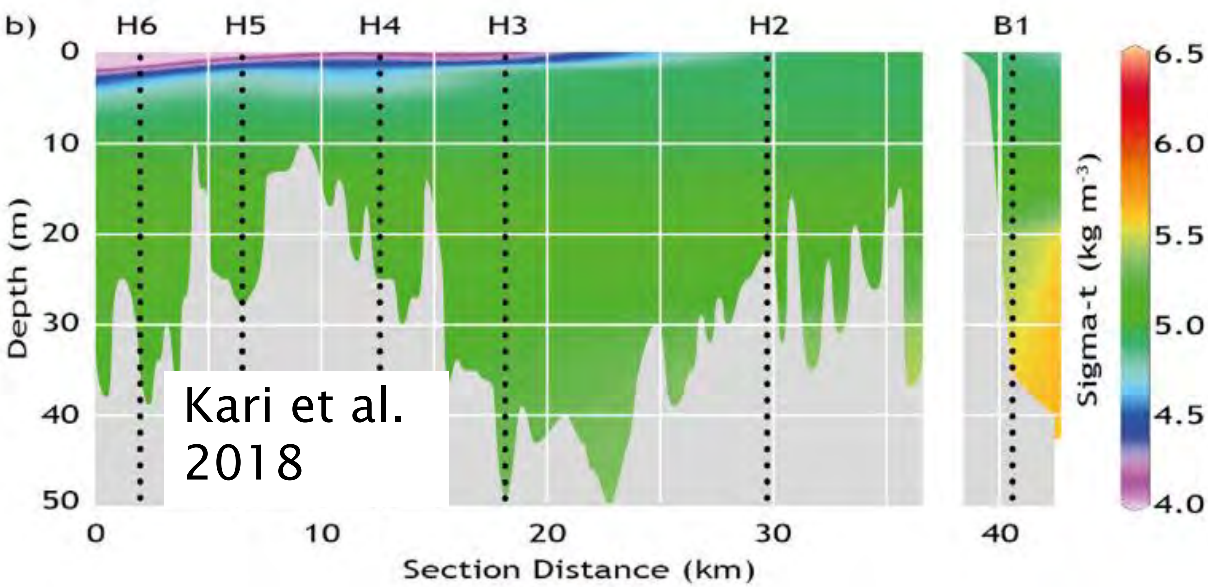
- Deep mixed layer during winter- well deeper than euphotic zone;

- Shallow mixed layer in spring/summer – in the same order with the euphotic zone depth.

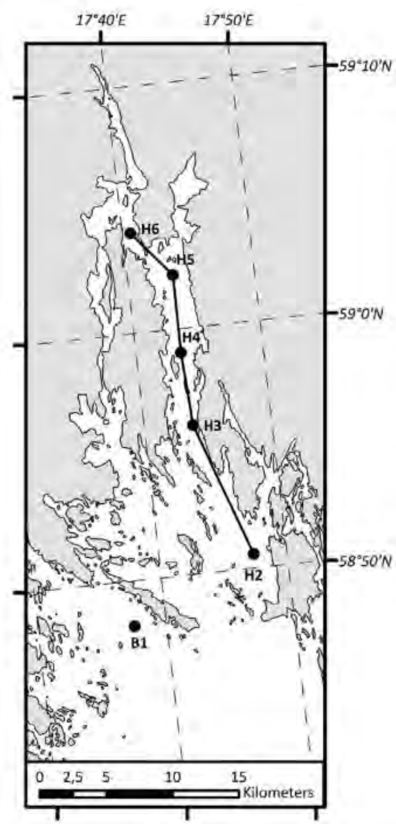
Background

- Wintertime stratification phenomena under ice near freshwater source at nearshore regions, extending 10–20 km from the coast, have been reported (Granskog et al., 2005; Kari et al., 2018; Merkouriadi and Leppäranta, 2015).

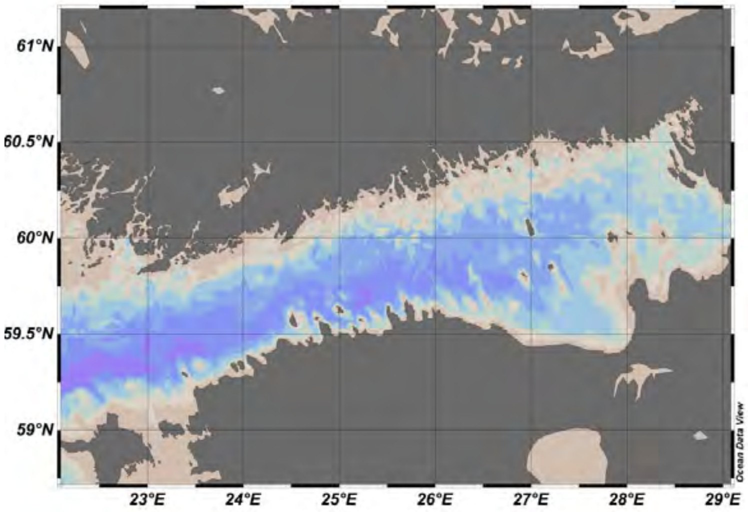
Kari et al. 2018



Kari et al. 2018



Background- Gulf of Finland

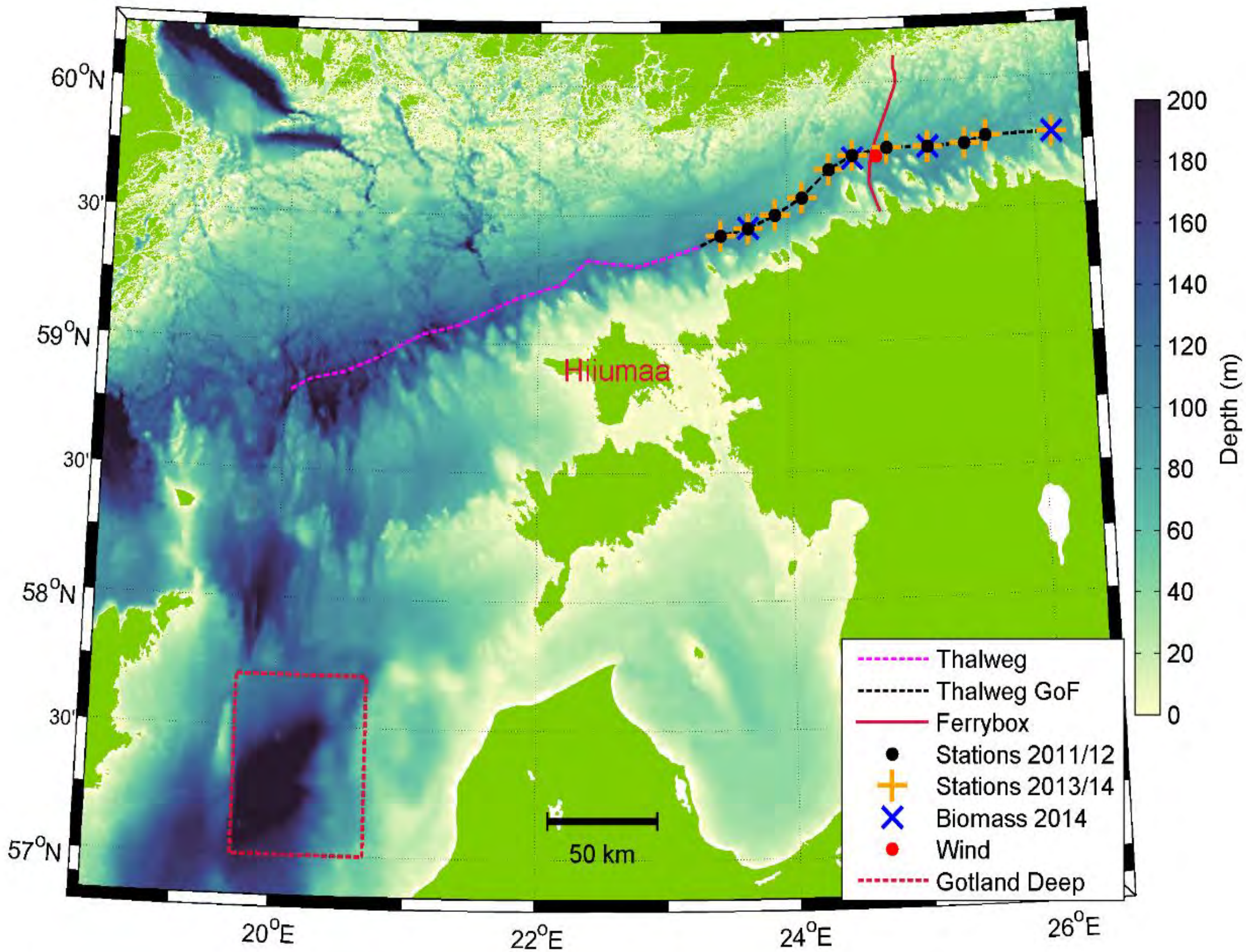


- Large freshwater input, which is concentrated to the east;
- Elongated shape;
- SST passes temperature of maximum density

Hypothesis: Haline stratification occurs at depth comparable to the euphotic zone depth in the whole Gulf of Finland in winter.

Data

- Along gulf RV surveys (CTD, Chl *a*, phytoplankton biomass) 2011/2012 and 2013/2014.
- Across-gulf ferrybox transect.
- Historical CTD data.
- GETM model run 2010–2019.



Along-gulf W-E section 2011/12

Mixed layer depth > 40 m

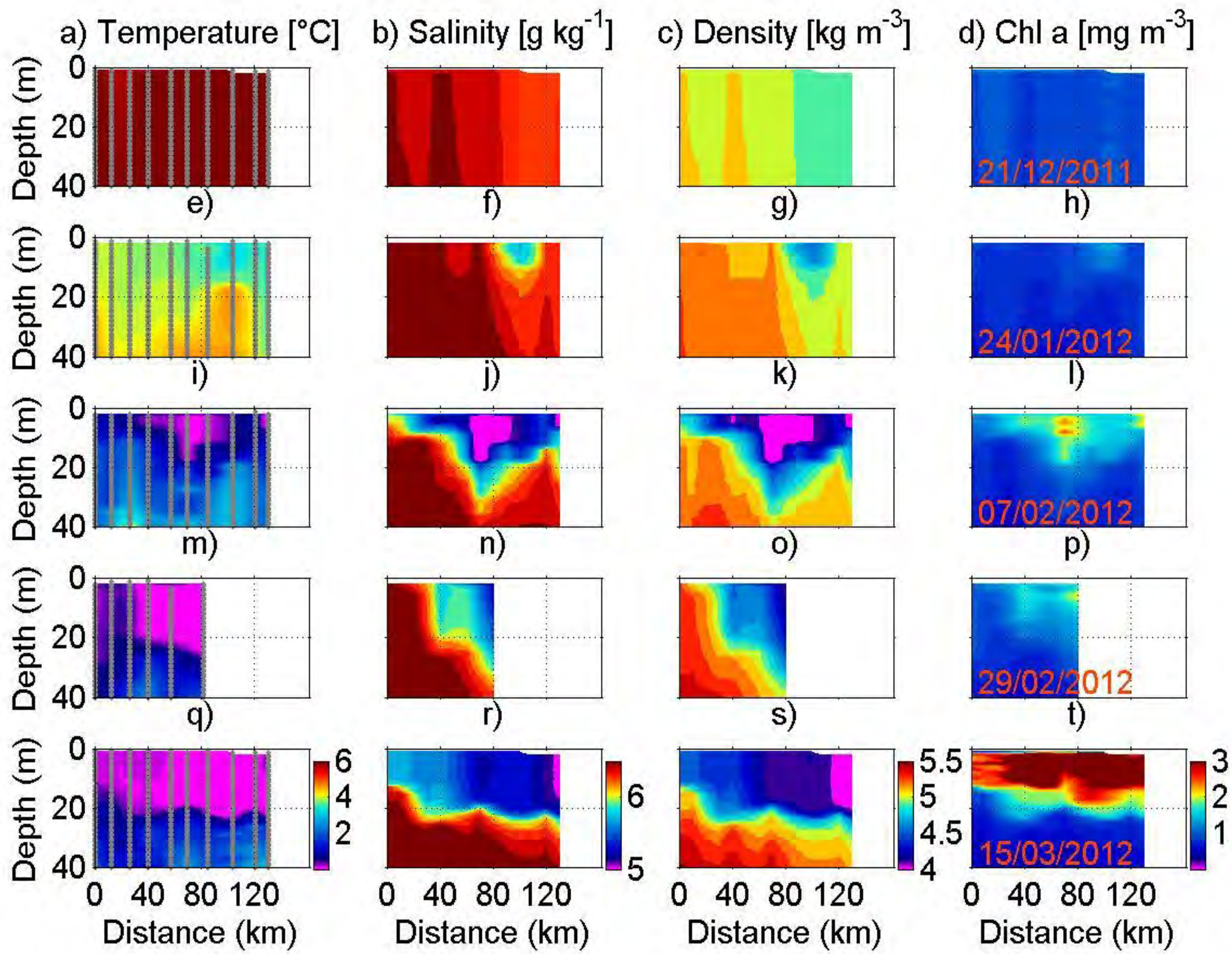
Shallow mixed layer, slightly higher Chl-a

Shallow mixed layer, Chl-a ~2 mg/l

Deepening of the mixed layer

Shallow mixed layer, Chl-a > 3-4 mg/l

Patterns confirmed by observations in 2013/14 winter

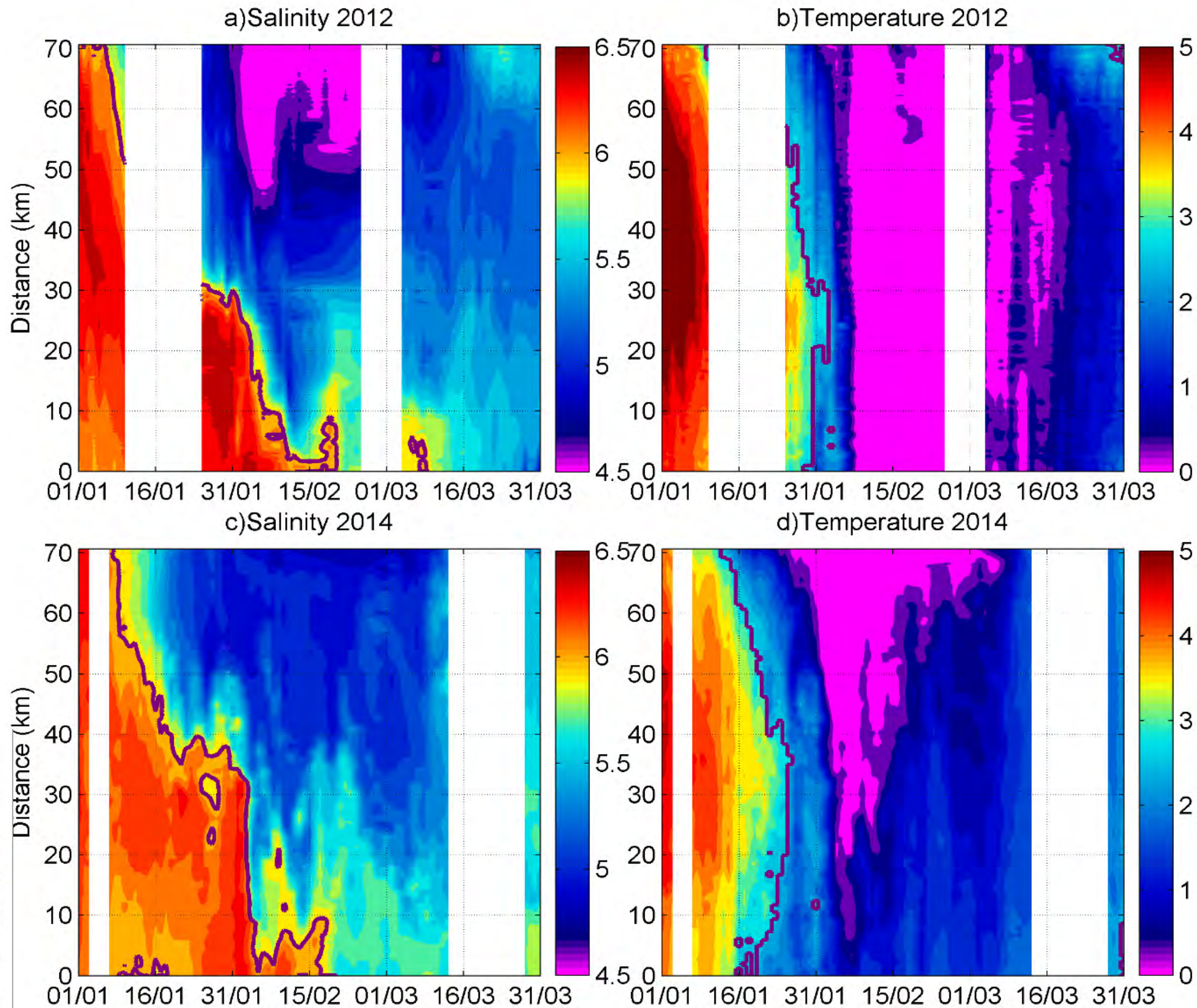


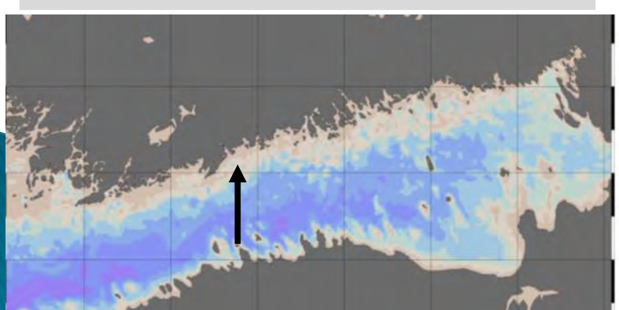
Westerly wind – Easterly wind or neutral

Across-gulf ferrybox

- Saltier and warm water occupied the transect at the beginning of January;
- Fresher water was spreading along the northern coast starting in mid-January
- Whole gulf filled by fresher water in mid-February

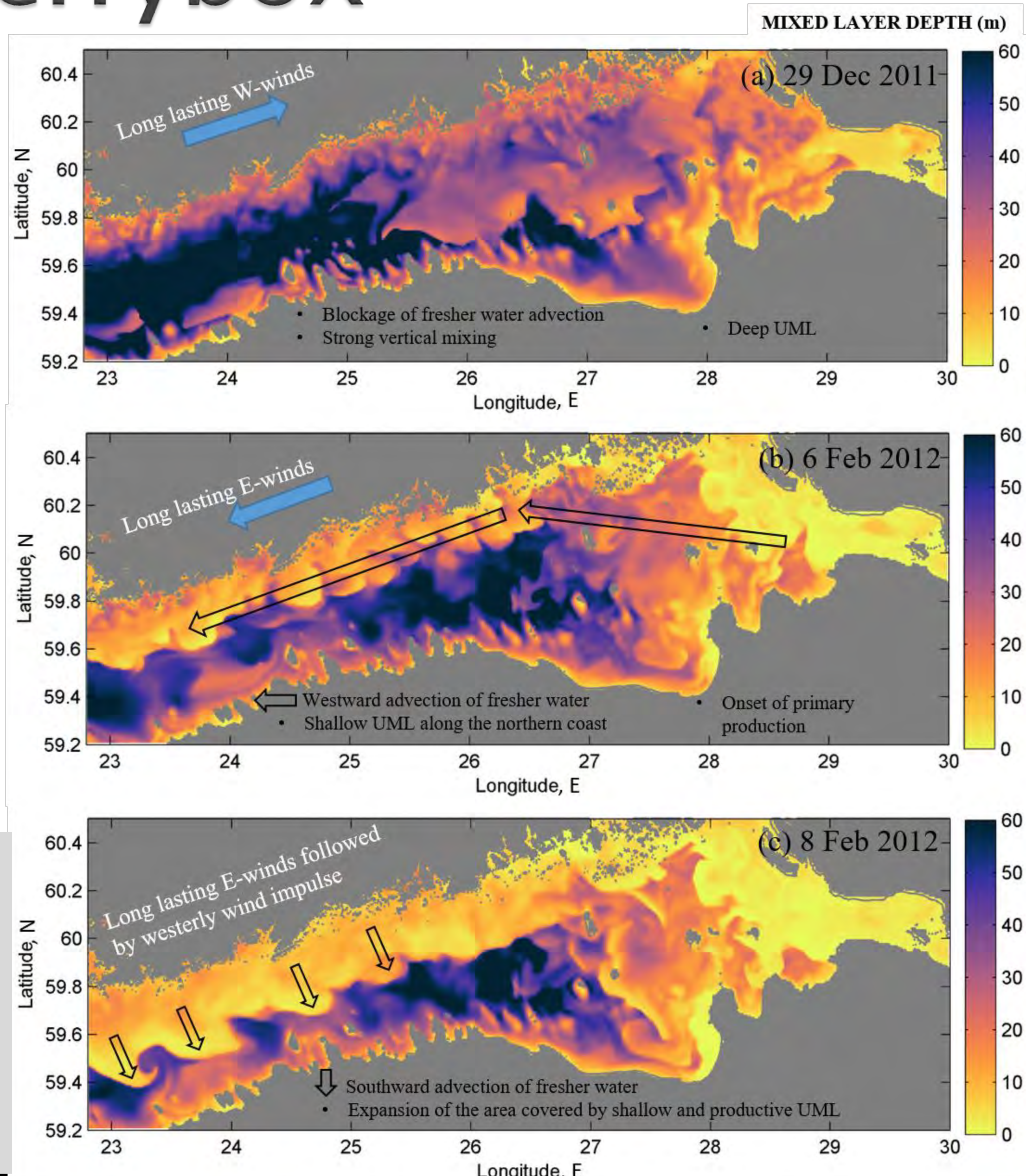
Tallinn-Helsinki ferrybox 2011/12 and 2013/14 winter





Across-gulf ferrybox

W-wind prevailing: blockage of fresher water advection, strong vertical mixing;

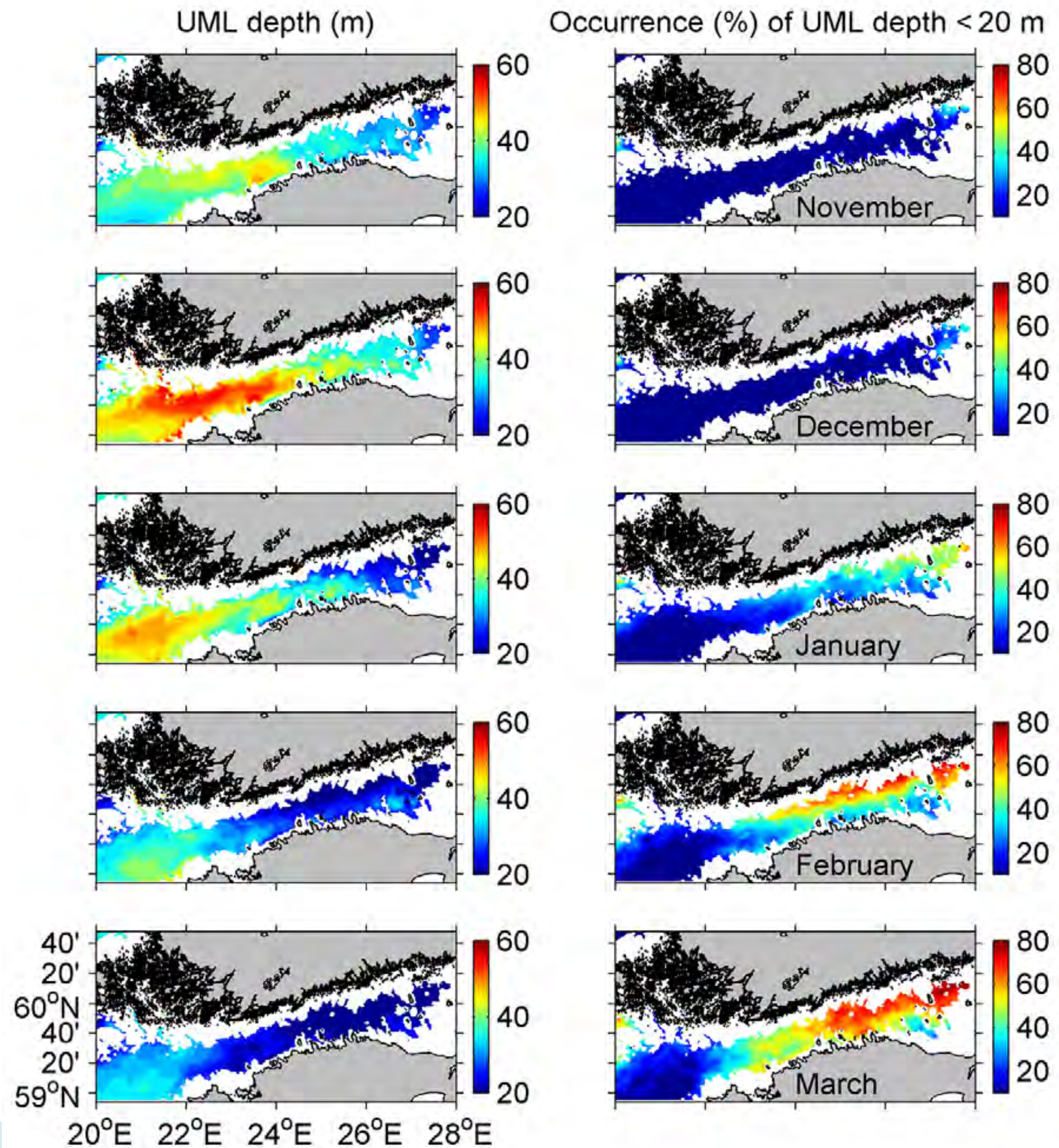


E-winds: westward advection of fresher water, shallow UML along the northern coast

W-wind impulse after E-wind prevailing: southward advection of fresher water and expansion of area covered by shallow and productive UML

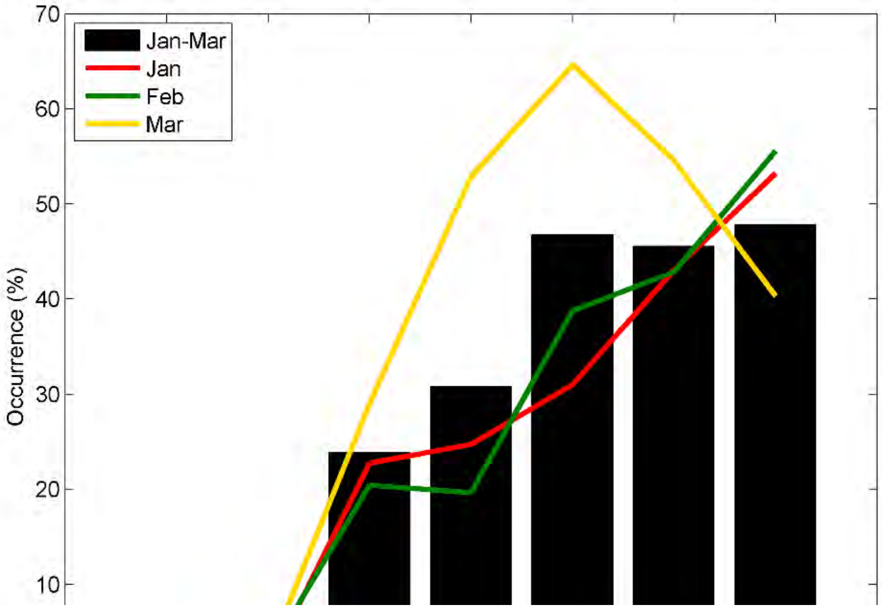
Model res. 2010–2019

- November – December: Deep UML, shallow mixed layer unlikely.
- January: Shallow mixed layer occurrence up to 40 % in the NE.
- February: Shallow mixed layer occurrence around 50–60% in the northern coast.
- March: Shallow mixed layer occurrence around >50% in the whole gulf.

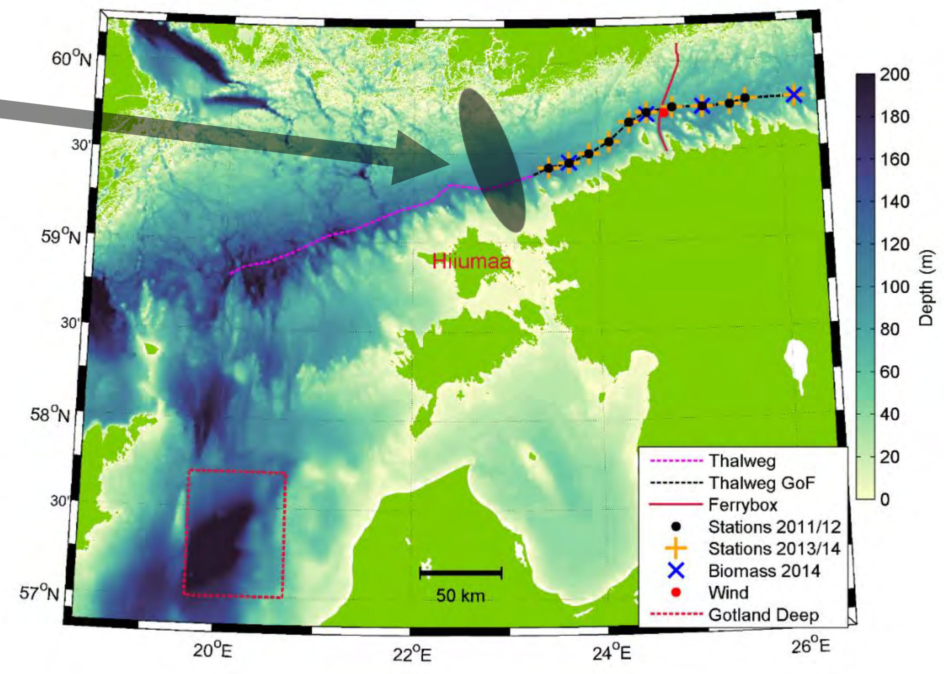


Hist. CTD

- Occurrence of density difference between 40 m and sea surface >0.5 kg m^{-3}, 2560 historical measurements.



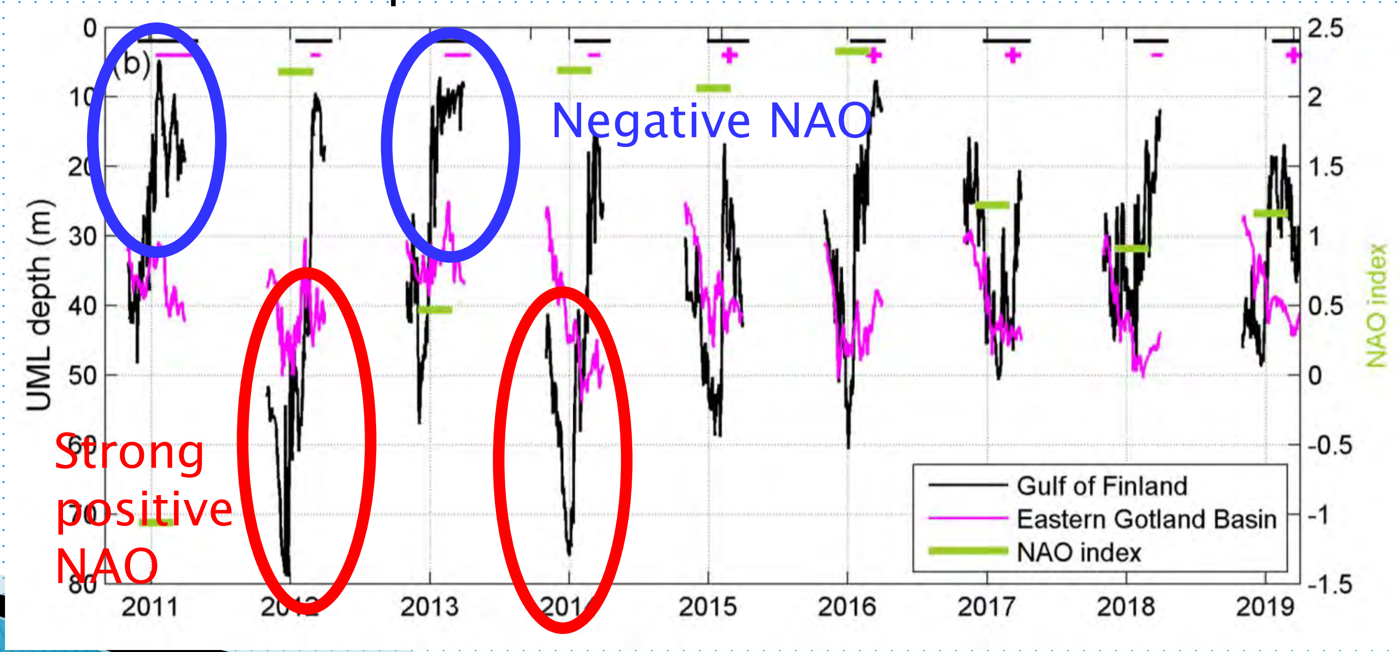
- Longitude 23 is the western border of the phenomena.
- Probably related to the coastal morphology– the Gulf of Finland extension in the Baltic Proper gets wider.



Long-term time-series

- The maximum of the UML depth in the gulf mostly occurred in December and well before SST decreased to T_{md} (maximum density temp.)
- The onset of re-stratification occurred at temperatures below T_{md} in the gulf.
- Negative NAO associates with early onset of stratification.
- Strong positive NAO in 2011/12 and 2013/14 (our surveys).

UML depth from October to March



Conclusions

Stratification at the depth comparable to the euphotic zone (10–20 m) forms in late January–early February along the northern coast and one month later in the whole gulf.

Stratification is mainly maintained by the positive buoyancy flux created by the fresher water advection.

Elevated Chl *a* and phytoplankton biomass were registered in the shallow mixed layer in winter.

Wintertime stratification is a common phenomenon, which also evokes without ice in the gulf. Its western boundary is at the entrance area to the gulf.

Interannual variations in the wintertime UML are connected to the North Atlantic Oscillation.

Study is published: Liblik, T., Väli, G., Lips, I., Lilover, M.-J., Kikas, V., & Laanemets, J. (2020). The winter stratification phenomenon and its consequences in the Gulf of Finland, Baltic Sea. Ocean Science, 16, 1475–1490.

Thank you!

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WATER MEETS PEOPLE

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SEVIRA

CBC 2014-2020

SOUTH-EAST FINLAND - RUSSIA

Climate impact on runoff and nutrient load for the Gulf of Finland tributaries.

Project SEVIRA

Sergey A.Kondratyev, Marina V.Shmakova, Ekaterina V. Ivanova*

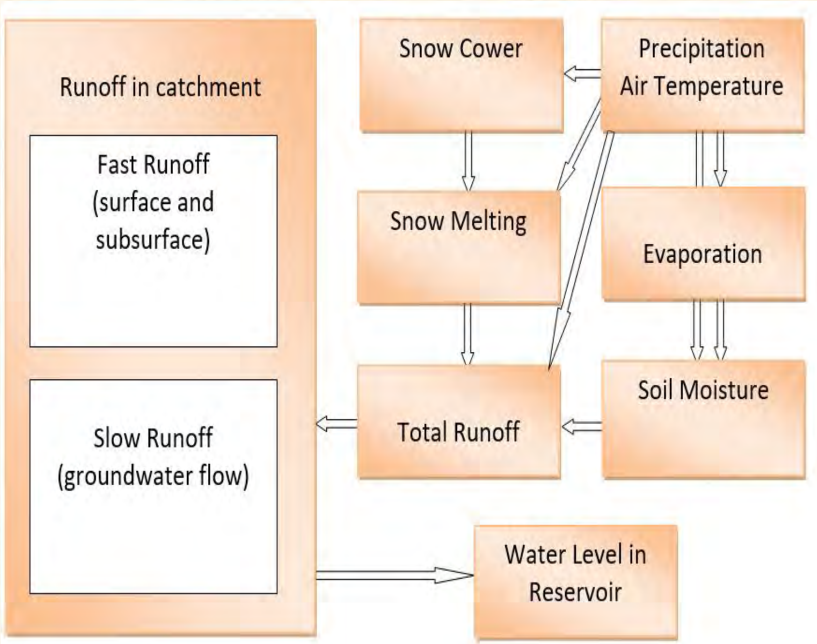
Institute of Limnology of the Russian Academy of Sciences IL RAS

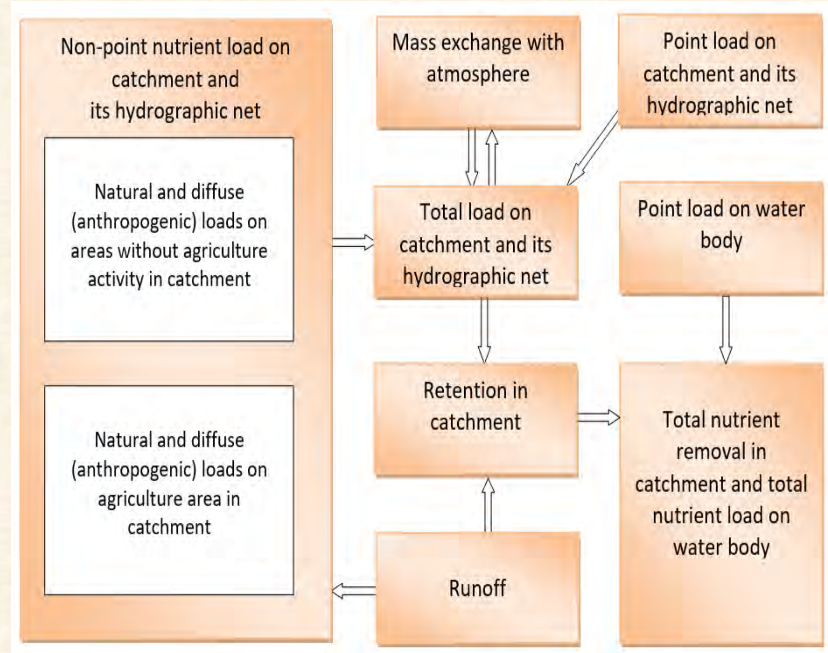
Pilot areas

3 rivers

- SEstra river Russia
- VIrojoki Finland
- RAkkolanjoki (Seleznevka) Transboundary

ILHM and ILLM - modeling tools

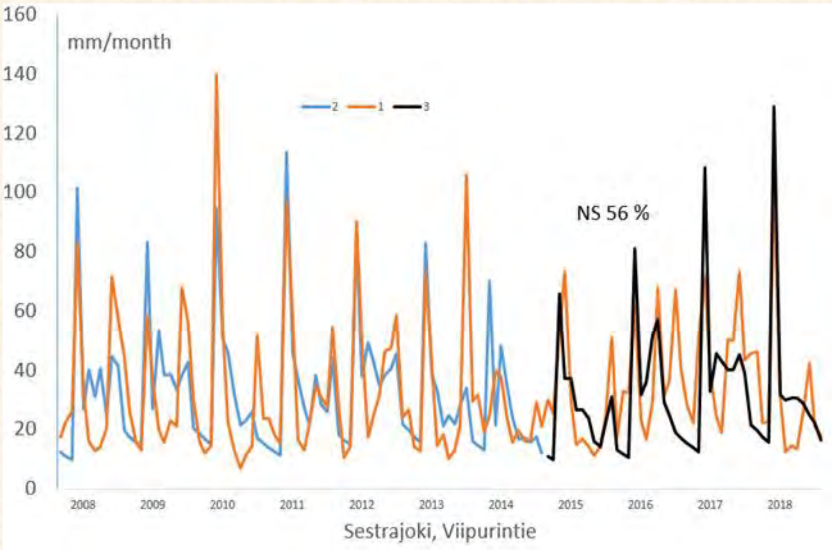




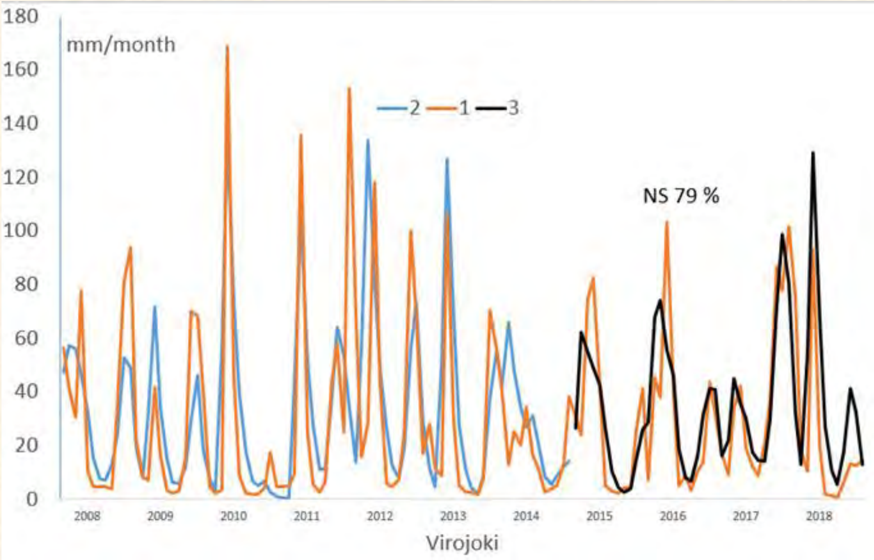
The runoff model - ILHM (Institute of Limnology Hydrological Model) was developed at the Institute of Limnology RAS [Kondratyev, Shmakova, 2005; Kondratyev, 2007] and is designed for calculations of hydrographs of snowmelt and rainfall runoff from the catchment area, as well as water levels in the waterbody. The model has a conceptual framework and describes the processes of snow accumulation and snowmelt, evaporation and soil moisture in the aeration zone, runoff formation, as well as runoff within a homogeneous catchment, the characteristics of which are assumed to be constant for the entire area.

The model of nutrient loading – ILLM (Institute of Limnology Load Model) was developed on the basis of existing modeling of runoff and removal of nutrients from the catchment areas and nutrient inputs into the water bodies [Kondratyev, 2007]. The recommendations of the HELCOM for assessing the load on water bodies of the Baltic Sea were also built into the model [Guidelines ..., 2005]. The model is designed to solve problems associated with the quantification of nutrient load formed by point and nonpoint sources of pollution, and a forecast of its changes under the influence of possible anthropogenic and climatic changes. The model incorporates the existing capabilities of data input from the state monitoring system of water bodies, as well as of materials of state statistical reporting on wastewater discharges and agricultural activities in catchment areas.

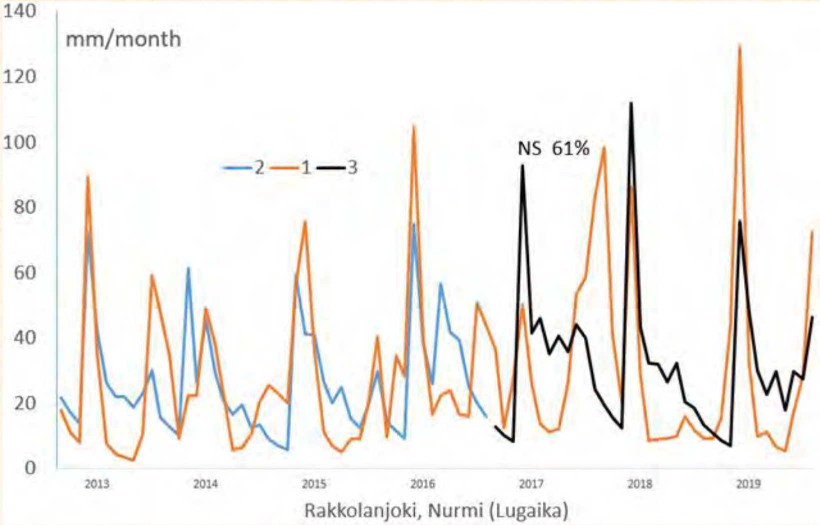
ILHM Runoff Modeling



Sestra



Vironjoki



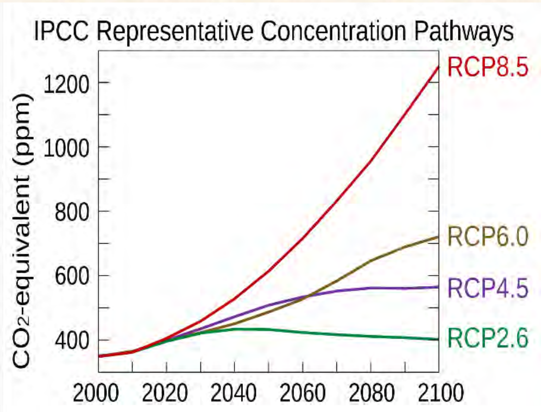
Rakkolanjoki

1 - Runoff monitoring,

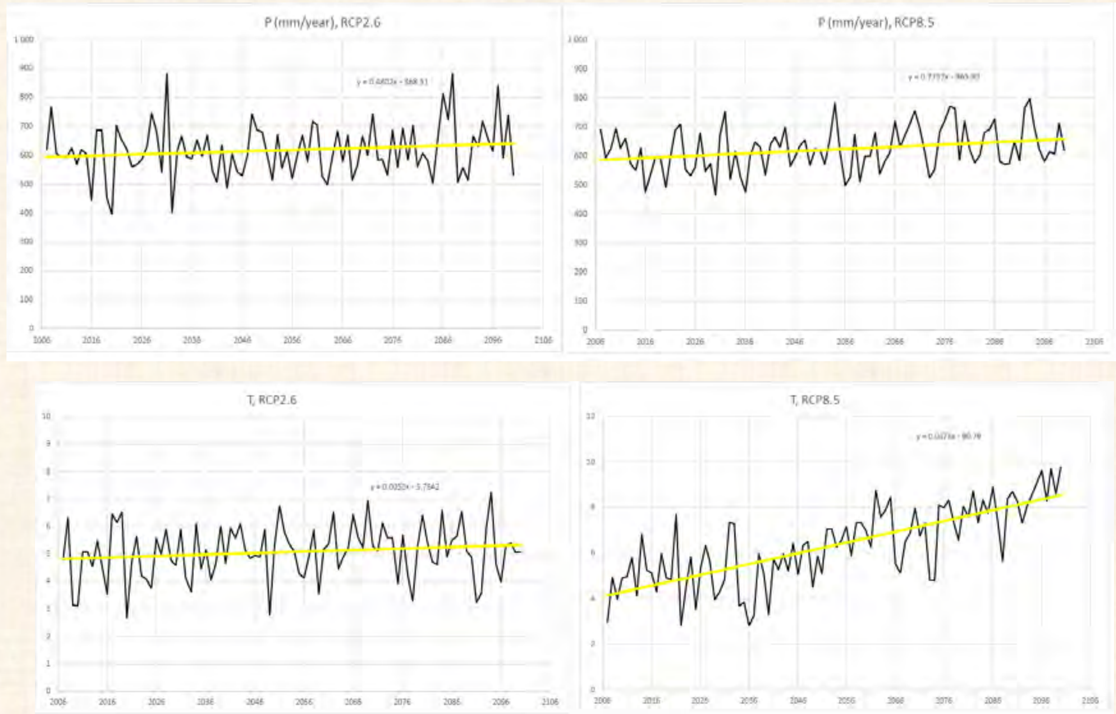
2 - ILHM calibration,

3 - ILHM testing

Climate change impact



All forcing agents' atmospheric CO_2-equivalent concentrations (in parts-per-million-by-volume (ppmv)) according to the four RCPs used by the fifth IPCC Assessment Report to make predictions.



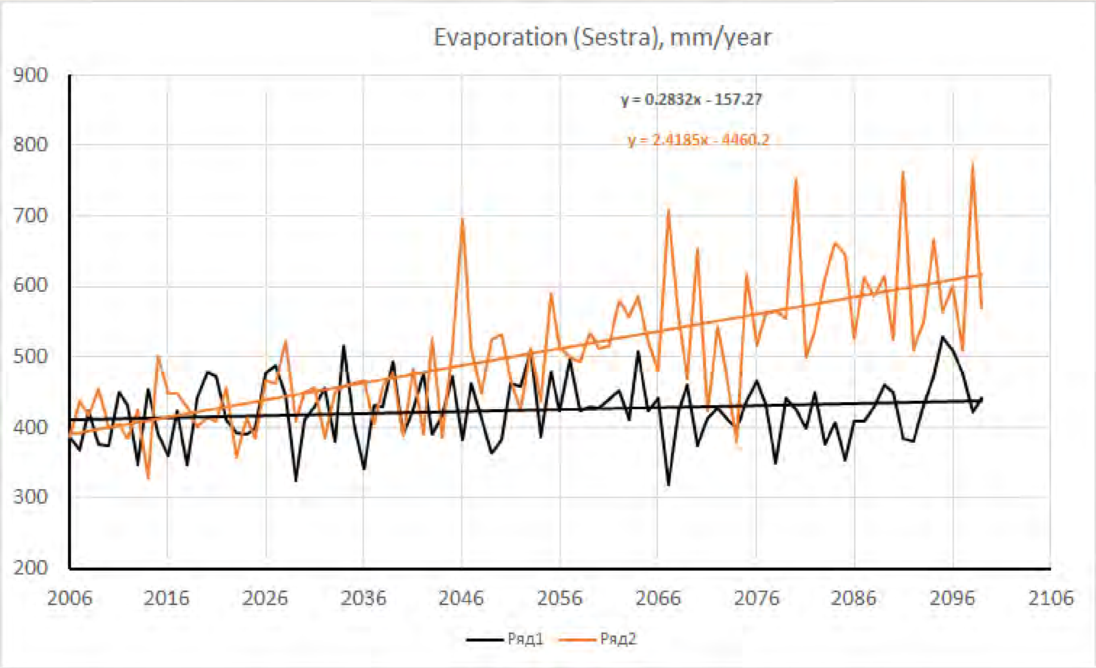
RCP2.6 & RCP 8.5 scenarios (P,mm/year & T,^{o}C)

Data on the selected scenarios are available in the Archives of the European Center for Medium-Range Weather Forecasts[https://cds.climate.copernicus.eu/cdsapp#!/search?type=dataset&keywords=((%20%22Temporal%20coverage:%20Future%22%20))

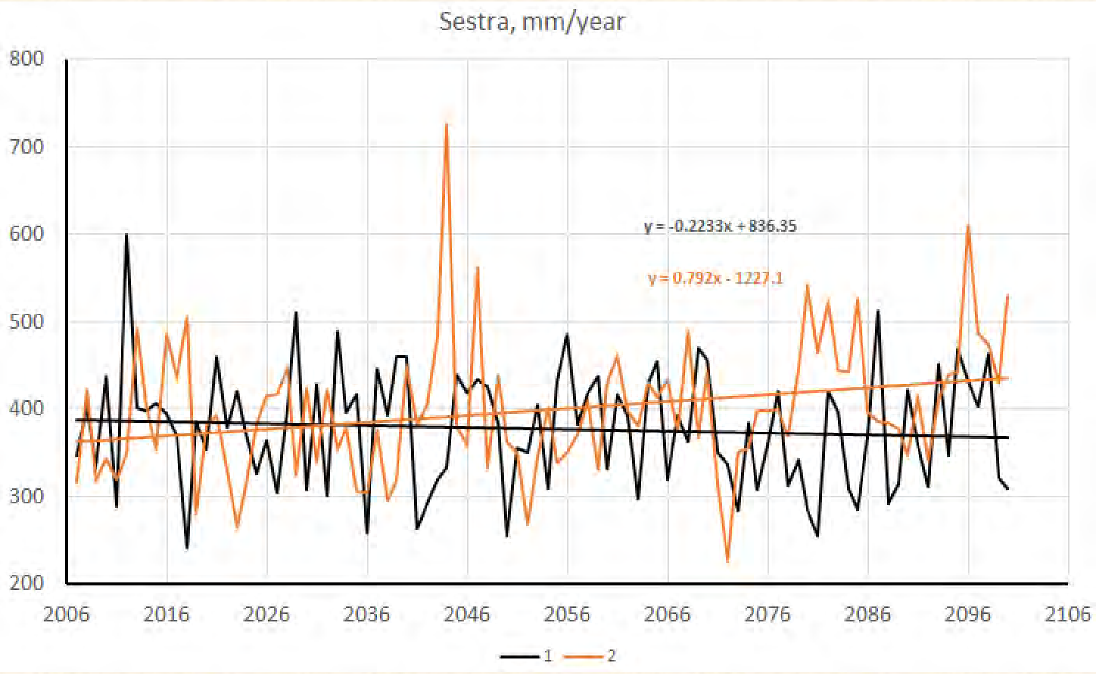
The climate scenarios were calculated using the Institute Pierre Simon Laplace climate model (IPSL-CM5A, 2010 – until now). It is the last version of the IPSL model and is based on a physical atmosphere-land-ocean-sea ice model, and it also includes a representation of the carbon cycle, the stratospheric chemistry and the tropospheric chemistry with aerosols.

Results of simulation Sestra river (evap. & runoff, mm/year)

Possible change in annual evaporation for the Sestra river (mm/year) for the perspective to 2100 according to the scenarios RCP 2.6 (1) and RCP 8.5 (2)

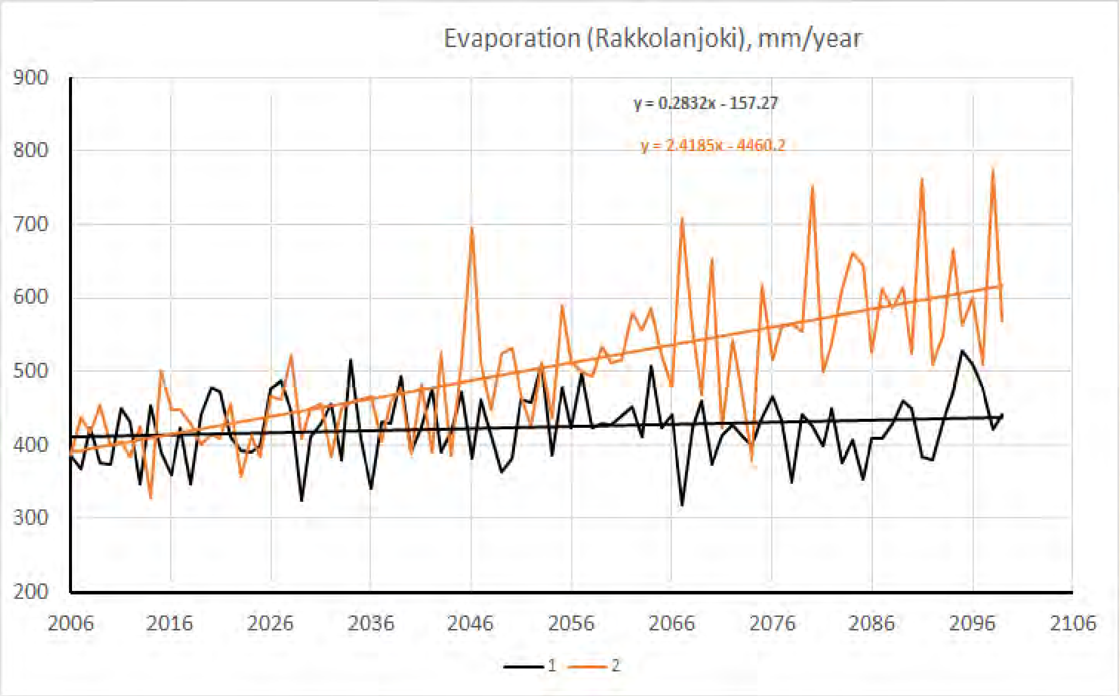


Possible changes in annual runoff for the Sestra river (mm/year) for the perspective to 2100 according to the scenarios RCP 2.6 (1) and RCP 8.5 (2).

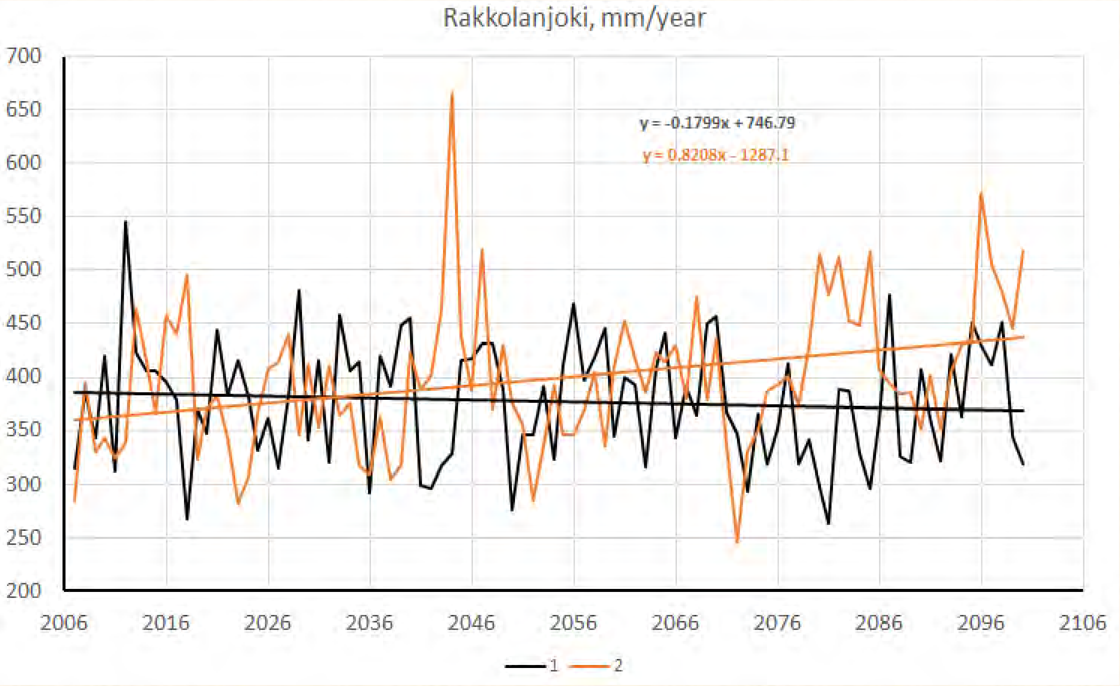


Results of simulation Rakkilanjoki river (evap. & runoff, mm/year)

Possible changes in annual evaporation for the Rakkolanjoki river (mm/year) for the perspective to 2100 according to the scenarios RCP 2.6 (1) and RCP 8.5 (2)

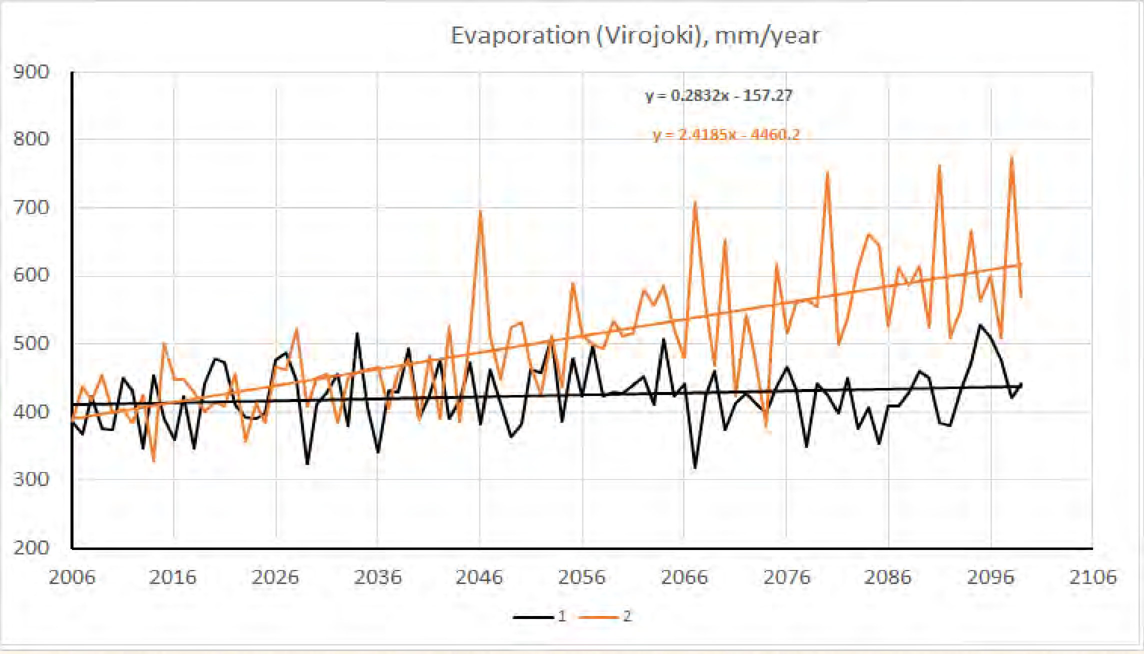


Possible changes in annual runoff for the Rakkolanjoki river (mm/year) for the perspective to 2100 according to the scenarios RCP 2.6 (1) and RCP 8.5 (2)

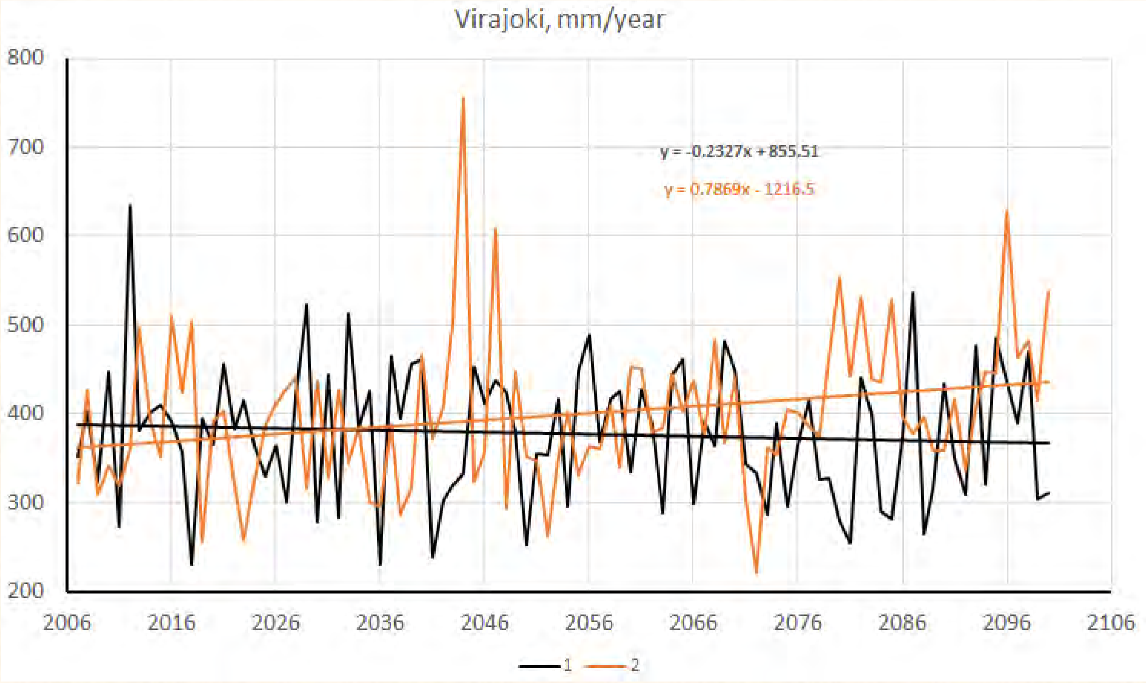


Results of simulation Virojoki river (evap. & runoff, mm/year)

Possible changes in annual evaporation for the Virojoki river (mm/year) for the perspective to 2100 according to the scenarios RCP 2.6 (1) and RCP 8.5 (2)



Possible changes in annual runoff for the Virojoki river (mm/year) for the perspective to 2100 according to the scenarios RCP 2.6 (1) and RCP 8.5 (2)



Runoff, P and N specific load assessment for 2006-2015 and 2091-2100 using RCP2.6 and RCP8.5 scenarios

	RCP 2.6		RCP 8.5	
	2006-2015	2091-2100	2006-2015	2091-2100
Sestra				
Runoff (mm/year)	402	386	368	458
Ptot Specific load (kg/ha year)	0.21	0.20	0.18	0.26
Ntot Specific load (kg/ha year)	4.65	4.32	3.92	5.77
Rakkolanjoki (Luzhaika site)				
Runoff (mm/year)	400	387	362	455
Ptot Specific load (kg/ha year)	0.33	0.32	0.29	0.38
Ntot Specific load (kg/ha year)	10.94	10.58	9.81	12.43
Rakkolanjoki (outlet)				
Runoff (mm/year)	403	385	369	458
Ptot Specific load (kg/ha year)	0.29	0.28	0.26	0.34
Ntot Specific load (kg/ha year)	7.63	7.24	6.91	8.71
Virojoki				
Runoff (mm/year)	403	379	375	458
Ptot Specific load (kg/ha year)	0.24	0.23	0.22	0.27
Ntot Specific load (kg/ha year)	5.06	4.83	4.78	5.61

The main results of modeling activity

The considered climatic scenarios are extreme. Most likely that real changes of greenhouse gas emissions into the atmosphere, meteorological parameters and river runoff will show mean values. Therefore, by the end of the 21st century we hardly expect significant changes in the hydrological regime and nutrient load in the studied area caused by climatic changes

Acknowledgements

Many thanks to Sirkka Tattari and Jari Koskiaho, SYKE

Thank you for attention