Gulf of Finland Trilateral Scientific Forum

30th November–1st December, 2016

Finnish Environment Institute SYKE

PRESENTATIONS

Gulf of Finland Co-operation

Contents

Gulf of Finland
Trilateral Scientific Forum
30th November–1st December, 2016
Finnish Environment Institute SYKE

1st Day

Gulf of Finland Co-operation

Paula Kankaanpää
SYKE Finnish Environment Institute
Marine Research Centre

SYKE
Finnish Environment Institute
Marine Research Centre

Paula Kankaanpää, Director

https://commons.wikimedia.org/wiki/File:Helsinki_fr

MARINE RESEARCH CENTRE

SYKE
the Finnish Environment Institute

S Y K E

- The expert and research agency for Finnish government and administration
- Director General Lea Kauppi
- Staff 550
- Ministry of the Environment

- Finland’s hub for environmental data and information
- Finland’s environmental laboratories

- Terrestrial, marine and freshwater environmental science
- Sustainable consumption and production
- Circulation economy and environmental policy

Ympäristöministeriö
Miljöministeriet
Ministry of the Environment

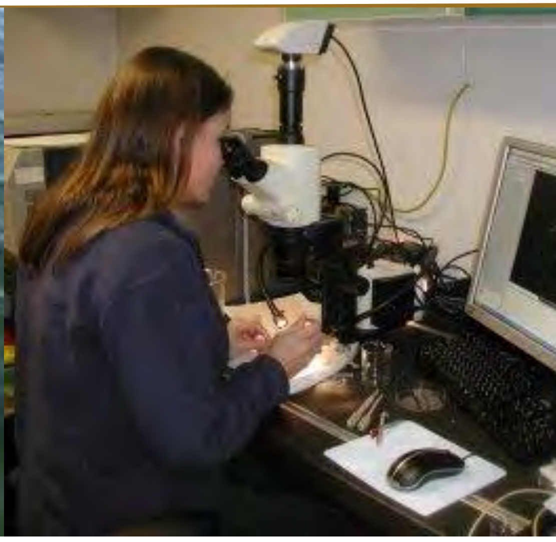
mmm.fi
MAA- JA METSÄTALOUSMINISTERIÖ

S Y K E

SYKE Marine Research Centre
Resurces

- Staff: 95 researchers and experts
  - 55 % men; 45 % women
  - 40 % PhDs
- Budget: 9 m€
- External funding: 70 %





SYKE Marine Research Centre
International co-operation

IMO INTERNATIONAL MARITIME ORGANIZATION

The Global Ocean Observing System GOOS

IOOS INTEGRATED OCEAN OBSERVING SYSTEM

esa

HORIZON 2020

Baltic Operational Oceanographic System BOOS

EuroGOOS

BONUS
...E FOR A BETTER FUTURE OF THE BALTIC SEA REGION

EMODnet European Marine Observation and Data Network

...opernicus The European Earth Observation Programme


SYKE Marine Research Centre
for Finnish Government on
marine environmental laws and regulations
Holistic Assessment
of the state of
marine environment
Every 6th year
Next: 2018
together with
the 10 Baltic States
According to EU Marine Strategy Directive
www.peda.net

MARINE RESEARCH CENTRE

SYKE Marine Research Centre

Research

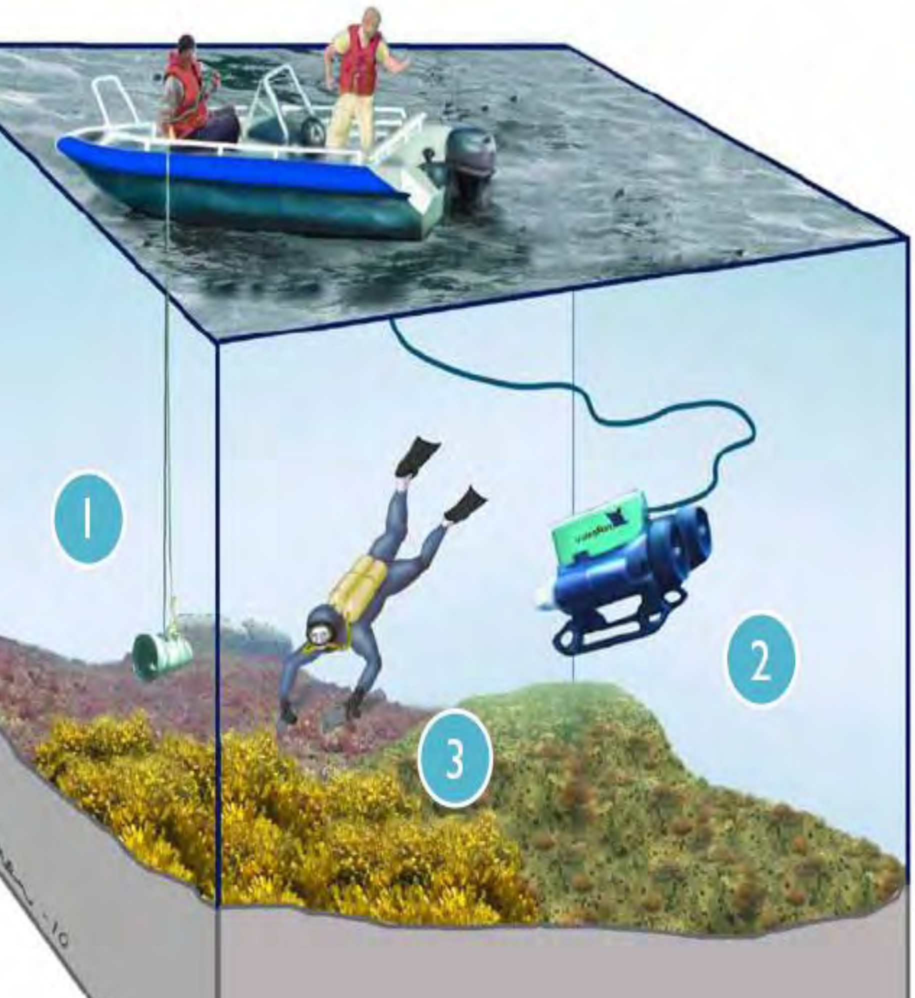
- Assessment methods of status of marine environment
- Climate change impacts
- Economic value of healthy sea
- Marine ecosystem functions
- Marine ecosystem modelling
- Empirical marine ecology research
- Eutrophication
- Harmful substances
- Marine biodiversity
- Invasive species
- Microplastic trash
- Underwater Noise

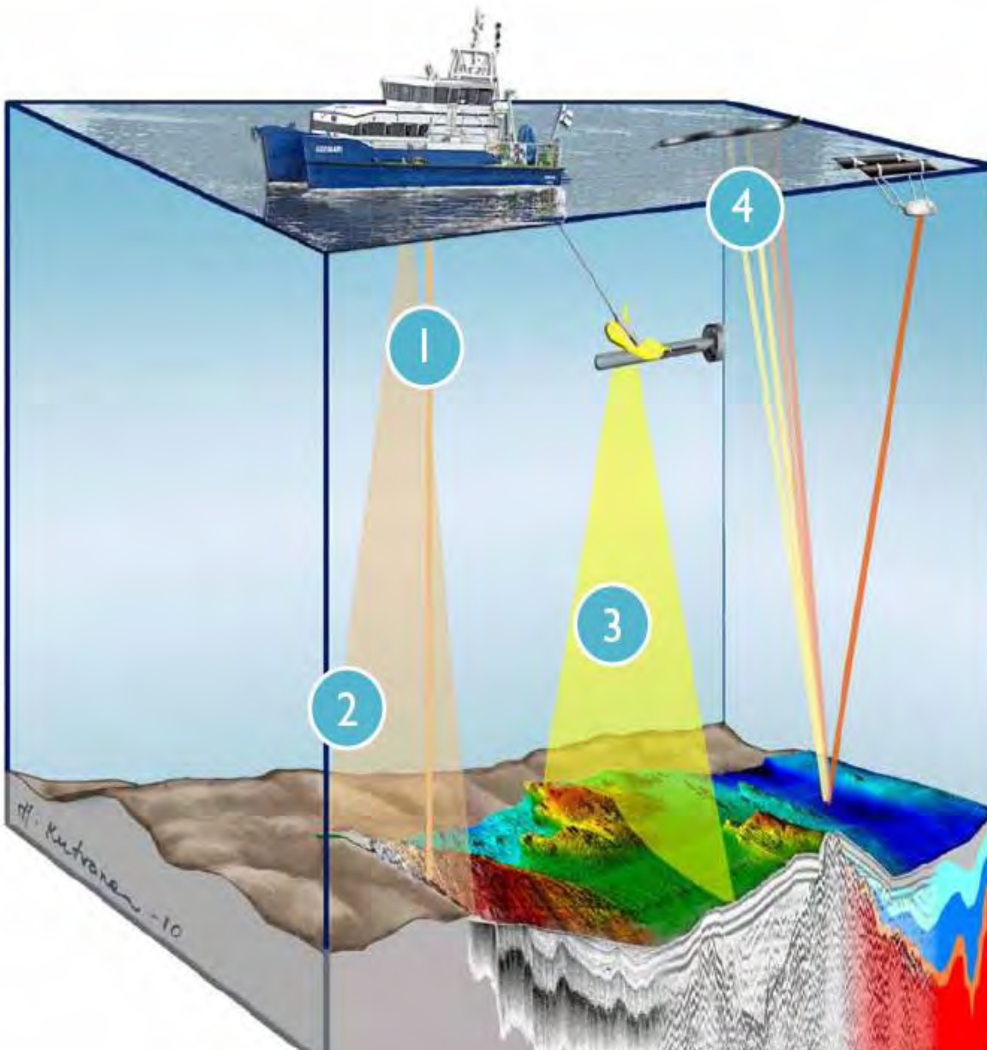
SYKE

The Finnish Inventory of Submarine Environment

VELMU
vedenalaisen meriluonnon monimuotoisuuden inventointiohjelma

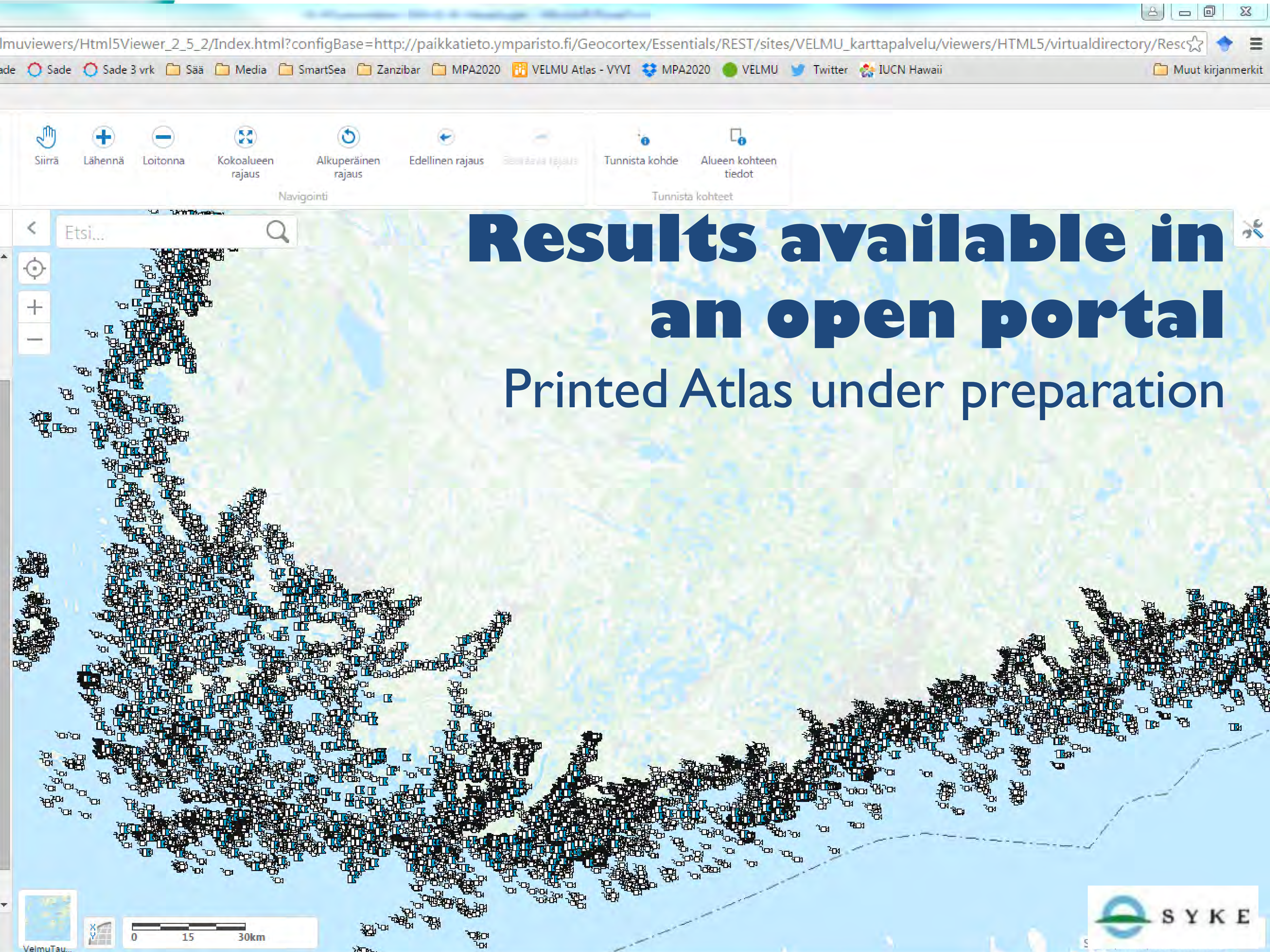
Surveys of underwater nature & Geological mapping





Results available in an open portal

Printed Atlas under preparation

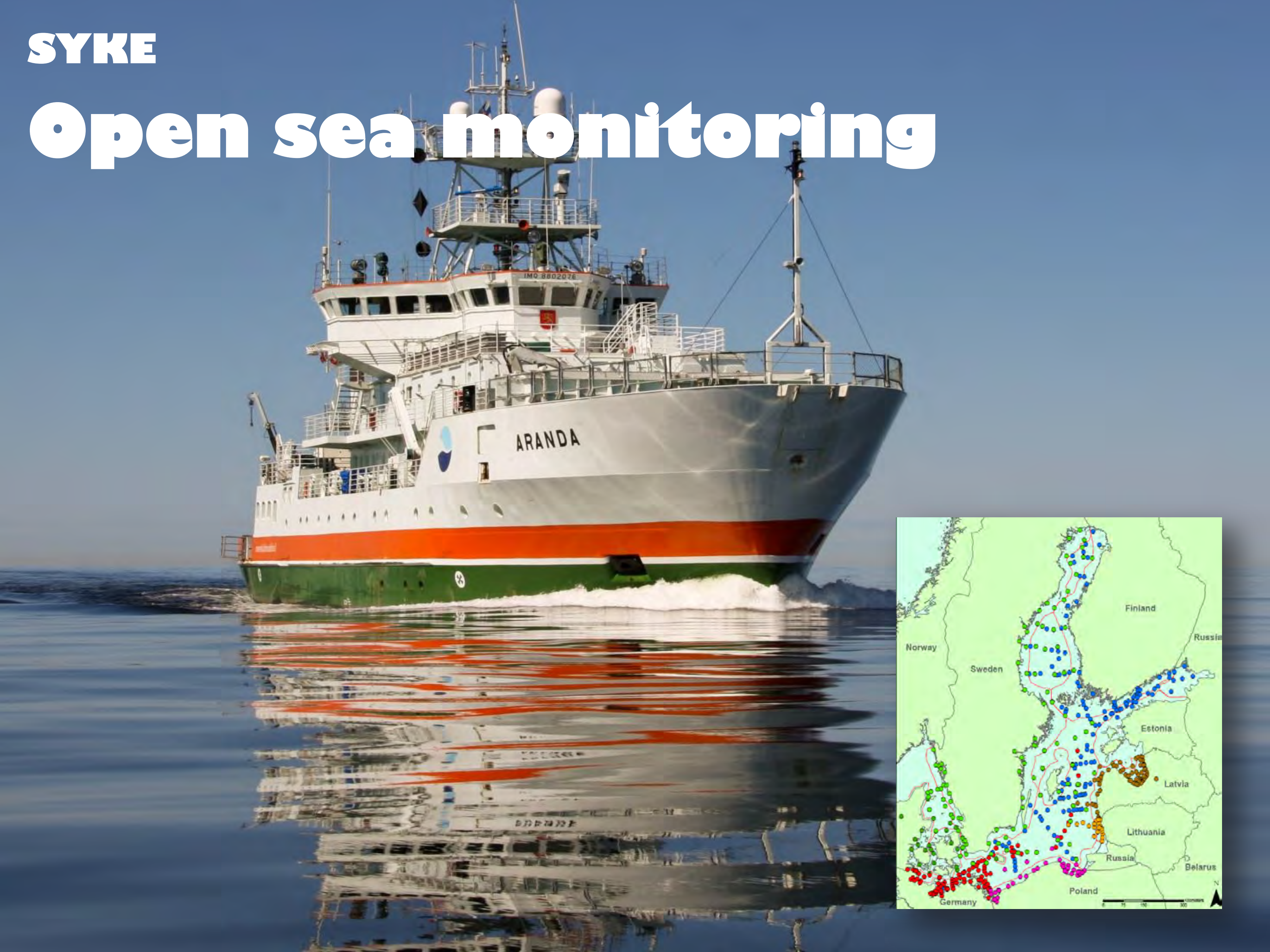


Information is used for

marine spatial planning

SYKE

Open sea monitoring

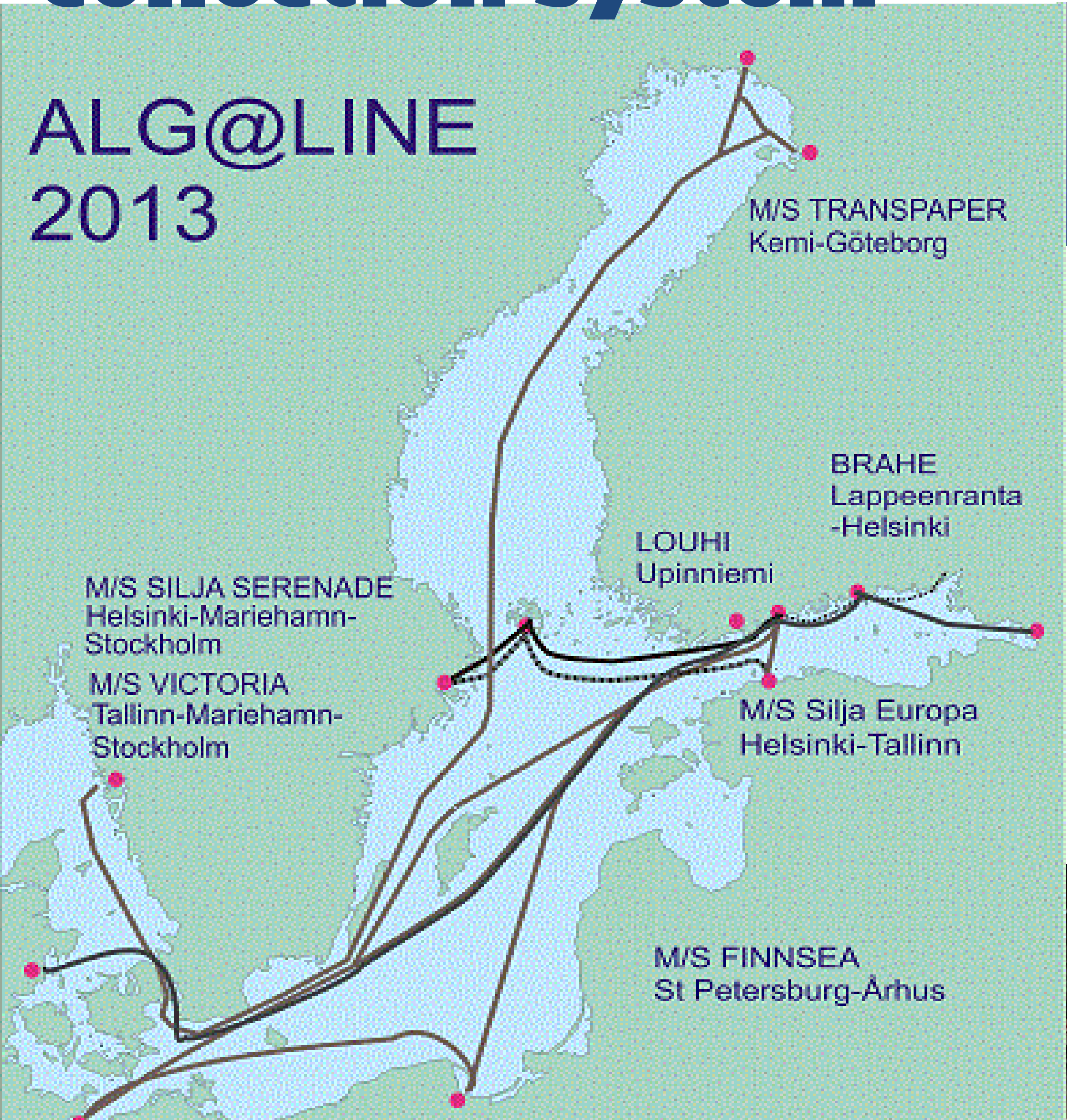


SYKE

Coastal monitoring

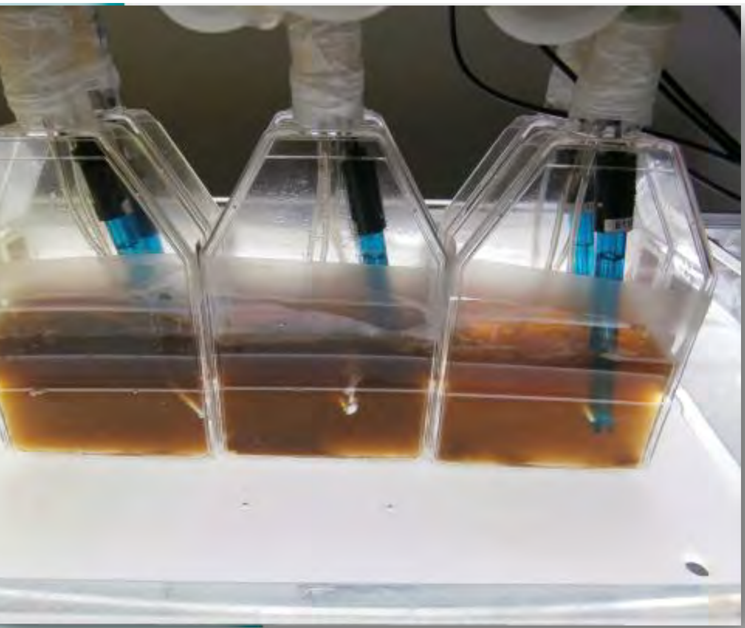
Continous data collection system

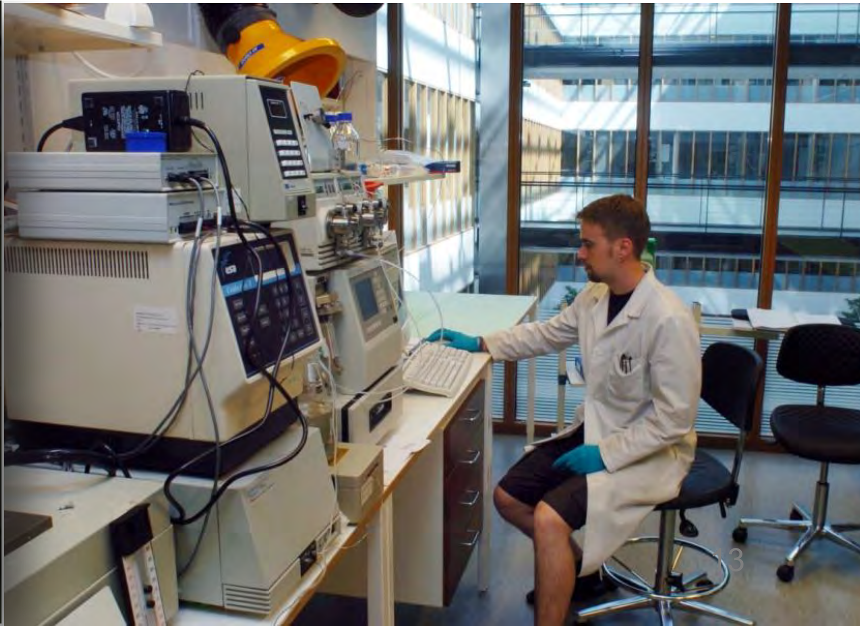
4-6 commercial ferries
automated measurements and
water sampling devices



SYKE Ecological Marine Research Laboratories

experimental research * method development * controllable facilities *
algae culture collection * novel instrumentation * bio-optics and imaging





SYKE - FINMARI
Consortium for Finland's National Marine Reseach Infrastructure

New solutions for automated sampling, real time measurement and integration of data production

Utö automated marine research station
a test base for physical and biological measurements in cold seas

ocean carbonate chemistry * acidification * sea-air gas flux * marine biota * minute scale observations of phytplankton productivty and taxonomy

- Research since 1881 -

Remote sensing products for monitoring of the Batlic Sea and the arctic environment

Sentinel-3A-satelliitti, © ESA–Pierre Carril.

MARINE RESEARCH CENTRE

SYKE is responsible for Finland's marine environmental emergency response

together with the Frontier Guard and the Finnish Naval Forces

SYKE

Ecological impacts of oil spill response methods

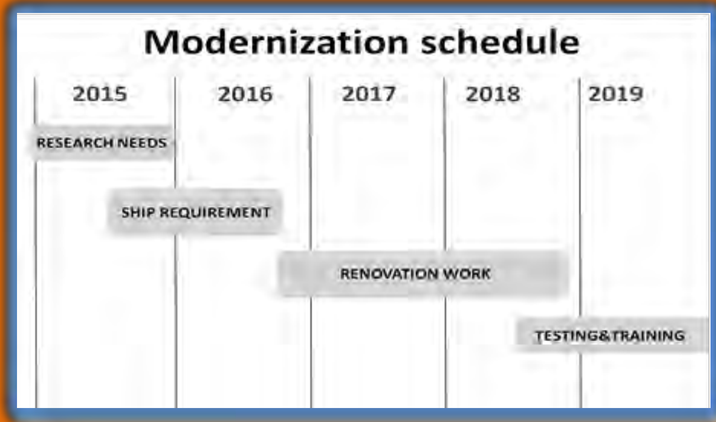
Mechanical cleaning
Burning
Chemicals
Biological remediation
Predictions
Prevention strateties

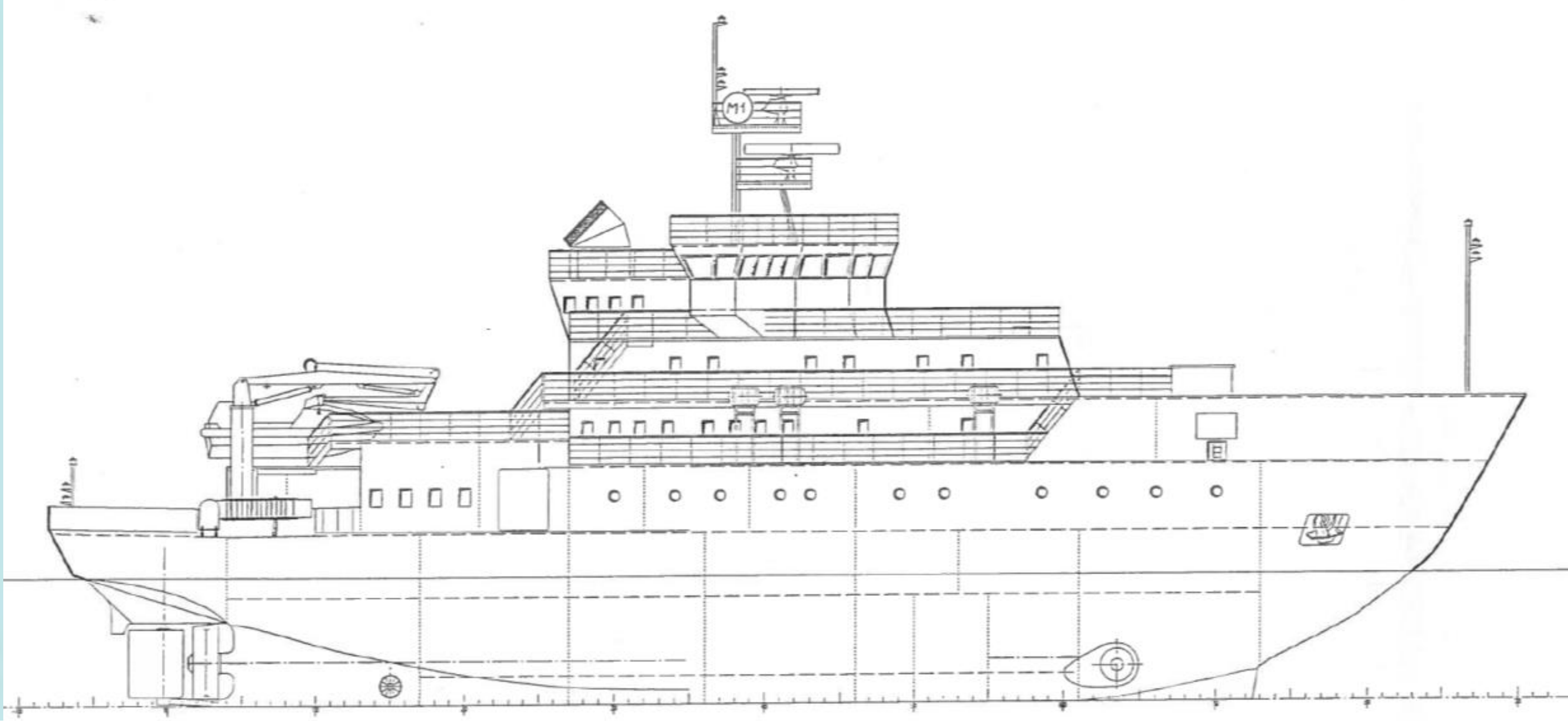
R/V Aranda
Ice Class A1 Super

- One of the few ice strenghtened fully equipped marine research vessels in the world

ARANDA2020

- Major refit now underway, 11 million €
- Modernized ship available in the end of 2018 -
- Ice Class A1 Super & IMO Polar Code
- Available for research, commercial charter and new projects in the Arctic





Arctic multi-diciplinary research

Baltic Sea as an arctic laboratory

Climate Change * Marine Food Webs * Sea ice ecology * Flux modelling

New developments

- Impacts of Oil Spill Response Methods in the Arctic
- Socio-economic importance of arctic freshwater ecosystems
- Marine Protected Areas and Marine Spatial Planning in Barents Sea
- Aranda in the Arctic Ocean as international cooperation?
- Finland's expert for PAME of the Arctic Council

Sea ice cruise, R/V Aranda, March 2016

MARINE RESEARCH CENTRE

Societal Impact

I GULF OF FINLAND 2014

SYKE

Thank you!

MARINE RESEARCH CENTRE

The Finnish Portal for the Underwater Marine Environment

For Marine Spatial Planning
Velmu Atlas
Co-operation with Zanzibar

S

R/V Aranda

- Built 1989
- ”Shopwindow” for Finnish ship building know-how and capacity
- Has withstood well for quarter of a century,
- Copied on many occasions

R/V Mirabilis, Namibia, 2012

R/V Aranda has proven herself in Polar Seas

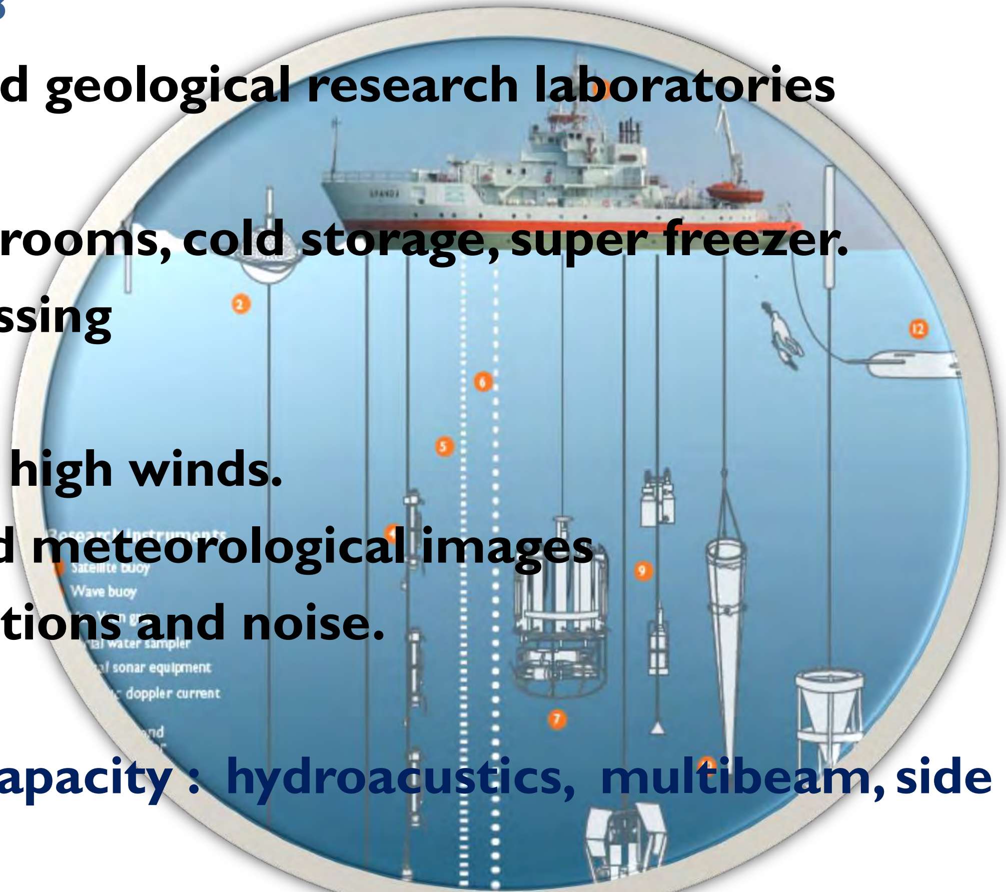
- Continuous year-round operations in the sub-arctic Baltic Sea
- Several cruises to Arctic;
- Two cruises to Antarctic
- Multi-diciplinary capacity and modularity


R/V Aranda
• Comfortable double cabins with showers and bathrooms for 26 scientists
• Common meeting rooms, gym and sauna
• Excellent kitchen services
12 crew members
• Made to operate in first year ice and ice margin areas
• cost-efficient, multi-capacity r/v for Arctic
• But NOT for multi-year ice

What Aranda can do ?

- biological, physical, chemical and geological research laboratories
- handling and storing samples
  - clean container, acclimated rooms, cold storage, super freezer.
- sample analysis and data processing

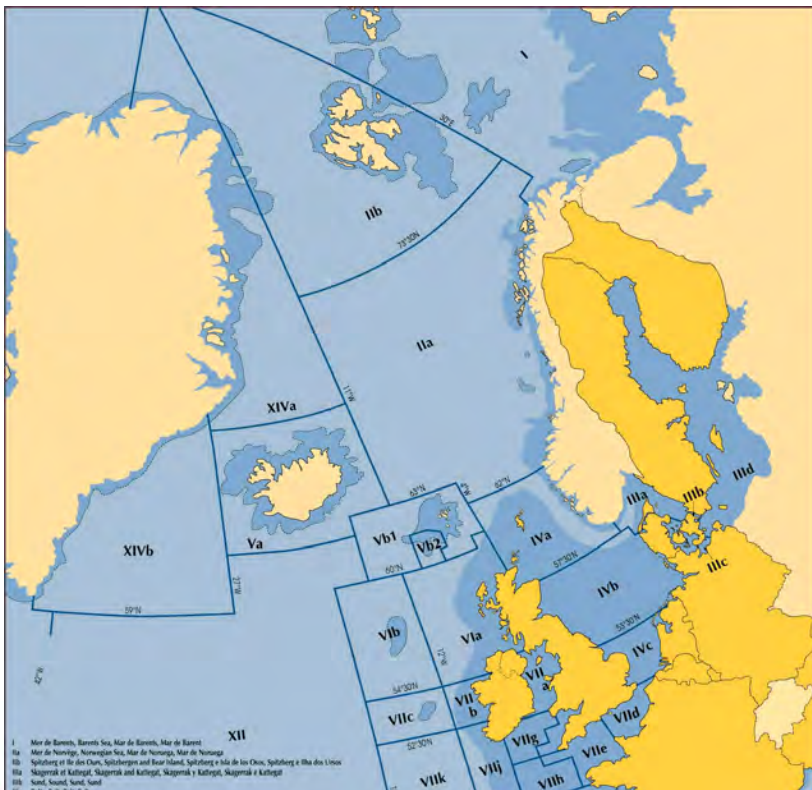
- can stay in a precise location in high winds.
- modern system for satellite and meteorological images
- floating floor to minimize vibrations and noise.



- Extra silent electronic engine capacity : hydroacustics, multibeam, side scan sonar
- Robotics: glider, automatic underwater vechile, aereal drones
- Capacity for ROV and diving operations
- Moon pool for water column sampling
- Multitasking towed vehicles: AquaShuttle, MultiNet, Utow, CPR
- Environmentally friendly: world’s first r/v operationally using domestically produced bio-oil and biodiesel – no/low CO_2

Finland

- **Finland - the Chair of the Arctic Council 2017-18**
- **Arctic Strategy adopted by Finnish Government in 2013**
- **Finland emphases**
  - **Arctic expertise, science and techology**
  - **International co-operation**



MARINE RESEARCH CENTRE

SYKE

SYKE Marine Research Centre has Arctic Expertize

- Co-operation with Russian colleagues for projects in the Arctic Ocean area?

Ice drilling in Baltic Sea

Arctic Combjelly in Baltic Sea

Itämeriportaali 2014 , Jään kairaus, Harri Kuosa; Arktinen kampamaneetti, Maiju Lehtiniemi

Gulf of Finland
Trilateral Scientific Forum
30th November–1st December, 2016
Finnish Environment Institute SYKE

1st Day

Gulf of Finland Co-operation

Mika Raateoja

The GOF Assessment -> The GOF Road Map

For getting the pdf >
Google: Gulf of Finland assessment

SYKE

The Gulf of Finland assessment

Hardcopies (there is plenty): Ljudmila !!

S Y K E

Topics

Baselines

- Eutrophication
- Hazardous substances
- Climate / Physics / Geology
- Fish and Fisheries

One step further

- Biodiversity
- Alien species
- Maritime traffic

Novelties

- Marine litter
- Underwater noise
- Valuation of environment

SYKE

A trilateral collaboration as never before...

Estonian Environment Agency
Estonian Marine Institute
Estonian Ministry of the Environment
Estonian University of Life Sciences
Hoia Eesti Merd
Marine Systems Institute
Tallinn University of Technology

Finnish Environment Institute
Finnish Geological Survey
Finnish Geospatial Research Institute, Aalto University
Finnish Meteorological Institute
Finnish Transport Safety Agency
Metsähallitus
Natural Resources Institute
University of Helsinki
University of Turku

A.P. Karpinsky Russian Geological Research Institute
Federal State Unitary Research and Production Enterprise for Marine Exploration
Institute of Cybernetics, Tallinn University of Technology
Institute of Lake and River Fishery
Institute of Limnology, Russian Academy of Sciences
North-West Interregional Territorial Administration for Hydrometeorology and Environmental Monitoring
Research Institute of Remote Sensing Data for Geology
Russian State Hydrometeorological University
SPb PO "Ecology & Business”
St. Petersburg Branch of institute of Oceanology, Russian Academy of Sciences
St. Petersburg Research Centre, Russian Academy of Sciences
St. Petersburg State University
State Marine Technical University
Zoological Institute, Russian Academy of Sciences

+ Baltic Nest Institute, Stockholm university

SYKE

Scientific foundation (writers: EST 30, FIN 60, RUS 40)

Heikki Pitkänen, Harri Kuosa, Tatjana Eremina, Urmas Lips, Jouni Lehtoranta, Alexey Maximov, Antti Räike, Seppo Knuuttila, Petri Ekholm, Sergey Kondratyv, Peeter Ennet, Reet Ulm, Natalia Oblomkova, Mika Raateoja, Pirkko Kauppila, Eugenia Lange, Tatjana Zagrebina, Andres Jaanus, Silvie Lainela, Hanna Alasalmi, Saku Anttila, Jenni Attila, Jan-Erik Bruun, Seppo Kaitala, Kari Kallio, Vesa Keto, Alexandra Ershova, Inga Lips, Dahlbo Kim, Savchuk Oleg, V. Ryabchenko, A. Isaev, Aarno Kotilainen, Anu Kaskela, Oleg Korneev, Daria Ryabchuk, Alexander Rybalko, Sten Suuroja, Henry Vallius, Kai Myrberg, Pekka Alenius, Zhamoida V., Grigoriev A., Sergeev A., Evdokimenko A., L. Sukhacheva, M. Orlova, M. Spiridonov, A. Grigoriev, O. Kovaleva, I. Neevin, Petra Roiha, Laura Tuomi, Heidi Pettersson, Outi Setälä, Marek Press, Jakub Montewka, Jani Häkkinen, Jorma Rytkönen, Risto Jalonen, Olli-Pekka Brunila, Tarmo Soomere, Jukka-Pekka Jalkanen, Antti Below, Inari Helle, Päivi Haapasaari, Riikka Venesjärvi, Annukka Lehikoinen, R. Aps, M. Fetissov, A. Jönsson, M. Heinvee, M. Kopti, K. Tabri, H. Tõnisson, Vadim K. Goncharov, Jukka Pajala, Aleksander Klauson, Janek Laanearu, Mirko Mustonen, Maiju Lehtiniemi, Alexander Antsulevich, Jonne Kotta, Henn Ojaveer, Riho Gross, Outi Heikinheimo, Meri Kallasvuo, Markku Kaukoranta, Martin Kessler, Marja-Liisa Koljonen, Antti Lappalainen, Hannu Lehtonen, Tapani Pakarinen, Andrey Pedchenko, Jukka Pönni, Tiit Raid, Jari Raitaniemi, Lauri Saks, Alexander Shurukhin, Pirkko Söderkultalahti, Sergey Titov, Lauri Urho, Lari Veneranta, Aarre Verlin, Jaakko Mannio, Kari Lehtonen, N. Fedorova, Kirsten Jørgensen, Harri Kankaanpää, Marja Keinänen, Jukka Mehtonen, Ott Roots, Alexander Rybalko, Sara Söderström, Raisa Turja, Pekka Vuorinen, Zoya Zhakovskaja, Lauri Äystö, Sergey Golubkov, Samuli Korpinen, Sirpa Lehtinen, Andrey Sharov, Larissa Litvinchuk, Arno Pöllumäe, Hermanni Kaartokallio, Riitta Autio, Veljo Kisand, Jonna Kotta, Liubov Zhakova, Yulia Gubelit, Henrik Nygård, Ilmar Kotta, Julia Bublichenko, Sergey Couzov, Mart Jüssi, Markus Ahola, Mikhail Verevkin

SYKE

Gulf of Finland Year 2014 → Gulf of Finland Co-operation

The GOF Assessment → The GOF Road Map

Mika Raateoja

Trilateral Scientific Forum 2016

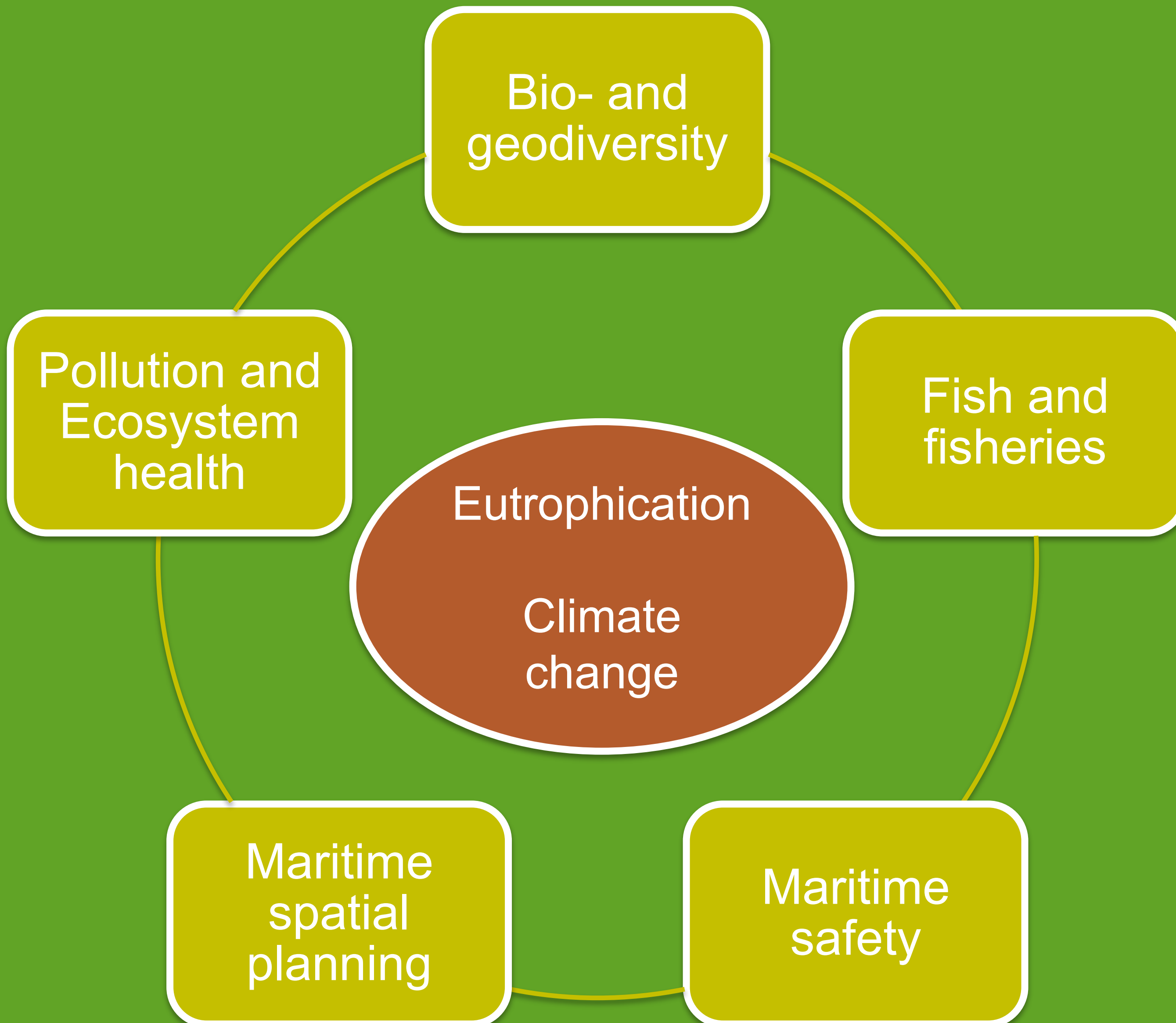
Helsinki, 30th Nov – 1st Dec

SYKE


GOF Assessment
GOF Road Map
Scientific community (media, university education, environmentally aware citizens, NGOs)
Decision-making level (Ministries)

SYKE

The research of the GOF2014



SYKE

The Gulf of Finland Road Map

Main f

Rec

F

A common view of the scientific community, that is, us

>

The GOF Road Map must be the priority!!

SYKE

Examples...

- Monitoring programs targeted to invasive species should be introduced in the vicinity of ports
- A joint open-access database for the available monitoring data of hazardous substances should be developed
- The best available technologies should be used to minimize the adverse effects of large-scale construction projects (e.g., land reclamation)
- The joint use of icebreakers between Russia and Finland needs to be improved and developed following the model existing in the Gulf of Bothnia
- There should be a joint maritime spatial plan of the GOF covering the waters of all three countries
- The operational monitoring on board merchant ships should be extended to cover the eastern GOF

SYKE

The GOF Road Map is a living document

- Regular updates will ensure the way towards a sustainable use of the GOF ecosystem also in the future
- Updating goes like this

One	Two	Three	Four
GOF expert group	Ministries	GOF secretariat	GOF Coordination Committee
Updates	Prioritization	Editing	Acceptance

SYKE

The GOF expert group also the coordinates the trilateral forums

Theme	Expert
Eutrophication	Harri Kuosa
	Tatjana Eremina
	Inga Lips
Biodiversity	Kirsi Kostamo
	Sergei Golubkov
	Georg Martin
Geodiversity	Aarno Kotilainen
	Darya Ryabchuk
	Sten Suuroja
Pollution and ecosystem health	Kari Lehtonen
	Alexander Rybalko
	Mailis Laht

SYKE

Theme	Expert
Fish and fisheries	Tapani Pakarinen
	Andrey Pedchenko
	Tiit Raid
Maritime safety	Jorma Rytkönen
	Sergey Aysinov
	Tarmo Kõyts
Maritime spatial planning	Frank Hering
	Oleg Korneev
	Robert Aps
Climate change	Markko Viitasalo
	Vladimir Ryabchenko
	Taavi Liblik
Monitoring	Heikki Pitkänen
	Tatjana Zagrebina
	Urmas Lips

SYKE

New website for the trilateral work

Google: Trilateral Gulf of Finland cooperation

e.g., abstracts of the forum

SYKE

Gulf of Finland
Trilateral Scientific Forum
30th November–1st December, 2016
Finnish Environment Institute SYKE

1st Day

Gulf of Finland Co-operation

Heikki Pitkänen

Monitoring of eutrophication: observations and recommendations emerging from the GOF assessment work and the most recent data

Gulf of Finland trilateral Forum, Helsinki
Nov 30-Dec 1, 2016

Monitoring of eutrophication: observations and recommendations emerging from the GOF Assessment work and the most recent data

Heikki Pitkänen[1], Urmas Lips[2], Tatjana Zagrebina[3], Tatjana Eremina[4] Andres Jaanus[5], Pirkko Kauppila[1], Silvie Lainela[5], Inga Lips[2] and Mika Raateoja[1]

[1] Finnish Environment Institute,[2]Marine Systems Institute, Tallinn University of Technology,[3] NW Interregional Territorial Administration for Hydrometeorology and Environmental Monitoring (Hydromet),[4]Russian State Hydrometeorological University, [5] Estonian Marine Institute

Introduction

- The GOF Data Set with other relevant data enabled the assessment of eutrophication and its dependency on external and internal factors in different parts of the Gulf

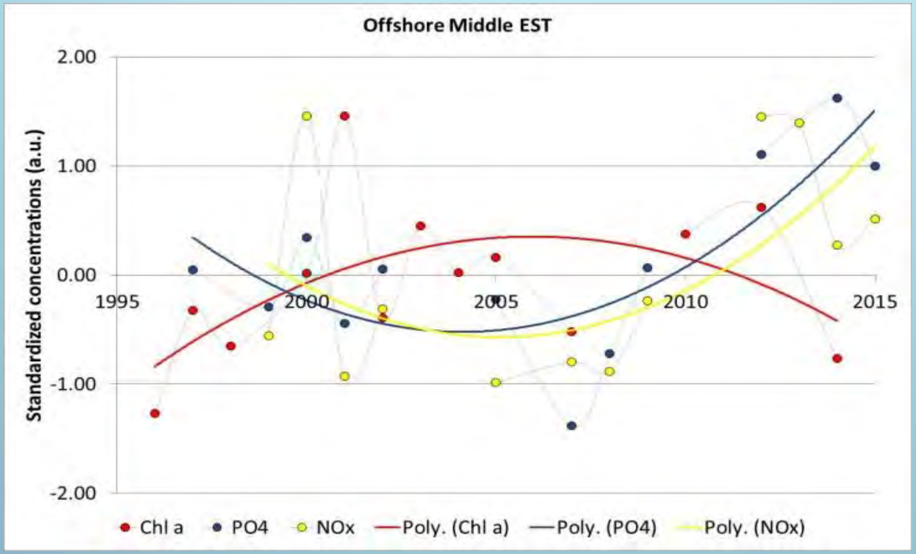
- The data revealed strong spatio-temporal variations of nutrients, oxygen and chl*a*

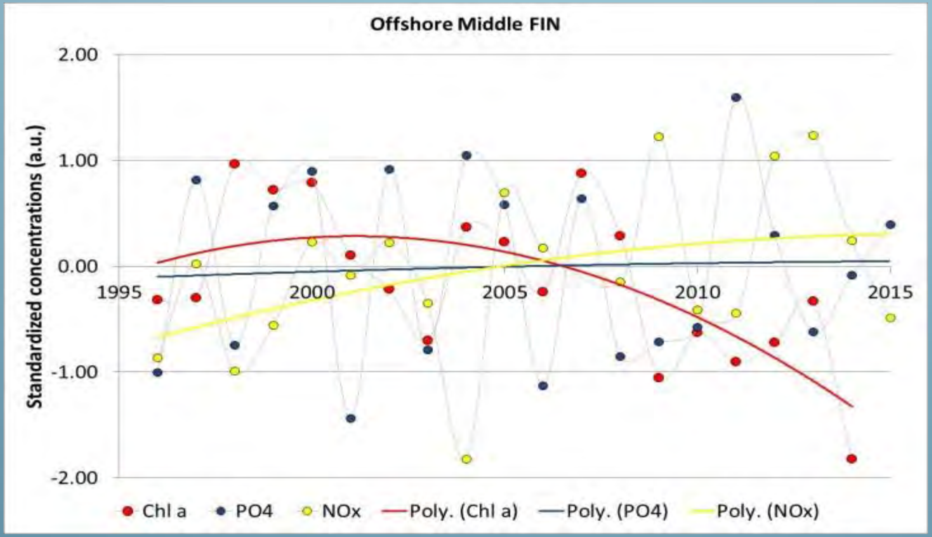
- Also inconsistencies in nutrients and chl*a* were found
  - partly explainable by differences in analytical methodology, varying sampling periods, locations and depths
  - in some cases the observed inconsistencies could not be explained

- In the cases of lack of direct comparability, it is not possible to produce uniform basin-wide concentration fields or fully consistent/ comparable trend analyses for different parts of the Gulf

=> importance to further develop both traditional and automated monitoring between the three countries

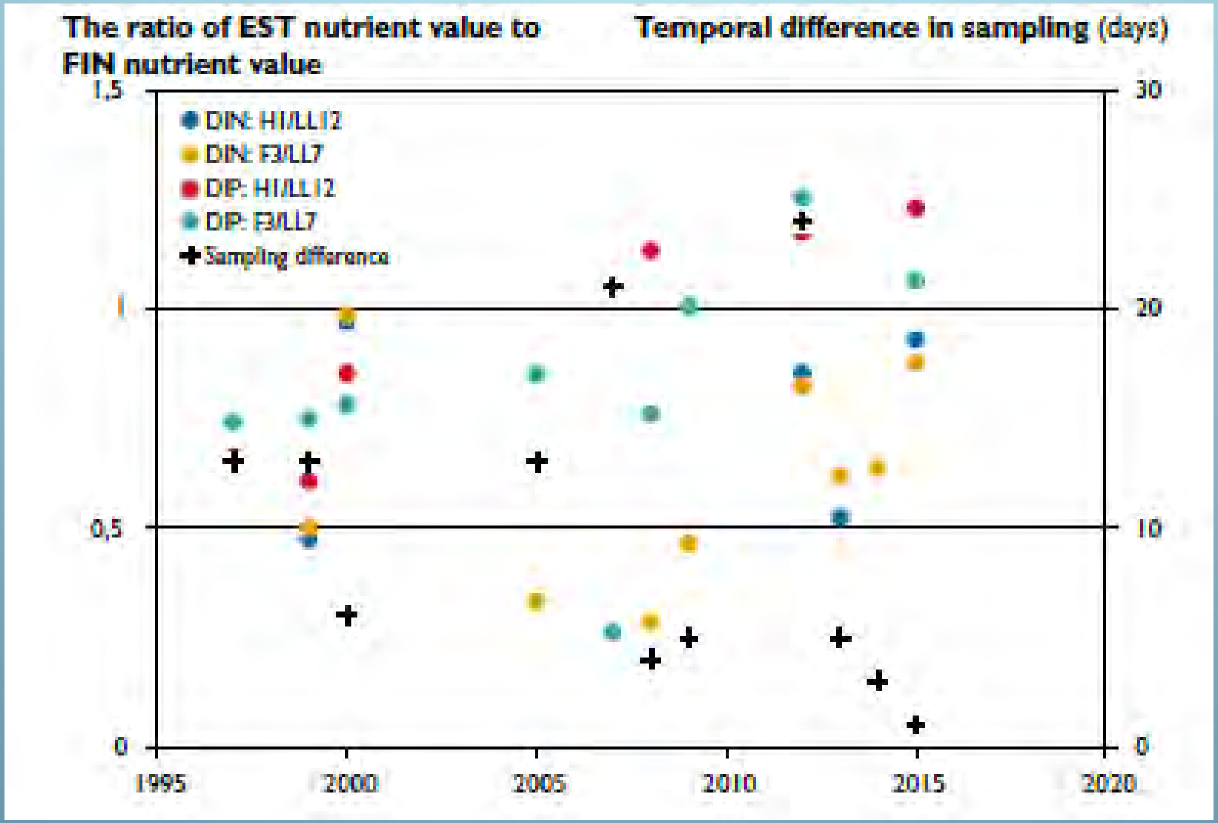
Trend assessments of DIN, DIP and chlorophyll-*a* for the open middle GOF according to Finnish and Estonian data





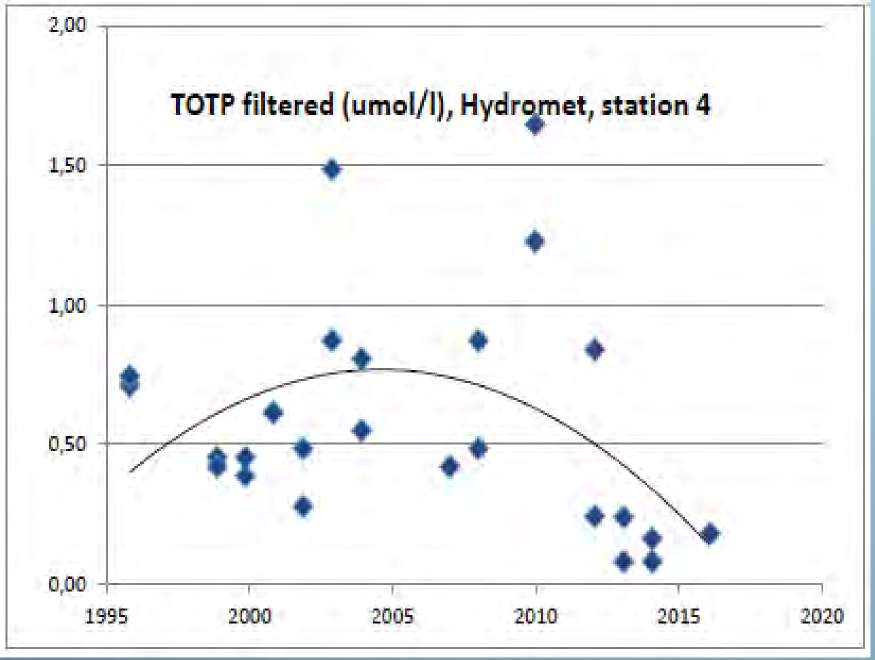
Source: Raateoja et al., The GOF Assessment

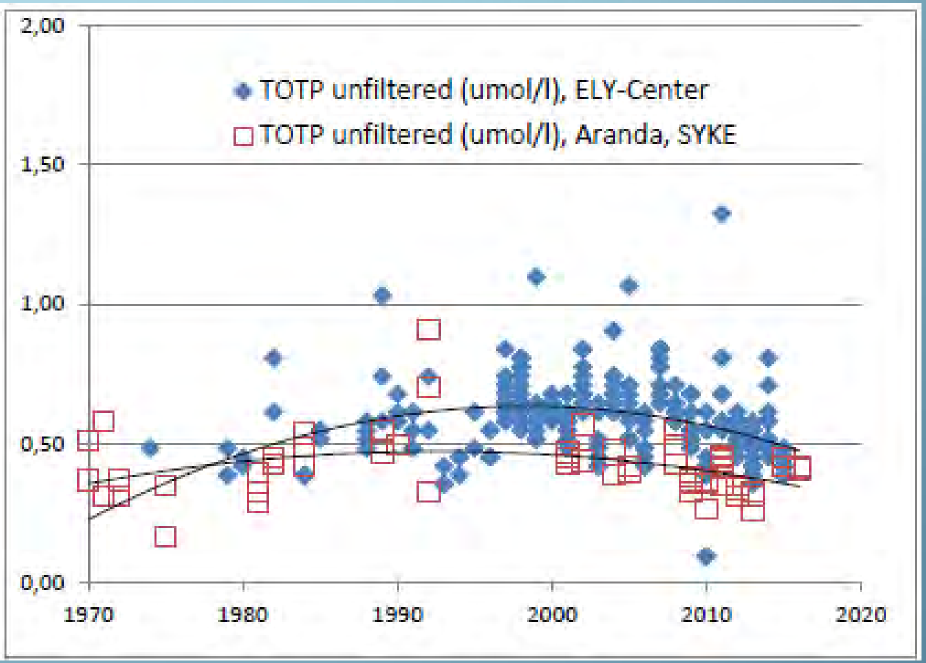
Ratios between Estonian and Finnish wintertime DIN and DIP measurements at stations H1/LL12 and F3/ LL7



Source: Raateoja et al.,
The GOF Assessment

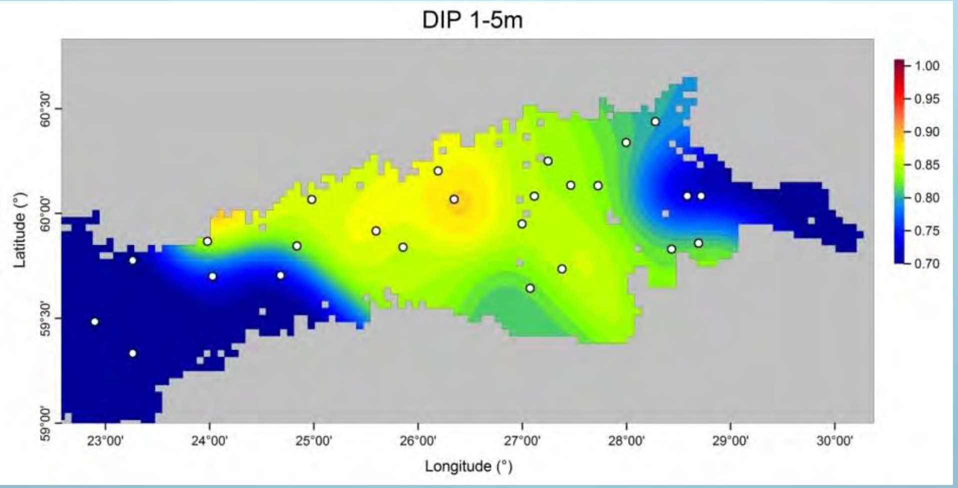
Surface layer summer TOT P in the eastern GOF at station 4 (Hydromet) and XV-1 (SE Finland ELY-Centre, SYKE)

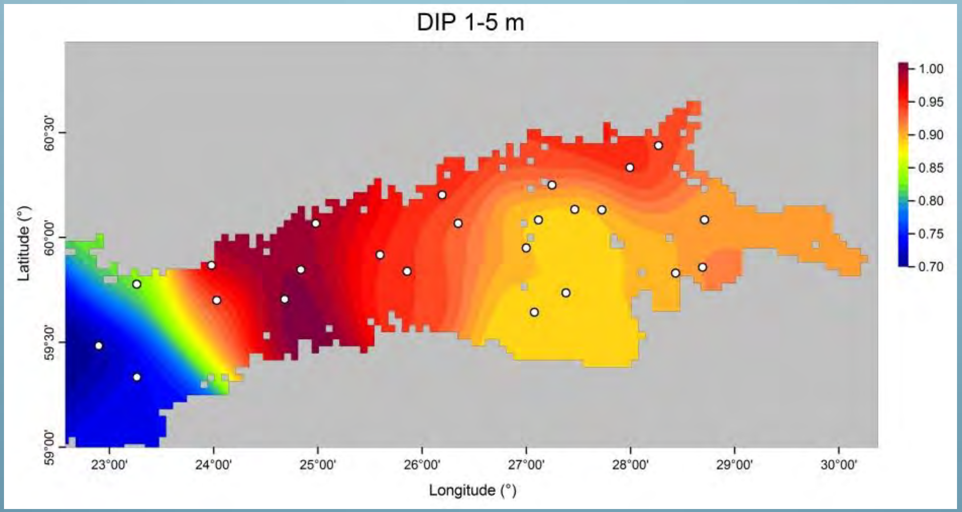




Source: GOF Data Set, Hydromet, SE Finland ELY-Centre, SYKE

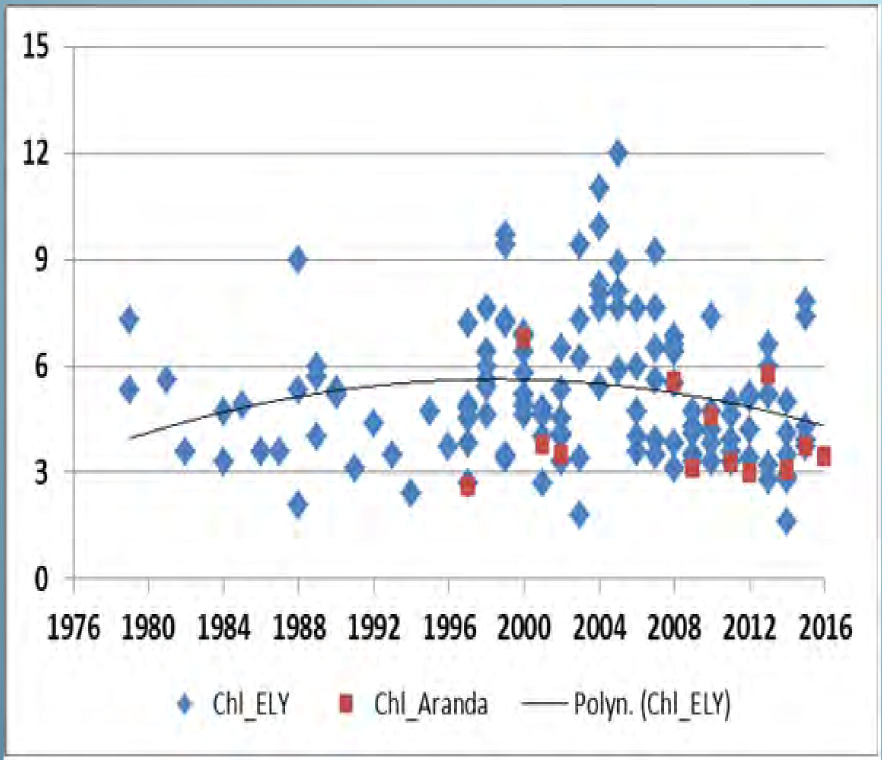
Surface phosphate-phosphorus in January 2014 and 2015

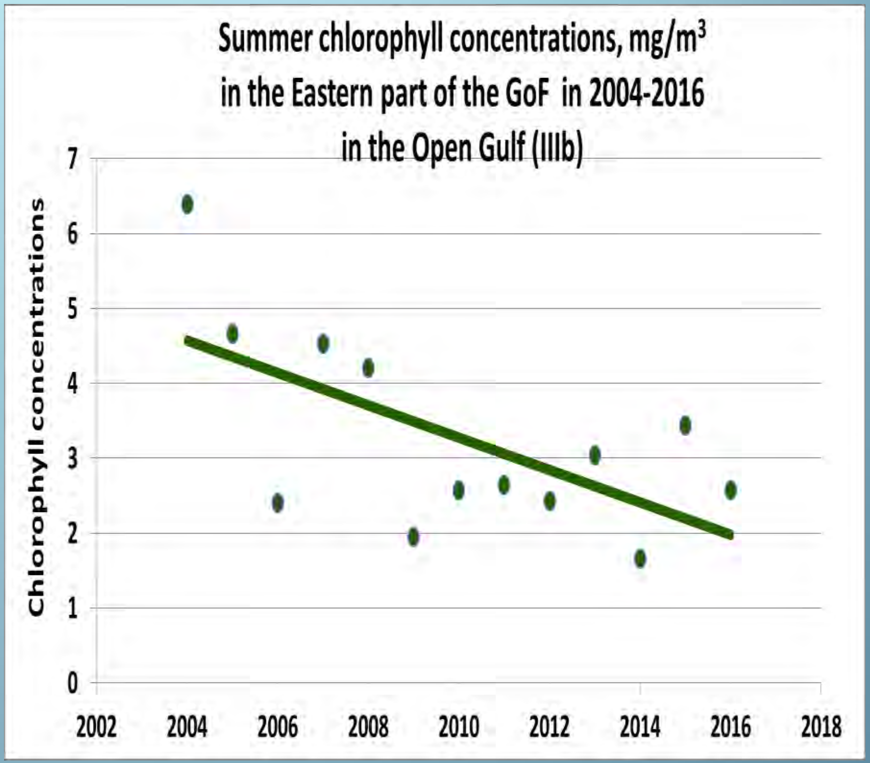




Data: SYKE
Data processing: Jan-Erik Bruun/ SYKE

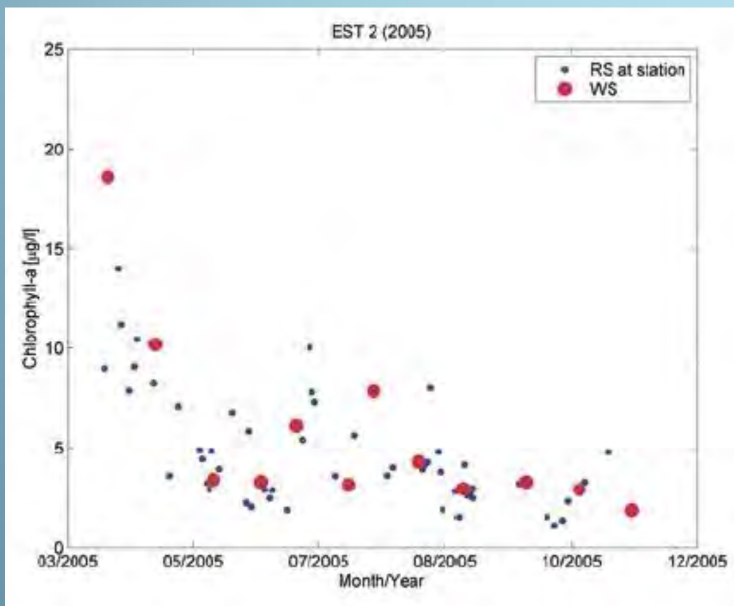
Temporal variation in chlorophyll-a in the eastern GOF (Haapasaari intensive station and RSHU's open sea stations) in late summers





Pirkko Kauppila/ SYKE, Tatjana Eremina/ RSHU
Data: SYKE, SE Finland ELY-Centre, RSHU

Comparison of remote sensing and water sample based chlorophyll-a



Source: Kauppila et al.,
The GOF Assessment

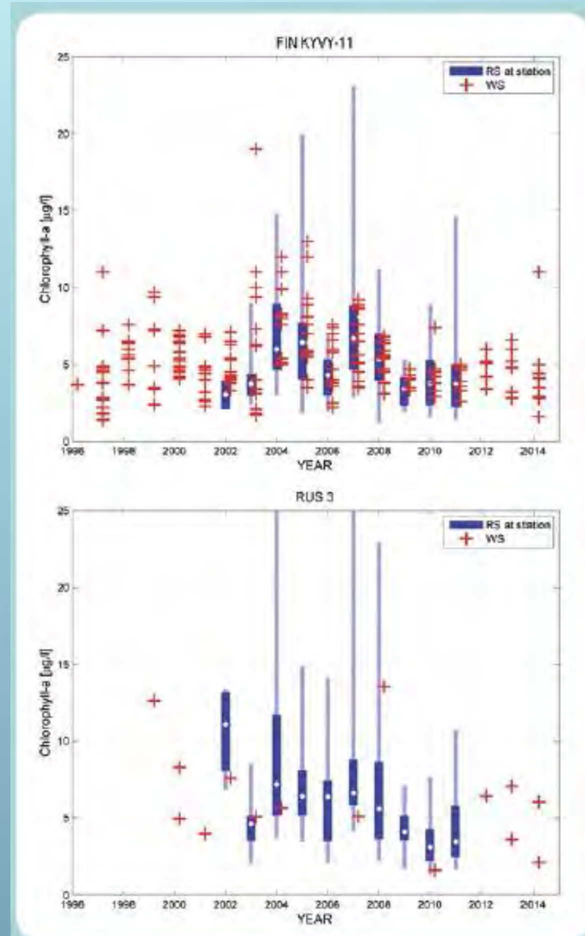


Figure 13.
The RS-based and WS-based Chl *a* (µg/l) at KYVY-11 (above) and at 3 (below) as a function of time in June–September in 1996/1998–2014. As for the RS data, the variation of Chl *a* was presented using boxplots, where the extremes of the thinner parts of the pillar describe the 5th and 95th percentiles and the box marks the of 25th and 75th percentiles. The white dots represent the geometric mean value (ChlGM) during the assessment period. As for the WS data, the results of Chl *a* are indicated by red crosses. Source: GOF2014 dataset (WS) and SYKE (RS).

Monitoring of eutrophication: recommendations for the trilateral cooperation based on the GOF Assessment

- A more closely integrated program for the conventional ship-based monitoring is needed within the frames of HELCOM and EU (sampling times, stations, methodologies)
- Regular wintertime monitoring in all parts of the Gulf is the basic condition for reliable assessment of eutrophication
- Remote sensing and autonomous platforms (buoys, flow-through systems) should be developed to supplement conventional monitoring and to produce spatio-temporally high-frequency data
- Operational automatic SOOP-monitoring (Alg@line) should cover also the eastern GOF with a regular line to St. Petersburg
- Results of the monitoring should be regularly reported under the GOF cooperation, the GOF Data Set should be kept up

- In order to ensure the reliability of the monitoring data, it is important that Estonia, Finland and Russia will use high-quality environmental analytics and fully comparable monitoring methods (intercalibrations) that are in line with the HELCOM's Guidelines

- As exchange of nutrients with the Baltic Proper and with internal nutrient inputs plays an important role in the overall trophic status of the GOF, the magnitude and dynamics of these processes should be subject to a special research and assessment effort. **High-quality monitoring data with good spatio-temporal coverage are needed also for studies on nutrient dynamics**


Thank you!

Gulf of Finland
Trilateral Scientific Forum
30th November–1st December, 2016
Finnish Environment Institute SYKE

1st Day

Gulf of Finland Co-operation

Oleg Korneev

Approach for joint Gulf of Finland marine spatial plan development

Trilateral Gulf of Finland Scientific Forum
30.11-01.12.2016

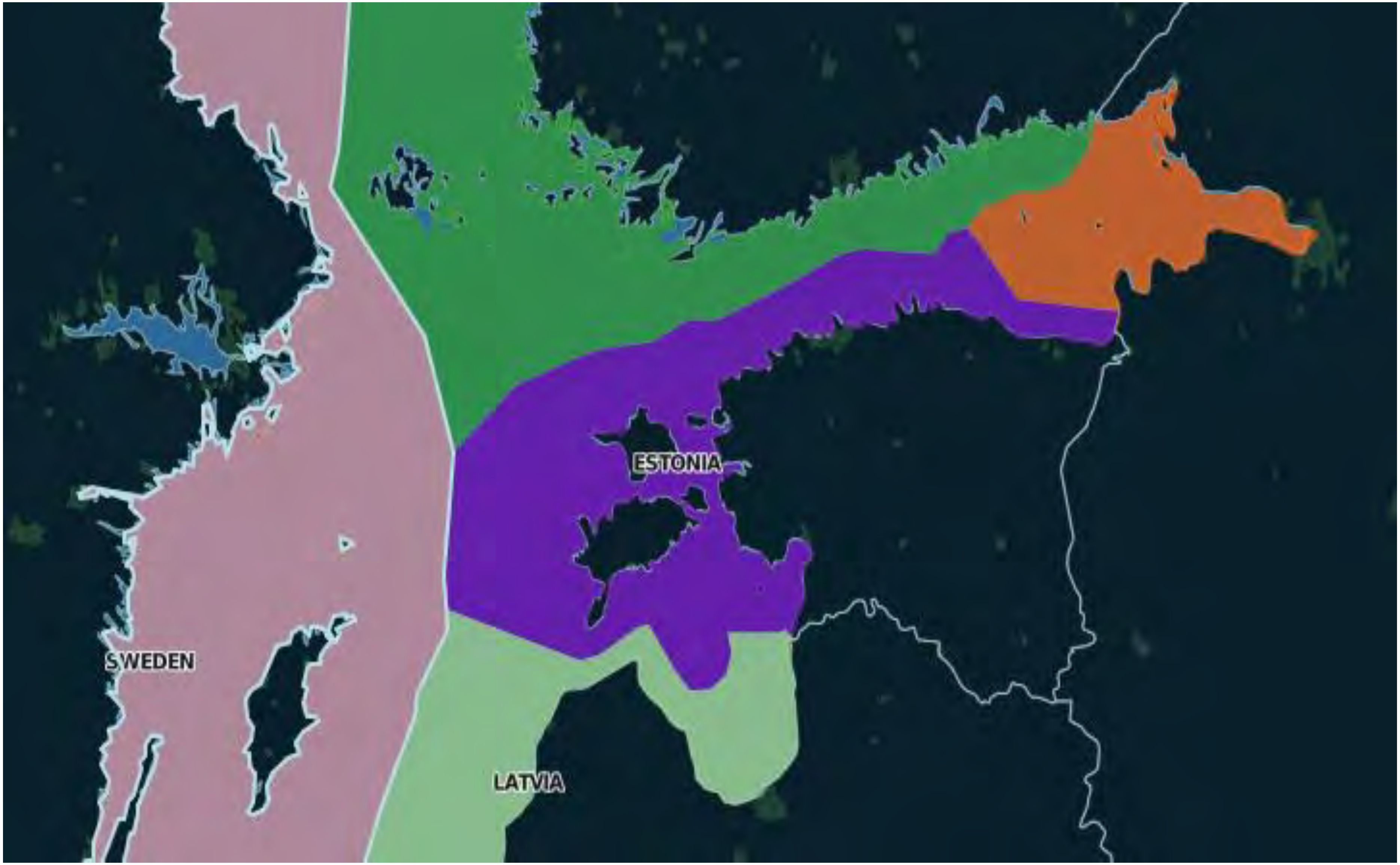
Gulf of Finland
Year 2014

Approach for Gulf of Finland Joint Maritime Spatial Plan development

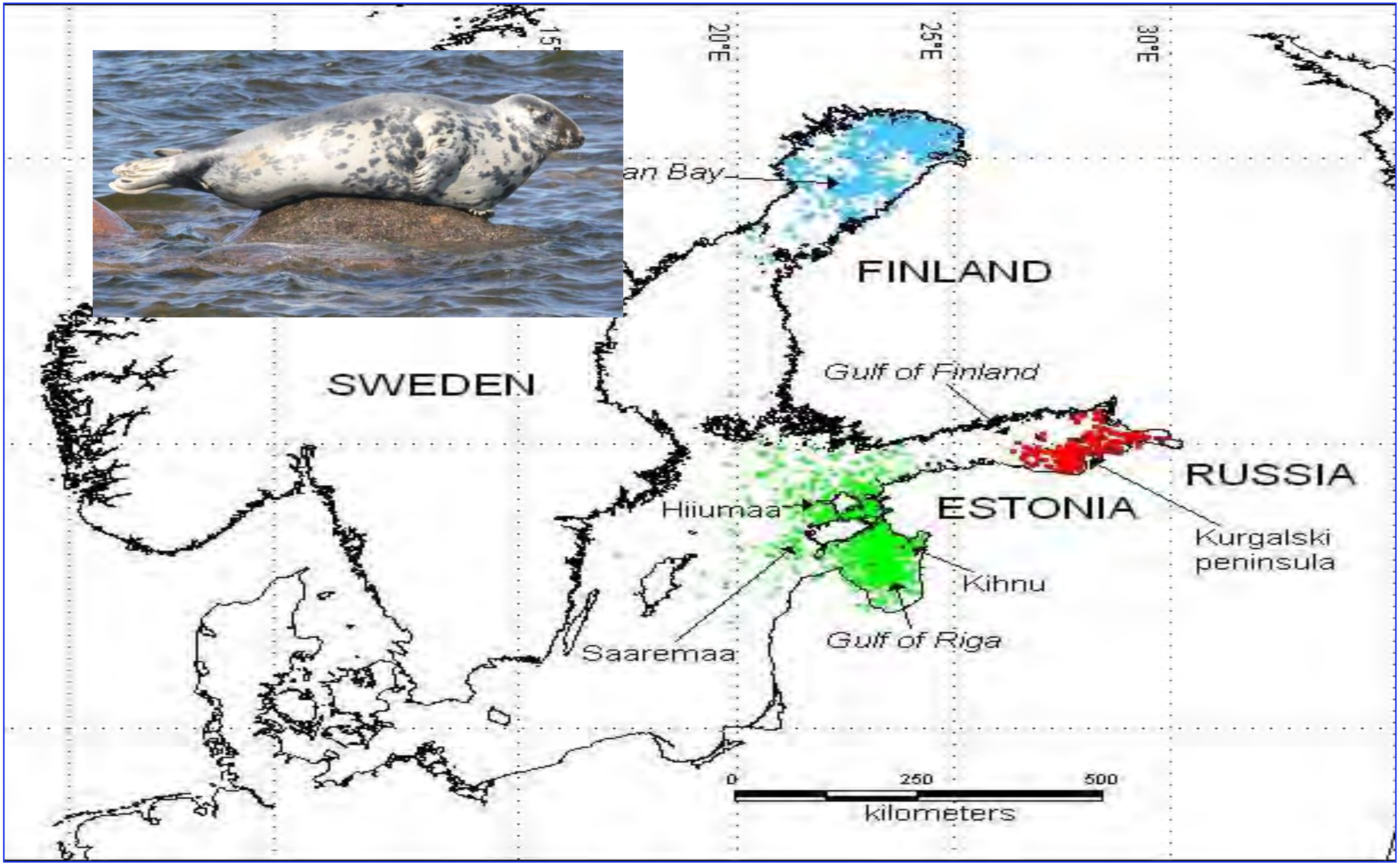
O. Korneev (Rosgeo)

Helsinki, SYKE, 2016

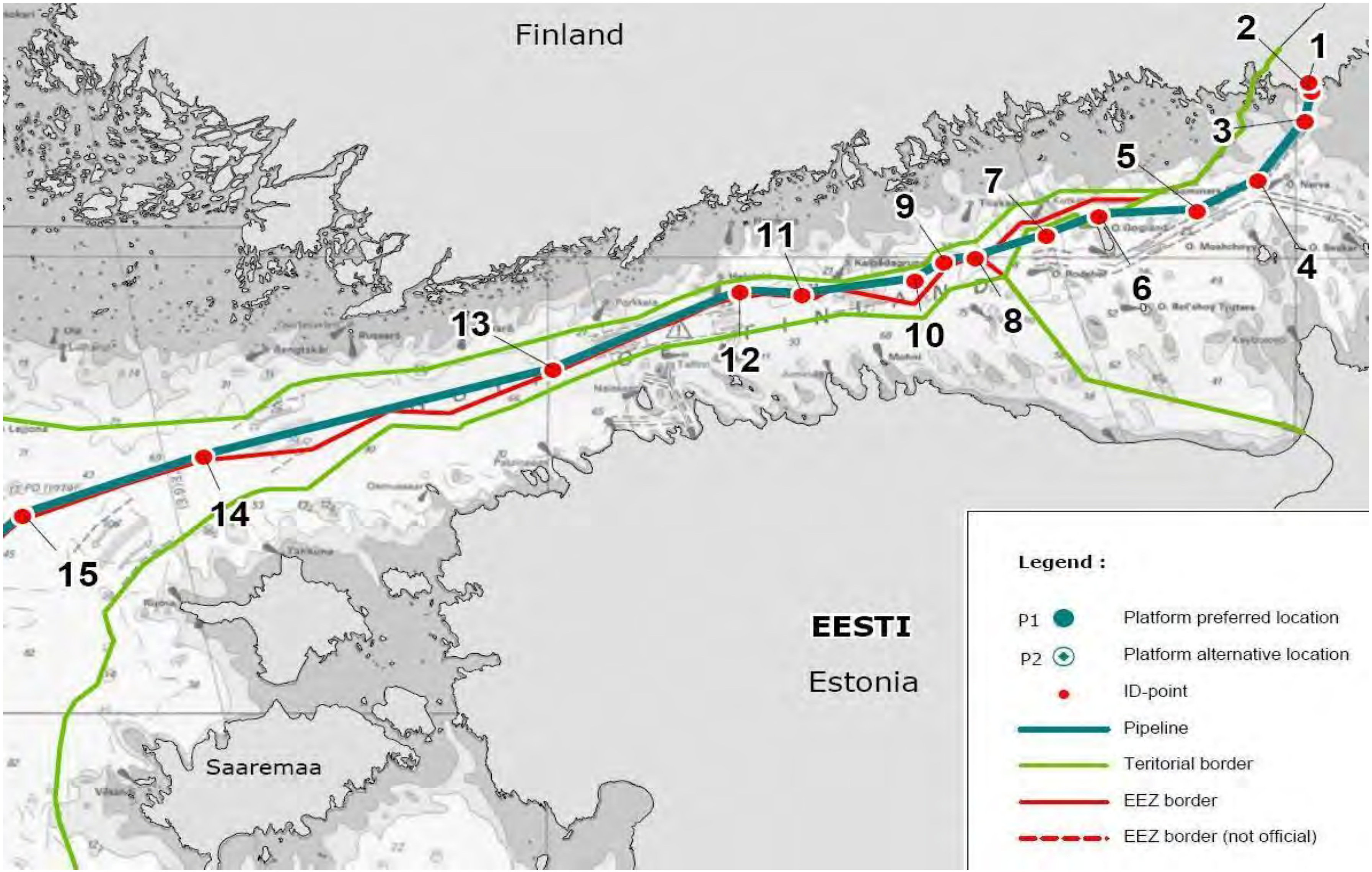
Trilateral national waters in Gulf of Finland



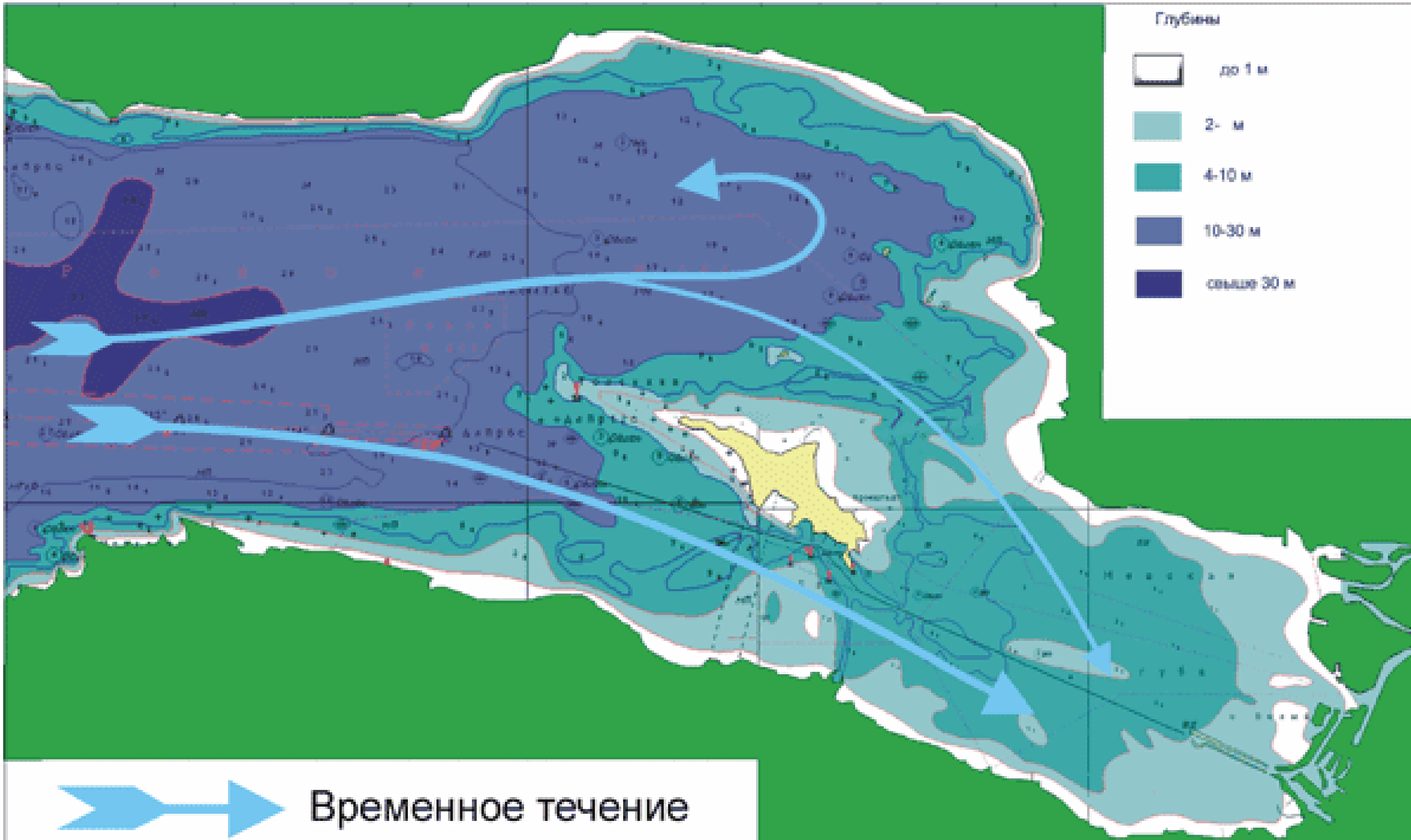
Common population of ring seal (satellite tagging data from the 1999)



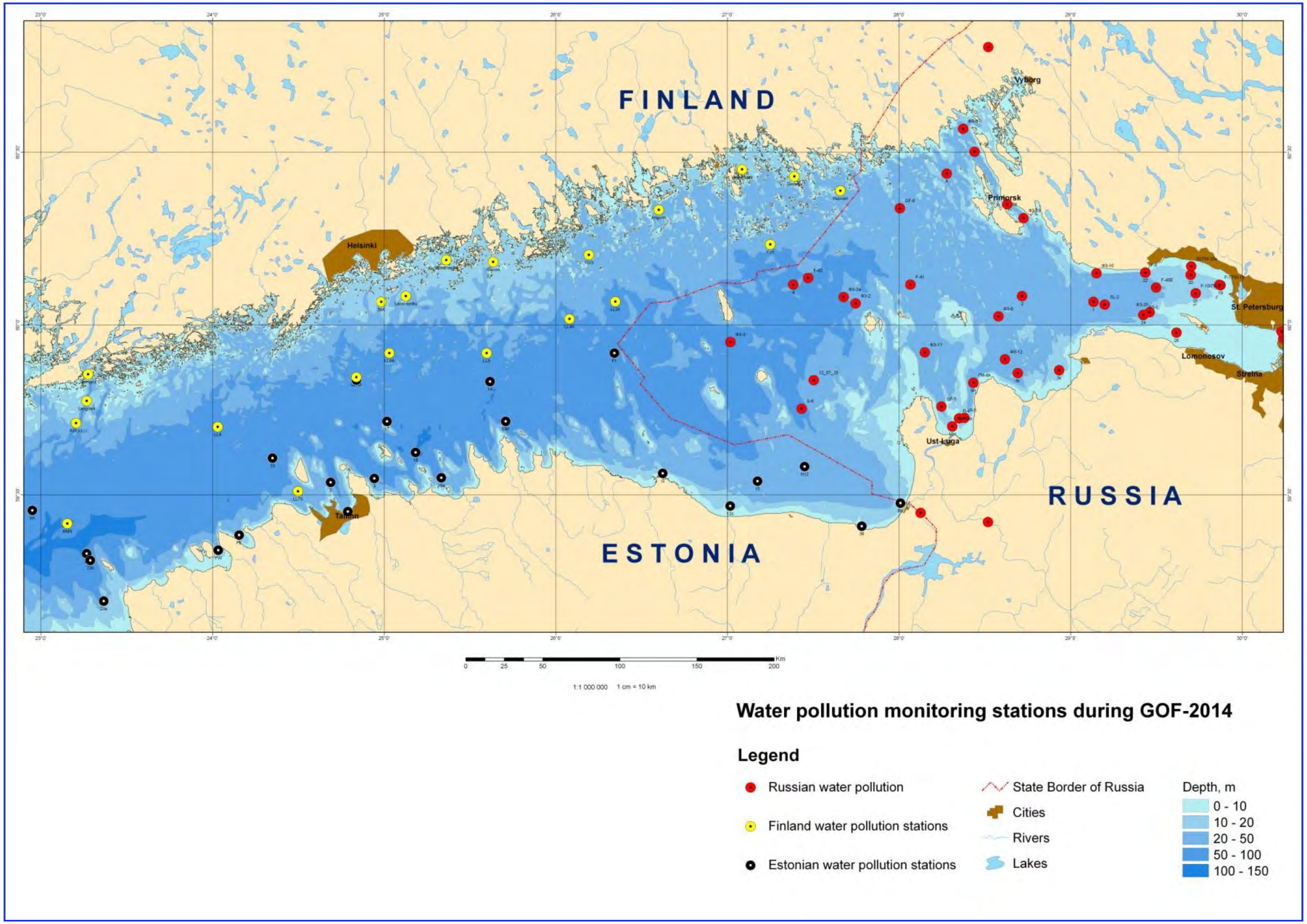
Common using – Nord Stream gas pipeline



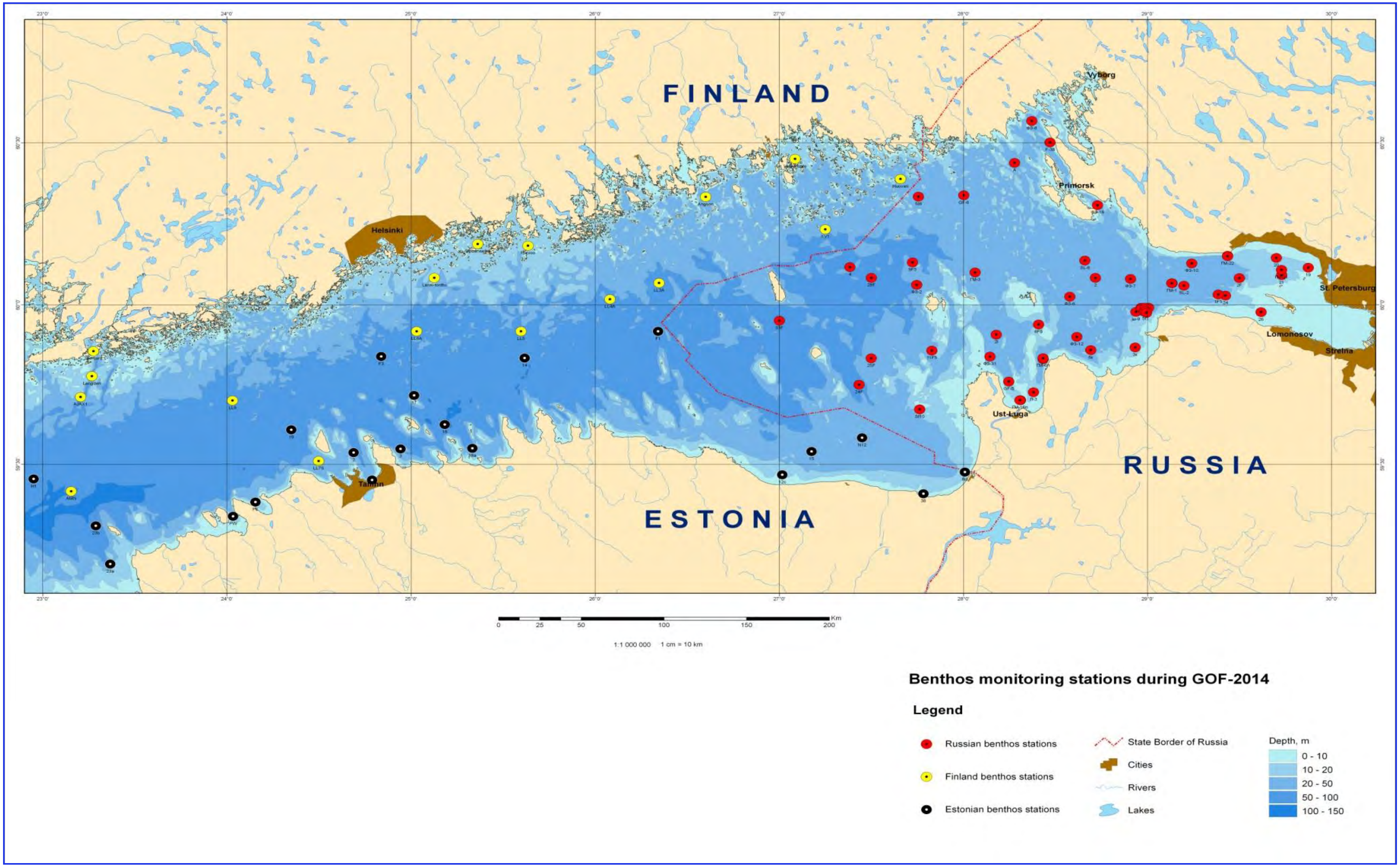
Mutual oceanographic conditions (currents)



Common station net for water monitoring



Common station net for benthos monitoring



Ecosystem-Based Approach

Marine spatial planning (MSP) is an important tool to achieve Ecosystem-based Management (EBM).

- The Gulf of Finland needs in a **Joint Maritime spatial plan** (JMSP) which would cover the waters of all three countries.
- At present, on the way to JMSP, the each country must to develop the own National MSP (NMSP) as a first step.
- Thanks to the MSP, the natural resources in the Gulf of Finland could be used in a sustainable manner, and the plan would help minimising the detrimental effects of human activities on the marine ecosystem.
- **There is a need for efficient cross-border coordination of the national maritime spatial planning activities** with aim to advance sustainable and resource efficient blue growth based on increased capacity of public authorities and practitioners within the blue economy sectors.
- This will prevent cross border mismatches and will secure transnational connectivity as well as efficient and sustainable use of the Gulf of Finland marine space and the natural resources.

Methodic base for GoF JMSP

2012 - Memorandum of Understanding on the Implementation of the Gulf of Finland Year 2014 Programme, (separate task "Marine spatial planning")

Intergovernmental Oceanographic Commission UNESCO:

- Manual and Guides No. 53, ICAM Dossier No. 6, **2009** **"MARINE SPATIAL PLANNING A Step-by-Step Approach toward Ecosystem-based Management";**
- Manuals and Guides, N°. 70, ICAM Dossier N°. 8, **2014** **"A GUIDE TO EVALUATING MARINE SPATIAL PLANS"**

Directive of the European parliament and of the Council:

2014/89/EU от 23.07.2014 "**Establishing a framework for maritime spatial planning"**

HELCOM

- BSAP Recommendation 28E/9 about principals of MSP, 2007, 2009
- Regional Baltic Maritime Spatial Planning Roadmap 2013-2020 (was adopted by the 2013 HELCOM Ministerial Meeting)

VASAB

VASAB Recommendation for MSP, 2010

Finish-Swedish BOTHNIA MSP Project

Regional Baltic MSP Roadmap 2013-2020

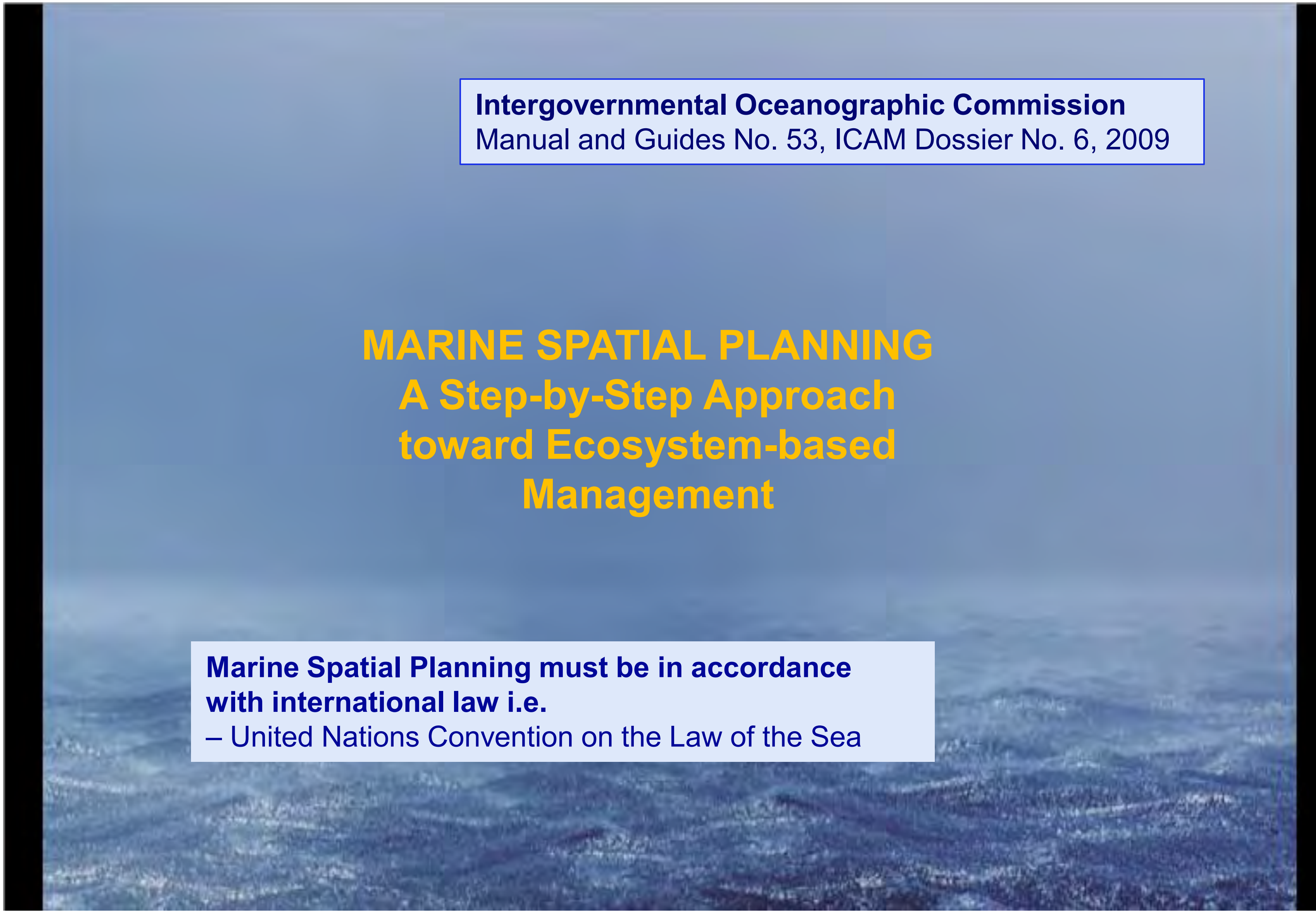
GOAL Will make every effort to draw up and apply maritime spatial plans throughout the Baltic Sea Region by 2020 which are coherent across borders and apply the ecosystem approach.

NECESSARY STEPS :

1. Intergovernmental cooperation on MSP: to facilitate reaching the **target of drawing up and implementing transnationally coherent Maritime Spatial Plans applying the ecosystem approach throughout the region by 2020.**

1. **2. Public participation:** adopt by 2015 "Guidelines on public participation for MSP with transboundary dimensions".
2. **3. Ecosystem approach in MSP:** adopt by 2015 "Guidelines on the application of Ecosystem Approach in transnationally coherent MSP" (was approved on HOD 50-2016 in June 2016);
3. **4. Information and data for MSP**
4. **5. Education for MSP**
5. **6. National and Baltic Sea regional frameworks for MSP in place:**
6. - National frameworks for coherent MSP are in place in all Baltic Sea countries by 2017. ***Apply by 2018*** :
7. - "Guidelines on transboundary consultations, public participation and co-operation"
8. - Guideline for the implementation of ecosystem-based approach in MSP in the Baltic Sea area"
9. **7. Evaluation and follow-up**

Manual and Guides No. 53, ICAM Dossier No. 6, 2009



Manual and Guides No. 53, ICAM Dossier No. 6, 2009

Step 1 Identifying need and establishing authority

Step 2 Obtaining financial support

Step 3 Organizing the process through pre-planning

Step 4 Organizing stakeholder participation

Step 5 Defining and analyzing existing conditions (Environment and Using)

Step 6 Defining and analyzing future conditions (same)

Step 7 Preparing and approving the spatial management plan

Step 8 Implementing and enforcing the spatial management plan

Step 9 Monitoring and evaluating performance

Step 10 Adapting the marine spatial management process

IOC Manuals and Guides, N°. 70, ICAM Dossier N°. 8, 2014

Marine spatial planning (MSP): a public process of analyzing and allocating the spatial and temporal distribution of human activities **in marine areas** to achieve ecological, social, and economic objectives that are usually specified through a political process.

Steps of Guide:

Step 1 Identify the need for monitoring and evaluation and prepare an evaluation plan.

Step 2 Identifying measurable objectives of the Marine Spatial Management Plan.

Step 3 Identifying Marine Spatial Management Actions.

Step 4 Identifying Indicators and Targets of performance for Marine Spatial Management Actions.

Step 5 Establishing a baseline for Selected Indicators.

Step 6 Monitoring indicators of management performance.

Step 7 Evaluating the Results of Performance Monitoring.

Step 8 Communicating the results of performance.

Step 9 Evaluation using the results of performance monitoring and evaluation to adapt the next cycle of Marine Spatial Planning.

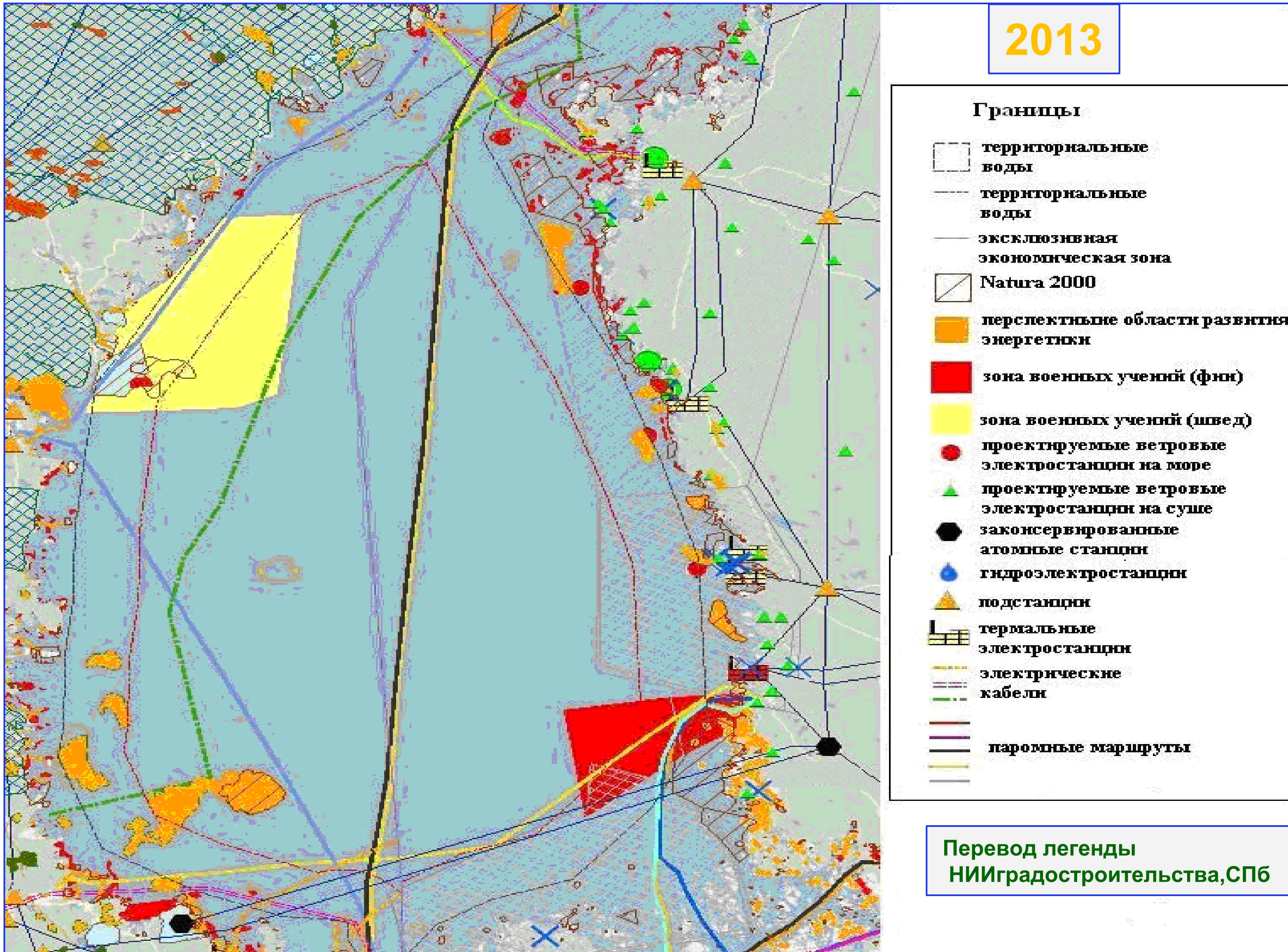
Directive of the European parliament and of the Council 2014/89/EU от 23.07.2014

(19) **The main purpose of maritime spatial planning** is to promote sustainable development and to identify the utilisation of maritime space for different sea uses as well as to manage spatial uses and conflicts in marine areas.

MSP also aims at identifying and encouraging multi-purpose uses, in accordance with the relevant national policies and legislation. In order to achieve that purpose, Member States need at least to ensure that the planning process or processes result in a comprehensive planning identifying the different uses of maritime space and taking into consideration long-term changes due to climate change.

(20) **Member States** should consult and coordinate their plans with the relevant Member States and **should cooperate with third-country authorities** in the marine region concerned in conformity with the rights and obligations of those Member States and of the third countries concerned under Union and international law. Effective cross- border cooperation between Member States and with neighbouring third countries requires that the competent authorities in each Member State be identified.

Шведско-финский опыт МПП – План Ботния



2013

Перевод легенды НИИградостроительства,СПб

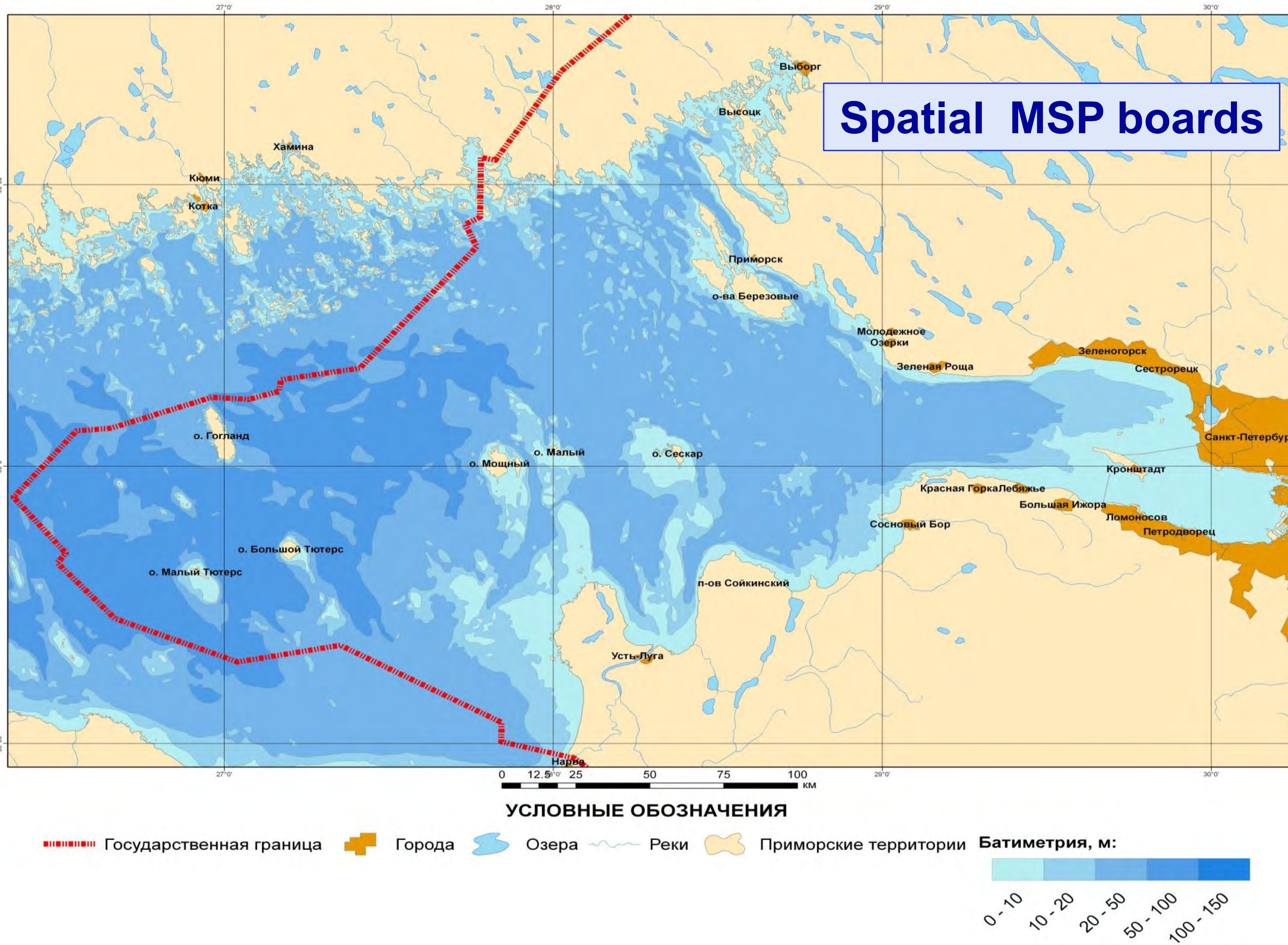
Goal and structure of MSP for Russian GoF part

MSP goal: Ensure sustainability of economic uses for Russian GoF part on base conservation of marine ecological structure—at all levels of biological organization

MSP Structure:

1. Analysis of the existing MSP approaches and documents.
2. Definition of the MSP spatial and temporal (base and target periods) boundaries.
3. Collecting and mapping information about ecological, environmental and oceanographic conditions
4. Collecting and mapping information about all kind of the human activities
5. Identifying current spatial conflicts and compatibilities
6. Projecting current trends in the spatial and temporal needs of existing human activities
7. Estimating spatial and temporal requirements for new demands of marine space
8. Identifying possible alternative futures for the planning area
9. Selecting the preferred spatial sea use scenario
10. Identifying alternative spatial and temporal management measures, incentives, and institutional arrangements
11. Specifying criteria for selecting marine spatial management measures
12. Development of the ecological requirements for limitation of the human activity

Российская часть Финского залива

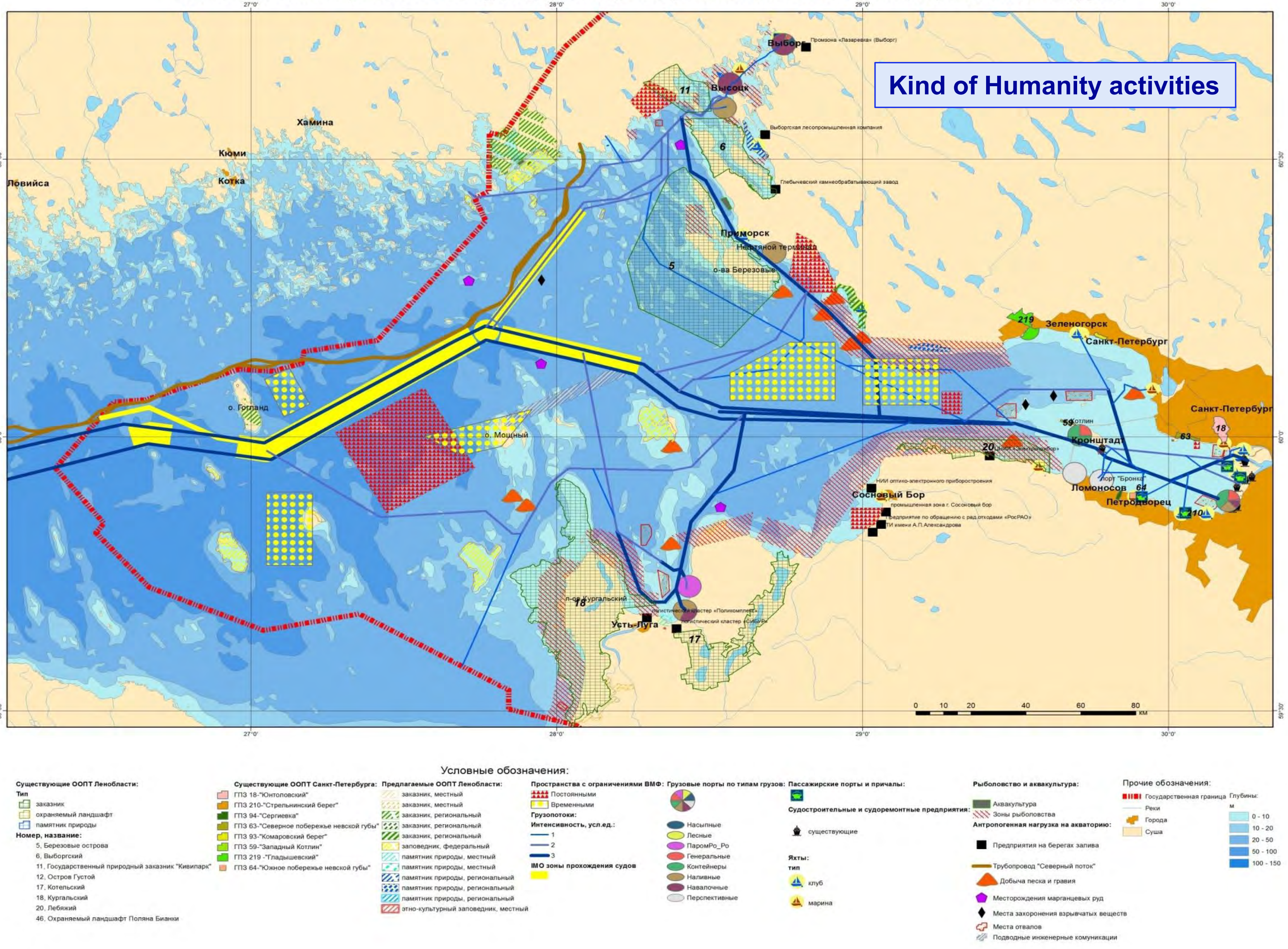


Ports

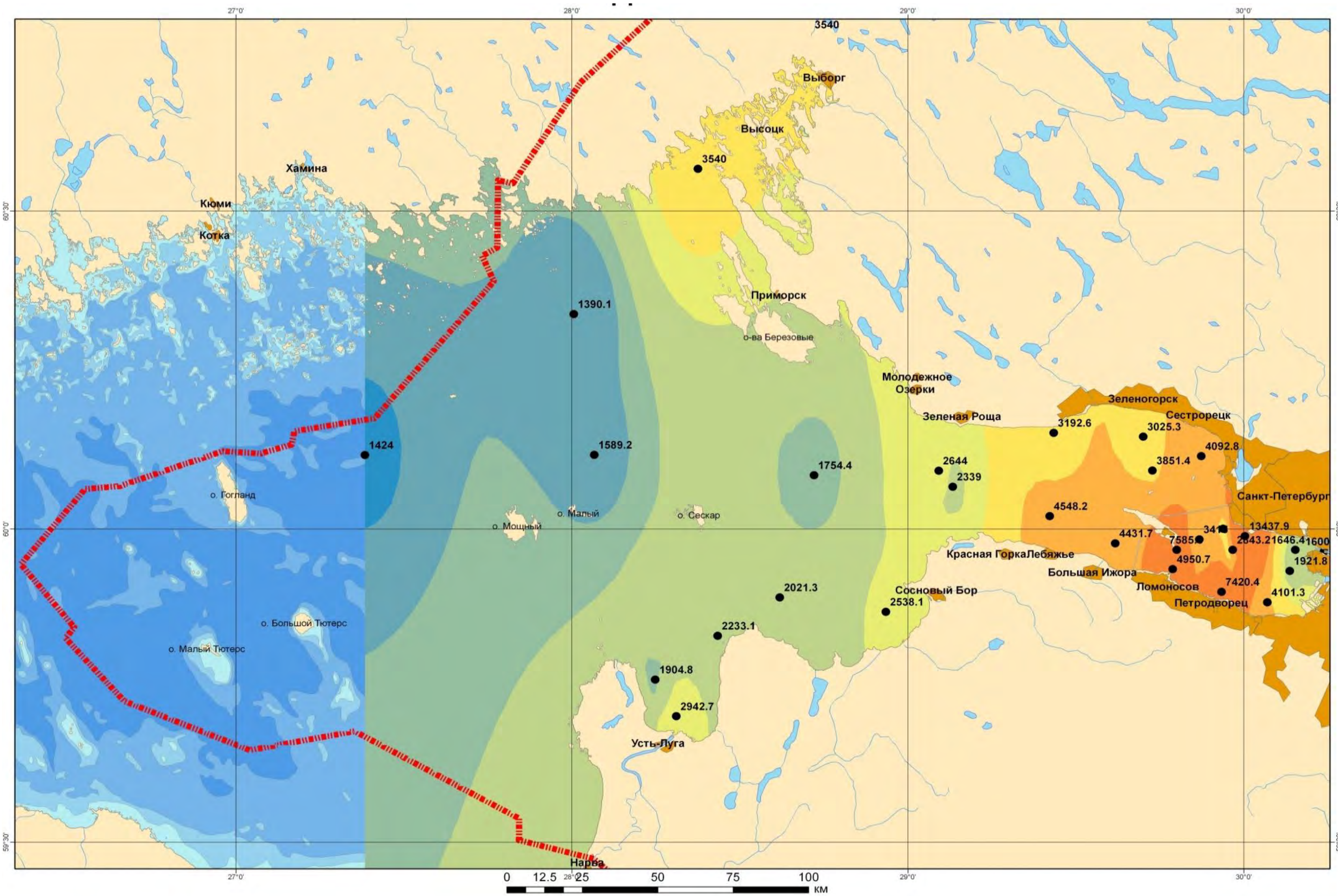
Port	Total freight/hydrocarbon freight, mln. t/year			
	2011-fact	2015	2020	2030
SPb with avanports	60,0/15,7	66,6/16,4	72,6/17,0	77,9/17,1
Vysotsk	13,4/10,2	19,6/14,6	21,2/14,8	21,6/15,0
Ust-Luga	22,7/6,5	69,4/28,0	87,4/30,0	98,8/30,0
Primorsk	75,1/75,1	81,0/81,0	81,0/81,0	81,0/81,0
Vyborg	-	2,0/-	2,5/-	3,2/-
Total	**171,2/107,5**	**239,6/140,0**	**265,2/142,8**	**282,5/143,1**

N п/п	Наименование аванпорта	Примерный грузооборот по годам, млн.т/год		
		2015 г.	2020 г.	2025 г.
1	2	3	4	5
1	**Бронка**, в том числе:	**17,60**	**18,90**	**48,90**
1.1	Морской терминал по перевалке контейнерных грузов N 1	15,00	15,00	15,00
1.2	Морской терминал по перевалке контейнерных грузов N 2	-	-	30,00
1.3	Морской терминал по перевалке накатных грузов	2,60	2,60	2,60
1.4	Морской терминал по перевалке легковых автомобилей	-	1,30	1,30
2	**Кронштадт,** в том числе:	**9,50**	**9,50**	**9,50**
2.1	Морской терминал по перевалке контейнерных грузов	7,50	7,50	7,50
2.2	Морской терминал по перевалке рефрижераторных, накатных и контейнерных грузов, из них:	2,00	2,00	2,00
2.2.1	Рефрижераторные грузы	1,50	1,50	1,50
2.2.2	Накатные грузы	0,20	0,20	0,20
2.2.3	Контейнерные грузы	0,30	0,30	0,30
3	**Ломоносов,** в том числе:	**11,65**	**11,65**	**11,65**
3.1	Морской терминал по перевалке рефрижераторных, контейнерных грузов и легковых автомобилей	10,45	10,45	10,45
3.2	Морской терминал по перевалке рефрижераторных грузов	1,20	1,20	1,20
	Всего	**38,75**	**40,05**	**70,05**

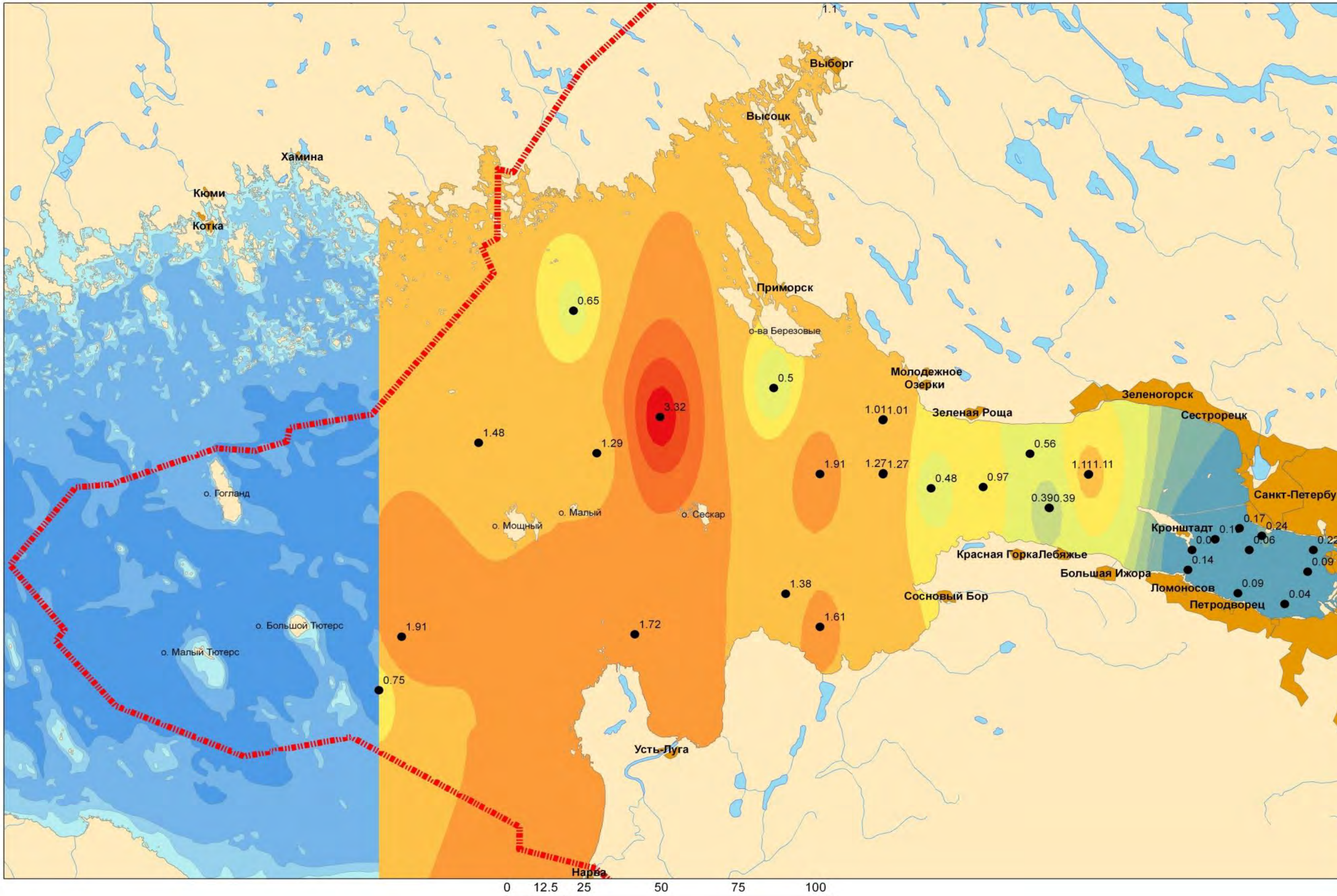
ФИНСКИЙ ЗАЛИВ рыболовство судоходство порты ограничения ВМФ ООПТ и антропогенная нагрузка



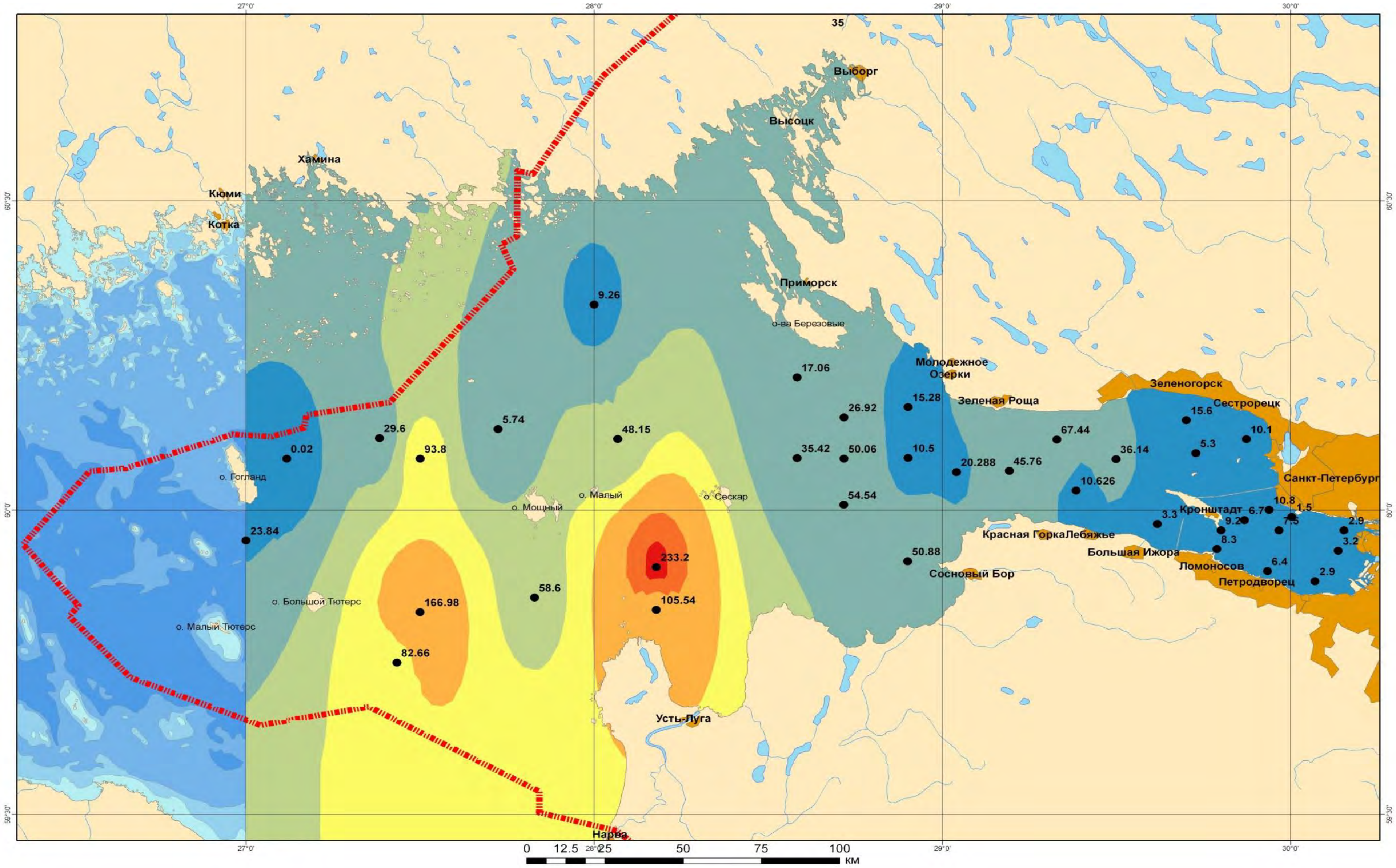
Spatial distribution of the phytoplankton, 2013 г.



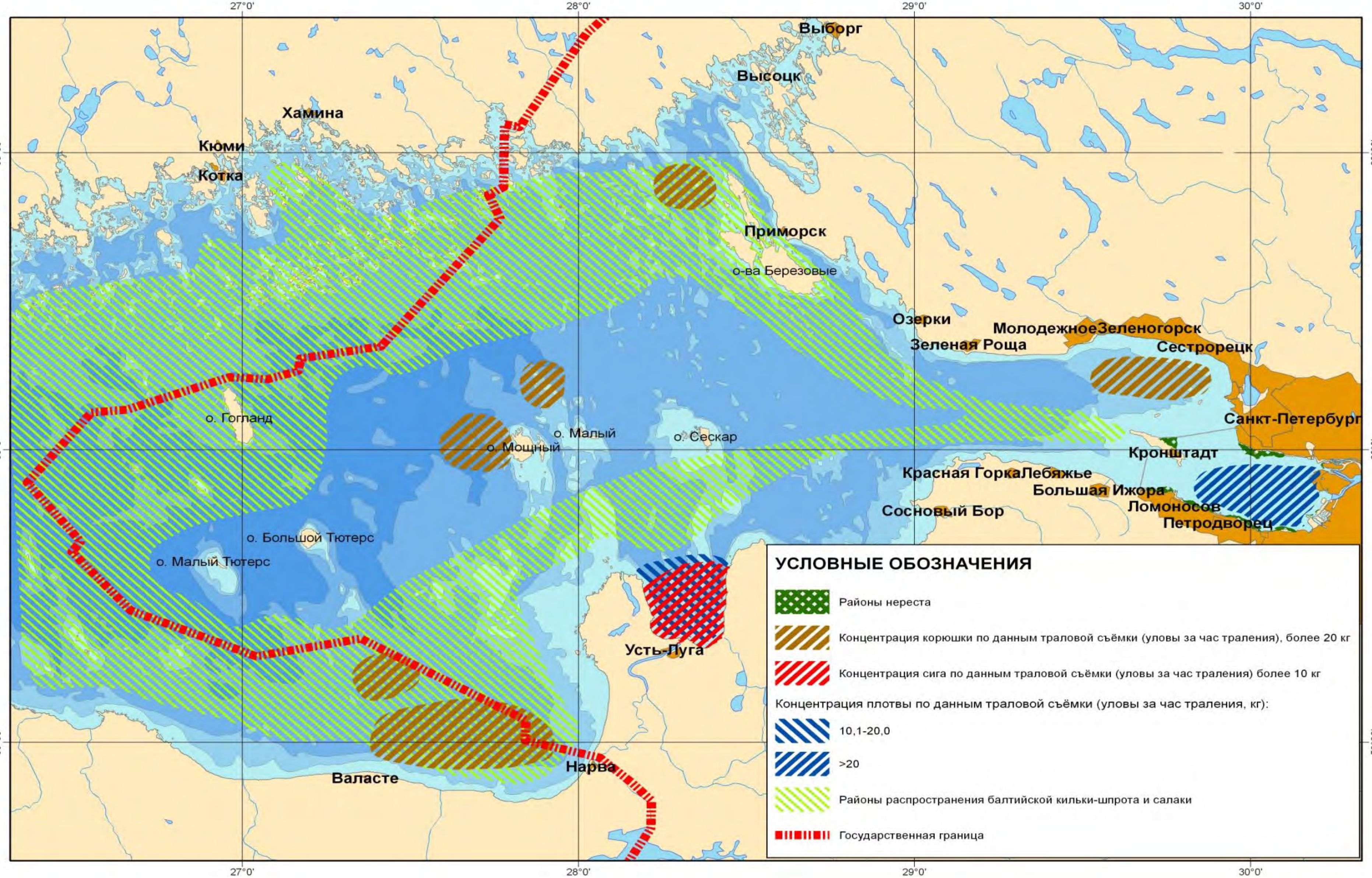
Spatial distribution of the zooplancton, 2012-2013



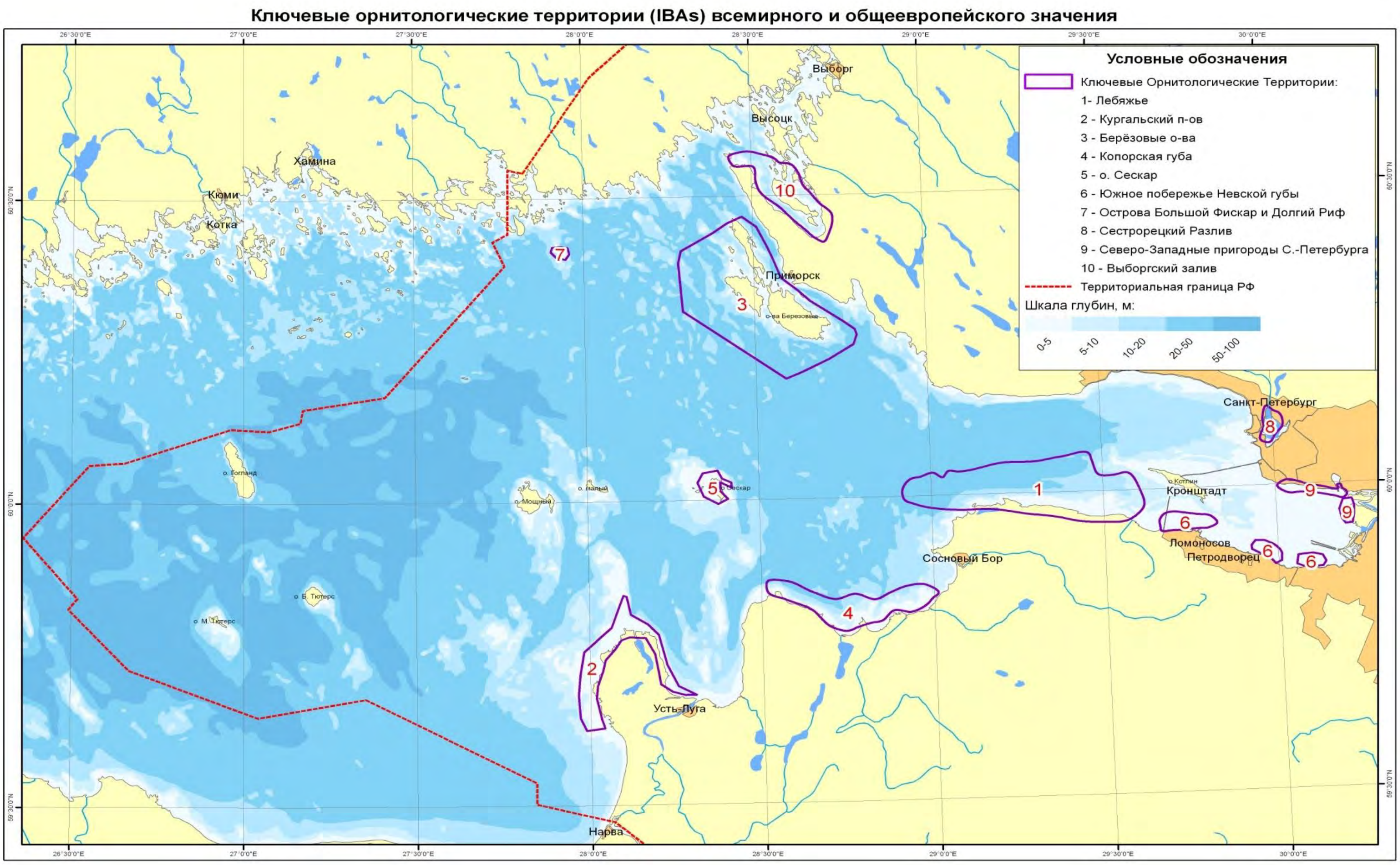
Spatial distribution of the zoobenthos, 2013-2014



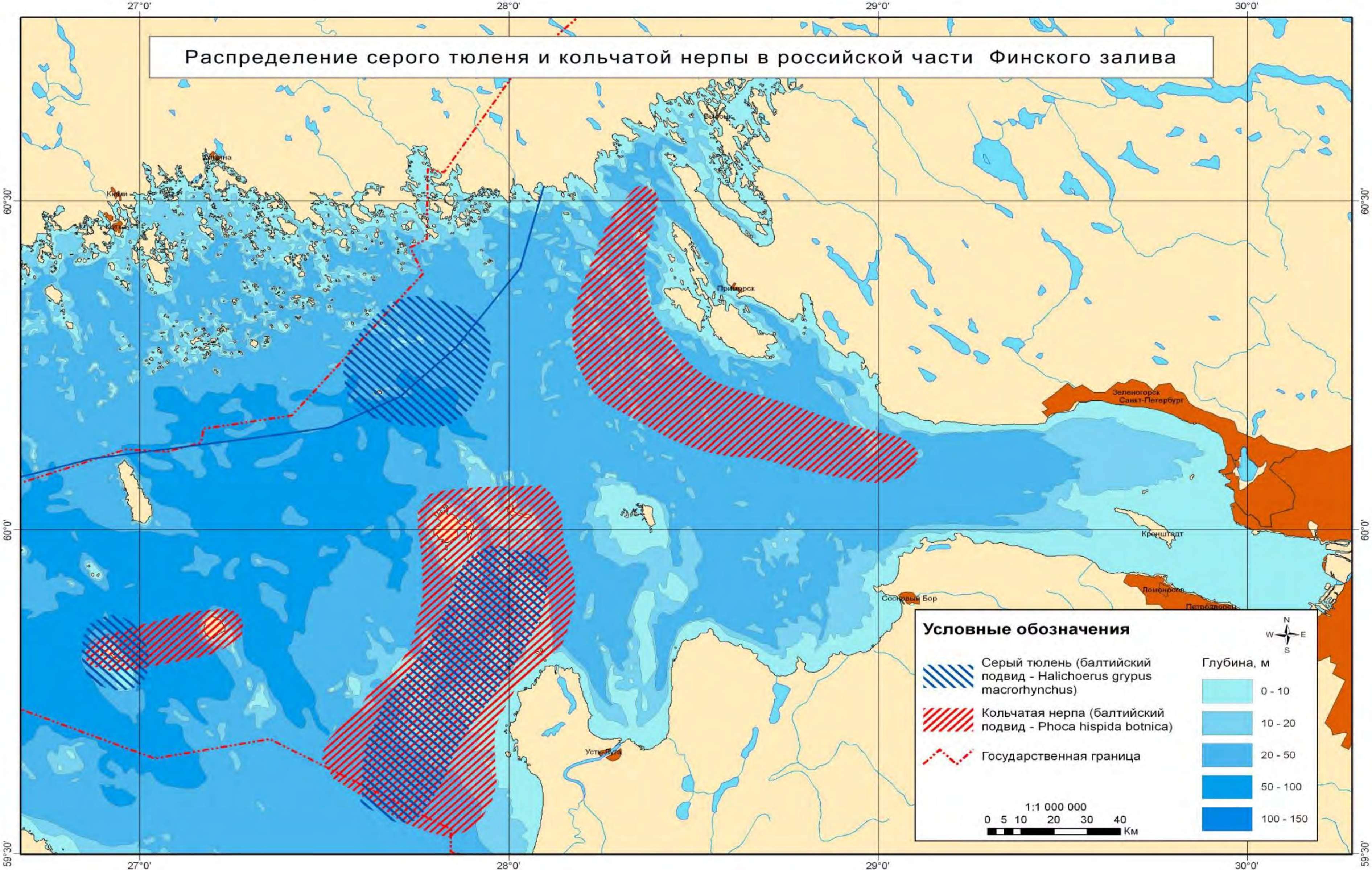
Spatial distribution of the commercial fishes



Spatial distribution of the sea birds nesting



Spatial distribution of the Red Book species

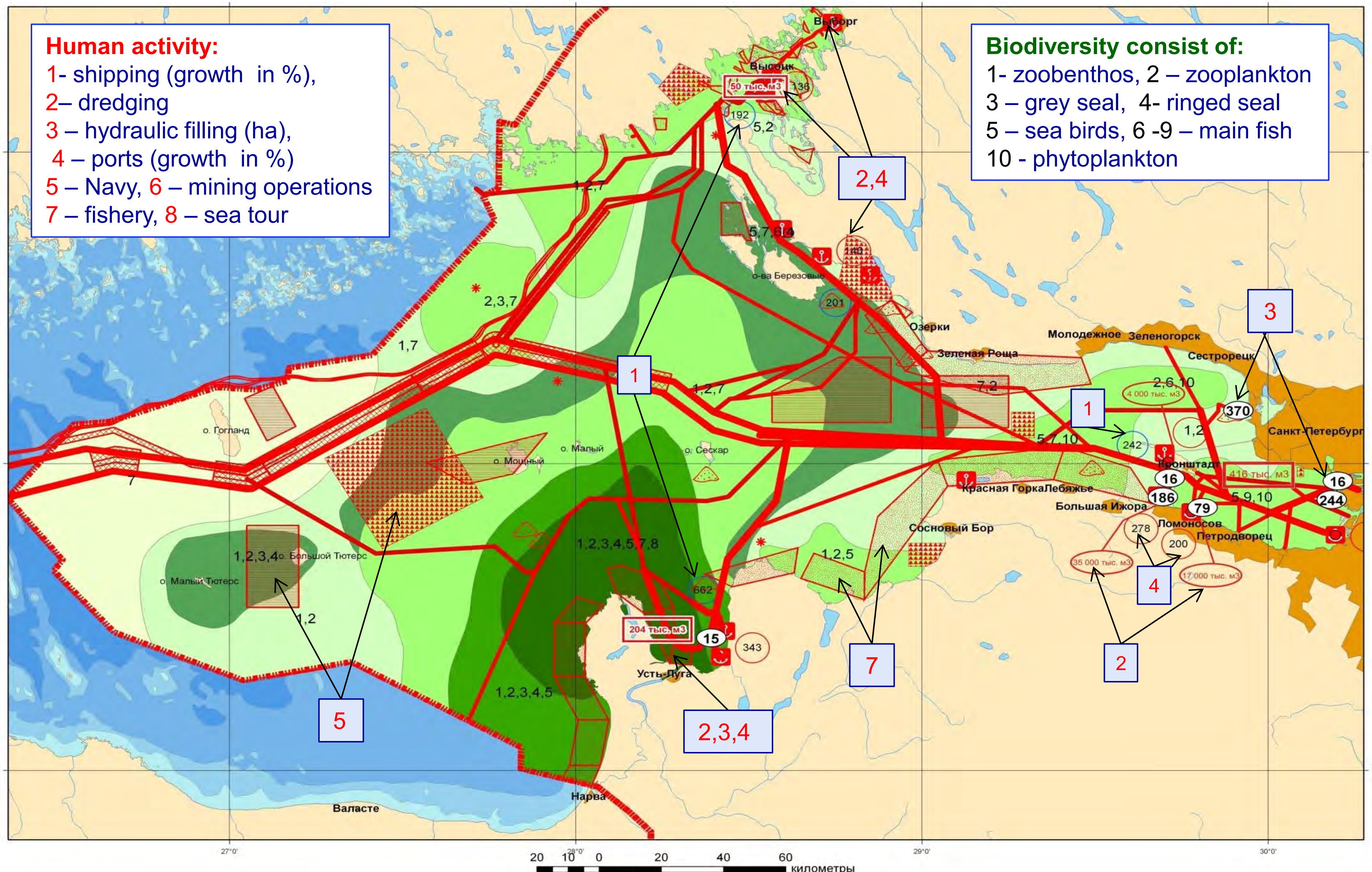


Main Benefits of MSP:

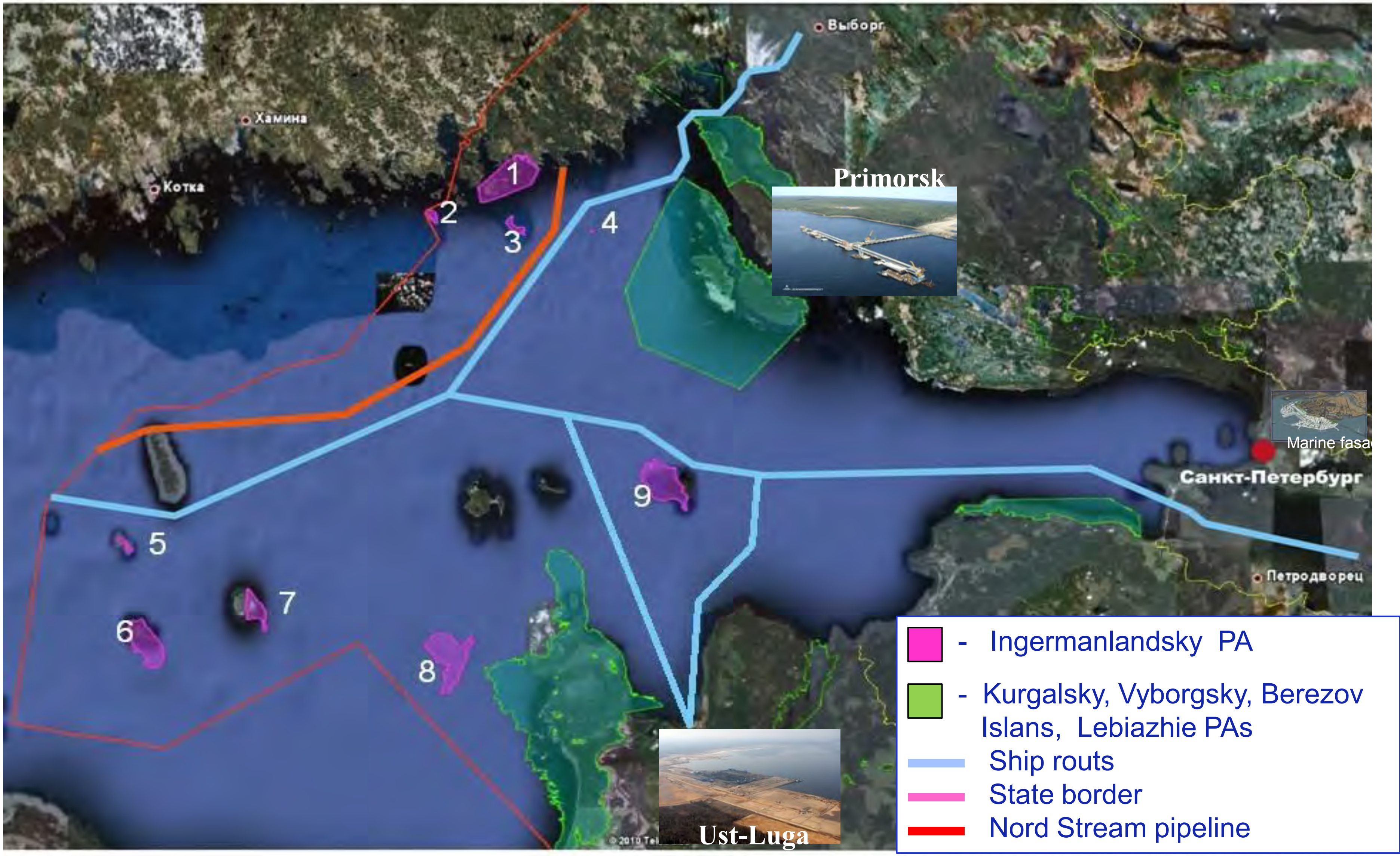
Main Benefits of MSP:

- Important for mitigation and adaptation to climate change ,by promoting the efficient use of maritime space and renewable energy,
- Allows for cost-efficient adaptation to the impact of climate change.
- A tool for promoting rational use of the sea and improved decision-making
- Arbitration or balance between competing human activities
- to balance sectoralinterests
- Essential for sustainable development of maritime regions
- Provides a stable planning framework for maritime investments

MARITIME SPATIAL PLANNING before 2021 (SMG)



Project GoF Nature Protection Areas



For JMSP achievement the next suggestions recommend to use:

- the best available technology should be used to minimise the adverse effects of large-scale construction projects (such as construction and enlargement of port facilities). If it can be anticipated that such projects have cross-border effects to marine life, e.g., due to transport of sediments, it is recommended that information of the plans, as well as their environment impact assessments, will be shared tri-laterally, and, when appropriate, monitoring of the cross-border effects will be agreed upon tri-laterally;

- identify the hotspots of bio- and geodiversity, and determine the extent of human-induced stress in these areas, and designate measures to reduce the stress in the worst affected areas;

- the authorized state institutions and organizations recommend to continue to further encourage sound planning, increased contacts, cooperation and training among port authorities, such as Big port Saint Petersburg, Primorsk, Vysotsk, Ust-Luga, Vyborg , Muuga, Hamina-Kotka, Vuosaari and Tallinn as well as the oil terminals;

- identify the past and present human activities to obtain understanding of cumulative environmental effects, especially regarding hazardous substances.

Suggested steps for JMSP a+chiviement

Step 1 - Organizing the process through pre-planning

Task 1: Creating the Trilateral marine spatial planning team
Task 2: Developing a work plan
Task 3: Defining boundaries and timeframe of MSP
Task 4: Defining MSP principles
Task 5: Defining goals and objectives
Task 6: Identifying risks and developing contingency plans

Step 2 - Organizing stakeholder participation

Task 1: Defining who should be involved in marine spatial planning
Task 2: Defining when to involve stakeholders
Task 3: Defining how to involve stakeholders

Step 3 - Defining and analyzing existing conditions

Task 1: Collecting and mapping information about ecological, environmental and oceanographic conditions
Task 2: Collecting and mapping information about human activities
Task 3: Identifying current conflicts and compatibilities

Step 4 - Defining and analyzing future conditions

Task 1: Projecting current trends in the spatial and temporal needs of existing human activities
Task 2: Estimating spatial and temporal requirements for new demands of GoF marine space
Task 3: Identifying possible alternative futures for the planning area
Task 4: Selecting the preferred spatial sea use scenario

Step 5 - Preparing the Marine spatial management plan

Task 1: Identifying alternative spatial and temporal management measures, incentives and institutional arrangements
Task 2: Specifying criteria for selecting marine spatial management measures
Task 3: Developing the zoning plan
Task 4: Evaluating the spatial management plan
Task 5: Approving the spatial management plan.

Gulf of Finland Year 2014

Kiitos!

Aitäh!

Спасибо!

For your attention!

Gulf of Finland
Trilateral Scientific Forum
30th November–1st December, 2016
Finnish Environment Institute SYKE

1st Day

Gulf of Finland
Co-operation

Jorma Rytkönen, Tarmo Kõuts, Sergey Aysinov

Some of the latest actions to improve maritime safety in the Gulf of Finland waters

Some of the latest actions to improve maritime safety in the Gulf of Finland waters

Gulf of Finland Co-operation

Trilateral Gulf of Finland Scientific Forum
30th November-1st December, 2016

Jorma Rytkönen, Tarmo Kõuts, Sergey Aysinov,

SYKE

Contents

Gulf of Finland Co-operation

- Baltic Sea Risks
- FSA
- GoFReP
- Oil Transportation in GoF
- GoF Risk studies
- TRAFI's accident data
- Case studies
- GoF Winter navigation
- RCO's
- Ongoing projects

SYKE

Jorma Rytkönen 13.12.2016

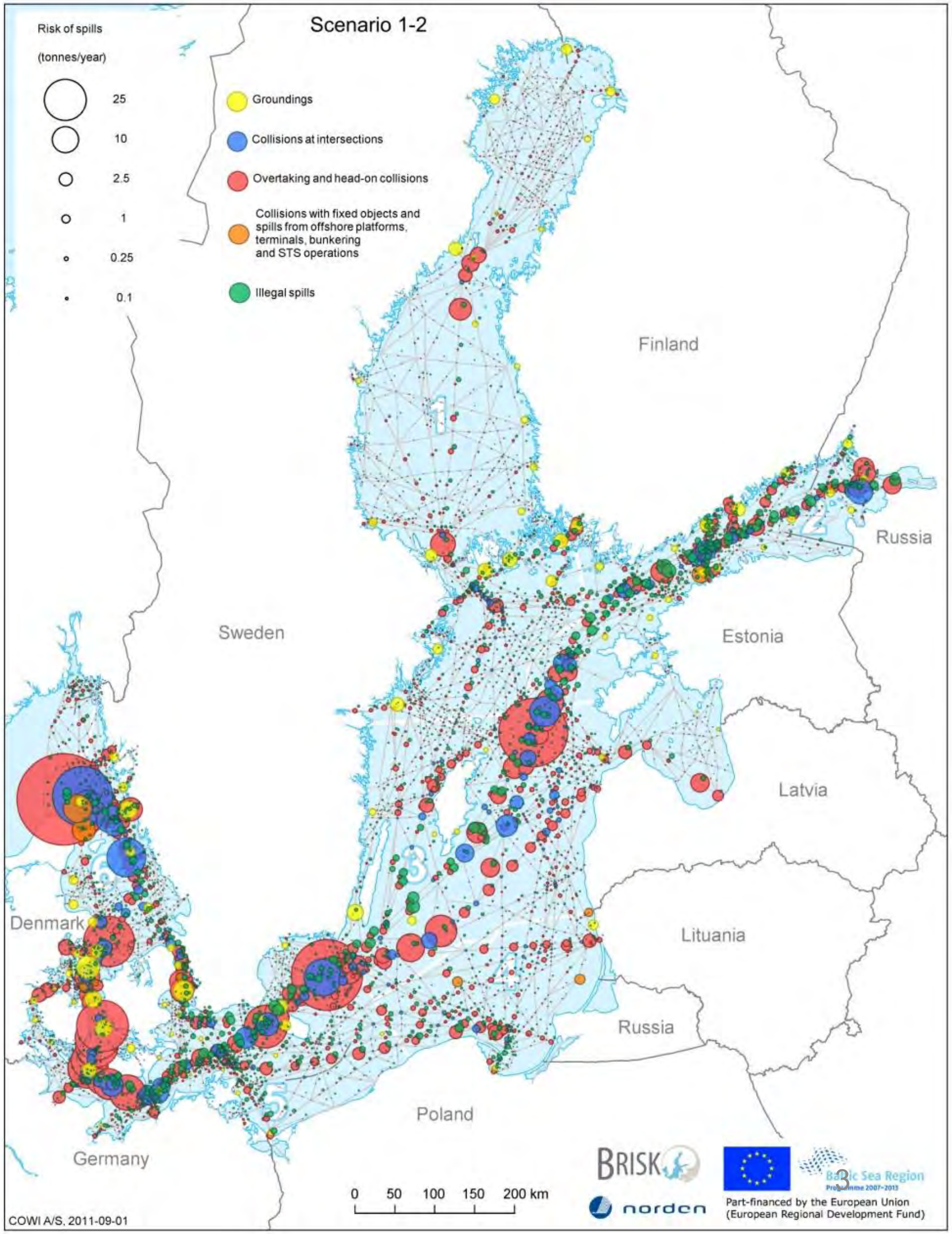
Scenario Results

All spills

- **Existing Ship Traffic**
- **Existing Response Capacities**
- **Existing Navigational Aid**

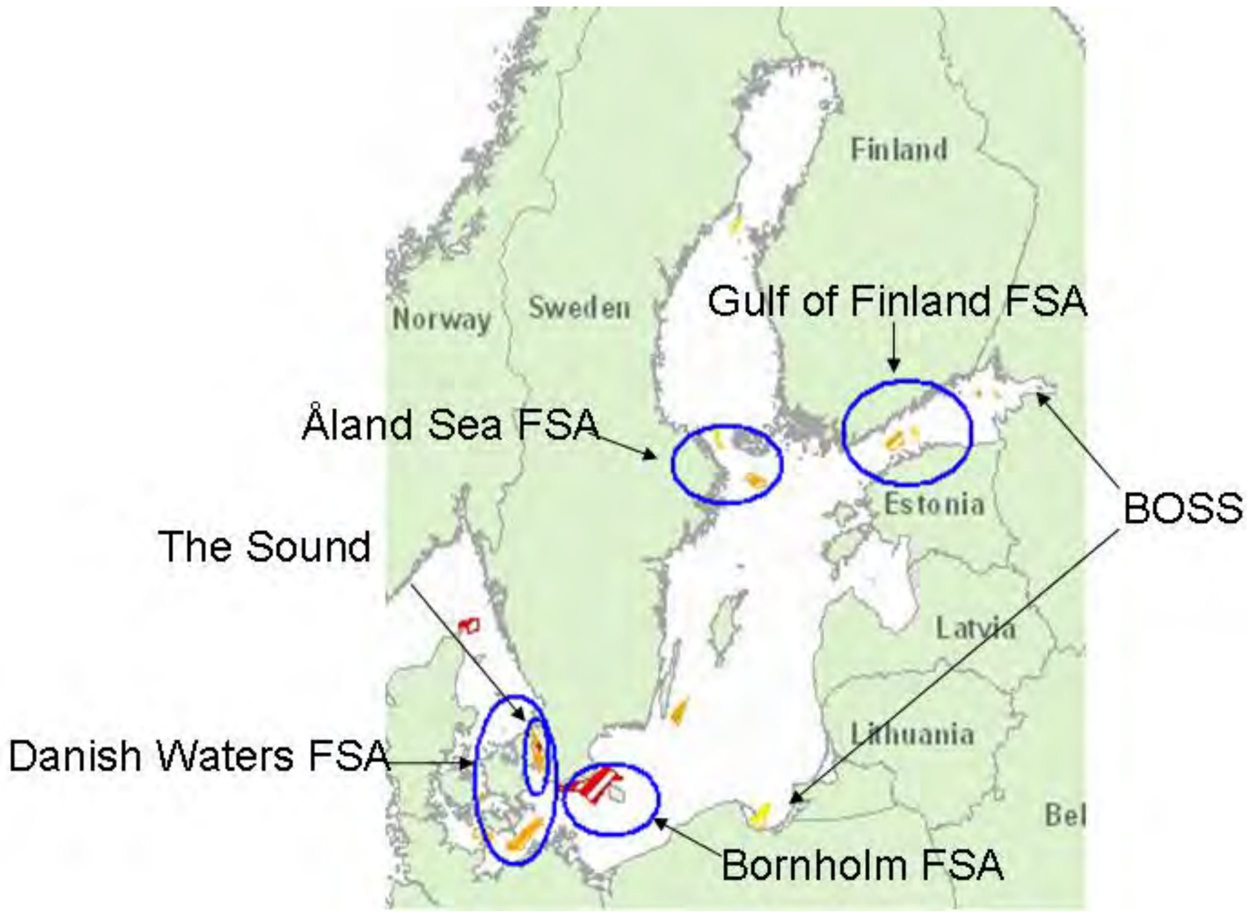
ESTIMATES OF EXPECTED INTERVALS BETWEEN SPILL EVENTS

Sub-region	*Large accidents: 300–5.000 tonnes spilt*	*Exceptional accidents: 5.000< tonnes spilt*
1. Gulf of Bothnia	36 years	600 years
2. Gulf of Finland	39 years	255 years
3. Northern part of the Baltic Proper	30 years	175 years
4. South-eastern Baltic Proper	140 years	1,060 years
5. South-western Baltic Proper	17 years	97 years
6. Sound and Kattegat	11 years	65 years
Entire Baltic Sea	4 years	26 years



FSA-related risk assessments made in the Baltic Sea area

Gulf of Finland Co-operation

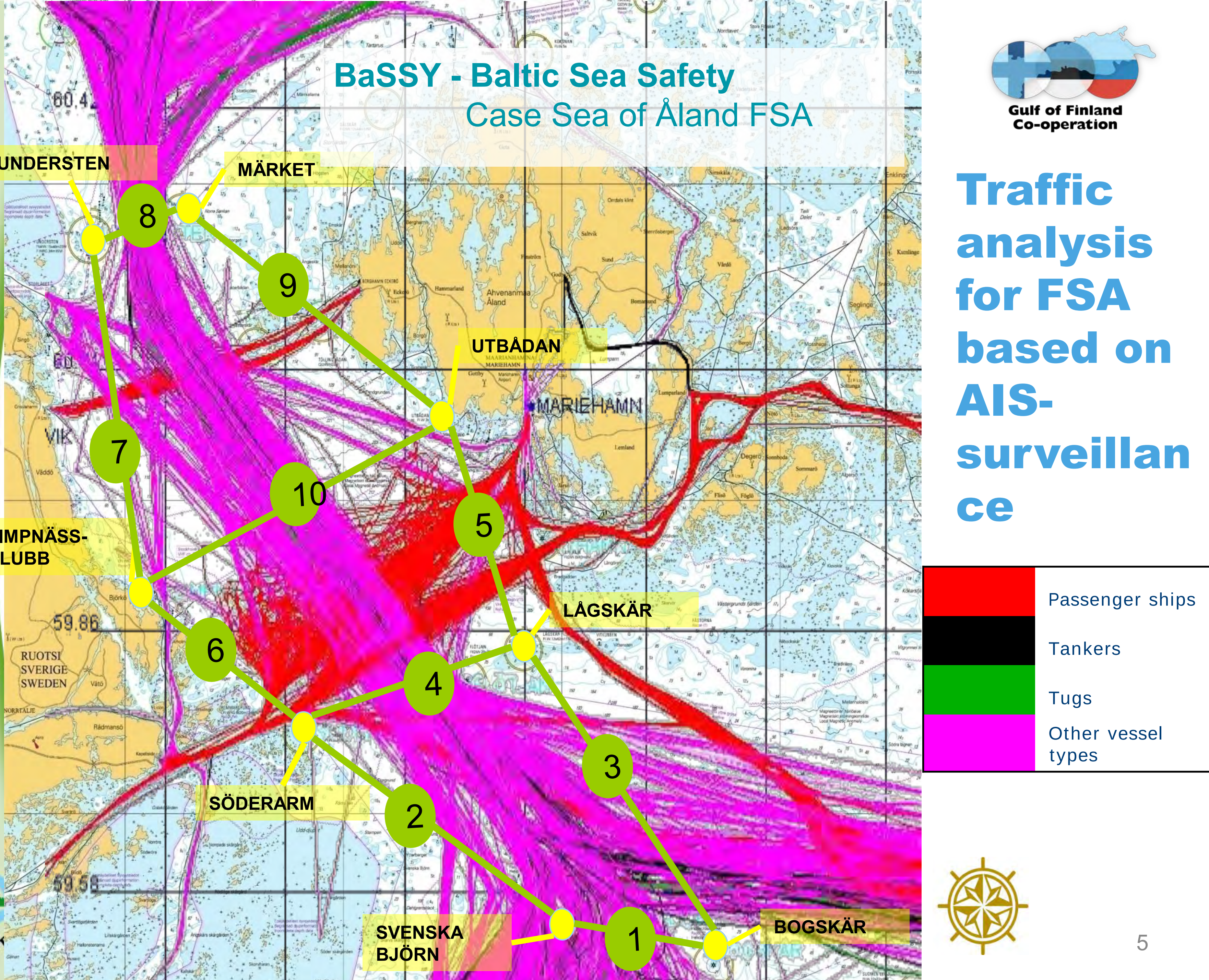


SYKE

BaSSY - Baltic Sea Safety
Case Sea of Åland FSA

Gulf of Finland Co-operation

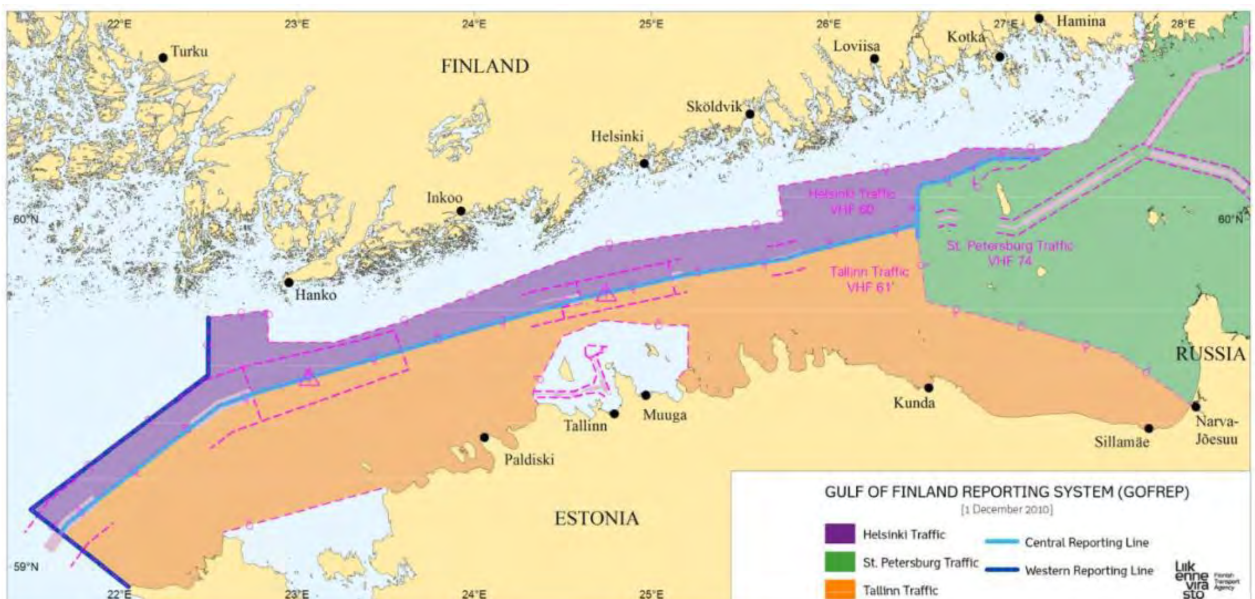
Traffic analysis for FSA based on AIS-surveillance



SYKE

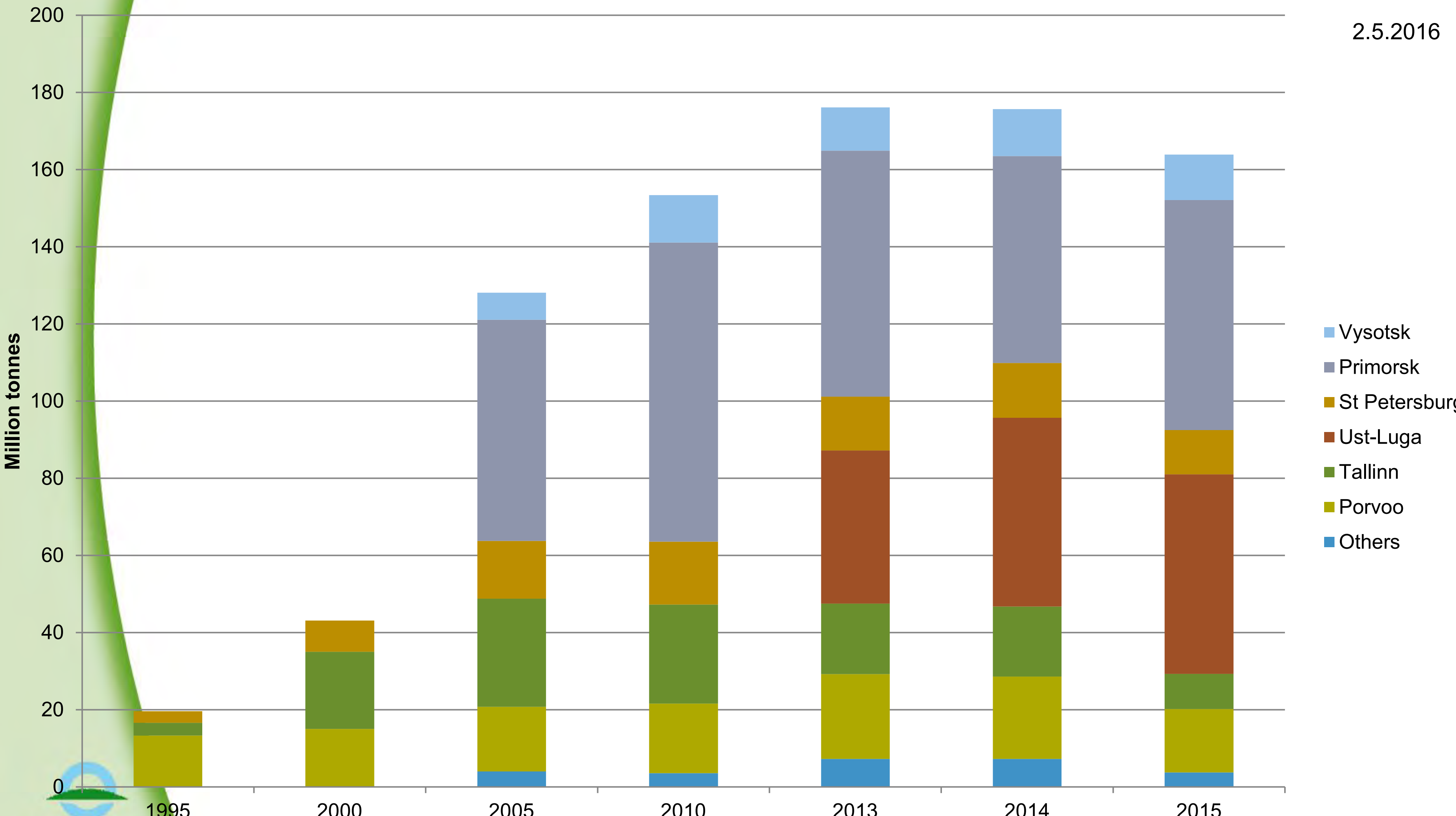
Case: GofRep Service - General Definitions

- The Gulf of Finland Mandatory Ship Reporting System
  - • Adopted in accordance with SOLAS V/11.
- ● The Gulf of Finland is monitored jointly by Finland, Estonia and the Russian Federation.
- ● Vessels of 300 GT and over are required to participate in the ship reporting system.
- ● The Traffic Centres monitor vessels by radar and AIS, and provide 24 h information service.



OIL TRANSPORTATION IN THE GULF OF FINLAND 1995-2015

2.5.2016



Others = Inkoo + Helsinki + KotkaHamina + Sillamäki + Vene-Balti
Estimated capacity in year 2015 is 235 million tonnes

GOFREP analyses based on traffic 2008 / VTT Report-R-06593-09

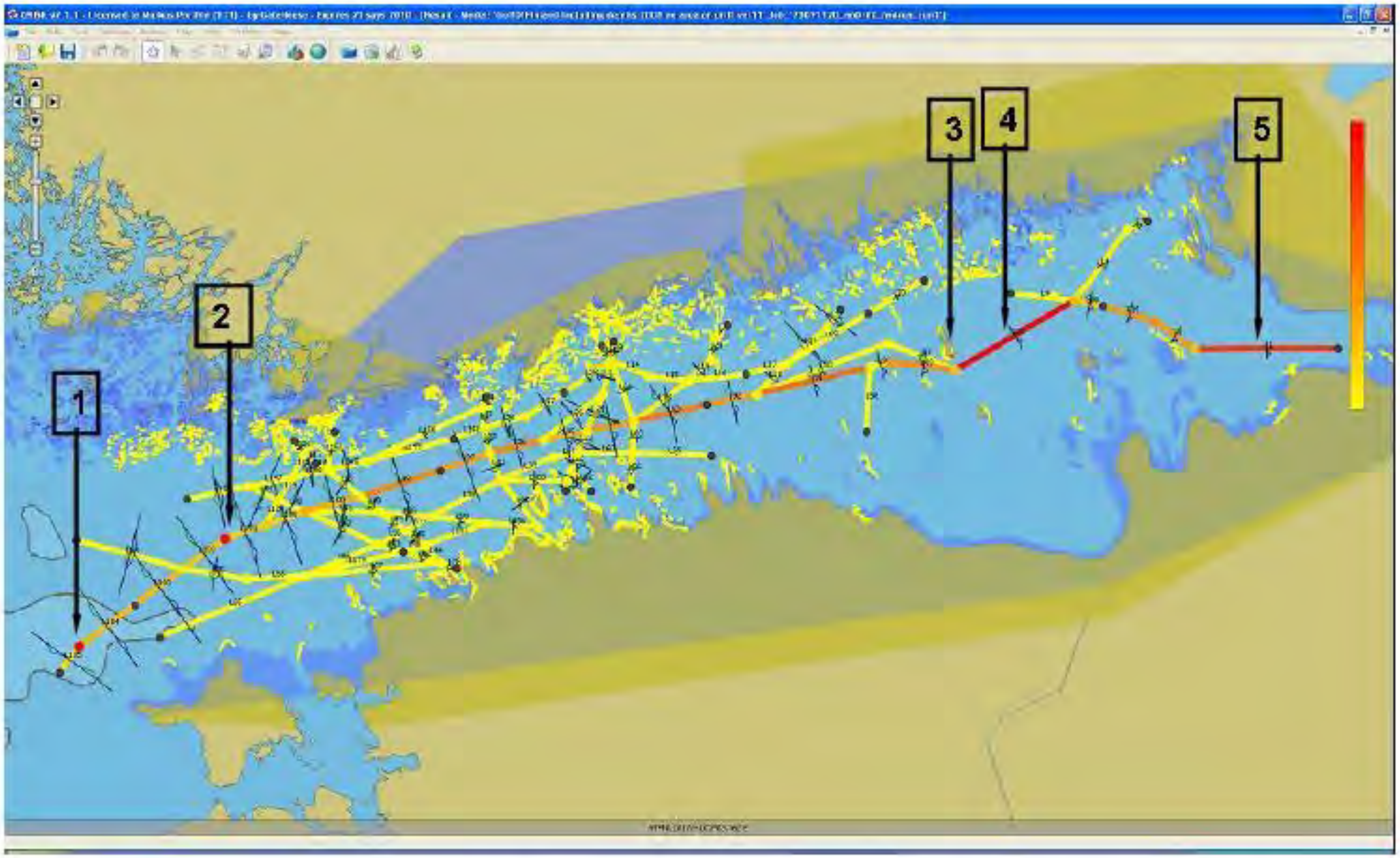


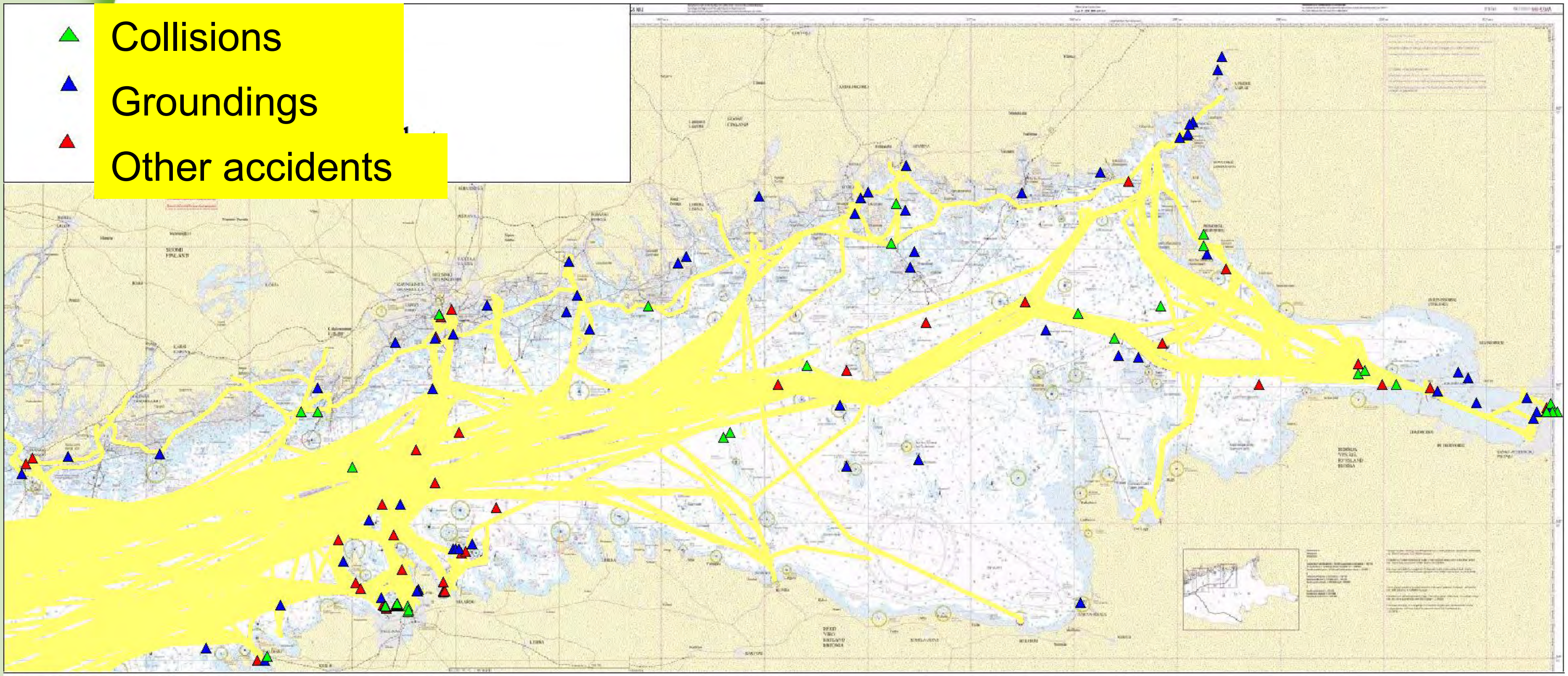
Figure 14 Results of collision and grounding frequency analysis. The legs, waypoints and shoreline areas with the highest accident frequencies are shown in red. Positions 1 and 2 are waypoints with a high frequency of bending collisions, position 3 denotes a high frequency of powered groundings, and positions 4 and 5 denote legs with a high frequency of overtaking collisions.

SYKE

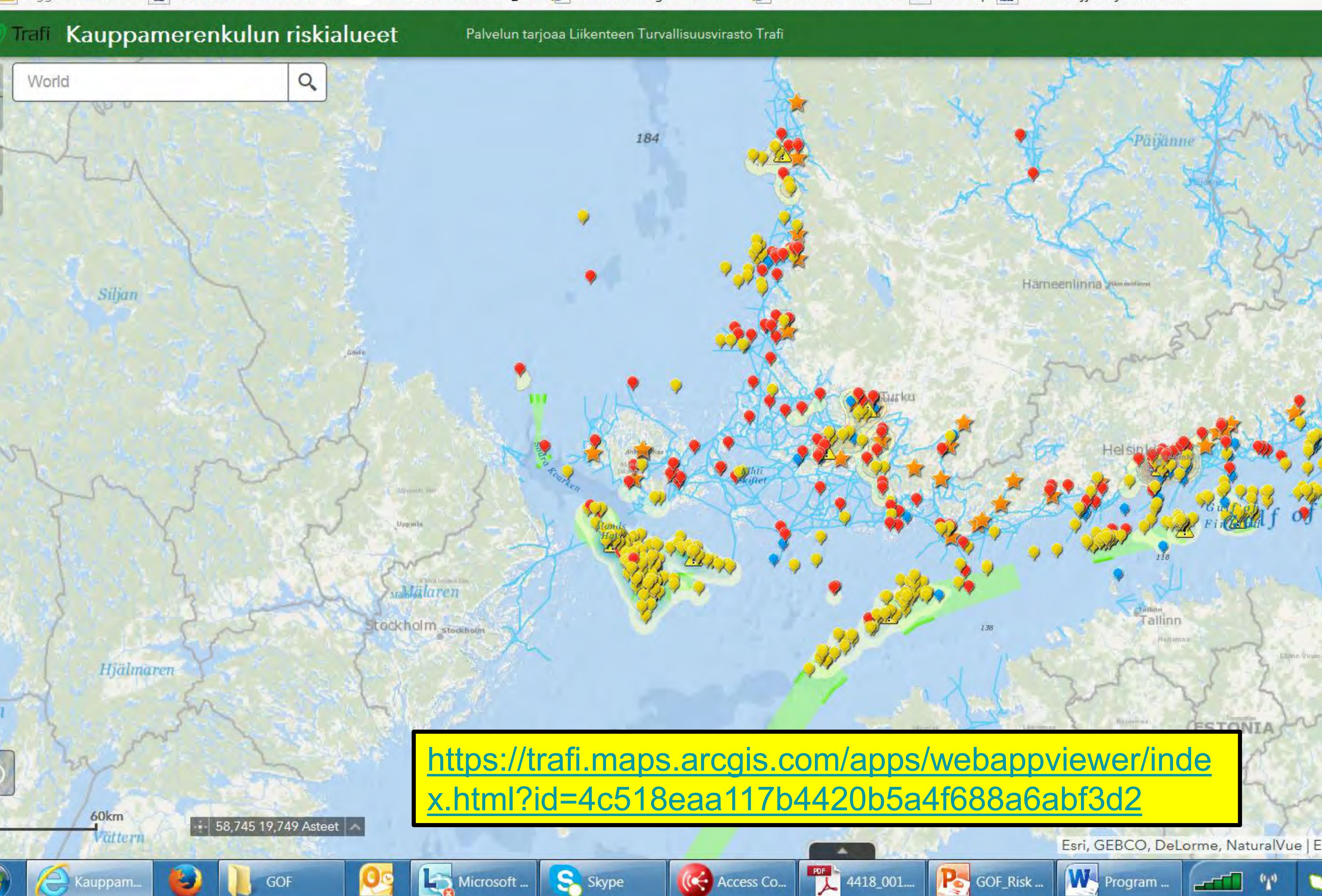
13.12.2016

Accident sites in GoF

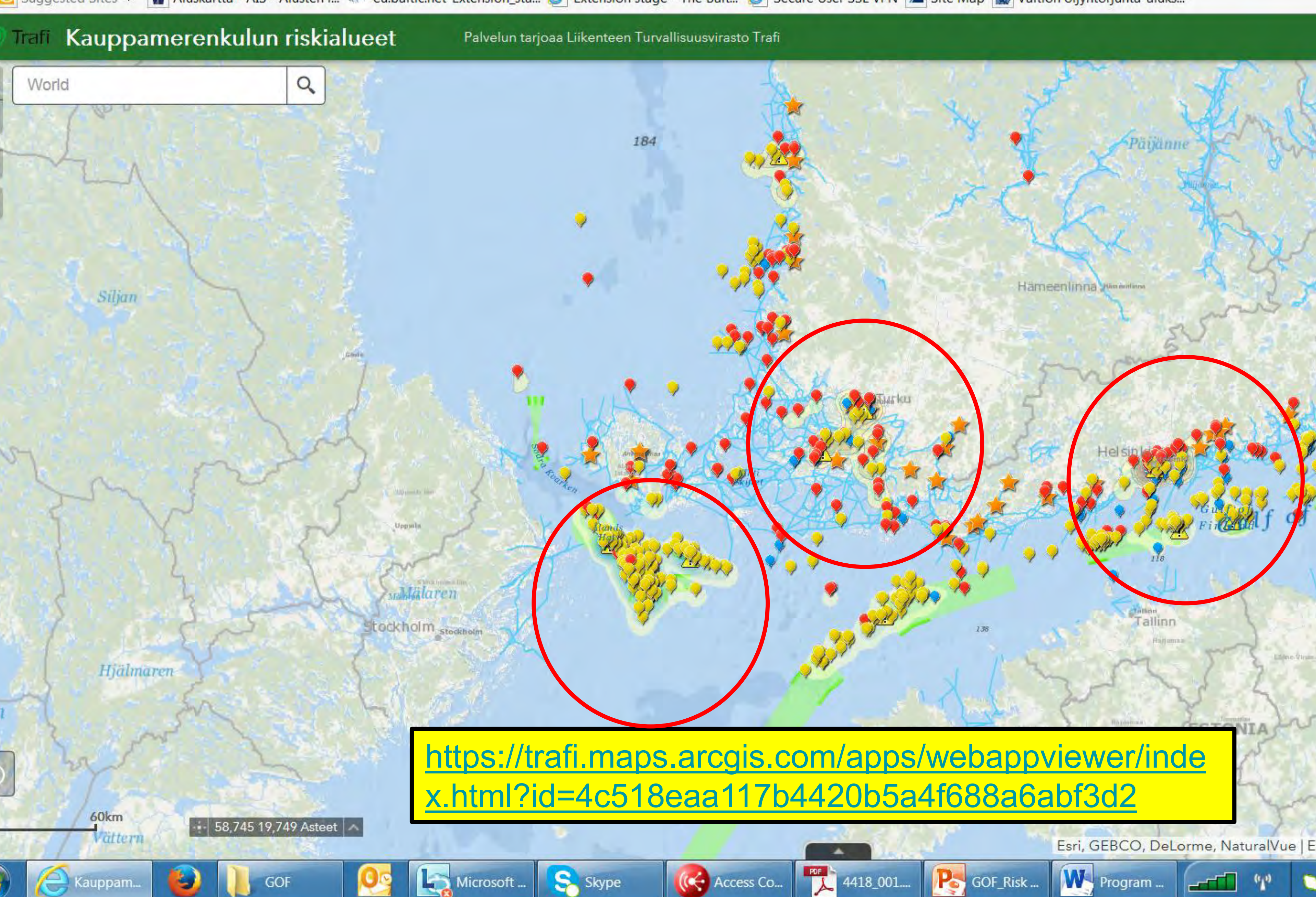
Gulf of Finland Co-operation



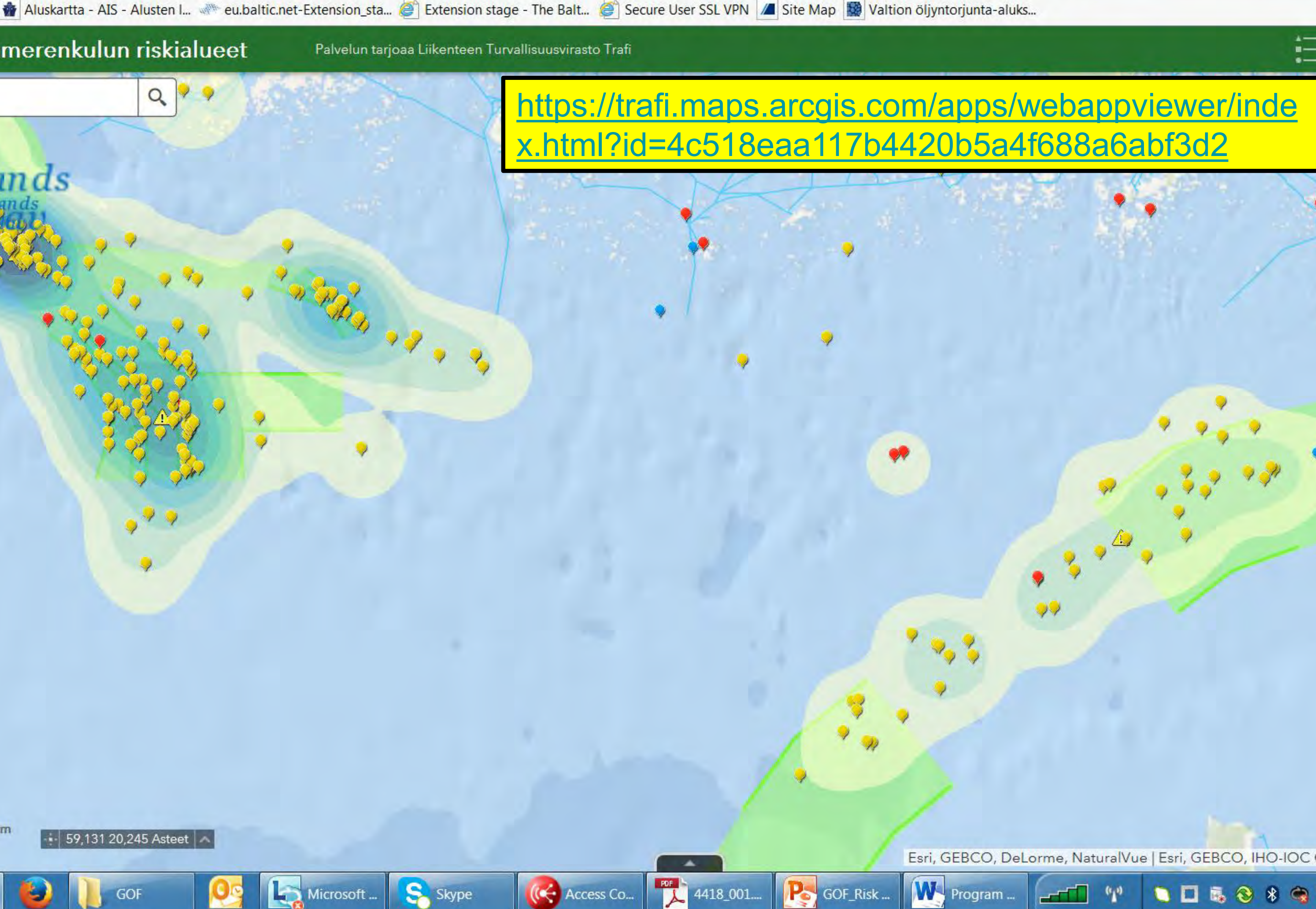
Lähde: Kujala P, Hänninen M, Arola T, Ylitalo J. 2009. Analysis of the marine traffic safety in the Gulf of Finland. Reliability Engineering and System Safety 94(8): 1349-1357.



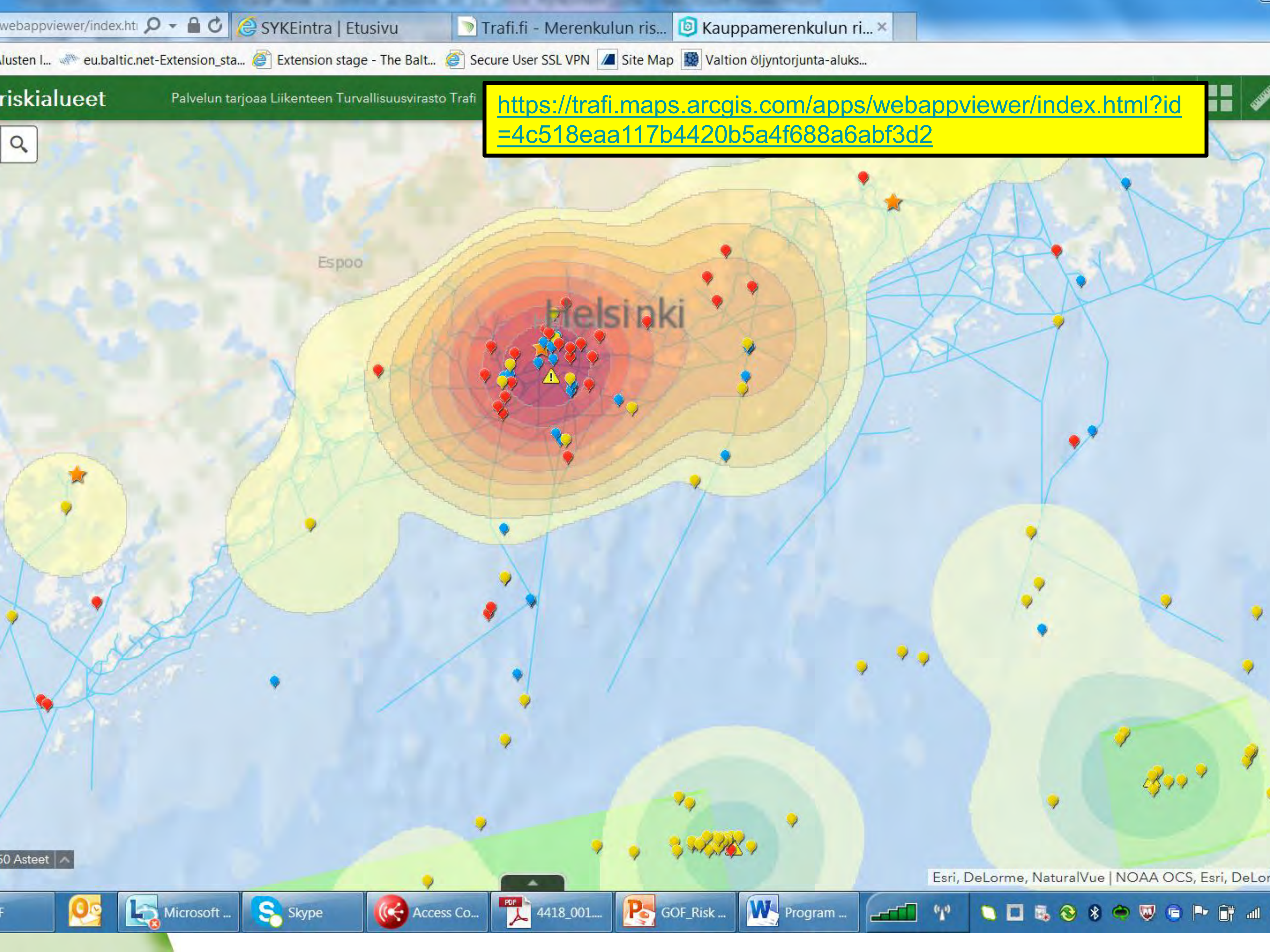
https://trafi.maps.arcgis.com/apps/webappviewer/index.html?id=4c518eaa117b4420b5a4f688a6abf3d2



https://trafi.maps.arcgis.com/apps/webappviewer/index.html?id=4c518eaa117b4420b5a4f688a6abf3d2



https://trafi.maps.arcgis.com/apps/webappviewer/index.html?id=4c518eaa117b4420b5a4f688a6abf3d2


webappviewer/index.htm
SYKEintra | Etusivu
Trafi.fi - Merenkulun ris...
Kauppamerenkulun ri...
eu.baltic.net-Extension_sta...
Extension stage - The Balt...
Secure User SSL VPN
Site Map
Valtion öljyntorjunta-aluks...
riskialueet
Palvelun tarjoaa Liikenteen Turvallisuusvirasto Trafi
https://trafi.maps.arcgis.com/apps/webappviewer/index.html?id=4c518eaa117b4420b5a4f688a6abf3d2
Espoo
Helsinki
50 Asteet
Esri, DeLorme, NaturalVue | NOAA OCS, Esri, DeLor
Microsoft ...
Skype
Access Co...
4418_001...
GOF_Risk ...
Program ...

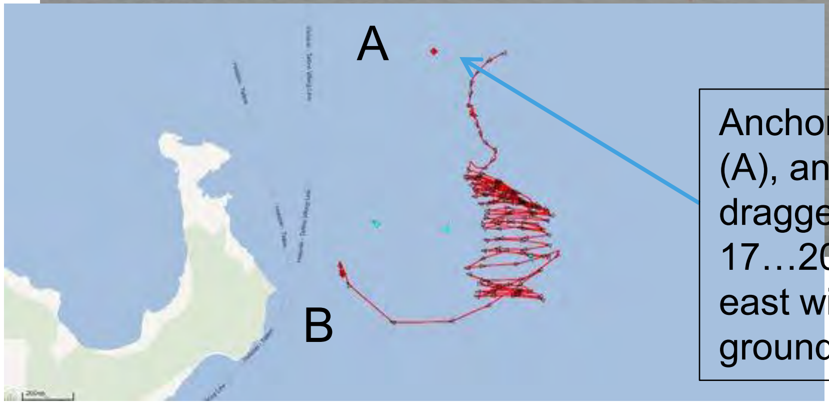
MT Propontis accident 2/2007

Gulf of Finland Co-operation

Karttakeskus JJ HS

SYKE

Largest Oil Combating Exercise BALEX DELTA in August 2012 – MT Kyeema Spirit grounding, Monday 8 October at 6.55am close to Muuga Port, Estonia



Anchor was failed (A), and ship was dragged by the 17…20 m/s north-east wind and grounded (B)

SYKE

November 7, 2012 – Maersk Hakone arrived to Muuga Port – 330 x 60 m VLCC carrier – was idling a couple of days due to the hard wind – 12th November in port - loading (??)

Jorma Rytkönen / SYKE

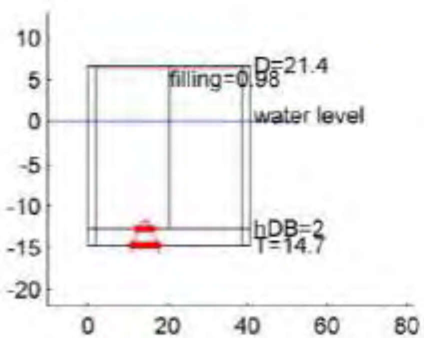
SYKE

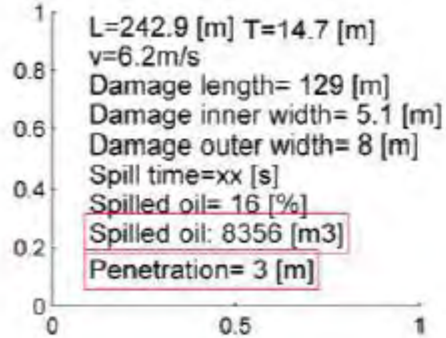
Case MT LOVINA 20.10.2012

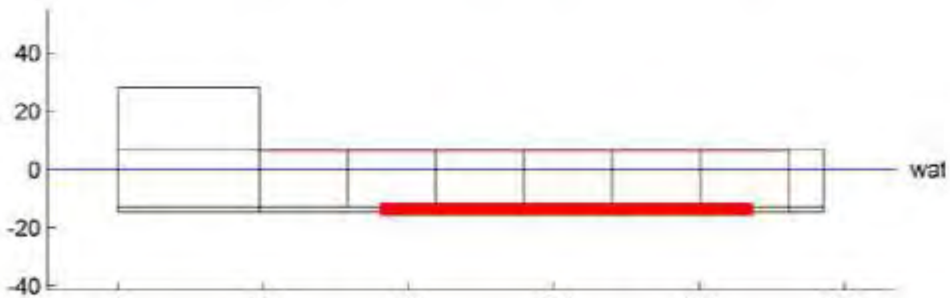
Gulf of Finland Co-operation

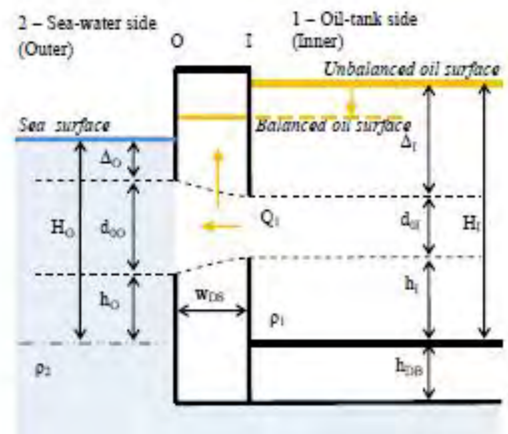
Note: MT Propontis' accident 2/2007 !!

Grounding analysis: M/T Lovina example





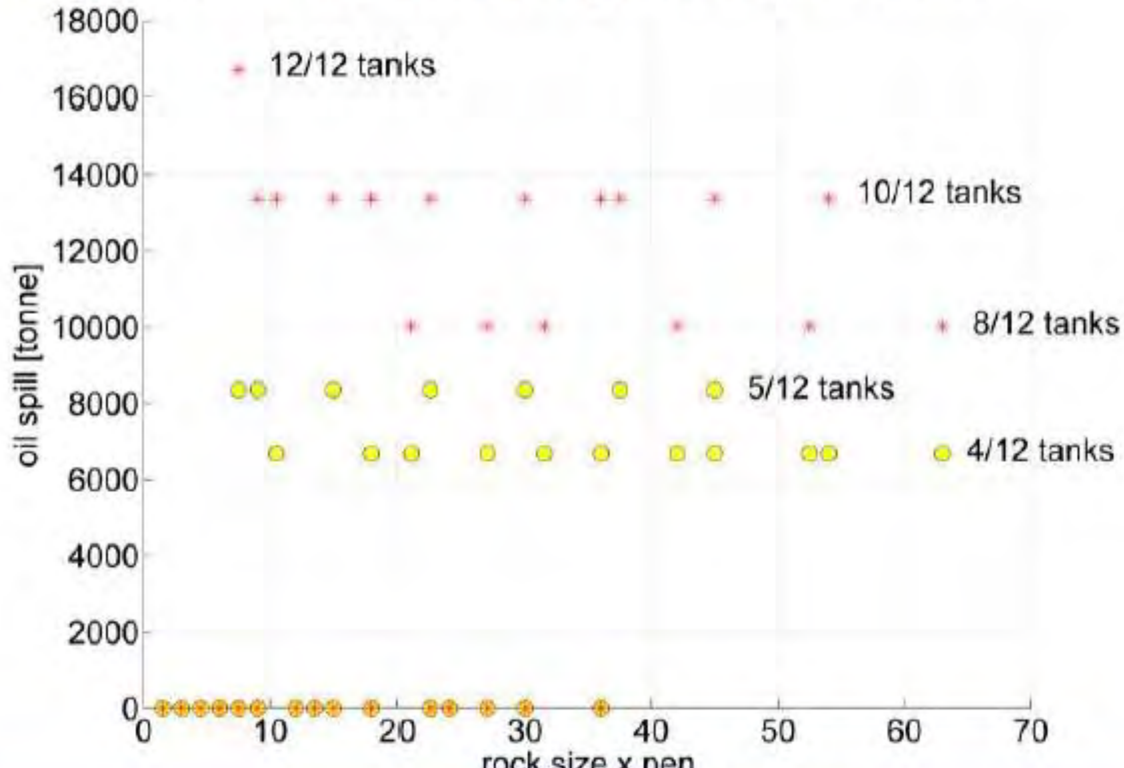




K. Tabri, M. Heinvee, J. Laanearu, M. Sergejeva, H. Naar, E.H. Kerge

Grounding analysis: M/T Lovina example

- Oil spill occured in 36/84 simulated grounding scenarios

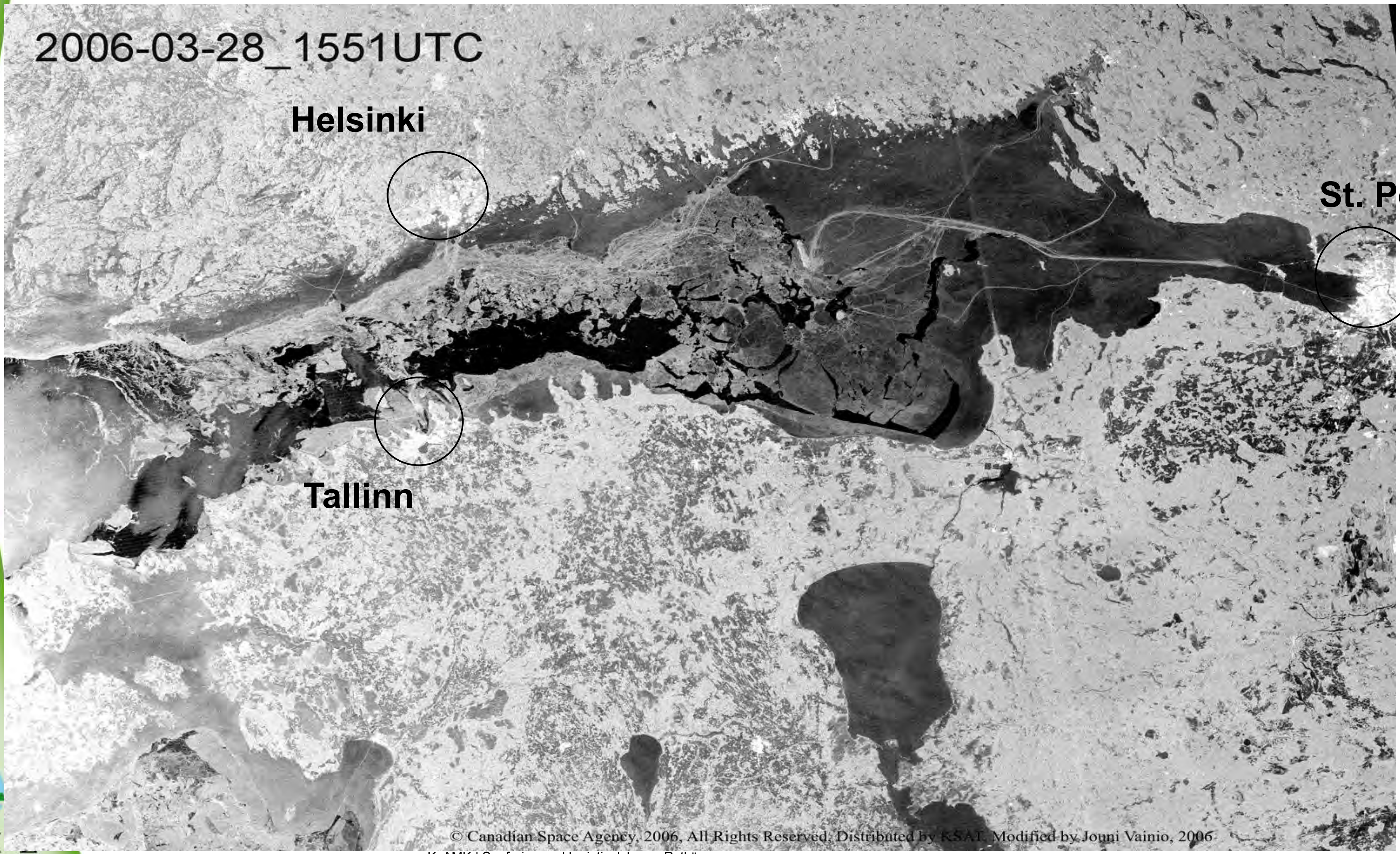


K. Tabri, M. Heinvee, J. Laanearu, M. Sergejeva, H. Naar, E.H. Kerge

S Y K E

Ice conditions in the GoF, based on the satellite image (source: www.Iceadvisors.fi/A. Uusiaho)

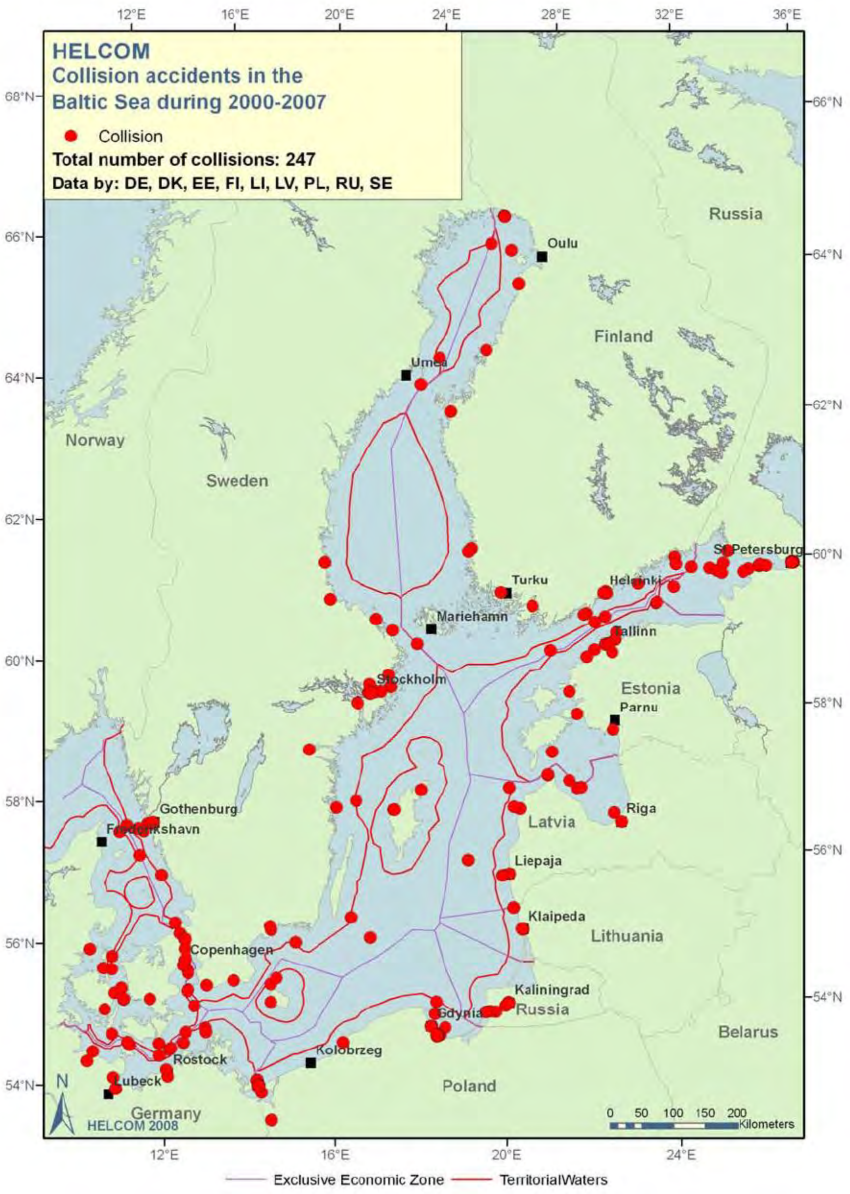
Gulf of Finland Co-operation

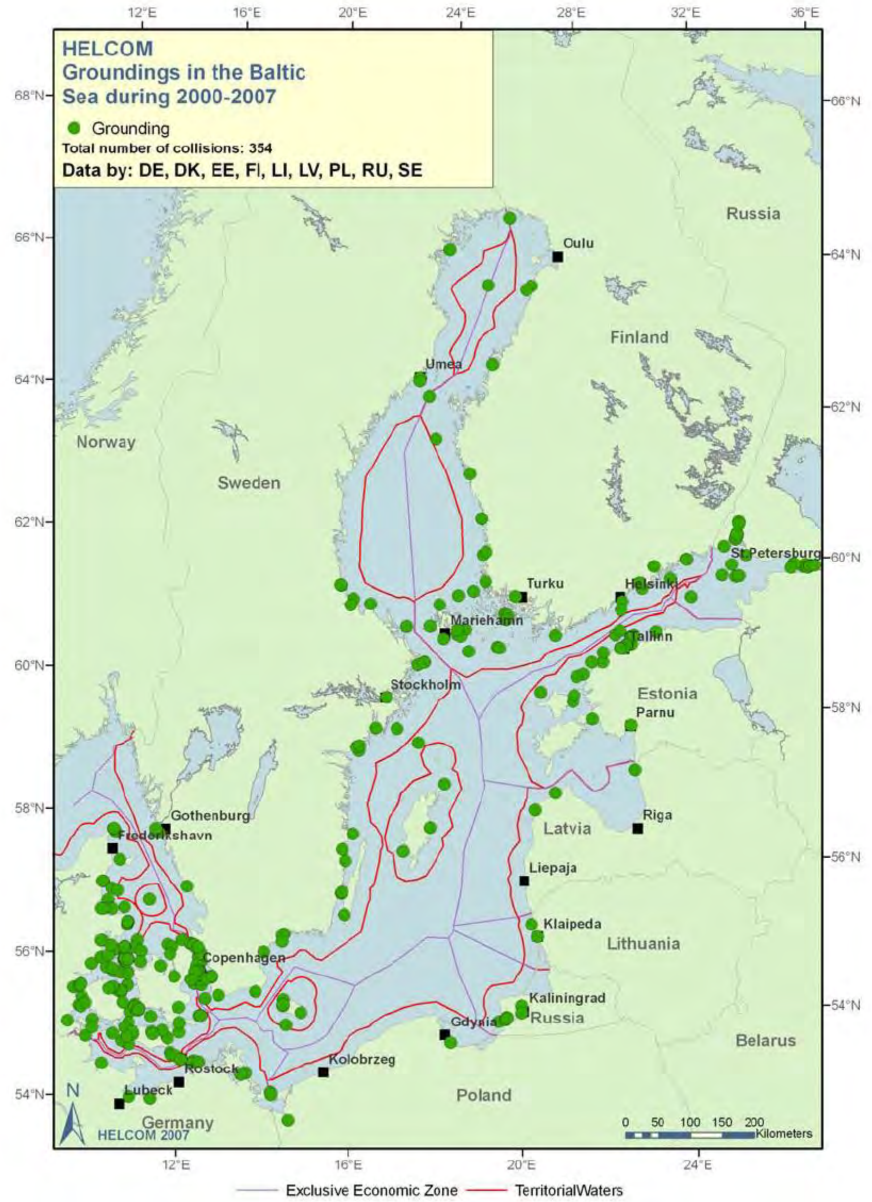


Recent Risk Control Options (RCO's)

- R&D activities (Risk evaluations) in the GoF
- Kotka Maritime Research Centre's Network (SAFGOF, OILRISK, MIMIC, CHEMBALTIC, WINOIL, CAFE,
- Living Net Work of top scienstists: Aps, Helle, Kuikka, Hänninen, Tabri, Goerlandt, Montewka, Kujala, Lehikoinen, Sormunen, Brunila, Mazaheri, Valdez Banda, Venesjärvi, Goncharov, Aysinov, Kouts, Semanov, etc….
- HELCOM Accident data collection
- EGDIS, VTS, GOFREP, AIS, AtoNs, DGPS, Routeing, Pilotage, ………..
- IALA, IMO
- Icebreaking assistance
- TRAFI Maritime Risk Indicators - TRIAGE

Collisions (left) and groundings (right) 2000 – 2007, by HELCOM





Risk Indicators & TRIAGE

- Three categories:
- Level 1: Very Serious Accidents with severe consequences such as human loss, large environmental pollution, total loss
- Level 2: Serious Accidents with economical losses usually
- Level 3: Near Miss, anomalies, VTS reports, inspections reports,

- Vessel TRIAGE is a method for assessing and communicating the safety status of vessels in maritime distress and accidents.
- The method expresses the safety status of the vessel in terms of a Vessel TRIAGE category. There are four categories: GREEN, YELLOW, RED and BLACK. The safety status of a vessel is least compromised when its Vessel TRIAGE category is green. Black represents the most unsafe conditions

http://www.raja.fi/vesseltriage

Some new projects

- Old risk analyses for GoF made by VTT for GOFREP justification under ”refreshment”. Report should be ready in Spring/2017
- DG Echo funding received for OPENRISK which aims to
  - Create a pan-european synthesis (“lessons learned”) of recent regional risk assessment projects within HELCOM, REMPEC, BONN, Copenhagen Agreement and other regional response organisations active in the EU
  - Develop transparent open access tools for high frequency, dynamic risk assessment for spatial component (locating risk areas)
  - Develop Best Practices for identifying best options for accident risk reduction in a given area
  - Develop Best Practices for implications for prevention, preparedness and response
  - Testing above tools of global/EU-wide applicability in a Baltic Sea case study.
- https://portal.helcom.fi/meetings/SAFE%20NAV%207-2016-301/MeetingDocuments/3-2%20OPENRISK%20Project%20Short%20Description.pdf

More Information: jorma.rytkonen@ymparisto.fi

Swedish and Finnish vessels outside of the Swedish coastline in a joint exercise, September 2016. Photo: J. Rytkönen

SYKE

Gulf of Finland
Trilateral Scientific Forum
30th November–1st December, 2016
Finnish Environment Institute SYKE

1st Day

Gulf of Finland
Co-operation

Robert Aps, Mihhail Fetissov, Ville Karvinen, Kirsi Kostamo, Jonne Kotta, Juho Lappalainen, Külli Lokko, Riku Varjopuro

Towards environmental safety of maritime spatial planning for sustainable blue economies

TARTU ÜLIKOOL 1632 UNIVERSITAS TARTUENSIS

PLAN4BLUE

Interreg Central Baltic

European Union

European Regional Development Fund

Gulf of Finland Trilateral Science Forum 2016

30 November – 1 December 2016 Helsinki Finland

Towards environmental safety of Maritime Spatial Planning for Sustainable Blue Economies

Robert Aps[a], Mihhail Fetissov[a,b], Ville Karvinen[c], Kirsi Kostamo[c], Jonne Kotta[a], Juho Lappalainen[c], Külli Lokko[a], Riku Varjopuro[c]

[a] University of Tartu, Estonian Marine Institute, Maealuse 14, 12618 Tallinn, Estonia

[b] Tallinn University of Technology, Estonian Maritime Academy, Kopli 101, 11712 Tallinn, Estonia

[c] Finnish Environment Institute, Mechelininkatu 34a, FI-00251 Helsinki, Finland

KIK

ENVIRONMENTAL INVESTMENT CENTRE

Outline

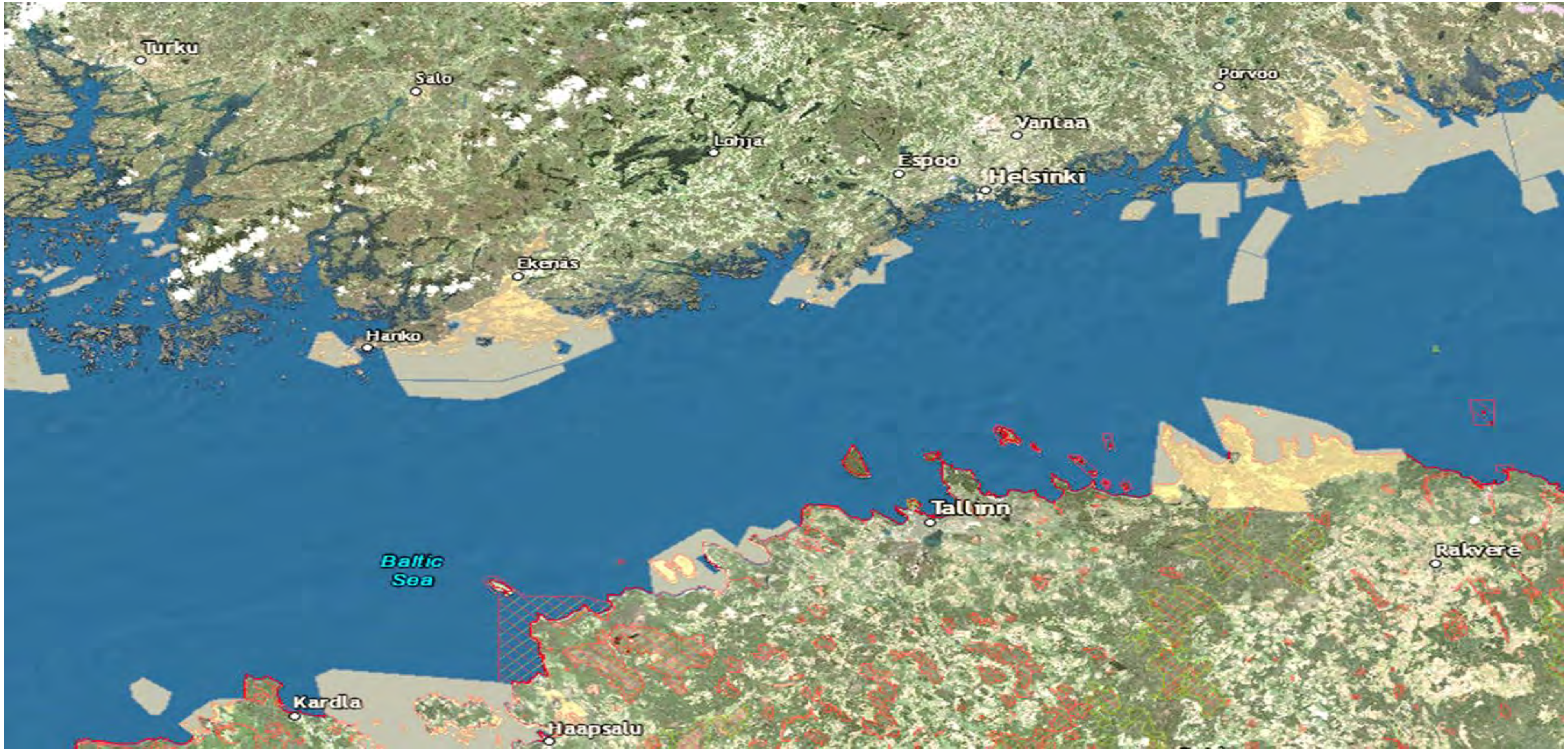
- Objective
- Ecosystem risk management
- Risk identification
- Risk analysis
- Risk evaluation
- Risk treatment

The Baltic Sea

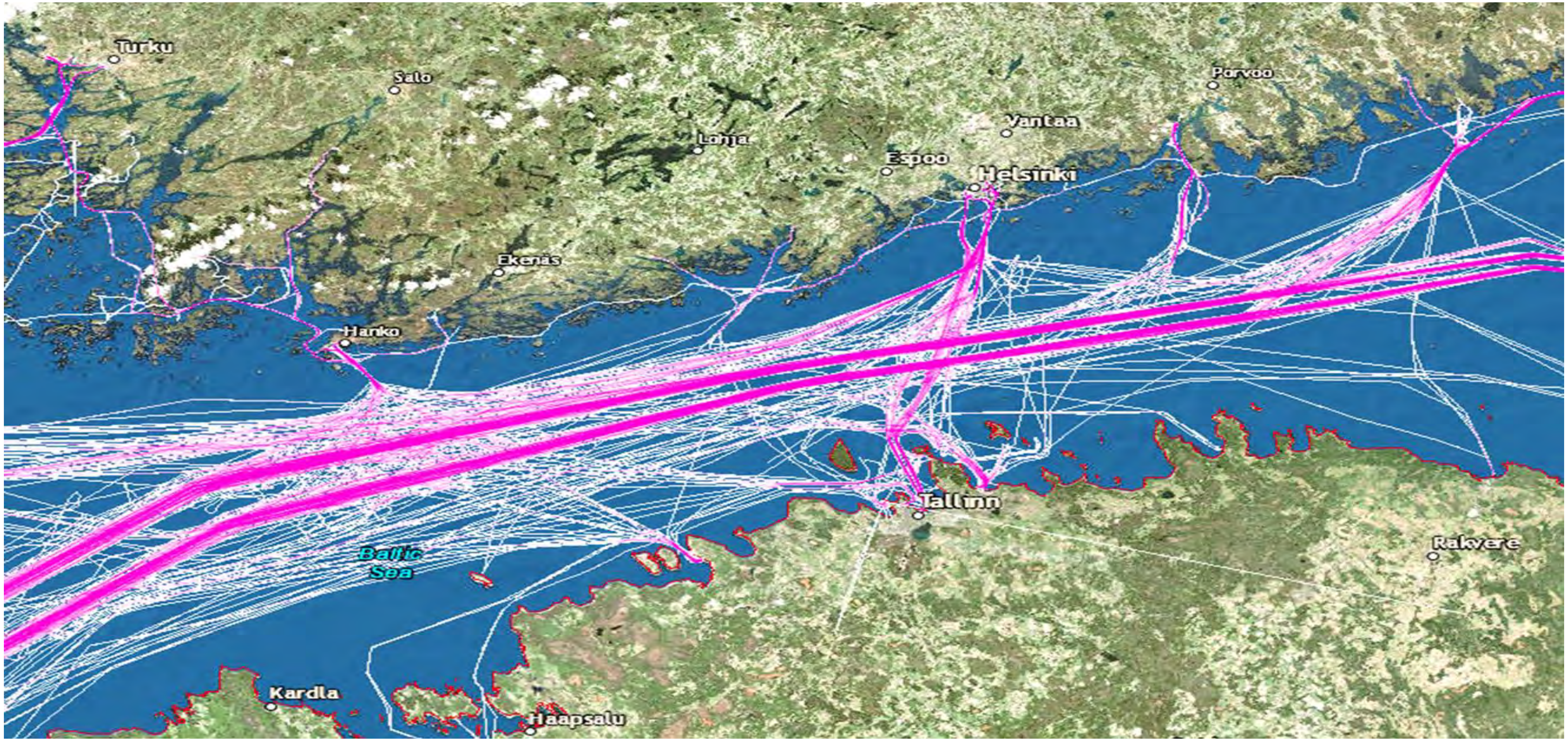
Objective

Integrate, referring to ecosystem-based MSP approach, the environmental risks assessment and management into the MSP process by continuously identifying, analysing, and evaluating environmental factors to determine if environmental risk management options are meeting pre-set ecosystem management risk criteria

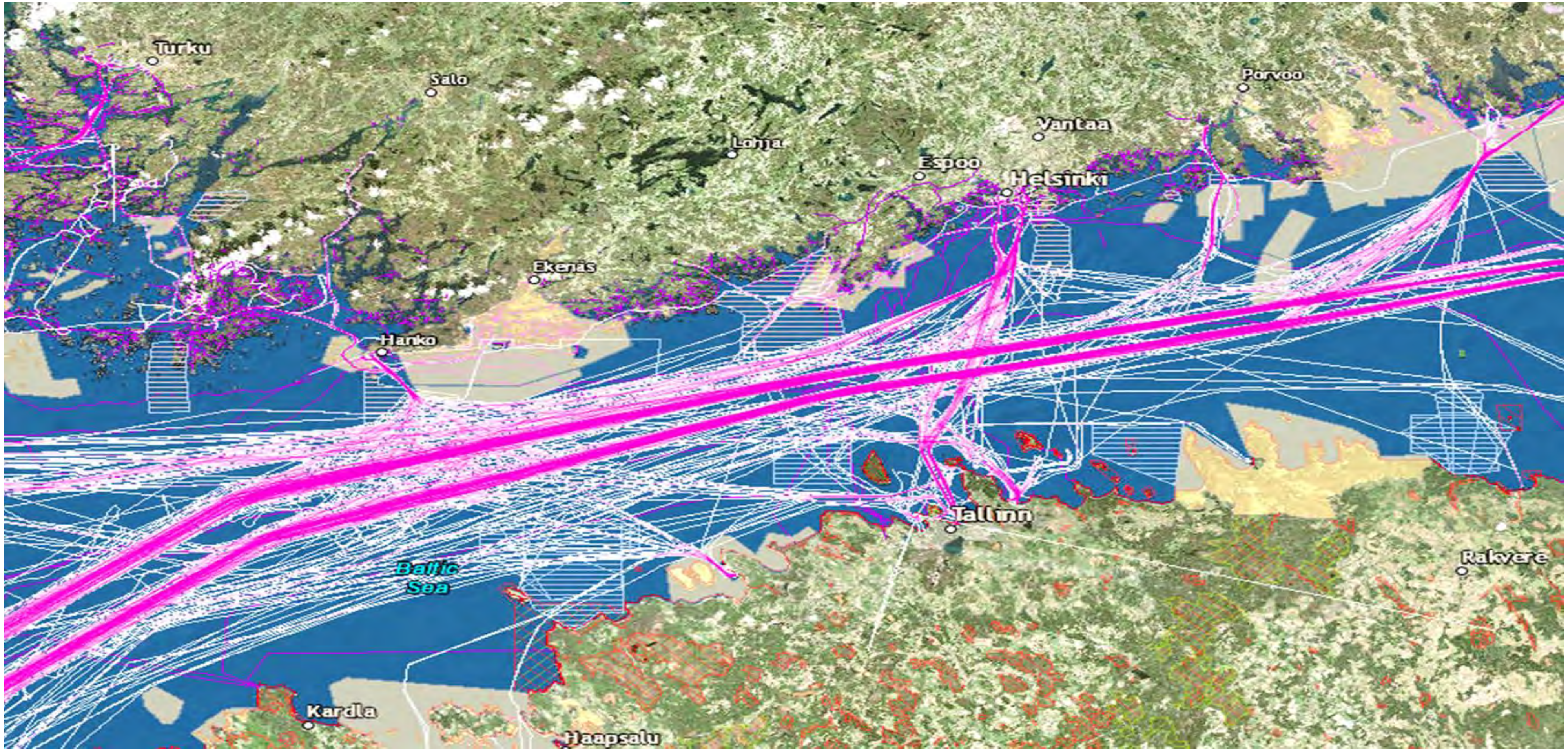
Sensitive environment



Heavy maritime traffic

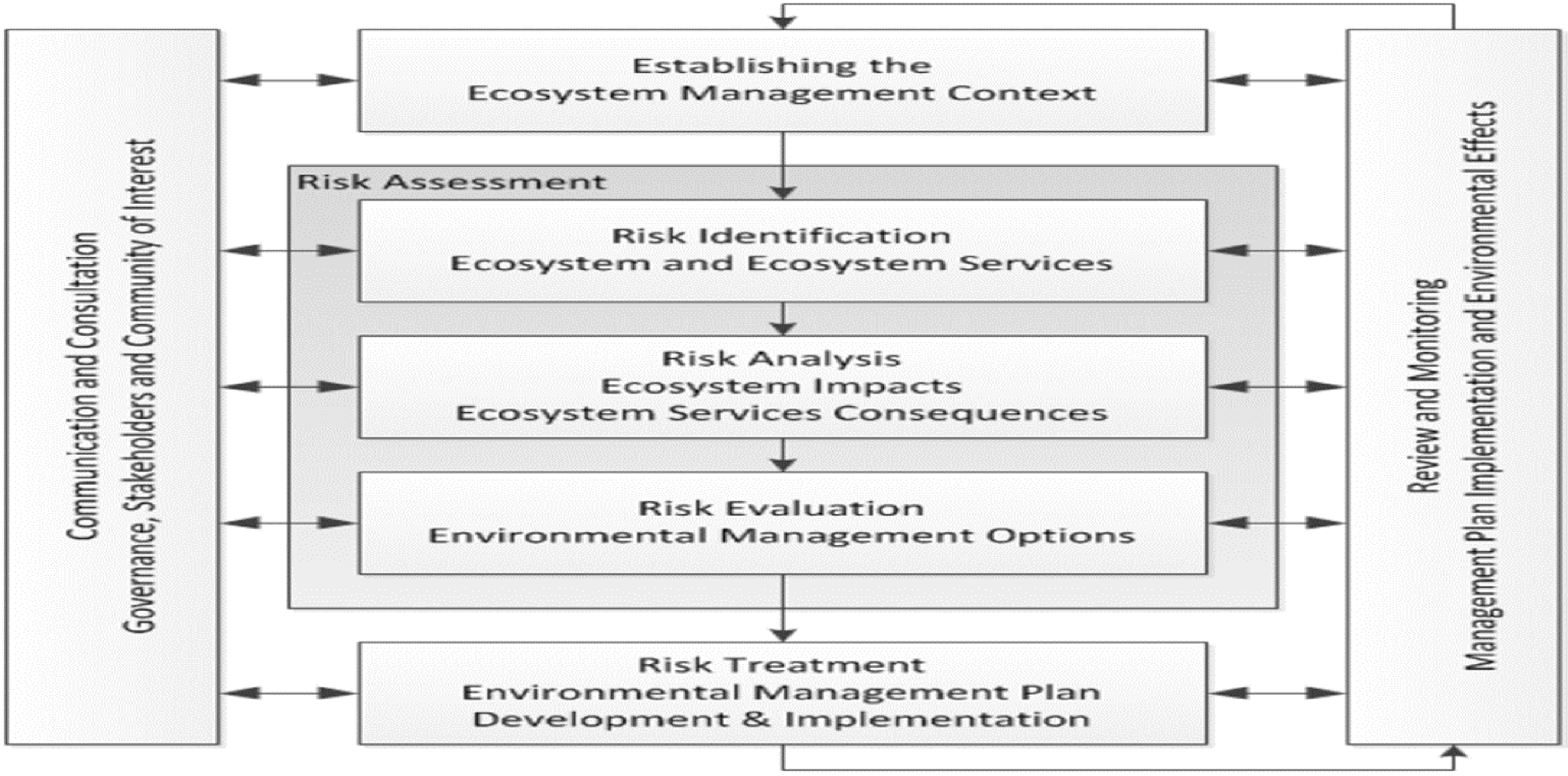


Multi-use of marine space



Ecosystem risk management for achieving ecosystem and socio-economic objectives within a maritime spatial planning management context

Ecosystem risk management approach adapted from ISO 31000:2009 risk management standard (ICES, 2014)



Risk identification

Significant ecosystem components: species, habitat features, community properties, ecosystem processes that provide ecological functions within the ecological unit

Ecosystem component susceptibilities (degree to which an organism, habitat, or ecosystem is open to impairment or change in its normal life cycle, functional properties, or processes as a result of inherent or predisposed weaknesses to environmental impacts)

Risk identification

Significant ecosystem services related to social, cultural, and economic benefits derived from the ecosystem, such as recreational area, aesthetics, and spiritual or fishery resources

ecosystem service susceptibilities (degree to which a social, cultural, or economic activity well-being is open to impairment of its normal operation or status owing to inherent or predisposed weaknesses to the loss of a goods or service caused by environmental impacts)

Risk identification

Environmental vulnerability profile **(descriptions of environmental vulnerabilities in light of driver/pressure cause-and-effect pathways to environmental impacts against the risk criteria) of the Gulf of Finland ecological unit is developed using the Bow-tie methodology and in consultation with the governance structure of the management area and the stakeholders as a geospatial and temporal representation of the ecological unit in relation to the intensity of the drivers and load of their respective pressures**

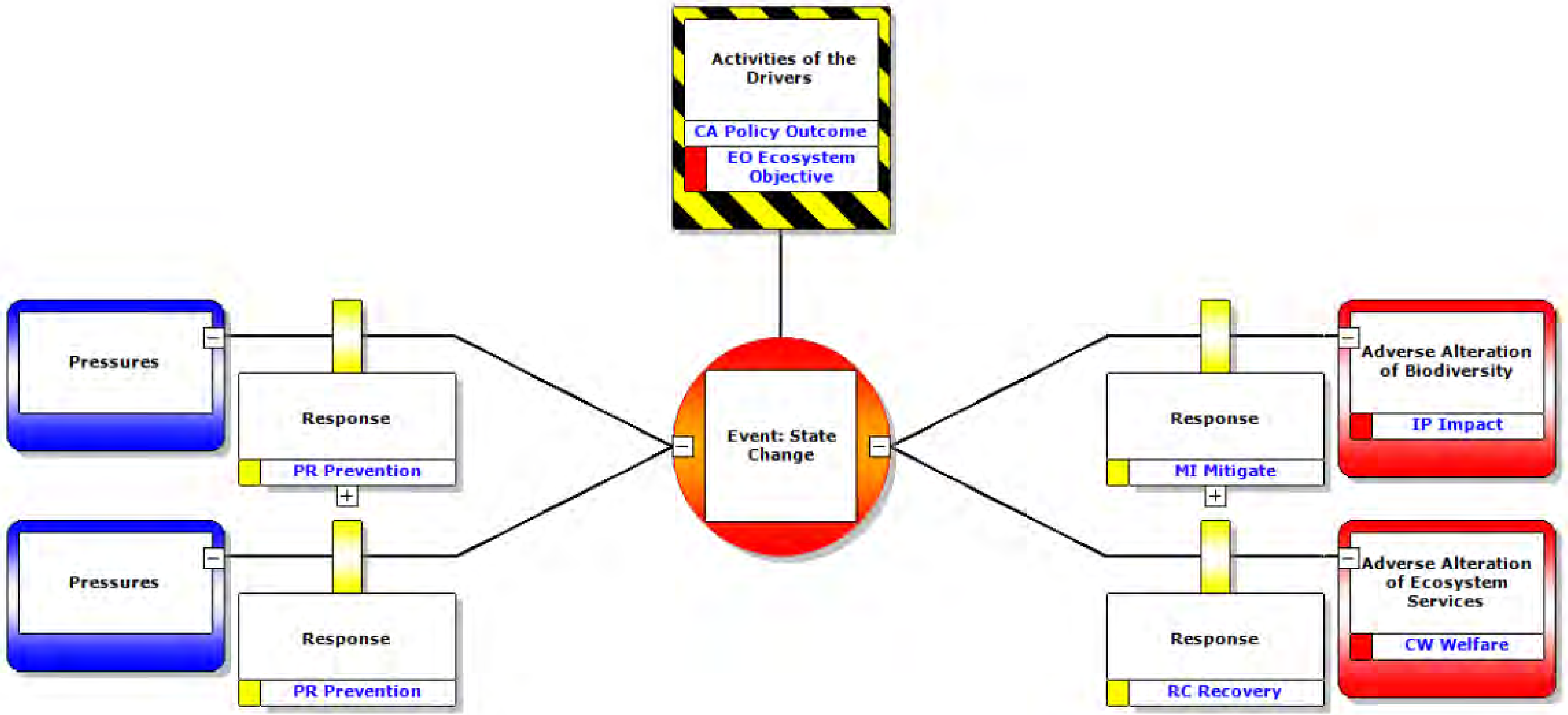
Risk analysis

The environmental risk profile - spatial and temporal areas of highest risk, based on the likelihood and magnitude of environmental impacts, the impacts to the ecosystem and environmental services, as well as the legislative policy repercussions is developed in consultation with the governance structure of the management area and the stakeholders

Risk evaluation

In a process of risk evaluation the risk analysis results are compared with with risk criteria in order to determine whether or not a specified level of risk is acceptable or tolerable

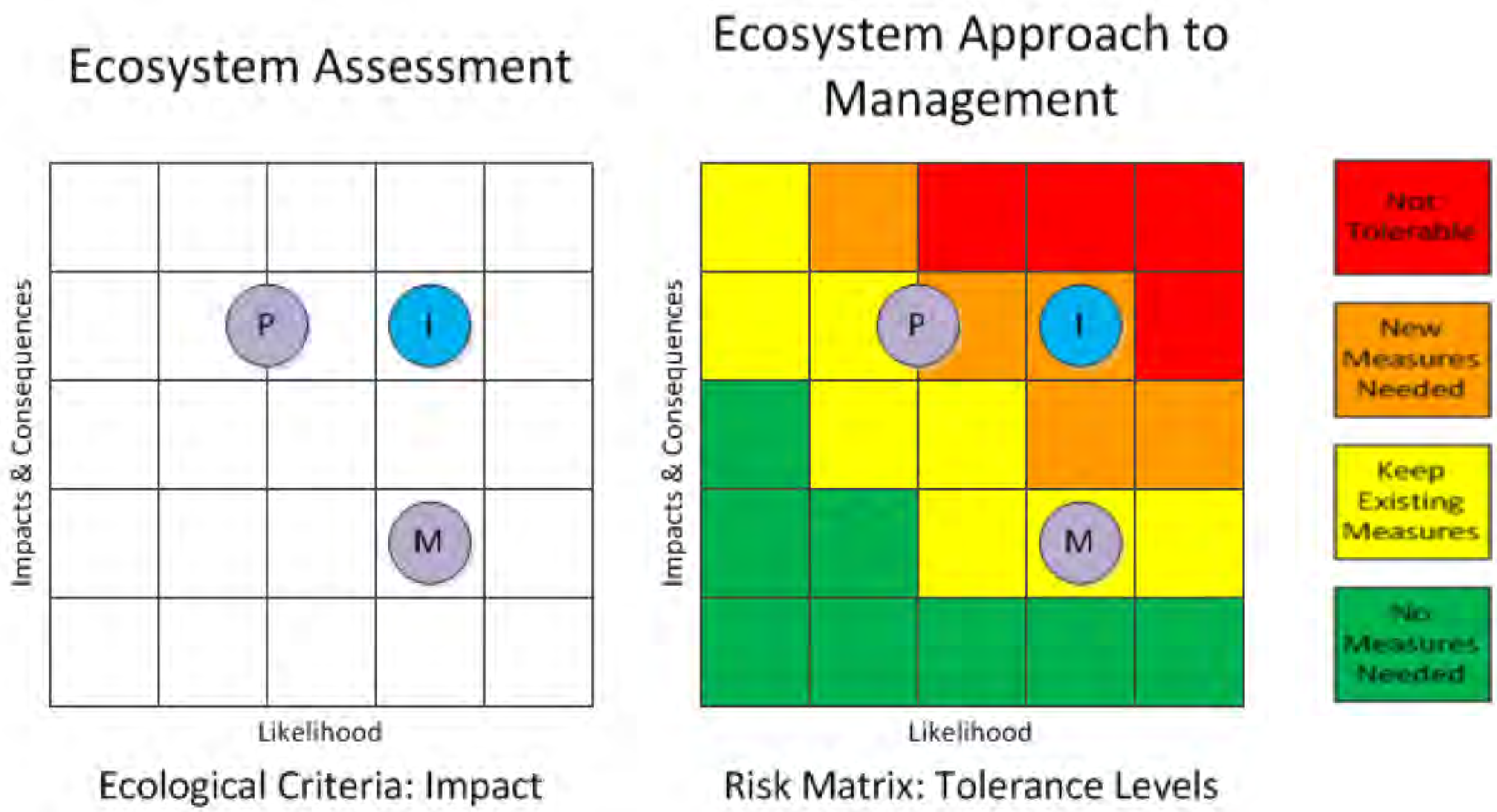
Bow-tie representation of the DPSIR/DPSWR framework (ICES, 2014)



“Given that a scientific assessment is objective and is based on facts, it would simply reflect likelihood and magnitude leaving the severity, tolerability or values to the governance decision-making processes and stakeholder constituency”

ICES, 2014

The risk matrix defines the tolerability or the acceptability of each likelihood and consequences combinations in terms of the need for taking management action (ICES, 2014)



Risk evaluation

Risk evaluation of management options for achieving ecosystem objectives in a MSP context is carried out with aim:

1) to assess the need to take ecosystem-based risk management action based on the level of risk considered acceptable by the competent authority in consultation with regulators, stakeholders, and the public (risk acceptance, tolerance or aversion)

2) to suggest enhancements to existing control and mitigation measures or new measures if the risks are unacceptable to regulators, stakeholders, and the public

3) assess existing control and mitigation measures to determine if enhancements are feasible based on available technologies, scientific knowledge, and implantation constraints. Identify new options as possible solutions

Risk treatment

Referring to risk treatment as a risk modification process and based on the risk evaluation results the most cost-effective Blue Economy scenarios related environmental risk management controls (policy, procedure, practice, process) are developed and implemented using the Bow-tie methodology in consultation with regulators and stakeholders considering control and mitigation options in terms of their position along the cause-and-effect pathway

The Vision

Acknowledgements

This study is supported by European Regional Development Fund, INTERREG Central Baltic project Plan4Blue "Maritime Spatial Planning for Sustainable Blue Economies" and the Estonian Environmental Investment Centre

Thank you very much for your attention!

Gulf of Finland
Trilateral Scientific Forum
30th November–1st December, 2016
Finnish Environment Institute SYKE

1st Day

Gulf of Finland
Co-operation

Andrey Pedchenko, Raid T, Pakarinen T

Some aspects on further joint fisheries research in the Trilateral Estonian-Finnish-Russian cooperation in the Gulf of Finland

ГОСНИОРХ

GoF : FISH AND FISHERIES

Finland Gulf – area of the joint scientific research

A. Pedchenko, T. Pakarinen, T. Raid

Gulf of Finland
Year 2014

GoF : FISH AND FISHERIES

Road Map for the Gulf of Finland

•Gain a good ecological state of migratory fish stocks by ensuring the access to spawning habitats and successful reproduction in rivers by:

- fisheries management and prevention of illegal fishing,
- removal of unnecessary dams from rivers and building fish passes at the migration obstacles,
- restoration of spawning and rearing habitats in rivers
- working with taking steps in order to reduce the load of solid matter and nutrients from of catchment areas of human impacted river ,

•Implementation of measures to restore Atlantic salmon stocks in the four major rivers: the Neva, Narva, Luga and Kymi.

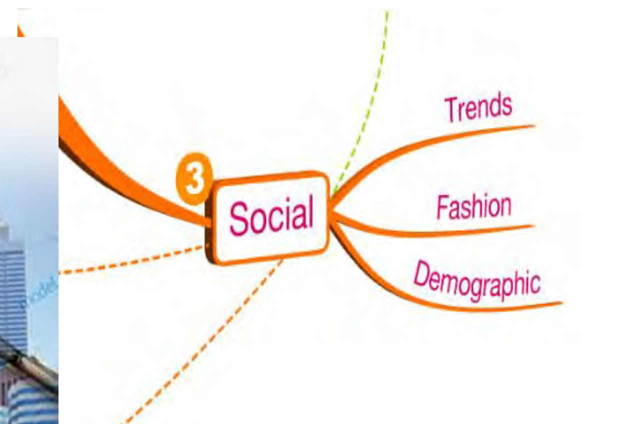
•Take actions to reach a good ecological state in the spawning and nursery areas for herring and other coastal fish species (e.g. by reducing eutrophication)

•Control and development of recommendations and implementation of measures for reducing the anthropogenic influence as a result of hydraulic engineering, pollutant emissions and other human activities in order to maintain the productivity of stocks of all fish species in the region and the health of the marine environment.

GoF : FISH AND FISHERIES

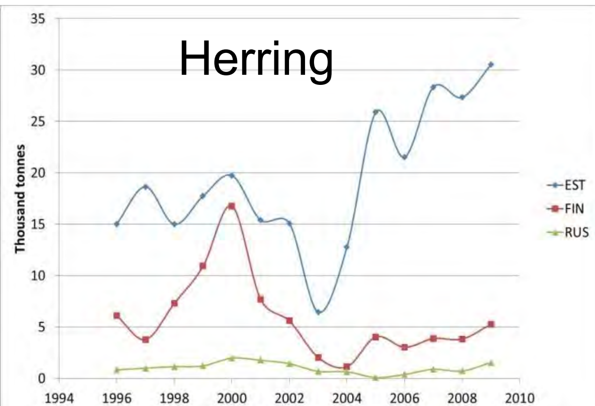
To have common goals,
but different opportunities

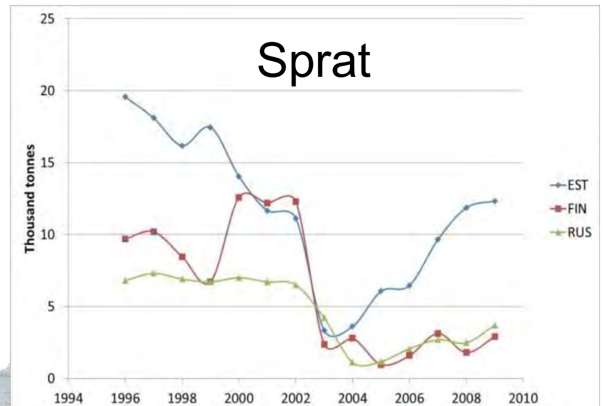
The implementation of the goals and joint research programms complicate the political, economic and social factors



GoF : FISH AND FISHERIES

Important tasks to ensure joint efforts are a scientific staff, methodological approaches and technical support of fisheries management observations and research.



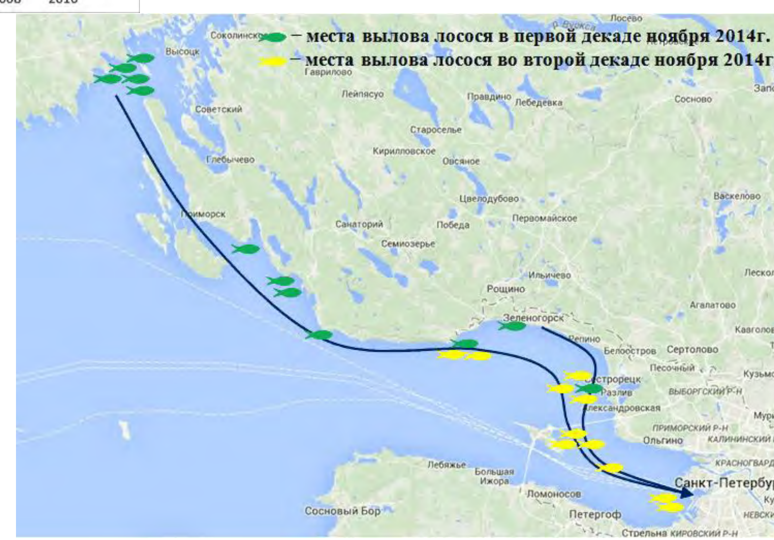


assessment of fish stocks,

fishery monitoring,

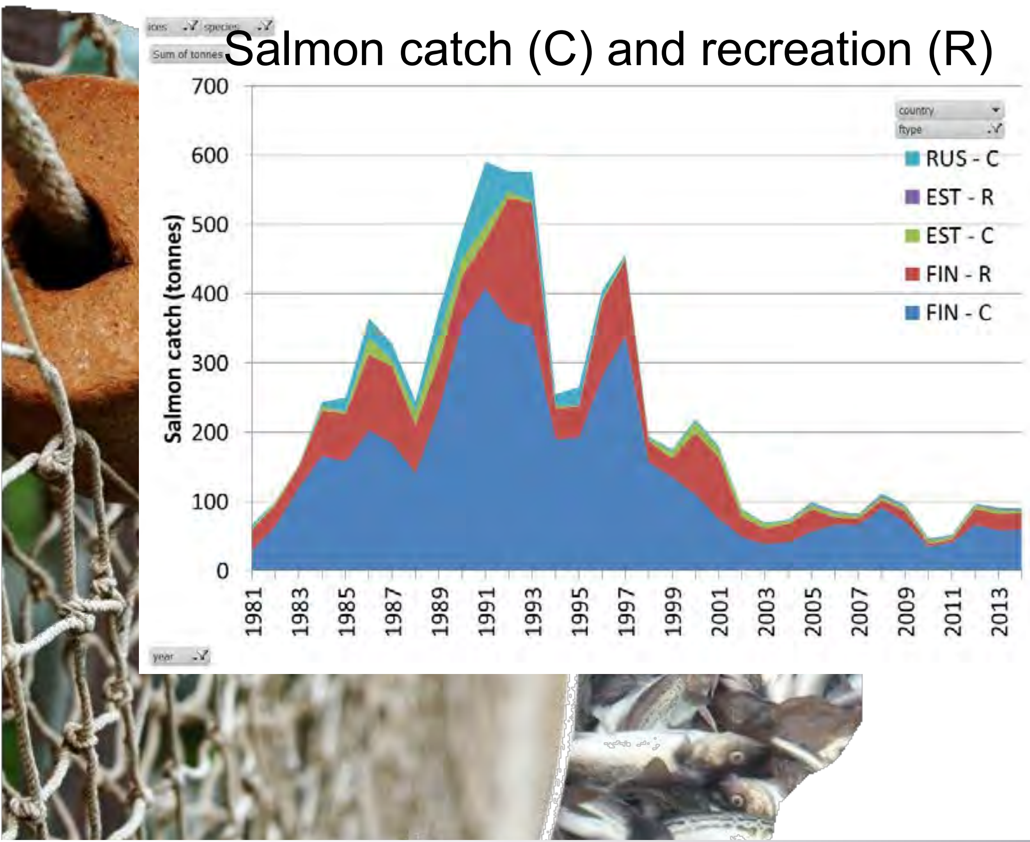
monitoring of fish migrations,

estimates of illegal fishing



GoF : FISH AND FISHERIES

We believe that the priority tasks for the near future are to maintain the volume of observations of the fisheries monitoring and surveys for the assessment of fish stocks of the Gulf of Finland, to determine the factors of negative impact on fish resources.



GoF: FISH AND FISHERIES

Expected results:

1. Fish community changes and their causes

•Changes in community structure and species abundance (long-term changes)
•Long-term changes in the habitat of fish
•Climate influence on fish distribution patterns (Baltic herring and sprat)
•Joint acoustic surveys of Baltic herring and a sprat
• Development surveys of the fresh-water fishes on the GoF area
•Salmon assessment and migrations in the GoF basin.
•Ecosystem research in shallow bays and gulfs in the eastern GoF
•New methods for assessing the state of the fish stocks

2. Anthropogenic forcing

•Environmental disturbance on fish populations
•Assessment of coastal and commercial fish contamination with hazardous substances (core indicators)
•Local physical disturbance, *e.g.*, dredging and dumping of the dredged material

3. Sustainable use of fish resources

•management of commercial stocks
•Long-term changes of commercial fish populations in the GoF
•Development of indicators to describe the status of fish stocks and the status of the marine environment

GoF : FISH AND FISHERIES

Gulf of Finland
Trilateral Scientific Forum
30th November–1st December, 2016
Finnish Environment Institute SYKE

1st Day

Gulf of Finland
Co-operation

Joni Kaitaranta, Leena Laamanen, Lena Bergrström, Ulla Li Zweifel

Developing a holistic assessment of ecosystem health in the Baltic Sea

Developing a holistic assessment of ecosystem health in the Baltic Sea

HELCOM Secretariat

Joni Kaitaranta, Leena Laamanen,
Lena Bergrström, Ulla Li Zweifel

HELCOM

Vision for the Baltic Sea

*"A **healthy** Baltic Sea environment with diverse biological components functioning in balance, resulting in a good ecological status and supporting a wide range of sustainable economic and social activities."*

HELCOM 2007

www.helcom.fi/baltic-sea-action-plan

Report on the status of the Baltic Sea – second HELCOM holistic assessment

Aims:

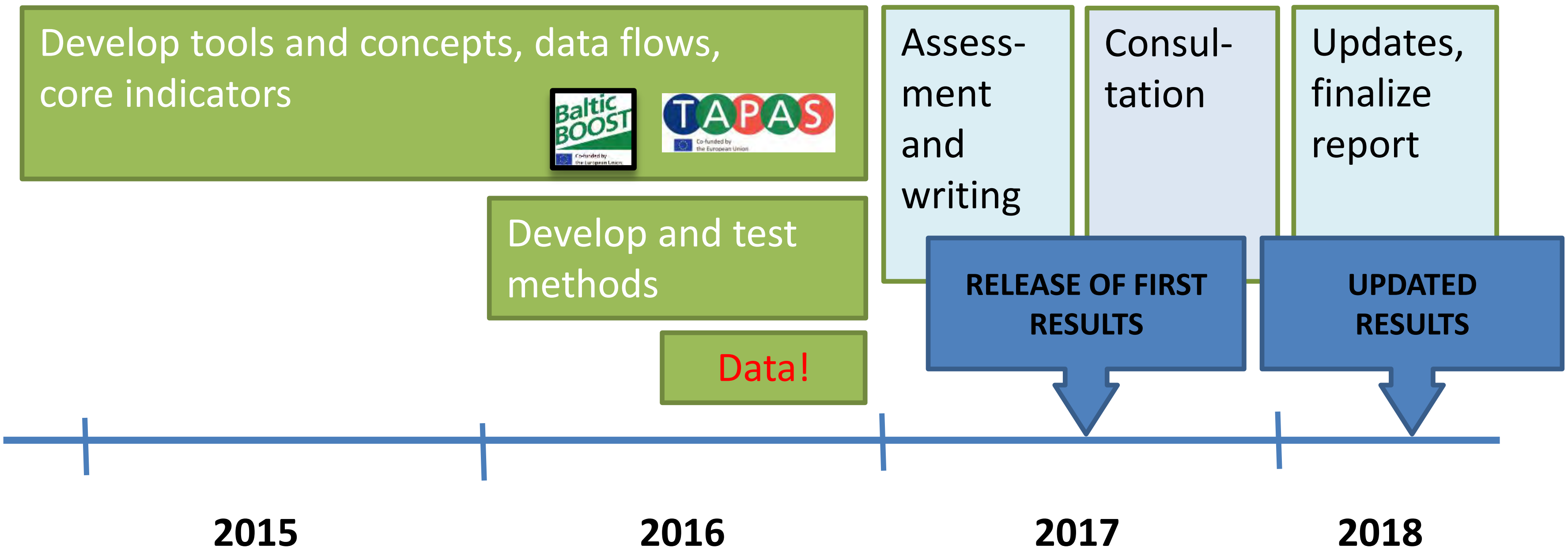
- Follow up on the **Baltic Sea Action Plan** (BSAP)
- In particular:
  - Better and more reliable indicators
  - Improved data flow
  - Increasingly automated and transparent assessment methods

Key parts of the assessment

- Integrated assessments of
  - Biodiversity
  - Eutrophication
  - Hazardous substances
  - Maritime activities
- The Baltic Sea Pressure Index (Cumulative impacts)
  - Human activities and resulting pressures as spatial datasets
  - Ecosystem component spatial datasets
- Regionally coordinated social and economic analyses of use of marine waters and cost of degradation

Timeline

Project from December 2014 to June 2018.

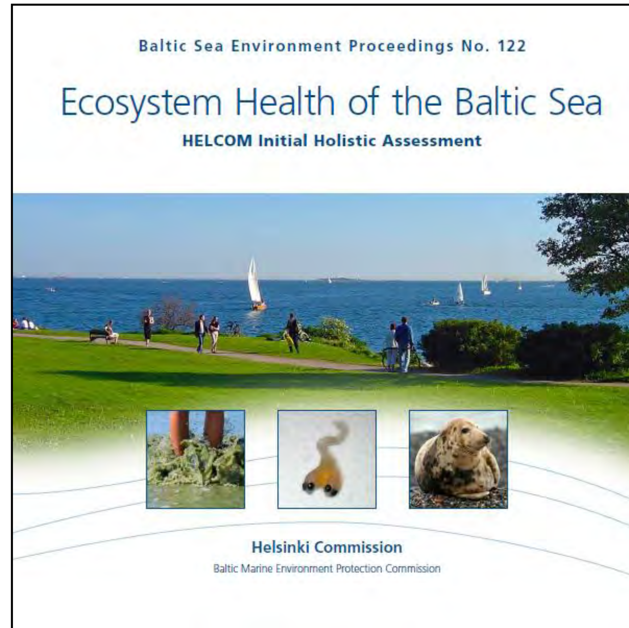


The report is part of HELCOM monitoring and assessment strategy

Builds on regionally agreed and coordinated assessment methods within HELCOM groups:

- Commonly agreed indicators
- Coordinated monitoring programmes
- Monitoring guidelines implemented e.g. COMBINE
- Data collection and regular data reporting workflows

  → **aim for comparable publicly available data**



Contents of the first report that was published in 2010:
Status - Causes - Solutions - Costs and benefits - Conclusions and perspectives

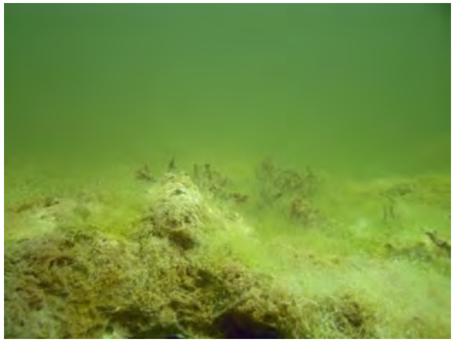
Filling data gaps

- Complete Baltic-wide datasets are limited
- How to fill in gaps → ad hoc data requests/ data mining
  - All available free spatial datasets explored and utilized when applicable
  - Targeted data requests

→ All efforts in making data available are highly welcomed!

Indicators

- "Building blocks" of the assessment
- Common regional scale indicators developed in order to:
  - show the status of the indicator for agreed spatial scale (good / not good environmental status)
  - To show trends over time



Indicators

- **Monitoring** → Data → Indicator results → Assessment

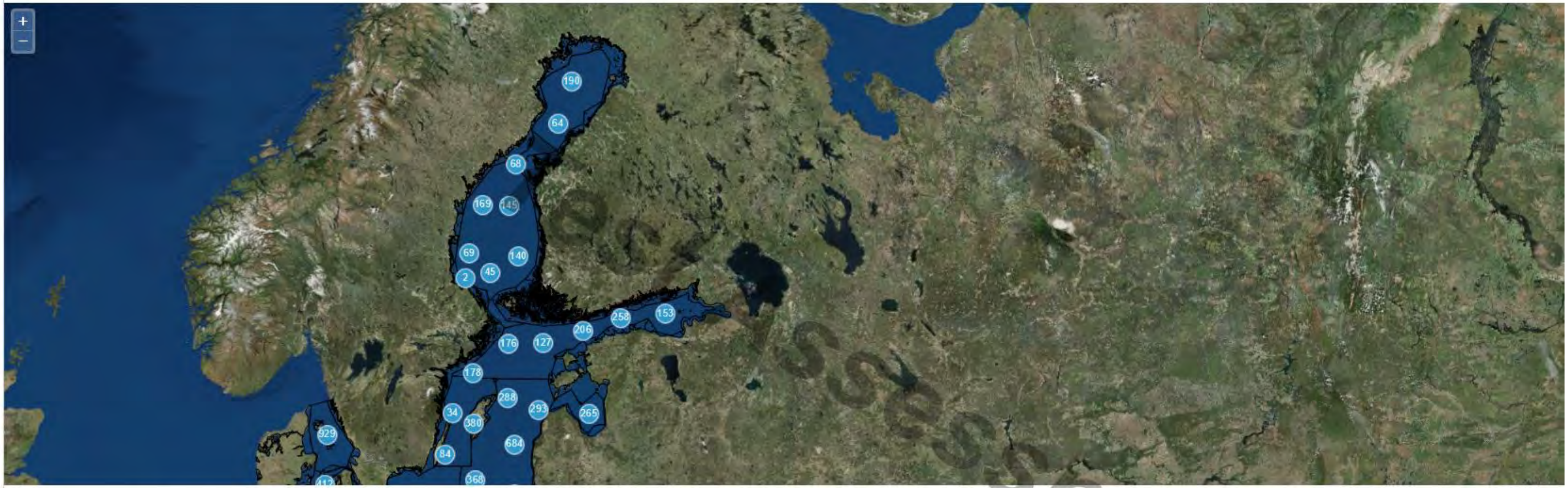
Photo: Henry Söderman - SYKE

Indicators

- Monitoring → **Data** → Indicator results → Assessment

Accessions | Stations | Indicators | Assessment

Download



Assessment Unit ID	Assessment Unit Description	Platform	Year	Month	Day	Hour	Minute	Latitude	Longitude	Sounding	Secchi
SEA-017	Bothnian Bay	77K5	2006	12	6	11	30	64.7075	22.0658	123	6.5
SEA-017	Bothnian Bay	77K5	2006	12	6	6	20	65.1673	23.2302	92	
SEA-017	Bothnian Bay	77AR	2006	12	7	18	15	64.7083	22.0667	126	

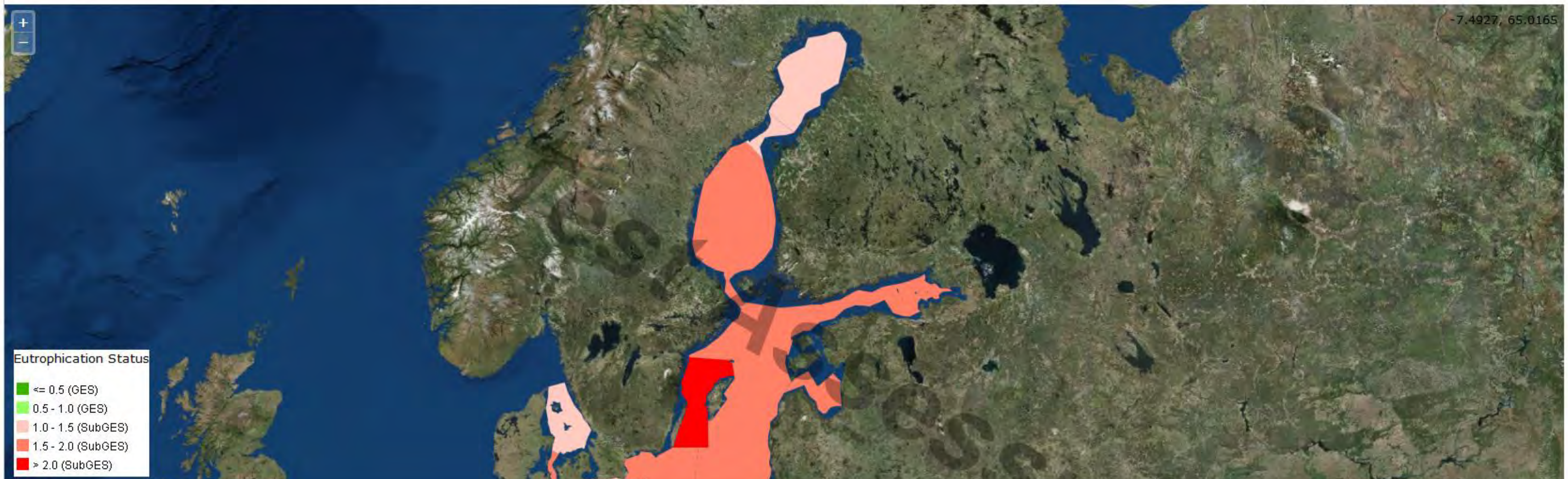
DEPH	TEMP	PSAL	DOXY	PHOS	TPHS	SLCA	NTRA	NTRI	AMON	NTOT	CPHL
1	3.01	3.056		0.02	0.15	33.7	6.8	0.1	0.1	20.9	
5	3.01	3.058		0.02	0.14	33.7	6.8	0.1	0.2	20.6	
10	3.02	3.061		0.02	0.14	33.8	6.8	0.08	0.1	20.6	
40	3.52	3.191		0.01	0.13	33.2	7	0.08	0.1	20.6	

Indicators

- Monitoring → Data → **Indicator results** → Assessment

Accessions | Stations | Indicators | Assessment

Download | MSFD classification with 5 subclasses | Chlorophyll a (in-situ) (Summer)



Assessment Unit		Period	ES	STD	N	ET	ER	ES-SCORE	ET-SCORE	I-SCORE
ID	Description									
SEA-001	Kattegat	20072011	1.55	0.53	298	1.50	1.04	100	0	50
SEA-002	Great Belt	20072011	2.82	0.70	71	1.70	1.66	100	50	75
SEA-004	Kiel Bay	20072009	2.75	0.54	38	2.00	1.37	100	50	75
SEA-005	Bay of Mecklenburg	20072011	2.61	0.60	111	1.80	1.45	100	50	75

Indicators

- Monitoring → Data → Indicator results → **Assessment**

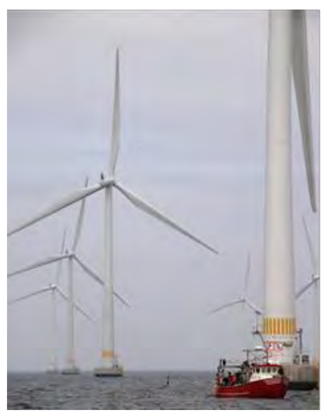
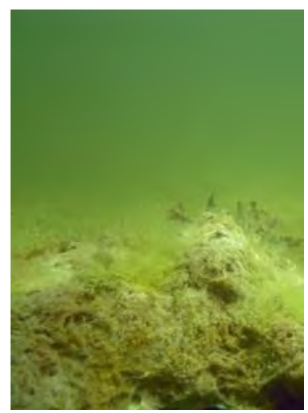
Accessions | Stations | Indicators | Assessment

Download | MSFD classification

Assessment Unit		C1: Nutrient levels			C2: Direct effects			C3: Indirect effects			Status	Confidence
ID	Description	ER	N	SCORE	ER	N	SCORE	ER	N	SCORE		
SEA-001	Kattegat	1.16	2	74	1.01	2	62				1.16	68
SEA-002	Great Belt	1.14	2	74	1.48	2	62				1.48	68
SEA-003	The Sound	1.76	2	50							1.76	25
SEA-004	Kiel Bay	1.20	2	74	1.33	2	74				1.33	74

Pressures and human activities

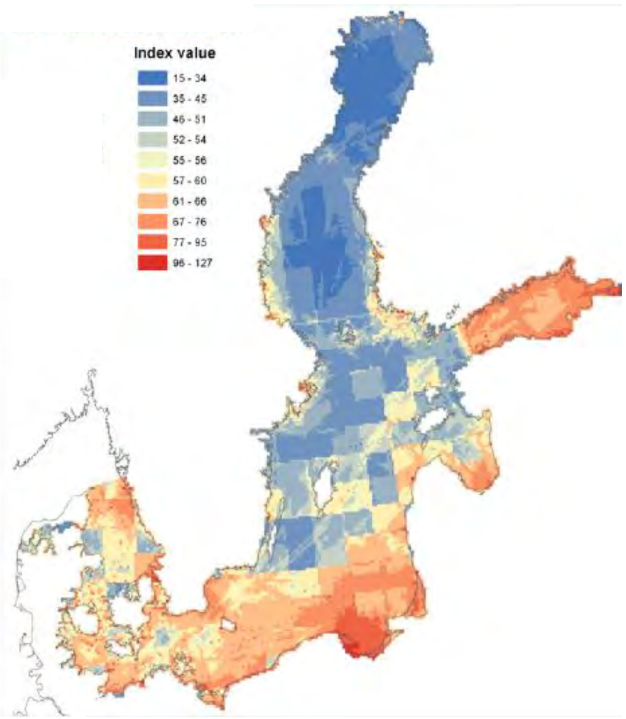
- Limited data collection framework → ad hoc data requests
- Visualise the spatial distribution of human activities and pressures → serves also data needs of transboundary MSP


The 2010 Pressure indices

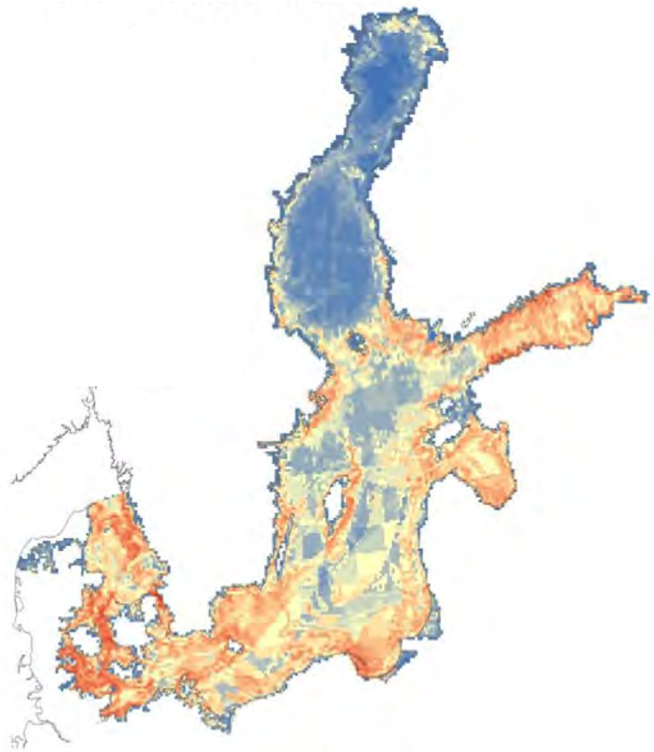
HELCOM BSPI (Baltic Sea Pressure index)

- Pressure data layers (intensity)



HELCOM BSPII (Baltic Sea Impact Index)

Pressure data layer & Ecosystem component data layers & Impact scores



Korpinen et al 2012. Ecological Indicators 15:105-114.

HELCOM

Baltic Marine Environment Protection Commission

Gulf of Finland
Trilateral Scientific Forum
30th November–1st December, 2016
Finnish Environment Institute SYKE

1st Day

Gulf of Finland
Co-operation

Sergei Golubkov, Alexey Tiunov, Mikhail Golubkov, Vera Nikulina

The role of allochthonous and autochthonous organic matter in benthic food webs in the upper and in the middle part of the Neva Estuary

ZOOLOGICAL INSTITUTE OF RUSSIAN ACADEMY OF SCIENCES
St. Petersburg

The role of allochthonous and autochthonous organic matter in benthic food webs in the upper and in the middle part of the Neva Estuary

Sergei Golubkov[1] Alexey Tiunov[2], Mikhail Golubkov[1], Vera Nikulina[1]

[1]Zoological Institute of Russian Academy of Sciences, Russia;

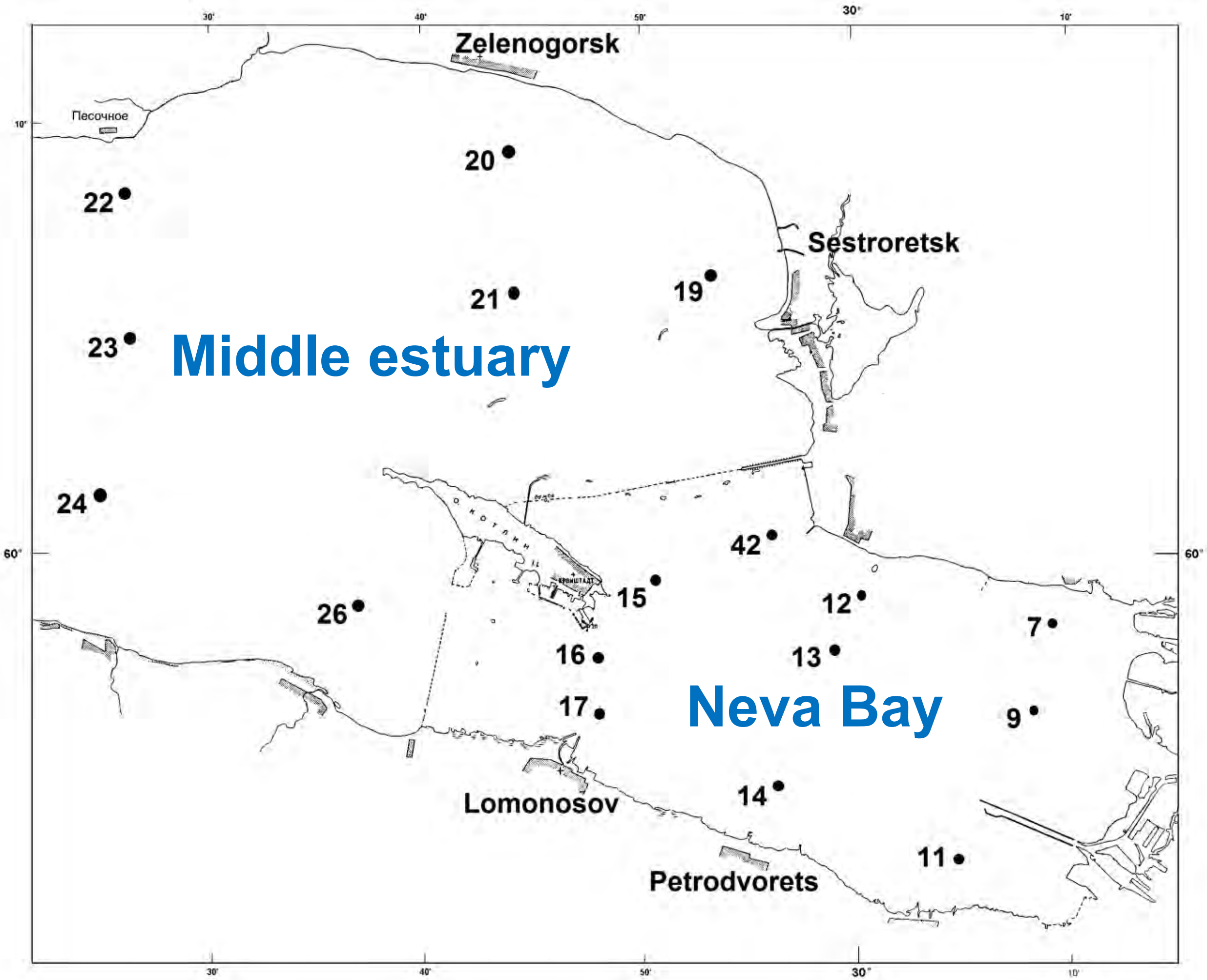
[2]A.N. Severtsov Institute of Ecology and Evolution, Russia

Introduction

Most studies on eutrophication in the Neva Estuary are focused on phosphorus budget. However, modern definition considers an eutrophication as an increase in the rate of supply of organic matter (OM) to an ecosystem (Omstedt et al., 2014). Therefore, detail investigations of different forms of OM coming from the watershed and creating in the system are required to realize the ecosystem function and to develop effective remedial measures.

The aim of the study was to ascertain the importance of allochthonous an autochtonous organic matter in food webs and ecosystem functioning of the Neva Estuary by analyzing its metabolism and the stable isotopic (C^{13} and N^{15}) composition of zoobenthos and seston.

Stations of the annual sampling of planktonic and benthic communities in the Neva Estuary



Neva Bay – freshwater (0,07-0,02 ‰), shallow (mean depth 3.5-4 m), separated from the Middle Estuary by Dam (surge protecting barrier)

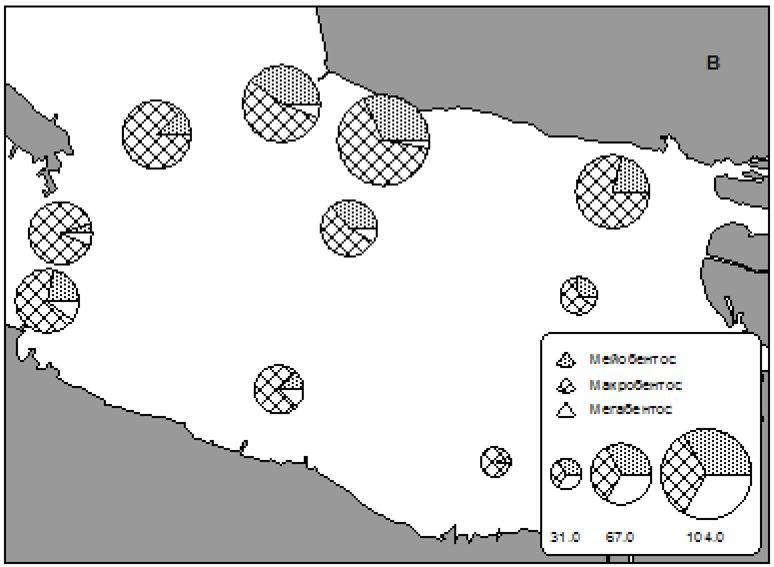
Middle estuary – salinity of surface water (1 - 3 ‰), depth – from 9 (st. 26) to 27 m (st. 23)

Mean values of plankton primary production (A, PP) and mineralization of organic matter (D, R) in the Neva Estuary for 2003-2015

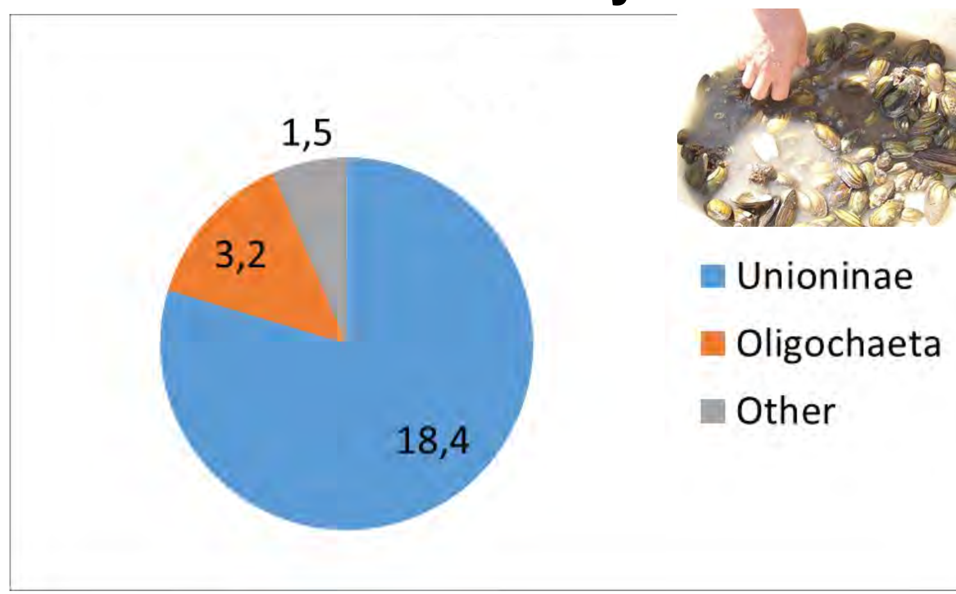
	A, $gC\ m^{-3}d^{-1}$	PP, $gC\ m^{-2}d^{-1}$	D, $gC\ m^{-3}d^{-1}$	R, $gC\ m^{-2}d^{-1}$	A/D	PP/R
Neva Bay						
Mean	0.61	0.62	0.30	1.04	2.02	**0.60**
±SD	0.17	0.18	0.08	0.30		
n	130	130	130	130		
Middle estuary						
Mean	0.94	1.39	0.29	2.46	3.25	**0.57**
±SD	0.34	0.58	0.11	0.83		
n	91	91	91	91		

Zoobenthos in Neva Bay

Energy flows (mg C $m^{-2}d^{-1}$) in zoobenthos (from Maximov, Golubkov, Petukhow, 2014)



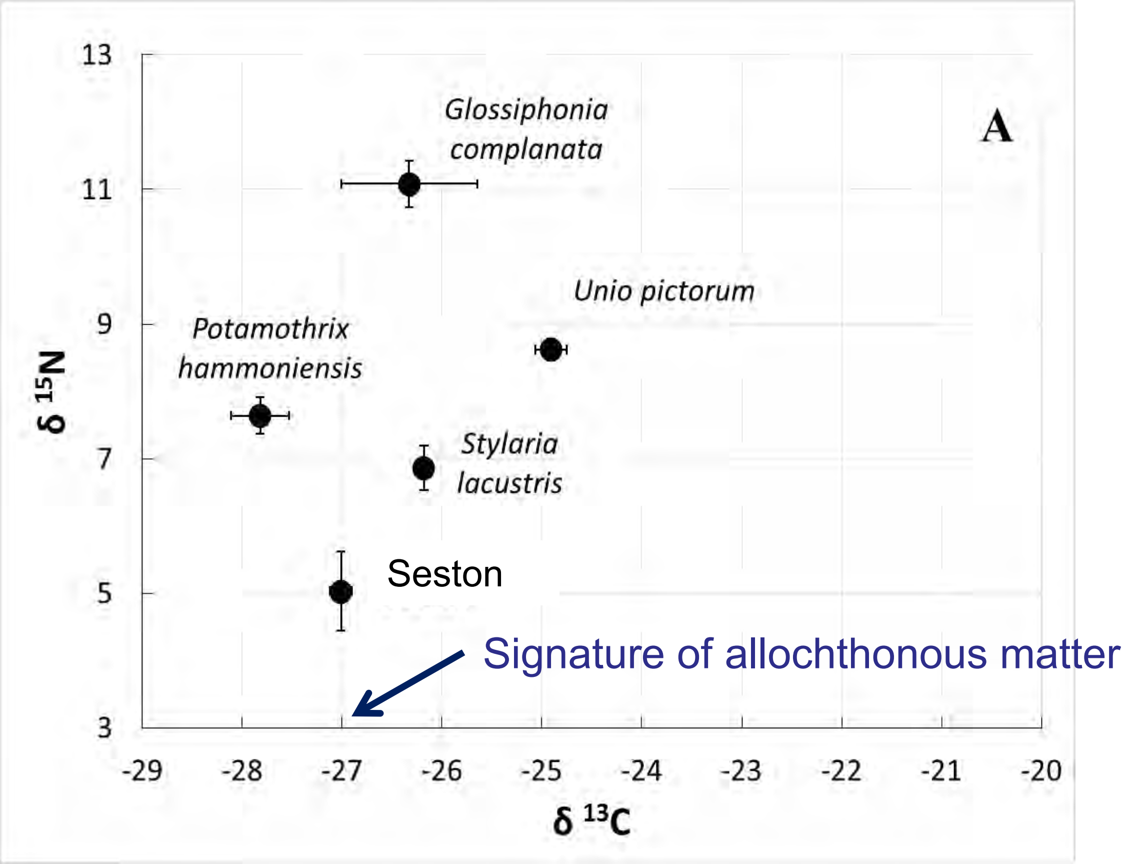
Mean biomass (g WW/m^2) of the dominant groups of zoobenthos in Neva Bay



Large mollusks Unionidae are predominant in zoobenthos in Neva Bay, but their role in energy flows are much lower than oligochaetes and meiobenthos

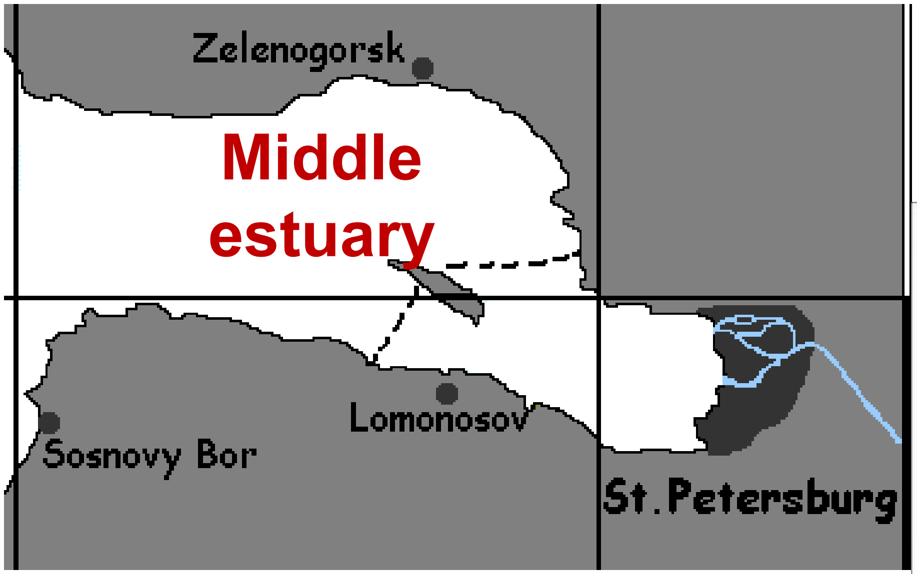
Origin of carbon in the organic matter in Neva Bay

Stable isotope signatures of seston and dominant zoobenthic species in Neva Bay
(from Golubkov, Tiunov, 2015)

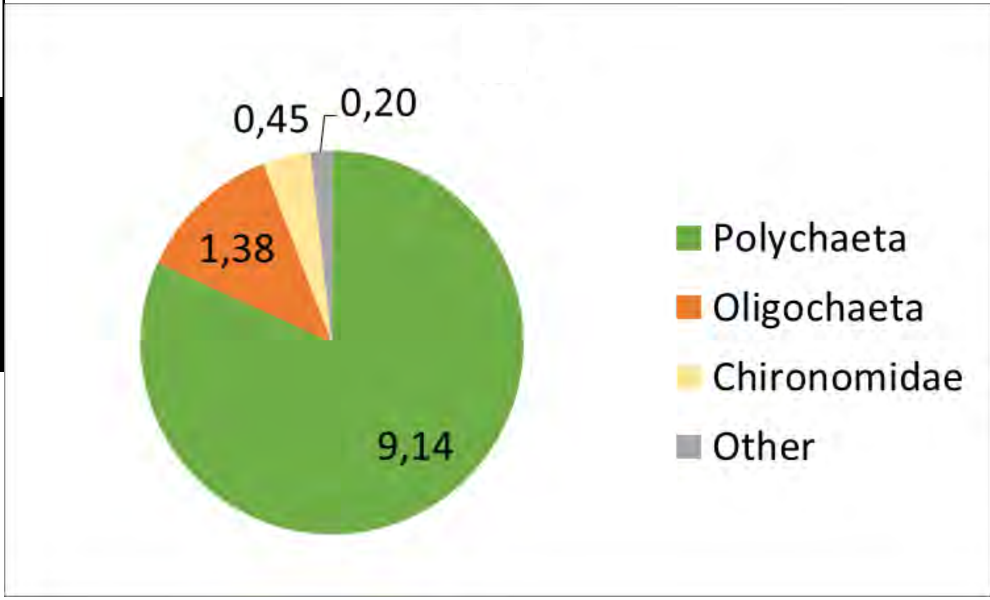


Isotope signatures ($\delta^{13}C$) of seston and most of the dominant zoobenthic species in Neva Bay are close to signature of allochthonous terrestrial carbon (−27 ‰) coming from watershed.

Zoobenthos in the Middle estuary



Mean biomass (g WW/m²) of the dominant groups of zoobenthos in the Middle estuary in 2013–2014



Marenzelleria arctia (Polychaeta) sharply dominates in the Middle estuary nowadays

Changes in zoobenthos of the Middle estuary

Saduria entomon

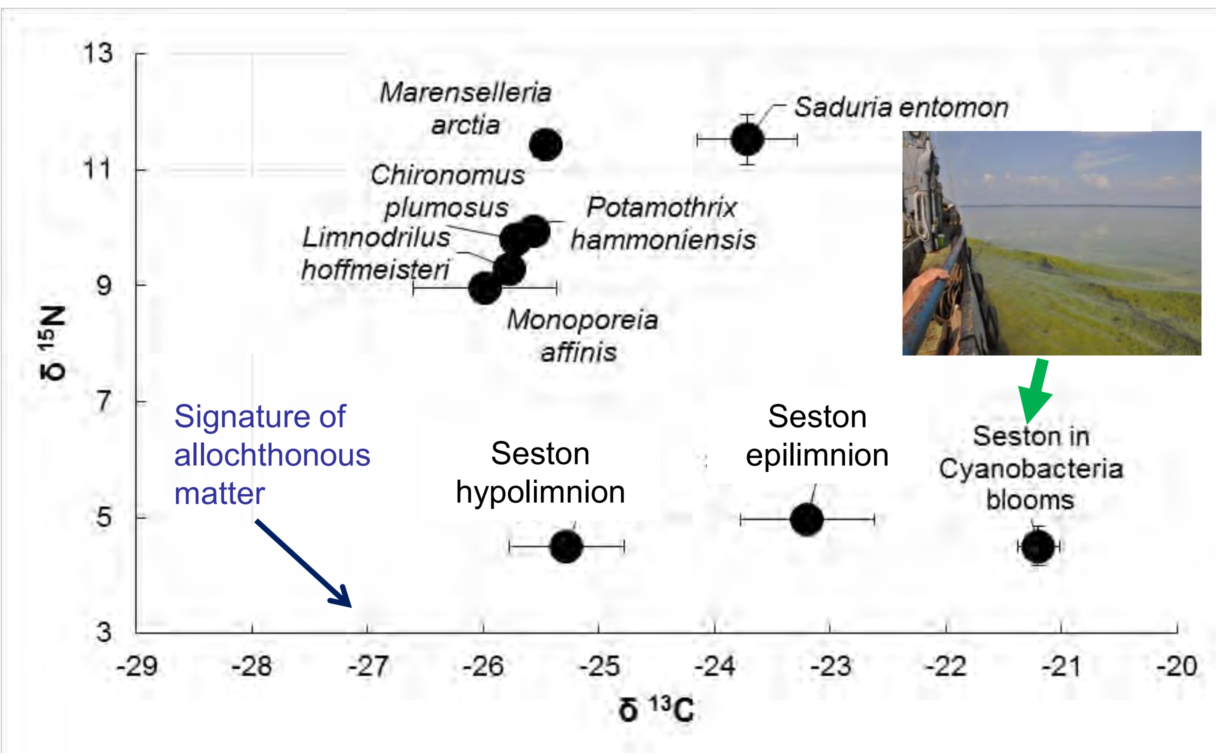
Monoporeia affinis

***Marenzelleria* sp.**

Native nectobenthic glacial relicts ***Monoporeia affinis*** and ***Saduria entomon*** sharply dominated in zoobenthos in middle part of the eastern Gulf of Finland until the early 2000s. they were replaced by alien worms ***Marenzelleria arctia*** at the late 2000s – early 2010's after several hypoxia events, which deteriorated native benthic communities and promoted distribution of alien species

Origin of carbon in the organic matter in the middle part of the Neva Estuary

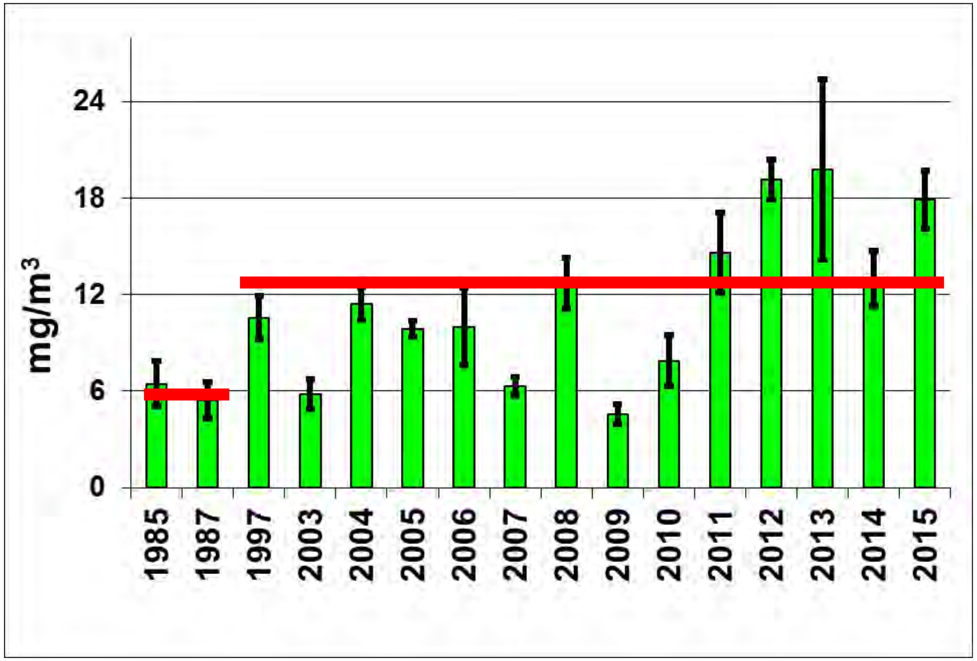
Stable isotope signatures of seston and dominant zoobenthic species in the Middle estuary



In the Middle estuary $\delta^{13}C$ signature of seston was distinctly higher than in Neva Bay. Especially high $\delta^{13}C$ signature (–21 ‰) was determined for seston from the local blooms of cyanobacteria. Most species of zoobenthos had $\delta^{13}C$ signature similar to the signature of seston in hypolimnion, which was notably lower than isotopic signature of cyanobacteria. Therefore, organic matter (OM) creating during cyanobacteria blooms was not important as a food for zoobenthos.

Changes in phytoplankton in the Middle estuary during the last decades

Average concentration of chlorophyll *a* in in mid-summer



Cyanobacteria blooms in the Middle estuary in August 2013

Concentration of chlorophyll *a* in the middle part of the estuary increased twice in 2000s as compared with 1980s.

Cyanobacteria and other low sinking groups became dominant in summer phytoplankton in 2000's.

Primary production (Pp) and production of zoobenthos (Pb) in the Inner Estuary in 1980s and 2010s

Index	1980s*	2014
Pp, mg C $m^{-2}d^{-1}$	340	890
Pb, mg C $m^{-2}d^{-1}$	12	13.3
Pb/Pp, %	3.53	2.02

* - from Golubkov *et al*., 2010

Changes in phytoplankton composition and deterioration of the native zoobenthos result in low effectivity of pelagic-benthic coupling and changes in zoobenthos in 2000s as compared with more early period. Alien *Marenzelleria* worms are less accessible for fish, as compared to the native crustaceans and their proliferation may be one of the reason great decline of fish stock in the eastern Gulf of Finland nowadays. The fish catch also declined from 30000 – 40000 t in 1970s to 4000 – 5000 t in 2000s

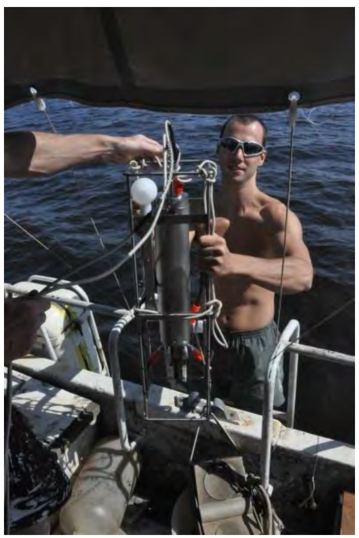
Mean biomass of different phytoplankton groups (±SE) and their proportion in the total biomass of phytoplankton (%) in the Middle estuary for different periods

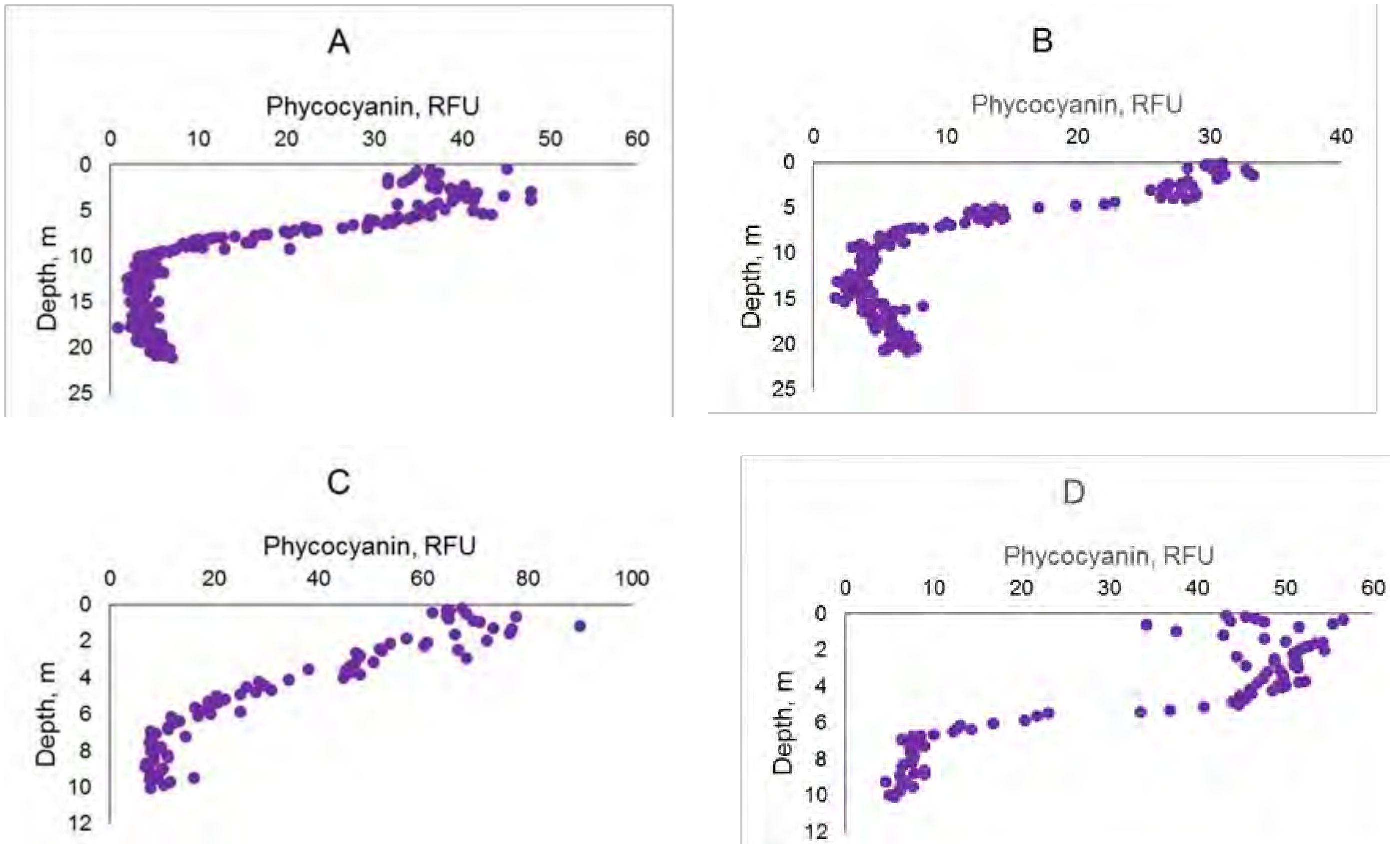
Years	Biomass mg/l	Cyano-bacteria	Bacillario-phyta	Crypto-phyta	Chloro-phyta	Others
1982-1988	1.9±0.2	38.0 ±5.5	42.5 ± 2.6	2.5 ±0.1	13.0 ±3.2	4.0 ± 0.9
1997-2000	3.9±0.8	65.4±12.6	10.0 ±2.1	9.5 ±3.2	7.2 ±2.5	7.9 ±3.1
2002-2004	5.2±0.4	63.0±5.6	13.2 ±3.3	7.5 ±3.4	14.3 ±2.2	2.0 ±0.5
2005-2010	3.6±0.8	34.8±9.8	25.7±6.1	19.1± 4.2	15.5 ±3.5	4.9±0.6
2013-2014	4.3±0.7	43.3±5.6	18.8±6.3	24.2±5.8	15.9±2.3	2.4±0.5

± - mean error

Biomass of diatoms (Bacillariophita) remains a proximally the same in 2000s as compared to 1980s (about 0.8 mg/l), but biomass of Cyanobacteria increased more then twice, from about 0.7 to 1.7 mg/l

Vertical distributions of cyanobacteria phycocyanine concentrations in relative fluorescence units (RFU) in the Middle estuary





A – station (st.) 23 in 2013, B – st. 23 in 2014, C – st. 19 in 2013, D – st. 19 in 2014.

Conclusions

- The prevalence of mineralization over production of organic matter in the upper and middle parts of the estuary confirms considerable role of allochthonous carbon in its ecosystem.
- The carbon isotope signature of seston and most of zoobentic species in Neva Bay was close to the signature of allochthonous carbon leaking from the watershed (−27‰).
- Higher values of $\delta^{13}C$ of zoobenthos and seston the Middle estuary then in Neva Bay indicate higher importance of autochthonous organic matter in food webs of the Middle estuary.
- Considerable increase of production and biomass of mid-summer phytoplankton was observed in the Middle estuary during the last decades mainly due to considerable increase in biomass of cyanobacteria. However, they are mostly concentrated in the upper water layers and only a small part of them reached the bottom and may be used as a food by zoobenthos. Therefore, additional amounts of autochthonous matter creating as a result of eutrophication poorly incorporates in benthic food webs.

Acknowledgements

The investigations were supported by

- Russian Foundation for Basic Research
- Ministry of Natural Resources of Russia


Thank you for your attention!

Gulf of Finland
Trilateral Scientific Forum
30th November–1st December, 2016
Finnish Environment Institute SYKE

1st Day

Gulf of Finland
Co-operation

Mikhail Golubkov, Sergei Golubkov

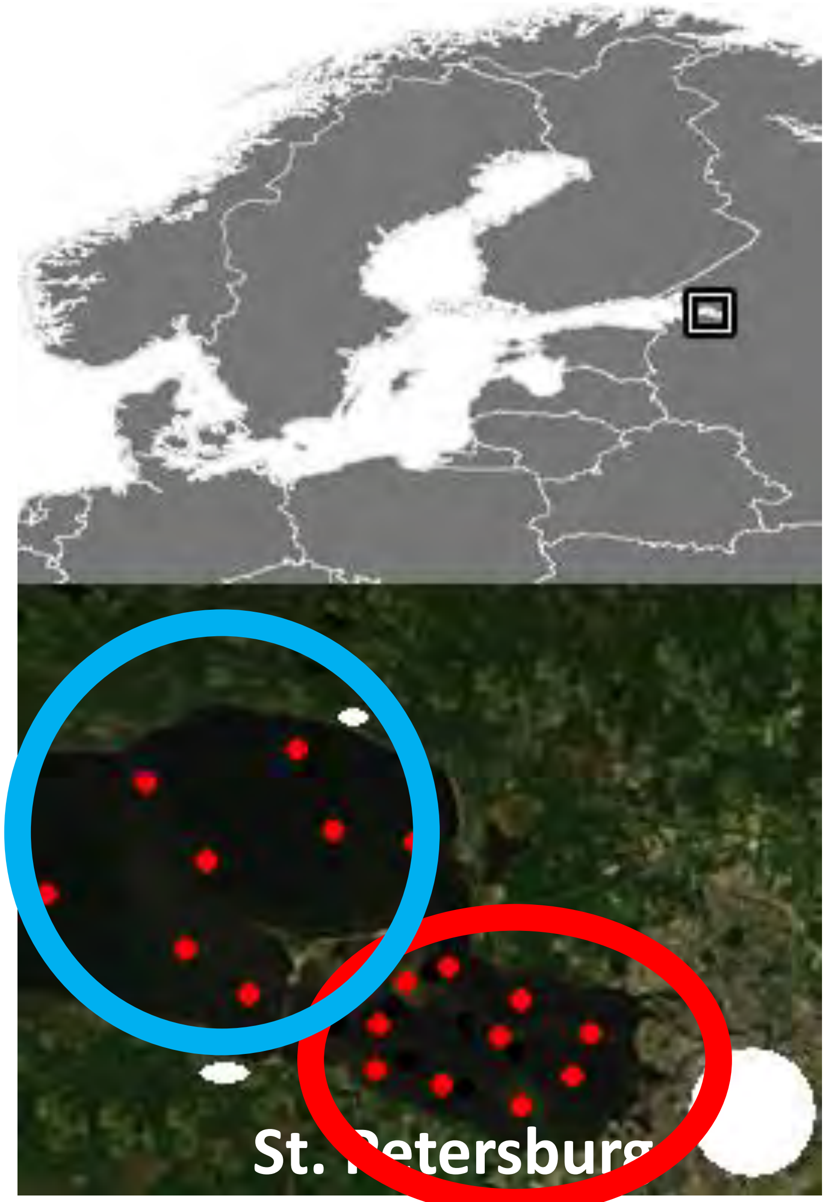
Primary production and Chlorophyll a concentration in mixing zone of the Neva Estuary

Zoological Institute of Russian Academy of Sciences
St. Petersburg

PRIMARY PRODUCTION AND CHLOROPHYLL A CONCENTRATION IN MIXING ZONE OF THE NEVA ESTUARY

Mikhail Golubkov, Sergei Golubkov

OBJECTIVE AND SAMPLING



- **Objective:**

  Determination of the tendencies in the development of eutrophication process during the last two decades

- **Sampling:**

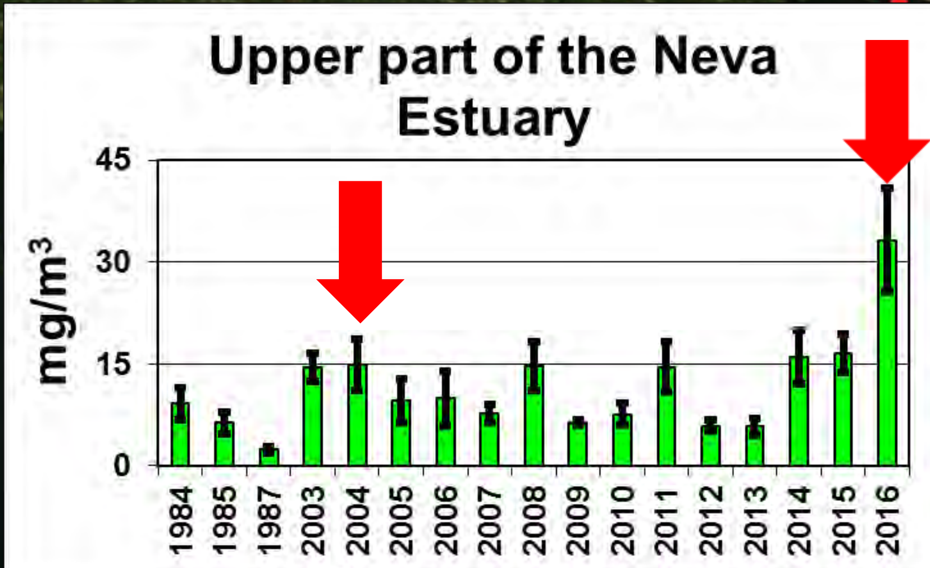
  19 sampling stations were done at summer 2003-2016 at the end of July and very beginning of August 2003-2016 in the Upper part of Neva Estuary – ***freshwater and shallow*** **Neva Bay and in the Middle part of Neva Estuary** (***salinity of surface water up to 3 PSU, depth up to 30 m***).

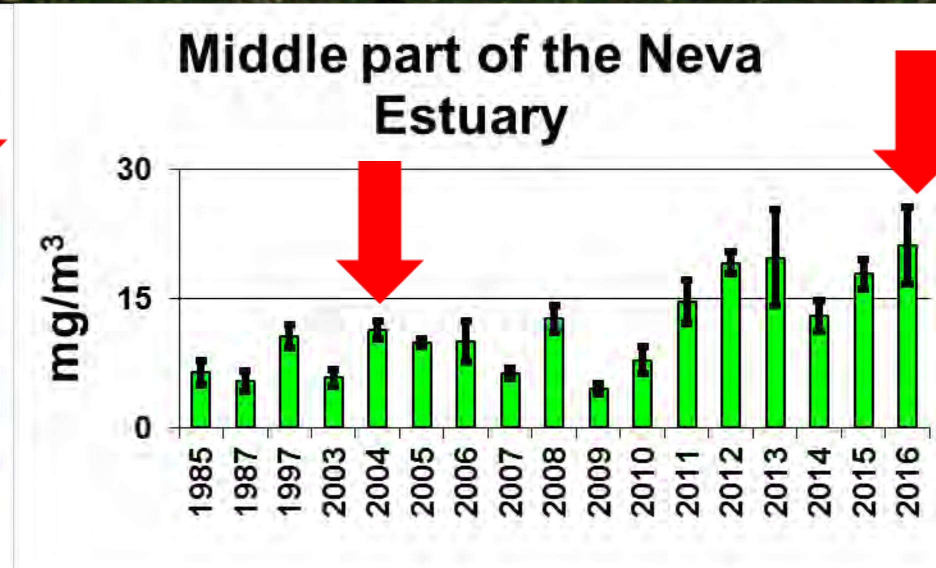
METHODS

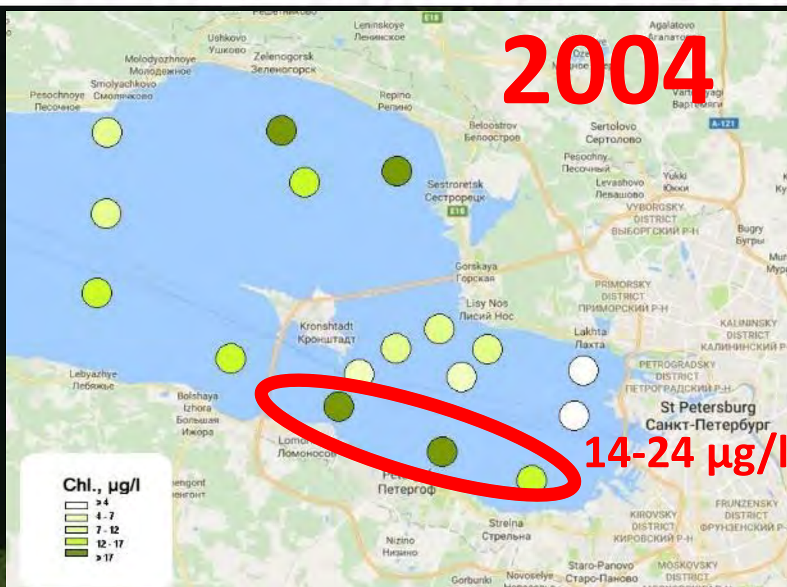
To characterize heterogeneity of the waters concentration of chlorophyll a, CDOM, turbidity, salinity, temperature were measured by C6-multisensor platform (TurnersDesigns, USA) and CTD90m probe (Sea&Sun Tech., Germany).

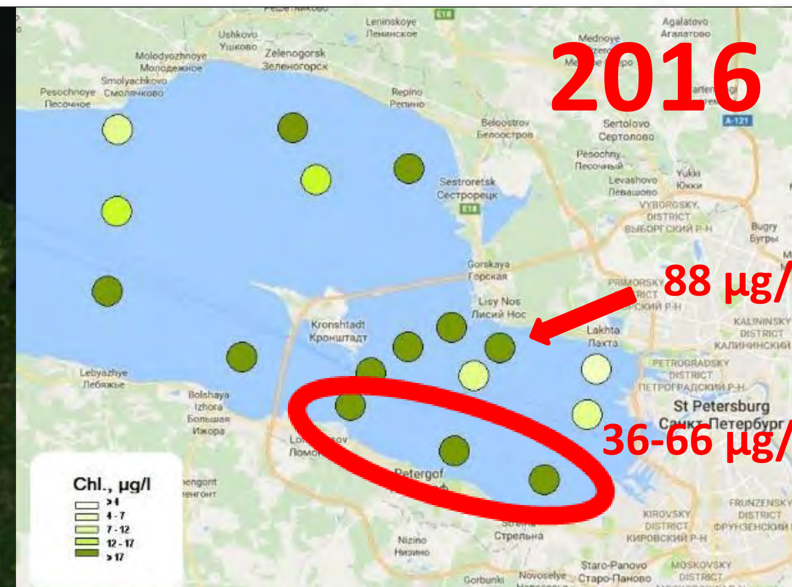
On each sampling station were measured Secchi depth, primary production of phytoplankton and decomposition of organic matter in water column, concentration of chlorophyll *a*, concentration of total phosphorus with classical hydrobiological methods.

Chlorophyll *a* in the Neva Estuary at the end of July and very beginning of August 2003-2016



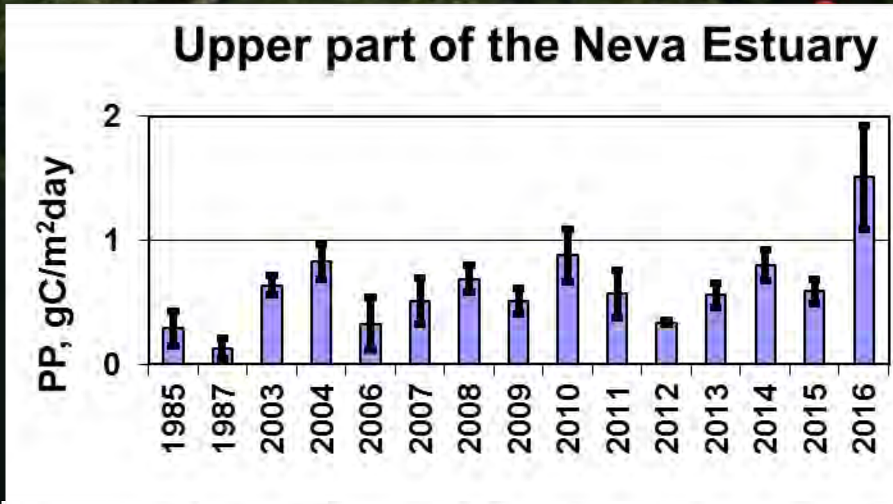


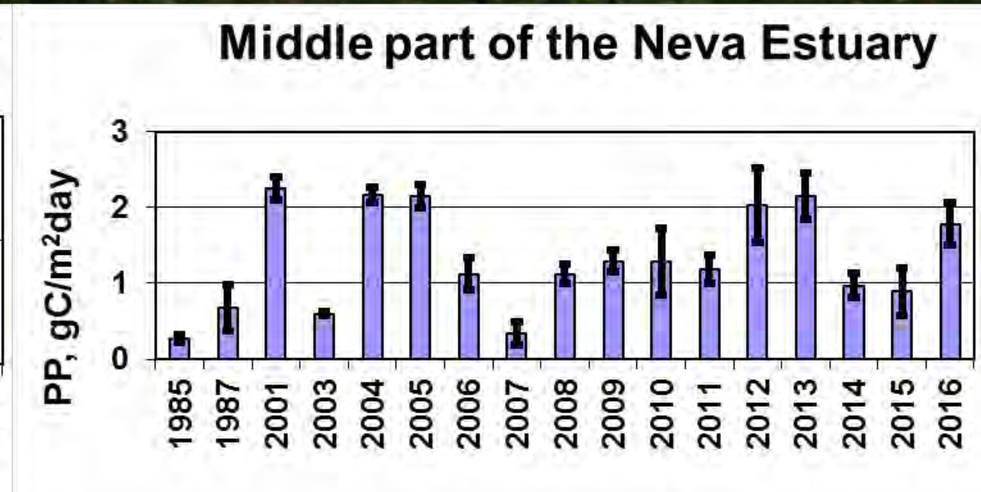


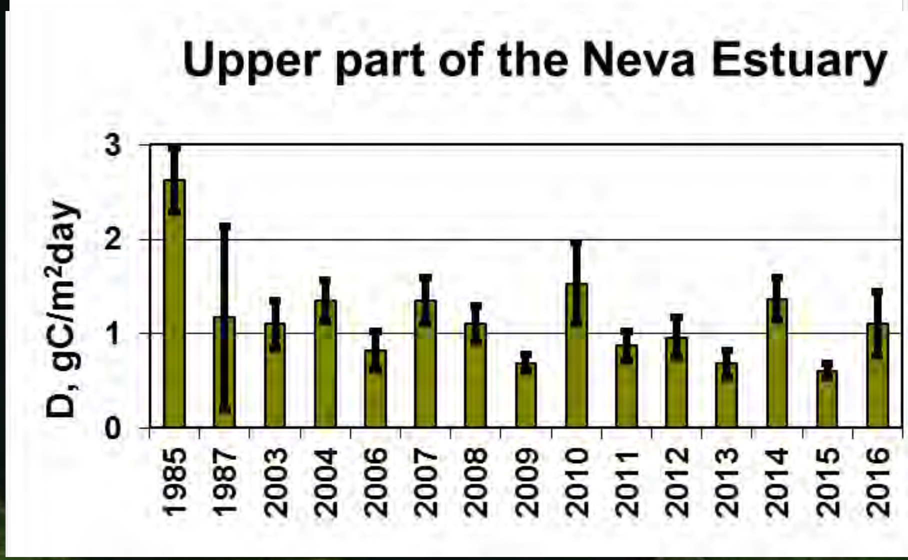


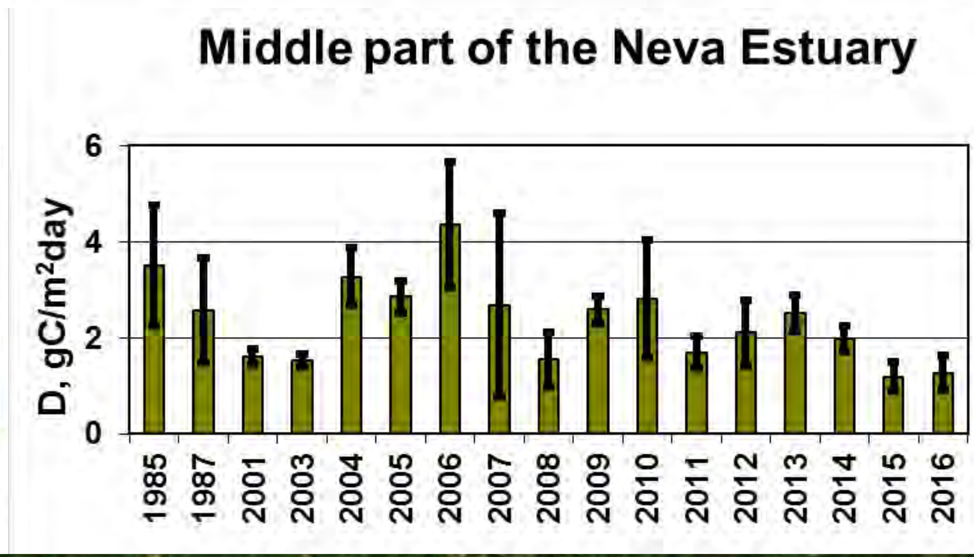
Data from Basova, 1986,1988; Telesh et al., 1999 and own data

Primary production of phytoplankton (PP) and decomposition of organic matter (D) in the Neva Estuary at the end of July and very beginning of August 2003-2016



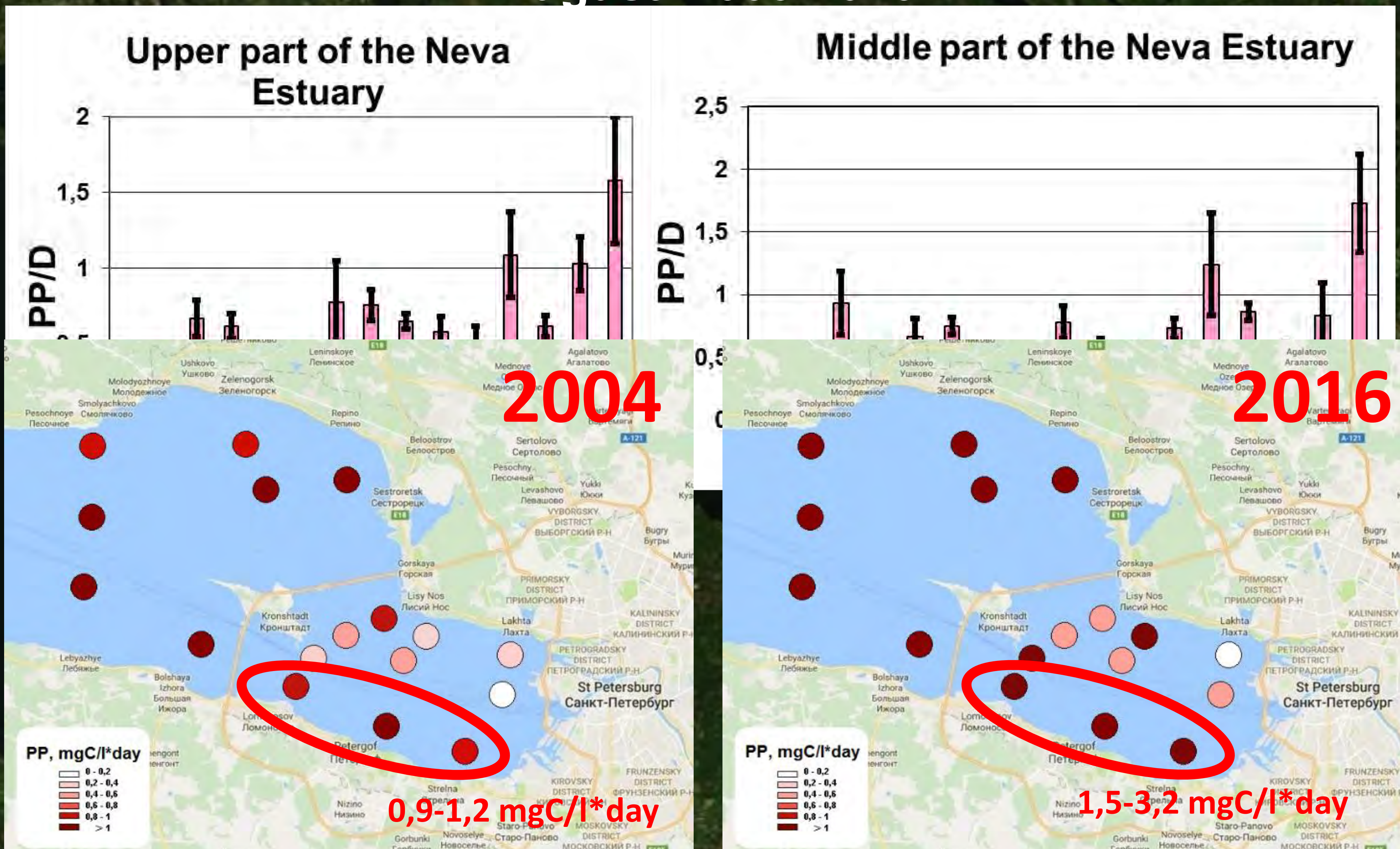






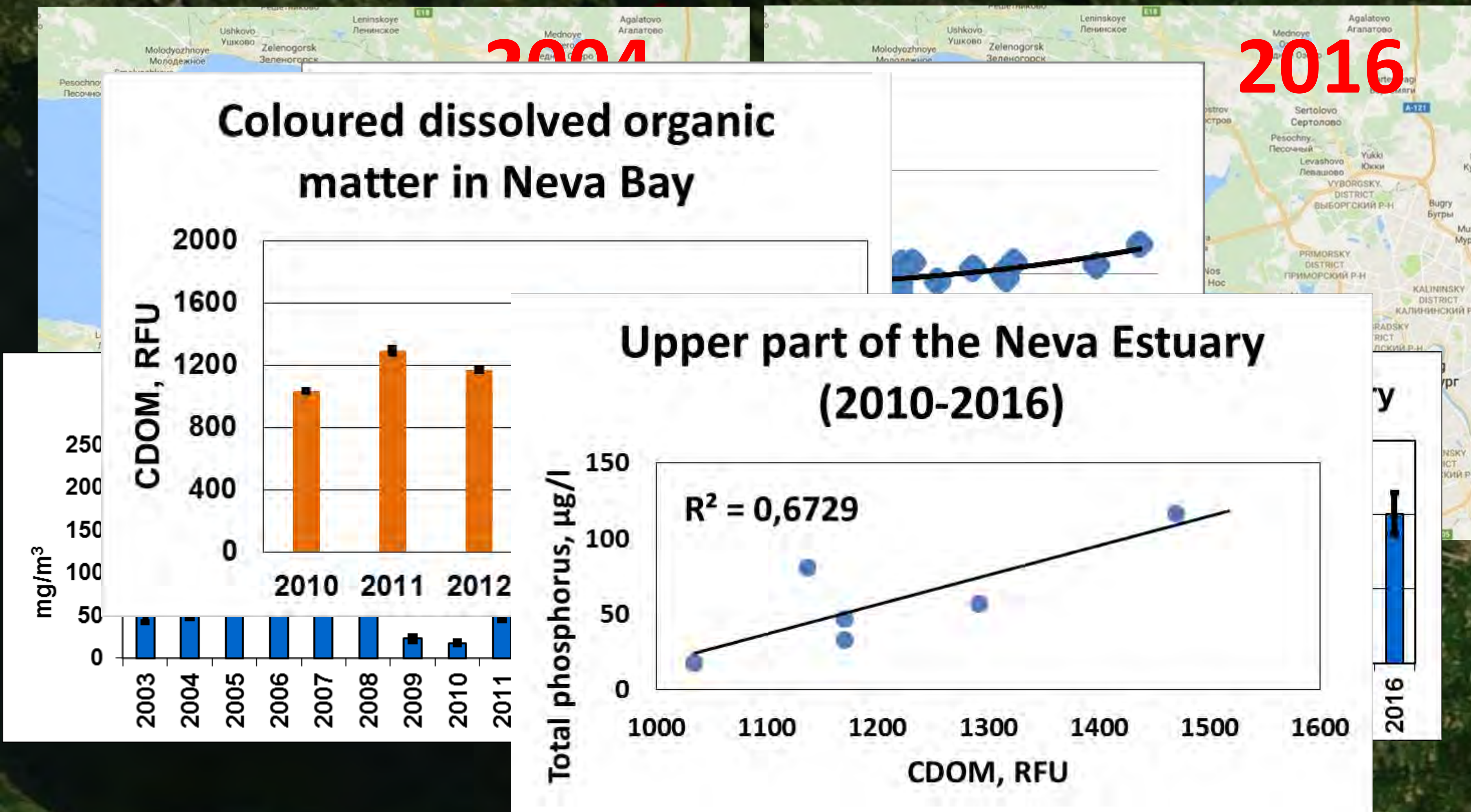
Data from Basova, 1986,1988; Golubkov et al. 2003 and own data

Ratio between primary production of phytoplankton and decomposition of organic matter in the Neva Estuary at the end of July and very beginning of August 2003-2016




Fazenda.spb.ru

Concentration of total phosphorus in the Neva Estuary at the end of July and very beginning of August 2003-2016



Conclusion

1. Investigations show the development of eutrophication process in Neva Bay and in the middle part of the Neva Estuary in recent decades, especially high was observed in 2016;
2. One of the reason of eutrophication process may be connected with the increase of nutrients input with waste waters from cottage villages around estuary;
3. Another reason of eutrophication may be increase of nutrients inflow from catchment area due to increase of precipitation in this region in recent years.


Thank you for your attention!

Gulf of Finland
Trilateral Scientific Forum
30th November–1st December, 2016
Finnish Environment Institute SYKE

1st Day

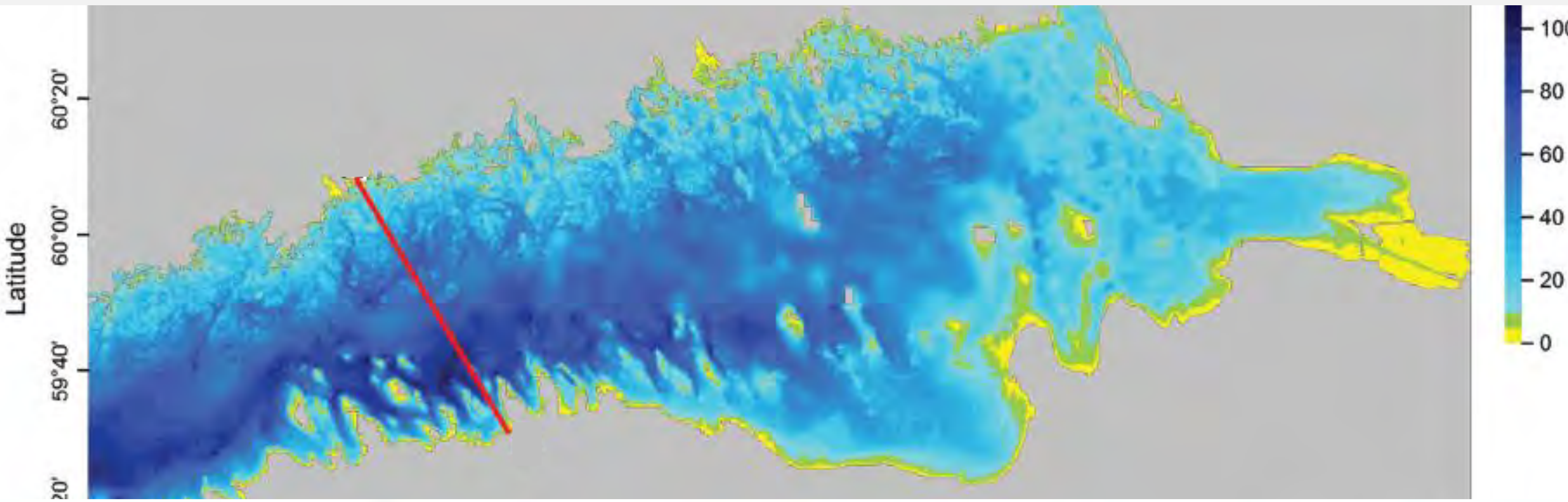
Gulf of Finland Co-operation

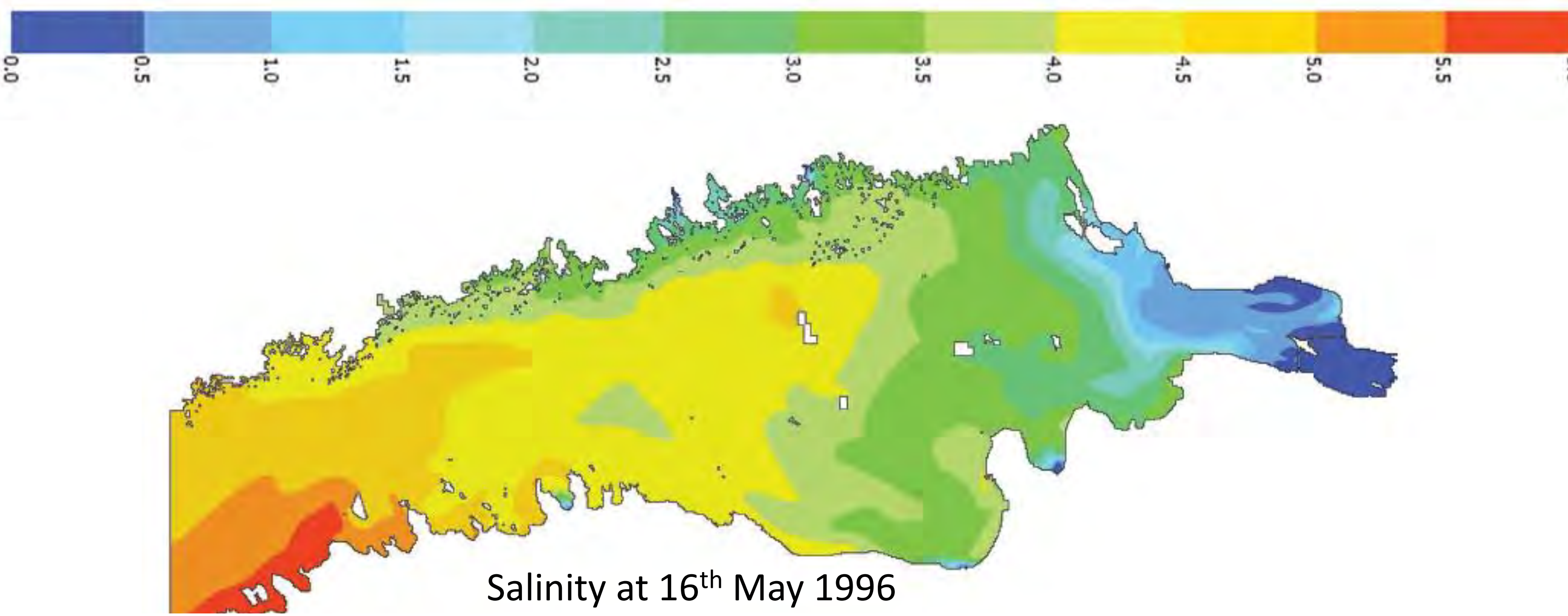
Harri Kuosa

The eastern Gulf of Finland eutrophication status according to GoF data set

The GoF dataset 1996 – 2013: A viewpoint on the eutrophication status in the Russian waters

Basic properties: Bathymetry and salinity

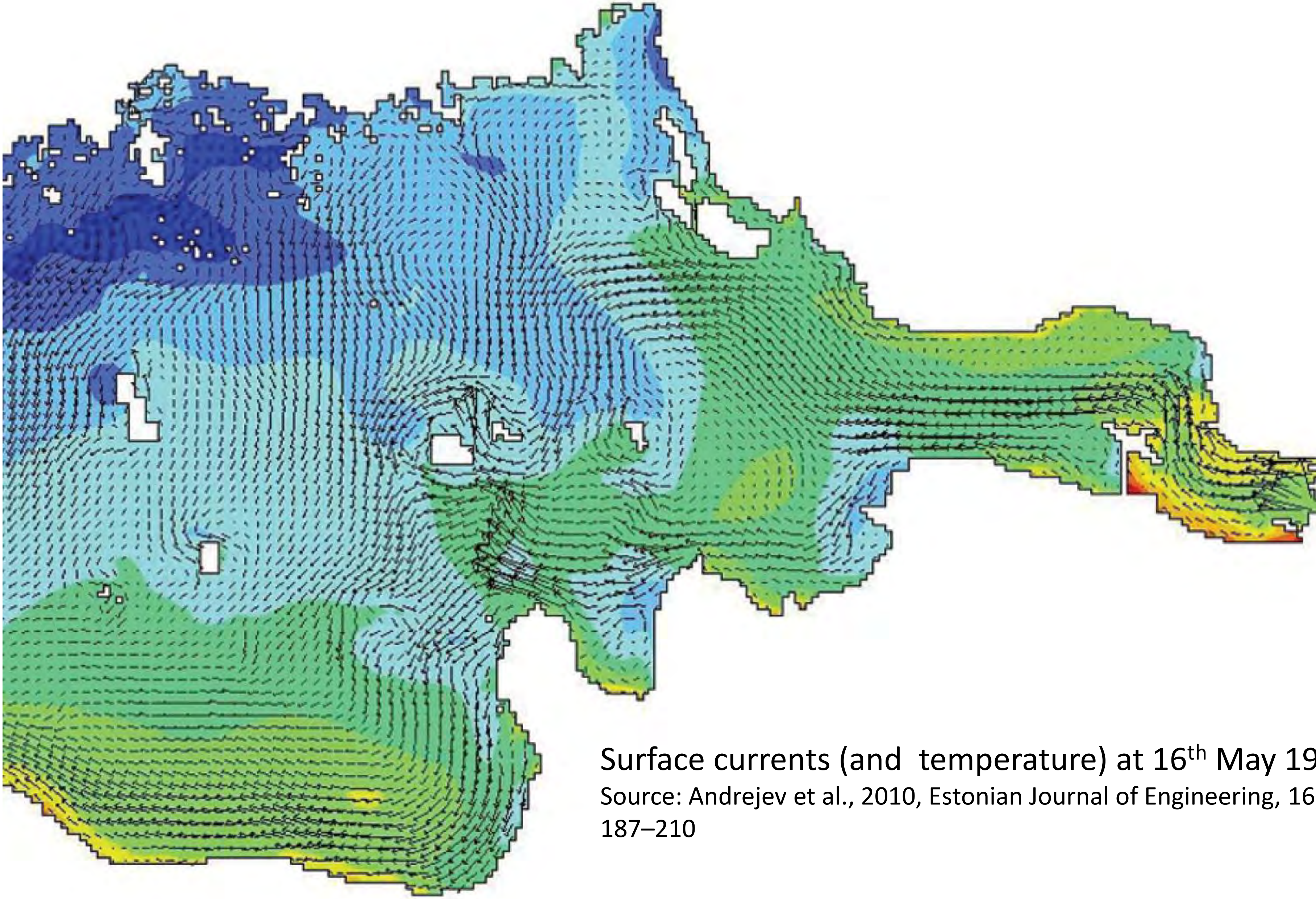




Salinity at 16th May 1996

Source: Andrejev et al., 2010, Estonian Journal of Engineering, 16,187–210

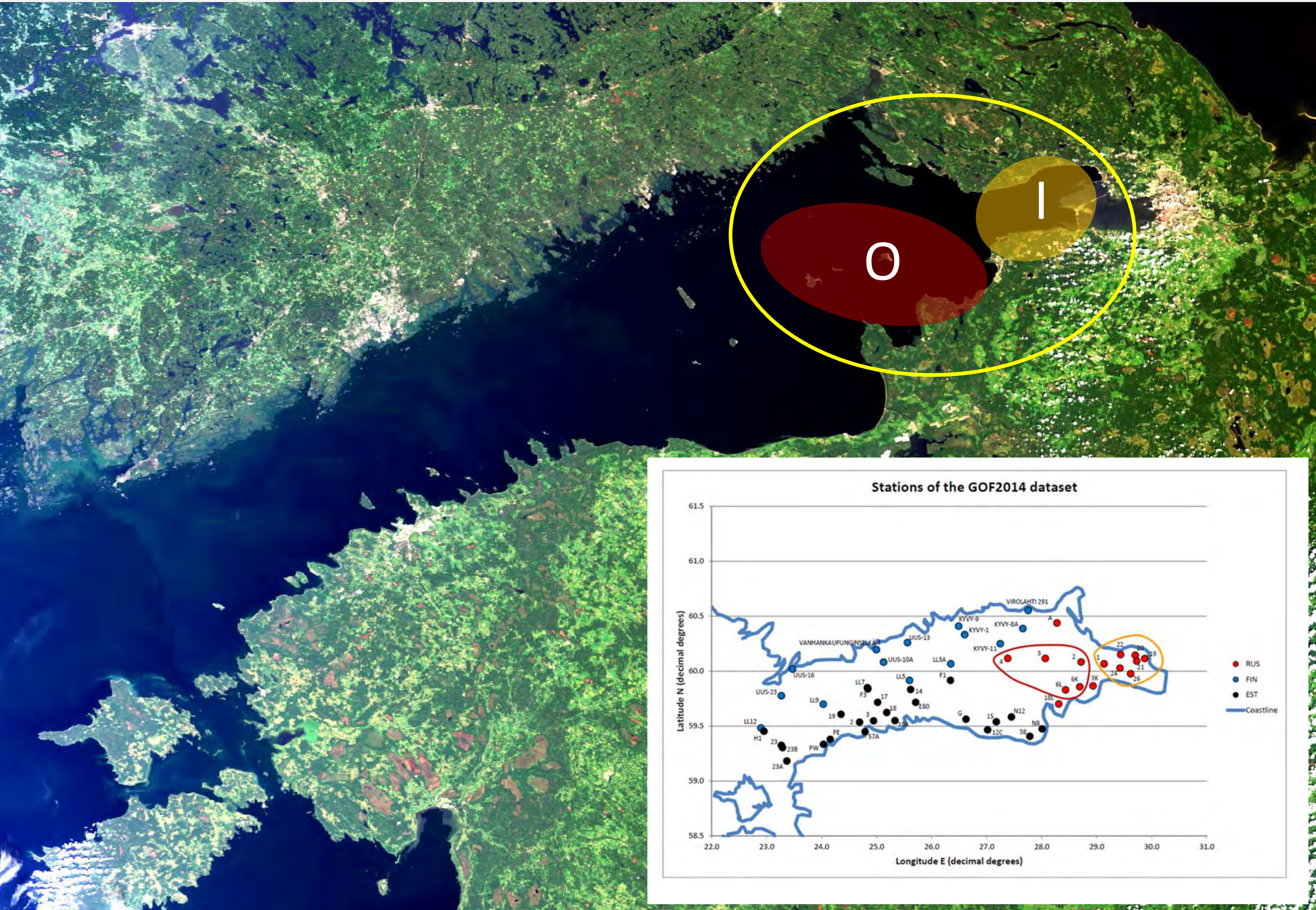
Basic properties: Surface currents



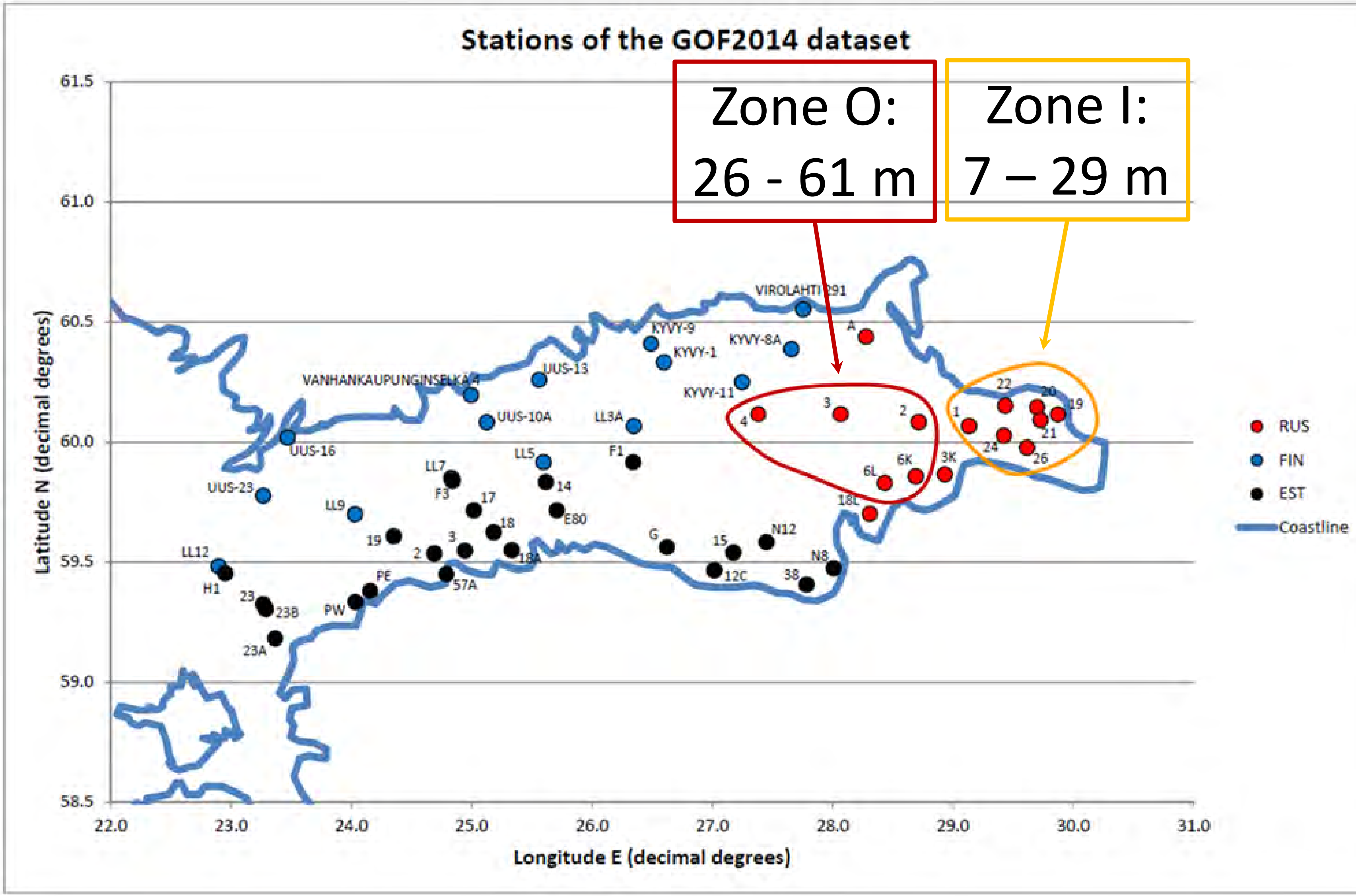
Surface currents (and temperature) at 16th May 1996

Source: Andrejev et al., 2010, Estonian Journal of Engineering, 16, 187–210

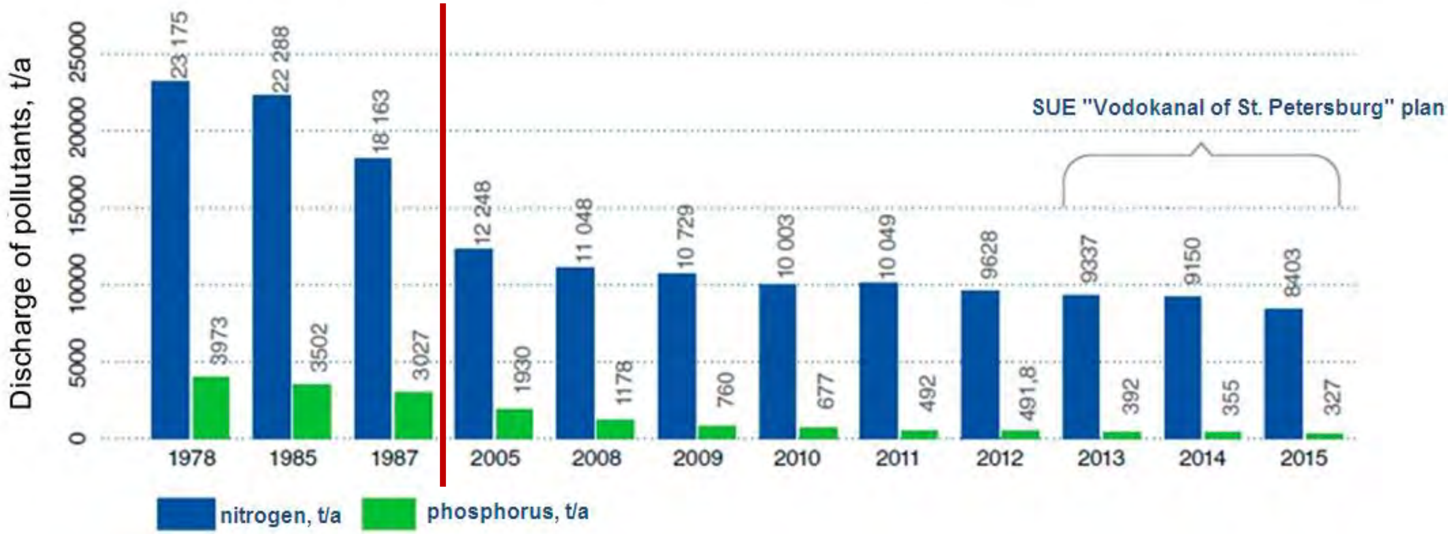
Gulf of Finland dataset: Zonation



Selected monitoring stations and zones

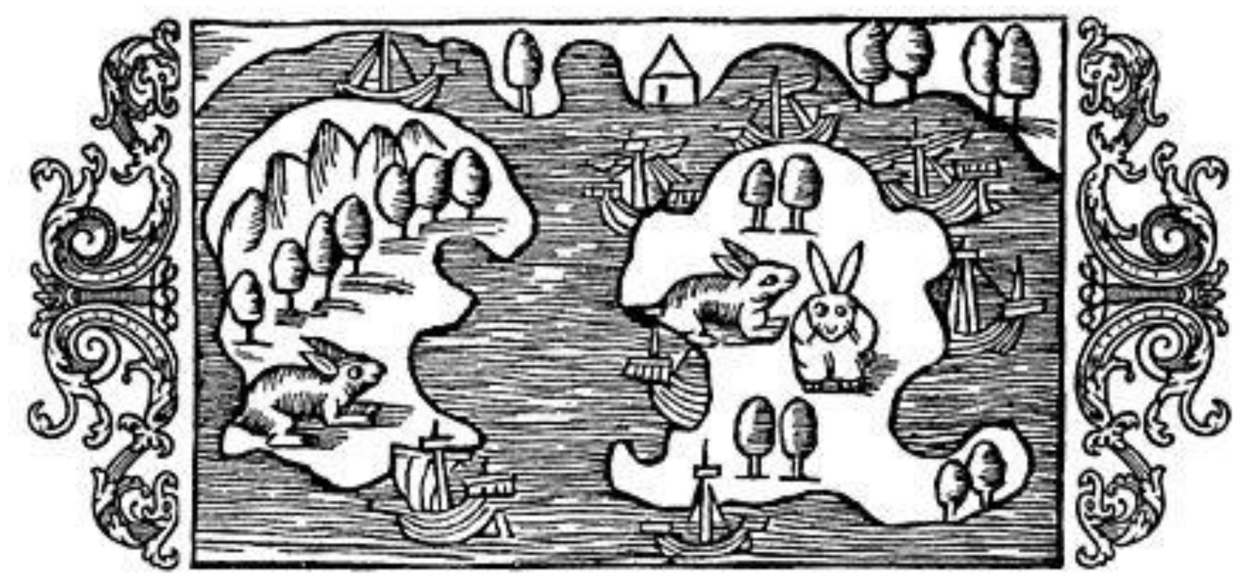


Expected changes: Periods 1996 – 2004 & 2005 - 2013



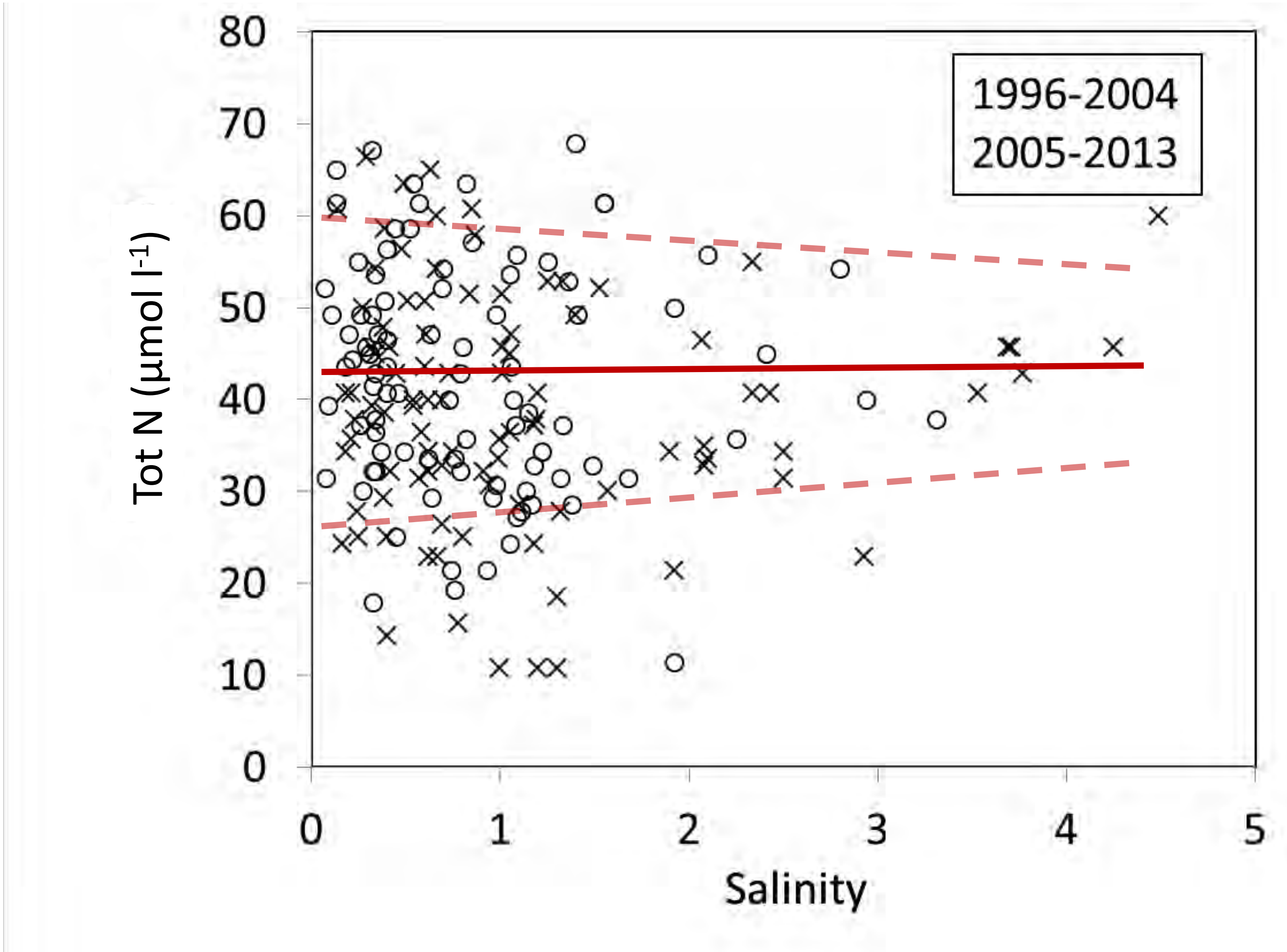
STATION	DATE	STATION DEPTH (m)	OBSERVATION DEPTH (m)	SALINITY (PSU)	TEMPERATURE (°C)	O_2 (ml l^{-1})
1	20.6.1996	29	0			
1	20.6.1996	29	5			
1	20.6.1996	29	10			
1	20.6.1996	29	15			
1	20.6.1996	29	20			
1	20.6.1996	29	27			
1	25.7.1996	29	0			
1	25.7.1996	29	10			
1	25.7.1996	29	20			
1	25.7.1996	29	28			
1	17.8.1996					
1	17.8.1996					
1	17.8.1996					
1	17.8.1996					
1	17.8.1996					
1	17.8.1996					
1	21.9.1996					
1	21.9.1996					
1	21.9.1996					
1	21.9.1996					
1	21.9.1996					
1	21.9.1996					
1	16.10.1996					
1	16.10.1996					
1	16.10.1996					

NO_{2+3}-N (µmol l^{-1})	NH_3-N (µmol l^{-1})	TotN-N (µmol l^{-1})	PO_4-P (filtered, µmol l^{-1})	Tot-P (µmol l^{-1})	CHL *a* (µg l^{-1})

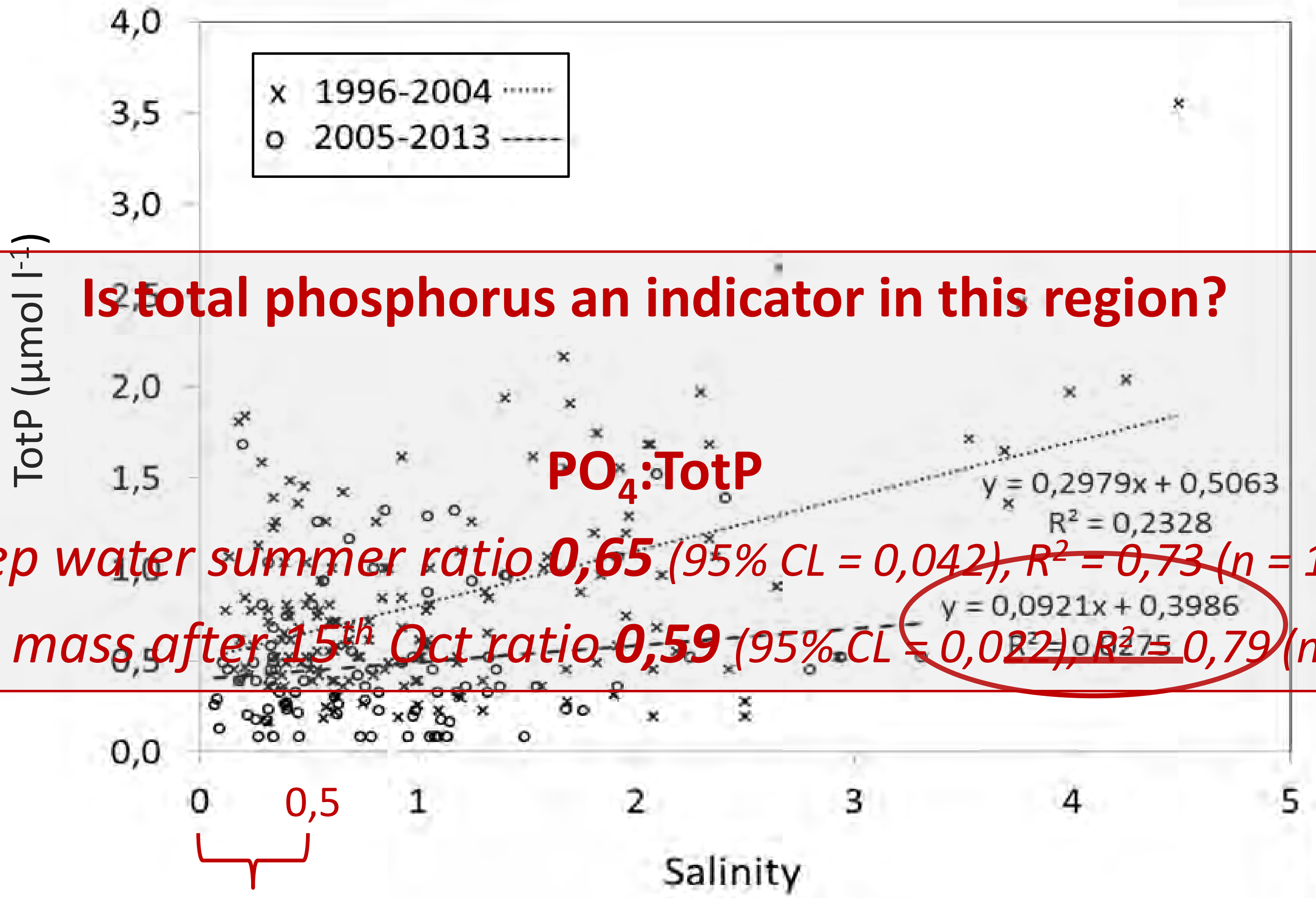


Inorganic nutrients: Summer/surface (µmol l^{-1})						
Zone	DIN 1996 – 2004	DIN 2005 - 2013	*p*	DIP 1996 - 2004	DIP 2005 – 2013	*p*
I	8,83	8,57	*n.s.*	0,20	0,20	*n.s.*
O	4,32	3,04	*n.s.*	0,15	0,17	*n.s.*

Potential eutrophication indicators: Total nitrogen (surface/summer)



Total phosphorus (surface/summer)



Is total phosphorus an indicator in this region?

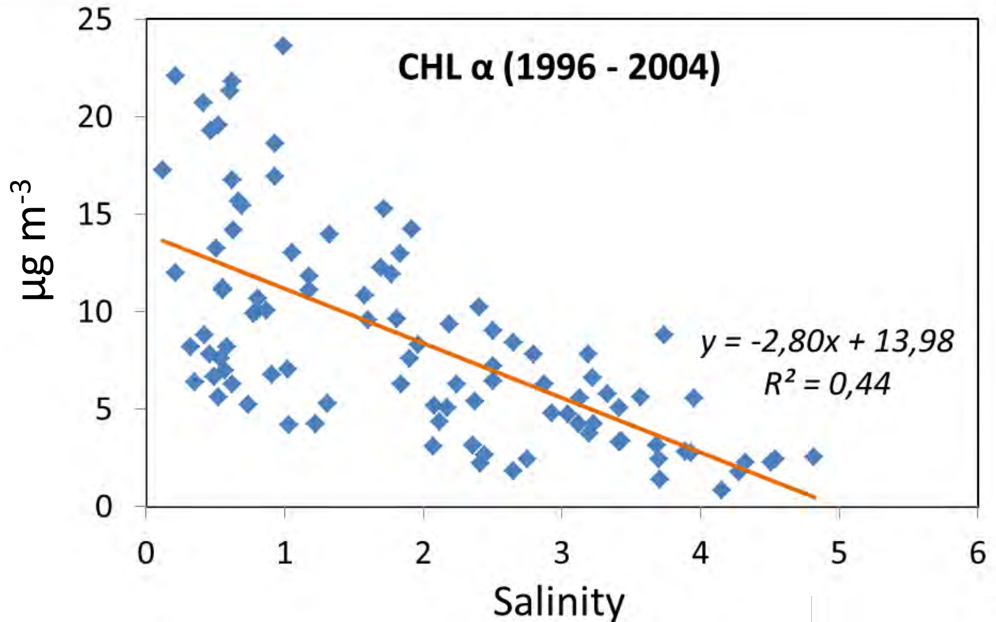
PO_4:TotP

Deep water summer ratio ***0,65*** *(95% CL = 0,042), R^2 = 0,73 (n = 128)*

Water mass after 15th Oct ratio ***0,59*** *(95% CL = 0,022), R^2 = 0,79 (n = 268)*

Period	**1996-2004**	**2005-2013**
TotP (µmol l^{-1})	*0,820*	*0,412*
n	*42*	*37*
p-value	*$4,67*10^{-6}$*	

Chlorophyll α (Zone I surface/summer)

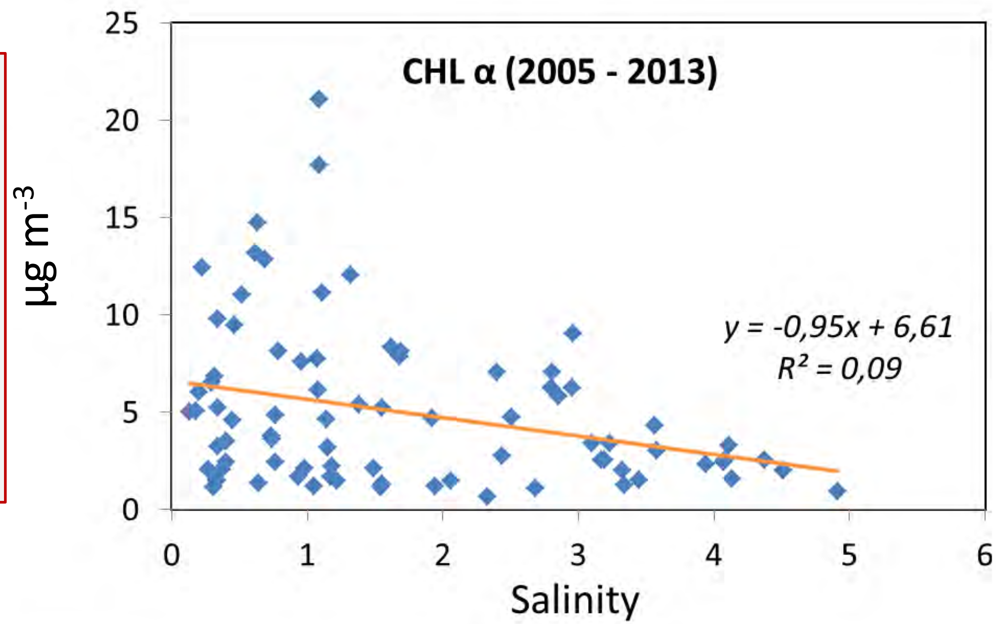


Zone I: Chlorophyll *a*

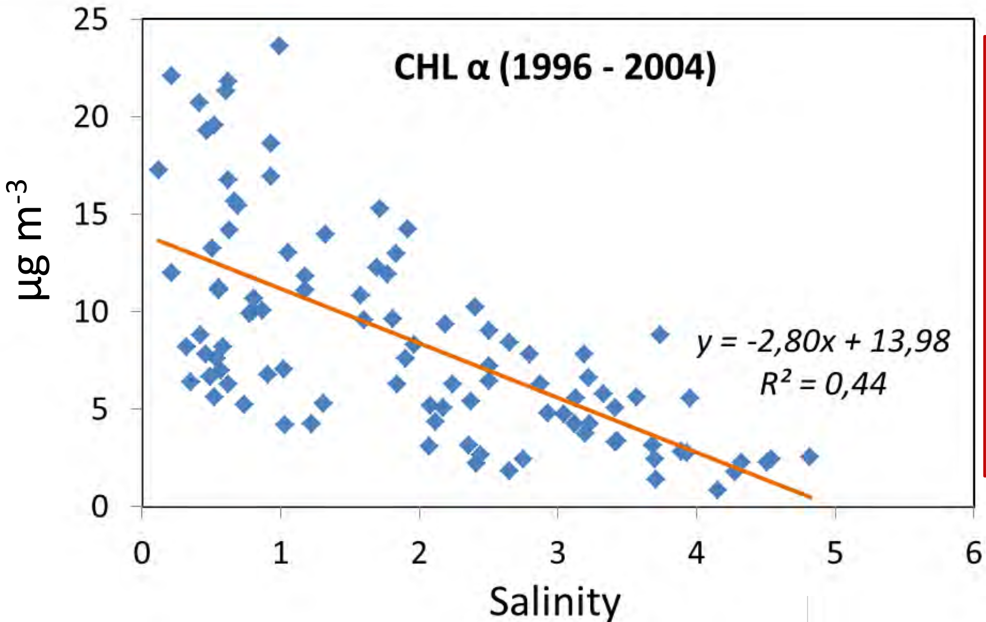
	1996-2004	2005-2013
	11,00	*5,96*
n	*54*	*50*
p-value	*$1,76*10^{-6}$*	

Zone I: Salinity

	1996-2004	2005-2013
	1,08	*0,83*
n	*57*	*50*
p−value	*n.s.*	

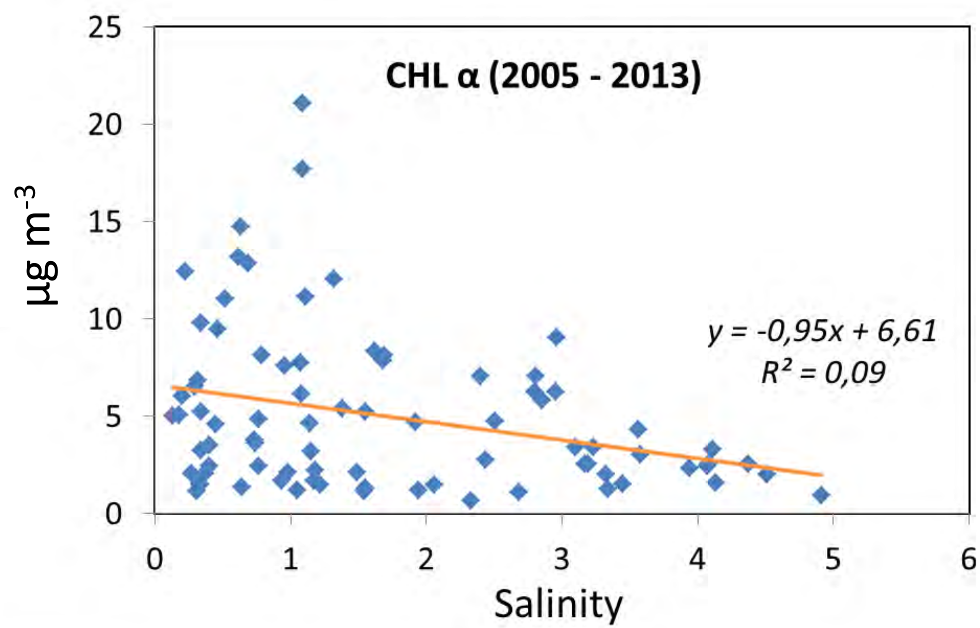


Chlorophyll α (Zone O surface/summer)



Zone O: Chlorophyll *a*

	1996-2004	2005-2013
	5,13	*3,42*
n	*41*	*31*
p-value	*0,017**	



Zone O: Salinity

	1996-2004	2005-2013
	3,14	*3,12*
n	*41*	*31*
p-value	*n.s.*	

Deep water dynamics in Zone O (= deepest sample)

Period (summer)	1996 – 2004	2005 – 2013	*p-value*	
Salinity	5,55	5,69	*n.s.*	
Temperature (°C)	4,76	6,07	*0,024**	
TotP (µmol l^{-1})	2,41	1,70	*0,008***	-29%
PO_4 (µmol l^{-1})	1,69	1,22	*0,032**	-28%
[DIN (µmol l^{-1})	8,52	9,87	*n.s.*] !small n	
Oxygen (ml l^{-1})	4,48	4,10	*n.s.* !sample >> bottom	

(SURFACE)				
(Salinity)	3,14	3,12	*n.s.*	
(Chlorophyll *a*; µg l^{-1}))	5,13	3,42	*0,017**	-33%

Conclusions

The GoF dataset points at changes in:

- Chlorophyll concentrations (summer)
- Phosphorus in more fresh water part
- Deep water phosphorus
- Hydrography does not explain the changes
- The analysis suggests a positive change in the Eastern Gulf of Finland

BUT

- Are these conclusions valid?
- Does this story correspond to other datasets?
- Can the analysis be strengthened?

Gulf of Finland
Trilateral Scientific Forum
30th November–1st December, 2016
Finnish Environment Institute SYKE

1st Day

Gulf of Finland Co-operation

Vladimir Ryabchenko, Isaev A, Eremina T, Savchuck O, Vankevich R

Model estimates of the eutrophication of the Baltic Sea and Gulf of Finland in modern and future climate

Model estimates of the eutrophication of the Baltic Sea and Gulf of Finland in modern and future climate

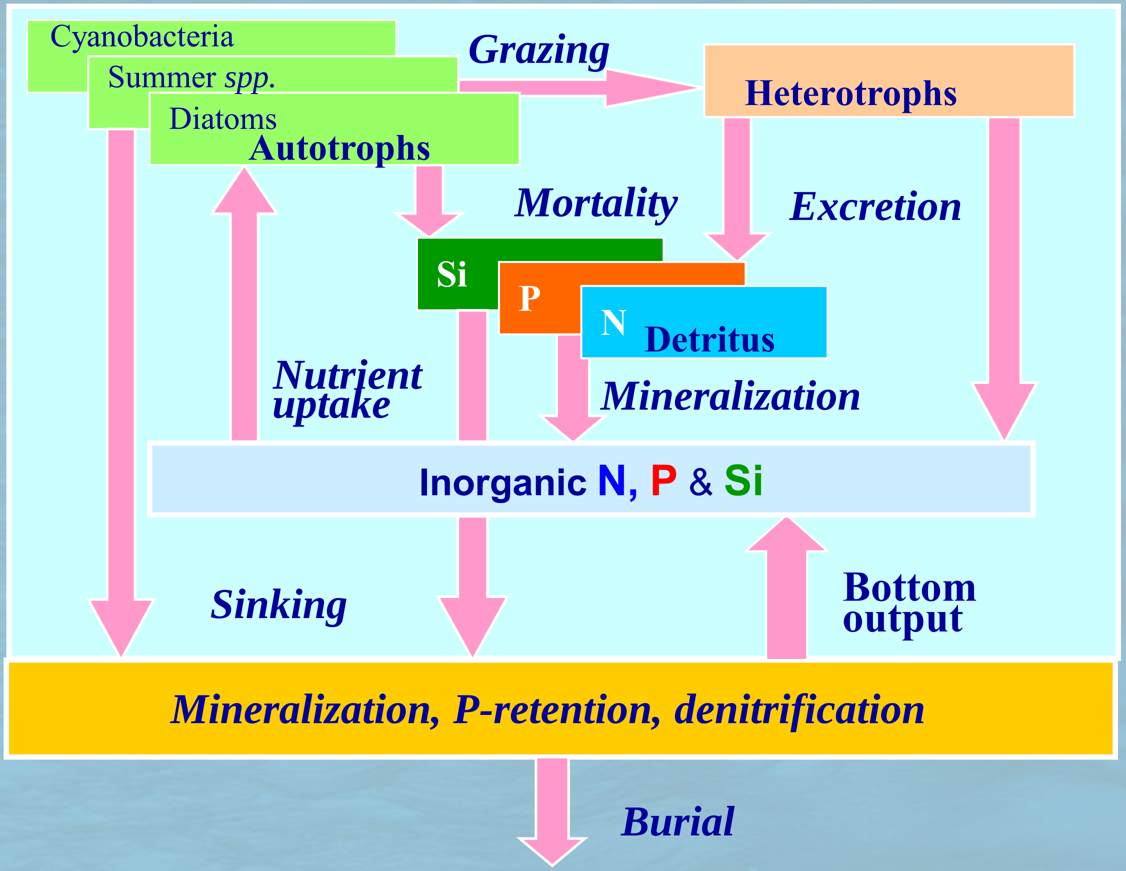
Vladimir Ryabchenko[1], Alexey Isaev[1,2] , Oleg Savchuck[3] , Tatjyana Eremina[2], Roman Vankevich[1,2]

[1]St. Petersburg Branch of P.P. Shirshov Institute of Oceanology, RAS
[2]Russian State Hydrometeorological University, St.Petersburg
[3]Baltic Nest Institute, Baltic Sea Centre, Stockholm University

Trilateral Scientific Forum
30 Nov – 1 Dec 2016 , SYKE, Helsinki

SPBEM
St.Petersburg Baltic Eutrophication Model

Biogeochemistry module



is based on the model of

O.Savchuk, 2002, J.Mar.Systems, **32**, 253– 280

describes N, P and Si cycling in the coupled pelagic and sediment sub-systems

has 12 pelagic & 3 sediment state variables

4 SCENARIOS OF CLIMATE & LOAD CHANGES

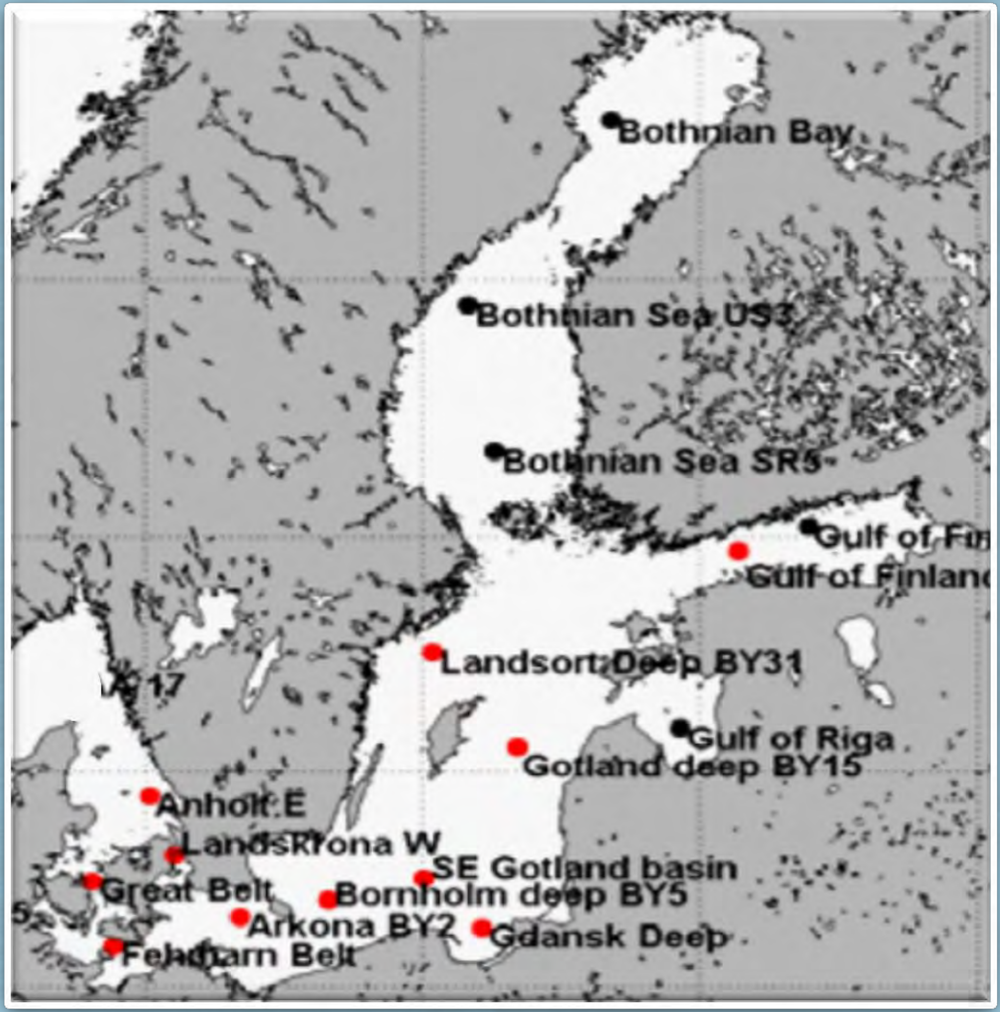
Scenario of CO_2 emission	Global climate model	Loads scenario name	Land loads		
			1971-2007	2007-2020	2021-2100
A1B	ECHAM5	REF	Observed mean monthly values	Fixed as mean values averaged over 1997-2003	
A1B	ECHAM5	BSAP	same	Linear Reduction to BSAP target	Fixed target values
A1B	HadCM3	REF	same	Fixed as mean values averaged over 1997-2003	
A1B	HadCM3	BSAP	same	Linear Reduction to BSAP target	Fixed target values

ECHAM5/MPI-OM from the Max Planck Institute for Meteorology in Germany
HadCM3 from the Hadley Centre in the UK

Roeckner et al. 2006; Jungclaus et al. 2006

Gordon et al. 2000

VERIFICATION



Map of the location of 16 oceanographic monitoring stations from the Baltic Environment Database (BED)

Averaged Data from

Gustafsson and Rodriguez-Medina, 2011

Model-data comparison

Mean observed (D) and difference (Δ) of observed and simulated values averaged over 16 stations (1971-2000), and amount of stations in different ranges of "cost" function (C)

Scenario	Upper layer (0-10m)								Near-bottom layer				
	T ann	T wint	T sum	S ann	NO_3 wint	PO_4 wint	O_2 Summ	Chl summ	T ann	S ann	NO_3 wint	PO_4 wint	O_2 aut
	° C			‰	mmol $м^{-3}$		ml/l	mg m^{-3}	° C	‰	mmol $м^{-3}$		ml/l
D_{obs}	8.0	1.7	14.4	8.8	5.6	0.5	7.3	2.5	5.4	14.0	6.0	1.6	4.0
Δ ECHAM5	1.1	0.7	1.5	1.5	0.9	0.3	-0.5	0.7	0.5	0.1	3.2	-0.1	0.5
$0 \le C < 1$	16	13	15	5	11	5	15	5	10	2	5	9	11
$1 \le C < 2$	0	3	1	1	3	9	1	8	4	6	3	3	4
Δ HadCM3	0.5	-0.6	2.1	3.7	-0.3	0.3	-0.5	0.4	-0.1	2.0	1.8	-0.1	0.5
$0 \le C < 1$	16	14	13	4	10	5	15	4	8	2	7	9	10
$1 \le C < 2$	0	2	3	0	5	8	1	10	7	4	3	3	6

$$C = \left| \frac{M - D}{S_d} \right|$$

$0 \le C < 1$ – good agreement

$1 \le C < 2$ – satisfactory

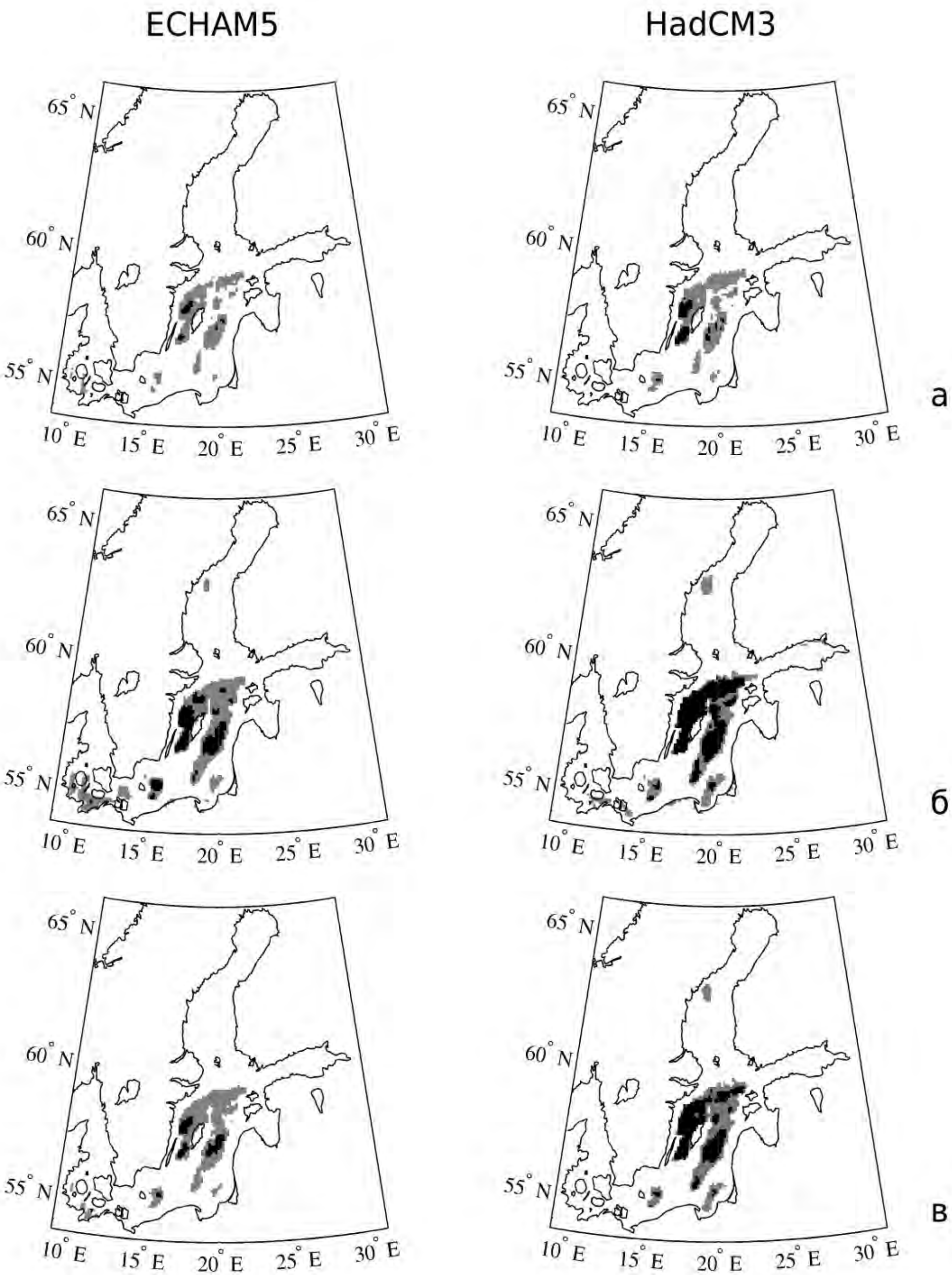
$2 \le C$ – bad.

RESULTS

The difference between the future(2071-2100) and modern(1971-2000) values of parameters

	Upper layer (0-10m)								Near-bottom layer				
REF	ΔT ann	ΔT wint	ΔT summ	ΔS ann	ΔNO_3 wint	ΔPO_4 wint	ΔO_2 sum	ΔChl summ	ΔT ann	ΔS ann	ΔNO_3 wint	ΔPO_4 wint	ΔO_2 aut
ECHAM5	2.1	2.7	1.4	-0.8	2.5	0.4	-0.6	0.8	1.0	-0.3	0.9	0.6	-1.3
HadCM3	2.9	2.9	2.5	-0.2	1.3	0.6	-1.1	0.8	1.2	-0.1	-0.1	0.9	-1.8
BSAP													
ECHAM5	2.1	2.7	1.4	-0.8	1.4	0.3	-0.3	0.3	1.0	-0.3	0.4	0.5	-0.8
HadCM3	2.9	2.9	2.5	-0.2	0.7	0.5	-0.6	0.4	1.2	-0.1	0.0	0.7	-1.0

1. Temperature increase in future climate, especially in summer, is higher in HadCM3 runs
2. In REF runs, O2 decrease is greater with HadCM3 than with Echam5 forcing
3. Oxygen decrease in near-bottom layer is less in BSAP runs than in REF runs. Unlike ECOSUPPORT simulations, there is an decrease rather than increase of near- bottom oxygen.



Averaged for August–September, anoxic ($O_2 \leq 0$ mL/L, in black) and hypoxic ($0 < O_2 < 2$ mL/L, in gray) areas in the Baltic Sea:

in the modern period (mean over 1971–2000) (a)

in the future (2071–2100 mean) in reference scenarios (b)

in the future (2071–2100 mean) in BSAP scenarios (c)

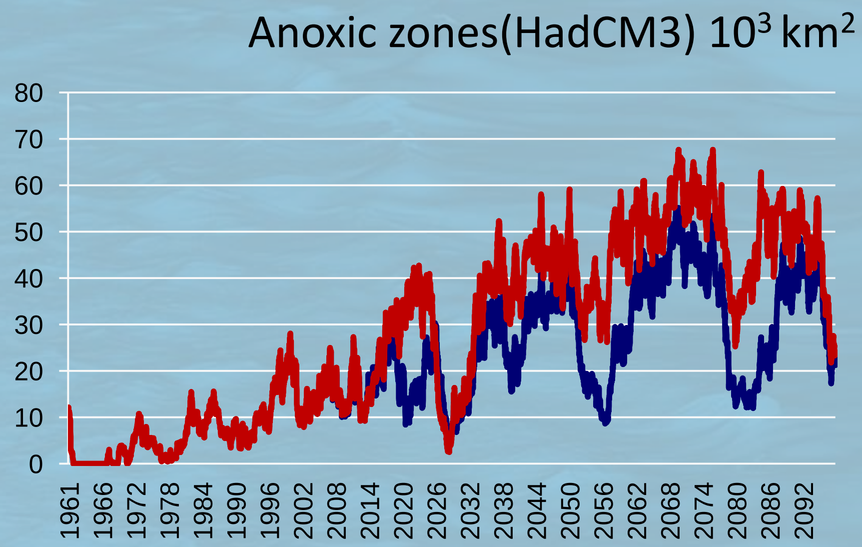
Left – ECHAM5 forcing
Right – HadCM3 forcing

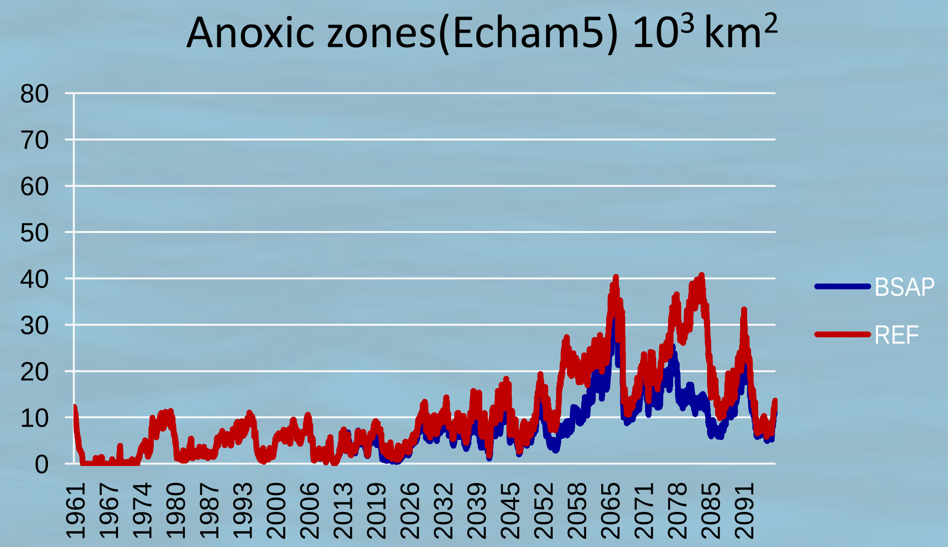
Long-term average (1970-2005) *m* and standard deviation *σ* of area S_{hypo} of hypoxic zones (in 10^3 km^2) for different models

Model /data	**Data (BED)**	**BALTSEM**	**ERGOM**	**RCO–SCOBI**	**Ensemble**	**SPBEM (ECHAM5)**	**SPBEM (HadCM3)**
S_{hypo}, m	49	58	54	57	56	46	53
S_{hypo}, σ	12	15	6	7	8	11	11

RESULTS

Comparison between REF and BSAP runs

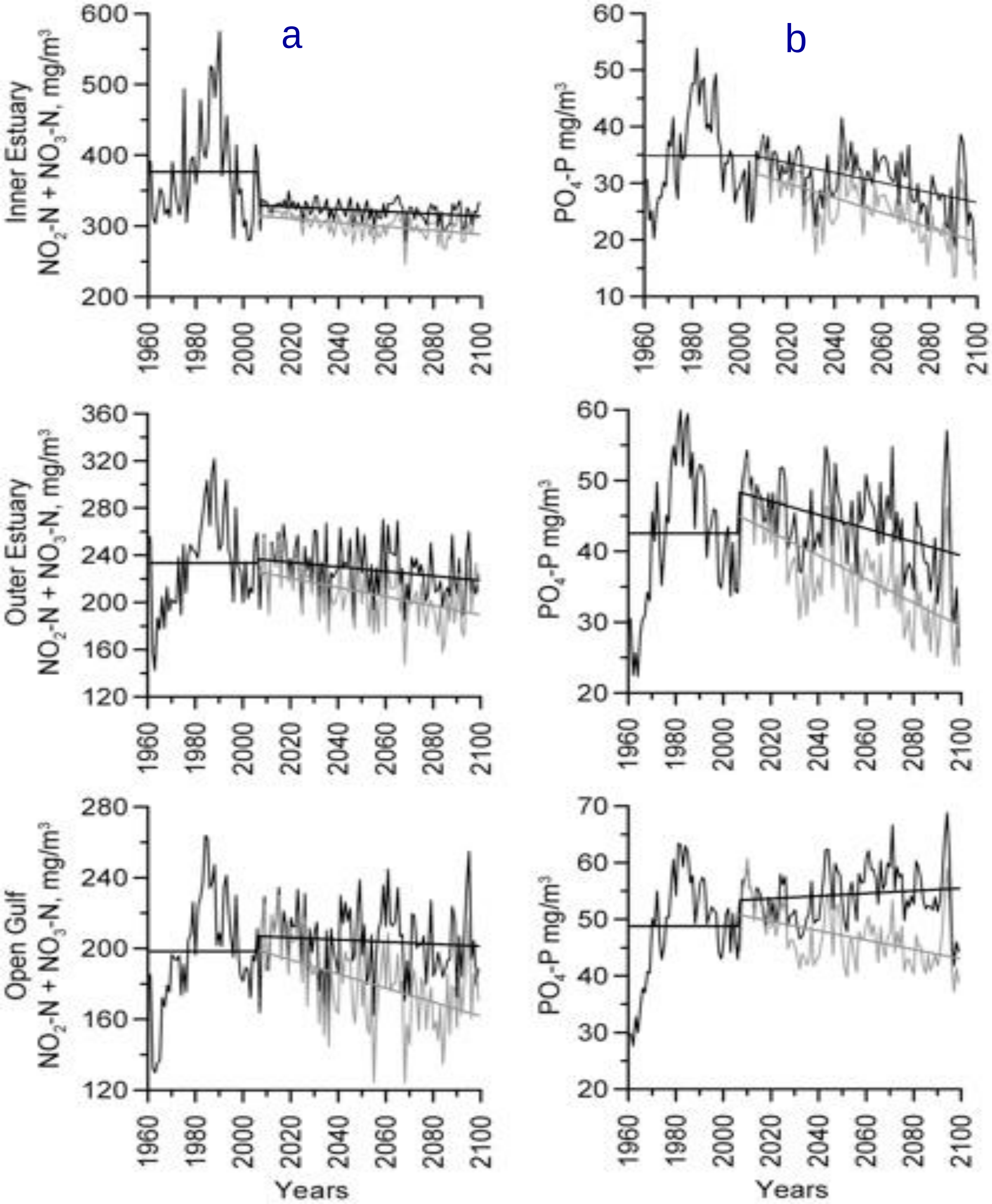




1. Nutrient load reduction suggested in BSAP will not lead to any fundamental changes in the water quality in the end of this century.
2. Areas of anoxia and hypoxia will grow in future climate, but slower than in the reference runs.

CONCLUSIONS
The whole Baltic Sea

1. Changes in eutrophication indicators in reference HadCM3 driven run is greater than in similar ECHAM5 driven run.
2. According to the ECHAM5 and HadCM3-driven BSAP scenario simulations, nutrient load reduction suggested in BSAP will not lead to any fundamental changes in eutrophication indicators in the end of this century. In particular, areas of anoxia and hypoxia will grow, but slower than in the reference runs.
3. The estimates are qualitatively consistent with the estimates of ECOSUPPORT, but impact of climate change on eutrophication was much stronger.



ECHAM5 driven runs

The winter depth-averaged concentrations of nutrients in 1961 – 2100 according to REF (black lines) and BSAP (grey lines) scenarios.
Straight lines: average concentration for the current period (1961 – 2006) and a linear trend in the future (2007 – 2100).
a - nitrate + nitrite
b - phosphate

Conclusions
Eastern Gulf of Finland

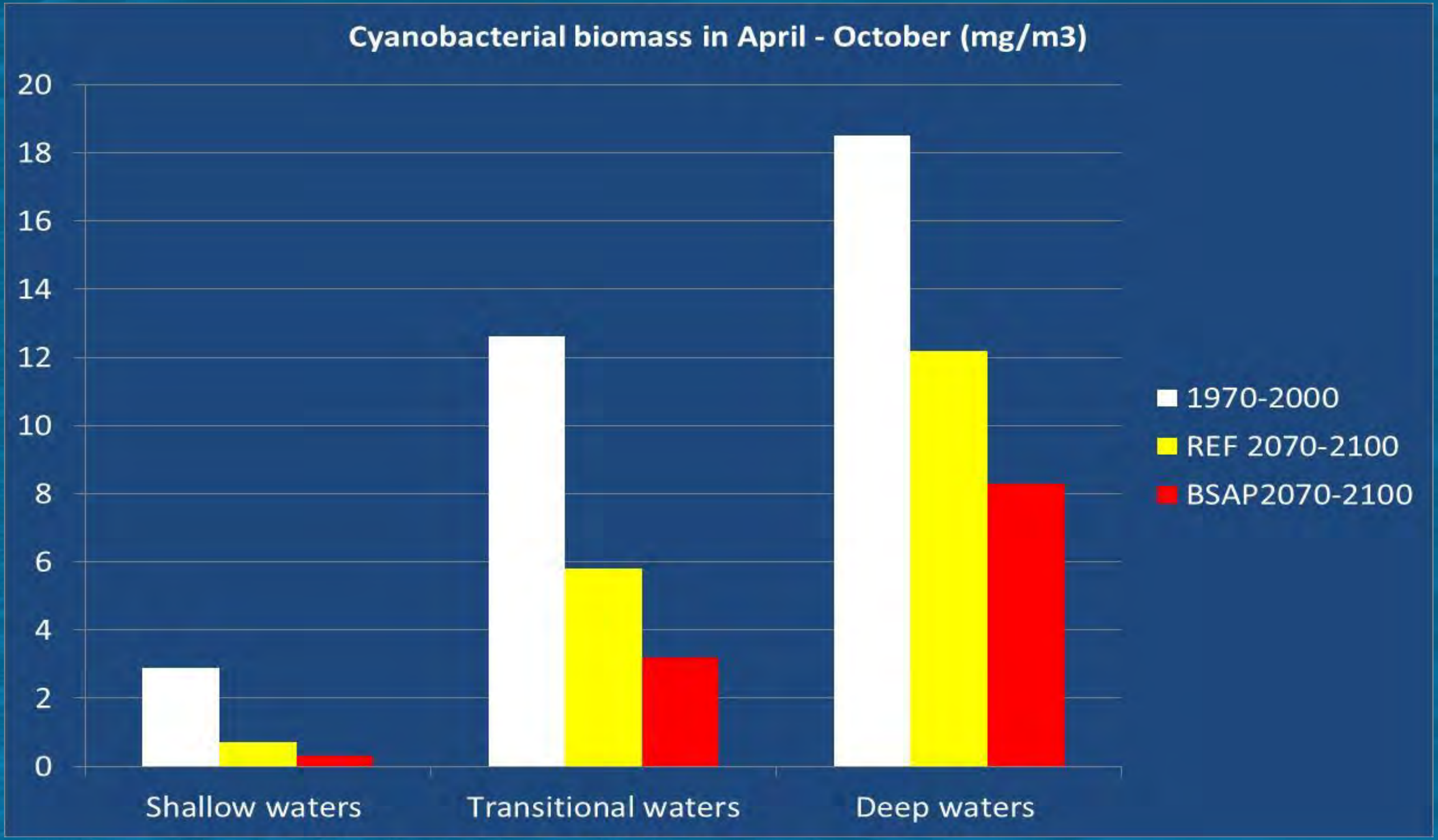
1. The reference ECHAM5 scenario suggests that the future climatic changes in the most eastern GOF area will lead to:

1) increased surface temperature and riverine inflow,
2) reduced salinity and weakened salinity stratification,
3) a rise of the bottom water oxygen concentration,
4) decreased release of P and N from the sediments, and
5) decreased nutrient stocks in the water.

2. Unlike the Baltic Sea as a whole, the DIN and DIP concentrations in the inner and external estuaries in the future climate would decrease rather than increase.

3. The BSAP scenario, if realized, will lead to a pronounced decrease in the DIN and DIP concentrations in all the sub-areas of the most eastern GOF area by the end of the 21^{st} century.

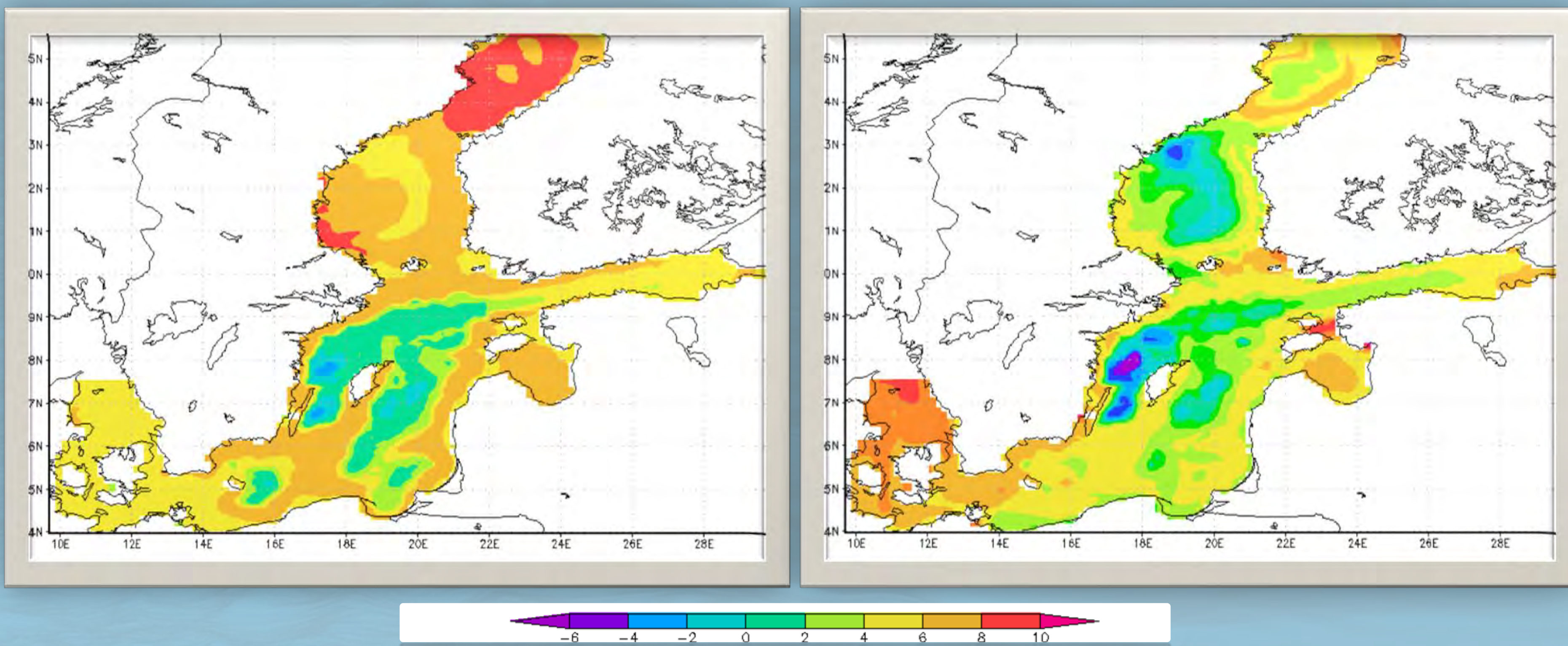
Shallow water – inner estuary, transitional waters – external estuary, deep water – open GoF



Cyanobacterial biomasses (mg/m^3) in the eastern GOF at present and in the future according to the combined effect of the climate change and decreased external loads (BSAP).

RESULTS

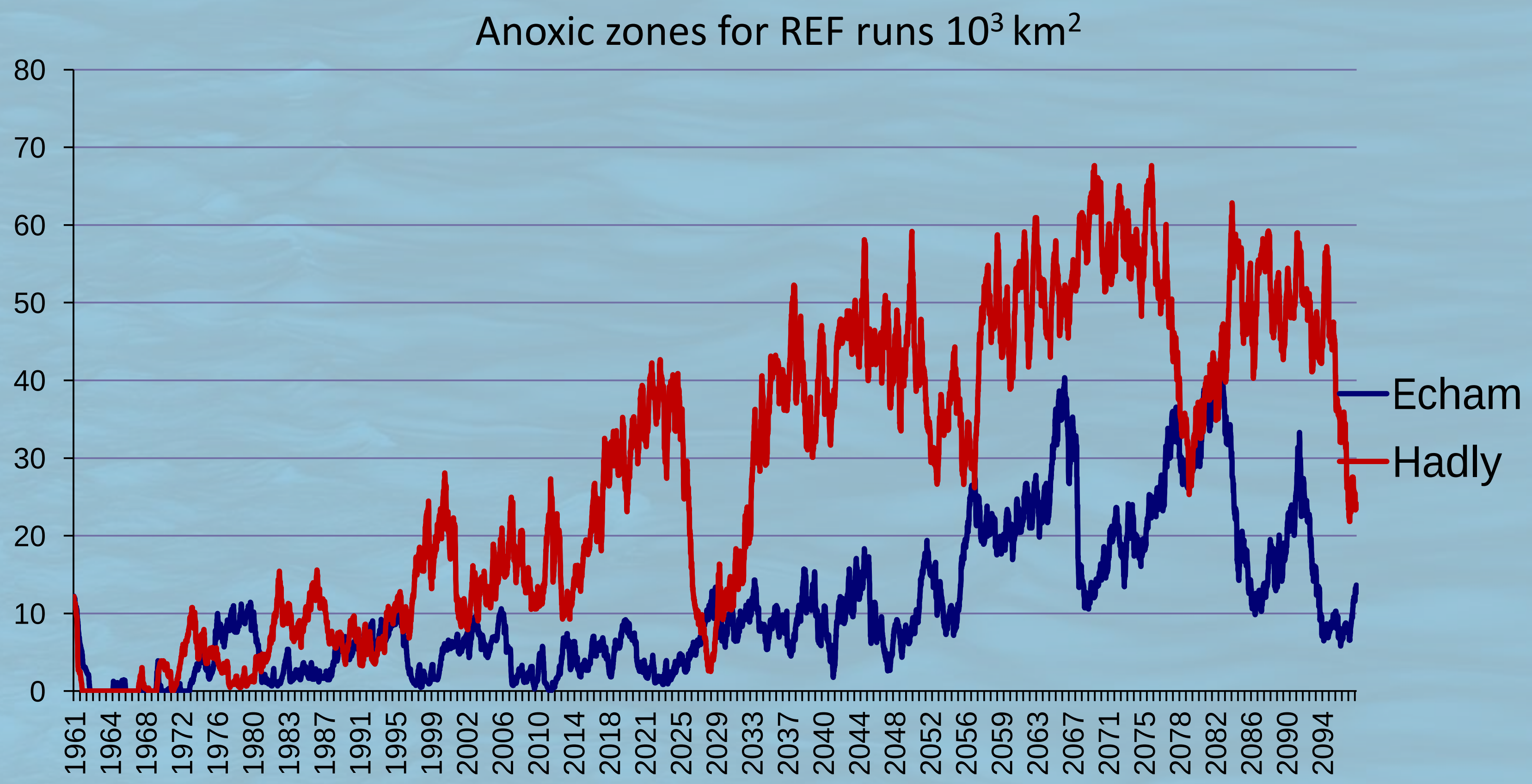
Oxygen concentration in the near-bottom layer in the case of HadCM3 forcing with REF loads



Modern(1971-2000)

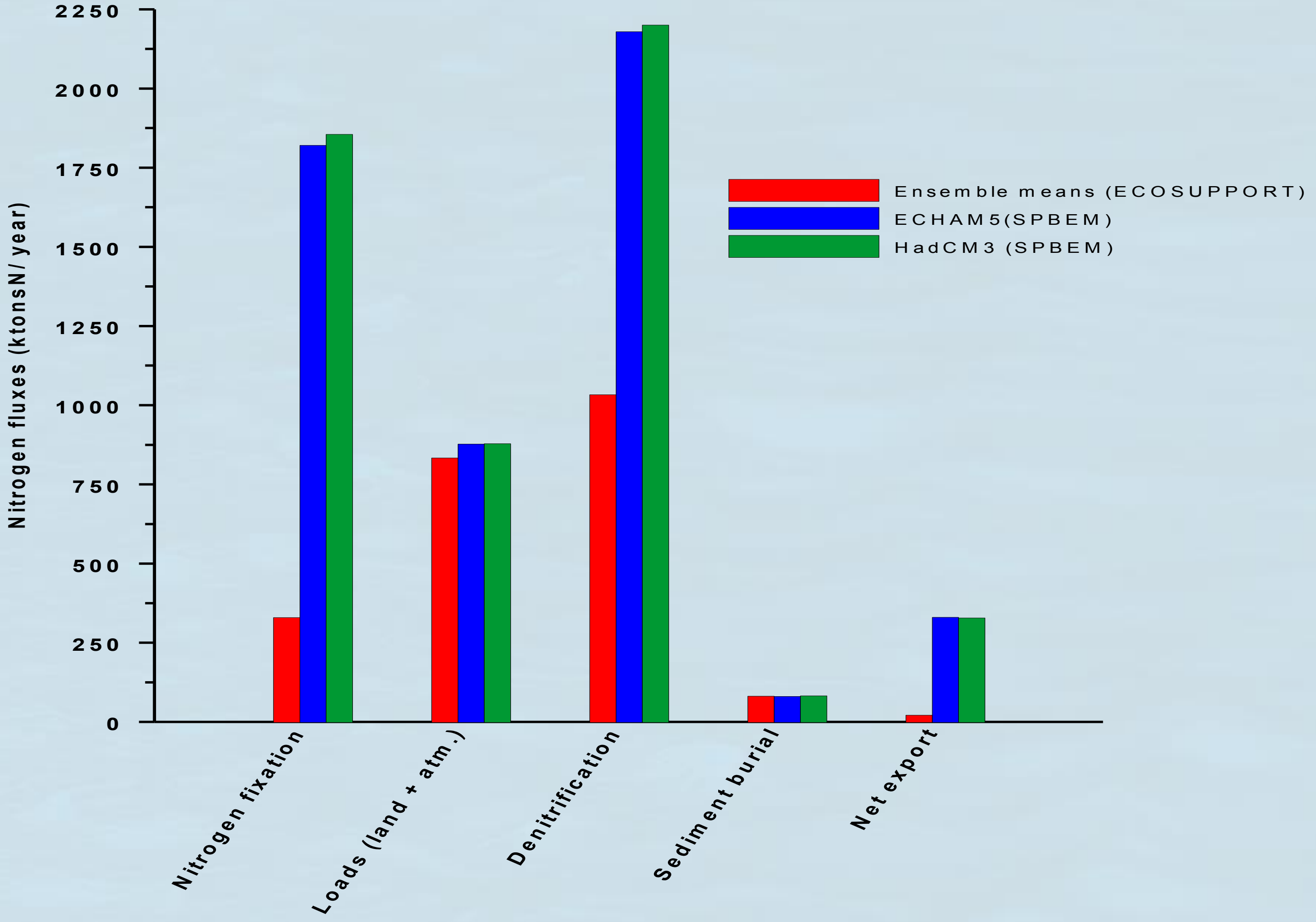
Future(2071-2100)

RESULTS



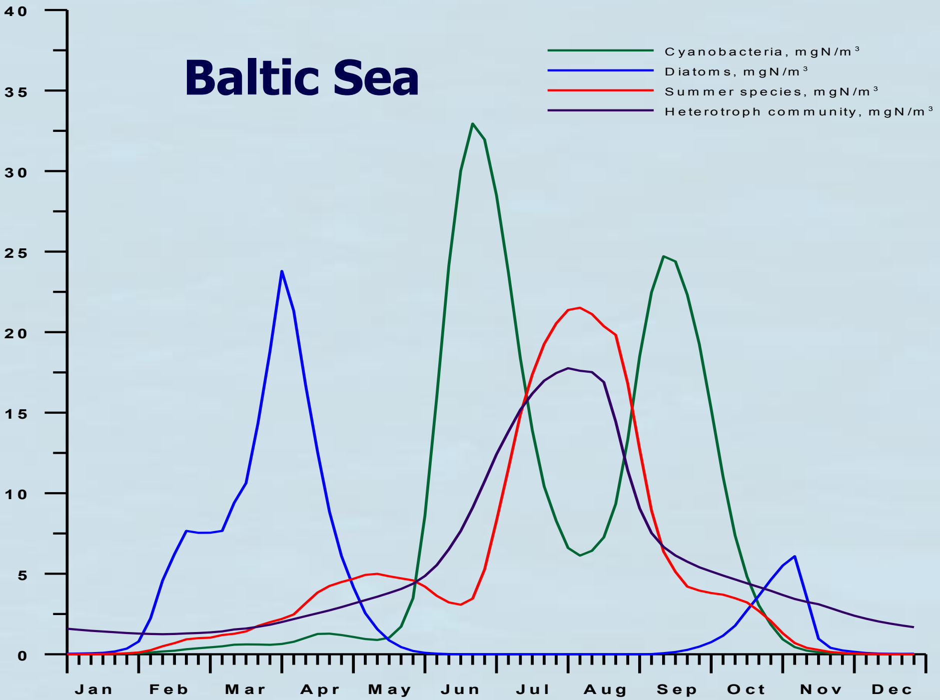
Anoxic zones by the end of 21st century will be wider, compared to current conditions in reference ECHAM5 and HadCM3 runs.

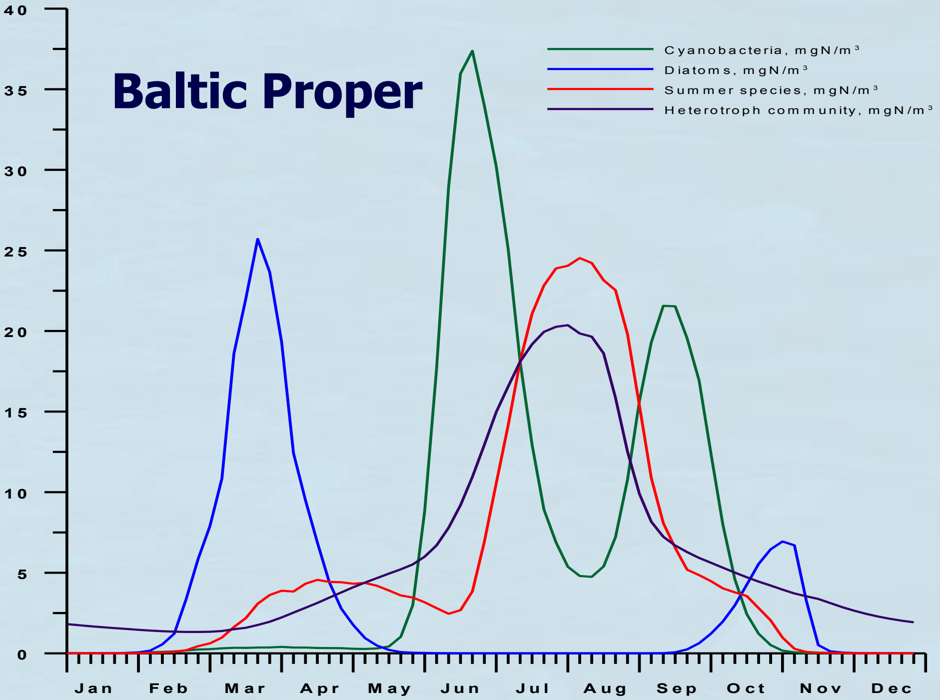
Modern climate, 1971-2000



Nitrogen fixation and denitrification in SPBEM runs are much higher than in ECOSUPPORT ensemble simulations

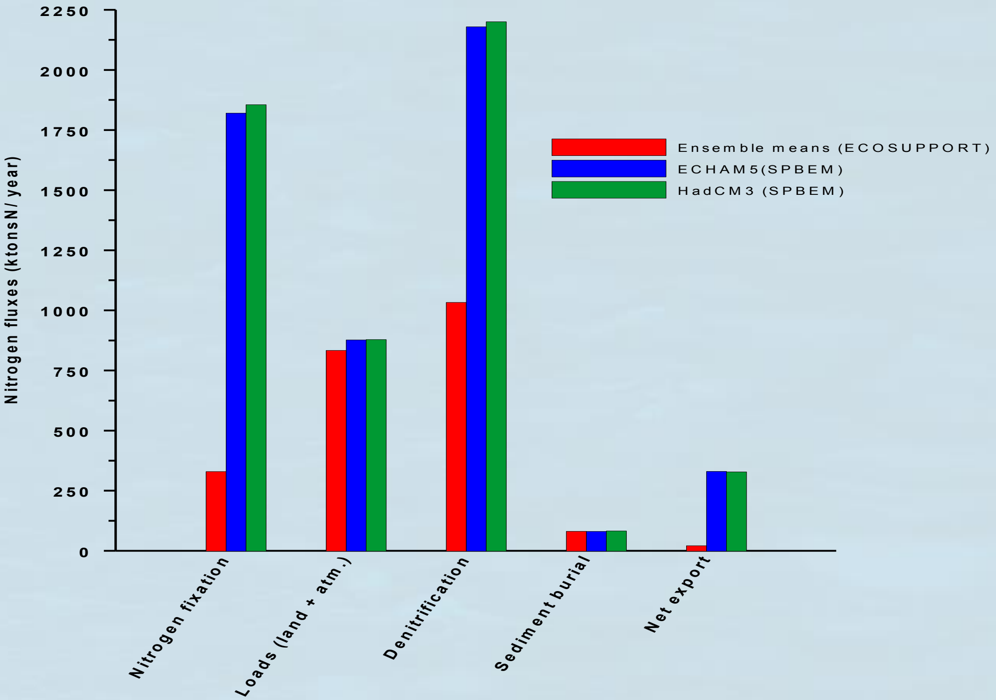
Why?



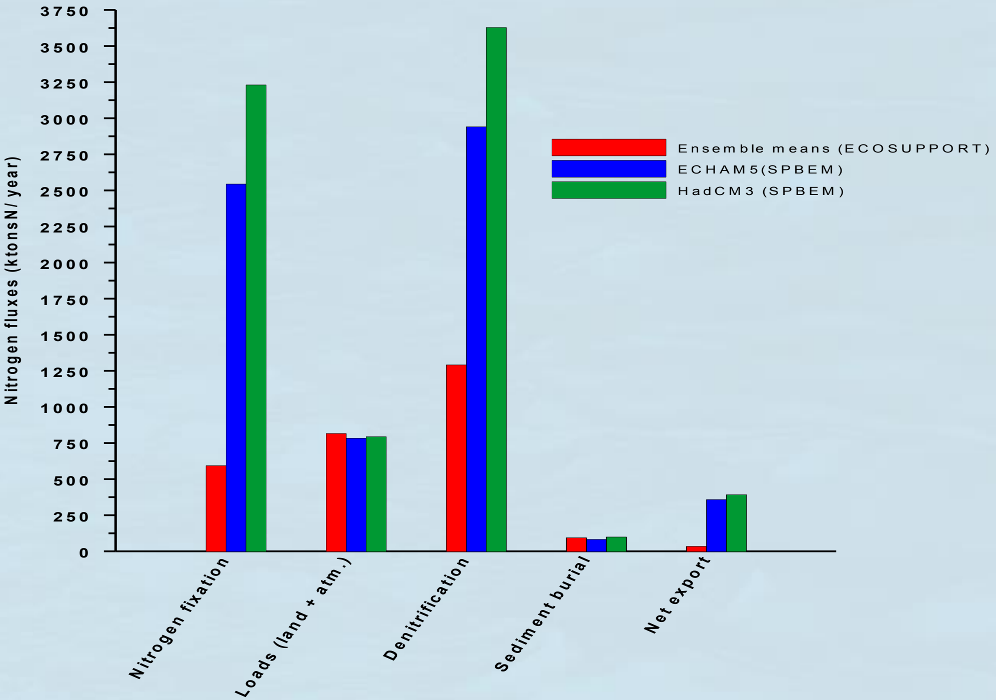


SPBEM ECHAM run

Seasonal succession of diatoms, summer species, cyanobacteria and zooplankton in the upper layer, averaged over 1971-2000



Modern climate, 1971-2000



Future climate, 2071-2100

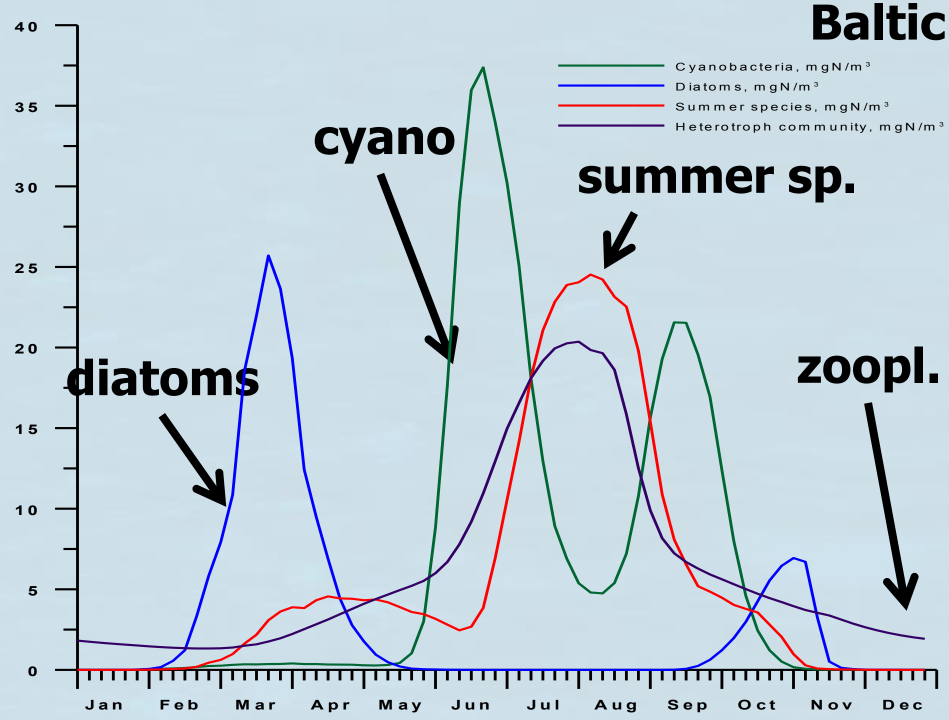
Nitrogen fixation and denitrification in SPBEM runs are much higher than in ECOSUPPORT ensemble simulations

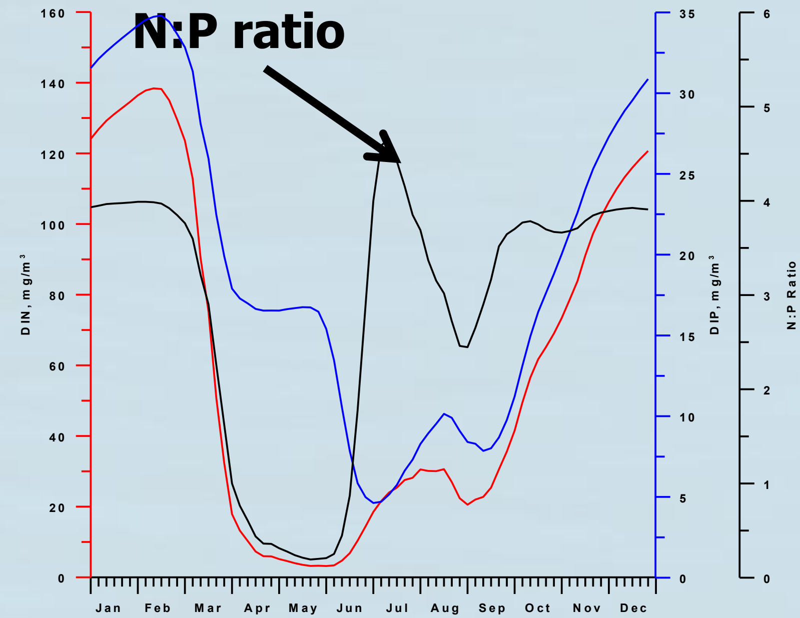
SPBEM ECHAM run

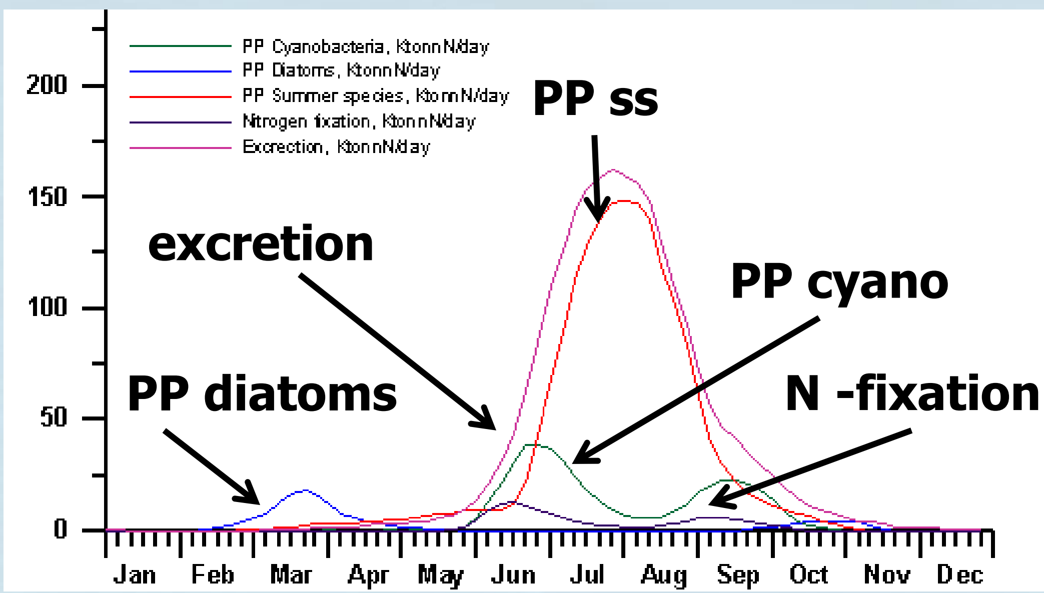
Table 3. Calculated (M) and observed (D) values of nitrate, phosphate, ammonium, dissolved oxygen and chlorophyll *a* in the sea upper layer (0-10m) at 2 monitoring stations in the Baltic Proper (averages over the period 1971 to 2000).

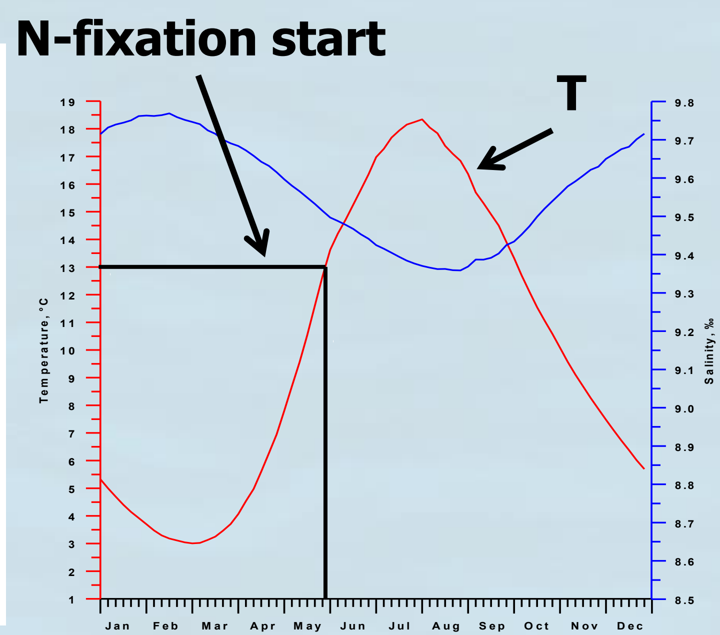
Station and forcing	Mean winter nitrate, mmol m^{-3}		Mean winter phosphate, mmol m^{-3}		Mean summer oxygen, $ml \cdot l^{-1}$		Mean summer chlorophyll a conc., $mg \cdot m^{-3}$	
	M	D	M	D	M	D	M	D
SE Gotland Basin ,E	9.2	4.8	0.8	0.5	6.2	7.4	3.0	2.9
Gotland Deep BY15, E	9.2	4.0	1.0	0.6	6.8	7.5	3.2	3.1
Entire Baltic Sea	6.4	5.6	0.8	0.5	6.8	7.3	3.2	2.5

Baltic Proper









1. N:P ratio reaches its minimum after N-limited spring bloom creating favorable conditions for N-fixation
2. Modeled summer T is higher than observed by 1.5 C and reaches prescribed NF-threshold (13 C) earlier (in the beginning of June)
3. The Redfield DIP excess is also two-three times higher than observed because of the overestimated winter values
4. Taken together, all these conditions lead to a massive nitrogen fixation and strong cyanobacteria bloom already in June
5. Zooplankton biomass increases accordingly, accompanied by increased nutrient excretion, thus introducing fixed nitrogen into biotic cycles
6. Intensification of nutrient regeneration favors the growth of summer species. As a result, their PP is much higher than PP of diatoms and cyanobacteria.

So, we have in SPBEM much more intensive recycling within water column under the same external loads as in ECOSUPPORT.

The main reasons of that are:
1) higher initial P and N sediment content (in the comparison with ECOSUPPORT simulations);
2) higher summer temperatures.

Initial (in 1970) mean volume averaged pools of dissolved inorganic nitrogen (DIN) and phosphorus (DIP) and area averaged pools of nitrogen and phosphorus in the sediments (in kton) for the entire Baltic

	Water DIN	**Water DIP**	**Sediment N**	**Sediment P**
ECOSUPPORT Ensemble mean	1600	600	3000	900
SPBEM	2400	700	13000	2400

CONCLUSIONS

1. Changes in eutrophication indicators in reference HadCM3 driven run is greater than in similar ECHAM5 driven run.
2. According to the ECHAM5 and HadCM3-driven BSAP scenario simulations, nutrient load reduction suggested in BSAP will not lead to any fundamental changes in eutrophication indicators in the end of this century. In particular, areas of anoxia and hypoxia will grow, but slower than in the reference runs.
3. The estimates are qualitatively consistent with the estimates of ECOSUPPORT, but impact of climate change on eutrophication was much stronger.
4. Nitrogen fixation and denitrification in SPBEM runs are several times higher than in ECOSUPPORT ensemble simulations. The main reasons of that are: 1) higher initial P and N sediment content; 2) higher summer temperatures in modern climate.
5. These simulations should be viewed as sensitivity analysis of the model solution to the initial conditions, which, as was shown, are a significant source of uncertainty of the final result.

The difference between the future(2071-2100) and modern(1971-2000) values of parameters

REF	Upper layer (0-10m)		Near-bottom layer	
	ΔNO_3 wint	ΔPO_4 wint	ΔNO_3 wint	ΔPO_4 wint
ECHAM5	2.5	0.4	0.9	0.6
HadCM3	1.3	0.6	-0.1	0.9