From small scales to large scales –The Gulf of Finland Science Days 2017
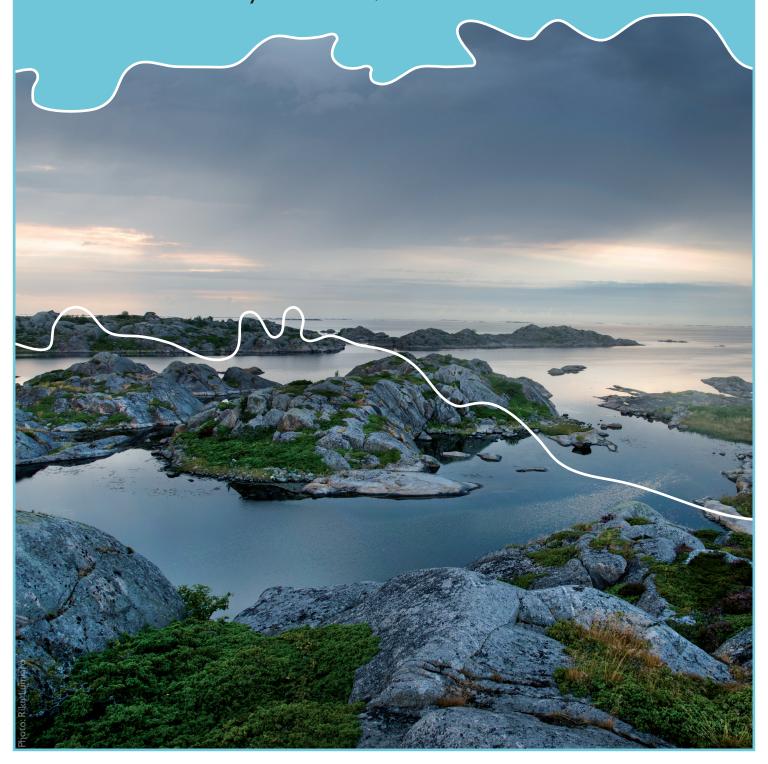
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Oral presentations

Phytoplankton structure in eastern part of Gulf of Finland

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oral

During last decades a lot of attention has been directed to cyanobacteria as potent producers of toxic substances during cyanobacterial water blooms. The eutrophication is currently for more than 90% of all water bodies in the world. Eutrophication of water bodies leads to active vegetation of cyanobacteria and water blooms. HAB have become common in North-West Russia water reservoirs.

For many years the eastern Gulf of Finland, Baltic Sea is exposed to anthropogenic pressure related to intensive human activities in the region. The Gulf of Finland is situated in the eastern part of the Baltic Sea. The eastern part of Gulf of Finland consists of three main areas: the Neva Bay (surface area 400 km^2), the inner and the outer estuary (total surface area 3200 km^2). Because of the large influx of fresh water from the Neva River, the gulf water has very low salinity – between 0 and 5 ‰ at the surface. The coastal zone of the eastern Gulf of Finland has been intensively used for recreation and different industries. Large oil and coal port terminals have been constructed in this part of the Gulf of Finland over last decades.

The study area covered both inner and outer parts located in the eastern Gulf of Finland, between the latitudes 59°42' and 60°09′ N and the longitudes 27°23' and 29°52′ E. The sampling area included 15 standard monitoring stations from Bjorkezund Strait (Primorsk) on the north to Luga Bay on the south. Sampling was performed in period of 2010 - 2016.

The total number of taxa identified in the studied material was 159. The discovered species consisted of nine taxonomic groups of algae and cyanobacteria. Large number of species of green algae (40 %), cyanobacteria (17%) and diatoms (22%) are typical for most water bodies in northwestern Russia.

 Different areas of the Gulf of Finland varied considerably in the structure of phytoplankton and concentration of chlorophyll a. The number of species varied greatly in different parts of the Gulf of Finland: the least of all species of algae have been found in Koporskaya Bay (37 - 57) and Luga Bay (39 - 57), the largest number of species - in Inner estuary (107 - 117) and Vyborg Bay (115). Usually freshwater species dominated in plankton in the inner estuary of the Gulf of Finland. Brackish-water species such as *Nodularia spumigena* and *Dinophysis sp.* were common in outer estuary of the Gulf of Finland. Cyanobacteria were dominated in phytoplankton in all part of eastern Gulf of Finland. Biomass of phytoplankton in studied samples varied in the range of 0.4 (outer estuary) - 25.3 g m^{-3} (inner estuary). The lowest average biomass of phytoplankton was recorded in outer estuary Gulf of Finland (1.8 g m^{-3}), the largest average biomass was noted in inner part (5.9 g m^{-3}). Also, the average biomass of phytoplankton varied significantly from year to year, the maximum average biomass was in 2014 (3.9 g m^{-3}), minimal – in 2013 (1.6 g m^{-3}). The greatest value of cyanobacteria is played in the inner estuary (more than 80% from total biomass). It's known that HABs occure annually in the Baltic sea. But last year's total biomass of cyanobacteria decreased in the Gulf of Finland. Species such as *Aphanizomenon flos-aquae, Snowella lacustris, Skeletonema subsalsum, Cryptomonas spp.* dominated during the summer. The share of *Planktothrix agardhii* in plankton decreased significantly in recent years.

The interannual dynamics of chlorophyll *a* due to the instability of hydrodynamic regime. Under conditions of high salinity, concentration of chlorophyll *a* was low throughout the eastern Gulf of Finland. The maximum concentration of chlorophyll a was in 2010, minimum – in 2016. Average value was 5.5 mkg dm^{-3}. In general, on concentrations of chlorophyll *a* and phytoplankton biomass eastern Gulf of Finland can be classified as mesotrophic waters.

Development of the program for combined restoration of European pearl mussel (*Margaritifera margaritifera*) and salmonid fishes local populations in two rivers inflowing to the Gulf of Finland in nature protected areas of Leningrad Oblast.

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The life cycle of *M. margaritifera* is strictly linked with salmonid fishes – *Salmo salar* and *S. trutta*. European pearl mussel is disappearing species in the Gulf of Finland catchment area. Recently these mollusks were registered in few small rivers and usually in very small quantities and they still survive thanks to mussels' long individual life duration. None local mussels population is able to reproduct itself successfully for sustainable level. There are two main reasons for it: either the mussels population is too small or spawning salmonid fishes income to the river is rare or absent at all.

There are two rivers in the eastern part of the Gulf of Finland which were formerly "salmon-pearl mussel rivers" and they still have suitable for this environmental conditions. However the first one (river Gladyshevka) has no mussels left, but has both species of salmonids. The second one (river Peipia) still has substantial population of old mussels, but no any salmonids to provide the mussels' reproduction.

The programm directed for joint restoration of European pearl mussel and salmonid fishes local populations in both rivers is pushed forward.

Systems approach based maritime traffic safety management in the Gulf of Finland (Baltic Sea)

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 Oral presentation

The Baltic Sea was designated a Particularly Sensitive Sea Area (PSSA) by IMO Marine Environment Protection Committee 2005. The Mandatory Ship Reporting System in the Gulf of Finland Traffic Area (GOFREP) was established by IMO in 2003. The Systems-Theoretic Accident Model and Processes (STAMP) methodology considers safety an emergent property of the system, arising from the interaction of systems' components within a given environment. The STAMP-Mar approach is recommended as a basis for safety management of a sustainable eco-socio-technical maritime transportation system. The STAMP based Systems-Theoretic Process Analysis (STPA) - a powerful new hazard analysis method is applied to analysis of maritime traffic safety in the Gulf of Finland. In this study in progress STPA hazard analysis methodology is applied to identify 1) potentially unsafe ship speed and maneuvering control actions, and 2) the potentially unsafe control actions that may lead to ships' routing hazardous design. STPA has proved to be an effective method to address the dynamic interactions between the integrated human and technical e-navigation components. It is suggested to use STPA in a proactive way guiding the maritime spatial planning processes including the ships' routing design by integrating the planning options hazard analysis into the safety-guided MSP development.

Assessing the environmental impacts and nutrient removal potential of mussel farms in the northeastern Baltic Sea

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Oral presentation

The Baltic Sea is facing many challenges. One of the most serious problems is eutrophication due to excessive inputs of nitrogen (N) and phosphorus (P). Mussel farming has been used to successfully remove N and P from eutrophic waters but to date we are not aware of its full potential in the low salinity, cold environment of the north-eastern Baltic Sea. Here, we characterized conditions in and around the Vormsi mussel farm (59.00° N, 23.04° E) through a combination of monitoring and modelling. Chemical and biological conditions in and around existing farms showed no adverse effects of mussel farming. At the farm site, mussels slightly reduced pelagic primary production and increased the biomass of benthic macroalgae. The modelled estimates of nutrients removed from the Vormsi farm suggest about five times lower efficiency compared to farms deployed in fully marine conditions. Under these assumptions, about 25 km of rope is needed to remove one ton N in harvested mussels. The model also shows that elevated food availability (higher phytoplankton concentration) may partly compensate for the adverse effects of low salinity and when the farms are located in highly eutrophic areas, mussel yields/nutrient removal rates close to oceanic waters may be achieved.

A spatially extensive validation of three different wave models in the Helsinki coastal archipelago

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Wind generated surface waves affect maritime traffic and spatial planning. The waves in the Gulf of Finland have been studied for decades using both observations and wave simulations. As a result we have a good grasp on how the waves behave in the middle of this narrow gulf. However, the dense coastal archipelago that characterises especially the northern shoreline of the Gulf of Finland has a substantial impact on the waves. Consequently, the results obtained further away from the shoreline are not representative of the nearshore conditions. Compared to the open sea, wave measurements in the coastal archipelago are sparse. Furthermore, previous modelling efforts have highlighted unsolved challenges in simulating the nearshore wave field in the Gulf of Finland. In this study we present a validation of wave parameters modelled by three different high-resolution third generation wave models – WAM, SWAN and WaveWatch – of which WaveWatch has previously not been implemented in the Baltic Sea. The wave model results are compared to wave buoy measurements from different geographical locations made during the years 2012–2016. The results show that the models work well in principle, but certain discrepancies still exist that are typically manifesting as an overestimations of the significant wave height from certain wave directions. The performance of the wave models can clearly vary within a small area; south-westerly waves are overestimated at the edge of the archipelago, while 5 km closer to the shore easterly waves seems to be overestimated. No conclusive results are yet available, but further research into the performance of the different wave models is still needed.

The state and environmental consequences of pollution air pool of the Gulf of Finland transport emissions

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In industrialized countries, transport accounts for emissions of CO - 70-90%, emissions of NOx - 40-70%, emissions of CO2 - 30%. The distribution of transport pollution in the air is extremely uneven. The highest concentration of contaminants into the atmosphere with the exhaust gases transport engines, according to the urban areas. In Moscow, these ratios are according to CO-96.3%, CH-64.4%, NOx-32.6%, in St. Petersburg - CO-88.1%, CH-79.0%, NOx-31, 7%. In the technical, ecological and hygienic relations, vehicles and engines used on them are far from homogeneous. In terms of the amount of harmful substances released into the air and their impact on the environment, motor transport takes the first place. Its share in various countries accounts for up to 85%. The remaining 12-13% fall on railway transport, 1-2% for air transport and 1-3% for water. Large capacities of the main and auxiliary engine of ships create powerful local foci of pollution in the places of their accumulation, for example, in ports on raids, near locks, etc. And a dangerous local level of air pollution can create not only the accumulation of ships, but even one vessel. The main air pollutants in many cases are nitrogen oxides. With regard to the discharge of CO2 transport engine, the in spite of their low toxicity, this component is given the most attention as the main source of the greenhouse effect. The role of carbon dioxide in the Earth's atmosphere is more than significant, since together with water they absorb the infrared part of the thermal radiation of the Earth's surface, heated by the Sun, thus creating a greenhouse effect.

NOx Control Area

In Europe and the USA, the current national programs for protecting the environment from harmful emissions of transport have the status of national priorities. In these camps, the formation of regulatory documents regulating the procedure and methods for the implementation of environmental control, mixed (river-sea) and inland navigation vessels has already been completed and work is under way to accumulate practical experience in carrying out emission checks from ships in service. In the process of carrying out these inspections, shipowners, as a rule, carry out voluntary certification of vessels for compliance with technical standards for emissions of harmful substances into the atmosphere.

In contrast to international practice, the Russian manufacturers of marine engines for marine and river vessels last decade produced engines without certificates of compliance with technical standards of emissions into the atmosphere. For this reason, in-service marine engines installed on vessels of the Russian River Register class, overwhelmingly do not have certificates of conformity, and shipowners are not ready to conduct regular checks of air emissions from power plants of river vessels.

Preliminary assessment of water and sediment pollutions in littoral zone of the Kotlin Island.

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Anthropogenic impact on nature depends on many factors (mechanical, physical, chemical, etc.). They could not always be identified. It is even more difficult to foresee the result of an interaction of all these factors.

To assess the overall anthropogenic load on the ecosystem of the coastal zone of the island of Kotlin, we used crustacean *Gmelinoides fasciatus*. This species is originated out of Baikal Lake and now wide spread in the North-West region of Russia. It is important component of food webs of aquatic ecosystems.

Since the state of any living organism depends on the integrity of genetic apparatus of its cells, we conducted a preliminary analysis of samples collected in two sites of the Kotlin Island. "West" sampling site is an area with relatively clean territory (officially protected). In contrast, "East" site is located in the city of Kronstadt (close to the car wash, residential buildings, road with heavy traffic).

Ten gravid females of *Gm. fasciatus* per each site were collected. Slides of 6-10 embryos per female for cytogenetic analysis were prepared. We analyzed the frequency of chromosomal abnormalities in embryonic cells by ana-telophase method.

Preliminary data obtained show that the frequency of chromosomal aberrations and other mitotic disturbances four times higher in the "dirty" than in the "clean" site. To identify the exact reason(s) of cytogenetic disturbances in dividing cells of *Gm. fasciatus* embryos further detailed analysis of the main soluble and sedimentary pollutants seems necessary.

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Reducing agricultural phosphorus load by gypsum: results from the first year after amendment

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Novel measures may be needed in reducing agricultural phosphorus load into the Baltic Sea. The SAVE project examines the feasibility of a gypsum ($CaSO_4 \cdot 2H_2O$) amendment in cutting down the losses of both particulate and dissolved phosphorus from clayey agricultural fields. In autumn 2016, gypsum was spread (4 t/ha) on 1550 hectares in the middle reaches of the river Savijoki catchment, south-western Finland. The upper reaches of the river were left as a control area, where gypsum was not used.

This presentation will summarize the results obtained during the first year after the gypsum amendment: the losses of different forms of phosphorus in the gypsum area and the reference area, the effect of the measure on the sulfate concentrations in the river, and potential side-effects. In addition, we present our experiences in the logistics and spreading of gypsum and on the attitudes of farmers and the public towards the measure. We also discuss whether there is potential to apply gypsum on a substantially larger area in Finland and elsewhere.

Ecosystem-based Maritime Spatial Planning – impact on navigational safety from offshore renewable energy developments

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Oral presentation

According to EU Directive establishing a framework for Maritime Spatial Planning (MSP) the main purpose of MSP is to promote sustainable development and to identify the utilization of maritime space for different sea uses as well as to manage spatial uses and conflicts in marine areas. The offshore wind energy production is considered to be one of the main drivers of MSP in the Baltic Sea Region. However, the impact on navigational safety from offshore renewable energy developments should be assessed and taken into account in a course of MSP processes. This planning issue is addressed by the simulations based analysis of the potential impact on navigational safety from planned offshore wind parks off the Hiiumaa Island in the Baltic Sea using the navigational simulator TRANSAS NTPRO 5000. As a result, the safe distance of turbines' boundary from shipping route is evaluated taking into account the most important international regulations determining the manoeuvring space that vessels need in order to keep a safe distance from multiple structures such as wind farms. Accompanying navigational safety issues related to subsea electricity power transmission grid and the gas pipelines are addressed. The Bow-tie conceptual representation is used to outline the case specific navigational and environmental risks sources, causes and consequences.

Assessing the sea together - HELCOM HOLAS II eutrophication assessment

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The Baltic coastal states, via HELCOM, begun developing a common eutrophication assessment methodology in 2005. The first quantitative indicator-based eutrophication assessment for the Baltic Sea was published in 2009. Today, a decade of eutrophication data has produced all together three updates to the integrated eutrophication assessment, the HOLAS II eutrophication assessment 2011-2016 being the latest. This time has been a period of strong development: indicators have been developed, environmental thresholds have been agreed upon, new data types have been accepted and an operational assessment system, with procedures leading from database to indicator web site, have been built. The challenge has been to create a transparent and labour-efficient system, where all developmental as well as update phases are accepted by all HELCOM Contracting Parties. A critical step is finding the most suitable and practical indicators for each habitat. This requires continuous exchange of information between all participants to keep the mutual learning process ongoing.

DYNAMICS OF WATER QUALITY OF THE TRANSBOUNDARY RIVER OF NARVA

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Narva is a river on the border of Estonia and the Leningrad Region of the Russian Federation. The river originates from the Peipsi Lake and flows into the Narva Gulf of the Gulf of Finland in the Baltic Sea. The length is 77 km, the basin is 56200 km^2, the average long-term water discharge is 399 m^3/s. International conventions and agreements regulating the mutual relations of states in the joint use of water bodies cover a wide range of problems, one of the most important is the problem of assessing the quality of water resources and the degree of their contamination. The purpose of the study was to assess the interannual dynamics of the water quality of the Narva River.

An attempt to assess the quality of river water based on chemical criteria was made in the Bavarian Water Use Service. This method is based on studies conducted earlier in the US and Scotland. The method involves the measurement of a few chemical parameters in water samples followed by a representation of the resulting combination of results in the form of a single number (chemical index) which is the generalized water quality in a given sample. The chemical index is multiplicative and is expressed in the following form:

$$CJ = \prod_{i=1}^{n} q_i^{w_i} = q_1^{w_1} \cdot q_2^{w_2} \ldots q_n^{w_n}$$

where CJ is the chemical index, the dimensionless value of the continuous scale is from 0 to 100 (here 0 is the worst and 100 is the best water quality); N is the number of parameters; Qi - subindex for the i-th parameter (dimensionless value between 0 and 100, which is a function of the i-th parameter); Wi is the weight of the i-th parameter, the number between 0 and 1, and the sum of the weights is 1.

In addition to the above a classification system for assessing the quality of transboundary water bodies was developed on the basis of the "broken rod" model. It was taken into account that the value of CJ varies from 0 to 100 ($0 \leq CJ \leq 100$). The number of water quality classes was taken equal to five (n = 5) (Table 1).

Table 1. Classification of water quality

Characteristics of water pollution	Value CJ	Quality class
Conditionally pure	98-100	1
Slightly contaminated	88-97	2
Contaminated	73-87	3
Dirty	46-72	4
Extremely dirty	0-45	5

The primary data of hydrochemical monitoring carried out by the Ministry of Environment of Estonia from 2006 to 2016 (Table 2) were used to assess the dynamics of water quality in the transboundary river Narva. The calculations used the average annual values of the parameters (average values from 12 determinations).

Table 2. Interannual dynamics of water quality in the Narva River (Narva Gate)

Year	CJ	Quality of water	Quality class
2006	92,1	Slightly contaminated	2
2007	90,5	Slightly contaminated	2
2008	90,8	Slightly contaminated	2
2009	92,5	Slightly contaminated	2
2010	92,0	Slightly contaminated	2
2011	91,0	Slightly contaminated	2
2012	90,8	Slightly contaminated	2
2013	91,9	Slightly contaminated	2
2014	92,1	Slightly contaminated	2
2015	92,1	Slightly contaminated	2
2016	92,5	Slightly contaminated	2

As follows from the data given in Table 2 the quality of the Narva River (Narva) is characterized as "slightly contaminated" (second class of quality). Over the considered period, the chemical index CJ varied from the minimum value in 2007 ($CJ = 90,5$) to the maximum in 2009 and 2016 ($CJ = 92,5$).

Influence of weather conditions on midsummer primary production and mineralization of organic matter in the Neva Estuary (eastern Gulf of Finland, Baltic Sea)

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A 14-year continuous record of midsummer concentration of total phosphorus, chlorophyll a, primary production and mineralization of organic matter from 17 locations in the Neva Estuary were tested for the correlations to air temperature, water temperature and salinity, precipitation and the number of rainy days, NAO, AO, EAWR indexes. The analysis of long term data showed that weather conditions in the region strongly affected these characteristics. The concentrations of total phosphorus positively correlated with winter NAO index, precipitation and the amount of rainy days that probably resulted in the changes of the soil processes on the watershed. Spearman's rank correlations yielded significant relationships between concentration of total phosphorus and chlorophyll a concentration. In rainy and cool years, concentration of chlorophyll a was higher. Mineralization of organic matter strong positively correlated with air and water temperatures. Principal component and classification analysis showed that in the years with numerous rainy days, the air temperature was lower. As a result, in the wet and cool years, the concentration of phosphorus and primary production were higher, but mineralization of organic matter was lower due to more cool water. Rainy weather in the Neva Estuary region corresponded the positive phase of the winter NAO and negative phase of EAWR pattern during 2012–2016 resulted in an increase of primary production, and mitigated the remedial measures undertaken in recent years to improve the environmental conditions in the estuary.

Contribution of the carbon from green tides in the coastal food webs in the eastern Gulf of Finland: stable-isotope estimate using Bayesian mixing model

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The shallow coastal zone of the eastern Gulf of Finland is one of the most eutrophic parts of the Baltic Sea as reflected in intensive filamentous algae blooms in summer time (green tides). We analyzed stable isotope composition of carbon and nitrogen of suspended organic matter (seston) and tissues of filamentous algae, macroinvertebrates and fish from the shallow coastal area of the estuary to test a hypothesis that organic carbon of dominating filamentous algae (*Cladophora glomerata* and *Ulva intestinalis*) may be among primary sources supporting coastal food web. We applied the Stable Isotope Bayesian mixing model (SIAR) to quantify basal resources of benthic macroinvertebrates and fish. The results showed that consumers in general poorly used organic carbon produced by filamentous algae, especially by *U. intestinalis*. According to SIAR modeling, macroinvertebrates and fish mostly relied on the pelagic seston as a basal resource. Only a few species of macroinvertebrates could effectively consumed filamentous algae. Fish used pelagic resources directly by consuming zooplankton or indirectly via benthic macroinvertebrates that in turn relied heavily on pelagic sources of carbon. This was consistent with the results of gut content analysis. Taking into account that green tides of filamentous algae in the Neva Estuary resulted in intensive oxygen depletion and in periodic substantial decrease of abundance of macroinvertebrates we likely should consider this phenomenon as a negative one, which contaminates coastal zone of eastern Gulf of Finland by excessive amount of organic matter and destabilizes benthic communities.

"Green tides" in the eastern Gulf of Finland: factors affecting the biomass accumulation and its consequences for the coastal zone.

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Oral. Topic - Eutrophication, pollution and monitoring

Our long-term study was carried out at permanent monitoring sites along northern and southern shorelines of the Gulf of Finland between the latitudes 59°49' and 60°00′ N and the longitudes 28°36' and 30°08′ E. Studied area is suffered by massive macroalgal blooms during the last two decades (Bäck et al., 2002; Gubelit, 2015). We analyzed the long-term data on the biomass dynamics of opportunistic macroalgae. The factors regulating the biomass accumulation as well as its consequences were defined. Our study has shown that in 2014-2015 the biomass dispersion and its maximum had increased at Primorsk, however ANOVA didn't show significant difference. Nevertheless in 2014-2015 the macroalgal biomass exceeded 1200 gDWm^{-2}, although in previous years (2004-2011) it was not higher than 500 gDWm^{-2}. In 2014 observed average biomass in Petrodvoretz also exceeded the maximum biomass, which was reported for this site previously but was near maximum of 2005. On the other sites of the southern shore sharp rise of the biomass was registered in 2016. In Koporskaya bay on the depht 0.5 m biomass varied from 1129±522 (Sisto-Palkino) up to 4630±1506 gDWm^{-2} (Grafskaya bay) while in previous years the biomass on these two sites did not exceed 718±405 and 500±180 gDWm^{-2} respectively. Traces of hypoxic conditions had a presence in Primorsk under thick layer (up to 20 cm) of alive macroalgae. In Koporskaya bay conditions of hypoxia varied from strong, caused by mass of decaying algae near the shore, to the traces under the scattered and unconsolidated alive algal biomass with areas of clean bottom. At the second monitoring site in Koporskaya Bay (Grafskaya Bay) we had observed conditions of strong hypoxia with thick (30cm) continuous layer of decaying macroalgae that had created some difficulties for quantitative assessment of the algal biomass at this site. Since statistical analysis shown significant correlations between algal biomass and climatic factors (wind speed, air temperature, NAO – index) we have proposed that, besides of anthropogenic impact, the rise of macroalgal biomass in Primorsk and Petrodvoretz may be caused by climatic factors. This assumption requires confirmation by further observations. Long-term observations together with investigation of concentrations of metals in surface sediments, macroalgal biomass and water in the coastal zone, allowed to define negative consequences of macroalgal blooms. As a rule, in the published literature about "green tides" the main recorded consequences are substitution of perennial algal species, hypoxia, mass mortality and migration of benthic animals, accumulation of enterobacteria in algal biomass (Valiela et al. 1997; Berger et al. 2003, etc.). All these consequences were also confirmed for the eastern Gulf of Finland. Our recent study also confirmed a high degree of metal bioaccumulation in macroalgal biomass. Since the coastal eutrophication is significant problem for the eastern Gulf of Finland, the mass development of these algae in the coastal area may contribute to accumulation of organic matter, nutrients and associated metals. On the other hand decomposition of this biomass may promote anoxic conditions and contribute to remobilization of adsorbed metals. In our study the highest metal concentrations in sediments were found at sites with dense and continuous layer of fresh or decaying macroalgal biomass accompanied by hypoxic conditions. Nevertheless our study has shown that accumulated biomass may be a significant source of nutrients in the coastal ecosystem. Concentrations of main nutrients in algae *Cladophora glomerata* and *Ulva* sp. were 1.65±0.22 and 1.38±0.52 mg gDW^{-1} for phosphorus, 8.3±0.71 and 11.33±2.40 mg gDW^{-1} for sulfur, 20.69±1.81and 9.20±1.81 mg gDW^{-1} for nitrogen, 303.11±11.93 and 310.14±5.05 mg gDW^{-1} for carbon, respectively. According to defined nutrient concentrations in algal biomass, we estimated that nutrient loading to the coastal zone from algal biomass may reach 0.8-2.51 g m^{-2} for phosphorus, 4-12 g m^{-2} for sulfur, 9-27 g m^{-2} for nitrogen and 147- 443 g m^{-2} for carbon. In recent years so-called "green tides" has become a widespread phenomenon, reaching a great scale. Thick layer of opportunistic macroalgae may cover hectares of the coastal area of seas and lakes (Smetachek and Zingone, 2013). In view of this large-scale problem there is a need in further and more detailed studies of the effect of accumulated algal biomass on biogeochemistry and health of the coastal ecosystems.

Patchiness of the sea surface under the combined effects of winds and currents.

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Compressibility of surface flows is known to be the main driving force of the patchiness of floating litter on free surface of turbulent fluids. However, in the case of quasi-two-dimensional flows (such as marine flows in many cases), the surface flow compressibility is strongly suppressed; then, the bathygraphy might play an important role giving rise to up- and downwelling regions. However, there are other effects which may increase effective compressibility and thereby the clustering rate of floating litter.

There is still one more important factor which may increase the effective compressibility and which, to our best knowledge, has not been discussed in literature: the effect of wind drift, and more specifically, the effect of the differences in the wind drift speed depending on the size of the floating objects. This mechanism is expected to be coupled with the turbulent mixing and the intrinsic compressibility of the flow field. We present the result on surface clustering of accounting for such differences in drift speed within a novel Eulerian tracking model..

Spatial overlap of nature values, protected areas, and human uses in the Baltic Sea

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Oral presentation

Human use of marine areas is increasing worldwide, resulting in conflicts between different interests for the space and marine resources and environmental sustainability. The multiple uses of marine areas have resulted in a rapid increase of marine spatial planning to minimize cross-sectoral and cross-border conflicts over marine space. Spatial overlap of seabed nature values, protected areas (PAs), shipping (AIS density), total fishing effort and cables and pipelines was assessed using the data compiled in the HELCOM HOLAS II project. The distribution of benthic key species *Charophytes*, *Fucus vesiculosus*, *Furcellaria lumbricalis*, *Mytilus trossulus*, and *Zostera marina* and EU Habitats Directive annex 1 habitat types "reefs" and "sandbanks which are slightly covered by sea water all the time" (hereafter "sandbanks") were used as nature values. We found significant differences in the spatial overlap of the nature values and nature protected areas both between different habitat types and countries. The proportion of distribution area of sandbanks inside PAs was twice as large as that of reefs with substantial variation among the countries. Contrastingly, compared to sandbanks, reefs had twice as large overlap with cables and pipelines. The overall AIS density was only marginally lower inside PAs than outside of PAs. *Zostera* had the highest overlap with PAs among the key species while the distribution area of *Mytilus* had the highest AIS density and fishing effort. Both fishing effort and AIS density were higher on cable and pipeline areas than outside of those areas. The findings indicate potential discrepancies in the spatial arrangement of protected areas in the context of multiple human uses and emphasize the need for large-scale cross-border approach in marine spatial planning.

Developing the guidelines for the ecological post-spill monitoring of the accidental chemical spills

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Oral

Worldwide, approximately 2,000 chemicals are transported by sea either in bulk or in packaged form. Chemical releases are thought to be potentially more hazardous or impact more unpredictable than releases of oil. Regarding marine spills, chemicals may have both acute and long-term environmental effects and may not be as easily recoverable as oil spills.

Chemicals can behave in a number of ways once they are spilled into the sea. Based on type of chemicals can be determined hazard potential to different environmental compartments. Hazards to the environment can vary a lot depending on the chemical in question and impact can be acute or long-lasting. Accidental release or loss of containment may lead to mortality of certain species, contamination of coastline or underwater ecosystems or disturbances to local amenities. The choosing the right ecological species and parameters based on chemical type and spreading is essential for successful monitoring. Further, choosing similar reference areas or comparisons with pre-existing baseline data are key components for monitoring programme. The proper and good quality data keeping is needed all the way in order to demonstrate ecological damage and economic losses in the context of spill-related claims and compensations.

The purpose of the EKOMON project is to make guidance for post-spill environmental monitoring, which can be widely utilized in the Baltic Sea and also other cold waters like the Arctic seas. In case of sudden spill, the guidelines are needed e.g. establishing the reference conditions, chemical and biota sampling, bioassays, ecological impact assessment and reporting.

Retrospective analysis of biodiversity indicators in the Gulf of Finland

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Gulf of Finland is facing multiple human induced pressures that are changing the structure and functions of the ecosystem. Knowledge about the state of the biodiversity and the environment is needed in order to achieve sustainable management and use of marine resources. Environmental indicators are essential in evaluating the state of the marine environment, and new indicators are being developed because of the need of more exact information about the ecosystems, as required by the EU's Marine Strategy Framework and as also outlined in HELCOM's Baltic Sea Action Plan. Integrated assessments bring together the various indicators' results and help in communicating effectively about the overall status of the seas. In this study, we performed a retrospective integrated assessment of the Gulf of Finland biodiversity using available datasets and indicators developed in HELCOM and in Finland. Included indicators covered marine mammals, fish, benthic, bird, and planktonic indicators. HELCOM Biodiversity Assessment Tool (BEAT) was used to carry out the assessment. Our results show how the indicators are able to operate together and indicate the biodiversity status of the study area in the past. They also offer information about the usefulness of the indicators in future assessments.

EMODnet Geology - Geological data from the European marine areas

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Oral

The European Commission has adopted the European Marine Observation and Data Network (EMODnet) in 2009 to combine dispersed marine data into publicly available datasets covering broad areas. Geology is one the themes of the EMODnet.

The 3rd phase of EMODnet Geology project started in 2017 and it will run for 2 years. The current partnership includes 39 marine organizations from 30 countries. The partners, mainly from the marine departments of the geological surveys of Europe (through the Association of European Geological Surveys – EuroGeoSurveys), aim to assemble and harmonise marine geological information at a scale of 1:100 000 or higher from all European sea areas (e.g. the Baltic Sea, the Barents Sea, the North Sea, the Iberian Coast, and the Mediterranean Sea within EU waters).

Here we will present a seabed substrate dataset for the Baltic Sea produced by EMODnet Geology project. We will also present a case study, where the seabed substrate dataset and some other EMODnet products have been used to develop new data on the distribution of seabed geodiversity for the Baltic Sea (Kaskela & Kotilainen, 2017). The broad-scale analysis was performed in GIS environment using spatial analyst methods.

Reference: Kaskela, A.M., Kotilainen, A.T., 2017. Seabed geodiversity in a glaciated shelf area, the Baltic Sea. Geomorphology, 295, 419–435.

Development of a new approach in the assessment of biological effects of pollution in the Gulf of Finland

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The water areas of the Gulf of Finland differ in the expanded salinity gradient of its waters that defines non-uniformity in the distribution of specific composition and the quantitative indices in living here aquatic organisms. This is caused by different levels of animal's adaptive capacities to specific conditions of dwelling. Besides, it is known that the salinity of the environment considerably influences on biological effects of pollutants on water organisms. Therefore, a fundamental problem in support of ecological safety of the Gulf of Finland is the absence of uniform approaches and valuation methods of an ecological status assessment of its water areas significantly differing on ecology and a hydrology. Field studies, including caged mussels studies, conducted in the areas of the Gulf needs taking into account specific features of the ecology of target species from different locations based on the biomarkers of pollution, i.e. the responses of local species of the invertebrates, for example, instrumentally measured by testing adaptive potential of the cardiac system of animals in the presence of additional loading (a short-term salinity change). In the case of salinity gradient in the sites of concern one must need to develop zone approach in water areas of transitional type from sea to brackish water and from the brackish to nearly freshwater areas with its specific fauna and characteristics of organism's functioning. This includes development of new express methods of bioindication of the water quality based on physiological and behavioral responses. As biomarkers characteristics of heart rate variability as well as the valve movements and intensity of filtration (at mollusks) measured by means of optical fiber sensors, Hall sensor for valve gape measurements, by video registration under water, etc. could be used. Data handling will be carried out by means of original computer programs, including assessment in real time.

Non-Stationary Extreme Value Modeling of Trends in Extreme Water Levels in the Gulf of Finland

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Oral

Proper quantification of extreme water levels, their return periods and particularly the possible long-term trends in these quantities is crucial to establish appropriate mitigation and adaptation strategies for potential coastal erosion, flooding, and agricultural soil contamination.

The classic approach to extreme water levels relies on the choice of a suitable extreme value distribution and the subsequent evaluation of its parameters based on a long time series of data. However, there is increasing evidence that because of the climate change, these parameters show variability with time. To account for that, we perform a novel non-stationary modeling of parameters of a generalized extreme value (GEV) distribution based on the block maximum method and annual maxima. The goal is to identify linear trends in the location, scale, and shape parameters of the GEV distribution for water levels in the Gulf of Finland. We also perform a search for correlations between the parameters of the distribution of the extreme water levels and major climatic indices. We performed an analysis of two sets of simulated water level data provided by Swedish Meteorological and Hydrological Institute (SMHI). Data covers all the Baltic Sea with a spatial resolution of 2 nautical miles. The first set of data is extracted from Rossby Center Ocean model with a temporal resolution of 3 h for years 1961–2005. The second set of numerically simulated water levels is obtained from Nemo-Nordic model for years 1979–2012. We found significant trends along the Baltic Sea coast showing non-homogeneous spatial distribution. We also discovered that the extremes in the water levels show a complex relationship with the North Atlantic Oscillation climatic index.

Baltic Sea Pressure and Impact indices and their potential for Marine Spatial Planning

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Implementation of ecosystem-based approach in Marine Spatial Planning includes identification of actual and potential threats and impacts on the marine ecosystems, including cumulative effects. With georeferenced data sets of human activities, pressures and ecosystem components, and estimating species and habitats' sensitivity to pressures, the Baltic Sea Pressure index (BSPI) and the Baltic Sea Impact index (BSII) can support such objectives by visualizing cumulative pressures and impacts. The BSPI and BSII were first applied in the initial HELCOM holistic assessment of ecosystem health and were further improved for the 2018 HELCOM 'State of the Baltic Sea report' (HOLAS II). In this presentation, we synthesize the new developments made for HOLAS II and highlight some key challenges remaining to be solved for their full application in MSP. In brief, the development focused on data preparation, including more realistic spatial presentation and influence of depth and seabed exposure, but also improving the habitat and species sensitivity estimates and linking the underlying human activities to the pressures. Despite the full compatibility with the assessment for the Marine Strategy Framework Directive, the indices still face the challenge of gaps in scientific understanding; most significantly in synergistic and antagonistic effects but also in differences between acute and chronic effects.

The Intensity of Leisure Boating and Services for Sailors – Does the supply meet the demand?

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Coastal areas of the Baltic Sea are important for leisure activities and there are thousands of yachts, boats and summer cottages along the complex archipelago. Services available for sailors provide income for coastal entrepreneurs and are important to consider when aiming for blue growth. Nevertheless, there are no spatial estimates for boat density nor for accessibility of port services in Finland.

We made a first attempt to assess the supply and demand of services available for boaters. There were 41 service categories, from piers, fuel pumps and septic tanks to restaurants and boat repair facilities. The services were grouped to three different classes: "essential", "useful" and "other" services. The accessibility to each individual service was calculated in travelling hours at sea using the cost-distance method. The density of leisure boats was estimated using data consisting of boats registered to yacht clubs, locations of summer houses and the number of docks rented to sailors by coastal cities.

The highest number of boats and the highest density of services are located in the sea area of the capital city Helsinki. Services follow a south-north trend: all service categories can be found within short travel time in the Gulf of Finland and around Archipelago Sea, whereas the number of useful and especially other services thins out towards the north.

The results provide background data for marine spatial planning. While the analysis confirms that the supply of services is largely governed by demand, there are certain cities and ports where there is room for new and more advanced services for boaters. The knowledge can be used, for example, in workshops where stakeholders can themselves estimate the blue growth potential of the service sector.

Social aspects of maritime spatial planning

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From the main provisions of the EU Directive on MSP it follows that MSP is the process by which the relevant authorities of the contracting countries analyze and organize human activities in marine areas for achieving environmental, economic and social goals. There is no legislative basis for MPP in Russia yet, but it can be assumed that the tasks of the MSP process in Russia will be close to what is stated in the EU Directive.

To implement this provision, it is necessary to pay attention not only to the problems of environmental protection and biodiversity conservation, the solution of problems of interaction of various types of marine activities, but also to the social problems of the population of coastal regions. The economic and industrial orientation of the Gulf of Finland is diverse and concentrated not only in the water areas, but also in the settlements located on the banks and having different city-forming base and population.

Due to the fact that the maritime activity of the coastal regions is a stabilizing factor, and also considering that the purpose of MSP is, among other things, the creation of favorable conditions for human habitation, it is necessary to study the indicators characterizing the achieved standard of living of the population and the share of maritime specialization of the population during the MSP process - that is, to include social aspects in the composition of the analysis (substantiating) data and information.

The main purpose of incorporating population development data in the documentation for MSP is to find opportunities to effectively use the labor potential of the Gulf of Finland countries, determine population distribution and educational level, its influence on the GOF water area, including not only large cities, but also small urban and rural settlements. This program of action should ensure sustainable employment of the population, improve production efficiency and living standards, and create an enabling environment within the framework of the Blue Growth strategy.

Iron–manganese concretions contribute to benthic release of phosphorus and arsenic in anoxic conditions in the Gulf of Finland

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Eutrophication is one of the main environmental problems of the Gulf of Finland. In the Gulf the abundant iron/manganese concretions (FeMn) may mitigrate eutrophication and provide ecosystem services by sequestering significant amounts of phosphorus (P) along with other harmful substances like arsenic (As).

There is expanding evidence on the influence of the activity of microbes on the transformation of multitude of early-diagenetic minerals, which formation regulate the biogeochemical cycles of other elements. For concretions, it is known that they are formed under oxidizing conditions and dissolved under anaerobic conditions. However, the direct role of microbes in the dissolution of concretions is less studied despite the fact that the geochemical and physical properties of the concretions favor microbial life in many ways. Our studies point out that spherical concretions host a diverse and densely populated microbial community. Additionally, our experiments show that the dissolution of concretions releases significant amounts of both P and As to ambient water in anoxic conditions.

To summarize, concretions constitute compact three-dimensional microenvironments for microbes. The significance of FeMn concretions and associated microbial communities at the ecosystem level of the Gulf of Finland is at yet poorly understood, but considering their abundance and ability to release P and As, we propose that they have a detectable influence on the bottom water quality in the regions which they have colonized.

Greenhouse Gas Inventory as the first stage of reducing energy consumption in the Leningrad region

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Oral

The GHG inventory is currently the most important tool on the way to reducing global warming, one of the problems facing all of humanity.

"The Concept of monitoring, reporting and verification of greenhouse gas emissions system in the Russian Federation" was approved by order of the Government of the Russian Federation dated 22.04.2015 N 716-R.

In the framework of international agreements and the RF Concept for the first time for the territory of the Leningrad region held a regional greenhouse gas inventory and estimated the trend in emissions and removals of greenhouse gases. The estimation of emissions and removals of greenhouse gases in the territory of Leningrad region is performed on the source categories of greenhouse gases defined in accordance with the structure of the region's economy.

The emissions inventories developed for the sectors "Energy", "Industrial processes and product use", "Agriculture", "Land use, land-use change and forestry" and "Waste" for the period 2008 - 2013.

Based on greenhouse gases Inventory was investigated the distribution of emissions and removals of all greenhouse gases by source category of the relevant five sectors, their dynamics and trends over the available period.

For the territory of Leningrad region the emission of carbon dioxide predominates and accounts for 84.4%. Methane emission is 10.9% and nitrous oxide is 4.7% of total greenhouse gas emissions.

The greatest contribution to greenhouse gas emissions gives the "Energy" sector (84,8%), much lower emissions in the sector "Industrial processes" (6.4%), and fewer emissions sources from "Agriculture" and "Waste".

The inventory and analysis will allow us to develop regional plans to reduce greenhouse gas emissions and mitigate/adapt to the impacts of climate change up to 2020. This opens up the possibility of implementing projects to reduce energy consumption and use renewable sources of energy. The most promising projects should be environmental areas of reforestation and sustainable land use.

Towards harmonisation of monitoring hazardous substances

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Oral

The trilateral cooperation of Gulf of Finland has identified commonly important elements of monitoring hazardous substances and their effects, including harmonisation and optimization. Assessment threshold values (e.g. environmental quality standards. EQS) for hazardous substances and their effects should be compared with the aim to having mutually-agreed values that enable harmonised status assessments. Additionally, a set of regional priority substances for the monitoring of both "old" and "emerging" substances is needed, as well as methods used for the assessment of biological effects should be harmonized.

Harmonisation of the monitoring should be applied – as far as feasible - to all steps in the process: site and matrix selection, sampling methods, frequency, sample preparation, analyses and finally assessment of the results. HELCOM community has long tradition in harmonisation of the monitoring. Latest efforts are indicators developed within expert network on Hazardous Substances (EN Haz). In this presentation, latest information (2010-) of key indicator ("core indicators") measurements in Finland will be shown, including PBDEs, PCDD/F, PFAS, TBT and selected heavy metals. Additionally, National indicators important for the Gulf of Finland: oil and algal toxins will be presented. Baltic Sea wide maps and reports for individual indicators are available in HELCOM portal to get the picture "from small scales to large scales".

Interannual and long-term changes in the benthic communities: analysis of 30-years data series from the eastern Gulf of Finland

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Analysis of 30-years benthic data series (1985 – 2015) from monitoring sites in the eastern Gulf of Finland demonstrated the considerable variations in structure and abundance of macrozoobenthos. The results suggest that factors controlling temporal changes in macrobenthic communities differed with scale. The interannual short-term (with period equal to a few years) and site-specific variations were related to the cyclic processes in the local benthic populations and/or communities. These oscillations were density dependent and governed by inter- or intraspecific competition for limited food resources. The more long-term and large-scale changes were triggered by periodical hypoxic events leading to mass mortality of benthic organisms and subsequent recovery succession. Immediate causes of these events were variations of hydrographic conditions in the Baltic Sea controlled by large-scale climatic factors. The most significant changes were related to invasions and mass development of non-indigenous annelid species especially *Marenzelleria arctia*. Introduction of these hypoxic-tolerant polychaetes mitigated the negative effects of oxygen depletion on benthic communities. In contrast to the reversible population cycles and climate-driven variations invasion-induced changes can be characterized as irreversible regime shifts resulting in formation of new alternative communities. This shift however is in line with the concept of continuing postglacial succession of the Baltic Sea and in geological scale it can be considered as restoration of natural estuarine community destroyed during Ice Age.

Implication of genetic approaches for biosystem state and dynamics survey of the Gulf of Finland.

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It is well known, that the Gulf of Finland has been subject to long-term significant anthropogenic pressure. The latter is due to heavy navigation activity and operation of seaport facilities. In addition, a vast number of major built-up areas including large cities belonging to different states are located along the coastal area of the Gulf of Finland. Industrial and economic activities carried out to maintain sustainability of those areas, the dam of St. Petersburg could be given as an example of such, are having certain impact on the aquatic state of the littoral zone. Complex monitoring of ecological situation is needed, but so far hydrological state has being assessed as well as hydrochemical analyses and biological monitoring have been pursued. Biosystem dynamics of the Gulf has been studied by means of traditional hydrobiological methods using biodiversity criteria in particular. This type of assessment allows for estimation of the current state of investigated biosystem at particular moment, but does not allow giving a long-term prognosis for possible changes. Various genetic approaches are indispensable for complex assessment of water system state including investigations on water organisms. On one hand, genetic methods give possibility to estimate genotoxic effects of water pollution, on the other hand, allows to give make a forecast on the possible structure dynamics of biosystem under investigation.
The results of genetic monitoring and assessment of the aquatic system of the Gulf of Finland will be presented and discussed.

Environmental vulnerability profile and HELCOM Baltic Sea Pressure Index as tools in site selection of offshore wind farms

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oral presentation

Human use of marine and coastal areas is increasing worldwide, resulting in conflicts between different interests for the space and marine resources and environmental sustainability. Maritime spatial planning requires an easy to use tool that would highlight the areas of conflict between economic activities, e.g. offshore wind farms (OWF) developments, and ecological sustainability. To provide such tool, environmental vulnerability profile (EVP) was developed: a spatial data layer that incorporates the distribution of nature values (benthic key species, biodiversity, seals, birds) and their sensitivities to disturbances. The practical use of EVP was exemplified with comparisons of potential sites of OWF developments in Estonian waters. Two-dimensional scatterplots of pixel values with EVP on the horizontal axis and cumulative human pressures (HELCOM BSPI) on the vertical axis and boxplots were produced to visualize the differences between OWF areas compared to the values outside of OWF polygons followed by ANOVA tests. The results reveal variation and differentiation of environmental vulnerability and cumulative human pressure (BSPI) among the potential OWF development areas enabling quantitative ranking of the potential areas based on their vulnerability and existing pressures. Thus, EVP and BSPI based analytical framework can be successfully used as a decision support tool for efficient ecosystem-based evaluation of OWF site selection.

Toxic cyanobacteria of the eastern Gulf of Finland: their ecology, toxicological effects, and control

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Algal blooms are observed in the Gulf of Finland and freshwater ecosystems of Russian Northwest region over a period of decades. Bloom-forming cyanobacteria (blue-green algae) are known for their ability to produce toxins that have caused adverse effects to aquatic organisms and humans. Oral intake through contaminated water is a key cyanotoxin exposure route. The bioaccumulation of cyanotoxins in the food web is another mechanism that has been shown to be responsible for cyanotoxin intoxication. Microcystins, a large group of cyclic peptides, are the most commonly occurring toxins in the eastern Gulf of Finland. They have allelopathic properties that may influence the biological processes of other microorganisms, phytoplankton or aquatic plants. Several environmental factors such as light intensity, wind, temperature, trace metals, ultraviolet radiation, pH, nutrients, salinities, etc. influence the growth of cyanobacterial species and their microcystin production. Microcystins are resistant to chemical hydrolysis or oxidation. They can remain unchanged in the darkness for months and even years. Several processes such as adsorption, photolysis, biodegradation, chlorination, ozonization, ultrasounding and electrochemical oxidation have been proposed to degrade or reduce the activity of microcystins. Among them microbial degradation can be the most realistic approach to remove or cease the toxicity of cyanobacteria. In spite of stability and persistence to bacterial and eukaryotic peptidases microcystins could be exposed to biodegradation by aquatic bacteria. However, information regarding this method is limited and it needs more extensive research. The risk assessment of cyanotoxins and permanent monitoring of the eastern Gulf of Finland are necessary to limit health risks and mitigate environmental problems.

Coastal erosion caused by storm surges and protection measures for the Kotlin Island's coastline in the Gulf of Finland: data analyses and modeling

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Oral

According to air-photography and satellite images of the surface, intense erosion of shores in the area of the Kotlin Island (KI), the Gulf of Finland (GoF), was observed in the last 70 years. The trend can lead to the complete disappearance of sandy beaches of the western KI in the nearest future. The intensity of the coastal erosion of the western KI is assessed and a method aimed to maintain the safety of its sand beaches is proposed. The method is based on information from geological researches of the study area, meteorological information and mathematical modeling. The vast geological near-shore zone research and onshore geological research revealed the following features of the western KI coastal zone: 1) wide spreading of boulder-pebble benches within near-shore bottom, indicating significant sediment deficiency; 2) small thickness of active sand layer within longshore sand ridge system, 3) prevailing of narrow (10-15 m) sand beaches and 4) low and smooth offshore and onshore relief. Taking into account revealed features, it could be recommended artificial sand nourishment for sediment deficiency compensation for preventing the future erosion. Quantity of sand as well as other parameters of artificial beach is determined from a coupled mathematical model, including models of water circulation, wind waves, and sediment dynamics. Calculations of current velocities were performed using the 3D hydrodynamic model of the eastern part of the GoF [Ryabchenko et al., 2010]. Calculation of wind waves was carried out using the SWAN wind wave model on the same grid as for the circulation model. Coast deformation due to storms was calculated with making use of the CROSS-P model [Leontyev, 2014]. Initial data for these calculations are the initial depth profile, sediment characteristics, wave parameters, height of the storm surge, wind speed, and duration of a storm. Given the actual external forcing (atmospheric forcing from HIRLAM, open boundary conditions from HIROMB, relief of the bottom and beach in the coastal area from above geological researches), the artificial beach profiles parameters are calculated at the maximum storm surge and the annual volume of sand necessary for conservation artificial beach is estimated. The proposed method can be applied to other areas of the coast of the Baltic Sea, as well as to other seas.

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Sedimentary processes and pollution history of Neva Bay bottom sediments (eastern Gulf of Finland, Baltic Sea)

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Neva Bay is the shallowest and easternmost part of the Gulf of Finland (Baltic Sea). St. Petersburg, Russia's second largest city, occupies the coastal area where the Neva River debouches into Neva Bay. St. Petersburg has a protracted history of industrial, transportation and urban related activity that have affected Neva Bay. By the sealing off the bay from the eastern Gulf of Finland, the St. Petersburg Flood Protective Facility, which was constructed from the 1970's to 2011, transformed Neva Bay into a "technogenic" lagoon. This paper analyzed sedimentological data collected by 20th and 21st century scientific surveys to interpret major sedimentary and heavy metal contamination events affecting Neva Bay. Neva Bay sediments record a unique history of pollution near the metropolis. Heavy metal concentrations of most elements studied varied consistently throughout sediment cores. Temporal trends indicate that metals started to accumulate abruptly in the first half of the 20th century. Zinc, lead and copper were the first metals to reach contaminant thresholds implicating the regional base metal industry as a source. Significant increase in cadmium levels a decade or two later suggests pollution from the regional chemical industry. Comparison of geochemical data collected from sediment cores and recent annual sediment surveys highlighted the temporal history and potential sources of pollution in Neva Bay. This inventory coupled with an understanding of primary natural and anthropogenic processes can help inform decision makers to support the overall ecosystem health of the bay.

Facies features (geodiversity) of sedimentation in the Eastern Gulf of Finland and their use for proper assessment of the results of geochemical monitoring of hazardous substances.

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Facies features of sedimentation largely determine the conditions of accumulation of hazardous pollutants, including heavy metals and hydrocarbons. The facial zonation of the bottom of the Eestern Gulf of Finland was carried out on the basis of geological mapping data at a scale of 1: 200000 (VSEGEI) and geoecological monitoring (State company Sevmorgeo). More than 50% of the seabed occupy aleuropelitic nepheloid deposits localized in the deeps of the bottom relief and having a Holocene age. Their thickness can reach 10m or more. The remaining 40-50% of the seabed at depths from 3-5 to 40-50 m are occupied by sediments of the transit range (sea perlium) or zones of modern erosion. They are composed of sediments from clayey sands to boulder-pebble deposits. Along the coast, in the zone of wave action, the undaluvial sands accumulate. The difference in the granulometric composition and features of the sedimentation processes leads to a completely different level of concentration of microelements in them, including pollutants. A higher level of concentrations is conected in the nepheloid deposits. But the highest contets of microelements and hydrocarbons are related to man-made rainfall in artificial quarries.The report shows how these features were taken into account when creating a network of observations and interpretation of chemical analyzes of bottom sediments. The seabed zonation according to the level of accumulation of various pollutants for the entire observation period was carried out.

"HELCOM "hot spots". Current status and plans for elimination. Russian overview from the catchment area of the Gulf of Finland"

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Oral

In 1992, HELCOM approved the Joint Comprehensive Program of measures (JCP) which included 162 "hot spots" located in all countries of the Baltic Sea basin. The "hot spots" included industrial enterprises, municipal sewage treatment plants, agricultural enterprises, as well as other objects of economic activity, causing significant damage to the environment. The list of the Program included 9 "hot spots" located in the territory of St. Petersburg and the Leningrad region (in Gulf of Finland catchment area) and 7 "hot spots" - on the territory of the Kaliningrad region. At the 11th meeting of the HELCOM LAND "hot spots" of SUE "Vodokanal of St. Petersburg" was revised.

To the Copenhagen Ministerial Meeting (October 3, 2013), all Contracting Parties evaluated the effectiveness of the Joint Comprehensive Program (1992 -2012), it was recognized that due to joint efforts 110 "hot spots" were eliminated (including 4 "hot spots" in Russia), which led to a significant reduction in pollution, including nutrients, and confirmed the importance of the program in improving the ecological state of the Baltic Sea.

Within the framework of the Ministerial Meeting, the Contracting Parties adopted the Copenhagen Ministerial Declaration of HELCOM, according to which the member states agreed to exclude municipal (23) and industrial (20) hot spots from the list of the JCP until 2016, HELCOM Baltic Sea Action Plan until 2018.The last "hot spots": agriculture (6) and joint programs for management of coastal areas (3) should be included in national programs for the implementation of the Baltic Sea Action Plan.

In order to achieve the goals of the Helsinki Convention, the Baltic Sea Action Plan and the Copenhagen Ministerial Declaration, the development of environmental policy in the future, the assessment of the state of the marine environment of the Baltic Sea, and the effectiveness of measures taken in countries, it is necessary to provide reliable data on HELCOM the current state of Russian "hot spots" for possible exclusion from the Program.

At present time, a number of industrial enterprises of the "hot spots" (Neman Pulp and Paper Mill, Tseprus pulp and paper mill, Soviet CBZ) finished their work, some industrial enterprises were reorganized and changed their legal status, due to which it is necessary to revise the name of the "hot spot" (Volkhov aluminum plant), part of the enterprises carried out significant environmental protection measures (2 substudes operated by the State Unitary Enterprise "Vodokanal of St. Petersburg", as well as sewage treatment plants in Kaliningrad).

Thus, carrying out this work will allow us to assess the current state of Russian hot spots, further prospects for the implementation of the JCP program and assess the potential for reducing of negative impact on the Gulf of Finland ecosystem in a positive and negative scenario.

NITROGEN DIOXIDE OVER THE GULF OF FINLAND

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Oral

Keywords: nitrogen dioxide, satellite

Nitrogen dioxide is a highly toxic gas with 2 class of danger (Russian classification). Main source of nitrogen dioxide in atmosphere are organic fuel combustion with temperatures more than 1000 ºC. It is generated in forest, coal and peat fires and in small amount in thunderstorms. Modern vehicles are responsible up to the 80% of gas income into the atmosphere. Gas concentrations can exceed 1000 mkg/m3 in cities, that much higher than maximum allowable concentration. Current remote sensing systems allow to control nitrogen dioxide in atmosphere. Current devise for gas measurements from satellite is OMI on AURA satellite. Daily Earth monitoring is impossible due to low spatial resolution and clouds. Monthly and yearly mean values are reasonable for analysis. Large city agglomerations as St-Petersburg, Helsinki and Tallinn are clearly defined on the yearly mean data. Data analysis also indicates significant gas transfer from the shore to the Baltic Sea and the Gulf of Finland. The next source of nitrogen dioxide over the Gulf of Finland is shipping traffic. Comparison with volumes of transport work and estimated NOx emission by HELCOM Baltic Sea Environment Fact Sheets do not indicates evident correlations. Gas concentration over the Gulf keeps stable and even probably goes down in warm season last years. The spatial distribution of nitrogen dioxide is not uniform. Gas concentrations are changed in two orders.

Modelling Surface Stokes drift in the Baltic Sea

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The Stokes drift is one of the components that affect the drift of substances and objects on the surface layer of the sea. Previous studies have shown that the drift of surface following drifters, such as oil, is in some conditions significantly affected by the surface wave-induced Stokes drift and that including this component to the drift forecast model improves the drift trajectory estimates. In many of the currently used Baltic Sea drift models, the Stokes drift is estimated based on wind forcing and paremeterised wave spectrum. However, most accuracte estimates of the Stokes drift can be obtained by using 2D wave spectra, which is avaibale e.g. from directional wave buoys and third generation wave models.
To estimate the magnitude and directional distribution of the Stokes drift in the Baltic Sea, we ran the wave model WAM for a ten-year period (2006-2015). We calculated the mean values and percentiles of surface Stokes drift for the whole Baltic Sea. In the open sea areas the mean values were between 0.08 and 0.10 m/s. The 99.9[th] percentile of Stokes drift magnitude was generally between 0.3 and 0.4 m/s in the open sea areas. In the Gulf of Finland it was between 0.3 and 0.35 m/s. We validated the model results by comparing modelled wave parameters to data from wave buoys. We also compared the modelled Stokes drift to the Stokes drift calculated using wind forcing and parameterised wave spectrum. Compared to the Stokes drift calculated by WAM, the parameterised methods overestimated the magnitude of the small values of Stokes drift and underestimated the larger ones. An additional comparison of the wind direction and the surface Stokes drift direction showed that the modelled Stokes drift direction mostly followed the wind direction. However, the directional behaviour of Stokes drift requires still more analysis with measured wave spectra.

Eulerian and Lagrangian submesoscale coherent structures on the sea surface driven by coastal upwelling: a case study for the Gulf of Finland

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Oral

The aim of the study is to investigate clustering of floating Lagrangian particles (surface drifters) into coherent structures during their advection by currents. This process is thought to contribute to formation of complex structures of phytoplankton distribution observed on remote sensing images and also it is of practical importance in relation to forecast of pollutant fields on the sea surface.

Velocity field simulated by a circulation model (mpiPOM) with very high, submesoscale-permitting horizontal resolution in the Gulf of Finland during a summer upwelling is used to calculate advection of floating Lagrangian particles that are initially uniformly distributed on the sea surface. For a relatively short time of advection (of the order of one day), the particles are found to gather within a narrow, elongated stripes characterized by extremely high, positive values of vorticity, Finite-Time Lyapunov Exponent, and lateral thermohaline gradients module (fronts). The clustering rate, defined as the time derivative of standard deviation of normalized particle concentration, tends asymptotically at small to the standard deviation of flow divergence. The standard deviation of flow divergence, it its turn, displays a considerable growth with the refinement of the model grid (for comparison we performed simulations with 0.5 and 1 nautical mile grid), confirming the important role of submesoscale dynamics in clustering of floating particles. At large, the probability density function of floating particle concentration is shown to tend to lognormality. Based on the back-time integration of the Lagrangian velocity convergence, a criterion for finite-time clustering is introduced.

Sediment quality in Estonian western Gulf of Finland

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Abstract. The seafloor sediments of the Gulf of Finland are loaded with heavy metals, sometimes with rather high contaminant levels. As proper maritime spatial planning requires reliable knowledge of the seafloor, established sediment quality guidelines (SQG: s) provide good frame for evaluation of sediment quality for the permitting authorities. In the northern part of the Gulf of Finland this approach has been used for a rather large dataset, where the existing heavy metal data were classified using different SQG:s. In this study recent sediment cores from Estonian seafloor were classified using three different SQG:s and compared to the results from the northern Gulf of Finland.

The principal target of the European Union marine strategy framework directive (MSFD) is to preserve the good environmental status of the sea areas or reach it by 2020. In order to reach these goals the Estonian SedGof project contributed with an assessment on seafloor quality.

The results of this study reveal that in less than half of the subsamples from Estonian seafloor heavy metals and arsenic exceed the threshold levels of both used American SQGs. Some of the subsamples, however, exceed the probable effect level (PEL), and a few belong to the third and fourth classes of the Norwegian guidelines. No subsamples exceeded the highest, fifth class of the Norwegian guidelines. The quality of the sediments in western Estonian waters were assessed as good for most of the studied elements according to the used guidelines, and the already rather low concentrations are decreasing further. The concentrations of copper and zinc, however, are at some sites on a moderately high level, and as these levels were observed from subsamples from close to the sediment surface, raising a potential threat to benthic biota, the situation regarding these two metals was not assessed as satisfactory. Also cadmium reaches elevated levels at one coring site off Tallinn.

Aerial estimating abundance of ringed seals in the Russian part of the Gulf of Finland on April 2017

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Results of the conducted aerial surveys revealed the expected number of ringed seals on April 2017 in the Russian part of the Finland Gulf amounted to 71–90 individuals. More precisely, on April 11th between 10:30 and 14:30 a total of 1 639.84 km2 was surveyed; the length of the flight route was 361.199 km. In total 22 transects of meridional direction were worked out; the average distance between transects was 4.5 km. The actual studied area was 289 km^2, which corresponds to the number of elementary segments of the route (1 segment = 1 km^2). There were seven ringed seals within the route on the right board (MV), and only two animals on the left board (LV). The total number of the met animals was nine specimens. Relative spatial density of individuals per 1 segment (= 1 km^2) of the route was 0.031±0.004 (m±95% confidence interval), SD = 0.17. The expected number of ringed seals within the studied area was 51 individuals, with a 95% confidence interval of 44 to 57 individuals. On April 15th between 9:16 and 14:11 a total area of 2451 km^2 was surveyed; the length of the flight route was 490.2 km. In total 21 transect of meridional direction were worked out; the average distance between transects was 5 km. The actual studied area was 392.16 km^2, which corresponds to the number of elementary segments of the route. There were six ringed seals within the route on the right board (MV), and nine animals on the left board (LV). However, two meeting points were excluded from the calculation of the relative density, because these animals were marked outside the transect. Thus, 15 individuals were recorded, but the calculation included only 13. The relative density of individuals per 1 segment was 0.033±0.004 (m±95% confidence interval), SD = 0.19. The expected number of ringed seals within the studied area was 81 individuals, with a 95% confidence interval from 71 to 90 individuals. The number of Baltic ringed seals in the Russian part of the Finland Gulf from 2012 to 2017 stably remains low, and amounts to approximately 71–90 individuals (maximum up to 95–100 individuals).

Posters

Water quality and biodiversity of benthic animals in the Neva Estuary under anthropogenic stress

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Zoological Institute of RAS has been studying the biodiversity of benthic animals in the Neva Estuary since 1982. In 1994-2005 188 taxa of benthic animals were recorded for the whole Neva Estuary. Of these 68 were common for the Neva Bay and the eastern part of the Gulf of Finland (Balushkina et al., 2008). Maximum species richness (22-35 species per station) and species diversity of zoobenthos (Shannon's index: 3.04 to 3.7 $bit \cdot ind^{-1}$) was recorded in the zone of maximum flow velocity in the eastern part of the Neva Bay. The lowest species richness and species diversity was recorded in St. Petersburg commercial port. A small number of species and low Shannon's indices were also found in the southern part of the bay. Statistical analysis showed that the number of species was determined by toxic pollution, primary production and chlorophyll "a" concentration.

Structural and functional characteristics of benthic communities were used for the assessment of the state of the Neva Estuary ecosystem. Four periods were established. In the Neva Bay during the first period (1994-2002), processes of restoring of the ecosystem related to the decline of industry in St. Petersburg were observed. The number of benthic species increased from 11±1 to 23±2 species per station and index of species diversity from 2±0.2 to 3±0.2 bit/ind. Average for the Neva Bay values of *IP'* declined from 64.5±2 in to 56.8±2 %. The state of the ecosystem was assessed as "critical", and waters, as "polluted" (4th class). The second stage (2003-2006) was accompanied by revival of industry, construction of ports, active navigation, development of the Sea Facade and completion of the construction of the St. Petersburg Flood Prevention Facility Complex. The number of species of benthic animals declined from 23±2 to 15±2 species per station, and Shannon index decreased from 3±0.2 to 2.6±0.2 bit/ind. Average *IP'* increased from 60.9±2 % in 2003 to 68.2±4 % in 2006. The state of the ecosystem of the Neva Bay in 2006 was worst during the whole period of observations and was assessed as "crisis", and waters, as "polluted-dirty" (4-5th class). In the third stage, 2007-2011, the Neva Bay restored, which was related to cessation of the large-scale dredging that accompanied the construction of St. Petersburg Sea Facade. The number of benthic species increased from 14±1 to 20±1 species per station, species diversity – from 2.4±0.2 to 3.1±0.2 bit/ind. The average *IP'* declined from 63.4±3 % to 58.7±2 %. The water quality improved to class 4 ("polluted"). The fourth stage (2012-2015) was accompanied by the building of the Marine Multifunctional Reloading Complex (MMRC) "Bronka". Average values of *IP'* increased from 62.8 ± 2 to 67.6 ± 3%. The state of the ecosystem deteriorated and was assessed as "crisis", and waters, as "polluted-dirty" (4-5th class). The number of species declined from 18±1 to 15±2 species per station.

Species diversity of benthic animals in the Health-resort zone of the eastern part of the Gulf of Finland was notably lower than in the Neva Bay. Mean values of the *IP'* integrated index changed during the whole period of studies from 63.7±5 to 65.1±4 %, characterizing the state of the ecosystem as "critical" and water quality as "polluted". In 2014-2015 the state of this part of the estuary worsened and assessed as "crisis", and the water – as " polluted-dirty."

Cytogenetic characteristics of amphipoda *Gmelinoides fasciatus* - biodiversity component of the Gulf of Finland.

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The amphipod *Gmelinoides fasciatus* is one of the most numerous species among alien organisms. Its emergence in the Gulf of Finland of Baltic Sea is the consequence of artificial introduction into water bodies of North-Western regions of Russia. Starting from the end of the last century *G. fasciatus* became widely spread in the Gulf of Finland, being even dominant in a number of locations. Appearance of a new species in a coherent ecosystem can seriously influence biodiversity of the latter. In particular, it has been demonstrated that the introduction of Baikal amphipod *G.fasciatus* into the shallow water area of the Gulf of Finland had already led to replacement of a number of native amphipod species. Successful adaptation of *G.fasciatus* to the new living environment stimulated a series of investigations of organism physiological reactions to the change of key ecological parameters. In addition, *G. fasciatus* , representing the most numerous group of crustacean organisms that was successfully used in eco-genetic monitoring of the Gulf of Finland water environment condition. At the same time, the amphipod *G. fasciatus* has not yet been subjected to substantial genetic studies. Cytogenetic features have considerable significance with respect to establishment of phylogenetic links within this systematic category, as well as to disclosing genetic mechanisms underlying high degree of adaptation of this species to varying environmental conditions. We have analyzed the karyotype of *G. fasciatus* inhabiting the littoral zone of the Gulf of Finland. The data on diploid chromosome number and chromosome characteristics obtained with the help of molecular probes will be presented and discussed.

Aerial survey of waterfowl spring stopovers in the Russian part of the Gulf of Finland

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At the present time, aerial surveys are becoming a more widely used method of the remote monitoring of birds in their natural habitat, due to the fact that they cause them the least disturbance. The high resolution of modern digital cameras allows to take sufficiently detailed images of individuals and flocks sitting on water from a remote distance. Main aims of the study were discovery and mapping of concentration sites of migratory waterfowl in places of rest and feeding in spring in the waters of the Russian part of the Gulf of Finland. Surveys were performed on April 23 and May 8, 2016 under optimal weather conditions with minimal wind and clear weather. Surveys were carried out on board of the aircraft Cessna 182. The average flight speed on transects was 180-200 km / hour. The speed of the aircraft at time of observing birds flocks varied from 70 to 90 km / h, altitude - from 50 m to 100 m, above the detected birds stopovers - no more than 75 m. Observations were carried out from the right and left side of the plane. The following equipment was used: Canon SX280 HS 20x optical zoom camera, CanonEOS 40D camera with Canon70-200 lens, Nikon D750 with Nikor lens c variable focal length up to 300 mm, and navigators Garmin GPSmap 60Cx and GPS Garmin 78s, configured in the coordinate system of WGS 84. During each aerial survey all flocks of waterfowl found were recorded and their coordinates noted using GPS and photography.

In total, 21,372 (of those on 04/23 – 11 552, 05/8 – 9829) birds of 38 species from 5 orders (Pelecaniformes, Podicipediformes, Ciconiiformes, Anseriformes and Charadriiformes) were registered during the observation period. Representatives of Anatidae family (Anseriformes) dominated, their total number amounted to 11 247 individuals, i.e. 52.6%. The most numerous were the Tufted Duck *Aythya fuligula* and Greylag Goose *Anser anser.* 5 species of geese, 3 species of swans, 14 duck species were observed. The second dominant group consisted of Laridae reached 31.6% in numbers. Of the 5 recorded species of gulls, the most numerous was the Herring Gull (*Larus argentatus*). On our opinion, majority of birds belonged to local individuals who concentrated near the sites of future breeding colonies. The third dominant group consisted of great cormorants *Phalacrocorax carbo sinensis* numbered of 2968 individuals, i.e. 13.9%. A significant number of herring gulls and great cormorants registered on May 8 were already on nests.

From 38 species recorded during the aerial surveys, 5 species are included in the Red Book of the Russian Federation (2001) – Atlantic subspecies of the Brant Goose *Branta bernicla hrota,* Tundra Swan *Cygnus bewickii*, White-tailed Sea-eagle *Haliaeetus albicilla*, subspecies of Eurasian Oystercatcher *Haematopus ostralegus longipes*, Little Tern *Sterna albifrons.* 14 species are listed in the Red Book of the Leningrad Region (2002) and 11 species - in the list of protected species HELCOM (2017).

In total 16 major sites of waterfowl concentrations on stopovers and breeding plots were recorded: Vyborg Bay, Beryozovye islands, Kotlin isl., Lebyazhe, Koporye Bay, Kurgalsky Peninsula with Kurgalsky Reef islands, Seskar, Moshchny, Maly, Bolshoi Fiskar, Gogland, Bolshoi Tyuters, Maly Tyuters, Rodsher, Southern and Northern Virgins islands. The largest concentrations were registered around Bolshoi Fiskar and the Beryozovye islands (with the exception of Rondo), near Kurgalsky peninsula and Kurgalsky Reef islands, also on Maly, Moshchny, and Seskar islands. Our works were conducted under financial support of «Nord Stream 2 AG» company.

MSP Law in the Russian Federation: a place in the system of strategic planning documents. Suggestions

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Poster

According to the definition of UNESCO, which was used as a basis for activities in particular the Helsinki Commission for the Protection of the Environment of the Baltic Sea (HELCOM), "MSP is a public process for analyzing and allocating spatial and temporal distribution of human activities in marine areas to achieve environmental, economic and social goals, which, as a rule, were set by means of a political process". In our view, in addition to the technical definition of the MSP content, a very significant factor here is that the objectives of maritime spatial planning are set by the political will in the process involving all stakeholders of human society - population, business, government, non-state organizations, etc.

Russia currently has a system of state strategic planning that, as an integral part of public administration, defines the main directions, ways and means for achieving sustainable development of the Russian Federation. This system is described by the Federal Law "On Strategic Planning in the Russian Federation" and covers all levels of government, from the federal to the local. This law defines a system of strategic planning documents, differentiated by designation and levels of public authorities. In accordance with this law, the system of strategic planning documents is built on the basis of goal-setting, forecasting, planning and programming documents.

The effect of the Federal Law "On Strategic Planning in the Russian Federation" extends to relations in the sphere of strategic planning carried out in the territory of the Russian Federation, as well as in territories under the jurisdiction of the Russian Federation or used on the basis of international treaties, including maritime space. However, the issue of ensuring the regulation and use of the sea space remains open due to the imperfection (more precisely, the absence) of legislation on maritime spatial planning.

The poster session presents proposals for determining the location of MSP documents in the system of strategic documents of the Russian Federation on the basis of the structure of the Federal Law "On Strategic Planning in the Russian Federation", based on an integrated socio-economic and spatial goal setting and taking into account the sectoral, scientific, budget forecasting, spatial planning and programming.

Feeding patterns of the abundant coastal fish species in the Eastern Gulf of Finland

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Poster

Study of fish diet characteristics during periods of active feeding in shallow coastal habitats (depths from 0 to 1.5 meters) was conducted in 2014-2016 based on fish observations in the eastern Gulf of Finland, from Neva Bay to the Vyborg and Luga bays.

The dominant fish species in summer in the surveyed area were bleak (*Alburnus alburnus* L.) and roach (*Rutilus rutilus* L.). Also gudgeon (*Gobio gobio* L.) and three-spined stickleback (*Gasterosteus aculeatus* L.) were common and abundant. All the species were presented in samples of juveniles and adults. Bleak was mostly numerous in July-August in the Neva bay, in the Resort area of Saint Petersburg, and in the Vyborg bay. Roach and gudgeon were mostly abundant on the shallows in the open part of the gulf. Stickleback was numerous on the well vegetated biotopes in the different parts of the gulf.

In the stomachs of fishes in samples we found organisms from 6 major taxonomic groups: crustaceans (Copepoda, Cladocera, Ostracoda and Amphipoda), molluscs (Gastropoda), and insects (Chironomidae). 26 different prey items were identified. The food composition of cyprinid species was combined by the planktonic and benthic species. The most frequent of planktonic organisms were the cladoceran *Daphnia cucullata* (present in more than 70% of all stomachs) and *Bosmina sp.* (about 50%), followed by the copepod *Eurytemora sp.* (45%). Benthic organisms such as Chironomidae and Amphipoda also were found in stomachs, but they not were common. All these taxa were presented (F) on average in 90% of stomachs, and comprised about 80% of the total weight of stomach contents (I_i) cyprinid fish species. Feeding of three-spined stickleback was different from that of cyprinid fish species. Dominant taxa in the stomachs of stickleback were Chironomidae*, Eurytemora* sp.*, Cyclopoida* sp. and *Polyphemus pediculus,* in conjunction accounting for more than 90% of the food biomass and appearing in more than 85% of stomachs. Other prey organisms were also presented in stomachs, but their cumulative contributions never exceeded 10–20% of total food items.

Influence of temperature and salinity variability on late-summer phytoplankton structure in the eastern Gulf of Finland

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Poster

The phytoplankton structure in the Eastern part of the Gulf of Finland is characterized by considerable inter-annual variability. The formation of the phytoplankton structure in the GoF depends on the hydrophysical conditions with a significant spatial variability due to the impact of the Neva river and the open Baltic. The study analyzes the long-term data on the structure of late-summer phytoplankton, salinity and surface water temperature obtained during the cruises of the RSHU in the eastern part of the GoF for the period from 2002 to 2016 aa.

A statistically significant feedback was found between the number of taxons in the phytoplankton sample (α-diversity) and the surface salinity, with the most pronounced relationship being in the shallow-water region where the Spearman correlation coefficient was -0.53 (n = 52) and the weaker -0.28 (n = 108) in the deep-water part of the GoF. The greatest α-diversity of phytoplankton was in 2011, when along with low salinity the water temperature was up to 26 °C. In the western direction, where salinity is increased, the α-diversity of phytoplankton decreased due to the reduction of green and diatoms species. In 2002-2016 aa. the abundance of late-summer phytoplankton was determined by cyanobacteria in both the shallow and deep-water regions of the eastern GoF. In the shallow and inland deep-water regions cyanobacteria filamentous *Planktothrix agardhii* was periodically dominant. Its distribution in the GoF is limited by a salinity of 3.5-4 ‰ [Kononen K., 1992, Makarova, 1997]. The abundance of cyanobacteria *Planktothrix agardhii* and α-diversity of phytoplankton were negatively associated with water salinity. Water temperature rise significantly inhibited the development of cyanobacteria *Aphanizomenon flos-aquae* and contributed to an increase in the taxonomic diversity of phytocenoses in the shallow water area.

MELICA PICTA IN THE BALTIC REGION: DISTRIBUTION AND HABITATS

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The Painted Melic (*Melica picta*) is a red-listed vascular plant species both in the Leningrad Region and Finland. According to the Red Data Book of the Leningrad Region (2000), it has status E (Endangered), and in the Red List of Finnish Species (2010) it is listed as NT (Near Threatened). The main range of the species occupies more southern regions of Russian European part (north to the Oka River) and Caucasia, Central Europe, the Balkans and Transcaucasia. In the Baltic Region *Melica picta* was discovered for the first time on a small island Lehtinen in the southeastern Finland in 1949 (Kurjala, Hämet-Ahti 1966). Later, in 1980s it was found for the first time in the Leningrad Region on the Island of Maly Berezovy in the Gulf of Finland (Tzvelev 1991) and near the inflow of the Tigoda River. These localities are very far from the main distribution area of *Melica picta*. For this reason, the question about the origin of this species in the Baltic region has been open for a long time, and a possibility of its introduction has not been excluded (Kurjala, Hämet-Ahti 1966).

In 2003-2014 *Melica picta* was recorded by the author from 17 new localities on the islands of the Gulf of Finland, where the species grows in the zone between the forest margin (usually, open black alder coastal forests or forest with broad-leaved trees) and seashore meadows, and is fairly abundant there (Glazkova 2004, 2012). On some islands *Melica picta* occurs also in open small-leaved forests, where it often predominates in the herbaceous layer. In many respects, the habitats of *Melica picta* in the Baltic Region closely resemble those in Central and Eastern Europe; the acidity is low and the seashores of as well as the slopes of ravines along the rivers fairly rich in nutrients.

The research has proved that *Melica picta* is a native species in the Baltic Region. The possibility of the introduction of the species has been absolutely excluded. New data on the distribution and number of populations of the species allows to suggest replacing the present species status "E" by a status "VU" in a new Red Data Book of the Leningrad Region, expected to be published in 2017.

SmartSea toolbox for Maritime Spatial Planning

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The "SmartSea – Gulf of Bothnia as Resource for Sustainable Growth" project of the Strategic Research Programme of the Academy of Finland will develop an open-source toolbox for Maritime Spatial Planning (MSP). A prototype of the toolbox has been developed as a software system platform utilizing several existing open-source software libraries, a relational database, three programming languages, and the client-server distributed application structure. The system supports flexible modelling of the maritime spatial planning problem and mathematical modelling of the spatial planning problem using a range of techniques.

MSP is a relatively new concept and thus few fixed rules, and institutions exist for it. Analysis and allocation of spatial and temporal distribution of human activities in the light of existing knowledge of ecological values is at the heart of MSP. Modelling is needed for structuring the planning problem and for solving specific valuation, comparison, and evaluation problems.

The SmartSea MSP toolbox aims for supporting the planning of the use of marine space by allowing definition of use profiles, which can then be analyzed by defining spatial attributes. The spatial attributes are composed of simple exclusive or inclusive rules, rules based on patterned and weighted attributes, or more complex analytical models including Bayesian networks. The use profiles are also used to define the activities taking place in the respective sea areas, thus allowing a link to ecological impact models.

The software system separates the database, data services, and client programs with planner or modeller oriented user interfaces. The work presents new results in linking models associated with spatial plans to dynamic web mapping.

Using of the microcosm method to determine the pollution of the shores of the eastern part of the Gulf of Finland.

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Poster

The nearness of the St. Petersburg Maritime Canal with intensive large-tonnage shipping on the one hand and urban infrastructure on the other makes the narrow strip of the coast highly susceptible to anthropogenic influences. To investigate the possibility of contamination, the microcosm technique was used, when animals from clean habitats were placed in a transparent cage in a contaminated biotope with the preservation of the vegetation cover, which was the food for the mollusks. *Bradybaena fruticum (Mull)*, pulmonary mollusks inhabiting the shore, was chosen as a bio-indicator of the accumulation of TM. The following experiments were used: animals from the supposedly polluted locations were placed in cages in a clean biotope, and from clean locations to contaminated areas. Exposure time was the same and was 1-2 months from August to September of 2015-16. Hepatopancreas of mollusks were studied for the content of Cd, Ni, and Cu before and after the exposing in cages. For this purpose, the device AA-7000 of firm SHIMADZU was used. So mollusks from contaminated locations during their stay in a clean biotope lost part of the accumulated Cd and Cu, and animals from a pure biotope gained excess Ni during their stay in the contaminated one.
 The obtained data demonstrated the promise of the microcosm method for ecotoxicological studies of coastal biotopes in the eastern part of the Gulf of Finland.

Mass occurrence of "brown" macroalgae mats   on the Eastern part the Gulf of Finland (EGoF).

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According to different chemical and hydrological conditions, EGoF was districted on few areas: Neva Bay, Tranzition Zone, Brakish-water shallow area and Eastern Deep-water area (Ostov, 1971).

In recent years, during the field work and the processing of collected samples, a number of original data were obtained about the distribution of the annual brown alga Pylaiella littoralis (Linnaeus) Kjellman in Brakish-water shallow & Eastern Deepwater hydrological regions of the EGoF. The work was done in Lab. of Algology of The Komarov Botanical Institute of The RAS. For the first time on the Russian sector of the Gulf of Finland, the status of this species in the communities of perennial brown alga Fucus vesiculosus has been determined. It is shown that P. littoralis forms a well-developed epiphytic synusia in communities of the Fucus belt. Also for the first time for the Russian sector of the Gulf of Finland **it** has been shown that P. littoralis form well-developed macroagal mats at depths from 1.5 down to 8.5 meters. According to the results of field observations, it may be argued that the algal mats formed by P. littoralis cover extensive areas of the bottom in the surveyed water areas of the Brackish & Eastern Deepwater hydrological regions. In some water areas, the thickness of algal mats reached values of up to 40 -50 cm. It should be specially noted that these mats completely covered the belt of Fucus very often. It is well known that with the die-of algal mats, in the bottom layer conditions of hypoxia and anoxia are formed. These conditions influenced on the state of benthic communities very negative. The harvesting of these algal mats will promote the de-eutrophication of coastal ecosystems and the preservation of important habitat-forming species of seaweeds such as Fucus vesiculosus. Also, harvesting produced by P. littoralis biomass will help to improve the ecological situation in the coastal waters as a whole, since it will prevent microbial destruction of the macroagal mats. Studies were carried out with financial support OF the Program of the Presidium of the RAS "Biological Resources of Russia: assessment of the state and fundamental principles of monitoring". (Name of the project "Assessment of the distribution and some quantitative characteristics of populations of the harvesting species of the macroalgae Pylaiella littoralis on the Gulf of Finland in the Baltic Sea"

Toxicological investigation of the bottom sediments of the Gulf of Finland

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Heavy metal and petroleum products content in the bottom sediments of the Gulf of Finland was determined, and the toxicity of sediment samples was estimated in 2014-2016. The content in bottom sediments varied from 0,041 till 5,40 mg/kg, for cadmium, from 0,62-till 69,79 for the lead, from 0,0,68 till 64,71 mg/kg for the copper and from 82 till 156404 mg/kg for the manganese. The maximum concentrations of metals were determined in sediments from the deep-sea site near Vyborg Bay. According to the Dutch Lists the lead content was not above the target value, the portion of samples with metal content above the target value amounts to 44% for cadmium and 30% for copper. The petroleum products content in bottom sediments varied from 0,041 till 5,40 mg/kg and was above the target value in 87% of samples. The largest concentrations were marked at coastal and deep-sea sites. By the results of bioassay in the acute and chronic tests with the standard test-object as crustacean *Daphnia magna* the acute toxicity was detected for the single sediment sample from Koporskaya Bay whereas in contrast the chronic toxicity was detected for the most part of the other sediment samples (82%). The 29% of samples had the chronic toxic effect by the test function of «reproduction», and the 31% by the «mortality». The 22% of samples had the chronic toxic effect by the both test-function. The status of investigated water area can be characterized as chronically toxic. By the results of the 2014-2016 years investigation there was no trend towards an increase in the concentration of heavy metal and petroleum products in bottom sediments/. The externally high concentrations of manganese at separate sites were not typical for the whole water area. The average concentrations of cadmium, copper, lead, manganese were below average for the bottom sediments of the Gulf of Finland, noted in the early 2000s.

The relative contributions of advection, turbulent diffusion, and the components of the freshwater balance in the salinity changes of the Gulf of Finland

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Poster

Significant changes in the hydrometeorological conditions observed in the last decades in the Baltic Sea region. In particular, there is a sharp reduction in the number of large Baltic inflows. However, despite the recorded changes in water exchange with the North Sea, fluctuations in salinity in the Gulf of Finland do not go beyond the historical range of its variability. To study the mechanisms of salt redistribution in water from the Baltic Proper to different part of the Gulf of Finland in this work we propose to assess the comparative contribution of advection, turbulent diffusion, and the components of the freshwater balance in salinity changes of this region.

According to this purpose, the data series for the three areas of the Gulf of Finland (LL7, LL3A, LL9), the most provided with data, were formed on the basis of ship data measurements DAS (http://nest.su.se/das/), reanalysis MyOcean (http://marine.copernicus.eu/) and reanalysis of the meteorological fields ERA (https://www.ecmwf.int/). Using these data, the following characteristics were evaluated: the rate of salinity changes, zonal and meridional components of the salt advection, the vertical gradient of salt, the second derivative of salinity changes along the axes x , y and z, as well as a series of changes in precipitation, evaporation and continental runoff. To assess the comparative contribution of the predictors listed above, the salt transport and diffusion equation was represented as a multiple regression. In the multiple regression equation the rate of salinity changes in one point was used as a predicate, and as predictors − components of the salt advection at the Meridian and the Parallel, the vertical gradient of salt, the second derivative of salinity changes along the axes x , y and z, as well as changes in precipitation, evaporation and continental runoff.

Estimates of the multiple regression coefficients showed that the greatest contribution to the salinity changes in the surface layers of the Gulf of Finland is due to horizontal turbulent diffusion (34-52%). The second important process was the salt advection by currents (17-19 %), in the third place is the fluctuation of the vertical component of the current velocity (14-19 %). The contribution of the other processes turned out to be smaller. Taking into account that the spatial resolution of the Myocean data is 5 km, which is close to estimates of Rossby's internal deformation radius in the Gulf of Finland, we are assumed that the greatest importance in the redistribution of salt from the open Baltic to the Gulf of Finland have mesoscale eddies.

Dynamics of bacterioplankton development of the Neva bay Gulf of Finland

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Poster

The microflora in the biocenosis of the reservoir is the most rapidly and actively reacting element for any impact. With a high physiological activity and adaptability of microorganisms involved in the decomposition, transformation and utilization of incoming contaminants. Changes caused by human factors, appears in a quantitative and specific restructuring water microbiocenosis. They stimulate the accelerated development of groups of bacteria that use pollutants as a nutrient substrate. Thus, the aquatic microflora plays an important role in the circulation of organic substances and biogenic elements and microflora is of decisive importance for the formation of hydrochemical and hydrobiological regimes and processes of self-purification. The viability of microbial populations contributes to the maintenance of natural balance in the aquatic ecosystem and affects the habitat and development of the entire interrelated set of organisms inhabiting the reservoir.
It was analyzed the data of microbiological studies of the aquatic environment of the Neva Bay of the Gulf of Finland from the end of the IXX th century to the present day.

Littoral communities monitoring in the Neva river estuary: case study of Zelenogorsk and Olgino

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The environmental situation in the Neva river estuary is constantly changing. The most significant changes in the ecosystems of the estuary are caused by such factors as direct anthropogenic impact (destruction of habitats: the construction of the dam, new land reclamation from the sea), eutrophication, alien species invasion, toxic pollution.

Composition and structure of littoral macrozoobenthos communities were studied in order to analyze anthropogenic impacts on living ability of coastal communities. Samples were taken at two stations located along the northern shore of the eastern part of the Gulf of Finland – Olgino and Zelenogorsk.

Structure and composition of macrozoobenthos littoral communities at the northern shore of the Neva river estuary were studied in summer seasons 2009-2011 and 2017. Comparison of data on abundance and biomass of macrozoobenthos at stations Olgino and Zelenogorsk allows to evaluate changes in the composition and structure of the littoral comunties due to the negative impact of hydraulic works carried out at the western tip of Vaslyevsky island.

From the start of hydroengineering work in the Neva river mouth the substantial changes occurred in the littoral communities structure at the studied sampling stations: the correlation between species in communities changed, quantitative characteristics of all macrozoobenthos groups declined.

The data on the heavy metal concentrations in water obtained in the study indicate that the established maximum permissible concentration are exceeded (for water bodies of drinking and household and cultural and general water use). At this time, the benthic community consisted mainly of oligochaetes, which may be resistant to adverse environmental conditions.

Web-based geographic information system for analyzing and visualising biological monitoring data from the Neva Bay and the Eastern part of the Gulf of Finland

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Poster

Large amount of biological monitoring data was collected from the Neva Bay and the Eastern Gulf of Finland starting from 1980s. The raw data is separated into several unrelated sources and databanks, stored in different places and in different formats. Combining all the data together is an important task for solving data mining problems, analyzing human impact on the water body, researching dynamics of the Neva Bay ecosystem.

A web-based geographic information system (GIS) was designed to solve the problems mentioned above. This GIS tool provides access to the following databanks with raw monitoring data related to the Neva Bay and the Eastern Gulf of Finland:

- phytoplankton data such as species, their biomass and abundance;
- zooplankton data;
- zoobenthos data;
- photosynthetic pigments concentrations (mainly chlorophyll *a* observations);
- weather conditions and hydrological data;
- hydrochemical characteristics (just a few data points available).

For example, web-interface to the photosynthetic pigments databank consists of:

- Visual query builder for selecting area of interest, which is based on the Yandex.Maps cartography service with selectable monitoring stations displayed in a separate clickable layer on top of the basemap;
- Heatmap data visualization tool, which can be used to create a colored layer on top of the Neva Bay and Eastern Gulf of Finland basemap. Color intensity is correlated with one of monitored parameters (e.g. chlorophyll *a* concentration) and also depends on the distance from the observation point;
- Report generation tool which is a RESTful web-service that can be used to extract data either in Excel table format to be used by a researcher or in JSON format to be used by other web applications.

Current implementation utilizes several mathematical models, which are used for prediction of phytoplankton dynamics, filling blank spaces on the heatmap and geographical data mapping.

Full version of the GIS would implement more sophisticated data analysis algorithms to evaluate and predict pollution risks, eutrophication and ecosystem health.

Currents of the Gulf of Finland: instrumental measurements and numerical hydrodynamic modeling.

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To research the temporal variability of currents and their statistical characteristics, the data of instrumental measurements currents for the period 2011-2015 in different regions of the Gulf of Finland, obtained on the basis of acoustic Doppler current profiler are used. Within the framework of the vector-algebraic method of analyzing processes, the time and the depth variations of the value of the mathematical expectation, various invariants of the dispersion ellipses, and the invariants of the correlation and spectral tensor-function are estimated. To study the spatial variability of currents in the Gulf of Finland, numerical experiments on the three-dimensional baroclinic hydrodynamic model INMOM for the period 2009-2013 are conducted. The model results with the above-mentioned instrumental measurements of currents is verified. Verification results showed good agreement between instrumental and model values of currents. Based on the analysis of modeling results, the mean circulation of the Gulf of Finland at different horizons, and also its inter-annual and seasonal variability are estimated.

Distribution of invasive gobies in the Eastern Gulf Of Finland

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Poster

Annual coastal fish community monitoring was conducted on shallow water biotopes of the eastern part of the Gulf of Finland in 2010-2017. Two Gobiidae species are the most abundant and widely distributed fish invaders ― tubenose goby *Proterorhinus marmoratus* (Pallas, 1814) and round goby *Neogobius melanostomus* (Pallas, 1814).

The tubenose goby is widely distributed on shallow water vegetated biotopes of the Neva Bay and below the northern coast to the eastern part of the Viborg Gulf and below the southern coast to the western part of the Kopora Bay. Goby shows preference to mixed sandy and stony bottoms with well-developed underwater vegetation. In general, the species is not abundant on shallows in the first half of summer, but in August and September it is generally numerous in samples. The average abundance of tubenose goby in the end of summer on sites below northern coast amounts 4 ind./100m^2. On sites below the southern coast it amounts to 27 ind./100m^2. The max mean of goby abundance for the southern coast was identified for site "Grafskaya Bay" (162 ind./100m^2) in 2016.

The round goby first registration in the Russian part of the Gulf of Finland occurred in 2012 on the shallows of the Luga Bay during the present monitoring. Some specimens were collected in 2014-2016 by different sampling methods. Primarily fertile round gobies were caught with gill nets and traps in the Kopora Bay, Luga bay, Narva bay, near Seskar Island and in the outer area near the northern hand of the FPFC Dam. In 2015-2016 numerous young-of-the-year fry was caught with the beach seine in the Kopora Bay (10 ind./100m^2) and some on the south bank close to the FPFC Dam (1 ind./100m^2).