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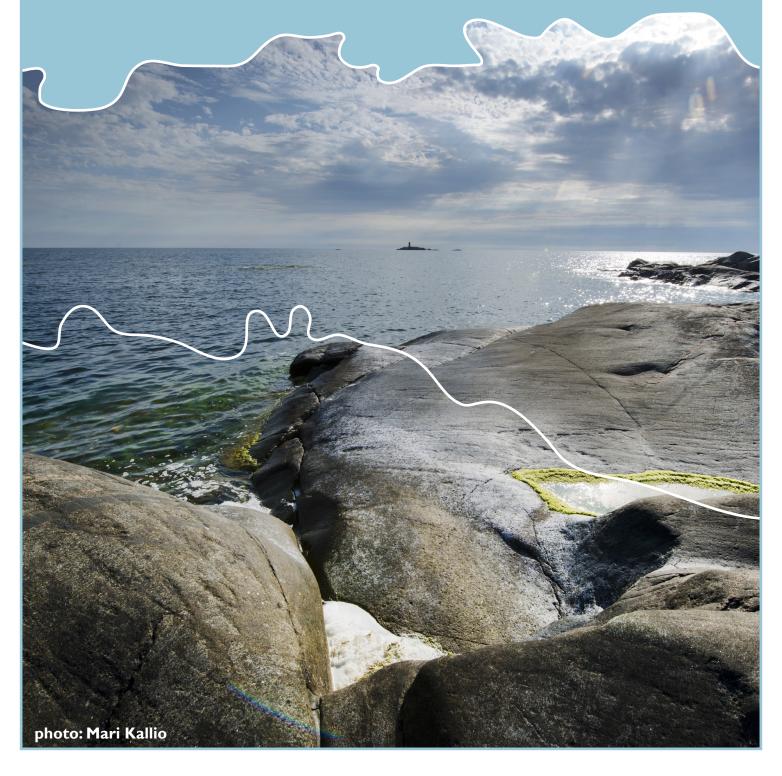# –The Gulf of Finland Science Days 2019

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**Gulf of Finland
Co-operation**

photo: Mari Kallio

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Modeling eutrophication in the Gulf of Finland – oxygen and nutrient dynamics

Kõuts, M.[1*], Raudsepp, U.[1], Maljutenko, I.[1], Treimann, M.L.[2]

[1] *Department of Marine Systems at Tallinn University of Technology*
* mariliis.kouts@taltech.ee

Oral / Session 1

Eutrophication of the Baltic Sea is still a serious problem, showing an even strengthening tendency. Therefore, we present a long-term (39-year) analysis of the nutrient and oxygen dynamics in the Gulf of Finland, the most eutrophic part of the Baltic Sea, based on the numerical model simulation. Seasonality dominates in the variability of the biogeochemical variables and processes in the entire GoF, regardless of the location and depth. Physical processes, such as the seasonal estuarine exchange control the oxygen and nutrient dynamics in the deep central part of the GoF. In the eastern part of the GoF the Neva River discharge has a strong influence on the local biogeochemistry. Local biogeochemical processes dominate in the oxygen and nutrient dynamics in shallow (depth ≤ 50 m) coastal areas. The frequency and strength of the Major Baltic Inflows (MBI) determine long-term variations of the oxygen and nutrient dynamics in the deep areas (depth > 50 m) of the open GoF. After MBIs, vertical stratification is strong, oxygen concentration is low and nutrient concentrations are high in the bottom layer of the GoF. The situation is opposite during the stagnation period (1980--1993). Over the study period, the GoF experienced a tendency towards expanding eutrophication. There were positive trends for primary production, surface phosphate and a decreasing trend for bottom dissolved oxygen in the whole GoF. In the central Gulf of Finland, nitrate was increasing, whereas in the Neva Estuary no trend was observed, which could be attributed to the increased denitrification, which removes excess nitrogen (N) from the system. According to these results, it could be discussed whether the GoF ecosystem has shifted into a new biogeochemical stable state, which is largely influenced by internal processes and water exchange with the Baltic Proper.

Sediment stratigraphy can reveal that regulation of hazardous substances is working

Jaakko Mannio[1]*, Henry Vallius[2] & Ville Junttila[1]

[1] *Finnish Environment Institute, Latokartanonkaari 11, 00790 Helsinki, Finland*
[2] *Geological Survey of Finland P.O.Box 96, FI-02151 Espoo, Finland*
* *jaakko.mannio@ymparisto.fi*

Oral / Session 1

There is an urgent need in practically all international conventions (POP, Minamata, LRTAP, OSPAR, HELCOM…) and EU legislation to show the effectiveness of the already implemented regulation of the most dangerous substances.

Sediment core studies are a cost-effective method to check the recent history of substances with high affinity to particle phase. The concept is based on short sediment core sampling (ca. 10 to 30 cm/ 1-2 cm slices), checking the trend of priority hazardous substances such as Hg and other metals, organotins, OC pesticides, PCBs, PCDD/F, PBDEs and PAHs. The method is readily applicable also to many "emerging compounds" such as PFAS and chlorinated paraffins (SCCP/MCCP). Why not microplastics as well? Of course, sedimentation conditions have to be undisturbed and assured. Dating of the core (Pb210 and/or Cs137) should be done preferably before chemical analyses.

This method is actually described in the HELCOM COMBINE Manual, but has been somewhat forgotten in the 2000's, due to focusing on quality standards based on water and biota. However, sediment core sampling and analyses may actually be much easier to harmonise between countries, compared e.g. to differences in food web structures affecting the species selection for monitoring. We certainly need biota/fish monitoring for status and future scenarios and simply for "All fish safe to eat" objective, but as philosopher Søren Kierkegaard said in 1843: "*Life is understood backwards, but must be lived forwards*".

Beached marine litter in the Russian part of the Gulf of Finland: monitoring methods and accumulation trends

Tatjana Eremina, Alexandra Ershova *

Russian State Hydrometeorological University, St.Petersburg, Russia
* Tanya.er@gmail.com

Oral / Session 1

Many monitoring campaigns have been started in recent years in the Baltic Sea region to study the distribution and accumulation patterns of marine litter in the sea. The first monitoring studies of beaches and inland coastal waters of the Russian part of the Gulf of Finland have been started in 2018 and continued in summer 2019. Two methods of beach sand sampling are discussed with recommendations on their adaptation for monitoring of the beached litter in the Neva estuary and the Eastern Gulf of Finland. Results showed an overall high level of contamination with marine debris and its polymer components, microplastics in particular, on the Russian beaches – both regularly cleaned and "wild" isolated beaches. The largest amount of litter of all fractions was found on the beaches of the inner part of the estuary in the Neva Bay. The outer part of the estuary is dominated by microlitter, and in general, the coasts of the Neva Bay differ significantly in the amount and composition of marine litter: there is more heavy glass and metal microparticles in the southern shores, and northern shores tend to accumulate more light microplastic particles. Microplastics averaged up to 10-12% in total amount of marine litter accumulating to a greater extent in the open part of the Gulf of Finland than in the Neva Bay.

Towards the formation of a Russian national position on the development of MSP and the Blue economy in view of the Blue Growth initiative for the Baltic Sea and Black Sea regions.

Andrei Lappo, Larisa Danilova

Scientific and Research Institute of Maritime Spatial Planning Ermak NorthWest (ErmakNW) 191014 Russia, St. Petersburg, Liteiniy prospect 51A pom 14-N
l.danilova@ermaknw.ru

Oral / Session 1

The regulatory framework of the Russian Federation lacks the concepts of Blue Economy, Blue Growth, Marine Spatial Planning (MSP), Integrated Coastal Zone Management (ICZM) and others, on the basis of which EU countries develop national and regional plans (concepts, strategies) for marine economic development based on the nature preservation. Nevertheless, in the framework of international cooperation and projects, Russian organizations participate in the development of international documents concerning the methodology and practice of its implementation. The results of such a projects are reported to the relevant authorities, discussed with Russian stakeholders at seminars and conferences, which allows for a Russian synopsis to be produced on Blue Growth initiative, in particular for the Baltic and Black Sea regions.

The presentation discloses the main provisions arising from the results of international projects in the Baltic Sea, the implementation of which is necessary for the final development of a national position on the development of maritime spatial planning and the Blue Economy concept. Such a provisions include, for example tasks to be solved on the national level:

a) to identify the authorized executive bodies responsible for the maritime activities of the Russian Federation;

b) to delegate of a number of responsibilities for marine management of the federal government to the regional and municipal levels;

c) to define the lines of authority for the authorities of federal, regional and municipal levels

d) to develop and adopt the relevant legislative framework.

In recent years, a lot of work has been done in this direction and some progress has been made. The new edition of the Water Code of the Russian Federation adopted in 2015 allows the transfer of a number of federal powers in the marine management to the regional level. The "Strategy for the Development of the Russian Maritime Activities - 2030" (08/30/2019) stipulates the requirement for regional authorities to be responsible for a number of sectors of the marine economy, as well as to develop coastal-marine components of regional strategies for the socio-economic development of coastal regions as well as regional programs for integrated environmental management of coastal and marine areas. In accordance with the Strategy St. Petersburg prepared a legislative initiative to include the adjoining marine areas in the Gulf of Finland in the city's limits (boundary) and to transfer to it a number of federal powers in this area. Some another initiatives are started in this direction.

The presentation contains an analysis of initiatives to harmonize Russian national framework, including actual information on the Federal Law "On State Administration of the Marine Activities of the Russian Federation" development. This law defines the Marine Board under the Government of the Russian Federation as the body that is responsible for the maritime activity in all sea basins of the Russian Federation. However, the Marine Board is the coordinating body under the Government of the Russian Federation and does not have the ability to carry out continuous management of maritime activities.

The report also contains information on new research projects in the Baltic and Black Seas, which are supported by the Government of the Russian Federation, in particular projects Capacity4MSP and BlackSeaConnect. It's make it possible to clearly formulate Russian position on the Blue Growth challenges, maritime spatial planning and marine management in Russian marine and coastal areas.

Issues of identifying climatic factors in zooplankton dynamics in the eastern part of the Gulf of Finland

Natalia Lemeshko[1*], Natalia Silina[2*], Elena Pavlova[3*]

[1] Saint-Petersburg State University, Institute of Earth Sciences. 199178 St-Petersburg, Russia, 10-ya Liniya, 33
*n.lemeshko@spbu.ru
[2] Pushkin Leningrad State University, St. Petersburg sh., d. 10., Pushkin, 196605
* nislenoblvin@mail.ru
[3] Saint-Petersburg State Marine Technical University, 190121 St-Petersburg, Lotsmanskaya, 3
*pen2712@mail.ru

Oral / Session 1

Modern environmental and climate change, caused by natural and man-made factors, drives to important changes in temperature and hydrological regime of seas what affect marine biota. However, the response of individual zooplankton species to these changes depends on the magnitude and characteristics of regional climate change. In addition, it is necessary to take into account the heterogeneity of water masses in the Eastern part of the Gulf of Finland, which is closely related to the significant spatial variability of salinity and water temperature.

Current global warming is manifested in uneven changes in air temperature in the Russian part of the Baltic Sea basin and is characterized by significant differences over seasons. In recent decades, there has been an increase in the variability of meteorological parameters, including air temperature against the background of climate change. Such changes lead to an increase in the number of weather anomalies, which indeed have the negative impacts on the environment, including the marine and terrestrial biota.

The salinity and water temperature in the Gulf are determined by the inflow of fresh water of the Neva River and the flow of sea water from the West. These factors determine the biomass, structure and species of zooplankton. To highlight climate forcing, it is necessary to establish causality links in this system against the background of global warming. However, the lack of regular monitoring significantly complicates this task. Therefore, in this study, only August was analyzed, when the water temperature maximal and the most intensive development of zooplankton are observed. Dynamics of the biomass of zooplankton was analyzed for the period 1985–2016. Over the study period, there is a tendency to increasing water temperature in the surface layer in August about 4^0C per 10 years. The analysis showed that the Eastern part of the Gulf of Finland is characterized by significant interannual changes in zooplankton biomass values and unidirectional trends in zooplankton dynamics were not detected.

Fucus belt and brown algal mats in coastal waters of the PAs "Kurgalsky", "Berezovye Islands"and East Gulf of Finland (Ingermanlandsky) - current situation and possible perspectives

Nikolai Kovalchuk

Murmansk Marine Biological Institute of RAS 17, Vladimirskaja St., Murmansk, 183010, Russia
nickkovaltchouk@hotmail.com

Oral / Session 1

The results of our field work show that the Fucus belt is well developed along exposed and semi-exposed seashore stretches of "Kurgalsky", "Berezovye Islands" and "East of the Gulf of Finland" ("Ingermanlandsky") PAs. These communities are present on hard bottoms such as rocks, boulders and stones from a depth of ca. 0.5 to 4-5 m (Kovalchuk, 2000; Kovalchuk, 2008; Kovalchuk, 2010; Kovalchuk, 2011). Fucus vesiculosus is as one of the most important phytobenthic species in the Baltic coastal zone. This is due to its wide distribution and high biomass and productivity along rocky and stony coasts. Fucus belts play an important structuring role and have a positive effect on biodiversity as habitats of species-rich epiphytic and epibenthic communities (Martin, 2009). In our opinion, it is thanks to the well-developed Fucus belt, the coastal waters of these PAs are very important as a stop-over sites of migrating waterfowl. Nearshore areas of these PAs are also spawning grounds for Baltic herring, as well as feeding grounds for the juveniles of many species of fish in the EGoF. However, the waters of these PAs currently experience considerable environmental problems caused by eutrophication of the EGoF waters. A serious negative consequence of eutrophication is the development of "brown" algal mats. They are formed by two species of seasonal filamentous brown algae, Pilayella littoralis (L.) Kjellm. and Ectocarpus siliculosus (Dillwyn) Lyngbye. In some water areas, brown algal mats was up to 40 -50 cm thick. Noteworthy, these mats often completely cover the Fucus belts. As they decompose, hypoxic and anoxic conditions are formed in the bottom layer (Vahteri et al., 2000). These conditions have a negative effect on the state of benthic communities, often proving fatal to them. In 2014, we noted the disappearance of a large spot of Fucus vesiculosus near the peninsula Pustynnyy (Zapadnyy Berozovyy Island). Degradation of the Fucus belts can have a significant negative impact on the coastal ecosystem of these PAs. The quality of these water areas will deteriorate as a stop-over site of migrating waterfowl, as spawning areas of herring, and as well as feeding grounds for the juveniles of many species of fish in the EgoF.

Different aged macrophyte thickets of anthropogenic origin: role in the ecosystem of the Eastern Gulf of Finland

V. Zhigulsky[1], V. Shuisky[1], E. Chebykina[1*], D. Zhigulskaya[1,2], M. Bulysheva[1], V. Fedorov[3], A. Uspenskiy[4], V. Panichev[1]

[1]"Eco-Express-Service" LLC, 32/3, Zanevskiy pr., 195112, St. Petersburg, Russia
[2]Lomonosov Moscow State University, GSP-1, Leninskie Gory, 119991, Moscow, Russia
[3]Saint-Petersburg State University, 7-9, Universitetskaya nab., 199034, St. Petersburg, Russia
[4]National Research Institute of Lake and River Fisheries, 26, nab. Makarova, St. Petersburg, 199053, Russia
e.maximova@ecoexp.ru

Oral / Session 1

Coastal macrophyte thickets are known for their multifaceted role in the Baltic sea ecosystem. They provide conditions favorable conditions for breeding, spawning and fattening of different fish species, serve as habitats, nesting grounds and migratory stopovers for aquatic and semi-aquatic birds, form aquatic organisms' communities with high biodiversity, purify water, strengthens the shore, etc. In the last decades, various hydraulic works in the Eastern Gulf of Finland (EGoF) are actively carried out.

Some of these works have a destructive or inhibitory effect on macrophytes and ecosystems they create. However, the consequences of other hydraulic works (and sometimes the same) often stimulate an emergence and an expansion of new macrophyte thickets. It is important to find out the balance of these processes, to study trends in resource changes of both the macrophyte thickets themselves and the useful services they create for the entire marine ecosystem. In particular, it is necessary to understand how useful new macrophyte thicket ecosystems arising after hydraulic construction are. Do they give a full replacement for thickets lost during hydraulic construction? These issues are resolved by the comprehensive research programme of "Eco-Express-Service" LLC, that has started in 2016.

Annual comprehensive studies include the following: aerial survey and mapping of aquatic communities (more than 35 km^2); phytocenological studies; water, soil, phytoplankton, zooplankton and zoobenthos sampling and analysis at 28 stations – tri-annual; observations of aquatic and semi-aquatic birds at spring and autumn migration and nesting; studying of phytophilous fish species spawning, breeding and fattening.

Some preliminary results are as follows.

The research showed that macrophyte thickets, arising directly near new hydraulic engineering structures or in places of their influence on the marine environment, reach optimum environment-forming characteristics approximately in 30-40 years. By this time, they expand quite widely and densely, but also they have multiple internal gaps. Such "openwork" thickets' configuration allows birds, fishes and other animals to use not only external border, but also all internal area of thickets quite actively. Older macrophyte thickets gradually become too dense (compact) so that they force animals to use mainly their periphery. Younger thickets, on the contrary, are still too thinned and not capable to fulfill basic ecosystem functions yet.

Threespine stickleback: a successful species in the Anthropocene?

Lajus D.L.[1*], Makhrov A.A.[1], Ivanova T.S.[1], Ivanov M.V.[1]

[1]*St. Petersburg State University, Department of Ichthyology and Hydrobiology, 16 linia V.O. 29. 199034, St. Petersburg, Russia.*
* corresponding author (Dmitry Lajus): dlajus@gmail.com.

Oral / Session 1

Anthropocene is a geological epoch when human activity plays an important role in geology of ecosystems of the Earth. The most important human-induced factors changing aquatic ecosystems are fishing, chemical pollution and eutrophication, disruption of habitats, introduction of invasive species, climate change. All these factors lead to fast changes of ecological niches challenging adaptive capacities of biological species and thus changing their relative completeness. This results in increase of populations of some species and decrease in others.

One species increasing its abundance during the last decades is threespine stickleback *Gasterosteus aculeatus,* which is a mass species throughout the entire Baltic Sea. Stickleback appeared in a number of new locations increasing their range (Svalbard, Northern Land, Caspian Sea, upper and midstream of rivers entering the Black Sea) and drastically increases their abundance in the Baltic and White Seas and Lake Constance.

In the Baltic Sea the increase of stickleback abundance is considered to be associated with eutrophication. Eutrophication results in decrease in water transparency, suppressing the growth of benthic macrophytes, which provide spawning substrate for fish actively preying on stickleback (perch, pike). At the same time, stickleback actively consumes eggs of predators and, in addition, feeds on invertebrates grazing filamentous algae, which may suppress growth of benthic macrophytes. Development of filamentous algae inhibits growth of macrophytes, exacerbating the impact of reduced water transparency, which causes further growth of stickleback population. In the White Sea, the growth of stickleback population is primarily related to climate change and was very quick since late 1990s when temperatures increased significantly. In the lake Constance stickleback actively prey on juvenile whitefish which is their food competitor. Thus, in different ecosystem different factors during last decades resulted in increase of abundance of the same species, threespine stickleback. It is likely non accidental.

The stickleback have a number of following characteristics allowing them to quickly occupy new ecological niches: (i) small size and quick maturation; (ii) exceptional euryhalinity, which allows the species not only to survive, but also to reproduce in both fresh and sea waters; (iii) high plasticity with respect to feeding and habitats (they inhabit coastal marine biotopes, open sea, rivers, lakes); (iv) ability for a quick genetic adaptations; (v) structures protecting stickleback from predators (bone plates, spines); (vi) complex behavior, in particular protection of male offspring and cannibalism; (vii) high tolerance to chemical pollution.

We assume that the above characteristics were reason of the observed increase of stickleback abundance and distribution range during the decades. This was due to relatively high competitive capacity in situation of quick and unpredictable human-induced changes of ecosystems. As in future such changes are forecasted to progress, we may expect the further increase of global abundance of threespine stickleback in their entire distribution range including the Baltic Sea.

A retrospective analysis of the biota status of the Luga Bay of the Gulf of Finland over a 25-year period

Olga Susloparova[1], Evgenia Lange[2], Oksana Liashenko[3], Yury Zuyev[3], Aleksandr Shuruhin[3], Dmitry Bogdanov[3]

[1]*St.Petersburg Scientific Research Center for Ecological Safety RAS, Russia, 197110, St. Petersburg, Korpusnaja, 18.*
[2]*Shirshov Institute of Oceanology, Russian Academy of Sciences, Russia, 117997, Moscow, Nahimovskiy prospekt, 36.*
[3]*St. Petersburg brunch of Russian Research Institute of Fisheries and Oceanography (Berg State Research Institute on Lake and River Fisheries). Russia, 199053, St. Petersburg, Makarova Emb., 26.*
olga_susloparova@mail.ru

Oral / Session 1

The purpose of the research is to characterize the biota of the Luga Bay in a comparative aspect over 25 years including the period before the construction of the Ust-Luga port (1994-1997) and the period of its construction and operation (2000-2018).

Cyanobacteria (*Limnothrix planctonica*, *Planktothrix agardhii*, *Aphanizomenon flos-aquae*, *Nodularia spumigena*, *Woronichinia compacta*) have been predominant in summer **phytoplankton** in the past 25 years. Phytoplankton biomass was irregularly dominated by diatoms, dinophytes, greens and cryptophytes. Peaks of local development for organic pollution indicators (euglena *Eutreptiella spp.*, diatom *Cylindrotheca closterium*) and eutrophication indicators (diatoms *Skeletonema costatum*, *Chaetoceros minima*) were recorded in 2006-2010. In August 2018 *C. closterium* was also dominant in the port area. In the summer of 1994 and 2006-2009 the average algal biomass had a similar value and amounted to 0.3 and 0.4 $g \cdot m^{-3}$ respectively. A local biomass growth of an average of 2.4 $g \cdot m^{-3}$ (maximum 14 $g \cdot m^{-3}$) was measured during dredging as a result of organic pollution. In August 2018 phytoplankton biomass varied from 1 to 2 $g \cdot m^{-3}$ which was higher than the corresponding data of the 1990s.

Over 25 years of research 200 species have been found in zooplankton. Their maximum number (145) was noted before 2000. In subsequent years it did not exceed 70 (43 species are in August 2018). Mostly the number of species of shelless rotifers (pp. *Polyarthra*, *Conochilus*, etc.) and cladocerans-filtering organisms decreased. From 1994 until 1997 zooplankton abundance varied in the bay areas from 7.46 to 532.72 thousand ind. m^{-3}, and biomass is from 0.04 to 3.82 $g \cdot m^{-3}$ with maximum values in the southern part of the bay. During the summer-autumn period of 1994 biomass was 0.75 $g \cdot m^{-3}$ on an average. In subsequent years the average biomass for the growing season was from 0.20 to 0.92 $g \cdot m^{-3}$. In August 2018, the average abundance and biomass for the study area were 195.36 thousand ind.$\cdot m^{-3}$ and 0.77 $g \cdot m^{-3}$ respectively. Carapace rotifers and copepods prevailed in numbers, copepods are in biomass. The highest productivity of zooplankton as before was characterized by the southern region of the bay (up to 3.0 $g \cdot m^{-3}$).

There were 50 taxons of **zoobenthos** in the Luga Bay at the end of 1990th. *Limecola balthica*, *Saduria entomon*, *Procladius ferrugineus* and *Chironomus gr. plumosus* were the widest distributed species. The zoobenthos of the most part of the Luga Bay had low numbers. The average number and biomass were 590 ind.$\cdot m^{-2}$ and 7,7 $g \cdot m^{-2}$. The biomass of mollusks and larvae of chironomids decreased and benthic communities were being extremely poor from 2000 until 2010. In the last years, the quantity characteristics of bottom invertebrates have increased in the result of the hydrological regime change of Luga Bay. The polychaetes *Marenzelleria sp.*, molluscs *L. balthica* and crustaceans distributed all-round so the average numbers and biomass of zoobenthos had increased and had been 2810 ind.$\cdot m^{-2}$ and 33,2 $g \cdot m^{-2}$ to August 2018.

The **ichthyofauna** of the Luga Bay during the period of studies 1994-2018 included 34 species of fish and lamprey. Species diversity has remained at a high level to date while some species have not been found in research catches (for example cod) since the 1990s, but new ones (for example round goby) have appeared. The nature of the distribution of fish over the bay is largely determined by the morphological features of the reservoir and the salinity factor, the gradient of which is strongly pronounced in the bay. In the coastal zone (depths up to 2.5 m) and in the southern shallow-water region (depths up to 10 m) fish species of the freshwater complex prevail. The core of the ichthyocene of the coast includes three-spined and nine-spined sticklebacks, perch, bleak, roach, and in shallow water - ruff, perch, white bream and pike-perch. In the deep-sea biotope both freshwater and brackish-water species live with the predominance of the latter. The ichthyocene core includes Baltic herring, smelt and three-spined stickleback. During the period of intensive hydrotechnical work off the southeast coast of the bay a decrease in the density of the fish population was noted. Against the background of a decrease in the intensity of hydro construction, there is a tendency towards an increase in the number and biomass of fish. It was noted that the observed interannual differences are also associated with climatic factors and the natural dynamics of fish numbers.

Thus, the data obtained over a 25-year period on structural and quantitative indicators of hydrobionts in the Luga Bay primarily indicate the influence of natural factors on their seasonal and interannual dynamics. Local changes in species diversity, dominant structure and/or abundance, and biomass of aquatic organisms due to the impact of the construction and operation of the port of Ust Luga are mainly temporary.

Aquaculture Test Ground for environmental monitoring of Transneft Primorsk Port oil terminals at the Gulf of Finland

Bugrov L.Yu.[2], Nikolaeva A.V.[1*], Rodkin M.M.[1]

[1] *Pipeline Transport Institute, LLC (Transneft R&D, LLC), 47a, Sevastopolsky prospect, Moscow, 117186, Russian Federation*
[2] *Sadko Co. Ltd., Zheleznovodscaya St., nº 17/5, letter D, St-Petersburg, Russia*
* NikolaevaAV@niitnn.transneft.ru

Oral / Session 1

The Pipeline Transport Institute started developing environmental monitoring technology in 2012 and first experimental aquaculture test ground was created in 2014 at Kozmino Bay of the Japan Sea near the port's oil terminal. Monitoring of the ecological state of the bay showed that the production activity of Transneft Kozmino Port does not have a negative impact on the water area. On the contrary, enhanced control and cultivation of aquatic organisms contribute to the improvement of its environment condition and populations of hydrobionts.

The similar research project was started in 2017 in Björkesund Strait of the Gulf of Finland in order to demonstrate that Transneft Primorsk Port's facilities are safe for the environment. For 2 years before the construction of the test ground, the water area was investigated and the optimal species composition for aquaculture was selected. At June 2019 over 900 fishes including Baltic whitefish (*Coregonus lavaretus*) and trout (*Oncorhynchus mykiss*) were placed in 3 special volière-cages inside "Sadco"-type submersible (protected from ice) platform near the oil terminals. There are also 6 mini-cages for local bivalve molluscs (*Dreissena polymorpha*) and 3 artificial substrates for green seaweeds (*Cladophora glomerata; Ulothrix sp.*) installed at the aquaculture test ground. The technology used at the test ground is aimed at monitoring and measuring the accumulation of toxic substances in the tissues of marine organisms. This is an objective indicator of the ecological state of the Primorsk Port's water area in the long term.

Earth observations in monitoring and status assessment

Jenni Attila*, Sampsa Koponen, Hanna Alasalmi, Vivi Fleming-Lehtinen, Pirkko Kauppila, Vesa Keto, Kari Kallio, Eeva Bruun

[1] *Finnish Environment Institute*
* jenni.attila@ymparisto.fi

Oral / Session 1

Earth Observation with satellite instruments enable capturing surface water quality and its changes in spatial and temporal variations that are beyond the capabilities of traditional station sampling based methods. These observations can be utilised to complement the status assessment information of surface waters set by regulations such as the EU (European Union) Water Framework Directive (WFD) and Marine Strategy Framework Directive (MSFD). Phytoplankton chlorophyll-a is one of the main variables considered here. Furthermore, Secchi disk depth, turbidity, the level of humic substances and surface temperature are important surface water quality parameters. We present the current capabilities of EU Copernicus Sentinel satellite series for use in the monitoring and assessment applications in the Gulf of Finland and their joint use along with other monitoring methods such as station sampling and ferrybox (Alg@line) measurements.

Cross-comparisons between EO products and monitoring site observations are presented as time series at the station sampling sites (soon available also in a web application TARKKA (www.syke.fi/tarkka/en).

A novel user interface called STATUS has been created to distribute EO-based water quality information for national and regional authorities responsible for the assessment in Finland. The interface also includes observations from the Baltic Sea with 20km grid division. The STATUS interface visualizes the statistics and the distributions of each EO instrument and provides them together with the station sampling data and ferrybox observations collected within the water body. Currently it holds chl-a time series starting from 2003-2011 (satellite instrument ENVISAT MERIS) and from 2015 onwards (Copernicus Sentinel-2A and Sentinel-2B). Turbidity, Secchi disk depth and absorption by CDOM (Coloured Dissolved Organic Matter) are covered with a time span starting from year 2013 (Landsat-satellite) with increasing frequency of observations after the launches of Copernicus Sentinel-2 series. The optimal use of Earth Observations in forthcoming assessments can increase the confidence of the status assessment of surface waters. Furthermore, the use of satellite observations as true color images and capturing events such as upwelling and resuspension are important to be included in modern monitoring of assessment areas.

Dynamics pollution by metals of the Neva Bay

Grigory Frumin, Natalia Malysheva

Russian State Hydrometeorological University, 192007, Saint-Petersburg, Voronezhskaya ulitsa, 79 *Russia*
e-mail: gfrumin@mail.ru

In recent decades, the system of maximum permissible concentrations of water bodies has been criticized. In this regard, a new approach has been developed to assess the pollution of surface land waters. The approach to the integrated assessment of water pollution by heavy metals, based on the magnitudes of the risk of lethal outcomes when exposed to heavy metal cations on daphnia over a wide range of concentration variations (risk of combined exposure), has been improved. Due to the need to assess the toxicity of natural and wastewater in many countries around the world, biotesting with *Daphnia magna Straus* began to be used. Daphnia or "water fleas" are widely used in biotesting in many countries such as the USA, Germany, France and Hungary. In many of them, daphnia is accepted as a standard test organism. According to the literature on the toxicity of metal cations for daphnids, mathematical models have been constructed that link the magnitude of the risks (probabilities) of deaths when exposed to metal cations on daphnia in a wide range of concentrations. The developed approach is based on linear-exponential mathematical models (Table 1). The following mathematical model was used to calculate the risk of combined action

$$\text{Combined risk, Risk}_{comb} = 1 - (1 - \text{Risk}_1)(1 - \text{Risk}_2)(1 - \text{Risk}_3)\ldots(1 - \text{Risk}_n)$$

Table 1. Mathematical models for assessing the risks of deaths due to the effect of metal cations on daphnia at an exposure of 48 hours.

Me^{2+}	Model	Me^{2+}	Model
Hg^{2+}	$\text{Risk}=1-\exp(-13{,}777C^{0,547})$	Zn^{2+}	$\text{Risk}=1-\exp(-2{,}02C^{1,168})$
Cu^{2+}	$\text{Risk}=1-\exp(-25{,}103C^{0,956})$	Co^{2+}	$\text{Risk}=1-\exp(-0{,}011C^{1,36})$
Pb^{2+}	$\text{Risk}=1-\exp(-0{,}2653C^{1,1})$	Fe^{2+}	$\text{Risk}=1-\exp(-0{,}017C^{1,319})$
Cd^{2+}	$\text{Risk}=1-\exp(-1880409C^{4,6135})$	Mn^{2+}	$\text{Risk}=1-\exp(-0{,}007C^{1,489})$

C - concentration of metal cation, ppm

A classification of water quality according to the values of combined risks (Risk$_{comb}$), based on the «broken rod» model, is proposed (Table 2).

Table 2. Classification of water quality by the values of combined risks.

Water quality	Combined risk, Risk$_{comb}$	Quality class
Very good	0.00-0.04	I
Good	0.04-0.09	II
Satisfactory	0.09-0.16	III
Bad	0.16-0.26	IV
Very bad	0.26-1.00	V

The values of the combined risks for the Neva Bay have been calculated (Table 3).

Table 3. Interannual dynamics of metal pollution in the waters of the Neva Bay.

Year	Risk$_i$				Risk$_{comb}$	Water quality
	Pb^{2+}	Cu^{2+}	Zn^{2+}	Mn^{2+}		
2008	0.00	0.13	0.01	0.00	0.13	Satisfactory
2009	0.00	0.11	0.01	0.00	0.13	Satisfactory
2010	0.00	0.12	0.01	0.00	0.13	Satisfactory
2011	0.00	0.11	0.02	0.00	0.12	Satisfactory
2012	0.00	0.11	0.02	0.00	0.12	Satisfactory
2013	0,00	0.11	0.01	0.00	0.12	Satisfactory
2014	0.00	0.09	0.01	0.01	0.10	Satisfactory
2015	0.00	0.14	0.01	0.01	0.15	Satisfactory
2016	0.00	0.13	0.01	0.00	0.14	Satisfactory
2017	0.00	0.09	0.01	0.00	0.10	Satisfactory
2018	0.00	0.14	0.03	0.00	0.17	Bad

On the distribution of microplastics in the Neva Bay and the eastern part of the Gulf of Finland

Martyanov S. D.[1], Ryabchenko V. A.[1]*, Ershova A.A.[2], Eremina T.P.[2], Martin G.[3]

[1] *Shirshov Institute of Oceanology, Russian Academy of Sciences; Moscow, Russia*
[2] *Russian State Hydrometorological University (RSHU), St. Petersburg, Russia, ul. Voronezhskaya, 79.*
[3] *Estonian Marine Institute, University of Tartu, Tartu, Ülikooli 18*
vla-ryabchenko@yandex.ru

Oral / Session 1

To study the propagation characteristics of microplastic particles coming with the Neva river waters, in the Neva Bay and in the eastern part of the Gulf of Finland, a three-dimensional numerical hydrodynamic model based on the Princeton Ocean Model is used [1]. The model is implemented on a uniform quasi-orthogonal horizontal grid with a step of 100 m, in the vertical direction 7 uniformly distributed sigma levels are used. The marine initial conditions and conditions at the western boundary for water level, temperature and salinity were taken from the Baltic Sea operational Hiromb-Boos Model of the Danish Meteorological Institute [http://marine.copernicus.eu] with discreteness in 1 hour. On the eastern boundary at the mouth of the Neva, the average monthly climatic river discharge and temperature of the Neva were set. Atmospheric forcing was taken from the results of the ECMWF ERA-Interim reanalysis [https://www.ecmwf.int] with 6-hour resolution and with a spatial resolution of 0.125 ° x0.125 °. Two types of suspension were considered that simulated the propagation of microplastic particles in water: admixture of neutral buoyancy (C1) and a sinking suspension (C2) with a sinking velocity of 0.2 m / day. Both types of suspension come from the Neva river water with a constant volume concentration of 10^{-6}. To calculate the thickness of the layer of the settling fraction at the bottom, the simplified Exner equation is used [2,3]. The calculations were performed for the period May – August 2018, when the quantity and composition of plastic litter was monitored on the beaches of the Neva Bay and the eastern part of the Gulf of Finland.

According to the calculation results, the spatial distribution of the sinking particles, in general, replicates the distribution of the admixture of neutral buoyancy, with the only difference being that the farther from the particle source to the west, the lower the concentration of the sinking particles. An essential feature of the distribution is that during the most of the considered period the concentration of both suspensions in the northern part of the model domain is higher than those found in its southern part. The change in the thickness of the bottom layer of the sinking particles at the end of the period on August 31, 2018, i.e. the accumulation of microplastic particles in bottom sediments for the period under consideration, showed that the accumulation of microplastic in bottom sediments in the northern part of the Neva Bay was noticeably greater than in the southern part, especially in the coastal zone.

The data on monitoring coastal pollution by plastic litter indirectly confirm the results: there was practically no plastic litter on the southern coast of the considered region between June and August 2018, while it was found in significant quantities on the northern coast. Thus, model estimates of the propagation of microplastic particles in water and its accumulation in bottom sediments can be used to select areas for future work on monitoring plastic pollution on the coast of the eastern Gulf of Finland.

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Eutrophication indicators in the Neva Estuary in 2003–2019: response to temperature and precipitation patterns

Mikhail Golubkov[1]*, Sergey Golubkov[1]

[1] Zoological Institute of the Russian Academy of Sciences, 199039, Universitetskaya emb., 1, St. Petersburg, Russia
golubkov@zin.ru

Oral / Session 1

Estuaries provide valuable ecosystem services but are threatened by eutrophication caused by increasing nutrient concentrations and climatic factors. We tested the hypothesis that cool and rainy weather in midsummer has a stronger stimulatory effect on indicators of eutrophication in the Neva Estuary than warm weather. The analysis showed that the eutrophication indicators in the estuary in midsummer were closely related to the weather conditions: temperature in winter and summer, as well as the rainfall and number of rainy days in summer. In contrast with expectations, warm winters usually corresponded to cool summers with high rainfall amounts. An increase in temperature did not have a stimulatory effect on the eutrophication indicators. By contrast, despite the low water temperatures in the rainy years, there were increases in phosphorus and chlorophyll concentrations in the water and plankton primary production in the upper part of the estuary, Neva Bay. Moreover, low temperatures led to a decrease in mineralisation of organic matter and resulted in an increase in phytoplankton production over the mineralisation of organic matter. This phenomenon exacerbated the effect of eutrophication and led to the accumulation of excess amounts of organic matter in the upper part of the estuary that were apparently carried by the current and mineralised in its lower parts. The threefold increase in precipitation in July in recent years followed by increasing phosphorus concentrations may negate remedial measures to improve environmental conditions in the estuary. Further measures should be taken to reduce eutrophication in the estuary.

Long-term mean, interannual and seasonal circulation in the Gulf of Finland — the wide salt wedge estuary or gulf type ROFI

Ilja Maljutenko[1], Urmas Raudsepp[1*]

[1]*Tallinn University of Technology, Department of Marine Systems, Akadeemia tee 15a, 12611 Tallinn, Estonia* *urmas.raudsepp@taltech.ee*

Oral / Session 1

Circulation of the wide gulf type ROFI or salt wedge estuary, the Gulf of Finland (GoF), was studied using a numerical 3D hydrodynamic model with 1 nmi horizontal resolution and 40 vertically adaptive layers for a period of 40 years. The results show an extensive down estuary or westward coastal current (WCC) on the left hand flank of the GoF. The WCC is more vigorous during the spring and summer months when longitudinal positive estuarine circulation with salt wedge up estuary transport and less saline upper layer water (LSULW) down estuary transport prevails. In the beginning of summer, the coastal current forms an extensive northward cross-shore current in the center of the gulf, giving rise to two basin-wide anticyclonic circulation gyres. The intensity of the WCC, anticyclonic gyres and estuarine transport vary interannually. The zonal wind component averaged over the period of the dominance of a particular feature — April–June for the WCC, July–September for the anticyclonic gyres and annual for estuarine exchange flow — modulates the strength of these circulation patterns. A negative/positive zonal wind supports/destroys the WCC and increase/decrease the intensity of the salt wedge and LSULW transport. The anticyclonic gyres are well developed during weak positive zonal wind, mainly.

Organization and results of the geological environment monitoring in the Gulf of Finland and prospects for its development

Rybalko A.[*] , Korneev O**, Tokarev M.***

[*] *Institute наук о Земле СПБГУ, Sant.Petersburg, Russia, ** Rosgidromet, Sant.Petersburg, Russia, ***Moscow State University, Moscov, Russia*
alek-rybalko@yandex.ru

Oral / Session 1

State monitoring of the geological environment of the Gulf of Finland began in 2000. Back in 1993, the first joint work was carried out with the Geological Survey of Finland. At the first stage, the main task of this type of monitoring in Russia was to assess of bottom sediments pollution, near-bottom and pore waters. The results of this research cycle were summed up in the materials of "GOF-14". After 2014, much attention was paid to natural geological hazardous processes in connection with development of the engineering works on the bottom of the Gulf of Finland. The role of geophysical processes has substantially increased. The widespread occurrence of structurally substantiated and geodynamically active discontinuous faults in the northern part of the bay, large fields of pok-mark were found. The gravitational movement of clastic material in the area of construction of the Nord Stream gas pipeline was also identified. It is necessary to clarify the boundaries of sedimentation basins and the thickness of modern sediments in order to assess the intensity of modern sedimentation. This is necessary to clarify the network of monitoring stations for geochemical monitoring. Methodological questions on establishing criteria for pollution of the water column and bottom sediments by indirect (geophysical) methods are also relevant. All this requires substantial refinement of the monitoring work program and the inclusion of a modern multi-channel seismic-acoustic profiling.

The project GET READY for the Cross-Border Challenges: Capacity Building in Sustainable Shore Use

V. Zhigulsky[1], A. Bogush[1], A. Nazarova[1*], M. Mamaeva[2], M. Shilin[3]

[1]"Eco-Express-Service" LLC, 32/3, Zanevskiy pr., 195112, St. Petersburg, Russia
[2]State Hydrological Institute, 2nd line of Vasilievsky island, 23, 199004, St. Petersburg, Russia
[3]Saint-Petersburg State University, 7-9, Universitetskaya nab., 199034, St. Petersburg, Russia
*nazarova@ecoexp.ru

Oral / Session 2

The coastal zone is one of the most important components of the natural environment. A network of new ports, aimed to traffic flows expansion and sustainable development of coastal infrastructure, has been created in the coastal zone of the Eastern Gulf of Finland (EGoF) from both the Russian and Finnish sides. At the same time, the EGoF coastal zone is recognized as a valuable natural object, that is very sensitive to anthropogenic impact and consequences of global warming. The development of the "coastal technosphere" is accompanied by significant environmental risks in the EGoF coastal zone arising at the cross-border level.

Having regard to the above, the task to ensuring an environmental safety and preserving the biological diversity of coast at the Gulf of Finland becomes the problem number one at present.

The project "Getting Ready for the Cross-Border Challenges: Capacity Building in Sustainable Shore Use, GET READY" was approved as part of South-East Finland – Russia Cross-border cooperation Programme 2014-2020 with funding from the European Union, the Russian Federation and Finland. The purpose of the project is to carrying out researches and development of technologies and innovations in the region in the field of sustainable shore use and coastal zones management with a clear priority "Education, researches, technological development and innovations support in the cross-border region".

It is supposed to use the accumulated experience, best practices and innovations of shore use in Russian and Finnish Ports for the project implementation. The success of the project is provided by a combination of "science-innovation-education/training-business". The project foreseen strenghtening Public-Private-People Partnership in the cross-border region having appropriate represetatives on board.

The project GET READY covers 4 work packages (WPs): science (WP1), business and innovations (WP2), education, training and raising awareness (WP3) and network of professional expertise (WP4).

The project partners are Institute of Earth Sciences of St. Petersburg State University, State Hydrological Institute, Finnish Environmental Institute, University of Turku, South-Eastern University of Applied Sciences (XAMK) and Kotka Maritime Research Association. The lead partner is "Eco-Express-Service" LLC.

A plan of safe using the coastal zone of the Gulf of Finland and creation the Russian-Finnish center for advanced training in the field of sustainable shore use will be the final result of collaboration.

Maritime and Inland Shipping: Gulf Connecting Inland Waterways

Anatoly Burkov and Tatiana Pantina

Admiral Makarov State University for Maritime and Inland Shipping 198035 Russia, St.-Petersburg, Dvinskaya str. 5/7
burkovav@gumrf.ru

Oral / Session 2

Finnish Gulf as the eastern part of Baltic Sea plays a significant role in international trade and transportation especially between Finland and Russia. Transport logistics of Russian North-West region benefits of millions tons of cargoes passing through and from bordering with Finland as one of the EU developed countries. There are three main modes of transport interact actively in the bordering countries: maritime, railway and road, with the fourth mode – inland waterway shipping gradually becoming more visible and potential for the future of the region.

In Finnish Gulf, there are two commercially operable inland waterways meet. From Finland side these are mostly the Saimaa lakes and Saimaa canal system (with Russian part near Vyborg). From Russian side there is the Volgo-Balt waterway system, which is a northern "slope" of 9th international transport corridors, going via Neva river, Ladoga, Onega Lakes and further on to White Sea or to Volga river and down to Caspian and Black Seas.

Project INFUTURE (Future Potential of Inland Waterways) implemented under ENI CBC 2014-2020 Programme is undertaken to three main areas of applied research: current and potential cargoflows in regional logistics included in inland shipping, safety technologies of the maritime and inland fairways, and new concepts of vessel's design navigable both in Saimaa waterway system and in Russian lakes and rivers too. Enlarged locks chambers at Saimaa canal shall foster the replacement of existed vessels for bigger and preferably "greener" ones, making cargo round a year transportation more economical by waterways marked by intelligent AIS-ATON buoys.

Assessment of Hazardous substances in the eastern GoF: interregional monitoring and comprehensive approaches in the course of HAZLESS project

Ivan Kuprijanov*[1], Kai Künnis-Beres[1], Natalja Kolesova[1], Germo Väli[1], Nadezhda Berezina[2], Andrey Sharov[3], Yulia Gubelit[2], Zoya Zhakovskaya[3], Inga Lips[1]

[1] *Department of Marine Systems, Tallinn University of Technology (TalTech), Akadeemia Rd. 15a, Tallinn, Estonia*
[2] *Zoological Institute of the Russian Academy of Sciences, Universitetskaya 1, Saint-Petersburg, Russia*
[3] *Institution of Russian Academy of Sciences Saint-Petersburg Scientific-Research Centre for Ecological Safety, Korpusnaya 18, Saint-Petersburg, Russia*
* ivan.kuprijanov@taltech.ee

Oral / Session 2

The array of cross-border stressors caused by different kind of human activities are deteriorating the Gulf of Finland (GoF). Environmental problems related to ecological effects of hazardous substances (HS), like heavy metals and multitude organic pollutants, produce threat to the eastern GoF environment through accumulating in the sediments and aquatic organisms. Nevertheless, assessment of the environmental status in the region with the heterogeneous benthic environment was coupled with some obstacles so far mainly due to data deficiency. Besides, using some organisms from matrix biota as a secondary substance for chemical analyses needed adjustment as long as benthic communities along the GoF experienced changes since various invasive species become established.

According to the EU Marine Strategy Framework Directive, the evaluation of pollution indicators have to show whether the measured levels within waterbody are below the commonly agreed threshold values and subsequently meet the Good Environmental Status (GES). Present policy-driven and solution-oriented cross-border study will contribute to the reliable assessment of HSs, predominantly from HELCOM Core Indicators (e.g. heavy metals, PAHs, PCBs, organotins, PFOSs and diclofenac), considering their probable distribution in the marine environment and estimating their effects on the biological processes of the key invertebrate species (crustaceans, molluscs) of the eastern GoF.

Compiled monitoring dataset point out that some persistent organic pollutants (POP) in accumulation areas and around centres of the maritime activity might closely approach or exceed manifold of suggested good-quality threshold.

Activities of the HAZLESS project include experiments and transplantations along with checking the biomarkers for determination of biological effects to adapt and implement uniform biological indicators for estimation and control of environmental quality in the eastern GoF. Eventually, integration of standard approach and strategies for transnational monitoring and assessment of HSs and their effects in the programme area will foster the development of recommendations for monitoring programme in the whole GoF.

Future potential of inland waterways

Pentti Kujala[1*], Fang Li[1]

[1] *Aalto University, School of Engineering, Department of Mechanical Engineering, Marine Technology, P.O. Box 14100, Aalto, FI-00076, Finland*
* pentti.kujala@aalto.fi

Oral / Session 2

Most international freight traffic happens on roads, such as the busy route between Finland and St. Petersburg. Road transport presents its own set of challenges, including pollution, accidents and road network congestion. Inland waterway traffic, however, could constitute a cost-effective and environmentally friendly option that also attracts the interest of transport companies. The "Future potential of Inland Waterways" (INFUTURE) project takes a wide-ranging approach to finding solutions for sustainable and cost-effective inland waterway traffic. We examine the legislation on freight traffic as well as Finnish and Russian customs policies, and identify the most efficient ways of handling cargo. In addition, we are creating an IT system that helps customers quickly find the most suitable service for their cargo transport needs. Moreover, we develop next generation vessel concept for future cargo transportation. The focused area of INFUTURE project includes Saimaa Lake and canal area, as well as Russian Volgo-Balt area, which connects Finnish and Russian inland ports to the Gulf of Finland.

Blue Platform project: gathering blue bioeconomy actors and information together

Luhtanen, Anne-Mari[1*] and SUBMARINER Network team[2]

[1] *Finnish Environment Institute, Agnes Sjöbergin katu 2, FI-00790 Helsinki, Finland,* [2] *SUBMARINER Network for Blue Growth EEIG, Kärntener Str. 20, DE-10827 Berlin, Germany*
* anne-mari.luhtanen@ymparisto.fi

Oral / Session 2

In the blue bioeconomy aqatic biomass can be turned into novel food or feed ingredients, energy, new materials or pharmaceuticals by new innovations and without compromising the state of the seas. Blue bioeconomy has also been recognized as one of the most promising fields in blue economy.

In Blue Platform project our aim is to gather actors and all the results of different blue bioeconomy projects in Baltic Sea Region together to create a network and information databank for the benefit of sustainable blue growth.

The work is based on the SUBMARINER Roadmap (2013), which has been implemented by SUBMARINER Network (flagship under the priority area "Innovation" of the EU Strategy for the Baltic Sea Region). The SUBMARINER Network is a unique platform that brings actors from the whole Baltic Sea Region together to actively promote innovative and sustainable uses of marine resources.

In Blue Platform project we have also partners from Estonia (University of Tartu) and Russia (Kaliningrad State Technical University). To be able to achieve the goals of blue bioeconomy we think that all the actors in blue bioeconomy in the Baltic Sea Region should combine forces, strengthen transnational cooperation and develop new ideas by sharing experiences.

'Water meets people: learn, act, influence - SEVIRA' – the implementation of the international cooperation

Zagrebina, Tatiana [1*]; Fomina, Liubov [1]; Andreeva, Irina [1]

[1] North- West AHEM'; 23 line,V.O., 2a, St.Petersburg, 199106, Russia
[*] zagrebiba@meteo.nw.ru

There are several main objectives of the SEVIRA Project. Among them - improving the environment of the Gulf of Finland by combining scientific and social activities of the surrounding areas, managing the environmental conditions of the Gulf in such way that really takes into account the characteristics of the ground load (with taking into account the geographical factor).

Thus, it is proposed that coastal areas could be considered as separate cases adapted to local requirements. These are only the first step of a long way to effective environmental management, which in the future will help to solve the problems both of certain areas and the whole coastal area of the Gulf of Finland.

The project is expected to increase public awareness of the environment: citizens have a knowledge base on environmentally friendly living and consumption habits. Recommendations will also be made for the local environmental administration to improve casual monitoring practices and cost-effective monitoring tools.

As a final participants will try to form a roadmap with a number of specific actions for improving the state of Finnish-Russian transboundary waters.

 The Project participants:

- Finnish Environment Institute, SYKE Leader partner
- Centre for Economic Development, Transport and the Environment for
- Northwest administration for hydrometeorology and environmental monitoring
- Institute of Limnology RAS
- Ecocetrum Ltd

From the beginning of the Project till this moment, there were a lot of different interactions between the participants: several practical and theoretical seminars have been held between experts in the field of hydrology and environmental monitoring. Since November 2018, active monitoring has begun on the rivers selected as the base for study under the project. At the moment, there are enough materials to start a detailed analysis of the hydrological regime and compile a hydrochemical characteristic. In August 2019 (on week 34) in the eastern Gulf of Finland site two parallel ship cruises for coastal monitoring were carried out by both participating countries. A complex of hydrological, hydrochemical, and hydrobiological observations was done there. At the same time, intercalibration between the laboratories of Finland and Russia was also realized.

Findings from the ongoing study of ringed seals' habitat use in the Gulf of Finland

Mart Jüssi[1*] , Mikhail Verevkin[2]

[1] *Pro Mare NPO (non-profit consultancy), Marja 14, EE 51007 Tartu, Estonia*
[2] *Federal State budget Institution of sciences St. Petersburg Scientific Center of the Russian Academy of Sciances (SPbSC RAS). Russia, 199034, St. Petersburg, 5 Universitetskaya Naberezhnaya*
* Mart@promare.ee

The small, critically endangered sub-population of the Baltic ringed seal in the Gulf of Finland is inhabiting waters of all three littoral countries. The status of the population has deteriorated over the past half century as the counts along the shores of the Gulf reveal drop in numbers from some thousands in the 1970s to a recent maximum population estimate of only 113 (upper 95% CI) in 2018. The observed distribution range has also shrunk substantially. We have used high resolution telemetry tags to measure ringed seal behaviour in the sea area. By September 2019, 20 animals have been marked and 3D data has been retrieved on seal activities. The GPS locations and measured dive profiles suggest that the core distribution area for the population lies in the East-Central part of the sea area in the Moshnyi - Seskar - Kurgalski Reef "triangle" with a satellite area around Malyi Tyters island. Foraging trips of the seals are predominantly to the shoals and steep underwater slopes of the core area, but coast of Finland (Loviisa) and Estonia (Uhtju) are in the reach of the ringed seals foraging trips. Seals breed on the limited ice fields of North-Eastern part of the Gulf. The main pressure factors related to seals' sea use are reduced ice availability for breeding and disturbance by shipping and boating, health condition of the population remains unknown. The factors need to be addressed with adequate conservation measures to ease the anthropogenic impact and allow the population to recover.

ADRIENNE: Increasing capacity of environmental protection to maintain biodiversity and ecosystem performance under multiple human uses as well as climate change

Jonne Kotta[1*]; Andresmaa, Eda[2]; Aps, Robert[1]; Bublichenko, Alexander[3]; Bublichenko, Julia[3]; Herkül, Kristjan[1]; Kiiski, Anna[4]; Kostamo, Kirsi[5]; Liversage, Kiran[1]; Nesterova, Elena[6]; Orlova, Marina[3]; Peterson, Anneliis[1]; Rene Reisner[2].

[1] Estonian Marine Institute, University of Tartu; Mäealuse 14, 12618 Tallinn, Estonia
[2] Ministry of the Environment, Republic of Estonia; Narva maantee 7a, 10117 Tallinn, Estonia
[3] St.-Petersburg scientific centre of the Russian academy of sciences; 5 Universitetskaya Nab., St. Petersburg 199034, Russia
[4] Kotka Maritime Research Centre; Keskuskatu 10, 48100 Kotka, Finland
[5] Finnish Environment Institute; Latokartanonkaari 11, 00790 Helsinki, Finland
[6] A.P. Karpinsky Russian Geological Research Institute; 74, Sredny prospect, 199106, St. Petersburg, Russia
* jonne@sea.ee

Oral / Session 2

ADRIENNE project sets out to assess how alternative human uses of the environment combined with various environmental pressures may affect ecosystem diversity, functioning and services important for human well-being in the Gulf of Finland – A region of significant maritime importance in the northern hemisphere. The idea to assess cumulative impacts of human use on the natural environment in the Gulf of Finland is linked to increasing maritime activities and undermanaged coastal resources, now threatening the sustainability of the marine environment and maritime-based economies. Rapidly growing demand for shipping, fisheries, energy sector and aquaculture provide some relevant examples of various human induced pressures to the marine environment. In order to achieve this goal, we will combine novel spatial modelling of species, habitats and fishery-related ecosystem services with expert-based assessment of synergistic effects of human uses on natural environment. All information will be gathered and summarized in a publicly accessible GIS portal with a capability of assessing interactive responses of various human-induced stressors on the Gulf of Finland ecosystem under different climate change scenarios. Designed web portal will be state-of-the-art tool built on harmonization of big data, machine learning and scientific expertise. As such, the project helps to find new ways to mitigate risks of intensified human uses and climate change in the fragile and valuable ecosystem of the Gulf of Finland. By ensuring an effective transboundary engagement of key stakeholders through all our activities, the project fosters multidisciplinary co-operation and communication.

New microbiological indicators for the heath assessment of the eastern Gulf of Finland

Yulia Polyak[1,2*], Anna Demchuk[3], Yulia Gubelit[3], Nadezhda Berezina[3], Andrey Sharov[1]

[1] *Scientific Research Center for Ecological Safety of Russian Academy of Sciences, 18 Korpusnaya str., St. Petersburg, 197110, Russia*
[2] *St. Petersburg University, 7-9 Universitetskaya Emb., St. Petersburg 199034, Russia*
[3] *Zoological Institute of the Russian Academy of Sciences, 1 Universitetskaya Emb., St. Petersburg, 199034, Russia*
* *yuliapolyak@mail.ru*

Oral / Session 2

A major mechanism for the removal of petroleum hydrocarbons from the environment is biodegradation by naturally occurring populations of microorganisms. In coastal sediments of the eastern Gulf of Finland hydrocarbon-oxidizing bacteria are heterogeneously distributed with higher average percentage of degrading ability at contaminated sites [Berezina et al. 2017; Polyak et al. 2018]. In May-September 2019 we investigated the abundance of hydrocarbon-oxidizing bacteria in digestive systems of hydrobionts, and assessed the applicability of these microbiological markers in monitoring of the eastern Gulf of Finland health. The results revealed an obvious increase in the number of hydrocarbon-oxidizing bacteria in the digestive tract of fish at contaminated sites. Hydrocarbon utilizes in an intestinal tract may play a role in adaptation and survival of fish exposed to oil contamination. The proportion of hydrocarbon-oxidizing bacteria in digestive systems of fish within the heterotrophic bacterial community appears a sensitive indicator of exposure of the GoF to oil and oil products.

GRASS: unlock the potential of macroalgae as a sustainable biomass in the Baltic Sea Region

Jonne Kotta[1*]; Aps, Robert[1]; Arvaniti, Efthalia[2]; Bārda, Ieva[3]; Grickus, Armands[4]; Gröndahl, Fredrik[5]; Ilisson, Raul[6]; Jakubowska, Magdalena[7]; Kokaine, Ligita[8]; Kulikowski, Tomasz[7]; Lingegård, Sofia[5]; Luhtanen, Anne-Mari[9]; Lähteenmäki-Uutela, Anu[9]; Nathaniel, Hanna[5]; Peterson, Anneliis[1]; Petkevica, Aiga[8]; Piiparinen, Jonna[9]; Purina, Ingrida[3]; Rahikainen, Moona[10]; Reisner, Rene[6]; Rosenqvist, Gunilla[11]; Spilling, Kristian[9]; Tuomasjukka, Saska[10]; Yang, Baoru[10]; Zalesiak, Kamila[2]

[1] *Estonian Marine Institute, University of Tartu; Mäealuse 14, 12618 Tallinn, Estonia*
[2] *Submariner Network EEIG; Kärntener Str. 20, 10827 Berlin, Germany*
[3] *Latvian Institute of Aquatic Ecology; Voleru iela 2, Rīga, LV-1007, Latvia*
[4] *Liepaja University; Lielā iela 14, 3401 Liepāja, Latvia*
[5] *KTH Royal Institute of Technology; Brinellvägen 8, 11428 Stockholm, Sweden*
[6] *Ministry of the Environment, Republic of Estonia; Narva maantee 7a, 10117 Tallinn, Estonia*
[7] *National Marine Fisheries Research Institute; Hugo Kołłątaja 1, 81-332 Gdynia, Poland*
[8] *Kurzeme Planning region; Valguma str. 4a, 1048 Riga, Latvia*
[9] *Finnish Environment Institute; Latokartanonkaari 11, 00790 Helsinki, Finland*
[10] *University of Turku; 20500 Turku, Finland*
[11] *Uppsala University; 75236 Uppsala, Sweden*
* jonne@sea.ee

Oral / Session 2

Macroalgae production is an upcoming sector for growing biomass for producing food, consumables such as plastics and energy without competing for arable land, depleting fresh water and using non-renewable fertiliser. However, the sector is still in its infancy in the Baltic Sea Region (BSR) and there is a lack of in-depth and wide-spread knowledge on the potential benefits of macroalgae production. GRASS project seeks to enhance the capacity of public authorities to unlock the potential of macroalgae as a sustainable biomass in the BSR. During this project we look into the environmental, regulatory and socio-economic aspects of macroalgae cultivation, harvesting and use across the BSR. An important themes of the project is (1) to identify suitable areas and technologies for cultivation in the Baltic Sea Proper; (2) to raise awareness on the benefits, risks and opportunities of macroalgae as climate-smart catch crops as well as a versatile biomass resource in circular economy and food context; (3) to build capacity on dealing with current legislation barriers and gaps, and to improve governance capacities among public authorities to support the macroalgae sector in the BSR.

Fish migration and provenance studies in the Gulf of Finland using otolith microchemistry

Rohtla, Mehis[1,2]*; Matetski, Lagle[1]; Taal, Imre[1]; Svirgsden, Roland[1]; Vetemaa, Markus[1].

[1] *Estonian Marine Institute, University of Tartu, Vanemuise 46a, Tartu, 51014*
[2] *Norwegian Institute of Marine Research, Saugeneset 16, Storebø, 5392*
* *mehis.rohtla@ut.ee*

Oral / Session 2

Otolith microchemistry is a powerful yet an underused tool for investigating fish migration patterns and provenance in the Baltic Sea region. Here we briefly summarize and reflect on some of our recent findings in this relatively novel field through a number of case studies conducted on facultatively anadromous and catadromous species living in the Gulf of Finland and elsewhere on our coast: 1) Atlantic salmon and brown trout descend to the sea also as parr in autumn; 2) Atlantic salmon and brown trout fry and parr shift streams through the marine environment; 3) sea trout parr surveys monitor the densities of mostly anadromous maternal origin parr, but parr with resident maternal origin can be dominant in sites with poor sea connectivity; 4) low share of wild and high share of stocked (Finnish origin) European whitefish in the Estonian coastal sea; 5) high share of wild Estonian origin sea-trout in the Estonian coastal sea with significant input from the south (and not so much from the north!); 6) high share of wild and low share of restocked eels in the Estonian coastal sea and vice versa for the Finnish coastal sea.

In our research we have learned that there is much more variability in the life-history strategies of fish that we know of and have accounted for in our stock management plans. Here we urge different stakeholders not to only rely on "textbook knowledge" in advising or deciding on different matters, but to use and advocate the use of novel methods to gather new knowledge in this ever-changing environment. In the light of our results on stocked/restocked species we often ponder over why do we stock/restock them in the first place - is it mostly to supplement the catches under the disguise of conservation? Here we urge different stakeholders to pay more attention and dedicate more resources to investigating the multi-faceted effects of stocking/restocking fish to ensure that the deed indeed (primarily) serves the purpose of conservationism of natural resources.

Pre- and under construction environmental monitoring along the Baltic Connector transect (southwestern Gulf of Finland)

Jekaterina Jefimova, Arno Põllumäe, Andres Jaanus, Georg Martin

[1] *Estonian Marine Institute of University of Tartu (Mäealuse 14, 12618, Tallinn)*
* *jekaterina.jefimova@ut.ee*

Oral / Session 2

This work was carried out to detect disturbances in physico-chemical and biological characteristics throughout the water column before and under the construction of Baltic Connector – the gas pipeline between Estonia and Finland. The measurements were carried out from April to June 2019. The concentrations of nutrients (phosphate, nitrate, nitrite, ammonia), suspended particular matter and heavy metals were monitored. Analysis of nutrient data from 6 station in the Gulf of Finland showed that dynamics of total phosphorus (TP) concentrations at bottom layer was complicated, increasing in BCV1, BCV5 and BCV6 in May 2019, if compare with April, and being averagely on the same level in BCV2 through the described period. The concentration of total nitrogen (TN) at bottom layer slightly decreased under construction period and returned then to the initial value. Ammonium nitrogen concentration on the bottom increased 20 times for BCV5, and 5 times for BCV6 if compared to April and May, whereas in stations BCV1, BCV2 and BCV3 the concentration of ammonium nitrogen were not significantly changed through the all study period. Further analysis will be conducted to compare nutrient dynamics with data obtained by water quality monitoring in the Baltic Sea during study period and previous construction works in the Gulf of Finland.

The ecological role of FeMn concretions in the Gulf of Finland

Elli Leinikki[1,2*], Laura Kaikkonen[1,2], Kirsi Kostamo[2], Aarno Kotilainen[3]

[1] *University of Helsinki, Faculty of Biological and Environmental Sciences, Finland*
[2] *Finnish Environment Institute (SYKE), Finland*
[3] *Geological Survey of Finland (GTK), Finland*
elli.leinikki@helsinki.fi

Oral / Session 2

Ferromanganese (FeMn) concretions are found on soft sediment bottoms both in the deep sea and coastal sea areas, formed as a result of microbial activity in oxic conditions. Concretions form hard substrates on predominantly soft seafloors, and they are therefore suggested to increase habitat complexity and to provide shelter from seafloor erosion. Geological diversity and habitat complexity of seafloor has been found to correlate with biodiversity (Kaskela et al. 2017). Despite their widespread occurrence in the northern Baltic Sea, their ecological importance has been left unaddressed. In the recent assessment of threatened habitat types in Finland, FeMn concretion bottoms were classed as a data deficient habitat type (Kotilainen et al. 2017). It has been estimated that concretions occur at least in 11 % of the Finnish marine areas (Kaikkonen et al. 2019).

In this study, we examine the role of FeMn concretions as habitats in the Baltic Sea ecosystem. We investigated the benthic biodiversity utilising two approaches: the coverage and abundance of sessile macrofauna growing on concretions and mobile fauna were studied with point-dives. Samples for sediment in-fauna were taken with a Van Veen Grab Sampler. The data collected from concretion bottoms was compared to pre-existing data from similar soft bottoms where there are no observations of concretions, collected in the Finnish Inventory Programme for the Underwater Marine Environment (VELMU).

We will present the first results from field surveys in the Gulf of Finland. The results from this study will further characterize concretion bottoms as a habitat, as well as provide new insights of their ecological importance. Knowledge on the ecological role of concretion fields in the marine ecosystem can be utilised both in questions related to environmental protection and economic utilisation of the mineral resources in the future.

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Inland waterways fairway technologie

Karetnikov Vladimir

Admiral Makarov State University for Maritime and Inland Shipping 198035 Russia, St.-Petersburg, Dvinskaya str. 5/7
karetnikovvv@gumrf.ru

Oral / Session 2

Currently, water transport specialists are of great interest to the issues of ensuring the safety of navigation, including in the waters of the Gulf of Finland and the rivers flowing into it due to the rational distribution of floating navigation signs of the navigation fence system. As you know, an excessive number of floating navigation signs can lead to a disorientation of the navigator, especially at night, in addition, there will be an increase in operating costs for their maintenance.

To determine the optimal number of floating navigation signs, the optimality criterion can be normalized from the point of view of assessing navigation risk. To do this, based on the risk-based approach, it is possible to assess the navigation risks in the area for various schemes for the placement of floating navigation signs based on the FSA method. In order to solve this problem, you will need to use a modern navigation simulator. It should be noted here that the decision to select specific types of vessels for simulations should be based on quantitative estimates of the movement of specific vessels in the area. According to experts, when using the risk of a sound approach to the formation of the layout of floating navigation signs, the total number of elements can be reduced by at least 30%. In addition, in the case of the use of floating navigational signs included in the monitoring system together with the use of AIS technologies, it will allow optimization of the layouts currently in use by more than 50%.

This approach was chosen to solve problems within the framework of the international project INFUTURE KS1006, WP 2 - INLAND WATERWAYS FAIRWAY TECHNOLOGIE.

Maritime Risk Assessment through collaborative projects in Finland

Ketki Kulkarni[1*], Osiris Valdez Banda[1], Pentti Kujala[1]

[1] *Aalto University, Tietotie 1 C, Espoo, Finland*
* ketki.kulkarni@aalto.fi

Oral / Session 2

Gulf of Finland is an important socio-economic zone in the Baltic region and is home to many sensitive ecosystems. Increased marine traffic in the region has increased the risk of accidents involving oil and chemical spills. In the last 15 years, various research organizations and universities in Finland have collaborated on short-term projects of 1-5 years, to study the challenges and threats to the Gulf of Finland. The projects cover a wide variety of issues such as oil spill response, overfishing and sustainability and control through rules and regulations. While some of the work from these projects is available in scientific databases, there exists a significant body of work that is not published in these databases. This project conducted a review of such "grey" literature, which is open access and resulted from publicly funded projects. An analysis is performed to identify the main risk management issue target by the project, along with the modelling techniques and tolls used in the implementation. The projects are evaluated to understand if they are applicable to wider geographical areas and how easily they could be adapted for future needs. An important part of the work involves identification of factors that make a project applicable for generic problems and reusable across the regions. One of the aims of this exercise is to give more visibility to these models and studies, which are the result of collaboration between industry experts, government agencies and academic rigour. These projects could provide foundations for future researchers and practitioners, while also helping narrow the gap between practice and scientific research.

Maritime Cultural Heritage in the Gulf of Finland – The BalticRIM-project

Riikka Tevali[1*]

[1] *Finnish Heritage Agency, Sturenkatu 2a, Helsinki*
* riikka.tevali@museovirasto.fi

Oral / Session 2

The BalticRIM-project (Baltic Sea Region Integrated Maritime Cultural Heritage Management) brings together cultural heritage experts and maritime spatial planners from six countries around the Baltic Sea. Our aim is to promote the maritime cultural heritage around the Baltic Sea and introduce it to maritime spatial planning, which is an EU process ongoing until 2021.

The Finnish Heritage Agency is working together with the Estonian Heritage Board and Russian partners to highlight the transboundary elements in our maritime cultural heritage. With Estonia, we have a long history of intangible heritage, contacts and tangible underwater heritage, spanning from the Middle Ages to the world wars.

The connections to north-eastern Russia have been lively in the eastern Finland since prehistory. Joint economic and maritime landscapes are manifested in the stone quarries, stretching from Kymenlaakso to the Bay of Viborg, from the 18th century onwards. Cultural heritage can be linked to our common Baltic Sea strategy, "Save the Sea", where maritime and underwater landscapes are actively promoted to maritime spatial planning. Landscape is a useful tool, used to bring nature and culture together with their active users in the spirit of the Faro convention. From this joint project and research, we hope to gain a broader view to our common maritime cultural heritage and history, when the boundaries in the Gulf of Finland were truly flexible.

Maritime Cultural Heritage impact assessment strategy for MSP

Robert Aps[1*]; Lees, Liisi [1]; Herkül, Kristjan[1]; Roio Maili [2]; Karro, Krista[2]

[1] *University of Tartu, Estonian Marine Institute, Tallinn, Estonia*
[2] *National Heritage Board of Estonia, Tallinn, Estonia*
* *robert.aps@ut.ee*

Oral / Session 2

Referring to the UN Law of the Sea Convention (1982) states have the duty to protect objects of an archaeological and historical nature found at sea and shall cooperate for this purpose. UNESCO Convention on the Protection of the Underwater Cultural Heritage (2001) defines Underwater Cultural Heritage as all traces of human existence having a cultural, historical or archaeological character which have been partially or totally under water, periodically or continuously, for at least 100 years. As a part of EU's Blue Growth strategy (2012), the coastal and maritime tourism sector has been identified as an area with special potential to foster a smart, sustainable and inclusive Europe. The European coastal and maritime heritage is, in particular, one of the best tourism products Europe has to offer visitors and gives a competitive advantage over other touristic regions of the globe. This impact assessment study is a part of the INTERREG BSR project "Baltic Sea Region Integrated Maritime Cultural Heritage Management (BalticRIM)". The "Maritime Cultural Heritage impact assessment strategy for MSP" is a general guidance document to planners, decision makers and stakeholders with the aim to improve the Baltic Sea Region Integrated Maritime Cultural Heritage Management competitiveness and effectiveness of activities existing within the national and transboundary marine jurisdiction to achieve the MSP related environmental, economic and cultural policy objectives. The strategy is targeted especially to MSP planners, decision makers and stakeholders with the aim to establish ISO 31000 risk management standard based common understanding and language for evaluating cross-border MCH risk options by referring to all phases of MSP - the visioning, planning and implementation including review, monitoring, evaluation, and adaptation.

Important habitats for ecosystem services production in the Northern Baltic Sea

Susanna Jernberg[1]* Harri Kuosa[1], Chirstoffer Boström[2], Daryl Burdon[3], Fiia Haavisto[4], Anna-Stiina Heiskanen[1], Suvi Kiviluoto[1], Sanna Kuningas[5], Mervi Kunnasranta[5], Laura Uusitalo[1], Anna Villnäs[6], Mats Westerbom[6], Kirsi Kostamo[1]

[1] *Finnish Environment Institute SYKE, Latokartanonkaari 11, 00790 Helsinki, Finland*
[2] *Åbo Akademi University, Tuomiokirkontori 3, 20500 Turku, Finland*
[3] *University of Hull, Cottingham Rd, Hull HU6 7RX, United Kingdom*
[4] *Metsähallitus, Ratatie 11 B, 01300 Vantaa, Finland*
[5] *Natural Resources Institute Finland LUKE, Latokartanonkaari 9, 00790 Helsinki, Finland*
[6] *Tvärminne zoological station, University of Helsinki, J.A. Palménin tie 260, 00014, Finland*
susanna.jernberg@ymparisto.fi

Oral / Session 3

The Gulf of Finland is a very important economic area in the Baltic Sea as it offers many benefits to the surrounding countries. These benefits are called ecosystem services and they include services such as fisheries, recreational opportunities but also services such as ecosystem's capacity to buffer the effects of eutrophication. In order to take the ecosystem services better into account in the marine spatial planning and decision-making, we need to know how the ecosystems are producing the services and how the services are linked to habitats and species. In our study, we linked habitats and selected mobile species to ecosystem services in the Northern Baltic Sea by using existing literature and expert judgment. Our results demonstrate the relationship between habitats and ecosystem services and show which habitats are important for a certain services production.

Coexistence of native *Eurytemora affinis* and invasive American *E. carolleeae* in the Gulf of Finland

Sukhikh Natalia*, Alekseev Victor

1 Zoological Institute of the Russian Academy of Sciences, Universitetskaya emb., 1, St.-Petersburg, 199034, Russia
* Susikh1@mail.ru

Oral / Session 3

E. affinis is the dominant pelagic species and constitute the main food source for animals at higher trophic levels of estuaries including the Gulf of Finland (GoF). In 2007 American copepod *E. carolleeae* was found in the eastern part of the Gulf of Finland. Later, this species was also detected in the Gulf of Riga and in the Amsterdam channels, as well as in additional locations of the Baltic and North Seas. Nowadays sibling species *E. affinis* and *E. carolleeae* coexist in the same places. The detection of these related species in Baltic waters is likely the result of recent invasion via the ballast water of ships from the Atlantic coast of the United States.

In our study two of these populations were conducted in nearshore stations in Luga Bay (GoF). These two species, living in the GoF differed in morphology, genetics and had some differences in physiological traits. At the same time, it appears as though they occupy, more or less, the same ecological niches and have largely parallel population dynamics. Throughout the study period, Invasive *E. carolleeae* is usually second to *E. affinis* in terms of density and consists 15-30% of total *Eurytemora* community. However sometimes we observed a temporal shift in zooplankton populations, featuring a total replacement of *E. affinis* by invasive *E. carolleeae*. Study of the reproductive parameters of the two *Eurytemora* species living in sympatry revealed a significant difference in clutch size, but not in egg size. The larger body size invasive E. carolleeae produced almost double the clutch size (62 eggs/female) than that of the native smaller *E. affinis* (34 eggs/female). As the invasion of *E. carolleeae* seems to be a recent and rapid process, we hypothesize here that it has the potential to displace native *E. affinis* in the GoF ecosystem and possibly in the entire Baltic Sea.

Effect of surface currents on modelled wave fields in the Gulf of Finland

Hedi Kanarik[1*], Laura Tuomi[1], Tuomas Kärnä[1], Antti Westerlund[1], Jan-Victor Björkqvist[1]

[1] *Finnish Meteorological Institute, Erik Palménin aukio 1, 00560 Helsinki, Finland*
* hedi.kanarik@fmi.fi

Oral / Session 3

Sea surface currents can noticeably refract surface waves in certain conditions. We study this phenomenon in the Gulf of Finland using the WAM model forced with surface current and ice fields from the NEMO model. Changes in the significant wave height, spectral peak period and direction are examined to identify the areas and conditions, in which currents have a notable effect on the wave field. The quality of the model runs is verified against available wave buoy and altimeter measurements. Preliminary results show surface currents in Gulf of Finland affect significant wave height (SWH) most in western half of the Gulf. Largest variations are located in the south-western coast of the gulf, where the strongest currents occur. Changes in the SWH are up to 30 cm, with decrease near coast and increase in more open sea areas.

Oil spill risk management in ice infested Northern Baltic Sea

Liangliang Lu[1*], Floris Goerlandt[2], Osiris A. Valdez Banda[1], Pentti Kujala[1]

[1] *Aalto University, School of Engineering, Marine and Arctic Technology, Tietotie 1 C, Espoo 02150, Finland*
[2] *Dalhousie University, Department of Industrial Engineering, Halifax, Nova Scotia B3H 4R2, Canada*
* *liangliang.lu@aalto.fi*

Oral / Session 3

The Northern Baltic Sea, as one of the few areas with busy ship traffic in ice-infested waters, is a typical sea area exposed to risk of ship accidents and oil spills in ice conditions. Therefore, oil spill risk management is essential in this area to reduce oil spill risks and potential impacts. This abstract will present three parts of the on-going oil spill risk management research: 1) A Bayesian Network model developed for assessing oil spill recovery effectiveness, which aims to generate holistic understanding and insights about the oil spill-to-recovery phase, and to estimate oil recovery effectiveness in representative winter conditions. 2) An oil spill response and recovery system model based on ship-ship collisions, which is used to identify critical system risk aspects so that the key risk control elements can be determined to get an effective and efficient risk control. 3) Further risk management focuses on the maritime traffic and response fleet in ice conditions, which will be studied in the new coming project SIMREC (Simulators for Improving Cross-Border Oil Spill Response in Extreme Conditions).

Examples of reconstruction of fine-grid SST and SSS patterns using less than 0.5% of grid coverage by observations

Mihhail Zujev [1] *, Jüri Elken [1], Jun She [2] and Priidik Lagemaa [1]

[1] *Department of Marine Systems, Tallinn University of Technology, Tallinn, Estonia*
[2] *Research and Development Department, Danish Meteorological Institute, Copenhagen, Denmark*
* *mihhail.zujev@taltech.ee*

Oral / Session 3

Method for assimilation of sparse ship-borne observations (salinity and temperature) is developed allowing full reconstruction of high resolution model field using <0.5% data coverage. Well-known EOF technique is used to calculate covariance matrices between wet-points, which are then used to find the three most significant (powerful) spatial modes and amplitudes of pseudo-observations. The latter were generated with sub-regional HBM model for five consecutive years.

Several examples of assimilation of various types of observations with different coverage like satellite and FerryBox, ranging from 0.5% to 70% are presented. The algorithm is applied in northern Baltic sea region. Comparison with other assimilation methods and validation with in-situ data shows significant improvement of forecast quality.

Efficacy estimation of electron irradiation and sodium ferrate usage for purification of water samples contaminated with diclofenac

Nekrasov R.E.[1*], Orekhova N.A.[1], Petkova A.P.[1], Lomasov V.N.[1]

[1] Peter the Great St. Petersburg Polytechnic University, Russia, St. Petersburg, Polytechnicheskaya street № 29
[*] korlian@yandex.ru

Oral / Session 3

Nowadays there is observed a rapid growth of pharmaceutical industry in the
World and traditional methods of water parameters control, such as Total Coliforms Amount and residual chlorine, is amplified with new problems in face of DBPs. In waters of Saint Petersburg and the Leningrad region this problem also appeared, e.g. with sodium diclofenac as example.

Goal of current research is compare two methods of purification for Diclofenac-contaminated water: reagent based method with oxidizer (sodium ferrate) and electron irradiation. As a result of provided experiments, there were analyzed optical densities before and after treatment by both methods. The research revealed minimal doses for maximal degree of purification, attained in current research = 46 % (for purification of the sample of 25 ml with sodium diclofenac concentration of 100 mg/L was required dose: 0,15 mg/L of sodium ferrate or irradiation by 1 MGy). Finally approbation of both methods could be considered as successful, but more objective results need in-depth study with model solution concentrations be close to MRL levels.

OneDrop – A Novel Mobile Water Purification Plant: Possibilities for the Gulf of Finland Water Treatment

Daria Navolotskaya[1], Tatiana Ermakova[2], Sergey Ermakov[1*]

[1] *Saint-Petersburg State University, Universitetskaya emb., 7-9, 199034, St. Petersburg, Russia*
[2] *OMEGA NPK, Yelizarova av., 31/2, 38, 192148, St. Petersburg, Russia*
* s.ermakov@spbu.ru

Oral / Session 3

"OneDrop" is an interdisciplinary project aimed at the development of a novel mobile water purification plant. The project is funded by "The South-East Finland – Russia CBC 2014-2020 Programme". There are five partners involved in the project: Lappeenranta-Lahti University of Technology, Saint-Petersburg State University, Peter the Great Saint-Petersburg Polytechnic University, NPK Omega and the Port of Lappeenranta. The main part of the mobile plant under development is the electrolysis unit producing ferrate (VI). Being a strong oxidizing agent, ferrate (VI) can be used for oxidizing emerging contaminants and toxins and for deactivating harmful micro-organisms in water treatment without generating hazardous by-products as opposed to chlorination and ozonation. That's why ferrate (VI) is often termed as a "green chemical". Moreover, the decomposition of ferrate (VI) produces Fe (III), which itself is an excellent coagulant for removal of metals and radionuclides from contaminated water. Ferrate technology can be used for the treatment of both drinking water and wastewater. By the moment we have already developed and tested a prototype of the electrolysis unit, as well as methods for determination of ferrate concentration. Removal efficiency of ferrate (VI) towards inorganic and organic water contaminants, including pharmaceuticals, was studied. Testing the proposed water purification technology on the water samples from the Gulf of Finland is planned.

The effects of tire rubber powder and its leachates on the Baltic clam (*Limecola balthica*)

Näkki, Pinja[1,2*], Ahvo, Aino[1], Turja, Raisa[1], Sainio, Erika[1], Koistinen, Arto[3], Hartikainen, Samuel[3,4], Peräniemi, Sirpa[5], Lehtonen, Kari[1], Setälä, Outi[1] & Lehtiniemi, Maiju[1]

[1] *Marine Research Centre, Finnish Environment Institute, Latokartanonkaari 11, FI-00790 Helsinki, Finland*
[2] *Tvärminne Zoological Station, University of Helsinki, J.A. Palménin tie 260, FI-10900 Hanko, Finland*
[3] *SIB Labs, University of Eastern Finland, P.O. Box 1627, FI-70211 Kuopio, Finland*
[4] *Department of Environmental and Biological Sciences, University of Eastern Finland, P.O. Box 1627, FI-70211 Kuopio, Finland*
[5] *School of Pharmacy, University of Eastern Finland, P.O. Box 1627, FI-70211 Kuopio, Finland*
* *pinja.nakki@ymparisto.fi*

Oral / Session 3

Wear and tear from car tires has been proposed to represent a major microplastic pollution source. A mesocosm experiment was conducted to investigate the effects of environmentally relevant concentration of tire rubber particles on Baltic clams (*Limecola balthica*) in both acute (4 days) and chronic (1 month) exposure scenarios. The impacts of exposure were studied by combining a set of behavioural and physiological biomarkers to histopathological examination of clam tissues. The leaching of contaminants from tire rubber was verified by analysing water samples throughout the experiment, and their uptake by clams was analysed from tissues at the end of the experiment. Preliminary results show leaching of heavy metals and polycyclic aromatic hydrocarbons (PAHs) from tire rubber to seawater, and accumulation of these contaminants to clams.

Controllable predator-prey model with nutrients

Mark Polyak[1*], Svetlana Kolesnikova[1]

[1] *Saint-Petersburg State University of Aerospace Instrumentation, Saint-Petersburg, Russia*
* markpolyak@gmail.com

Oral / Session 3

Methods of control theory are applied to synthesize control laws for population processes in "predator-prey" ecological system described by Lotka-Volterra equations, as well as more complex models. Those models are used to investigate relationships between nutrients, phytoplankton and other species in the water body. The task of managing population dynamics with a system of differential equations can be achieved by synthesis of control laws that are able to keep "prey" and "predator" populations inside a predefined range. Introduction of additional parameters allows to fine tune models so they reflect a water body state under specific initial conditions. Behavior of synthesized models is investigated under different initial conditions and modelled results are compared with real monitoring data from the Neva Bay and the Eastern part of the Gulf of Finland.

One of the most well-known mathematical models in biology is the predator-prey model used to describe population dynamics. In its simplest form the model is described by a pair of first-order non-linear differential equations:

$$\begin{cases} \frac{dx_1}{dt} = x_1(\alpha_1 - \beta_1 x_2) \\ \frac{dx_2}{dt} = -x_2(\alpha_2 - \beta_2 x_1) \end{cases} \qquad (1)$$

Where: $x_1 \geq 0$ is "prey" population size;
     $x_2 \geq 0$ is "predator" population size;
     $\alpha_1 \geq 0, \beta_1 \geq 0, \alpha_2 \geq 0, \beta_2 \geq 0$ are model parameters that describe interaction between two species.

In this research, the "prey" and "predator" are treated as phytoplankton and zooplankton populations respectively. In order to make the model realistic coefficient $\alpha_1 = const$ is substituted by a function of time $\alpha_1(t)$ and a third differential equation is added to the system:

$$\begin{cases} \frac{dx_1}{dt} = \alpha_1(t)x_1 - \beta_1 x_1 x_2 \\ \frac{dx_2}{dt} = -\alpha_2 x_2 + \beta_2 x_1 x_2 \\ \frac{d\alpha_1(t)}{dt} = U(t) \end{cases} \qquad (2)$$

Here function $U(t) = U(x_1, x_2)$ describes the factor of phytoplankton growth rate (e.g. related to nutrient load) and is used to control the state of the system.

The analytical design of aggregated regulators (ADAR) method is used to derive the function $U(t)$ under predefined goals and set of constraints. This method is based on introduction of invariant manifold attractors that have the best fit to the properties of controllable object and control objective.

ADAR method and its modification (non-linear adaptation to a target manifold) allow designing optimal control for complex multidimensional multiply-connected and even non-linear objects. We have used this method to synthesize new states and ways of reaching them for several phytoplankton models.

Application of synergetic control theory for prediction of ecological situations in water bodies can be based on decision rules of the form "what will happen, if …". Those rules will form the basis of mathematical tools for the environmental decision support system.

Modelling the drift of objects in the Gulf of Finland

Olga Vähä-Piikkiö[1*], Pekka Alenius[1], Antti Westerlund[1], Laura Tuomi[1]

[1] *Finnish Meteorological Institute, Erik Palménin aukio 1 00560 Helsinki*
* olga.vaha-piikkio@fmi.fi

Oral / Session 3

The Gulf of Finland is an area of high volumes of oil transport. The risk of a major oil accident is ever-present. Other chemicals are transported via the Gulf of Finland as well. Drift modelling is essential for accurately forecasting the trajectory of an oil or chemical spill and consequently clearing it up before it reaches the shore. Drift modelling can also be used to predict the movement of organic matter, such as algae blooms and fish eggs, and larger objects and people in case of a rescue mission. The drift of surface objects is affected by wind, currents and waves. In order to study the importance and the proportion of each component in different conditions, we did a modelling study using the OpenDrift model with inputs from 3D NEMO-LIM, WaveWatchIII and HIRLAM. The wave and circulation fields were produced with high horizontal resolution (0.25 NM). The drift forecast system is evaluated by comparing the simulated results to drift experiments conducted in the Gulf of Finland in 2012.

Uncertainties of modelling the dissolved organic matter and its components in the Gulf of Finland

Oksana Vladimirova[1*], Tatiana Eremina[1], Oleg Savchuk[3,4], Vladimir Ryabchenko[2], Alexey Isaev[2]

[1] *Russian State Hydrometeorological University, Russia,* [2] *P. P. Shirshov Institute of Oceanology of the Russian Academy of Sciences, Russia,* [3] *Institute of Earth Sciences, St. Petersburg State University, Russia,* [4] *Baltic Nest Institute, Stockholm University Baltic Sea Centre, Sweden*
[*] *3256767@gmail.com*

Oral / Session 3

The Gulf of Finland has the status one of the most eutrophic water area in the Baltic sea. The eutrophication of the Gulf of Finland is determined by the supply of nitrogen and phosphorus directly from the catchment area of the gulf, water exchange with the Baltic Sea, as well as the transport of the substance between different areas of the gulf, internal chemical and biological processes. In most existing ecosystem models of the Baltic sea organic matter is represented only as suspended organic matter. Such a formulation of the problem implies the use of a bioavailability factor for organic matter entering with the river runoff. Organic loads are lumped together in detritus and availability coefficients differ from model to model. In the result, there are large differences between actual nutrient inputs prescribed in different models, especially for phosphorus. These differences originate from the models' formulations and calibration, including assumptions on bioavailable fractions in external nutrient inputs. In result, the external loads range between models up to 50 % for nitrogen and almost three-fold for phosphorus. To eliminate this kind of uncertainties, St.-Petersburg model of eutrophication (SPBEM) has been modified by explicit description of total amounts of organic nutrients, including both dissolved and particulate forms. The modification was developed and calibrated in numerical experiments at the Gulf of Finland made with plausible initial and realistic boundary conditions for the recent years. Results of both model-data comparison and sensitivity analysis are presented and discussed.

Dynamics of phytoplankton structure and chlorophyll *a* in eastern part of Gulf of Finland.

Andreeva I.V.[1], Voyakina E.Yu.[2*]

[1]*FSBI "North-West department for Hydrometeorology and Environmental Monitoring" Pr. Popova str. 48 Saint Petersburg, Russia*
[2] *Institution of Russian Academy of Sciences Saint-Petersburg Scientific-Research Center for Ecological Safety, Korpusnaya str.18 Saint Petersburg, Russia*
**katerina.voyakina@gmail.com*

Poster / Session 1

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. During last decades a lot of attention has been directed to cyanobacteria as potent producers of toxic substances during cyanobacterial water blooms. HAB's 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.

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 2007 – 2008 and 2010 - 2018.

The total number of taxa identified in the studied material was 162. The discovered species consisted of nine taxonomic groups of algae and cyanobacteria. Large number of species of green algae (41 %), cyanobacteria (17%) and diatoms (23%) 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 and Luga Bay, the largest number of species - in Inner estuary and Vyborg Bay. 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 2007 (0.9 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.

Monitoring of hazardous substances and biotic responses in the eastern Gulf of Finland: first results of field survey of 2019

Nadezhda Berezina [1*], Alexey Maximov[1], Yulia Gubelit[1], Andrey Sharov[2], Yulia Polyak[2], Anna Demchuk[1, 3], Oksana Vladimirova[4], Nikolay Kamardin[2], Tatyana Shigaeva[2], Valeria Kvitkovskaya[3], Alexey Isaev, Tatyana Kuznetsova[2], Sergey Kholodkevich[2]

[1]*Zoological institute RAS, Universitetskaya 1, St. Petersburg, 199034, Russia*
[2]*SRCES RAS, Korpusnaya 18, St. Petersburg, 197110, Russia*
[3]*St. Petersburg State University, Universitetskaya 5/7, St Petersburg, 199034, Russia*
[4]*Russian State Hydrometeorological University, 195196 St. Petersburg, Russia.*
***na-berezina@rambler.ru**

Poster / Session 1

Field works were conducted in spring, summer and autumn 2019 according to purposes of the Project ER90 HAZLESS, Estonia – Russia Cross Border Cooperation Programme 2014-2020. Bottom sediment and biota from 30 hotspots of the eastern Gulf of Finland were collected during research cruise (r/v Maria) and survey of coastal areas in regard to evaluate hazardous substances, the status of the environment and assess the potential impact on the benthic organisms. Biota (algae, crustaceans, molluscs, polychaetes, fish), and bottom sediments were sampled for the measurement of priority substances included in the HELCOM Core Indicators list: the metals Cd, Cu, Zn, PAHs, PCBs. During this phase of project, species composition, animal and plant biomass were studied, dominating taxa were selected. Also, biossay with the amphipod *Gmelinoides fasciatus* (sediment exposure test) and bioaccumulation of studied hazardous substances in algae, invertebrates and fish were evaluated. This integrated approach will provide link between the quality of environment and health of living organisms.

Non-targeted and targeted analysis of emerging pollutants in the bottom sediments of the Eastern Part of the Gulf of Finland

Zoya Zhakovskaya*, Larisa Metelkova, Anastasia Egorova, Galina Kukhareva

St.-Petersburg Scientific Research Centre for Ecological Safety, Russian Academy of Sciences, Korpusnaya st. 18, 197110, St.-Petersburg, Russia
zazhak@hotmail.com

The application of non-target screening techniques is needed in order to detect the presence of harmful substances (including degradation by-products and metabolites) potentially overlooked. The results of this kind of analysis are the basis for performing a targeted analysis. Such work was carried out for samples of bottom sediments taken in the eastern part of the Gulf of Finland during the navigation seasons of 2018. As a result of non-targeted analysis by GC-MS with identification by mass-spectra library, tetrabutyltin (TTBT), triclosan, p-DETA, polychlorinated naphtalenes (PCNs) and others were identified. The presence of TTBT in bottom sediments indicates the presence of a number of other organotin compounds. As such, a targeted analysis of other organotin compounds was carried out using the selective method with ethyl derivatives obtaining with GC-MS in SIM mode. TBT was found in the all samples in the range 1.7-26 ng·g^{-1}. Monobutyltin (MBT) and dibutyltin (DBT) were detected in the range of 2.1-28 ng·g^{-1}dw and 0.5-23 ng·g^{-1}dw in all sediment samples, respectively. Concentrations of triphenyltin (TPhT) and tricyclohexyltin (TCHT) have not been determined above LOD. Following the results of non-targeted analysis of several samples a targeted analysis for triclosan was carried out in SIM mode. Triclosan was detected in several sediment samples (in the range of 1.0-184 ng·g^{-1}dw).

Bioassay using amphipod and bivalve mollusk endpoints as a good tool for active monitoring of bottom sediments in the Gulf of Finland

Andrey N. Sharov[1*], Nadezhda A. Berezina[2], Alexey A. Maximov[2]

[1]*Saint-Petersburg Scientific Research Center for Ecological Safety Russian Academy of Sciences, Korpusnaya 18, St. Petersburg, 197110, Russia*
[2]*Zoological institute Russian Academy of Sciences, Universitetskaya nab. 1, St. Petersburg, 199034, Russia*
sharov_an@mail.ru

Poster / Session 1

Experimental study was conducted in the frame of the Estonia – Russia Cross Border Cooperation Programme 2014-2020, Project ER90 HAZLESS. The muddy bottom sediments were collected at five sites in the eastern part of Gulf of Finland (2F, 4F, 2ugms, 17 F and 2L with depths of 21-50 m, salinity of 1-3). For the 10 days exposure xperiment, the upper 3-cm oxic sediment layer was taken. Test-organisms, the amphipod *Gmelinoides fasciatus* and the bivalve mollusk *Anodonta cygnea,* were collected from the reference site (Dubki park) and transplanted to the treatments (active monitoring method, bioassay). At the end, amphipod survival rate and recovery time of the mollusk's heart rate after acute salinity increase (6 ppt), content of metals and oxygen in the sediments were evaluated. Results showed that amphipod survival rates (12.5±2.5%) were lowest at central site 2ugms testifying high sediment toxicity. Site 17 F was characterized by low oxygen (3 mg/l) resulting in 80% amphipod mortality. Sediments in areas of Luga Bay (2L) and Kronstadt (2F) were in good condition. Test with mollusk heart rate did not reveal significant differences between experimental treatments but all of them differed notably from the same endpoint in mollusks from the reference site. Thus, bioassay using amphipod is a good marker and powerful tool of assessing sediment toxicity.

Occurrence of some pharmaceuticals in the waters of the Gulf of Finland, the Baltic Sea

Ekaterina Chernova[*], Iana Russkikh, Zoya Zhakovskaya

Saint-Petersburg Scientific Research Centre for Ecological Safety, Russian Academy of Sciences, 197110, St-Petersburg, Russia
* s3561389@yandex.ru

Poster / Session 1

During the past two decades scientists, regulatory agencies and the European Commission have acknowledged pharmaceuticals to be an emerging environmental problem. In Russia, pharmaceuticals have not been monitored in the environment yet and little data is available on their presence. In our study, we choose some most used pharmaceuticals in the Russian Federation for the determination in water samples of the Baltic Sea, including recreation zones. Water samples were collected during 6 research cruises in summer of 2019. The applied analytical procedure included solid phase extraction (Oasis HLB, pH 3) and chromato-mass-spectrometry determination. The limits of detection were 0.3 - 4.0 ng L^{-1}. Predicted No Effect Concentrations (PNEC) of the studied pharmaceuticals were in the range of tens – hundreds ng L^{-1}. Caffeine presented in most samples, its concentration rose to hundreds ng L^{-1}. Diclofenac (considered as HELCOM core indicator) was detected in 14 % of samples (in the range of 0.5 - 4 ng L^{-1}). Some other pharmaceuticals belonging to stimulators, antibiotics, anti-inflammatory, and antiepileptic pharmacological groups were determined in low concentration.

Can the "green tides" affect the metal distribution in the coastal sediments? A case study in the eastern Gulf of Finland, Baltic Sea

Yulia Gubelit[1*], Yulia Polyak[2], Tatyana Shigaeva[2], Ludmila Bakina[2], Valentina Kudryavtseva[2]

[1] *Zoological Institute of the Russian Academy of Sciences, Universitetskaya Embankment 1, St. Petersburg 199034, Russia*
[2] *Scientific Research Center for Ecological Safety Russian Academy of Sciences, Korpusnaya 18, St. Petersburg 197110, Russia*
e-mail of corresponding author: Gubelit@list.ru

Poster / Session 1

Our study has been conducted along the coastline of the eastern Gulf of Finland for three years. Our study showed significant changes in concentrations of Zn, Cd and Pb, which reflected influence of the sources of anthropogenic contamination such as the port Vysotsk and a new one – Bronka. Some results of the principal component and classification analysis have shown that main factors, which affected the metal distribution in the coastal zone of EGoF were related to riverine water discharge and terrestrial input from the new anthropogenic sources. During our study the biomass of macroalgae at the study sites exceeded the means reported during the previous long-term monitoring. We have reported recently about the highest metal contamination at the sites which are affected by the massive "green" tide events every year (Gubelit et al., 2016). This findings allowed to propose that massive algal mats may enforce the contamination of the sediments by metals because hypoxia and release of accumulated metals from the algal biomass. In this study we measured the metal content in the sediments under a continuous algal cover and in a "clean" area, which was free of algae. Almost in all cases the metal content in the sediments under algal layer was higher than in the "clean" sediments. We found the significantly higher metal contamination of sediments under algal mats. Known metal concentration in algae and their biomass give us possibility to assess a metal loading from the algal biomass into a square meter of the coastal zone, which we named "additional". Since usually the clusters of algae on the shore are mobile, we took into account the sites which are closed from surf influence and every year have been serving as a points for a permanent accumulation of algal biomass, i.e. site S7. According to the data on the biomass and its metal content, we may conclude that additional metal loading varied from year to year and depended on how favorable conditions had been for the growth and development of opportunistic algae. In years with low algae biomass (2014 and 2017) the additional loading was insignificant and could reach 0.3-0.7 mg of copper, 6.6-11.7 mg of Zn, 0.025-0.04 of Cd, and 2.41-4.25 mg of Pb per m^2 of the shore. However in the years with favorable conditions for the growth of macroalgae, these values may increase significantly. In 2016 the additional loading reached 61 mg of copper, 246.5 mg of zink, 0.97 mg of cadmium and 89.4 mg of lead per m^2 of the coast. Regarding the complex of the biogeochemical processes at the sediment-water boundary including the hypoxia caused by algae and the fact that during the algae decomposition the elements are going into the water as well as to demersal layer, it is difficult to predict the share of the metals which are going into sediments. However we can suppose that the rise of the green tides caused by both natural and anthropogenic impact can result additional metal and nutrient contamination of the coastal zones in the nearest future.

Study of the coastal territories of the Neva Bay with the land mollusk *Arianta arbustorum*

N.N.Kamardin

Saint-Petersburg Scientific Research Centre for Ecological Safety RAS, Russia
nik-kamardin@yandex.ru

Terrestrial pulmonary mollusk-invaders Arianta arbustorum (Linnæus, 1758) spread widely in the Leningrad region and inhabited moist coastal biotopes up to the supralittoral. Their ability to accumulate anthropogenic pollutants and the possibility of conducting physiological experiments with them makes them a successful test-object for bio ecological monitoring. The concentration of heavy metals (HM) in the hepatopancreas of snails was measured using (AAS) and (ICP AES) methods. The thermo resistance of snails from various coastal biotopes was determined physiologically by the comparative drop in heart rate (HR). The rate of decrease in HR after turning off the heat was compared in snails from the village. N. Ropsha (reference location) with other locations: Alexandria Park (Peterhof), Oranienbaum Park (Lomonosov), Dubki Park (Sestroretsk). The thermo resistance of snails from the Oranienbaum park (Lomonosov city) was characterized as low, which indicates a possible violation of the protective system of heat shock proteins (HSP), which may reduce their ability to restore heat-denatured proteins, including contractile proteins of the heart, which usually leads to a rapid drop in heart rate in mollusks from contaminated sites. A possible violation of the HSP protective system may occur due to the accumulation of TM in the body of snails, especially along the banks of the canal in the Oranienbaum park. Here, a significant ($p \leq 0.05$) excess of interstitial concentration was found for all the studied metals (**Cu, Mn, Zn, Ni, Cd, Pb**) compared with the reference location in the N. Ropsha village and with other biotopes studied. The potential environmental risk (RI), determined by Hakanson (Hakanson, 1980), where the denominator is the concentration of metal in the soil, the channel leading from the bay to the Oranienbaum coastal park, was assessed as high.

Потенциальный экологический риск / potential environmental risk (RI)

Название	Cu C_i/C_n	Zn C_i/C_n	Ni C_i/C_n	Cd C_i/C_n	Pb C_i/C_n	RI
Поселок«N.Ропша»/ village «N. Ropsha»	3, 04	4.2	1,36	0,83	1,35	53,96
Парк «Александрия»/ Park "Alexandria»	2.14	4,56	1,52	0.68	1.95	54,53
Парк«Ораниенбаум»/ Park "Oranienbaum»	8.57	45.3	0.70	8.16	2.72	350,7
Парк «Дубки»/ Park "Dubki»	1,04	11,19	0,71	1,83	3.8	94,3

where C_i / C_n is the environmental risk from a single metal, RI is the potential environmental risk from all metals.

The phytoplankton of Luga Bay of the Gulf Finland under the dredging and climate changes

Oksana Liashenko,[*] Andrey Pedchenko[**]

[*] *Saint Petersburg National Research University of Information Technologies, Mechanics and Optics (ITMO University) Kronverkskiy pr., 49, lit. A, St. Petersburg, 197101, Russia;*
[**] *Russian Research Institute of Fisheries and Oceanography (VNIRO), 17 V. Krasnoselskaya, Moscow, 107140, Russia*
ksenia892@mail.ru

Poster / Session 1

The Luga Bay water area where Ust-Luga commercial seaport situated was determined of longstanding dredging and other types of anthropogenic impact. The phytoplankton from the southeast part of Luga Bay was investigated in the ice-free period from 2005 until 2018. The main systematic groups of algae which formed of phytoplankton were cyanoprokaryotes, cryptomonads, dinoflagellates, diatoms and green algae, in some cases the euglenids.

The maximum values of the phytoplankton abundance and biomass were detected in spring. The mainly part of biomass which was up to 7,66 g/m^3 was formed by diatoms and dinoflagellates. The summer biomass was up to 5,12 g/m^3 and it was lower than in spring in most cases. The part of cyanoprokaryotes (and cryptophytes or green algae in some years) increased in the total biomass. In autumn the biomass continued to decrease and it was up to 3,55 g/m^3, cyanoprokaryotes and cryptomonads dominated. The most significant dominants of the Luga Bay phytoplankton were *Skeletonema costatum, Peridinium aciculiferum, Peridiniella catenata, Aphanizomenon flos-aquae, Plankthothrix agardhii, Stephanodiscus spp. Cryptomonas spp.* From 2005 until 2018 the quantitative indicators of phytoplankton development in all seasons were varied from year to year but they kept in frames of values which observed for the water area of the Luga Bay previously. The influence of the trend for increasing of average annual water temperature on phytoplankton development was not traced.

The certain differences between the quantitative development and composition of the complex of dominant phytoplankton species were rather similar in the water areas of dredging and control water areas. It is probably due to the fact that the bottom sediments mostly consist of sends.

The influence of dynamic processes on the change in the oxygen regime in the Baltic Proper and in the Gulf of Finland

Litina Ekaterina[1] , Zakharchuk Evgenij [1, 2]

[1] *Saint-Petersburg Branch of State Oceanographic Institute (SPB SOI) - Russia, Saint-Petersburg, Beringa 38*
[2] *Saint Petersburg State University (SPBU) – Russia, Saint-Petersburg, Universitetskaya nab. 7-9*
warzuga@yandex.ru
spbsoi@rambler.ru

Poster / Session 1

Interannual changes in hypoxic conditions are investigated based on an analysis of in situ measurements of oxygen concentration for the period from 1989 to 2017. It has been shown that the number of zones with hypoxic conditions has been increasing and spreading to the Gulf of Finland since 1993. If in the previous thirty years (1959-1988) hypoxic conditions were observed only in the western part of the gulf, then, since 1993, zones of hypoxia have been noted here every year, spreading over time to the east of the gulf, more often observed in its central and eastern parts.

The hypothesis of this work is that a significant impact on the negative changes in the oxygen regime of the Baltic Sea and the Gulf of Finland can be exerted by dynamic processes. The influence of the following parameters on the change in the oxygen regime of the Baltic Sea is investigated to test this hypothesis: oxygen advection by currents, horizontal and vertical turbulent diffusion. It was shown that among these processes, the greatest influence on the change in the oxygen regime is exerted by horizontal and vertical turbulent diffusion of oxygen. However, the effect of these processes is nonstationary. Based on the results, it is concluded that one of the possible reasons for the deterioration of the oxygen regime in the Baltic Sea and the Gulf of Finland in recent decades is an increase in water masses stratification.

Degradation of NPs in microcosm using Gulf of Finland sediments

Medvedeva N.[*], Kuzikova I., Zaytseva T., Zinovieva S., Russu A.

Institution of Russian Academy of Sciences Saint-Petersburg Scientific-Research Centre for Ecological Safety RAS, Korpusnaya ul. 18, 197110, St. Petersburg, Russia
* ngmedvedeva@gmail.com

Nonylphenols (NPs) are an estrogenic pollutants which widely present in the aquatic environment. Biodegradation of NPs can reduce the toxicological risk.

The degradation of NPs and changes of bacterial number and community structure were investigated in microcosm using Gulf of Finland sediments, Baltic Sea.

In this microcosm experiment, initial concentration of NPs (300 mg/kg dw) decreased to 121 mg/kg dw during 240 days, whereas that in control microcosm with autoclaved sediments did not change, indicating that Gulf of Finland sediments contain NPs-degrading activity by microorganisms. The time taken for 50% of initial concentration of NPs to dissipate (T_{50}) based on a first-order model, was 177 days.

Changes of microbial community structures during the degradation of NPs in sediments are discussed.

Heavy metal content in the bottom sediments and benthic animals in the coastal zone of the eastern Gulf of Finland

Natalia Alekseeva[1]*, Tatiana Shigaeva[1], Yulia Polyak[1], Anna Demchuk[2], Yulia Gubelit[2], Valentina Kudryavtseva[1]

[1] *The St. Petersburg Research Center for Ecological Safety, Russian Academy of Sciences (RAS), Saint Petersburg, Russia, 197110, Korpusnaya Street, 18*
[2] *Zoological Institute of the Russian Academy of Sciences (RAS), Saint Petersburg, Russia, 199034, Universitetskaya Embankment, 1*
* *analyt@list.ru*

Poster / Session 1

Bottom sediments are a complex multicomponent object which is capable to sorb heavy metals. Their potential toxicity for aquatic organisms and humans depends on concentrations and forms of the heavy metals. Interacting constantly with surrounding water, the bottom sediments can serve as both: storage of the metals as well as a source of them into surrounding aquatic environment. The aim of the work is to clarify the features of the pollution of the coastal zone of the eastern Gulf of Finland by the heavy metals and to reveal the possible link between contamination of the bottom sediments and zoobenthos.
Research methods: inductively coupled plasma mass spectrometry (ICP-MS), anodic stripping voltammetry, potentiometry, laser granulometry.

Multiparameter environmental studies of the total metal concentrations as well as their labile forms in the samples from the northern and southern coasts of the eastern Gulf of Finland have revealed the main features in the contamination of the bottom sediments, algae, and benthos by the heavy metals. A study of dynamics of the total concentrations and labile forms of the heavy metals in correlation with dynamics of physical and chemical parameters (pH, temperature, redox potential) in the bottom sediments had been carried out during the growing period from May to September 2018.

Study results shown the shift in the redox processes to the negative potentials from May to June at all sampling stations, and then the rise of oxidative conditions. These observations made possible to predict a rise in the concentrations of labile forms of the heavy metals in May and June, which was recorded at two sampling sites "Big Igora" and "Grafskaya Bay".

At the same time we found that from May to July at these two sites the gross concentrations of the metals (Cd, Pb, Cu, Zn) and total phosphorus decreased, and then, from August to September they were rising again.

We found the strong correlation between Zn, Pb and Cu concentrations in the sediments and their content in the tissues of Amphipoda (Pearson correlation coefficient was 0.99). According to the metal content in the tissues the studied zoobenthos followed the order: Amphipoda > Hirudinea ≥ Oligochaeta ≥ Gastropoda > Bivalvia. These results shown that amphipods have higher ability to absorb heavy metals then mollusks. However, it should be confirmed by further studies. Copper and zinc had higher concentrations in studied groups of zoobenthos than lead and cadmium. In general, from the presented set of the benthic animals, amphipods preliminary can be nominated on the role of the most suitable bioindicators of the metal pollution. Of course, the final choice requires an additional research involving different types of hydrobionts as well as more heavy metals.

Our study is promising for development of the universal methods of bioindication, based on the macrozoobenthos.

Unprecedented deoxygenation of the coastal Archipelago Sea over the 20th century inferred from a 1500-year sediment record

Sami A. Jokinen[1, 3*], Joonas J. Virtasalo[2], Tom Jilbert[3], Jérôme Kaiser[4], Olaf Dellwig[4], Helge W. Arz[4], Jari Hänninen[5], Laura Arppe[3], Miia Collander[3], Timo Saarinen[1]

[1] *Department of Geography and Geology, University of Turku, 20014 Turku, Finland*
[2] *Marine Geology, Geological survey of Finland, P.O. Box 65 00014 Helsinki, Finland*
[3] *University of Helsinki, P.O. Box 65, 00014 Helsinki, Finland*
[4] *Leibniz Institute for Baltic Sea Research Warnemünde (IOW), Seestrasse 15, 18119 Rostock, Germany*
[5] *Archipelago Research Institute, University of Turku, 20014 Turku, Finland*
* sami.jokinen@utu.fi

Poster / Session 1

The human-induced spread of hypoxia due to eutrophication and global warming is a major environmental problem affecting coastal marine environments. A number of paleoenvironmental studies evidence that the central deep basins of the Baltic Sea, have undergone marked expansion of hypoxia during warm climatic phases of the Holocene. Yet, millennial-scale records of past shifts in bottom water oxygenation in shallow coastal areas of the Baltic Sea are sparse, irrespective of the significant role of these areas in nutrient cycling. Here we combine detailed sedimentological, ichnological, and geochemical analyses to elucidate changes in near-bottom water oxygenation in the coastal zone of the northern Baltic Sea over the past 1,500 years. Our reconstruction shows that although multicentennial climate variability has modulated bottom water conditions in the basin, whereby warm climatic phases are characterized by lower oxygen levels, the exacerbation of coastal hypoxia since the turn of the 20th century is unprecedented in the record, and has largely been forced by excess human-induced nutrient loading. Our results demonstrate that the eutrophication and associated deoxygenation began decades earlier than previously thought, highlighting the value of sedimentary archives when assessing reference conditions for coastal water quality. Despite the recent measures to alleviate eutrophication in the area, we observe no signs of improved bottom water oxygenation so far.

Assessment of ecological state (health) in water areas on the base of physiological state evaluation for local species of mollusks

S.V. Kholodkevich[1,2*], A.N. Sharov[1,3], T.V.Kuznetsova[1]

[1] *Scientific Research Center for Ecological Safety RAN, 18 Korpusnaya, St. Petersburg, 197110, Russia*
[2] *St. Petersburg State University, Institute of Earth Sciences, St. Petersburg, Russia, 5-7 Universitetskaya nab. St. Petersburg, 199034, Russia*
[3] *Papanin Institute for Biology of Inland Waters, Russian Academy of Sciences,Borok Settl. Yaroslavl obl., 152742 Russia*
kholodkevich@mail.ru

Poster / Session 1

The main objective of the work was to develop and testing previously proposed assessment method the state (health) of aquatic ecosystems based on testing of the functional state of bivalves. In the work we study HR in the several species of freshwater bivalves family Unionidae: *Anodonta anatina* (L., 1758), *A. cygnea* (L., 1758) and *Unio tumidus* (Philipsson, 1788) from the coastal areas of the eastern part of the Gulf of Finland and the Rybinsk Reservoir differing in level of anthropogenic load. Assessment of mollusk's functional state were carried out on the basis of their responses to the functional load - short (1 hour) change in water salinity up to 6 g/l by adding NaCl solution and subsequent replacement of the fresh water on the natural source. Mollusk's HR was recorded using original non-invasive fiber-optical method.

As a result of the research is proposed that T_{rec} less than 50 min as the reference value. Increasing of this period may be associated with the decline of mollusks physiological state due to environmental changes. Authors offered to share possible range T_{rec} into five classes of ecological status of water area: high (<50 min), good (50-70 min), moderate (71-100 min), poor (101-200 min) and bad (>200 min).

The Marine Cultural Heritage of the eastern Gulf of Finland in maritime spatial plans

Andrei Lappo, Larisa Danilova

Scientific and Research Institute of Maritime Spatial Planning Ermak NorthWest (ErmakNW) 191014 Russia, St. Petersburg, Liteiniy prospect 51A pom 14-N
l.danilova@ermaknw.ru

Poster / Session 1

Blue Growth initiative allows increase the socio-economic condition of the region and its attractiveness, while at the same time reducing the anthropogenic load on the marine and coastal areas due to a change in the composition of marine economic activity. The preservation and use of marine cultural heritage (MCH) is one of the main sectors of the Baltic Sea blue economy and should be considered in terms of its possible contribution to Blue Growth.

However, the Gulf of Finland countries do not fully utilize MCH potential both in national and transboundary management measures. There are no comprehensive national registers of monuments, especially underwater marine heritage (UCH), regional tourist routes have not been develop and issues of involving UCH objects in tourism have not been resolved. There is also no cross-border cooperation in the tourism use of MCH objects, and weak links between museums, public bodies and MCH experts on the international level. Pan Baltic project BalticRIM (Baltic Sea Region Integrated Maritime Cultural Heritage Management. 2017-2020, Interreg Baltic Region)[1] seeks to improve the situation.

The poster shows the locations of the main MCH objects in the marine and coastal areas of the eastern part of the Gulf of Finland within the national borders of the Russian Federation. The classification of UCH objects is made: warships killed in the battle of Vyborg (1790), warships killed in the World War II, other groups. Among the dead cargo (commercial) vessels, there are the wrecks of cargo vessels with a load of granite blocks for the construction of St. Petersburg. The zones of concentration of the UCH objects are mapped as well as other marine activity. The maps show overlapping and possible incompatibilities, capable of creating a threat to the UCH objects.

The results of the Meeting of the interagency commission on MCH of the Marine Board of the Russian Federation held in August 2019 also reflected as well as meeting recommendations. Proposals for integrating MCH of the eastern part of the Gulf of Finland into international tourism routs based on ongoing and upcoming cross-border projects are shown: • RUS-FIN case "Granite stones for St. Petersburg" (BalticRIM); • RUS-FIN Case Gogland-Kotka tourism route; • RUS-FIN (or Pan Baltic) case "GOF sea fortress"; • other possible tourist routes.

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[1] https://www.submariner-network.eu/projects/balticrim

The effect of Cd on the respiratory activity of *Limecola balthica* (Linnaeus, 1758) of the Koporye Bay of the Gulf of Finland

S.V.Sladkova[1,2*], N.N. Kamardin[1,2], A.N.Sharov[1]

[1]*Saint-Petersburg Scientific Research Center for Ecological Safety Russian Academy of Sciences, Korpusnaya 18, St Petersburg, 197110, Russia*
[2]*Saint-Petersburg State University, 5-7 Universitetskaya nab. St Petersburg, 199034, Russia*
*sladkova_sv1@mail.ru

Poster / Session 1

To study the effect of Cd on the physiological state of *Limecola balthica* (14.2 ± 1.3 mm), a solution of $CdCl_2$ at a concentration of 1.0 mg/l was used. The exposure was 2 and 6 days. The oxygen consumption rate of *L. balthica* was 0.18 ± 0.03 mgO_2/h/g w.w. at a temperature of 13.2 ± 0.2 °C. As a result of the 24-hour exposure of Cd to mollusks, abnormal opening of shells occurs in 90% of the animals. The siphons were expanded to the maximum value, but at the same time they remained mobile when touched. The toxic effect of Cd affected the decrease up to 0.08 ± 0.04 mg O_2/h/g in the rate of oxygen consumption compared to control mollusks (p <0.05). Their physiological state did not recover after moving these mollusks into clean water (wash-out). As a result of the 6 days exposure respiratory activity was 0.10 ± 0.03 mg O_2/h/g. 100% mortality of mollusks was after 10 days of exposure.

Thus, a relatively high concentration of Cd in water leads to a pathological opening of the shell cusps and a significant decrease in the rate of aerobic respiration in *L. balthica.*

Delta-horohalinicum in the Baltic Sea

Aladin N.V.[*], Gontar V.I., Plotnikov I.S., Smurov A.O., Zhakova L.V.

Zoological Institute RAS, Universiteskaya emb. 1, St.-Petersburg, Russia
* nikolai.aladin@zin.ru

Poster / Session 1

Water salinity is one of the major abiotic environmental factors influencing aquatic animals and plants. According to the concept of the relativity and plurality of barrier salinity zones: 1) these zones are relative; 2) there are several zones of barrier salinities and they are unequal by their importance. One of them is δ-horohalinicum (0.5–2‰) – the upper limit of stenohaline freshwater species distribution. Arvid Järvekülg from Estonia was the first scientist who in the 1970s clearly described this barrier salinity. It divides freshwater ecosystems from brackish water ones. Freshwater ecosystems in the Baltic Sea occupy mouths of inflowing rivers and also waste adjoining areas of shallow gulfs. Absence of pronounced high and low tides in the Baltic Sea contributes to stable existence of δ-horohalinicum. This barrier salinity is well distinguished in the eastern part of the Gulf of Finland and the Northern part of the Gulf of Bothnia. Water areas of Vistula and Curonian lagoons are divided by this barrier salinity into fresh and brackish water zones. In the South-Eastern area of the Gulf of Riga being constantly influenced by riverine water inflow δ- horohalinicum zone is well distinguished also. The area of freshwater zone is not large – only 6% of the total Baltic Sea area. This is only small areas where fresh riverine waters are mixing with brackish waters. Salinity here varies from fresh water up to 2‰. However many freshwater plants and animals are living only here and are never found in the Baltic Sea proper. In Baltic freshwater ecosystems there are about 1200 species of fishes, free-living invertebrates and plants (without bacteria, protozoans and tiny metazoans). These areas are shallow, maximal depth does not exceed several tens of meters. Restricting zone for freshwater organisms invading Baltic Sea is δ-horohalinicum.

Preliminary study on adaptive potential of indigenous bivalves from transboarder Narva River: searching reference site and reference values

Tatiana V. Kuznetsova, Sergey V. Kholodkevich, E.V.Matveeva

[1] Saint-Petersburg Scientific Research Center for Ecological Safety Russian Academy of Sciences
*kuznetsova_tv@bk.ru

Poster / Session 2

The study is concerned to the experience of application of proposed approach to assess biological effects of environmental chemical stress through evaluation of adaptive potential of indigenous bivalves (Kholodkevich et al, 2011; 2017). The aim was to make an attempt to determine physiological status of mussels from transboarder area to search reference site and reference values for further comparative assessments of differently contaminated sites in the Eastern Gulf of Finland In the proposed procedure of testing mussel's adaptive capacities, methodology that address those parameters of organism's adaptivity as the time of heart rate (HR) recovery (T_{rec}, min) and HR variability after loading (changes in salinity of medium up to 6 g/l from fresh water) was used. *Unio pictorum* of 3-years old was collected from the Narva River (3 km downstream from the settlement), transported to the laboratory with 12 l of ambient water and tested with salinity load. It was found that mean background HR for the group of mussels (n=6) was 18,6±2,8 beats/mins and mean T_{rec} of tested mussels was 46±18 mins. Taking into account our previous study we could conclude that the Narva River could be attributed as a reference site and mussels from that site had a good physiological status as they rapidly restore their HR after disturbances. Method used is additional and has to be combined with other biomarkers for assessing environmental quality. This study supported by the Estonia-Russia Cross Border Cooperation Programme 2014-2020, Project ER90 "Hazardous chemicals in the eastern Gulf of Finland – concentrations and impact assessment (HAZLESS)".

Highly dynamic hydrographic conditions at a submarine channel in the western Gulf of Finland

Joonas Virtasalo [1*], Harri Kankaanpää [2], Okko Outinen [2], Satu Huurtomaa [1], Hedi Kanarik [3], Laura Tuomi [3], Jouko Nuorteva [4]

[1] *Geological Survey of Finland (GTK), Vuorimiehentie 5, 02151 Espoo, Finland*
[2] *Marine Research Centre, Finnish Environment Institute (SYKE), Ultramariinikuja 4, 00430 Helsinki, Finland*
[3] *Finnish Meteorological Institute, Erik Palménin aukio 1, 00560 Helsinki, Finland*
[4] *Finnish Naval Academy, Research Centre, PO Box 5, FI-00191 Helsinki, Finland*
[*] *joonas.virtasalo@gtk.fi*

Poster / Session 2

We report first results from an integrated hydrophysical, hydrochemical and sediment sampling campaign, which was carried out over a large submarine channel in the western Gulf of Finland between 1st and 5th September 2019, on the r/v Aranda of the Finnish Environment Institute (SYKE). We visited 15 sites in the channel and along the margins of the channel, covering on area of ca. 2 km[2]. The sites were selected on the basis of multibeam and sub-bottom profiler pre-site surveys, previously run onboard the r/v Geomari of the Geological Survey of Finland (GTK). The water column measurements were carried out using an instrumented bottom lander, recording O_2, H_2S, pH, turbidity and suspension grain-size distribution, along with the usual salinity and temperature. In addition, currents were measured from the whole water column with an ADCP, and near the bottom with two single point current meters from April until August. The collected sediment cores were split and studied for sediment texture onboard, and will later be analysed for Cs activity, organic content and grain size distribution. The overall purpose of the campaign was to improve our understanding of stratification, water exchange and sedimentation dynamics in and along large submarine channels in the northern Baltic Sea, which have so far been less studied.

The measured parameters show a significant redoxcline at the water depth of 71–78 m, which is slightly above the level of surrounding seafloor at ca. 83 m. This stratification is typical for the Baltic Sea. At the redoxcline, O_2 concentration drops to near-zero values, whereas H_2S concentration rapidly increases, followed by a gentle increase and homogenization toward the channel bottom at 100–120 m water depth. A significant turbidity peak with the thickness of a few metres underlies the redoxcline. The redoxcline depth, anoxic bottom-layer thickness and H_2S concentration vary during the five-day measurement campaign. Minute-scale variability is observed in O_2, H_2S and pH at the redoxcline. ADCP data show large variation in the bottom layer currents. Most of the time, current speed at ca. 10 m above the channel floor is <10 cm/s, but there are short events with current speeds up to 30–40 cm/s.

Birds and mammals as an alien species in the Gulf of Finland: problems and outlooks

Bublichenko J.N. [1]*, Bublichenko A.G.[2]

[1] - *Saint-Petersburg Research Centre of Russian Academy of sciences, Universitetskaya nab., 5, Saint-Petersburg, Russia*
[2] - *Zoological institute of Russian Academy of sciences Universitetskaya nab., 1, Saint-Petersburg, Russia*
julandb@mail.ru

During the past decades, 5 new bird species have appeared in the Russian part of the GOF. Also, 5 mammal species were introduced or settled by themselves in the Leningrad Region (LR) in the mid-20th century and became a part of coastal ecosystems. The observations were carried out on the mainland coast and islands in the Russian sector of the Gulf of Finland in 1994-2019.

Phalacrocorax carbo is the most numerous and dominant seabird. Species first appeared near the Russian coast in 1991-1994 (the Kurgalsky pen.). The first two breeding colonies were found on rocky islands (the Dolgy Reef and the Bolshoy Fiskar) in 1994. By 2010-2015, more than 9500 breeding pairs were registered in the GOF Russian part (Bublichenko, 2016;2017). In 2018-2019, we observed that the population tended to decline: colonies on Bolshoy Fiskar, Hangeloda and Rondo isl. diminished, the colony on the Rodsher isl. disappeared. Possibly, the population have exceeded the capacity of nesting sites and now it will dwindle gradually. Among the GOF sea birds, the Great Cormorant impacts its nesting habitats most aggressively. *Casmerodius albus* expands its habitat northwards rapidly. This species was first encountered in the LR in 2011-2014; since 2017, single birds are recorded periodically in autumn. On 23.05.2019, two pairs were registered in the Kurgalsky pen. and the Moshchny isl. throughout June, indicating breeding attempt possibility. *Uria aalge* was first found in the Russian part of the GOF on the Severny Virgin isl.(9 nests (Vysotsky et al., 2010)); 8-10 pairs were registered on the Rodsher isl. during aerial surveys in May 2018, and small flocks - on the Bolshoy Fiskar and Nerva isl. In 2019 we found 98 nests on the Severny Virgin isl. *Alca torda* was first registered on the Kurgalsky Reef in early 1990s. In 1995, breeding was registered on the Bolshoy Fiskar and the Virgins isl. (14 and 66 nests, respectively). In May 2018, birds were recorded during aerial surveys on the Bolshoy Fiskar (10-12 pairs) and on the Rodsher isl. (up to 20 pairs). On 12.06.2019, we registered 2 large colonies: about 150 nests (the Rodsher isl.) and 35-40 nests (the Severny Virgin isl.). *Recurvirostra avosetta* was first recorded during a springtime fly-by near the Kurgalsky pen. in 2016 (Kouzov, Loseva, 2016), and on 07.06.2019 two nests were found on the Kurgolovskaya Reima isl. (Brylyakov et al., 2019); this is the first case of their breeding in the LR. Besides, since 1990s a number of species (such as *Branta leucopsis, Anser anser*, *Somateria mollissima* and *Tadorna tadorna*) that were earlier encountered in the GOF only during migration period began to breed on the islands as well and nowadays their population grows gradually.

All alien mammal species on the GOF are invaders that were introduced by man or appeared in the region because of human activity. *Ondatra zibethicus* introduction began in Russia in 1938-1945, and became a numerous species by the early 1960s. It adapts to habitats at any water bodies, including brackish ones. Nowadays it is encountered in all suitable habitats of the GOF mainland, as well as on the Beryozovye isl.; however, the species population is small at present there. Nevertheless, the Muskrat feeding requirements result in removal of a significant part of the offshore phytomass, deterioration of the protective and reproductive functions of the environment and an increase in the abrasion process. It is deleterious to bivalved mollusks that are preferred food items of animal origin. *Rattus norvegicus* began to settle in the European port cities as seaborne trade developed (in XV - XVI cent.), then migrated with flows of goods. At present, it's population is relatively high in the LR. Brown rats choose human buildings as their main habitat everywhere, but in summertime, they migrate to natural habitats where they can inflict a significant damage to the local fauna because of their eurybiontity and euryfagia. *Nyctereutes procyonoides* was introduced in the LR in 1934-1955, and nowadays its population is growing gradually. E.g., in spring 2019 about 20 animals were registered on a scrap heap near the Kurgalsky pen. coast. Species is frequently encountered on the Soikinsky and Kiperort pen. coastline, they are permanent inhabitants of the Beryozovye and Moshchny isl. As the Raccoon Dog population increases, the viper and number of bird species populations decreases sharply (Fokin, Airapetyants, 2005). They eated away up to 90% of waterfowl nests (on the Kurgolovskaya Reima in 2000s; our data). *Neovison vison* introduction started in 1928 in Russia, but species began to settle in the LR in 1950-1970s. Successful colonization was facilitated greatly by permanent inflow of animals from Scandinavia and Karelia, as well as from local fur farms. As a result, American Mink has almost completely replaced the indigenous species *Mustela lutreola* in the LR. They settle both on the GOF mainland coast and many islands. In some areas American minks cause the Muskrat population to decrease significantly; when they settle near small colonies of terns, they destroy them completely. *Cervus nippon* was introduced outside their natural habitats as a game species in Russia in the early 20th century. At present, two herds (30-35 animals in total) survive on the Kurgalsky pen.; in summertime they often feed on the coast, eating up reeds.

During the recent decades, the quantity and species composition of the Baltic Sea region fauna is changing noticeably because of climate change, anthropogenic habitats transformation, intensive building-up of the shores, an increase in wildlife disturbance, deliberate or accidental introduction of alien species, etc. Which of those causes determines appearance and expansion of new species, or it's a complex of reasons? These questions must be settled by

subsequent comprehensive ecological monitoring of aquatic and semi-aquatic ecosystems. The 2019 surveys were carried out with the financial support of Estonian-Russian grant ER55.

Alisma wahlenbergii in the Gulf of Finland: distribution and status

Elena Glazkova

Komarov Botanical Institute of Russian Academy of Sciences, Prof. Popov str.2 197376, Saint-Petersburg, Russia
eglazkova@hotmail.com

Poster / Session 2

Baltic water-plantain (*Alisma wahlenbergii*) is a rare aquatic plant that is endemic to the Baltic Sea area (Jonsell, 1988). It belongs to globally threatened plants (IUCN 2019) and is listed as a priority species in the EU Habitats Directive. *A. wahlenbergii* is included in Annex I to the Bern Convention and HELCOM Red List (2013), and is red-listed and protected in Sweden, Finland and Russia. The species occurs in three regions of the Baltic Sea: Lake Mälaren (Sweden), the Gulf of Bothnia (Sweden and Finland) and the Gulf of Finland (Russia). On the Finnish side of the Gulf of Finland *A. wahlenbergii* is regarded extinct (Kotiranya et al. 1988).

Baltic water-plantain current distribution and population status in Russia has been recently studied by the author. In 2004–2019 the field investigations were carried out in the islands and coastal areas of the Gulf of Finland. The species was recorded from 8 islands of the Berezovye Islands Archipelago (Glazkova&Tzvelev 2007, Glazkova 2017), 8 islands in Vyborg Bay (Glazkova 2012) and Kotlin Island in Neva Bay (Glazkova&Tzvelev 2006, Glazkova 2018). In 2018-2019 during the field investigations within the Finnish-Russian project "Improving the nature protection on the Finnish Gulf valuable coastal areas" financed by the Baltic Sea Conservation Foundation, 18 new occurrences of *A. wahlenbergii* were found between Kyrönniemi Cape and Ozerki (Glazkova et al. 2019), in Baltiyskoye vicinity (near Yermilovo), between Dalnyay and Baltiyets Bays, as well as in the area SE of Ozerki. The number of individuals in the most of locations is less than several hundred, but at the largest site (SE of Ozerki) ca. 5000 individuals were recorded. It is the largest population of *A. wahlenbergii* in the Gulf of Finland. However, the species has disappeared from most of its locations in Neva Bay, where it was formerly abundant. Only few individuals have been recently observed on Kotlin Island (Glazkova 2018).

The species presumably disappeared from Portovaya Bay, where it was recorded in 1990s (Korelyakova 1997). The main causes of decline of Baltic water-plantain are pollution, eutrophication, increase of reed beds, and construction activities.

A conservation plan for *A. wahlenbergii* must be realized in Russia. The growing sites of the species should be protected from urbanization, construction activities and other human disturbance; control of water pollution is urgently recommended. The data on the distribution and population status of Baltic water-plantain will be provided for the BaltiCheck project to upgrade the Helcom Checklist of Baltic Sea Species.

Preliminary study on adaptive potential of indigenous bivalves from transboarder Narva River: searching reference site and reference values

Tatiana V. Kuznetsova, Sergey V. Kholodkevich, E.V.Matveeva

[1] *Saint-Petersburg Scientific Research Center for Ecological Safety Russian Academy of Sciences*
*kuznetsova_tv@bk.ru

Poster / Session 2

The study is concerned to the experience of application of proposed approach to assess biological effects of environmental chemical stress through evaluation of adaptive potential of indigenous bivalves (Kholodkevich et al, 2011; 2017). The aim was to make an attempt to determine physiological status of mussels from transboarder area to search reference site and reference values for further comparative assessments of differently contaminated sites in the Eastern Gulf of Finland In the proposed procedure of testing mussel's adaptive capacities, methodology that address those parameters of organism's adaptivity as the time of heart rate (HR) recovery ($T_{rec,}$ min) and HR variability after loading (changes in salinity of medium up to 6 g/l from fresh water) was used. *Unio pictorum* of 3-years old was collected from the Narva River (3 km downstream from the settlement), transported to the laboratory with 12 l of ambient water and tested with salinity load. It was found that mean background HR for the group of mussels (n=6) was 18,6±2,8 beats/mins and mean T_{rec} of tested mussels was 46±18 mins. Taking into account our previous study we could conclude that the Narva River could be attributed as a reference site and mussels from that site had a good physiological status as they rapidly restore their HR after disturbances. Method used is additional and has to be combined with other biomarkers for assessing environmental quality. This study supported by the Estonia-Russia Cross Border Cooperation Programme 2014-2020, Project ER90 "Hazardous chemicals in the eastern Gulf of Finland – concentrations and impact assessment (HAZLESS)".

Highly dynamic hydrographic conditions at a submarine channel in the western Gulf of Finland

Joonas Virtasalo [1*], Harri Kankaanpää [2], Okko Outinen [2], Satu Huurtomaa [1], Hedi Kanarik [3], Laura Tuomi [3], Jouko Nuorteva [4]

[1] *Geological Survey of Finland (GTK), Vuorimiehentie 5, 02151 Espoo, Finland*
[2] *Marine Research Centre, Finnish Environment Institute (SYKE), Ultramariinikuja 4, 00430 Helsinki, Finland*
[3] *Finnish Meteorological Institute, Erik Palménin aukio 1, 00560 Helsinki, Finland*
[4] *Finnish Naval Academy, Research Centre, PO Box 5, FI-00191 Helsinki, Finland*
[*] *joonas.virtasalo@gtk.fi*

Poster / Session 2

We report first results from an integrated hydrophysical, hydrochemical and sediment sampling campaign, which was carried out over a large submarine channel in the western Gulf of Finland between 1st and 5th September 2019, on the r/v Aranda of the Finnish Environment Institute (SYKE). We visited 15 sites in the channel and along the margins of the channel, covering on area of ca. 2 km[2]. The sites were selected on the basis of multibeam and sub-bottom profiler pre-site surveys, previously run onboard the r/v Geomari of the Geological Survey of Finland (GTK). The water column measurements were carried out using an instrumented bottom lander, recording O_2, H_2S, pH, turbidity and suspension grain-size distribution, along with the usual salinity and temperature. In addition, currents were measured from the whole water column with an ADCP, and near the bottom with two single point current meters from April until August. The collected sediment cores were split and studied for sediment texture onboard, and will later be analysed for Cs activity, organic content and grain size distribution. The overall purpose of the campaign was to improve our understanding of stratification, water exchange and sedimentation dynamics in and along large submarine channels in the northern Baltic Sea, which have so far been less studied.

The measured parameters show a significant redoxcline at the water depth of 71–78 m, which is slightly above the level of surrounding seafloor at ca. 83 m. This stratification is typical for the Baltic Sea. At the redoxcline, O_2 concentration drops to near-zero values, whereas H_2S concentration rapidly increases, followed by a gentle increase and homogenization toward the channel bottom at 100–120 m water depth. A significant turbidity peak with the thickness of a few metres underlies the redoxcline. The redoxcline depth, anoxic bottom-layer thickness and H_2S concentration vary during the five-day measurement campaign. Minute-scale variability is observed in O_2, H_2S and pH at the redoxcline. ADCP data show large variation in the bottom layer currents. Most of the time, current speed at ca. 10 m above the channel floor is <10 cm/s, but there are short events with current speeds up to 30–40 cm/s.

Birds and mammals as an alien species in the Gulf of Finland: problems and outlooks

Bublichenko J.N. [1]*, Bublichenko A.G.[2]

[1] - *Saint-Petersburg Research Centre of Russian Academy of sciences, Universitetskaya nab., 5, Saint-Petersburg, Russia*
[2] - *Zoological institute of Russian Academy of sciences Universitetskaya nab., 1, Saint-Petersburg, Russia*
julandb@mail.ru

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During the past decades, 5 new bird species have appeared in the Russian part of the GOF. Also, 5 mammal species were introduced or settled by themselves in the Leningrad Region (LR) in the mid-20th century and became a part of coastal ecosystems. The observations were carried out on the mainland coast and islands in the Russian sector of the Gulf of Finland in 1994-2019.

Phalacrocorax carbo is the most numerous and dominant seabird. Species first appeared near the Russian coast in 1991-1994 (the Kurgalsky pen.). The first two breeding colonies were found on rocky islands (the Dolgy Reef and the Bolshoy Fiskar) in 1994. By 2010-2015, more than 9500 breeding pairs were registered in the GOF Russian part (Bublichenko, 2016;2017). In 2018-2019, we observed that the population tended to decline: colonies on Bolshoy Fiskar, Hangeloda and Rondo isl. diminished, the colony on the Rodsher isl. disappeared. Possibly, the population have exceeded the capacity of nesting sites and now it will dwindle gradually. Among the GOF sea birds, the Great Cormorant impacts its nesting habitats most aggressively. *Casmerodius albus* expands its habitat northwards rapidly. This species was first encountered in the LR in 2011-2014; since 2017, single birds are recorded periodically in autumn. On 23.05.2019, two pairs were registered in the Kurgalsky pen. and the Moshchny isl. throughout June, indicating breeding attempt possibility. *Uria aalge* was first found in the Russian part of the GOF on the Severny Virgin isl.(9 nests (Vysotsky et al., 2010)); 8-10 pairs were registered on the Rodsher isl. during aerial surveys in May 2018, and small flocks - on the Bolshoy Fiskar and Nerva isl. In 2019 we found 98 nests on the Severny Virgin isl. *Alca torda* was first registered on the Kurgalsky Reef in early 1990s. In 1995, breeding was registered on the Bolshoy Fiskar and the Virgins isl. (14 and 66 nests, respectively). In May 2018, birds were recorded during aerial surveys on the Bolshoy Fiskar (10-12 pairs) and on the Rodsher isl. (up to 20 pairs). On 12.06.2019, we registered 2 large colonies: about 150 nests (the Rodsher isl.) and 35-40 nests (the Severny Virgin isl.). *Recurvirostra avosetta* was first recorded during a springtime fly-by near the Kurgalsky pen. in 2016 (Kouzov, Loseva, 2016), and on 07.06.2019 two nests were found on the Kurgolovskaya Reima isl. (Brylyakov et al., 2019); this is the first case of their breeding in the LR. Besides, since 1990s a number of species (such as *Branta leucopsis, Anser anser*, *Somateria mollissima* and *Tadorna tadorna*) that were earlier encountered in the GOF only during migration period began to breed on the islands as well and nowadays their population grows gradually.

All alien mammal species on the GOF are invaders that were introduced by man or appeared in the region because of human activity. *Ondatra zibethicus* introduction began in Russia in 1938-1945, and became a numerous species by the early 1960s. It adapts to habitats at any water bodies, including brackish ones. Nowadays it is encountered in all suitable habitats of the GOF mainland, as well as on the Beryozovye isl.; however, the species population is small at present there. Nevertheless, the Muskrat feeding requirements result in removal of a significant part of the offshore phytomass, deterioration of the protective and reproductive functions of the environment and an increase in the abrasion process. It is deleterious to bivalved mollusks that are preferred food items of animal origin. *Rattus norvegicus* began to settle in the European port cities as seaborne trade developed (in XV - XVI cent.), then migrated with flows of goods. At present, it's population is relatively high in the LR. Brown rats choose human buildings as their main habitat everywhere, but in summertime, they migrate to natural habitats where they can inflict a significant damage to the local fauna because of their eurybiontity and euryfagia. *Nyctereutes procyonoides* was introduced in the LR in 1934-1955, and nowadays its population is growing gradually. E.g., in spring 2019 about 20 animals were registered on a scrap heap near the Kurgalsky pen. coast. Species is frequently encountered on the Soikinsky and Kiperort pen. coastline, they are permanent inhabitants of the Beryozovye and Moshchny isl. As the Raccoon Dog population increases, the viper and number of bird species populations decreases sharply (Fokin, Airapetyants, 2005). They eated away up to 90% of waterfowl nests (on the Kurgolovskaya Reima in 2000s; our data). *Neovison vison* introduction started in 1928 in Russia, but species began to settle in the LR in 1950-1970s. Successful colonization was facilitated greatly by permanent inflow of animals from Scandinavia and Karelia, as well as from local fur farms. As a result, American Mink has almost completely replaced the indigenous species *Mustela lutreola* in the LR. They settle both on the GOF mainland coast and many islands. In some areas American minks cause the Muskrat population to decrease significantly; when they settle near small colonies of terns, they destroy them completely. *Cervus nippon* was introduced outside their natural habitats as a game species in Russia in the early 20th century. At present, two herds (30-35 animals in total) survive on the Kurgalsky pen.; in summertime they often feed on the coast, eating up reeds.

During the recent decades, the quantity and species composition of the Baltic Sea region fauna is changing noticeably because of climate change, anthropogenic habitats transformation, intensive building-up of the shores, an increase in wildlife disturbance, deliberate or accidental introduction of alien species, etc. Which of those causes determines appearance and expansion of new species, or it's a complex of reasons? These questions must be settled by

subsequent comprehensive ecological monitoring of aquatic and semi-aquatic ecosystems. The 2019 surveys were carried out with the financial support of Estonian-Russian grant ER55.

Alisma wahlenbergii in the Gulf of Finland: distribution and status

Elena Glazkova

Komarov Botanical Institute of Russian Academy of Sciences, Prof. Popov str.2 197376, Saint-Petersburg, Russia
eglazkova@hotmail.com

Poster / Session 2

Baltic water-plantain (*Alisma wahlenbergii*) is a rare aquatic plant that is endemic to the Baltic Sea area (Jonsell, 1988). It belongs to globally threatened plants (IUCN 2019) and is listed as a priority species in the EU Habitats Directive. *A. wahlenbergii* is included in Annex I to the Bern Convention and HELCOM Red List (2013), and is red-listed and protected in Sweden, Finland and Russia. The species occurs in three regions of the Baltic Sea: Lake Mälaren (Sweden), the Gulf of Bothnia (Sweden and Finland) and the Gulf of Finland (Russia). On the Finnish side of the Gulf of Finland *A. wahlenbergii* is regarded extinct (Kotiranya et al. 1988).

Baltic water-plantain current distribution and population status in Russia has been recently studied by the author. In 2004–2019 the field investigations were carried out in the islands and coastal areas of the Gulf of Finland. The species was recorded from 8 islands of the Berezovye Islands Archipelago (Glazkova&Tzvelev 2007, Glazkova 2017), 8 islands in Vyborg Bay (Glazkova 2012) and Kotlin Island in Neva Bay (Glazkova&Tzvelev 2006, Glazkova 2018). In 2018-2019 during the field investigations within the Finnish-Russian project "Improving the nature protection on the Finnish Gulf valuable coastal areas" financed by the Baltic Sea Conservation Foundation, 18 new occurrences of *A. wahlenbergii* were found between Kyrönniemi Cape and Ozerki (Glazkova et al. 2019), in Baltiyskoye vicinity (near Yermilovo), between Dalnyay and Baltiyets Bays, as well as in the area SE of Ozerki. The number of individuals in the most of locations is less than several hundred, but at the largest site (SE of Ozerki) ca. 5000 individuals were recorded. It is the largest population of *A. wahlenbergii* in the Gulf of Finland. However, the species has disappeared from most of its locations in Neva Bay, where it was formerly abundant. Only few individuals have been recently observed on Kotlin Island (Glazkova 2018).

The species presumably disappeared from Portovaya Bay, where it was recorded in 1990s (Korelyakova 1997). The main causes of decline of Baltic water-plantain are pollution, eutrophication, increase of reed beds, and construction activities.

A conservation plan for *A. wahlenbergii* must be realized in Russia. The growing sites of the species should be protected from urbanization, construction activities and other human disturbance; control of water pollution is urgently recommended. The data on the distribution and population status of Baltic water-plantain will be provided for the BaltiCheck project to upgrade the Helcom Checklist of Baltic Sea Species.

Simulators for Improving Cross-Border Oil Spill Response in Extreme Conditions

Dmitrij V. Nikushchenko

Saint – Petesburg State Marine Technical University, 190121, Saint – Petesburg, Locmanskaya 3
science@smtu.ru

Poster / Session 2

Goals of SMTU works under Project SIMREC:

1. Development of the mathematical model for the side force and yawing moment evaluation and the safe sailing recommendations while navigation within the filled by grated ice channel (Joint activity 1).
2. Development of recommendations for safe regimes sailing behind icebreaker for navigators to avoid collisions while the icebreaker maneuvering development (Joint activity 1).
3. Development of the methods for the oil spreading forecast while accidental spillage within the navigable ice channel (Joint activity 5).
4. Investigations and looking for possibilities for the oil pollution under an ice cover detection (Joint activity 5).

First year activities: Analysis of the known data about interaction of the ice ships while navigation within the filled by grated ice channel including

- Features of the interaction of the ship hull with grated ice when moving in the channel.
- Effects of grated ice on the ice resistance of an icebreaker and ice ship while navigation within ice channel.
- Interaction of the propeller of the icebreakers and ice ships with the grated ice within channel.
- Analysis of the known data about sizes and concentration of the ice floes within navigable ice channels in dependence on the ice cover thickness and its effective life.
- Looking for and analysis of the known models applicability for the oil spreading forecast within the ice channel filled by small ice floes and with grated ice.
- Formulation of the analytical and experimental studies problems to develop model of oil spreading within ice channel filled with ice floes of various sizes and concentration.

  Lab experimental investigations of the capabilities and effectiveness of the Infrared imager and GeoRadar for the oil pollution under ice cover detection including:

- Development methods for the ice floe modeling.
- Development methods for under ice floe oil film creation.
- Working of methods for the Infrared Imager and GeoRadar application for the oil film under ice floe detection.
  As a result:
- Formulation of the analytical studies problems and approaches.
- Formulation of the analytical studies problems and approaches.
- Availability for the field experiments at next winters.

Circulation patterns in the Gulf of Finland from daily to seasonal timescales

Antti Westerlund[1*]

[1] *Finnish Meteorological Institute, Helsinki, Finland*
* antti.westerlund@fmi.fi

Poster / Session 3

Circulation dynamics were investigated for the Gulf of Finland (GoF) with a high-resolution configuration of the NEMO model.

The cyclonic circulation pattern visible in earlier studies was not seen in the GoF in the overall means calculated from the model results for the studied periods 2007–2013 and 2012–2014. Circulation patterns in the GoF were further investigated with the self-organizing map (SOM) algorithm. SOM analysis of currents in the GoF revealed that they are highly variable and complex. There was significant inter-annual and intra-annual variability in the circulation patterns. A connection between wind forcing and the characteristic patterns from the SOM analysis was found.

Analysis emphasized the estuary-like nature of the GoF. Small changes to wind direction distribution can have a significant effect on the long-term circulation patterns. The NEMO model proved to be a suitable tool for the studies of circulation in the area. Its quality seems comparable to other models commonly used in the GoF.

The GoF is still a challenging environment for circulation modelling. Salinity gradients in the GoF are still not reproduced in a satisfactory manner by the models. The need for accurate model inputs, especially wind forcing, was demonstrated. The value of observations (especially the better spatial coverage of current measurements) was once again emphasized.

Feeding interactions between three-spined stickleback (*Gasterosteus aculeatus* L.) and nine-spined stickleback (*Pungitius pungitius* L.) in the eastern part of Gulf of Finland

Smirnova K.A.[1], Demchuk A.S.[1,2]*, Kvitkovskaya V.A.[1], Ivanov M.V.[1], Ivanova T.S.[1], Lajus D.L.[1]

[1] - *Saint Petersburg State University, 7/9 Universitetskaya Emb., 199034, Saint Petersburg, Russia*
[2] - *Zoological Institute of the Russian Academy of Sciences, 1 Universitetskaya Emb., 199034, Saint Petersburg, Russia*
* anndemch@gmail.com

Poster / Session 3

Threespine stickleback (*Gasterosteus aculeatus* L.) is a mass fish of the Baltic Sea, with abundance rapidly grew during the last few decades, resulting in change of abundance of other species in the ecosystem. Despite ecological importance, their biology is relatively poorly studied. Of particular interest is their massive inshore spawning migration when threespine stickleabck, as shown in a number of studies, actively prey on eggs and juveniles of other fish, including their own species. Information on feeding patterns of threespine stickleback and their possible competition with other species allows better understand of drivers changing their abundance. Here, we study diet overlap of threespine stickleback with ninespine stickleback (*Pungitius pungitius* L.), another common ecologically similar species.

Methods: The sampling was done in the eastern Gulf of Finland, from May to the end of June 2019, during the spawning season of the threespine stickleback. Of all samples, 5 contained sticklebacks. The fish were preserved in 4% formalin, then the stomachs were extracted and their contents were identified. For the niche overlap quantification we used Pianka, Levins and Horn indices, which are all based on object occurrence in the diet.

Results: Threespine stickleback diet consisted of 33 types of organisms, and ninespine one of 21. All species encountered in ninespine stickleback stomachs also occur in threespine stickleback. Chironominae (pupae and larvae), Ostracoda gen. sp., *Eurytemora spp*., and threespine stickleback eggs were dominating food items.

Assessing the feeding niche width of both species showed that the value for threespine stickleback was about 3,5 times larger than for ninespine stickleback. The Pianka, Levins and Horn indices values for the entire sampling area of 5 sites were 0,8220, 0,8227 and 0,8220, respectively, thus showing considerable similarity, because far exceed commonly accepted biologically relevant value equal to 0,6. The highest value found in a sample near the Vyborg Bay was 0,9560, lowest values ranging from 0,4216 to 0,5883 which are considered below the biologically relevant level, were observed in the Vyborg Bay itself.

Conclusion: Our analyses shows a significant overlap of feeding niches of three- and ninespine stickleback during spawning period of the latter, when they massively appear inshore. Thus abundance of ninespine stickleback may be important factor influencing availability of food for threespine stickleback and therefore may affect their population dynamics through strong food competition. At the same time, wider feeding niche of threespine stickleback probably allows them higher flexible in using feeding resources.and the arrival of three-spined stickleback can exceptionally increase the effects of competition for habitat resource, with potential negative effects on nine-spined stickleback.

Numerical simulation of ship operation in ice

Fang Li[1*], Pentti Kujala[1]

[1] *Aalto University, School of Engineering, Department of Mechanical Engineering, Marine Technology, P.O. Box 14100, Aalto, FI-00076, Finland*
* fang.li@aalto.fi

Poster / Session 3

Navigation of modern ships through ice-covered water has been present for over one century in the Gulf of Finland. The design and operation of ice-going ships, however, are still largely dependent on empirical approaches. The development of computational power and deeper understanding on ice mechanics enable the development of numerical approach. Numerical approach has the advantage of high-fidelity, potentially leading to higher accuracy, and high flexibility, allowing analysis of different ship operation modes. As the result, numerical approach can promotes innovative ship design and improve safety level during multi-ship operations. The presented doctoral thesis work deals with fundamental issues of numerical simulation of ship performance in ice, including methodology, framework and an example model. The model is capable of simulating a ship going through level ice in both straight course and in turning. All the work is supported by full-scale ship measurement, providing solid foundation to actual modelling.

New data about geochemistry and sedimentation processes of the eastern Gulf of Finland during Holocene based on high resolution sediment core study

Prischepenko D.[1]*, Sergeev A.[1], Grigoriev A.[1], Ryabchuk D.[1], Zhamoida V.[1], Budanov L.[1], Krek A.[2]

[1] *A.P.Karpinsky Russian Geological Research Institute (VSEGEI), 74, Sredny pr., St.Petersburg, Russia, 199106;*
[2] *Shirshov Institute of Oceanology, Russian Academy of Sciences (IO RAS), 36, Nahimovskiy prospekt, Moscow, Russia, 117997*
diana.pr@inbox.ru

Poster / Session 3

In frame of joint cruise of Institute of Oceanology RAS (ABIO RAS) and A.P. Karpinsky Russian Geological Research Institute (VSEGEI) on board of R/V "Academician Nickolay Strakhov", bottom sediment core 17-GG-1T (480 cm long) was collected from the underwater slope of the Mordvinov bank in the northern part of sedimentation basin, located to the east of Gogland Island. According to visual lithological description this is a section of Late Pleistocene - Holocene sediments accumulated from the late stage of Baltic Ice Lake to postLittorina sea stage.

For this core, a complex of high-resolution sedimentological studies was performed in VSEGEI laboratories, including grain-size analysis, using a "Microsizer 201A" laser diffractometer (subsampling every 1 cm). Chemical analysis was carried out using X-ray scanning crystal-diffractive spectrometer (SPEKTROSKAN-MAX-G) (measurements of Sr, Pb, As, Zn, Cu, Ni, Co, Fe_2O_3, TiO_2, MnO, V, Cr, Br; subsampling every 3 cm). Besides the distribution of chemical content in the core was studied using a handheld XRF analyzer Innov-X, OLYMPUS (measurements of Al, Si, P, S, Cl, K, Ca, Mn, Fe, As, Y, Zr, Nb, Ba, Pb, Bi). The measurements were carried out along the surface of bisected core every 2 cm (sediment moisture is close to natural values). The obtained results were processed together with the results of grain-size analysis using "Statistica" software. Distribution of Br along the core was used for calculation of palaeosalinity, according to original method developed by A.G.Grigoryev (Grigoriev et al., 2011). For five samples AMS ^{14}C dating has been carried out in Laboratory of Moscow University (IGAN$_{AMS}$ 7160-7164). Radiocarbon data were converted into calibrated ages using CALIB REV7.1.0 (www.calib.qub.ac.uk/calib) and the IntCal13 and Marine13 Radiocarbon calibration curves 0-500000 years calBP (Radiocarbon 55(4)).

Integrated statistical analyses of chemical and grain-size data shows that all distinguished lithostratigraphic units was characterized by specific litho-geochemical relations, which is probably due to changing mechanisms of sedimentary input into basins. Sediments of Baltic Ice Lake (BIL) represent association of most studied chemical elements (Pb, Ni, Co, Fe, Ti, Mn, V, Cr, Br) with clays. Ancylus Lake sediment's relations between chemical content and grain-size fractions show perceptible changes: wide range of elements (Pb, Ni, V, Cr, Fe, Zn) in this case is connected with sand fraction, and group of Br, As, Co, Sr, Ti, Mn - with silt fraction. Chemical characteristics of "blue clays" sediments are indifferent to the grain-size distribution in this layer. Deposits of the Littorina Sea demonstrate the same trend as for BIL sediments: most of studied elements (except Cu, Pb, Br) are associated with fine fraction of clays.

Changes in sedimentation conditions were also considered, based on variability of chemical ratios distribution in the core (geochemical indicators - Sr/Ba, Fe/Mn, Ti/Mn, Ti/Zr, etc). The most obvious graphic bends characterize sharp changes in palaeoenvironment near the upper boundary of Ancylus Lake sediments. The distribution of calculated salinity corresponds to brackish and freshwater basins; calculated salinity increases in the "blue clay" sediments, allowing to consider this layer as Mastogloya sea deposits. According to results of grain-size analyses and AMS dating, the upper part of this sediment layer was formed about 9.4 ka BP. The abrupt changes in grain-size distribution of sediments revealed (increasing of sand and silt particle content) marks a regressive phase (an erosion hiatus) by 8.4 ka BP, when Littorina Sea sediments started to deposit. Between 8.4 and 6.4 ka BP sedimentation rate was 0.22 mm/year, after that a second hiatus marked by sandy layer is observed. Sedimentation started again 1.3 ka BP. All sedimentation changes are accompanied by variations in concentrations of most studied elements.

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