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TABLE OF CONTENTS

INVITED KEYNOTE SPEAKERS 7
ORAL PRESENTATIONS 17
POSTER PRESENTATIONS 125
WORKSHOPS 277
INDEX 281

INVITED KEYNOTE SPEAKERS

16 June

L1

DETECTION AND ATTRIBUTION OF CLIMATE CHANGE IN THE BALTIC SEA REGION

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The climate in the Baltic Sea Region (BSR) has seen changes in terms of air temperature and precipitation amounts, in recent decades. We have examined if these changes are within the range off natural variations, as given my multi-millennial "control" simulations with conventional climate models. It turns out that temperature has seen an increase in all seasons, as well as annually, which is beyond this range, so that we may conclude that we "detect" a change, which needs explanation by anthropogenic factors. Similarly for precipitation amounts, even if the pattern in different seasons and for the year is variable. When we compare these changes "which need explanation" with what climate models suggest as responses to elevated greenhouse gas concentrations (GHG), we find that the induced temperature change fits the sign of the observed change, but is too weak. In terms of precipitation, we find sometimes inconsistency, i.e., opposite sign, and different magnitudes. Thus, the change may be in part related to elevated GHGs, but not entirely so.

To shed further light on the attribution issue, we fitted a regression model, which describes BSR annual temperature and precipitation amounts as a response to Northern Hemisphere temperature and BSR aerosol emissions. The predictor "Northern Hemisphere temperature" is supposed to describe mostly the GHG related change, but it includes also global aerosol effects, global volcanic effects as well as cosmic effects such as solar activity. The regression models fit the observed records rather well, even if the year-to-year variability is underestimated, as was to be expected. Then, we modified the BSR aerosol emissions in the regression model – being constant at low levels since 1920, and being constant at high levels since 1980. It turns out that constant emissions lead to a reduced temperature increase in recent decades and to a positive trend in precipitation amounts. Thus, regional aerosol emissions together with global GHG atmospheric accumulation together may be "attributed" as causes of the recent trends in BSR climate change, at least qualitatively.

17 June

L2

IN SEARCH OF THE BEST CROSS-BORDER AND -SECTOR GOVERNANCE MODEL

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Marine management worldwide has to tackle transboundary and cross-sectoral issues respectively because of seas encompassing the waters of many countries and because of the many activities in the seas and their catchments. The nature of the marine environment, in having *unbounded boundaries* (because of the dynamic nature of both the natural and societal aspects) and *moving baselines* (because of climate change) makes it a particularly challenging environment to manage. Accordingly, regional seas, such as the Baltic, have evolved environmental protection bodies such as HELCOM which have to operate across geo-political boundaries but which have to encompass all the prevailing philosophies and approaches to marine environmental management; the latter are within national, regional, international and global governance mechanisms. This presentation illustrates an integrated marine management framework based on the DAPSI(W)R(M) approach (Drivers, Activities, Pressures, State changes, Impacts (on human Welfare) and Responses (using Measures)), the Ecosystem Approach, the 10-tenets of sustainable management, and the Risk Assessment and Risk Management Framework. This takes note of vertical integration in governance and horizontal integration across stakeholders by showing the system of interlinked European marine governance, the plethora of bodies involved in marine management in a country, and the stakeholder typology. Finally, the presentation shows the successes of such approaches but also notes the impediments to a successful and sustainable management outcome.

18 June

L3

PATTERNS OF BIODIVERSITY IN COASTAL BENTHIC ECOSYSTEMS: A COMPARISON FROM THE GENETIC TO THE SYSTEM LEVEL AT EUROPEAN SCALE

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Along Europe a northeastward shift in distribution of marine species has been noticed and often attributed to global change. The best examples are available for pelagic marine species and for benthic species at national level. However, the pattern, degree, and eventual consequences of changes, of the biodiversity in benthic coastal ecosystems at larger European scale remains largely unknown. To address this issue, the gradients and relations in genetic, ecophysiological and community diversity (and impact of changes) in coastal benthic systems and a few key-species were assessed in parallel in a range of European coastal ecosystems using harmonised tools and methods.

In this presentation we will show examples of patterns of diversity at different organisational levels in benthic ecosystems along the European coastline as obtained in the BIOCOMBE and EMBOS projects. In series of surveys, translocation experiments in the field, and exposure experiments in the lab, carried out at a range of marine stations along the European coastline, aspects of the degree and variation in genetic, ecophysiological and community diversity of benthos have been studied during several years. A focus has been on zoomacrobenthic communities of shallow coastal systems and in particular on the diversity of two key-species, the clam *Macoma balthica* and the mussel *Mytilus spp*. in the Mediterranean, Atlantic and Baltic

For the mussels as well as clams distinct genetic groups could be recognized. The genetic diversity of the studied key-species showed opposite gradients, i.e. for clams an increase of diversity towards the North, yet for mussels a decrease. The latitudinal gradients and distinct genetic groups are (partly) explained by the geological history (e.g. alternation of ice-ages), present major geographic barriers (Bosporus, Gibraltar and Sont-Kattegat), and recent age of some areas (as Baltic and Black Sea) in comparison with other European regions.

The distinct genetic groups in both the key species largely coincided with the distribution of separate ecophysiological groups (ecotypes). Particularly the respiration rates, and to

a lesser extent the growth rates, can be linked to genetic markers. Clear patterns with latitude (North to South), temperature and salinity gradients and among regions (Baltic, Atlantic, Mediterranean) were found.

The clams from the southern French Atlantic coast, *i.e.* living at the edge of their natural range, showed the lowest genetic diversity, coinciding with their higher sensitivity to disturbance.

The optimal ecophysiological performance (on basis of respiration rates) of the southern group of mussels (*M. galloprovincialis*) was found around 25 °C, for the Atlantic mussels (*M. edulis*) around 20 °C and for Baltic mussels (*M. trossulus*) around 16 °C (and at lower or higher temperatures the growth and decrease). For mussels these data can indicate at which latitude a specific mussel group is expected to survive, or will disappear (i.e. to which extent the distribution range will shift in response to Global Change).

From the data we were able to calculate a northward shift of the ranges of mussel and clam groups that is expected to continue with further warming at an average speed of approx. 100 km in 10 to 20 years. This may mean that with further climatic changes specific groups of the key species will disappear in about 50 to 100 years from now from their southern distribution limits (i.e. with an ongoing increase of T at similar rates of about 1.5 °C per 40 years).

At community level a relation was found between community diversity and the latitude, salinity, temperature, tidal level, and type of substratum. Low diversity occurs at higher latitudes (north) and at low salinity.

Dominance of specific taxa in the soft substrata differentiated strongly between regions (crustaceans dominate in the Mediteranean, polychaetes in the Atlantic, and insects in the northern Baltic).

Therefore it may be argued that latitudinal trends in diversity are merely a result of including typical regions, like the Baltic (being an enclosed area with strong salinity clines and a high proportion of insects) and the Mediterranean (semi-enclosed with relative high salinities and high temperatures, and a high proportion of crustaceans).

The results can be used as ecologically-relevant tools for evaluating risks of adverse conditions, and potential impacts of global change in particular, leading to changes in species diversity of benthic communities.

18 June

L4

THE INTERNATIONAL GULF OF FINLAND YEAR 2014 -MAIN SCIENTIFIC FINDINGS

Kai Myrberg, Oleg Korneev, Urmas Lips, Alexandr Anstulevitch, Robert Aps, Tatiana Eremina, Alexandra Ershova, Sergey Golubkov, Kirsten Jörgensen, Anu Kaskela, Kirsi Kostamo, Aarno Kotilainen, Sergey Kondratyev, Pentti Kujala, Andrey Lappo, Inga Lips, Kari Lehtonen, Georg Martin, Marina Orlova, Anita Mäkinen, Andrey Pedchenko, Heikki Pitkänen, Mika Raateoja, Darja Ryabchuk, Ljudmila Vesikko, Markku Viitasalo and Pekka Vuorinen

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In this presentation the main, novel scientific findings gained during the International Gulf of Finland Year 2014 will be presented. First of all, researchers from Finland, Russia and Estonia, as well as from other Baltic countries, have carried out investigations on five research themes supporting the HELCOM BSAP and EU MSFD. The themes were: bio-and geodiversity, pollution and ecosystem health, fish and fisheries, maritime transportation and maritime spatial planning, on which more evidence-based data are needed for proper political decision-making. Eutrophication, caused by nutrient loading, combating eutrophication as well as climate change were overarching themes.

Secondly, as a part of the Gulf of Finland Year 2014 agenda, the riparian countries Estonia, Finland and Russia performed that year an extended environmental monitoring programme in the gulf. The aim was to get a profound insight into the current state of water quality and biology of the basin. Additionally, an assessment was made for years 1996-2014, i.e. from the first Gulf of Finland year 1996 until now, and in the presentation it will be shown how the ecological state of the gulf has changed under the period of investigation.

19 June

L5

FRESH OXYGEN FOR THE BALTIC SEA – THE MAJOR BALTIC INFLOW 2014

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Keywords: Baltic Sea, Major Baltic Inflow, ventilation, water exchange, environmental conditions, climate change

The ecological state of the Baltic depends crucial on the periodic deep water renewal by inflow events of saline oxygen rich water. Due to the strong density stratification these inflows are the solely source for deep water ventilation. Since the early eighties of the last century the frequency of inflow events dropped drastically from 5 to 7 major inflows per decade to only one inflow per decade. Wide spread anoxic conditions becomes the usual state in the central Baltic. The rare Major Baltic Inflow (MBI) events in 1993 and 2003 could interrupt the anoxic bottom conditions only temporary. After more than ten years without a major Baltic inflow event, in December 2014 a strong MBI brought large amounts of saline, and well oxygenated water into the Baltic Sea. The strength of the MBI exceeded considerably the previous 1993 and 2003 events. In the list of the MBI's since 1880 (Matthäus, 1996) the 2014 inflow is the third strongest event ever observed. In total, a volume of 198 km^3 saline water with approximately 4 giga tons of salt were added to the Baltic Sea. This inflow event will most probably turn the entire Baltic deepwater from anoxic to oxic conditions, with wide spread consequences for marine life and biogeochemical cycles. A detailed analysis of the physical forcing and the further development of the inflow in the western Baltic will be presented, together with observations of the eastward spreading of the saline waters into the eastern Gotland basin.

19 June

L6

AquaNIS IN ACTION: COMPREHENSIVE OVERVIEW ON THE NON-INDIGENOUS SPECIES INVASIONS AND THE VECTORS RESPONSIBLE IN THE BALTIC SEA

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Keywords: pelagic invertebrates, benthic invertebrates, fish, from 1990 onwards, spatio-temporal dynamics, invasive and unique-to-location species, taxonomic distinctness, invasion vectors/pathways

Non-indigenous species (NIS) can substantially change local biodiversity, modify the structure and functions of marine ecosystems they inhabit, alter services that these systems provide for humans. Therefore, advanced knowledge on NIS invasions, linked to the invasion vectors and pathways, is essential. The current paper utilises the most up-to-date information on NIS available in AQUANIS, the new-generation information system designed to assemble, store and disseminate comprehensive data on NIS, and assist the evaluation of the progress made towards achieving management goals. The paper will i) summarise information on NIS invaded the Baltic Sea by major groups – pelagic invertebrates, benthic invertebrates, fish; ii) provide country-specific decadal-scale invasion dynamics since 1900 and iii) identify the most invasive and/or unique-to-location species based on spread. The paper will also analyse temporal dynamics in the country-level distinctiveness of NIS. Most essentially, the paper will link both NIS as well as their taxonomic distinctness to invasion pathways/vectors. As the invasion vectors should be in focus in NIS management, results of the current paper form the basis for designing further management strategies and identifying priority actions to reduce the risk of new NIS invasions to the Baltic Sea.

19 June

L7

SOCIETAL CHALLENGES IN MARINE SCIENCE

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Marine and maritime aspects are found in Horizon2020 among core societal challenges such as food security, sustainable agriculture, forestry and the bioeconomy. This positioning radically changes the meaning of different services to society compared to the classic notion of marine science – that mostly understands but usually does not interfere. The 'different' service means not only studying and mitigating the problems we know already (like eutrophication, invasive species, degradation of habitats, sensitivity of coasts, integrity of seafloor) but looking at the sea more widely and prospectively. It becomes increasingly important to highlight problems to come, reveal concealed hazards, and divulge their consequences on longer time scales than political elections. This is followed by the challenge of applying 'out-of-the-box' thinking to things that we understand only superficially and the necessity to realise that it is not enough to simply publish (and forget) the outcome. We have to learn both the courage and virtuosity to talk about our results to stakeholders and policy-makers in a clear and strident manner. These aspects are visualised via a selection of marine and coastal hazards where 'serving society' has a distinct (even monetary) meaning and simple explanations based essentially on Newton's laws are possible. The pool of examples involves certain aspects of nearshore hydrodynamics (such as water level and wave impact) and structural stability of the coasts in the eastern Baltic Sea. The aim is to demonstrate that it is no more sufficient for scientists or universities to simply serve society. It is time to become the major driver of society.

ORAL PRESENTATIONS

O 1

STORM SURGE CLIMATE IN THE WESTERN BALTIC SEA 1948-2012

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Keywords: storm surges, extreme sea levels, climate, Baltic Sea, seiches

Storm surge activity in the Baltic Sea is usually analyzed from tide-gauge data covering more or less extended periods. More comprehensive spatial or systematic analyses are mostly lacking. We use a high-resolution numerical tide-surge model driven by high-resolution reanalyzed atmospheric fields to reconstruct Baltic Sea sea levels from 1948 to 2012 on an hourly basis. We show that the model reasonably reproduces observed water levels and provide a systematic analysis of the storm surge climate during the past 65 years in the western Baltic Sea. We found that storm surge climate showed pronounced inter-annual and decadal fluctuations but could not detect substantial long-term trends over the period considered. Prefilling and seiches contributed substantially to some of the observed peak water levels in the past. For the German coast, we demonstrate that storm surges with and without contributions from prefilling occurred at about equal shares. When prefilling was present, lower wind speeds were generally needed to sustain comparable peak water levels. Seiches also contributed to some of the observed surges usually with a preferred phase shift. In about one third of the cases contributions from seiches at peak water level were found to be larger than about 10 cm.

O 2

EFFECTS OF GEOSTROPHIC CURRENTS AND INERTIAL WAVES ON SEDIMENT EROSION IN THE SOUTH-EAST BALTIC

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Keywords: bottom sediments, erosion, quasi geostrophic currents, inertial waves, numerical modelling, South-East Baltic

The influence of currents on erosion of bottom sediments in the Baltic is investigated. Bottom sediments data obtained in the South-East Baltic are compared to spatial distributions of model current velocity calculated on the base of POM (Princeton Ocean Model). Special attention is given to investigation of the influence of Western and North-Eastern winds which lead to the formation of intensive along shore quasi geostrophic currents in the South-East Baltic and may cause such high velocities in the near bottom layer that the erosion of bottom sediments and transport of their fine fractions take place. It was revealed that under abrupt change of wind velocity the effect of erosion can intensify due to arising of inertial internal waves penetrating into the bottom layer. The comparison of spatial distributions of current velocity in the surface and near bottom layers with the distribution of bottom sediments showed that areas with highest velocities induced by Western and North-Eastern winds in most cases coincide with the areas where bottom sediments determines by coarse fractions – gravel and sands. It is assumed that namely in the areas where quasi geostrophic currents are most intensive the subsequently arising inertial waves transfer the impulse and energy concentrated in the surface layer downward which leads to sharp increasing of near bottom velocity and transport of fine sediments.

O 3

THE GOOD ECOLOGICAL STATE IN THE SOUTH-WESTERN BALTIC SEA – DEFINIED WITH AN INTEGRATED MODELING APPROACH AND REACHED WITH THE BSAP

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Keywords: water quality indicators, Water Framework Directive, Baltic Sea Action Plan, integrated modeling

The Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD) aim both on achieving a good ecological status. For the MSFD ecological targets have been set for the Baltic subbasins within TARGREV and revised nutrient load reductions of the HELCOM parties have been adopted in the Baltic Sea Action Plan (BSAP).

To define the targets for the German WFD waterbodies we transferred today measured concentrations of Chlorophyll, Total Nitrogen and Phosphorus to the state of 1880, which serves as reference for a ecological status only minor disturbed by human activities. For that purpose we run two simulations with the Baltic Sea ecosystem model ERGOM-MOM, one with the present nutrient loads and one with the reconstructed loads for the historical state. For the German loads and the Oder we used the results of the catchment model MONERIS. From this two simulations we computed the relative change between the historical and the present loads and multiplied the median of the measured concentrations with the transfer factors from the simulations. Thereby step gradients within the factors occurred from the nutrient sources to the open sea, showing the different reactions of the coastal waters and the open sea to the changed nutrient loads. Further first results will be presented, if the nutrient reductions of the BSAP from 2013 are ambiguous enough to reach the WFD goals in the three major southern lagoons.

O 4

SEDIMENT STABILITY AND RESUSPENSION INDUCED NUTRIENT FLUXES OVER HABITAT GRADIENTS

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Keywords: resuspension, critical shear stress, nutrients, macrofauna

In coastal environments hydrodynamic forces, such as waves and currents, cause sediment resuspension. Resuspension occurs when critical shear stress is exceeded at the seabed and sediment particles are lifted up into the near-bottom water. Nutrients are thus released from pore water and sediment particles into the water column and become available to algae. Biogeochemical and biological features of the sediment play a key role in determining sediment erodibility and thus sediment‘s tendency to resuspend. We studied the main biological and physical sediment features controlling the critical shear stresses, reflected in resuspension induced nutrient fluxes, in different habitats. The study was conducted in the Hanko archipelago in the summer of 2014. The 18 sampling sites covered various sediment types from mud to sand. The critical shear stresses and nutrient concentrations before and after resuspension were measured with an EROMES-device. The cores for the EROMES-experiments and for the analysis of sediment characteristics were collected from each site by SCUBA-diving. After the experiments macrofauna and the roots and rhizomes of macrophytes were collected from the cores and analysed together with sediment characteristics. The results of the study will be discussed.

O 5

A NITROGEN SOURCE IN SPRING IN THE SURFACE MIXED-LAYER OF THE BALTIC SEA: EVIDENCE FROM TOTAL NITROGEN AND TOTAL PHOSPHORUS DATA

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The combined mass balance for total nitrogen (TN: concentrations of organic + inorganic nitrogen compounds) and total phosphorus (TP: concentrations of organic + inorganic phosphorus compounds) at 12 stations in the Baltic Sea for the period 1995-2013 clearly indicated the existence of a significant nitrogen source in the surface mixed layer in May of up to 86 mmol m^{-2} $month^{-1}$ at the Baltic Proper stations after the exhaustion of nitrate in mid-April. The analysis is based on monthly changes in TN with reference to the concentrations in April, and taking into account the atmospheric deposition of inorganic nitrogen compounds and the sedimentation of particulate organic nitrogen. The sedimentation term in the budget was derived from changes in TP. The ratio of the calculated nitrogen source and the consumption of phosphate was reasonably consistent with the Redfield N/P ratio at all stations in the Baltic Proper. A nitrogen source could not be detected in the Bothnian Sea where no phosphate is left after the spring nitrate depletion. The nitrogen source is closely linked to the consumption of excess phosphate and thus to the production of organic matter in the surface mixed-layer. Processes such as early nitrogen fixation and nitrogen transport by migrating plankton organisms are discussed as possible causes for the nitrogen input into the surface mixed layer in May. The long-term mean of the nitrogen source amounted to 55 mmol m^{-2} in the Baltic Proper corresponding to a regional nitrogen input of 83 kt. We also obtained data for the mid-summer nitrogen fixation of 141 mmol m^{-2} which is equivalent to an input of 202 kt.

O 6

THE USE OF *CERAMIUM TENUICORNE* GROWTH INHIBITION TEST FOR TESTING EFFECTS OF BOAT ACTIVITIES – LEAKAGE FROM ANTIFOULING PAINTS, CONTAMINATED SEDIMENT AND SOIL

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The marine red macroalga *Ceramium tenuicorne* is the most common red alga species in the Baltic Sea. A growth inhibition test has been developed based on two clones, one originating from 7 ‰ and the other from 20 ‰. This test became an ISO standard in 2010 (ISO 107 10) for testing of chemicals and water effluents. The test has now been further developed for use of testing also leachates from sediment and soil. Leachates was prepared from different anti-fouling paints and used for ranking different paints according to their toxicity. Sediments from small town harbours and from natural harbours used for anchoring by pleasure boats, was collected and leachates were prepared and tested with the growth inhibition method with *C. tenuicorne*. The result show that this method could rank the harbours according to their toxicity and proved the small town harbours to be the most toxic and that compounds originating from antifouling paints was responsible for a large part of the inhibiting effect. Soil from boatyards was used for preparing lecahates, which was tested with the bacterium *Vibrio fisherii* in the Microtox test, growth inhibition of the macrophyte *Myriophyllum aquaticum* and the alga *C. tenuicorne* and larval development rate of *N. spinipes*. The alga proved to be the most sensitive species to the contaminants found at such places. The growth inhibition test is an easy test that easily can be applied on both water, soil and sediment samples without being too costly.

O 7

ROLE OF INTERMEDIATE LAYERS IN THE THERMOHALINE CIRCULATION OF THE BALTIC SEA

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Keywords: thermohaline circulation, seasonal variations, cold intermediate layer, field data analysis, the Baltic Sea

Structure of thermohaline circulation of the Baltic Sea and its seasonal variations are examined on the base of CTD-data collected in 2004-2013 by various institutions in Arkona, Bornholm, Gdansk and Gotland basins. Process of formation of the Cold Intermediate Layer (CIL) is discussed in detail using data of 5-year spring monitoring program on the shelves (5-70 m) of Kaliningrad oblast. Numerous intrusions of cold waters of close-tolocal salinity in the depth range of 10-25 m and cold waters of slightly higher (0.1-0.3 psu) salinity at 40-60 m depth in April prove almost purely advective origin of the Baltic CIL. Concept of the Bornholm Intermediate Waters is introduced (as a direct analog of, e.g., Levantine Intermediate Waters in Mediterranean), with their low temperature (1.5-4 C) and intermediate salinity (7.4-8 psu), which are formed in March – April over the shelves in the upper 30-40 m of the Bornholm basin and then are shown to be registered all over the Baltic Proper as a cold core at the depths of about 50-70 m, constituting lover 10-30% of the CIL and the upper pycnocline. Overall, in general (quasi-estuarine) thermohaline circulation of the sea, the lower part of the CIL (about 2/3 of its thickness) drifts “upstream” (northwards), and only upper part drifts downstream, even though the CIL belongs to the upper freshened layer of the estuary. The investigations are supported by RFBR via grant number 13-05-01041a.

O 8

SIMULATING EDDY – WIND INTERACTION WITH MOMBA

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Keywords: eddy, wind, circulation model, high-resolution modelling

The discovery of the ubiquitous nature of oceanic meso- and sub-mesoscale features entailed a discussion on their relevance for marine biota. As concerns the association of mesoscale processes with nutrient transport to the surface (often referred to as "eddy-pumping"), the controversy is on-going. Among the mechanisms discussed is the eddy – wind effect. As proposed by Martin and Richards [2001], surface currents can effect substantial wind stress curls even though they are - as concerns the magnitude of their velocities - far smaller compared to atmospheric winds blowing over the ocean. The reason is that oceanic surface currents vary on much smaller spacial scales than atmospheric winds. This effects horizontal gradients which yield significant wind stress curls and associated vertical Ekman velocities, of the order of ≈ 0.5 m/day in open-ocean conditions characterized by Rossby radii of the order of 50km. In the Baltic Sea, however, effected by shallower water depths and strong stratification, the Rossby radii are typically one order of magnitude smaller. This, in turn, suggests that hitherto unaccounted eddy/wind effects are an order of magnitude stronger in the Baltic than in the open ocean. Based on simulations with the eddy-resolving ocean circulation model MOMBA we will report on eddy/wind effects in the Baltic.

O 9

SEASONAL SMALL-SCALE VARIATION IN DISTRIBUTION AMONG DEPTH ZONES IN A COASTAL BALTIC SEA FISH ASSEMBLAGE

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Keywords: fish community, habitat, depth zone, seasonality, littoral, archipelago, Baltic Sea

We studied seasonal and small-scale spatial variation in fish assemblage structure in the northern Baltic Proper archipelago. The study was conducted in a shallow coastal basin during three consecutive production-seasons. The structure of the fish assemblage changes significantly seasonally, from early summer (May–June) to late summer (August–September), and spatially over short distances (ca 500 m) and small depth intervals (ca 5 m) in an area without physical barriers. The magnitude of the seasonal variation was depth-specific, indicating that seasonal patterns from a given depth zone cannot be directly extrapolated to adjacent ones, let alone to a whole water body. In early summer, the adult fish displayed spawning aggregations, and their abundance was highest closest to the shoreline. In late summer, the adult fish were more evenly distributed and the assemblage was dominated by high abundances of juvenile fish. The results underline the importance of including several spatial and temporal scales into studies on fish distribution. The resulting patterns from such studies may appear idiosyncratic unless the nature and magnitude of seasonal variation and small-scale depth distribution are taken into account. By the same token, a proper understanding of this small-scale variation is necessary for efficient targeting of marine conservation measures.

O 10

MULTIDISCIPLINARY MAPPING OF FISH HABITATS IN THE SOUND, DENMARK FOR MARITIME SPATIAL PLANNING

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Key words: fish habitat mapping, maritime spatial planning, ecosystem based management, Denmark

Conflicts arising among users of the marine environment as well as between human uses and vulnerable components of the ecosystem can to a large extent be mitigated through mapping and visualization of ecological features and human activities, which serve as a solid foundation for informed spatial planning and management that takes account of the needs of society as well as the conservation of e.g. functional marine habitats. The Sound between Denmark and Sweden is a sea area with a myriad recreational and commercial uses such as commercial gillnet fishing, angling and sports diving as well as shipping, the wind energy sector and marine aggregate extraction. Conflicts arise e.g. between the fishing sector and sectors impacting the sea floor and its habitats. A project was therefore carried out in 2014-2015 in the Danish part of the Sound with the aim to collect information from all existing sources as well as from interviews with small-scale commercial gillnetters and anglers to map the habitats of ecological importance for selected fish species of commercial value. Resulting maps of fish habitats and the methods and challenges related to interdisciplinary fish habitat mapping in coastal areas will be presented. In addition, implications of such fish habitat mapping will be discussed in the perspective of intertwining marine and maritime policies such as the MSP Directive, the Marine Strategy Framework Directive, Natura 2000 and the reformed Common Fisheries Policy.

O 11

ZEBRA MUSSEL FARMING IN A BALTIC LAGOON - APPLICATION OF AN ICZM SYSTEMS APPROACH FRAMEWORK

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The Oder (Szczecin) Lagoon in the southern Baltic is a heavily eutrophicated and degraded coastal ecosystem. We applied a Systems Approach Framework to critically evaluate whether existing water management measures achieve water quality objectives for the river and lagoon system. Our model simulations suggest that external nutrient load reductions in the river basin alone seem insufficient to reach a good water quality in the lagoon. A comprehensive eutrophication management approach should also include internal nutrient retention and removal measures in the lagoon. We focus on Zebra mussel farming (Dreissena polymorpha), because they are efficient in removing nutrients and improving water transparency in the Oder Lagoon. For this purpose, the ecosystem model ERGOM is extended by a mussel module and an economic model. The economic model describes costs and benefits of mussel cultivation depending on the the farm size. We included additional potential sources of income such as water quality tax or emission certificates. The model simulations show that mussel farming in the lagoon is a suitable supportive and, at a load reduction target of 50% and more, a cost-efficient measure to remove nutrients and to implement the Baltic Sea Action Plan. In the Oder Lagoon, mussel farming could potentially remove nearly 1000 t N (70 t P) per year or about 2% of the present N and P load and has the additional benefit of improving water transparency, which is important for ecosystem services.

O 12

MOLECULAR APPROACHES FOR NON-INDIGENOUS SPECIES SURVEILLANCE – FROM INTRODUCTION PATHWAYS TO ESTABLISHED POPULATIONS

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Keywords: early detection, invasive species, metabarcoding, high-throughput sequencing, species-specific markers

Non-Indigenous Species (NIS) are one of the greatest threats to marine biodiversity and ecosystem. Efforts are increasingly focused on development of effective surveillance methodologies for early detection of new introductions and monitoring the dynamics of the established populations. Most current marine surveillance programs rely predominantly on taxonomic expertise, are laborious, and often fail to identify cryptic species or those at the dispersal stage (eggs or larvae). Therefore, current approaches are often insufficient to deliver timely information on NIS distribution and advice on rapid response action plans. Developing an effective surveillance tool for NIS presents a major challenge to biologists as it requires accurate detection of species at low densities and often in early life-stages. Here we showcase the application of molecular techniques for NIS research at different stages of incursion: identifying risks while species are still at the pathway, early detection of their spread and further surveillance of existing populations. The results of our case studies suggest that employment of molecular methods have evident advantages against the conventional approaches and provide a powerful tool for biosecurity research in diverse and heterogeneous marine ecosystems. The applicability of these methods will expectedly increase even more with further development of technologies and improvement of our baseline knowledge on genetics of marine biota.

O 13

SEASONAL SEDIMENTATION CYCLE AND FLOW-INFLUENCED MUD DEPOSITION INFERRED FROM A MICROFABRIC STUDY OF LAMINATED SEDIMENTS IN THE NORTHERN BALTIC SEA COAST

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Keywords: microfabric, mud deposition, laminated sediments, varves, Baltic Sea

Microfabric of the modern laminated sediments in the coastal areas of the northern Baltic Sea was investigated through X-radiography and scanning electron microscopy of samples embedded in epoxy resin. The sedimentary fabric comprises rhythmic biogenic and lithogenic laminasets reflecting seasonal changes in the composition of accumulating material. The biogenic laminaset is formed during vernal phytoplankton bloom through rapid sedimentation of aggregates composed of intact diatom frustules and minor proportion of clay-rich lithic material that are entrained in a matrix of amorphous phytodetritus. Accumulation of the lithogenic laminaset results from decline in primary production, enhanced recycling of organic carbon and intensified resuspension concomitantly with increased cyclonic activity towards late autumn and winter. The inclusion of silt grains, isolated diatoms and faecal pellets in the lithogenic laminae attest to deposition from near-bottom flows, contradicting the generally accepted view that laminated sediments accumulate by suspension settling under quiescent conditions only. ^{137}Cs-dating results coincide relatively well with the laminaset couplet thickness, bolstering that the couplets reflect annual cycle of deposition. These modern laminated sediments provide a high-resolution archive for assessing recent human-induced environmental changes as well as a robust tool for evaluating the lateral expansion of seafloor anoxia in the area during the past decades.

O 14

INTEGRATION CHALLENGES IN MSP AND THE CONCEPT OF AN ECOSYSTEM APPROACH

Holger Janßen, Stephen Jay, Thomas Klenke, Michael Gilek

Maritime Spatial Planning (MSP) has been given increased prominence recently in the Baltic Sea Region (BSR) in response to the problems of fragmentation of marine regulation, increasing pressures upon the seas and tensions between interests and environmental damage. In policy terms, MSP has been identified as the key tool in which to give effect to the EU Blue Growth Strategy that promotes more intensive utilisation of marine resources for a growth of maritime economies, while in parallel improving ecological conditions in line with the EU Marine Strategy Framework Directive and the HELCOM Baltic Sea Action Plan.

It can be argued that achieving the ambitions of MSP in the BSR, depend on obtaining different forms of integration (e.g. across policies, sectors, stakeholder inputs, knowledge, ecological and (geo)political scales, scientific disciplines) to deliver coherent outcomes that are more likely to optimise the types of multidimensional regional opportunities inherent in Blue Growth. Integration is commonly stated as a key mechanism and challenge in MSP (BONUS 2014), but it is rarely elaborated on what integration might mean in different MSP related processes (e.g. in terms of improved effectiveness and efficiency of MSP, distributive effects, stakeholder participation and political legitimacy). While analysis is needed to identify enablers and constraints of the several integration dimensions, science-based approaches and tools prioritising and addressing various types of integration-related challenges and possibilities in MSP are also in need of further development.

BaltSpace, a BONUS project, will address a wide range of integration challenges. The presentation will highlight the BaltSpace concept with a focus on first results on the integration of an Ecosystem Approach in MSP as required by the European MSP directive, looking especially at the importance and meanings that are being attributed to ecosystem concepts in current MSP discourse and initiatives, and the extent to which these concepts are finding expression in MSP outcomes. This is with a view to contributing to a fuller understanding of the ways in which environmental imperatives are being advanced in the development of MSP, and assisting in the interpretation of these concerns. The presentation refers to ecosystem approaches in MSP thought and practice based on an empirical analysis of a statutory MSP processes in Germany in which an ecosystem approach was given importance. Consideration of planning documentation and stakeholder opinion reveals the contested meanings and unresolved tensions implicit in the attempt to implement this approach. This leads to a discussion on the ways in which ecosystem understandings might be more satisfactorily incorporated into the development of MSP.

O 15

LONG-TERM MODEL STUDY OF NUTRIENT AND DETRITUS DYNAMICS IN THE BALTIC SEA

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Eutrophication resulting from input of nutrients is considered one of the major environmental problems in the Baltic Sea. Stronger eutrophication is manifested through increased summer cyanobacteria blooms and expanding hypoxia. It has been recognized that cycling of organic matter is a considerable source of nutrients in the Baltic Sea. Nutrient pools in the sediments have increased over the last decades. Our study aims at understanding the eutrophication of the Baltic Sea by looking at spatial patterns and temporal variation of biogeochemical parameters. We focus on spatial detritus dynamics during the period of 40 years in the Baltic Sea. Model simulations were performed using a three-dimensional free-surface hydrodynamic model GETM coupled with the ERGOM biogeochemical model. The model domain covers the entire Baltic Sea area and the period modelled is 1966-2006. Our results show that nutrient and detritus dynamics differ between shallow and deep areas. Seasonal cycle is dominant in the shallow areas (water depth less than 60 m approximately) and nutrients-organic matter are recycling there. Deep areas, however, could be storage for organic matter where halocline acts as a kind of barrier for nutrients to be transported to the upper layer. Still, nutrients are mixed from the upper halocline into upper layer and fuel primary production there, so deep areas become important source of nutrients, especially during MBIs. Horizontal transport of nutrients from upstream basins of the Baltic Sea is a considerable source of nutrients for downstream basins.

O 16

WATER PROTECTION IN THE BALTIC SEA AND THE CHESAPEAKE BAY: INSTITUTIONS, POLICIES AND EFFICIENCY

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Keywords: Cost-efficiency, nutrient abatement, point source pollution, nonpoint source pollution, nutrient trading, 'polluter pays' principle, Chesapeake Bay, Baltic Sea

The Baltic Sea and the Chesapeake Bay share many characteristics. Both are shallow, brackish marine areas that suffer from eutrophication. Successful policies targeting point source pollution have lowered nutrient loads in both sea areas, but improving their marine quality to desired levels will require further abatement: Efforts must be extended to more complicated and expensive pollution sources, notably agricultural nonpoint loads. Despite their ecological similarities, the two watersheds have different histories and institutional settings and have thus adopted different policies. Comparing and contrasting the policies reveal ways to improve the efficiency of each and, in particular, ways to avoid the path of trial and error. No comparison of the parallel protection efforts, which involve expenditures of hundreds of millions of dollars annually, has been carried out to date. The present paper analyzes the policies applied in the two regions, distilling the results into six clear recommendations for future steps in preserving what are valuable sea areas.

O 17

RECENT CHANGES IN BALTIC SEA OCEANOGRAPHIC CONDITIONS, WITH SOME EFFECTS TO THE ECOSYSTEM STATUS

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Keywords: Baltic Sea oceanography, climate change, sea warming, salinity change

We rely on the results of physical oceanography review from BACC II (2nd BALTEX Assessment of Climate Change for the Baltic Sea basin) book.

A warming of sea surface waters over recent 2-3 decades has been clearly demonstrated by all available methods. The greatest SST increase has occurred in the northern Bothnian Bay, but large increases were found also in the northern Baltic Proper and connected gulfs. Warming is evident during all seasons, with the greatest increase occurring in summer. The least warming of surface waters occurred along the coast of southern Sweden, probably due to more frequent coastal upwelling forced by the westerly wind events.

Recent 2-3 decades are also characterized by slightly lower top-layer salinity, caused by higher accumulated river runoff, and by reduced stratification strength and deep salinity, caused by increased mean zonal wind stress. Important are also changes in water exchange and mixing events, dependent on frequency of deep cyclones and their pathways over the Baltic area. In particular, Major Baltic Inflows, usually of barotropic origin, occur during winter and spring when easterly winds are followed by several weeks of strong westerly winds. Since 1996, summertime baroclinic inflows have been observed; they transport high-saline, but warm and low-oxygen water into the deep layers of the Baltic Sea. We discuss also oceanographic changes in other basins, with some effects to the oxygen, nutrients and biological indicators.

O 18

POSSIBLE CAUSES OF SEDIMENT DYNAMICS AND MIXING IN WESTERN BALTIC SEA BASINS

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Keywords: Geochemistry, Microfacies, Radionuclides, Sediment mixing

Based on results of geochemical and radionuclide measurements, indicators for possible causes of sediment dynamics and mixing in the Mecklenburg Bight and the Arkona Basin are investigated. Instead of expected sharp 137Cs peaks and characteristic Hg profiles the data often show blurred signals that sometimes even match each other indicating varyingly strong mixing effects on these event stratigraphic signals.
Most likely mixing processes involved are: (i) bioturbation, (ii) hydroturbation and (iii) direct anthropogenic impacts.
(i) The interpretation of fine scale X-radiographs for sediment fabric analysis and chlorophyll measurements provide insight into bioturbation. Ichnofossils found in short sediment cores suggest that the sedimentary structure is partly overprinted by burrowing organisms living in the surface layer of the sediment.
(ii) Meteorological and hydrographical data from automated measuring stations allow statements concerning the hydroturbation potential (e.g. storms, inflows). Such events can be found as layers in the X-radiographs.
(iii) The anthropogenic impact through bottom trawling and dredging can be made visible through side-scan sonar mapping of the sea floor. Here, data from largely "undisturbed" sedimentation areas, e.g. in the vicinity of larger sea floor obstacles shall serve as reference.
The overall goal is to distinguish between these different factors influencing sedimentation.

O 19

SIMULATED SEA LEVELS OF THE BALTIC SEA FROM DIFFERENT CLIMATE SCENARIOS

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Keywords: sea level, climate change, extreme events.

The long-term changes in the climate conditions affect the Baltic Sea level in the future. For the evaluation of the effects of the climate change, various regional climate simulations that range over the Baltic Sea region have been produced. The changes in the Baltic Sea levels can be calculated using a sea level model that uses the regional climate scenario simulations as an atmospheric input data.

We have developed a combined sea level model for the Baltic Sea, that calculates a thousand-year sea level simulation in few hours with a laptop.

The internal variations of the Baltic Sea level are calculated with the two-dimensional Hansen sea level model that treats Baltic Sea as a closed basin. The variations in the total water volume due to wind-induced water exchange through the Danish Straits are estimated from the westerly geostrophic winds close to Bornholm. The tide, land uplift and the effect of the global mean sea level rise are also included. The combined sea level model comprises these five components.

We have performed a 850-year long simulation of Baltic Sea levels using six different climate scenarios. The simulated sea levels can be used both to evaluate the effects of the climate change on the sea levels, and to calculate the probabilities of extreme sea levels for different locations on the Baltic Sea coast.

O 20

UNSTRUCTURED GRID MODEL SIMULATIONS IN THE NORTH AND BALTIC SEAS DURING A STORM SURGE EVENT

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Keywords: numerical modelling, SCHISM, wave-current interaction, unstructured grid model, North and Baltic Seas, storm surge

A two-way coupled model system based on the unstructured grid model SCHISM (Semi-implicit Cross-scale Hydroscience Integrated System Model) and the surface wave model WWM-III (Wind Wave Model) is used to investigate the impacts of a storm surge event that happened in the North and Baltic Seas in December 2013. SCHISM is an open-source community-supported code based on unstructured triangular grids and is designed for the effective simulation of 3D baroclinic circulation. The model system is forced by data originating from MyOcean products.

The results show that the highest effects of the wave-current interactions can be observed in coastal areas. Strong longshore currents and a pronounced surface elevation setup are generated in shallow areas during the storm surge event due to effects of the waves on the current system. The analysis of numerical simulations demonstrated that the significant wave height in coastal areas is substantially affected by the tidal signal and wave-current interaction.

The validation against observations justifies the superiority of using a coupled model system when investigating geophysical processes in the coastal areas, especially during storm surge events.

O 21

EUTROPHICATION AND POLLUTION OF THE CURONIAN AND VISTULA LAGOONS

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Keywords: eutrophication, pollution, water quality, Curonian and Vistula Lagoons

The Curonian and Vistula Lagoon are the largest lagoons of the Baltic Sea. Monitoring of the Russian parts of the lagoons is carried out monthly since 1991 and includes a lot of physical, chemical (nutrients, oil, BOD_5, etc.), biological (chlorophyll, primary production, benthos, etc.) indicators. The Curonian Lagoon may be characterized as a hypertrophic water body with "poor" or "bad" ecological status. In 2001-2014 the number of stations increased where the average for growing season chlorophyll "a" > 100 µg/l. Climate warming is the cause of the ongoing eutrophication. Hyperblooming of Cyanobacteria causes water pollution. Primary production and BOD5 increased due to eutrophication and algal blooms in the last 20 years. However, oil products and detergents as indicators of industrial pollution decreased in the last 15 years.

Eutrophication of the Vistula Lagoon is lower than in the Curonian Lagoon. The climate warming was the cause eutrophication and algal blooms in 1990-2010 despite of significant reduction of nutrients loading. After the invasion of the filter-feeding bivalve *Rangia cuneata,* ecological status is improved from "poor" to "moderate", e.g., transparency increased by 2 times in 2011-2014, but lagoon remained at eutrophic level. The waste waters from Kaliningrad agglomeration are significantly affected on the nutrient and organic pollution (BOD_5) of the Vistula Lagoon. However, long-term studies did not show increase in oil products and detergents in the last 15 years.

O 22

SEAFLOOR ENVIRONMENT AND ZOOBENTHIC COMMUNITIES IN THE EASTERNMOST GULF OF FINLAND DURING THE PAST SIX MILLENNIA, AND THE INFLUENCE OF THE BIRTH OF THE NEVA RIVER

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Keywords: ichnofossils, zoobenthos, hypoxia, Gulf of Finland, Holocene, mud, storm deposits

Two replicate sediment cores, collected from the easternmost Gulf of Finland, record brackish-water mud deposition after 5900±60 cal. BP. The brackish-water muds are characterized by thin beds with erosional bases, fining-upward grain sizes and increasing-upward organic contents. A storm-induced flow origin is inferred for the mud beds. The bed primary microstructures are obliterated by biodeformation and burrow-mottling by small *Planolites* and *Arenicolites*/*Polykladichnus* ichnofossils, left behind by endobenthic oligochaetes and chironomid larvae. The depositional succession is cut by an erosional hyperpycnal flow event at 3320±40 cal. BP, caused by the birth of the Neva River. Increased diameter and deeper penetration of ichnofossils demonstrate improved seafloor oxygenation and zoobenthic community after the river birth. The river birth shifted the freshwater influx to the easternmost end of the gulf, which may have reduced the intrusions of poorly oxygenated deep waters from the west. Large *Planolites* up to 6 mm in diameter are produced by the isopod *Saduria entomon*. During recent warm decades and the Medieval Warm Period, increased sedimentary lithic content and magnetic grain size indicate elevated riverine influx due to increased precipitation, potentially caused by the enhanced flow of moist air from the Atlantic (persistent positive winter NAO), and/or increased seafloor reworking by storms.
[Original publication: Virtasalo et al., 2014, Marine Geology 350, 84–96]

O 23

SETTING WFD N REDUCTIONS BASED ON MECHANISTIC MODELS

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Keywords: WFD, mechanistic, dynamic, models, Denmark, nitrogen, reductions, good environmental status

In October 2014, the *Minister of Environment* announced that Denmark got its 1st generation *River Basin Management Plans* (RBMP) related to the *Water Framework Directive* (WFD). The plans were heavily delayed and the scientific rationale behind the plans have been subject to extensive criticism, why improvements were called for, for the 2nd generation of RBMPs.

Primo 2013 the work to improve and develop the tools for 2nd generation was initiated and on 22. of December, the new RBMPs were made public, the result of an interesting and professionally challenging project.

As part of the 2nd generation of RBMPs were the development of a marine modeling tool based on mechanistic models. These mechanistic models describe the causal link between the physical parameters (wind, currents, mixing etc.), and the chemical and biological parameters (nutrients, primary production, organic matter mm.), which are important for ecosystem functioning. Important inputs to the models are therefore both meteorological data and information on nutrient input from Denmark, as well as from our neighbors around the Baltic Sea.

Following the model build the results were used to develop relationships between nutrient loadings from Denmark and environmental status, and hence, priovinding the water authorities with an improved tool for setting differentiated actions and estimate nitrogen targit loads within each specific water body.

O 24

INTERPRETING ECOLOGICAL FUNCTIONING IN COASTAL WATERS: SPATIAL AND TEMPORAL TRAIT PATTERNS ACROSS THE BALTIC SEA

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Keywords: traits, multifunctionality, functional diversity, macrofauna, species loss, anthropogenic pressure

Coastal areas harbour high biodiversity but are also heavily impacted by human-induced stress. Such alterations affect functioning of the ecosystem. The potential for functional consequences due to e.g. species loss, in coastal areas of the Baltic Sea are also linked to the natural gradient in taxonomic diversity. We present functional trait patterns in relation to taxonomic richness and human impact in the Skagerrak-Baltic Sea region, using marine benthic macrofaunal data. By defying multiple traits we examine i) how the potential for function (functional richness and diversity) is affected by the natural reduction in taxon richness (from 151-6 taxa) across the entire geographic gradient, and ii) how functional diversity change over a 10 year period in three areas differing in human pressure along the Finnish coastline. Results show that the natural decrease in taxon richness across the Baltic Sea leads to an overall reduction in function, but thresholds and subtler changes in function can be found along the gradient. Trait categories related to feeding, living and movement were altered by the reduction in species richness. These findings are related to our results showing that areas differing in human pressure also vary functionally and that the most stressed area (Gulf of Finland) showed lower redundancy over a 10-year period. Thus we highlight the role of the trait-approach for theoretical understanding of functional diversity and for marine spatial planning.

O 25

EMODNET-GEOLOGY - SEABED SUBSTRATES AND SEDIMENTATION RATES OF THE EUROPEAN SEAS

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Keywords: EMODnet, sediment, seabed substrate, sedimentation rate, harmonization

The EU's Marine Strategy Framework Directive targets the achievement of Good Environmental Status of the EU's marine waters by 2020. However, it has been acknowledged that poor access to data from the marine environment was a handicap to government decision-making, and a barrier to scientific understanding and development of the economy of the marine sector. The effective management of broad marine areas requires spatial datasets covering all of Europe's regional seas. As a consequence the EC adopted the European Marine Observation and Data Network (EMODnet) in 2009 to combine dispersed marine data into publicly available datasets.

The 2nd phase of the EMODnet–Geology project started in 2013 with 36 marine organizations from 30 countries. The partners, mainly from the geological surveys of Europe, aim to assemble marine geological information at a scale of 1:250,000 from all European sea areas.

The project includes compiling and harmonizing national seabed substrate maps for the European Seas, as well as data showing sedimentation rates at the seabed. The data will be essential not only for geologists, but also for others interested in marine sediments such as marine managers. A 1:250,000 GIS layer on seabed substrates will be delivered in the portal, in addition to an updated 1:1 million map layer from the previous phase of the project (2009-2012). A confidence assessment will be applied to all areas to identify the information that underpins the geological interpretations.

O 26

ON THE ATMOSPHERIC AND OCEANIC CONDITIONS ASSOCIATED WITH LARGE VOLUME CHANGES (LVCS) AND MAJOR INFLOWS (MBIS) TO THE BALTIC SEA

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Keywords: large volume changes, major Baltic inflows, Landsort sea level, SLP patterns, cyclone tracks, haline stratification

The salinity and the stratification in the deep basins of the Baltic Sea are linked to the occurrence of major Baltic inflows (MBIs), which occur sporadically and transport higher saline and oxygenated water of North Sea origin to deeper layers. Since the mid-1970s, the frequency and intensity of MBIs have decreased, they were completely absent between February 1983 and January 1993. However, in spite of the decreasing frequency of MBIs, there was no obvious decrease of larger Baltic Sea volume changes (LVCs), that were defined as volume changes of at least 60 km^3. LVCs can be identified from the sea level at Landsort which is known to represent the mean sea level of the Baltic Sea very well. Our results confirm that most effective inflows occur if about a month before the main inflow period eastern air flow with anticyclonic vorticity over the western Baltic prevails. These conditions reduce the mean sea level of the Baltic Sea and lead to an increased saline stratification in the Belt Sea area. An immediate period of strong to very strong westerly winds trigger the inflow, and three different cyclone pathways (two across Scandinavia, and one along the Norwegian coast) have been linked to the occurence of LVCs/MBIs. Based on numerical modeling the stratification in the entrance area of the Baltic Sea was related to the occurrence of MBIs.

O 27

HOLOCENE SEDIMENTATION IN ESTUARIES OF THE BALTIC SEA – AN ÅNGERMANÄLVEN CASE STUDY

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Keywords: IODP Expedition 347, Holocene, sediment, varves, precipitation, Baltic Sea

The IODP Expedition 347 "Baltic Sea Paleoenvironment" drilled two sites in the Ångermanälven River estuary. Sites M0061 and M0062 are located in an area that was deglaciated ca. 10 ka ago. It has long been known that varves continue to form in this estuary and previous work has shown that a correlation exists between maximum daily discharge and mean varve thickness at least AD 1901-1971. One aim of the IODP drilling was to recover a uniquely long varve record from these two sites and study varve thickness and sediment geochemistry, potentially yielding estimations on past changes in discharge and sedimentation processes in the estuary.

In this presentation, we show the preliminary results from site M0062. The core recovery was ~ 36 m and the sediment sequence was divided into two lithological units. Unit 2 (17.09-35.9 mbsf) consists of well-sorted sand, deposited by a (glacio)fluvial system. Unit 1 (0-17.09 mbsf) contains a transition from clastic varves typical of a glaciolacustrine environment to couplets characteristic of a glaciomarine, or brackish environment. The uppermost 18 metres were analysed for grain-size and elemental geochemistry every 0.3-0.5 m. From selected intervals, a 1mm-resolution XRF-scanning of the split core surface was done to compare changes in the relative abundance of light elements. Results from Ångermanälven were compared with measurements from glacial varved sediments, retrieved from the Gulf of Finland. This work is part of the CISU project.

O 28

COMPARATIVE SEDIMENTOLOGY AND INTERNAL STRUCTURE OF EARLY STAGE COASTAL MEGA-RIDGES AT CAPE KOLKA, LATVIA

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Keywords: paleo-shoreline, dune, progradation, weathering, GPR, IR-OSL

We present one of the first high-resolution geophysical datasets from the oldest section of Kolka Cape (Kolkasrags), a massive Holocene strandplain in western Latvia. The vegetated beach/dune ridges (kangari) attain >10 m in relief, which are separated by depressions ranging from dry swales to freshwater bogs and lakes (vigas). This study focused on high-resolution ground-penetrating radar (100-500 MHz GPR) imaging and sedimentology of high-relief (> 6 m) ridges in the landwardmost section of the strandplain. Separated by a perched wetland from a Late Pleistocene terrace of the Baltic Ice Lake, Ridge 1 is flat-topped and exhibits a steep seaward face. In contrast, Ridge 2 has steep flanks, similar to younger kangari. Geophysical images show attenuation within Ridge 1, consistent with clay-rich core and a sand drape along the seaward slope. Ridge 2 exhibits seaward-dipping clinoforms overlain by hummocky cross-bedding in the aeolian sand lithosome at least 3 m in thickness. High iron content (mean bulk low-field magnetic susceptibility ~ 200-300 μSI) indicates prolonged weathering and explains attenuation (thick red clays), as well as accentuation (thin heavymineral and oxidation zones), of the electromagnet GPR signal. Optical dating is underway to help constrain the timing of early progradation (latest Pleistocene vs. early-mid Holocene), with the ultimate goal of testing a hypothesis of Baltic Sea storms as key mechanisms in the genesis of Kolkasrags mega-ridges.

O 29

GEOARCHAEOLOGICAL IMPLICATIONS OF BIOGENICALLY INDUCED HIGH-AMPLITUDE GPR ANOMALIES IN BALTIC AND BAHAMIAN COASTAL DUNES

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Keywords: aeolian, bioturbation, vegetation, diffraction

Subsurface investigations of coastal archaeological sites have been revolutionized by the application of ground-penetrating radar (GPR) imaging. An important aspect of site detection and characterization is the ability to both detect and resolve the cultural features (graves, middens, hearths, post holes) and large artifacts. Even where attenuation by saltwater or thick clays is not an issue, high-amplitude (>5 dB) hyperbolic diffractions from archaeological remains may be cluttered by point-source signal return from buried vegetation and bioturbation structures. Traditional methods of enhancing signal-to-noise ratio in B-scans and 3D images may have limited success due to similarities in dielectric properties of subsurface targets. This study presents examples of high-frequency (>500 MHz) georadar surveys proximal to several important archaeological sites (Great Dune Ridge, Lithuania; White Dune, Latvia; San Salvador, Eleuthera, and Little Exuma Islands, The Bahamas). Along the Baltic sea coast, buried trees, extensive root structures, and pediturbation by large ungulates must be considered as potential contributors to near-surface target clutter. At Bahamian sites, recent carbonate dunes have substantially higher numbers of unfilled burrows (mostly land crabs) and undecayed vegetation than their lithified equivalents (aeolianites). Experimental imaging of known targets and attribute analysis of radargrams (amplitude and velocity structure) will aid in improving our ability to discriminate between diffraction patterns of diverse origin.

O 30

SYNCHRONOUS SHIFTS IN NUTRIENTS AND MACROZOOBENTHOS IN THE EASTERN GULF OF FINLAND

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Keywords: bioturbation, bioirrigation, biological invasion, non-indigenous species

In the last decade the shift in near-bottom hydrochemical regime took place in the eastern Gulf of Finland, which coincided with drastic increase of biomass of macrozoobenthos because of introduction and mass development of invasive polychaetes *Marenzelleria arctia*. Under similar oxygen conditions, the pre-invasion years were characterized by higher phosphate concentrations than post-invasion years. In contrast, the concentration of inorganic nitrogen (nitrites and nitrates) increased markedly. Apparently, the main reason of these changes connected with burrowing activity of polychaetes. *Marenzelleria* spp. dig deeper than native Baltic species, affecting nutrient cycling and biogeochemical processes at the sediment – water interface. Bioturbation by polychaetes increases the nitrogen fluxes from the sediment to water column. Whereas the phosphate concentration declines because bioirrigation activity of polychaetes favors the penetration of oxygen into sediments resulting in formation of a thicker oxidized layer and subsequently in increased phosphorus retention. The opposite trends in the dynamics of nitrogen and phosphorus levels resulted in the increased N/P ratio. In the eastern Gulf of Finland it had positive consequences because of mitigation of harmful nitrogen-fixing cyanobacteria blooms during summer. However it is possible that in other seasons and/or areas the polychaete-induced increase of nitrogen concentration can stimulate eutrophication.

O 31

EXAMINATION OF THE EFFECTS OF WIND INDUCED FORCINGS ON SURFACE DRIFTERS CIRCULATION PATTERNS IN THE GULF OF FINLAND

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Keywords: Surface drifters, circulation pattern, Gulf of Finland

The surface circulation pattern of the Gulf of Finland is influenced mainly by the wind induced forcing(either directly through shear stress acting on the sea surface or indirectly via surface waves (Stokes drift)) and/or the underlying estuarine circulation pattern that also influences the sub-bottom layer. Many model simulations have successfuly attempted to replicate this surface layer circulation, that can often have a turbulent and meandering nature. However few recent studies have attempted by means of field experiments to investigate the surface circulation. In this study transport by surface currents in the Gulf of Finland is examined by use of surface drifters deployed within the period 2010-2014. Drifters were mostly deployed in pairs or triplets in order to study the relative separation rate. The correlation between drifter motion within a cluster was reduced as the separation distance increased, but some coordination of motion was often observed even for separation distances of several kilometres.

We examine in this study the effects of the wind on surface drifter motion by using data from the Kalbådagrund weather station in the central Gulf of Finland. The aim of the study is to investigate the correlation between drifter motion and wind direction and speed, and to examine if the wind forcing could explain the transition from highly correlated to uncorrelated drifter motion within a cluster.

O 32

USE OF STABLE ISOTOPES TO TRACK THE FATE OF CYANOBACTERIA PRODUCTION IN ESTUARINE FOOD WEBS

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Cyanobacteria blooms pose a threat to coastal fisheries due to the low nutritional quality of cyanobacteria and the potential for human exposure to cyanotoxins (e.g., Microcystin).

Our stable isotope study of a Baltic Sea coastal lagoon showed that transient changes in POM isotopic signatures during a cyanobacteria bloom propagated to primary and secondary consumers. These findings suggest that cyanobacteria production is rapidly exploited by diverse consumers. The variable rate at which consumers equilibrate to changes in their diet resulted in a gradient of consumer stable isotope values which paralleled the stable isotope shift in their food resources. We suggest that reconstruction of the food web at upper trophic levels should incorporate a multi-species baseline composed of both fast and slow-growing primary consumers. It also remains uncertain whether the isotopic signal of cyanobacteria is transformed during sedimentation when it becomes available to benthic fauna in this shallow ecosystem. Further work showed the long-term (>3 y) persistence of Microcystin in the food web, even in the absence of recurring blooms of toxin-producing cyanobacteria. We attribute this to the presence of Microcystin in sediments which are consumed by benthivorous fish, and pelagic fish when periodically resuspended through wind-driven mixing events.

O 33

IMPACT OF HURRICANE FELIX ON THE LITHUANIAN SE BALTIC SANDY BEACH

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Keywords: hurricanes, sandy beaches, erosion

Lithuanian sea coast has been affected by the several heavy storms in the XXI century, but last noticeable sea coast lost were done by the Hurricane Anatolij at the December of the 1999 when SW, S wind reached 40m/s. The total of 3,94 million m3 of sand was washed out from the Lithuanian coast. In January 10th-12th of 2015 Lithuanian Baltic sea coast were hit by Hurricane Felix with predominant WSW, W winds with up to 32 m/s wind speed in gusts.

Differently from hurricane Anatolij central part of the Palanga beach, historically one of the important Lithuanian summer resort, has not suffered from large damage after the storm. Up to two meters of the dunes high were washed away southerly from Palanga. This area was not under the coastal protection work program in 2006-2012. We can affirm that sand replenishment works, which were performed at the Palanga beach, helped protect this coastal sector from the significant sand losses. At the same time coastal stretch northward form Klaipeda straight lost 20 m of beach width in average, and dune was washed out. Formal military buildings which were covered by sand, now is open and appear on the beach. Hurricane Felix identified new areas of the Lithuanian sea coast which requires careful supervision and management to help faster coastal recovery and prevent future erosion.

O 34

NEW DATA ABOUT POSTGLACIAL DEVELOPMENT OF THE EASTERN GULF OF FINLAND

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Keywords: Late Pleistocene, Holocene, Eastern Gulf of Finland, paleogeography

Despite significant data amount there are still lots of debatable questions and unsolved problems concerning postglacial geological history of the Eastern Gulf of Finland. Among these problems are: 1) locations of the end moraine and glacial-fluvial deposits; 2) time and genesis of large accretion forms (spits, bars, dunes); 3) correlation of transgression/regression culminations with the other parts of the Baltic Sea basin; 4) study of salinity, the time, frequency and intense of Holocene saline water inflows and links of sedimentation processes with climate change. Aiming to receive new data about regional postglacial development, the GIS analyses of bottom relief and available geological data was undertaken to localize key study areas: areas of probable location of end moraine complexes; lake glacial sediments' disturbance, possibly caused by ice sheet oscillations; areas of the maximal and minimal thickness of different types of Quaternary deposits, convenient for different aims of long cores sediment sampling; areas of the "blue clay" horizon occurring between Ancylus and Littorina clays. In October 2014 four long cores were taken during marine research expedition onboard of R/V "N.Matusevitch". The high resolution study of the cores permitted to trace important changes in paleoenvironments, which will be correlated further with results of the IODP Expedition 347. Research is supported by RFBR Projects 14-05-91763 (joint VSEGEI-GTK project CISU) and 15-05-08169.

O 35

IMPACT OF MAJOR ENVIRONMENTAL STRESSORS ON BACTERIAL COMMUNTY IN THE BALTIC SEA

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Keywords: Baltic Sea, DOM source, Hypoxia, Nutrient load, Cyanobacterial bloom

Microbes are the first link in the food web and environmental conditions affect strongly on the composition of their communities. Despite their importance in the water bodies, influence of the surrounding conditions on the bacteria are not well understood in the Baltic Sea. Small-scale batch experiment (10 L) was carried out in western Gulf of Finland (Tvärminne, Finland) in the purpose to unravel the effects of hypoxia, dissolved organic matter (DOM) load, toxic cyanobacteria and adjusted N:P ratio to the structure of bacterial communtiy from the upper seawater column. Bacterial growth rates in the batches modified by DOM were most increased, indicating the importance of DOM to the heterotrophic bacterial growth. DOM loaded cultures also contained higher amount of nitrogen and phosphorus (similar to N:P modified culture) providing better growth conditions and led to higher growth rates in these batches compared to controls. On the contrary, bacterial growth was dramatically arrested by reduced O2 level. DNA samples collected over the experiment will be further analyzed enabling us to follow the trends in bacterial communities caused by environmental changes.

O 36

MEASUREMENTS OF WAVE TRANSFORMATION IN THE COASTAL ZONE

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Keywords: Ship wake, Wave transformation, Surf zone

Wave transformation in the coastal zone is analyzed based on field measurements of wave conditions at two measurement sites located about ~20 m and ~100 m from the shore. The measurement sites near Aegna Island in Tallinn Bay are partly sheltered from impact of wind generated waves but exposed to frequent occurrences of large amplitude ship wakes. Previous studies have established that the coastal morphology is strongly influenced by the ship wake impact at the site. These studies have largely relied on data of water elevation measured in a single point.

In the present study, measurements of water elevation are combined with measurements of particle velocity near the sea bed, in order to obtain a better understanding of the energy flux and momentum transfer associated with the wave motion. Furthermore, comparing wave measurements obtained at different distances from the shore provides information about the wave transformation in the surf zone. Analysis of ship wakes has revealed a reduction in potential energy as the waves propagate through the surf zone, which can be attributed mainly to the breaking of large amplitude, steep wave wake components, whereas the potential energy associated with long wave wake components was found to be stable or increasing, indicating that these waves undergo a non-breaking shoaling process.

O 37

VARIABILITY OF LOW-FREQUENCY CURRENTS IN THE GULF OF FINLAND

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Keywords: Gulf of Finland; ADCP measurements; vertical kinetic energy variability; bottom-trapped topographic waves.

Frequently observed strong currents appear characteristic to the lower layer of the Gulf of Finland (GoF). These currents are responsible for enhanced resuspension and transport of sediments near the bottom. The aim of this study was to determine the vertical distribution of kinetic energy of low-frequency currents, to find out the prevailing periods and to detect the physical factors responsible for the phenomenon. For that purpose the long term records of bottom-mounted ADCPs deployed along the GoF in different regions were studied. It was found that in many cases the maximum amplitudes of low-frequency currents were observed directly near the bottom and sometimes in the middle of the bottom layer. Still, there were also observation periods when the low-frequency variability did not exist. The dominant frequencies of oscillations varied by region in the GoF and therefore a role of bottom topography in determination of the observed oscillation frequencies could be expected. In the low-frequency range the rotary spectra of the current velocity revealed two high-energetic sub-ranges: the oscillations with periods 4 to 7 and 10 to 14 days. In cases when amplitudes of oscillations in the low-frequency range were increasing with depth near the bottom, the observed oscillations with periods 4 to 7 days could be interpreted as the bottom-trapped topographic waves. The varying wind from the south-west direction was assumed to be the main source of the energy forcing the oscillations.

O 38

CORRELATION AND CAUSATION: CHANGING BALTIC SEA CLIMATE

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Keywords: Climate change, Regional Sea, Correlation, Causality

The atmospheric concentration of CO_2 has been increasing the last centuries, but at an especially fast rate during the last 5-6 decades. Contemporary global air temperatures have been warming at a rather high rate and are well correlated with rising CO_2. Coinciding trends and good correlations are found in many other global and regional variables, as increasing sea level, increasing sea surface temperature, decreasing ice cover or increasing alien species entries.

However, correlation does not necessarily imply causation, as known from the good correlation between the number of storks and the number of newborn babies. Therefore we apply here a newly developed technique that allows discrimination between correlation and causality by quantifying the information flow between time series.

With this method we can demonstrate a clear one-way causality in the sense that the CO_2 increase is causing the temperature increase and not the other way around. This result cannot be inferred from traditional time delayed correlation analysis.

Many Baltic climate variables and ecosystem variables are well correlated as for example air temperature and alien species entry, but are they causal connected? We use this new method for answering the question for which variables correlation also means causation and for which not. For the first time we can demonstrate the strong causality of rising CO_2 levels on the increasing number of alien species entries.

O 39

ASSESSING THE OCEAN HEALTH OF THE BALTIC SEA

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Keywords: ecosystem-based management, holistic assessment,

As decision-makers shift towards more comprehensive approaches to managing ecosystems, management goals and targets increasingly focus on overall ecosystem health rather than on single sectors or stressors. This trend is particularly apparent for marine ecosystems. We present the recently developed international assessment Ocean Health Index and the ambition to develop a regional study, the Baltic Health Index (BHI). The aim of the BHI will be to assess the health of the sea in the relatively data-rich Baltic Sea region. The BHI will be developed in collaboration with scientists as well as policymakers and experts in countries around the Baltic Sea. The BHI will a) have the capacity to inform and guide regional marine ecosystems managers and policy makers, b) reflect regional priorities by modifying goal weights according to local priorities and c) to assess the impact of potential actions through "management scenario" studies. A state-of-the-art transdisciplinary research project, the BHI strives to create a new, comprehensive understanding of the health of the marine ecosystems in the Baltic Sea and is expected to heavily impact management in the region.

O 40

A SIMPLE APPROACH TO DETERMINE THE STOKES DRIFT FOR THE ENTIRE BALTIC SEA

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Keywords: Baltic Sea modeling, Stokes drift, sea state, surface waves

The ocean surface velocity is a combination of Ekman surface flow, baroclinic flow components and Stokes drift. The first two components can be calculated by standard hydrodynamic 3-dimensional ocean circulation models. But the calculation of the Stokes drift needs an additional approach. The Stokes velocity is a function of the significant wave height and period. It is important for the generation of Langmuir circulation which in turn contributes to the vertical mixing near the ocean surface and to the wind-driven surface transport. The Stokes drift can not be validated by direct measurements, but of course it can indirectly be validated by observed significant wave heights and periods. Furthermore, the determination of the wave climate by a wave model such as WAM is rather expensive. An alternative could be formulas for the calculation of sea state parameters (e.g. based on Schmager or Bretschneider) which are a function of wind speed and fetch only. Based on ERA-Interim reanalysis data (1979-2014), 10-m wind and the corresponding fetch data have been calculated for the entire Baltic Sea on a 2.5 km model grid. The wave climate calculated by Schmager's formula corresponds best with local wave observations in different positions of the Baltic Sea. Furthermore, from significant wave heights and periods we calculated annual means and seasonal variability of Stokes drift velocity for the entire Baltic Sea including Kattegat and Skagerrak. It turned out, that the Stokes drift velocity is a significant contribution to the surface flow field.

O 41

PROJECTED CHANGES OF THE SIGNIFICANT WAVE HEIGHT IN THE BALTIC SEA BY THE END OF 21TH CENTURY

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Keywords: Climate change, SWAN, numerical modelling

For the first time the response of monthly mean and 95th percentile of significant wave height to climate change by the end of the twenty-first century was evaluated in the Baltic Proper, assuming RCP4.5 global greenhouse gas emission scenario. The SWAN wave model with 3 nm spatial resolution was used for the simulation of the wave field for the period of 1966-2100. Regional climate projection for Europe at 12.5 km (EUR-11) resolution was used for the SWAN model simulation. The SWAN model was previously validated for the hindcast period of 1966-2006. All changes in mean and 95th percentile have been analysed for each month of the year over the time period of 2071-2100 relative to control period of 1971–2000. The focus is on the Baltic Proper where the ice coverage is rare and does not influence the wave field during winter month. Preliminary results indicate spatial heterogeneity of the response of monthly mean and 95th percentile of significant wave height to climate change.

O 42

PROFILING MOORING GODESS – THE FIRST 100 KM OF PROFILES FROM THE GOTLAND BASIN

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Keywords: profiling mooring, autonomous instrumentation, measurement, Gotland basin, redoxcline

The profiling mooring GODESS (Gotland Deep Environmental Sampling Station) is designed to autonomously collect profiles through the redoxcline between the oxygenated surface layers and the anoxic deep layer in the central Gotland Basin. The data allow assessment of shorter term dynamics of a number of parameters between the regular research cruises.

The main components of the profiling mooring are an underwater winch (Nichiyu Giken Kogyo Co. Ltd., Japan) and a custom build profiling instrumentation platform (PIP). The PIP payload initially consisted of a multi-parameter CTD (Sea & Sun Technology) and an optode dissolved oxygen sensor (Rinko).

In later deployments further instruments were added to a modified PIP2, namely a combined data logger and power supply (SubCtech), an optical nitrate sensor (TriOS), an acoustic current profiler (Nortek) and a microstructure profiler (Rockland Scientific).

While the configuration of the mooring is flexible most deployments were carried out with a 'parking depth' of 180 m and a minimum depth of 30 m (avoiding problems with ship traffic). So far in six deployments in the Gotland basin over 700 profiles through the redoxcline with a total length of 108 km have been recorded giving new insights in the dynamics of the redoxcline. The dissolved oxygen concentration in the hypoxic depth range (about 70 m to 120 m) shows short lived fluctuations, occasionaly intrusions of higher dissolved oxygen concentration waters down to 140 m depth have been observed.

O 43

LONG-TERM TRENDS OF HYPOXIA IN THE COASTAL ZONE, NORTH-WESTERN BALTIC PROPER

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Keywords: hypoxia, eutrophication, climate change, diatom stratigraphy, IODP Expedition 347

In the open Baltic Sea, Holocene hypoxic events are recorded during three time periods: Holocene Thermal Maximum, Medieval Climate Anomaly and Modern Warm Period, but in the coastal zone data on long-term trends are lacking. There is currently no consensus on what caused the past oscillating oxygen content in the open Baltic Sea; proposed explanations include changes in agricultural practice and land-use, fluctuations in human population density in the drainage area and climate change.

This ongoing project aims to disentangle the role of human-induced and natural climate-driven processes that have resulted in times of eutrophication and hypoxia in the Baltic Sea during the last 2000 years. Research is focused on the coastal zone where responses to changed human land-use can be expected to be first recorded. This a multiproxy study uses sediment core diatom stratigraphy and geochemistry and published historical data on land-use changes. Eight sites from the Swedish east coast have been cored and radiometrically dated. Total nitrogen content changes will be reconstructed using diatom-based transfer functions. Lithologic descriptions using laminated sediments as a proxy for hypoxic conditions will increase the knowledge on the extension of coastal hypoxic areas in time and space. A link to the open Baltic Sea and possible asynchronous development will be achieved by correlating to a unique high resolution sediment record from Site M0063 Landsort Deep, drilled within the IODP Expedition 347.

O 44

ABSTRACT ON THE DYNAMICS OF THE RIVER BULGE USING SATELLITE IMAGERY AND NUMERICAL MODEL, CASE STUDY OF DAUGAVA RIVER BULGE.

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Keywords: buoyant river bulge, satellite remote sensing, numerical modelling, coastal circulation, Gulf of Riga

The dynamics of buoyant water entering the coastal non-tidal sea is studied using satellite images of total suspended matter (TSM) concentrations and numerical circulation model GETM in the Gulf of Riga (GoR) of the Baltic Sea in March 2007. Fresh water from Daugava River which is discharged at the head of the GoR forms a buoyant bulge. A period of 11 days of low wind allows us to study the bulge formation as well as estimate the spreading velocity and rotation inside the bulge. An estimation of bulge radius from satellite imagery confirms that the bulge expands proportionally to the bulge Rossby radius. The recirculating bulge grows radially as ~ t^0.4 that is in good agreement with laboratory experiments. Numerical model simulation run is made for the same study period. Simulated bulge reproduces the evolution of the observed bulge, but the offshore extent of the bulge is underestimated. The distribution of total suspended matter concentration inside the bulge as well as model simulation results confirm that rotation inside the bulge is anti-cyclonic. Satellite images show that after decrease of the river inflow the bulge is transported along the left hand coast of the river mouth due to anti-cyclonic ambient circulation in the south-east of the GoR.

O 45

RESPONSE OF WATER CIRCULATION, TEMPERATURE AND SALINITY TO WIND WAVE EFFECTS IN THE BALTIC AND NORTH SEA'S

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Keywords: waves, currents, temperature, salinity, NEMO,WAM

The effects of wind waves to the Baltic Sea–North Sea (BS-NS) hydrodynamics are studied by coupling the hydrodynamical model NEMO with the wave model WAM. The wave forcing terms that have been taken into consideration are: (1) the Stokes-Coriolis force, (2) turbulent kinetic energy created by breaking waves and (3) the wave dependent wind stress. Both models have a horizontal resolution of 2 nautical miles. The hourly atmospheric forcing is taken from German Weather Service (DWD). The open boundaries of the BS-NS model system are situated in west of English Channel and near the continental shelf break of the North Sea.

The role of wind, waves and tidal forcing are quantified. The performance of the coupled model system is illustrated for several extreme event cases. The effects of ocean waves on circulation, temperature and salinity simulations are investigated. The role of the new wave parametrization on mixing processed in the Baltic Sea is analysed and the simulations are compared with data from observations. The effects, which the circulation exerts on the wind waves is tested for the Baltic Sea area as well. The examples provided in this study are considered as a step towards further developing new coupled ocean forecasting systems for the Baltic Sea area.

O 46

INTERACTIONS BETWEEN SUBBASINS MITIGATE THE EFFECTS OF HYPOXIA ON CENTRAL BALTIC SEA NUTRIENT DYNAMICS

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Bottom topography divides the Baltic Sea into a system of interconnected subbasins. Its central deep area, the Central Baltic Sea, is characterized by a strong permanent halocline, which makes the basin sensitive to hypoxia. We use a series of BALTSEM model simulations forced by a nutrient load gradient from preindustrial loads to hypertrophic conditions to demonstrate how the resulting hypoxia affects nutrient and phytoplankton dynamics in the Central Baltic Sea itself. Further, we show that export to neighboring basins mitigates the effect of increased phosphorus release from the Central Baltic Sea sediments and analyze the effects on the recipient subbasins.

O 47

REGIME SHIFTS IN THE NATURAL ENVIRONMENT IN THE NORTHERN BALTIC SEA REGION IN LATE 1980s

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Keywords: climate change, regime shift, meteorology, marine systems, hydrology, coastal proceses, land ecosystem, Baltic Sea

There are numerous evidences of regime shifts in the North Atlantic and European region in the late 1980s. The aim of this study is to demonstrate its impact to the fresh water and marine systems, coastal processes and land ecosystem in the NE Baltic Sea region. Rodionov test was used based on measured time series complemented with a few numerical model simulations (1950-2013). AO and NAO indices showed the most obvious intensification of westerlies in February 1989. On a local scale, a positive shift in wintertime air temperature together with some increment in precipitation was detected in 1989. Similarly, a positive regime shift was observed in monthly discharges of all Estonian rivers in January-March and negative shift in April 1989. The wintertime positive shifts in 1989 were quite distinctive in the selected series of sea level data and significant wave height semi-empirical hindcast at the coast of Estonia. The positive regime shifts were detected in wave period and significant wave height in February 1989. Shore processes were intensified from the beginning of the1980s until the middle of the 1990s. In marine biology variables the regime shifts were likely around 1970 and 2000. Strongly expressed regime shift reflected by bog pines occurred in period 1968-1972 and remained high until next shift in 1990 and followed by weaker shift in 2004.

O 48

KNOWLEDGE ON MARINE GEO-BIOINTERACTIONS FOR THE SPATIAL PLANNING AND CONSERVATION OF THE GULF OF FINLAND

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Keywords: Gulf of Finland, Ecosystem based management, Biodiversity, Geodiversity

Ecosystem based management (ESBM) requires accessible and reliable information concerning the state, species distributions and physical characteristics of coastal and marine environments. Nevertheless this type of marine environmental data is often spatially limited and collected using different methods. Here we will present an example of an interdisciplinary approach that targeted to integrate marine environmental knowledge with information about human pressures.

We have produced new spatial knowledge on marine environmental characteristics by studying geo-bio interactions in a fragmented seafloor area, the Eastern Gulf of Finland. Here we will present our key findings regarding the benthic environment and demonstrate that physical heterogeneity of the seafloor should be considered in broad scale habitat mapping and marine spatial planning.

The study was made within ENPI CBC funded Finnish-Russian co-operation project, the TOPCONS (2012-2014). The aim was to develop innovative spatial tools for the regional planning of the sea areas in the Gulf of Finland, the Baltic Sea.

O 49

ECOSYSTEM FUNCTIONING IN COASTAL AREAS – THE ROLE OF THE MACROFAUNA

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Keywords: benthic macrofauna, ecosystem functioning, nutrient fluxes, biological traits, Baltic Sea

The heterogeneous coastal areas are important, since they maintain many vital ecosystem functions, such as primary production and nutrient cycling, as well as a high biodiversity. The activities of the benthic macrofauna are tightly linked to biogeochemical processes included in nutrient transformation and retention in marine sediments. Thus, it is important to investigate the biodiversity-ecosystem functioning relationships in order to enhance our knowledge and development of sufficient nutrient management strategies for our coastal areas. Studies have shown that the benthic macrofauna affects the biogeochemical processes at the sediment-water interface, but few have explored and compared the relationships under natural conditions in different habitats and over gradients. We sampled 18 stations on a gradient from silt to coarse sand while ensuring to include the variability of shallow coastal habitats regarding vegetation and exposure. Sediment cores from each station were incubated in order to obtain information on sediment oxygen and nutrient fluxes to accompany the faunal results. With this information we are able to observe links between nutrient cycling processes and faunal functioning, as well as possible differences in functional trait distribution across habitats.

O 50

RESPONSE OF MACROALGAL VEGETATION TO EUTROPHICATION AND NATURAL ENVIRONMENTAL GRADIENTS – IMPLICATIONS FOR INDICATOR DEVELOPMENT

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Keywords: macroalgae, indicators, eutrophication, WFD, MSFD

Marine macroalgae are important ecosystem components as efficient primary producers and by providing habitat for a large number of species. This means that abundance, diversity and composition of macroalgae are highly relevant indicators for marine ecosystem health. Macroalgal communities respond to a range of natural environmental gradients such as salinity and wave exposure, which makes it challenging to identify indicators that respond predictably to anthropogenic pressures across sea areas. We have analysed how a number of variables describing macroalgal abundance, diversity and composition respond to antropogenic pressure (from eutrophication) and natural gradients (depth, salinity and wave exposure) along the Swedish coastline, representing a long gradient in climate and salinity from Skagerrak to the Bothnian Bay. The analyses are based on a large monitoring data set on benthic vegetation. Of the tested variables, cumulative cover and species richness of macroalgae showed the clearest response to eutrophication across the whole study area. For these variables, around 80% of the variation between areas could be explained by water quality together with the measured natural gradients. The results suggest that cumulative cover and species richness of macroalgae may act as promising indicators for eutrophication in coastal waters of the Baltic Sea. The applied method proved to be useful for the development of biological indicators that can be applied across strong natural gradients.

O 51

ANALYSIS OF AN OFFLINE COUPLING APPROACH FOR THE NORTH-BALTIC SEA

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Keywords: Danish Straits, Two-Way Coupling

Aim of the study is to evaluate the performance of coupled North and Baltic Sea models with an enhanced resolution in the Danish Straits area, where the focus of the evaluation is on the integrated transport through the Danish Straits. The reference coarse resolution setup includes both basins, uses a 2 nm resolution in the horizontal and 21 terrain-following sigma-levels in the vertical. The second setup includes three nested areas: one for the North Sea, one for the Baltic Sea and one for the Danish Straits. The horizontal resolution for the North Sea and the Baltic Sea nests is coarse as in the reference setup. In the vertical the North Sea model uses the same grid as the reference setup. The Baltic Sea model uses 35 z-levels in the vertical. For the Danish Strait we set up a finer horizontal resolution model with 0.5 nm in the horizontal and 31 terrain-following sigma-levels in the vertical. The two coarse resolution models include the entire area of the fine resolution model. Temperature and salinity fields are exchanged between the three models. The coarse resolution model runs are segmented in a one day hindcast and a one day forecast phase. During the hindcast phase the coarse resolution models receive the enhanced fine resolution information via a nudging approach. During the forecast phase of the coarse resolution model no nudging is applied and the models run in a free prognostic mode. In the next cycle of coupling procedure the fine resolution model is rerun for the whole hindcast-forecast period of the coarse resolution models using interpolated coarse resolution output as boundary condition.

O 52

COMBINING SHORT- AND LONG-TERM SEA LEVEL VARIATIONS TO EVALUATE FUTURE FLOODING RISKS ON THE FINNISH COAST

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Keywords: sea level, sea floods, flooding risks, coastal planning, Baltic Sea

Preparing for sea flooding is an essential part of coastal planning in the changing climate. A method of combining two independent sea level distributions, one for mean sea level change and the other for short-term sea level variations, is presented here. The combination is made using the probability of the sum of two independent random variables as a central tool. By combining short- and long-term sea level distributions, we can establish a comprehensive overview of sea level changes in the future and form combined sea level distributions (flood level distributions) for the Finnish tide gauge locations. Short-term sea level changes originate mostly from weather phenomena (e.g. wind and air pressure). In our assessment, the distribution of short-term sea level changes consists of 30 years (1982-2011) of data from the 13 tide gauges on the Finnish coast. The long-term mean sea level scenarios include land uplift, global sea level projections that are adjusted regionally for the Finnish coast, and changes in the total amount of water in the Baltic Sea. The outcoming combined distributions give estimates of sea levels at different exceedance probabilities for the years 2050 and 2100. According to the results, flooding risks will increase from their present level everywhere on the Finnish coast by 2100. Also differences in combined sea level distributions between the years 2050 and 2100 can be seen in all of the studied tide gauge locations.

O 53

GEOGRAPHIC DATA PROPERTIES AND APPLICABILITY IN MARITIME SPATIAL PLANNING

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Keywords: Maritime spatial planning, Spatial data, GIS

Maritime spatial planning (MSP) involves geographic data in three roles: 1) as input describing the current state of affairs in the marine space, 2) as material in analyses about different processes and their spatial relationships, and 3) as means to communicate planning results in graphical form, i.e. maps. The spatial data requirements of MSP are diverse, involving several sectors of administration, business, research and society in general. Thus, a great variety of data sources, data types and data management practices must be brought together, especially in international activities. The variety is reflected in the information content of the data: why, how, and by whom the data have been collected and compiled has a significant impact on the applicability of data. As the information carried in data is a subjective presentation of a given issue, metadata should be reviewed carefully when working with marine GIS in order to verify that the data actually include the information which is assumed. We present a structured view of spatial data properties and applicability in MSP, with emphasis on semantic interoperability and information content. Also spatial conformity and spatial scale are discussed in the context of cross-border cooperation in MSP. We draw experiences from the initial phases of a project supporting the Gulf of Finland MSP process.

O 54

RENEWED CIRCULATION SCHEME OF THE BALTIC SEA – BASED ON THE 40-YEAR SIMULATION WITH GETM

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Keywords: Baltic Sea, hindcast, termohaline circulation, long-term hydrodynamic modelling, currents

The general circulation of the Baltic Sea has been characterized as cyclonic in all sub-basins based on numerous measurements and model simulations. From the long-term hydrodynamical simulation our model results have verified the general cyclonic circulation in the Baltic Proper and in the Gulf of Bothnia, but the Gulf of Finland and the Gulf of Riga have shown tendency to anticyclonic circulation. We have applied the General Estuarine Transport Model (GETM) for the period of 1966 – 2006 with a 1 nautical mile horizontal resolution and density adaptive bottom following vertical coordinates to make it possible to simulate horizontal and vertical density gradients with better precision. The atmospheric forcing from dynamically downscaled ERA40-HIRLAM and parametrized lateral boundary conditions are applied. Model simulation show close agreement with measurements conducted in the main monitoring stations in the BS during the simulation period. The geostrophic adjustment of density driven currents along with the upward salinity flux due to entrainment could explain the anticyclonic circulation and strong coastal current. Mean vertical velocities show that upward and downward movements are forming closed vertical circulation loops along the bottom slope of the Baltic Proper and the Gulf of Bothnia. The model has also reproduced patchy vertical movement across the BS with some distinctive areas of upward advective fluxes in the GoF along the thalweg. The distinctive areas of deepwater upwelling are also evident in the Gdansk Basin, western Gotland Basin, northern Gotland Basin and in the northen part of the Bothnia Sea.

O 55

MESOSCALE VARIABILITY AND RIVER PLUME DYNAMICS IN THE GULF OF RIGA (A MODEL STUDY)

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Keywords: Gulf of Riga, POM model, river plume, coastal currents, eddies

A regional eddy-resolving model is developed (based on the Princeton Ocean Model; horizontal resolution 0.5 nm, 20 sigma layers) to study mesoscale processes in the Gulf of Riga in relation to river runoff, saltwater inflow, and atmospheric forcing. A number of mesoscale phenomena are simulated and discussed, such as meandering of coastal buoyant plume/current of riverine waters and formation and splitting of cyclonic eddies related to the saltwater inflow. It is shown that the Daugava River discharge forms a "classical" surface-advected plume (Yankovsky and Chapman, 1997) consisting of a growing anticyclonic bulge and coastal buoyant jet. In the absence of other forcing factors, the total river runoff is distributed between the anticyclonic bulge and the coastal current in proportion of about 7:6. In the summer season, some fraction of freshwater from the anticyclonic bulge is transported to the north by the anticyclonic whole-basin circulation gyre leading to the formation of an intrusion with salinity inversion of approximately 0.1 g kg^{-1} in the subsurface layer. In the case of no atmospheric forcing, the saltwater inflow into the gulf consists of a chain of cyclonic eddies, which propagate to the east and split into smaller cyclones in the gulfs interior.

O 56

MORTALITY AND GROWTH AT LARVAL STAGE: ADVANCING THE UNDERSTANDING OF STOCK DYNAMICS PROCESSES IN THE GULF OF RIGA SPRING SPAWNING HERRING (*CLUPEA HARENGUS MEMBRAS*)

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Keywords: coastal area, *Clupea harengus membras*, water temperature, prey abundance, temporal overlap

Revealing the mechanisms what determine the recruitment abundance is one of the key elements in understanding the general stock dynamics of fishes. Evidence suggest that in the Baltic spring spawning herring, as in most of marine fish species, the regulation of year class abundance occurs during the short period of the early life history. The recruitment abundance of the Baltic herring may vary in a broad range between years, referring to highly variable conditions experienced during the early life history stages. The fine-scale monitoring data on herring larvae and their prey in a coastal habitat in the Gulf of Riga revealed a statistically significant relationship (r^2=0.63) between the abundance of large larvae (>17mm) and herring recruitment in 2004-2013. The present study sheds some light on habitat conditions that influence the larval traits of herring, such as instantaneous mortality rate and individual somatic growth. The key habitat characteristics involved into the analysis include water temperature, abundance of the main prey – the copepod *Eurytemora affinis*, and match-mismatch between the occurrence of larval fish cohorts and their prey.

O 57

BALTIC SEA OCEAN STATE PREDICTIONS BY ASSIMILATING OF TEMPERATURE AND SALINITY DATA

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Integrated ocean observing systems closely link in-situ and remote measurements with numerical models enabling the reconstruction and forecast of key state variables with full spatial coverage. Such a nowcast/forecast model system has been developed for the North Sea-Baltic Sea. It is used to produce nowcasts and short-term forecasts of the circulation and physical properties in the North Sea/Baltic Sea One of the expectations is that the model can provide consistent temperature and salinity three-dimensional fields to fill in the gaps in observation and satellite observations and eventually produce reliable physical components to be used in further bio-geochemical/management/ fishery applications.

The three-dimensional primitive equation model GETM ("General Estuarine Transport Model") is used to simulate the circulation and salinity and temperature fields for the North Sea-Baltic Sea system. The atmospheric data from the German Weather Service (DWD) are used for the metereological forcing. This work presents a framework of the nowcast/forecast system, which includes an algorithm to assimilate temperature and salinity derived from measurements (such as FerryBox, MARNET stations, etc.) as well as satellite derived sea surface temperature (SST) for the Baltic Sea.

The numerical performance of the Baltic Sea model with the data assimilation method based on Kalman filter appears to be efficient enough to be used in an operational ocean forecast system. For the assessment of forecast skill of the regional ocean model we compare the free run and assimilation run with independent data from observations. Model-data comparison shows that the reanalysis produced by the data assimilation fairly well represents the physical properties in the Baltic Sea. The overall root-mean-square errors between temperature and salinity fields of reanalysis and observation are significantly reduced after the assimilation. Furthermore, seasonal variation in temperature is well reproduced and the predicted synoptic variation is significantly correlated with its counterpart from the mooring measured temperature. Of particular interest is the question how long the information from the measurements used in the model predicted system has an influence on the forecast.

O 58

CONTROLS ON METHANE FLUXES AND TURNOVER IN THE WATER COLUMN OF THE BALTIC SEA – A REVIEW REFLECTING THE POTENTIAL IMPACT OF THE 2014/2015 MAJOR INFLOW EVENT

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Keywords: biogeochemistry, greenhouse gases, methane, review, inflow, long-term data series

The Baltic Sea is a unique natural laboratory to study the marine methane cycle. With its brackish character, a gradient from nearly marine to almost limnic conditions, and large vertical redox gradients in the water column, the Baltic and its individual sub-basins cover a wide range of boundary conditions for the methane cycle and its controlling variables. Over the past several years, we performed intensive research on the distribution of methane in the water column of the Baltic, its transport, and microbial oxidation in the pelagic redoxcline. We also monitored the spatiotemporal pattern of methane concentrations in the surface waters using continuously operating instrumentation on a voluntary observing ship. Major findings include:

- high methane concentrations (> 100 nM) are confined to the anoxic parts of the water column;
- methane oxidation predominantly takes place in the Pelagic redoxcline by a single phylotype of a type I methanotroph, and its extend is mainly controlled by physical transport of methane from the methane-rich deep anoxic waters;
- enhanced surface concentrations are usually linked to physical transport processes such as sporadic wind-induced complete mixing of the water column, mixed layer deepening in late fall and winter, or coastal upwelling;
- in the central Baltic, a slight oversaturation of the surface waters with respect to the atmosphere between spring and fall appears to be maintained by *in situ* production in the subsurface layer rather than transport from the methane-rich deeper waters.

Based on our findings, and data still to be gathered over the next couple of months, we will also venture into some insights how the 2014/2015 major inflow is likely to affect the methane cycle in the water column in the years to come.

O 59

TRENDS IN EXTREME WATER LEVELS OF THE EASTERN BALTIC SEA

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Keywords: Water level, Storm surge, Baltic Sea

The course of the local water level does not follow any simple rule. Still, its linear trends based on its past behaviour allow for a first approximation of its present and future. The aim is to analyse separately the contribution of drivers that act at different scales into the overall course of water level. A specific feature of the Baltic Sea is the possibility of extensive variations in the entire water volume on a weekly scale. We construct a separation procedure of the weekly-scale and short-term variations into a weekly-scale average (a proxy of the water volume of the entire sea) and a residual (total water level minus the average) that characterises storm surges.

Long-term changes in the extremes of these constituents of the water level in the eastern Baltic Sea are studied separately using numerically simulated water level time series (1961-2005) produced by the RCO model and observed time series from 4 sites along the Estonian coast.

The annual maxima of the weekly-scale average exhibit an increasing trend. The slope of the trendline is almost constant over the entire study area from Kurzeme Peninsula and the Gulf of Riga to the eastern Gulf of Finland. The slopes of trendlines of the maxima of the residual (storm surges) vary from almost zero to a level twice as large as the similar slope for the weekly average. This signals that a large part of the variability in the extremes of the local water level in the Baltic Sea is controlled by changes in storm directions.

O 60

MODELING THE GENERATION AND TRANSPORT OF PARTICULATE ORGANIC CARBON IN THE BALTIC SEA WATERSHEDS

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Keywords: Model, POC, Watershed, Baltic Sea, Erosion, Litterfall, Primary production

Approximately twice as much terrestrial carbon enters inland freshwater systems than is exported directly to the sea and this makes rivers an important system boundary between the terrestrial and the aqueous environment. In the Baltic Sea catchment rivers are the largest input source of carbon to the marine environment, but also globally rivers are an important carbon source. In the present study a novel, dynamic mass balance model is developed for the riverine flux of particulate organic carbon (POC) from all the major watersheds draining into the Baltic Sea catchment area. The dominating factors regulating the POC generation and transport in rivers, i.e. terrestrial (allochthonous) production, water fluxes and in-stream primary (autochthonous) production, are described in the model in relation to land use (e.g. forest, cultivated land, urban areas) within each watershed to yield the total monthly mass of POC discharged to the Baltic Sea via rivers. The model is parameterized using GIS data on soil and topographical characteristics and the driving forces are hydrological parameters and seasonal fluctuations in leaf onset and offset. The developed model gives a comprehensive insight into the current knowledge of POC dynamics in whole river systems in relation to land use and can be used as a means of identifying areas where important information is lacking in the Baltic Sea catchment area.

O 61

A ZOOM TO THE GULF OF FINLAND HYDROGRAPHY

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Keywords: Gulf of Finland, hydrography, model, temperature, salinity, NEMO

The Gulf of Finland Year 2014 aimed at better understanding of the environmental problems in the gulf. Understanding the marine environment is based on the knowledge of the detailed physics of the sea. The Gulf of Finland has been in focus already for decades, but the small dynamic scales and large horizontal and vertical gradients make the studies still demanding.

FMI conducted three cruises to the gulf in 2013 - 2014 using a relatively dense grid that was possible to cover in the ship time allocated for hydrographic measurements. The three data sets from our 84-point grid shows that more attention should be paid to the bottom boundary layer in areas where the halocline is near to or intersects the bottom. These data sets are also very valuable for verification and development of the hydrodynamic models. Preliminary comparisons between data and FMI's NEMO implementations results demonstrate the necessity of having high resolution spatial data in evaluating the models ability to simulate the 3D structure of the temperature and salinity. Although the model simulated the surface salinity fairly accurately at most of the comparison points it had some difficulties in producing the salinity gradients. For example the more saline surface water in the Estonian coast extended further to the gulf than was simulated in the model.

O 62

A MULTI-YEAR WAVE MEASUREMENT CAMPAIGN IN THE HELSINKI COASTAL ARCHIPELAGO

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Keywords: wave measurements, coastal archipelago, sheltering, maximum wave height

The Finnish shoreline structure and coastal archipelago results in a heterogeneous wave field that is a challenge to evaluate. Nevertheless, accurate information about the maximum wave height is central for the planning of coastal structures. In addition, even heavily attenuated longer waves penetrating the archipelago can affect floating constructions. In 2012 the City of Helsinki launched a research project relying on model results and extensive measurements aimed to map the wave field in its archipelago. By 2014 wave measurements from 15 locations were completed, while wind measurements at two locations are still ongoing. The wave measurements, with a typical length of about one month, are compared to FMI's operational wave observations from the central Gulf of Finland. The campaign confirms that the wave conditions are very heterogeneous; variability is observed not only between the outer and the inner archipelago, but also between different locations that at first glance seem to represent equally sheltered conditions. The wave height at the outer archipelago is already significantly lower compared to that of the open sea, but the exact rate of the attenuation and shape of the wave spectrum is highly dependent on the wave direction. The inner archipelago wave field is usually generated by the local winds with a small (or no) amount of low-frequency wave energy propagating from the open sea, although this characterisation of a typical wave field is not without exceptions.

O 63

GLIDERS IN THE BALTIC SEA

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Keywords: Baltic Sea, glider, hydrography, marine observations, autonomous vehicle

The use of gliders is a rapidly growing branch of global oceanography. European glider users have build a concept for European glider infrastructure in the EU funded project GROOM in 2012-2014. The project scopes were from legal to financial frameworks, from technologies to glider component of GOOS and to targeted experiments. The deliverables form a solid basis forfuture work with gliders in the Baltic Sea, too.

The Baltic Sea is a demanding area in administrative, logistic and scientific senses. Close co-operation is a necessity because of many EEZ's. Ship traffic is intensive in areas that are also scientifically interesting. The dynamic scales are small and horizontal and vertical gradients big.

FMI conducted a glider experiment in the Bothnian and Archipelago Seas in 2013 under GROOM with PLOCAN, Spain. We proved the usefulness of gliders in giving new detailed insight to the dynamics of the sea in coastal zone and in the archipelago using both section and virtual mooring techniques.

New monitoring demands with diminishing resources force to find complimentary observation capabilities. FMI already uses Argo buoys successfully in the Baltic Sea. Gliders can be the next step to view the marine processes. We foresee new possibilities for studies of frontal dynamics and the coastal open sea interaction and even studies under the sea ice. Gliders can easily collect many-sided data to a broad scientific community.

O 64

ECOLOGICAL MODEL OF THE RIGA BAY AREA: A CONTRIBUTION TO THE BONUS PROJECT BIO-C3

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Keywords: Ecological model, Riga Bay, Baltic Sea, BIO-C3

One objective of the ongoing BONUS project BIO-C3 "Biodiversity changes-cause, consequences and management implications" is to increase our understanding of the food web processes by quantifying bottom up and top down control of biodiversity in the Baltic Sea on regional and local scale. The importance of bottom up control is studied in the Riga Bay and the Odra-Rygen area using fine scale ecological modelling. Model results for Riga Bay are presented covering 8 years (2000-2007) but it is planned to cover 1970 to 2007 on a later stage. Besides simulating the hydrodynamic parameters the ecological part of the model include nutrients, oxygen, 3 phytoplankton groups, benthic macroalgae (ephemeral and perennial), rooted vegetation, a suspension feeding mussel (*Mytilus edulis*) and a deposit feeding mussel (*Macoma balthica*). The presented model results will be used to model the "connectivity" or spreading of the mentioned mussels and the vegetation and serve as input for estimation the "bottom-up" and "top-down" control. The latter task include predation by fish and grazing of birds on vegetation and predation on the mussels.

O 65

MODELING SUBMESOSCALE PROCESSES IN THE GULF OF FINLAND - CASE SCENARIO UPWELLING EVENTS IN THE SUMMER 2006

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Keywords: Gulf of Finland, modeling, mesoscale, submesoscale

The present study is aimed to estimate the role of submesoscale processes in the Gulf of Finland using the model simulations and real case scenario for the summer 2006 when a series of upwelling events occurred along the southern coast of the gulf. These upwelling events were widely documented by in situ observations and satellite sea surface temperature (SST) maps making it possible to validate different simulated parameters. The model applied is the Princeton Ocean Model with a domain comprising the Baltic Sea with orthogonal grid. Simulations with different horizontal resolution in the Gulf of Finland, from the lowest resolution of 0.5 nautical miles to the highest resolution of 0.125 nautical miles, have been carried out to detect and emphasize the role of submesoscale processes. The initial conditions of the thermohaline fields is taken from the High Resolution Operational Model of the Baltic Sea (HIROMB) andatmospheric forcing from the High Resolution Limited Area Model (HIRLAM). The ability of the model to reproduce upwelling and its relaxation process was verified from comparison with the simulated SST images. In addition, the validation of the model against in situ measurements from the transect Tallinn-Helsinki has been carried out. The changes of the modeled wavenumber spectra of parameters due to the increased resolution will be discussed. The simulated submesoscale patterns of vorticity field were found to be completely different depending on the upwelling phases such as the active upwelling phase and the relaxation upwelling phase.

O 66

FOOD WEB STRUCTURE IN THE COASTAL AREAS OF THE NEVA ESTUARY UNDER EUTROPHICATION

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Keywords: trophic interaction, invasive species, eutrophication, coastal community

This paper studies dynamics of macroinvertebrate communities and shifts in structure of biocenosis under eutrophication phenomena in the Neva River estuary, largest estuary of the Baltic Sea. High nutrient inputs to the Neva estuary result in algal blooms and in deoxygenating of near-bottom areas during algae decomposition. The hypoxia shifts structure of macroinvertebrate communities leading to a decrease of species number and abundance. The community in these stressed habitats consists mainly of eurybiotic taxa (chironomids, annelids and recent invasive amphipods and molluscs) that are tolerant to the temporal threats and capable reproduce their biomass over short time.

The assessment of species significance in the food web dynamics was performed, and their possible impact on different food chains as a result of predation was evaluated. Stable isotope analysis (δ15N) allocated several trophic levels in the coastal food webs of the Neva estuary. The lowest values (2-4 ‰) were evaluated for detritus and algae (producers), and the largest for carnivorous invertebrates (8-10,5 ‰) and fish (12-14 ‰). Important role of newly established invasive amphipods (Gmelinoides fasciatus, Gammarus tigrinus, Pontogammarus robustoides) in coastal food chains are confirmed by this analysis. These species are classified as omnivores (consumers of second and third orders), capable to change their food habits from typically plantivorous to carnivorous preying upon other invertebrates (chironomids, isopods, oligochaetes). We conclude that the species position in trophic structure of the estuary is vary being determined not only species abundance and its food habits but related to hierarchical complexity of community, food resources availability and degree of ecosystem disturbance under eutrophication.

O 67

SEPARATION OF THE BALTIC SEA WATER LEVEL INTO SHORT-TERM AND MULTI-WEEKLY COMPONENTS

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Keywords: water level; subtidal scale; statistical analysis; Poisson distribution; Baltic Sea

The largest contributors to the water level variations at the eastern Baltic Sea coasts are storm surges and changes in the water volume of the entire sea. A large difference in their typical time scales (about a day and a few weeks, respectively) makes it possible to separate the relevant constituents in the water level time series.

We employ time series of sea levels numerically reconstructed using the RCO (Rossby Centre, Swedish Meteorological and Hydrological Institute) ocean model for 1961–2005. The distribution for the weekly-scale water level is defined as a running average over a certain time interval. The distribution of the frequency of occurrence of various average water levels has an almost Gaussian shape for a wide range of averaging lengths.

The residual (total water level minus the weekly average) can be interpreted as reflecting the contribution of storm surges to the water level. The shape of the distribution of this constituent (equivalently, storm surges of different height) substantially varies for different averaging lengths. Importantly, it almost exactly matches a Poisson distribution for 8-day average.

All outliers of the water level are a part of the Poisson-like distribution of storm surges for averaging intervals >3 days. This separation is universal for the entire eastern Baltic Sea coast. The slopes of the Poisson-type distribution provide a useful quantification of different coastal sections with respect to the probability of coastal flooding.

O 68

ENSEMBLE APPROACH FOR THE PROJECTIONS OF EXTREME WATER LEVELS REVEALS BIAS IN WATER LEVEL OBSERVATIONS

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Keywords: water level, extreme value distribution, ensemble approach, wave set-up

The complexity of the impact of various drivers of the water level in the eastern Baltic Sea and the presence of statistically almost impossible outliers in the time series of observed and modelled water level naturally lead to large spreading of projections of future extreme water levels and their return periods. We present several outcomes of the technique of using an ensemble of projections for return periods of extreme water levels in Estonian coastal waters.

The ensemble is constructed via fitting several sets of block maxima (water level maxima over calendar years and over stormy seasons) with a Generalised Extreme Value, Gumbel and Weibull distribution. The projections are based on two data sets with a different resolution (6 h and 1 h) produced by the Rossby Centre Ocean model (RCO; Swedish Meteorological and Hydrological Institute). The data are complemented by observed values from four sites along the Estonian coast.

The analysis reveals two types of coastal segments. If the observations represent the offshore water level well, the errors of single projections are randomly distributed and a certain average over the ensemble provides a rational projection. In some locations the observed water level involves local wave-driven impacts. In such cases the resulting ensemble consists of two distinct clusters. The difference between the clusters of projections can be interpreted as an indirect measure of the impact of local features on the water level observations.

O 69

BIOLOGICAL EFFECTS OF CHEMICAL WARFARE AGENTS ANALYSED IN THE HEAD-KIDNEY OF COD

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Keywords: CWA, biomarker, cod, environmental health

After World War II, at least 50.000 tonnes of chemical munitions containing an estimated amount of 15.000 tonnes of chemical warfare agents (CWAs) were dumped in the Baltic Sea, primarily in the Bornholm Basin. Within the framework of the EU project ChemSea, the environmental health effects caused by CWAs have been studied for the first time in the Baltic Sea by using a suite of biomarkers in an integrated approach. One of the chosen indicator organisms was Baltic cod (*Gadus morhua* L.). Cod was sampled at different locations, the main dumping site in the Bornholm Basin, an unofficial potential dumping site in the Gdansk deep, and at a reference location without major anthropogenic impact. Since arsenic compounds have been detected in the sediment of the Bornholm dumping area, the head-kidney and kidney of cod was identified as suitable target organ and investigated for histopathological alterations and lysosomal membrane stability. Head kidneys from cod caught at the Bornholm dumping site showed significantly higher rates and grades of histopathological alterations compared to the reference location. Tissue alterations like vacuolization, shrinkage of hematopoietic clusters, and loss of integrity were accompanied by significantly decreased lysosomal membrane stabilities. These results indicate toxic effects at least at a low biological level. The head-kidney of fish proved to be a suitable organ for the analysis and assessment of biological effects of CWAs in the Baltic Sea.

O 70

CONTRIBUTION OF WAVE SET-UP INTO THE TOTAL WATER LEVEL IN THE TALLINN AREA

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Keywords: Marine coastal hazards, flooding, wave set-up, water level

Wave-induced set-up is a nonlinear phenomenon that is driven by the release of momentum from breaking waves. It may cause systematic rise (additionally to the storm surge) in the water level in coastal segments that are open to high waves. The location of the highest set-up is a function of the waves' approaching angle and thus sensitive to the propagation direction of the high waves and with respect to changes in the strong wind direction.

The highest set-up does not necessarily occur during the strongest storms or with the highest water level. We address the interrelations between the dangerous water levels and substantial set-up events. The focus is on the contribution of wave-driven set-up into the formation of extreme water level at the waterfront of Tallinn in the north-eastern Baltic Sea. Extreme water levels have reached here 1.52 m above the long-term mean whereas wave set-up may add 0.8 m in some areas.

The parameters of set-up are evaluated using the wave properties computed with triple nested WAM model with a horizontal resolution of about 470 m. The model is forced by one-point open-sea wind data. The offshore water level is extracted from the output of the Rossby Centre Ocean (RCO) model. The high offshore water levels are only infrequently synchronised with extreme set-up events. The most dangerous situations in which the total water level at the waterline exceed the all-time maximum for the offshore water level usually occur during (north-)westerly storms.

O 71

WHETHER ONLY CLIMATE CHANGES INFLUENCE STOCKS, DISTRIBUTION OF PELAGIC FISHES AND FISHING IN THE BALTIC SEA?

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It is known that change of a biodiversity, condition of stocks and catch of fishes of the Baltic region it is caused by natural and anthropogenous impact on an ecosystem of the Baltic Sea.

Significant connections between interannual changes of number and catch of pelagic fishes and salinity on a surface around deep-water basins of the Baltic Sea, conditional speed of rotation of the Earth, repeatability of types of atmospheric circulation were established during researches, and also periods and duration of years during which they were observed are revealed. Interannual changes of circulation of waters, distribution of salinity and temperature make impact on distribution and formation of pelagic fish concentrations in different parts of the Baltic Sea.

Researches of GOSNIORH showed that condition of fish stocks, food supply and indexes of pollution of hydrobionts are the reliable indicator of changes in an ecosystem of the Gulf of Finland, and their monitoring allows tracing an extent of influence of natural cycles and anthropogenous factors.
Further study of fish stock dynamics and reaction of ecosystem components to influence of technogenic and climatic factors will allow determining consistent patterns of structural and functional changes in the Baltic Sea.

O 72

CHALLENGES IN CLIMATE SYSTEM MODELLING FOR THE BALTIC SEA, NORTH SEA, MEDITERRANEAN SEA AND ARCTIC OCEAN REGIONS

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Keywords: climate, system modeling, Baltic Earth

Whereas the first regional coupled atmosphere – sea ice – ocean models were developed to improve the short-range weather forecasting or to study processes and the impact of the coupling on the air-sea exchange, recent model development was more aligned to perform studies on climate change. Applying the so-called dynamical downscaling approach regional climate models driven with global models at the lateral boundaries are used to assess changing shelf seas in future climate. In line with the objectives of the Baltic Earth program the increase of the degree of complexity and the increase of the resolution of the models are the main challenges of model development. Coupled atmosphere – sea ice – ocean models are further elaborated by using a hierarchy of sub-models for the Earth system combining regional climate models with sub-models for surface waves, land vegetation, hydrology and land biochemistry, marine biogeochemistry, marine carbon cycle, marine biology and food web modelling. In this presentation the challenges in climate system modeling for regional seas like the Baltic Sea, North Sea Mediterranean Sea and Arctic Ocean regions are discussed based upon a series of recently published papers within a special issue of Tellus A.

O 73

SPECIES DISTRIBUTION MODELLING AS BASIS FOR THE ECOSYSTEM-BASED MANAGEMENT: A CASE STUDY FOR THE EASTERN BALTIC SEA

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Keywords: Ecosystem-based management, Species distribution modelling, Gaussian processes, Eastern Gulf of Finland

Ecosystem-based management is an approach that recognizes the full array in interactions within anecosystem rather than single species. However, the information of species occurrence has a great relevance to the ecosystem-based management and especially to marine conservation. The spatial knowledge of keystone species and valuable habitats is essential in planning of management actions. We identify the geological and hydrographical variables that describe the occurrences of benthic keystone species and fish nursery grounds in the eastern Baltic Sea. We use Gaussian processes as a method for the species distribution modelling. As an output, we present an occurrence probability of a species in a spatial grid cell. These probabilities can be utilized in a risk analytical marine spatial planning, where the harmful effects of human activities are quantified and calculated as a pressure-induced loss of species occurrence. Species distribution modelling is necessary since no comprehensive data on species distribution in the eastern Gulf of Finland can be provided. We also suggest that this method can be applicable for studying the biological interactions between species i.e. how species can explain the occurrences of others in addition to environmental variables. Thus, ecosystem-based management can be supported by spatially-orientated marine ecology.

This study has been mainly funded by TOPCONS project (ENPI CBC 2007-2014), where the aim was to develop transboundary tools for spatial planning and conservation of the Gulf of Finland (Eastern Baltic Sea).

O 74

ANALYSIS OF THE EXCEPTIONAL VENTILATION EVENT DURING WINTERTIME AND SPRING 2014 AFTER A DECADE OF ANOXIC DEEP-WATER CONDITIONS IN THE BALTIC SEA

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Keywords: Baltic Sea, Major Baltic inflow, hypoxia, deep water renewal, numerical modeling, anthropogenic impact

Eventually, after ten years of stagnation and oxygen depletion in the deep-water of the Baltic Sea, in 2014 an inflow of highly saline water from the North Sea has ventilated abyssal areas up to the central part of the eastern Gotland Basin. The observed MBI was caused by an interplay of three smaller phases of inflowing water during the wintertime 2013/14 and spring 2014. Surprisingly, none of these events separately fulfilled the typical conditions for a MBI scenario. Such a special mechanism has not yet been observed before.

The succession started with a strong winter gale in December 2013, which despite the strong wind forced pressed in relation to the wind strength only a small volume of 150 km^3 from the Kattegat into the western Baltic. This event was followed by second inflow phase of a volume of 140 km^3 caused by a long-lasting period of westerly winds in February 2014. Both events raised the near-bottom salinity and oxygen content in the Arkona and the Bornholm Basin in the south-western Baltic. These initial inflow volumes of saline water were not large enough to overcome the Stolpe Sill at the entrance to the deeper basins of the central Baltic Sea located farther eastward. In March 2014, a larger volume of 200 km^3 flowed into the western Baltic which in combination with the earlier events induced an overflow to the central basins. Based on observations and model results, this process will be described in detail and provides new insights in Baltic ventilation dynamics.

O 75

ANALYSIS OF SEDIMENT TRANSPORT PATTERN ALONG THE COASTAL LINE OF THE RUSSIAN PART OF THE CURONIAN SPIT

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Keywords: the Curonian Spit, Baltic Sea, alongshore sediment transport, grain-size analysis

Changes in grain-size parameters (mean, sorting, skewness) can be used for determination of a direction of sediment alongshore transport. There are two trends in alongshore distributions of surface sediments grain-size parameters which may indicate an alongshore transport (McLaren, Bowles, 1985): (a) sediments become finer, sorting and skewness decreases; (b) sediments become coarser, sorting decreases and skewness increases.

To analyse the alongshore transport pattern the 42 samples of beach sediment along the coastline of the Russian part of the Curonian Spit were collected during field works in August 2014 executed by A.P. Karpinsky Russian Geological Research Institute, the grain-size analysis of the samples were carried out and mentioned above grain-size parameters were calculated. Shore segments with different trends were identified using a running 9-nodes window, level of significance of trend analysis were estimated. Results didn't prove an idea about unified alongshore flux of sedimets along the Curonian Spit, different flux directions were attributed to different shore segments.

The method allows to determine the alongshore flux pattern formed by the last significant storm event, i.e. to estimate an actual consequence of winds and waves influence in the studied area and can not be used for describing multiannual longshore sediment transport.

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O 76

WIND-DRIVEN VARIABILITY OF PYCNOCLINES IN THE GULF OF FINLAND

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Keywords: Gulf of Finland, upwelling, downwelling, thermocline, halocline, pycnocline

Water column has a three-layer structure in the deeper areas of the Gulf of Finland in summer. Two pycnoclines separate these layers: the seasonal thermocline at 10-30 m depth (upper pycnocline – UP) and the halocline (deeper pycnocline - DP) at 50-80 m depth. Variations of the UP are most prominent, when the thermocline slope across the gulf is evoked by wind forcing. Often, the slope is enough steep to induce a coupled upwelling-downwelling event. The DP is sensitive to wind-forced modifications of estuarine circulation.

The main aim of the present study was to characterize the dynamics of the two pycnoclines – to relate transverse structure of pycnoclines to the forcing and suggest governing mechanisms. Altogether 35 CTD surveys across the gulf were conducted in 2006-2013 (April-October). It is shown that a shallower UP near the southern coast is associated with the winds from ENE and a shallower DP near the northern coast with the winds from NNE. Across-gulf slope of the UP was on average +0.23 m km^{-1} (positive implies shallower pycnocline near the southern coast) and the DP slope +0.02 m km^{-1}. The absolute slope of the UP (DP) was in 60% (50%) of cases steeper than 0.20 m km^{-1}. Coupled upwelling-downelling events induced the cascade of water movements at the entire cross-section, which led to modified thermohaline structure and location of pycnoclines. The impact was essentially different in case of an upwelling near the northern and the southern coast.

O 77

WINTERTIME REVERSALS OF ESTUARINE CIRCULATION AND RELATED CHANGES IN OXYGEN AND NUTRIENT CONDITIONS IN THE GULF OF FINLAND

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Keywords: Gulf of Finland; estuarine circulation reversal; stratification; oxygen conditions; nutrient dynamics.

Estuarine circulation in the Gulf of Finland (GoF) consists of an outflow of the gulf water in the surface layer and spreading of saline, hypoxic and phosphate rich waters from the Northern Baltic Proper (NBP) into the deep layer of the GoF. Autumn-wintertime intensification of southwesterly wind forcing causes frequent reversals of estuarine circulation leading to the vanishing of stratification and mixing of the water column in the deeper areas of the western and central GoF. The aim of this study was to investigate the impact of circulation reversals on the oxygen and nutrient conditions in the GoF. Wintertime CTD measurements and wind data over several decades and data of two field campaigns (in winters 2011/2012, 2013/2014) are analyzed. Field measurements consisted of temperature, salinity, oxygen and current measurements (using CTD probes and ADCP), and water sampling for nutrient analyses along the thalweg of the GoF. It is shown that stratification collapses during the reversal ventilated the deep layer and changed its nutrient content. Strong currents (up to 40 cm/s) in the deep layer accompanied the circulation regime alternations. At the entrance area, the oxygen and nutrient conditions changed rapidly due to inflows from NBP while in the eastern part the changes in oxygen and nutrient conditions took more time. In the long-term, the increase of reversal events frequency since the beginning of 1990s caused by the shift of winter wind forcing was observed.

O 78

SEASONAL BENTHIC GAS AND NUTRIENT DYNAMICS AT DIFFERENT SEDIMENT WATER INTERFACE, WESTERN BALTIC SEA (GERMANY)

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Keywords: biogeochemistry, benthic flux, sediment function, nutrients, trace gases

Early diagenetic processes in the upper sediment are known to play a pivotal role for nutrient and oxygen turnover and a large range of other benthic ecosystem functions. Yet, the exchange of constituents across the sedimentwater interface, especially in regions with permeable sediments, remains poorly constrained in the shallow regions of the Baltic Sea. Benthic fluxes of soluble reactive phosphorus (SRP), dissolved inorganic nitrogen (DIN: NO_2^-, NO_3^-, NH_4^+) and silicate, as well as gas exchange of O_2 and the greenhouse gas nitrous oxide, were measured seasonally on characteristic (muddy to sandy) sediment and habitat locations within the German EEZ. Investigations were performed in situ using autonomous benthic chambers equipped with syringe water samplers and sensors, as well as "ex situ" under constant temperature and decreasing oxygen concentrations in order to simulate environments of anoxic deeper waters. The data reveal multiple dependencies on sedimentary properties or external drivers, which hinders a simple description. We discuss our results in the framework of existing data and suggested parameterizations, and also address the discrepancy of benthic flux rates obtained by different methodological approaches.

O 79

INVASIVE EPIBENTHIC PREDATORS' IMPACT ON BENTHIC COMMUNITIES FUNCTIONING

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Keywords: benthic communities, epibenthic predators, habitat selection, invasive species

In the last decade two invasive epibenthic predators, the Harris mud crab *Rhithropanopeus harrisii* and the round goby *Neogobius melanostomus*, have established abundant and rapidly expanding populations in northern Baltic Sea. Prior to their arrival, the area lacked abundant benthic predators. Previously bottom-up regulated benthic communities' response to the strong top-down control posed by the invasive predators is largely unknown. Both species have colonised bivalve-dominated areas and experiments indicate strong impact on both bivalve abundances and distribution. Concurrent with these invasions native bivalves have significantly declined. In addition to molluscs both the round goby and the mud crab consume amphipod gammarids indicating food competition with native fish. Presence of alga and rocks provide the gammarids with shelter, however mud crab habitat selection experiments have shown higher occupancy rates of such habitats. Experiments indicate that both species are generalists with no preference towards prey species, which could lead to the consumption of all key benthic species. Bivalves are important in nutrient depositing and buffering effect of eutrophication through bivalve removal might be compromised. This indicates severe impacts in all trophic levels and in the whole ecosystem functioning. So far native predators have failed to control the species abundance. Further investigations of their densities and establishment of a monitoring program is necessary.

O 80

TOWARDS AN INTEGRATED AGE-MODEL FOR THE INTERNATIONAL OCEAN DISCOVERY PROGRAM (IODP) EXPEDITION 347 SITE M0059, LITTLE BELT

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Keywords: IODP Expedition 347, Little Belt, ^{14}C dating, OSL dating

During IODP Expedition 347 sediments were recovered from five holes at Site M0059, Little Belt. The sediments at this site consist of c. 52 m organic rich clay on top of c. 31 m of varved glacial clay. These two units are separated by a thin layer (< 10 mm) of silty sand indicating an erosional unconformity. Below the varved glacial clay a c. 7 m thick unit of alternating laminated silty clay and massive sand is recorded. Between c. 90 mbsf and 158 mbsf the recovery lessened but several units of silt and sand with a diamict character occur.

26 samples of mollusc shells and foraminifers from the uppermost 40 m have been submitted for ^{14}C dating. First results from four samples give ages between 479±50 cal yr BP at 3.43 mbsf and 4225±144 cal yr BP at 23.25 mbsf indicating a very high sedimentation rate of 5-7 mm/year. The results from the remaining samples will refine and enable the construction of a reliable age-model for the uppermost c. 50 m of sediments.

The lower part of the sediment sequence has been dated by Optically Stimulated Luminescence (OSL). 17 samples from the quartz fraction have been analysed of which 12 gave reliable ages ranging between 45±4 ka at 84.11 mbsf and 362±37 ka at 146 mbsf. Five samples could not be dated due to poor luminescence characteristics or the lack of pure quartz. These will instead be dated using the feldspar or polymineral fraction.

O 81

CISOCUR – NUMERICAL MODELLING OF STABLE ISOTOPE DISTRIBUTION IN THE CURONIAN LAGOON

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Keywords: Curonian Lagoon, stable isotopes, numerical modeling

The spatial pattern of the hydrodynamic circulation of the Curonian lagoon, the largest European coastal lagoon, is still little understood. In absence of automatic current registration data all the existing models relied mostly on such data as water levels leaving high level of uncertainty. Here we present CISOCUR, a new project financed by European Social Fund under the Global Grant measure. The project applies a new methodology that uses the carbon stable isotope (SI) ratio of C_{12} and C_{13} that characterize different water sources entering the lagoon and may be altered by internal kinetic processes. Through the tracing of these isotope ratios different water masses can be identified. This gives the possibility to validate several hypotheses of water circulation and validate hydrodynamic models. In particular it will be possible to 1) trace water masses entering the lagoon through the Nemunas and the Klaipeda strait; 2) test the hypothesis of sediment transport mechanisms inside the lagoon; 3) evaluate the importance of physical forcing on the lagoon circulation. The use of a hydrodynamic finite element model, coupled with the SI method, will allow for a realistic description of the transport processes inside the Curonian lagoon. So the main research goal is to apply the stable isotope tracers and a finite element model to determine the circulation patterns in the Curonian lagoon. Here we show how the SI analysis was used to validate the hydrodynamic model on the basis of residence time. The average residence time of the Nemunas waters is estimated through SI data and is then compared with the model data computed through standard algorithms. Seasonal changes of carbon content are taken care of through a preliminary application of a carbon kinetic model. The results are compared to literature data.

O 82

INTER-ANNUAL CHANGES IN TEMPERATURE, SALINITY AND DENSITY DISTRIBUTION IN THE GULF OF RIGA

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Keywords: Gulf of Riga, CTD profiles, salinity, upper mixed layer, deep layer

Available CTD profiles from the Gulf of Riga during the period of May-August, 1993-2012 were analyzed (vertical resolution 0.5 m) to study inter-annual and long-term changes in temperature, salinity and density in relation to river runoff and atmospheric forcing (e.g. Baltic Sea index). To analyze the changes in vertical stratification, the estimates of parameters of the upper mixed layer (UML) and deep layer (DL >35 m) were obtained. The results show that the average depth of UML increases from 8.7 m in May to 9.0, 11.5 and 13.7 m in June, July and August, respectively. Mean salinity of UML increases from 4.90 g kg^{-1} in May to 5.14, 5.28 and 5.38 g kg^{-1} in June, July and August, while mean density (sigma-t) of UML, in opposite, decreases from 3.59 kg m^{-3} in May to 3.32 and 2.39 kg m^{-3} in June and July (with August being similar to July at 2.48 kg m^{-3}). Comparison between UML and DL revealed that difference between salinity and density in these layers can be as high as 1.38 g kg^{-1} for salinity and 3.46 kg m^{-3} for density. These maxima were found in August 2010, which stands out as a year with the lowest mean salinity in the UML but the highest salinity in DL and with the highest mean UML temperature (21.8 C°) and lowest mean DL temperature (1.6 C°). Thus, August 2010 was the month with most pronounced stratification in 1993-2012. Rather high correlation (r = -0.82, data from 14 out of 20 years) was found between the river runoff in spring and mean salinity in UML in August.

O 83

RESULTS OF THE SECOND ASSESSMENT OF CLIMATE CHANGE FOR THE BALTIC SEA REGION (BACC II)

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Keywords: climate change, regional climate modelling, Baltic Sea, climate change impacts

Baltic Earth is the new Earth system research network for the Baltic Sea region. It is the successor to BALTEX and stands for the vision to achieve an improved Earth system understanding of the Baltic Sea region. A first major outcome of Baltic Earth is the publication of the Second Assessment of Climate Change for the Baltic Sea Basin (BACC II, published with Springer Open Access).

This new study after 7 years, to which 140 authors have contributed, finds the results of BACC I still valid. Climate change can be detected at the regional scale but attribution is still weak. The effect of changing atmospheric aerosol loads and land use change is largely unknown so far and needs further attention in the coming years. For the observed changes in biogeochemical and ecological systems, multiple drivers are at work of which climate change is one. Their relative importance still needs to be evaluated. When addressing climate change impacts on e.g. forestry, agriculture, urban complexes and the marine and terrestrial environment in the Baltic Sea basin, a broad perspective is needed which considers not only climate change but also other significant factors such as emission changes, demographic, economic as well as land-use changes.

The BACC II Author Team is credited at www.balticearth.eu/BACC2/team.html.

O 84

SANFISH: FISH IN NEST VS. FISH IN NETS

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Keywords: Baltic Sea, eutrophication, fish, fishery, modeling, management

Publicly available decision support system Baltic Nest links watershed and offshore ecosystems through data and models and is an important tool in the Baltic ecosystem studies and adaptive management. Particularly, the marine biogeochemical models SANBALTS and BALTSEM are well validated and have been used both for reconstruction of the historical trophic states and scenario computations, including quantification of the Baltic Sea Action Plan. The Ecopath with Ecosim models, being originally developed for reconstruction of the food web structure from observations in the Central Baltic, use top-down approach and are rather vulnerable to a shortage of data for lower ecosystem levels. In contrast, newly developed Simple As Necessary Fish model uses SANBALTS and BALTSEM outputs as forcings for simulating of combined effects of eutrophication, climate change, and fishery on a fish component of the entire Baltic Sea ecosystem.

O 85

CARBON STORAGE IN COASTAL REED BEDS OF THE SOUTHERN BALTIC SEA – A POSSIBLE CONTRIBUTION TO GREENHOUSE GAS MITIGATION?

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Keywords: soil carbon, greenhouse gas, Phragmites australis, Southern Baltic Sea, Darss-Zingst Bodden Chain.

Coastal reed beds are abundant in the Southern Baltic Sea region , especially within lagoon systems such as the *Darss-Zingst Bodden Chain*. Those coastal reed beds are important as carbon stores, but quantitative assessments of actual amounts of carbon stocks are rare. There is some evidence that reed beds are propagating seawards at several locations at the Southern Baltic Sea and that appreciable carbon amounts are stored in those belts not only in near-surface sediments but also at larger sediment depths until1m. Quantitative data about carbon storage in reed beds are useful to assess the potential of carbon sequestration and mitigation of greenhouse gas emissions. In order to elucidate the potential for carbon storage, carbon stocks at two sites in the *Darss-Zingst Bodden Chain* were assessed by means of spatially distributed sediment sampling up to 1 m depth in three different zones of the reed beds (terrestrial, transitional, littoral).

The results revealed large stocks of organic carbon up to 60 kg C / m^2, and maximum storage in 40 – 60 cm soil depth. The depth distribution of carbon storage and historical maps of reed distribution suggest that the reed belt is steadily progressing seawards within the Bodden. This implies that reed belts at the Southern Baltic Sea could possibly contribute substantially to carbon sequestration and greenhouse gas mitigation, although for quantitative conclusions, similar analyses at further, different reed bed sites along the Baltic Coast are necessary.

O 86

PELAGIC-BENTHIC COUPLING IN THE NEVA ESTUARY (EASTERN GULF OF FINLAND)

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Keywords: pelagic-benthic coupling, estuary, zoobenthos, primary production, alien species

Long-term researches in the Neva Estuary have shown that primary production and intensity of eutrophication differ in different parts of the estuary that are resulted in abundance and specific food web structure of zoobenthic communities and their vulnerability to alien species. Zoobenthic biomass positively, but species richness negatively related to primary production and chlorophyll *a* concentration. The highest level of primary production was measured at the middle part of the estuary where fresh and saline waters intensively mixed, and also in the shallow coastal waters where intensive filamentous algae blooms were observed in summer times. High level of eutrophication in these parts of the estuary resulted in periodic hypoxia which deteriorated aborigine communities and made them more vulnerable to alien species. Food web structure of modern zoobenthic communities was studied using the method of stable isotopes ^{13}C and ^{14}N. It showed that dominant alien species, amphipods in shallow coastal waters and *Marenzelleria arctia* in deep waters are now closely integrated in food webs. Trophic position of alien amphipods is omnivores. They are important food item for coastal fish. *Marenzelleria arctia* is a primary consumer and probably inaccessible for fish, but it is a prey for aborigine *Saduria entomon*, which population grows last years after invasion of *Marenzelleria.*

O 87

DEVELOPMENT OF GUIDELINES FOR COASTAL EROSION MITIGATION IN LATVIA

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Keywords: coastal erosion, mitigation, coastal protection

In many developed coastal areas of Latvia, where the residential buildings, infrastructure facilities, as well as other intangible assets are located, coastline is retreating. The total length of such coastal sections in Latvia today is approximately 120 km. In addition, over the last 20 years, intensification of coastal processes takes place.

Coastline in the past often was considered as the natural boundary between diverse marine and terrestrial environments. However, this setting is static and therefore incorrect, but historically, typical actions in the face of coastal retreat were installation of the protection structures and holding of the "front line". Today, it is clear that some of these "front holding" cases where management mistakes. Coastal defense options applied at that time, resulted in new problems, or were simply a transfer of the problem to another location.

In October 2014, the project done by University of Latvia completed, within which Methodological material "Guidelines for coastal erosion mitigation" was developed. The project aims to provide support for coastal municipalities and landowners in decision-making, coastal territory management and development in order to reduce adverse consequences of coastal erosion.

Inter alia, during Guidelines development framework, in accordance with evaluation of all available data on the coastal processes in Latvia, five coastal classes were separated, each characterized by a different degree of erosion risk.

O 88

SEAGATE: NAVIGATION SATELLITE SYSTEM ENVIRONMENT FOR TESTING AND VALIDATION

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Keywords: SeaGATE, Galileo, GNSS, Testing, Validation

A Captain Assistant System for Navigation and Routing during Operations in Harbor will be developed in ANCHOR a project funded in the BONUS program. Due to high accurate position and velocity data as well as information on the approaching respectively departing routes predictions on the traffic will be made. These predictions will lead to a suggested route helping the pilots in the decision-making process. So ANCHOR supports safety in the harbor and the pilots of large vessels. The main goal is to offer a unique tool to analyse the influence of the traffic within coastal areas and to raise safety and efficiency of maritime traffic.

To achieve this goal the ANCHOR system needs to know the position of all vessels in the harbor area. Global Navigation Satellite Systems (GNSS) are a way to determine the position vessels. If two or more receivers are used it also becomes possible to calculate the heading of a ship. The continuing improvement of such GNSS leads to more and more sophisticated and better solutions. One step in that direction is the ongoing launch of the Galileo satellite system. It improves the accuracy of the position solution and therefore will lead the ANCHOR system to better results.

At the moment Galileo is being set up by launching new satellites within the next few years, so that Galileo will probably become fully operational in 2020. But it is important to already develop technologies capable of the new system. This is where SeaGATE comes into play. SeaGATE is a Galileo Application Test Environment especially for maritime applications. It is located at the German Baltic Sea harbor Rostock. Nine so called pseudollites cover the whole harbor area of about 20 square kilometers with terrestrial transmitted Galileo conform signals. So Galileo can already be tested despite the lack of enough satellites covering that area. Therefore SeaGATE delivers perfect conditions to test and validate the ANCHOR system.

This Paper shows the opportunities of Galileo testing for maritime applications given by SeaGATE. It discusses how the pseudollite system operates and how it can help to test and validate new applications. The planned activities of the ANCHOR project are described as example.

O 89

SPRING BLOOM IN THE GULF OF FINLAND – INTERANNUAL VARIABILITY CAUSED BY METEROROLOGICAL AND HYDROLOGICAL CONDITIONS

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Keywords: spring bloom, diatom-dinoflagellate ratio, *Mesodinium rubrum*, inorganic nutrients

Spring bloom is the most prominent feature of the planktonic ecosystem in the Baltic Sea that in a large extent defines vertical flux of carbon and sets pre-conditions for recurrent blooms of cyanobacteria in summer. Due to interannual variability in meteorological and hydrological conditions, large variations in spring bloom intensity, phytoplankton community composition, nutrient and chlorophyll *a* concentrations exists, as it was observed in 2009-2012 in the Gulf of Finland. The prevailing circulation in the surface layer and the development of stratification, together with upward and downward movement of the seasonal thermocline, influenced most the heterogeneity of the spring bloom. The estimated ratio of nitrogen to phosphorus consumption during the growth phase of the spring bloom and the transition in the community dominance from diatoms to dinoflagellates was followed. The importance of dinoflagellate *Peridiniella catenata* and ciliate *Mesodinium rubrum* is discussed as these species might have a substantial biogeochemical impact to the Gulf of Finland pealgic ecosystem due to the increase of retention time of newly produced organic matter in the nutrient-limited surface layer in late spring - early summer. The decline of the spring bloom and the changes between autotrophic, heterotrophic and mixotrophic compartments are discussed.

O 90

WHY IS THE BALTIC SEA SPECIAL IN COASTAL MORPHODYNAMICS? – A COMPARATIVE STUDY

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Keywords: coastal processes, regionalization, modeling, Baltic Sea, Bohai Sea, South China Sea

Coastal zones have to be assessed based on their role on the pathway of particulate matter from terrestrial sources to the marine sinks. The interference of the generation of accommodation space in the result of the interplay of climatically controlled eustasy and vertical crustal displacement (isostasy), sediment supply and meteorological and hydrographic driving forces determine the position of coastal zone in a system of controlling factors. The position of the Baltic Sea coasts in a system determined by such factors as waves, rivers, tides and vertical displacement of the coastal zone can be made visible by comparison with marginal sea coasts at lower latitudes. We have selected the Bohai Sea and the South China Sea for comparison. Whereas the latter one are characterized by their settings dominated by fluvial sediment supply and the action of waves and tides, the settings of the Baltic Sea coasts vary regionally between the dominance of isostatic uplift (in the North) and waves (in the South). Besides the exceptional steep N-S trending gradient of vertical crustal displacement, a rapid temporal change of influencing factors during the Holocene is special for the Baltic. The relative sea level change record in conjunction with the geological build up of the coast and meteorological driving forces can be used to separate three main compartments of coastline change and morphodynamics for the Baltic Sea: I) The regressive (uplifting) Fennoscandian Shield, II) the slightly regressive, but morphodynamically wave-shaped coast of the Russian Plate (Gulf of Finland and Estonian coast), and III) the transgressive wave-shaped coast of the Baltic Syneclise to the NE-German-Polish Depression. For each of these zones special implementations of numerical models can be used to describe the change of coastal morphology in the geological past and future. Whereas for Zone I and II the Sea level equation serves as an sufficient tool, for zone II and III this equation has to be coupled with models of sediment dynamics describing wavedriven erosion, transport and accumulation. Some of these models have been originally implemented for coasts in the South China Sea, but adjusted successfully to the special conditions of the Baltic Sea. Numerical models play an irreplaceable role for future projection of coastal development within the frame of Integrated Coastal Zone Management.

O 91

THE REACTION OF THE MARINE ECOSYSTEM ON TOXIC MERCURY

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Keywords: Mercury, Cyanobacteria, mercury transformation, detoxification, Baltic Sea mercury emission

As an element, mercury is purely natural that however shows anthropogenic influence on its distribution in the environment. This is caused by mobilization of originally deposited mercury by atmospheric emission from fossil fuel combustion, artisanal small scale gold mining, and industrial processes like cement production and metal smelting. Another source of atmospheric mercury, almost of similar size as anthropogenic atmospheric emissions, is the oceanic emission of mercury. This source is partly a reaction of marine organisms on the presence of toxic mercury and the transformation of ionic mercury to volatile elemental mercury exhibits a detoxification strategy. But in addition to algae and bacteria also abiotic photochemistry contributes to the transformation.

In a project funded by the German Science Foundation (DFG) culture experiments were done to separate and quantify biogenic and photochemical mercury transformation. It turned out that during daylight about 60% was light controlled biogenic transformation and about 30% was abiotic photochemistry. During night however, significant amounts were re-oxidized to ionic mercury but also dark transformation importantly contributed to Hg0 production. Hence, on a 24 h average, abiotic photochemistry and light dependent biotic transformation accounted for 30% each and dark production contributed 40% to the total transformation. About 30% of the average mercury emission of the Baltic Sea in summer of about 60 ng/m²d was thus likely caused by summer cyanobacteria: 20 ng/m²d, that is ~700 kg for the whole Baltic Sea. The estimate is of similar size as the average annual atmospheric deposition to the Baltic Sea of 25 ng/m²d. Summer algae blooms and the mercury cycle of the Baltic Sea will probably be influenced by climate change in the near future.

O 92

FROM MECHANISTIC TO FUNCTIONAL MONITORING – GUIDING MICROBIAL INDICATORS INTO PRACTICAL OPERABILITY

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Keywords: Standardization, Monitoring, metagenomics, metranscriptomics

Environmental processes are overwhelmingly driven by microorganisms. In aquatic systems they generally process more than 50% of the carbon fixed by local photosynthesis and mediate most transformations in the cycling of nitrogen, phosphorus, trace metals and other macro- and micronutrients. In addition microorganisms react sensitively and rapidly to any environmental changes, which can be observed in their expression profiles. Still, bacterioplankton have only marginally been included in monitoring programs; thus, our knowledge about these organisms has lagged far behind other components of the pelagic system (e.g., fish, zoo- and phytoplankton). Current descriptors in Baltic Sea monitoring assessing biologically driven processes are largely focusing on structural components. A general understanding, however, exists that new indicators representing distinct biogeochemical processes are needed. The complex aquatic nutrient biogeochemistry is practically driven by microorganisms and it seems likely that monitoring of microbial activity would have the potential to improve Baltic biogeochemistry models and complement the environmental indicators recommended by HELCOM. But several aspects have to be considered – going deep into different disciplines ranging from basic science over bioinformatics and to the potential adaptation of instrumentation or methodology. This development has to be integrated with comprehensive evaluation and standardization of general and specific workflows. Within the BONUS project BLUEPRINT (biological lenses using gene prints) our aim is to guide microbial indicators into practical operability. Here, we report the current status on the genetic workflow and discuss first outcomes.

O 93

PRESENT AND FUTURE WAVE CLIMATE FOR THE BALTIC SEA

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Keywords: baltic sea, ocean waves, emission scenario

The knowledge of long-term changes of marine conditions is important for many aspects of the marine environment. Among other, extremes in wind and wave climate are a potential treat for commercial shipping, off- shore and coastal infrastructure and human safety. Specially, changes expected due to an anthropogenic climate change may substantially alter the hazards associated with these marine conditions. Using present day climate and four transient future climate projections such potential long-term changes in wind and wave conditions have been investigated for the Baltic Sea using the spectral wave model WAM. Large parts of the Baltic Sea area show an increase towards the end of this century of the severe significant wave heights, specially in the south eastern parts. However changes vary only within a few percent relative to the reference period and differ spatially and between the four climate change simulations.

O 94

RADIATION BUDGET OF THE SEA SURFACE FROM SATBAŁTYK OPERATIONAL SYSTEM DATA

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Keywords: radiation budget, Baltic Sea, SatBaltyk, satellite

The system of radiation budget components creation and verification for the Baltic Sea will be presented. The system uses satellite, model and empirical data. It was developed within the **SatBałtyk** project (**Satellite Monitoring of the Baltic Sea Environment - www.satbaltyk.eu**). The energy radiation budget is one of the elements of the project. The SatBaltyk system generates daily maps of the radiation budget components every day. We show the scheme of creating daily maps, used algorithms and empirical data collection system. Empirical verification of instantaneous and daily products will be presented. The satellite material comes from SEVIRI/MSG and AVHRR radiometers. An auxiliary data comes from Prognostic Model UM. The empirical materials used to develop and verify algorithms were collected on the Baltic Sea during the ship cruises and from actinometrical station on an oil rig.

O 95

TOWARD A SUSTAINABLE SPATIAL ISLAND ECOSYSTEM OF ISLAND ARCHIPELAGO IN ZADAR, CROATIA

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Keywords: island archipelago, ecosystem, sustainability, biosphere

Long-term sustainable development of the rural and remote island archipelagos remains a key matter for island communities and local political actors alike. Island communities face a challenge of preserving 'islander' cultural identity and way of life and slowing down historical litoralisation to the coastal areas. Political actors seek a viable urban-rural spatial governance model. Previous study in Zadar island archipelago in Croatia suggests that current spatial planning model of urban-rural governance focuses on metropolitan development, resulting in lack of infrastructure investment in island development. The study also uncovers a need for changing the island communities' perceptions about finding alternative sustainable ways of managing their local ecosystem. A concept of biosphere as an ecosystem provides a viable way for exploring the range of socio-economic and environmental benefits that could emerge from the island archipelago ecosystem. The case of Suomenlinna is an example of these emerging symbiotic benefits and working towards balancing the needs of the island communities and preserving the island natural ecosystem as a desire of political actors, at the same time. In conclusion, island communities and political actors need to work closely to preserve a long-term sustainable island ecosystems and this would require developing a better reciprocal urban-rural governance model that meets the needs of all stakeholders.

O 96

COLONIZATION PATTERN OF NEW HARD SUBSTRATE – STUDY ON THE POSSIBLE EFFECTS OF CONSTRUCTION OF WIND FARM IN THE NORTHERN GULF OF RIGA

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Keywords: eutrophication, disturbance, offshore wind park, the Baltic Sea

Rapid development of offshore wind energy projects in the Baltic Sea may create additional impacts on benthic ecosystem of the vulnerable Baltic Sea. Set of experiments with incubation of new hard substrate was set up in the area of planned offshore wind park project in the northern part of the Gulf of Riga. The aim of the experiment was to assess the effect of eutrophication and other environmental factors on the colonization pattern and structure of pioneer community on new hard substrate. Experiment was set up in May and June 2012 and ended in spring of 2013. We placed 2 transects covering different depth zones in 3 different areas with different levels of eutrophication in Gulf of Riga – Kõiguste, Sõmeri and Orajõe. The natural rustic granite stones in five depth zones were put on a seafloor and later collected to study fouling communities. Analysis of the data revealed that pioneer community varied by location and local benthic community, surrounding the incubated new substrate, had a strong effect on pioneer species colonizing new substrate. At the same time both depth of the incubation and location against eutrophication gradient had significant effect on the colonizing communities in some cases overruling the effect of neighboring native communities. From the results of experiment we concluded that in the Baltic Sea conditions the detailed experimental studies need to be conducted in the framework of EIA studies in each case and simple transfer of knowledge from other similar projects is not possible.

O 97

NEW SPATIAL MODEL ON BENTHIC OXYGEN CONDITIONS REVEALS PROBLEM AREAS PRONE TO ANOXIA IN THE COMPLEX ARCHIPELAGOES OF THE NORTHERN BALTIC SEA

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The Baltic Sea ecosystem is severely affected by anoxia, causing inhospitable conditions for benthic organisms. Anoxic and hypoxic bottoms not only characterize the open sea, but are also common in shallow archipelago areas where water exchange is limited. Although the factors creating anoxia are well known, there are no spatially detailed quantitative assessments of anoxic bottoms in archipelago areas with complex topographical characteristics.

We hypothesized that the probability of bottom-water anoxia in the Finnish archipelagoes can be estimated with spatial modelling techniques from relatively simple topographical information, and without knowledge on nutrient loading. We modelled mean oxygen levels with random forests algorithm using available oxygen measurements from 2003-13, and a topographic exposure model. The model explained ~70 % of the total oxygen variation and also detected anoxic bottoms in areas from where field measurements do not yet exist.

We show preliminary results of the analysis and test (in one case study area, S coast of Finland) the explanatory power of the model related to species composition and abundance variability of soft bottom invertebrate communities. We conclude that the model is useful in indicating anoxic-prone areas and also areas that more easily remain in good condition. We discuss the usefulness of such information in deciding upon spatial conservation and mitigation of eutrophication.

O 98

THE FINNISH INVENTORY PROGRAMME FOR UNDERWATER ENVIRONMENT (VELMU) PRODUCES DATA FOR KNOWLEDGE-BASED MARITIME SPATIAL PLANNING

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Keywords: Biodiversity, biogeography, habitats, inventories, spatial modelling, maritime spatial planning

Maritime Spatial Planning (MSP) is a process that helps to make informed and coordinated decisions about sustainable use of the resources of the sea. In addition to information on human activities and claims on sea areas, MSP requires a large amount of data on biophysical environment, including habitats and species.

In the Finnish Inventory Programme for Marine Underwater Environment, data on species, communities and habitats have been collected in 2004-2015. The programme includes ~17.000 stratified-random observation sites, positioned throughout the sea area, and ~44.000 grid observation points, placed in focus areas for conservation. The biological and habitat data have been collected with drop-video, ROV, scuba-diving and benthic and fish sampling; geological data have been collected using echosounding and sediment sampling methods. In addition, satellite observation, LIDAR, aerial photography with UAV's, and automatic video platforms have been tested.

The field campaigns will be finished in the summer 2015, after which a comprehensive map service and a marine atlas will be produced. Preliminary results, including geographical distribution maps and spatial models for various species, habitats and environmental factors, are presented. We also show how the VELMU data have been used in maritime spatial planning in Kymenlaakso Region, eastern Gulf of Finland. In this process, marine areas with high nature values and areas which are more suitable for human activities, such as dredging, dumping, fish farming and wind energy production, have been indicated.

O 99

BALTIC COASTAL SYSTEM ANALYSIS AND STATUS EVALUATION (BACOSA)

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Keywords: shallow coastal ecosystem, phosphorus, submerged macrophytes, reed, sedimentation, ecosystem services

The project BACOSA (funded by the German Federal Ministry of Education and Research, BMBF) analyses nutrient flows through coastal ecosystems with and without macrophyte populations. These data, together with secondary data (literature data, statistics, results of previous projects) build the basis for an assessment approach of ecosystem services by relevant categories (such as regulating, provisioning and cultural services).

Using the example of the Darß-Zingst Bodden Chain (a series of shallow coastal bays in the southern Baltic Sea, Germany) scientists of three Universities work together in investigating phosphorus-flows in coastal ecosystems. In spite of the eutrophic character and the high turbidity of the bays, phytoplankton is phosphorus-limited. First results indicate that only low concentrations of phosphorus are in bioavailable form and phosphorus flows from the sediment into the water column are minimal. Thus, the system seems to act as a sink for phosphorus from terrestrial sources. The high turbidity of the water is partly due to high concentrations of suspended particles in the completely mixed water body. Populations of submerged macrophytes, which faced large losses in the past, might not be dense enough to enhance sedimentation.

Retention and storage of nutrients are examples for important ecosystem services provided by coastal ecosystems. Considering the total catchment area, further services, such as food production and tourism, add to the list. The monetary assessment of these services together with the results of field measurements will be an important tool in political and social decision-making.

O 100

LONG-TERM ABUNDANCE DYNAMICS OF INVADER CERCOPAGIS PENGOI (Ostroumov, 1891) IN THE VISTULA LAGOON OF THE BALTIC SEA AND ITS IMPACT ON ZOOPLANKTON

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Keywords: invader, zooplankton. impact

Since the invasion of C. pengoi in the Vistula Lagoon about 15 years have passed. Species was first recorded in the Lagoon in August 1999 where it was brought by the piled-up currents of the Baltic Sea. The species successfully naturalized and became a permanent mark in zooplankton samples from May to July-August. Abundance of crustaceans in the period of invasion made up 312 spec./m^3 The population was represented by specimens with a body length of 0.75 to 2.50 mm. Juveniles were the basis of the population (more than 50% of its abundance). The abundance of gamogenetic females was low - about 1% of the total population abundance; most females had one winter, resting egg. The abundance of males was approximately the same as the gamogenetic females' one. The size of crustaceans inhabiting the Vistula Lagoon is slightly higher than in the other recipient reservoirs. Crustaceans from the Caspian Sea - 1.73 mm, in Lake Ontario - 1.45 mm. Sexual maturity of C. pengoi in the Vistula Lagoon occurs when the length of females is 1.00-1.25 mm. Females of 2.00-2.50 mm size group had maximum number of eggs (25 pcs), the lowest fecundity - one egg. C. pengoi fecundity in the Caspian Sea is 13-20 eggs per parthenogenetic female. In the long-term abundance dynamics, the maximum values of the species are observed in 2000 and 2010, and made up 207 and 226 spec./m^3 respectively. The minimum abundance values were recorded in 2009, 2011 and 2013 – about 70 spec./m^3. The maximum abundance values corresponded to the range of the average water temperature for May-July - from 18 to 19.5 °C. Value of the impact-factor on zooplankton community in the lagoon was constantly increasing having reached its maximum in 2006 (17.5). The minimum value of the impact factor was observed in 2011. It should be noted that the magnitude of Cercopagis impact on the zooplankton is closely related to the pressure of the Baltic herring fry Clupea harengus membras which spawns in the mass in the Vistula Lagoon. The invasion of the large predatory crustacean led to the restructuring of the zooplankton community. In the spring period, the following small species gained a competitive advantage among rotifers: Keratella cochlearis, Filinia longiseta. Thus, during C. pengoi naturalization, the changes in morphological parameters of the species in comparison with the area occurred in the Vistula Lagoon, that was apparently determined by adaptation to new environmental conditions. In addition, the species naturalization caused changes in the structure and functioning of zooplankton community, as well as helped to increase community resistance to external influences due to lengthening of the food chain and structured community.

O 101

INFLUENCE OF THE GATEWAY FEHMARN BELT ON THE HOLOCENE DEVELOPMENT OF MECKLENBURG BAY

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Keywords: Fehmarn Belt, Mecklenburg Bay, Holocene Development

Fehmarn Belt is an important gateway for the whole Baltic Sea since the onset of the Littorina transgression. Its role during former stages of the Baltic Sea is not fully understood yet. Recent geophysical and sedimentological investigations could clearly show indicators of strong erosion even at the interface between Fehmarn Belt and Mecklenburg Bay. Deposits of limnic origin of former stages of the Baltic Sea crop out at the surface. Geomorphological structures mapped during multibeam and sidescan sonar surveys show as well an erosional character of the seafloor. The fate of the eroded sediment is still unknown.

Mecklenburg Bay is situated between the gateways Fehmarn Belt and Kadet Channel, which are controlling most of the water mass exchange between the Baltic Sea and the North Sea. It is is assumed to be the accumulation area of the material erodod in Fehmarn Belt. However, even here limnic deposits of pre-Littorina origin are cropping out at the seafloor.

This study combines recent geophysical and sedimentological investigations and flow conditions through Fehmarn Belt to explain the Holocene development of Mecklenburg Bay.

O 102

CLUES ABOUT WATER CIRCULATION IN THE BALTIC ICE LAKE (BIL) RECORDED IN THE VARVE CLAYS IN THE PÄRNU BAY AREA

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Keywords: Baltic Ice Lake, varved clays, grain size

We speculate that the seasonal layer thickness data and detailed highresolution grain size analysis of the varved clays can shade light on the water circulation in the large ice-contact glacial lake. The summer and winter layer thickens variations in space and time was analysed for previously established varve chronology comprised of 26 individual sections at the Pärnu Bay area. In addition a high resolution grain size analysis for 11 varves reflecting changing sedimentary conditions close to the retreating ice margin was performed.

The study site is located just south from the Pandivere-Neva line of marginal formations that is correlated to the BIL stage A1. Increased summer layer thickens with depth and away from the ice margin indicates that the sedimentation before the ice retreat from Pandivere-Neva line was dominated by sediment loaded underflows. When ice retreat reassumed, underflow activity ceased and strong water-depth winter layer thickness correlation suggests uniform suspended sediment distribution in the basin. However the preliminary results indicate that the largest particle size encountered at the top of the winter layer is too small to be compatible with sedimentation out of a stagnant water column with uniform sediment distribution.

The research was supported by the European Union through the European Social Fund (Mobilitas grant No MJD309).

O 103

RATES OF DENITRIFICATION IN A FRESHWATER SHALLOW ESTUARY: A REAL SINK OF NITRATE GENERATED IN THE WATERSHED?

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Much of our current knowledge of the Nitrogen pathways in the continuum *river →lagoon →coastal zone* is based on long-term, fixed-station monitoring which is often just focusing on inflowing and outflowing water and associated nutrient loads. Such black box approach does not allow disentangling the multiple co-occurring internal processes in sediments. Because frequent shift between dominant opposite processes (i.e. denitrification and N-fixation) as a consequence of N excess or limitation is expected. An interesting question is to analyze comparatively the quantitative relevance of N-related benthic processes with respect to external riverine loads. In particular, the main aim is to analyze on a seasonal basis if and how much microbially mediated processes affect N loads passing through a large freshwater estuary as Curonian lagoon. Obtained data demonstrate that net N_2 fluxes do vary on a seasonal basis. Large seasonal variations of denitrification rates reflect more the NO_3^- availability in the water column than water temperature, with highest rates measured in high flow and high NO_3^- concentrations autumn spring periods. Under pronounced inorganic summer N limitation, net N_2 fluxes are reversed and N-fixation prevails over denitrification. This phenomena contradicts the common perception of estuaries as N sinks but it is limited in time and constrained by riverine loads and nutrient stoichiometry.

O 104

NUTRIENT LOAD, NET BALANCES AND ECOLOGICAL STOICHIOMETRY IN A HYPEREUTROPHIC ESTUARY

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Keywords: Curonian lagoon, nutrient stoichiometry, nutrient budget

Extreme eutrophication, aging and long term accumulation of organic matter can menace the one-way sink function of estuaries for nutrients and in their ecosystem services, with undesired effects as anoxia, biodiversity loss and massive release of metabolism end products. Adding to this picture is the unpredictable and poorly studied effect of climate change that will alter temperatures, the timing of water and nutrient transport to the coastal zone. In this contribution, a nutrient annual budget for the hypereutrophic Curonian Lagoon is presented, with the overall aim to investigate whether they are net retained, released or unaffected while being transported from the river to the open Baltic Sea. The proposed mass budget is oversimplified but robust: it integrates monthly loads of N, Si and P calculated at the main tributary closing section and at the lagoon mouth. Three main outcomes are apparent. 1) There is a strong effect of seasons on the river discharge, its associated N, Si and P loads and on the stoichiometry of nutrients, with pronounced summer N limitation. 2) The lagoon exports large amounts of particulate matter, mostly as phytoplankton, to the Baltic Sea, and removes, transforms or retains relevant fractions of inflowing inorganic N, Si and P. 3) There are evidences that internal load nutrient regeneration from surface organic sediments sustains a relevant fraction of primary production, in particular during summer, when allochtonous nutrient loads decrease.

O 105

INTENSITY AND SPATIO-TEMPORAL DYNAMICS OF BOTTOM TRAWLING IN THE LITHUANIAN PART OF THE SOUTH-EASTERN BALTIC SEA

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Keywords: seabed, fishing pressure, human uses, marine spatial planning

This study will present results of vessel monitoring system (VMS) data analysis carried out for the period from 2005 to 2013. It covers changes in the fishing practice as well as years with different climate conditions which drive fishing effort during late autumn, winter and early spring.

The bottom trawling intensity was mapped using 1 NM grid resolution on monthly basis (178 thous. records in total), then monthly situations were aggregated to common fishing practice periods.

The results demonstrate about 75% of the Lithuanian marine waters are being covered by bottom trawling activity. Although there are large temporal differences in the distribution of trawling intensity both within and between years, approx. 20% of the impacted area falls under constant and relatively high pressure with the seabed trawled up to two times per year.

In this study we present distribution of bottom trawling intensity in the context of demersal fish and migratory bird feeding grounds as well as existing and planned marine uses. It will be interpreted in a view of potential future conflicts and major overallap of marine values and fishing pressure.

O 106

COASTAL CHANGE AND STONE AGE SHORE-BOUND SETTLEMENTS IN ESTONIA

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Keywords: sea-level change, palaeogeography, Holocene

In the early phases of cultural development, Mesolithic and Neolithic human populations in the Baltic region experienced times of significant marine transgressions and regressions owing to the melting of the continental ice sheet and glacial isostatic land uplift. Geological–archaeological studies in the southern Baltic Sea area have revealed a number of Mesolithic and Neolithic traces of human occupation off from the Danish and German coasts as a result of Holocene sea-level rise. Prehistoric coastal sites in the northern Baltic Sea areas have, however, been uplifted and are located successively at different altitudes as a result of glacial rebound. In transitional areas, prehistoric man experienced transgressions and regressions of the shifting coastline owing to competition between glacial rebound and eustatic sea level rise. Stone Age coastal settlement data together with geological record can provide detailed information about RSL changes in the Baltic Sea. In current paper case studies form transitional area in Estonian coastal zone will be presented demonstrating potential of archaeological record for reconstruction of Holocene relative sea-level change. Interdisciplinary approach in RSL research is important to improve our understanding on the interplay between sea-level rise and glacial rebound for better RSL predictions for 21st century.

O 107

A SURVEY OF NON-INDIGENOUS AQUATIC SPECIES IN THE BALTIC SEA PORTS – PORT OF LIEPAJA AND PORT OF RIGA

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To manage biosecurity risks effectively it is important to know what indigenous and non-indigenous species are already present in our marine environments. From 2014 to 2017 the Latvian Government implementing a nationalwide programme „ The value and dynamic of Latvia's ecosystems under changing climate – EVIDEnT" where one of the main objective is biological surveys in main Latvian ports – places where any new species are most likely to appear first. The purpose of the surveys was (1) to gather baseline information on marine biodiversity within the ports, with emphasis on establishing what non-indigenous species were already present and where, and (2) test applicability of different sampling methods in two Latvian ports based on HELCOM-OSPAR Port Survey Protocol.

Biological sampling conducted during the spring and fall of 2013 – 2014 and took place in multiple habitats focusing on soft bottom benthic, epifaunal (hard substrate fouling), zooplankton, phytoplankton and mobile organism communities. A wide range of sampling techniques was used to collect aquatic organisms from a range of habitats within the Port of Liepaja and Port of Riga. Fouling assemblages were scraped from hard substrata, soft bottom benthic assemblages were sampled using a benthic grab, plankton assemblages were sampled using plankton nets. Mobile predators were sampled using baited fish and crab traps. The distribution of sampling effort in the both ports was designed to maximise the chances of detecting non-indigenous species and concentrated on high-risk locations and habitats where non-indigenous species were most likely to be found. Eleven non-indigenous taxa were recorded in the Port of Liepaja: *Prorocentrum minimum, Acartia tonsa, Evadne anonyx, Amphibalanus sp. nauplii (*most probably the cryptogenic species *A. improvisus), Palaemon elegans, Cordylophora caspia1, Dreissena polymorpha, Potamopyrgus antipodarum, Marenzelleria sp., Rhithropanopeus harrisii* and *Neogobius melanostomus,* whereas *Mya arenaria* was the cryptogenic species recorded. Four non-indigenous taxa were recorded in the Port of Riga: *Acartia tonsa*, *Dreissena polymorpha, Potamopyrgus antipodaru* and *Marenzelleria* sp., whereas *Amphibalanus improvisus* and *Mya arenaria* were the cryptogenic species recorded.

Data collected during this study will provide the basis for a comprehensive analysis of impacts from non-indigenous species and served as a baseline to determine effectiveness of future management efforts to control species introductions.

POSTER PRESENTATIONS

P 1

ANALYSIS OF NATURAL BACKGROUND AND DREDGING-INDUCED CHANGES IN TSM CONCENTRATION FROM MERIS IMAGES NEAR COMMERCIAL HARBOURS IN THE ESTONIAN COASTAL SEA

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Keywords: Dredging, MERIS, remote sensing.

We studied the changes of total suspended matter (TSM) distribution in Estonian coastal sea with special focus on Paldiski harbor at the Pakri Bay. Pakri Bay is environmentally sensitive area: most of the bay is covered by Natura 2000 Special Protection Area. The purpose of current study was to examine the suitability of remote sensing data to detect the turbidity differences caused by dredged sediments and to evaluate the impact of monthly mean dredging amount to the surface TSM concentration retrieved from satellite images.

The MERIS (Medium Resolution Imaging Spectrometer) Full Swath Geo-located (FSG) products with 300m resolution from years 2006-2010 were used. Images were processed using Case II Regional (C2R) and Free University of Berlin (FUB) processors available in BEAM software. Validation with in situ measurements showed that both processors represent the changes in TSM concentration adequately. C2R processors showed better statistics (R^2= 0.61, root mean square error = 0.82 mg l^{-1}, SD = 0.77 mg l^{-1}, mean bias = –0.28 mg l^{-1}) compared to the FUB processor.

For analysis of environmental impact we calculated the differences between monthly mean maps from dredging period (2008) versus non dredging period (monthly mean 2006-2010). A threshold TSM concentration value of >2.26 mg l^{-1} difference from background TSM was defined as a criterion for dredging impact detection for Pakri Bay. The area of dredging-induced turbidity was between 0.56 and 1.25 km^2 and did not reach the environmentally sensitive NATURA 2000 region adjoining Paldiski South Harbour.

P 2

CHARACTERIZATION OF ICE COVER EXTENT FROM MODIS IMAGERY DURING DIFFERENT WINTER SCENARIOS IN THE GULF OF RIGA, BALTIC SEA

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Keywords:: MODIS, ice, Baltic Sea.

Baltic Sea is well known for seasonal ice cover. Current study is focused on Gulf of Riga that is located in the eastern part of the Baltic Sea. Previous studies have shown that the ice conditions in Gulf of Riga can vary significantly from year to year depending on the weather conditions. Depending on the year the ice cover season starts between late November and middle January. The length of the ice season which can last until late April is in the range of 3-5 months. In addition to interannual ice cover variations there are significant spatial variations between different Gulf areas.

The use of remote sensing methods enables to monitor ice extent during different winter scenarios. Although during the last years the emphasis in operational ice remote sensing has been on exploiting the capabilities of active sensors (e.g. SAR) the optical imagery can provide valuable information as well. Data from Moderate Resolution Imaging Spectroradiometer (MODIS) can be used for ice extent monitoring and for characterization of average winter conditions. We used MODIS data from visible range channels of spectrum with 250 m resolution (620 – 670nm ; 841 – 876 nm) to detect ice extent in the Gulf of Riga (Baltic Sea). In total 366 images were used for ice extent detection.

After processing all the 366 images the average ice cover maps for different months and years were calculated. The ice cover probability maps were calculated which showed the percentage of time that each pixel was covered by ice. Based on the negative degree days, calculated from the data obtained in Kihnu meteorological station, the winter scenarios were defined. In case the sum of negative degree days (^{o}C day) is above 400 the winter was considered as severe (2003, 2006, 2010 and 2011). In case of medium (2004 and 2005) winters the corresponding value was between 200 and 400 and for mild (2007, 2008 and 2009) winters the sum of negative degree days was below 200.

P 3

STUDY OF HYDROLOGICAL CONDITIONS CHANGE IN THE SOUTH-EASTERN BALTIC SEA USING SPATIAL-TEMPORAL ANALYSIS AND MULTIPLE LINEAR MODEL

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Keywords: water and air temperature, water salinity, ice phenomena, regression, kriging.

Inclosed and shallow Curonian lagoon of the Baltic Sea is the small continental sea model with a sensitive ecosystem to internal and external pressures. Intensifying climate change processes in the Baltic Sea region may have further impact on the Curonian Lagoon hydrological conditions change. The subjects of this research are the surface layer hydrophysical and meteorological parameters and their spatial-temporal statistical models in the south-eastern Baltic Sea. One of the main aims of this study is to compare two methods: linear regression (LR) and regression kriging (RK). Often spatial data sets are limited and the observation points are distributed irregularly. While investigating the geographic characteristics of the geosphere spatial distribution in nature, their change dependencies in general environment system, we often face with a lack of data. The purpose of the article is to analyse the changes and trends of the ice phenomena, their dependence on changes of air temperature, surface water temperature and water salinity in a part of the Curonian Lagoon. The prediction carried out in the stations of different distance shows that spatial information is an extremely important factor in making forecast. The obtained results show that application of the regression kriging is more efficient than the multivariate linear regression for predicting the ice cover in closed basins of sea coasts, lagoons.

P 4

USING SECCHI DEPTH AS WATER QUALITY INDICATOR OF COASTAL WATERS

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Keywords: water quality indicators, coastal waters, integrated modeling

A newly developed method to determine ecological target values for the Secchi Depth (SD) in the German coastal waters of the Baltic Sea is presented, which is a hard to handle but nevertheless very useful parameter to determine water quality. Further, it can be a crucial parameter for the renaturation of oligotrophic water, by controlling the spreading of macrophytes. SD depends on different optical active components, mainly Chlorophyll a (CHL.a), coloured dissolved organic material (CDOM) and suspended particulate matter (SPM), from which in most ecosystem models only CHL.a is included explicitly, while the others are just parameterized. Hence the direct definition of target values (e.g. for Water Framework Directive or Marine Strategy Framework Directive) with respect to SD by purely using an ecosystem models fails - especially in coastal waters. To avoid this problem, an integrated model approach is applied for Germany's coastal waters combining an ecosystem model with the observed values from the monthly monitoring. Thereby, for every station a site-specific function to calculate SD from the model values of CHL.a and detritus is used, which is validated with the observations. Thus, a station specific higher background attenuation due to higher concentrations of SPM or CDOM is included. In the next step, the mean SD from simulations with the present day loads and historical ones were computed and by dividing one by the other the relative change for every station was calculated. Finally, to determine the site-specific target value - representing the very good ecological state - the present day observed SD was multiplied with the relative change.

P 5

SEASONAL EVOLUTION OF THE COLD INTERMEDIATE LAYER OF THE BALTIC SEA

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Keywords: thermohaline structure, seasonal variations, cold intermediate layer, the Baltic sea.

Seasonal evolution of the Baltic CIL is investigated on the base of expeditional field data for 2004-2013. It is argued that seasonal development of the CIL may be divided into 3 stages, different in duration and physical forcings. The first stage - formation of the CIL – lasts for 1-1.5 months (conditionally – March, April) during early-spring warming, with the major driving factor being local winds, pumping cold coastal and shelf waters into the intermediate layer. The role of early-spring heating from water temperature below that of maximum density is discussed. Quantitative analysis of probable residues of vertical winter-time mixing within the CIL shows that homogeneous sublayers make up less than 10% -12% of the total CIL thickness in late April, about 6% in May and no more than 4% in early July. Second period of the CIL evolution is characterized by the geostrophic adjustment of initially inhomogeneous layer and its slow modification in the sea-scale pressure field. It takes place in "quiet" summer period of strong vertical stratification - approximately from May to August. The last period is the destruction of the CIL; it begins with first autumn storms and lasts till next spring warming (approximately from September to February). The main driving factor is again local wind forcing in coastal areas. The study confirms the hypothesis of advective formation of the Baltic CIL.

P 6

DETERMINING OPTIMAL SAMPLING STRATEGIES TO PRESERVE IN SITU MICROBIAL GENE EXPRESSION FOR ENVIRONMENTAL MONITORING IN THE BALTIC SEA.

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Keywords: bacterial communities, monitoring, gene expression

Bacterial communities react rapidly to changing environmental conditions in the ocean by modifying their functional activities at the genetic level. Due to this ability, bacterial gene expression patterns have the potential to be good indicators for environmental monitoring. However, the rapid turnover of messenger RNA molecules within cells can become a major obstacle to the study of gene expression among in situ bacterial communities, as sampling procedures tend to cause a transcriptomic response that masks the original environmental expression profiles. Highfrequency long-term monitoring surveys of gene expression in bacterial communities would require a refined sampling tool, to instantaneously preserve water samples by injection of a fixative. With the objective of developing such an instrument, we empirically determined the minimal seawater volume necessary for adequate coverage of community gene expression and the suitability of fixatives for long-term preservation of metatranscriptomes.

An artificial bacterial community was aliquoted into different experimental volumes, injected with a fixative Stop Solution (5% phenol, 95% pure ethanol), and filtered at different time intervals (0-192h). The number of cells in these aliquots remained constant (~10^7cells mL^{-1}) in contrast to the unfixed aliquots of the artificial community, which exhibited increases in cell counts over time. The total RNA content of both fixed and unfixed aliquots of 1L showed a marked decrease over time (from 6-8 µg to <3 µg), and after 48h some aliquots had lost more than half their initial RNA content. As expected, at lower volumes, such as 250 mL, total RNA contents remained proportionally lower than in the 1L aliquots, with a maximum of 1 µg RNA. The quality of the total RNA, assessed by Fragment Analyzer, also showed a rapid decrease over the duration of the experiment, especially marked within the few 24 hours of incubation. All aliquots were affected by this trend, but the unfixed communities retained higher RNA quality numbers than those preserved with the fixative. These results imply that the Stop Solution accelerated degradation of the total RNA in artificial bacterial communities. Whether this apparent degradation of the total RNA is truly representative of a degradation of transcripts remains to be assessed by the comparative metatranscriptomic analyses of gene expressions among the different experimental treatments. In the meantime we must test other fixation methods, which would allow preservation the gene expression profiles for a longer period.

P 7

EXTENDING THE ECOSYSTEM MODEL ERGOM ACROSS THE SEDIMENTWATER INTERFACE

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Keywords: diagenetic modelling, pore water, sediment-water interaction, phosphate retention, iron cycle, ecosystem model, ERGOM

For a predictive modelling of sedimentary ecosystem services, we extend our ecosystem model ERGOM into the pore water. The result is a coupled ecosystem / early diagenetic model system. The diagenetic model component has been calibrated against measured pore water profiles from sandy to muddy locations. While several processes like, e.g., sulphate reduction, act in the same way both in sediment and in the pelagic, other, additional sedimentary processes such as the precipitation of different iron species had to be included. We applied the model system for the German area of the Baltic Sea in the framework of the national project SECOS. First results will be presented in this talk with a focus on the differences in the results compared to the previous model version with a more simplified representation of the sediments.

P 8

IDENTIFICATION OF THE FEATURES OF THE COASTAL UPWELLING IN THE SOUTHEASTERN BALTIC SEA ACCORDING TO DATA OF SATELLITE SENSING

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Keywords: remote sensing, upwelling, underwater coastal slope, sea surface temperature, the Baltic Sea, MODIS, SST profile

Coastal upwellings are important phenomena in water dynamics of lakes, seas and the ocean. Upwellings are associated with well pronounced decrease of surface water temperature (SST) towards the shore. We examine MODIS (Aqua/Terra) SST-pictures of the southeastern Baltic Sea during 2000–2014 years with the aim to extract those characteristic features of the sea-coast SST-profiles of the coastal upwelling which allow to distinguish it from other differential coastal cooling cases. About 135 events of coastal upwelling (94– 96% of which were of the Ekman type) in May–October 2000–2014 were aalyzed. Characteristic features of the upwelling profiles are: (i) the core of the upwelling (the lowest temperature) shows up at the surface at some distance from the shore; (ii) quite often the strip of warm water separates the core of the upwelling from the coast, (iii) temperature difference between the upwelling zone and adjacent deep waters is large – up to 14°C; (iv) general shape of the sea-coast SST-profile is irregular, and can be much different at neighboring cross-sections. Upwelling is always limited to a certain restricted area along the shore. Overall, the shape of the SST-profiles can be used as an indicator of a dynamic regime (upwelling) of coastal waters. The investigations are supported by RFBR via grant number 13-05-01041a.

Intellectual property rights to the original data of MODIS belong to American space agency (NASA).

P 9

REVISITING BASIS-ICE, A HISTORICAL DATA SET COVERING THE PERIOD 1960/61-78/79

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Keywords: Sea ice, Baltic Sea, Ocean Observations, Monitoring, Historical Data

Historical monitoring data are essential to rate and understand the present status of the Baltic Sea. In the present study we revisit a historical monitoring data set of Baltic sea ice conditions, covering the winters 1960/1961 to 1978/1979. This data set, dubbed Data Bank for Baltic Sea Ice and Sea Surface Temperatures (BASIS) ice, is based on hand-drawn ice charts that were collected and then digitised in 1981 in a joint project of the Finnish Institute of Marine Research (today the Finnish Meteorological Institute (FMI)) and the Swedish Meteorological and Hydrological Institute (SMHI). BASIS ice was designed for storage on punch cards and all ice information is encoded by five digits. This makes the data hard to access. We present a postprocessed product.

Specifically, we convert to standard ice quantities (including information on ice types), which we distribute in the current and free Network Common Data Format (NetCDF). Our post-processed data set will help to assess numerical ice models and provide easy-to-access unique historical reference material for sea ice in the Baltic Sea. We illustrate the data quality by providing statistics of different ice types. For further information the website http://www.balticocean.org hosts the post-processed data as well as the conversion code.

P 10

REGULATING SALT-WATER INFLOWS IN A HIGH RESOLUTION Z-LEVEL MODEL (MOMBA 1.2)

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Keywords: Coupled Ocean-Circulation-Ice Model, Baltic Sea, Salt Water Inflows, MOMBA, Hindcast

Advancing an existing ocean-circulation–ice model configuration of the Baltic Sea, we present a suite of sensitivity experiments with the aim to model realistic salt water inflows from the North Sea. The underlying model features, contrary to most existing configurations, a high horizontal resolution of ≈ 1 nautical mile (≈ 1.85 km), which is eddy-resolving over much of the domain. The vertical discretisation comprises a total of 47 vertical levels. Results from a 1987 to 1999 hindcast simulation show that the model's fidelity is competitive. As suggested by a comparison with sea surface temperatures observed from space, this applies especially to near-surface processes. Nevertheless the model version 1.1 failed to reproduce major inflow events. We trace this back to spurious vertical circulation patterns at the sills (which may well be endemic to high-resolution models based on geopotential coordinates) and discuss a pragmatic approach to cure the problem.

P 11

THE NEW MAJOR BALTIC INFLOW AS OBSERVED FROM OCTOBER 2014 IN THE BALTIC PROPER

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Keywords: inflow, salinity, temperature

In October 2014 the saltwater inflow from Danish Straits was observed in the Baltic Proper region. After twelve years of stagnation, this inflow brought warm (about 15°C) waters into the Bornholm Basin. Unlike the previous inflow in January 2003, during the first stage of the process water moved at the halocline depth in form of intrusion and advection speed was similar in both cases (approx. 30 cm/s). The second stage of the process in January 2015 brought highly saline and oxygenate waters into deeper parts of the Baltic Proper. This presentation shows the most recent data collected from October 2014 to February 2015 and compares their preliminary analysis to earlier results from the r/v 'Oceania' cruises in 2000-2014.

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P 12

ICE AND AIS: EVALUATING SEA ICE FORECASTS BASED ON SHIP SPEED OBSERVATIONS

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Keywords: Numerical Sea Ice Model; Forecast; Model Evaluation; Ship Speed Observations; Automatic Identification System for Ships (AIS)

The Baltic Sea is a vital waterway connecting densly populated and highly industrialized countries in Northern Europe. In wintertime, on-time shipping relies crucially on local weather services now- and forecasting ice conditions. Crucially – because ice conditions can hamper progress or even endanger ships and crews. Among the forecasting tools heavily applied are numerical models. These models, however, suffer from a lack of calibration data because relevant ice properties (such as concentration, thickness, drift, deformation) are difficult (and expensive) to monitor. By applying ship speed observations, obtained by the Automatic Identification System (AIS), we present an innovative and inexpensive approach to evaluate such models. In our pilot study, we compare ship speed observations in a test region in the Bothnian Bay to the sea ice forecast of the Swedish Meteorological and Hydrological Institute (SMHI). Both data sets show a surprisingly good agreement and 62–67% of ship speed variations can be explained by the forecasted ice properties (when fitting a mixed-effect model). This statistical fit is based on 15 to 25 min averages of ship speed from the severe winter 2011.

P 13

CHANGES IN ZOOPLANKTON COMMUNITY AND ITS RESPONSE TO VARIOUS ENVIRONMENTAL STRESSORS – THE CASE OF THE SOUTHERN BALTIC SEA

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Keywords: southern Baltic Sea, zooplankton, community change, environmental stressors

Mesozooplankton is a key element in marine food web. In the southern Baltic Sea conditions it is extremely vulnerable to environmental forcing – observed changes in temperature and salinity influenced the zooplankton community structure significantly. Differences in abundance and biomass of key species at open-waters as well as coastal stations located in the Polish EEZ are analysed and their response to the environmental factors is tested.

Zooplankton samples collected within the Polish National Monitoring Programme are the contribution to the HELCOM COMBINE Programme. Data from the 2002-2013 period were used for the purpose this analyses. In general, at three deep-water stations (P1, P140, and P5) samples were taken 5 times per year and the same sampling frequency was applied for six more coastal ones (K6, P16, L7, P110, B13, KW). One station located in the Puck By (ZP6) is regarded as a higher frequency one and sampling occured there 8-9 time per year.

Results on mesozooplankton community structure dynamics provide valuable information on understanding of ecosystem functioning and contribute to the assessment of Good Environmental Status as defined in the Marine Strategy Framework Directive.

P 14

THE ROLE OF COASTAL SANDS IN THE N-CYCLING OF THE BALTIC SEA

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Keywords: coastal sand sediment, nitrogen cycling, denitrification

The transition zone between the coast and the open sea, often referred to as the 'coastal filter', has an important function in the turnover of land derived nutrients and organic matter. Sand sediments are an integral part of this coastal filter, but have often been assumed to host negligible biological activity. Rate measurements in sands are methodologically difficult due to the advective pore water flow that governs the transport of particles and solutes. Being a dynamic variable, it is difficult to implement into measurement design. The faster transport of matter into the sediment may increase turnover and elemental cycling, and sands could thus be highly active biofilters rather than "ecological deserts".

In the presented project we want to assess the role of coastal sands in the nitrogen cycling of the Baltic Sea. Recent studies have shown that most of the riverine nitrate input to the Baltic Sea disappears quickly within the coastal sediments, which cannot be explained by denitrification in coastal mud sediments. Modelling results showed that advective pore water transport in sand sediments increased denitrification of nitrate from the water column but simultaneously decreased coupled nitrification-denitrification. It is thus not yet clear whether sands are actually sinks or sources of nitrogen. Therefore, we aim to measure denitrification rates in sands of the Baltic Sea coastal filter zone spatially (Baltic wide) and seasonally with a focus on the dark sediments. Planned measurement areas for the spatial coverage are the Vistula estuary (Bay of Gdansk, Poland), the Öre estuary (Bay of Bothnia, Sweden) and the Tvärminne archipelago (Gulf of Finland, Finland). The seasonality is followed via monthly rate measurements at the Finnish coast site. Rate measurements will be done using different approaches that aim to implement the advective flow as close to *in situ* conditions as possible. First results will be presented.

P 15

THE EFFECT OF THREE DIFFERENT ORGANIC ACIDS ON THE ACID/BASE SYSTEM OF COASTAL WATERS

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Keywords: acid/base system, organic acids, total alkalinity, artificial seawater, dissolved organic carbon

The accurate characterization of the acid/base system by the four parameters: total alkalinity (A_T), total inorganic carbon (C_T), partial pressure of CO_2 (pCO_2) and the pH, gains in importance in the context of ocean acidification. However, previous investigations in the Baltic Sea showed an inconsistency between these four measured parameters in coastal waters. This can be attributed to high DOC (dissolved organic carbon) levels and low total alkalinity concentrations which are characteristic for the Baltic Sea. Recent studies have shown that the dissociation of weak organic acids contribute significantly to the total alkalinity and thus to the marine acid/base system. The contribution of the organic alkalinity (A_{org}) results from the difference between the measured total alkalinity and the inorganic alkalinity calculated from two other variables of the CO_2 system. To investigate the importance of specific organic compounds, artificial seawater samples were spiked with three different substances representing acid/base-active compound classes like carboxylic acids, amino acids and humic acids. The effect on the acid/base system was determined in terms of changes in pH and alkalinity. Furthermore, effective dissociation constants of the corresponding organic compounds were determined. The results clearly indicated that the effect of the three classes of organic acids is not neglectable and that for accurate calculations of the marine CO_2 system it is essential to take into account the concentrations and dissociation constants of weak organic acids.

P 16

WHAT TELL US FIFTEEN YEARS STUDIES ABOUT CHINESE MITTEN CRAB *PARAERIOCHEIR SINENSIS* FROM THE GULF OF GDANSK AND VISTULA LAGOON (SOUTHERN BALTIC SEA)?

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Keywords: non-indigenous species, invasive species, *Eriocheir sinensis*

Nowadays non-indigenous species are one of the biggest threats for marine ecosystems, due to their negative influence on ecosystems structure and functioning. The Baltic Sea is often called a sea of invaders and so far about 120 non-native species has been recorded, and new species still appear in the Gulf of Gdansk and Vistula Lagoon. *Paraeriocheir sinensis* is on the list of the 100 most invasive alien species in the world, because of its negative impact on the environment and economy. The first reports about presence of *P. sinensis* in the Baltic Sea are from 1926 and thereafter *P. sinensis* was noted in every part of the Baltic Sea.

In years 1999-2014 in the Gulf of Gdansk and Vistula Lagoon (southern Baltic Sea) adult specimens of *P. sinensis* were collected during commercial fishing. Despite observations of *P. sinensis* from more than ninety years the status of this species in southern Baltic Sea is still unknown. Though continuous increase of abundance of Chinese mitten crab individuals in many parts of the Baltic Sea, there is no documented information, such as numbers of individuals nor the size and sex structure, which are the basis for reasoning, about its invasiveness.

Aim of presented work was to characterise the introduced Chinese mitten crab, what will enable species management. Monitoring of the occurrence of alien species is the first step to prevent the invasion, and is also very important in estimating the unpredictable results of alien species expansion.

P 17

HYPOXIA AND NUTRIENT LOADING IN COASTAL AREAS OF THE BALTIC SEA DURING THE LAST 2000 YEARS

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Keywords: hypoxia, eutrophication, palaeoecology, diatom analysis

The open Baltic Sea has shown a rapid expansion of hypoxic bottoms since the 1950´s, and it now contains one of the largest hypoxic areas worldwide. Hypoxia has severe impacts, for example by killing benthic fauna and altering biogeochemical cycles which in turn affects the entire ecosystem. Also the coastal areas of the Baltic Sea suffers from hypoxia, showing the same trend with an increase of hypoxic sites since the 1950´s.

In the coastal zone, in contrast to the open Baltic Sea, data on long-term trends of hypoxia is lacking. In order to increase our understanding of human impact on the Baltic Sea, coastal sites should be more carefully studied; land-based human activities will probably influence the coastal zone first, before the effects are registered in the open Baltic Sea.

This ongoing project aims to identify how the distribution of hypoxia and the nutrient loading in the coastal zone have varied during the last 2000 years. This will be done using laminated sediments as a proxy for hypoxia and diatom analysis followed by statistical analyses using transfer functions to reconstruct historical nutrient levels. We will further explore if there is a synchronicity between coastal areas and the open Baltic Sea in registered environmental changes. Hopefully it will be possible to disentangle the relative importance of the two drivers climate and nutrient loading as unique or interactive predictors of environmental change.

Eight sites located along the Swedish east coast, from Stockholm archipelago to Bråviken, have been sampled using piston-and gravity corer. The sediment cores have been lithologically described and radiometric dated. Preliminary results will be presented.

P 18

THE USE OF X-RAY FLUORESCENCE FOR MEASUREMENT OF METALS ON BOAT HULLS

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Keywords: TBT, toxic antifouling paints, xrf, copper

Fouling on boats may considerably reduce the speed of the boat. The most common way to prevent fouling is to use toxic leaking antifouling paints on the boat hull. However, the toxic substances may also affect non-target organisms and disturb the coastal ecosystem. We have observed that boat hulls often contain many layers of toxic substances which potentially leak into the water, or are scraped off and accumulated on the ground and eventually end up in the Baltic Sea. The most common compounds are copper (Cu), zinc (Zn) and lead (Pb) as well as the banned TBT (indicated by tin (Sn)), which can be found in older paint layers. We have developed a special calibrated module by which we can measure the amount of metals on a certain hull area with a handheld X-ray analyzer. The concentration of toxic metals can in seconds be measured directly on boat hulls. This screening method means that the potentially most harmful boats may be identified. In a survey of 197 boats all these metals were found in different combinations on the boat hulls between 0 and the maximum value. The highest detected values of each metal was for Cu, Zn, Sn and Pb 25 000, 20 000, 3000 and 7000 μg/cm^2, respectively. A model was made to weigh the different values and produce just one value, which represents the total toxicity of the boat hull. This information would make it possible to take measures to eliminate further discharge of toxic substances to the environment.

P 19

EMERGING CONTAMINANTS IN THE GERMAN BALTIC SEA COAST

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Keywords: pollutants, polar pesticides, UV-filters, Baltic estuaries, seasonal changes

The inland seas, such as the Baltic Sea are particularly susceptible to pollution due to many anthropogenic activities taking place within a large catchment area. The pollutants released from these sources are transported further to the marine environment causing a threat for the marine organisms. Due to sensitivity problems of the analytical methods, data for many emerging contaminants, especially in the marine ecosystems, are still scarce.

Our aim was to evaluate a composition, a distribution and the present concentrations of polar anthropogenic substances in the Baltic Sea. Our sampling programme was intended to study a river transport and the seasonal changes of several groups of emerging contaminants (polar pesticide, personal care products additives and industrial chemicals) in a German part of the Baltic Sea coastal region.

The river and sea water samples were collected during winter, spring and summer 2014. The polar contaminants were extracted from the filtered seawater by solid phase extraction (SPE) and determine with liquid chromatography tandem mass spectrometry (LC-MS/MS) technique.

The distribution of the investigated substances showed that the rivers play a vital role in a transport of these pollutants into the Baltic Sea. The concentrations of the polar pesticide in the Baltic Sea were rather low (in low ng L^{-1} levels) and relatively stable over time. In the river water their concentrations differed significantly between the stations and the seasons. UV-filters (e.g. PBSA) used in the personal care products were detectable only in summer, while disinfectants (e.g. triclocarban) and material additives (e.g. bisphenol A) were below detection limits in the Baltic Sea surface water.

P 20

BALTIC SEA THERMOHALINE STRUCTURE AND ITS TEMPORAL VARIABILITY

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Keywords: water masses, temperature and salinity, structure of water, structural zones, halocline.

Structure of Baltic water (SW) is divided in two structural zones (SZ): surface (with two water masses – West (SWB) and East (SEB)) and deep (similarly – DWB and DEB). The Baltic Sea water structure may be divided into five subtypes: I-II – proper Baltic Sea (deepwater), which consist of SWB, SEB, DWB, DEB; III-IV –shallow one (SWB, SEB) and V – west coastal, under the influence of waters of the North Sea. The first subtype consists of two WM – SB and DB, the second one – only of one SB. The border between surface and deep water in the Baltic to the east of the island of Rügen and except bays lies on isohaline S=9,5 PSU. The border deepens eastwards from 50 m in the western Bornholm basin to 90 m in the western Gulf of Finland. Statistical T,S-analysis showed that the initial and the final S-index of core of SB and DB within the year practically unchanged (while remaining within 3,00 ÷ 8,50 and 5,00 ÷ 16,00 PSU, respectively to the west and east), only T-indexes of cores vary. Temporal variability analysis of the boundary position between SWB and DWB in different regions of the sea showed that during inflows from the North Sea the depth of SB in Bornholm Deep decreased to 42-45 m, in Gdansk - to 60-72 m, in the center of Gotland - 65-76 m, in the west of the Gulf of Finland (SEB and DEB) - 69-80 m. Between inflows the depth of SWB increased to 50-58 m in the Bornholm, 79-106 m in Gdansk and Gotland basins; depth of SEB - to the bottom at the entrance to the Gulf of Finland.

P 21

THE INFLUENCE OF 17α-ETHINYLESTRADIOL (EE2) ON THE REPRODUCTIVE BEHAVIOUR OF *GAMMARUS TIGRINUS* SEXTON, 1939 –RE-CAPTURE TIME EXPERIMENTS

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Keywords: 17α-ethinylestradiol (EE2), *Gammarus tigrinus,* reproductive behaviour, re-pairing

Due to the growing amount of pharmaceuticals containing hormone compounds it is important to understand their impact on aquatic organisms. Estrogens are not subjected to complete elimination in the course of sewage treatment and finally they find their way to lakes, seas and oceans. 17β-estradiol has a negative effect on aquatic animals which is exemplified by: impaired fertility and development, a change in the sex ratio, an occurrence of hermaphroditism, as well as various types of deformation. Still little is known about the impact of synthetic 17α-ethinylestradiol on invertebrates.

Gammaridae have specific reproductive behaviours directly preceding the act of copulation. The change in precopulatory guarding can be a sensitive indicator of environmental stress. The aim of the study was to determine the influence of 17α-ethinylestradiol on reproductive behaviour of *Gammarus tigrinus,* which is considered as a highly tolerant species.

In the experiment, 20 precopula couples, with not egg-bearing females, were used. The paired animals were exposed to two different compound concentrations 50 ng/L (environmental dose) and 500 ng/L (laboratory dose).

The obtained results showed that EE2 in concentration of 50 and 500 ng/L significantly (Wilcoxon signed-rank test: $P<0.05$) extended the time needed for male-female to re-coupled. To conclude, EE2 affects the reproductive behaviour of tiger shrimp.

P 22

RISK ASSESSMENT OF METAL CONTAMINATIONS AT RECREATIONAL BOATYARDS AND HARBOURS: APPLICATION OF A FPXRF SPECTROMETER FOR MEASUREMENTS OF SOIL AND SEDIMENTS

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Keywords: metals, XRF, soil, sediments, boatyard, harbour

At recreational boatyards, the use of anti-fouling paints on boat hulls has led to metal contamination of both sediments and soil. In the harbour, metals leached from the hulls when the boats are berthed accumulate in the sediments, whereas on land in the boatyard, paint particles shed during hull maintenance end up on the ground and contaminate the soil. In Sweden, concentrations well above the national guideline values for soil of, amongst others, Cu and Zn, are a common find. There is a total estimate of 2500 boatyards in Sweden and a large number of these boarder the Baltic Sea which is designated as a PSSA (Particularly Sensitive Sea Area) by the IMO (International Marine Organization). It is therefore important to assess the risk and the remediation need of boatyards and harbours around the Baltic Sea. A method using a FPXRF (Field Portable X-Ray Fluorescence) spectrometer was used to measure metals in soil and sediments at a recreational boatyard in Sweden by lake Mälaren (Märsta). Through direct field measurements of around 50 sampling points, the metal contamination of the surface soil of the boatyard was mapped. Sediment samples from 7 cores were also collected, dried and analyzed with the FPXRF in the lab. The study showed that with the FPXRF, concentrations of metals in soil and sediments could be measured cheaply, quickly (only 2 min per measurement) and accurately, as confirmed by chemical analysis. The FPXRF could therefore be a very useful tool for risk assesment of boatyards and harbours around the Baltic Sea.

P 23

COASTAL CLIMATE ZONE INDICATION IN BALTIC APPLYING REMOTE SENSING DATA

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Keywords: remote sensing, coastal climate, air temperature, shorwave solar radiation, satellite data.

The aim of this work is to distinguish coastal climate zones in Baltic Sea region using shortwave solar radiation and near surface air temperature satellite data during years of 2000-2013. The amount of solar radiation that reaches the Earth surface (both land and sea surfaces) and its atmosphere defines the local temperatures, meteorological conditions and may indicate climate change processes in the environment systems. Naturally solar radiation reaching the Earth is the main energy source governing the surface temperature dynamics both on the land and in the ocean. While the grid of meteorological stations measuring the solar radiation especially in eastern Baltic States is rather sparse, satellite remote sensing data can be effectively used instead. However, the latter should also be treated carefully taking into account atmospheric clarity, signal absorption, could coverage, etc. In this work Terra and Aqua, MODIS and AIRS data of 15 x 15 km resolution was used to evaluate the incoming shortwave solar radiation and near-surface air temperature in the Baltic Sea region and determine coastal climate zones by correlating data spatially. The results fairly demonstrate how CM SAF satellite data can be applied for the coastal climate zone indication, breeze dynamics research and cartography of the whole Baltic region.

P 24

ON DYNAMICS IN THE SLUPSK FURROW BASED ON THE DATA OF ATONOMOUS SYSTEM FOR VERTICAL PROFILING AT A MOORED STATION

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Keywords: measurements, aqualog, currents, inertial waves, spectra, numerical modelling, Slupsk Furrow

Time series of horizontal velocity, temperature and salinity vertical profiles obtained by means of Autonomous System for Vertical Profiling (Aqualog) moored at the point located in the Slupsk Furrow close to the Slupsk Sill are analysed. Time periods of measurements are 22 December 2011 – 22 January 2012, 05 February – 17 March 2012 and 06 April – 13 April 2012. Joint analysis of field and model velocity data showed that during the whole winter period of 2012 the meandering of currents with prevailing Eastward direction took place. During periods of current's intensification the Eastward velocity component amounted to 25-60 sm/s, the Northward component – to 10-20 sm/s. The main peak at the horizontal velocity spectra referred to the period of 32h (in the majority of the water column). Next in energy significance peaks corresponded to the periods of 7.1 and 12.8h. At separate time periods the inertial peak corresponding to 12.8h dominated which indicates the dynamic significance of the inertial waves in the Baltic. The potential energy spectra calculated on the base of isopycnic surface elevation data (the isopycnic surface denoting the beginning of the halocline was considered) reveal the oscillations with period of 3.7 days in winter and – 5.6 days in summer period. As well as on the velocity spectra the oscillations with the period of 30h were distinguished. Separate time intervals characterized by intensification of near bottom velocity are noted. One may suggest that these comparatively rare situations which duration amounted to 5% of the whole period of measurements may refer to gravity current's manifestations.

P 25

CUAL APPROACH FOR THE STANDARD STRATIGRAPHIC CLASSIFICATION OF THE BALTIC SEA SEDIMENTS

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Keywords: allostratigraphy, lithostratigraphy, sequence stratigraphy, Pleistocene, Holocene, Baltic Sea

Long sediment cores and seismoacoustic sub-bottom profiles are studied from an offshore area south of Hanko in the Gulf of Finland. The Lateglacial to present sediments are divided on the basis of sedimentologic criteria into 3 allostratigraphic formations with subordinate allostratigraphic members and lithostratigraphic formations, following the combined allostratigraphic and lithostratigraphic (CUAL) approach. Sedimentologic features are chosen as the primary stratigraphic classification criteria because they do not require the paleoenvironmental inferences of salinity and water level that are inherent in the conventional practice of sediment classification according to the Baltic Sea stages: Baltic Ice Lake, Yoldia Sea, Ancylus Lake and Litorina Sea. The presented stratigraphic division is proposed as a flexible template for future stratigraphic work in the Baltic Sea basin, whereby lower-rank allounits and lithounits can be included and removed locally, while the alloformations will remain at the highest hierarchical level and guarantee the regional correlatability. The described stratigraphic units and unconformities are explainable by the current (glacial) sequence stratigraphic models and compatible with international guidelines (International Stratigraphic Guide, North American Stratigraphic Code), facilitating communication to the wider scientific community and comparison to other similar basins.

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P 26

QUANTIFICATION OF THE IMPACT OF WIND FOR OPTIMISING FAIRWAYS IN THE GULF OF FINLAND

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Keywords: optimised fairways, Lagrangian trajectories, environmental management

Statistical analysis of large pools of Lagrangian trajectories of persistent parcels of water or pollution, passively advected by surface currents is employed to calculate the spatial distributions of probabilities and time it takes for such parcels to reach the coastal area. The resulting distributions are subsequently used for development of various options of environmental management of ship traffic and for specification of environmentally optimised fairways. The analysis is mostly based on trajectories evaluated by the TRACMASS code from velocity fields calculated by the RCO circulation model for 1965–2004 with a horizontal resolution of 2 nautical miles.

Spatial distributions of probabilities and of the time it takes for a pollutant to reach the nearshore are calculated based on 20-day-long trajectories. Alltogether our simulations cover a period of 40 years, with 72 time windows for each year and more than 3000 water parcels for each time window. The outcome is about 9 million single trajectories.

Finally, we assess, how large is the contribution of wind in the Gulf of Finland by analysing the seasonal variability of the optimised fairways.

P 27

PALEOGEOGRAPHIC RECONSTRUCTION OF THE SAMBIAN PENINSULA (KALININGRAD REGION) NORTHERN COASTAL ZONE DEVELOPMENT IN HOLOCENE

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Keywords: Holocene, coastal zone, coastal processes, Kaliningrad region, paleogeography.

Geological (bottom sampling, grain-size analyses) and the geophysical (seismic acoustic, sonar profiling) investigations of the Sambian Peninsula (Kaliningrad region) nearshore were carried out by VSEGEI during 2007-2014. According to analysis of new geological and geophysical dates, submarine wells and previously published data compilation the paleogeographic three-dimensional reconstruction of the Northern coastal zone of the Sambian Peninsula in the Holocene time was developed using GIS-software. Investigation shows that ersiosn processes has dominated within study area during the Holocene. The active development of coastal zone with transformation of coastal line and changing of lithodynamic system started in the beginning of Littorina transgression about 7000 yrs.BP. During 7000-5000 yrs.BP lithodynamic system was the most heterogeneous, because of the simplification of coast line and ingression in the mouth of the ancient rivers. At the beginning of the post-Littorina stage the northern coastal zone of the Sambian Peninsula was almost adjusted and sediment transport was directed to the east. The exception is a windless region of a coastal promontory (in front of Taran cape) on the western part of the shore, which created conditions for possible migration of sand sediments to the west. Nowadays the lithodynamic schema is still the same. The work was supported by Russian Foundation for Basic Research grant 14-35-50114 and Russian Scientific Found grant 14-37-00047.

P 28

INVESTIGATION OF SURFACE CURRENTS NEAR CAPE KOLKA IN THE GULF OF RIGA BY USE OF SURFACE DRIFTERS

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Keywords: Surface drifters, Gulf of Riga, Current structure

Cape Kolka is located at the northern end of the Courland Peninsula in Latvia, and forms a natural border between the Gulf of Riga and the Irbe Strait leading out to the Baltic Proper. A shallow sandbank extends northeast from the cape to Kolka lighthouse, situated on an artificial island about 6 km offshore. The particular coastline and bathymetry shape suggests that the cape is a convergence point for different current structures within the Gulf of Riga and the Irbe Strait.

In order to study properties of the surface currents in this area, two experiments using surface drifters were carried out in 2013 and 2014, deploying 5 drifters simultaneously in each experiment at locations northwest and southeast of Cape Kolka. The current motion in the Irbe Strait was found to be predominantly directed parallel to the coast, whereas the drifter motion within the Gulf of Riga was found to be highly convoluted. Only one drifter passed through the Irbe Strait into the Baltic Proper, following a path close to Sõrve Peninsula. These results support previous observations in the Irbe Strait, suggesting a quasi-permanent flow regime of inflow to the Gulf of Riga at the southern part and outflow to the Baltic Proper at the northern part of the strait. Drifter data also provided information about the typical surface current speed in both the Irbe Strait and the western and central parts of the Gulf of Riga.

P 29

POSSIBLE FUTURE CONSEQUENCES OF *MARENZELLERIA SPP.* INVASION IN THE EASTERN PART OF THE GULF OF FINLAND: RESULTS OF DIAGENETIC SEDIMENT MODEL

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Keywords: benthos layer, biogeochemical prosesses, invasive species, diagenetic model

Polychaete species of the genus *Marenzelleria spp.* by 2009 became the dominant component of the soft-bottom zoobenthos of the Eastern part of the Gulf of Finland.

During their vital activity those polychaetes could make certain adjustments in the functioning of the benthic system. Warm's bioturbation and bioirrigation activity in the sediments for the recent years might lead to suppress the development of blue-green algae. Comparative analysis of biogeochemical changes in the sediments was held for 2 groups of stations: with high and low *Marenzelleria* population. Differences in distribution of various substances in the pore water (ΣPO_4^{3-}, NO_3^-, ΣSO_4^{2-} and ΣH_2S) and in the sediments (Fe^{3+}) were found.

For quantitative assessment of worm's activity contribution to benthic layer changes diagenetic sediment model was applied. According to the model estimates in 5 years pore water ΣPO_4^{3-} store at the station with higher population of *Marenzelleria spp*. might be less in 11 times in comparison with the station with a low worms population. Store of Fe-bound P might be in 1.6 times higher at the station with high polychaetes population. The obtained estimates suggest that polychaetes population can significantly affect burial of P in the bottom sediments of the Gulf of Finland. However it is still not clear how those processes might affect eutrophication in this region, since nitrogen concentration in the water body in improved aeration of bottom sediments increases.

P 30

THE DISTRIBUTION OF TRACE METALS IN GROUNDWATER SEEPAGE IMPACTED AREA LOCATED ON POLISH COASTLINE, SOUTHERN BALTIC SEA

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Keywords: Submarine groundwater discharge (SGD), speciation, metals fluxes, geochemistry

Groundwater discharge has been identified as a significant source of nutrients and dissolved carbon to the southern Baltic Sea. However, trace metals fluxes via groundwater seepage have not been assessed so far. Thus, the aim of this study was to identify concentrations of selected trace metals in submarine groundwater discharge (SGD) areas located along Polish coastline. Part of the research was carried out in the Bay of Puck (2009-2010), while in 2013 and 2014 the study was extended to include several other groundwater seepage impacted areas situated along the Polish coastline (Międzyzdroje, Kołobrzeg, Łeba, Władysławowo).

The end-members, groundwater and seawater, differ with concentrations of trace metals. Generally, the concentrations of some trace elements in groundwater were one (Pb, Cd, Co, Zn) or two (Mn) orders of magnitude higher than in seawater. No significant seasonal change in trace metals concentrations in groundwater was detected in the cause of the study. Dissolved Co and Zn both exhibited conservative distribution relative to salinity while dissolved Mn, Pb, Cd, Cu, Ni and Cr showed non-conservative behavior. This suggests that distribution of metals in groundwater impacted areas is impacted by geochemical reactions.

P 31

PHYSIOLOGICAL AND BEHAVIOURAL RESPONSES OF BLUE MUSSEL *MYTILUS EDULIS TROSSULUS* TO WATER ACIDIFICATION AND REDUCED OXYGEN SATURATION

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Keywords**:** *Mytilus edulis trossulus*; ocean acidification; hypoxia; total metabolic rate, gaping behaviour

The ocean acidification connected with absorption of anthropogenic CO_2 is a global problem also observed in the Baltic Sea. Moreover, high biological production and decomposition of organic matter, especially near the bottom layers, results in high CO_2 inputs but it is also a reason of the oxygen deficiency. Thus decreased pH and O_2 saturation commonly co-occur in highly eutrophicated coastal areas and simultaneously affect the physiology of living organisms.

The aim of this study was to investigate the effect of carbon dioxide-induced decreased water pH (8.1 – control, 7.5 and 7.0), oxygen saturation (~100% and ~20%) and the combination of both factors on the behaviour (gaping activity) and the total metabolic rate of blue mussel *Mytilus edulis trossulus* from the Gulf of Gdańsk. Heat dissipation measurements were carried out in a self-made isothermal twin calorimeter of the Calvet type.

The resting metabolic rate was not significantly ($p > 0.05$) affected by pH or oxygen saturation. The synergistic effect of both factors on this process was also not observed ($p > 0.05$). Similarly, the lowered pH did not significantly ($p > 0.05$) affect the behaviour (time spent for activity). There was, however, significant effect ($p < 0.05$) of lowered oxygen saturation on this parameter, which indicates that this factor may impact the Baltic population of *M. edulis trossulus* more seriously than acidification.

P 32

DISTRIBUTIONS AT THE SOUTH EASTERN BALTIC SEA COAST

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Keywords: Extreme wind, GEV, Gumbel distribution

Increasing of storminess is one of the major sign of climate variability. High wind velocities are main driver of the water masse hydrodynamic and different coastal processes. The purpose of this study is to determine the most suitable extreme value distributions for the maximum wind speeds recorded in SE Baltic Sea coast for 1994-2014 years.

To achieve this objective, we are using the Generalised Extreme Value (GEV) distribution and Gumbel distribution as the diagnostic tool for determining the types of maximum wind speed distributions at the Lithuanian Baltic sea coast (Klaipeda, Nida, Palanga) and inland (Silute) meteorological stations. In this study, both models were fitted by maximum likelihood estimation to monthly maximum wind speed. To confirm significant differences between both models, we carried out an analysis using ANOVA. The Gumbel distribution could not be applied for Palanga meteorological station data, as the confidence interval for shape parameter not contained zero. Significant difference between two models was noticed at the Nida and Silute with the 0.1 reliability. Plotting the predicted wind speed quantiles give the average wind speed for any given return period. This will help us to derive wind speed for any return period, or risk of occurrence, extreme wind speed that is not available in short record of observed wind data. One would expect the maximum wind speed >15 m/s on average every 4 year, for Klaipeda, Nida, Palanga, and Silute, respectively.

P 33

APPLICATION OF SIGNAL DETECTION THEORY APPROACH FOR SETTING THRESHOLDS IN BENTHIC QUALITY ASSESSMENTS

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Keywords: macrozoobenthos, GES, BQI, sensitivity, specificity, Baltic Sea

The European Marine Strategy Framework Directive requires EU Member States to prepare national strategies and manage their seas to achieve Good Environmental Status (GES) by 2020. There are many multimetric indices proposed as indicators of ecological quality of the benthic environment. Their functionality and utility are extensively discussed in the literature. Different frameworks are suggested for comparative assessments of indicators with no agreement on the standardized way how to select the most appropriate one. In the current study we apply signal detection theory (SDT) to evaluate the specificity and sensitivity of the Benthic Quality Index (BQI), its response to eutrophication pressure and performance under effect of the estuarine water outflow. The BQI showed acceptable response to total nitrogen, total phosphorus and chlorophyll-*a* concentrations at the study area. Based on the study results we suggest to use SDT for setting GES thresholds in a standardized way. This would aid a robust assessment of the environmental status and support differentiation of environmental quality classes, particularly specifying GES threshold.

P 34

SPATIAL PATTERN IN HEAVY-MINERAL CONCENTRATIONS ON THE CURONIAN SPIT SEA COAST AS INDICATOR OF HUMAN ACTIVITIES AND NATURAL PROCESSES

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Keywords: magnetite, magnetic susceptibility, sandy berm, foredune

The 98-km-long Curonian spit is fronted by beaches that are dominated by quartz sand with minor high-density fractions. In this study, we use heavy-mineral concentartions (HMCs) as indicators of natural processes and human activities. A total of 92 surface sand samples were collected at 1 km intervals from the foredune toe (seaward base of the protective dune) along the Baltic Sea shoreline of the spit between Klaipėda strait, Lithuania and Zelenogradsk, Russia. The digree of concentration was assessed in the laboratory using bulk low-field magnetic susceptibility (MS) as a proxy for ferrimagnetic and paramagnetic mineral content. Generally, quartz sand is characterised by low MS values of $\kappa<50$ μSI, whereas higher values $\kappa>150$ μSI are typical for heavy mineral-rich sand. The greatest MS values at the foredune toe occur in the southern part of the spit, and are 10 times higher than in the northern part. This pattern suggests the existence of a longshore particle flux, with HMC factors having the potential as useful tracers of longshore sediment transport. Local anomalously high MS excursions are associated with contribution of iron-rich materials from adjacent man-made structures. Therefore, temporally constrained HMC distribution along the foredune base reflects a combination of antecedent geologic framework, longshore sediment transfer, erosional and accretionary processes, wave and wind climate, and local coastal protective structures.

This study was supported by Lithuanian Science Council (Grant No. MIP-039/2014), the Internationalization Program Award, Temple University, Russian Scientific Fund (Grant No. 14-37-00047).

P 35

HYDROMETEREOLOGICAL IMPACT ON SHORELINE CHANGE FOR THE SE BALTIC SEA COAST

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Keywords: Shoreline monitoring, Baltic Sea coast, multiple regressions, wind gusts, wave heights, SWL

Palanga Beach is hot point of the interest at the South Eastern part of the Baltic Sea. These short stretches (3 km) of the straight, exposed, sandy coast is massively occupied in high tourist season and heavily suffers from coastal erosion in last decades.

In this study effects of hydro meteorological parameters, such as wind velocity in gusts, wind direction, wave height and SWL, on the shore-face variability at the Palanga beach were investigated by a multiple regression analysis. The shoreline change rates used for the analysis were estimated from the shoreline positions measured every week from 1st of June to 9th of December 2012.

Five models were analysed to find time periods of hydro meteorological parameters which influence on the coast: average of the parameters for one, two, three, four and five weeks before shoreline position measurement. In the best, four weeks average, model the independent variables together explained ~66% of the variance. In comparison one week average model explained ~50% of variance.

For the shoreline change, at the Palanga beach, wind velocity in gusts has the largest impact than other parameters in analysis comparing by standardized partial regression coefficients ($r2>\pm0.5$) at the 87% of the investigated area. The second major parameter was – wave height ($r2>\pm0.5$ at the 75% of the area). SWL have significant impact on the shoreline change ($r2>\pm0.5$) only at the 30% of the Palanga beach.

P 36

IMPACT OF SHIPWRECKS TO MARINE ENVIRONMENT: MS VOLARE CASE STUDY

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Keywords: hazardous ship wreck, oil pollution, underwater salvage, models for risk assessment

Wrecks of sunken ships may pose different environmental risks. Based on preliminary there are more than 1000 wrecks in the Baltic Sea alone which contain significant amounts of oil. Wrecks can potentially be the cause of pollution both in form of continuous leaking as well as large accidental oil spills. Most wrecks with oil on-board are from the World War II, thus already being corroded and rusty with a higher potential of oil outflow.

In order to evaluate environmental impact from shipwrecks risk assessment is needed. Another important issue is to evaluate the possibility of underwater salvage operation and oil removal from the shipwrecks.

MS Volare beached in 1980 west of Saaremaa. Since then the wreck has been scrapped many times. Unfortunately the engine room and fuel tanks with oil residues have also opened. It is quite probable that the wreck still contains unknown amount of fuel. Last but not least, shipwrecks as traps for sea animals and birds must also be mentioned.

VRAKA, a risk assessment method for potentially polluting shipwrecks. This method will contain tools for assessing risk from shipwrecks and today there are tools for estimating the probability of release, quantifying environmental, ecological and social consequences of a hazardous release from a shipwreck. The VRAKA is applied on MS Volare and performed measurements and observations serve as input.

P 37

EFFECT OF SEA LEVEL FLUCTUATION ON FOREDUNE DYNAMICS. LITHUANIAN BALTIC SEA COAST

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Keywords: sea level, foredune, Curonian Spit, mainland coast.

The fluctuation in sea level is reflected in the foredune dynamics. Depending on the nature of the sea level change (rising or faling), the foredune volume may change dramatically. The objective of this paper is to assess the impact of sea level fluctuation on foredune volume based on the coastal monitoring data. The monitoring of coastal dynamics has been carried out since 2002. Based on the obtained data, the annual foredune volume (m^3/m) was determined. In addition to morphometric data, sea level data from the Klaipėda gauge station for 2002–2014 were used. The results showed that long-term tendencies of the foredune volume changes are not uniform in Curonian Spit cost and Mainland coast. In 2002–2014, a foredune volume growth was observed on the mainland coast and on the Curonian Spit. However, this growth was not uniform. Accumulation on the Curonian Spit foredunes was nearly twice greater that those in the mainland coast. Also, negligible sea level rising trend from 2002–2014 was observed. No significant correlation between foredune volume and sea level on decadal time scale was found. This may be due to the fact that long-term trend of sea level is negligible and has no distinct impact on foredune dynamics. On the other hand, other factors as sand supply, wind and wave climate, coastal morphology, extreme events and human impact play more important role in foredune dynamics on decadal time scale than sea level fluctuation solely. Therefore, for assessment of the impact of sea level rise on the foredune dynamics it is important an impact on other factors.

This study was partly supported by Lithuanian Science Council Grant No. MIP-039/2014.

P 38

DISTRIBUTION OF CHAROPHYTES IN THE CURONIAN LAGOON AND IMPACT OF ENVIRONMENTAL FACTORS

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Keywords: macrophytes, acoustic techniques, mapping

The last study of Charophytes in the Curonian lagoon 10 years ago was mainly focused on the species diversity and occurrence of brackish water species of Charophytes.

In 2014 the national research project has started, with the aim – to assess the recent distribution of charophytes and occurrence of their generative propagules bank in the sediments as possible source for the increase of submerged vegetation areas. Recently the changes of water salinity and turbidity in the lagoon strongly depends on Klaipeda strait, where channel of harbor is constantly being modified and most likely impact charophytes habitats. Generalization of both biological (helohytes, epiphytic organisms) and physical-chemical impacts on charophytes is going to be assessed by statistical predictive species habitat models, which will be tested for use of ecological scenarios analysis.

In the presentation the main results obtained in 2014 will be presented covering: mapping of Charophytes and other macrophytes distribution, usability of water acoustic techniques for mapping macrophytes, and species relationships to environmental factors.

P 39

UPWELLING RELATED DYNAMICS FROM BIAS-CORRECTED SATELLITE SST MAPS IN THE GULF OF FINLAND

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Keywords: sea surface semperature (SST), upwelling, remote sensing, bias correction, Gulf of Finland

The current paper proposes a method for using operational ship of opportunity temperature data at a fixed depth for bias correction of satellite sea surface temperature (SST) images. The bias-corrected SST imagery from MODerate Resolution Imaging Spectroradiometer (MODIS) and Advanced Along-Track Scanning Radiometer (AATSR) sensors were used to calculate mean upwelling characteristics in the Gulf of Finland (Baltic Sea). Firstly, we determined that the operational flow through temperature data at a 4-m depth can be used for validation and bias correction of satellite SST images in cases of wind speed over 5 m s^{-1}. The composite sea temperature maps were calculated from bias-corrected images collected during upwelling events in the Gulf of Finland in 2000–2009. Mean upwelling characteristics were estimated from composite maps for both the northern and southern coasts of the gulf [1].

[1] Uiboupin, Rivo; Laanemets, Jaan (2015). Upwelling Parameters From Bias-Corrected Composite Satellite SST Maps in the Gulf of Finland (Baltic Sea). IEEE Geoscience and Remote Sensing Letters, 12(3), 592 - 596.

P 40

A STUDY OF THE SEA SURFACE BOUNDARY LAYER DYNAMICS

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Recent studies have showed that discrepancies of the numerical hydrodynamic models as well as of the Lagrangian models could be attributed to the course grid resolution and lack of small-scale turbulence studies. The concept and the first results of the study addressing the joint impact of wind- and current-induced Lagrangian transport in marine surface layers by combining field measurements and numerical modeling will be presented. Autonomous drifters will be used to track the flow at different depths within the surface boundary layer. Each drifter will be equipped with a GPS tracker to record the position, and an accelerometer to measure the local wave conditions. The aim of the study is to understand the dynamics of motions in the shallow stratified surface boundary layer, typical for the Baltic Sea and general estuary conditions.

P 41

IN SITU TESTING OF ANTIFOULING PAINT TOXICITY ON SNAILS

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Keywords: snail, antifouling paint, in situ, marina

The toxic effects of antifouling paints were tested in a long-term field experiment on a common snail in the Baltic Sea (*Theodoxus fluviatilis*). As representative sources of antifouling paint pollution a marina and a guest harbor nearby Stockholm, Sweden were chosen. For comparison, Askö was used as a reference area. Plastic cages containing snails and tips of bladderwrack (*Fucus vesiculosus*, to resemble their natural substrate) were placed at each site, at a depth of 1 m for 8 weeks. Both water and sediment samples were taken from each site for chemical analysis (Cu, Zn, TBT, Diuron and Irgarol).The reproduction of the snails was assessed by counting the number of eggs laid in each cage. A significant difference was found between the marina and the reference site, the former having a reproduction rate 92 times lower than the latter. Moreover, the mortality rate was highest in the marina (i.e. 10 times higher than at the reference site). The copper concentration in the marina was also the highest from all sites and this might be one of the reasons behind the observed effects. We concluded that in situ exposure of snails is a good tool for evaluating the long-term effects of marinas on gastropods, which are a highly relevant and yet underrepresented group of organisms in toxicity testing. As mixture toxicity is difficult to assess, we will complement the observed physiological effects with analysis of specific biomarkers such as Cu/Zn superoxide dismutase and metallothionein.

P 42

RADIATIONAL TIDES IN THE BALTIC SEA

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Keywords: Baltic Sea, radiational tides, Curonian Lagoon, sea level, breeze winds

Tides in the Baltic Sea are weak but unmistakably recognizable in sea level spectra. The use of long-term hourly tide gauge observations allow us to examine specific tidal properties in detail and to identify some unexpected effects. High-resolution spectral analysis revealed fine structure of well-defined spectral peaks at tidal frequencies. At stations Narva and Daugavgriva high-frequency radiational tidal peaks, multiple of solar day (3, 4, 5, 6 and 8 cpd), were identified; the respective oscillations are supposed to be caused by breeze winds. Two nearby stations on the southeastern coast of the sea: Baltiysk, located at the strait connecting the Baltic Sea with Vislen Bay, and Otkrytoe, at the coast of Curonian Lagoon, demonstrated different characters of tidal motions. Following analysis indicated that tides at Baltiysk are produced by the ordinary gravitational tidal forcing, while at Otkrytoe they are induced by the solar radiation, specifically by breeze winds creating wind set-ups and set-downs in Curonian Lagoon. Moreover, our findings demonstrate that the observed K_1 and P_1 peaks at the station Otkrytoe are related not to the respective gravitational tidal harmonics but to the seasonal modulation of the S1 radiational tidal constituent. The separate analysis of "summer" and "winter" sea level spectra at Otkrytoe revealed prominent radiational tidal peaks (S_1 and S_2) in summer and absence of these peaks in winter.

P 43

MONITORING OF BENTHIC MOBILE EPIFAUNA IN THE PORT OF GDYNIA (POLAND) – IS THE TRAP TYPE IMPORTANT?

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Keywords: non-indigenous species, port, monitoring methods

Non-indigenous species (NIS) are considered to be one of the major threats to biodiversity of coastal ecosystems. The mian pathway of NIS spreading are vessels and ports are the locations particularly vulnerable to new introductions. Only regular and effective monitoring of port waters gives a chance of quick detection of a new species and applying a proper management method. Unfortunately in many countries, including Poland, port areas are excluded from national monitoring programs. First survey in Port of Gdynia took place in May-July 2014. One of the monitored group was mobile benthic epifuna. Besides determining the diversity of mobile epibenthos with a special regard to NIS, our goal was also to define the most effective trap type. As the sampling method we applied commercial baited traps recommended by HELCOM, as well as seld-made traps ("crab condo" and "artificial habitat crate") providing a shelter for organisms. We identified 7 taxa (including 2 NIS) in baited traps and 19 taxa (including 3 NIS) in these habitat-like, which would make them a reasonable choice for supplementing the recommended monitoring methods.

P 44

CURRENT STATUS OF MARINE LITTER POLLUTION AND MAIN LAND LITHUANIAN COASTAL ZONE SENSITIVITY OF MARINE LITTER EVALUATION

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Keywords: Marine litter, coastal zone sensitivity, waste management.

The understanding of growing pressure on natural marine resources has resulted in the first legislative instrument developed by the European Union – Marine Strategy Framework Directive (MSFD) aiming to achieve Good Environmental Status (GES) of the EU's marine waters by 2020. Defining and ensuring Good Environmental Status (GES) within the frame of 11 qualitative descriptors, including and marine impact, becomes increasingly important not only for Lithuania but also for the whole Baltic Sea region. An attempt to investigate the marine litter pollution level of the Lithuanian coastal zone was carried out based on different marine litter monitoring methods and according to the lists of identifiable items. A comparison of marine litter, at four Lithuanian beaches, within different categories of coastal zone urbanization and functional use, characteristics with local waste management system indexes was done. Statistical analysis of collected data was used to identify possible spatial and temporal tendencies. The results have proven that plastic is the dominant type of marine litter. It seems that tourism and fishery related marine litter occurrence do not significantly depend on seasonal variations, however are strongly location dependent. The study links marine litter, tourist flows, local waste generation and composition for evaluation of anthropogenic pressures on main land Lithuanian coastal zone.

P 45

THE EFFECT OF CYANOBACTERIUM *MICROCYSTIS AERUGINOSA* TOXINS ON THE CRUSTACEAN *DAPHNIA MAGNA* LIFE CYCLE

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Keywords: cyanotoxins, *Microcystis, Daphnia*, reproduction, growth rate The main problem of the freshwaters is extensive load of nutrients causing eutrophication and intensive cyanobacteria bloom. Cyanobacteria can produce compounds, which can be toxic to other water organism, as well as can accumulates in higher trophic levels and can influence human food quality.

One of the most toxic cyanobacterium is *Microcystis aeruginosa*. The aim of this work was to evaluate the impact of *M. aeruginosa* to the crustacean *Daphnia magna* reproduction and growth rate.

Individuals of *Daphnia magna* clone were fed by toxic and non-toxic *Microcystis aeruginosa* culture. The growth rate of daphnia eggs and offspring were measured. The results showed that there were no statistically significant difference of growth rate between two groups, however the minimal adult size of individuals fed by toxic cyanobacterium were smaller comparing with the individuals fed by non-toxic cyanobacterium, while the eggs growth rate – conversely.

P 46

ESTIMATION OF WAVE AND WIND FIELD PARAMETERS FROM TERRASAR-X IMAGERY IN THE BALTIC SEA

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In this paper detection of wave field parameters from SAR imagery in the Baltic Sea is presented. Over the Baltic Sea region common SW and W winds induce steep waves with shorter wavelengths compared to ocean waves. With the use of TerraSAR-X high spatial resolution data, it is possible to measure sea state parameters.

The main objective of this work was to demonstrate the capability of detecting wave field parameter from TerraSAR-X imagery in the Baltic Sea. The wave field parameters obtained from SAR imagery was compared with in situ measurements and SWAN wave model.

The comparison showed a significant correlation between SWAN and SAR derived wave propagation direction ($r = 0.872$; $P < 0.001$; RMSD = 25°) and wavelengths ($r = 0.907$; $P < 0.001$; RMSD = 9.4 m). The peak period was also calculated from SAR based 2D wavenumber spectrum and compared with SWAN results ($r = 0.697$; $P < 0.001$; RMSD = 1.19 s). The comparison of SAR based wave field information with buoy measurements showed also good agreement in case of wave propagation direction ($r = 0.950$; $P < 0.001$; RMSD = 30°), wavelengths ($r = 0.831$; $P < 0.001$; RMSD = 13.2 m) and peak period ($r = 0.633$; $P < 0.001$; RMSD = 1.38 s).

With the case studies, it is shown that SAR data enables to detect land shadow effects and small scale wave field variations in the coastal zone. It was shown that SAR data is also valuable for improving the wave model results. In consequence of common slanting fetch cases over the Baltic Sea region, wave directions are investigated in relation to wind directions.

P 47

THE SEA LEVEL SPECTRA IN WIDE FREQUENCY RANGE IN THE BALTIC SEA AND ITS GULFS

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Keywords: Baltic Sea, sea level spectra, Gulf of Finland, eigen modes

In this study the formation of sea level spectrum in wide frequency range in the Baltic Sea as a whole and in its main gulfs is considered. The processes with periods greater than 100 days are induced by the oscillations arriving from the North Sea. In contrast, relatively short period processes (periods < 30 days) are generated within the Baltic Sea itself and are almost unaffected by external oscillations. Danish straits act as a low-pass filter, strongly suppressing high-frequency processes but allowing low-frequency processes to pass through freely. At frequencies more than 0.3 cpd the individual spectral characteristics of the Gulf of Bothnia, Gulf of Finland and Gulf of Riga become apparent. Their character is determined by the frequency-selective properties of these basins. Thus, in the Gulf of Finland the wide peak is formed which corresponds to the main eigen mode of the gulf with a period of 26-29 hours.. In the Gulf of Bothnia in the mesoscale frequency range eigen modes are less pronounced. Tidal oscillations in the Baltic Sea are relatively weak, but in the sea-level spectra they have well-defined tidal peaks. At frequencies above 3 cpd in nearby bays the spectra can have greate differences. Thus, in the spectrum of sea level fluctuations in Kronstadt a continuous increase of the spectrum with a period of about 8 hours, caused by the fundamental mode of the Neva Bay, is formed.

P 48

DESCRIPTION, HABITAT RANGE AND SEASONALITY OF A NEW NON-INDIGENOUS POLYCHAETE *LAONOME* SP. (SABELLIDA, SABELLIDAE) THE NORTH-EASTERN BALTIC SEA

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Keywords: Benthic, brackish, establishment, nonindigenous, shallow water, spatial modelling

A new, non-indigenous polychaete was found at very high densities in the eastern part of the Baltic Sea in Estonia in 2012. The species represented the sabellid genus *Laonome* Malmgren, 1866, but it could not be assigned to any of its previously described species. The alien polychaete was described by examining living specimens and with scanning electron and light microscopic methods. Morphological analyses were supplemented by molecular characters from sequences of the mitochondrial and nuclear genes. To study the local distribution and abundance of the species a spatial sampling grid with some stations replicated seasonally and interannually were examined. Together with this survey and estimated environmental data, the current niche width of the polychaete was determined using the boosted regression trees modelling approach. The abundance of the new *Laonome* sp. exhibited a strong seasonal variation, peaking between July and November. Besides seasonality, the quantity of decomposed microalgae in the sediment and exposure to waves contributed the most to explaining the abundance variation in the niche model. Due to its high densities this non-indigenous polychaete may potentially modify sediment morphology together with its chemistry and disrupt natural infaunal communities by establishing new ecological relationships. Furthermore, range extension into low salinity areas of the Baltic Sea can be expected.

P 49

OPERATIONAL MONITORING OF THE SURFACE WATERS OF THE BALTIC SEA WITH SOOGUARD SYSTEM.

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Keywords: FerryBox, Real-time data, Baltic Sea, Surface water monitoring

SOOGuard is fully automatic, compact modular flow-through system primarily intended for surface water monitoring from ships, boats or other moving platforms, also known as ferrybox system. In June 2013 one of these systems was installed on M/S ROMANTIKA (TALLINK) on route between Riga-Stockholm and from August 2014 between Tallinn-Stockholm. Parameters measured in the surface water, about 5m depth at 1-minute interval are transferred immediately to server on shore using GSM/GPRS protocols and displayed in real-time on webpage http://on-line.msi.ttu.ee/lvferry3/ . Set of measured parameters include: Temperature, Salinity, O_2, Chlorophyll A, Turbidity, Phycocyanin, pCO_2. As shiproute cover different watermasses, this set of parameters allow to study and monitor wide range of processes from coastal to open sea exchange, thermohaline circulation, productivity estimations to vertical water exchange processes in open sea. Data quality control is essential and discussed, especially in biogeochemical implications, emphazising on multiscale analysis of processes in marine environment of the Baltic Sea.

P 50

ECOLOGICAL NICHE MODELLING OF NON-INDIGENOUS SPIONID MARENZELLERIA SPP. IN THE SE BALTIC SEA

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Keywords: biological invasion, zoobenthos, species distribution modelling, random forests, Lithuanian marine area

Since the appearance of *Marenzelleria* genus in early 1990's, the polychaete became a widespread species in the most of Lithuanian marine area (LMA) and the northern part of the Curonian lagoon. Today the species is present in high abundances in variety of benthic habitats: from shallow mobile sands and coastal reefs to deeper muddy and even sub-halocline habitats. The biomass of this polychaete can reach more than 50 % of total zoobenthos biomass, thus dominate some benthic communities. The main interest of this study was to generate a species distribution map for all LMA and to assess which habitats were invaded most heavily. Random forests modelling technique was used to predict the distribution of *Marenzelleria* spp. in LMA based on several environmental predictors such as depth, sediment types, Secchi depth, minimum near-bottom oxygen concentration, near-bottom current velocity, wave generated orbital near-bottom velocity, topographic features, temperature and salinity. The results have shown, that the highest densities of non-indigenous spionids occur in coastal shallow sands, where local species richness is very poor, while in habitats with rich benthic communities the share of *Marenzelleria* spp. is less considerable.

P 51

VERTICAL COARSE AEROSOL FLUXES IN THE BOUNDARY LAYER OVER THE BALTIC SEA

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Keywords: Marine boundary layer, Air-sea interaction, Sea spray aerosol, Aerosol concentration gradient

The results of studies of the vertical gradient of aerosol concentration measurements made during cruises of r/v "Oceania" between 2008 and 2012 are presented. Using the results from those experiments, sea spray emission fluxes were calculated for all particles of sizes in the range from 0.5 μm to 8 μm, as well as for particles of sizes from fifteen channels of 0.5 μm width. The information obtained was further used to calculate the Sea Salt Generation Function (SSGF) for the Baltic Sea depending on the wind speed and the aerosol size distribution.

P 52

SIGNAL CRAYFISH *PACIFASTACUS LENIUSCULUS* (DANA, 1852) (CRUSTACEA: DECAPODA) – THE HIGHLY INVASIVE SPECIES ENTERS THE POLISH COASTAL WATERS OF THE BALTIC SEA

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Keywords: *Pacifastacus leniusculus*, occurrence, alien species

Signal crayfish *Pacifastacus leniusculus* (Dana, 1852) is native to North America. In 1960's it was introduced to Scandinavia and later to other countries (in 1970's to Poland). It is now the most widely spread alien crayfish in Europe. The most common pathways of introduction are stocking for commercial and recreational purpose. The signal crayfish is plastic towards environmental factors as temperature and salinity makes him very expansive. It is an omnivorous species that characterized by higher fecundity and greater aggression than native crayfish species.

The study was carried out in the Wieprza River and its tributaries (NW Poland) outside of the introduction places. The Wieprza River flows into the southern Baltic Proper. The material was collected during field trips in May, June and July 2014. In total 28 sites were sampled and at 8 sites 127 specimens were collected. The high catches of the signal crayfish were observed close to the Wieprza River mouth.

The appearance of the signal crayfish *P. leniusculus* (Dana, 1852) in the Wieprza River forecasts the disturbances for biodiversity of the coastal rivers as well as zones of the Baltic Sea.

This species extends into the brackish waters: in 1960 it was noted in the Gulf of Bothnia, and was reported in Danish coastal waters of the Baltic Sea in 2010.

We suspect that in the near future the signal crayfish might be found in Polish Baltic Sea as spiny-cheek crayfish.

P 53

APPLICATION FOR WATER QUALITY MODELLING SYSTEM IN THE FINNISH ARCHIPELAGO SEA

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Keywords: Archipelago Sea; COHERENS; hydrodynamic modelling; water quality

High resolution coastal modelling is needed in the future to provide information of the coastal processes and interaction between the coastal and open sea processes. Moreover, applicable modelling tools are needed in decision making for providing reliable information on the effects of the planned actions on the state of the coastal waters. Modelling in the coastal areas of Finland is challenging because of the irregular structure of the coastline and thousands of small islands. This is especially the case in the Archipelago Sea,where the variations in the bathymetry are also large; the mean depth is ca. 23 m but there are faultlines exceeding 100 m depth.

We used 3D hydrodynamic model COHERENS to model the Baltic Sea with 2 nmi resolution and the Archipelago Sea with 0.25 nmi resolution. Atmospheric forcing was taken from FMI's operational HIRLAM model with 4 nmi spatial and 3h temporal resolution. The output from the COHERENS model is used to force the water quality modelling system implemented to the Archipelago Sea.The first results from the Archipelago Sea model show that in some areas the horisontal and vertical structure of temperature and salinity fields is modelled with good accuracy. Also, the seasonal variation of modelled SST is mainly in good agreement with observations. However, in some areas with sharp vertical gradients in bathymetry, the model shows too extensive mixing leading to lower accuracy in the results.

P 54

ON DATA ASSIMILATION ON BALTIC SEA WITH HBM MODEL AT FMI

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Keywords: data assimilation, HBM circulation model, Operational, Gulf of Finland Year, Argo float

Finnish Meteorological Institute has been implementing data assimilation system for the Hiromb-Boos Model (HBM). HBM has been FMI's operational circulation model since 2012.The data assimilation system implemented integrates satellite SST data from MyOcean service into the model.

Data assimilation scheme used is Optimal Interpolation. Original SMHI implementation has been further developed and adjusted for HBM by FMI. Results so far have been promising, and the assimilation is scheduled to be part of the operational system on spring 2015.

Here we examine the effects of Data assimilation on model results. We compare the results with hydrographical data acquired from Gulf of Finland measurement campaign 2014, and on FMI Argo float data gathered from Bothnian Sea and East Gotland Basin.

Further developing plans include adding new data sources, like Argo floats and ferry-boxes into the assimilation. The possibility to include other parameters like salinity and ice thickness into the assimilation process is also discussed.

P 55

SPECTROPHOTOMETRIC AND FLUORESCENCE PH MEASUREMENT METHODS IN THE BALTIC SEA

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Keywords: pH, spectrophotometry, fluorescence, seawater carbon dioxide system, Baltic Sea

Some processes result in only small changes in the oceanic carbon dioxide system, thus researches for analytical techniques with high accuracy and precision are needed. After improvements in relative sensitivity and reliability, pH determination has become a preferred parameter in marine carbon dioxide monitoring in pairing with other acidification parameters. Herein three different methods of measuring seawater´s pH have been evaluated in comparison with calculated pH results (using CO2SYS program with total alkalinity and dissolved inorganic carbon). Approaches for spectrophotometric and fluorometric pH determinations are different from frequently used potentiometric method, which measures difference between the chemical potential of the species considered in the sample solution and its chemical potential in the reference state. To cover most of geological and physical-chemical characteristics in the Baltic Sea, samples were taken and analyzed from the northernmost up to southwestern part of the Baltic Sea. Preliminary results showed better correlations with calculated results using spectrophotometrically and fluorometrically obtained pH values. Nearly constant offset of 0.2 units in potentiometric pH values was due to the different pH scale used. As pH of natural environments frequently varies by several units even on short time-scales, relationships with biological activities will be studied.

P 56

HIGH RESOLUTION WAVE HINCASTS

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Keywords: wave modelling, statistics, Archipelago Sea

Foreacasts and statistics of wave conditions in the coastal areas are needed e.g. for shipping and planning of offshore structures. Several studies have presented wave statistics for the open sea areas of the Baltic Sea based on wave measurements and model hindcast. The resolution of these statistics is typically insufficient to describe the wave conditions in the coastal areas especially where the coastline is well sheltered by islands.

Previous studies have shown that with sufficiently high resolution the wave field in the Archipelago Sea can be modelled with good accuracy. We used wave model WAM with 0.1 nmi resolution to model the wave field for 2012- 2013. The model results were verified against wave measurements available from the Northern Baltic Proper and the Archipelago Sea. Monthly, seasonal and annual wave statistics are compiled based on the hindcasts. The preliminary analysis shows that the wave climate in the Archipelago Sea is considerably milder than that of the Nothern Baltic Proper or the Southern Bothnian Sea. E.g. in October, the mean values of significant wave height were ca. 1.2 m in the Northern Baltic Proper whereas in the Archipelago Sea the largest mean values were ca. 0.5m. The statistics clearly show up the areas in the southeastern Bothnian Sea and in the Northern Baltic Proper were the wave refraction on shoals causes concentration of wave energy leading to higher values of significant wave height than in the surrounding areas.

P 57

BENTHIC COMMUNITIES AND HABITATS IN THE RUSSIAN EEZ IN THE SOUTH–EASTERN BALTIC

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Keywords: habitat mapping, bottom sediments, zoobenthic communities, underwater meadows

The development of different offshore facilities (ports, oil platforms, pipelines) is included into economic strategy of Kaliningrad region and already lead to an increase of anthropogenic stress on coastal zone. However, biological aspects of underwater habitats almost were not studied.

Basing on 2001-2014 data (ABIORAS) benthic communities were classified according to species diversity, abundance and composition of dominant species and mapped. Analysis of community distribution against the habitat features (substrate types, photic, hydrological, trophic conditions) allowed to recognize benthic habitats, according to HELCOM habitat classification.

More than 70 macroinvertebrate and 32 macroalgae species were recorded in the study area. Five main bottom communities with several variations each, dominated by macroinvertebrates – bivalves *Mytilus edulis, Macoma balthica, Mya arenaria*, polychaetes *Marenzelleria neglecta, Hediste diversicolor* or oligochaetes have been identified. In several nearshore areas of photic zone the bottom communities with dominance of macroalgae were found. The use of underwater video recording, SCUBA diving, side scan imaging let to identify rather detailed features of coastal benthic biotopes and made evident the existence of several unique or sensitive seascapes: "ancient lagoon mud" and under water meadows in the study area.

Recommendation for further establishment of new marine protected areas in the region were developed on base of the results.

P 58

MEASURING SUSTAINABILITY OF COASTAL REGIONS BASED ON INDICATORS

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Keywords: Sustainability, indicator, coastal, ICZM, Systems Approach Frameworks

Coastal regions are tremendously important for Europe's economy. Activities such as shipping, fishing, resource extraction and renewable energy are all putting pressure on marine and coastal areas. The coastal zone is a very complex social-ecological system that varies in relation to its environmental, socio-economic, cultural and governance factors. The coastal areas of Baltic Sea are among the most intensively used worldwide and this has resulted in habitat loss, pollution and accelerated coastal erosion. Climate change is likely to make these regions and the societies that live in them more vulnerable.

Increasing problems in coastal zones and high-ranking political initiatives promoting Integrated Coasdtal Zone Management (ICZM) have resulted in indicator-based efforts to measure the state of and the progress towards sustainability in coastal zones. Indicators are popular because they provide a simplified view of complex phenomena, quantify information, and make it comparable. Indicators are regarded as important tools in European coastal and maritime policy and have been used for years to monitor the EU Sustainable Development Strategy.

We present a set of indicators designed to measure sustainable development in coastal areas on a local and regional level and show first application examples. The set can be adjusted to the needs of municipalities and can serve as a decision support and strategic planning tool.

Within the BONUS-project BaltCoast, a Systems Approach Framework (SAF) for the assessment of coastal management activities shall be adapted and the indicator set shall be further developed. It will be provided as generalized spreadsheet tool to allow scientists, authorities and municipalities map the present state of sustainability, to quantify changes in past and future and to evaluate the success of ICZM initiatives.

P 59

SHORT-SCALE VARIABILITY OF ZOOPLANKTON ABUNDANCE IN A TEMPERATE SEA: NEW INSIGHTS TO ECOLOGY AND IMPLICATIONS FOR LONG-TERM ASSESSMENTS

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Keywords: Baltic Sea, copepods, cladocerans, rotifers, abundance, biomass, coastal areas, large gulfs, open sea

Zooplankton constitutes an important component in marine realm through its multiple roles in shaping the structure, dynamics and functions of marine ecosystems. Therefore, advanced knowledge of its variation and changes is essential to understand the interactions between different internal ecosystem features and effects of external forcing factors. Over 24 000 sample-based data records from the Baltic Sea collected between 1957-2013 were assembled to estimate the short-scale spatiotemporal variability of zooplankton. The temporal signal in zooplankton variability is generally stronger than spatial with exception of large copepods which are under stress of physical environment. Of the three distinct spatial areas investigated – coastal, large gulfs and open sea – large gulfs are most and coastal areas least stable. Small copepods that constitute majority of the zooplankton biomass in all three areas, have the lowest short-scale variability (maximum 5 times in samples that were collected in < 3 months and < 100 km apart), whereas cladocerans are the most unstable component (up to 30 times). Due to different scales of abundance/biomass variability of different zooplankton groups, taxon-specific approach in spatio-temporal data availability is inevitable for adequate and representative assessments. Our results indicate a need to revise present zooplankton monitoring programmes to obtain more reliable estimates of the zooplankton population changes.

P 60

SEA LEVEL RISE IN THE BALTIC BY 2200 – WHAT CAN WE SAY?

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Keywords: sea level rise, regional sea level projections, Baltic Sea, climate change adaptation

Predicting global sea level rise involves large uncertainties, especially due to the unknown behaviour of the ice sheets of Greenland and Antarctica. Most projections available in recent scientific literature extend to the year 2100, and those extending longer into the future are characterized by low confidence. The lifespan of new coastal infrastructure often exceeds 100 years, however, and multi-century predictions are required for coastal planning. This presentation reviews the global sea level rise projections extending to 2200 that are available in the recent scientific literature, discusses regional anomalies from the global mean in the Baltic Sea, and presents a method to combine different projections into one probability distribution of regional sea level rise. This distribution has been combined with land uplift and short-term sea level variations to give crude estimates of sea flood heights at different return periods in 2100–2200 on the Finnish coast.

P 61

COASTAL WATER ECOSYSTEM SERVICES ASSESSMENT WITHIN A SYSTEMS APPROACH FRAMEWORK

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Keywords: Ecosystem services, SAF, Coastal Lagoons, BaltCoast

Transitional waters are very important ecosystem services suppliers that are extremely important for environment and humans, these ecosystem services divided into: supporting, regulating, provisioning and cultural services. These are areas very vulnerable to environmental and anthropogenic impacts, and only recently ecosystem services raised awareness for stakeholders due to economic valuation and in parallel environmental conservationists and managers adopted a multidisciplinary approach for a more integrative and adaptive output. Most of them applying SAF framework that encompasses the ecological, social and economic components of coastal zones producing outputs that can be communicated to stakeholders and policy makers.

The objective of this study is to assess and compile information about ecosystem services in Oder and Curonian Lagoons, allowing comparisons and adopting SAF approach. This will be achieved by literature review and long term data analysis; also using Starmans study as pilot approach with the aim to improve it to a more generalized methodology applicable to a wide range of ecosystems possible using as much ecosystem services as possible.

This study will be developed in cooperation with a new project called BaltCoast, which aims to develop a systematic management approach that encompasses multiple impacts in a spatially heterogeneous context, by using SAF and to implement a long lasting Baltic coastal management competence network and integration with EU policies.

P 62

ANALYSIS OF SCENARIOS FOR SOCIO-ECONOMIC DEVELOPMENT AND CLIMAT CHANGES OF THE PLEGOLYA RIVER CATCHMENT AS A DETERMINING FACTORS IN THE NUTRIENT LOAD

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Keywords: nutrient load, socio-economic development, climate changes, scenarios, Baltic Sea catchment

Pregolya is the largest river that draining to the Vistula Lagoon of the Baltic Sea. The drainage basin of the Pregolia River is about 65% of the lagoon catchment area that occupied by Russia and Poland in approximately equal proportions. Large amounts of nutrients comes from the river catchment. In the framework of the Soil2Sea Project and RFBR research project No 14-05- 91730 BONUS_a the estimation of possible nutrient load from the Pregolya River catchment due to the scenarios of socio-economic development and climate changes was done. The data analysis showed that there is great potential for agricultural development in the Kaliningrad Oblast. Currently about 50% of arable land are not used. According to the "Strategy of socioeconomic development of the Kaliningrad Oblast until 2020" is expected to increase arable land by 70%, the number of cattle 3.5 and pigs 9.5 times. At the same time more than 80% of the wastewater in Kaliningrad Oblast is not sufficiently treated. This factor is a great potential for nutrient load reduction. Polish territory is well agricultural developed. It is caused significant nutrient inputs. The implementation of environmental technologies could reduce it. The ongoing climate changes (the ratio of dry and wet periods) leads to the annual redistribution of river runoff and leaching of nutrients. Analysis of scenario of nutrient inputs needed for strategic socio-economic planning for the consideration of environmental issues during development.

P 63

BALTIC SEAGRASS MEADOWS AS A SEDIMENT CARBON SINK

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Keywords: Baltic Sea, blue carbon sink, coastal biogeochemistry, ecosystem engineer, eelgrass

Seagrass meadows are highly productive habitats also regarded as ecosystem engineers. They have strong capacity to change abiotic conditions by facilitating sedimentation, reducing resuspension, trapping seagrass derived and other particles. Recently a lot of studies are dedicated to "the blue carbon sinks" subject. Most of the studies assessing seagrass sediment carbon sink capacity are based on results obtained in the *Posidonia oceanica* meadows. Present study is the first estimation of seagrass sediment carbon sink storage in the *Zostera marina* beds. To evaluate seagrass engineering effects, we compared main parameters describing organic matter and sediment characteristics as well as possible organic matter sources in the sediment at vegetated and unvegetated bottom. The study was conducted in Southern Baltic Sea in summer seasons of 2012, 2013 and 2014. Collected data indicate that carbon stock in the Baltic Sea vegetated area (1480-2100 km^2) amounts 0.6-0.8 Mt, whereas Carbon annual accumulation is around 0.08 Mt. All tested descriptors of organic matter, pigments and sediment were enhanced at vegetated bottom. The result of SIAR modeling (Stable Isotopes in R) show high percentage of organic matter originated from seagrass production. Therefore, the obtained results indicate the importance of seagrass vegetated coastal habitats in the Baltic Sea as carbon storage and efficient ecosystem engineers.

P 64

THE CURRENT STATE OF FISH FORAGE BASE EASTERN GULF OF FINLAND.

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Keywords: fish forage base, zooplankton, zoobenthos

Two main components of a fish forage base eastern Gulf of Finland have been evaluated: zooplankton and macrozoobenthos. In 2014 the weight-average numbers of summer zooplankton on different parts eastern Gulf of Finland have been 28.0–85.5 thousands ind./m^3 and weight-average biomasses have been 0.5–1.5 g/m^3. Values have been close to the long-term average (23.25–53.75 thousand ind./m^3 and 0.5–0.8 g/m^3) and have corresponded to the level of productive years.

The average abundance and biomass of macrozoobenthos in 2014 have been within the ranges of long-term fluctuations and have corresponded to 4550 ind./m^2 and 15.3 g/m^2, respectively. More than 64% of the benthic biomass was classified as "soft" forage for fish benthophagous. On the whole the feeding conditions for fish in different areas eastern part of the Gulf of Finland can be considered favorable.

In recent years there has been an increase in the number of alien macrobenthic species to eastern Gulf of Finland. In 2014, alien species have been observed at all stations without exception. The ratio of these species in total biomass varied greatly from 4% in Koporskaya Bay, 13% in Luga Bay, 30% in Shallow-water area, 88% in Deep-water area and up to 94% in the Gulf of Vyborg. Therefore, reserves of fish forage base due to alien species have increased significantly.

The paper summarizes the data from 2014 and previous years. Planktonic and benthic communities eastern Gulf of Finland have provided favorable conditions for the reproduction of aquatic biological resources.

P 65

SEAGRASS VEGETATION ENHANCES THE BACTERIAL ABUNDANCE (BALTIC SEA)

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Keywords: bacteria, sediment characteristics, eelgrass meadows, Baltic Sea

This study presents the first report of the bacteria abundance in the sediments of eelgrass (*Zostera marina*) meadows in the shallow southern Baltic Sea (Puck Bay). Total bacteria cell number (TBN) and bacteria biomass (BBM) was compared between bare and vegetated sediments in the vegetated summer seasons. Significantly higher abundance of bacteria community were recorded at bottom covered by the seagrass meadows (vegetated: 2.8 ± 1.45, unvegetated 1.85 ± 2.05 [cell/g sed. DW*10^7]) in both localities and in both sampling months. The same trend was observed for bacteria biomass (vegetated: 10.6 ± 5.1, unvegetated: 8.1 ± 2.4 [μgC/g sed. DW]). The DISTLM procedure indicated that main parameters which may explain bacteria characteristics are: meiofauna community structure, bottom type (vegetated, unvegetated), total nitrogen in the sediment, percentage of coarse sand fraction and sediment sorting. The strong positive effect of seagrass meadows on bacteria abundance reported by this study, highlight the importance of the macrophyte vegetation for the microbial communities associated with marine sediments.

P 66

COASTAL UPWELLING IN THE SE BALTIC SEA: COUPLING OF REMOTE SENSING AND MODEL DATA

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Keywords: upwelling, SST, IR remote sensing

The aim of this study is to combine satellite observations and model data for analysis of coastal upwelling and associated processes in the SE Baltic Sea. Changes of water temperature, salinity and underwater currents during upwelling events are examined and analysed based on Aqua/Terra MODIS imagery and hydrodynamical modeling.

As was recently shown, coastal upwelling along the SE Baltic Sea coast, depending on its scale and intensity, may lead to an intensive intrusion of cold and salty marine waters to the Curonian Lagoon resulting in hydrodynamic changes and pronounced density drop extending up to 30-40 km down the lagoon. Availability of modelling results helps to understand the hydro-dynamical processes taking place during the intrusion of the Baltic Sea waters to the Curonian Lagoon.

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P 67

REDUCING NUTRIENT LOADINGS FROM AGRICULTURAL SOILS TO THE BALTIC SEA VIA GROUNDWATER AND STREAMS (Soils2Sea)

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Keywords: Nutrient retention, surface water, groundwater, spatially differentiated regulation, stakeholder involvement

Both the Baltic Sea Action Plan and the EU Water Framework Directive requires substantial further reductions of nutrient loads (N and P) to the Baltic Sea during the coming years. Soils2Sea, which is funded by BONUS, proposes to exploit the fact that the retention (removal by biogeochemical processes or sedimentation) of nutrients in groundwater and surface water systems shows a significant spatial variation, depending on the local hydrogeological and riverine regime to achieve the goals for nutrient load reduction set out in the Baltic Sea Action Plan. The key outcomes of Soils2Sea will be: i) new methodologies for the planning of differentiated regulations based on new knowledge of nutrient transport and retention processes between soils/sewage outlets and the coast; ii) evaluation of how differentiated regulation can offer more cost efficient solutions towards reducing the nutrient loads to the Baltic Sea; iii) analysis of how changes in land use and climate may affect the nutrient load to the Baltic Sea; iv) a high-resolution model for the entire Baltic Sea Basin with improved process descriptions of nutrient retention in groundwater and surface water tailored to make detailed simulations of management regulations differentiated in space; and v) new knowledge based governance and monitoring concepts that acknowledge the relevant aspects of EU directives and at the same time are tailored towards decentralised decision making.

P 68

MAJOR DECLINE OF BLUE MUSSEL MYTILUS SPP. POPULATION IN COASTAL LITHUANIAN BALTIC SEA

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Keywords: Lithuanian coast, blue mussel, decline

Until last several years, the coastal reefs in Lithuanian part of the Baltic Sea were densely covered by blue mussels, providing food for marine birds and fishes, shelter for other benthic invertebrates. In fact, the population was so dense, that it was hard to imagine it could decline significantly never mind disappear entirely. Nevertheless, during the last decade obvious decrease in blue mussel population was observed while no shift in environment was evident. The aim of this work was to investigate the distribution of blue mussel biomass changes and possible causes during the period of 2003 - 2013 in Lithuanian coastal waters of the Baltic Sea. The study area was the northern part of the coast, from 2.5 to 18 meters depth. The average biomass of blue mussels decreased from 2 313 ± 1 513 g m^{-2} to 62.4 ± 45.6 g m^{-2} during period of 2003 – 2013. Blue mussel biomass decreased more than 90 % at all depths along whole coast. There were no significant changes in abiotic parameters during the period of investigation suggesting increased pressure by predators. While the increase of local predators was not evident, the appearance and sudden increase of invasive mussel eating fish species round goby *Neogobius melanostomus* since 2002 was observed. It can be assumed that the invasion of round goby was the main cause leading to the decline of blue mussel population in Lithuanian coastal waters, but this assumption should be verified by further investigations.

P 69

MORPHOMETRIC RELATIONSHIPS OF RANGIA CUNEATA IN THE VISTULA LAGOON (BALTIC SEA)

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Keywords: Rangia cuneata, growth, equation simple allometry

Allometric growth of invasive bivalve of Rangia cuneata was studied. There are high numbers and few generations (cohorts) in the initial stages of the invasion of alien species. The molluscs are easily identified by age, which makes it easier for their release. Monthly observations of two cohorts of R. cuneata (cohort I – September-October 2010, cohort II – June-July 2011) from September 2010 to April 2013 were performed. The relationships between linear and weight parameters were approximated by the equation simple allometry. In order to confirm if the values of b obtained in the linear regressions were significantly different from the isometric value (b = 1 or b = 3), a t-test (H0) with a confidence level of ± 95% (α = 0.05). Seasonal changes in growth allometry were found. The statistically significant differences between the allometric constant b and an average temperature of water for the equations H = f(L) and W = f(L) were established. Shell growth in length began to prevail over the shell growth in height upon reaching the water temperature 9.2° C, with an increase in temperature to 14.8° C increased growth in width, and vice versa, with decreasing water temperature. Statistically significant differences between the allometric constants equations W = f(H), LWM = f(L), SWM = f(L), SFWM = f(L), SDM = f(L), SFDM = f(L), SFDM = f(SDM) and an average water temperature were not established.

P 70

POINT SAMPLING REPRESENTATIVENESS IN UNDERWATER LIGHT STUDIES OF COASTAL WATERS

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Keywords: euphotic depth, representativeness, point sampling

Underwater light field undergoes great multidimensional fluctuations, especially in coastal and archipelago environments. Better understanding of this multiscale dynamics is needed to improve, for example, the methods of water quality monitoring and modelling. We assessed the representativeness of point sampling by in situ underwater PAR (photosynthetically active radiation) measurements on three 8 km by 8 km sampling networks in a highly dynamic coastal environment. For each station, we measured the euphotic depth in which 1 % of solar radiation entering the water remains. The euphotic depth range of each network was then compared to the value of the centremost station of the respective network to analyse the capacity of one station to represent its surroundings. Furthermore, we computed the relative shares of euphotic depth ranges covered by differently sized subsets of data. In other words, inclusion of different number of stations was tested in order to establish adequate sampling extent. The results from our study area, the coastal archipelago of south-western Finland, show occurrences of very local variations in water quality. Thus, a single measurement is not representative for even a relatively small water area or basin. A station reflecting average conditions in the nearby area at one occasion may well represent extreme values at another time. Inappropriately scarce sampling scheme may thus lead to a biased conception of the overall underwater light conditions.

P 71

REMOTE SENSING OF SEA ICE REGIME ALONG THE LITHUANIAN BALTIC SEA COAST AND IN THE CURONIAN LAGOON

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Keywords: sea ice regime, ice thickness, optical remote sensing, SAR, ice freeze-up & breakup dates, SE Baltic Sea, Curonian Lagoon.

In this work we analyse some features of sea ice regime along the Lithuanian Baltic Sea coast and in the Curonian Lagoon using remote sensing observations and *in situ* data from coastal stations.

First, we compare ice freeze-up and breakup dates in the Curonian Lagoon recorded from visual observations at several coastal stations (Nida, Vente, Otkrytoje) with the cloud-free satellite images of sea ice extent taken by MODIS Aqua/Terra between 2002-2013. Comparison of the MODIS images with *in situ* records reveals that in satellite data total freeze-up of the lagoon is detected later than it is recorded at coastal stations, whereas ice breakup dates are detected earlier.

Second, we compare *in situ* and space-derived measurements of sea ice thickness in the Curonian Lagoon using Envisat ASAR (2009-2012) and Radarsat-2 (2009-2013) ice thickness products from PolarView and MyOcean. It is shown that ASAR-based product agrees with *in situ* measurements much better than the one derived from Radarsat-2. Though ASAR-based ice thickness product also systematically overestimates *in situ* records, in general it follows *in situ* data quite well.

Finally, we describe spatial patterns of sea ice formation and decay in the Curonian Lagoon and the SE Baltic from combined optical and SAR observations. At first sea ice forms in the south-western and south-eastern parts of the Curonian Lagoon, and later it covers the northern part. Ice melt starts from the north towards the south-west, and the south-eastern lagoon part defrosts at the latest.

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P 72

QUANTIFICATION OF THE CHANGES IN SEDIMENT VOLUME IN A SMALL BEACH APPLYING LASER SCANNING TECHNOLOGY

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Keywords: sandy beaches, coastal processes, laser scanning

Many features of the evolution of small beaches are often concealed by apparent local changes in short-term morphological features or temporary shifts of the waterline. We demonstrate the ability of the method of laser scanning technology combined with the application of the theory of the equilibrium beach profile in conjunction with inversion of Bruun's Rule to quantify the nature and intensity of coastal processes in sandy beaches. The study site is a small accumulation beach section (Russalka beach) of the bayhead of Tallinn Bay.

This analysis requires high-resolution and high-accuracy spatial data about the 3D surface of the beach area. Such data sets were obtained using the terrestrial and airborne laser scanning technology. The changes in the sediment volume on the subaerial beach were analyzed by means of comparing two digital terrain models from scanning performed in different seasons and by different methods. The total loss or gain of sand over the entire equilibrium beach profile was evaluated using an inversion of Bruun's Rule based on the width and slope of the equilibrium profile and shifts of the shoreline in 2008–2014.

The technology was able to identify spatially inhomogeneous changes to the subaerial beach, to characterize the intensity of coastal processes and to quantify the changes in sediment volume over the entire beach profile. This small beach receives about 2000 m^3 of sand annually, a large part of which accumulates in the underwater part of the beach.

P 73

THE ANALYSIS OF THE LONG-TERM AVERAGE AND FIELD DATA FOR COMPARISON OF THE COASTAL AND TRANSITIONAL WATERS CHARACTERISTICS IN DIFFERENT TIME PERIODS AND FOR THE DETECTING OF THE MOST PROBABLE CIL WATER FORMATION AREAS IN THE MAJOR BASINS OF THE BALTIC SEA.

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Keywords: cold intermediate layer, thermohaline structure, Baltic Sea

In this paper results of the TS climate data analysis for the Baltic Sea are presented. The TS climate data analysis aim is to compare the characteristics of coastal and transitional waters in different periods of time and to identify the most likely areas for formation waters CIL in main basin of the Baltic Sea (Bornholm Basin, Gdansk Pool, Gotland Basin and the Bothnian Sea). Results of the analysis confirmed the assumption that the characteristics of the waters under shelves at south-western part of the sea in March - and the waters of the CIL core in June in Gdansk and Gotland basins. Thus, in the long-term average characteristics Gdansk basin (T; S) nucleus CIL water in June (at 60 m depth) comprise (3.1-3.9 ° C; 7.77-8.04 psu), which corresponds with a surface layer of water on the basin in the west Bornholm at March (2.25- 2.56 ° C; 7.81-7.99 psu).In the north of Gotland Basin waters core characteristics CIL in June (at a depth of 60 m) - (2.8 ° C-2.9 ° C; 7.81-7.88 psu), which corresponds to the characteristics of surface waters offshore Bornholm Basin in March (2.56 ° C; 7.81 psu).

Investigations are supported by RFBR, project№ 13-05-01041 a.

P 74

ANALYSIS OF MANAGEMENT APPROACHES AND LONG TERM WATER QUALITY TRENDS IN MAIN RIVERS OF LATVIA

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Keywords: surface waters, water quality, environmental management, nutrients, nitrates , phosphorous, chemical oxygen demand, monitoring of water quality, Latvia

History of water management practice and results of the long term (1977-2012) water quality monitoring in Latvia are reviewed. The aim of this study is to analyse the development of surface water management practices in Latvia in different socio-economic and political conditions, by reviewing modern data sources as well as historical data: reports and internal documents of USSR environmental protection organizations that in Soviet times was classified as secret information. Long term water quality monitoring data were analysed with Mann Kendall test to evaluate sustainability of water management approaches. Results show a certain progress in a field of environmental management after a collapse of the SU and transposition of European environmental legislation. However, in some aspects of river basin management (for example, water quality monitoring), the situation is getting worse, thus indicating serious failures in a field of environmental policy that must be clearly identified and corrected. It would also be very important to prevent such mistakes in other countries.

P 75

CHAROPHYTA IN CURONIAN LAGOON: PHOTOSYNTHETIC ACTIVITY AND ASSOCIATED MICROORGANISMS

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Keywords: salinity gradient, associated microorganisms, *Charophyta*

Chara is multi-cellular macro-alga, common in lakes. Charophytes often play an important role in water ecosystems as they have a particularly strong positive effect on water transparency compared to other macrophytes. Charophytes can be epiphytized by phytoplanktonic algae, for example *Gloeotrichia sp*., what can inhibit the photosynthetic capability by blocking the transmission of light. On the other hand microorganisms (fungi, bacteria) associated with Charophytes has an antagonistic effect that limits the colonisation of algae by biofouling organisms.

In Curonian lagoon (South-East Baltic Sea) Charophytes are affected by changing water salinity and turbidity. Despite the necessity to evaluate recent distribution and status of this algae in Curonian Lagoon, it's also important to evaluate how the changing conditions affects their photosyntetic activity and associated microorganism dynamics. With this aim research was performed in Curonian lagoon in 2013 and under controlled laboratory conditions (different salinity) using repeated series of incubation.

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P 76

QUANTIFICATION OF THE IMPACT OF VESSEL WAKES ON A SHINGLE-GRAVEL BEACH

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Keywords: Vessel wakes, sediment transport, experiment, Gulf of Finland

Vessel wakes may considerably impact sediment transport at the coasts in the vicinity of waterways of semi-sheltered seas. Our aim was to characterize the relocation rates of various fractions or size classes of coarse sediment under the impact of ship-induced wakes.

The study area is a small gravel and shingle beach on the island of Aegna in the Gulf of Finland, Baltic Sea. During the calm season main sediment flow is driven by vessel wakes with a height below 1 m and approaching from the south or south-west. In the stormy season much higher wind waves approach from the north-west.

We performed an experiment with coarse sediments: coarse gravel (1–2.5 cm), pebbles (2.5–5 cm) and cobbles (5–10 cm). Painted sediments were lined up in the swash zone across the waterline from a depth of 0.5 m to a height of 1.3 m above the sea surface. The location of single clasts was tracked daily with a RTK-GPS for 9 days in June–July 2013.

The motions are expressed in terms of the dispersion of each fraction and relocation of the centre of mass of painted sediment clusters. The relocation speed of each size class was quite stable during the nine days. The transport speed was 16–28 m (2–3 m/day on average) whereas it was larger for coarser clasts. Therefore, less than 1 m high vessel wakes are able to relocate coarse sediments to remarkable distances and may considerably reshape gravel and shingle beaches with a limited amount of sediments.

P 77

INVASION OF CYANOBACTERIUM *PLANKTOLYNGBYA BREVICELLULARIS* CRONB. ET KOM. INTO THE CURONIAN LAGOON (BALTIC SEA) IN 2000s

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Keywords: cyanobacteria, invasive species, Curonian Lagoon, Baltic Sea

Filamentous cyanobacterium Planktolyngbya brevicellularis, an inhabitant of the plankton of eutrophic water bodies, was first recorded in the Baltic region in the lakes of southern Sweden in 1994. In accordance with long-time studies of the phytoplankton of the shallow hypereutrophic Curonian Lagoon (South-Eastern Baltic Sea) P. brevicellularis was not found in the plankton in 1980s-1990s, but in the second half of the 2000s the species had already naturalized in the lagoon ecosystem. A cyanobacterium dominates (e.g. Aphanizomenon flos-aquae, the genus Microcystis, Planktothrix agardhii, Anabaena spp., Woronichinia compacta) in the Curonian Lagoon during the entire summer and autumn season, wherein within this period the composition of dominants vary. The development of P. brevicellularis and one of the dominants, P. agardhii, are closely linked because the correlation analysis has revealed their biomasses were related positively, whereas no relation with other dominant species was found. As a possible the Mazurian Lakeland (Poland) is source of the invasion of P. brevicellularis into the Curonian Lagoon. Its flow is mainly directed at the basins of the Vistula and the Pregola, whose arm, the river Deyma, falls into the freshwater Curonian Lagoon. There, unlike in the brackish Vistula Lagoon, some auspicious conditions for the development of this Planktolyngbya exist.

P 78

ABUNDANCE AND COMPOSITION OF ZOOPLANKTON COMMUNITIES IN THE CONTINUUM OF THE NEMUNAS RIVER, CURONIAN LAGOON AND BALTIC SEA

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Keywords: zooplankton, biodiversity, salinity gradient

Zooplankton is an intermediate link between primary producers and upper trophic levels. Its quantity and taxonomic composition determines the feeding conditions for fish, therefore is directly linked to fish population recruitment and balance of the food chain. Environmental degradation such as eutrophication and climate warming causes shifts of larger zooplankton species towards smaller, which potentially leads to deteriorated feeding conditions for juvenile fish. Small zooplankton species are frequently not counted in the samples provided by environmental monitoring, therefore important trends in functioning of pelagic food webs might be missed.

The aim of this work was to investigate micro- and mesozooplankton taxonomic composition, biomass, abundance in the continuum of large river delta and coastal waters of the Baltic Sea. We collected zooplankton samples during two cruises in April and July 2014. Microzooplankton, dominated by ciliates and rotifers, prevailed in the transitional areas of Curonian Lagoon (Nemunas River avandelta and northern euryhaline part) and plume zone of the Baltic Sea, while mesozooplankton was most abundant in stagnant part of the Lagoon and open Baltic Sea.

P 79

THE TRANSFORMATION AND RUN-UP OF LONG BREAKING SOLITARY WAVES OF VARIOUS POLARITIES ON A SLOPING BEACH

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Keywords: long waves, wave run-up, numerical study

The transformation and run-up of long breaking solitary waves of various polarities in a composite basin containing a section of constant depth and a section with a slopping beach is studied numerically in the nonlinear shallow-water theory framework using CLAWPACK-software. For small-amplitude incident waves regardless their polarity, the results of numerical computations usually coincide with predictions of the nonlinear shallow water theory for non-breaking waves. Nonlinear effects start to be important when incident wave is located far from the shoreline even for initially small-amplitude waves. With further increase in incident wave amplitude, the wave transforms into the shock wave (bore) before approaching the beach. Run-up characteristics of waves of different polarities are compared. Nonlinear effects and induced energy dissipation caused by wave breaking during its run-up on a beach are more prominent for negative pulses rather than for positive ones.

P 80

SAND GRAIN-SIZE VARIABILITY IN EROSIONAL AND ACCRETIONAL ZONES ALONG THE BALTIC SEA COAST, LITHUANIA

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Keywords: grain size, Curonian Spit, mainland coast

The Baltic Sea coast of Lithuania is distinguished for differences in sand granulometric composition with respect to coastal zones under different dynamic processes. The aim of this research: assessment of changes in sand grain size in erosional, accretional and stable sea coast zones. To determine differences, surface sand samples were collected from the middle of the beach, foredune toe and stoss slope at 500m interval along the Baltic Sea coast of Lithuania. All samples were divided into 11 fractions using sieve method. Sediment mean and sorting were calculated. The dynamics tendencies of the Baltic Sea coastline were determined using topographic maps and orthophotos. The results showed the tendency to an increase of sediment mean grain size all over the mainland sea coast. Sand grain size within accretional coastal zones hardly changed or slightly fined down. Sand grain size along the Curonian Spit coast had a tendency to decrease. It was on the increase just in some sectors of erosional zones.

This study was partly supported by Lithuanian Science Council Grant No. MIP-039/2014.

P 81

MODERN MORPHODYNAMICS OF MARINE SHORE OF LARGE BARRIER FORMS IN SOUTH-EASTERN BALTIC

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Keywords: Vistula and Curonian Spits, monitoring, coastal dynamics

Curonian and Vistula Spits (South-East Baltic) have similar origin and morphological structure, sea shore is formed by sandy sediments. Coastal monitoring in Kaliningrad Oblast, running by Atlantic Branch of P.P. Shirshov Institute of Oceanology (2003-2014) consists from yearly measurements (Boldyrev, Bobykina, 2007) of location of cliff line, dune crest line or dune scarp line (where applicable), which dynamics is a true indicator of coastal retreat. Monitoring results showed considerable difference between modern dynamics of sea shores of both sandy spits. Variations in erosion rate in time (year-to year)and along the shore are rather big, depends on storm history, but the general tendency is as described further. Sea shore at the Vistula Spit (Russian part) is stable. Monitoring data for some points showed even accretion - sea edge of foredune is moved seaward by 0.1 – 1.2 m per year. The exception is only the 4-km segment south to Baltiysk Strait (connection between the Vistula Lagoon and the Baltic Sea), which is under the influence of the entrance moles – the erosion rate is 1-4 m per year there. Sea shore of the Curonian Spit (Russian part) is mostly eroded except the segment just tosouth from the Lithuania-Russia border line, where the shore is stable. The erosion rate is about 2 -2.5 and 1.6-2.0 m per year at the segments near Zelenogradsk (root part of the spit), near Morskoe, near Rybachiy respectively. The reason is deficit of sediments at the sea slope.

P 82

NUMERICAL STUDY OF PROPAGATION SHIP-INDUCED WAVE TROUGHS IN VENICE LAGOON

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Keywords: vessel wakes, nonlinear waves, shallow-water waves, Riemann wave, bore formation, Venice Lagoon

We demonstrate that ships of moderate size, sailing at low depth Froude numbers (0.37–0.5) in a navigation channel surrounded by shallow banks, produce depressions with depths up to 2.5 m. These depressions (Bernoulli wakes) propagate as long-living strongly nonlinear solitary Riemann waves of depression substantial distances into Venice Lagoon. They gradually become strongly asymmetric with the rear of the depression becoming extremely steep, similar to a bore. As they are dynamically similar, air pressure fluctuations moving over variable-depth coastal areas could generate meteorological tsunamis with a leading depression wave followed by a devastating bore-like feature. The properties of such depressions are numerically replicated using nonlinear shallow water theory and the CLAWPACK software to simulate their propagation.

P 83

ESTIMATION OF CURRENT TROPHIC LEVEL OF THE NEVA BAY (GULF OF FINLAND) ON THE BASIS OF STRUCTURAL AND FUNCTIONAL CHARACTERISTIC OF PHYTOPLANKTON

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Keywords: phytoplankton, chlorophyll, primary production, trophic, Gulf of Finland, Neva Bay

During the last decade the intensive hydroengineering works have been conducted in the Neva Bay. So it is important to evaluate the possible change in the trophic level of the waterbody. The phytoplankton biomass (Bw) and chlorophyll-a concentration (Chl-a) (38), primary production (PP) (20 station) were measured from June to October in 2014 in two parts of the Neva Bay. In the eastern part Chl-a varied from 0.93 to 9.71 (average 4.11 μg l-1), PP – from 0.1 to 1.10 (0.7 mg C l-1), Bw – from 0.10 to 1.32 (0.54 mg l-1). The phytoplankton productivity was higher in the western part: Chl-a –3.29-19.60 (9.75 μg l-1), PP – 0.1-2.40 (0.6 mg C l-1), Bw – 0.13-1.50 (0.5 mg l-1). Phytoplankton was dominated by diatom species of genus Aulacoseira, Tabellaria fenestrate, Fragilaria crotonensis and cryptomonads throughout the bay. Chrysophyte Uroglena sp. and cyanobacteria Oscillatoria spp. prevailed in the eastern part; the diatoms Diatoma tenuis, Stephanodiscus hantzschi and Skeletonema subsalsum, cyanobacteria Aphanizomenon flos-aqua and Planktothrix agardhii were prevalent in the western part. On the basis of the most studied indicators in 2014, the Neva Bay was characterized as a mesotrophic water area.

P 84

RESULTS OF MICROBIOLOGICAL STUDIES OF COMMERCIAL FISH SPECIES IN THE GULF OF FINLAND IN THE AREA OF SAINT-PETERSBURG AND LENINGRAD REGION

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Keywords: Microbiological studies, microbiological safety indices, water bioresources, Gulf of Finland, anthropogenic impact

Microbiological studies have of particular importance in conditions of man's impact on surface water bodies. Economic activities, discharge of raw and untreated wastewater, insufficient efficiency of water-protective measures are basic measures of change of indigenous microflora, ratio of autochthonous and allochthonous microorganisms, microbial contamination of hydrobionts. The aquatic environment is as a rule an object of research in works on this problem. The estimation of commercial fish species by microbiological safety indices in compliance with health standards specified in the Russian Federation was carried out within the framework of water areas studies of Gulf of Finland in the area of Saint-Petersburg and Leningrad Region. The data were acquired in 2011-2014. Carried microbiological studies permit to judge about ecological stability of water bodies. Analysis of microbiological factors is necessary, urgent and essential condition of adequate integrated assessment of anthropogenic impact on surface water bodies.

P 85

COMPARISON OF THE WAVE POWER FOR THE OPEN AND SHELTERED SEGMENTS OF THE BALTIC SEA COAST

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Keywords: wave energy, variability of energy flux, eastern Baltic Sea

The largest average wave intensity in the Baltic Proper is found in the north-eastern part of this water body and near its south-eastern coast. The nearshore of the Sambian (Samland) Peninsula is open to both predominant wind directions (western and north-western) and thus is the most suitable region for wave energy production. The eastern Gulf of Finland hosts much milder wave climate.

The main aim of the work is to provide an insight into long-term properties and short-term variability of the wave energy flux along coastal segments that may host wave energy converters in the future. The theoretical wave energy potential along the shorelines of the Sambian Peninsula, the Gdańsk Bay and the eastern Gulf of Finland is evaluated using hourly time series of wave properties (wave direction, peak period and wave height) for the time period of 1970–2007, hindcast using the third generation wave model WAM driven by adjusted geostrophic winds.

In both locations the wave energy flux exhibits substantial spatial (along the coast) and temporal variation. The highest values of the wave energy fluxes occur during the stormy (late autumn and winter) season. This flux may be partially or totally blocked by sea ice in the eastern Gulf of Finland. The major limiting factor affecting the industrial production of wave energy is the high intermittency in the wave properties. However, arrays of wave energy converters may serve as a substitute for breakwaters or "soft" measures of coastal protection.

P 86

THE ASSESSMENT OF BIODIVERSITY AND ENVIRONMENTAL QUALITY BASED ON MACROZOOBENTHOS COMMUNITIES IN THE AREA OF SEAGRASS MEADOWS ON THE LONG SHALLOW (GULF OF GDAŃSK)

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Keywords: biodiversity; environmental quality; macrozoobenthos; seagrass

The aim of the studies was to assess the taxonomic diversity of macrozoobenthos and to evaluate the environmental status on the seagrass meadows. These aims were defined inview of increasing need to protect the marine sources, especially in last years. The range of seagrass meadows in Puck Bay decreased mainly due to eutrophication and in 2000ts itstarted to increase. The meadow described in this work is very little known in terms of ecological status. It is a part of Natura 2000 area and within the Seaside Landscape Park. Index for the quality assessment was the Benthic Quality Index (BQI), which uses the sensitivity of taxa, number of taxa and their abundance at stations. Samples were collected on 16 stations in 2008, with DAK net and core. Organisms were identified, their abundance and biomass calculated. Then, biodiversity indices H', J' and BQI were calculated. In total, 34 taxa were identified, including several taxa characteristic for plants, e.g. Idotea balthica. For the first time in the Gulf of Gdańsk, the leech Piscicola pojmanskae Bielecki, 1994 was identified. Differences in number of taxa,abundance, biomass, H' and BQI indices were statistically important in favor of the overgrown bottom. On the basis of those studies, we concluded that overall environmental status of the seagrass meadow on the Long Shallow, assessed on macrozoobenthos biodiversity, is good.

P 87

HAZARDOUS SUBSTANCES AS THE ENVIRONMENTAL STRESSORS OF BALTIC SEA CATCHMENT AREA.

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Keywords: Baltic Sea catchment area, hazardous substances, POPs, environmental status

The Health 2020 policy framework proposes creating resilient communities and supportive environments. Building resilience is a key factor in protecting and promoting health and well-being at both the individual and community levels. People's health chances are closely linked to the conditions in which they are born, grow, work and age. Systematically assessing the health effects of a rapidly changing environment – especially related to technology, work, energy production and urbanization – is essential and must be followed by action to ensure positive benefits to health. Hazardous substances emitted or discharged by households, waste damping sites, traffic, industries and agriculture are transported to the sea via watercourses and air. The HELCOM Action Plan sets out four strategic goals related to hazardous substances: "concentrations of hazardous substances close to natural levels", "all fish safe to eat", and "healthy wildlife and radioactivity at pre-Chernobyl levels" by use of Hazardous Substances Status Assessment Tool (CHASE). The CHASE tool gives each element a status (bad, poor, moderate, good or high) and the final status is defined as the lowest status of the four elements. According to the results of the CHASE assessment, the entire Baltic Sea was an area with a high contamination level in 1999–2007 because 137 out of the 144 areas assessed were classified as being "disturbed by hazardous substances". The status classifications of coastal areas were highly variable, but there was a certain tendency for the waters near larger cities generally classified as having a "moderate" hazardous substances status. Point sources of pollution situated either on the coast or inland in the catchment area have historically contributed significant amounts of heavy metals and persistent organic pollutants (POPs) to the Baltic Sea surface waters. The National Implementation Plan on POP for the years 2004 – 2020 indicates the polychlorinated biphenyls (PCB) as the priority category of POPs in Latvia. The survey of fatty fish eating habits and assessment of the exposure of breast milk to persistent organic pollutants in case study in Latvia indicated that the concentration of POPs corresponds to lowest levels detected in European countries. The concentration of dioxine like PCBs and PCDD/PCDF according to toxicity equivalents do not exceeds WHO accepted level 15 TEQ pg/g milk fat. These are set of Ecological Objectives which correspond to good environmental status. That status would be implementable for biosphere reserves in the research project "The impact of social consciousness changes on ecosystems sustainable provision" (EKOSOC - LV). The objective of research is to investigate public awareness, quality of life in connection with ecosystem state in the specially protected nature territories.

P 88

ESTIMATION OF COASTAL DUNES RECESSION RATE IN THE RUSSIAN PART OF THE CURONIAN SPIT

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Keywords: the Curonian Spit, Baltic Sea, coastal erosion, cliff retreat

In geological time scale the Curonian Spit is retreating towards the land advancing in the area of the Curonian Lagoon. The coastal dunes of the Curonian Spit form a continuous alongshore foredune bank bordered the beach from landward side of the spit. The best indicator for coastal erosion for marine shore of the Curonian Spit is the rate of retreat of seaward dune scarp line (Boldyrev, Bobykina, 2007).

To estimate nowadays retreat rate the topographic maps of 1983 year and the satellite image of 2014 year were used. In some parts of the foredune the rate exceeds 10 m per 31 years. Three shore segments on the marine shore of the Curonian Spit were selected according to mean rates of dunes retreat; topographic and geological particularities (20% of total length of Russian part of the spit). First, the nowadays erosion rate was applied for next 50 and 100 years, the maximum retreat was 80 and 160 meters respectively. The prediction has low probability to be realized, but it characterizes the most unfavourable scenario of the Curonian Spit evolution. Second, more realistic projection was developed using the assumption that retreat rate estimated for period of 1983-2014 gives us the range of possible medium-terms rate, and in fact the retreat rate for particular shore segment is changing in these range during long-term period.

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P 89

THE OXYGEN AND NUTRIENTS EXCHANGE ON WATER-SEDIMENT LAYER UNDER MACROFAUNA INFLUENCE IN SHALLOW WATERS OF PUCK BAY (SOUTHERN BALTIC SEA) - PRELIMINARY RESULTS

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Key words: benthic fluxes, coastal waters, macrozoobenthos, Baltic Sea

In terms of biodiversity, Puck Bay is one of the most valuable area in the southern Baltic Sea. The broad diversity of habitats and fact that up to 65% of bottom is shallower then 20 m, makes this bay favourable for benthic macrofauna. There are different types of sediments, from sand with low carbon contents (<0.5% TOC) to muddy sediments with a high organic matter contents (9% TOC) and hydrogen sulfide. The aim of this study was to determine the direction and estimate rate of oxygen and nutrients fluxes across sediment-water interface at shallow water stations with different fauna communities. Research was conducted in Puck Bay at two stations (depth 5 and 20 m). Before experiments, faunal community structure, burial depth and chemical parameters of water and sediment were analyzed. Laboratory experiments were conducted in chambers from cores collected at stations. Oxygen and nutrients fluxes were measured both for day and night conditions. After experiments, macrofaunal composition and burial depth in incubation cores were also determined. The biodiversity varied between stations, but was relatively high with burial depth at shallower station up to 25 cm. Generally, sediments were a source of ammonia, nitrite, phosphate and silicate whereas the oxygen and nitrogen were consumed by sediments. Usually higher fluxes were measured at the deepest station. Additionally, the rate of nutrients exchange at the water-sediment interface grows at night.

P 90

INDICATORS OF EUTROPHICATION IN THE EASTERN GULF OF FINLAND: LONG-TERM TRENDS AND VARIABILITY

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Keywords: eutrophication indicators, nutrients, Gulf of Finland

The goal of the study was to find possible trends for eutrophication indicators of the Eastern Gulf of Finland during the period of 2001-2014 based on RSHU observational data. Nutrient concentrations, Secchi depth, cholorophyll "a" content, phytoplankton biomass were studied in the two layers: surface layer (0-5 m) and "near-bottom" layer. The years 2007-2008 seem to be a clear "turning point" for the ecosystem with a stable upward trend of water temperature, decrease of bottom water temperature and increase of salinity as well as aggravation of oxygen conditions near the bottom. The statistical analysis showed no clear trends for Phosphorus and surface Nitrogen, the concentrations vary throughout the decade due to the action of many natural factors (salt water inflows and upwellings, low water years, stratification). However, in 2014 there was a pronounced increase in PPO4 both at the surface and in bottom waters despite the treatment efforts of "St.Petersburg Vodokanal", that may be explained by the internal P-load. At the same time there is a clear trend of accumulation of Nitrogen (NO2+NO3) near the bottom since 2008. As for chl a content - in 2014 it was at its minimum during the decade (similar values observed in 2003) that is explained by high surface salinity in summer 2014. The study showed deep changes occurring in the ecosystem of the Eastern part of the Gulf of Finland in the last decade.

P 91

THE MOST RECENT RECORDS OF BENTHIC NON-INDIGENOUS SPECIES IN THE POLISH COASTAL WATERS

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Keywords: non-indigenous species, Mytilopsis leucophaeata, Rangia cuneata, Palaemon macrodactylus

Throughout the time, numerous non-indigenous species (mainly benthic) have been introduced to the region of the Baltic Sea. Some of the most recently observed are bivalves: the Conrad's false mussel Mytilopsis leucophaeata and the Atlantic rangia Rangia cuneata and the oriental shrimp Palaemon macrodactylus. M. leucophaeata, native to Atlantic coast of North America, was recorded for the first time in Europe in year 1835. It was discovered in the Polish waters in year 2010 (Dziubińska, 2011), but since only juvenile individuals were found, the ability of the species to reach maturity and reproduce in this region was uncertain. It remained that way until year 2013, when several adult individuals were discovered in the Gulf of Gdansk. R.cuneata originates from the Atlantic coast of North America too, but it appeared in European waters only 10 years ago. Five years later it was recorded in the Russian part of the Vistula Lagoon, following with the appearance in the Polish part a year later (Rudinskaya & Gusev 2012, Warzocha & Drgas 2013). In 2014, the Atlantic rangia was recorded in the mouth of Wisła Śmiała. P. macrodactylus originates from eastern Asian seas. It was introduced to Europe in the 1990s. In year 2014 the oriental shrimp was recorded in the mouth of Wisła Śmiała, which is the first record of that species in the Baltic region. Preliminary morphological studies of the three non-indigenous species and possible way of introduction will be presented.

P 92

APPLICATION OF SULFUR, CARBON AND NITROGEN STABLE ISOTOPES TO FOOD WEB RESEARCH IN THE BALTIC SEA: A CASE STUDY ON FOOD SOURCES OF WINTERING PISCIVOROUS WATERBIRDS

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Keywords: coastal waters, Great Crested Grebe; Red-throated Diver; Common Guillemot

Using combination of stable sulfur ($\delta^{34}S$), carbon ($\delta^{13}C$), and nitrogen ($\delta^{15}N$) isotopes, it might be possible to distinguish food sources of consumers in complex ecosystems such as the Baltic Sea where end-points have not been clarified by commonly used $\delta^{13}C$ and $\delta^{15}N$. However applicability of $\delta^{34}S$ has not been widely tested in food webs of the Baltic Sea. In this study, we used $\delta^{34}S$, $\delta^{13}C$, and $\delta^{15}N$ analysis to discriminate the main food sources of wintering piscivorous waterbirds in the Lithuanian coastal zone of the Southeastern Baltic Sea. Isotopic measurements in blood of Common Guillemot (*Uria aalge)*, Red-throated Diver *(Gavia stellata)*, and Great Crested Grebe *(Podiceps cristatus)* allowed us to study their diet in non-lethal way and discriminate isotopical niches. The results revealed differentiation of δ34S values among pelagic, benthic fish, and benthopelagic European smelt *(Osmerus eperlanus)* in the food web. The use of mixing models revealed proportions of fish species or their ecological groups in bird diet. The widest range of feasible proportions was obtained by single $\delta^{34}S$ mixing model, whereas the combination of $\delta^{34}S$ and $\delta^{15}N$ revealed more precise discrimination among the fish groups. This study highlights $\delta^{34}S$ analysis as an important complement to $\delta^{13}C$ and $\delta^{15}N$ analysis for food web studies in the Baltic Sea.

P 93

THE PREDICTION OF POTENTIAL HUMAN HEALTH EFFECTS BASED TO BALTIC SEA POLLUTION BY PERSISTENT ORGANIC POLLUTANTS

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Keywords: persistent organic pollutants health effects prediction estimated dose through ingestion

The environmental pollution of Baltic Sea region countries plays main role to healthy marine ecosystem of Baltic Sea. Still actual and incomplete measured is persistent organic pollutants (POP's) in the country continental air, soil and water to evaluate impact on marine ecosystem of Baltic Sea and herewith also to human health. POP's are synthetic organic chemicals, persistent in environment, long-range transport leads to global pollution, lipophilic, accumulate in food chain, high levels in fish and marine mammals. The POP's are pesticides, industrial chemicals and unintended by-products. Main effects of POP's to wildlife are: mammals - reproductive and immune effects in Baltic seals, birds - eggshell thinning, gonadal and embryo alterations, fish - reproductive alterations, snails - masculinisation and population decrease. If taken into account that the POP's are lipophilic, then for human health assessment is important to estimate POP's concentration in fishes. One of routes of contamination by POP's is ingestion through food chain, it is possible to calculate and predict estimated dose through ingestion (contaminated Baltic Sea fishes). There are necessary to know how polluted is, for example, Baltic sea Salmon or herring etc. to predict health effects caused by contaminated Baltic Sea fish eating. Many of accessible models for POP pollution calculations gives results of water and sediment pollution levels, several studies gives the results also for sea wildlife (includes fishes). All these data are useful for health risks calculations and health effects prediction. If the pollution of sea fish is known, then health prevention will be done, e.g., following the dietary recommendations concerning contaminated fish will give these risk groups adequate protection from a high pollution intake. From a public health standpoint, the consumption of fish is generally beneficial. The main issues, of course, are industrial and agricultural pollution, but also housing activities (e.g. burning of plastics etc) in continental part of country can lead the higher POP's concentration to marine ecosystem of Baltic Sea. Therefore for everyone is necessary understand, that our housing activities realise negative impact to rivers, forests, etc. as well as Baltic Sea ecosystems sustainability (e.g., reducing of marine wildlife) and generate the higher health risks for ourselves and next generations in future, too.

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P 94

THE BALTIC SEA NATURAL LONG-TERM VARIABILITY OF SALINITY

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Keywords: Baltic Sea, long-term variability, regional climate modeling

The Baltic Sea is one of the largest brackish sea areas of the world. The sensitive state of the Baltic Sea is sustained by a fresh-water surplus by river discharge and precipitation on one hand as well as inflows of highly saline water masses from the North Sea on the other. Major inflows occur very intermittent with a mean frequency of approximately one per year but longer stagnation periods have been observed, too. Depending on the amount of salt water inflow and fresh-water supply the deep water salinity of the Baltic Sea varies between 11 to 14 PSU on the decadal scale.

The goal of this study is to understand the contribution of different driving factors for the decadal to multi-decadal variability of salinity in the Baltic Sea. Continuous measurement series of salinity exist from the 1950 but are not sufficiently long for the investigation of long-term fluctuations. Therefore, a regional climate simulation of more than 800 years has been carried out with the Rossby Center Ocean model.
The analysis focus on the role of variations in river discharge and precipitation, changes in wind speed and direction, fluctuations in temperature and shifts in large scale pressure patterns (e.g. NAO). Hereby, the length of the simulation will allow to identify mechanisms working on decadal to multi-decadal time scales. Moreover, it will be discussed how likely long stagnation periods are under natural climate variability.

P 95

FOOD SUPPLY STATE OF YOUNG FISHES ON THE SPAWNING AREAS IN THE NEVA BAY LAST DECADE

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Keywords: food supply, phytoplankton, zooplankton, zoobenthos

The Neva Bay is the major fish natural nursery for many fishes in the eastern part of the Gulf of Finland. In 2005-2014 complex fishery researches were carried out on shallows and banks of the Neva Bay, serving by fish spawning areas. Phytoplankton, zooplankton, zoobenthos were objects of study. Phytoplankton biomass in June 2014 was rather high – 0,9-2,3 g/m^3. On a level of phytoplankton development the water area on shallows as a whole corresponds now to mesotrophic state. Zooplankton biomass in the same period was rather low – 0,005-0,177 g/m^3. Shallows in the northern and partly southern parts of the bay are characterised by higher zooplankton quantity indices that creates favourable conditions for fattening of fishes consuming a plankton. The level of zooplankton development in the eastern and south-western parts of the bay, exposed to the greatest anthropogenic influence, remains now rather low. Zoobenthos biomass in June 2014 was 0,04-201,04 g/m^2. The most part of the bay corresponds to water bodies with lowtrophic state on a level of zoobenthos development. The average value of biomass for 12 stations (without 3 stations with biomass 7,28, 17,57, 201,04 g/m^2, where large molluscs dominated) was less than 1 g/m^2. Researches, including 2014, allow to conclude that along with the natural factors, a significant impact, limiting the productivity of food supply of young fishes in the Neva Bay, render the intensive hydrotechnical works, carried out on its water area last decade.

P 96

OIL DROPLETS IN RADIATIVE TRANSFER MODELLING IN THE BALTIC SEA

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Keywords: radiative transfer, dispersed oil, oil emulsion, remote sensing reflectance, seawater

Dispersed oil occurs in seawater mainly as the result of human interference, including daily shipping activities and riverine runoff. In the coastal regions of Baltic Sea typically the concentration of oil varies from several ppb to several ppm. Oil droplets, as optically active components, are involved into radiative transfer of energy within the water body, affecting the Apparent Optical Properties (AOPs) of seawater. The magnitude of oil impact on these quantities has been evaluated for different kinds of oil-in-water emulsions, using numerical radiative transfer modelling combined with measured data. The Inherent Optical Properties (IOPs) of dispersed crude oils and their products were calculated on the basis of Mie theory using measured oil absorption coefficient and different size distributions. Then, a set of radiative transfer simulations was performed, using natural seawater IOPs measured in the Baltic Sea, in order to evaluate the contribution of dispersed oil to the seawater AOPs. In this study we show that this contribution depends not only on the type and concentration of oil emulsion, but also on its size structure. We discuss the impact of oil emulsion on the parameters commonly measured *in situ* and remotely sensed, such as remote sensing reflectance Rrs, downwelling irradiance Ed, and diffuse attenuation coefficient Kd, in the spectral range of photosynthetically active radiation.

P 97

MEASURING SUSTAINABILITY IN COASTAL COMMUNITIES – AN APPLICATION OF QUALITYCOAST INDICATORS IN TOURISM DESTINATIONS IN GERMANY, LITHUANIA AND INDONESIA

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Keywords: Coastal Sustainability, Indicators, Self-assessment Methodology, ICZM, QualityCoast

In the context of Integrated Coastal Management and Sustainable Development, the use of indicators to measure sustainability in coastal communities has garnered increasing interest. Within the project SUSTAIN an indicator-based assessment method tailored for European coastal municipalities, was developed. However, on a local level indicator use is often restricted to one-time applications or project duration, as they often lack direct and clearly visible benefits.

Linking the assessment method with a certification scheme, such as the QualityCoast Award, is hoped to add value and increase incentives for coastal communities. A combined tool in which the QualityCoast indicators are merged into the SUSTAIN methodology was developed. Its potential to measure and compare sustainability in coastal communities was assessed based on sixteen evaluations in ten contrasting destinations. Thereby, comparisons between and within regions, countries and destinations were made.

Variability of results was high even within single destinations due to a lack of clearly defined benchmarks resulting from the qualitative nature of indicators. Also evaluators' subjectivity affected indicator results significantly. Yet, similarities within countries could be found for indicators that exceeded the sphere of local influence and were affected by higher levels. Despite lacking reproducibility and comparability of results the assessment proved successful in raising awareness about sustainability and supporting strategic planning in coastal communities.

P 98

THE INFLUENCE OF NEMUNAS WATER ON THE BATHING WATER QUALITY IN THE CURONIAN LAGOON

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Keywords: Curonian Lagoon, Bathing water, numerical modeling

The project BaltCoast, funded by EU BONUS, aims to tackle systematic coastal management issues using Systems Approach Framework (SAF). The SAF will be applied through case studies that reflect current Baltic Sea region management challenges and develop a generic tool for integrated system assessment: one of which is bathing water quality and tourism. Increasing tourism causes demand to re-open closed beaches with insufficient water quality, as well to establish new ones, for example in Curonian lagoon. Our task is to combine traditional monitoring methods, with 3Dhydrodynamic transport models and strain-specific genetic fingerprint methods that will allow us to use it for risk analysis and scenario and will provide a new, transferable bathing water quality management and evaluation system, with high practical relevance for end-users and the implementation of the Bathing Water Directive. The Nemunas River is entering the Curonian lagoon on its eastern side. Yearly average discharge is over 500 m^3/s. This makes the Curonian lagoon basically a freshwater lagoon. The water quality of the Curonian waters is heavily influenced by the quality of the Nemunas River. This is especially true for microbiological pollution that is picked up by the river along its course through its watershed. A Lagrangian model has been used to simulate the spreading of the Nemunas waters inside the Curonian lagoon. The Lagrangian particles are subject to biological decay that will simulate the natural pollution reduction of the waters. Study of the particle distribution and concentration close to the Curonian Spit will allow an assessment of the suitability of possible beaches inside the Curonian lagoon.

P 99

CONTRIBUTION OF ANTHROPOGENIC ACTIVITY AND CLIMATE CHANGE TO SALINITY VARIATIONS IN THE CURONIAN LAGOON

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Keywords: Curonian Lagoon, salinity variation, climate change, numerical modeling

The purpose of this study was to evaluate the salinity variation, and to indicate natural and anthropogenic factors having influence on the salinity change in the Curonian Lagoon in the past and future. This coastal system is a heavily modified shallow water body with available long-term salinity datasets, and thus provides a good case study for the salinity changes. During the last decades the annual average of the salinity in the northern part of the Lagoon increased. Many factors, like Klaipėda Strait deepening, westerly winds intensification, decrease of fresh water input and increase of the water level in the Baltic Sea may have had an impact on the salinity of the Curonian Lagoon. The investigation was carried out by analysing long-term salinity data and using a model system based on the finite element programme package SHYFEM. Several 3-D model simulations with real hydrological and meteorological forcing with different depth of the Klaipėda Strait and different climate change scenarios were performed. Analysis of salinity data and simulations results revealed that the decrease of rivers discharge into the Curonian Lagoon due to climate change was the main factor determining the salinity change of the Curonian Lagoon in the last three decades, while deepening of the Klaipėda Strait together with sea gates narrowing contrasted intrusion of salty water. However, deepening alone during the period 1925-1987 leads to a significant salinity increase. The results of salinity prediction for the end of 21st century in the Curonian Lagoon showed that climate change will significantly affect only the northern part of the Curonian Lagoon. It appeared also that more drastic climate change can lead to lower salinity levels than in the case of milder climate change. Two main factors determining future salinity change of the Curonian Lagoon will be the rivers discharge and the salinity of the Baltic Sea.

P 100

UNDERWATER NOISE RESEARCH IN LITHUANIAN MARINE AND ESTUARINE WATERS

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Keywords: Baltic Sea, underwater noise, ecological impacts, aquatic animals

In the light of Marine Strategy Framework Directive underwater noise research have been initiated in Lithuanian Baltic Sea area as well as in estuarine waters. Since year 2010 first field measurements have been implemented in Klaipėda Strait and Lithuanian Baltic Sea area. During the acoustical surveys it was measured continuous ambient noise, port construction noise, dredging noise in highly pressured Klaipėda Strait area. In the Baltic Sea area it was surveyed II World War ammunition detonation noise. The ambient noise and other noise levels in the Baltic Sea area is under research at the present date. The obtained data indicates that ambient underwater noise level in Klaipėda Strait is elevated comparing with neutral areas. The overall ambient noise level at these areas is contributed by various anthropogenic sources which inevitably impacts life cycle of aquatic animals. The data regarding local animal species hearing sensitivity is inconsistent though the hearing sensitivity data in one or another form available at least for 70 % of local aquatic animal species. The data regarding behavioral reactions of local species due to noise however is poor.

Consequently the new obtained underwater noise research results will be summarized and main ideas introduced.

P 101

COMPARISON OF THE DIFFERENT SANDY BEACH MONITORING METHODS

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Keywords: sandy beach, beach profile, beach research methods

Coastal zone management requires frequent and prompt information about coastal features such as shoreline positions, rates of its movement, and volumetric nearshore changes. To effectively monitor beach changes, accurate measurements of beach morphology are required. Usually beach monitoring is carried out by land-based surveying methods which are not sufficient enough in order to develop three dimensional beach model and time-consuming especially observing long segment of the coast. The challenge to coastal scientists is to apply new beach monitoring methods that address these needs and are rapid, reliable, relatively inexpensive, and maintain or improve measurement accuracy.

In this work direct and remote coastal monitoring methods were compared. Beach profiling was performed in two coastal stretches (Palanga and Melnrage beaches) of the Lithuanian Baltic sea coast employing total stations Leica TS06 and GPS Leica 900 surveying system. Airborne remote sensing was performed employing Unmanned Aerial Vehicle (UAV). UAV is a pilotless airplane that can be controlled by radio signal remote. Digital camera makes 148 high-resolution photos of study area. Photos converted into orthographic projection were used for shoreline position mapping. Both methods provide convenient results of beach morphology measurements. In combination of the costs, time and reliability of data GPS surveying and UAV could be used for the future coastal monitoring at the Lithuanian Baltic sea coast.

P 102

ANALYSING UNDISTURBED BOTTOM BOUNDARY LAYER PROFILES OF SOME NORTH-ESTONIAN COASTAL AREAS

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Keywords: bottom boundary layer, BBL, sediment sampler, Voll sampler, coastal sea, dioxins, PSBs, HELCOM metals

A new device for taking samples from the bottom boundary layer (BBL) of a water column built in the Marine Systems Institute in cooperation with Dimentio LLC and protected by the US patent (US 8,511,184 B2, Aug. 20, 2013) was tested in North-Estonian coastal waters. Compared to samplers used earlier, this device (Voll's sampler) enables simultaneous taking profiles from BBL, i.e. to get samples with their composition and stratification representing the actual condition at the site as truthfully as possible. Collected samples were analysed against Hg, Cd, Cu, Pb and Zn, (as in water as well in sediment) and 7 polychlorinated dibenzo-p-dioxins (PCDD), 10 polychlorinated dibenzofurans (PCDF) and 12 dioxin-like polychlorinated biphenyls (dl-PCBs) (in sediment). Amount of the most toxic HELCOM metals Hg, Cd and Pb was very low in most stations, but considerable amounts of Zn and Cu were found in near bottom water layer (55 μg /L of Zn and 3 μg/L of Cu) as well as in soft sediments (50 mg/kg of Zn and 20 mg/kg of Cu in dry matter) in some stations. Also the concentrations of organic contaminants were low, and in upper layers the concentrations of dioxins and dioxin-like PCBs were much lower than in deeper layers. Cu, Zn and Pb varied synchronously in sediment profiles, also Cd and Hg were sync. In most cases maximum concentrations were detected within a depth interval 10–15 cm. The study showed that the device enables taking undisturbed profiles of BBL.

P 103

TRANSFORMATION OF GEOLOGICAL ENVIRONMENT OF THE SEA BOTTOM AS A RESULT OF UNDER-WATER MINING IN THE EASTERN GULF OF FINLAND

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Keywords: under-water mining, Gulf of Finland, sedimentation

The eastern Gulf of Finland is the area of active under-water commercial mining during a long period of time. Primarily these are under-water minings of raw material (gravel and sand). The most part of them are situated within the ancient coastal zones, some within the areas of recent wave activity. Rarely the mining sandy-gravel bodies are represented by fluvial-glacial sediments. Analysis of data based upon the results of multibeam echosounding, seismic-acoustic and side-scan sonar profiling accompanied by sediment sampling allowed to understand the main features of sedimentation processes transformation. In most cases, the bottom relief, formed as a result of underwater sandy mining, sharply differing from the natural, but characterized by relative stability over the time. Anthropogenic depressions located within the natural areas of sandy domination become the sediment traps, where the silty-clayey mud accumulation achieves very high rate, up to several centimeters per year. Sometimes under-water sandy mining was responsible for coastal retreat. Experimental extraction of Fe-Mn concretions by private company "Petrotrans ltd." carried out in 2004-2006 also dramatically changed sedimentation environments. The area of concretions extraction which previously characterized by low sedimentation rates became silty-clayey accumulation zone. Concretions buried under silty-clayey mud are dissolved and characterized by essential changes in their geochemical structure.

P 104

COMPARISON OF ECOSYSTEM MODELLING AND ISOTOPIC APPROACH TO RECONSTRUCT FOOD WEB OF EXPOSED SANDY COASTAL ECOSYSTEM IN SE BALTIC

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Keywords: ECOPATH model, stable isotopes, Baltic Sea, trophic position

Lithuanian coastal zone in the SE Baltic represents a sandy exposed coast ecosystem strongly influenced in the northern part by the organic enriched waters from the Curonian lagoon, while fish communities are dominated by fish species migrating between the coastal habitats and the Baltic proper (herring, sprat), the Curonian lagoon (perch, pikeperch, ruffe) or performing migrations between the Baltic and inland waters (smelt, salmon). The ECOPATH model comprising 40 living compartments in the Lithuanian coastal zone (<20 m isobate) was constructed. The model setup was mostly based on the original monitoring and trophology data providing comparatively high for ECOPATH models pedigree index. Model was balanced taking into account the different time spent by the migratory fish species in the coastal zone and evaluating massive organic material exports from the adjacent Curonian lagoon. The system was found to be heterotrophic and providing a sink for most of migratory fish populations. It also revealed the inconsistency in the biomass evaluation methods for some sessile fish species. The trophic position of common fish, invertebrates, and waterbirds were determined by both ECOPATH modelling and stable nitrogen isotope ratios ($\delta^{15}N$). Differences in trophic position assignments from profiles of $\delta^{15}N$ and outputs of the model were attributed to the ecological characteristics of some species and the accuracy of certain assumptions used for each method.

P 105

SEASONAL NEAR-SHORE NUTRIENTS LOAD IN TALLINN BAY COMING FROM STORM WATER OUTLETS

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Keywords: Tallinn Bay, storm water, nutrient load, decaying algae

Ecological conditions of Tallinn Bay are in the last 50 years improved, but its good ecological status is still not yet been evaluated. Thanks to the management of waste water, the situation has improved, but the Pirita River and storm water outlets continue to bring large amounts of nutrients into the Gulf, and unpleasant odours from decaying algae has remained a problem. The aim of the study is to evaluate the impact of storm water to the local nutrient load of the southeast coast of Tallinn Bay and to find the best ways to reduce it. Van Veen sampler was used for taking bottom samples for the sieve analysis, and a unique Voll sampler for taking near-bottom water and soft sediment profiles, and heavy metals (Hg, Cd, Pb, Zn, Cu), total nitrogen, total phosphorus, and WHO PCBs were determined. Water samples from the Pirita River and storm water outlets were taken during May to September (both in 2012 than in 2013), and concentrations of nitrates and nitrites and phosphates were measured. It was shown that the concentration of nitrates and nitrites grow significantly with precipitations, concentration of phosphates remain about the same. Pirita River portion of the total load was about 95%. No residual contamination in the bottom sediment was found. Model calculations have shown that the near-shore load improved significantly if drawing the outlets' water deeper into the sea (~ 1 km from the beach), at the same time proper bay conditions remained virtually unchanged.

P 106

SEASONAL AND SPATIAL OCCURRENCE AND DEVELOPMENT OF MESOZOOPLANKTON BENTHIC EGGS UNDER VARIOUS ENVIRONMENTAL CONDITIONS IN SEDIMENTS OF THE GULF OF RIGA, BALTIC SEA

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Keywords: mesozooplankton, benthic eggs, egg bank, recruitment, the Gulf of Riga

Diapause and resting eggs are common in mesozooplankton life cycles and their importance for survival is not debatable. It is well known that large part of laid eggs accumulate in sediments and create so-called "egg bank" that for some species is vital, but for most species is additional overwintering strategy. Research area of this study was Gulf of Riga – a waterbody that has not been included in any resting egg related study, leaving spatial knowledge gap in one of the most researched seas. The aim of present study was to analyse amount and spatial distribution of mesozooplankton benthic eggs in the Gulf of Riga during different seasons, and also to determine environmental factors affecting mesozooplankton recruitment from egg bank. During this research we concluded that mean amount of mesozooplankton benthic eggs in the Gulf of Riga did not vary strongly between seasons, mean value ranged between $3{,}1\times10^5$ and $3{,}6\times10^5$ eggs m^{-2}, but the difference among regions of the gulf was noticeable. The highest amount of benthic eggs was often found in the eastern part, but the lowest was always in the western part of the Gulf of Riga. According to the results of incubation under different treatments, Copepoda eggs responded differently depending on oxygen treatment, but cumulative amount of rotiferan juveniles significantly differed between 4°C and 8°C temperature groups.

P 107

PHOSPHORUS STORAGE AND MOBILIZATION IN COASTAL REED BEDS: INFLUENCE OF LOCAL-SCALE HYDRODYNAMICS

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Keywords: phosphorus, coastal wetland, Phragmites australis, turbulent kinetic energy, Southern Baltic Sea, Darss-Zingst Bodden Chain.

Coastal reed beds are at the interface between terrestrial and aquatic ecosystems and are of paramount importance for nutrient regulation. They can act both as sinks and sources for phosphorus, depending on environmental conditions, sediment properties as well as on antecedent nutrient loading and sorption capacity of the sediments. The *Darss-Zingst Bodden Chain* is a shallow lagoon system at the German Baltic Sea coast with a long eutrophication history. It is lined almost at its entire length by reed beds. In order to elucidate under which conditions these reed beds act as sources or sinks for phosphorus, in-situ data of chemo-physical characteristics of water and sediment samples were combined with hydrodynamic measurements and laboratory experiments. Small-scale basin structures within the reed bed serve as sinks for fine-grained particles rich in phosphorus, iron, manganese and organic matter. Without turbulent mixing the bottom water and the sediment surface lack replenishment of oxygen. During stagnant periods with low water level, low turbulence and thus low-oxygen conditions phosphorus from the sediments is released. But the sediments are capable of becoming sinks again once oxygen is resupplied. A thin oxic sediment surface layer rich in iron and manganese seems to re-adsorb phosphorus quickly. We demonstrate that sediments in coastal reed beds can serve both as sources and sinks of soluble reactive phosphorus on a very short time-scale, depending on local-scale hydrodynamics and the state of the oxic-anoxic sediment interface.

P 108

DETERMINATION OF CLOSURE DEPTHS FOR SHELTERED AREAS OF THE EASTERN PART OF THE BALTIC SEA

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Keywords: closure depth, sheltered areas, eastern Baltic Sea

Closure depth is one of the key characteristics of the long-term wave regime and properties of equilibrium beach profile, and a basic input for various engineering applications. It is understood as a depth down to which surface waves maintain a universal shape of the coastal profile.

While reasonable approaches exist for the evaluation of the closure depth from the properties of wave climate for open ocean coasts, these methods often fail in semi-enclosed areas where the proportion of remote swell is very low in the wave energy budget. We compare various estimates for the closure depth extracted from published sources with alternative estimates based on numerically simulated time series of nearshore wave properties for semi-sheltered regions of the eastern Baltic Sea. The target areas are the Gdańsk Bay and the eastern Gulf of Finland that host largely different wave properties. The wave data were extracted from model runs of the third generation wave model WAM driven by adjusted geostrophic winds in 1970 till 2007.

Not surprisingly, the closure depths for the target areas are generally smaller than for open areas such as the Sambian Peninsula. The match of different estimates varies depending on the exposedness of a particular coastal section to the predominant wind directions. The presence of ice cover was ignored but ice conditions may have great influence on the extremes of nearshore wave regime (that determine the closure depth) during autumn and winter storms.

P 109

THE HYDROGRAPHIC CONDITIONS IN THE GULF OF FINLAND IN 2014 BASE ON EXTENSIVE JOINT MONITORING

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During the Gulf of Finland Year 2014 Estonia, Finland and Russia carried out a greatly extended joint monitoring programme covering the entire Gulf. One key issue of the Thematic Year was to get seasonal synoptic views of the Gulf's hydrography. This was realised by extensive field campaigns in January, May-June, August and October-November. In these surveys about 450 vertical profiles of e.g. salinity, temperature and oxygen were measured. The results showed strong intrusion of saline anoxic water from the Baltic Proper deep layer up to the eastern part of the central gulf. That led to a strong stratification and poor oxygen conditions in the near bottom waters of the gulf. In addition, the July-August period of 2014 was extremely warm with sea-surface temperatures up to 23 degrees. At that time it became interestingly visible how cooler river waters, especially from River Neva with temperature of 16 degrees, had a clear cooling effect to the surface waters of the gulf. Some strong upwelling events were found during the warm summer period, too. The pronounced vertical stratification coupled with already anoxic conditions prior to 2014, lead to intense blue-green algae blooms in the western gulf in summer 2014. This is a strong reminder on the dependence of the environmental conditions of the Gulf on those of the Baltic Sea Proper; especially because of the large anoxic bottom areas there. It stresses the needs to study and understand the Baltic Sea as an entity when dealing with regional or local problems.

P 110

MACROALGAE COASTAL COMMUNITIES OF THE GULF OF GDANSK

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Keywords: macroalgae, pollution, water quality, Gulf of Gdansk

The estimation of species composition and abundance of algal flora as indicators of the ecological status of water was carried out in coastal areas of the Russian part of the Gulf of Gdansk (Kaliningrad region). The materials of investigation were fouling and emissions drifting macroalgae collected in the period from June to August 2012. Coastal communities of the Gulf of Gdansk included 15 species of macroalgae, belonging to 3 phylum: Chlorophyta – Urospora peniciliformis, Ulva prolifera, U. Intenstinalis, Cladophora glomerata, C. rupestris; Phaeophyta – Pilayella littoralis, Ectocarpus confervoides, Fucus vesiculosus, Elachista fucicola, Stictiosiphon tortilis; Rhodophyta – Bangia atropurpurea, Furcellaria lumbricalis, Coccotylus truncates, Polysiphonia fucoides, Ceramium tenuicorne. Longshore fouling communities were represented 6 species. Longshore drift algae emissions were represented 15 species. The main part of the community was represented Ulva prolifera and Cladophora glomerata. The dominant species was Cladophora glomerata. Strict biotopical dependence among fouling macroalgae isn't revealed. Of the 15 identified species, 14 are indicators of saprobity. Most of the species are mezosaprobic - 50%, 36% - oligosaprobic, 14% - polisaprobic. Biomass of oligosaprobic species was 8.3%. Frequency of occurrence and predominance of biomass by β- mesosaprobic species (Cladophora glomerata – 41,6%; Polysiphonia fucoides – 40,6%) indicate poor or moderate water quality of study area.

P 111

APPLICATION OF NEW BIOMARKERS FOR ASSESSMENT ENVIROMENTAL STATE IN THE NEVA ESTUARY

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Keywords: malformed embryos rate, gammaridean amphipods, heart rate recovery time, bivalve molluscs, toxicity, coastal area

Gammaridean amphipods and bivalve mollusks have great potential for the sediment toxicity tests in estuarine areas. The malformation rate in amphipods as as general bioindicators of contaminants effect in the Baltic Sea was recommended by HELCOM (2010, 2013). This abstract presents result of comparative assessment for environmental state at four locations of the Neva estuary (in summer-autumn of 2014) using physiological variables in amphipods (embryos malformation rate) and in mollusks (heart rate recovery time after loading) as bioindicators of contaminants effect.

The embryos malformation rates in two dominating amphipods *Gmelinoides fasciatus* and *Pontogammarus robustoides* from the Neva estuary were measured as frequency proportion of malformed, enlarged, undifferentiated and dead embryos per female. The good status is reached if the rate is <5-8 % of embryos are malformed and the bad status is given if it >40% of embryos are malformed.

The heart rate in mollusk *Anodonta anatina* measured basing on infrared light remote registration of the heart volume change. Heart rate recovery time was calculated as the time (min) needed to recover to individual heart rate to background level after hyperosmotic test. The recovery time was <60 min testifies about good ecological status at sites and bad status if >120.

By this research was found a tendency for the poorest status (30-40 % of malformation and high mortality of embryos) at the southern coast of Neva Bay while the northern sites situated after storm surge dam were testified as the area with low toxicity of bottom areas. The both methods showed the high similarity in results.

P 112

SPATIO-TEMPORAL DISTRIBUTION OF THE BALTIC SEA NEAR-SHORE WAVE POWER POTENTIAL IN KLAIPĖDA, LITHUANIA

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Keywords: near-shore wave power, spatio-temporal distribution, Klaipėda, Baltic Sea

Wave power is abundant source of energy that can be utilized to produce electricity. Nevertheless, the development of wave energy converters is still at the phase of prototypes testing and the main focus of scientists is related with the sites of highest wave power potential sites, such as the Northern Atlantic coast. Still, the amount of scientific work concerning wave power topic in the European semi-enclosed seas, like the Black Sea and the Mediterranean Sea, increased rapidly in the last years, what leaves the Baltic Sea a blank spot on the European wave energy map. Therefore, the aim of this study is to assess spatio-temporal distribution of the Baltic Sea near-shore wave power potential along the Klaipėda coast.

Multi-year wave height observations from the Klaipėda coastal hydrometeorological station were used as the initial data in this study. Statistical methods were applied and the temporal distribution of wave power potential was assessed in selected design years. Selected design years were: high intensity (5 % probability), median intensity (50 % probability) and low intensity (95 % probability) wave years. The spatial distribution of wave power potential in Klaipėda near-shore area was assessed using numerical wind-wave model *MIKE 21 NSW*. Propagation of the design years‘ maximum seasonal, minimum sesonal and average annual wave heigts to the coast were modelled. The impacts of depth, wave propagation direction and wind speed on wave power potential were examined.

P 113

RETURN PERIODS OF EXTREME WATER LEVELS ALONG LITHUANIAN SEA COAST BASED ON A SIMPLE ENSEMBLE OF PROJECTIONS

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Keywords: SE Baltic Sea, extreme water level, ensemble approach

High water levels and associated damages by large waves to sedimentary coasts are one of the major problems in the management of coastal areas in the most of the SE Baltic Sea. Higher surges and the related increase in the total wave energy approaching the coasts in this area are likely to enhance coastal erosion, to change the erosion, accretion and deposition patterns, and to amplify loads on the unprotected sediments far inland from the current swash zone, and also to deteriorate habitats.

We explore the options for using an ensemble of projections to more reliably evaluate return periods of extreme water levels. The target area is the Lithuanian coastline that is representative for a large part of the SE Baltic Sea as a relatively straight coast that is fully open to the sea. The focus is on the Klaipeda region. Water level in this area is the major driver of floodings in the Curonian lagoon.

To identify biases in the estimates of extreme water levels and their return periods caused by local effects (e.g., wave set-up), we construct an ensemble of projections, applying the block maxima method to two independent data sets (one measured and one modelled) and employing three common statistical distributions of extreme values (Weibull, Gumbel and General Extreme Value distributions). The analysis is based on observed water level data in Klaipeda Strait for a period of 1898-2012 and numerically simulated water levels for 1961–2005.

P 114

AN OPEN-SOURCE BASED SYSTEM FOR NEAR-REAL TIME SEA FLOOD EXTENT WEB MAPS FOR THE SOUTHERN COAST OF FINLAND

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Keywords: spatial analysis, flooding, digital elevation model, open-source, uncertainty

Near real-time environmental data and information services – especially weather forecasting – have proven to be of great value the society, such as rescue services and policy-making. At the same time, the interest of the general public is increasing concerning such information. We present a system architecture and a working implementation providing near-future estimates of uncertainty-aware sea flood inundation in a web client. The system is based on open data and loosely coupled open-source software components.

The system uses water level estimates of the Finnish coast from the Finnish Meteorological Institute computed with the OAAS model, statistics of past water gauge observations and predictions, and the digital elevation model of the National Land Survey of Finland with a resolution of 2 meters as input data.

The hourly water level estimates for the following days are accessed via standardized web-interfaces after they are published. Next, the extent of flood inundation is analyzed by taking into account uncertainties in sea level predictions and the digital elevation model. The analysis is performed with Monte Carlo simulation using parallel computing. Finally, we publish the combined result for each timestamp in a standardized web interface and provide access to the new inundation estimates and past estimates on top of open background maps in a web map application.

P 115

ASSESSING SEDIMENT TRANSPORT AND DISSOLVED OXYGEN CONDITIONS IN THE WESTERN PART OF THE GULF OF FINLAND

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Keywords: Gulf of Finland, dissolved oxygen, turbidity, sediment transport, currents, ADCP

The Baltic Sea, especially the Gulf of Finland is one of the most polluted waters in the world. High nutrient loads have caused an excessive growth and decay of aquatic organisms which in turn, has resulted in water quality reduction. In recent years the situation has started to improve, still the environment must be constantly monitored in order to detect any changes. The current work focuses on observing near-bottom sediment dynamics and oxygen conditions based on multiple acoustic Doppler current profiler (ADCP) and shipboard CTD measurements along with laboratory water sample analyses. Two bottom mounted RDCPs (one equipped with CTD probe) and one ADCP (equipped with CTD probe) were installed in the western part of the Gulf of Finland. Laboratory analyses included dissolved oxygen measurements using dissolved oxygen meter and the determination of sediment concentration using dry-weight method. All these measurements were carried out between 8 December 2013 and 6 May 2014. During that period six research cruises were undertaken to collect data from 15 stations. Further work comprised interpreting the results and finding relations between detected processes.

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P 116

ROLE OF NITRIFICATION ON COASTAL NUTRIENT DYNAMICS

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Keywords: nitrification, benthic boundary layer, eutrophication

Coastal zones of the Baltic Sea are among the most eutrophied in the world receiving high loads of nutrients and organic matter from rivers. However, not only riverine nutrient input but also the internal cycle of nutrient uptake, particle formation, sedimentation and remineralisation might have a positive feedback on eutrophication. Therefore we study particulate organic matter degradation within the benthic boundary layer (BBL), where low current velocities occur and POM accumulates. The generated ammonium acts as a substrate for nitrification, the production of nitrite and nitrate which may further be denitrified under hypoxic conditions or re-used by photoauotrophs in surface waters. Full comprehension of the nitrification process and its regulation is essential for the understanding of the coastal filter function. Previous studies have shown a strong correlation between nitrification rates and the ammonium concentrations which indicate that not only riverine input but also enhanced nitrification can be a source of nitrate. Within the project COCOA we investigate nitrification in the BBL along a depth/eutrophication gradient in river plume impacted coastal seas. We focus our studies on the nutrient rich Vistula River plume but will also participate in sampling campaigns in a Nordic low-nutrient estuary. We use stable nitrogen isotopes to better understand the nitrogen cycle and to determine nitrification rates along with controlling factors in the BBL. First data from the Bay of Gdansk will be presented.

P 117

PAST CLIMATE VARIABILITY - CLIMATE CHANGES DURING THE HOLOCENE IN THE BALTIC SEA BASIN (THE LAST 12000 CAL YR)

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Keywords: Baltic Sea, Holocene, climate variability

This poster summarises the climatic and environmental information that can be inferred from proxy archives over the past 12000 years in the Baltic Sea region, including continental and lake sediments, pollen, insect remnants, and isotopic data. Over the Holocene, the Baltic Sea area underwent major changes due to two interrelated factors – melting of the Fennoscandian ice sheet, causing global sea-level rise and regional isostatic rebound of the Earth's crust causing a drop in relative sea level- and changes in the orbital configuration of the Earth, triggering the glacial to interglacial transition and affecting incoming solar radiation. The Holocene climate history showed three stages of natural climate oscillations: short-term cold episodes related to the deglaciation during a stable and positive temperature trend (11,000–8000 cal yr BP); a warm and stable climate with air temperature within the range 1.0–3.5 °C above modern levels (8000–4500 cal yr BP); a period with a cooling temperature trend and increased climatic instability (last 5000–4500 years). The climatic variability during the Late Glacial and Holocene is reflected in the changing lake levels and vegetation, and in the formation of a complex hydrographical network that set the stage for the Medieval Warm Period and the Little Ice Age of the past millennium. This poster summarizes the main results of Chapter 2 of the second Assessment of Climate Change in the Baltic Sea Basin (BACC).

P 118

OPTIMIZING TRADITIONAL NUTRIENT LIMITATION EXPERIMENTS FOR MODERN MONITORING PURPOSES

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Keywords: Nutrient limitation, phytoplankton, eutrophication, monitoring

Managing nutrient inputs is one of the cornerstones in reaching a good environmental status as defined by the HELCOM Baltic Sea Action Plan. Depending on characteristics of the nutrient load, the receiving water body the present primary producer community and associated benthic habitat, pools of nitrogen and phosphorus are translated into biological production while being modulated by biogeochemical processes in the coastal zone. Thus, determining the most cost efficient nutrient management measures on local scales is a difficult task based on traditional monitoring data. We have tested an application of traditional nutrient limitation experiments for monitoring the effects of nutrient loads to coastal seas. We have focused on the development of methodology in order to streamline and minimize the effort traditionally put into the experimental setup. We have run several experiments in order to identify the minimum allowable sample volume and the applicability of fluorometric methods in assessing treatment responses of the primary producer community. The results indicate acceptable reproducibility of results with fluorometric results, down to sample volumes of 30 ml, allowing for the execution of experiments on well-plates with minimal attendance to sampling. An unattended classification scheme is used to translate results into easily understandable nutrient limitation classes. This allows experiments to be run in large numbers, leading to more precise management options.

P 119

ANALYSIS OF EUPHOTIC BOTTOMS BY SATELLITE REMOTE SENSING AND FIELD MEASUREMENTS IN ASSESSING THE SPATIAL CHANGES OF MACROALGAL BELTS IN THE NORTHERN BALTIC SEA

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Keywords: Macroalgal communities, Euphotic depth, Spatial distribution, MERIS satellite, Boosted regression trees (BRT), Trophic level changes

The vertical distribution of macroalgae depends among other things on the availability of light in water, often described by euphotic depth. The penetration of light in turn is dependent on the amount and type of plankton, organic debris, mineral particles and coloured dissolved organic matter (CDOM) in water. However, despite the empirical information of the vertical response of different algal groups to light, a gap in knowledge exists of the changes of *spatial distribution* of algal belt in altered light conditions.

We hypothesized that a detailed remote sensing-based analysis of euphotic depth will reveal temporal and spatial differences in algal communities in different coastal areas, with variable topography and benthic substrates.

Euphotic depth and Secchi disk transparency were estimated by a bio-optical model with input from MERIS satellite images (chlorophyll a and turbidity, data from 2003 – 2011, 300 m x 300 m resolution) and an average CDOM map (based on in situ measurements). Chlorophyll a was estimated with the FUB processor and turbidity with the Case2 regional processor. We modelled the spatial extent of euphotic depth in the Finnish sea areas using available sea bottom topography data. From literature review and our own laboratory experiments we assessed the responses of dominant algal species to light levels. Finally, we modelled the current and changed spatial distribution of macroalgae under different light availability conditions using analyzed euphotic layer depths using state-of-the-art modelling technique, boosted regression trees (BRT). Other environmental factors, such as depth attenuated wave exposure, salinity and bottom substrate were also considered.

We show preliminary results of this analysis and discuss the usability of this approach e.g. in evaluating the potential effects of trophic level changes on the spatial dynamics of macroalgal communities.

P 120

ANALYSIS OF VERTICAL MIXING IN THE NORTHERN BALTIC SEA BASED ON 3D MODELLING AND DATA FROM SHALLOW-WATER ARGO FLOATS

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Keywords: NEMO model, Argo floats, Bothnian Sea, vertical mixing.

Vertical mixing remains a challenge for ocean models. Several studies have shown that 3D hydrodynamic models often produce considerable errors in mixed-layer depths regardless of chosen vertical turbulence parameterisations. These errors can be especially pronounced in areas with complex hydrography such as the Baltic Sea.

In this work vertical mixing is studied in the Bothnian Sea. NEMO 3D ocean model has been set up at Finnish Meteorological Institute (FMI) for the Baltic Sea, based on the NEMO NORDIC configuration. The model has been run for a Baltic Sea - North Sea grid with 2 nautical mile resolution.

FMI has been testing Argo floats in the Baltic Sea since 2011. This is the first time Argo floats have been successfully used in the Baltic Sea. This new data set is well suited for evaluating the capability of hydrodynamic models. It provides a time series of profiles from the area of interest with good temporal resolution.
Preliminary comparisons of model results to Argo measurements have shown that the model is able to describe the basic features of the vertical structure of temperature in the Bothnian Sea. Thermocline depths are reproduced with good accuracy, although measurements show steeper gradients in temperatures than the model. The old winter water or dicothermal layer is not produced correctly. Tuning of vertical mixing parameterisations in the model is discussed in the light of the results.

P 121

MEASUREMENT OF SPONTANEOUS CURRENT-INDUCED PATCH FORMATION PROCESSES IN THE MARINE SURFACE LAYER

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Keywords: Finite-time compressibility, patchiness, downwelling, floating pollution

I make an attempt at developing a technology for identifying areas of spontaneous patch formation in the marine surface layer. The mechanism of patch formation addressed in this work is the impact of three-dimensional downwelling motions in the water column on a two-dimensional field of substance. The test area is the Gulf of Finland in the Baltic Sea.

A modified measure of surface flow compressibility, called finite-time compressibility (FTC), is introduced. This measure is evaluated by means of geometric properties of triplets of floats that are passively carried by surface currents. It is designed to account for time correlations of the realistic flows and to directly relate them with the ability of a region to form clusters of passive surface tracers. A quadratic relationship between the classical flow compressibility and FTC exists for ideal Kraichnan flows. Spontaneous clustering of passive surface tracers may occur if finite-time compressibility exceeds a critical value of 0.7.

Spatial maps of FTC are calculated for the Gulf of Finland using Lagrangian trajectories of passive floating items or selected water parcels at the sea surface. The basic properties of this measure are established using velocity data across a time span of 5 years (1987–1991).

The regions where instantaneous values of FTC often exceed the threshold for the clustering of surface floats correspond to the areas in which spontaneous patch formation is likely. Nine such regions of different size have been identified in the study area. The persistency of these regions is analyzed by means of their appearance patterns and their average persistency. The areas showing a high count of over-threshold values of FTC exhibit substantial seasonal variation.

P 122

SEDIMENT AND HABITAT CHARACTERIZATION ON THE ABRASION PLATFORM SAGASBANK (MECKLENBURG BAY, SOUTH-WESTERN BALTIC SEA) BY DIFFERENT HYDRO-ACOUSTIC METHODS

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Keywords: sidescan sonar, multibeam, acoustic ground discrimation, ROV, FFH, EU directives

Due to environmental requirements the protection of subnarine hard-bottom substrates have become a key issue as the EU Habitats Directive, the EU Water Framework Directive, the Marine Strategy Framework Directive and HELCOM claim efforts to reach a "good ecological status" of marine habitats. Sagasbank is a submarine shoal in western Mecklenburg Bay reaching from -22 m up to -7 m water depth. Its sediment and habitat distribution is strongly related to the Post-Pleistocene geological development. We demonstrate an example of habitat mapping focusing on sedimentological and geomorphological characterization of the seafloor. The results are based on high resolution hydroacoustic data (sub-bottom profiler, multibeam, side-scan sonar, ground discrimination system). Calibration of the hydro-acoustic data is supported by underwater video and ROV observations, grab sampling and vibro-coring. By merging the data sets we reveal an abrasion platform with a shore parallel zonation of seabed facies. The exposed areas are characterized by rest and relict sediments, densely overgrown boulders and sandy habitats in the sheltered areas. Adopting the definitions from the EU Habitats Directive we identified the two habitat types "reef" and "sandbank".

P 123

DIAGNOSTIC MAGNETIC SUSCEPTIBILITY SIGNATURES OF EPISODIC PEDOGENESIS IN AEOLIAN SLIPFACE SEQUENCES, GREAT DUNE RIDGE, LITHUANIA

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Keywords: podzol, heavy minerals, paramagnetic, GPR, Curonian Spit

Buried and exposed paleosols in coastal dunes serve as valuable archives of regional climatic conditions, vegetation dynamics, fire history, as well as geomorphic indicators (dune paleo-dimensions and chronology of Aeolian stability phases). Their identification, mapping, and sampling has been hampered by spatial variability and delicate nature of organic horizons within unconsolidated sand. To address this problem, in situ bulk low-field magnetic susceptibility (MS) was measured along deflated paleo-slipface sections at two locations along the Curonian Spit, Lithuania (Vingio and Nagliu Reserves). Susceptibility values of incipient soil horizons, podzols, and more mature paleosol sections dating between 3.5-0.7 ka BP were compared with enclosing clastic aeolian sequences of varying composition. Whereas background quartz-rich sands typically measure at <20 μSI, thin organic horizons yield higher values of 23-36 μSI (O), 33-38 μSI (B/podzol), 40-44 μSI (E), ~50-100 μSI (Bh/oxidized), with higher variability for the C horizon. This also distinguishes an organic layer from a visually similar heavy-mineral concentration (HMC) that often exceed 100 μSI (>2,000 μSI for cm-scale HMCs). Only a specific low fraction of ferri-/paramagnetic minerals, including glauconite-clay coated quartz grains, may produce mid-range values. Similar to paleosols, HMCs serve as stratigraphic index horizons and produce strong signal return on high-resolution geophysical images (georadar B-scans). Georadar surveys along MS transects formed the basis for establishing diagnostic criteria for compositional anomalies, including impulse (A-scan) analysis. Our findings show that MS is a valuable tool for assessing pedogenesis in dune exposures, with potential applications in paleopedological, geological (borehole analysis) and geoarchaeological (occupation surface and hearth detection) research.

P 124

TRANSITIONAL FISH CLASSIFICATION INDEX (TFCI) ADAPTATION FOR LATVIAN TRANSITIONAL WATERS.

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Keywords: TFCI, Water Framework Directive (WFD), Transitional waters, Fish

An international commitment to assess the ecological status of transitional waters (estuaries) has been introduced by the Water Framework Directive 2000/60/EC (WFD). Fish communities are one of the key monitoring components and they can be described by determining trends in such characteristics as composition, trophic structure, diversity of the assemblage, abundance and biomass of the individuals. These trends then serve as indicators for monitoring the ecological functioning of an ecosystem

There was no index specifically developed for fish communities in transitional waters of Latvia, therefore the Transitional Fish Classification Index (TFCI) by Coates et. al (Coates et.al 2004 and Coates et.al 2007) has been adapted according to research conducted previously and to experience of other countries, as well as taking into account following characteristics of transitional waters of Latvia: salinity, ground relief, depth and almost non-existent water level fluctuations.

The TFCI adapted for transitional waters in Latvia is calculated by using 12 metrics that cover four most important characteristics of fish communities: species diversity and composition, species abundance, nursery function, and trophic integrity. TFCI is expressed as coefficient of ecological quality (EQR – Ecological Quality Ratio) against the reference status.

Data obtained by Institute of Food Safety, Animal Health and Environment „BIOR", Fish Research Department and covering period from 1994 to 2013 were used for calculations of TFCI metrics thresholds. It must be noted that transitional waters is an ecosystem that has been affected by human disturbances for decades therefore the metrics characterizing an intact environment cannot be obtained. In order to determine the reference status the metrics for ecological quality were calculated for each year between 1994 and 2013, and the year with the highest values that indicate high ecological quality was defined as the year with reference status.

Project Nr. 1-08/447/2014 " Implementation of EU Water Framework Directive 2000/60/EC for Latvian coastal and transitional waters (Baltic Sea): the biological quality elements (phytoplankton, macrophytes, benthic invertebrates) intercalibration exercise and testing (fish)" is supported by Administration of Latvian Environmental Protection Fund.

P 125

DIVERSITY OF HARD BOTTOM HABITATS IN THE LATVIAN PART OF THE GULF OF RIGA

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Keywords: Baltic Sea, Gulf of Riga, Marine Protected Area, biodiversity, hard bottom habitats, littoral biomass

The littoral zone of Latvian part of the Gulf of Riga represents rather heterogenous coastal ecosystem providing a suitable place for a large number of different benthic communities. The present study describes distribution of hard bottom habitats and habitat-forming species in the Gulf of Riga as results of one of the most comprehensive investigations in the last 30 years. In total, more of 1200 drop video data transects and 110 macrobenthos samples were analyzed. Our investigations also include comparison of changes in species distribution and biomas with previous studies in late 1980's and 1990's. Some sites of the study area with high benthic biodiversity are designated as Marine Protected Areas and some part of the coastline is also assigned as Natura 2000.

Results of our study indicate that the eastern coast of the Gulf of Riga is rich in diversity of hard bottom habitats and has a high coverage of habitat forming species (Mytilus, Dreissena, Fucus and Furcellaria). The western coast of the Gulf of Riga has low coverage of Mytilus, Dreissena and Furcellaria and represent the dominance of annual vegetation. The reason of observed differences between sites could be a strong regional pattern related to existing differences in ecological conditions and will be discussed further.

P 126

IMPACT OF MESOSCALE AND SUBMESOSCALE DYNAMIC ON SEASONAL MIXED LAYER EVOLUTION OF THE BALTIC SEA

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Keywords: mesoscale and submesoscale eddies, restratification, mixed layer depth

The stratification in the Baltic Sea follows a well-known annual cycle of well-mixed conditions in winter, surface warming in spring and summer, maximum vertical temperature gradient in late summer, and erosion of stratification in fall. At the same time a number of studies report about a short term variations of mixed layer (ML). Density fronts commonly observed throughout the mixed layer are often unstable to mixed layer instabilities (MLIs: Boccaletti et al., 2007; Samelson and Chapman, 1995; Haine and Marshall, 1998). These ageostropic baroclinic instabilities grow and form mixed layer eddies (MLEs) when they reach finite amplitude. MLE act to restratify the ML and also affect biology via impact on the physical environment and nutrient transport properties. Diameters of such eddies are between 2 and 7 of Rd, where Rd is the local Rossby radius of baroclinic deformation [Zatsepin et al. 2011]. At the next level of the cascade of energy dissipation are the smaller sub-mesoscale eddies (radius <= Rd). In the Baltic sea the Rossby radius varies from 1 to 7 km [Fennel W. et al. 1991].

For the numerical experiments we use based on NEMO-nordic [Hordoir, R. 2013] ocean model realization for Baltic sea including free surface, time split surface pressure gradient, variable volume, GLS mixing, iso-neitral lateral diffusion. With horizontal resolution 1 nm the model can explicitly resolve mesoscale eddies while submesoscale dynamic remains only partly resolved and to be parametrized.

For comparative analyses we used two available in NEMO 3.6 parametrizations of eddy mixing: eddy induced velosity [Gent et al. 1995] and MXL Kemper parametrizations [Fox-Kemper, B., and R. Ferrari (2008)].

From the numerical experiments we had found a considerable impact of applied parametrizations on short term mixed layer depth variations during the ice free period.

P 127

PHOTO- AND CHROMATIC ACCLIMATION OF MARINE PHYTOPLANKTON IN THE BALTIC SEA

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Keywords: monitoring, accessory pigment concentrations, vertical distribution, remote sensing

Vertical distributions of phytoplankton pigments in seas and oceans are the result of phytoplankton adaptation to different environmental conditions, especially light. Chlorophyll *a* is the basic pigment in photosynthesis process in algae, while other pigments fulfil accessory functions. The processes by which cells of phytoplankton adapt to light factors may be of two kinds: photoacclimation (which gives rise to changes in the relative concentrations of photoprotecting pigments) and chromatic acclimation (which gives rise to changes in the relative concentrations of photosynthetics pigments). The aim of this paper was to determine the statistical relationships between the concentrations of accessory pigments in natural populations of marine phytoplankton and the absolute levels and spectral distributions of underwater irradiance. This aim was achieved with statistical analysis of appropriate data sets from various regions of the Baltic Sea during cruises of research ships in 1999-2013.

The analysis showed that the factor governing the occurrence of photoprotecting carotenoids (PPC) is short-wave (blue) radiation $\lambda<480$ nm. Analysis of the relationships between particular accessory photosynthetic pigments (PSP), i.e. chlorophyll *b*, chlorophyll *c*, photosynthetic carotenoids (PSC), and the underwater irradiance characteristics indicated that these concentrations were only slightly dependent on the absolute level of irradiance $E0(\lambda)$, but that they depended strongly on the relative spectral distribution of this irradiance $f(\lambda)=E0(\lambda)/ PAR0$.

These relationships were used in a Baltic environmental satellite remote sensing system – SatBaltic.

P 128

THE DEPENDENCE OF THE MAGNETIC SUSCEPTIBILITY OF THE OCCURRENCE OF CONCENTRATIONS OF SELECTED METALS IN SURFACE SEDIMENTS PORT ON THE EXAMPLE OF HEL

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Keywords: magnetism, ferromagnetic, susceptibility

In recent years, more and more studies are being conducted on environmental magnetism in particular variation anomalies of magnetic susceptibility caused by various geogenic and anthropogenic factors. Magnetic susceptibility determines the size of the magnetization as a function of field strength magnetic. Due to the magnetic properties of elements, minerals and sediments is distinguished by 3 groups, which is a division criterion behavior in an external magnetic field: a ferromagnetic ($\chi >> 0$) paramagnetic ($\chi > 0$), diamagnet ($\chi < 0$). Oversize metal concentration are one of the major threats to human health and life. However, many of them in low concentrations plays a fundamental role in the proper the functioning of organisms. Factor affecting the metal content of the bottom sediments of the mineral composition and size distribution of sedimentary material. An important parameter in the study is to determine the magnetic properties participation in the sediment metals, in particular Fe, Cu, Cr, Ni, Zn and Hg. The study was conducted in the area of the old war port in Hel in 2013. Surface sediment samples were collected by van Veen scooper . Analysis sieve deposits made using nylon sieves. Metal concentrations were analyzed using a Perkin Elmer AAnalyst 300 (ASA), the prior mineralization (Milestone Ethos One) in concentrated acid (9HNO3: 1HF). For the determination of the magnetic susceptibility of the samples MFK1 used-bridge-FA. The studies found a correlation of elevated concentrations of selected metals in the surface layer of sludge tested port along with the anomalies and the variation of the magnetic susceptibility granulometric sediment, which may be indicative of a strong human pressure in the test the environment. The results will be used to correlate the signs of vulnerability magnetic in other areas of the port.

P 129

CLIMLINK: CLIMATE FORCING FACTORS FOR MARINE ENVIRONMENTAL CHANGE DURING THE MIDAND LATE HOLOCENE – A LINK BETWEEN THE NE ATLANTIC AND THE BALTIC SEA.

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The impacts of climate change in the Baltic region can be expected to be substantial. CLIMLINK project aims to reconstruct mid- to late Holocene ecosystem changes in the eastern Nordic Seas, Skagerrak, Kattegat and the Baltic Seas, to target key unknowns that need to be studied, to form a baseline of knowledge of how future changes may impact the Baltic region. High-resolution sediment records from key sites in the Atlantic and Baltic sectors are being studied by using multiple micropalaeontological and geochemical proxies: diatoms, foraminifera, stable isotopes, Mg/Ca, TOC, TIC, C/N, XRF and magnetic susceptibility. The chronology of the cores is secured by using multiple dating tools: Hgpollution records, ^{137}Cs, ^{210}Pb, ^{14}C and tephra layers. Herein we present the first results of the project.

P 130

COMPARATIVE STUDIES OF BIOLOGICAL EFFECTS OF SURFACE WATER POLLUTION ON PHYSIOLOGICAL STATE OF MOLLUSCS: EXPERIENCE OF CAGING STUDIES IN THE TALLINN BAY

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Keywords: bioindication of water quality, caged molluscs studies, cardiac activity of invertebrates, heavy metals in tissues

Application of improved fiber-optic bioelectronic system for cardiac activity measurement (Kholodkevich et al., 2008) in environmental monitoring and ecosystem health assessment can be useful for the advancement of bioindication of surface water quality.

Changes in cardiac activity reflect the whole organism response to the action of a mixture of pollutants in the environment, therefore, the proposed biomarkers of cardiac activity (Kholodkevich et al., 2011) are also being useful to link harmful effects of pollution in individual sentinel animals to the their ecological consequences.

Cages with mollusks (Mytilus trossulus and Macoma balthica) were deployed in 4 locations (2 contaminated and 1 reference for each species), time of exposure – more than 2 months. After exposure in cages mollusks were tested by using short time functional load (Kholodkevich et al., 2011) based on the assessment of HR recovery time. Prolonged HR recovery and high coefficient of HR for group of mussels from study site are signs of stressful impact on these animals, caused by environmental pollution of their habitat. Also the analysis of content of heavy metals in tissues was performed. In particular, obtained data can improve our ability to predict the responses of biondicator species to environmental pollution. Obtained results are discussed.

P 131

CURONIAN LAGOON WATERSHED MODELING AND ASSESSMENT OF CLIMATE CHANGE IMPACT

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Keywords: Curonian Lagoon, Nemunas watershed, watershed modeling, Climate change

With the increasing water management problems, a need for a sophisticated hydrological model of the Curonian Lagoon watershed area arose, to assess possible changes due to local and global processes. To correctly predict the movement of pesticides, sediments or nutrients, evaluate water management practices, the hydrologic cycle simulated by the model must conform to what is happening in the watershed. For this purpose a sophisticated hydrological model was created and calibrated, which represents the study area with a required accuracy. The model can be used to identify hydrological changes of the Curonian Lagoon watershed due to global processes (climate change, etc.), as well as local anthropogenic activities, and forecast possible changes in the future. The conducted model hydrology calibration, uncertainty analysis and sensitivity analysis enables a broader understanding of key processes in the watershed. With further research and additional calibration this model can be used to simulate sediments, pesticide and nutrient transport in the watershed. The created model can be coupled with ecological, biochemical, sediment or other models, contributing to respectful researches in the selected study area.

P 132

PRIMARY PRODUCTION OF MACROPHYTES AND PHYTOPLANKTON IN A SHALLOW COASTAL BAY OF THE SOUTHERN BALTIC SEA

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Keywords: alternative stable states, productivity, photosynthesis, irradiance, biomass

High nutrient input into coastal waters of the Baltic Sea during the past decades resulted in many areas in a shift from a clear, macrophyte-dominated state to a phytoplankton-dominated state, characterized by high turbidity. Despite recent reductions of nutrient inputs the systems have not recovered; turbidity is still high. However, in some areas, such as the Darß-Zingst Bodden-Chain (DZBK) macrophytes can be found once again. The here presented project (funded by the "Forschungsstiftung Ostsee") is to gain insight in whether the current state of the DZBK is a transition to the macrophyte-dominated state or a distinct stable state. Therefore, the relative importance of the two groups of primary producers (macrophytes and phytoplankton) will be analyzed and the total productivity of the system will be calculated. Photosynthesis-irradiance curves, biomass distribution and data on global irradiance as well as under water irradiance build the basis for a balance model for the calculation of primary productivity. Understanding of the state and the system DZBK is of great importance especially against the background of achieving the good environmental status as defined by the EU-water framework directive.

P 133

FUCUS VESICULOSUS RELATION WITH TROPHIC STATE AND OXIDATIVE STRESS LEVEL

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Keywords: Fucus vesiculosus, oxidative stress, trophic state,

In the Baltic Sea ecosystem several fish species and molluscs have been used as biomarkers of oxidative stress, there is less information regarding Fucus vesiculosus as key species of coastal habitats. The aim of this study was to examine spatial differences in the activity of enzymes Glutathione - S transferase (GST), glutathione reductase (GR) in connection with macrophyte community diversity, productivity and trophic state level in the littoral of the Gulf of Riga, Finland and Bothnian Bay at 6 stations. The Bray-Curtis cluster analyses of stations with macrophyte communities main groups biomass (Chlorophyta, Phaeophyta, Rhodophyta) revealed that Tvaerminne, Mersrags and Hanko habitats are rich with Fucus vesiculosus biomass (460,0, 338,0 and 302,0 mg dry weight/m^2). At stations Rauma and Klamila F. vesiculosus biomass lowered– 137,0 and 137,0 mg dry weight/m^2, but at Saulkrasti habitat (eastern part Gulf of Riga) only 57,0

mg dry weight/m^2. The species diversity in 6 habitats correlates with brown algae biomass level – 10 species were identified in the Tvaerminne habitat (the Gulf of Finland) but in the Saulkrasti habitat – only 5 species were identified. Enzyme activity results for the GST are as follows: the highest activity in 2009 and 2010 in Fucus vesiculosus was found in Saulkrasti habitat - 587 and 490 nanomoles / min / mg protein, and the minimum activity – Mersrags and Klamilla (2010) habitats - 105.0, 100.0, 104.0 nanomoles / min / mg protein respectively. GR activity also shows the maximum value for F.vesiculosus at Saulkrasti and Klamilla habitats in 2009 - 607.0 and 403.0 nanomoles / min / mg protein, thereby producing increased environmental stress effects on macrophyte populations in the investigated habitats. There is no clear trend in oxidative stress level in the Gulf of Riga between 2009 and 2014.

P 134

PCDD/PCDF IN BOTTOM SEDIMENTS FROM THE SOUTHERN BALTIC SEA AREA

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Keywords: dioxins, bottom sediments, dumping sites

The term "dioxin" is commonly used to refer to a family of toxic chemicals that all share a similar chemical structure and a common mechanism of toxic action. The accumulation in sediments promotes large octanol-water partition coefficients. Sediments are known to be an important and final sink for non-polar organic contaminants, including dioxins and dl-PCBs. The Baltic Sea is contaminated with PCDD/PCDFs and dl-PCBs. A large extent the pollution is attributed to the effluents of the pulp and paper industry which used chlorine as a bleaching until the early 1990s and also due to the fact that Baltic Sea is an inland sea with low water exchange. In the Baltic Sea Region in 2010-2014 was realized project ECODUMP (Application of ecosystem principles for the location and management of offshore dumping sites in SE Baltic region). Among others the ECODUMP project has been studied contents of dioxin in surface sediment samples collected from the Gdynia Port and former shipyard area, Gdynia and Gdansk dumping sites, the Gulf of Gdansk and Klaipeda dumping site. The highest concentrations of analysed PCDD/PCDFs were indicated in sediments from former shipyard area in Gdynia Port. The highest concentrations of dioxins on Gdynia Dumping Site were found in sediments located in shallower part of dumping site, on both sides of the ridge. A very small percentage of furans relative to PCDD may indicate a low deposition from the atmosphere as a source of these pollutants. Among analysed dl-PCBs congeners PCB 105 and PCB 118 were found in highest concentrations.

P 135

DEGRADATION OF PAHS IN DREDGED MATERIAL

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Keywords: PAHs, biodegradation, remediation, dredged material, dumping sites

PAHs are a group of persistent pollutants due to its property such as hydrophobicity, easy sorption, resistance to decomposition and stability, but nevertheless they still slowly undergo the physic-chemical and biological changes. Many years of research on this group of compounds has shown that some of them are carcinogenic, mutagenic or teratogenic, which makes the problem of the presence and persistence of these substances in the environment is serious. Not only the basic compounds have these properties, but also the intermediate products of changes taking place in the changing environmental conditions. Among the various processes which lead to the transformation of major importance in the removal of these compounds from the aquatic environment plays biodegradation, a natural process of decomposition. Biodegradation of PAHs is favourable to the environment. Microorganisms (bacteria, algae, fungi) present in soils and sediments, due to the constant contact with the contaminants, and specialized in the transformation of these compounds in the metabolic processes including catabolism processes, in which PAHs are a source of carbon and anabolism where they constitute starting materials for the synthesis of cells. In samples of surface sediments collected from Gdynia Port and dumping site in the framework of project ECODUMP (Application of ecosystem principles for the location and management of offshore dumping sites in SE Baltic region) were analysed PAHs biodegradation products. The presence of them was confirmed in examined dredged material.

P 136

PROCESSES OCCURRING IN DREDGED MATERIAL DEPOSITED ON OFFSHORE DUMPING SITES IN THE SOUTHERN BALTIC SEA

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Keywords: dumping sites, bottom sediments, dredged material, pollution

Dumping Sites are separate areas of the seabed, where dredged sediments from ports may be deposited. Dredging is necessary to prevent flooding, to facilitate sailing, to keep ports vital, to allow all the uses of a given water system. Big part of dredged material is deposited on dumping sites in the sea. Currently, there are more than 20 offshore dumping sites in South-Eastern Baltic Sea. Improperly managing dumping site may pose a threat to the marine environment and ultimately the health and life of marine organisms and humans. The aim of the study was to examine processes occurring in dredged material deposited on Dumping Sites in the Southern Baltic and assessed their impact on the marine environment. Processes occurring during dredging and depositing the sediments are very dynamic (changes in salinity, mechanical mixing during the dredging process, oxygenation). They can cause among others the transition of harmful substances (e.g. metals, PAHs, biogenic substances, etc.) from the sediment to the water column. As a result of deposition small particles of sludge can be moved out of the Dumping Site. To recognize the scale of these processes, the research of physical-chemical, biological, geological in selected Dumping Sites in Poland and Lithuania were carried out. Based on hydrological measurements, model proliferation of the fines suspended in water was developed. Results presented in this material were obtained in the ECODUMP project (Application of ecosystem principles for the location and management of offshore dumping sites in SE Baltic region) - WTPB.02.01.00-72-016/10.

P 137

PATTERN OF SPRING PHYTOPLANKTON BLOOM DEVELOPMENT AND PRIMARY PRODUCTION IN GULF OF RIGA (BALTIC SEA)

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Keywords: Primary production, Phytoplankton, Mesodinium rubrum, Nutrient limitation, Gulf of Riga, Baltic Sea.

Climate changes in the Baltic Sea region have affected the winter and spring time weather, resulting in mild winters with week snow and ice cower on land and the sea. The break of ice cover and spring flooding usually triggers off the beginning of spring phytoplankton bloom. After the mild winters the spring bloom is triggered by nutrients and increasing irradiation. The aim of this study was to follow the development of spring phytoplankton species succession and primary production during frequent sampling campaign using ferry-box mounted on Tallink ferry "Romantica" on the ship route Stockholm-Riga. Manual sampling was preformed once a week in 3 stations corresponding to stations 101A, 119 and 135 of Latvian monitoring from early March until the end of May 2014. Moderate phytoplankton growth was observed since the beginning of March (812 mg m^{-3} of biomass and 6.7 mg m^{-3} of chlorophyll a), fluctuating around these values till the second part of April. Accordingly, the gross primary productivity was low (<0.85 g C $m^{-2}d^{-1}$) and mostly used for community respiration. The maximum of diatom bloom was reached at the end of April reaching the biomass of 3360 mg m-3, followed by increase of dinoflagellates and Mesodinium rubrum. The primary production reached 1.7-3.2 g C $m^{-2}d^{-1}$. However during the development of dinoflagellates and Mesodinium rubrum the phytoplankton biomass still increased till 3360-6370 mg m^{-3} with second increase of primary production (1.7-3.86 g C $m^{-2}d^{-1}$). Depletion of phosphates in the water column terminated the spring bloom of phytoplankton. However the nutrient pulses from the river Daugava continued to increase the nitrate concentration in the river plume waters still at the end of May while the concentrations of phosphates remained low. The mild winters result in prolonged moderate development of spring phytoplankton. Frequent rains caused the pulse-like increase of nutrient concentrations near the river plume, however the bloom conditions were not reached due to phosphorus limitation.

The studies were performed in the framework of LIFE+ MARMONI project (Project Nr. LIFE09 NAT/LV/000238).

P 138

INTERDISCIPLINARY APPROACH FOR SUSTAINABLE COASTAL GOVERNANCE: INDICATOR SYSTEMS

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Keywords: coastal governance, socio-ecological systems, indicator system, climate change

Integrated coastal management studies in Latvia recognize: generally missing governance process cycle and real stakeholders partnership/ownership approaches; one sided (mainly land based) and sector based planning for coastal areas; missing coast as local whole development resource. There should be basically confirmed the need for sustainable **coastal governance** (SCG) **understanding and collaboration** at all sectors, levels, target group dimentions complementary.

The study results refers on construction of coastal municipal indicators and building of **indicator systems** as a immediate necessary tool for SCG. At Saulkrasti municipality indicators system proposal was designed/implemented to be used for supervision of municipal sustainable development strategy. The climate change effects are increasingly impacting both sides of coastal border areas and improving the skills/knowledge of local communities in sustainable usage of nature resources as well as **design/integration of climate change adaptation planning** within municipal sustainable development strategy and medium/short term action plans has been studied at the case of Salacgriva municpality.

Coastal indicators observatory system shall developed for sea-land border area admin territory, characterized by vertical levels complementary integration, respecting coastal area typology, using physical, socio-economical and governance characteristics as for understanding and collaboration for SCG as specific **socio-ecological systems.**

P 139

ACCUMULATION OF BISPHENOL A IN GRAY SEAL *HALICHOERUS GRYPUS* FROM THE GULF THE GDANSK

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Keywords: bisphenol A, endocrine compounds, Baltic Sea, gray seal, blood, fur, milk

Living organisms in the process of evolution developed a number of ways to detoxify and eliminate various chemical compounds. Female giving birth to offspring gives him a load of pollutants thus detoxifying your own body. During breastfeeding female transfers a load of pollutants to their children. Another way to detoxify harmful organisms is the incorporation of the substance in the feathers and removal of toxic substances with the faeces into the environment.

The aim of the study was to determine the accumulation of bisphenol A and ways to detoxify the body of this compound with gray seals inhabiting the salarium. To achieve the objective bisphenol A concentrations were examined in the fur, faeces, milk and blood of adult and young seals from sealarium.

In the fur of adults and seal pups bisphenol A was on measurable level. Based on these concentrations can be concluded that marine mammals have the ability to incorporation of BPA in the fur, which during the shedding season is introduced to the environment of the Baltic Sea. Another secondary source of pollution of the marine ecosystem seals are faeces that contain high concentrations of BPA, extending more than one thousand ng / g. Female milk analysis indicated that breastfeeding promotes the transfer of lipophilic endocrine compounds to the offspring. Moreover, the concentration in the blood indicate that bisphenol A can be transported through the body and ultimately can be accumulated in the organs of the animal.

This research was financed by the National Science Centre and Polish Ministry of Science and Higher Education within Framework of the Project No N N 305 106840.

P 140

ENDOCRINE DISRUPTING COMPOUNDS ON THE LOWEST MARINE TROPHIC LEVEL OF THE GULF OF GDAŃSK (SOUTHERN BALTIC)

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Keywords: endocrine compounds, zooplankton, phytoplankton, bioconcentration

Bisphenol A (BPA), 4- *tert*- octylphenol (OP) and 4- nonylphenol (NP) are classed as dangerous compounds. They belong to Endocrine Disrupting Compounds (EDCs) and may influences on homeostatic, reproduction, growth, digestion, behavior and cancer of organisms.

The aim of our study was to determine the concentration levels of BPA, OP and NP in phyto-, zooplankton and mussels (*Mytilus edulis trossulus*), organisms from the lowest marine food web. Samples were collected from Southern Baltic (Gulf of Gdansk) in 2011-2012 years. In laboratory samples were purified on Oasis HLB (Waters) glass cartridges. The final analysis was performed with the use of HPLC with FL detection. EDC's compounds concentrations in the organisms from the lowest marine food web varied from < 0.8 to 968.3 g^{-1} d.w. Large variability in the concentrations of analyzed compounds depends on the season, location of the station in relation to the inland sources. The highest concentration of BPA, OP and NP were measured in cold seasons, spring and autumn. Near the water purification plant the concentrations of BPA was the higher.

Phyto-, zooplankton and mussels may introduce EDCs on higher trophic levels. Possible bioconcentration of BPA, OP and NP in plankton organisms and mussels from the Gulf of Gdańsk were rather high (BCF values were > 1000) but biomagnification factor (BMF) was lower and not exceed 70.

This research was financed by the National Science Centre and Polish Ministry of Science and Higher Education within Framework of the Project No N N 305 106840.

P 141

MATERNAL TRANSFER OF MERCURY IN BALTIC GREY SEAL (*HALICHOERUS GRYPUS*)

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Keywords: grey seal, maternal transfer, mercury, blood, milk, placenta

The main route of exposure to methylmercury, the most neurotoxic form of mercury, is dietary intake. As top predators, marine mammals accumulate high levels of pollutants. Mammalian females may also pass mercury (inorganic as well as methylated forms) to their offspring across the placenta and during lactation.

This work presents study of 5 mother – pup pairs of Baltic grey seal (*Halichoerus grypus*) living in the sealarium in Hel Marine Station of the Institute of Oceanography, University of Gdańsk. Each pair sample collection period consisted of 5 stages (last month of pregnancy, childbirth, nursing, pup physiological fasting, adaptation to life in the wild, when the pups learn to catch food independently) and lasted about 3 months until the release of pups to the sea. In all samples total and methylmercury concentration (HgTOT, MeHg) were measured using atomic absorption spectrometer AMA 254. Samples of female and pup blood were colected once a week. During lactation also samples of milk were collected. Additionally 5 placentas were analysed. This allowed to determinate amount of mercury introduced to the offspring during fetal life and lactation and invesitigate female's detoxification during birth of offspring and lactation.

P 142

DECREASING THE COPPER LOAD FROM ANTIFOULING PAINTS USED ON LEISURE BOATS TO THE BALTIC SEA ENVIRONMENT: DETERMINING PAINT MINIMUM AMOUNTS OF COPPER FOR ANTIFOULING EFFICACY ON A BALTIC SEA GEOGRAPHICAL SCALE

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Keywords: Antifouling, copper, environment

Some 3 million leisure boats are found in the Baltic Sea countries. The majority of these boats are painted with copper containing paints that release copper into the ambient water in order to prevent the settlement of fouling organisms on the hull. In many cases painting of the hull is performed every year. The amount of copper allowed in antifouling paints vary throughout the Baltic Sea countries; in Sweden approximate 8.5 % (w/w) copper is allowed south of Örskär (Latttitude: 60.52 Longitude: 18.39), whilst in Finland, 35 % (w/w) is allowed along the entire coastline. Surveys performed with Swedish boat owners in the Baltic Sea show that it is not uncommon to find boat owners that paint their boats with a paint containing 30% (w/w) Cu or higher even though it is prohibited. These practices inevitably lead to large amounts of copper leaching from the paint and accumulating in the sediment in marinas and other sites were boats are kept on water during the summer season. Generally, the fouling pressure in the Baltic Sea differs in a north-south gradient with a lower fouling pressure in the north and a quite substantial fouling pressure in the Southern parts, e.g., Kiel area. Hitherto, the antifouling efficacy of antifouling paints containing different amounts of copper throughout the Baltic Sea has not been examined. Thus, finding the copper cut-off concentration in a north-south gradient in the Baltic Sea could provide a basis for guidelines to manufacturers on what maximum amounts of copper allowed to be used in antifouling paints in the Baltic Sea, as well as to competent authorities who approve antifouling products, since copper should not be overused in regard to antifouling efficacy. In order to identify the amount of copper needed for a satisfactory efficacy in antifouling paints, copper was added to a generic paint formulation containing no biocides or heavy metals. Panels were coated with finely-tuned copper concentrations ranging from 1%-11% and were deployed in marinas at 9 different localities (Vaasa, Åbo, Helsinki, Bullandö, Simrishamn, Kiel, Helsingör, Fiskebäck, Strömstad) throughout the Baltic Sea. Preliminary results from this field panel test performed during June to October 2014 show that we can drastically lower the amount of copper leached into the environment by using paints containing less copper without compromising the antifouling efficacy. Our results indicate that a very low eroding paint containing 7% -10% (w/w) copper is, in most cases enough to show very high efficacy against macrofoulers such as barnacles during the full boating season throughout the Baltic Sea.

This project is a part of the CHANGE project funded by the Bonus under the call Viable ecosystems 2012.

P 143

FLUXES OF MERCURY INTO SOUTHERN BALTIC SEA AND ITS POSSSIBLE CHANGES WITH REGARD TO PREDICTED CLIMATE CHANGE

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Keywords: mercury, climate change, extreme events, bioaccumulation

The occurrence of climate change is now indisputable, and its impact on the hydrological cycle more visible. Also the transformation, turn-over and mobility of many substances are changing. The aim of this research was to observe the tendency of possible shift in mercury cycle under the influence of climate change in the coastal zone of a boreal environment.

The study area was situated in the Gulf of Gdansk (southern Baltic). Between 2010 and 2012, samples of water from the Vistula River and from the sea, as well as samples of precipitation, plankton, sediment and benthic biota were collected and analysed according to an accepted methodology. At this time samples of boulder clay from the cliff at Gdynia Orlowo were collected.

Extreme flood on Vistula in 2010 caused 6-time increase of Hg load carried by this river compared to previous years. As a result of Polish cliff erosion almost as much as half of the Vistula load could be introduced to the sea. Preliminary studies indicated that warm winters are responsible for 40-55% rise of mean Hg concentration in plankton and benthic communities. These processes result in an increase of the organic mercury concentration in the first levels of marine food web.

P 144

ECO-EVOLUTIONARY EFFECTS OF NOVEL CYANOPHAGE ON CYANOBACTERIAL COMMUNITY DYNAMICS

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Keywords: eco-evolution, cyanophage, host-parasite interaction, Nodularia spumigena

Research during recent decades has demonstrated that evolutionary change in host parasite interaction can happen rapidly and on the same time scale as ecological processes. The long-standing assumption in ecology that evolutionary change is slow enough to be ignored over the time span of ecological interactions is now demonstrably incorrect. Microbes provide a good tool for studying the eco-evolutionary dynamics due to their short generation times and large population sizes. One class of microorganisms that has attracted a great deal of interest, both from the scientific community and general society, is toxic cyanobacteria. Cyanobacteria, like most organisms, are strongly influenced naturally occurring parasites. In marine environments viruses lyse up to 60% of the cyanobacterial biomass every day. Remarkably, some studies have demonstrated that viruses infecting cyanobacteria can even contribute to the termination of the cyanobacterial blooms. In principle this shows that there is scope for biological control of cyanobacterial blooms, using their natural occurring parasites. Parasites, besides being a major factor driving ecological dynamics of cyanobacterial populations, can also generate a huge selective force which would drive eco-evolutionary dynamics, e.g. through the emergence of resistant genotypes. In here we tested the ecological and evolutionary roles of novel cyanophage 2/AV2 on bloom forming toxic Baltic Sea cyanobacteria Nodularia spumigena. One key characteristic of our host cyanobacteria is that it can fix atmospheric nitrogen giving it a competitive advantage over non-nitrogen fixing phytoplankton. However when infected by lytic cyanophages this competitive advantage can turn to disadvantage. Viruses, which lyse the susceptible host Nodularia cells, can release nitrogen bound to host cells to the environment radically altering competitive landscape. These dynamics are altered if host population becomes resistant to the viral infection. In here we demonstrate that cyanophages can be one of the key groups in aquatic food webs and we also link eco-evolutionary host-parasites dynamics with biogeochemical cycles and community dynamics.

P 145

GEOLOGY DATA FROM LATVIAN OFFSHORE AREA - EUROPEAN MARINE OBSERVATION AND DATA NETWORK (EMODNET) GEOLOGY PROJECT

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Keywords: Emodnet, marine data, compilation, geology, maps

Emodnet-Geology project started in October 2013 and will end in October 2016. The aim of the EMODnet-Geology project is to bring together and harmonise fragmented marine data products of the regional seas of Europe and make them available through a single web portal. The target scale for geological information is 1:250 000. State Ltd "Latvian Environment, Geology and Meteorology Centre" (LEGMC) is one of the project partners who provides marine geological information from Latvia. Geology data from Latvian territory of the Baltic sea that will be submitted to project are following: sea-bed substrate data, sea-floor geology data (pre-Quaternary and Quaternary geology) and mineral occurrences. To compile the sea-bed substrate map the information based on bottom sediment maps were used. Sea-bottom sediment maps were prepared as a result of geological mapping (1984-1992) in the Latvian territorial waters at the scale 1:200 000. These maps have been generalized into a target scale (1:250 000) and the former Soviet Union sea-bed substrate data classification have been translated into Emodnet-geology substrate classification system. For the preparation of the sea-floor geology map LEGMC have used information based on pre-Quaternary and Quaternary geological maps of Latvia (1992-1997) at the scale 1:200 000. National geologic unit descriptions used in maps have been transformed according to the INSPIRE geology data specifications. Marine mineral deposits were indicated from the maps of mineral resources that were prepared as a result of geological mapping from 1970 to 1996. The areas of the occurrence of ferro-manganese nodules, placers of titan – zircon minerals and aggregate (boulders, claystones, sand and sand-gravel) resource areas were digitalized.

P 146

SUSTAINABLE SHIPPING AND ENVIRONMENT OF THE BALTIC SEA REGION (SHEBA) - NEW BONUS RESEARCH PROJECT

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Keywords: Baltic Sea shipping, Integrated assessment, Good Environmental Status Indicators, Numerical Modelling, Air pollution, Water pollution, Fates and effects of pollutants

SHEBA will analyse the drivers for shipping, obtain the present and future traffic volumes and calculate a set of scenarios which will then feed into calculations of emissions to water, to air, and of underwater noise using and extending the currently most advanced emission model based on Automatic Identification System (AIS) ship movement data. Atmospheric, oceanic and noise propagation models in combination with ecotoxicology studies will then be used to assess spatio-temporal distributions, fates and effects of these stressors in the Baltic Sea region. The project will assess the impact of different pollutants to the water quality indicators of the MSFD and WFD and to the air quality indicators. Further, the project will provide an integrated assessment of policy options to mitigate pressures linked to shipping, quantifying as far as possible anticipated changes in ecosystem services compared to an established baseline. This will include an analysis of trade-offs between options as well as synergies, and the marginal changes in costs and benefits of options to reduce environmental pressures from shipping and support the achievement of Good Environmental Status as prescribed by the MSFD. SHEBA is supported by a wide group of stakeholders, including harbours, shipping industry and authorities, who will be consulted about the input of data, feedback and results of the project.

P 147

EXTERNAL TOTAL ALKALINITY LOADS VERSUS INTERNAL GENERATION: THE INFLUENCE OF NONRIVERINE ALKALINITY SOURCES IN THE BALTIC SEA

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Keywords: Riverine TA loads to the Baltic Sea are presented; External loads alone cannot explain observed TA; Internal TA generation similar to river loads in magnitude

River loads of total alkalinity (TA) were recently compiled for the various Baltic Sea sub-basins. Data were based on monthly measurements in 82 rivers that represent 85% of the total runoff. Further, the TA source related to North Sea water inflows is fairly well known (approximately linear TA-S relation in inflowing water). Model calculations demonstrate that these external sources are not by far sufficient to reproduce observed TA concentrations in the Baltic Sea; it is thus implied that there must be a considerable internal TA generation in the system. The internal sources are at this point not known in detail, but can be coupled to processes such as denitrification, burial of reduced sulfur (e.g. pyrite and organically bound sulfur), and silicate weathering in anoxic sediments. Budget calculations indicate that the total nonriverine TA source presently amounts to approximately 340 Gmol y^{-1}. This source is of the same order of magnitude as the average total riverine TA load to the system (470 Gmol y^{-1}). Internal TA generation enhances the ability to buffer atmospheric CO_2; our calculations imply that the present-day TA generation in the Baltic Sea increases CO_2 absorption in the system by on average almost 10 g C m^{-2} y^{-1}. Thus, internal TA sources in the Baltic - and other coastal seas - generate a significant carbon sink, mitigating CO_2 evasions from coastal systems.

P 148

SURVIVAL AND GROWTH OF GLASS AND ON-GROWN YOUNG EELS UNDER NATURAL FOOD CONDITIONS

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Keywords: Anguilla anguilla, on-grown eels, glass eels, stocking, survival rate, specific growth rate.

Stock of European eel *Anguilla anguilla* is in steep decline since the 1980s. Stocking of glass eels to establish or enhance local eel populations was common practise in Europe for many decades. Stock decline and high demand for glass eels on the Asian market resulted in the increase of eel restocking costs in Europe. Therefore, as it is broadly believed in better survival and faster growth rates of stocked on-grown eels, the practise to on-grow glass eels became quite common. However, some evidences of field surveys suggest the opposite. The aim of this experimental study was to test survival and growth of glass and on-grown eels under conditions of natural food (*Chironomus spp*. larvae). In the run of 30–day long indoor experiment glass and on-grown eels demonstrated significant differences in survival and specific growth rate (SGR). Three groups were used for the experiment: glass eels and two groups of young eels on-grown for different periods in aquaculture. Glass eels demonstrated 100% survival rate in contrast to 87% and 84% survival of eels on-grown in aquaculture for 42 and 196 days accordingly. SGR of glass eels was higher (0.77) comparing to the SGR of eels on-grown for 42 days (0.51) and for 196 days (0.01). The results of the study support hypothesis of possible poorer survival and growth of eels on-grown in aquaculture after their release to the wild. Weak ability of some farm-cultured eels to switch their diet to natural food might be the reason of the phenomena.

P 149

SEASONAL DYNAMICS OF DIET COMPOSITION OF PELAGIC FISH SPECIES IN WESTERN GOTLAND BASIN

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Keywords: Kalmarsound, three-spined stickleback, sprat, herring, feeding.

In the western Baltic Sea populations of three-spined sticklebacks (Gasterosteus aculeatus) are increasing exponentially and evidence of the impact of sticklebacks on the ecosystem structure and functioning are now accumulating. With this study we aim to elucidate the functional role of sticklebacks in the Baltic Sea, with particular emphasis on food web interactions. Diet of three pelagic fish species: three-spined stickleback, sprat (Sprattus sprattus) and herring (Clupea harengus) in Western Gotland Basin (Kalmarsound) was examined in relation to seasonality (2009 – 2011 April -October). In spring, all fish fed almost exclusively on calanoid copepods, however, on different species. In summertime the copepod Eurytemora affinis was the most important prey for all fish species, while cladocerans (Podon sp. and Bosmina sp.) made a considerable portion only in sticklebacks' diet. The largest proportion of cladocerans in fish diets was in late autumn, with Bosmina dominating. Results suggests potential competition between pelagic fish species, although in different intensity depending on the season.

P 150

THE LONG TERM CHANGES OF HYDROLOGICAL REGIME IN LATVIA'S COASTAL WATERS

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Keywords: sea level, ice period, water temperature

The hydrological regime is analysed by sea level observations data starting from the end of 19th century, ice period and water temperature data (1945-2010) for the coastal stations. The sea level is characterized by decrease from January to May and increase in June, July. The sharpest rise and falls are evident in autumn and winter. Annual mean sea levels were gradually rising over the observation period. The rate of the average sea level rise is estimated about 0.3-0.5 mm/year on the coast of the Baltic Sea and 2 mm/year in the southern part of Gulf of Riga. The longest ice season is observed in the north part of the Gulf of Riga. The ice season has significantly decreased in the longer period, but during the past decade there still have been some winters with significant ice cover over the coastal waters of Latvia. The total number of days with ice cover for the last 10 years remains rather high – from 452-491 days in the coastline of the Baltic Sea up to 677-757 days in the Gulf of Riga. According to the long-term data, the sea water temperatures have increased by 0.7-0.8°C near the Baltic Sea coast and up to 1.1°C in Gulf of Riga. The increasing tendency is very well pronounced during winter, spring and for southern part of Gulf of Riga also in summer period. The increasing tendency of minimum water temperature was found for spring and autumn seasons and maximum of seawater temperature for winter and summer. However the changes of extreme water temperature were not significant.

P 151

HEAVY METALS IN FISHES, BIVALVES AND PLANKTON OF THE BALTIC SEA AND GULF OF RIGA – DEVELOPMENT OF INDICATORS OF PRIORITY SUBSTANCES FOR THE MSFD

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Keywords: perch, herring, cod, bivalves, limit values

Intensification of global metal mining industry, recycling and waste creates huge metal emissions in environment every year. It causes wide biological availability of toxic metals and accumulation in food chain with following harmful effects for environment and human health. Together with fish toxic metals enter food market. It is well known that seafood is high valued source of omega 3 fatty acids. On the other hand according to World Health Organization the intake limit for humans should not exceed 1.6 ug Hg and 7 ug Cd per kg of body weight per week. What is balance between toxicity and health?

The aim of study (launched in April 2015) is to determine chemical quality status of Latvian coastal and offshore waters based on metal accumulation and distribution in local commercial fish species and bivalves as well as plankton – the base of fish diet. The second aim of study is to compare the environmental quality standard values with values set in food and health legislation.

Preliminary observations of metal concentrations in fish perch (*Perca fluviatilis),* herring (*Clupea harrengus*), cod (*Gadus morhua*) and bivalve *Macoma balthica* tissues gave the puzzle over toxicant level by species, age and annual distribution changes.

Present study could be an incentive for wider collaboration between the Baltic Sea countries on local commercial fish species.

Project Nr. 1-08/554/2014 "Development of indicators of priority substances for the Marine Strategy Framework Directive – Heavy metals" is supported by Administration of Latvian Environmental Protection Fund.

WORKSHOPS

W1

DEVELOPMENT AND IMPLEMENTATION OF NOVEL INDICATORS FOR BALTIC SEA MONITORING - A ROUND-TABLE DISCUSSION

Chaired by
Lasse Riemann, University of Copenhagen, Matthias Labrenz*
and
Christin Bennke, Leibniz Institute for Baltic Sea Research Warnemünde.

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The EU Marine Strategy Framework Directive (MSFD; 2008/56/EC) puts new demands on the Member States (MSs) to monitor and assess the state of the Baltic Sea. The MSFD focuses on implementing an ecosystem-based approach to management of the human activities and pressures affecting the marine environment. With the goal of reaching Good Environmental Status (GES) in European marine waters by year 2020, MSs are guided by the 11 thematic areas (descriptors) defined in the MSFD as well as a set of criteria and proposed indicators to assess the state of the Sea (GES; 2010/477/EU). Continuous optimization and development of new indicators, e.g. genetically based, should to some extent be guided by scientific advances improving the understanding of Baltic Sea ecology. There is, however, no doubt that development and subsequent political acceptance and practical implementation of novel indicators is often hampered by the inability of researchers to understand and maneuver in the decision-making system. To accommodate this, the round-table discussion will contain a brief explanation of the decision-making process, followed by an open discussion of indicators, the need for new ones, and a discussion of the long road from the initial idea of a novel indicator to political decision and practical implementation in Baltic Sea monitoring.

Speakers:

Lena Avellan, HELCOM: "HELCOM core indicators on Baltic Sea environmental status"

Lasse Riemann, University of Copenhagen: "Development of molecular microbial indicators: the BONUS project BLUEPRINT"

Christin Bennke, IOW Warnemunde: "Guiding a molecular indicator into practical operability"

W2

THE BALTIC SEA LITHO- AND ALLOSTRATIGRAPHY WORKSHOP

Chaired by Joonas J. Virtasalo, Geological Survey of Finland (GTK), Finland

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Keywords: allostratigraphy, lithostratigraphy, sequence stratigraphy, Pleistocene, Holocene, Baltic Sea

This workshop invites everybody who is interested in novel approaches to the stratigraphic classification and correlation of Baltic Sea sediments. The plan is to discuss how sedimentologic and seismoacoustic studies could be carried out in different areas of the Baltic Sea in order to identify local and regionally significant unconformities that could be useful for local (allo)stratigraphic classification and regional correlation. Such studies are so far published for SW Finnish coastal areas and the Gulf of Riga. Studies on land, including e.g. pit exposure and ground-penetrating radar studies would also be important to facilitate stratigraphic correlation across the waterline. There is an obvious link to IODP materials and sediment units older than the last deglaciation. We will discuss what kind of data and samples would be needed (e.g. sediment cores, seismoacoustic profiles) for this kind of work, and what should be looked for. Required data may already be available for some well-studied areas. We may even discuss producing a thematic collection of papers if we get that far.

For background; recent studies criticize the conventional practice of sediment classification according to the Baltic Sea stages (Baltic Ice Lake, Yoldia Sea, Ancylus Lake, Litorina Sea) for being ambiguous and not particularly useful for regional correlation (cf. Virtasalo et al., 2014, Boreas 43, 924–938). Purely sedimentologic features have been recommended as the primary stratigraphic classification criteria because they do not require the paleoenvironmental inferences of salinity and water level that are inherent in the conventional classification practice. Regional allostratigraphic units, identified by their bounding unconformities, are explainable by the current (glacial) sequence stratigraphic models and compatible with international guidelines (International Stratigraphic Guide, North American Stratigraphic Code), facilitating communication to the wider scientific community and comparison to other similar basins.

W3

WORKSHOP ON TECHNOLOGY TRANSFER IN MARINE SCIENCE. SCIENCE'S NEEDS AND MARKET'S MEANS – DO THEY FIT?

Organized by Leibniz Institute for Baltic Sea Research Warnemünde, Germany

www.io-warnemuende.de

Can market´s means meet science´s needs (and vice versa)? We will discuss this question during the first Baltic Technology Transfer workshop, organized by the Leibniz Institute for Baltic Sea Research Warnemünde under the umbrella of the Baltic Sea Science Congress BSSC in Riga. Speakers from marine research institutes from the Baltic Sea region will present how science pulls technological development towards innovation: They demand new, more exact, more stable measuring and sampling devices with higher resolution, working more and more autonomously or even triggered by events. For the suppliers and manufacturers only adequate sales markets justify the high costs of development of new instruments but the local niche markets are small. So how can marine science be provided with the needed technology? To bring scientists and suppliers from the whole Baltic region together gives scientists the chance to clarify their needs and can help the suppliers to broaden the market for new developments in marine sensing and sampling. Even joint development projects where science and manufacturers work together could be initiated during this occasion. Throughout the whole week engineers, suppliers and manufacturers will be given the chance to present new developments, prototypes or even new products of the shelf at an exhibition.

INDEX

Abel , Dirk	O 88
Aftanas , Barbara	P 135, P 136
Aigars , Juris	P 151
Alanen , Ulla	O 25
Alari , Victor	O 41, O 45, O 47, P 46
Alberte , Madara	O 107
Aleksandrov , Sergey	O 21, P 110
Alenius , Pekka	O 61, O 63, P 109
Alexanderson , Helena	O 80
Anders , Sarah	O 101
Andersen , Tom	P 118
Anderson , Agnes	O 28
Andersson , Anders	O 92, P 6
Andrén , Thomas	O 27, O 43, O 80, P 17
Andrén , Elinor	O 43, P 17
Anstusevitch, alexander	L 4
Aps, Robert	L 4
Ardura , Alba	O 12
Arula , Timo	O 47, O 56
Arz , Helge W.	O 18
Atamanchuk , Dariia	P 49
Attila , Jenni	P 119
Avotniece , Zanita	P 150
Axell , Lars	P 12
Bacevičius , Egidijus	P 104
Bagdanavičiūtė , Ingrida	O 33, O 105, P 101
Bagočius , Donatas	P 100
Bąk , Małgorzata	P 129
Bake , Marite Arija	P 87, P 93
Balciunas , Arunas	P 44
Bārda , Ieva	O 107P 137
Barisevičiūtė , Rūta	P 92
Barkhordarian, Armineh	L 1
Bartl , Ines	P 116
Bartoli , Marco	O 103, O 104
Bastrop , Ralf	P 48
Baude , Regina	O 69
Baydova , Tatyana	P 84
Bełdowska , Magdalena	P 143
Bennke , Christin	O 92, W 1
Berezina , Nadezhda	O 66, O 86, P 111
Bick , Andreas	P 48
Bighiu , Maria	P 18
Bighiu , Maria A.	P 41
Bińczewska , Anna	P 129

Bite , Ivita	P 151
Bitinas , Albertas	O 28, O 29, P 123
Björkqvist , Jan-Victor	O 62
Blankett , Penina	O 98
Blenckner , Thorsten	O 39
Blomqvist , Mats	O 50
Bobykina , Valentina	P 81
Boikova , Elmira	P 133
Bonsdorff , Erik	O 9, O 24, O 49
Borecka , Anna	P 89
Borisova , Olga	P 117
Borówka , Ryszard	P 129
Borzenkova , Irena	P 117
Boteler , Benjamin	P 146
Brake , Marie	O 29
Brenner , Matthias	O 69
Briede , Agrita	P 150
Broeg , Katja	O 69
Brown , Elliot	O 10
Bruun , Jan-Erik	P 109
Brūniņa , Līga	O 28, O 29
Brzana , Radosław	P 91
Buczko , Uwe	O 85, P 107
Bučas , Martynas	P 38, P 75
Budanov , Leonid	O 34
Bukaveckas , Paul A.	O 32
Bukovska , Ieva	P 145
Bunke , Dennis	O 18
Burchard , Hans Prof.	O 74
Burska , Dorota	P 89
Buschmann , Fred	O 77, P 102, P 105, P 115
Buynevich , Ilya	O 28, O 29, P 34, P 123
Calkiewicz , Joanna	P 13
Carstensen , Jacob	O 50
Charvet , Sophie	P 6
Chubarenko , Irina	O 7, P 8
Chubarenko , Boris	O 75, P 62, P 81, P 88
Chuseve , Romualda	P 33
Coloma , Sebastian	P 144
Curran , H. Allen	O 29
Čerkasova , Natalja	P 98, P 131
Dąbrowska , Anna Halina	P 86, P 89, P 91
Dahlgren Straat , Kim	O 60
Dahlström Sjögren , Mia	P 142
Dailide , Remigijus	P 23, P 71

Dailidiene , Inga	P 66, P 3, P 32, P 40, P 71, P 99, P 112, P 113
Dainys , Justas	P 148, P 149
Damušytė , Aldona	O 28, O 29, P 123
Darecki , Mirosław	P 96
Daunys , Darius	O 105, P 33
Davuliene , Lina	P 66, P 40
Delpeche-Ellmann , Nicole	O 31
Dembska , Grazyna	P 134, P 135, P 136
Deng , Junjie	O 90
Denisov , Vitalij	P 131
Didenkulova , Ira	O 36, O 40, P 79
Dietze , Heiner	O 8, P 9, P 10
Dinesen , Grete E.	O 10
Diushkov , Nikolay	P 110
Dobosz , Sławomir	P 129
Dobrotin , Nikita	O 28, O 29, P 123
Dobrzycka-Krahel , Aldona	P 52
Domnin , Dmitriy	P 62
Drozdowska , Violetta	P 51
Dubravin , Vladimir	P 20
Dučinskas , Kęstutis	P 3
Dudzinska-Nowak , Joanna	O 90
Eelsalu , Maris	O 67, O 68, P 72, P 76, P 85, P 108, P 113
Egekvist , Josefine	O 10
Eggert , Anja	O 5
Ekebom , Jan	O 98
Eklund , Britta	O 6, P 18, P 22, P 41
Elfwing , Tina	O 39
Elken , Jüri	O 17, O 37, O 65, O 77
Elliott, Mike	L 2
Emelyanov , Emelyan M.	O 2
Eremina , Tatjana	L 4, O 30, P 29, P 90, P 126
Erichsen , Anders Christian	O 23
Eriksson Wiklund , Ann-Kristin	P 41
Erm , Ants	P 102, P 105
Ernsteins , Raimonds	P 138
Ershova , Alexandra	L 4, P 90
Erturk , Ali	O 81, P 98, P 131
Esiukova , Elena	P 8
Ezhova , Elena	L 6, P 57
Falkowska , Lucyna	P 139, P 140, P 141, P 143
Fedorovič , Julija	P 34, P 80
Feistel , Rainer Dr.	O 74
Feldens , Peter	O 101
Felgar , Christina	O 29

Ferrarin , Christian	P 99
Fisch , Kathrin	P 19
Floth-Peterson , Mareike	O 42
Forster , Stefan	P 116
Fridell , Erik	P 146
Friedland , Rene	O 3, P 4
Galer-Tatarowicz , Katarzyna	P 134, P 135, P 136
Gammal , Johanna	O 49
Garcia-Gorriz , Elisa	O 38
Garcia-Vazquez , Eva	O 12
Gasiūnaitė , Zita R.	O 32, P 45, P 92
Getzlaff , Klaus	O 26
Giczewska , Magdalena	P 86
Gilek , Michael	O 14
Giordani , Gianmarco	O 104
Giudici , Andrea	P 121
Glatzel , Stephan	O 85, P 107
Glockzin , Michael	O 58
Gnivecki , Perry	O 29
Golenko , Mariya N.	O 2, P 24
Golenko , Nikolay N.	O 2, P 24
Golmanova , Alexandra	P 110
Golubkov , Sergei	L 4, O 86
Golubkov , Mikhail	O 86
Gorbunova , Julia	P 62
Grajewska , Agnieszka	P 141, P 143
Grashorn , Sebastian	O 20
Gräwe , Ulf Dr.	O 74
Grayek , Sebastian	O 51, O 57
Gregorauskienė , Virgilija	P 123
Grigoriev , Andrey	O 34, P 103
Grinienė , Evelina	P 78
Groeneveld , Jeroen	O 80
Groh , Andreas	O 90
Groll , Nikolaus	O 93
Grünthal , Erkko	P 72
Gulbinskas , Saulius	O 33
Gülzow , Wanda	O 58
Gusev , Andrey	P 69
Gustafsson , Bo	O 46, P 147
Gustafsson , Erik	P 147
Gutowska , Dorota	P 51
Gyraitė , Greta	P 75
Habicht , Hando-Laur	O 106
Halpern , Ben	O 39

Hämäläinen , Jyrki	O 98, P 25
Hammer , Karoline	P 15
Hang , Tiit	O 102
Hanna , Raig	O 106
Hansen , Frank Ivan	O 10
Harff , Jan	O 90
Hassellöv , Ida-Maja	P 146
Haule , Kamila	P 96
Heinrich , Christoph	O 101, P 122
Hellemann , Dana	P 14
Hemanth , V.V.S.S.R.	O 36
Herrero-Bervera , Emilio	O 80
Hietanen , Susanna	O 4, P 14
Hiltunen , Teppo	P 144
Höflich , Katharina	O 26, O 40
Holmqvist , Albin	P 142
Humborg , Christoph	P 147
Hummel, Herman	L 3
Hyttinen , Outi	O 27, O 34
Hyytiäinen , Kari	O 16
Iho , Antti	O 16
Ikauniece , Anda	P 59
Inácio , Miguel	P 61
Jaagus , Jaak	O 47
Jaanus , Andres	P 55
Jakobs , Gunnar	O 58
Jakubaviciute , Egle	P 148, P 149
Jakubowska , Magdalena	P 16, P 31
Jalkanen , Jukka-Pekka	P 146
Janas , Urszula	P 86, P 89, P 91
Jankowska , Emilia	P 63, P 65
Jankowska , Katarzyna	P 65
Jansen , Eystein	P 129
Jansone , Agnese	P 145
Jansons , Mintauts	P 151
Janßen , Holger	O 14
Jarmalavičius , Darius	P 34, P 37, P 80
Järnström , Marie	O 49
Järvet , Arvo	O 47
Jay , Stephen	O 14
Jędruch , Agnieszka	P 143
Jensen , Jørn Bo	O 80
Jensen , Kathe	L 6
Joensuu , Mari	O 4
Johansson , Milla	O 19, O 52, P 60

Johnson , Sean	O 80
Jokinen , Henri	O 9
Jokinen , Sami	O 13
Jost , Guenther	P 6
Jörgensen, Kirsten	L 4
Julge , Kalev	P 72
Junttila , Sofia	P 119
Juodeikytė , Monika	P 78
Jurasinski , Gerald	P 107
Kaas , Hanne	O 23
Kahma , Kimmo K.	O 19, O 52, O 62, P 60
Kallasvuo , Meri	O 73, O 98
Kallio , Kari	P 119
Kalnina , Laimdota	P 117
Kalvāns , Andis	O 102
Kämäräinen , Matti	O 19
Kaniak , Aleksandra	P 129
Kapustina , Mariia	P 20
Kargol , Jadwiga	P 135, P 136
Karjalainen , Miina	O 48
Karlson , Bengt	P 55
Karmanov , Konstantin	P 81
Karnauskaite , Donalda	P 58, P 97
Karstens , Svenja	O 85
Karstens , Svenja	P 107
Kasiulis , Egidijus	P 112
Kaskela , Anu M.	L 4, O 25
Kaskela , Anu	O 48, O 73
Kataržytė , Marija	P 75
Kataržytė , Marija	P 98
Kaulins , Janis	P 138
Kauppinen , Olli-Kalle	P 56
Kedzior , Stine	O 58
Kelpšaitė , Loreta	O 33, P 32, P 35, P 40, P 101
Kendzierska , Halina	P 86, P 89, P 91
Kenzler , Michael	O 80
Kholodkevich , Sergey	P 111, P 130
Khozyaykin , Anatoly	P 95
Kikas , Villu	O 89
Kirk Sørensen , Thomas	O 10
Kirka , Mindaugas	P 148, P 149
Kisand , Veljo	O 35
Kisieliene , Dalia	P 117
Klais , Riina	P 59
Klenke , Thomas	O 14

Kłostowska , Żaneta	P 128
Kļaviņš , Māris	P 74, P 150
Koch , Wolfgang	O 20
Kocheshkova , Olga	P 57
Kock Rasmussen , Erik	O 64
Koff , Tiiu	P 117
Kolesova , Natalja	P 130
Kondratyev, Sergey	L 4
Koniecko , Iga	P 139, P 140
Kont , Are	O 47
Koponen , Sampsa	P 119
Korneev , Oleg	L 4, P 109
Koskelainen , Meri	O 98, P 119
Kostamo, Kirsi	L 4
Kotilainen , Aarno T.	L 4, O 13, O 22, O 25, O 27, O 34, O 48, P 25
Kotta , Jonne	O 47, O 79, P 48
Kotta , Ilmar	O 79, P 48
Kõuts , Mariliis	O 15
Kõuts , Tarmo	P 36, P 49
Kovaleva , Olga	O 34, O 75, P 27, P 34, P 85, P 88, P 108
Kovanen , Janne	P 114
Kozlov , Igor	P 23, P 66, P 71, P 112
Krause-Jensen , Dorte	O 50
Krężel , Adam	O 94
Kriiska , Aivar	O 106
Krüger , Siegfried	L 5, P 6
Krūze , Ēriks	P 124
Krupasheva , Tatiana	P 84
Kudrenickis , Ivars	P 138
Kujala, Pentti	L 4
Kulikov , Evgueni	P 42, P 47
Kulikova , Irina	P 133
Kulinski , Karol	P 15
Kull , Ain	O 47
Kurakin , Anton	P 130
Kurvinen , Lasse	O 98
Kuss , Joachim	O 91
Kuznetsov , Denis	P 117
Kuznetsova , Tatiana	P 130
Kybrancienė , Raimonda	P 38
Laanemets , Jaan	O 47, O 65, O 77, P 39, P 115
Labrenz , Matthias	O 92, P 6
Labuce , Astra	O 107, P 106
Labucis , Atis	O 107 P 137
Lagemaa , Priidik	O 68

Lagerström , Maria	P 22
Lai , Derrick	O 85
Laine , Ari	O 73
Lainela , Silvie	P 55
Landquist , Hanna	P 36
Lange , Evgenia	P 57, P 77, P 83, P 90
Lapinskis , Jānis	O 87
Lappalainen , Juho	P 119
Lappo, Andrey	L 4
Larsen , Trine Cecilie	O 23
Łęczyński , Leszek	P 128
Lehmann , Andreas	O 17, O 26, O 40
Lehtiniemi , Maiju	L 6, P 59
Lehtonen, Kari	L 4
Leijala , Ulpu	O 52, P 60
Leinonen , Katri	O 52
Leipe , Thomas	O 18
Lemdahl , Geoffrey	P 117
Lesutienė , Jūratė	O 32, P 78, P 92
Liashenko , Oksana	P 83
Liblik , Taavi	O 76, O 77
Lignell , Risto	P 53
Lilover , Madis-Jaak	O 37
Lipka , Marko	O 78
Lips , Urmas	L 4, O 55, O 65, O 76, O 77, O 82, O 89, P 109, P 130
Lips , Inga	L 4, O 77, O 89
Liskow , Iris	P 116
Lizuma , Lita	P 150
Lloyd , Gwen	O 29
Lobchuk , Olga	P 73
Loeptien , Ulrike	O 8, P 9, P 10, P 12
Ložys , Linas	O 32, P 148, P 149
Lubiene , Irma	O 103, O 104
Luhtala , Hanna	O 53, P 70
Łukawska-Matuszewska, Katarzyna	P 89
Lundgren , Lennart	P 18
Machuta , Magdalena	P 89
Macias , Diego	O 38
Majchrowski , Roman	P 127
Mäkinen, Anita	L 4
Makuch , Przemysław	P 51
Maljutenko , Ilja	O 15, O 44, O 54, P 105
Männik , Aarne	O 47
Marcinkowski , Tomasz	P 136
Margonski , Piotr	P 13, P 59

Markuszewski , Piotr	P 51
Marszewska , Lena	P 21, P 43
Martin , Georg	L 4, O 96
Martinsone , Zanna	P 87, P 93
Matthias , Volker	P 146
Mattila , Johanna	O 9
Mattila , Antti	O 35
Maximov , Alexey	O 30, P 29
Maximova , Olga	P 83
Medvedev , Igor	P 42, P 47
Meerits , Aet	P 105
Meese , Michael	O 93
Meier , H.E.Markus	O 72, P 94
Mendas , Zrinka	O 95
Mėžinė , Jovita	O 81, P 98, P 99
Michalek , Monika	P 136
Michel , Loïc	P 63
Middelboe , Anne-Lise	O 64
Miettunen , Elina	P 53
Mingėlaitė , Toma	P 66, P 112, P 113
Moehlenberg , Flemming	O 23
Mohrholz , Volker	L 5, O 74
Moldanova , Jana	P 146
Molodkov , Anatoly	O 28
Morkūnas , Julius	P 92
Morkūnė , Rasa	P 92, P 104
Moros , Matthias	O 18, P 129
Mörth , Carl-Magnus	O 60, P 147
Morys , Claudia	O 18
Müller-Karulis , Bärbel	O 46
Muru , Merle	O 106
Mustamäki , Noora	O 9
Myrberg , Kai	L 4, O 17, O 26, P 109
Narščius , Aleksas	L 6
Naumann , Michael	L 5, O 74
Naumenko , Elena	O 100
Nausch , Günther	L 5, O 74
Neevin , Igor	O 48, P 103
Nekrasov , Maxim A.	O 2
Neumann , Thomas	O 3, O 11, P 4, P 7
Norbäck Ivarsson , Lena	O 43, P 17
Norkko , Alf	O 4, O 49, O 97
Norling , Matz	P 22
Normant , Monika	L 6, P 16, P 31, P 43
Nurkse , Kristiina	O 79

Nygård , Henrik	P 33
Obrochta , Stephen	O 27
Odegova , Natalya	P 84
Ogorodnikova , Vera A.	P 64
Ojaveer , Henn	L 6, O 47, O 56, O 79, P 59
Oksanen , Juha	P 114
Olenin , Sergej	L 6
Olsson , Jens	P 149
Omstedt , Anders	O 83
Orav-Kotta , Helen	O 79
Orlikowska , Anna	P 19
Orlova , Marina	L 4, O 48
Orviku , Kaarel	O 28
Ossowski , Tadeusz	P 128
Pakszys , Paulina	P 51
Paredne , Inguna	P 138
Park Boush , Lisa	O 29
Parnell , Kevin E.	P 82
Pärnoja , Merli	O 79
Pärt , Siim	P 36, P 49
Passchier , Sandra	O 80
Paszkuta , Marcin	O 94
Pawliczka , Iwona	P 141
Pārpuce , Santa	P 151
Pedchenko , Andrey	L 4, O 71
Pelinovsky , Efim	P 79
Pellikka , Hilkka	O 52, P 60
Pempkowiak , Janusz	P 30
Perner , Kerstin	P 129
Pērkons., Viktors	O 107, P 124
Petelski , Tomasz	P 51
Petkuvienė , Jolita	O 104, P 75
Pettersson , Heidi	O 4, O 62
Pickett , Wesley	P 123
Piepho , Maike	O 99, P 132
Pilditch , Conrad A.	O 4
Pilkaitytė , Renata	O 32, P 45
Pindsoo , Katri	O 59, O 68, O 70, P 76, P 113
Piskozub , Jacek	P 51
Pitkänen, Heikki,	L 4
Poikāne , Rita	P 151
Põllumäe , Arno	P 59
Polovodova Asteman , Irina	P 129
Porshnov , Dmitry	P 74
Post , Piia	O 26

Post , Triine	O 106
Prien , Ralf	O 42
Pryputniewicz-Flis , Dorota	P 89
Punys , Petras	P 112
Pupienis , Donatas	O 28, O 29, P 34, P 37, P 80, P 123
Purina , Ingrida	P 137
Puro , Helena	O 48
Pūtys , Žilvinas	O 32
Quante , Markus	P 146
Quintana Krupinski , Nadine	O 80
Raag , Laura	P 2
Raateoja , Mika	L 4, P 109
Rabinovich , Alexander	P 42
Raczyński , Michał	P 52
Radtke , Hagen	P 4, P 7
Raid , Tiit	O 56
Rak , Daniel	P 11
Rästas , Henri	O 41
Raubienė , Rūta	P 45
Raudsepp , Urmas	O 15, O 41, O 44, O 47, O 54, O 77
Razinkovas-Baziukas , Arturas	O 81, O 103, P 104
Reckermann , Marcus	O 83
Refsgaard , Jens Christian	P 67
Rehder , Gregor	O 58, O 78
Reihan , Alvina	O 47
Reimers , Hans-Christian	P 122
Repina , Olga	P 84
Ribaudo , Marc	O 16
Riemann , Lasse	O 92, P 6, W 1
Rikka , Sander	P 46
Rinne , Henna	O 98
Risebrobakken , Bjørg	P 129
Rockström , Johan	O 39
Rodin , Artem	P 79, P 82
Rohde Krossa , Veronika	O 101
Romanovich , Svetlana	P 125
Ronkainen , Minna	O 48
Rõõm , Rein	O 47
Roots , Ott	P 102
Ropponen , Janne	P 53
Rosentau , Alar	O 106
Rostin , Liis	O 96
Rousi , Heta	O 48
Rubene , Gunta	P 59
Rudinskaya , Liliya	P 69

Rukšėnienė , Viktorija	P 3, P 32
Rünk , Nelli	O 89
Ruuskanen , Ari	P 119
Ryabchenko , Vladimir	P 29
Ryabchuk , Daria	L4, O22, O27, O34, O48, O75, P34, P88, P103, P108
Saarinen , Timo	O 13
Samuiloviene , Aurelija	O 12
Saniewska , Dominika	P 141, P 143
Sapelko , Tatyana	P 117
Sapota , Grazyna	P 134, P 135, P 136
Sarjakoski , Tapani	P 114
Särkkä , Jani	O 19
Savarese , Michael	O 29
Savchuk , Oleg	O 46, O 84
Scheinin , Matias	O 9
Schernewski , Gerald	O 3, O 11, P 4, P 58, P 61, P 97, P 98
Schewenius , Maria	O 39
Schimanke , Semjon	P 94
Schmale , Oliver	O 58
Schmidt , Martin	O 74
Schneider , Bernd	O 5, P 15
Schönwald , Silke	P 97
Schubert , Hendrik	O 99, P 132
Schulz-Bull , Detlef	O 42, P 15, P 19
Schulz-Stellenfleth , Johannes	O 57
Schumacher , Joahanna	P 58, P 97
Schumann , Rhena	P 132
Schwarzer , Klaus	O 101, P 122
Semenova , Anna	P 59
Sepp , Mait	O 47
Seppälä , Jukka	P 118
Sergeev , Alexander	O 34, O 48, P 27, P 34, P 103
Sharov , Andrey	P 111, P 130
Shchuka , Sergey A.	P 24
Siegel , Herbert	P 4
Siiriä , Simo-Matti	P 54, P 120
Siitam , Laura	P 1
Sildever , Sirje	O 89
Simm , Mart	P 59
Sinkevičienė , Zofija	P 38
Sipelgas , Liis	P 1, P 2
Sivonen , Kaarina	O 35
Skeff , Wael	P 19
Skóra , Michał	P 52
Skov , Henrik	O 64

Skudra , Māris	O 44, O 55, O 82
Sławińska , Joanna	P 129
Smedberg , Erik	O 60
Snowball , Ian	O 27
Sobek , Anna	O 60
Sofina , Ekaterina	P 126
Soomere , Tarmo	L7, O59, O67, O68, O70, P26, P72, P76, P82, P85, P108
Soosaar , Edith	O 44
Stancikaite , Migle	P 117
Stanev , Emil V.	O 20, O 51, O 57
Staneva , Joanna	O 45, O 57
Staniszewska , Marta	P 139, P 140
Staśkiewicz , Antoni	P 24
Statulevičiūtė , Martyna	P 71
Stepanova , Natalia	O 7, P 5
Stevenson , Alan	O 25
Stips , Adolf Konrad	O 38
Ston-Egiert , Joanna	P 127
Stont , Zhanna	P 8
Støttrup , Josianne	O 10
Strāķe , Solvita	O 107, P 106, P 124, P 137
Strzałkowska , Agata	P 51
Stupelytė , Aistė	P 68
Stybel , Nardine	O 11
Subetto , Dimitry	P 117
Suhhova , Irina	O 77, P 105
Susloparova , Olga	P 95
Suursaar , Ülo	O 47, O 77, P 115
Suzdalev , Sergej	P 136
Szaniawska , Anna	P 21, P 52
Szczepanska , Katarzyna	P 136
Szymczycha , Beata	P 30
Šaškov , Aleksej	P 38
Šiaulys , Andrius	P 50
Šiaulys , Andrius	P 68
Tallberg , Petra	P 14
Tamm , Ottar	O 47
Tamm , Toomas	O 47
Tamminen , Timo	P 118
Tassone , Spencer	O 32
Teikari , Jonna	O 35
Tengberg , Anders	P 49
Tereshenkova , Tatyana	P 95
Thorbjørn Hansen , Flemming	O 64
Tikka , Kimmo	O 61, O 63

Toczek , Henryk	P 96
Tolvanen , Harri	O 53, P 70
Tomasz , Zapadka	O 94
Tõnisson , Hannes	O 28, O 47, P 76
Törnroos , Anna	O 24
Torsvik , Tomas	O 31
Torsvik , Tomas	O 36, P 26, P 28, P 40
Treimann , Meri Liis	O 15
Trzuskowsky , Andreas	O 88
Tuomi , Laura	O 61, P 53, P 56, P 120
Tutak , Beata	P 91
Uhrenholdt , Thomas	O 64
Uiboupin , Rivo	O 44, P 1, P 2, P 39, P 46
Umgiesser , Georg	O 81, P 98, P 99, P 131
Undeman , Emma	O 60
Vähäaho , Ilkka	O 62
Vähä-Piikkiö , Olga	P 54
Vahter , Kaimo	P 36
Vahtera , Emil	P 118
Vaiciute , Diana	O 104, P 33, P 75
Väinölä , Risto	P 48
Valaitis , Edvardas	O 33, P 101
Väli , Germo	O 55, O 65
Vandel , Egert	O 28
Vanhatalo , Jarno	O 73
Vankevich , Roman	P 126
Venesjärvi , Riikka	O 48, O 73
Vessiko, Ljudmila	L 4
Viikmäe , Bert	P 26, P 28
Viitasalo , Markku	L 4, O 97, O 98, P 119
Viktorsson , Lena	O 39
Vilumaa , Kadri	O 28
Vinther , Morten	O 10
Virtanen , Elina	O 97, O 98, P 119
Virtasalo , Joonas	O 13, O 18, O 22, P 25, W 2
Vishnyakova , Lyudmila	P 84
Viška , Maija	O 90, P 108
Voll , Martin	P 102
Volodina , Alexandra	P 57
Voloshchuk , Ekaterina	P 29
Von Storch , Hans	L 1, O 83
Voss , Maren	P 116
Vuorinen, Pekka	L 4
Vyčienė , Gitana	P 112
Wällstedt , Teresia	P 147

Wasmund , Norbert	O 74
Weidemann , Hendrik	O 1
Weisse , Ralf	O 1
Werner , Jan	O 58
Werner , Malin	L 6
Westerbom , Mats	O 97
Westerlund , Antti	O 61, P 120
Wikström , Sofia A.	O 50
Wiśniewska , Monika	P 21
Włodarska-Kowalczuk , Maria	P 63, P 65
Wójcik , Dagmara	P 16
Wojtkiewicz , Marta	P 135
Wölfel , Jana	O 78
Wranne , Anna	P 55
Wróbel , Iwona	P 51
Yermakov , Vadim	P 125
Ytreberg , Erik	P 18
Ytreberg , Erik	P 22
Zaborska , Agata	P 63
Zaggia , Luca	P 82
Zaiko , Anastasija	O 12, P 33
Zegarowski , Lukasz	P 136
Zemlys , Petras	O 81, P 99, P 131
Zhamoida , Vladimir	O 22, O 34, O 48, P 103
Zhang , Y. Joseph	O 20
Zhang , Wenyan	O 90
Zhurbas , Victor	O 55, O 65
Zieliński , Tymon	P 51
Zilniece , Ilga	P 138
Zolubas , Tomas	O 105
Zorita , Eduardo	P 117
Zuyev , Yury A.	P 64, P 95
Žalys , Marius	P 35
Žilinskas , Gintautas	P 34, P 37, P 80
Žilius , Mindaugas	O 103, O 104
Emodnet-Geology Partners	O 25
Iodp Science Party	O 80
Iodp Science Party	O 43
The Iodp Expedition Baltic Sea Paleoenvironment Science Party	O 27
Velmu Programme Participants	O 98

Notes