

Zuwendungsempfänger: Universität Hamburg (Institut für  
Hydrobiologie und Fischereiwissenschaften (IHF))  
Förderkennzeichen: 03F0485B  
Vorhabenbezeichnung: Verbundprojekt BONUS-8 (AMBER) –  
Bewertung und Modellierung des Responseverhaltens des marinen  
Ökosystems des Ostsee auf Klimaänderung und Änderung der  
Landnutzung  
Laufzeit des Vorhabens: Januar 2009 – Dezember 2011

## **Abschlussbericht**

### **Teil I & II**

Teil I und II des Abschlußberichtes sind der englische Teil des Abschlußberichtes (siehe Datei 2-BMBF-Fkz03F0485B). Dieser Abschlußbericht wurde vom BONUS Sekretariat am 8.6.2012 als Deliverable 721 akzeptiert.

Zusätzlich zum englischen Abschlußbericht (Stand Januar 2012) erfolgt im folgenden eine aktualisierte Liste der abgeschlossene Arbeiten des ZE aufgeführt:

Gårdmark A, Nielsen A, Floeter J, Möllmann C (2011) Depleted marine fish stocks and ecosystem-based management: on the road to recovery, we need to be precautionary. ICES Journal of Marine Science, 68:212-220

Lindegren, M., Dakos, V., Gröger, J.P., Gårdmark, A., Kornilovs, G., Otto, S. and Möllmann, C. 2012. Early detection of ecosystem regime shifts: a multiple method evaluation for management application. PloS ONE 7.

Möllmann C, Blenckner T, Tomczak M. Effect of coastal eutrophication on open Baltic Sea fish community - a modeling study. Submitted to PloS ONE.

Otto SA, Flinkman J, Kornilovs G, Postel L, Möllmann C. Habitat heterogeneity influences climate impact on long-term changes in community structure. Submitted to PloS ONE.

Otto SA, Llope M, Kornilovs G, Möllmann C. Life cycle dynamics of a key copepod over long time scales: A complex interplay of internal and external drivers. Submitted to Proceedings of the Royal Society B-Biological Sciences.

Otto SA, Blenckner T, Kornilovs G, Llope M, Müller-Karulis B, Niiranen S, Tomczak MT, Möllmann C. A novel approach to modelling life cycle dynamics of a key marine species under past and future environmental changes. Submitted to Ecology Letters.

Otto SA (2012) Long-term population dynamics of key copepods under climate and foodweb changes: The Baltic Sea as a case study. Dissertation zur Erlangung der Würde des Doktors der Naturwissenschaften des Fachbereichs Biologie, der Fakultät für Mathematik, Informatik und Naturwissenschaften der Universität Hamburg, 157pp.

## **Teil III - Erfolgskontrollbericht**

### ***1. Beitrag der Ergebnisse zu den förderpolitischen Zielen des Förderprogramms /-schwerpunkt/-konzepts .***

Das Verbundvorhaben AMBER trägt zu den folgenden BONUS-169 Forschungsthemen bei:

1. Verknüpfung von Wissenschaft und Politik
2. Klimaänderung und geophysikalischer Antrieb
3. Bekämpfung der Eutrophierung
4. Erreichen nachhaltiger Fischerei
5. Schutz der marinen Biodiversität
6. Integration von Ökosystem und Gesellschaft

Zusätzlich liefert das Verbundvorhaben AMBER einen Beitrag zu den Forschungszielen von CLIVAR, LOICZ, ELOISE und BALTEX.

### ***2. Wissenschaftlich-technisches Ergebnis des Vorhabens, die erreichten Nebenergebnisse und die gesammelten wesentlichen Erfahrungen***

Die wissenschaftlich-technischen Ergebnisse sind ausführlich im englischen Abschlussbericht aufgelistet. Deshalb werden im Folgenden nur die herausragenden wissenschaftlichen Ergebnisse sowie die Highlights des Projektes aufgelistet.

#### ***Wissenschaftliche Ergebnisse***

- Gegenwärtige und zukünftige Änderungen in Niederschlagsmustern über dem Einzugsgebiet der Ostsee verursacht eine Abnahme im Salzgehalt und einen Verlust an mariner Biodiversität.
- Die küstennahen Gebiete der Ostsee haben eine eigene Dynamik im Nährstoffkreislauf, die entkoppelt ist von der offenen See.
- Die Kombination von Klima- und Landnutzungsmodellen deuten daraufhin, dass die Umweltziele des Baltic Sea Action Plans nicht einzuhalten sind, wenn der menschliche Bedarf an Proteinverzehr weiter anwächst wie projiziert.

## Highlights

- Das AMBER Projekt wurde am 21.7.2010 den Präsidenten der Republik Finnland Tarja Halonen und der Russischen Föderation Dimitri Medwedew vorgestellt.
- Der AMBER PI Prof. Christian Möllmann erhielt den 2010 ESA Preis der Ecological Society of America.
- Das AMBER Projekt wurde am 16. 7. 2011 dem Generalsekretär der Vereinten Nationen Ban Ki Moon vorgestellt.
- AMBER Ergebnisse wurden am 24.10.2011 auf der BONUS Stakeholder Konferenz in Gdansk vorgestellt.
- AMBER Ergebnisse wurden am 8.11.2011 auf der BONUS Stakeholder Konferenz in Brussels vorgestellt.
- Dea AMBER PI Frau Dr. Maren Voß hielt am 6.12.2012 einen eingeladenen Vortrag vor der Royal Society London.
- AMBER Ergebnisse wurden am 14.12.2011 auf der nationalen Stakeholder Konferenz in Warnemünde vorgestellt.

### 3. Einhaltung des Finanzierungs- und Zeitplans

Alle Deliverables wurden vom BONUS Sekretariat akzeptiert. Das Vorhaben AMBER hat sowohl die Ausgaben als auch die Zeitplanung eingehalten. Mit den zugewiesenen Mitteln wurde sparsam und wirtschaftlich umgegangen.

### 4. Fortschreibung des Verwertungsplans.

**4.1 Erfindungen/Schutzrechtsanmeldungen und erteilte Schutzrechte, die vom Zuwendungsempfänger oder von am Vorhaben Beteiligten gemacht oder in Anspruch genommen wurden, sowie deren standortbezogene Verwertung (Lizenzen u. a.) und erkennbare weitere Verwertungsmöglichkeiten,**

nicht zutreffend

**4.2 Wirtschaftliche Erfolgsaussichten nach Projektende (mit Zeithorizont) – z.B. auch funktionale/wirtschaftliche Vorteile gegenüber Konkurrenzlösungen, Nutzen für verschiedene Anwendergruppen/-industrien am Standort Deutschland, Umsetzungs- und Transferstrategien (Angaben, soweit die art des Vorhabens dies zulässt)**

Die Kombination von verschiedenen IPCC Klimaszenarien mit Landnutzungsszenarien liefert ein verbessertes Verständnis der natürlichen Variabilität des Gesamtsystems Ostsee. Damit wird ein erster Schritt unternommen, in dem komplexen System Ostsee die natürliche Variabilität von anthropogenen Einflüssen zu trennen. Dieser Schritt ist von fundamentaler Bedeutung für eine nachhaltige Nutzung der Ostsee, da sich hieraus unmittelbar Empfehlungen für ein integriertes Küstenzonenmanagement sowie für ein nachhaltiges Fischereimanagement ableiten lassen. Zusätzlich lassen sich aus den Ergebnissen Empfehlungen ableiten für effizientere, kostensparende Monitoringprogramme auf nationaler und internationaler Ebene.

**4.3 Wissenschaftliche und/oder technische Erfolgsaussichten nach Projektende (mit Zeithorizont) – u.a. wie die geplanten Ergebnisse in andere Weise (z.B. für öffentliche Aufgaben, Datenbanken, Netzwerke, Transferstellen etc.) genutzt werden können. Dabei ist auch eine etwaige Zusammenarbeit mit anderen Einrichtungen, Firmen, Netzwerken, Forschungsstellen u.a. einzubeziehen.**

Das Verbundvorhaben AMBER ist ein innovativer, interdisziplinärer Forschungsansatz zum verbesserten Verständnis des Einflusses von Klimawandel und Änderung in der Landnutzung auf hydrologische und biogeochemische Kreisläufe. Methodisch wurde eine komplexe Modellhierarchie, statistische Analysen von historischen Datensätzen und *in situ* Messungen miteinander verknüpft. Der vorgeschlagene Weg stellte nach dem gegenwärtigen Stand der Forschung die zweckmäßigste Methode dar, das angestrebte Ziel zu erreichen. Die einschlägigen und anerkannten Vorarbeiten der am Verbundvorhaben AMBER beteiligten Partner waren eine gute Voraussetzung dafür, dass das angestrebte Ziel auch erreicht wurde. Alle Modelle, statistische Auswerteprogramme und Datensätze sind bei den Antragstellern vorhanden und keine zusätzliche Modellentwicklung ist nötig gewesen.

Mit dem Landesamt für Umwelt, Naturschutz und Geologie wurde eine enge Zusammenarbeit gepflegt.

#### ***4.4 Wissenschaftliche und wirtschaftliche Anschlussfähigkeit für eine mögliche notwendige nächste Phase bzw. die nächsten innovatorischen Schritte zur erfolgreichen Umsetzung der Ergebnisse***

Das Verbundvorhaben AMBER dient der verbesserten Abschätzung natürlicher Variabilität im Ökosystem Ostsee als Folge klimatisch bedingter Änderungen und Änderungen in der Landnutzung. Besonderes Gewicht hat die verbesserte Unterscheidung menschlicher oder natürlich bedingter Veränderungen.

Diese Fähigkeit zur Unterscheidung hat Konsequenzen auf politische und administrative Ziele zur Entwicklung des Ostseeraumes (Agenda 2010) sowie indirekte volkswirtschaftliche Konsequenzen. In den vergangenen Jahren verpflichteten sich die Ostseeanrainerstaaten zu erheblichen ökonomischen und technologischen Anstrengungen, die anthropogene Nährstoffbelastung der Ostsee auf den Stand von 1950 zurückzuführen. Dieses Ziel scheint nach neueren Erkenntnissen fragwürdig, da der Nährstoffhaushalt der Ostsee mittelbar vom Klima abhängig zu sein scheint. Das politische Ziel der Halbierung der Phosphat- und Nitratgehalte, welches von den Ostseeanrainern in den nächsten Jahren angestrebt wird, erfordert erhebliche Mittel (geschätzt: 50 Mrd. Euro). Das Vorhandensein nennenswerter natürlicher Quellen, die durch Klimaschwankungen moduliert werden, erfordert eine Neuorientierung von Monitoringmaßnahmen und eine Neueinschätzung der aufzuwendenden Mittel. Damit liefert AMBER einen Beitrag zur Implementierung der Meeresrahmenrichtlinie.

##### ***4.4.1. Arbeiten, die zu keiner Lösung geführt haben***

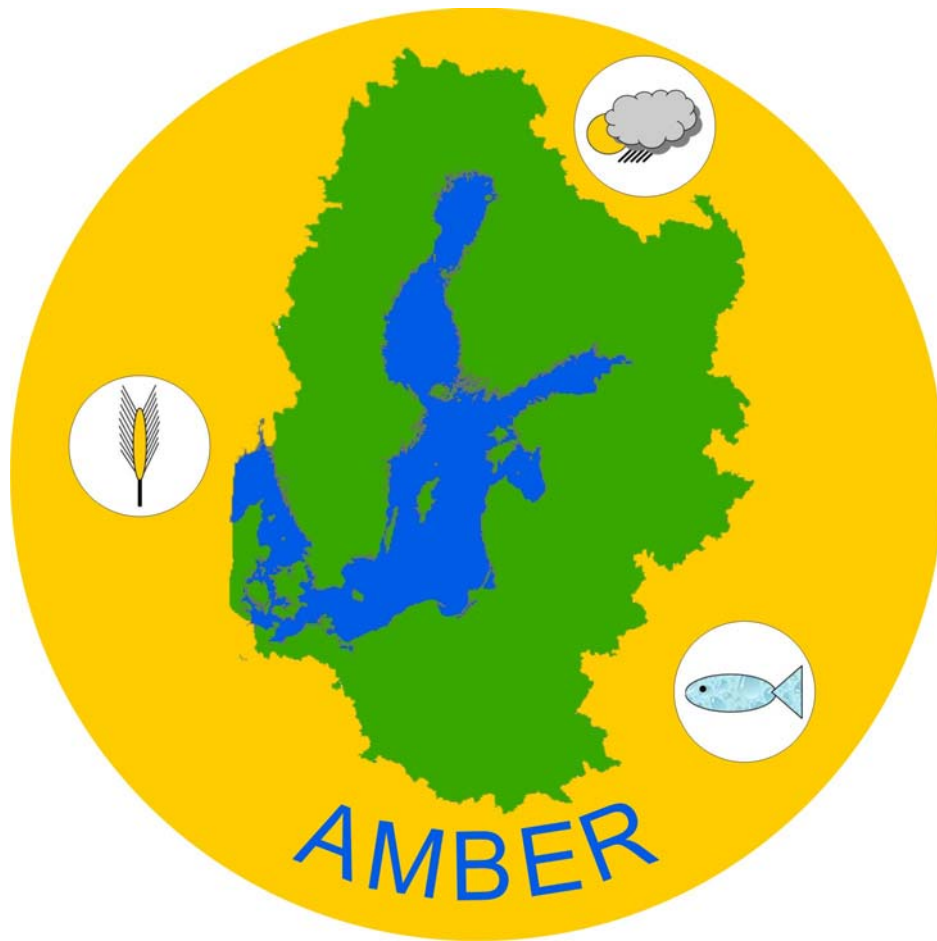
Im WP A3 war geplant, POP- Modellierung auf biologische Daten anzuwenden. Aus Code-Konvertierungsproblemen war dies nicht realisierbar. Stattdessen wurden generalisierte Additive Modelle angewandt.

##### ***4.4.2. Präsentationsmöglichkeiten für mögliche Nutzer- z.B. Anwenderkonferenzen (Angaben, soweit die Art des Vorhabens dies zulässt)***

Zahlreiches Ergebnismaterial wird auf der Homepage des Projektes zur Verfügung gestellt, das für Nutzer und Anwender von Interesse sein kann.

#### **4.4.3. Patente**

Es wurden keine Patente erhoben.



# AMBER Final Report

Compiled by

Joachim W. Dippner

Leibniz Institute for Baltic Sea Research Warnemünde



# BONUS

SCIENCE FOR A BETTER FUTURE OF THE BALTIC SEA REGION



# Final Report

**Project Acronym:** AMBER

**Reporting Period:** months 1-36

## Organisation

The project AMBER started on January 19, 2009 with a kick-off meeting. Presentations and protocols are given under:

<http://www.io-warnemuende.de/amber-kick-off-warnemuende.html>

2010 started with the BONUS Conference in Vilnius. This conference was quite successful for the AMBER Project (6 oral and 13 poster presentations):

<http://www.io-warnemuende.de/amber-presentations.html>

The Consortium Agreement was signed by all legally responsible persons and distributed.

The annual meeting took place in Warnemünde on March 15. 2010. Details are given in:

<http://www.io-warnemuende.de/amber-annual-meeting-2010.html>

The annual meeting took place in Warnemünde on March 21.-23. 2011. On the last day students have to develop strategies for the improvement of Baltic Sea management. Details are given in:

<http://www.io-warnemuende.de/amber-annual-meeting-2011.html>

AMBER results were presented at the ASLO Meeting in Puerto Rico, February 2011

Numerous oral talks and posters were presented at the 8<sup>th</sup> BSSC in St. Petersburg.

AMBER results were presented on the Stakeholder Conferences in Gdansk (Oktober 2011), in Brussels (November 2011) and in Warnemünde (December 2011).

In the following the highlights are presented, the gained scientific results during the project, the education program, the supplement to "Statistics and Research Infrastructure", followed by a complete list of all peer reviewed presentations, oral and poster presentations and the Theses.

Altogether 67 oral presentations have been given and 29 poster presentations.

The overall number of peer reviewed publications up to now is 45 where 21 have been published, 11 have been accepted and 13 are submitted.

<http://www.io-warnemuende.de/amber-publications.html>

***It is important to note that the attached list of publications and theses is preliminary and subject of update because some papers and theses are in preparation. Interested readers are kindly asked to visit the project's homepage.***

### **Highlights:**

The AMBER Project was presented to the President of the Republic Finland Tarja Halonen and the President of the Russian Federation Dimitri Medwedew during their stay on Seili at July 21, 2010.

The AMBER PI Prof. Christian Möllmann has received the 2010 ESA Price from the Ecological Society of America.

The AMBER Project was presented to the General Secretary of the United Nation, Ban Ki Moon during his stay on Seili at July 16, 2011.

AMBER results have been presented on the BONUS Stakeholder Conference in Gdansk on October 24, 2011.

AMBER results have been presented on the BONUS Stakeholder Conference in Brussels on November 8, 2011.

The AMBER PI Maren Voss has given an invited presentation at the Royal Society London, at December 6, 2011.

AMBER results have been presented on a national Stakeholder Conference in Warnemünde on December 14, 2011. In addition a podium discussion with stakeholders has been organized.

The AMBER Coordinator Joachim Dippner has given an invited talk on the 8<sup>th</sup> meeting of the Expert Group on Maritime Policy in the Ministry of Transport, Building and Urban Development, Berlin on January 11, 2012.

## **Gained scientific results during the reporting period**

### **Research Cluster A: Time series analyses**

WP A1 **Updated Data Collections.** A metadata base has been established and grouped into model results, monitoring data and own observations. The metadata base is permanently updated with respect to new model simulations and new observations. Details are given under:

<http://www.io-warnemuende.de/amber-metadata.html>

WP A2 **Maps of ecological patterns** in form of Hovmöller diagrams and phase diagrams are presented on the AMBER home page:

<http://www.io-warnemuende.de/results-cluster-a.html>

WP A3 **General knowledge on predictability on species level including species composition and biodiversity.** The paper "Biological regime shifts and changes in predictability" by J.W. Dippner, K. Junker and I. Kröncke has been published in Geophysical Research Letter. In this paper we show why some biological regime shifts in benthic macrofauna communities structures are predictable and others not and relate these finding to climate regime shifts.

**Transfer functions for the prediction of future changes.** Generalized Additive Models have been developed for the main zooplankton species in the Baltic Sea, i.e. Pseudocalanus accusers, Temora longicornis and Acartia spp.. Predictor variables include abiotic variables salinity and temperature as well biotic variables such as

predation pressure by clupeid fish species herring and sprat. Two manuscripts are being prepared presently.

WP A4 **Maps of the influence of climate change on ecological patterns** in graphical form are presented on the AMBER home page. The impact of changing climate on Baltic Sea biogeochemical cycles at the end of the 21st century was studied using a three-dimensional coupled physical-biogeochemical model. Four climate change scenarios using regionalized data from two General Circulation Models (GCMs) and two greenhouse gas emission scenarios (A2, B2) have been investigated. In this study we have focused on maps of annual and seasonal mean changes of ecological quality indicators. We found that the impact of changing climate on the horizontal distribution of ecological parameters might be significant. For instance, in the scenario simulation with the largest changes Secchi depth might decrease by up to 2 m in some regions. However, due to reduced stratification also increased Secchi depths might occur.

<http://www.io-warnemuende.de/results-cluster-a.html>

WP A5 **Definition of EcoQOs and system indicators**. The paper Ilppo Vuorinen, Jari Hänninen, Marjut Rajasilta, Päivi Laine, Jan Eklund, Federico Montesino-Pouzols, Francesco Corona, Karin Junker, H.E. Markus Meier and Joachim W. Dippner (2011) *Horohalanicum revisited -- alternative food webs developing in coastal seas*, has been submitted to PLOS ONE. In this paper, recommendations for an improved monitoring on a species level are given.

**Assessment of changes of Baltic Sea Ecosystem properties in graphical form for potential end users**. The state of the marine ecosystem of the Baltic Sea is graphically displayed as AMOEBA Model for three different ICES subdivisions in the Baltic, the Latvian zooplankton data from SD28-2 and the phytoplankton monitoring for the coast of Mecklenburg Western Pommeranian. The status during specific regimes, and changes during extreme winters and during regime shift are shown.

[http://www.io-warnemuende.de/tl\\_files/projects/amber/results/AMBER-WPA5.pdf](http://www.io-warnemuende.de/tl_files/projects/amber/results/AMBER-WPA5.pdf)

WP A6 **Assessment of changes of taxonomic groups as function of environmental parameters in graphical form**. A presentation is available on the AMBER webpage under:

[http://www.io-warnemuende.de/tl\\_files/project/amber/results/Fitness.pdf](http://www.io-warnemuende.de/tl_files/project/amber/results/Fitness.pdf)

The presentation combined the theory of fitness landscape and optimal environmental window and presents phytoplankton monitoring data in a fitness landscape under consideration of projected climate change. The summary displays which taxonomic groups will decrease or increase due to climate change.

### **Research Cluster B: Process studies and observations**

WP B1 The observation program was subject of reduction due to budget reduction. A lot of cruises with different research vessels took place as documented in the "Cruise Reports" and "Sampling Reports"

<http://www.io-warnemuende.de/amber-reports.html>

and all collected data are documented in the AMBER metadata base

<http://www.io-warnemuende.de/amber-observations.html>

WP B2 All own observations carried out in this WP are documented on the AMBER metadata base:

<http://www.io-warnemuende.de/amber-observations.html>

More than 70% of all analyses were performed and a first end-member-mixing-model approach (EMMA) was carried out by means of  $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$ -DOM values. The remaining samples will be prepared and analyzed in the first quarter of 2011. This is documented on

<http://www.io-warnemuende.de/results-cluster-b.html>

and on

<ftp://amberdel:amber@bnisrc.dyndns.org/AMBER/Deliverables/>

**Data set DOM isotope signatures ( $\delta^{13}\text{C}$ -DOC,  $\delta^{15}\text{N}$ -DON) over an annual cycle in Kalix and Nemunas river.** Seasonal samples from the rivers Kalix and Nemunas were analyzed for  $\delta^{15}\text{N}$  values of DON and some additionally for  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values of high molecular weight DOM (HMW-DOM).

[http://www.io-warnemuende.de/tl\\_files/project/amber/results/Scientific%20Report%20of%20AMBER%20subproject%20WP%20B.docx](http://www.io-warnemuende.de/tl_files/project/amber/results/Scientific%20Report%20of%20AMBER%20subproject%20WP%20B.docx)

WP B3 All own observations carried out in this WP are documented on the AMBER metadata base:

<http://www.io-warnemuende.de/amber-observations.html>

and additional information is given in the “Cruise Reports” and “Sampling Reports”

<http://www.io-warnemuende.de/amber-reports.html>

N uptake rates in the Oder outflow were eight times higher than in the Nemunas due to the already developed spring bloom in the Oder. Longer nitrate turnover times than residence time of the water suggest that not all of the incoming nitrogen can be taken up by phytoplankton. It is further suggested that a huge amount of nitrate is removed via denitrification. But only a few rate measurements quantified the losses up to now. Here the stable isotope signature of nitrate will give an insight into the processes that take place. The isotopic signature in nitrate for source identification is given in a scientific report:

<http://www.io-warnemuende.de/results-cluster-b.html>

**WP B4 Identification of the groundwater influence on the coastal environment.** The major aim of subproject WP B.4 was the identification of submarine ground water discharge (SGD) at selected sites in the southern Baltic Sea. The major research area formed the Puck Bay, southern Baltic Sea (north Poland). In addition, sampling campaigns have been carried out at a site of ground water efflux close to Meschendorf (Germany) as well as in the Oder lagoon in cooperation with the WP B.3. Field sampling was conducted between years 2009 and 2011 at Hel Peninsula (7 sampling campaigns), in the Oder lagoon in 2010 (1 sampling campaign), and at

Meschendorf in 2011 (3 sampling campaigns). Following successful ex-situ and in-situ SGD site identification, a quantification of near-shore SGD rates was estimated with Lee-type seepage meters (Hel Peninsula). A small arithmetic overflow was applied to a discrete ground water seep at the shore line close to Meschendorf. A detailed data description is available under

<http://www.io-warnemuende.de/amber-observations.html>

A description of the results is given in

<http://www.io-warnemuende.de/amber-results-cluster-b.html>

**WP B5 Isotopic and geochemical characterization of groundwater.** The major aim of subproject WP B.5 was the hydrogeochemical and isotopic characterization of submarine ground water discharge (SGD). Major research area was the Puck Bay, southern Baltic Sea (Hel peninsula, north Poland). In addition, sampling campaigns were carried out at a site of ground water efflux in the German part of the southern Baltic Sea, close to Meschendorf. In cooperation with the WP B.3, on one occasion investigations were also carried in the Oder lagoon. Field sampling was conducted between years 2009 and 2011 at Hel (7 sampling campaigns), in the Oder lagoon in 2010 (1 sampling campaign), and at Meschendorf in 2011 (3 sampling campaigns). Pore water profiles were taken with pore-water lances and the SGD composition extrapolated based on vertical covariations of geochemical parameters with salinity. In addition results from the time-dependent applications of benthic chambers were used to estimate the composition of SGD. In year 2009, a cruise with the RV Professor A. Penck was carried out to investigate vertical profiles through the water column in the Puck Bay and to retrieve short sediment cores from the central part of the Bay for pore water analyses and further geochemical characterization of SGD. In collaboration with colleagues from Helmholtz UFZ, Halle (S. Weise), a preliminary  $^3\text{H}$  dating of SGD at Hel peninsula was carried out. A more detailed continuation is planned on a final sampling campaign in fall 2011. Sediments affected by SGD were geochemically characterized to derive an estimate for possible compositional changes of the SGD composition due to water-solid interactions and the microbially catalyzed degradation of organic matter. Finally, different possible SGD sources in northern Poland, e.g. ground waters from major aquifers (Quaternary, Tertiary, and Cretaceous units) accessible via drinking water wells on Hel peninsula and the polish mainland were sampled and analyzed for essentially the same set of hydrogeochemical (Sal, pH, Na, Ca, Mg, K,  $\text{SO}_4$ , TA, DOC,  $\text{CH}_4$ ,  $\text{H}_2\text{S}$ ,  $\text{NO}_3$ ,  $\text{NH}_4$ , Si, P, Sr, Ba, Mn, Fe, Mo, Li, Cr, Co, Ni, Cu) and isotopic ( $^{13}\text{C}$ -DIC,  $^{18}\text{O}$ - $\text{H}_2\text{O}$ ,  $^2\text{H}$ - $\text{H}_2\text{O}$ ,  $^{34}\text{S}$ - $\text{SO}_4$ ,  $^{34}\text{S}$ - $\text{H}_2\text{S}$ ) parameters that were applied to the SGD sites.  $^{18}\text{O}$ - $\text{H}_2\text{O}$  and  $^2\text{H}$ - $\text{H}_2\text{O}$  measurements were carried out at the Museum of Naturkunde, Berlin (U. Struck), and  $^{15}\text{N}$ - $\text{NH}_4$  measurements at IOW by colleagues from WP B.3. A detailed data description is available under

<http://www.io-warnemuende.de/amber-observations.html>

A description of the results is given in

<http://www.io-warnemuende.de/amber-results-cluster-b.html>

**WP B6 Data on variations in a SGD influenced ecosystem as a new parameter for ecosystem modelling.** The major aim of subproject WP B.6 was to investigate the impact of groundwater seepage on the existing fauna (meio and macrofauna assemblages) on a seasonal scale and the effects of SGD (Submarine Groundwater Discharge) on biodiversity in coastal areas of the Baltic Sea to identify the potential threats of SGD on the biodiversity in the coastal area. Discharge of groundwater into

the sea is widespread. Submarine groundwater discharge (SGD) is one of the water pathways connecting land and ocean in the global water cycle. Moreover it has been recently recognized as important factor influencing coastal zone. In comparison with easily seen and typically large point sources surface of water inputs (e.g., rivers and streams), which are gauged and well analysed, estimations of groundwater inputs are much more difficult due to lack of simple mean to gauge these fluxes. Groundwater in many areas has become contaminated and therefore is a source of nutrients, trace metals, organic compounds and radionuclides. Overlooking it may lead to serious misinterpretations of ecological data in studies of coastal pollution, of benthic zonation and productivity, and of the flux of dissolved substances within and between bottom sediments and overlying water. Freshwater discharges change salinity, temperature and nutrient regimes and degrade nearshore environments. Details are given in

<http://www.io-warnemunde.de/amber-observation.html>

<http://www.io-warnemunde.de/amber-results-cluster-b.html>

### **Research Cluster C: Spatial river basin – coast – sea interaction**

WP C1 **Spatial data of Baltic rivers basins.** The GIS maps showing model input data are available under:

<http://www.io-warnemuende.de/amber-results.html>

WP C2 **Future scenarios considering climate change and change in land use**  
We have calculated the effect of changes in temperature and precipitation on N and P fluxes for 83 watersheds using the strong correlation functions between load and runoff for the catchments of the various Baltic Sea basins (n=7). We have not calculated the land cover scenarios because we realized that agricultural practices which we calculated with the NANI tool (Net anthropogenic nutrient inputs) are much more significant for N and P fluxes than relatively moderate changes in agricultural areas. We calculated therefore 4 lifestyle scenarios:

- i) the effects of 20% increase in fertilizer use, human consumption, animal consumption, animal production, crop production to humans and animals;
- ii) effect of adjustment of agricultural practices to EU-15 level on nutrient fluxes from transitional countries (Poland, Baltic States and Russia);
- iii) effect of 20% decrease in atmospheric deposition following the NEC directive and
- iv) business as usual, increase in human consumption of animal proteins by 3% annually with using the relationships of the various NANI components (animal and crop production and finally fertilizer use).

Furthermore we have used several climate scenarios to drive the hydrological changes that are forecasted; ECHAM5 A1B\_1, ECHAM\_B1 and ECHAM5\_A2. We can also provide data from runs using the following weather, ECHAM5\_A1B\_2, ECHAM5\_A1B\_3, HADCM3\_A1B and CCSM3\_A1B. All runs gives data for the period 1961 to 2100. All runs are documented on:

<ftp://amberdel:amber@bnisrc.dyndns.org/AMBER/Deliverables/>

WP C3 **The results of the climate change scenarios** (ECHAM A2 and B2, HADAM A2 and B2) have been used for a first application of MONERIS for the period from 2071 to 2100. As the modelled climate data showed a considerable bias from the observed values, we analysed the relative change of precipitation and added this to the mean precipitation values of 1983 to 2005. Modelled runoff data for this period have not been available yet and had to be estimated too. Here, the mean monthly precipitation-runoff ratio for each analytical unit of the period 1983 to 2005 has been transferred to the period of 2071-2100. As the precipitation-runoff ratio will change with changing temperatures these results can only be seen as preliminary and have to be corrected as modelled runoff is provided by the project partners. The model results are presented in a scientific presentation. Both can be found on:

<http://www.io-warnemuende.de/results-cluster-c.html>

WP C4 **The climate change scenarios** are documented on the AMBER Web page:

<http://www.io-warnemuende.de/amber-model-data.html>

A publication on the analysis of climate change is in press. A further paper has been submitted to Transitional Water Bulletin..

WP C5 **The river–coastal water–sea model system** which allows projections of anthropogenic and climate changes is documented in two peer reviewed publications and a comparative study of lagoons and their functional changes is under revision.

<http://www.io-warnemuende.de/amber-publications.html>

WP C6 The deliverable “Quantification of mean integrated ecological quality indicators suggested by HELCOM for 1961–1990 and 2071–2100” has been skipped due to budget reduction. The biogeochemical fluxes between coastal regions and the open sea are documented on the AMBER metadata database. All data are available at the National Swedish Supercomputer Centre.

#### **Research Cluster D: Policy and advisory**

WP D1 **An indicator system for Baltic cod ecosystem-based fisheries management.** A paper has been published in ICES Journal of Marine Science (2011), 68(1), 212–220. doi:10.1093/icesjms/fsq158. The paper among others presents alternative stock and ecosystem indicators for Eastern Baltic cod. It demonstrates that estimates of recent fishing mortality and recruitment of this stock were highly uncertain and show that these uncertainties are crucial when combined with management plans based on fixed reference points of fishing mortality. It calls for fisheries management that does not neglect uncertainty and outlines a four-step approach to handle uncertainty of stock status in advice and management.

**Early detection of ecosystem regime shifts: a multiple method evaluation for management application.** A paper is submitted to the journal "Ecology Letters" and uses real monitoring data of a key ecosystem component, we here apply and compare multiple early-warning indicators in order to assess their predictive ability to forewarn a major ecosystem regime shift in the Central Baltic Sea.

<http://www.io-warnemuende.de/amber-publications.html>

WP D2 The Ecopath with Ecosim model is used forced by two different nutrient load and two fishery management scenarios to evaluate the relative effect of the two external driver on cod, sprat and herring dynamics in the central Baltic Sea. A paper is submitted to PlosONE.

<http://www.io-warnemuende.de/amber-publications.html>

**WP D3 Publication (critical evaluation and suggestions towards implementation of European water policy).** The results allowed scientific articles instead of only a scientific report. The following publications evaluate existing water quality objectives, suggest new hydrochemical concentrations for the EU Water Framework Directive and address implications for water quality management: Schernewski G., T. Neumann, S. Maack & M. Venohr (2011): Gewässereutrophierung – vom globalen Problem zum regionalen Lösungsansatz. In: Fränze, Müller & Schröder (Hrsg.) Handbuch der Umweltwissenschaften - Grundlagen und Anwendung der Ökosystemforschung, Wiley –VCH Verlag 20. Erg. Lfg. 3/11, 1-20. Schernewski, G., N. Stybel & T. Neumann (accepted): Managing Eutrophication: Cost-effectiveness of Zebra mussel farming in the Oder (Szczecin) Lagoon. Ecology and Society

**WP D4 Report on scientific perspectives for long-term development of European water policy and for ICZM.** Instead of a short technical report, two publications cover the task. During the work it turned out that Climate Change effects (at least in the Oder region) have only little impact on adjacent coastal ecosystems (and quality objectives) compared to ongoing and future transformation processes in agriculture. Therefore, the latter became the focus of work. Krämer, I., J. Hürdler, J. Hirschfeld, M. Venohr & G. Schernewski (accepted): Nutrient fluxes from land to sea: consequences of future scenarios on the Oder river basin – lagoon – coastal sea system. International Review of Hydrobiology. Voss, M., J. Dippner, C. Humborg, J. Hürdler, F. Korth, T. Neumann, G. Schernewski & M. Venohr (2011): History and scenarios of future development of Baltic Sea eutrophication. Estuarine, Coastal & Shelf Science. Doi:10.1016/j.ecss.2010.12.037

**WP D5 Publication (towards an EAM of human activities in the southern Baltic).** Two paper in international reviewed journals have been published recently. The first, Venohr et al. (2011): Modelling of Nutrient Emissions in River Systems – MONERIS – Methods and Background, give a detailed description of the model and the basis for the different scenarios. The second one, Krämer et al. (2011): Nutrient Fluxes from Land to Sea: Consequences of Future Scenarios on the Oder River Basin – Lagoon – Coastal Sea System, describes the direct and indirect effects of climate, land-use and management changes on the emissions and loads in the Oder and the effect on the lagoon. A third paper has been published in 2010 (Venohr, M. et al. (2010): Potential von Maßnahmen zur Reduktion der Nährstoffflüsse im Einzugsgebiet der Oder.) describing in more detail the potential of measures to reduce emissions and loads in the Oder catchment.

**WP D6 EcoQOs and targets for coastal areas, eutrophication, and ICZM.** The paper Dippner, Möller, Häninnen (2012) Regime shifts in North Sea and Baltic Sea: a comparison, has been submitted to Journal of Marine Systems. In this paper a modified AMOEBA model is presented and the possible contributions of this approach to the implementation of Marine Strategy Framework Directive is discussed.



## **Education**

Altogether four workshops or summer schools are organized for the education of Ph.D. student in BONUS+ projects.

1. The BONUS+ AMBER workshop “Time Series Analysis and Modelling of Environmental Data” took place from September 13–17, 2009 on the island of Seili in the Finnish Archipelago Sea. A list of participants and teachers and details of the complete teaching program, the presentations and the exercises can be found on:

<http://www.io-warnemuende.de/amber-time-series-analysis.html>

and

<ftp://amber:workshop@ftp.io-warnemuende.de>

2. The BONUS+ AMBER summer school “Stable isotope analysis in biogeochemistry with focus on the Baltic Sea and its catchment” took place at the Stockholm University from September 15-23, 2010. The summer school was sponsored by the ESF Nitrogen in Europe Research Networking Programme which is greatly acknowledged. Without this support, we would not have been able to invite Prof. Brian Fry as teacher to this summer school. A list of participants and teachers and details of the complete teaching program, the presentations and the exercises can be found on:

<http://www.io-warnemuende.de/stable-isotope-analysis.html>

3. The BONUS+ AMBER “Climate Modelling School” took place at SMHI Norrköping on October 13, 2010. All details are given at:

<http://www.io-warnemuende.de/climate-modelling-school.html>

4. The AMBER workshop “Lagoon Ecosystem Modelling (ECOPATH/ECOSIM): From Hydrodynamics to Fisheries” took place from June 21–23, 2011 in Klaipeda/Lithuania. 11 students (6 female & 5 male) from Latvia, Lithuania and Russia (see list of participants on AMBER webpage) were educated by five teachers from Germany, Italy, Lithuania and Turkey (see list of teachers on AMBER webpage). In the following a short description of the course is given. Details of the complete teaching programme can be found on the AMBER homepage.

<http://www.io-warnemuende.de/lagoonecosystemmodelling.html>

## **Supplement to “Statistics and Research Infrastructure”**

1. Number of times your project has contributed to consultations carried out by European commission.

*A. Briefing note for workshop of Directorate General for Internal Policies, Policy Department B: Structural and Cohesion Policies Fisheries, Title: Ecosystem regime shifts triggered by overfishing.*

2. Number of times the scientists working in your Project have served as members or observers in stakeholder and scientific committees.

*A. Razinkovas-Baziukas was a member and convener of the Curonian lagoon transboundary international stakeholder committee (meetings in Lithuanian and Russian Federation).*

*B. Christian Möllmann is Council Member of ICES Scientific Committee (SCICOM)*

*C. Maren Voss took place in the formulation of a global policy text at a Kavli Royal Society Meeting in December 2011 to suggest reactive nitrogen to be globally managed.*

*D Markus Meier was member of the scientific committee of the 8<sup>th</sup> Baltic Sea Science Congress (BSSC) 2011 “joint research efforts for sustainable ecosystem management” in St. Petersburg.*

*E. Joachim Dippner and Markus Meier were conveners of the theme session “Impact of changing climate and human-induced pressure in the Baltic Sea ecosystem” at BSSC 2011*

*F. Markus Meier was topic editor of the EGU journal Ocean Science (<http://www.ocean-science.net/index.html>)*

*G. Gerald Schernewski was invited to the DWA expert commission and discussion forum at BfG Koblenz, 31.05.2011*

*H. Gerald Schernewski was invited to the national German board for the implementation of the Water Framework Directive in the Baltic. Altogether 3 joint meetings took place.*

*I. Gerald Schernewski organized the international workshop “Mussel farming in the Baltic: experiences and perspectives, Workshop, 08.06.2011, in Warnemünde <http://musselnet.eucc-d.de/>.*

3. Number of times the effort of your project has resulted in modifications made to relevant policy documents and action plans (in particular, Baltic Sea Action Plan)

*A. During the discussions with the national German board for the implementation of the Water Framework Directive, it became obvious that water quality objectives for the German Baltic coastal waters have to be redefined. A separate workshop was organized by Gerald Schernewski in Warnemünde, 29.08.2011. On the workshop the concrete process towards a re-definition has been outlined. It is documented under: <http://waterquality.eucc-d.de/home.html>*

*B. AMBER results were provided to the Ministry of Environment in Lithuania and serve as background for nutrient reduction plan.*

4. Number of suggestions for designing, implementing and evaluating the efficacy of pertinent public policies and governance originating from the work of your Project.

*A. Results of the modelling efforts were taken into account when Lithuanian ministry of Environment was building the plan of Activities Nemunas basin*

*B. Based on the project's results, report for the Nida city municipality on eutrophication and public bathing possibilities was prepared.*

*C. At the HELSINKI COMMISSION Land-based Pollution Group 16th Meeting, Dessau, Germany, 18-20 May 2011 results of the AMBER project were presented along the ARTWEI project presentation calling for more attention to the transformation of terrestrial loads in the transitional waters of the Baltic. Opinion was strongly supported by the delegates and comment was included in the HELCOM LAND minutes.*

12. Number of times your project has contributed to dissemination products/events addressed to general public concerning coupling between marine environmental quality and human health and well-being.

*Numerous lectures have been given in public, for visitors at Seili and in various occasions in Turku and elsewhere, throughout the whole year when Turku was the cultural capital of Europe.*

16. Number of modifications made to current PhD course programmes that resulted from the work of your Project.

*Ongoing changes to the course "Ecology of fresh and brackish waters"*

- List of peer reviewed papers
- List of theses
- List of oral presentations
- List of poster presentations

## List of peer reviewed papers

### Published

[Almroth-Rosell, E., K. Eilola, R. Hordoir, H. E. M. Meier, and P. O. J. Hall \(2011\) Transport of fresh and resuspended particulate organic material in the Baltic Sea -- a model study. Journal of Marine Systems, 87, 1-12, doi: 10.1016/j.jmarsys.2011.02.005](#)

Dailidienė I., Davulienė L., Kelpsaitė L. and Razinkovas A. (2010) Analysis of the Climate Change in Lithuanian Coastal Areas of the Baltic Sea. Journal of Coastal Research, DOI: 10.2112/JCOASTRES-D-10-00077

[Dippner, J. W., K. Junker, and I. Kröncke \(2010\) Biological regime shifts and changes in predictability, Geophys. Res. Lett., 37, L24701, doi:10.1029/2010GL045696](#)

[Gårdmark, A., Nielsen, A., Floeter, J., and Möllmann, C. \(2010\) Depleted marine fish stocks and ecosystem-based management: on the road to recovery, we need to be precautionary. ICES J. Mar. Sci.,doi:10.1093/icesjms/fsq158](#)

[Hänninen, J., I. Vuorinen \(2011\) Time-varying parameter analysis of the Baltic Sea freshwater runoffs. Environmental Modeling and Assessment, 16, 53-60 doi: 10.1007/s10666-010-9231-5.](#)

Jens Hürdler, M.Venohr, 2011: Auswirkungen des Klimawandels und der sozioökonomischen Entwicklung auf zukünftige Nährstoffeinträge in die Oder. Deutsche Gesellschaft für Limnologie (DGL). Erweiterte Zusammenfassungen der Jahrestagung 2010 (Bayreuth), Hardegsen 2011, 361-365.

[Jäntti H, Stange F, Leskinen E, Hietanen S \(2011\) Seasonal variation in nitrification and nitrate-reduction pathways in coastal sediments in the Gulf of Finland, Baltic Sea. Aquatic Microbial Ecology 63:171-181, doi:10.3354/ame01492](#)

[Korth, F., Deutsch, B., Liskow I. and Voss M. \(2011\) Uptake of dissolved organic nitrogen by size-fractionated plankton along a salinity gradient from the North Sea to the Baltic Sea, Biogeochemistry, DOI: 10.1007/s10533-011-9656-1](#)

[Krämer, I., Hürdler, J., Hirschfeld, J., Venohr, M. and Schernewski, G. \(2011\). Nutrient Fluxes from Land to Sea: Consequences of Future Scenarios on the Oder River Basin – Lagoon – Coastal Sea System. International Review of Hydrobiology, 96: 520–540. doi: 10.1002/iroh.201111293](#)

Meier, H. E. M., and K. Eilola, 2011: Future projections of ecological patterns in the Baltic Sea. SMHI Reports Oceanography No.107.

[Meier, H.E.M., K. Eilola, and E. Almroth, 2011: Climate-related changes in marine ecosystems simulated with a three-dimensional coupled biogeochemical-physical model of the Baltic Sea. Climate Research, 48, 31-55.](#)

Pempkowiak, Janusz; Szymczycha, Beata; Kotwicki, Lech (2010): Submarine groundwater discharge (SGD) to the Baltic Sea. ROCZNIK OCHRONA SRODOWISKA, 12, 17-32.

[Philippart, C. J. M., R. Anadón, R. Danovaro, J. W. Dippner, K. F. Drinkwater, S. J. Hawkins, T. Oguz, G. O'Sullivan, and P. C. Reid \(2011\) Impacts of climate change on European marine ecosystems: Observations, expectations and indicators. \*Journal of Experimental Marine Biology and Ecology\*, 400, 52-69, doi:10.1016/j.jembe.2011.02.023](#)

[Rönkä, M., Saari, L., Hario, M. Hänninen, J. & Lehikoinen, E. \(2011\). Breeding success and population trends of waterfowl - implications for monitoring. \*Wildlife Biology\* 17: 225-239.](#)

[Schafmeister, M.-T. and A. Darsow, 2011: Potential Change in Groundwater Discharge as Response to Varying Climatic Conditions – An Experimental Model Study at Catchment Scale. \*The Baltic Sea Basin\*, J. Harff, S. Björck, and P. Hoth, Eds., Springer Berlin Heidelberg, 391-404.](#)

[Schernewski, G., T. Neumann, and H. Behrendt \(2011\) Sources, Dynamics and Management of Phosphorus in a Southern Baltic Estuary. \*The Baltic Sea Basin\*, J. Harff, S. Björck, and P. Hoth, Eds., Springer Berlin Heidelberg, 373-388](#)

[Stybel, N., Fenske, C., Schernewski, G. \(2009\) Mussel cultivation to improve water quality in the Szczecin Lagoon. \*J. Coastal Res.\*, S156, 1459-1463](#)

[Venohr, M., Hirt, U., Hofmann, J., Opitz, D., Gericke, A., Wetzig, A., Natho, S., Neumann, F., Hürdler, J., Matranga, M., Mahnkopf, J., Gadegast, M. and Behrendt, H. \(2011\), Modelling of Nutrient Emissions in River Systems – MONERIS – Methods and Background. \*International Review of Hydrobiology\*, 96: 435–483. doi: 10.1002/iroh.201111331](#)

[Venohr, M., Hürdler, J., Opitz, D. \(2010\) Potential von Maßnahmen zur Reduktion der Nährstoffflüsse im Einzugsgebiet der Oder. In: Kannen, A., Schernewski, G., Krämer, I., Lange, M., Janssen, H., Stybel, N. \(Eds\) \*Forschung für ein Integriertes Küstenzonenmanagement: Fallbeispiele Odermündungsregion und Offshore-Windkraft in der Nordsee\*, \*Coastline Report\* 15, 151-166](#)

[Voss, M., J. W. Dippner, C. Humborg, J. Hürdler, F. Korth, T. Neumann, G. Schernewski, and M. Venohr \(2011\) History and scenarios of future development of Baltic Sea eutrophication. \*Estuarine, Coastal and Shelf Science\*, 92, 307-322 doi:10.1016/j.ecss.2010.12.037](#)

Vuorinen, I. (2011) Climate Change in the Baltic Sea marine environment. *Baltic Rim Economic Quarterly Review* 2, 31 May 2011. p 27

### **Accepted Publications**

Dippner, J.W., G. Kornilovs, K. Junker (2012) A Multivariate Baltic Sea Environmental Index. *Ambio*, accepted

Hänninen, J, I. Vuorinen (2012) Comparison of several climate indices as input in modelling of the Baltic Sea runoff. *Boreal Environment Research*, accepted.

Hietanen, S., H. Jäntti, C. Buizert, K. Jürgens, M. Labrenz, M. Voss, J. Kuparinen: Hypoxia and nitrogen processing in the Baltic Sea water column. *Limnology&Oceanography*, accepted

Jäntti, H., Leskinen, E., Stange, C.F., Hietanen, S. (2010) Measuring nitrification in sediments – comparison of two methods and three  $^{15}\text{NO}_3^-$  measurement techniques, Stable isotopes and Environmental Health Studies, in Press

Jäntti, H., Hietanen, S. (2012) The effects of hypoxia on sediment nitrogen cycling in the Baltic Sea. *AMBIO*, accepted

Junker, K., D. Sovilj, I. Kröncke, J.W. Dippner (2011) Climate induced changes in benthic macrofauna - a non-linear model approach. *Journal of Marine Systems*, accepted

Meier, H.E.M., A. Höglund, R. Döscher, H. Andersson, U. Löptien and E. Kjellström: Quality assessment of atmospheric surface fields over the Baltic Sea from an ensemble of regional climate model simulations with respect to ocean dynamics. *Oceanologia*, accepted

Schernewski, G., Neumann, T., Maack, S., Venohr, M. (2010) Gewässereutrophierung – vom globalen Problem zum regionalen Lösungsansatz. In: Fränze, Müller & Schröder (Eds) *Handbuch der Umweltwissenschaften, Grundlagen und Anwendung der Ökosystemforschung*, Kap. VI, 2.2, Wiley –VCH Verlag

Schernewski, G., Neumann, T., Opitz, D., Venohr, M. (2011) Long-term eutrophication history and functional changes in a large Baltic river basin - estuarine system. *Estuaries and Coasts*, accepted

B.Szymczycha, L. Kotwicki, J. Pempkowiak. (2010): Submarine Groundwater Discharge (SGD) to the Baltic Sea, *Ann. Set Envir. Prot.*, accepted

Zilius, M., M. Bartoli, D. Daunys, R. Pilkaityte and A. Razinkovas: Benthic oxygen uptake in the shallow eutrophic Curonian lagoon (Baltic Sea), *Hydrobiologia*, accepted.

### **Submitted Publications**

Dippner, J.W., Möller, C., Hänninen, J., 2012. Regime shifts in North Sea and Baltic Sea: an intercomparison. *J. Mar. Syst.*, submitted.

Eilola, K., E. Almroth-Rosell, C. Dieterich, F. Fransner, A. Höglund, and H. E. M. Meier, 2012: Nutrient transports and interactions between coastal regions and the open Baltic Sea: A model study in present and future climate. *AMBIO*, under review.

Hänninen, J., I. Vuorinen (2010) Transfer-function modelling from climate indices and runoff to nutrient loading and concentrations in the Baltic Sea. *Global Change Biology*, submitted

Korth, F., Liskow, I., Fry, B., and Voss, M. (2011) Nitrogen turnover during spring outflow from the nitrate-rich Curonian and Szczecin lagoon using dual isotopes in nitrate. *Marine Chemistry*, submitted

Lech Kotwicki, Katarzyna Grzelak, Michal Czub, Olaf Dellwig, Torben Gentz, Beata Szymczycha, Michael Böttcher: Submarine Groundwater Discharge to the Baltic coastal zone - impact on meiofaunal community. *Journal of Marine System*, submitted

Maiju Lehtiniemi, Elena Gorokhova, Sören Bolte, Holger Haslob, Bastian Huwer, Tarja Katajisto, Lennart Lennuk, Arno Põllumäe, Matthias Schaber, Outi Setälä, Thorsten B.H. Reusch, Satu Viitasalo-Frösén, Ilppo Vuorinen, Pentti Välipakka (2011) Distribution and reproduction of the Arctic comb jelly *Mertensia ovum* in the Baltic Sea – genetic analyses suggest a long history for a recently identified species. *Marine Ecology Progress Series*, submitted

C Möllmann, T. Blenckner, M. Tomczak: Effect of coastal eutrophication on open Baltic Sea fish community - a modeling study. *PlosONE*, submitted.

Pouzols, F.M., Lendasse, A. (2011) Adaptive Kernel Smoothing Regression for Spatio-Temporal Environmental Datasets. *Neurocomputing*, submitted.

Razinkovas-Baziukas, A., G. Schernewski, D. Baziuke (2011): Long term trends in temperature and river forcing of the Curonian and Oder lagoons: a comparison. *Transitional Water Bulletin*, submitted

Szymczycha B. , Vogler. S, Pempkowiak J., (2011) Nutrients fluxes via submarine groundwater discharge to the Bay of Puck, Southern Baltic. *Journal of Soils and Sediments*, submitted

Voss, M., H. W. Bange, J. W. Dippner, J. Middelburg, J. P. Montoya, B. Ward: The marine nitrogen cycle: recent discoveries, uncertainties and the potential relevance of climate change. *Philosophical Transactions of the Royal Society*, submitted

Ilppo Vuorinen, Jari Hänninen, Marjut Rajasilta, Päivi Laine, Jan Eklund, Federico Montesino-Pouzols, Francesco Corona, Karin Junker, H.E. Markus Meier and Joachim W. Dippner (2011) *Horohalanicum* revisited -- alternative food webs developing in coastal seas. *Global Change Biology*, submitted.

M. Zilius, D. Daunys, M. Bartoli, A. Razinkovas-Baziukas: Sediment-water oxygen and nutrient fluxes in a turbid freshwater estuary (Curonian Lagoon, Lithuania): evidences of benthic microalgal activity. *Journal of Limnology*, submitted.

## List of Theses

Verena Enzner (2010): Flächendifferenzierte Grundwasserneubildung im Einzugsgebiet der Puck Bay/Polen mithilfe eines Geoinformationssystems. EMA Universität Greifswald, Germany, BSc Theses, pp.38.

Claudia Frey (2010): Uptake of dissolved organic nitrogen by phytoplankton communities of the Baltic Sea. Diploma Thesis, Univ. of Rostock, Germany, pp. 65.

Helena Jäntti (2012): The roles of nitrification and nitrate reduction pathways in nitrogen cycling of Baltic Sea. PhD Thesis, Univ. of Helsinki, Finland, pp. 60.

Axel Kreutle (2012): Charakterisierung von Stickstoffeinträgen in die Ostsee an zwei Einzugsgebieten in Jütland/Dänemark, Diploma Thesis, Univ. of Rostock, Germany,

Sabine Nestler (2011): Input and fate of dissolved nitrogen compounds via submarine groundwater discharge into the Puck Bay (Poland). Diploma Thesis, Univ. of Rostock, Germany, pp.73.

Mindaugas Žilius (2011): Oxygen and nutrient exchange at the sediment-water interface in the eutrophic boreal lagoon (Baltic Sea). PhD Thesis, Klaipeda University, Lithuania, pp.102.



## List of oral presentation

M.E. Böttcher, Al-Raei A.M., Vogler S., Winde V. & Dellwig O. (2010) Biogeochemical Processes in coastal sands of the southern Baltic Sea and North Sea. Workshop Pore water flow in coastal systems. Hanse Wissenschafts-Kolleg, Delmenhorst, 5.-6.8.2010

Böttcher M.E. (2010) Biogeochemical processes in Marginal Seas. Biogeochemical Seminar. 12.2010, University of Hamburg.

Böttcher, M.E. (2011) Biogeochemistry of Marginal Seas. Wissenschaftliches Instituts-Kolloquium, Geowissenschaften, Universität Münster, 13.1.2011.

Böttcher, M.E. (2012) Biogeochemical processes in coastal seas. Geosciences Seminar, CAUniversity of Kiel, 13.2.2012

Dellwig, O., R. Endler, P. Escher, S. Vogler, D. Donis, F. Jansen, F. Wenzhöfer, M. Gehre, U. Struck, S.M. Weise, B. Szymczycha, L. Kotwicki, T. Gentz, M. Schlüter & M.E. Böttcher (2012) Coastal sands affected by Submarine Groundwater Discharge: A hydro-biogeochemical and multi-isotope (C, O, S, H) study in the southern Baltic Sea. FH-DGG conference, Dresden, 16.-20.Mai 2012, Abstract, in press

Joachim W. Dippner, 2009: The uncertainty of Baltic Sea's Future - The project AMBER. BUP Summer Course on Sustainability, River Basin Management and Climate Change in the Baltic Sea, HAW Hamburg 1.10.2009

[Joachim W. Dippner and AMBER project team, 2010:Climate change versus anthropogenic impacts–first results from the AMBER Project. International Workshop28-30 June, 2010, Boulogne surMer, France, "Climate Change Impacts on Estuarine and Coastal Ecosystems: a Zooplankton Perspective"](#)

Joachim W. Dippner, 2011: The AMBER Project. Workshop on Lagoon Ecosystem Modelling, Klaipeda, Lithuania, 21.6-23.6.2011

Joachim W. Dippner, 2011: The Project AMBER, BONUS Stakeholder Conference Gdansk, 24.10.2011

Joachim W. Dippner, 2011: The Project AMBER, BONUS Stakeholder Conference Brussels, 8.11.2011

Joachim W. Dippner, 2011: Global climate change and regional impact (in German), Heinrich Böll Stiftung, Rostock 17.11.2011

Joachim W. Dippner, 2011: Quo vadis, Ostsee? Institutskolloquium IFM-Geomar, Kiel, 24.11.2011

Joachim W. Dippner, 2011: Ohne Water geht dat nich! AMBER Stakeholder Conference Warnemünde, 14.12.2011

Joachim W. Dippner, 2011: Quo vadis, Ostsee? AMBER Stakeholder Conference Warnemünde, 14.12.2011

Joachim W. Dippner, 2012: Quo vadis, Baltic Sea. 8th meeting of Expert Group on Marine Policy Federal Ministry of Transport, Building and Urban Development, Berlin 11.1.12

Donis, D., Janssen, F., Böttcher, M.E., McGinnis, D. Holtappels, M. & Wenzhöfer, F. (2012) Application of an eddy correlation system for the estimation of oxygen benthic fluxes in coastal permeable sediments impacted by submarine groundwater discharge. *Geophys. Res. Abs.* 14, #11471

Kari Eilola, Almroth-Rosell, E. ,Dieterich, Chr. ,Höglund, A. , H.E. Markus Meier, H.E.M., 2011: Interactions between coastal regions and the open sea in the Baltic Sea: A model study in present and future climate. BSSC 2011, 22-26 August, 2011, St. Petersburg, Russia

Kari Eilola, Gustafson, B., Kuznetsov, I., Meier, H.E.M., Neumann, T. Savchuk, O.P., 2011: Comparison of observed and simulated dynamics of biogeochemical cycles in the Baltic Sea during 1970-2005 using three state-of-the-art numerical models. BSSC 2011, 22-26 August, 2011, St. Petersburg, Russia

Jens Hürdler, M.Venohr, 2010: Modelling future nutrient emissions from the Oder River Basin: An application of socio-economic development and climate change scenarios. 14th IWA Diffuse Pollution and Eutrophication Conference, Mont Sainte-Anne, Beaupré, Kanada. 02.-17.09.2010

Jens Hürdler, M.Venohr, 2010: Auswirkungen des Klimawandels und der sozioökonomischen Entwicklung auf zukünftige Nährstoffeinträge in die Oder. 26. Jahrestagung der Deutschen Gesellschaft für Limnologie 2010, Bayreuth. 29.09.-01.10.2010

Jens Hürdler, M.Venohr, 2010: Effect of socio-economic development and climate change scenarios to the Oder River - Modelling future nutrient emissions. Conference of the Global Catchment Initiative (GCI) - The Global Dimensions of Change in River Basins, Bonn. 06-08.12.2010

Jens Hürdler, Venohr, M., 2011: Future nutrient emissions and loads to the Oder River Basin. BSSC 2011, 22-26 August, 2011, St. Petersburg, Russia

Jens Hürdler, M.Venohr, 2011: Future nutrient emissions and loads to the Oder River Basin – How to reach a Good Ecological Status? 15th IWA Diffuse Pollution and Eutrophication Conference, Rotorua, New Zealand. 18.-23.09.2011

Jens Hürdler, M.Venohr, 2011: Zukünftige Nährstoffeinträge in das Einzugsgebiet der Oder. 27. Jahrestagung der Deutschen Gesellschaft für Limnologie 2011, Freising, Deutschland. 12.09.-15.09.2011

Christoph Humborg, Wulff, F., Mörh, C.-M., Hägg, H., Smedberg, E., Hong, B., Swaney, D.P., 2011: Net anthropogenic nutrient inputs to Baltic Sea catchment regional Riverine nutrient input/export patterns and implications for nutrient management strategies. BSSC 2011, 22-26 August, 2011, St. Petersburg, Russia

Helena Jäntti and S. Hietanen, 2010: Measuring nitrification in sediments: comparison of two <sup>15</sup>N stable isotope techniques. BONUS - Annual Conference 2010, Vilnius/Lithuania. 19.-21.01.2010.

Helena Jäntti, 2011: Nitrification, denitrification, and the actively nitrifying microbial community in the Baltic Sea water column. SAME12 Conference, IOW, Germany. 28.8.-2.9.2011

Karin Junker, 2009: Investigation of Potential Predictability of the Baltic Sea Ecosystem, PhD-Seminar 3.9.2009, IOW, Germany

Karin Junker, 2011: Relating Ecosystem Shifts to Climate Variability, Physics Seminar, 17.5.2011, IOW, Germany

Karin Junker, 2011: Climate Variability and Predictability of the Baltic Sea Ecosystem, PhD-Seminar, 14.7.2011, IOW, Germany

Karin Junker, Dippner, J.W., 2011: Relating Baltic Sea Ecosystem Shifts to Climate Variability. BSSC 2011, 22-26 August, 2011, St. Petersburg, Russia

Frederike Korth, 2009: Investigation of nitrogen components from river discharges as well as their turnover in the coastal zone of the Baltic Sea. PhD-Seminar 6.08.2009, IOW, Germany

Frederike Korth, Liskow, I., Voss, M., 2011: Uptake of Dissolved Organic Nitrogen by Heterotrophic Bacteria and Phytoplankton along a Salinity Gradient from the North Sea to the Baltic Sea. 2011 ASLO Annual Meeting, 13–18 February 2011, San Juan, Puerto Rico

Lech Kotwicki, Szymczycha B., Vogler, S., Grzelak, K., Czub, M., Dellwig, O., Gentz, T., 2011: Groundwater seepage impact on biota. BSSC 2011, 22-26 August, 2011, St. Petersburg, Russia

Inga Krämer, Schernewski G, Behrendt H, Neumann T, Stybel N. 2009: Nutrient load reduction measures in a river basin and efficiency for coastal lagoon management. 4th European Conference on Coastal Lagoon Research, Montpellier/Frankreich. 14.-18.12.2009

Inga Krämer, Schernewski, G., Behrendt, H., Neumann, T., Stybel, N., 2010: Nutrient load reduction measures in a river basin and efficiency for coastal lagoon management. BONUS - Annual Conference 2010, Vilnius/Lithuania. 19.-21.01.2010.

H.E.M. Meier, 2009: Havsmiljö och klimatförändringar, Seminar on the Baltic Sea organized by the Swedish Environmental Protection Agency, Stockholm, 23 April 2009

H.E.M. Meier, 2009: Future challenges for regional coupled climate and environmental modeling in the Baltic Sea Region, 2nd Lund Regional-scale Climate Modelling Workshop: '21st Century Challenges in Regional-scale Climate Modelling', Lund, Sweden, 4 - 8 May 2009

H.E.M. Meier, 2009: Regional coupled climate and environmental modeling for the Baltic Sea Region, Joint Assembly of IAMAS (International Association of Meteorology and Atmospheric Science), IAPSO (International Association for the Physical Sciences of the Oceans) and IACS (International Association of the Cryospheric Sciences), Montreal, Canada, 20-24 July 2009

H.E.M. Meier, 2009: New modeling tools for scenarios of the Baltic Sea ecosystem to support decision making, International conference on 'Linking Science and Management in the Baltic Sea Ecoregion, Copenhagen, Denmark, 9-10 September 2009.

[H.E. Markus Meier and ECOSUPPORT co - workers, 2010: First results of recently performed scenario simulations for the Baltic Sea for 1961 - 2099. BONUS - Annual Conference 2010, Vilnius/Lithuania. 19.-21.01.2010.](#)

H.E.M. Meier, 2010: Impact of changing hydrography on biogeochemical cycles in future climates of the Baltic Sea, Workshop on the effects of climate change on the marine environment organized by the Nordic Council of Ministers, Copenhagen, Denmark, 9-10 March, 2010 (invited presentation).

H.E.M. Meier, 2010: Klimaszenarien für das 21. Jahrhundert - neue Ergebnisse basierend auf einem regionalen gekoppelten Atmosphäre-Eis-Ozeanmodell für die Ostsee. Deutsche Meteorologische Gesellschaft, Deutscher Wetterdienst, Seewetteramt Hamburg, Hamburg, 16 March, 2010. (invited presentation)

H.E.M. Meier, 2010: Quality assessment of atmospheric surface fields over the Baltic Sea of an ensemble of regional climate model simulations with respect to ocean dynamics, BONUS+ program cluster workshop on "Uncertainties of scenario simulations", Norrköping, Sweden, 14 October 2010.

H.E.M. Meier, 2011: Assessment of Climate Change for the Baltic Sea - an update. 8th Baltic Sea Science Congress, St. Petersburg, Russia, August 22-26, 2011

H.E.M. Meier, 2011: Einfluss der Klimaerwärmung auf das Ökosystem der Ostsee. AMBER Stakeholder Conference Warnemünde, 14.12.2011

C Möllmann, 2011: Nachhaltiges Fischereimanagement: Probleme und Fortschritt am Beispiel des Ostseedorsches. AMBER Stakeholder Conference Warnemünde, 14.12.2011

[Arturas Razinkovas, Ch. Ferrarin, D. Daunys et al., 2010: Resuspension effects in the shallow freshwater eutrophic lagoon: experimental & modelling study. BONUS - Annual Conference 2010, Vilnius/Lithuania. 19.-21.01.2010.](#)

Arturas Razinkovas, Zita Gasiunaite, Ali Erturk and Evelina Griniene, 2010: Consequences of global change on the plankton communities in the Curonian lagoon (SE Baltic Sea). International Workshop 28-30 June, 2010, Boulogne sur Mer, France, "Climate Change Impacts on Estuarine and Coastal Ecosystems: a Zooplankton Perspective"

[Arturas Razinkovas, M. Žilius, R. Paskauskas and R. Pilkaityte, 2010: Nitrogen balance in the Curonian lagoon of the Baltic Sea revisited. BONUS - Annual Conference 2010, Vilnius/Lithuania. 19.-21.01.2010.](#)

Schafmeister, M.T. & Böttcher, M.E. (2011) Süß und begehrt: Grundwasser in Küstenökosystemen der Ostsee. AMBER-BONUS Stakeholder Conference, Leibniz IOW, 14.12.2011

[Gerald Schernewski, Jens Hürdler, Thomas Neumann, Nardine Stybel, and Markus Venohr, 2010: Impact of river basin management on coastal water quality and ecosystem services: A southern Baltic estuary. EGU General Assembly 2010, Vienna, Austria. 02.-07.05.2010.](#)

Gerald Schernewski & Nardine Stybel, 2010: Activities and Perspectives of water quality management in transitional waters - the Oder/Odra Estuary Action for Reinforcement of Transitional Waters' Environmental Integrity (ARTWEI) Workshop on 23. June 2010 in Szczecin, Poland

Oda Störmer, 2009: Interactions between ecosystem and human environment - adaptation strategies for Baltic coastal waters essential for the future. 4th European Conference on Coastal Lagoon Research, Montpellier/France. 14.-18.12.2009

[Beata Szymczycha, Anna Maciejewska, Karol Kuliński, Janusz Pempkowiak, 2009: DIC and DOC fluxes to the Baltic Sea -originating from the Submarine Groundwater Discharge \(SGD\). BALTIC-C workshop, Lund/Sweden, 8-11.11.2010.](#)

Beata Szymczycha, Susan Vogler, Lech Kotwicki, Janusz Pempkowiak (2011): Groundwater impact on the interstitial and seawater in the Puck Bay, Baltic Sea. IASWS 2011

Beata Szymczycha, Vogler, S., Dellwig, O., Böttcher, O., Pempkowiak, J., 2011: Nutrients fluxes via Submarine Groundwater Discharge to the Baltic Sea, extrapolation based on the Bay of Puck study. BSSC 2011, 22-26 August, 2011, St. Petersburg, Russia

Rasa Uznyte, 2011: A Food Web of the Lithuanian Coast. PhD-Seminar 20.01.2011, IOW, Germany

M Venohr, 2011: Maßnahmen zur Reduktion der Frachten in die südliche Ostsee. AMBER Stakeholder Conference Warnemünde, 14.12.2011

Susann Vogler, 2009: Identification and Quantification of Submarine Groundwater Discharge in the Baltic Sea. PhD-Seminar 19.11.2009, IOW, Germany

Vogler S., Dellwig O., Escher P., Struck U., Weise S.M., Szymczycha B., Kotwicki L., Mörth C.-M., Böttcher, M.E., Schlüter M. (2011) A multi-isotope (C, O, S, H) and trace metal study in coastal permeable sands affected by submarine groundwater discharge *Geophys. Res. Abs.* 13, #8757

Maren Voß, Carstensen, J., Frey, C., Conley, D., Dippner, J.W., Hietanen, S., Jilbert, T., Korth, F., Slomp, C. 2011: On the Role of Land Derived N and P Input for Eutrophication in the Baltic Sea, 2011 ASLO Annual Meeting, 13–18 February 2011, San Juan, Puerto Rico

Maren Voß, Carstensen, J., Frey, C., Conley, D., Dippner, J.W., Hietanen, S., Jilbert, T., Korth, F., Slomp, C. 2011: Coastal N and P cycling in the southern Baltic proper. BSSC 2011, 22-26 August, 2011, St. Petersburg, Russia

Maren Voß, 2011: Fluch und Segen der Stickstoffdüngung. AMBER Stakeholder Conference Warnemünde, 14.12.2011

I. Vuorinen, Hänninen, J. 2010 Changing Climate effects in the Baltic Sea - a review of time series studies and modelling. 4th International Scientific Conference to commemorate Professor G.G. Winberg "MODERN PROBLEMS OF AQUATIC ECOLOGY", 11-15 October 2010, St. Petersburg

I. Vuorinen, Hänninen, J. 2011: Baltic Sea Time Series updated, and modeling extended to the North Sea. BSSC 2011, 22-26 August, 2011, St. Petersburg, Russia

M. Zilius 2011: Seasonal changes and mechanisms of the nutrient exchange at the sediment-water interface in the eutrophic boreal lagoon of the Baltic Sea. 5th European Conference on Coastal Lagoon Research, Aveiro, Portugal, July 25–30, 2011.

## List of poster presentations

Barbara Deutsch, Christoph Humborg, Magnus Mörtz (2011): Tracing Riverine Inputs of Dissolved Organic Matter into the Baltic Sea Ecosystem

[Rabea Diekmann, S. Otto, G. Kornilovs et al. \(2010\): Climate - related long - term trends and spatial variability in the zooplankton community of the Central Baltic Sea](#)

Kari Eilola, H.E. Markus Meier (2011): Modelling the biogeochemical changes in the Baltic Sea with RCO-SCOB from 1850-2007.

[Claudia Frey, Claudia Fellerhoff, Frederike Korth, Iris Liskow, Maren Voß \(2009\): Uptake of <sup>15</sup>N Labeled Dissolved Organic Nitrogen by Plankton Communities in the Baltic Sea](#)

[Evelina Griniene, Zita Gasiūnaite, Renata Pilkaityte, Sigitas Sulčius \(2010\): The large scale spatial distribution of plankton communities in a transitional coastal lagoon](#)

[Z. Gasiūnaite, E. Griniene, A. Razinkovas, R. Pilkaityte, S. Sulčius \(2009\): Temporal Patterns of Plankton Dynamics in Eutrophic Coastal Lagoon](#)

[Jari Hänninen, Ilppo Vuorinen \(2010\): Transfer-function modelling from climate and runoff to nutrient loading and concentrations in the Baltic Sea](#)

[Susanna Hietanen, Kirsi Kähkönen, Helena Jäntti, Adrien Vetterli, Elina Leskinen\(2009\): Denitrification and DNRA](#)

[Jens Hürdler, Markus Venohr\(2010\): Monthly nutrient emissions and loads to the Odra River Basin.](#)

J.Hürdler, M.Venohr (2010): Modelling future nutrient emissions from the Oder River Basin: An application of socio-economic development and climate change scenarios. 14th IWA Diffuse Pollution and Eutrophication Conference, Mont Sainte-Anne, Beauré, Kanada

[Helena Jäntti, Adrien Vetterli, Elina Leskinen, Susanna Hietanen \(2009\): Nitrogen cycling in coastal Gulf of Finland II: Nitrification](#)

[Helena Jäntti, Susanna Hietanen \(2010\): The Effects of Hydrography and Anthropogenic Pressure on Benthic Nitrogen Cycling in the Gulf of Finland \(Baltic Sea\)](#)

[Karin Junker, Joachim W Dippner, Anders Höglund, Markus Meier, Ilppo Vuorinen \(2010\): Filling Gaps in Environmental Data Using Statistical Downscaling](#)

[Karin Junker, Joachim W. Dippner, \(2011\): A New Baltic Sea Environmental Index](#)

[Frederike Korth, Iris Liskow, Christoph Humborg, Maren Voß \(2010\): Nitrate uptake during spring outflow from the nitrate-rich Curonian and Szczecin lagoon](#)

F. Korth, I. Liskow, M. Voss (2011): Nitrate turnover during spring outflow from the nitrate-rich Curonian and Szczecin lagoon, 12th Symposium on Aquatic Microbial Ecology, Rostock, Germany.

[Lech Kotwicki, O. Dellwig, K. Grzelak et al. \(2010\): Impact of groundwater discharge on fauna](#)

[Frank Schäffer, T. Neumann and G. Schernewski \(2010\): Adaptation and application of the Baltic Sea Ecosystem Model to a coastal ecosystem](#)

[G. Schernewski, N. Stybel, T. Neumann, J. Hürdler, M. Venohr and J. Hirschfeld \(2010\): Water quality management in the Oder/Odra estuary. Conference "Science and Policy Integration for COastal System Assessment", November 8th to 12th The Hilton Malta, Portomaso, St. Julians, Malta](#)

[Oda Störmer, M. Mossbauer, G. Schernewski and T. Neumann \(2010\): Interactions between ecosystem and human environment in Baltic coastal waters under Climate Change and the need for adaptation measures](#)

[B. Szymczycha, S. Vogler, L. Kotwicki, O.Dellwig, J. Pempkowiak, M. Boettcher \(2010\): Submarine Groundwater Discharge to the Gulf of Gdańsk](#)

[B. Szymczycha, M. Miotk, L. Kotwicki, J. Pempkowiak \(2010\):Mercury concentrations in the seepage water discharged to the Puck Bay](#)

Szymczycha, B., Vogler, S., Kotwicki, L., Dellwig, O., Gentz, T. Pempkowiak, J., Böttcher, M.E. (2011) Groundwater impact on the interstitial and sea water in the Puck Bay. IASWS conference 2011. Abstracts, subm.

[R. Uznyte \(2011\): Stable isotope approach for trophic relationships among some waterbirds on the Baltic Sea Lithuanian coast. 8th Conference of the European Ornithologists' Union 27-30 August 2011, Riga, Latvia](#)

[S. Vogler, B. Szymczycha, T. Gentz, O. Dellwig, L. Kotwicki, M. Schlüter, M. E. Böttcher \(2010\): The impact of submarine groundwater discharge \(SGD\) on a coastal ecosystem of the southern Baltic Sea: Results from the AMBER project. Geophys. Res. Abs. 12, #2974](#)

[S. Vogler, B. Szymczycha, T. Gentz, O. Dellwig, L. Kotwicki, R. Endler, J. Pempkowiak, J.M. Weslawski, M. Schlüter, and M.E. Böttcher \(2010\): The impact of submarine ground water discharge on a coastal ecosystem of the southern Baltic Sea: Results from the BONUS+ project AMBER. Annual BONUS conference, 18.-24.1.2010, Vilnius, Abstracts](#)

[Vogler, S., Dellwig, O., Escher, P., Struck, U., Weise, S.M., Szymczycha, B., Kotwicki, L., Mörth, C.-M., Schlüter, M. & Böttcher, M.E. \(2011\) A multi-isotope \(C, O, S, H\) and trace metal study in coastal permeable sands affected by Submarine Groundwater Discharge \(southern Baltic Sea\). Geophys. Res. Abs. 13, #8757](#)

Susann Vogler, O. Dellwig, P. Escher, B. Szymczycha, T. Gentz , L. Kotwicki, U. Struck, S. M. Weise, C.-M. Mörth, M. Schlüter, M. E. Böttcher, 2011: A multi-isotope and trace element study on highly anoxic groundwaters escaping from coastal sands of the southern Baltic Sea. BSSC 2011, 22-26 August 2011,



Mindaugas Zilius, M. Bartoli and A. Razinkovas(2010): Benthic oxygen uptake in the eutrophicated boreal lagoon (SE Baltic Sea)