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The invasion of lakes by *Gonyostomum semen* – an indicator for climate change?
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Gonyostomum semen (G.) is an invasive, large flagellate that has rapidly increased its distribution and abundance in Swedish lakes during the last decades, particularly in southern Sweden. It can form intensive blooms that can be harmful to humans by causing skin irritation and allergic reactions. Previous and my own preliminary studies have pointed out that high DOC (> 10 mg DOC l^{-1}) and high total phosphorus concentrations (> 30 µg l^{-1}) are favorable for the development of *G.* Since DOC concentrations have increased in many regions of Northern Europe, probably due to climatic changes the increase in the distribution and abundance of *G.* could be a result of climatic changes. In my poster I will show first results that support the close relationship between climatic changes and the occurrence of *G.* since it increased particularly in October when water temperatures have increased over time. *G.* has a life cycle that involves switching between a planktonic vegetative phase and an overwintering resting stage. Field observations indicate that massive cyst formation occurs at around 10°C and I conducted laboratory experiments that confirm that growth of *G.* is limited by temperatures below 10°C. If the time span of temperatures above 10°C is extended due to global warming, we can expect a prolongation of periods when *G.* can cause negative socio-economic and ecological effects. Negative ecological effects might be that *G.* displaces other phytoplankton species that provided a good food source for primary consumers.

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Emergent cyanobacterial blooms in an oligotrophic lake: impacts on nutrient cycling and food webs
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Gloeotrichia echinulata is a toxic, nitrogen-fixing cyanobacterium that causes problematic blooms in oligotrophic lakes across the northeastern United States. Due to its toxicity and potential ability to transport phosphorus from the lake sediments to the water column, *G. echinulata* may substantially impact the lake ecosystems in which it is now blooming. We added *G. echinulata* colonies to *in situ* mesocosms in Lake Sunapee, New Hampshire (USA) and measured the effect of these simulated *G. echinulata* blooms on water column toxicity, nitrogen and phosphorus concentrations, and the phytoplankton and zooplankton communities. In this poster, we present preliminary data demonstrating that large simulated *G. echinulata* blooms (400 colonies/L) increase the water column concentrations of total phosphorus, particulate phosphorus, total nitrogen and chlorophyll. Associated lab experiments demonstrate that *G. echinulata* can also stimulate certain phytoplankton species to accelerate growth and division.

These data suggest that *G. echinulata* may have important implications for nutrient availability and phytoplankton community structure in oligotrophic lakes.

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Depth-integrated, continuous estimates of metabolism in a clear water lake.
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High-frequency dissolved oxygen (DO) measurements have been used for estimating gross primary production (GPP) and respiration (R) in lake ecosystems. Most researchers have determined GPP and R only in surface waters, a practice that may underestimate R in general and GPP in clear-water lakes in particular. We deployed oxygen sondes at multiple sites and depths in a clear-water lake. Rates of GPP or R were similar horizontally over the surface waters of the lake. Diel DO signals weakened with depth; however, removing noise from the data, by either wavelet transforms or moving averages, enhanced our ability to resolve diel metabolic signals. While GPP declined sharply with depth, R was unrelated to depth. The majority of GPP and R occurred in the upper mixed layer, but deeper water accounted for 14-28% of GPP and 20-43% of R depending on the statistical filtering technique used. GPP and R were nearly in balance in the surface waters, but for the entire lake R exceeded GPP, and net ecosystem production was negative. Deployment of oxygen sondes in various habitats and at multiple depths allows for a more complete estimate of whole-lake metabolism and a better understanding of the spatial and temporal complexity of lakes.

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Community metabolism in coastal wetlands of the Laurentian Great Lakes
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A growing body of evidence suggests that community metabolism (the total and relative rates of primary production and respiration) contributes substantially to the structure of faunal communities in coastal wetlands of the Laurentian Great Lakes. The objective of this research was to quantify community metabolism in Great Lakes coastal wetlands and describe its relationship with natural hydrologic and physical variables (e.g., effective fetch, sediment characteristics, wave energy) as well as measures of anthropogenic disturbance (e.g., surrounding land use, dissolved nutrients, dissolved chloride). During the spring, summer, and fall of 2007, community metabolism of the sediment, water column, and epiphyton was measured and aggregated to provide aerial estimates in 12 coastal wetlands of Lakes Huron and Michigan. After removing variability due to water temperature, community respiration correlated positively with sediment organic content and negatively with effective fetch. Gross primary production correlated negatively with anthropogenic disturbance represented by a

principal component axis that integrated land use and cover variables, road density, and dissolved ion concentrations. Net daily metabolism was lowest at sites that were protected from hydrologic energy by their geomorphology and had the greatest proportion of surrounding land in agriculture and development. Rates also varied seasonally with community respiration higher in summer than spring and gross primary production higher in summer than fall. Our results suggest that community metabolism, and the faunal communities that respond to metabolism, are constrained by both natural hydrogeomorphic and anthropogenic disturbance variables. Thus, management agencies should consider both of these classes of drivers when making decisions to maximize the ecosystem services provided by coastal wetlands.

P.E. GARCIA[1]; Pérez, A. P.[1]; Zagarese, H. E.[2] & Diéguez, M. C.[1]

Bioaccumulation of photoprotective compounds and mortality patterns in cold-adapted calanoid copepods from North Patagonia: synergetics effects of UV radiation and temperature

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Climate change is likely to impact aquatic ecosystems in the Patagonia region of Southern South America through different mechanisms: (i) direct increase in UV due to ozone depletion, (ii) direct effect on water temperature and (iii) indirect effects of temperature on tolerance of organisms to UV and changes in the radiation environment mediated by changes in DOC levels. The identification of biological processes influenced by UV exposure and temperature in predictable ways will improve our appreciation of their combined effects on freshwaters. Cold adapted populations of the genus *Boeckella* are common in freshwaters of South America and may be suitable sentinels of climate change since they also occur in lakes and ponds highly exposed to RUV. In this work we focus in two species of *Boeckella*, *B. antiqua* that is restricted to a few sites in Northwestern Patagonia and *B. gracilis*, which has a broad distribution from 31°S 64°W to 49°S 72°W. We analyse the combined effects of RUV and warming on the bioaccumulation of the photoprotective compounds MAAs (mycosporine-like amino-acids) and on species survivorship. Our results indicate that photoprotection by MAAs in B. *antiqua* and B. *gracilis* increases with temperature and exposure to UV radiation. The accumulation of MAAs could be dissected out into uptake and elimination processes, both of which are strongly and predictably influenced by UV and temperature. Bioaccumulation rates of MAAs increase with temperature. The patterns found in both species seem to point out alternative photoprotective strategies. B. *gracilis* bears high amounts of constitutive MAAs which are stable while MAAs concentration in B. *antiqua* is more plastic perhaps compensating its lower amounts of constitutive pigments. These patterns may reflect also specific adaptation to environmental seasonality. In fact, B. *antiqua* inhabits semi and permanent ponds and must adjust photoprotection to a wide temperature gradient B. *gracilis* dwells in ponds with a winter hydroperiod bearing high levels of constitutive MAAs which readily provide photoprotection at a narrower temperature range. Survivorship of *Boeckella antiqua* and B. *gracilis* was found to be significantly conditioned by temperature and UV radiation. Temperatures beyond 12°C pose a

bottleneck for both species and increase UV impact. The bioaccumulation of photoprotective compounds and the survivorship of cold adapted zooplanktonic species could be used to assess the potential effects of warming and increased UV exposure due to climate change.

Emily KARA[1], Ashley Shade[1], and Robert Bohanan[2]
Iterative development of web-based learning module for high school science classrooms using GLEON real-time buoy data
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We aim to complement curricula in Wisconsin high school science classrooms by collaborating with science educators to generate a web-based learning module. We use real-time GLEON sensor data to create and investigate inscriptions of the chemical, biological, and physical relationships within Wisconsin lakes and across scales, and then to generate and test hypotheses based on these explorations. Educators' reported curricular needs with respect to fulfillment of the Wisconsin Educational Science Standards informed module content. We are currently developing a workshop for Wisconsin science teachers to evaluate the first prototype of the web-based learning module. The workshop will include preliminary and summative evaluations to determine the quality of teachers' own experience as *learners* with the module, and a pedagogical analysis by the teachers of the module as a tool for teaching scientific concepts.

Samuel KIBICHII[1], William Shivoga[2] and Scott N. Miller[3]
Seasonality in water quality and its influence on the ecosystem of lake Nakuru, Kenya
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Lake Nakuru is world famous for the millions of Flamingos that have made it an important tourist destination. Recently, it has come under intense human influence leading to sporadic fish and bird kills. It is suspected that seasonal changes in water quality caused by reduced water inputs from the watershed due to abstraction and catchment destruction are the major drivers of ecosystem change yet little is known on specific changes in physicochemistry, phytoplankton and benthic fauna. Physico-chemical variables, chironomid larva and phytoplankton were monitored between February 2004 and March 2005 to determine their patterns as seasons change throughout the year. Strong gradients in physicochemical conditions were observed between the times its rivers flood and dry up. Average depth decreased from ~1.4 to ~0.9 m in the deepest part of the lake. This was followed by a doubling of salinity from 15.1 PSS to 33.5 PSS and increasing pH (10.4-11.4). Vertical gradients in DO remained strong with bottom waters being <1mg DO/L while surface water remained >10mg/L all year round. Over the same time, the

abundance of Chironomidae decreased throughout the lake although significantly lower abundances were recorded in the Northern side of the lake all year round. This part of the lake is closer to Nakuru town. In contrast, phytoplankton abundance fluctuates between blooms and crushes with out particular correlation with season despite phosphorus and nitrogen nutrient concentrations increasing in the dry season. While we have recorded seasonal patterns in physico-chemistry, chironomid larva and phytoplankton that will aid in conservation efforts, challenges remain in trying to link these patterns because the temporal scales we used were too wide in between study periods for more resolved analyses to be done. In future, automated, near real time monitoring using the 'GLEON-type' sensor systems may be necessary.

Gregory R. KOCH[1], Peter A. Staehr[2], and Daniel L. Childers[3]
Preliminary metabolic estimates of an oligotrophic, subtropical pond using diel changes in dissolved oxygen
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I present initial estimates of aquatic ecosystem metabolism from a pond in the Southern Everglades, Florida, USA. This pond is one of several along the reach of Taylor River, an important hydrologic linkage between the freshwater Everglades and Florida Bay. My research aims to understand carbon, nitrogen, and phosphorus transformation and transport in the pond-and-creek pattern of Taylor River and how these dynamics are influenced by season (wet vs. dry), storm events, and anthropogenic water management. This poster shows data from the first of six sensor stations that will be deployed in Taylor River for the purpose of monitoring aquatic metabolism year-round. Relationships between metabolic processes and key driving variables are also explored.

Owen C. LANGMAN[1], and Paul C. Hanson[1], Stephen R. Carpenter[1], Kenneth Chiu[2]
Event detection in limnological time series data
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This poster describes an online method of detecting novel events within commonly measured limnological variables. Dynamic Bayesian Networks (DBNs) and bayesian models (Surprise Theory) are used to map statistical characteristics of variables as well as inter-variable relationships, with events corresponding to outliers within these contexts. Several historical datasets are used to evaluate the method.

Hannes PETER[1], Eva Lindström[1], Silke Langenheder[1], and Lars Tranvik[1]
Microbial diversity and ecosystem functioning - redundancy and resilience in communities degrading aquatic organic matter
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In my thesis, I will focus on the relationship of ecosystem functioning and diversity of aquatic microbial communities. Fundamental hypotheses will be tested regarding the connections between microbial diversity, ecosystem functioning, and resilience using aquatic microbial communities and their degradation of organic matter as a model. The PhD study will be made up of two main parts (i) bacterioplankton diversity and ecosystem functioning and the importance of functional redundancy *per se* and (ii) how diversity affects the patterns of resilience of microbial communities to different kinds of perturbations. The role of functional redundancy will be studied using batch and chemostat cultures and sterilized natural lake water as culture media and dilution-to-extinction series of natural bacterioplankton assemblages as inocula. Resistance and resilience against perturbations will be investigated using chemostat cultures and the dilution approach mentioned above.

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The development of an optical indicator of allochthony and photobleaching in low DOM lakes

Regional and global changes in climate and other environmental factors can alter the degree of allochthony in lake ecosystems. Allochthonous dissolved organic matter (DOM) is an important ecosystem subsidy that regulates many limnological characteristics including transparency, euphotic zone depth, net ecosystem production, pH and buffering capacity, microbial communities, thermocline and temperature stratification, metal availability, and toxicity of many xenobiotics. While studies have used a variety of methods to assess allochthony in lakes with high concentrations of dissolved organic matter (DOM), little research has focused on how differences in allochthony influence low DOM systems such as alpine lakes. Small environmental changes may substantially alter both the degree of allochthony and transparency of alpine lakes. The effects of climate change may be understood by examining how transparency varies in relation to allochthony. In the summers of 2007 and 2008 we examined the relationship between several optical indices (absorbance derivatives, PAR:UV ratios) and degree of allochthony (DOM/chl ratio) in a suite of alpine and subalpine lakes in the Beartooth plateau, WY/MT. Short wavelength UV-B absorbance was related to photobleaching, while longer wavelength UV-A was related to degree of allochthony in the lakes. This suggests that transparency and absorbance may be used to understand both the source and exposure history of dissolved organic material in low DOM lakes.

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Lake Monitoring Network at Burrishoole Co. Mayo, Ireland
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The Burrishoole catchment is an important index system for salmon, trout and eels in the NE Atlantic region. The catchment has been monitored since the mid-1950s and several automatic monitoring stations have been in use since the mid 1990's. There are two Automatic Water Quality Monitoring Stations (AWQMS) in place. The first on Lough Feeagh (freshwater) was installed in 1996 and the second AWQMS was installed on Lough Furnace in May 2008. Lough Furnace is a brackish lake, with sea water entering the lake at every tide. The data presented from Lough Furnace represents initial results.

Matthew C. VAN DE BOGERT[1], Owen C. Langman[1], Darren L. Bade[2], Stephen R. Carpenter[1], Jonathan J. Cole[3], Paul C. Hanson[1], Tim K. Kratz[1], Michael L. Pace[4].
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Confronting within-lake heterogeneity: How many sensors does it take to measure whole-lake metabolism?

Automated, high-frequency, in-situ dissolved oxygen (DO) sensors are widely used to obtain estimates of gross primary production (GPP) and respiration (R) in aquatic ecosystems. While researchers often rely on a single, centrally-located, sensor for these estimates, recent work has shown considerable heterogeneity of these measurements within lakes. How can researchers best measure whole-lake metabolism when faced with that heterogeneity? We addressed this question by deploying 35 and 28 high-frequency temperature and DO sensors throughout the epilimnia of two lakes in Northern Wisconsin, USA, respectively. These sensors provided location-specific dissolved oxygen measurements as well as spatially-weighted lake-wide estimates. The average range of daily variation in dissolved oxygen was approximately 0.1 $mg \cdot L^{-1} d^{-1}$ in pelagic sites, while much greater, 0.8 $mg \cdot L^{-1} d^{-1}$, in littoral zones. Individual locations often did not follow the classic Odum model(1956) and prevented the estimation of GPP and R. When averaged lake-wide, however, dissolved oxygen did follow the Odum model and we were able to calculate whole-lake GPP and R. The minimum number of sensors needed to obtain acceptable results was determined using rarefaction techniques.

Carola WAGNER[1], and Rita Adrian[1]
Cyanobacteria blooms – when climate dominates the spiel
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In the context of global warming, an increase in cyanobacteria bloom formation in lakes has been forecasted. We were interested in the particular physical and chemical thresholds within which cyanobacteria are favoured. We based our study on decadal records of polymictic eutrophic Müggelsee, a lake affected by significant warming trends and a substantial reduction in external nutrient loads. We tested water temperature, Schmidt stability, oxygen, and pH; nutrients such as phosphorous, nitrogen as well as their ratios along with zooplankton during thermally stratified periods in summer by means of classification tree analysis. Although nutrient concentrations, especially total phosphorous (TP), were the primal forces for cyanobacteria contribution to total algal mass, climate induced changes in thermal regime rather than direct temperature effects caused cyanobacteria to gain dominance. Stratified periods exceeding four weeks and exhibiting a Schmidt stability of >44 g cm cm^{-2} acted in favour of cyanobacteria. Though, this was only true within a critical range of TP concentrations between 70 and 215 $\mu g\ L^{-1}$. Given the broad range of TP concentrations within which warming enhances the risk of cyanobacteria dominance, cyanobacteria blooms will certainly become a rising problem in a variety of lakes under future climate scenarios.

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The filtration of water-samples onto membrane-filters and subsequent double staining by DAPI (DNA) and fluorescence in-situ hybridisation (FISH) offers a fast way to quantify microbial populations in natural freshwater and marine environments as well as in artificial systems. The manual evaluation of the samples by epifluorescence microscopy represents the most time-consuming step in this procedure. To overcome this problem we created an automated high-throughput system for sample-localization, high-resolution image acquisition and evaluation of multiple FISH-stained preparations. The core of the system is formed by a motorized epifluorescence microscope equipped with a camera and stage capable of holding up to 99 individual samples on eight slides. The microscope is fully programmable with Visual Basic for Applications (VBA). Using an object oriented programming approach we developed a user-friendly system for the high-throughput evaluation of FISH experiments. The system is able to evaluate preparations that are stained with up to three fluorescence dyes, and to combine fluorescence staining with transmission illumination (e.g., for cell activity measurements by microautoradiography). In addition to validation and counting, a size measurement and a morphological classification of cells is also possible. The new system promises great simplification of the evaluation of large numbers of samples. It might thus be valuable both for

monitoring purposes as well as for high-resolution studies of microbial population dynamics and activity.

Qiang ZHANG[1], and Zhengwen Liu[1, 2]

Effects of periphyton in artificial substrata on the change of water quality

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The effects of periphyton on the water quality was examined in the experimental tanks near Lake Taihu (China). Throughout the study period, the periphyton was allowed to grow on artificial substrata in tanks filled with water from Lake Taihu. The tanks were fertilized with nitrogen and phosphorus (N:P $\geq$ 25 by masses) at rates 5 mg $P \cdot m^{-3} \cdot d^{-1}$. Compared with control(no artificial substrata), the nutrient concentration and phytoplankton chl a decreased significantly. We also evaluated vertical distribution of periphyton biomass, high proportion of periphyton was found within the uppermost 50 cm of the substrata. These results suggest that establishment of periphyton by constructing artificial substrata can improve water quality significantly. Additionally, there were difference between tanks with and without artificial substrata in zooplankton, indicating the effects of periphyton on the whole ecosystems.