# GLEON 8 Student Poster Session

## Abstracts

Ina Bloch[1] and Gesa A. Weyhenmeyer[1]

**Will a decrease in nitrogen deposition favor nitrogen-fixing cyanobacteria?**

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Our poster gives an overview about our future research plans. The overall aim is to assess the effects of changes in atmospheric nitrogen deposition on the phytoplankton community composition in Swedish lakes by using long-term data series from the Swedish lake monitoring program. Preliminary results show a strong decrease in N:P ratios in many Swedish lakes probably resulting in N-limitation of primary producers. At the same time as the N:P ratios decreased, we observed an increase in the occurrence and the biomass of the nitrogen-fixing phytoplankton species *Anabaena sp*. Since an increase in the biomass of *Anabaena sp*. can result in harmful algal blooms nitrogen reduction measures need to be carefully evaluated for each lake ecosystem.

Cayelan C. Carey[1,2], Kathleen C. Weathers[3], Karin Rengefors[4], Kathryn L. Cottingham[2]

**Emergent cyanobacterial blooms in an oligotrophic lake: *Gloeotrichia echinulata* may accelerate eutrophication**

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*Gloeotrichia echinulata* is a toxic, nitrogen-fixing cyanobacterium that has recently begun blooming in oligotrophic lakes across the northeastern United States. Due to its toxicity and ability to potentially transport nutrients from the lake sediment to the water column, *G. echinulata* may substantially impact the lake ecosystems in which it is now blooming. We added *G. echinulata* colonies to bag mesocosms in Lake Sunapee, New Hampshire (USA) and measured the effect of these simulated *G. echinulata* blooms on water column toxicity, nitrogen and phosphorus cycling, and the phytoplankton and zooplankton communities. In this poster, we present data demonstrating that simulated *G. echinulata* blooms (400 colonies/L) significantly increased phytoplankton biomass and species diversity. Associated lab experiments confirm this result and demonstrate that *G. echinulata* specifically targets certain phytoplankton species to accelerate division. These data suggest that *G. echinulata* may have important implications for the ecosystem and food web processing of oligotrophic lakes.

Emily Kara[1] and Katherine McMahon[1]

**Investigating phosphorus fractionation and bacterial 33PO43- uptake in eutrophic lakes.**

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The research aims to increase the understanding of the mechanisms involved in P cycling, particularly with respect to bacterial community composition, using traditional limnologic techniques and modern molecular microbiological tools. Though it is generally understood that bacteria and algae control P-cycling in lakes, knowledge of the taxonomic groups responsible for specific P transformations, the biochemical mechanisms involved, and the contributions of different taxonomic groups to P transformations is limited. Studies of eutrophic lakes indicate that freshwater bacterial community composition is variable, and this variation is correlated to differences in nutrient availability.

Distribution of polyphosphate, a biogenic polymer composed of phosphate residues linked by high-energy phosphoanhydride bonds, was investigated in surface sediments over a depth transect in Lake Mendota, Wisconsin. Cellular polyphosphate granules were quantified microscopically; polyphosphate concentrations were supported by chemical fractionation results.

Bulk uptake of 33PO43- was measured in Lake Vallentunasjon, Sweden, via liquid scintillation analysis. Population-specific bacterial uptake is being further investigated, qualitatively, using fluorescence in situ hybridization combined with microautoradiography (FISH MAR).

Samuel Kibichii[1]

**Towards a sustainable management program for the saline-alkaline Lake Nakuru ecosystem: Identifying the key limnological variables for monitoring**

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A literature review of publications based on research done in Lake Nakuru over the last 50 years was done to help in understanding key ecosystem dynamics and the physicochemical factors underpinning them. Biological diversity and community structure, of soda lakes in general, seem to be controlled by salinity and the degree of environmental stability of one given area. They tend to have low biodiversity but high biomass of few well adapted species of flora and fauna. In Nakuru, the phytoplankton community is dominated overwhelmingly by the cyanobacterium *Arthrospira fusiformis* during the rainy season, but another cyanobacteroum *Microcystis* sp. tends to dominate the community during dry spells when frequent algal crashes and fish and bird die-offs are recorded. During either season, algal biomass is always high reflecting its hyper-eutrophic status. Being shallow and endorheic, the lake responds very fast to increased or reduced water inputs from the watershed; flooding when the rains are high and losing up to 90% of its surface area during dry spells, and when there are elongated droughts. These fluctuations are accompanied by changes in the concentrations or proportions of all major ions which comprise the anions $Cl^-$, $HCO_3^-$ + $CO_3^{2-}$, F– and $SO_4^{2-}$, and the cations $Na^+$ and $K^+$. Unfortunately, some of these fluctuations are as a result of water abstraction from the main rivers draining into the lake. Conservationists are concerned with frequent die-offs of the elegant flamingo *Phoeniconaias minor* Gregory and the introduced fish *Oreochromis algalicus grahami* occasioned by cyanobacterium poisoning following an algal crash. On the other hand, water resource managers are interested in knowing the safe level of water they can extract to satisfy community needs. Such expectations are complicated by an erratic weather pattern, watershed degradation and possibly a changing climate regime. Nonetheless, it's hoped that monitoring key ecosystem variables over a long time will enable stakeholders to determine the minimum lake level beyond which the ecosystem undergoes irreversible change leading to fish and bird deaths, and where the lake must be maintained to conserve its biodiversity while allowing watershed communities access to the rivers. It would seem that monitoring conductivity as a surrogate of physicochemical condition, flamingo populations as a surrogate of water bird populations, chlorophyll a for the phytoplankton biomass and total nitrogen and total phosphorus would be necessary to develop an early warning system for both conservationists and water resource managers.

Anniina Kiiltomäki[1], [2], Lauri Arvola[2], Matti Leppäranta[1], Timo Huttula[3], Hanna Huitu[4], and Jussi Horelli[5]

**High frequency measurements and modelling in environmental monitoring of a shallow large lake**

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Water quality and prediction of water quality are questions that need to be answered daily in many different occasions, e.g, in environmental decision-making in industry, agriculture and use of water for human consumption. High frequency measurements combined with numerical modeling provide a wide range of possibilities that can be utilised in environmental monitoring of lakes, which has been traditionally based on manual measurements.

The focus of our research is in the interface of physical, chemical and biological properties of Lake Vanajavesi, a large shallow, eutrophicated lake close to the city of

Hämeenlinna in southern Finland. The lake has a long eutrophication history with very poor water quality in 1960´s and 1970´s. Since those days, water quality has improved a lot but still the lake has many serious problems due to oxygen deficiency in deeper areas, heavy algal blooms with high percentage of blue-greens during late summer and diseased food-web structure because of major changes in fish community, macrocrustaceans and benthic animals. The state of the lake has been influenced by long-lasting nutrient and toxic element inputs and water level alternations caused by a various human actions. Thus one of the final goals in using the monitoring data together with the model predictions is to better understand factors, which are influencing the growth of cyanobacteria and their massive blooms in the lake. The ultimate goal is to prevent the harmful blooms and to improve the water quality as a whole.

The high frequency data will be produced by a measuring station that has sensors for physical, chemical and biochemical properties including weather conditions. Additionally, other measurement techniques and possibly satellite images will be used as well to improve the model that links the physical properties with nutrient variations and phytoplankton development. As a result, we aim to produce algorithms, which can be utilised in the evaluation and prediction of water quality of eutrophicated lakes and in different environmental decision making and management purposes. Also, up to date information of the status of Lake Vanajavesi will be obtained, and the factors affecting to that will be closely investigated.

This poster will give some basic information on our project which has started at the end of 2008 and will continue till spring 2011. We look forward to collaborating within the GLEON network. Our main focus will be in modeling of the lake physics combined with lake water quality and ecosystem modeling with the blue-green algae blooms. Any collaboration dealing with these matters is welcome.

Alo Laas[1], Tiina Nõges[1]

**Investigation of water chemical and physical parameters by using the automatic monitoring station in Lake Võrtsjärv, Estonia.**

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L. Võrtsjärv (area 270 km$^2$; maximum depth 6.0m; mean 2.8 m) is the largest lake belonging entirely to Estonia. The volume of Võrtsjärv is 0.75 km$^2$ and the retention time is around one year. Lake Võrtsjärv, together with the watercourses in its drainage basin, represents one of the most intensively investigated inland aquatic systems in Estonia. Occasional hydrological research on Lake Võrstjärv began at the beginning of the 20th century. The lake level has been recorded daily at the only outflow Rannu-Jõesuu in the northeast part of the lake since November 1921. A new period in lake research started in the 1960s, after the foundation of Võrtsjärve Limnological Station (today - Centre for Limnology). The regular investigation of lake hydrochemistry was started in 1968.

In 2008 we started to use additionally the automatic monitoring station for measuring the turbidity, $NO_3$, TOC, DOC and water temperature during ice free period in Lake Võrtsjärv. We present the first results of 2008 collected data.

Rebecca Lawson[1] and Sally MacIntyre[1]

**Identifying Mixing Regimes Associated with Storm Events in Toolik Lake, AK**

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The Lake Number ($L_N$) is a useful index to classify the mixing regime of lakes in response to climatic forcing. Low Lake Numbers ($L_N < 10$) are indicative of thermocline tilting, to a varying degree, which can give rise to internal waves, sheer production along the thermocline, and turbulent mixing at the lake boundaries thus facilitating exchange between the epilimnetic and hypolimnetic waters. Data was collected at Toolik Lake, AK during June – August 2008 to identify physical mixing mechanisms which may be important to the phytoplankton and microbial communities. The lake quickly stratified after ice-out allowing stable conditions and development of chlorophyll maximum. Many strong wind events occurred in the region later in the summer where winds exceeded 5 m/s on several occasions and reached 10 m/s on two occasions. Low $L_N$ events were observed where internal waves coincided with wind forcing on a few occasions. Mixing mechanisms in early July were more strongly influenced by wind forcing where the turbulent velocity scales from wind, $u_*$ = 0.8-1 cm/s, were higher than the velocity scales due to convective cooling, $w_* \simeq$ 0.5 cm/s, during low $L_N$ events. Heat loss became more important to the mixing regime in late July through the rest of the season where $w_*$ values were about equal to $u_*$ at ~0.8 cm/s, and high wind speeds were often associated with cold fronts. Eddy diffusion coefficients consistently reached $10^{-4}$ $m^2$/s in the surface layer after mid-July and reached $10^{-5}$ $m^2$/s in the hypolimnion during a various low $L_N$ events (usually $L_N \simeq 1$) throughout the summer. The first storm event of the season where significant decreases in air temperature coincided with high wind speeds occurred around 20 July. During this event the thermocline was compressed approximately 2 m deeper into the water column. This event was responsible for dispersing the chlorophyll maximum and weakening vertical gradients of ammonium and DOC.

Jordan S. Read[1], Ashley Shade[2], Chin Wu[1], and Katherine D. McMahon[1]

**The physical response of a small bog lake to an artificial mixing manipulation**

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Artificial mixing was used to eliminate the barrier to vertical transport associated with seasonal temperature stratification of a small bog lake. The mixing method reset gradient variables to a near-homogeneous state and monitored post-treatment trajectories to gain insight on altered lake mixing regimes. We used the buoyant transport of air injection, without an air-water interface, to repeatedly exchange water between the epilimnion and hypolimnion. The method minimized the confounding variables of sediment re-suspension and gas exchange associated with traditional mixing methods. High frequency physical data were collected by use of an instrumented buoy (met., temperature), profiling sonde (DO, turbidity) and upward pointing ADCP (acoustic doppler current profiler). Spatial temperature transects were obtained with HOBO water temperature loggers. The mixing treatment produced high-frequency internal waves during periods of calm winds and intrusions centered on the thermocline during sustained winds. The water column temperature differential (surface to 3.5m depth) changed from a pre-treatment measurement of 19.2°C to a differential of 0.2°C measured at the conclusion of treatment. The initially anoxic hypolimnion increased to a dissolved oxygen concentration of 2.8 mg L-1, while the epilimnion DO decreased from 7 to 3.2 mg L-1. Sediment re-suspension (as measured by the proxy of turbidity) showed a downward trend in the hypolimnion and a slight upward trend in the epilimnion.

Kevin Rose[1], Craig Williamson[1], and Jasmine Saros[2]

**Transparency patterns of high elevation lakes in the Beartooth Moutains, MT/WY, USA**

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High elevation lakes, both alpine and subalpine, often differ from temperate lakes in several important ways. High elevations are projected to increase in temperature more than lower elevations due to global climate change. At high elevations, temperatures are lower and more precipitation falls as snow, influencing ice phenology and watershed vegetation biomass. While dissolved organic carbon (DOC) is often responsible for controlling transparency in most temperate lakes, chlorophyll *a* often becomes an important model component in high elevation systems when DOC is low. Climate driven changes in transparency and the materials that control transparency have the potential to influence lake ecosystem structure and function. We present data on seasonal patterns of transparency for 320 nm, 380 nm, and PAR (photosynthetically active radiation, 400-700 nm) in a series of alpine and subalpine lakes in the Beartooth Mountains, MT/WY, USA. Seasonally, lakes generally increased in transparency, beginning soon after ice out. Models that include only DOC overestimated 380nm UV transparency at low DOC concentrations (<1 mg/L). Lakes ranged in DOC concentration from 0.4 – 3.0 mg/L and lakes that consistently changed the most in transparency were of lower DOC (0.8

- 1.4 mg/L). In three lakes, residuals about the modeled seasonal changes in transparency were significantly related to the previous winter's total snowfall, indicating snowfall as a potential climate driver of transparency.

Carola Wagner[1] and Rita Adrian[1]

**Hierarchy responses to climate warming? Timing and type of changes and regime shifts in lakes**

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Shifts in climate regime have provoked substantial trophic- and species-dependent changes within ecosystems. With growing concerns of present global warming, we examined potential lake ecosystem responses, natural hierarchy responses (i.e. immediate responses at lower system levels as opposed to delayed responses at higher system levels), and possible shifts among abiotic (physics, nutrients) and biotic (phytoplankton, zooplankton) system components. Specifically, we analyzed decadal data collected from Müggelsee, a lake in Berlin, Germany, for climate induced abiotic and biotic changes, their timing and type, and classified them as abrupt permanent, gradual permanent, abrupt temporary, or monotonic. We further categorized variable changes as a function of system hierarchy, including lake physics (ice, temperature, stratification), nutrients (phosphorus, nitrogen, silicate), plankton, and levels of integration (i.e. species, taxonomic groups, and total plankton). Contrary to current theory, data suggests abrupt responses did not occur in a hierarchy-dependent manner, nor was a clear pattern observed among functional system based categories. Nevertheless, the complexity of response patterns at the single system level manifested clear chronological regime shifts in abiotic and biotic parameters in spring and, to a lesser extent, in summer. With regard to projected global warming, the majority of currently unaffected system levels may face impending thermal thresholds, achievement of which would result in an accelerated shift in ecosystem state.

Shen Yan[1] and Gao Guang[1]

**Community Analysis of the Bacterial Assemblages in the Winter and summer of Meiliang Bay of a large, shallow Lake Taihu by In Situ Hybridization**

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My research focuses on the diversity of bacterial community structure during winter and summer in a large, shallow, eutrophic Lake Taihu.

From December 2007 to March 2008, and from June to September in 2008, surface water samples (top 50 cm) were collected monthly at Meiliang Bay (3#), a

hypereutrophic site of Lake Taihu. The variability of the bacterial community was studied by fluorescence in situ hybridization (FISH). This whole-cell hybridization with fluorescently labeled oligonucleotide probe facilitates the microscopic determination of absolute abundances and cell morphologies or sizes of different bacterial taxa. According to our previous research, the dominant phyla of bacteria (the free-living and attached bacteria) were acquired through a series of complicated molecular biological techniques and procedures. Major phyla were α-proteobacteria, β-proteobacteria,γ-proteobacteria, Bacteroidetes and Planctomycetes, respectively. Consequently, six probes were used, which were Alf968, Bet42a, Gam42a, CF319a, Eub338 and Non338, to detect the variety of bacterial community composition. Except the probe Non338, the other five probes all hybridized with the samples and demonstrated significant fluorescent signals. The results of FISH illustrate that the abundances of bacterial community structure varied obviously during the winter and summer.