GLEON 15 Bahia Blanca, Argentina

GLEON 15 Poster Session

Tuesday November 5, 2013 15:30-17:30
Wednesday November 6, 2013 14:45-15:45

GLEON 15 Bahia Blanca, Argentina

Poster Abstracts

1. Dilek Eren AKYUZ

Eutrophication model application to Egirdir Lake, Turkey.

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Numerical method can be accepted useful tools to understand eutrophication process which is under effects by anthropogenic and natural change. In this study, Lake Egirdir, Turkey is selected as study site and modeled with using Elcom-Caedym. A large shallow lake has an essential role in irrigation, supplying drinking water and tourism as the third largest lake in Turkey. The lake's shape is like number eight: connected one small and one large lake via surface. The bathymetrical and meteorological properties, main rivers of discharge rates and concentrations are defined in the model. And then the model ran from October 1th, 2008 to March 31th, 2010 with 500m x 500 m resolution in surface and 0.5m in depth for each 300 seconds. It simulates total nitrogen and total phosphorous concentrations which are selected as main eutrophication parameter. The parameters are measured each season during study period in lake and main rivers by Tubitak-Mam (The Scientific and Technological Research Council of Turkey- Marmara Research Center). The comparisons between measurements and simulation results in study periods show that ELCOM can successfully use to simulate the temporal and spatial variations of physical (temperature), and chemical (nitrogen and phosphorus) parameters. The results are also shown that lake acted as separated two different lakes: the small part of the lake has lower nutrient concentration in summer but higher nutrient concentration in winter period and the bigger part of the lake has on contrary.

2. M. Belén ALFONSO[1], Alejandro Vitale[1,3], M. Clara Menéndez[1], Vanesa L. Perillo[2], M. Cintia Piccolo[1,3] and Gerardo Perillo[1,3]

Assessment of physicochemical and biological characteristics of La Salada shallow lake (Argentina) using high frequency buoy data*

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Argentinian Pampean lakes are shallow and naturally eutrophic. Because of their great area/volume ratio they respond to environmental, hydrological and anthropogenic changes modifying their water characteristics. La Salada is a saline shallow lake located in the South of Buenos Aires Province (Argentina). Water Authority maintains its water level discharging water from the Colorado River. A buoy installed on the lake since October 2012 provides high frequency water and meteorological data. The purpose of the investigation is to analyze the physico-chemical water characteristics and the presence of zooplankton. The study period is from October 2012 to September 2013. Monthly measurements with an *HORIBA U10* meter and zooplankton samples (47 µm mesh pore size net) were taken. Transparency was measured with a Secchi disk. Monthly chlorophyll-a values ranged between 16.6-54.7 µg L^{-1}, classifying as a mesotrophic to eutrophic lake. The Chlorophyll-a/Phaeopigments ratio was always >1, indicating a good status of phytoplankton population. This lake is classified as mesosaline (34.5) and turbid (Z_m/Z_p >1). Precipitation influenced water pH, Secchi depth and chlorophyll-a values ($p = 0.03$, $p = 0.004$ and $p = 0.04$ respectively). Water level showed a significant correlation with electrical conductivity ($p= 0.0018$) and chlorophyll-a ($p = 0.0317$). Chlorophyll-a correlated to air temperature ($p = 0.006$) and conductivity ($p = 0.01$). These results show the impact of water discharge from human management on the structure and dynamics of the biologic community. Typical halophytic Rotifera species, *Brachionus plicatilis* and the large predatory pleurotosmatid *Paradileptus elephantinus* were registered. This study presents the first scientific basis for further studies in La Salada shallow lake.

3. Vanina S. ALIAGA, Federico Ferrelli, María C. Piccolo, Gerardo M.E. Perillo

APPLICATION OF NUMERICAL MODELS FOR THE STUDY OF SURFACE WATER BODIES ON THE PAMPAS REGION*

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Numerical models and satellite information are important tools to characterize the climate in a region, while the climate is an essential element to understand the dynamics of water bodies. We studied the evolution of a set of shallow lakes (Chasicó, Paso de las Piedras, las Encadenadas del Oeste, La Picasa and Chascomús) distributed along a climatic gradient. The aim of the study was to compare the changes occurred in those lakes based on results obtained from numerical models and information from satellite images (LANDSAT 5 and 7). Data from the Reanalysis (NCEP / NCAR) and Bioclim models were processed for each lake. Dry, wet and normal years were identified within the period 1981-2012. The occurrence of extreme events was studied by the Quintiles and Normal methods. The results showed that the numerical models represent accurately the climate of the Pampas region. In general, the lake area was directly related with the amount of precipitation. For example, in the Encadenadas del Oeste, the lake area presented an increase of 4l946.4 ha in

a very wet year (1991) and a decrease of 12726.5 ha in a dry year (2008) compared with a normal one (2006). To the south, in the semiarid region of the Pampas region, the Chasicó lake presented a decreased of 126.8 ha in a very dry year (2008) compared with a normal one (1995). Similar results were found in the other lakes. Climate information derived from numerical models represented the climate variability of the Pampas water bodies. Remote sensing and free online acquisition and availability of the models make these tools useful when weather stations are not available over the region.

4. Orlane ANNEVILLE[1], Sami Souissi[2], Anissa Souissi[2], Sophie Chambord [3], Emilien Lasne[1], Marie-Elodie Perga[1] and Isabelle Domaizon[1]

GLACPE: for a better understanding of changes in processes and regulatory mechanisms of pelagic ecosystems

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Lakes Geneva, Annecy and Bourget are deep peri-alpine lakes located in the western part of the Alps. They have been involved in long-term water quality and biological monitoring programs since the end of the 1950's for Lake Geneva and more recently for Lakes Annecy and Bourget. These programs, conducted by the INRA with the funding provided by socio-economic partners, focused primarily on the measurement of physical, chemical parameters and plankton abundance and composition. Their objectives were to highlight changes in the water quality and evaluate the efficiency of restoration programs. In 2010, the lakes monitoring merged within an Observatory project (GLACPE) dedicated to research achievement. GLACPE program aims at providing data to better understand the functioning of ecosystems in a changing world. Consequently, the monitoring has been complemented with fish data and a sample archiving service is now being developed. Analyses of *in-situ* measurements have allowed drawing relationships between changes observed in pelagic communities and environmental variables. Fish abundances are a valuable complement that gives new insights on mechanisms regulating plankton biomass. Finally, sample archiving allows additional data acquisition to test hypothesis for changes in processes or mechanisms. Our poster will discuss how coupling between analysis of *in-situ* data and organisms preserved in archived samples bring new clues to better understand how lake ecosystems respond to changes in environmental pressures. Undeniably, *in-situ* data and stored biological materials make together a scientific heritage that should improve our understanding of ecosystems sensitivity to global changes.

5. Roxanna L. AYLLON [1], Carlos Oyarzún[2], Brian Reid[3]

Evaluating C:Si biogeochemical cycling through the Ecohydrology and Ecophysiology of Freshwater Forested Wetlands ("Hualves") in Southern Chile.

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The cycling of amorphous silica (ASi, phytoliths) in terrestrial vegetation has important implications for Phytolith Occluded Carbon (PhytOC), which allows long-term sequestration of atmospheric CO_2. Estimation of sequestration rates in "hualves" forested wetlands through its Si:C stoichiometry is proposed across an altitudinal gradient in Chile. **Hydrology** (evapotranspiration and hydroperiod) and **vegetation** processes (photosynthetic attributes, mainly stomatal conductance) control the ASi and PhytOC storage and fluxes in these sensitive wetlands. The consistent presence of water and dense vegetation in "hualves" generates the highest evapotranspiration rates within a watershed clearly indicating the ecological relevance of these ecosystems. "Hualves" in southern Chile are locally undervalued and usually drained for agriculture, livestock raising or highly logged for firewood extraction, thus there is an urgent need to understand their ecosystem functioning and identify the specific ecosystem services they provide. Mass balance approach combined with continuous monitoring of hydrological drivers, and corresponding stoichiometric relationships in "hualves" will enable evaluation of ecosystem services such as carbon sequestration, and may demonstrate their potential role as sentinels of climate change within the watershed.

6. Bahnmüller[2], Calissano[2], A., Gilabert[2], A., Nieva[2], N., Arena[2], M., Vitale[2,3], A. J., Bohn[2], V. Y., Piccolo[2,3], M. C. and Perillo, G. M. E.

HOW THE STORM EVENT OF APRIL 2, 2013 AFFECTED THE SHALLOW LAKES IN THE PAMPAS?

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An extreme weather event occurred from March 30 to April 2, 2013 on the Pampa region, Argentina. The storm was characterized by severe precipitation rates and a large spatial variability. The intensity of the rain generated several problems in the area: flooding, death of people (many others suffer injuries) and significant economic losses. The precipitation of April 2, 2013, with 392.2 mm is the highest values measured in the Astronomic Observatory of La Plata University. The meteorological situation associated with the event of heavy rainfall over the Buenos Aires Province was dominated by the presence of a low pressure center at middle levels of the troposphere. The phenomenon persisted for more than 36 h. The purpose of the study was to analyze the change of the water parameters at four shallow lakes due to the passage of the storm. The studied lakes are: La Helvecia (33° 25´ 28.30" S - 62° 53´ 55.26" W), La Barrancosa (37° 05' 53.34" S - 58° 11' 49.58" W), La Salada (39° 27' 43.78" S - 62° 41' 55.82" W) and Grande de Otamendi (34° 13' 58.33" S - 58° 52' 21,51" W). Limnological high frequency parameters were acquired from buoys deployed on each lake. The synoptic weather conditions were obtained from the National Argentine Meteorological Service. Water level, temperature, salinity and suspended

sediment, caused by the strong winds, were the main physical parameters affected by the storm. In the lakes, the event originated an average decrease of water temperature of 2 °C generated by the rapid decrease in air temperature. The surface salinity decrease because of the intense rain and the daily water level raised 10 cm in few hours in almost all the lakes. Although the four lakes are separated by thousands of km (e.g., 1200 km between La Helvecia and La Salada) the response of the shallow lakes to the passage of the storm was similar. However, the economical and property damage occurred in the communities of each lake were different. Not all the studied lakes presented management plans to prevent damages from extreme weather events. The main result of this analysis is to highlight that the management in lakes is critical to avoid serious inconvenient to the communities living on their coasts.

7. Sarah L. BARTLETT[1], Todd R. Miller[2]

Influence of lake metabolism on toxic cyanobacteria bloom production

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The highly eutrophic Lake Winnebago in Wisconsin has a history of producing large blooms of potentially toxic *Microcystis* and *Aphanizomenon*. Using a moored buoy, we monitored high-resolution variability in lake metabolism and cyanotoxin production during an August bloom event using dissolved oxygen measurements and auto-sampling. Water quality parameters were recorded every minute for 2 weeks to calculate net ecosystem production (NEP) and gross primary productivity (GPP). Samples for toxin measurements were collected twice per day (12:00 and 24:00) and immediately acidified. Microcystins (MC), homoanatoxin-a, cylindrospermopsin, nodularin, anabaenapeptins, cyanopeptolins and microginin were measured from lyophilized water samples using liquid chromatography tandem mass spectrometry with electrospray ionization. Microcystin-LR (MC-LR), the dominant toxin produced during this event, was present for the duration of the bloom. All other MC variants were < 1.0 μg L^{-1}. The average MC-LR concentration was 3.27 μg L^{-1} with a coefficient of variation of 0.69 and peaked at 9.63 μg L^{-1} twelve days into the sampling period during which NEP was -1.00 gO_2 L^{-1} d^{-1}. NEP did not correlate to measured concentrations of chlorophyll-*a* (r^2 = 0.00), phycocyanin (r^2 = 0.02), or MC-LR (r^2 = 0.04). Pearson's correlation revealed a weak dependence between NEP and MC-LR (r = -0.19, p=0. 0.54) and a weak dependence between GPP and MC-LR (r = -0.25, p=0.42). To our knowledge, this is the first study to monitor the variability of cyanotoxin production and lake metabolism at a sub- daily resolution.

8. L.P.M. Brandão, Mello, N.A.S.T., Pujoni, D.F., Gagliardi, L.M., Brighenti, L.S., Elias, E.C., Bezerra-Neto, José F.*

Is it possible to estimate DOC from absorbance spectrum of CDOM? A case study in 12 tropical lakes

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Studies in temperate lakes have demonstrated simple models capable of measuring the concentration of dissolved organic carbon (DOC) from the absorbance of colored dissolved organic matter (CDOM). Little is known about this relationship in tropical lakes. Aiming to evaluate the relationship between DOC and CDOM and check the differences in CDOM quality, 12 lakes were sampled in Middle Rio Doce, MG, Brazil (n = 152) (2011-2013), with 6 lakes located inside the State Park of Rio Doce (PERD) and 6 outside the PERD. Water samples were filtered (0.22 µm) to determine DOC concentrations and absorbance of CDOM. The wavelengths were evaluated between 250 and 700 nm with 1 nm intervals. Simples and multiples linear models were tested between DOC and the wavelengths (AICc criterion for ranking). For CDOM quality was used spectral slope (S275-295) and SUVA254. It was not possible to estimate DOC from CDOM by simple linear regressions. Only for lakes outside the PERD was possible to estimate DOC from a multiple linear regression (explanatory variables: S275-295 and 365nm, r^2=0.89). Although no difference has been observed in the concentration of DOC, there were differences in the quality of CDOM comparing lakes inside and outside the PERD (SUVA > outside). Lakes with the surroundings preserved with rainforest (inside the PERD) presented CDOM less chromophoric and higher transparency (Kd < inside) than the lakes surrounded by eucalyptus and pastures (outside the PERD). The organic matter derived from eucalyptus may take longer to be decomposed, increasing the turbidity and hindering photobleaching.

9. Jennifer A. BRENTRUP[1], Craig E. Williamson[1], Bruce R. Hargreaves[2], Lesley B. Knoll[3]

Tea or Coffee Anyone? Using high-frequency sensor data to understand differences in DOM optical quality

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Lakes are undergoing rapid ecological changes and new tools are needed to forecast the effects of climate stressors. Dissolved organic matter (DOM), a yellow-brown substance, is a primary regulator of lake ecosystems because it can alter transparency and fuel microbial metabolism. Differences in DOM quality can also have a significant effect on lakes as the photolability and biolability vary greatly with depth. At the lake surface, DOM loses color through photobleaching during the summer, but due to the rapid attenuation of light, anoxic deepwater DOM remains free from photodegradation and anaerobic microbial respiration releases DOM with properties that make it appear optically similar to terrestrial DOM. But does the deep water microbial DOM have the same effects on lake ecosystems as inputs of surficial terrestrial DOM?

We used two metrics of DOM optical quality to characterize samples from dystrophic Lake Lacawac and compared these with high-frequency CDOM sensor data from a profiling buoy in the lake. Preliminary results found changes in CDOM fluorescence

correlated well with changes in spectral slope in the 275-295 nm range at the lake surface. In the hypolimnion, an expected correlation with a*320 (DOC specific absorbance at 320 nm) was not observed.

Differences in DOM optical quality are known to affect the microbial loop, which may influence the balance of energy sources and production in the lake. As the lowest point in the landscape, lakes are strongly influenced by the quantity and quality of external inputs, and an improved understanding of carbon processing will help determine their role in the global carbon cycle.

10. Ludmila S. BRIGHENTI[1], Peter A. STÆHR[2], Laura M. GAGLIARDI[1], Luciana P.M. BRANDÃO[1], Nelson A.S.T MELLO[1], Eliane, C. ELIAS[1], José F. BEZERRA-NETO[1]*

Photoinhibition in stratified tropical lakes

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Lakes are in general reported as light limited, since the absorption of light in the water column diminish the mean light available (E_{mean}) inside the lake. Nevertheless, it's well known that the increase of light availability can lead to light saturation and even to photoinhibition at cellular and organismal levels. So it's possible that in clear-water lakes with overall high light availability, the upper mixed layer experienced some degree of light saturation and maybe photoinhibition. The occurrence of light saturation and photinhibition in two tropical lakes was assessed during 2011 and 2012. For that, we evaluated two types of metabolic models based on variations in dissolved oxygen (DO) concentrations: Model-1, that estimated GPP as a non-linear function of light (Webb, 1974); and Model-2, that added to the Model-1 a photoinhibition term (Platt, Gallegos & Harrison, 1980). Model-2 showed better fit than model-1, measured by percent of days with $R^2 > 0.6$ and $p < 0.05$, (Model 1: 64%, Model 2: 67%). This highlights that photoinhibition is important to daily metabolic rates estimations. Variability in light saturation (I_{sat}) and photoinhibition (I_β) levels were very high during the entire period, due to large variability in surface light. However consistently lower light levels during winter appears to cause less photoinhibition than during summer. I_{sat} didn't showed significant correlation with environmental variables, although I_β was strongly negative correlated to E_{mean} ($r = -0.62$, $p < 0.001$), remembering that higher I_β lower the degree of photoinhibition, *i.e* more light available leads to more photoinhibition.

11. Noelia L. CONY[1,2], Nora C. Ferrer[2] and M. Cintia Piccolo[3,4]

STUDY OF THE PHYTOPLANKTON OF THE SAUCE GRANDE SHALLOW LAKE (PROVINCIA DE BUENOS AIRES, ARGENTINA) DURING WINTER 2010*

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Sauce Grande shallow lake (38°57' S - 61°24'W) is located in the southwest of the Buenos Aires province, Argentina. The river Sauce Grande is both affluent and effluent of this water body. The aim of this work was to study the composition and abundance of phytoplankton communities of the Sauce Grande shallow lake during the winter of 2010. Phytoplankton samples were collected at monthly intervals from June to August, at three sample stations: in the input of the river, in the river output and in the deepest point of the shallow lake. Samples were taken with bottles and net. They were fixed with lugol for quantitative analysis, and with formaldehyde (final concentration of 0.4%) for their qualitative study. Chlorophyll *a* was measured with a spectrophotometer following the method described in APHA (1998). The trophic state of the water body was determined with the Trophic State Index (TSI) of Carlson (1977) based on Chlorophyll *a*. Total phytoplankton abundance ranged from 341000 to 510000 ind.ml^{-1} and chlorophyll *a* values ranged between 107.25 and 127.44 mg/m^3. Chlorophyta was the most widely represented algal group in terms of number of taxa for the entire study period. Additionally, *Planctonema lauterbornii* Schmidle (Chlorophyta) was the dominant species. Cyanobacteria and Heterokontophyta were also present. There were no major qualitative and quantitative spatial differences in phytoplankton during the period under study. Carlson's TSI varied from 76 to 78, thus Sauce Grande shallow lake was classified as eutrophic for winter 2010.

12. Jessica R. CORMAN[1,], Sudeep Chandra[2], Clint Davis[3], Margaret Dix[4], Nancy Girón[5], Eliska Rejmánková[6], Amber Roegner[6], Jana Veselam[7], and James J. Elser[1]*

Ecosystem effects of cultural eutrophication in a large, tropical lake

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Nutrient availability can be an important indicator of trophic status and limitation of primary production. When nutrients are in excess in aquatic systems, it can lead to eutrophication and diminishing ecosystem services. However, much of our knowledge of eutrophying systems derives from temperate lakes. Lake Atitlán, Guatemala, is a tropical, volcanic lake experiencing increasing rates of nutrient inputs from anthropogenic activities in the watershed. Phosphorus concentrations in the lake have increased during the last 30 – 40 years, shifting the lake away from an oligotrophic state. To test whether nutrient limitation can be predicted by nutrient availability, we performed bioassays during several different seasons in the lake. While total nitrogen and phosphorus levels in Lake Atitlán suggest nitrogen limitation, bioassays indicate that there is a shift from co-nitrogen and phosphorus limitation in the epilimnetic waters to slightly nitrogen limited in the

metalimnetic waters. Understanding nutrient dynamics in this lake has important implications for attenuating eutrophication.

13. Benjamin CRARY[1], Ben Oyserman[1], Leong Keat-Chan[2], Stephanie Malfatti[2,3], Tijana Glavina del Rio[2], Stefan Bertilsson[4], Rex Malmstrom[2], Katherine D McMahon[1,5]

Temporal Patterns of Microbial Community Genomic Structure in Lake Mendota and Trout Bog Lake

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We have investigated genome streamlining of microbial communities as a response to nutrient limitations in two temperate lakes located in Wisconsin, USA. Specifically, we studied the bacterial communities in Lake Mendota and Trout Bog Lake, both of which are parts of the Global Lakes Ecological Observatory Network (GLEON) and the North Temperate Lakes Long Term Ecological Research (NTL-LTER) program. Lake Mendota is a eutrophic lake that is heavily impacted by anthropogenic activities, while Trout Bog Lake is a humic lake that is largely undisturbed. Each lake has a permanent weather buoy supported by GLEON that takes temperature and dissolved oxygen profiles continuously, and measurements of carbon, nitrogen, phosphorus, and other environmental variables are taken from each lake on a biweekly schedule. We will use this buoy data to measure environmental change throughout the ice-off season. Each lake is dimictic and experiences nutrient depletion in the upper mixed layer throughout the stratified period. Beginning in 2007, approximately 90 metagenomes were sequenced from integrated epilimnetic samples taken from both lakes, with samples spanning the ice off periods through 2009. Using metagenomic reads, we observed the changes in average genome size and correlated these changes to variations in the environment. We also measured the nutrient requirements and codon usage in each lake using metagenomic assemblies. Finally, we explored the population dynamics of abundant community members in each lake. These results provide insight into how aquatic microbial communities from ecosystems of varying trophic levels compete for nutritional resources.

14. Fabien CREMONA[1], Alo Laas[1], Peeter Nõges[1], and Tiina Nõges[1]

Modelling a shallow lake metabolism from high-frequency measurements using Bayesian Metabolic Model (BaMM): preliminary results

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The development of high-frequency measurements in lakes has facilitated the tracing of O_2 fluxes and ecological parameters fluctuations within very short periods of time. The parallel advent of robust metabolic models which necessitate relatively few variables has made possible the assessment of lake metabolism on a very fine time scale. One of these models, BaMM, is a Bayesian statistical model that can estimate simultaneously GPP, R and their uncertainties. We wanted to assess the metabolism of Lake Võrtsjärv, a large, shallow North-European lake during two months of the ice-free period (May and August) using BaMM. With high-frequency measuring BUOY positioned in the lake we have managed to measure water temperature, irradiance, and dissolved O_2 with 10 min-frequency. These parameters were then entered into the model with each day separated, starting at 7:00am of day d and finishing at 6:55am of day d+1. Preliminary results show that BaMM successfully modelled integrated daily GPP dynamics during both months and within credible uncertainties. However instantaneous R show little variation as temperature of the water column, which is the most important variable in BaMM for predicting R, is stable in Võrtsjärv. This finding is inconsistent with previous studies which reported a coupling between instantaneous GPP and R because of an increase of plankton-specific and microbial R in high productivity conditions.

15. Lucy C. CROCKFORD[1,2], Phil Jordan[3], Alice Melland[4], and David Taylor[5]

Quantifying phosphorus release from lake sediments and the ensuing photosynthetic response: results from high frequency monitoring

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Shallow lakes in Europe are susceptible to eutrophication in part due to anoxia-mediated release of phosphorus (P) from bed sediments after periods of thermal stratification. However, while the relative influence of this internal P loading compared with external loading from the catchment is often cited as a driver for eutrophication, it is quantified using antiquated methods. To develop a new method of quantifying sediment-derived P loading, water chemistry was continuously monitored by sensors installed in the epilimnion and hypolimnion of a small meso-eutrophic lake, and by monthly and fortnightly, manual sampling over the period April 2011 – March 2013, on the eastern Atlantic fringe of Europe.

A strong relationship between high frequency hypolimnetic conductivity, pH and redox potential and infrequently manually sampled hypolimnetic SRP concentrations was observed. This relationship between conductivity and SRP was used to provide a more accurate estimation of hypolimnetic SRP concentration prior to lake-turnover for both summers providing both quantification and timing of internal loading.

Furthermore, analysis of high frequency data showed that sediment released-P was introduced to the lake's epilimnion prior to increasing temperatures and calm weather in

water year 1. While in water year 2, although receiving more loading from catchment-derived sources, the lake was also impacted by lake-turnover "fertilisation" events; this time during mid-summer which was observed by increased chlorophyll *a* measurements indicating an algal bloom, although of less intensity in comparison to that observed in water year 1. Phosphorus released from sediments may therefore provide an underestimated eutrophication pressure in similar dimictic-polymictic lakes.

16. Blaize DENFELD[1] and Gesa Weyhenmeyer[1]

Under ice high frequency pCO_2 dynamics in a boreal lake and subsequent CO_2 outburst

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It is well established inland waters have the capacity to efficiently transform carbon, resulting in substantial emissions of carbon dioxide (CO_2) to the atmosphere. However, annual CO_2 emissions do not typically account for the ice-cover period, which is a defining aspect of high latitude regions. Thus, there is a need to better understand under ice CO_2 accumulation patterns and to quantify the contribution of this accumulation to annual CO_2 emissions. Measuring hourly partial pressure of CO_2 (pCO_2) in a boreal lake during ice cover and spring melt (Jan 22 to May 6, 2013), we observed pCO_2 increased the first few months of ice cover, stabilized thereafter until rapid evasion from the lake at ice melt. pCO_2 exponentially accumulated towards bottom waters and at ice melt, bottom waters contributed to high pCO_2. Although the initial outburst was rapid (~4 days) the complete outburst period lasted ~ 2 weeks until complete mixing of the water column and daily variations in pCO_2 were reached. CO_2 outburst was driven by in lake process initially (i.e., CO_2 accumulation), followed by catchment processes (i.e., runoff). Making a back of the envelope calculation, we conclude that CO_2 outburst after ice melt accounts for about 11% of the annual CO_2 emissions from the lake. Thus, given that lakes in the boreal and arctic region are ice covered for a significant portion of the year, adequately accounting for CO_2 emissions during ice melt may have a profound impact on current annual CO_2 emission estimates.

17. Margaret A. DIX[1], Sudeep Chandra[2], Eliska Rejmankova[3], Michael Dix[1], Nancy Giron[2], Melissa Orozco[1], Gerson Ochaeta[1], Lidia Tanaka[2], and Alecia Brantley[2]

People, pollution and cyanobacterial challenge at Guatemala's Lake Atitlán

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Lake Atitlán, a deep endorrheic volcanic caldera in Guatemala, faces increasing eutrophication due to accelerated population growth (from 200, 000 inhabitants in 2002 to 400,000 inhabitants in 2013) with concomitant higher nutrient input from untreated liquid and solid wastes as well as increased erosion and fertilizer runoff. More frequent

occurrence and greater density of cyanobacterial blooms from the nitrogen-fixing, *Limnoraphis robusta* (first major bloom worldwide caused by this species) and more recently *Aphanizomenon,* are symptoms of deterioration. Other indicators include a reduction in transparency (Secchi depth 11 to 5 m from 1969 to 2012); increased chlorophyll a levels (range 1.5 to 35 µgm/ L); increasing hypolimnetic hypoxia; higher phosphorus and nitrogen concentrations, as well as a decline in local fishery resources.

Bioassays show nitrogen and phosphorus as co-limiting factors for algal production, raw sewage as a major stimulator of chlorophyll production, and both raw sewage and, to a lesser extent, soils contributing to oxygen consumption.

Economic impacts on tourism and potential for disease outbreaks are challenging local institutions to maximize available resource and promote international cooperation for developing adequate facilities for research and monitoring. We are also establishing long-term inter-university collaborative programs for training and research as well as on designing innovative strategies for waste and drinking water treatments. Keeping the local population informed and empowered is an important requisite for success.

18. Jonathan P. DOUBEK and Cayelan C. Carey

Different physical, chemical and human use properties promote higher dominance of N–fixing, potentially toxic cyanobacteria in reservoirs compared to natural lakes

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Reservoirs are important sources of drinking water and other ecosystem services in regions without many natural lakes or other water sources. As such, it is important to understand how reservoirs and natural lakes differ in their physical, chemical, and human use properties, which may influence biological differences. We analyzed these biophysical characteristics across five distinct U.S. EPA type III nutrient ecoregions that had a relatively equal number of reservoirs and natural lakes within the same climatic region and elevation. Contrary to our expectations, we found that across all ecoregions, natural lakes had significantly higher nutrient concentrations (TP, TN, silicate, and DOC) than reservoirs. By comparison, reservoirs had greater surface area, depth, surface temperature, mean water column temperature, and human land use within their watersheds than natural lakes. As a result, natural lakes had on average greater phytoplankton biomass, species richness, and diversity than reservoirs. However, reservoirs had greater dominance by diatoms and N–fixing cyanobacterial genera. Although natural lakes had overall greater nutrient concentrations, it appears that lower TN:TP ratios and higher water temperatures in reservoirs interact to promote dominance by N–fixing cyanobacteria, many of which are also potentially toxic. Likewise, phytoplankton genera that prefer well–mixed water columns, such as diatoms, were dominant in reservoirs, despite lower silica concentrations. This study highlights that reservoirs differ greatly from natural lakes in their chemical and physical properties, which can interact to influence differences in their biology.

19. Eliane Corrêa ELIAS[1]; José F. Bezerra-Neto[1]; Ludmila S. Brighenti[1], Laura M. Gagliardi[1], Luciana P. M. Brandão[1]; Nelson Mello[1] and Mariana P. Bezerra[1]

Estimate of the heat flux of a tropical lake: Lake Dom Helvécio, Minas Gerais, Brazil.

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The total flux of thermal energy of a closed system can be measured considering the heat input via shortwave solar radiation and by, the flux of longwave radiation and, sensible and latent heat flux. This study analyzed of the temporal variability of heat flux in Don Helvécio Lake, located within the limits of a governmental conservation unitParque Estadual do Rio Doce, Minas Gerais state, Brazil. In 2012, shortwave radiation data were collected hourly from a sensor deployed at the central part of the lake. The energy flux of longwave radiation and of latent and sensible heat were measured based on data from a weather station located no far of 2km from the lake. We conducted descriptive statistical study (average, minimum and maximum) of air temperature and surface water temperature. Vertical profiles of water temperature were measured at every 15 minutes using a thermistor chain. The average temperature of each water column layer was used to estimate the heat content of the lake. The results indicate the relative importance of each heat flux component to the heat budgets in Dom Helvécio Lake, especially the heat input via short-wave solar radiation and heat output by long wave radiation emitted by the lake.

20. V. ESTRADA, J. Di Maggio and M. S. Diaz

A SYSTEMS ENGINEERING APPROACH TO THE RESTORATION OF EUTROPHIC LAKES

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Eutrophication has become the most serious environmental problem in many lakes and reservoirs, especially those located next to densely populated or agricultural areas. One approach applied to address the problem of nonpoint nutrient sources for water bodies is the use of artificial wetlands to decrease nutrient loading. To accelerate recovery, several in-lake restoration strategies have been proposed and widely applied in the last decades, including hypolimnetic oxygenation or aeration and biomanipulation (Søndergaard et al., 2007).
In this work, we address restoration of eutrophic lakes and reservoirs through the formulation of dynamic optimization problems subject to complex partial differential algebraic equations (PDAE) systems representing the main biogeochemical processes that take place within these water bodies. The PDAE system results from dynamic mass balances for three phytoplankton groups (cyanobacteria, diatomea, chlorophyta); two zooplankton groups (cladocera, copepoda) and three size classes of zooplanktivorous fish (*Odontesthes bonariensis*), as well as dissolved oxygen and main nutrients (Estrada et al., 2011). Algebraic equations stand for forcing functions profiles, such as temperature, solar radiation, river inflows and concentrations, etc. Optimization variables (time dependent degrees of freedom) are associated to the reduction of nutrient loading by deviation to a nearby wetland (tributary flowrate to wetland profile) and in-lake restoration through either biomanipulation (fish removal rate profile) or aeration (oxygen addition rate profile). The dynamic optimization problem is formulated within a control vector

parameterization framework (PSEnterprise, 2009). The present study has been performed on Paso de las Piedras Reservoir (38° 22´ S and 61° 12´ W), which is the drinking water source for two cities in Argentina. Numerical results provide optimal profiles for restoration actions, as well as associated costs and a quantitative estimation of restoration effects on the water body, along a middle term time horizon. Additional results are obtained for a five-year time horizon, considering warmer scenarios.

21. Jessica CORMAN[1], Emily NODINE[2], Vijay PATIL[3], Richard Iestyn WOOLWAY[4], Jake ZWART[5], Hilary Dugan[6], Aline Jaimes[7], Arianto Santoso[8], Luke Winslow[9], Jennifer Brentrup[10], Amy Hetherington[11], Paul Hanson[9], Grace Hong[9], Sam Oliver[9], Emily Read[9,12], Kirsten Winters[13], Kathleen Weathers[12]

Comparison of gas flux in lakes and consequences for metabolism and CO_2 emissions

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[10]Miami University, Oxford, OH, USA
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Inland waters may be an important source or sink of carbon globally. However, understanding the influence of aquatic bodies on global carbon cycling is hindered by the use of poorly constrained ecosystem metabolism budgets. In lakes, biological respiration can supersaturate surface waters with CO2 and lead to a net flux of the greenhouse gas to the atmosphere. Previous research has shown that physical processes such as wind mixing and convection strongly control gas exchange at the air-water interface; yet, flux variability is not incorporated into most modeled estimates of ecosystem metabolism. This study uses a high frequency, globally distributed lake dataset to examine how the variability in gas exchange values output from four published models influences estimates of lake productivity and net carbon flux.

22. Marieke A. FRASSL[1], Dirk Schlabing[2], M. Magdalena Eder[2], Karl-Otto Rothhaupt1, and Karsten Rinke[3]

Climate sensitivity of a large lake ecosystem

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With a changing climate, not only mean air temperatures are expected to increase, but also climate variability. While changes in mean temperature are broadly studied, a change in climate and meteorological variability has attracted less attention in the past. Aquatic organisms are directly affected by changes in temperature, e.g. in their physiology. They are also affected indirectly by physical properties of their habitat, which are driven by climate conditions.

In this study, we addressed the sensitivity of a large lake ecosystem towards different climatic and meteorological conditions by running climate scenarios with a hydrodynamic-ecological lake model (DYRESM-CAEDYM). Meteorological input was generated with a statistical weather generator (VG) that allowed differentiating between an increase in mean air temperature and in temperature variability.

Our results showed the sensitivity of phytoplankton spring bloom onset to spring weather conditions. An increase in climate variability increased the probability of very early spring blooms. A prolonged phytoplankton growth throughout the year was more probable under a warmer climate. VG keeps the dependency structure between meteorological variables. That is, changes in temperature come along with changes in other meteorological variables. This fact showed to be important when comparing our results to simulations with an exclusively constant increase in air temperatures.

23. *Laura M. GAGLIARDI[1], Ludmila S. Brighenti[1], Luciana P. M. Brandão[1], Eliane C. Elias[1], Nelson A.S.T. Mello[1], José Fernandes Bezerra Neto[1]*

Tropical lake metabolism and its major drivers

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In recent years many papers have shown the importance of metabolism in lakes, how it varies in temporal scale and how it is regulated by environmental conditions and resources availability. However, the vast majority of these studies are carried out in temperate lakes leaving a gap for tropical systems. This study aims to verify the metabolism in 11 tropical lakes and its main drivers. A buoy was deployed in the pelagic region of each lake. Measuring DO, wind speed, water temperature and sub aquatic radiation at every 15 minutes. The buoy stayed in each lake for 5 days during two different seasons, wet and dry. Physic-chemical parameters were also sampled. There was no significant difference in metabolic rates of the lakes. Some of them were net heterotrophic while others were net autotrophic. However, the lakes that have pristine Atlantic forest in catchment showed GPP and R significant different from those that have their catchment changed by human activities. The major drivers of GPP and R were Chlorophyll-a, mean available light and light attenuation. However, correlations indicated that GPP and R are reduced in highest light levels. NEP on these lakes presented a negative, but significant correlation with Phosphorous. Other parameters, like lakes morphology and catchment, must also be

consider for better understand the dynamic of internal and external parameters and their implications for tropical lakes metabolism.

24. Bruce R. HARGREAVES[1], Jennifer A. Brentrup[2], Craig E. Williamson[2], Lesley B. Knoll[2,3]

Profiling buoy improvements yield new insights on climate change signals in a NE Pennsylvania (USA) lake

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ARTHUR is our small-lake profiling buoy, now in its second year deployed in Lake Lacawac. Using improved software and hardware it completed up to 4 profiles per day and monitored surface conditions and water column temperatures nearly continuously for periods from June to October. Multiple readings per depth allowed us to evaluate slow sensor accuracy (pH, oxygen). We were able to characterize PAR attenuation (to ca. 3% of incident PAR), metabolism (via oxygen and pH changes), heat budget (net radiation and water column temperatures, adding 0.1m), phytoplankton and CDOM distribution (including effects of photobleaching, metabolism, rain events, anoxic sediments, and mixing).

Unexpected observations included increases in CDOM at all depths in response to a small rain event, and the steady decline in dissolved oxygen and CDOM throughout the unmixed water column (we expected a graded response related to distance from the bottom). Wind-corrected net radiation data were used to estimate net longwave radiation. We found (as expected) that variations in net LWR were correlated with average daily vapor pressure and with the average daily ratio of incoming solar radiation to incoming PAR radiation (PYR/PAR) measured nearby. Also correlated (as expected) were daily average mixed-layer K_{dPAR} and CDOM fluorescence.

More work is needed to validate the net radiometer signal and estimated net LWR against a reference instrument that separately measures SWR and LWR. Adaptive sampling should also be implemented to adjust dwell time at depth to accommodate the slowest sensor, and to add extra depth intervals in specific depth ranges.

25. Thomas C. HARMON[1,2], Steven Jepsen[2], Henry Pai[1], Kumaraswamy Sivakumaran[1], Sandra Villamizar[1], Steven Coles[1], Jacob Flanagan[1], Qinghua Guo[1,2]

Mountain Stream Flow Response to Climate Variability in the Snow-Rain Transition Zones: Influence on Aquatic Habitats in Streams and Reservoirs – A SAFER-WSC Project

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California's southern Sierra Nevada mountain range is the primary water supply to the San Joaquin Valley for agriculture, municipalities, hydropower, and environmental flows. It is

essential to understand how the timing and quantity of mountain runoff to this region will respond to changes in the timing and phase of precipitation (snowfall versus rainfall) that accompany climate change, as this will better inform efforts to predict and adapt to future water supply scenarios in a region where water will become increasingly scarce. Our goal is to understand and characterize the hydrologic mechanisms that control runoff to streams flowing from mountain catchments, how climate change will impact runoff, and how runoff changes will impact human behavior (e.g., reservoir operation) and downstream aquatic habitat. We use the integrated watershed computer model PIHM, Penn State Integrated Hydrologic Model, to simulate watershed processes. We use CE-QUAL-2D and HEC-RAS to model downstream reservoir and stream flows and temperatures. Preliminary results are presented for (1) the Providence watershed of the Southern Sierra Critical Zone Observatory, located in the current rain snow transition zone (~ 1500-2100 m elevation) and (2) the Lower San Joaquin River, which is the site of a major restoration effort focused on reintroducing a native Chinook salmon population.

26. John J. HERNANDEZ[1], Todd R. Miller[1]

Development of a "do-it-yourself" thermistor chain for high-frequency measurement of vertical temperature gradients in aquatic environments

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A simple "do-it-yourself" (DIY) thermistor chain was designed to allow greater flexibility, lower cost, and ease of construction. Each thermistor node consisted of a single LM35 precision centigrade temperature sensor drawing 60 μA and rated for temperatures from -55º to +150ºC. Six thermistors, located every 0.5 meters were isolated from direct water contact through insertion into copper tubes filled with a thixotropic, two-part epoxy featuring high thermal conductivity and high electric insulation. Output signals (in mV) from individual thermistors were recorded by a Campbell Scientific CR1000 datalogger. Thermistors were individually calibrated at 4ºC, 29.9ºC and 37ºC. The Pearson correlation coefficients for individual calibration curves were >0.998. The average output standard deviation from all thermistors was 0.80 mV, giving a resolution of ± 0.08ºC. The DIY thermistor chain was deployed for two months in a eutrophic recreational lake attached to a monitoring buoy. Fluctuations in output were noted for two thermistors, likely due to water infiltration at the node or data logger connection. Due to the thermistor chain design these nodes could be easily replaced. The thermistor chain design presented is a low cost flexible system for monitoring temperature gradients in lakes.

27. Amy L. HETHERINGTON[1], Alicia Zhao[1], Lars G. Rudstam[1], Rebecca L. Schneider[1], and Jonathan Hunn[1]

Re-Engineering Oneida Lake: The Impacts of Climate Change and New Invasive Species on the Dynamics of Oneida Lake

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As climate is changing, invasive species are also impacting the structure and function of inland waters. Predictions of the effects of climate change on lakes and reservoirs need to include the influence of new invasive species on the ecological interactions within bodies of water. The goal of this study was to understand the interactive impacts of climate change and invasive mussel species on phytoplankton in Oneida Lake, a 207 km^2 shallow, polymictic lake in Central New York, USA. Replicated, microcosm experiments were used to measure and compare filtration rates of zebra, *Dreissena polymorpha*, and quagga, *Dreissena rostriformis bugensis*, mussels at a range of temperatures from 2-30°C. A single species of algae, *Chlamydomonas reinhardii*, was used as the food source and feeding rates were measured as a change in fluorescence, translated to chlorophyll-a concentrations, over a 2 hour period. Preliminary experimental results indicated filtration rates of zebra and quagga mussels at different temperatures followed the same general pattern, peaking at 18°C with lower rates at higher and lower temperatures. However, filtration rates of zebra mussels consistently exceeded those of quagga mussels at all temperatures. Based on the results of this study, zebra mussels would be expected to dominate across current and predicted temperature regimes; however, other factors need to be considered due to the ubiquity of quagga mussels in numerous lakes worldwide.

28. Agron IDRIZAJ[1]

Sonde-data estimates exhibit a new changing trend in metabolic rates and climate effects in a large and shallow temperate lake

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In the present study we analyzed the significant annual influences of the limnological variables on metabolic rates of gross primary production (GPP), respiration (R) and net ecosystem production (NEP), in a large and shallow temperate Lake Võrtsjärv. High-frequency of continuous measurements of dissolved oxygen (DO) method was conducted, during two years (2011-2012), over the ice-free period. Our results derived from stepwise multiple regression analysis provide clear evidence that the water temperature was the most ubiquitous variable, which displayed significant influence on metabolic rates of GPP, R and NEP. Regression results indicate that the overall model significantly predict GPP (R^2 = .636, R^2_{adj} = .626), R (R^2 = .500, R^2_{adj} = .492) and NEP (R^2 = .420, R^2_{adj} = .400) in Võrtsjärv Proper and in southern part GPP (R^2 = .479, R^2_{adj} = .467), R (R^2 = .240, R^2_{adj} = .230), and NEP (R^2 = .346, R^2_{adj} = .322). Based on our results the climate effects on lake metabolism suggest us for a new changing trend in metabolic rates and bioproduction. It can be considered that the signals reflected such as the significant variability in NEP rates between Võrtsjärv Proper and southern part over the 2012 year, higher amount of precipitations and micro-stratification are the result of the interactions between the limnological variables and the current status of Lake Võrtsjärv.

29. Meilan JIANG, Jonghyun Lee, Keunyoung Lee, Karpjoo Jeong

A Case Study for real-time runnable Empirical Prediction Model

Department of Advanced Technology Fusion, Konkuk University Korea

The quality of water in nature affects the condition of ecosystems that all living organisms depend on. Under the unpredictably and rapidly changing climate, water quality changes more frequently. To react with the change of water quality immediately without delay, we propose a systematic approach to predict water quality in real-time by runnable empirical model. Usually, for the management of water quality, model predictions were used in addition to or instead of monitoring data. In this work we linked an empirical model to real-time monitoring data input so that made the model runnable for water quality prediction in Soyang River.

In this case study, we present a result of the study in the Soyang River that intended to define and explain the development process of empirical model. It predicts water temperature based on ANN empirical prediction models using meteorological data and water flow. The prototype system consists of a real-time monitoring module, a modeling module and a prediction module, that are interrelated. It extracts real-time data from sensors that deployed in the field and historical data set updated to developed system and generates predicted real-time outcome using MatLAB operating in background.

30. Bomchul KIM, Sungmin Jung, Jai-ku Kim

Monitoring dissolved oxygen fluctuation in an urban stream, the Anyang Stream (Seoul, Korea)

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DO and turbidity monitoring system will be installed in a eutrophic urban stream (the Anyang Stream) in Seoul Korea. This stream receives effluents from sewage treatment plants and surface runoffs from a densely populated residential area. High biomass of periphyton renders large diel fluctuation of DO. Occasional DO depletions occur at the early stage of rain events because organic ooze is washed off from the stream bottom. In the fish survival test it was found that fish cannot survive the first flush of a rain. During the early phase of a rain water quality parameters changed drastically with the increase of turbidity, ammonia, and BOD, which killed all test fish of the experimental cage.

In order to monitor DO fluctuation and develop an empirical method of prediction two sets of monitoring system will be installed in the stream. The system will include data logging sensors of water level, conductivity, DO, and turbidity. The final goal of the monitoring is to develop a model of predicting the suitability of the stream water for fish survival and the possibility of fish kill accident.

31. Benjamin M. KRAEMER[1], Peter, B. McIntyre[1], Yvonne Vadeboncoeur[2]

Nonlinear costs of climate change in lakes

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A growing literature suggests that ecosystems in the tropics may be more sensitive to the negative impacts of climate change than those at higher latitudes. We add to that growing literature by showing that the responses of lake ecosystems to warming are greater in the tropics even when warming rates are relatively small compared to higher latitudes. This pattern can be explained by nonlinear ecosystem responses to temperature. For example, due to nonlinear responses of water density to temperature, warming can have disproportionately large impacts on lake stratification trends in the tropics where baseline temperatures are higher. Secondly, due to nonlinear responses of organism metabolic rates to temperature, higher temperatures can have disproportionately large metabolic costs for tropical organisms whose baseline metabolic rates are already relatively high. Climate change exerts a powerful force on freshwater ecosystems worldwide, but while warming rates may be higher at higher latitude, ecosystem impacts on lakes may be disproportionate to warming rates.

32. Ibañez Martín, Ma. María[i], Bertoni, Belén[ii], Dra. London Silvia[1]

Ecosystem Services and Sustainable Development: analysis proposal under Participatory Research Methodologies

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The main objective of the proposed research is the characterization of ecosystem services and their risks of the lagoon "La Salada", from the perspective of social actors who are directly or indirectly engaged with it. The methodology consists in the realization of three types of workshops (COMET-LA, 2013). A significant proportion of the work is to conduct informational seminars and participatory workshops.

The first type of workshops will be to identify the main problems (variables), mapping the stakeholders and, in general, identifying of social capital. The stakeholders were selected in accordance with the SES characterization. Two selection criteria will be used during the SH mapping: pertinence and representation. Internal and external SH (i.e., decision makers) will be evaluated under the same criteria. The second type of workshops will be for discussing variables, identifying functional relationships, intrinsic relation causality, and conducting a structural analysis of prospective (PSA). The PSA tool has been designed to link ideas in order to describe how a system is operating. Finally, in the last set of workshops, the main objective will be to analyze (stakeholders and academics, together) the relationships found, and draw conclusions.

The proposed methodology for the study of stakeholders and characterization of ecosystem services will provide for Participatory Research (PR). PR emerged in 1970 with the main objective to find a new way of doing science, based on three main aspects: the first, regarding the relationship between sciences, knowledge and reason; the second, related to the dialectics between theory and practice; and the third, with the tension between subject and object (Fals Borda, 2008). In this methodology, stakeholders play a central role in the study of the phenomenon. The characterization of the actors and how they identify their environment is fundamental for research (Maya Velez et al, 2004).

33. Nelson Azevedo Santos Teixeira de MELLO[1], Luciana Pena Melo Brandão[1], Ludmila Brighenti[1], Laura Gagliardi[1], Eliane Elias[1] and José Fernandes Bezerra Neto[1]

Temporal and spatial variability of methane ebullition in a shallow hypereutrophic tropical urban reservoir

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Climate change has been one of the most relevant topics for the past decades. There is a growing interest in the emissions of greenhouse gases by lakes and reservoirs. Since the concentration of methane (CH_4) in the atmosphere has doubled over the last 200 years, it became crucial to understand the spatio-temporal variation of this gas. The CH_4 ebullition is the dominant pathway (>50%) in shallow environments (<50%) and more difficult to quantify due to its episodic nature and heterogeneous spatial distribution. In order to verify the temporal and spatial variability of CH_4 ebullitive emissions, this pathway of emission was measured at 15 points for 5 days in the summer and winter of 2013, in a shallow hypereutrophic urban reservoir in Belo Horizonte City, Brazil, using inverted funnels and gas chromatography. The average emission in summer was 779.98 $mgCH_4.m^{-2}.d^{-1}$, ranging from 1.33 to 3070.52 (n=75). In winter the average was 315.68 $mgCH_4.m^{-2}.d^{-1}$, ranging from 3.73 to 1253.10 (n=75). There was a strong spatial variation ($p<0.0001$) in both seasons with a longitudinal gradient. The mouth of the main tributary is a "hotspot" of methane, since it is a shallow area with low hydrostatic pressure and high temperature in the sediment, aggravated by the intense siltation process. A clear seasonal variation was confirmed ($p<0.0001$), mainly in the shallow sampling points (0.5-1.0m). This study was the first assessment of methane emissions in Pampulha Reservoir, which is paramount as a starting point for future studies.

34. R.A. Müller[iii,], D. Kothawala[1], E. Podgrajsek[iv], E. Sahlée[2], G.A. Weyhenmeyer[1]*

CDOM absorption variations in a shallow mixed lake: short term dynamics (30 min. interval) in comparison to seasonal changes

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Optical properties of lake waters can give insights into the quantity and quality of dissolved organic carbon (DOC). DOC from terrestrial production provides energy for aquatic ecosystems. This energy is used by various biotransformation processes that affect the carbon budget. We tested a spectrophotometric probe (spectrolyser s:can, Austria) which is capable of measuring absorption by chromophoric dissolved organic matter (CDOM) at high frequency intervals. In water quality monitoring CDOM absorption has previously been used as a surrogate for DOC concentrations. During the ice-free season, we retrieved continuous scans in a humic lake, located in a cold temperate region of Sweden. The *in situ* optical probe was connected to a meteorological field station that synchronously measured water and air temperatures, solar irradiance and partial pressures of CO_2 (pCO_2). The

monitoring was supported by grab-sampling to quantify DOC concentrations along with relevant water quality parameters (pH, in laboratory spectral analysis of absorbance and fluorescence, total inorganic carbon, turbidity). Based on our results we discuss in-lake CDOM absorption variations at the high-frequency interval, and with a particular focus on relationships between CDOM absorption and pCO_2.

35. Kohji MURAOKA[1], Paul Hanson[2], David Hamilton[1], Eibe Frank[3], and Ken Chiu[4]

Automated quality assurance of dissolved oxygen time-series – a data mining practice in ecology

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[2]Center for Limnology, University of Wisconsin-Madison, USA
[3]Department of Computer Science, University of Waikato, NZ
[4]Department of Computer Science, Binghamton University, USA

This project aims to provide for automation of quality assurance of high-frequency dissolved oxygen data. The project is primarily intended to create a dataset for lake productivity (metabolism) calculations. One major outcome of the project is that we it will be possible to generate a standard and comparative method to estimate productivity using sensor DO readings from different systems. The result is also interesting from theoretical ecology point of view in terms of understanding when ecological signals are produced by biological versus physical processes in lakes. We use machine learning technologies, such as classification techniques and data dimensionality reduction techniques to classify the time series data. In order to train and validate the algorithm, we engaged GLEON scientists to create a standardized training dataset for the classification using a multivariable data.

36. *Emily R. NODINE[1] and Evelyn E. Gaiser[1]*

Seasonal patterns in diatom assemblages and water quality across a coastal watershed: the changing effects of freshwater flow through seasons and following a tropical storm

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Florida coastal ecosystems are highly sensitive to changes in fresh water influx driven by tropical cyclone activity, changing climate cycles such as the Atlantic Multidecadal Oscillation and El Nino, and water management practices. Changes in freshwater flow drive changes in water chemistry that affect the composition of diatom assemblages because different species have different tolerances for environmental variables like salinity and nutrient availability. The goal of this research is to identify changes in diatom assemblage dynamics that can be used as a signal of tropical storm activity and detected in long-term sediment records.

Phytoplankton and water samples were collected across the Charlotte Harbor watershed, on Florida's southwest gulf coast, during the dry season, the wet season, and

twice following a tropical storm. Tropical Storm Debby, in June 2012, dropped as much as 20 inches of rain in parts of Florida and caused substantial flooding. Diatom assemblage responses were highly variable across sites, as were nutrient loading patterns. In general, sites show a storm effect of nutrient loading followed by recovery in the wet season. Diatom assemblages became more similar across sites following the storm. This work will continue to identify species-nutrient responses that may be indicators of storm activity. These results will be applied to long-term analysis using sediment cores from Charlotte Harbor to detect past tropical storm activity.

37. Samantha OLIVER[1], Emily Stanley[1]

The importance of depth measurements for large-scale limnology

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Depth is an important intrinsic lake characteristic that is related to a variety of physical, chemical and biological processes. Despite being a simple measurement that requires limited technology, lake depth is mostly unavailable for large numbers of lakes across the globe. Here, the National Lakes Assessment data from the U.S.E.P.A were used to show that depth is negatively related to total phosphorus (A; R^2=0.37, p<0.001), total nitrogen (B; R^2=0.36, p<0.001), turbidity (C; R^2=0.36, p<0.001) and DOC (D; R^2=0.31, p<0.001) in lakes across the U.S.A. In a dataset that includes multiple observations in 925 lakes in the U.S.A., lake depth interacts with the relationship between chlorophyll and TP, where deep lakes have smaller intercepts and less variable slopes. Additionally, an analysis of 572 lakes shows that maximum depth can be used to predict mean depth in lakes (R^2=0.78, p<0.001). These analyses show the importance of depth information for large-scale studies that focus on water quality. A publically available, standardized database such as www.bathybase.org is recommended for the collection and distribution of depth information.

38. Vijay PATIL

Species richness, functional diversity, and ecosystem function in drying boreal lake-margin wetlands

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Lakes and wetlands contain most of the boreal biome's organic carbon. In addition, wetlands are among the most diverse and productive boreal ecosystems, making them valuable habitat for wildlife. Boreal lakes have been shrinking across the state of Alaska, resulting in an estimated 18% loss in net surface water over the last 30 years. The consequences of this trend for lake margin wetlands are unknown. We address two main questions: 1) What is the relationship between plant diversity and ecosystem function in Alaskan wetlands, and 2) how are wetland structure and function affected by lake shrinkage? I compared vascular plant species richness, functional type diversity, and

aboveground biomass in wetlands at 96 lakes in northern Alaska. Lakes were classified as shrinking or stable using remote-sensing techniques.

Species richness and biomass were significantly elevated at shrinking lakes, while functional diversity was not. However, species richness and functional diversity were positively associated with the width of the lake-margin wetland community, which was not influenced by lake drying. Mean aboveground biomass decreased with increasing wetland area.

Lake shrinkage rate, wetland area, and functional type diversity were the best predictors of aboveground biomass, even when fire history, climate, and soil type were included in the analysis. Species richness and functional type composition were not strong predictors of biomass. Although richness and biomass have responded to lake shrinkage in similar ways, they appear to be controlled by different aspects of the lake-margin environment, and their trajectories are likely to diverge if shrinking trends continue.

39. Federico QUINTANS[1], Daniel Conde[1,2] & James Rusak[3]

Nitrogen and denitrification dynamics on wet prairies at a coastal lagoon: effect of soil management

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Runoff from agricultural soils exports nitrogen (N) to waterbodies. In soils with permanent moisture the N removal processes are quantitatively important due to conditions that favour denitrification (DNT). Such places are very important as buffer sites to control non-point sources of N from agricultural lands and therefore contribute to prevent the eutrophication of waterbodies.

Laguna de Rocha (LR) is a coastal brackish lagoon of 72 km^2 located on the Atlantic coast of Uruguay. It is a Protected Area because of its high biodiversity and landscape quality. Surrounding the lagoon, floodplains with herbaceous communities ranging from euryhaline environment to prairies dominate the landscape. Although high grasslands are above the normal level of the lagoon, groundwater flows from upper areas and rises, saturating the soil. At such places it is expected to find significant DNT processes. As a rule upper soils around the lagoon are used for cattle breeding, although some crops as wheat and soy beans are also becoming an important activity.

This project intends first to measure the magnitude of DNT at the floodplain as well to establish its dynamics and main factors controlling the process. We also intend to estimate the N retention in the floodplain and hence determine its importance as a buffer system that contributes to prevent the eutrophication process in LR. Basic information on main N transformation and paths and control factors of DNT may be useful in order to improve soil management plans also involving water quality conservation.

40. Emily READ[1‡], Vijay Patil[2‡], Sam Oliver[3‡*], Amy Hetherington[4‡*], Jennifer Brentrup[5†*], Jake Zwart[6†*], Kirsten Winters[7†], Jessica Corman[8*], Emily Nodine[9*], Richard Iestyn*

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Exogenous drivers of lake water quality in the continental US

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Lakes are known to respond to surrounding drivers of water quality, including geomorphology, landscape position, land cover, land use, and physical characteristics of the lake. In this study, we are using regression tree analysis and general linear models to quantify the extent to which these exogenous drivers predict key in-lake water quality variables across the continental scale, including total nitrogen and phosphorus, chlorophyll-a, dissolved organic carbon, and conductivity using the EPA's National Lakes Assessment (NLA) data. This EPA NLA dataset is one of the largest and most consistent water quality datasets available, and includes measures of hundreds of variables for >1,000 lakes across the continental US, and description of land use at the watershed and lake buffer scales. In addition, we have collected and derived several additional explanatory variables including road density and proximity, soil type, and lake residence time. We aim to identify the most important drivers of water quality at the regional and continental scales, and the processes that underlie them.

41. Eva-Ingrid Rõõm[1] and Alo Laas[1]

CO_2 accumulation in two calcareous lakes: Lake Vissi and Lake Viisjaagu, Estonia

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Current study characterizes spatial and temporal variability, accumulation and release of dissolved carbon dioxide (CO_2) in two neighboring calcareous lakes.
Membrane covered optical CO_2 sensors (AMT Analysenmesstechnik GmbH) and a floating chamber method were used to measure and estimate CO_2 accumulation during the winter and release after the ice-thaw in year 2013. The compatibility of those two methods as well

as differences between daytime and 24-hour experiments were estimated. The affect of lake depth to hibernal CO_2 oversaturation and O_2 deficiency was evaluated for both lakes with the same climatic conditions and catchment area.

Under ice CO_2 concentration varied between 12 to 19 mg l^{-1} thru the water column of Lake Vissi and between 6 to 15 mg l^{-1} thru the water column of deeper Lake Viisjaagu, while after ice-thaw the values varied between 0.6 to17 mg l^{-1} and 0.4 to 13 mg l^{-1} respectively.

42. Ana L. RUIBAL-CONTI[1], Louise C. Bruce[1] and Matthew R. Hipsey[1]

An inverse approach of a simple mass model (SMILE) to explore how internal nutrient fluxes in Lakes and Estuaries responds to management and climate change.

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While long-term monitoring data is useful for the investigation of water quality trends of lakes and estuaries, the data alone are not always enough to fully understand the underlying mechanisms responsible for observed responses in the water bodies. The use of complex hydrodynamic-biogeochemical models are increasingly being used to supplement process-studies to predict aquatic ecosystem responses to changes in external factors such as flows, nutrient loads, climate and hydrodynamics. However, the use of such complex models is limited by the lack of data to parameterise or calibrate and poor performance, and difficulty to run them over long (decadal) periods. In this study, an inverse model was developed (SMILE: Simple Mass Inverted model for Lakes and Estuaries) that can be driven by long-term water quality time-series data to explore changes internal nutrient fluxes in lakes and estuaries and assess how their nutrient budgets respond to management and climate changes. To demonstrate the approach, the model was applied to monthly hydro-meteorological, hydrographic and water quality data over a 25 year period to reconstruct the nutrient budget of the Peel-Harvey Lagoon. The model used mass balance equations to quantify nutrient inputs, outputs and relative significance of internal sources and sinks. In particular the analysis was able to unravel the direct and indirect effects of both changing nutrient loads and a constructed channel (the 'cut') that was introduced during the study period, and the results outline the extent to which altered hydrodynamic regimes have contributed to observed changes in biogeochemical dynamics.

43. James A. RUSAK[1], and Christopher T. Solomon[2]

High-frequency in-situ carbon dioxide measurements in the surface waters of boreal lake: metabolic insights and assumptions

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The diel dissolved oxygen (DO) technique for estimating lake metabolism assumes that changes in oxygen concentration of a body of water reflect the biological balance between

photosynthetic production and respiratory consumption as well as the physical exchange of oxygen between air and water. Production of DO via photosynthesis occurs only during daylight whereas consumption of DO occurs throughout the diel period and is the only metabolic process occurring at night. Thus, net ecosystem production (NEP), ecosystem respiration (R), and gross primary production (GPP) can be directly quantified by measuring temporal changes in DO concentration throughout a 24-h period. Although the high-frequency *in-situ* measurement of DO in surface waters needed to estimate lake metabolism is now relatively routine, the *in-situ* measurement of CO_2 is only an emerging technology that is yet to be widely deployed. We compare *in-situ* DO and CO_2 concentrations measured simultaneously in an oligotrophic northern lake in Ontario for similarities and differences and evaluate how these patterns might inform the calculation of lake metabolism estimates.

44. Elizabeth RYDER[1], Elvira de Eyto[2], Mary Dillane[2], Russell Poole[2] and Eleanor Jennings[1]

Using a combination of high frequency and low frequency data to estimate carbon pools in a humic lake

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In humic lakes, the main energy base is derived from allochthonous carbon which generally represents a more important source of carbon than the autochthonous pool. The aim of this research was to quantify the main carbon pools during the spring bloom in Lough Feeagh, a humic lake in the west of Ireland. These estimates were based on both routine biological sampling, together with high resolution data on chlorophyll (Chl) and chromophoric dissolved organic matter (CDOM) fluorescence. Results indicate that allochthonous carbon was estimated to contribute two orders of magnitude more carbon than the autochthonous pool. The maximum peak in Chl fluorescence and maximum Chl *a* coincided with the lowest allochthonous carbon levels, as measured by CDOM fluorescence and with the onset of lake stratification and an increase in Schmidt stability. During the spring bloom, algal biomass was dominated by Bacillariophyta and Cryptophyta. Results indicated that the carbon pool in zooplankton and ciliate biomass combined exceeded the carbon contained in phytoplankton biomass (autochthonous) for all months in 2010, with the exception of the months of May, July and August. Suggesting that while autochthonous carbon may make a contribution to zooplankton requirements, allochthonous carbon is also contributing to zooplankton biomass and this is also informed by the results from zooplankton stable isotope analysis. Overall these results provide insight into carbon processing and the factors influencing phytoplankton and zooplankton growth in humic lakes under current climate conditions.

45. Nihar R. SAMAL[1], Klaus D. Jöhnk[2], Don C. Pierson[3], Matti Leppäranta[4], Huaxia Yao[5], Bruce R. Hargreaves[6], Tim Kratz[7], Sapna Sharma[8], Alo Laas[9], David Hamilton[10], Rita Adrian[11], James Rusak[12], Deniz Oezkundakci[13], Craig Williamson[14], Dominic Vachon[15], Blaize Denfeld[16], Georgyi Kirillin[17], Kevin Czajkowski[18], Lluís Camarero[19]

Modeling long-term trends in ice seasons of seven geographically distributed freshwater lakes

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Changes in the duration and timing of ice cover are well documented effects of climate change that are expected to continue into the future. Long-term simulations of lake ice timing and duration are essential to understand the mechanisms through which ice cover mediates the effects of climate on lake thermal structure and mixing, and how changing ice cover may ultimately influence phytoplankton succession and trophic status of a lake. In the present study, a simple model that predicts the onset, loss and duration of ice cover and its thickness has been applied to seven freshwater lakes and reservoirs around the globe. The model is driven by readily available daily or hourly measurements of air temperature and wind speed, as these are the most important factors influencing formation and breakup. The effects of snowfall and solar radiation on ice thickness and breakup are not implemented in the simple ice model but can be parameterized. Even though the model does not make detailed calculations of the ice cover energy budget it reproduces long-term trends and allows for historical analysis of ice cover for a >60 year simulation of the ice cover on Otsego lake. The timing and duration of ice cover are also well reproduced in several of the other study sites. Work is ongoing to include simple snow cover estimates derived from precipitation and temperature data and expand simulations to a wider set of lakes which will allow more in-depth model inter-comparison.

46. Ryan C. SCHOENEMAN[1], Darren Bade[1]

Cranberry: An affordable, multi-parameter sonde assembled from open-source hardware and common materials.

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Sondes (multi-probe, submersible water quality sensors) are indispensable for unattended sensing of aquatic or marine environments, but their astronomical prices are prohibitive for many labs. With the widespread dissemination of open-source hardware and affordable aquatic sensor probes, an affordable sonde is within reach. Cranberry is a multi-parameter aquatic sensor platform controlled by Arduino and Raspberry Pi architecture. The goals of this project are threefold: Simplicity, affordability, and scientific relevance. The chassis is easily constructed from materials commonly available at local hardware stores. A graphical Linux interface on its Raspberry Pi microcontroller will contain all the software necessary to operate the sonde as well as access and process data in R. For maximum power efficiency, Arduino executes data logging and direct control of the sensor probes. The sonde is designed to operate to a depth of 15 meters with up to four water quality sensors (pH, ORP, DO, temperature, and/or conductivity) for up to two weeks. While this project is still in its nascent stage, strides have been made in stable, simultaneous data logging from multiple sensors and in the completion of its watertight chassis.

47. Facundo SCORDO; Federico Ferrelli; María Cintia Piccolo;Gerardo M. E. Perillo

PRELIMINARY STUDY OF ARGENTINIAN PATAGONIC LAKES WITH GIS AND BIOCLIM*

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The concept of lakes as "sentinel of climate change" involves how the structure and functioning of these surface water ecosystems respond under climate variability and change. The Fontana, Muster and Colhué Huapi lakes and Florentino Ameghino Dam are located in the Senguer River watershed in the South West of the Chubut Province in the Patagonia region. The area has the distinction of being the only one in America where an analysis of the influence of climate and topography along a transcontinental transect can be made when interconnected with lakes at the same latitude on the Chilean side of the Andes. These water bodies are located along a significant gradient of temperature, precipitation and topography. The objective of this study is to present a preliminary study of precipitation and temperature related to topography in the study area using Geographic Information System and the Bioclim climatic model. A Digital Terrain Model (DTM) was built from data provided by the Instituto Geográfico Nacional (IGN, Argentina), allowing the subdivision of the Senguer watershed in High, Medium and Low topography. Employing the Bioclim climatic model, we characterized seasonal temperatures and precipitation for the region. Thus, we observed a significant relationship between topography and

meteorological parameters. Future studies will evaluate the particular behavior of each of these reservoirs depending on climate and topographic characteristics.

48. Yuliana SERNA

Organic matter composition as a tool of reconstruction for riparian environments of the Cauca river during the Holocene (Antioquia, Colombia)

Universidad del Norte, Colombia

The analysis of organic matter composition of the sediments of a stratigraphic sequence can lead to the most comprehensive picture of the ancient environments and processes that have brought to their formation. The optical characteristics (color, shape, size, etc) of organic matter can change enormously with the income to high-energy environments such as riverine and riparian systems, whereby destruction and alteration signs are excellent indicators of primary source but also of processes occurring during transportation and sinking. The stratigraphic section studied here, Sucre-II, is located on the eastern bank of the Cauca river at 430 msnm, it is composed of fine grain laminated sediments with organic matter rich laminae at the base and sand and paleosols strata at the top.

The analysis of organic matter composition of the main strata types (clay laminations, paleosols and organic matter laminae) of Sucre-II was complemented with the analysis of organic matter of the two most likely modern analogues: the sediment accumulated in the bottom of a pond flooded by the river during rainy season and the mantle from a soil of a grazing area. We conclude that fine grain clay laminations correspond to ancient ponds. Organic matter laminae correspond to swamps formed on a floodplain. Paleosoils were soils with different moisture content. Additionally, the disappearance of organic matter sheets from the middle part to the top was interpreted as a process of aridification.

49. Denise TONETTA[1], Mauricio Mello Petrucio[1]

Are lakes dominated by cyanobacteria net heterotrophic?

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There is consistent evidence that oligotrophic aquatic systems tend to be net heterotrophic and that tropical lakes are more supersaturated and variable in CO_2 than temperate lakes. We were interested in knowing how oligotrophy (total phosphorus concentration) and the presence of the cyanobacteria *Cylindrospermopsis raciborskii* in a freshwater subtropical costal lake (Peri Lake) drives the pCO_2 and the aquatic metabolism. To address this, samples were taken monthly during six years (2007-2013), which included the vertical and horizontal dimension, and the pCO_2 was calculated from pH and alkalinity data. The values for pCO_2 ranged from 38 to 16,477 µatm, which is within the range of variation observed in various lakes distributed throughout the world. The soluble reactive phosphorus ranged from 0.70 to 9.18 ug L^{-1} while the chlorophyll *a* increased in latter months, reaching 45.39 ug L^{-1} and the depth of the Secchi disk decreased. Approximately 61% of the sampled

months were supersaturated with CO_2, supporting the hypothesis that oligotrophic lakes act as emitters of CO_2. Annually, there was a net heterotrophic predominance, with the exception of 2009, which showed values below saturation, suggesting net autotrophy. The pCO_2 was positively correlated with chlorophyll *a* and soluble reactive phosphorus, suggesting that eutrophication can boost net heterotrophy. The results demonstrate that the environment is predominantly net heterotrophic, even during an increase of chlorophyll *a,* with occasional autotrophic events. The question remains: are there other oligotrophic lakes that have Cyanobacteria dominance with pCO_2 above the atmosphere equilibrium or is Peri Lake unique?

50. Vicky VEERKAMP[1], Valerie McCarthy[1], Suzanne Linnane[1] and Eleanor Jennings[1]

Exploring the thermal stratification patterns of Milltown Lake

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Milltown Catchment is approximately 34 km^2 and is located in the north-eastern part of Irelands drumlin belt, giving rise the to the catchments hilly landscape. Grassland agricultural practices are the main industry within the catchment and population settlements is sparse. The catchment consists of a lake referred to as Milltown Lake. The lake is 22 ha in area and is supplied by three inflowing tributary streams. The maximum depth of the lake is 12 m with a mean depth of 5 m. Milltown Lake is used as a domestic water supply for the local community, and keen fishing location for the local angling club.

The current status of the lake is eutrophic to strongly eutrophic. Past work on the lake has also indicated that the lake may be polymictic and that sediment phosphorus release may play a role in the eutrophic classification. A chain of temperature loggers was deployed in April 2010. Further work has included the installation of sediment traps which allows the rate of phosphorus sedimentation in the lake to be quantified. In addition to this a sensor buoy has been deployed late 2011 which is collecting, real-time data and water quality form the lake. Sampling for Chlorophyll *a* and phytoplankton is carried out on a weekly basis. This will facilitate modelling of nutrient export on phytoplankton. One of the main aims of this project is to explore the thermal stratification patterns in Milltown Lake aiding in determining the classification of lakes trophic status.

51. Chelsea WEIRICH[1] and Todd R. Miller[1]

A global characterization of cyanotoxins in freshwater lakes

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Cyanobacterial harmful algal blooms (cyanoHABs) are a global phenomenon, however, cyanotoxin production in eutrophic lakes is variable even during bloom conditions. Mixtures of cyanobacterial secondary metabolites found in freshwater are important toxicologically for the types of compounds humans are exposed to during recreational activities and in drinking water. Our laboratory received ~300 samples for cyanotoxin

analysis from lakes in Wisconsin, Virginia, Connecticut, Northern Ireland, Argentina, and France, as part of the GLEON Microbes Working Group Cyanotoxin Project and the North Temperate Lakes Long Term Ecological Research collection. Eight cyanotoxins and six peptides were detected using HPLC-electrospray ionization tandem mass spectrometry. The resulting data characterizes cyanotoxin profiles of 23 different lake sites between 2008 and 2013. The goal of these analyses was to compare and contrast the types and concentrations of cyanobacterial toxins and bioactive peptides present in lakes from around the world. All toxins measured (microcystin-LR, -RR, -LA, -YR, cylindrospermopsin, nodularin, homoanatoxin-a, microginin 690, cyanopeptolins 1020, 1007, and 1041, anabaenopeptins B and F) were detected in at least one sample. Anabaenopeptin B, anabaenopeptins F, microcystin-RR (MC-RR) and MC-LR were most frequently detected with occurrences of 80.83, 68.33, 62.5 and 61.67%, respectively. Nodularin was the least frequently detected, in 14.17% of samples. The highest toxin concentration detected was MC-LR at 974 μg/L. This study illustrates that cyanotoxin profiles differ despite lake geography or trophic status. Future work will include examining cyanotoxin profiles of more lakes and relating toxin production to global land-use patterns and lake characteristics, such as zebra muscle invasion.

52. Beverley C. WEMPLE[1] and Donald S. Ross[2]

Assessing the effects of unpaved road networks on water quality in the Lake Champlain basin

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Unpaved road networks have been widely recognized for altering watershed and ecosystem processes. Roads modify hydrologic processes, accelerate rates of erosion, and modify hillslope to channel connectivity, with associated downstream cumulative impacts on channel morphology and aquatic ecology. This study examined the impact of unpaved roads on pollutant (sediment, phosphorus) production within the Lake Champlain basin, located in the US states of Vermont and New York and the Canadian province of Quebec. A broad scale inventory of erosional features was conducted on 100 km of gravel roads in the 1000 km^2 Winooski River watershed of the Lake Champlain basin, and storm-based runoff and water quality sampling was conducted on 12 road segments in the 360 km^2 Mad River watershed, a tributary to the Winooski. Pollutant production from the unpaved road network in the Mad River watershed averaged 5093 kg/km/year of suspended sediment and 10 kg/km/year of phosphorus. Our analysis of road and catchment scale pollutant flux indicates that roads contribute approximately 17% of the annual average suspended sediment load and 28% of the annual average phosphorus load yielded from these upland catchments. Within the larger Winooski basin, inventory results showed that road erosion was associated with steep road segments and the absence of best management practices in the most incised portions of the watershed. This work is the first attempt to quantify pollutant loadings associated with unpaved roads in this lake basin and provides a bench mark for assessing the importance of this unrecognized source of water quality impairment.

53. R. Iestyn WOOLWAY[1, 2,], Ian D. Jones[1], Stephen C. Maberly[1], Heidrun Feuchtmayr[1].*

Diel variability in high resolution lake surface water temperature measurements from five lakes in the English Lake District.

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High temporal resolution surface water temperature measurements were analysed for five neighbouring lakes in the English Lake District. These lakes undergo essentially the same climate, but are characterised by different morphometric features. The high frequency measurements were used to assess how the amplitude of the diel surface temperature cycle, which has a major effect on lake ecology, varied among the lakes. The amplitude of the diel temperature cycle was evaluated by (1) the absolute difference between the maximum and minimum daily lake surface water temperature measurements, and (2) using an autocorrelation technique with a loess smoothing function. Our analysis demonstrated that the amplitude of the diel temperature cycle was primarily influenced by the depth of the actively mixing layer, and the strength of net surface heating. The amplitude of the diel temperature cycle was lowest for the largest lake, Windermere, which varied by approximately half that of the smallest lake, Blelham Tarn. A significant correlation between the diel temperature cycle and lake area was observed in the summer months due to the larger lakes being exposed to higher wind speeds, in turn leading to larger wind shear mixing, and consequently leading to large mixing depths and thus low diel temperature change.

54. Yang YANG

Patterns of phytoplankton community dynamics and its environmental factors

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The temporal development of the phytoplankton community in lakes is the outcome of a complex interplay of environmental factors and its dynamics is a good indicator for the water quality and healthy status, even the climate change. This study used four-year monitoring data from Lake Erken in order to describe and understand the pattern of phytoplankton community succession pattern and its underlying mechanisms. We applied the measurements to 1) time series analysis and found that there was a seasonal pattern of phytoplankton community development, corresponding to four periods; 2) correlation analysis to see the relationship between main phytoplankton groups and other environmental factors, results suggested that the limiting factors are different in each periods; 3) examine the influence of stratification events on the dynamics of phytoplankton community using the time frequency data of temperature profile in Lake Analyzer.

55. Mengyuan ZHU[1], Guangwei Zhu[1]

Daily variation of Chl-a and nutrient concentration within a year in Lake Taihu, China

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Daily observations of water quality were taken for Lake Taihu from November 2011 to December 2012. Chlorophyll-a (Chl-a) concentration was measured every day and phytoplankton was identified. Nutrient concentration, including total nitrogen (TN), total phosphorus (TP), dissolved total nitrogen (DTN), dissolved total phosphorus (DTP), ammonium (NH_4^+-N), nitrate (NO_3^--N), nitrite (NO_2^--N) and phosphate (PO_4^{3-}-P), were determined. High-frequency data of wind speed, wind direction, solar radiation, water temperature, turbidity and dissolved oxygen (DO) were measured by GLEON buoy. Water level and rainfall were also recorded. Two peaks of Chl-a concentration were observed through the high-frequency observation. The first small phytoplankton peak in spring was dominated by Anabaene, and the second peak in summer to autumn was dominated by Cyanophyta. Temperature was an important factor for phytoplankton growth. Anabaene and Bacillariophyta grew in spring when water temperature was low, and Microcystis rapidly replaced them when temperature increased. Nutrients showed strong internal cycling in Taihu, and Anabaena did not show nitrogen fixation. Phosphorus could be pulled from sediments, and both nitrogen and phosphorus were cycled by phytoplankton growth and degradation. Solar radiation and water level also influenced phytoplankton growth.

56. Josefina ZUNINO [1], Nora C. FERRER [1] and M. Cintia PICCOLO [2,3]

PRELIMINARY STUDY OF THE PHYTOPLANKTON OF LA SALADA SHALLOW LAKE (PROVINCIA DE BUENOS AIRES, ARGENTINA)*

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La Salada shallow lake (39º28'S; 62º42'W) is located in the South of the Buenos Aires province, Argentina. It is characterized by a high salinity (greater than 3). The phycoflora of this water body is unknown. For this reason, the aim of this work was to study the composition and abundance of its phytoplankton community. Phytoplankton samples were collected at monthly intervals from March to June 2013, in the deepest point of the shallow lake. The samples were taken with bottles and net (30 µm mesh) and were fixed with lugol and with formaldehyde (final concentration of 0.4%) for quantitative and qualitative analysis, respectively. In addition, turbidity, temperature, pH and conductivity parameters were simultaneously measured with a Horiba U-10 multisensor. Chlorophyll *a* concentration was measured with a spectrophotometer in accordance with APHA (1998).

The chlorophyll *a* values ranged from 5.3 to 15.8 µg/L, defining a mesotrophic state for the studied period (OCDE, 1982). Total phytoplankton abundance ranged from 66000 (in May) to 143000 (in June) ind/ml. The main algal group was Crysophyta, and *Ochromonas* sp. was the dominant species. Members of Chlorophyta, Cyanobacteria, Dinophyta and Heterokontophyta were also found in the lake.

57. Jake A. ZWART[1], Christopher T. Solomon[2], and Stuart E. Jones[1]

Ecological Applications of Sensor Technology: Phytoplankton Traits Detected at the Ecosystem Scale

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Trait-based community ecology of phytoplankton predicts community assembly by examining traits related to predator avoidance, resource utilization efficiency, and reproduction. Many of these traits are well documented in freshwater phytoplankton based on laboratory studies and often there is often a trade-off between traits, for example the trade-off between competitive abilities for light and nutrients. Spatial distribution of these traits based on a species-sorting (or trait-sorting) framework has been shown in lakes of varying environmental conditions across the United States. However, characterization of whole-community traits and the controls of these traits has not been observed or tested for freshwater phytoplankton. This step is the next scale up in examining trait-based ecology, linking community structure to ecosystem functioning. To examine drivers of phytoplankton community traits, we utilized data collected from automated sensors in 22 lakes distributed globally through the GLEON. Diel dissolved oxygen cycles were explained using a simple metabolism model and the average rate of photosynthesis parameter (light use efficiency) was used to test a representative phytoplankton community trait. Across lakes, light use efficiency increased in lower light climates ($p = 0.02$, $R^2 = 0.19$). Trait trade-offs were also evident, as the best predictive models of light use efficiency were those that included nutrient availability along with light availability ($p < 0.0001$, $R^2 = 0.67$). Within lake analyses exhibited similar predictor variables of light use efficiency as the across lake analysis. Interesting seasonal patterns in LUE, with many lakes demonstrating hysteresis, suggests that community phytoplankton traits are also influenced by phytoplankton community composition.