# Book of Abstracts

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**A Low-Cost, Customizable Water Quality Sensing System for the Detection of Algae and Cyanobacteria in Lake Monitoring**

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Most aquatic monitoring programs rely on commercially available sensors and their communication networks. This reliance potentially limits the customization of sensor networks, restricts the spatial and temporal coverage of data collection, and introduces barriers to accessing and using sensors. Many of these challenges can be overcome by using low-cost sensing systems. Therefore, we developed a low-cost, customizable water quality sensing system for use in lakes. Our sensor system measures water clarity (turbidity), phycocyanin fluorescence (as a proxy for cyanobacteria presence, chlorophyll-a fluorescence (as a proxy for phytoplankton biomass), and water temperature. The system is designed for near surface measurements. The sensor system uses a 3D-printed fluorometer instrumented with LEDs and photodiodes. The system operates by an ARM microcontroller programmed by Arduino. The electronics and fluorometer are housed in a waterproof case and water flows through the fluorometer using a peristaltic pump. Data are transmitted using a Long-Range Wide Area Network (LoRaWAN) protocol and stored locally (SD). Detection ranges are typically 3-275 FTU for turbidity, 50-2000 µg-PC/L for phycocyanin, and 5-75 µg-chl/L for chlorophyll-a, but customizations can be used to change sensor sensitivity. In repeated laboratory tests using standard or reference materials, our sensor system had relative percent differences of <10%. In laboratory incubation trials, when compared to a commercial multiparameter sonde, our low-cost sensor followed a similar time-series profile with an average correlation coefficient of 0.87 for phytoplankton biomass and turbidity. These results are promising and suggest low-cost sensor systems could be a useful tool in aquatic monitoring.

**Are Water Treatment Plant Intake Samples Representative of the Epilimnion?**

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Monitoring year-round changes in lakes and reservoirs is essential for understanding the impacts of climate change and other environmental stressors on aquatic ecosystems. Winter is an important period for various limnological processes; almost half of the lakes worldwide periodically freeze. Climate change is causing shorter ice cover durations worldwide. This reduction in ice cover complicates access to lakes and increases the risks associated with sampling under changing ice conditions. To address this challenge, collaborations with drinking water treatment plant (WTP) operators can provide a viable solution. The University of Missouri (MU) Limnology Lab collaborates with the Marceline, MO City WTP operators who collect weekly epilimnetic water samples from the intake pipe in Marceline Reservoir. We aim to investigate whether WTP intake water samples are representative of the epilimnion of the reservoir. We hypothesize that there will be no differences between the WTP intake samples and the reservoir samples taken by the MU Limnology Lab. Total Nitrogen (TN), Total Phosphorus (TP), Chlorophyll a (Chl a), Total Suspended Solids (TSS), and cyanotoxins (microcystin and cylindrospermopsin) were analyzed for both types of samples. There were no significant differences between the parameters listed above, concluding that there is no difference between the intake pipe and reservoir water samples ([TN, TP = 4], [Chl a, microcystin, cylindrospermopsin = 3], [TSS = 8]). Engaging WTP operators in winter sampling can help ensure the continuity of lake monitoring programs and support effective lake management.

**Assessing Central European Lake Dynamics: Mapping, Hydrology, and Environmental Influences**

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This research aimed to comprehensively assess selected Central European lakes, focusing on mapping, hydrological analysis, and understanding factors influencing water balance, groundwater dependency, and water quality. Utilizing chemical and land use data, alongside advanced statistical techniques and artificial intelligence models, it was found that air temperature and precipitation patterns influence evaporation rates. Additionally, catchment characteristics, particularly groundwater table depth, indicate hydrological connectivity between surface water bodies and groundwater systems, impacting their lake water balance. Different patterns among lakes were observed, influenced by geographical and environmental factors. Lakes at lower elevations with shallow depths and urban or agricultural catchments exhibited higher susceptibility to shifts in water balance, elevated evaporation-to-inflow ratios, and higher total nitrogen (TN) concentrations. Conversely, lakes at higher elevations with deeper depths and forested catchments displayed greater resilience. Lakes originating from glacial sources experienced reduced evaporation losses, resulting in better water quality regarding TN concentrations. Furthermore, this study aims to expand its analysis by incorporating additional European lakes, inviting collaboration to gather additional data and samples. This collaborative effort, combined with advanced techniques, will enhance the representativeness and robustness of findings, facilitating comprehensive management strategies for European lake ecosystems. This research will contribute significantly to understanding the hydrological processes and environmental factors affecting the water balance, groundwater dependency, and water quality of European lakes. Such understanding is essential for informed water management strategies, ecosystem conservation efforts, and sustainable development initiatives across the region.

**Assessing the Impact of Dynamic Chloride Exposures on Zooplankton in Toronto's Inner Harbour**

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Application of de-icers is enmeshed in Great Lakes cities, contributing excessive volumes of chloride (Cl-) to waterbodies. Nearshore, high Cl- levels are concerning, as Cl- alters ecosystem functions and biodiversity bottom-up, often with sizable impacts on sensitive primary consumers (zooplankton). In the Toronto and Region Area of Concern (TRAOC), Cl- levels fluctuate around chronic Canadian Water Quality Guidelines for the protection of aquatic life (120 ppm Cl-); however, recent work has shown this guideline is too lenient, leading to reductions (>50% lethality) among various zooplankton. In the TRAOC, consequences of impairment include increased nuisance algae and bacteria, lower population densities and smaller body sizes of zooplankton, and an over-abundance of zooplankton species typically found in more stressed environments (e.g., Bosmina). Even so, zooplankton status remains indeterminate, and Cl- data in the nearshore is temporally- and depth-limited (as surface grab samples). The proposed PhD research will collect stratified Cl- measurements (using a YSI EXO2 sonde) and zooplankton samples (using a Schindler-Patalas trap) to assemble zooplankton exposure profiles to Cl- in the TRAOC. Subsequently, in-laboratory intermittent exposure tests (with varying duration, concentration, and frequency of Cl- exposure) and diel vertical migration bioassays will be conducted to understand the effect of dynamic exposures, and the impacts of zooplankton modulating behaviour to reduce Cl- exposure. This aims to be a logical next step to the recent status assessment of the TRAOC, while supporting the continued development of environmentally relevant ecotoxicological methods that can elucidate the dynamic impacts of Cl- loading to nearshore communities.

**Capitan Taki - Climate Adaptation Planning through water monitoring in the lakes Tanganyika and Kivu**

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With more than 18% of the world's available freshwater, the Tanganyika and Kivu Lake Basins are of global importance and sources of socio-economic well-being, serving over 12 million people. Nonetheless, the lakes are experiencing water quality deterioration due to climate change, poor land-use and urbanisation, while overfishing and the impact of invasive plant species are exerting high pressure on the aquatic food systems. Furthermore, the effect of climate change is exacerbated by the unique and complex morphologies of the lakes, and the complex fluctuations of winds, the influence of which on the lakes is not yet fully known. Capitan Taki aims for both lakes to (1) create a community, (2) collect and make available information, studies and data on environmental and climate issues, (3) organise capacity building on climate adaptive measures, (4) share the collected (incl. satellite-based) information, knowledge and materials on a demo platform, as a first stage for further implementation of environmental monitoring systems, and (5) prepare a roadmap based on building blocks for the environmental monitoring system. It is a G-STIC CAP quadruple helix capacity building project (March 2024-October 2026) funded by the Flemish government and builds on and complements Enabel's (Belgian Development Agency) work of the Latawama project (2019-2023) funded by EU DG INTPA on water quality management of Lake Tanganyika. It brings together key actors from the Lake Tanganyika Authority (LTA) and ABAKIR with experts from Flanders, Burundi, Rwanda, Zambia, Tanzania and Democratic Republic of Congo to take concrete steps towards climate-resilient transboundary water management.

**Changes of temperate lake ice due to climatic variability: critical contribution of snowfall in early winter**

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Climatic change in the ice regime of seasonally ice-covered lakes is an urgent problem of limnology. Most of the research is focused on climatic changes of duration of ice period and ice thickness, while climatic changes of ice structure are still poorly studied. The ice structure of a number of lakes and reservoirs in the Kola Peninsula, Karelia and the Moscow region in 2022-2024 was analyzed as a continuation of research begun in the GLEON Ice Blitz campaign 2020-2021. It was found for all lakes that the proportion of white ice was significant and increased during the winter. Long-term measurements on Lake Vendyurskoe (Karelia) and the Mozhaysk Reservoir (Moscow region) revealed a strong inverse relationship between the thickness of black ice in the end of winter and the amount of precipitation in the first month of freeze-up. A statistically significant increase of thaws, a decrease of frosty days, as well as a change in the precipitation pattern was shown in study areas in 1950–2023. Frequent thaws and an increase in precipitation lead to the structure of ice changes: the proportion of white ice becomes larger, and the proportion of black ice decreases. The high albedo of white ice (up to 0.6) and the low transparency (extinction coefficient 6-8 m-1) prevents the penetration of radiation under the ice and slows down the development of radiatively-driven convection. From this point of view, white ice can be considered as an important regulator of thermal regime of lakes in warm winters.

**Citizen Science: Ecological Water Quality Monitoring of Small Waters in the Netherlands**

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The Water Framework Directive (WFD) states that all water quality in Europe should be of good ecological status. The deadline for the Netherlands is 2027, we found out that almost all small waters are neglected in the monitoring for the WFD. However an insight in these small waters is important, since there is value in these small waters as they can provide habitat to many species. The processes in and pressures on these small waters will be different than in larger lakes or canals. That is why we want to gain insight in the ecological water quality of small waters in the Netherlands. However about one third of the surface water in the Netherlands consists of these small waters, that is why we decided to use a citizen science approach to collect data on a national scale. Additionally, these small waters are often close to citizen, so measuring the water quality can be a great way to increase the scientific literacy of citizens. On top of that involving a lot of citizens promotes awareness of the poor water quality that we find in the Netherlands. And can promote action in the context of environmental compliance. The project was called "Vang de Watermonsters" and citizens performed measurements of aquatic plants, water clarity, nutrients (N&P) and macro-invertebrates. We validated those measurements. In the follow-up of the project, called "Water op de Kaart" (Putting water on the map) we will focus on effect monitoring of measures and quantifying the pressures on small waters.

**Climate and land use shape the water balance and water quality in selected Central European lakes**

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This study offers insights into the factors influencing the water balance of Central European lakes and their impact on water quality. Through the analysis of diverse datasets encompassing isotopic, chemical, and land use data, and utilizing advanced statistical techniques and artificial intelligence models, the research aimed to identify these factors. Notably, the study highlights the substantial influence of climate, particularly air temperature and precipitation, on increasing evaporation losses from these lakes. Additionally, catchment characteristics, particularly groundwater table depth, play a crucial role in indicating hydrological connectivity between surface water bodies and groundwater systems, further impacting lake water balance. Distinctive patterns among lakes were observed, influenced by geographical and environmental factors. Lakes at lower elevations, with shallow depths and urban or agricultural catchments, exhibited heightened susceptibility to shifts in water balance, showing elevated evaporation-to-inflow ratios and higher total nitrogen (TN) concentrations. Conversely, lakes at higher elevations, with deeper depths and forested catchments, displayed greater resilience to water balance fluctuations. Originating from glacial sources, these lakes experienced reduced evaporation losses, resulting in comparatively better water quality regarding TN concentrations. Overall, understanding these interactions is crucial for effective lake management and freshwater ecosystem preservation, enabling policymakers to develop targeted strategies for long-term sustainability.

**Controlling cyanobacterial blooms through nutrient load reduction: evaluating experience from around the globe**

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Mitigating eutrophication and thus cyanobacterial blooms through reducing phosphorus loading is showing success in an increasing number of waterbodies around the globe. However, it often takes decades for in-lake TP-concentrations to decline sufficiently, particularly due to internal loading. While bloom control can also be achieved through sufficient reduction of nitrogen loading with the advantage of N leaving the system via denitrification, there is little experience with sufficient N load reduction. An international collaborative group of limnologists ("CyaNuCo": Cyanobacteria Nutrient Control) is striving to compile and evaluate the experience with the trophic state development of lakes and reservoirs undergoing restoration. A key aspect is the responses of a wide range of waterbodies to nutrient load reduction. This requires longer-term lake data sets, typically covering decades not only of hydrophysical and chemical parameters, but also including biovolumes of cyanobacteria and their fraction of total phytoplankton. We are looking for partners with such data who are interested in joining CyaNuCo to compare waterbody responses and tease out key criteria for successful bloom control. As first step we target consolidating scientific insight into mechanisms of in-lake responses to load reduction, including under-represented regions such as warm climate lakes. As second step we aim at making this knowledge available for waterbody management by developing criteria to optimise management strategies for the specific conditions of different catchments and waterbodies around the globe. For more information about CyaNuCo visit: Controlling cyanobacterial blooms through nutrient load reduction – SIL-International Society of Limnology.

**Decreasing greenhouse gas emissions from surface waters by climate-smart water management**

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Inland water bodies, such as ditches, are considered to be major natural greenhouse gas (GHG) contributors. However, there is a lack of effective mitigation measures due to limited insights of GHG processes in aquatic ecosystems linked to water quality and ecological status. The impacts of internal (vegetation mediation) and external factors (climate change and nutrient loading) on GHG emissions are unclear. Developing a GHG emission model for ditch networks based on PCDitch considers the combined effects of vegetation mediation, climate change, and nutrient loading. This GHG model will assess GHG fluxes in ditch networks and evaluate mitigation measures, which will support GHG mitigation policy making. A systematic literature review for existing aquatic GHG models provides an overview of how current models simulate GHG fluxes in inland waters and furthermore pave the way to extend PCDitch.

**Drivers of Algal Metacommunity Assembly and Resilience in a Subtropical Wetland**

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Within aquatic landscapes, species assemblages vary across space, time, environmental gradients, and biological interactions. This research investigates how these ecosystem dimensions mediate the taxonomic assembly and ecosystem functions for benthic algae in the Florida Everglades. Our analyses reveal that factors occurring at very large and very small spatial scales (dispersal limitation and biotic interactions) play important roles in the regulation of the Everglades algae. Our results yield implications for the success of ecosystem management approaches and the future resilience of this climate change-threatened landscape.

**Drivers of water quality and biogeochemistry of waterpans in Afrotropical arid and semi-arid lands**

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Waterpans, colloquially known as pans, are shallow ponds or reservoirs found in Africa, particularly in arid and semi-arid regions, either naturally occurring or artificially constructed for water harvesting. They serve various purposes such as livestock watering, crop irrigation, and domestic water supply, while also providing ecological functions like wildlife habitats and erosion control. However, their water quality is influenced by multiple factors, including human and animal activities, making research vital for effective management. This study aims to provide baseline information on waterpan use, sizes, nutrients, organic matter, and greenhouse gas flux dynamics. A preliminary investigation was conducted in Kenya's Lower Mara Region, selecting study sites based on size, land use, and human impact. Observations and questionnaires were used to gather baseline data. Of the 20 identified waterpans, 55% were communal and 45% were on private lands, mainly replenished by surface runoff. Most were permanent, but some dried up during the dry season, showing signs of pollution such as high turbidity in 90% of cases. These waterpans supported diverse uses, often receiving organic matter and nutrients from wildlife and livestock, impacting water quality and biogeochemistry. Many waterpans lacked protection, especially on public lands, with vegetation-free banks exacerbating sedimentation. Additionally, most lacked direct access for livestock and wildlife, except for one with separate troughs. This preliminary study informs further investigation into waterpan management and environmental mitigation strategies. The subsequent year-long study, starting June 2024, will provide data crucial for informed decision-making regarding waterpan sustainability amidst human and animal activities.

**Ecological memory of spring air temperature drives summer water quality dynamics across 615 temperate lakes**

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In many temperate lakes, summer bottom-water temperature and dissolved oxygen regulate both habitat viability and biogeochemical cycling, affecting ecological function year-round. However, trends in summer bottom-water dynamics are poorly explained by trends in summer air temperature, limiting our ability to predict the future effects of climate change on lake ecosystem function. To characterize drivers of variation in summer bottom-water dynamics, we analyzed data from 615 temperate lakes, with a median time series duration of 30 years at each lake. The database used in this analysis was compiled as a community-wide effort within GLEON, and includes lakes across 18 countries and 5 continents. Our results indicated that many lakes exhibit seasonal ecological memory, whereby summer bottom-water temperature and dissolved oxygen were more associated with spring air temperature than summer air temperature. Conversely, summer surface-water temperature was more strongly associated with summer air temperature. Across lakes, the extent of seasonal ecological memory in bottom waters was mediated by both the strength of thermal stratification and lake size, and the timing of thermal stratification regulated which window of spring air temperature was most influential. Ultimately, our results help explain why trends in summer bottom-water temperature diverge from trends in summer air temperature and suggest that predicting future water quality may require accounting for differential changes in climate among seasons.

**Effects of multiple stressors on freshwater quality and growth of microalgae, Selenastrum Capricornutum: A microcosm assay**

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Freshwater communities are often affected by multiple stressors, such as pollutants, climate change, habitat degradation, and invasive species. Multiple pollutants affecting the same environment might have individual or synergistic effects. The primary goal of our research was to elucidate the independent and interactive effects of multiple pollutant stressors on freshwater phytoplankton communities. Atrazine, a chlorinated herbicide of the triazine class, and the road-deicing salt NaCl can enter freshwater systems through runoff or be applied directly. Therefore, investigating their impacts is essential to managing and conserving the functions of freshwater ecosystems. Extensive research has been conducted on the effects of each pollutant independently, but the interactive effects of these pollutants on freshwater systems have been largely ignored. Using a microcosm study, we investigated the effects of two concentrations of NaCl (120 mg/L and 230 mg/L) and two concentrations of atrazine (1µg/L and 5µg/L) on water quality and the growth of Selenastrum capricornutum, a primary producer and common food source for many zooplankton taxa. The DO and nitrate concentrations were higher at high concentrations of atrazine and atrazine-NaCl mixtures. Additionally, high atrazine-NaCl interplay increased the Chl-a concentration in algae. We did not observe any significant differences in the cell density and growth rate of the algae among treatments. Therefore, when combined with atrazine, NaCl exhibited some synergistic effects in terms of the productivity of Selenastrum capricornutum. These results provide a further understanding of the consequences of multiple anthropogenic stressors, such as salts and pesticides, on freshwater organisms.

**Enhanced heterotrophy in aquatic ecosystems linked to plastic pollution**

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Plastics present in aquatic environments undergo rapid biofouling, fostering the formation of a novel ecosystem known as the 'plastisphere' on their surfaces. However, there is a dearth of studies quantifying the impact of plastics and their associated communities on various ecosystem traits. In this research, we evaluated algal biomass, bacterial and algal biodiversity (16S and 18S rRNA), and metabolic traits of communities inhabiting the surfaces of different plastic polymers incubated in rivers within the Lower Mekong Basin (Cambodia). These rivers exhibit distinct ecological characteristics but share high levels of plastic pollution. Our study investigated the impacts of biofouled plastics on ecosystem production, community dark respiration, and the ability of the epiphytic community to influence nitrogen, phosphorus, organic carbon, and oxygen levels in water. Our results revealed limited microalgal biomass and bacterial predominance, with the presence of potential pathogens. Community composition varied significantly based on location, underscoring the influence of environmental conditions on community dynamics. Our experiments demonstrated that biofouled plastics caused a considerable decrease in oxygen concentration in river water, leading to hypoxic/anoxic conditions and consequent profound effects on system metabolism and biogeochemical cycles. Scaling up our findings suggests that plastic pollution could exert a more substantial and ecosystem-altering impact than previously assumed. This underscores the importance of recognizing the plastisphere as a habitat for biologically active organisms crucial for essential ecosystem processes, necessitating dedicated attention and investigation, especially in ecologically sensitive areas like the Mekong River, which sustains rich biodiversity and supports the livelihoods of millions of people.

**Freshwater zooplankton diel vertical migration and carbon flux under varying levels of planktivory: a mesocosm-based approach**

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Zooplankton often exhibit diel vertical migration (DVM) in lakes, whereby they reside in deeper waters during the day to avoid fish predation and migrate to surface waters at night to feed on phytoplankton. Zooplankton are expected to exhibit more pronounced DVM behavior in lakes with higher predation risk from planktivorous fish. However, zooplankton trait-based groups differ in their evasion capabilities, which may drive diverse behavioral responses to planktivory. Zooplankton DVM behavior contributes to the downward transport of organic carbon to deep waters and sediments in the ocean, but DVM-mediated carbon flux has not been quantified in freshwater systems. We manipulated densities of planktivorous fish in 14 large enclosures (9 m diameter x 20 m deep) at the LakeLab in Lake Stechlin, Germany for six weeks in spring 2023 to investigate differences in DVM behavior of zooplankton functional groups, and to quantify impacts of DVM on carbon cycling. DVM was quantified using AI-supported high-resolution in situ video (MDPI). Preliminary results indicate stronger migration responses for larger individuals and taxa with weaker evasion capabilities. We use zooplankton respiration and fecal pellet production models, combined with physical parameters and particulate and dissolved carbon concentrations, to investigate how DVM drives carbon flux dynamics through changes in respiration and excretion across time and space. Our results will contribute to better understanding impacts of fish community changes on zooplankton behavioral dynamics and roles in lake ecosystem function.

**How different New Jersey zooplankton communities respond to natural and anthropologically derived salt gradients – a microcosm study**

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Freshwater ecosystems worldwide are being polluted by salts applied to roads as. The most common deicer used worldwide is sodium chloride (NaCl), which can negatively affect the abundance and diversity of organisms that live in freshwater. Aquatic organisms vary in their tolerance to salt pollution. Evolutionary responses of freshwater zooplankton to natural compared to anthropogenically derived salt gradients remains largely unexplored. To understand differences in evolutionary response to natural compared to human-induced salt gradients, we conducted a microcosm experiment using soils collected from a gradient of salinized ponds. Half of the ponds were considered "naturally" salinized along a gradient at different distances from the ocean. Locations close to the ocean had higher concentrations of salts compared to ponds farther from the ocean. The other half of the samples were collected from inland ponds that had differentially experienced salt pollution. Soil samples containing resting eggs of zooplankton were collected from each pond and exposed to different concentrations salt pollution ranging from 0.0mg L-1 to 1000 mg L-1. We found no differences in rates of emergence of zooplankton among the source ponds that experienced low, medium, or high salt treatments. Source pond concentration, or whether the pond was naturally saline or polluted did not affect nitrogen or phosphorus concentration. Polluted ponds with low or medium concentrations of salt had reduced dissolved organic matter as the treatment salinity increased. These results highlight differences in how naturally saline and ponds polluted by road deicers respond differently to changing salinity conditions.

**Increasing warm-season evaporation rates across European lakes under climate change**

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Lakes represent a vital source of freshwater, accounting for 87% of the Earth's accessible surface freshwater resources and providing a range of ecosystem services, including water for human consumption. As climate change continues to unfold, understanding the potential evaporative water losses from lakes becomes crucial for effective water management strategies. Here we investigate the impacts of climate change on the evaporation rates of 23 European lakes and reservoirs of varying size. To assess the evaporation trends, we employ a 12-member ensemble of model projections, utilizing three one-dimensional process-based lake models. These lake models were driven by bias-corrected climate simulations from four General Circulation Models (GCMs) from the Coupled Model Intercomparison Project Phase 5 (CMIP5), considering both a historical (1970-2005) and future (2006-2099) period. Our findings reveal a consistent projection of increased warm-season evaporation across all lakes this century, though the magnitude varies depending on specific factors. By the end of this century (2070-2099), we estimate a 21%, 30% and 42% average increase in evaporation rates in the studied European lakes under RCP (Representative Concentration Pathway) 2.6, 6.0 and 8.5, respectively. Moreover, future projections of the relationship between precipitation (P) and evaporation (E) in the studied lakes, suggest that P-E will decrease this century, likely leading to a deficit in the availability of surface water. The projected increases in evaporation rates underscore the significance of adapting strategic management approaches for European lakes to cope with the far-reaching consequences of climate change.

**Inter-year and inter-season variability of zooplankton of a mountain lake with a special emphasis on under-ice communities**

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Lake Tovel, an oligotrophic mountain lake (1177 m a.s.l.), is regularly sampled during the ice-free season and occasionally under ice from 1995 onwards. We analysed seasonal and yearly differences of environmental data and the zooplankton community (crustaceans and rotifers) from 11 years. Preliminary results of taxonomic and functional diversity are shown. Inter-year differences were greater than inter-season difference. Possible relationships will be discussed.

**Investigating how winter algal growth facilitates summer algal growth**

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This study investigates the potential role of winter light conditions in facilitating the growth of algae in the littoral zones of oligotrophic lakes. Climate change-induced reductions in winter ice cover have altered the light environment in lakes, impacting the availability and quality of light for photosynthesis. This study predicts that sites with higher levels of winter algal growth will exhibit greater summer algal biomass. The study deployed sampling stations in 24 unshaded sites in Lake George's nearshore area.

**Investigating the Impacts of Heatwaves and Salinization on the Respiratory Rates of Freshwater Crustacean Zooplankton**

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Zooplankton are crucial microscopic crustaceans in food webs, transferring energy from primary producers to higher trophic levels. However, environmental stressors such as increased salinity (i.e., chloride Cl-) and more frequent and intense heatwaves (HW) can significantly influence zooplankton population dynamics, diversity, and ecological functions and can thus have significant impacts on freshwater ecosystems. Little is known about the effects of both stressors on zooplankton metabolism and how these impact overall freshwater ecosystem function. We tested the effects of HW and elevated Cl- on freshwater crustacean zooplankton communities using 9 indoor mesocosms (Limnotrons) over a 6-week period. We hypothesized that: 1) elevated Cl- concentrations and HW-induced temperature spikes increase individual respiration rates; and (2) differential metabolic responses at the family level lead to reduced taxonomic diversity, biomass, and shifts in community composition in favor of tolerant taxa. Analysis of Variance revealed significant differences in zooplankton community respiration rates in weeks 2 and 5 and, contrary to our expectations, we found lower respiration rates across treated mesocosms with the lowest rates in the combined stressor treatment. The effect size of individual Cl- and HW treatments on zooplankton metabolism decreased in week 5, while that of the combined treatments remained relatively high, suggesting limited recovery when stressors were applied jointly.

**LTER-LIFE: where you build digital twins of ecosystems**

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Digital twins are dynamic model-data fusion tools that can help revolutionize ecological research. But how does a digital twin of an ecosystem look like, and how would you build one? The LTER-LIFE infrastructure (www.lter-life.nl) started in 2023 to address these questions and – in doing so –build an infrastructure that allows ecologists to create digital twins for their own research. We illustrate the concept of digital twins, and the infrastructural needs to flexibly assemble them, using two proto-DTs – workflows that have characteristics of full digital twins but are still in their developmental stages. The first proto-DT builds upon the well-established relationship between tree phenology and temperature at the Veluwe, whilst the second provides a near-continuous view on primary production in the Wadden Sea. These proto-DTs illustrate how Digital Twins can be used to gain insights into the functioning of ecosystems. We highlight pros and cons of different approaches, discuss tools currently available and identify the gaps in the infrastructure needed for digital twinning.

**Mapping human impact: A multivariate index for lakes across the conterminous US**

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Land use such as urbanization and agricultural practices within a watershed all contribute to factors such as eutrophication. Current human disturbance assessments often lack the representation of multiple disturbances at the macroscale. Therefore, the goal of this study was to develop a multivariate index of human disturbance factors for lakes across the conterminous United States. The overarching goal was to evaluate combined human-induced stressors on lakes, which could aid in targeted management practices. We then looked at indicators such as microcystin levels, pathogen discharge, nutrient concentrations, and heavy metal concentrations. In order to collect quantified variables, we used the 2017 National Lakes Assessment (NLA), EnviroAtlas database, and USGS datasets, along with the LAGOS-US research platform. Then, we utilized structural equation modeling (SEM) to create a full index that provides both inferences and indicators of anthropogenic stress upon lakes. From this database, we were able to quantify the factor of anthropogenic disturbance on each lake and where it was sourced from. The final product is a SEM path diagram that represents all statistically significant connections ($p$-value $< 0.05$). When comparing the final response thresholds established by the EPA with the standard deviations created by the SEM, there were specific IDs that exceeded these thresholds, implying excessive human disturbance.

**Nuanced connections between ice phenology and summer phytoplankton blooms**

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Northern hemisphere lakes have experienced a decrease in the duration, spatial extent, and quality of lake ice over the past century. There have been recent advances in the understanding of how ice conditions can drive some summer processes, however much is unknown regarding how changes in ice conditions will affect the timing and severity of summer phytoplankton blooms. To investigate this knowledge gap, we examined a 20-year data set, consisting of ice phenology and coverage data and summer water quality information for Lake Erie. We found significant correlations between the duration of ice coverage and both chlorophyll concentration and phytoplankton community composition. Chlorophyll was negatively correlated with the duration of ice cover, and percent ice coverage in Lake Erie's western basin. In the central basin, chlorophyll was negatively correlated with the date of ice-on. In both the central and western basin, chlorophyll was positively correlated with date of ice-off, ice duration, and percent ice coverage. Phytoplankton community composition was also related with ice phenology and we found that dinoflagellate biomass was negatively correlated with ice duration and percent ice coverage in the western basin. In the central basin, the average chlorophyte biomass and the yearly chlorophyte maxima were negatively correlated with the date of ice off. These connections may help to elucidate not only the role that winter conditions play in summer dynamics, but also how the loss of lake ice may shape the severity of phytoplankton blooms.

**Observed and simulated future climate-related changes in thermal regime of a small lake in European Russia**

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We present the results of thermal regime and water balance simulations for a small lake in Moscow Region of European Russia made with General Lake Model. With six years of continuous high-frequency measurements of water temperature during the summer stratified period, as well as monthly observations of thermal structure and snow and ice thickness in winter, Lake Glubokoe is now one of the few lakes in Russia whose regime can be reliably assessed based on coupled analysis of field observations and model simulations. Our observations show increased stability and duration of summer stratification compared to data from the first half of the 20th century. Model simulations ran on CMIP5 climate change projections show statistically significant changes in the lake's future regime even under the mildest trends of climate warming, and in the worst-case scenario surface water temperature may rise as fast as 0,5 °C/10 years and the stratification duration may increase by a month and more.

**Partitioning potential productivity through the water column across time and space in US lakes**

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Primary productivity serves as the base of the food web and regulates numerous aspects of ecosystems, including carbon cycling. In lakes, primary productivity can vary substantially among habitats, but measurements are often constrained to well-mixed surface waters. This neglects the contributions of deep chlorophyll layers and benthic production that can make substantial contributions to whole-lake productivity. Here, we generate lake habitat-specific estimates of light availability partitioned between surface waters, below the surface mixed layer, and benthic habitats seasonally and through time in >90,000 lakes in the contiguous United States. We use water clarity estimates from Landsat imagery, lake depth and hypsography estimated from landscape metrics, and modelled lake temperature and stratification to develop a model to estimate the potential for contributions of productivity of these three zones to whole lake estimates. We use this model to describe seasonal and spatial patterns at the macrosystem-scale and relate patterns to lake and watershed characteristics, climate drivers, and landscape metrics. Our work demonstrates that whole-lake estimates based on surface water measurements miss a substantial fraction of lake productivity, and that benthic producers and deep chlorophyll layers are important sources of productivity in many lakes. Incorporating seasonal dynamics and depth-resolved potential sources of productivity improves the understanding of lake food web dynamics and the role of lakes in the global carbon cycle, and provides a baseline for future studies of whole-lake productivity and metabolism.

**Quantifying the role of aggregate-associated microbial processes and interactions for C-cycling and aquatic terrestrial coupling in the Elbe Estuary**

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Estuaries are the intermediate between freshwater and marine ecosystem, made up of abiotic condition gradients and are one of the most active carbon cycling ecosystems. In this project, the Elbe estuary represents a model system due to its diverse morphology, varying levels of urbanization, and extensive historical literature. The Elbe is part of a blue carbon zone, where detailed biota-mediated mechanism of carbon cycling remain elusive. We will explore these mechanism with metagenomics approaches for water samples from a longitudinal transect, and water and sediment samples from terrestrial-aquatic transition transects. We will incorporate prokaryotic, microeukaryotic and viral community distributions, interaction networks and metabolism analyses. Complementing metagenomic approaches are microscopic plankton analyses and mesocosm experiments. Viruses play a significant role in aquatic carbon fluxes through host killing, and carbon redistributions. Preliminary viral analyses with previously generated data shows the hosts distribution along the salinity gradient and high viral abundance in brackish zones. Our findings will provide insight into the microbes-mediated carbon cycling mechanism in the Elbe estuary and a framework for similar research in other estuaries and coastal areas.

**Rapid responses of tropical plankton communities to nutrient and light manipulations**

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Plankton communities play a vital role in the functioning of lake ecosystems, influencing carbon and nutrient cycling. However, their response to environmental changes, particularly in tropical lakes, remains poorly understood. This study investigates how varying levels of nutrients, organic matter, and sunlight affect phytoplankton and zooplankton in a natural tropical lake. Using in situ mesocosms, we manipulated nutrient and organic matter additions, as well as sunlight availability, monitoring limnological parameters and plankton for 12 days. Our factorial design included eight treatment combinations. We found that inorganic nutrient additions reduced phytoplankton species richness, favoring Chlorella sp. dominance. Organic matter increased light attenuation, altering species composition from Pseudanabaena catenata to Aphanocapsa elachista. Interestingly, physical shading had minimal influence on plankton communities. Zooplankton also showed shifts in dominance, with copepod populations decreasing with higher Chlorella sp. densities. Additionally, plankton communities exhibited associations with light attenuation and bacterioplankton. These findings highlight the rapid response of tropical plankton to environmental changes, with significant shifts occurring within days. Nutrient additions alone were sufficient to induce community changes, underscoring the impact of anthropogenic nutrient inputs. Understanding these dynamics is crucial for predicting the effects of climate and anthropogenic changes on tropical lakes, aiding in freshwater conservation efforts and informing strategies to maintain water quality and the aquatic food chain.

**Resolving chlorophyll-a using Planet SuperDove imagery in a small, shallow lake**

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Algae can form nuisance and unsightly blooms in lakes, with cyanobacteria being particularly problematic as they can be toxic and scum-forming, posing a risk to the ecosystem and to public health. The ability to monitor algal blooms using satellite imagery has been previously demonstrated using several sensors, including ESA Sentinel-2 imagery, however spatial and temporal resolution is limited (10-60 m pixels, images every 5 days). In 2022, Planet launched a fleet of satellites named SuperDoves which provide daily images with 3 m spatial resolution and 8 spectral bands, which are designed to somewhat mimic the ESA's Sentinel-2 band configuration. Therefore, this study is focused on evaluating the capability of this new satellite constellation to measure the water quality parameter chlorophyll-a in the context of monitoring algal blooms in Airthrey loch – a small, shallow eutrophic lake which, in terms of size, is at the limit of the capabilities of alternate sensors such as Sentinel 2 MSI. Here, we use chlorophyll-a as a proxy for algal-biomass, and evaluate the quality of this parameter when generated using Planet Labs images compared with Sentinel 2 images. We find that the new Planet Labs satellite constellation shows promise for higher frequency algal bloom monitoring in smaller water bodies than previously possible, albeit with some drawbacks and remaining challenges.

**Shifts in carbon emissions versus sequestration from hydropower reservoirs**

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Reservoirs are significant sources of carbon (C) to the atmosphere, but their emissions rates vary in space and time. We compared C emissions via diffusion and ebullition pathways across several stations in six large hydropower reservoirs in the southeastern US that were sampled in summer 2012 and ten years later in summer 2022. We found that carbon dioxide (CO2) diffusion was the dominant flux pathway, with only three exceptions where methane (CH4) diffusion or CH4 ebullition dominated. However, the direction of the CO2 diffusive flux shifted between 2012 and 2022, where most stations emitted CO2 in summer 2012, but every station sequestered CO2 in summer 2022. Next, we explored drivers of variation and found that indicators of greater algal production were associated with CO2 sequestration, including chlorophyll-a concentration, dissolved oxygen saturation, and pH. We also linked CH4 diffusion rates with water temperature as a likely driver of CH4 production. However, we found limited predictors of CH4 ebullition, likely due to extremely high variability, with rates ranging from 0 to 739 mg C m-2 day-1. Additional sampling campaigns outside the summer highlighted the importance of seasonal phenology in primary production on the direction of CO2 diffusive fluxes, which showed emissions by the end of August as productivity decreased. Our results demonstrate the importance of capturing CO2 sequestration in field and modelling measurements for appropriate temporal upscaling of emissions. Measuring C emissions from multiple pathways and understanding their spatiotemporal responses and variability is vital to reducing uncertainties in global upscaling efforts.

**Sounds of the Water: Studying the Influence of Macrophyte Removal on the Underwater Soundscape in Lake Scugog, Ontario**

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Freshwater lakes provide an array of ecosystem services like fishing, drinking, and swimming opportunities, and lakes can support highly diverse aquatic communities that are surprisingly rich in sound producing organisms. Passive acoustic monitoring (PAM), a technology using hydrophones, provides a non-invasive approach to studying underwater ecosystems, and there are many unanswered questions about aquatic bioacoustics – particularly in the ultrasonic frequency range. By detecting sound-producing species and analyzing local soundscapes, PAM can help identify essential areas and ecosystem conditions. In the face of declining aquatic biodiversity, it is imperative to thoroughly document and comprehend biotic sound sources and assess any anthropogenic induced alterations. In this ongoing study, I utilize a wide range of sound data (2Hz – 250 kHz) collected from Lake Scugog, a lake in Southern Ontario experiencing excessive macrophyte growth, to investigate the influence of macrophyte removal on the abundance of sounds produced by soniferous aquatic organisms. Biweekly measurements were taken 3 times before and after an aquatic macrophyte removal event using a hydrophone (SM4 Song Meter from Wildlife Acoustics) for acoustic recordings and an EXO2 Multiparameter Sonde for water quality measurements. Preliminary spectral analyses showing the abundance of varying sound frequencies across recordings before and after macrophyte removal indicate a slight decrease in sounds produced, but these results are inconclusive and require further data analysis.

**Spatial and Temporal metagenomic analysis of the microorganism community in the Oder after the appearance of the toxic brackish water alga Prymesium p**

**Sai Hariharan[1]**
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In August 2022, the Oder River experienced an ecological catastrophe triggered by a massive algal bloom of *Prymnesium parvum*, leading to significant biodiversity loss. This study employs spatial and temporal metagenomic analyses to investigate the microbial diversity of the Oder River post-disaster, focusing on recovery and ecological shifts within the aquatic system. It aims to elucidate patterns of microbial diversity, functional significance, and ecological shifts, and to build potential models to understand ecosystem changes. Comparative analysis of microbial communities in water and sediment samples, from both the river's main flow and its side channels, provides critical insights into the ecosystem's resilience, recovery trajectories, and trophic interactions post-disturbance. The methodology encompasses comprehensive sample collection and processing, with DNA extracted from both water and sediment samples. High-throughput metagenomic sequencing, employing both Illumina and Nanopore technologies, offers a detailed view of microbial diversity and functional capacity, facilitating the recovery of high-quality Metagenome Assembled Genomes (MAGs) from the river system. Bioinformatics pipelines enable the analysis of these complex datasets, allowing for taxonomic profiling, functional annotation, and metagenome assembly. This approach identifies key microbial players involved in antimicrobial resistance, anthropogenic pollutant degradation, nutrient cycling, and resistance to toxic substances, shedding light on the ecosystem's functional resilience. Findings from this study are expected to elucidate the impacts of *Prymnesium parvum* on the river's microbiome, revealing shifts in microbial diversity and function post-bloom. The research will enhance understanding of the potential of microbial communities in pollutant bioremediation, and antimicrobial resistance due to the impacts of anthropogenic activities.

**Understanding the effects of a Poly Aluminium Chloride treatment on lake ecology**

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Poly Aluminium Chloride (PAC) is commonly used in water treatment as a coagulant, binding to contaminants and then flocculating out of solution. PAC treatments have also been used in lakes to reduce phosphorus levels. Despite being considered a sustainable method for improving water quality, little is known about the ecological impacts of PAC on lakes. Lake Waynewood, a small eutrophic lake in the Pocono Mountains in Pennsylvania, USA underwent a PAC treatment in 2022. Data collected from high-frequency sensors combined with monthly point sampling directly after the lake-wide PAC treatment shows a direct decrease in phosphorus concentrations and an increase in dissolved oxygen at 4m, where hypolimnetic anoxia had previously extended to. This deepening of oxygenated water likely resulted from an increase in water clarity and a downward shift in the euphotic zone and therefore location of primary productivity in the water column. Despite this locational shift in peak primary productivity, net whole-lake metabolic rates did not change.

**Winter impacts on water quality and cyanotoxin dynamics in dimictic versus warm monomictic lakes: Climate change implications**

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Climate change affects lake ecosystems in winter, shortening ice-cover periods. Coupled with elevated temperatures, it can alter lake mixing regimes in temperate regions, leading to a shift from dimictic to warm monomictic systems. Our study investigates year-round water quality parameters and cyanotoxin concentrations (2019-2023) in two eutrophic water bodies: Sakatah Lake, which is dimictic with three months of ice cover, and Bethel Lake, a warm monomictic reservoir that remains ice-free during winter. We study these model systems to understand how lakes respond under climate change projections, hypothesizing significant effects on microcystin (MC) and cylindrospermopsin (CYL) concentrations, phycocyanin concentrations, and nutrients including nitrogen and phosphorus due to differing winter conditions. Our findings indicate that MC was detectable year-round in both water bodies, peaking in summer, while CYL was detectable year-round in Bethel Lake, peaking in summer, and in Sakatah Lake only during fall and winter, with its peak occurring in the fall. During the winter, ice-covered Sakatah Lake exhibited higher concentrations of total phosphorus (TP), nitrate ($NO_3^-$), ammonium ($NH_4^+$), urea, and microcystin (MC) compared to Bethel Lake. Conversely, Bethel Lake showed higher levels of total suspended solids (TSS), particulate inorganic matter (PIM), and cylindrospermopsin (CYL) concentrations during the winter ($p$-value $< 0.05$). No significant difference was detected in winter phycocyanin concentration between two water bodies. Our study underscores the necessity of year-round monitoring of cyanobacteria and cyanotoxin, offering insights into the effects of winter conditions on lakes' biochemical properties within the context of climate change.