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Book of Abstracts

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Impacts of trophic structure and oxygen regime on freshwater zooplankton migration

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Rotifers are integral to lake ecosystem function through their roles in food webs. Rotifer behavior may be altered by hypolimnetic hypoxia, due to climate change and eutrophication. Zooplankton exhibit diel vertical migration (DVM), living in the dark hypolimnion during the day to avoid visual predators and migrating to the epilimnion at night to feed. Hypolimnetic hypoxia may disrupt zooplankton migration and force a shift towards diel horizontal migration (DHM), with zooplankton occupying the more oxygenated littoral zones instead of the hypoxic hypolimnion during the day. However, little is known about daily migration patterns of rotifers, specifically under hypoxic conditions. We hypothesize that hypolimnetic hypoxia will shift rotifer behavior towards DHM, but that this shift will be lessened in the presence of piscivorous fish through a trophic behavioral cascade. Rotifer samples were collected at the National Experimental Platform in Aquatic Ecology (PLANAQUA) in Saint-Pierre-lès-Nemours, France. We sampled 16 macrocosm ponds with different fish and nutrient treatments (2 levels each). Each pond was sampled at four locations (hypolimnion, epilimnion, inner-littoral, and outer-littoral), during the day and night. We are assessing rotifer community composition and density at each pond, location, and time of day, and we will use these data to investigate rotifer daily migration patterns in relation to fish and nutrient treatments and other environmental variables. Preliminary findings suggest that weak migration patterns are exhibited by some rotifer genera. Further analysis will take a functional trait approach to investigate rotifer migration patterns in relation to environmental drivers.

Hydrology drives interannual variability in hypoxia in Lake Lillinonah (Northeastern USA)

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Interannual variability in environmental conditions has important consequences for the organisms living within aquatic systems. For example, years with higher incidence of stressful conditions such as deepwater hypoxia can restrict habitat use by fish. We studied drivers of interannual variability in deepwater hypoxia in Lake Lillinonah, a eutrophic reservoir in the Northeastern USA. The lake may be dimictic or polymictic depending on the amount of river inflow. Although deepwater hypoxia occurs in most years, the timing of onset and total number of hypoxic days varies. Using data from a 10-year period, we found that years with lower early summer river flow had higher rates of early summer oxygen depletion which translated to earlier onset of hypoxia and more total days of hypoxia. These findings indicate that hypoxia within this system is driven by river hydrology. As changes in river hydrology are expected with the progression of climate change, uncovering consequences is essential for protecting biota that make use of deepwater habitat.

AQUACOSM-plus: Network of Leading Ecosystem Scale Experimental AQUAtic MesoCOSM Facilities Connecting Rivers, Lakes, Estuaries and Oceans in Europe

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The AQUACOSM plus RI project is a unique consortium of experimental mesocosm facilities representing a full cross section of Experimental Aquatic Ecosystems, ranging from Sub Arctic to the Mediterranean, from mountains to lowlands, from freshwater to marine, and from ultra oligotrophic to hyper eutrophic conditions, including benthic and pelagic systems. It brings together scientists and professionals from 60 mesocosm facilities in order to to promote effective international scientific collaboration, knowledge transfer, development of new technology and enhance collaboration among the European Environmental Research Infrastructures. The 2023 call for transnational access, facilitates access to 60 state of the art mesocosm facilities across Europe, with travel and accommodation fully covered.

Water quality monitoring: potential bias and optimal measurement frequency

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Many water quality parameters can be monitored with in situ sensors that can capture changes at sub-hourly resolution, including some nutrients. This project aims to (i) determine sampling bias caused by sampling at specific times of day, days of the week and weeks of the month; and (ii) find the optimal measurement frequency for water quality parameters in chosen catchments. High-frequency data was obtained from 6 different UK rivers, in which a range of standard and novel in situ sensors collected water quality data, including nitrate and phosphorus, at least every hour. These datasets were analysed using artificial distillation to explore the effects of temporal variation in sampling frequency on sample bias. Water temperature and dissolved oxygen, with expected daily cyclic patterns, were time dependent in all catchments. Electrical conductivity, pH, turbidity and nitrate also showed significant differences in variance between times of day in some catchments, which could cause bias. The day of the week and week of the month are an unlikely cause of bias. To accurately monitor the fluctuations of each parameter, the variance needs to be fully captured. The optimal measurement frequency for most investigated parameters was between 4 and 12 hours, but in some cases (e.g. turbidity) hourly data could be essential. As technological improvements increase in situ sensing capabilities, designing appropriate sampling regimes that maximise use of resources, is critical. This study shows that sampling frequency can bias results, but with good understanding of catchment characteristics and response time, sampling regimes can be optimised.

Decreasing greenhouse gas emissions from surface waters by climate-smart water management (DIGS)

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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 (trophic mediation) and external factors (climate change and nutrient loading) on GHG emissions are unclear. Therefore, this research aims to develop a GHG emission model for ditch networks based on the PCDitch model considering the combined effects of trophic mediation, climate change, and nutrient loading. This GHG model will assess GHG fluxes in ditch networks and evaluate mitigation measures, which will provide overview of GHG emissions from ditch networks and support GHG mitigation policy making.

Exploring the response of phytoplankton composition and metabolites to essential and substitutable nutrient supply in large scale mesocosms

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Nutrient concentrations and stoichiometry affect phytoplankton biomass and shape community composition. In this study, we test the effect of essential (nitrogen [N] and phosphorus [P]) and substitutable (nitrate [NO3-] and ammonium [NH4+]) resource ratio theory on phytoplankton composition, metabolites, and microcystin cell quotas. We conducted a 21-day mesocom experiment using 18 closed bottom tanks (11,000 L) with six nutrient amendment treatments, including ambient control, tanks fertilized with NO3-, NH4+, and P, as well as tanks fertilized with both N and P (NO3- + P and NH4+ + P). We hypothesized that cyanobacteria would dominate (>50% biovolume) the phytoplankton community under low total N (TN): total P (TP) ratios (<20 by mass). Also, we expect that a low NO3:NH4 ratio (<5 by mass) favors cyanobacteria and cyanotoxins (e.g., microcystin [MC] and nodularia [NOD]). Our results show that cyanobacteria was dominant in + P (51%), NH4+ + P (61%), and NO3- + P (65%) treatments under low TN:TP (<20), and NO3-:NH4+ ratios (<5). We found higher levels of MC in the NH4+ + P and NO3- + P treatments which increased over the 21-day experiment. NOD was detected in NH4+ + P and NO3- + P treatments and reached its maximum on Day 14. The MC-NOD cell quota ratio substantially increased in +NO3-, NO3- + P, and + P treatments after receiving the first addition, but the ratio decreased by the end of the experiment. Our results revealed that the low essential and substitutable resource ratios favor cyanobacteria dominance and cyanotoxins.

Full assessment of climate change impacts on Germany's largest drinking water reservoir until 2100 including ways towards adaptation

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Lentic waters are commonly cited as sentinels of climate change. While most of the previous studies focused on climate change effects on their physical structures, very few took the ecological part into account. To fill in the gap, our study coupled the climate projections, from an ensemble of global climate models, with a well-established water quality model to depict the future ecological changes of Rappbode Reservoir. To our knowledge this is the first study fully assessing the physical, chemical and biological response in aquatic systems under different future climate conditions. Besides we systemically evaluated the possibility of alternative withdrawal strategies in mitigating the negative effect of climate warming on ecological development. Our results documented a chain of climate change effects propagating through the aquatic ecosystem, and we accordingly put forward a new "climate cascading effects" theory. Based on the theory we argue intense climate warming (RCP8.5) will firstly trigger strong increase in water temperatures, then lead to the occurrence of metalimentic hypoxia , accelerate nutrient release from sediment and finally boost the cyanobacterium blooms in pelagic zone. By comparison such ecological changes will be strongly suppressed under RCP2.6 and 6.0. Corresponding to this theory we further confirmed the surface withdrawal can be an effective adaptation strategy helping ecological status of the reservoir rather immune to strong climate warming over the whole century. Our research not only provides a new process-based framework for elucidating the climate change effects on aquatic ecosystems, but also guide stakeholders to confront with potential climate changes.

CO_2 evolution in surface waters of Lake Tovel

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Lake Tovel, a mountain lake (1177 m a.s.l.), is regularly samples during the ice-free season from 1995 onwards. Based on chemical data and the PhreeQC software, the CO_2 content in the surface is calculated and the CO_2 flux to the atmosphere is assessed. Lake Tovel shows considerable variability, coinciding with changing dissolved oxygen concentrations in the hypolimnion. Possible relationships will be discussed.

Using stable isotope analysis for the detection of niche differentiation among four invasive Ponto-Caspian mysid species

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Freshwater ecosystems are under multiple threats including the spread of invasive species. In Europe as well as in North America, crustaceans of Ponto-Caspian origin are becoming widespread and abundant. So far, four invasive mysid shrimp species have been recorded in lakes and rivers. Although they are commonly found in the diet of fish, little is known about their trophic status and prey preference. In some cases, these four invasive species occupy the same area, which suggests niche differentiation in terms of prey and habitat preference. In our study, we determined the trophic position of four invasive shrimp (based on δ15N) and their habitat preference (based on δ13C) in a semi-enclosed inlet of the Danube River in Hungary. The preliminary results indicate that the three larger-sized and more often predator species occupy higher trophic positions, while the smallest species has slightly lower trophic position. Their common prey items also showed differences: Copepoda was more similar to the mysids' trophic position, and the Cladocera and Rotifera/Copepoda Nauplii functional groups were positioned lower. Along the δ13C axis, the two pelagic mysid species separated from the two benthic species. Since these values can vary seasonally, we plan to conduct follow-up surveys in other seasons.

Seasonal patterns in reservoir greenhouse gas emissions and the influence of changing pool elevation

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Reservoirs are a major source of greenhouse gasses (GHGs), especially highly potent methane, with high variability in emissions rates over short to long time scales. However, most studies have focused on single sampling points during summer, limiting our understanding of temporal dynamics and drivers of GHG emissions. Reservoirs are unique for their controlled water level, where seasonal drawdown is typical in fall to winter to manage high water influxes that arrive in spring. Water levels can fluctuate by several meters and alter stratification patterns, hydrostatic pressure, and oxygenation, that in turn can influence GHG emissions. Further, when upscaling emissions estimates to the entire reservoir, changes in surface area due to drawdown are rarely taken into account. Here, we study Douglas Reservoir (Tennessee, USA) to assess how drawdown influences GHG emissions, with measurements during full summer pool, mid-drawdown (fall), and winter pool. In Douglas Reservoir, diffusive and ebullitive methane emissions were highest in winter, likely due to reduced hydrostatic pressure allowing for methane release from the sediment and formation of methane bubbles. Carbon dioxide diffusion was negative (influx) during full summer pool when primary production was highest, and positive (efflux) during fall and winter. These seasonal patterns reflect influences by both operational controls on water level as well as seasonal biogeochemical phenology typical of temperate reservoirs. Future research plans for 2023 at Douglas Reservoir include higher-resolution seasonal measurements of all GHG emissions pathways to better capture the full phenology of reservoir drawdown and its effects on GHG emissions.

Effect of reducing lake volume and increasing salinity on the Carbon and Nitrogen biogeochemistry of a shallow subtropical lake

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Inland waters are sentinels of climate change and also acts as hotspots for C and N cycling. With rising temperature, reduced precipitation and changes in land use patterns, lakes across the world are facing the severe crisis of desiccation and salinization. Shift in the physical and hydrological regimes of lakes controls the in-lake biogeochemical processes that ultimately govern the fluxes of CH_4, CO_2, and N_2O from these systems. In this study we attempted to understand the biogeochemistry of C and N in Nalsarovar Lake, situated in the semi-arid region of western India. Nalsarovar gets recharged through the monsoonal precipitation and later it starts to dry towards winter which is accompanied by a sharp increase in salinity. Significant increase in 18O of lake water from post monsoon to winter and pre-monsoon reflected the shift in evaporative regime of the lake across seasons. Dissolved inorganic carbon, particulate organic carbon, and particulate nitrogen showed similar increase in concentration as the lake volume reduced. Interestingly the 15NPN steadily decreased from post monsoon (15NPN: 4.6 ± 1.0 ‰) to winter (2.5 ± 0.9 ‰) and pre monsoon (1.3 ± 0.8 ‰). Over all it seemed that the lake productivity increased towards pre-monsoon with signatures of potential N_2 fixation as well. The lake behaved as a steady source for CH_4 and CO_2 with highest fluxes during the pre-monsoon season. During the same period the lake shifted from a net N_2O source (post-monsoon and winter) to sink.

Investigating the impacts of planktivory and dissolved oxygen on zooplankton daily migrations using experimental ponds

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Zooplankton perform daily migrations between the surface pelagic waters, where they feed at night, and the deeper waters (diel vertical migration, DVM) or littoral zone (diel horizontal migration, DHM), where they hide from visual predators during the day. We hypothesized that DHM is more prevalent than DVM in hypoxic hypolimnetic waters because zooplankton require oxygen. We also hypothesized that DVM and DHM are more extensive in lakes with higher predation pressure from planktivorous fish (trophic behavioral cascade). We sampled zooplankton in 16 ponds (each 30 m x 15 m x 3 m) at the National Experimental Platform in Aquatic Ecology (PLANAQUA) at the CEREEP-Ecotron ÎledeFrance facility in Saint-Pierre-lès-Nemours, France, to test these hypotheses. The ponds are manipulated with a fish and a nutrient treatment (2 levels each) in a 2 x 2 factorial design. We sampled zooplankton in the epilimnion, hypolimnion, and outer and inner littoral zones of each pond near noon and midnight to characterize DVM and DHM. We found that DVM decreased and DHM was not impacted by lower hypolimnetic dissolved oxygen, partially supporting our first hypothesis. We found no support for our second hypothesis - as planktivore abundance increased (a proxy for predation pressure), DVM decreased and DHM was not impacted. Future analyses will include investigation of zooplankton community composition and size structure, multivariate analyses with additional abiotic and biotic variables, and functional trait analysis. These findings contribute to the body of knowledge regarding the impacts of global changes on zooplankton community dynamics and lake ecosystem function.