mentioned above, cyanobacteria produce many other bioactive compounds, which are less investigated but are equally important because they can be also toxic. The full determination of the chemical profile can be therefore very useful for a correct determination of the toxic potential inside a cyanobacteria population. Moreover, the chemical profile can have very important applications from an ecological point of view, since secondary metabolites play an important role in determining the cyanobacteria success over other organisms. The chemical profile (and consequently the toxic potential) is specific for any single species, and, within one species, can be subject to changes in response to environmental (biotic and abiotic) factors. We have started a detailed investigation aimed at defining the chemical profiling inside the cyanobacteria populations typical of the perialpine lakes. These lakes are experiencing the colonization of new algal species (i.e. *Dolichospermum lemmermannii* and *Tychonema bourrellyi*) and therefore we focused our attention on these species. We used LC-MS techniques for the determination of a wide panel of secondary metabolites classified in two major classes: *i)* alkaloids (anatoxins, cylindrospermopsins, saxitoxins) and *ii)* peptides (microcystins, nodularins, anabaenopeptins, aeruginosins, micropeptins, microviridins). We analyzed cultures of selected species as well as field samples. Analysis carried out on cultures allowed to identify molecules produced in lower concentrations. We found considerable differences among species in terms of nature and amount of secondary metabolites. For example, *T. bourrellyi* resulted to produce two neurotoxic alkaloids (anatoxin-a and homoanatoxin-a), while *D. lemmermannii* and *Planktothrix rubescens* did not; *P. rubescens*, instead, resulted to produce five different epatotoxic peptides (microcystins). A number of peptides in the mass range between 400 and 1100 dalton were also identified. The investigation allowed us to determine that the investigated cyanobacteria produce and release in the water many different compounds belonging to different chemical classes (anatoxins, microcystins, cyanopeptolins, aeruginosins, anabaenopeptins) and that each species has a specific chemical finger print.

39-O Phytoplankton community response to extreme meteorological events in a deep alpine lake.

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In the course of climate change, extreme meteorological events (EMEs) like heat waves or heavy rainfall are expected to increase in frequency in central Europe within the next decades. These events can significantly alter nutrient, light and temperature levels in lake ecosystems. Protist communities are known to react immediately to abiotic changes and hence community composition may shift due to EMEs. Here, we show the response of protist communities, especially phytoplankton, to a summer heat wave in 2015 and heavy rainfall events in 2015 and 2016. In each case we sampled 9 stations across a deep meso-oligotrophic Austrian lake, Lake Mondsee. Water samples were taken from several depths of the upper 20 m or from 0-20 m using an integrating water sampler and nutrients as well as temperature, conductivity and pH were analysed. Nutrient inflows of the three main tributaries of Lake Mondsee were also monitored. Phytoplankton identification and biomass calculations were estimated using three complementary methods: FlowCAM, flow cytometry and light microscopy (Utermöhl technique). During the heat wave, we found relatively low horizontal variation but significant changes in phytoplankton community composition at the central station of the lake with increasing water temperature. Changes were not restricted to the epilimnion; for instance we observed a vertical shift in the *Planktothrix* peak at 12-16 m depth according to PE-levels and microscopic counts. During the heavy rainfall events we found significant variations of plankton community compositions at sampling stations across the lake, indicating a high horizontal variation. Our results show, that EMEs significantly alter phytoplankton community composition. As these communities constitute a fundamental part of limnetic food webs, EMEs have the potential to change the trophic structure of lake ecosystems.

39-O Long-term ecosystem responses to multiple stressors in a large lake: a functional principal components analysis.

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In this study we describe from a Functional Data Analysis perspective the long-term (1981-2008) dynamics of Lake Maggiore, the second largest Italian lake, located in the subalpine lake district. Several physical (i.e. water temperature,

total phosphorus concentration) and biological variables (i.e. phytoplankton and zooplankton population density, biomass and cell size) were analyzed. Data, available only for the 1981-1992 and 1995-2008 periods, were collected as part of the long-term monitoring program of Lake Maggiore, funded since the late 1970s by the International Commission for the Protection of Swiss-Italian Waters (CIPAIS). The data gap between 1992 and 1995 coincides with the end of oligotrophication phase and the transition of the system to a more stable oligotrophic condition. Hence the 1981-1992 and 1995-2008 periods were analysed separately, allowing to distinguish between the effect of trophic change and the response of the system to other constraints, such as those due to climate variability. Specifically, in each period, the variation in time of the considered variables was characterized by means of penalized B-spline expansions and Functional Principal Components Analysis (FPCA). Briefly, first the standardized time-series for the considered variables were smoothed by means of penalized B-splines. This technique allows to fit the data points by a smoothed piecewise-polynomial function in a way that minimizes the "wiggliness" of the resulting curve (thus avoiding overfitting). Second, FPCA was performed on the B-spline-smoothed time series to assess the dominant modes of variation of their temporal trajectories. For both periods, the first 4 FPCs explained about 60% of the overall variation of the smoothed standardized variables (55% for 1981-1992, 65% for 1995-2008). The ordination along the four FPC indicates that, during the first period the zooplankton-related variables were strongly associated to changes in phosphorus concentration, whereas phytoplankton-related variables only showed a weak association. In the second period phosphorus was still important, although there was an increasing role of temperature: zooplankton again showed a strong association, but that of phytoplankton became also evident. The effect of anomalous environmental changes, characterizing distinct years, was also pointed out by FDA.

39-O Deep lakes in the 19th, 20th and 21st centuries: shifting perceptions on potential, threats and management at Lake Tahoe, USA.

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Lake Tahoe, USA, has only been identified on maps for 170 years, yet in this short period it has undergone tremendous changes in how it has been perceived and managed. In the first few decades it was considered an ethereal water body, capturing the imaginations of both artists and the founders of the new field of limnology. The subsequent thirty years saw the clear cutting of its watershed and a precipitous decline in water quality, a period that was followed by an equally rapid, natural recovery of the lake's natural physical and ecological integrity. Since that time, however, the lake has seen a steady succession of environmental threats. These have included species extirpation due to overfishing, the introduction of new species in all trophic levels, the impacts of increased urbanization and associated eutrophication, and most recently the impacts of climate change. Each of these threats has been met with a range of responses that include diversion of sewage outside the watershed, stringent land development codes, mandatory boat inspections, and prescribed pollutant reduction targets. Many of these measures have been successful, in part because they were based on an understanding of the physical and ecological cycles at play within the lake. However, with climate change, these physical and ecological processes are showing signs of greater change than has previously been experienced, and shifts toward regimes that have never been experienced. These changes will be described using a combination of field measurements and numerical modeling results, and the range of potential management responses will be discussed.

39-O Population structure of vendace in L. Vänern – what can be inferred from multiple sources of information?

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Fish species in large lakes may occur in more or less discrete sympatric or allopatric populations. Typical drivers of the persistence of local subpopulations are local migration barriers, habitat patchiness and homing behavior. We aimed to investigate if potential local populations of vendace (*Coregonus albula*) in Lake Vänern, the largest lake in the EU, may be separated by a migration rate low enough to allow for independent demographic dynamics but large enough to prevent other than subtle genetic differentiation. Lake Vänern consists of two main basins, Värmlandssjön and Dalbosjön, separated by a shallow sill potentially reducing fish migration. Vendace are of high importance to the food