This study outlined that the ecological conditions of large and deep lakes in Northern Italy, such as Lake Garda, are mainly driven by nutrient enrichment, and that climate change can effectively modulate the lake ecological response to nutrients. The results stresses that the establishment of sustainable management policies and realistic restoration goalsof large subalpine lakes, which are usually based on the definition of lake reference conditions, need to pay particular attention to lake-specific sensitivity.

39-O Degenerative processes in a deep meromictic lake: anoxia, reducing conditions and internal loadings.

Pierluigi Viaroli [1] - Daniele Nizzoli [1] - Daniele Longhi [1] - Roberta Azzoni [1] - Rossano Bolpagni [1] - Gianmarco Giordani [1] - Giampaolo Rossetti [1] - Silvia Tavernini [1] - Marco Bartoli [1] - Nico Salmaso [2]

Department of Life Sciences, Parma University, Parma, Italy [1] - Istituto Agrario di San Michele all'Adige, Fondazione E. Mach, San Michele all'Adige, Trento, Italy [2]

Ecological studies in Lake Idro (Northern Italy), performed in the last five years (May 2010 - April 2012 and September 2013 - November 2014), evidenced a progressive deterioration of water quality and ecosystem status. The water column is permanently stratified and the chemocline is presently at about 40-50 m depth, out of a maximum depth of 120 m. The monimolimnion, which is ~50% of the water volume, is devoid of oxygen, with a concurrent accumulation of Fe^{2+} and Mn^{2+}, methane, dissolved sulphides, ammonium (NH_4^+), soluble reactive phosphorus (SRP) and dissolved reactive silica. Conversely, in the mixolimnion NH_4^+, SRP and trace metals are almost completely depleted, whilst nitrate is the main nitrogen species. The development of phytoplankton and the contribution of cyanobacteria to total biovolume are quite limited (<~10%), because of the moderate availability of nutrients in the upper layers. For the trophogenic waters, we can propose the term “meromictic induced mesotrophy”. The littoral zone (<10 m depth) is colonized by a wide macrophyte belt, with the dominance of invasive elodeids. The internal SRP regeneration is recognized as a major P source, whilst nitrogen is mainly imported from the watershed. The meromixis is a critical threat to lake recovery. The reducing compound bulk in the monimolimnion can potentially account for an oxygen demand which is nearly threefold the actual oxygen availability. Hence, in case of complete water overturn, oxygen dilution and consumption, might lead to a critical oxygen shortage with a possible collapse of the aquatic food web, coupled with and exceptional fertilization of the surface waters. In fact, the monimolimnion and the surface sediment horizon have accumulated a great quantity of phosphorus. Here, the strong reducing conditions of the monimolimnion favour the SRP release from sediments: At the same time a very small quota of inorganic nitrogen is recycled into the water column. The resulting inorganic N to P ratio is thus imbalanced and can be recognized as a possible trigger of the development of toxigenic cyanobacteria. The internal P recycling, which greatly exceeds the external P inputs, can counteract the effort aimed at reducing the external loading. However, the P speciation indicates that, a significant quota of the sedimentary P is not readily available, constituting the so called calcium bound fractions, either authigenic or detrital. The P speciation and its potential availability have also been analysed in sediments at different depth, with different oxygen concentrations, in order to explore the effects of oxic to anoxic conditions on sedimentary SRP retention and exchanges.

39-O Long-tern nutrient dynamics in a deep subalpine lake (Lake Maggiore, Italy): the role of atmospheric deposition, catchment sources and climate.

Michela Rogora, Rosario Mosello, Marzia Ciampittiello, Claudia Dresti, Helmi Saidi, Giuseppe Morabito

Institute of Ecosystem Study, ISE CNR, Verbania, Italy

Lake Maggiore, one of the deep subalpine lake (DSL) in Italy, achieved a stable oligotrophic status after a recovery process started at the beginning of the 1980s. As an effect of decreasing nutrient loads from the catchment, concentrations of total phosphorus (TP) in the lake reached values of 9-10 µg L^{-1} at winter overturn in the late 1990s. The oligotrophic condition was also testified by chlorophyll concentration of about 3 µg L^{-1} as annual mean.
TP concentrations constantly decreased within 1980-1995, whereas total nitrogen (TN) progressively increased in the same period and beyond, mostly due to nitrate (NO_3) concentrations. Despite the adoption of measures to control N input from the catchment, NO_3 increased in the lake, as an effect of the high atmospheric input of N affecting this area. Recently, a slight decrease of NO_3 and TN concentrations has been observed, mainly affecting summer values in the

upper water layer. A decrease in the atmospheric load of N was also detected in the last few years through the data collected at a number of monitoring sites in the watershed of Lake Maggiore.
The change point in NO_3 trend in the lake was around 2010; in the same period, both reactive and total phosphorus started to increase slightly, with TP moving from 9 µg L^{-1} as yearly average on the whole water column to 11-12 µg L^{-1}.
Some re-arrangement inside the phytoplankton assemblage was also detected, such as the non-occasional record of "eutrophic" species among the dominant taxa.
The present work will present and discuss some hypotheses to explain these trends in nutrient concentrations, taking into account the role played by atmospheric deposition and meteorological drivers, such as precipitation regime. The catchment loads, calculated trough the chemical monitoring of the main tributaries, will be considered. The thermal regime of the lake, and particularly the mixing depth and its effect on nutrient replenishment at winter overturn, will also be discussed.

39-O Biogeography of *Dolichospermum lemmermannii* (Nostocales, cyanobacteria) in european waterbodies: a multidisciplinary approach.

Camilla Capelli [1] - *Andreas Ballot* [2] - *Leonardo Cerasino* [3] - *Nico Salmaso* [1]

Istituto Agrario di S. Michele all'Adige - Fondazione E. Mach, Iasma Research and Innovation Centre, San Michele all'Adige, Trento [1] *- Norwegian Institute for Water Research (NIVA), Freshwater Ecology, Oslo,* [2]

The presence of *Dolichospermum lemmermannii* was documented in northern temperate and boreal regions, between the 40th parallel and the Arctic Circle. In the last decade, this species spread towards southern Europe, making its appearance also in the largest lakes south of the Alps (Garda, Iseo, Como and Maggiore). Extended surface water blooms of this species were observed in Lake Garda at the beginning of the 1990s, and afterwards in lakes Iseo (second half of the 1990s), Maggiore (2005), and Como (2006). Blooms were always observed in summer and early autumn, during calm weather.
The study of sub-fossil akinetes preserved in core sediments allowed antedating the introduction of this species in Lake Garda in the middle of the 1960s. The significant increase in water temperatures and nutrient enrichment of the lake seemingly supported the development of this species in the successive decades. Global warming is indeed considered one of the major factors favouring the invasion of Nostocales, particularly due to the ability of the large gas-vacuolated species belonging to this group to control vertical movements in stratified water columns.
The large perialpine lakes are a renewed tourist destination and an important source of water for drinking, irrigation and industry. The appearance of *Dolichospermum* in this group of lakes represents a new potential risk because of the previous identification of several toxigenic populations associated with animal poisoning events in northern European countries. Despite serious concerns raised by the ecological, health and economic impacts, a comprehensive taxonomical, ecological, and toxicological study was begun only very recently.
The variability of morphological features in natural populations of *D. lemmermannii* are quite wide and some strains showed high temperature optima. The recent expansion towards the south highlights the ecological heterogeneity of this species and the conceivable existence of different ecotypes. In this work, we report the results of a wide research aimed to deepen the biogeography of *D. lemmermanni* at a continental level, along climatic and trophic gradients. The research was based on a wide multidisciplinary approach, including taxonomical, genetic and metabolomic determinations of several strains. A phylogenetic analysis of the 16S rRNA and *rpoB* genes was followed by the identification of toxic strains, evaluating the presence of cyanotoxins (i.e. microcystins, nodularins, anatoxins, cylindrospermopsins, saxitoxins) by LC-MS and cyanotoxins encoding genes (*mcyE*, *anaF*) by PCR.
This study will allow understanding the ecological factors involved in the development of this recently expanding species, contributing to identify the better management options finalized to relieve the economic impact on the large subalpine lakes, which are increasingly more exposed to high anthropogenic activities and climate change.

39-O Effects of eutrophication management on the interactions between zoo- and phytoplankton in a deep perialpine lake (Lake Lugano, Switzerland and Italy).

Fabio Lepori, Andreas Bruder, Gabriele Consoli

Institute of Earth Sciences, University o Applied Sciences and Arts of Southern Switzerland, Canobbio, Switzerland