Conference on
„Ecological problems of tourist lakes”

20–23 June 2011, Tihany, Hungary

Balaton Limnological Research Institute of the Hungarian Academy of Sciences
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Arnold Móra and Péter Biró

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Programme

Sunday, 19 June 2011

17.00  Registration
19.00  Informal welcome party

Monday, 20 June 2011

8.00–10.30  Registration
10.30  Welcome address
   András SPECZIÁR, deputy scientific director, BLRI of the HAS
   Pál KISZELY, councillor, Self-government of Balatonfüred

Plenary lectures
   Chairperson: András SPECZIÁR

10.40  Impact of tourism on lakes
   Chairperson: Martin DOKULIL
   Abstract 3  Martin DOKULIL

11.20  Water management of Lake Fertő/Neusiedler See
   Abstract 20  Miklós PANNONHALMI

12.00  Lunch

Session 1
   Chairperson: Martin DOKULIL

13.40  Unexpected cyanobacterial dominance in a deep oligo-
       mesotrophic lake, Lake Stechlin, Germany: Aphanizomenon
       flos-aquae, an ecosystem engineer
   Abstract 17  Judit PADISÁK, Viktória ÜVEGES, Kálmán TAPOLCZAI, Géza Balázs
               Selmeczy, Nico SALMASO, Peter KASPRZAK, Rainer KÖSCHEL, Lothar KRIENITZ

14.00  Photosynthetic characteristics of winter phytoplankton
       dominated by the bloom-forming Aphanizomenon flos-aquae
   Abstract 26  Viktória ÜVEGES, Lothar KRIENITZ, Judit PADISÁK

14.20  Conservation and tourism at the Lake Fertő
   Abstract 1  András AMBRUS, Attila PELLINGER

14.40  Nature conservation aspects of Lake Balaton
   Abstract 2  Judit CSERVENKA, Lajos NAGY, Imre PETRÓCZI

15.00  Coffee break

15.10  A tourist town on the lakeside of a tourist lake –
       Balatonfüred
   Abstract 13  Pál KISZELY

16.00  Walk in Tihany and dinner
Tuesday, 21 June 2011
Trip around Lake Balaton

9.00 Departure by bus to Keszthely

10.30 **Boat trip in Keszthely basin**
The region lying west of Lake Balaton occupies a unique place on the map of Hungary. Being the part of an important region from the point of view of tourism, that of Balaton, it is a favourite destination for both Hungarian and foreign tourists. As for its climate, it is a pleasant place, it may have the most predictable climatic character, and rarely do we have unsettled weather. As for the features of the terrain – it is Hungary on a small scale as tourists can find here gentle hills, extended flat plains, rivers, lakes. The West-Balaton region offering so many pleasant features, it is easy and fast to get to the right spots, as all the traffic routes lead to the places where the curious visitor can find everything that interests him.

12.00 Lunch in Hévíz

14.00 **Guided tour and birdwatching at Kis-Balaton, Balaton Uplands National Park**
The Kis Balaton, as a huge wetland habitat is unique in the whole of Europe, which is why it has always been recorded by international nature conservation. Its wonderful world of birds was already famous in the last century; and has survived despite the draining of the marsh started in 1922. It is therefore not surprising that when Hungary joined the Ramsar Convention in 1979, the Kis Balaton was included in the list of "Wetlands of International Importance as Waterfowl Habitat".

17.30 Departure to Hévíz, dinner

20.00 Departure by bus to Tihany

21.30 Arrival at Tihany
Wednesday, 22 June 2011

**Session 2**
Chairperson: Judit PADISÁK

10.00 Abstract 14  
**Pollution danger of the Lake Atitlan, Guatemala, C.A.**  
Jiří KOMÁREK, Jaroslava KOMÁRKOVÁ, Eliška REJMÁNKOVÁ

10.20 Abstract 10  
**Nitrogen-fixation of phytoplankton in a water quality control reservoir (Kis-Balaton, Hungary)**  
Hajnalka HORVÁTH, Kálmán MÁTYÁS, György SÜLE, Mártyás PRÉSING

10.40 Abstract 23  
**The role of reed periphyton in the primary production of Lake Balaton (Hungary)**  
Boglárka SOMOGYI, Sára PADOS, Balázs NÉMETH, Lajos VÖRÖS

11.00 Abstract 24  
**Diatom assemblages and ecological status of Lake Balaton favored by tourism**  
Csilla STENGERT-KOVÁCS, Luciane O. CROSSETTI, Renáta HORVÁTH, Beáta SZABÓ, Judit PADISÁK

11.20 Coffee break

**Session 3**
Chairperson: Arturs ŠKUTE

11.40 Abstract 15  
**The effect of bathing on the vertical physico-chemical gradients and microbial communities in the hypersaline and heliothermal Lake Ursu (Sovata, Romania)**  
István MÁTHÉ, Tamás FELFÖLDI, Laura JURECSKA, Zsolt KELEMEN, Erzsébet ELEKES, Katalin BARKÁCS, Károly MÁRIALIGETI

12.00 Abstract 9  
**Effect of the increasing turbulence on zooplankton in the large and shallow Lake Balaton (Hungary)**  
László G.-TÓTH, Laura PARPALA, Eszter BARANYAI, Tünde P. KLEIN

12.20 Abstract 6  
**Characterization of non-indigenous species inhabiting Lake Balaton: a risk based approach**  
Árpád FERINCZ, Gábor PAULOVITS, András ÁCS, Nóra KOVÁTS

12.40 Lunch

14.00 **Poster session**
Chairperson: Károly MÁRIALIGETI

Abstract 7  
**Distribution and characteristics of the reed Phragmites australis in the Lake Peipsi**  
Lilian FREIBERG
Abstract 8  Characterization of the management of the shore zone of Ukiel Lake (Olsztyn, Poland)  
Grazyna FURGALA-SELEZNIOW, Andrzej SKRZYPczAK, Adam KAJKO, Andrzej MAMCARZ

Abstract 16  Huge swarming of non-biting midges (Diptera: Chironomidae) at Lake Balaton  
Arnold MÓRA

Abstract 20  The impact of fishponds on water quality of Orlik Reservoir – the question of their retention capacity  
Jan POTUZÁK, Jindřich DURAS

Abstract 21  Trophic pressure of the introduced brown bullhead (Ictalurus nebulosus Leseur.) on native fish fauna in lakes of the Shatsky National Park  
Mykola SIDORENKO

Abstract 22  Diel vertical migration of pelagic fish in the Lake Svente  
Arturs ŠKUTE, Pavels JUREVIČS, Edgars BAUMANIS, Ilmars BRIEDIS, Marija STEPANOVA

Abstract 27  Comparative analysis of zooplankton in two transboundary lakes  
Vasil Vezhnavets, Arturs Škute

15.30  Coffee break

15.40  Balaton Limnological Research Institute of the Hungarian Academy of Science  
a short film

18.00  Boat trip to Balatonfüred

19.00  Walk and dinner in Balatonfüred  
Balatonfüred is a small town with 13.500 inhabitants, on the north shore of Lake Balaton, surrounded by gently sloping hillocks. Foreign travellers – may they come here by rail, by road or by boat – start to feel the harmonious blend of past and present at the moment of their arrival. First and foremost the location of the town captures everyone: tender mountains on the north, the beautiful lake on the south embrace the town, which radiates that special Transdanubian serenity for ages.

22.00  Departure by bus to Tihany
Thursday, 23 June 2011

Session 4
Chairperson: Jiří Komárek

10.00 Abstract 5
Revitalization of Orlík Reservoir – an ambitious project for water quality improvement
Jindřich DURAS, Jan POTUŽÁK, Marek LIŠKA

10.20 Abstract 18
Phytoplankton functional diversity and its relationship with trophic state in Lake Balaton
Károly PALFFY, Lajos VÔRÔS

10.40 Abstract 12
Trophic state of Transylvanian hypersaline lakes
Zsolt-Gyula KERESZTES, Boglárka SOMOGYI, Tamás FELFÔLDI, Csaba BARTHA, Nicolae DRAGOS, Gyôngyi SZÈKELY, Lajos VÔRÔS

11.00 Coffee break

Session 5
Chairperson: László G.-TÔTH

11.20 Abstract 11
Evaluation of integrity of shoreline of Lake Balaton by the Shorezone Functionality Index (SFI)
Katalin Eszter HUBAI, Franciska TÔTH, Viktória ÜVEGES, Judit PADISÁK

11.40 Abstract 4
Submersed macrophytes in three recreational lakes with different treatment
Jindřich DURAS, Tomáš Č. KUČERA, Jakub BOROVEC

12.00 Abstract 25
Potential environmental impacts of tourism on the macrophyte vegetation of freshwater lakes
Viktor R. TÔTH

12.20 Closing

12.40 Lunch

14.00 Departure by bus to Sümeg

Visiting the medieval castle of Sümeg
Sümeg and it’s region belongs to the cultural heritage of the Hungarian nation which owns 1100 years history. More than 1500 castles, fortresses and manor houses have been built over the centuries.

18.00 Dinner and farewell party
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Abstracts
Conservation and tourism at the Lake Fertő

András AMBRUS, Attila PELLINGER
Fertő-Hanság National Park Directorate, Sarród, Hungary

Lake Fertő is a specific habitat type, it is the last piece of the series of shallow alkaline steppe-lakes from West-Asia to Europe. Typical characteristics are: unstable water regime (once in a hundred years can dry up), high dissolved salt content, quick warming up. Nowadays high rate of sedimentation and eutrophication take place, the reed zone has reached several km in some places, while inner bays, lakes are under separation from the open water body. The most important and characteristic vegetation type in the lake is the reed (Phragmites australis), but other communities can cover locally reasonable areas too, such as Cladium mariscus, Typha sp., etc. Floating and submerged macrophyte communities are not so abundant. The huge reed zone offers specific habitat for nesting birds, colonies of great egrets, purple herons and a lot of other water birds which need undisturbed territories. One of the most important conservational issues is the conservation of bird fauna with its habitats.

The human impact on the lake consist of different topics: nutrient load (from the land use and waste water), pressure from the need to access to „lake services” such as fishing, boating, swimming, etc., and need to access to ecosystem services, such as ecotourism, or especially birdwatching. Nutrient load should be cut down in all possible ways, including change in land use intensity (agro-environmental schemes), improving the efficiency of waste water treatment and so on, but it needs higher level of decision making than the National Park administration.

The public access to the lake in general has been regulated (more or less effectively) with the setting up the zonation of the lake. Roughly the Fertőrákos-bay is the main place for tourism, fishing, swimming, etc.

The specific need to access to the natural values is the most important and sensitive area which has to be balanced well by the National Park staff to offer enough places of interest without disturbing the natural communities. The guided tours, experimental canou trips in the reed zone, visits at the grey cattle herds of the National Park which sustain the traditional land use and keep grasslands as a basic elements of the landscape, and other means all should express the importance of nature conservation as a final message to the visitors.
Nature conservation aspects of Lake Balaton

Judit Cservenka, Lajos Nagy, Imre Petróczy
Balaton Uplands National Park Directorate, Csopak, Hungary

Lake Balaton is the largest permanent shallow freshwater lake in Central Europe (59 800 ha), with reedbeds and marshy meadows that are still in close-to-natural state. It was designated as a Natura 2000 site according to Habitats Directive and Birds Directive in 2004 and it has an important role as a part of the European Ecological Network. Uniquely, it is the only periodic Ramsar site (between 1 October and 30 April) in the world. The site hosts large numbers of ducks, geese and coots during migration season, including over 1% of their European wintering populations. The lake is an important staging area during migration and wintering seasons for more than 25-40 thousand individuals of more than 70 waterbird species. Most of the vegetation is water-logged for most of the vegetative season. There are different habitat types of reedbed vegetation. Outside wintering and migration seasons, the large reedbeds bordering the shoreline of the lake are important for reed-dwelling bird species. Different natural types of wetland vegetation co-exist from the free water surface to wet meadows. Populations of Thelypteris palustris, Pedicularis palustris, Hydrocotyle vulgaris, Urtica kioviensis, Ranunculus lingua, Orchis laxiflora, Dactylorhiza incarnata and the endemic Cirsium brachycephalum are illustrative botanic values of the lake. The invertebrate fauna of the lake is rich in species. Macrolea mutica balatonica (Székessy, 1941) is an endemic Hungarian Red Listed species of Chrysomelidae living in the lake. 41 fish species exist in its catchment area (together with the lake it is 5 775 km²), and 23 of them inhabit the lake recently. There are stable populations of Pelecus cultratus and Aspius aspius which are used for designating the site into the Natura 2000 network. A diverse amphibian and reptile fauna populates the vegetation and artificial shoreline regions.

Traditions for fisheries and reed harvesting date back to centuries. It is very important to reconcile different points of view in nature conservation and economic land use inside the Ramsar area. Recently, fisheries activity concentrates first of all on the wise use of fish community. The site is one of the largest areas for tourism in Europe, and the largest one in Hungary. The lake has made an imprint on the cultural traditions and values in the small villages and towns around the lake. Lake Balaton ensures the livelihood for most of the people living here.

Present and potential threats are originating from the situation sketched out: unwise reed harvesting; construction of sailing ports and stages for anglers; increasing motor sports activity on water, illegal embankments and uprooting of reed, keeping of continuous high water-level.

The information centers (10) managed by BUNPD, the more than 20 nature trails, the several guided tours around the lake and the great number of information booklets all serve the raising of consciousness for the conservation of the natural values of Lake Balaton and the beautiful surrounding areas.
The impact of tourism on lakes

Martin T. Dokulil
EX Institute for Limnology, Mondsee, Austria

Ecosystem services are the benefits provided to people by ecosystems and biodiversity. Fresh water is a ‘provisioning’ service referring to the human use of fresh water for several purposes. The hydrological cycle also sustains inland water ecosystems, including rivers, lakes, and wetlands. These ecosystems provide regulating, supporting and cultural services that contribute directly and indirectly to human well-being through recreation, scenic values, and fisheries. To maintain ecosystem health or ecosystem integrity external or internal perturbations must be kept below the carrying capacity.

Anthropogenic disturbances of freshwater resources as a consequence of tourism are diverse. In many regions of the world, lakes and ponds in particular are important freshwater habitats providing significant attraction for the public. Impacts to lakes from tourist activities occur directly to the lake water and shoreline, or can affect the water body indirectly through various actions in the catchment. The response of a specific freshwater ecosystem depends on the type of interference, as well as the type and size of the lake. Shallow lakes are affected and hence behave differently from deep lakes. Large lakes react in a different way than small lakes. Impacts are also modified and mediated by the characteristics of the catchment, such morphology, size, land-use, population structure etc.

Impacts to tourist lakes are classified, direct and indirect effects analysed and exemplified for different types of lakes and catchments.
Submersed macrophytes in three recreational lakes with different treatment

Jindřich DURAS¹, Tomáš Č. KUČERA¹, Jakub BOROVEC²

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Every project aimed to lower trophic state of a shallow lake should take into account aquatic vegetation, as aquatic macrophytes are necessary for the successful transformation of pelagic ecosystems into littoral ones. On the other hand, it may be difficult to keep their growth within limits acceptable for swimmers or yachtmen.

We compared the situation in three shallow lakes near the city Plzeň (CZ), where biomanipulation projects have been realized in the last years. Following the reduction of fish stock (carp), two lakes (3 and 4 ha) exhibited considerable improvement in water transparency, followed by an intensive growth of aquatic plants: *Elatine hydropiper, Nitella flexilis, Potamogeton crispus*, and, especially, *Myriophyllum spicatum*, whose biomass increased vigorously. During 2009-2010, both lakes were repeatedly harvested from the depth of ~1.8 m– harvested biomass was always recovered within the period of one month. In the third shallow lake (43 ha), in addition to gradually reducing fish stock, the water and sediments were repeatedly treated by Al coagulants and experimental aquatic plants were systematically cultivated in a big enclosure. At the beginning of the the project’s third year, macrophytes massively expanded and water transparency increased markedly (to 2-4 m). Dominant species were: *Myriophyllum spicatum, Potamogeton crispus, Nitella flexilis, Batrachium sp.*. In the following year the “eutrophic” plants stopped their growth and modestly growing species, esp. *Eleocharis acicularis* and *Elodea canadensis* progressed. Fractionation of the sediments and pore water minipeeper analyses in the third lake showed that oligotrophication of the water column was followed by oligotrophication of the sediments, where added Al locked bioavailable P. This was not observed in the first two lakes where P in sediments was predominantly bound to Fe in bioavailable compounds.
Revitalization of Orlík Reservoir – an ambitious project for water quality improvement

Jindřich DURAS, Jan POTUŽÁK, Marek LIŠKA
Vlava River Authority, Praha, Czech Republic

Orlík Reservoir is the biggest man made lake in Czech Republic (Summer values: V = 605 mil. m³, A = 23.4 km², max depth 75 m, 55 km long). Its high recreational potential should play an important role in socio-economic development of adjacent region, but cyanobacterial blooms usually deteriorated water quality in the reservoir. Therefore, a project „Revitalization of Orlík Reservoir“ was started in 2009. Research of nutrient balance of the reservoir indicated too high P load by inflows (250-800 t of P per year or 11-35 g.m⁻².year⁻¹). It was estimated that to keep cyanobacteriae in acceptable limits it is necessary to cut down P input to 1/3 of present load, especially during vegetation period that is of principle importance, i.e. to only 51 t of P against present 151 t per veg. period. A special study concentrated on P balance in drainage area of the reservoir (12 117 km²) concluded that (i) agriculture was important source of P in very small number of sub-watersheds only, (ii) main P sources were wastewaters from settlements of all size, but (iii) very important appeared to be also fishpond areas (carp production). Very interesting is the issue of fishponds that are naturally able to trap great amounts of P. On the other hand intensive fishery management not only brings „extra“ P inputs (fish food), but remarkably decreases P retention coefficient, too. Moreover, fishponds often serve as P time bomb during summer because increased flows wash up P rich warm water from ponds that enters epilimnetic layers of the reservoir downstreams where supplies cyanobacterial growth. For integrated watershed management fishponds represent potentially important P retaining component in efforts to minimize P emissions, especially from small villages (<500 inhabitants) where is very difficult to install highly efficient waste water treatment technologies. An uneasy question is opening, now: „Are we able to estimate potential ecological services of fishponds?“ Or: „How to optimize the fishpond management in the the terms of acceptable fish production and so much needed high P retention capacity?“
Characterization of non-indigenous species inhabiting Lake Balaton: a risk based approach

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Although, the invasive and non-native species are recognized as one of the main ecological problem in the 21st century, in numerous cases we could not even determine the exact status of an alien species in a given locality. In our study we presenting the qualitative risk assessment of non-indigenous fish species living in the ecosystem of Lake Balaton, based on the ISEIA (Invasive Species Environmental Impact Assessment) methodology and give an up to date view of risk priority of alien species. The systematic review of all available literature has been carried out and 15 recent non-indigenous species were assessed. This project is implemented through the CENTRAL EUROPE Programme (European Lakes Under Environmental Stressors, 2CE243P3).
Distribution and characteristics of the reed *Phragmites australis* in the Lake Peipsi

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Lake Peipsi is the largest transboundary water body in Europe and the fourth largest lake in Europe. Lake Peipsi is a eutrophic and biologically highly productive lake. Nutrient pollution is a major threat to water quality in the lake. The main source of this water pollution is agriculture and municipal wastewaters. The sandy beaches of Lake Peipsi is used for active recreation. Distribution of the reed *Phragmites australis* in the Lake Peipsi is a nuisance for a recreation activities. The reedbed areas in the lake have increased considerably in the past and reach at present 9.3 km2 in Estonian part of the lake. The reed of the Lake Peipsi belongs to the group of the most productive in biomass in Estonia and probably it has reached its maximum already by populating in suitable areas. During the last 20 years, the reed of the Lake Peipsi has not expanded noticeably in any way towards any direction of the lake.

This paper gives survey of the distribution and production of the reed of the Lake Peipsi. The morphometric indices and the factors that influence the growth of the reed have been taken into account. The trophic level of different parts of Peipsi can also be seen when watching the characteristics of *Phragmites australis*. Its length, diameter and biomass grow from north to south. On the western coast the same indicators are bigger that on the eastern coast.
Characterization of the management of the shore zone of Ukiel Lake (Olsztyn, Poland)

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Ukiel Lake (surface area 412 ha, maximum depth 43 m), the largest of the eleven lakes in Olsztyn, consists of four distinct basins, each with different environmental features. The presence of urban infrastructure, including a grid of streets, in the nearest proximity of the lake arises much interest in the recreational use of the lake. The present description of how the lake’s shore zone around each basin is developed and managed relies on some observations gathered from the monitoring of the nature in the shore zone and access to the lake’s water. The analysis of the actual use of the lake’s tourist space was conducted on the basis of direct observations, including our assessment of the recreational pressure on the beaches, baths and near the water table. The results thus obtained suggest that, owing to its size and diverse character, Ukiel Lake can be used for many different forms of recreation. Among the four basins, the most intensively developed and subjected to the highest recreational pressure is Olsztyńskie Basin.
**Effect of the increasing turbulence on zooplankton in the large and shallow Lake Balaton (Hungary)**

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Numerical density of the large sized Rotatoria and Cladocera, Calanoida copepods and veligers in the large shallow Lake Balaton (area: 596 km², mean depth: 3.2 m) decreased with 30-70 percentile during the dramatic water level decrease in the drought years of 2000-2003 and regenerated from 2004 with the recovery of the water level. RMS-turbulent energy content of the water mass of the open lake increased with the water level decrease (range: 0.5-21 cm sec⁻¹). We found negative effect of laboratory simulated turbulence on Cladocera and Rotifera in 600 litres tanks, where survival of some large Cladocera was < 3-4 days, of some Calanoida < 8 days and of some small Cladocera and Rotifera < 8-12 days at higher than 3.5 cm sec⁻¹ RMS turbulence. Nauplii and Cyclopoida copepods tolerated the turbulence even increased in their abundances at > 3.5-4.0 sec⁻¹ RMS turbulence. It is suggested by the results that beside the mineral turbidity (resuspended sediment particles), the increasing turbulence also can cause shift of the zooplankton structure from the large but sensitive filter-feeder Cladocera and Rotatoria to the direction of small Cladocera, Rotatoria and Cyclopoida in large shallow lakes.
Nitrogen-fixation of phytoplankton in a water quality control reservoir (Kis-Balaton, Hungary)

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The Kis-Balaton Water Protection System (KBWPS) was established for improving and protecting of the water quality of Lake Balaton, one of the most significant tourist regions in Hungary. The end of the 1960's the water quality has degraded a great extent and a lake went through a man-made eutrophication. One of the reasons was Zala River carrying one/third-half of the total external load to the Keszthely basin. The high P and the low N concentrations (low N:P) favour the growth of cyanobacteria. The role of the nitrogen-fixers in aquatic ecosystems became more significant. The fixed amount of nitrogen have been exceeded the total external N-load in summer which could obtain 10% of the yearly total N-load in the KBWPS. The aim of this study was to specify the earlier data obtained by acetylene reduction method and a more accurate estimation the nitrogen turnover of the system. Therefore we determined the nitrogen fixation by phytoplankton on four sites of the KBWPS in 2009 with ¹⁵N-isotop technique. The light dependence of N-fixation was described with an exponential saturated curve and used to calculate the daily nitrogen fixation of the water column for unit surface area. The calculated amount of fixed nitrogen during 4 months (July-October) was approximately 150 tons for 21 km² open water area of KBWPS. The TN/TP mass ratios (2.5-11.5) favoured for the N₂-fixing cyanobacteria, which contribution sometimes reached 70 and 90 % of total algal biomass. The estimated primary production of phytoplankton was used to calculate the contribution of nitrogen fixation (5-20 %) for the algae nitrogen demand and for the yearly external nitrogen load (15 %).
Evaluation of integrity of shoreline of Lake Balaton by the Shorezone Functionality Index (SFI)

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Shoreline is a transition zone between the surrounding territory and lake, and has important ecological functions. It regulates nutrient inputs, protects the lake from no-point source pollution, guarantees the execution of ecological processes, serves food and habitat for biota, protects the shoreline from erosion, etc. The Shorezone Functionality Index (SFI) was developed to assess how much the shorezone is likely to support the above processes. Development of tourism and use of shorezones for recreational purposes often conflicts with integrity of ecological processes. A lake shorezone management based on the concepts of functionality allows reconciling the environment protection with the human use of the lake, and helping an eco-sustainable city planning and watershed management. A further advantage of the SFI is that its simplicity allows understanding of basic processes by non-specialists since it uses five categories that can be visualized by different coloration on graphical displays. Data for calculating the SFI for lake Balaton were recorded between 7-9 September, 2010. We identified 155 homogeneous stretches. The data collected in the field were entered into the Shorezone Functionality Software, which then calculates a functionality value for each homogeneous stretch. According to the SFI index, of shorezone of Lake Balaton spans all different categories of functionality, ranging from Excellent to Poor.

This project is implemented through the CENTRAL EUROPE Programme (European Lakes Under Environmental Stressors, 2CE243P3)
The saline lakes of the Carpathian Basin were emerged in the last century from the flooding of abandoned salt mines. The concentration of salt in these relatively young, deep lakes is extremely high, nearly saturated. During last decades these lakes underwent high human modifications and became popular spas. The bath season starts in May and lasts until September. The shore of most lakes is a built up area, the inflow water is mainly rain water. Water samples were collected from nine saline lakes situated near Cluj-Napoca, in 2010 July and 2011 February. Summer samples were taken from the lake surface, while winter samples were collected from different depths. The major physicochemical characteristics of the water such as temperature, conductivity, pH, dissolved oxygen concentration, Secchi-disk transparency, and ice-thickness were determined in the field. The chlorophyll $a$ concentration, the abundance and the biomass of the phytoplankton were determined in laboratory. Molecular biology techniques (DGGE, cloning, sequencing) were applied for the identification of phytoplankton taxa. Based on our results, most of the lakes were hypertrophic, meromictic and highly stratified. During winter, in most cases we observed a deep (approximately 4 m) chlorophyll maximum. The stratification observed in winter disappeared in summer due to the bathing. In two lakes the phytoplankton was dominated by picocyanobacteria and picoeukaryotes respectively. Diatoms (e.g. *Cymbella* sp., *Amphora* sp.), common halophytic species (*Dunaliella salina* (Dunal) Teodoresco), and marine phytoplankton taxa (*Picochlorum*, *Nannochloris*, *Synechococcus* marine clade VIII. and *Isochrysis* species) were identified. The presence of marine phytoplankton species and the dominance of picophytoplankton make these continental salt lakes very particular environment.
A tourist town on the lakeside of a tourist lake – Balatonfüred

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Self-government of Balatonfüred, Balatonfüred, Hungary

Main points of the presentation are:

- Introduction
- Geographical situation
- History
- Balatonfüred today
- Population
- Roads & transport
- Tourism: main attractions
- Most important events
Pollution danger of the Lake Atitlan, Guatemala, C.A.

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The Lake Atitlan, Guatemala, is famous lake in the whole Central America. It belongs to most beautiful and hydrologically important water reservoirs in the whole area. In last years, they appeared serious problems with increasing water pollution. The uncontrolled nutrient input has lead to high P levels and low N:P ratios, initiating cyanobacterial blooms. The first bloom appeared in December of 2008, followed by more extensive bloom in next seasons. The blooms are formed by cyanobacteria from the rare planktic, tropical Lyngbya robusta. It is the first case of water bloom of this species worldwide. At the maximum bloom development, 40% of the 137 km\textsuperscript{2} of the lake area were covered by dense patches of Lyngbya, with the chlorophyll a concentration reaching over 100 \(\mu\text{g L}^{-1}\). The toxins were not detected. The nitrogen fixation followed a pattern expected in non-heterocytous cyanobacteria, i.e., the nitrogenase activity was minimal during the day, while during the night the activity reached 2.2 nmol C\textsubscript{2}H\textsubscript{4} \mu\text{g Ch a}^{-1} \text{h}^{-1}. Lyngbya robusta was isolated and studied also in vitro. It was found that planktic \textit{Lyngbya} species (together with \textit{L. hieronymusii} and \textit{L. birgei}) belong into a special genetic cluster and must be taxonomically classified in a special genus. The renovation of the lake is difficult; strict control of nutrient input into the lake and public education are the necessary prerequisites for potential prevention of even more severe blooms than the one from previous years, and the prompt restriction of input of pollutants into the lake is required.
The effect of bathing on the vertical physico-chemical gradients and microbial communities in the hypersaline and heliothermal Lake Ursu (Sovata, Romania)

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The protected Lake Ursu is situated in Sovata (Mureș County, Transylvania Region, Central Romania). The hypersaline, meromictic Lake Ursu is one of the largest heliothermal salt lakes in Europe. The lake has a long axis of 366 m and a short axis of 239 m. The surface area is 41,270 m² and the maximum depth is 18.2 m. The lake is of karstosaline origin, formed between 1870 and 1880. The lake has a 10-15-cm-deep surface layer of poorly mineralized water (15-54 g/L), resulting from rainfall and two influent creeks. Salt concentration increases up to the depth of 3-3.5 m, where it reaches values above 250-300 g/L, then remains constant until the sediment surface. Na⁺ and Cl⁻ ions dominate, and SO₄²⁻, HCO₃⁻, Ca²⁺, Mg²⁺, iron ions are also present in lesser amounts. Since the 1920's the lake has been increasingly used for bathing. Today it is one of the most important health spas of Romania, the salt water of the lake and the organic mud are both used for therapeutic purposes throughout the year. Bathing in the lake is restricted to the summer period. The water column above the deepest point of the lake (within the bathing area) was chosen for sampling and in-situ measurements to reveal the effect of bathing. Samplings were made before and after the summer bathing season, and in the bathing season monthly. In the season three samplings were made in a day: at down before opening, at noon, and evening, after hours. Results showed slight, but characteristic changes in the physico-chemical parameters, and biological data determined from water samples. The measurements corroborated the well principled limitation of the length of the bathing season, moreover the restriction of the daily bathing hours. Microbiological data draw the attention to the possible presence of allochtonous microorganisms in the surface water body.
Huge swarming of non-biting midges (Diptera: Chironomidae) at Lake Balaton

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The mass swarming of adult non-biting midges (Diptera: Chironomidae) can cause strong inconvenience to tourists, disturbing them in resting and recreational activities and often forcing them to leave home earlier than they planned. This problem negatively affects the local business, resulted in a claim to extermination of chironomids. Due to chironomids are essential for healthy ecosystem of the lake the public claim is diametrically opposed to environmental protection and nature conservation. However, possibilities for controlling the swarming are exist. As a first step of controlling measures, the temporal pattern of swarming was studied in the summer season of 2010 at the most impacted part of Lake Balaton. The huge swarming started at the end of June and ended in the middle of October. The quantity of chironomids ranged from 534 to 7,450 ind./hour. The large sized *Chironomus balatonicus* was the dominant species constituting 22–72% of the specimens (296–2662 ind./hour). Taking into consideration the reports of tourists, even cca. 500 ind./hour appeared as unbearable mass of swarming *Ch. balatonicus*. As this species occurred in higher mass in almost the whole season, it caused serious problems in 2010. At the same time, long-term data are not available on swarming at Lake Balaton, such it cannot be determined whether the huge swarming recently observed is exceptional or shows a rising tendency.
Unexpected cyanobacterial dominance in a deep oligomesotrophic lake, Lake Stechlin, Germany: \textit{Aphanizomenon flos-aquae}, an ecosystem engineer

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Recent research detected an ongoing expansion of cyanobacteria in European lakes with moderate trophic states without parallel increase in trophic state indicators. A perennial \textit{Aphanizomenon flos-aquae} bloom in Lake Stechlin, Germany in 2009-2010 represents such a case. Lake Stechlin is a deep (z\textsubscript{max}: 69.5 m) glacial lake that used to be considered oligotrophic in the recent past of its history. Records on phytoplankton are available since 1994. The first filament of \textit{Aphanizomenon flos-aquae} appeared in the lake in 2000 and then it developed minor peaks by every late summers. In 2009, however, an intensive growth started reaching a maximum (310 µg L\textsuperscript{-1}) in August. After a decline in August a winter population started to develop with a maximum around 920 µg L\textsuperscript{-1} in December-February that persisted almost as monoculture under thick ice and snow. This project was implemented through the CENTRAL EUROPE Programme (European Lakes Under Environmental Stressors,2CE243P3) and the project Klimagetriebene Veränderungen der Biodiversität von Mikrobiota (TemBi) supported by the Leibniz Gemeinschaft (WGL).
Phytoplankton functional diversity and its relationship with trophic state in Lake Balaton

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Studying the diversity of phytoplankton communities and its relationship with changes in the environment has long been an important field of research in freshwater ecology. Relevant work on Lake Balaton, the largest lake and a popular holiday resort in Central Europe, started several decades ago. The lake went through considerable changes in trophic state from the early 1970s, and a substantial amount of work was devoted to monitoring related changes in the phytoplankton community. Most of these studies were conducted from a taxonomic aspect, however, functional approaches seem to be more appropriate for understanding phytoplankton community responses. With this end in view, we investigated the spatiotemporal diversity pattern of phytoplankton functional groups in the mesotrophic eastern and eutrophic western basin of the lake.

The basis for classifying species into groups was constituted by a selection of functionally relevant traits (cell size, surface to volume ratio, photosynthetic pigment composition, N2-fixation, phagotrophy, degree of organisation (unicell, filamentous, colony- or coenobium-forming) and motility), consequently, species belonging in the same group are supposed to play a similar role in ecosystem functioning. Our results have pointed out that trophic state (total phytoplankton biomass) and water temperature have a significant effect on the functional diversity of phytoplankton communities in Lake Balaton. The variability in functional diversity seems to be more sensitive to ecological processes within the phytoplankton than the taxonomic measures of diversity, thus it could be applied as an efficient tool for detecting structural changes of the community.
Water management of Lake Fertő/Neusiedler See

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The largest lake of Austria and the second largest lake of Hungary are situated at the Austro-Hungarian border about 113 m a.s.l. At the present time Lake Fertő has a total surface approaching 315 km$^2$, of which about 180 km$^2$ are covered by *Phragmites*. Lake Fertő has a great natural conservation value and highly protected National Park status in Austria and Hungary. In 1954 Hungarian initiative began the negotiation between the two countries to aim a new comprehensive border water management treaty. The principle of the negotiation was solidarity and equality. After relative short negotiation a Hungarian-Austrian Water Commission was established in 1956 and the convention came into force in 1959. The commission was established in order to promote co-operation in matters of water management. The kidney-shaped Lake Fertő is highly astatic with a fluctuating water level. The deepest water column of the modern lake is not more than 2 m. The average depth is somewhat less than 1.5 m. The climate of the Lake Fertő region is determined by its continental character, with special west wind effects of the Eastern Alps resulted in higher temperatures in the warmer season and relatively little rainfall and low temperatures in the cooler season. Throughout the year northwest and southeast winds prevail in the region around the lake. The slight breezes are very typical for this region, the wind still days are rare. The light climate of Fertő Lake is also extreme, and influenced by large degree of turbidity. Even a light breeze whirls up mud and organic and inorganic substances suspended in the water and this is why the lake often changes colour, transmission within a short period of time. Hydro-chemically Lake Fertő can be considered as a gigantic shallow mixing pan into which normal mountain water flows from the north and west and stored for a long time. Due to the above mentioned specialities the water changes into Fertő water. The nutrient conditions in Lake Fertő show a decreasing tendency of phosphorus compounds due to the waste water management around the lake. Very distinct horizontal variations in oxygen content occur, due to the two sub-biotopes, the open lake and the reed belt. The reed belt of Lake Fertő plays a very important role in the life of the lake: main functions are filtration and reducing loads, trap of sediments, natural conservation area, nesting place for birds, spawning place for fishes, furthermore it has a high commercial value. In fact this reed belt is the largest continuous reed area, as a *Phragmites* monoculture in Central Europe.

Ecological problems of Lake Fertő are eutrophication processes accelerated, high human pressure, the overall trophic situation of the shallow lake is meso-(eutrophic), algal blooms occurred, lack of water exchange between open lake and reed belt. Measures to conserve the good ecological status are reed belt growth decreasing, reduce point like loads, minimize diffuse loads, reduce internal-loads, sustainable reed management, common Hungarian-Austrian lake strategy. Management strategy considers water level elevation by a new sluice management, aerobe conditions in reed belt, water change between open lake water and reed belt water, investigation on the interaction between hydrodynamics and reed belt, interaction sediment/water, engineering works for improving water quality in reed belt.
The impact of fishponds on water quality of Orlík Reservoir – the question of their retention capacity

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Project “Revitalization of Orlík Reservoir” was started in 2009 with clear object – to reduce trophy of the reservoir and restrict occurrence of cyanobacterial blooms that deteriorated recreational use. Research of nutrient balance of the reservoir and its watershed showed that among important sources of phosphorus (P) belong drainage areas with numerous fishponds. Because very little was known about P balance of fishponds in general and quite unclear was issue concerning the relevance of fishery and/or nutrient inputs from pond drainage area for final water quality, we selected two different fishponds for our study during 2010 - 2011. Hypertrophic fishpond Dehtář (246 ha) was intensively stocked with carp (fed by grain) and meso-eutrophic fishpond Hejtman (82 ha), used for recreation, with extensive fishery only (angling). Phosphorus retention (R) estimated from measured data was compared with modelled values (after Hejzlar et al., 2006).

Dehtář: Specific P load was estimated as 1.71 g m⁻² year⁻¹, half of it was input from fishery management. P concentrations in water ranged between 0.11–0.34 mg l⁻¹ i.e. was in surplus, chlorophyll-a reached 160 µg l⁻¹. P retention was positive (R – 10%, 0.42 t P, exported was 3.78 t P), but the potential (modelled) retention should be much higher (R – 55%, 2.31 t P, export of 1.85 t P). If we estimate a situation for only extensive management of the pond (no extra P input from fishery, R=55 %) then we obtain quite different values (export of 0.95 t P only).

Hejtman: P load was estimated as 3.20 g m⁻² year⁻¹, P concentrations in water ranged between 0.010–0.056 mg l⁻¹ i.e. biocoenose was P limited, maximal chlorophyll-a concentrations reached 50 µg l⁻¹. P retention was positive (R – 26%, 0.66 t P, exported was 1.89 t P) what fitted well with modelled values (R – 24%, 0.61 t P).

Different management of both the fishponds was considered to be the principal reason of their different P retention. The results documented that potential P retention capacity of fishponds should be considerable, but interests of fish production still dominate. It is time to estimate also ecological services of fishponds.
Trophic pressure of the introduced brown bullhead (*Ictalurus nebulosus* Leseur.) on native fish fauna in lakes of the Shatsky National Park

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Shatsky lakes, which are located on the territory of the Shatsky National Park (Volyn region), are the largest natural and the most visited lakes of Ukraine. Among 23 lakes with total area of 70 ha, the largest are Svityaz (2620 ha), Pulemets (1570 ha), and Luki-Peremut (588 ha). 17 fishes inhabit these lakes including eel. Brown bullhead (*Ictalurus nebulosus*) was introduced here in 1937 and since then it developed large and well established populations.

The aim of this work was to study the brown bullhead effect on local native fish fauna by investigating its diet. Data collection was performed during 2008-2009 in the lakes Luki-Peremut, Svityaz, and Pulemets.

The brown bullhead diet in the studied lakes was diverse and depended on available food base. In 2008, the basis of its diet in Svityaz consisted of Cladocera (41±10.8), in Pulemets Insecta larvae (38±10.5%) and *Asellus aquaticus* (27±10.8%), and in Luki-Peremut macrophytes (35±13,5%), Insecta larvae (30±15.3%) and fish scale (24±12,8%). In 2009, in the Svityaz and Pulemets lakes, the dominating items were Cladocera (18±4.7 and 19%±5.6, respectively), *A. aquaticus* (16±6.1 and 15±5.6%), and detritus (16±5.7 and 19±4.9%), and in Svityaz else Insecta larvae (19±6.2%); and in Luki-Peremut detritus (57±3.4%) and filamentous alga (23±12.0%). Fish eggs and small fish in the brown bullhead diets were recorded in insignificant quantities: 0.08%–1.29%, 1.3%–6.0%, respectively. Thus, the brown bullhead in the Shatsky lakes has negative effects on fattening conditions of native fishes mostly by competing for their main food items (Crustacea) and by feeding on fish juveniles and eggs, however in insignificant amounts.
Diel vertical migration of pelagic fish in the Lake Svente

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Hydroacoustic data were collected in Lake Svente in August of 2010. Lake Svente takes place in South Latvia, average depth 7.8 m, maximum depth 38 m. Total area of the Lake is 735 ha. The data were collected from the boat moving along the same route several times a day using Biosonics DT-X 200 kHz split beam sonar. Collected data was georeferencing by the JRC GPS. Data were processed by Echo View 4.9 software. Two standard outputs are derived during the processing hydroacoustic data. Volume backscattering strength (Sv), and an integration of the acoustic energy scattered from discrete targets per unit volume of water in decibels (Target strength, TS). Target strength is an acoustic measure of fish length and can be used under certain conditions to estimate both length-frequency relationships of ensonified fish and relative fish density. Study results show that most of the identified fish are staying in the 20-30 m depth during morning, noon and evening. While during the night fish spatial range is wider: from 10 to 27 m depth. Maximum concentrations of fish at this time occur 15-25 m below the surface. The largest concentrations of fish is observed in a depression, approximately 7 m above the deepest location of depression. An increased concentration of fish also occurs 5 m below the surface. Available data show that the target strength (TS) values ranges from -60 to -17 dB. Study results show that biomass of zooplankton differs in spatial and temporal dimensions: total biomass of Cladocera 0.1-4.9 g/m³, total biomass of Copepoda 0.1-7.1 g/m³. This study was supported by European Social Fund project “Formation of interdisciplinary research group for securing the sustainability of salmonid lakes in Latvia” No. 2009/0214/1DP/1.1.1.2.0/09/APIA/VIAA/089.
The role of reed periphyton in the primary production of Lake Balaton (Hungary)

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The primary production of the reed periphyton (epiphyton) was measured in Lake Balaton (10 sampling stations) in situ in July 2007 and photosynthesis-irradiance curves (P-I) were determined in August 2007. Every sampling stations and date the periphyton dominated by diatoms. The photosynthesis of the intact periphyton communities was measured by light-dark bottle oxygen method. The in situ incubations were carried out in closed transparent tubes within the reed stand. In the laboratory the samples were incubated in Karlsruhe-bottles at eight different light intensities (between 10 and 1400 µmol m⁻² sec⁻¹). On the basis of the experimentally determined P-I curves we determined the photosynthetic parameters (Pmax, Ik, α) of the periphyton communities. In July 2007, the production of the periphyton ranged between 16 and 1630 mg C m⁻² day⁻¹. Inside the reed stand, the production and the biomass of the periphyton were lower due to the shading effect of the reed stems, than in the outer edge (close to the open water), where more light was available. Clear tendency was not observed along the longitudinal axis of the lake, which means that the production of the periphyton was not nutrient-limited in contrast to the phytoplankton. The chlorophyll-specific maximum photosynthetic rate (Pmax) of the periphyton varied between 5 and 10 µg C µg Chl⁻¹ h⁻¹. The obtained P-I curves indicated, that the production of the periphyton inside the reed stands was severely light-limited in Lake Balaton. In contrast to the generally accepted opinion, the role of reed periphyton was negligible in the primary production of Lake Balaton during summer.
Diatom assemblages and ecological status of Lake Balaton favored by tourism

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According to Water Framework Directive, European countries must assess the ecological status of surface waters based on different groups of biota. In this study, biotic (diatoms) and abiotic variables were investigated and the ecological status assessment based on attached diatoms was evaluated in the littoral region of Lake Balaton.

Samplings of periphytic diatoms and water were carried out in ten different littoral sites, in the northern and southern shore of the lake from 2006 to 2008. Using diatom data of the quantitative analyses, diatom indices were calculated.

Temperature, dissolved oxygen, nitrite, conductivity, chemical oxygen demand and orthophosphate were the most influential chemical variables of the lake. Clear seasonal and spatial patterns were observed. All the samples of summer and spring correlated with the higher temperature values. In contrast, sample units of winter and autumn correlated with higher concentration of dissolved oxygen. Samples of northern shore of Balaton were associated to the higher levels of pH, and the southern samples were ordinated to the higher values of all dissolved nutrients, conductivity and chemical oxygen demand. Benthic diatoms species responded well to the environmental variation, specially related to the patterns observed into the western-eastern basin gradient. The ecological status varied from medium to excellent in both South and North shorelines of Lake Balaton.

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Potential environmental impacts of tourism on the macrophyte vegetation of freshwater lakes

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Environmental changes (climate change, water pollution, etc.) of recent times show the vulnerability freshwater habitats. Human impact on this ecosystem is the key issue of relations between humans and the freshwater environment, while its design ultimately determines the sign of these relationships, i.e. how positive or negative effect is achieved at both natural environment and human society. Researchers of the BLRI of the HAS are examining the direct and indirect environmental impacts of the tourism on the macrophyte vegetation of Lake Balaton. Lake Balaton for the last 150 years several times changed its outlook and mostly due to presence or absence of macrophyte vegetation. While the emergent vegetation (mostly reed - *Phragmites australis*) was a common element of the ecosystem of Lake Balaton, the changes of the last 30-40 years results in the slowly die-back of reed stands. In the same time submerged flora changed substantially over this time several times, and most of this changes were severely influenced by recreational exploration of the Lake Balaton.
Photosynthetic characteristics of winter phytoplankton dominated by the bloom-forming *Aphanizomenon flos-aquae*

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The appearance of *Aphanizomenon flos-aquae* at higher latitudes is known and there are sporadic data about its high biomass in winter in temperate lakes, sometimes under ice and snow. In winter of 2009/2010 *A. flos-aquae* bloomed in the ice and snow covered oligo-mesotrophic Lake Stechlin, Germany. To understand the appearance of *A. flos-aquae* with high biomass in winter, it needed research to explore not only its optimum but also the upper and lower light/temperature tolerance limits.

The photosynthesis of the integrated samples was measured with the $^{14}$C method at 8 temperatures (2, 5, 10, 15, 20, 25, 30, 35°C). For the P-I measurements the samples were incubated at nine different light intensities in the range of 0-1320 µmol m$^{-2}$ s$^{-1}$ PAR for 2 hours.

At low light intensities the photosynthesis in the temperature range 2-5°C was the most intensive. This temperature range is similar to the in situ temperature in the euphotic layers of Lake Stechlin in winter. The Ik increased with the increasing temperature, but it was at all temperature low, which enables the development of *A. flos-aquae* DCM in summer, furthermore the active photosynthesis under ice cover at lower light intensities.

The applied low temperatures (2 and 5°C) are the lowest experimental conditions ever used in photosynthetic measurements of *A. flos-aquae*, and the results of the P-I and P-T measurements provide novel information about the physiology of *A. flos-aquae*.

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Comparative analysis of zooplankton in two trans-boundary lakes

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Lakes Rica (area 12.84 km², maximum depth 51.9 m) and Sita (area 1.88 km², maximum depth 28.5 m) both are located in trans-boundary area of Latvia and Belarus, from Daugavpils and Braslav districts respectively. Both lakes are favorite objects of tourists and fishermen. Because of high diversity of rare and protected species such as vendace Coregonus albula (L.), European smelt Osmerus eperlanus (L.), calanoid Limnocalanus macrurus Sars, relic mysid Mysis relicta Loven and amphipod Pallasiola quadrispinosa (Sars), lake Rica has become a part of protected areas in both countries. Pelagic zooplankton samples of both lakes from the period of time in July 1988, 2008 and 2010 were compared. Such trophy reflecting indices as changes in species composition, total number of animals and dominating species complex, ratio of the three main groups – Rotifera, Copepoda and Cladocera, as well as changes of number of L. macrurus were examined. Number of species and their ratio in the lakes has not significantly changed. The total number increased slightly in the lake Rica from 44400 to 55800 ind./m³, while in lake Sita from 55700 to 114600 ind./m³. As for the ratio of the three main groups of zooplankton in Lake Rica Rotifera showed a trend with an increase from 21.6% in 1988 to 49.1% in 2008 and 33.8% in 2010. Thus in general, studied lakes retain their status of mesotrophic type water bodies with some oligotrophic features. Changes of some parameters for zooplankton populations indicate a slow process of eutrophication, what appears differently in each lake. This research was supported by ESF project “Formation of interdisciplinary research group for securing the sustainability of salmonid lakes in Latvia” No.2009/0214/1DP/1.1.1.2.0/09/APIA/VIAA/089.