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Research Priorities in the Freshwater Ecosystems of the Czech Republic

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Preface

This review was elaborated within the international project BioStrat (http://www.biostrat.org). It is not expected that it will cover all aspects of the topic, but the compilation of the reviews from different countries may produce an interesting overview, which will help to develop the recommendations at the European Platform for Biodiversity Research Strategy (EPBRS) meetings. Additionally, this research review cannot give neither legislative nor practical recommendations. The on-coming Slovenian EPBRS meeting will deal with aspects of Research Priorities for Sustaining Freshwater Biodiversity.

Our aim was to address people across various sectors. Each of eight co-authors (scientists publishing in ISI journals, member of NGO) has been asked for providing a short review on topic, which are they interested in. One employee of Ministry of Agriculture was asked to provide an official statement of the ministry. One per reviewer has kindly provided his comments to the text. Most of them are members of the Czech BioPlatform project (http://www.ibot.cas.cz/biop) directly related to the EPBRS (www.epbrs.org).

Introduction

(Authors: P. Petřík and Z. Poštulka)

Description of the status of the freshwater ecosystems in the CR

According to the National Biodiversity Strategy (2005), the freshwater biodiversity is endangered more than biodiversity of terrestrial ecosystems due to strong anthropogenic effects. Extensive drainage of the landscape has occurred over the past 50 years and only one quarter of the original 1 300 000 ha of wetlands has been preserved. In general, water quality in watercourses has been significantly improving over the past decade in the CR. However, in comparison with 2005, in 2006 the water pollution sligthly increased and started positive trend has been changed (Environment Report, Ministry of the Environment 2006, www.env.cz).

In spite of the improvement achieved, the current conditions cannot be considered fully satisfactory; problems have persisted mainly in the parts of watercourses with lower flow rates and high accumulation of pollution sources. The most of forest streams are significantly altered, mostly due to incision and a lack of large woody debris elements in the Czech Republic (Stevens 1997). It has been resulting in higher erosion, smaller retention and changed hydraulic characteristics of the streams. The process has last for many centuries and there are nearly no natural streams left as a reference. Due to clear-cut logging and plantation like forest stands there is a significant drainage of catchments due to accelerated erosion and humus degradation. There is a slight progress towards the restoration of polders and ponds, yet the streams and most of wetlands are regulated and drained and both result in high rate of diffusion pollution of our surface waters (Davis et al. 2002). Due to the lack of action within previous parts of catchment areas, together with piecemeal fragmentation (buildings, infrastructure, arable land) of floodplains, the Catchment Area Administrations enterprises have been constantly forced to accept measures damaging river dynamics and to canalise rivers, which results in terrifying biodiversity loss (Jungwirth et al. 2002). The numbers of wetlands that can increase biodiversity and improve water retention in the Czech landscape are gradually decreasing. Eutrophication was reported in a number of water reservoirs in 2003 (caused by pollution of water by municipal waste, and partly also by inflow of nutrients washed out from the agricultural land and from commercial fishing activities, particularly the compounds of phosphorus and nitrogen in the water). Construction of water works has led to interrupting of the continuity of water courses by barrages and dykes, the regime of suspended solids has been modified, the physical and chemical characteristics have been changed, and genetic exchange, active and passive drifting, migration and natural dispersion of aquatic organisms has been prevented.

Climate change related to water cycle

We are facing growing flood and drought risks (see extreme seasons with floods in 1997, 2002 and heats in 2006 in the CR, http://www.chmi.cz) due to the destabilization of climate and due to the decrease of the retention capacity of catchment areas (Brown 2002, Prach et al. 2003). According to the results of the National Climate Program of the Czech Republic, the impact of climate change is manifested particularly by changes in the hydrological balance, surface waters and groundwater regime, reserve volumes of water reservoirs and the quality of surface waters.

Monitoring of freshwater ecosystems

Aquatic and wetland ecosystems have long been monitored in the CR (e.g. Straškrabová et al. 1998, Jelínková & Straškrabová 2001). A detailed survey of current conditions and trends has been supported by programmes and inventories performed in the framework of fulfilling the obligations of the Ramsar Convention and also habitat and species mapping for establishing the Natura 2000 network. Important results have already been obtained from a long-term hydro-biological study of lakes, artificial freshwater reservoirs and watercourses. Thus, we already have very good data with which to assess good ecological status of freshwater ecosystems. What we need is a national, integrated and comprehensive monitoring system, including monitoring of hydromorphological and biological components of surface waters in accordance with the Water Framework Directive (2000/60/EC).

Implementation of Water Framework Directive in the CR

We asked two questions related to the WFD to two representatives (water directors) from the Ministry of Agriculture and the Ministry of the Environment, respectively. The water directors are responsible for the implementations of the Directive in our country. Only one

representative from the Department of Water Management Policy (Ing. Libor Ansorge, Ministry of Agriculture) answered.

Q: What is the contribution of practitioners or policy makers that deal with the daily problems in implementing the directive? Where do you see knowledge/methodological gaps that hinder the proper implementation of the WFD?

A: Related to the biodiversity issue and nature and habitat conservation, the main problems in implementation of the WFD lie in a lack of information relating to the links between anthropogenic pressures , aims specific to target communities, indicators of community status and suitable measures. In the cultural landscape of Central Europe, a definition of "good ecological status of water bodies" (particularly in the area of biological measures describing the status) is very problematic. The definition of measures is even more difficult, because the monitoring has only just started and so far we lack quantifiable results.

Q: Where do you see the role of scientists contributing to the process of defining programmes of measures?

A: Until good ecological status, parameters and links between anthropogenic pressures and impacts of measures proposed in Plans of Catchment Areas (Plány oblasti povodí, see Catalogue on www.mze.cz) on the quality of communities or their biological parts are better known, there is no way we can propose a programme of measures for good ecological status. All the measures are so far based on expert judgement.

Research priorities in freshwater ecosystems

(edited by P. Petřík)

The research is needed for running water with dead and unused arms and alluvial waters that are an integral part of close-to-nature river systems (see the contribution of Z. Poštulka). There are only a negligible number of natural aquatic ecosystems with still water in the Czech Republic. Their ecological functions are replaced, to a certain degree, by fish-pond systems and shallow water bodies, which form an essential part of the Czech cultural landscape (see contribution of J. Květ, D. Pithart & J. Pokorný). Dam lakes constitute a special transitional body between still and running water and they should be consider as integral part of water ecosystems (see contribution of J. Matěna) but their eutrophication caused by high water pollution may represent ecological problems (see the contribution of B. Maršálek). Although the flood events may be very destructional for people, several freshwater habitats are dependent on regular floods and their specific ecology is not yet well-known (see the contribution of J. Elster). Finally, most of aquatic and wetland ecosystems, phyto/zooplankton, phyto/zoobentos, macrophytocenoses, amphibians, reptiles, and birds bound on water belong amongst endangered species. Totally, 31% of fish and cyclostomata species are protected by law in the Czech Republic and their ecology and taxonomy is not yet well studied (see contribution of P. Ráb).

Research priorities within catchment areas (running water)

(Author: Z. Poštulka)

In the Czech Republic, there are three basic elements within catchment areas with different administrative and management authorities responsible for those three pillars.

1. Streams and rivers in forested parts of catchment areas are usually under the governance of the Forests of the Czech Republic (LČR, http://www.lcr.cz), the state owned enterprise. The most lacking is the geomorphologic and eco-hydrologic research estimating best management practices within sensitive catchments. We need to estimate, what is the retention potential of undisturbed catchments *vs.* disturbed catchments (Gurnell et al. 1995). We need a swift change towards water sensitive forestry using natural forest restoration/recovery as a basic tool. It needs a research on economy, on new forestry methods, etc. However, there is no negative interference between biodiversity-oriented sustainable forestry and mountain forest catchment areas restoration, just only positive interrelationship (see also the text box at the end of this review).

2. Small agricultural streams (catchments) are under the management of the Agricultural Water Management Board (http://www.zvhs.cz). The most important research is needed to estimate the water retention achievable by means of soft restoration methods (landscape management), as e.g. restoration of contour coppice woods combined with contour ditches, ponds, infiltration pits, wetlands, stream restoration and so on (Vašků 2003). The measure can bring not just only water retention, but it also increases biodiversity, improves the landscape thermodynamics and contributes to carbon sink (Ripl 1997, Eiseltová & Pokorný 1998). There is mostly no negative interference between the biodiversity-oriented agricultural catchment areas restoration, as the restoration aims to bring the landscape closer to its traditional biodiversity-rich structure. There might be conflict if coppice woods were planned on biodiversity-rich meadows.

3. Large rivers and their floodplains are administrated by various local Catchment area Administrations, the state owned enterprise. River landscape is very fragmented in the Czech Republic, it has lost its dynamics and there are mostly occurring only isolated island populations of rare organisms recently (Šeffer & Stanová 1999, Petts 2001). It would bring a problem: If we would like to restore the river dynamics and flooding, we could sometimes endanger some of the last island habitats, if we won't restore the river dynamics, the populations will become extinct (but still this strategy of inaction is being preferred). We need a research, how to combine flooding and river restoration together with supporting endangered species (Leuven & Poudevigne 2002). Still there is no other alternative to restoration of the natural river and flood dynamics, rehabilitation of river continuity, connection of the river to its floodplain, replanting floodplain forests (Gurnell et al. 2002) and renewing floodplain meadows instead of arable land and recreational buildings protected by levees (Church 2002). Generally speaking, the restoration of the river continuum is very beneficial for biodiversity (Matthaei et al. 2005).

Research priorities in wetlands and shallow water bodies

(Authors: Dr. Jan Květ, Dr. David Pithart and Dr. Jan Pokorný)

1. Wetlands' and shallow water bodies' responses to climate changes; mitigation of their impact on wetlands – according to different wetland types in different regions. The responses of the following ecosystem processes acquire high priority:

(a) Carbon cycling and balance.

(b) Processes controlling the energy, heat and water balance.

(c) Processes affecting biodiversity and rate of succession in wetlands.

(d) Study and minimization of health hazards caused by wetland- and water-borne diseases.

2. Wetlands' and shallow water bodies' response to eutrophication and pollution – according to different wetland and shallow water bodies types in different regions. The responses of the following ecosystem processes acquires high priority:

(e) Balance between aerobic and anaerobic processes in sediments and water.

(f) Mineral nutrient transformations in wetlands. The role of wetlands in nutrient cycling.

(g) Contamination with toxic substances (particularly pesticide residues and heavy metals) and its prevention and/or mitigation.

(h) Processes controlling the energy, heat and water balance.

(i) Processes affecting biodiversity and rate of succession in wetlands.

(j) Study and minimization of health hazards caused by wetland- and water-borne diseases.

3. Evaluation of ecosystem services provided by wetlands – according to different wetland and shallow water bodies types in different regions:

(k) Definition and quantification of ecosystem services of wetlands and shallow aquatic ecosystems at different stages of transformation (devastation).

(l) Estimation of the economic values of particular services and/or their integrated effect, also using the method of "shadow prices", i.e., what would be the cost of a service if it were provided in a more technical way (e.g., water reservoir, technical water purification).

(m) Evaluation of the role of wetlands, incl. floodplains, in flood and drought mitigation, stabilization of carbon and nutrient cycles, biodiversity conservation and production of organic matter. The recreational and aesthetic values of wetlands and shallow water bodies should also be evaluated.

1. Applications of research results to different types of wetland and shallow water bodies in different regions:

(n) Finding ways of sustainably managing/conserving wetlands and shallow water bodies with respect to various kinds and intensities of anthropogenic pressure.

(o) Elaboration of suitable approaches to the environmental impact assessment (EIA) for wetlands and shallow water bodies.

(p) Assessment of the respective roles of different types of wetlands and shallow water bodies in different landscape types. Evaluation of and support to their role in the small water cycle.

Research priorities in ecology of water reservoirs

(Author: Assoc. Prof. Josef Matěna)

Freshwaters were almost generally neglected in the previous 5th and 6th FP and most attention was payed to oceans and seas.

Artificial man-made freshwater reservoirs (dam lakes) are of prime importance for countries lacking the access to sea and natural lakes. The use of reservoirs is widely multipurpose – flow regulation, hydropower generation, irrigation, fisheries/angling, recreation, drinking water supply etc.

The multipurpose use of reservoirs implies clearly direct socio-economic importance of these water bodies on human population living close to them and in their catchments. The human activities have decisive influence on the water quality in reservoirs and vice versa.

Unfortunately, there is a strong tendency (even in the WFD EC) to regard reservoirs as only technological basins. This is a basically wrong approach – reservoirs are man-made ecosystems, OK, but still ecosystems. With increasing residence time of water they behave closely to natural lakes. In countries with very few natural lakes like in the Czech Republic and Spain, the reservoirs actually play the same role as natural lakes and should receive comparable attention.

Czech Republic is among the leading countries with respect to the knowledge about research, management and multipurpose use of reservoirs. There are unique long term data sets (for about 50 years in some cases) about abiotic and biotic parameters for several reservoirs. These data enable to distinguish long-term trends from short-term changes with respect to global and local changes.

During implication of the WFD attention should be paid to the definition of ecological state/potential of these ecosystems. Classification system using fish, phytoplankton, zooplankton, microbial food webs, macrophytes, water chemistry and internal nutrient load should be elaborated.

Biology and ecology of periodical shallow wetlands created during the floods

(Author: Assoc. Prof. Josef Elster)

Floodplain river areas are very specialized ecosystem such as an ecotone, i.e. a transition zone between terrestrial and aquatic ecosystems. This ecosystem type is characterised by high productivity and open energy, mass, and information flows.

In 1986–1996, in floodplain river area of the Horní Lužnice River (Třeboňsko Biosphere Reserve and Protected Landscape Area), large interdisciplinary ecological project was carried out (for results, see Prach et al. 1996) including both biotic and abiotic studies. As a part of this study detailed hydrobiological survey of permanent pools influenced by periodical floods was performed. Much less attention was paid to the soil algae and phytobenthos of temporary pools. Excessive phytobenthos development and massive occurrence of soil cyanobacteria and algae represent one of the most important regulating factors in energy and mineral nutrients flow through these ecosystems. This is thanks to the occurrence of periodical flooding by cool water coming from melting snow in spring areas of the Lužnice River at the end of winter or

early spring. The low temperature and frozen soil profile predetermine character of these specific habitats and their microvegetation. In addition, the flooding period avoids growing season of vascular plants, whereas the most important production part of these ecosystems in this period are algae and cyanobacteria. In other words, the growth of phytobenthos, soil algae and cyanobacteria is not suppressed by vascular plants in competition on light supply and minerals from water.

This issue was not yet studied in detail.

Research priorities in freshwaters – issue of Cyanobacteria

(Author: Assoc. Prof. Blahoslav Maršálek)

Serious problem of aquatic ecosystems is nutrients pollution, resulting in the cyanobacterial water blooms. Mass proliferation of cyanobacteria causes hygienical, aesthetical and ecological problems. Cyanobacterial water blooms produce toxins, reduce biodiversity and degrade aquatic ecosystems. Moreover – new, invasive cyanobacterial species are detected in water bodies, so more research attention is necessary to be able understand and prevent cyanobacterial water blooms.

Research priorities of freshwaters – issue of ichthyology

(Author: Assoc. Prof. Petr Ráb)

Despite the fact that Europe is cradle of ichthyology, diversity of freshwater fish is not yet well-known. Kottelat and Freyhof (2007) recently report over 500 freshwater fish species recorded in Europe, however many of them are so-called catch-all taxa where more detailed and further analyses are needed (e.g. gudgeons of the genus *Gobio*, sculpins of the *Cottus gobio* assemblage, minnow of the genus Phoxinus, etc.) and using molecular methods and. phylogeographic framework. On of the most exciting case is a system of asexually reproducing hybrid spined loaches (genus *Cobitis*) occurring throughout whole Europe. Their asexual and sperm-dependent clones are spreading actively into their specific habitats. They are important not only as a unique model in evolutionary biology but also as bioindicators for nature conservation. Due to their complicated reproductive cycles and link to ground substrate the strict protective management of existing habitats remains as an only solution.

Conclusions

(edited by P. Petřík based on contribution of all authors)

The forest-water ecotone, the riparian zone, and related groundwater are all understudied ecosystems in the Czech Republic (see EPBRS recommendations 2001). Scientists dealing with biology and landscape ecology do not usually get the opportunity to collaborate enough with those studying atmospheric deposition, soil science, soil, and water chemistry. There is no cooperation between academic natural science and so-called forest and agricultural science. The forest and agricultural sciences are usually oriented towards increasing production and benefits and biodiversity is not yet seen as an important goal for such

research. There is also a huge gap between findings of natural scientists and industrial forestry and water management. Coordination of activities among the individual sectors is unsatisfactory and the competence is not clearly defined (e.g. amongst the administrators of watercourses, fishing organizations and private owners). Conservation and management of inland water biodiversity is inconsistent, extensive pollution is not tackled sufficiently, and there is no clear programme for remedying unsuitable hydrological regulation of watercourses, which contributes to the progressive destructive consequences of floods. There is a lack of attention to catchment area integrated management (i.e. in catchment area plans). Economic management of fishponds emphasizes production benefits and the management is in no way based on the ecosystem approach. There is not enough demand for knowledge at responsible institutes (Ministry of the Environment and Ministry of Agriculture) related to the WFD. Basic research should be better supported by these administrative bodies. To avoid the separation of basic and applied research in water management, better coordination between science and policy is urgently required. In the implementation of the WFD, attention should be paid to the definition of ecological state/potential of freshwater ecosystems.

According to the National review (see Petřík et al. 2007) two main actions are needed: (i) reduction of emission and deposition of nitrogen within the National Emission Ceiling Directive and (ii) changing the paradigm of strictly benefit-oriented forestry and agriculture toward sustainable management aiming to increase or at least conserve existing biodiversity of water and wetland ecosystems.

To fulfil these actions in general, the most important research needed is to:

- Determine wetlands' and shallow water bodies' responses to climate changes; mitigation of their impact on wetlands
- Determine wetlands' and shallow water bodies' response to eutrophication and pollution on system of effective measures preventing eutrophication, erosion and excessive transport of sediments in the cultural landscape
- Evaluate ecosystem services provided by wetlands (e.g. to estimate the water retention achievable by means of soft restoration methods, such as restoration of contour coppice woods combined with contour ditches, ponds, infiltration pits, wetlands, stream restoration, etc.)
- Applications of research results to different types of wetland and shallow water bodies in different regions
- Taxonomy and ecology of freshwater organisms such as, e.g., cyanobacteria (to prevent water blooms) or fish (determination of the driving factors responsible for their life cycle)
- Ecology of specific freshwater habitats such as, for example, periodical shallow wetlands created during floods
- Implication of present knowledge and future research into management of artificial water bodies, and in addition, their influence on water quality and biodiversity (on all trophic levels from bacteria to fish) of rivers.

There are also some specific technological research needs, including the need to determine:

- How to deactivate the old phosporus ballasts in the sediments of water reservoirs without draining them off (as they are used for water supply)
- How to reduce water blooms in water reservoirs without using chemicals

- How to assess the potential of water retention in the landscape with respect to climate change
- How to influence the processes responsible for the denitrification process both in the soil and water

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Best planning practices in forested catchments – UK example (Source: DEFRA, www.defra.gov.uk)
Forest and woodland are a major component of land cover in certain parts of England and Wales. In some upland areas, the large extent of commercial coniferous forest represents significant pressures on the freshwater environment. Through bad management or insensitive design, these pressures can lead to deleterious impacts and have done so in some water bodies. In such cases, continuing control of both pressures and impacts will be required to achieve the WFD's environmental objectives. Broadleaved native woodland, which is increasingly favoured by forestry policies in England and Wales, leads to cover pressures and impacts and is a land use considered relatively benign with respect to diffuse pollution.

Operational issues
Forest planting can have a number of positive impacts on the water environment; for example, strategically placed woodlands acting as riparian buffer zones help to reduce soil loss from arable cropping sites. However, some forestry management practices can also cause significant pressures on water quality and water resources. These pressures will need to be considered as part of the pressures and impacts assessment required by the WFD to identify water bodies 'at risk' of not achieving its objectives. The Forestry Commission's Forests and Water Guidelines provide a firm basis for sustainable management of the water environment by forest planners and managers. Compliance with the Forests and Water Guidelines is a requirement for approval of forest plans, grant aid, felling licences and operations subject to environmental impact assessment regulations. The Forestry Commission administers the environmental impact assessment regulations for all new planting, felling and certain other forestry operations. The main aquatic pressures associated with catchments containing large tracts of commercial coniferous forest are acidification, nutrient enrichment and siltation. When such forests are first planted, the associated land preparation and drainage leads to increased run-off, though this largely declines as they mature.