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The Nature Conservancy's approach to conserving and rehabilitating biological diversity in the Upper Mississippi River system

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With 4 figures and 1 table in the text

Abstract: Ten years ago, The Nature Conservancy, recognizing the importance of large rivers to the biodiversity of the Midwest region of the United States, began a major conservation project on the Lower Illinois River. Since then the scope of the project has been expanded to incorporate a basin approach centered on the Upper Mississippi River and intended to rehabilitate ecosystems and abate threats at key sites that cross several spatial scales. A particular emphasis is on spatial strategies that result in cumulative downstream benefits. The use of the best available science, applied in an adaptive and accountable manner, is a fundamental principle of The Nature Conservancy and the Upper Mississippi River Project. This paper briefly explains the mission and work of The Nature Conservancy and then explores a few of the ways we are supporting river science to improve management strategies, influence the vast array of public and private institutions working in this basin, and more effectively direct the allocation of public dollars to conservation.

The Nature Conservancy

The Nature Conservancy is a private, not-for-profit conservation organization with offices in more than two-dozen countries around the world, most in North and South America and the Pacific Rim. The Conservancy's mission is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by preserving the lands and waters they need to survive. We carefully set priorities, design landscape-scale projects, establish partnerships for coordinated action, and advocate sound public policies. Our approach is one of continuous improvement

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and adaptive management, based on a four-step process that includes: a) setting priorities, b) developing strategies, c) taking action, and d) measuring success. The Nature Conservancy takes a non-confrontational and partnership-oriented approach to problem solving, and outside the U.S. we allocate much of our resources to providing technical and financial support to local partners. Above all, we pride ourselves on basing our conservation actions on sound science.

The Upper Mississippi River project

The Conservancy's Upper Mississippi River project grew out of concern for the health of large, floodplain-river systems worldwide, and in the United States in particular. The United States is a world center of freshwater species diversity (Master et al 1998; Stolzenburg 2000), and researchers estimate that during recent decades at least 20 per cent of the world's 10,000 freshwater fish species have become endangered, threatened with extinction, or have already gone extinct (Postel & Richter 2003).

The Upper Mississippi River Basin includes many river-floodplain systems. The Upper Mississippi River proper, beginning at Lake Itasca, Minnesota, flows more than 2,080 km to the confluence with the Ohio River at Cairo, Illinois. More than 490,000 km^2 drain to the river, equivalent to 15 per cent of the entire Mississippi River basin, or 6 per cent of the area of the lower 48 United States (Weitzell et al. 2003). Currently, these lands and waters are home to nearly 200 native, regularly occurring fishes, roughly 25 per cent of approximately 800 species occurring in the U.S. (Page & Burr 1991). The basin also sustains a rich diversity of freshwater mussels, crayfish, amphibians, reptiles and mammals (Weitzell et al. 2003). It is a globally important flyway for 60 per cent of all North American bird species, and the river currently supports 286 state-listed or candidate species and 36 federally-listed or candidate species of threatened or endangered plants and animals endemic to the basin (UMRCC 2000).

A study conducted by the National Research Council (1992) highlighted the Upper Mississippi River and its component Illinois River system as large, river-floodplain systems where recovery of ecological integrity is still feasible. Our project seeks to conserve and rehabilitate these large-floodplain rivers and other freshwater and terrestrial ecosystems of the Upper Mississippi River basin and to conserve the "ecological services" these basins provide to freshwater and coastal/marine ecosystems downstream (Clancy 2001; The Nature Conservancy 2003, 2004). The project is rooted in more than ten years of Conservancy work on the Lower Illinois River, which occupies an ancient valley of the Mississippi (The Nature Conservancy of Illinois 1999), and nearly 50 years of Conservancy work at projects throughout the Upper Mississippi River basin (The Nature Conservancy 2004). The project requires combined staff time, equipment, facilities, land, and private donations from State chapters in Illinois, Iowa, Minnesota, Missouri, and

Wisconsin and the World Office of The Nature Conservancy, and similar resources from a variety of private and public partners.

The freshwater components of the project specifically focus on restoring degraded ecosystem conditions and abating continuing threats from flow alteration, floodplain isolation, and pollution, all of which have been driven by the farming economy of the region, urban and industrial development, and associated demands for navigation management and flood control. Large rivers integrate these impacts over vast areas, and solutions demand that work at individual locations throughout the basin be prioritized, strengthened and amplified by core investments in systemic science and broad-scale policy tools. Because there are already many public institutions spending billions of dollars annually to manage individual components of the Upper Mississippi River system, the Conservancy's efforts seek to leverage or influence these resources through the application of strong science at multiple scales.

Basin strategy development: "Where should we work?"

A key problem is determining where resources should be invested in such a large and complex basin to maximize recovery of the **system.** The Upper Mississippi River Basin, our defined system, includes more than 3,200 headwaters and creeks and 300 small rivers. In response to this challenge, the Conservancy borrowed a strategy from our experience in terrestrial systems – specifically using an ecoregional framework to develop priorities. In our lexicon, "targets of conservation" can include species, communities and ecosystems (Groves et al. 2000; Groves 2003). Ecoregions are defined as relatively large geographic areas of land and water delineated by climate, vegetation, geology and other ecological and environmental patterns. In the case of freshwater, however, a systems classification did not exist, so during the past two years a classification scheme of representative basin-wide ecological systems has been developed with an associated species database (Weitzell et al. 2003).

The classification is based on a hierarchy of watersheds, and uses six variables to assess five main aspects of aquatic systems: size and gradient (to assess morphology); flow; network position (to assess local zoogeography); dominant geology; and temperature. This classification system is considered to be a working framework. We will continue to validate the importance of its elements as additional biotic information becomes available. Because it was originally intended to address the basin scale, it does not distinguish river-floodplain macrohabitat types. However, several river-floodplain habitat schemes have been developed, including one designed specifically for the Upper Mississippi River (Wilcox 1993). Floodplain categories will be added to the classification scheme as we inventory specific opportunities at floodplain rehabilitation sites.

The classification scheme and species database enabled the creation of a map of areas of freshwater biodiversity significance (Fig. 1). Our prioritization strategy

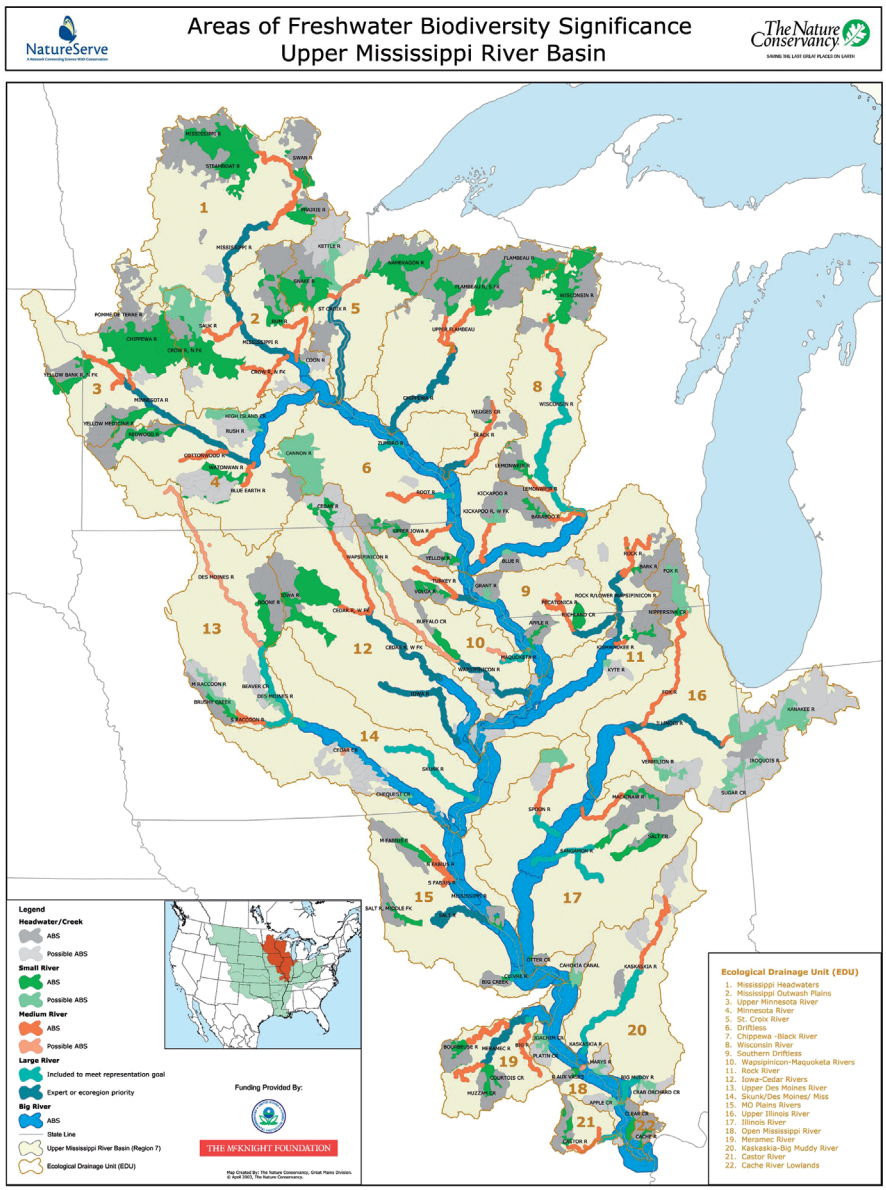

Fig. 1. The Upper Mississippi River Basin, and areas of freshwater biodiversity significance identified during a recent two-year analysis. The insert shows the relative positions of the Upper and entire Mississippi River basins in the United States.

identified examples of all representative ecosystems, and rare or imperiled species, at best existing occurrences within the basin, with an emphasis on system connectivity (Weitzell et al. 2003). The resulting suite of sites thus answered the question of where we need to focus our initial conservation work to restore and protect the freshwater species and systems of the basin.

This is the first time such a comprehensive assessment for the basin has been completed, and it is intended to influence not only our own activities, but the public and private resources being invested in nature conservation in the basin. For example, each year the U.S. Department of Agriculture alone spends several hundred million dollars across the basin to control soil erosion, reduce nutrient runoff, and reduce other agricultural impacts on water quality. Such efforts could be much more effective if guided by priorities based on scientific analysis. Our intention is to shift such funding from a local perspective, where we say "the squeaky wheel gets the grease," to a systems perspective, where local action is informed by a set of goals and objectives for conservation and restoration of the larger ecological system. This principle aligns the project with a recent change in the Conservancy vision that defines priorities not by traditional boundaries, but "by the integrity of the land" (McCormick 2003).

Implementing successful demonstration projects

A second key challenge for this system is getting sufficient focus on reducing the broad, recurring threats that manifest themselves across the basin. Using a comprehensive and well-tested regional planning process (Groves et al. 2000), and the experiences of scientists from a wide range of disciplines, we:

1. identified floodplain and tributary conservation targets,
2. identified key ecological attributes that control each target, and
3. evaluated existing and potential future threats to each target.

Four floodplain conservation targets for the Upper Mississippi River were identified (Table 1). In addition, we created nine tributary targets by grouping tributaries that were similar in zoogeography, physiography, climate, and threats. Scientists involved in the planning process recommended the earlier work of Karr et al. (1986), and Karr & Chu (1999) as a foundation for the consideration of the key ecological attributes. Our current model of key ecological attributes modifies Karr & Chu's work slightly by placing added emphasis on the element of connectivity (Fig. 2). To complete the first program planning iteration, experts identified five major threats within the basin to the key ecological attributes: floodplain isolation, incompatible agriculture practices, in compatible navigation system designs and operations, invasive species and climate change (The Nature Conservancy 2004).

Using the freshwater biodiversity map and the assessment of recurring threats, the Conservancy has initiated several large-scale demonstration projects in the basin to deliver broad, systemic benefits while preserving high quality "sub-sys-

Table 1. Upper Mississippi River program floodplain conservation targets.

Target	Description
Channel Community Complex	Habitats and animal and plant assemblages of the relatively narrow, linear features of the floodplain that transport water and materials 99% of the time. This target includes primary and secondary channels as well as their associated sand bars. It is bounded laterally by natural or artificial banks.
Floodplain Community Complex	Habitats and animal and plant assemblages of non-channel features (aquatic, terrestrial and transitional) of the floodplain. This community is bounded laterally by elevated terraces of glacial origin or the valley wall. Seasonal flooding of this complex results in increased lateral connectivity. The scope of this target includes lands currently isolated from the river by levees and areas that have been permanently inundated by navigation dams.
Bluff and Terrace Community Complex	Habitats and animal and plant assemblages of relatively high elevation floodplain areas that are relicts of glacial activity. These areas are not subject to 1 in 500 year floods. This target supports extensive sand prairies on some terraces and a mosaic of prairie, savanna, woodland and forest on the bluffs.
Ebony Shell Mussel (*Fusconaia ebena*)	A globally rare species that used to armor large sections of the river bed. Its recovery is limited by both habitat degradation and reduced range of its host species, skipjack herring (Alosa chrysochloris). This target serves as an umbrella for many other mussel species and several migratory fish species.

tems". We are developing landscape projects at places where we are best able to demonstrate successful naturalization of flows, restoration of floodplains, or improvement in agriculture and forestry practices.

At the sub-basin scale, the Conservancy has chosen five high-profile areas to focus its initial resources in collaboration with our partners (Fig. 3). Work at these sites (the Mackinaw River in Illinois, the Lower Cedar River in Iowa, Weaver Dunes in Minnesota, the Meramec River in Missouri, and Military Ridge in Wisconsin) addresses altered water quality (including sediment loading) and altered flow, and includes adaptive management to influence public policy. More sub-basin sites are expected to follow this first set. Recognizing that incompatible land use must be addressed at multiple scales, we are searching for ways to set goals at

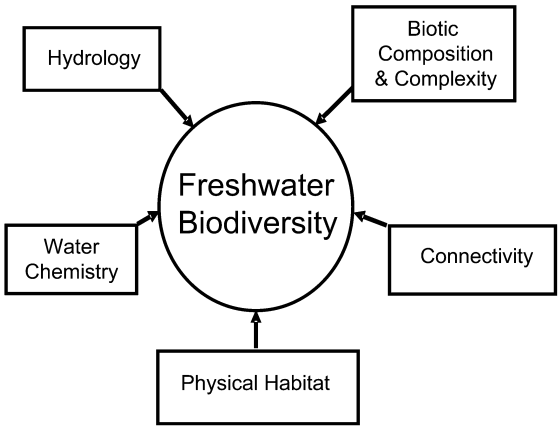

Fig. 2. Key ecological attributes that control 13 of 14 of the floodplain and tributary conservation targets of the Upper Mississippi River Basin. This model closely follows KARR et al. (1986) and KARR & CHU (1999).

the local scale informed by the needs of the larger system. We are asking questions such as "How much is enough?" in order to influence federal agricultural programs and ultimately to demonstrate accountability (ELLISON 2003) for the conservation effort that will be expended. At the Mackinaw River, we have developed a paired-watershed project in a landscape that is 98 % agricultural. We are measuring the effectiveness of outreach to improve land management practices being implemented voluntarily by landowners, as well as measuring the impact of these practices on the ecological health of the river system. Early observations indicate that outreach has increased adoption of traditional conservation practices, such as installing grass waterways or reducing tillage, and that this increase in use has slightly improved ecological health. But these practices will not be nearly enough. To sustain ecological systems in such an intensive agricultural setting will require more intensive, non-traditional conservation practices such as wetland restoration and increasing perennial vegetation cover.

The Emiquon floodplain wetland restoration project

On the large-river floodplains, we have been particularly active at two locations, including a 3,200-hectare lowland area called Emiquon and a 900-hectare lowland area called Spunky Bottoms (Fig. 3). Each of these will serve as a "stage" to test new strategies to re-connect land currently farmed and isolated from the river, a land use practice common to about half the floodplain of the Upper Mississippi River. Isolation has eliminated or reduced the functional services, such as fish

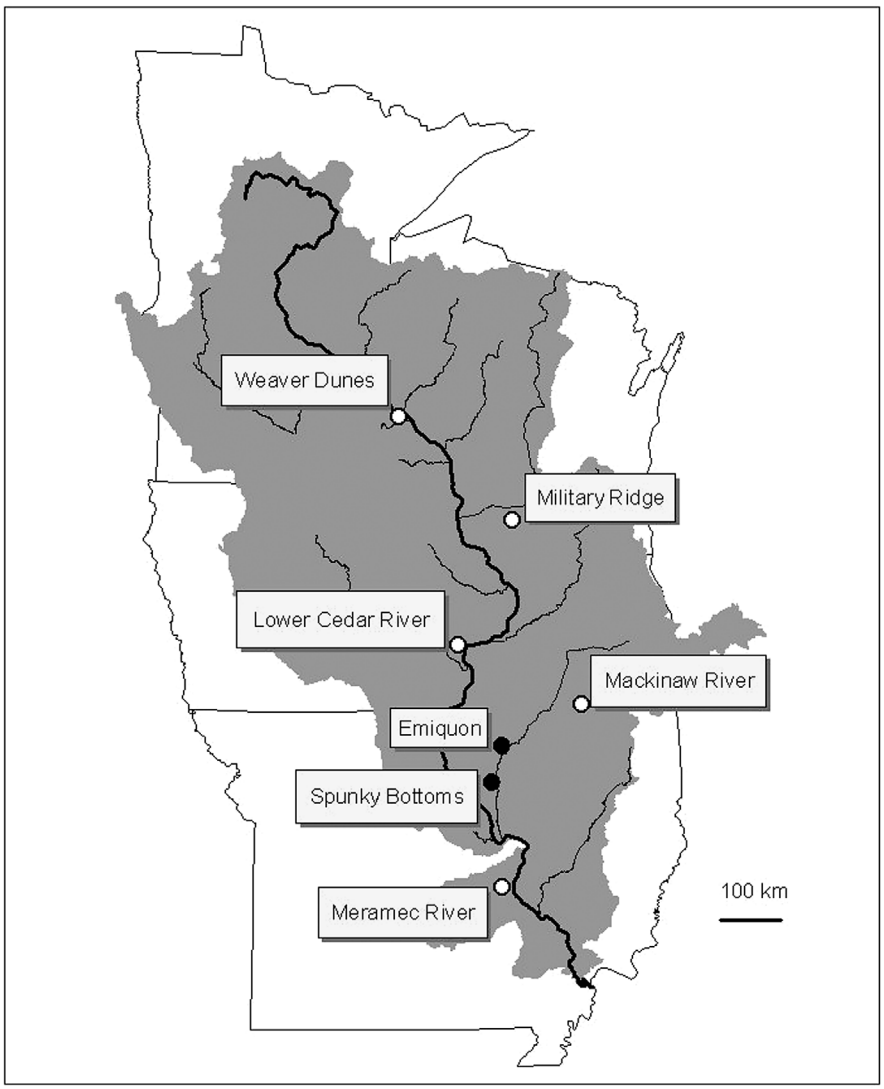

Fig. 3. Floodplain (solid circles) and sub-basin sites referred to in the text.

spawning, nutrient re-cycling, and flood storage and conveyance, that these areas contribute to the greater river ecosystem (LUBINSKI 1999). Fortunately, our experience at Spunky Bottoms suggests that correctly restoring water flows to the floodplain leads to a quick recovery of native wetland habitats.

The Nature Conservancy acquired the largest portion of Emiquon nearly three years ago, enabling what will become one of the largest floodplain wetland restorations in the United States. Our floodplain rehabilitation work at this site is

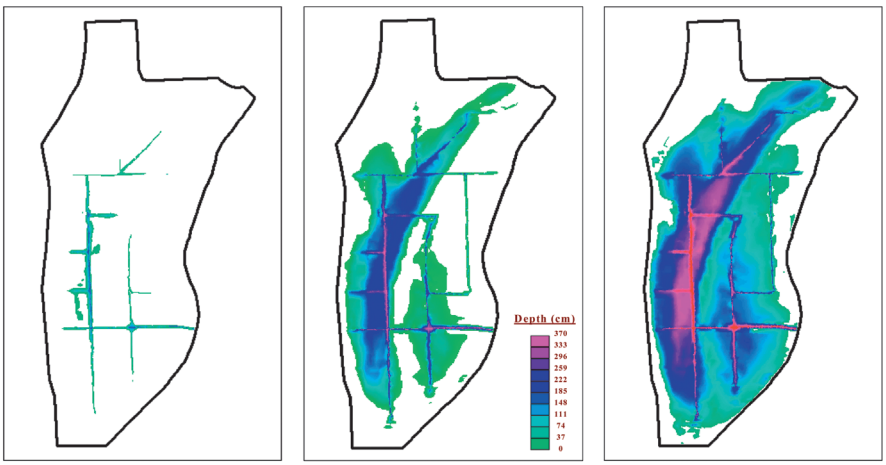

Fig. 4. Model results showing the extent and depth of water at the Emiquon site under three conditions of annual precipitation (source: Illinois Water Survey). The site is separated from the Illinois River by a levee on its east side, and from tributaries by levees to the west, north and south. Strategies for reconnecting the site to its sub-basin and the river include placing gates or spillways in the levees at alternative sites (triangles on the average year image).

coordinated with both federal and state partners. These partnerships are vital to insuring future replication of successful restoration lessons up and down river. The Conservancy has assembled an advisory team of 40 top scientists from across the United States to direct our rehabilitation strategy.

The Nature Conservancy established goals and objectives for the Emiquon project based on an understanding of, and our intent to rehabilitate, the river system, rather than the individual site. Our primary and secondary objectives are rooted in the ecological as well as socio-economic needs of the larger system. The primary objective for the restoration and management of the lands within the boundaries of the Conservancy's Emiquon Project is to restore natural ecological processes and habitats that promote and sustain the native species and aquatic and terrestrial communities once found in this region of the Illinois River. Secondary objectives are to:

1. develop, test, and export successful techniques for restoring and sustaining the natural biological diversity of large floodplain river ecosystems;
2. incorporate the principles of adaptive management as a necessary component of natural area management;

3. demonstrate the benefits of ecological restoration of critical habitats for threatened and endangered species;
4. evaluate the potential for storing floodwaters and reducing unnatural water level fluctuations;
5. promote the ecological and cultural importance of the Emiquon area by developing and implementing educational programs;
6. demonstrate that natural area conservation efforts can be an important component of local and regional economic development strategies; and
7. provide excellent recreational opportunities.

We envision this project as a "platform" from which to build a public constituency for additional projects of this type, because while this project is relatively large, it alone will not ensure the recovery of the Illinois or Upper Mississippi River system.

In partnership with scientists at the University of Illinois and the Illinois State Water Survey, the Conservancy has been modeling important causal relationships at the project to inform our rehabilitation plan as well as provide a framework for adaptive management. A floodplain inundation model has been especially valuable in predicting how the size and depth of aquatic habitats will vary in dry, average, and wet years (Fig. 4). We are using this model to evaluate the impacts of several potential floodplain connectivity options.

A second model has been developed to evaluate sediment dynamics, particularly those predicted to occur in response to a managed connection with the river. Outputs from the water level and sediment models are being used to predict the successful regeneration of moist soil plants, which is considered to be a key ecological factor and indicator for the health of this floodplain site and the river as a whole.

We are also assessing Emiquon's potential contribution to the larger system in the context of flood storage and conveyance. One analysis has demonstrated that a 0.6-m notch in the levee at Emiquon would reduce moderate, 50-year flood levels by nearly 20 cm along an 80-km stretch of river. Finally, we are evaluating the potential for socio-economic impacts at Emiquon, and again using Emiquon as a stage from which to launch a strategic planning process to promote nature- and cultural-based tourism throughout the river valley. Our intention is to show that projects like Emiquon can be economic generators and enhancers of quality of life.

All of this information is helpful to determining our site plan for Emiquon, but even more significant, we are documenting how work at this site, in combination with activities like it up and down river, could lead to the recovery of the large-floodplain river system as a whole. It is with this intention that the Conservancy is positioning itself as a catalyst for large-floodplain river restoration in the Upper Mississippi River Basin, applying science at multiple scales to build momentum, influence priorities, and demonstrate progress.

References

CLANCY, P. (2001): Add water and stir: restoring the Illinois River. – Nature Conservancy **51** (4): 12–19.

ELLISON, K. (2003): Accounting for Nature. – Nature Conservancy Mag. **53** (3): 44–50.

FERBER, D., HERRING, H. & MLOT, C. (2004): New Life on the Mississippi. – Nature Conservancy Mag. **54** (2): 24–33.

GROVES, C. (2003): Drafting a conservation blueprint: a practitioner's guide to planning for biodiversity. – Island Press, Washington, 457 pp.

GROVES, C., VALUTIS, L., VOSICK, D., NEELY, B., WHEATON, K., TOUVAL, J. & RUNNELS, B. (2000): Designing a geography of hope: a practitioner's handbook for ecoregional conservation planning, Vol. **1**, 2nd ed. – The Nature Institute, Arlington, Virginia.

KARR, J.R. & CHU, E.W. (1999): Restoring Life in Running Waters: Better Biological Monitoring. – Washington (DC), Island Press.

KARR, J.R., FAUSCH, K.D., ANGERMEIER, P.L., YANT, P.R. & SCHLOSSER, I.J. (1986): Assessing biological integrity in running waters: a method and its rationale. – Illinois Nat. Hist. Surv. Spec. Publ. **5**: 28 pp.

LUBINSKI, K.S. (1999): Floodplain river ecology and the concept of river ecological health. – In: Ecological status and trends of the Upper Mississippi River system 1998: a report of the long term resource monitoring program: pp. 2-1 to 2-12. U.S. Geol. Surv., Upper Midwest Environm. Sci. Center, La Crosse, Wisconsin, LTRMP 99-T001, 236 pp.

MASTER, L.L., FLACK, S.R. & STEIN, B.A. (eds.) (1998): Rivers of Life: Critical Watersheds for protecting Freshwater Biodiversity. – The Nature Conservancy, Arlington, Virginia.

MCCORMICK, S.J. (2003): President's view: parks in a new light for a new century. – In: Nature Conservancy Landmarks Special Report. The Nature Conservancy, Arlington, Virginia, 25 pp.

National Research Council (1992): Restoration of Aquatic Ecosystems: Science, Technology and Public Policy. – National Academy Press, Washington, D.C., 552 pp.

PAGE, L.M. & BURR, B.M. (1991): A Field Guide to Freshwater Fishes North of Mexico. – Houghton Mifflin Co., Boston, Massachusetts.

POSTEL, S. & RICHTER, B. (2003): Rivers for Life. – Nature Conservancy Mag. **53** (4): 30–35.

STOLZENBURG, W. (2000): America the bountiful: taking stock of the Nation's biological diverisity. – Nature Conservancy **50** (3): 10–23.

The Nature Conservancy (2003): Nature Conservancy Landmarks Special Report. – The Nature Conservancy, Arlington, Virginia, 25 pp.

– (2004): Restoring the Upper Mississippi River and its network of tributaries: a conservation plan. – The Nature Conservancy, 23 pp. + Appendix 1.

The Nature Conservancy of Illinois (1999): Conserving the Illinois River: a 20-yr Action Plan – Plan Summary. – The Nature Conservancy of Illinois, Peoria, Illinois, 6 pp.

UMRCC (2000): A River That Works and a Working River: A Strategy for the Natural Resources of the Upper Mississippi River System. – Upper Mississippi River Conservation Committee, Rock Island, Illinois, 40 pp.

Weitzell, R.E., Khoury, M.L., Gagnon, P., Schreurs, B., Grossman, D. & Higgins, J. (2003): Conservation Priorities for Freshwater Biodiversity in the Upper Mississippi River Basin. – Nature Serve and The Nature Conservancy, Arlington, VA, 89 pp.

Wilcox, D.B. (1993): An aquatic habitat classification system for the Upper Mississippi River System. – U.S. Fish and Wildlife Service, Environm. Managem. Techn. Center, Onalaska, Wisconsin, EMTC 93-T003, 9 pp. + Appendix A.

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