UPPER MISSISSIPPI RIVER CONSERVATION COMMITTEE

HABITAT CONNECTIVITY WHITE PAPER

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SUMMARY

In the Upper Mississippi River Conservation Committee's (UMRCC) recent report "A River That Works and a Working River," restoring habitat connectivity is cited as a major goal (McGuiness 2000). Generic terms such as "connectivity, habitat connectivity or aquatic connectivity" can be interpreted in several different ways and has caused some confusion as to how the goal of "Restore Backwater/Main Channel Connectivity" could best be accomplished. To address this confusion, and ensure consistent use and understanding of the different terms used for connectivity, the UMRCC Fisheries and Wildlife technical sections developed definitions for some of the different types of aquatic connectivity recognized by river managers and scientists.

Restoration of habitat connectivity is a management objective (tool) utilized to achieve desired plant and animal responses. Although restoration/simulation of a natural river hydrograph is a worthy paradigm, restoring hydraulic/hydrologic connections may not be naturally achievable or desirable under current altered hydrologic regimes. Sedimentation, unnaturally fluctuating water levels and non-native species continue to degrade limited warm- and cold-blooded animal habitats. It may be desirable to moderately sequester additional floodplain acreage (at some river locations) from man-induced river regulation in order to achieve desired acreages of waterbird habitats and to create connections between habitats to achieve desired fish, mussel and other aquatic organisms population levels.

Scientific monitoring and research efforts are needed to assess the merits of connectivity-related management alternatives. The large-scale agricultural isolation of much of the Mississippi, Missouri, and Illinois River floodplains has been detrimental to aquatic flora and fauna. Shoreline and island erosion have resulted in excessive connectivity between some aquatic habitats under current hydrologic regimes.

The UMRCC considers restoring lateral surface and subsurface connectivity in the UMRS a management tool for achieving specific habitat restoration/enhancement opportunities and complimentary animal population and diversity objectives based on site-specific, habitat-driven goals.

Introduction

In the Upper Mississippi River Conservation Committee's (UMRCC) recent report "A River That Works and a Working River," restoring habitat connectivity is cited as a major goal (McGuiness 2000). Generic terms such as "connectivity, habitat connectivity or aquatic connectivity" can be interpreted in several different ways and has caused some confusion as to how the goal of "Restore Backwater/Main Channel Connectivity" could best be accomplished throughout the Upper Mississippi River (UMR) basin including the Illinois Waterway (IWW) and herein will be referred to as the UMR.

The UMRCC Fisheries and Wildlife technical sections would like to present some clarifying information on the topic of "Connectivity" to assist in the use of this term in future documents, meetings and discussions. This paper will focus on the aspects of connectivity to help clarify the types of connectivity possible to "Restore Backwater/Main Channel Connectivity". Aquatic connectivity can be subdivided into at least these different categories: (1) habitat connectivity, (2) lateral flood pulse connectivity, (3) lateral non-flood connectivity, (4) longitudinal connectivity, (5) main stem to tributary connectivity, and (6) sub-surface connectivity. These categories of connectivity are often overlapping, but each is also unique in the role it plays in addressing habitat needs for the variety of animal and plant species found within the UMR ecosystem. Therefore, the purpose of this paper is to provide definitions for some of the different types of aquatic connectivity recognized by river managers, scientists and other natural resource managers, their impact on the UMR ecosystem and present factors to consider when addressing connectivity issues on the UMR.

1. Definition of Connectivity - ***Connectivity is a dynamic natural pathway that provides for the movement of energy and/or materials such as organisms from one habitat type to another and/or creates a physical linkage between habitats through a natural conduit. Materials may also be abiotic (such as water, sediment and nutrients) and/or biotic (such as organisms, species or groups of species).***

Movement of particulate and dissolved nutrients and carbon among habitats on the floodplain represents an important aspect of river ecosystem function. Water quality of isolated and semi-isolated backwaters is controlled largely by the frequency and duration of flooding (Knowlton and Jones 1997, Richardson et al. 2004, Strauss et al. 2004). Hydrology of backwaters is primarily a function of river stage and extent of connection with flowing channels.

When habitat connectivity is an issue, the relationship between location "X" and location "Y" must be defined for the target organism. There are other types of habitat connectivity in addition to the hydrological-driven (the flood pulse is one example) surface connection and the subsurface connectivity between the agriculturally leveed and unleveed floodplain, including habitat fragmentation. Not all hydrologic isolation is a result of leveeing – natural low water levels commonly isolate and isolated many backwater areas now and in the natural pre-regulated system.

Conversely when the nine-foot channel project was accomplished many areas that used to be isolated were connected permanently or the frequency/duration of isolation was decreased or eliminated.

2. Lateral flood pulse connectivity- ***The hydrologic connectivity a river has with its floodplain during a flood event or over bankfull conditions. A conduit that provides for the movement of energy, water or nutrients and/or biotic matter between the river and its floodplain.***

Declines in fish, mussel and waterbird diversity and populations in river systems where access to seasonally flooded terrestrial habitats has been denied by agriculture have been well documented (Starrett 1971; Welcomme 1979, 1989; Bayley 1991; Sparks 1995; Havera 1999). Diminished lateral connectivity combined with loss of floodplain area and unnatural fluctuating water levels contribute to degradation of aquatic habitat diversity (Mills et al. 1966; Bellrose et al. 1983; Havera and Bellrose 1985; Havera 1993; Sparks 1995). Agricultural floodplain development has eliminated a large segment of the naturally occurring feeding and resting habitats needed by a multitude of migratory bird species (Havera 1995, 1999) and spawning, rearing and feeding areas for aquatic species (McGuiness 2000). One of the UMRCC's major concerns regarding connectivity has been the loss of lateral connectivity for the natural hydrologic connection between terrestrial and aquatic floodplain habitats during critical seasons, such as spring floods. Lateral floodplain connectivity also affects the ability of the floodplain to store and convey floodwaters. Natural resource managers recognize that "habitat connectivity" has other connotations and this paper will define those as well.

Engineering solutions to restore lateral surface connectivity may be relatively simple (i.e. levee setbacks and breeching), but there is considerable additional knowledge necessary in developing management techniques for surface reconnection of habitats. Additional research is needed to determine the amount and quality of habitat types necessary for surface reconnection to maintain desired habitat, which sustains populations of fish and wildlife and the restored habitat goals. Learning from demonstration projects, such as The Nature Conservancy's Spunky Bottoms and The Wetlands Initiative's Hennepin/Hopper areas along the Illinois River, and Iowa DNR's Odessa, Princeton, and Green Island areas will be important. All of these sites, as well as Banner Marsh, are providing critical and depleted marsh habitat in restored drainage and levee districts via subsurface water connectivity with the agricultural levee intact. And a case can be made that these areas are managed "naturally" with the levees in place on a highly altered system.

In addition to landowner and agricultural industry concerns (e.g., row crop production) in the floodplain, restoring lateral habitat connectivity sometimes creates differing objectives for resource managers. For example, in order to provide dependable food and mudflats for waterfowl, shorebirds and marsh birds, managers manipulate water stage elevations similar to the historic hydrograph (i.e. moist soil management) in floodplain areas that are somewhat protected below flood stage from the main stem river's current, unpredictable and altered water stages. Given the limited funding for river habitat restoration, habitat projects often must be prioritized for whether a given site is best suited for migratory bird habitat, fish spawning or over-wintering habitat.

UMRCC biologists at times have considered differing objectives over the years, but have yet to develop site-specific management regimes that address various objectives.

3. Lateral non-flood pulse – The connectivity of the main channel of the river to its backwaters.

Lateral non-flood pulse connectivity has been altered in a variety of ways. A common focus of altered lateral non-flood pulse connectivity has been on the diminished egress and ingress between aquatic habitats resulting from sedimentation and leveed agricultural areas present an impediment to some UMR fishery populations as the access to suitable backwaters diminish. Additionally, diverse waterbird habitat is extremely limited in river systems not only in their floodplains but also in their watersheds in the UMR region where several states have lost approximately 90 percent of their pre-settlement wetlands. Furthermore, the capacity of river ecosystems to remove dissolved and particulate nutrients are strongly dependent on connectivity of nitrogen and phosphorus-rich main channel to carbon-rich backwater wetlands.

***4a. Longitudinal connectivity* (aquatic) – The interaction between river reaches either upstream or downstream.**

Upstream fish movements (particularly in spring) are impeded by the navigation dams and result in decreased reproductive success. Sedimentation of backwater habitats has impeded certain fish species' ability to move to over-wintering areas of sufficient depth. Shallow water connections between backwaters and channels resulting from sedimentation can expedite fish kills at low water stages.

4b. Longitudinal connectivity* (aerial, straight line distance) – *The distance between wetland and terrestrial feeding, nesting, and resting habitats

The distance between deep water overwinter, wetland and terrestrial feeding, nesting, and resting habitats, critical to many warm-blooded and some cold-blooded (amphibians and reptiles) vertebrates, is also a connectivity/fragmentation issue.

5. Main Stem to Tributary Connectivity – *The connection between a main stem river and its tributaries.*

The ecological functions of the aquatic connection(s) between a tributary and the main stem of the river are important and influenced by numerous and often inter-related factors including hydrology, hydraulics, geomorphology, topography, water quality, and habitat area and quality. On the UMR, many tributary streams no longer meander across the floodplain before entering the main channel. Sediment and nutrients that were formerly deposited and processed across the tributary floodplain now enter the River unimpeded, without the natural management and processing that occurred historically on these areas. Combined with dramatic changes in the tributary watersheds, this contributes to unnaturally fluctuating volumes of water and increased loads of sediment and chemicals delivered to the river.

6. Subsurface Connectivity (below ground) – *Hydrologic connection of shallow ground water among channel and lateral habitats, with movement of water and solutes a result of differences in hydraulic head.*
Dissolved nutrients, carbon, and hyporheic micro-organisms likely move among habitats via means of subsurface connections. Flows may be impeded by sediment compaction associated with dam and levee construction or clogging of sediment interstices by fine particles.

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