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Upper Mississippi River
Long Term Resource Monitoring Program
U.S. Geological Survey

Landscape Patterns along the Upper Mississippi River

by

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The corridors of large-river floodplain ecosystems, like the Upper Mississippi River (UMR), are important conduits for the movement of water, minerals, nutrients, and species. In riverine landscapes, where physical and biological processes are closely linked, alterations in landscape structure have the potential for not only affecting the dynamics of water and sediment routing and delivery but of also affecting the population dynamics of cross-continental migratory species.

The ability of any large-river floodplain ecosystem to function as a corridor is largely dependent upon the pattern of landscape structure along the river's course. Despite the importance of riverine systems as movement corridors, longitudinal (source to mouth) patterns in landscape structure have not been quantified for any large-river floodplain ecosystem. The objective of this research, which is being conducted as part of the Long Term Resource Monitoring Program, is to quantify and analyze longitudinal differences in landscape structure along the Upper Mississippi River. The study area extends from River Mile 830, just downstream of St. Paul, Minnesota, to River Mile 0 at Cairo, Illinois. The lateral (horizontal) boundaries of the study area are the bases of the river's valley walls.

Geographic information system (GIS) coverages of land cover, derived from 1989 Landsat Thematic Mapper data and classified to seven categories (water, marsh, grasses/forbs, forest, sand/mud, urban/developed, and cultivated) were used in this analysis. The coverages were divided into smaller segments by perpendicularly splitting them at 1-mile intervals along the long axis of the river valley (Figure 1). For each river segment, FRAGSTATS (McGarigal and Marks, 1994), a spatially-oriented statistical program, was used to calculate measures of landscape structure in three general categories: landscape composition (the relative proportions of land cover), landscape configuration (the spatial arrangement of land cover within landscapes), and measures of patch shape.

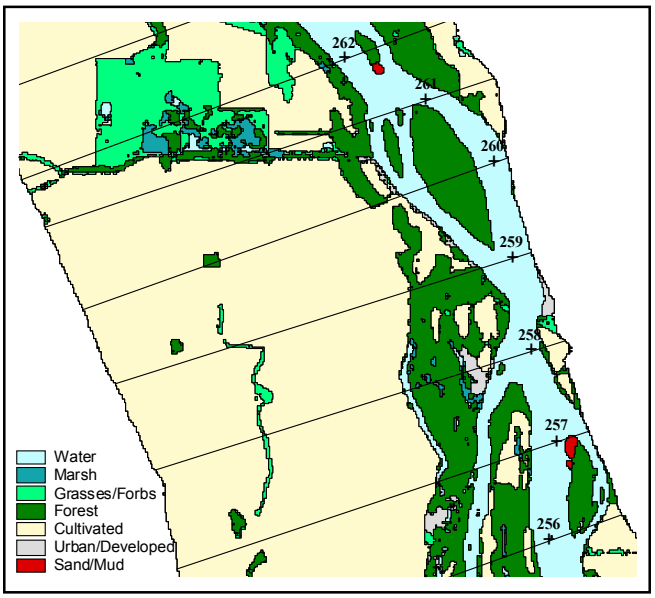

Figure 1. An example of a portion of a Geographic Information System coverage that has been split into smaller segments. The area of the Upper Mississippi River depicted extends across the river valley from River Mile 256 to 262.

Changes in the measures of landscape structure are being traced along the course of the UMR (Figures 2 and 3). The resulting graphs reveal repetitions in longitudinal patterns of landscape structure, as river segments and navigation pools tend to be most similar to their immediate neighbors. Figure 2, for example, shows that patterns of edge density (km/ha) among upper navigation pools (Pools 3 through 13) are self-similar. River segments for the lower portions of this set of

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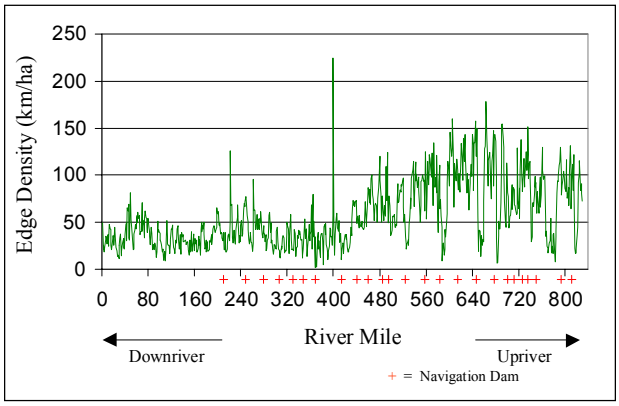

Figure 2. Changes in edge density (km/ha) along the corridor of the Upper Mississippi River.

pools have low edge density while the middle and upper portions have greater edge density. The analyses, however, are also revealing overarching trends in landscape structure along the UMR. For example, Figure 3 shows that the proportions of cultivated land and marsh found within river segments are inversely related to one another along the river's length. Landscapes of upper river reaches have greater proportions of marsh and lower proportions of cultivated land than the intensively cultivated landscapes of lower river reaches. And, although the landscapes of upper reaches of the Upper Mississippi River proportionally contain more marsh, they are also more urbanized than the landscapes of lower reaches.

Analyses of longitudinal patterns of landscape structure along the corridors of large-river floodplain ecosystems like the UMR have the potential for detecting human impacts at a scale appropriate for planning resource management. These types of analyses can be used to identify key areas that are in need of protection and restoration efforts. Figure 3, for example, shows that the lower reaches of the river have lower proportions of marsh. The figure suggests that one restoration opportunity for the lower 400 miles of the river might be the creation of more marsh habitat, especially for migratory bird species that rely on marshes. The figure also suggests that landscapes at river miles 60, 200, and 240 may be "stepping stones" for marsh birds migrating along the Mississippi Flyway. Even though these landscapes are composed of, at most, 10 percent marsh habitat, they contain significant amounts of marsh when compared to their neighbors on the lower 360 miles of the river. This graph further serves to pinpoint where, along the lower 400 miles of the river, the restoration of marsh habitat might be focussed. In terms of migratory marsh birds, the lack of marsh habitat for significant distances (up to 140 miles) along the UMR may be a limiting factor for migrating birds. The addition of stepping stones of marsh habitat between river miles 240 and 360 would likely benefit migratory marsh birds.

Refuge managers have used some of the results of these analyses at public meetings, and the analytical techniques developed in this research are being used in the development of Decision Support System applications for Upper Mississippi River System resource managers. The analytical approaches developed in this study have further application for assessing habitat needs and are being adopted for the Upper Mississippi River Habitat Needs Assessment (HNA). ❐

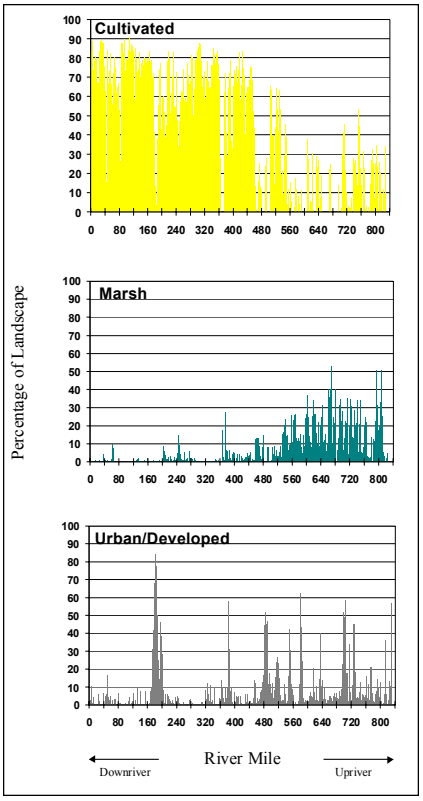

Figure 3. Changes in selected land cover types along the corridor of the Upper Mississippi River.

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