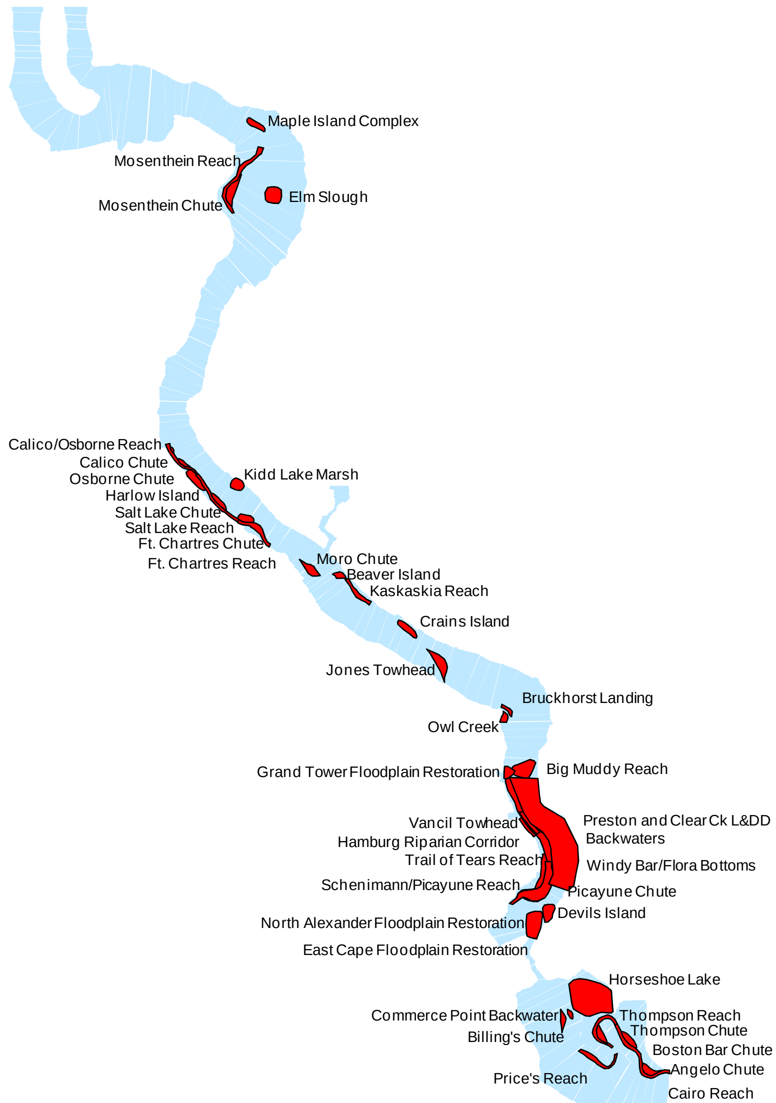
UPPER MISSISSIPPI RIVER SYSTEM
ECOSYSTEM RESTORATION OBJECTIVES 2009

APPENDIX C

UNIMPOUNDED (MIDDLE MISSISSIPPI) REACH PLAN

Contents

Appendix C
Unimpounded (Middle Mississippi) Reach Plan



I. Executive Summary

The Upper Mississippi River System (UMRS) Unimpounded Reach, or Middle Mississippi Reach (MMR), that occurs between the Missouri and Ohio Rivers shares common physical characteristics caused by its alluvial origin. The region can be further divided into two or three geomorphic reaches (Figure C-1). There are no navigation pools, channelization, channel training structures maintain navigable water depths. Levees significantly alter regional hydro-geomorphology.

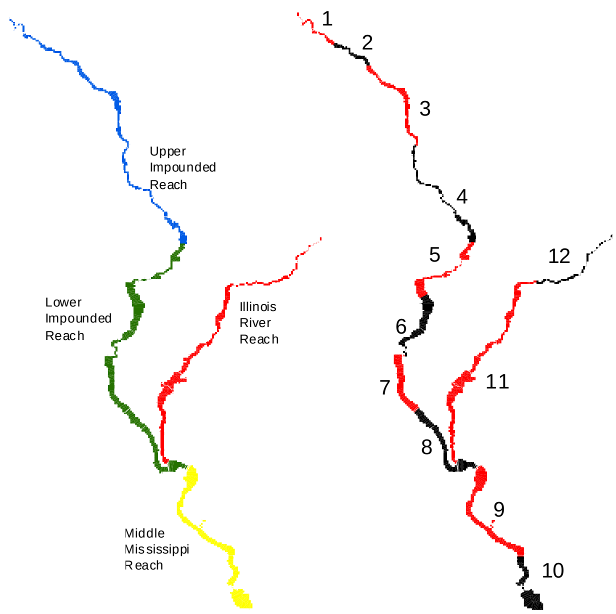


Figure C-1. Upper Mississippi River System Floodplain Reaches (left) and Geomorphic Reaches (right)

The River Resources Action Team (RRAT) was the coordinating team in the MMR. The teams met several times beginning in Spring 2009 to identify unique characteristics, stressors, and objectives for the region. Reach planning followed the top-down process recommended by the UMRS Navigation and Ecosystem Sustainability Program (NESP) Science Panel (SP) and outlined in the Reach Planning Notebook. Most regional team participants from state and Federal agencies, and non-governmental organizations were also participants in prior planning studies and had contributed site specific information during the 2000 Habitat Needs Assessment.

The UMRS Reach Planning process and system-wide results were summarized in the main report for this appendix. The system-wide objectives were presented to the regional team members using the UMRS conceptual model (Figure C-2) to help explain how process and structure objectives were inter-related to achieve biological objectives. Floodplain reach scale data were used in workshop discussions to refine objectives for the Lower Impounded Reach. Results of MMR reach planning presented below were used to help formulate priority ecosystem restoration subarea recommendations.

The MMR is fairly uniform in physiography and development. Alluvial processes caused mostly by Missouri River influences created a meandering bedform that left scars and that support diverse plant communities. Stressors are similar throughout the reach (Table C-1). The reaches below the Missouri River are uniform leveed urban and agriculture areas with very narrow riparian corridors and island habitat connected to the river. Hydro-geomorphic characterizations for the MMR graphically summarize impacts of levees and development on the water levels and channel form. River-floodplain development has leveed the floodplain and essentially eliminated the ecological benefits of the floodplain from the river. The hydrologic impact is visualized as maps of potential inundation area that illustrate how common floods impact the most floodplain area. Levees impede the distribution of the common annual flood (i.e., 50 percent recurrence interval or 2-year flood) which is an important ecological driver. Channelization caused relatively little planform change in river surface water distribution compared to the disturbed floodplain area, but the main channel was highly regulated and many side-channels were eliminated. River flow in the summer is augmented by releases from Missouri River reservoirs, a bimodal hydrograph (rainfall, snowmelt) has been eliminated by changes in the watershed.

Floodplain development and channelization established ecological conditions that are consistent through the reach and reflected by the ecosystem restoration objectives (Table C-2). Regional teams used the UMRS conceptual model (Figure C-2) and information from the Decision Support System (DSS) to identify high priority ecosystem restoration subareas (Table C-3). These priorities were forwarded for final project selection by the RRAT executive committee.

Reach planning teams did not feel that subarea scale summaries of DSS parameters alone provided the spatial discrimination required to identify restoration sites. A prior analysis that ranked secondary channel connectivity was incorporated in a spatial analysis, using high quality sites as the centroid to visualize the distribution of high quality sites and gaps in habitat (Figure C-3). This sort of analysis could be done for other restoration objectives and integrated benefits modeling and was adopted by another reach planning team as well.

Table C- 1. Factors Limiting Natural Processes and the Distribution and Abundance of Biota (Stressors) in the Middle Mississippi River

- Navigation traffic impacts including fleeting/mooring
- Levees and floodplain development
- Channel training structures - riprap, wing dams, closing dams, port facilities
- Invasive species - Asian carps, Johnson grass
- Urbanization - metro St. Louis
- Sedimentation in side channels, backwaters
- Nutrient loading from tributaries
- Sediment loading from tributaries
- Dredging, material placement
- Contaminants from non-point urban and rural run-off
- Altered hydrology
- Low percentage of public land in floodplain

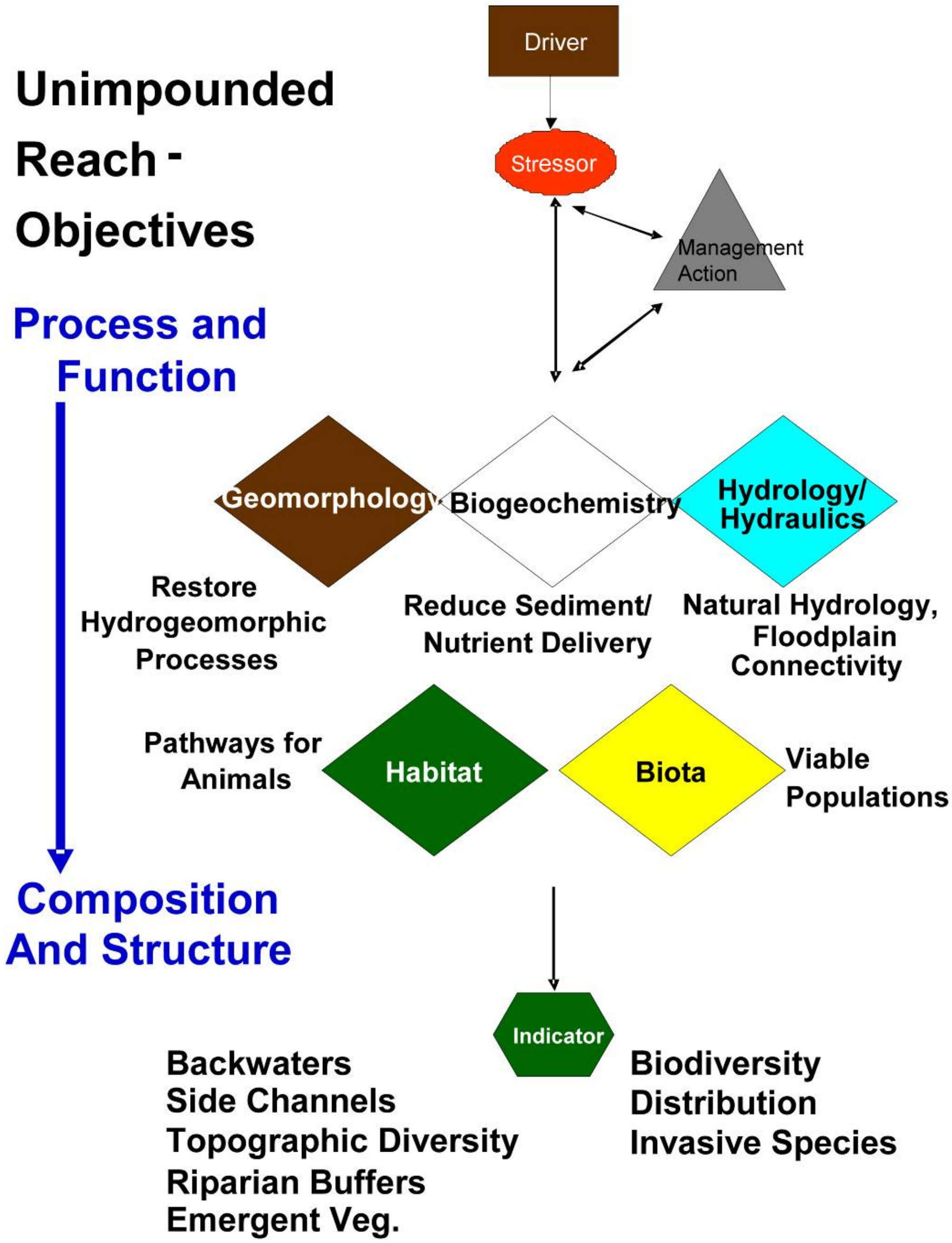


Figure C-2. Upper Mississippi River System ecosystem conceptual model helps organize process and function objectives that support structural habitat outcomes

Appendix C
Unimpounded (Middle Mississippi) Reach Plan

Table C- 2. Upper Mississippi River System Unimpounded Reach ecosystem restoration objectives

Geomorphology: Mange for processes that shape a physically divers and dynamic river floodplain system	**Hydrology and Hydraulics: Mange for a more natural hydrologic regime**	**Biogeochemistry: Manage for processes that input, transport, assimilat4, and output material within UMR basin river floodplains, e.g., water quality, sediments, and nutrients**	**Habitat: Manage for a diverse and dynamic pattern of habitat to support native biota**	**Biota: Manage for viable populations of native species within diverse plant and animal communities**
Restore hydro-geomorphic processes that create, maintain, and improve connectivity, bathymetric diversity and flow variability of channel borders, side channels, islands, sand bars, shoals, and associated habitats.	Restore hydraulic connectivity (surface and ground water) between rivers and their floodplains, especially backwater flows into lakes, wetlands, sloughs, swales, abandoned channels, and backswamp depressions.	Enhance water quality parameters (e.g. nutrients, dissolved oxygen) sufficient to support native aquatic biota and consideration of designated uses.	Restore, expand, and maintain the amount and diversity of floodplain terrestrial habitats emphasizing contiguous patches of plant communities to provide a corridor along the UMR and riparian buffers.	Maintain and restore viable populations of native species and communities throughout their range in the UMRS in suitable geomorphic areas of the landscapes.
			Restore habitat types most reduced from their pre-settlement extent (e.g., Bottomland and mesic prairies, Savanna, Floodplain Lake, Floodplain Forest, and Bottomland Hardwoods) and the ecological processes and functions to support them.	Reduce the adverse effects of invasive species on native biota.
			Protect, restore and manage complex wetland areas (including within leveed areas) to provide diverse habitat	Provide nesting, feeding and resting habitat for migratory birds.
			Increase the extent and number of sand bars, mud flats, gravel bars, islands, and side channels towards a more historic abundance and distribution.	Provide habitat for all life stages of native fishes and other aquatic biota.

Table C-3. Unimpounded Reach priority ecosystem restoration subareas

Project Name or Description	River Mile	Project Type
Maple Island Complex	200-198	Island/Side Channel/Backwater
system fisheries mitigation	200-196	Spawning Habitat
Mosenthein Reach	196-184	Dike Alteration/Island/Sandbar Creation
Mosenthein Chute	189-185L	Side Channel
system fisheries mitigation	189-185L	Spawning Habitat
Elm Slough	186-182	Floodplain Restoration
Salt Lake Chute	139-137L	Side Channel
Ft. Chartres Chute	134-132L	Side Channel/Backwater
Salt Lake Reach	143-134	Dike Alteration, Island/Sandbar creation
Fort Chartres Reach	134-128	Dike Alteration, Island/Sandbar creation
Harlow Island	144-142	Floodplain/Side Channel/Backwater
Calico Chute	148-147L	Side Channel
Osborne Chute	146-144L	Side Channel
Calico/Osborne Reach	150-143	Dike Alteration, Island/Sandbar creation
Moro Chute	123-120L	Side Channel
Kidd Lake Marsh Complex	138.5	Floodplain Restoration
Beaver Island	118-116	Side Channel
Kaskaskia Reach	113-112L	Dike Alteration, Island/Sandbar creation
Crains Island	107-104	Floodplain/Side Channel/Backwater
Bruckhorst Landing	85-84	Floodplain/Backwater
Owl Creek	85-83	Dike Alteration, Island/Sandbar creation
Vancil Towhead Sidechannel	74-63L	Side Channel
Trail of Tears Reach	69-66	Dike Alteration, Island/Sandbar creation
system cultural mitigation	69-66	TBD
Picayune Chute	61-55L	Side Channel
Schenimann/Picayune Reach	63-54	Dike Alteration, Island/Sandbar creation
Devils Island	60-55L	Floodplain Restoration
Windy Bar/Flora Bottoms	63-54	Island/Side Channel
Big Muddy Reach	76-75L	Dike Alteration, Island/Sandbar creation
Grand Tower Floodplain Res	82-75	Floodplain Restoration
Hamburg Riparian Corridor	75-60	Floodplain/Side Channel/Backwater
East Cape Floodplain Res	51-46	Floodplain/Backwater
North Alexander Floodplain Res	51-46	Floodplain Restoration
Boston Bar Chute	11-8L	Side Channel/Backwater
Angelo Chute	5-2L	Side Channel
Cairo Reach	12-0	Dike Alteration, Island/Sandbar creation
Price's Reach	29-20	Dike Alteration, Island/Sandbar creation
Billings Chute	35-31R	Side Channel/Backwater
Commerce Point Backwater	32	Backwater Restoration
Horseshoe Lake	38-33	Floodplain Restoration
Thompson Reach	20-12	Dike Alteration, Island/Sandbar creation
Thompson Chute	19-16	Backwater Restoration
Preston & Clear Creek D&LD - Backwater res	75-60	Backwater Restoration
Jones Towhead Floodplain Res	97-95R	
entire MMR	200-0	Island Building
Fisheries mitigation	200-0	Floodplain Reconnection/Gravel Bars/Other

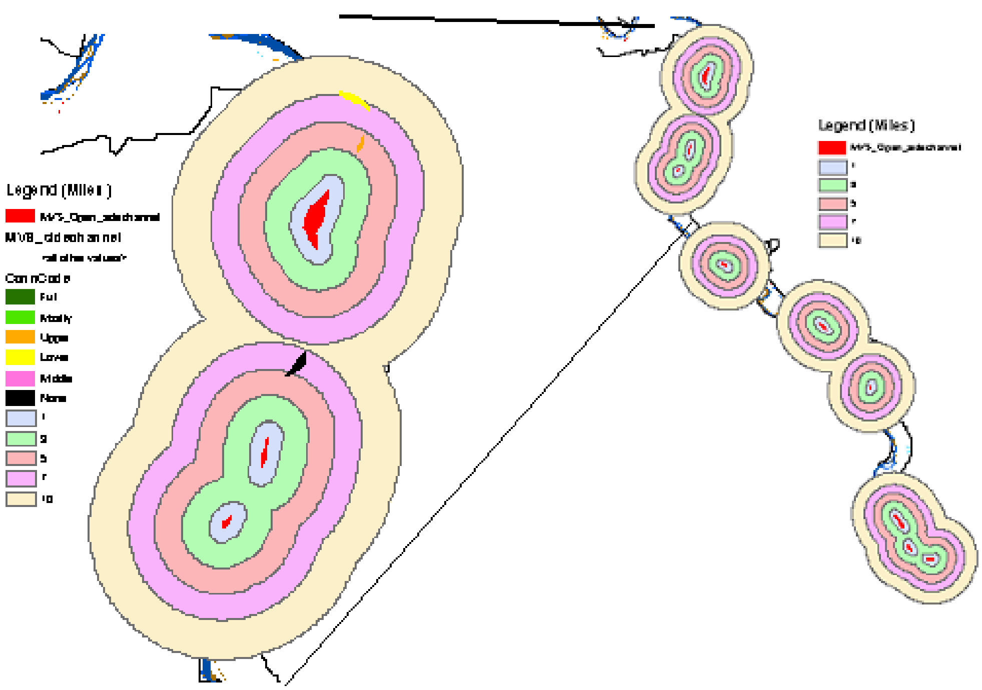


Figure C-3. Buffer analysis identifies gaps among high quality habitat areas to help identify high priority restoration areas

II. Reach Characteristics

An early geomorphic classification divided the Unimpounded reach into two distinct ecoregions, but subsequent work subdivided on of those reaches to make three hydro-geomorphic reaches. Evaluations of ecosystem condition and restoration options are categorized by these regions. The first ecoregion, Reach 9a, referred to also as the American Bottoms, encompasses the section of the river from below Lock & Dam 26 to where the Kaskaskia River enters the Mississippi River floodplain near Chester, Illinois, The second ecoregion, Reach 9b, extends from the Kaskaskia to the narrow floodplain constriction at Thebes Gap, immediately south of Cape Girardeau, Missouri, at RM 40. The third ecoregion, Reach 10, extends from Thebes Gap south to the confluence of the Mississippi and Ohio rivers near Cairo, Illinois, RM 45-0, and represents the northern most part of the Mississippi Alluvial Valley (MAV) that extends from the Gulf of Mexico to Thebes

A. Unique Characteristics

The entire Middle Mississippi River Reach is unique in the UMRS because three large rivers join to create a larger river that assumes a meandering geomorphology. The modern river is not impounded like the river upstream, but it is regulated with dikes and bank stabilization. Presettlement conditions supported a larger proportion of savanna habitat than other southern river reaches. In modern conditions, however, levees are large and continuous nearly to the river bank. There is about 30 percent more floodplain isolated in the MMR (80 percent leveed) compared to the Lower Impounded and Lower Illinois Reaches which are 50 percent leveed. Side channel restoration is another problem in the entire reach. Most side channels need restoration work, and the MMR partnership has prioritized restoration activity among suitable sites.

Considering individual reaches, the upper part of the reach is greatly influenced by urbanization around St. Louis, Missouri (Table C-4). In the river channel, the Chain-of-Rocks (Figure C-4) is a large rapids over bedrock that supports large fish populations including endangered sturgeon species. Tributary confluence areas support important off-channel fish habitat (Figure C-5), so the few large tributaries in the reach are quite unique in this region. The Shawnee National Forest and Oakwood bottoms provide rare large blocks of natural habitat in the MMR. American Land Conservancy is working to expand conservation lands to hopefully connect the Shawnee property to the river some day. The lowest part of the reach below Thebes Gap is a true southern bottomland forest habitat unique to the UMRS but common southward. The area has extensive meander scars including Horseshoe Lake which is a popular state park (Figure C-6). Side channel loss and channelization is extensive.

Table C-4. Unique characteristics in Middle Mississippi River reaches

Geomorphic Reach 9a: ***Below Pool 26 to RM 117 (conflu. with Kaskaskia River)***
- Pallid Sturgeon – value of Chain of Rocks
- Influence of Illinois and Missouri Rivers – sediment, spring rise
- Chain of Rocks
- Confluence of Meramec, Kaskaskia Rivers
- Urbanization and agriculture
- Training structures – habitat, hydrology
- Barge traffic
- High fish density – per IDNR (Atwood)
- Commercial fishing
- American Bottoms – HGM, Heitmeyer
- Narrower river width
- Side channels
- “Proto-type” dike reach
- Public access limited
- Historically, more abandoned channels

Geomorphic Reach 9b: ***RM 117 (conflu. with Kaskaskia) to RM 40***
- Confluence with Kaskaskia and Big Muddy
- Shawnee National Forest
- Limited floodplain connectivity
- Heavy on training structures (see dike alteration report)
- Heavy barge traffic
- Cottonwood Island and sturgeon records
- Interior Least Tern habitat present
- Highly leveed
- High agriculture
- Oakwood Bottoms
- Side channel loss
- Schenimann, Wilkinson, Jones, Establishment, Salt Lake/Chartres…..

Geomorphic Reach 10: ***Thebes Gap to Ohio River***
- Ohio River
- Mississippi alluvial valley
- Thebes Gap
- Cache River
- Horseshoe Lake
- High agriculture
- Buffalo, Sister, Angelo
- Increased sinuosity
- Least Tern, Pallid Sturgeon sites
- Extensive meandering over time
- Side channel loss

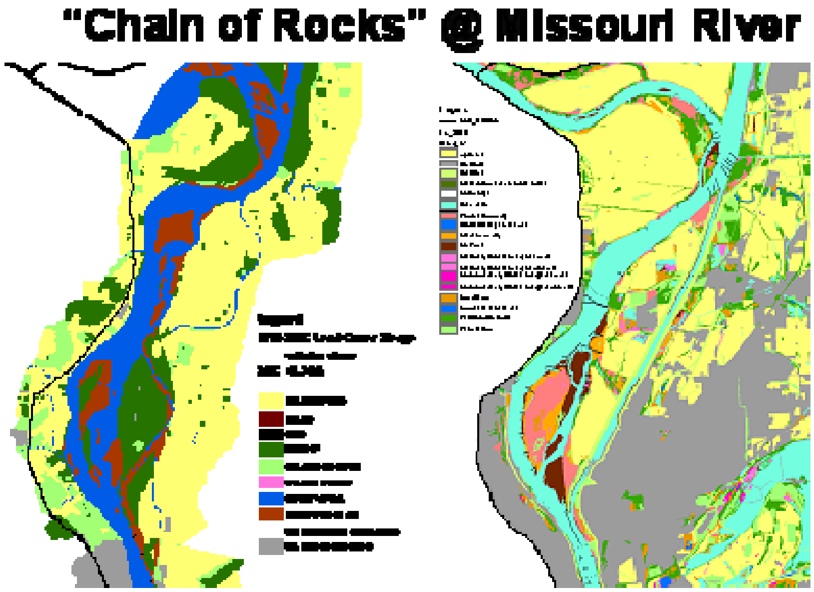


Figure C-4. The Chain-of-Rocks rapids in 1890 (left) and in its modern impounded and channelized condition

Figure C-5. Tributary rivers provide important off-channel habitat and habitat diversity. Channel avulsion at Kaskaskia island occurred within the historic record

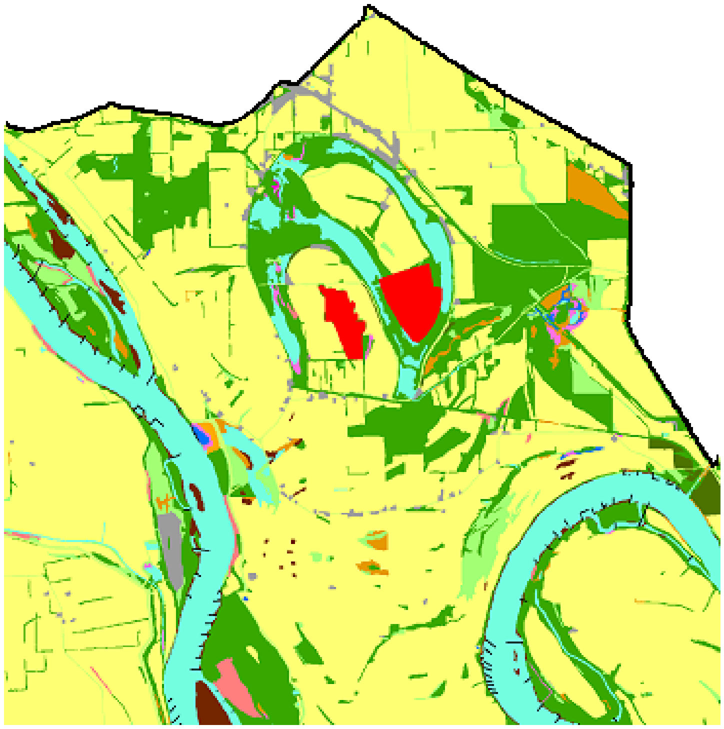


Figure C-6. Horseshoe Lake State Park, Illinois

B. Geomorphology and Land Cover

Repeated cycles of vertical incision, agradation, erosion of bluff materials, and lateral migration by the Mississippi River formed and reshaped the geomorphological surfaces of the Unimpounded Reach. Eight distinct, Holocene-derived, geomorphic surfaces are present in the Unimpounded Reach and include: 1) the main Mississippi and tributary river channels, 2) abandoned river channels, 3) point bars, 4) river chutes and bars, 5) backswamp, 6) alluvial fans and colluvial aprons, 7) natural levees, and 8) tributary valley alluvium. A Pleistocene-age sand and gravel terrace, the Savanna Terrace, also is present at the north end of the American Bottoms and in a small area north of Prairie du Rocher, Illinois. The complex geomorphology of the Unimpounded Reach has created a heterogeneous mosaic of floodplain topography, soils, and elevations that in turn have created a complex and heterogeneous vegetation ecosystem.Major historical vegetation communities/habitat types in the Unimpounded Reach included: 1) the main channel and islands of the Mississippi River and its tributaries, 2) river Chutes and Side Channels, 3) Bottomland lakes, 4) Riverfront Forest, 5) Floodplain Forest, 6) Bottomland Hardwood Forest (BLH), 7) Slope Forest, 8) Bottomland Prairie, 9) Mesic Terrace Prairie, and 10) Savanna (Figure C-7). The diversity of Presettlement communities was highest in the American Bottoms and lowest in the southern Thebes ecoregion.

Moving from north to south in the Unimpounded Reach, prairie was abundant (29% of total mapped area excluding the Mississippi and tributary river channels, bars, and side channels/chutes) in the American Bottoms, but is now present only on Kaskaskia Island (1.8% of the Kaskaskia ecoregion), and did not occur in the Thebes ecoregion. Floodplain Forest increased from 19% in the American Bottoms to 53% in Kaskaskia and then declined to 10% at Thebes. In contrast, BLH was absent of the American Bottoms, but increased to 8% at Kaskaskia and 63% at Thebes. Riverfront Forest occupied 25% in the American Bottoms, but only 20% and 16% at Kaskaskia and Thebes, respectively. Bottomland Lakes occupied 6-8% of all ecoregions.

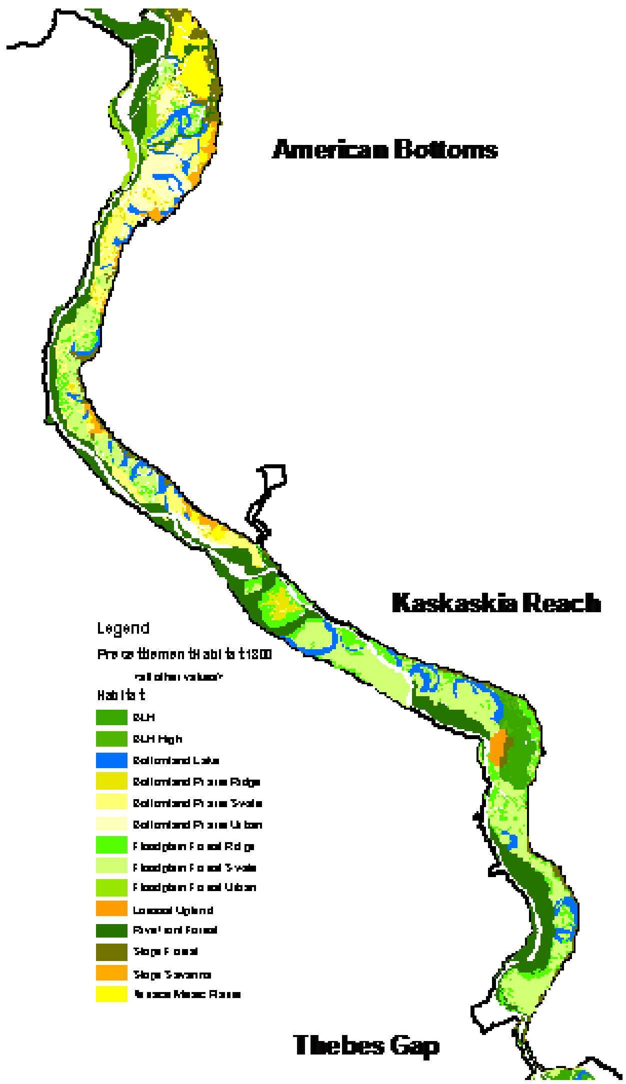


Figure C-7. Unimpounded Reach natural potential vegetation

The modern Unimpounded Reach channels and floodplain are highly regulated with hydraulic structures and dredging in the main channel and constricted by levees for its entire length. Urban development is significant in the upper reach, St. Louis Metropolitan Area (Figure C-8). The rest of the floodplain in the reach is substantially agricultural with a few prominent floodplain natural areas. Islands and connected secondary channels are the only off-channel aquatic habitat.

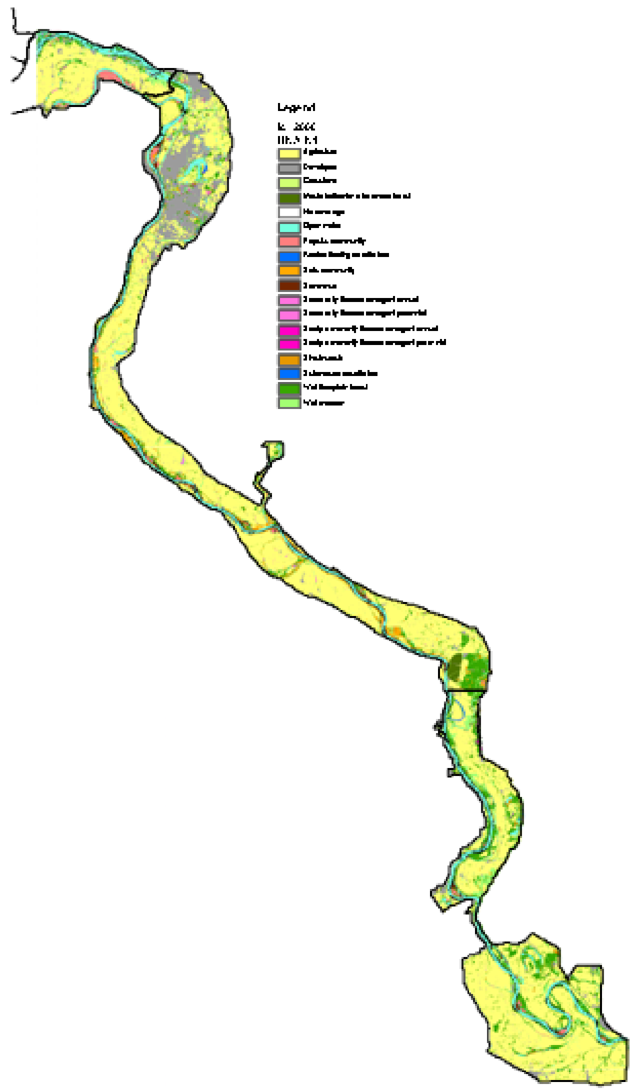


Figure C-8. Unimpounded Reach contemporary vegetation

The American Bottoms Reach is a globally- unique confluence of three great rivers, the Illinois, Mississippi, and Missouri Rivers. The geology of the American Bottoms has been heavily influenced by sediments and flows of the Missouri River and 24 extinct meanders of the Mississippi and Missouri Rivers are present in the northern part of the American Bottoms; most of these abandoned channels were created in the last 5,000 years. The meanders were formed by the decreasing amplitude of river flow as the Holocene environment settled into the contemporary climate. The cutting and migration of channels created the ridge and swale topography characteristic of the reach. Paleo-bar and chute formations also create the ridge and swale topography. Large oxbow lakes formed in cut-off meanders were common in the reach, but have now mostly been drained. The reach had relatively few islands in 1890, but the region was already highly developed by then.

The Kaskaskia ecoregion reflects attenuation of sediments and flows from the American Bottoms, entry of sediments and flows from the Kaskaskia River, and floodplain constriction at Thebes. The Mississippi River cut through Thebes Gap about 14,000 years ago and the region below Thebes is the northern most extension of the historic Mississippi Embayment.

C. Hydrology

The Middle Mississippi Reach is greatly influenced by the Missouri River. Prior to Missouri River regulation, the annual hydrology exhibited a bi-modal spring flood, one from spring rains, and another from mountain snowmelt (Figure C-9). Common, high probability floods would potentially inundate much of the floodplain in the Unimpounded Reach if levees were not present (Figure C-10). The levees act like lateral dams, effectively eliminating the floodplain from normal high water. This loss of floodplain connectivity prevents the creation of new wetlands, prevents the deposition of nutrient-rich sediment, and reduces the amount of fish spawning and nursery habitat. Levees protect about 80 percent of the 7-10 mile wide floodplain south of St. Louis except during the most extreme floods that achieve catastrophic proportions. Channelization has cut off river meanders and isolated side channel and backwater habitats to improve sediment transport efficiency in the main channel. Loss of a functional floodplain not only affects the ecosystem, but also significantly impacts its ability to store and convey flood waters. The water between the levees has nowhere to go but up, which raises flood elevations downstream by forcing the waters to pass through a narrow opening between the levees. Prior to human modification of the hydrograph, floods normally occurred in the spring and fall, wetlands dried out in the summer, and changes in water levels were fairly gradual.

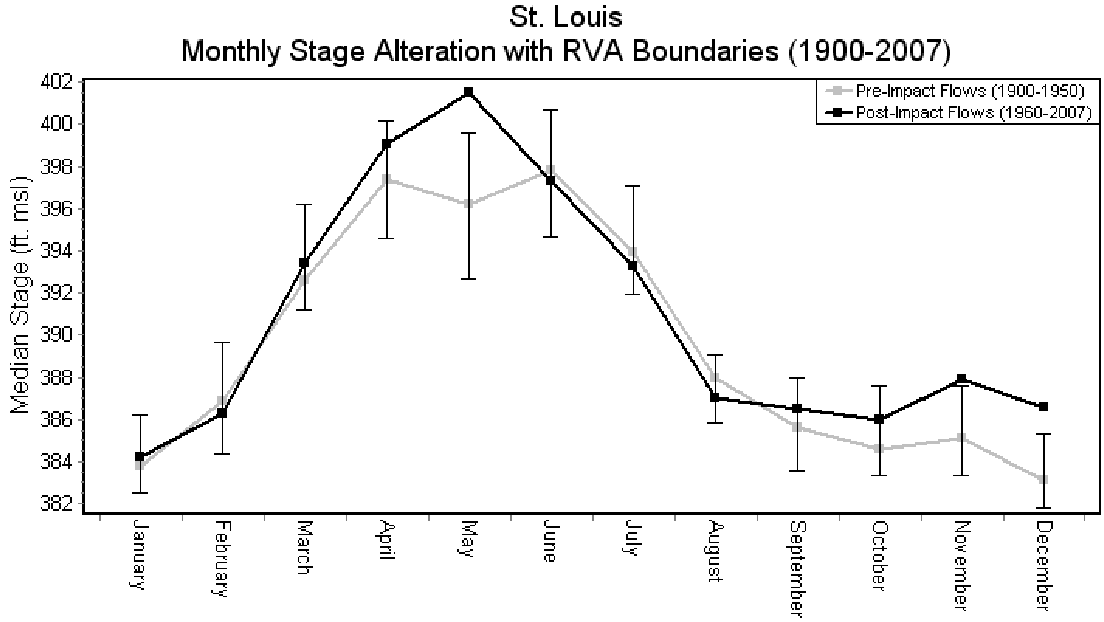


Figure C-9. The Indicators of Hydrologic Alteration Range of Variation Analysis (RVA) shows similarity in river stage for pre and post impact river stage (overlapping splines) except during the peak flood in May where the historic rain-snowmelt bi-model hydrograph from Missouri River is replaced by a unimodal signal because of regulation of the Missouri River

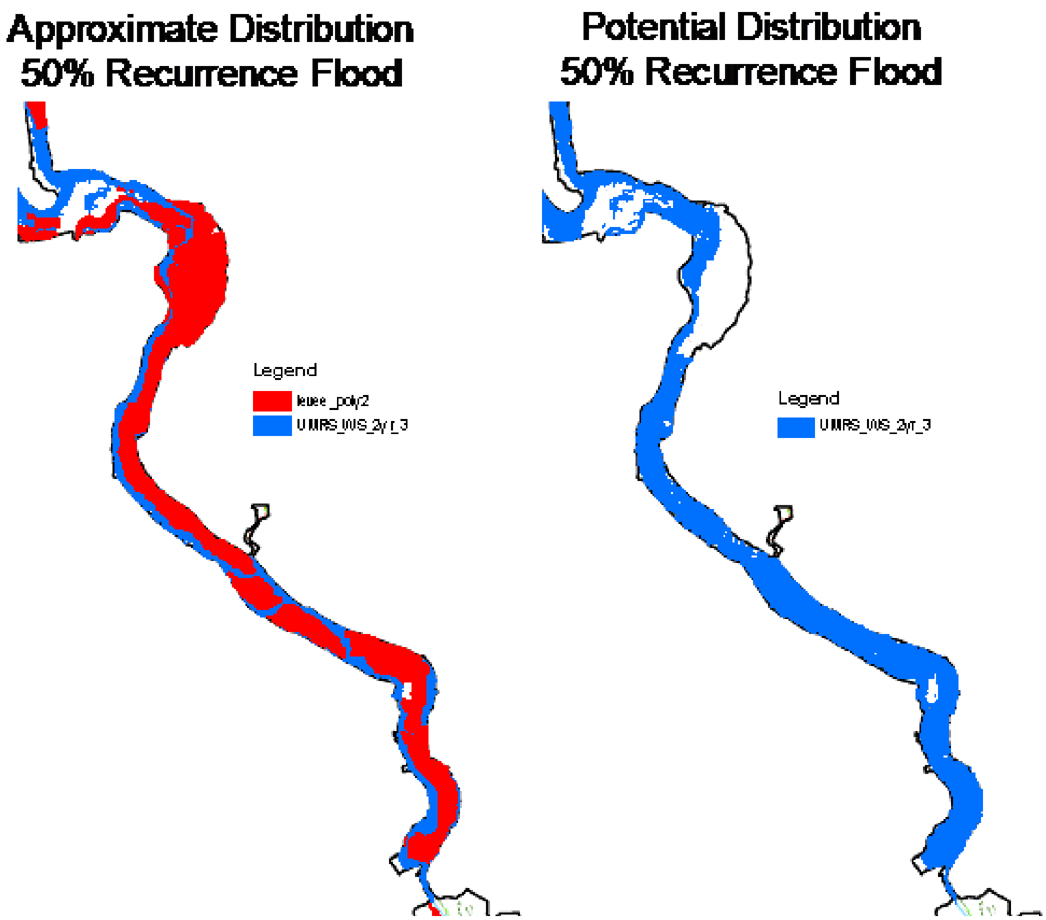


Figure C-10. Two-year flood events; the red area represents the current levees where flooding does not inundate floodplain

Flood heights have increased over time (Figure C-11), and the number of days that water elevations are above flood stage also is increasing. Present-day floods on the Mississippi River at St. Louis tend to be 9 feet higher than historic floods. The Mississippi River in the Unimpounded Reach reached flood stage almost every year (often multiple times/ year) prior to major levee, wing dike, and other flood control developments (i.e., pre-1945). Flooding at St. Louis is influenced more from upstream and Missouri River contributions, whereas flooding in the lower parts of the reach at Cape Girardeau is influenced both from upstream flows and the Ohio River. When the Ohio River is in flood stage water discharge from the Mississippi River slows and essentially is backed upstream. Analyses of long-term flooding data suggest that large flood events, that covered most of the Unimpounded Reach floodplains, occurred about every 11- 15 years with intervening periods of low, non-flood, conditions.

There is considerable interest among Unimpounded Reach partners for rehabilitation of hydrologic regimes in side channels. Where the opportunity exists projects could establish annual flow connectivity between the river and side channels. This component of any side channel project may be achieved by identifying and securing flood easements or fee title to sites compatible with the project objective. Also, increasing wetland diversity along the Unimpounded Reach is desired. To accomplish this it would be necessary to establish hydraulic connection between the river's main channel and selected semi-permanent wetlands while leaving other semi-permanent wetlands unconnected to dry annually (e.g., especially in the vicinity of known heron rookeries).

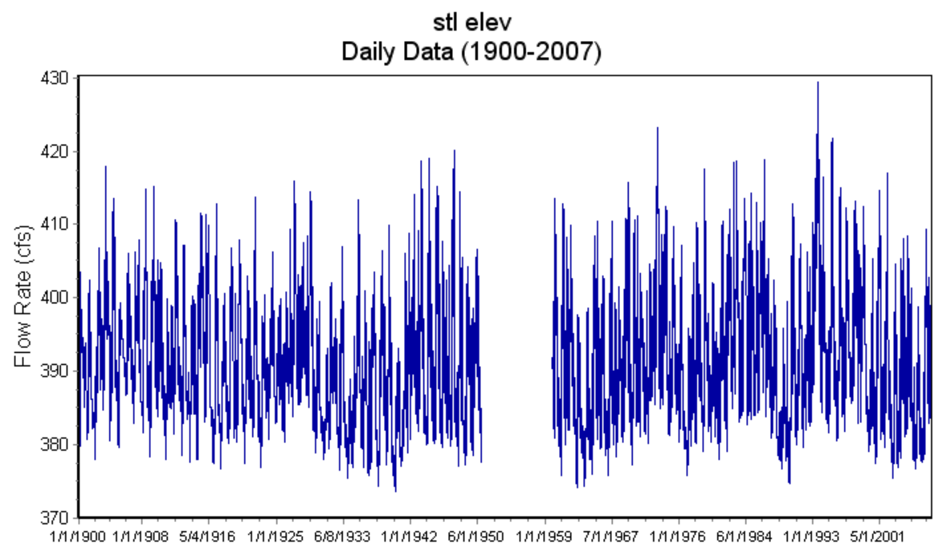


Figure C-11. Long term daily stage at St. Louis does not show dam effects, but does display lower low stages and higher high stages in the last half of the 1900s

III. Desired Future Conditions

A. Side Channels and Backwaters

The desired future river does not necessarily have to resemble the river of 1817 to be considered restored or environmentally sustainable. In fact, unless navigation ceases and landowners evacuate the floodplain, this is a physical impossibility. However, with that being said, modern river engineering methods combined with the latest fisheries and waterfowl management strategies can develop a river that achieves the goals of a healthy ecosystem.

A tremendous opportunity for creating new habitat above and beyond the constraints of the current planform rests on the fact that a substantial amount of land exists alongside most of the river between the riverbanks and the agricultural levees. This land is mostly in private ownership. A very small portion of it is actually farmed because most of the area is subject to periodic flooding. Hence, most of the land is forested. There also exists many small lakes formed by borrow areas created by the construction of the levees. Unlike many of the rivers in Europe where restoration has been limited because the levees have been constructed along or near the riverbanks, a far greater potential for additional river restoration exists on the Unimpounded Reach of the Middle Mississippi River.

Within this land exist old remnant channels, sloughs, oxbows, and wetlands. Over time many of these features have become filled with sediment, making them barely discernable or in many cases non-existent (Figure C-8). In general, the conditions of the Unimpounded Reach in the Year 2050 are expected to be similar to existing conditions, with the exception that a significant percentage of secondary channels and related backwater areas could fill with sediment. By extrapolation of the estimated rate of loss for secondary channels, approximately 6 of the remaining 25 secondary channels along the reach could be lost. However, this result is highly dependent on future river management decisions. Using ground based excavation, dredging, and/or a combination of river engineering structures, these features can be restored and connected to the modern day river, producing a new river planform never before seen or realized.

B. Wildlife and Vegetation

All remaining habitats within the Unimpounded Reach are altered to some degree, usually because of changed hydrology, altered size, connectivity, and interspersion with other habitats, and influences of adjacent lands. Agricultural and urban land conversion is widespread and influences all remnant habitat. Despite alterations, the unimpounded hydrology supports relatively unchanged composition of riverfront vegetation communities compared to Presettlement periods.

All remnant habitats within the Unimpounded Reach (both leveed and connected to the river) should be evaluated to determine if future protection or changes in management are needed. Private land acquisition or easements may be possible for some remnant patches, other patches should be evaluated for conservation opportunities that benefit landowners.

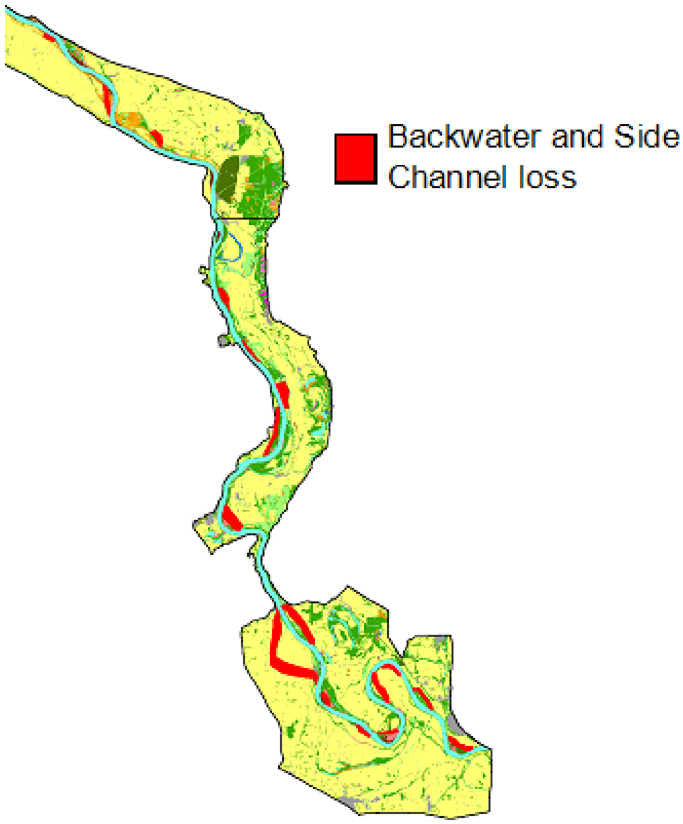


Figure C-8. Sedimentation in secondary channels and backwaters is widespread in MMR connected aquatic areas

Conservation of existing habitat remnants should go beyond simply purchasing lands or securing deed/management restrictions for certain uses. Sustaining existing habitats also requires protecting or restoring the ecological processes that created, and can sustain, the habitat. Often these ecological processes are disturbance events such as flood and drought, fire, and periodic physical disruption of sediments or plant structure. Unfortunately, most remnant habitats in the Unimpounded Reach have at least some disruption in these ecological "driving" processes and restoration of most habitats will require at least some active management, whether it be manipulation of water regimes (e.g., periodic drawdowns of Bottomland Lakes), periodic scouring or disturbance of sediments (e.g., dredging or removal of plugs in Side Channels or discing in Bottomland Prairie swales), disturbance of vegetation (e.g., fire or mechanical removal of prairie vegetation or timber management in Floodplain Forest), or reduction in contaminant inputs from adjacent lands (e.g., silt basins or vegetation buffers along edges of Bottomland Lakes and other floodplain wetlands). Attempts to restore specific habitat types must "match" the physical attributes of a site with requirements of each community, and not try to "force" a specific habitat type to occur on a site where it cannot be sustained. The degree that landscapes and processes have been altered will influence the difficulty and cost of both restoring and managing the site in the future

Where possible, habitats should restored where they can: 1) occur in larger patches, 2) connect remnant or other restored patches, 3) provide physical and hydrological connectivity, 4) emulate natural water regimes and flooding dynamics, and 5) fill critical gaps in former distribution patterns of communities. This will be difficult in some locations and for some habitats. For example, prairie historically was confined to areas north of Kaskaskia in the Unimpounded Reach and the larger prairie patches in the American Bottoms have been almost entirely converted to agricultural fields or to urban areas. Despite difficulties, some priority should be given to restoring at least some functional patches of all historic habitats to restore parts of the integrity of the entire Unimpounded Reach.

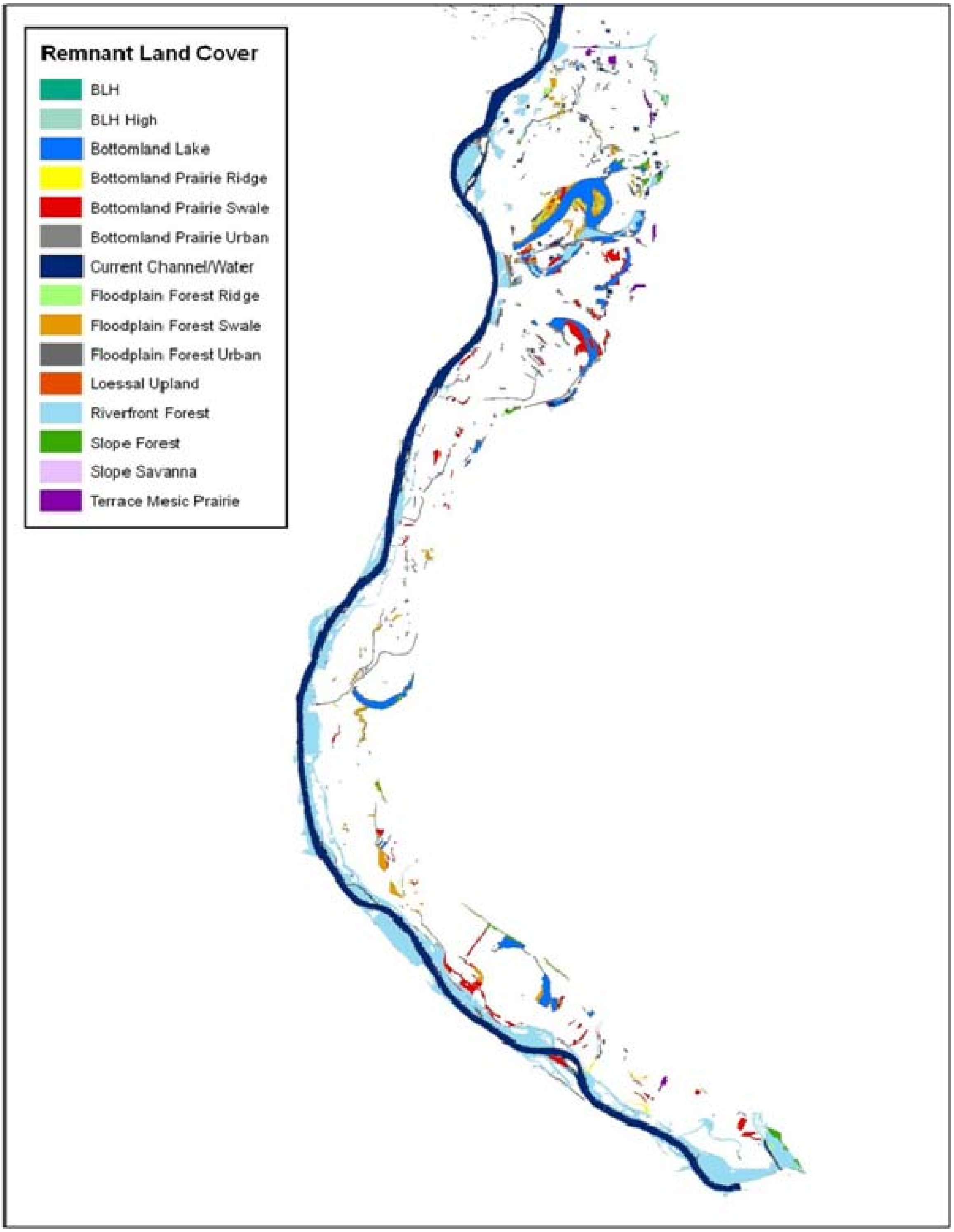
C. Adaptive Management

Restoring components of the historic Unimpounded Reach ecosystem will require many physical and biological strategies. Engineering and science information is available to inform, design, and implement these strategies, but some uncertainties remain about specific techniques, hydrological variables, community responses, and larger-scale interactions of habitats and sites. Future restoration and management of ecosystems in the Unimpounded Reach can be done in an adaptive management framework where predictions about specific management or restoration actions can be made and then select biotic and abiotic features and variables are monitored and evaluated to determine system responses and to suggest changes in management or strategies that are needed to achieve desired results. In most cases, the most important features that need monitoring are the primary abiotic features and ecological mechanisms that sustain communities and their productivity. These features include: 1) hydrological regimes including routes and interactions of surface and subsurface water flows, 2) sediment and nutrient loads and contamination rates, and 3) occurrence and effect of soil and vegetation disturbances. Key biotic features that must be monitored include: 1) composition, distribution, survival, and regeneration of plant species expected in the restored community; 2) invertebrate diversity and distribution, both aquatic and terrestrial; and 3) vertebrate occurrence, distribution, and abundance.

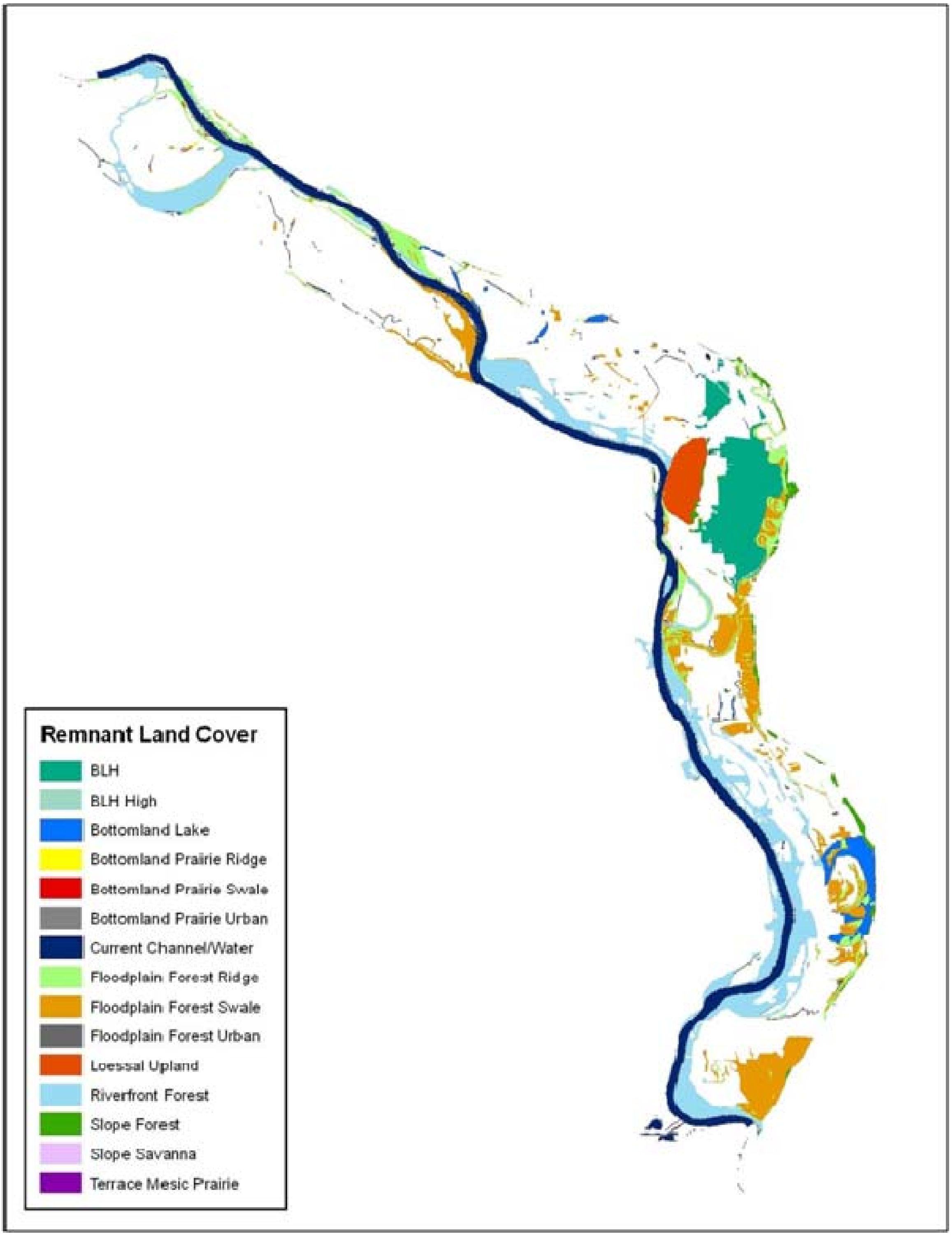
Baseline inventory data are needed on the distribution and abundance of both native and non-native plant and animal species the Unimpounded Reach, especially for sites that are targeted for restoration. Further monitoring is needed to document animal responses to actual restoration sites to determine effects of restoration methods, habitats, and landscape features such as size, complexity, configuration, proximity to other habitats and refuges, public use, etc. Many invasive plant and animal species now occur in the Unimpounded Reach and their abundance and distribution must be monitored regularly to determine changes and impacts on ecosystems.

Appendix C-1. Remnant natural habitats in Upper Mississippi River System Unimpounded Reaches.

C-1A. American Bottoms Reach



C-1B. Kaskaskia Reach



C-1C. Thebes Gap Reach