UPPER MISSISSIPPI RIVER SYSTEM
ECOSYSTEM RESTORATION OBJECTIVES 2009

APPENDIX B

LOWER IMPOUNDED REACH PLAN

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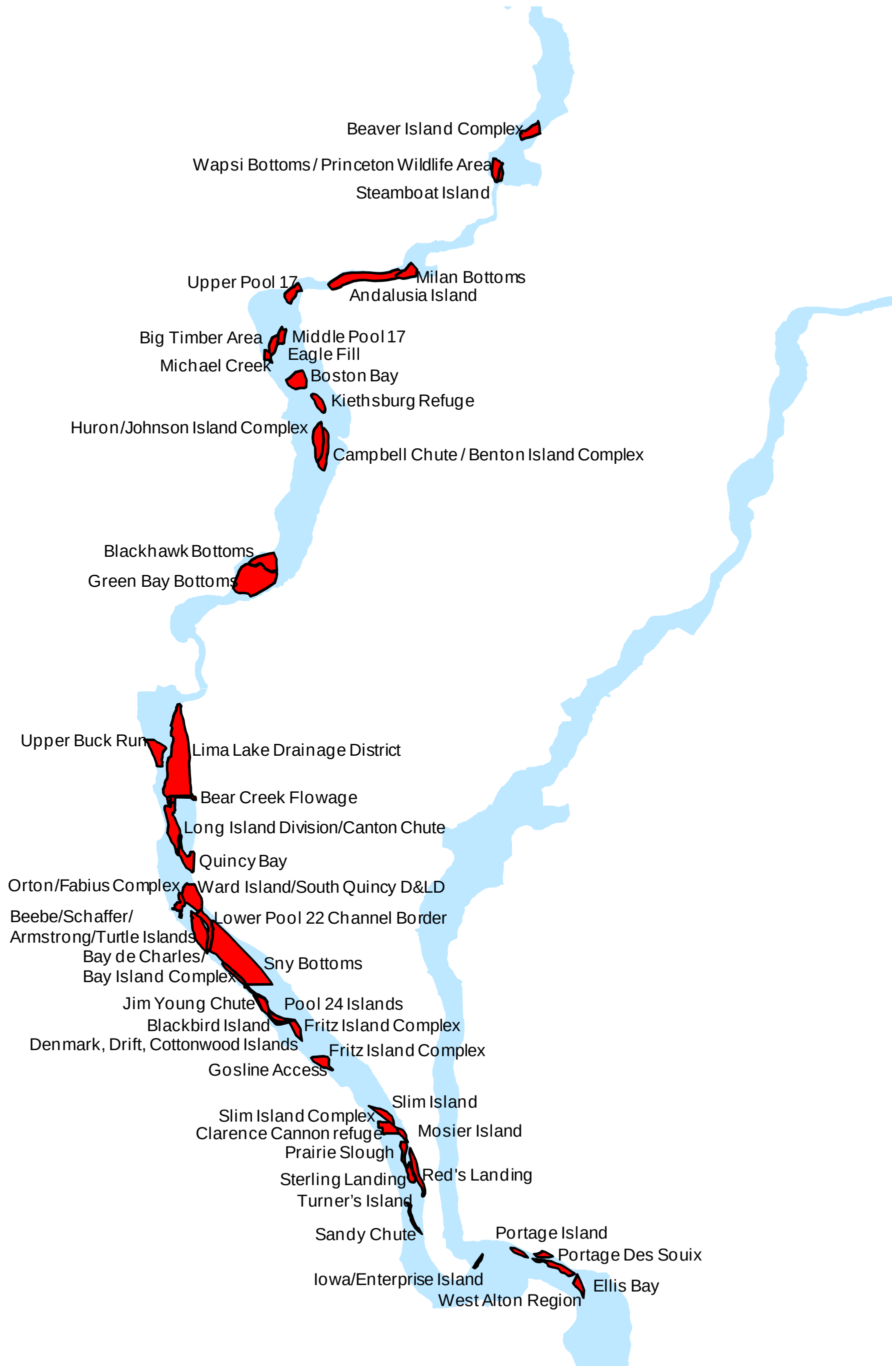

Beaver Island Complex
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Steamboat Island
Upper Pool 17
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Middle Pool 17
Eagle Fill
Michael Creek
Boston Bay
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Quincy Bay
Orton/Fabius Complex
Ward Island/South Quincy D&LD
Beebe/Schaffer/
Armstrong/Turtle Islands
Lower Pool 22 Channel Border
Bay de Charles/
Bay Island Complex
Sny Bottoms
Jim Young Chute
Pool 24 Islands
Blackbird Island
Fritz Island Complex
Denmark, Drift, Cottonwood Islands
Fritz Island Complex
Gosline Access
Slim Island
Slim Island Complex
Clarence Cannon refuge
Mosier Island
Prairie Slough
Sterling Landing
Red's Landing
Turner's Island
Sandy Chute
Portage Island
Portage Des Souix
Iowa/Enterprise Island
Ellis Bay
West Alton Region

UPPER MISSISSIPPI RIVER SYSTEM
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APPENDIX B

LOWER IMPOUNDED REACH PLAN

Executive Summary

The Upper Mississippi River System (UMRS) Lower Impounded Reach (LIR) shares common physical characteristics caused by its glacial origin and contemporary human use. The region can be further divided into 4 geomorphic reaches (Figure ES-1; Reaches 5, 6, 7, and 8) and 12 navigation pools (Pool 14 – 26). Dams and levees significantly alter regional hydro-geomorphology.

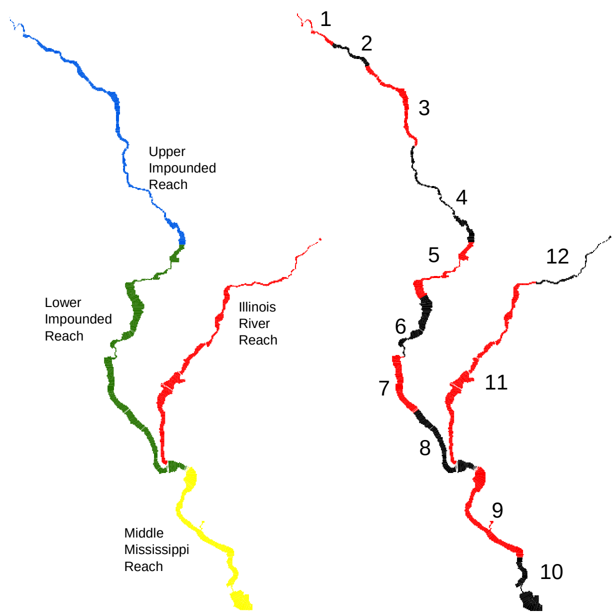

Figure ES-1. Upper Mississippi River System Floodplain Reaches (left) and Geomorphic Reaches (right)

The Fish and Wildlife Interagency Committee (FWIC) was the local coordinating team for Ecosystem Restoration (ER) planning in Geomorphic Reaches 5, 6, and 7 and the River Resources Action Team (RRAT) was the coordinating team in Reach 8. The teams met several times beginning in Spring 2009 to identify unique characteristics, stressors, and objectives for each geomorphic reach. Reach planning followed the top-down process recommended by the UMRS Navigation and Ecosystem Sustainability Program (NESP) Science Panel (SP) and outlined in the UMRS Ecosystem Restoration Objectives 2010 report. Most managers from state, Federal, and Non-governmental agencies were 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 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 (Table ES-1; Figure ES-2). Examples of the hydrogeomorphic data are presented in this summary to illustrate the condition of important drivers when selecting priority ecosystem restoration subarea recommendations. Individual reaches are described below to present information at a scale to match the planning area.

The Lower Impounded Reach is fairly uniform in physiography and human development. Glacial geomorphic processes created the terraces and ancient channels that support diverse plant communities. Stressors are similar throughout the reach (Table ES-2), with the most prominent stressor being the nearly uniform leveed floodplain agriculture land use. Hydro-geomorphic characterizations completed for Geomorphic Reaches 5, 6, 7, and 8 graphically summarize impacts of levees and dams on the water levels and surface water distribution on the floodplain. Levees and agriculture have reduced many of the ecological benefits of flooding. Levees impede the distribution of the common annual flood (i.e., 50 percent recurrence interval or 2-yr flood) which is an important ecological driver. Dams caused relatively little planform change in surface water distribution, but they stabilized river stage in the lower parts of navigation pools. Stable river stages eliminate the ecological benefits of backwater desiccation at the low range of the annual river hydrograph.

Table ES-1. Upper Mississippi River System Lower Impounded Reach ecosystem restoration objectives

Geomorphology: Manage for processes that shape a physically diverse and dynamic river floodplain system	**Hydraulics & Hydrology: Manage for a more natural hydrologic regime**	**Biogeochemistry: Manage for processes that input, transport, assimilate, and output material within UMR basin river floodplains: e.g. water quality, sediments, and nutrients**	**Habitat: Manage for a diverse and dynamic pattern of habitats to support native biota**
Lower Impounded Reach			
			Increase vegetated riparian buffers along tributaries and ditches in the floodplain
Modify contiguous backwater areas	Restore a more natural hydrologic regime in the navigation pools	Reduce sediment loadings to the rivers and backwaters	Modify the extent, abundance and diversity of submersed aquatic plants
Modify the channels and floodplains of tributary rivers	Increase storage and conveyance of flood water on the floodplain	Reduce nutrient loading from tributaries to rivers	Modify the extent, abundance and diversity of emergent aquatic plants
Restore hydro-geomorphic processes that create, maintain, and improve bathymetric diversity, islands, sand bars, shoals and mudflats	Naturalize the hydrologic regime of tributaries	Enhance Water Quality	Provide pathways for animal movements
Increase topographic diversity			

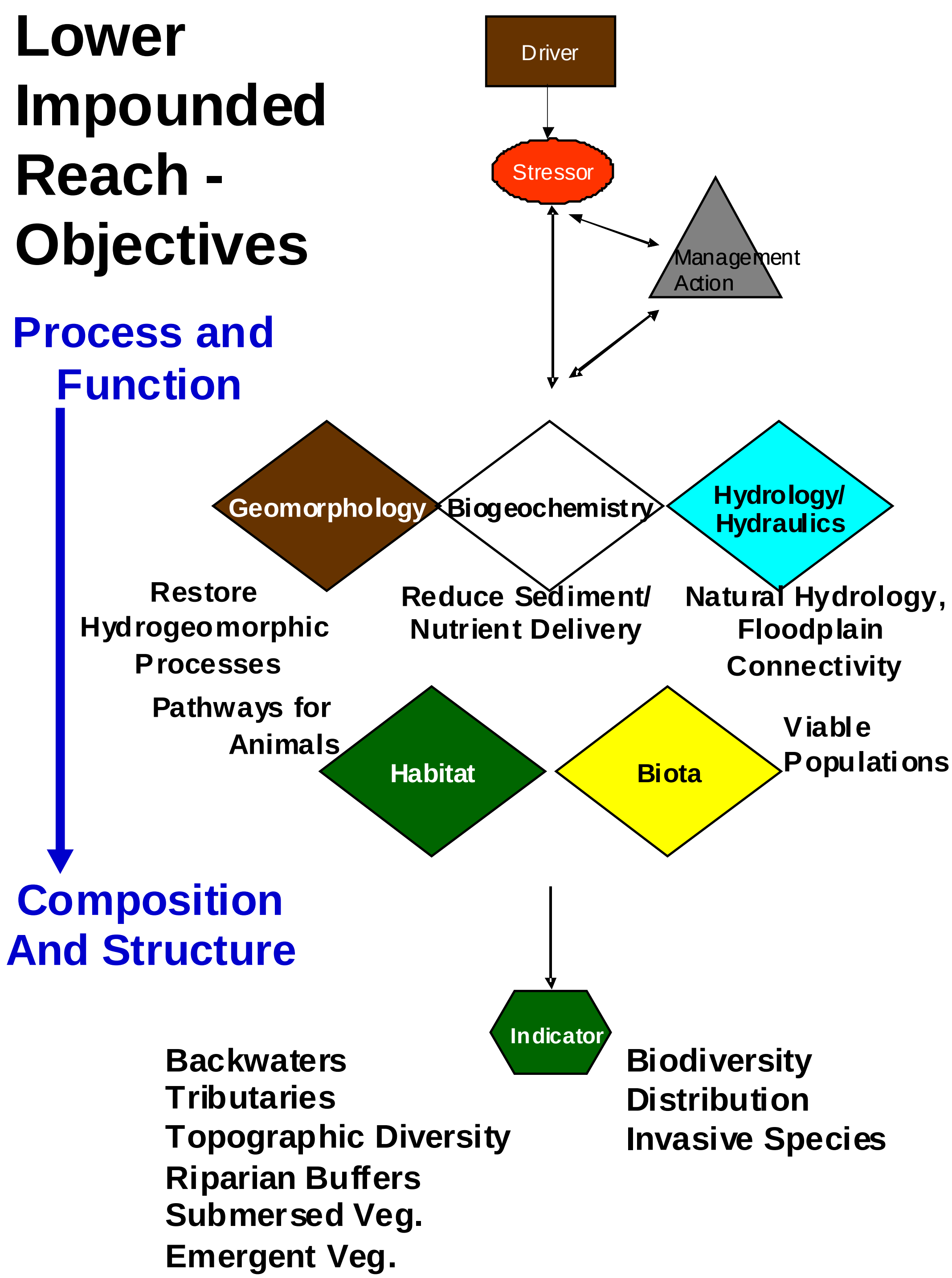

Figure ES-2. UMRS ecosystem conceptual model helps organize process and function objectives that support structural habitat outcomes

Table ES-2. Lower Impounded Reach Ecological Stressors

Stressors
Impoundment by locks and dams
River regulation affecting stage hydrograph
Dredging, sand/gravel mining removing bed material
Channel training structures - riprap, wing dams, closing dams
Sedimentation/sediment loading
Nutrient loading
Thermal loading from Nuclear Generating Plant in Cordova
Levees, floodplain development, drainage
Port facilities, riprap, floodwalls affecting main channel borders
Impacts of recreational boating traffic
Locks and Dams near-complete barriers to upriver fish movements
Navigation traffic impacts including fleeting/mooring
Contaminants from non-point sources
In-place pollutants
Increased annual discharge
Invasive species
Abundant common carp, sediment resuspension
Wind fetch, sediment resuspension in impounded areas (exascerbated by increased sediment)
Shoreline development
Contaminants loading and in-place pollutants
High lateral hydraulic connectivity, increasing over time
Sedimentation in off-channel areas
Altered sediment transport and depsosition
Floodplain encroachments (roads, embankments, dredged material deposits) limiting hydraulic connectivity
Littoral processes in impounded areas eroding islands
Long shorelines with riprap

Reach Planning teams did not feel the DSS parameters alone captured all the characteristics of subareas and they asked for more discrimination among potential restoration sites. Following a similar approach investigated for the Middle Mississippi River reach planning team, the FWIC assigned generic quality ratings to subareas in reaches 5 and 6 (Appendix B-1). The quality ratings were then used to help visualize the distribution of high quality areas and gaps in habitat (Figure ES-3). While subjective, the quality ranking analysis helps visualize the spatial distribution of subareas. At the conclusion of the planning activity, the FWIC and RRAT had identified 54 high priority subareas among the four geomorphic reaches. As they were asked to narrow projects down to a single subarea new project start selection, a lack of coordination between the groups made it hard to integrate priorities over large areas. The priority projects recommended by the River Resources Coordination Team (Table ES-3) ultimately included projects from this list (Eagle Fill and Lower Pool 22) and Lead Island in Pool 19 which are small-scale backwater clean-outs and drawdowns or have close association with navigation channel maintenance needs also.

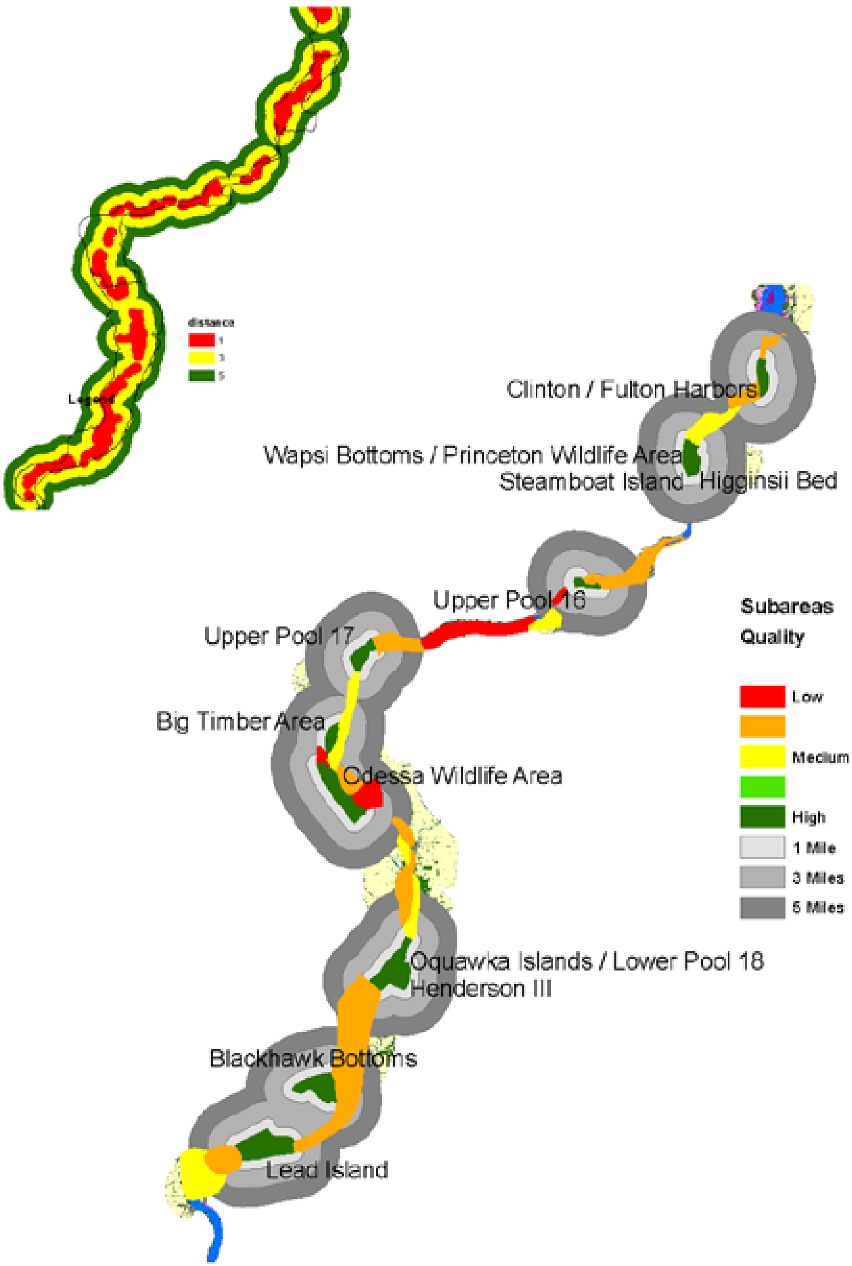

Figure ES-3. Buffer analysis identifies gaps (distance in miles) between high quality habitat areas to help identify high priority restoration areas

Table ES-3. Lower Impounded Reach high priority ecosystem restoration subareas

LOWER IMPOUNDED REACH					
Subarea Name	**Pool**	**River Mile**	**Type**	**State**	**Program**
Beaver Island Complex	14	516	Island/Side Channel	IA	EMP
Steamboat Island	14	503	Island/Side Channel	IA	EMP
Wapsi Bottoms / Princeton Wildlife Area	14	503	Floodplain Restoration	IA	
Milan Bottoms	16	475	Floodplain Restoration	IL	
Andalusia Island	16	474	Island/Side Channel	IL	EMP
Upper Pool 17	17	455	Island/Side Channel	IL/IA	
Middle Pool 17	17	446	Island/Side Channel	IL/IA	
Big Timber Area	17	443	Backwater Restoration	IA	EMP
Eagle Fill	17			IL ?	
Michael Creek	17	443	Floodplain Restoration	IL	
Boston Bay	17	438	Backwater Restoration	IL	
Kiethsburg Refuge	18	432	Backwater Restoration	IL/FED	
Huron/Johnson Island Complex	18	419	Island/Side Channel/Backwater	IA	EMP
Campbell Chute / Benton Island Complex	18	418	Island/Side Channel/Backwater	IL	
Blackhawk Bottoms	19	399	Floodplain Restoration	IA	
Green Bay Bottoms	19	387	Floodplain Restoration	IA	
Lima Lake Drainage District	20	356	Floodplain Restoration	IL	
Upper Buck Run	20	350	Floodplain Restoration	MO	
Bear Creek Flowage	21	341	Floodplain Restoration	IL	
Long Island Division/Canton Chute	21	332	Island/Side Channel	IL	
Quincy Bay	21	332	Island/Side Channel/Backwater	IL	
Ward Island/South Quincy D&LD	22	325	Island/Side Channel/Floodplain	IL	
Orton/Fabius Complex	22	323	Floodplain Restoration	MO	
Bay de Charles/Bay Island Complex	22	317	Island/Side Channel	IL	
Beebe/Schaffer/Armstrong/Turtle Islands	22	317	Island/Side Channel	IL	
Sny Bottoms - Detention Basins	22	315	Floodplain Restoration	IL	
Lower Pool 22 Channel Border/Lower P-22	22	307	Island/Side Channel	IL/MO	
Fisheries mitigation	All	multiple		NA	
Jim Young Chute (Cottel/Taylor Island Complex)	24	297	chute	IDNR	
Gilbert Island/Chute	24	294	island/chute	MDC	EMP
Blackbird Island complex	24	291	island/chute	MDC	EMP
Fritz Island Complex (Fritz,Willow)	24	286	island/chute	MDC	EMP
Denmark, Drift Cottonwood Islands	24	285	island/chute	IDNR	
Gosline Backwater	24	280	backwater	COE	
Slim Island Complex (Grimes, Willow Bar, McCoy)	24	263	chute	N/A	
Mosier Island Area - Howard Island	25	260	island/chute	MDC	
Clarence Cannon NWR	25	260	floodplain	FWS	EMP
Red's Landing Region - Kelly Island	25	256	island/chute	IDNR	
Prairie Slough/Deer Slough	25	255	island/chute	N/A	
Reds Landing - Wetland/Floodplain (EMP)	25	252	floodplain	IDNR	EMP
Sterling Landing Complex (Schwanigan, Eagle, Sterling, Maple, Norton Woods)	25	250	chute	MDC	EMP
Red's Landing Area - Maple Island	25	249	island/chute	IDNR	
Turner Island	25	244	island/chute	IDNR	
Sandy Slough - Side Channel	26	241	island/chute	MDC	EMP
Iowa Island/Enterprise Island	26	223	island/chute	COE	
Mason Island complex (Island 526)	26	219	island/chute	MDC	EMP
Portage Island	26	213		MDC	EMP
Upper Portage DesSioux Powerplant	26	210	backwater	COE	
Piasa Island Area -includes Eagles Nest Island	26	208	island/chute	IDNR	EMP
Brickhouse Slough	26	204	backwaters	MDC	EMP
Luesse Lake/Mile 215 tract (W. Alton EMP)	26		backwaters	MDC	EMP
Pool 26 WLM	26	201	system/policy	NA	EMP
Alton Slough	26	201		MDC	
Ellis Bay	26	200	backwater	COE	

UPPER MISSISSIPPI RIVER SYSTEM
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APPENDIX B

LOWER IMPOUNDED REACH PLAN

I. Geomorphic Reach 5

A. Reach Characteristics

Geomorphic Reach 5 includes the highly constricted Fulton-Rock Island gorge in pools 14 and 15, and the wide valley expansion in pools 16 and 17 (Figure 1). The portion of the reach through the gorge is a steep constrained channel with few islands and little floodplain terrestrial area. The river flattens in Pool 16 and large islands were formed when sediment was deposited in a main stem delta downstream of the steep gorge. Island formation in the Pool 17 channel is similar to Pool 16, but the valley widens significantly in the ancient Iowa River valley. The plan form changes in surface water distribution from impoundment are not as apparent in Geographic Reach5 compared to upstream reaches. Agriculture is an important component of the floodplain landscape; levees protect 12 percent and 74 percent of the pools 16 and 17 floodplain, respectively. The Quad Cities area is a large urban concentration which accounts for about 30 percent of the
floodplain in the reach.

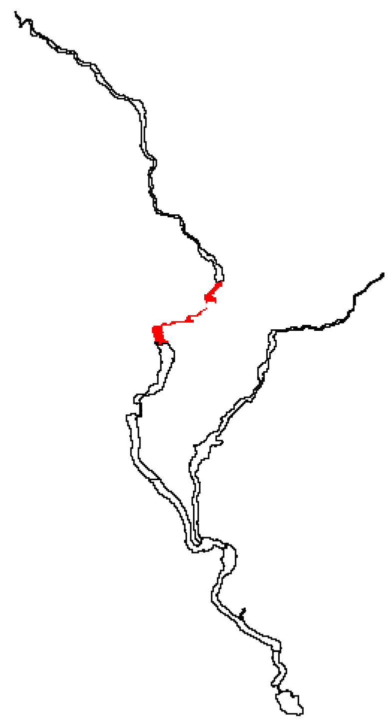


Figure 1. Upper Mississippi River System Geomorphic Reach 5 location map

Important ecological characteristics emphasize the transitional nature of this reach which separates the narrow valley reaches upstream from the broad valley reaches downstream (Table 1). Climate transitions and geomorphic factors cause a transition from forest and wetland to mixed forest, prairie, and wetland communities in the floodplain. While navigation system development was influential in upstream reaches, floodplain development is a major human disturbance in Reach 5. Low elevation, meandering rivers in oversized glacial valleys are important ecological areas in the valley constrained Geomorphic Reach 5. The Wapsipinicon and Iowa-Cedar River floodplains are less developed than the Rock River which is less visible in the agricultural matrix (Figure 2).

Table 1. Unique and important ecological characteristics of Upper Mississippi River System Geomorphic Reach 5

Transitional reach, end of north mixed and broadleaf forest, start of prairie parkland;
Change from forested wetland to prairie river
Narrow floodplain to broad floodplain; till to loess watersheds
Rock Island rapids gorge
Upper 16, ancient Iowa River valley, significant loess influence, "overbank alluvium"
Large islands, abundant
Shift to emergent annuals?
Shift to ephemeral isolated backwaters?
High degree of control, low frequency of open river @ L&D 15
Urban influence
Start of large agriculture influence
Start of leveed reaches.
Refuges patchily distributed, low public land

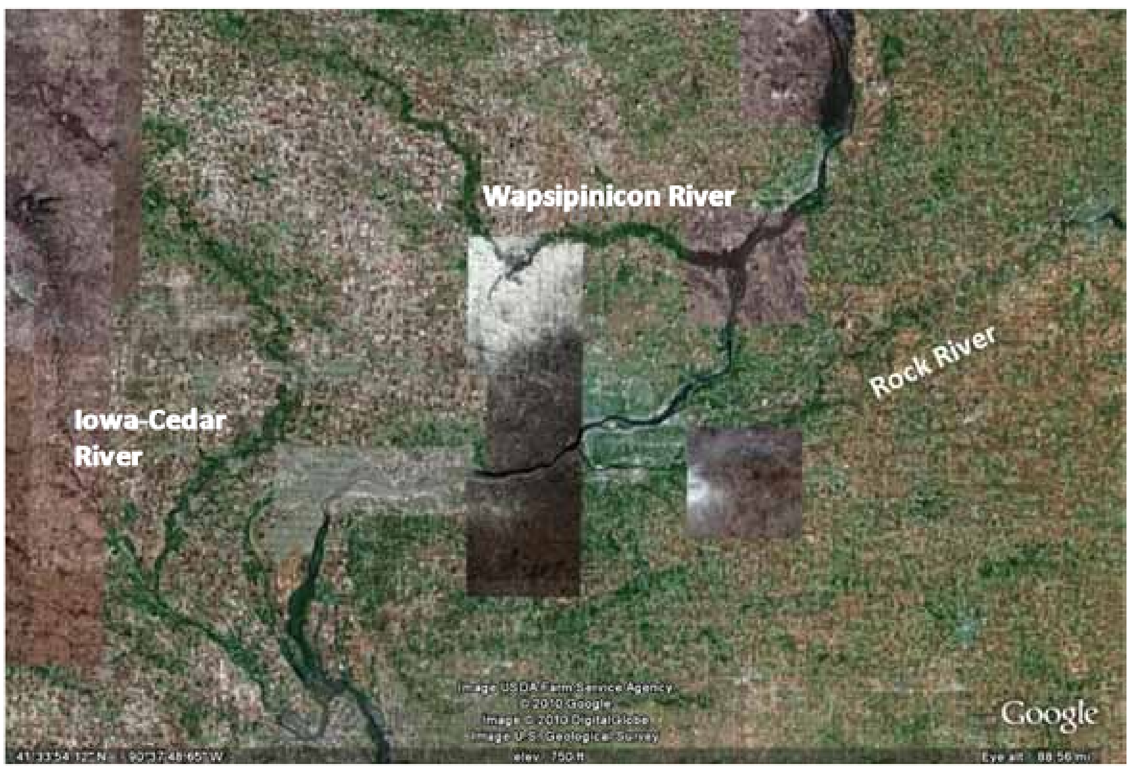


Figure 2. A large regional image of Geomorphic Reach 5 shows the proximity of large tributaries and differences in their ecological status

B. Land Cover

Geomorphic Reach 5 is The Wisconsin River and Rock Island Gorge Reaches are narrow forested corridors with the widening Maquoketa River Reach (Pool 13 and upper 14) separating them. The Maquoketa River Reach was shaped by glacial channels that carved a wider floodplain through erosive shale as the river migrated between the Mississippi and Illinois valleys. Forests dominated the narrower segments, wetlands and prairies occur in the wider sections (Figure 3). The river opens to the ancient Iowa River Valley below the Rock Island Gorge.

Development of UMRS rivers, floodplains, and watersheds occurred on a massive scale: 80 percent of the basin developed for human use, 50 percent of the floodplain isolated and converted to agriculture, 100 percent of the channels developed for commercial navigation, impounded backwaters over one-half of the floodplain in the upper pools, or the massive changes in sedimentation characteristics and rates in the middle and lower valley. Changes of such magnitude have obvious direct effects reflected in the land cover change (Figure 3), but there are also indirect effects not so readily apparent in the large community classes discussed here. Forest community composition and structure which has changed considerably in response to impoundment altering groundwater dynamic is not detected in the broad ecosystem classes used here. It is important to refine investigations to appropriate scales and extrapolate to this large ecosystem scale as applicable.

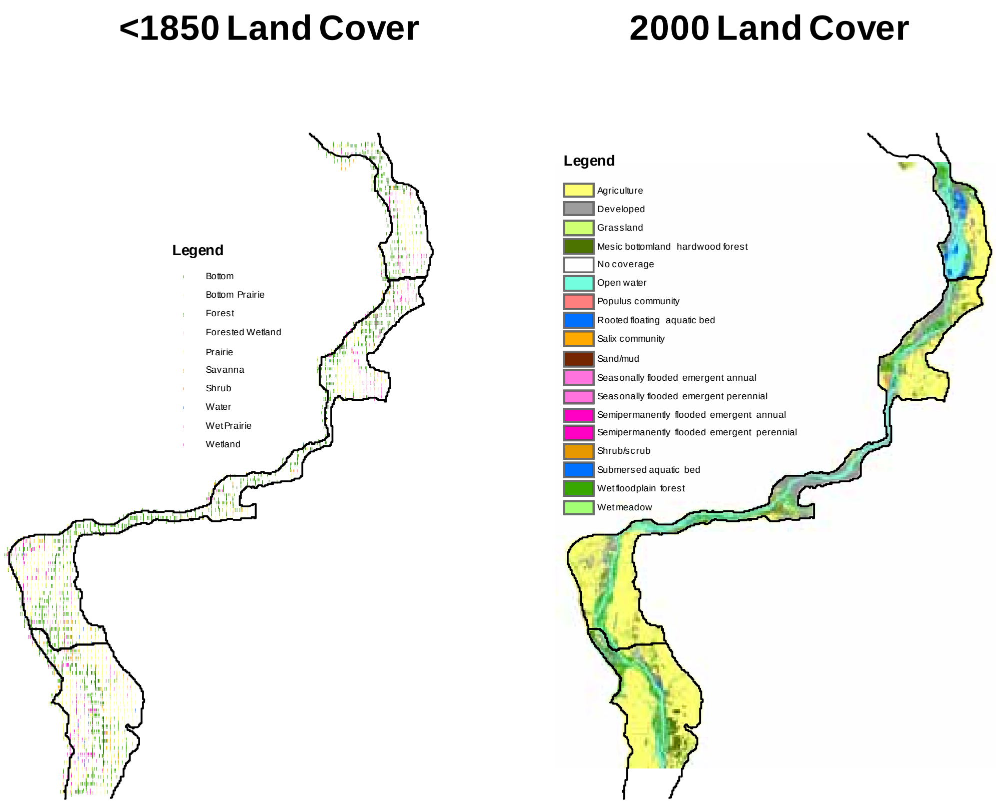


Figure 3. Upper Mississippi River Geomorphic Reach 5 land cover representing presettlement and contemporary conditions

C. Geomorphology

Geomorphic Reach 5 was defined by navigation pools for convenience, but it actually includes three separate geomorphic regions. The upper portion includes an erosive glacial river confluence at the Wapsipinicon River. Glacial rivers have flowed in many directions several times in this area, creating oversized valleys for the Wapsipinicon, Mississippi, and Rock Rivers which converge in this area. Glacial terraces and active floodplain are the dominant landforms in the reach (Figure 4). The Maquoketa River Reach has an unusually high topographic diversity.

The Rock Island Gorge Reach is a young reach formed during the peak of the Wisconsin glacier when marginal lakes cut through resistant rock to the ancient Iowa River Valley. The reach is steep, forming rapids that were a notable navigation hazard in the steamboat era. The mid section of the reach includes terraces that the Quad Cities, Illinois and Iowa are built on, but the lower part of the reach has low elevation floodplain because impoundment effects are minimal and sedimentation from the Rock River and other tributaries is high.

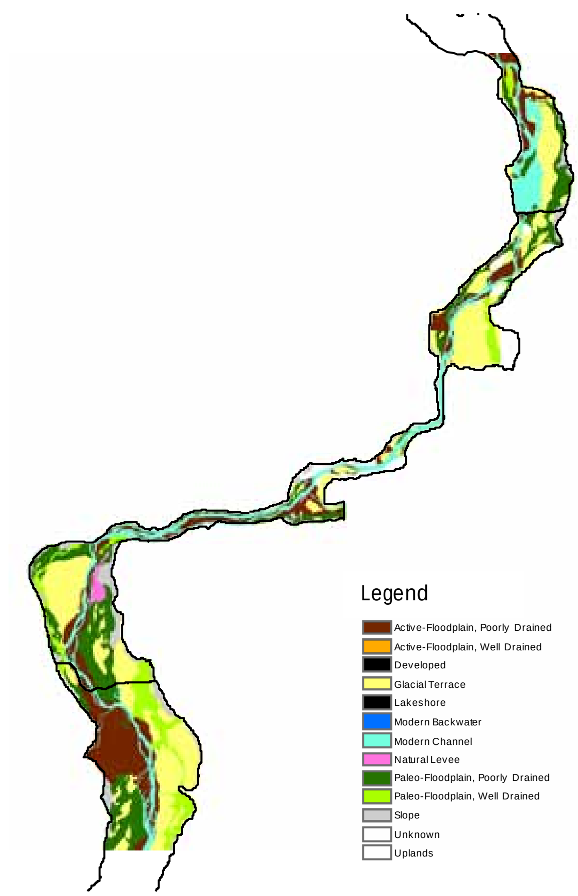


Figure 4. Upper Mississippi River Geomorphic Reach 5 geomorphology

D. Hydrology

Low head dams impounded water onto low elevation UMRS floodplains to maintain navigable waterways 9 feet deep (i.e., the 9-Foot Channel Project) and locks step boats and barges past the dams. The effects of dams are detectable in the stage hydrograph where river stage is greatly modified in the lower parts of each navigation pool, but less so in the upper parts of the pools (Figure 5). Large scale changes in the distribution of water differ upstream and downstream of Rock Island, Illinois. Most river miles upstream from Rock Island, Illinois have much more aquatic area, three times as much or more, than in pre-dam conditions. There is a within-pool hydrologic gradient that is more impounded and less variable in the lower region of pools and more naturalistic and dynamic in the upper pool (Figure 6). The planform distribution of water in river reaches below Rock Island, Illinois are not changed as much, except in the lower parts of Pools 16, 17, and 18.

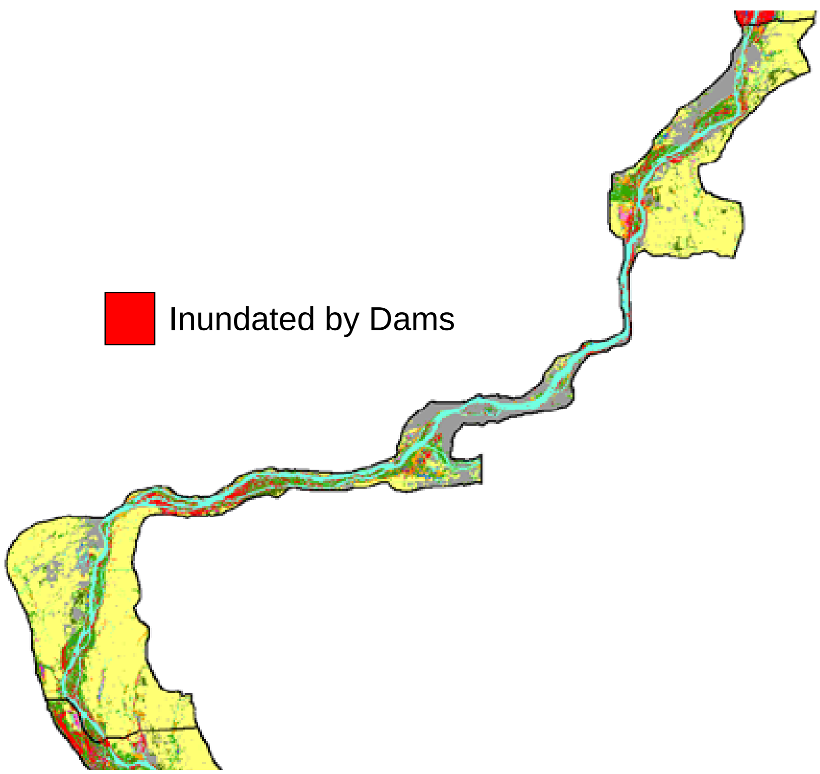


Figure 5. Areas inundated by dams in Upper Mississippi River Geomorphic Reach 5

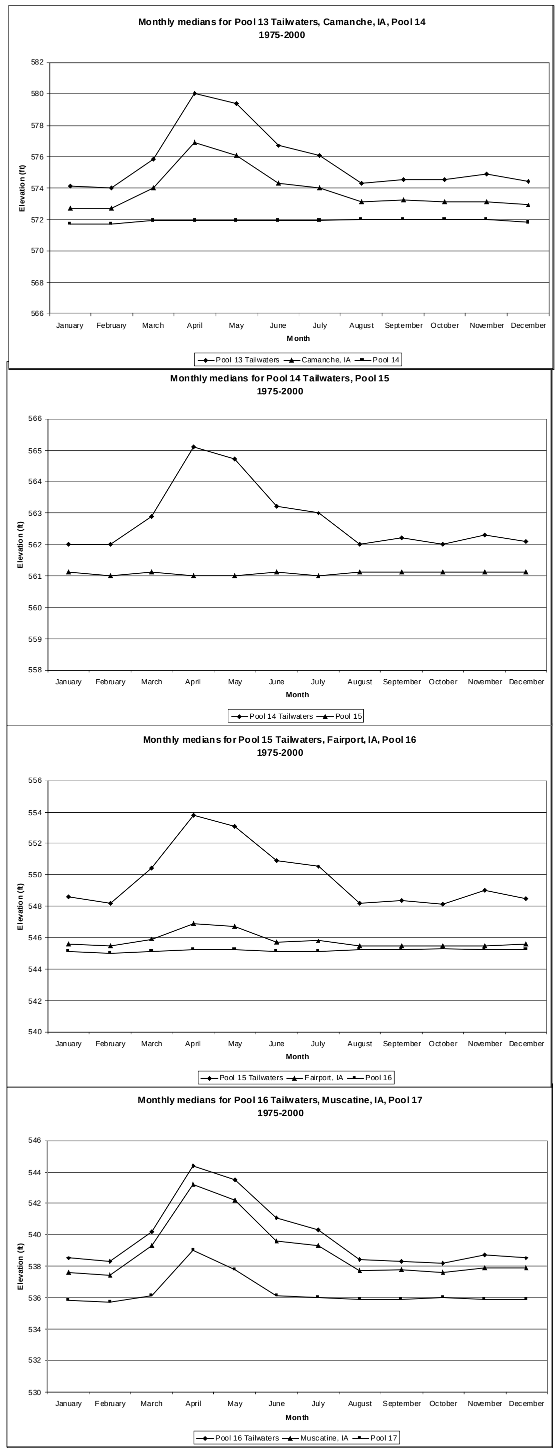


Figure 6. Average monthly river stage at lower, middle, and upper pool gauges in Upper Mississippi River System Geomorphic Reach 5

Main channel and secondary characteristics remain relatively constant between pre-dam and post-dam periods in impounded reaches (Figure 7). Backwater sedimentation gets increasingly worse progressing downstream from RM 500 where excessive sedimentation and loss of low river stage because of impoundment have degraded backwater habitat quality. There were very large increases in connected backwaters in the Upper Impounded Reach.

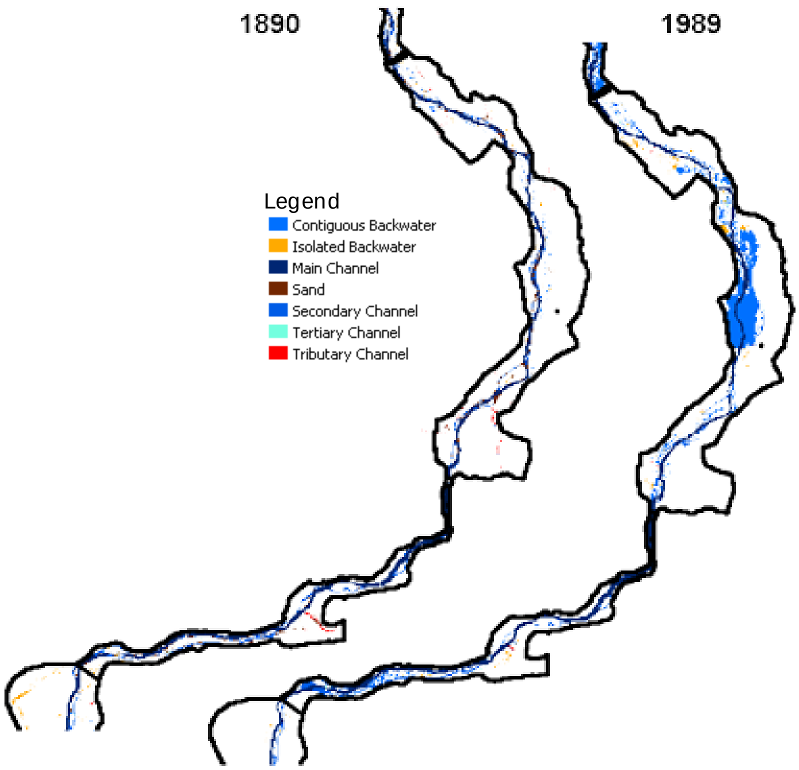


Figure 7. Upper Mississippi River System Geographic Reach5 aquatic areas were mapped for pre-dam (1890) and contemporary (1989) conditions

Common, high probability floods would potentially inundate much of the floodplain in river reaches below Rock Island if levees were not present (Figure 8). Uncommon floods only influence larger areas in steep valley segments in the Rock Island Gorge and Maquoketa River Reaches. Floodplain development changes hydraulic connectivity differently throughout the UMRS. Leveed area (shown in red) distribution is weighted toward the south and unleveed reaches occur north of Rock Island.

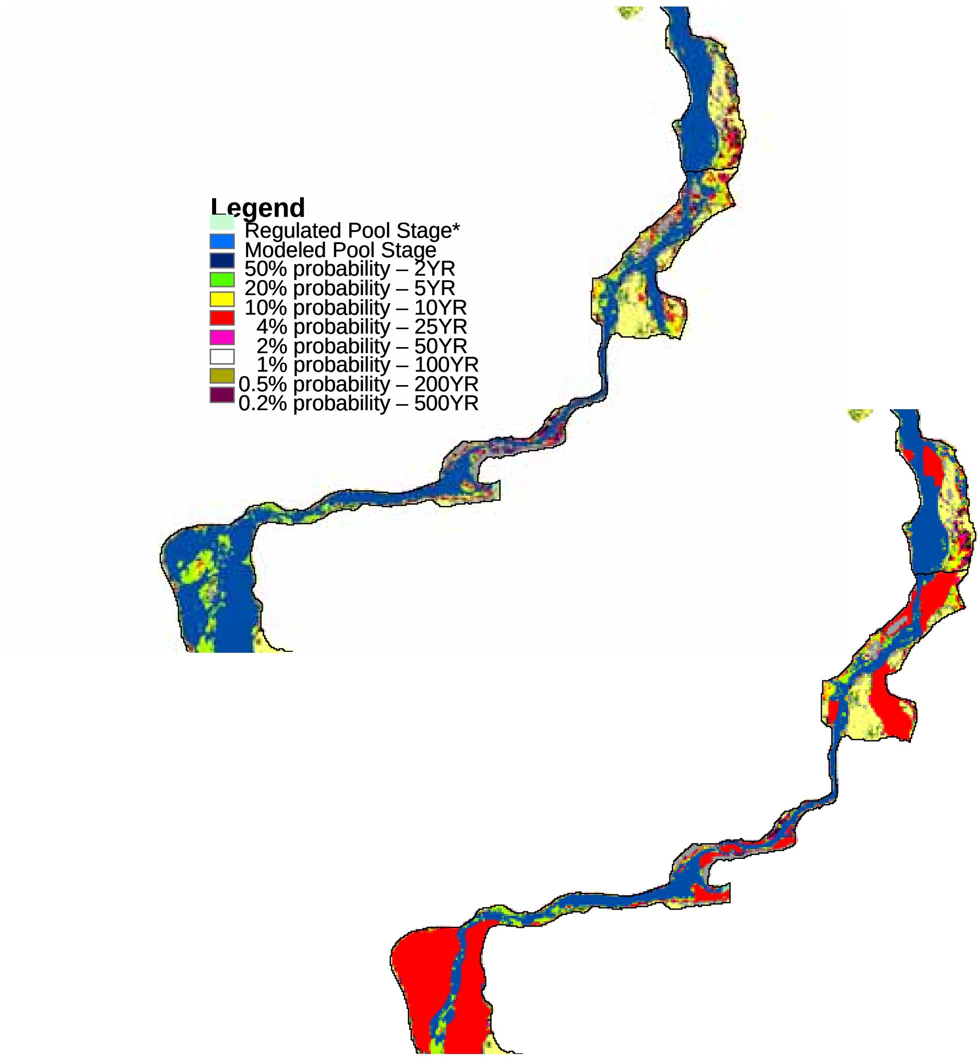


Figure 8. Simulated potential inundation for common (2-yr) to uncommon (500-yr) floods (top) and the simulated actual inundation area with leveed areas superimposed in red

E. Stressors

Levee and drainage districts pump against the head of navigation dams at great expense (Figure 9). Energy and economic savings could be matched with habitat, carbon, and nutrient sequestration gains to re-examine the types of ecosystem services that can be achieved in a multifunctional floodplain landscape.

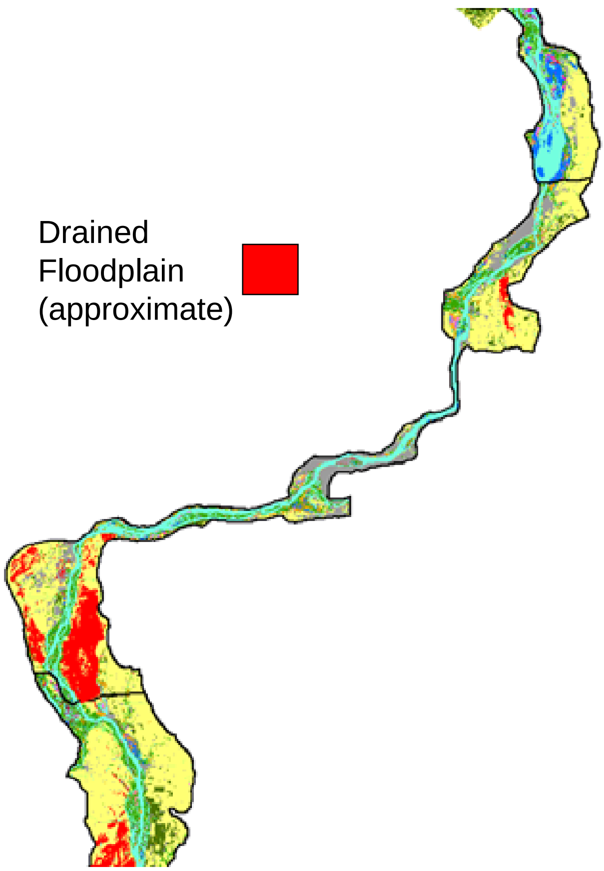


Figure 9. Simulated potential floodplain inundation if levee and drainage district pumps were turned off

Sedimentation in secondary channels and backwaters is widespread in connected aquatic areas of Upper Mississippi River system Geographic Reach 5 (Figure 10).

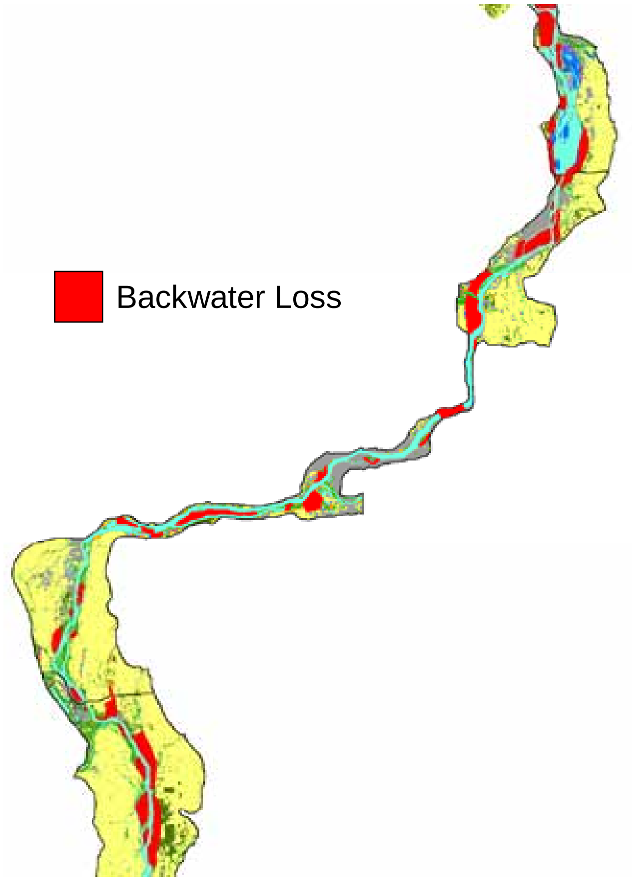


Figure 10. Historic and predicted backwater loss in Upper Mississippi River System backwaters and secondary channels

F. Cumulative Effects Studies Projected Future Condition

Reach 5 involves Pools 14 through 17. A significant portion of Pool 14 and all of Pool 15 occupy a relatively steep narrow bedrock gorge which greatly limits areas of contiguous and isolated backwater and numbers of islands. Downstream, in Pool 16, the valley gradient flattens and the valley width expands as the modern valley occupies a segment of an ancient river system. Islands become more numerous here, probably in response to flow expansion and velocity reduction that contribute to deposition of sediment transported through Pool 15. Farther downstream in Pool 17, the Mississippi River enters the ancient pre-glacial Iowa River valley where the valley width becomes exceptionally wide. The wide floodplain promotes flow expansion, velocity reduction, and contributes to extensive island development here. Reach 5 continues the trend of downstream decreasing complexity of aquatic areas that was noted previously. Areas of contiguous and isolated backwater and the total number of islands decrease significantly from Reach 5 downstream..

1. Pool 14. A loss of contiguous backwater was observed from historic data. This trend is predicted to occur throughout the upper pool. The loss of contiguous backwater area in the upper pool is probably due to the existence of a geologic control in the lower pool. The geologic control is seen to flatten the slope of the river in the upper pool. The reduction in slope results in the deposition of sediment and loss of backwater areas. However, it is important to note that the absolute change in total water area is small. Although a loss of 25 percent in backwater areas in upper pool 14 is predicted, the absolute change in total water acreage is small. A large decrease in perimeter of islands is expected as their shape simplify as the contiguous backwaters fill in.

The lower pool is controlled by the geology of the area. The river enters the Fulton to Rock Island gorge in the lower pool. Consequently, there is little diversity in the aquatic areas of the lower pool. Almost all of the water area within the lower pool is classified as main channel. Therefore, little change can occur in the future within the lower pool.

2. Pool 15. This pool is contained within a rock gorge. The geologic control provided by erosion resistant bedrock results in overall uniform conditions throughout the pool. Therefore, the area of backwaters within the pool is small. No significant changes in the aquatic areas are predicted.

3. Pool 16. Overall, the magnitude of change in Pool 16 is small. No concentrated areas of change in aquatic areas are predicted to occur in Pool 16. One localized area of contiguous backwater loss was identified from the analysis of historic plan form data. Pool 16 also is confined within a bedrock gorge, but the valley width is considerably wider than the Fulton-to-Rock Island sector in Pools 14 and 15. The greater width and various orientations of ancient buried bedrock valley systems in the area suggests that the Pool 16 bedrock gorge has greater antiquity than the gorge in Pools 14 and 15.

4. Pool 17. In total the size of aquatic area changes that were observed in Pool 17 are small. Similarly, the predicted future changes are also minor and no areas of concentrated change are expected. The small amount of isolated backwater area in the pool has been decreasing steadily since impoundment by the Lock & Dam. Although the percentage change in isolated backwater area over time has been large, the area this change represents is small.

From the historical data, one area was observed along the reach where sedimentation between wing dams was occurring. Upstream of this pool, this process was not observed in the historical plan form data set. However, it is believed that numerous wing dams have been buried by sediment deposited within upstream pools although this process was not specifically observed. The filling of sediments between wing dams could be the result of either natural deposition or placement of dredged materials or both. Most wing dams along the UMR were constructed prior to the installation of the existing lock & dam system and it is likely that sediment deposition between wing dams began immediately following their construction. The long term effect of the wing dams has been concentration of flow, narrowing of the channel and deposition of sediment within the channel border areas.

Ii. Geomorphic Reach 6

A. Reach Characteristics

Geomorphic Reach 6 consists of pools 18 and 19 (Figure 11). Pool 18 and upper 19 aquatic habitats are similar to reach 5, with many large islands and secondary channels. Impoundment effects are not pronounced in lower Pool 18, but Pool 19 is unique in the UMRS. Lower Pool 19 was a steep 10-mile long rapids through a rock gorge from Fort Madison to Keokuk, Iowa prior to impoundment. The 38-foot head hydroelectric dam constructed in 1913 inundated the gorge and about one-half of the 46-mile long reach. Much of the impounded area has filled with sediment, aquatic plants grow in areas that were 30 feet deep when the dam was constructed. The dam is the major impediment to fish migration throughout the basin, but it does allow fish movement through locks. The broad floodplain upstream from the gorge has largely been converted to agriculture. A little more than 30 percent of the reach is leveed, but most of the Illinois side of the river is a high glacial terrace that is not influenced by the river. Several moderate sized cities occur in the reach, and less than 15 percent of the floodplain is in public ownership.

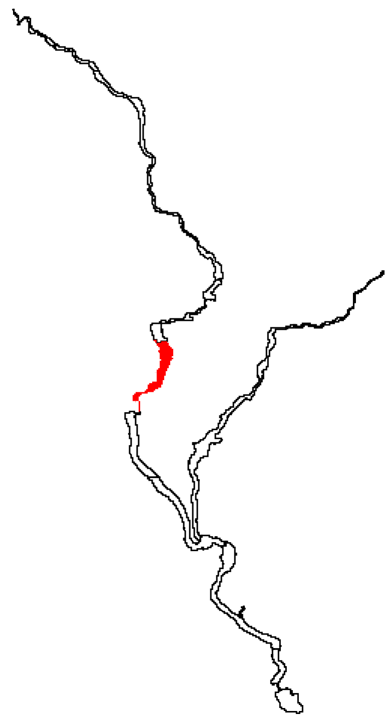


Figure 11. Upper Mississippi River System Geomorphic Reach 5 location map

Important ecological characteristics of the reach include the Keokuk Gorge which was a notable navigation and fish migration impediment (Table 2). Large aggregations of spawning blue suckers and other channel adapted species were annual occurrences. Floodplain plant communities included more prairie and riparian forests. The Iowa River is important because of the nutrients and sediment delivered, and also as a migration corridor for fishes moving into upper parts of watersheds (Figure 12). Impoundment changed the floodplain characteristics, but the resulting habitat developing in channel margin shallows and mudflats supports very large numbers of migratory waterfowl during spring migrations. Both pools are filling rapidly from high sediment transport from the Iowa River and upstream. Pool 18 islands are developing in the same footprint they occurred prior to impoundment.

Table 2. Unique and important ecological characteristics of Upper Mississippi River System Geomorphic Reach 5

Keokuk rapids
Keokuk dam/Pool 19
Pool 19 geomorphic change
Pool 19 longitudinal connectivity
Floodplain prairie
Floodplain ag
Large terraces
Iowa River distributary lowlands
Sediment trapping
Diving duck migratory habitat! (shift from Illinois)
High rate backwater loss
Relatively small surface water planform change due to impoundment
Pool 18 evolution toward pre-dam planform

Figure 12. The Lower Iowa-Cedar River meets the Mississippi River in Upper Pool 18 near the Port Louisa Refuge/Lake Odessa Wildlife Area

B. Land Cover

The Iowa River Reach is low elevation floodplain flanked by terraces supporting broad prairies and low elevation floodplain and tributary deltas supporting forest and wetland classes (Figure 13). The general impression of modern UMRS habitat quality is of a healthy functioning ecosystem that is attractive and fun for recreation in the Upper Impounded Reach, and more degraded and commercially developed agricultural and urban systems in the other reaches. Land cover characteristics in Geographic Reach 6 typically include a narrow riparian corridor of degraded habitat between levees (Figure 13). Agriculture and levee and drainage district development both have significant direct effects changing land cover. The conversion from forested wetlands, wetlands, and braided channels to lakes, marshes, and open impounded areas in the Upper Impounded Reach was indeed a massive direct effect conversion from ephemeral floodplain-aquatic habitat to a permanent aquatic habitat. Impoundment did not create significant new aquatic area below Rock Island and levee districts actively pump water to drain floodplain areas.

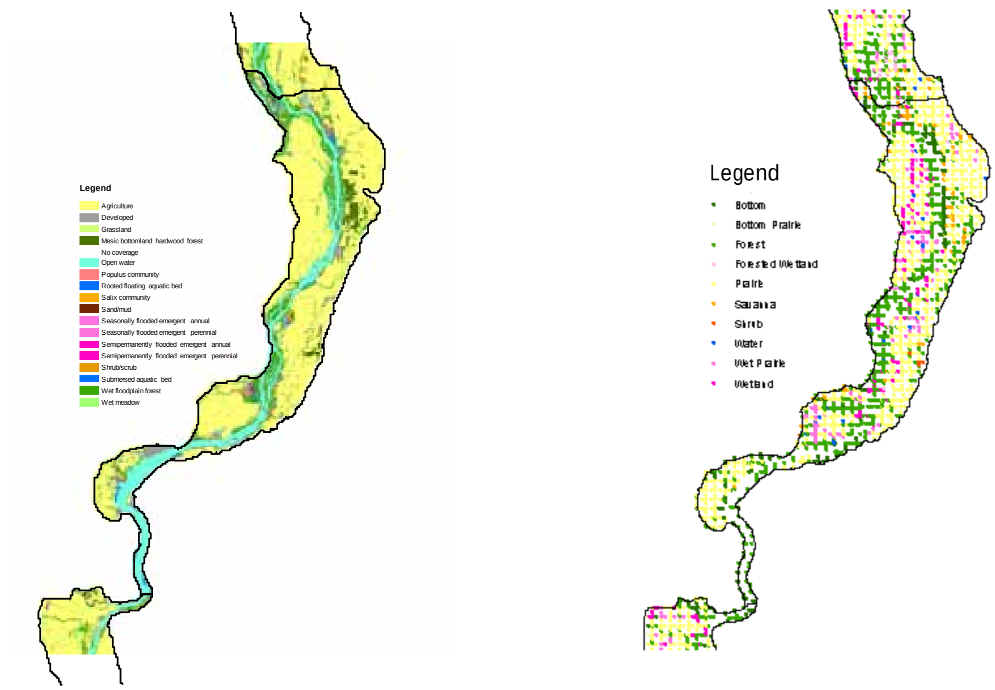


Figure 13. Upper Mississippi River System Geographic Reach 6 land cover for contemporary (left) and presettlement (right) conditions

C. Geomorphology

Prior to the construction of locks and dams this reach was among the steepest in the UMR system where it encompasses the Fort Madison to Keokuk gorge. The floodplain in Illinois is mostly terraces with embedded ancient anabranch channels (Figure 14). The Iowa floodplain has active floodplain deposits at tributaries and paleo-channels intersecting various floodplain surfaces. Due to the relatively narrow valley width of Pool 19, the relatively high dam, and the large sediment loads contributed to Reach 6 by the Iowa and Skunk Rivers, there has been considerable sedimentation in Pool 19 since lock and dam construction in 1913. The characteristics of the geology and structures in the reach make its geomorphic conditions unique along the UMR.

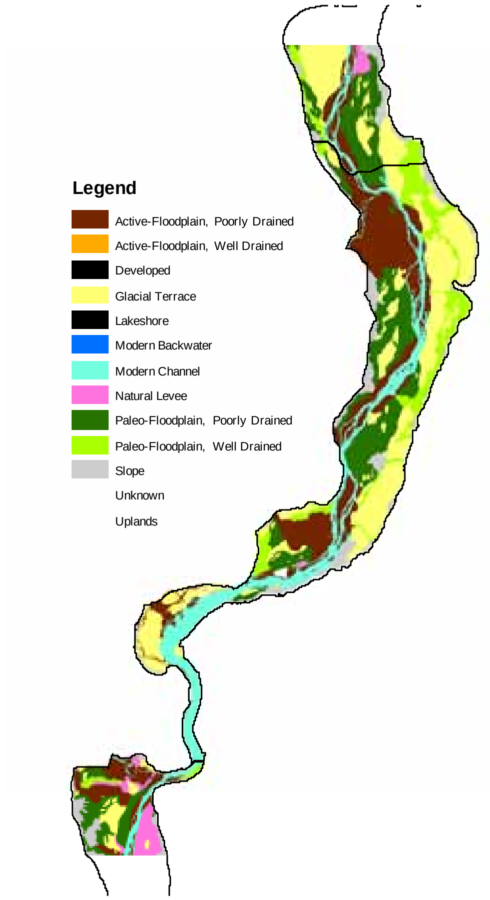


Figure 14. Upper Mississippi River System Geographic Reach 6 geomorphology

D. Hydrology

Low head dams impounded water onto low elevation UMRS floodplains to maintain navigable waterways 9 feet deep (i.e., the 9-Foot Channel Project) and locks step boats and barges past the dams. Large scale changes in the distribution of water are not apparent in Reach 6 (Figure 15). Most river miles upstream from Rock Island, Illinois have much more aquatic area, three times as much or more, in most areas than pre-dam conditions. The effects of dams are detectable in the stage hydrograph, however, where river stage is greatly modified in the lower parts of each navigation pool, but less so in the upper parts of the pools (Figure 15). There is a within-pool pattern that generally inundates the lower region of pools, partially inundates mid-pool reaches, and has relatively little planform change in the upper pool (Figure 16). The planform distribution of water in river reaches below Rock Island, Illinois are not changed as much, in Pool 18 as in Pool 19. Impoundment effects at Pool 19 are less pronounced in the constrained valley reach compared to Upper Impounded Reach impounded areas.

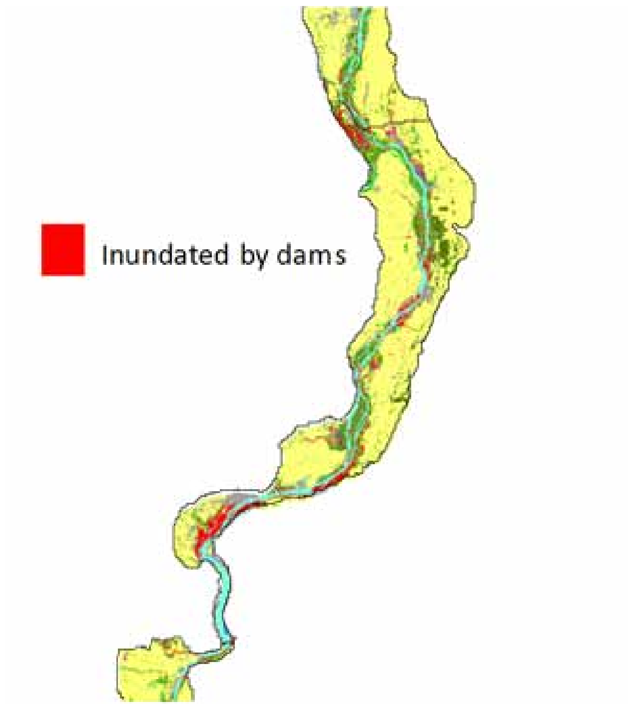
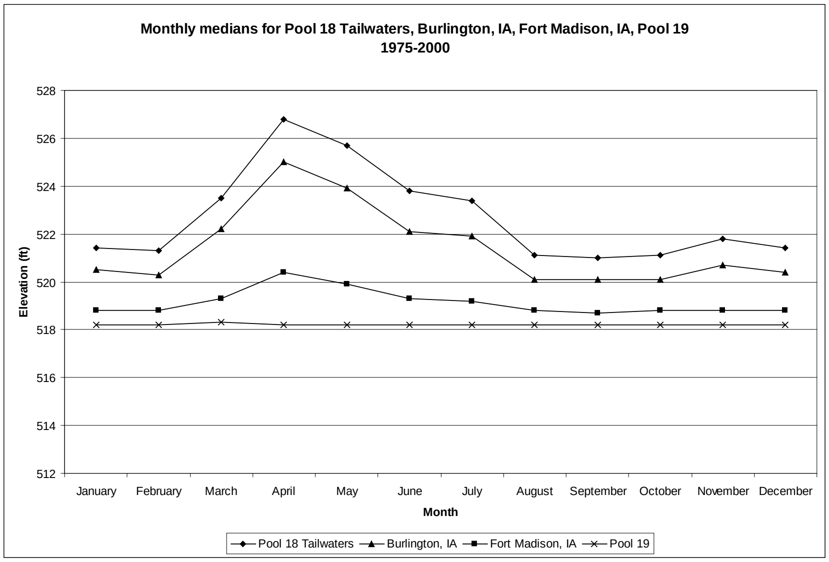


Figure 15. Areas inundated by dams in Upper Mississippi River Geographic Reach 6



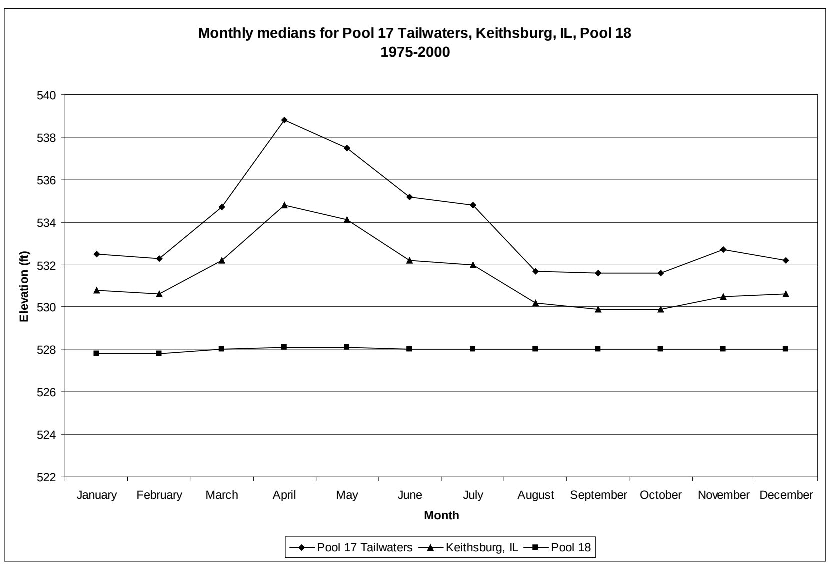


Figure 16. Average monthly river stage at lower, middle, and upper pool gauges in Upper Mississippi River System Geomorphic Reach 6

Common, high probability floods would potentially inundate much of the floodplain in river reaches below Rock Island if levees were not present (Figure 17). The uncommon 2 percent and 1 percent recurrence interval floods are only apparent in the alluvial fans of large tributaries and at the floodplain margins of Geomorphic Reach 6. The image of potential flood inundation illustrates the impoundment effect of Dam 19 which masks all flood stages under the Regulated Pool Stage compared to the rest of the reach where the 2-year flood distribution exceeds Regulated Pool Stage. Floodplain development changes hydraulic connectivity differently throughout the UMRS. Geomorphic Reach 6 is highly leveed, the unleveed area in Illinois are high terraces that do not interact with the river.

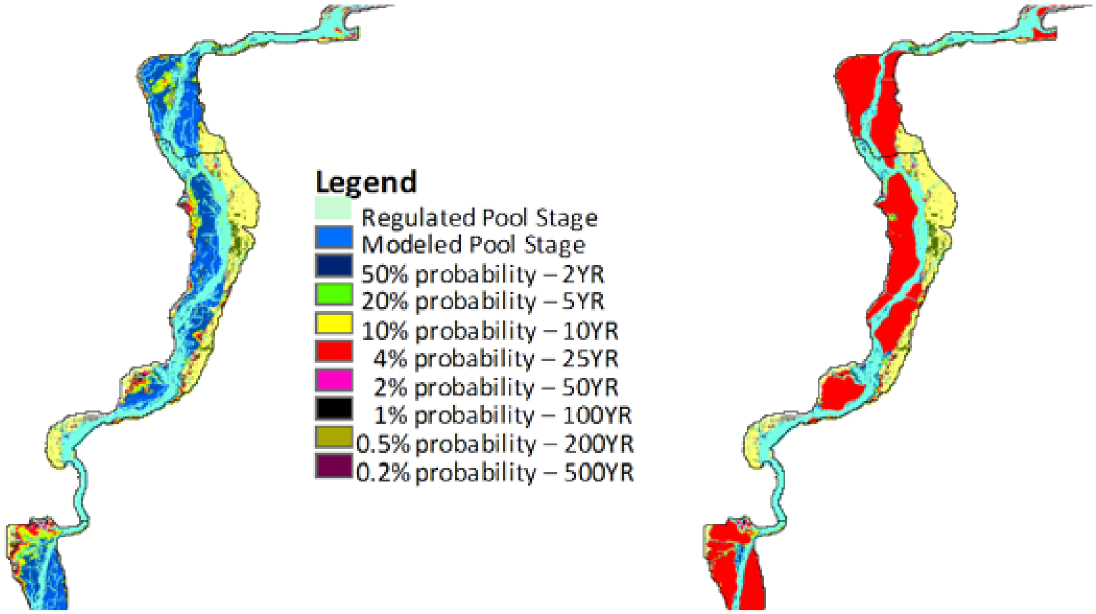


Figure 17. Simulated potential inundation for common (2-yr) to uncommon (500-yr) floods (top) and the simulated actual inundation area with leveed areas superimposed in red

E. Stressors

Levee and drainage districts pump against the head of navigation dams at great expense (Figure 18). Energy and economic savings could be matched with habitat, carbon, and nutrient sequestration gains to re-examine the types of ecosystem services that can be achieved in a multifunctional floodplain landscape.

High rates of sedimentation from Iowa tributaries combined with the oldest dam on the system and Dam 18 created a highly depositional reach (Figure 19). Pool 18 is the most highly dredged in the Rock Island District Sedimentation in the former gorge has filled the former valley and backwaters throughout the reach have increased sedimentation rates.

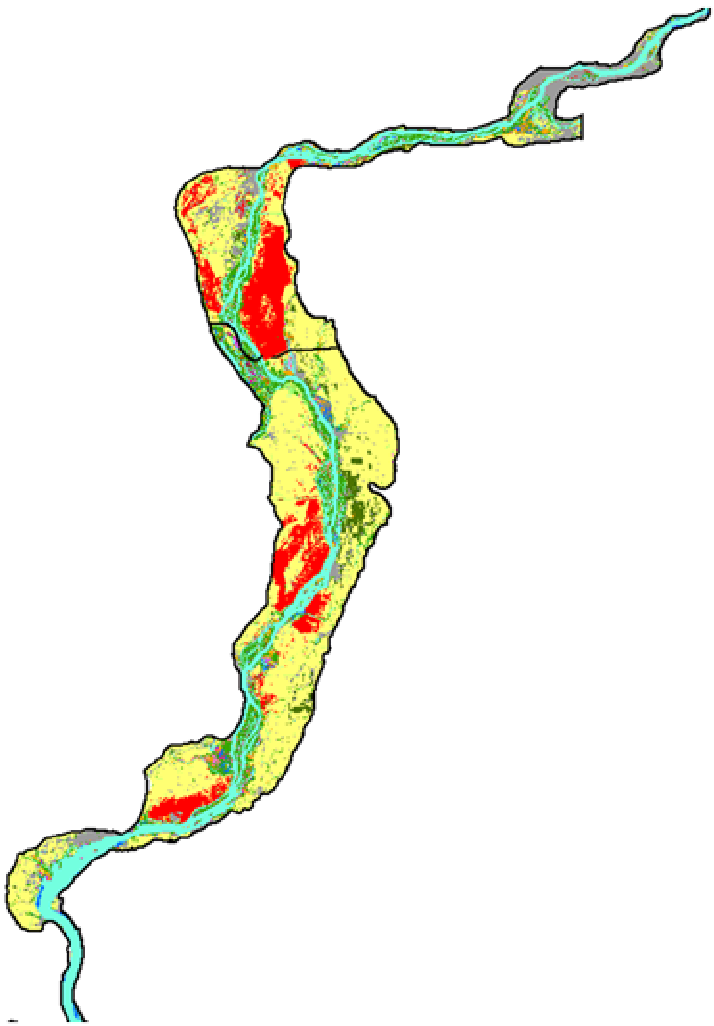


Figure 18. Simulated potential floodplain inundation if levee and drainage district pumps were turned off

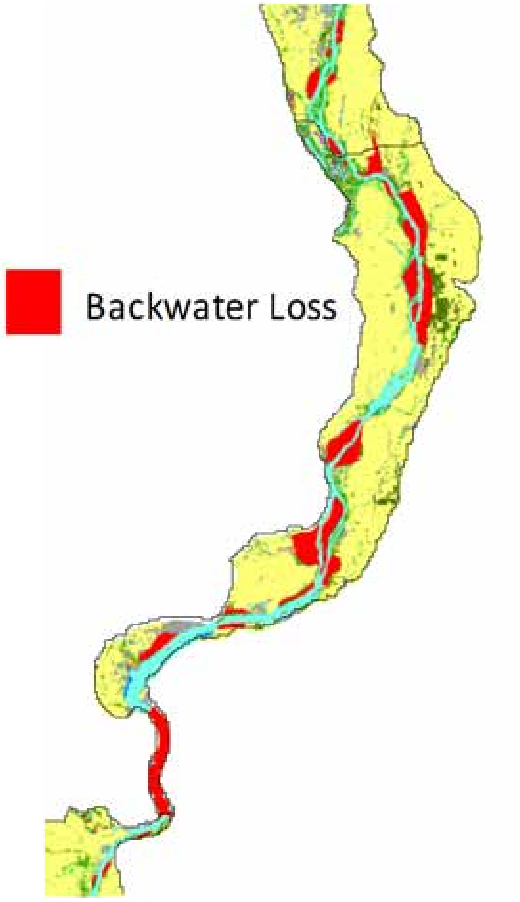


Figure 194. Historic and predicted backwater loss in Upper Mississippi River System backwaters and secondary channels

F. Cumulative Effects Future Geomorphic Change

Reach 6 involves Pools 18 and 19. Prior to the construction of locks and dams this reach, where it passed through the Fort Madison to Keokuk Rock Gorge, was among the steepest in the UMR system. It encompasses the Fort Madison to Keokuk Rock Gorge. Accordingly, the lift at Lock & Dam 19 is the highest and Pool 19 is the longest along the UMR. Due to the relatively narrow valley width of Pool 19, the relatively high dam, and the large sediment loads contributed to Reach 6 by the Iowa and Skunk Rivers, there has been considerable sedimentation in Pool 19 since lock and dam construction in 1913. The characteristics of the geology and structures in the reach make its geomorphic conditions unique along the UMR.

1. **Pool 18.** Several related processes were observed in Pool 18. In the upper pool, steady loss of backwater areas has been occurring. This trend is expected to continue. Deposition is located downstream of the confluence with the Iowa River, a large sediment source. Historical filling between wing dams is also observed and is depicted in a photo sequence in Section.

In the lower pool, both island formation and wind-wave erosion of islands were observed in the historical data. It is expected that island formation will continue in the future considering the available sediment supply from the Iowa River and the historical trend from the plan form data. The area of wind-wave erosion is small and therefore wind-wave erosion is expected to be insignificant in the future.

2. **Pool 19.** Pool 19 is unique due to its size and age. Lock & Dam 19 was constructed in 1913, much earlier than the other locks & dams in the system. With the exception of Lock & Dam 1, all other locks & dams were constructed in the 1930s. The lift of the lock is 38 ft, which is the highest on the UMR. A hydroelectric power plant is also located at the dam. This high dam created a unique situation for sediment deposition in the pool, as the storage volume created by the dam is the largest in the UMR system.

Results of the sediment budget show that Pool 19 accumulated about 10 times the amount of sediment that other pools collected prior to the 1950s. Consequently, comparison of conditions within Pool 19 to other pools along the UMR is generally not valid. The causes of sediment deposition in the pool are related to the operation and physical characteristics of the dam. The operation of Pool 19 is significantly different than all other locks & dams on the UMR. The other locks & dams operate as open river for a small percentage of each year. During open river operation all gates at the dam are fully open and no regulation of the flow occurs. However, at Lock & Dam 19, the only time it has had all its gates open was during the great flood of 1993. In fact, opening of the gates at that time, was found to be very difficult due to the sediment accumulation at the gates.

The Skunk River, a significant sediment source to the UMR, enters the upper pool. A significant and steady loss of backwater areas was identified in the upper pool from historic plan form data. Close to half of the backwater areas were determined to have been lost over the periods of analysis. A photo sequence depicting the loss of backwater area and filling of isolated backwater, in a portion of upper Pool 19, is shown in Section. It is predicted that such loss of backwater areas will continue in the future.

In the lower pool, no concentrated areas of plan form change were observed from the historical data. Absolute values of all aquatic areas, other than the main channel, are small. Overall, the lower pool is not expected to exhibit significant plan form change in the future.

III. Geomorphic Reach 7

A. Reach Characteristics

Geomorphic Reach 7 (Figure 20), including pools 20, 21, and 22, has a steep gradient because of sediment from the Des Moines River entering the Mississippi below the Keokuk Gorge and Lock and Dam 19. The reach shows evidence of ancient meander belts through the post-glacial alluvial soils. The modern river resembles the pre-development plan form because impoundment effects are not pronounced in plan form. There are fewer shoals and sand bars exposed because dams prohibit low river stages. Large island complexes and long interconnected secondary channels characterize much of the reach, but unstructured channel reaches are evident too. Agriculture is the dominant floodplain landscape element, whereas forest and wetlands formerly occurred at low elevations and prairies occurred on high elevations. The floodplain in the reach is about 70 percent leveed. There is little urban development, but less than 10,000 acres of public land.

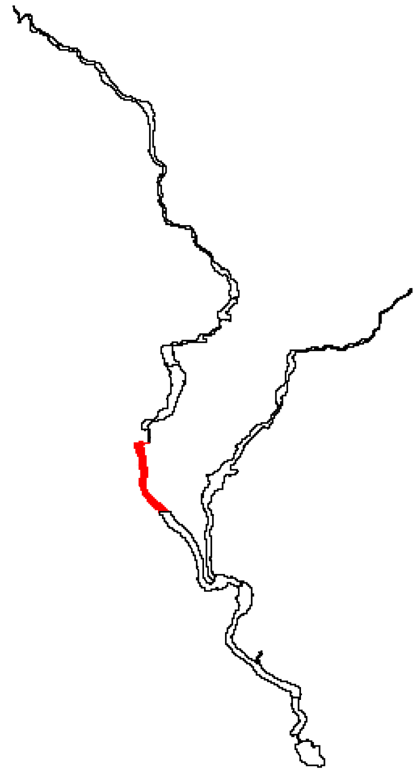


Figure 20. Upper Mississippi River System Geographic Reach7 location map

An important characteristic of the contemporary UMRS Geomorphic Reach 7 is that it is a highly agricultural region with many levees (Table 3). The Des Moines River confluence is a unique feature that creates high topographic diversity at the outflow from the Keokuk Gorge. A large natural levee formed on the Illinois floodplain by Des Moines River outflow helped create Lima Lake which was a large isolated floodplain lake visible through the 1800s (Figure 21). The lake was drained for agricultural production and not present in modern maps. The reach had a meandering character in the past which has left large anabranch channels with variable river connectivity in the floodplain. Similar to changes in Lima Lake, floodplain development also isolated large secondary channels and ancient overflow channels that convey water on the floodplain. Secondary channels and large islands closer to the active channel remain as the predominant aquatic habitat now.

Table 3. Unique and important characteristics in Upper Mississippi River System Geographic Reach7

Prairie river
Straight, sandbed channel
Large islands and side channels
Small post impoundment planform change
Large agricultural production
Large proportion of levees
Start of meandering planform
Lima Lake

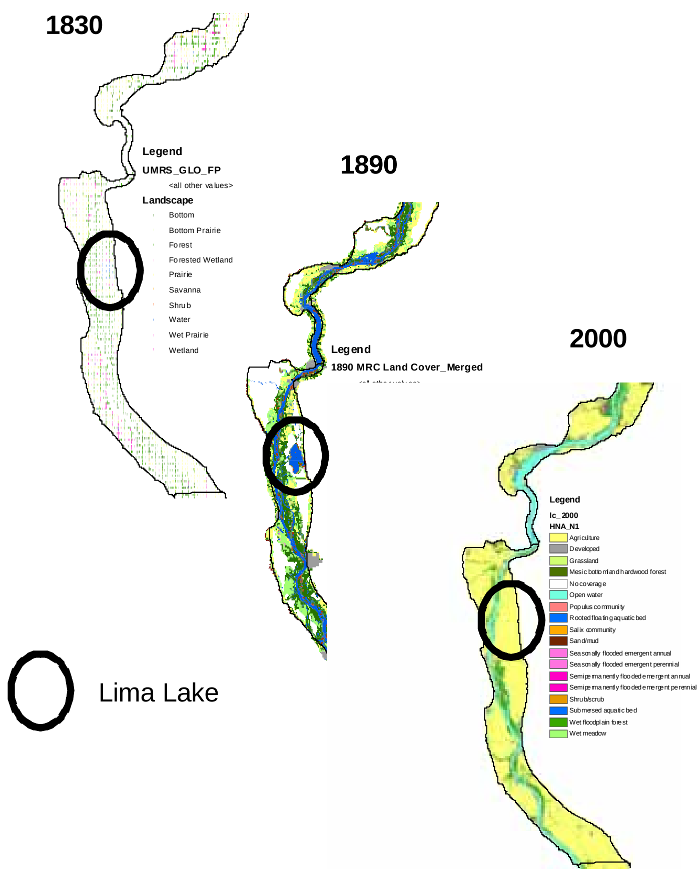


Figure 21. Lima Lake was a persistent isolated floodplain lake until drained for crop production.

B. Land Cover

The Des Moines and Salt Rivers tributary fans from the west supported prairie and wetlands in the in the upper part of Reach 7 on the Missouri floodplain (Figure 22). Prairie on the Illinois floodplain occurred on the prominent colluvial slopes along the base of the bluff. An ancient Des Moines River levee on the east bank of the river and colluvial slopes fingering in from the bluff formed a basin, Lima Lake, which was a persistent feature of the Illinois floodplain landscape. Colluvial slopes along the Illinois bluff in the toward the lower end of the reach supported prairies. A large natural levee splays onto the Illinois floodplain and small tributaries from the Missouri bluff create topographic diversity for the mixed riparian forest community through the middle of the reach. Riparian forest was distributed rather continuously on the active floodplain near the channel. The modern land cover is mostly agriculture except for several island-side channel complexes between levees lining the banklines.

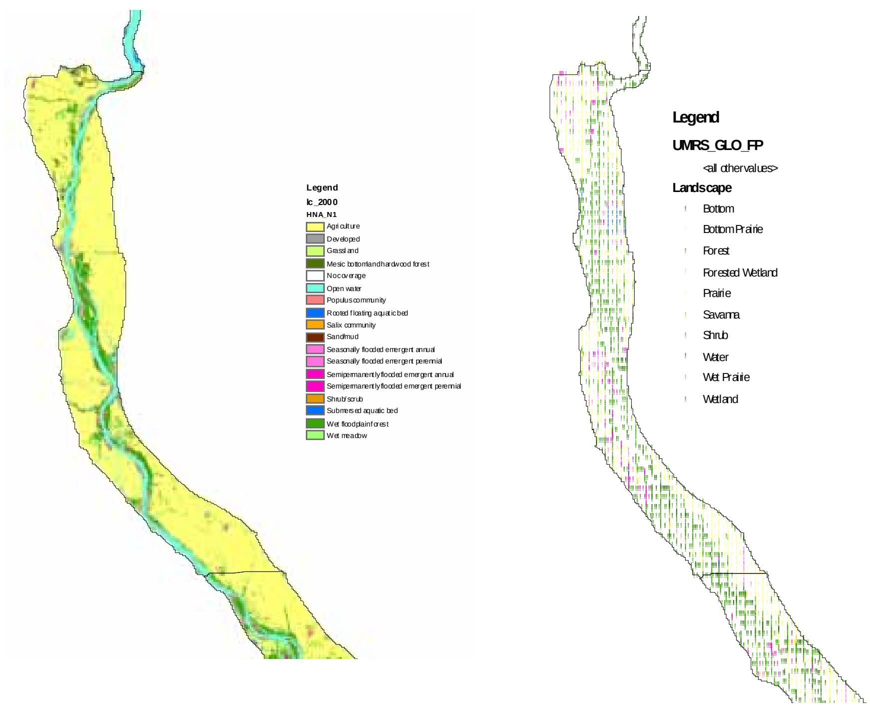


Figure 22. Upper Mississippi River System Geographic Reach7 land cover for contemporary (left) and presettlement (right) conditions

C. Geomorphology

1. Des Moines River Reach. The Des Moines River Reach is dominated by a very large sediment fan formed from the West and North (Figure 23). The fan creates great diversity of high and low elevation floodplain at the confluence of the gorge and the Des Moines River. A large levee and crevasse splay develops over paleo-floodplain and becomes interfingered with colluvial material to the east. The river channel crosses the floodplain several times in the reach. Active floodplain is coincident with tributaries on the Iowa side of the river. Islands occur as fewer, larger individual islands with a moderate total area compared to other reaches. Island abundance increases at the lower end of the reach.

2. Quincy Anabranch Reach. In the Quincy Anabranch Reach the river runs close to the Missouri bluffs and a sequence of levee and crevasse splays, Yazoo meander belt, and colluvial slope progress across the floodplain to the Illinois bluff line (Figure 23). Active floodplain area increases downstream through the reach and at the Salt River tributary fan which moves the river off the Missouri bluff for several miles before it moves back to the bluff. The natural levee forms a partial barrier between the river and backswamps which have hydraulic connections back to the bluffs.

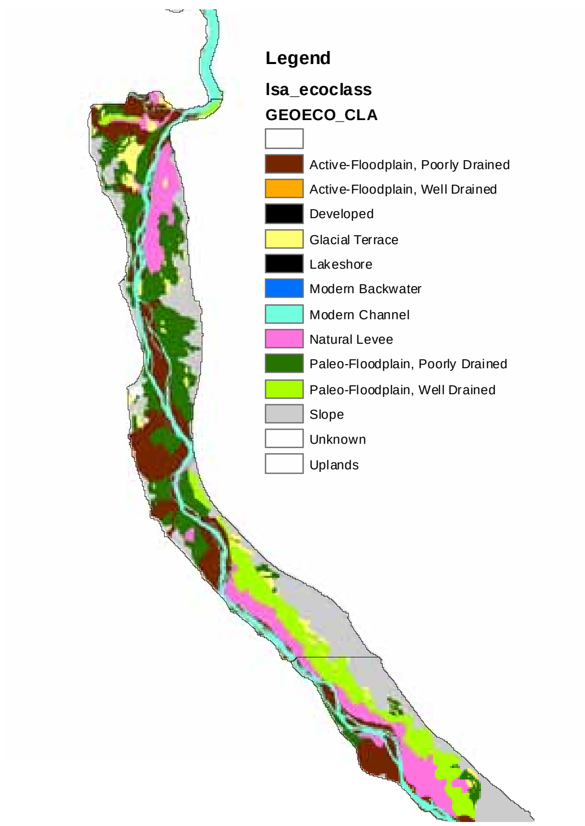


Figure 23. Upper Mississippi River Geomorphic Reach 5 geomorphology

D. Hydrology

The effects of dams are detectable in the stage hydrograph where river stage is greatly modified in the lower parts of each navigation pool (Figure 24), but less so in the upper parts of the pools. Large scale changes in the distribution of water differ upstream and downstream of Rock Island, Illinois. Most river miles upstream from Rock Island, Illinois have much more aquatic area than in pre-dam conditions. The planform distribution of water in Reach 7 is not changed very much (Figure 25), but impacts to the annual hydrologic variation are evident in lower parts of each pool.

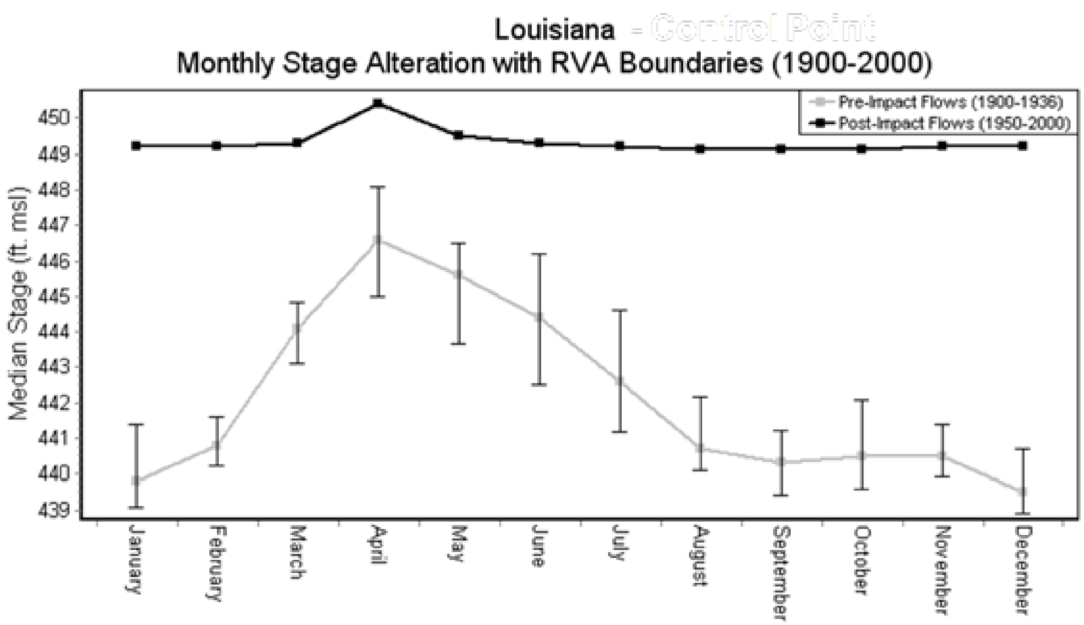


Figure 24. The annual stage hydrograph at the Pool 24 control point at Louisiana, Missouri is raised 10 feet over pre-dam low flow conditions and can be regulated so the spring flood is only slightly higher than the regulated stage

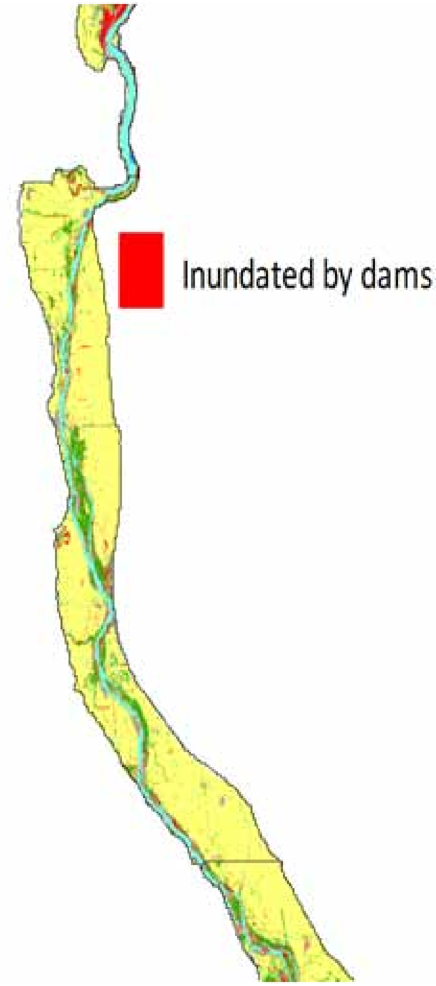


Figure 25. The change in surface water distribution is barely detectable in Geographic Reach7

Low head dams impounded water onto low elevation UMRS floodplains to maintain navigable waterways 9 feet deep (i.e., the 9-Foot Channel Project) and locks step boats and barges past the dams. The effects of dams are diminish upstream from the dams, where the stage hydrograph is greatly modified in the lower parts of each navigation pool, but less so in the upper parts of the pools (Figure 26). Large scale changes in the distribution of water differ upstream and downstream of Rock Island, Illinois.

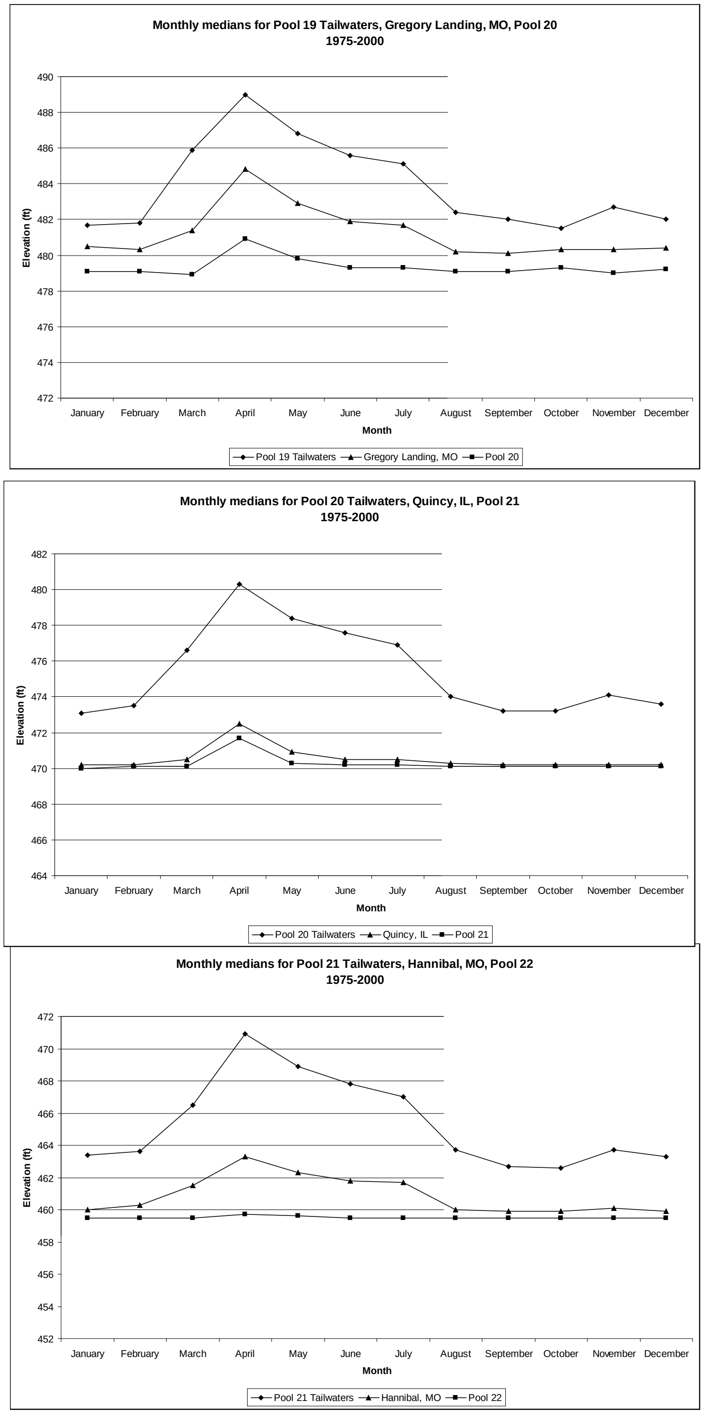


Figure 26. Annual monthly stage hydrographs at the upper and lower dams and a mid-pool gauge illustrate the hydrologic zonation within each navigation pool in Geographic Reach7

Common, high probability floods would potentially inundate much of the floodplain in river reaches below Rock Island if levees were not present (Figure 27). The uncommon 50 and 100 year floods (i.e., 2 percent and 1 percent recurrence interval) are only apparent in the alluvial fans of the Des Moines River and at the colluvial slopes at the floodplain margins of Geomorphic Reach 7. The regulated pool stage illustrates the minimal impoundment effects in Geomorphic Reach 7, and in this highly leveed reach, the contemporary 2-year flood distribution barely exceeds the regulated pool stage distribution of water. Floodplain development changes hydraulic connectivity differently throughout the UMRS, Geographic Reach7 is entirely leveed by various sized levee districts; some very large ones in Illinois.

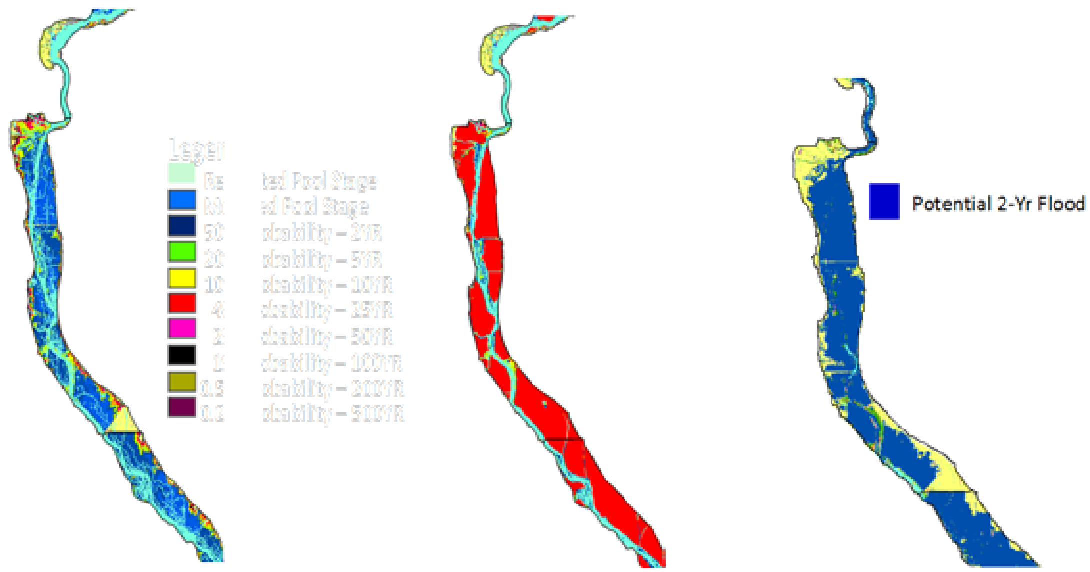


Figure 27. Simulated potential inundation for common (2-yr) to uncommon (500-yr) floods (top) and the simulated actual inundation area with leveed areas superimposed in red

E. Stressors

Levee and drainage districts pump against the head of navigation dams at great expense (Figure 28). Energy and economic savings could be matched with habitat, carbon, and nutrient sequestration gains to re-examine the types of ecosystem services that can be achieved in a multifunctional floodplain landscape.

High rates of sedimentation from the Des Moines and upstream concentrated between levees causes excessive sedimentation in connected floodplains and backwaters. Backwaters are degraded throughout Geomorphic Reach 7 (Figure 29).

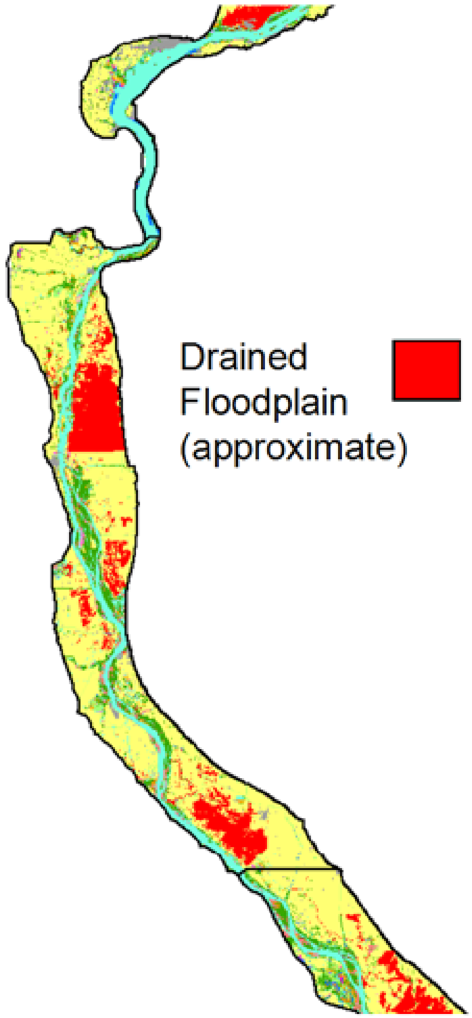


Figure 28. Simulated potential floodplain inundation if levee and drainage district pumps were turned off

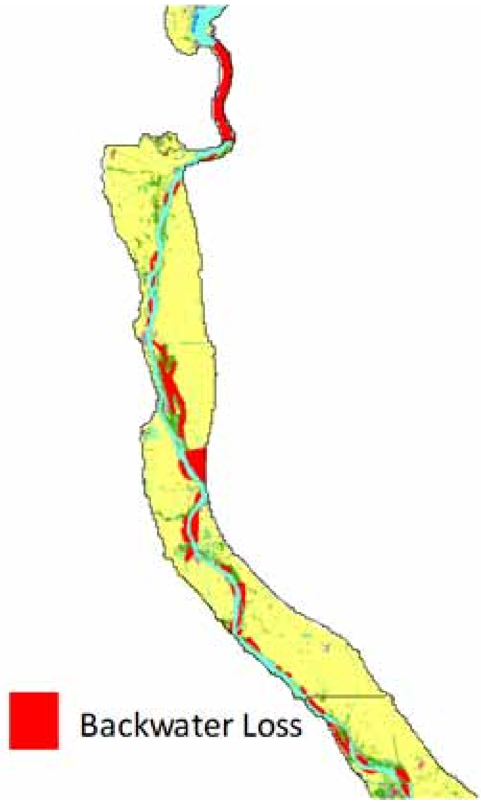


Figure 29. Historic and predicted backwater loss in Upper Mississippi River System backwaters and secondary channels

F. Cumulative Effects Future Geomorphic Change

Reach 7 is comprised of Pools 20 through 22. As seen from historic maps and aerial photographs, the reach exhibits evidence of old meander belts and has extensive deposits of post-glacial alluvium. These phenomena indicate that lateral channel migrations and adjustments were a common natural process in this reach during post-glacial time, but during historic time the river has been largely artificially confined by training structures..

1. Pool 20. Overall, changes in aquatic areas of the pool are small. Historic plan form data analysis results indicate the loss of various small areas of contiguous backwaters and the filling of sediment between wing dams. It is noted that area of contiguous and isolated backwaters is small. The percentage change of isolated backwater areas is a reflection of their small size.

The Des Moines River, a major tributary to the UMR and source of bedload sediment, joins Pool 20 in the upper pool. Backwater areas downstream of the confluence were found to be filling with sediments and are predicted to continue to do so. The filling between wing dams is judged to have been substantially completed. No significant future filling between wing dams is predicted as the aerial photos show that most of the areas between the wing dams are filled in.

2. Pool 21. The geomorphic changes, observed in Pool 21, are very similar to those observed for Pool 20. Backwater areas were observed to be decreasing over the historic period of record. This change is most significant in the upper portion of the pool. This trend is expected to continue. Areas between wing dams were also observed to be filling at several locations over the period of record. Future filling between wing dams is expected.

3. Pool 22. The results for Pool 22 are similar to those for the other pools within Reach 7. The overall change in aquatic areas within the pool is small. Results of the analysis of historic plan form data indicate increase of contiguous backwaters. However, the total open water area has historically decreased by a similar amount. It is expected that sedimentation in backwater areas will reverse the increasing trend for contiguous and isolated backwaters. The loss is expected primarily within the upper pool.

IV. Geomorphic Reach 8

A. Reach Characteristics

Geomorphic Reach 8 includes pools 24, 25, and 26 (Figure 30). The slope of the riverbed decreases through the reach to the hump of the Illinois and Missouri river alluvial fans. The Missouri River contributes most to this feature because of the lower flow and higher suspended sediment component of the Illinois River. The modern river resembles the pre-development plan form, but there are fewer shoals and sand bars exposed at low flows. Upper pool reaches of the pools have numerous large islands and mostly simple single thread secondary channels. Lower pool reaches generally have smaller and fewer islands. Impoundment effects are noticeable immediately upstream from locks and dams 25 and 26. Agriculture is the dominant floodplain landscape element. About 70 percent of pools 24 and 25 is leveed. Only about 23 percent of the Pool 26 floodplain is leveed on the available GIS coverages. There is little urban development in the floodplain, but less than 15 percent of the floodplain is public land.

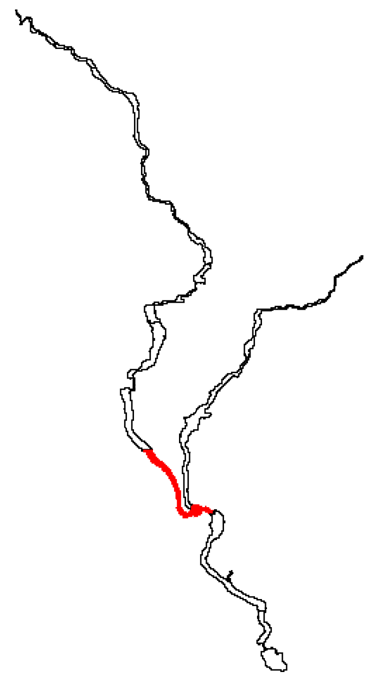


Figure 30. Upper Mississippi River System Geographic Reach 8 location map.

An important characteristic of the contemporary UMRS Geomorphic Reach 8 is that it is a highly agricultural region with many levees (Table 4). Geomorphic Reach 8 has a unique geomorphology, with resistant rock walls on the East bluff forming prominent limestone cliffs. Many small tributaries enter from the Missouri Ozarks and deposit coarse bedded alluvial fans that fill over older floodplain surfaces (Figure 31). Former channels, overflow channels, and active secondary channels on the Illinois floodplain were incorporated into the Sny Levee and Drainage District infrastructure (Figure 32). The region is frequently flooded because flood waters are impounded by a mound of sediment at the Missouri River. Frequent flooding has limited agriculture somewhat and encouraged development of numerous private duck hunting clubs in the region.

Table 4. Unique and important characteristics in Upper Mississippi River System Geographic Reach7

Prairie river
Straight, sandbed channel
Large islands and side channels
Small post impoundment planform change
Large agricultural production
Meandering planform locked by channel training/regulating structures
Salt, Illinois, Sny and Cuivre River distributary lowlands
Secondary channels isolated as sloughs incorporated into floodplain drainage systems
Historic waterfowl management (w/in St Charles,Lincoln and Pike Counties, MO - 30,000 acres private duck-hunting ground)
Spectacle case mussel presence (pool 24)
Hill prairies (limestone bluffs)
Presence of wet prairie
Pin Oak complex

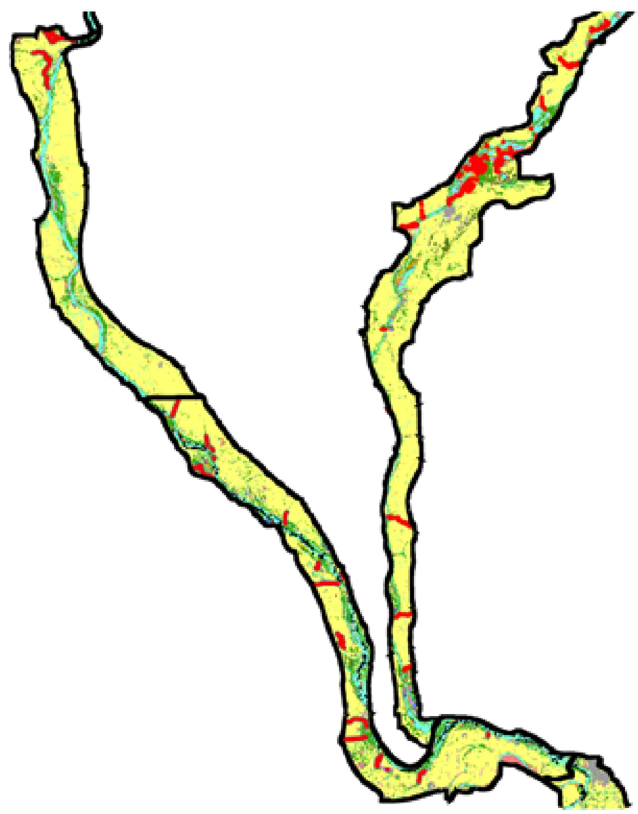


Figure 31. Tributaries from the Missouri bluffs increase topographic diversity in Geographic Reach 8

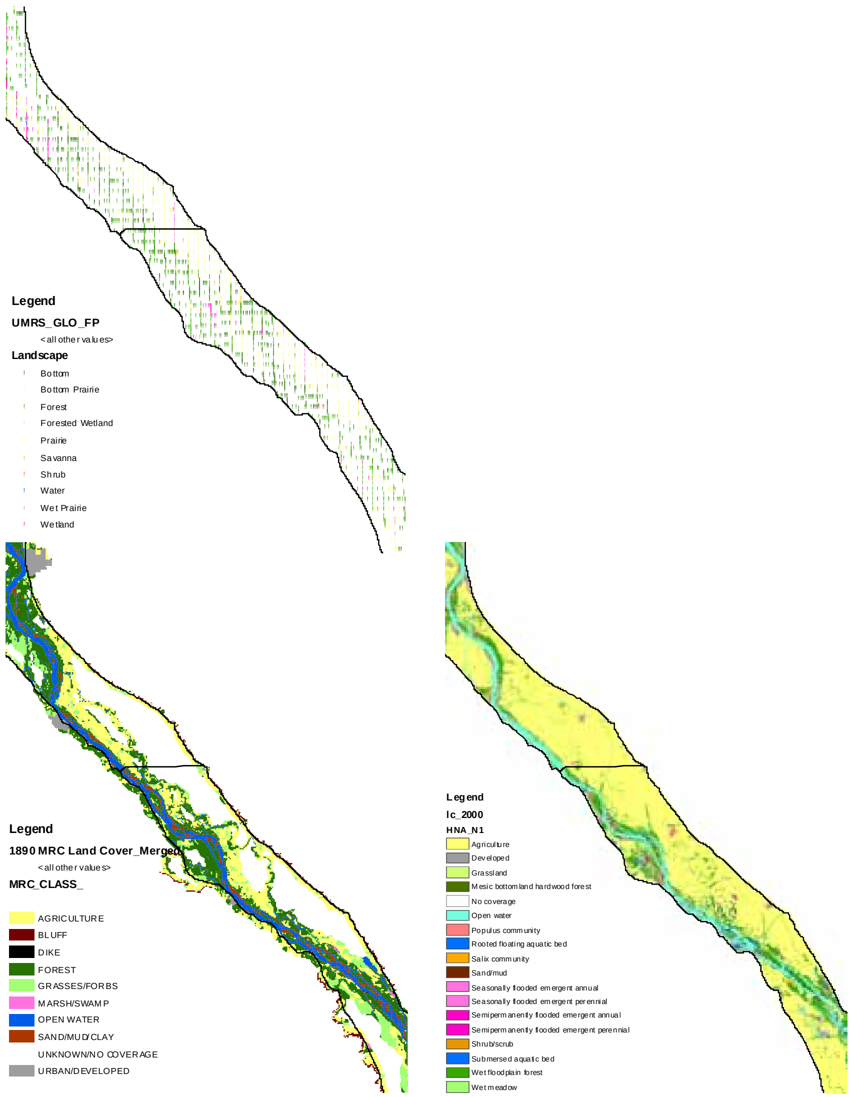


Figure 32. Ancient meandering channels created extensive side channels and floodplain overflow channels that have been isolated behind levees and mostly drained

B. Land Cover

The Sny Anabranch Reach supported prairie on the colluvial slope in the upper part of the reach (Figure 33). Prairie mixed with wetland on active and paleo-floodplain above the confluence with the Missouri River. Riparian forest was distributed rather continuously on the active floodplain near the channel. The Columbia-American Bottoms is physically unique region because of a huge sand mound deposited by the Missouri River. The PLS survey documents large patches of prairie and forest. The proportion of Forest increases downstream through the Jefferson Barracks Reach. The modern floodplain is converted to intensive agriculture isolated from the river by significantly large levee districts (Figure 33).

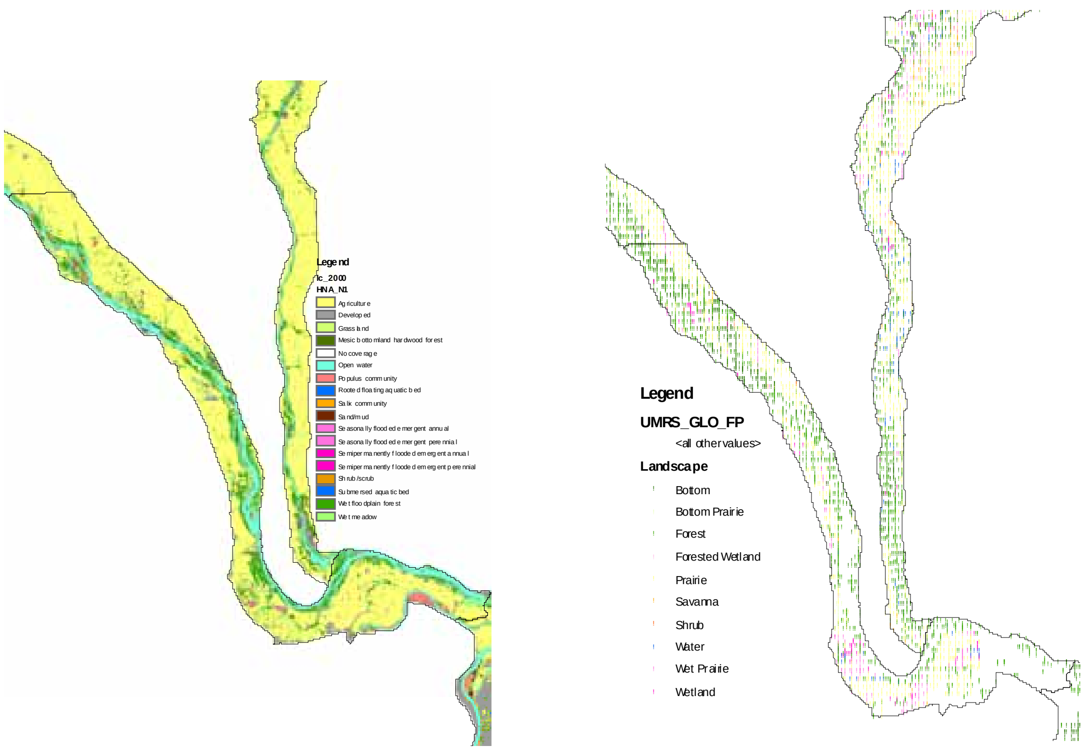


Figure 33. Upper Mississippi River System Geographic Reach 8 land cover in contemporary (2000; left) and historic (<1850; right) conditions

C. Geomorphology

1. Sny Anabranch Reach. The Sny Anabranch Reach (Figure 33) is a low elevation floodplain that flattens toward the Missouri River confluence. The river crosses the floodplain at the upper end of the reach and flows along the Illinois bankline. Colluvial slopes interfinger from Missouri tributaries. Larger tributary fans and islands near the channel form patches of active floodplain. The reach has a high proportion of active and paleo-floodplain area and a low abundance of higher elevation terraces or natural levees (Figure 34). The reach falls in the mid-range of island characteristics.

2. Columbia-American Bottoms Reach. This reach (Figure 34) is a globally- unique confluence of three great rivers, the Illinois, Mississippi, and Missouri Rivers. The Missouri River dominates the geomorphology having deposited a huge sediment mound forming a peninsula between the Mississippi and Missouri Rivers. Below the confluence, a broad meandering form takes shape with the high bedload from the Missouri River. Geomorphologists describe the decreasing amplitude of the meanders as river flow in the Holocene environment settled into the contemporary climate. The cutting and migration of channels creates 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. The reach had relatively few islands in 1890, but the St. Louis, Missouri area was highly developed by then.

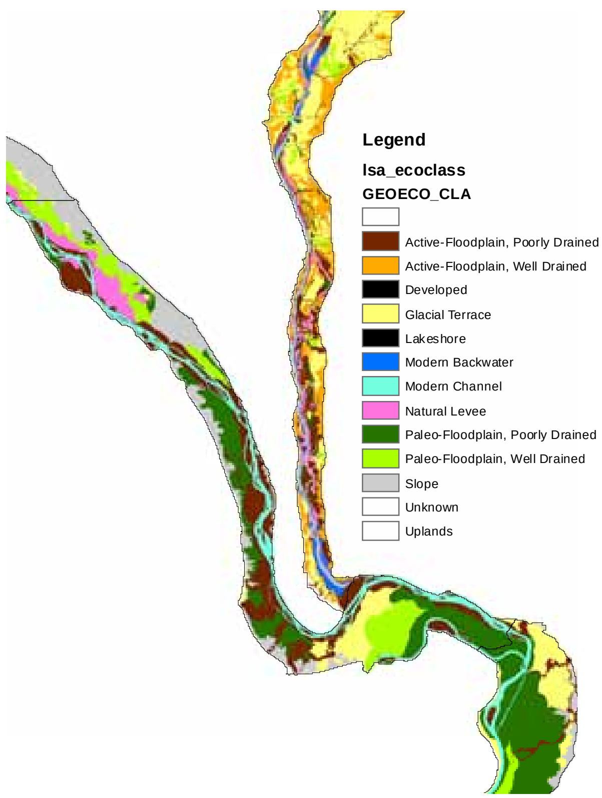


Figure 34. Upper Mississippi River Geomorphic Reach 8 geomorphology

D. Hydrology

Low head dams impounded water onto low elevation UMRS floodplains to maintain navigable waterways 9 feet deep (i.e., the 9-Foot Channel Project) and locks step boats and barges past the dams. The effects of dams are detectable in the stage hydrograph where river stage is greatly modified in the lower parts of each navigation pool (Figure 35), but less so in the upper parts of the pools. Large scale changes in the distribution of water differ upstream and downstream of Rock Island, Illinois. The planform distribution of water in river reaches below Rock Island, Illinois are not changed as much (Figure 36). Impoundment effects are most apparent above Dam 25 and on the Lower Illinois River. Stage regulation stabilized water levels in backwater lakes and shorelines.

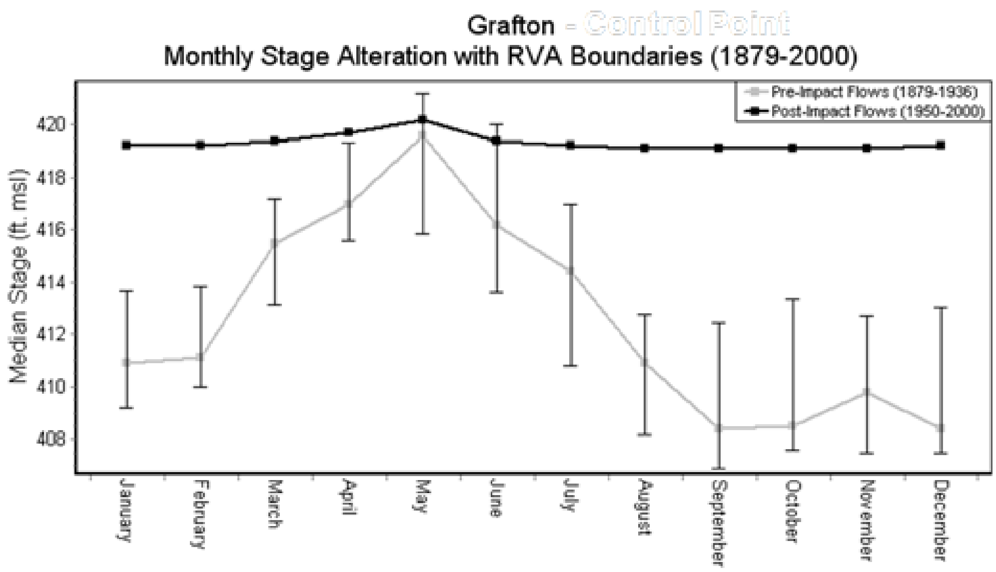


Figure 35. The annual stage hydrograph at the Pool 24 control point at Louisiana, Missouri is raised 10 feet over pre-dam low flow conditions and can be regulated so the spring flood is only slightly higher than the regulated stage

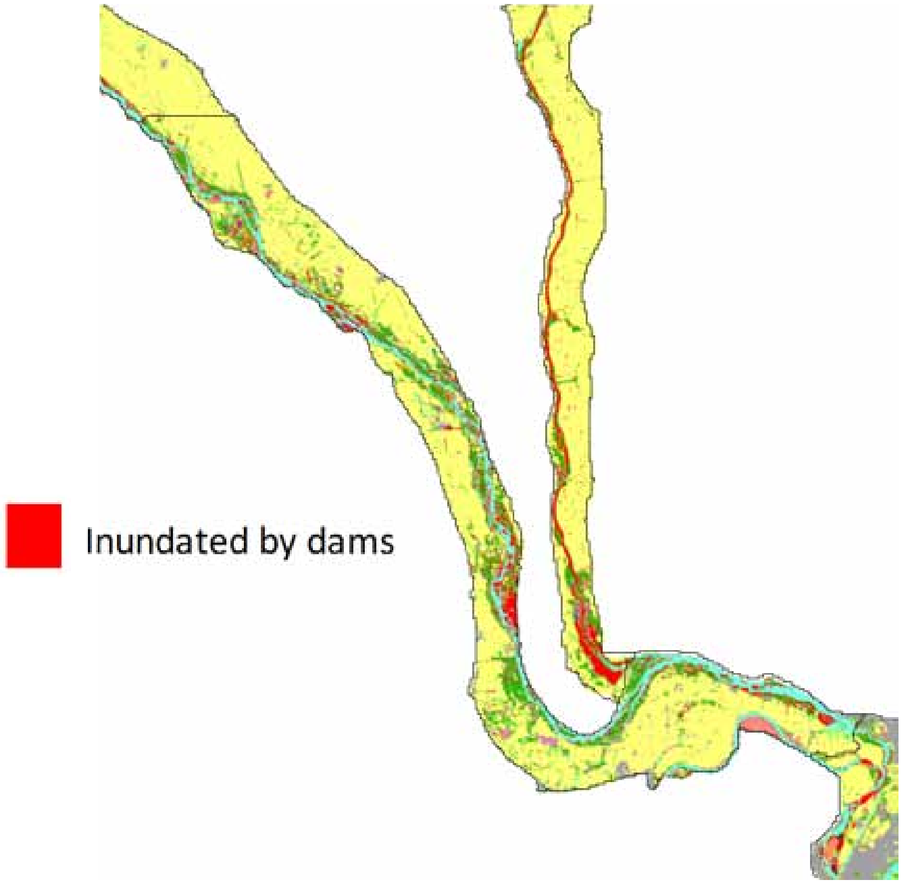


Figure 36. The change in surface water distribution slight in Geographic Reach 8 with only a few mid-pool backwaters created.

Common, high probability floods would potentially inundate much of the floodplain in river reaches below Rock Island if levees were not present (Figure 37). The uncommon 2 percent and 1 percent recurrence interval floods are only apparent in the alluvial fans of tributaries from Missouri, colluvial slopes along the Illinois bluffs, and the large region at the Missouri River confluence in Geomorphic Reach 8. The image of potential flood inundation illustrates the difference in flood distribution between the low elevation floodplain in Pools 24, 25, and upper 26 compared to the high elevations and diverse inundation patterns at the confluence.

Floodplain development changes hydraulic connectivity differently throughout the UMRS. Leveed area distribution is weighted toward the south and unleveed reaches occur north of Rock Island. The confluence with the Missouri River in Geomorphic Reach 8 is a unique area with high elevations that do not interact with the river on an annual basis and water level management strategies that minimize flooding in lower Pool 26.

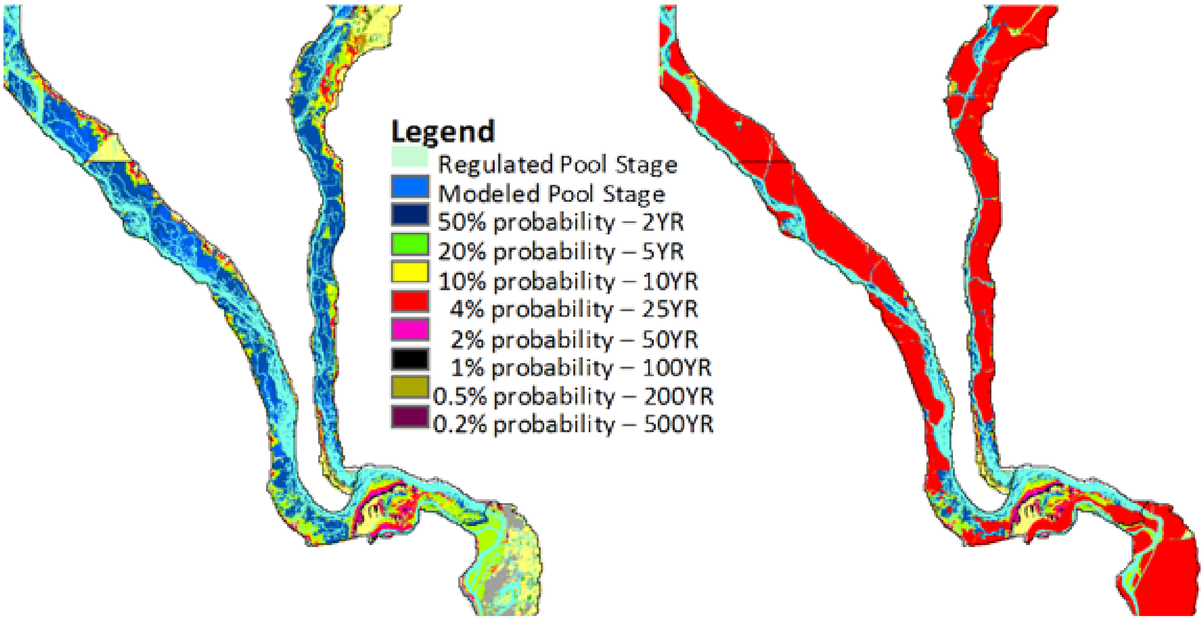


Figure 37. Simulated potential inundation for common (2-yr) to uncommon (500-yr) floods (top) and the simulated actual inundation area with leveed areas superimposed in red

E. Stressors

Levee and drainage districts pump against the head of navigation dams at great expense ((Figure 38). Energy and economic savings could be matched with habitat, carbon, and nutrient sequestration gains to re-examine the types of ecosystem services that can be achieved in a multifunctional floodplain landscape.

Figure 38. Simulated potential floodplain inundation if levee and drainage district pumps were turned off

High rates of sedimentation from the upstream concentrated between levees causes excessive sedimentation in connected floodplains and backwaters. Backwaters are degraded throughout Geomorphic Reach 8 (Figure 39).

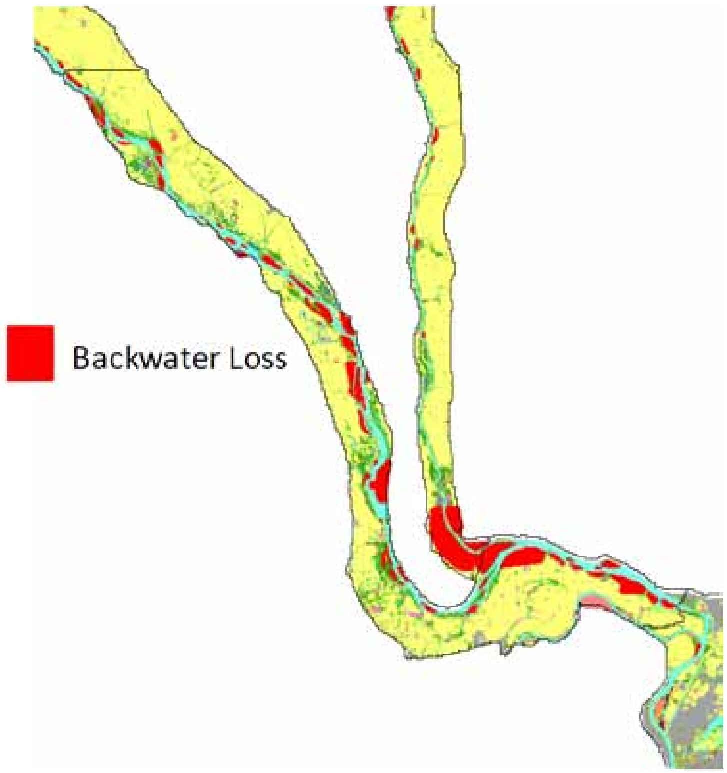


Figure 39. Historic and predicted backwater loss in Upper Mississippi River System backwaters and secondary channels

F. Cumulative Effects Future Geomorphic Change

Reach 8 includes Pools 24 through 26. The profile of the reach has been historically influenced by the alluvial fans of the Illinois and Missouri Rivers. The alluvial fan complex has produced a hump in the longitudinal profile of the UMR, and is responsible for a pronounced flattening of hydraulic and thalweg profiles in Pools 25 and 26. Similar to Reach 7, evidence of post-glacial meander belts and extensive deposits of post-glacial alluvium are observed in historic plan form data. As in Reach 7, these meander scars and alluvial deposits of post-glacial age, are evidence that the UMR has experienced relatively large lateral adjustments in this reach during post-glacial time, but historic changes have been very minor. Generally, the complexity of aquatic areas appears to be somewhat greater in Reach 8 than Reach 7.

1. Pool 24. The extrapolation of future conditions for Pool 24 are hampered by the lack of historic data since the construction of the lock & dam. However, the trend of change can be inferred by comparison of 1989 data to 1930 pre-dam data. This is considered possible because the change between pre- and post-dam conditions is small. Hence, small future changes are expected. The only historic concentrated change noted in the pool was the filling of sediment between wing dams. A single location of concentrated loss of contiguous backwater area is predicted for the future.
It is observed that Pool 24 is influenced by the confluence of the Salt River, a significant sediment load contributor to the UMR. In addition, the profile of the UMR in Pool 24 begins to be influenced by the alluvial fan of the Illinois River. Although the Lock and Dam 24 is about 56 miles upstream of the Illinois River the thalweg profile is observed to be flattening. The average thalweg slope in the reach is less than 0.5 ft/mile so a build up of an alluvial fan over geological time of about 30 ft would create backwater effects about 60 miles upstream. The combination of a significant tributary sediment supply and a flattening river profile would be expected to increase sediment deposition within the pool. Available historic dredging information support this conclusion, average annual dredging volumes in Pool 24 are and have always been significantly larger than in the pools immediately upstream.

2. Pool 25. Historic data for Pool 25 was also limited. However, comparison of pre-lock & dam conditions to 1989 conditions revealed slight overall change in aquatic areas. Similar to Pool 24, it is expected that the observed loss of backwater area and filling between wing dams will continue.

Also similar to Pool 24, the profile of Pool 25 is influenced by the downstream alluvial fan complex of the Illinois River and Missouri River. The reduction in slope caused by the fan likely impacts the hydraulics of flow and sediment transport of the reach. Historic dredging information for the pool indicate that dredging volumes increase significantly in Pool 25 compared to upstream pools.

3. Pool 26. The historic data for Pool 26 indicates that backwater areas have decreased somewhat. This trend is expected to continue. Areas between wing dams were also noted to have filled over the historic period of record. It is predicted that backwater areas will fill at a rate similar to the historic trend. Overall, the relative change in aquatic area within the pool is small.

The Illinois River joins the pool about midway along its length. The influence of the Illinois River alluvial fan is observable on thalweg elevation profiles of the UMR. The thalweg slope upstream of the confluence can almost be characterized as adverse. The slope influences the hydraulics of flow and associated sediment transport. Evaluation of historic dredging data reveals that dredging activities are concentrated just upstream of the confluence. The records show no dredging has occurred in the pool downstream of the confluence. This reflects the influence of the confluence on the deposition of sediment. The amount of dredging in Pool 26 is greater than almost any other pool in the UMR.

It is also noted that the Missouri River joins the UMR about 8 miles downstream of Lock & Dam 26. The alluvial fan of the Missouri River also influences the slope of the upstream UMR, the hydraulic conditions within Pool 26, and the evolution of aquatic areas within upstream pools.

UPPER MISSISSIPPI RIVER SYSTEM
ECOSYSTEM RESTORATION OBJECTIVES 2009

APPENDIX B

LOWER IMPOUNDED REACH PLAN

APPENDIX B-1

LOWER IMPOUNDED REACH SUBAREA QUALITY SCORES

Subarea Name	Pool	River Mile	Quality 1-5	Priority Y or N	Risk of continued degradation
Upper Pool 14	14	520	2	0	2
Beaver Island Complex	**14**	**516**	**2**	**1**	**5**
Clinton / Fulton Harbors	14	516	4	0	3
Meredosia/Swan Islands	14	510	3	0	2
Schrickers Lake Complex	14	510	3	0	2
Higginsii Bed	14	503	5	0	5
Steamboat Island	**14**	**503**	**5**	**1**	**5**
Wapsi Bottoms / Princeton Wildlife Area	**14**	**503**	**4**	**1**	**3**
Higginsii Bed	14	501	2	0	5
High Diver Use / Good Val Bed	14	501	0	0	0
Land Accretion	14	500	0	0	0
Higginsii Bed / Rock Garden	14	497	0	0	0
Lower Pool 14	14	497	2	0	4
Upper Pool 15	14	494	2	0	2
Lower Pool 15	15	488	2	0	4
Mussel Habitat	15	488	0	0	0
Modified Hydropower Regulation	15	485	0	0	0
Upper Pool 16	15	485	4	0	3
Credit Island	16	479	1	0	5
Milan Bottoms	**16**	**475**	**3**	**1**	**5**
Andalusia Island	**16**	**474**	**1**	**1**	**5**
Geneva Island	16	463	2	0	4
Upper Pool 17	**17**	**455**	**4**	**1**	**2**
Blanchard Island	17	448	3	0	3
Middle Pool 17	**17**	**446**	**3**	**1**	**3**
Big Timber Area	**17**	**443**	**4**	**1**	**4**
Bogus Island	17	443	3	0	3
Eagle Fill			**2**	**0**	**5**
Michael Creek	**17**	**443**	**1**	**1**	**5**
Boston Bay	**17**	**438**	**1**	**1**	**5**
Odessa Wildlife Area	17	438	4	0	2
Turkey Island	17	438	2	0	4
Kiethsburg Refuge	**18**	**432**	**2**	**1**	**5**
Blackhawk Island	18	430	3	0	4
Mapes Island	18	425	2	0	1
Huron/Johnson Island Complex	**18**	**419**	**2**	**1**	**5**
Campbell Chute / Benton Island Complex	**18**	**418**	**3**	**1**	**4**
Henderson III	18	414	4	0	3
Oquawka Islands / Lower Pool 18	18	414	4	0	2
Upper Pool 19	18	411	2	0	5
Blackhawk Bottoms	**19**	**399**	**5**	**1**	**4**
Green Bay Bottoms	**19**	**387**	**0**	**1**	**0**
Lead Island	19	385	4	0	5
Rabbit Island	19	384	2	0	5
Devils Creek	19	380	3	0	4
Lower Pool 19	19	375	0	0	0
Mud Island Complex	19	365	0	0	0