Upper Mississippi River

Systemic Forest Stewardship Plan

St. Paul District
Rock Island District
St. Louis District

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U.S. Army Corps of Engineers
Forest Management Project Delivery Team

US Army Corps of Engineers

St. Paul District
Rock Island District
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I. Executive Summary

Introduction

The Mississippi River is the largest riverine ecosystem in North America and third largest in the world. The Upper Mississippi River (UMR) floodplain ecosystem supports more than 300 species of birds, 57 species of mammals, 45 species of amphibians and reptiles, 150 species of fish, and nearly 50 species of mussels. It is the backbone of the Mississippi Flyway, which is used by more than 40 percent of North America's migratory waterfowl. The Upper Mississippi River also has a record of human history spanning over 12,000 years and is increasingly being documented as one of the most archeologically and historically significant regions in the country. The river has played a significant role in the development of the modern Midwestern economy and culture, and it continues to provide many benefits to the States and local communities along the river corridor.

The UMR Systemic Forest Stewardship Plan was developed to provide a guide for the sustainable management of Upper Mississippi River System (UMRS) forests, including opportunities for their restoration, and to ensure that the UMRS maintains its recognition as a nationally treasured ecological resource. The Plan accomplishes this by describing the current understanding of the state of the resource and its ecological stressors; providing guidance for forest restoration activities; establishing goals and objectives; identifying opportunities and data needs; establishing a monitoring strategy through an adaptive management framework; and developing additional recommendations that will ensure the long-term sustainability of this key component of the UMRS ecosystem.

Development of the Plan largely followed from agency and stakeholder recognition of the need for a framework of coordinated management at a system level to advance the overarching ecosystem goal of conserving, restoring, and maintaining the ecological structure and function of the UMRS. The coordinated effort was guided by a Product Delivery Team (PDT) consisting of members from the three UMRS Corps of Engineers Districts, five UMRS States, multiple Federal Agencies, non-governmental organizations, and additional stakeholders. The Plan establishes a foundation for the Corps and these partner agencies and stakeholders to more effectively collaborate on and implement environmental stewardship activities in UMRS forests.

Designated Project Area

The Systemic Forest Stewardship Plan project area is designated as the Upper Mississippi River System (UMRS) 500-year floodplain, regardless of ownership. The UMRS itself is a subset of the larger Mississippi River system, and includes the Mississippi River from Minneapolis–St. Paul, Minnesota, to its confluence with the Ohio River; the Illinois River from Chicago to Grafton, Illinois; and navigable sections of the Minnesota, St. Croix, Black and Kaskaskia Rivers. The lateral extent of the 2.6 million acre UMRS floodplain ecosystem generally encompasses the river valley lands from bluff to bluff, and consists of a mosaic of land and water that contains bottomland forests, grasslands, islands, backwaters, side channels and wetlands.

Resource Trends

Modern UMRS forests represent only a small portion of pre-settlement floodplain forests in some reaches. The development of the UMRS floodplain for agriculture, combined with extensive logging for fuel wood and lumber, resulted in widespread conversion of forest and prairie habitats. Today, contiguous forest cover is primarily confined to a relatively narrow strip on the riverward side of agricultural levees, although large portions of forest remain relatively intact in some protected refuge areas. In many river reaches, most natural floodplain communities have been replaced by agriculture. Species composition of the remaining forest has also become less diverse, due in part to altered hydrology, a loss of the seasonal "flood pulse," and the effects of periodic severe flooding, particularly the flood of 1993. This change is especially evident in the decline of mast producing species such as oaks and hickories, and corresponding increase in dominance by silver maple in many floodplain forest communities. Diseases, insects and invasive plant species also continue to have negative impacts throughout the UMRS.

Future Trends in UMRS Floodplain Forests – *Without Management*

Some of the changes we might expect to see over the next 50 years, without active forest management, are outlined below:

- A reduction in pioneer species such as cottonwood and willow
- More open forest canopies as trees die and canopy gaps are invaded by herbaceous vegetation and/or grasses (e.g., reed canary grass)
- Continued loss of forest in the lower parts of navigation pools due to island erosion
- Conversion of forest to other vegetation types in mid-pools due to elevated water tables
- Fewer mast trees as species composition in intact forests continues to shift towards silver maple and other more shade and water tolerant trees

Adaptive Management

Partners have agreed to include the incorporation of an adaptive management framework in forest management and restoration activities as a variety of uncertainties exist regarding the long-term trajectory of the forest resource. Restoration projects can then become learning opportunities by utilizing an experimental design or technique and effective monitoring strategies that in turn inform future management decisions.

UMRS Floodplain Forest Ecosystem Services

Water Quality – Improvement to ground and surface water by promoting infiltration, recharge, detoxification, and nutrient cycling; natural flood and erosion/scour control by absorbing energy from floodwaters, reducing flood velocities and peaks, and reducing sediment loads.

Living Resources – Provision of fish and wildlife habitat, organic matter production, natural genetic diversity, pollination, protection of rare and endangered species, and creation of corridors for migration.

Land Based Resources – Establishment and enhancement of forests, harvests of natural products, wind breaks, and carbon sequestration.

Education/Research – Opportunities for environmental education and the scientific study of physical, biological and cultural resources.

Cultural/Recreational Resources – Consumptive and non-consumptive uses, open space, and aesthetic values.

Desired Future Condition

Among the public lands in the UMRS floodplain, Corps-managed lands have become critical for the ecological sustainability of floodplain forests and associated terrestrial and aquatic ecosystems. The Corps forestry program will provide high-quality, sustainable bottomland forest on Corps lands along the UMRS, including a natural diversity of tree species, ages, canopy heights, and understory vegetation. The "ideal" floodplain forest will support floodplain ecosystem functions and sustainable habitat for wildlife. Therefore, the vision is to maintain a healthy, nearly contiguous forest that spreads across wide stretches of the floodplain and contains a sufficient diversity of tree species, size and age classes to provide a wide array of habitat structure and food (mast) resources.

Box ES1. Floodplain Forest Restoration Tools

- Timber stand improvement (TSI)
- Harvesting methods
    - Group selection, shelterwood, & seed tree
- Site preparation
- Forest establishment
    - Natural regeneration
    - Tree plantings
        - Containerized saplings, bare root seedlings, & direct seeding
- Prescribed burning
- Elevation modification
- Water level management

System-Wide Goals

The UMR Systemic Forest Stewardship Plan is based upon a set of ecologically and socially desired future UMRS ecosystem conditions, summarized in the following vision statement endorsed by the Navigation Environmental Coordinating Committee (NECC) and in the overarching ecosystem goal developed by the Navigation and Ecosystem Sustainability Program (NESP) Science Panel:

Vision Statement – To seek long-term sustainability of the economic uses and ecological integrity of the Upper Mississippi River System

Overarching Ecosystem Goal – To conserve, restore, and maintain the ecological structure and function of the Upper Mississippi River System to achieve the vision.

The following system-wide goals were developed for inclusion in the UMR Systemic Forest Stewardship Plan:

- A functional, sustainable floodplain ecosystem that includes a mosaic of native vegetation communities sufficient to support important wildlife habitat
- Restore and maintain forest diversity, health, and sustainability on Federal lands
- Provide support for the restoration and maintenance of forest diversity, health and sustainability on non-Federal lands
- Adaptive management: science-based decision-making

Box ES2. Desired Stand Conditions for UMRS Forests

Forest Variables	Desired UMRS Stand Structure	Conditions that may warrant active management
Overstory canopy cover	70 – 80%	> 80%
Overstory Species	2 or more species	Large blocks of single species
Basal area	90-160 ft^2 per acre	> 200 ft^2 per acre
Tree stocking	50% – 90%	< 50% or > 90%
Emergent trees	> 2 per acre	< 1 per acre
Understory cover	> 10 %	< 10%
Regeneration	> 10% of area	< 10% of area
Coarse woody debris	Present	Not present
Small cavities	≥ 2 visible holes per acre	< 2 visible holes per acre
Den trees/large cavities	≥ 1 visible hole per 10 acres	< 1 visible holes per 10 acres
Standing dead trees	≥ 2 large trees per acre	< 2 large trees per acre
Invasive (herbaceous)	< 10%	> 10% of herbaceous layer
Invasive (woody)	< 10%	> 10% of any canopy layer

Recommended Priority Actions

Development of a system-wide hydrogeomorphic model (HGM) – Hydrogeomorphic modeling can provide a science-based approach to identifying ecosystem restoration options and developing recommendations for sustainable management of large river floodplain systems such as the UMRS. The HGM approach allows managers to determine historical conditions and ecological processes of an area, determine ecosystem alterations by comparing historic and current landscapes, and identify options and approaches to restore specific habitats and ecological conditions (Heitmeyer 2008).

Data acquisition **–** Data needs include extensive baseline vegetation inventories and fine-scale elevation contours (e.g., LIDAR).

Identification and prioritization of "on-the-ground" forest restoration projects **–** For example, the Reno Bottoms Forest Restoration Project, located in upper Pool 9, is focused on restoring forest species and age class diversity on up to 1,100 acres negatively impacted by tree mortality, altered hydrology, and invasion by reed canary grass.

Coordinated system-wide data management – There is a demonstrated need for coordinated database management and data archiving related to a variety of management and restoration efforts throughout the UMRS.

II. Introduction

A. Purpose

The purpose of this Systemic Forest Stewardship Plan is to provide a long-range plan of action for the sustainable management of Upper Mississippi River System (UMRS) forests so the UMRS can maintain its recognition as a nationally treasured ecological resource. Key components of this process are identifying goals and objectives; establishing a foundation to improve and enhance coordination with stakeholders; fostering a better understanding of the state of the resource and its ecological connection to adjacent watersheds; identifying problems, opportunities and data needs; and developing recommendations that will ensure the long-term sustainability of this critical component of the UMRS ecosystem. Specifically, this plan makes recommendations and provides implementation guidelines for the management of UMRS floodplain forests by:

- Providing guidance for forest and grassland restoration activities
- Identifying goals and objectives
- Establishing management standards and guidelines
- Identifying desired future conditions
- Recommending the use of standardized inventory, monitoring and evaluation guidelines
- Committing to a policy of adaptive management.

Designed as a systemic forest management plan to manage and restore the UMRS floodplain forests to healthy and sustainable levels, this plan includes management practices, restoration measures, and cost effective actions affecting the broad array of terrestrial habitat types within the floodplain. It recommends specific actions to communicate and coordinate systemic forest management goals, objectives, guidelines, and adaptive management concepts among all floodplain stakeholders. This plan is intended to function as a living document, and will be reviewed and updated every 5-10 years.

B. Scope

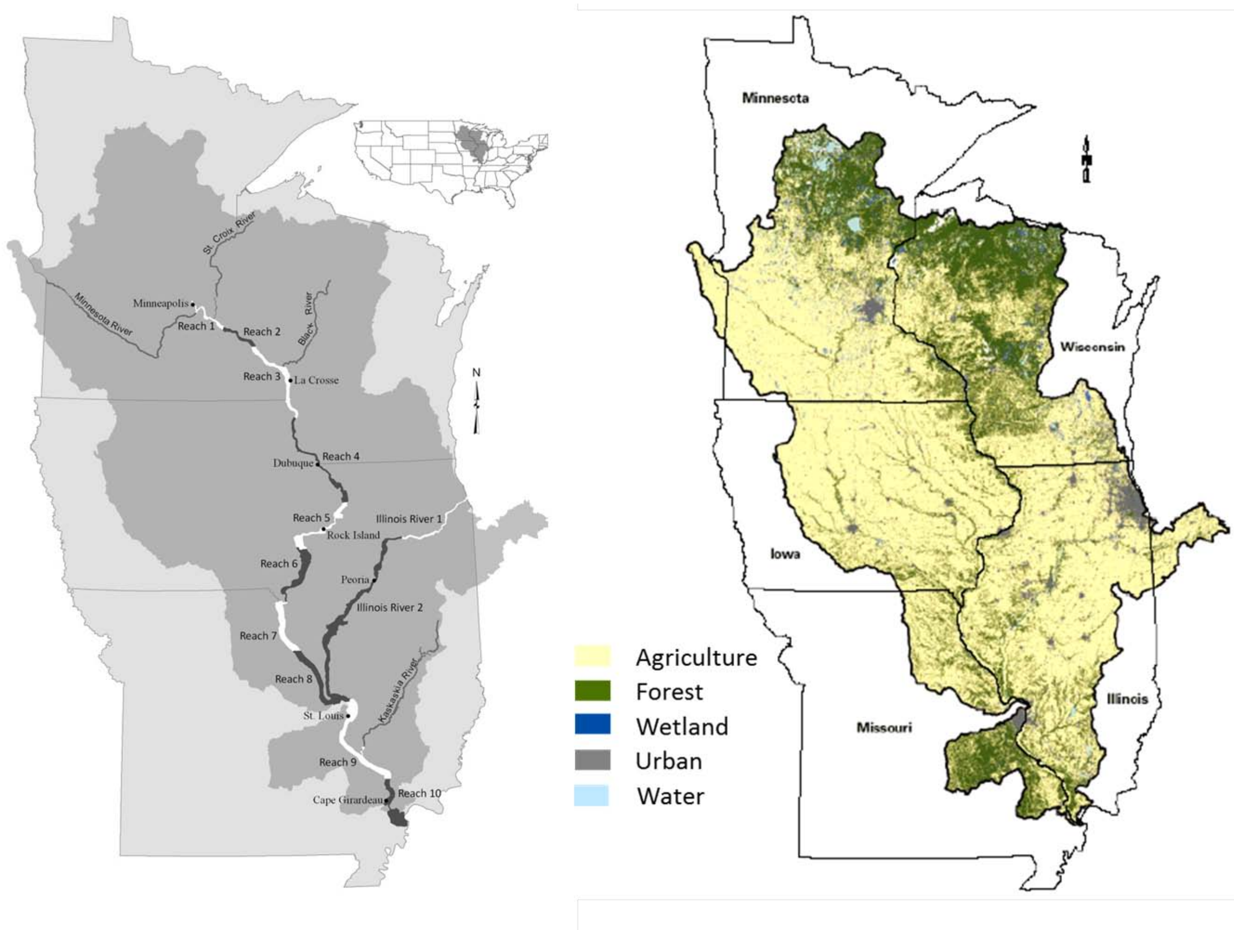
The Forest Stewardship Plan project area is designated as the UMRS 500-year floodplain, regardless of ownership. The lateral extent of the UMRS floodplain ecosystem is generally the river valley lands from bluff to bluff, or to elevated terraces. The primary intent of this plan is for the Corps, working with others, to improve management and restoration efforts along the UMRS, and to seek eventual sustainability of its floodplain forest and other terrestrial habitats.

The Mississippi River in its entirety is considered the largest riverine ecosystem in North America and the third largest in the world. The UMRS itself is a subset of this larger river system, and includes the Mississippi River from Minneapolis–St. Paul, Minnesota, to its confluence with the Ohio River; the Illinois River from Chicago to Grafton, Illinois; and navigable sections of the Minnesota, St. Croix, Black and Kaskaskia Rivers (USACE 2004) (figure 1).

The UMRS floodplain ecosystem covers 2.6 million acres of land and water and includes portions of five Midwestern States: Minnesota, Wisconsin, Iowa, Illinois, and Missouri. Major river communities along the banks of the Upper Mississippi River (UMR) include Minneapolis–St. Paul; La Crosse, Wisconsin; Dubuque, Davenport, and Keokuk, Iowa; Rock Island, Quincy, Alton, and Cairo, Illinois; and St. Louis and Cape Girardeau, Missouri. Major communities along the Illinois River include: Chicago, Peoria, Beardstown, and Grafton, Illinois.

Land cover in the Upper Mississippi River basin is primarily agriculture (figure 1). The majority of forestland occurs in the northern (Minnesota and Wisconsin) and southern (southwestern Illinois and southeastern Missouri) parts of the basin. A considerable amount of forestland in the central portions of the basin is associated with river and stream corridors, including floodplains and tributaries of the UMRS.

Figure 1. The UMRS project area and land cover in the UMRS basin.

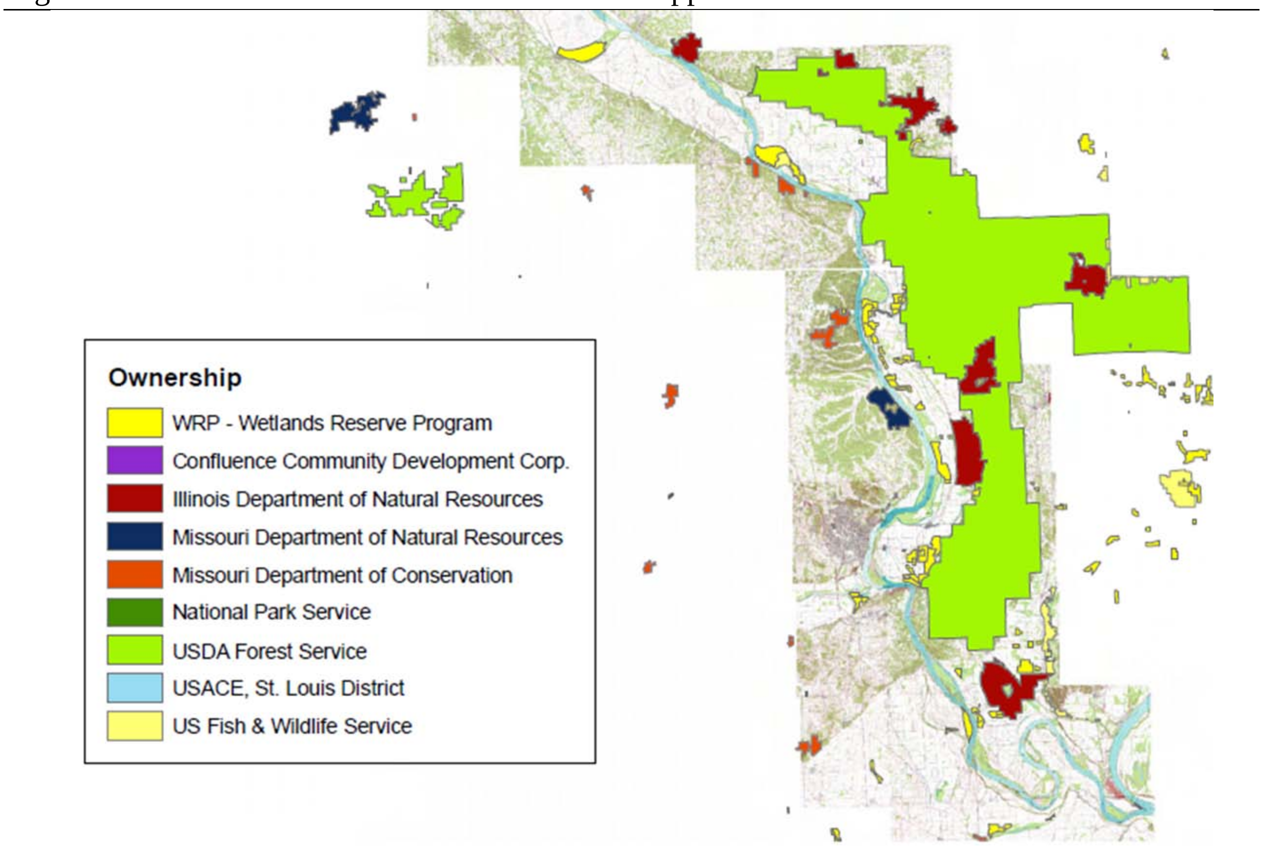


(Sources: USACE and Fry et al. 2011)

Public ownership and management patterns in the UMRS are complex, often overlapping, and therefore require a high degree of communication and collaboration between the multiple State, Federal, and Tribal entities involved (figure 2). For example, the U.S. Fish and Wildlife Service (USFWS) National Wildlife Refuge System contains over 240,000 acres of this floodplain ecosystem (figure 3). Many of these acres are Corps of Engineers General Plan (GP) lands purchased in support of the Upper Mississippi River-Illinois Waterway (UMR-IWW) navigation system which have been made available to the USFWS for wildlife management.

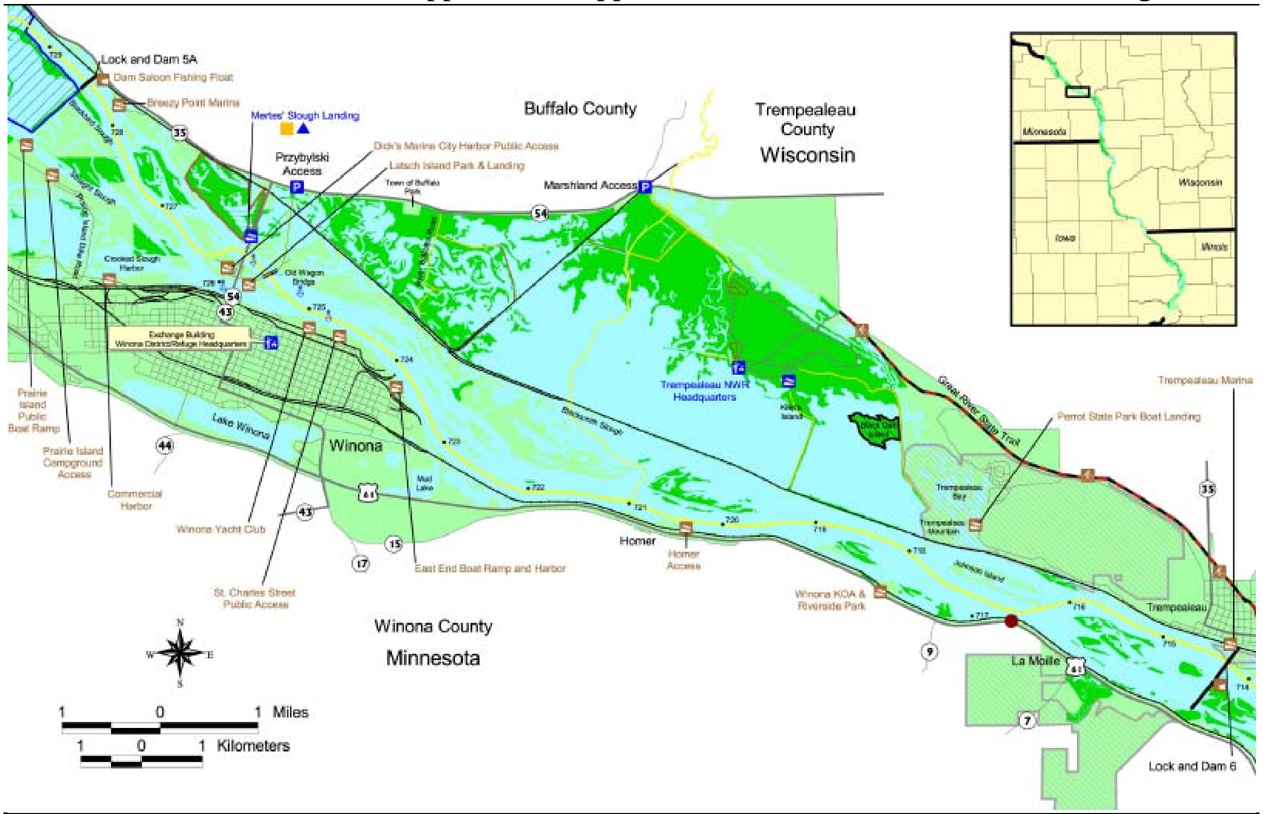
The amount of land in the UMRS floodplain contained in the USFWS National Wildlife Refuge System indicates the importance of coordinating management for wildlife habitat at the system level. Furthermore, the UMRS is the backbone of the Mississippi Flyway, which is used by more than 40 percent of North America's migratory waterfowl. A 261-mile portion of the Upper Mississippi River was designated a Globally Important Bird Area in 1998 because it harbors significant numbers of waterfowl, raptors, wading birds and song birds. Approximately 60 percent of all bird species and at least 25 percent of all fish species in North America have been observed in the UMRS. It is also important habitat for 286 State-listed or candidate species and 36 Federal-listed or candidate species of rare, threatened, or endangered plants and animals endemic to the Upper Mississippi River Basin (USACE 2004).

Figure 2. Conservation lands in the Middle Mississippi River Corridor.



(Source: Heitmeyer 2008)

Figure 3. Pool 6 in the UMRS. USFWS Refuge lands are shown in green. The inset illustrates the full extent of the 240,000-acre Upper Mississippi River National Wildlife and Fish Refuge.



(Source: USFWS)

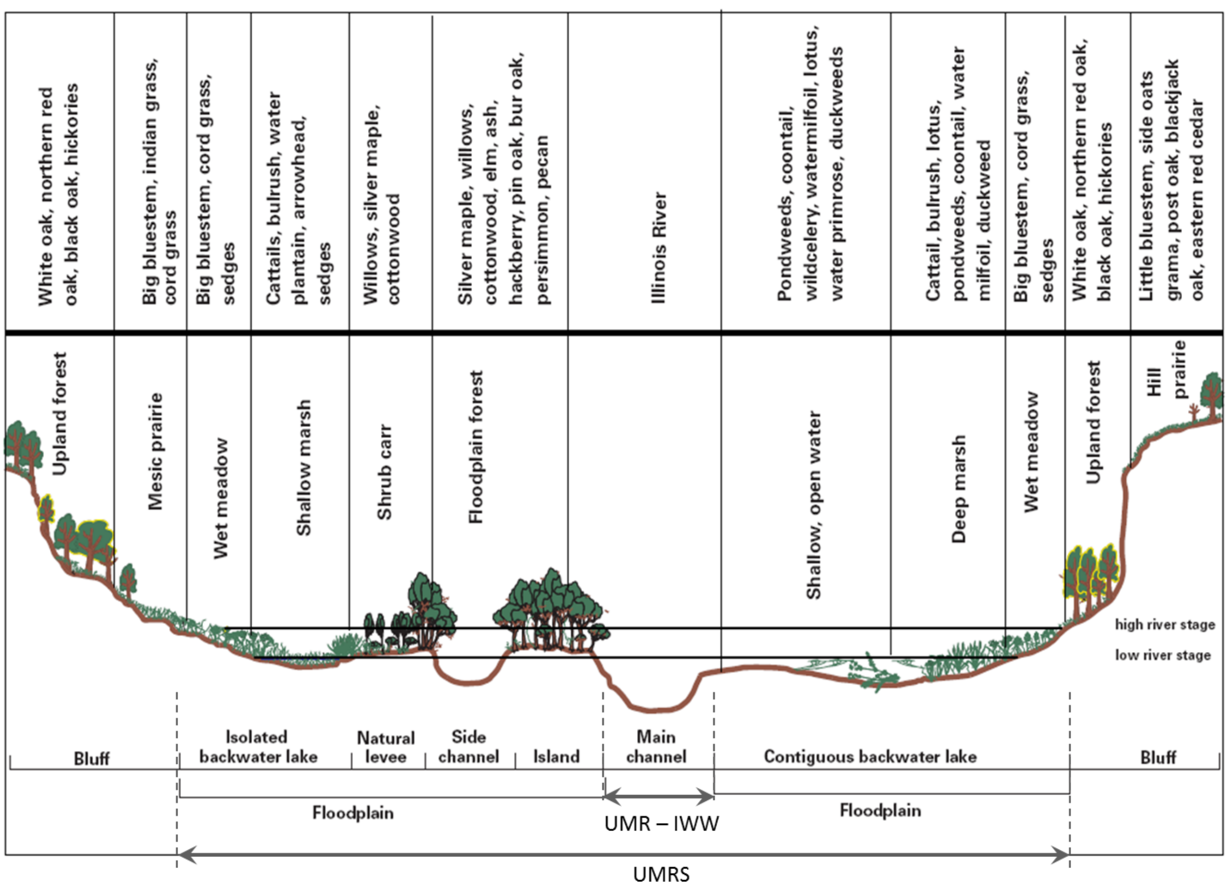
It is important to understand the difference between the UMR-IWW navigation system and the larger UMRS floodplain ecosystem. The navigation system refers to the 1,200 miles of 9-foot deep navigation channel, 37 lock and dam sites (containing 43 locks), and thousands of channel training structures that are maintained in the Upper Mississippi and Illinois Rivers. The width of the navigation channel is maintained at approximately 300-500 feet and is delineated with red and green buoys maintained by the U.S. Coast Guard. By contrast, the UMRS floodplain ecosystem encompasses to the entire river-floodplain area. This includes all of the aquatic and terrestrial habitats and species associated with these large river floodplain ecosystems, and their associated physical, chemical, and biological components (figure 4).

Due to the vast spatial scale of the UMRS it is often subdivided into smaller management units often described by a variety of different terms. For example, although the term "reach" can be used to describe any continuous stretch of river, in the UMRS it has a more specific meaning. The term "impounded reach" refers to that portion of the river system just above St. Louis, Missouri, that contains navigation locks and dams. Within the impounded reach are a series of "pools", which refer to areas of water impounded behind navigation dams. Pool numbers correspond to the number of the lock and dam that created them, and are often used to describe the entire length of river between two sequential dams. For example, Pool 9 refers to the stretch of river between Lock and Dam 9 and Lock and Dam 8 just upriver. The term "unimpounded reach", also described as the "open river reach", refers to the Mississippi River below its confluence with the Missouri River near St. Louis where navigation locks and dams are no longer needed for navigation. The term "Illinois River reach" refers simply to the Illinois River.

The scope of this plan encompasses the entire UMRS floodplain ecosystem, regardless of ownership. In addition, while the primary focus of this plan is related to forest management, it also addresses and provides management guidelines for other terrestrial habitats. Forests, grasslands, wet meadows, and shrublands often combine to form an interconnected mosaic of terrestrial and aquatic habitats within larger floodplain ecosystems and even smaller project-scale management units.

This plan recognizes the management limitations of addressing the vast 2.6-million-acre floodplain area, both ecologically and economically. Societal infrastructure, where present in the floodplain, is not at risk by any actions prescribed by this plan. Rather, this plan strives to achieve an improved balance and approach to ensuring both the ecologic and economic sustainability of the UMRS floodplain ecosystem.

Figure 4. Hypothetical illustrative cross section of the river valley showing the primary ecosystem habitat types and their representative species and the spatial differentiation between the UMR-IWW Navigation System and UMRS Ecosystem. (Adapted from: USGS 1999)



III. The Floodplain Setting

A. Background

The Mississippi River is the largest riverine ecosystem in North America and third largest in the world. The combined floodplains of the Upper Mississippi, Illinois, Kaskaskia, Minnesota, Black and St. Croix Rivers, which lie within the scope of this stewardship plan, cover approximately 2.6 million acres. The UMRS floodplain ecosystem consists of a mosaic of bottomland forests, grasslands, islands, backwaters, side channels and wetlands – all of which support more than 300 species of birds, 57 species of mammals, 45 species of amphibians and reptiles, 150 species of fish, and nearly 50 species of mussels. It is a migratory flyway for more than 40 percent of North America's migratory waterfowl and shorebirds, and a globally important flyway for 60 percent of all bird species in North America (USACE 2004).

The UMRS also has a record of human history spanning over 12,000 years and is increasingly being documented as one of the most archeologically and historically significant regions in the country. The abundant and diverse ecological resources found along the river have attracted and sustained human populations for thousands of years, providing food, water, shelter, and transportation. The UMRS has continued to play a significant role in the development of the modern Midwestern economy and culture. The presence of the river provides many benefits to the States and local communities along the river corridor. Benefits are derived from the employment and income generated from transportation of goods, recreation, hydropower production, and water supply for municipalities and commercial, industrial and domestic use (USACE 2004). The river system generates over $6.6 billion dollars in revenue annually from some 12,000,000 visitor-days of use by people who hunt, fish, boat, sightsee or otherwise visit the river and its local communities (Black et al. 1999).

1. Historic floodplain

Prior to European settlement, the Mississippi River fit the model of a free-flowing large-river ecosystem. Periodic flooding and drought were major forces responsible for maintaining the complex physical structure and rich plant and animal diversity of the river system. In addition, fire helped sustain prairie, wet meadow, and savanna habitats.

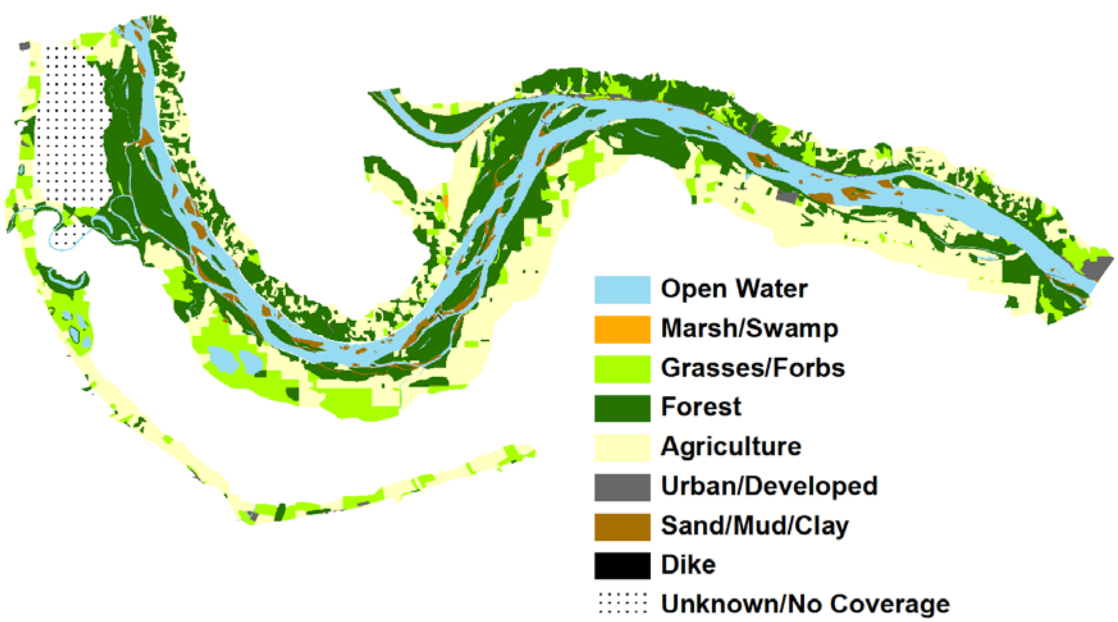
The Habitat Needs Assessment (HNA) Summary Report (USACE 2000) describes the early floodplain:

> *"At a system-wide scale there were natural gradients in habitat among river reaches. Northern river reaches were more forested and were composed of mixed silver maple forests, river channels, seasonally flooded backwaters, floodplain lakes, marsh, and prairie. Beginning around the northern Iowa border and along the lower Illinois River, grasslands and oak savanna dominated floodplain plant communities. Historic surveys reveal a higher proportion of oaks and other mast trees in the forest community than at present. Below the Kaskaskia River, the floodplain was heavily forested with species characteristic of southern bottomland hardwood communities."*

Maps of portions of the pre-European UMRS landscape have been reconstructed for parts of the UMRS using records gathered during early 1800s U.S. Government Land Office (GLO) surveys (Nelson et al. 1994, Yin and Nelson 1995, Nelson et al. 1996, and Nelson and Sparks 1998). GLO maps and survey notes are the primary source of information for reconstructing historic landscapes. The records contain, among other things, plat maps showing the location and extent of former prairies, timberlands, marshes, swamps, and rivers. Survey notes often also contain information on the composition and structure of former timberlands on islands, floodplains, and adjacent uplands. Although land cover area estimates must be carefully interpreted, this approach is very useful for mapping historic landscapes at a coarse scale.

A much more comprehensive set of historical land cover data exists for a time period in the late 1800s. In the late 1880's to early 1900's the Mississippi River Commission (MRC) conducted an extensive high-resolution survey of the Upper Mississippi River from Minneapolis to Cairo. These data were published as a series of 89 survey maps and indexes. In the 1990's, the Long Term Resource Monitoring (LTRM) component of the Corps of Engineers' Upper Mississippi River Restoration – Environmental Management Program (UMRR-EMP), in conjunction with the U.S. Geological Survey's Upper Midwest Environmental Sciences Center (UMESC), automated the maps land cover/land use symbology to create a fully digitized, geo-referenced turn of the century/pre-impoundment land cover/land use data set that is available online at http://www.umesc.usgs.gov/data_library/land_cover_use/1890s_lcu_mrc.html. Figure 5 was produced from this data and represents historical (circa 1890) land cover in Pool 26.

Figure 5. Historical (circa 1890) land cover in Pool 26 of the Mississippi River.

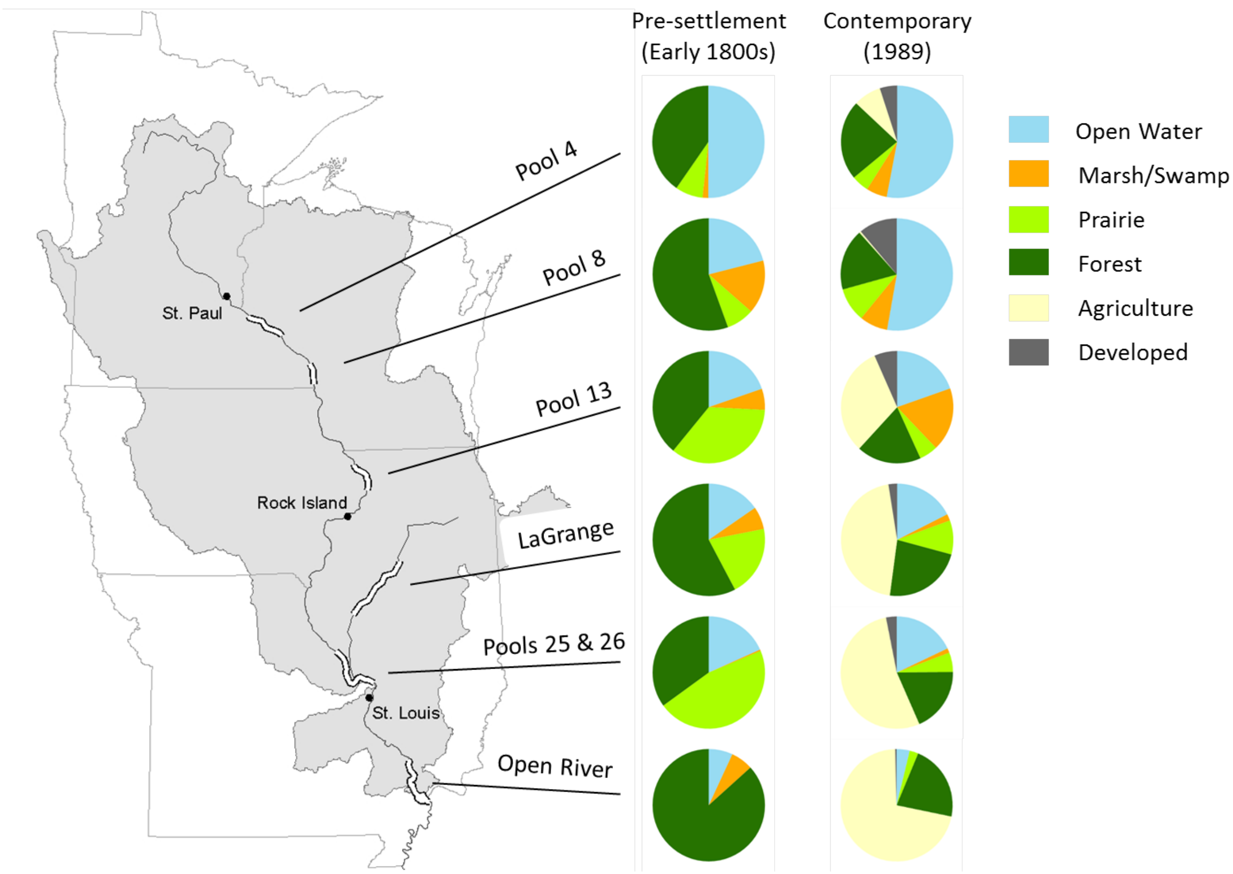


(Source: UMRR-EMP, LTRM Component)

2. Changes

European settlers who developed the Mississippi River valley during the 1800s brought many changes to the landscape and waterways. Prior to widespread European settlement of the region, the UMRS was a diverse landscape of tallgrass prairie, wetlands, savannas, and forests. Logging, agriculture, and urban development over the past 150-200 years have resulted in the present floodplain landscape, which is highly developed. Wetlands were drained and floodplain forests were extensively logged for lumber and fuelwood. Much of the fuel that heated the boilers of steamboats plying the waters of the UMRS was firewood cut from the river's forested islands and shorelines. During the same period, much of the floodplain (including native prairie areas) was cleared for agriculture. The hydrologic regime was also highly modified, with increased fluctuations in river discharge. Dams and river regulation throughout the basin also altered river flows. The modern landscape delivers large amounts of sediment, nutrients, and contaminants to the river. Since the construction of locks and dams, referred to herein as river impoundment, sediment accumulation and other processes in the navigation pools have greatly altered both aquatic and terrestrial habitats. Figure 6 shows the cumulative land cover changes in selected reaches of the UMRS from pre-settlement to contemporary times.

Figure 6. Land cover changes from the early 1800s to 1989 in selected pools in the UMRS.

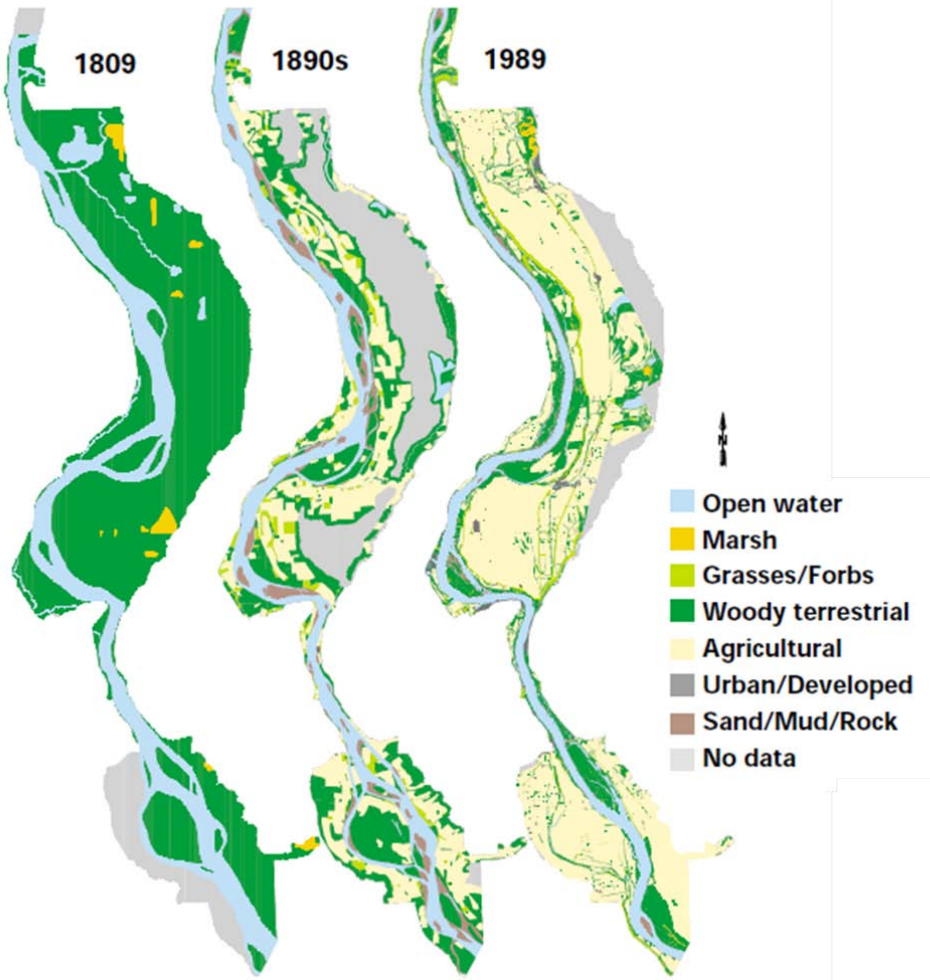


(Adapted from: Theiling et al. 2000)

Modern UMRS forests represent only a small portion of pre-European settlement floodplain forests in some reaches. The amount of bottomland forest within the Upper Mississippi River floodplain has been significantly reduced from historic levels by clearing of land for agriculture and development, primarily on the lower impounded, unimpounded, and Illinois River reaches. Although river impoundment flooded considerable forested area in northern reaches, large portions of forest remain relatively intact in Refuge areas. In other river reaches, most natural floodplain communities have been replaced by agriculture. Channel dynamics and water level fluctuations that support diverse, productive floodplain communities have been altered throughout the UMRS.

For example, forests covered 56 percent of the landscape at the confluence of the Illinois and Mississippi Rivers in 1817. By 1975, these forests were reduced to 35 percent of the landscape (Nelson et al. 1994). Similarly, floodplain forests covered 71.4 percent of the landscape in a 63-mile-long portion of the unimpounded reach in 1809, but by 1989 covered only 18.3 percent of the same landscape (figure 7) (Yin et al. 1995).

Figure 7. Landscape changes from 1809-1989 in the vicinity of Cape Girardeau, Missouri.



(Source: USGS 1999)

Table 1 shows pre-settlement to contemporary landcover changes in select reaches of the Upper Mississippi and Illinois Rivers. The dramatic loss of forested and prairie landcover throughout the majority of these reaches is immediately discernable. For example, forested landcover decreased by about 75 percent in the open river reach, where 68 percent of the floodplain is currently in agricultural production. Agriculture is the dominant landcover class throughout, except for the northernmost reaches where the lateral extent of the floodplain is much narrower.

Table 1. Percent composition of major landcover types in selected Upper Mississippi and Illinois River pools in pre-settlement and contemporary time periods.

Pool	**Land Cover Type**						
	Open Water	**Marsh**	**Prairie**	**Timber**	**Swamp**	**Agriculture**	**Developed**
	Pre-settlement (ca. early 1800s)						
4	49.8	1.5	7.9	40.2	0.2	---	---
8	21.0	14.8	8.0	55.5	0.6	---	---
13	19.7	4.5	35.1	39.1	1.6	---	---
17	14.6	0.7	57.0	25.8	1.9	---	---
22	13.3	0.0	35.0	51.7	0.0	---	---
24	13.2	0.1	46.4	40.3	0.0	---	---
25 & 26	18.3	0.4	46.3	35.0	0.0	---	---
OR	6.9	0.0	0.0	86.7	6.4	---	---
LaGr	15.3	2.4	20.3	57.5	4.1	---	---
	Contemporary (1989)						
4	53.0	6.0	5.0	23.0	0.0	8.0	5.0
8	52.8	8.1	9.8	17.7	0.0	0.5	11.1
13	19.6	18.3	5.3	18.6	0.0	31.6	6.6
17	25.4	1.8	6.6	28.4	0.0	32.4	5.4
22	9.9	0.1	3.6	12.2	0.0	72.4	1.8
24	10.3	0.7	3.3	13.4	0.0	71.4	0.9
25 & 26	17.9	1.3	5.6	18.6	0.0	53.4	3.1
OR	3.6	0.0	2.4	20.9	0.0	68.0	0.4
LaGr	17.5	1.9	9.8	22.9	0.0	45.4	2.5
	Percent change						
4	6.4	300.0	-36.7	-42.8	---	---	---
8	151.4	-45.3	22.5	-68.1	---	---	---
13	-0.5	306.7	-84.9	-52.4	---	---	---
17	74.0	157.1	-88.4	10.1	---	---	---
22	-25.6	---	-89.7	-76.4	---	---	---
24	-22.0	600.0	-92.9	-66.7	---	---	---
25 & 26	-2.2	225.0	-87.9	-46.9	---	---	---
OR	-47.8	---	---	-75.9	---	---	---
LaGr	14.4	-20.8	-51.7	-60.2	---	---	---

(Adapted from: Theiling et al. 2000)

In addition to landscape-level changes in land cover/land use, alterations in hydrological regimes and the isolation of large portions of the floodplain behind mainline levees have resulted in significant compositional shifts in floodplain forest communities. Many mast-producing species such as oaks and hickories have declined in importance, while silver maple has dramatically increased in importance throughout the UMRS. Importance values combine measures of relative density, relative frequency, and relative dominance into a single metric and indicate the overall abundance of a species in an ecological community. Table 2 illustrates these long-term shifts in importance values for many common floodplain tree species in a couple of selected reaches of the Upper Mississippi River. For the open river reach, the data also illustrate compositional differences between floodplain forests that remain connected to the river and those that are protected behind mainline levees.

3. Public Lands Management

a. Corps of Engineers

As early as 1824, the Department of the Army began navigation improvements on the UMRS when it was directed to clear impediments from the river. Navigation projects such as dike construction, dredging and snag clearing continued throughout the 19th and early 20th centuries, culminating in the 1930's in construction of the nine-foot channel and locks and dam system still

Table 2. Pre-settlement and contemporary floodplain forest tree species importance values.

Species	Open river - protected[1]		Open river - unprotected[1]		Pool 26 – impounded[2]	
	1809	1993	1809	1993	1817	1996
Elm	28.5	14.8	15.4	7.5	22.1	7.8
Hackberry/sugarberry	25.4	8.6	9.4	3.2	30.4	0.3
Ash	21.6	21.5	3.7	1.6	11.0	29.4
Hickory	10.9	4.3	4.6	---	30.0	10.9
Sycamore	7.4	4.3	51.2	11.8	2.8	0.6
Silver maple	6.5	3.4	---	39.7	16.1	110.0
Boxelder	5.8	6.3	8.3	28.2	5.8	11.2
Cottonwood	3.4	---	80.2	36.1	20.4	7.8
Mulberry	2.0	---	4.1	3.2	3.5	0.1
Black walnut	1.5	1.1	0.6	---	---	---
Overcup oak	1.3	---	1.2	---	---	---
Pin oak	1.1	30.6	---	---	11.5	3.7
Willow	1.0	9.0	3.3	60.3	20.7	12.1
Persimmon	---	4.4	---	---	---	1.7
Bur oak	---	3.2	---	---	1.7	1.7
White oak	10.8	12.7	---	---	3.1	---
Sweetgum	23.5	23.3	9.6	0.5	---	---
River birch	---	---	---	---	1.4	0.7
Kentucky coffeetree	1.0	---	---	---	---	---

(Adapted from: Yin & Nelson 1996; Yin et al. 1997; Nelson & Sparks 1998)
[1] Importance values = the sum of relative frequency and relative basal area (scale of 0-200).
[2] Importance values = the sum of relative density and relative dominance (scale of 0-200).

in use today. The Corps of Engineers was also given flood control responsibilities and began building levees that protected agricultural and developed lands but decreased the lateral connectivity of the river.

The St. Paul, Rock Island, and St. Louis Districts contain project lands totaling 50,500 acres, 93,600 acres, and 49,247 acres, respectively. No lands were acquired on the Illinois River or on the unimpounded reach of the Mississippi River south of St. Louis. The majority of project lands are outgranted for a variety of purposes, though the Corps maintains primary administrative authority and a stewardship role. Each Corps District manages its respective natural resources through conservation, maintenance, and enhancement practices. Guidance for management is provided in Federal legislation such as the National Environmental Policy Act (NEPA), the Water Resources Development Act (WRDA), the Forest Cover Act, and the Historic Preservation Act. Additional guidance is dictated by agency policy and regulations. The Corps retains responsibility for protecting forest and other vegetative cover on these lands in compliance with the Forest Cover Act and to establish and maintain other conservation measures on these areas. Corps management programs are designed to promote the integrity of future resources and to increase the value of such areas for conservation, recreation, and other beneficial uses, provided that management is compatible with other uses of the project. Specific management goals and objectives are included in each District's Master Plans and Operational Management Plans (OMPs). Lands identified as particularly valuable for migratory waterfowl habitat are outgranted to the USFWS for fish and wildlife management purposes via cooperative agreements. Additional lands are sub-granted to State conservation agencies for similar purposes. The USFWS outgrants 83,638 acres in the Rock Island District, 43,400 acres in the St. Paul District, and 35,775 acres in the St. Louis District.

During construction of the nine-foot channel project, many acres of federally acquired land were cleared prior to impoundment of the navigation pools. For example, within the Rock Island District, over 40,000 acres (43 percent) of the original 93,600 acres acquired in fee title for the navigation project were permanently flooded. By 1947, approximately 20,000 acres were in agricultural use (crops or pasture) and 23,000 acres were in merchantable timber.

b. U.S. Fish and Wildlife Service

The Upper Mississippi River National Wildlife & Fish Refuge (NWFR) was established in 1924 as a refuge and breeding place for migratory birds, fish, other wildlife, and plants. Today the refuge encompasses approximately 240,000 acres of Mississippi River floodplain in a more or less continuous stretch of 261 river miles from near Wabasha, Minnesota to near Rock Island. The refuge is divided into four separate districts: Winona, Minnesota (Pools 4 through 6); La Crosse (Pools 7 through 8); McGregor, Iowa (Pools 9 through 11); and Savanna, Illinois (Pools 12 through 14). Approximately 40 percent of the refuge is land acquired for the nine-foot navigation channel project. This land is owned by the Corps and managed by the USFWS through cooperative agreements. The remainder is owned and managed by the USFWS.

The Mark Twain National Wildlife Refuge (NWR) Complex originally was one refuge established in 1958 from lands purchased by the Corps for construction of the 9-foot navigation channel project. In 2000, the Mark Twain NWR Complex was separated into five refuges spread out over 350 miles of the Upper Mississippi River south of Rock Island (Port Louisa NWR, Great River NWR, Clarence Cannon NWR, Two Rivers NWR, and the Middle Mississippi River NWR). In early 2009, the Mark Twain Refuge Headquarters in Quincy, IL, was closed and oversight for these five Refuges shifted back to the Upper Mississippi River National Wildlife and Fish Refuge in Winona, MN. Today, this refuge Complex contains approximately 45,000 acres, which the USFWS manages cooperatively with the Corps of Engineers and the states of Iowa, Illinois, and Missouri (table 3).

The Illinois River NWFR began with the purchase of the Chautauqua Drainage and Levee District by the USFWS in 1936. Today, the four Illinois River refuges span 125 miles of the Illinois River, and include Chautauqua NWR, Meredosia NWR, Emiquon NWR, and the Cameron/Billsbach Unit. Part of Two Rivers NWR is also located in the lower Illinois River.

c. States

State lands in or adjacent to the project area are managed or designated for several purposes. These uses include recreation, wildlife/fisheries management, areas designated for research or habitat preservation, or for historic significance. State-managed parks and conservation areas include approximately 50,585 acres on the Illinois River. The States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin manage over 192,230 acres for fish and wildlife purposes at more than 80 sites along the Upper Mississippi River. These sites often are Federal lands leased from the Corps of Engineers. Additional information on these areas may be found in the OMPs and Land Use Allocation Plans (LUAPs) for St. Paul and Rock Island District and in the St. Louis District's Rivers Project Master Plan (USACE 2001 and 2004).

Table 3. Summary of USFWS lands within the UMRS. (Adapted from: USACE 2004)

Refuge Complex	Management Unit	Acres	Location
	Mississippi River		
Upper Mississippi River National Wildlife and Fish Refuge	Winona District	37,513	Pools 4-6
	La Crosse District	46,648	Pools 7-8
	McGregor District	91,662	Pools 9-11
	Savanna District	64,397	Pools 12-14
Trempealeau NWR		5,733	Pool 6
Mark Twain National Wildlife Refuge Complex*	Port Louisa NWR	8,375	Pools 17-18
	Great River NWR	15,000	Pools 20-24
	Clarence Cannon NWR	3,750	Pool 25
	Two Rivers NWR	2,660	Pools 25-26
	Middle Mississippi NWR	7,000	Open River
Total Mississippi River Acres:		*271,065*	
	Illinois River		
Mark Twain NWR Complex*	Two Rivers NWR	5,840	Alton Pool
Illinois River National Wildlife and Fish Refuges	Cameron-Billsbach Unit	1,709	Peoria Pool
	Chautauqua NWR	4,488	La Grange Pool
	Emiquon NWR	1,303	La Grange Pool
	Meredosia NWR	3,852	Alton Pool
Total Illinois River Acres:		*16,223*	

* The Mark Twain NWR Complex has been reorganized, and no longer exists by that name

d. Native American Land

The Prairie Island Indian Reservation, located in Pool 3 near Red Wing, Minnesota, is the only Native American landholding within the project area. The reservation contains about 1,200 acres along the river and is owned and managed by the Mdewakanton Dakota Sioux. The Department of the Interior also holds some land in trust for the tribe.

e. Levee and Drainage Districts

Agricultural, municipal, and industrial levees and drainage districts are most prevalent in the Upper Mississippi River below Clinton, Iowa, and the lower Illinois River below Peoria. The percentage of the floodplain that is leveed varies as follows:

- 3 percent north of Pool 13
- 50 percent from Pool 14 through Pool 26
- 80 percent in the open river south of St. Louis
- 60 percent in the lower Illinois River below Peoria

The levees are generally designed to protect human life and property by reducing or eliminating the threat from recurrent annual flood events. The interior of leveed areas is often networked with a system of tile lines, ditches, and pumps designed to remove excess water from surface runoff and seepage, allowing for the production of agricultural row crops, corn, and soybeans. Agricultural levees are often of lower elevation than municipal and industrial levees and may be breached periodically. Roughly 15 percent of the area within levee districts contains natural habitats other than agriculture. The amount of forested and grassland habitat in leveed areas is approximately 38,000 and 71,000 acres, respectively. System-wide, approximately 23 percent of the contiguous floodplain remains connected to natural river hydrology and is susceptible to seasonal flooding. River islands, many of which are heavily forested, constitute another 8 percent of the total UMRS floodplain land area (USACE 2004). Table 4 shows total and relative distribution of leveed areas (and public lands) in each UMRS Pool.

f. Public Lands

The total amount of public lands in the UMRS is approximately 530,000 acres (table 4). However, the distribution of these lands is highly variable and is heavily skewed towards the upper impounded reach. By comparison, public lands are much less prevalent in lower Mississippi River and Illinois River reaches. The percentage of the floodplain in public ownership in each of the four major river reaches is as follows (USACE 2004):

- Upper Impounded Reach: 57 percent pubic land
- Lower Impounded Reach: 11 percent public land
- Unimpounded Reach: 8 percent public land
- Illinois River: 12 percent public land

Table 4. Leveed area and public lands distribution in the UMRS.

River/Pool/Reach	Total Floodplain Acres	Leveed Area		Public Ownership	
		Acres	Percent	Acres	Percent
Upper Mississippi River (UMR)					
Pool 2	21,620	1,013	4.7%	4,723	21.8%
Pool 3	23,584	0	0.0%	10,468	44.4%
Pool 4	70,062	188	0.3%	19,893	28.4%
Pool 5	29,931	82	0.3%	18,616	62.2%
Pool 5a	16,887	5	0.0%	12,399	73.4%
Pool 6	25,011	5,968	23.9%	11,609	46.4%
Pool 7	41,543	0	0.0%	19,834	47.7%
Pool 8	47,110	1,400	3.0%	29,272	62.1%
Pool 9	52,166	2	0.0%	45,944	88.1%
Pool 10	39,863	274	0.7%	23,754	59.6%
Pool 11	31,959	222	0.7%	25,387	79.4%
Pool 12	21,981	1,084	4.9%	14,677	66.8%
Pool 13	85,287	8,408	9.9%	52,228	61.2%
Pool 14	65,840	22,042	33.5%	12,150	18.5%
Pool 15	10,307	2,067	20.1%	1,040	10.1%
Pool 16	33,906	4,090	12.1%	10,517	31.0%
Pool 17	80,554	59,925	74.4%	7,820	9.7%
Pool 18	126,123	46,436	36.8%	20,432	16.2%
Pool 19	123,312	37,156	30.1%	842	0.7%
Pool 20	70,402	47,513	67.5%	3,922	5.6%
Pool 21	61,081	39,918	65.4%	12,024	19.7%
Pool 22	88,643	68,340	77.1%	8,129	9.2%
Pool 24	88,774	65,245	73.5%	14,062	15.8%
Pool 25	89,071	50,677	56.9%	16,292	18.3%
Pool 26*	138,382	32,290	23.3%	3,633	2.6%
L&D 26 to Kaskaskia R.	278,559	209,221	75.1%	1,709	0.6%
Kaskaskia R. to Grand Tower	130,399	87,492	67.1%	27,471	21.1%
Grand Tower to Ohio R.*	264,095	65,917	25.0%	25,518	9.7%
Total UMR	*2,156,461*	*856,981*	39.7%	*454,361*	21.1%
Illinois Waterway (IWW)					
Lockport	15,433	0	0.0%	412	2.7%
Brandon	1,855	0	0.0%	0	0.0%
Dresden	6,076	0	0.0%	647	10.7%
Marseilles	25,503	0	0.0%	37	0.1%
Starved Rock	13,956	0	0.0%	0	0.0%
Peoria	131,476	4,952	3.8%	13,590	10.3%
La Grange	221,226	119,590	54.1%	39,599	17.9%
Alton	196,652	133,563	67.9%	21,104	10.7%
Total IWW	*612,177*	*258,105*	42.2%	*75,389*	12.3%

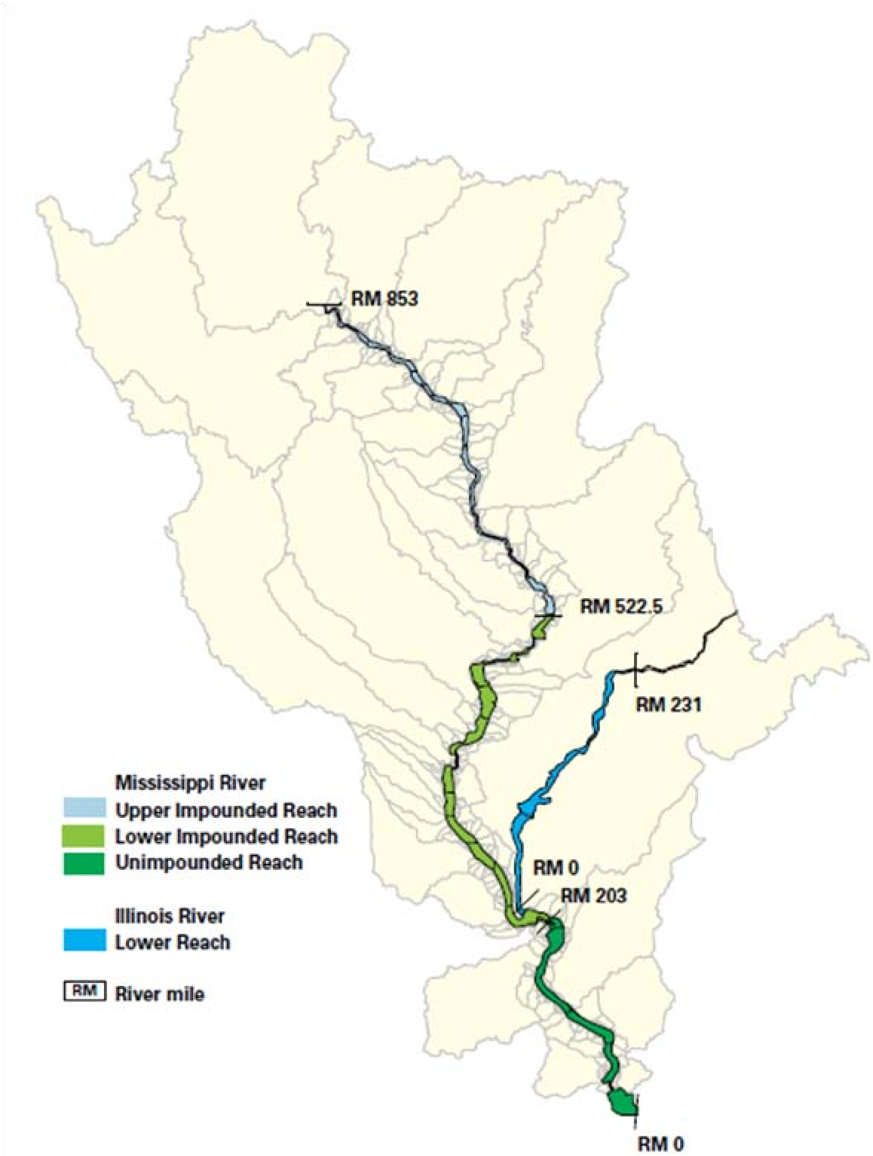
(Adapted from: USACE 2004)

*GIS levee coverage incomplete

B. Define the Reaches

Spatial differences in floodplain geomorphology and modern land use provide an ecological basis to separate the UMRS into four distinct river reaches (figure 8). Changes in response to river and floodplain development differ among geomorphic reaches, as do habitats and the ecological communities they support. Thus resource opportunities, problems, and management will differ among the river reaches. The distribution of terrestrial land cover types in the four large-scale river reaches is illustrated in table 5 and figure 9. Following is a summary of reach characteristics.

Figure 8. The UMRS is classified into four major floodplain reaches.



(Source: USGS 1999)

1. The Upper Impounded Reach

The Upper Impounded Reach extends from Minneapolis (Pool 1) to Clinton (Pool 13). It is characterized by numerous islands and a narrow floodplain that terminates at steep bluffs. The relatively narrow lateral extent of the floodplain is reflected in the fact that only about 3 percent of it is protected by levees in this reach. Natural habitats in this portion of the UMRS are highly connected because of the abundance of public lands, much of which are managed as part of the Upper Mississippi River National Wildlife and Fish Refuge. Landcover diversity is also the highest of the four reaches. The pre-settlement landscape of the UMRS in the upper impounded reach was largely riparian forests interspersed with numerous marshes and wet prairies. Historic floodplain forests were commonly replaced by water due to impoundment by dams and subsequent erosion of islands and by development to a lesser degree. Although remaining forests have a species composition similar to the past, forest cover as a whole has been declining. The corresponding terrestrial shift toward wet meadow land cover is driven in large part by the widespread occurrence of reed canary grass (*Phalaris arundinacea*), an invasive species that dramatically limits tree recruitment in this reach. In general, aquatic vegetation is much more prevalent in the Upper Impounded Reach than in lower river reaches.

2. The Lower Impounded Reach

The Lower Impounded Reach lies between Clinton (Pool 14) and Alton (Pool 26). In the upper portion of this reach the river continues to flow through a relatively narrow floodplain, but islands are typically fewer and larger than in the Upper Impounded Reach. Floodplains in the lower portion of this reach (Pool 20 and southward) are highly developed for agriculture. Corresponding HNA habitat diversity scores are moderate in Pools 14 through 19 and 24 through 26, but are low from Pools 20 through 22. Overall, levees protect about 50 percent of the floodplain in this reach, and discontinuity in the distribution of levees and public lands has resulted in significant habitat fragmentation. The pre-settlement landscape in the Lower Impounded Reach was dominated by riparian forests that bordered more open savannas, which then graded into a significant amount of prairie habitat. Disturbance regimes were characterized by flooding in the lower elevation riparian habitats, and fire was likely an ecological driver in the higher savanna and prairie habitats. The riparian forest remains fairly contiguous in a relatively narrow band between levees and the river, but much of the open forests, savannas and grasslands were eliminated. The pre-settlement floodplain forest composition was relatively diverse, with hackberry, pecan, elm, willow and cottonwood occurring as co-dominants. The current forest is primarily dominated by silver maple. Floodplain soils in the Lower Impounded Reach are thick layers of silt, sand, and gravel deposited behind natural levees during floods occurring over thousands of years.

3. The Unimpounded Reach (Open River)

The Unimpounded Reach, also commonly referred to as the Open River Reach, occurs below the confluence of the Mississippi and Missouri Rivers near St. Louis. Flow increases by nearly 50 percent below this confluence, making the lock and dam system unnecessary for navigation. The Missouri River contributes vast quantities of sand and silt from the Great Plains and Rocky Mountains, and the river generally assumes a meandering pattern, resulting in numerous old oxbow lakes and other backwaters as it has shifted course over the years. The river flows through alluvial lowlands to the confluence with the Ohio River, where the floodplain is up to 50 miles wide. About 80 percent of the floodplain is protected behind levees in this reach, agriculture is dominant land cover class, and Habitat Needs Assessment (HNA) habitat diversity scores are correspondingly low. Historically, the unimpounded reach below the Kaskaskia River supported extensive tracts of mature southern bottomland hardwood communities more typical of the Lower Mississippi Alluvial Valley. Today, the riparian forest remains fairly contiguous in a narrow band along the longitudinal gradient of the river, but open forests, savannas, and grasslands have been mostly eliminated, particularly above the Kaskaskia River.

4. The Illinois River

The Illinois River Reach can be, and commonly is, further divided into upper and lower reaches. The Lower Illinois Reach downstream of Starved Rock Lock and Dam is more characteristic of river-floodplain ecosystems in form and function than is the Upper Reach. It has a stable, low-gradient channel and numerous large lakes. Given the glacial origin of the Illinois River valley, the floodplains are much larger than would be expected for a river of its present size. Flood flows historically may have formed new channels and backwaters, but the trend was toward filling in the river valley because flow generally has been insufficient to transport the mass of sediment entering the broad floodplain. The average floodplain width in the lower 80 miles of the river is about 4 miles. The floodplain soils are a rich alluvium that overlay sandy glacial outwash. Forests, composed of a mix of hackberry (*Celtis occidentalis*), pecan (*Carya illinoinensis*), willow (*Salix*), elm (*Ulmus*) and cottonwood (*Populus deltoides*), were the dominant land cover class in the Lower Illinois Reach during pre-settlement times. Hydrological alterations due to the historical diversion of Lake Michigan and the construction of locks and dams raised the water level, killing lower lying forests and shifting overall dominance toward more flood tolerant species such as silver maple (*Acer saccharinum*). Today, levees protect about 60 percent of the lower Illinois River floodplain, in which agriculture is the dominant land cover class. Discontinuity in the distribution of public lands and levees has resulted in significant habitat fragmentation. HNA habitat diversity scores are moderate for much of the Illinois River valley except for the Alton Pool, which are significantly lower.

5. Geomorphic Reaches

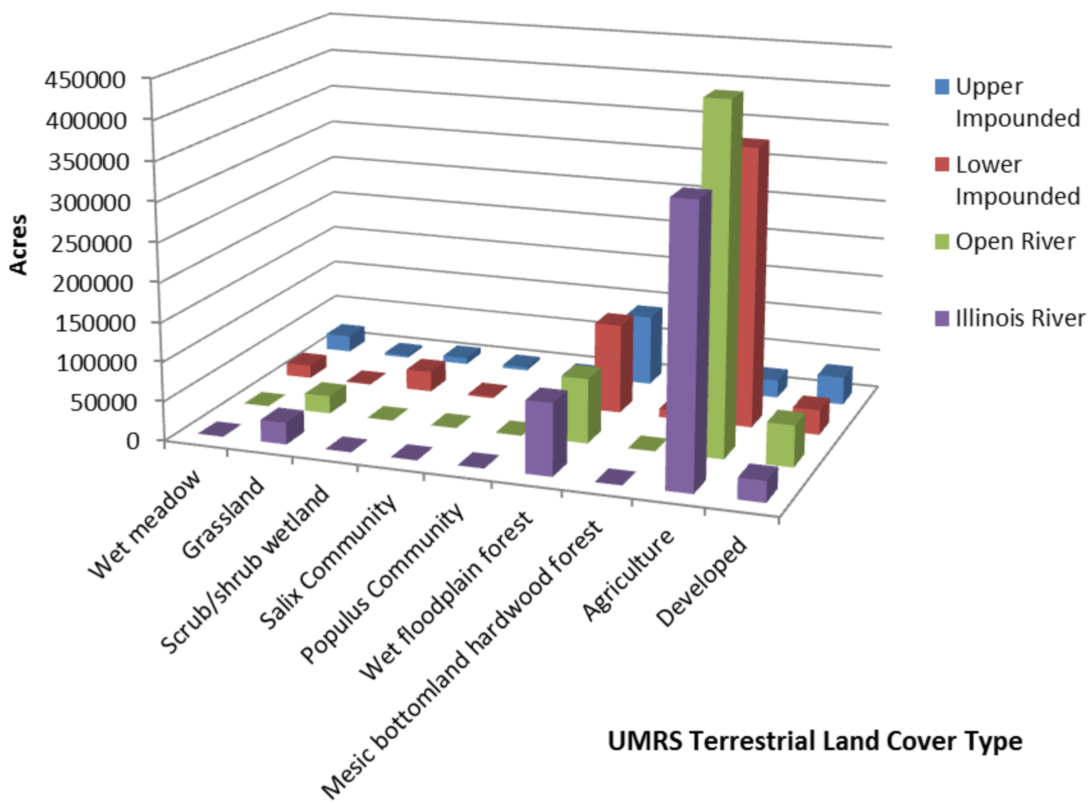
The UMRS can be described by a more detailed breakdown of twelve geomorphic sub-reaches within the four major UMRS reaches (*see figure 1*). Detailed descriptions of these geomorphic sub-reaches can be found in the HNA (Theiling et al. 2000); the Cumulative Effects Study (WEST 2000); and in the Upper Mississippi River System Ecosystem Restoration Objectives plan (USACE 2010). Detailed tables and figures describing the distribution of land cover types within these geomorphic reaches (and individual pools in the impounded reaches) can also be found in the HNA and the UMRS Ecosystem Restoration Objectives plan.

Table 5. Terrestrial land cover in UMRS reaches.

Land Cover Type	Reach							
	Upper Impounded		Lower Impounded		Open River		Illinois River	
	Acres	%	Acres	%	Acres	%	Acres	%
Wet meadow	21686	4.9	16764	1.8	0	0.0	0	0.0
Grassland	3206	0.7	858	0.1	22677	3.4	27713	4.5
Scrub/shrub wetland	8164	1.9	26229	2.9	0	0.0	0	0.0
Salix Community	4093	0.9	2265	0.2	0	0.0	0	0.0
Populus Community	417	0.1	2877	0.3	0	0.0	0	0.0
Wet floodplain forest	90449	20.5	114288	12.5	82219	12.2	91326	14.9
Mesic bottomland hardwood forest	7518	1.7	10471	1.1	0	0.0	0	0.0
Agriculture	22772	5.2	355581	38.8	439201	65.2	349136	57.0
Developed	35933	8.1	31839	3.5	52765	7.8	26740	4.4

(Adapted from: Theiling et al. 2000)

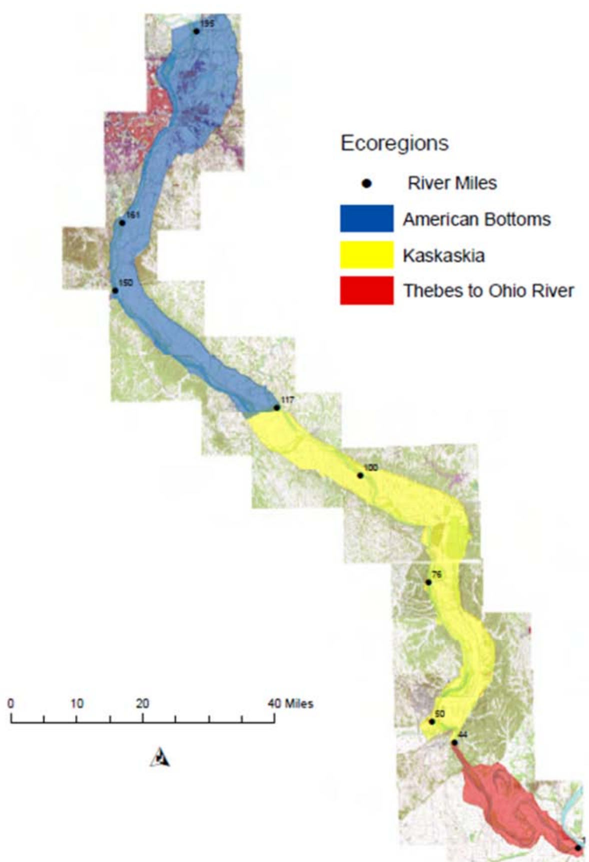
Figure 9. Terrestrial land cover in UMRS reaches. (Adapted from: Theiling et al. 2000)



6. Hydrogeomorphic (HGM) Ecoregions

A hydrogeomorphic modeling study conducted on the Unimpounded Reach of the UMRS (Heitmeyer 2008), referred to therein as the Middle Mississippi River Regional Corridor, revealed three distinct ecoregions that do not correspond exactly to the previous set of delineated geomorphic reaches in the open river (figure 10). The American Bottoms ecoregion extends from the confluence of the Mississippi and Missouri Rivers south to the Kaskaskia River, and was heavily influenced by sedimentation and flow from the Missouri River. The Kaskaskia ecoregion extends from the Kaskaskia River to a narrow constriction of the floodplain at Thebes Gap near Cape Girardeau. Geomorphic influences in this ecoregion include attenuation of sediments and flows from the American Bottoms ecoregion, influx of sediments and flow from the Kaskaskia River, and floodplain constriction at Thebes Gap. The third ecoregion extends from Thebes Gap to the confluence of the Mississippi and Ohio Rivers and is generally characterized as the northernmost extension of the historic Mississippi Embayment (Heitmeyer 2008). A study assessing the feasibility of conducting a series of hydrogeomorphic analyses in the Impounded Reaches of the Mississippi and Illinois Rivers has been completed (Heitmeyer 2007). As that project moves forward, it may very well provide a similarly distinct set of finer scale geomorphic classifications of the UMRS that will have wide applicability to floodplain restoration efforts throughout the system.

Figure 10. HGM ecoregions in the Middle Mississippi River Regional Corridor.



(Source: Heitmeyer 2008)

C. UMRS Floodplain Ecosystem

The UMRS floodplain ecosystem is complex, spatially and temporally dynamic, and interspersed with a mosaic of habitat types differentiated by an interacting combination of environmental factors and gradients such as hydrology, soils, geomorphology, elevation, biological succession, and disturbance (figure 4). Various land classification efforts describing the multiple habitat types present in the UMRS have been developed over the years from a combination of historical, aerial, and satellite imagery (e.g., Dieck and Robinson 2004; Theiling et al. 2000; Heitmeyer 2008; Faber-Langendoen 2001). However, the most pertinent for the purposes of this report are likely the General Wetland Vegetation Classification System developed and used by the LTRMP program and the hydrogeomorphic classification system recently developed and used by Heitmeyer (2008) in the Middle Mississippi Regional Corridor, both of which are described in more detail below.

1. Floodplain Habitats

a. General Wetland Vegetation Classification System

The General Wetland Vegetation Classification System (GWVCS) is a 31-class land cover/land use classification system developed and used by the EMP-LTRMP (table 6). It was developed from year 2000 color infrared aerial photography and was designed primarily for use in systemic level studies. It basically represents an integrated, coarser scale version of a 151-class system that can be used for more focused studies. A full description of the development of the GWVCS and all 31 land use/land cover types it encompasses can be found in the General Classification Handbook for Floodplain Vegetation in Large River Systems (Dieck and Robinson 2004). Following are brief descriptions of some of the terrestrial UMRS vegetation types most relevant to this report.

Wooded Swamp (WS) – Wooded Swamp represents areas in or around shallow lakes, ponds, oxbows, or backwaters that are more than 10 percent vegetated with semipermanently flooded forests. Common vegetation types include bald cypress (*Taxodium distichum*), water tupelo (*Nyssa aquatica*), sourgum (*Nyssa sylvatica*), and black ash (*Fraxinus nigra*). This general class is most common in southern reaches of the UMRS. It may have inclusions of submersed, nonrooted-floating aquatics, rooted-floating aquatics, or emergent vegetation. It is typically found growing in shallow water.

Floodplain Forest (FF) – Floodplain Forest represents areas on islands, near the shoreline, or around lakes, ponds, and backwaters that are more than 10 percent vegetated with seasonally flooded forests. These forests are predominantly silver maple, but also include elm, cottonwood, black willow (*Salix nigra*), and river birch (*Betula nigra*). This general class is typically found growing at or near the water table where it becomes inundated from spring flooding and high-water events.

Populus Community (PC) – Populus Community represents lowland areas that are more than 10 percent vegetated with seasonally flooded cottonwood trees. These forests are more than 50 percent cottonwood and may include other floodplain and lowland forest types. This general class is typically a pioneering species of disturbed areas and is generally found growing on moist soils. Populus communities are tall and often grow monotypically, as well as adjacent to or along with floodplain forest or lowland forest types.

Salix Community (SC) – Salix Community represents areas near the shoreline or around lakes, ponds, and backwaters that are more than 10 percent vegetated with seasonally flooded willow trees or shrubs. These forests or shrub communities are more than 50 percent willow and may include other floodplain forest types. This general class typically grows with an emergent, grass, and/or forb understory on moist and saturated soils.

Table 6. General wetland vegetation classification system. (Source: Dieck and Robinson 2004)

Map class	Map code	Hydrologic regime	Density*	Height*
Open Water	OW	Permanently Flooded		
Submersed Vegetation	SV	Permanently Flooded	X	
Rooted-Floating Aquatics	RFA	Permanently Flooded	X	
Deep Marsh Annual	DMA	Semipermanently Flooded	X	
Deep Marsh Perennial	DMP	Semipermanently Flooded	X	
Shallow Marsh Annual	SMA	Seasonally Flooded	X	
Shallow Marsh Perennial	SMP	Seasonally Flooded	X	
Sedge Meadow	SM	Temporarily Flooded	X	
Wet Meadow	WM	Saturated Soil	X	
Deep Marsh Shrub	DMS	Infrequently Flooded	X	
Shallow Marsh Shrub	SMS	Infrequently Flooded	X	
Wet Meadow Shrub	WMS	Infrequently Flooded	X	
Scrub-Shrub	SS	Infrequently Flooded	X	
Wooded Swamp	WS	Semipermanently Flooded	X	X
Floodplain Forest	FF	Seasonally Flooded	X	X
Populus Community	PC	Temporarily Flooded	X	X
Salix Community	SC	Infrequently Flooded	X	X
Lowland Forest	LF	Seasonally Flooded	X	X
Agriculture	AG	Seasonally Flooded		
Conifer	CN	Semipermanently Flooded	X	X
Plantation	PN	Seasonally Flooded	X	X
Upland Forest	UF	Temporarily Flooded	X	X
Developed	DV	Infrequently Flooded		
Grassland	GR	Infrequently Flooded	X	
Levee	LV	Infrequently Flooded	X	
Pasture	PS	Infrequently Flooded		
Roadside	RD	Infrequently Flooded	X	
Mudflat	MUD	Seasonally Flooded		
Sand Bar	SB	Temporarily Flooded		
Sand	SD	Infrequently Flooded		
No Photo Coverage	NPC	No Photo Coverage		

* Indicates whether density and/or height modifiers apply to that map class

Lowland Forest (LF) – Lowland Forest represents areas along the riverbanks and within the floodplain that are drier than floodplain forest sites and are more than 10 percent vegetated with temporarily flooded forests. Common vegetation types include pecan, hickory (*Carya*), river birch, sycamore (*Platanus occidentalis*), and red/black oak (*Quercus*). This general class is most common in southern reaches of the Upper Mississippi and Illinois River Systems and is typically found growing on moist, well-drained soils.

Wet Meadow Shrub (WMS) – Wet Meadow Shrub represents lowland areas that are more than 25 percent vegetated with temporarily flooded shrubby vegetation. This general class tends to be drier than shallow marsh shrubs, but wetter than scrub-shrubs, and typically grows with a mix of sedges, grasses, and forbs. Common vegetation types include alder (*Alnus*), elder (*Sambucus*), false indigo (*Amorpha*), dogwood (*Cornus*), and willow. Wet meadow shrub is typically found growing on saturated soils.

Scrub-Shrubs (SS) – Scrub-Shrubs represent upland areas that are more than 25 percent vegetated with infrequently flooded shrubby vegetation. This general class is the driest of the shrub classes and typically grows with a mix of grasses and forbs on drier soils.

Wet Meadow (WM) – Wet Meadow represents lowland areas that are more than 10 percent vegetated with perennial grasses and forbs. Common vegetation types include reed canary grass, rice cut-grass (*Leersia*), and goldenrod (*Solidago*). This general class may have small inclusions of woody vegetation, sedges, or emergent vegetation, such as smartweed or purple loosestrife. It is typically found growing on saturated soils and is often considered the transition zone between aquatic communities and uplands.

Grassland (GR) – Grassland represents drier upland areas that are more than 10 percent vegetated with perennial grasses and forbs. This general class may include fallow fields, sand prairies, and shrubby vegetation. It generally exists near other upland types, such as scrub-shrubs or upland forest. Grasslands are infrequently flooded and are typically found growing where soils are dry.

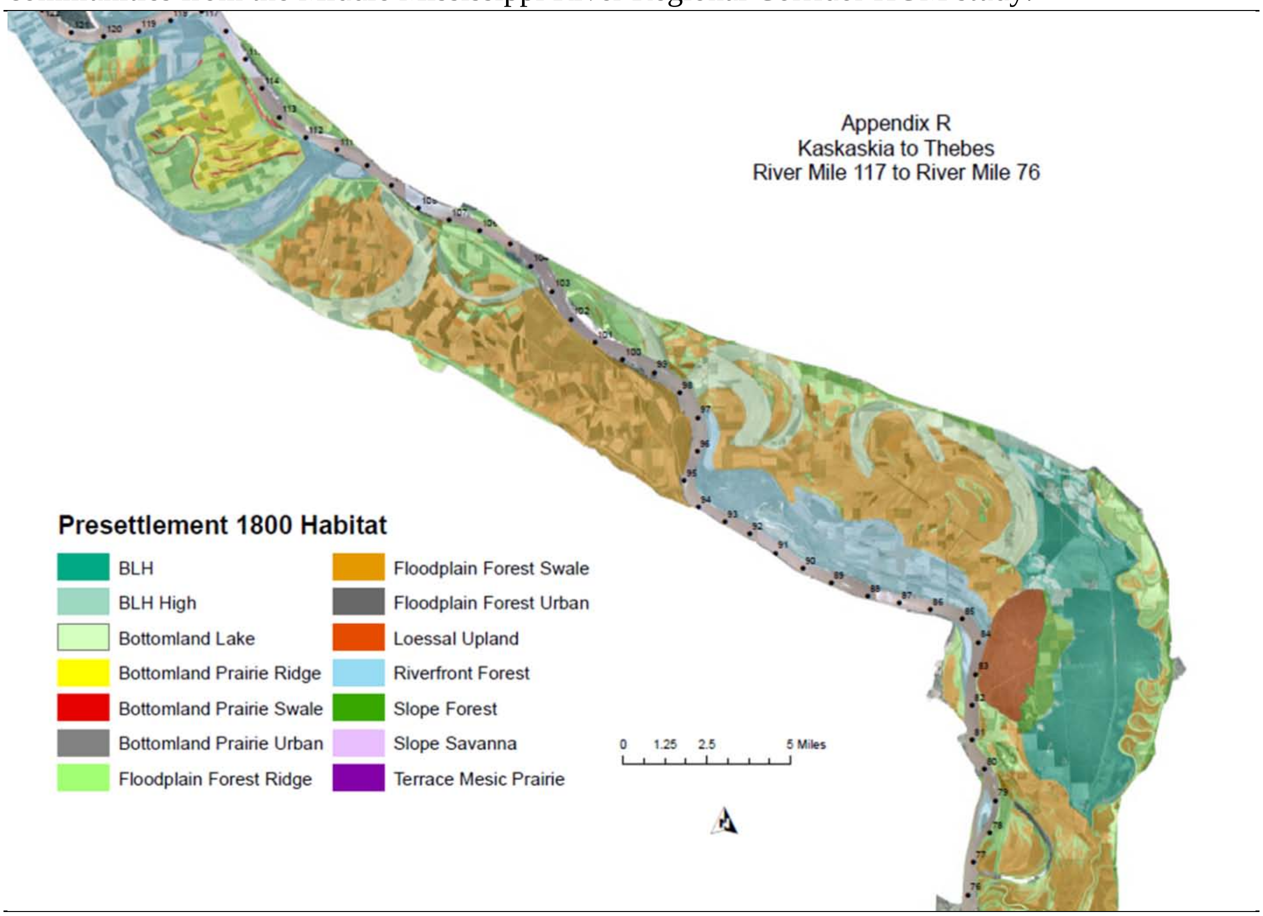
b. Hydrogeomorphic (HGM) Classification System

The HGM Classification System developed and used by Heitmeyer (2008) for the Middle Mississippi River Regional Corridor study used a discrete set of hydrogeomorphic data to classify ecosystems in that portion of the river system. The utility of this classification system for the entire UMRS is unknown at this time. However, the feasibility of using HGM analyses for the entire UMRS has been assessed and this study may be undertaken in the near future. Therefore, it is expected that a classification system with similar metrics will be developed for application to the entire system in the foreseeable future. An example of a map plate from the Middle Mississippi study showing the spatial distribution of areas that could potentially support the restoration of presettlement floodplain habitats is shown in figure 11. Terrestrial HGM habitat types described in the Mississippi study are summarized below.

Riverfront Forest – Riverfront forests primarily occurred on chute and bar surfaces, some point bar areas, and along the edges of some abandoned channels. Soils were generally young, well drained sands, sandy loams and silt loams. Flood frequency was less than 1 year in swales, and 1 to 2 years on ridges. This forest type was dominated by early successional tree species, with willow and silver maple commonly occurring in lower elevations and a mix of elm, ash (*Fraxinus*), cottonwood, sycamore, pecan and sugarberry (*Celtis laevigata*) on ridges. Oak species such as swamp white oak (*Quercus bicolor*) and pin oak (*Quercus palustris*) occurred occasionally on higher elevations in small, scattered groups.

Floodplain Forest – Floodplain forests were fairly widespread, occurring on point bar surfaces and along tributaries. They typically developed in mixed silt loams in conjunction with older ridge and swale topography. Ridges commonly had a 2- to 5-year flood frequency, while swales had a 1- to 2-year flood frequency. This forest type represents a transition from early successional riverfront forests to older bottomland hardwood forest that occurred in backswamps and depressions contained clay soils. Composition was dominated by elm, ash, sweetgum (*Liquidambar styraciflua*), sugarberry, and boxelder (*Acer negundo*), but included a mix of other species depending on elevation and soils. For example, higher elevations often contained pecan, pin oak, swamp chestnut oak (*Quercus michauxii*), and scattered hickories. Lower elevations included more willow, cottonwood, maple and sycamore.

Figure 11. Map plate of areas that could potentially support restoration of pre-settlement communities from the Middle Mississippi River Regional Corridor HGM study.



(Source: Heitmeyer 2008)

Bottomland Hardwood Forest (BLH) – Bottomland hardwood forests were present in low elevation depressions, backswamps, larger point bar swales, and old braided river terraces. They typically occupied zones between floodplain forests and the edges of bluffs, primarily south of Kaskaskia in the Mississippi Alluvial Valley (MAV) portion of the UMRS. Soils in these areas were primarily silty clays, and flood frequency was typically on the order of 2 to 5 years. These vegetation communities were distributed along elevation and flood frequency gradients, with the lowest lying areas containing baldcypress-tupelo swamps. At slightly higher elevations, low bottomland hardwood forests contained trees such as overcup oak (*Quercus lyrata*), green ash (*Fraxinus pennsylvanica*), red maple (*Acer rubrum*), and pecan, with scattered pin oak on higher ridges. Intermediate bottomland hardwood forests, which occurred mostly in backswamp areas that typically flooded 1 to 2 months in the dormant season, contained a mix of pin oak, swamp chestnut oak, sugarberry, American elm (*Fraxinus americana*), sweetgum, and scattered swamp white and willow oak (*Quercus phellos*). The highest elevation bottomland hardwood forests typically contained a mix of pin oak, cherrybark oak (*Quercus pagoda*), willow oak, shagbark hickory (*Carya ovata*), shellbark hickory (*Carya laciniosa*), sweetgum, and American elm.

Slope Forest – Slope forests occupied alluvial fans and higher terraces along the edges of floodplains, were rarely flooded, and had soils that were a unique mix from both erosional sources and alluvium. These forests contained a diverse mix of species common to both upland and floodplain communities including hickories, sugarberry, swamp white oak, swamp chestnut oak, white oak (*Quercus alba*), bur oak (*Quercus macrocarpa*), various red oaks, black walnut (*Juglans nigra*), ash, mulberry (*Morus*), maple, pawpaw (*Asimina triloba*), persimmon, honey locust (*Gleditsia triacanthos*), hawthorn (Crataegus), Kentucky coffeetree (*Gymnocladus dioicus*), and slippery elm (*Ulmus rubra*). Fire may have been a regular occurrence in these habitats, particularly in the American Bottoms just south of St. Louis where savanna and prairie systems were more ubiquitous.

Bottomland Prairie – Bottomland prairie occupied extensive tracts of the Middle Mississippi River floodplain north of Kaskaskia, and typically occurred on older point bar surfaces with 2 to 5 year flood frequencies. Soils were variable, ranging from clay-silts to silty and sandy loams. Fire was likely an important factor in the maintenance of these systems. Higher elevation ridges commonly contained a mix of prairie grasses such as big bluestem (*Andropogon gerardii*), blue joint (*Calamagrostis Canadensis*), and switchgrass (*Panicum*). Lower elevation swales usually contained a mix of sedges (*Carex*) and plants more typical of wetlands, such as river bulrush (*Schoenoplectus fluviatilis*), floating manna grass (*Glyceria septentrionalis*), bur-reed (*Sparganium*), sweetflag (*Acorus*), and smartweeds (*Polygonum*).

Mesic "Terrace" Prairie – Higher elevation terraces in the Middle Mississippi River floodplain contained mesic prairies that were dominated by perennial upland-type grasses including little bluestem (*Schizachyrium scoparium*), switchgrass, Indian grass (*Sorghastrum nutans*), dropstem (*Sporobolus*), side-oats gramma (*Bouteloua curtipendula*), bunch grass, and panic grasses. Fire was likely a common disturbance factor in these ecosystems.

Savanna – Savannas typically occurred on higher elevation alluvial fans, colluvial aprons, and terrace "interface" zones between slope forest and prairie dominated ecosystems. Soils were usually a mix of silt loams, and flood frequency was generally on the order of 10 to 20 years.

Fire was also likely a common disturbance factor in these systems, which were most common in the American Bottoms region of the Middle Mississippi River.

2. Ecosystem Services

Society benefits from both the products and functions generated by large river floodplains. Since many of these resources cannot be measured on the same scale it is often difficult to assess their relative values and outputs. A system which uses a multiple-value approach must be used to evaluate the floodplain for both economic and natural resource worth. A generalized (and not all-inclusive) list of floodplain forest ecosystem outputs is listed in five broad categories below (USACE 1995).

- Water Quality – The improvement to ground and surface water, by promoting infiltration, recharge, detoxification, nutrient cycling, and natural flood and erosion/scour control by reducing flood velocities and peaks. Floodplain forests have the ability to absorb energy from floodwaters and reduce sediment loads.
- Living Resources – The supporting vegetation that provides fish and wildlife habitat, organic matter production, natural genetic diversity, pollination, protection of rare and endangered species, and creation of corridors for migration.
- Land Based Resources – The creation and enhancement of forests, natural product harvests, wind breaks, and carbon sequestration.
- Education – The opportunity for education and the scientific study of physical, biological and cultural resources.
- Cultural/Recreational Resources – Consumptive and nonconsumptive uses, open space and aesthetic values. For example, the river "… provides for over $6.6 billion dollars in revenue annually from some 12,000,000 visitor-days of use by people that hunt, fish, boat, sightsee or otherwise visit the river, its magnificent bluffs and communities" (McGuiness 1999).

Some floodplain forest lands have been converted into agro-systems which, depending on their location and conditions, have proven to be less stable and more susceptible to floods or other damage. When forests and other natural communities are restored in these areas, stability, diversity and potential for long-term sustainability are increased. In some instances agro-forestry practices (i.e., trees that work for agriculture) can be an answer for sustainable agriculture in floodplains by helping to control the natural forces of the river (Hershey et al. 1994). Even numerous small scale projects and actions taken by the Corps or partners through this plan, and/or independent private actions, can make a difference in natural resource values within the river corridor. However, when coupled with a few larger scale restoration projects, located at strategic sites within the corridor, sustainability will be enhanced for both ecological and economic systems.

Floodplain Forest Functions – The conversion of the present day UMRS floodplain from its historic natural ecosystem to its human-altered ecosystem requires a realignment of restoration thinking due to the incremental losses of naturally occurring functions and processes and their outputs of goods, services and societal values. It is not the intent of this plan to measure the magnitude of these effects, but rather to understand the existing floodplain's functional capability to produce those achievable benchmark services that are now valued by society.

Although research has revealed a basic understanding of the fundamental ecological processes of large river floodplains, it is the long-term effects of the many and cumulative human changes upon the UMRS floodplain ecosystem that remain uncertain. Ecosystems operate in such intricate and unexplored ways that most could not be replicated by today's technology. Human civilizations would cease to thrive, if it was not for natural ecosystems' fundamental life-support services, namely air and water purification, detoxification and decomposition of wastes (Daily et al. 1997). Still, present day UMRS floodplains perform their important basic hydrologic, geomorphic, and biological functions and processes as did their historic counterparts.

The UMRS floodplain ecosystem, located at the convergence of terrestrial and aquatic ecosystems, is a regional hot spot of biodiversity and exhibits a high rate of biological productivity in marked contrast to the larger landscape. Restoration of the UMRS floodplain will require a firm understanding of riparian structures and functions at even larger watershed scales.

The inherent benchmark ecological processes that floodplain ecosystems perform can be categorized into three major types: (1) hydrology and sediment dynamics, (2) biogeochemistry and nutrient cycling, and (3) habitat and food web maintenance. These functions have both on-site and off-site effects, some of which may be expressed as goods and services. Common examples of UMRS floodplain functions, their indicators and effects, and those goods and services produced are shown in table 7 (National Research Council 2002).

Knowledge of large river floodplain functions is sufficiently well developed that indicators can be used as shortcuts to judge whether the functions are occurring at appropriate levels. However, the exact relationship between indicators and current ecological functional benchmarks of the UMRS, together with proven methodologies for comprehensive measurements, will challenge restoration attempts at any scale until they are further refined.

Except for support of biodiversity, some environmental services of the UMRS floodplain can be produced by technologies. Reservoirs for flood peak reduction and wastewater treatment plants for pollutant removal are examples of process substitutions that are directed at single rather than multiple functions that riparian areas carry out simultaneously. Human activities that destroy or even modify the natural ecosystem may deteriorate ecological services whose long term value dwarfs short-term economic benefits gained by society from such activities (Daily et al. 1997).

Hydrology and Sediment Dynamics – The UMRS floodplain is characterized by a spatial and temporal mosaic of conditions reflecting variability in sediment type and particle size distribution, timing of water sources and water quality, and flood disturbances. Seasonal dynamics in flow and sediment transport constitute the foundation of the UMRS structure and thus influence many ecosystem functions. Moisture availability and anoxia in riparian soils are additional factors that are related to soil particle size and fluvial processes (National Research Council 2002). In the present day UMRS floodplain, the natural variability of flow has been regulated and sediment inputs have been altered by water regulating works including dikes, dams and levees. The influence of regulating these river flows has had overwhelming effects on ecological processes in the UMRS floodplain as a result of the disruption of flow seasonality, sediment dynamics and moisture availability.

Hydrologic Processes – Hydrologic fluxes in the UMRS floodplain are highly variable in both space and time, ranging from minutes to decades, and as a result it is entirely possible that a single area could function some of the time as a pathway for groundwater, at other times as a hyporheic zone, and at other times as a zone of bank storage. There is no universally acceptable approach to characterizing the water balance of riparian areas, and many studies employ significant simplifications, assumptions, or other qualifications (NRC 2002).

Table 7. UMRS ecosystem functions, indicators, effects, and goods and services.

Examples of Functions	Indicators that Functions Exist	On- or Off-Site Effects of Functions	Goods and Services Examples
Hydrology and Sediment Dynamics			
Stores surface water over the short term	Floodplain connected to the stream channel	Attenuates downstream flood peaks	Water regulation; peak flood reduction; water detoxification; nutrient cycling
Maintains a high water table	Presence of flood-tolerant plant species	Maintains vegetation structure	Regional biodiversity
Accumulates and transports sediments	Riffle-pool sequences; point bars; other features	Contributes to fluvial geomorphology	Sediment load reduction; landform diversity
Biogeochemistry and Nutrient Cycling			
Produces organic carbon	A balanced biotic community	Provides energy to maintain aquatic and terrestrial food webs	Production of organic matter / food /fiber
Contributes to overall biodiversity	High species richness of plants and animals	Provides reservoirs for genetic diversity	Support of biodiversity; pollination; pest / disease regulation
Cycles and accumulates chemical constituents	Chemical and biotic indicators	Intercepts nutrients and toxicants from runoff	Pollutant removal
Sequesters carbon in soil	Organic-rich soils	Contributes to nutrient retention and carbon dioxide sequestration	Air quality regulation; carbon sequestration; climate regulation
Habitat and Food Web Maintenance			
Maintains streamside vegetation	Presence of forest canopy	Provides shade to stream	Thermal regulation
Supports characteristic terrestrial vertebrate populations	Appropriate species having access to riparian area	Allows daily movements to annual migrations	Education/scientific study; wildlife habitats
Supports characteristic aquatic vertebrate populations	Migrations and populations maintenance of fish	Allows migratory fish to complete life cycles	Education/scientific study; fish habitats

(Adapted from: National Research Council 2002)

Biogeochemical Processes – The transport and transformation of chemical and particulate matter are key factors that affect the ecology of the UMRS floodplain. The major physical, chemical, and biological fate and transport processes associated with the UMRS floodplain include infiltration, deposition, filtration, adsorption, degradation, and assimilation. A greater portion of the water flow passes though the riparian areas of low-order streams in the Upper Mississippi River watershed before reaching the UMRS floodplain, making these upstream watershed areas more instrumental in removing pollutants from runoff. Today a smaller portion of the historic UMRS floodplain receives flood event flows now confined by levees, suggesting that if water-quality protection is a primary objective, priority might be given to restoration of functional riparian areas along ephemeral and first- and second-order streams over the UMRS floodplain.

Habitat and Food Web Maintenance – The biodiversity of both the historic and present day UMRS floodplain is well documented. The structural diversity of UMRS floodplain plant species creates a wide variety of feeding niches for herbivores and carnivores alike. Species dispersal, including immigration, emigration and/or migration, occurs for all species within the floodplain. The thermal regulation of streams and the supply of large woody debris afforded by the floodplain forest lead to its characteristically valuable invertebrate species habitat within both the aquatic and terrestrial environments.

Valuation of Ecosystem Services – Rivers have provided free ecosystem services to humans for thousands of years. Their ability to provide food, water, and transportation has been vital to the development of many civilizations. Unfortunately, civilizations have often only found out how valuable ecosystem services are when the service has been lost or degraded to the point where the sustainability of the socio-economic system is threatened. Then, the value of the service is reflected in the cost of artificial structures, substitute or imported resources, or ecosystem restoration measures needed to replace the lost service (Barko et al. 2006).

Understanding, identifying, and adopting a set of ecosystem services to be used for evaluating "balance" among the UMRS floodplain ecosystem and economic and social facets of the river system would benefit long-term river management decision-making. However, the objective and consistent valuation of these ecosystem services continues to challenge managers and stakeholders, as methods and assumptions for quantifying river ecosystem services are far from being standardized.

It has been suggested that we should follow the definition of ecosystem services from the U.N. Millennium Assessment Report (2005): "*Ecosystem services are the benefits people obtain from ecosystems.*" The Millennium Assessment Report's categorization scheme for ecosystem services includes provisioning, regulating, cultural, and supporting services. Provisioning services are those that generate products. Regulating services are associated with the regulation of ecosystem processes. Cultural services create nonmaterial benefits valued by society. Supporting services are necessary for the production of the other services. Their impacts on humans are often indirect and may influence the other services over long periods of time. Table 8 provides examples of large river ecosystem services under these respective headings.

Table 8. Large river ecosystem services.

Provisioning Services	Regulating Services	Cultural Services	Supporting Services
▪ Food ▪ Fresh Water ▪ Timber ▪ Fiber ▪ Genetic Resources ▪ Biochemicals ▪ Natural Medicines ▪ Pharmaceuticals ▪ Biodiversity	▪ Air Quality Regulation ▪ Water Purification ▪ Water Regulation ▪ Waste Treatment ▪ Climate Regulation ▪ Pollination ▪ Disease Regulation ▪ Pest Regulation	▪ Spiritual Enrichment ▪ Cognitive Development ▪ Recreation Enjoyment ▪ Aesthetic Appreciation ▪ Transportation	▪ Soil Formation ▪ Photosynthesis ▪ Primary Production ▪ Nutrient Cycling ▪ Water Cycling

(Source: Institute for Water Resources)

Some of the more promising attempts at the consistent standardization, quantification and valuation of ecosystem services have originated from current projects at the Corps' Institute for Water Resources (IWR). Several reports of the IWR capture these efforts toward ecosystem services evaluation, including Stakhiv et al. (2003) and Shabman and Stephenson (2007).

D. UMRS Forests

1. Current forest condition and threats

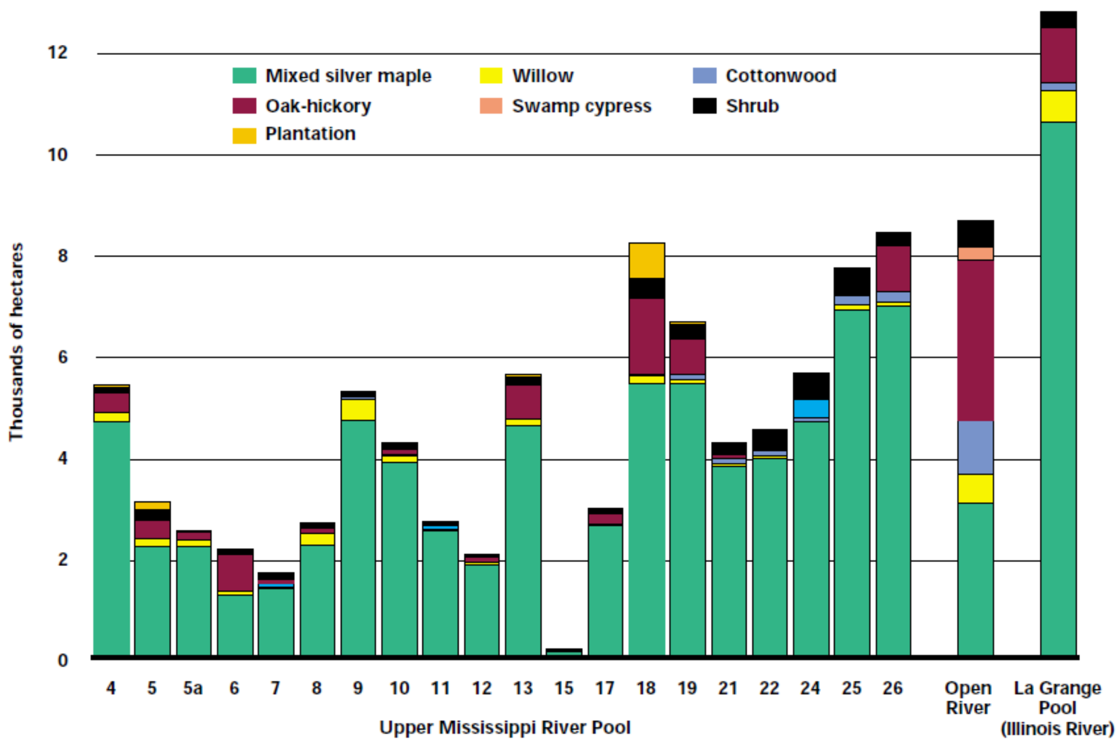
The development of the UMRS floodplain for agriculture, combined with extensive logging for fuel wood and lumber, resulted in widespread conversion of the historic mosaic of forest and prairie habitats. Today, contiguous forest cover is primarily confined to a relatively narrow strip on the riverward side of agricultural levees (USACE 2004). Natural channel dynamics and water levels fluctuations have also been altered throughout the UMRS, thereby further reducing the natural diversity and productivity of floodplain ecosystems (Theiling et al. 2000). Species composition of the remaining forest has also become less diverse, due in part to altered hydrology, a loss of the seasonal "flood pulse," and the effects of periodic severe flooding, particularly the flood of 1993. This change is especially evident in the decline of mast-producing species such as oaks and hickories. Bank erosion also has affected floodplain forests to some degree (USACE 2004). Diseases, insects and invasive plant species also continue to negatively impact UMRS floodplain forests throughout the system.

a. Diversity

A healthy, functioning floodplain forest requires a diversity of forest structural components including tree species, age classes, canopy heights, and understory composition. However, changes in flood frequency, duration, and depth resulting from river impoundment and channelization have reduced diversity within remaining Upper Mississippi River forests in all four river reaches (Yin and Nelson 1995). Much of the current floodplain forest is between 50 and 70 years old, consisting of three or four flood and shade tolerant species, and heavily dominated by silver maple (figure 12). With sustained high water levels, little germination takes place and seedlings are unable to survive frequent floods. The closed canopy of these even-aged forests also prevents the reestablishment of other species that are shade intolerant such as cottonwood, black willow, and river birch. Hard mast species, such as oaks, have significantly declined and now occur on less than 10 percent of the floodplain (Urich et al. 2002).

Knutson and Klaas (1998) calculated tree species importance values and made comparisons between presettlement and 1992 floodplain forests of the Upper Mississippi River. In general, they found that all mast species except white oak declined in importance since presettlement. Early successional stands of cottonwood and willow have generally declined as a result of alterations in bank erosion and accretion processes, although the extreme flood of 1993 did result in the establishment of a significant amount of cottonwood and willow habitat in the lower river reach (Yin 1998). It is expected that significant canopy die-off will occur in many locations throughout the UMRS within about 50-70 years due to the mature, even-aged condition of the majority of the forest resource (USGS 1999). This will likely result in open conditions and promote undesirable species such as reed canary grass that make it difficult for floodplain forest trees to regenerate. Large scale die-off from floods or other disturbances could also result in a conversion of vegetation type. In addition to the wildlife habitat it provides, closed canopy forest limits the establishment and expansion of the invasive reed canary grass through shading. Partial forest canopy, to the point of a savanna, has the potential to provide high quality habitat if the understory vegetation consists of native, noninvasive species. However, this type of habitat is very difficult to maintain in areas where invasives are present.

Figure 12. Forest community distribution throughout the UMRS in 1989. (Source: USGS 1999)



Recent forest inventories on Corps lands show a heavy dominance by silver maple throughout St. Paul, Rock Island and St. Louis Districts (figure 12). Other common tree species of lesser frequency include cottonwood, green ash, black willow, river birch, sycamore, American elm, boxelder, swamp white oak, pin oak, bitternut hickory (*Carya cordiformis)*, black walnut, and pecan. Average tree age is generally between 50 and 70 years. Statistics on timber size class distribution from the Rock Island District (Pools 11 through 22) indicate that more than 40 percent of these forest stands are dominated by trees that are 18 inches or larger in diameter at breast height (DBH). Over 30 percent are dominated by trees between 12 and 18 inches DBH. These numbers indicate a maturing, even-aged forest with an insufficient number of replacement trees in the seedling/sapling layer. Yin (USGS 1999) provides additional information on the current structure of UMRS floodplain forest communities, stating that many stands are dominated by large trees, with silver maple or eastern cottonwood trees usually the largest in a community. Yin further states that many floodplain forests along the Upper Mississippi and Illinois Rivers appear to be similar in average tree size, basal area, density, and diversity.

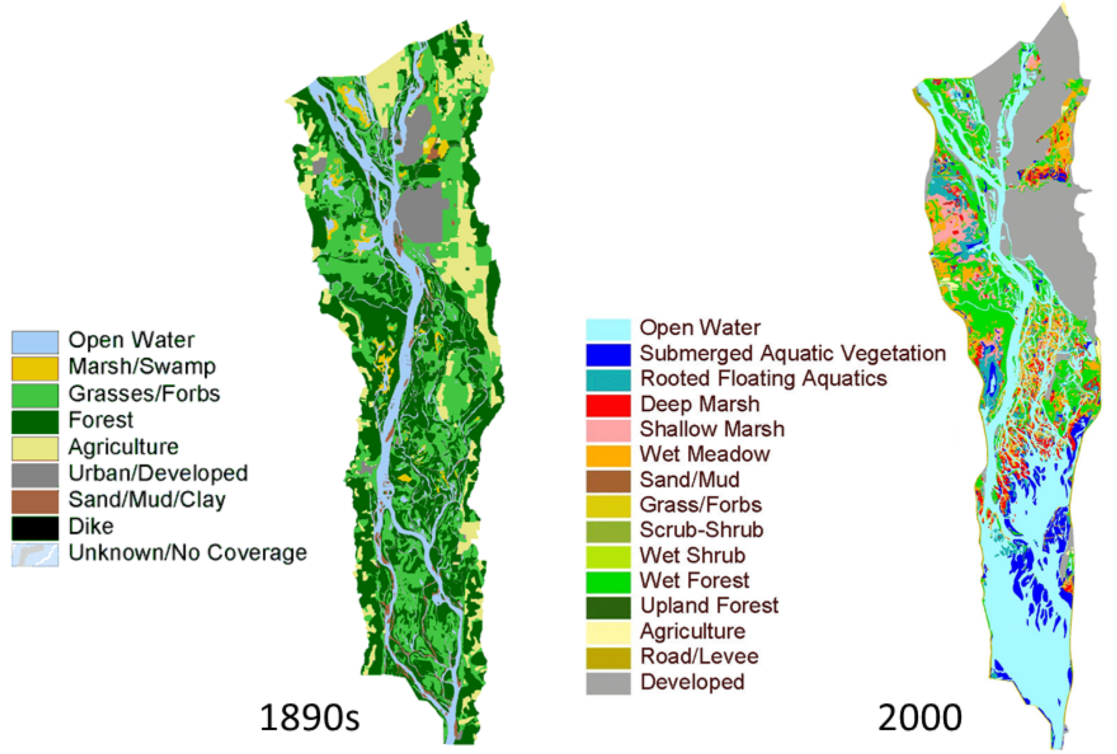
Upper Mississippi River floodplain forest tree species are distributed along ecological gradients defined mostly by their ability to survive various levels of flooding (Urich et al. 2002). Lower lying areas typically support the most flood-tolerant species, including willows, cottonwood, silver maple, and green ash. Trees located on higher elevations along ridges or terraces have less tolerance to flooding and high water tables. Such is the case with species like oaks and hickories that occupy formerly high points of land in the floodplain but are no longer able to reproduce successfully because of inundation and/or permanently elevated water tables. Just as an overhead view would show how acreage of forested land diminished following construction of the 9-foot Channel Project through clearing and inundation (figure 13), a side view would show how elevated water levels, caused by impoundment of each pool, have reduced the acreage available for less flood tolerant species (Yin et al. 1997).

b. Distribution

Modern UMRS forests represent only a small portion of pre-European settlement floodplain forests in some reaches. The amount of bottomland forest within the Upper Mississippi River floodplain has been significantly reduced from historic levels by clearing of land for agriculture and development, primarily on the Lower Impounded, Unimpounded, and Illinois River reaches. For example, forests covered 56 percent of the landscape at the confluence of the Illinois and Mississippi Rivers in 1817. By 1975, these forests were reduced to 35 percent of the landscape (Nelson et al. 1994). In 1809, floodplain forests covered 71.4 percent of the landscape in a 63-mile-long portion of the Unimpounded Reach but, by 1989, covered only 18.3 percent of the same landscape (Yin et al. 1995). (*See previous section on historic changes*)

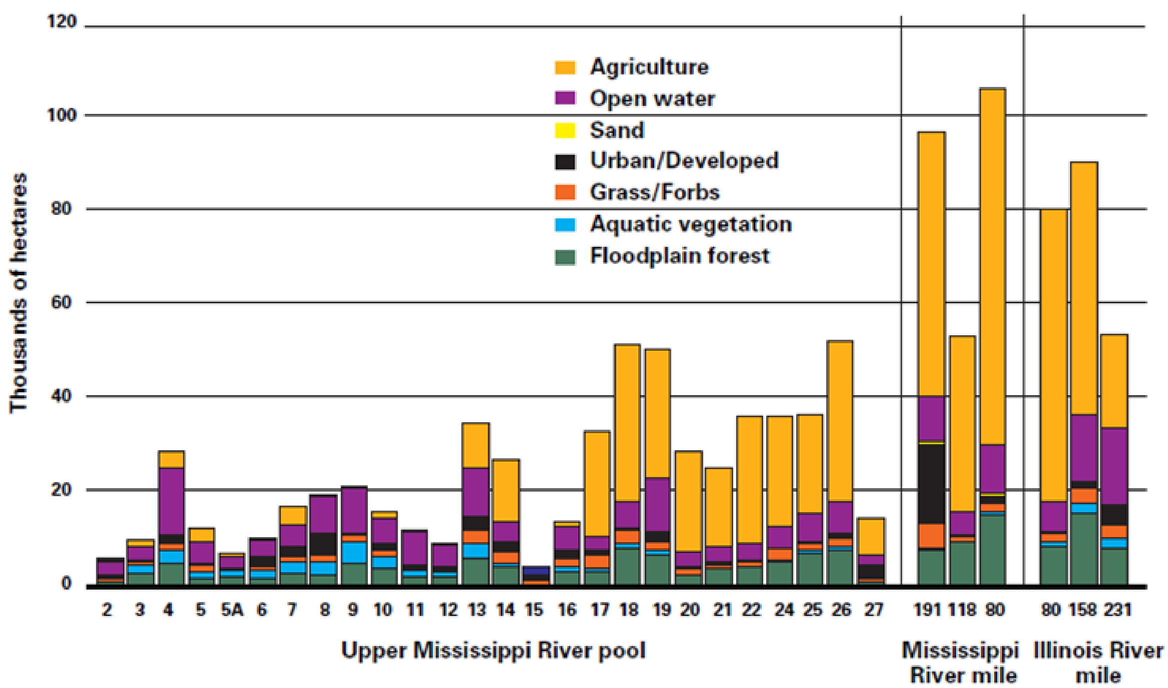
An analyses of 1989 satellite data showed that 303,933 acres of floodplain forests covered 18.6 percent of the land in the Upper Mississippi River valley (USGS 1999). An additional 78,467 acres of floodplain forests covered 17.6 percent of the land in the Illinois River valley (figure 14). The data also indicated that forests in the UMRS are unevenly distributed along floodplain areas. Forests are more often present in periodically flooded lands adjacent to the rivers. They are less often present in areas that are rarely flooded, such as terraces or levee protected land.

Figure 13. Loss of terrestrial landcover in lower Pool 8 from the 1890s – 2000.



(Source: UMRR-EMP, LTRM Component)

Figure 14. 1989 landcover in the Upper Mississippi and Illinois River floodplains.

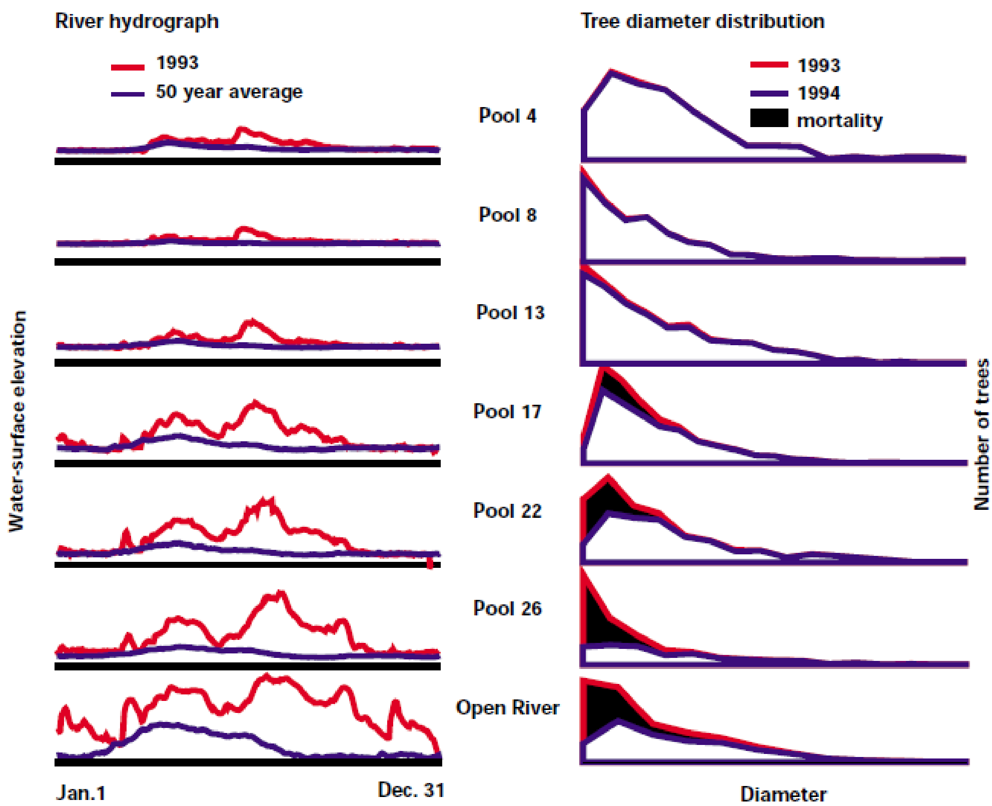


(Source: USGS 1999)

More recently, a large portion of floodplain forest area in the UMRS is recovering from natural disturbance caused by the Great Flood of 1993 (Yin et al. 1994; USGS 1999). Floodplain forests can endure brief inundation, but prolonged inundation can be deadly. While floodplain forests above Pool 13 only experienced slight mortality, that mortality increased markedly in downstream reaches that experienced much longer flood durations. In Pool 26, nearly 40 percent of trees 4 inches in diameter or greater were killed. A remarkable 80 percent of smaller trees less than 4 inches in diameter were killed. Mortality rates throughout were positively correlated with flood duration and negatively correlated with the diameter of the trees (figure 15).

Hackberry and pin oak were the two species most severely affected by the flood. In addition, the difference in post-flood cottonwood and willow regeneration between the Impounded and Unimpounded Reaches was notable. After the flood, willow and cottonwood seedlings occurred abundantly in the Unimpounded Reach but did not regenerate vigorously after the flood in the Impounded Reaches. It remains unclear why these specific floodplain forest communities regenerated well in the Unimpounded Reach but poorly in Pool 26, even though both reaches were equally disturbed. Willow and cottonwood communities in the impounded reaches will likely decline further in the future unless additional management actions are taken (USGS 1999).

Figure 15. Duration of 1993 flood and associated tree mortality.



(Source: USGS 1999)

Forest fragmentation occurs when large contiguous blocks of forest are divided into smaller patches by clearing of land for agriculture and development. During the past 150 years, much of the contiguous forest in the UMRS has been lost, resulting in fragmentation of remaining areas. Areas with large blocks of interior forest dominated by silver maple meet the needs of area-sensitive species, including red shouldered hawks, cerulean warblers, Acadian flycatchers, prothonotary warblers, veerys, wood thrushes, pileated woodpeckers, and eastern wood peewees (Knutson et al. 1996). Recent research in the Vermillion/Cannon River Bottoms in Pools 3 and 4 suggests that some floodplain bird assemblages may respond more to forest width than edge versus interior habitat or habitat patch size (Kirsch 2009). In addition, the concept of forest interior-dependent species may be less applicable in situations where forest "patches" are surrounded by a mosaic of other natural habitats rather than row crops. Nevertheless, it is generally agreed that floodplain forests support a greater number of bird species than other UMRS habitats (USGS 1999), and that conditions for UMRS floodplain birds will deteriorate as floodplain forests continue to decline, become more open-canopied, and disappear from the landscape (Knutson et al. 1996).

c. Diseases and Insects

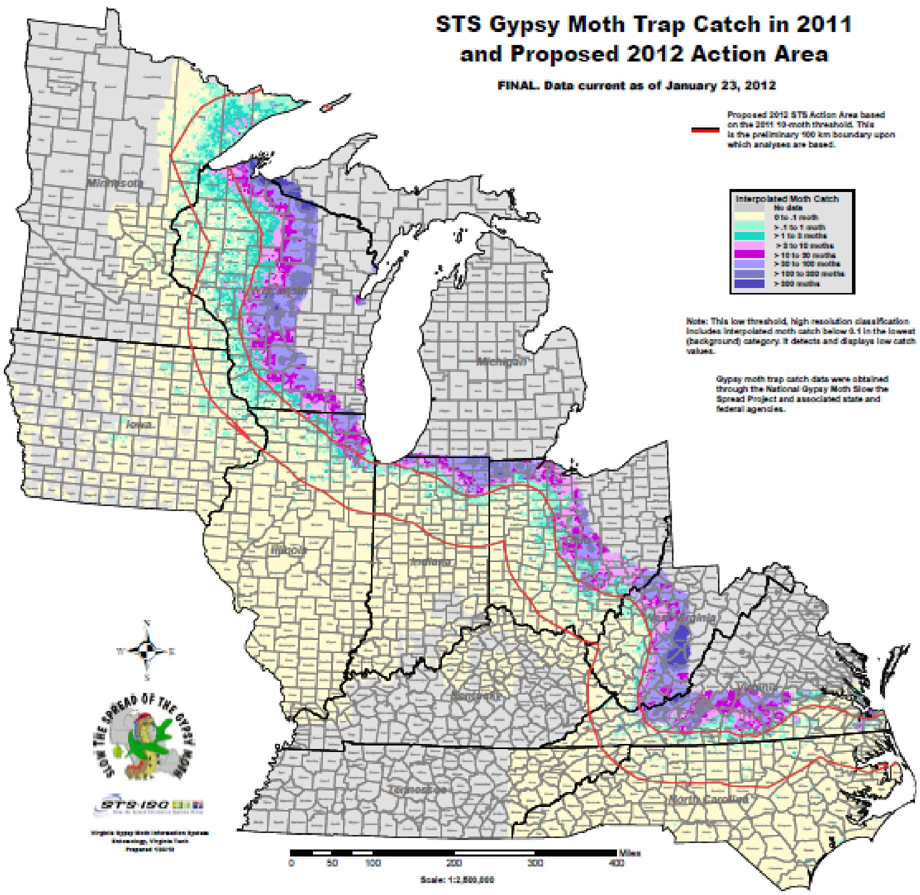
Forest health can be severely impacted by diseases, insects and other pests. In addition to more historic occurrences like Dutch elm disease, several contemporary forest pests and diseases could pose a significant threat to the UMRS floodplain forest, including gypsy moth (*Lymantria dispar*), emerald ash borer (*Agrilus planipennis)*, and oak wilt. (*See section IV.D.4 for additional information on forest health monitoring*)

Gypsy Moth – Gypsy moth is an exotic insect pest that can cause defoliation on a number of hardwood tree species and is of particular concern for oaks (GMSTS 2008). The moths were first introduced to North America approximately 120 years ago on the East Coast. They have been slowly spreading westward and southward since they arrived. As of 2010, the larger infestations were approximately 100 miles from the UMRS (figure 16).

Gypsy moths have been captured on the UMRS with pheromone traps under a U.S. Department of Agriculture (USDA) program. Typically only one or two moths have been found in the traps throughout the UMRS with a few areas near Brownsville, Minnesota, having traps catch as many as eight moths. An eradication treatment was used on the infestation near Brownsville in 2001. Follow-up trapping showed that it was successful with only a few traps catching moths, and only one or two moths per trap. Trapping continues throughout the UMRS floodplain, but there has been no significant catch to date. Some moths are still being caught but not enough for action. Large catches continue in Wisconsin approximately 100 to 150 miles east of the Upper Mississippi River. These catches are being treated with *Bacillus thuringiensus* (BT), which works by interfering with the caterpillar's digestive system.

Suppression, eradication, or "slow the spread" are actions that can be taken when these moths are discovered. Suppression can be used in areas where the gypsy moth caterpillar is already established to reduce high populations to prevent or minimize heavy defoliation. Eradication is an action that can be used to eliminate isolated infestations of the gypsy moth to prevent establishment in new areas. "Slow the Spread" is a USDA Forest Service program developed to

Figure 16. Gypsy moth “Slow the Spread” program areas. (Source: www.gmsts.org)



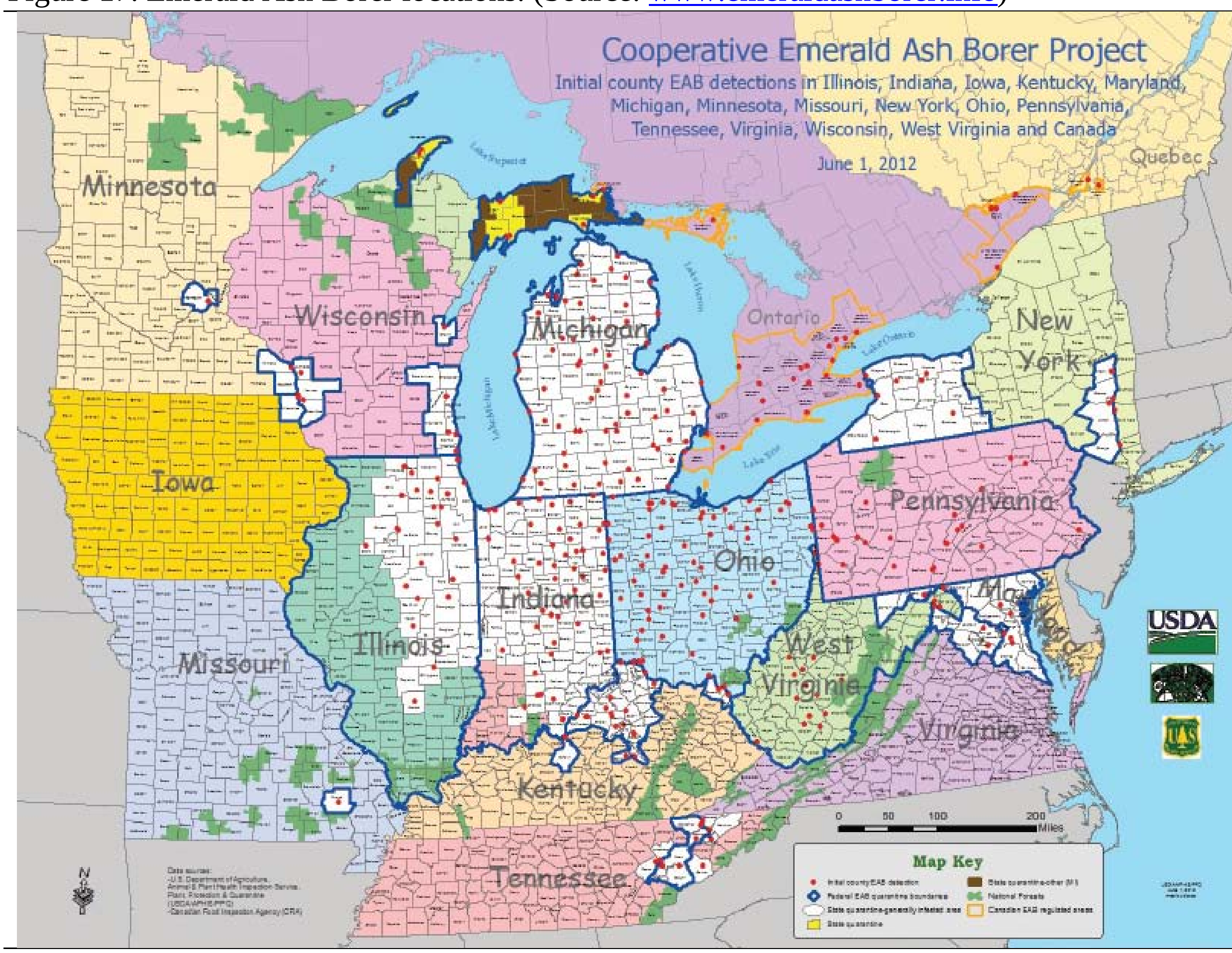
keep low-level populations of the gypsy moth from rapidly increasing and spreading from areas where it is already established. All three of these actions can be used independently or in combination. As a defoliator, the gypsy moth can effectively strip the foliage from a wide variety of trees. Significant defoliation over consecutive years will severely stress trees, and if it continues for multiple years will kill the tree.

Emerald Ash Borer (EAB) – The EAB is a beetle native to Asia that was first discovered in the U.S. near Detroit, Michigan, in 2002. The larvae feed on the inner bark of ash trees, causing near 100 percent mortality. More than 20 million ash trees have died so far in Michigan, Ohio, and Indiana (www.emeraldashborer.info). The EAB is present in Michigan, Indiana, Illinois, Minnesota and Wisconsin (figure 17). As of August 2008, it was present in the Corps of Engineer’s Wappapello Lake – Greenville Recreation Area in southeast Missouri. More recently, in spring 2009, it was confirmed in the community of Victory, Wisconsin. This community lies in an upland location along the Mississippi River about 20 miles south of La Crosse. Also in 2009, it was found nearby within the Upper Mississippi River floodplain at Blackhawk Park, and in St. Paul and Minneapolis, Minnesota, within a half mile of the Mississippi River. In 2010, EAB was discovered on an island within the Upper Mississippi River National Wildlife and Fish Refuge in Pool 9 of the Mississippi River, about three miles from Blackhawk Park.

Foresters consider the eventual range expansion of EAB throughout this area to be inevitable. It is believed that it is most commonly spread by transporting firewood. State regulatory agencies and the USDA are enforcing quarantines in infested areas with fines to prevent potentially infested ash trees, logs or firewood from moving into new areas. Some areas in the UMRS are dominated by green ash trees so the effects of this insect pest could be devastating. Many areas in the UMRS are already eliminating ash trees from tree planting plans and are trying to diversify as much as they can. A large ongoing effort to mark and monitor trap trees will help aid in early discovery of infestations. Research is being conducted at universities to understand the beetle's life cycle and find ways to detect new infestations, control EAB adults and larvae, and contain the infestation.

Extensive monitoring for EAB was conducted within the upper part of the Pool 9 floodplain in 2009 and 2010. The Minnesota Department of Agriculture, with the cooperation of the USFWS, Corps of Engineers, and Minnesota Department of Natural Resources released a biological control agent (stingless predatory wasps) on the affected USFWS island in Pool 9 in September 2010 in an attempt to control the spread of EAB in that area. In response to recent EAB infestations, the Corps of Engineers and USFWS have implemented firewood restrictions on agency-owned lands within the Upper Mississippi River floodplain.

Figure 17. Emerald Ash Borer locations. (Source: www.emeraldashborer.info)



Oak Wilt – Oak wilt infestations have been detected on the UMRS, specifically in areas ranging from pool 12, near Bellevue, Iowa, up river to pool 3 at Red Wing. These infestations have significantly affected red and black oaks. Most of the infected trees have died.

Oak wilt fungus is spread by two methods – overland spread and root graft transmission. Overland spread occurs via insect transmission of the fungus to fresh wounds on oak trees and establishes new infection centers. Fruity-smelling mats of fungal tissue are produced beneath the bark of trees killed by the oak wilt fungus. In the spring of the year, the mats attract nitidulid beetles, which acquire fungal spores in and on their bodies as they feed and walk in the mats. The infested nitidulids are then attracted to fresh wounds on uninfected trees, where the spores from their bodies infect the previously healthy trees. In addition to overland spread, root-graft transmission of the fungus expands the size of infection centers, especially if many oaks are concentrated in an area. Sandy soils, which increase the extent of the root systems, and therefore the number of root grafts, promote root graft transmission of the disease. Oak wilt control in a forest setting is possible if the fungus is detected early. Techniques include cutting infected trees and disposing of bark to control overland spread, or trenching around an infestation with a vibrating plow to sever roots and halt spread between trees through root grafts.

Although not an epidemic at this time, the oak wilt fungus can be locally severe with potential to impact the few black and red oaks that occur at higher elevations along the floodplain. Swamp white, bur, and pin oaks are less susceptible (Urich et al. 2002).

Dutch Elm Disease – Dutch elm disease (DED) changed the face of the bottomlands in the 1960's when it effectively eliminated the American elm as a dominant component of the floodplain forest (Urich et al. 2002). The American elm was once a major component of the floodplain forests along the Upper Mississippi River, providing important habitat for migratory songbirds and other wildlife. Currently, it typically only survives in younger age classes before eventually succumbing to the disease.

From the 1970s to the present, more than 100,000 American elm trees were tested for resistance to DED. Although no trees were found to be completely resistant, five exhibited a high tolerance to this disease. These five selections are now being used for a restoration project, which was started in 2003 by the U.S. Forest Service in cooperation with the Corps, USFWS and other agencies. Disease-tolerant elms were planted at five different locations in the UMRS in 2005, and again in 2007. These trees are being protected, measured and monitored with the goal of having them produce seedlings that are DED tolerant. The Bottomland Hardwood Working Group of the Upper Mississippi River Forestry Partnership is very interested in promoting an expansion of the project, including propagation of larger numbers of seedlings for transplanting in more locations. The limiting factor at this point appears to be funding for the Forest Service and/or other researchers to do additional monitoring and testing, increase the number of cultivars, and produce more seedlings. With proper funding, it may be possible to eventually re-establish healthy American elms across the floodplain.

d. Invasive Plant Species

Infestations of invasive plants, diseases, animals, and insects are fast becoming one of the greatest threats to the earth's biological diversity and human health. Invasive species are defined as species that do not naturally occur in a specific area and whose introduction causes or is likely to cause economic or environmental harm or harm to human health. These exotic species did not evolve with the ecosystem they invade and their introduction usually irreversibly degrades the native ecosystem and may ultimately affect the survival of native species. A number of invasive plant species suppress regeneration in the floodplain forest. They do this by out-competing the native vegetation for water, sunlight, nutrients, and space. While the overall number of invasive plant species is very large and continues to grow, river managers along the UMRS have identified a select number of invasive and/or weedy species of special concern. These include reed canary grass, johnsongrass (*Sorghum halepense*), European buckthorn (*Rhamnus cathartica*), various species of honeysuckle (*Lonicera spp.*), white mulberry (*Morus alba*), black locust (*Robinia pseudoacacia*), garlic mustard (*Alliaria petiolata*), Japanese knotweed (*Polygonum cuspidatum*), oriental bittersweet (*Celastrus orbiculata*), Japanese hops (*Humulus japonicus*), crown vetch (*Coronilla varia*), bur cucumber (*Sicyos angulatus*), and trumpet creeper (*Campsis radicans*).

Reed canary grass (RCG) – Reed canary grass is likely the most damaging of all the invasive plant species in the UMRS floodplain forest at this time. This grass can establish itself quickly in floodplain forest openings and along forest edges, often forming dense monocultures. This dense growth can out-compete existing seedlings or even prevent germination of native species, resulting in a gradual loss of bottomland forest and the proliferation of monotypic grassland conditions.

RCG has been reported to be most problematic in the upper reaches of the UMRS through pool 18. Additionally, St Paul District has found that it is most aggressive in the middle reaches of each pool. It is also reported to be a major problem in pool 24 and is at least present throughout the rest of the UMRS.

In recognition of the severity of this management problem, the three UMRS Corps Districts have employed a number of forest restoration measures. These include planting larger root production method (RPM®) trees that already extend above the height of RCG, using tree mats and tubes to reduce root competition and limit damage by voles and other rodents, planting cuttings or bare-root stock where applicable, scarifying sites prior to planting or using natural seed catch, and/or using both pre- and post-emergent herbicides. These techniques have been met with varying degrees of success and are continually being refined.

Johnsongrass – Johnsongrass was introduced to the United States from the Mediterranean region in the early 1800s as a forage crop. It is currently present throughout the lower 48 states, and is a major problem in the in the Gulf Coast region. It spreads aggressively in open, disturbed, and cultivated areas, and can displace native vegetation and suppress tree seedling establishment. It is commonly found along river bottoms, riparian areas, and forest edges in the southern portion of the UMRS. Control methods primarily involve treatment with herbicides.

European buckthorn and bush honeysuckle – European buckthorn and bush honeysuckle are exotic shrubs that are becoming established in many areas. Their seed provides food for wildlife, including birds, which facilitate their spread. These plants grow in shade or sun and can form dense thickets in the forest understory, which can leave the forest floor underneath them devoid of other plants, thus preventing natural regeneration of desirable species and eventually creating a shrubby monoculture and loss of bottomland forest. These shrubs have been reported to be present in St. Paul, Rock Island and St. Louis Districts. Control methods include pulling, cutting, and herbicides.

White mulberry – White mulberry grows in partial shade to full sun and tolerates both extended flooding and droughty conditions. The seeds are spread by wildlife that feed on the mulberry fruits and it expands locally by producing root sprouts. Its negative impacts include hybridization with and replacement of native red mulberry (*Morus rubra*), to which it can also transmit a harmful root disease. White mulberry also competes with other desirable bottomland forest species. It occurs throughout the UMRS and active control measures have not yet been taken.

Black locust – Black locust was introduced to areas within the UMRS beginning in the early 1900s to aid in erosion control. It reproduces vigorously by root suckering and stump sprouting to form groves (or clones) of trees interconnected by a common fibrous root system. Physical damage to roots and stems often increases suckering and sprouting, making control difficult. These groves create shaded monocultures with little ground vegetation. Black locust is present throughout the UMRS. However, it is only reported to be a problem within the St. Paul District. Control measures used include cutting followed by herbicide treatment or basal bark treatment of smaller trees with an herbicide.

Garlic mustard – Garlic mustard, a biennial herb, poses a significant threat to the native floodplain forest herbaceous layer and the wildlife that depend on it by dominating the forest floor and displacing most native herbaceous species. In addition, it has been found that it disrupts a healthy relationship between hardwood tree seedlings and mycorrhizal soil fungi, with results that can be damaging for a forest. Garlic mustard is present throughout the UMRS. Control measures include fire and herbicides. Biological controls may eventually be available.

Japanese knotweed – Japanese knotweed spreads quickly to form dense thickets that exclude native vegetation and greatly alter natural ecosystems. It poses a significant threat to riparian areas, where it can survive severe floods, grow in full shade, and is able to rapidly colonize scoured shores and islands. Once established, populations are extremely persistent. It spreads primarily by vegetative means with the help of its long, stout rhizomes. It is transported to new sites as a contaminant in fill dirt, distributed by water, and carried to a lesser extent by the wind. Escapees from gardens and discarded cuttings are common routes of dispersal from urban areas. Japanese knotweed is present throughout the UMRS, though it is not yet widespread. Control methods include grubbing, mowing, and herbicides.

Japanese hops, bur cucumber, oriental bittersweet, crown vetch, and trumpet creeper – Some of these species are more widespread than others, but all are of major concern to managers throughout the UMRS. These weedy and/or invasive vines engulf other vegetation, sometimes causing mortality. They accomplish this by enveloping plants in so much shade that they rob the plant of the sunlight required for proper photosynthesis. Woody plants such as oriental bittersweet can even reach a tree's crown. Capable of reaching four inches in diameter, oriental bittersweet vines wrap so tightly around their host trees that they can effectively girdle them. Uprooting can also occur, as the trees' root systems are unable to contend with the massive weight of entrenched vines. Trailing invasive vines such as Japanese hops form dense monocultures that overtop and outcompete native vegetation. It readily colonizes canopy gaps and other open areas and can inhibit tree regeneration. Other plants such as crown vetch create a thick mat over the ground and can provide cover for rodents that then girdle trees that have been planted as part of reforestation efforts. For all, control methods include pulling, mowing, and herbicide application.

The plants discussed above are but a handful of the hundreds of invasive species that have already infested and continue to arrive in the UMRS. These plants are thought to currently pose the greatest threat to the UMRS floodplain forests. This list will likely grow in the future and managers must remain vigilant and act quickly as new threats arise.

e. Herbivory

Herbivory by deer and small mammals poses an additional threat to understory floodplain forest vegetation, and can be particularly problematic for both natural and artificial tree regeneration. Deer browse inhibits the survival and growth of understory vegetation due to the fact that in addition to consuming foliage, deer also commonly eat the terminal and lateral buds of tree seedlings and saplings. In areas that contain high deer population densities, damage to tree plantings can be extensive. Several ongoing deer exclosure studies are attempting to find out just how deer may be impacting the composition and distribution of vegetation in portions of the UMRS, as well as the specific tree planting sites.

Small mammals such as rabbits, voles, and beavers also cause browse damage to natural tree regeneration and artificial tree plantings. For example, rabbits eat the cambial tissue from around the lower stems of seedlings and small saplings and can effectively girdle them. This can be especially problematic in tree planting sites where small trees are interspersed with grasses and/or other ground cover that provides habitat for these animals. Voles and other rodents cause similar problems, and will also consume belowground portions of saplings. Beaver kill even larger trees in the process of foraging and construction of beaver dams.

The use of protective measures such as stem guards, ground mats, fencing, and other types of exclosures can limit browse damage in tree plantings, but options for controlling herbivory in established forest settings are of course very limited. However, managing wildlife populations (e.g., deer numbers) may be effective in some locations.

f. Climate Change

The potential long-term impacts of climate change on floodplain forests in the Upper Mississippi River System are not well known at this time, but some inferences can be made based on predicted changes to temperature and precipitation patterns in the Upper Mississippi River Basin.

Warmer temperatures, a longer growing season, and increased atmospheric CO_2 levels all have the potential to increase productivity in forested ecosystems (Ryan et al. 2008). However, climate change may also affect the frequency of natural disturbances such as fires, floods, insect outbreaks, ice storms, and windstorms (CCSP 2008). Some climate models link projected increases in precipitation over the Upper Mississippi River Basin to increased runoff, but considerable uncertainty remains (Lettenmaier et al. 2008). Increased rates of precipitation and associated runoff could impose a greater degree of water stress on river floodplain ecosystems. In addition, climate change has the potential to affect biodiversity in the UMRS through changes to growing season length, species distributions and phenology, and other components of ecosystem function (Janetos et al. 2008).

Box 1. Future UMRS Floodplain Forest Changes

A general summary of some of the changes we might expect to see over the next 50 years, without active forest management, are outlined below (adapted from Urich et al. 2002):

A reduction in cottonwood and willow. These are typically pioneer species that become established on newly accreted islands or exposed substrates. They require open sunlight and will not regenerate in the shaded understory of an established forest.

More open forest canopy. Much of the current floodplain forest is closed canopy, where trees are spaced close enough together to create a continuous layer of upper tree crowns. As these trees age, die off and fall to the ground, openings will be created. If conditions are not present for regeneration of trees, these canopy gaps may be invaded by herbaceous vegetation (e.g., reed canary grass) and remain in an open condition for many years. Even if conditions are suitable for tree regeneration, maple and ash may continue to dominate.

Continued loss of forest in the lower parts of pools. Gradual loss of islands to erosion will also result in less overall forest area and fewer trees.

Conversion from forest to other vegetation types in mid-pools. As a result of dam construction and water level control, the water table is higher in islands and shorelines located within the lower and middle portions of each pool. Higher water tables create site conditions that may be less suitable for forest, but better for other species, such as reed canary grass. Thus, the trend may be a gradual replacement of forest species with herbaceous vegetation.

Fewer mast trees. Mast trees such as oaks and hickories are generally less tolerant of flooding and saturated soil conditions than other floodplain tree species. They also produce a heavy seed, which is not as widely dispersed as the lighter, wind-carried seed of cottonwood, willow, maple, and ash. These two factors may contribute to a continued reduction of mast within these floodplains.

Increase in shade tolerant species. Box elder and mulberry are highly shade tolerant. It is likely that these two species will increase through natural establishment in the understory of existing maple stands with dense canopies. Although there is some habitat value associated with them, box elder and mulberry are generally not considered as desirable as other floodplain tree species.

Scientists working in association with the U.S. Forest Service have accomplished a significant amount of work in mapping the potential response of tree and bird species in the eastern United States to various climate change scenarios (Prasad et al. 2009). Results of these analyses are available via the Climate Change Tree and Bird Atlases, interactive online tools maintained on the Forest Service's website: http://www.nrs.fs.fed.us/atlas/.

Relevant federal initiatives in response to the potential risk to U.S. ecosystems posed by climate change include the U.S. Fish and Wildlife Service's Climate Change Strategic Plan (USFWS 2010) and the U.S. Forest Service's Strategic Framework for Responding to Climate Change (USFS 2008). Both plans emphasize mitigation, adaptation, and advancing efforts to share knowledge and build collaborative partnerships as key strategies to address climate change.

2. Wildlife and the UMRS Forest

a. Birds

Songbirds and their allies (e.g., woodpeckers, swallows, jays and crows, blackbirds, icterids, hummingbirds, nightjars, and cuckoos) – One notable feature of the breeding bird community in Upper Mississippi River floodplain forests is the dominance of the community by birds that breed here and winter elsewhere. Resident birds make up only a small portion of the breeding bird community. Two major classes of migrant birds are in the western hemisphere: neotropical and short distance migrants. Neotropical migrants are species whose winter range largely lies south of the U.S.-Mexico border, and short-distance migrants are species whose winter ranges are largely in the southern US but can extend into Mexico and Central America. Many neotropical and short distance migrant birds that use Upper Mississippi River floodplain forests and associated habitats are of management concern nationally, regionally, or for certain Upper Mississippi River States. Resident birds are those that are present all year. One species, the red-headed woodpecker (*Melanerpes erythrocephalus*), is more properly referred to as nomadic. Although they have a breeding range, their winter range and abundances vary from year to year as they follow food resources. Finally, some species do not breed on the Upper Mississippi River but occur here in the winter, such as the snow bunting (*Plectrophenax nivalis*), hoary redpole (*Acanthis hornemanni*), fox sparrow (*Passerella iliaca*), American tree sparrow (*Spizella arborea*), and purple finch (*Carpodacus purpureus*).

During the breeding season, in general, the same suite of birds can occur in what to human eyes might appear to be a wide variety of Upper Mississippi River forest types (Kirsch unpubl. manuscript). The birds one is likely to observe in a large forest patch are almost the same species one is likely to see in a small forest patch on an island, and birds in mature silver maple monocultures do not differ markedly from those occurring in more mixed stands (Kirsch unpubl. manuscript). Rather, the likelihood of observing a particular species is related to overall abundance of that species in the floodplain. However, the forest breeding bird community of the Upper Mississippi River is different from that occurring in upland forests adjacent to the river, particularly in supporting an abundance of 7 woodpecker species, 13 species of secondary cavity nesters, red-shouldered hawks (*Buteo lineatus*) and prothonotary warblers (*Protonotaria citrea*) (both floodplain obligates in this region), American redstarts (*Setophaga ruticilla*), and warbling vireos (*Vireo gilvus*) (Knutson et al. 1996).

In upland forests the effects of forest block size and amount of edge have been demonstrated to affect avian diversity and productivity. However, this has not been clearly demonstrated for riparian areas in the Midwest. It is important to keep in mind that floodplain forests of the UMR, even pre-impoundment, were fragmented and interspersed with aquatic areas, wet meadows, emergent wetlands, and shub carr (primarily sandbar willow). This natural fragmentation and aquatic habitat matrix probably has a great deal to do with the bird community we see on the river today. Effects of block size and edge observed in uplands (which largely are fragmented by agricultural or development) may not hold in a linear, naturally fragmented forest that is interspersed largely with aquatic areas and other somewhat naturally occurring habitat types.

The abundance of cavity nesters indicates the great importance of standing dead wood on the floodplain versus the uplands. The size and abundance of snags, dead trees and live trees with large dead limbs on the UMR floodplains versus the uplands are caused by differences in the types of tree species present, harvest practices, and hydrological regimes. Dead trees are also critical for nesting brown creepers (*Certhia americana*). Brown creepers are usually a northern nesting species in the Midwest (as far south as central Wisconsin), but the availability of dead trees with slip bark, underneath which brown creepers nest, has allowed them to nest on the UMR as far south as Pool 24.

Raptors (migrating raptors, nesting bald eagles, and red-shouldered hawks) – Bottomland forests along the UMR support migrating and nesting populations of bald eagles (*Haliaeetus leucocephalus*), ospreys (*Pandion haliaetus*), red-shouldered hawks, and other raptors. During the mid-1990s, raptor migration studies on the bluffs bordering Pool 10 of the UMRS revealed 17 species of raptors, totaling 14,000 to 30,000 individuals passing through the area during the fall season (Mandernack et al. 1997). The UMR is a major migration route and wintering area for bald eagles. Depending on river and ice conditions, large groups of wintering eagles may roost at sites near dams. During the spring migration, approximately 3,000 bald eagles have been tallied on single day counts on Pools 4 through 14, 2007 to 2009. Numbers of breeding bald eagles along the Upper Mississippi River have greatly increased over the past several decades, from 9 nests in 1986 to 250 active nests in 2009 (figure 18) (USFWS 2009a). Although the bald eagle was de-listed from the Endangered Species Act in 2007, it is still protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act (USFWS 2007).

The floodplain of the UMR provides habitat for nesting red-shouldered hawks. Nest territories of the floodplain typically are in blocks of mature timber greater than 500 acres in size (nests may be found on the edges of the blocks), include both floodplain and upland slope forest types within the tract, are within 200 yards of ponds or small streams, and are greater than 500 yards from the main channel (Stravers and McKay 1994). These investigators recommended restricting logging in nesting areas, avoiding fragmentation of large forest tracts, allowing some thinning of younger forest stands to assist in development of overhead canopy cover, and combating invasion of reed canary grass that might inhibit growth of cottonwood and silver maple.

The red-shouldered hawk is listed as endangered in Iowa, threatened in Wisconsin, and of special concern in Minnesota. The UMR floodplain contains a considerable amount of forested habitat and is thus important for maintaining red-shouldered hawk populations in these States and providing a corridor for linking the habitats of northern and southern populations. The ecology of red-shouldered hawks has been studied along the UMR since 1983 and surveys have since been expanded to cover more of the river (USGS 1999).

Colonial waterbirds – Great blue herons (*Ardea herodias*), great egrets (*Ardea alba*), and double crested cormorants (*Phalacrocorax auritus*) are the most notable species in this community, and the species we know the most about. Not much is known about how colonial black-crowned night herons (*Nycticorax nycticorax*) and semi-colonial to solitary yellow-crowned night herons (*Nycticorax nycticorax*) and green-backed herons (*Butorides virescens*) use the floodplain forest. However, these three species require trees and shrubs to nest. Cattle egrets (*Bubulcus ibis*) have recently begun nesting in trees on islands in Pool 13.

The Upper Mississippi River is an important nesting and feeding area for great blue herons, double crested cormorants, and great egrets because extensive bottomland forests and diverse aquatic areas provide suitable nesting and foraging habitat. Herons require large mature trees for nesting (Butler 1992, McCrimmon et al. 2001). Silver maple is the dominant component of the Upper Mississippi River floodplain forest and most forest areas have relatively even-aged silver maple stands approaching maturity (Knutson and Klaas 1998; Yin 1999; UMRCC 2002). Other tree species usually co-occur with silver maple, and for herons cottonwood and swamp white oak seem to be important. Herons and egrets nest most frequently in silver maple trees along the Upper Mississippi River above Dubuque. Between Dubuque and Rock Island, they nest most frequently in large cottonwood and swamp white oak trees (Kinkel and Koehring 1992). Herons in a large, notable rookery on Eagle's Nest Island in Pool 26 have been observed to primarily use large cottonwoods for nesting sites.

Figure 18. Annual bald eagle production on the Upper Mississippi River National Wildlife and Fish Refuge, Pools 4-14, 1986 – 2009. (Source: USFWS)

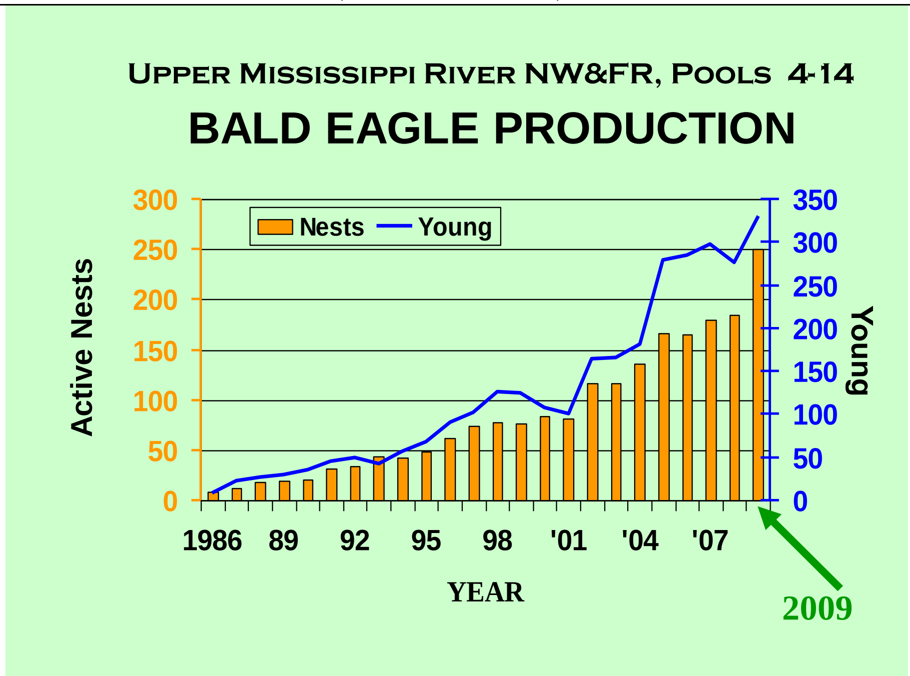
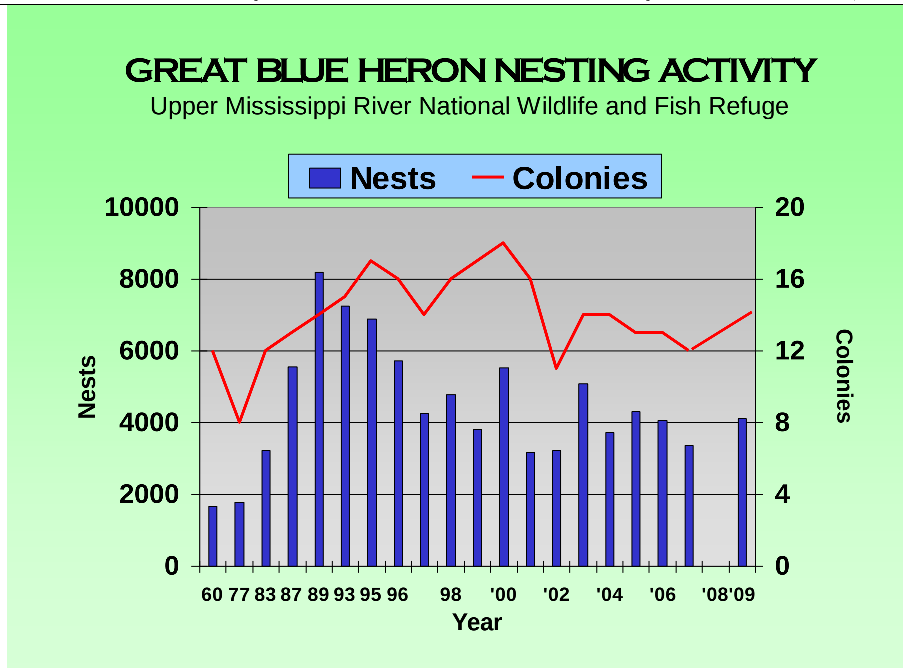


Figure 19. Number of active great blue heron colonies and nests on the Upper Mississippi River NW&FR, Pools 4 – 14, selected years 1960 – 1993 and annually 1995 – 2009. (Source: USFWS)



In general, herons and egrets on the Upper Mississippi River have declined since 1993, but the cause for the decline does not appear to be related to nesting or foraging habitat (Kirsch et al. in review). However, projected losses of large trees and forest habitat in general may limit these species in the future and cause greater declines. The number of active heron nests on the Upper Mississippi River NW&FR (Pools 4 through 14) increased between 1970 and 1990, peaking above 8,000 in 1989. Since the late 1990s, the number of heron nests has stabilized to between 3,000 and 5,000 (figure 19) (USFWS 2009b).

Waterfowl – Waterfowl are likely the most visible and certainly the most economically important group of bird species on the river system. Large numbers of diving and dabbling ducks migrate through the system, and some species are common nesters (e.g., mallard (*Anas platyrhynchos*), wood duck (*Aix sponsa*), hooded merganser (*Lophodytes cucullatus*), and Canada geese (*Branta canadensis*)) (USACE 2004). Nearly 60 percent of waterfowl hunting in the U.S. occurs in USFWS management areas that border the Mississippi Flyway (USGS 1999). Although waterfowl remain abundant, their numbers have declined since the 1950s, due primarily to habitat alteration, habitat loss, and pollution. These declines have been most evident on the Illinois River (USACE 2004).

Two species of forest nesting waterfowl can be found on the Upper Mississippi River – the wood duck and hooded merganser. Both of these species nest in large cavities in trees over or near water. Wood ducks are omnivorous but a large part of their diet consists of acorns, seeds and berries. Hooded mergansers are primarily piscivorous, supplementing their diet with crustaceans and aquatic insects. During fall staging and migration mallard and blue winged teal (*Anas discors*) can be found in small wetlands surrounded by floodplain forests.

Terrestrial game birds – Game birds that occur on the floodplain include the mourning dove (*Zenaida macroura*), ruffed grouse (*Bonasa umbellus*), wild turkey (*Meleagris gallopavo*), ring-necked pheasant (*Phasianus colchicus*), and in rare instances bobwhite quail (*Colinus virginianus*). Wild turkey, ruffed grouse, ring-necked pheasants and bobwhite quail are ground nesters and require a good amount of heavy ground cover for nest concealment. Wild turkeys are notably tied to forest habitat because acorns are a preferred food source and they roost in trees at night. Pheasants and bobwhites are probably not of concern for forest management because they typically do not occur in forest, although they can use forest edge and shrub habitat for shelter. Furthermore, only the mourning dove is fairly common in floodplain forests and all of these species are far more common in upland habitats than floodplains.

b. Mammals

Historically, American Indians and European trappers capitalized on the diverse and abundant assemblage of terrestrial and aquatic furbearing mammals that inhabit the UMRS. They found a seemingly endless food supply consisting of large mammals such as elk (*Cervus canadensis*), bison (*Bison bison*), and white-tailed deer (*Odocoileus virginianus*) and small mammals such as squirrels (*Sciurus* spp.), raccoon (*Procyon lotor*), muskrat (*Ondatra zibethicus*), and beaver (*Castor canadensis*). European exploitation eventually led to the extirpation of the elk and bison; however, most of the remaining mammals have continued to thrive in and along the river (USACE 2004).

Terrestrial mammals such as the white-tailed deer, red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), coyote (*Canis latrans*), squirrels, raccoon, and opossum (*Didelphis virginiana*) are found in abundance, primarily inhabiting the river's floodplain and islands. Bobcat (*Lynx rufus*) and black bear (*Ursus americanus*) are occasionally observed in the upper reaches of the Upper Mississippi River, primarily above Pool 11. Aquatic mammals, such as the river otter (*Lontra canadensis*), beaver, and muskrat, are commonly observed along the riverbanks and/or backwaters. A few species of bats rely on cavities in the floodplain forests for shelter and the flying insects that are produced in and along the river for food.

Overall, mammal populations within the river corridor are considered abundant and healthy. However, there are relatively few sources from which to draw upon for a comprehensive systemic assessment. Dahlgren (1990) provides an assessment of trends in furbearer harvest within the Upper Mississippi River NW&FR and States along the corridor between 1940 and 1990. In general, most aquatic mammal populations showed a measurable increase in abundance following the creation of slackwater pools. Some declines noted in the early to late 1960s for mink (*Neovison vison*) and river otter were linked to polychlorinated biphenyl (PCB) contamination of fish, their primary food source. River otter numbers have increased since 2000, as reported by refuge trappers and State furbearer biologists. The number of muskrat harvested off the refuge has been fairly constant, while beaver harvest has declined in the past 10 years.

c. Reptiles and Amphibians

The eastern massasauga (*Sistrurus catenatus catenatus*) is a reptile species closely tied to floodplain forests. This snake occurs in wetland complexes containing floodplain forest, emergent wetlands and wet meadows, and has been documented at Trempealeau NWR (Pool 6), Nelson-Trevino Research Natural Area and adjacent Tiffany Bottoms State Wildlife Area in Wisconsin (Pool 4), and the Black River Bottoms of Pool 7. Massasaugas hibernate below ground in tree root balls, crayfish burrows, and small mammal holes. The interspersion of different floodplain habitat types may be important because primary prey are small mammals (e.g., voles, deer mice, meadow jumping mice, and shrews) that can occur in these habitats, and these snakes tend to have relatively large home ranges (1 to 25 hectares). However, eastern massasaugas prefer areas with large woody debris, high leaf cover and high herbaceous cover for concealment from predators (King et al. 2004).

A study documenting the amphibian use of the floodplain on the Upper Mississippi River was conducted by the USGS UMESC, in conjunction with the Amphibian Research and Monitoring Initiative (ARMI). This study documented ten species of frogs, one species of toad, and two species of salamanders in the Upper Mississippi River floodplain. These observed species of amphibians breed in wetlands among all habitat types in the floodplain, but most of the breeding sites studied were within the wet forest land cover type. In general, small, closed-canopy sites with less emergent vegetation and primary productivity are probably less productive for amphibians than more open canopy, often larger, wetlands.

It is challenging to think about how the Upper Mississippi River and its component habitat types support amphibian populations for their entire life cycle. Clearly, floodplain forest and other land cover types, in combination with wetlands, constitute the critical matrix that supports amphibian diversity in the floodplain. But how amphibians use forests and other habitats during the nonbreeding season is not well known.

Additional studies in other parts of the UMRS are ongoing. For example, the Illinois Natural History Survey maintains an amphibian and reptile collection and associated database, with species distributions throughout Illinois mapped by county.

d. Fish

Terrestrial floodplain vegetation communities provide an important source of energy for aquatic food webs throughout the UMRS. This occurs both in the form of direct allochthonous inputs from riparian vegetation as well as inputs derived from groundcover and plant litter during inundation events. Floodplains are also important spawning grounds during seasonal spring floods for many fish species. In addition, floodplain forests provide important contributions to fish habitat in the form of large woody debris inputs to side channels, backwaters, and other aquatic zones near forested riparian areas.

A recent planning document published by the Fishers and Farmers Partnership Program (Steingraeber et al. 2009) included assessments of aquatic biodiversity, imperiled, and non-native fish species throughout the UMR Basin summarized by 8-digit hydrologic unit. The report raised the possibility that a longitudinal decline in species richness in the central portion of the UMR could be linked to a loss of seasonal floodplain habitat in that region.

e. Federally Listed Threatened and Endangered Species

Comprehensive lists of Federal and State listed threatened and endangered species can be accessed from the U.S. Fish and Wildlife Service's website: www.fws.gov/endangered. These lists are even available at the county level. Several federally listed threatened and endangered species occur in conjunction with terrestrial habitats in the UMRS, including the decurrent false aster (*Boltonia decurrens*), interior least tern (*Sterna antillarum),* and Indiana bat (*Myotis sodalist).*

Decurrent false aster – The decurrent false aster is a federally listed, threatened floodplain species that occurs along a 400-kilometer (km) section of the lower Illinois River and nearby parts of the Mississippi River. It is an early successional species that occupies disturbed alluvial soils in the floodplains of these rivers and requires either natural or human disturbance to create and maintain suitable habitat. Its natural habitat was wet prairies, shallow marshes, and shorelines. In the past, the seasonal flood pulse of the Illinois River provided the open, high-light habitat required by this species and reduced competition by killing other less flood-tolerant early successional species. No critical habitat is listed for this species. Field observations indicate that in areas without disturbance, the species is eliminated by competition within 3 to 5 years.

Interior least tern – The interior least tern is a federally listed, endangered breeding migratory bird species that occurs in the Missouri River, Arkansas River, Mississippi River, Ohio River, Red River, and Rio Grande River systems. On the Mississippi River the least tern is most abundant on the Lower Mississippi River below Cairo, but is known to occur between St. Louis and the mouth of the Ohio River. In addition, the St. Louis District recently constructed a least tern nesting island in Pool 26 just above Melvin Price Locks and Dam that is showing promise as a nesting site. The wintering area of the interior least tern is unknown, but is believed to be in Central and/or South America (USFWS 1990). No critical habitat is listed for this species.

Indiana bat – The Indiana bat is an endangered species that has been found in 27 states throughout much of the eastern United States. Indiana bats are associated with the major cavernous limestone (karst) regions of the midwestern and eastern United States. They winter in caves or mines that satisfy their highly specific needs for cold, but not freezing, temperatures during hibernation. The fact that Indiana bats congregate in only a small percentage of known caves suggests that very few caves meet their requirements. Exclusion of Indiana bats from hibernacula by blockage of entrances, gates that do not allow for bat flight or proper air flow, and human disturbance of hibernating bats have been major documented causes of Indiana bat declines.

IV. Management

The 2004 UMR-IWW Feasibility Study specifically includes the adoption of an adaptive management approach to both navigation improvements and ecosystem restoration (USACE 2004) and notes that:

> *Adaptive management identifies uncertainties, and then establishes methodologies to test hypotheses concerning those uncertainties. It uses management actions as tools to not only change the system, but as tools to learn about the system.*

Forest management is currently an authorized activity within the Corps of Engineers Civil Works Program and will remain an ongoing activity with implementation of NESP or other authorized programs. Partners have agreed to include incorporation of the adaptive approach to forest management and restoration as a variety of uncertainties exist regarding the long-term trajectory of the forest resource. These uncertainties arise from the competing and compounding effects of such drivers and stressors as altered hydrology, increased sedimentation, and invasive species.

The NESP Science Panel strongly endorsed adaptive management to advance learning and improve future ecosystem restoration on the Upper Mississippi River. According to the Science Panel Adaptive Management report (Barko et al. 2006):

> *Restoration projects can become learning opportunities by incorporating an experimental technique or technology, being part of a larger experimental design, and by incorporating effective monitoring. Exploiting these learning opportunities will result in fundamental knowledge gains, improved design criteria for future projects, and in widely adopted management innovations.*

One of the main benefits of adaptive management is the development of an iterative and flexible approach to management and decision-making. This iterative approach emphasizes the fact that management actions can be viewed as experimental manipulations of the system of interest. The results of the management actions can then be monitored and future management decisions can be informed by the outcomes of previous decisions. Another important benefit of adaptive management lies in the opportunity for scientists and managers to collaborate in the design of innovative solutions to the challenges of managing complex and incompletely understood ecosystems. Alternative management actions can be stated as hypotheses and addressed from the framework of experimental design. The outcomes of management alternatives and the values of such outcomes can be estimated in relation to management goals and objectives. The adaptive management approach recognizes that uncertainty is unavoidable in managing large-scale ecosystems. Importantly, uncertainty can be analyzed to identify key gaps in information and understanding. The results of such analyses can be used to efficiently allocate limited management resources to new research or monitoring programs (USACE 2004).

A. Adaptive Management Framework

Adaptive management is a process that promotes flexible decision-making that can be adjusted as outcomes from management actions and other events become better understood (Williams et al. 2007). The NESP Science Panel states that a system-based approach for UMRS restoration encompasses project-based planning and management and effective science within an adaptive management conceptual framework (Galat et al. 2007). A conceptual framework of adaptive ecosystem management for large river floodplain restoration is shown in figure 20 (Galat et al. 2007). The three loops of the figure represent scientific research (inner loop); bottom-up, project-based adaptive management (middle loop); and a top-down, system-wide approach (outer loop). Scientific hypotheses developed and tested in the inner loop can be transformed to knowledge for better project development in the middle loop and potential systemic forecasting on the outer loop. Alternatively, system-wide goals and objectives proposed in the outer loop can be translated into project design criteria in the middle loop and tested using the scientific approach outlined within the inner loop. (Galat et al. 2007)

Steps that are generic to many models of adaptive management include (1) Problem Definition, (2) Design, (3) Implementation, (4) Monitoring, (5) Evaluation, and (6) Adjustment. These steps provide an action sequence that is applicable at both the individual project scale and the program scale. They can assist interagency coordination groups and nongovernment stakeholders in developing their respective or collective management plans to optimize learning opportunities during plan or program implementation.

Figure 20. A conceptual framework of adaptive ecosystem management for large floodplain river restoration. (Source: Galat et al. 2007)

Problem definition – In the adaptive management process, problem definition documents baseline knowledge and provides the necessary justification for appropriately focusing and marshalling resources to address the issue of concern. As noted previously, the forest resources and associated terrestrial vegetation or landcover classes on the Upper Mississippi have declined in value over time. The future forecast condition, while uncertain, is assumed to be less than desirable and a number of factors are suspected to be responsible, some of which are within the scope of existing agency authorities to address. This assumption is based on historic changes in landcover classes over time and managers' observations of change at the site scale.

Design – The design step is a key point in the planning process that sets measurable goals and objectives, and provides implementation guidelines for projects under consideration. It may also provide for the development of models that document partners' understanding of the system in question. Modeling also informs development of forecasts and hypotheses about the system, actions or projects to test those hypotheses, and appropriate monitoring to evaluate the accuracy of forecasts and model assumptions. Adaptive management's emphasis on learning requires that monitoring efforts be designed to support decision-making.

Implementation – Although authority for management of much of the forest resource under consideration is retained by the Corps, implementation of forest management has been an ongoing collaborative effort directed at habitat improvement over the last several decades. Implementation of specific NESP projects should closely follow the implementation guidelines set forth in the design phase. Effective communication is necessary to ensure these collaborative efforts remain consistent with stated project goals, objectives and guidelines, because implementation often requires the cooperation of multiple agencies and/or stakeholders. Any alterations in the scope of projects that take effect during the implementation phase should be appropriately documented so that subsequent phases of the adaptive management process (i.e., monitoring) can be adjusted accordingly.

Monitoring – Monitoring is an integral component in the adaptive management process. In the monitoring stage, questions, indicators, and hypotheses are studied to determine the effectiveness of management actions in meeting the specific objectives of the project under consideration. Effective monitoring programs will also improve understanding of the driving factors influencing floodplain habitats. Monitoring coupled with research and use of models will help answer these key questions as well as assist in identifying gaps in knowledge. See section IV.D for more discussion and detailed information regarding specific UMRS forest resource monitoring programs currently in effect and/or under consideration.

Evaluation – As suggested by the Science Panel, evaluation should be a thorough performance review and comparison to forecasts at both the program and project scales. For example, the initial development of an indicator selection framework and draft indicator list by the first Science Panel resulted in the selection of mast trees as an indicator and the suggestion that the indicator metric of measurement would be percentage of mast trees present in aggregate landcover classes (Barko et al. 2006). The periodic change (e.g., positive, neutral, or negative) would become part of a proposed ecosystem restoration report card. Subsequent evaluations of forestry program success and lessons learned could be sought from an array of extant Upper Mississippi River coordination groups, as well as the newly proposed River Council.

Adjustment – Even if results are as desired or expected, new knowledge gained may redefine problem statements, hypotheses, or alternative practices leading to continuous improvement and efficiencies. This point may be the most contentious in an adaptive management process under NESP, as equitable geopolitical distribution of program resources may periodically need to be set aside in pursuit of answers to systemic problems. Additionally, at times the appropriate parties may not be fully engaged to implement program changes suggested by the learning process. Under current authorities, funding levels, and stakeholder involvement, it is anticipated that the annual Forestry Coordination Meetings will provide a functional venue for program direction and adjustment as necessary.

B. Floodplain Forest Restoration Tools

The following section describes a number of common forest management tools available for restoration practices in UMRS floodplain forests. It includes general descriptions of harvesting methods; forest establishment methods, including specific tree planting techniques; and other considerations that often must go into restoration planning efforts such as site preparation, prescribed burning, and water level management. It also contains references to more detailed sources of silvicultural information and bottomland hardwood management guidelines.

1. Harvesting Methods

Group Selection Method – The group-selection harvest method is intended to mimic small openings in the canopy and regenerate small groups of trees within a stand. Species of intermediate shade tolerance are best regenerated under these conditions. The size of the openings is typically 1.5 to 2 times the height of the tallest tree (Smith 1986). The group selection method could be implemented in a few areas, with follow-up monitoring, to determine if this may be an effective method of regeneration for uncommon and hard-to-regenerate species such as oaks, hickories, sycamore, hackberry, and Kentucky coffeetree. For example, it has been noted that canopy openings created by tree mortality following the flood of 1993 have been colonized by intermediate intolerant tree species like silver maple, hackberry, elm, and to a lesser extent, sycamore (Urich et al. 2002). The group selection method may be an effective tool for increasing structural and compositional diversity in monotypic stands heavily dominated by over-mature silver maple. Inter-planting desirable and/or under-represented tree species (e.g., oaks) within small group selection harvests may be a viable option for increasing the diversity of forest stands.

Shelterwood Harvest Method – The shelterwood method allows for the establishment of forest regeneration in partial shade before the entire canopy is removed (Smith 1986). Part of the canopy is removed initially, the residual stand of trees is left as a shelter for regeneration, and then the remaining canopy is removed when regeneration is established. This method produces an even-aged forest stand. The advantage over full removal of the canopy (i.e., clearcutting) is that in clearcutting, annual and perennial herbaceous and grass species can shade out tree regeneration. It is possible that the partial shade created by the shelterwood method will eliminate much of the herbaceous competition that requires direct sunlight, thus giving regenerating trees a better chance for survival. Several variations of this method may be applicable to the Upper Mississippi River's forests, and could be tested. For example, it may have advantages in areas where reed canary grass is predominant. A variation that may be readily adapted for present conditions is the "one-cut shelterwood" or "overstory removal" method. The entire canopy could be removed in one cutting if advance regeneration already existed under the canopy. These conditions may exist in areas where there was heavy thinning in the past, accomplished under a selective cutting forest management plan. These types of conditions may also be common in areas hard hit by the 1993 flood (Urich et al. 2002).

Seed Tree Method – The seed tree harvest method consists of removing most mature timber in one cutting except for a small number of seed trees left singly or in small groups. The remaining trees provide a source of tree seed to quickly regenerate the site, but do not create a significant shading condition that certain sun-loving species will not tolerate. This method also results in an even-aged forest stand and is likely to be most applicable when attempting to naturally regenerate light seeded species such as cottonwood (Urich et al. 2002). However, it may not be feasible if conditions favor invasion by reed canary grass or other groundcover species that may inhibit tree regeneration.

2. Site Preparation

The primary purpose of site preparation is to create optimal growing conditions for tree regeneration. The type and extent of site preparation is determined by the site itself and the regeneration methods planned. Preparing a site for bottomland hardwood regeneration can be relatively easy or rather complex. On some sites, sufficient soil scarification or other processes may have eliminated enough competing vegetation that no further site preparation is necessary. On sites where a thick litter layer or existing vegetation is present, disking or plowing may be necessary to expose mineral soil. Many abandoned agricultural fields have some degree of soil compaction that may need to be addressed by disking prior to planting. Herbicides or prescribed burning can also be effective tools for controlling competing vegetation in bottomland hardwood stands. Forestry mulchers have been used successfully to establish reforestation lanes in some bottomland sites, especially where reed canary grass is present. These lanes can then be planted or direct seeded, alone or in combination with natural seed fall. Hydrological restoration may be required where drainage ditches, field tiling, and other water control structures are present.

3. Forest Establishment

Natural regeneration – As a highly cost-effective measure, natural regeneration should be used whenever possible in reforestation or forest restoration projects. Although it is generally understood that natural regeneration will not be effective for re-establishing mast producing species in the UMRS except perhaps in limited situations, it may be quite effective for a variety of other floodplain tree species whose populations appear to be self-perpetuating. For example, it may be particularly effective when immediate colonization of abandoned agricultural land by light seeded species such as cottonwood is desirable.

Tree Planting – Hard mast trees such as oaks and hickories are much less abundant on the river than in the past, and they are not regenerating successfully. Efforts to restore mast trees are therefore likely to rely on tree plantings in the short term or until such time as these species are documented to be self-sustaining in the UMRS floodplain at acceptable levels. However, many past tree plantings in the UMRS have been characterized by low survival rates which have limited their overall effectiveness as well as driven up associated costs. In all tree planting projects, viable stock should have a local seed source (within about 100 miles) that has been collected from the Upper Mississippi River bottomlands or areas with similar moisture regimes (Urich et al. 2002). Every effort should be made to use existing Geographic Information System (GIS) resources and HGM analyses to plant different species of trees in the areas most suited to their preferred microhabitats (elevation, soil type, etc.). Tree planting efforts may often be coupled with, or components of, larger scale habitat restoration projects, such as elevation modifications using dredged material from side channel improvements or navigation channel maintenance. Decisions on what type of planting methods to use (direct seeding, bare root seedlings, RPM trees, etc.) should be cost-effective over the long term and incorporated into an adaptive management-based monitoring program whenever possible.

a. Containerized and RPM® Seedlings – Containerized seedlings range in size from small seedlings to large saplings in pots or bags. They tend to have more extensive root systems and high survival rates due to their ability to capture nutrients and water. Recent advances have been made in improving the stock of containerized seedling trees, particularly with regard to root-prune methodologies (RPM®). Larger and faster growing stock has a better chance of survival against herbaceous competition and flooding. These root-pruned trees also produce seed at a considerably earlier age, sometimes within 5 years of planting. The use of tree tubes, tree mats, and other protective measures can further increase survival in areas where herbivory and competition from weedy ground cover are problems.

b. Bare Root Seedlings – Bare root seedlings are much less expensive and are easier to transport than containerized seedlings. They are removed from the planting bed they were grown in by a process known as “lifting,” which involves cutting the tap root 6 to 12 inches below the soil surface and loosening the soil surrounding the roots. Bare root seedlings and can survive and grow well on sites that are not overly prone to flooding or drought. They must be planted during the dormant season, which may be the preferred time to access bottomland sites in the UMRS.

c. Direct Seeding – Direct seeding is relatively inexpensive and may be used in conjunction with tree planting and/or natural regeneration to achieve broad regeneration goals. The planting window is also much wider, allowing for more flexibility in scheduling site preparation and planting operations. However, direct seeding is largely restricted to large-seeded species such as oak, hickory, sycamore, and pecan, and there is a development period before measureable growth occurs. Direct seeding can be accomplished by hand or with a planting machine. Broadcast or aerial seeding is also an option for covering large areas.

Detailed technical information regarding specific tree planting techniques relevant to the UMRS can be found from a variety of sources such as the U.S. Forest Service Southern Research Station’s published document, “A Guide to Bottomland Hardwood Restoration” (Allen et al., 2001). As an additional consideration, planting or allowing for the natural regeneration of fast-growing tree species (e.g., cottonwood) in conjunction with mast-producing species has been shown to encourage rapid avian colonization in the Lower Mississippi Alluvial Valley, and may therefore be preferred over monotypic plantings of oaks (Twedt and Portwood 1997; Wilson and Twedt 2005).

4. Additional Forest Management Options

Timber Stand Improvement (TSI) – Timber stand improvements may be an effective management technique for increasing the compositional and structural diversity, as well as the health and vigor of UMRS floodplain forests. When coupled with small selective cuts to open areas for less-shade tolerant species tree species, it could improve tree regeneration and increase the diversity of age classes. However, in some areas it could facilitate invasion by non-natives such as reed canary grass.

Prescribed Burning – Generally, fire is detrimental to most bottomland forest tree species due to their thin bark. Most oak species, however, do have suppressed buds and can sprout following fire. Fire could potentially be used to suppress more aggressive bottomland species, such as silver maple, in areas where oak and hickory species are present and have the potential to regenerate. A few sites have been tested in Lake Odessa, Pool 17. These areas will continue to be monitored for regeneration of oak and hickory species, and new potential sites could be identified and evaluated for possible prescribed burning (Urich et al. 2002).

Elevation Modification – The sedimentation that often occurs during floods can lead to gradual improvement of site conditions on bottomlands for forest growth. The accumulation of soil and organic material can increase elevation and cause a transition to less saturated soil conditions. Silts and clays may be deposited over sand, resulting in better soils for the germination and survival of forest species. Consideration should be given to the direct placement of sand and fine materials on low-lying islands and other areas from dredging or other alternate sources. Follow-up monitoring and additional management actions may also be required to ensure an effective vegetative response or to make additional changes such as planting of seedlings (Urich et al. 2002). The use of fine-scale LIDAR elevation data and detailed hydrogeomorphic models (HGM) is also recommended when planning elevation modifications.

Water Level Management – The concept of using drawdowns to temporarily reduce pool levels on the Upper Mississippi River to encourage growth of aquatic vegetation may also prove to be beneficial for promoting natural regeneration of floodplain forest species. Additional attention should be focused in this area and applied where possible (Urich et al. 2002).

5. Bottomland Forest Management Guides

U.S. Forest Service North Central Region Bottomland Hardwood Forest Management Guide – The bottomland hardwoods of the Lower Mississippi Alluvial Valley have received a great deal of attention over the past 100 years, and U.S. Forest Service publications dating back almost as far present early growth and yield information, planting recommendations, and management approaches. However, much less attention was given to the bottomland hardwood forests of the North Central States, and the U.S. Forest Service *Manager's Handbook for Elm-Ash-Cottonwood in the North Central States* was not published until 1984. This handbook was the first attempt at providing a comprehensive overview of the silvicultural techniques used to manage hardwood tree species growing on moist sites in the Lake States for timber production.

To provide a guide for managing bottomland hardwoods with multiple objectives in mind, a new guide was recently developed by a multidisciplinary team of public and private forestry professionals, researchers, and practitioners. The new Bottomland Hardwood Management Guide brings up-to-date information from many disciplines to address a wider range of management issues, and is available online from the U.S. Forest Service Northern Research Station at: http://nrs.fs.fed.us/fmg/nfmg/bl_hardwood/index.html.

Forestry Best Management Practices – Many states in the Upper Mississippi River basin have published forestry best management practices, which provide technical guidelines for implementing forestry practices while protecting forest, soil and water resources. These voluntary guidelines are directly applicable to the sustainable management of riparian and floodplain forests, and are geared towards private as well as public land owners and managers. Links to published forestry best management practices for the five UMRS States are listed below:

- Illinois (IDNR 2000): http://web.extension.illinois.edu/forestry/publications/index.html
- Iowa (IDNR 2004): http://www.iowadnr.gov/Environment/Forestry.aspx
- Minnesota (MFRC 2005): http://www.frc.state.mn.us/initiatives_sitelevel_management.html
- Missouri (MDC 2005): http://mdc4.mdc.mo.gov/Documents/441.pdf
- Wisconsin (WDNR 2010): http://dnr.wi.gov/topic/ForestManagement/

C. Management Programs

A wide variety of land management programs are available in the UMRS. The following summary is adapted from the Middle Mississippi River Regional Plan. Further detail regarding specific programs, with reference to the appropriate management agencies, can be found in the Middle Mississippi River Regional Plan (available online at: http://www.swircd.org/mmrp/).

Conservation Easement Programs – One method of protecting valuable habitat is through the use of conservation easements on lands that private owners wish to protect. Conservation easements are agreements that set restrictions of varying levels on lands to protect their associated resources. They can restrict types of land use or even development. Easements are often in perpetuity but can often be effectual for only a limited period of time. Numerous types can be obtained through several agencies. Each easement type has unique attributes making it easier to find one that suits the landowners' interests and needs.

Grant & Cost Share Programs – Numerous grant and cost share programs are available for both agencies and private landowners. Agencies can use these programs to help fund their restoration projects. Landowners can also use these programs to help fund their own private restoration efforts if they choose to do so.

Land Acquisition Programs – Programs for land acquisition enable lands to be put into public ownership. Local, regional, and national land trusts and other private and/or nongovernmental organizations often play an important role in the acquisition of lands from private ownership and their transition to public ownership. Any land acquisition would be from willing sellers only.

Technical Assistance Programs – Many agencies and organizations have technical assistance programs that are applicable to public and private lands assistance. These programs allow agency personnel with technical knowledge to assist private landowners with natural resource questions, issues, or problems they may have on their property.

Education Programs – Education is likely to be an important element of success in attaining the goals of the Upper Mississippi River Systemic Forest Stewardship Plan. It is necessary to help the public understand what the regional issues are, and why this work is so important. The public is an integral part in working toward the completion of these goals.

Land Banking Initiatives – Private individuals have several options to benefit economically from the preservation of their land. Although the following summary includes some specific examples, it is not meant to be all inclusive. In addition, programs that support some of these types of initiatives are still under development at this time (e.g., carbon and nitrogen banks).

- Wetland Mitigation Banks – A wetland mitigation bank is a wetland, stream, or other aquatic resource area that has been restored, established, enhanced, or (in certain circumstances) preserved for the purpose of providing compensation for unavoidable impacts to aquatic resources permitted under Section 404 or a similar State or local wetland regulation. A mitigation bank may be created when a government agency, corporation, nonprofit organization, or other entity undertakes these activities under a formal agreement with a regulatory agency (such as the Environmental Protection Agency). Private landowners can convert their lands to a mitigation bank and then sell the rights to the land to an entity needing to compensate for their impacts to aquatic resources.

- Carbon Banks – The Illinois Conservation and Climate Initiative (ICCI) is a joint project of the State of Illinois, the Association of Illinois Soil and Water Conservation Districts, and the Delta Institute that allows farmers and landowners to earn greenhouse gas emissions credits when they use conservation tillage, plant grasses and trees, or capture methane with manure digesters. These practices keep carbon out of the atmosphere while providing other environmental benefits such as the creation of wildlife habitat and reduced runoff from fields.

  The Chicago Climate Exchange (CCX®) allows greenhouse gas benefits from conservation practices to be quantified, credited and sold. The credits are aggregated, or pooled, from many different producers and landowners by the Delta Institute, which is a nonprofit organization that is partnering with the State on ICCI. Credits are sold on the Chicago Climate Exchange trading platform to CCX® members that have made voluntary commitments to reduce their greenhouse gas contributions.

  Enrollment in ICCI is similar to other conservation programs, such as the Conservation Reserve Program (CRP), Conservation Stewardship Program (CSP) and Conservation Reserve Enhancement Program (CREP), and requires some of the same forms. Landowners can enroll by contacting the Delta Institute or their local Soil and Water Conservation District office.

- Nutrient Banks – Nutrient banks could be the operated under the same concept as a carbon bank program. An example of a project exploring the feasibility of this type of initiative can be found in a water quality trading program under research and development by the Wetlands Initiative (wetlands-initiative.org).

D. Monitoring

1. Key Questions

Why do the monitoring? – Monitoring is an integral component of the adaptive management process. In the monitoring stage, key questions and indicators are studied to determine the effectiveness of specific management actions and to improve understanding of the driving factors influencing the habitat. These should be the "need to know" questions to steer management, not the "nice to know" questions. Monitoring coupled with research and use of models helps answer these key questions and assist in identifying gaps in knowledge.

Following are some of these key questions:

- What level of diversity of forest structure, age, and species is needed for a sustainable forest and what are the appropriate management actions?
- What are the physical drivers on tree survival, stand dynamics, and habitat potential? How do these drivers like flooding, water table depth, sedimentation, and/or geomorphology interact to enable different habitats?
- What are the scale and impact of invasive species and appropriate control measures?
- What is the relationship between patch size and wildlife usage and is there an appropriate minimum size?

What monitoring is needed? – Multiple types of monitoring are needed to help answer these questions and steer management, including a combination of baseline, status and trends, implementation, effectiveness, validation, and compliance monitoring as described in Table 9 below. The geographic scale of monitoring is also a consideration. Local scale monitoring necessitates finer detail and resolution. System-wide monitoring requires coarser data collection than the local scale. Otherwise, the data collection process would quickly become too costly and too cumbersome to analyze. Table 10 describes these different levels of monitoring.

What monitoring techniques are available? – Many of the monitoring techniques needed for adaptive management already are in use. For example, land use and land cover data collected by the EMP-LTRMP and served by USGS UMESC and forest inventory data collected by the Corps of Engineers and USFWS provide good examples of baseline monitoring. The Corps also uses site visits, photo points, regeneration surveys, plant surveys, tree survival monitoring, and some wildlife surveys on selected forest management sites. The USFWS along with many State agencies complete key wildlife monitoring to include waterfowl, shorebirds, eagles, neo-tropical migratory birds, colonial nesting birds, and other surveys. The U.S. Forest Service completes forest pest monitoring on the gypsy moth and emerald ash borer. State and Federal agencies also collect disparate information on invasive species like reed canary grass. The Corps and others are collecting longer-term forest and reference site data using permanently marked forestry plots.

Table 9. Monitoring categories applicable to the UMRS. (Source: Barko et al. 2006)

Category	Scale of Monitoring[1]	Purpose
Baseline monitoring	L, P, R, S	Characterize existing conditions, including natural variability; establish a database for planning or future comparisons; use as a reference of either existing or undisturbed conditions.
Status & trend monitoring	P, R, S	Evaluate state of system over time, with emphasis on "trends". Key issue is change of conditions over time. May or may not be related to specific project or question.
Implementation monitoring	L	Evaluate whether the restoration practices were carried out as planned. Includes monitoring of construction impacts, constructed features, and characterizing immediate post-project conditions.
Effectiveness monitoring	L,P,R,S	Evaluate whether the restoration practices met stated objectives. May be directed at an individual project or a coordinated suite of multiple projects. Typically requires information about baseline and reference conditions, or desired state of system.
Validation monitoring	L,P	Advance knowledge of underlying causal relationships. Use demonstration projects to strengthen scientific basis for particular restoration approaches. Monitoring data used to validate models.
Compliance monitoring	None	Determine whether specific water quality or ecological integrity criteria are being met, as specified in some environmental standard, regulation, or law.

[1] L = local or project scale; P = navigation pool or multiproject scale; R = floodplain reach; S = system wide.

Table 10. Monitoring levels applicable to the UMRS. (Source: Barko et al. 2006)

Scale of monitoring	Type of objectives
Floodplain reach & System-wide	• Measure indicators of system health within major floodplain reaches.
Navigation Pool or Reach	• Measure indicators of system health within reaches of the system. • Determine effect of multiple projects within a reach.
Multiple projects	• Determine interaction among multiple projects of different types. • Assess incremental effects of multiple projects of the same type. • Assess role of different factors in success of specific restoration techniques
Individual projects	• Determine if project was built as designed and is operating as designed • Determine if project produced the anticipated local effects

Although these monitoring efforts are a good start to adaptive management, many are piecemeal and do not cover the entire system. Additional baseline information is needed, such as the forest inventory data along the Mississippi River from Saverton, Missouri to the confluence with the Ohio River and on the Illinois River that St. Louis District is currently collecting. Land cover data are not as comprehensive on the Illinois River, where additional land use and land cover data would help clarify current baseline conditions. The 2010-2014 Strategic and Operational Plan for the LTRM component of the UMMR-EMP has identified floodplain forest monitoring as one of several priority components being considered for addition to the program.

Validation and effectiveness monitoring have been used by agencies but could benefit from a more focused and rigorous approach. Not every action needs full monitoring, but select sites should receive both pre- and post-monitoring efforts along with the study of control sites. Ideally, monitoring should be done 1 or 2 years prior to the management action to develop a baseline at the site. To allow for more thorough statistical analyses, the same methodology should be continued post action in both the affected and control sites. This type of monitoring should be targeted for pilot projects or areas as is feasible because of its cost and difficulty. For, example, designation of a pool or length of each reach within the system as an Adaptive Management Study Area for more intense monitoring and to test assumptions could help focus efforts. Using areas undergoing pool planning efforts such as in Pools 5, 9, and 18 is worth consideration as additional monitoring and modeling efforts are underway in those areas. Comparison of management options and their effects, such as harvesting techniques, may be one use of the study area concept. Pre-, post-, and control site data should be collected through plant, wildlife, regeneration, and other effectiveness/validation monitoring. Photo plots and site visits could also help document results.

Research and objective confirmation of management concepts through the use of model validation is another facet of adaptive management. The Regional Forestry Project Delivery Team (PDT) is examining the use of an HGM to determine terrestrial habitat capability. Completion of this type of model will help confirm, refine, or refute existing assumptions on the physical drivers of habitat. See Section VI.A for additional information on HGM and its applicability to the UMRS.

Who determines the monitoring needs? – Monitoring details will be set forth by the action agency/group concurrently with the management prescription. The monitoring results should be used in a direct feedback loop to the action and managing agencies/groups on a yearly basis.

Who does the monitoring? – Monitoring will be undertaken by the Corps of Engineers, USFWS staff, and cooperating partners as able. Pending funding availability, other agencies and/or nongovernmental organizations such as UMESC, the U.S. Forest Service, the National Great Rivers Research and Education Center (NGRREC), or even private contractors could be contracted to extend monitoring capabilities. Additional monitoring resources might be provided by universities through graduate study research, memorandums of understanding (MOUs), and funded research.

Who funds the monitoring? – Future NESP appropriations may provide additional funding to allow for a more comprehensive effort and enable more formalized adaptive management monitoring. However, monitoring efforts will also continue to be implemented through multiple existing authorities including Corps of Engineers Operations and Maintenance funds, EMP (HREP and LTRM), USFWS refuge operations, and other sources. Standardizing methods at various spatial scales among and between these existing programs would be beneficial.

Who keeps the data? – Data should be centrally stored and accessible by all partners and managing agencies. Formalizing data storage outside of individual agencies and projects will help standardize data making it more comparable over a system wide basis. For example, UMESC could provide this service in addition to its current capabilities.

Who analyzes the data? – No one single agency is capable of all the analyses that might be required because of the complex nature of monitoring data. Therefore, this process should be flexible and analyses should be done in a collaborative manner using managing agencies, the USGS, universities, and even private contractors. Memorandums of agreement with one or more universities could provide a good source. The Regional Forestry PDT should be the central managers of analysis efforts using data derived from projects and/or directly related to UMRS forest ecosystems under Corps authorities.

How is monitoring related to adaptive management? – Good communication and sharing of information will be central to the success of this adaptive management effort. Closing the gap between monitoring of actions and baseline conditions and refining management prescriptions will be imperative. A formalized communication effort including centrally stored data as mentioned above is a good start. Secondly, annual coordination meetings to present information and adjust management will be necessary. Integrating Regional Forestry PDT coordination into existing Corps of Engineers annual Forestry Coordination Meetings would provide a good means of communicating with all members of the PDT and other partners.

2. Forest Monitoring Protocols

a. Forest Inventory

A maintained inventory of bottomland forests on the Upper Mississippi and Illinois Rivers would provide baseline information for several key issues. Forest inventories currently exist for most of the Corps fee title lands in the St. Paul, Rock Island, and St. Louis Districts. Many additional USFWS lands have also been surveyed. The corresponding database, stored digitally in GIS format, includes detailed information on stand locations, canopy layers, species, size, and the age of trees and stands. The stands were delineated into nested geographic units starting at the stand level, which were then aggregated by compartment, and finally by Pool.

A new and systemic forest inventory protocol for Corps lands in the UMRS has been recently developed. This methodology harnesses new technologies in field data entry equipment, Global Positioning Systems (GPS), and computers for post processing power. After stand mapping, inventory plots are surveyed. For example, plots are randomly allocated in the field at an average rate of 1 plot per 2.5 acres. Using a variable radius plot with a Basal Area Factor (BAF) of 10, count tree information includes species, diameter, height, and canopy class. Additional information is collected on understory and ground layers, including data on invasive species. The position of the plots is recorded using a GPS unit. Tree age information is collected on every fifth plot.

The plot-level data that are gathered are stored in a GIS database and post processed to provide stand structure information in trees per acre format by size and species. Additional information such as Basal Area (BA) and the number of snags per acre can also be calculated. The plot data is available for summarization into larger stand aggregates, or other discrete landforms such as islands via the GIS software. Storing the plot-level data in an easily accessible database allows for future comparative analyses, such as when more detailed hydrogeomorphic data becomes available (including accurate elevation information).

It is recommended that forest landcover should be inventoried on a 10-year cycle. The forest can change radically from disturbance events such as prolonged floods, wind storms, or a pest outbreak. Continuing the inventory on a rotating basis will keep the information current for management decisions. Contracting forest inventory work to outside groups will be an option if funds are available. Forest inventory information from adjoining Federal, State, Tribal, and private lands could be incorporated as it becomes available for systemic planning efforts.

b. Permanent Forest Inventory Plots

Resurveying standard inventory plots on a recurring basis will provide information on changes over time. However, this approach will only provide accurate information on changes when summarized at larger spatial scales. To capture more detailed information on forest changes at local scales, one would need to permanently mark individual plots and revisit them using the same protocol. Currently, the three Upper Mississippi River Corps Districts have created a permanent plot methodology to capture such detailed plot information.

The U.S. Forest Service's Forest Inventory and Analysis (FIA) Program completes this type of inventory on a nationwide basis. The ability to access FIA data where it overlaps with UMRS floodplain forests may provide additional information useful to the Corps' Upper Mississippi River forest management programs.

3. Management Impacts / Effectiveness Monitoring

Assessing implemented management actions involves additional monitoring. Although changes will be noted in periodic forest inventories after a management action, the timing and level of detail may not enough to determine success or failure. Monitoring will provide the assessment feedback loop that is integral to the adaptive management process, and it should be designed to assess how the outcome compares to the objectives. Different kinds of management actions such as harvesting, timber stand improvement, planting, or geomorphic changes will all require different monitoring protocols. Anecdotal observation is always part of post-project monitoring in addition to the more formalized measures discussed below.

Harvesting – In general, monitoring post-harvest sites should provide information on dominant ground cover along with coverage, species, and size of regenerating seedlings/saplings. Regeneration surveys should be conducted the first 2 years post-harvest and then once every 5 years until the site is captured by pole size trees. Depending on the goals of the harvest, the size of fixed plots for regeneration surveys will vary. For example, if the goal is to have 300 stems per acre established, then the plot size would be 1/300 acre. The plots would be established randomly throughout the harvest. The species and heights of trees within the plot along with the dominant cover would be recorded. The percentage of those plots that had at least one tree would provide the coverage estimate. If trees are counted within the plots, this count would provide estimates of trees per acre. Because of the high level of variability of regeneration within and between plots, enough should be established to achieve a statistically valid sample.

Planting – The follow-up information needed on tree planting includes percent survival by species or planting method, coverage, height growth, dominant ground cover, cover crop success, and documentation of influencing factors such as animal predation, flooding, or invasive species colonization. As with harvest sites, tree plantings should be visited the first 2 years, and then at least once every 5 years until the trees reach pole timber size. On small plantings, or moderately sized RPM plantings, a 100-percent survey could be accomplished fairly quickly. On larger plantings, one could survey a subsample of the rows. On a very large planting, one could count and measure trees on subsection(s) of each row. If rows are not readily visible, one can monitor similar to a harvest site using fixed radius plots documenting woody and herbaceous ground cover.

Timber stand improvement (TSI) – Depending on the goals of the TSI, the monitoring will be different. A heavy TSI designed for regeneration should be monitored similar to the harvest protocols. A moderate TSI for encouragement of growth and health of desired species might be monitored more informally with site visits and anecdotal observations.

Geomorphic changes (e.g., dredge placement, dredging) – For topographic modifications such as creating large mounding or ridge and swale topography, the site should be monitored for pre- and post-construction vegetation.

4. Forest Health Monitoring

In addition to the suite of pests, diseases, and invasive species already present in the UMRS floodplain, new diseases and pests are being discovered or transported here all the time, so ongoing monitoring will be crucial. Monitoring efforts will consist of informal observation by field personnel during normal work activities. Documentation of invasive plants will occur as a part of regularly conducted vegetation surveys. Corps environmental stewardship staff will maintain awareness of signs and symptoms of potential pests and report infestations to the U.S. Forest Service, State and Private Forestry, Forest Health staff.

The Forest Service is the leading agency on forest pests, and its National Forest Health Monitoring Program has many facets related to monitoring forest health. Detection monitoring is done nationally through the use of aerial photos and a systematic grid of ground surveys and currently provides coverage of portions of the UMRS floodplain. In the advent of a serious pest outbreak, consultation with the Forest Service on additional monitoring would be appropriate. Transferring additional funding to the Forest Service to evaluate the outbreak and provide recommendations for control should also be considered as an option.

V. Desired Future Condition

A. Vision

Corps-managed lands have become critical for the ecological sustainability of UMRS floodplain forests and associated terrestrial and aquatic ecosystems. The Corps forestry program will provide high-quality, sustainable bottomland forest on Corps lands along the UMRS, including a natural diversity of tree species, ages, canopy heights, and understory vegetation. The "ideal" floodplain forest will support floodplain ecosystem functions and sustainable habitat for wildlife. Therefore, the vision is to maintain a healthy, nearly contiguous forest that spreads across wide stretches of the floodplain and contains sufficient diversity of tree species, size, and age classes to provide a wide array of habitat structure and food (mast) resources (Urich et al. 2002).

Species Diversity – The ideal floodplain forest should have a wide range of tree species present, including any that are known to have historically existed on the floodplain but may not be present today. For example, researchers and nurseries have been attempting to produce disease-resistant American elms, and some experimental plantings of this stock have already been done. In the future, it may be possible to reestablish healthy elms across the floodplain. A forest with more mast trees is also desirable. Hard mast, such as acorns, pecans, and hickory nuts, are important food sources for the wood duck, mallard, deer, beaver, blue jay, and other wildlife (Urich et al. 2002).

Size and Age Diversity – Size and age diversity is another key characteristic of the ideal floodplain forest. A forest with trees in all stages of development provides a wider range of habitat, while ensuring a source of replacement trees after older trees reach senescence. Age diversity automatically brings size diversity, which benefits wildlife as some species require younger trees for their various life stages. Others species, such as the bald eagle, require older trees to use as nest and roost areas (Urich et al. 2002).

Structural Diversity – Structural diversity is an important forest component. Forests can be categorized into different vertical layers or zones. The older, taller trees make up the highest layer, or the main forest canopy. Under these dominant trees there is often another layer of vegetative structure made up mostly of co-dominant or mid-story trees. The next layer might be saplings and shrub species. The lowest layer of vegetation is typically composed of tree seedlings, forbs, grasses, sedges, mosses, and other plants. The ideal forest would also include snag and cavity trees to provide nesting and feeding places for various wildlife species (Urich et al. 2002)

Diversity of Vegetative Types – At the landscape scale, floodplain forest is often interspersed with blocks of other vegetation types, such as savannas, wetlands, or open grasslands. These other habitats occur at different locations adjacent to the forest, providing additional variation in structure and species composition (Urich et al. 2002).

The full range of multiple use forest values (aesthetic, productive, recreational, cultural, protective, etc.) should be considered in the development of management prescriptions. The underlying management philosophy should be to avoid any potential actions that might result in long-term harm to the ecosystem (Urich et al. 2002).

Successful management of UMRS floodplain forests will require effective Corps leadership and coordinated action between districts and programs (UMRR-EMP, NESP, O&M, etc.). In addition, strong partnerships and cooperation between Federal and State agencies, Tribal governments, nongovernmental organizations, private landowners, and additional stakeholders will be necessary for sustainable habitat restoration on the entire floodplain ecosystem. An essential component of this process will be prioritized restoration planning for the entire floodplain (bluff-to-bluff) with identified areas of focused effort. This planning will include a coordinated, landscape-scale program of restoration, management, monitoring, and research embraced by all agencies and the public. For example, current reach planning efforts included in the Upper Mississippi River System Ecosystem Restoration Objectives 2009 report (USACE 2010), additional efforts by the NESP Floodplain Restoration Team, and the ongoing development of a system-wide HGM model for the UMRS are also key elements. In the future, the floodplain management program on the UMRS will be an exemplary model for partnerships and science-based habitat and wildlife management.

B. Sustainability

Most definitions of sustainability in common usage today are adapted from the 1987 Brundtland Commission Report (WCED 1987), which defined sustainable development as "… *development that meets the needs of the present without compromising the ability of future generations to meet their own needs*." Implicit in this definition of sustainable development is that the environment, society, and the economy are interrelated components of the same system and must all be addressed if sustainability is to be achieved. NESP also incorporated these common elements into its definition of sustainability, which is stated as: "*the balance of economic, environmental, and social conditions so as to meet the current, projected and future needs of the Upper Mississippi River System without compromising the ability of future generations to meet their needs*" (Upper Mississippi River Summit 1996; USACE 2004).

The term *sustainable forest management* also incorporates many of these same concepts, as described in great detail in the U.S. Forest Service's National Report on Sustainable Forests – 2003 (USFS 2004). This report and its second iteration (USFS 2008) adopt the following definition of sustainable forest management from the Dictionary of Forestry (Helms 1998):

> *The stewardship and use of forests and forest lands in such a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, and vitality, and their potential to fulfill, now and in the future, relevant ecological, economic, and social functions at local, national, and global levels, and that does not cause damage to other ecosystems.*

The concept of sustainable forest management represents an extension of the earlier concept of multiple-use sustained-yield, which was primarily focused on outputs, by focusing on maintaining processes and sustaining communities, economies, and all aspects of a forest (USFS 2004).

Ultimately, the essential components of sustainable forest management, as well as a common framework for describing, assessing, and evaluating progress towards it, are contained in the Montreal Process Criteria and Indicators for the Sustainable Management of Temperate and Boreal Forests. The Montreal Process Criteria and Indicators have been adopted by the United States and the 11 other member countries of the Montreal Process Working Group, which together contain 90 percent of the world's temperate and boreal forests and 60 percent of all forests globally (USFS 2004). The seven Montreal Process criteria for the sustainable management of temperate and boreal forests are as follows:

(1) Conservation of biological diversity
(2) Maintenance of productive capacity
(3) Maintenance of forest ecosystem health
(4) Conservation and maintenance of soil and water resources
(5) Maintenance of forest contribution to global carbon cycles
(6) Maintenance and enhancement of long-term multiple socioeconomic benefits to meet the needs of society
(7) Legal, institutional, and economic frameworks for forest conservation.

The Montreal Process Criteria and Indicators are used to assess sustainable forest management at the national level by the U.S. Forest Service. They have also been considered and/or adapted for use at regional (e.g., Carpenter et al. 2003; GLFA 2004) and State levels (e.g., ODF 2007; Guyon and Edgington 2004).

Sustainable ecosystems must be resilient to natural and/or anthropogenic disturbances. The term *ecological resilience* refers to the ability of a system to absorb disturbance and still retain its basic function, structure, and feedbacks (Galat et al. 2007). The NESP Science Panel (Galat et al. 2007) contends that collective disturbances over the past two centuries have changed the UMRS enough to have forced it over a threshold and into a new ecological regime. This makes it difficult to predict when the river ecosystem might again become sustainable, which will occur when it becomes resilient enough to establish a new range of variation to which its biological communities will adapt (Galat et al. 2007).

A sustainable river system should maintain its capacity to provide the nation with the goods and services that support its expected quality of life. It should require less effort and funding for management and be able to withstand future threats. However, the navigation system is not self-sustaining, so society must determine the degree of sustainability desired and river managers such as the Corps of Engineers must reflect that in their ecosystem restoration goals and objectives (Galat et al. 2007).

C. Restoration

Repairing the ecological damage inflicted on our nation's aquatic resources is the foremost challenge for the emerging science of restoration ecology in the 21st century (Barko et al. 2006). The National Research Council (NRC) defined ecological restoration as *returning an ecosystem to a close approximation of its condition prior to disturbance* (NRC 1992). Numerous revisions and synonyms for the term *restoration* have appeared since the original NRC definition in 1992.

Box 2. Attributes of Restored Ecosystems (adapted from: SER 2004)

(1) Contains a characteristic assemblage of the species that occur in the reference ecosystem and that provide appropriate community structure.
(2) Consists of indigenous species to the greatest practicable extent.
(3) Is represented by all functional groups necessary for its continued development and/or stability, or if not, they have the potential to colonize by natural means.
(4) Has a physical environment capable of sustaining reproducing populations of the species necessary for its continued stability or development along the desired trajectory.
(5) Functions normally for its ecological stage of development.
(6) Is suitably integrated into a larger ecological matrix or landscape with which it interacts through abiotic and biotic flows and exchanges.
(7) Has potential threats to its health and integrity from the surrounding landscape eliminated or reduced as much as possible.
(8) Is sufficiently resilient to endure the normal periodic stress events in the local environment that serve to maintain its integrity.
(9) Is self-sustaining to the same degree as its reference system and has the potential to persist indefinitely under existing environmental conditions, fluctuate in response to normal disturbance events, and evolve as environmental conditions change.

For example, Wohl et al. (2005) define river restoration as *assisting the establishment of improved hydrologic, geomorphic, and ecological processes in a degraded watershed system and replacing lost, damaged, or compromised elements of the natural system*. The NESP Science Panel recommends adopting the Society for Ecological Restoration's (SER) definition: *the process of assisting the "recovery" of an ecosystem that has been degraded, damaged, or destroyed* (SER 2004). Box 1 lists the nine attributes used by the SER as a basis for determining when restoration has been accomplished.

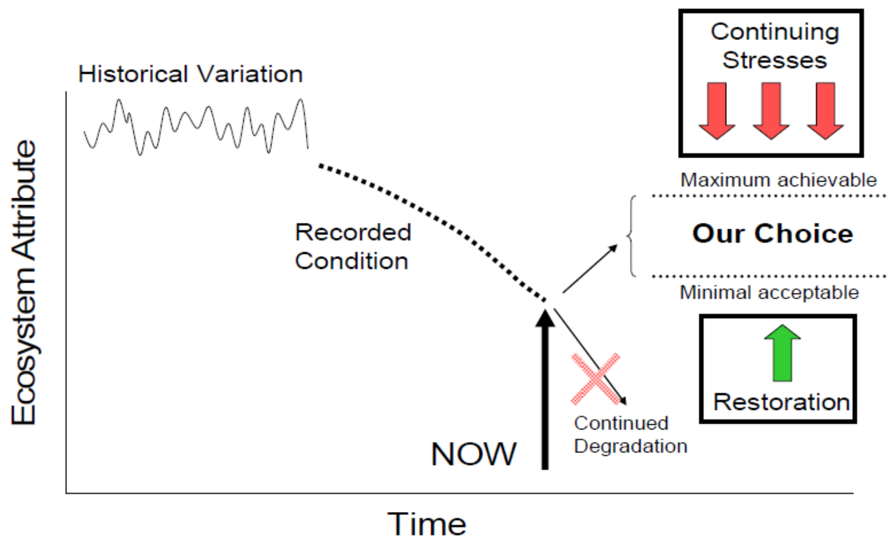
Early river restoration efforts typically addressed restoring riverine ecosystem structure (e.g., imperiled fishes and riparian vegetation). More recent efforts are addressing restoration of river functions and/or dynamics (e.g., nutrient cycling and hydrologic regime) (Barko et al. 2006).

River restoration is intended to bring the level of the river's quality up to some desired level. However, if that state is not self-sustaining, restoration efforts will have to continue indefinitely. The "recovered" state of the Upper Mississippi River will likely be greater than what is minimally acceptable, but less than the historical quality of the river due to the ongoing impacts of ecological stressors to the system. The maximum achievable level of recovery will be constrained by these stressors and the amount of resources allocated to restoration activities (figure 21).

D. Goals and Objectives

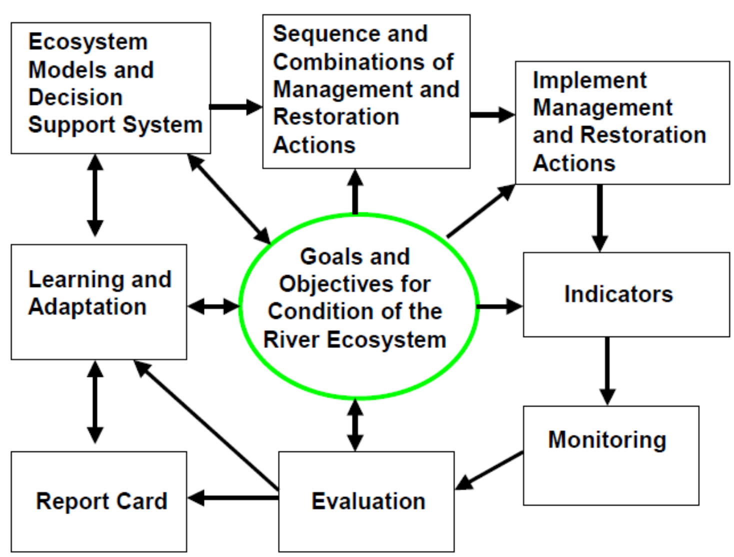
Broadly stated, specifying goals and objectives is an important task for restoration planning because it sets expectations for success, drives plans for implementation, and determines the types and extent of pre- and post-project monitoring (Ehrenfeld 2000). Similarly, goals and objectives for restoration of the Upper Mississippi River ecosystem are central to river management (figure 22). They are logically linked to management actions, action agencies, indicators of ecosystem conditions, monitoring activities, and ecosystem services (Barko et al. 2006).

Figure 21. The restoration state of the river as constrained by stresses and resources.



(Source: Galat et al. 2007)

Figure 22. Relationship among goals and objectives and other ecosystem restoration activities.

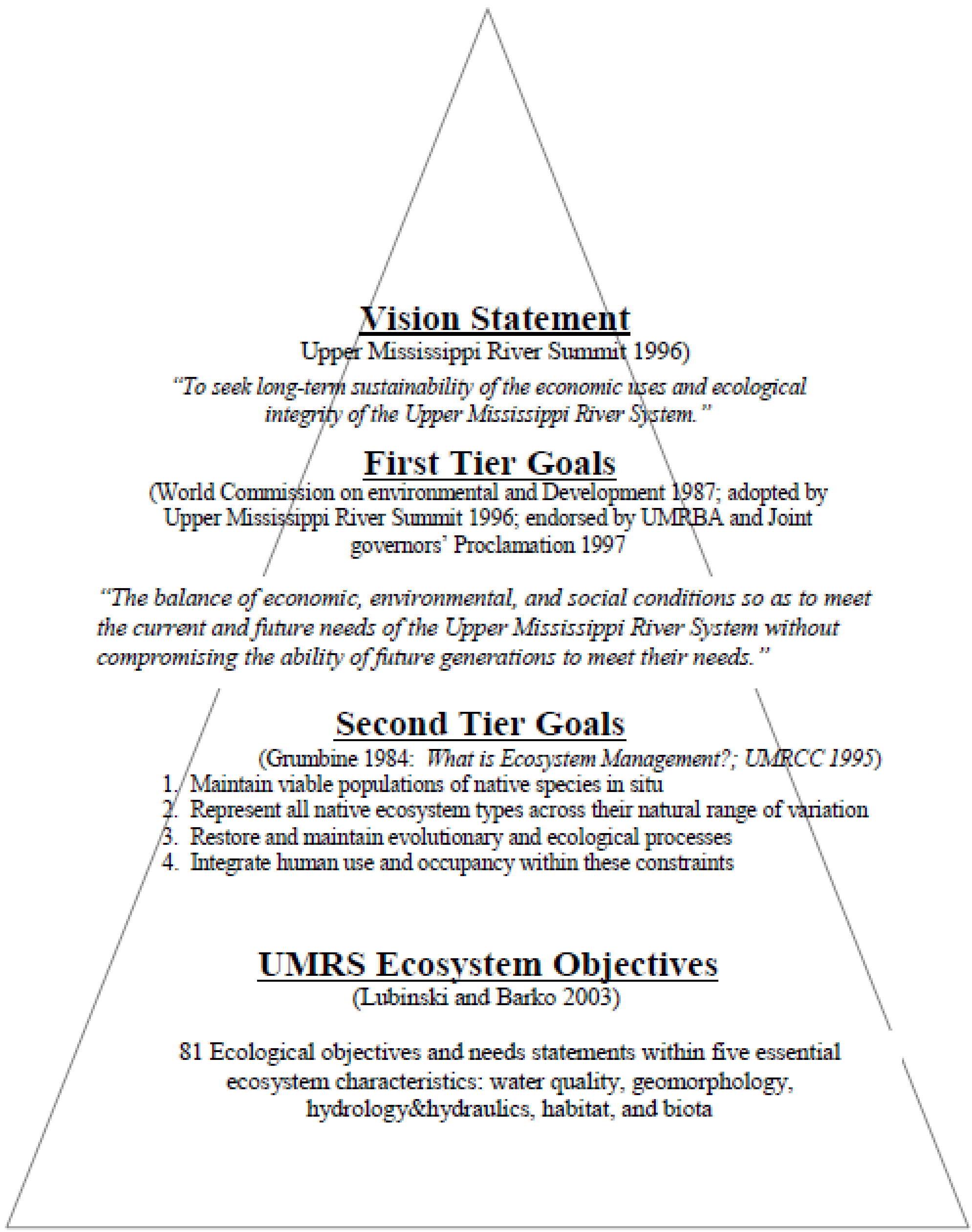


(Source: Barko et al. 2006)

1. Goals and Objectives Framework

Much effort has gone into establishing goals and objectives for the UMRS (e.g., Upper Mississippi River Summit 1996, DeHaan et al. 2003, Lubinski and Barko 2003, Barko et al. 2006, Galat et al. 2007). Barko et al. (2006) adopted the tiered approach for ecosystem restoration previously used by Lubinski and Barko (2003) for the UMR-IWW system. Arranging goals and objectives in a tiered approach emphasizes their hierarchical nature and the dependency of objectives on goals (figure 23).

Figure 23. UMRS Vision Statement and Tiered Goals and Objectives.



(Source: Barko et al. 2006)

The 2003 Navigation Study Science Panel compiled over 2,500 previous objectives for condition of the river system provided by stakeholders and synthesized them into 81 ecological objectives under five essential ecosystem characteristics: biogeochemistry (water quality), hydrology and hydraulics, geomorphology, habitat, and biota (Lubinski and Barko 2003). The ecosystem objectives were further refined by identifying their applicable spatial and temporal scales and linking them to management actions, action agencies, potential geographic ranges of application, performance indicators, monitoring activities, and ecosystem services (Barko et al. 2006). Ultimately, the Science Panel (Barko et al. 2006) and additional refinement efforts condensed the list of 81 ecological objectives to 42 goals and objectives.

The Science Panel (Galat et al. 2007) also developed an over-arching ecosystem goal for the UMRS and a series of ecosystem goals addressing the five essential ecosystem characteristics (EECs). The ecosystem goals were updated slightly from Galat et al. (2007) by the Navigation Environmental Coordinating Committee (NECC) and adopted by the NECC and Environmental Management Program Coordinating Committee (EMPCC) (USACE 2010 and 2010b).

Overarching Ecosystem Goal:

To conserve, restore, and maintain the ecological structure and function of the Upper Mississippi River System to achieve the vision

Ecosystem Goals:

1. Manage for a more natural hydrologic regime (hydrology and hydraulics)
2. Manage for processes that shape a physically diverse and dynamic river-floodplain system (geomorphology)
3. Manage for processes that input, transport, assimilate, and output material within Upper Mississippi River basin river floodplains: e.g. water quality, sediments, and nutrients (biogeochemistry)
4. Manage for a diverse and dynamic pattern of habitats to support native biota (habitat)
5. Manage for viable populations of native species within diverse plant and animal communities (biota)

Relationship of UMRS Forest Stewardship Goals to NESP and Reach Planning Goals – The goals and objectives contained in the UMRS Systemic Forest Stewardship Plan are meant to be program-neutral, and provide broad guidelines for sustainable forest management across agency and land ownership boundaries. However, many of the elements of these goals and objectives overlap considerably with those of other programs. Where overlap exists, this will hopefully provide opportunities to broaden support for the implementation of specific management and restoration practices.

The subset of NESP goals and objectives that are directly related to the Corps' Upper Mississippi River forest management programs include the following:

2.8) Increase topographic diversity and elevation of floodplain areas
4.3) Modify the extent, patch size, and successional variety of plant communities

4.6) Restore and maintain large contiguous patches of plant communities
4.9) Increase habitat corridor sizes and connectivity
4.10) Increase vegetated riparian buffers along tributaries and ditches in the floodplain
5.1) Maintain viable populations of native species throughout their range in the UMRS at levels of abundance in keeping with their biotic potential
5.2) Maintain the diversity and extent of native communities throughout their range in the UMRS
5.3) Reduce the adverse effects of invasive species on native biota

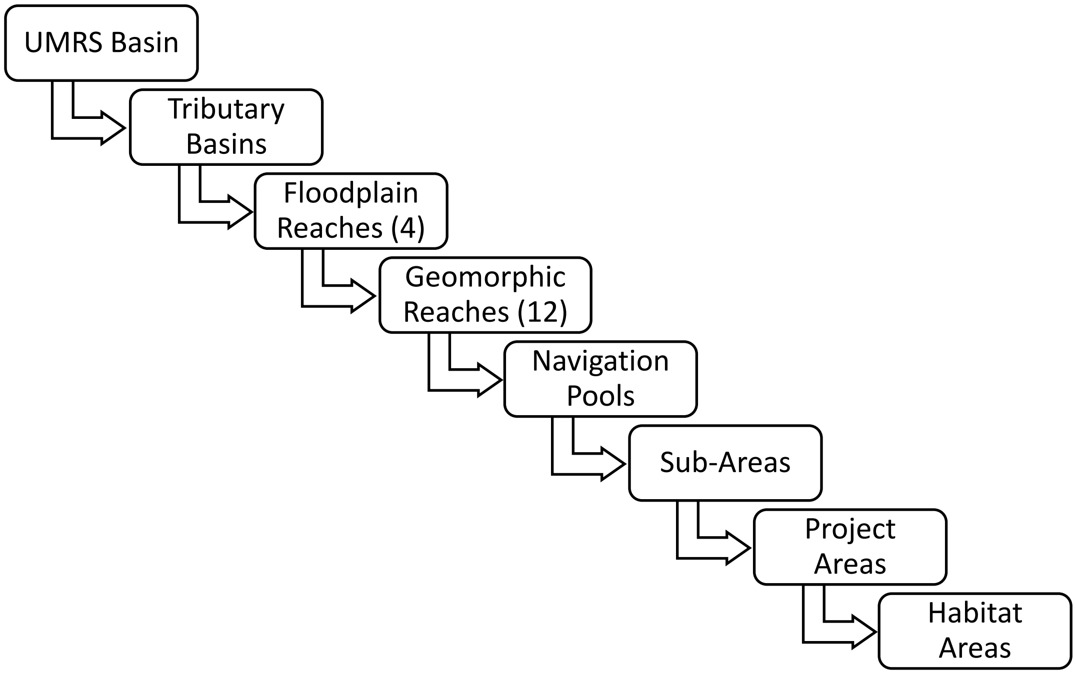
Although the majority of goals set by the NESP Environmental Science Panel do not directly apply to forests within the UMRS floodplain, the implementation and success of the forestry related goals will help achieve other systemic ecosystem objectives, including the additional NESP goals and objectives below:

1.1) Reduce contaminant loadings to the river
1.2) Reduce contaminants in the river
1.3) Reduce mobilization of sediment contaminants
1.4) Achieve State Total Maximum Daily Loads
1.5) Reduce, maintain, or increase sediment loadings to the rivers
1.6) Reduce nutrient loading from tributaries to rivers
1.7) Reduce nutrient export from the Upper Mississippi River to the Gulf of Mexico
1.8) Maintain adequate dissolved oxygen (DO) concentrations for fishes
1.9) Maintain water clarity sufficient to support submersed aquatic vegetation, aquatic invertebrates and fish species appropriate to location
2.11) Modify exchange between channels and floodplain areas
3.6) Increase storage and conveyance of flood water on the floodplain
4.2) Provide pathways for animal movement

The relationship of forest management goals to NESP goals and Reach Planning efforts (USACE 2010) illustrates the importance of focusing on ecosystem functions and processes. By creating a more sustainable forest, ecosystem functions and processes can be restored, especially pertaining to water quality. For example, although forest restoration alone will not solve water quality issues, it will greatly improve the ecosystem's natural ability to remove toxins, nutrients, and sediments from the UMRS, thereby creating a more sustainable system.

Spatial Hierarchy – A great deal of geomorphological and ecological variability is inherent to the UMRS due to its spatial and longitudinal scale. Effective management approaches must take this variability into account. Using an appropriate set of hierarchical levels of spatial analysis so that management activities can simultaneously target local issues and be integrated into analyses at the system-level will assist in the development of management prescriptions. The large-scale UMRS has been organized into a hierarchy of scales for program management, planning and implementation (figure 24).

Figure 24. Hierarchy of UMRS spatial scales for program management. (USACE 2010)



Goals Applied to the System Level – A system-wide approach generally emphasizes restoring ecosystem functions and processes over ecosystem structure (pattern of habitats, life forms) at individual project areas (USACE 2010b). At the system scale, an appropriate question might be: what is the current and desired future condition of the forest resource? The following metrics would likely be relevant at this scale:

- Total amount of forest landcover
- Percent cover of respective forest communities in the UMRS forest. For example:
    - Early successional (e.g., cottonwood – willow)
    - Riverfront (e.g., silver maple)
    - Floodplain (e.g., elm – ash – pecan)
    - Bottomland hardwoods (e.g., oak – hickory)

System-level analyses must also account for longitudinal differences in forest type due to climate and/or other ecosystem characteristics (i.e., desired future condition for northern and/or impounded reaches will likely be different than for southern open river reaches).

Goals Applied to the Floodplain or Geomorphic Reach Level – The goals developed by the Science Panel report(s) are system-wide goals. They provide a general direction for forest restoration, but prescribe no specific actions. According to Galat et al. (2007), “the cornerstone of UMRS sustainability is resilience.” Resilience is achieved through diversity – diversity in geomorphology, hydrologic regimes, habitats, and species. The historical mosaic of land cover types varies from reach to reach, based on differing geomorphology, hydrologic regimes and species composition. Therefore the large spatial and temporal scales involved with the UMRS mean that desired future conditions may best be determined on a reach or ecoregion basis.

At an appropriate scale (e.g., floodplain reach, geomorphic reach, or ecoregion as defined by HGM), this will involve identifying target characteristics of representative communities based on a combination of historical and baseline inventory data, including the following:

- Historical landcover characteristics (e.g., total forest landcover)
- Relative forest cover by community type if available
- Diversity and structural characteristics of individual forest types
- Wildlife habitat requirements/concerns applicable at specific locations.

HGM will be very useful in developing goals and objectives across multiple spatial scales including the system, reach, ecoregion, and project site scale. These models incorporate historic and current geomorphology and hydrologic regimes by reach, and can determine the land cover types that have existed in the past and that are feasible to restore in the future. By using this type of model, land managers will be able to determine what sites can be successfully converted to which desired land covers (e.g., forest, wet meadow, etc.). Therefore, this model can be used to develop goals regarding the ideal mosaic of land cover types for a particular reach of the UMRS. Once goals are outlined for land cover proportions by reach, goals can then be established for the desired future conditions of stands. It is important to note that HGM models have only been completed for the unimpounded reach and several sections of the impounded reach of the UMRS. Expanding these models to cover the entire UMRS is therefore a key to the success of future restoration efforts.

Goals for Desired Future Conditions at the Project or Habitat Level – Once goals have been established, managers can develop objectives for individual sites. In terms of forests, these goals should include ideal species composition, stocking levels, canopy coverage, and size and age class distributions. The Lower Mississippi Valley Joint Venture (LMVJV) provides an excellent example of what forests should “look like” in that region. By developing standards similar to the LMVJV, land managers can use baseline data to determine what sites need restoration and measure the success of restoration activities. It is important to note that the LMVJV’s larger goal is forest restoration for the benefit of priority wildlife species and therefore focuses solely on bottomland forests. The broader vision of this plan dictates that other land cover types such as prairie, marsh, and savanna not be ignored, and detailed compositional benchmarks will likely be useful for these types of land cover classifications as well.

At the project scale, the above should be cross-referenced with “on-the-ground” conditions (e.g., the current vegetation and hydrogeomorphic characteristics at a specific project site) to arrive at the goal of an ecologically functional forest community that is sustainable over the long term:

- Identify potential floodplain habitat (e.g., via HGM analysis)
- Identify current vegetation and ecosystem characteristics (e.g., silver maple and RCG)
- Identify appropriate silvicultural and/or other restoration techniques to move habitat towards desired future condition (e.g., tree plantings, TSI, and invasive species removal)

Linking Project Goals to System Goals – Finally, the results of management activities (e.g., reintroduction of hard mast species) at the project site level should be evaluated for their effects on (or contribution to) the entire system, consistent with the feedback mechanisms inherent to the adaptive management process.

2. Goals and Objectives

The following goals are generally open-ended, and fully realizing them will require ongoing efforts and substantial resource inputs for an indefinite period of time. Many of the objectives, particularly those associated with forest planning and adaptive management efforts, may also involve long-term time frames. Others, such as those associated with programmatic aspects or project implementation, may be accomplished over much shorter and discrete time frames and may benefit from additional prioritization.

a. Goal 1: A functional, sustainable floodplain ecosystem that includes a mosaic of native vegetation communities sufficient to support important wildlife habitat.

Historically, the UMRS floodplain supported a mosaic of community types including riverfront forest, bottomland hardwood forest, bottomland slope forest, savanna, bottomland prairie, mesic prairie, seasonal herbaceous wetland, emergent wetland, and shrub/scrub. Plant community distribution varied according to abiotic site characteristics including geomorphology, soils, elevation, and hydrology. Boundaries between vegetation communities were dynamic, varying over time due to processes such as flooding, drought, sedimentation, erosion, and fire.

Human changes to the ecosystem (such as levees, dams, agriculture, and urban development) have negatively altered floodplain functions and native vegetation communities. Complete restoration of historic ecosystem conditions is not feasible given these modifications, although some level of restoration of forests, grasslands, wetlands and their associated functions within the UMRS floodplain is certainly possible and desirable. However, many questions remain about what has been lost and what still can be restored and sustained given the altered ecosystem conditions.

Goal 1 Objectives:

- Develop a system-wide, spatially explicit database/model containing both reference and current site conditions, among other attributes. This can be accomplished by conducting an HGM analysis of the entire UMRS, which is a recommended priority action (see below).

- Based on analyses of historical and current landcover and compositional studies, identify and prioritize habitats and/or species that are underrepresented in today's floodplain ecosystem.

- Using the results of HGM, combined with other efforts as applicable, establish priority focus areas where restoration efforts are likely to have the most impact.

- Use landscape-scale analyses to establish and maintain larger blocks of closed-canopy floodplain forest patches of at least 2500 acres, with width and length of at least 1/3 mile, where possible for nesting forest birds. The landcover matrix around these patches should be more than 50 percent forested, with more than 25 percent mature forest, and less than 15 percent open habitat.

- In reaches where optimum configuration is not currently achievable, forest restoration projects should be designed to maximize the amount of interior forest habitat for each tract.

b. Goal 2: Restore and maintain forest diversity, health, and sustainability on Federal lands.

Goal 2 Objectives:

- Restore and maintain a diversity and distribution of tree species on Federal lands at sustainable levels.
    - For example, determine the appropriate percent coverage of UMRS floodplain forests by hard mast trees by geomorphic reach or ecoregion and restore to that level.

- Use HGM and/or historical reference conditions to generate target levels of representative communities. These targets should be compared to site restoration potentials given current conditions.
    - For example – target percentages for landcover types by reach:
        - Silver maple dominated forest 50 to 80 percent
        - Cottonwood 5 to 10 percent
        - Willow 5 to 10 percent
        - Oak/hickory/pecan 5 to 10 percent
        - Shrub/scrub 5 to 10 percent
        - Grassland 0 to 5 percent
        - Sand prairie 0 to 10 percent
        - Savanna 0 to 10 percent

- Establish the ideal distribution of age and structure classes in UMRS floodplain forests.
    - For example:
        - 20 percent sapling (0 to 5 inches dbh)
        - 35 percent pole (5 to 12 inches dbh)
        - 45 percent mature/over-mature (more than 12 inches dbh).
    - Base goals for the abundance of different size classes partially on the average number of stems per acre in each size class. This will allow for comparison between reaches with extensive canopy openings (due to disturbance from wind, flooding, or pathogens) filling in with a mix of younger trees and reaches that are more even aged. For example:
        - more than 500 sapling size stems per acre
        - more than 75 pole size stems per acre
        - more than 25 mature stems per acre

- Establish targets for canopy coverage by forest type and successional stage.
    - For example: mature forests should have at least 70-percent canopy cover.

- Use a variety of management actions to achieve target percentages, including harvesting, planting, timber stand improvements (TSI), and/or passive management.

- Establish tree planting guidelines for Federal lands.

- Many hydrologic factors lie outside the scope of this plan, but the impact of this issue on forest restoration success is recognized. Every effort should be made to support restoration of a more natural floodplain hydrology whenever possible. For example, efforts are underway through Environmental Pool Management to partially restore summer low-water periods, and the effects of these and similar actions on forest attributes should be monitored.

- A portion of lands should be designated for passive management only, including sensitive areas or those lands where site harvest access is deemed commercially unfeasible.

- Provide special consideration for Federal and State listed species in all management decisions.
    - Establish buffer zones around active bald eagle nests, heron colonies, known Indiana bat maternal roosts, etc.

- Tailor site specific management prescriptions to benefit the managing agency's wildlife goals
    - Adjust patch size, leave trees, snags, harvest type, etc.

- Reduce the adverse effects of invasive species on native biota.
    - For example, the suppression of native tree regeneration by reed canary grass.
    - See the Reno Bottoms Forest Restoration Project (a recommended priority action).

c. Goal 3: Provide support for the restoration and maintenance of forest diversity, health and sustainability on non-Federal lands.

Funding arrangements for forest and grassland management and restoration activities under NESP authority are dependent on land ownership. For fee-title lands owned by the Federal Government within the UMRS project area, the arrangement is 100 percent Federal funding. A cost share arrangement of 65 percent Federal and 35 percent non-Federal applies on land that lies within the UMRS project area but is non-Federal in ownership. This authorization follows directly from the Water Resources Development Act of 2007 (WRDA 2007). A non-Federal partner and landowner cooperation would be required to implement projects on non-Federal lands. The Corps has the ability to work directly with States and nongovernmental organizations, but not private landowners. Proposed management actions on any project off Federal lands would follow traditional Corps planning guidance to determining a Federal interest and benefit with regard to NESP project cost share funding.

Goal 3 Objectives:

- Provide technical support for forest restoration efforts on non-Federal and private lands in the UMRS floodplain as needed and pursuant to relevant NESP authority, memorandums of understanding and/or agreement, etc.

- Provide financial support for forest restoration efforts on non-Federal land in the UMRS floodplain pursuant to the applicable NESP cost-share guidelines

d. Goal 4: Adaptive management

The use of an adaptive management framework incorporating science-based decision-making in sustainable floodplain forest management efforts in the UMRS is highly recommended.

Goal 4 Objectives:

- Continue to acquire additional management information as necessary. For example:
    - Fine-scale elevation data (e.g., LIDAR)
    - Forest inventory data

- Develop a web-accessible GIS-based planning and decision-support database to include restoration, inventory data, habitat and wildlife monitoring, etc.

- Establish a partnership with the Lower Mississippi Valley Joint Venture (LMVJV).

- Implement adaptive management by:
    - Setting measurable benchmarks against which to gauge the success of projects
    - Monitoring the results of projects and use lessons learned in future project planning
    - Incorporating statistically valid methods in project planning whenever feasible
    - Linking project-level accomplishments back to system-level goals and objectives

3. Desired Future Landscape and Stand Conditions

The desired future landscape and stand conditions expressed in the following tables are general estimates based on the consensus of experienced land managers and other resource professionals familiar with UMRS floodplain forests. It is expected that these future desired conditions will be refined and updated over time as additional data (e.g., HGM) become available to support specific recommendations, particularly during the 5-year review cycles of this Plan.

Table 11. Desired landscape-level forest conditions within the UMRS.

Metric	Proposed UMRS Forest Conditions[1]	Description[2]
Forest Cover	70-90%	Large (>2,000-acre) contiguous forested areas are desired. At any point in time, 50% of the forest should meet the desired stand structure conditions (min. 33%)
Passively Managed Forest	40-50%	Forest areas that are not subjected to silvicultural manipulation (e.g., no-cut, wilderness, set-aside, and natural areas)
Mature forest	40-50%	---
Pole forest	30-40%	---
Regenerating Forest	15-20%[3]	Forest regeneration on areas > 5 acres (e.g., clearcuts); or forest restoration on agricultural lands (i.e., reforestation).
Shrub/scrub	5-10%	Shrubby vegetation (hydric or mesic) within bottomland forests, including forests in early successional stages

[1] Should reflect historical variability, use HGM, and be different by reach

[2] Adapted from LMVJV (2007)

[3] Achieving increased forest cover via reforestation overrides the percentage limitation

Table 12. Historic, current, and potential landscape conditions for floodplain areas.[1]

Land Cover	Historic (%) (ca. early 1800s)	Current (%)	Change (%)	Potential (%)[2]
	Upper Impounded[3]			
Forest	43.4	20.1	-53.7	25
Shrub / scrub	---	---	---	5-10
Wet meadow / marsh	5.8	11.1	91.2	10-15
Grasses / forbes	18.0	6.3	-65.3	5-10
Water	31.7	40.5	27.7	40
	Lower Impounded[4]			
Forest	37.7	17.9	-52.6	20
Shrub / scrub	---	---	---	5-10
Wet meadow / marsh	0.3	1.0	231.8	1-5
Grasses / forbes	45.9	4.9	-89.3	5-10
Water	15.7	16.0	1.9	15-20
	Unimpounded[5]			
Forest	86.7	20.9	-75.9	25
Shrub / scrub	---	---	---	5-10
Wet meadow / marsh	0.0	0.0	---	1-5
Grasses / forbes	0.0	2.4	---	1-5
Water	6.9	3.6	-47.8	3-5
	Illinois River[6]			
Forest	57.5	22.9	-60.2	25
Shrub / scrub	---	---	---	5-10
Wet meadow / marsh	2.4	1.9	-20.8	1-5
Grasses / forbes	20.3	9.8	-51.7	10-15
Water	15.3	17.5	14.4	15-20

[1] Historic and current data are derived from Theiling et al. (2000)

[2] Potential landscape conditions could be refined by hydrogeomorphic models

[3] Pools 4, 8, and 13; [4] Pools 17, 22, 24, 25 & 26; [5] Grand Tower – Ohio River; [6] LaGrange Pool

Table 13. Desired stand conditions for bottomland forests within the UMRS.

Forest Variables[1]	Desired UMRS Stand Structure	Conditions that may warrant active management
Overstory canopy cover	70 – 80%	> 80%
Overstory Species	2 species or more	large blocks of single species
Basal area	90-160 ft^2 / acre with ≥25% in older age classes[2]	> 200 ft^2 / acre
Tree stocking	50% – 90%	< 50% or > 90%
Emergent trees[3]	> 2 / acre	< 1 / acre
Understory cover	> 10 %	< 10%
Regeneration[4]	> 10% of area	< 10% of area
Coarse woody debris	Present	Not present
Small cavities (< 10 inch diameter)	≥ 2 visible holes/acre	< 2 visible holes/acre
Den trees/large cavities (> 10 inch diameter)	≥ 1 visible hole / 10 acres mature timber	< 1 visible holes / 10 acres
Standing dead and/or stressed trees	≥ 2 large trees / acre	< 2 large trees / acre
Invasive herbaceous	< 10%	> 10% of herbaceous layer
Invasive woody	< 10%	> 10% of any canopy layer

[1] Promotion of species and structural diversity within stands is the underlying principle of management
[2] "Older age class" stems are those approaching biological maturity (i.e., senescence)
[3] Emergent trees make good perch/nesting sites and should have stronger consideration on diverse sites
[4] Advanced regeneration of trees in sufficient numbers (e.g., 400/acre) to ensure their succession to forest canopy

Table 14. Existing[1] and target terrestrial communities by land cover type, reach and percentage of floodplain.[2]

Land Cover Type	Upper Impounded		Lower Impounded		Unimpounded		Illinois River	
	Existing	Target	Existing	Target	Existing	Target	Existing	Target
Silver maple mix	20.5	20	12.5	10-15	12.2	1-15	14.9	10-20
Willow	0.9	1-5	0.2	1-5	0.0	1-5	0.0	1-5
Cottonwood/sycamore	0.1	1-5	0.3	1-5	0.0	1-5	0.0	1-5
Oak/hickory/pecan	1.7	1-5	1.1	1-5	0.0	1-5	0.0	1-5
Swamp cypress	---	---	---	---	---	1-5	---	---
Shrub / scrub	1.9	1-5	2.9	1-5	0.0	1-5	0.0	1-5
Grasses / forbes	0.7	1-5	0.1	1-5	3.4	1-5	4.5	1-10
Wet meadow / marsh	4.9	1-10	1.8	1-5	0.0	1-5	0.0	1-5

[1] Source: Theiling et al. (2000)
[2] Further spatial analyses would be required to limit this matrix to public lands only

VI. Recommended Priority Actions

The following recommended priority actions are not presented in a prioritized order. For example, the acquisition of forest inventory and fine-scale elevation data would complement efforts to develop accurate hydrogeomorphic models (HGM). In addition, while additional data acquisition and the development of comprehensive hydrogeomorphic models would benefit specific on-the-ground restoration efforts, it is not recommended that these efforts be put on hold indefinitely while waiting for these acquisition and development programs to be completed system-wide.

A. Hydrogeomorphic Model (HGM)

HGM can provide a solid science-based approach to identifying ecosystem restoration options and providing recommendations for sustainable management of large river floodplain systems such as the UMRS. The HGM approach includes three stages: (1) determining historical condition and ecological processes of an area from a variety of historical information such as geological, hydrological, and botanical maps and data; (2) determining ecosystem alterations by comparing historic versus current landscapes; and (3) identifying options and approaches to restore specific habitats and ecological conditions. The foundation of ecological history coupled with assessment of current conditions helps to determine which system processes and habitats can be restored or enhanced and where this is possible, if it is at all. For example, in the Mississippi-Missouri River Confluence Area, wet bottomland prairie that was dominated by prairie cordgrass historically occurred at elevations higher than 417 feet, on relict alluvial floodplain terrace surfaces, on Beaucoup silt loam soils, and between 2- and 5-year flood frequency zones. Contemporary areas that offer these conditions now offer the best potential sites for restoring wet bottomland prairie communities.

Hydrogeomorphic analysis is the critical first step in developing a landscape-scale restoration plan for the UMRS floodplain. A 2007 report sponsored by the Corps of Engineers (Heitmeyer 2007) assessed the feasibility of conducting such an analysis by examining the availability of historic and current data, identifying constraints and assumptions, and proposing a framework for evaluating the entire system (2.8 million acres). The report concluded that the evaluation is feasible and probably could be completed within 3 to 5 years. The UMRS would be separated into ecological units with a unique HGM "matrix" developed for each ecoregion. An important next step in this process was the identification of appropriate ecoregions for a section of the UMRS from the confluence of the Mississippi and Missouri Rivers at St. Louis north to the Quad Cities (Heitmeyer 2009). The final product would integrate these ecoregions into a comprehensive systemic framework for understanding the entire UMRS system and would provide recommendations and guidance for restoration and conservation at a truly systemic level based on ecology of the region, not political boundaries.

The Corps of Engineers St. Louis District together with the Middle Mississippi River Partnership has already supported an extensive HGM analysis of the unimpounded reach between St. Louis and Cairo in order to identify ecosystem restoration options and provide recommendations for development and sustainable management of the reach (Heitmeyer 2008). Site-specific HGM analyses will be beneficial in developing detailed restoration plans for complex areas that include a diversity of potential habitat types. Examples of these types of HGM analyses include the Gilbert and Calhoun Divisions of Two Rivers National Wildlife Refuge in Pool 26 (Heitmeyer and Westphall 2007), Ted Shanks Conservation Area in Pool 24 (Heitmeyet 2008b), Rip Rap Landing Conservation Area in Pool 25 (USACE 2009), and the Keithsburg Division of Port Louisa NWR in Pool 18 (Heitmeyer et al. 2009b). These studies provide an important foundation for successful management of the UMRS, and the Regional Forestry PDT recommends continuing this effort as a highest priority until completed.

B. Data Acquisition

1. Forest Inventory

Extensive inventories of forested lands within local landscapes (e.g., specific refuge or management areas) throughout the UMRS are recommended. These inventories will help to assess existing habitat conditions and aid in formulating and prioritizing silvicultural treatments. To assess forest change and region-wide progress towards desired forest conditions, the use of a continuous forest inventory (CFI) network that is monitored at 5- to 10-year intervals is also recommended. This process will require the design and implementation of inventory and monitoring programs coordinated throughout the three UMRS Corps Districts. Given the prevalence of USFWS refuge lands throughout the UMRS, this inventory and monitoring program should also evaluate wildlife habitat and use of forested and other lands to ensure relevant wildlife management goals are being met. The use of a multilevel protocol containing a network of permanent field plots as well as fine-scale stand mapping techniques is recommended.

2. Fine-Scale Elevation Data

Subtle differences in elevation in terrestrial floodplain zones can have a profound influence on the response of associated vegetation across elevational and hydrological gradients. Fine-scale elevation data are therefore generally required in the developmental and implementation stages of site-specific habitat restoration plans. Although ground-level surveys might be feasible to implement on a project by project basis, the procurement of LIDAR (Laser Imaging Detection and Ranging) data has the potential to address these data needs at the system level. Fortunately, this data acquisition need has been addressed and the Corps of Engineers has collected systemic UMRS bluff-to-bluff LIDAR. Some is already available, and the remainder is undergoing processing and quality review and should be available in 2012. These data will be served by USGS UMESC, along with systemic bathymetry. Eventually, these two data sets will be merged to create a seamless topographic layer for the entire UMRS floodplain.

C. On-the-Ground Projects

1. Programmatic Implementation

On-the-ground forest restoration efforts would be guided by the development of a Forest Management Programmatic Implementation Report (PrIR). The PrIR would identify ecosystem restoration goals and objectives for forest management. The PrIR would enable continuous implementation of site specific measures on Federal lands through the approval of annual Forest Management Plans. The PrIR would function on a continuous basis rather than expire upon completion of a specific project, would cover multiple local-scale projects rather than a single project site, and would focus more on processes than on ground-level restoration and construction guidelines for individual projects.

2. Example: Reno Bottoms Forest Restoration Project

The Reno Bottoms Forest Restoration Project is an excellent example of an "on-the-ground" forest restoration project that is recommended by the Regional Forestry PDT. Much of the current floodplain forest in the Reno Bottoms/Minnesota Slough subarea, located in upper Pool 9, is not regenerating. Flat topography, higher ground water levels caused by impoundment, increased frequency and duration of inundation, reduced creation of new islands and shoreline and subsequent plant succession, and increased competition from reed canary grass and other herbaceous vegetation have all adversely affected forest regeneration. Dutch elm disease has also eliminated most mature American elm, a historic component of the river corridor. Thus, the current forest is composed mainly of a few highly water tolerant species, such as silver maple, which are now approaching the end of their life span. A younger tree age class replacement component is generally lacking throughout the area. Reed canary grass competition is particularly problematic here because it effectively precludes the use of many conventional forest management (regeneration) practices. Proposed actions would focus on restoring forest species and age class diversity on up to 1,100 acres. See the project fact sheet attached in Appendix 3 for additional information regarding this project.

D. Data Management

There is a demonstrated need for coordinated database management and data archiving related to a variety of management and restorations efforts throughout the UMRS. For example, see the following excerpt from the HGM Feasibility Report (Heitmeyer 2007):

> *ArcGIS and the geospatial data identified in this report can now be readily archived and housed in central and repository sites, assuming that some entity is willing and capable of managing the data. The availability of this data is increasing and an important outcome or product of an extensive HGM evaluation for the entire UMRS would be the collation of a comprehensive, readily available geospatial dataset(s) on the primary HGM datasets.*

The Long Term Resource Monitoring (LTRM) component of the UMRR-EMP currently supports a variety of monitoring, data serving, and research efforts. Monitoring data, results of various analyses and focused studies, decision-support tools, and UMRS GIS data layers are publicly available from the LTRM website (www.umesc.usgs.gov/ltrmp.html). The LTRM component of the UMMR-EMP would be a potential site for this type of centralized database management and data archiving effort.

VII. Implementation

A. OMPs, HMPs, and other existing programs

The Corps of Engineers develops and implements Master Plans (MPs) and Operational Management Plans (OMPs) for each Corps civil works project. Although separate documents, they work in tandem to set management direction for the project. The master plans primarily focus on three components: (1) regional and ecosystem needs, (2) project resource capabilities and suitabilities, and (3) expressed public interests and desires. Within this framework, a master plan addresses resources such as fish and wildlife, vegetation, recreation, cultural resources, and water. Corps projects also develop and implement an OMP to achieve the objectives outlined in the MP. OMPs contain a summary of natural resource inventories and evaluations, specific resource goals and objectives, and site specific prescriptions for resource management. Lands cooperatively managed by the USFWS and state natural resources agencies are included in the MP and OMP with significant input and coordination from those agencies during the planning process.

MPs provide the framework for compatible multiple-use forest management, and OMPs provide for the specific management prescriptions that strive for healthy and sustainable forests through techniques like timber stand improvement (TSI), harvest, reforestation, and accepted conservation practices where applicable. These specific prescriptions for forest and woodland management are applied to conserve and/or improve vegetation conditions for wildlife, timber, soils, recreation, water quality and other beneficial uses.

The USFWS has completed Comprehensive Conservation Plans (CCPs) for the National Wildlife and Fish Refuges on the Upper Mississippi River. These CCPs recognize the importance of forest and grassland resources, and guide management efforts by setting visions, goals, and measurable objectives, as well as outlining strategies for reaching those objectives. Strategies include vegetation inventories and active management through the preparation and implementation of step down plans, including Habitat Management Plans (HMPs). The USFWS CCPs and HMPs will be an integral part of the process for implementing UMRS systemic forest management goals and objectives on National Wildlife Refuge System lands addressed through this plan.

The Upper Mississippi River Restoration – Environmental Management Program (UMRR-EMP) is managed by the Corps of Engineers and implemented in cooperation with the USGS, USFWS, U.S. EPA, USDA NRCS and the five UMRS States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The collaborative relationships among these Federal agencies, States, Tribal governments, and other stakeholders developed by the EMP provide a national model for large-scale restoration and monitoring work. The EMP consists of two principal components: (1) the Habitat Rehabilitation Enhancement Project (HREP); and (2) the Long Term Resource Monitoring (LTRM) Program. The HREP component is managed by the Corps in consultation with the USFWS and the natural resource agencies of the five UMRS States. Through HREP, the Corps and its partners rehabilitate aquatic habitats degraded by navigation development and other changes to the river and its basin. The LTRM component is a multipurpose program of monitoring, applied research, and management evaluation designed to achieve the broad goals of developing a better understanding of the ecology of the UMRS and its resource problems, monitoring resource change, developing alternatives to better manage the UMRS, and providing for the proper management of monitoring information.

B. Programmatic Implementation Report (PrIR)

The development of a Forest Management Programmatic Implementation Report (PrIR) or other NEPA compliance document would guide forest restoration projects on the UMRS at the local scale. The PrIR would guide the implementation of ecosystem restoration goals and objectives for forest management outlined in this plan. Program alternatives would be formulated with benefit-cost analyses where feasible. General planning details would be provided for measures that would be similar across different project sites (e.g., site preparation and tree planting recommendations). The development of performance indicators would allow for monitoring and evaluation of the attainment of objectives. A monitoring plan for performance measures would include both a timeline to achieve identified target goals and a timeline for the demonstration of program performance.

The PrIR would enable continuous implementation of site specific measures on Federal lands through the approval and implementation of annual Forest Management projects. The PrIR would be a feasibility level decision document, and its approval and authorization would allow the Forest Management Program to proceed to implementation.

The PrIR would be different from a traditional Project Implementation Report (PIR) in several fundamental ways. First, with respect to time, it would function on a continuous basis rather than expire upon completion of a specific project. Second, regarding restoration sites, it would cover multiple local-scale projects rather than a single project site. Third, the focus would be more on process (e.g., management, measures, priorizitation) than on ground-level restoration/ construction guidelines for individual projects. Finally, the development and authorization of a Forest Management PrIR would dramatically streamline the allocation of both time and resources.

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IX. Appendixes

Appendix A: Definitions and Acronyms

Age-class – A category into which the average age or age range of trees or other vegetation is divided for classification or use. It represents the dominant age of the main body of trees in a stand.

Adaptive Management – An approach to natural resources management that acknowledges the risk and uncertainty of ecosystem restoration and allows for modification of restoration measures to optimize performance. The process of implementing policy decisions as scientifically driven management experiments that test predictions and assumptions in management plans, and using the resulting information to improve the plans. A mechanism for integrating scientific knowledge and experience for the purpose of understanding and managing natural systems.

Backwater – A small, generally shallow body of water attached to the main channel, with little or no current of its own; shallow, slow-moving water associated with a river but outside the river's main channel.

Bathymetry – The measurement of water depth across a water body.

Biodiversity – The variety of living organisms considered at all levels of organization, from genetics through species, to higher taxonomic levels, and including the variety of habitats and ecosystems, as well as the process occurring therein. Biodiversity occurs at four levels; genetic diversity, species richness, ecosystem diversity, and landscape diversity.

Biomass (woody) - The mass of the woody parts (wood, bark, branches, twigs, stumps, and roots) of trees (alive and dead) and shrubs and bushes. Excludes foliage.

Channel Training Structure – A man-made flow obstruction (e.g., wing dam, closing dam or revetment) used to divert river flow to a desired location, usually toward the center of the main channel to increase flow and limit sedimentation or to protect the river bank from eroding.

Co-dominant tree – A tree that extends it crown into the canopy and receives direct sunlight from above but limited sunlight from the sides. One or more sides of a co-dominant tree are crowded by the crowns of dominant trees.

Community – A grouping of populations of different species found living together in a particular environment.

Conservation – Active management to ensure the survival of the maximum diversity of species, and the maintenance of genetic diversity within species; implies the maintenance of ecosystem functions; embraces the concept of long-term sustainability. A careful preservation and protection of something, especially planned management of a natural resource to prevent exploitation, destruction, or neglect.

Corridor – A relatively narrow strip of habitat that crosses an area of non-habitat land and serves to connect larger areas of habitat.

Disturbance regime – The spatial and temporal characteristics of disturbances affecting a particular landscape over a particular time (e.g., fire, flood, drought). Any relatively discrete event in time that disrupts the ecosystem, community or population structure and changes resources or the physical environment.

Dominant trees – Trees with crowns receiving full light from above and partly from the side; usually larger than the average trees or shrubs in the stand, with crowns that extend above the general level of the canopy and that are well developed but possibly crowded on the sides.

Drawdown – Lowering the level of the water in a selected portion of an aquatic system; conducted for habitat management purposes with dams or pumps.

Dredged material – The excavated material from dredging operations.

Dredging – The removal of underwater material (e.g., sediment) from the bottom of a harbor or waterway.

Ecological (or biological) integrity – The ability of an ecosystem to retain its complexity and capacity for sustainability (i.e., its health).

Ecosystem – Dynamic and interrelating complex of plant and animal communities and their associated nonliving environment; a biological community together with the physical and chemical environment with which it interacts.

Ecosystem function – Processes that drive the ecosystem; any performance attribute or rate function at some level of biological organization (e.g., energy flow, sedimentation, detritus processing, nutrient spiraling).

Ecosystem management – Protecting, conserving, or restoring the function, structure, and species composition of an ecosystem, recognizing that all components are interrelated.

Ecosystem (or environmental) restoration – Management actions that attempt to accomplish a return of natural areas or ecosystems to a close approximation of their conditions prior to human disturbance, or to less degraded, more natural conditions.

Ecosystem services – All of the goods and services provided to humanity by natural ecosystems; examples include wood products, fertile soils, genetic variation, clean water, and clean air.

Environmental sustainability – The ability of aquatic, wetland, and terrestrial complexes to maintain themselves as self-regulating, functioning systems.

Floodplain – Lowlands bordering a river that are subject to flooding. Floodplains are composed of sediments carried by rivers and deposited on land during flooding.

Forest ecosystem – A dynamic complex of plant, animal, and micro-organism communities, and their abiotic environment interacting as a functional unit, where the presence of trees is essential.

Forest type – A category of forest defined by its vegetation, particularly composition, and/or locality. The broadest general groups are broad-leaved (hardwoods), coniferous (softwoods), and mixed broad-leaved and coniferous

General Plan Land – Lands that the Corps outgrants to the USFWS through a Cooperative Agreement for fish and wildlife management purposes.

Geographic Information Systems (GIS) – A set of computer hardware and software for analyzing and displaying spatially referenced features, such as points, lines or polygons, with non-geographic attributes, such as species, age, etc., used for mapping and analysis.

Geomorphology – The science that deals with land and submarine relief features (landforms) of the earth's surface; the physical structure of the river floodplain environment.

Habitat – The living place of an organism or community, characterized by its physical or biotic properties; habitats can be described on many scales from microhabitat to ecosystems to biomes.

Habitat fragmentation – The process whereby a larger, continuous area is both reduced in area and divided into two or more pieces. The disruption of extensive habitats into isolated and small patches. Fragmentation has three negative components: loss of total habitat area and smaller, more isolated remaining habitat patches, increased potential for edge effects

Hydrologic – (1) Rise and fall of river crest; (2) Pertaining to the water cycle; through precipitation, runoff, storage and evaporation, and evapotranspiration and quantitatively as to distribution concentration, and quality.

Hydrology – A science dealing with the properties, distribution, and circulation of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere.

Importance Value – The sum of relative density, relative frequency, and relative dominance (scale from 0 - 300). Indicates the overall abundance of a species in an ecological community.

Impoundment – In reference to rivers, the area of water that is captured and held back by a dam.

Indicator – A measurable surrogate for environmental end points, such as biodiversity, that is sensitive to changes in the environment and can warn that environmental changes are taking place.

Invasive species – Any species that has the tendency to invade or enter a new location or niche; an introduced species that outcompetes native species for space and resources; whose introduction does or is likely to cause economic or environmental harm or harm to human health.

Landscape – A heterogeneous land area composed of interacting ecosystems that are repeated in similar form throughout; landscapes are variable in size; usually overlaps governmental jurisdictions, thus requiring collaboration from a broad range of participants.

Landscape ecology – The study of the structure, function, and change in a heterogeneous land area composed on interacting ecosystems.

Lateral connectivity – The connection of a river and its floodplain, allowing access across aquatic and terrestrial habitats by organisms as well as flood waters.

Levee – An embankment constructed to prevent flooding.

Levee district – Cooperative quasi-governmental organizations that protect areas from floodwaters and serve as wildlife refuges.

Life history – An organism's patterns of growth, reproduction, and longevity that are related to specific demands for survival.

Littoral - area of a stream, river, wetland, lake or pond that can support rooted aquatic plant growth.

Longitudinal connectivity – Allows for the upstream and downstream movement and/or migration of aquatic organisms.

Moist soil unit – Areas where water levels are controlled to provide a desired mix of moist soil vegetation.

Pool – The area of water that is impounded and maintained at a higher level behind a navigation dam; generally refers to the entire length of river between sequential dams.

Reach – A continuous stretch or expanse. In reference to rivers, it can be used to define portions of rivers at different scales (i.e., floodplain reach, pool reach, and reach between two river bends).

Resilience – The ability of a system to maintain its structure and patterns of disturbance in the face of disturbance.

Restoration – The objective of ecosystem restoration is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition (ER 1105-2-100). As defined under Section 519, in its broadest usage, restoration encompasses the following concepts: conservation, enhancement, naturalization, preservation, protection, rehabilitation, restoration, and stabilization.

Riparian – Areas that are contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent water bodies (e.g., rivers, streams, lakes, or drainage ways).

Riparian corridor – a corridor of habitat that is directly related to or situated along the banks of rivers or streams; a riparian corridor is in contact with the stream during annual floods.

River stage – The elevation of the water surface, usually above an arbitrary datum.

Sapling – A tree at least 4½ feet tall and up to 5 inches in diameter.

Silviculture – The art and science of controlling the establishment, growth, composition, health, and quality of forests to meet diverse needs and values of landowners and society on a sustainable basis.

Species – One or more populations of individuals that can interbreed, but cannot successfully breed with other organisms.

Species diversity – The richness, abundance, and variability of plant and animal species and communities.

Species richness – A simple count of the number of species in an area.

Succession – Sequential change in the vegetation at a particular location over time.

Sustainable/sustainability – A level and method of resource use that does not destroy the health and integrity of the systems that provide the resource; thus the long-term resource availability does not ever diminish due to such use.

Sustainable forest management – The stewardship and use of forests and forest lands in such a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, and vitality, and their potential to fulfill, now and in the future, relevant ecological, economic, and social functions at local, national, and global levels, and that does not cause damage to other ecosystems.

Threatened and endangered species – Those species that are listed as threatened or endangered under the Federal Endangered Species Act (ESA) of 1973 and those species that are candidates or proposed as candidates for listing under the ESA; listing can occur at the Federal or State level or both.

Upper Mississippi River – Illinois Waterway (UMR-IWW) – The narrow (300- to 500-meter) 1,200 miles of 9- foot navigation channel, 37 lock and dam sites (43 locks), and thousands of channel training structures of the Upper Mississippi River and Illinois Waterway.

Upper Mississippi River System (UMRS) – The entire floodplain area and associated physical, chemical, and biological components of the Upper Mississippi and Illinois Rivers.

Watershed – The geographic area that naturally drains into a given watercourse such as a stream or river.

AEM	Adaptive Ecosystem Management
ANS	Aquatic Nuisance Species
BA	Biological Assessment
BIA	Bureau of Indian Affairs
BMP	Best Management Practices
BO	Biological Opinion
CEMVS	Corps of Engineers, St. Louis District
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
DNR	Department of Natural Resources
DOC	Department of Conservation
DOD	Department of Defense
DOI	Department of the Interior
DOT	Department of Transportation
EA	Environmental Assessment
EEC	Essential Ecosystem Characteristic
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Program
EMPCC	Environmental Management Program Coordinating Committee
EMTC	Environmental Management Technical Center
EO	Executive Order
EPA	Environmental Protection Agency
EPM	Environmental Pool Management
EQ	Environmental Quality
ER	Engineering Regulation
ERDC	Engineering Research and Development Center
ESA	Environmental Site Assessment
FIA	Forest Inventory and Analysis
FONSI	Finding of No Significant Impact
FWCA	Fish and Wildlife Coordination Act
FWIC	Fish and Wildlife Interagency Committee
GIS	Geographic Information Systems
GREAT	Great River Environmental Action Team
HEP	Habitat Evaluation Procedures
HNA	Habitat Needs Assessment
HQUSACE	U.S. Army Corps of Engineers, Headquarters
HU	Habitat Unit

ICA	Incremental Cost Analysis
IDNR	Illinois Department of Natural Resources
ITR	Independent Technical Review
IWR	Institute for Water Resources
IWW	Illinois Waterway
L/D	Lock and Dam
LIDAR	Laser Imaging Detection and Ranging
LMAV	Lower Mississippi Alluvial Valley
LMVJV	Lower Mississippi Valley Joint Venture
LTRM	Long Term Resource Monitoring
MDOC	Missouri Department of Conservation
MDNR	Missouri Department of Natural Resources
MFL	Managed Forest Law
MNDNR	Minnesota Department of Natural Resources
MOA	Memorandum of Agreement
MSL	Mean Sea Level
MVD	Mississippi Valley Division
MVP	St. Paul District
MVR	Rock Island District
MVS	St. Louis District
NAS	National Academy of Sciences
NECC	Navigation Environmental Coordinating Committee
NEPA	National Environmental Policy Act
NESP	Navigation and Ecosystem Sustainability Program
NER	National Ecosystem Restoration
NHPA	National Historic Preservation Act
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NWI	National Wetland Inventory
OASA(CW)	Office of Assistant Secretary of the Army-Civil Works
O&M	Operations and Maintenance
OMRR&R	Operation, Maintenance, Repair, Replacement, and Rehabilitation
P&G	Principles & Guidelines
PA	Programmatic Agreement
PDT	Project Delivery Team
PED	Preliminary Engineering and Design
PEIS	Programmatic Environmental Impact Statement
PCB	Polychlorinated biphenyl
PIR	Project Implementation Report
PMP	Project Management Plan

RC&D	Resource Conservation and Development
RED	Regional Economic Development
RM	River Mile
ROD	Record of Decision
RRCT	River Resources Coordinating Team
SEA	Supplemental Environmental Assessment
SHPO	State Historic Preservation Office
T&E	Threatened and Endangered Species
THPO	Tribal Historic Preservation Office
UMESC	Upper Midwest Environmental Sciences Center
UMR	Upper Mississippi River
UMR-IWW	Upper Mississippi River-Illinois Waterway System
UMRBA	Upper Mississippi River Basin Association
UMRCC	Upper Mississippi River Conservation Committee
UMRR-EMP	Upper Mississippi River Restoration – Environmental Management Program
UMRS	Upper Mississippi River System
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USDA	U.S. Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WMA	Wildlife Management Area
WRDA	Water Resources Development Act

Appendix B. Scientific and Common Names of Plant Species

Scientific Name	Common Name
Aster spp.	aster
Acer negundo	boxelder
Acer rubrum	red maple
Acer saccharinum	silver maple
Acer saccharum	sugar maple
Ambrosia trifida	great ragweed
Asimina triloba	pawpaw
Betula nigra	river birch
Boehmeria cylindrica	false-nettle
Carya alba	mockernut hickory
Carya cordiformis	bitternut hickory
Carya glabra	pignut hickory
Carya illinoinensis	pecan
Carya laciniosa	shellbark hickory
Carya ovata	shagbark hickory
Campis radicans	trumpet creeper
Carex spp.	sedge
Cercis canadensis	eastern redbud
Celtis laevigata	sugarberry
Celtis occidentalis	hackberry
Cephalanthus occidentalis	buttonbush
Cornus drummondii	rough leafed dogwood
Crataegus spp.	hawthorn
Diospyros virginiana	persimmon
Elymus virginiana	Virginia wildrye
Forestiera acuminata	eastern swampprivet
Fraxinus americana	white ash
Fraxinus pennsylvanica	green ash
Gleditsia aquatica	water locust
Gleditsia triacanthos	honeylocust
Gymnocladus dioicus	Kentucky coffeetree
Humulus japonicus	Japanese hops
Ilex decidua	deciduous holly
Impatiens capenis	jewelweed
Juglans nigra	black walnut
Laportea canadensis	Canadian woodnettle
Leersia oryzoides	rice cutgrass
Leersia virginica	whitegrass
Lindera benzoin	northern spicebush
Liquidambar styraciflua	sweetgum

Liriodendron tulipifera	tuliptree
Lonicera japonica	Japanese honeysuckle
Morus alba	white mulberry
Morus rubra	red mulberry
Nyssa sylvatica	blackgum
Parthenocissus quinquefolia	Virginia creeper
Phalaris arundinacea	reed canarygrass
Pilea pumila	Canadian clearweed
Plantanus occidentalis	American sycamore
Populus deltoides	cottonwood
Quercus alba	white oak
Quercus bicolor	swamp white oak
Quercus imbricaria	shingle oak
Quercus lyrata	overcup oak
Quercus macrocarpa	bur oak
Quercus michauxii	swamp chestnut oak
Quercus palustris	pin oak
Quercus pagoda	cherrybark oak
Quercus rubra	northern red oak
Quercus shumardii	Shumard's oak
Quercus velutina	black oak
Rosa multiflora	multiflora rose
Robinia pseudoacacia	black locust
Rubus spp.	blackberry
Sassafras albidum	sassafras
Saurunus cernuus	lizard's tail
Sambucus spp.	elderberry
Salix nigra	black willow
Secale cereale	cereal rye
Sicyos angulatus	oneseed bur cucumber
Smilax spp.	greenbrier
Solidago spp.	goldenrod
Toxicodendron radicans ssp. radicans	eastern poison ivy
Ulmus americana	American elm
Ulmus rubra	slippery elm
Urtica dioica	stinging nettle
Vitis spp.	grape

Appendix C: Legal, Policy, and Administrative Guidelines

1. NESP and Prior Forest and Ecosystem Management Authorities

Development of this Forest Stewardship Plan largely followed from recognition of the need for a framework of coordinated management at a system level to ensure long-term sustainability of the terrestrial communities of the UMRS floodplain. The original authority for the plan came from the Navigation and Ecosystem Sustainability Program (NESP), authorized in turn by the Water Resources Development Act of 2007 (H.R. 1495).

> *… the Secretary shall undertake navigation improvements and restoration of the ecosystem for the Upper Mississippi River and Illinois Waterway System… (H.R. 1495, Section 8002)*

NESP is a long-term program combining navigation improvements and ecological restoration for the UMRS over a 50-year period that will be implemented in increments through integrated, adaptive management. The Systemic Forest Stewardship Plan is one of 23 initial ecosystem restoration component projects potentially implemented under NESP. NESP is currently authorized, but it is unclear if it will be funded at this time, and the included references to future program capabilities are contingent on that funding. However, implementation of the plan is not solely contingent upon NESP, and other operational programs are also detailed below. Regardless, the plan is intended to establish a foundation for the Corps, partner agencies and stakeholders to more effectively collaborate on and implement environmental stewardship activities within UMRS forests.

The following assumptions and constraints were considered in this process:

- The 9-foot channel navigation project will continue to be operated and maintained throughout the UMRS and implementation of the Systemic Forest Stewardship Plan will not negatively affect navigation.
- Federal flood reduction projects will continue to be operated and maintained by the Corps and non-Federal sponsors.
- Partner, stakeholder and public involvement is critical for program and project success.
- Implementation is dependent on receiving adequate funding.
- If lands are acquired from willing sellers by the Corps or partner agency through the floodplain restoration project of NESP or other authorities, these floodplain areas will be evaluated for forest restoration in the context of this plan.
- The private land conservation programs of other agencies (e.g., USDA NRCS) will be continued, remain viable, and are an integral part of the plan.
- No single agency has sole management authority over the UMRS. Success of the plan is dependent upon collaboration among the various landowners, partners and stakeholders.
- There will continue to be other valuable land uses (e.g., agricultural, commercial, recreation) within the UMRS.
- Sediment and nutrient loading from upland sources will continue.
- Monitoring and adaptive management will be critical components of the plan.

- Assessment of environmental impacts will occur in later phases of planning and habitat project design.

The program presumptions contained in this plan are based on current NESP authorization, in material contained in the UMR-IWW System Navigation Feasibility Study Final Integrated Feasibility Report (USACE 2004), and in the authorities of the Upper Mississippi River Restoration – Environmental Management Program (EMP). One of the benefits of these programs is that the area in which the Corps is authorized to conduct direct and partner cost-share ecosystem restoration projects is not restricted to fee title lands associated with the 9-foot Navigation Project but includes all lands within the 500 year floodplain of the UMRS. The Illinois River Basin Restoration Program (Section 519 of WRDA 2000) has similar authority on the Illinois Waterway (IWW) but also includes all lands within the Illinois River watershed. Another significant emphasis in the WRDA 2007 authorization is the inclusion of language focused on ecosystem management attributes. This emphasis on ecosystem restoration authorization in WRDA 2007 is a critical component of NESP and EMP:

> *To ensure the environmental sustainability of the existing Upper Mississippi River and Illinois Waterway System, the Secretary shall modify, consistent with requirements to avoid adverse effects on navigation, the operation of the Upper Mississippi River and Illinois Waterway System to address the cumulative environmental impacts of operation of the system and improve the ecological integrity of the Upper Mississippi River and Illinois River. (H.R. 1495, Section 8004)*
>
> (and)
>
> *The Secretary shall carry out, consistent with requirements to avoid adverse effects on navigation, ecosystem restoration projects to attain and maintain the sustainability of the ecosystem of the Upper Mississippi River and Illinois River… (H.R. 1495, Section 8004)*

The primary legal authority informing Corps forest management on the Mississippi River for the past 51 years has been the Forest Cover Act. On September 6, 1960, Congress addressed the issue of forest management on Corps projects nationwide. Public Law 86-717 (16 USC 580m-n; 74 Stat. 817) spoke to the Corps' overall stewardship responsibility for forest resources on project lands. The Act states that,

> *...reservoir areas of projects for flood control, navigation... shall be developed and maintained so as to encourage, promote, and assure fully adequate and dependable future resources of readily available timber, through sustained yield programs, reforestation, and acceptable conservation practices, and to increase the value of such areas for conservation, recreation, and other beneficial uses: provided, that such development and management shall be accomplished to the extent practicable and compatible with other uses of the project. (16 USC 580m)*

For the General Plan lands along the Upper Mississippi River, the 9 foot Navigation Project and the National Wildlife Refuge System are both "other" designated uses in this context. Regarding vegetative cover, including forest, the Corps is to pursue:

> *... the establishment and maintenance of other conservation measures... to yield the maximum benefit and otherwise improve such areas. Programs and policies developed pursuant to the preceding sentence shall be coordinated with the Secretary of [Interior], and with appropriate State conservation agencies. (16 USC 580n)*

The following excerpt is from Engineering Regulation (ER) 1130-2-540 (USACE 1996). Under this authority the Corps currently manages forest resources within the UMRS on Corps fee title lands purchased under the authority of the 9-foot Navigation Channel Project under the multiple-use paradigm:

> *The Army Corps of Engineers is the steward of the lands and waters at Corps water resources projects. Its Natural Resources Management Mission is to manage and conserve those natural resources, consistent with ecosystem management principles, while providing quality public outdoor recreation experiences to serve the needs of present and future generations. In all aspects of natural and cultural resources management, the Corps promotes awareness of environmental values and adheres to sound environmental stewardship, protection, compliance and restoration practices. The Corps manages for long-term public access to, and use of, the natural resources in cooperation with other Federal, State, and local agencies as well as the private sector. The Corps integrates the management of diverse natural resource components such as fish, wildlife, forests, wetlands, grasslands, soil, air, and water with the provision of public recreation opportunities. The Corps conserves natural resources and provides public recreation opportunities that contribute to the quality of American life.*

EP 1130-2-540 further directs the Corps of Engineers operations element to prepare an Operational Management Plan (OMP) for natural resources management consistent with an approved Master Plan. The natural resources management component is based on a total ecosystem or compartment approach, and includes compartment descriptions, management objectives, and implementation plans.

Particularly during the past 20 years, during which Upper Mississippi River Districts have increased the level of forest management on the UMRS, the Corps has been committed to working with the USFWS, and States, on GP land activities in support of the goals of National Wildlife Refuges in the project area for wildlife management. Any economic value resulting from managed harvest has remained a secondary outcome realized from an active conservation-oriented program. Regularly scheduled coordination meetings among the Corps, USFWS and States have been effective in assuring that the activities of the forest management program are compatible with refuge wildlife goals and objectives. The Corps has also provided technical support to partner agencies involved in complimentary management actions on their own lands.

Forest restoration projects and measures would likely be modified and refined based on information gained through performance evaluations and the adaptive implementation feedback process. An updated feasibility report will be prepared using knowledge gained from the initial increment and will make recommendations for any necessary modifications to future increments of this ecosystem restoration authorization.

2. Partnerships

The Corps realizes that one agency cannot accomplish all the goals and objectives for an ambitious ecosystem restoration and sustainability program covering 2.6 million acres. The Corps therefore recognizes the importance of not only continuing to work with existing partners, but to establishing new partnerships as well. Cooperative agreements already exist for some partners, while others will need to be created, particularly where shared costs are involved.

Collaboration – Maintaining existing partnerships and establishing new ones is essential for the implementation of this Forest Stewardship Plan. Multiple Federal, State, Tribal and private organizations are currently involved in managing natural resources within the UMRS. This plan was developed with input from a multitude of agencies and organizations, which will facilitate future coordination on implementation strategies.

The value of partnerships goes beyond having all involved striving for common goals or sharing costs. Division of tasks can make the most of each organization's skills and talents. Private organizations, or nongovernmental organizations (NGOs), are often less encumbered by processes that may inhibit quick actions by governmental agencies. Likewise, actions that are difficult to perform by one agency may be relatively easy for another. By working together and dividing duties for a project, partners can more efficiently achieve mutual goals and objectives.

The following is a list of agencies/organizations known to be active within the UMRS. The Corps has formed direct partnerships with the majority of those listed. This list is not all-inclusive and new partnerships will be formed as opportunities arise.

a. Federal Agencies

- U.S. Army Corps of Engineers (Corps)
- U.S. Fish and Wildlife Service (USFWS)
- National Park Service (NPS)
- Natural Resources Conservation Service (NRCS)
- U.S. Forest Service (FS)
- U.S. Geological Service (USGS)
- Bureau of Indian Affairs (BIA)
- Environmental Protection Agency (EPA)

b. State Agencies

- Wisconsin Department of Natural Resources
- Minnesota Department of Natural Resources
- Iowa Department of Natural Resources
- Illinois Department of Natural Resources
- Missouri Department of Conservation
- Missouri Department of Natural Resources

A noteworthy State partnership is the Illinois Rivers 2020 initiative. The Illinois River basin has experienced a loss of ecological integrity due to sedimentation of backwaters and side channels, degradation of tributary streams, increased water level fluctuations, reduction of floodplain and tributary connectivity, and other adverse impacts caused by human activities. In 2000, the Illinois governor set the vision for Illinois Rivers 2020, a proposed $2.5 billion, 20-year State and Federal restoration program to restore the Illinois River basin. The program is a cooperative effort among the Corps of Engineers, the Illinois River Coordinating Council, the Illinois Department of Natural Resources, the Illinois Department of Agriculture, and the Environmental Protection Agency. This structure provides an excellent opportunity for focused input into activities and priorities.

c. Non-Governmental and Quasi-Governmental Organizations

There are a large number of non-governmental and quasi-governmental organizations that have natural resource objectives and/or conservation operations in the plan's project area. The degree that each of these organizations has the potential to be involved in the strategies outlined in this plan varies considerably. Some may only wish to review and comment on this or subsequent "step-down" plans, while other may become specific project sponsors and cost share partners. Groups also vary in the scope of their interests. Some are national organizations that have an involvement in the entire UMRS, while others are organized around more local issues. This provides the Corps the opportunity of working with organizations within the project area at multiple scales. Although some cooperative agreements exist to work with larger organizations for system-wide interests, specific projects are administered at the District level where the project site is located. Cooperative agreements could be generated at any level necessary to ensure that both Corps and partner interests are defined and protected and so that the overlap of missions can create actionable opportunities.

Examples of groups in this category are land trust organizations, whose missions include acquisition and management of land for the purpose of habitat conservation; conservation organizations such as Ducks Unlimited and the Wild Turkey Federation, who often sponsor habitat projects; local conservation or sportsmen clubs, who often sponsor habitat projects and the volunteer labor to accomplish them; and quasi-governmental organizations, such as the Resource Conservation and Development Program (RC&D), which helps people protect and develop their economic, natural, and social resources. This program is administered by the Natural Resources Conservation Service (NRCS).

Another noteworthy example of an NGO actively working within the UMRS in a variety of capacities is The Nature Conservancy (TNC). TNC, with the support of donors, recently established the Great Rivers Partnership in support of conservation efforts targeting three of the world's largest river systems: the Mississippi, the Par-Paraguay-Parana in Brazil, and the Yangtze in China. In addition, the TNC's dedicated Upper Mississippi River Program works directly with a number of priority conservation and restoration sites throughout the UMRS, including the Illinois River.

d. Private Partners

The vast majority of land within the 500-year floodplain of the UMRS is in private ownership. Each landowner is a potential partner in meeting the objectives of this plan. Many resources can be made available to landowners who are voluntarily managing their lands in a manner that would contribute to systemic forest management goals. For example, the USFWS can partner on private land projects and NRCS can restore habitat working with landowners on conservation easement areas. Corporate landowners usually have a specific focus, such as timber production. However, there are often common goals that overlap, such as disease and invasive species control in bottomland forests.

Although most activities outlined in this forest stewardship plan are focused on public lands within the UMRS as defined above, it is widely recognized that additional conservation treatment of uplands could dramatically reduce both nutrient and sediment loads entering the river system. Many landowners in the UMRS floodplain and larger basin independently maintain effective conservation practices on their private forest lands. Many other have enrolled in State programs such as Wisconsin's Managed Forest Law (MFL), or the Illinois Forestry Development Act (IFDA), which can result in tax benefits to the landowner. Typically these programs require that a forest management plan must be written for the parcel. The plans are based on sustainable forest management practices, primarily focusing on timber production, and a State forester must approve them. The expectation is that the land is managed to meet that objective, with other objectives secondary, such as wildlife enhancement or recreation.

These State land management programs could be a valuable tool in meeting the objectives of the UMRS Forest Stewardship Plan. By partnering with State foresters/landowners, it is possible that forest management plans developed by private landowners might better address UMRS forest management goals in the context of a larger system, rather than solely on a parcel by parcel basis. In addition, many States have published Forestry Best Management Practices (e.g., IDNR 2000), which are often primarily targeted toward private landowners and provide guidelines for implementing forestry practices directly applicable to sustainable floodplain and riparian forest management (IDNR 2000).

In addition to the types of State programs mentioned above, several Federal partner agencies have the authority to provide direct assistance to private landowners in the UMRS. One example is the NRCS, which implements the Wetlands Reserve Program (WRP), among other conservation programs that provide an incentive-based mechanism for private landowners to maintain or restore lands to natural conditions. Another is the Northeastern Area State and Private Forestry branch of the U.S. Forest Service, which provides a number of outreach programs and administers the Upper Mississippi River Forest Partnership.

e. Existing Multiple Stakeholder Partnerships

A number of partnerships involving stakeholders across multiple agencies, organizations and spatial scales have been active within the UMRS for many years. The following examples are not meant to be all-inclusive but do provide a brief overview of the scopes and objectives of the many additional types of partnerships currently working within the UMRS. Representatives of the Corps actively participate with many of them on a regular basis. Also included are a couple of examples from the Lower Mississippi Alluvial Valley (LMAV), which represent opportunities to broaden the range of interaction across an even greater range of experience and expertise throughout the entire Mississippi River system.

The Upper Mississippi River Restoration – Environmental Management Program (UMRR-EMP) – The UMRR-EMP was established by Section 1103 of the Water Resources Development Act of 1986. The UMRR-EMP is managed by the Corps of Engineers and implemented in cooperation with the USGS, USFWS, USEPA, USDA NRCS, and the five UMRS States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The collaborative relationships among these Federal agencies, States, and other stakeholders developed by the UMRR-EMP provide a national model for large-scale restoration and monitoring work. The program area includes the bluff to bluff floodplain ecosystem on the Upper Mississippi River from Minneapolis, to Cairo; the Illinois Waterway from Chicago to Grafton; and navigable portions of the following rivers: Minnesota (15 miles), St Croix (24 miles), Black (1 mile), and Kaskaskia (36 miles), encompassing a total area of 2.6 million acres.

The UMRR-EMP consists of two principal components: (1) the Habitat Rehabilitation Enhancement Project (HREP); and (2) the Long Term Resource Monitoring (LTRM) component. The HREP component is managed by the Corps in consultation with the USFWS and the natural resource agencies of the five UMRS States. Through HREP, the Corps and its partners rehabilitate aquatic habitats degraded by navigation development and other changes to the river and its basin. The LTRM component is a multipurpose program of monitoring, applied research, and management evaluation designed to achieve the following broad goals (USGS 1997):

(1) Develop a better understanding of the ecology of the UMRS and its resource problems
(2) Monitor resource change
(3) Develop alternatives to better manage the UMRS
(4) Provide for the proper management of monitoring information.

The LTRM component is implemented by the USGS Upper Midwest Environmental Sciences Center (UMESC) and six field stations (Lake City, MN, Pool 4; La Crosse, WI, Pool 8; Bellevue, IA, Pool 13; Alton, IL, Pool 26; Havana, IL, La Grange Pool and Cape Girardeau, MO, Open River) operated by staff from the UMRS states. Overall program responsibility rests with the U.S. Army Corps of Engineers. The program supports a variety of monitoring, data serving, and research efforts. Monitoring data, results of various analyses and focused studies, and management tools and models developed under LTRM are publicly available on the internet (www.umesc.usgs.gov/ltrmp.html). For example, the LTRM component recently released an updated Status and Trends report on the ecological condition of the Upper Mississippi and Illinois Rivers (Johnson and Hagerty 2008).

The data and information generated by LTRM have been used in designing habitat rehabilitation projects and in developing various ecosystem restoration plans, including the Upper Mississippi River and Illinois Waterway Navigation Study and the Illinois River Basin Restoration Comprehensive Plan. The monitoring components of LTRM are not designed to evaluate individual projects but to assess changes over time in response to larger scale influences such as natural fluctuations and cycles, multiple rehabilitation projects, or modifications to the watershed, as these effects become evident at the scale of a pool or river reach.

The core monitoring effort for LTRM currently samples three primary ecological components; fisheries, water quality, and aquatic vegetation, from six 30- to 60-mile river sections that embody the wide range of environmental gradients within the UMRS. Sampling of the fourth component, aquatic macroinvertebrates, has been suspended. Data on land cover, hydrology, and bathymetry are also collected, permitting the development of landscape indicators for comparison with biological and chemical indicators. LTRM is currently collecting LIDAR for the entire UMRS floodplain ecosystem, as well as systemic bathymetry and land cover data.

Upper Mississippi River Basin Association (UMRBA) – The Upper Mississippi River Basin Association (UMRBA) is a regional interstate organization formed by the governors of Illinois, Iowa, Minnesota, Missouri, and Wisconsin to coordinate the States' river-related programs and policies and work with Federal agencies that have river responsibilities. UMRBA is involved with programs related to ecosystem restoration, hazardous spills, and water quality, as well as floodplain management and flood control, commercial navigation, and water supply. Through its ecosystem restoration program, UMRBA is engaged in interagency efforts to restore and protect fish and wildlife habitat on the UMRS. UMRBA works closely with member States, Federal agencies, and others in planning, implementing, and managing these programs. (www.umrba.org)

The Illinois River Basin Restoration Program – The Illinois River Basin Restoration Program, authorized by Section 519 of WRDA 2000 seeks to restore and maintain ecological integrity, including habitats, communities, and populations of native species, and the processes that sustain them. The program also strives to develop, evaluate, and implement a collaborative and sustainable watershed-based approach to ecosystem restoration in the Illinois River basin. While a number of existing programs within the Corps and other Federal agencies are designed to plan and implement ecosystem restoration or environmental quality improvements at specific locations in the basin, no program was in place that allowed for watershed-wide comprehensive planning, evaluation, problem identification, and project selection within one authority. Existing programs are often limited in geographic extent or by available resources. The Illinois River Basin Restoration program meets that need by allowing for a comprehensive and collaborative watershed-based approach to solving the basin's problems and maximizing opportunities.

The Upper Mississippi River Conservation Committee (UMRCC) – The UMRCC was formed in 1943 to promote the preservation and wise use of the natural and recreational resources of the Upper Mississippi River and to formulate policies, plans and programs for cooperative studies. Its executive board includes voting members from each of the five Upper Mississippi River States (Minnesota, Wisconsin, Iowa, Illinois and Missouri). Nonvoting members include the five technical committee chairmen, an observer from the Upper Mississippi River National Wildlife and Fish Refuge, and the UMRCC Coordinator. Additional representatives from the EPA, Corps, USGS, and numerous other organizations are active participants within the UMRCC in various capacities. (www.mississippi-river.com/umrcc/)

The Middle Mississippi River Partnership (MMRP) – The MMRP is a collaboration of 20 Federal and State agencies and not-for-profit organizations that share a common goal of restoring and enhancing the natural resources of the Mississippi River corridor from its confluence with the Missouri River at St. Louis to its confluence with the Ohio River at Cairo. The partnership seeks to accomplish its goals and objectives through a combination of public and private resource management, compatible economic development, private lands conservation, and education and outreach to the citizens of the region. The MMRP developed a Regional Coordination Plan in 2005 and more recently released a report identifying ecosystem restoration options for the Middle Mississippi River Regional Corridor (MMRRC) using hydrogeomorphic (HGM) analyses (Heitmeyer 2008). (www.swircd.org/mmrp/index.htm)

Upper Mississippi Forest Partnership (UMFP) – A notable opportunity for collaboration is the Upper Mississippi Forest Partnership, which was formed in 2004 by State foresters from six states (Wisconsin, Minnesota, Iowa, Illinois, Missouri, and Indiana) and a forester from the USDA Forest Service Northeastern Area (St. Paul). The resulting action plan seeks to strengthen coordination among the Upper Mississippi River basin State forestry agencies, link State foresters directly to other agencies and groups working on common basin issues, develop and implement assessments and demonstration projects, and conduct educational efforts that will help address key watershed issues. (www.na.fs.fed.us/watershed/upper_mississippi_partnership/)

The Illinois River Coordinating Council (IRCC) – The IRCC was created by the Illinois River Restoration Act of 1997 (20 ILCS 3967) and is chaired by the Illinois lieutenant governor. Among its responsibilities are the coordination of policy and initiatives within the Illinois River watershed for the preservation and restoration of the watershed, including a focus on the inter-related issues of economics, flooding, recreation, and tourism. Members include representatives from various State and Federal agencies and not-for-profit organizations working within the Illinois River watershed, appointed by the governor of Illinois. (www.standingupforillinois.org/cleanwater/ircc.php)

The Lower Mississippi Valley Joint Venture (LMVJV) – The Lower Mississippi Valley (LMV) Joint Venture is a self-directed, non-regulatory private, State, and Federal conservation partnership that exists for the purpose of implementing the goals and objectives of national and international bird conservation plans within the Lower Mississippi Valley region. The LMVJV Forest Conservation Working Group actively focuses on issues such as defining desired future conditions for the Mississippi Alluvial Valley (MAV); developing coordinated forest inventory and monitoring protocols; developing web-based conservation planning, restoration, inventory and monitoring applications; and evaluating the effects of forest management on bird communities. (www.lmvjv.org/index.htm)

The Lower Mississippi River Conservation Committee (LMRCC) – The LMRCC is in many respects the Lower Mississippi River equivalent of the UMRCC. It is a cooperative, nonprofit organization of State and Federal agencies formed to address the challenges of renewing and effectively managing the natural resources of the Lower Mississippi River. Its mission is to promote the wise use of the natural resources of the Lower Mississippi River through cooperative efforts involving planning, management, information sharing, public education, advocacy and research. Its members include representatives of the six Lower Mississippi River states (Missouri, Kentucky, Tennessee, Arkansas, Mississippi and Louisiana), and additional cooperating Federal agencies including the USFWS, USGS, Corps of Engineers, U.S. EPA, and NRCS. (www.lmrcc.org/index.htm)

f. Cooperative Ecosystem Studies Units (CESU)

The Great Rivers CESU is part of a network of cooperative ecosystem studies units focusing on high-quality science, usable knowledge for resource managers, responsive technical assistance, continuing education, and cost-effective research programs. The Great Rivers CESU is a cooperative effort of 17 institutions (including universities and NGOs) and 7 Federal agencies, focused on the geographic area of the upper and middle Mississippi Valley. The mission of the Great Rivers CESU is to partner with Federal agencies in an effort to better understand and adaptively manage biophysical, cultural, economic and social resources and issues, especially those pertaining to large river ecosystems. (http://greatrivers-cesu.missouri.edu/)

3. Institutional Framework for Projects Off of Federally Owned Lands

Funding Arrangements – NESP funding arrangements for site specific forest and grassland management and restoration activities are dependent on land ownership. For fee-title lands owned by the Federal Government within the UMRS project area, the arrangement is 100 percent Federal funding. A cost share arrangement of 65 percent Federal and 35 percent non-Federal applies on land that lies within the UMRS project area, but is non-Federal in ownership. This authorization follows directly from WRDA 2007 (H.R. 1495, Section 8004). A non-Federal partner and landowner cooperation would be required to implement projects on non-Federal lands, and a Federal interest must be shown to justify expenditure for any project. Proposed management actions on any project off of Federal lands would follow traditional Corps planning guidance to determining a Federal interest and benefit with regard project cost share funding.

The rationale behind the recommendation of 100 percent Federal funding on such a large scale follows from three primary factors. The first is the extensive amount of Federal resources within the waterway, including almost 285,000 acres of National Wildlife and Fish Refuges. More than 40 percent of North America's migratory waterfowl and shorebirds depend on the food resources and other life requisites that the system provides. Furthermore, the health of the project area upon the system as a whole extends system-wide, benefitting not only the five UMRS States, but also the five lower Mississippi Valley States, the Gulf of Mexico, and multiple tributaries within the entire Mississippi River system. Therefore, the benefits accrue to the nation and not just any individual State or region. The second factor is the large impact that the operation of the 9-foot navigation project has had on the environmental conditions of the river system. There is a convincing body of research and documentation related to the direct and indirect effects of creating, operating and maintaining the navigation system. Congress has declared the UMR-IWW to be nationally significant both as a navigation system and as an ecosystem. Therefore it is appropriate that the majority of the costs of sustaining the ecosystem as well as the navigation system be borne by the nation. The third reason is that the interstate nature of the navigation system would significantly and unreasonably complicate resultant cost sharing arrangements.

Appendix D: Relationship to other Plans

A number of existing planning and management documents are in place that are relevant to this systemic forest stewardship plan. Brief explanations of these and other key technical reports are provided below.

1. Upper Mississippi River-Illinois Waterway System Navigation Feasibility Study

The Upper Mississippi River-Illinois Waterway System Navigation Feasibility Study, Final Integrated Feasibility Report and Programmatic Environmental Impact Statement (USACE 2004) is a long-term planning document that forms the foundation of the Navigation and Ecosystem Sustainability Program. The goal of the feasibility study was to outline an integrated plan to ensure the economic and environmental sustainability of the UMR-IWW Navigation System to ensure it continues to be a nationally treasured ecological resource as well as an efficient national transportation system. Ultimately, the result was an integrated plan that was approved as a framework for modifications and operational changes to the Upper Mississippi River and Illinois Waterway System to provide for navigation efficiency and environmental sustainability and to add ecosystem restoration as an authorized project purpose. Also included was a long-term ecosystem restoration plan to be accomplished in cooperation with the USFWS, the five States, and private non-profit groups to improve the natural resources of the river through projects for habitat creation, water level management, fish passage, and floodplain restoration.

2. The Upper Mississippi River Restoration - Environmental Management Program (EMP)

The Upper Mississippi River Restoration – Environmental Management Program (UMRR-EMP) is authorized by the Water Resources Development Act (WRDA) of 1986 and managed by the Corps of Engineers. The collaborative relationship among the multiple Federal agencies, States, and other stakeholders involved in the implementation of the UMRR-EMP provides a national model for large-scale restoration and monitoring work. The EMP currently consists of two principal components: (1) Habitat Rehabilitation Enhancement Projects (HREP), and (2) the Long Term Resource Monitoring Program (LTRMP). HREPs are effectively preserving and improving fish and wildlife habitat on the UMRS, as well as providing new information regarding river ecology and physical processes. The HREP program has fostered interdisciplinary and collaborative planning for habitat restoration, preservation, and enhancement. The LTRMP provides resource managers and decision-makers with information necessary to maintain the UMRS as a sustainable multiple-use large river ecosystem. The long term goals of the LTRMP were established through extensive Federal and State agency participation, and include developing a better understanding of the ecology of the UMRS and its resource problems; monitoring resource change; developing alternatives to better manage the UMRS; and providing for the proper management of LTRMP information. The 2004 Report to Congress contains additional information about the accomplishments of the EMP (USACE 2004b).

3. Corps of Engineers Master Plans and Operational Management Plans.

It is the policy of the Corps of Engineers that Master Plans (MPs) and Operational Management Plans (OMPs) be developed and implemented for each Corps civil works project, and they are intended to work in tandem. The master plans cover a single project or several projects, depending on what is best for the management of the resources involved. Their primary focus is on three components: (1) regional and ecosystem needs, (2) project resource capabilities and suitabilities, and (3) expressed public interests and desires. Within this framework, a master plan addresses all resources, including but not limited to fish and wildlife, vegetation, cultural, aesthetic, interpretive, recreational, mineral, commercial, out-granted lands, easements, and water.

Based on an approved MP, projects develop and implement an OMP to achieve the objectives outlined in the MP. OMPs contain a summary of natural resources inventories and evaluations, the inventory methodologies used, resource objectives, and site specific prescriptions for the management of the resources.

Forest and Woodland Management – MPs provide for multiple-use forest management wherever practicable and compatible with other uses of project land. Where applicable, OMPs provide for the continued production and harvest of forest products through sustained yield programs, reforestation, and accepted conservation practices. OMPs also can provide site specific prescriptions for forest and woodland management. Forest and woodland management is to be applied to develop, maintain, protect, and/or improve vegetation conditions for timber, fish, wildlife, soils, recreation, water quality and other beneficial uses.

Grassland Management – The Corps provides for the protection and development of vegetative cover other than forests and woodlands as well as the establishment of conservation measures for its maintenance. Grassland management techniques are to be applied whenever the opportunity exists to protect native grasslands or prairie and/or improve vegetative conditions as a soil conservation, watershed protection, fish and wildlife habitat, or range management practice. The range and grassland management program must comply with the resource objectives and/or land use classifications stated in the MP and OMP. Where applicable, the OMP provides site specific prescriptions for range and grassland management.

MPs and OMPs for the St. Paul, Rock Island and St. Louis District portions of the Upper Mississippi River have been completed. In close collaboration with partners, Corps staff regularly develop, budget for and implement site specific forest and grassland management prescriptions on Corps fee title lands through the OMP 5-year planning process. This process will be maintained under NESP program authority and will serve as one of the primary vehicles for implementing systemic forest stewardship goals and objectives.

4. LTRM Strategic and Operational Plan – FY 2010-2014

The 2010-2014 Strategic and Operational Plan for UMRR-EMP LTRM builds upon previous experience and knowledge to focus the LTRM component and maximize benefits of the public investment. For example, full implementation of the plan will result in systemic coverage of the

2.7 million acres of the UMRS floodplain with high resolution topographic, bathymetric, and land cover data. These data can be combined with other data sets to help develop more effective models that improve our scientific understanding of processes that drive habitat patterns and ecological responses. This knowledge will increase the effectiveness of large river restoration efforts and greatly reduce costs for project planning and design. During 2010-2014, LTRM will maintain the commitment expressed in the 2005-2009 plan to a complete program, including monitoring, analysis, research, communication, and management and serving of data and products. In addition, the plan also addresses important new information needs resulting from data gaps that have been identified as understanding of the river ecosystem improves. For example, floodplain forest monitoring was identified as one of the priority additional components over the plan's 5-year time frame.

5. U.S. Fish and Wildlife Service Comprehensive Conservation Plans.

The USFWS has completed Comprehensive Conservation Plans (CCPs) for the Upper Mississippi River National Wildlife and Fish Refuge, Trempealeau National Wildlife Refuge, and the Mark Twain National Wildlife Refuge Complex. These CCPs guide management for 15 years, help the Refuges meet their original purpose, and contribute to the mission of the National Wildlife Refuge System. The CCPs set visions, goals, measurable objectives, and outline strategies for reaching the objectives.

Floodplain Forest and Grassland Habitat – The CCPs recognize the importance of forest and grassland resources and include goals and objectives for maintaining these habitats across wide stretches of the floodplain. Strategies include vegetation inventories and active management through the preparation and implementation of habitat management step-down plans.

The CCPs and associated step-down plans will be an integral part of the process for implementing systemic forest stewardship goals and objectives on National Wildlife Refuge System lands addressed through this plan.

6. Upper Mississippi River System Ecosystem Restoration Objectives 2009

The Upper Mississippi River System – Ecosystem Restoration Objectives 2009 report is the final product of a planning process initiated in 2008 for the purpose of identifying areas for new restoration projects and identifying knowledge gaps at a system scale. The Report is intended to serve as a technical basis for investment decisions through 2013, and as a backdrop for the formulation of specific restoration projects and their adaptive ecosystem management (AEM) components.

Reach Planning teams were established in the four major UMRS floodplain reaches to refine ecosystem restoration objectives and to develop Reach Plans for ecosystem restoration for the first NESP 4-year planning cycle. The reach planning process leads to the identification of high priority areas for restoration of natural river processes, and provides context for formulating project features, defining performance measures, and designing monitoring plans. Additional cycles of reach planning will be completed every 4 years as part of the AEM process. Lessons learned from each planning cycle will be incorporated into the following cycle.

7. Environmental Pool and Reach Plans.

Environmental Pool Plans were prepared by the St. Paul District's Fish and Wildlife Work Group and the Rock Island District's Fish and Wildlife Interagency Group. Environmental Pool and Reach Plans are currently being drafted by the St. Louis District's River Resource Action Team. These plans identify desired future habitat conditions for which resource agencies and other river interests can strive in the Mississippi River Pools 1 through 26 and the 200-mile unimpounded reach of the Middle Mississippi River. These plans identify management needs and opportunities for each pool or reach, including forest and grassland habitats.

8. Habitat Needs Assessment.

As part of the reauthorization of the UMRR-EMP in 1999, a Habitat Needs Assessment (HNA) was developed in 2000. This report was an effort to document broad habitat protection and restoration needs to assist in planning future UMRR-EMP habitat projects. The HNA begins to identify long-term system-wide habitat needs at the system, reach, and pool scales. It also serves to focus future monitoring and research activities under the UMRR-EMP. This report identifies broad restoration objectives by reach, and addresses prairie and forest habitats.

9. Illinois River Basin Restoration Comprehensive Plan

The Illinois River Basin Restoration Comprehensive Plan assesses the total basin restoration needs and makes recommendations regarding continuing implementation under the existing authority and conducting further evaluations of ways to improve implementation. The Corps of Engineers and Illinois Department of Natural Resources worked in close coordination with numerous other State and Federal agencies in developing the plan. The Comprehensive Plan provides the vision, goals, objectives, and desired future and identifies the preferred alternative plan to restore the ecological integrity of the Illinois River basin system. The plan documents the need for and potential scope of the four components called for in Sec 519 (b)(3) of the Water Resources Development Act (WRDA) 2000: a restoration program; a long-term resource monitoring program; a computerized inventory and analysis system; and a program to encourage sediment removal technology, sediment characterization, sediment transport, and beneficial uses of sediment. An implementation framework and criteria are also presented to guide the identification, selection, study and implementation of restoration projects, monitoring and adaptive management activities, and further system investigations. The report also identifies the organizational structure and proposed roles of the other agencies in implementation.

10. Upper Mississippi and Illinois River Floodplain Forests - Desired Future and Recommended Actions.

This report was completed in September 2002 by the Upper Mississippi River Conservation Committee (UMRCC) to speak specifically to the forested component of the UMRS. The document reviews some of the past practices that have shaped the nature of the existing forests, describes processes currently underway, and recommends management actions to shape the future of the Mississippi and Illinois River forests.

11. Partners in Flight Physiographic Areas Plans.

Partners in Flight is a cooperative effort involving partnerships among Federal, State, and local government agencies, philanthropic foundations, professional organizations, conservation groups, industry, the academic community, and private individuals. This coalition has developed Bird Conservation Plans for different physiographic areas within the United States. A number of these plans overlap areas encompassed by the UMRS. Each plan discusses bird species of that region that are of special concern, habitat needs of those species, and desired management actions that could help these species.

12. U.S. North American Bird Conservation Initiative.

The U.S. North American Bird Conservation Initiative (NABCI) Committee is a forum of government agencies, private organizations, and bird initiatives helping partners across the continent meet their common bird conservation objectives. Its strategy is to foster coordination and collaboration among the bird conservation community on key issues of concern. Through annual work plans, the committee focuses its efforts on advancing coordinated bird monitoring, conservation design, private land conservation, tri-national projects, and institutional support in State and Federal agencies for integrated bird conservation. Bird Conservation Plans have been prepared for each region of the country, including areas adjoining the UMRS, along with conservation/management objectives for selected priority species.

13. Middle Mississippi River Partnership (MMRP) Coordination Plan.

The Middle Mississippi River Partnership (MMRP) is a collaboration of Federal and State agencies and not-for-profit organizations that have a common goal of restoring and enhancing the natural resources of the river corridor from St. Louis to Cairo. In 2005, the group issued the Middle Mississippi River Partnership Coordination Plan. This plan highlights historical natural resource trends, identifies priority resource issues along the corridor, and outlines goals and strategies for addressing those resource needs. The partners aim to achieve their goals through public resource management, resource compatible economic development, private lands conservation, and education and outreach. A subsequent document, the Middle Mississippi River Regional Plan, was released in 2008.

14. Upper Mississippi River and Great Lakes Region Joint Venture Plans.

The North American Waterfowl Management Plan (NAWMP) is a conservation initiative that seeks to restore waterfowl populations to 1970 levels in Canada, the United States and Mexico. The Upper Mississippi River and Great Lakes Region Joint Venture is one of several areas determined to be priority habitat areas of concern to waterfowl under the NAWMP. The goal of the Joint Venture is to increase populations of waterfowl and other wetland wildlife by protecting, restoring and enhancing wetland and associated upland habitats within the Joint Venture region. Specific habitat restoration acreage objectives are identified for focus areas within the Joint Venture region. Many of these focus areas are included in the NESP project area and will be considered in forest and grassland restoration and management planning decisions to contribute to Joint Venture goals and objectives.

15. Upper Mississippi Watershed Partnership Action Plan.

The Upper Mississippi Watershed Partnership Action Plan (2009-2013) was developed by the Upper Mississippi Forest Partnership, which in turn was initiated by the U.S. Forest Service Northeastern Area State and Private Forestry and the State foresters from Wisconsin, Minnesota, Iowa, Illinois, Missouri, and Indiana. The goals of the action plan were to strengthen coordination among the Upper Mississippi River basin State forestry agencies, link State Foresters directly to other agencies and groups working on common basin issues, develop and implement assessments and demonstration projects, and conduct educational efforts that will help address key watershed issues.

16. Lower Mississippi Valley Joint Venture (LMVJV) Forest Resource Conservation Working Group Plan.

The LMVJV Forest Resource Conservation Working Group produced a final report in 2007 entitled "Restoration, Management, and Monitoring of Forest Resources in the Mississippi Alluvial Valley: Recommendations for Enhancing Wildlife Habitat." This planning document was developed to meet three specific goals: (1) to define desired forest conditions that result from management of bottomland hardwood forests where the primary objective is the conservation of wildlife, (2) to provide technical recommendations for the restoration of bottomland hardwood forest on areas that have been converted to non-forested land uses (e.g., agriculture) that reflect the cumulative knowledge and experiences of land managers and researchers from the past decades of active reforestation, and (3) to recommend protocols and procedures for coordinated inventory and monitoring of forest resources on public lands managed for wildlife conservation such that restoration and management can be implemented in an adaptive manner. Although the recommendations contained within this report were developed to specifically address issues related to forest resources in the MAV, the working group believed that these recommendations were applicable to other bottomland hardwood systems across the southeastern United States, and they likely have a high degree of applicability to floodplain systems in the UMRS as well.

17. State Comprehensive Wildlife Conservation Plans

To receive funds through the Wildlife Conservation and Restoration Program (WCRP) and the State Wildlife Grants Program (SWGP), Congress charged each State and territory with developing a wildlife action plan. These proactive plans, known technically as "comprehensive wildlife conservation strategies," assess the health of each State's wildlife and habitats, identify the problems they face, and outline the actions that are needed to conserve them over the long term. For example, the Illinois Wildlife Action Plan is administered by the Illinois Department of Natural Resources and went into effect in 2006. More information about wildlife action plans is available from the Association of Fish and Wildlife Agencies (www.fishwildlife.org), and links to individual state wildlife action plans can be found at: www.wildlifeactionplan.org.

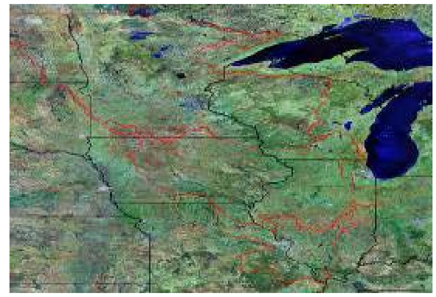
Appendix E: Project Fact Sheets

This section includes fact sheets for individual projects formulated at the time of report development. As indicated in the implementation plan, new projects will be developed on an annual cycle. Prior to being scheduled for implementation through this plan, project sponsors will coordinate with the PDT.

NAVIGATION AND ECOSYSTEM SUSTAINABILITY PROGRAM

UMRS SYSTEMIC HYDROGEOMORPHIC (HGM) MODELING AND ANALYSIS PROJECT

Upper Mississippi River System
Illinois, Missouri, Iowa, Wisconsin, Minnesota
St. Paul, Rock Island & St. Louis Districts



EXPECTED ECOLOGICAL OUTCOMES:
Sustainable systemic natural community ecosystem restoration, management, and restoration performance.

ADAPTIVE MANAGEMENT OPPORTUNITIES:
Refinement of existing hydro-geomorphological science with applied research toward application of UMR-IWW lock and dam operations hydrologic modifiers.

RESOURCE PROBLEM:

Design of sustainable system-wide floodplain forest ecosystem restoration in an ecological, economic and efficient manner.

PROJECT FEATURES:

The project area extends from the Upper Mississippi River from Minneapolis, MN to Cairo, IL; and the Illinois Waterway from Chicago to Grafton, IL; and navigable portions of the Minnesota, St. Croix, Black and Kaskaskia Rivers. The project area floodplain is 2,787,629 acres, the Upper Mississippi River and Illinois Waterway having 2,156,452 and 612,177 acres respectively, and is divided into 5 reaches:

Reach	Acres
UMR Upper Impounded	507,004
UMR Lower Impounded	976,395
UMR Un-Impounded	673,053
IWW Upper	62,823
IWW Lower	549,354

The Project is a systemic measure for hydro geomorphic modeling and analysis of 2.8 million acres of the project area to provide an evaluation of ecosystem restoration options for the UMR floodplain. The analysis will be required to ascertain viable and sustainable sites for restoring native ecosystem natural communities, including forest, prairie, and emergent wetland habitats.

The analysis will produce referenced hypothetical historical natural communities in contrast to current existing landscapes and hydro-periods to arrive at restorable natural community sites. These restorable sites will be recommended toward prioritization and /or management actions in collaboration with all stakeholders and in coordination with the NESP Floodplain Restoration Projects to attain sustainable systemic floodplain forest ecosystems.

FINANCIAL DATA:

The total estimated project cost is $675,000, with additional $100,000 for adaptive management. The project is 100% federal cost.

Phase I – HGM Modeling & Analysis – MVS – Middle Mississippi River – 900,000 Acres
$225,000 - Analysis
$225,000 - Total

Phase II – HGM Modeling & Analysis – MVS Lower Pools – 900,000 Acres
$225,000 - Analysis
$225,000 - Total

Phase III – HGM Modeling & Analysis – MVR & MVP Upper Pools – 900,000 Acres.
$225,000 - Analysis
$225,000 - Total

STATUS and SCHEDULE:

Phase I - MVS Modeling & Analysis.
BY1 – Plans and Specifications
BY2-3 - Analysis
Phase II- MVS Modeling and Analysis.
BY2 – Plans and Specifications
BY3-4 - Analysis
Phase III - MVR & MVP Modeling & Analysis.
BY3 - Plans, Specifications
BY4-5 - Analysis

INFORMATION NEEDS:

BY1 – Scope of Work.

190 5th St. East, St. Paul, MN 55101

US Army Corps of Engineers
St. Paul District

Information Paper

M1. Reno Bottoms Forest Restoration

Upper Mississippi River System - Navigation and Ecosystem Sustainability Program

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Location/Description

Pool 9, Upper Mississippi River
Miles 671 - 681
Houston County, Minnesota
Vernon County, Wisconsin
Allamakee County, Iowa
St. Paul District

Problem Statement

Much of the current floodplain forest in the Reno Bottoms / Minnesota Slough sub area is not regenerating. Flat topography, higher ground water levels caused by impoundment, increased frequency and duration of inundation, reduced creation of new islands and shoreline and subsequent plant succession, and increased competition from reed canary grass and other herbaceous vegetation all adversely affect regeneration. Dutch elm disease has also eliminated most American elm, an old growth component of the river corridor. Thus, the current forest is composed mainly of a few highly water tolerant species, such as silver maple, which are now approaching the end of their life span. A younger tree age class replacement component is generally missing throughout the area. Reed canary grass competition is particularly problematic here because it effectively precludes the use of many conventional forest management (regeneration) practices. Proposed actions would focus on restoring forest species and age class diversity on up to 1,100 acres.

Project Features :

- Backwater dredging and placement of fine material over 50 acres of low lying area at 1-2' additional elevation to improve site conditions for tree planting; plant and protect mast and other native tree species
- Eradication and control of reed canary grass with reforestation on up to 1,100 acres
- Control undesirable vegetation around seedlings for 3-5 growing seasons
- Monitor tree survival and growth for 3-5 years

Expected Ecological Outcomes:
The project would directly improve habitat conditions over approx. 1,100 acres by providing forest species, size, age, and structural diversity. Adjacent upland and lowland forest habitats would be improved for forest interior species by larger contiguous forest block size.

Adaptive Management Opportunities:
Project monitoring will enable learning for future forest restoration actions.

Current Status

Environmental assessment, plans and specifications are scheduled to begin in FY10. Dredging and site preparation will start in Spring 2011. Reforestation will be completed by June 15, 2012. Vegetation control and monitoring will continue in CY12 through CY15.

Authority

The Water Resources Development Act of 2007, TITLE VIII Upper Mississippi River and Illinois Water-Way System, authorized the project.

Fiscal (FY11-15)

Estimated Federal Cost	$660,000
Allocation through FY 2010	$80,000

The total estimated project implementation cost is $575,000, with an additional $5,000 for monitoring. The breakdown is $405,000 for dredging and site preparation, $125,000 for planting and materials, and $45,000 for follow-up vegetation control. The project is 100% federal cost.

Appendix F: Plan Comments

The Upper Mississippi River Systemic Forest Stewardship Plan was developed by a team of federal, state and non-governmental (NGO) partners. The development process included multiple rounds of document review and comment by team members leading up to a draft report that was reviewed by the NESP Science Panel and the Upper Mississippi River Restoration – Environmental Management Program (UMRR-EMP) Management Team. The comments were incorporated into an updated draft plan which was then distributed widely for review and comment by many Upper Mississippi River (UMR) partners, stakeholders and the public. The vast majority of comments were positive and supportive of the plan. The following table summarizes the plan comment process.

DATES	REVIEWERS	FOCUS OF COMMENTS
May 2005	Agency and NGO Team	Revisions to the project management plan and general outline for system plan development
Aug 2005	Agency and NGO Team	Revisions to plan goals and objectives
Jul 2006	Agency and NGO Team	Technical review of plan components
Sep 2006	NESP Science Panel	Technical review of plan components
Sep 2009	UMRR-EMP Team	Programmatic review of plan
Jan 2010	UMR Partners and Stakeholders	Comprehensive review of final draft. Results were positive and supportive of the planning effort.
Jun 2011	Public	Comprehensive review of final draft. Received a total of 12 public comments, all from citizens of St. Charles County, MO and Madison County, IL who were not in support of the plan. The team agreed the public comments received were not directly related to systemic forest management planning, which does provide significant benefits to the public.

U.S. Army Corps of Engineers District Contact Information:

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Phone Number: 651-290-5894

Mississippi River Project Office - Rock Island District
25549 182nd Street, Pleasant Valley, IA 52767
Phone Number: 309-794-4528

Rivers Project Office - St. Louis District
301 Riverlands Way, West Alton, MO 63386
Phone Number: 636-899-2600

For additional copies of the complete Upper Mississippi River Systemic Forest Stewardship Plan please visit www.OurMississippi.org.

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National Great Rivers Research and Education Center

U.S. Fish & Wildlife Service

Forest Service U.S. Department of Agriculture

USGS science for a changing world

Minnesota Department of Natural Resources

Wisconsin Dept. of Natural Resources

DNR

Illinois Department of Natural Resources

Missouri Conservation Department

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