Chapter 3: Affected Environment

Physical Environment

The Upper Mississippi River National Wildlife and Fish Refuge (Refuge) encompasses one of the largest blocks of floodplain habitat in the lower 48 states. Bordered by steep wooded bluffs that rise 100 to 600 feet above the river valley, the Mississippi River corridor and Refuge offer scenic beauty, a wild character, and productive fish and wildlife habitat unmatched in mid-America. The Refuge covers 240,220 acres and extends 261 river miles from north to south at the confluence of the Chippewa River in Wisconsin to near Rock Island Illinois.

While extensive wetland habitat losses have occurred well beyond its boundaries in neighboring states, the Refuge has retained much of its biological integrity and is a stronghold of bottomland forests and wetlands vital to breeding and migrating fish and wildlife. Nonetheless, Refuge wetland habitat has degraded significantly over the past 40 years due to human influence and natural processes.

The Refuge is one of several management entities on the Mississippi River. The U.S. Army Corps of Engineers operates the 9-foot navigation project within the Upper Mississippi River System (Public Law 99-662), and overlays the entire Refuge. The navigation project provides a continuous channel for barge traffic through a series of reservoirs created by 29 locks and dams on the Mississippi River and eight on the Illinois River. These reservoirs (pools) create and maintain most of the Refuge's floodplain habitat. The Refuge occurs in Pools 4 through 14.

In addition to Corps and Refuge ownership, the adjoining states of Iowa, Illinois, Minnesota, and Wisconsin own wildlife management units within the floodplain. Many of the 70 counties, towns and other municipalities adjacent to the Refuge have property within the floodplain as well. With all these entities

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having divergent roles and interests in River management, Congress declared in the Upper Mississippi River Management Act of 1986 that the Upper Mississippi River is both a nationally significant ecosystem and nationally significant commercial navigation system.

Over the past 40 or more years, scientists, managers and other writers have produced an extensive amount of literature addressing the physical, biological, and cultural resources and challenges of the Mississippi River and the Refuge (GREAT I and II, UMRBC Master Plan, Navigation Project EIS, Status and Trends Report, Refuge Master Plan and EIS, local studies, etc). This CCP will make brief summaries and references to these documents; refer to Appendix F, Literature Cited, for details.

Geomorphology – Effects of Water, Wind and Ice

The Refuge lies within the Mississippi River floodplain, an ancient river valley filled with alluvial

material (mud, sand, and gravel) carried and deposited by surface water. The river and its tributaries traverse sedimentary rock formations (dolomite, sandstone, and shale) that accumulated under inland seas during the early Paleozoic Era about 400 to 600 million years ago (Fremling and Claflin, 1984).

In more recent geologic times, the river valley has taken shape due to the presence (and absence) of glacial action. Global warming ended the last period of glaciation, about 12,000 years ago, and melted glaciers created huge clear-water lakes. Glacial Lake Agassiz covered much of northern Minnesota, the Dakotas, and central Canada. Most of that lake emptied to the south via the River Warren through which water ran in torrents for about 3000 years, trenching the Mississippi River valley by as much as 200 feet (Fremling and Claflin, 1984). Once the flow from glacial lakes subsided, the river lost much of its velocity and sediment transport capabilities. Sediment deposition ensued, and the valley partially refilled with sand and gravel. Several episodes of flushing and filling of the river valley have followed. Sand terraces that presently flank the river valley are remnants of ancestral floodplains not scoured during the most recent postglacial floods.

Today, over 30,700 miles of streams course through the basin, merge, and eventually enter the Upper Mississippi River Basin (Figure 3). That number does not include many smaller streams not detected by large-scale mapping techniques (Gowda, 1999). The Refuge receives water from 530 of the estimated 1300 streams that occur within the Upper Mississippi River Basin. The illustration of sub-basins by stream order helps depict the relative size of drainage areas and channel lengths. The ordering system (Strahler, 1957) starts with the uppermost channels in a drainage network, they are the first-order streams downstream to their first confluence. A second-order stream is formed below the confluence of two first-order channels. Third-order streams are created when two second-order channels join, and so on. "Tributaries of the Mississippi have steeper gradients than the master stream and they now deliver sediments faster than the Mississippi can remove them; thus the valley floor is slowly agrading once more" (Fremling and Claflin, 1984).

Much of the Refuge follows the Mississippi River as it flows through the carved Driftless Area, a non-glaciated "island" within a huge area of central North America shaped by a series of glaciers (Albert, 1995). This region has minimal amounts of glacial deposits known as "drift" and is therefore known as the Driftless Area. This landscape features a combination of steep, exposed bluffs and eroded ravines that bound the wide floodplain of the Upper Mississippi River, creating an unmatched wild and scenic character so prized by many viewers. The blufftops mark the edge of a plateau, extending many miles from the river, that is capped with loess soils that range in depth from 2 to 20 feet, the thinnest being along the valley walls. The Driftless Area includes parts of southwest Wisconsin, southeast Minnesota, northeast Iowa, and northwest Illinois. It also is called the Blufflands or Paleozoic Plateau.

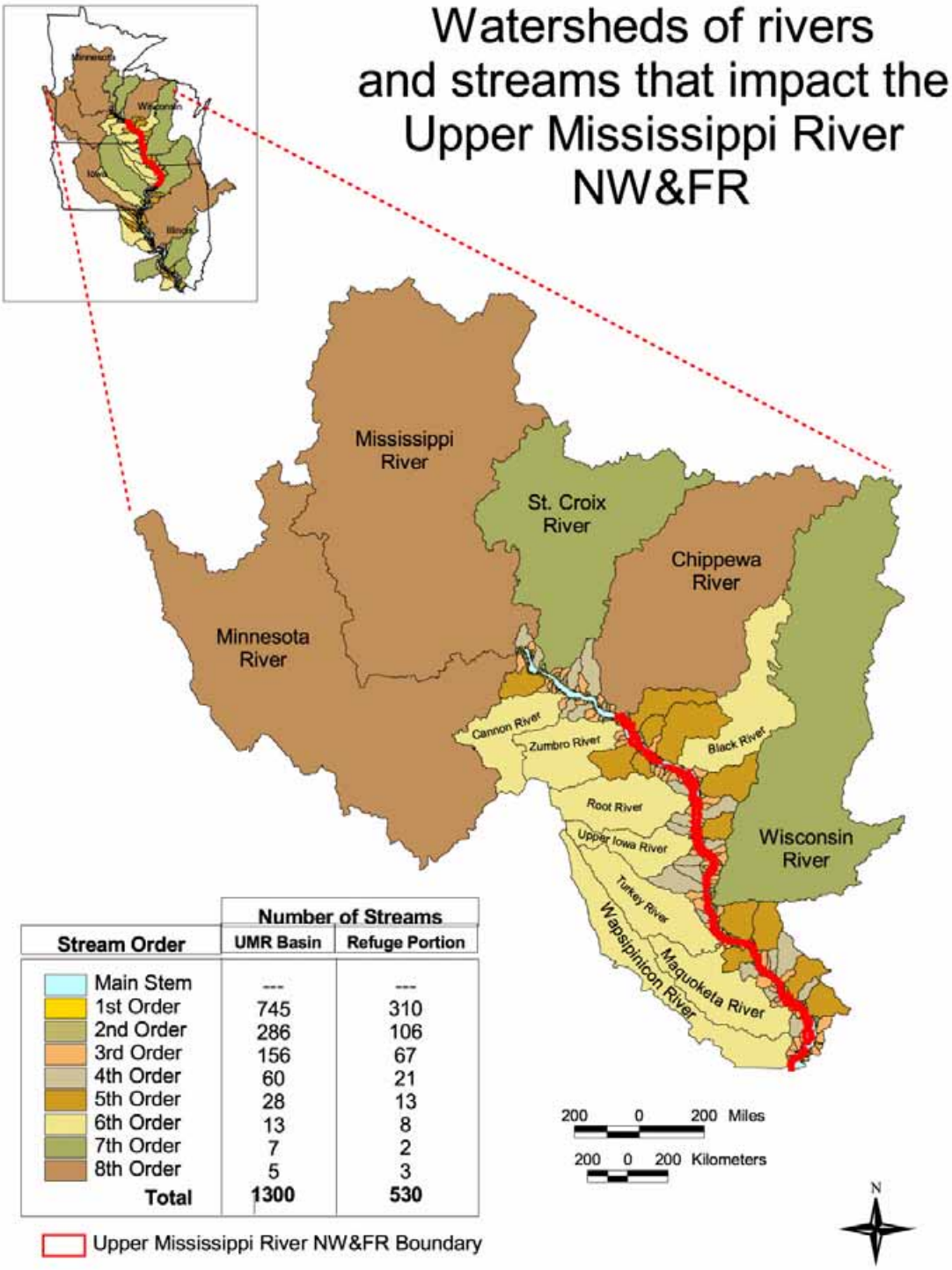
Land Use Characteristics of the Upper Mississippi River Basin

The Upper Mississippi River Basin is a major sub-basin of the entire Mississippi River. It includes approximately 800 miles of river and covers 189,189 square miles, about 15 percent of the entire Mississippi River Basin. More than 60 percent of the land area in the Upper Mississippi River Basin is devoted to cropland or pasture. Between 1945 and 1985, the application rate of commercial fertilizers increased twenty-fold and contributed to nutrient enrichment of the river. The Upper Mississippi River Basin accounted for 31 percent of the total nitrogen delivered from the Mississippi River to the Gulf of Mexico between 1985 and 1988, despite being only 15 percent of the entire basin's land area (Gowda, 1999).

Sediments, nutrients, and pesticides that erode from urban and agricultural lands enter the Mississippi River by many streams. "Because of modern urban and rural drainage networks (tiles, ditches, culverts, etc.), water reaches the rivers [of the basin] more quickly, with greater velocity, and at higher stages than in the past (Bellrose et al., 1983)." Nitrogen and herbicides arrive in pulses that coincide with snow melt, spring rains, and planting and growing seasons. Average soil loss in the Upper Mississippi River Basin is 4.4 tons per acre per year. In 1993, a very wet year, Iowa annual losses approached 20 tons per acre per year (Bhomilk, 1996).

Agricultural practices of the recent past caused extensive erosion of sediments that reached the river and were transported downstream. However, some of these sediments remain in tributary chan-

Figure 3: Watersheds of the Rivers and Streams that Impact Upper Mississippi River Refuge



Stream Order	Number of Streams: UMR Basin	Number of Streams: Refuge Portion
Main Stem	---	---
1st Order	745	310
2nd Order	286	106
3rd Order	156	67
4th Order	60	21
5th Order	28	13
6th Order	13	8
7th Order	7	2
8th Order	5	3
Total	**1300**	**530**

nels and deltas, and thus "present a major problem because treatment to reduce soil erosion on land may not benefit the river until stored sediments are transported by high flows (Gowda, 1999)".

Researcher Prasanna Gowda states, "we do know that basin-level factors (sedimentation, nutrient enrichment, pollution) have degraded environmental quality in the river floodplain and beyond. Previous and ongoing studies have identified land-use practices that create high rates of erosion and runoff. Land management agencies could use this information to implement increasingly cost-effective measures to retain soil and contaminants in the uplands (Gowda, 1999)."

Locks and Dams and River Reaches

People began making structural changes to enhance navigation on the Mississippi River during the 1830s when a 5-foot channel was blasted through the Des Moines Rapids (Theiling, 1999). Snags were pulled, wing dams installed, and channels dredged to 4, 4.5, and 6 feet deep between 1866 and 1907. The current structure originated in 1930 when Congress authorized the 9-foot navigation channel project for the Upper Mississippi River System to be constructed, operated, and maintained by the U.S. Army Corps of Engineers. This navigation system, including 29 locks and dams on the Mississippi River and eight on the Illinois River, has brought the most significant change to the river ecosystem since European settlement (Figure 4). The Refuge occurs within Pools 4-14.

The navigation dams were installed by the late 1930s and created a stairway of reservoirs (navigation pools) from Minneapolis, Minnesota, to St. Louis, Missouri, allowing boats and barges to pass obstacles and readily traverse this 400-foot elevation gradient and 670 mile stretch of the Mississippi River. The navigation pools permanently raised water levels and inundated thousands of acres of floodplain habitat (Figure 5). The newly created backwater wetlands and shallow lakes immediately supported an abundance of fish and wildlife adapted to this new water regime. Some existing plant and animal species did not survive the change, including some migratory fish and associated mussels.

With time, floodplain productivity has declined because sediments from the uplands have filled backwaters, floods and river currents have eroded away plant beds and islands, and relatively stabilized water levels have eliminated natural processes of drying and flooding, key ingredients to maintaining highly productive wetlands.

In order to evaluate habitat needs, the Upper Mississippi River System is categorized into 12 dominant geomorphic areas, or river reaches. The Refuge occurs in Reaches 2-5, or Pools 4-14 (USACE, 2000). The first three reaches (2, 3, 4), Pools 4-13 of the Refuge, are characterized by many braided channels and a mix of open water, aquatic vegetation, floodplain forest, some agricultural and urban areas, numerous islands, and a narrow floodplain (about 1 to 3 miles) that terminates at steep bluffs. The fifth Reach (including Pool 14 of the Refuge) is dominated by agriculture, with occasional floodplain forest and wetland habitats.

Hydrology and Water Quality

Hydrology and water quality play a vital role in maintaining the ecological integrity of the Refuge, a national treasure. A rich assemblage of species requires an appropriate mix of physical, chemical and biological features, such as water flow and depth, adequate but not excessive nutrients in the substrate, appropriate temperature, oxygen and light levels, food sources and escape cover.

Water quantity and quality within the Upper Mississippi River Basin and the floodplain go to the very heart of the conservation conundrum of the Refuge. Besides trying to deal with an increasing array of environmental degradation symptoms, it is important to trace the problems to their sources for long-term solutions. Monitoring on the river has demonstrated that some forms of pollution have actually declined since the federal Water Pollution Control Act was passed in 1972, mandating the secondary treatment of sewage effluents.

However, the river and the Refuge are still being exposed to biotic risks and threats from a growing array of agricultural chemicals and their degradation products, excess nutrients from both point and non-point sources, dissolved heavy metals in water and sediment, and other toxic compounds or invasive organisms.

Water flow within the entire basin is influenced by agriculture, urban development and even the thousands of reservoirs installed throughout the basin. The Corps of Engineers has 76 reservoirs, holding 40 million-acre feet of water; this volume would take three months to flow past St. Louis at average discharges (Wlosinski 1999). An estimated 3,000 more reservoirs with unknown capacity also occur in the basin.

Figure 4: Upper Mississippi River Navigation System with Locks and Dams numbered; Navigation Pools Occur Above Each Lock (Source: Lubinski, 1999)

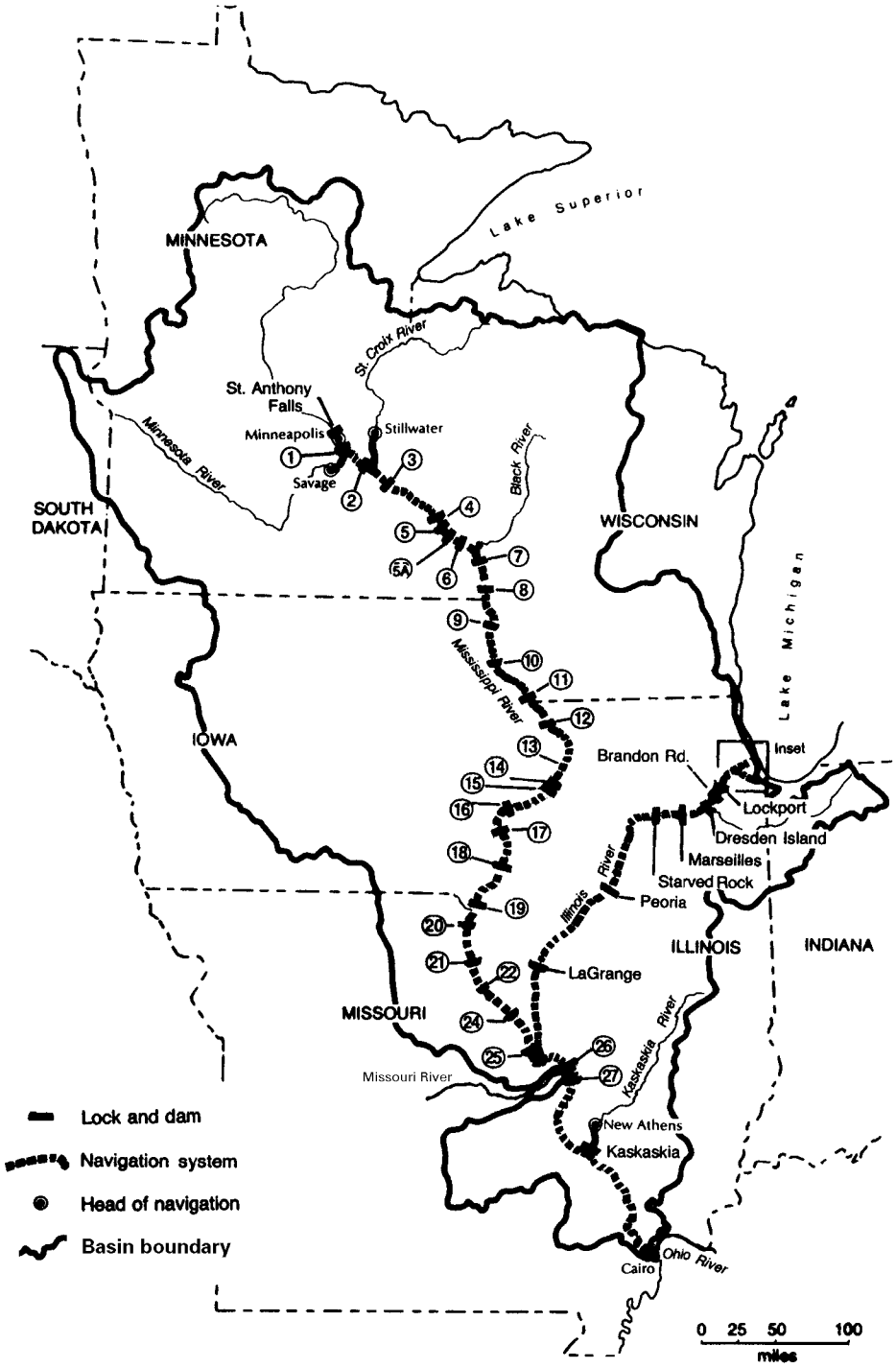
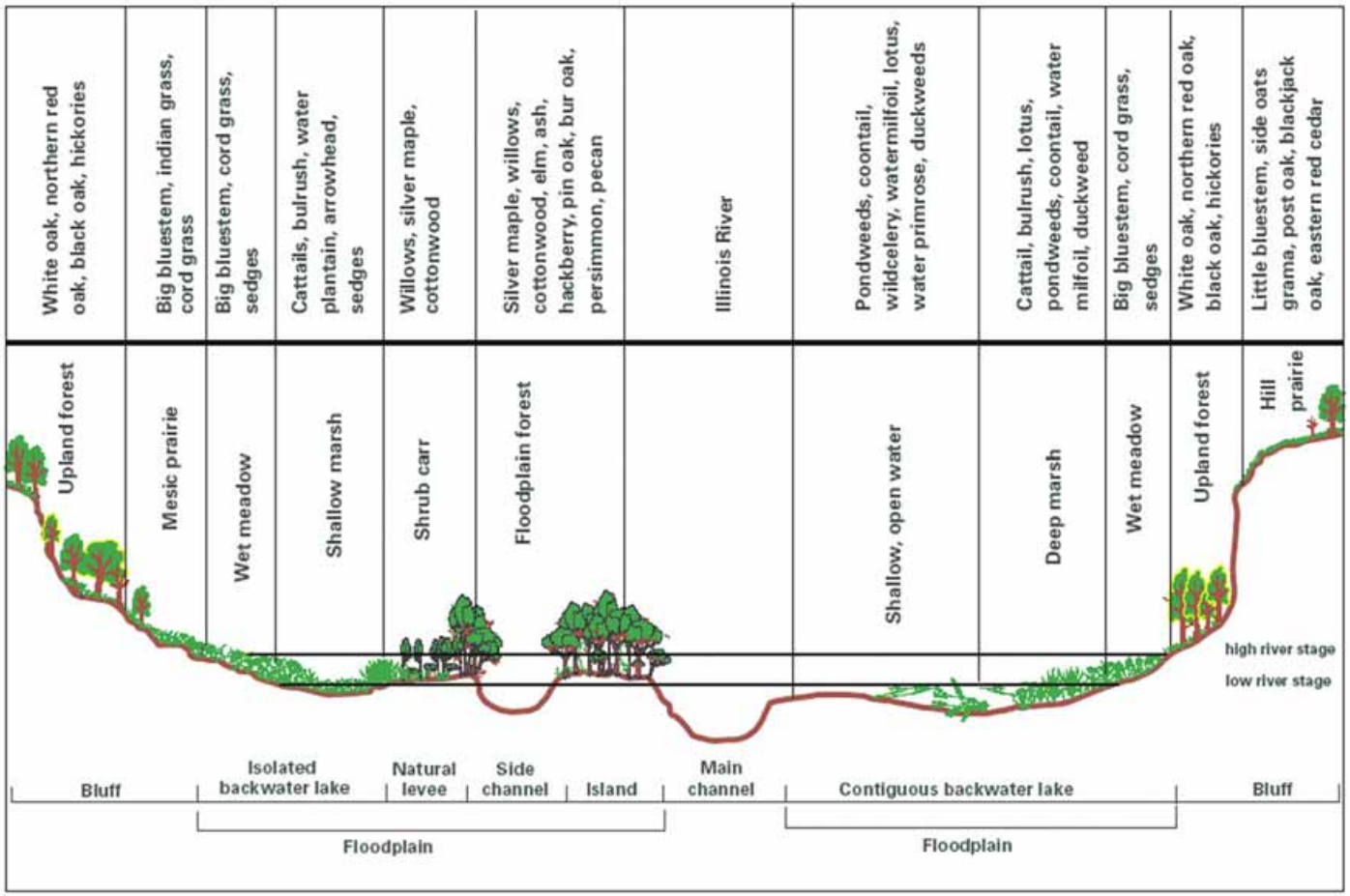


Figure 5: Typical Floodplain and Bluff Habitats of the Upper Mississippi River[1]



1. *Source: J.C. Nelson, Illinois Natural History Survey, Great Rivers Field Station, Alton, IL. In Theiling, 1999)*

Wetland drainage has affected 26 million acres in the Mississippi River Basin. An estimated 34 to 85 percent of wetlands have been lost in Wisconsin and Minnesota and 85 to 95 percent in Iowa and Illinois (Dahl 1990). These losses are critical because wetlands help regulate hydrology (water movement to tributaries), they filter nutrients from the water, and sustain highly diverse plant and animal populations.

Flow on the mainstem of the Mississippi and Illinois Rivers has been altered by installation of 37 dams, thousands of wing dams, and 8,000 miles of levees. Since 1933, the long-term average hydrologic pattern on the Upper Mississippi River System shows an approximate 11-year cycle of low and high flow, an apparent long-term increase in flow, and an increase in the frequency and amplitude of multiyear fluctuations in flow. Flood heights have increased and the number of days water elevations are above flood stage is increasing; present day floods on the Mississippi River at St. Louis tend to be 9 feet higher than historic floods at the same discharge (780,000 cfs). Major floods at St. Louis now occur once every six years (Wlosinski 1999).

The lock and dam system has permanently inundated lands previously rejuvenated through annual drying and "flood pulse" cycles. While initially the pools supported flourishing, productive wetlands, within a few decades the vast marshes became decadent as they filled with fine sediments, and turbidity from rough fish and wave action suppressed growth of aquatic plants. To compensate for degradation, attempts are now being made to simulate natural cycles of drought with periodic drawdowns and to assist island or channel creation with specially designed habitat projects in cooperation with the Corps of Engineers and the states.

Improved agriculture and development practices can significantly reduce the rates of sediment, nutrient and chemical contaminant delivery and deposition within the Refuge. This translates to better quality habitat for a wider array of species. Progress has been made, but much more can be done. The link between fish and wildlife health, water quality, and inputs from the basin or watershed is well documented. The Refuge has a role in promoting the use of cost-effective measures in the watersheds to enhance its fish and wildlife resources.

Soils

Much of the Upper Mississippi River Basin is covered by loess, a silty soil deposited by postglacial winds. These soils form a mantle over half the Upper Mississippi and Illinois sub-basins and serve as a major source of silt to the Upper Mississippi River System (Nielsen et al., 1984). Floodplain bedrock is covered by up to 150 feet (Pool 10) of alluvial soils (clay, silt, sand and gravel). Soils within the pools vary from silty clay to sand. Sand terraces, occurring at slightly higher elevations bordering the floodplain of the Mississippi and its larger tributaries, consist of glacial outwash deposited during periods of higher average flow.

The soils of the Refuge floodplain from Pools 4 through 6 are alluvial in origin, and vary in texture from silty clay to sand. The composition of the soil at any particular location depends upon the manner in which it was deposited. These irregular strata are composed of clay, silt, sand and gravel. The sands and gravels border many sloughs, while heavy silt loams underlain by sand or gravel can be found on higher terrain between sloughs. Before impoundment and refuge creation, these elevated areas supported bottomland timber, or were cleared and managed for hay or pasture.

Soils of Pools 7 and 8 are derived from a wider variety of parent material, ranging from weathered bedrock to glacial till, alluvium and loess. The weathering of the predominant till has taken place under different vegetative influences, resulting in several soil types. Podzolic soils have formed under deciduous trees with grass cover. The bog soils are represented by muck and peat, formed by decomposition of sedges and grasses at the wet lower margins of sand terraces exposed by river meanders. Regisols consist of deep, soft mineral deposits. Alluvial soils consist of water-borne materials recently deposited on the floodplain. A loess cap of silty particles covers most of the parent material.

Pool 9 parent materials also include loess, alluvium and drift. Pockets and fans of glacial outwash were formed as ice melted at the end of the most recent glacial period, known as the Wisconsin epoch. The main soil associations are Fayette-Dubuque-Stonyland, or "FDS." The FDS association is characterized by a high percentage of shallow limestone soils over steep slopes that are susceptible to erosion. Sediment subsequently delivered to Pool 9 by the Upper Iowa River causes extensive siltation in backwaters and channels. The primary soil type of islands and upland peninsulas in this area is

Dorchester silt loam, which is a light-colored soil that lacks a B-horizon. It forms on relatively flat sites over black soils that are usually flooded annually after spring thaw or after heavy rains.

Some of the high terraces bordering Pool 10 have sandy loam soils developed under prairie or savanna vegetation. The bottomlands have diverse soils of alluvial origin that are composed of sand, silt and clay layers deposited by flood events. In areas of annual flooding, there is little soil development, since humus is mostly removed or covered. Higher elevation terraces may have a thin layer of humus over sandy material. A grey layer of sticky, fine clay with blue-green mottling from reduced iron is present on bottomland soils, indicating poor internal drainage and anaerobic soil conditions. Soils information for navigation pools 4-10 was obtained from the Mississippi River Operational Management Plan (USACE, 1993).

In the lower portion of the Refuge (pools 11-14), three major zones are identified for the river ecosystem in the current Operational Management Plan of the Corps of Engineers, Rock Island District: the streamside buffer zone, a higher elevation natural levee zone, and a lower elevation floodplain zone.

The buffer zone is an area close to the stream bank that is distinguished by floodplain edges and point bars. This zone is subjected to a rapidly aggrading alluvium, harsh stream velocities, and heavy debris accumulation. Common soil textures include coarse loams or sandy loams which have poor moisture holding capacity and high infiltration rates causing rapid drainage after flooding cessation. This zone has the most dynamic land/water interfaces.

Natural levee areas are associated in or near buffer zones. The elevation is often higher than the surrounding floodplain due to high silt aggradation. Soil textures are often fairly coarse loams and are moderately drained to well drained sites. Even though levees are relatively close to the stream, they flood less frequently and soils have high infiltration rates and are often dissected with drainage channels which facilitate rapid removal of flood waters.

The lower elevational floodplains consist of more poorly drained silty loams and silty clay loams best suited for moderately flood tolerant to very tolerant bottomland hardwoods. These floodplains are often inundated for longer periods due to their low elevation and high soil moisture holding capacity.

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The Natural Resource Inventory System (NRIS), which provides basic soil information for soils on project lands between pools 11 and 14, can be found in Section 3.043 of the Army Corps of Engineers Mississippi River Operational Management Plan, Rock Island District, 1989 (http://www.mvr.usace.army.mil/missriver/).

Soil association maps and descriptions for the Refuge are available for review at the Refuge Headquarters.

Climate

The climate of the Mississippi River Basin is subhumid continental with cold dry winters and warm moist summers. Average annual precipitation varies from about 22 inches in the western part of the basin to 34 inches or more in the east. About 75 percent of the total annual precipitation falls between April and September. Basin-wide, the average monthly temperature ranges from about 11 degrees F in January to 74 degrees F in July. Most of the river within the refuge usually freezes solid each winter. Refer to Table 1 for Refuge climate data.

The global warming trend documented nationally and globally in recent years has affected precipitation patterns in the Midwest, resulting in unusual flooding intensity and duration.

As noted above, unusually high floods of long duration have occurred on the Upper Mississippi River over the past decade. Professor James Knox at the University of Wisconsin-Madison has found that "model results and instrument records both support the idea that global warming magnifies hydrologic variability and enhances the hydrologic cycle of the Upper Mississippi River basin (Knox, 2002)." He continues, "analyses of sediment proper-

Table 1: Climate Data, Upper Mississippi River Refuge, River Mile 764 to 503.

Location	Average Maximum Summer Temp (Jun, July, Aug) (degrees Fahrenheit)	Average Minimum Winter Temp (Dec, Jan, Feb) (degrees Fahrenheit)	Average Annual Precipitation (inches)	Average Annual Snow Fall (inches)
La Crosse, Wisconsin (River Mile 700)	83.0	10.9	32.36	44.3
Moline, Illinois (River Mile 485)	84.2	16.3	38.04	35.0

ties [in Wisconsin] indicate that large floods on the Upper Mississippi River have commonly accompanied the beginning of warm and dry climate episodes in the region, but long-term persistence of warming and drought eventually results in smaller floods of high short-term variability.

"Short-term occurrences of large floods were common about 4700, 2500-2200, 1800-1500, 1280, 1000-750, and 550-400 calendar years B.P. [before present], all times that approximate rapid warming and drought in the upper Midwest identified by others. The recent high frequency of large floods on the Upper Mississippi River since the early 1990s may be a modern analogue because these floods have accompanied major hemispheric warming during the same period."

The research by Knox and others indicates that climate is less stable and predictable than people previously thought, and this means that resilience must be a primary consideration in making management decisions. Resilience requires a largely preventive or precautionary approach that leaves an adequate margin for error. The floodplain marshes and forested islands or bluffs of the Upper Mississippi River corridor could have important future roles to play in excess nutrient processing and carbon sequestration, as a means of mitigating effects of climate change.

Contaminants

Refuge and Vicinity on the Upper Mississippi River

Land use practices, floods, other natural events, spills, and other human caused incidents within the watershed affect contaminant levels in river water and sediments. These, in turn affect quality and quantity of fish and wildlife habitat. Dissolved oxygen (DO) is crucial to fish and invertebrate survival and DO levels are good indicators of pollution (Soballe and Wiener, 1999). For example, for decades, untreated sewage entering the river in metropolitan Twin Cities depleted DO level in Pools 2, 3, and 4 had an adverse impact on fish and invertebrates. Between 1978 and 1995, treatment plants were installed and storm water was separated from sewage lines; fish and wildlife has responded favorably. Current measurements by Long Term Resource Monitoring Program show that DO levels on 3 Pools of the Refuge (4, 8, and 13) are generally above 5 parts per million (the level considered marginal for aquatic biota). DO levels below that threshold usually occur in backwaters with low current velocities. This has direct bearing on distribution of backwater fish species.

Agricultural fields, animal feedlots, and urban areas are principle sources for plant nutrients that enter the river (Soballe and Wiener, 1999). Excessive inputs of nitrogen and phosphorus can cause algal blooms, contribute to excessive plant growth and subsequent decomposition that depletes DO (limiting fish ant other aquatic life distribution and survival), and cause public health concerns. This same enrichment may contribute to degraded water quality (hypoxia) in the Gulf of Mexico. Plant decomposition in the sediment can also be a source of ammonia that adversely affects burrowing organisms such as fingernail clams and mayflies.

The Upper Mississippi River transports moderate to high quantities of sediments that enter the river from row crop farming, mining, and urban development. Turbidity levels, a measure of suspended sediments, at the Maquoketa River (Pool 13) in Iowa are more than double all up-river inputs combined. This reflects a substantial increase in inputs from erodible agricultural lands. Sediments fill backwaters and reduce the diversity of water depths, thereby reducing biological diversity of the system. Sediments also reduce light penetration

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necessary for plant growth, as well as absorb and transport containments.

In summary, water quality of the Upper Mississippi River has improved in recent decades in the area of gross sewage pollution, but the river still receives a wide array of agricultural, industrial, and urban contaminants. The risks and threats of certain herbicides, such as atrazine, on the aquatic biota are largely unknown. Excessive nutrients cause excessive plant growth, which upon decomposition, can impact benthic organisms such as fingernail clams.

Polychlorinated biphenyls (PCBs) have been linked to a contaminated Upper Mississippi River food web affecting fish, mink, and burrowing mayflies (Soballe and Wiener, 1999). For additional information see the book *Contaminants in the Upper Mississippi River* (Wiener, et. al., 1984).

Contaminant levels in great blue herons of the Upper Mississippi River have been studied since the mid-1970s (Custer et al, 1997). Levels of PCBs in great blue heron chicks were 29 times greater on the Upper Mississippi River below St. Paul, Minnesota than above St. Paul in the mid 1970s. In 1978 great blue heron eggs had average PCB levels (14.1 μg/g = parts per million) that were possibly sufficient to induce adverse effects on embryos. In 1993, investigators collected great blue heron eggs from 10 colonies on the Upper Mississippi River (8 on the Refuge) to determine the effect of organochlorines, mercury, and selenium on heron nesting (Custer et al, 1997). The authors concluded that these contaminants do not seem to be a serious threat to nesting great blue herons on the Upper Mississippi River. Organochlorine concentrations (including DDE, the metabolite of the insecticide DDT or dichlordiephenyltrichloroethane) were generally low (mean DDE = 1.3 μg/g; PCB = 3.0 μg/g; TCDD [dioxin] = 11.5 μg/g). Eggshell thickness was negatively correlated with DDE concentrations but eggshell averaged only 2.3 percent thinner than eggs collected during the years prior to the use of DDT. Mercury and selenium concentrations (mean = 0.8 and 3.1 μg/g, respectively) in eggs were within background levels.

Mercury, a heavy metal, and PCBs are present in fish of the Mississippi River. Sources of mercury are both natural and man-made; PCBs do not occur naturally. Both contaminants build up through the food chain and the highest levels occur in predatory fish (walleyes, bass, and northern pike), scavengers (catfish) and bottom feeders (carp). Fish consumption advisories are issued by the Health Departments of the four states overlapping the Refuge. Iowa had an active advisory against consumption of fish by children in 1998-1999. This advisory addressed elevated PCB levels in fish along an 11-mile stretch of the Mississippi River in Pool 14 near Davenport, Iowa; it is no longer active.

Minnesota, Wisconsin, and Illinois all have advisories directed primarily toward reducing intake of mercury and PCBs by pregnant women and children under the age of 15. In Illinois, channel catfish, less than 18 inches should be consumed at the rate no greater than one meal per week; catfish over 18 inches, at the rate of one meal per month. Illinois also has carp recommendations, but does not have advisories on walleye, bass, or northern pike taken from the Mississippi River.

Minnesota and Wisconsin have detailed advisories for consumption of fish taken from various pools of the Refuge. However, the extent of consumption and the number of species included on the lists vary between states along the same pool. In order to address PCB concerns in Wisconsin waters of the Mississippi River, buffalo (>15 inches), carp (> 15 inches), catfish (> 20 inches), walleye (>25 inches) , and white bass (all sizes) taken in Pool 4 are limited to one meal per month for pregnant women and for children under 15. In Pools further down river (Pools 5-12) channel catfish, rather than all catfish are on the list, and buffalo, white bass and walleye are removed at various intervals along the Refuge pools. In the case of mercury, Wisconsin advisories indicate that pregnant women and children should consume only one meal of any sport fish per month, state-wide. The Wisconsin advisory brochure defines sport fish as “any fish you catch or are given,

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such as bass, walleye, northern, perch, or crappie. Sport fish are not fish you purchase in a store or restaurant."

Minnesota advisories limit consumption of 10 to 14 species of fish for mercury and/or PCB concerns in Minnesota waters of Pools 4-9. In general, targeted fish less than 20 inches (except pan fish) are limited to one meal per week, larger fish are limited to one meal per month, again for pregnant women and children under 15 years of age. Species included on the Minnesota list include: crappie, flathead catfish, channel catfish, freshwater drum, largemouth bass, smallmouth bass, northern pike, walleye, white bass, white sucker, bluegill sunfish, carp, sauger, smallmouth buffalo, and bigmouth buffalo. Snapping turtles are also on the list for Pool 4.

Lost Mound Unit

The Lost Mound Unit of the Refuge (formerly the Savanna Army Depot) was placed on the National Priorities List for Superfund cleanup in 1989. This addressed the Comprehensive Environmental Response Compensation and Liability Act requirements. Approximately $198 million may be budgeted during the next 20 years for contaminants removal. Presently 69 environmental sites may require cleanup. Some of these contaminants include solvent, petroleum, lead, cadmium, and mercury. TNT contamination has been confirmed to have reached the groundwater and has spread three-fourths of a mile westward toward the Mississippi River. It is reported that 70 percent of the Depot has the potential to contain some unexploded ordnance to include 155 mm and 75 mm howitzers, mortars, grenades, and small arms ammunition.

These environmental contamination, health, and safety issues will be considered in identifying areas for public access to Lost Mound Unit. The 9,715 acres of the Lost Mound unit are to be used for conservation purposes, therefore the degree of clean-up will not be as strict as if housing or industry were proposed for the site. The U.S. Environmental Protection Agency (EPA), the Illinois Environmental Protection Agency (IEPA), Rock Island Ecological Services Office (FWS) and the Department of Army (DA) will ultimately determine when, and if, the contaminated sites are cleaned up to the extent that there are no environmental contamination, health, and safety concerns.

Fish, Wildlife and Habitat

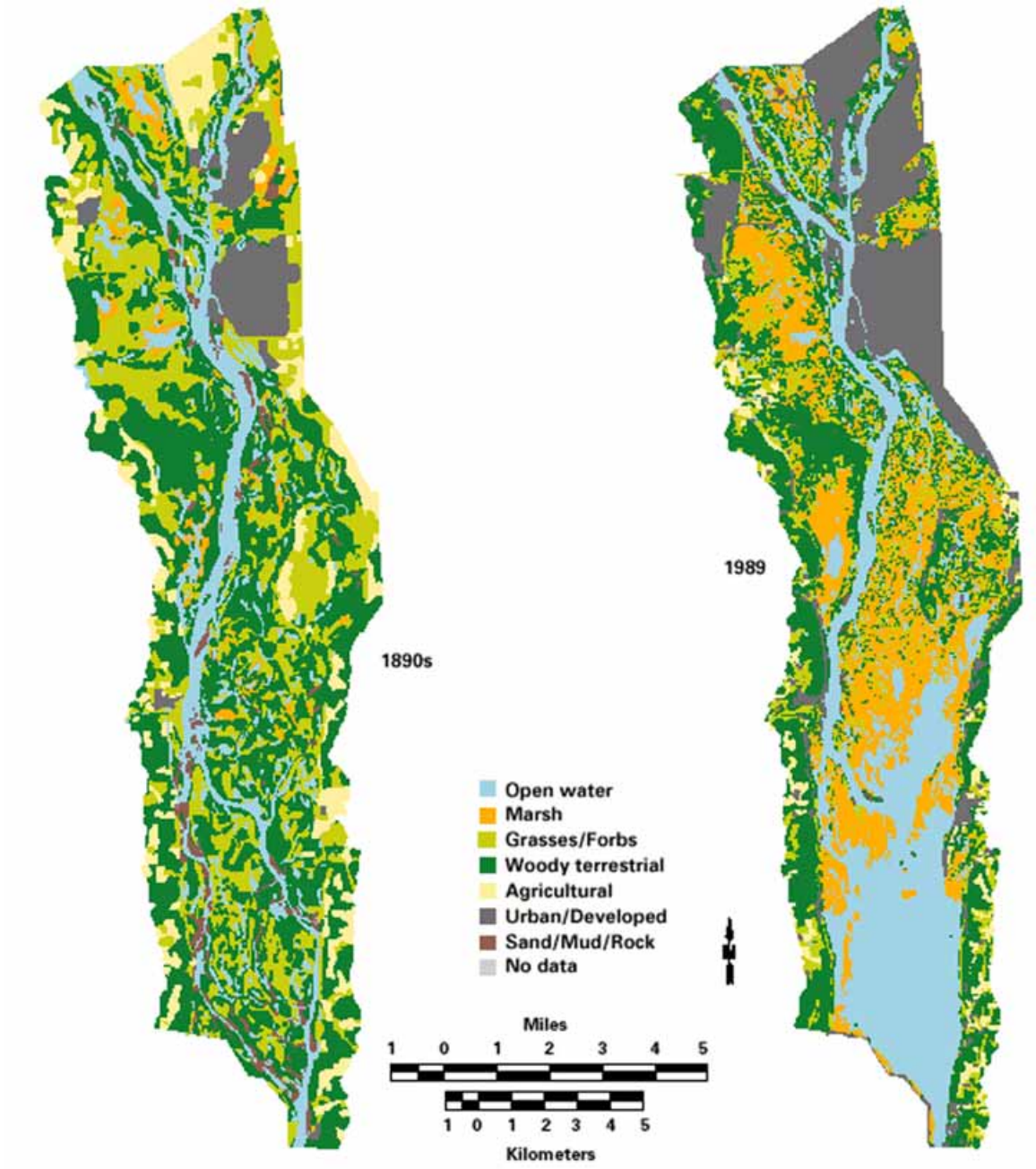
Navigation Pools and Habitat Change

The area of river between two dams is called a "pool," each numbered according to the dam that creates it. Pools are river-like in nature having various flow velocities extending laterally from the navigation channel to the backwaters. Upon impoundment, water levels were permanently raised and stabilized, profoundly changing the character of the river (Green, 1970).

Turn-of-the-century (1890s) and modern (1989) land-cover maps of Pool 8 demonstrate the effect of impoundment on the river in the vicinity of the Refuge (Figure 6). Water levels were increased permanently in the lower half of the pools to create open water areas close to the dam and marshy areas near the middle of the pools. The upstream reaches scoured deeper but were largely unchanged in shape (Theiling, 1999).

Three prominent ecologic zones developed within each pool, particularly in the upper reaches of the Upper Mississippi River System. The lower, impounded zone occurs in roughly the lower half of the pools and generally contains the deepest water of the pool where open water and heavy silts cover former marshes and the lower terrestrial areas. This zone is interspersed with islands that once were high ground and ridges in the pre-lock and dam floodplain. The middle zones of the pools contain extensive backwater marshes and shallow lakes interspersed with tree stump fields where former forests, wet meadows and marshes occurred within the floodplain. These backwaters are, or were at one

Figure 6: Landcover Maps of Pool 8, 1890s and 1989; Upper Mississippi River Refuge[1]



1. *Source : Theiling, 1999*

time, extremely productive. The upper pool zones extend downstream of dams, and retain a system of braided channels and forested islands that occurred prior to installation of the locks and dams. Many of the wet meadows that existed prior to inundation in the upper and middle zones are now forested due to succession and elimination of fire.

The pools are now almost 70 years old and are changing due to sediment accumulation, long-term inundation, and erosional processes that typically occur as shallow reservoirs age. Many of the productive marshes of mid-pool backwaters have lost their vegetative habitats and converted to open water, wind-swept, riverine lakes (Fremling et al., 1976). Sediment continues to fill and degrade aquatic habitats. Other backwaters have attained equilibrium with riverine conditions and maintain aquatic habitat. Erosional action of river currents, wind-driven waves, and boat-generated waves have reduced shorelines and eliminated thousands of islands in the mid-pool to lower impounded areas of the pools (Theiling, 1999) (Figure 7). In many backwaters, heavy wind and wave action has resuspended bottom sediments, resulting in the erosion of shallow areas and the filling of deeper ones. This geomorphic action has eliminated much of the "bathymetric diversity" (e.g., high spots, pockets and channels) that once punctuated the wetland bottoms, making the area so productive for fish and wildlife. In addition, resuspended sediment has increased turbidity levels in the water, thus reducing the amount of sunlight that penetrates the water and is available for aquatic plant growth.

Island loss in the lower one half of UMR pools has occurred since the locks and dams were installed in the mid 1930s, resulting in decreases in habitat for plants and animals. Islands eroded away due to current and wind- and boat-generated waves (Theiling, 1999).

Since the mid 1980s, large-scale projects have been constructed to slow habitat loss in backwaters by combating geomorphic processes of sedimentation and erosion. These projects include installation of low levees to block sediment-laden water from entering the backwaters, dredging channels and pockets to provide bathymetric diversity, constructing islands to reduce wind fetch and direct flows, and protecting (armoring) existing islands from erosion. Experiments have also been done with pool-scale (Pool 8) water level management, drawdowns, to replicate natural low-water conditions and thereby, promote growth of marsh vegetation.

Various river entities recognize there is a critical need to stop the accelerated loss of habitat and general decline of the river. In 1993, the Upper Mississippi River Conservation Committee first sent out a call for action in "Facing the Threat: An Ecosystem Management Strategy for the Upper Mississippi River (UMRCC, 1993)." The same committee repeated the sounds of urgency and warning in its recent publication, "A River that Works and a Working River" (UMRCC 2000):

> "If the UMRS is to continue to survive as a nationally and internationally significant ecological and economic resource we, who are its beneficiaries and stewards, will have to develop, very soon, more efficient and effective restoration and management strategies."

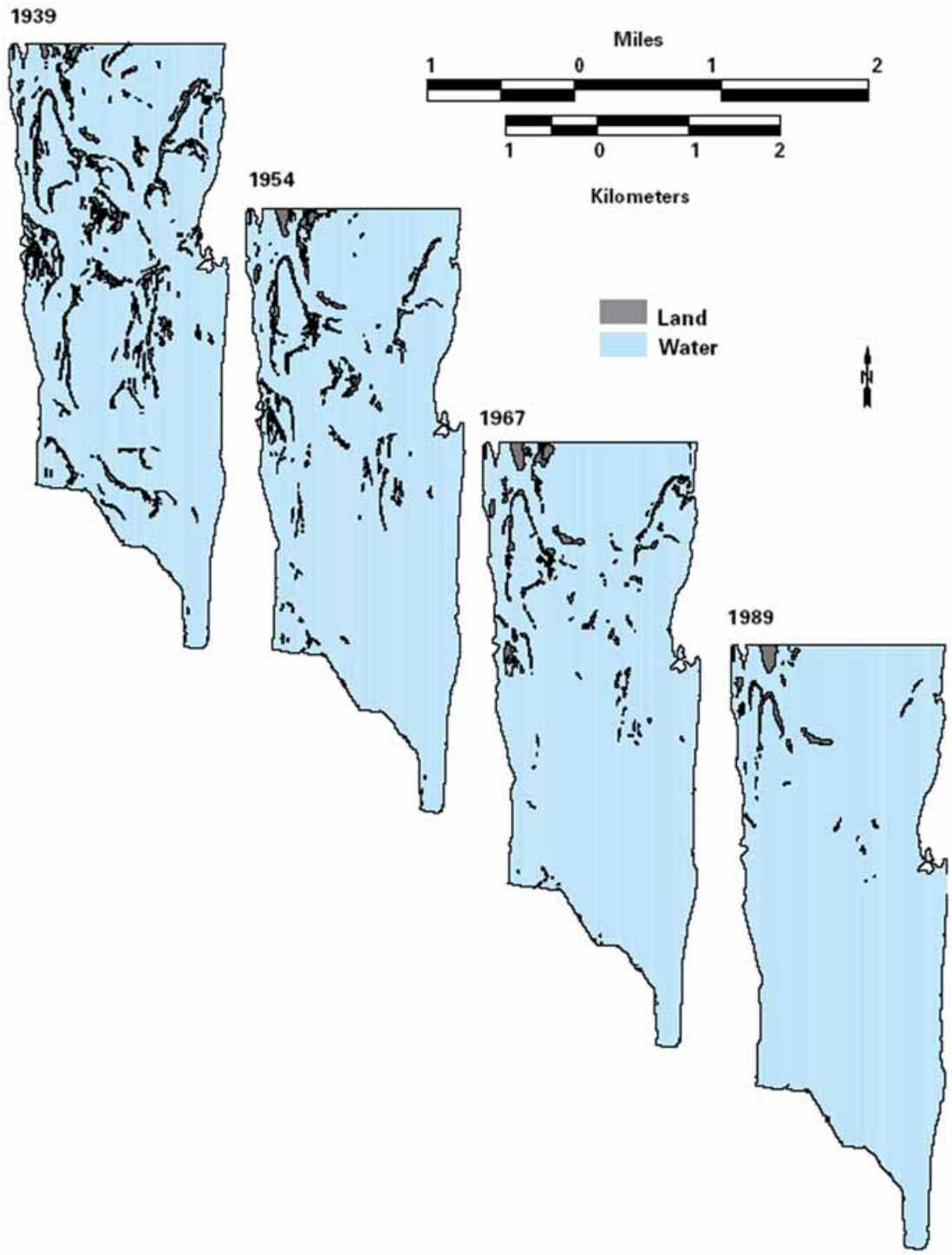
The publication identifies nine tools and measures to restore natural river processes, some of which include improving water quality, providing for seasonal low flow (drawdown) conditions, creating islands, severing pathways for exotic species and providing for fish passage. The actions proposed by this CCP match the Upper Mississippi River Conservation Committee tools for achieving restoration of the ecosystem.

In a more specific follow-up to the Upper Mississippi River Conservation Committee publication, the River Resources Forum, an interagency advisory group to the St. Paul District of the Corps of Engineers, has endorsed Environmental Pool Plans that include practices and plans to achieve desired future environmental conditions of Pools 1-10 (River Resources Forum, 2004). The Rock Island District counterpart to the River Resources Forum is the River Resource Action Team which has also endorsed Environmental Pool Plans for Pools 11-22. This CCP will promote the same strategies described in the Environmental Pool Plans documents to meet Refuge goals and objectives. Refer to Appendix N of the Final EIS/CCP for examples of Environmental Pool Plan maps.

The Izaak Walton League of America recognizes an uncertain future for the Refuge in terms of development pressures, impacts of navigation, and ever-increasing recreational use (Izaak Walton League, 1999).

In addressing concerns about the future health and sustainability of the Upper Mississippi River Basin, The Nature Conservancy has identified areas of greatest freshwater biodiversity in the basin. Its purpose is to "galvanize conservation and restora-

Figure 7: Island Loss in the Lower Half of the Upper Mississippi River Pools, Upper Mississippi River Refuge[1]



1. *Source: Theiling 1999*

Table 2: Special Designated Areas Within the Upper Mississippi River Refuge

Name of Area	Category[1]	State	Acres	Habitat Type	Pool	River Mile(s)
Winona District						
Nelson-Trevino Bottoms	RNA SNA NNA	Wisconsin	3,740	Silver Maple; American Elm	4	760-763
La Crosse District						
Midway Railroad Prairie	SNA	Wisconsin	5	Bluestem Grassland	7	706
McGregor District						
Reno Bottoms	RNA	Minnesota	1,980	Silver Maple; American Elm	9	679-681
Twelve-Mile Island	RNA	Iowa	900	Silver Maple; American Elm	11	610-614
Savanna District						
Thomson-Fulton Sand Prairie	RNA	Illinois	321	Bluestem Grassland	13	525-527
Total Acreage			6,946			

1. *RNA = Research Natural Area; SNA = Scientific and Natural Area; NNA = National Natural Area.*

tion action by all stakeholders at the critical places within the UMRB" (Weitzell, et al., 2003).

Special Management Areas

Wilderness

No lands within the existing Refuge boundary are suitable for designation as wilderness, which is defined in the Wilderness Act of 1964 and subsequent amendments. Roadless areas within the larger bottomlands associated with major river deltas are too small and too frequently accessed or impacted by human activities to meet Wilderness designation criteria. However, some of these areas do satisfy the criteria for other categories of special management designation, such as Research Natural Areas, which recognize wild qualities and fragility of habitats by restricting the nature or intensity of activities that disturb wildlife or damage habitat.

Special Designated Areas

Within the refuge, there are currently four designated Research Natural Areas (RNA), one National Natural Landmark (NNA) that partially overlaps a Research Natural Area, and one state-designated Scientific and Natural Area (SNA) (Table 2). These areas total 6,946 acres.

These areas assist in the preservation of examples of significant natural ecosystems for comparison with those that are more influenced by human activities. They provide educational and research areas where ecological observations and studies can be conducted with minimal disturbance, and natural processes can evolve without significant human intervention. Under certain circumstances, some manipulation of the environment through active management may be allowed to maintain special features. Hunting, fishing, bird watching, photography, wildlife observation, nature interpretation and environmental education may be allowed with adequate justification.

Conservation Easements

When the Farm Services Agency (FSA), formerly known as the Farmers Home Administration (FMHA), acquires property through default on loans, it is required to protect wetland and floodplain resources on the property prior to public resale. The U.S. Fish and Wildlife Service assists the Farm Services Agency in identifying important floodplain and wetland resources for protection with perpetual conservation easements. Management responsibility for the easement may be transferred to a state or federal agency for administration. The Refuge has held a number of such easements since the late 1980s, and may, in the future, hold more of these or other types of conservation easements

Table 3: Conservation Easements Maintained by Upper Mississippi River Refuge

Name	Habitat	Acres	Year	State	County
Winona District					
Haney	Riparian	38	1989	Minnesota	Mower
Jeche	Wetland	1	1989	Minnesota	Fillmore
McCabe	Riparian	36	1989	Minnesota	Fillmore
Gardemann	Riparian	35	1990	Minnesota	Fillmore
Heggedahl	Riparian	8	1990	Minnesota	Dodge
Rediske	Riparian	6	1990	Minnesota	Fillmore
Yenter	Riparian	51	1990	Minnesota	Fillmore
La Crosse District					
Engh	Riparian	30	1988	Wisconsin	Vernon
Nerison	Riparian	18	1988	Wisconsin	Vernon
Barton	Riparian	16	1989	Wisconsin	La Crosse
Straight	Wetland	5	1995	Wisconsin	Richland
Schminick	Wetland	25	1999	Wisconsin	Sauk
McGregor District					
Riley	Wetland	10	1989	Wisconsin	Grant
Rosonke	Wetland	157	1989	Iowa	Chickasaw
Engle	Wetland	87	1990	Iowa	Floyd
Quade	Wetland	47	1990	Iowa	Bremer
Beine	Wetland	20	1991	Iowa	Bremer
Gott	Wetland	18	1995	Iowa	Bremer
Rossol	Wetland	24	1995	Iowa	Bremer
Kleve	Wetland	29	2000	Iowa	Clayton
Hartwig	Wetland	20	2001	Iowa	LaFayette
Savanna District					
Reese	Grassland	42	1990	Iowa	Blackhawk
Atkinson	Timber	107	1990	Iowa	Delaware
Krogman	Timber	66	1991	Iowa	Delaware
Dickel	Timber	108	1990	Iowa	Iowa
Telandis	Wetland	235	1992	Iowa	Scott

which are becoming popular tools for maintenance of water quality and wildlife diversity through habitat protection.

The authority for the Farm Services Agency easements comes from the Consolidated Farm and Rural Development Act (7 U.S.C. 1981 and 1985, as amended); Executive Order 11990 providing for the protection of wetlands; and Executive Order 11988 providing for the management of floodplain resources. The U.S. Fish and Wildlife Service administers the easements through the National Wildlife Refuge System. This Refuge maintains a total of 30 conservation easements totaling approximately 1,178 acres, located in 16 counties of three states, Minnesota, Wisconsin, and Iowa (Table 3). Widely dispersed easements have proven difficult to adequately manage with limited refuge private lands staff. Easements need regular inspection and management to prevent encroachment and resource degradation.

Notable State Management Areas

The states manage some important and often magnificent wildlife management areas, parks, and

Table 4: Notable State Management Areas

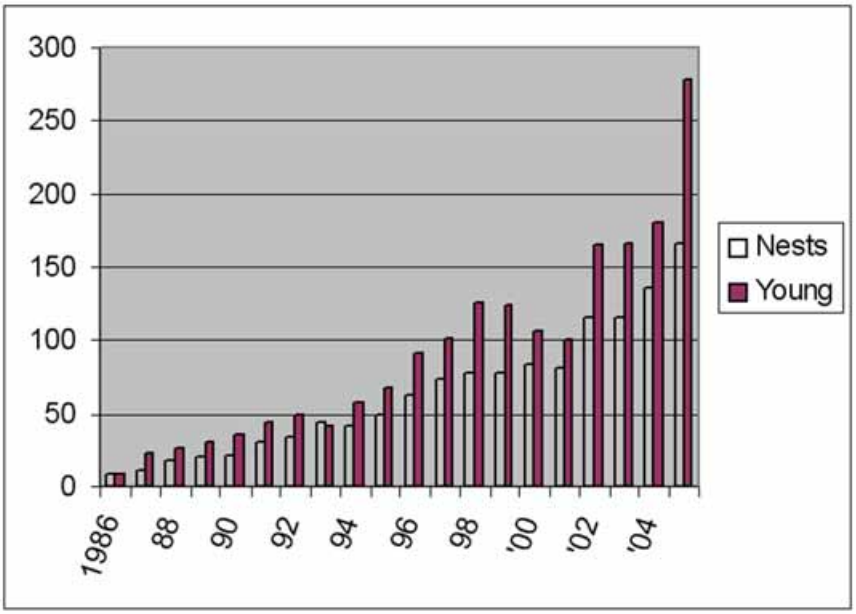
Location	Area (acres)
Minnesota	
Pool 4 Wildlife Management Area	146
McCarthy Lake Wildlife Management Area	2,873
Kellogg-Weaver Dunes Scientific and Natural Area	1,004
John A. Latsch State Park	1,654
Thorpe Wildlife Management Area	139
Great River Bluffs State Park	3,067
Total for Minnesota	8,883
Wisconsin	
Tiffany Bottoms Wildlife Area	12,740
Whitman Dam Wildlife Area	2,173
Merrick State Park	320
Perrot State Park	1,270
Van Loon Wildlife Area	3,981
Rush Creek State Natural Area	2,265
Wyalusing State Park	2,628
Wyalusing Unit Lower Wisconsin State Riverway	690
Total For Wisconsin	26,067
Great River State Trail	24 miles
Iowa	
Pool Slough Wildlife Management Area	555
Fish Farm Mounds Wildlife Management Area	576
Village Creek Area	52
Yellow River State Forest	8,503
Pike's Peak State Park	970
Mines of Spain State Recreation Area	1,387
Bellevue State Park	770
Green Island Wildlife Management Area	3,722
Princeton Wildlife Management Area	1,208
Total for Iowa	17,743
Illinois	
Palisades State Park	2,500
Total for Illinois	2,500

forests adjacent to the Refuge, both in and outside the floodplain. Coordination of similar land management needs and programs is regular and ongoing since fish and wildlife, and at times the public, do not distinguish between administrative boundaries. Table 4 shows the notable state resource lands next to the Refuge.

Threatened and Endangered Species

This section and the following section address two federally listed threatened and endangered species and three candidate threatened and endangered species that occur on or very near the Refuge. State listed threatened and endangered species are not described in this section but will be addressed in

Figure 8: Annual Bald Eagle Production on Upper Mississippi River Refuge, 1986-2005



appropriate step-down plans. The state listed species that occur on Refuge include: six mammals, 40 birds, 18 fish, seven reptiles, three amphibians, and 20 mussels (Appendix K of the Final EIS/CCP).

Bald Eagle

The Bald Eagle *(Haliaeetus leucocephalus)* was declared an endangered species in 1973 due to low populations that existed following a century of persecution and habitat loss and several decades of poisoning from hard core pesticides (DDT, dieldrin, endrin, etc.). The species began to recover after these pesticides were banned in 1972 and public awareness and management provided protection for the bird. It continues to recover and its full recovery is possible. The success story of Bald Eagle recovery is reflected in the number of active nests found on the Refuge since 1972 when one nest was present. In 1986, nine nests produced nine young, and by 1996, 62 active territories produced an estimated 91 fledged young (Figure 8). In 2005, 167 active territories produced and estimated 279 young, 98 more eaglets than in 2004. This was the largest annual increase in production recorded on the Refuge. Total production estimates were based upon the average number of young (1.67 young per nest) on 106 nests with known outcomes. Bald Eagle nesting territories occur over the length of the Refuge and are most numerous within the McGregor District which has over 90 active nests. Annual Bald Eagle production on the Refuge has shown a 31-fold increase in the 19 years between 1986 and 2005.

Higgins Eye Pearlymussel

The Higgins eye pearlymussel *(Lampsilis higginsii)* was listed as endangered in 1976 due to declines in abundance and distribution. Causes include commercial harvest, creation of impoundments in the 9-foot navigation system, channel maintenance dredging and disposal activities, changes in water quality from municipal, industrial, and agricultural activities, unavailability of appropriate fish hosts for mussel larval stages, disease (USFWS, 1983), and exotic species (especially zebra mussels).

The biological assessment of the navigation system (USACE, 2004a) indicates that *L. higginsii* occurs most frequently in medium to large rivers with current velocities of 0.49 to 1.51 feet per second and in depths of 2 to 19.7 feet. It appears to prefer water with dissolved oxygen greater than 5 parts per million and calcium carbonate levels greater than 50 parts per million. The species is significantly correlated with a firm, coarse sand substrate.

L. higginsii is usually found in large, stable mussel beds with relatively high species and age diversity.

Nearly all remaining habitat on the Upper Mississippi River for *L. higginsii* is within the 9-foot navigation project. Higgins eye pearlymussel recovery teams have identified Essential Habitat Areas that are believed to contain viable reproducing *L. higginsii* populations. These teams indicate that recovery of the species could not be accomplished without maintaining the Essential Habitat Area populations. Five of the 10 identified Essential Habitat Areas are within or near the Refuge (USACE, 2004a) as follows:

Wisconsin River (River Mile 0 - 0.2)
Upper Mississippi River at Whiskey Rock, Ferryville, Wisconsin, Pool 9 (River Mile 655.8 - 658.4)
Upper Mississippi River at Harpers Slough, Pool 10 (River Mile 639.0 - 641.4); Upper Mississippi River Main and East Channels at Prairie du Chien, Wisconsin, and Marquette, Iowa, Pool 10 (River Mile 633.4 - 637)
Upper Mississippi River at McMillan Island, Pool 10 (River Mile 616.4 - 619.1)
the Upper Mississippi River at Cordova, Illinois, Pool 14 (River Mile 503.0 - 505.5)

Recent Refuge activities involving Higgins eye pearlymussel include limited participation in recruitment projects, monitoring zebra mussels, reviewing permits for river projects, designing habitat projects, and environmental education.

Candidate Threatened and Endangered Species

Eastern Massasauga Rattlesnake

The Eastern massasauga rattlesnake *(Sistrurus catenatus catenatus)* has declined throughout its range, an area that extends from New York and southern Ontario westward to Iowa and Missouri. The decline is from 33 percent in Michigan to 100 percent in Minnesota. The primary causes are habitat loss and persecution. Past anti-rattlesnake campaigns have reduced some populations beyond a recoverable threshold. Habitat (wet sedge meadow, emergent wetland, shrub-carr) has been lost to natural succession, conversion, changes in hydrology (prolonged saturation of soil), and fragmentation (USFWS, 2003).

Eastern massasaugas occur at only one known site (Nelson-Trevino Research Natural Area, Pool 4) within the Refuge, although potential habitat exists elsewhere within the system. The snake occurs within the Black River Bottoms (Pool 7) on private land, adjacent to the Refuge and within the approved acquisition boundary of the Refuge. Small populations of massasaugas are scattered along the length of the lower Wapsipincon River in Scott and Clinton Counties, Iowa (VanDeWalle and Christiansen, 2002). The most recent records of live specimens found in that area were near Long Grove and Calamus, 13 and 30 miles west of the Upper Mississippi River floodplain. Searches in 2001 and 2002 found no live specimens in these counties.

U.S. Fish & Wildlife Service

The Refuge is participating in developing and implementing Candidate Conservation Agreements for massasaugas at Nelson-Trevino, the Black River Bottoms, and adjacent private and state land in Wisconsin.

Sheepnose

This summary is from the sheepnose *(Plethobasus cyphyus)* status report (USFWS, 2002a). The sheepnose has been eliminated from two-thirds of the total number of streams from which it was historically known (26 streams versus 77, historically). It was uncommon in what are now Mississippi River Pools 13-23.

In the upper Mississippi River, the sheepnose is an example of a rare species becoming rarer. Despite the discovery of juvenile recruitment in Pool 7, the sheepnose population levels appear to be very small and of questionable long-term viability given the threats outlined below. Along with other mussels of the Upper Mississippi River, the sheepnose is seriously threatened by zebra mussels. Other threats include channel maintenance dredging and sedimentation from tributary systems. Sedi-

ment accumulations above lock and dams generally preclude the occurrence of sheepnose.

The majority of the remaining populations of the sheepnose are generally small and geographically isolated, which makes them much more susceptible to extirpation from single catastrophic events such as toxic chemical spills. Furthermore, this level of isolation makes natural repopulation impossible without human intervention. Isolation prohibits the natural interchange of genetic material between populations, which can lead to inbreeding depression.

Conservation activities that would benefit the species include funding programs, research and surveys, outreach, and habitat improvements and conservation.

Spectaclecase

The spectaclecase *(Cumberlandia monodonta)* was declared a candidate species May 4, 2004 (USFWS, 2002b). As reported in the Federal Register, the spectaclecase is apparently more of a habitat specialist than are most mussel species. Primarily a large-river species, it can occur on outside river bends below bluff lines. It often inhabits riverine microhabitats sheltered from the main force of current. It occurs in substrates from mud and sand to gravel, cobble, and boulders in relatively shallow riffles and shoals with slow to swift current.

The spectaclecase occurred historically in at least 45 streams in the Mississippi, Ohio, and Missouri Basins. Extant populations of the spectaclecase are known from 20 streams. Seven of those populations are represented by a single specimen each. Only three or four populations could be characterized as large or stable. Threats to the continued existence of the spectaclecase appear to include exotic species, especially zebra mussels; delivery and deposition of fine sediments; small population sizes; isolation of populations; livestock grazing; wastewater effluents; mine runoff; unstable and coldwater flows downstream of dams; gravel mining; and channel dredging. Although there are ongoing attempts to alleviate some of these threats at some locations, there appear to be no populations without significant threats and many threats are without obvious or readily available solutions. In addition, the fish host of the spectaclecase is unknown; thus, propagation to reestablish the species in restored habitats and to maintain nonreproducing populations and focused conservation of its fish host are not yet possible. Therefore, the threats to spectaclecase are considered to be of high magnitude. However, 10 populations are reproducing or supported via immigration from large populations, and three or four of these populations may be described as large.

The spectaclecase disappeared from the Prairie du Chien, Wisconsin area in the 1920s. A 1981 survey failed to locate living spectaclecase in the Wisconsin portion of the upper Mississippi River (between Pool 3-11) using brail and SCUBA, but reported dead shells in Pool 11. The only live specimens found recently on the Upper Mississippi River were in Pool 15 and further down river; none on the Refuge portion of the Upper Mississippi River, Pools 4-14.

Wildlife Resource Conservation Priorities

The U.S. Fish and Wildlife Service's Region 3 list of Resource Conservation Priorities contains 243 species of fish and wildlife, of which, 65 birds, three mammals, six fish, two reptiles, 26 invertebrates, and 13 plants occur on the Refuge (Appendix K of the Final CCP/EIS). These species are considered to be in the greatest need of attention under the Service's full span of authorities. The Resource Conservation Priorities identifies strategies that will contribute to the conservation, protection, and recovery of migratory birds, threatened and endangered species, and interjurisdictional fish, as well as the habitats on which they depend, thus assisting in fulfilling Service missions.

The fact that a species is not included on the Resource Conservation Priorities list does not mean it is unimportant; it means only that when faced with the choice of addressing the needs of several species, the Service should place emphasis on those identified as priority from a Regional perspective. Many species not listed will receive incidental benefits from Refuge management. The Resource Conservation Priorities list will assist in prioritizing workloads, focusing conservation actions, identifying research priorities and training needs, preparing of Refuge plans, and developing budgets.

Migratory Birds

The U.S. Fish and Wildlife Service is responsible for the conservation and management of more than 800 species of migratory birds that occur in the country. In 2004, the Service released the Migratory Bird Program's ten-year strategic plan, "A Blueprint for the Future of Migratory Birds" (USFWS,

2004). It calls for cooperation from all governments and partners to ensure the continued survival of migratory birds. The Blueprint identifies three priorities for the Service's Migratory Bird Program: 1) address the loss and degradation of migratory bird habitat, 2) improve scientific information on bird populations, and 3) increase partnerships to achieve bird conservation. Implementation of Refuge plans will compliment these priorities by addressing needs of some Birds of Management Concern listed in an appendix to the Blueprint.

Waterfowl

National Wildlife Refuges play a crucial role in providing breeding, migrational, and wintering ground habitat for waterfowl. Over the past 75 years, the U.S. Fish and Wildlife Service has strategically established many of its refuges to help meet widely held waterfowl conservation goals. Features common to refuges is the inclusion of closed areas, which provide waterfowl the opportunity to feed and rest without disturbance during migration and at wintering locations. Without disturbance, waterfowl are provided opportunity for molting, preening, pair bonding and fat storage, all of which help build healthier populations. Closed areas also help keep regional populations in and around refuges, providing hunting opportunity on adjacent public and private lands. The value of closed areas to waterfowl would decline if they were frequently moved around or rotated.

Refuge Waterfowl

The Refuge lies within the Mississippi Flyway, through which an estimated 40 percent of the continent's waterfowl migrate. It is a critical migration corridor (Reid et al. 1989) for 10 species including Tundra Swans, Ring-necked Duck and Hooded Merganser. The other seven species are also on the U.S. Fish & Wildlife Service's Region 3 Resource Conservation Priority List and include: Lesser Snow Geese, Canada Geese, Wood Duck, Mallard, Blue-winged Teal, Canvasback, and Lesser Scaup. The corridor is also important for an additional eight species of waterfowl.

Waterfowl populations on the Refuge can fluctuate widely from year to year due to variations in flyway populations, water, and food conditions off-river, food availability in the backwaters, and weather (Korschgen et al. 1999). These factors, combined with survey variability over the years, are considered when analyzing waterfowl use data collected on the Refuge.

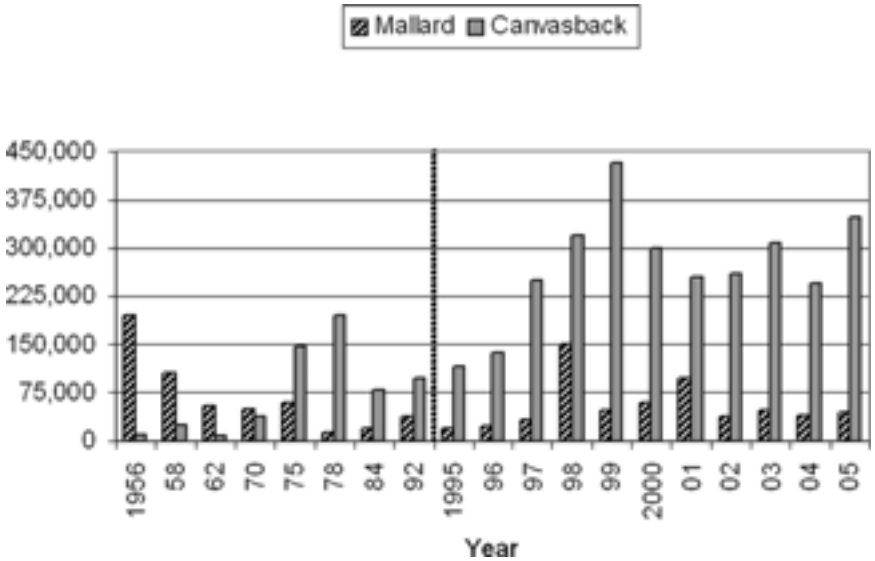
Biologists have conducted various types of ground counts and aerial waterfowl surveys of the Refuge since the 1920s. These surveys are not all-inclusive counts, but rather indices to the number of birds present on the Refuge. Changes in methods, observers, survey routes, and aircraft types preclude direct comparisons of one year or group of years to another. However, general trends and descriptions of changes in distribution of the birds can be made using the data. These variables need to be considered when interpreting data presented below.

The following discussion addresses four main groups of waterfowl: diving ducks, puddle ducks (also called dabbling ducks), geese, and swans. Common diving duck species on the Refuge are the Canvasback, Lesser Scaup, Common Goldeneye, Ring-necked Duck, Bufflehead, Ruddy Duck, and mergansers (Hooded, Common and Red-breasted). Diving ducks are recognized by their generally white, black, and gray colors. Their wings are relatively small compared to their body size, so divers must use rapid wing beats when they fly, and when launching into flight, most of this group patter along the water before becoming airborne. Divers have large feet, placed well back on the body and are not agile on land. They frequent large deep marshes, lakes, rivers, and coastal bays. They dive, sometimes to great depths, to feed on aquatic plants, fish, clams, and snails. Favorite diver foods on the Upper Mississippi River are wild celery, sago pondweed, fingernail clams, and snails.

The most common puddle duck species on the Refuge are the Wood Duck, Mallard, Blue-winged Teal, Wigeon, Gadwall, Pintail, and Green-winged Teal. Puddle ducks often have brightly colored wing patches (speculum) and males are colorful throughout, while females are generally a camouflage

U.S. Fish & Wildlife Service

Figure 9: Peak Number of Mallards and Canvasback Ducks on Upper Mississippi River Refuge, Selected Years 1956 to 2005[1]



1. *Canvasback numbers for the years 1962-1975 are for Pools 7 and 8 only. Years 1978 and 1984 are for Pools 7, 8 and 9 only.*

brown. Puddle ducks are sure-footed, often seen feeding or roosting on land. They typically utilize freshwater, shallow marshes, rivers, and ponds where they feed by dabbling on the water surface or tipping, rather than diving. Puddlers feed on aquatic insects and plants, acorns, or grain. On the Upper Mississippi River, they frequent backwater marshes containing arrowhead, river bulrush, cattail, and other emergent and submergent vegetation. These plant communities are steadily declining on the Refuge.

In the early years of the Refuge (1924-1935), when no locks and dams were present, lesser and greater scaup were the most common migrants (Green 1970). They utilized riverine conditions of the main and secondary channels. In the pre-lock and dam era, most of the many sloughs and wetland pockets were dried out by the fall season and not suitable for migrating waterfowl. During spring, when the bottoms were flooded, there was a greater waterfowl use and diversity.

Installation of the locks and dams brought about instant change with stabilized water levels creating productive shallow marshes and aquatic areas. Increase in waterfowl use was "phenomenal", with both diving ducks and puddle ducks migrating and staging on the Refuge. After flooding and until the 1960s, puddle ducks (such as Mallards) were more abundant than divers (such as Canvasbacks) in the fall (Figure 9). In 1956, the peak count of Mallards reached 190,000 birds while Canvasbacks reached only 10,000. By 1978, those numbers were almost reversed, with 195,000 Canvasbacks counted on Pools 7 and 8 only and 12,000 Mallards counted, Refuge-wide.

Puddle ducks declined in response to losses of secure emergent habitat due to sedimentation, wind and wave action, and continuous flooding regimes. Divers responded to habitat changes on the river toward more open water conditions that support underwater plants. At the same time, crucial diving duck habitat was lost in adjacent states due to habitat degradation and drainage.

During the 1980s, numbers of Canvasbacks declined to about 80,000 birds and mallard numbers increased to about 40,000. These declines reflected reductions in continental populations and losses in Refuge habitat. Since 1997, canvasback peak numbers on the Refuge have exceeded 250,000 birds each year, with a peak of 431,000 observed October 25, 1999. The Refuge generally supports 60 to 75 percent (82 percent in 2005) of the Canvasbacks counted in the eastern U.S during annual Coordinated Canvasback surveys (Figure 10).

Figure 10: Percent of the Eastern Population of Canvasbacks that Occurred on Upper Mississippi River Refuge During the Coordinated Canvasback Survey, 1974-2005

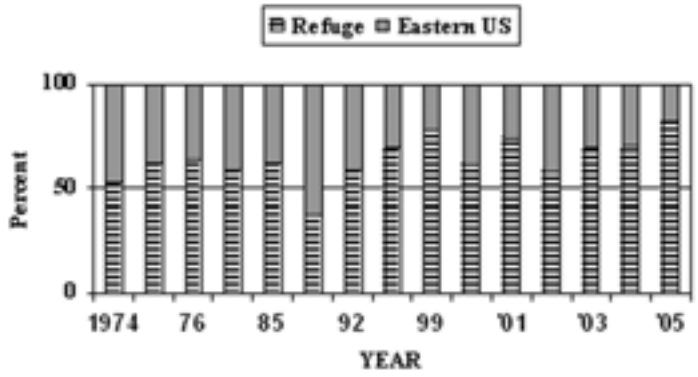
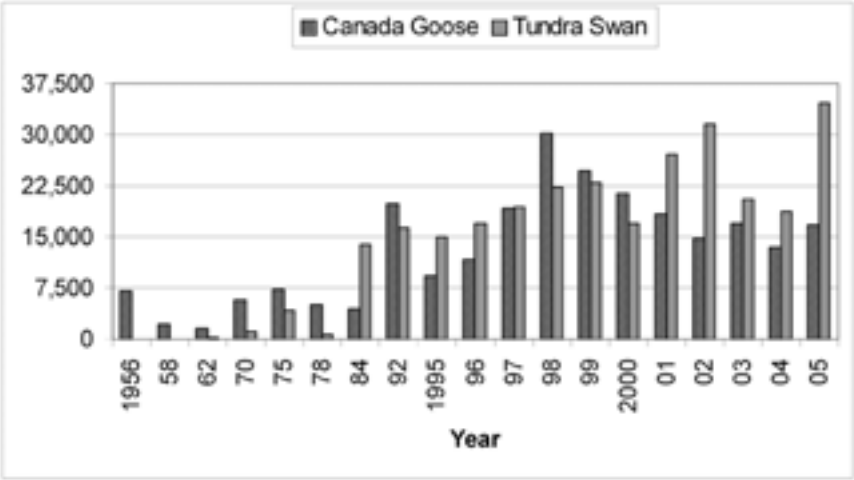


Figure 11: Peak Number of Canada Geese and Tundra Swans on Upper Mississippi River Refuge, Selected Years 1956-2005



Canada Goose and Tundra Swan numbers were much lower between 1924 to 1965 than they are today (Figure 11). Canada Goose peaks ranged from less than 1000 to about 7,500 during that period. Recent peaks range from 10,000 to 30,000 geese. The increase reflects higher populations of geese in the flyway and the availability of habitat on the river.

Tundra Swans did not begin to use the Mississippi River as a significant migration stop-over until the mid-1980s when peak numbers reached nearly 15,000 swans in 1984. Only about 100 were counted in the 1950s. Peak counts have exceeded 30,000 birds in recent years and it is estimated that 20 percent of the Eastern continental population migrates through the Refuge each fall. The Refuge is an important rest stop for family groups of swans during migration. Aerial surveys and video surveys in 1998-99 revealed that "at one point in late November, Pools 4-9 could have been used by 51.7 percent of all cygnets in the eastern population" of Tundra Swans (Thorson, 2002).

Figure 12: Average Dabbling Duck Use-days by Pool, 1997-2004, Upper Mississppi River Refuge

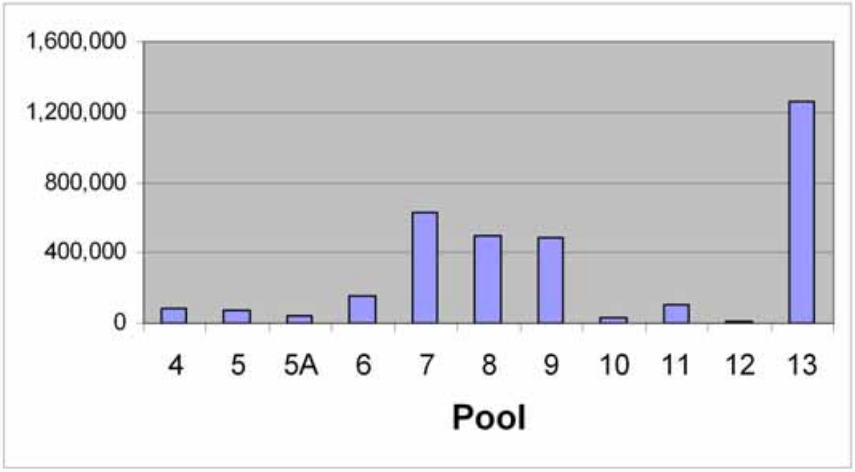
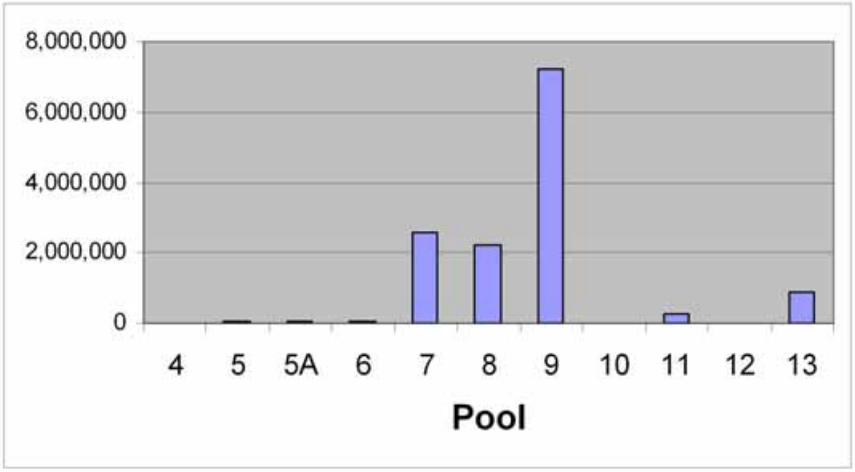


Figure 13: Average Diving Duck Use-days by Pool, 1997-2004, Upper Mississippi River Refuge

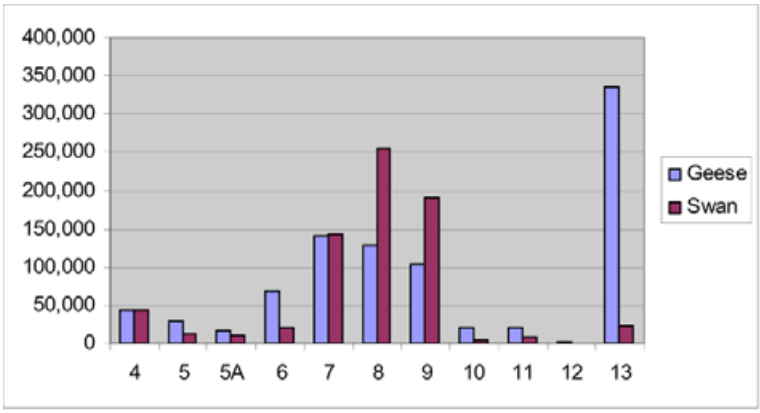


The Refuge supports breeding waterfowl populations of Mallards, Wood Ducks, Hooded Mergansers and Canada Geese. Mallard duckling production on islands in Pools 7 and 8 has been monitored most years since 1981 by Wisconsin Department of Natural Resources (Nelson and Andersen, 2003). Success rates range from 11 percent to 89 percent (average is 66 percent in Pool 7 and 52 percent in Pool 8). Nest success reflects the extent of predator-free conditions on islands. Annual production (duckling hatched) averages 785 on Pool 7 and 229 on Pool 8 islands. State biologists and managers are interested in promoting local mallard production on natural and man-made islands of the Refuge. Grassland nesting cover is difficult to maintain in floodplain habitat where natural processes are promoted.

Waterfowl Management Challenges

Waterfowl management challenges on the Refuge center around the need to provide secure resting and feeding habitat for birds in migration, as well as distribute hunting opportunities throughout the Refuge. Optimal bird distribution is achieved by

Figure 14: Average Tundra Swan and Canada Goose Use-days by Pool, 1997-2002, Upper Mississippi River Refuge



providing adequate food resources (carrying capacity) where birds will not be disturbed. Managers consider various factors that influence waterfowl distribution on the Refuge including the affects of hunting and other forms of human disturbance on waterfowl, the amount of available food, the longitudinal distribution of food resources on the river, the distances ducks are known to fly from roosting to feeding sites, and other biological needs.

Current observations and survey data clearly show that ducks, swans and geese are not evenly distributed on the Refuge during fall migration (Figure 12, Figure 13, and Figure 14). This is validated with weekly aerial waterfowl survey data that are converted to use-day numbers. Such data help describe the carrying capacity of an area, i.e., how many birds can be supported with food and resting sites for how long. Use-days are the product of the average the number of birds counted between two counts multiplied by the number of days between those counts. For example, first count has 1,000 birds, second count eight days later has 2,000 birds (1500 x 8 = 12,000 use-days). Between 1997 and 2004, most of the annual use-days occurred in four of 12 Pools on the Refuge (Pools 7, 8, 9, and 13). These pools total 91,143 acres, or 38 percent of the entire Refuge, but have over 80 percent of the total waterfowl use-days over the past 8 years. On average, 86 percent of the puddle duck use-days were in these four pools, as were 98 percent of the diving duck, 81 percent of the Canada Goose, and 87 percent of the Tundra Swan use-days .

This uneven distribution is attributed to the presence or absence of abundant food resources that occur in areas with reduced levels of human disturbance (closed areas). Optimal conditions occur best in Pools 7, 8, 9, and 13 and are nearly absent in other Pools. Management intends to achieve a more even distribution by enhancing habitat conditions and minimizing human disturbance factors for all waterfowl groups throughout the Refuge.

If habitat quality and levels of protection were similar in all Refuge pools, waterfowl distribution would continue to be somewhat uneven along the Refuge because of inherent differences in size, geomorphology, and hydrology among the pools. However, a more optimal distribution is possible if carrying capacity and habitat security are improved in pools up and downstream of Pools 7, 8, and 9.

It is widely understood that human disturbance of waterfowl on the breeding grounds can be detrimental to production of young birds. Human disturbance of migrating waterfowl can “have dramatic effects on the bird’s energy balance” (Korschgen et al., 1985) and influence survival and production of young in subsequent years. The better the quality of habitat, with no disturbance, the quicker birds replenish fat reserves during migration.

Four major categories of human disturbance have varying impacts on waterfowl (Korschgen and Dahlgren, 1992). These factors, listed in order of decreasing disturbance, include “rapid over water movement with loud noise (power boats, airboats, low-flying airplanes, and helicopters), over water movement with little noise (sail boats, canoes, kay-

aks), little overwater movement or noise (wading or swimming), and shoreline activities (bank fishing, birdwatching, hiking, car traffic)." Raptors and mammals (Bald Eagles, raccoon) can also disturb waterfowl.

The "closed area" system on the Refuge attempts to provide reduced disturbance to waterfowl within an established area via the following closed area regulations:

> "closed to all migratory bird hunting; other hunting and trapping is only allowed beginning the day after the close of the state duck hunting season, until season closure or March 15, whichever comes first, except turkey hunting is allowed during state seasons."

Complete sanctuary conditions do not occur in Refuge closed areas with one exception, Spring Lake on Pool 13, because public entry is allowed for other purposes, including recreational boating, angling and commercial fishing.

Upon establishment of the Refuge in 1924, the entire Refuge was closed to entry. Soon, in the 1930s, the Refuge was open to hunting except for 20 closed areas, totaling 34,150 acres (see Appendix Q of the Final EIS/CCP). Closed areas were on U.S. Fish and Wildlife Service fee-title lands only and did not have easily recognizable boundaries, nor did they protect the best habitats for migrating waterfowl. Actually, these early closed areas were put in place for reasons of management convenience more so than meeting needs of migrating waterfowl. Eventually, modifications were made in 1957-58 to include 14 units, covering 41,600 acres. At the time of establishment, these closed areas were all quite functional in harboring birds because they had adequate habitat and successfully reduced impacts of hunting and other disturbance factors. These closed areas continue to provide core elements of the existing system of 15 areas (14 closed areas and one sanctuary) that total 44,544 acres.

Over the years, boundary adjustments have been made which have reduced the size of many closed areas. An exception is the Trempealeau National Wildlife Refuge which has increased from about 700 acres in 1957 to nearly 6,226 acres today. One new closed area, the Pool Slough Closed Area, became operational on Pool 9 in 2003. About 1,100 acres of this 1,350-acre closed area are located on the Refuge. The Iowa Department of Natural Resources owns the remaining acres and has designated the site a waterfowl refuge and closed to all trespass from September 15 through December 25, then open to hunting and trapping.

In the 45 year interval since 1957, changes have occurred within the closed area system so that not all closed areas are functioning as intended. Changes include habitat loss and associated amount of available food, waterfowl population changes, dominant species present, and extent and type of public use. This imbalance in closed area ecology has contributed to the uneven distribution of waterfowl on the Refuge as noted in the discussion above. For example, Canvasback use has greatly increased in some closed areas and "open" areas of Pools 7, 8 and 9, but declined precipitously in others due to habitat losses and possible disturbance factors. The extensive loss of shallow- and deep-water marshes of the Refuge, both within and outside closed areas has resulted in declines in puddle duck use of the Refuge.

A key factor influencing waterfowl distribution and use of closed areas is carrying capacity, or the amount of available food for waterfowl, such as plant seeds and tubers and fingernail clams and mayflies. This carrying capacity component "is probably the most important variable for evaluating criteria for managing waterfowl closed areas" (Kenow, et al. 2003). The availability of plant food resources has been assessed for various aquatic, marsh, and wet meadow plant communities in Pools 7 and 8 (Kenow, et al. 2003). Kenow acquired seeds and tubers from 9 selected vegetation types within Pools 7 and 8 to generate production estimates for each type. These estimates were then extrapolated to the larger Upper Mississippi River landscape using a GIS application model. Plant food production is expressed in terms of gross energy value to waterfowl. The investigators note that plant food productivity estimates are inherently variable. Consequently, production variance estimates are large and need be considered when using extrapolated production estimates.

Tuber production, primarily from arrowheads and wild celery, provided the most significant contribution to overall gross plant food energy available to waterfowl. Arrowheads are found primarily in deep marsh perennial vegetation types, while wild celery occurs in submerged vegetation types.

Slivinski (2004) conducted a GIS analysis (based on year 2000 photography) of the potential waterfowl carrying capacity for the entire Refuge, and for existing and proposed closed areas within the Refuge. The entire report and appendices are posted at

Table 5: Estimated Waterfowl Food Plant Energy Production in Closed Areas on Pools 4-14 Under Four Alternatives, Upper Mississippi River Refuge[1]

Selected Land Cover Types	Refuge		Alternative A Closed Areas		Alternative B Closed Areas			Alternative C Closed Areas			Alternative D Closed Areas		
	Total Area (Acres)	Plant Food Energy (million Kcal)	Total Area (Acres)	Plant Food Energy (million Kcal)	Total Area (Acres)	Plant Food Energy (million Kcal)	Percent Change from Alt. A	Total Area (Acres)	Plant Food Energy (million Kcal)	Percent Change From Alt. A	Total Area (Acres)	Plant Food Energy (million Kcal)	Percent Change From Alt. A
Deep Marsh Annual	482	300	280	174	280	170	0%	280	174	0%	240	150	-14%
Deep Marsh Perennial	5,496	39,606	852	6,142	1,431	10,313	68 %	863	6,222	1%	1,119	8,064	31%
Open Water	95,734	1,110	18,771	218	22,819	265	22%	18,823	218	0%	18,777	218	0%
Rooted Floating Aquatic	19,091	4,051	3,957	840	5,743	1,219	45%	3,984	845	1%	4,428	940	12%
Shallow Marsh Perennial	11,354	5,112	1,202	541	2,579	1,161	115%	1,192	537	-1%	1,534	691	28%
Sub-merged Vegeta-tion	20,978	14,801	7,659	5,404	9,009	6,356	18%	7,649	5,396	0%	7,937	5,600	4%
Wet Meadow	10,586	1,237	1,281	150	1,770	207	38%	1,292	151	1%	1,280	150	0%
Other Cover	70,112	0	9.968	0	16,846	0		10,008	0		8,506	0	
Total	234,327	66,127	43,970	13,625	60,476	19,694	45%	44,091	13,701	1%	43,821	15,811	16%

1. *Acreage values were made at the time of the Slivinski study (2004); values shown in Table 3, Appendix C, are current and correct.*

http://midwest.fws.gov/planning/uppermiss/index.html. Refuge-wide, total gross energy available in eight vegetative types was calculated to be 66.2 billion kilocalories. If all that energy were present in just wild rice, it would equal 33.2 million pounds of wild rice; if it were all arrowhead tubers it would equal 45.6 million pounds of tubers. The actual usable (metabolizable) energy for seed and tuber resources are about one half to three fourths of the gross energy values, depending on the plant species. Variations in plant species, growing conditions, availability, human disturbance, and weather are important factors in determining the number of birds that might utilize this energy source on the Refuge.

A disproportionately high amount (63 percent) of this total energy source occurs in Pools 7, 8 and 9 and is an important factor in accounting for the uneven distribution of waterfowl using the Refuge during the fall migration (refer to discussion above). This GIS investigation shows that the presence (or addition) of deep marsh perennial and submerged vegetation types, along with the shallow marsh perennial type, is crucial to the improvement of the carrying capacity for waterfowl in the Refuge's closed area system.

Existing closed areas now encompass approximately 20 percent of the total energy present in eight vegetation types studied (Table 5). This analysis did not include forest cover types, to which future investigations should be directed.

Table 5 also shows estimates of waterfowl food plant production (gross energy) in closed areas on Pools 4-14 of the Upper Mississippi River under four alternative closed area configurations. Since Alternative E and the subsequent Final CCP were developed after Slivinski's report, it is not included in the table. However, Final CCP values are similar to Alternative D since the core areas changed little in the Final CCP.

Waterfowl managers and biologists have identified the need for refuges to be placed along migration corridors at intervals that provide secure habitat in the form of "stepping stones" or "a string of pearls." One factor used in selecting refuge or closed area locations along the corridor is the flight distance various waterfowl species will take in order to roost and/or find food free from disturbance. In

general, puddle ducks fly shorter distances (Wood Ducks 1 mile; Black Ducks 4 miles; Mallards 4-25 miles; and Pintails 12-30 miles), while Canvasbacks, a diver, will fly up to 24 miles. We have a double management challenge in this regard because some of the existing Refuge closed areas are 37 to 46 miles apart, while others are 4-16 miles distant, but have minimal waterfowl use because food resources are inadequate and/or human disturbance factors are present.

In 1978, and again in the early 1980s, river biologists and managers made three assessments of the existing closed area system in regards to its functionality in holding birds for feeding and resting, as well as providing hunting opportunities. The Wildlife Technical Committee of the Upper Mississippi River Conservation Committee proposed changes in reports completed in 1978 and 1985. The committee recommended changes to closed areas in Pools 4, 5A, 8, 9, 10, 13, and 14, but none were implemented.

Further considerations were made to modify closed areas during early stages of preparing the Refuge's 1987 Master Plan (USFWS, 1987). At that point, two new options were drafted to increase the number of acres of closed areas, but no closed area changes were included in the final Master Plan. Instead, the Plan recommended to delay any changes, pending completion of closed area studies about impacts of recreation on waterfowl concentrations and the effectiveness of voluntary waterfowl avoidance areas.

A voluntary waterfowl avoidance area (VWAA) was established, in cooperation with state and local governments and conservation organizations, on Lake Onalaska in Pool 7 in 1986 to reduce boating disturbance to waterfowl within the existing closed area. Studies on boater compliance were conducted in 1993 and 1997 (Kenow et al., 2003a). Despite a 60 percent increase in boating traffic from 1986 to 1997, lake-wide disturbance rates were comparable to 1981 levels. Investigators reported that about one third of the observed intrusions in the VWAA were by anglers and commercial fisherman. The avoidance areas contributed to the value of Lake Onalaska as a waterfowl refuge and demonstrated an effective collaboration among government agencies and non-government organizations. Further studies of the Lake Onalaska VWAA in the fall of 2004 revealed similar trends in boating activity and disturbance rates (Kenow et al., 2005).

In some areas, waterfowl hunters concentrate along sections of closed area boundaries. The quality of the hunting experience may be lessened in areas where this occurs as waterfowlers compete for prime locations. Other characteristics of these "firing line" conditions include crowding and excessive "skybusting", which can result in an increase in the number of un-retrieved birds.

On a continental scale, the Refuge is a key component of the Upper Mississippi River and Great Lakes Region Joint Venture of the North American Waterfowl Management Plan. The continental plan seeks to restore waterfowl populations to levels observed in the 1970s. The goal of the Joint Venture is to increase populations by habitat enhancement in the area, which includes Wisconsin, Michigan, and parts of Minnesota, Iowa, Illinois, and Indiana. Population objectives are set at 1,542,000 breeding ducks and 773 million duck use-days during fall migration. The goals will contribute to the continental goals of 62 million breeding ducks and 100 million ducks in the fall flight.

Recent fall migration counts reveal a peak in 1998 of nearly 33 million use-days on surveyed areas of the Refuge; more recent years range between 12 and 16 million use days. Joint Venture goals for carrying capacities of fall migration habitat are 500 duck use-day per acre in states with mid-migration habitat (in Illinois) and 200 duck use-days per acre in habitats within production focus areas (Iowa, Minnesota, and Wisconsin).

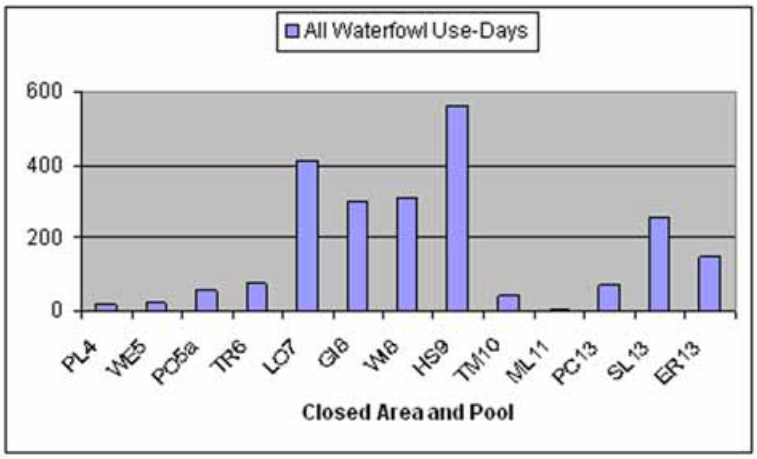
Refuge closed areas secured an average of 48 to 73 percent of the duck use-days for the period 2000-03. The closed areas of Pools 7, 8, 9 and 13 exceeded the 200 duck use-day per acre goal for divers, but puddle duck goals were met only in the Goose Island closed area of Pool 8 (Figure 15, Figure 16, and Figure 17). Harpers Slough closed area of Pool 9 was the only closed area of the Refuge to exceed the 500 duck use-day per acre goal for waterfowl, in this case it was met for diving ducks.

Other Migratory Birds

Songbirds

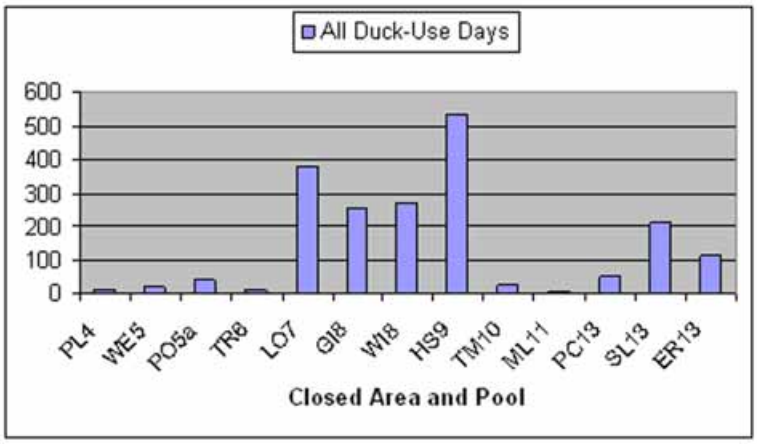
Songbirds include a wide array of landbirds such as hummingbirds and woodpeckers, as well as the large order of birds called passerines or "perching" birds. Passerines comprise more than half the world's species of birds and all have a perching foot that includes three toes forward and one toe backward. They range in size from wrens to ravens. Many passerines eat insects as well as fruit, and

Figure 15: Average Number of Duck-use-days per Acre of Closed Area, 2000-2003, Upper Mississippi River Refuge[1]



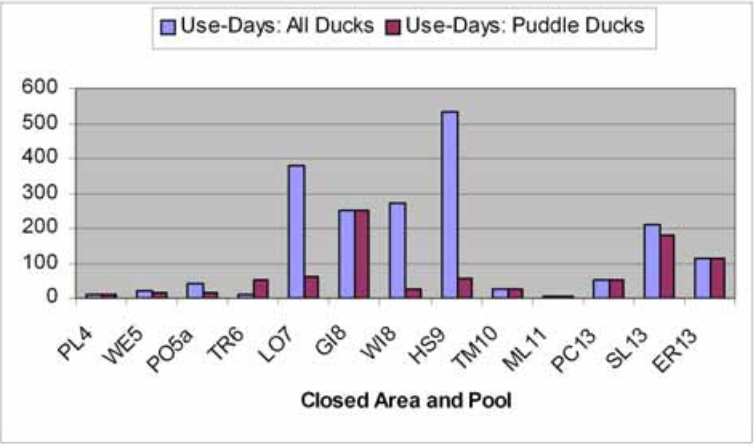
1. *Abbreviations: PL=Peterson Lake, WE=Weaver Bottoms, PO=Polander Lake, TR=Trempealeau NWR, LO=Lake Onalaska, GI=Goose Island, WI=Wisconsin Islands, HS=Harpers Slough, TM=Twelve Mile Island, ML=McCartney Lake, PC=Pleasant Creek, SL=Spring Lake, EL=Elk River. Data based on aerial surveys, except ground surveys at TR.*

Figure 16: Average Number of Waterfowl (Ducks, Geese, and Swans) Use-days per Acre of Closed Area, 2000-2003, Upper Mississippi River Refuge[1]



1. *Abbreviations: PL=Peterson Lake, WE=Weaver Bottoms, PO=Polander Lake, TR=Trempealeau NWR, LO=Lake Onalaska, GI=Goose Island, WI=Wisconsin Islands, HS=Harpers Slough, TM=Twelve Mile Island, ML=McCartney Lake, PC=Pleasant Creek, SL=Spring Lake, EL=Elk River. Data based on aerial surveys, except ground surveys at TR.*

Figure 17: Puddle Duck Portion of the Average Number of Duck Use-days per Acre of Closed Area, 2000-2003, Upper Mississippi River Refuge[1]



1. *Abbreviations: PL=Peterson Lake, WE=Weaver Bottoms, PO=Polander Lake, TR=Trempealeau NWR, LO=Lake Onalaska, GI=Goose Island, WI=Wisconsin Islands, HS=Harpers Slough, TM=Twelve Mile Island, ML=McCartney Lake, PC=Pleasant Creek, SL=Spring Lake, EL=Elk River. Data based on aerial surveys, except ground surveys at TR.*

include flycatchers, shrikes, vireos, crows, jays, chickadees, nuthatches, tanagers, cardinals, sparrows, and finches.

Prior to the 20th century, songbirds were abundant beyond our imaginations. However, in the last 75 years scientists have documented declines in many songbird species (Terborgh, 1989; Finch, 1991), particularly the "neotropical migrants," those that breed in North America and overwinter in the neotropics of Mexico, Central and South America and the Caribbean. Habitat loss here and there is the main culprit. Nonetheless, the Refuge still provides a vital migration corridor for songbirds, many of which fly thousands of miles each year between Central and South America and the United States and Canada. We estimate that millions of birds migrate through the area each year.

Volunteer "birders" and researchers have documented over 160 species of songbirds, including 32 species of warblers, on the Refuge. "Point count" surveys (Ralph, et al., 1993) have detected a total of 199 species of birds on the Refuge. During the period 1994-2003, observers conducted an average of 323 counts per year. The surveys reveal an average of about 120 species during spring migration (the first two weeks of May are the Refuge's peak spring migration dates), and about 80 species of summer nesting residents (Figure 18). Nesters include the American Robin, Downy Woodpecker, Great-crested Flycatcher, Prothonotary Warbler, Tree Swallow, Yellow-headed Blackbird, Belted Kingfisher, Northern Cardinal, Brown Creeper, and the rare Cerulean Warbler.

The Refuge is developing a cooperative project with U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin to analyze the songbird point count data in terms of bird habitat associations and seasonal abundance. Population trend analysis is pending.

The U.S. Fish and Wildlife Service and various conservation organizations have identified several bird species of management concern that occur on the Refuge (see Appendix K of the Final EIS/CCP for a complete bird list). Five of seven species singled out for priority work by Partners in Flight in its Bird Conservation Plan for Physiographic Region 16 (in which most of the Refuge occurs) are found on or adjacent to the Refuge (Knutson et al., 2001). Some use the Refuge only in migration, others nest there (Table 6).

The U.S. Fish and Wildlife Service's Region 3 identified 26 songbirds as Regional Conservation Priority (RCP) species that occur on the Refuge (Appendix K of the Final EIS/CCP, bird list).

American Bird Conservancy (ABC), a not-for-profit organization, whose mission is to conserve

Figure 18: Average Number of Bird Species Observed and Number of Counts Conducted,1994-99, Upper Mississippi River Refuge

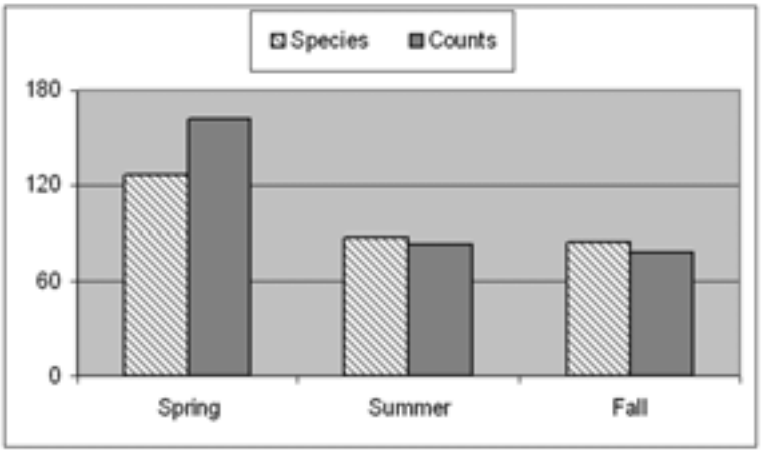


Table 6: Partners in Flight, Physiographic Region 16 Priority Bird Species Found on Upper Mississippi River Refuge Including Seasonal Occurrence and Habitat Associations.

Species	Habitat Association[1]					
	Bottomland Forest	Emergent Wetland	Mixed Wetland - Upland	Prairie	Upland Forest / Bluff	Wet Meadow
Sedge Wren		1,2,3	2	1,2		1,2,3
Golden-wing Warbler	1,		1,	1, 2	1	
Cerulean Warbler	1, 2, 3		1		1, 2	
Black-billed Cuckoo	1, 2	2, 3	2	2	1, 2	
Red-headed Woodpecker	1, 2, 3	1,2, 3	1,2, 3	1, 2, 3	1, 2, 3	

1. 1= spring migrant; 2= summer (potential nesters), 3= autumn migrant

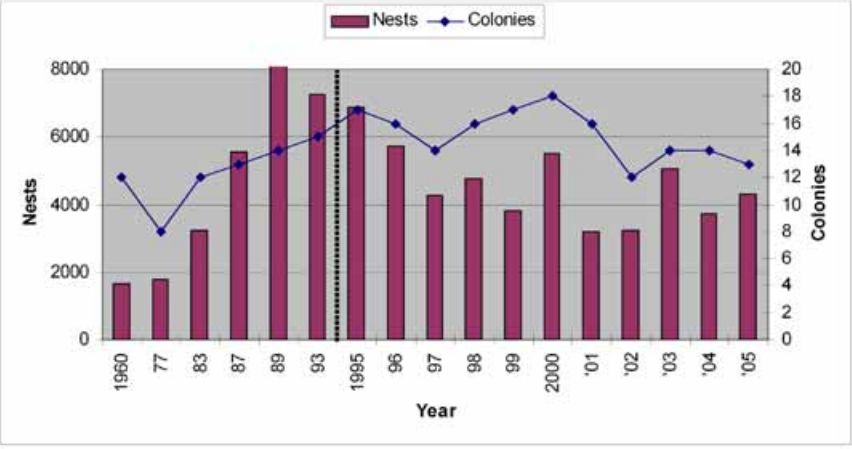
wild birds and their habitats throughout the Americas, produces a "Green List" that contains all the highest priority birds for conservation in the continental United States and Canada (American Bird Conservancy, 2004). This list builds on the Partners in Flight assessments and expands the list to all taxa and divides it into three broad categories. The Highest Continental Concern birds suffer multiple problems and include federally listed threatened and endangered species. The only two species of this category on the Refuge are the Golden-winged Warbler, seen in migration, and the Whooping Crane, recently observed in Refuge floodplain wetlands. The cranes are part of an experimental flock released at Necedah National Wildlife Refuge in central Wisconsin, over the past 3 years.

The second American Bird Conservancy category, Moderately Abundant Species with Declines or High Threats lists birds with relatively high numbers but are declining at an alarming rate. Of this group (see Appendix K of the Final EIS/CCP, bird list), the Refuge harbors 32 species of waterbirds, shorebirds, woodpeckers, warblers, and blackbirds.

The Blue-winged Warbler is the only bird that occurs on the Refuge that is included in American Bird Conservancy's third category, Species with Restricted Distributions or Low Population Size, a group with populations stable and threats apparently limited, but are limited in number or range.

American Bird Conservancy also designates Important Bird Areas that are exceptionally impor-

Figure 19: Number of Colonies and Number of Nests of Great Blue Herons on the Upper Mississippi River Refuge, Selected Years 1960-2005.



tant and essential for bird conservation (American Bird Conservancy, 2004). The goal of the Important Bird Areas program is not just to recognize the sites as important, but also to mobilize the resources needed to protect them. One-third of the areas are on national wildlife refuges.

American Bird Conservancy designated the Upper Mississippi River Refuge a Globally-Important Bird Area in 1997 because it had, at that time, over 70 breeding pairs of Bald Eagles, which was over 1 percent of the United States breeding population; greater than 16,900 Tundra Swans, over 20 percent of the eastern population; and greater than 136,000 Canvasbacks, also over 20 percent of the world's population. Numbers of eagle pairs, swans and Canvasback have been significantly larger in the over the past 5 years. In addition, the Refuge had over 5,700 pairs of Great Blue Herons, concentrations of nesting neotropical migrants, and 78,500 hectares (200,000 acres) of wetlands.

Colonial Nesting Birds

Colonial nesters on the Refuge include species that nest on floating mats of aquatic vegetation, such as the Black Tern, and tree-nesting species, including Great Blue Herons, Double-crested Cormorants, Great Egrets, and Green Herons. The later species nest in small trees and shrubs throughout the Refuge, but little is known of their nesting status.

The herons, egrets and cormorants utilize floodplain forest trees (usually silver maple, cottonwood, or swamp white oak) in colonies (rookeries) containing 15 to 1,000 nests. Colonies are often on islands and/or located in the upper third of the pools where forests are most extensive. Maintenance of the floodplain forest is crucial to sustaining these tree-nesting birds.

A few colonies have been active for 15 or more years. Many colonies are abandoned within a few years and new ones show up taking their places. Great Blue Herons will generally feed near their colony within the floodplain and do not venture near other colonies (Dr. C. Custer, USGS, La Crosse, Wisconsin, personal communication). There are between 12 and 16 Great Blue Heron colonies on the Refuge, supporting a total of about 5,000 nests (Figure 19). In the 1960s there were only about 2,000 nests, but expanded to peak numbers of over 8,000 nest in 1989. The average number of nests between 1999 and 2005 was about 4,100.

Double-crested Cormorants nest in single-species colonies or in colonies shared with Great Blue Herons and Great Egrets. The Refuge's largest concentration of nesting Cormorants occurs on two adjacent islands in lower Pool 13 where more than 1,000 nests have been counted. These islands had only 16 Great Blue Heron nests present in 2003 and 2004. In the remainder of the Refuge, Cormorant nests comprise less than 20 percent of all nests in three or four colonies dominated by Great Blue Herons. Double-crested Cormorants migrate and stage along the Upper Mississippi River where up to 90,000 were observed in the 1940s. Recent counts reveal about 5,000 Cormorants staging on the Ref-

uge in the fall. This species is on the Regional Resources Conservation Priority list.

Great Egrets occur in three to five colonies dominated by Great Blue Herons on the Refuge, with a total of 90 to 400 nests present over the past 3 years. Great Egrets were rarely seen on the Refuge prior to the 1950s.

Black Terns prefer shallow-water marsh and backwater lake habitat with sparse emergent vegetation that consists of water lily, burreed, or bulrush. Dense cattail stands are avoided. Breeding habitat is variable within backwaters and the birds do not necessarily nest in the same area each year but utilize available sparsely vegetated sites. Water level is an important factor, with high water delaying or ending breeding seasons, low water facilitating access to tern colonies by predators. Terns are often in areas generally inaccessible to boaters, except airboats. Custer et al. (1998) indicated that a proposed pool-wide drawdown in Pool 8 could have a detrimental affect on nesting birds but could also enhance wetland habitat for Black Terns. Faber (1992) surveyed Black Terns Pools 4, 5, 6, 7 and 8 and found variable nest success at 7 colonies, influenced by high water and possible mammalian predators, ranging from 0 to 67 percent hatching success. The Black Tern is on the Regional Resource Conservation Priority list.

The American White Pelican is a relatively new, but common, visitor to the Refuge in spring, summer and fall. The bird does not nest on the Refuge. The closest nesting colonies are in western Minnesota (Marsh Lake) and east-central Wisconsin (Horicon National Wildlife Refuge). Large numbers (less than 100) of pelicans first showed up on the Refuge in the early 1980s, with sudden build-ups of more than 1,000 in the mid-1980s. This increase in numbers coincides with a continental increase following the ban on DDT and other pesticides in 1972. The pelican joined other species that are high on the food chain (Bald Eagle, Peregrine Falcon, Great Blue Herons, and Double-crested Cormorants) in making a strong population recovery.

Seasonal aerial and ground surveys since 1994 reveal that flocks ranging from 2 to 600 birds occur at many locations throughout the Refuge (and adjacent Trempealeau National Wildlife Refuge) spring, summer and fall. Refuge-wide, total numbers in the summer have reached nearly 1,500 birds. Aerial survey fall counts peak in late September or early October and have ranged from 442 birds in 1994 to 3,222 in 2001. Prior to 2000, pelicans had departed the Refuge by November 11; since then birds have remained until late November.

While no nesting occurs on the Refuge it is anticipated that pelicans may nest there in the future. Breeders might originate from the western Minnesota colonies, therefore, Refuge staff have color-marked nearly 1,000 flightless young birds at Marsh Lake between 1999 and 2002. Four observations of these color-marked (pink, numbered patagial tags) pelicans have been made on the Refuge and Trempealeau National Wildlife Refuge since then.

The public has indicated a concern that pelicans (as well as Double-crested Cormorants) are consuming game fish or competing with game fish for food. Food habitat studies, which require the collection of birds for stomach analysis, have not been conducted. However, cursory fish sampling in Pools 5 and 7 in 1997 indicated that primarily gizzard shad and shiner minnows were present in areas where pelicans were actively feeding. A few individuals of game fish were also present.

Secretive Marsh Birds

Secretive marsh birds include bitterns and rails that utilize wet meadow and emergent wetland habitats, both of which are declining on the Refuge. Surveys (tape play-backs) conducted during the breeding season, 1994-1999, show that Virginia Rails comprise 70 percent of the secretive marsh birds detected, followed by Sora (20 percent), Least Bittern (7 percent), and American Bittern (2 percent). More recent surveys show that Virginia Rails and Soras have about equal detectability, and the bitterns remain uncommon. The two bittern species are on the Regional Resource Conservation Priority list.

Raptors

Raptors are birds of prey that include vultures, hawks, and eagles. Several species nest on the Refuge and more migrate along the Mississippi River Corridor. The Refuge supports approximately 160 nesting pairs of Bald Eagles (see Endangered Species section), 30 Red-shouldered Hawk pairs, and probably less than 10 Osprey nest sites.

Red-shouldered Hawk breeding populations in the midwestern states have declined since the 1960s. The floodplain of the Upper Mississippi River provides habitat for nesting Red-shouldered Hawks. Nest territories on the Upper Mississippi River 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 to restrict logging in nesting areas, avoid fragmentation of large forest tracts, allow some thinning of younger forest stands to assist in development of overhead canopy cover, and combat invasion of reed canary grass that might inhibit growth of cottonwood and silver maple.

The fall raptor migration along the river corridor has been monitored along the bluffs adjacent to Pools 4, 5A, 8, 10 and 13. Migration data can be used to monitor raptor populations but surveys on the Upper Mississippi River are inadequate to reflect population trends in the Midwest. In the mid-1990s, observers at Eagle Valley Nature Preserve, Glen Haven, Wisconsin, (on bluffs overlooking Lock & Dam 10), documented between 14,600 and 30,700 raptors, of 17 species, during standard observation periods (Mandernack, et al. 1997). Peak daily counts totaled over 1,000 individuals on three different occasions. Four species comprised 87 percent of the count in 1996: Bald Eagle, Broad-winged Hawk, Sharp-shinned Hawk and Red-tailed Hawk. The majority of the migration occurs from mid-September to mid-October.

The Bald Eagle, Northern Goshawk, Red-shouldered Hawk, and Peregrine Falcon occur on the Refuge and are on the Regional Resource Conservation Priority list.

Fish

The Refuge supports at least 119 species of fish, including sport fish (a $250 million industry riverwide), commercial fish (a $5 million industry), forage fish (gizzard shad, minnows and other small fish on which predatory fish feed), ancient fish (paddlefish and sturgeon), and many other unique species that make the river's fishery so diverse (Gutreuter and Theiling, 1999). Populations of at least 41 fish species are in such poor shape that they are listed as threatened or of concern by state or federal agencies along the Upper Mississippi River (see Appendix K of the Final EIS/CCP). Loss of habitat, the navigation system, over-exploitation, and impacts of exotic species (see discussion below) are the main causes. Pools 4, 8 and 13 each support 55 to 80 species of fish, as determined from recent surveys.

Unlike most Refuges, Congress established the Upper Mississippi River Refuge (1924) for both fish and wildlife, not just wildlife as in most cases. Specific concern was noticed over fish being stranded due to low water conditions (see discussion below), the lack of habitat for black bass (largemouth bass), and prospects of converting the floodplain to agriculture. During this period prior to locks and dams, the river was free flowing and fish migrated north and south. The most prevalent fish were species adapted to river flow, such as walleye, skip-jack herring, paddlefish, sturgeon, and catfish. Buffalo fish and catfish were primary commercial fish at the time.

U.S. Fish & Wildlife Service

Species that required ponded, slack-water habitats, such as bass, northern pike and sunfish were present but not as common. Unfortunately, the northerns and bass would get stranded when floodplain ponds dried up in the summer. In fact, a major function of the Refuge in the 1920s was to "rescue" these fish, sometimes netting hundreds of thousands of pounds, some shipped by train across the country, others released in area lakes and rivers. With construction of the locks and dams, flooding solved the stranding problem and since then backwater fish have become abundant.

Sport Fish

Favorite sport fish on the Refuge include walleye, sauger, white bass, largemouth bass, smallmouth bass, channel catfish, northern pike, bluegill, and crappies. Fishing tournaments are ever-increasing and may put extra pressure on local fish populations. The following fish species accounts are largely based upon data supplied in the Upper Mississippi River Conservation Committee's Fisheries Compendium, Third Edition (UMRCC, 2004a).

Walleye populations flourish in the Upper Mississippi River due to high quality habitat meeting life requirements. Recent creel surveys show they rank third in harvest behind white bass and sauger in Pool 4. A 15-inch length limit, implemented in 1990, has increased harvest weights by 50 percent on Pools 11 and 13, as well as catch rates. Upper Mississippi River Conservation Committee biologists concluded in the 2004 report that a continuous open season on walleye should continue on the Upper Mississippi River while agencies continue to monitor population trends. Similar conclusions were made concerning sauger populations on the Upper Mississippi River.

Summer creel surveys of white bass in Pools 11 and 13 from 1993 to 2000 showed the species ranked from third to seventh in the annual numerical harvest. On the Upper Mississippi River, creel limits are liberal, as over-harvest does not appear to be a problem.

Prior to locks and dams, prime smallmouth bass fishing grounds were found between Wabasha and Minneapolis, Minnesota, and near Lansing, Iowa. Presently, smallmouth bass populations in Pools 1-14 are increasing and are a significant component of the fishery. This species is prominent in bass tournaments. For example, Minnesota's records of four tournaments held between 1996 and 2000, show that all the largest fish were smallies (20 to 21.5 inches long) and 66 to 85 percent of the bass caught were also smallmouths. The public is showing interest in managing this species separate from largemouth bass (UMRCC, 2004a).

Recent creel surveys show that largemouth bass ranked second to fifth in numeric harvest in backwater complexes of the Upper Mississippi River. This species is the number one preference of anglers fishing in backwater habitats. Catch and release has become a common practice; of 19,000 largemouths caught by interviewed anglers, 87 percent were released. Largemouth bass are intensively managed by state agencies. In 1991, a 14-inch minimum limit was established. "Under present conditions, it appears that largemouth bass are not being over-harvested, except possibly during winter where bass are concentrated in over-wintering areas and are subject to high angling pressure. Harvest regulations between adjoining states should attempt to be uniform if possible" (UMRCC, 2004a).

Bluegills are the number one harvested fish species of the Upper Mississippi River backwaters. Loss of suitable spawning and over-wintering backwaters due to sedimentation poses the most serious threat to bluegill survival. Overwinter survival is directly related to sufficient oxygen level and sufficient water depth to maintain ingress and egress under thick ice and snow cover. Preferred winter habitat for bluegill on the Upper Mississippi River contains depths in excess of 3 feet, temperatures above 34.7 degrees Fahrenheit, and no continuous flow (UMRCC, 2004a). Quality sized bluegill (> 7 inches) in Pool 5 and 5A backwaters experienced over 80 percent percent winter angling exploitation in 1997-98. Bluegills are very prolific and therefore have few harvest restrictions, although there is a 25 bag limit on the Minnesota-Wisconsin border waters. Minnesota has an experimental bag limit of 10 fish daily on the Minnesota side of Pools 5, 5A, and 8. The lack of uniform regulations between states has created recurrent controversy between anglers and biologists in areas where restrictive bag limits exist (UMRCC, 2004a). Bluegills are an important prey species for flathead catfish, largemouth bass, and bowfin. They are host to 14 species of mussels found in the Upper Mississippi River.

Recent creel surveys of various pools of the Upper Mississippi River show that crappies ranked as one of the top two most harvested sport fish. Data from 1990-1997 reveal abundance is variable and no observable trend in population. No new changes in regulations of crappie harvest are recommended at this time (UMRCC, 2004a).

Other Fish

Paddlefish

The paddlefish is one of the ancient fish of the Upper Mississippi River and is distinguished from all other fish by its broad, flat bill-like snout. It may weigh up to 90 pounds. They spawn in flowing water. People consume paddlefish meat and roe (caviar). The worldwide protection of sturgeon species in 1998 is expected to have a dramatic impact on commercial paddlefish harvest by creating a greater demand for paddlefish caviar as a surrogate to sturgeon roe. It has declined throughout its range due to habitat loss and over-harvest. Its northern-most range on the Upper Mississippi River is in the Minnesota – Wisconsin border area. They migrate along the Upper Mississippi River and will move between pools, usually over dams in high water. They feed on plankton in both fast flowing main channel areas and in the backwaters. Competition from invasive species such as silver and big head carp, plankton eaters, is a potential serious threat to paddlefish if

these species move up the Upper Mississippi River (UMRCC, 2004a). Paddlefish are a protected species in Minnesota and Wisconsin.

Sturgeon

Included in the list of "ancient species" three kinds of sturgeon inhabit the Upper Mississippi River: the lake, pallid and shovelnose. These species date back to 50 million years ago. The pallid sturgeon is endangered and occurs in waters well south of the Refuge. Lake and shovelnose are rare or uncommon in most Refuge waters, but the shovelnose can be an important commercial species in some areas.

The shovelnose feeds on aquatic insects and fish, and grows to about 24 inches. They spawn on gravel in fast flowing water. They are harvested for their meat and roe. Shovelnose populations are limited due to over-harvest, habitat degradation, and water pollution of the last century. Flow alteration and habitat fragmentation by dams has jeopardized the long term health of the species. However, present commercial harvest of sturgeon on the Upper Mississippi River does not appear to be affecting shovelnose. The shovelnose is the host to three species of mussels and is the only known host of the hickorynut mussel, which inhabits water of 3.9-5.9 feet deep over sand or gravel in good current. This coincides with shovelnose sturgeon habitat (UMRCC, 2004a).

A framework for the management of paddlefish and sturgeon in the United States was developed under the auspices of the U.S. Fish and Wildlife Service, National Paddlefish and Sturgeon Steering Committee. Eleven management recommendations were made but little funding is available to address these issues. Sturgeon management on the Upper Mississippi River should focus on: 1) structural habitat features, 2) alterations of flow variability necessary to maintain and enhance natural and manmade habitat, 3) harvest restrictions, and 4) supplementation of population numbers through aquaculture (UMRCC, 2004a).

Invasive Fish

See Section on page 68 for a discussion of invasive fish species.

Fish Passage

Fish that migrate in rivers are classified as potamodromous. There are at least 34 species of fish that migrate on the Upper Mississippi River, some of which include: paddlefish, sturgeon, gar, skipjack herring, suckers, redhorse, channel catfish, flathead catfish, northern pike, white bass, largemouth bass, smallmouth bass, walleye, sauger and freshwater drum.

Locks and dams disrupt the ecological integrity of the river systems and have been implicated in the decline of numerous fish species (UMRCC, 2004a). These structures restrict upstream movement of fish, alter migration behavior, and impede access to foraging habitat and wintering areas. The Upper Mississippi River System dams create a head and current velocity that exceeds the swimming speed (about 1-4 feet per second.) of most fish known to migrate in the Upper Mississippi River. Current velocities are sufficiently low when the dam gates are out of the water during high discharge conditions to allow some fish to move upstream.

Fish passage can be enhanced with modifications to operation of the dam gates, locking fish through a dam similar to boat lockage, modifying water level management plans (to allow longer periods of open river conditions), and modifying the lock filling and emptying system. Structural alternatives include Denil fishways, fish elevators, and bypass channels. It is recommended that if fishways are selected they first be done on an experimental basis and selected on physical, biological, and economic factors, and in the interest of management partners (UMRCC, 2004a).

Freshwater Mussels

There are 297 species of freshwater mussels in North America. About 50 species have been recorded on the mainstem of the Upper Mississippi River. A recently completed Conservation Plan for Freshwater Mussels of the Upper Mississippi River System (UMRCC, 2004b) says that "no other group of animals in North America is in such grave danger" of population declines and extinctions. In North America, it is estimated that 55 percent of the freshwater mussel species are in danger of extinction and only 25 percent are considered stable. Over-exploitation, water pollution and habitat alteration are responsible.

Prior to the 1800s, an estimated 44 species occurred on the Refuge portion of the Upper Mississippi River. Since then, five species have been extirpated, and four are extremely rare (Appendix K of the Final EIS/CCP) (Mike Davis, Minnesota Department of Natural Resources, personal communication). The remaining 39 species that occur in the Refuge (Pools 4-14) vary in distribution from

localized populations (e.g. mucket in Pool 11) to Refuge-wide occurrences (e.g. pink papershell and giant floater).

The main mussel beds found on the Refuge occur in main channel areas, secondary channels, and adjacent backwater habitats. The East Channel area at Prairie du Chien Wisconsin (Pool 10) is historically the premier mussel bed of the Refuge. It suffered near-catastrophic loses due to zebra mussel infestations in the late 1990s and early 2000s (see Invasive Species section). General locations of crucial mussel beds for Higgins eye pearlymussel are described above in the section on Candidate, Threatened and Endangered Species. Some of the historically important mussel beds of the Upper Mississippi River that occur on the Refuge are:

Winters, Wisconsin – Pool 7
Harpers Slough, Iowa – Pool 9
Whiskey, Iowa – Pool 9
East Channel, Wisconsin – Pool 10
McMillian, Iowa – Pool 10
Cassville, Wisconsin – Pool 11
Bellevue, Iowa – Pool 13
Cordova, Illinois (near Refuge) – Pool 14.

An unexplained massive mussel die-off occurred in 1983-1985 between La Crosse, Wisconsin, and Hannibal, Missouri. This unknown aspect of mussel ecology stimulated further agency cooperation and mussel research that continues today (Tucker and Theiling, 1999).

The endangered species, Higgins eye pearlymussel, and the candidate species, spectaclecase and sheepnose, occur within, or near the Refuge. See Section and Section for a full description of their status.

Reptiles and Amphibians

There are 22 species of reptiles and 13 species of amphibians that occur on the Refuge (Appendix K of the Final EIS/CCP). See the section on Candidate, Threatened and Endangered Species for a discussion of massasauga rattlesnake on the Refuge.

Turtles

Our most current reptile information concerns the 11 species of turtles found on the Upper Mississippi River. Some turtle species prefer the river's quiet backwater habitats (such as Blanding's, painted, snapping and common map turtles) while others occupy more riverine or faster flowing waters (smooth and spiny softshells, and Ouachita and false map turtles). The Blanding's turtle population is threatened in states bordering the Upper Mississippi River, but one of its largest populations in the world is located on the Minnesota side of Pool 5 and is found on Refuge, state and private lands. "Turtle crossing" caution signs are posted where Blanding's must cross county roads during their annual trek from shallow wetlands to nesting sites in local sand dunes.

Good turtle habitat along the river proper includes sandy shorelines (nesting habitat) that border the main navigation channel and are close to backwater marshes (hatchling nurseries). Potential human conflicts occur when people camp and picnic, or where channel maintenance dredge material is piled for storage on sandy beaches used by nesting turtles. An added threat comes from egg-eating predators, particularly raccoons, which are extremely efficient in finding nests concentrated in areas where prime sand and moisture conditions prevail.

Research and habitat modeling work is needed to determine baseline information on the distribution (current and historical), relative abundance, and reproductive success of turtles on the Refuge. Concerns about harvest rates and population levels of snapping turtles lead to radio-telemetry studies of snappers by Wisconsin Department of Natural Resources in 1997-2001 (Andersen, 2003). Investigators found survival rates to be high; average home ranges were between about 50 and 108 acres in size; hibernation sites were in various habitats but mostly in backwaters and secondary channels in depths of 0.1 to 5.6 feet; woody structure is important in winter and summer habitat; snappers utilized runs and lodges of muskrat and beaver; and the turtles have strong homing abilities. Public educational materials will be produced, emphasizing the need to protect adult females and inform harvesters how to distinguish males and females.

Investigations are also needed to determine human impacts of operation and maintenance of the 9-foot navigation channel project and of recreational use of sandy islands and shorelines. Results of studies will be used in developing science-based turtle management on the Refuge.

The conservation of riverine turtles is a worldwide problem in which this group of turtles is subject to over-exploitation, habitat alteration, run-off and siltation, changes in predator populations, and alteration of river flows through dams, wing dam

Table 7: Occurrence of Frogs and Toads on Upper Mississippi River Refuge, 1994 to 2004

District	No. of Routes	No. of Survey Years	Number of Years Species Detected										
			Wood Frog	Chorus Frog	Spring Peeper	Leopard Frog	Pickerel Frog	Am. Toad	East Gray Tree	Copes Gray Tree	Cricket Frog	Green Frog	Bull Frog
Winona	1	7	1	3	6	2	2	6	6			5	
La Crosse	3	11	7	11	11	11	6	11	11	4	3	11	1
McGregor	2	10	1	10	10	10	3	10	10	4	7	10	10
Savanna	2	11		10	10	10	1	9	11	11	11	11	11

and channelization (Moll and Moll, 2000). These authors recommended conservation measures to include establishment of sanctuaries, protection of nest areas and hatcheries, public education, and captive breeding.

Frogs and Toads

Nine species of frogs and one toad occur on the Upper Mississippi River. Current Refuge knowledge of frog and toad distribution on the Refuge is based upon call surveys conducted by staff and volunteers. An extensive long term monitoring study is being conducted by Dr. Walt Sadinski of the Upper Midwest Environmental Sciences Center in La Crosse, Wisconsin, as part of the nation-wide Amphibian Research and Monitoring Initiative (ARMI).

Standardized frog and toad surveys were initiated on the Refuge in 1994 due to concern about the apparent rarity, decline and/or population die-offs of certain species in the surrounding states. Populations of these amphibians serve as an index to environmental quality. Survey routes consist of 10 wetland sites which are visited 3 times annually. Observers identify species present, based on their calls, and make simple estimates of abundance. The survey periods and corresponding minimum water temperatures (Wisconsin) are April 15-30, 50 degrees Fahrenheit; May 20-June 5, 60 degrees Fahrenheit; and July 1-15, 70 degrees Fahrenheit. Eight routes are surveyed most years (Table 7).

The bull frog occurs in all Districts but has not been detected on survey routes in the Winona District. Detection rates of wood and pickerel frogs are lower than other species on the Refuge. In addition, Blanchard's cricket frog has not been detected on survey routes but three individuals were heard by herpetologists visiting the Refuge near Winona, Minnesota, during the summer of 2004.

Invasive Species

Invasive and exotic species are the "greatest threat to ecosystem integrity within the refuge system" (USFWS, 2004a). The Refuge and Upper Mississippi River System are inundated with invasive fish, plants, and invertebrates. Invasive species are those that dominate an ecosystem at the expense of other species, causing population crashes and ecological changes. These species invade or increase within the ecosystem as the result of a disturbance or degradation of the natural system. A healthy native system usually will not experience the invasions. Many invasive species are not indigenous (native) to North America, but are imported intentionally or by accident from another continent. Newly arrived species often exhibit population explosions due to lack of competition or natural control.

Examples of invasive species threatening wildlife populations and habitat are varied. Native mussels, particularly the Higgins eye pearlymussel, are threatened by zebra mussels imported from Europe via ship's ballast water (USACE, 2004a). Asian carp threaten native paddlefish via competition for plankton. These carp also can potentially eliminate vegetation beds, snail and mussel populations, and deplete the commercial fishing industry on the Upper Mississippi River System.

Invasive Fish

An ever-increasing list of uninvited fish to the Upper Mississippi River is cause for alarm by anglers, commercial fishermen, ecologists, biologists, and others who also admire the river. Exotic fish originate from other parts of the world and

these fish eat other fish, out-compete native fish for food, can wipe out vegetation beds, and even cause bodily harm to boaters.

The common carp, a native of Europe and Asia, was first found in the Upper Mississippi River in 1883 and presently comprises most of the commercial harvest of fish in the Upper Mississippi River. It has increased in abundance in Pools 4, 8, 13, and 26 of the Upper Mississippi River from 1990-94 (Gutrueter and Theiling 1999). As the common carp increased, the native buffalo fish, the ecological equivalent, has declined in the harvest by about 50 percent.

Four species of asian carp (big head, black, silver, and grass) were imported to control weeds, snails, or plankton at fish farms. They escaped the farms and are moving from southern United States into the river basin (UMRCC, 2004a). They are large, voracious eaters that consume so much they could even affect aquatic life beyond just fish, including waterfowl, clams and mussels, and marshbirds. The bighead carp, a plankton eater in competition with paddlefish, buffalo fish and gizzard shad, and larval forms of native fish, can grow to 90 pounds. The silver carp, another planktivore grows up to 110 pounds. When bothered by sounds of a boat motor, silver carp often jump 4-6 feet or more out of the water, literally landing in boats or crashing into people, causing bodily harm.

Another invasive fish, the round goby, will likely be a species of concern in the near future. These small but voracious fish are already halfway down the Illinois River, having moved from Lake Michigan.

Control of these invasive fish is crucial to retention of the river's ecological integrity. The Corps of Engineers has recently installed an electrical aquatic nuisance species dispersal barrier in the Chicago Sanitary and Ship Canal to prevent interbasin movement between the Great Lakes and the Upper Mississippi River. However, exotic species have passed the barrier and a second barrier further downstream will be installed in the spring of 2005 (UMRCC, 2004a). Findings of a recent feasibility study funded by Minnesota Department of Natural Resources noted "that an acoustic deterrent such as a Sound Projector Array based acoustic bubble curtain downstream of a lock location perhaps in conjunction with attractants (i.e. pheromones, plankton, lights, etc.), and an integrated management/harvest plan may provide the most feasible opportunity to limit or slow the upstream invasion of Asian Carp" (FishPro, 2004).

Control of these species and prevention of additional invasions will be addressed in Refuge step-down plans for fish, wildlife, and habitat management. Control will only be achieved through cooperative efforts of all agencies and partners on the Upper Mississippi River System. A potential avenue of cooperation in control of invasive species is through the Mississippi River Basin Aquatic Nuisance Species Panel (UMRCC, 2004a).

Invasive Plants

Of the 591 plant species known to occur within the Upper Mississippi River, 36 are not indigenous to North America (Appendix K of the Final CCP/EIS). Approximately 15 of these non-native species and aggressive native species adversely affect Refuge native plants and habitat (Table 8). Native species, such as reed canary grass, can take on invasive qualities when natural processes like fire, drought, and flooding are altered. Over the past five years, the Refuge has attempted to control several plant species using various techniques, including biological control, mowing, cutting, exchanges of ornamental plants, and the use of herbicides.

It is estimated that purple loosestrife has invaded thousands of acres of the Refuge, replacing large blocks of native vegetation, decreasing species diversity, and affecting local wildlife populations by reducing available wetland habitat. Control efforts include the release of beetles (*Galerucella* sp. and *Hylobius* sp.) that consume only this plant. Success in controlling loosestrife via biological methods, and restoring native plants has been documented throughout the Refuge. Each Refuge District has raised beetles in nurseries and conducted beetle "releases" to control loosestrife over the past decade. Releases have ranged from 500 to 20,000 beetles per site. The herbicide glyphosate was used in the 1990s throughout the Refuge and was used in 2002 on a limited basis in the Savanna District.

No control efforts are under way to combat Eurasian milfoil, other than through public education efforts that encourage people to remove all vegetation from their boats and boat trailers upon exiting the water. This combats spread of the plant between water bodies.

Reed canary grass ecotypes of both native and non-indigenous origins have invaded Refuge wetlands. It is virtually impossible to distinguish native from non-native plants. This species is preventing

Table 8: Invasive Plants and Their Control on the Upper Mississippi River Refuge

Plant Name (Native or non-native)	Scientific name	Control method	Comments
Purple loosestrife (non-native)	*Lythrum salicaria*	Beetles (*Galerucella* and *Hylobius*) pulling, herbicide (glyphosate)	Large-scale, Refuge-wide problem. Biological control is effective.
Eurasian milfoil (non-native)	*Myriophyllum spicatum*	Public education to prevent spread to other bodies of water	Wide-spread, but not considered a major threat to aquatic habitats
Spotted knapweed (non-native)	*Centaurea maculosa*	Mowing	Increasing problem in Sand prairies
Garlic mustard (non-native)	*Alliaria petiolata*	Pulling	Widespread in shady upland habitats
Reed canary grass (native and non-native ecotypes)	*Phalaris arundinacea*	Root Pruned Method (RPM) trees; mowing	Wide-spread problem; threat to forest regeneration
Crown vetch (non-native)	*Coronilla varia*		Widespread
Siberian or Chinese elm (non-native)	*Ulmus pumila*	Cutting; herbicide (Triclopyr)	Localized problem
Honey locust (native)	*Gleditsia tricanthos*	Cutting; herbicide (Triclopyr)	Localized problem
European (common) buckthorn (non-native)	*Rhamnus cathartica*	Cutting; herbicide	Widespread
Leafy spurge (non-native)	*Euphorbia esula*	Biological control	Localized problem
Black locust (native, imported from Appalachia and the Ozarks)	*Robinia pseudoacacia*	Cutting; herbicide	Localized problem
Japanese Bamboo (Japanese knotweed)	*Polygonum cuspdatum*	Pulling; grubbing roots; herbicides	Localized problem
Bush Honeysuckles (non-native)	*Lonicera tatarica and others*	Pulling; herbicides	Localized problem

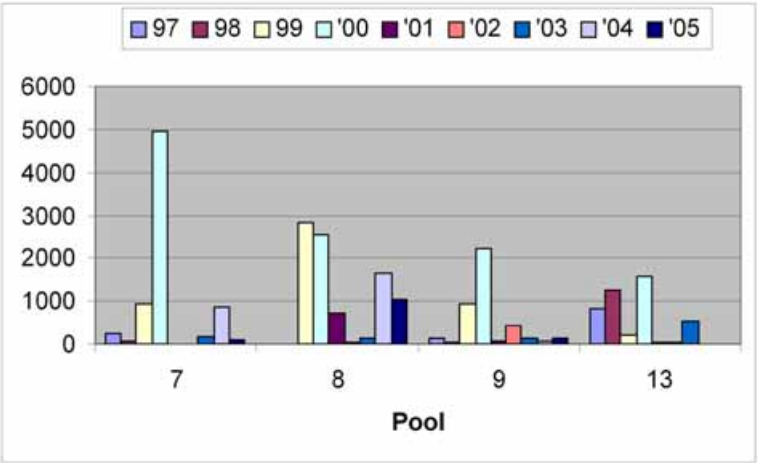
regeneration of native forest trees and other floodplain vegetation (UMRCC, 2002). Mowing and the use of mats around planted trees controls competition and discourages voles that may girdle newly planted trees. Experimental control using soil scarifying techniques, followed by herbicide treatments, have been attempted in cooperation with the U.S. Army Corps of Engineers at small timber harvest areas of the Refuge. The Refuge is supporting research to develop an effective means of stopping the spread of reed canary grass.

Illinois garlic mustard invades woodland habitats, smothering most of the native herbaceous vegetation. It occurs on higher sites of the floodplain forest (e.g. Goose Island in Pool 8 and Potosi River delta of Pool 11) in Pools 8-14. Control efforts have included the use of herbicides and pulling operations.

Invasive Invertebrates

The zebra mussel is a threat to native mussel populations. Based on North American studies, zebra mussels are believed to impact native mussels by interfering with siphoning, feeding, gamete release, reproductive displays, and respiration. This species presumably was brought to North America from Europe in ballast water of ocean-going vessels. In 1991 the zebra mussel was found first in the Upper Mississippi River and Refuge near La Crosse, Wisconsin (UMRCC, 2004b). Since their appearance, zebra mussel populations have

Figure 20: Average Number of Zebra Mussels per Meter Square Collected During Fall Sampling Periods in Selected Areas of Pools 7, 8, 9, and 13, 1997-2005, Upper Mississippi River Refuge



expanded exponentially, sometimes reaching population densities of 60,000 per square meter (on Pool 13).

The native mussel community of Pool 10 at Prairie du Chien, Wisconsin, (East and West Channels) was valuable and well known to biologists and commercial mussel fishermen. In particular, this area was considered to be the most valuable Essential Habitat Area for the federally endangered Higgins eye pearlymussel. In the late 1990s, the native mussel community at Prairie du Chien was devastated by zebra mussels. Zebra mussel densities in the East Channel rose dramatically from 2 per square meter in 1993 to 56,507 per square meter in 1999. Consequently, density of native mussels in the East Channel fell from 59.2 per square meter in 1996 to 1.7 per square meter in 1999; no juvenile native mussels were found between 1999 and 2001.

Like the rest of the mussel community there, the abundance of Higgins eye pearlymussel in the East Channel drastically declined with the expanding zebra mussel population. Zebra mussel population assessments are an important component of the Higgins eye pearlymussel recovery plan.

Zebra mussels have appeared in bottom samples collected by the Refuge and states during the fall to assess available food sources for migrating waterfowl in Pools 2-13. These samples come from both open water and backwater habitats. Peak numbers of zebra mussels in Pools 7, 8, 9, and 13 appeared in 2000 (Figure 20). Maximum average densities ranged from 1,500 to 5,000 per meter square. Numbers declined throughout the Upper Mississippi River in 2001, probably due to warm water conditions and the stresses of flooding. Numbers have risen since 2004 and 2005. Zebra mussel numbers were sparse in Pools 4, 5, 5A, and 11 throughout the 1997-2005 period.

The faucet snail or mud bithynia (*Bithynia tentaculata*) is an invasive snail first introduced to the Great Lakes in about 1870 from Europe (Scandinavia to Greece), possibly with packing material. This snail is an intermediate host for two intestinal trematodes (flukes), *Sphaeridiotrema globulus* and *Cyathocotyle buchiensis* that cause mortality in waterfowl and coots. The incidence of trematode-infected faucet snails collected in bottom samples has reached over 50 percent in some parts of Lake Onalaska (Pool 7).

Bird mortality caused by these trematodes was first detected in the spring of 2002 when one lesser scaup was found dead in upper Pool 8. In the fall of 2002, the trematodes killed an estimated 1,500 to 1,900 diving ducks and Coots on Pool 7 and 8. In the same season, nearly 100 Coots and diving ducks were collected in open water between Ferryville and Lynxville, Wisconsin, on Pool 9. Spring and fall die-offs also occurred on Pools 7 and 8 in 2003, killing an estimated 8,000 waterbirds. Species affected include Lesser Scaup, Ring-necked Ducks, Canvasback,

Figure 21: Average Number of Mayflies per Meter Square Collected During Fall Sampling Periods From Selected Areas on Pools 7, 8, 9 and 13, 1995-2003, Upper Mississippi River Refuge

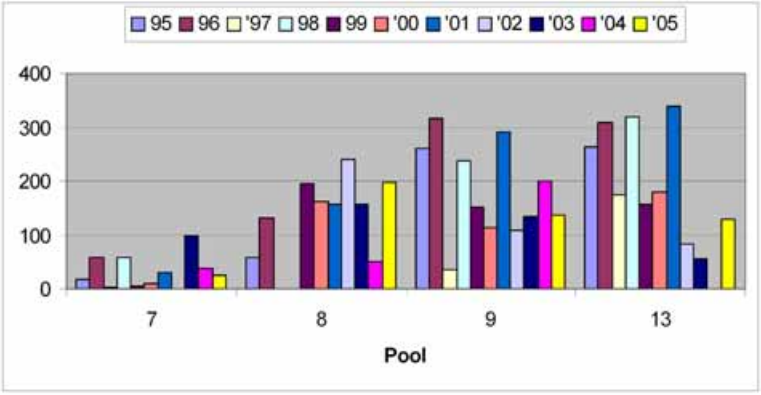
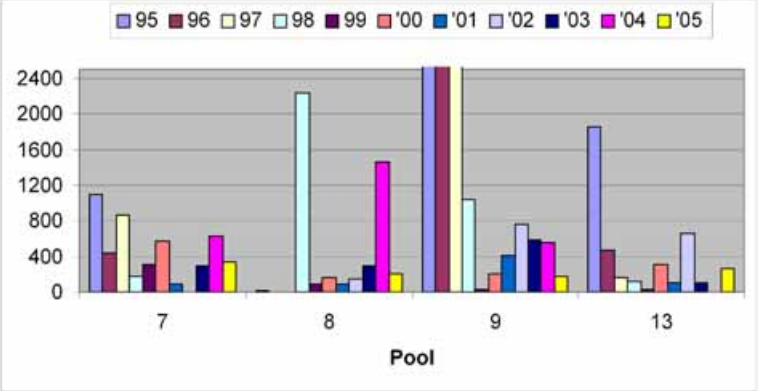


Figure 22: Average Number of Fingernail Clams per Meter Square Collected During Fall Sampling Periods From Selected Areas on Pools 7, 8, 9 and 13, 1995-2005 Upper Mississippi River Refuge[1]



1. *High values for Pool 9 are: 1995 (5,985); 1996 (5,856); 1997 (3,790).*

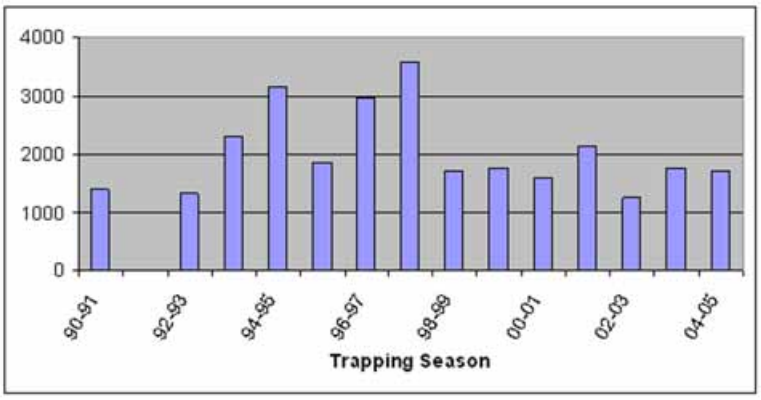
Bufflehead , and Coots. Raptors that scavenge these birds are not susceptible to the trematodes.

Researchers and managers are investigating potential actions to prevent major die-offs caused by the presence of this snail. Population monitoring and removal of bird carcasses is a continuing practice.

Other Aquatic Invertebrates

Aquatic invertebrates play an important role in fish and wildlife ecology on the Refuge and are a useful indicator of environmental quality. Fingernail clams and burrowing mayflies are often target organisms of studies and monitoring. They are important foods in the Upper Mississippi River System for diving ducks, sport fish and commercial fish. Declines in diving ducks using the Illinois River valley during the 1950s was attributed to the loss of the fingernail clam community (Sauer and Lubinski, 1999). Long-term monitoring on the Upper Mississippi River System shows that Pool 13 backwaters have held the highest densities of mayflies and fingernail clams, possibly because Pool 13 is outside the pollution gradient that extends downstream

Figure 23: Number of Beaver Harvested, 1990-91 Through the 2004-2005 Seasons, Upper Mississippi River Refuge[1]



1. *Note that 1991-1992 data are not included in this figure.*

from Minneapolis, Minnesota, and that Pool 13 substrates are especially suitable for these critters.

The Refuge and the states sample invertebrates in the fall to assess available food sources for migrating waterfowl in Pools 4-13. Our most complete data are for pools 7, 8, 9 and 13. Mayfly numbers are generally highest in pools 8, 9 and 13 (Figure 21). Off-refuge data from pools 2 and 3 show even higher mayfly densities. Fingernail clam numbers are ususally greatest in Pool 9 (Figure 22). Values for both fingernail clams and mayflies in pools 4, 5, 5A, 10, 11, and 12 are consistently much lower than the pools listed above. Differences in invertebrate densities between pools is often controlled by local conditions and not necessarily due to whole-river factors (Sauer and Lubinski, 1999).

Refuge data indicate that when fingernail clam densities exceed about 200 clams per meter square, diving duck use-days on that pool can exceed 500,000 use-days or peak numbers over 80,000 birds. Data also indicate that fingernail clams were abundant in years when submerged aquatics were lacking during the early 1990s and were crucial to migrating diving ducks during those years.

Mammals

The 51 species of mammals that occur on the Refuge (Appendix K, Final EIS/CCP) play an important role in Upper Mississippi River System ecology and some are the object of furbearer management on the Refuge. Prior to locks and dams, the high, semi-dry river bottoms held higher populations of skunk, badger, foxes, and rabbits than occur at present. The marsh conditions of today now support higher numbers of muskrat, mink, and especially raccoon than in the past.

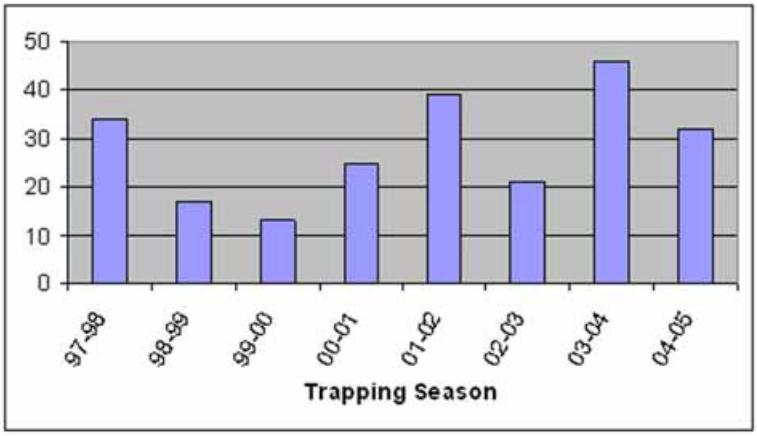
Furbearing mammals (beaver and river otter) were key elements in the development and exploitation of the Mississippi River Basin. Early explorers and trappers established settlements (Prairie du Chien, Wisconsin, for example) to carry on the fur trade. Over-exploitation nearly extirpated beaver from the Upper Mississippi River by the mid-1800s. They made a comeback in the 20th century with reintroductions (1927 and 1928), control of the harvest, and new habitat created by the lock and dams in the 1930s. Beaver lodges and cuttings are now a moderately common sight on the Refuge. About 2,100 beaver are harvested each year (1990-2003) (Figure 23).

Beaver lodge surveys conducted in Pools 12-14 from 1993 to 2002 revealed an average of 41 lodges per year along established survey routes. Numbers ranged from a high of 62 in 1993 to a low of 20 in 2002.

River otter were also trapped extensively at the time of early European settlement. These predators probably maintained small populations in tributaries of the UMR. Today they are an uncommon sight, but occupy most areas of the Refuge, as evidenced by trapping records, local observations, and radio-tracking studies.

Currently, Wisconsin is the only state that allows the take of river otter on the Refuge, one per sea-

Figure 24: Number of River Otter Harvested Between 1997-1998 and 2004-2005, Upper Mississippi River Refuge



son. Otter are taken incidentally on the Refuge in Minnesota, Iowa, and Illinois for which State conservation officers may allow retention of the fur on a case by case basis. Since 1997, an average of 28 otter have been trapped on the Refuge, ranging from 13 to 46 animals per season (Figure 24). Approximately 90 percent of the otter harvested on the Refuge are taken in Wisconsin. In the past eight years, the state-wide annual otter harvest in Wisconsin has been about 2,000 animals, except in 1998-99 and 2003-04 when it was near 1,500 otter.

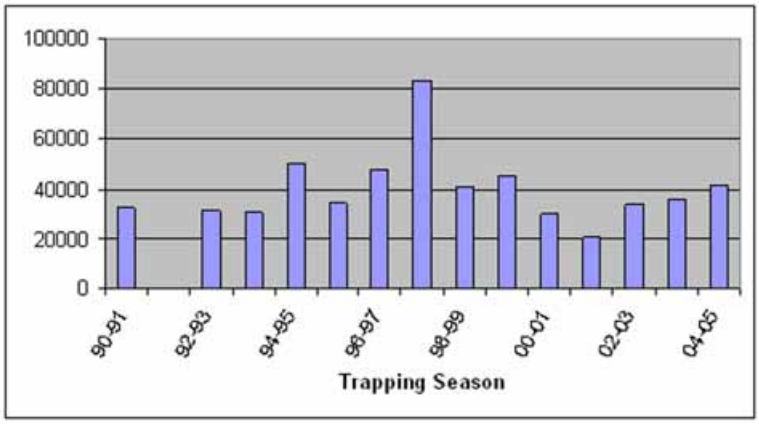
The State of Minnesota is investigating home range characteristics, habitat selection and survival of river otters in southeast Minnesota and portions of the Refuge (T. Gorman, student at Mankato State University, personal communication). Data from this study will be used in decisions whether to have a trapping season on these animals in southeastern Minnesota. Preliminary reports indicate radio-tracked river otters established natal dens along fence rows and up to several miles away from streams. Investigators reported four of 24 radio-marked otters died of incidental take; one of 24 was a road-kill mortality.

Prior to locks and dams, muskrats were widespread, but not abundant on the Upper Mississippi River System. At that time the shallow lakes and marshes often dried up each fall, forcing muskrats to dig bank dens, rather than build typical "rat houses". Muskrats flourished after the 1930s when permanent shallow wetlands were created by installation of the locks and dams. High muskrat numbers coincided with those of puddle ducks, bitterns and rails, sunfish and bass in the hey-day of shallow wetland productivity witnessed in the 1935-65 period. Since then, the decline of cattail, burreed, arrowhead, and bulrush has resulted in reductions in muskrat populations, although "rats" still utilize muddy banks along the many side channels now coursing through the bottomlands.

Trappers have harvested millions of muskrats from the Refuge since the 1940s. Between 1940 and 1970, over 2.25 million rats were harvested (average of 83,000 per year) by an average of 750 Refuge-permitted trappers per year. Recent annual harvest reports (1991-2004) show about 40,000 animals taken by 290 trappers per year (Figure 25 and Figure 26). Muskrats reproduce prolifically and changes in their populations generally reflect ebb and flow of habitat, rather than the extent of harvest.

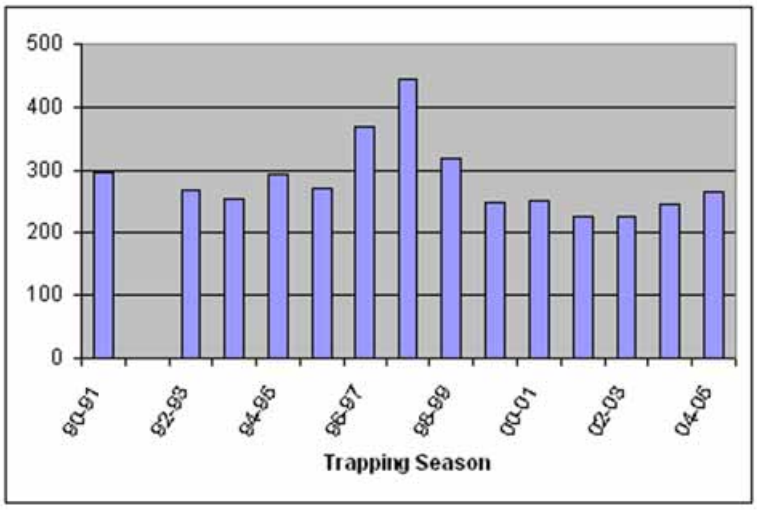
Recent population status and distribution data are available from studies, inventories, and fur catch reports submitted by trapping permittees. Muskrats were studied in the early 1980s in Pool 9 to determine density, survival and harvest rates (Clay and Clark, 1985). The authors reported that muskrat populations on Pool 9 "showed the characteristic resiliency for the species with great reproductive capability and consistent survival." They also found that distribution and harvest was not uniform, which support the idea of management by zones to provide sustained harvest.

Figure 25: Number of Muskrats Harvested, 1990-91 Through 2004-2005 Season, Upper Mississippi River Refuge[1]



1. *Note that 1991-1992 data are not included in this figure.*

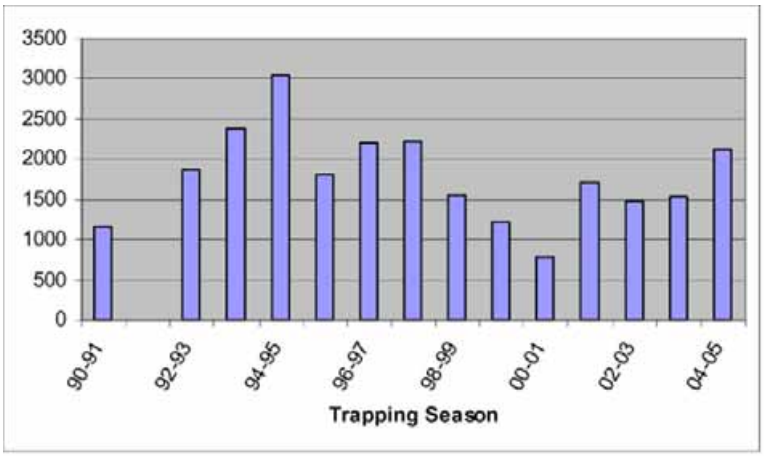
Figure 26: Number of Active Trappers, 1990-91 Through the 2004-2005 Season, Upper Mississippi River Refuge[1]



1. *Note that 1991-92 data are not included in this figure.*

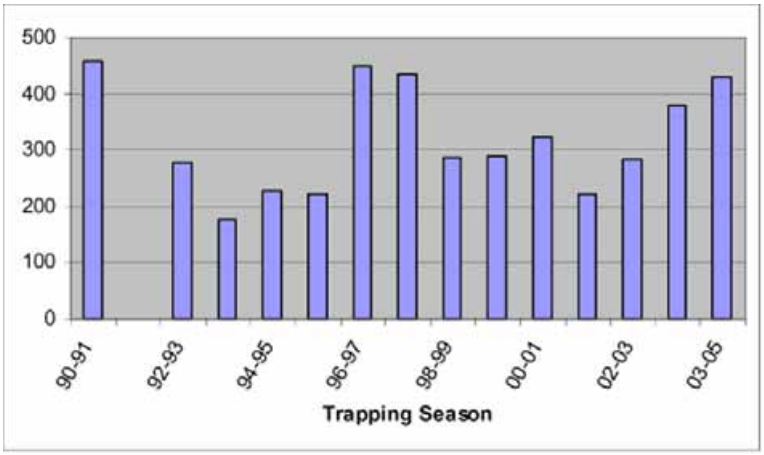
Are muskrat harvests affected by water level fluctuations? Regression analyses said "no" in tests of water levels (at tailwaters and headwaters) in Refuge Pools 4 through 14 compared to muskrat harvest for the period 1990 and 1992 to 1996 (Wlosinski and Wlosinski, 1998). The authors concluded that water levels did not affect muskrat harvest on the Refuge, but noted that numerous other studies showed that muskrat populations are affected by water levels. Other factors affecting harvest include length of trapping season, fur prices, weather conditions, habitat changes, and trapping effort. The authors concluded that "although sometimes used as a surrogate for population estimates, harvest may not be a good estimator for muskrat populations." The same authors reported that the

Figure 27: Number of Raccoon Harvested, 1990-91 Through the 2004-2005 Season, Upper Mississippi River Refuge[1]



1. *Note that 1991-92 data are not included.*

Figure 28: Number of Mink Harvested, 1990-91 Through the 2004-2005 Season, Upper Mississippi River Refuge[1]



1. *Note that 1991-92 data are not included.*

average number of muskrats trapped is positively correlated to differences in aquatic vegetation coverage estimates (1989 emergents and floating leaved aquatics).

In 1988, the Wisconsin Department of Natural Resources began making annual muskrat house counts at specific locations within Pools 4-11 (WDNR, 2004). Fewer houses have been found in the past four years compared to 1989-91. Counts are on the rise in the last 2 years, however. These data reflect variability observed in trapping data over the past 40 years.

The recent (1990-2003), average annual raccoon harvest on the Refuge has averaged 1,793 animals, ranging from 800 to over 3,000 per year (Figure 27). Raccoon numbers have increased dramatically since the early 1990s in each of the four states in which the Refuge occurs. Scientists estimate that there

are more raccoons in Illinois today that when the first European settlers arrived there.

The annual mink harvest averaged 310 animals, ranging from about 175 to 450 per year (Figure 28). Minnesota, Wisconsin, and Illinois report that mink populations are stable in areas with adequate wetland resources.

Vegetation

A diversity of plant communities occurs on the Refuge, located in aquatic to upland bluff terrains. These communities have been classified for management and research purposes specific to the Mississippi River by the U.S. Geological Survey's Upper Midwest Environmental Sciences Center (UMESC) (web site is www.umesc.usgs.gov) and the U.S. Army Corps of Engineers, Habitat Needs Assessment program (USACE, 2000). The Refuge uses these mapping sources on a daily basis for developing Geographic Information System management and habitat maps.

On a national level, the Federal Geographic Data Committee has established the National Vegetation and Information Standard (NVCS) to produce uniform statistics in vegetation resources from data collected nation-wide. These three classification systems have three distinct descriptors of vegetation types which have been cross-referenced ("cross-walked') by the Upper Midwest Environmental Sciences Center (Appendix O in the Final EIS/CCP). An example of the NVCS maps for the Refuge (Pool 8) appears in Appendix O as well. Land cover maps, based on UMESC interpretation and digitization of 2000 photography, for the entire Refuge are available at Refuge headquarters.

Submerged Aquatic Vegetation

Submerged aquatic vegetation includes plants that grow below the surface of the water and are usually anchored to the bottom by their roots. Examples are wild celery, water milfoil, and sago pondweed (see the plant list in Appendix K in the Final EIS/CCP). This group of plants generate dissolved oxygen, filter suspended material, stabilize bottom sediments, and cycle nutrients (Rogers and Theiling, 1999). Submerged aquatics provide crucial fish habitat, provide substrate for invertebrate growth, and are important foods for mammals and migratory birds. They are most often found in backwater areas of low water velocity, adequate light penetration and relatively stable water levels.

Prior to locks and dams most species that are now present occurred in localized wetland pockets and channel border areas, but their group was not a major component of the floodplain vegetation community (Green, 1970). Many aquatic areas dried up by the end of the summer growing season. At that time, floodplain forests dominated the river bottoms with hundreds of lakes and ponds scattered through the wooded areas. Wet meadows and hay fields were also present. After inundation, the stabilized water levels created shallow and deep water wetlands that supported an abundance of submerged plants. The response by wetland fish and wildlife was phenomenal in its diversity and abundance. In the 1940s, refuge biologist, Bill "Doc" Green noted that he could find "two dozen species of submergent plants in a matter of minutes anywhere in the better marshes and aquatic beds." Backwater sport fish (bluegill, bass, and crappies) and diving ducks (Canvasbacks, Scaup, and Ring-necked Ducks) utilize submerged plants extensively.

Beginning in the 1960s and 1970s, river scientists and users noted declines in submerged (and emergent) vegetation cover throughout the Refuge. Factors included wind and wave action, poor light penetration due to highly turbid water conditions, sedimentation and filling of backwaters, major flooding events, and long term inundation with few drying periods.

Due to these factors, there is an uneven distribution of submerged plants through the length of the Refuge. Recovery of lost submerged plant beds has occurred naturally or through habitat rehabilitation projects in Pools 4, 5A, 7, 8, 9, and 13. More work is necessary in other Refuge pools to gain a more even distribution of aquatic plant growth and associated fish and wildlife use.

Emergent Aquatic Vegetation

Emergent aquatic vegetation (emergents) are plants whose roots are anchored under water with much of the plant extending above the water surface. They include cattail, river bulrush, giant reed grass, burreed, arrowheads and wild rice. They are backwater plants adapted to low water velocities and shallow- to deep-water marsh conditions.

Prior to the lock and dams, river bulrush was the most abundant marsh species and continues to be prominent today. Cattail was uncommon, as it is today on the floodplain. Burreed was common before inundation, became abundant soon after, but has since declined. The arrowheads were present

before, but after became widespread and abundant, until suffering declines since the 1970s. The arrowheads (rigid and duck potato) are important waterfowl and muskrat foods.

The lack of emergent vegetation on the Refuge is a key concern in management and restoration of puddle duck and tundra swan migration habitat. Studies of available kilocalories (bioenergetics) for waterfowl reveal that deep marsh perennial emergent vegetation (particularly arrowhead tubers), provides some of the highest valued resources on the Refuge (Kenow et al., 2003).

Floodplain Forest

Floodplain forests are important to the biological integrity of the Upper Mississippi River System (UMRCC, 2002). They provide rich habitat for wildlife (and fish during high-water events), reduce soil erosion, improve water quality and provide a scenic and recreational landscape. Among vegetation communities of the Upper Mississippi River, the highest number of birds species observed during spring migration in 1995 and 1996 were found in floodplain forest habitat (Yin, 1999).

Floodplain forests are declining in the Upper Mississippi River System and the Refuge due to agricultural and urban developments, changes in natural riverine flood pulses, the rising water table, and island loss due to wind and wave action. The forests that remain are changing in composition from a diversity of species, including mast producing trees, to a more monotypic forest dominated by silver maple and herbaceous openings. In some pools, many forest stands are even aged mature trees with little or no understory or seedling regeneration (UMRCC, 2002).

River mangers and biologists have identified what an "ideal" floodplain forest would look like (UMRCC, 2002). Basically, it would contain a diversity of tree species to include existing silver maple and potential codominant species such as eastern cottonwood, elm, green ash and river birch. The forest would also contain mast producing species such as oak, pecan and hickory whose seeds are food sources for Wood Ducks, squirrels, deer and Blue Jays. Diversity would also be evident in size and age, with older mature woods available for nesting eagles and herons.

The driving forces of forest change or succession in the floodplain environment is ecological disturbance, such as flooding, tornados, severe winds, disease, pests, and occasional fire. The great flood of 1993 caused relatively minor tree mortality above Pool 13, but below that pool mortality escalated sharply. Mortality rates were positively correlated with flood duration and negatively correlated with the diameter of the trees (Yin et al., 1994).

Recommended forest management practices would replicate these natural processes (UMRCC, 2002). These practices include: forest regeneration, shelterwood harvest methods, seed tree methods, group selection methods, tree planting, the use of herbicides, water level management, and potential modification of site elevation (increase) to promote growth. Invasive species (particularly reed canary grass) present problems in forest regeneration within the upper pools of the Refuge. Research and experimental cuts will need to be conducted to achieve successful regeneration in these areas.

Reforestation projects may include increasing land elevations to avoid impacts of flooding. Those impacts may also be avoided by selecting appropriate tree species and locating tree plantings in areas less prone to flooding. Foresters have a tool to determine predicted flood potential throughout the pools in models available at the Upper Midwest Environmental Science Center's web site (Wlosinski and Wlosinski, 2001).

The Refuge is cooperating with Corps of Engineers foresters in completing a forest inventory of both the Corps-acquired land and U.S. Fish and Wildlife Service-acquired lands in the St. Paul and Rock Island Corps Districts. This is crucial to establishing objectives and meeting management goals in the Refuge's future forest management plan.

Grasslands

Grassland and prairie habitats are generally uncommon in the floodplain, but there are several units that occur on islands or sand terraces adjacent to the floodplain. There are two prominent prairie systems within the Refuge adjoining Pool 13. One is the newly acquired Lost Mound Unit (the former U.S. Army Savanna Depot) that protects a seven-mile long sand dune along the river's edge and contains approximately 4,000 acres of sand prairie and oak-ash savanna associations. There are 488 buildings, left over from the Depot operations, scattered throughout the unit. The Refuge's Thomson Prairie protects similar habitat 25 miles down river of Lost Mound. These units contain some of the last remaining habitats of their kind in the state of Illinois. Habitat management of these areas includes burn-

ing, limited grazing, and mechanical, biological and chemical treatments.

There are 39 other grassland units (ranging in size from 1.4 to 125 acres) distributed throughout the Refuge for which fire prescriptions have been developed. These units are managed primarily for migratory bird nesting cover, moist soil feeding sites, and to enhance biological diversity. Grassland habitats support state-listed plant and animal species of concern, such as crucial nesting habitat for the Blanding's turtle.

Natural and Current Role of Fire

The following discussion is from the Refuge Fire Plan, approved in 2002.

There is no recorded history of fire on the Refuge prior to its establishment in 1924. Our best estimate is that fire played a minor role within the river valley. That is not to say wildfires did not occur on lands now managed as part of the Refuge, as the river was certainly heavily used by Native Americans and fire surely occurred in the historic meadows and grasslands that were once part of the original river valley. However, since the placement of the locks and dams the areas that would have been influenced by fire are now mostly under water.

As wildfires have been limited in scope on the Refuge there is little documentation as to their impact on the areas burned with regard to the vegetation, wildlife and/or soils.

Prescribed fire has been mostly confined to the prairie areas of the Refuge for the purpose of restoring and/or maintaining the diverse native plant community. This is very important in areas which have remnant native prairie vegetation. To date fire has been used successfully to maintain the native plant species on these areas.

Fire has had no negative impact on threatened and/or endangered species on the Refuge.

Wild Fires and Prescribed Burns

Between 1989 and 2000, there were 29 reported wildfires on the Refuge. Of those, 23 were 10 acres or less in size and of these 14 burned 1 acre or less. Eighteen wildfires occurred in the March-May period and 4 in October. The remaining fires were scattered throughout the rest of the year with only January, August and September wildfire free. The main causes of wildfires were arson or escaped campfires. It should be noted that arson fires have accounted for all fires over 10 acres in size except for one escaped campfire which burned 60 acres. In looking at the past fire data most wildfires are contained almost immediately upon attack.

A total of 80 prescribed burns were completed on the Refuge between 1991 and 2000, covering 1,592 total acres. The Savanna District had the most active burning program due to the abundance of native prairie and grasslands; see District summary below.

Winona District	19 burns 170 acres
La Crosse District	10 burns 103 acres
McGregor District	10 burns 295 acres (1996-2000)
Savanna District	41 burns 1,100 acres

Environmental Management Program.

The Upper Mississippi River System Environmental Management Program (EMP) was created due to controversies surrounding the replacement of Lock and Dam No. 26 near Alton, Illinois. The debate began in the 1970s when environmental groups and area railroads opposed the proposed construction of two 1,200-foot locks at the site. In 1978, Congress authorized construction of a new dam with one 1,200-foot lock and directed the Upper Mississippi River Basin Commission to study and make recommendations on further navigation capacity expansion and its ecological impacts.

The Commission completed the study and recommendations in 1982 and presented its findings in the *Comprehensive Master Plan for the Management of the Upper Mississippi River System*. Some of the Master Plan recommendations included a second

U.S. Fish and Wildlife Service

lock (600 feet) at Lock and Dam 26, a habitat rehabilitation and enhancement program, a long-term resource monitoring program, a computerized inventory and analysis system, recreation projects, and a study of the economic impacts of recreation. Section 1103 of the 1986 Water Resources Development Act (Public Law 99-662) declared that the Upper Mississippi River System is a "nationally significant ecosystem and a nationally significant navigation system." In addition, the act authorized the second lock at Lock and Dam 26 and several environmental initiatives on the Upper Mississippi River. The environmental initiatives became known as the Upper Mississippi River System Environmental Management Program. The 1990 Water Resources Development Act extended the original EMP authorization period for an additional 5 years, through fiscal year 2002. The 1999 Water Resources Development Act increased the annual authorization to $33 million and established two main elements as continuing authorities:

Planning, construction, and evaluation of fish and wildlife habitat rehabilitation and enhancement projects (HREPs).
Long term resource monitoring, computerized data inventory and analysis, and applied research (LTRMP).

The EMP is a coordinated habitat restoration program for the Upper Mississippi River system administered by the Corps of Engineers in partnership with several federal, state, and non-governmental agencies. Partners include the federal agencies of the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, U.S. Geological Survey, and U.S. Environmental Protection Agency; the state natural resource agencies of Minnesota, Wisconsin, Iowa, Illinois, and Missouri; and non-governmental agencies. Through this coordinated, effective planning process based on sound science, a built-in evaluation process, and a strong partnership between the agencies, EMP has evolved into a premier river habitat restoration program.

Because the Refuge is located entirely within the Upper Mississippi River system, the Refuge is fully involved with planning, designing, constructing, evaluating, and operating and maintaining all EMP habitat rehabilitation and enhancement projects (HREPs) built on the Refuge. In addition, the Refuge is involved in the EMP Long Term Resource Monitoring Program (LTRMP).

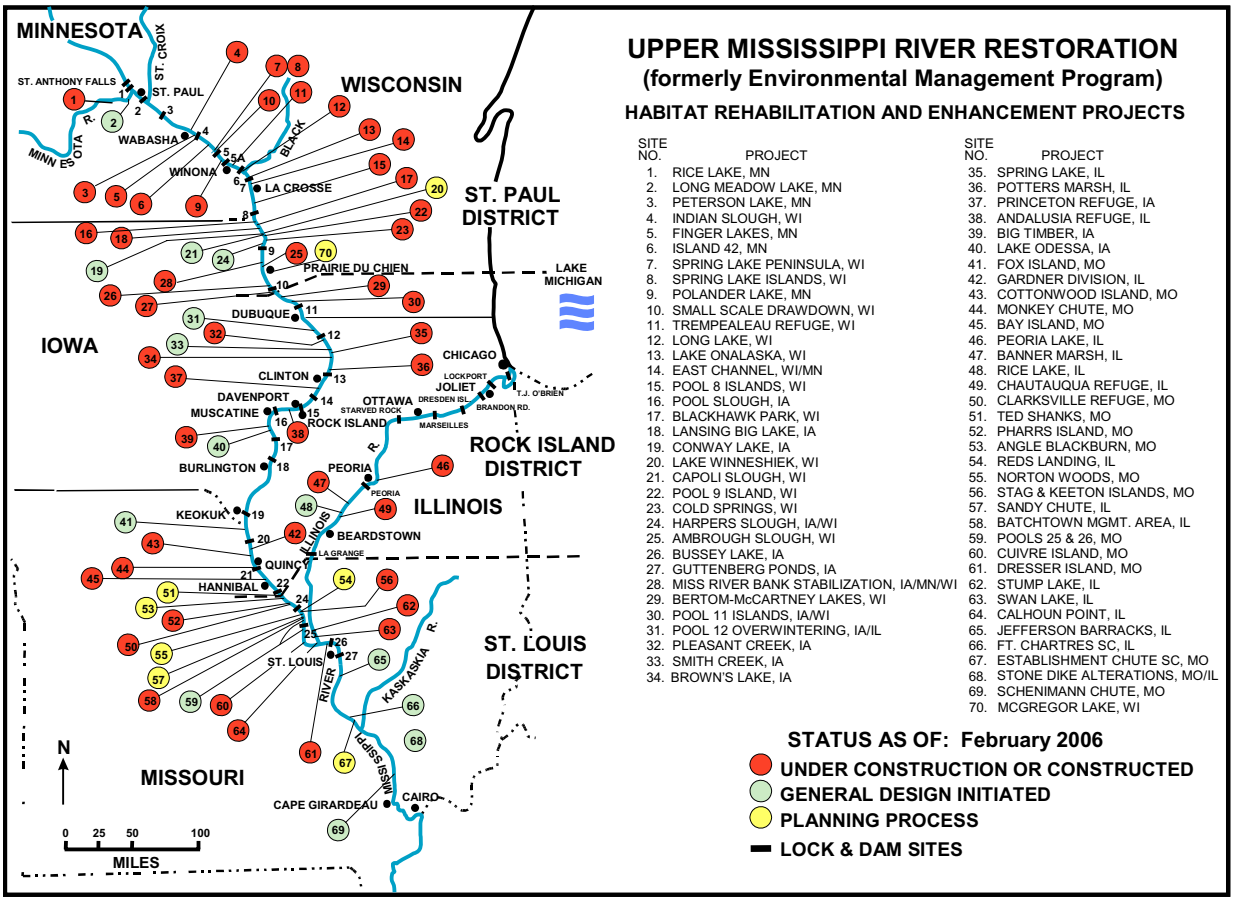
The mission of the EMP LTRMP is to provide decision makers with the information needed to maintain the Upper Mississippi River System as a viable multiple-use large river ecosystem. LTRMP works to develop a better understanding of the Upper Mississippi River ecosystem and its problems; monitor and evaluate long term resource changes and trends; develop alternatives to better manage the river system; and to manage, organize, and distribute scientific information about the river (USACE, 2004b). Three (3) pools within the Refuge are monitored closely by the LTRMP: 4, 8, and 13. The Refuge and LTRMP exchange data and the Refuge has assisted with data collection.

The purpose of building HREPs on the Upper Mississippi River is to counteract the effects of an aging impounded river system by changing the river's floodplain structure and hydrology. This can involve altering sediment transport and disposition, water levels, connectivity between the river and its floodplain, and constructing structures in the floodplain.

This program has made it possible to improve tens of thousands of acres along the Upper Mississippi River system. Since the program began in 1987, 40 completed HREPs have affected over 72,000 acres of habitat. In addition, 24 projects which could affect over 70,000 acres are in the construction, design, or planning phases (Figure 29). Directly on or adjacent to the Refuge itself, there are 27 completed HREPs affecting over 43,000 acres of habitat, and the Refuge is solely responsible for operating and maintaining 25 of those projects (Table 9). The Refuge is currently involved in the planning, design and construction of 10 HREPs which will affect an additional 30,800 acres of habitat. When these 10 projects are completed, the 37 HREPs on or next to the Refuge will improve approximately 73,800 acres of habitat. Eventually, more projects will be added to the program through the selection process.

Potential HREPs on the Refuge are identified, prioritized, and selected by a partnership which includes the Corps of Engineers, U.S. Fish and Wildlife Service, and the four states of Minnesota, Wisconsin, Iowa, and Illinois. Once the projects are identified, the partners, along with the interested public, prioritize, select and plan each project. Considerations for prioritization, selection, and planning to meet overall program and individual project goals include ecological merits, Environmental Pool Plans, sequencing, geographic distribution, and available funds. In addition, the partners use the

Figure 29: Upper Mississippi River System Environmental Management Program Habitat Rehabilitation and Enhancement Projects[1]



1. *Site Nos. 3 through 37 are on or adjacent to the Upper Mississippi River Refuge (USACE, 2004b).*

Habitat Needs Assessment, developed under EMP, as a tool for project identification and planning.

Refuge and other Service personnel are completely involved with the entire HREP process including identifying, prioritizing, selecting, planning, designing, constructing, and evaluating all projects on the Refuge. The Refuge is also responsible for operating and maintaining all HREPs constructed on the Refuge. The Refuge employs an EMP Coordinator to oversee Refuge involvement in HREPs, to serve as a liaison between the Refuge and the other partners, and to ensure that projects are designed and built to serve their intended function with reasonable operation and maintenance costs. In addition, Refuge and other Fish and Wildlife Service personnel are involved with other interagency planning teams where EMP projects are identified, prioritized and selected such as the Fish and Wildlife Interagency Committee, Fish and Wildlife Work Group, River Resources Forum, River Resources Coordination Team, and the EMP Coordinating Committee.

To meet the habitat objectives of each project, several techniques are used, usually in combination: backwater dredging, water level management, island creation, shoreline stabilization, secondary channel modification, and aeration (USACE, 2004b). Table 10 describes the purposes of these techniques.

The Pool 8 Phase II HREP is an example of a project which combined several techniques to dramatically improve the habitat in Stoddard Bay, near Stoddard, Wisconsin. This project incorporated

Table 9: Summary of Environmental Management Program Habitat Rehabilitation and Enhancement Projects On or Adjacent to the Upper Mississippi River Refuge (Adapted from USACE, 2004b)

Environmental Management Program												
Pool	Project Name	Cost	Project Status[1]	Year Completed	Affected Acres	Project Features/Techniques						
						Back-water Dredging	Water Level Mgmt.	Island	Bank Stabilization	Side Channel Restoration	Aeration	Other
	Bank Stabilization, Pools 6, 9 & 10	$1,697,000	F	1999	1,500				X			
4	Indian Slough	$988,000	F	1994	631	X				X		X
	Peterson Lake	$1,179,000	F	1996	500			X	X	X		
5	Island 42	$262,000	F	1987	95	X				X	X	
	Finger Lakes	$1,445,000	F	1994	113						X	X
	Spring Lake Penninsula (Pool 5)	$448,000	F	1995	300	X		X	X	X		
	Small Scale Drawdown	$97,000	F	1997	52		X					X
	Spring Lake Islands (Pool 5)	$2,930,000	C	N/A	500	X		X	X	X	X	X
5A	Polander Lake	$3,000,000	F	2002	1,000	X		X	X			
6	Trempealeau[2]	$5,723,000	F	1999	5,620		X		X			
7	Lake Onalaska	$2,064,000	F	1989	7,000	X		X	X		X	
	Long Lake	$1,037,000	F	2002	15				X		X	
8	Pool 8 Islands, Phase I	$2,314,000	F	1993	1,000	X		X	X			
	East Channel	$558,000	F	1997	19				X			
	Pool 8 Islands, Phase II	$3,482,000	F	1999	500	X		X	X			X
	Pool 8 Islands, Phase III	$15,120,000	D	N/A	3,000	X		X	X	X		X

Table 9: Summary of Environmental Management Program Habitat Rehabilitation and Enhancement Projects On or Adjacent to the Upper Mississippi River Refuge (Adapted from USACE, 2004b) (Continued)

Environmental Management Program												
Pool	Project Name	Cost	Project Status[1]	Year Completed	Affected Acres	Project Features/Techniques						
						Back-water Dredging	Water Level Mgmt.	Island	Bank Stabilization	Side Channel Restoration	Aeration	Other
9	Pool Slough[3]	$715,000	C	N/A	52		X					
	Blackhawk Park[4]	$309,000	F	1990	282		X			X	X	
	Lansing Big Lake	$2,089,000	F	1994	9,755				X	X		X
	Conway Lake	$2,460,000	P	N/A	560	X	X	X	X	X	X	X
	Lake Winneshiek	$4,560,000	P	N/A	6,000	X		X	X	X		X
	Capoli Slough	$1,995,000	P	N/A	600	X		X	X	X		X
	Pool 9 Islands	$1,266,000	F	1995	320			X				
	Cold Springs	$463,000	F	1994	35	X					X	
	Harpers Slough	$9,000,000	P	N/A	2,200	X		X	X	X		
10	Ambrough Slough[4]	$2,142,000	F	2004	2,500	X		X		X	X	X
	Bussey Lake	$3,594,000	F	1995	213	X	X	X			X	
11	Guttenberg Ponds	$327,000	F	1989	35	X	X					
	Bertom McCartney Lakes	$2,244,000	F	1992	2,000	X		X	X	X		X
	Pool 11 Islands	$8,559,000	C	N/A	10,342	X		X	X	X	X	X
12	Pool 12 Overwintering	$2,500,000	P	N/A	6,900	X						X
13	Pleasant Creek	$1,404,000	F	2003	2,350	X						
	Brown's Lake	$1,993,000	F	1990	453	X					X	X
	Smith Creek	$850,000	P	N/A	650							X
	Spring Lake (Pool 13)	$6,646,000	F	2002	3,300		X					
	Potters Marsh	$2,975,000	F	1995	2,305	X	X					X

Table 9: Summary of Environmental Management Program Habitat Rehabilitation and Enhancement Projects On or Adjacent to the Upper Mississippi River Refuge (Adapted from USACE, 2004b) (Continued)

Environmental Management Program												
Pool	**Project Name**	**Cost**	**Project Status[1]**	**Year Completed**	**Affected Acres**	**Project Features/Techniques**						
						Back-water Dredging	Water Level Mgmt.	Island	Bank Stabilization	Side Channel Restoration	Aeration	Other
14	Princeton Refuge[3]	$3,983,000	F	1999	1,129		X					X
	Completed (27 projects)	$53,729,000			43,022							
	Under Construction (3 projects)	$12,204,000			10,894							
	Design (2 projects)	$15,120,000			3,000							
	Planning (6 projects)	$21,365,000			16,910							
	Totals (37 Projects)	$102,418,000			73,826							

1. *Project status as of January 2004. F = Finished; C = Under Construction; D = Design; P = Planning and preliminary design.*
2. *Project located on Trempealeau NWR adjacent to the Upper Mississippi River Refuge. Trempealeau NWR is responsible for operation and maintenance.*
3. *Project located adjacent to the Refuge. Iowa Department of Natural Resources is responsible for all or a portion of the operation and maintenance.*
4. *Project located adjacent to the Refuge. Wisconsin Department of Natural Resources is responsible for all or a portion of the operation and maintenance.*

Table 10: Upper Mississippi River System Environmental Management Program Habitat Rehabilitation and Enhancement Project Techniques. (USACE, 2004b)

Technique	Objectives
Dredge backwaters	Alter flow patterns and velocity Improve floodplain structural diversity Increase deep water fish habitat Provide access for fish movement Provide dredged material to support revegetation
Manage water levels using dikes and water control systems	Restore natural hydrologic cycles Promote growth of aquatic plants as food for waterfowl Reduce backwater sediment loads Consolidate bottom sediments Control rough fish
Build islands	Decrease wind and wave action Alter flow patterns and sediment transport Improve aquatic plant growth Improve floodplain structural diversity Provide nesting and loafing habitat for waterfowl and turtles
Stabilize shorelines	Prevent shoreline erosion Maintain floodplain structural diversity Create fish habitat Reduce sediment loads to backwaters
Modify secondary channels	Improve fish habitat and water quality by altering inflows Stabilize eroding channel Reduce sediment load to backwaters by reducing flow velocities Maintain water temperature and provide rock substrate
Aerate	Improve fish habitat and water quality by introducing water
Miscellaneous Experimental and Complementary Techniques:	
Large scale water level management	Seed islands
Upland sediment control	Isolated wetlands
Land acquisition	Weirs
Riffle pools	Rock sills
Potholes	Sediment traps
Notched wing dams	Mussel substrates
Anchor tree clumps	Bottomland Forest Restoration
Vegetative plantings	

backwater dredging, island construction, and bank stabilization techniques to improve 500 acres of habitat (Figure 30). Wisconsin Department of Natural Resources monitoring of the area documented immediate vegetative response and among the highest abundance of bluegills in Pool 8 after the project was completed (USACE, 2004b). Duck and swan use in the area also increased significantly from the early 1990s pre-project conditions.

HREP design has evolved appreciably since the program began in 1986. As projects are completed and evaluated, design has improved and innovative new techniques have developed. Some examples:

Island design has evolved from just being a wind and wave barrier to incorporating areas for specific habitat such as humps for turtles, mudflats for waterbirds, and dynamic shorelines for shorebirds. Islands are also designed with varied elevations above the average water level to provide additional vegetation habitat diversity.

Island design has also evolved into providing more natural-looking layouts and features. Islands are now designed to replicate historical islands that have eroded away since the river was impounded. Use of rock for shoreline stability has decreased with the use of native vegetation such as willow plantings. Sacrificial berms with rock groins allow the river to shape and stabilize the islands which provides for a dynamic, more natural-looking shoreline (Figure 31).

Figure 30: Phase II Habitat Rehabilitation and Enhancement Project, Stoddard Islands, Upper Mississippi River Refuge, Aerial Photo Sequence (Wisconsin Department of Natural Resources)

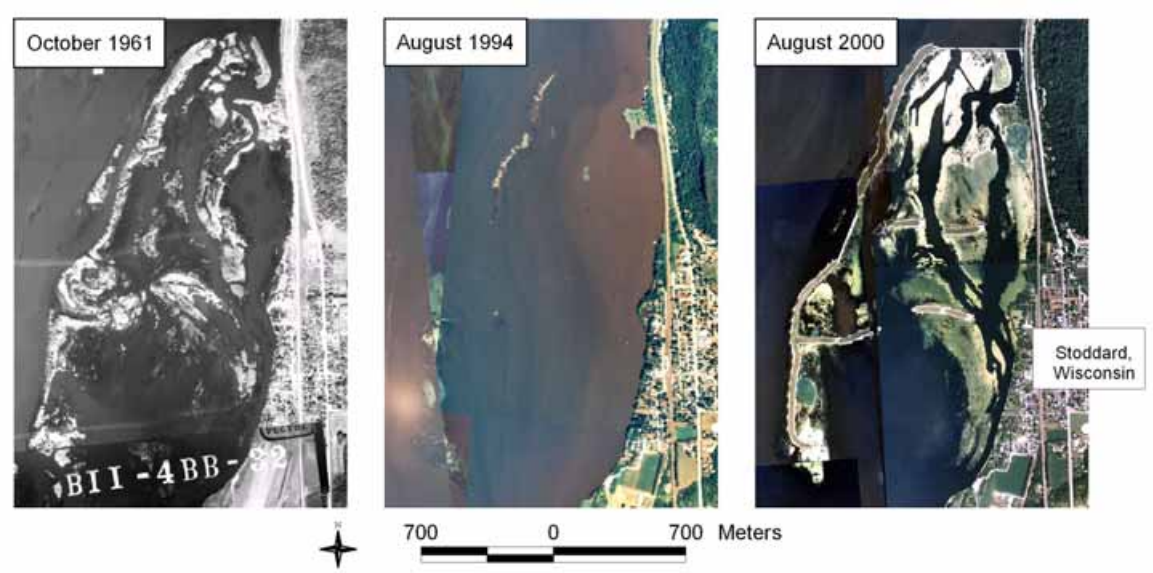


Figure 31: Constructed Islands with Sacrificial Berms, Rock Groins, and Native Vegetation, Upper Mississippi River Refuge

Figure 32: Seed Islands Constructed and "Growing" on Upper Mississippi River Refuge

Seed islands are a new concept that developed as a direct result of the HREP program. Seed islands are designed for areas of flowing water where sediment transport is occurring. With the river's natural process, the sediment will deposit on these obstructions and form low islands which will protect areas from wave action and provide additional habitat diversity within the floodplain (Figure 32).

HREPs now include designs for experimental features such as rock/log structures for offshore island protection which provide more diverse habitat than using only rock. Another experimental feature, wildlife loafing structures, consists of tree clumps extended into the river and anchored into island shorelines to provide loafing habitat for turtles and birds and to provide fish habitat (Figure 33).

Water Level Management

The purpose of water level management is to partially re-create the natural river hydrology that occurred before the locks and dams were constructed (refer to Section on page 41). The entire 261-mile length of the Refuge is impounded by the locks and dams, from Pool 4 through Pool 14. Temporarily lowering water levels behind dams during the summer months can stimulate the growth of aquatic plant beds in the lower portion of the pools. This process is called a drawdown.

Since the early 1990s the Service, Corps of Engineers, U.S. Geological Survey, state natural resource agencies, navigation industry, and the public have been working together to perform drawdowns at various pools throughout the Upper Mississippi River. Refuge and other U.S. Fish and Wildlife Service personnel are completely involved with water level management and belong to two

Figure 33: Wildlife Loafing Structures Placed on Constructed Islands Upper Mississippi River Refuge

field-level multi-agency committees which work to recommend water level management practices in their respective navigation pools:

Pools 1-10: Water Level Management Task Force, subcommittee of the River Resources Forum.

Pools 11-22: Water Level Management Subcommittee, subcommittee of the Fish and Wildlife Interagency Committee of the River Resources Coordinating Team.

The Corps of Engineers operates the dams to provide a 9-foot channel for commercial navigation. (The dams do not provide flood control as many people believe.) Each dam has a specific operating plan and is regulated on the basis of discharge (i.e. flow) and maintaining certain water levels at its control point. During times of low flow, gates are lowered into the water backing up the river to maintain the 9-foot channel. As the flow increases, gates are raised allowing more water to pass through the dam while minimizing flooding on adjacent property. When the flow is great enough to provide a 9-foot channel without dams, gates are raised completely out of the water, resulting in the "open river" condition.

To perform a drawdown, water levels are temporarily reduced by half a foot to several feet behind specific dams during the summer months, mimicking natural water level fluctuations. The drawdown to the lower water level is performed gradually, usually over a two week period, in order to allow fish, mussels, and other wildlife to move and adjust to the water level rather than become stranded in an isolated area. The water level is held at the lowered level until the desired performance period is complete or discharges through the dam become too high or low to maintain the lowered level. Once the

Table 11: Upper Mississippi River Pools on Refuge Most Suited for a Drawdown (Adapted from USACE, 2004c), Upper Mississippi River Refuge

Pool	Drawdown[1] Magnitude (ft)	Drawdown Success Rate	Acres Exposed	Dredging Required (yd^3)	Dredging Cost	Cost per Acre
5	1	95%	1,100	135,811	$643,175	$585
	2	81%	2,200	287,236	$1,365,093	$620
	3	55%	4,000	448,088	$2,137,217	$534
	4	38%	5,500	610,333	$2,935,132	$534
7	1	98%	1,206	0	$0	$0
	2	74%	2,331	215,000	$1,280,000	$549
	3	40%	3,385	475,000	$2,800,000	$827
8	1	74%	1,300	2,000	$88,000	$68
	2	50%	3,090	120,253	$475,000	$154
	3	33%	5,215	300,000	$1,185,000	$227
9	1	71%	4,751	0	$0	$0
	2	57%	6,932	75,000	$375,000	$54
	3	40%	9,497	165,000	$825,000	$87
11	1	91%	399	0	$0	$0
	2	86%	883	49,368	$399,400	$452
	3	86%	1,606	109,076	$762,441	$475
	4	64%	2,744	162,800	$976,800	$356
13	1	86%	1,560	35,200	$316,800	$203
	2	86%	2,822	131,032	$1,021,093	$362
	3	68%	4,519	229,768	$1,581,487	$350
	4	55%	6,821	325,600	$1,953,600	$286

[1] *"Drawdown" refers to a reduction in the target operating level for the navigation pool, as measured at the dam.*

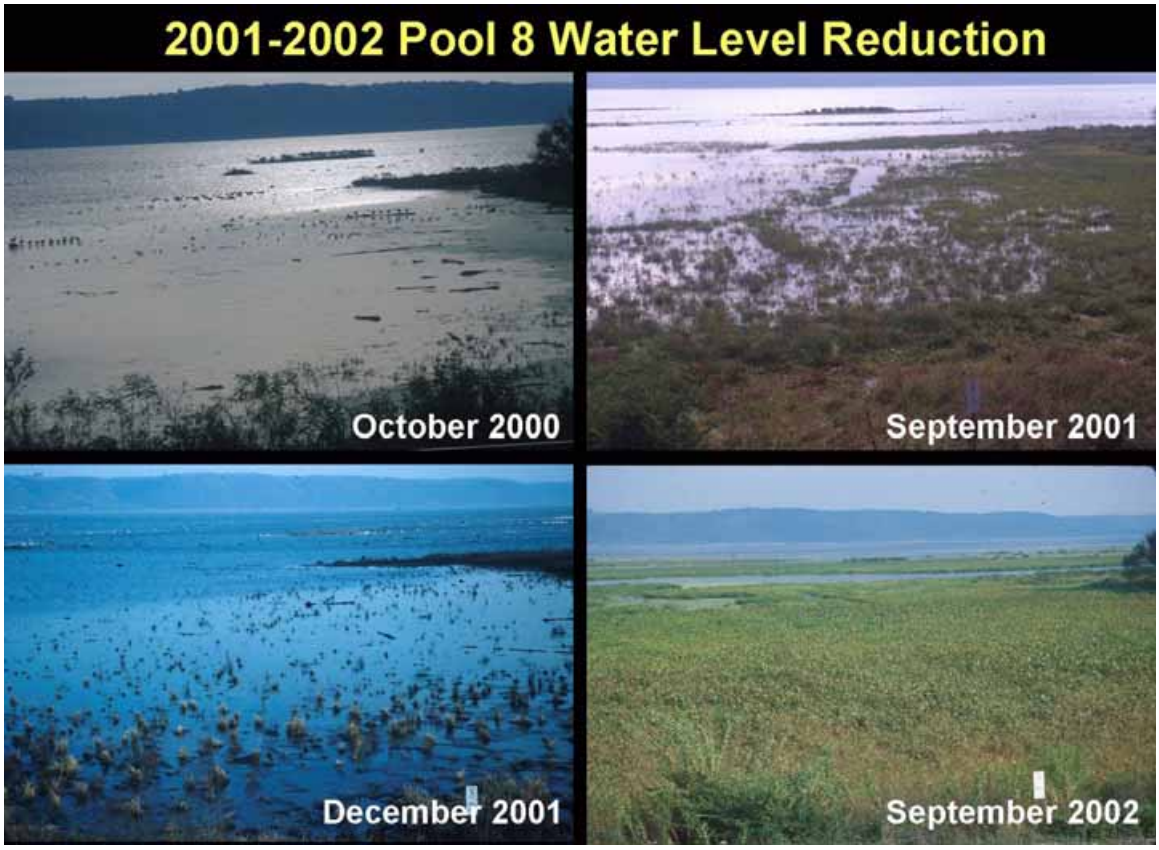
drawdown period is complete, the water level is gradually brought up to its normal level.

There are many factors that limit the use of drawdowns in specific river stretches. These include the amount of acres which can be economically exposed, how much dredging is required to maintain commercial navigation and recreational access to the river, affects to industry barge staging areas, locations of water intake pipes for industry or municipalities, and exposure of archeological sites. Drawdowns can only be performed under specific discharge ranges developed for each dam. Some dams have very narrow drawdown discharge ranges which makes them poor candidates for drawdowns. Within the Refuge, the Corps of Engineers has determined that pools 5, 7, 8, 9, 11, and 13 are best suited for drawdowns based on discharge conditions (USACE, 2004c) (Table 11).

Timing of the drawdown period is also important. The main purpose of a drawdown is to stimulate aquatic vegetation growth; therefore most drawdowns begin in mid-June and end in August or September. However other concerns are considered in the timing such as disturbance to nesting birds, disruption of fish spawning, exposure of mussel populations, and stranding of fish. Many of these concerns are mitigated by the gradual lowering and raising of the water levels.

To determine how successful a drawdown is, data such as land cover, vegetation surveys, and bathymetry is gathered prior to the drawdown. During a drawdown, the effects are carefully monitored; aerial photos are taken and vegetation surveys conducted to determine how much influence the drawdown had. In addition, the effects are monitored for several years after selected drawdowns to see how

Figure 34: Pool 8 Drawdown Sequence (Upper Mississippi River Refuge, La Crosse District)



long the effects last. This information will help river managers determine when the next drawdown of that pool should occur to maximize the effects for that river reach.

Drawdowns have been successfully performed in several areas of the Upper Mississippi River. The U.S. Army Corps of Engineers, St. Louis District has been performing annual drawdowns of Pools 24, 25 and 26 (Melvin Price) since 1995 creating thousands of acres of critical vegetation in those pools. In the late 1990s, small, isolated drawdowns were performed successfully on the Refuge in Pools 5 and 9, demonstrating improved vegetation growth through a drawdown.

In Pool 8, large-scale drawdowns, 18-inches at the dam, were successfully performed in 2001 and 2002. More than 1,950 acres of river bottom were exposed, growth of perennial emergent vegetation was robust (Figure 34), and arrowhead tuber production increased 16-fold in selected areas (RRF, 2004a).

In 2005, a 1.5-foot drawdown of Pool 5 was performed that exposed over 1,000 acres of mudflats and sand bars. Initial results indicate that 72 species of plants were detected in the drawdown area. The resource agencies are evaluating monitoring results for drawdown effects to plant response, waterbirds, mussels, recreation, transit time for commercial navigation, water quality, sediment movement and budget, and sediment nitrogen cycling (RRF, 2005). A second year Pool 5 drawdown, maximum of 1.5 feet, is planned for the summer of 2006.

Drawdowns of Pool 13 have been attempted three times but were discontinued due to low flows. Planning for Pool 13 continues and planning for drawdowns of Pools 6, 8, and 9 is under way.

Drawdowns have proven to be a cost effective way to restore habitat in large reaches of the river. The resulting increased vegetation provides valuable food and cover for fish, migrating waterfowl, and other species along the river. In addition, the

Table 12: Estimated Annual Hunting Visits to the Upper Mississippi River Refuge (Fiscal Years 1999-2003 Refuge Management Information System Reports)

Hunting	Estimated Total Number of Hunter Visits per Fiscal Year				
	1999	2000	2001	2002	2003
Waterfowl	160,936	176,313	189,453	339,430[1]	248,640
Other Migratory Birds	1,645	3,386	4,000	4,591	4,899
Upland Game	19,414	11,872	10,542	10,046	10,084
Big Game	35,921	23,470	23,812	22,371	21,080
Total	217,916	215,041	227,807	376,438	284,703

1. This number is probably too high and reflects a reporting anomaly.

vegetation can absorb nutrients from upland runoff, helping reduce excess nitrogen and phosphorus input into the Mississippi River system. This could in turn contribute to the reduction of Gulf hypoxia.

General Public Use

Hunting

Hunting, one of the priority public uses of the Refuge System, has a deep history and tradition on the Refuge where several species of upland game, big game, and migratory waterfowl and birds are hunted. In fiscal year 2003, over 284,000 hunter visits were made to the Refuge, and approximately 87 percent of those visits were for waterfowl hunting (Table 12). Between 1999 and 2003, waterfowl hunting accounted for 74 to 90 percent of the estimated hunter visits. Portions of the Refuge are open to hunting in accordance with federal, state, and local regulations. Four states overlap with the Refuge, each with their own hunting regulations and seasons (Table 13), requiring hunters to be aware of which state they are hunting in on the Refuge.

Two managed hunts, Potter's Marsh and Blanding Landing, are conducted on the Refuge (Table 5, Appendix C). Since 1980, the Savanna District has conducted a lottery drawing for waterfowl hunting blind sites on 1,923 acres of Potter's Marsh in Pool 13. Applicants pay a $10 non-refundable application fee, and successful applicants pay an additional $100 fee for the 49 blind sites. Successful applicants construct blinds for the season according to guidelines provided. Over 500 persons apply for a blind permit annually. In 2002, hunter bag checks showed that hunters using Potter's Marsh blinds averaged 3.8 birds/day compared to 2.9 birds/day on other areas in Pool 13.

The other managed hunt for waterfowl hunting, Blanding Landing, is a 412-acre area within the former Savanna Army Depot that is now part of the Lost Mound Unit of the Refuge. The Illinois Department of Natural Resources conducts a managed hunt on the area.

Closed Areas

The Refuge currently includes 14 closed areas and one sanctuary encompassing 44,544 acres. The closed areas do not prohibit entry, but are closed to hunting and furbearer trapping during the duck hunting season and to migratory bird hunting at all times. The sanctuary, the Spring Lake Closed Area (Pool 13), is closed to all public entry from October 1 to the end of the duck hunting season. For background information on the closed areas, refer to Appendix Q in the Final EIS/CCP.

In recent years, eight administrative "No Hunting Zones" totaling nearly 3,555 acres were established (6 on Pool 13 and 1 on Pool 7) for public safety, to reduce potential user group conflicts, and provide opportunities for wildlife observation. This includes part of the former Savanna Army Depot that is now part of the Lost Mound Unit. Due to contamination, 2,467 acres of the Lost Mound Unit Crooked Slough Backwater are closed to entry. These "No Hunting Zones" are not intended to augment the Refuge's waterfowl closed area system. (see maps in Appendix E, and Table 2 in Appendix C.)

Fishing

Fishing, another priority public use of the Refuge System, remains an important, traditional use of the Refuge. In fiscal year 2004, over 1 million visitors fished either from boat, shore or on the ice (Table 14). Fishing occurs year-round, with the possible exception of spring ice break-up. The most

Table 13: Comparison of Hunting Seasons 2003 - 2004 on Upper Mississippi River Refuge For Minnesota, Wisconsin, Iowa, Illinois

Event	Dates	Minnesota		Wisconsin		Iowa		Illinois	
Deer Hunting									
Gun Season	Start	22-Nov-03		22-Nov-03		6-Dec-03	13-Dec-03	21-Nov-03	4-Dec-03
	End	30-Nov-03		30-Nov-03		10-Dec-03	21-Dec-03	23-Nov-03	7-Dec-03
	# of Days	9		9		5	9	3	4
Special Management Zones	Start			30-Oct-03	11-Dec-03				
	End			2-Nov-03	14-Dec-03				
	# of Days			4	4				
Wild Turkey Hunting									
Fall Season	Start	15-Oct-03	22-Oct-03	11-Oct-03		13-Oct-03		25-Oct-03	
	End	19-Oct-03	26-Oct-03	9-Nov-03		5-Dec-03		2-Nov-03	
	# of Days	5	5	30		54		9	
Spring Season	Start	14-Apr-04	(Separated into 8 5-day seasons)	14-Apr-04	(Separated into 6 5-day seasons)	12-Apr-04	(Separated into 4 various length seasons)	12-Apr-04	(Separated into 5 various length seasons)
	End	27-May-04		23-May-04		16-May-04		13-May-04	
	# of Days	44		40		35		32	
Migratory Game Bird Hunting									
Dove	Start	1-Sep		1-Sep-03		N/A		1-Sep-03	1-Nov-03
	End	30-Oct		30-Oct-03				14-Oct-03	16-Nov-03
	# of Days	60		60				44	16
Sora and Virginia Rails	Start	1-Sep-03		4-Oct-03	18-Oct-03	6-Sep-03		6-Sep-03	
	End	4-Nov-03		12-Oct-03	7-Dec-03	14-Nov-03		14-Nov-03	
	# of Days	65		9	51	70		70	
Common Snipe	Start	1-Sep-03		4-Oct-03	18-Oct-03	6-Sep-03		6-Sep-03	
	End	4-Nov-03		12-Oct-03	7-Dec-03	30-Nov-03		21-Dec-03	
	# of Days	65		9	51	86		107	
Woodcock	Start	20-Sep-03		20-Sep-03		4-Oct-03		18-Oct-03	
	End	3-Nov-03		3-Nov-03		17-Nov-03		1-Dec-03	
	# of Days	45		45		45		45	
Waterfowl Hunting									
Ducks	Start	27-Sep-03		4-Oct-03	18-Oct-03	20-Sep-03	11-Oct-03	16-Oct-03	
	End	25-Nov-03		12-Oct-03	7-Dec-03	24-Sep-03	4-Dec-03	14-Dec-03	
	# of Days	60		9	51	5	55	60	

Table 13: Comparison of Hunting Seasons 2003 - 2004 on Upper Mississippi River Refuge For Minnesota, Wisconsin, Iowa, Illinois (Continued)

Event	Dates	Minnesota		Wisconsin		Iowa		Illinois	
Canvas-backs	Start	11-Oct-03		18-Oct-03		18-Oct-03		16-Oct-03	
	End	9-Nov-03		16-Nov-03		16-Nov-03		14-Nov-03	
	# of Days	30		30		30		30	
Pintails	Start	27-Sep-03		4-Oct-03	18-Oct-03	20-Sep-03	11-Oct-03	16-Oct-03	
	End	26-Oct-03		12-Oct-03	7-Nov-03	24-Sep-03	4-Nov-03	14-Nov-03	
	# of Days	30		9	21	5	25	30	
Canada Geese	Start	27-Sep-03	12-Dec-03	4-Oct-03	18-Oct-03	27-Sep-03		1-Sep-03	16-Oct-03
	End	5-Dec-03	21-Dec-03	12-Oct-03	17-Dec-03	5-Dec-03		15-Sep-03	13-Jan-04
	# of Days	70	10	9	61	70		15	90
Furbearer Hunting									
Raccoon	Start	Continuous		18-Oct-03		1-Nov-03		5-Nov-03	
	End			31-Jan-04		31-Jan-04		10-Feb-04	
	# of Days	365		106		92		98	

Table 14: Estimated Annual Fishing Visits to the Upper Mississippi River National Wildlife and Fish Refuge (Fiscal year 1999-2004 Refuge Management Information System reports.)

	Estimated Total Number of Fishing Visits per Fiscal Year					
	1999	2000	2001	2002	2003	2004
Total	824,983	1,150,477	1,057,978	1,141,173	943,916	1,303,130

popular fishing spots are below the dams, near wing dams and spillway notches, and in backwaters. The Refuge provides many facilities to promote fishing including 26 boat ramps and 15 fishing piers and platforms (see maps in Appendix E and Tables 1 and 14 in Appendix H of the Final EIS/CCP).

According to a 2003 Minnesota Department of Natural Resources Mississippi River boating survey, half of all boaters indicated that their primary activity on the Mississippi River was fishing. In addition, 70 percent of boaters using public accesses indicated that fishing was their primary activity. This survey also concluded that the most common boat type on the Mississippi River in Pools 4-9 during the summer season is a fishing boat, followed by runabouts. A bass boat falls into the classification of a runabout because it has a windshield (MNDNR, 2004).

Fishing tournaments, particularly for bass and walleye, occur on the Refuge and are permitted by the states. Exact numbers of fishing tournaments are unknown since each state or other authority often has different permit and reporting requirements, or may not issue permits at all. In Illinois, only fishing tournaments initiating from an Illinois Department of Natural Resources launch site are required to have a permit. In Minnesota, permits are issued for tournaments with 30 participants or more. Permitted tournaments are limited to two weekends each month per pool. In Iowa, permits are issued to tournaments with 20 or more boats or 50 or more people. In addition, Iowa requires Illinois tournaments to have an Iowa permit if anglers are fishing in Iowa waters. Wisconsin issues permits for tournaments meeting a minimum participation threshold. Tournaments initiating from boat landings operated by the U.S. Army Corps of Engineers, Rock Island District are required to have

Table 15: Summary of Upper Mississippi River Fishing Tournaments by State

Year	Tournament Fish Species					No. of Tourn-aments	No. of Boats	No. of Anglers (Estimated)
	All	Walleye	Bass	Panfish	Catfish			
Minnesota (Pools 4-7)								
1996	4	9	2	0	0	15	1,072	21,44
1997	2	13	4	0	0	19	1,125	2,250
1998	4	13	4	0	0	21	981	1,962
1999	4	12	6	0	0	22	1,116	2,232
2000	5	12	3	0	0	20	1,430	2,860
2001	4	12	6	1	0	23	1,366	2,732
2002	2	13	4	0	0	19	1,363	2,726
2003	5	15	6	0	0	26	1,992	3,984
Totals for Minnesota						165	10,445	20,890
Iowa (Pools 9-14)								
1996	6	14	38	6	3	67	1,573	3,146
1997	10	19	37		4	70	2,583	5,167
1998	11	16	32	1	5	65	1,401	2,803
1999	8	10	44		3	65	1,433	2,867
2000	13	16	72	1	2	104	2,666	5,333
2001	15	22	104		2	143	2,682	5,364
2002	3	17	102	1	2	125	4,997	9,994
Totals for Iowa						639	17,335	34,674
Wisconsin (Pools 4-11)								
2002		20	77	2		99	922	1,620
2003		12	24			36	686	810
Totals for Wisconsin						135	1,608	2,430
Illinois (Pool 13)								
2003			14			14	155	330
Totals for Illinois						14	155	330

permits if they meet the minimum threshold of 15 boats. Table 15 summarizes fishing tournaments held on the Refuge.

There are few restrictions to lessen the biological impacts from tournaments. Some of the states are requiring catch and release in the same pool that the fish were caught, and in Iowa, during June, July and August immediate release of walleyes is required.

Wildlife Observation and Photography

Two of the six priority public uses for the Refuge System are wildlife observation and photography. The Refuge provides outstanding wildlife viewing opportunities due to the abundance of eagles, swans, ducks, warblers, pelicans, herons and other birds. The National Scenic Byways that border the Refuge for hundreds of miles and the relatively open access to lands and waters of the Refuge, make the Refuge one of the premier wildlife viewing and photography areas in the nation. The Refuge provides many facilities to support wildlife observation and photography including 15 observation decks, six hiking trails, three biking trails, four canoe trails, and one auto tour route (maps, Appendix E, and Table 3, Table 4, Table 5, Table 15 and Table 19 in Appendix H of the Final EIS/CCP). In fiscal year 2003, the Refuge recorded 220,000 wildlife observation and photography visits, and in fiscal year 2004, the visits increased to over 389,000 visits (Table 16).

Table 16: Estimated Annual Wildlife Observation and Photography Visits to the Upper Mississippi River Refuge (Fiscal year 2002-2004 Refuge Management Information System Reports)

Estimated Total Number of Wildlife Observation and Photography Visits per Fiscal Year		
2002	2003	2004
240,088	220,000	389,080

Interpretation and Environmental Education

For the Refuge System, interpretation and environmental education are two of the six priority public uses. Interpretive signs are the primary method of interpretation used by the Refuge. They are relatively inexpensive and convey messages at the visitor's convenience since they are available any time of the day or season. A total of 66 interpretive signs are used along the National Scenic Byways, bike trails, walking trails, overlooks and off-refuge sites overlooking the Refuge. In addition, 66 kiosks, 25 entrance signs and 30 official notice boards provide information about the Refuge. (See maps in Appendix E. Also, see and Table 16 in Appendix H of the Final EIS/CCP)

The Refuge has three full-time visitor services specialists, along with staff, volunteers and interns who conduct on- and off-site educational programs. The La Crosse and Savanna Districts have meeting rooms where educational activities are conducted. Lacking any classroom facilities, the McGregor and Winona Districts conduct all environmental education activities out on the Refuge or at off-site facilities.

Educational materials including books, posters, videos, equipment, and learning trunks are available for loan to area educators. In addition, Refuge staff, working with other agencies and organizations, coordinates special events including the Upper Mississippi River Festival, River Education Day, Birding Festivals, Eagle Days, and Refuge Week.

A yearly average of 6,000 students and teachers participate in on- and off-site environmental education activities. The number of students participating in on-site environmental education decreased 39 percent from 2000 to 2003 while off-site instruction increased 45 percent over the same period. This trend toward off-site instruction can be attributed to the lack of indoor and outdoor Refuge classroom facilities that accommodate students during inclement weather, as well as the lack of funding for school field trips. The Refuge has requested funding from the Friends Group to help defray bus transportation to Refuge sponsored activities such as the Upper Mississippi River Fest. .

Recreational Boating, Camping, and Other Beach-Related Uses

Although they are not wildlife-dependent priority uses of the Refuge System, an estimated 1.8 million visitors use the Refuge annually for recreational boating, camping, picnicking, swimming, social gatherings, and other beach-related uses. There is a long history of beach use on the Upper Mississippi River as the public took advantage of beach areas created by placement of dredged sand during navigation channel maintenance operations. The public also takes advantage of natural sand shorelines and sand placement sites often called "bathtubs".

For 10 years, extensive data from aerial photo surveys has been collected to evaluate the extent of watercraft use along a 150-mile section of the main navigational channel during the Memorial Day to Labor Day summer season (Resource Studies Center, St. Mary's University of Minnesota, 2001). This

U.S. Fish & Wildlife Service

study section starts at the lower end of Lake Pepin (Pool 4, River Mile 764.5) and ends at Guttenberg, Iowa (Pool 10, River Mile 614.2). Study data indicate that the highest percent of boating use occurs on Pools 10, 4 and 8. The areas that have the highest percentage of beached boats in the study area include:

Pool 4: Wabasha Bridge to Teepeeota Point
Pool 5: West Newton to Minneiska
Pool 5A: Bass Camp to Fountain City boat yard
Pool 8: Mouth of Root River to Deadman Slough Daymark
Pool 10: Wisconsin River confluence to Lock and Dam 10

Boating activity decreases where there are fewer beaches. In 2003, the Minnesota Department of Natural Resources conducted a recreational boating study on the Mississippi River, Pools 4-9, from Memorial Day through Labor Day (MNDNR, 2004). This study involved direct interviews and the use of questionnaires. It revealed that there were 670,345 boater-occasions (number of people in a boat using the river). While previous aerial photo surveys were limited to the main navigation channel, the Minnesota study attempted to locate all boats, regardless of their location on the river. A comparison of the 2003 Minnesota study to previous aerial photo counts shows the photos measure approximately 60 percent of all boating use. Therefore, it was estimated that 60 percent of recreational boating takes place in the main navigation channel, and 40 percent takes place in side channels and backwater areas. The 2003 Minnesota study also noted several boating trip characteristics:

The average boating party size is 2.9 people, most of whom are adults.
Overnight boating trips account for 12 percent of all trips.
Most boaters (87 percent) do not leave (lock out) the pool into which they launch.
One-third of all trips (32 percent) involve beaching.
Anglers spend most of their time in side channels and backwaters.
Fishing is the primary activity for half of all boaters.

The Refuge has designated four canoe trails and one electric motor area for recreational boaters engaged in "silent sport" activities such as kayaking and canoeing. In these areas, the public can at times experience the quiet and solitude of the Refuge backwaters (maps in Appendix E and Table 4 in Appendix C). Boats with motors are allowed in the canoe trail areas.

On several areas of the Refuge, boat traffic levels and size of boat wakes is leading to erosion of island and shoreline habitat. Some areas also present a safety hazard for boaters due to level of use and blind spots in the channel. To address these issues, there are 46 no-wake zones on the Refuge.

While not a wildlife-dependent use, camping is allowed on the Refuge. However, camping at any one site on the Refuge is restricted to no longer than 14 days during any 30-consecutive day period. In addition, tents, camping equipment, boats or other property cannot be left unattended at any site for over 24 hours. During waterfowl hunting seasons, camping is prohibited within Closed Areas, no hunting zones, or on any sites not clearly visible from the main navigation channel.

Public Use Facilities

The Refuge has four visitor contact stations, one each located at the La Crosse, McGregor and Savanna District Offices and one located at the Lost Mound Unit (Table 17). These contact stations feature small displays areas adjacent to the office area. The La Crosse and Savanna visitor contact stations also feature a sales area with natural history books and other products.

The Refuge maintains 26 boat landings with 700 parking spaces (maps Appendix E and Table 1 in Appendix C). The landings can accommodate flat bottom boats, v-bottom fishing boats, runabouts, powerboats, pontoon boats, canoes, and kayaks. An additional 221 non-U.S. Fish and Wildlife Service landings also provide access to the Refuge. There are numerous walk-in sites and roadside pull-off areas where access management and control is varied and inconsistent. Providing access to the Refuge is challenging given the rail and highway systems in place, and the physical restrictions of floodplain and terrain.

Scenic Byways

The Refuge winds through beautiful bluff country in Minnesota, Wisconsin, Iowa and Illinois. The Great River Road National Scenic Byways border the Refuge on both sides (Figure 35), providing access to many of the Refuge's visitor contact

Table 17: Upper Mississippi River Refuge Visitor Contact Stations

District	Exhibits	Classroom	Book Store	Year Opened
La Crosse	Yes	Yes	Yes	1995
McGregor	Yes	No	No	1986
Savanna	Yes	Yes	Yes	2000
Savanna, Lost Mound Unit	Yes	No	No	1999

stations, boat ramps, trails, observation decks, kiosks, and interpretive signs. The Great River Road includes the following highways near the Refuge:

Minnesota: U.S. Highway 61
Wisconsin: State Routes 35 and 133, County Road C, and U.S. Highway 61
Iowa: State Route 26, Iowa 340, U.S. Highway 52
Illinois: U.S. Highway 20, State Route 84

In addition to the Great River Road, the Lincoln Highway National Scenic Byway, US 30, intersects the Refuge at Fulton, Illinois. Refuge personnel work with state representatives of the scenic byways on projects that are beneficial to both the Refuge and the scenic byways.

Socioeconomic

The Upper Mississippi River Refuge comprises over 240,000 acres along the Mississippi River in the Upper Midwest. The Refuge covers 261 river miles beginning north of Wabasha, Minnesota, where the Chippewa River flows into the Mississippi River and ending just above Rock Island, Illinois. The Refuge has four management districts that encompass four states and 19 counties.

This section summarizes Dr. James Caudill's socio-economic information about the Refuge. For further documentation refer to his two reports, "Affected Environment: Socio-Economics" and "The Economic Effects of the Upper Mississippi River National Wildlife and Fish Refuge Baseline and Effects of Alternatives." Both documents can be found on the Refuge planning web site http://midwest.fws.gov/planning/uppermiss/index.html .

Population, Income, Employment and Demographics

For the Refuge area (19 counties) as a whole, the 2001 census population was over 933,000 which represented a 2.8 percent increase from 1991. This increase lagged behind population increases for the four states and for the U.S. Total employment in 2001 was over 589,000 for the Refuge area, representing a 12.7 increase from 1991. This increase, as with population, lagged behind state and U.S. employment increases. Per capita income (total area income [county, state or U.S.] divided by area population, and adjusted for inflation to 2003 dollars) was $25,514 for the Refuge area counties, increasing by 16.9 percent from 1991. While greater than the U.S. per capita increase, state increases in per capita income were greater than the Refuge area counties, ranging from a 24.4 percent increase for Minnesota to a 17.5 percent increase for Iowa.

While most of the counties are rural in nature, two of the districts have a fairly low level of farm-related employment. The Savanna District has only 4.2 percent of total employment in farming and the La Crosse District has only 6.0 percent of total employment in farming (Table 18). The other two districts, Winona and McGregor, show farm employment comprising 9.8 and 10.3 percent of total employment respectively. All four districts show a 10-year decline in farm-related employment, ranging from a 9.5 percent decline in the Savanna District to a 7.1 percent decline for both the Winona and McGregor districts.

Manufacturing, retail trade and services comprise the major employment sectors for all four districts. These three sectors comprise 59 percent of total employment for the Winona District, 61.5 percent for the La Crosse District, 59.3 percent for the McGregor District and 62.9 percent for the Savanna District. The fastest growing sectors for the Winona District are manufacturing (23.2 percent), services (21.4 percent) and retail trade (14.4 percent). In the La Crosse District, the fastest growing sectors include finance, insurance, and real estate (FIRE) (39.0 percent), services (34.0 percent) and wholesale trade (28.4 percent). For McGregor District, services was the fastest growing sector (32.5 percent), with retail trade sector (16.9 percent) and manufac-

Figure 35: National Scenic Byways Bordering the Upper Mississippi River Refuge

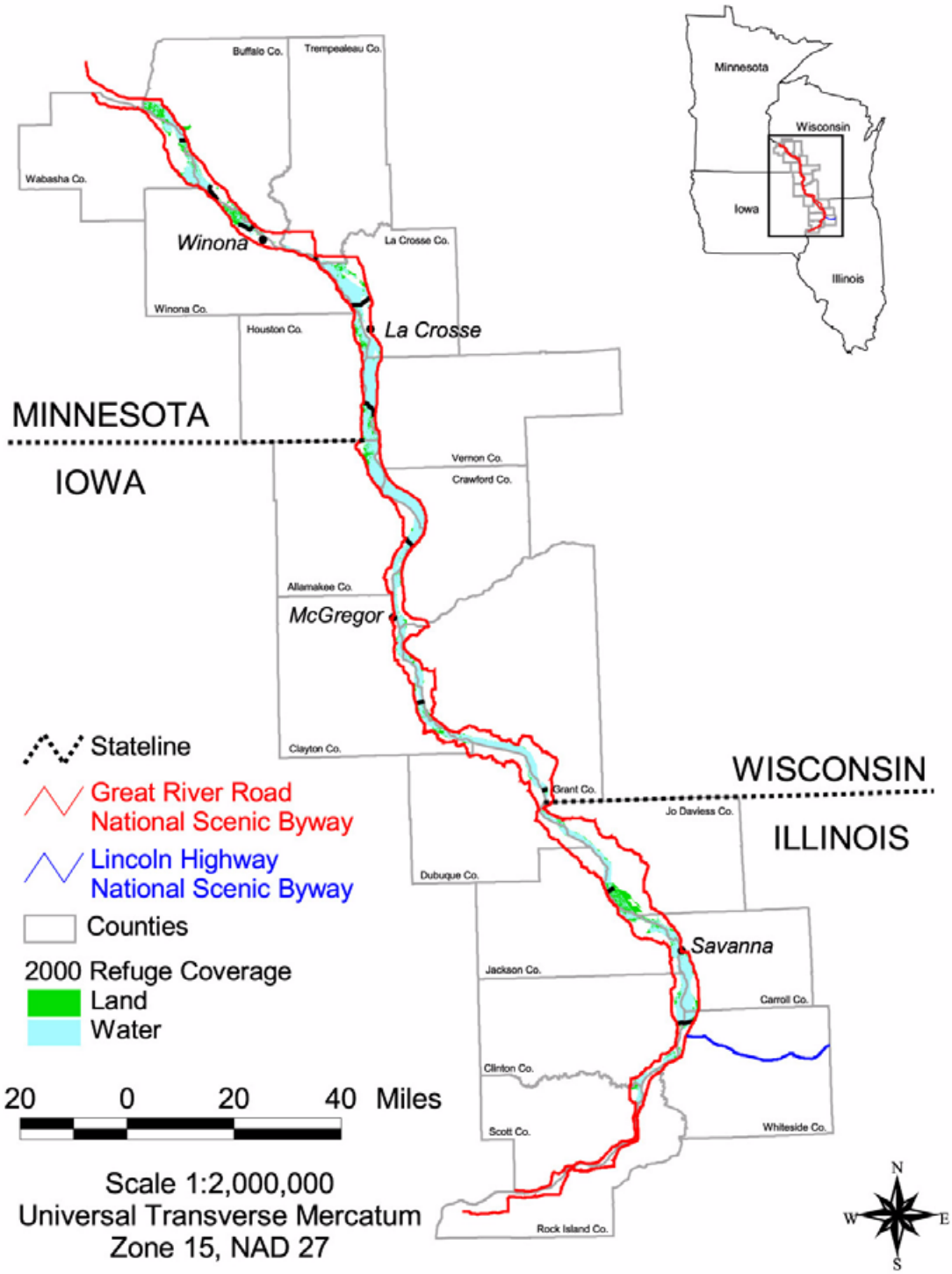


Table 18: Employment Characteristics by Major Economic Sectors and Refuge District[1]

Sector	Winona District		La Crosse District		McGregor District		Savanna District	
	Percent change 1990-2000	Sector as percent of total employment 2000	Percent change 1990-2000	Sector as percent of total employment 2000	Percent change 1990-2000	Sector as percent of total employment 2000	Percent change 19902000	Sector as percent of total employment 2000
Farm	- 7.1	9.8	- 9.0	6.0	- 7.1	10.3	- 9.5	4.2
Nonfarm	24.4	90.2	22.6	94.0	20.0	89.7	14.8	95.8
Manufacturing	23.2	23.2	8.3	16.9	1.5	15.1	2.0	15.8
Wholesale	4.5	4.5	28.4	5.4	31.0	4.4	6.9	4.9
Retail	14.4	14.4	17.6	16.9	21.1	16.9	9.8	17.6
FIRE	3.5	3.5	39.0	5.1	26.7	5.0	11.1	5.7
Services	21.4	21.4	34.0	27.7	32.5	27.3	33.5	29.5
Government	11.8	11.8	14.3	12.4	- 2.3	10.1	- 4.2	11.3
Other	NA	21.3	NA	15.8	NA	21.4	NA	15.2

1. *Source: Caudill, 2004*

turing (15.1 percent) following. In the Savanna District, the service sector had the highest increase, 33.5 percent, followed by FIRE (11.1 percent) and the retail trade sector (6.9 percent).

Caudill's "Affected Environment: Socio-Economics" (Caudill, 2004) report also details the demographics of the 19 counties in the Refuge area. The populations are more than 95 percent white. When compared to their respective states and the U.S. as a whole, the counties within the Refuge area have a:

lower proportion of children under 5.
higher proportion of people over 65.
varying proportion of high school graduates from slightly lower to slightly higher.
lower rate of college graduates.
higher rate of home ownership.
about the same rate of population below the poverty line.

Refuge Economics

Recreation visits to the Refuge and Refuge budget expenditures generate significant local and regional economic effects (Caudill, 2004a). In 2003, the Refuge accounted for over 3 million visitor days; boating, camping, and other beach-related uses accounted for 43 percent of total visitor days; fishing accounted for 38.3 percent; wildlife observation for 9.7 percent; migratory waterfowl hunting for 8 percent; big game hunting for 0.7 percent and small game hunting for 0.3 percent. These visits resulted in $73.5 million in retail expenditures in the nineteen-county area surrounding the Refuge. Total economic output associated with these expenditures amounted to $89.9 million (Table 19, Caudill, 2004a).

Recreational use of the Refuge generated 1,173 jobs in the 19-county area with job income of $19.7 million. Non-residents (living outside the 19-county area) spent $27.8 million in the local area resulting in $33.9 million in economic output and 431 jobs with labor income of $7.4 million. Recreational use of the Refuge generated over $9.6 million in federal, state and local taxes. The economic value of the recreational use of the Refuge is estimated to be between $46 million and $60 million annually.

Refuge budget expenditures average over $5 million annually. These expenditures generate $8.3 million in economic output, 93 jobs and over $1.7 million in job income. Over $731,000 in federal, state and local taxes are generated by Refuge budget expenditures.

Table 19: Total Economic Impacts of Recreational Use: Upper Mississippi River Refuge, 2003[1]

Activity	Expenditures	Output	Jobs	Job Income
Wildlife Observation	$4,063,292	$4,968,614	68	$1,071,484
Small game hunting	$160,431	$196,291	3	$42,497
Big game hunting	$501,106	$619,673	8	$142,627
Migratory bird hunting	$4,542,451	$5,609,297	76	$1,268,309
Fishing	$29,576,333	$36,223,053	483	$8,119,297
Boating	$34,673,216	$42,266,199	535	$9,044,582
Refuge Totals	$73,516,829	$89,883,127	1,173	$19,688,796

1.Source: Caudill, 2004a)

Considering both Refuge visitor and budget expenditures, the Refuge generates over $19 million annually in expenditures and economic value, $98 million in economic output, 1,266 jobs with an income of $21.4 million and federal, state and local taxes of $10.4 million. Each dollar of Refuge budget expenditures generates $23.90 of economic effects and $2.08 of federal, state and local tax revenue.

It is important to note that previous reports on the economic impacts of recreational use on the Upper Mississippi River System show a much higher impact than presented here. For example, the Corps of Engineers' 1993 report on economic impacts of recreation on the Upper Mississippi River System (USACE, 1993a) estimated recreational expenditures at $387 million, and economic output and jobs supported in adjacent counties of $200 million and 3,000, respectively. The report concluded that overall U.S. economic output resulting from recreation on the system at $1.1 billion per year and supporting 12,600 jobs.

The State of Wisconsin, using previous economic reports, estimated that the 19 counties adjacent to the Refuge accounted for 7.6 million visits, $255 million in economic output, and support for 4,580 jobs.

These differences compared to Refuge figures reflected above and in Table 19 can be attributed to a number of factors. Earlier reports were not Refuge-specific and covered areas beyond the Refuge. Refuge visitation figures only reflect people actually within the Refuge doing recreation and do not account for visits to private marinas; state, county, and Corps of Engineers recreation areas; persons traveling along the scenic byways adjacent to the Refuge; or general "tourism" visits to the host of communities adjacent to the Refuge. Thus, how one defines a visitor to the Refuge has a huge impact on the actual number of visits used in economic models, and visits drive the models. Refuge information in this section was also only for travel-related expenditures, and only for in-state impacts. Regardless of the estimates, the economic impact from recreation on the Refuge, and the Upper Mississippi River as a whole, is critical to the socioeconomic fabric of the area.

Commercial Use of Refuge

Commercial use of the Refuge consists of hunting, wildlife observation and fishing guides, commercial trappers, recreational fish float operators and commercial fishing. Farming, grazing and timber harvesting have a minimal impact on the Refuge. Commercial navigation passes through the Refuge.

Hunting, Fishing and Other Guide Services

A number of guides operate on the Refuge, providing services for anglers, hunters and wildlife observers. In recent years, the Refuge has averaged about 15 guides operating on the Refuge per year. Specific information on the number of clients, party size and client expenditures for guide services is not available, but it is estimated that each guide is engaged for about 30 – 40 trips per year. Guides who obtain permits from the Refuge pay $100 annually.

Table 20: Comparison of Trapping Seasons, Upper Mississippi River Refuge

Furbearer Trapping	Dates	Minnesota	Wisconsin	Iowa	Illinois
Muskrat	Start	1-Nov-03	10-Nov-03	1-Nov-03	5-Nov-03
	End	29-Feb-04	29-Feb-04	31-Jan-04	15-Jan-04
	# of Days	121	112	92	72
Otter	Start	Not Allowed	6-Dec-03	Continuously Closed	N/A
	End	N/A	7-Mar-04	N/A	N/A
	# of Days	0	93	0	0
Beaver	Start	1-Nov-03	8-Dec-03	1-Nov-03	5-Nov-03
	End	15-May-04[1]	15-Mar-04	15-Apr-04[1]	31-Mar-04[1]
	# of Days	197	99	167	148

1. Refuge season closes March 16.

Commercial Trapping

Muskrat, beaver, raccoon, and mink are the primary furbearing species harvested on the Refuge. A relatively few number of red fox and otter are also trapped. Over 75 percent of the animals trapped are muskrats. The average age of trappers continues to increase as fewer young trappers replace the older trappers who either quit or pass away. Four states overlap the Refuge, each with their own trapping regulations and seasons (Table 20). This is a source of confusion for some trappers, who must be well aware of what state they are in when trapping on the Refuge.

Trappers must have a Special Use Permit and pay an annual fee of $20.00 (since 2000) to trap on the Refuge. Annual revenue from trapping fees has averaged $4,740 since 2000. In the 2003-04 season , 245 active trappers spent an average of 24.1 days each trapping on the Refuge; they harvested 36,108 muskrats (Table 21). Based on an average price of $2.72 per pelt (based on a Wisconsin Department of Natural Resources survey, one local buyer, and two national auctions), gross revenue for the muskrat harvest by these trappers amounted to $98,214 (Table 21). Gross revenue for beaver was $29,835, for otter it was $4,117. Pelt prices vary considerably between years, for example, muskrat prices have ranged from $6.50 per pelt in 1979, to $4.00 in 1987, $1.00 in 1990, and $2-2.50 in 2004. Beaver sales at the North American Fur Auctions varied between $16 and $21 from 2000 to 2004. For further details on the Refuge's trapping program refer to Chapter 3, page 73.

Fish Float Operators

Fish floats are private businesses which provide fishing opportunities to the public for a fee. Operators pick up customers via boat and transport them to the fishing facility (float) below a lock and dam. There are currently four fish float operators within Refuge boundaries. About 15,000 anglers per year use the floats with the largest operator servicing about 6,000 anglers per year while the remaining operators average about 3,000 anglers each per year. For calendar year 2003 gross receipts ranged from $10,000 to $44,000 per float. Float operators are required to obtain an annual special use permit from the Refuge for a fee of $100.

Commercial Fishing

Commercial fishermen usually harvest 17 species of fish, plus turtles, within the Refuge (Pools 4-14). During the period 1998 to 2001, annual commercial catch within Refuge pools (Table 22) averaged 6.6 million pounds, with a gross value of $1.7 million (2003 dollars), based on ex vessel price per pound (the price paid to the commercial fisher dockside: i.e., before any processing or distribution). Commercial catch of turtles averaged 8,475 pound annually. People who fish commercially must obtain annual commercial fishing licenses issued by the four States. An individual commercial fisherman may require one or more licenses to cover the harvest of

Table 21: Estimated Gross Revenue from Furbearers Harvested by 245 Trappers During the 2003-2004 Trapping Season, Upper Mississippi River Refuge

Species	Fur Prices from Various Sources[1]				Average Price (Dollars)	Trapper-reported Harvest on Refuge	Gross Revenue (Dollars)
	Wisconsin Fur Prices	Fur Harvesters Auction, June 2004 (Dollars)	North American Fur Auctions, 2004 (Dollars	Wiebke Fur Company, LaCross Wis., November 2004 (Dollars)			
Beaver	15	17	21	15	17	1,755	29,835
Raccoon	12	14	n/a	11	12	1,533	18,907
Otter	89	84	105	80	90	46	4,117
Muskrat	2.65	3	n/a	2.50	2.72	36,108	98,093
Red Fox	21	n/a	20	15	19	4	75
Mink	19	13	n/a	11	14	380	5,447

1. *Fur prices rounded to the nearest dollar, except muskrat.*

Table 22: Summary of Commercial Fishing, Upper Mississippi River Refuge

Year	Species	Pounds of Fish	Value ($)[1]	Pounds of Turtles	Value ($)[1]	No. of Fishermen
Pools 4-14						
1998	17	6.25 million	1.50 million	8,900	4,100	599
1999	17	5.98 million	1.53 million	8,000	3,600	397
2000	17	5.61 million	1.49 million	9,000	4,700	537
2001	17	8.46 million	1.81 million	8,000	4,400	576
Spring Lake Pool 13						
1998	3	35,595	5,339	N/A	N/A	14
1999	3	63,557	10,169	N/A	N/A	13
2000	3	73,544	11,031	N/A	N/A	12
2001	3	38,322	5,365	N/A	N/A	8
2002	3	63,463	9,519	N/A	N/A	14
2003	3	57,532	8,629	N/A	N/A	14

1. *Minimum value ($) based on dead weight.*

various fish species and/or utilize different types of nets and lines. Therefore, annual data described herein (except Spring Lake, see below) are attributed to the number of licenses, not the number of commercial fishermen (Table 22). Between 1998 and 2001, an average of 527 commercial fishing licenses were issued to people who operate within Refuge pools. The annual gross revenue per commercial fishing license was $2,963.

The only location on the Refuge where commercial fishermen must have Refuge permits is on Spring Lake in Pool 13. During 1998-2003, an average of 13 fishermen were issued permits through the Savanna District office (Table 22). Total average annual harvest at Spring Lake was 55,335 pounds of fish, yielding an average gross income of $642 per fisherman. This low dollar value is based on the low-

est values fishermen are paid, based on whether fish are bought live, whole or processed.

Clamming

There is virtually no clamming industry on the Mississippi River at the present time. In the early 1990s clamming was a million dollar industry. The market for clams was primarily in Japan where the shell "seeds" were used to implant oysters for pearl production. However, in the late 1990s the combination of large stockpiles of shells and a disastrous red tide in Japan that destroyed oyster beds depressed the market for clamming. Today the price is what drives this industry and with the introduction of a synthetic bead into pearl production, it is not likely the local commercial clamming industry will be revived. In addition, some States are restricting commercial clamming activities because of population declines due to competition of invasive species, habitat changes, and changes in host fish populations.

As of the 2006-2007 season, all Wisconsin waters, including the Mississippi River, have been closed to commercial clamming. Wisconsin allows pearl hunting and personal clamming (up to 50 pounds per day) but it is illegal for anyone to sell or barter clams. Minnesota has also closed the clamming season on waters infested with zebra mussels to include the Mississippi River south of St. Anthony Falls (St. Paul, Minnesota). Iowa has closed the commercial clamming season in the Mississippi River along the Wisconsin/Iowa border, but not as yet on the Illinois border waters. Illinois allows commercial clamming on the Mississippi River but has one sanctuary in the Blanding Landing area of Pool 12.

Administration and Facilities

The Refuge is divided into four districts to optimize management, administrative, and public service effectiveness and efficiency. District offices are located in Winona, Minnesota (Pools 4-6), La Crosse, Wisconsin (Pools 7-8), McGregor, Iowa (Pools 9-11), and Savanna, Illinois (Pools 12-14). The Refuge currently has 37 permanent employees and an annual base operations and maintenance budget of $3.1 million.

U.S. Fish & Wildlife Service

The Refuge has its overall Headquarters in Winona, Minnesota, that provides administrative, biological, engineering, private lands, mapping, visitor services, planning, and policy support to the districts. District managers are supervised by the refuge manager located in Winona. Two other national wildlife refuges, Trempealeau NWR and Driftless Area NWR, are also part of the Refuge complex. Driftless Area NWR is under the supervision of the McGregor District manager.

The Headquarters office is currently in the old historic Exchange Building in downtown Winona, a building shared with private enterprise. Customers to these businesses provide a considerable distraction in terms of traffic and non-refuge-related inquiries. The building has no physical connection to the Refuge. The building offers little to no Refuge or Fish and Wildlife Service identity and very limited visitor parking. There are inadequacies in the heating and cooling system, disabled access, and staff parking. The building space is currently rented for $70,000 per year. The current lease expires in 2006. Boats and other vehicles and equipment are stored in a garage a few blocks away.

The Winona District is currently located on the second floor of the Exchange Building in downtown Winona, Minnesota as noted above for Headquarters. The same inadequacies affect the operation of Winona District. The District shop is one stall of an old garage attached to the Sign Shop several blocks away. Other storage includes an open pole barn built about 10 years ago. Both of these facilities are Fish and Wildlife Service-owned. With the pending

replacement of the Sign Shop, Winona will lose their current shop and storage facilities.

La Crosse District currently has a modern office and limited garage space that is rented through General Services Administration. The building is shared by Fisheries, Law Enforcement, and National Wetland Inventory staff. The building has a shared visitor contact component with exhibits, meeting rooms, and a cooperative sales area. The La Crosse District accounts for approximately $100,000 of the annual rental cost paid by the Service, and soon, the Region. The lease expired in December 2004 and was extended for 5 years, with an option to vacate in 3 years, or the end of 2007. The District also has a modest maintenance and storage facility built in the 1960s near La Crescent, Minnesota. This building is owned by the Fish and Wildlife Service, and needs to be replaced in a different location since it is in the floodplain. The current office, although modern and adequate, presents a high, re-occurring annual rental cost, is several miles from the Refuge, and is located in a highly developed retail business area of Onalaska. The office is difficult to find and not frequented by most people who use the Refuge.

The McGregor District office is currently Service-owned but on a small site with severe physical limitations due to tract size and a sheer bluff in the back and a major highway and rail line in front. Staff is crammed into tiny offices or divided areas/hallways, and an excess Federal Emergency Management Agency trailer is wedged between the office and the cliff. The office and trailer were cited in 2004 for several structural/location-related safety violations which are beyond the staff's control. The office turn from the highway is unsafe, and there is not enough space for parking. Staff park across the highway on private land, although this arrangement is dependent on the continued good will of the owner. Staged trains sometimes block access to personal vehicles. A small maintenance building is also on the site. Roof problems were repaired and the storage area expanded upward during a 2004 renovation, but the building is still judged inadequate from both a size and location standpoint. Three equipment storage buildings are located in Cassville, Lansing, and Genoa for logistical reasons given the size and length of the District. The Cassville and Genoa buildings were built in the 1960s and are reaching the end of their useful life. The Lansing building is newer and deemed adequate.

The Savanna District has an office and visitor contact station (Ingersoll Learning Center) on the Refuge adjacent to wildlife viewing areas and hiking/biking trails. However, the environmental education and interpretation program is limited by inadequate facility size. An equipment storage building was recently constructed, but the District has a tiny, outdated maintenance building.

The existing Lost Mound Unit office is an old Savanna Army Depot administrative building shared with the Illinois Department of Natural Resources. There is an area dedicated to locally prepared displays. Although part of the Savanna District, the Lost Mound Unit has its own identity and visitor-base from the Savanna Depot era, and promises to be a major attraction for visitors given its large size, location, unique wildlife and prairie, and history in the greater community. A new office and maintenance facility would enhance the Service's image and the quality of service and programs to the public.

Cultural Resources and Historic Preservation

Archeological records show evidence of human use along the Mississippi River from the earliest generally accepted cultural period, the Paleo-Indian tradition that commenced about 12,000 years before present. Archeologists hypothesize that small family-groups of hunters-gatherers roamed widely in search of mega-fauna and other resources. The presence of these people is usually recognized through surface finds of their fluted spear points. Such Paleo age materials (e.g., Quad/Chesrow points) are present within Pool 10 of the Refuge (Kolb and and Boszhardt, 2004).

Numerous sites from the following Archaic tradition have been found on the Refuge. People of this 6,000-year long tradition adapted their subsistence practices to changing environmental, habitat, and resources based changes including the 2,000-year very warm and dry altithermal that ended about 5,000 years ago. Extensive trade routes brought in exotic materials. People buried their dead in natural knolls. Archaic tradition cultural practices gradually evolved into the subsequent Woodland tradition.

Commencing around 3,000 years ago was the Woodland tradition. Archeological sites are widespread in the Refuge and usually include pottery, arrowheads, and artificial mounds used for human burials and for other purposes. People exploited a wide range of habitats in an environment similar to

that found in the early historic period. The people lived in larger, semi-permanent villages, practiced horticulture, and at some period participated in long distance trade. In some respects, Europeans coming into the Upper Mississippi River valley encountered people of the Woodland culture, some of whom may have been the ancestors of the Eastern Dakota Indians.

The Mississippian period started in the Saint Louis area about 1,000 years ago and moved up the Mississippi River. But few archeological sites of that period have been found in the Refuge area. A related cultural group known as the Oneota, which may have developed from the Late Woodland culture, is more evident in the archeological record. Late Oneota people probably were the ancestors of the Ioway, Oto, Missouria, and Winnebago Indian tribes.

The Upper Mississippi River was, of course, the major route of European-based exploration and subsequent Western culture population growth and development. Archeological sites associated with exploration, military activities, the fur trade, lead and zinc mining, lumbering, steamboats, bridges, railroads, and conservation are known or expected along most of the river.

The following listed Indian tribes have been recognized by the federal government or self-identified by the tribe as having a potential concern for traditional cultural resources, sacred sites, and cultural hunting and gathering areas in the counties in which the Refuge is located.

Bad River Band, Chippewa
Boise Forte Band, Chippewa
Fond du Lac Band, Chippewa
Grand Portage Band, Chippewa
Lac Courte Oreilles Band, Chippewa
Lac du Flambeau, Chippewa
Leech Lake Band, Chippewa
Mille Lacs Band, Chippewa
Red Cliff Band, Chippewa
Red Lake Band, Chippewa
Sandy Lake Band, Chippewa
Sokaogon Chippewa
Devils Lake (Spirit Lake) Sioux
Flandreau Santee Sioux
Lower Brule Sioux
Lower Sioux Mdewakanton
Prairie Island Sioux
Santee Sioux
Shakopee Mdewakanton Sioux
Sisseton-Whapeton Sioux
Upper Sioux Community
Iowa Tribe of Kansas
Iowa tribe of Oklahoma
Menominee Indian Tribe
Miami Tribe
Stockbridge-Munsee
Peoria Indian Tribe
Citizen Potawatomi
Forest County Potawatomi
Hannahville Indian Community, Potawatomi
Prairie Band of Potawatomi
Sac & Fox Nation of Missouri
Sac & Fox Tribe of the Mississippi
Ho-Chunk Nation
Winnebago Tribe of Nebraska

Although Indian tribes are generally understood to have concerns about traditional cultural properties, other organizations such as church congregations, civic groups, and county historical societies could have similar concerns.

The Refuge archeological collections contain prehistoric artifacts currently not associated with any modern tribe. Furthermore, the collections contain human remains but no funerary objects, sacred objects or objects of cultural patrimony as defined in the Native American Graves Protection and Repatriation Act. Although not all sites of historic period Indian occupation have been identified on the Refuge, they could be located and could contain cultural items.

The Refuge has museum collections that are managed under a Refuge Scope of Collection Statement dated October 31, 1994. To date, 108 archeological and geomorphological and history and research investigations have produced a calculated 129,339 artifacts from Refuge lands; artifacts are or will be stored at several repositories under terms of cooperative agreements. Artifacts are owned by the federal government and can be recalled by the Service at any time. Some historic items and historic documents are housed at the Refuge headquarters. From 1999 through 2001 the Refuge contracted to have the documents and photographs scanned into a data base.

A cultural resources overview and management study was prepared in 2003 as part of the Comprehensive Conservation Plans for the Refuge and Trempealeau National Wildlife Refuge (Gregory, et al., 2003). The document is available at Refuge Headquarters, Winona, Minnesota. The report presents a cultural history beginning 12,000 years ago through prehistoric and historic periods, ending in the 20th century. An inventory of cultural sites is not included in that document. However, a list is available upon request. Sites are recorded by fee-title and by cooperative agreement with the U.S. Army Corps of Engineers. The list is too long to include in this document. The document has a chapter about consultation processes identified in the National Historic Preservation Act of 1966 as amended, and a chapter that summarizes the methodology of, and responses to, a questionnaire sent to over 200 tribal communities, historical societies, and research groups who have potential interest in resources on the Refuge. The report concludes that a variety of cultural resources must be considered during any field project associated with the Refuge. A comprehensive bibliography of cultural resources reports produced for Refuge studies is also included. Finally, a supplement to the report contains a manual for Native American Consultation documents that may be used or modified for Service purposes.

Cultural resources are an important part of the nation's heritage. The U.S. Fish and Wildlife Service is committed to protecting valuable evidence of human interactions with each other and the landscape. Protection is accomplished in conjunction with the U.S. Fish and Wildlife Service's mandate to protect fish, wildlife, and plant resources. The Refuge is fully aware of cultural resource management challenges presented by physical changes brought on by erosion and accretion of sediments in riverine settings. Artifact looting is also a management concern.