Chapter 4: Management Direction

Refuge Management Considerations

Wetland Management[22]

Jim Rathert

Management techniques on moist soil units (MSUs) and other wetland types are variable and include relatively passive methods, as well as active applications. The goal is to produce mudflat conditions that promote the germination of wetland plants for use by migratory birds. De-watering the units - a drawdown - in the spring is the initial step in the plant regeneration process. Gravity flow of water or pumping is used to drawdown the units. Once dry, mechanical manipulations such as discing, mowing, burning or cropping can be used to reset the successional process. Some units may require no management at all until re-flooding in late summer and early fall to provide migratory birds with access to seeds and tubers for their southbound journey. Experience and experiments have shown that a variety of techniques used in rotation provide a healthy diversity of plant species.

Drawdowns in our latitude ideally begin in April or early May. Water control structures that allow the passage of water are typically placed at the lowest elevation within each impoundment to allow a complete de-watering and drying out of the unit. Although gravity flow of water is far less expensive than pumping, unpredictable water levels in the

22. The habitat values and balance of habitat types are addressed in the Goals/Objectives/Strategies (Habitat) Section of this plan. This section addresses some of the implications of utilizing this tool at the Mark Twain NWR Complex.

Mississippi River necessitate the use of pumps on some areas. Pumps may increase the rate at which water is removed, but they are even more important in August, September and October, when river levels are typically low and not conducive to gravity flow for re-flooding the units.

The drawdown process stimulates the growth of naturally occurring plants. Gradual drawdowns, lasting 2 weeks or more, provide slowly receding water lines. This allows a variation in plant germination timing and offers migrating shorebirds an opportunity to feed on invertebrates in open mudflats. Drawdown timing also affects which plant species will grow. For instance, "early drawdowns tend to stimulate germination of smartweeds on early successional sites. However, smartweeds are less likely to respond to early drawdowns by the third year after a soil disturbance such as discing or continuous flooding. Mid-season drawdowns result in millets, and late-season drawdowns result in sprangletop, beggartick, panic grass and crabgrass" (Fredrickson and Taylor 1982). Annual plants, which live through only one season, are high seed producers, but frequent disturbance of each unit is required for the highest yield of these species. Perennials, which have indefinite lifespans, become more common when units have had no disturbance for a number of years and may become dense stands, shading out more desirable food-producing species. However, some perennials can be beneficial in limited amounts. Rice cutgrass and marsh smartweed, for instance, can provide excellent habitats for invertebrates, which in turn are fed upon by waterfowl, rails and herons.

Mechanical manipulations can be used to set back encroachment of woody vegetation and to influence which species of wetland plants will germinate. Optimum seed production is obtained by early season discing. Deep discing followed by shallow flooding promotes germination of annuals over perennials. Tuber production can also be promoted with discing. If possible, shallow discing early in the season enhances the decomposition process and provides invertebrate foods for migratory birds. Rotation of row crops into moist soil units is another technique used on the Complex to provide diversity and control succession. Because farming methods can loosen and roll the soil, it can be used to control undesirable stands of rank vegetation and woody plants. Control of woody vegetation is a constant management concern within most moist soil impoundments of the Complex. Following flooding or management disturbances that result in late season bare ground, several refuges have aerially seeded Japanese millet to produce a quick cover and, that same year, provide an otherwise absent food source on the unit for waterfowl. This method gives way to good early successional annuals the following year, if water can be managed appropriately.

Burning will remove plant litter and expose the soil for new plant growth. Mowing, followed by burning and/or flooding, can be used to eliminate rank stands of low-value vegetation. Both burning and mowing help break down organic matter, which then decomposes and provides invertebrate habitat and nutrients for new plant growth. Slow drawdown and refilling of wetlands will make invertebrates available to shorebirds during migration.

A potential problem during drawdowns and re-flooding for migratory bird use is the possibility of an avian botulism outbreak. In recent years the nearby Illinois River Refuge Complex experienced outbreaks of this disease due to incomplete water management control. Avian botulism is caused by the ingestion of toxin produced by the bacterium, *Clostridium botulinum*. Fluctuating water levels contribute to outbreaks when terrestrial and aquatic invertebrates die as areas are flooded and subsequently become dry when the water recedes. The presence of vertebrate carcasses and high ambient temperatures are conducive to the buildup of fly populations involved in the bird-maggot cycle for avian botulism transmission. Intentional re-flooding of refuge areas that have been dry for a

longtime will not be done during the summer months. Similarly, sharp drawdowns of water will be avoided to the extent possible since they could result in fish-kills and die-offs of aquatic invertebrates whose carcasses could then become a center for the growth of C. botulinum. Fortunately, units of the Mark Twain Refuge Complex have not experienced a history of this problem.

Divisions within the Mark Twain Refuge Complex contain over 21 miles of ditches that deliver water to individual impoundments or wetland complexes. Seven permanent pump stations permit the lowering of water levels within units; four of these stations also allow the pumping of water into the units for re-flooding in the fall. More than 100 water control structures (stoplog structures and flap gates) are used to manipulate water levels for optimal moist soil plant growth on more than 7,000 acres of wetlands.

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Even with varying levels of water management control on eight divisions (Louisa, Horseshoe Bend, Keithsburg, Fox Island, Delair, Calhoun, Batchtown, Gilbert Lake) and Clarence Cannon NWR, the River's fluctuations and precipitation dictate the amount of drawdown and re-flooding each year. Gravity flow of water from the River into impoundments can limit the amount of irrigation and re-flooding permitted in the fall if river levels are low. Refuge impoundments cannot always be flooded to the capacity desired during fall migration. Conversely, early spring drawdowns generally are impossible due to seasonal high water. Under these conditions, drawdowns can not begin until June or even July.

Fredrickson and Taylor (1982) noted that fast drawdowns late in the season may produce less desirable vegetation than those early in the season. Several years may go by before weather and soil conditions are dry enough to allow the mechanical manipulation of MSUs. These disturbances set back undesirable vegetation such as invasions by silver maple, willow, green ash and cottonwood seedlings. Because these tree seedlings are so prolific, several techniques, including chemical applications, may be used to regain control of open areas for moist soil plant production.

Operation and maintenance of pumps and water control structures can cost the refuge a great deal of time and money. Significant structural losses and damages have occurred due to flooding and we must be cognizant of the need to construct “flood-friendly” forms within the floodplain. Therefore, each location is evaluated for its suitability before facilities are added to gain control over water level management. Within the current Refuge Complex boundary, all areas with suitable topography and drainage for operating water control structures economically are already being managed for moist soils or other wetlands. A few areas have been identified for possible moist soils expansion and improvements that would require a more substantial capital outlay, such as the creation of perched wetlands on fine sediment disposal areas.

Forest Management[23]

Open water and forest are the largest habitat cover types along the river corridor, both historically and presently[24]. Forest management can be confusing because the Service shares management responsibility for this habitat type in the UMR with the COE on the GP lands which are managed by the Service and states for conservation. The COE's involvement could be at conflict with the Service if the COE managed its forest interest for economic purposes. However, an interagency relationship has been developed on this topic that can be characterized as a mutually beneficial partnership. Refuge goals to maintain a healthy river system have been helped by COE involvement in the forest management facet of the corridor. The following is a summary of the COE forest program interests on refuge GP lands and the resulting interagency program.

Logging caused significant changes in the habitat of the UMR floodplain during the 1800s and continued into the 1930s. Timber harvest was necessary to supply fuel for steam boats and railroads, firewood for heating and cooking, and lumber to construct the towns along the river. Most of the cut over land was converted to farmland. Much of the lowland timber that was still present along the river prior to the construction of the locks and dams was cut and burned on site. In spite of this depression era "waste," the Department of Defense developed an interest in standing timber as a valuable natural resource during the Second World War. This interest was incorporated into the Cooperative Agreement with the Service for the management of GP lands.[25] In each of these agreements the COE has retained rights for "harvesting and selling of merchantable timber" on state and federally managed GP lands.

On September 6, 1960, Congress addressed the issue of forest management on COE projects nationwide. Public Law 86-717 spoke to the COE's overall stewardship responsibility for forest resources on project lands. The Act states that "..reservoir areas of projects for flood control, navigation... shall be developed and maintained so as to encourage, promote, and assure fully adequate and dependable future resources of readily available timber, through sustained yield programs, reforestation, and acceptable conservation practices, and to increase the value of such areas for conservation, recreation, and other beneficial uses: Provided, that such development and management shall be accomplished to the extent practicable and compatible with other uses of the project." For the GP lands along the UMR, the 9-foot Navigation Project and the National Wildlife Refuge System are both "other" designated uses in this context. Regarding vegetative cover, including forest, the COE is to pursue "... the establishment and maintenance of other conservation measures... to yield the maximum benefit and otherwise improve such areas. Programs and policies developed pursuant to the preceding sentence shall be coordinated with the Secretary of [Interior], and with appropriate State conservation agencies."

During the past 20 years it has become evident in the Mark Twain river reach that the COE is committed to restoring and maintaining a sound and diverse forest resource in support of Refuge Complex goals for wildlife management. Any economic value resulting from managed harvest has remained a secondary outcome realized from an active conservation-

23. Habitat values and the balance of other habitat types are addressed in the Goals/Objectives/Strategies (Habitat) section of this plan. This section addresses a possible jurisdictional implication on the Refuge Complex forest.
24. While there is still a high percentage of riverine forest cover in the "between the levees" portion of the AEC, two-thirds of the historic floodplain making up the AEC is now in agricultural production.
25. See History and Establishment of the Mark Twain NWR in Chapter 3 for more information on GP lands.

oriented program. Regularly scheduled coordination meetings between the COE, Service and states have been effective in assuring that the program is compatible with Refuge Complex wildlife goals and objectives. During this period the Rock Island District (and the St. Paul District north of the AEC) has conducted a more formal and active forestry management program than has the St. Louis District. Although the St. Louis District program is not as well developed, its staff have been equally cooperative with the Service and states regarding case-by-case forest management concerns. The Mark Twain Refuge Complex has advocated a more active forest program in the St. Louis District by means of coordinating the comprehensive conservation planning effort, our active participation in the development of the St. Louis District Master Plan, and in efforts to revise the Cooperative Agreement for management of all GP lands.

The Rock Island District has set forth goals and objectives for forestry operations and maintenance in its 5-year plan. The District's long-term management goal is to "manage project lands to provide a continuing public benefit from natural resources by perpetuating a diversity of ecological communities that are suitable for a variety of public purposes." District foresters plan to increase and maintain healthy and productive stands of bottomland and forest timber in varying stages of growth from seedling to mature forest through various acceptable silvicultural techniques. By doing this, the COE will help support a diversity of productive fish and wildlife habitat for both game and non-game species, and any affected endangered species. Rock Island foresters have used timber stand improvement (TSI), planting and small timber sales to manipulate forest resources for fish and wildlife habitat. They have maintained an active database of all federal- and state-listed threatened and endangered species (including candidate or sensitive species) and their habitats on project land in order to protect specific habitats. Information is also kept on active nesting colonies, eagle nests and roosting areas, and Indiana bat brooding and roost areas. Through participation in development of Environmental Management Program projects, and with other project authorities, Rock Island District foresters have played an active role in efforts to regenerate mast-producing trees on higher elevation sites in the floodplain.

During the CCP process, many conversations and meetings between the Service, states, USGS scientists and COE resource management personnel occurred to coordinate ideas on the best means to enhance floodplain forests. The Habitat Needs Assessment (HNA) process spawned an interagency forest management model team effort that was just starting near the end of this CCP process.

Refuge goals, objectives and strategies for forest resources are found in the Forest Habitat Goal section of this Plan. Additional efforts are needed between refuge managers, state biologists and COE forestry professionals to develop a forest management step-down plan for GP and Service fee title lands. From the Service's perspective, the desired partnership outcome for COE-owned lands within the National Wildlife Refuge System includes: 1) consistent programs are conducted on each COE District of the UMR; 2) programs are well coordinated with partners; 3) programs support partner agencies' habitat management goals; 4) programs fit with Service fee title land management in a seamless manner; and 5) programs provide data complementary to and consistent with the Long Term Resource Monitoring Program (LTRMP).

Cropland Management[26]

Beginning in the 1970s, the Service decreased emphasis on agriculture on National Wildlife Refuges and increased emphasis on wetlands and moist soil units to enhance species diversity and to provide a healthy diversity of diet for waterfowl. However, cropland management remains an important tool for managing refuges and in providing high-energy food for waterfowl and other wildlife. In addition, it provides managers a means to effectively set back succession in moist soil units. Agriculture also can be used to maintain fields in an open condition in preparation for other habitat types, such as, grasslands, moist soil units or bottomland hardwood plantings. The costs of a crop program are primarily administrative if cooperative arrangements are made with local farmers. This tool can only be used if it is economically beneficial to the farm partner. Crops include winter wheat, corn, soybeans, buckwheat and sorghum. Soybeans are used as the farmers' share and are rotated with other crops to fix nitrogen in the soil and reduce cutworm infestations.

Cooperative cropland management requires staff time in pre-planning, farmer selection and subsequent coordination. Once these tasks are completed, the farmer must then deal with the difficulties of farming in the floodplain environment, which can include unpredictable river flood pulses. With the assistance of a reliable and conscientious cooperative farmer the Refuge Complex can secure supplemental food sources for migratory birds and resident wildlife without utilizing refuge labor, equipment and supplies. By rotating cooperative farmers through different units of the refuge, the program can provide successional setback in other habitats at no direct costs to the refuge. At current staff and funding levels, most of these actions would not be possible without the assistance of the cooperative farmers.

Traditional cropping techniques and rotations require the application of herbicides and fertilizers. Any herbicide applied on refuge lands must be pre-approved by the Regional Office. Herbicides and fertilizers can be detrimental to the aquatic environment and their use is limited and strictly monitored when they are utilized on refuge grounds.

Thirteen of the 15 Mark Twain Refuge Complex divisions and Clarence Cannon NWR serve as a migratory sanctuary for waterfowl during hunting season. Eight divisions presently contain cropland as a habitat type to provide a supplemental food source for migratory birds. In 1999, cropping totaled approximately 2,622 acres, ranging from 64 acres at Gilbert Lake to 675 acres at the Fox Island Division. This represents a significant decrease from more than 6,100 acres cropped on refuge lands when the last Master Plan was done in the 1970s. This decrease took place at the same time that thousands of acres were added to the overall Refuge. Most of the land taken out of crop production has been converted to wetland, grassland, or hard mast trees; or else been allowed to naturally regenerate to wet floodplain forest. Further cropland reductions are proposed in the strategies for the desired future condition.

Port Louisa NWR has worked cooperatively with local farmers to plant from 130 to 330 acres of crops on the Louisa Division, depending on moisture conditions, to provide supplemental food for waterfowl. Changes to the program are proposed through wetland development projects in the habitat section of this plan that would result in an average of 80 acres per year being farmed.

26. The habitat values and balance of habitat types are addressed in the Goals/Objectives/Strategies (Habitat) section of this plan. This section addresses some of the implications of utilizing this tool at the Refuge Complex.

Great River NWR administers cooperative farming agreements for crop production ranging from 1,300 to 1,725 acres annually on four divisions. Under implementation of this plan, farming will be substantially reduced to an annual range of 550-850 acres. On Clarence Cannon Refuge, the farming program is used primarily as a tool for maintaining high quality seasonal wetlands. Crops are rotated through the moist soil units on average every 4 years to disturb vegetation and soils, to control pest plants, and to promote the growth of desirable vegetation. Outside of the moist soil units, crops are also planted in a limited area as a supplemental food source for migrating waterfowl. On Delair Division, farming is used primarily to provide a supplemental food source for migrating waterfowl. Farming is rotated through some fields with subsequent years of fallow condition. Winter wheat is generally a portion of the Refuge share on both of these Refuges and is used extensively by geese. On Long Island, the remaining 120 acres of agriculture are scheduled for reforestation beginning in 2001. On Fox Island, the remaining 675 acres of cropland is on lands acquired during the past 10 years that are planned for re-forestation either through planting or natural regeneration. This transition will be phased in over several years due to the size of the acreage. In the interim, the remaining cropland will be farmed to keep it in an open condition.

Two Rivers NWR administers cooperative farming agreements to provide supplemental food for migratory waterfowl. Corn, wheat and soybeans have been planted annually on a maximum of 800 acres. Current plans call for an average of 450, unless further reduced by force account management with additional staff and funding. The cooperators are also required to aerially seed winter wheat into harvested soybean fields as green browse for geese.

Middle Mississippi River NWR Divisions are subject to WRP easement and are not cropped. There are no plans to implement a farming program on the Refuge in the future.

One problem confronting the Refuge Complex in recent years is how to manipulate crops to make supplemental grain available to waterfowl. Although the divisions containing crops are not hunted, each is in some proximity to public or private waterfowl hunting areas. Even manipulation of crops via normal agricultural practices can be a problem if the activity draws birds to the area, creating hunting opportunity. But the "zones of influence," or distance by which birds are influenced, can only be determined site-by-site considering many variables. There is no standard distance, as the influence of bait (such as grain on the ground) depends on factors such as topography, proximity to other crops or water bodies used for feeding or resting, and the usual waterfowl flight patterns for the area. The law prohibits hunting if bait is present that could lure or attract birds "to, on, or over areas where hunters are attempting to take them." (50 CFR 20.11). Complex refuges do not conduct practices that would be likely to place hunters in a position of hunting by the influence of bait.

Complex Refuges have in the past knocked down crops during the season in the core refuge areas away from hunted areas. During the mid-1990s, the baiting issue went through some controversy and changes. Since then the Complex refuges have taken a more conservative approach to crop manipulations until waterfowl seasons are closed to ensure that no bird flight patterns are being influenced by grain on the ground during an open season. This practice makes the high-energy food available to birds late in their stay, and when returning in late winter. However, late Snow Goose seasons (as per state conservation order) have lasted through mid-March during the past several seasons in an effort to reduce their over-population. Most waterfowl have already migrated north of the Complex by the end of the snow goose season when the crops could be made more readily available. It is not known how long this situation may last, but some cropland reductions are proposed

for the Complex, especially along border areas where baiting is a concern. This represents a plan topic to be monitored closely and evaluated for future adaptive management strategies.

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Prescribed Fire Management

General Land Office surveys have helped researchers to reconstruct a picture of the habitat present in the Mississippi River Valley prior to European settlement. Prairie cordgrass, a fire-dependent grass species, appears to have been the predominant species in much of the UMR floodplain. For instance, a prairie community dominated the floodplain in pools 25 and 26 (Clarksville, Missouri, to Alton, Illinois) prior to settlement. "Timberlands were restricted to islands, the margins of the river and its tributaries, and valley slopes. Tree density and composition estimates indicate that oak savanna and oak woodland communities also were important features of the floodplain and adjacent uplands whereas closed-canopy forests of cottonwood, hackberry, box elder, elm, ash, and silver maple prevailed on the islands. This apparent "mosaic" of habitats contradicts the long-held perception that forests alone once dominated the bottomlands of the Mississippi River Valley. It is now apparent that fire as well as floods helped shape and maintain the diversity of pre-settlement habitats." (Lubinski and Theiling 1999).

It would be impossible to reconstruct the UMR floodplain prairies as they once existed along with the hydrological changes caused by the locks and dams. However, refuge managers still use prescribed fire to enhance native prairie restorations and existing prairie cordgrass remnants in the floodplain. Fire is also used as a tool in moist soil units and wet meadows to alter vegetation composition and patterns, and to set back woody and undesirable herbaceous vegetation in various other habitat types. In addition, prescribed fires have been used for oak regeneration in forest habitats. Although mowing can be used in some instances, the optimal management technique for tallgrass prairie is fire.

To meet prescribed fire goals and objectives as described in individual burn plans, each unit is planned on a 4-6 year rotation. Burns are done in early to mid-spring or in late summer to mid-fall. The timing and occurrence of burns are not always ideal, but are dictated by seasonal weather and flood conditions. Currently there are nine refuge staff trained to assist with prescribed fires; three of these individuals are certified burn bosses. By 2001, official burn plans had been prepared for approximately 6,355 acres on eight divisions. Potentially, over 9,500 acres of existing refuge land could be burned for habitat management purposes.

Table 7 shows the prescribed burn units within Mark Twain NWR Complex refuges.

With increased requirements for explicit burn plans, updated station fire plans, and higher levels of accreditation needed by refuge staff in order to execute prescribed burns, the cost effectiveness of this practice has decreased. Each burn boss spends large amounts of time preparing extensive plans for annual prescribed burning on refuge divisions. Plans must then be submitted to a Fire Management Officer (FMO) for approval. In order to

Table 7: Prescribed Burn Units, Mark Twain NWR Complex

Refuge Complex Prescribed Burn Unit	Acres
Port Louisa NWR	
Big Timber	506
Horseshoe Bend	2,357
Keithsburg	67
Louisa	1,047
Total	3,972
Great River/Clarence Cannon NWR	
Clarence Cannon NWR	3,680
Delair	1,648
Fox Island	170
Two Rivers NWR	
Calhoun	190
Gilbert Lake	83
Total	273
Refuge Complex Totals	9,573

effectively implement this management tool, additional staff and funding are needed. GIS maps have been prepared showing all burn units and fire management areas in the Complex. No burning is being proposed at Middle Mississippi River NWR at this time. Any future fire management proposed at that refuge will first be evaluated and documented in a station fire plan.

Invasive Species Management

The Service has made prevention and control of invasive plant and animal species a top priority. Exotic, invasive or alien species cause vast ecological and economic damage and range across almost every ecosystem of the country. Invading species are usually very successful when introduced to a new environment because they have no natural enemies that keep the population in check. Non-native mammals, birds, insects, mollusks, fish and plants have been accidentally or intentionally introduced to our country since the 1800s. Many species, such as the European Starling, Ring-necked Pheasant, and common carp, have been here for so long that we forget they are not native to the United States. Other species have been here a shorter period of time but are no less detrimental to native fauna and flora, including zebra mussels, purple loosestrife, gypsy moths, and Asian bighead carp. More than 135 non-native species have been introduced to the Mississippi River Basin during the past 100 years.

The Federal Noxious Weed Act (Act) of 1974 provides for the control, eradication, and regulation of interstate movement of those weeds that interfere with the growth of useful plants, clog waterways, interfere with navigation, cause disease, have other adverse effects on humans and the environment, or are detrimental to agriculture, commerce, or public health of the United States. A 1990 amendment to this Act, the National Undesirable Plant

Management Act, mandates a national comprehensive plant management program to control and contain undesirable plant species on Federal lands in order to alleviate damage to the environment.

Implementation of Integrated Pest Management (IPM) techniques have been Service policy since at least 1990 (30 AM 12.1). Integrated Pest Management is the thoughtful selection and use of multiple strategies and tactics to suppress target pest populations to tolerable levels within a given habitat or ecosystem. It is an ongoing process of addressing pest-related damages in ways that tend to preserve biological stability, reduce risks of catastrophic losses, and are less intrusive upon the environment than more conventional, purely chemical approaches. A critical component of IPM is the establishment of an acceptable threshold of pest numbers and/or level of damage. It is Service policy that all reasonable steps should be taken to minimize or, when feasible, eliminate dependence on chemical pest control agents.

Biological control can involve the use of natural predators, parasites, and pathogens. Any management practice that encourages natural populations of those organisms is a viable IPM component. Attractants, pheromones, and trap crops can also be used for biological control. Physical control methods include removal of small populations of plants by pulling them, removing them from the area and burning them. Mechanical control methods include such practices as burning, mowing, discing, managing water levels or rotating crops. Chemical control becomes necessary when other methods are impractical or not sufficiently effective in achieving identified pest population thresholds.

Very few weeds have biological control agents. Two exceptions are the Galerucella beetle species available for control of purple loosestrife, and three types of weevils for the control of musk and Canada thistle. These insects will be used where applicable. In fact, thistle weevils were released on the Gilbert Lake Division in 1996 and 1997 and have been somewhat successful in reducing the thistle population in the immediate area. While biological control methods are the most environmentally friendly, they can be labor intensive.

Missouri, Iowa and Illinois each have noxious weed laws that require land managers to control specific weeds including marijuana (*Cannabis sativa*), musk thistle (*Carduus nutans L.*), Canada thistle (*Cirsium arvense*), Johnson grass (*Sorghum halepense*), field bindweed (*Convolvulus arvensis*) and purple loosestrife (*Lythrum salicaria*). Many units of the Mark Twain NWR Complex have noxious and exotic weeds that are controlled biologically, mechanically, or chemically. Chemical use has been greatly reduced on the Mark Twain Complex but is still needed in some instances to control invasives. When necessary, FWS-approved chemicals will continue to be employed to control large outbreaks of noxious weeds. Abandoned agricultural land is particularly susceptible to invasion by these weeds and can quickly be overcome by annual species. Chemicals should be considered after first attempting to eradicate the problem by other means. Preferred methods of control include burning, mowing or discing.

Plants

Reed canarygrass (*Phalaris arundinacea L.*) is distributed throughout the United States. Botanists believe a native variety of reed canarygrass existed prior to major European settlement, but it seems likely that the native variety has mixed with more aggressive cultivars from Europe. This plant can reach 6 feet in height, and out-compete more beneficial wetland plants within the floodplain, quickly developing into a monoculture with

very little proven wildlife benefit. The Flood of 1993 provided an avenue for wide disbursement of reed canarygrass seeds. As a result, the grass has invaded some fields, forests and wetlands within the Upper Mississippi River floodplain.

Reed canarygrass is very difficult to eradicate, once established. Where invasions are just beginning, tillage in combination with water management works well. These techniques must be implemented immediately after an invasion is recognized, or when a disturbance such as a flood creates conditions conducive to reed canary grass germination. Many sites invaded by this plant are too wet to be immediately attacked, allowing the grass to proliferate before attempting control. Prescribed fire, chemical and mechanical treatments have all been used in an attempt to control reed canarygrass, with varying degrees of success. Greatest success appears to involve a regimen of herbicide treatment, discing, and deep flooding.

Both Port Louisa NWR and Great River NWR have experienced problems with reed canarygrass. Mowing and burning on Horseshoe Bend Division have promoted healthy prairie cordgrass stands that seem to be out-competing the canarygrass. Mowing to address this problem has also been done at Louisa Division, and spraying has shown some effectiveness at Clarence Cannon NWR and Delair Division. To date, there has not been a significant reed canarygrass problem at Two Rivers NWR.

Eurasian watermilfoil (*Myriophyllum spicatum L.*) is considered one of the most widely distributed of all nonindigenous aquatic plants, with confirmed specimens in 45 states and three Canadian provinces. Spread by boats and waterbirds, it became established in the mid-western states between the 1950s and 1980s. Watermilfoil is tolerant of low water temperatures and can quickly grow to the water surface, creating dense mats that overtop and shade surrounding vegetation. Canopy formation and light reduction result in the decline of native plant abundance and diversity. This plant has less value as a good food source for waterfowl than the native plants it replaces. And although fish may initially experience a favorable edge effect, Eurasian watermilfoil's overabundant growth quickly negates any short-term benefits it may provide fish.

Current methods of Eurasian watermilfoil eradication include mechanical, chemical and biological control. Biological control offers a distinct advantage over both mechanical and chemical treatments by reducing cost, providing long-term effectiveness, and contributing little or no negative impacts on other aspects of aquatic systems. Several aquatic insects have been associated with declines of Eurasian watermilfoil. Current efforts are focused on the native milfoil weevil, *Euhrychiopsis lecontei*, which has been associated with natural declines of Eurasian watermilfoil and has shown potential in controlled experiments.[27]

Purple loosestrife, *Lythrum salicaria L.*, is a native of Europe and Asia. It aggressively reproduces, choking out domestic grasses, sedges, and other flowering plants that provide a higher quality source of nutrition for wildlife. It was introduced to the northeastern U.S. and Canada in the 1800s for ornamental and medicinal uses. It currently occurs in every state except Florida and is still widely sold as an ornamental, except in states such as Minnesota, Wisconsin and Illinois where regulations now prohibit its sale, purchase and distribution. Purple loosestrife adapts readily to natural and disturbed sites, allowing dense, homogenous stands to form. It is capable of invading many wetland types, including freshwater meadows, tidal and non-tidal marshes, river and stream banks, pond edges, reservoirs, and ditches. Blooming from June to September, a mature plant may have as

27. www.fw.umn.edu/research/milfoil/milfoilbc.html

many as 30 flowering stems capable of producing 2 to 3 million minute seeds per year. It also reproduces vegetatively through underground stems at a rate of about 1 foot per year.[28]

Small infestations of young plants may be pulled by hand. Older plants develop woody stems, making them difficult to pull, and small populations may be spot treated with glyphosate-type herbicides. Biological control of this invasive species has also been successful in the United States. The USDA has approved three insect species from Europe for use as control agents on purple loosestrife. These plant-eating insects include a root-mining weevil (*Hylobius transversovittatus*), and two leaf-feeding beetles (*Galerucella calmariensi*) and *Galerucella pusilla*). Root mining weevil larvae feed on vascular tissue in the root and often completely destroy mature plants. Galerucella adults and larvae feed on shoots, leaves and flowers. When beetle densities are high (greater than 200 per plant), entire plants are either destroyed or weakened sufficiently to prevent seed production. As few as 10 larvae can kill terminal buds and prevent seed production. Galerucella beetles have been released on several midwestern national wildlife refuges. Although purple loosestrife populations are not high enough on the Refuge Complex at this time to warrant biological control, this aggressive invader requires active monitoring. Small, isolated patches of this plant were found growing on several divisions following the Flood of 1993.

Garlic mustard, *Alliaria petiolata*, was first collected in 1868 on Long Island, New York. It has since spread to 30 eastern/midwestern states and three Canadian provinces. This biennial herb from the *Brassicacea* (mustard) family invades forested communities and edge habitats where it rapidly spreads and displaces native herbaceous species. The plant has no known enemies and, once established, is very difficult to control. Annual monitoring and rapid removal of plants are the most effective measures in preventing the establishment of garlic mustard. Hand-pulling small communities is very effective, while chemical control with glyphosate may be necessary for larger infestations. Burning can provide control if fire burns completely through the affected area. Illinois and Indiana have issued "garlic mustard alert" fact sheets. Illinois and Missouri have developed vegetation management guidelines for Alliaria. This invasive terrestrial plant has been found in small patches on the Louisa Division, and may be on several other Mark Twain Refuge Complex divisions.

The invasive biotype of the common reed *Phragmites australis* is regarded as an unwanted invader in many parts of the East and Upper Midwest. The plant spreads by rhizomes and is capable of forming large monoculture stands from just a few seeds. mowing, burning, discing and pesticide application have all been used in attempts to control it. In the Chicago area, *Phragmites* has out-competed cattail in many urban wetlands, and many islands and shorelines on the upper half of the Illinois River are loaded with the species. Isolated patches of *Phragmites* have been found on the Upper Mississippi River north of the Area of Ecological Concern, but for unknown reasons it does not appear to be spreading within the UMR floodplain at this time.

Exotic Mussels

Zebra mussels (*Dreissena polymorpha*) were introduced to the Great Lakes from European oceanic ships as they exchanged ballast water. They entered the UMRS through the Illinois waterway from Lake Michigan and attached to the hulls of boats. They were first documented in the Illinois River in 1991 when a commercial sheller brought a single specimen attached to a native mussel to biologists at the Illinois Natural History Survey. Since then, the prolific zebra mussel has been transported throughout the inland waterway

28. www.nsp.gov/plants/alien/fact/lysal.htm

system on the hulls of barges and by river currents that carry their larval stage. Zebra mussels do not have a fish host; they develop as planktonic organisms drifting in the current. They have a very high reproductive rate and can produce several broods per summer season (Lubinski and Theiling 1999).

Monitoring efforts conducted on the Illinois River from 1992-1995 by the Illinois Natural History Survey showed maximum densities approaching 83,612 mussels per square meter. This population was found at one site in Pool 26, near the Two Rivers NWR in 1993. That particular population crashed and was mostly gone by 1994, but zebra mussels have moved rapidly upstream since then. By 1997, densities of more than 25,000 per square meter were reported in Pools 9 and 10 of the UMR. Apparently, population densities in pooled reaches of the Mississippi continue to increase and the native mussel fauna are being colonized at a high rate (Lubinski and Theiling 1999).

Zebra mussels attach to hard surfaces, such as rocks or native unionid mussels, with byssal threads that secrete a strong glue-like substance. Zebra mussels attached to native mussels compete for food, make movement difficult, and can force shells open. Dense beds of zebra mussels can completely cover and kill native mussels, causing a reduction in overall numbers and species diversity. At one zebra mussel location in Pool 26, 18 species of native mussels with three co-dominant species were found at a density of 15.5 mussels per square yard in 1993. One year later, the site contained only 10 native species, density was reduced to 5.5 mussels per square yard, and the fauna was dominated by a single species. In 1995, only four native species were collected, density was 1.7 mussels per square yard, and threeridge mussels (*Amblema plicata*) constituted nearly all specimens (Lubinski and Theiling 1999).

In Europe, a number of fish species are known to feed on zebra mussels, including the common carp (*Cyprinus carpio*), bream (*Abramis brama*), and pumpkinseed (*Lepomis gibbosus*). In North America, freshwater drum (*Aplodinotus grunniens*) prey on the exotic mussels. A 1996 study by Tucker et al. also found that "Americanized" common carp are feeding on zebra mussels. Carp collected at Mississippi River Mile 217 contained between 1 and 407 zebra mussel beaks in 83.9 percent of the fish examined. While this may sound like a potential biological control method, managers would prefer not to enhance carp reproduction in order to reduce zebra mussel populations.

In experiments conducted in Pool 26 by the Illinois Natural History Survey, high zebra mussel mortality was noted following aerial exposure for 24 hours during warm summer conditions. In contrast, native unionid mussel survival was generally unaffected under the same conditions. The experiments suggest that pool level drawdowns in mid-summer could cause a profound reduction in zebra mussel distribution (Tucker et al. 1997).

Exotic Fish

The common carp was introduced into the U.S. from its historic European range during the late 1800s. Several other exotic carp species including the grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*) and bighead carp (*Hypophthalmichthys nobilis*) have recently made a widespread assault on the UMR. These species have been used since the 1970s for aquaculture and pond applications. Another exotic carp species, the black carp (*Mylopharyngodon piceus*), feeds on shellfish and has been approved by the Mississippi Department of Agriculture and Commerce for control of snails on the state's catfish farms. When the black carp eventually finds its way to the Mississippi, the basin's already suffering mussel and shellfish populations could be devastated.

Fisheries biologists believe the Asian carp species (silver, bighead, grass and black) may be more threatening than the common carp because they compete more directly with native fish and shellfish for food and habitat. The bighead carp, currently reported in 22 states, feeds on zooplankton, which places it in direct competition for food with native paddlefish, bigmouth buffalo, and gizzard shad. Grass carp and silver carp are fast approaching the bighead's numbers and also have the ability to capitalize on degraded habitat not preferred by native species.

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In October 1999, during a fish kill investigation on the Wilkinson Island Division, a Service fisheries biologist discovered that 97 percent of 219 dead fish were comprised of exotic carp species. Silver, bighead, grass, and common carp accounted for nearly all the dead fish present in the seasonally flooded borrow ditch that had dried up. Additional observations show that the bighead carp is firmly established in the open river segments of the Mississippi River; three year-classes were documented in 1999 by LTRM researchers from the Cape Girardeau, Missouri, field station. Concerns over continued expansion of bighead carp populations have prompted Iowa, Kansas, Missouri and South Dakota to begin developing a multi-state study of the species (River Crossings 1999).

The invasive round goby has spread from the Great Lakes to the upper Illinois River and continued downstream movements of the species may soon present an additional threat to native fish communities (especially darters) of the UMR.

Other Invasive Species

Many other foreign aquatic and terrestrial species are on their way to the Midwest and/or Mississippi River, and monitoring efforts must be continued to determine their progress. The Great Lakes has become the dumping ground for alien species' introduction through ballast water exchange. Several aquatic species are currently in the Great Lakes and will eventually enter the Cal-Sag and Chicago Sanitary and Ship Canals leading from Lake Michigan to the Illinois River. These exotics include two small fish – the round goby (*Neogobius melanostomus*), which has already been found in the Illinois River near Romeoville, moving towards the UMR; and the Eurasian ruffe, (*Gymnocephalus cernuus*), which currently is found in Lake Huron.

Daphnia lumholtzi (a zooplankton native to Africa, Asia and Australia) was imported in the early 1990s with African fish for the aquarium trade or to stock reservoirs. It is now well established in the Illinois River. And a tiny crustacean, the water flea *Cercopagis pengoi*, has been dumped into the Great Lakes from its Russian origin. The effects of these invasive organisms on native zooplankton and crustaceans is unknown. However, studies of reservoirs in Kentucky and Illinois indicate that *Daphnia lumholtzi* may be replacing native Daphnia and other zooplankton species (Stoeckel and Charlebois 1999).

Kudzu, (*Pueraria montana* (Lour.) Merr.), is a terrestrial plant creeping in a northerly direction from its footholds in Mississippi, Alabama and Georgia. It currently covers an estimated 7 million acres in the southeastern U.S., and is already known to exist in southern Illinois. A native of Asia, kudzu can grow up to 50 feet in one growing season.

The gypsy moth, (*Limantria dispar*), is expected to arrive in western Illinois, and eastern Missouri and Iowa, within the next 5-10 years. Gypsy moths are known to feed on the foliage of hundreds of species of plants in North America, but its most common hosts are oaks and aspen.

Commercial Fishing

The targeted species of commercial fishermen on the Mississippi River are generally common carp, bigmouth and smallmouth buffalo, channel and flathead catfishes, and freshwater drum. The common carp, an introduced non-indigenous species, was first reported in the Mississippi River in 1883. Although total commercial harvest by weight has not changed that much in a century (6,200 metric tons in 1894 to 5,200 tons in 1987), the percentage of individual species within the catch has changed dramatically. In 1894, common carp averaged only 3 percent of the total harvest, but increased to 47 percent between 1953 and 1977. The decline in the harvest of buffalo fishes occurred with increased carp harvest. The decline in buffalo fishes may have resulted from competition with common carp and from destruction of their spawning habitat. (Wiener et al. 1998). Buffalo fishes made up 43 percent of the 1894 catch, but were down to an average of 22 percent of the 1953-1977 harvest. Grass carp is another non-indigenous species that has expanded upstream from the Lower Mississippi River. This species is now spawning successfully as far north as Illinois River tributaries and has also become a commercial harvest target.

Commercial fishing has been permitted within a few refuge divisions by issuance of Special Use Permits to help control carp and other "rough" fish that compete with native fish for habitat. In addition, these fish stir up bottom sediments, increase turbidity, and forage in beds of submersed plants. Grazing fish such as carp may inhibit re-establishment and growth of submersed aquatic vegetation. (Wiener et al. 1998). Populations of rough fish are reduced within refuge waters to improve water quality for growth of aquatic vegetation and to enhance habitat for native fish. (See Water Quality Goals and Objectives section).

Currently, commercial fishing is permitted at Big Timber Division and Swan Lake in the Calhoun Division. Occasionally, when the Mississippi River and Keithsburg Division become contiguous during periods of high water, commercial fishing within the Division has been permitted. During 1999, eight Special Use Permits were issued for fishing within the Big Timber Division and five for the Keithsburg Division. Four permittees were also issued Special Use Permits to commercial fish within Swan Lake. Native paddlefish use Swan Lake for spring feeding, but because their numbers have dramatically declined since 1900, commercial fishermen are not allowed to harvest them in Swan Lake. The fishermen have been requested to call the Illinois Department of Natural Resources fisheries biologists for on-site gathering of data when paddlefish are present. Concern about legal and illegal harvest of paddlefish for the lucrative caviar trade has resulted in Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) listings and proposals to ban harvest in some states.

In addition to the above areas, commercial fishing is being proposed within the waters of the Bear Creek Unit of the Long Island Division in this plan. Other areas, such as newly acquired lands, may be included if habitat conditions warrant these control measures. Permits require harvest reports and a fee to cover the costs involved with issuing the permits. Commercial fishermen may be contacted to salvage rough fish from impoundments when drawdowns occur. Some refuge waters are open to both commercial and recreational fishing opportunities. Potential conflicts between these two user groups will be addressed through commercial fishing special use permits and compatibility determinations written on a site-by-site basis.

Trapping

Trapping of furbearers is utilized occasionally as a management tool by Complex refuges to address infrastructure damage caused by muskrat and beaver. Muskrats construct houses from aquatic vegetation when constant water levels and adequate vegetation are available. However, when water levels remain too high or low, or when populations become too high, muskrats often resort to burrowing into roads and dikes. Their tunnels generate cave-ins, weaken roads and water management systems, increase maintenance costs and can create a safety hazard to visitors and staff. Beavers create quiet pooled waters by blocking the flow with sticks and mud. When culverts are blocked, effective water level management of refuge impoundments becomes difficult, if not impossible. Blocked ditches and culverts may also affect refuge neighbors by backing water onto private property. Such restriction of drainage is unwanted by landowners and can be a violation of state law.

Trapping is done by refuge staff when feasible or by issuing special use permits to local trappers. Since these services may be needed during a period of the year when muskrat or beaver have no commercial value, it is possible the refuge would need to arrange a contractual service to assist with reducing this type of problem. During the past 5 years trapping has been used one to three times at four divisions. The scope and scale of trapping within the Refuge Complex is so limited that no specific plan for this intermittent management activity will be prepared. The entirety of the program is defined here and management action is based on a site evaluation of conditions at the time damage is occurring. If it is decided that non-staff special use permit trapping will be utilized to address an occasional infrastructure problem, a site-specific evaluation will be documented. A compatibility determination for trapping on the Refuge Complex was published for public review as part of the Draft CCP in August 2003. The final compatibility determination can be reviewed at headquarters for each Refuge.

Environmental Management Program (EMP)

The Upper Mississippi River System-Environmental Management Program (UMRS-EMP) originated due to controversies over the proposed construction of twin 1,200-foot locks to replace Lock and Dam 26. Conflicts arose between further development of the navigation system and maintenance of the environmental values of the Upper Mississippi River System.

In 1978, Public Law 95-502 authorized the Lock and Dam 26 Replacement Project, but also directed the Upper Mississippi River Basin Commission to prepare a Comprehensive Master Plan for the management of the Upper Mississippi River System. The Master Plan was completed on January 1, 1982 and recommended, among other things, development of an Environmental Management Program (EMP). The environmental recommendations contained in the plan were tied to past, present, and future deterioration of fish and wildlife habitat of the river system, and were not to be considered as “mitigation” for any past or future lock construction. According to the Master Plan, the environmental recommendations were to be implemented by the U.S. Fish and Wildlife Service as the lead agency. However, Congress authorized the EMP for implementation by the U.S. Army Corps of Engineers under P.L. 99-662, the Water Resources Development Act of 1986. The Water Resources Development Act of 1990, P.L. 101-640 extended the authorization period for EMP an additional 5 years, through fiscal year 2002. In 1999, the Water Resources Development Act extended the EMP for an indefinite period and increased the annual authorization to over $33 million.

The purpose of the EMP is to ensure the coordinated development and enhancement of the Upper Mississippi River System, recognizing its several purposes while supporting "environmentally sustainable development." The primary elements of the EMP include: Habitat Rehabilitation and Enhancement Projects (HREP), Long Term Resource Monitoring (LTRM)[29]; and, new in 1999, the Habitat Needs Assessment (HNA). (See Monitoring Goal Section.)

The HREP program is making it possible for the Refuge Complex to convert 2,300 acres of open water with highly degraded habitat at Swan Lake to wetland and aquatic vegetation of value for big river fish and wildlife species. The costs of the project would prohibit the Service from achieving these goals without the partnership of the Congressionally funded program administered by the COE. Another project was constructed at the Big Timber Division to enhance the backwater habitat values. Projects are also being constructed, or near construction, at Batchtown, Long Island and Louisa divisions. The EMP will provide a mechanism to accomplish some of the habitat strategies outlined in this plan. While the construction cost of these projects is borne by the COE, interagency planning and subsequent operations and maintenance costs can be significant at the Complex Refuges. In order to sustain the Service share of this river restoration program, additional funding will be required.

Navigation Pool Water Level Management

About 260 miles of the AEC is impounded by the lock and dam system built in the 1930s by the Army Corps of Engineers. These dams were authorized by Congress and constructed in order to maintain a 9-foot navigation channel for commercial barge traffic. Waters backed up by the dams are known as "pools." The area just upriver of a dam is known as the headwater, and the area immediately down river is called the tailwater.

Water level elevations at the navigation system dams are regulated as a function of discharge, with specific operating plans for each dam. The COE strives to maintain a target water level at a specific location in a pool (control point) within a specific range of discharges (control range). At very low discharges, dam gates remain in the water impeding flow and backing up water to maintain the 9-foot navigation channel. As discharge increases above relatively low values, gates are raised, allowing more water passage in order to maintain the proper water level at the control point and avoid flooding adjacent property. As discharge increases toward the high end of the range of control, the water level in the tailwater increases until it is near the elevation of the dam's headwater. At discharges where a 9-foot channel would occur without the dams, the gates are raised above the water surface and "open river" conditions are said to exist.

The current operating procedures at each dam were established during the development of the navigation system, mostly to minimize land acquisition costs to the federal government. However, under the broad authority of the Secretary of the Army, operations may be tuned to produce benefits for environmental and social goals such as flood control, water quality, fisheries habitat, recreation, or other goals as long as navigation is not compromised. In recent years, the COE has been working with the Service and UMRS states to develop modified operation plans that would improve fish and wildlife habitat by partially re-creating historic low summer water levels in the navigation pools.

29. See the Monitoring section for more information on the LTRM, including its relationship and utility to the Mark Twain Refuge Complex.

Water level fluctuations play a major role in ecosystem processes in large floodplain rivers. Extreme floods can alter floodplain geomorphology and reset advanced stages of vegetative succession. More often, moderate floods maintain riparian vegetation in early successional stages and control the annual movement of carbon, nutrients, debris, and fish between the floodplain and the river channel. Lubinski's 1991 paper on UMRS water level regulation for fish and wildlife quotes the Junk et al. hypothesis that 'the principal driving force responsible for the existence, productivity and interactions of the major biota in river-floodplain systems is the flood pulse', and defines the area of the floodplain that is alternately wet and dry because of floods as the 'aquatic/terrestrial transition zone' (ATTZ).[30]

To achieve the objective of creating a continuous channel nine feet deep, the navigation dams were constructed to raise water elevations. The higher water resulted in more backwater and side channel aquatic habitat, but constant maintenance of higher water levels greatly reduced the ATTZ. Backwaters and side channels acted as sediment traps, greatly decreasing habitat diversity. The loss of historic low water periods that consolidated bottom sediments has resulted in flocculent sediments subject to resuspension by wind and waves. Increased turbidity has contributed to a decline in aquatic plant communities throughout the UMRS.

Since 1994, natural resource managers have worked with COE water control managers on experiments with water level drawdowns in Pools 24, 25 and 26, termed Environmental Pool Management (EPM). A pool drawdown of 0.5-2.0 feet for at least 30 days yields successful results for these pools. Pool drawdowns can occur between May and August, with the May-June period being the most desirable for vegetative growth, seed production and the predicted flows to accomplish the technique. After the initial drawdown, the goal is to allow the pool to rise at a rate not greater than 0.2-foot per day so that plants are not inundated too rapidly. Floods and droughts can affect the ability to achieve and maintain drawdowns without compromising flood control or navigation. In such years, drawdowns may not be possible. Discharge data compiled by the St. Louis COE District shows that a 0.5-foot drawdown could have occurred during 92 percent of the years since impoundment. Table 8 shows the predicted reliability of pool level management in the St. Louis District.

Table 8: Predicted Reliability of Pool Level Management in St. Louis District

Drawdown (feet)	Number of Years (59 total)	Percent Reliability
0.5	54	92%
1.0	51	86%
1.5	41	70%
2.0	36	61%
2.5	25	42%

EPM represents a large scale habitat management practice that mimics historic wet/dry cycles that produced the same type of responses. These drawdowns dry and consolidate flocculent sediments found in the lower end of the affected pool and permit aquatic plants to germinate, thus creating a wider diversity of habitat. The only other opportunity to accomplish such benefits, albeit on a smaller scale, is by isolating selected areas with low

30. Lubinski 1991

berms and installing infrastructure to permit drawdown and re-filling. Although the weather must cooperate to a greater degree for EPM than for impoundment management, its potential to impact larger areas throughout the upper river makes it an attractive management alternative.

Several studies have been initiated to monitor fish and wildlife use of vegetated areas produced by EPM. Timing of the drawdowns should be optimized to allow maximum growth of aquatic vegetation, but consider the possibility of stranding fish populations in backwaters. Bathymetric data is lacking for nearly all the impounded pools. Collection of this data would be invaluable in the EPM process because it would allow an estimate of the number of acres to be exposed during a drawdown. The 1994 drawdown exposed over 2,000 acres of floodplain backwaters in Pools 24, 25 and 26, producing a lush growth of wetland vegetation.

The restoration of wetland vegetation via EPM could benefit the entire Mississippi River ecosystem by reducing excess nitrogen and phosphorus input, and potentially contributing to the reduction of Gulf hypoxia. As upland run-off passes through vegetated wetlands, plants absorb these nutrients during growth periods, reducing output to the system. Also, as soils are allowed to dry, nitrogen is released from the soil into the atmosphere. A significant portion of the nutrients entering the Gulf come from the UMR north of the Missouri River, so expansion of EPM to the entire UMR lock and dam system has the potential to measurably reduce the amount of nitrogen entering the Gulf of Mexico. (See Water Quality section for more details.)

Many factors must be considered within each pool before any type of drawdown can be performed. These factors include maintenance of the 9-foot navigation channel, potential dredging program impacts, recreational impacts (e.g. marinas), and water intake supplies to cities. Careful consideration of the effects of drawdowns on all user groups must be weighed site-by-site, but the Refuge Complex is supportive of the concept and will encourage the practice with the Corps of Engineers wherever it is deemed feasible.

Management of Lands Associated with Agriculture Department (USDA)[31]

Conservation Easements

In the mid-1980s, Farmer's Home Administration (now Farm Service Agency, or FSA), foreclosed on many farm loans due to delinquent payments. One of the provisions in the 1985 Farm Bill requires FSA to protect wetland and floodplain resources on the default property prior to resale to the public. The Service assists the FSA in identifying wetlands and important floodplain resources on these properties. Once identified, the FSA assigns a perpetual conservation easement on the property and transfers management responsibility to the Service as part of the National Wildlife Refuge System.

Each refuge in the Complex is responsible for reviewing foreclosed properties in an assigned number of counties. Port Louisa NWR has been responsible for reviewing properties in 11 southeastern Iowa counties and 11 Illinois counties, stretching to the Indiana border. The Refuge has management responsibilities for permanent FSA conservation easements on seven properties in four Iowa counties, and five properties in

31. In addition to the active land management efforts described in this section, the Complex is involved with other technical service and coordination efforts with the USDA. See section, "Legal, Policy and Administrative Guidelines – Other Interagency Coordination – U.S. Department of Agriculture."

four Illinois counties, totaling 759 acres. Another property located in Davis County, Iowa, was transferred to the County Soil and Water Conservation District for environmental education purposes.

Great River NWR has management responsibilities for 17 eastern Missouri counties. Seventeen permanent FSA conservation easements have been obtained, totaling 778 acres in eight different counties. Two other properties were acquired in fee title in Clark County (80 acres) and Lewis County (43 acres).

Two Rivers NWR manages 19 FSA conservation easements totaling 257 acres. Farm Service Agency inventory property review is limited to Pike, Calhoun, Greene and Jersey counties in Illinois. Also, a 269-acre easement referred to as the Apple Creek Division was transferred in fee title to the Service from FSA in Greene County.

The Quincy Complex Office has FSA property review responsibility for five west-central Illinois counties and oversees one 173.9-acre conservation easement in Schuyler County, Illinois.

Each station administers this program through the Partners for Fish and Wildlife Program. Management and enforcement of easements is a problem with current refuge staffing levels. Sub-dividing of easements due to land sales is increasing the number of landowners and impacts. Existing conservation easements are up to 2.5 hours drive from each office, making inspections and management difficult to achieve. Good working relationships and coordination efforts between refuge staff, other federal agencies, and local law enforcement personnel is critical to maintain the integrity of this program.

Private Land Assistance Through the Partners for Fish and Wildlife Program

The Partners for Fish and Wildlife (PFW) program focuses on restoring and enhancing wetland and grassland habitats that provide wildlife, fisheries, water quality and recreation benefits. The Refuge Complex staff provide technical and cost-share assistance to private landowners for wetland and upland restorations in 48 counties in Iowa, Missouri and Illinois.

Port Louisa NWR covers 11 southeastern Iowa and three west-central Illinois counties. Great River NWR has local coordinator responsibilities for 17 eastern and northeastern Missouri counties. Two Rivers NWR is accountable for private lands activities in 12 west-central Illinois Counties. The Quincy office is responsible for five west-central Illinois counties regarding private lands issues. The entire area covered by the Complex is within the UMR drainage basin and projects generally target the most erodible soil areas. Eighteen of the counties actually lie within the 500-year floodplain planning area.

Partners for Fish and Wildlife funding is used for cost-sharing wetland restorations, including water control structures and pipe, or upland restoration such as re-establishment of prairies. Landowners must agree to maintain the area for a period of 10 years or more. Within assigned areas, refuge staff also provide technical assistance to the state Departments of Natural Resources, FSA, NRCS, private conservation organizations, and private individuals on wetland issues, habitat conservation and enhancement, and regulatory requirements.

Goals, Objectives and Strategies Discussion

Habitat Goals

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Land and water resources within the UMR floodplain have been heavily altered for agriculture, development, navigation, and flood control. Due to these changes, wildlife habitat diversity has been reduced. According to the 1989 LTRMP land cover maps for the river corridor within the AEC, more than 53 percent is in agricultural production, while 17 percent offers a habitat consisting of floodplain forest. Only 2 percent of the coverage contained wetland vegetation while 4 percent was classified as grassland or wet meadow. Most of the fish and wildlife habitat remaining today is on public lands managed by the Service or States.

The Mark Twain Refuge Complex seeks to protect, enhance, and restore a natural diversity of habitat types sufficient to maintain healthy populations of native wildlife relying on the AEC. The Refuge Complex protects and enhances habitat where it still exists and restores it in appropriate places where it is lacking. Fish and wildlife habitats are intricate combinations of vegetation, soil, weather, water, invertebrates, etc. Service management control over some of the complex set of environmental conditions that make up "habitat" is minimal. Vegetation communities and species composition sometimes can be influenced using techniques such as water level control (flooding/drying), burning, discing, and planting. However, the river is often beyond management control. High water out-of-season can inundate or saturate soils, requiring adjustments to planned management actions. The strategies in this section are not intended to represent static conditions. The habitat within refuge units can oscillate between two or more cover types, often due to conditions outside management control.

As was mentioned earlier ("Need for Action/Planning Perspectives " on page 6), to help focus this decision process and to ensure that a broad array of wildlife needs were accounted on a landscape scale, a "Species Priority List" was generated for the Mark Twain Refuge Complex. These species were selected by developing a sub-set of the Regional Resource Priorities List. This list was first narrowed to all those priority species found within the UMR ecosystem, then to those found within the planning area, or AEC. The resulting list was further modified by considering Refuge purposes, the historic range, habitat types found within the AEC and whether there were major voids or duplications. These species are essentially "indicators" with associations across the spectrum of lower UMR habitats upon which the Refuge can relate the effect on wildlife of CCP habitat goals, objectives and strategies. The Complex refuges are not managing exclusively for these species. Species on the Complex priority list can be considered representatives of guilds, or other groupings, of species that are dependent on a particular type of Refuge habitat. For that reason they provide an identifiable link between a wildlife species and its associated habitat managed by the Complex.

Vegetation types used in this plan are based on the Habitat Needs Assessment (See Monitoring Section). The 155 vegetation cover types used in the existing LTRM database were organized into 18 data groupings for the HNA. For Mark Twain Complex planning and management purposes, this number has been further reduced into six major vegetation types (plus open water): wetland, forest, grassland, wet meadow, scrub-shrub, and agriculture. Future LTRM Land Use/Cover data will contain only 31 cover types, but both the old and new databases will yield the same result when combined to produce our six coverages.

Table 9 illustrates the number of species that have a very high association with the habitats managed by the Complex. The wildlife numbers on the table are up to twice as high for many habitats when including species with a high and/or moderate habitat association.

Plant composition is continually changing with trends in the environment, especially in the disturbance-prone habitats of floodplains. Nonetheless, vegetation patterns can be characterized by often-found groups of plants that together can explain prevailing environmental conditions. The floodplain of the Mississippi River has distinctive habitat zones because of differences in water flow, depth, and duration. The relative depth and duration of flow can be approximated by examining topographic and bathymetric data. Aquatic plant communities prevail at the lowest elevations. Communities dominated by submersed and floating aquatics indicate a place that is persistently flooded, year after year. Emergent stands will occur in areas of prolonged flooding, but at shallower depths. At higher elevations, where flooding is seasonal, terrestrial communities including floodplain forests, wet meadows, and grasslands predominate. Plant communities often are banded, following contours of flood frequency. (Galatowitsch, 1994)

As a result of changes planned and documented in the CCP, Refuge Complex habitats will be managed in a different proportion from the 1989 systemic coverage to the desired future condition in 2015. The following figures do not include lands within the proposed boundary or refuge lands outside the AEC at Apple Creek (Two Rivers) and the Iowa River Corridor Project (Port Louisa). Open water areas will be reduced from 5,200 acres to 2,900 acres. This is largely due to the conversion of Swan Lake (Two Rivers NWR) from a backwater and flocculent bottom and no aquatic vegetation to a harder bottom wetland that will support aquatics (primarily permanent and semi-permanent flooded emergents). The conversion will be the result of an Environmental Management Program (EMP) project that permits periodic drawdown. Within the Complex, all wetland types will increase by 4,500 acres to a total of over 9,000 acres. Forest habitats will increase by 4,630 to a total of 18,460. Grasslands increase from 725 to 1,900 acres. Agriculture decreases from 9,100 to 1,100 acres. Much of this agriculture conversion is due to areas acquired since 1989 being restored and converted to one of the above type habitats after purchase, along with a substantial shift in previous refuge management practices. However, farming continues to be an invaluable management tool for periodically setting back wetlands types, such as seasonally flooded emergent (moist soils). Scrub/shrub (875 acres), sand/mud (185 acres) and developed area (20 acres) cover types are changed very little due to the proposals.

It is difficult to accurately project the acreage figures for each type of planned habitat types for the areas within the expanded boundary proposal of the plan. These areas are private lands that have not been surveyed for wetland or other specific restoration project design. However, once purchase and restoration are completed, the flood prone areas

Table 9: Mark Twain NWR Complex Habitats and Prevalent Wildlife Associations

General Habitat Type for CCP Goals and Objectives	Cover Types for CCP Habitat Strategies	Habitat Needs Assessment (HNA)[1] Cover Type	Priority Species Ranked by HNA With a "High Probability of Occurrence' in Each Cover Type[2]	Total Number of Species with High Probability of Occurrence in AEC (Appendix B)			
				Birds	Mam.	Herps	Fish
Watershed / Aquatic	Open Water	Open Water (no vegetation)	Least Tern, paddlefish, pallid sturgeon, mussels.[3]	59	2	4	79
	Permanently Flooded Aquatics	Submersed Bed	Canvasback, Lesser Scaup	59	2	8	36
		Floating-leaved aquatic bed	Wood Duck	49	2	8	36
	Semi-permanently Flooded Emergents	Semi-permanently flooded emergent annual	Canada Goose, Wood Duck, Mallard, Teal	58	5	3	38
		Semi-permanently flooded emergent perennial	American Bittern, Canada Goose, Wood Duck, Mallard, Teal, Least Tern, Paddlefish	59	5	8	41
	Seasonally Flooded Emergents	Seasonally flooded Emergent Annual	Canada Goose, Wood Duck, Mallard, Teal, Canvasback	52	4	3	0
		Seasonally Flooded Emergent Perennial	American Bittern, Canada Goose, Wood Duck, Mallard, Teal, Least Tern	56	4	8	0
	Sand/Mud	Sand/Mud	Least Tern, Short-billed Dowitcher	41	0	0	0
Wet Meadow	Wet Meadow	Wet Meadow	Wood Duck, Mallard, Henslow's Sparrow	62	6	32	0
Scrub/Shrub	Scrub/Shrub	Scrub/Shrub	Wood Duck, Mallard, Teal	72	1	0	0
Grassland	Grassland	Grassland	Grasshopper Sparrow, Henslow's Sparrow	45	17	20	0

Table 9: Mark Twain NWR Complex Habitats and Prevalent Wildlife Associations (Continued)

General Habitat Type for CCP Goals and Objectives	Cover Types for CCP Habitat Strategies	Habitat Needs Assessment (HNA)[1] Cover Type	Priority Species Ranked by HNA With a "High Probability of Occurrence' in Each Cover Type[2]	Total Number of Species with High Probability of Occurrence in AEC (Appendix B)			
				Birds	Mam.	Herps	Fish
Forest	Wet Floodplain	Salix community	Red-shouldered Hawk, Yellow-billed Cuckoo	63	1	0	0
		Populus community	Red-shouldered Hawk, yellow-billed cuckoo	67	1	0	0
		Wet floodplain forest	Wood Duck, Bald Eagle, Red-shouldered Hawk, Cerulean Warbler, Indiana bat	91	21	24	0
	Mesic Bottomland	Mesic bottomland forest	Bald Eagle, Cerulean Warbler, Red-shouldered Hawk, Indiana bat	96	25	29	0
Agriculture	Agriculture	Agriculture[4]	Canada Goose	38	12	0	0

1. HNA species probability of occurrence for Agriculture included some passerine birds associated with pasture cover type.
2. These species were selected by developing a sub-set of the Regional Resource Priorities list.
3. Guild contains sheepnose, salamander mussel, round pigtoe, rock pocketbook, pistolgrip, monkeyface, Higgins' eye pearlymussel, fat pocketbook, black sandshell.
4. HNA species probability of occurrence for Agriculture included some passerine birds associated with pasture cover type.

identified in the Refuge Boundary Expansion section are estimated to yield approximately the same distribution of habitats current managed by the Complex in both the pool and open river portions of the river. For those locations above St. Louis habitat types are generally proportioned as; forest types 50 percent, wetland and aquatic types 30 percent, and other terrestrial types 20 percent. For newly acquired areas in the Middle Mississippi River forest types will likely be slightly higher while wetlands are projected to be slightly lower.

Goal 1 Discussion: Wetlands and Aquatic Habitat

Wetlands provide habitat for a wide variety of wildlife including ducks, shorebirds, marsh and wading birds, fish, reptiles and amphibians. On the Complex list of species of concern, nine birds, two fish, and the mussel guild have high probability of being found in at least one of the wetland vegetation types. In addition to fish and wildlife habitat, wetlands also serve water purification and flood storage functions. Because of wetland conversion to agriculture and changes in natural flood/drought patterns, the amount of wetland habitat

providing natural wildlife foods has decreased significantly (see Floodplain Management). Wildlife managers have increasingly emphasized the importance of wetland restoration and management for healthy fish and wildlife populations.

Wildlife managers try to provide a variety of natural foods for migratory waterfowl and other wetland wildlife. Each food may accommodate nutritional requirements of different species at different times. Seeds, browse, tubers, invertebrates and crops are all important food items at various times. The higher the habitat quality and diversity of plant foods and invertebrates available to migratory birds, the greater the diversity of bird species that are attracted to the area.

Aquatic vegetation also plays an important role in structuring fish communities because many fish species use vegetation for feeding, refuge from predators, and spawning substrate. In the UMR, more than 80 species of fish use vegetated habitats during some stage of their life cycle (Janacek 1988). However, large expanses of highly dense submersed vegetation can result in problems with dissolved oxygen that are harmful to fish.

Wetland habitat strategies include purchase and restoration of former wetlands, and improvement of management capability and habitat quality on existing wetlands. Ability to manage existing wetlands varies from unit to unit within the Complex. Some areas are completely open to river pulses and have no independent water level control. Other units have varying elevation levels of protection by dikes and a variety of pumps, ditches, and water control structures to allow some water level management. Over 7,500 acres within the Complex can be manipulated to some degree in most years to achieve optimum growth of natural wetland vegetation for use by fish and wildlife. A combination of flooding, drying, mowing discing, burning, and agriculture are used to enhance wetland habitat on Louisa, Horseshoe Bend, Keithsburg, Delair, Clarence Cannon, Calhoun, Gilbert Lake, and Batchtown Divisions. Some potential for water level management also exists at Fox Island, given adequately low Mississippi River levels. Variation in flooding regimes and mechanical disturbance are used to encourage growth of the desired vegetation type in each wetland unit. Individual wetlands may contain a combination of vegetation communities at one time, or over a period of years. In addition, mud flats are typically exposed at the water's edge as wetlands recede. Refuge wetland units with good water control capabilities can be managed to provide mudflat habitat in the spring and fall to benefit migrating shorebirds. For Complex planning and management purposes, wetlands have been divided into four categories based on their HNA cover types - open water, permanently flooded aquatic vegetation, semi-permanently flooded vegetation, and seasonally flooded emergent vegetation.

Open Water

Open water areas contain no vegetation. Lack of vegetation may be due to many factors such as current, depth, water quality, etc. In backwaters and side channels that are devoid of vegetation due to sedimentation, turbidity, altered flood regimes, and other effects of navigation and flood control, the Complex seeks to increase wetland vegetation growth. Other open water areas are naturally free of vegetation and provide a variety of substrates for fish and wildlife. Deep open water with low current velocity provides fish overwintering habitat. “Big River” fish such as paddlefish and sturgeon use side channels and main channel borders for feeding. Gravel bars with water flow provide habitat for native mussels and some spawning fish. Other fishes are associated with gradually sloping sand bars, turtles nest on sand bars, and many shorebirds, gulls and terns use these exposed areas. The endangered Least Tern is a sandbar nester. Navigation structures such as wing dikes and partial closing structures can be designed to restore some open water habitat diversity

such as slack water, plunge pools, and substrates for invertebrate colonization. The Service coordinates with COE and States throughout the entire AEC on issues related to open water habitats.

Permanently Flooded Aquatic Plants

Upper Mississippi River System submersed aquatic beds include about 30 species of plants, including pondweeds, waterweeds, and wild celery. Most are found at depths less than 1.5 meters in areas that rarely dry out. Submersed communities invest little in structural tissue, and so thrive when supported by the water column. Submersed aquatics will be found in a variety of semi-shallow, lake-like environments. Most species are rooted, but others (e.g. coontail) can float freely. A few fish species feed on plants, but most eat the macroinvertebrates found on the plants. Waterfowl feed on a variety of the plants, tubers, and the invertebrates they host, as do wading birds and shorebirds. Beaver and muskrats feed on stems and tubers. Of the priority species within the AEC, Canvasback and Lesser Scaup have a high probability of occurrence in this vegetation type.

Semi-permanently Flooded Vegetation

This category consists of two HNA classes: floating-leaved aquatics and semi-permanently flooded emergents. Floating-leaved aquatics are rooted in the substrate. Their leaves extend to the surface on a single stem where they spread flat. These species are restricted to low current velocity environments, usually less than 1 meter deep. They tend to form beds in deeper water than is optimal for emergent vegetation, but shallower than submersed aquatics. Floating-leaved plants support relatively few invertebrates compared to submersed beds, but the leaves provide feeding surfaces for insect-eating birds and many amphibians. The leaf mats provide shady refuge for fish and turtles. Waterfowl feed on the seeds; beavers and muskrats feed on the tubers.

The semi-permanently flooded emergent community is composed of a wide range of plants that grow in shallow water, e.g. bullrushes, cattails, arrowheads, and pickerelweed. The community can form dense thickets at the margins of stable shorelines, but most can tolerate periods of exposure. Emergent vegetation can withstand flooded conditions and exposed-but-saturated conditions because plants that grow there have an erect growth form with enough structural tissue to remain upright even when water recedes. Many species are prolific seed producers important to dabbling ducks and other seed-eating birds. Wading birds and shorebirds feed on small fishes and insects found in the vegetation. Amphibians, reptiles, and small mammals also use the seeds and macroinvertebrates associated with this group.

Of the priority species within the AEC, Wood Duck, Mallard, Blue-winged Teal, Least Tern, Canvasback, Canada Goose, American Bittern and paddlefish have a high probability of occurrence in this vegetation type.

Seasonally Flooded Emergents

This community occurs on mudflats associated with backwater lakes, sloughs, and impoundments. Normally, these sites are flooded throughout much of the year and are too wet for terrestrial plant establishment. However, during periods of low water levels in mid to late summer, these sites are colonized by wetland plants such as: wild millet, sedges, rice cutgrass and, in the northern reaches, wild rice. Seasonally flooded emergents provide food, cover, and nesting habitat for waterfowl, marsh birds, reptiles and amphibians, and small mammals. When inundated, fish spawn in the emergent grasses and feed on insects colonizing the detritus. Management for this class of vegetation is commonly referred to as "moist soil management."

Of the priority species within the AEC, American Bittern, Blue-winged Teal, Canada Goose, Canvasback, Least Tern, Mallard, and Wood Duck have a high probability of occurrence in this vegetation type.

Mudflats

When water is drawn down slowly during the appropriate times of the year, shorebirds are attracted to the available invertebrates. Some species may be attracted by shallow water, others by mudflats. Some forage at the edge of the receding water line. If the interface between mud and water remains constant, they can deplete the invertebrates available to them. A slow, continuous drawdown provides the birds with new habitat and invertebrates.[32] Many refuge units are managed to provide mudflats during shorebird migration periods as part of regular moist soil management techniques. The Complex refuges will include specific shorebird habitat strategies in their step-down habitat management plans.

The AEC provides important wetland and aquatic habitat for migrating birds along the Mississippi Flyway and for fish seeking spawning and overwintering areas. However, little data is available to determine an appropriate north-south spatial distribution of habitat in the river corridor. Until additional studies are completed, reviews of the literature and conversations with river biologists indicate that reasonable figures are: a minimum of 500 acres of wetland habitat every 60 miles for waterfowl, and overwintering and off-channel habitat every 5-7 miles for fish.

Goal 1. Wetlands and Aquatic Habitat:

Restore, enhance, and manage refuge wetland and aquatic areas to provide quality diverse habitat for waterfowl, shorebirds, big river fish, and other wetland-dependent species.

Considerations: Vegetation types are based on the UMR Habitat Needs Assessment. In addition to the vegetation types, refuge divisions also provide unvegetated deepwater holes and channels (open water). The ability to control water levels and vegetation types varies between units and between years depending on flood regime, ground water table, elevations, soil type, and infrastructure. "Optimum Acres" indicates the preferred distribution of vegetation type in late summer/early fall during years of average flood regime and when the unit is not being managed for periodic setback of succession. More detailed wetland management background information is provided in Refuge Management Considerations Section.

Objective 1.A. Provide a 6-year average[33] of 2,200 acres seasonal, 1,800 acres semi-permanent, and 1,200 acres of permanently flooded wetland vegetation types in refuge wetland impoundments for waterfowl, shorebirds and other wetland-dependent wildlife species.

32. Eldridge, January 1992.
33. Average acreage figures represent 80 percent of total "optimum acres" for each habitat type on lands currently managed by the Mark Twain NWR Complex.

Strategies: Manage the following wetland impoundments to protect and enhance wetland vegetation:

Goal 1: Port Louisa NWR / Objective 1.A / Strategies 1.A

Strategy No.	Units	Total Wetland Acres	Vegetation Type of Optimum Acres				Additional Information
			SFE	SPF	P	OW	Additional Information: "✔" indicates that a unit can be managed to provide mudflat habitat for migrating shorebirds during drawdowns and refilling.
1.A.1	Keithsburg	408	4	108	80	216	✔Enhance water control through modification of existing spillways, and installation of water control structure. Dredge deep holes to improve fish habitat.
1.A.2	Louisa fields 4, 5, 12, 13, 14, 16, 17, 20, 21	524	147	343	25	10	✔Improve wetland habitat by scraping, filling ditches, standardizing water control structures, enhancing water delivery system to allow independent delivery. Periodically set back succession through mowing, discing, and/or burning.
1.A.3	Louis units 7 and 8	58	58	0	0	0	✔Improve water control by installing inlet structure from Goose Pond and outlet structure at Fox Pond, if feasible.
1.A.4	Louisa: Fox	53	0	10	0	43	✔
1.A.5	Louisa: Lake Odessa, Muscatine Slough, Goose Pond, Swarms Pond, Beebe Pond	468	64	131	6	267	Continue to coordinate water regime with IDNR.
1.A.6	Louisa: Prairie Pocket	45	0	0	0	45	Work with COE to obtain bathymetry data. Enhance fisheries habitat through dredging, if needed.
1.A.7	Horseshoe Bend, Rush Lake, Spitznogle Slough, Volunteer Marsh	183	74	73	0	36	✔ Open to river, with limited ability to control water levels when not flooded.
1.A.8	Horseshoe Bend, Mud Bottoms	133	0	133	0	0	Restored in 2000 by breaking tiles, installing ditch plugs and water control structures.

Goal 1: Great River NWR / Objective 1.A/ Strategies 1.A

Strategy Number	Units	Total Wetland Acres	Vegetation Type of Optimum Acres				Additional Information
			SFE	SPF	P	OW	Additional Information: "✔" indicates that a unit can be managed to provide mudflat habitat for migrating shorebirds during drawdowns and refilling.
1.A.9	Delair: 4C, 7, 15A, Shoveler Marsh	87	87	0	0	0	✔ Convert fields 4C and 7 to wetlands if elevations are feasible. Supplemental pumping would be required. Enhance existing wetlands 15A and Shoveler Marsh through installation of wells.
1.A.10	Delair: Upper/ Lower, Swan Lake, Hanei/ Lower Hanei Marsh, Cattail Marsh, Lower Butcher	399	83	225	63	28	✔ These units do not dry out completely and usually cannot be mechanically manipulated. Install WCS and well to allow fall flooding of western portion of Cattail Marsh.
1.A.11	Delair: Lower Cattail Marsh	17	0	15	2	0	Restore water control by installing control structure in existing dike. Unit also provides 21 acres of scrub-shrub. (See Objective 3D).
1.A.12	Delair: Garner Slough	1	0	1	0	0	Potential to form partnership with adjacent landowner to enhance water control. Unit also provides 15 acres of scrub-shrub habitat. (See Objective 3D.)
1.A.13	Delair: South Marsh	27	0	27	0	0	Investigate methods to improve water level control.
1.A.14	Clarence Cannon 1,778 MSUs 1-8, 10-12, Goose Pasture, Big Pond, Rabbit Ears Pond, Supply Pond, Crane Pond	1,778	1,266	436	4	34	✔ Construct 25,000 gpm Mississippi River pump station to enhance management of all units in north half of Refuge. Install up to five wells to enhance shorebird management. Construct WCS to enhance management of Crane Pond.
1.A.15	Clarence Cannon 28, Rabourn Slough, Buttonbush pond, Display Pond, Heron Pond	28	0	8	9	11	These impoundments provide valuable wildlife habitat, but little water level control or habitat manipulation is possible. Investigate need for dredging in Rabourn Slough for deep water fisheries habitat. Renovate Display Pond shoreline by reshaping and stabilization.

Goal 1: Two Rivers NWR / Objective 1.A/ Strategies 1.A

Strategy Number	Units	Total Wetland Acres	Vegetation Type of Optimum Acres				Additional Information
			SFE	SPF	P	OW	Additional Information: "✔" indicates that a unit can be managed to provide mudflat habitat for migrating shorebirds during drawdowns and refilling.
1.A.16	Calhoun: MSUs 1-7	285	285	0	0	0	✔ Scrape bottom of most of MSU-7 for more uniform water depths. Investigate alternativs to improve water supply to MSU 4.
1.A.17	Calhoun: MSU 8	29	29	0	0	0	✔ Convert existing crop ground to moist soil unit with dike, WCS, and portable pump.
1.A.18	Calhoun: Yorkinut, Duckpocket	27	27	0	0	0	Investigate alternatives for developing better water control.
1.A.19	Calhoun Swan Lake-Middle	1,058	347	404	269	38	✔ Do periodic (based on monitoring results) complete drawdowns for bottom solidification. Do annual partial drawdown to promote seasonally flooded vegetation around the perimeter.
1.A.20	Calhoun: Swan Lake - Lower	1,333	0	99	1,108	126	Do periodic (based on monitoring results) complete drawdowns for bottom solidification. Keep unit open to the river at other times for connectivity.
1.A.21	Calhoun: Schoolhouse	22	13	9	0	0	Continue management for bulrush marsh in center and seasonally flooded emergents around perimeter.
1.A.22	Gilbert Lake	237	21	210	1	5	Improve water level control by replacing pump system and dredging to improve drainage. Push back willows in upper end.
1.A.23	Gilbert Lake: S-Trap U-Trap	27	17	10	0	0	Develop water level control by rehabilitating dikes and WCSs and using a portable pump. Control willow encroachment and manage for moist soil conditions.
1.A.24	Batchtown: Prairie Pond	337	202	74	10	51	Improve drainage and fish habitat by dredging channel and deep holes. Push back willow encroachment along edges of waterways when dry enough.
1.A.25	Batchtown: MSU-1	55	55	0	0	0	✔ Install permanent pump. clean out ditches to improve drainage.

Goal 1: Two Rivers NWR / Objective 1.A/ Strategies 1.A (Continued)

Strategy Number	Units	Total Wetland Acres	Vegetation Type of Optimum Acres				Additional Information
			SFE	SPF	P	OW	Additional Information: "✔" indicates that a unit can be managed to provide mudflat habitat for migrating shorebirds during drawdowns and refilling.
1.A. 26	Batchtown: MSU-2	17	17	0	0	0	✔ Convert from crop ground to wetland with low level dike, WCS, and portable pump. this MSU was a dredge disposal area constructed during Phase 1 of the Batchtown HREP in 2000.
1.A.27	Batchtown: Watson Pond	16	16	0	0	0	✔ Improve water level control by replacing stop log structure and adding portable pump sites. Push back and control wood encroachment.

Objective 1B: Protect, enhance, and maintain a 6-year average of 300 acres of isolated backwaters and ephemeral wetlands, providing seasonal and semi-permanently flooded wetland vegetation types in unleveed areas of the Refuge with little water level control for the benefit of migratory birds and other wetland -dependent species.

Strategies: Manage isolated wetlands to protect and enhance wetland vegetation as shown below:

Goal 1: Port Louisa NWR / Objective 1.B/ Strategies 1.B

Strategy Number	Units	Total Wetland Acres	Vegetation Type of Optimum Acres			Additional Information Additional Information:
			SFE	SPF	OW	
1.B.1	Horseshoe Bend, Hall's Lake, Sunfish Lake, Diggins Slough, Iowa Pool	214	0	84	130	Evaluate fishery resources and methods of improving winter connectivity with the Iowa River.
1.B.2	Horseshoe Bend	24	0	15	9	
1.B.3	Big Timber: Isolated back-waters and ephemeral wetlands	27	8	15	4	Maintain and protect existing habitat.

Goal 1: Port Louisa NWR / Objective 1.B/ Strategies 1.B (Continued)

Strategy Number	Units	Total Wetland Acres	Vegetation Type of Optimum Acres			Additional Information Additional Information:
			SFE	SPF	OW	
1.B.4	Fox Island: Coin Pond, Logsden Slough, Slim Slough, Nelson Lake, Willow Lake	21	0	0	21	Determine feasibility of fall pumping on Coin, Logsden, and Slim by installing WCS and two wells.
1.B.5	Long Island	41	0	21	20	

Goal 1: Great River NWR / Objective 1.B/ Strategies 1.B

Strategy Number	Units	Total Wetland Acres	Vegetation Type of Optimum Acres			Additional Information
			SFE	SPF	OW	
1.B.4	Fox Island: Coin Pond Logsden Slough Slim Slough Nelson Lake Willow Lake	21	0	0	21	Determine feasibility of fall pumping on Coin, Logsden, and Slim by installing WCS and two wells.
1.B.5	Long Island	41	0	21	20	

Goal 1: Two Rivers NWR / Objective 1.B / Strategies 1.B

Strategy Number	Units	Total Wetland Acres	Vegetation Type of Optimum Acres			Additional Information
			SFE	SPF	OW	
1.B.6	Calhoun: Murphy Slough	27	0	27	0	Evaluate alternatives for improving backwater habitat.
1.B.7	Portage Islands	14	0	14	0	Evaluate alternatives for improving backwater habitat.

Goal 1: Middle Mississippi River NWR/ Objective 1.B/ Strategies 1.B

Strategy Number	Units	Total Wetland Acres	Vegetation Type of Optimum Acres			Additional Information
			SFE	SPF	OW	
1.B.8	Wilkinson Island	125	40	60	25	
1.B.9	Harlow Island	100	80		20	

Objective 1.C. Protect, enhance, and maintain 3,000 acres of contiguous backwater and side channel habitat in unleveed areas of the refuge for migratory birds and fish. Increase bathymetric diversity and wetland plant growth in these areas as feasible by 2015 where little or no local water level control exists.

Strategies: Protect and enhance contiguous aquatic habitat on refuge divisions as shown as follows:

Goal 1: Port Louisa NWR / Objective 1.C/ Strategies 1.C

Strategy Number	Units	Total Wetland Acres	Vegetation Type Average Acres			Additional Information
			OW	P	SPF	
1.C.1	Big Timber: Round Pond Little Denny Big Denny	81	18	52	11	Continue monitoring for desirability of future dredging.
1.C.2	Big Timber: Turkey Island Otter Island Main Island	100	36	28	36	Enhance permanent wetlands using potential techniques such as deepening, improving connectivity, and construction of partial closing structures. (Also will include 40 acres in SFE.)
1.C.3	Big Timber: other backwaters and side channels	213	92	115	6	Explore feasibility of environmental pool management to improve aquatic habitat on Big Timber.

Goal 1: Great River NWR / Objective 1.C/ Strategies 1.C

Strategy Number	Units	Total Wetland Acres	Vegetation Type Average Acres			Additional Information
			OW	P	SPF	
1.C.4	Long Island: Long Island Lake, Indian Graves Lake	146	138	0	8	Investigate need and potential benefits of dredging opening at mouth of lakes.

Goal 1: Great River NWR / Objective 1.C/ Strategies 1.C (Continued)

Strategy Number	Units	Total Wetland Acres	Vegetation Type Average Acres			Additional Information
			OW	P	SPF	
1.C.5	Long Island: O'Dell Chute	54	54	0	0	Dredge lower end of chute and construct closing structure to enhance deep water habitat. (Approved HREP project feature.)
1.C.6	Long Island: Canton Chute	1,250	1,250	0	0	In cooperation with partner agencies
1.C.7	Long Island: LaGrange Chute, Smoots Chute	617	604	0	13	Continue to maintain existing habitat.
1.C. 8	Fox Island: Fox River	23	23	0	0	Continue to maintain existing habitat.

Goal 1: Two Rivers NWR / Objective 1.C/ Strategies 1.C

Strategy Number	Units	Total Wetland Acres	Vegetation Type Average Acres			Additional Information
			OW	P	SPF	
1.C.9	Calhoun: 6-Mile Slough	23	23	0	0	Evaluate alternatives for improving backwater habitat at side channel; dredging and adding structures to maintain river connectivity and flow.
1.C.10	Batchtown: Church Gilead Other sloughs in the Maple Island Unit	431	389	8	34	Evaluate costs/benefits of dredging backwater areas that appear to be slowly filling in.
1.C.11	Portage Islands	10	10	0	0	Investigate need for dredging at lower end of backwater channel to improve connectivity.

Goal 1: Middle Mississippi River NWR / Objective 1.C/ Strategies 1.C

Strategy Number	Units	Total Wetland Acres	Vegetation Type Average Acres			Additional Information
			OW	P	SPF	
1.C.12	Harlow Island	12	11	1	0	Investigate feasibility of reconnecting remnant side channel with main channel by opening lower end and dredging to provide habitat for over-wintering fish.
1.C.13	Wilkinson Island	100	20	20	60	Develop active side channel at the upper end of Wilkinson Island. By connecting scour holes along a naturally occurring floodway, a 1.5-mile-long active side channel could be encouraged to form.

Goal 2 Discussion. Forest Habitat

Forest habitats within the floodplain are used by many wildlife species including migrating and nesting songbirds, waterfowl, raptors, herons, egrets, deer, small mammals, reptiles, and amphibians. Of the wildlife species on the Species of Concern List for the Complex, six have a high probability of utilizing at least one of the four forest types described in the HNA. These species are Bald Eagle, Red-shouldered Hawk, Cerulean Warbler, Wood Duck, Yellow-billed Cuckoo, and Indiana bat. Floodplain forests provide a different type of habitat than upland forests, as demonstrated by differences in presence/absence and abundance of different bird species. Floodplain forests support higher abundances of birds than upland habitats, in some cases nearly double the abundance (Knutson 1996, 1998). Species such as Brown Creeper, Yellow-billed Cuckoo, Yellow-bellied Sapsucker, and Great Crested Flycatcher show a clear preference for floodplain forests, and a few species, such as Red-shouldered Hawk and Prothonotary Warbler, are dependent on these forests (Fitzgerald and Pashley, 2000).

The amount of floodplain forest within the AEC has been significantly reduced from historic levels by clearing of land for agriculture and development. In addition, changes in flood frequency, duration, and depth resulting from impoundment and channelization have reduced the diversity within the remaining forests. Prior to European settlement, Upper Mississippi River floodplain forests were dominated by hackberry, elm, pecan, sycamore, willow, and cottonwood. Today, these forests are dominated by mature flood-tolerant silver maple. Less flood-tolerant hard mast species, such as oaks, have significantly declined. With sustained high water levels, little germination takes place, and seedlings are unable to survive the frequent floods. Absent restoration efforts, early successional stands of cottonwood and willow have declined due to the loss of large areas of mudflats and sandbars.

These changes could adversely affect species richness and relative abundance of some floodplain forest-nesting species. For example, species preferring the habitat structure provided by silver maples will likely increase on the UMR and those requiring the structure and/or mast provided by cottonwood, elm, and oak will likely decline. The

Complex seeks to restore and enhance the amount and diversity of floodplain forest within the AEC to meet the needs of forest-dependent wildlife. Three components of an improved floodplain forest component within the AEC are (1) reduced forest fragmentation (increased size of forest blocks), (2) increased diversity of habitat within those forest blocks, and (3) adequate spatial distribution of forest habitat throughout the length of the river corridor.

Fragmentation

Forest fragmentation occurs when large, contiguous forests are divided into smaller patches due to clearing of land for agriculture and development. During the past 150 years, much of the contiguous forest in the AEC has been lost, resulting in fragmentation of the remaining areas. Wildlife species richness increases as forest patches become more contiguous. Those species whose occurrence or reproductive success is reduced in small habitat patches are referred to as "area-sensitive." Many species of forest-dwelling birds, such as the Cerulean Warbler, are area-sensitive, but there is no simple answer regarding how big forest blocks need to be to support long-term self-sustaining populations. Sensitivity to forest fragmentation varies between species and between regions. The shape of the patch also affects the likelihood of finding area-sensitive species in a particular forest block. Round or square forest blocks provide less edge (and better quality habitat for forest interior birds) than narrow or irregular blocks. Research indicates that area-sensitive species generally tend to use forested areas that are at least 330 feet (100 meters) from an edge. The type of habitat in the surrounding landscape has an influence as well. The more forest that exists in the surrounding area, the more likely that a block will contain area-sensitive species. Isolation from other similar habitat significantly influences forest bird distribution and abundance in fragmented landscapes.

For example, Cornell Lab of Ornithology developed a table of minimum area requirements for Scarlet Tanagers, a moderately area-sensitive species. According to the study, if there is 40 percent forest in the surrounding landscape, block size in the Midwest must be at least 605 acres to provide high suitability for scarlet tanagers. If the surrounding area contains 70 percent forest, minimum block size drops to 66 acres. The Illinois Natural History Survey developed graphs giving estimates of the likelihood of encountering area-sensitive birds in forest patches of varying sizes in the Midwest. In an Illinois forest of 100 acres there is roughly a 70 percent likelihood of encountering a Wood Thrush or Red-eyed Vireo (moderately area-sensitive), and a 40 percent probability of encountering an Ovenbird (a highly sensitive forest species). The most imperiled area-sensitive species in the floodplain forest is the cerulean warbler, largely as a result of extensive loss of mature, deciduous forest habitat throughout its breeding range. Minimum area requirements for this species in the Middle Atlantic States have been estimated to be 1,750 acres, with maximum densities reached only when woodlands exceeded 7,500 acres (Fitzgerald and Pashley 2000).

Within the UMR, Knutson et al. 1996, found that wider riparian corridors can increase species richness. The fact that riparian forests are interspersed with marshes, sloughs, and lakes did not appear to have negative effects on species presence or abundance. On large rivers, Knutson recommended that floodplain forests be a minimum of 2,000 feet wide.

Establishing large forest tracts will not guarantee the presence of area-sensitive species and, conversely, these species are sometimes found on smaller tracts. But, in general, management activities that enlarge the amount of contiguous habitat are beneficial and actions that reduce tract size also reduce the likelihood that area-sensitive species will be found or persist there. Even when forest patches are large enough to attract area-sensitive species, mating success may be compromised until an even greater size threshold is reached. Some area-sensitive species will only establish breeding territories in the interior

of large forest tracts, far from an edge. Others may attempt to nest in small forest blocks but are often unsuccessful due to high rates of nest predation (by jays, crows, raccoon, cats, etc.) and brood parasitism (notably by Brown-headed Cowbirds).

Studies of nesting success indicate that many forest bird populations are unable to produce enough young to balance adult attrition even in the largest forested tracts (up to 2,200 ha) in Illinois; it is only because of immigration from individuals outside the region that bird populations appear stable at some sites. Robinson et al. found high levels of parasitism in tracts as large as 3,300 acres in Illinois but substantial reductions in predation and parasitism in tracts in the size range of 25,000 to 62,500 acres. While little potential exists for restoring acreage of this size within the AEC, smaller tracts of forest may be able to support populations of less "cowbird-vulnerable" species of forest birds (Fitzgerald et al. 2000).

Diversity

A healthy floodplain forest that supports the full range of native wildlife species requires a diversity of forest structure that includes a variety of tree species, ages, canopy heights, and under story diversity. The HNA characterizes species diversity of Upper Mississippi River forest using four categories: willow, cottonwood, wet floodplain, and mesic bottomland communities.

Willow (*Salix*) and cottonwood (*Populus*) communities consist of pioneering trees, most often found nearest the banks of the river or slough. They are more flood-tolerant than most species, grow under full sunlight on bare soils, and are the first forest communities established after disturbance. Salix communities are most often associated with backwater lakes, sloughs, and side channels. Unless disturbed, willow stands will be replaced by wet floodplain forest species after 20-30 years. Willow thickets attract a variety of species including song birds, muskrats, beavers, and deer.

Populus communities are most often established on newly formed land at the downstream ends of islands and inside bends of meandering tributaries. Populus stands are likely to persist about 50 years before being overtaken by wet floodplain forests, but many individual trees typically survive much longer. They do not provide much wildlife food, but the leaf fall promotes secondary aquatic production and soil development. Communal nesting wading birds (e.g. Great Blue Herons and Great Egrets) and Red-shouldered Hawks often nest in the top-most branches of mature cottonwood stands and Bald Eagles use them for roosting and nesting.

As organic matter accumulates, conditions become favorable for other species to establish. Maple, ash, and sycamore soon colonize in cottonwood-willow communities. Trees and shrubs of these "wet floodplain" forests are shade tolerant and can establish under a canopy unlike those of cottonwood-willow communities. Consequently, in the absence of disturbance, these mixed forests may persist indefinitely. The community is flood tolerant up to a few weeks each year, but can be killed if inundated for long periods during the growing season. These wet floodplain forests occur at intermediate elevations on islands, riverbanks, floodplains, tributary deltas, and abandoned agricultural fields.

The wet floodplain forest is the most common type occurring along the AEC. River impoundment, increased flood frequency and duration, and increased sedimentation are thought to have benefited this forest type, although much has been lost due to clearing for agriculture and development. Remaining forests are mostly even-aged stands. Wet floodplain forest communities do not provide much wildlife food beyond deer grazing on saplings, but the leaf fall promotes secondary aquatic production and soil development.

Many neotropical migrant birds feed on insects and nest in the forest canopy, branches, bark, and snags. Indiana bats roost under the peeling bark of dead trees. Several groups of reptiles and amphibians are adapted to the moist woodland conditions of this forest type.

"Mesic bottomland" forests are commonly found on the floodplain of the Mississippi River at a slightly higher elevation than the wet floodplain communities. They are generally associated with natural ridges, and terraces. Although soils may be saturated for prolonged periods in the spring, extended periods of inundation are uncommon. A 1-foot or 2-foot difference in elevation can make a significant difference in the survival rate of mesic bottomland species. Common tree species include hard mast (nut) producers such as pin oak, bur oak, swamp white oak, northern pecan, and shellbark hickory. Mesic bottomland forests were once much more extensive along the Upper Mississippi River than their current limited status suggests. Natural regeneration has been poor due to river impoundment, the floods of 1973 and 1993, logging, conversion to agriculture, and elimination of associated prairies and fire disturbance. The remaining forests are mostly even aged stands. Mast producing species are a valuable food source for many wildlife species (e.g. waterfowl, deer, squirrels). Neotropical migrant birds feed on insects and nest in the forest canopy, branches, bark, and snags. Mesic bottomland forests also provide habitat for Indiana bats, small mammals, deer, reptiles, and amphibians.

Diversity of forest age also provides a variety of habitat types for wildlife and assures steady replacement of mature forest as trees become overmature and die. The COE forest management program in the Rock Island District has established a target for the ideal distribution of age classes. This standard calls for 20 percent sapling (0-4 inches dbh), 35 percent pole (4 inches to 12 inches), and 45 percent mature/overmature (greater than 12 inches). They are concerned that the present extensive stands of mature silver maple in the UMR are even-aged and a healthy distribution of younger trees is missing. As these forests mature, there is evidence that they may be replaced by shrub-scrub habitats with delayed regeneration of forests. To counteract this predicted outcome, the COE is harvesting small patches (less than 15 acres) from forest stands where trees are over mature. These canopy openings allow sun-loving species to regenerate, creating a diversity of canopy and under story heights. A few large trees are left in each cut area for use by wildlife and to provide a seed source. The COE has begun monitoring bird use of these cuts by conducting point counts annually at Pleasant Creek and Huron Island.

Greater diversity of tree species and age within the forest provides habitat for a greater diversity of wildlife species. For example, woodpeckers create nest holes for secondary cavity nesters including Prothonotary Warbler, Great Crested Flycatcher, Chimney Swift, Tree Swallow, and House Wren. These cavity nesters need an abundant supply of dead trees and snags. Cerulean Warblers nest in a variety of trees but seem to prefer large oaks, elms, and sycamores. Oaks have been reported to be an integral component of Cerulean Warbler breeding habitat. They also prefer forests with a high canopy, moderate to high vertical structural diversity, and moderate to dense ground cover. Red-shouldered Hawks also are forest interior breeders, preferring large blocks of mature riparian forest with a high closed canopy and low ground cover. Conversely, the Yellow-billed Cuckoo prefers open riparian woodlands with clearings and low dense scrubby vegetation. They are often found in early successional willow/cottonwood forests with dense stands of small trees. Indiana bats typically roost under the loose bark of larger dead trees.

Spatial Distribution

Floodplain forests within the AEC provide an important migratory pathway for neotropical forest-dwelling birds moving between breeding and wintering grounds. Migrating neotropical birds need stopover sites with adequate food to replenish fat reserves and protection from predators. As with breeding birds, plant species and

structural diversity influence habitat suitability and can affect the rate at which migrants replenish their energy reserves. Because migrants feed both on fruit and insects, forest management techniques that foster adequate production of these should improve the tracts' suitability as stopover sites (Fitzgerald et al., 2000). Block size may be less critical for migrating birds than the spatial distribution of habitat along the migration corridor. Smaller tracts that do not support breeding populations may provide valuable stopover habitat for in-transient migrant birds needing to replenish fat supplies. Moore et al. 1992 suggests that a matrix of widely distributed habitats may be more effective than a small number of large habitat areas. Adequate spacing of migratory stopover habitat has not been well-defined and may not be a limiting factor within the AEC. As additional information becomes available through refined GIS data and HNA, the Complex will adapt its land acquisition and forest restoration strategies and priorities to meet those needs.

Refuge Complex Forest Management

A step-down management plan will be developed in partnership with Corps of Engineers foresters to achieve healthy floodplain forest diversity of adequate size and distribution. Management actions may include a selective harvest program in some areas to create early successional forest, diversity of canopy heights, and diversity of understory. Species diversity will be enhanced where feasible through planting of Root Production Method (RPMr) trees. This nursery method produces many lateral roots on seedlings instead of one long taproot through tree seedling root pruning. Trees that would normally take 20 years to produce acorns can begin producing in 3 or 4 years when planted with the RPM method. The expanded root system close to the surface also provides greater resistance to flood damage. RPM trees appear to have faster growth and greatly improved survival in the floodplain compared to plantings of acorns or bare-root seedlings. These plantings are being evaluated at several sites in the Upper Midwest. Hard mast trees will only be planted on higher elevation areas of the AEC. One or 2 feet of elevation can make a substantial difference in survival of hard mast trees in the floodplain. In some instances, elevation may be raised slightly using dredge material from side channel improvement projects or navigation channel maintenance. Forest fragmentation and spatial distribution will be addressed through a combination of land acquisition, conversion of former agricultural fields, and protection of existing forest tracts.

Goal 2. Forest Habitat:

Conserve and enhance floodplain forest to meet the needs of migrating and nesting neotropical birds and other forest-dependent wildlife.

Considerations: Important components of healthy floodplain forest include adequate block size to provide habitat for area-sensitive nesting neotropical migrants, adequate spatial distribution along the river corridor to provide stopover sites for feeding and resting birds during migration, and adequate diversity of forest structure within the blocks to provide for the habitat needs of a wide variety of forest-dwelling wildlife species. Factors influencing the definition of "adequate" are discussed in the narrative above and have been considered in development of these objectives and strategies.

Objective 2.A. Conserve and enhance floodplain forest block size and spatial distribution along the river corridor through management of existing 18,000 acres and restoration of an additional 800 acres by 2011 for the benefit of nesting neotropical birds, feeding and resting birds during migration, and other forest-dependent wildlife.

Strategy 2.A.1. Maintain existing tracts of floodplain forest on the refuge. Some existing forest areas may require active management to maintain overall health. A step-down plan will be developed to determine management needs for each unit. (See strategy 2.B.1.)

Goal 2: Port Louisa NWR / Objective 2.A/ Strategies 2.A.1

Division	Acres of Existing Forest	Additional Information
Louisa	871	Louisa also contains 37 acres of upland forest on the bluff near Headquarters.
Keithsburg	672	
Big Timber	1,278	
Horseshoe Bend	580	

Goal 2: Great River NWR / Objective 2.A/ Strategies 2.A.1

Division	Acres of Existing Forest	Additional Information
Long Island	5,620	Rip rap portions of bankline to protect forest habitat from further loss. (Approved HREP project feature.)
Delair	512	
Fox Island	1,716	
Clarence Cannon	798	Large percentage of hard mast trees were killed by 1993 flood.

Goal 2: Two Rivers NWR / Objective 2.A/ Strategies 2.A.1

Division	Acres of Existing Forest	Additional Information
Batchtown	1,207	Extend off-bank revetment (rock wall) north to fully protect shoreline and prevent loss of forest.
Calhoun	1,275	
Gilbert Lake	295	
Portage Islands	110	Construct hard points or revetment to promote island growth, protect island heads, and prevent loss of mature forest.

Goal 2: Middle Mississippi River NWR / Objective 2.A/ Strategies 2.A.1

Division	Acres of Existing Forests	Additional Information
Wilkinson Island	2,238	
Harlow Island	1,190	

Strategy 2.A.2. Convert refuge units to floodplain forest. Many of these areas will be left idle for natural succession to floodplain forest to reduce forest fragmentation. Depending on elevation and flood frequency/duration, sites that might be suitable for future hard mast plantings are also included under strategy 2.B.3. All of these areas also will provide age/ structural diversity during the regeneration process.

Goal 2: Great River NWR / Objective 2.A/ Strategies 2.A.2

Division	Units	Acres	Additional Information
Fox Island	All	483	
Long Island	Field 7	94	Approved HREP project feature. (About 60 acres of this field will be planted with hard mast species.)
Clarence Cannon	F1, F2	64	

Goal 2: Two Rivers NWR / Objective 2.A/ Strategies 2.A.2

Division	Units	Acres	Additional Information
Batchtown	F1-F11	67	F1 and F5 are dredged material disposal sites used for the HREP in 2000. Oaks were planted in F2, F3, F6, F9, F10 and F11 in 1994-95. Some have survived, but no additional platings are planned for these areas. F5 will be planted to hard mast if elevations are suitable. Field will be converted to forest. Not suitable for wetland conversion due to small size (cost/benefit of O&M) and lack of access. Hard mast trees will be planted if elevations are suitable.
Calhoun	F3, F4, F6-11	170	Hard mast trees were planted in parts of F4, F8, F9, F10 and F11 in the middle 1990s with varying survival rates. F7 was planted to grass in the early 1990s and F3 and F6 are agricultural fields that will be converted to hard mast trees. (See 2.B.3)
Gilbert Lake	F1	10	Hard mast trees were planted in 1995 but did no survive. allow natural revegetation.
	F2	28	Field will be converted to forest, and will also include hard mast plantings.

Objective 2.B. Conserve and enhance structural (age and species) diversity on 2,500 acres of refuge floodplain forests by 2015 for the benefit of neotropical migrants, raptors, bats, and cavity nesting birds.

Strategy 2.B.1. Develop a forest management plan for the Complex. The plan will detail the management actions needed for long-term maintenance of healthy bottomland forest habitats, in cooperation with the Corps. The plan might include replanting flood-damaged areas, selective cutting, and/or prescribed fire in some areas. Plan implementation will result in an appropriate diversity of forest structure including diverse canopy, understory, age, and species.

Strategy 2.B.2. Maintain existing hard mast (mesic bottomland) component. The forest management plan will determine best management techniques.

Goal 2: Port Louisa NWR / Objective 2.B/ Strategies 2.B.2

Division	Acres of Existing Hard Mast Trees	Additional Information
Louisa	224	Maintain through possible selective thinning of the mature hard mast trees near Goose Pond and in the 18-acre pecan grove. Mow around saplings in pecan grove. Work with Forrest Keeling Nursery to collect pecans and maintain seed bank.
Keithsburg	31	Explore alternatives for maintaining the mature hard mast trees that survived the 1993 flood in the north end of the unit.
Big Timber	185	

Goal 2: Great River NWR / Objective 2.B/ Strategies 2.B.2

Division	Acres of Existing Hard Mast Trees	Additional Information
Long Island	1,680	Large block of mature hard mast trees.

Strategy 2.B.3. Plant hard mast (mesic bottomland) trees on suitable sites. The forest management plan will evaluate each Division in more detail to determine the best sites for planting, but these are currently thought to be potential sites:

Goal 2: Port Louisa NWR / Objective 2.B/ Strategies 2.B.3

Division	Unit	Potential Acres	Additional Information
Horseshoe Bend	Northwest corner	29	Plant higher elevations in northwest corner.

Goal 2: Great River NWR / Objective 2.B/ Strategies 2.B.3

Division	Unit	Potential Acres	Additional Information
Clarence Cannon	Bryants Creek	122	Convert Field 25 and MSU 9 to green tree reservoir by planting hard mast trees and installing two water control structures.
	GTR-7	105	Plant hard mast trees to restore 1993 flood damage. Flood periodically during fall waterfowl migration.
	Fields 3, 4, 5 and Part of Field 15	40	Supplement existing plantings with additional hard mast plantings.
Fox Island		339	Plant selected sites above elevation 488.
Long Island	Field 7	60	Approved HREP project feature.
Delair	Field 6	10	Convert to hard mast trees.
	15B, 15C, 20, 21, 22, 23, Hanei Fields	214	Supplement existing plantings with additional hard mast plantings.

Goal 2: Two Rivers NWR / Objective 2.B/ Strategies 2.B.3

Division	Unit	Potential Acres	Additional Information
Batchtown	Field 5	10	Plant portion used for HReP dredge material disposal. Remainder will be allowed to covert by natural regeneration.
Calhoun	Field 3, Field 6, Field 7	85	Agricultural fields to be planted with hard mast trees.
	AG3, AG4, AG5	246	Adaptive management focus area. May be converted to forest if future monitoring indicates low waterfowl utilization of agricultural crops.
Gilbert Lake	Field 2	28	Convert from cropland to forest.

Goal 2: Middle Mississippi NWR / Objective 2.B/ Strategies 2.B.3

Division	Unit	Potential Acres	Additional Information
Harlow	Scattered	191	Higher elevations of former cropland.
Wilkinson	Scattered	43	Higher elevations of former croplands and levees.

Strategy 2.B.4. Leave large dead trees in place on all divisions for Indiana bats and cavity-nesting birds. Dead trees creating a safety hazard will be removed.

Strategy 2.B.5. Use the deer hunting program as a tool to maintain forest understory quality by reducing browsing damage to bottomland forests where determined necessary by monitoring.

Strategy 2.B.6. (Great River NWR, Clarence Cannon). Allow cottonwood seedlings to grow to maturity along selected service roads to provide roosting sites for Bald Eagles.

Strategy 2.B.7. Study bird species composition and productivity in early successional forests of the Upper Mississippi River to evaluate the importance of this habitat type and to provide information for making forest management decisions.

Strategy 2.B.8. Work with navigation industry, the public and the COE to eliminate the forest resource damage done by approved and non-approved barge fleeting activities by 2004. Accomplished by moving fleeting out from shorelines to off shore locations under Section 10 permits.

Goal 3 Discussion. Other Terrestrial Habitats

Grassland

Floodplain grasslands are composed of mesic to xeric grasses and forbs, and may occur mixed with trees as savannas. They are intolerant of prolonged flooding. Without disturbances of fire or mowing the community tends to progress toward later successional woody stages. Grassland communities are rare compared to their former occurrence because they were widely converted to agriculture and urban development on high elevation floodplains and terraces. Most former grasslands in the AEC are now behind high levees, protected from 100-to-500 year flood events.

Grasslands provide forage for herbivores, abundant seeds, and cover. Grasshopper Sparrow and Henslow's Sparrow are AEC species of concern with a high likelihood of occurrence in grassland habitat. Many species of grassland birds have declined significantly in the past 30 years, probably due in large part to loss of habitat. Many grassland bird species are area-sensitive. Because area requirements (50 percent probability of occurrence) of Henslow's Sparrows and Grasshopper Sparrows have been shown to be relatively large in fragmented landscapes in Illinois (140 and 125 acres respectively), management for these species should focus first upon tracts of grassland as large or larger than those sizes. In less fragmented landscapes, where a high proportion of grassland exists in the matrix surrounding the patches, the same species may be less area-sensitive. Refuge Complex management will focus on areas at least 150 acres in size.

These acreages are only minimal areas for a reasonable probability of species occurrence, not minimal areas required for self-sustaining populations. Studies have shown that larger populations have a greater probability of persistence. However, little information is available on what constitutes a viable population size for most grassland species. Areas that are much larger than a species' minimum area of occurrence will likely be required to ensure the long-term survival of area-sensitive species.

Small fragments also have a greater proportion of edge habitat than larger fragments. Several studies have shown that nesting success of grassland birds is lower when nests are placed in close proximity (150-200 feet) to a forest edge, apparently due to nest predation. Grasshopper Sparrows rarely attempt to build nests near edges.

Finally, the structure of the vegetation within a patch also plays a role in determining what species are attracted to a site where patch size and landscape conditions are adequate. For example, Henslow's Sparrows seek dense, tall grass cover and a deep litter layer characteristic of relatively undisturbed prairies. Little habitat for Henslow's Sparrows exists in landscapes dominated by cropfields, annually mowed hayfields, or heavily grazed pastures. In contrast, Grasshopper Sparrows seek grass cover of intermediate height with low to moderate litter depth interspersed with patches of bare ground.

Grasslands are disturbance-adapted systems. In the absence of periodic disturbance, invasion of woody plants occurs, and fewer grassland bird species and individuals are supported. Fire is one of the most important types of disturbance for suppressing woody encroachment, decreasing litter cover, and improving grass and forb production, thereby maintaining bird species diversity. Some grassland bird species are reduced immediately following a burn, while others are increased. Grazing and mowing/haying also limit vegetation height, litter accumulation, and woody encroachment. Grazing can benefit bird species that prefer short to medium height vegetation, although moderate to heavy grazing can be detrimental to Northern Harriers, Short-eared Owls, Sedge Wrens, and Henslow's Sparrows. Bird species' response to mowing and haying is similar to their response to fire. Species such as Sedge Wren, Henslow's Sparrow, and Dickcissel are negatively affected immediately following mowing, while others such as Upland Sandpipers, Horned Larks, and Killdeer are consistently more abundant on recently burned or mowed grasslands. Management actions must be timed to reduce negative effects to nesting birds. As a result of different habitat preferences, bird responses to various forms of grassland management are variable. Some bird species are more abundant in areas recently managed by fire, grazing, or mowing, while others are more abundant in undisturbed areas. Land managers, therefore, strive for a rotational system of management that provides a mosaic of grassland habitat types.

The greatest potential for restoring large tracts of grasslands in the Midwest occurs in the Great Plains outside of the AEC for this plan. Grassland restoration within the floodplain is risky due to the potential for flood damage. In some cases, however, grassland restoration is appropriate within the Mark Twain reach of the UMR. Small tracts have been established for maintenance purposes on levees, for protection of cultural resource sites, or for use in environmental education and interpretive programs. Several remnant sand prairies, formed from sand deposited by glacial meltwaters, can be found on the Louisa and Keithsburg divisions of Port Louisa NWR. Sand prairie plant communities are a mix of native tallgrass prairie species and plants more commonly associated with the western U.S., such as prickly pear cactus. The Illinois chorus frog, a state-listed threatened species, is restricted to sandy floodplains, so sand prairies provide ideal chorus frog habitat (www.inhs.uiuc.edu). The sand prairies of Port Louisa NWR are potential seed sources for future restorations.

A large block (more than 1,500 acres) of the Horseshoe Bend Division of Port Louisa NWR has been restored successfully to native prairie, wet meadow, and wetland habitat under a management plan that was developed for the Division following acquisition. A 1995 bird survey on Horseshoe Bend found more than 100 species including Grasshopper Sparrow, Savannah Sparrow, Eastern Meadowlark, and Dickcissel. Birders on an Audubon Society visit to the unit in 1999 reported seeing and hearing Henslow's Sparrows, a highly area-sensitive grassland species.

Wet Meadow

Wet meadows are most often found along protected backwater areas, at higher elevations than emergent marshes, in areas flooded for brief to moderate periods during the growing season. Characteristic plants include prairie cord grass, rice cutgrass, panic grass, sedges, and marsh aster. An occasional willow or buttonbush also may be found in wet meadows. The dense growth provides cover and nesting habitat for reptiles and amphibians, marsh birds, and small mammals. When inundated, fish spawn in the emergent grasses and feed on insects colonizing the detritus. Three AEC species of concern (Henslow's Sparrows, Mallards, and Wood Ducks) have a high likelihood of occurrence in wet meadow habitat. Habitats such as wet meadows are affected not only by conventional grassland management activities but also by water level manipulations. Thus, water level manipulations must be carefully managed to maintain wet grassland and sedge communities. Too little water can cause conversion to forest. Too much water can alter the vegetation composition and result in lower habitat quality for grassland and wet meadow wildlife.

Scrub-Shrub

Scrub-shrub wetlands are characterized by small, woody vegetation, primarily buttonbush and scattered willows that are less than 20 feet tall. Along the Upper Mississippi and Illinois rivers, scrub-shrub wetlands represent a successional stage in the transition of an emergent wetland to a forested wetland. Unless sedimentation rates are very high, this community can be relatively stable. With high rates of sedimentation, these areas are likely to convert quickly to forest. Buttonbush can be important an important waterfowl food source by providing nutlets and associated invertebrates. The community attracts wading birds, marsh birds, upland game birds, song birds, beaver and muskrats. Of the AEC priority species, Wood Duck, Blue-winged Teal, and Mallard have a high likelihood of occurrence in scrub-shrub habitat. Buttonbush is the preferred vegetation type for the copperbelly water snake, a rare species recently confirmed on the Louisa and Big Timber divisions. Management techniques that reduce sedimentation and willow encroachment along wetland edges can promote scrub-shrub habitat.

Agriculture

Agricultural grains can provide a concentrated source of the high energy needed by waterfowl to maintain body temperature and fat reserves during migration, reproduction, and overwintering. A diversity of invertebrate and vegetative foods (agricultural and natural) is needed on migration and wintering areas to meet the nutritional demands of waterfowl and to provide them with a complete diet. Loss of wetland habitat within the Mississippi Flyway has severely reduced the amount of natural foods available to wildlife and increased the importance of agricultural foods, such as corn, to supply their nutritional needs. “Most species of ducks prefer to forage in wetlands or artificially flooded areas when sufficient food is available. However, after foods become depleted, some waterfowl species (such as Mallards and Canada Geese) readily venture into upland sites in search of waste grain and other foods” (Havera 1999).

There are extensive agricultural areas surrounding Refuge Complex lands, but efficient harvest techniques and fall plowing have resulted in little waste grain being available for waterfowl on most privately-owned fields. In addition, most private lands in the area are heavily hunted during waterfowl season. Crops on Complex lands provide feeding and resting areas for waterfowl in unhunted sanctuaries during fall migration. The Complex provides a variety of grains (including corn, wheat, rye, milo, buckwheat) for waterfowl in varying amounts annually. Soybeans provide little wildlife value, but they add nitrogen to the soil and are sometimes planted for the farmer's share under the cooperative farming program. Crops are selected based on factors such as wildlife value, crop rotation needs, drought and flood tolerance, growing season, and ability to fix nitrogen. Other wildlife, such as deer and turkeys, can also benefit from the Refuge Complex crops.

Although agricultural grains can provide a high-energy carbohydrate source for wildlife, they provide only a portion of the total nutrients needed and therefore are only used as a supplement, not a substitute, for natural wetland foods. Crops planted for wildlife are generally low in protein and lacking in minerals and other nutrients that waterfowl need for good health. In fact, ducks fed an exclusive diet of corn steadily lose weight and after 100-120 days begin to die due to nutritional deficiencies. Wetland plants generally contain a better balance of nutrients. In addition, agricultural crops benefit only a limited number of wildlife species. Fredrickson and Taylor (1982) recorded 80 percent more species visiting managed moist-soil wetlands than fields of row crops. The diverse array of species in the seasonal wetlands included mammals, herons, rails, small passerines, and upland game birds.

Agriculture also is used on the Refuge Complex as a rotational tool to set back natural succession in wetlands. Unmanaged wetlands in the UMR floodplain can quickly convert to weeds, grassland, or forest depending on their elevation and the weather conditions during the growing season. Farming is one of the tools used to maintain long-term productivity of wetland units.

A third purpose of the agriculture program in the Complex is to maintain open conditions in units prior to conversion to another habitat type. Funding and staff constraints may delay desired habitat restoration (hardwood forest, grassland, wetland) for several years. If the areas are left idle, they can quickly grow up to thick stands of willow, cottonwood, and weeds. Nearly all areas on the Complex suitable for conversion to moist soil units have already been converted. This type of seasonal wetland is most scarce along the Middle Mississippi where the Complex will seek to acquire and reduce agricultural areas to increase seasonal wetland habitats and convert to wetlands where possible.

Goal 3. Other Terrestrial Habitats:

Protect, enhance, and restore other terrestrial habitats to benefit grassland birds, waterfowl, and neotropical migrants.

Considerations: Wet meadow and scrub-shrub cover types exist in the zone between wetland and terrestrial habitats and could be considered under either category. Both are treated under the terrestrial objective for purposes of this CCP. Wet meadows are often managed in conjunction with adjacent grasslands using similar techniques. Scrub-shrub habitats typically border existing floodplain forest. Both are treated under the terrestrial objective for purposes of this CCP.

Objective 3.A. Provide three large areas (>150 acres) of contiguous native grassland/wet meadow complexes on refuge divisions by 2010 to benefit migrating as well as declining nesting populations of grassland birds.

Strategies: Protect, enhance, and restore large grassland/wet meadow complexes on refuge units shown below:

Goal 3: Port Louisa NWR / Objective 3.A/ Strategies 3.A

Strategy No.	Unit	Acres Grassland	Acres Wet Meadow	Additional Information
3.A.1	Horseshoe Bend	807	634	Maintain native grasslands through mowing, prescribed fire, possible grazing, etc.

Goal 3: Great River NWR / Objective 3.A/ Strategies 3.A

Strategy No.	Unit	Acres Grassland	Acres Wet Meadow	Additional Information
3.A.2	Fox Island: Logsden Tract	71	11	Plant native grassland and wet meadow species on 90 acres of former farm fields adjacent to 400-acre MDC Rose Pond Conservation Area grasslands.
3.A.3	Clarence Cannon: WM-2	1	229	Experiment with managing unit as wet meadow habitat through prairie cordgrass plantings, water level manipulation, burning, exotic grass control.

Objective 3.B. Maintain 500 acres of smaller patches of grassland habitat where established for levee maintenance, cultural resource protection, or environmental education using techniques such as mowing, prescribed burning, and/or spraying of undesirable vegetation as needed (typically on a 3- to 5-year cycle).

Strategies: Maintain small grasslands on the following divisions:

Goal 3: Port Louisa NWR / Objective 3.B/ Strategies 3.B

Strategy No.	Unit	Acres	Additional Information
3.B.1	Keithsburg: Sand Prairie	1	Maintain with fire to promote natural diversity of dry prairie grasses/forbs. Site provides potential seed bank for future sand prairie restorations.
3.B.2	Keithsburg Levee	45	Burn periodically to maintain switchgrass.
3.B.3	Louisa 18 and 19	18	Maintain newly restored wet prairie grasses.
3.B.4	Louisa Sand Prairie	23	Water level control will be enhanced when strategy A.24 is implemented.

Goal 3: Port Louisa NWR / Objective 3.B/ Strategies 3.B (Continued)

Strategy No.	Unit	Acres	Additional Information
3.B.5	Louisa: Teaching Prairie	5	
3.B.6	Louisa: Trail Base	8	
3.B.7	Louisa: Michael Creek Levee	9	

Goal 3: Great River NWR / Objective 3.B/ Strategies 3.B

Strategy No.	Unit	Acres	Additional Information
3.B.8	Delair: Swan Lake grassland	45	Includes Field 1; native grasses have been established to protect cultural resources.
3.B.9	Clarence Cannon: Main perimeter levee, interior dikes	214	

Goal 3: Two River NWR / Objective 3.B/ Strategies 3.B

Strategy No.	Unit	Acres	Additional Information
3.B.10	Calhoun: Office Prairie	23	Established for environmental education purposes.
3.B.11	Calhoun: GL1	41	Convert crop ground to grassland if adjacent private land is acquired and converted to grassland.
3.B.12	Calhoun: GL-2, GL 3, GL-4	95	Convert cropland to grassland to provide buffer strips.
3.B.13	Gilbert Lake, west side of GL-1	43	Native grasses have been planted to protect cultural resources.
3.B.14	Gilbert Lake, east side of GL-1	17	Establish cool season grasses on eastern portion for green browse.
3.B.15	Gilbert Lake GL-2	13	Maintain cool season grasses to protect cultural resource area.

Objective 3.C. Provide a 6-year average of 400 acres of smaller wet meadow areas for marsh and grassland birds and spring foraging waterfowl using a combination of water level manipulation, mowing, discing, and burning. Water level manipulations may occur annually; other techniques are typically necessary on a 3- to 5-year cycle. Most sites border existing wetland or grassland units.

Strategies: Manage small wet meadow sites on the following divisions:

Goal 3: Port Louisa NWR / Objective 3.C/ Strategies 3.C

Strategy No.	Unit	Acres	Additional Information
3.C.1	Keithsburg	60	
3.C.2	Louisa	159	
3.C.3	Horseshoe Bend	50	Plant two 25-acre experimental seed bank plots near Rocky Road to prairie cordgrass capable of surviving on saturated floodplain soils. Plots are adjacent to existing large grassland areas.

Goal 3: Great River NWR / Objective 3.C/ Strategies 3.C.

Strategy No.	Unit	Acres	Additional Information
3.C.4	Delair	33	
3.C.5	Clarence Cannon	179	

Goal 3: Two Rivers NWR / Objective 3.C./ Strategies 3.C

Strategy No.	Unit	Acres	Additional Information
3.C.6	Gilbert Lake	7	Manage for the enhancement of Boltonia decurrens. Develop step-down management plan in consultation with Service endangered species specialist. control encroaching willow by mowing and discing as needed.

Objective 3.D. Provide a 6-year average of 450 acres of scrub/shrub habitat for waterfowl broods and neotropical migrants through a combination of water level manipulation, mowing, discing, and burning. Water level manipulation may occur annually; other techniques typically are necessary on a 3- to 5-year cycle. Most scrub/shrub sites occur naturally at the interface between wetland and forest, but may need management action to hold back succession.

Strategies: Maintain existing scrub/shrub habitat on the following Divisions:

Goal 3: Port Louisa NWR / Objective 3.D/ Strategies 3.D

Strategy No.	Unit	Acres of Scrub/shrub	Additional Information
3.D.1	Big Timber	3	
3.D.2	Louisa	81	
3.D.3	Keithsburg	175	

Goal 3: Great River NWR / Objective 3.D/ Strategies 3.D

Strategy No.	Unit	Acres of Scrub/shrub	Additional Information
3.D.4	Delair	36	
3.D.5	Delair	2	Potential to develop partnerships with adjacent landowners to enhance water control capabilities.
3.D.6	Clarence Cannon	86	
3.D.7	Fox Island	175	These areas have limited management capabilities but provide reliable scrub/shrub habitat.

Goal 3: Two Rivers NWR / Objective 3.D/ Strategies 3.D

Strategy No.	Unit	Acres of Scrub/shrub	Additional Information
3.D.8	Batchtown	40	

Goal 3: Middle Mississippi River / Objective 3.D/ Strategies 3.D

Strategy No.	Unit	Acres of Scrub/ shrub	Additional Information
3.D.9	Wilkinson Island	60	Potential for partnership with the local levee and drainage district to allow the development of seasonally flooded scrub/shrub wetlands near Reed's Creek.

Objective 3.E. Plant seed and browse crops to provide a dependable supplement to natural food sources for waterfowl, and to provide needed open-space resting areas. The amount and spacing of this refuge resource along the river corridor is based on historic concentration areas (bird use days) while considering surrounding conditions off-refuge including hunting pressures that may reduce utilization of habitats outside refuge sanctuary units. Approximately 1,000 acres will be planted annually Complex-wide.

Strategies: Plant seed and browse crops on the following units:

Goal 3: Great River NWR / Objective 3.E/ Strategies 3.E

Strategy No.	Unit and Fields	Annual Acres	Comments
3.E.1	Clarence Cannon: 14A, 14B, 14C, 15, 16	266	Use rotational cropping program on these fields on an annual basis. Fields will be monitored for bird use and evaluated for possible conversion to perched wetland, forest or grassland cover, also subject to future funding and staffing necessary to manage habitats currently maintained by cooperative farmers.
3.E.2	Delair: All designated cropland fields	325	Plant 300-400 acres annually on a rotational basis. Remaining fields will lie fallow 1-2 years to provide habitat diversity and reduce soil erosion and chemical usage. Flood farmed units periodically to enhance food availability for waterfowl. These agricultural units will be monitored for bird use and evaluations made regarding their suitability for conversion to perched wetland, forest and grassland covers, also subject to future funding and staffing necessary to manage habitats currently maintained by cooperative farmers.

Goal 3: Two Rivers NWR / Objective 3.E/ Strategies 3.E

Strategy No.	Unit and Fields	Annual Acres	Comments
3.E.3	Calhoun: AG-1a, 1b, 2	181	Utilize short season corn or harvest in strips in AG-1a to increase grain availability to migratory waterfowl, especially ducks.
3.E.4	Calhoun: AG-3, 4, 5	246	These agriculture units will be monitored for waterfowl use and evaluations made regarding their suitability for conversion to hard mast forest habitat.

Objective 3.F. Utilize agriculture as a management tool, as necessary, to maintain high-quality wildlife habitat in refuge wetlands by periodically setting back succession or invasion of undesirable species. Approximately 400 acres will be planted annually. Where practical, manage this temporary land cover type in a manner that provides supplemental food value as a secondary benefit.

Strategies: Use agriculture periodically to set back succession on the following units:

Goal 3: Port Louisa NWR / Objective 3.F/ Strategy 3.F

Strategy No.	Units	Total Unit Acres	Average Acres Planted Annually	Comments
3.F.1	Louisa: 2, 4, 6, 7, 8, 9, 10, 11, 21	326	80	Grassland and seasonally flooded areas average once every 4 years to set back succession.

Goal 3: Great River NWR / Objective 3.F/ Strategies 3.F

Strategy No.	Units	Total Unit Acres	Average Acres Planted Annually	Comments
3.F.2	Clarence Cannon: All non-forested wetland management units	2,285	300	Use cooperative farming program, rotated through all managed wetland units, to set back succession.
3.F.3	Delair: 4C, 7, 15A	68	20	Fields 4C and 7 planned for conversion to managed wetlands, if feasible.

Goal 3: Two Rivers NWR / Objective 3.F/ Strategies 3.F

Strategy No.	Units	Total Unit Acres	Average Acres Planted Annually	Comments
3.F.4	Calhoun: MSU 1-8	314	70	Use cooperative farming program, rotated through all managed wetland units, to set back succession.
3.F.5	Batchtown: MSU 1, 2, 3	84	20	

Objective 3.G. Use farming techniques to maintain 675 acres of open fields until they can be converted to another planned habitat type, such as on newly acquired lands. Conversion will occur by 2012.

Strategies:

Goal 3: Great River NWR / Objective 3.G/ Strategies 3.G

Strategy No.	Unit	Acres	Comment
3.G.1	Fox Island: Existing fields	675	Planned for reforestation through a combination of natural regeneration and hard mast tree plantings.

Goal 4 Discussion. Sedimentation and Water Quality

The two goals of increasing floodplain connectivity and reducing sedimentation are inherently at odds with each other. The sediment load in the river is deposited everywhere the waters can reach, particularly if the flow is slowed down. The main channel is designed to "self-scour" due to the rock training structures (wing dams) positioned in a perpendicular direction to flow on both sides of the shipping channel. All other locations are, by design, sediment traps. Eventually the result would be a river that includes nothing but a channel, which is not a healthy system. The problem is that adjacent areas that provide an open connection to the river provide a benefit to the river system itself, but can themselves be negatively impacted by the exposure to poor water quality. Each refuge division has been evaluated during this planning process regarding its degree of floodplain connectivity to the river. The value of a unit's contribution to floodplain connectivity was compared to the potentially negative impacts of exposure to artificial river level spiking and the associated influx of sediment and other pollutants. These evaluations must be site specific and include factors such as location in either open river or pooled river. In 1995, the National Biological Survey developed a plan, under the Quick Response program, for monitoring sedimentation rates on two units of the Complex that had experienced levee breeches. Reconstruction decisions included building a spillway to allow more frequent connections to the river during high water events. At different levels of connectivity it is predicted that proportional levels of sedimentation will occur. A plan was designed to measure the impact of several factors that may contribute to successional changes in habitats. Baseline data was gathered regarding status of floodplain forests on each unit, and the sedimentation rate on one. Higher quality water flowing down the river is the best solution for impacted riverine habitats.

Management Approaches

Although legislation has been passed that helps control contaminant discharges to the river, there are still accidents and illegal dumping in the UMR basin that affect water quality. But overall, the major pollutant inputs come from non-point sources, and include nitrates, phosphates and pesticides. Because there are no regulations to control over-application of fertilizers, anhydrous ammonia and chemicals to agricultural ground, landowners must act responsibly based on their own values and self-interests. Despite improved farm conservation practices in some locations (terraces, sediment retention basins, grassed waterways, filter strips riparian buffer strips, etc.), nutrients, contaminants and sediments still make their way to the Mississippi River.

The USDA offers several set-aside programs such as the Conservation Reserve Program (CRP), that assist farm owners and operators in conserving and improving soil, water, air, and wildlife resources by converting highly erodible and other environmentally sensitive land to a long-term resource-conserving cover. Highly erodible ground is planted with grasses or trees that help stabilize the soil, thereby decreasing erosion. When it was first introduced in the mid 1980s, the CRP was extremely popular and millions of acres of farm ground within the UMR basin were retired for 10 years. But as the easements expired, much of the cropground was returned to production. The current levels of CRP enrollment along the planning area are: Illinois 715,000 acres, Iowa 1.5 million acres and Missouri 1.4 million acres. Over 800,000 acres of the Iowa total are enrolled in the CRP continuous sign-up, which is directed toward decreasing erosion by including riparian buffer strips, grassed water ways, filter strips, contour buffers and shallow water impoundments.

Another USDA set-aside program is the Wetland Reserve Program (WRP), in which landowners are paid for permanent, 30-year or 10-year easements on cropground that is too wet to farm. These fields have been declared by NRCS to be converted wetlands, making them eligible for this program. Wetland restoration costs are also paid for in full by NRCS

for permanent easements, or cost-shared with the landowner for 30- and 10-year easements. Following record flooding on the Mississippi River, USDA offered landowners the opportunity to place permanent easements on flooded cropground through the EWRP, or Emergency Wetland Reserve Program. Hundreds of landowners accepted this offer and placed thousands of acres of floodplain cropground and converted wetlands into the program. Illinois currently has 21,382 acres (174 easements) protected by the WRP, EWRP and Emergency Watershed Programs. Iowa has 91,026 acres (826 easements) in EWRP and WRP, while Missourians have placed 65,480 acres into similar easements.

The Service is in partnership with USDA on these and other programs that affect UMR water quality. These efforts must be maintained at a minimum, but to make measurable differences on Complex resources these programs will have to be accelerated in targeted areas. Refuge land acquisition funds have been used to purchase the residual value of fee title lands along with the USDA payment for an easement of flood-prone farmland in the corridor. This has the benefit of stretching FWS funding through the partnership to acquire the lands that can be restored and contribute to water quality, habitat and floodplain goals. In some instances, landowners are attracted to an easement but don't want to hold lands they cannot farm and the Service partnership is necessary to complete an agreement to remove a flood-prone field from crop production efforts. Opportunities to partner with USDA will be a considered factor in prioritizing future land acquisition within the expanded Complex boundary.

An effort currently under way to try to slow down the eutrophication of river backwaters involves public and private interests from Minnesota, Iowa, Wisconsin, Illinois and Missouri that have developed a 10-year initiative to reduce the amount of sedimentation and nutrients entering the UMR. The Upper Mississippi River Stewardship Initiative, if funded, is to identify major sources of sediments and nutrients, target technical and financial assistance, develop and implement new solutions and to create a basin-wide monitoring network to coordinate public and private activities. The Complex refuges will be involved in initiatives such as this in the watershed in order to meet CCP goals and objectives.

Mark Twain Complex staff work with private landowners and other agencies to improve the water quality within the UMR basin through the Service's Partners for Fish and Wildlife (PFW) program. This program provides an avenue for refuge staff to interact with landowners and provide technical and cost share assistance for wetland and native grass restorations. Thousands of wetland acres have been restored throughout the UMR basin via private lands partnerships. This total acreage has little effect on the river itself due to scale. However, these efforts can make a measurable difference to refuge wetlands and other corridor resources when the projects are located on adjacent or nearby lands. Refuge staff will seek to expand these efforts in order to increase the scale of effect in UMR tributaries.

The Environmental Management Program (EMP) was legislated through the 1986 Water Resources Development Act. The COE, Service, USGS, and all five UMRS states are partners in the process of design, construction and evaluation of Habitat Rehabilitation and Enhancement Projects (HREPs), the largest component of the program. Goals of these projects include reduction of sediment deposition to backwaters, prevention of shoreline erosion and restoration of aquatic habitat for fish and migratory waterfowl. Several projects contain upland components aimed at reducing hillside erosion into backwater units of the AEC. To date, more than 60,000 acres of UMRS fish and wildlife habitat have been restored, protected or enhanced through HREPs. The WRDA was re-authorized by Congress in 1999 providing for continuing river water quality improvements and restoration projects. The Complex will remain an active partner in the EMP and will

attempt to utilize the program authority to accomplish the appropriate goals and objectives of this plan. In addition, the COE has coordinated with the Service and made many modifications to river structure in the past decade that are intended to restore side channel habitats through their channel maintenance program.

Goal 4. Sedimentation and Water Quality:

Identify and reduce the impacts of sedimentation and other water quality factors, such as contaminants, on fish and wildlife resources.

Objective 4.A. Continue current and develop new partnerships with government agencies and private landowners to reduce the effects of erosion and contaminant runoff affecting fish and wildlife resources in the Upper Mississippi River watershed.

Goal 4: Mark Twain NWR Complex / Objective 4.A/ Strategies 4.A

Strategy No.	Strategies	Comments
4.A.1	Work in partnership with NRCS to encourage private landowners to adopt sustainable agricultural practices within the UMR watershed through programs such as CRP.	Practices include conservation tillage, terraces, sediment control basins, etc.
4.A.2	Work in partnership with agencies and private landowners to encourage wetland restoration projects through programs such as PFW, WRP, EWRP, etc.	
4.A.3	Work in partnership with agencies and private landowners to encourage restoration of terrestrial habitat through programs such as CRP, FSA easements, etc.	
4.A.4	Provide technical and financial assistance for watershed improvement projects on targeted tributaries such as the Iowa River Corridor, Fox River and Michael Creek.	Specific attention will be given to watersheds that affect Refuge lands.
4.A.5	Continue coordination with NRCS to identify landowners within the Refuge acquisition boundary who are willing to participate in a WRP easement if they can sell the residual value to a third party.	Leverage Service land acquisition dollars with NRCS easements.
4.A.6	Work with partner agencies to promote Environmental Pool Management to consolidate flocculent bottom sediments and improve overall habitat quality.	
4.A.7	Ensure that appropriate Refuge personnel are trained to assist with interagency spill response efforts on the River.	

Objective 4.B. Reduce sedimentation and improve overall water quality on Refuge System lands by 2010 for the benefit of fish and wildlife populations.

Goal 4: Objective 4.B / Strategies Common to All Complex Refuges

Strategy No.	Division	Strategies	Comments
4.B.1	All	Complete Containment Assessment program (CAP) reports on Refuge divisions that have not yet been assessed. Includes Louisa, Big Timber, Clarence Cannon, Long Island, Batchtown, and Delair.	Requires assistance of Rock Island Ecological Services Office Contaminants biologist.
4.B.2		Analyze ditch runoff for contaminants at points that enter Refuge divisions.	Use Service Contaminant Assessment Program and GIS models to assist with this effort.
4.B.3		Partner with COE and states to develop and construct habitat restoration projects to improve water quality through authorities such as EMP, 1135, etc.	
4.B.4		Evaluate identified tracts within Refuge expanded boundary proposal for each site's potential to contribute to nutrient recycling and other water quality improvements.	Evaluation used for land acquisition priority and site development plans.
4.B.5		Use integrated pest management techniques to address invasive species issues, where practical.	
4.B.6		Ensure that an updated Spill Prevention, Control and countermeasure Plan is available for each Refuge.	

Goal 4: Port Louisa NWR / Objective 4.B / Strategies 4.B

Strategy No.	Division	Strategies	Comments
4.B.7	Keithsburg	Create "No Wake Zone" to reduce shoreline erosion and decrease turbidity.	
4.B.8		Reduce contaminant and nutrient loading by creating a treatment wetland north of the Spring Slough Road.	Treating non-point source pollution prior to its reaching the rest of the Division will slow down the nutrient loading process.
4.B.9		Dredge deep water areas to prevent low dissolved oxygen levels during drawdowns.	

Goal 4: Port Louisa NWR / Objective 4.B / Strategies 4.B (Continued)

Strategy No.	Division	Strategies	Comments
4.B.10	Louisa	Create "No Wake Zone" to reduce shoreline erosion and decrease turbidity and wildlife disturbance.	All navigable waters north of Lake Odessa State Game Area.
4.B.11	Big Timber	Create "No Wake Zone" to reduce shoreline erosion and decrease turbidity and wildlife disturbance.	
4.B.12	Horseshoe Bend	Create "No Wake Zone" to reduce shoreline erosion and decrease turbidity and wildlife disturbance.	Access primarily during Iowa River high water periods.
4.B.13	All Divisions	Allow commercial fishing (by special use permit only) to reduce exotic fish populations.	Reduction of exotic fish numbers to improve water clarity and enhance growth of aquatic vegetation.

Goal 4: Great River NWR / Objective 4.B/ Strategies 4.B

Strategy No.	Division	Strategies	Comments
4.B.14	Clarence Cannon	Develop a program to monitor water quality and sedimentation during flooding resulting from the increased connectivity to the River due to the lowered spillway.	
4.B.15	Clarence Cannon	Conduct comprehensive contaminant survey of wetlands to identify potential water quality or sediment contaminant issues.	Preliminary sampling conducted in the 1980s indicated potential problems.
4.B.16	Long Island	Dredge lower O'Dell Chute and construct closing structure at head of chute to reduce sediment loading and provide deep water fisheries habitat.	HREP feature. Monitoring efforts will be needed to assess changes within this system.
4.B.17	Delair	Conduct comprehensive contaminant survey of wetland to identify water quality or sediment contaminant issues.	A cement plant that burns chemical wastes is located in the vicinity.

Goal 4: Two Rivers NWR / Objective 4.B/ Strategies 4.B

Strategy No.	Division	Strategies	Comments
4.B.18	Calhoun	Draw down Swan Lake periodically to consolidate flocculent bottom and thereby reduce the effects of sedimentation.	
4.B.19	Batchtown	Dredge deep water holes to improve water quality (low dissolved oxygen) for fish.	HREP project features.

Goal 4: Two Rivers NWR / Objective 4.B/ Strategies 4.B (Continued)

Strategy No.	Division	Strategies	Comments
4.B.20	Gilbert Lake	Dredge deep water holes to improve water quality (low dissolved oxygen) for fish.	

Goal 4: Middle Mississippi NWR / Objective 4.B/ Strategies 4.B

Strategy No.	Division	Strategies	Comments
4.B.21	Harlow Island	Dredge side channel areas to improve water quality (low dissolved oxygen) and overwintering habitat for fish.	
4.B.22	Wilkinson Island	Dredge side channel areas to improve water quality (low dissolved oxygen) and overwintering habitat for fish.	

Goal 5 Discussion. Floodplain Management

Natural River Hydrologic Cycle

Periodic flooding and drought are characteristic features of large river floodplain ecosystems, including the Mississippi. These changing water levels are the major force responsible for maintaining the complex physical structure, and rich plant and animal diversity of the river system. In free-flowing rivers, floods create an ever-changing system of sloughs, islands, sandbars, and backwaters. Some habitats, such as patches of mature floodplain forest, are destroyed by floods while others, like sand islands, are created; but over time, the river maintains a balance between these various habitats. Not only is periodic flooding important, but also low water periods and occasional droughts are essential for a healthy, dynamic floodplain river system. The timing and duration of high and low water levels are critical for productive fish and wildlife habitat.

Low water levels in the summer allow wetlands to dry out, which consolidates mucky bottoms and encourages the growth of wetland vegetation. The vegetation in floodplain wetlands and the associated invertebrates provide important feeding and resting areas for migratory birds during fall and spring migration. Fish use flooded vegetation for spawning and feeding areas during spring high water events. The wetlands also absorb nutrients, sediments, and floodwaters that otherwise would be carried downstream. These functions improve water quality and reduce flood height.

River Modifications and Modified Hydrology

Historically, the Mississippi River fit this model of a free-flowing, ever-changing system of riverine and floodplain habitats. However, as the River became an increasingly important travel and trade route, Congress began authorizing a series of navigation improvements to be implemented by the Corps of Engineers. Wingdams, closing structures, and a series of locks and dams were built to constrict the channel and control its depth. The COE also was given flood control responsibilities and began building levees to protect agricultural lands and growing cities. These changes to the natural flow of the river have created a reliable 9-foot-deep navigation channel and have increased protection from flooding in most of the

historic floodplain. While some flow management structures are advantageous to fish, the overall navigation and flood control systems have altered the natural river hydrology in a manner deleterious to pre-project native fish and wildlife habitat.

Flood control levees have isolated the river from much of its floodplain. The levees act like lateral dams, effectively eliminating the floodplain from normal high water. This loss of floodplain connectivity prevents the creation of new wetlands, prevents the deposition of nutrient-rich sediment, and reduces the amount of fish spawning and nursery habitat. Levees protect about 3 percent of the floodplain north of Rock Island, 50 percent of the floodplain between Rock Island and St. Louis, about 80 percent of the floodplain south of St. Louis, and 60 percent of the floodplain on the Lower Illinois River. Channelization has cut off river meanders and isolated side channel and backwater habitats. Loss of a functional floodplain not only affects the ecosystem, but also significantly impacts its ability to store and convey flood waters. The water between the levees has nowhere to go but up, which raises flood elevations downstream by forcing the waters to pass through a narrow opening between the levees. Flood heights have increased over time, and the number of days water elevations are above flood stage also is increasing. Present-day floods on the Mississippi River at St. Louis tend to be 9 feet higher than historic floods. A plot of the 10 greatest floods at St. Louis shows they were all recorded after 1942. In the last 60 years, a major flood (at least 12 feet above flood stage) has occurred at St. Louis about once every 6 years on average (Galloway).

Prior to human modification of the hydrograph, floods normally occurred in the spring and fall, wetlands dried out in the summer, and changes in water levels were fairly gradual. Floodplain flora and fauna were adapted to these water level variations. Now, however, the lock and dam system has created a series of navigation "pools" resembling shallow reservoirs, so many areas that used to dry out during the summer months are now permanently flooded. In addition, water level fluctuations from upstream dam releases are now more rapid and irregular with sharper increases and decreases. Rooted aquatic plants find it extremely difficult to germinate and grow under these conditions, leaving many shallow areas devoid of vegetation. Sudden dam releases can leave fish stranded in upstream backwaters. And in areas with permanently higher water levels, many mature forests have died, reducing species diversity and developing into monocultures of silver maple.

Dams also can adversely affect migration of fish between pools on the UMR. A total of 25 species are either known to be migratory in the UMR or are probably migratory, based on their behavior in other river systems. Upper Mississippi River migratory fishes include lake sturgeon, shovelnose sturgeon, paddlefish, skipjack herring, bigmouth and smallmouth buffalo, blue sucker, and blue, channel, and flathead catfish. Lock and dam 19 presents a complete barrier to fish passage. Other locks and dams can allow limited fish passage for some species either through the locks with barges or through the dams during open river conditions. Restricted fish passage and limited geographic range may reduce the size and health of some fish populations. Hydraulic conditions, migratory fish behavior, and potential operational changes and structural modifications at the dams are all being studied to develop alternatives for improving fish passage in the UMR.

Increased sedimentation is another major cause of deteriorating fish and wildlife habitat in the UMR. Impoundment, channelization, agriculture, and development have all played a role in drastically altering the River's sediment transport mechanisms. While impoundment for navigation created a variety of backwater and side channel habitats, these dams also slowed river currents, increasing the retention of sediment. Runoff has increased because water storage in the watershed has been reduced by drainage of wetlands, urbanization, and other factors. Thousands of square miles of historical wetlands,

prairies, and forests have been converted to agricultural and urban areas, increasing the velocity and erosiveness of waters flowing through the watershed. Sediment from soil erosion reduces water clarity, fills backwaters, prevents the growth of aquatic vegetation, and destroys fish spawning and overwintering habitat.

Floodplain Management and the Flood of '93

The negative effects of navigation, flood control, and development on the UMR were becoming apparent by the 1970s. The natural hydrology had been altered so that the Mississippi was no longer a free-flowing river. In this altered state, connectivity of the river to its floodplain could actually be detrimental to wetland habitat due to unnatural water level fluctuations and high rates of erosion and sedimentation. On the other hand, completely isolating the floodplain from the river with high levees prevented the inflow of nutrients, cut off important fisheries habitat, and increased flood heights.

Federal and state land managers began examining ways to balance the need for floodplain connectivity with the need for high quality, reliable fish and wildlife habitat. Spillways in levees would reconnect the floodplain to the river more often and reduce the chances of repeated levee breaks. Facilities and development in the floodplain could be reduced to minimize flood damage costs. Farming programs (and associated erosion and chemical use) on public lands subject to frequent flooding could be reduced. And marginal agricultural land in the floodplain could be purchased and reconnected to the river.

The record-setting 1993 Midwest flood accelerated the move toward a more balanced floodplain management approach. The ‘93 flood was notable for its extent, duration, and volume of runoff. During nearly the entire growing season, from April 1 to Sept. 30, 1993, the Mississippi River remained above flood stage at St. Louis. The Upper Mississippi, Lower Missouri, and Illinois rivers experienced extensive damage to training structures and levee systems. It was one of the most damaging floods in the nation's history, causing billions of dollars in damages and displacing thousands of people.

Negative ecological effects of the '93 flood included water-quality degradation by massive inputs of agricultural chemicals, sewage, livestock waste, and industrial and household chemicals; high tree mortality in floodplain forests; the loss of wetland plant production to support migratory waterfowl, and the drowning of mammals, reptiles, and amphibians as levees were breached and levee districts flooded overnight. However, the extended flood pulse was beneficial to fish as they regained access to the floodplain. Aquatic insects flourished on the decaying plants and fish moved in to feed on the abundant food resources and to spawn in the expanded habitat.

Some areas were so damaged by the '93 flood that there was uncertainty as to whether these lands could, or should, be restored to pre-flood conditions. National attention was focused on the need for an integrated approach to floodplain management; an approach that balances flood protection and economic development with the need to reduce flood damage, enhance fish and wildlife habitat, and reconnect the river to its floodplain.

Mark Twain Complex Floodplain Management

The Complex refuges will continue to be managed using an integrated approach to floodplain management. When making floodplain management decisions within the AEC, refuge managers will consider a range of desirable options including:

- Connecting the river to its floodplain.
- Reducing backwater sedimentation.
- Managing water levels to re-create natural wet/dry cycles.

Table 10: Connectivity and Sedimentation, Mark Twain NWR Complex

Refuge	Division	Acres (From GIS Data)		
		Open to River	Levee with Spillway (Connectivity Every 1 to 5 Years)	Major Levee
Great River	Fox Island	2,019	0	90
	Long Island	6,300	0	0
	Delair	0	0	1,737
Clarence Cannon		150	3,600	0
Two Rivers	Cahoun	0	4,836	0
	Gilbert Lake	0	736	0
	Batchtown	1,149	995	0
	Portage Islands	230	0	0
Port Louisa	Big Timber	1,758	0	0
	Horseshoe Bend	2,606	0	0
	Keithsburg	0	1,400	0
	Louisa	0	2,609	0
Middle Mississippi	Harlow Island	1,224	0	0
	Wilkinson Island	2,532	0	0
	Meissner	78	0	0
Total	34,049	18,046	14,176	1,830

- Reducing agriculture and facilities in flood-prone areas.
- Promoting partnerships and interagency coordination to encourage a balanced floodplain management program throughout the AEC.

All of these options cannot be applied to every Division. Decisions on how to manage each unit are based on local and system-wide habitat needs; area elevation, geomorphology and landscape features; authorized purposes of the unit; political and social considerations; and funding limitations.

Connectivity and Sedimentation

The divisions of the Complex have varying amounts of water level control, flood control, and floodplain connectivity. Some divisions are completely open to the river and its flood pulses; others are partially protected by levees with spillways; and two divisions (Delair and Louisa) receive protection from major levees constructed by the COE and private agricultural drainage districts prior to Service acquisition (Table 10).

Wilkinson Island, Harlow Island and Horseshoe Bend are primarily former agricultural lands purchased fee title after the '93 flood. Existing levees on these Divisions were not repaired following acquisition, so an additional 6,400 acres now are open to the river at these units. Big Timber, Long Island, Portage Islands and the upper end of Batchtown also have complete connectivity to the river. This plan includes factors and priorities for

additional land acquisition within the AEC. One factor considered in selecting tracts is the ability to restore river connectivity. Complete connectivity provides unrestricted high water fisheries access and flood storage, but also gives managers no ability to control water levels and often results in high rates of sedimentation.

Keithsburg, Clarence Cannon, Gilbert Lake, Calhoun, and the lower end of Batchtown are protected by levees of varying heights with spillways that overtop during floods. These spillways provide periodic river connectivity during 1-year to 5-year flood events, but still provide protection from the artificial daily fluctuations caused by the lock and dam system. Other benefits of the levee/spillway system are reduced sediment input into the divisions, reduced likelihood of a levee breach during flood events, and the ability to manage wetland water levels during years of normal river flow. This spillway concept balances the need for floodwater storage with the need to provide high quality wildlife habitat through continued management programs on the Refuge Complex.

Since it was purchased in 1964, the main perimeter levee of Clarence Cannon NWR had been overtopped or breached an average of once every 5 years until 1993. The record '93 flood also caused record damage to the levee, resulting in 16 levee breaks. The decision was made to repair the breaks, but also to construct an 800-foot spillway in the levee. Since the spillway was constructed in 1995, the river has overtopped three times, in the spring of 1996, 1998 and 2001. Each time the Refuge was entirely flooded to an average depth of 4-6 feet. Because this spillway project was precedent setting with uncertain long-term effects, ongoing monitoring will examine frequency of flooding, sedimentation rates, habitat quality in wetlands and moist-soil units, and effects on fish and wildlife resources. As waters slowly receded following the 1996 and 1998 floods, tremendous numbers of fish fry were observed being released into the river. Future monitoring will include efforts to quantify this potentially significant benefit to fisheries resources.

The Swan Lake Habitat Restoration and Enhancement Project (Calhoun Division) provides another example of the balanced approach to river connectivity that has been implemented at the Complex. Prior to the project, Swan Lake had been completely open to the river and was filling rapidly with sediment. Between 1940 and 1990, the average sedimentation rate was 0.5 inch per year. Sedimentation and uncontrolled flooding had also caused the loss of almost all wetland vegetation. As part of the restoration, a levee was constructed to enclose the lake, gain some control of water levels, and reduce sediment input. A spillway was constructed in the levee to provide regular river connectivity during floods.

In order to create greater habitat diversity, the Service-managed portion of the lake was divided by a cross-dike into two compartments to allow some independent management options. The stoplog structure in lower Swan Lake will be open to the river during most years for complete floodplain connectivity and fish access. The middle Swan Lake structure will normally be closed to the river to allow more control over water levels and to promote the growth of wetland plants. Both units will flood when the river rises, which will only be during the spring runoff period. Both units will also be completely drawn down periodically to consolidate bottom sediments and reduce water turbidity. Habitat and wildlife responses will be monitored and the water management regime will be modified as necessary to achieve the best mix of backwater aquatic habitat types.

Re-creation of Natural Wet/dry Cycles

In order to meet its main purpose (migratory bird habitat), the Complex simulates natural water level fluctuations on units where some level of water control is possible. This managed flooding usually involves re-creating fall and spring wet periods and the summer

dry cycle. Stoplog structures, gates, pumps, and gravity flow are used to control water levels. The levees on these units keep out the unnatural water level changes caused by dam flow regulation.

Reduction of Farming and Facilities in the Floodplain

Farming in the floodplain has been reduced on refuge lands since the 1970s. At that time, management emphasis started shifting to enhancement of wetlands, forests and grasslands that provide natural foods and habitat for a greater diversity of wildlife species. Reduction of farming in low, frequently flooded areas has also reduced crop loss, soil erosion, and chemical use. Farming will be reduced further with implementation of this plan. The goal is not to eliminate farming completely, but to farm only enough to support migratory waterfowl and manage other habitat. Former croplands will be restored to wetlands, forests, or other native flood-tolerant habitats. Acquisition of other flood-prone areas in the AEC will contribute to the floodplain goals and objectives listed in this section, as well as the Habitat and Water Quality goals.

Repair of flood-damaged roads, signs, and other facilities is costly, so they will be constructed outside of frequently flooded areas whenever possible. When facilities are necessary at lower elevations, they will be simple and designed to be flood-resistant to reduce repair costs following floods.

Partnerships and System-wide Floodplain Management

The Complex will work with the States, COE, other organizations, private landowners, private organizations, and the public to encourage a balanced floodplain management program on a system-wide level beyond the immediate refuge boundary. Environmental pool management (EPM), for example, is an interagency partnership to modify dam operations for fish and wildlife benefits within entire navigation pools. Modification of water release schedules for navigation dams can benefit plants and animals over extensive reaches of the river and floodplain, beyond single moist soil units or even individual refuges. The Service is working with the COE and the States to promote improved water level management on a pool-wide scale. (See Environmental Pool Management in the Management Considerations Section)

As another example, the Service is partnering with the COE and the States of Illinois, Missouri and Iowa to develop comprehensive “pool plans” for each of the navigation pools. A similar effort is under way on the un-pooled Middle Mississippi River, which is extensively leveed but not impounded by navigation dams. The plans will look at overall floodplain needs within each pool and throughout the system and recommend areas for habitat restoration projects, river connectivity improvements, and land acquisition needed to facilitate these projects.

Other Considerations

Fish and Wildlife Service policy recognizes that intensive habitat management is sometimes necessary in highly altered ecosystems. Under guidelines set out in a 2001 Service Manual chapter (601 FW 3: Biological Integrity), refuges will be managed to maintain biological integrity, natural biological diversity, and environmental health by restoring or replicating natural conditions. In highly modified ecosystems where natural conditions cannot be restored, the Service favors management actions that mimic natural ecological processes, even when intensive actions and technological methods may be required. Within the UMR system, where natural flooding regimes have been eliminated as a result of altered hydrology, Complex refuges will continue to use water control structures, pumps, and delivery canals to re-create historic flooding cycles where feasible.

Because of the unpredictability of the river and variations between refuge units, not every refuge division can produce ideal habitat for every species of fish and wildlife every year. As stated by Sparks, Nelson, and Yin (1998), "Adaptive management recognizes that the structure and function of natural and restored systems vary across space and time; indeed that variation (disturbance regime) is required to maintain many ecosystems." For example, drought years may result in poor fish spawning and recruitment, but good wetland plant growth due to increased ability to dry out backwaters. And flood years may result in poor growth of wetland plants, but great fish spawning and recruitment. If enough habitat is available in the floodplain, then "most species' habitat requirements will be met somewhere, if not on the same site every year." This level of variation and change is natural and desirable in large river floodplain ecosystems. Therefore, the desired outcome of floodplain management for the Refuge Complex is not to create a static system, but to restore river function according to this concept of dynamic equilibrium.

Goal 5. Floodplain Management:

Enhance floodplain functions and, where practicable, mimic historical water level fluctuations in the river corridor.

Objective 5.A. Conduct activities and promote partnerships and interagency coordination that encourage a balanced floodplain management program throughout the AEC.

Goal 5: Mark Twain NWR Complex / Objective 5.A/ Strategies 5.A

Strategy No.	Strategies
5.A.1	Promote adoption of Environmental Pool Management (EPM) in the pooled portions of the River to recreate natural wet and dry cycles. Work to acquire privately owned lands from willing sellers necessary to move pool control "hinge points," or other actions to remove obstacles in order to facilitate this management approach.
5.A.2	Participate in interagency development of habitat improvement plans for pooled and unpooled River reaches in a manner that also contributes to other Complex goals, such as floodplain management and water quality.
5.A.3	Partner with COE, states and non-governmental organizations to develop and construct habitat restoration projects to enhance habitat, water quality, and floodplain management through possible funding sources and authorities, such as EMP, Section 1135, Avoid and Minimize, Ducks Unlimited, Marsh, North American Waterfowl Management Plan, WRP, etc.
5.A.4	Work in partnership with NRCS to encourage primate landowners to adopt sustainable agricultural practices within the UMR watershed through programs such as CRP or WRP on their most erodible ground, and to promote other conservation practices in basin uplands.
5.A.5	Participate in COE dredged material management program to enhance system topographic and bathymetric diversity, and other floodplain functions.
5.A.6	Explore solutions to fish passage through COE locks and lateral obstructions, such as levees, drain pipes and water control structures, to enhance migration and spawning opportunities for big river fish species.
5.A.7	Work on AEC system waters to reduce the impacts of sedimentation through the location of river training structures (wing dams, etc.) that direct flows in a manner that creates or maintains diversity in areas that would otherwise fill with fine silt or coarse bed-load material.
5.A.8	Encourage the COE to utilize their full operation authorities to minimize artificial spikes in river levels throughout the year.

Goal 5: Mark Twain NWR Complex / Objective 5.A/ Strategies 5.A (Continued)

Strategy No.	Strategies
5.A.9	Acquire up to 27,659 acres of floodplain lands from willing sellers during the 15-year planning period that will contribute to restoring floodplain function and improve the habitat and water quality conditions within AEC and downstream areas.
5.A.10	Work with Ameren/Union Electric on improving river conditions and the privately owned Pool 19.

Objective 5.B. Manage refuge lands for wildlife first, while considering UMR floodplain functions and contributing to improving those values.

Goal 1: Mark Twain NWR Complex / Objective 5.B/ Strategies 5.B

Strategy No.	Strategies
5.B.1	Evaluate effects of Refuge management activities on sedimentation, water quality, wetland vegetation, and fish passage. For example, monitor floodplain function factors of Keithsburg and Clarence Cannon spillways, and the lower Swan Lake water control structure.
5.B.2	Evaluate identified tracts within Refuge expanded boundary proposal for each site's potential to contribute to nutrient recycling, River connectivity as well as potential habitat improvement.
5.B.3	Restore backwater and side channel habitat on Refuge lands. Increase bathymetric diversity, including fish overwintering habitat.
5.B.4	Manage wetland impoundments to recreate natural wet/dry cycles where possible.
5.B.5	Continue to study River hydrology to evaluate the feasibility of improving connectivity at Refuge units with some level of levee protection while monitoring high-quality wetland or other habitats. Use of 1- to 10-year flood level spillways at locations such as Keithsburg Division or some newly acquired areas.

Goal 6 Discussion. Public Use and Education

In 1962, the Refuge Recreation Act authorized recreational uses of national wildlife refuges when such uses do not interfere with the primary purpose of a refuge. In 1966, the National Wildlife System Administration Act established a "compatibility standard" for allowing public uses on refuges. This Act introduced for the first time the requirement only "compatible uses" would be permitted on refuge lands. However, standards that would guide Refuge Managers on the implementation of this requirement throughout the National Wildlife Refuge System in a consistent manner were not developed until the mid-1980s. In 1997, Congress passed the National Wildlife Refuge Improvement Act (RIA) which spoke more specifically to the compatibility issue. It reinforced the requirement that no refuge use, including some non-recreational uses, may be allowed unless it is first determined to be compatible by the refuge manager. A compatible use was defined as a use that, in the sound professional judgment of the Director, will not materially interfere with or detract from the fulfillment of the mission of the System or the purposes of the refuge. The term 'sound professional judgement' means the determination is consistent with principles of sound fish and wildlife management and administration, available science and resources, and adherence to applicable laws.

Refuge Purpose Statements are primary to the management of each refuge within the System. The Purpose Statement is derived from the legislative authority used to acquire specific refuge lands and is, along with Refuge System goals, the basis on which primary

management activities are determined. Additionally, these statements are the foundation from which "allowed" uses of refuges are determined through a defined "compatibility process." Purpose Statements for Mark Twain Refuge Complex:

- "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds...", 16 U.S.C. - 715d (Migratory Bird Conservation Act)
- "... shall be administered by [Secretary of the Interior] directly or in accordance with cooperative agreements .... and in accordance with such rules and regulations for the conservation, maintenance, and management of wildlife, resources thereof, and its habitat thereon, ...", 16 U.S.C. - 664 (Fish and Wildlife Coordination Act)
- "... suitable for- (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ...", 16 U.S.C. - 460k-1 (Refuge Recreation Act)
- ".... the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ...", 16 U.S.C - 3901(b) 100 Stat. 3583 (Emergency Wetlands Resources Act of 1986)
- "....for conservation purposes", (1985 Food Security Act in conjunction with the transfer of Farm Service Agency, formerly Farmers Home Administration, property)

The Refuge Manager also has the authority and responsibility on Service fee title lands to deny any use, regardless of compatibility, if it is deemed an inappropriate use on the refuge for other reasons. The same authority and responsibility applies to General Plan lands unless the issue relates to an authority retained by the Corps of Engineers, as defined by the Cooperative Agreement.

The 1997 Refuge Improvement Act gives priority to certain wildlife-dependent recreational uses of national wildlife refuges when compatible. The Act states that, first and foremost, the purpose of the National Wildlife Refuge System should be focused on wildlife conservation. Because the legislation states that each refuge shall be managed to fulfill both the mission of the Refuge System and the individual refuge purposes, Congress recognized that certain public uses should take priority and would not detract from the Refuge System's mission of wildlife, fish and plant conservation. These wildlife-dependent recreational uses are hunting, fishing, wildlife observation and photography, and environmental education and interpretation.; they are commonly referred to within the Service as the "Big 6." These uses are deemed by the legislature to be programmatically legitimate and appropriate public uses on refuges, conditioned that they are dependent upon healthy wildlife populations, and are found to be compatible.

Wildlife viewing and hunting within the UMR ecosystem provide a significant economic benefit to the five-state region. Direct retail sales associated with hunting and viewing total over $670 million (Black et al., 1999). An economic study sponsored by the FWS found that non-consumptive use of wildlife at refuges generated more economic activity than hunting and fishing. Nationally, non-consumptive wildlife users generally stay for shorter periods of time and spend less, but their numbers at many refuges far exceed those of hunters and anglers (Laughland 1997). Within the Complex, each of these uses can be accommodated to various degrees.

Not every division in the Complex is open to all six wildlife-dependent public uses. Some refuge divisions are open year-round for public use (e.g., Big Timber, Long Island), while the Delair Division is closed year-round to all public use, except for specific events, as a condition of its acquisition from the previous owners. Many of the divisions are closed to public access in the fall and early winter to provide sanctuary for migratory birds.

The Mark Twain Complex Refuges are located in more rural regions of Iowa, Missouri and Illinois. However, each Refuge is within 50 miles of a metropolitan area. Two Rivers NWR, Great River NWR and Middle Mississippi River NWR are near St. Louis, and Port Louisa NWR is near the Quad Cities (Moline and Rock Island, Illinois, and Davenport and Bettendorf, Iowa). Tourism is increasing within the UMR corridor (Black et al., 1999), which provides additional opportunities for wildlife education and interpretation. The Great River Road, a network of federal, state and county roads covering 3,000 miles, which parallels the Mississippi River, passes very close to each refuge. Each office has an inadequate visitor contact station and public use/education activities account for no more than 10 to 15 percent of staff members' job duties at current staffing levels.

In general, the only sites where interpretive panels are currently found include the refuge headquarters and trails on higher ground. Because most of the land managed by the Complex is found within the Mississippi River floodplain, care must be exercised regarding the building of structures (observation decks and platforms) due to the impacts of flooding. Sign and structure maintenance and replacement caused by floodwater stains and rotting wood could be time-consuming and costly if these facilities are inappropriately located. In this plan, new observation decks and interpretive signs are being proposed at several divisions at optimal, higher elevations. Each refuge recreation program will be conducted in a manner that is compliant with Americans with Disabilities Act (ADA).

Bird and wildlife viewing have become increasingly popular in America. Since about 40 percent of all waterfowl in North American rely on the Mississippi Flyway, the opportunities for the public to visit Complex Refuges and view waterfowl and other migrating birds is great. Designated hiking trails on the Mark Twain Complex are currently limited, but visitors can walk, bike and/or drive their cars on service roads within several divisions during open seasons. The development of several new trails are proposed in this plan, while most other areas are opened but undeveloped for this use. There are currently no specific facilities on the Complex for photography, although visitors are encouraged to participate in this use along with their wildlife viewing and bird watching activities. Wildlife and environmental education programming has been limited due to staff availability, but each station has conducted special events or field trips on an opportunistic basis.

Hunting and fishing regulations that were in place for the 2000-2001 season are summarized below for the Complex. Any major changes or additions to the existing refuge program are listed in the Public Use strategies tables that follow. However, these programs are reviewed annually with regulations published and distributed locally. Future minor adjustments to the program will be addressed in this manner and will not trigger a revision process of this plan.

Recreational fishing is permitted on 13 refuge divisions. Clarence Cannon NWR and Delair Division are the only two units closed to fishing (except fishing by boat in Bryants Creek is permitted on Clarence Cannon NWR). Fishing is permitted year-round on Big Timber, Long Island, Harlow Island and Wilkinson Island Divisions in accordance with state seasons and regulations. Bank and/or boat fishing is available at all other divisions during designated times.

Big game (deer) hunting is permitted on seven divisions. Big Timber, Long Island and Wilkinson Divisions are open in accordance with state seasons and regulations. The Fox Island and Horseshoe Bend Divisions have been open for late state seasons. Archery hunting is permitted at Harlow Island Division. A special muzzleloader deer hunt is offered by special permit only on the Great River NWR, Delair Division. The deer hunt on Delair Division was specifically instituted in 1991 to try to improve habitat conditions within the unit, which is otherwise closed to all public use. A managed hunt was initiated on Clarence Cannon NWR in January 2002 to help control an expanding deer population. Similar hunts may be necessary on other refuge divisions as a habitat protection measure due to increasing midwestern deer populations. Potential opportunities for disabled hunters or youth hunts will be explored for specially conducted hunts.

Upland game such as Pheasants, rabbits, squirrels, Quail and Turkey may be hunted in accordance with state seasons and regulations on Big Timber, Long Island, Harlow Island and Wilkinson Island Divisions. Fox Island, Horseshoe Bend and Keithsburg Divisions are open with restricted seasons or limited species. All refuge divisions are closed to nighttime hunting of furbearers. Hunters must possess and use only non-toxic shot while hunting all permitted birds, except Wild Turkeys. Lead shot may be used for hunting Wild Turkeys.

Waterfowl hunting is permitted on Big Timber, Long Island and Wilkinson Island Divisions. At the Big Timber Division hunters have applied hunting areas by entering a lottery to build a season-long “permanent” blind. This practice began in 1991 due to competition between parties for certain spots. Elimination of seasonal blinds is proposed at the division in this plan by 2004. Instead, waterfowl hunters will be permitted temporary daily concealment or boat blinds that would be removed following the day's hunt. Migratory waterfowl hunting is permitted on the Long Island Division, but is permitted only from blinds constructed on sites posted by the Illinois DNR. Portable blinds are permitted for migratory waterfowl hunting on the Wilkinson Island Division, but they must be removed at day's end.

Although allowed under provisions of some state fishing or hunting license regulations, the taking of turtles and frogs is prohibited on all Refuge Complex Divisions.

By policy, refuges prepare visitor services step-down plans, which are tiered down plans based on the goals, objectives and strategies for visitor services included in this document.

St. Louis Area Wildlife Education and Urban Outreach – Riverlands Demonstration Area

The Riverlands Environmental Demonstration Area, located in West Alton, Missouri, was established by the COE in association with the relocation of Lock and Dam No. 26. The Rivers Project Office implements a comprehensive interpretive services and outreach program designed to enhance the public's understanding of and appreciation for the lands and waters managed by the COE. The program aims to educate visitors on the natural, cultural, historical and socio-economic importance of the Mississippi watershed. Educational programs are offered on prairies, wetlands, riverine ponds and the river. Another part of the program involves the development of the National Great Rivers Museum, which will be dedicated to tell the story of the river in a comprehensive way. The Museum will include a Distance Learning Center, where interactive video teleconferencing will enable the center to offer opportunities to students and the public at other locations.

In 1997, the COE Rivers Project Office entered into a Memorandum of Agreement with the Service establishing a resource-sharing partnership that enabled the two agencies to work together on public education programs centered on the river. The purpose of the partnership is to enhance public understanding of basic fish, wildlife, and water related issues pertaining to the Mississippi River. This agreement provides for a Service employee

from Mark Twain National Wildlife Refuge Complex Office to utilize the Rivers Project Office facilities in West Alton, Missouri and to conduct joint programing with the Corps. Service presence at the Riverlands Project will help provide the metro area public with a better understanding of Service involvement in the Nation's wetlands, fish and wildlife resources, and how the two agencies' share responsibilities on these important matters. Urban Outreach and wildlife education highlighting the natural resources of the Mississippi River are key components of each education program. Due to an increasingly urban and suburban society, the Complex seeks to work with kids and adults where they live – away from the refuge – to help them understand the basic factors that support life, including safe water supplies. The Refuge Park Ranger works with groups on-site at the Riverlands Demonstration Area, off-site at St. Louis area schools and other outreach venues, and serves collateral public use program duties for the entire Refuge Complex, such as development of signs, leaflets and special programming.

Goal 6. Public Use and Education:

Provide wildlife-dependent recreation opportunities where appropriate, and improve the quality and safety of the recreational experience. Enhance environmental education and interpretive efforts consistent with the vision statement in this document by developing and improving refuge programs and facilities based on or allied with the issues in this document, and partnering with others to increase awareness of the Mark Twain NWR Complex, the Mississippi River, and the National Wildlife Refuge System.

Objective 6.A. Enhance visitor experiences involving wildlife observation and photography. This will be accomplished in part by constructing observation platforms, trails, and auto tour routes where appropriate. All facilities will be ADA-compliant and where necessary, "flood friendly". Two platforms will be constructed by 2005 and two trails by 2008.

Goal 6: Port Louisa NWR / Objective 6.A/ Strategies 6.A

Strategy No.	Division	Strategies	Comments
6.A.1	Horseshoe Bend	Provide parking area and trail on east side of Division.	Requires acquisition of additional tracts.
6.A.2		Develop overlook at Rush Lake near visitor parking lot.	
6.A.3		Maintain and improve newly developed Blue Bird Trail.	
6.A.4	Louisa	Replace existing observation deck on auto tour route and Fox Pond. Add spotting scope.	
6.A.5	Keithsburg	Maintain and improve the levee top trail surrounding the unit.	

Goal 6: Great River NWR / Objective 6.A/ Strategies 6.A

Strategy No.	Division	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.A.6	Clarence Cannon	Develop auto tour route with associated directions signs and a seasonal Mississippi River overlook.	✔ Pullouts, wider roads, and directional signs will improve visitor safety.
6.A.7		Construct loop nature trail with interpretive information.	✔
6.A.8	Fox Island	Improve public road access, where practical, by coordination and partnership with Clark County Highway Department and Wayland Special Road District.	✔

Goal 6: Two Rivers NWR / Objective 6.A/ Strategies 6.A

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.A.9	Calhoun	Construct short grassland trail from Visitor Center west toward old home site. Install observation platform with interpretive panels just below old home site.	✔
6.A.10		Construct forest trail adjacent to Swan Lake Boat Ramp area from gate to edge of lake with parking area near trail head. Construct three observation blinds along route.	✔ Trail and blinds to remain open year-round. This trail will connect with grassland trail in previous strategy via the access road. Areas of elevated boardwalk required.
6.A.11		Construct entrance drive from County Road 1 to Headquarters along terrace. Include turnouts, interpretive panels, and elevated observation deck overlooking moist soil units, Swan Lake, Illinois River, and Gilbert Lake.	✔ Requires acquisition of area CAL-1
6.A.12		Construct parking area at lower Swan Lake water control structure. Widen access road and construct spillway in road if needed to manage flood water events.	Allow vehicle access unless flooded or road conditions require temporary closure.
6.A.13	Calhoun	Construct an observation deck and parking area just east of the Pump Station Road gate.	

Goal 6: Two Rivers NWR / Objective 6.A/ Strategies 6.A (Continued)

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.A.14	Gilbert Lake	Construct parking area along levee road south of Highway 100 on east side of the Division.	Will improve visitor safety by eliminating need to park on the highway.
6.A.15		Construct raised observation deck with interpretive panels on west side of ditch in agricultural field.	Also needs parking area nearby. Will provide view of Gilbert Lake.

Goal 6: Middle Mississippi NWR / Objective 6.A/ Strategies 6.A

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.A.16	Harlow Island	Develop public access at end of County Road AA.	Requires acquisition of 90-acre Kimmswick Isle of Capri Casino property.
6.A.17		Work with MDOC to improve road/ parking area on Big Hollow Road for access to south end of Division.	Approved as FHWA Federal Lands Discretionary Project.
6.A.18	Harlow Island	Develop 1.5 miles of hiking trails from newly constructed access point at Big Hollow Road/Truman Park.	
6.A.19	Wilkinson Island	Construct three public parking areas on or adjacent to the COE levee.	
6.A.20		Maintain one trail from each parking area into the interior of the unit for public access.	

Objective 6.B. Enhance the education and interpretive program on Complex refuges by providing visitors key river resource messages through contact stations, kiosks, interpretive panels, educational programs and special events. The visitors experience will focus on the messages of: changes in the floodplain, wildlife management choices in this changed setting, and the public's opportunity to be involved in river issues and the Refuge Complex responses.

Goal 6: Port Louisa NWR / Objective 6.B/ Strategies 6.B

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.B.1	Horseshoe Bend	Develop and install interpretive panels at new observation platform.	✔

Goal 6: Port Louisa NWR / Objective 6.B/ Strategies 6.B (Continued)

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.B.2	Louisa	Expand headquarters/visitor contact station. Expand and improve interpretive and educational exhibits HQ.	✔
6.B.3		Develop replacement interpretive panels for observation deck at HQ.	✔
6.B.4		Provide outdoor classroom facilities in HQ area and develop local wildlife education programming to assist area teachers when using these facilities.	✔
6.B.5		Conduct Refuge-sponsored events that provide opportunities for interpretive bus or auto tours at times and locations that are compatible.	
6.B.6	Keithsburg	Develop and install interpretive panels at the boat ramp parking lot kiosk.	
6.B.7	Big Timber	Develop and install interpretive panels and kiosk at the boat ramp parking lot.	
6.B.8	Overall Refuge	Develop an interpretive information brochure for local Spanish speaking populations that would include Refuge rules and regulations.	

Goal 6: Great River NWR / Objective 6.B/ Strategies 6.B

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.B.9	Clarence Cannon	Expand headquarters/visitor contact station. Expand and improve interpretive and education exhibits in visitor center.	✔ Install 1.4-mile water line to provide safe drinking water.
6.B.10		Provide interpretive panels on proposed auto tour route to enhance visitor knowledge of the Refuge System, management practices and potential wildlife sightings.	✔

Goal 6: Great River NWR / Objective 6.B/ Strategies 6.B (Continued)

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.B.11	Delair	Construct vehicle turnout with interpretive signs along public road to COE Gosline boat access.	
6.B.12		Improve education activities and curriculum material used by local schools.	
6.B.13		Conduct public open house every 3 years (open to public to drive through).	Staff and portable displays available during event.

Goal 6: Two Rivers NWR / Objective 6.B/ Strategies 6.B

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.B.14	Calhoun	Expand headquarters/visitor contact station. Expand and improve interpretive and education exhibits in visitor contact area.	✔ Examine alternative entrance road directions to provide safer access.
6.B.15		Install interpretive panels on grassland trail, forest trail, wildlife drive, at lower Swan Lake stoplog structure, and at both Swan Lake boat ramps.	✔
6.B.16	Gilbert Lake	Install interpretive panels along State Highway Rt. 100 turnout road over looking the Division.	Include short messages that can be read from a vehicle.
6.B.17		Provide interpretive eagle viewing tours in January and February.	✔ Partnership effort with Pere Marquette State Park.

Goal 6: Middle Mississippi NWR / Objective 6.B/ Strategies 6.B

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.B.18	Harlow Island and Meissner Island	Develop one interpretive panel for each of the three Middle Mississippi NWR divisions.	
6.B.19		Provide interpretive eagle viewing tours in April at Wilkinson Island.	

Goal 6: Mark Twain NWR Complex / Objective 6.B/ Strategies 6.B

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.B.18	All	Install flood-friendly kiosks on Louisa (including Schafer's and Sand Run accesses on Lake Odessa) Big Timber, Horseshoe Bend, Keithsburg, Long island, Fox Island, Harlow Island, Batchtown (Prairie Pond) Gilbert Lake and Calhoun.	✔ Will include general Refuge information, interpretive panels, and regulation panels.
6.B.19		Develop Refuge celebration program for International Migratory Bird Day, National Wildlife Refuge Week, Earth Day, and other wildlife events.	✔
6.B.20		Develop general information brochures for the complex, the Refuges, and the Divisions. Continue providing annual hunting/fishing brochures for Refuges and overall Complex.	
6.B.21		Develop comprehensive species lists for birds, mammals, reptiles/amphibians for the AEC and for each Refuge.	✔ Wildlife inventories are needed for some divisions.
6.B.22		Develop and conduct Refuge-specific wildlife education curriculum modules for children and adults.	✔
6.B.23		Produce informational videos for the Complex and for each Refuge.	
6.B.24		Develop annual special events calendar pertaining to outreach and education.	Distribute to each Refuge and to local communities.
6.B.25		Develop public outreach program material on the issue of "casual mooring" and its effects on forest and aquatic habitats owned by the government.	Include information on alternative approaches, and effect change by 2004.

Objective 6.C. Enhance outreach through off-refuge activities by conducting education and interpretive programs for schools, youth, civic and conservation groups to increase understanding and appreciation of wildlife and wildlife habitat on the river corridor.

Goal 6: Port Louisa NWR/ Objective 6.C/ Strategies 6.C

Strategy No.	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.C.1	Continue to partner with Louisa County conservation Board to provide wildlife-dependent interpretive and educational activities.	

Goal 6: Great River NWR/ Objective 6.C/ Strategies 6.C

Strategy No.	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.C.2	Continue annual participation in Big River Days in Clarskville, Missouri.	
6.C.3	Work cooperatively with Clarksville, Missouri, to provide interpretive display for the proposed Heritage Center, if built.	

Goal 6: Two Rivers NWR/ Objective 6.C/ Strategies 6.C

Strategy No.	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.C.4	Develop Refuge exhibit with information on FWS, the Two Rivers Refuge and river habitat management to locate at Pere Marquette State Park. (Visitor Center, lodge, campground, or boat ramp area.)	✔
6.C.5	Develop partnership with Calhoun County to develop annual wildlife celebration event. Ideas include Bald Eagles, White Pelicans, and waterfowl.	Would focus local attention on the Refuge and support county tourism.
6.C.6	Continue annual co-sponsorship of Two Rivers Family Fishing Fair at Pere Marquette State Park during National Fishing Week.	

Goal 6: Two Rivers NWR/ Objective 6.C/ Strategies 6.C (Continued)

Strategy No.	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.C.7	Develop Environmental Education and interpretive program for students and visitors, on and off-site. Recruit, organize, and equip a cadre of volunteers to provide these educational opportunities.	✔ Would meet need generated by Riverlands outreach efforts.
6.C.8	Install Refuge/Complex/Service information kiosk near Brussels Ferry.	Partnership with Illinois DOT.

Goal 6: Middle Mississippi NWR/ Objective 6.C/ Strategies 6.C

Strategy No.	Strategies	✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.C.9	Continue to develop environmental education partnerships with local schools in the Middle River floodplain.	
6.C.10	Continue to provide public information, displays and programs at area fairs and other events.	

Goal 6: Complex and Riverlands Project/ Objective 6.C/ Strategies 6.C

Strategy No.	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.C.11	Create a portable exhibit showcasing Refuge resources, delivering Refuge messages, and elevating awareness of River resources to the public.	In cooperation with COE.
6.C.12	Develop and conduct complementary off-site wildlife education curriculum modules for children and adults.	
6.C.13	Develop a Complex website that includes maps, visitor and volunteer information, wildlife species information, River information, special events and links.	
6.C.14	Develop Service kiosks and displays on partner-managed land (COE, Illinois, Iowa, Missouri)	The Complex will also seek partnerships at other appropriate municipal locations for these outreach efforts.
6.C.15	Prepare briefing folder about mission, goals, objectives, strategies and program highlights for Congressional State, and local representatives.	

Goal 6: Complex and Riverlands Project/ Objective 6.C/ Strategies 6.C (Continued)

Strategy No.	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.C.16	Develop interpretive panels for the kiosk at Riverlands Environmental Demonstration Area. Focus on Mississippi River, its watershed, and the FWS/COE partnership.	Requires close coordination with COE Public Relations Coordinator.
6.C.17	Maintain urban environmental education efforts by continued partnership with COE. Refuge will provide staff time for outreach opportunities at Riverlands facility near St. Louis. Educational materials, exhibits, displays and support services such as bus rentals are needed to provide a more complete vision of the Service, Refuge System, and Complex connection to the Mississippi River.	
6.C.18	Develop partnership with local chapters of Eco-Watch organization and other groups to assist with River monitoring activities, special events, community outreach, and volunteer program.	
6.C.19	Co-produce with COE an education video for teachers that highlights our curriculum-based programs. This may be accompanied by an educator's guide to assist and encourage more teachers to use Riverlands and Complex refuges as outdoor classrooms.	
6.C.20	Assist with development and installation of exhibits in COE National Great Rivers Museum in Alton, Illinois.	

Goal 6: Mark Twain NWR Complex/ Objective 6.C./ Strategies 6.C

Strategy No.	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.C.21	Provide news releases to local media regarding refuge events and achievements. Consider monthly columns for newspapers. Investigate short-range radio broadcasts highlighting our refuges and seasonal activities.	✔
6.C.22	Expand level of speeches and presentations to civic and other community organizations describing the value of the Refuge complex lands and the role of the FWS on the Mississippi River.	✔
6.C.23	Develop and use traveling education trunks to increase awareness about the refuges, the River and its resources, and the Service mission.	✔

Goal 6: Mark Twain NWR Complex/ Objective 6.C./ Strategies 6.C (Continued)

Strategy No.	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.C.24	Expand the volunteer program to increase public appreciation and support for the Refuges.	✔ Could include programs such as Friends Groups and National Audubon Society "Refuge Keepers."
6.C.25	Incorporate Refuge information into Great River Road highway kiosks, visitor centers, etc.	Requires partnership with state/ local coordinators. Great River Road is a designated National Scenic Byway.
6.C.26	Support formation and maintenance of Friends Groups at individual refuges throughout the Complex.	

Objective 6.D. Increase fishing opportunity by improving access at five Divisions by 2010.

Goal 6: Port Louisa NWR/ Objective 6.D/ Strategies 6.D

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.D.1	Big Timber	Modify the north end of Big Timber boat landing, including relocating the ramp.	

Goal 6: Great River NWR/ Objective 6.D/ Strategies 6.D

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.D.2	Fox Island	Evaluate feasibility of constructing boat ramp and parking area at old Lone Star Bridge site.	In coordination with MDOC, Clark County Highway Department and Fox River Drainage District.

Goal 6: Two Rivers NWR/ Objective 6.D/ Strategies 6.D

Strategy No.	Division	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.D.3	Calhoun	Install ADA-compliant fishing pier and transfer dock at Swan Lake boat ramp.	
6.D.4		Improve parking facilities for bank fishing in lower Swan Lake.	
6.D.5	Batchtown	Upgrade prairie pond and Gilead boat ramps and parking areas to meet ADA standards.	
6.D.6	Gilbert Lake	Improve parking facilities for fishing access at lower portion of Gilbert Lake.	Also improve visitor safety.

Goal 6: Middle Mississippi NWR/ Objective 6.D/ Strategies 6.D

Strategy No.	Divisions	Strategies	Comment
6.D.7	Harlow Island	Maintain fishing access trail from Big Hollow Road parking area to the River, approximately one-half mile.	
6.D.8	Wilkinson Island	Improve fishing access trail from the southern parking area to Reed's Creek, approximately .15 mile, and potentially to the Wilkinson side channel when completed.	

Objective 6.E. Improve the quality, as measured through visitor satisfaction surveys, and safety of the hunting program and increase opportunity, where appropriate, in accordance with sound biological management objectives by 2008.

Goal 6: Port Louisa NWR/ Objective 6.E/ Strategies 6.E

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.E.1	Big Timber	Division to remain open to waterfowl hunting as per state regulations. Eliminate drawing for permanent waterfowl hunting blinds by 2004. set a minimum distance of 200 yards between hunters. Restrict permanent blind construction.	Temporary daily concealment only; it would be removed following each day's hunt.

Goal 6: Great River NWR/ Objective 6.E/ Strategies 6.E

Strategy No.	Division	Strategies	Comments
6.E.2	Clarence Cannon	Continue special deer hunt at levels appropriate to protect habitat.	In coordination with the Missouri Department of Conservation.
6.E.3	Long Island	Coordinate annually with the Illinois DNR on waterfowl hunting program and on the placement of waterfowl blinds before each drawing period.	
6.E.4	Delair	Continue special deer hunt at levels appropriate to protect habitat.	In coordination with Illinois DNR.
6.E.5	Fox Island	Continue to monitor deer populations and state special seasons, and adjust seasons if necessary to control deer and provide hunting opportunity when possible.	In coordination with Missouri Department of Conservation.

Goal 6: Two Rivers NWR/ Objective 6.E/ Strategies 6.E

Strategy No.	Division	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.E.6	Calhoun	Open lands east of Illinois River Road to upland and big game, consistent with DNR Mississippi River State Game Area seasons and regulations.	

Goal 6: Middle Mississippi NWR/ Objective 6.E/ Strategies 6.E

Strategy No.	Division	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.E.7	Wilkinson Island	Provide seasonal access to hunters on the upper end of Wilkinson Island by repairing a bridge, nd surfacing a three-quarter-mile segment of the old Wilkinson Landing road. Access to a central parking area would be allowed between October 1 and January 31.	

Objective 6.F. Increase protection of refuge visitors, natural resources, and facilities through enhanced law enforcement, boundary marking, and sign programs. Refuge facility vandalism and habitat damage will be reduced by 75 percent by 2010.

Goal 6: Mark Twain NWR Complex/ Objective 6.F/ Strategies 6.F

Strategy No.	Division	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.F.1	All Divisions	Conduct regular law enforcement patrols of each division (three times per week on average) to protect Refuge resources and visitors, and to deter illegal activities such as vandalism, tree cutting, poaching and camping.	✔
6.F.2		Continue partnerships with local law enforcement authorities and State conservation officers to protect wildlife/habitat resources. Assist with law enforcement patrols on State-managed General Plan lands.	✔
6.F.3		Develop and implement new sign plan to include entrance, regulatory, directional, boundary, and interpretive signs at their locations.	
6.F.4		Ensure proper boundary posting on all Refuge divisions. Maintain existing survey monuments.	✔ Surveys may be necessary to assure correct property lines.
6.F.5		Ensure proper boundary posting of all Farm Service Agency conservation easements.	✔

Goal 6: Port Louisa NWR/ Objective 6.F/ Strategies 6.F

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.F.6	Louisa	Install gate at headquarters entrance to prevent off-hours traffic from accessing the area.	
6.F.7	Keithsburg and Louisa	Modify Division closed for sanctuary period dates to September 16 to December 15.	

Goal 6: Port Louisa NWR/ Objective 6.F/ Strategies 6.F (Continued)

Strategy No.	Division	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.F.8	Horseshoe Bend	Modify Division closed for sanctuary period dates to September 16 to December 15.	Changes in waterfowl season dates could result in these closed periods being adjusted and posted locally.

Goal 6: Two Rivers NWR/ Objective 6.F/ Strategies 6.F

Strategy No.	Division	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.F.9	All Divisions	Change closed sanctuary period to October 15-December 31 each year.	Previously October 15-December 15. Access is permitted at designated locations.
6.F.10	Batchtown	Install gate on Prairie Pond levee to prevent traffic past the Mississippi River boat ramp during the closed period in the fall.	

Goal 6: Middle Mississippi NWR/ Objective 6.F/ Strategies 6.F

Strategy No.	Division	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
6.F.11	Harlow Island	Install gate at County Road AA access point to prevent vehicle trespass.	
6.F.12	Wilkinson Island	Install gates at three existing access roads to prevent vehicle trespass.	
6.F.13	All divisions	Ensure proper boundary posting on all refuge divisions and complete, maintain and update boundary surveys.	

Goal 7 Discussion. Monitoring

Monitoring of wildlife, habitat and public use on refuges accomplishes several purposes: it allows for evaluation of current land use and management practices, it can provide early warning of problems in the system, and it provides the foundation for future management decisions. Service policy on refuges (701 FW 2) is to (1) collect baseline information on plants, fish, and wildlife, (2) monitor, as resources permit, critical parameters and trends of selected species and species groups on and around Service units, and (3) base management on biologically and statistically sound data derived from such inventory and monitoring. When operating with limited budgets and personnel, the monitoring program on Complex

Refuges will focus on a few reliable surveys designed to evaluate and improve specific management actions. Priority surveys will focus on the Mark Twain Complex species of concern and their preferred habitats.

In addition, there are numerous other parties involved in monitoring efforts conducted within the Area of Ecological Concern. The Complex will integrate these larger-scale river corridor monitoring efforts with refuge site-specific data to the degree applicable. Normally the subject of monitoring would not be treated as a separate goal topic in Comprehensive Conservation Planning, but rather as individual component strategies under other management actions, such as habitat manipulations. This type of site-specific monitoring will be a major part of the Mark Twain program. However, the magnitude of the interagency monitoring efforts throughout the entire UMR System have led the Complex to treating the subject separate from other management proposals in this document. A step-down Monitoring Plan will detail the program associations with on-refuge management actions as well as ecological and biological conditions throughout the river corridor.

The Long Term Resource Monitoring Program (LTRMP), a component of EMP, conducts much of the current monitoring within the UMR corridor, both within defined areas and on a systematic scale. The LTRM program is managed by the COE in partnership with the USGS Upper Midwest Environmental Science Center (UMESC) in LaCrosse, Wisconsin. The mission of the LTRMP is to "provide decision makers with the information needed to maintain the Upper Mississippi River System as a sustainable large river ecosystem given its multiple use character." Six state-operated field stations have been established for data collection in Lake City, Minnesota (Pool 4); Onalaska, Wisconsin (Pool 8); Bellevue, Iowa (Pool 13); Alton, Illinois (Pool 26); Jackson, Missouri (Open River); and Havana, Illinois (Illinois River). Since shortly after the program was established in 1986, the field stations have gathered baseline data on fisheries, macroinvertebrates, water quality, and vegetation in each of these "key pools." Recently, discussions have begun about the future direction of the LTRMP. Planned modifications to the program include monitoring more pools, increased emphasis on data analysis, and developing systemic elevation and bathymetry coverages for the UMRS.

The UMRS Habitat Needs Assessment (HNA) provides additional corridor-wide habitat information for use by land managers. The initial HNA was completed in 2000 as part of the EMP program. It provides a first approximation of a system-wide set of objectives for use in planning habitat protection and restoration projects on the UMRS. The interagency HNA team evaluated existing habitat conditions, reviewed and refined the "predicted" future habitat conditions, and identified "desired" future habitat conditions. Habitat needs were identified on system-wide, river reach, and pool levels by comparing the current, predicted, and desired conditions.

A GIS-based "query tool" was developed as part of the HNA to help managers evaluate potential distribution of species and habitat types throughout the river corridor. The user may query on a species to obtain likely habitat types, or may query on a habitat to obtain likely species information. The query tool also provides several analytical tools to describe habitat diversity measures (e.g. shoreline length, number of islands, number of species, etc.). However, this initial version of the query tool is focused only on adult, mid-summer habitat needs of species and is based on 1989 land cover maps with incomplete coverage of the AEC. Future versions of the HNA will incorporate updated, refined, and expanded habitat and species information. For example, UMESC is now using aerial photos taken in 2000 to digitize updated land cover maps for the entire 500-year floodplain based on the HNA cover classes.

There are many other examples of monitoring and research programs being conducted by Service partners on the UMR and some include locations on Refuge-managed lands. The Illinois Natural History Survey conducts weekly aerial waterfowl flights on many sections of the river during fall migration. The Rock Island District of COE conducts forest inventories on General Plan lands, timber stand improvement studies, and red-shouldered hawk and forest songbird monitoring. Federal and State fisheries biologists monitor fish populations annually. Paddlefish activity, for instance, has been studied in Swan Lake since 1994. Biologists also have been monitoring the effects of Environmental Pool Management on wetland vegetation and fisheries, and USGS has developed a protocol to evaluate the effects of spillways (e.g. Clarence Cannon and Keithsburg) on sedimentation and vegetation response. There are many additional partners involved in monitoring and research efforts within the AEC, including the Upper Mississippi River Conservation Committee (UMRCC), Environmental Protection Agency (EPA), Mississippi Interstate Cooperative Resource Association (MICRA), Columbia Environmental Research Center (CERC - USGS), state universities, and non-governmental organizations such as Audubon Society and RiverWatch.

In addition to these systemic efforts by Service partners, on-refuge data is collected by staff and volunteers whenever possible. For example, waterfowl and shorebird counts, songbird point counts, frog call counts, and vegetation transects have all been conducted on various refuge divisions. Due to personnel and funding limitations, however, refuge-specific monitoring has been sporadic, and data compilation and analysis are incomplete.

The monitoring priorities of the Complex will focus on data pertinent to Service policies and on management objectives of the refuge units. The Complex monitoring program will be integrated with UMESC, other FWS offices, and other partner efforts along the river corridor. The data collected will be compatible with the standards of UMESC and the HNA. The HNA cover types are becoming the UMR standard for habitat data collection. Table 11 shows how the habitat categories used in this CCP are related to the HNA cover types.

Table 11: Cover Types for CCP Habitat Management Strategies

Cover Types for CCP Habitat Management Strategies	HNA Cover Type	Typical Species
Open Water	Open Water	No vegetation
Permanently Flooded Aquatics	Submersed Bed	Wild celery, coontail
Semipermanently Flooded Emergents	Semi-permanently Flooded Emergent Annual	Wild iris
	Semi-permanently Flooded Emergent Perennial	Cattail, arrowhead, giant bur-reed, hardstem bulrush
Seasonally Flooded Emergents	Seasonally Flooded Emergent Annual	Wild millet, beggartick, smart-weed
	Seasonally Flooded Emergent Perennial	Yellow nutsedge, sedge meadows
Sand/Mud	Sand/Mud	Exposed sand beaches and mud flats
Wet Meadow	Wet Meadow	Reed canary grass, rice cut-grass, prairie cord-grass
Scrub-Shrub	Scrub-Shrub	Buttonbush, false indigo
Grassland	Grassland	Big bluestem, foxtail, roadside/ levee grass

Table 11: Cover Types for CCP Habitat Management Strategies (Continued)

Cover Types for CCP Habitat Management Strategies	HNA Cover Type	Typical Species
Wet Floodplain Forest	Salix Community	Willow-dominated shrubs
	Populus Community	Cottonwood-dominated flood-plain forest
	Wet Floodplain forest	Silver maple, green ash, black willow
Mesic Bottomland Forest	Mesic Bottomland Forest	Oaks, hickories
Agriculture	Agriculture	Cultivated fields

The Complex will develop a step-down inventory and monitoring plan for wildlife and habitat according to the guidance in 701 FW 2. Public use monitoring also will be implemented in order to minimize visitor impacts to the resource, to evaluate visitor activities and needs, and to develop improved public recreation and education programs.

A well-designed monitoring program for the Complex will improve refuge management by focusing limited resources on specific management questions and enabling the adoption of adaptive management techniques. Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Adaptive management acknowledges uncertainty and the value of experimentation and learning from experience. Some of the differentiating characteristics of adaptive management are:

- Acknowledgment of uncertainty about what is "best" for the particular management issue,
- Thoughtful selection of the policies and practices to be applied,
- Careful implementation of a plan of action designed to reveal the critical knowledge that is currently lacking,
- Monitoring of key response indicators,
- Analysis of management outcomes in consideration of the original objectives, and
- Incorporation of the results into future decisions.

The AEC is a highly variable, constantly changing system due to floods, droughts, and the effects of man-made features, such as locks, dams, and flood-control levees. These changing conditions, together with a steady stream of new information from the LTRMP, make adaptive management an essential approach to implementation of this CCP. The Refuge Complex will use adaptive management techniques to assess and modify management strategies to achieve the planned goals and objectives. Individual refuges will implement minor modifications to management strategies if warranted by changing circumstances. Any major modifications of program direction will be reflected in formal revisions of this CCP.

Goal 7. Monitoring:

Develop and implement a wildlife, habitat, and public use monitoring program, integrated with interagency efforts along the river corridor, to evaluate the effectiveness of Refuge management programs and to provide information for adaptive management strategies.

Objective 7.A. Monitor habitat communities within the Refuge Complex to evaluate the effects of current management actions and gather data to improve future management practices.

Goal 7: Mark Twain NWR Complex / Objective 7.A/ Strategies 7.A

Strategy No.	Strategies	Comments ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
7.A.1	Establish annual transects on wetland units to evaluate the quality of vegetation communities and the need for additional management action.	✔
7.A.2	Complete baseline forest inventory for all Refuge divisions. Continue to monitor forest block size and diversity every 5 years.	✔ Partnership with COE
7.A.3	Evaluate Refuge grassland and wet meadow annually for species composition, litter layer, woody vegetation, etc. to determine the need for management action. Run vegetation transects after prescribed burns according to Service policy.	✔ Post-burn monitoring now required by FWS burn program.
7.A.4	Develop step-down inventory and monitoring plan with specific survey locations and protocols.	

Objective 7.B. Monitor wildlife use of refuge to verify a response to habitat management efforts, and to contribute to systematic scale evaluations on the Mississippi River with our partners.

Goal 7: Mark Twain NWR Complex / Objective 7.B Strategies

Strategy No.	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
7.B.1	Monitor waterfowl use of wetland and agricultural areas during spring and fall migration.	
7.B.2	Monitor shorebird use of Refuge wetlands during spring and fall migration.	
7.B.3	Monitor migrating and nesting neotropical songbirds on Refuge forests, grasslands and wet meadows.	✔
7.B.4	Monitor size of deer populations and habitat damage where necessary to determine need for population control.	

Goal 7: Mark Twain NWR Complex / Objective 7.B Strategies (Continued)

Strategy No.	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
7.B.5	Develop step-down inventory and monitoring plan with specific survey locations and protocols to cover above effects.	

Objective 7.C. Monitor public use and environmental education programs to ensure compatibility with wildlife purposes, visitor satisfaction/safety and outreach effectiveness.

Goal 7: Mark Twain NWR Complex / Objective 7.C Strategies

Strategy No.	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
7.C.1	Track visitor numbers and activities at major public use sites.	✔
7.C.2	Monitor public use effects on wildlife and habitat in areas of compatibility concern.	✔
7.C.3	Evaluate visitor satisfaction with recreational facilities and interpretive and environmental education programs – comment cards, interviews, etc.	✔
7.c.4	Evaluate environmental education and interpretation programs for effectiveness, including off-refuge programs and activities.	✔

Objective 7.D. Work with partners to monitor systemic fish, wildlife, and habitat resources of the UMR floodplain and gather data to assist with resource management decision-making.

Goal 7: Mark Twain NWR Complex / Objective 7.D Strategies

Strategy No.	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
7.D.1	Identify and promote research projects designed to answer specific resource management questions or problems.	Partners include USGS, universities and the COE.
7.D.2	Promote continued monitoring of key fish, wildlife and habitat resources in the river corridor through programs such as LTRM, INHS aerial flights, COE forest inventories, etc.	Partners include USGS, States, COE.
7.D.3	Work with partners to expand monitoring efforts on water quality and contaminants in the UMRS.	Partners include USGS, EPA, other FWS offices.

Goal 7: Mark Twain NWR Complex / Objective 7.D Strategies (Continued)

Strategy No.	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
7.D.4	Work with partners to evaluate floodplain management, connectivity and sedimentation in the River corridor and on Refuge divisions (Environmental Pool Management, fish passage at Swan Lake, effects of clarence Cannon spillway, etc.).	Partners include USGS, COE, NRCS
7.D.5	Work with partners to monitor status and trends of threatened and endangered species (*Boltonia*, pallid sturgeon, Indiana bat, etc.) and other species of concern within the River corridor.	Partners include universites, USGS, other FWS offices.

Objective 7.E. Develop and implement an effective record-keeping and data analysis system, compatible with HNA, to facilitate adaptive management decision-making.

Goal 7: Mark Twain NWR Complex / Objective 7.E Strategies

Strategy No.	Strategies	Comment ✔ *Indicates that strategy requires a fractional addition of Refuge staff to accomplish*
7.E.1	Keep records of management actions and conditions (water level, prescribed fire history, etc.) for all Refuge divisions.	Data associated with GIS assigned polygons where applicable.
7.E.2	Develop system of databases/graphs/tables to facilitate management and analysis of monitoring data.	
7.E.3	Maintain updated GIS database at Refuge Complex level on lower half of UMR.	
7.E.4	Annually compare monitoring data with CCP strategies. Modify management actions as needed.	✔ Major modifications to be reflected in the CCP update.
7.E.5	Promote interagency HNA process to point out deficiencies in UMR habitats that could identify gaps to be addresed through land acquisition or partnership projects.	