ST. JOHNS BAYOU AND NEW MADRID FLOODWAY

PROJECT

East Prairie Phase

Fish and Wildlife Coordination Act Report

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Executive Summary

This is a summary of the findings and recommendations of the Fish and Wildlife Service (Service) and the Missouri Department of Conservation (MDC) contained in the Fish and Wildlife Coordination Act Report for the U.S. Army Corps of Engineers' (Corps) St. Johns Bayou and New Madrid Floodway, Missouri, East Prairie Phase, Re-evaluation Study. The Corps has identified two alternatives that include: vegetative clearing along 4.3 miles of rural channels; channel enlargement along the St. Johns Bayou, the Setback Levee ditch, and St. James ditch east of East Prairie; and a 1,000 cubic feet per second (cfs) pumping station near the existing gravity drainage outlet in St. Johns Bayou. The project also includes a 1,500 cfs pumping station at the mouth of the New Madrid Floodway in conjunction with a separately authorized levee closure.

The St. Johns Bayou basin and the New Madrid Floodway are drainages comprising part of the historic Mississippi River floodplain, and although highly altered, still perform floodplain functions critical to regional fish and wildlife resources. The New Madrid Floodway is unique in Missouri because it is the only significant portion of the historic Mississippi River floodplain still largely connected to the river. That connection provides ecologically valuable hydrologic exchange between the Mississippi River system and adjacent terrestrial ecosystem. Large portions of Mississippi and New Madrid counties, including the project area, support a wider array of diverse habitats and natural biological communities than elsewhere in southeast Missouri (i.e., the Bootheel). That high biodiversity is reflected by the large number of state-listed plant, mussel, fish, amphibian, reptile, bird, mammal, and natural biological communities reported for the those counties, and is due in part to the influence of the Mississippi River's annual hydrologic regime on the lower St. Johns Bayou basin and New Madrid Floodway. The project area still functions as an integral part of the Mississippi River ecosystem, and provides important breeding, migration and overwintering habitat for numerous species of neotropical migratory songbirds, and migratory waterfowl, waterbirds and shorebirds. The forested wetlands in the project area, a small remnant of a once extensive floodplain complex are becoming increasingly scarce. That habitat has become so rare that it is now considered critical as refugia for a variety of scarce fish and wildlife species that formerly flourished throughout the lower Mississippi River ecosystem. In spite of extensive modification, the diverse wetland habitats within the project area support nationally significant fish and wildlife resources that enhances biodiversity state-wide and regionally, and helps preserve the ecological integrity of the lower Mississippi River.

Both proposed project alternatives will eliminate spring overbank flooding that periodically may inundate tens of thousands of acres in the St. Johns Bayou basin and the New Madrid Floodway. Upon receding, those flood waters produce thousands of acres of shallow, temporarily flooded wetlands in a variety of cover types. A wide variety of waterfowl, numerous other wetland dependent birds, amphibians, invertebrates, and mammals use those habitats during all or part of their life cycle. Some of the largest remaining forested wetland tracts in southeast Missouri are found in the project area and would be negatively affected by either project alternative. Approximately 36,313 acres of wetlands would no longer be seasonally inundated by backwater flooding under the Authorized Project alternative. Reduced flooding will result in a decrease of at least 215,000 Duck Use Days during spring migration. Project implementation will decrease

fish spawning and rearing habitat values by approximately 50 percent in the St. Johns Bayou basin and at least 93 percent in the New Madrid Floodway. In addition, closing the levee to prevent natural spring flooding from the Mississippi River will virtually eliminate fish access to the Floodway during the critical spawning season.

We are greatly concerned about altering the extent and timing of seasonal flooding in the project area not only because of adverse impacts upon numerous Federal and State trust resources, but also because of the potential adverse impacts to the regional ecosystem and cumulative impacts in the Lower Mississippi Valley. The Corps has proposed reforesting 9,560 acres of frequently flooded croplands (i.e. farmed wetlands) near the project area to compensate for project-related fish and wildlife habitat losses. That plan, however, would result in a net loss of wetland acreage and functions within the project area, and a regional net loss of wetland acreage. In addition, although the proposed mitigation measures would compensate losses of wetland habitat value, they would not mitigate impacts to floodwater storage, nutrient cycling or detrital export/import, water quality changes, etc.. Fish and wildlife species with limited mobility (i.e., reptiles and amphibians) will experience a net loss of habitat within the project area that will not be compensated through the proposed mitigation lands. For those reasons, the Service urges the Corps to pursue measures to avoid project impacts rather than try to compensate for them after the fact.

Because the proposed alternatives will negatively affect nationally significant fish and wildlife resources in the project area, we recommend that the Corps implement the following mitigative measures to ensure that fish and wildlife receive equal consideration with other project purposes:

1.) Consider alternatives that specifically address East Prairie flooding problems, including ring levees, flood-proofing, and local drainage improvements. If additional flood control work is necessary, limit that work to the St. Johns Bayou basin. Work in the New Madrid Floodway will not provide flood relief to areas in and around East Prairie.

2.) Minimize dredging and channel modifications to the maximum extent possible by implementing the following conservation measures.

    a.) Installing gradient control structures at the upper end of all work reaches and at the mouths of all major tributaries to prevent headcutting.

    b.) Installing transverse dikes in the Setback Levee Ditch and the St. Johns Bayou reach to offset fisheries habitat losses from shallower water depths. Those dikes should be designed to maintain a sinuous, continuous thalweg along the length of the channel.

    c.) Constructing a low-head weir where the Lee Rowe ditch branches off the St. James ditch to prevent perching that channel during base flows.

d.) Constructing vortex weirs in the St. James Ditch to compensate for habitat losses from shallower water depths along those reaches. They may also function as grade control structures.

e.) Avoid dredging impacts to the maximum extent possible in the entire reach of the St. James ditch that contains suitable habitat for the State-listed golden topminnow.

f.) Avoid dredging in a 9-foot strip along the right descending side of the Setback Levee ditch to reduce dredging impacts to mussels and possibly leave a population to recolonize the ditch. In addition, a minimum of 1,500 mussels (species composition to be determined by the Service and MDC) should be relocated from selected sites within the dredge path to other appropriate areas in the St. Johns basin. A long-term monitoring plan should be developed, in coordination with the Service and MDC, to determine the success of those mitigation measures. In addition, that monitoring plan should contain a provision to evaluate the suitability of the above-mentioned dikes, weirs, and gradient control structures as mussel habitat.

3.) Evaluate non-structural measures (e.g., flooding easements, etc.) to address agricultural flood damages in the New Madrid Floodway. If those are infeasible, the Corps should investigate alternative levee closure locations, such as that proposed by MDC, further north in the Floodway to avoid significant adverse effects to fish and wildlife.

4.) If the Corps determines there are no feasible flood control measures other than the proposed alternatives, they should incorporate the following measures as integral features of the selected plan.

a.) Prevent the conversion of forested wetlands in both basins due to project-related hydrologic changes. This should be done by purchasing a conservation easement or other protective measure on forested wetlands between elevations 290 and 287 feet NGVD in the St. Johns basin, and between 290 and 277 (Authorized Project) or 281 feet (A&M) NGVD in the Floodway.

b.) Fully compensate all unavoidable losses to fish and wildlife resources. Compensation measures should include the following measures. (average annual acres)

1.) Reforest cropland to compensate for forested wetlands habitat losses associated with channel enlargement, levee closure and pump operations (i.e., altered hydrology). Approximately 2,118 acres (Authorized Project) or 1,546 acres (A&M) would be needed to mitigate direct project impacts. If protective covenants have not been placed on BLH forest as described in 4(b), the Corps should reforest an additional 6,998 acres (Authorized Project) or 6,788 acres (A&M) to compensate for induced forested wetland losses because project-related reductions in flooding.

2.) Reforest cropland to compensate for losses in spring waterfowl migration habitat. Acreage to compensate for forested wetland losses mentioned above could also meet waterfowl compensation needs, provided the sites were reforested with at least 50 percent red oak species and flooded during late winter and early spring to depths no greater than 24 inches.

3.) Reforest flooded cropland that has unimpeded access for river fish during the spawning season (i.e., March through June) to compensate fisheries spawning and rearing habitat losses on the floodplain (excluding seasonally-connected waterbodies - see below). Approximately 7,968 acres (Authorized Project) or 7,607 acres (A&M) of flooded agricultural lands would be necessary to mitigate those habitat losses.

4.) To the maximum extent possible, mitigate in-kind (i.e., similar habitat) for fisheries habitat losses of permanent waterbodies. This could include improving existing permanent waterbodies, or reconnecting old chutes, sloughs, and oxbows with the Mississippi River. If in-kind mitigation is infeasible, reforest an additional 2,343 acre (Authorized Project) or 1,950 acres (A&M) of flooded cropland to compensate for those losses. Those sites must be easily accessible to river and floodplain fishes during the spawning season (i.e., March through June). The Corps should ensure public access to those sites through fee-title purchase or easements.

5.) Provide shallow flooded (i.e., $\leq$ 18 inches) land in April and May to compensate for project-related losses in shorebird migration habitat. (Such areas could also partially compensate for losses to fisheries and waterfowl habitat.) Approximately 1,583 acres (Authorized Project) or 1,523 acres (A&M) of flooded cropland would be necessary to compensate shorebird habitat losses. Constructing moist soil areas to mitigate those losses would roughly halve the necessary acreage.

6.) Acquisition of mitigation lands, reforestation, and shorebird management measures should be accomplished concurrently with project construction and should be in place prior to project operation.

Service Position

The Service and the Corps have strived to develop measures that fully address project-related impacts to Federal trust resources. However, providing the appropriate cover types (i.e., BLH, moist soil, borrow pits), only partially meets the needs of fish and wildlife. To fully compensate for project-related impacts, habitat functions must also be maintained. While the proposed mitigation plan would potentially compensate fish and wildlife habitat losses that can be quantified with current models for estimating wildlife effects of water development projects, it would not, unfortunately, sustain all the important ecologic functions of the floodplain-river ecosystem in the project area.

The Service opposes the St. Johns Bayou and New Madrid Floodway preferred alternative because:

1.) As proposed, the preferred alternative would cause substantial, irretrievable losses of nationally significant fish and wildlife resources, and greatly diminish rare and unique habitats found in southeast Missouri.

2.) We believe project-related wetlands losses are at odds with the Administration's conservation policy goals and those of the Clean Water Action Plan.

If the Corps proceeds with project construct, at a minimum, they should include the Service's above-mentioned recommendations as integral components of the project.

Introduction

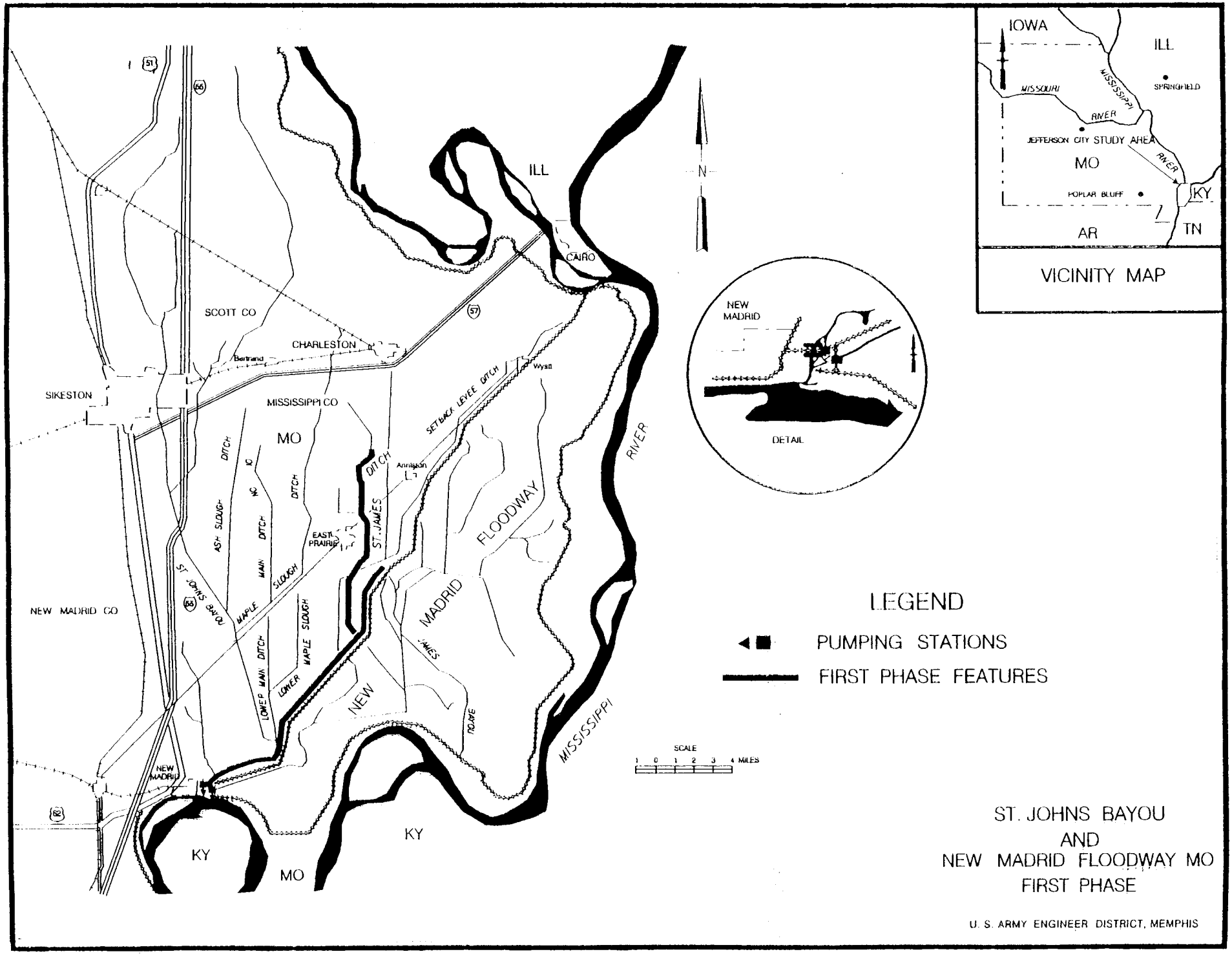
The St. Johns Bayou and New Madrid Floodway Project was authorized for construction by the Water Resources Development Act of 1986. The original project included 130 miles of channel widening and clearing, construction of a 1,000 cubic-feet-per-second pump station at the outlet of St. Johns Bayou, construction of a 1,500 cfs pump station at the outlet of East Bayou (Mud) Ditch on the Floodway, and several mitigation features. The project also included closure of a 1,500-foot gap in the Mississippi River Frontline Levee at the lower end of the New Madrid Floodway authorized by the 1954 Flood Control Act. A Feasibility Report and Environmental Impact Statement for the original project were filed in 1976 and a Supplemental EIS was completed in 1982. The U.S. Army Corps of Engineers (Corps) completed the Phase II General Design Memorandum in 1986, and it serves as the basis for the current re-analysis. The original project was never constructed because the local sponsor(s) could not meet cost-share requirements.

In 1996, Congress appropriated funds for the Corps to reformulate the original project. At the same time, the U.S. Department of Agriculture (USDA) designated the community of East Prairie, Missouri, which lies within the St. Johns Bayou basin, an Enterprise Community. In addition, the 1996 Water Resources Development Act exempted the East Prairie Phase from normal cost-sharing requirements, allowing USDA funds allotted to the community of East Prairie to be used to fulfill non-federal cost share requirements for a reformulated East Prairie Phase of the project. The purpose of the East Prairie Phase of the St. Johns Bayou and New Madrid Floodway Project is economic and infrastructure development in the project area (U.S. Army Corps of Engineers 1997). It includes 23.4 miles of channel work within the St. Johns Bayou basin, the St. Johns Bayou pump station, the New Madrid Floodway pump station, and the frontline levee gap closure. The project will provide a 25-year level of flood protection to the immediate area in and around East Prairie, and a 1.1-year level of flood protection to the New Madrid Floodway.

Description of Project Area

The St. Johns Bayou and New Madrid Floodway Project is located in southeast Missouri, adjacent to the Mississippi River and includes all or portions of New Madrid and Mississippi Counties (Figure 1). The project area extends from the vicinity of Commerce to New Madrid, Missouri. The area is divided into two drainage basins; the St. Johns Bayou basin and the New Madrid Floodway. The East Prairie Phase covers only those portions of the basins that provide the greatest benefits to East Prairie.

The St. Johns Bayou basin covers approximately 324,173 acres and is drained by St. Johns Bayou through the Birds Point to New Madrid Setback Levee ditch via a gravity drainage structure near the City of New Madrid. The area is approximately 40 miles from north to south and reaches a maximum width of 25 miles. The basin has very low relief, ranging from 280 to 325 feet National Geodetic Vertical Datum (NGVD).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ST. JOHNS BAYOU
AND
NEW MADRID FLOODWAY MO
FIRST PHASE
U. S. ARMY ENGINEER DISTRICT, MEMPHIS

The New Madrid Floodway is approximately 33 miles long with a maximum width of 10 miles and covers 132,602 acres. The Floodway was authorized by the Flood Control Act of 1928 and constructed in the 1930s. In the event of a Mississippi River project flood, the Corps would breach the mainline levee along the Floodway to reduce flood stages in the vicinity of Cairo, Illinois and Paducah, Kentucky. The Floodway is bounded on the west by the Setback Levee, on the east by the Mississippi River Frontline Levee, and on the south by the Mississippi River. The upper third of this basin drains through a culvert in the Frontline Levee or via the Peafield Pumping Station during high river stages. The lower two-thirds of the basin drain through St. Johns Diversion Canal and Wilkerson Ditch into East Bayou Ditch (Mud Ditch) and then into the Mississippi River. Similar to St. Johns Bayou basin, the Floodway has little relief; elevations range between 280 and 315 feet NGVD. The New Madrid Floodway is unique in that it is the only significant portion of the historic Mississippi River floodplain in Missouri still largely connected to the river.

Originally part of the Mississippi River floodplain, both basins have been highly modified by intensive agriculture, the primary land use. St. Johns Bayou basin and the Floodway have approximately 280,290 and 113,006 acres in production, respectively. The primary crops are soybeans, corn, cotton, wheat and milo. In addition to agricultural acreage, there are approximately 30,463 acres of wooded habitat in the project area.

Fish And Wildlife Resources

Wetlands

Historically, the project area was covered by a mosaic of river meanders, oxbows, natural levees, forested wetlands, marsh, and open water. Federal flood control projects and Federal and local drainage projects, however, have significantly altered the hydrology of the project area. Of an original 2.5 million acres of forested wetlands in southeast Missouri, approximately 50,000 acres remain (L.H. Fredrickson, cited in MDC 1989). The Corps used aerial photography to develop a land-use cover map for the project area and acreage estimates for wetlands in each basin (Table 1).

Within the project area, there are approximately 10,207 acres of forested wetlands. Most of those acres are bottomland hardwood (BLH) forests found along the lower reaches of St. Johns Ditch in the St. Johns Bayou basin, and adjacent to the Ten Mile Pond Conservation Area and Big Oak Tree State Park in the Floodway. BLH forests are subject to regular seasonal flooding most years. The Missouri Department of Conservation (MDC) has identified several significant examples of this rare community that occur in the project area (MDC 1999). The extent and duration of flooding determines the vegetation structure in any particular area resulting in an extremely diverse plant community. Tree species typically found in those forests are overcup oak, Nuttall oak, pin oak, willow oak, swamp chestnut oak, cherrybark oak, bald cypress, tupelo gum, sweetgum, sugarberry, green ash, pumpkin ash, American elm, black willow, black gum, cottonwood, water hickory, and red maple. Many of the forests in the project area also contain

Table 1. Wetland acres in the St. Johns Bayou basin and New Madrid Floodway.

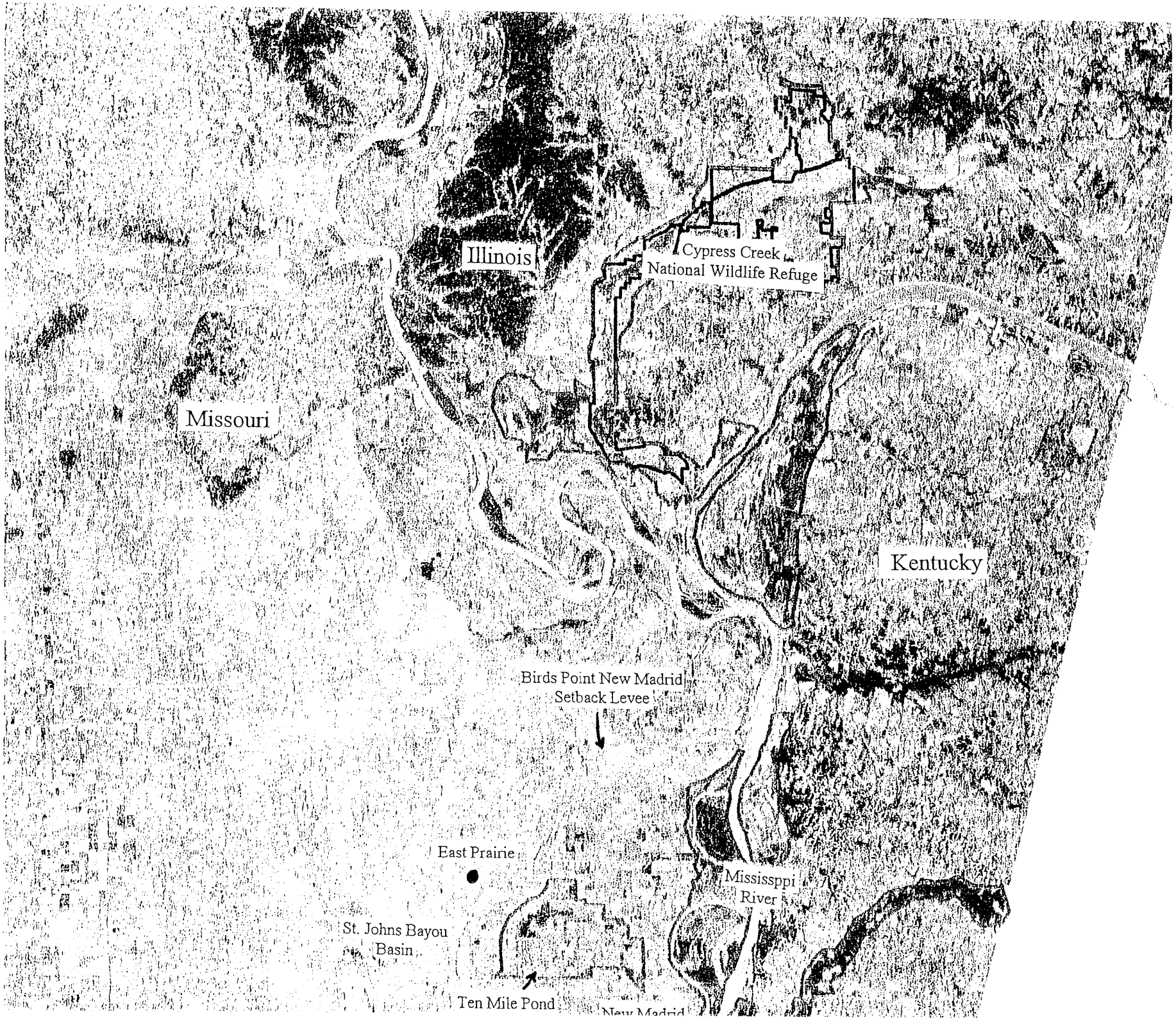
Landcover type	St. Johns Bayou basin	New Madrid Floodway
forested wetlands	4,473	5,734
scrub/shrub marsh	13	194
herbaceous vegetation	2,045	1,938
cropland	22,999	27,903
pasture	135	206
sand bar	11	NA
open water	944	797
urban	2	NA
Total	**30,622**	**36,773**

understory composed of swamp privet, buttonbush, possumhaw, sweet greenbriar, poison ivy, trumpet creeper, Virginia creeper, blackberry, and various herbaceous species.

The remainder of forested wetlands in the project area include riparian forest and swamp. Riparian forests have vegetation similar to BLH forests, and are found along the St. Johns Bayou, St. Johns Ditch, Mud Ditch, and most of the large drainage ditches. Swamps are found along old oxbows and permanently flooded lakes and ponds. They are often flooded a significant portion of the growing season, and in some cases all year. While swamps may contain tree species found in drier forests, the majority of vegetation consists of bald cypress, tupelo gum, red swamp maple, black willow, box elder, buttonbush, swamp privet, duckweeds, lizard's tail, and numerous other herbaceous species. MDC has identified several significant examples of this increasingly rare community that occur in the project area including Big Oak Tree State Park, Ten Mile Pond and Weasel Woods (MDC 1999).

Scrub/shrub marsh and freshwater marsh are found in much smaller quantities in both basins, most of which is located on public land (e.g., Ten Mile Pond Conservation Area and Big Oak Tree State Park) and along perennial stream and lakes. Common shrub species in those habitats include young black willow, box elder, red maple, buttonbush, and swamp privet. Herbaceous species include *Carex* spp., cattail, giant cane, lizard's tail, smartweeds, and aquatic plants such as water lotus, coontail, duckweeds, Elodea, and water primrose.

The vast majority of the study-area wetlands, approximately 50,900 acres, consists of wet croplands dissected by numerous ditches and scattered tracts of BLH forest. Most of that acreage, especially the lowest, most flood-prone lands, is planted in soybeans. The remaining wetlands are largely composed of 4,000 acres of wet herbaceous vegetation, much of which are adjacent to croplands and levees. Although such habitats have been highly altered, they can provide valuable wintering, migration, and breeding habitat for numerous species of fish and wildlife depending on the period and depth of inundation.


Illinois
Cypress Creek
National Wildlife Refuge
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Birds Point New Madrid
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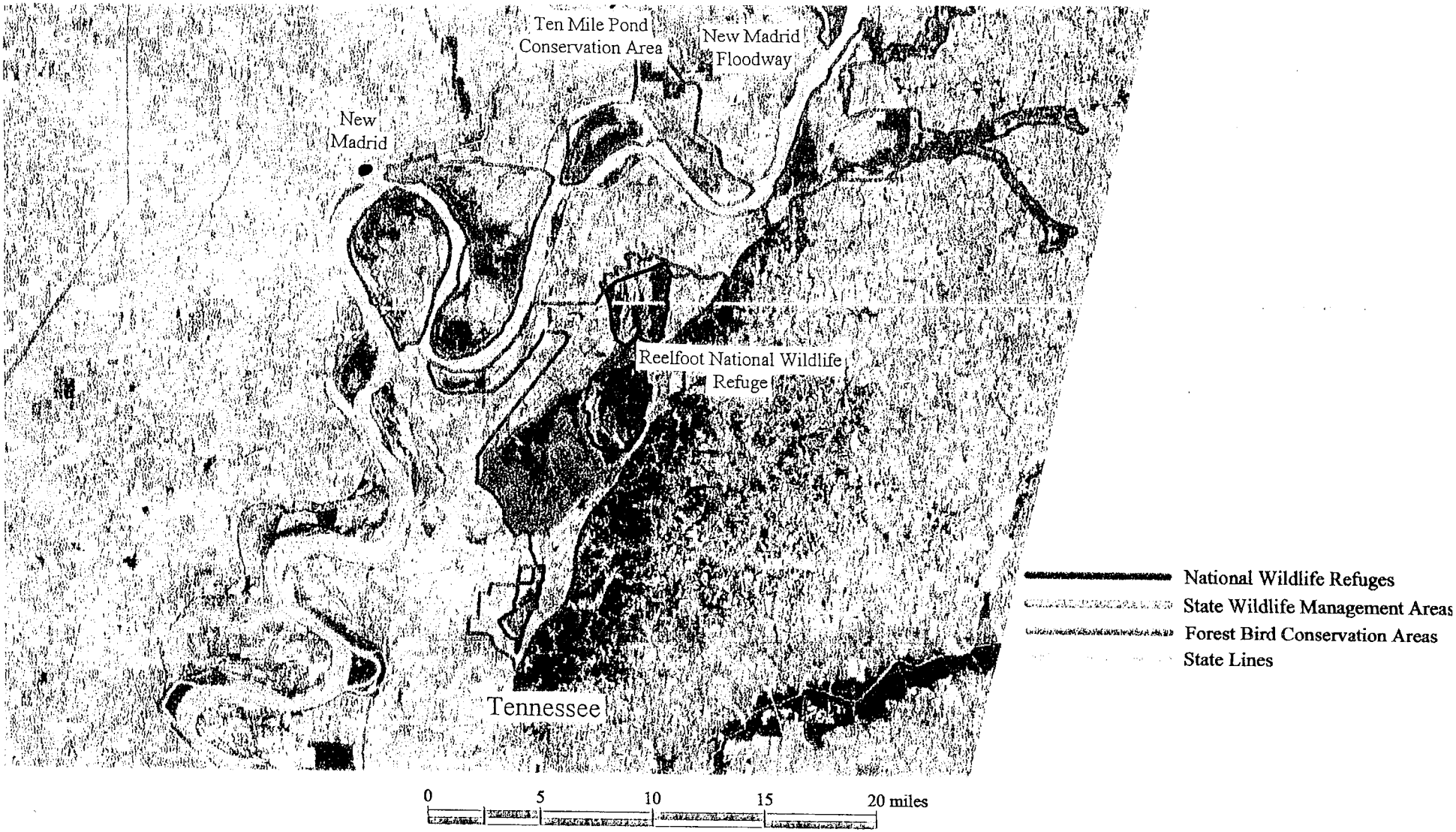


Figure 2. Forest Bird Conservation Areas in and around the St. Johns Bayou/New Madrid Floodway project area

Open Waters

Permanent open water in the project area consists of natural streams, oxbows and ponds, ditches, and borrow pits. The sand and gravel alluvium underlying much of the lowlands act as a vast reservoir for storing precipitation. This water reserve is released slowly into the ditches creating well-sustained base flows (Pflieger 1997). The riparian corridor along many reaches of the major drainage ditches, streams, and borrow pits provides shade needed to sustain aquatic life by maintaining moderate summer water temperatures. These waterways vary greatly in size, current velocity, water clarity, depth, and amount of aquatic vegetation. Some ditches also contain deeper pools, woody debris, and a variety of emergent and submergent vegetation (Pflieger 1997). Lentic habitats (i.e., borrow pits, oxbow lakes, and ponds) also contribute to habitat diversity in the project area, which in turn supports an extremely diverse shellfish and finfish fauna.

Another critical component of project-area waters are temporary ponds and overflow areas. Although localized rainfall can produce these ephemeral features, particularly in the St. Johns Bayou basin, inundation from the Mississippi River produces up to tens of thousands of acres of this habitat annually. Such areas hold water for only days or weeks, yet are critical to migratory birds and breeding reptiles, amphibians, and fish.

Wildlife Resources

In the project area, waterfowl are present throughout year. Wood duck, and to a lesser extent, mallard, hooded merganser and blue-wing teal, breed in the project area. During migrations and overwintering, the St. Johns Bayou basin and the New Madrid Floodway are important areas for hundreds of thousands of dabbling ducks (i.e., mallard, gadwall, green and blue-wing teal, pintail, widgeon, shoveler, and black duck), coots, and geese. Diving ducks, such as lesser scaup, ring-neck, and canvasback use the deeper waters of the project area. Migration is a slow, drawn-out process during which waterfowl require feeding and resting habitat. Earliest fall migrations of waterfowl occur in mid-August when the first flocks of blue-wing teal arrive. Fall migration continues through late December and even early January as more winter hardy species make their way south. Fall/winter migration has barely concluded before early migrants fly north. Wintering may occur at various latitudes and is dictated by habitat availability and freeze up. Spring migration through the project area generally concludes by mid-March as the last of the shovelers and blue-wing teal depart. Because of their importance to waterfowl, wetlands in the project area are a key component in the Lower Mississippi Valley Joint Venture, a feature of the North American Waterfowl Management Plan (MDC 1989).

The diverse habitat in the project area also supports hundreds of water-dependent and terrestrial bird species, both during breeding and migration. Although there are no heronries in the project area, wading birds such as the great blue heron, little blue heron, great egret, snowy egret, and yellow-crowned night heron depend on project area wetlands as foraging habitat. During migration thousands of shorebirds, such as greater yellowlegs, killdeer, dunlin, short-billed dowitcher, lesser golden-plover, semipalmated plover and solitary sandpiper, rely on shallow

water, overflow areas to forage, replenishing critical energy supplies for the flight to northern breeding grounds. Forested wetlands have been found to support a significantly higher abundance and diversity of birds species compared to upland forests (Brinson et al. 1981). In the project area, numerous species of raptors, woodpeckers, warblers, thrushes and flycatchers use BLH forests as migration and breeding habitat. The State-listed Mississippi Kite (rare) has been known to nest in BLH forests within the project area. Recent research, however, has pointed to sharp population declines in several neotropical migratory songbird species (e.g., white-eyed vireo, northern parula, cerulean warbler), particularly those that require large forested tracts to successfully reproduce (Robbins et al. 1989, Askins et al. 1990). In the Lower Mississippi Valley, the Partners in Flight Program is focusing on forested wetlands conservation because 13 of the 14 priority species require BLH forests for breeding. The Service, state agencies and the private sector are developing management objectives to protect forest breeding birds and their habitats in the Mississippi Alluvial Valley. As part of that effort they have identified "birds conservation areas" (i.e., forest patches 10,000 acres or greater to support long-term, self sustaining populations of forest breeding birds) that contain cleared areas to potentially be reforested. Several of those areas are in or near the project area (Figure 2).

Important game mammals that occur in the project area include white-tail deer, eastern gray and fox squirrels, State-listed rare swamp rabbit and eastern cottontail rabbit. The mink, beaver, raccoon, and muskrat are economically important furbearers found in the project area. Other common mammals found in the project area are striped skunk, coyote, red fox, various rodents, and big and little brown bats.

Johnson (1997) notes that "The native swamplands of southeast Missouri provide unmatched habitat for many species of amphibians and reptiles...." Amphibians expected to occur on stream and lake edges, ponds, and in forested wetlands in the project area include the western lesser siren, marbled and small mouth salamanders, Fowler's toad, eastern narrow-mouthed toad, spring peeper, green treefrog, and bronze frog. Wetlands in the project area also support a number of State-listed rare species including the three-toed amphiuma, Illinois chorus frog, and the eastern spadefoot toad. Reptiles found in sloughs, swamps, ditches, oxbows, and ponds in the project area include Mississippi mud turtle, stinkpot, southern painted turtle, State-listed rare western chicken turtle, red-eared slider, alligator snapping turtle and the eastern spiny softshell, broadhead skink, black rat snake, State-listed rare dusky hognose snake, speckled king snake, water snakes, western ribbon snake, eastern garter snake, and rough green snake.

Aquatic Resources

The network of drainage ditches in southeast Missouri was largely constructed at the turn of the century when the region was converted to agricultural land. This development replaced the majority of the natural landscape leaving the ditches as the principal habitat for aquatic resources (Pflieger 1997). Changes in the aquatic fauna were undocumented, but this large-scale disturbance undoubtedly altered the original assemblage of species. Many species characteristic of lowland habitats have managed to persist in the area, but not necessarily in their former

abundance. Other species that were able to exploit ditch environments may have benefitted from the altered conditions.

The project area supports a remarkably rich and distinctive fishery. In all, 114 species representing 22 families have been collected from the project area-drainages and the Mississippi River (Appendix A, Table A-1). Of these species, 93 have been collected from ditches and bayous in the project-area drainage (Sheehan et al. 1998, MDC 1997). The remaining 21 species have been collected from the Mississippi River proper (U.S.G.S. 1991-1996, MDC 1997). Of the 93 species collected from the project area, 10 are considered endangered, rare, or on the watch list in the state of Missouri. One species, the golden topminnow, once believed to be extirpated from Missouri, was collected recently from the St. James Ditch (Sheehan et al. 1998). Many fish species collected in the St. Johns Bayou basin and the Floodway are either confined to the Mississippi lowlands or occur only occasionally elsewhere in the state (Pflieger 1997). The diversity and abundance of the fish fauna reflects the regionally-rare and diverse aquatic habitats in the project area (see above).

The New Madrid Floodway is the only portion of the historic Mississippi River floodplain and its tributaries in Missouri still connected to the river. Annual flooding in the Floodway is an important natural cycle of the Mississippi River. Backwater flooding in that area provides significant spawning, nursery, and foraging habitat for river fish (Sheehan et al. 1998). This event greatly enhances fish stocks and plays an important role in maintaining fish diversity in the Mississippi River and its floodplain. Most of the fish species that have been collected in the project area use the inundated floodplain for rearing and spawning or depend on free access to small tributaries such as Mud Ditch during their reproductive season in the spring (Sheehan et al. 1998). Baker et al. (1991) noted that floodplain ponds support some of the most unusual fish communities in river systems. Uncommon species characteristic of that habitat include chain pickerel, golden topminnow, flier, banded pygmy sunfish, and the cypress, mud, bluntnose and slough darters, all of which have been documented from the project area (MDC 1997, Sheehan et al. 1998, U.S.G.S. 1991-1996).

Recent sampling in the project area has documented significant fish production from flood waters. Sampling of Mud ditch and St. Johns Bayou below the outlet structure in 1993 and 1994 (mid-May to early July) collected large numbers of young-of-the-year (YOY) fishes. Those collections were made as backwaters drained to the Mississippi River (John Tibbs, Texas Wildlife and Parks, pers. comm.). The YOY specimens represented 27 and 17 species in 1993 and 1994, respectively. Similar results were reported by Sheehan et al. (1998) after collecting fishes from inundated floodplain and channel habitats during a time period which coincided with a rise and fall of flood waters in the project area. Adult fish and YOY collected represented 24 species from the New Madrid Floodway and 11 species from the St. Johns Bayou basin. Adults of many species showed a reduction in gamete presence starting from the beginning of the flood pulse which suggested that spawning occurred during the flood event. The majority of species reported by Tibbs and Sheehan are river species that require quiet, off-channel habitat for spawning and rearing of young including sportfishes such as white bass and channel catfish and three species of commercially important buffalo (black, bigmouth, and smallmouth). These

collections also contained extremely large numbers of YOY gizzard shad, which are a principal prey species for predaceous fishes (e.g. largemouth bass, white bass, catfishes, sauger, crappie, and gar).

Sheehan et al. (1998) also reported differences in species composition between the St. Johns Bayou basin and New Madrid Floodway. Although more shad were collected in the St. Johns Bayou basin, the New Madrid Floodway yielded twice as many YOY fish species other than shad, including white bass and buffalo species. Sampling data also suggested either a single, protracted or more than one major white bass run occurring in the New Madrid Floodway. Those species differences are believed to be related to the hydrologic connectivity (i.e., fish access) between the Mississippi River and the Floodway during the spring spawning period.

Project-area waters also support diverse sport-fish communities in both the St. Johns and the New Madrid basins that provide significant angling opportunities for the public. The recreational fisheries provided by Mud Ditch, St. Johns Bayou, and the Mississippi River are important to this area of the state because of the lack of other fishable waters in the Bootheel. The lower New Madrid Floodway is the site of an important white bass fishery. In the spring, white bass from the Mississippi River enter Mud Ditch in large numbers to spawn. This annual event attracts anglers from New Madrid as well as surrounding areas of Sikeston and Dexter, Missouri (Randy McDonough, MDC, pers. comm.). During spring flooding, several species of buffalo and carp also enter the floodway from the Mississippi River to spawn. Anglers take these fish by gigging in shallow floodplain waters. In spring, Mud Ditch also provides significant angling opportunities for crappie, channel catfish, and flathead catfish as far as Ten Mile Pond Conservation Area (Dave Wissehr, MDC, pers. comm.). Those fisheries depend on that open connection between Mud Ditch and the Mississippi River to allow those species access into the Floodway to spawn.

In addition to seasonally abundant sportfishes, the project area supports a diversity of resident sport fishes. Abundant species include channel catfish, flathead catfish, largemouth bass, bluegill, white crappie, freshwater drum, and common carp. While fishing for any of the above species, anglers can also anticipate occasional action from a variety of less common sport fishes depending on the fishing technique used. These species include: spotted bass, blue catfish, yellow bass, sauger, rock bass, black crappie, longear sunfish, warmouth, black bullhead, yellow bullhead, chain pickerel, grass pickerel, bowfin, quillback, river carpsucker, northern hogsucker, river redhorse, shorthead redhorse, golden redhorse, spotted sucker, grass carp, and bighead carp.

The drainage ditches of southeast Missouri provide significant freshwater mussel habitat. The combination of moderate depth and current velocity, stable flows, sandy substrates, substantial groundwater flow, and abundant fish hosts found in these ditches provide good conditions for a variety of unionid species. Relative to natural rivers of similar size, mussel populations in these ditches are relatively diverse, abundant, and rather uniformly distributed (Barnhart 1998). Recent studies in the lowland region show that at least 30 species of unionids presently inhabit the lowland drainage ditches (Jenkinson and Ahlstedt 1987, Ahlstedt and Jenkinson 1991, Roberts et al. 1997). Such numbers are particularly significant in light of the dramatic decline in freshwater

mussels in the southeastern United States which has one of the richest mussel fauna in the world (Williams et al. 1993). That decline is attributed to habitat destruction by dams, channel improvements and siltation (Neves 1993). In addition, competition from exotic species such as the Asian clam *(Corbicula fluminea)* and the zebra mussel (*Dreissena polymorpha*) is believed to be hastening the demise of native mussel fauna (Williams et al. 1993).

In a survey of project-area drainages, Barnhart (1998) collected 24 unionid species (Table A-2), representing over one-third of those known to occur in Missouri. The highest species diversity and greatest abundance of individuals was found in the lower portions of Lee Rowe Ditch and in the Setback Levee Ditch. Species composition differed between the Floodway and St. Johns Bayou basin. Thirteen species were found in the St. Johns basin that were not found in the Floodway. Only one species, *Obliquaria reflexa*, was found in the New Madrid ditches and not in the St. Johns ditches. Four species that occur in the project area, the rock pocketbook (*Arcidens confragosus*), flat floater (*Anodonta suborbiculata*), wartyback (*Quadrula nodulata*), and Texas liliput (*Toxolasma texasensis*) are considered rare in Missouri. Of these species, the rock pocketbook and flat floater are among the most rare unionids in the State (Oesch 1995). The ditches of the Bootheel lowlands appear to provide the most important habitat for these four species within the State (Barnhart 1998).

Crayfish are one of the dominant groups of invertebrates occurring in a variety of flowing and standing-water habitats (Pflieger 1997). They are an important food source for many fish (Momot et al. 1978) and are a major food item in the diet of bullfrogs in ponds, lakes and streams (Korschgen and Moyle 1963, Korschgen and Moyle 1955). A wide variety of other wildlife species, including snapping turtles, racoon, mink, great blue heron, and belted kingfisher also prey heavily on crayfish (Pflieger 1997).

Although crayfish surveys specific to the project area have not been conducted, the Lowland Region in Missouri's Bootheel, supports a small but distinctive crayfish fauna. A State-wide crayfish survey conducted by the MDC found 10 species representing six genera in southeast Missouri (Pfleiger 1997). These species include, the shrimp crayfish (*Orconectes lancifer*), grey-speckled crayfish (*O. palmeri*), devil crayfish (*Cambarus diogenes*), White River crayfish, (*Procambarus acutus*), red swamp crayfish (*P. clarkii*), vernal crayfish (*P. viaeveridus*), Cajun dwarf crayfish (*Cambarellus puer*), Shufiddt's dwarf crayfish, (*C. shufeldtii*), digger crayfish (*Fallicambarus fodiens*), and shield crayfish (*Faxonella clypeata*). While most of these species have large distributions nationwide, the occurrence of several of those species in Missouri is limited to the bootheel. The State-listed species are the shrimp crayfish , the shield and digger crayfish, and the Cajun and Shufeldt's crayfish. Swamp and seasonally flooded roadside ditches and sloughs are important habitat these macroinvertebrates (Pfleiger 1997). The variety of ditch habitats are also important for crayfish.

Available data on the benthic larval insect fauna from the project area is limited to a small number of collections made in St. Johns ditch in 1995 and 1996. Those samples revealed a surprisingly diverse non-dipteran insect community (Samuel McCord, QST Environmental, pers. comm.). Several "intolerant" taxa were found including *Perlesta* (Plecoptera), *Brachyucentrus*

(Trichoptera, caddisflies) and *Ploycentropus* (Trichoperta). The presence of these species indicates good water quality and favorable conditions. Dominance of dipteran (flies) taxa usually indicates polluted waters.

Endangered Species

Two federally listed endangered species, the interior least tern (*Sterna antillarum athalassos*), and pallid sturgeon (*Scaphirhynchus albus*), and one federally listed threatened species, the bald eagle (*Haliaeetus leucocephalus*), occur in the project area. That area is also within the historic range of the endangered fat pocketbook pearly mussel (*Potamilus capax*).

Interior least terns nest in colonies on barren sandbars in the Mississippi River adjacent to the New Madrid Floodway. Based on a 1999 census, there were seven tern colonies within several miles of the project area (Jones 1999). Both adult birds and chicks require an abundant supply of small fish, and adults may forage for fish up to two miles from the nest site. Large numbers of adult terns have been observed foraging in the spring (mid to late May) in the lower end of St. Johns Bayou below the outlet structure and its confluence with Mud Ditch, because of the availability of large numbers of forage fish (Katie Dugger, University of Missouri, pers. comm.) as the backwater drained to the river.

Both adult and juvenile pallid sturgeon are reported from the Mississippi River and associated off-channel habitats in the project area. MDC documented a juvenile pallid sturgeon that was released in the Middle Mississippi River and later caught in a river backwater near Point Pleasant, Missouri (River Mile 878) in 1994. Nine of the sub-adult pallid sturgeon released by MDC into the Mississippi and Missouri rivers have been recaptured in tributaries or tributary confluence areas. Commercial fishermen report capturing adult pallid sturgeon in these same habitats. While these data suggest that connected tributaries and backwaters of the Mississippi River, such as Mud Ditch and the New Madrid Floodway, may be important feeding habitats or refugia for some life stages of pallid sturgeon, most adult pallid sturgeon from the lower river have been captured over sand in deep, main channel habitats with current (Reed and Ewing 1993, Constants et al. 1997).

Low numbers of wintering and nesting bald eagles (*Haliaeetus leucocephalus*) occur along the Mississippi River in New Madrid and Mississippi counties. In early 1998, three bald eagle nests (one of which is active) were observed in the project area near Hubbard Lake. That year the active nest contain one chick (Chris Mills, pers. comm.) In 1999, that nest fledged 2 young. Bald eagles generally build nests in the tops of large bald cypress or cottonwood trees near water. Their diet consists of fish, although waterfowl and small mammals will also be taken. Waterfowl is particularly important to wintering bald eagles who often are associated with major waterfowl concentration areas. Just south of the Floodway, eagles successfully fledged young at Donaldson Point Conservation Area in 1992 and have made several nest attempts elsewhere in Mississippi County.

The project area is within the range of the federally endangered fat pocketbook mussel, *Potamilus capax*. This species was historically widespread and ranged from the Mississippi River, Minnesota, southeast to the Wabash and Ohio rivers and west to the St. Francis River drainage of Arkansas. Currently, fat pocketbook mussels are limited to the St. Francis River drainage in Arkansas, the lower Wabash and Ohio Rivers in Illinois, Indiana, and Kentucky, and possibly in stretches of the upper Mississippi River adjacent to Missouri (U.S. Fish and Wildlife Service 1989, Cummings et al. 1990). The most significant remaining population of *P. capax* resides in ditch tributaries of the St. Francis River in northeast Arkansas and southeast Missouri (Jenkinson and Alstedt 1993-1994, Roberts et al. 1997).

An environmental survey reported *P. capax* in the project area from Fish Lake Ditch at Hwy 80, just northeast of the Ten Mile Pond Conservation Area (CA) (Environmental Science and Engineering, Inc., (ESEI) 1978), however, no voucher specimens were provided. A 1980 survey of Fish Lake Ditch by Alan Buchanan, MDC, failed to find this species. He believed the mussel reported by ESEI to be *P. capax* was actually mistaken for *L. ventricosa* (=*cardium*), a similar species. The most comprehensive mussel survey of the St. Johns and New Madrid basins did not find any evidence of this species (Barnhart 1998). However, many of the ditches in the project area may be suitable habitat (Brian Obermeyer, Kansas Wildlife and Parks, pers. comm.).

Federal Candidate Species

Two candidate fish species, the sicklefin chub and sturgeon chub, occur in the main channel of the Mississippi River in the project area. The chubs are small, native river cyprinids which are currently being considered for federal listing as threatened or endangered. Both those fish occur along and over sandbars in main channel border areas and chutes between the mainland and sandbar islands. Typically, they are found over sand and gravel substrate and in current velocities of 0-1.3 feet-per-second. The reformulated project will not affect habitat for these species.

Public Lands

The MDC manages two conservation areas in the project area. The Ten Mile Pond CA covers 3,793 acres of cropland, wetlands and forest. It is located in the Floodway along an old oxbow lake formed when the Mississippi River meandered over that section of floodplain. The ditches, ponds and lake on the CA provide significant opportunities for anglers. That area also provides opportunities for small and big game hunting, as well as waterfowl. The Donaldson Point CA lies largely outside the frontline levee along the Floodway. That 5,785-acre area is mostly BLH forest. Bald eagles have been known to nest there.

Big Oak Tree State Park is managed by the Missouri Department of Natural Resources. It includes approximately 1,000 acres of rare swamp and BLH forest. Because it is one of the few remaining forested wetlands in southeast Missouri, it serves as a refugia for many increasingly rare species and contributes significantly to the biodiversity of the region. The Park claims two

national and three state champion trees. Several State-listed rare plant and animal species have also been recorded in the Park.

Floodplain Ecology

The St. Johns Bayou basin and the New Madrid Floodway were originally part of the historic Mississippi River floodplain, and although highly altered, still perform floodplain functions critical to nationally significant fish and wildlife resources. As previously mentioned, the Floodway, in particular, is still largely connected to the Mississippi River which annually inundates much of the lower study area, providing an important exchange between terrestrial habitats and the aquatic system. Such flood pulses have been called "the principal driving force(s) for the existence, productivity, and interactions of the major biota in river-floodplain systems..."(Junk et al. 1989). Not only do flood waters rejuvenate aquatic habitats (e.g., bayous, oxbows, sloughs, ditches, ponds and wetlands) on the floodplain, they also provide access to the floodplain's productivity which is far greater than that of the river main stem (Junk et al. 1989, Guillory 1979). Much of that productivity is organic detritus (e.g., leaves, grasses, etc.), however invertebrate levels are also significant. Eckblad et al. (1984) found the number of macroinvertebrates drifting from an upper Mississippi River backwater was three to eight times higher than in the main channel upstream of the backwater. Hrabik (1994) notes that floodplain production is high relative to the other macrohabitats based on estimated zooplankton densities and biological oxygen demand rates. In 1993, zooplankton density was 500 times greater in the wide versus the moderately-wide floodplain near Cape Girardeau (Hrabik 1994). That productivity in turn supports the fisheries and other aquatic resources of the river proper (Junk et al. 1989, Amoros 1991, Lambou 1990, Welcomme 1979). Based on post-flood studies on the Missouri River, Galat et al. (1998) noted that river flooding can facilitate zooplankton colonization of floodplain habitats as documented by higher cumulative species richness in scour holes that were continuously or periodically connected to the river than scour holes with no such connection.

The variability of natural flooding regimes and associated ecologic processes, both within and among years, creates and maintains diverse habitats and differential species success that supports the greatest biodiversity (Poff et al. 1997, Galat et al. 1998). Because of Mississippi River flooding, the study-area floodplain provides diverse habitats essential for spawning, rearing, foraging, and refuge to numerous aquatic species. Fishes that seasonally use the floodplain dominate the fisheries, biomass, and production in river-floodplain systems (Junk et al. 1989). Approximately half of the fish species of the lower Mississippi River use the floodplain as a nursery (Gallagher 1979). In most years, rising river levels inundate the floodplain in the spring, while rising temperatures and increased photoperiod trigger spawning in numerous fish species. In their work on a southern BLH forest along the Tallahatchie river, Turner et al. (1994) collected more larval and juvenile fish from the floodplain than from the adjacent river, consistent with several other studies. Unlike the main stem of the river, the floodplain is characterized by slackwaters, beds of aquatic vegetation, and organically rich substrates (Guillory 1979, Rissoto and Turner 1985), important habitat for fish spawning and rearing. Those areas often have

aquatic vegetation, snags, and logs that also provide refuge from predators (Killgore and Hoover 1998).

Other wildlife also benefit from spring floods. Many species of amphibians throughout the project area require shallow waters to successfully reproduce. In addition to permanent ponds, sloughs, and ditches, spring flooding can cover up to 75,000 acres in the New Madrid Floodway alone. As those waters recede, they create thousands of ephemeral ponds critical to maintaining a healthy and diverse amphibian population. Habitats with variable flooding regimes have been shown to support highly divers herptofauna. Work by Galat et al. (1998) documented differential use and abundance of reptiles and amphibians in a variety of wetland types. For example, connected scours were dominated by false map turtles and softshells; remnant wetlands had more sliders and painted and snapping turtles. Scour holes contained to the river contained the highest species richness. Remnant wetlands had the more species of salamanders and snakes than other types of wetlands. Those various wetland types also supported a diverse bird assemblage, where species use of a particular type of wetlands appeared to depend on wetland size, structural diversity, and depth. In addition, flooding increases invertebrate biomass, which then becomes an important protein source for waterfowl and shorebirds on their migration to northern breeding grounds (Helmers 1992, Reinecke et al. 1989).

Mississippi and New Madrid counties, including the project area, support more diverse habitats and natural communities than elsewhere in the Bootheel. That increased diversity is reflected in the number of State-listed plant, mussel, fish, amphibian, reptile, bird, mammal, and natural communities reported for the two-county area (Table 2) and is due in part to the influence of the river's annual hydrologic regime on the lower St. Johns Bayou basin and New Madrid Floodway. Although greatly altered, the project area still functions as an integral part of the Mississippi River ecosystem, and provides important breeding, migration and overwintering habitat for numerous species. The forested wetlands in the project area, a small remnant of a once extensive forest complex, are becoming increasingly scarce. At the same time, they become more and more critical as refugia to numerous species that once flourished on the floodplain. In spite of numerous modifications, the varied habitats within the project area contribute significantly to the State's biodiversity and the ecological integrity of the lower Mississippi River.

Fish and Wildlife Concerns and Planning Objectives

Historically, the Mississippi River Alluvial Valley floodplain was the largest bottomland forested wetland in North America covering approximately 2.5 million acres. Most of that area was subject to periodic flooding by the Mississippi River, providing invaluable habitat for fish and wildlife. Since the early 1700s, however, channelization and levee construction have reduced the natural floodplain of the lower Mississippi River by 90 percent (Fremling et al. 1989). Most of the forested wetlands have been converted to cropland. Private and publicly funded flood control and drainage projects have drastically changed the hydrologic relationship between the floodplain and the river, essentially eliminating seasonal interchange. Baker et al. (1991) have called the reduction of seasonally inundated floodplain due to levee construction the single most

Table 2. State-listed rare and endangered species in New Madrid and Mississippi counties

Plants	Mississippi	New Madrid
Gourd (*Cayaponia grandifolia*)	S1	
Juniper leaf (*Polypremum procumbens*)	S2	S2
Trepocarpus (*Trepocarpus aethusae*)	S1	
Primrose willow (*Ludwigia leptocarpa*)	S2	
Yellow false mallow (*Malvastrum hispidum*)	S3	
Arrow arum (*Peltandra virginica*)	S2	
American frogbit (*Limnobium spongia*)	S2	
American cupsale (*Sacciolepis striata*)	S1	
Swamp loosestrife (*Decondon verticillatus*)	S1	
Bristly sedge *(Carex comosa*)	S2	
Sedge (*Carex socialis*)	S2	
Corydalis (*Corydalis micrantha*)		S2
Leatherflower (*Clematis viorna*)		S1
Finger dog-shade (*Cynosciadium digitatum*)		S2
Weak nettle (*Urtica chamaedryoides*)	S1	S1
Narrow-leaved wild crabapple (*Malus augustifolia*)		S1
Eastern blue-eyed grass (*Sisyrinchium atlanticum*)	S2	S2
An umbrella sedge (*Cyperus retroflexus*)	S1	
An umbrella sedge (*Cyperus grayoidies*)		S2
Many-spiked cyperus (*Cyperus polystachos*)		S2
Baldwin's cyperus (*Cyperus croceus*)		S1
Mussels		
Rock pocketbook (*Aricidens confragosus*)	S3	S3
Wartyback (*Quadrula nodulata*)	S3	S3
Flatfloater (*Anodenta suberbiculata*)	S2	S3
Texas lillput (*Toxolasma texasensis*)	S3	S3
Fish		
Harlequin darter (*Etheostoma histrio*)	(E)S2	
Flier (*Centrarchus macropterus*)	S3	

E - State listed endangered X- communities no longer ranked

Rank:

S1 - Critically imperiled in state because of rarity or other factors; vulnerable to extirpation from state (typically 5 or fewer individuals, very few remaining individuals).

S2 - Imperiled instate because of rarity or other factors; vulnerable to extirpation from state (6 to 20 occurrences or few remaining individuals or acres).

S3 - Rare and uncommon in the state (21 to 100 occurrences).

Table 2 (cont'd.). State-listed rare and endangered species in New Madrid and Mississippi counties

	Mississippi	New Madrid
Fish		
Ironcolor shiner (*Notropis chalybaeus*)	S1	S1
Mississippi silvery minnow (*Hybognathus nuchalis*)	S3	
Pallid sturgeon (*Scaphirynchus albus*)	(E)S1	
River darter (*Percina shumardi*)	S3	
Blue sucker (*Cycleptus elongatus*)		S3
Lake chubsucker (*Erimyzon sucette*)	S2	S2
Brown bullhead (*Ameiurus nebulosus*)		S3
Mooneye (*Hiodon tergisus*)	R	S2
Paddlefish (*Polydon spathula*)	S3	
Sicklefin chub (*Macrhybopsis meeki*)	S3	
Golden topminnow (*Fundulus chrysotus*)	S1	
Reptiles and Amphibians		
Illinois chorus frog (*Pseudacris streckeri illinoensis*)	S2	S2
Western chicken turtle (*Deirochelys recticularia miaria*)	(E)S1	
Eastern spadefoot *(Scaphiopus holbrookii)*	S2	
Alligator snapping turtle (*Macroclemys temminckii*)	S2	S2
Birds		
Bald eagle (*Haliaeetus leucocephalus*)	(E)S2	(E)S2
Mississippi kite (*Ictinia mississippiensis*)	S2	S2
Pied-billed grebe (*Podilymbus podiceps*)	S2	S2
Interior least tern	(E)S1	(E)S1
Barn owl (*Tyto alba*)	(E)S2	(E)S2
Swainson's warbler *(Limnothlypis swainsonii)*		(E)S1
Little blue heron *(Egretta caerulea)*	(S2)	
Snowy egret *(Egretta thula)*	(S1)	
Mammals		
Swamp rabbit (*Sylvilagus aquaticus*)	S2	S2
Cotton mouse (*Peromyscus gossypinus*)		S2
Communities		
Wet Bottomland Forest	X	X
Swamp	X	X
Shrub swamp	X	

Source: MDC (1997 and 1999), Carter and Bryson (1991), Barnhart (1998), MDNR (1997)

deleterious alteration to the lower Mississippi River. Today, drainage ditches are the principal remaining aquatic habitat in much of the Bootheel (Pflieger 1997).

The above alterations to the Mississippi River floodplain have been accompanied by marked declines in both the abundance and diversity of fisheries and wildlife of the region. Many once-common species are becoming scarce and several are Federally listed as endangered or threatened. Most of the remaining unique flora, fauna, and natural communities in the project area are associated with the wetlands that still remain in portions of the St. Johns Bayou basin and the Floodway. Those wetlands, however, will lose most their wetland functions, and will be more likely converted to agriculture once they are no longer subject to backwater flooding.

In recognition of the critical functions wetlands provide to fish, wildlife, and humans (e.g., improve water quality, store storm water, reduce flood stages, etc.), Congress has enacted legislation (i.e., Clean Water Act) to protect remaining wetlands and to reverse historic wetland losses (e.g., 1985 and 1990 Farm Bills; Emergency Wetlands Protection Act of 1986; Water Resources Development Acts of 1986, 1992, and 1996; Agriculture Credit Act of 1987; Conservation Reserve Program; Food Security Act of 1992; Wetlands Reserve Program (WRP); and Federal Agriculture Improvement and Reform Act of 1996). Approximately 1,024 acres within the project area are enrolled in the WRP.

The National Research Council (1992) noted that the cornerstone of modern floodplain restoration and integrated floodplain management rests on the understanding that "rivers and their floodplains are so intimately linked that they should be understood, managed, and restored as integral parts of a single system." To underscore the importance of floodplains as an integral part of the river ecosystem, Executive Order 11988 on floodplain management states that Federal agencies should avoid undertaking actions that directly or indirectly adversely affect natural floodplain functions and values. Furthermore, the President's Clean Water Initiative has a goal of gaining 100,000 acres of wetlands annually by the year 2005. Clearly, the above authorities direct agencies to take advantage of every opportunity to protect, improve and restore wetland habitat in the study area and enhance regional fish and wildlife resources.

To address the previously noted problems and ensure that fish and wildlife resources receive equal consideration with other project purposes, the Service and MDC developed the following planning objectives to be incorporated into the St. Johns Bayou and New Madrid Floodway Project:

1. Avoid and/or minimize adverse impacts on fish and wildlife resources by minimizing negative impacts to marshes, forested wetlands and aquatic habitats in the project area, and ensuring fisheries access to the Floodway during spring for spawning and nursery habitat.;

2. Incorporate the goals of the North American Waterfowl Management Plan and other Administration wetland-related initiatives in project planning;

3. Provide compensatory mitigation to fully offset unavoidable project-related losses of wetlands and aquatic habitat in the study area.

Evaluation Methodology

Estimation of project-related habitat changes is a fundamental technique used to assess project impacts to fish and wildlife resources. Those estimates also form the basis of other evaluations conducted by the Corps. For this project, we quantified habitat changes associated with the project construction rights-of-way (ROWs) for the levee closure and channel enlargement, and hydrologic changes from pump operations.

As part of an interagency team that included the Corps and MDC, the Service used several tools to evaluate project-related changes in the quantity and quality of habitat for fish and wildlife. Most of those tools are based on the Habitat Evaluation Procedures (HEP) (USFWS 1980). HEP is a method of estimating habitat suitability for evaluation species based on field measurements of parameters that limit the relative population density of a selected species. Using HEP (and similar tools), habitat quantity and quality can be measured for baseline conditions, and can be predicted for future without-project and future with-project conditions. The standardized, species-based method numerically compares future with-project and future-without project conditions to provide an estimate of project impacts on fish and wildlife resources. Further details on specific analyses are in Appendices B through E.

The Memphis District Corps of Engineers used a Geographic Information System to determine acreage of various land cover types within the study area based on satellite imagery. Those cover types and acreage were used to determine available habitat for the HEP analyses. The Corps then used stage area curves to determine the acreage that is inundated at least 5 percent of the growing season (approximately 12 days); those areas are considered wetlands. The Corps used changes in the stage area curves for each alternative to determine changes in wetland acreage. The Corps also used the stage area curves to determine acreage suitable for waterfowl and shorebirds (Appendices B and D).

Fish and Wildlife Resources Without the Project

Fish and wildlife resource conditions in the project area are unlikely to change appreciably without project implementation. Existing wetland protection should minimize conversion of small wetlands to other uses. Some additional landowners may even take advantage of several wetland programs that offer financial incentives to restore or improve wetlands on their property. Mature forested wetlands, such as in Big Oak Tree State Park, will continue to degrade (e.g., no regeneration) from previous hydrologic alterations unless water control programs are implemented to restore historic water levels. Forested wetlands along the lower reaches of St Johns Bayou may change to include species with greater water tolerance (e.g., cypress,

buttonbush, etc.), responding to the high water levels when the St. Johns gravity drainage structure is closed.

Fisheries resources will continue to have access to the Floodway ensuring nursery and spawning habitat and refugia, as well as contributing to the productivity of the river system. Project area ditches will be disturbed periodically during channel maintenance. Those events, however, generally occur over small reaches, several years apart, allowing the much of the ditch biota to recolonize the affected area. Both waterfowl and shorebirds will continue to benefit from seasonal flooding in the project area during spring migration. Tens of thousands of acres of permanent, seasonal and ephemeral ponding will help meet the life requirements of numerous reptiles and amphibians.

Description of the Proposed Alternatives

The Authorized Project alternative includes vegetative clearing along 4.3 miles (which has been conducted under a separate review) and enlarging 23.4 miles of rural channels in the St. Johns basin. The improved channel would be 200 feet wide along the lower St. Johns Bayou to the Setback Levee Ditch where it would narrow to 50 feet. The lower 3.5-miles of the St. James ditch will become 45 feet wide and the top bank along northern most reach (7.8 miles) will be widened to 100 feet. The project also includes a 1,000-cfs pump station near the existing gravity drainage outlet to accommodate the increased runoff. In the New Madrid Floodway, the Crops would construct a 1,500-cfs pump station in conjunction with a separately authorized levee closure and drainage structure at the southern end of the Floodway.

In addition to the authorized project, the Corps is also evaluating an Avoid and Minimize (A&M) alternative. Under the A&M alternative, channel widening in St. Johns Bayou would be reduced from 200 to 120 feet wide; bank work along the St. James Ditch would be restricted to one side of the channel to minimize impacts to riparian corridors; and pump operations would allow higher spring water levels in the St. Johns basin and the Floodway (i.e., pumping would stop at 282 and 280 NGVD versus 277 and 275 NGVD).

Project Impacts

Wetlands

Implementation of the either the Authorized or the A&M alternative would greatly alter the hydrologic regime of ten of thousands of acres of wetlands (Table 3). According to the Corps, approximately 36,480 acres of wetlands would no longer be seasonally inundated by backwater flooding under the Authorized Project alternative. Under the A&M alternative, approximately 36,000 acres would no longer be seasonally flooded. In the St. Johns Bayou basin, both alternatives would decrease the acreage of existing forested wetlands receiving riverine backwater flooding by approximately 27 percent. In the New Madrid Floodway, implementing

Table 3. **Wetland acreage affected under the Authorized Project and the A&M alternatives.**

St. Johns Bayou Basin

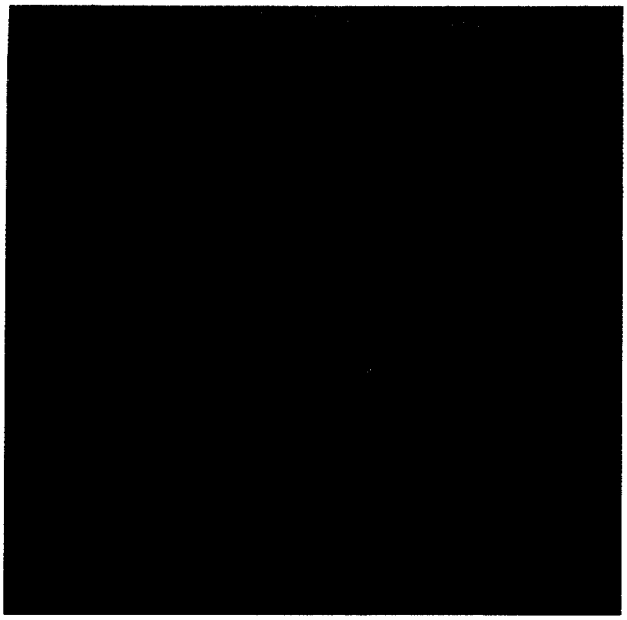
Land Use	Total Wetland Acres	Wetland Acres 300 and below	Authorized Acres	Authorized Percent total wetland acres	Avoid & Minimize Acres	Avoid & Minimize Percent total wetland acres
Forested	4,473.26	3,163.58	592.41	13.24	564.97	12.63
Scrub/Shrub/Marsh	12.54	4.14	1.11	8.85	1.11	8.85
Cropland	22,998.61	9,303.23	5,632.87	24.49	5,633.25	24.49
Pasture	135.23	75.87	19.26	14.24	19.36	14.32
Herbaceous	2,044.96	719.26	294.85	14.42	294.58	14.41
Open Water	944.24	286.97	169.02	17.90	166.28	17.61
Sandbar	11.47		-	-	-	-
Urban	1.96		-	-	-	-
Total	**30,622.27**	**13,553.05**	**6,709.52**	**21.91**	**6,679.55**	**21.81**

New Madrid Floodway

Land Use	Total Wetland Acres	Wetland Acres 300 and below	Authorized Acres	Authorized Percent total wetland acres	Avoid & Minimize Acres	Avoid & Minimize Percent total wetland acres
Forested	5,734.30	5,402.64	5,329.81	92.95	5,137.55	89.59
Scrub/Shrub/Marsh	193.62	139.17	139.1	71.84	138.14	71.34
Cropland	27,903.54	21,922.54	21,900.53	78.49	21,791.64	78.1
Pasture	205.78	140.9	139.53	67.8	135.59	65.89
Herbaceous	1,938.64	1,578.51	1,572.07	81.09	1,550.92	80
Open Water	797.29	691.4	689.16	97.5	622.37	87.63
Sandbar	0.33	-	-	-	-	-
Urban	-	-	-	-	-	-
Total	**36,773.50**	**29,875.16**	**29,770.20**	**81.14**	**29,376.21**	**80.07**

either alternative would reduce forested wetlands flooded by backwater by 90 percent. The Floodway would also have an 80 percent decrease in herbaceous wetland acreage affected by riverine flooding. Such changes in the hydrology of those wetlands would greatly diminish, and in some cases eliminate, their contribution to the riverine ecosystem. Those remaining wetlands not dependent on backwater flooding would become isolated, depressional systems. Wharton et al. (1982) noted that the productivity and ecologic value of forested wetlands depend on the "...primary driving force, the fluctuating water levels of the riverine system." As previously mentioned, the New Madrid Floodway currently is the only tributary floodplain still connected to the Mississippi River in Missouri. Implementation of either project alternative would sever that connection, essentially decoupling the floodplain from the river.

Project-related hydrologic changes would also lead to widespread dewatering of the remaining wetlands. Currently, 10,208 acres of forested wetlands occur in the project area. Some of the largest unprotected, contiguous stands of bottomland hardwood forests remaining in southeast Missouri occur in the lower St. Johns Bayou basin and will be most affected by project implementation. Under existing conditions, forested wetlands account for approximately 7.2 and 5.8 percent of the wetlands in the area below 300 feet NGVD (the area to be affected by either alternative). That figure includes public land, timber company land, and WRP land.



Although the remaining wetland areas are characterized by very heavy soils and a high water table, the same is true for much of the cropland in the project area. Overlaying the Corps' landcover data on the wetland map shows that most of the remaining undeveloped wetlands, particularly forested wetlands, correspond most closely to property lines and drainage networks, not the underlying soils. In many cases, modifications to the project area's natural hydrology and land owner practices have a greater effect on the distribution of wetlands than does the presence of hydric soils (Figure 3).

Figure 3. Big Oak Tree State Park

Although the Mississippi River seasonally recharges the groundwater in the eastern portions of the project area, the interaction between surface water, groundwater and river seepage is poorly understood (U.S.G.S., per. comm.). Currently, the Corps is working on several seepage control features in the Floodway as part of the Mississippi River Mainline Levee enlargement that will further modify water patterns in the project area. In addition, the cropping patterns in areas previously subject to backwater flooding are likely to emphasize more profitable crops and increase the use of irrigation, increasing surface and groundwater demands. Both project

alternatives would lower portions of the Setback Levee Ditch and the St. James Ditches by 5 feet. In a study of the effects of channelization on forested wetlands, Maki et al. (1980) noted that outside of seasonal effects, the greatest differences in ground water levels were caused by channel modification. They noted that deepened channels intercepted the groundwater table and depleted soil moisture in adjacent bottomlands. The water table in channelized basins remained at least 1.3 feet below the level found in natural watersheds regardless of land use. Luckey (1985) also found a similar pattern in southeast Missouri; namely that enhanced drainage lowers the groundwater levels in the soil. Maki et al. (1980) further noted that channelization not only reduces the amount of ponding on floodplains, but shortens ponding duration. During spring, summer, and fall, evapotranspiration demands can effectively eliminate surface ponding.

In light of the above factors, it is extremely to predict with certainty post-project surface water patterns in either basin. Under either project alternative, however, spring water levels will be significantly lower than existing conditions. The Corps believes that there will be no indirect project-related changes in jurisdictional wetlands because they anticipate that rainfall and groundwater seepage will maintain saturated soils in the existing wetlands sufficient to meet the wetland criteria. However, widespread changes in the hydrology of existing farmed wetlands, from pre-project inundation to post-project saturation, would have significant implications under the Food Security Act (FSA). The FSA stipulates that farmed wetlands must have a 50 percent chance of being seasonally ponded or flooded at least 15 days during or 10 percent of the growing season, whichever is less. Although the USDA, Natural Resources Conservation Service (NRCS), has previously called many of the farmed wetlands in the project area prior converted wetlands, recent discussions with NRCS (Pat Graham, pers. comm.) indicate that the mapping protocols used for those uncertified determinations were very limited, and that using current wetland protocols would show far more wetlands in the same area. A 1997 interagency review of those previous determinations, signed by NRCS, the Corps, EPA and the Service, showed that zero percent of those determination were found to be "... of sufficient quality for implementation of wetland conservation provisions of the Food Security Act and for purposes of implementing section 404 of the Clean Water Act."(See attached). Based on the Corps' modeling results, project-related hydrologic changes may remove inundation on up to 20,000 acres of farmed wetlands in the Floodway alone. Without surface-water flooding or ponding during the growing season, those acres would no longer meet the wetland criteria under the FSA. The Service believes such conversion would possibly violate the "Swampbuster" provisions of the FSA, which in turn could affect project sponsors who participate in Federal agricultural programs.

Swampbuster has been an effective mechanism to greatly reduce wetlands conversion associated with agricultural development. In fact, the Corps believes that Swampbuster regulations will reduce or prevent future wetlands conversion in the project area. Under the 1996 Federal Agricultural Improvement and Reform Act, however, current farm program payments (which play a large role in Swampbuster) are scheduled to end in 2002. After that time, there will be no financial disincentives for agricultural conversion of wetlands. In a recent publication the USDA (Heimlich et al.1998) summarized what they believe will happen if those payments are phased out:

> "... in the short run, 5.8 to 13.2 million acres [of wetlands] would be profitable to convert to agricultural production based on expected prices, increasing income for those farmers with wetlands to convert. In the long run, some marginal cropland would drop out of production, leaving a net cropland addition of 2.2 to 5.0 million acres. Increased commodity supplies from the added acreage would depress commodity prices for all farmers, resulting in reductions of farm income of $1.6 to $3.2 billion."

Furthermore, project implementation will replace a naturally-variable flooding regime with a well-regulated, fairly predictable flooding pattern. The level of risk to farmers who chose to crop previously marginal areas is greatly lowered. Considering the changes in future surface-water levels throughout the project area, reasonably foreseeable modifications to the project area's drainage patterns, existing land practices, and the USDA projections of future wetland conversion to agriculture, the Service believes most of the privately-owned forested wetlands no longer subject to backwater and overland flooding will face greater development pressure and likely will be converted to agriculture use.

Project implementation would not only reduce riverine flooding in both basins, but it would also significantly alter the temporal and spatial variability of that flooding. As proposed, pumping operations in the St. Johns Bayou basin and the New Madrid Floodway would replace a natural, highly variable flooding regime with a flooding pattern that would be the same each year; higher water levels (i.e., + 11 to 17 feet) in the winter, and lower water levels (i.e., - 4 to 8 feet) throughout much of the spring. This will eliminate years of high waters levels that infrequently rejuvenate higher elevation marshes, forested wetlands, and riparian areas. Based on the Corps' hydrologic analyses, the proposed alternatives would eliminate such flooding on 1,574 acres of forested tracts in the St. Johns Bayou basin, and 6,577 acres in the New Madrid Floodway. In addition, the proposed pumping operations will maintain artificially high winter water levels in the lower portions of both basins, further stressing the forested wetlands in those areas.

In their treatise on greentree reservoir management, Fredrickson and Batema (1992) underscore the importance of fluctuating water regimes to the maintenance of high productivity in forested wetlands. They noted several characteristic flooding patterns in unaltered forested wetlands that should be emulated in managed systems. Those include ensuring flooding after trees break dormancy in the spring; minimizing flooding that overtops red oak species during the dormant season that could lead to high mortality and prevent regeneration; and ensuring hydrologic variability within and among years (Fredrickson and Batema 1992). Neither of the proposed pumping operational alternatives incorporate those measures. Consequently, we believe those few forested wetlands remaining after project implementation may progressively degrade.

Floodplain wetlands provide an extremely important function at a landscape-level. Their capacity to store flood waters can greatly reduce river stages downstream (Taylor et al. 1990). In fact, cumulative losses of floodplain storage capacity in the Mississippi River Valley have led to increased flood stages in the lower river (U.S. Army Corps of Engineers 1998). Those higher

stages, in turn, lead to additional flood control projects (e.g., levee enlargements) to protect lives, property, and existing infrastructure. The Corps, recognizing the importance of that storage capacity, has designated certain floodplains along the lower river valley as "floodways." Those floodways are integral components of the Mississippi River and Tributaries Project. For example, the New Madrid Floodway was constructed to lower stages in Cairo, IL and Paducah, KY during a project flood. The proposed levee closure at the mouth of the Floodway would further decrease the available floodplain storage capacity along the lower river during river stages lower than a "project flood" (when the Corps would operate the Floodway), possibly affecting flood stages along this reach of the Mississippi River.

Wildlife Resources

Project-related impacts that have been quantified to date include changes in: winter carrying capacity for waterfowl (Appendix B), habitat value for forest wildlife (Appendix C) and foraging habitat for migratory shorebirds (Appendix D). Effects on other wildlife (e.g., reptiles and amphibians, wading birds), although not quantified, will be discussed qualitatively.

Implementation of the proposed project alternatives would greatly alter the habitat available for wintering and migrating waterfowl. One negative impact will be the loss of flooding diversity. Flood timing, duration, and depth will be controlled through pump operations, removing natural variability which contributes to the overall health and stability of wetland ecosystems. The Waterfowl Assessment Methodology (WAM) was used to quantify changes in the potential carrying capacity (i.e., food) for wintering and spring migrating waterfowl in the project area. WAM results indicate that the Authorized Project and the A&M alternatives would potentially produce an increase in duck-use days (DUDs) in December and January, while reducing DUDs in February and March. In the St. Johns Bayou basin, the Authorized Project alternative would potentially increase winter DUDs by 464,906 but reduce waterfowl habitat by 74,390 DUDs in February and March, during spring migration. WAM results for the A&M alternative in that basin show a similar winter increase, primarily because of increased moist soil and soybean acreage. That alternative would provide important habitat during spring migration by inundating forested wetlands. In the New Madrid Floodway, the Authorized Project would potentially increase the winter DUDs by 50,140 while reducing February and March usage by 225,822 DUDs; a pattern similar to that seen in the St. Johns basin. WAM results for the A&M alternative show a similar winter increase, and a significant decrease in spring usage by 222,588 DUDs. Under both those alternatives, moist soil and BLH forest acreage flooded during spring migration would be significantly lower, reducing habitat that provides necessary protein sources particularly important to waterfowl migrating to their breeding grounds (Fredrickson and Heitmeyer 1988).

Increased DUDs indicated by WAM during December and January for both basins are the result of ponding in the sump as specified by the operational plan. Those potential gains, however, are very questionable. Traditional use of wintering waterfowl habitats in southeast Missouri is closely linked to the relative wetness (i.e., rainfall) within the regions during late October through January (Bellrose and Crompton 1970, Nichols et al. 1983). Forty-nine hundred acres of

ponded water in an otherwise dry St. Johns basin and New Madrid Floodway is an relatively small tract of habitat to migrating waterfowl. For example, over the last several years, the Eagles Nest Wetland Reserve Program tract and rice fields on Hunter Farms have been annually flooded using pumps during fall and winter for hunting. Those habitats, however, receive significantly less waterfowl use in dry years than in years when the region is wet (D. Wissehr and B. Allen, MDC, pers. comm.). Under the proposed alternatives, bottomland hardwoods in the sump area would be flooded annually to great depths for extended periods. Such inundation is detrimental to bottomland hardwood species (Fredrickson and Batema 1992) and could undermine their long-term survival. In light of the above, we strongly recommend that the operational plan be altered to allow for the greatest possible diversity of flood timing, duration, and depth November through March. We believe such a plan would realize more benefits to waterfowl, as well as other species. Altering the operational plan would also allow the river to ebb and flow into both basins during that time, greatly benefitting fisheries resources by maintaining connectivity between the river and its floodplain.

It is important to note that WAM does not consider the increasing importance of invertebrates in waterfowl diets during late winter and spring, when the project area traditionally has the highest waterfowl use (D. Wissehr and B. Allen, MDC, pers. comm.). Furthermore, the WAM does not consider other forested wetland habitat components necessary for healthy waterfowl populations. During spring migration, waterfowl are forming pairs, molting, and preparing to breed (Heitmeyer 1985). Forested wetlands fulfill special seasonal waterfowl habitat requirements not found in open land (i.e., moist soil areas and farmed wetlands). In addition to producing nutritious food for waterfowl, wooded habitats provide secure roosting areas, cover during inclement weather, loafing sites, protection from predators, and isolation for pair formation. Both project alternatives would eliminate backwater flooding on thousands of acres of forested wetlands and moist soil areas during spring migration, significantly reducing habitat that provides necessary protein sources particularly important to waterfowl at that time of year. Under existing conditions, those waterfowl acres occur during spring flooding and are distributed over up to 75,000 acres. Large flooded areas such as those are critical for waterfowl, especially as they form breeding pairs. Because of the differing seasonal habitat requirements of waterfowl, potential fall migration and winter habitat benefits cannot replace significant spring migration habitat losses that would occur with either project alternative.

The proposed project alternatives would also negatively affect forested wetland habitat value for wildlife. Results of the HEP analyses of direct habitat losses attributable to levee construction and channel enlargement are summarized on Table 4. Channel enlargement will include clearing portions the riparian corridor within the channel work rights-of-way and, in some reaches, removing the banks to enlarge the channel. A narrow berm would be constructed adjacent to the new channel, seeded and periodically maintained. An elevated spoil area would be located landslide of the berm. The direct impacts in Table 4 assume that a protective easement will be placed over the construction rights-of-way for channel work in the St. Johns basin and the levee closure in the Floodway, and that berm maintenance along the enlarged ditches will be minimal, allowing all rights-of-way to revegetate naturally. Levee construction will directly affect only a small acreage of forested wetlands in the Floodway.

Table 4. Direct forested wetland habitat losses from levee construction and channel enlargement (expressed in average annual habitat units).

Species	St. Johns basin Author.	St. Johns basin A&M	New Madrid Floodway Author./A&M
Barred owl	677.81	488.82	15.22
Fox squirrel	386.57	281.54	11.49
Pileated woodpecker	547.44	393.23	12.56
Carolina chickadee	714.33	514.83	15.43
Mink	428.21	314.13	11.28
Total	2754.37	1992.55	65.98

The indirect effects of the proposed alternatives will be far greater, particularly in the Floodway. As previously mentioned, the Service believes implementation of either project alternative will lead to conversion of significant tracts of forested wetlands that are no longer subject to backwater flooding. Based on historic and existing land use patterns, and the enhanced drainage system throughout the project area, the HEP team originally predicted that approximately 90 percent of privately owned forested wetlands no longer subject to riverine flooding (because of the project) would be converted to another land use over the 50-year project life. That acreage excluded lands enrolled in WRP and timber company property that will be managed as forested habitat. Table 5 summarizes the habitat losses associated with converting existing forested

Table 5. Indirect forested wetland habitat losses from reduced backwater flooding. (expressed in average annual habitat units).

Species	St. Johns basin Author/A&M.	New Madrid Floodway Author.	A&M
Barred owl	645.85	1,714.75	1,642.37
Fox squirrel	613.35	1,349.50	1,292.53
Pileated woodpecker	512.68	1,498.32	1,436.41
Carolina chickadee	661.04	1,717.50	1,645.00
Mink	390.01	216.45	200.85
Total	2,822.93	6,496.52	6,217.16

wetlands to cropland. All wildlife evaluation species showed significant losses in habitat values due to induced wetland impacts. In addition to impacts that can be quantified through HEP analyses, wildlife using the remaining forested tracts will also be negatively affected by increasing forest fragmentation which is particularly detrimental to certain neotropical migratory

bird species (Robbins et al 1989, Askins et al. 1990). Fragmentation can lead to higher rates of nest parasitism and competition from birds species that prefer edge habitat.

Three species (i.e., muskrat, red-winged blackbird, and great blue heron) were used to evaluate project-related changes in marsh habitat values. Most of the marsh in the study area is found in the New Madrid Floodway, primarily along borrow pits. The HEP team assumed those acres would remain the same because those areas should receive enough rainfall and runoff to maintain marsh vegetation. Based on that assumption, HEP results indicate that project-related changes in marsh habitat values will be insignificant.

To quantify project-related changes in shorebird migration habitat value, a HEP-based model was developed by a small workgroup (Appendix C). Shorebird habitat is considered that area within one foot of the 50 percent flood exceedence elevation for the months of April and May (the months of peak shorebird use in the project area), and non-forested wetlands, wet croplands, and rice fields above the 50 percent exceedence elevation. Implementation of either project alternative would significantly reduce shorebird migration habitat value in both basins (Table 6).

Table 6. Project-related losses of shorebird habitat values during April and May.
(Expressed in average annual habitat units).

	Author. Proj.	% net change	A&M	% net change
St. Johns Bayou basin	119.17	-30.8	104.42	-27.0
New Madrid Floodway	672.28	-69.9	656.78	-56.5
Total study area	791.45	-58.7	761.2	-56.5

The A&M alternative, however, would prevent some of the losses anticipated under the Authorized Project alternative in the St. Johns Bayou basin by allowing an 1.5 feet increase in water levels before pumping begins during April and May. In the New Madrid Floodway, either alternative would reduce shorebird habitat value between 56 and 70 percent. Both the Authorized Project and the A&M alternatives would greatly lower water levels in April and May (up to eight feet), virtually eliminating suitable shorebird habitat acreage in the years following project completion. Moreover, after 50 years, suitable habitat will still only be 4.5 percent of that provided under future without-project conditions. The HEP team assumed that cropping patterns under future with-project conditions would include increasing rice acreage; that assumption accounts for the majority of shorebird habitat value under both project alternatives. It is important to note that the shorebird HEP analyses address only spring migration habitat. In years when high river stages occur in June and July (e.g., 1993, 1995, 1996, 1997), backwater flooding and the thousands of acres of ephemeral ponds left behind provide important habitat for shorebirds which begin migrating south in late July and early August.

Project implementation is also expected to negatively affect reptiles and amphibians in the project area. Eliminating seasonal backwater flooding over thousands of acres, and the ephemeral ponds that remain after flood waters recede will significantly reduce suitable habitat for reptiles and amphibians, particularly during spring breeding. In addition, project-related changes to surface water patterns may eliminate ponding in many areas in all but the wettest years. This would not only reduce available habitat, but further fragment and isolate tracts of remaining habitat and their reptile and amphibian populations.

Aquatic Resources

The most significant project impact to aquatic resources is the loss of seasonal flooding in the St. Johns and New Madrid basins. Under the Authorized Project alternative, the levee closure and pumping operations will eliminate Mississippi River backwaters from entering the New Madrid Floodway and significantly reduce interior flooding in both basins. That, in turn, reduces spawning and rearing habitat for river and floodplain fishes. Killgore and Hoover (1998) used HEP procedures to quantify project-related reductions in flooding on fish spawning and rearing habitat in both basins (Appendix D). *The analyses did not assess the effects of the levee closure on fisheries access to the floodway.* On average, rearing habitat in the St. Johns Bayou basin will be reduced from 3,069.9 to 1,602.0 acres (47 percent loss) and spawning habitat will be reduced from 1,519.8 to 729.7 acres (54 percent loss)(Table 7). The lost acreage represents 2,243 HUs. Floodplain habitat losses are substantially higher in the Floodway. Rearing habitat will be reduced from 4,230.8 to 115.8 acres (97 percent loss), and spawning habitat will be reduced from 2,179.3 to 49.3 acres (97 percent loss). The lost acreage represents 4,868 HUs. Under the Authorized Project alternative, floodplain habitat losses in the project area represent 7,111 HUs.

The A&M alternative would not significantly reduce losses of fish spawning and rearing habitat. That alternative would increase the start and stop pump elevations to 282.5 and 280.0 feet NGVD, respectively, which would only reduce the losses by 6 percent (Killgore and Hoover 1998). During the spawning period, it is expected that the gravity gates at the levee closure will remain open until the water level reaches an elevation of 282.5 feet NGVD in the New Madrid (on average of 14.3 in March and 12.9 days in April) which may allow for some fish access. It is unknown whether such actions will ensure fisheries access to the Floodway because fish movement through structures (e.g., box culverts) can be confounded by high velocities, restricted openings, and head differentials. Spawning and rearing habitat losses quantified in the HEP analysis were based on average annual acres of fisheries habitat at elevation 290' NGVD (2-year frequency flood) and below (Killgore and Hoover 1998). The acres of floodplain habitat that are inundated during larger flood events can be far higher. While such flooding occurs infrequently (> every 2 years), a substantially greater portion of floodplain habitat is available to fish during those events. For example, river stages of 295 feet NGVD were equaled or exceeded in ten of the last 35 years (i.e., 1997, 1996, 1995, 1994, 1979, 1978, 1975, 1974, 1973, 1963). Such flood events can inundate up to 47,960 acres in the New Madrid Floodway and benefit fisheries by greatly increasing available spawning and rearing habitat, as well as primary and secondary productivity associated with those areas. It should be noted that habitat losses associated with

Table 7. Direct fish spawning and rearing losses (expressed in average annual habitat units) from levee construction and pump operations. Reproductive chronology is indicated as Early (March), Mid (1 Apr-15 May), and Late (16 May-30 June).

	St. Johns Basin						New Madrid Basin					
	Spawning			Rearing			Spawning			Rearing		
	Early	Mid	Late	Early	Mid	Late	Early	Mid	Late	Early	Mid	Late
Authorized Project												
Agricultural Land	35.8	626.1	140.3	1107.7	647.6	230.0	-	1191.7	315.2	3593.3	1381.5	614.6
Fallow Land	62.0	190.1	48.4	189.2	125.6	65.7	-	224.3	47.8	234.0	129.5	95.5
Bottomland Hardwoods	275.6	904.9	266.5	624.4	904.0	479.2	-	804.1	279.7	502.9	731.6	550.1
Large Permanent Waterbodies	8.8	36.1	14.6	31.1	70.2	27.3	-	187.4	79.1	195.2	439.7	158.4
Small Permanent Waterbodies	49.5	221.0	84.0	122.0	334.4	201.1	-	247.5	89.9	97.6	240.0	226.7
Total HUs Lost	431.7	1978.2	553.8	2074.4	2081.8	1003.3	-	2655.0	811.7	4623.0	2922.3	1645.3
Avoid and Minimize												
Agricultural Land	34.0	607.1	136.5	1059.6	622.1	218.2	-	1179.8	307.5	3520.5	1352.2	592.5
Fallow Land	56.8	179.8	45.4	175.7	117.1	59.6	-	212.8	43.4	221.6	122.5	87.4
Bottomland Hardwoods	243.4	827.3	241.1	555.7	813.3	419.1	-	737.8	239.2	465.4	677.1	486.8
Large Permanent Waterbodies	6.6	29.1	11.4	23.9	53.4	18.9	-	177.2	70.7	162.0	364.3	122.1
Small Permanent Waterbodies	40.3	187.6	68.4	100.5	278.4	157.5	-	221.8	72.3	82.8	202.8	178.4
Total HUs Lost	381.1	1830.9	502.8	1915.4	1884.3	873.3	-	2529.4	733.1	4452.3	2718.9	1467.2

permanent waterbodies may be overestimated under both alternatives. Although those areas will no longer be available to riverine fish, they will continue to provide habitat for resident fish. Closing the gap in the New Madrid Floodway will severe the link between the Mississippi River and its only connected tributary floodplain in Missouri. The riverine ecosystem will lose the productivity that is released by the floodplain during high water. River fishes, such as white bass, will loose most, if not all the extensive spawning, rearing, and foraging habitat provided by the Floodway. Numerous studies have examined the relationship between floodplain habitat and fisheries productivity. Lambou (1962) noted that the timing and extent of overflow on the floodplain can significantly affect the year classes of fish. Barnickol and Starrett (1951) documented a reduction in game fish in a reach of the Mississippi River with reduced backwater habitat. Levees in southeastern Missouri are associated with reduced fish diversity and abundance of characteristic floodplain species such as starhead topminnow, banded pygmy sunfish and bantam sunfish (Finger and Stewart 1978, as cited in Hoover and Killgore 1998). Where adjoining backwaters along the lower Colorado River were drained, there was a 100 percent reduction in fishery value (Beland 1953). Karr and Schlosser (1978) suggested that standing fish stocks may decline as much as 98 percent when floodplains are removed from the channel. Eliminating fish access to floodplain areas can also alter the composition of river fish communities by limiting recruitment of certain species (Turner et al. 1994). In addition, Bryan and Sabins (1979) attributed the productivity and resiliency of the populations of commercial and sport [fish] species in the Atchafalya Basin to wide variations in water levels year to year. Given the significant project-related decrease in the extent and variability of floodplain habitat available to both resident and river fishes in the study area, it is likely that both those fish stocks will decline as a result of project implementation.

The loss of fish spawning and rearing habitat in the project area could potentially affect freshwater mussel populations through alteration of the fish community. Mussels are susceptible to such changes because their life cycle includes an obligatory parasitic stage on fish. The larval stage (glochidia) of mussels must attach to the appropriate fish host to complete development (Neves 1993). The representative fish species used by Killgore and Hoover (1998) to report the losses in spawning and rearing habitat described previously include largemouth bass, white crappie, channel catfish and freshwater drum. Those fish species are important hosts for the majority of mussel species found in the project area (Table A-2). Several species, including the abundant threeridge, use sunfish (i.e., largemouth bass, bluegill and white crappie) as hosts. Catfishes serve as hosts for members of the genus *Quadrula*, and the yellow sandshell utilize gar. Several species appear to rely solely on freshwater drum. These include *Leptodea*, *Potamilus*, and *Truncilla* species. Currently, those fish species are common in the project area. Reduction or loss of those fish populations and suitable habitat, however, could potentially reduce recruitment into, or exchange among mussel populations throughout the project-area.

Killgore and Hoover (1998) quantified the reduction of instream fish spawning and rearing habitat caused by channel dredging and widening. The Authorized Project alternative will remove 60.57 acres of riverbank structure in the St. Johns basin resulting in a net loss of 145 HUs. Structure loss includes removal of logs and debris (0.8 acres), live trees (28 acres), and aquatic vegetation (32.57 acres). No other forms of riverbank structure were noted during habitat

surveys. The A&M alternative would reduce the impacts to a loss of 36.17 acres or 58 HUs. Switching channel work to the opposite bank in various reaches will avoid 5.91 acres of live trees. A total of 18.83 acres of aquatic vegetation, which provides habitat for the golden topminnow (*Fundulus chrysotus*), will be avoided by designating the upper 3.7 miles of the St. James Ditch as a no work reach. Nine dikes would be constructed in lower four miles of the St. Johns Bayou which is estimated to create 3.6 HUs.

Unquantified hydrologic changes associated with the proposed channel widening may create unsuitable conditions for some aquatic life. The reduced water depths, uniform shaping and smoothing of the channel for flow conveyance, and loss of woody debris will decrease habitat diversity and food supplies for the fish community in St. Johns Bayou, and in some cases could make certain ditch reaches completely unusable by fish. Both the Authorized Project and the A&M alternatives would significantly reduce riparian forests in the St. Johns Bayou basin. Maximum water temperatures may increase substantially because of increased light absorption through removal of riparian corridor, decreased current, decreased water depths, and expanded surface water (Ebert 1993). Stern and Stern (1980) documented summer temperatures up to 12.8 degrees Celsius (° C) warmer and winter temperatures 4 °C cooler in farm streams than in similar woodland streams. Similar patterns in unforested stream reaches have been noted by Hansen (1971) and Karr and Schlosser (1978). In addition, removal of the riparian corridor will reduce influxes of leaf litter to the aquatic community. Such influxes are the primary energy source for instream communities (Brinson et al. 1981). Brinson et al. (1981) note that because of shading and organic inputs, riparian vegetation plays a profound role in the structure of invertebrate communities, and indirectly in fish community structure. Because project implementation will remove (temporarily or permanently) much of the riparian forests in St. Johns Bayou basin (and to a lesser extent in the Floodway) aquatic communities are expected to be negatively affected as well.

Project-area ditches have been periodically dredged to maintain adequate drainage. Unfortunately, the timing of the faunal population recovery and species succession following dredging in those ditches is unknown. The altered environmental conditions left by dredging may benefit some species, but may threaten the existence of many others including those endemic to this region. Dredging can disrupt the entire aquatic ecosystem and cause significant losses of biodiversity. The process removes macroinvertebrate assemblages and trapped organic matter that form integral parts of the trophic web (Cummings et al. 1973, Ebert 1993). Habitat heterogeneity is reduced by the elimination of instream cover (i.e., woody debris and vegetation) which is important to the production and diversity of both invertebrates and fish (Benke et al. 1985, Marzolf 1978, Cobb and Kaufman 1993).

Other effects of dredging extend beyond the excavated area. Aquatic organisms may be adversely affected by burial, exposure to contaminants, increased turbidity, and decreased dissolved oxygen levels (Ebert 1993). Headcutting, the upstream progression of bank erosion and substrate destabilization, has occurred following dredging in low-gradient ditches similar to those found in the project area (Hartfield 1993). Headcutting has been associated with the following: extensive bank erosion; wide, degraded channels; meander cutoffs; whole trees within

the channel; quicksand or otherwise loose, unstable sediments; perched tributaries at low water; and the absence of bald cypress and tupelo trees where those species are characteristic components of stable riparian ecosystems.

Dredging and widening in the St. Johns Basin will also severely impact the local mussel fauna. The most direct effect will be the physical removal and destruction of the majority of mussels in the dredge path. Potentially, some individual mussels could be missed by the dredge and survive. Barnhart (1998) found a number of mussels in Setback Levee Ditch whose ages predated the last dredging event. Those individuals were generally found along the wooded bank at sites where only one side was cleared at the time of the dredging. Since the proposed project also involves widening, the impacts to mussel are likely to be far more extensive than past dredging events.

The mussel assemblage in the project area is particularly vulnerable from the direct effects of the proposed dredging because the majority of the species have relatively small populations. Twenty of the 24 species found by Barnhart (1998) each made up less than 5 percent of the 998 individual mussels collected. The proposed dredge area contains the greatest diversity and abundance of mussels found in the project area (Barnhart 1998). A large-scale disturbance, such as dredging, has the potential to cause localized extirpation of some mussel species.

Since mussels are relatively immobile, recovery of depleted populations will depend upon recruitment of juveniles transported by fish hosts from adjacent populations unaffected by the dredging. Those "seed" populations would largely be restricted to the upper Setback Levee Ditch and the St. Johns Ditch. The mussels in those areas are relatively less abundant and species rich compared to the proposed dredged area. It is uncertain whether the Lee Rowe Ditch would serve as an adequate seed population. Although this ditch is not in the proposed dredge path, it may be severely altered. Dredging will lower the bottom of the Setback Levee Ditch and St. James Ditch. As a result, the Lee Rowe Ditch could become perched during base flows resulting in decreased water velocity. The natural succession to follow may transform this area into a more lentic environment suitable for very few mussel species (Fuller 1974, Oesch 1995).

The timing of the population recovery and species succession following dredging in lowland ditches is unknown. The degraded habitat left by the dredging is unlikely to be suitable for colonization by juvenile mussels and may require several years to recover. Since mussels are obligate parasites of fish, the recovery of specific host populations is a prerequisite to the restoration of habitat for juveniles. Considerable time may be required to restore adequate spawning habitat (i.e., snags and aquatic vegetation) for these fishes.

Endangered Species

Three federally listed species occur in the project area; the bald eagle, the pallid sturgeon, and the interior least tern. Project implementation will significantly reduce backwater flooding in the project area during spring, particularly in the New Madrid Floodway. That, in turn, will virtually eliminate seasonal use of the floodplain by Mississippi River fishes. Bald eagles have recently constructed nests in the lower Floodway in an area that will no longer be subjected to spring

flooding. In addition, several least tern colonies occur adjacent to and downstream of the project area. Because of the importance of fish in the diets of both species, significant project-related impacts to fisheries production may also affect those species. The Corps has submitted a Biological Assessment to the Service and requested formal consultation on those species. The Service has concurred with the Corps that the project is not likely to adversely affect the pallid sturgeon based on insignificant effects (i.e., effects that can not be meaningfully measured or detected.). The Service prepared a June 1999 biological opinion on project effects to the bald eagle and the least tern. In that biological opinion, the Service determined that the project is likely to adversely affect the bald eagle and the interior least tern, and we developed a list of reasonable and prudent measures to minimize incidental take of those species.

Fish and Wildlife Conservation Measures

The proposed project alternatives will have significant adverse impacts on fish and wildlife resources. Although the A&M alternative will avoid important BLH tracts and maintain slightly higher water levels in both basins, that alternative would still have substantial effects on fish and wildlife. Of equal or greater concern are the indirect, project-related hydrological changes that will result in degradation and loss of fish and wildlife habitat due to the levee closure and pumping operations. Closing the gap in the New Madrid Floodway will severe the link between the Mississippi River and its only connected tributary-floodplain conplex in Missouri. The riverine ecosystem will lose the productivity that is released by the floodplain during high water. River fishes, such as white bass, will lose 100 percent of the extensive spawning, rearing, and foraging habitat provided by the Floodway. Because of the significant project-related impacts to fish and wildlife resources, the Service believes that project plans can and should be further modified to mitigate those negative impacts.

The President's Council on Environmental Quality defined the term "mitigation" in the National Environmental Policy Act regulations to include:

> (a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the actions; and (e) compensation for the impact by replacing or providing substitute resources or environments.

The Service's Mitigation Policy (U.S. Fish and Wildlife Service 1981) supports and adopts that definition of mitigation and considers its specific elements to represent the proper sequence of steps in the mitigation planning process. That policy identifies four resource categories to ensure that the level of mitigation recommended by Service biologists is consistent with the fish and wildlife resources affected by the project. Considering the high fish and wildlife value and relative scarcity of the forested wetlands to be impacted by the proposed project, those habitats

have been designated Resource Category 2 habitats. The upper ditch reaches in the St. Johns basin contain valuable instream habitat (i.e. logs, debris, and submerged vegetation) and support diverse freshwater mussel populations which are becoming rare both regionally and nationally, and thus are also considered Resource Category 2. The mitigation goal for that resource category is no net loss of in-kind habitat value. The majority of wetlands in the project area are composed of croplands, pasture, and fallow fields. Because those wetlands provide high to medium habitat value to fish and wildlife, and are relatively abundant nationally, those habitats are considered Resource Category 3 with the mitigation goal of no net loss of habitat value while minimizing loss of in-kind habitat value. What makes those areas especially important to fish and wildlife is periodic inundation during high river stages. In fact, backwater flooding is a critical factor in determining the habitat value of most of the wetlands in the project area. Such flooding provides not only habitat, but also makes floodplain productivity accessible to the riverine system. Unfortunately, such systems are also becoming increasingly scarce at both the regional and national level. Gore and Shield (1995) noted that the stability and functioning of large river ecosystems depends on maintaining watershed and floodplain integrity. Consequently, mitigation measures should ensure, to the maximum extent possible, continued connectivity between the floodplain and the river to maintain the functions of those habitats and the ecologic integrity of the floodplain-river ecosystem.

St. Johns Bayou Basin

According to the Corps, the New Madrid Floodway is hydrologically separate from the St. Johns basin. Therefore, flood control efforts in the Floodway would not address flood damage in and around East Prairie. The Service and MDC fully support measures to protect homes, businesses, and public infrastructure from flooding. However, we believe there are several alternatives to better address flooding problems in and around East Prairie that would avoid all or most of the adverse environmental impacts associated with the proposed alternatives. According to the Corps, local drainage improvements are necessary to significantly reduce municipal flooding. In combination with that work, the Corps should consider flood reduction benefits from a ring levee or similar structure (with or without pumps) to protect East Prairie from both backwater and headwater flooding. In addition, flood-proofing measures (e.g., elevate structures/roadways) should be considered to protect private property, highways, and other public infrastructure from flood damage. Such measures would avoid fish and wildlife impacts in the St. Johns Bayou basin associated with channel enlargement and lower water levels while ensuring the public safety. Moreover, those measures would also avoid adverse impacts to the New Madrid Floodway and retain the connectivity between the Floodway and the Mississippi River, as well as the habitat values and functions of the system.

If the Corps determines that more extensive work is necessary to reduce flooding in East Prairie, such work should be limited to that basin. Channel enlargement impacts to both the riparian corridor and in-stream habitat along the St. James and Setback Levee ditches, and St. Johns Bayou should be minimized to the greatest extent possible. The A&M alternative would avoid some impacts to the riparian corridor by limiting channel enlargement of the St. Johns Bayou to 120 feet, and working from only one bank, switching work in the St. James ditch to the right

bank between Missouri Highways 80 and OO. The Corps has proposed to construct transverse dikes every half mile on alternating banks in the lower four miles of St. Johns Bayou to mitigate for in-stream habitat losses. Such dikes are reported to create a more natural stream morphology and provide riverbank habitat (Killgore and Hoover 1998). Before such measures can be fully evaluated, however, it should be determined whether sedimentation will occur between the rocks, which would reduce the habitat quality of those structures.

No mitigation measures have been proposed by the Corps to compensate for in-stream habitat losses in the Setback Levee or St. James ditches. While the losses under the A&M alternative are reduced, 35 acres will still be removed (Killgore and Hoover 1998). Vortex weirs, a relatively new technology to provide in-stream cover, have been proposed by MDC (Mark Boone, pers. comm.). Vortex weirs are a low-head structure consisting of series of large rocks or boulders anchored across the channel. The rocks are spaced apart to allow water to flow through. Vortex weirs have been used successfully in streams with high bedloads (similar to the project area ditches) because they allow sediment transport. In addition to providing habitat for host fishes, the weirs may also create habitat for freshwater mussels by providing substrate stability and a wide range of current velocities without creating backwater and sediment deposition which most species of unionids cannot tolerate (Fuller 1974). MDC recommends the weirs to be a minimum of 25 feet long and installed every 0.25 miles.

The A&M alternative would avoid the upper 3.7 miles of the St. James ditch to protect the aquatic vegetation that provides habitat for the golden topminnow. While this will leave the upper reach of habitat intact, additional habitat may still be affected downstream. Similar habitat occurs in the St. James ditch as far south as County Road 525. In that reach, Service and MDC biologists observed another rare species, the northern starhead topminnow, which has similar habitat requirements. Because the range of the topminnow species and its habitat in the project area have not been determined, and it is uncertain if that habitat will reestablish itself after dredging, the Corps should minimize dredging and channel modifications in the entire reach of St. James ditch that contains the topminnow's preferred habitat (i.e., quite waters with aquatic vegetation).

Several additional actions could be taken by the Corps to mitigate loss of aquatic habitat diversity, shallower water depths, higher water temperatures during the low flows, headcutting, and perching caused by channel enlargements. Transverse dikes could be constructed to offset losses from a shallower, wider channel in all work reaches. The dikes should be designed to scour a continuous, sinuous thalweg along the entire channel. The Corps has proposed such structures in the lower four miles of St. Johns Bayou (discussed previously), but as a means to create riverbank habitat. The reaches that will be affected most by reduced water depths will be the Setback Levee and St. James ditches.

Gradient control structures to prevent headcutting should be placed at the upper end of all work reaches including the St. James and Setback Levee ditches. Those structures should also be placed at the mouth of all major tributaries including the St. Johns and Lee Rowe ditches. Vortex weirs, discussed previously as a means to create in-stream fish habitat, are also designed

to provide gradient control. Therefore, installing weirs may compensate for habitat losses as well as prevent headcutting. A low water weir should also be installed where the Lee Rowe ditch branches off St. James ditch to prevent perching this channel during base flows. Without these measures, aquatic habitat losses from dredging and channel widening will go unmitigated.

The dredging plan should also be modified to reduce impacts to freshwater mussels. Of the reaches surveyed in the project area, the Setback Levee ditch contained the highest mussel diversity and abundance (Barnhart 1998). Most individuals collected from that ditch were in a 6.5-foot strip along the wooded bank (right descending side). To reduce impacts to mussels, at least a 9-foot strip along the right descending side of the channel should be avoided entirely. This measure is intended to leave enough mussel breeding stock to repopulate the dredged reaches. (It should be noted that avoiding one side of the ditch would also minimize negative impacts to wildlife such as wading birds, mink, otter, and numerous reptiles and amphibians.) Because survival of mussels in that strip is uncertain, that effort should be supplemented with mussel relocation from sites within the dredge path to other areas in the project area. In addition, a monitoring plan should be developed, in coordination with the Service and MDC, to determine the success of mussel mitigation measures. Although the dikes, weirs, and gradient control structures all have potential to provide suitable mussel habitat, mussel use of those structures has not been evaluated. Therefore, the mussel monitoring plan should also include long-term monitoring to determine the value of those structures as mussel habitat. The monitoring program should quantify changes in population densities and habitat conditions over time and determine the timing of population recovery in dredged reaches. Given the longevity of unionids, populations should be monitored prior to project construction and for at least 10 years post project. The information gained from that study could be used to better evaluate and manage impacts to mussels in future projects.

New Madrid Floodway

The proposed work in the New Madrid Floodway will have significant negative effects on fish and wildlife resources. Therefore, if the Corps determines that flood control measures are required in the Floodway, we strongly encourage them to consider other alternatives that would avoid most of the adverse environmental impacts associated with either of the proposed alternatives. For example, a non-structural alternative such as the use of flood easements in the lower portion of the Floodway could reduce flood-related agricultural damages while ensuring that area will continue to provide habitat to nationally significant fish and wildlife resources. (That measure could also be considered for the St. Johns basin.) The Service has recently learned of efforts coordinated by the Business Council for Sustainable Development, Gulf of Mexico, to reforest up to 1 million acres of marginal farmlands in the lower Mississippi River Valley. The goals of the program are to improve water quality, recreation, and fish and wildlife habitat; provide an economically viable alternative to farming flood-prone lands; ensure adequate future supplies of forestry products, and provide communities with a sustainable way to diversify their economic base. The Service strongly supports such efforts and believes the Corps should further consider this and similar efforts as a way to reduce flood damages in the project area while

enhancing fish and wildlife resources, and providing diverse, sustainable benefits to the local and regional economies.

Another option to avoid impacts to fish and wildlife is an alternative levee alignment further north in the Floodway. MDC has recently proposed an alternative levee alignment that would extend north from the mainline levee east of Big Oak Tree State Park to Barkers Ridge (a natural watershed divide) and follow that ridge to the Setback Levee. The Floodway north of the levee would drain through a structure where St. James Bayou intersects the Mississippi River mainline levee. This would preserve thousands of acres of floodplain as habitat for numerous fish and wildlife, but would also maintain the ecologic functions (e.g., primary and secondary productivity export to the river, flood water storage, etc.) of floodplain wetlands by ensuring hydrologic connectivity between the floodplain and the river.

Of the two proposed alternatives, the A&M alternative would have fewer negative impacts to fish and wildlife in the Floodway. The Service and MDC, however, believe there are additional measures that would further reduce fish and wildlife impacts. In the A&M alternative, the drainage structures will remain open in the St. Johns basin and New Madrid Floodway an average of 14.4 and 12.9 days (i.e., the average number of days interior water levels are expected to be higher than river stages, and thus allow drainage to the river) in March and April respectively. Although that operation plan potentially provides Mississippi River fish limited access to floodplain habitats during part of the spawning season, the extent of fish movement through the box culverts is unknown (Killgore and Hoover 1998). Furthermore, that alternative would still cause significant losses of floodplain spawning and rearing habitat. If river fish were able to access those basins, little if any of the existing floodplain would be inundated at that time under either proposed project alternative.

St. Johns Bayou Basin and New Madrid Floodway

The most effective measures to mitigate project impacts would maintain the natural connectivity and water level variability of the floodplain which, in turn, would protect the ecologic functions of project-area wetlands. The Service has suggested to the Corps that the pumps be operated according to a "Rule Curve" that would ensure the greatest interchange possible between the Floodway and the river. Such a plan would have both outlet structures open to allow flooding up to the elevation that avoids inundation of important public infrastructure. Pump operations could be determined by a that would have specified target elevations during the spring fish spawning season. The purpose of a "Rule Curve" is to use a combination of gate openings, target elevations, and pumping to prevent damaging water levels, while allow some interchange between the river and the Floodway. For example, if river stages exceeded the trigger elevation, the gates could be closed and water levels reduced (via pumping) to (or slightly below) the trigger elevation, so that the gates could be reopened. Such measures would allow for more floodplain-river interchange (and fish and wildlife habitat) in the St. Johns Bayou basin while reducing some of the negative project impacts to the New Madrid Floodway by increasing the time the drainage structures would remain open.

An operational rule curve would also promote the long-term variability in water depths important to wetland invertebrate production, wetland plant response during the growing season, and overall wetland health. In addition, such operations would allow much of the lower basins to flood naturally during wet years when they would have the greatest waterfowl use. In addition to the fish and wildlife benefits, we believe that such a plan has the potential to lower long-term pumping costs in comparison to the proposed plans. According to Corps' analyses, however, sump elevations could be raised only approximately 6 inches without affecting the economic benefits of the project. Unfortunately, such operations would produce minimal habitat benefits, and increase fisheries access less than a day.

The following sections address quantitative mitigation requirements to compensate for project-related losses to fish and wildlife habitat value. Ideally, those measures would be conducted within the affected basin to ensure that wetland and floodplain ecologic functions were conserved in the project area. In this case, however, it will be impossible to compensate habitat losses within the project area. Even with the proposed A&M alternative, fisheries access through the drainage structure to the floodplain will be drastically reduced in the Floodway. The 1,500-foot gap in the levee that currently provides river fish access to floodplain habitats throughout the spring spawning season (i.e., March - June) will be restricted to a single 10-foot by 10-foot box culvert that would be open only periodically during part of the spawning season (i.e., an average of 14.3 and 12.9 days in March and April respectively), generally during lower river stages. There no measures within the project area to fully mitigate the loss of the natural connectivity between the Mississippi River and the New Madrid Floodway as a result of either proposed alternative. In addition, after project implementation, not only would fisheries access into the basins be reduced, but suitable habitat would be almost eliminated. In March, during the spring spawning season and waterfowl and shorebird migration, median monthly water levels in the project area would flood only 154 acres of farmed wetlands in the St. Johns Bayou basin, and 56 acres in the Floodway.

Floodplain habitats that will be substantially reduced by the project include cropped agricultural land (CAG) (including farmed wetlands), fallow land, BLH forests, and seasonally connected large and small permanent water bodies. The Corps has proposed to convert flooded agricultural land to BLH forest to compensate fisheries habitat losses of seasonally inundated CAG, fallow land, and forested wetlands. Since forested wetlands generally have higher fisheries habitat value than seasonally inundated CAG or fallow land, well as wildlife, we believe that re-establishing forested wetlands can be an effective measure to compensate losses of floodplain fisheries habitat losses, provided the site has significant access for riverine fish from March through June (See details on reforestation below). The compensation acreage in Table 8 is designed to mitigate losses of rearing habitat during April and May (mid-season). Although the fisheries HEP model shows substantial early-season rearing losses in both basins, much of those losses are attributable to changes in white bass habitat. Sheehan (1998), however, did not record white bass in spring sampling in the St. Johns Bayou basin. In addition, according to the HEP model, agricultural fields, rather than forested wetlands, appear to have a higher suitability index for larval white bass, which would derive minimal benefit from reforestation as a compensation measure. Therefore, we believe mid-season habitat losses better reflect habitat changes to a larger number

of both floodplain and riverine species, and compensation based on those losses would benefit the majority of the fish fauna.

Table 8. Comparison of acres needed for reforestation to compensate for spawning and rearing floodplain habitat losses (excluding permanent waterbodies) in the St. Johns Basin and New Madrid Floodway. (average annual acres)

St. Johns Bayou Basin	**Authorized**	**A&M**
CAG	1,173	1,086
Fallow	1,597	1,479
New Madrid Floodway	**Authorized**	**A&M**
CAG	6,796	6,520
Fallow	7,475	7,173

CAG = seasonally inundated agricultural land
Fallow = seasonally inundated unplanted land

The Service recommends that rearing acres be mitigated because of their importance to fisheries and their ecological functions. Since little is known of the distribution of larval fishes in floodplain habitats, there has been some debate on the need to mitigate rearing habitat losses of areas less than 1 foot deep and flooded agriculture fields (inlcuding farmed wetlands). Available data on fish use of flooded agricultural fields is varied. Hoover and Killgore (1996) collected larval fish from various floodplain habitats in the Big Sunflower River system in Mississippi. Invasive and ubiquitous species such as carp and shad were most often found on flooded agricultural and fallow land. Other species were concentrated around bottomland hardwoods. In contrast, data from extensive fish sampling of floodplain habitats near Cape Girardeau, Missouri show other fish species use agricultural fields as rearing habitat. In 1993, large numbers of larval fish were collected by trawl from agricultural fields up to 3/4 of a mile away from permanent waterbodies. The most abundant larval fishes were drum, silversides, various species of minnows, and several species of darters (Bob Hrabik, Cape Girardeau Long-term Resource Monitoring Station, pers. comm., 1998).

We know of only one study that quantified the relationship between water depth and larval fishes (Killgore and Hoover 1996). In that study, fishes were sampled from the Yazoo River system in Mississippi. From these collections, Killgore and Hoover concluded that water less than one foot is not extensively used by larval fishes. Bob Hrabik (pers. comm.), however, collected various species of minnows from flooded agricultural fields in water less than one foot. He believed that larval fish were most likely present in those areas but are not often sampled with electroshocking. While larval fishes may prefer slightly deeper water, those shallow waters do provide habitat and significant floodplain functions (detrital input, nutrient cycling, floodwater storage, etc.). The wide-spread, shallow flooding in the project area provides a large surface area for planktonic

production driven by sunlight and warm temperatures. It is generally accepted that floodplain waters (including shallow waters) are important for the production of phytoplankton and zooplankton (Robert Sheehan, pers. comm.), which are the principle food source for larval fish (Pflieger 1997). In addition, a major factor involved in the transition of larval fish from endogenous (yolk sac) to exogenous nutrition is the density of food organisms (Hall and Lambou 1990). As previously mentioned, Hrabik (1994) noted the extremely high zooplankton productivity on a wide floodplain near Cape Girardeau. Because larval fish use shallow-water habitat and because of the contribution of that habitat to the primary and secondary productivity of the floodplain, the Service recommends that all fish rearing habitat losses be fully compensated. From a practical standpoint, it would be very difficult to ensure that all compensation acres meet the spawning criteria (i.e., flooding > 1 foot for 8 days or more) to replace spawning habitat losses over an area of such small topographic relief. Although water depth and duration depend on the characteristics of a particular site, Corps hydrologic modeling shows that spawning acres account for only a portion of the area inundated under natural flooding patterns. Therefore, achieving the necessary compensation acres to meet the spawning criteria may involve inundating considerably more acreage.

Ideally, mitigation lands should be located in an area currently not subject to flooding, but with potential to restore the hydrology to a functioning forested wetland. The greatest habitat gains would result from reforesting an area that does not flood (hence no existing fisheries value), but has the potential for restored wetland hydrology. Such a site, however, would most likely involve significant water management and fisheries access issues. Locating compensation area(s) on farmed wetlands would address the hydrology, but result in a net loss of wetland acreage due to the project. In addition, the value of restoration lands designed to compensate lost fisheries habitat differs greatly with location and flooding regime. The estimated acreage is an annual average over the life of the project (consistent with the methods used to assess existing habitat value). That means over the next 50 years, the mitigation tract(s) must provide functions equivalent to those acres, taking into account effects of variable river flooding. For example, a selected track is inundated only 60 percent of the years, then additional acres may be required to provide the remaining 40 percent of the mitigation value necessary to compensate for those habitat losses.

Another confounding factor is flooding duration. If the mitigation tracts are inundated March through June, they could potentially compensate for the early, mid, and late spawning and nursery needs. Unfortunately, such an extended flooding period is not compatible with reforestation of bottomland hardwood tree species. Many previous reforestation projects in the lower Mississippi River Valley have met with poor success because of problems with modified flooding regimes that can drown seedlings and/or acorns. Although reforestation benefits many fish species, the proposed compensation acreage will not meet the substantial spawning and rearing needs of the white bass. Flooded cropland and fallow fields provide greater habitat value for that species. Therefore, we recommend that the Corps consider measures to seasonally inundate cropland during the month of March to meet the habitat needs of white bass. Possibly such flooding could also be used to compensate for spring shorebird habitat losses (see below).

The Corps had previously suggested creating borrow pits to partially mitigate for habitat losses of seasonally connected large and small permanent water bodies on the floodplain, including natural oxbow lakes. Although the functional similarity of borrow pits and oxbow lakes is unknown, borrow pits have been shown to function as effective fish nurseries if they are properly constructed (Sabo and Kelso 1991). The Corps recently adopted guidelines for borrow pit construction along the lower Mississippi River (Aggus and Ploskey 1986). Several features important to fisheries are high shoreline to surface-area ratio; various depths, both shallow and deep (as refuge); various substrate materials; and riparian vegetation. Those guidelines stressed the importance of maintaining connections to the Mississippi River so that spawning adults can access the ponds and young-of-the-year fish can escape when conditions in the ponds become stressful. Permanent waterbodies appear to be particularly important as nursery habitat for larval fish (J. Killgore, pers. comm.). Killgore and Hoover (1996) noted that larval fish were found most often in waters greater than 1 foot deep. To provide in-kind mitigation for project-related habitat losses, it would be necessary to construct approximately 321 acres of borrow pits under the Authorized Project alternative and 261 acres under the A&M alternative. Because of the expense of borrow pit construction, the Corps' original proposal would result in only a small portion of permanent waterbody habitat losses mitigated in-kind. More recently, the Corps is recommending reforesting flooded croplands to compensate for permanent waterbody habitat losses. In light of the cost constraints and minimal habitat gains from the proposed borrow pit construction, the Service has agreed to reforestation as an appropriate mitigation measure. Table 9 details the reforestation acres needed to compensate (albeit out-of-kind) for fisheries habitat

Table 9. Reforestation acres needed to compensate for permanent floodplain waterbody habitat losses in the St. Johns Basin and New Madrid Floodway. (average annual acres)

	Authorized Project	A&M
St. Johns Bayou Basin		
CAG	283	232
Fallow	385	316
New Madrid Floodway		
CAG	2,060	1,718
Fallow	2,266	1,890

CAG - seasonally inundated agricultural land
Fallow - seasonally inundated unplanted land

losses associated with permanent waterbodies. The estimates were based on habitat value necessary to mitigate mid-season rearing habitat, which would also compensate for spawning habitat losses as well. Given the importance of permanent waterbody habitat to larval fish, however, we recommend that the Corps provide in-kind habitat compensation for those losses to the maximum extent possible. This could be done by purchasing mitigation lands that include permanent waterbodies that could be improved (i.e., reforest or regrade old borrow pits) or

reconnected to the Mississippi River (i.e., old chutes, sloughs, or oxbows). Such areas should allow *significant* fisheries access to riverine species from March through June to realize the estimated habitat benefits. In addition, to compensate for losses to recreational fishing we recommend that the Corps ensure public access to those waterbodies through fee-title purchase or easements.

Habitat value of forested wetlands in the project area will decline significantly because of channel enlargement, levee closure, and pumping operations. To compensate for that habitat loss, we recommend that the Corps purchase croplands in fee-title to be reforested. Reforestation can be a very effective and efficient compensation measure. Depending on the location and flooding regime, restoration of forested wetlands could meet the needs of forest wildlife, waterfowl, and fisheries. Ideally, those lands should be located in an area currently not subject to flooding, but with potential to restore the hydrology to a functioning forested wetland. As previously mentioned, locating compensation area(s) on farmed wetlands would result in a net loss of wetland acreage due to the project. In addition, as shown in the fisheries analyses, farmed wetlands have important habitat value and their use would further increase the acreage required to compensate habitat losses. Specific details on species mix and reforestation methods will depend on the location of the compensation site(s) (e.g., soil, flooding regime, size, etc.) and will be developed by the Service and MDC. In general, however, compensation acres should be directly seeded, weeds controlled for a minimum of five years, and 70 percent tree survival attained at the end of five years. If necessary, at the end of five years, the area should be replanted and weed control implemented until the 70 percent survival threshold is met.

The project will directly decrease forested wetland habitat value in the project area by 2,820 and 2,058 AAHUs under the Authorized Project and A&M alternatives, respectively. To compensate that habitat loss, approximately 2,118 acres (Authorized Project alternative) or 1,546 acres (A&M alternative) of croplands should be reforested as described above. It should be noted that full replacement of forested wetland functions will not occur for many years given the time needed to grow large, mature trees. We estimate that it will take at least 50 years for a mitigation site to approach the habitat quality that currently exists in the project area. In addition, using the direct seeding method, the mitigation site will not compensate for lost habitat value for such species as the pileated woodpecker (an evaluation species) which require the large trees and structural complexity found only in mature forested wetlands. There is an experimental method, however, that may provide some of that habitat value within the project life. The root production method (RPM) has been shown to give young trees a several years "head start" (i.e., mast production within 7-10 years)(B. Allen and D. Wissehr, MDC, pers. comm.). Because of this potential and its experimental nature, we recommend that the Corps plant a portion ($\leq$ 15 percent) of the compensation area with trees subject to RPM to possibly compensate for mature BLH habitat losses. In rare instances, preservation of an existing high quality tract of forested wetlands, may be an acceptable compensation measure. Such cases, however, occur when there is no suitable acreage to reforest. Preservation is another instance where compensating wetland habitat losses with existing wetlands results in a net loss of wetlands in a project area.

We believe there will be significant indirect, project-related effects to forested wetlands because of hydrologic changes (i.e., eliminating seasonal inundation). As previously mentioned, conversion of forested wetlands to other land uses (primarily agriculture) would result in a loss of approximately 2,823 AAHUs in the St. Johns basin, and 6,496 AAHUs for the Authorized Project or 6,217 AAHUs for the A&M alternatives in the New Madrid Floodway. The Phase I General Design Memorandum for the St. Johns and New Madrid Floodway project recognized the value and vulnerability of remaining forested wetland in the project area (U.S. Army Corps of Engineers 1980). We believe that it is still appropriate to protect important bottomland hardwood wetland habitats in the project area from future conversion. Under either project alternative, the most effective means to avoid the complete loss of forested wetland function within the project area is to prevent the conversion of those remaining forested wetlands through protective covenants. A restrictive covenant or some other appropriate protective measure should be used to prevent the clearing of all existing unprotected forested wetlands that will no longer be seasonally inundated. Those include privately owned tracts that are not being managed for timber or enrolled in wetlands restoration programs (i.e., WRP). Based on the Corps hydrologic analyses, such measures should cover forested wetlands between elevations 290 and 287 feet NGVD in the St. Johns Bayou basin, and 290 and 277 feet (Authorized Project) or 281 feet (A&M) NGVD in the New Madrid Floodway. Those measures would also preserve the habitat value of mature BLH forests, which is unlikely to develop on reforested compensation areas over the project life.

If the protective measures for forested wetlands mentioned above are not implemented, we recommend that the Corps purchase in fee-title, sufficient croplands to fully compensate habitat losses from induced development of those wetlands. Using the same reforestation methods described above, approximately 2,120 acres would be necessary to compensate for project-related habitat losses in the St. Johns Bayou basin. In the New Madrid Floodway, 4,878 or 4,669 acres would be required to compensate for forested wetland habitat losses from the levee closure and pump operations under the Authorized Project and A&M alternatives, respectively.

Implementation of either project alternative will greatly reduce waterfowl habitat values during spring migration. Using the WAM to estimate spring waterfowl carrying capacity in the project area, the Authorized Project alternative will reduce waterfowl habitat value by 71,527 DUDs in the St. Johns basin, while both alternatives would lead to habitat losses in the New Madrid Floodway: 215,373 DUDs under the Authorized Project or 215,645 DUDs under the A&M alternative. Therefore, we recommend that the Corps re-establish forested wetlands, as previously described, to compensate for those habitat losses. Not only will reforestation meet the food requirement of migrating waterfowl, but forested wetlands will also provide secure roosting areas, cover during inclement weather, loafing sites, protection from predators, and isolation for pair formation. Assuming that the compensation sites are reforested with a mix of 70 percent red oak species, approximately 1,221 acres would be necessary to compensate for habitat losses in both basins under the Authorized Project alternative. Under the A&M alternative, 891 reforested acres would be necessary to compensate for project-related habitat losses which would be limited to the Floodway. Acres reforested to compensate for BLH wetland losses and fisheries habitat losses could also compensate waterfowl habitat losses, provided the flooding regime was

appropriate. Acreage to compensate for spring waterfowl habitat losses should be flooded only to a depth of 18 to 24 inches to be accessible to most dabbling and diving ducks in the project area.

Spring shorebird migration habitat will also be significantly reduced under either of the proposed project alternatives. In the St. Johns basin, habitat value would decrease approximately 30 percent, while in the Floodway either project alternative would cause a 70 percent decrease in spring shorebird habitat value. To compensate for those habitat losses, we recommend the Corps secure, either through fee-title or easements, appropriate acreage (that would not be flooded under future project conditions) to be managed for shorebirds during April and May. As shown in Table 10, moist soil areas provide more habitat value per acre than flooded cropland, so fewer compensation acres of that habitat type would be needed. In addition, depending on the depths

Table 10. Acres needed to compensate spring (April and May) shorebird habitat losses. (average annual acres)

St. Johns Bayou basin	**Authorized Project**	**A&M**
flooded cropland	238	209
moist soil areas	120	105
New Madrid Floodway		
flooded cropland	1345	1314
moist soil areas	676	660

of and access to an area, shallow flooded croplands or moist soil acreage could be used to offset a small portion of the habitat losses to fisheries and waterfowl. Structures within the existing drainage network in the project area could possibly be used to seasonally trap rainwater on agricultural lands to provide spring shorebird habitat. Alternatively, areas could be engineered, by installing small dikes and pumping systems, to control water levels regardless of precipitation or backwater flooding (i.e., moist soil units). Both those measures, however, would largely reduce or eliminate fisheries access at that site. Furthermore, although shallow water along the edges of borrow ditches may be suitable for shorebirds, existing borrow pits in the project area do not receive much shorebird use (B. Allen and D. Wissehr, MDC, pers. comm.). That may be related to the size of the borrow pits, or the presence of tall riparian vegetation and proximity to the Setback Levee both of which could obstruct the birds long-range vision.

Table 11 summarizes the reforestation needs for various fish and wildlife by basin. Although project impacts in the Floodway were not further broken down by project feature (i.e., levee closure and pump operations), most of the indirect wetland impacts in the Floodway (and all the indirect wetland impacts in the St. Johns basin) result from the proposed pumping operations. The Corps has proposed reforesting 9,560 acres of frequently flooded agricultural fields near the project area to compensate for habitat losses to fisheries habitat. As Table 10 shows, that acreage

could also offset project-related impacts to forested wetlands and waterfowl in both basins. Although the Corps recognizes the importance of mitigation in the area of project impacts, we have noted previously that there will not be suitable habitat under post-project conditions to reestablish forested wetlands within the basins. In addition, the Corps has noted to the Service that restoration of significant acreage of lands within the project-area could greatly reduce the economic benefits of the project.

Table 11. Summary of reforestation acreage to compensate fish and wildlife habitat losses by basin for each alternative. (average annual acres)

	St. Johns		New Madrid	
Forested wetlands	Author. Proj.	A&M	Author. Proj.	A&M
direct	2,068	1,496	50	50
indirect	2,120	2,120	4,878	4,669
Fisheries				
floodplain	1,173	1,086	6,795	6,521
perm. waterbody*	283	232	2,060	1,718
Waterfowl	305	0	916	891

* reforestation acres

Another important factor in the feasibility of implementing the recommended mitigation measure is the Corps' policy that relies on purchasing mitigation lands from willing sellers. Considering the strong local support for the project, finding enough interested willing sellers is extremely unlikely. Furthermore, while it is also Corps policy to compensate project impacts concurrently with project construction, reliance on willing sellers places significant constraints on both the timing of land acquisition as well as the location of those acquired lands. The mitigation acreage necessary for each species group is based on those acres *in place and functioning* when project construction is complete. In addition, for lands to offset both wetland and fisheries impacts, they must have significant inundation and fisheries acres in the spring while also able to support viable bottomland hardwood forest species. Acres that mitigate waterfowl impacts must be flooded no more than 24 inches to be accessible to most dabbling and diving ducks in the project area. Given the hydrology and large acreage necessary to compensate project impacts, acquiring suitable land from willing sellers in a timely manner would seem to present a great challenge to the Corps and the local sponsors.

The Service supports the Corps' policy of mitigation acquisition during project construction because it is critical to adequately compensate project-related impacts to fish and wildlife. However, we also recognize that circumstances beyond the Corps' control may significantly delay or otherwise impede timely implementation of the mitigation plan. That could result in significant unmitigated adverse impacts to fish and wildlife resources. Therefore, to ensure that fish and wildlife resources are conserved, we recommend that the Corps not operate either of the

pump stations until mitigation for that project feature is in place. The Corps should include that condition as part of the operation plans for both pumping stations. To provide some flexibility, if a significant portion of the mitigation for the pump stations is in place by the time project construction is complete, the Service offers to work with the Corps to develop an alternative pump operation plan that would ensure those operations result in impacts no greater than what has been mitigated for at that time. The Service recommends that such operation guidelines become an integral part of the either alternative. We believe adherence to those guidelines is the only way to ensure that fish and wildlife resources receive equal consideration with other project purposes.

Summary and Recommendations

Both proposed project alternatives will eliminate spring overbank flooding that currently may cover ten of thousands of acres in the St. Johns Bayou basin and the New Madrid Floodway. Upon receding, those flood waters produce thousands of acres of shallow, temporarily flooded wetlands in a variety of cover types. A variety of waterfowl, numerous other wetland dependent birds, amphibians, invertebrates, and mammals benefit from those habitats. Some of the largest remaining forested wetland tracts in southeast Missouri are found in the project area and would be negatively affected by either project alternative. Seasonal backwater flooding in the New Madrid Floodway provides important floodplain habitat that supports an extremely abundant and diverse fish fauna (both floodplain and riverine), some of which are becoming regionally scarce. The interchange between the Floodway and the river supports a sustainable ecosystem not found elsewhere along the Mississippi River in Missouri. Alterations in the extent and timing of seasonal flooding in the project area greatly concern the Service not only because of adverse impacts upon numerous Federal and State trust resources, but also because of the potential adverse impacts to the study area ecosystem and cumulative impacts in the Lower Mississippi Valley.

The Corps has proposed reforesting 9,560 acres of frequently flooded croplands (i.e. farmed wetlands) near the project area to compensate for project-related fish and wildlife habitat losses. That plan, however, would result in a net loss of wetland acreage and functions within the project area, and a regional net loss of wetland acreage. In addition, although the proposed mitigation measures would compensate losses of wetland habitat value, they would not mitigate impacts to floodwater storage, nutrient cycling or detrital export/import, water quality changes, etc.. Fish and wildlife species with limited mobility (i.e., reptiles and amphibians) will experience a net loss of habitat within the project area that may not be compensated through the proposed mitigation lands. For those reasons, the Service urges the Corps to pursue measures to avoid project impacts rather than try to compensate for them after the fact.

Because the project will negatively affect nationally significant fish and wildlife resources in the project area, the Service recommends that the Corps implement the following measures to ensure that fish and wildlife receive equal consideration with other project purposes:

1.) Consider alternatives that specifically address East Prairie flooding problems, including ring levees, flood-proofing, and local drainage improvements. If additional flood control work is necessary, limit that work to the St. Johns Bayou basin. Work in the New Madrid Floodway will not provide flood relief to areas in and around East Prairie.

2.) Minimize dredging and channel modifications to the maximum extent possible by implementing the following conservation measures.

a.) Installing gradient control structures at the upper end of all work reaches and at the mouths of all major tributaries to prevent headcutting.

b.) Installing transverse dikes in the Setback Levee Ditch and the St. Johns Bayou reach to offset fisheries habitat losses from shallower water depths. Those dikes should be designed to maintain a sinuous, continuous thalweg along the length of the channel.

c.) Constructing a low-head weir where the Lee Rowe ditch branches off the St. James ditch to prevent perching that channel during base flows.

d.) Constructing vortex weirs in the St. James Ditch to compensate for habitat losses from shallower water depths along those reaches. They may also function as grade control structures.

e.) Avoiding dredging impacts to the maximum extent possible in the entire reach of the St. James ditch that contains suitable habitat for the State-listed golden topminnow.

f.) Avoiding dredging in an 9-foot strip along the right descending side of the Setback Levee ditch to reduce dredging impacts to mussels and possibly leave a population to recolonize the ditch. In addition, a minimum of 1,500 mussels (species composition to be determined by the Service and MDC) should be relocated from selected sites within the dredge path to other appropriate areas in the St. Johns basin. A long-term monitoring plan should be developed, in coordination with the Service and MDC, to determine the success of those mitigation measures. In addition, that monitoring plan should contain a provision to evaluate the suitability of the above-mentioned dikes, weirs, and gradient control structures as mussel habitat.

3.) Evaluate non-structural measures (e.g., flooding easements, etc.) to address agricultural flood damages in the New Madrid Floodway. If those are infeasible, the Corps should investigate alternative levee closure locations, such as that proposed by MDC, further north in the Floodway to avoid significant adverse effects to fish and wildlife.

4.) If the Corps determines there are no feasible flood control measures other than the proposed alternatives, they should incorporate the following measures as integral features of the selected plan.

a.) Prevent the conversion of forested wetlands in both basins due to project-related hydrologic changes. This should be done by purchasing a conservation easement or other protective measure on forested wetlands between elevations 290 and 287 feet NGVD in the St. Johns basin, and between 290 and 277 (Authorized Project) or 281 feet (A&M) NGVD in the Floodway.

b.) Fully compensate all unavoidable losses to fish and wildlife resources. Compensation measures should include the following measures. (average annual acres)

1.) Reforest cropland to compensate for forested wetlands habitat losses associated with channel enlargement, levee closure and pump operations (i.e., altered hydrology). Approximately 2,118 acres (Authorized Project) or 1,546 acres (A&M) would be needed to mitigate direct project impacts. If protective covenants have not been placed on BLH forest as described in 4(b), the Corps should reforest an additional 6,998 acres (Authorized Project) or 6,788 acres (A&M) to compensate for induced forested wetland losses because project-related reductions in flooding.

2.) Reforest cropland to compensate for losses in spring waterfowl migration habitat. Acreage to compensate for forested wetland losses mentioned above could also meet waterfowl compensation needs, provided the sites were reforested with at least 50 percent red oak species and flooded during late winter and early spring to depths no greater than 24 inches.

3.) Reforest flooded cropland that has unimpeded access for river fish during the spawning season (i.e., March through June) to compensate fisheries spawning and rearing habitat losses on the floodplain (excluding seasonally-connected waterbodies - see below). Approximately 7,968 acres (Authorized Project) or 7,607 acres (A&M) of flooded agricultural lands would be necessary to mitigate those habitat losses.

4.) To the maximum extent possible, mitigate in-kind (i.e., similar habitat) for fisheries habitat losses of permanent waterbodies. This could include improving existing permanent waterbodies, or reconnecting old chutes, sloughs, and oxbows with the Mississippi River. If in-kind mitigation is infeasible, reforest an additional 2,343 acre (Authorized Project) or 1,950 acres (A&M) of flooded cropland to compensate for those losses. Those sites must be easily accessible to river and floodplain fishes during the spawning season (i.e., March through June). The Corps should ensure public access to those sites through fee-title purchase or easements.

5.) Provide shallow flooded (i.e., $\leq$ 18 inches) land in April and May to compensate for project-related losses in shorebird migration habitat. (Such areas could also partially compensate for losses to fisheries and waterfowl habitat.) Approximately 1,583 acres (Authorized Project) or 1,523 acres (A&M) of flooded cropland would be necessary to compensate shorebird habitat losses. Constructing moist soil areas to mitigate those losses would roughly halve the necessary acreage.

6.) Acquisition of mitigation lands, reforestation, and shorebird management measures should be accomplished concurrently with project construction and should be in place prior to project operation.

Service Position

The Service and the Corps have strived to develop measures that fully address project-related impacts to Federal trust resources. However, providing the appropriate cover types (i.e., BLH, moist soil, borrow pits), only partially meets the needs of fish and wildlife. To fully compensate for project-related impacts, habitat functions must also be maintained. While the proposed mitigation plan would potentially compensate fish and wildlife habitat losses that can be quantified with current models for estimating wildlife effects of water development projects, it would not sustain all the important ecologic functions of the floodplain-river ecosystem in the project area.

The Service opposes the St. Johns Bayou and New Madrid Floodway preferred alternative because:

1.) As proposed, the preferred alternative would cause substantial, irretrievable losses of nationally significant fish and wildlife resources, and greatly diminish rare and unique habitats found in southeast Missouri.

2.) We believe project-related wetlands losses are at odds with the Administration's conservation policy goals and those of the Clean Water Action Plan.

If the Corps proceeds with project construction, at a minimum, they should include the Service's above-mentioned recommendations as integral components of the project.

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