BIOLOGICAL OPINION
FOR THE OPERATION AND MAINTENANCE
OF THE 9-FOOT NAVIGATION CHANNEL
ON THE UPPER MISSISSIPPI RIVER SYSTEM

SUMMARY OF FINDINGS

In this Biological Opinion, the U.S. Fish and Wildlife Service (Service) has determined that the continued operation and maintenance of the 9-foot Navigation Project will jeopardize the continued existence of the Higgins' eye pearly mussel (*Lampsilis higginsi*) and the pallid sturgeon (*Sacphirhynchus albus*). We have also provided reasonable and prudent alternatives that will allow the continued operation and maintenance of the 9-foot Navigation Project while offsetting adverse impacts to the species and avoiding jeopardy. If the reasonable and prudent alternatives are not implemented, then the likelihood of survival and recovery of these species will be appreciably reduced. The Corps of Engineers (Corps) is required to notify the Service of its final decision on the implementation of the reasonable and prudent alternatives described herein.

In addition, we have found that the project will not jeopardize the least tern (*Sterna antillarum*) and winged mapleleaf mussel (*Quadrula fragosa*) but will result in incidental take. We have provided an Incidental Take Statement with reasonable and prudent measures that will minimize the impacts of this take on these species.

We also have determined that the proposed action will likely adversely affect the bald eagle (*Haliaeetus leucocephalus)* and the Indiana bat *(Myotis sodalis).* However, while the project may affect individuals, the impacts will be offset by management actions proposed by the Corps or will be negligible, and will not rise to the level of incidental take (i.e., harm and harassment). For the decurrent false aster (*Boltonia decurrens)* we found that while adverse effects will result, the species will not be jeopardized. Because it is a plant, take is not prohibited.

The Service considered including the sturgeon chub (*Macrhybopsis gelida*) and sicklefin chub (*Machrybopsis meeki*), which are candidate species, in this biological opinion. However, because it appears that these species are more than a year away from a listing proposal, we chose not to include them at this time. When they are proposed for listing, we recommend that you request use of the conferencing process to consider project effects on these species.

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BACKGROUND

This programmatic (Tier I) consultation considers the systemic impacts of the operation and maintenance of the 9-Foot Channel Navigation Project on the Upper Mississippi River System (UMRS) on listed species as projected 50 years into the future. This consultation does not include individual, site specific projects or new construction. These will be handled under separate (Tier II) consultations if it is believed that they may affect a listed species. This consultation establishes a baseline on which any future expansion of the navigation system on the UMRS can be assessed.

This consultation was conducted by an interagency Corps of Engineers (Corps) - U.S. Fish and Wildlife Service (Service) Consultation Team composed of representatives of the three Corps Districts (St. Paul, Minnesota, Rock Island, Illinois and St. Louis, Missouri) and the three Service Field Offices involved (Twin Cities, Minnesota, Rock Island, Illinois and Marion, Illinois). The Team members cooperated with each other in exchanging information preparing and reviewing the Biological Assessment and this Opinion. Each team member took responsibility for one or more species covered in the consultation. Ultimate responsibility for the content of the Biological Assessment rests with the Corps of Engineers, however, and for this Opinion, with the U.S. Fish and Wildlife Service.

The outline for the Biological Assessment was recommended by the Service to insure that all the necessary topics would be addressed and that the need for additional information would be minimized once the Assessment was completed. An impacts matrix was jointly developed by the Team in an attempt to identify all the potential impacts for each species that would be addressed.

Oversight of the consultation process was provided by the Service's Field Office Supervisors and the Corps' Mississippi Valley Division Office Staff. Conflict resolution was the primary responsibility of the Service's Regional Office and the Corps' Division Office but, generally, all parties to the consultation took part in these discussions. A set of guidelines or ground rules were jointly developed by the two agencies to guide the process.

SPECIES COVERED IN THIS CONSULTATION

This consultation covers the following species: Indiana bat (*Myotis sodalis*), decurrent false aster (*Boltonia decurrens*), bald eagle (*Haliaeetus leucocephalus*), Higgins' eye pearlymussel (*Lampsilis higginsi*), winged mapleleaf mussel (*Quadrula fragosa*), least tern (*Sterna antillarum*), and pallid sturgeon (*Scaphirynchus alba*). During informal consultation, the Interagency Corps/Service Consultation Team concluded that pink mucket pearly mussel (*L. abrupta*) and fat pocketbook mussel (*Potamilis capax*) have been extirpated from the UMRS and need not be addressed. By letter dated June 10, 1999, the Service concurred with the Corps' findings in its Biological Assessment that the project may adversely affect the pallid sturgeon and Higgins' eye pearly mussel. However, the Service did not concur with the Corps that the project would not adversely affect the Indiana bat, bald eagle, winged mapleleaf mussel and decurrent false aster.

The Service considered including the sturgeon chub (*Macrhybopsis gelida*) and sicklefin chub (*Machrybopsis meeki*), which are candidate species, in this biological opinion. However, because it appears that these species are more that a year away from a listing proposal, we chose not to include them in this opinion. When they are proposed for listing, we recommend that you request use of the conferencing process to consider project effects on these species.

CONSULTATION HISTORY

February 23, 1993 - The Service's Rock Island Field Office transmits a letter to the St. Louis Corps District Engineer requesting that the District initiate Section 7 consultation on various construction (operation and maintenance) activities on the Mississippi River.

November 22, 1993 - The Service's Rock Island Field Office transmits a letter to the Rock Island Corps District with a species list for Section 7 consultation for their expanded navigation study. In that letter the Service urged the Corps to address operation and maintenance of the navigation channel.

July 8, 1994 - St. Louis Corps District requests a list from the Service's Rock Island Field Office of threatened and endangered species that may occur within the area of the Upper Mississippi 9-Foot Navigation Project.

November 25, 1994 - The Service's Rock Island Field Office transmits a species list to the St. Louis District for preparation of a Biological Assessment for the operation and maintenance of the Upper Mississippi River 9-Foot Navigation Project.

May 15, 1995 - St. Louis Corps District transmits a Tier I (programmatic) biological assessment (BA) for the operation and maintenance of the UMR Navigation Project within the St. Louis District to the Service's Rock Island Field Office.

June 16, 1995 - The Service's Rock Island Field Office responds to St. Louis District's BA concurring with a tiered approach but noting that the Corps did not request formal consultation on the Tier I assessment and recommended that the two agencies continue in informal consultation until it is determined which species should be consulted on, what data are required, and how any formal consultation should be accomplished.

August 7, 1995 - St. Louis Corps District responds to the Service's June 16, 1995 letter concurring that the two agencies should remain in informal consultation for the present time.

April 12, 1997 - The Service's Deputy Assistant Secretary for Fish, Wildlife and Parks transmits a letter to the Assistant Secretary of the Army requesting assistance in resolving the issue of the Corps' reluctance to address operation and maintenance of the navigation channel in its navigation improvements study.

May 20, 1997 - The Service's Rock Island Field Office transmits a letter to the Rock Island Corps District Engineer again requesting that the Corps address impacts of the operation and maintenance of the navigation channel on endangered and threatened species.

October 1, 1997 - Rock Island District Corps District notifies the Service's Rock Island Field Office that it intends to prepare a BA for the operation and maintenance of the O&M Project, and a separate BA for their Navigation Study.

December 21, 1997 - Conference call between the Service's Rock Island Field Office and Rock Island Corps District to discuss the approach of preparing a separate BA for operation and maintenance and one for the Navigation Study.

March 27, 1998 - Rock Island Corps District transmits a draft biological assessment for the UMR Expanded Navigation Study to the Service's Rock Island Field Office.

April 1, 1998 - Service's Regional Office transmits a letter to Mississippi Valley Division Engineer expressing concern regarding Section 7 compliance for the O&M Project and the Corps' Navigation Study. The Service recommends that the Corps initiate a single consultation with the Service on the systemic impacts of the O&M Project for all three UMR Corps Districts. This programmatic consultation would then form the baseline on which to assess the impacts of the Corps' Navigation Study.

April 17, 1998 - Meeting between Service's Regional Director and Mississippi Valley Division Engineer to discuss a Plan of Action completing a systemic consultation on the O&M Project. The Plan calls for establishing a Consultation Team consisting of Corps and Service representatives. The Corps assigned the St. Louis District as their lead and the Service assigned the Rock Island Field Office as their lead. Regional and Division Office Staff will serve as advisors and facilitators.

May 15, 1998 - Service's Rock Island Field Office transmits a letter to St. Louis Corps District enclosing an outline for the consultation and a draft impacts matrix for the Corps to use in preparation of its biological assessment.

May 20, 1998 - Meeting between Corps and Service Consultation Teams to discuss the consultation process, impacts matrix, and the preparation of the Corps' biological assessment.

June 9, 1998 - Service's Rock Island Field Office transmits a letter to St. Louis Corps District enumerating the listed species found in the O&M Project area.

June 14, 1998 - The Service's Rock Island Field Office transmits a letter to the Corps indicating that the Higgins' eye pearly mussel occurs in an additional six counties.

August 4, 1998 - Meeting between Corps and Service Consultation Teams to discuss a revised impacts matrix and other consultation issues.

September 28, 1998 - Corps and Service Consultation Team Leaders finalize a set of Ground Rules for completing the consultation.

November 1998 - Corps Consultation Team members transmit draft sections of the biological assessment to their Service counterparts for review and comment.

January 26, 1999 - Service's St. Paul and Rock Island Field Offices and St. Paul Corps District meet with the Higgins' eye pearlymussel and winged mapleleaf mussel Recovery Teams to discuss O&M Project related impacts on these species.

January/February, 1999 - Service Consultation Team members provide comments to the Corps Consultation Team members on individual sections of the draft Biological Assessment.

February 4, 1999 - Service and Corps Consultation Teams meet to discuss progress on the biological assessment, areas of agreement and disagreement, and to establish a schedule for the remainder of the consultation.

March 30, 1999 - The Service's Marion Illinois Sub-office provides information to the St. Louis Corps District regarding the collection of a young-of-the-year pallid sturgeon at approximate Mississippi River Mile 49.5L.

May 3, 1999 - Corps' Division Engineer transmits its biological assessment to the Service's Regional Director requesting the initiation of formal consultation on the O&M Project.

June 10, 1999 - Service's Assistant Regional Director responds to Corps' Division Engineer's biological assessment requesting additional information.

July 28, 1999 - Corps' Division Engineer transmits a letter to the Service' Regional Office amending page 1 of its Biological Assessment to include language that the Corps "... is not required ... to provide the attached BA ..., the BA is being voluntarily submitted to the ... Service ... for the purpose of fulfilling the Corps' commitment to conservation of endangered species."

August 2, 1999 - Corps' Division Engineer responds to Service's June 10 letter providing some of the information requested and enumerating the reasons why the remainder will not be provided.

August 31, 1999 - Service's Regional Office transmits a letter to the Corps' Division Engineer acknowledging the receipt of additional information and that formal consultation has been initiated as of August 6, 1999.

September 27, 1999 - Meeting between the Service's Rock Island Field Office and St. Louis Corps District at which the Service presented its anticipated finding of jeopardy for the pallid sturgeon and a Reasonable and Prudent Alternative (RPA) to avoid jeopardy.

October 21, 1999 - Meeting between Service and Corps Consultation Teams, the Service's Regional Office and the Corps' Mississippi Valley Division to discuss RPA's and reasonable and prudent measures (RPM's) for all species, and the consequences of jeopardy findings for *L. higginsi* and *S. alba*. It was agreed to extend the consultation period one month to December 3, 1999.

October 27, 1999 - Meeting among representatives of the Service's Rock Island Field Office, St. Louis Corps District, Corps' Mississippi Valley Division, the Waterways Experiment Station, Southern Illinois University, and the Long Term Resource Monitoring Station (Cape Girardeau, MO) to discuss and attempt to develop a mutually acceptable RPA for pallid sturgeon. No agreement was reached on the RPA but the Service offered to provide a list of benchmarks (performance measures) for the Corps to use in estimating costs of the RPA.

November 2, 1999 - Service's Regional Office transmits a letter to Corps' Mississippi Valley Division acknowledging an extension of the consultation period to December 3, 1999.

November 8, 1999 - Service's Marion, IL suboffice faxes draft benchmarks to the Corps' St. Louis District for review and comment.

November 18, 1999 - Meeting between Service Regions 3 and 6 to discuss the status of pallid sturgeon, the validity of a jeopardy opinion in this consultation, and to refine the RPA and RPM's.

November 19, 1999 - Telephone conversation between George Rhodes, Corps' Mississippi Valley Division, and John Blankenship, Assistant Regional Director, FWS Region 3, Twin Cities, MN to discuss an extension of the consultation for 90 days.

November 23, 1999 - Letter from Service's Regional Office to the Corps' Mississippi Valley Division Engineer confirming a joint agreement to extend the consultation period for an additional 90 days to March 2, 2000.

November 30, 1999 - Conference call between FWS staff Rock Island, IL, Twin Cities, MN, and Marion, IL and Corps staff St. Louis, MO and Vicksburg, MS to discuss the 90 day extension of the consultation period. The Corps requested it be modified to 60 days because of a concern for the timely completion of a future consultation for the Navigation Expansion Study and the Service agreed.

December 6, 1999 - Letter from Service's Regional Office to Corps' Mississippi Valley Division Engineer confirming a revised extension of the consultation period for an additional 60 days to February 2, 2000. In addition, the Service notifies the Corps that if a Biological Assessment for the least tern is not received by January 3, 2000, the Service will proceed with the consultation for this species using existing information.

December 9, 1999 - St. Louis Corps District faxes review comments on the Service's draft benchmarks for habitat restoration in the Middle Mississippi River to the Service.

December 15, 1999 - Meeting between Service's Regional Office, Rock Island Field Office and Marion Sub-office staff and Corps' St. Louis District and Mississippi Valley Division Staff to develop a workable RPA. Tentative agreement was reached on the elements of the RPA, prioritization of RPA actions, and benchmarks for the 4 years following this consultation.

December 28, 1999 - Service receives Biological Assessment for the least tern from Corps' Mississippi Valley Division.

January 11, 2000 - Service transmits preliminary draft sections of the Biological Opinion for the pallid sturgeon and Higgins' eye pearly mussel to the Corps for review and comment.

January 12, 2000 - Corps transmits comments on preliminary draft sections of the Biological Opinion to the Service.

February 2, 2000 - The Mississippi Valley Corps Division transmits a letter to Service's Regional Office providing comments on draft sections of the Biological Opinion for the Higginsi' pearly mussel and pallid sturgeon.

February 4, 2000 - Consultation Period Ends

February 9, 2000 - Corps transmits a document entitled "Future Corps of Engineers and Fish and Wildlife Service Actions to Improve the Status of the Pallid Sturgeon in the Middle Mississippi River" to the Service as a supplement to its Biological Assessment.

On or about February 14, 2000 - The St. Louis Corps District forwarded a revised Reasonable and Prudent Alternative for the pallid sturgeon to the Service.

February 17, 2000 - Meeting between the Service's Regional, Rock Island and Marion, Illinois offices and the Corps' Division and St. Louis District offices to discuss the draft Reasonable and Prudent Alternative for the pallid sturgeon.

February 18, 2000 - Draft Biological Opinion provided to the Corps for review and comment.

February 24, 2000 - The Service transmits a revised draft Reasonable and Prudent Alternative for the pallid sturgeon to the Corps' Mississippi Valley Division.

April 2, 2000 - Corps' comments on Draft Biological Opinion received by the Service.

April 19, 2000 - Meeting between Service and Corps representatives to discuss the final findings of the Biological Opinion, implementation of the RPMs and RPAs, and outreach.

May 15, 2000 - Final Biological Opinion delivered to the Corps.

BIOLOGICAL OPINION

1.0 Description of the Proposed Action

1.1 Action Area

The UMRS 9-Foot Navigation Project includes the commercially navigable portions of the Mississippi, Illinois, Kaskaskia, Minnesota, St. Croix, and Black Rivers. As the impacts of the proposed action affect pallid sturgeon populations in the lower Missouri and Mississippi rivers, the action area also encompasses these river stretches (see section 8.3 below for further discussion).

The U.S. Army Corps of Engineers is responsible for maintaining navigation by means of a series of 37 locks and dams, channel training structures, and dredging on over 1,200 miles of navigable waterway. Flood control is maintained to a large extent by a system of agricultural and urban levees, some of which were designed and built by the Corps of Engineers. In addition, the Corps operates and maintains 31 recreational areas and provides for stewardship of the natural resources on project lands and waters. There are also outgrants to Federal, State, public and private institutions and individuals for various purposes, including cottage leases, wildlife management, and recreation.

The 9-Foot Channel Navigation Project encompasses three separate Corps of Engineers districts. Its area is defined as the entire Illinois Waterway from the confluence with the Mississippi River at Grafton, Illinois (River Mile 0.0), to T. J. O'Brien Lock in Chicago, Illinois (River Mile 327.0). The segment of the UMR starts at the confluence with the Ohio River (River Mile 0.0) and extends to Upper St. Anthony Falls Lock in Minneapolis-St. Paul, Minnesota (River Mile 854.0). It also includes the navigable portions of the Kaskaskia, Minnesota, Black and St. Croix Rivers.

The St. Louis District includes the UMR from its confluence with the Ohio, River Mile 0.0 to River Mile 300. 1, near Saverton, Missouri, and the navigable portion of the Kaskaskia River. It also includes the Illinois River from its confluence with the Mississippi at Grafton, Illinois, to immediately below La Grange Lock and Dam at River Mile 79.8. The Rock Island District includes the UMR (River Mile 300. 1) near Saverton, Missouri, through Guttenberg, Iowa (River Mile 615), and the Illinois River from the junction of the Calumet-Sag Channel and the Chicago Sanitary Canal (River Mile 303.4) to the La Grange Lock and Dam (River Mile 79.8). The St. Paul District includes the UMR from Guttenberg, Iowa (River Mile 615), to Minneapolis-St. Paul, Minnesota (River Mile 854.0), as well as the navigable portions of the Minnesota, Black, and St. Croix Rivers.

1.1.1 Middle Mississippi River

The first modification to the river for navigation began in 1824 with clearing and snagging to remove hazards for wooden hull vessels. In the 1830's, the first channel stabilization works were built. In 1881, a comprehensive plan was authorized to maintain an 8-foot channel through bankline revetments and permeable dikes. Congress authorized the existing 9-foot channel project in 1927 for the purpose of securing a 9-foot-deep by 300-foot-wide channel between St. Louis, Missouri, and Cairo, Illinois.

1.1.2 Upper Mississippi River

Modifications to the UMR for navigation began in 1824 when the Government authorized removal of snags, shoals, and sandbars; excavation of rock at several rapids; and closing off of meandering sloughs and side channels to maintain flows in the main channel. The first comprehensive modification of the river was authorized by the Rivers and Harbors Act of June 18, 1878.

A 4½ foot channel was maintained from the mouth of the Missouri River to St. Paul, Minnesota, by constructing dams at the headwaters of the UMR to impound water for low-flow supplementation, and by bank revetments, closing dams, and longitudinal dikes. In 1890, the 4½ foot channel was extended to Minneapolis, Minnesota. A 6-foot channel was authorized by the Rivers and Harbors Act of March 2, 1907. The additional depth was obtained primarily by construction of rock and brush wingdams designed to constrict low-water flows to a narrower channel.

Dam 19 at River Mile 364.2 (Keokuk, Iowa) was constructed in 1913 and is the only dam not federally-owned or operated. It is one of two sites generating hydropower on the system, the other being at Lock and Dam 1 in the Twin Cities which is partially owned by the Ford Motor Company. Congress authorized the 9-Foot Channel Navigation Project in the Rivers and Harbors Act of July 3, 1930, to be achieved by a series of locks and dams and supplemented by dredging. The project extended from the mouth of the Missouri River to Minneapolis, Minnesota. The Rivers and Harbors Act of August 26, 1937, authorized a 4.6-mile extension of the project to ascend St. Anthony Falls.

1.1.3 Illinois River

Between 1871-1878, the State of Illinois built two locks and dams for navigation on the Illinois River and the Federal Government built two locks and dams for the 7-foot navigation project. The 1900 completion of the Chicago Sanitary and Ship Canal created a connection between Lake Michigan and the Illinois River. This increased Illinois River flows and diverted urban wastes into the Illinois River. By 1930, the State had completed 75% of the 9-Foot Channel Navigation Project but was unable to raise funds for completion. The Rivers and Harbors Act of July 3, 1930, authorized the Corps of Engineers to complete the project and assigned responsibility to the Federal Government. The Rock Island District is responsible for operating and maintaining eight locks and dams along 327 miles of the system, and the St. Louis District is responsible for the lower 80-mile reach from La Grange Lock to Grafton, Illinois, the Illinois Waterway portion of Alton Pool.

1.1.4 Kaskaskia River

The Kaskaskia River Navigation Project was authorized by the 1962 Rivers and Harbors Act to provide a navigation channel 9 feet deep and 225 feet wide on the lower 50.5 miles of the

Kaskaskia River. The project shortened the river between its mouth and Fayetteville, Illinois, from 52 to 36 miles. Meanders were left as cutoffs, much of the channel was excavated, and flow was partially regulated by a lock and dam near the river's mouth.

1.1.5 Minnesota River

A 4-foot navigation channel on the Minnesota River to Mile 25.6 near Shakopee, Minnesota, was authorized by the Rivers and Harbors Act of July 13, 1892. Congress authorized a 9-foot channel on the Minnesota River up to Mile 14.7 near Savage, Minnesota, in the Rivers and Harbors Act of July 3, 1958. The Peavey Company maintains a 9-foot channel from Mile 14.7 to its grain terminal at Mile 21.8.

1.1.6 St. Croix River

The Rivers and Harbors Act of June 18, 1878, authorized a 3-foot navigation channel on the St. Croix River from the mouth to Mile 51.8 at Taylors Falls, Minnesota. A 6-foot channel to Mile 24.4 at Stillwater, Minnesota, was authorized by the Rivers and Harbors Act of January 2 1, 1927. The present 9-foot channel to Stillwater was authorized by the Rivers and Harbors Act of August 30, 1935, and was assured as a result of the completion of Lock and Dam 3 in 1938.

1.1.7 Black River

The Rivers and Harbors Act of August 26, 1937, authorized a 9-foot navigation channel on the Black River at La Crosse, Wisconsin, to a point 1.4 miles above the mouth. Dredging a channel approximately 300 feet wide, which is considered adequate for existing commerce, was completed in 1941.

1.2 Proposed Action

The proposed action is the continuance, for the next 50 years, of the operation and maintenance of the 9-Foot Navigation Channel Project on the UMRS which has been on-going for the past 60-70 years.

1.2.1 Lock and Dam Operations

Water levels upstream of the dams are based upon depths needed for navigation and are controlled by systematically raising or lowering the dam gates. Water elevations at all of the dams are regulated based upon discharge. The goal is to maintain a target water level at a control point within each pool. Control ranges are defined within each district. Water level control is described completely in pool operation plans for each lock and dam. An analysis of water level management on the Upper Mississippi River System was completed by the Long Term Resource Monitoring Program and is available in Wlosinski and Hill (1995).

Maintenance at locks and dams is performed on a daily basis or at longer intervals for major work. Personnel perform day-to-day maintenance of operating machinery and minor repair work on the facilities. During major maintenance and rehabilitation, lock gates and valves are removed, sandblasted, and repaired, as are dam gates when necessary. Major rehabilitation at Locks and Dams 2-22 and the Illinois Waterway was evaluated in a Programmatic Environmental Impact Statement (USACE 1989b). The associated Biological Assessment is hereby incorporated by reference.

1.2.2 Recreation

The three Corps districts operate and maintain 31 recreation areas along the river. Seventy-three additional recreation areas are located on Corps lands but are leased to other organizations that are responsible for operation and maintenance. Twenty-two major public parks are located along the river. Boating access to the river is provided by approximately 360 boat access points and/or marinas and 11,500 marina slips along the Upper Mississippi River, excluding the St. Croix and Minnesota Rivers. Carlson *et al.* (1995) estimated that over 12 million daily visits occurred throughout the Upper Mississippi River System during the study year. The study also determined that the top three activities in which those visitors engaged were recreational boating, boat fishing, and sightseeing.

The guiding documents governing operation and management of Corps of Engineers' administered recreational facilities and grounds is the Operational Management Plan (OMP) Part II. Currently, the St. Paul and Rock Island Districts have completed OMP’s that include a detailed synopsis describing a 5-year plan of action on how facilities will be operated and maintained. Annual updates of the OMP Part II are reviewed for appropriateness and to ensure that long-term management is provided in an environmentally sound manner. The St. Louis District is currently developing a comprehensive master plan for the river projects and concurrently developing OMP’s. The OMP’S will be similar in scope to those described above and completed after Master Plan approval. The Kaskaskia OMP was recently approved (USACE 1998). Complete description of operation and maintenance of recreation areas can be found in the OMP (USACE 1992, USACE 1993). Additional information is found in Land Use Allocation Plans and Master Plans (USACE 1969-1973, 1983, 1989a).

The St. Paul District manages one major recreation area and three boat ramps. Blackhawk Park, about 25 miles south of La Crosse, Wisconsin, is the only full service staffed campground/park that the district operates on the Mississippi River above Guttenberg, Iowa. The district has a few real state outgrants, but 460 private recreational facilities and a few hundred others on municipal leases are managed in accordance with the Shoreline Management Plan, which allows private structures and use while affirming public ownership and management.

The Mississippi River recreational facilities that the Rock Island District directly manages include six Class A campgrounds (modern facilities), one Class B campground (semi-modern facilities), two Class C campgrounds (primitive facilities), six no-fee primitive campgrounds, 10 day-use areas with day-use fee boat ramps, 10 free day-use areas with boat ramps, 10 no-fee day-use areas with picnic shelters, four lock and dam overlooks, and one Class B project visitor center.

In calendar year 1997, there were approximately 55 million visitor hours of use on Rock Island District Mississippi River Project lands and waters, with about 10% or 5.5 million visitor hours occurring at Corps-administered recreational facilities. Visitor assistance and resource management at these facilities are administered by the Mississippi River Project Office staff located at Pleasant Valley, Iowa; and by park ranger staff assigned to remote field station offices located in Dubuque and Muscatine, Iowa, and Thomson, Rock Island, and Quincy, Illinois. In addition to managing developed recreational facilities, these park rangers are also responsible for managing dispersed recreational activities occurring on all 93,600 land and water acres of the Rock Island District, Mississippi River Project. Mississippi River Natural Resource Management staff are empowered to enforce Part 327, Title 36 of the Federal Code of Regulations in order to protect recreational and natural resource features found within project lands and waters of the Mississippi River Project.

In the Rock Island District, approximately 565 private recreational and residential leases encompass 465 acres of land. Public Law 99-662 allows-for these leases to continue indefinitely until terminated by the lessee or the Secretary of the-Army. New leases are not being issued, but existing sites are maintained. If leased areas are returned to the Corps, natural resource management prescriptions are implemented, which include closure or removal of the access road and conversion to natural habitat. The OMP contains additional information on other types of leases.

The St. Louis District manages seven recreation areas, 18 access areas, and five marinas. Eighteen cabin subdivisions (350 recreational cottage leases are still active on 244 acres) dot the riverbanks. The States of Illinois and Missouri operate three recreation areas and 17 accesses on Corps-owned land. The city of Alton operates one marina on Corps land. Local governments, as well as the states, operate an additional 23 access areas. Marinas, harbors, and boating clubs on the Mississippi and Kaskaskia Rivers total 27 and 2, respectively, providing some 3,198 boat slips. The Rivers Project Office operates a regional visitor center at the Melvin Price Locks and Dam area and Class C visitor centers at Locks 27 and Kaskaskia Lock and Dam.

The rivers of the St. Louis District are a major recreational resource for the people living in the bi-state area. A portion of the Great River Road from Melvin Price Locks and Dam visitor center to Hardin, Illinois, was recently designated a National Scenic Byway. Recreational points of interest are the Mark Twain National Wildlife and Fish Refuge, Lewis and Clark State Historical Park, the Corps' Riverlands Environmental Demonstration Area adjacent to Melvin Price Locks and Dam, the multi-agency confluence greenway (Mississippi and Missouri Rivers), and the regional bike trail system. According to a recent survey, recreational use of the area is varied. Fishing from a boat is the most popular (23.4%), followed closely by sightseeing (19.6%) and recreational boating (17.9%). Bank fishing (14.6%) is the fourth most popular activity, followed by waterskiing (7.1%), hiking (6.4%), and swimming (4.1%). Picnicking is participated in by 2.7%, only slightly above camping at 2.7%. All other activity totals approximately 1.6%.

1.2.3 Natural Resource Management

The Corps of Engineers maintains primary administrative authority over all fee title lands and waters acquired for construction and operation of the Mississippi River Project. The Corps has the responsibility and authority to manage the natural resources on fee title lands, which includes forest, fish and wildlife, water, aesthetic, and vegetative resources. Detailed descriptions of the projects are included in the Rock Island District, Natural Resource Management, Operational Management Plan Part I (USACE 1992) and the St. Paul District, Mississippi River Operational Management Plan (USACE 1993). With the exception of the Kaskaskia River OMP that was recently approved (USACE 1998), the St. Louis District OMP will be completed after approval of the Comprehensive Rivers Project Master Plan.

Estimates from 1989 satellite data indicate that approximately 304,000 acres of the UMR floodplain remains forested (Yin 1998). The St. Louis District has mapped a total of 800,000 acres of floodplain forest as of 1994 (USACE 2000). Much of this remaining bottomland forest is managed for natural resource benefits in the St. Paul and Rock Island Corps Districts, and efforts are under way to maintain forest age class and diversity. The St. Louis District does not directly manage any of its forest lands; rather, it oversees the management of its fee title lands managed by state and federal agencies such as the Fish and Wildlife Service.

The goals of the forest management in the Corps' Rock Island District are as follows:

1. Complete and maintain a detailed comprehensive stand-mapping database to use in future forest management decisions.

2. Promote size class diversity through continued silvicultural practices such as TSI's, tree plantings, and timber sales to maintain and improve forest quality for wildlife habitat and provide a regulated and sustained yield of forest products.

3. Protect habitat for all endangered and threatened species found on project lands.

4. Maintain existing and future nesting sites for colonial nesting birds.

5. Manage habitat to provide nesting and feeding sites for local and migratory birds.

6. Maintain and enhance communication with coordinating agencies and the general public.

Specific management practices are outlined in the OMP, and the Management Plan is updated annually. At that time, review and coordination ensure that management is provided in an environmentally sound manner.

In addition to lands managed by the Corps, other fee title lands are managed by the U.S. Fish and Wildlife Service and several of the states under Cooperative Agreements. These lands include portions of the Upper Mississippi National Wildlife and Fish Refuge, the Mark Twain National Wildlife Refuge, the Minnesota Valley National Wildlife Refuge, the Illinois River

National Wildlife and Fish Refuge, and a number of state conservation areas in Minnesota, Wisconsin, Illinois, Iowa, and Missouri. At the present time, all Service Refuges in the action area are preparing Comprehensive Conservation Plans (CCPs) which will address forest land management. While still in draft stage, these plans will likely include goals similar to the following:

- reduce forest fragmentation by conserving and enhancing the size of bottomland forest blocks;

- enhance forest structural diversity within blocks (age class, species, canopy, understory, etc.);

- ensure adequate spatial distribution of bottomland forest along the river corridor for neotropical migrants;

- promote natural biological diversity through the protection, restoration, and management.

1.2.4 Channel Maintenance

The navigation channel is maintained by periodic maintenance dredging and regulatory structures (wing and closing dams and revetment). Description of channel maintenance in the three districts varies slightly due to differing river conditions. A general description of channel maintenance follows, along with a list of documents in which more specific information can be found.

1.2.4.1 Dredging

Periodic dredging is required in order to maintain a 9-foot channel. In required locations, dredging occurs with hydraulic cutterhead, mechanical, or dustpan dredge. In accordance with the Federal Standard, dredged material placement sites are identified that represent the least costly alternative with sound engineering practices and meet environmental standards pursuant to the Clean Water Act. Placement of dredged material has occurred within the thalweg, shoreline, bottomland forests, agricultural fields, and beneficial use sites and for environmental restoration. Where recurrent dredge cuts occur, long-term site plans have been and are being developed. Placement sites are chosen in conjunction with On-Site Inspection Teams (OSITs), public coordination, and various other committees of river managers and biologists.

Detailed description of the St. Paul District's process and program can be found in their Channel Maintenance Management Plan (CMMP) (USACE 1996) and associated Environmental Impact Statement dated March 20, 1997. A Biological Assessment was prepared for the district and is included within the Environmental Impact Statement. That Biological Assessment is hereby incorporated by reference.

Detailed description of the Rock Island District's program is found in the Long Term Management Strategy for Dredged Material Placement, Main Report Mississippi River

(USACE 1990) and Illinois River (USACE 1995) and associated Dredged Material Management Plans.

Detailed description of channel maintenance dredging in the St. Louis District is found in the Environmental Impact Statement on operation and maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers (USACE 1975). Dredged material is generally placed adjacent to the main channel where beneficial uses may occur, such as recreational beach creation, least tem island habitat, and island creation. Approximately 150 sites have been dredged in the past, with between 30 to 50 locations in the district dredged regularly for a total of approximately 8 million cubic yards annually.

1.2.4.2 River Regulatory Structures

The Corps of Engineers began building regulatory structures in 1878 with the authorization of the 4.5 foot channel. Since that time, many wingdams, closing dams, and bank-line revetment have been constructed and maintained to assist in channel maintenance. Regulatory structures help to reduce channel maintenance dredging, reduce costs and environmental effects of channel maintenance, restore or maintain natural river processes, and restore and enhance habitat quality. Use of structures is mainly limited to the Mississippi River with few used on the Illinois River.

Regulatory structures are described in more detail within various documents, including the 9-Foot Channel Environmental Impact Statements for each district, the CMMP (USACE 1996), and various other project-specific documents. In addition to meeting the goal of reducing channel maintenance, the planning and design of regulatory structures includes consideration of environmental impacts and compliance with various regulations. The process varies within each district, but involves coordination with other agencies. In St. Paul District, the process includes project review by the River Resources Forum. The Rock Island District has the Committee to Assess Regulatory Structures (CARS), which consists of representatives from the engineering, operations, and environmental officer and the U.S. Fish and Wildlife Service. In addition, a document produced by the St. Louis District describes their environmental river engineering project in which biologists and engineers cooperate to improve navigation and habitat diversity through the use of river structures (USACE, no date).

1.2.4.3 Clearing and Snagging

While clearing and snagging was once widespread prior to the completion of the current project, it now takes place only on the St. Croix and Minnesota Rivers. Snags on the river are recognized as providing valuable aquatic habitat and are only removed when safety is a concern. Removal of trees snagged in the navigation channel of the Minnesota River is an infrequent requirement. They are only removed when they become a navigation concern. On the St. Croix River, snag removal is limited to requests from the National Park Service and takes place only during safety concerns and channel blockage (USACE 1996).

1.3 Conservation Measures

Conservation Measures to minimize harm to listed species which are proposed by the action agency are considered part of the proposed action and their implementation is required under the terms of the consultation. The Corps included the following Conservation Measures in its April 1999 Biological Assessment:

1.3.1 Indiana bat

- Any activities that are determined to impact potential Indiana bat habitat will prohibit tree removal/clearing during the period of April 1 to September 30, unless mist net surveys indicate that no bats are present and there is no known roosting at the site. If a site is within a 5-mile radius of hibernacula, the period is April 1 to November 15.

- Forest management efforts within the range of the Indiana bat will be carried out to establish and maintain forest species and size class diversity in order to ensure a long-term supply of potential Indiana bat roosting trees.

- Current Corps of Engineers operations and maintenance programs will be evaluated to determine if additional opportunities exist to promote hardwood regeneration and species diversity in floodplain forests.

1.3.2 Decurrent false aster

- Each project that requires bankline or upland dredged material placement, or bankline habitat modification along the Illinois River or the UMR (within the known range of the species) will be addressed in a separate site-specific Tier II Biological Assessment to the U.S. Fish and Wildlife Service. An inspection of bankline habitat or upland placement sites will be conducted by Rock Island District personnel, St. Louis District personnel, or an expert contractor prior to habitat modification. If plants are encountered, Section 7 coordination will be completed prior to any habitat disturbance.

- All Section 10/404 actions for fleeting, port development or recreation-related facilities will be reviewed for potential impacts to federally proposed species and threatened or endangered species. Appropriate Section 7 review will include consideration of habitat potential at the project site by Corps regulatory staff and coordination with the U.S. Fish and Wildlife Service when necessary. Applicants for projects that require bankline or floodplain habitat modifications along the Illinois River or UMR within the existing range of the species may be required to conduct a survey for *B. decurrens*. If plants are encountered, Section 7 consultation will be completed prior to any habitat disturbance.

1.3.3 Pallid Sturgeon

- The St. Louis District will continue to conduct maintenance dredging outside the presumed "window" of pallid sturgeon reproduction of April 12 - June 30. In cases where emergency dredging is required, the U.S. Fish and Wildlife Service will be contacted.

- The St. Louis District's Avoid and Minimize Team will be asked to prioritize physical-biological monitoring of point-bar habitat of bendway weirs in the Middle Mississippi River in FY 2000.

1.4 Literature Cited

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2.0 Indiana bat

2.1 Status of the Species

This section presents the biological or ecological information relevant to formulating the biological opinion. Appropriate information on the species' life history, its habitat and distribution, and other data on factors necessary to its survival, is included to provide background for analysis in later sections. This analysis documents the effects of all past human and natural activities or events that have led to the current range-wide status of the species. This information is presented in listing documents, the draft revised recovery plan (USFWS 1999), and the Biological Assessment (USACE 1999).

2.1.1 General

The Indiana bat *(Myotis sodalis)* was listed as an endangered species on March 11, 1967 *(Federal Register* 32[48]:4001), under the Endangered Species Preservation Act of October 15, 1966 (80 Stat. 926; 16 U. S. C. 668aa[c]). Eleven caves and two mines in six states were listed as critical habitat on September 24, 1976 (41 FR 41914), but none are within the action area.

The Indiana bat is a migratory species found throughout much of the eastern half of the United States. During winter, Indiana bats are restricted to suitable hibernacula, mostly caves, but also a few abandoned mines, and even a tunnel and a hydroelectric dam, that are primarily located in karst areas of the east-central U. S. More than 85 percent of the range wide population occupies nine Priority One hibernacula (hibernation sites with a recorded population >30,000 bats since 1960 - although two of these currently have extremely low numbers of bats) Indiana, Kentucky, and Missouri each contain three Priority One hibernacula. Priority Two hybernacula (recorded population >500 but <30,000 bats since 1960) are known from the above mentioned states, in addition to Arkansas, Illinois, New York, Ohio, Tennessee, Virginia, and West Virginia. Priority Three hibernacula with recorded populations <500 bats or records of single hibernating individuals have been reported in 17 states, including all of the above mentioned states. Hibernacula with recorded populations of <500 bats (Priority Three hibernacula) or records of single hibernating individuals have been reported in the above mentioned states plus Alabama, Connecticut, Florida, and Georgia.

Although the number of band returns for the Indiana bat are limited, certain migration patterns may be inferred from what little information that does exist. Based on sparse band recovery records, all of which are from the Midwest, it appears that females and some males generally migrate north in the spring upon emergence from hibernation (Hall 1962; Myers 1964; Hassell and Harvey 1965; Barbour and Davis 1969; Kurta 1980; LaVal and LaVal, 1980; Bowles 1982), although there also is evidence that movements may occur in other directions. However, summer habitats in the eastern and southern United States have not been well investigated; it is possible that both sexes of Indiana bats occur throughout these regions. Very little is known about Indiana bat summer habitat use in the southern and eastern United States, or how many Indiana bats may migrate to form maternity colonies there. Most summer captures of reproductively active Indiana bats (pregnant or lactating females or juveniles) have been made between April 15 and August 15 in areas generally north of the major cave areas.

Most of the maternity records of the Indiana bat originated in the Midwest (southern Iowa, northern Missouri, northern Illinois, northern Indiana, southern Michigan, and western Ohio). The first maternity colony was found and several studies of Indiana bat maternity habitat were conducted in the midwest region. Although the woodland in this glaciated region is mostly fragmented, it has a relatively high density of maternity colonies. Today, small bottomland and upland forested tracts with predominantly oak-hickory forest types and riparian bottomland forests of elm-ash-cottonwood associations exist in an otherwise agriculturally dominated (non-forested) landscape (USFWS 1999). Unglaciated portions of the Midwest (southern Missouri, southern Illinois, southern Indiana), Kentucky, and most of the eastern and southern portions of the species' range appear to have fewer maternity colonies per unit area of forest. However, such conclusions may be premature, given the lack of search effort in these areas.

Trees in excess of 16 inch diameter at breast height (dbh) with exfoliating bark are considered optimal for maternity colony roost sites, but trees in excess of 9 inch dbh appear to provide suitable maternity roosting habitat (Romme *et al*. 1995). Cavities and crevices in trees may also be used for roosting. In Illinois, Gardner *et al*. (1991) found that forested stream corridors, and impounded bodies of water, were preferred foraging habitats for pregnant and lactating Indiana bats.

Females typically utilize larger foraging ranges than males (Garner and Gardner 1992). Bats forage at a height of approximately 2-30 meters under riparian and floodplain trees (Humphrey *et al*. 1977). They forage between dusk and dawn and feed exclusively on flying insects, primarily moths, beetles, and aquatic insects. Female Indiana bats exhibit strong site fidelity to summer roosting and foraging areas, that is, they return to the same summer range annually to bear their young.

Male Indiana bats may be found throughout the entire range of the species. Males appear to roost singly or in small groups, except during brief summer visits to hibernacula. Males have been observed roosting in trees as small as 3 inch dbh.

After the summer maternity period, Indiana bats migrate back to traditional winter hibernacula. Some male bats may begin to arrive at hibernacula as early as July. Females typically arrive later and by September the number of males and females are almost equal. Autumn “swarming” occurs prior to hibernation. During swarming, bats fly in and out of cave entrances from dusk to dawn, while relatively roost in the caves during the day. By late September many females have entered hibernation, but males may continue swarming well into October in what is believed to be an attempt to breed with late arriving females.

Indiana bats will forage over a variety of habitat types but prefer to forage in and around the tree canopy of both upland and bottomland forest or along the corridors of small streams. Females in Illinois were found to forage most frequently in areas with canopy cover of greater than 80% (Garner and Gardner 1992). The species feeds on flying insects, both aquatic and terrestrial. Lee (1993) found that reproductively active females consume more aquatic insects than do males (USFWS 1996). 3D/E (1995) summarizes dietary information on the species where they reviewed the known literature. They found that the predominant prey include terrestrial orders such as moths (Lepidoptera) and beetles (Coleoptera). Aquatic insects such as flies (Diptera), caddisflies (Trichoptera), and stoneflies (Plecoptera) are also consumed. As would be expected, in conditions where riparian woodlands are present, more aquatic insects are consumed. Females also have been found to consume higher percentages of aquatic insects. The study area contains a variety of habitats where the species could forage. These include floodplain forests, backwaters, sloughs, and over open water. It is likely that foraging Indiana bats within the project vicinity will forage upon both aquatic and terrestrial insects near the canopy of floodplain forests.

2.1.2 Current Status and Population Trends in Hibernacula

Based on censuses taken at hibernacula, the total, known Indiana bat population in 1997 was estimated at 353,000 bats (Table 2-1). Indiana bat populations first were first surveyed in the late 1950s (Hall 1962). In the decades since then, additional colonies of hibernating Indiana bats were discovered and our knowledge of the distribution and status of the species has expanded. Many hibernacula populations have decreased in number since monitoring began, especially in Kentucky and Missouri.

Table 2-1 Summary of hibernating Indiana bat populations by State, based upon estimates nearest to year indicated [1, 2] (from USFWS 1999).			
State	Historic Level (1960 or Earliest #)	When Regular Surveys Began (~1980)	Most Recent Survey (1995-1997)
Alabama	300	300	300
Arkansas	14,930	14,830	2,700
Illinois	4,140	3,990	4,530
Indiana	177,885	124,080	182,510
Kentucky	241,335	96,235	61,370
Missouri	323,120	302,915	47,135
New York	7,805	7,805	14,990
Ohio	---	—	9,300
Pennsylvania	65	65	270
Tennessee	19,305	19,305	16,580
Virginia	5,260	5,620	1,840
West Virginia	4,700	4,675	11,660
Total	808,505	589,120	353,185

[1] Due to inconsistent records, population estimates for a particular period were extrapolated from the nearest survey prior to or subsequent to the year displayed in the table; therefore, all caves are represented in each period.
[2] States with records of fewer than 100 hibernating Indiana bats are not listed.

2.1.3 Reasons For Decline

Not all of the causes of Indiana bat population declines have been determined; the decline of the species at its current rate is unknown. Although several known human-related factors have caused declines in the past, they may not solely be responsible for recent declines.

2.1.3.1 Documented causes.

Disturbance and vandalism. A serious cause of Indiana bat decline has been human disturbance of hibernating bats during the decades of the 1960s through the 1980s. Bats enter hibernation with only enough fat reserves to last until spring. When a bat is aroused, as much as 68 days of fat supply is used in a single disturbance (Thomas *et al.* 1990). Humans use (e.g., including recreational cavers and researchers) near hibernating Indiana bats can cause arousal (Humphrey 1978; Thomas 1995; Johnson *et al.* 1998). If this happens too often, the bats' fat reserves may be exhausted before the species is able to forage in the spring.

Active programs by State and Federal agencies have led to the acquisition and protection of a number of Indiana bat hibernacula. Of 127 caves/mines with populations >100 bats, 54

(43%) are in public ownership or control, and most of the 46 (36%) that are gated or fenced are on public land. Although such conservation efforts have been successful in protecting Indiana bats from human disturbance, they have not been sufficient to reverse the downward trend in many populations.

Improper cave gates and structures. Some hibernacula have been rendered unavailable to Indiana bats by the erection of solid gates in the entrances (Humphrey 1978). Since the 1950's, the exclusion of Indiana bats from caves and changes in air flow are the major cause of loss in Kentucky (an estimated 200,000 bats at three caves) (USFWS 1999). Other cave gates have so modified the climate of hibernacula that Indiana bats were unable to survive the winter because changes in air flow elevated temperatures which caused an increase in metabolic rate and a premature exhaustion of fat reserves (Richter *et al.* 1993; Merlin Tuttle, Bat Conservation International, *in litt.* 1998).

Natural hazards. Indiana bats are subject to a number of natural hazards. River flooding in Bat Cave, Mammoth Cave National Park, drowned large numbers of Indiana bats (Hall, 1962). Other cases of hibernacula being flooded have been recorded by Hall (1962), DeBlase *et al.* (1965), and USFWS (1999). A case of internal cave flooding occurred when tree slash and debris (produced by forest clearing to convert the land to pasture) were bulldozed into a sinkhole, blocking the cave's rain water outlet and drowning an estimated 150 Indiana bats (USFWS 1999).

Another hazard exists because Indiana bats hibernate in cool portions of caves that tend to be near entrances, or where cold air is trapped. Some bats may freeze to death during severe winters (Humphrey, 1978; Richter *et al.* 1993).

Indiana bats are vulnerable to the effects of severe weather when roosting under exfoliating bark during summer. For example, a maternity colony was displaced when strong winds and hail produced by a thunderstorm stripped the bark from their cottonwood roost and the bats were forced to move to another roost (USFWS 1999).

2.1.3. 2. Suspected causes.

Microclimate effects. Changes in the microclimates of caves and mines may have contributed more to the decline in population levels of the Indiana bat than previously estimated (Tuttle, *in litt.* August 4, 1998). Entrances and internal passages essential to air flow may become larger, smaller, or close altogether, with concomitant increases or decreases in air flow. Blockage of entry points, even those too small to be recognized, can be extremely important in hibernacula that require chimney-effect air flow to function. As suggested by Richter *et al.* (1993) and Tuttle (*in litt.* August 4, 1998), changes in air flow can elevate temperatures which can cause an increase in metabolic rate and a premature exhaustion of fat reserves.

Hibernacula in the southern portions of the Indiana bat's range may be either near the warm edge of the bat's hibernating tolerance or have relatively less stable temperatures. Hibernacula in the North may have passages that become too cold. In the former case, bats may be forced to roost near entrances or floors to find low enough temperatures, thus increasing their vulnerability to freezing or predation. In the North, bats must be able to escape particularly cold temperatures. In both cases, modifications that obstruct air flow or bat movement could adversely impact the species (USFWS 1999).

Land use practices. The Indiana bats' maternity range has changed dramatically since pre-settlement times (Schroeder 1991; Giessman *et al.* 1986; MacCleery 1992; Nigh *et al.* 1992). Most of the forest in the upper Midwest has been fragmented, fire has been suppressed, and native prairies have been converted to agricultural crops or to pasture and hay meadows for livestock. Native species have been replaced with exotics in large portions of the maternity range, and plant communities have become less diverse than occurred prior to settlement. Additionally, numerous chemicals are applied to these intensely- cropped areas. The changes in the landscape and the use of chemicals (McFarland 1998) may have reduced the availability and abundance of the bats' insect forage base.

In the eastern U. S., the area of land covered by forest has been increasing in recent years (MacCleery 1992). Whether or not this is beneficial to the Indiana bat is unknown. The age, composition, and size class distribution of the woodlands will have a bearing on their suitability as roosting and foraging habitat for the species outside the winter hibernation season.

Chemical contamination. Pesticides have been implicated in the declines of a number of insectivorous bats in North America (Mohr 1972; Reidinger 1972, 1976; Clark and Prouty 1976; Clark *et al.* 1978; Geluso *et al.* 1976; Clark 1981). The effects of pesticides on Indiana bats have yet to be studied. McFarland (1998) studied two sympatric species, the little brown bat *(Myotis lucifugus)* and the northern long-eared bat *(M. septentrionalis keenii)* as surrogates in northern Missouri and documented depressed levels of acetylcholinesterase, suggesting that bats there may be exposed to sublethal levels of organophosphate and/or carbamate insecticides applied to agricultural crops. McFarland (1998) also demonstrated that bats in northern Missouri are exposed to significant amounts of agricultural chemicals, especially those applied to corn. BHE Environmental, Inc. (1999) collected tissue and guano samples from five species of bats at Fort Leonard Wood, Missouri and documented the exposure of bats to p,p'-DDE, heptachlor epoxide, and dieldrin.

2.2 Environmental Baseline

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and ecosystem within the action area. The purpose is to describe the current status of the species within the action area and those factors that have contributed to this state.

Much of the UMRS corridor represents potential summer habitat for the Indiana bat. Due to their migratory behavior, Indiana bats likely traverse or follow the Mississippi and Illinois River corridors en route to their summer habitats and in returning to their hibernacula. In doing so, they may stop and roost temporarily in suitable floodplain trees, or may select an area to spend the summer in a maternity colony.

2.2.1 Status of the Species in the Action Area

In counties bordering the Mississippi River, bats have been collected at 24 sites between Cairo, Illinois, and Canton, Missouri (river miles 0-340), including 7 hibernacula. However, of these collections, only three females and three males have collected at two sites in the Mississippi River floodplain in Pool 21 in 1990 and 1997 (USGS/USFWS 2000). In counties bordering the Illinois River, bats have been collected at 13 sites, including 2 hibernacula, between Jersey and LaSalle Counties (Illinois DNR Natural Heritage Database 1999). However, only 1 site was located in the Illinois River floodplain where 1 specimen was collected (USGS/USFWS 2000).

The current population status in the action area is difficult to assess primarily because of the few collections that have been made. Based on hibernacula estimates, the species appears to be relatively stable in Illinois (see Table 2-1) while it is declining in Missouri. How this trend relates to the bat's status in the action area is unknown.

2.2.2 Factors Affecting the Species

2.2.2.1 Impoundment and Water Level Regulation

The discussion regarding the effects of impoundment and water level regulation on floodplain forest composition that is found in section 7.2.1.1.1 for the bald eagle is applicable to the Indiana bat and is hereby incorporated by reference.

The 9-Foot Channel Navigation Project has contributed to hydrological changes of the river floodplain and initially caused the conversion of some bottomland forest to aquatic and wetland habitat. However, many acres of farmed lands were purchased as part of the project and allowed to grow to forest. Were it not for the 9-Foot Channel Navigation Project and acquisition of lands by the Federal Government, much of the remaining forest would most likely have been cleared and would not exist today. Much of that remaining bottomland forest is managed for natural resource benefits in the Rock Island and St. Louis Corps District, and efforts are under way to maintain forest age class and diversity which will directly benefit the bat through long term maintenance of suitable habitat. The St. Louis District does not directly manage any of its forest lands; rather, the District exerts ultimate management responsibility over forested lands managed by state and federal agencies such as the Fish and Wildlife Service. The most important disturbance factor will remain flooding for the foreseeable future and areas of floodplain that are frequently inundated and have higher water tables will most likely continue to be comprised of water-tolerant species suitable for Indiana bat use.

While it is obvious that impoundment has contributed to hydrological changes in the floodplain of the project area and has affected forest composition, the magnitude of this impact cannot be evaluated due to lack of historical data. In total, however, the 9-Foot

Channel Navigation Project has been beneficial to the bat.

2.2.2.2 Dredging and Disposal

Dredging and disposal may have affected Indiana bats in two ways: disturbance and habitat alteration. Dredging occurs during the summer and fall months when bats may be present. Dredged material disposal may have disturbed Indiana bats if they were roosting in trees located at a disposal site. This could range from 'bumping' trees with heavy equipment causing bats to abandon the roost, to actually removing trees prior to disposal causing abandonment or, as a worst case, mortality. The magnitude of this impact cannot be determined due to a lack of historical data. On the positive side, disposal among living trees could have caused tree mortality, thus creating roosting habitat as the trees' bark becomes loose and exfoliates.

2.2.2.3 Clearing and Snagging

Removal of trees or other obstructions from the navigation channel may have affected Indiana bats by removing roost trees along the shoreline. However, the magnitude of this impact cannot be determined due to a lack of historical data.

2.2.2.4 Channel Structures and Revetment

Construction of channel control structures and revetment may have occurred in areas utilized by Indiana bats for roosting if bank reshaping and tree removal was included. The magnitude of these impacts cannot be determined due to a lack of historical data but, in total, has been detrimental to the bat.

2.2.2.5 Tow Traffic - No Effect

2.2.2.6 Fleeting

Development of fleeting areas may have affected Indiana bats in two ways: (1) disturbance or (2) loss of roost trees. Fleeting activities may have disturbed bats roosting in shoreline trees if trees are 'bumped' by barges or heavy equipment. A study of the effects of barge fleeting on bank erosion found that fleeting areas are of high risk for potential bank erosion (USACE 1998) and a subsequent loss of potential roost trees. In addition, barges have been tied off to shoreline trees in the past which may have resulted in their being pulled down. The magnitude of these impacts cannot be determined due to a lack of historical data.

2.2.2.7 Port Facilities

Terminal or port facilities have typically been constructed in urban or industrial areas, usually within floodplain habitat. There is one Corps of Engineers port facility within the range of the Indiana bat (LeClaire Service Base, IA), and numerous private facilities. In non-urban situations, it is possible that Indiana bat habitat has been destroyed or modified.

The magnitude of these impacts cannot be determined due to a lack of historical data.

2.2.2.8 Exotic Species - not applicable

2.2.2.9 Contaminants

It is possible that insects upon which the species feeds contain environmental contaminants. Meade (1995) describes contaminants in the Mississippi River in detail. Contaminants in the system include heavy metals, pesticides, and synthetic organic compounds with some specific areas known to have contaminated sediments. Mayflies *(Hexagenia* spp.) are considered to be an appropriate species to assess ecosystem contamination and have been studied to document substrate contamination by PCB's, mercury, and cadmium in reaches of the Upper Mississippi River (Steingraeber and Weiner 1995, Steingraeber *et al.* 1994, Beauvais *et al.* 1995). Bioaccumulation of these substances could possibly have also affected the Indiana bat. There is no historical information available by which to analyze the effects of project-related contamination on the Indiana bat.

2.2.2.10 Recreation Related Indirect Effects

Development and use of recreational facilities such as campgrounds, boat launch facilities, marinas, and beaches, may have impacted Indiana bats in two ways: 1) modification of habitat and 2) disturbance. Habitat modification would include loss of trees which may have been used by bats for roosting. Human activity in roost areas may have disturbed bats resulting in abandonment. The magnitude of this impact cannot be evaluated due to a lack of historical information.

2.2.2.11 Cabin Leases

Within the Rock Island District, there are 565 private recreational and residential leases encompassing 465 acres. In the St. Louis District, there are approximately 350 recreational cottage leases on 244 acres. Development and use of cabin lease sites may have impacted Indiana bats through habitat modification or disturbance if bats were present. Habitat modification would include loss of shoreline trees which may have been used by bats for roosting. The magnitude of this impact cannot be evaluated due to a lack of historical information.

2.2.2.12 General Plan Lands Management

The Corps has the responsibility and authority to manage the natural resources on fee title lands. The goals of the Corps' forest management in the project area are described in section 1.2.3 of this document.

As with most habitat management projects, the prescribed forest management practices may have caused temporary adverse impacts, but provided long-term benefits to the habitat (i.e., forest regeneration). All forest management prescriptions are evaluated for presence of threatened or endangered species, or species of special concern and actions are taken to avoid impacts to species. This includes designation of special management zones, observance of seasonal restrictions and provision of buffers. Forest management practices are carried out through close coordination with state and federal resource agencies including the U.S. Fish and Wildlife Service. Forestry practices diversify the habitat and strive to maintain size class diversity. Specific actions are described in the operating management plan (OMP) and five year plan and environmental assessment prepared for forestry, fish and wildlife management within the St. Paul and Rock Island Districts. Forest management practices that maintain forest age class and diversity have contributed to the conservation of the species through provision and maintenance of suitable habitat into the future.

Management of General Plan lands by the U.S. Fish and Wildlife Service and state natural resource agencies may have resulted in changes to Indiana bat habitat. Within the range of the bat, these areas include the Illinois River Refuges, Mark Twain National Fish and Wildlife Refuge, UMR National Wildlife & Fish Refuge, and various areas managed by state agencies. Detailed descriptions of the Refuges are included in their respective refuge Master Plans. In general, the management practices on General Plan lands that have maintained forest age class and diversity have contributed to the conservation of Indiana bat habitat. However, clearing of bottomland forest may have negatively impacted the bat.

The magnitude of this impacts cannot be evaluated due to a lack of historical information.

2.3 Effects of the Action

This section includes an analysis of the direct and indirect effects of the proposed action on the species and its interrelated and interdependent activities.

2.3.1 Direct Effects

2.3.1.1 Operation of the 9-Foot Channel Project

2.3.1.1.1 Impoundment and Water Level Regulation

The long-term impact of impoundment upon the bottomland forest and species composition is not yet fully understood. However, trees will continue to produce seeds as they have in the past, so the reproductive potential of the bottomland species is present as long as there are mature trees. As mentioned in Section 7.2.1, it appears that much of the forest is aging and not regenerating in a smooth transition. If forests are allowed to undergo natural succession, Indiana bat habitat could decline over the 50-year life of the project. However, the St. Paul and Rock Island Corps Districts have Operational Management Plans which incorporate forest management practices that will benefit the bat. In addition, the Corps' Conservation Measure for the Indiana bat (section 1.3.1) wherein "forest management efforts within the range of the bat will be carried out to establish and maintain forest species and size class diversity in order to ensure a long-term supply of potential Indiana bat roost trees", will mitigate any potential impacts of impoundment and water level regulation. Yin (1999) concluded that the composition of the present day forest will be sustained over the next 50 years.

The general habitat needs of the Indiana bat include dead or dying trees greater than 9 inches dbh with exfoliating bark for roosting purposes. While impoundment and water level regulation will continue to contribute to hydrological changes in the floodplain of the project area which, in turn, will affect forest composition and extent, we see no reason to believe that the availability of suitable roost trees will become a limiting factor to the potential use of the action area by Indiana bats over the life of the project. Therefore, impacts of impoundment and water level control will be offset and will not rise to the level of harm; i.e. will not cause death or injury of individual bats or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

2.3.1.2 Maintenance of the 9-Foot Channel Project

2.3.1.2.1 Dredging and Disposal

Channel dredging and disposal will continue over the life of the project and may affect Indiana bats through disturbance of roosting bats. Both the St. Paul and Rock Island Districts currently have dredged material placement coordination processes in place. Prior to the discharge of any dredged material, representatives of the Corps and state and federal resource agencies meet to determine the preferred placement site for the dredged material. Consideration of endangered species impacts is a part of this process. Potential impacts of dredged material placement can be minimized or avoided and, if necessary, Tier II Section 7 Consultation will be conducted. All dredged material in the St. Louis District is disposed of in the water and does not affect bat habitat. Therefore, while dredging and disposal may affect individual bats through disturbance, it will not rise to the level of harm or harassment; i.e., will not cause death or injury of individual bats or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

2.3.1.2.2 Clearing and Snagging

The majority of snagging presently occurs outside of the range of the Indiana bat. The future need for snagging on these rivers is unknown. However, given appropriate coordination with the Service in the Rock Island and St. Louis Corps Districts, any potential impacts can be minimized or avoided. Therefore, any impacts are likely to be negligible and it will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual bats or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

2.3.1.2.3 Channel Structures/Revetment

There is a potential to affect roosting or nursery trees if construction and maintenance of channel structures and revetment involves bankline grading and removal of trees. Current construction practices usually include placing stone from the river without the need for terrestrial staging areas. In cases where shoreline modification is required, it is usually minor, and the long-term effect is preservation of the shoreline and reduction in erosion and tree loss. In instances where clearing may be required, surveys would be conducted or clearing would occur outside the roosting season. However, we do not expect that tree clearing would occur to the extent that roosting habitat would be limited.

The planning and design of regulatory structures includes consideration of environmental impacts and compliance with various regulations. The process varies within each Corps district, but involves coordination with other agencies. The Rock Island District has the Committee to Assess Regulatory Structures (CARS), which consists of representatives from the engineering, operations, and environmental officer and the U.S. Fish and Wildlife Service. In addition, a document produced by the St. Louis District describes their environmental river engineering project in which biologists and engineers cooperate to improve navigation and habitat diversity through the use of river structures (USACE 1999). Given appropriate coordination, impacts to the bat within its range can be avoided. Tier II Section 7 Consultation will be conducted where necessary. Therefore, any impacts due to construction and maintenance of channel structures and revetment are likely to be negligible and will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual bats or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

2.3.2 Indirect Effects

2.3.2.1 Navigation Related Indirect Effects

2.3.2.1.1 Tow Traffic - No effect

2.3.2.1.2 Fleeting

The future need for fleeting areas will likely increase as tow traffic increases over the life of the project. However, potential impacts of development of fleeting areas can be minimized or eliminated through appropriate coordination with the Service. The State of Iowa regulates barge-fleeting activities through their own regulations and Illinois and Missouri regulate it through review of the Federal permitting process (Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act). Given appropriate coordination, potential impacts can be minimized or avoided. Tier II Section 7 Consultation will be conducted as necessary. Therefore, fleeting impacts are likely to be negligible and will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual bats or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

2.3.2.1.3 Port Facilities

The future need for private port facilities is unknown although it will likely increase as tow traffic increases. If construction requires removal of floodplain trees suitable for Indiana bat roosting, it may adversely affect the species. However, construction of terminals would be subject to floodplain regulations and environmental review. Given appropriate coordination, potential impacts can be minimized or avoided. Tier II Section 7 Consultation will be conducted as necessary. Therefore, construction and operation of port facilities may affect individual bats through disturbance or minor habitat alteration but will not rise to the level of harm or harassment; i.e., will not cause death or injury of individual bats or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

2.3.2.1.4 Exotic Species - Not applicable

2.3.2.1.5 Contaminants

Environmental contaminants from accidental spills could potentially affect the Indiana bat. However, the probability of a traffic-related catastrophic spill is considered low.

As discussed in Section 2.1.3 above, agricultural chemicals have been suggested in several sources to be a potential cause of population declines in insectivorous bats. Although it is true that the direct application of insecticides could affect the species, this is not of concern here. Chemical use has changed and is continuing to change. First generation insecticides such as DDT or chlordane are soluble in water and have higher potential to remain attached to sediment particles, thus attributing to their continued persistence (Goolsby and Pereira 1996). Presently, many agricultural insecticides are water soluble and have half lives in the hours, thus making them less likely to impact aquatic insects (USACE 1999). If they were to affect the Indiana bat or other insectivorous bats, it would most likely be through decreasing the abundance of their food source, not through direct toxic effects. Herbicides also have been documented to be in high concentrations through the river, especially from May through July. With longer half lives, they have higher potential to remain attached to sediments; however, they are also generally less likely to have direct toxic effects to animals.

Accidental spills of contaminants on the UMRS may affect the Indiana bat to a minor extent by reducing its food supply. However, due to the low frequency of spills on the UMRS, this impact is considered negligible and will not threaten the survival of the species in the action area.

2.3.2.2 Recreation Related Indirect Effects

Considering current population trends, human use of, and demand for recreational facilities in the UMRS corridor will likely increase, which will increase the potential for impact on the Indiana bat. Human activity at or near bat roost sites has the potential to cause disturbance. Operation of Corps' recreational facilities includes routine maintenance, such as mowing, but there is no plan to expand or increase the number of such facilities (USACE 1999). Due to the low number of documented roost sites in the UMRS floodplain, any impacts from recreational use are considered negligible.

Development of private recreational facilities would be subject to floodplain regulations and environmental review. Given appropriate coordination, potential impacts can be avoided and Tier II Section 7 consultation will be conducted as necessary. Therefore, impacts from the construction of recreational facilities may affect individual bats through disturbance but will not rise to the level of harm or harassment; i.e., will not cause death or injury of individual bats or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

2.3.3 Interrelated Effects

2.3.3.1 Timber Management - see 2.3.3.3 below

2.3.3.2 Cabin Leases

New leases are not being issued, but existing sites are maintained. If leased areas are returned to the Corps, natural resource management prescriptions are implemented which include closure or removal of the access road and conversion to natural habitat. Maintenance actions taken by lessees are subject to review, and therefore impacts to the Indiana bat would be considered at that time. However, this maintenance does not include expansion or additional clearing of trees. Should future clearing be proposed, a Tier II Section 7 consultation may be required. Therefore impacts from continued maintenance of cabin leases may affect individual bats through disturbance but will not rise to the level of harm or harassment; i.e., will not cause death or injury of individual bats or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

2.3.3.3 Management of General Plan Lands

Corps' forest management goals were described in section 1.2.3 of this document. In addition, the Corps' has proposed a Conservation Measure for the Indiana bat (see 1.3.1 above) wherein "forest management efforts within the range of the bat will be carried out to establish and maintain forest species and size class diversity in order to ensure a long-term supply of potential Indiana bat roost trees." Although forest management practices may cause temporary adverse impacts, there will likely be long-term benefits to the habitat. Prior to carrying out management actions, sites are evaluated for presence of threatened or endangered species and other natural resources of concern, and actions are taken to avoid impacts to these species. This includes designating special management zones, observing seasonal restrictions, and providing buffers. Forest management is carried out through close coordination with State and Federal resource agencies, including the U.S. Fish and Wildlife Service. Forestry practices diversify the habitat and strive to maintain size class diversity. Specific actions are described in the OMP, 5-year plan, and Environmental Assessment prepared for forestry, fish and wildlife management within the Rock Island District (USACE 1992, USACE 1981). Forest management practices that maintain forest age class and diversity contribute to the conservation of the species through providing and maintaining suitable future habitat.

As described in Section 1.2.3, a great deal of land in the project area is managed by the U.S. Fish and Wildlife Service and state natural resource agencies as fish and wildlife refuges and recreational areas. Within the range of the Indiana bat, these include the Illinois River National Wildlife and Fish Refuge, the Mark Twain National Wildlife Refuge, the Upper Mississippi River National Wildlife and Fish Refuge, and various areas managed by the states. At the present time, all Service Refuges in the action area are preparing Comprehensive Conservation Plans (CCPs) which will address forest land management. Forest management practices that maintain forest age class and diversity contribute to the conservation of the species through providing and maintaining suitable future habitat.

Therefore, any adverse impacts associated with General Plan Land management will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual bats or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

2.3.4 Interdependent Effects - None

2.3.5 Cumulative Effects

Cumulative effects include the effects of State, local or private actions that may occur in the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of ESA.

The Service is unaware of any non-Federal actions that are reasonably certain to occur which may affect the Indiana bat. However, most non-Federal actions in the floodplain of the Illinois and Upper Mississippi Rivers will likely require Federal review under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act. Given appropriate environmental coordination, impacts to the Indiana bat can be avoided. Therefore, any cumulative effects due to non-Federal actions are considered to be negligible.

2.3.6 Summary of Effects

In summary, loss of habitat may result from continued impoundment and water level regulation of the UMRS but these losses will be offset by forest management practices conducted by the Corps and other Federal and state resource agencies. Impacts from other aspects of the operation and maintenance of the 9-Foot Navigation Project are considered to be negligible and will not rise to the level of harm or harassment; i.e., will not cause death or injury of individual bats or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

2.4 Conclusion

After reviewing the current status of the Indiana bat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the species.

Potential impacts will be negligible, offset by forest management prescriptions, or will be avoided or minimized through appropriate environmental coordination. As any adverse effects will be minimized, the long-term persistence of the Indiana bat within the action area will not be threatened. Thus, the proposed action is also unlikely to appreciably reduce the likelihood of survival and recovery of the species rangewide. No Critical Habitat has been designated for the bat within the action area.

2.6 Incidental Take

Section 9 of the Act and Federal regulation pursuant to Section 4(d) of the Act prohibits the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such activity. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, and sheltering. Incidental take is defined as take incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), take incidental to and not an intended part of the agency action is not considered prohibited taking under the Act, provided such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Corps for the exemption in Section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps fails to assume and implement the terms and conditions, the protective coverage of Section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement (50 CFR, 402.14(I)(3)).

The Service does not anticipate that the proposed action will incidentally take any Indiana bats.

2.7 Conservation Recommendations - None

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3.0 Decurrent false aster

3.1 Status of the Species

This section presents the biological or ecological information relevant to formulating the biological opinion. Appropriate information on the species' life history, its habitat and distribution, and other data on factors necessary to its survival, is included to provide background for analysis in later sections. This analysis documents the effects of all past human and natural activities or events that have led to the current status of the species. This information is presented in listing documents, the recovery plan (USFWS 1990), and the Biological Assessment (USACE 1999).

The decurrent false aster *(Boltonia decurrens)* was listed as a threatened species by the Service on November 14, 1988 (53 FR 45861). It is a floodplain species that occurs along a 250 miles section of the lower Illinois River and nearby parts of the UMR (Schwegman and Nyboer 1985, USFWS 1990). *B. decurrens* is an early successional species that requires either natural or human disturbance to create and maintain suitable habitat. Its natural habitat is wet prairies, shallow marshes, and shores of open rivers, creeks, and lakes (Schwegman and Nyboer 1985). In the past the annual flood/drought cycle of the Illinois River provided the natural disturbance required by this species. Annual spring flooding created open, well lit habitat and reduced competition by killing other less flood-tolerant, early successional species. Field observations indicate that in "weedy" areas without disturbance, the species is eliminated by competition within 3 to 5 years (USFWS 1990).

Smith *et al.* (1998) found that populations of *B. decurrens* increased in size at three sites studied on the Illinois River following the flood of 1993, with the greatest increase occurring at the two sites which had the most severe flooding. These results suggest that the removal of competing species by flood waters may be an important factor in maintaining populations of

B. decurrens in the floodplain. *B. decurrens* has high light requirements for growth and achene germination (Smith *et al.* 1993, Smith *et al.* 1995), and shading from other vegetation is thought to contribute to its decline in undisturbed areas.

B. decurrens exhibits a number of morphological adaptations for life on the floodplain. Stoecker *et al.* (1995) found *B. decurrens* to be extremely tolerant when maintained under conditions of root zone saturation. All plants in the flood treatment replicate survived to the end of the study at 56 days. The formation of aerenchyma, a common plant adaptation to flooding which allows diffusion of oxygen from aerial shoots to maintain root metabolism, was extensive, increasing in adventitious roots from 26% of root cross-section area in non-flooded plants to 49% in flooded plants (Stoecker *et al. 1995).* Achenes of *B. decurrens* are morphologically structured for flotation and therefore presumably are adapted for dispersal on river currents. Smith and Keevin (1998) found that germination was not significantly reduced in achenes floated for 4 weeks, and 20% of achenes floated under conditions of simulated wave action were still floating after 4 weeks. These data indicate that achenes have the potential for long distance dispersal on water.

Smith and Keevin (1998) found that achenes of *B. decurrens* will not germinate in the dark. Achenes, which were covered with as little as 0.2 in. of sediment, did not germinate; therefore, if achenes are deposited by flood water and subsequently covered by a shallow layer of sediment, it is unlikely they will germinate. Natural or human disturbance of the soil, exposing the achenes to light, would be required for germination. Sediment type may also be an important factor in achene germination and long-term survival of populations. *B. decurrens* has been observed growing on a variety of soil types (Schwegman and Nyboer 1985, Smith 1991); however, laboratory studies (Smith *et al.* 1995) comparing achene germination and growth on two soil types, silty clay (6.7% sand, 53.3% silt, and 40% clay) and loamy sand (80% sand, 16.7% silt and 3.3% clay) indicate that germination and seedling growth were significantly greater on sand than on clay. These laboratory results suggest that the silt and clay sediment being deposited by flood events on the Illinois River (Lee and Stall 1976) is not ideal for germination and growth. Soil type may thus be important in determining the distribution pattern of this species.

B. decurrens reproduces vegetatively and sexually. Vegetative production of one or more basal rosettes occurs during the fall. Rosettes bolt the following spring; plants flower and set achenes from late August to early October. Field monitoring by Schwegman and Nyboer (1985) suggested prolific achene production. *B. decurrens* produces ca. 50,000 achenes per individual, and, based on achene viability, an average plant is capable of producing ca. 40,000 seedlings under optimal conditions for germination (Smith and Keevin 1998). Fall seedlings overwinter and bolt and flower the following spring and summer. Spring seedlings, however, may either bolt and flower the same year or overwinter as small rosettes which bolt and flower the following year (Smith 1991). In areas where seedling production is low or nonexistent, *B. decurrens* populations can be maintained by basal rosette production. In fact, few seedlings are found in established populations (Moss 1997, Smith 1991). Seedling establishment is expected to be low due to the small achene size, the high light and temperature requirements for germination, and specific soil texture and microtopography requirements for germination and seedling growth (Baskin and Baskin 1988, Smith *et al.*

1995).

Analysis of 19th century habitat data taken from herbarium sheets indicates that *B. decurrens*' natural habitat was the shores of lakes and streams in the Illinois River floodplain and the Mississippi River floodplain in the vicinity of its confluence with the Illinois River. It ranged along a 250 mile stretch between LaSalle, Illinois and St. Louis, Missouri. A disjunct population at Cape Girardeau, Missouri was reported in 1976, 120 miles downstream of St. Louis (Schwegman and Nyboer 1985), but it has not been found since.

The present distribution of the aster is essentially unchanged. Determining a total population for the species is difficult because individual populations may change dramatically from year to year; some increasing, some decreasing, new ones appearing and old ones disappearing depending on site conditions. Several notable populations include Riverlands Environmental Demonstration Area, Spatterdock Bottoms and Columbia Bottoms in St. Charles County, Missouri; and Rice Lake in Fulton County, and Worley Lake in Tazewell County, Illinois (Dr. Marian Smith, Southern Illinois University - Edwardsville *in litt*. to Gerry Bade December 4, 1999; *ibid*. January 28, 2000.).

In spite of the above, the species is considered to be stable ((Dr. Marian Smith, Southern Illinois University - Edwardsville *in litt*. to Gerry Bade December 4, 1999). The Recovery Plan states that the species will be considered recovered after 12 stable populations have been protected by purchase, easement or cooperative management agreement. The species is considered to be about 75% recovered at this time ((Dr. Marian Smith, Southern Illinois University - Edwardsville *in litt*. to Gerry Bade December 4, 1999).

Habitat destruction and modification has been blamed for the decline of the species, particularly of natural marshes, wet prairies, and shoreline habitats. Wetlands have been drained and converted to other uses, heavy siltation has buried suitable habitats, and construction of levee systems have altered the flooding regimes necessary for reduction of competition and prevented the dispersal of seeds to potential habitat. (USFWS 1990, Schwegman and Nyboer 1985, Smith *et al.* 1993, Stoecker *et al.* 1995, Smith *et al.* 1998, Smith and Keevin 1998).

3.2 Environmental Baseline

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and ecosystem within the action area. The purpose is to describe the current status of the species within the action area and those factors that have contributed to this state.

3.2.1 Status of the Species in the Action Area

The action area encompasses the entire range of the species, therefore its status within the action area is as described above.

3.2.2 Factors Affecting the Species

3.2.2.1 Impoundment and Water Level Regulation

The initial impoundment of the Illinois River by navigation dams Locks and Dam 26 on the UMR; La Grange Lock and Dam, Peoria Lock and Dam, Starved Rock Lock and Dam and Marseilles Lock and Dam on the Illinois River) within the historic range of the aster created a series of pools. The pooling of the Illinois River resulted in the inundation of shoreline habitat. Historic collections indicate that shoreline habitat was utilized by *B. decurrens* (USFWS 1990). The acreage of shoreline habitat lost during the initial inundation by the navigation pools has not been quantified. It should be noted, however, that "new" shoreline would have been created or shifted to a higher elevation when the river was impounded.

Maintenance of navigation pools on the Illinois River has resulted in stable water levels during low-flow periods while locks and dams have had little effect on water stages during high water events. During low-flow periods prior to lock and dam construction, especially during drought years, the river would have receded, providing additional shoreline habitat for *B. decurrens.* The magnitude of impact would depend on many factors including the timing and duration of shoreline dewatering and availability of a seed bank. While the natural drought process has been eliminated, the flood cycle remains unmodified.

3.2.2.2 Dredging and Disposal

Dredged material from the navigation channel by a hydraulic cutterhead dredge and is discharged to placement sites by floating pipeline. Under optimal conditions, the dredge can pump as much as 350 cubic yards per hour as far as 4000 feet up or downstream and up to 1000 feet inland. The Government hydraulic cutterhead dredge *William A. Thompson* is occasionally used for large jobs or jobs requiring longer pipeline, up to 1 mile.

Dredged material removed from the navigation channel in the Rock Island District portion of the Illinois River was usually placed along the shoreline or occasionally in upland sites located in close proximity to the dredging site. Depending upon location, dredged material is placed 1) linearly along the shoreline for bankline stabilization or to rejuvenate recreational beaches that have diminished because of erosion, or 2) in the upland out of the river, occasionally in bottomland forest, or, more likely, in industrial sites, on levees, or in beneficial use sites. Previous shoreline and upland placement may have destroyed populations of *B. decurrens* or rendered the habitat unsuitable for recolonization. Dredged material removed from the St. Louis District's portion of the Illinois River and the Mississippi River are placed in underwater sites near the shoreline. The magnitude of impact cannot be quantified due to a lack of historical data.

3.2.2.3 Clearing and Snagging - not applicable

3.2.2.4 Channel Structure/Revetment

Past activities related to the construction of channel training structures and revetment have likely affected *B. decurrens* or its habitat. Such modification includes bankline grading and placement of stone (covering habitat) for bank revetment, wingdams, and closure structures. Maintenance of existing structures where shoreline modification has occurred may also have affected the species. The magnitude of these impact cannot be quantified due to a lack of historical data.

3.2.2.5 Fleeting

Development of existing fleeting areas required various levels of habitat modification, including placement of on-shore deadmen. Operation of heavy equipment and soil disturbance may have affected *B. decurrens* to an unknown degree. A study of the effects of barge fleeting on bank erosion found that fleeting areas are of high risk for potential bank erosion (USACE 1998) which may have destroyed the plant's habitat. However, the magnitude of this impact cannot be determined due to a lack of historical data.

3.2.2.6 Recreation Related Indirect Effects

Development of recreation-related facilities required various levels of habitat modification including grading of shoreline areas, construction of boat ramps and docks, placement or riprap and bank revetment, and dredging access channels and harbors. Such actions may have destroyed the plant's habitat. The level of impact to *B. decurrens* or its habitat is unknown due a to lack of historical data.

3.2.2.7 Cabin Leases

Development and use of cabin lease sites may have impacted decurrent false asters through habitat modification. Habitat modification would include conversion of open floodplain habitat to maintained lawns or rip rap shore protection. Continual human traffic over an area of otherwise suitable habitat would render it unsuitable for the species. The magnitude of this impact cannot be evaluated due to a lack of historical information.

3.2.2.8 General Plan Land Management

Corps of Engineers' General Plan (GP) Lands in the St. Louis District include Riverlands Environmental Demonstration Area (EDA) managed by the Corps, Dresser Island/Spatterdock Bottoms managed by the Corps, Horseshoe Lake managed in part by the Corps and the State of Illinois) and Batchtown, Calhoun and Gilbert Lake Divisions and the Portage Island Group of the Mark Twain National Wildlife and Fish Refuge managed by the Service. *B. decurrens* occurs in the Gilbert Lake Division, Horseshoe Lake, the EDA and Dresser Island/Spatterdock Bottoms.

In the past, certain maintenance and management activities such as grading and filling, bank stabilization, mowing, drainage ditch clean-out and controlled burns may have impacted the aster on these areas. The magnitude of these impacts is unknown due to a lack of historical data. No previous Section 7 consultation has been conducted for these activities.

3.3 Effects of the Action

This section includes an analysis of the direct and indirect effects of the proposed action on the species and its interrelated and interdependent activities.

3.3.1 Direct Effects

3.3.1.1 Operation of the 9-Foot Channel Project

3.3.1.1.1 Impoundment and Water Level Regulation

The continued impoundment will not cause any additional impacts to the species or its habitat, i.e., no additional habitat will be lost due to inundation. Consequently, the impacts of impoundment will not threaten the survival and recovery of the species over the life of the project.

The future impacts of water level regulation will be the same as in the past, i.e stabilization of water levels during low flows and little or no affect on high flows. While the natural drought process has been eliminated, the flood cycle remains unmodified and will continue to provide the habitat disturbance on which the species depends. Consequently, the impacts of water level regulation will not threaten the survival and recovery of the species in the action area.

3.3.1.2 Maintenance of the 9-Foot Channel Project

3.3.1.2.1 Dredging and Disposal

The Rock Island District currently has a dredged material placement coordination process in place. Prior to the discharge of any dredged material, representatives of the Rock Island District and the On-Site Inspection Team (OSIT) meet to determine the preferred placement site for the dredged material. The OSIT is composed of representatives of the appropriate State and Federal agencies. The U.S. Fish and Wildlife Service, along with representatives of the affected State(s), participate in the OSIT. Additionally, appropriate Federal and State agency representatives are coordinated with concerning endangered species. Although the OSIT tries to avoid impacts from dredged material placement, there is a potential that *B. decurrens* may occur at sites where seed has settled but the plant has not yet sprouted. Potential impacts of dredged material placement can be minimized as much as possible through appropriate coordination with the Service. Tier II Section 7 Consultation will be conducted as necessary. In the St. Louis District, placement of dredged material within the range of *B. decurrens* does not involve land or shoreline disposal. Therefore, the impacts of maintenance dredging will not threaten the survival and recovery of the species in the action area.

3.3.1.2.2 Clearing and Snagging - not applicable

3.3.1.2.3 Channel Structure/Revetment

There is a potential to adversely affect decurrent false aster populations where construction and maintenance of channel structures and revetment would involve habitat modification. Such modification would include bankline grading and placement of stone (covering habitat) for bank revetment, wingdams, and closure structures. There is also a potential that bank grading and associated activities could create conditions suitable for the establishment of new populations of *B. decurrens* due to habitat disturbance. Current construction practices for off-bank revetment, chevron dikes, and bendway weirs do not involve terrestrial habitat destruction and construction is done from the river without terrestrial staging areas.

Potential impacts of constructing and maintaining channel structures and revetment can be avoided through appropriate coordination with the Service. Tier II Section 7 Consultation will be conducted as necessary. Therefore, construction and maintenance of channel structures and revetment will not threaten the survival and recovery of the species in the action area.

3.3.1.2.4 Lock and Dam Rehabilitation - no effect

3.3.2 Indirect Effects

3.3.2.1 Navigation Related Indirect Effects

3.3.2.1.1 Tow Traffic - no effect

3.3.2.1.2 Fleeting

The future need for fleeting areas will likely increase as tow traffic increases over the life of the project. Fleeting may affect individual plants through shoreline erosion. However, potential impacts of development of fleeting areas will be minimized or eliminated through appropriate coordination with the Service. The States of Illinois and Missouri regulate fleeting through review of the Federal permitting process (Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act). Given appropriate coordination, potential impacts can be minimized or avoided. Tier II Section 7 Consultation will be conducted as necessary. The survival of the species will not be threatened in the action area.

3.3.2.1.3 Port Facilities

The future need for additional port facilities is unknown although it will likely increase as tow traffic increases over the life of the project. Construction of port facilities may affect the aster through habitat modification. However, potential impacts of port facilities can be avoided through appropriate coordination with the Service. Tier II Section 7 Consultation will be conducted as necessary. Therefore, development of port facilities will not threaten the survival and recovery of the species in the action area.

3.3.2.1.4 Exotic Species - not applicable

3.3.2.1.5 Contaminants

The potential for a major spill of an herbicide that would harm the aster is extremely remote and would be mitigated by the dilution with river water, river stage, location and timing of the spill. Therefore, this impact is considered negligible and will not threaten the survival and recovery of the species in the action area.

3.3.2.2 Recreation Related Indirect Effects

Considering current population trends, human use of, and demand for recreational facilities in the UMRS corridor will likely increase, which will increase the potential for impact on the aster. Development of recreational facilities such as boat ramps and harbors, swimming beaches, and the like may affect the aster through habitat modification. However, potential impacts can be avoided through appropriate coordination with the Service. Tier II Section 7 Consultation will be conducted as necessary. Therefore, development of recreational facilities will not threaten the survival and recovery of the species in the action area.

3.3.3 Interrelated Effects

3.3.3.1 Timber Management - see section 3.3.3.3 below

3.3.3.2 Cabin Leases

The maintenance of cabin lease sites by the Corps of Engineers will not likely create any additional impacts to the aster. There will be no new leases issued, but those in existence will be maintained. All leases returned to the Corps are released and natural resource management prescriptions are implemented. This usually includes closure or removal of the access road and conversion to natural habitat (USACE 1999). All new maintenance actions taken by lessees are subject to review by the Corps. Therefore, maintenance of cabin lease sites will not threaten the survival and recovery of the species in the action area.

3.3.3.3 General Plan Land Management

The St. Louis District has recently completed an Action Plan for *B. decurrens* on Corps of Engineers General Plan lands within the St. Louis District (USACE 1998). Development of the Action Plan was a joint effort between the U.S. Fish and Wildlife

Service and the Corps of Engineers with participation from Dr. Marian Smith (Southern Illinois University - Edwardsville), an expert on the species. The action plan included a monitoring protocol and initial census, evaluation of management techniques, training of site personnel to identify the species, development of an education and outreach program, development of land management objectives, and development of a pre-action checklist for project implementation. The next step is to implement the plan and to incorporate a management protocol into the Corps' Operational Management Plan for the area. Consistent with the Action Plan, the St. Louis District has completed Phase I (Monitoring Protocol), an initial census of the Environmental Demonstration Area, to determine the locations and general population sizes of *B. decurrens* (USACE *in litt*. to Gerry Bade, November 3, 1999). Implementation of this Action Plan will provide benefits to the species and enhance the potential for its survival and recovery.

Similar management possibilities exist on other Corps lands, U.S. Fish and Wildlife Service refuge lands, including the Mark Twain National Fish and Wildlife Refuge and the Illinois River Refuge, and management lands owned and/or managed by the Missouri Department of Conservation and the Illinois Department of Natural Resources. The Service's Refuges are currently in the process of completing Comprehensive Conservation Plans which will address their goals and objectives for aster management. Although some land prescriptions may temporarily impact the species, management by these agencies will, in general, be of benefit to the aster in the action area.

3.3.3.4 Public Use Sites - see 3.3.2.2 above.

3.3.4 Interdependent Effects - none

3.3.5 Cumulative Effects

Cumulative effects include the effects of State, local or private actions that have occurred in the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of ESA.

The Service is unaware of any non-Federal actions that are reasonably certain to occur which may affect the decurrent false aster. However, most non-Federal actions in the floodplain of the Illinois and Upper Mississippi Rivers will likely require Federal review under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act. Given appropriate environmental coordination, impacts to the aster can be avoided. Therefore, any cumulative effects due to non-Federal actions are considered to be negligible.

3.3.6 Summary of Effects

In summary, all potential impacts from the continued operation and maintenance of the 9-

Foot Channel Project are considered to be negligible and will not threaten the survival and recovery of the species in the action area. Furthermore, all new construction of river training structures and bank revetment, maintenance of existing structures, and channel dredging and disposal will be subject to environmental review by the Service, and thus, additional measures to further minimize potential impacts will be implemented via a Tier II Section 7 consultation. Similarly, non-Federal activities such as fleeting, port facilities, and recreational facilities requiring authorization under the CWA or River and Harbors Act will also be reviewed by the Service and, if necessary, undergo a Tier II Section 7 consultation.

3.4 Conclusion

After reviewing the current status of *B. decurrens*, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the species.

Potential impacts will be negligible, offset by management prescriptions, or will be avoided or minimized through appropriate environmental coordination. As any adverse effects will be minimized, the long-term persistence of the aster within the action area will not be threatened. Thus, the proposed action is also unlikely to appreciably reduce the likelihood of survival and recovery of the species rangewide. No critical habitat has been designated for this species, therefore, none will be affected.

3.5 Incidental Take Statement

Sections 7(b)(4) and 7(o)(2) of ESA do not apply to the incidental take of listed plant species. However, protection of listed plants is provided to the extent that ESA requires a Federal permit for removal or reduction to possession of endangered plants from areas under Federal jurisdiction, or for any act that would remove, cut, dig up, or damage or destroy any such species on any other area in knowing violation of any regulation of any State or in the course of any violation of a State criminal trespass law.

3.6 Conservation Recommendations

Section 7(a)(1) of ESA directs Federal agencies to utilize their authorities to further the purposes of ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. The St. Louis Corps District and the U.S. Fish and Wildlife Service developed an action plan for managing and protecting populations of *B. decurrens* on the Riverlands Environmental Demonstration Area (EDA). The action plan included a monitoring protocol and initial census, evaluation of management techniques, training of site personnel to identify the species, development of an education and outreach program,

development of land management objectives, and development of a pre-action checklist for project implementation. Implementation of this action plan is hereby recommended.

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4.0 Interior Least Tern

4.1 Status of the Species

4.1.1 Species Description

Least terns (*Sterna antillarum*) are the smallest members of the subfamily Sterninae and family Laridae of the order Charadriiformes, measuring approximately 21-24 cm long with a 51 cm wingspan. The sexes are alike with a black-capped crown, white forehead, grayish back and dorsal wing surfaces, snowy white undersurfaces, legs of various orange and yellow colors depending on the sex, and a black-tipped bill whose color also varies depending on sex (Watson 1966, Davis 1968, Boyd and Thompson 1985). Immature birds have darker plumage than adults, a dark bill, and dark eye stripes on their white foreheads.

The least tern in North America was described by Lesson in 1847 (Ridgway 1895, American Ornithologists' Union (AOU) 1957, 1983). The least tern in interior North America was later described as a race of the Old World little tern (*Sterna albifrons*). As a result of studies on vocalizations and behavior, this group is now recognized as a distinct species, with the interior least tern recognized as a subspecies (*Sterna antillarum athalassos*) (AOU 1957, 1983). Unless otherwise specified, the term "least terns" will hereafter refer to the interior least tern.

4.1.2 Historic and Current Rangewide Distribution

The interior least tern is migratory and historically bred along the Mississippi, Missouri, Arkansas, Red, Rio Grande and Ohio river systems (AOU 1957, Anderson 1971, Coues 1874, Burroughs 1961, Hardy 1957, Youngworth 1930, 1931, Ducey 1981). The range extended from Texas to Montana and from eastern Colorado and New Mexico to southern Indiana. Incidental occurrences of least terns have been reported in Michigan, Minnesota, Wisconsin, Ohio and Arizona (Campbell 1935, Janssen 1986, Jung 1935, Mayfield 1943, Monson and Phillips 1981, Phillips *et al*. 1964). The species continues to breed in most of the above referenced river systems. However, its distribution is generally restricted to less altered river segments (USFWS 1990).

<u>Mississippi and Ohio Rivers</u>: In the Mississippi River valley, least terns historically nested from Lee County, Iowa, to Jefferson County, Mississippi (Hardy 1957, Smith and Renken 1993). Currently, the breeding range extends from Madison County, Illinois, (approximate Upper Mississippi River mile 196.0) to Madison Parish, Louisiana, on the Lower Mississippi River (Rumancik 1988). Surveys by the Corps of Engineers (Corps) (Rumancik 1985, 1986, 1987 and 1988, M. Smith 1986) and the Missouri Department of Conservation (MoDOC) (J. Smith 1985, 1986, 1987, and 1988, Smith and Renken 1990) indicate that about one-half of all least terns occur along 1100 km of the Lower Mississippi River. On the Ohio River, least terns nest just above the confluence of the Tennessee and Ohio Rivers and at one artificial site on the Wabash River in Indiana.

<u>Missouri River System</u>: In the Dakotas, least terns occur primarily on those river segments of the Missouri River and its tributaries that are not affected by impoundments or channelization. In South Dakota, the least tern nests primarily on flowing segments of the Missouri and Cheyenne Rivers (Nebraska Game and Park Commission 1985a, Schwalbach 1988, Schwalbach *et al*. 1986, 1988). Breeding areas in North Dakota constitute about 192 km of the Missouri River from Garrison Dam to the mouth of the Cannonball River south of Bismarck (Dryer and Dryer 1985, Mayer and Dryer 1988), and about 29 km of the Yellowstone River in North Dakota from the Montana border to the river's confluence with the Missouri River (Kreil and Dryer 1987). In Montana, breeding least terns have been recorded on the Yellowstone River and on the Missouri River between Ft. Peck Reservoir and North Dakota. In Nebraska, least terns breed along the lower section of the Niobrara River and on the Platte River and several of its tributaries (Nebraska Game and Fish Commission 1985a, 1987). Least terns no longer nest in the Missouri reaches of the Missouri River (Smith 1985, Sidle *et al*. 1988, Smith and Renken 1990).

Arkansas River System: Breeding least terns occur along the Arkansas River system in Colorado, Kansas, Oklahoma, Arkansas and Texas. In Colorado, least terns nest at Adobe Creek reservoir and have been observed at Nee Noshe reservoir (Carter 1989). In Kansas, least terns nest on the Cimarron River (Boyd 1983, 1986, 1987, Schulenberg and Ptacek 1984). Least terns occur on several tributaries of the Arkansas River in Oklahoma. These include the Salt Fork, Beaver River and Cimarron River (Boyd 1987). In Arkansas, the breeding range on the Arkansas River is above Little Rock (Smith and Shepard 1985, Smith *et al*. 1987, K. Smith 1986).

Red River System: Least terns are known to occur on the Prairie Dog Town Fork of the Red River in the eastern Texas Panhandle and along the Texas and Oklahoma boundary as far east as Burkburnett, Texas (McCament and Thompson 1985, 1987).

Rio Grande River System: Least terns occur at three reservoirs along the Rio Grand River and along the Pecos River at the Bitter Lake National Wildlife Refuge in New Mexico (McCament and Thompson 1985, 1987, Neck and Riskind 1981, Seibert 1951, Marlett 1984, 1987).

The wintering area of interior least terns is unknown. However, least terns of unknown populations or subspecies are found during winter along the Central American coast and the northern coast of South America from Venezuela to northeastern Brazil. Approximately 35 least terns of unknown subspecies have been recaptured in South America, mostly in Guyana. One interior least tern was captured in El Salvador and a California least tern has been captured in Guatemala.

4.1.3 Life History

4.1.3.1 Reproductive Biology

Least terns spend about 4-5 months at their breeding sites. They arrive at breeding areas from late April to early June (Faanes 1983, Hardy 1957, USFWS 1987a, Wilson 1984, Wycoff 1960, Youngworth 1930). Courtship occurs at the nesting site or at some distance from the nest site (Tomkins 1959). It includes the fish flight, an aerial display involving pursuit and maneuvers culminating in a fish transfer on the ground between two displaying birds. Other courtship behaviors include nest scraping, copulation and a variety of postures and vocalizations (Ducey 1981, Hardy 1957, Wolk 1974).

The nest is a shallow and inconspicuous depression in an open, sandy area, gravelly patch, or exposed flat. Small stones, twigs, pieces of wood and debris usually lie near the nest. Least terns nest in colonies and nests can be as close as just a few meters apart or widely scattered up to hundreds of meters (Ducey 1988, Anderson 1983, Hardy 1957, Kirsch 1990, Smith and Renken 1990, Stiles 1939). The benefit of semi-colonial nesting in least terns may be related to anti-predator behavior and social facilitation (Burger 1988).

The birds usually lay two to three eggs (Anderson 1983, Faanes 1983, Hardy 1957, Kirsch 1987, 1988, 1989, Sweet 1985, Smith 1985). The average clutch size for interior least terns nesting on the Mississippi River during 1986-1989 was 2.4 eggs (Smith and Renken 1990). Egg-laying begins by late May. Both sexes share incubation which generally lasts 20-25 days but has ranged from 17-28 days (Faanes 1983, Hardy 1957, Moser 1940, Schwalbach 1988).

The precocial behavior of least tern chicks is similar to that of other terns. They hatch within one day of each other and are brooded for about one week. They usually remain within the nesting territory but wander farther as they mature. Fledging occurs after three weeks, however, parental attention continues until migration (Hardy 1957, Massey 1972, 1974, Tomkins 1959). Departure from colonies by both adults and fledglings varies but is usually complete by early September (Bent 1921, Hardy 1957, Stiles 1939).

4.1.3.2 Dispersal Patterns

Breeding site fidelity of coastal and California least terns is very high (Atwood *et al*. 1984, Burger 1984). This may also be true for the interior least tern in its riverine environment. An interior least tern banded in 1988 as a breeding adult on the Missouri River in North Dakota returned in 1989 to breed on a Missouri River sandbar in North Dakota (Mayer and Dryer 1990). In the Mississippi River valley, a bird banded as a breeding adult in 1987 was observed nesting at the same site in 1989, and three others banded as breeding adults in 1988 returned to nest within the same stretch of the Mississippi River in 1989 (Smith and Renken 1990). Two of those birds had returned to within 4.8 km of their former nesting site. One least tern captured in 1987 as a breeding adult at a Mississippi River colony in Missouri had been banded as a chick in 1980; this bird was nesting at a site 131 km upriver from its natal Tennessee colony (Smith 1987, Smith and Renken 1990). Chick dispersal may be as far as that reported by Boyd and Thompson (1985) for a breeding Kansas bird that had been banded as a chick on the Texas coast.

4.3.1.3 Home Range and Territoriality

The least tern's home range during the breeding season is usually limited to a reach of river near the sandbar nesting site. Home ranges can be variable and have been documented ranging from 11 to 1,015 ha (Talent and Hill 1985). Variation in home range size is likely due to food limitations and chick loss. The home range may change if renesting birds select a different breeding site. Nesting territories are defended and birds defend any nest in the colony. In defending the territory, the incubating bird will fly up and give an obvious alarm call followed by repeated dives at the intruder (Hardy 1957).

4.1.1.4 Feeding Behavior and Habitat

Least terns feed almost entirely on small fish, primarily minnows (Cyprinidae), throughout their entire life (Youngworth 1930, Hardy 1957, Anderson 1983).

Important fish prey genera include *Fundulus, Notropis, Campostoma, Pimephales, Gambusia, Blonesox, Lepomis, Morone, Dorosoma* and *Carpiodes* (Hardy 1957, Grover 1979, Schulenberg *et al*. 1980 Rumancik 1988, 1989, Smith and Renken 1990, Wilson *et al*. 1989). This species requires shallow water areas in lakes, ponds and river backwater areas with abundant small fish populations near the nesting area (Ganier 1930, Youngworth 1930, Hardy 1957, Anderson 1983). In a study of eastern least terns in North Carolina, all 61 of the colonies observed were within 250 m of a large expanse of shallow water (Jernigan *et al*. 1978). In Georgia, eastern least terns foraged a maximum distance of 410 m from the colony (Tomkins 1959). Least terns in Nebraska generally were observed foraging within 100 m of the colony (Faanes 1983). Moseley (1976) believed least terns to be opportunistic feeders, exploiting any fish within a certain size range. Fishing occurs close to the riverine colony. Fishing behavior involves hovering and diving over standing or flowing water.

4.1.4 Population Status and Trends

The interior least tern was proposed for listing as an endangered species on May 29, 1984 (49 FR 22444-22447). The species was listed as endangered on June 27, 1985 (50 FR 21784-21792). According to the recovery plan (USFWS 1990), the least tern has been a species of concern for many years because of its perceived low numbers and the vast transformation of its riverine habitat. Barren sandbars, the least terns most common nesting habitat, were once a common feature of the Mississippi, Missouri, Arkansas, Ohio, Red, Rio Grande, Platte and other river systems of the central United States. Sandbars generally are not stable features of the natural river landscape, but are formed or enlarged, disappear or migrate depending on the dynamic forces of the river. However, stabilization of major rivers to achieve objectives for navigation, hydropower, irrigation, and flood control has destroyed the dynamic nature of these processes (Smith and Stucky 1988). Many of the remaining sandbars are unsuitable for nesting because of vegetation encroachment or are too low and subject to frequent inundation. The number and distribution of least terns probably declined accordingly.

Kirsch and Sidle (1999) compiled tern population data for 1984-1995 to assess the status of the population. Breeding population estimates were compiled for 35 local areas. Numbers of terns increased during the period 1984-1986, probably due to increased survey efforts. However, large population increases along the Middle Mississippi River (MMR) and Lower Mississippi River (Cape Girardeau, Missouri, to Vicksburg, Mississippi) (LMR) between 1989 and 1990 (100%) and between 1993 and 1994 (60%) cannot be attributed to increased survey effort or improved survey methods (Kirsch and Sidle 1999). Approximately 52-79% of least terns nest along this portion of the Mississippi River. The Platte River, Nebraska, harbors the second largest number of least terns [438-635 terns (6.2-13.6%)]. Two stretches of the Missouri River (Garrison Dam to Lake Oahe, North Dakota, and Gavins Point Dam, South Dakota to Ponca, Nebraska); Salt Plains National Wildlife Refuge; Oklahoma, Cimarron and Canadian Rivers, Oklahoma; and Falcon Reservoir on the Rio Grande River, Texas, all typically harbor more than 100 least terns (Kirsch and Sidle 1999). Although recent counts of least terns (approximately 8,800 terns in 1995) exceed the overall recovery objective of 7,000 birds, the mean number of least terns in 12 of 19 local areas designated in the recovery plan (USFWS 1990) do not reach corresponding objectives (Kirsch and Sidle 1999).

Overall population trends from 1986-1995 are positive. However, this positive trend is primarily due to increases in numbers of least terns on the Lower Mississippi River (Kirsch and Sidle 1999). Annual change for the entire population was approximately 9%. However, when data from the Lower Mississippi River was excluded, the annual change was 2.4% (Kirsch and Sidle 1999). At the scale of drainage basins, trends were positive for the Lower Mississippi River (13%), Platte River (2.6%) and the Missouri River (1.8%). However, only the trend for the Lower Mississippi River was significant (Kirsch and Sidle 1999).

Interior least tern numbers at local breeding areas fluctuate substantially. This is perhaps due to changes in local and regional habitat availability or differences in emigration, immigration or local recruitment (Kirsch and Sidle 1999). Kirsch and Sidle (1999) detected significant population trends in 7 of 31 local areas. Trends in 5 of these areas were significantly positive (Garrison Dam to Lake Oahe on the Missouri River, North Dakota; Elkhorn River, Nebraska; reservoirs in the Arkansas River watershed, Colorado; Gibson Lake on the Wabash River, Indiana; and the Lower Mississippi River). Two areas had significant negative trends. These were Council Bluffs, Iowa, near the Missouri River, and Optima National Wildlife Refuge, Oklahoma (Kirsch and Sidle 1999). Both of these areas support low numbers of least terns.

Kirsch and Sidle (1999) found fledging success estimates to be highly variable among colonies, river reaches and drainages, both within and among years. Fledging success estimates for the Lower Mississippi River do not support the positive population trend for that area. In addition, available data do not indicate high productivity in years prior to large population increases (Kirsch and Sidle 1999). Also, fledging success in many local areas was found to be below the 0.51 fledglings/pair thought to be required for population maintenance (Kirsch 1996). Kirsch and Sidle (1999) speculated that the most plausible explanation for the recent increase of interior least terns is surges of immigration from the least tern population along the Gulf of Mexico which is large and stable or increasing (Thompson 1982, Jackson and Jackson 1985, Thompson *et al*. 1997). Further, they state that regular immigration for the Gulf Coast population may be an important influence on the dynamics of the interior population of least terns. However, movement data are limited, with only one published report of a least tern moving between the Gulf Coast and interior breeding areas (Boyd and Thompson 1985). Kirsch and Sidle (1999) further state that low individual site fidelity and substantial fluctuations in local numbers suggest considerable movement among breeding areas.

4.1.5 Habitat Requirements

Interior least terns require open expanses of sand or pebble beach along river banks and reservoirs. Sandbars, islands, and dike fields are used for courtship and nesting. Terns choose sites that are well-drained and well back from the water line. Individual nests are usually near small ridges or pieces of driftwood (Bent 1921, Hardy 1957, Tomkins 1959, Ducey 1981, Anderson 1983, Evans 1984, Dryer and Dryer 1985, Landin *et al*. 1985). Least terns usually nest on sites totally devoid of vegetation, but have been found on sites with an average 11.4 to 30.4 percent vegetative cover (Hardy 1957, Anderson 1983, Faanes 1983, Schulenberg and Ptacek 1984, Dryer and Dryer 1985, Landin *et al*. 1985, Rumancik 1985).

Vegetation, if present, is usually located well away from the colony (Hardy 1957, Anderson 1983, Rumancik 1985, Smith and Shepard 1985). However, bugseed (*Corispermum hypssopifolium*), eastern cottonwood (*Populus deltoides*) and sandbar willow (*Salix interior*) are commonly found within or near some interior least tern colonies (Wycoff 1950, Faanes 1983, Evans 1984, Dryer and Dryer 1985). Thompson (1982) reported that vegetation associated with coastal least terns in Texas is usually clumped and scattered. This type of growth form appears to be particularly important for protection of young chicks from weather extremes and predators (Hardy 1957, Jernigan *et al*. 1978, Thompson 1982, Minsky *et al*. 1984, Schulenberg and Ptacek 1984) while not substantially obscuring the site vertically or horizontally.

Foraging habitat for least terns includes side channels, sloughs, tributaries, shallow-water habitats adjacent to sand islands and the main channel (Dugger 1997). To successfully reproduce, productive foraging habitat must be located within a short distance of a colony (Dugger 1997).

4.1.6 Rangewide Distribution and Abundance of Habitat

At a minimum, over 9,500 acres of sandbar (excluding vegetated areas) existed prior to impoundment of mainstem dams above Gavins Point Dam (USFWS 1984). While the reach of river below Gavins Point Dam still exhibits its somewhat free-flowing state, approximately 7,800 acres of sandbar habitat has been lost between 1956 and 1975 (Schmulbach *et al*. 1981). Gavins Point Dam closed in 1955. In 1981, Schmulbach *et al*. reported 2,200 acres of sandbar remaining along the 50 mile stretch of river below Gavins Point Dam that is designated as the Missouri National Recreation Area. In the LMR, 158,074 acres of bare sandbar habitat occurred above the Low Water Reference Plane (LWRP) in 1948. By 1994, the amount of bare sandbar habitat above the LWRP had declined to 105,797 acres (USACE 1999a). This represents a 33% decline in bare sandbar habitat. This decline is attributable to the river’s response to a series of bendway cutoffs and sandbar accretion and colonization by woody vegetation (USACE 1999a). Much of the sandbar habitat that remains is associated with wingdam systems, which may not provide optimal breeding habitat for least terns.

4.1.7 Factors Affecting Least Terns Rangewide

Channelization, irrigation and the construction of reservoirs and pools has contributed to the elimination of much of the least tern’s sandbar nesting habitat (Funk and Robinson 1974, Hallberg *et al*. 1979, Sandheinrich and Atchison 1986). Ducey (1985), for example describes the changes in the channel characteristics of the Missouri River since the early 1900's under the Missouri River Bank Stabilization and Navigation Project. The wide and braided character of the Missouri River was engineered into a single, narrow navigation channel. Most sandbars virtually disappeared between Sioux City, Iowa, and St. Louis, Missouri (Sandheinrich and Atchison 1986, Smith and Stucky 1988). The MMR and the Lower Mississippi River have experienced similar effects due to channelization.

Current regulation of Missouri River dam discharges pose additional problems for interior least terns nesting in remaining habitats (Nebraska Game and Parks Commission 1985c, Schwalbach *et al*. 1988). Before regulation of river flows, summer flow patterns were more predictable. Peak flow occurred in March from local runoff and then again in May and June when mountain snowmelt occurs. Flows then declined during the rest of the summer allowing least terns to nest as water levels dropped and sandbars became available (Stiles 1939, Hardy 1957). Currently, the main stem system is regulated for hydropower, navigation, water quality and supply, flood evacuation, irrigation, fish and wildlife conservation, and public recreation. However, system releases are designed to provide equitable service to power and navigation demands, except when they conflict with flood control functions of the system (USFWS 1990).

The demands are unpredictable and flows can fluctuate greatly. Flow regimes differ greatly from historic regimes. High flow periods may now extend into the normal nesting period, thereby reducing the quality of existing nest sites and forcing least terns to initiate nests in poor quality locations. Extreme fluctuations can flood existing nests, inundate potential nesting areas, or dewater feeding areas. Interior least terns along the Arkansas River in Oklahoma and Arkansas contend with dam discharge problems similar to those on the Missouri River (USFWS 1990).

Along the MMR, Lower Mississippi River, and elsewhere, river discharge may exert considerable influence on reproductive success. A wet spring may delay river fall and habitat may not be available until later. Rises in the river during spring and summer may inundate nests and wash away chicks (Rumancik 1986, 1989, Smith and Renken 1990). Renesting, however, does occur and may be an adaptation to river fluctuations. Dike construction has created many sandbars between the dikes and many nesting colonies are located on these sandbars (Landin *et al*. 1985, Rumancik 1986, 1987, 1988, 1989, J. Smith 1985, 1986, 1987). According to Smith and Stucky (1988) the process of dike field terrestrialization is well underway at several least tern colony sites in the Lower Mississippi River. However, according to USACE (1999a) approximately two-thirds of LMR sandbars are not connected to the riverbank at a river stage of Low Water Reference Plane (LWRP) +10 feet.

Reservoir storage of flows responsible for scouring sandbars has resulted in the encroachment of vegetation along many rivers such as the Platte River, Nebraska, and greatly reduced channel width (Currier *et al*. 1985, O'Brien and Currier 1987, Eschner *et al*. 1981, Lyons and Randle 1988, Sidle *et al*. 1989, Stinnett *et al*. 1987). In addition, river mainstem reservoirs now trap much of the sediment load resulting in less aggradation and more degradation of the river bed and, subsequently, less formation of suitable sandbar nesting habitat. Riverine habitat along the central Platte River may require extensive vegetation clearing and other intensive management. In contrast, the lower Platte River has not undergone as extensive habitat changes as the central Platte. During 1987-1989, riverine sandbar habitat hosted 72% of the nests on the lower Platte and only 12% of the nests on the central Platte (Kirsch 1989, Lingle 1989).

Human disturbance has been documented as a significant factor affecting tern productivity in many locations, including the Missouri River (Massey and Atwood 1979, Goodrich1982, Burger 1984, Dryer and Dryer 1985, Schwalbach *et al*. 1986, Schwalbach 1988, Mayer and Dryer 1990, Dirks and Higgins 1988). Many rivers have become the focus of recreational activities and sandbars are fast becoming the recreational counterpart of coastal beaches. Human presence reduces reproductive success (Mayer and Dryer 1988, Smith and Renken 1990). Domestic pet disturbance and trampling by grazing cattle are other factors that have contributed to the population decline.

Predation has also been documented as a significant factor affecting least tern productivity in many locations (Massey and Atwood 1979, Jenks-Jay 1982), including the Missouri River (Dirks and Higgins 1988). Grover (1979) attributed 25% to 38.5% of the observed nesting failures to coyote predation. Paige (1968) noted 40% to 100% of eastern least tern chicks were destroyed by predators.

Pollutants entering the waterways within and upstream of breeding areas can negatively impact water quality and fish populations in nearby foraging areas. Strip mining, urban and industrial pollutants, and sediments from non-point sources can all degrade water quality and fish habitat, thereby impacting small-fish populations on which least terns depend (Wilbur 1974, Erwin 1983). In addition, because least terns are relatively high on the food chain, they are in a position to accumulate contaminants which may render eggs infertile or otherwise affect reproduction and chick survival (USFWS 1983, Dryer and Dryer 1985). The extent of this impact, however, is undocumented. Mercury residues have been found in least terns from the Cheyenne River watershed in South Dakota. DDE's and PCB's have also been found in the two coastal subspecies in South Carolina and California (USFWS 1983).

4.1.8 Summary

Least tern distribution and abundance have been affected by channelization and impoundment projects throughout its range. Although this species is still widely distributed, it is generally restricted to less altered river segments. Overall population trends from 1986 to 1995 are positive. However, this positive trend is due to increases in numbers of least terns on the Lower Mississippi River. Fledging success rates for the Lower Mississippi River do not support the positive population trend for this area, indicating possible immigration from Gulf Coast populations. Although recent counts of least terns (approximately 8,800 terns in 1995) exceed the overall recovery objective of 7,000 birds, the mean number of least terns in 12 of 19 local areas identified in the recovery plan (USFWS 1990) do not reach corresponding objectives (Kirsch and Sidle 1999).

Suitable least tern nesting habitat is anticipated to continue to decline in quantity and suitability as sandbar habitat accretes and converts to woody vegetation and aquatic habitats continue to be degraded and lost due to sedimentation.

4.2 Environmental Baseline

The Section 7 environmental baseline for this biological opinion is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and ecosystem, within the action area. Along with a discussion of the past and present impacts associated with construction, operation and maintenance of the 9-Foot Channel Project, the baseline includes the following: 1) State, local and private actions already affecting the species or that will occur contemporaneously with this consultation; 2) unrelated Federal actions affecting least terns that have completed formal or informal consultations; and 3) Federal and other actions within the action area that may benefit least terns.

4.2.1 Status of the species in the action area

4.2.1.1 Historic and current distribution in the action area

In the Upper Mississippi River, least terns historically nested from the confluence with the Ohio River north to Lee County, Iowa (approximate river mile 362.0) (Hardy 1957, Smith and Renken 1991). Hardy (1957) states that least terns formerly ranged in eastern Iowa as far north as Dubuque, located at approximate river mile 580.0. Currently, the breeding range extends from the confluence of the Ohio River to the confluence of the Missouri River at approximate river mile 196.0 (MMR). However, least terns have recently been noted at the Riverlands Environmental Demonstration Area at approximate river mile 202.5 (Dan Erickson, USACE, pers.comm.), approximately 6.5 miles upstream from the confluence of the Missouri and Mississippi Rivers.

4.2.1.2 Population status and trends in the action area

Historical population data is lacking. The first published report of least terns nesting in Illinois was made by Widmann (1898) who observed breeding birds on Gabaret Island in Madison County, Illinois. Brewer (1954) reported nesting colonies at Horseshoe Lake in Alexander County in 1952. Downing (1980) did not note any least terns in the lower 30-50 miles of the MMR during surveys in 1974. Two colonies in the MMR were located in 1983. These were located at Bumgard Island at river mile 30.3 and Brown’s Bar at river mile 23.7 (Anderson 1983). Thirteen nests were noted for both colonies (Anderson 1983).

From 1989 to 1995 Corps’ surveys in the MMR noted least tern numbers ranging from 58 in 1989 to zero in 1995 (USACE 1995). Other small boat census information provided by the Corps noted least tern numbers ranging from 90 in 1986 to 9 in 1998. This would seem to reflect a downward trend. However, detailed surveys of the MMR in 1997 for least terns identified 169 nests (MoDOC 1997). Two large colonies totaling 160 nests were located on historical nesting islands (Bumgard Island and Brown's Bar). There has been great variability in the number of least terns observed in the MMR from year to year. This is likely a reflection of yearly fluctuations in river stages (e.g., flooding) and the availability of suitable nesting habitat.

4.2.1.3 Distribution and abundance of habitat in the action area

Data regarding the amount of sandbar habitat which historically occurred in the MMR is lacking. However, Collot's (1826) historical account of the MMR describes a very dynamic system with the capability to create and maintain a diversity of habitat types, indicating sandbar habitat at all elevations would have been abundant.

According to the Corps' least tern biological assessment (USACE 1999a), 20,412 acres of non-vegetated sandbar occurs above the LWRP and is potentially available to least terns in the MMR. This habitat is widely distributed throughout the MMR with approximately 4,975 acres occurring between river miles 0-45 and 15,437 acres between river miles 45-195. The biological assessment did not identify how much of this sandbar area occurs above various LWRP elevations (e.g., LWRP +10, LWRP +15, LWRP +20, etc.). Data for the LMR indicates that river stages exceed LWRP +10 elevation for considerable periods in any given year (e.g., 240 to 300 days exceedence). Therefore, the sandbar area occurring above LWRP +15 and LWRP +20 is most likely potentially available to least terns for nesting. The hydrologic analysis of sandbar habitat availability during the least tern nesting season (15 May - 31 August) did not consider how much of the area is emergent during the pre-laying period when least terns are searching for suitable nest sites or during the egg-laying period (approximately mid to late May for first nest attempts).

Instead, the Corps' analysis of available sandbar habitat considered the amount of sandbar which is emergent more than 50 continuous days from 15 May - 31 August. This analysis likely overestimates the availability of sandbar habitat for nesting as a higher percentage of sandbar habitat is emergent in July and August during low river stages. This is relatively late in the least tern nesting season and would only provide habitat for renesting or second nest attempts. Smith and Renken (1991) hypothesized that sandbar habitat that is continuously above the water for 100 days from 15 May - 31 August is important to least terns on the Mississippi River. The Corps' hydrologic analysis for the MMR (based on one gauging station) indicates that sandbar habitat is emergent for 100 continuous days above LWRP +15 elevation only 1 out of 10 years. Sandbar habitat is emergent for 100 continuous days above LWRP +20 elevation 1 out of 5 years. Given this, it is probable that much of the 20,412 acres of non-vegetated sandbar is not actually available during the time period when least terns are searching for nest sites or is only infrequently available depending on river stages in any given year.

In addition, much of the sandbar habitat that is available for least tern nesting is likely associated with wingdam fields. Sandbars associated with wingdam fields gradually accrete and attach to the riverbank. The process of terrestrialization eventually makes these areas unsuitable for least tern nesting. These areas are also more easily accessible by predators.

Dugger (1997) found that tern food availability is directly related to measures of reproductive success, such as clutch size, egg weight and chick growth. Foraging habitat for least terns includes side-channels, sloughs, tributaries, shallow-water habitats adjacent to sand islands and the main channel (Dugger 1997). Shallow-water areas may be of more importance than deep-water as these areas have higher fish abundance (Tibbs 1995) and very small fish which can be fed to tern chicks (Dugger 1997). To successfully reproduce, productive foraging habitat must be located within a short distance of a colony (Dugger 1997).

The MMR was historically a very dynamic system with the capability to create and maintain a diversity of habitat types. Today, the natural meandering processes of the MMR have been altered through channelization. Wingdams, revetments, closing structures and bendway weirs have fixed the channel in place, disrupting the dynamic processes that create and maintain least tern habitat. This has affected the quality and quantity of habitat in the MMR, thus affecting the abundance and distribution of least tern nesting and foraging habitat.

4.2.2 Factors affecting the species environment within the action area

4.2.2.1 Channel Training Structures

Channel training structures have reduced channel diversity through the loss of side channels, backwaters, islands, and meandering (Funk and Robinson 1974, Hesse *et al*. 1988). This has affected least terns by (1) reducing sandbar nesting habitat; (2) reducing foraging habitat; and (3) reducing the nutrient cycling capability of the river, therefore, reducing forage fish abundance.

The MMR historically had a meandering pattern and shifted its course over the years, leaving oxbow lakes and backwaters (Theiling 1999). The undeveloped river was shallow and characterized by a series of runs, pools and channel crossings that provided a diversity of depth. As a result, least tern nesting and foraging habitat would have been abundant. Currently the MMR channel is fixed as a result of channel training structures and no longer allowed to meander across the floodplain. In 1824, the MMR surface area totaled 109 mi^2 (87.2% riverbed 12.8% islands), and in 1888, surface area increased to 163 mi^2 (78.5% riverbed, 21.5% islands). Average river width increased from 3600 feet in 1824 to 5300 feet in 1888 (Simons *et al*. 1974). This increase in surface area and width is thought to have been caused by a series of floods between 1844 and 1888 and by changes in land use (e.g., clearing of floodplain timber for steamboat fuel and lumber and conversion of floodplain to agricultural use). These examples are an indication of the river's surface area and width at particular points in time. However, the magnitude of the change from 1824 to 1888 is indicative of the dynamic nature of the MMR and the great potential for change described by Collot (1826) indicating that the river surface area and width has probably never been static.

In 1968, due to the construction of channel training structures (dikes/revetments), the river surface area had decreased to 100 mi^2 and the river width to an average of 3200 feet. Given the above, from 1888 to 1968, there was a 38.7% decrease in river surface area and a 39.6% decrease in average river width (Simons *et al*. 1974, Fremling *et al*. 1986). The effect of channel training structures in reducing channel width and surface area, and thereby, habitat diversity, continues and is ongoing. Theiling *et al*. (1999) found that main channel habitat decreased by 1667 acres in six study reaches during the period 1950 to 1994. Of this amount, approximately 412 acres were lost from 1975 to 1994. Fixing the river channel in place and reducing river surface area and width has affected natural river processes that create aquatic and terrestrial habitats over time. As a result, island sandbar and aquatic habitat quantity and diversity has declined, affecting the availability of least tern nesting and foraging habitat.

In addition to constricting the channel width, dikes and revetments have also deepened the low water channel of the MMR. Wlosinski (1999) found water-surface elevations in the MMR have decreased at the same low discharge of 60,000 cfs during the period from 1880 to present. River stages fluctuate as much as 15m annually, effectively dewatering some secondary channels during low stages (Fremling *et al*. 1989). Previously aquatic habitats are now dry at low discharges (Wlosinski 1999). As a result, many least tern foraging habitats are dry during portions of the reproductive season. This limits the availability of least tern forage food. Dewatering of side channels has also increased predator accessibility to least tern nesting colonies. As discussed in the Status section, predators can significantly impact least tern reproductive success.

Channel training structures have also altered the natural hydrograph of the MMR by contributing to higher water surface elevations at lower discharges than in the past. Wlosinski (1999) documented a trend of increasing water surface elevations in the MMR at the same high discharge of 780,000 cfs for a 130 year period of record. Present day floods on the Mississippi River at St. Louis tend to be 9 feet higher than historic floods at the same discharge of 780,000 cfs (Wlosinski 1999). Wlosinski (1999) also noted that the number of days water elevations are above flood stage is also increasing. At St. Louis, water surface elevations were above flood stage for 217 days from 1880 to 1917; 312 days from 1918 to 1955; and 485 days from 1956 to 1993. The increasing occurrence of above floodstage days has limited the availability of least tern nesting habitat.

Channel training structures have also reduced the quantity and quality of MMR side channels. The loss of side channels is well documented. In 1797 there were 55 side channels (Collot 1826), 35 in 1860 (Simons *et al*. 1974), 27 in 1968 (Simons *et al*. 1974), and only 25 today (USACE 1999b). Many of those that remain are degraded and much smaller than in the past (Theiling *et al*. 1999). The loss of side channel habitat continues. Within six study reaches analyzed, Theiling *et al*. (1999) noted that approximately 918 acres of secondary channel habitat was lost during the period 1950 to 1994. Of this amount, approximately 271 acres was lost from 1975 to 1994. Side channels serve as important nursery areas and as refugia from the swift currents and harsh environments of the thalweg (Environmental Sci. and Eng. 1982, Fremling *et al*. 1989). These areas are an integral component of the habitat complexity of the MMR and serve an important role in the cycling of nutrients and primary productivity. The loss of side channels has reduced the production of least tern forage food organisms and the availability of foraging habitat.

Just as changes in river processes have eliminated channel meandering that creates new side channels, development of new sand bar habitat is also inhibited. Bendway weirs were developed to inhibit point-bar establishment in bends and channel crossings and to reduce the need for dredging in these areas. They consist of a series of submerged dikes (>3m below the LWRP) generally constructed around the outer edge of a river bend. In recent years, bendway weirs have also been utilized in other depositional areas in the MMR. Each dike is angled 30 degrees upstream of perpendicular to divert flow, in progression, towards the inner bank. The result is hydraulically controlled point par development and reduced channel downcutting throughout the bend.

Information concerning sandbar habitat loss is lacking for the MMR. However, data from the Lower Mississippi River may provide some indication of trends in sandbar habitat loss.
In 1948 bare sandbar occurring above the LWRP in the LMR totaled 158,074 acres. By 1963, bare sandbar area above the LWRP had declined to 108,660 acres, reflecting a 31% decline. From 1963 to 1988, bare sandbar above the LWRP increased to 116,685 acres. This increase in sandbar acreage can primarily be attributed to accretion of sand in wingdam fields and degradation of the low water channel. From 1988 to 1994 bar sandbar acreage above the LWRP declined to 105,797 acres (USACE 1999a). Overall, bare sandbar habitat has declined 33% from 1948 to 1994. Conversely, wooded sandbar habitat above the LWRP increased from 21,482 acres in 1948 to 27,794 acres in 1988, a 29% increase. Overall, bare and wooded sandbar habitat declined by 35,077 acres (20%) from 1948 to 1988 (USACE 1999a).

4.2.2.2 Locks and Dams

Impoundment due to construction of locks and dams has adversely affected least terns by eliminating the species from a portion of its historic range. Least terns historically nested as far north as Lee County, Iowa (Hardy 1957). Dams were constructed on the UMR for the specific purpose of increasing low and moderate flow water surface elevations to maintain a continuous nine-foot navigation channel from St. Louis, Missouri, to Minneapolis, Minnesota (USACE 1999c). Initial impoundment likely eliminated the least terns' nesting habitat in the UMR above St. Louis, Missouri.

Wlosinski (1999) found that water surface elevations in the MMR decreased at the same low discharge of 60,000 cfs during the period 1880 to present. This downward trend is likely to continue as a result of the proposed project. This downward shift in annual minimum stages has been attributed primarily to the degradation of the low water channel due to channel constriction by wingdams and levees (Simons *et al*. 1974). However, the MMR receives 60% of its flow from the Mississippi River basin

(Fremling *et al*. 1989). It is likely that holding water to maintain a 9-Foot Channel in the pools contributes to the low water surface elevations in the MMR at low discharges. Therefore, water level regulation contributes to water level fluctuations in aquatic habitats in the MMR. This has affected the availability of least tern foraging habitat. In addition, loss of aquatic habitat has reduced the nutrient cycling ability of the MMR, therefore, reducing the abundance of forage food.

One of the effects of impoundment of the UMR is a reduction in suspended sediment load in the MMR. MMR sediment load has declined 66% from pre-1935 levels mainly due to sediment entrapment in Missouri River impoundments (Fremling *et al*. 1989). However, as the UMR presently contributes approximately 20% of the average sediment load to the MMR (Tuttle and Pinner 1982), UMR dams have also contributed to the sediment load reductions. This lack of sediment delivery upset the natural channel equilibrium and was replaced by a variety of nonequilibrium processes such as hydraulic sorting and bed paving, which eventually will eliminate all sediment movement (USFWS 1993). Such reductions in suspended sediment load has likely affected the abundance of new sandbar habitat in the MMR.

4.2.2.3 Dredging/Disposal

Dredging occurs in depositional areas and channel crossings to maintain a nine-foot navigation channel with disposal occurring in the adjacent main channel border area near shore. From 1978 to 1998, the St. Louis District dredged an average of 6.0 million cubic yards (mcy) of material per year in the MMR. This ranged from a low of 0.5 mcy in 1993 to a high of 20.5 mcy in 1988 (USACE 1998). The amount of material dredged varies from year to year depending on river stages. In addition, there has been no consistent pattern in the locations of dredging activities as this also varies depending on river conditions.

The past effects of dredging and disposal activities have not been documented. At the present time, dredging occurs in depositional areas of the main channel with disposal occurring in the adjacent main channel border areas near shore. As such, dredging activities are not likely affecting least tern nesting activities. In recent years, the St. Louis District has been following general dredge disposal guidelines developed to protect important aquatic habitats, such as side channels. In this manner, impacts to least tern foraging habitats due to dredging and disposal activities have been minimized.

Dredging disturbs bottom sediments and associated contaminants. Main channel dredge cut sediment is periodically sampled and analyzed to determine bulk chemical concentrations of contaminants for use in assessing the water quality effects of dredging. However, no analysis of the effects of dredging on the mass balance of contaminant mobilization and transport in the UMR have been conducted. The concentrations of some contaminants, such as PCB’s have been homogenized in the Mississippi River due to repeated deposition and resuspension of contaminated silts

(Rostad *et al*. 1995). Although dredge material consists mainly of sand, some amount of silts are disturbed during the dredging process.

Dredging and disposal may have adversely affected least terns by contributing to the transference and homogenization of contaminants in the Mississippi River. Rostad *et al*. (1995) state that suspended material in the Mississippi River transport the following sparingly soluble synthetic chlorinated pesticides and industrial chemicals: aldrin, chlorthalonil, chlordane, DCPA, DDT, DDE, DDD, dieldrin, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene, PCB's and trifluralin. Least terns may accumulate contaminants which may render eggs infertile or otherwise affect reproduction and chick survival (USFWS 1983, Dryer and Dryer 1985), however, the extent of this impact is undocumented.

4.2.2.4 Commercial Sand and Gravel Dredging

Dredging disturbs bottom sediments and associated contaminants. Although the dredged material consists mainly of sand, some amount of silts are disturbed during the dredging process. As discussed above, the concentrations of some contaminants, such as PCB's, have been homogenized in the Mississippi River due to repeated deposition and resuspension of contaminated silts (Rostad *et al*. 1995). It is likely that commercial sand and gravel dredging has contributed to some degree to the homogenization of contaminant concentrations in the Mississippi River and potentially contributed to the transference of contaminants downstream. As such, least tern reproduction may have been adversely affected, however, the extent of this impact is unknown.

4.2.2.5 Flood Control Projects

Approximately, 80% of the floodplain in the MMR (approximately 500,000 acres) has been isolated from the main channel due to levee construction. Interior drainage ditches and large pumps drain groundwater seepage (Theiling 1999) and interior floodflows. This has allowed the conversion of floodplain habitats to agriculture and other land uses. Isolated backwaters, side channels and wetlands have been degraded due to incompatible agricultural practices, poor stormwater management and sedimentation. Destruction and isolation of these important floodplain features have reduced riverine productivity (Theiling *et al*. 1999) by decreasing energy inputs (e.g., organic matter, carbon) into the main channel. Isolation of wetlands reduces their habitat value to riverine fish that make seasonal movements to backwaters and floodplains (USACE 1999b). These factors affect the overall abundance and distribution of fish in the river system. Thus, flood control projects have affected the availability of least tern foraging habitats and the abundance of least tern forage food.

Levees contribute to increased flood heights and increased water level variability because floodwaters are confined in a smaller cross-sectional area (Belt 1975, Chen and Simons 1986, Bellrose *et al*. 1983). Wlosinski (1999) documented a trend of increasing water-surface elevations in the MMR at the same high discharge of 780,000 cfs. Present day floods on the Mississippi River tend to be 9 feet higher than historic floods at this discharge (Wlosinski 1999). Wlosinki (1999) also found that the number of days water elevations are above flood elevations has increased. At St. Louis, water surface elevations were above flood stage for 217 days from 1880 to 1917; 312 days from 1918 to 1955; and 485 days from 1956 to 1993 (Wlosinski 1999). As a result, flood control projects, in conjunction with channel training structures, have affected the availability of least tern nesting habitat, as many sandbar habitats are flooded at times when least terns are searching for suitable nesting areas.

4.2.2.6 Missouri River Impoundments

The MMR currently receives about 80% of its average suspended sediment load from the Missouri River and 20% from the UMR watershed above St. Louis. The sediment load is 109.8 million tons/year. This represents a 66% decline from pre-1935 levels, mainly due to retention by Missouri River reservoirs (Fremling *et al*. 1989). This lack of sediment delivery upset the natural channel equilibrium and was replaced by a variety of nonequilibrium processes, such as hydraulic sorting and bed paving, which eventually will eliminate all sediment movement (USFWS 1993). Such reductions in sediment load has likely affected the abundance of sandbar habitat in the MMR.

4.2.2.7 Avoid and Minimize Program

In October 1992, the St. Louis District issued Design Memorandum No. 24, “Avoid and Minimize Measures” developed as a result of commitments made in the Record of Decision of the Environmental Impact Statement for the Second Lock at Melvin Price Locks and Dam. The purpose of the Avoid and Minimize Program is to implement various measures to avoid and minimize impacts associated with operation and maintenance of the 9-Foot Channel Project. The avoid and minimize program is beneficially affecting least terns by restoring/enhancing habitat in the MMR.

In 1997, hard points were placed in the side channel between the mainland and the sandbar at Owl Creek, river miles 84-86(R). The purpose of this project was to isolate an existing sandbar to improve nesting habitat for least terns, by reducing predator accessibility. In addition, the hardpoints create a flow in the side channel that induces scour and creates a deeper channel; which contributes to overall aquatic habitat diversity (USACE 1997). Improvements in aquatic habitat diversity should result in increased forage fish abundance for least terns.

In 1998, the upper closing structure of Marquette Chute, river mile 51.0(R), was modified by placing a series of shallow notches in the structure. The idea was to create a “string of pools” which may someday connect to each other downstream of the closing structure. Two of the notches were designed to enhance an existing half-acre, shallow pool located on the adjacent sandbar. The intent was to increase the wetted edge of this area (Frazier and Hrabik 1998). This project increased fishery access to the side channel and improved the nutrient cycling ability of the side channel. This potentially benefitted least terns by increasing forage fish abundance in this portion of the MMR, which is a known least tern nesting area.

The Avoid and Minimize Program was originally proposed for implementation from 1994 to 2000 with an estimated cost of approximately 14 million dollars (2 million/year). After 2000, the program is to be completely absorbed into the normal operation and maintenance program or become part of the Integrated River Management Program (USACE 1992). Due to recovery efforts from the Great Flood of 1993, program construction did not become active until 1995 (USACE 1995). Since that time, the program has been extended to 2002, but funding has been reduced to 1-1.5 million dollars/year (USACE 1997). Funding for the Avoid and Minimize Program is currently divided between the impounded reaches of the St. Louis District (Pools 24, 25 and 26) and the MMR, with work in the MMR beginning in 1997.

The projects constructed by the Avoid and Minimize Program have served to increase aquatic habitat diversity in the MMR. This is a benefit to least terns, which are adapted to a dynamic environment with diverse habitat components. In addition, physical and biological monitoring have provided data that may be used to further refine structures for environmental benefits. However, the Avoid and Minimize Program can only implement small-scale improvements given funding limitations and the necessity to distribute those resources over a large area of river (approximately 300 river miles).

4.2.2.8 Refuge Land Acquisition and Management

Refuge land acquisition and management is beneficially affecting least terns by restoring/enhancing habitat in the MMR. Benefits include improved fishery access to off-channel habitat during flood stages and improving the nutrient cycling ability of the MMR, which increases the abundance of least tern forage fish.

Prior to the Flood of 1993, public land ownership in the MMR was virtually nonexistent. However, following the Flood of 1993, many private landowners and levee and drainage districts expressed the desire to sell their flood prone property. In response, Congress appropriated funding for the Emergency Wetland Reserve Program of the Department of Agriculture and for the Fish and Wildlife Service to assist with purchasing property from landowners who had been plagued by flooding and wanted to dispose of their flood prone property.

The Service completed an Environmental Assessment in 1995 that evaluated four areas (totaling 11,400 acres) of floodplain habitat in the MMR which contained unprotected wetlands, cropland and aquatic areas. The four specific areas identified included:

1) Meissner Island, 1,650 acres in Monroe County, Illinois at river miles 153-156;
2) Harlow Island, 1,050 acres in Jefferson County, Missouri at river miles 141-145;
3) Wilkinson Island, 2,700 acres in Jackson County, Illinois and Perry County, Missouri at river miles 88-94, and;
4) Powers Island, 6,000 acres in Scott County, Missouri at river miles 34-39 (USFWS 1995).

To date, the Service has purchased 1,224 acres on Harlow Island, 2,532 acres on

Wilkinson Island and less than 100 acres on Meissner Island. These areas are part of the Mark Twain National Wildlife Refuge (MTNWR) for management and administrative purposes. The purchased lands contribute to MTNWR goals and objectives by restoring habitat conditions on lands that will also increase floodplain functionality and the ecological integrity of the river. Acquisition of the properties has allowed flood-damaged agricultural lands to return to a more natural state by minimizing the reliance on levees and restoring the natural functions of the Mississippi River floodplain through re-connection with the river. This re-connection improves riverine fish access to off-channel areas during flood stages. Restoration of the cropland and improved floodplain function will increase organic matter and carbon inputs into the river locally while reducing nitrate input. This nutrient cycling function will benefit aquatic resources in this portion of the river. Thus, least tern forage fish abundance will increase.

4.2.3 Summary

Overall least tern population trends from 1986 to 1995 have been positive (Kirsch and Sidle (1999). Least tern populations along the Mississippi River have generally increased from 1986 to 1999 with some cyclic fluctuations (Kirsh and Sidle 1999). Total population numbers were relatively low (<2500) from 1986 to 1989 but remained relatively high (>3400) from 1990 to 1999 with a peak of approximately 6100 birds in 1999 (USACE 1999a). Populations in the MMR also exhibited cyclic fluctuations ranging from 90 in 1986 to 9 in 1998 and a peak of 169 nests in 1997. Although not stable, the Mississippi River population of least terns exceed the recovery goal of 2200 to 2500 birds. Least terns occurring in the MMR represent a small percentage of the Mississippi River population. In addition, the MMR represents a small percentage of the least terns' total range.

As discussed previously, the decline in least tern abundance and distribution has been coincidental with the development of river systems for navigation and flood control. Many factors influence least tern habitat availability and abundance in the MMR, with the most pervasive effect being a decrease in habitat quantity and quality as a result of channel training structures, locks and dams on the UMR, flood control projects and impoundment on the Missouri River. Other factors that have possibly affected least terns include dredging and disposal activities, commercial sand and gravel dredging and fleeting operations, all of which may contribute to the transference and homogenization of contaminant concentrations in the Mississippi River. Least tern abundance in the MMR appears to vary from year to year, likely as a result of river stages and the availability of suitable nesting habitat in any given year.

4.3 Effects of the Action

4.3.1 Direct Effects

Aquatic features in rivers and floodplains are transient (Leopold *et al*. 1964, Shields and Abt 1989, Salo 1990, Amoros 1990). Natural river systems are subject to high and low flow events and biological processes that can cause rapid changes in successional stage of a particular river feature (Theiling *et al*. 1999). A natural channel is neither straight nor uniform (Brookes 1996). Hydraulic and morphologic variability through space and time determine the different habitats found both within a given river channel and also in the adjacent riparian and floodplain zones (Brookes 1996).

The proposed project (operation and maintenance of the 9-Foot Channel Project) will continue to arrest some of the natural processes that provide dynamic physical change in rivers. As explained previously, the dynamic equilibrium of the MMR has been interrupted and replaced by unstable processes and hydraulic and morphologic variability has declined as the result of past operation and maintenance activities. This disruption will have continuing, ongoing effects. The result will be continued homogenization of the river system and loss of habitat diversity. This will adversely affect least terns through the loss of nesting and foraging habitat and by reducing forage food abundance.

4.3.1.1 Operation of the 9-Foot Channel Project

4.3.1.1.1 Water Level Regulation

During previous discussions with the Corps we concluded that water level regulation effects were not applicable to least terns. However, in further reviewing this issue, we believe this is not the case. Dams were constructed on the UMR for the specific purpose of increasing low and moderate flow water surface elevations to maintain a continuous nine-foot navigation channel. Wlosinski (1999) found that water surface elevations in the MMR decreased at the same low discharge of 60,000 cfs during the period 1880 to present. This downward trend is likely to continue as a result of the proposed project. The downward shift in annual minimum stages has been attributed primarily to the degradation of the low water channel due to channel constriction by wingdams and levees (Simons *et al*. 1974). However, the MMR receives 60% of its flow from the Upper Mississippi River basin (Fremling *et al*. 1989). It is likely that holding water to maintain a 9-Foot Channel in the pools contributes to the low water surface elevations in the MMR at low discharges. Therefore, water level regulation will continue to contribute to water level fluctuations in aquatic habitats in the MMR. This can affect the availability of least tern foraging habitat. In addition, loss of aquatic habitat will reduce the nutrient cycling ability of the MMR, therefore, reducing the abundance of forage food.

4.3.1.1.2 Impoundment

The UMR contributes approximately 20% of the suspended sediment load to the MMR (Tuttle and Pinner 1982). Impoundment due to UMR dams will continue to contribute to the reduction of sediment to the MMR. Theiling (1999) found that navigation pools may continue to accumulate this sediment. The lack of sediment delivery upset the natural channel equilibrium. This has been replaced by a variety of nonequilibrium processes, such as, hydraulic sorting and bed paving, which will eventually eliminate all sediment movement (USFWS 1993). Such reductions in sediment load will continue to affect least terns by reducing the abundance of bare sandbar habitat in the MMR.

4.3.1.2 Maintenance of the 9-Foot Channel Project

Maintenance of the 9-Foot Channel Project consists of channel maintenance dredging and disposal, maintenance of existing channel training structures and construction of new channel training structures. These activities work in combination to significantly alter the natural processes that provide dynamic physical change in the MMR. Such changes will continue to affect least terns by (1) reducing the availability of bare sandbar nesting habitat; (2) reducing the availability of foraging habitat; and (3) reducing the abundance of forage food.

4.3.1.2.1 Dredging/Disposal

Dredging occurs in depositional areas and channel crossings to maintain a nine-foot navigation channel with disposal occurring in the adjacent main channel border. Although dredge material consists mainly of sand, some amount of silts are disturbed during the dredging process. The amount of material dredged in the MMR will vary from year to year depending on river stages, and based on past data, there does not appear to be a consistent pattern in the location of dredging activities (USACE 1998). As discussed previously, dredging and disposal activity has likely contributed to the homogenization and transference of contaminants in the Mississippi River. This will continue to occur. Least terns may accumulate contaminants which may render eggs infertile or otherwise affect reproduction and chick survival (USFWS 1983, Dryer and Dryer 1985). However, it is unclear the extent to which this may affect least terns.

4.3.1.2.2 Snagging and Clearing

A well defined navigation channel has been established in the MMR as a result of various channel training structures and is maintained by dredging operations. As a result, snagging and clearing operations no longer occur in the MMR.

4.3.1.2.3 Channel Training Structures

4.3.1.2.3.1 Wingdams

Wingdams are designed to direct flow towards the middle of the channel, thus reducing the natural meandering capability of the river. Dike systems (wingdams) may cause localized flattening of the channel slope, increased roughness, vertical accretion of bars, increases in main channel volume, and stage reductions at low discharges (Elliot *et al*. 1991). Existing wingdams have the ongoing effect of altering natural river processes, thereby, reducing the quality, quantity and diversity of habitat in the MMR (see Environmental Baseline section). Continued disruption of natural processes will affect least terns by (1) reducing the availability of bare sandbar nesting habitat; (2) reducing the availability of foraging habitat; and (3) reducing the abundance of forage food.

Wingdam systems in the MMR are maintained for the purpose of maintaining the nine-foot navigation channel. As such, they continue to reduce the natural meandering capability of the river. Thus, the river remains constricted and the channel bottom degraded. River migrations that would naturally create new habitat no longer occur. In addition, there is evidence that wingdams in the MMR continue to accrete sediment and revert to woody habitat, further constricting the channel. This reduces the availability of bare sandbar nesting habitat.

Further, wingdams are frequently constructed near the mouths of side channels which modifies river hydraulics and hastens side channel filling. From 1950 to 1994, Theiling *et al*. (1999) noted the loss of approximately 918 acres of secondary channel habitat in the six study reaches analyzed. Of this amount, approximately 271 acres were lost from 1975 to 1994. Construction of wingdams near the mouths of side channels is at least partially responsible for this loss of habitat. This trend in side channel habitat loss is likely to continue as existing structures are maintained and new structures are developed. This reduces the availability of least tern foraging habitat and, as side channels serve an important role in nutrient cycling and primary production, this reduces the abundance of least tern forage food. Further, as side channels continue to accrete with sediment and disappear, predator accessability to least tern nesting colonies will increase. This will reduce least tern reproductive success in the MMR.

4.3.1.2.3.2 Bendway Weirs

Bendway weirs are designed to reduce dredging requirements in river bends by controlling point bar development (Davinroy 1990). Bendway weirs affect least terns by (1) reducing the availability of bare sandbar nesting habitat; (2) reducing foraging habitat availability; and (3) reducing the abundance of forage food. However, bendway weirs reduce channel degradation which may reduce water level fluctuations in adjacent side channels. As such, bendway weirs may benefit least terns by increasing the availability of least tern foraging habitat and increasing least tern forage food abundance.

Bendway weirs control point bar development along the inside of river bends. As such, new sandbar (aquatic and terrestrial) habitat development is prohibited. Existing sandbar habitat will continue to accrete and revert to woody vegetation to some extent. Thus, bendway weirs, reduce the availability of bare sandbar habitat for least tern nesting.

In general terms, the results of various studies indicate that fish redistribute across the channel cross-section from the inside bank (shallow-water) to the outside bank (deep-water) as a result of bendway weirs. This is most likely in response to increases in macroinvertebrate abundance (Ecological Specialists, Inc. 1997a) and the low velocity fields that develop behind each weir. Dugger (1997) noted that very small fish captured in shallow-water habitats seem to be particularly important during least tern chick-rearing periods, as only small fish can be fed to chicks. Further, data suggests that shallow-water habitats (primarily sand/water interface habitats) are likely the habitats utilized most by foraging least terns during low or normal flows (Dugger 1997). Therefore, by reducing the abundance of shallow-water habitat and causing a redistribution of fish across the channel cross-section, bendway weirs will continue to reduce the availability of least tern foraging habitat and forage food abundance.

However, bendway weirs also result in channel aggradation which may reduce water level fluctuations in adjacent side channels. This may benefit least terns by increasing the availability of least tern foraging habitat in side channels and increasing the abundance of least tern forage food, by improving nutrient cycling and increasing primary productivity. Therefore, the affect of bendway weirs on least tern foraging habitat and forage food abundance may be a trade-off in terms of effects.

4.3.1.2.3.3 Bank Revetment/Off-Bank Revetment

Bankline revetments are used to eliminate the tendency for the main channel to migrate within the floodplain. Revetments alter the sinuosity of the river channel and alter natural alluvial processes, such as erosion. This can affect least terns by (1) reducing the availability of bare sandbar nesting habitat; (2) reducing the availability of foraging habitat; and (3) reducing the abundance of forage food.

Revetments located on outside river bends led to channel downcutting and riverbed degradation. Thus, revetments, in conjunction with wingdams, are responsible for MMR channel constriction and degradation that has reduced river surface area/width and has resulted in a downward shift of annual minimum stages resulting in degradation of aquatic habitats by dewatering (Simons *et al*. 1974, Fremling *et al*. 1989, Wlosinski 1999). Revetments prohibit natural channel migrations that would result in establishment of new mid-channel sandbar habitats and new side channels as old side channels fill in with sediment or are cut-off from the main channel. By prohibiting natural channel migrations, revetments also reduce the input of organic matter and nutrients (woody debris) to the river and contribute to reductions in suspended sediment loads. Thus, revetments will continue to contribute to reductions in bare sandbar habitat, reductions in least tern foraging habitat, and reductions in the abundance of forage food.

Off-bank revetments were designed to reduce bank stabilization costs and increase habitat diversity in main channel environments. They differ from standard revetment in that the riprap is placed several meters away from the bank in areas where there is a gradually sloping river bed. The result is the creation of artificial backwaters adjacent to the main channel. Fish movement is allowed through notches in the revetment. Recent fish work suggests that off-bank revetment provides useful and valuable habitat for a large variety of riverine fishes (Atwood 1996).

Currently, there are no off-bank revetments constructed in the MMR. Therefore, these structures are not effecting least terns. Future construction of these structures in the MMR would increase off-channel habitat, therefore, increasing aquatic habitat diversity which would benefit least terns by increasing the abundance of foraging habitat. However, MMR banklines are already extensively revetted, therefore, the need for future revetments is uncertain. In addition, use of this type of revetment would generally be restricted to low velocity and gently sloping areas of the river (Rob Davinroy, USACE, pers. comm.). It is uncertain how this may affect forage food abundance, as small fish abundance has been found to be higher in shallow-water habitats compared to deep-water habitats (Tibbs 1995).

4.3.1.2.3.4 Chevron Dikes

Chevron dikes were designed to divert flow into a portion of the navigation channel impacted by sediment accumulation on the point bar at a river bend where the river channel splits. The dikes divert flow into the main channel by presenting the hydraulic appearance of a solid object without isolating the side channel with a closing structure. Flow between the structures maintains a permanent side channel connection, which provides important off-channel habitat for fishes. Dredge material is placed within chevron dikes, creating sandbar habitat (aquatic and terrestrial). The rock dike substrate provides habitat for epilithic macroinvertebrates that are capable of colonizing in very high densities and providing an important food source for fish. Chevron dikes also create habitat heterogeneity and appear to increase invertebrate abundance and diversity (Ecological Specialists, Inc. 1997b) and provide useful and valuable habitat for a large variety of riverine fishes (Atwood 1997).

No chevrons have been constructed in the MMR. Therefore, these structures are not currently affecting least terns. Any future construction of chevron dikes in the MMR would likely benefit least terns by (1) increasing the abundance of bare sandbar nesting habitat; (2) improving aquatic habitat diversity, thereby, increasing foraging habitat; and (3) increasing the abundance of forage food.

4.3.1.2.3.5 Closing Structures

Closing structures for side channels were constructed to divert flow towards the main channel to maintain sufficient depth for the navigation channel. Thus, these structures have reduced flow into side channels causing the channel to fill with sediment. Recently, low dissolved oxygen and high ammonia levels have been documented in side channels isolated from the river (Bob Hrabik, MoDOC, LTRM Station, pers. comm.). Side channel closing structures also inhibit fish ingress/egress in side channels. Closing structures disrupt natural geomorphic processes by isolating/destroying important side channel and backwater habitat, thereby, reducing riverine productivity (Theiling et. al. 1999). Thus, closing structures reduce the availability of least tern foraging habitat and reduce the abundance of forage food.

4.3.2 Indirect Effects

4.3.2.1 Navigation Related Indirect Effects

4.3.2.1.1 Tow Traffic

There is currently no indication that commercial navigation traffic disturbs least tern nesting or foraging. Tow traffic contributes to the resuspension of bottom sediments in the main channel depending upon water depths. As such, tow traffic may contribute to the transference and homogenization of contaminants in the UMR. As such, least tern reproduction may be adversely affected, however, the extent of this impact is unknown.

4.3.2.1.2 Fleeting

Sandbars are depositional areas and are not conducive to the establishment of fleeting areas. Currently, there are no fleeting areas located near known least tern nesting areas. The establishment of new fleeting areas will require a permit from the Corps and will require individual section 7 consultation to determine if any adverse affects are likely.

4.3.2.1.3 Port Facilities

Development of port facilities requires various levels of habitat modification (USACE 1999c). It is unknown to what degree future development of port facilities may contribute to loss of habitat for least terns.

4.3.2.1.4 Exotic Species

There are no exotic species currently known to be affecting least terns.

4.3.2.1.5 Contaminants

Rostad *et al*. (1995) state that suspended material in the Mississippi River transports the following sparingly soluble synthetic chlorinated pesticides and industrial chemicals: aldrin, chlorthalonil, chlordane, DCPA, DDT, DDE, DDD, dieldrin, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene, lindane, methoxychlor, mirex, pentachloroanisole, pentachlorobenzene, PCB’s and trifluralin. The concentrations of some contaminants, such as PCB’s, have been homogenized in the Mississippi River due to the repeated deposition and resuspension of contaminated silts (Rostad *et al*. 1995).

An analysis of reported oil spills in a portion of the MMR indicates that these types of spills are quite common (from 11/26/98 to 7/26/99 there were 21 spills reported for the area between UMR miles 170.0 to 196.0) (Stan Smith, USFWS, pers. comm.). Most of the spills were small quantities of oil and/or diesel. The potential for such future spills to have direct or chronic effects on least terns is unknown. However, such spills contribute to the accumulation of contaminants in the MMR.

4.3.2.2 Recreation Related Indirect Effects

Unlike the pooled portion of the UMR where the Corps maintains lake-like conditions and recreational facilities that are conducive to boating, no recreation facilities are maintained or planned for the MMR. Recreation activity in the MMR is not affected by maintenance of the 9-Foot Channel Project. Therefore, recreation related indirect effects to least terns are not anticipated.

4.3.3 Interrelated Effects

4.3.3.1 Management of Corps Lands

In 1996, least terns were observed at Riverlands Environmental Demonstration Area (approximate river mile 202.5) for several weeks during the nesting season. Since that time, the Corps has proposed a project under the Avoid and Minimize Program to raise the elevation of sandbar habitat in Ellis Bay to encourage least tern nesting in this area. The project was not funded, however, future construction of such projects may encourage least terns to return to a portion of their historical range.

4.3.3.2 Open River Habitat Enhancement Project

The St. Louis District is in the process of developing the Open River Habitat Enhancement Project to enhance and/or create side channel habitat in the MMR. In addition, the project proposes other activities, such as sandbar creation, riparian corridor restoration and restoring woody debris. Sandbar habitat creation will benefit least terns by increasing the abundance of nesting habitat. Aquatic habitat restoration/enhancement will also benefit least terns by increasing the abundance of foraging habitat and forage food.

While the Corps proposes to utilize some operation and maintenance and construction general funds to implement this program, much of this work is proposed under various cost-sharing mechanisms (e.g., Environmental Management Program, Section 1135 and Section 206). As a result, the Corps cannot guarantee how much of this program will be implemented, therefore, the amount of habitat that will be restored or enhanced is unknown at this time.

4.3.4 Interdependent Effects

4.3.4.1 Missouri River Bank Stabilization and Navigation Project

The Missouri River Bank Stabilization and Navigation Project (Missouri River Project) has restricted the Missouri River to a serpentine, self-cleaning navigation channel characterized by high water velocities. This has been accomplished through the use of wingdams and revetments which confine the river. Before the Missouri River was channelized and impounded, it annually eroded 3.1 hectares/km of its floodplain (USACE 1981). Most of this erosion has stopped due to channelization and impoundment. Erosion was a natural function of the river system, and through erosion, inorganic sediments, organic matter, and large woody debris were introduced into the river. This material import was essential to the habitat dynamics and nutrient cycling of the river system. Such sediment and nutrient discharge are the raw materials for habitat development in the Missouri and Mississippi River systems. By reducing erosion in the Missouri River, and thereby, reducing suspended sediment load, the Missouri River Project continues to reduce the abundance of sandbar habitat in the MMR, thus reducing nesting habitat for least terns.

4.3.4.2 USCG Buoy Tending

USCG buoy tending activities are not known to affect least terns.

4.3.5 Cumulative Effects

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation under section 7 of the Act.

The Service is unaware of any future State, tribal, local or private actions that are reasonably certain to occur in the action area that may affect least terns.

4.3.6 Summary of Effects

Operation and maintenance of the 9-Foot Channel Project will continue to arrest some of the natural processes that provide dynamic physical change in the UMR, including the MMR. The dynamic equilibrium of the MMR has been interrupted and replaced by unstable processes that have continuing, ongoing effects. The result will be continued homogenization of the river system, degradation of aquatic habitat and loss of terrestrial habitat diversity through succession.

The loss of dynamic physical change has and will continue to affect the availability of least tern nesting habitat. This is a result of the loss of channel meandering and reduced suspended sediment loads that would create new sandbars and the conversion of existing sandbar habitat to woody vegetation. The loss and degradation of aquatic habitat reduces the availability of least tern foraging habitat. A number of operation and maintenance activities work in combination to reduce nutrient cycling and primary productivity in the

MMR. This affects the abundance of least tern forage food. Operation and maintenance activities also contribute to the transference and homogenization of contaminants in the UMR, which may impair least tern reproduction. An indirect effect of operation and maintenance is increasing the accessibility of predators to least tern nesting colonies.

Channelization, irrigation and impoundment have contributed to the elimination of much of the least tern's sandbar nesting habitat (Funk and Robinson 1974, Hallberg *et al*. 1979. Sandheinrich and Atchinson 1986). However, the population remains widespread, occupying available, though not necessarily optimal, habitat. Continued operation and maintenance of the 9-Foot Channel Project over the next 50 years will result in continued habitat loss and degradation and continued disruption and alteration of natural river processes that create habitat over time. As a result, least tern nesting and foraging habitat will continue to decline in the MMR. The result will be declines in least tern population numbers in the MMR.

4.4 Conclusion

After reviewing the current status of the interior least tern, the environmental baseline for the action area, the effects of continued operation and maintenance of the 9-Foot Channel Project and the cumulative effects, it is the Service's biological opinion that the continued operation and maintenance of the 9-Foot Channel Project, as proposed, is not likely to jeopardize the continued existence of the interior least tern. No critical habitat has been designated for this species, therefore, none will be affected.

The proposed action will continue to cause a decline in habitat availability and least tern numbers in the MMR will likely decline as a result. However, the MMR represents a small percentage of the least tern's total range. Thus, even if the MMR population was decimated by the proposed action, such an event would not appreciably reduce the likelihood of survival and recovery of the least tern rangewide.

4.5 Incidental Take Statement

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered prohibited taking under the Act provided that such taking in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any contract, grant, or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms or conditions or (2) fails to require contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the contract, permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the interior least tern to the Service as specified in this incidental take statement. [50 CFR §402.14(i)(3)]

While the overall effect of new construction projects (e.g., bendway weirs, wingdams) are considered programmatically in this incidental take statement, it is not possible to determine the site-specific effects of these actions at this time. Therefore, all new construction projects will require a Tier II level of review to determine if formal section 7 consultation is necessary. A biological assessment that incorporates measures to further minimize incidental take and that contains pre-project physical and biological data, an analysis of predicted post-project effects and monitoring of post-project physical and biological effects will be developed and provided to the Service for review.

4.5.1 Amount or Extent of Take

The Service anticipates that 0.2 acres/mile/year of sandbar nesting habitat and 0.8 acres/mile/year of side channel foraging habitat could be taken as a result of continued operation and maintenance of the 9-Foot Channel Project. This incidental take is expected to be in the form of harm which is defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns including breeding, feeding or sheltering.

There is currently no data available for trends in sandbar habitat loss for the MMR. The best available information concerning sandbar trends in the Mississippi River has been developed for the LMR (USACE 1999a). Bare sandbar habitat acreage occurring above the LWRP (potentially available for least tern nesting) has varied from the 1960's to the 1990's as a result of many factors. These include sediment accumulation between wingdams, accretion of sandbars and conversion to woody habitat and degradation of the low water channel. A comparison of bare sandbar habitat occurring above the LWRP in 1963 (108,660 acres) and in 1994 (105,797 acres) was used to determine the likely trends in available sandbar habitat over the 50 year project life. Based on this data, bare sandbar habitat in the LMR, between river miles 315 and 954, has declined by 2,863 acres from 1963 to 1994. This equates to 0.14 acres/mile/year of bare sandbar habitat loss. Therefore, the 0.2 acres/mile/year is a conservative estimate of anticipated incidental take of least tern nesting habitat in the MMR. Recent studies by Theiling *et al*. (1999) indicate that side channel habitat is being lost at a rate of 0.8 acres/mile/year (1975-1994). The anticipated incidental take of least tern foraging habitat is based upon this trend in aquatic habitat loss in the MMR.

4.5.2 Effect of the Take

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

4.5.3 Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of least terns:

1. Channel training structure maintenance projects will incorporate modifications to maintain flow between sandbars and the adjacent shoreline and to reduce conversion of bare sandbar habitat to woody vegetation.

2. Evaluate dredge material disposal techniques in the MMR to examine opportunities and develop recommendations for restoring/enhancing sandbar habitat and aquatic habitat. Implement the recommendations where feasible and appropriate.

3. Utilize existing authorities to reduce the accretion of existing and/or newly established sandbars to the bankline and to reduce woody vegetation colonization.

4.5.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. At the beginning of each fiscal year, the Corps will provide the Service a list of new construction projects for which Tier II evaluations are anticipated.

2. Channel training structure maintenance projects will be submitted to the Service for a 30 day review period. Service recommendations for least tern nesting/foraging habitat improvement will be incorporated into project plans where feasible and appropriate.

3. Monitoring will be conducted to measure sandbar habitat trends in the MMR. This may be accomplished utilizing habitat mapping and spatial and hydrologic analyses similar to those utilized for the LMR. The monitoring plan must be approved by the Service.

4. Dredging and disposal activities will continue to be coordinated with the Service, Illinois Department of Natural Resources and Missouri Department of Conservation.

5. An annual dredge material management report will be provided to the Service at the end of each dredging season. The report will include information concerning

dredging/disposal locations, quantities of material, the results of sediment size analysis and methods of disposal.

6. An annual report will be provided to the Service which details actions taken regarding implementation of the reasonable and prudent measures.

4.5.5 Closing Paragraph

The Service believes that no more than 10.0 acres/mile (0.2 acres/mile/year X 50 years) of bare sandbar habitat and no more than 40 acres/mile (0.8 acres/mile/year X 50 years) of side channel habitat will be incidentally taken as a result of continued operation and maintenance of the 9-Foot Channel Project. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the ongoing effects of continued operation and maintenance activities. If, during the course of continued operation and maintenance of the 9-Foot Channel Project, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

4.6 Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. Utilize existing authorities and programs to restore/enhance sandbar habitat at all elevations.

2. Develop and implement an education program that publicizes information about the interior least tern, including its life history, reasons for current status and options for recovery.

3. Conduct a Geographical Information System analysis to determine locations in the MMR where lack of sufficient bare sandbar habitat and/or foraging habitat may be limiting or restricting least tern nesting.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

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5.0 Higgins' Eye Pearlymussel

5.1 Status of the Species

The Higgins' eye pearlymussel (*Lampsilis higginsi*) was listed as an endangered species by the Service on June 14, 1976 (Federal Register, 41 FR 24064). The major reasons for the listing of Higgins' eye was the decrease in both the abundance and range of the species. As stated in the original recovery plan [U.S. Fish and Wildlife Service (USFWS) 1983], Higgins' eye was never abundant and Coker (1919) indicated it was becoming increasingly rare around the turn of the century. The fact that there were few records of live specimens from the early 1900s until the enactment of the Endangered Species Act in 1973 was a major factor in its listing in 1976 (Hornbach 1999). A variety of factors have been listed as affecting Higgins' eye over time including commercial harvest, impoundment from the project, channel maintenance dredging and disposal activities, changes in water quality from municipal, industrial and agricultural sources, unavailability of appropriate glochidial hosts, exotic species and disease (USFWS 1983).

The historical distribution of Higgins' eye is not known with certainty. Although nowhere abundant, it is believed to have been widely distributed, inhabiting the UMR from just north of St. Louis, Missouri, to Minneapolis-St. Paul, Minnesota (Coker 1919). It was also found along the mainstem of the UMR and several of its tributaries including the Ohio, Illinois, Sangamon, Iowa, Cedar, Wapsipinicon, Rock, Wisconsin, Black, Minnesota, and St. Croix Rivers (USFWS 1983). The range of Higgins' eye has been reduced approximately 50 percent from its historic distribution to a 302-mile (485.9 km) reach of the UMR (Havlik 1980, Havlik 1987) and is now found only in the UMR upstream of Lock and Dam 19 at Keokuk, Iowa, in the St. Croix River between Wisconsin and Minnesota, the Wisconsin River, Wisconsin, and in the lower Rock River in Illinois (USFWS 1983). The southern-most population is believed to be pool 19 at River Mile 407 (Cawley 1984).

Higgins' eye occurs most frequently in medium to large rivers with current velocities of 0.49

to 1.51 ft/sec and in depths of 3.3 to 19.7 ft. It appears to prefer water with dissolved oxygen greater than 5 ppm and calcium carbonate levels greater than 50 ppm. The species is significantly correlated with a firm, coarse sand substrate (Hornbach *et al.* 1995a). Higgins' eye are usually found in large, stable mussel beds with relative high species and age diversity. Hornbach *et al.* (1995a) conclude Higgins' eye seems to be associated with areas of higher mussel species richness and generally higher mussel population densities.

The reproductive cycle of Higgins' eye is typical of the family Unionidae (Cummings and Mayer 1992). Males discharge sperm to the surrounding water; females obtain the sperm as they siphon water for food and respiration. Eggs are fertilized in gill sacs (marsupia) in the female; fertilized eggs are retained in the marsupia until they mature into glochidia and are released. The mantle edge near Higgins' eye's posterior end resembles a small swimming fish that attracts predator fish. Gill tissue containing glochidia protrudes between the mantle flaps. When the gill tissue is attacked by a fish, glochidia are released, thus enhancing the probability that glochidia will come into contact with a host fish. Released glochidia attach themselves to the gills of host fish. Successfully attached glochidia mature and excyst from hosts' gills as juvenile mussels; they settle to the substrate and become sedentary in the substrate, if it is suitable. The species is bradytictic (*i.e.*, a long-term breeder) retaining developing glochidia throughout the year, except for the period following glochidia release. Baker (1928) and Holland-Bartels and Waller (1988) indicate glochidia are carried in the gill marsupia through winter and released the following spring or summer.

Holland-Bartels and Waller (1988) tested 15 species of UMR fish and reported walleye (*Stizostedion vitreum*) and largemouth bass (*Micropterus salmoides*) as the most successful glochidia host fish for Higgins' eye, as determined by glochidial persistence and maturation to juvenile stage in the fish. Their study did not investigate sauger (*Stizostedion canadense*) nor smallmouth bass (*Micropterus dolomieui*). Waller (1995) considers these species also likely host fish in the UMR, particularly the sauger, whose range overlaps with Higgins' eye's more than smallmouth bass.

The Higgins' Eye Pearlymussel Recovery Team designated seven "Essential Habitat Areas" for Higgins' eye (USFWS 1983). The Essential Habitat Areas are believed to contain viable reproducing Higgins' eye populations. The Team believed recovery of the species could not be accomplished without maintaining the Essential Habitat Area populations. The seven Essential Habitat Areas are (1) the St. Croix River at Hudson, Wisconsin (River Mile 16.2 - 17.6); (2) the UMR at Whiskey Rock, at Ferryville, Wisconsin, Pool 9 (River Mile 655.8 - 658.4); (3) the UMR at Harpers Slough, Pool 10 (River Mile 639.0 - 641.4); (4) the UMR Main and East Channel at Prairie du Chien, Wisconsin, and Marquette, Iowa, Pool 10 (River Mile 633.4 - 637); (5) the UMR at McMillan Island, Pool 10 (River Mile 616.4 - 619.1); (6) the UMR at Cordova, Illinois, Pool 14 (River Mile 503.0 - 505.5); and (7) the UMR at Sylvan Slough, Quad Cities, Illinois, Pool 15 (River Mile 485.5 - 486.0). Three additional Essential Habitat Areas have been proposed by the Higgins’ Eye Pearlymussel Recovery Team; the St. Croix River at Prescott, Wisconsin, and near Taylors Falls, Minnesota (Interstate Park), and the Wisconsin River near Muscoda, Wisconsin (Orion mussel assemblage) (Hornbach1999).

A recent threat to Higgins' eye comes from zebra mussels (*Dreissena polymorpha*), freshwater mussels native to the Black and Caspian Seas. Zebra mussels were introduced into Lake Erie in the late 1980s from ship ballast water discharge (Benson and Boydstun 1995). The species is now reproducing and invading North America's lakes and rivers, including the UMR.

5.2 Environmental Baseline

The environmental baseline is an analysis of effects of past and ongoing natural and human factors, excluding the proposed project, pertinent to the current status of the species and its habitat. The UMR and tributaries are the only remaining habitat for Higgins' eye; it is found only in the UMR upstream of Lock and Dam 19 at Keokuk, Iowa, in the St. Croix River between Wisconsin and Minnesota, the Wisconsin River, Wisconsin, and in the lower Rock River in Illinois (USFWS 1983). The southern-most population is believed to be pool 19 at River Mile 407 (Cawley 1984). Nearly all of the remaining habitat for Higgins' eye is within the 9-Foot Channel Project.

In the mainstem of the UMR, approximately 50 species of freshwater mussels have been recorded over time, although only 30 species are found at present [U.S. Geological Survey (USGS) 1999]. Natural processes and features that made the UMR valuable mussel habitat in general include moderate to high flow currents, stable substrates, the presence of aquatic vegetation and relatively high water quality. Water quality has generally improved in recent times in many navigation pools due in part to improved waste water and stormwater treatment, and improved agricultural land treatment and erosion control measures.

The environmental baseline for this Biological Opinion includes the time period from construction of the 9-Foot Channel Project to the present. It includes impacts to Higgins' eye from construction of the original project and approximately 60 years of operation and maintenance activities which, except for maintenance dredging and disposal activities, have not substantially changed during this period. As will be discussed in Section 5.2.2.3, Modern Dredging and Disposal Activities, maintenance dredging and disposal practices have substantially changed since the mid 1970's to avoid and minimize environmental impacts. The environmental baseline also includes effects of the exotic zebra mussel on Higgins' eye which has become established in the project area since approximately 1991 (Refer to Section 5.2.5, Exotic Species). The following parameters are addressed in the environmental baseline.

5.2.1 Water Level Regulation and Impoundment

The impoundment of the UMR increased the area of benthic habitat for freshwater mussels, and changed the character of the original floodplain. However, it is unclear how impoundment of the UMR affected Higgins' eye. Archeological (Theler 1987) and historical (Ellis 1936, Coker 1919) pre-dam mussel studies in Pool 10 suggest the relative abundance of Higgins' eye may have been higher after construction of the navigation project (Thiel 1981, Duncan and Thiel 1983, Wilcox *et al.* 1993). This may in part be attributable to increased abundance/availability of host fish and stable water conditions associated with the navigation project. Baker and Hornbach (1997) associated Higgins' eye with areas of low velocity (<0.3 m/s), but not areas with no flow. Post-lock and dam (post-impoundment) conditions probably contained more area of low velocity habitat that Higgins' eye preferred. However, there are also observations which indicate fewer species of mussels were found after the project was constructed compared to pre-project conditions; also, it is difficult to determine a direct link between the distribution and abundance of Higgins' eye due to habitat alteration since it apparently has always been a relatively minor component of the mussel community (Hornbach 1999).

Impoundment accelerated sedimentation rates throughout the UMR, especially in overbank and backwater areas. Since substrate type and stability is important to most freshwater mussel species, high sedimentation rates or changes in substrate composition likely impacted mussels in these areas.

Several fish species have been identified as suitable hosts for Higgins' eye glochidia, including walleye and largemouth bass (Waller and Holland-Bartels 1988). Although fish movement was restricted by the locks and dams, the abundance of these host fish increased upon completion of the project (Fremling and Claflin 1984).

Wilcox *et al.* (1998) examined various factors to determine the likelihood a particular fish species could pass through the locks and dams of the UMR, such as hydraulic conditions, dam design, migration behavior, and seasonal timing. They found two UMR dams which completely restricted upstream fish movement: Lock and Dam 1 in St. Paul, Minnesota, and Lock and Dam 19 in Keokuk, Iowa. The exchange of gene flow within a mussel species may be inhibited by restricted inter- and intra-pool movements of fish serving as the glochidial host (Romano *et al.* 1991); however, there are no supporting data for Higgins' eye. Also, restriction of fish movement may limit or prevent the dispersal of parasitic mussel glochidia; likewise there are no supporting data for Higgins' eye. However, Coker (1930) discussed the historical movement of skipjack herring (*Alosa chrysochloris*), blue sucker (*Cycleptus elongatus*), and blue catfish (*Ictalurus furcatus*) where these species moved upstream in the spring, followed by downstream migrations to overwinter in warmer waters. The extirpation of the ebony shell (*Fusconaia ebena*) and the elephant ear (*Elliptio crassidens*) in the upstream portion of the UMR was attributed to the inability of the mussels' host fish, skipjack herring, to navigate past lock and dam 19 (Fuller 1980).

As stated previously, there are no data which quantify the abundance of Higgins' eye on the UMR pre- and post project. It is therefore questionable whether impoundment had positive or negative effects on Higgins' eye; there simply are no conclusive data. However, we do know that impoundment of the UMR created more lentic (lake-like) habitat, favoring conditions for certain aquatic species. Lentic habitat also proved favorable to the proliferation of the exotic zebra mussel (Refer to Section 5.2.5, Exotic Species).

5.2.2 Channel Maintenance

5.2.2.1 Dredging

Following impoundment by the locks and dams, periodic dredging was necessary to maintain the 9-Foot Channel Project. Maintenance dredging primarily affected the main channel of the river. However, dredging may have also affected side channels, sloughs and backwater lakes and ponds through increased suspended sediment levels during dredging events.

Channel maintenance dredging was normally conducted in areas of shifting/shoaling bedload; any mussels within the dredge cut were killed by either the dredging operation or from placement of dredged materials at the disposal site. Mussel shells are often found at historic disposal sites. Bottom substrates in dredge cuts were often unstable or shifting for some time following dredging and thus provided poor habitat for recolonization by mussels (Burky 1983); consequently, frequent dredging of these cuts for maintenance of the project likely had little effect on freshwater mussels.

However, if maintenance dredging did not occur frequently (every 5 to 10 years), recolonization of dredge cuts by native freshwater mussels was possible. Miller and Payne (1992) collected Higgins' eye from a location in the East Channel of the UMR at Prairie du Chien, Wisconsin, which had been dredged 8 years earlier, indicating some recolonization of dredge cut areas does occur. Eckblad (1999) reported nearly half of 38 historic dredge cuts studied contained 14 mussel species within 5 years. Fuller (1980) reported a live Higgins' eye in the mussel community located at Hudson, Wisconsin, in the St. Croix River adjacent to a frequently dredged channel. Mussels which recolonized historic dredge cuts were likely killed through the dredging/disposal process.

Suspended solids and sedimentation from dredging operations may cause clogging and abrasion of gills and other respiratory surfaces in mussels, however there are no data documenting this for Higgins' eye. Miller and Payne (1998) found that mussels tolerated discrete disturbances (*i.e.*, commercial vessel passage, dredging, and extreme high water), but no determination of the long-term effects to mussels could be made from a data set spanning approximately 10 years. Since contaminants have an affinity for smaller-sized particles, not the coarse-grained material of most dredge cuts, maintenance dredging activities in the main channel likely had only minor impacts on contaminant movement in these areas.

5.2.2.2 Disposal of Dredged Material

As previously stated, there are no data quantifying the impacts of the 9-Foot Channel Project on freshwater mussels in general and Higgins' eye in particular. However, some inference to possible impacts from channel maintenance activities can be made. Historic dredged material placement sites were either upland or aquatic habitats located adjacent to the main navigation channel. Dredging was conducted using hydraulic or mechanical equipment. In early years, it was routine practice by the Corps of Engineers to dispose of dredged material as close to the dredge as possible, often filling aquatic habitats (in-water disposal) adjacent to the main channel. Permanent in-water disposal also included thalweg disposal, placing dredged material in the deeper water area of the main channel where it could be assimilated into the river's natural sediment transport system. Mussels located within in-water disposal sites were presumed killed by burial due to the large quantities of material involved.

Current placement of dredged material focuses on using historic disposal sites, temporary transfer sites, and upland sites. Use of upland disposal sites likely had only minor effects on freshwater mussels, including Higgins' eye from activities such as equipment access to the site, and subsequent wind and water erosion of dredged materials into the river. Hydraulic placement of dredged material on upland sites normally required a settling basin from which effluent was discharged to the river. The quality of this effluent depended on the composition of the sediment dredged, including contaminants.

5.2.2.3 Modern Dredging and Disposal Activities

Since the mid 1970's, there have been many improvements in channel maintenance dredging and disposal activities in the St. Paul, Rock Island and St. Louis Corps Districts. The majority of these improvements came as a result of the interagency Great River Environmental Action Team (GREAT) studies. Channel maintenance activities are now routinely coordinated with the Service and State natural resource agencies with the objective of avoiding/minimizing riverine habitat impacts which often occurred in the past. An example of this interagency planning and coordination effort is the recent completion of the Channel Maintenance Management Plan (CMMP) in the St. Paul District which addresses dredging and disposal activities (Corps 1996). Today, channel maintenance activities associated with the 9-Foot Channel Project are routinely coordinated with such interagency groups as the On-Site Inspection Teams, River Resources Forum and River Resources Coordinating Team to avoid/minimize project impacts to fish and wildlife resources of the UMR, including freshwater mussels.

Of the 10 existing/proposed Essential Habitat Areas, only the Harper's Slough and Prairie du Chien Essential Habitat Areas are located within the 9-foot navigation channel. Historically, channel maintenance dredging has not occurred and is not proposed at the Harper's Slough area.

The Prairie du Chien Essential Habitat Area includes both the main navigation channel and the East Channel. Historically, channel maintenance dredging has not occurred and is not proposed in the main navigation channel. However, the St. Paul District is responsible for commercial navigation in the East Channel which is approximately 18,480 feet long and passes by the City of Prairie du Chien, Wisconsin. The Corps of Engineers proposed a 449-foot dredge cut (2,500 cubic yards, Dredge Cut 1) at the north end of the channel, and a 351-foot dredge cut (1,900 cubic yards, Dredge Cut 2) at the City Dock to maintain commercial navigation; frequency of dredging for Cuts 1 and 2 were once in forty years and twice in forty years, respectively. A Biological

Opinion was prepared for this activity on June 28, 1993, concluding jeopardy for Higgins' eye (FWS 1993). The project has since been deferred by the St. Paul District (Corps 1996).

5.2.2.4 Channel Control Structures

Thousands of channel control structures (wing dams, closing dams, shoreline protection) were constructed on the UMR as part of the 4.5 and 6-Foot Channel Projects (USGS 1999); new or rehabilitated structures have also been constructed as part of the 9-Foot Channel Project. Channel control structures were constructed by the Corps of Engineers to maintain the channel alignment or constrict flows to improve the sediment transport efficiency through a reach of the river (Corps 1996). As such, channel control structures reduce maintenance dredging by concentrating flows in the main channel to scour (deepen) it for navigation. Construction of channel control structures likely covered benthic habitat and buried mussels.

Wing dams were constructed/rehabilitated in main channel and channel border habitats, areas which may have contained Higgins' eye. Wing dams increased current velocities and thereby increased scouring of main channel areas near the wing dams, producing the desired increased channel depths and/or widths for commercial navigation.

Closing dams were constructed to reduce flows into side-channel areas and force flows to the main channel. In addition to burial impacts from the footprint of these projects, impacts such as reduced volume of flow, reduced current velocities, reduced sediment input, and increased water residence time in backwaters probably occurred in the closed side channels and affected mussels. The increased flows in the main channel resulting from side channel closure affects main channel and channel border habitats as well. Resulting impacts to mussels depended on the amount of change in the rates of sedimentation and erosion.

Sedimentation patterns changed in these areas, with sediment transported through wing dam fields to downstream areas of lower velocity likely burying freshwater mussels located in these areas. However, since areas of velocity change attract fish species, high mussel densities were subsequently found on or in the vicinity of wing dams near suitable substrate; Higgins's eye mussels have been collected between and on wingdams in Pools 7 and 10 of the UMR. Placement of riprap for bank stabilization also attracted host fish and some of these areas were also likely to have rich mussel assemblages.

In summary, while construction of channel control structures and subsequent changes to sedimentation and erosion rates likely adversely affected some freshwater mussels, wing dams, closing dams and other rock structures also provided habitat for fish (some of which were hosts for glochidia) and freshwater mussels, including Higgins' eye.

5.2.3 Commercial Navigation

Commercial navigation resulting from the 9-Foot Channel Project affected mussels by increasing suspended solids through propeller wash over a mussel bed, by striking or dislodging mussels from the sediment by propeller wash, or by burying or crushing mussels during barge groundings or fleeting in shallow water conditions. In a study in lower pool 10, Miller and Payne (1997, 1998) found no significant difference in shell morphometrics of common to abundant species in areas where barge passage occurred and in two nearby reference sites where barges did not pass. However, at this same location mussel densities ranged from 6.36-13.85 mussels/ft^2 in the reference area, while mussels in the turning basin ranged from 2.04-4.52 mussels/ft^2 (Miller and Payne 1992). Miller and Payne (1996) and Miller and Payne (1998) reported velocity change from barge passage did not damage benthic organisms or their habitat in reasonably straight reaches having more than 2 feet of water below the vessels.

Substantial erosion can result from propeller wash as tows negotiate tight turns in the channel, enter and exit lock chambers, and while awaiting lockage along shorelines. These areas may have been subjected to severe propeller wash creating an environment too hostile for mussel colonization. Barges sometimes ground for a number of reasons including running into unknown shoals in the navigation channel, operating outside of the navigation channel in shallow water, or by being loaded past the nine-foot draft. Barge grounding in newly formed shoals is unlikely to impact mussels because the new, unstable substrate is unlikely to be colonized by mussels. Substantial local mussel damage is likely if a barge grounded on an off-channel mussel bed. Mussels, including Higgins' eye, would be buried, crushed, and/or scoured by propeller wash and the weight of the barge(s).

There are approximately 120 commercial port facilities in the range of Higgins' eye (UMR upstream of lock and dam 19; Minnesota River; Black River; and St. Croix River). Port facilities likely impacted native mussels through habitat loss during construction or subsequent maintenance of facilities.

Spills of contaminants and cargo from commercial tows may have impacted Higgins' eye and other freshwater mussels by direct mortality and by chronic effects. Benthic organisms are sensitive to a wide range of contaminants including ammonium, pesticides, and petroleum products, all of which are commonly transported on the UMR. Weirs, locks and dams, and mooring sites made navigation safer on the UMR and have reduced the potential for hazardous spills, but accidents and spills have occurred on the UMR. To date, there are no data which conclude that these spills had an adverse impact on Higgins' eye populations.

5.2.4 Recreation

Some recreational facilities likely degraded habitat for freshwater mussels. Construction activities, such as sand fill for beach or swimming areas, placement of fill or dredging to create marinas/harbors, or riprap for shoreline protection likely covered or otherwise permanently changed mussel habitat. Large recreational boats also likely impacted mussels by inducing abortion, by physically damaging mussels, or by other factors similar to those noted for commercial navigation. Swimmers have been observed collecting mussels at some beach sites; indiscriminate collections may have included Higgins' eye at some locations.

5.2.5 Exotic Species

Of major concern to the well being of mussels in general, and Higgins' eye in particular, was the introduction of zebra mussels to the UMR. Zebra mussels have been found throughout the UMR and have the potential to kill or otherwise eliminate native mussels, including Higgins' eye.

Adult zebra mussels attach to natural substrates, such as rocks, native mussels, wood, aquatic plants, and other zebra mussels. They also attach to man-made materials, such as fiberglass, iron, plastic, and concrete [U.S. Army Corps of Engineers (Corps) 1992]. Male zebra mussels release sperm directly to the water to fertilize eggs released to the water by the females. Large females release up to one million eggs per season (Corps 1992). Eggs are released when water temperatures reach 52-54^{o} F. Immature zebra mussels (veligers) spread via passive drift on water currents. Adults and veligers attach to boat hulls, or to wet compartments, containers, and equipment in boats.

Zebra mussels affect other mussels by competing for food and by attaching to mussels in such numbers that infested mussels cannot travel or burrow. When infested by approximately 100 or more zebra mussels, native mussels cannot open their shells to respire, feed, burrow, or move, nor can they close their shells for protection. Zebra mussels can build up on native mussels in such numbers that waves and currents can dislodge native mussels from the substrate. Recent observations suggest infested native mussels may remove themselves from the substrate to escape zebra mussels (Miller 1995). Any of these impacts or combination of impacts can lead to the death of the infested mussel. Commercial and recreational boats are the main vectors carrying this species upstream and between water bodies, while currents carry veligers and juveniles downstream for further dispersal.

Zebra mussels attach themselves by byssal threads to nearly any hard surface. Zebra mussels reach a maximum length of about two inches, and hundreds of thousands can colonize a square meter. Up to 10,000 zebra mussels have been counted on a single mussel (Corps 1992). In Michigan's Lakes Erie and St. Clair, where zebra mussels have existed for several years, native mussel populations have been devastated, and in some areas eradicated (Masteller and Schloesser 1991, Gillis and Mackie 1991). Gillis and Mackie (1991) found a positive correlation between large increases in the average number of zebra mussels attached to native mussel shells and a decline in live native mussel numbers in Lake St. Clair. They also found that approximately 2,000 zebra mussels on a native mussel occluded the native mussel's siphon region completely, affecting its ability to filter. Colonization rates of approximately 0.4 to 1.0 g of zebra mussels per g of native mussel (dry mass) were recorded in native mussels immediately before extirpation from the Canadian side of the Detroit River (Ohnesorg *et al.* 1993).

Zebra mussels may have greater impact on some native mussel species than others although this is not conclusive. Haag *et al.* (1993), in a test of six species, found species in the Anodontinae subfamily to be the most sensitive to zebra mussels, followed by Lampsilinae and Ambleminae. Higgins' eye is a member of the subfamily Lampsilinae. Hunter *et al.* (1997 and references within) also found some species to be more sensitive to infestation than others. Giant floater (*Anodonta grandis*) was the most sensitive, followed by fragile papershell (*Leptodea fragilis*), fatmucket (*Lampsilis siliquoidea*), pink heelsplitter (*Potamilus alatus*), and black sandshell (*Ligumia recta*). Zebra mussel data collected by the Corps of Engineers at the Prairie du Chien Essential Habitat Area did not find a similar trend in sensitivity to zebra mussel infestation among species (Whiting 2000).

Zebra mussels were first discovered in Lake St. Clair in 1988 and in all the Great Lakes in 1989. They were found in the Chicago Sanitary and Ship Canal in 1989 and in the main stem of the Illinois river in 1991. The first zebra mussel collected from the UMR was taken in 1991, south of La Crosse, Wisconsin (Corps 1999). Miller (1995) sampled mussels of the lower East Channel at Prairie du Chien, Wisconsin. He found a maximum density of 14,000 zebra mussels/m^2 affecting up to 100 percent of the native mussels in some of his samples. He found the 1995 level of zebra mussels to be an order of magnitude greater than 1994 levels. An animated map of the spread of zebra mussels on the UMR produced by the U.S. Geological Survey (USGS) can be viewed on the Internet at www.nationalatlas.gov/zmussels1.html.

Unlike the Illinois River (via Lake Michigan and the Chicago Sanitary and Ship Canal), the UMR did not have an upriver source of veligers to spread downriver with the currents. Based on the zebra mussel's current distribution within the UMR, it appears tow traffic is the main transportation vector of upstream spread in the UMR upstream of the Illinois River (Carlton 1993, Keevin *et al.* 1992), while river currents are responsible for its downstream spread from the UMR/Illinois River confluence. With a less abundant upriver source, UMR zebra mussel populations grew at a slower pace than those in the Illinois River. Despite slower population growth rate, recent reports from Lake Pepin (Pool 4) and Pools 8-10 indicate high adult zebra mussel numbers and densities (>20,000/m^2) (Corps 1999, p. 71). Studies conducted by Minnesota and Wisconsin resource agencies since 1996 indicate Lake Pepin is the likely source population for the increasing zebra mussels in Pools 7 and 8 (Corps 1999, p. 71). Lake Pepin may be a substantial and long-term source of zebra mussels to the downstream UMR. Cope *et al.* (1997) found zebra mussel densities higher in the UMR downstream of Lake Pepin compared to densities upstream of Lake Pepin.

Based on current zebra mussel densities at dewatered lock chambers, it is likely that they harbor reproducing zebra mussels. Yager *et al.* (1994) estimated zebra mussel densities in lock chambers up to 68.4/m^2. Recent examination of Lock and Dam 5A revealed a much higher present density than was found in Yager *et al*'s earlier examination (Corps 1999, p. 72). Yager *et al*. (1999) report zebra mussel densities exceeding 7,000/m^2 at locks and dams downstream of Lake Pepin.

Hornbach *et al.* (1995b) stated the recent invasion of the UMR and probable future invasion of the St. Croix River with zebra mussels has cast the survival of Higgins' eye in doubt. With the continuing expansion of the zebra mussel and the limited locations of Higgins' eye populations, it is clear that Higgins' eye is under threat from the zebra mussel. Recent information from the East Channel Essential Habitat Area at Prairie du Chien, Wisconsin, supports this conclusion; the following discussion on zebra mussel impacts is from Corps unpublished 1999 data. Quantitative and qualitative samples for freshwater bivalves have been collected in the East Channel Essential Habitat Area of the UMR by personnel of the U.S. Army Engineer Waterways Experiment Station since 1984 (Table 1; Miller and Payne 1993). Samples have been collected at multiple sites where the river splits into an east and main channel near river mile 635. However, only data from a reference site, located downriver and away from a barge turning basin in the north section of the east channel, are presented in Table 1. These data provide a baseline for native mussel densities and recruitment rates prior to introduction and spread of zebra mussels. In addition, the data set illustrates effects of introduction and spread of zebra mussels on the native fauna.

All samples for mussels were collected by divers equipped with surface supplied air. Quantitative samples were obtained by having a diver excavate all substratum, which consisted of shells, live mussels, sand and gravel, from the confines of a 0.25 sq m aluminum quadrant. Substratum was washed through screens, live bivalves were removed, identified, and total shell length (SL) measured with digital calipers. From 10 to 60 quadrant were processed in any year. Qualitative samples were obtained by either having divers search an area for a specific period of time (15-30 min), or until a certain number of mussels were obtained. All searching was done by feel since visibility is extremely low.

Table 1 contains a measure of recent recruitment, as indicated by both the percentage of individual mussels less than 30 mm total SL, and the percentage of species with at least one individual less than 30 mm SL. Mussels less than 30 mm total shell length are typically 1-3years old; therefore a mussel in this size range could be evidence of recruitment that took place several years previously. In addition, Table 1 contains data on zebra mussel and native mussel density; the former were first collected in quantitative samples in 1993. Zebra mussel density increased to over 10,000 individuals/sq m in 1996. In 1998 density had dropped to approximately 1700 individuals/sq m and consisted mainly of older individuals and there were few new recruits in the population. In 1999, zebra mussel density increased to 56,507 individuals/sq m; it was observed that the older cohort present in 1998 had recruited and many juvenile zebra mussels were present. The substratum was virtually covered with a thick mat (up to 10 cm thick) of dead and living zebra mussels.

Table 1. Summary Data on Evidence of Recent Recruitment (Percent Individuals and Species Less than 30 mm Total Shell Length) and Unionid and Zebra Mussel Density in the East Channel of the Upper Mississippi River. Information from Corps 1999 unpublished data.					
Year	No. of Quadrants	Unionid Recruitment		Mean Density Individuals/sq m	
		% Ind. < 30mm	% Species < 30mm	Unionids	Zebra Mussels
1984	20	10.7	45.8	113.6	
1985	30	15.2	66.7	149.1	
1987	30	34.4	75.0	68.5	
1988	30	24.5	52.0	79.5	
1989	10	16.3	44.4	83.6	
1990	30	14.8	42.1	80.0	
1992	30	17.6	36.8	44.7	
1993	30	41.5	44.4	28.3	2.0
1994	40	20.7	52.0	63.4	36.5
1996	60	32.4	66.7	59.2	10,853.0
1998	60	25.8	45.0	10.1	1,762.0
1999	60	0.0	0.0	1.7	56,507.0

For the first 10 years (from 1984 to 1994), evidence of recent recruitment for native mussels was highly variable and obviously unaffected by zebra mussels. For example, the percentage of live unionids less than 30 mm total shell length during this period varied from 10.7 percent in 1984 to a maximum of 41.5 percent in 1993. The percentage of species showing at least some evidence of recent recruitment ranged from a low of 36.8 percent in 1992 to a high of 75 percent in 1987. In 1996, when zebra mussel density was at its maximum, there were still juvenile native mussels present. However, the percentage of recent native mussel recruits, both species and individuals, dropped to 0.0 in 1999. This was certainly the result of the high zebra mussel densities in 1996 and 1997 that virtually eliminated recruitment of native species.

Mean density of all unionids varied from a maximum of 149 individuals/sq m to a minimum of 28.3 individuals/sq m in the first 10 years (1984-1994; Figure 1). Year- to-year variation could have been caused by slight differences in sample site locations, mortality of older age classes, and variation in recruitment. However, the rapid decline in native mussel density after 1996, first noted in 1998 (10.1 individuals/sq m) and continuing in 1999 (1.7 individuals/sq m) is certainly related to the presence of zebra mussels.

Live specimens of *L. higginsi* were not collected at the east channel location in 1999. In all previous study years this species was collected in the east channel, typically representing approximately one percent or less of the total native mussel fauna. It should be noted that this species is often collected alive where zebra mussels are present. In 1999 quantitative and qualitative samples were also collected in the main channel of the UMR, at a location approximately 1 mile from where samples were taken in the east channel. In a qualitative sample obtained in the main channel, consisting of 198 native mussels, 5, or approximately 2.5 percent, were live *L. higginsi*. Zebra mussel densities have always been less in the main channel than the east channel; hence, the impacts to native species is greater in the latter location.

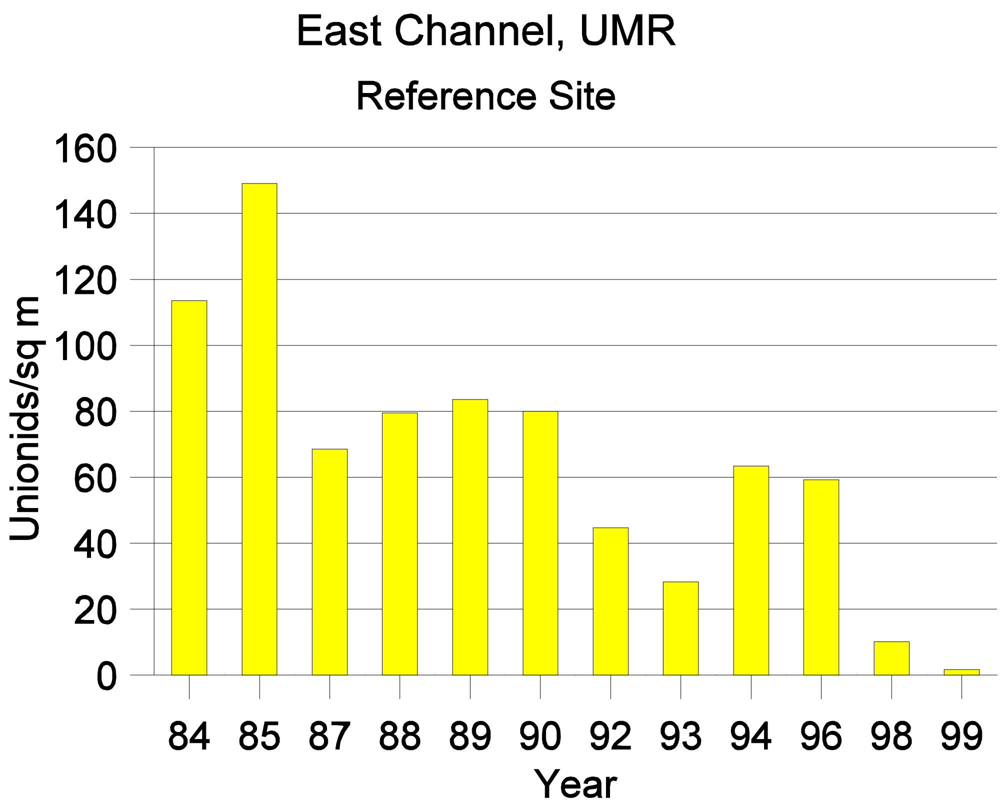

Figure 1. Density of native mussels collected at a reference site in the East Channel Essential Habitat Area, Upper Mississippi River, at Prairie du Chien, Wisconsin. (Corps, unpublished 1999 data).

5.2.6 Commercial Harvest

The commercial harvest of native freshwater mussels in the UMR peaked during the pearl button period of the 1920's and later during the cultured pearl era in the late-1980's and early 1990's. There are few documented reports of commercial clammers taking Higgins' eye. Other than harvest activities such as brailing that may have influenced the entire mussel community, little is known regarding the direct impacts of commercial harvest on Higgins' eye. Mathiak (1979), based on observations he made at a commercial clamming operation, concluded that hundreds of Higgins' eye had probably been harvested in 1975 before the species was placed on the endangered species list (paragraph from Hornbach 1999).

5.2.7 Summary

Since construction of the 9-Foot Channel Project approximately 60 years ago, the UMR continues to adjust from a riverine to a reservoir system. Because of the general lack of pre-project mussel data, it is impossible to assess with any certainty the impacts of the original 9-Foot Channel Project on Higgins' eye for use in establishing the environmental baseline for the Biological Opinion. In general, most adverse impacts to Higgins' eye were associated with the construction, operation and maintenance of the original 9-Foot Channel Project, and thousands of channel structures preceding it, for commercial navigation; these impacts are largely unknown and occurred nearly a century ago.

Studies before 1993 found no significant declines in the distribution and abundance of Higgins' eye on the UMR; since completion of the original Recovery Plan in 1983, its known range has been extended by 180 river miles and the Higgins' eye Recovery Team tentatively proposed an additional three Essential Habitat Areas (Hornbach 1999). For the species, the outlook was cautiously optimistic; it seemed plausible to consider that Higgins' eye populations were stable and perhaps recovering. Following the Flood of 1993, the Higgins' eye Recovery Team reassembled and began updating the original recovery plan.

Unfortunately, the recent invasion of the exotic zebra mussel has significantly changed this scenario. Due to upstream transport by commercial barge traffic, zebra mussels are now found throughout the UMR and have had a significant adverse impact on Higgins' eye and other native freshwater mussels. Based on Corps unpublished 1999 data on freshwater mussels from the Prairie du Chien Essential Habitat Area, and observations and recommendations of the Higgins' Eye Pearlymussel Recovery Team (Hornbach 1999), it is evident that zebra mussels are a significant threat to native freshwater mussels on the UMR, including Higgins' eye.

The environmental baseline for this Biological Opinion includes approximately 60 years of operation and maintenance of the original 9-Foot Channel Project. The environmental baseline also includes significant adverse impacts to Higgins' eye from the exotic zebra mussel at the Prairie du Chien Essential Habitat Area; it is probable that similar impacts have occurred to the other Essential Habitat Areas on the mainstem UMR. Fortunately, at this time, the existing/proposed Essential Habitat Areas on the Lower St. Croix (Karns 2000) and Lower Wisconsin Rivers are not infested with zebra mussels. The Proposed Action by the Corps of Engineers is to continue existing operation and maintenance activities for another 50 years. The effects of this action on Higgins' eye are described below.

5.3 Effects of the Proposed Action

5.3.1 Direct Effects

Direct effects in Biological Opinions are the direct or immediate effects on listed species caused by the proposed Federal agency action (including action to be permitted or authorized by the Federal agency). Direct effects of the proposed action include the effects of interrelated actions and interdependent actions. In this Biological Opinion, direct effects are effects likely to result to Higgins' eye from continued operation and maintenance of the 9-Foot Channel Project for the next 50 years.

The Biological Assessment (Corps 1999) was used in our assessment of project effects on Higgins' eye. As noted in the Biological Assessment, the Corps will consult with the Service on future operation and maintenance projects which may affect Higgins' eye to avoid and minimize adverse effects to the species. We also used information and observations of the Higgins' Eye Pearlymussel Recovery Team in determining effects of the Proposed Action on the species (Hornbach 1999). Our assessment of direct effects to Higgins' eye from continuing operation and maintenance of the 9-Foot Channel Project for an additional 50 years included the following parameters.

5.3.1.1 Operation of the 9-Foot Channel Project

5.3.1.1.1 Water Level Regulation

Refer to Section 5.3.1.1.2, Impoundment

5.3.1.1.2 Impoundment

The major adverse effects of water level regulation and impoundment of the UMR for an additional 50 years are associated with continuing the upstream transport of exotic zebra mussels by commercial barge navigation as discussed in Section 5.3.2.1.4, Exotic Species. Other impacts to Higgins' eye from continuing existing water regulation and impoundment activities by the Corps of Engineers for an additional 50 years are considered to be minor in comparison to zebra mussel impacts and any major physical changes to Higgins' eye habitat which occurred in the years following construction of the 9-Foot Channel Project approximately 60 years ago.

Water level management projects are being proposed on the UMR by the Corps of Engineers in cooperation with natural resource agencies as a tool to restore aquatic vegetation in the navigation pools. These projects will likely involve partial drawdowns of 1-3 feet at the dam in selected pools. Impacts to freshwater mussels including Higgins' eye will be assessed separately, including Section 7 consultation, as each project is developed. Through the Section 7 process, impacts to Higgins' eye will be avoided/minimized.

5.3.1.2 Maintenance of the 9-Foot Channel Project

5.3.1.2.1 Dredging

Refer to Section 5.3.1.2.1, Disposal

5.3.1.2.1 Disposal

Adverse impacts may occur to individual Higgins' eye on a site-specific basis from continuing modern dredging and disposal activities for another 50 years on the UMR. Unless relocated, any Higgins' eye located within the boundaries of a new/historic dredge cut will be killed as a result of the project.

No impacts are anticipated for upland disposal sites having 100 percent containment of dredged materials and effluent. Unless relocated, all Higgins' eye located within the boundaries of a new/historic dredged material placement site will be killed. Higgins' eye may also be killed as a result of dredging necessary to reach the disposal site, and placement of pipeline(s).

Use of temporary dredged material transfer sites may affect mussels through direct coverage, but the likelihood of Higgins' eye mussels colonizing open water areas of the transfer sites is quite low. The shifting sand substrates in these areas are typically poor habitat for freshwater mussels and are secluded from the UMR flow and these areas are frequently disturbed either through placement of dredged materials, or excavation of materials during transfer operations.

In-water placement of dredged material including thalweg disposal may affect freshwater mussels through direct burial. Depending on the thickness of the material, mussels buried by in-water placement of dredged material may perish as a result of asphyxiation and/or starvation. Although no permanent in-water placement of dredged material is proposed in the upstream pools, it is a common practice in lower reaches of the UMR (Corps 1999); it could also be considered in the future for other reaches (Corps 1996). In addition to the potential for burial, mussels inhabiting re-handling sites could be re-dredged and deposited on upland locations, leading imminently to death.

Today, channel maintenance activities associated with the 9-Foot Channel Project are routinely coordinated with such interagency groups as the On-Site Inspection Teams, River Resources Forum and River Resources Coordinating Team to avoid/minimize project impacts to fish and wildlife resources of the UMR, including freshwater mussels. The Corps of Engineers will continue to conduct individual Section 7 consultation on all projects which are likely to affect Higgins' eye (Corps 1999). Through the Section 7 process, impacts to Higgins' eye will be avoided/minimized. Based on the above, we do not anticipate major adverse impacts to Higgins' eye from continued maintenance dredging and disposal activities on the UMR for an additional 50 years.

5.3.1.2.3 Clearing and Snagging

Removal of trees or other obstructions from the navigation channel could affect Higgins' eye through disturbance of bottom substrates. Most snagging, however, occurs on the Minnesota River, outside the current known range of Higgins' eye.

Higgins' eye does occur in the Lower St. Croix River, but any snag removal is conducted only upon request of the National Park Service. Snag removal has not been requested for the past 20 years and in that time the National Scenic Riverway was established. The Corps does not anticipate snagging on the St. Croix River during the next 50 years (Corps 1999); we therefore do not anticipate major adverse impacts to Higgins' eye from clearing and snagging operations. In addition, the Corps of Engineers will enter into Section 7 consultation with the Service for any clearing and snagging project which is likely to affect Higgins' eye. Through the Section 7 process, impacts to Higgins' eye will be avoided/minimized.

5.3.1.2.4 Channel Structures/Revetment

5.3.1.2.4.1 Wingdams

Refer to Section 5.3.1.2.4.5, Closing Structures

5.3.1.2.4.2 Bendway Weirs - Not applicable

5.3.1.2.4.3 Bank Revetment/Off-Bank Revetment - Not applicable

5.3.1.2.4.4 Chevron Dikes - Not applicable

5.3.1.2.4.5 Closing Structures

Unless relocated, all Higgins' eye located within the boundary of proposed modifications to existing rock structures, or new closing dams, wing dams or rip rap will be killed. The Corps of Engineers will continue to conduct individual Section 7 consultation on all projects which are likely to affect Higgins' eye (Corps 1999). Through the Section 7 process, impacts to Higgins' eye will be avoided/minimized. Based on the above, we do not anticipate major adverse impacts to Higgins' eye from maintenance activities or new channel structures during the next 50 years.

5.3.1.2.5 Lock and Dam Rehabilitation

A programmatic Environmental Impact Statement on major rehabilitation of locks and dams 2-22 (Corps 1989) exists and is incorporated by reference. The Service's biological opinion on the project found the rehabilitation action was likely to incidentally take Higgins' eye. Rehabilitation of lock and dam structures would not cause permanent loss or disturbance of aquatic habitat. The work would entail repair or replacement of existing structures with very little intrusion into aquatic habitat during future rehabilitation. Petroleum or other hazardous materials can spill during construction, so contractors working on rehabilitation would have approved Environmental Protection Plans with spill prevention measures and spill response plans to minimize the likelihood of a spill. Once the structures are rehabilitated, their operation would be more efficient and safer for traffic, thereby reducing the spill potential. Riprapping is occasionally performed in downstream portions of spillways. Many of these areas attract high fish concentrations, hence some have rich mussel assemblages. Unless relocated, any Higgins' eye present in the riprap placement area(s) would be killed by the construction activities.

5.3.1.3 Summary of Direct Effects

Although the major direct effects to Higgins' eye from the 9-Foot Channel Project and preceding navigation projects occurred nearly a century ago, continued channel maintenance activities (dredging, disposal, clearing and snagging, channel structures/revetment) for an additional 50 years may affect individuals or populations of Higgins' eye at a local scale. As noted in the Biological Assessment (Corps 1999), the Corps will consult with the Service on future operation and maintenance projects which may affect Higgins' eye. Through the Section 7 process, impacts to Higgins' eye will be avoided/minimized.

5.3.2 Indirect Effects

Indirect effects in Biological Opinions are project impacts produced after the action has been completed or after the permitted activity terminates. Indirect effects are caused by or result from the proposed action, are later in time, and are reasonable certain to occur. They may occur outside the area directly affected by the proposed action.

5.3.2.1 Navigation Related Indirect Effects

5.3.2.1.1 Tow Traffic

Since most commercial navigation occurs in the main navigation channel and has been on-going since the project was completed early this century, impacts to Higgins' eye from individual tows (e.g., prop wash, increase in suspended sediments, physical impacts from grounding) are considered to be minor in nature and of a local scale. Any major physical changes to Higgins' eye from commercial navigation traffic in the main navigation channel occurred in the years following construction of the 9-Foot Channel Project.

Continued commercial barge transportation on the UMR for an additional 50 years will continue to transport zebra mussels on the UMR upstream from the Illinois River within the range of Higgins' eye to the detriment of freshwater mussels in general, and Higgins' eye in particular. Continued upstream transport of zebra mussels is a significant adverse impact to the species (Refer to Section 5.3.2.1.4, Exotic Species).

5.3.2.1.2 Fleeting

Continued use of existing barge fleeting areas, or development of new fleeting areas may adversely affect freshwater mussels including Higgins' eye. Under Section 10 of the Rivers and Harbors Act of March 3, 1899, the placement of permanent structures below ordinary high water on navigable waterways require a Department of Army permit. Where installation involves discharge of dredge or fill materials, permits under Sections 401 and 404 of the Clean Water Act of 1977 are required. Future expansion of fleeting areas or terminals will be subject to regulation and environmental review including Section 7 consultation with the Service. Through the Section 7 process, impacts to Higgins' eye will be avoided/minimized.

5.3.2.1.3 Port Facilities

Continued use of existing port facilities, or development of new port facilities may adversely affect freshwater mussels including Higgins' eye. Under Section 10 of the Rivers and Harbors Act of March 3, 1899, the placement of permanent structures below ordinary high water on navigable waterways require a Department of Army permit. Where installation involves discharge of dredge or fill materials, permits under Sections 401 and 404 of the Clean Water Act of 1977 are required. Any future expansion or new construction projects, or maintenance of existing facilities, would follow Section 404 permitting guidelines; Section 7 consultation with the Service would occur through the application process. Through the Section 7 process, impacts to Higgins' eye will be avoided/minimized.

5.3.2.1.4 Exotic Species

The major adverse effect of the Proposed Action on Higgins' eye is from indirect effects of zebra mussels, an exotic species which is transported upstream from the Illinois River by commercial barge traffic dependent on the 9-Foot Channel Project. Zebra mussels are considered to be a significant threat to Higgins' eye populations on the UMR (Hornbach 1999). Continued operation and maintenance of the 9-Foot Channel Project for an additional 50 years will facilitate the continued upstream transport of zebra mussels by commercial barge traffic if they are infested with zebra mussels. The upstream transport of zebra mussels will continue to replenish zebra mussels in the UMR, encompassing all UMR mainstem Higgins' eye Essential Habitat Areas, and potentially the existing/proposed Essential Habitat Areas on the Lower St. Croix and Lower Wisconsin Rivers which are not currently infested with zebra mussels.

Unfortunately, the likelihood of another exotic species invading the UMR is high; one exotic mussel that could impact Higgins' eye in the same fashion as the zebra mussel over the next 50 years is the quagga mussel (*Dreissena bugensis*). In 1997, it was well established in the lower Great Lakes and the St. Lawrence Seaway and has been found at one location in the UMR near St. Louis, Missouri (see Internet site www.entryway.com/seagrant/feb97q.jpg).

5.3.2.1.5 Contaminants

A large spill of salt, fertilizer, ammonia or petroleum products from a tow(s) could kill all freshwater mussels in its path. The overall consequence however, can not be predicted, but would depend on the amount and type of substance spilled, the effectiveness of spill containment and cleanup, river stage, and other factors (USFWS 1993). The same conditions apply to contaminants hauled by rail; in most cases railroad facilities are located on both sides of the UMR floodplain. We would anticipate that a spill(s) may adversely affect Higgins' eye on a local scale.

5.3.2.2 Recreation Related Indirect Effects

5.3.2.2.1 Facilities

Any future expansion or new construction projects, or maintenance of existing facilities, would follow Section 10/404 permitting guidelines. Section 7 endangered species consultation with the Service would occur through the permit application process. Through the Section 7 process, impacts to Higgins' eye will be avoided/minimized.

5.3.2.2.2 Large Vessels

Large recreational vessels will also continue to transport zebra mussels on the UMR within the range of Higgins' eye to the detriment of freshwater mussels in general, and Higgins' eye in particular referenced in Section 5.3.2.1.4, Exotic Species. However, while recreational boats may transport zebra mussels on the UMR, commercial barge transportation is the predominant upstream carrier. Barges have larger submerged surface areas than recreational craft for mussel attachment; they remain for long periods in the water (exposure and attachment time); they travel long distances within the UMR, from below lock and dam 26 to the head of navigation in Minneapolis, Minnesota; and they travel within and downstream of the Illinois River, a constant source of zebra mussels from Lake Michigan to the UMR.

5.3.2.2.3 Beach Use – Not applicable

5.3.2.2.4 Exotic Species

Refer to Section 5.3.2.1.4, Exotic Species

5.3.2.2.5 Contaminants

The risk to Higgins' eye and other freshwater mussels from small contaminant spills from recreational craft are considered to be minor in comparison to the potential for a large spill from commercial navigation or rail traffic. Refer to Section 5.3.2.1.5, Contaminants.

5.3.2.3 Summary of Indirect Effects

The indirect effects to Higgins' eye from continued zebra mussel persistence in the UMR are significant. As long as commercial barges, towboats and other equipment are infested with zebra mussels, continued operation of the 9-Foot Channel Project will facilitate the upstream transport of zebra mussels to the detriment of Higgins' eye and other native freshwater mussels on the UMR. Based on Corps unpublished 1999 data on freshwater mussels from the Prairie du Chien Essential Habitat Area, and observations and recommendations of the Higgins' Eye Pearlymussel Recovery Team (Hornbach 1999), it is evident that zebra mussels are a significant threat to native freshwater mussels on the UMR, including Higgins' eye. Due to upstream transportation by commercial barge traffic, zebra mussels are now found throughout the UMR. The indirect effect of continued operation and maintenance of the 9-Foot Channel Project for another 50 years will continue to facilitate this upstream transportation vector, and increase the risk of establishing zebra mussels at currently uninfested mussel beds containing Higgins' eye in the Lower St. Croix and Lower Wisconsin Rivers.

5.3.3 Interrelated Effects

An interrelated activity is an activity that is part of the proposed action and depends on the proposed action for its justification.

5.3.3.1 Timber Management – Not applicable

5.3.3.2 Cabin Leases - Not applicable

5.3.3.3 General Plan Lands - Not applicable

5.3.3.4 Public Use Sites - Not applicable

5.3.3.5 Corps Port Facilities

Two Corps-operated port facilities exist within the range of Higgins' eye: one in the St. Paul District (Fountain City, Wisconsin) and one in the Rock Island District (LeClaire, Iowa). No live Higgins' eye have been found recently near the Fountain City Base. The LeClaire Service Base is located immediately downstream of a high quality mussel bed. Any future maintenance or construction activities at these locations will be coordinated with the Service under Section 7 of the Endangered Species Act. Through the Section 7 process, impacts to Higgins' eye will be avoided/minimized.

5.3.4 Interdependent Effects

An interdependent activity is an activity, not part of the proposed project, that has no independent utility apart from the proposed action under consultation.

5.3.4.1 Missouri River Navigation - Not applicable

5.3.4.2 U.S. Coast Guard (USCG) Buoy Tending

A potential impact of buoy placement and maintenance by USCG is the transport of zebra mussels into previously unoccupied habitat; USCG buoy tending vessels entering the St. Croix River from the Mississippi River would very likely carry zebra mussels from the Mississippi into the St. Croix. This could lead to establishment of a zebra mussel population in the St. Croix River. However, on September 27, 1999, a Service representative met with representatives of the U.S. Coast Guard and other Federal, State, and local stakeholders regarding the maintenance of navigation aids in the St. Croix River. It was agreed that the USCG would replace the existing heavy metal buoys with lighter easy-to-service buoys and with on-shore daymarkers. This action will preclude the USCG having to bring zebra mussel-infested cutters and work barges into the St. Croix River.

5.3.5 Cumulative Effects

Cumulative effects in biological opinions are effects of future state, local, or private actions, not involving Federal action, reasonably certain to occur in the action area [50 CFR 402.14 (g)(3) & (4)]. Cumulative effects include the effect of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this Biological Opinion. Future Federal actions unrelated to the proposed action are not considered in this section because they will undergo separate consultation pursuant to Section 7 of the Act.

Cumulative effects will not be subject to future Section 7 review because no Federal action is associated with them. The Service knows of no projects reasonably certain to occur in the action area that will produce cumulative effects. Residential, industrial, and recreational uses will likely continue to increase on the UMR and may change habitat conditions for Higgins' eye.

5.4 Conclusion

5.4.1 Jeopardy Analysis

After reviewing the current status of Higgins' eye pearlymussel, the environmental baseline for the action area, the effects of the proposed action, the cumulative effects, and effects of exotic zebra mussels, it is the Service's biological opinion that the action, as proposed, is likely to jeopardize the continued existence of Higgins' eye pearlymussel. No critical habitat has been designated for this species, therefore, none will be affected.

The problem is not commercial barge transportation, per se. The ongoing problem is commercial barge transportation on the UMR with vessels and equipment infested with zebra mussels. The major adverse effect of the project on Higgins' eye is from the indirect effects of zebra mussels, an exotic species which is maintained by the conditions created from the operation and maintenance of the 9-Foot Channel Project and is transported upstream from the Illinois River by commercial barge transportation dependent on the navigation project. This jeopardy opinion is based on the Service's assessment of the project in light of information on Higgins' eye's range wide population size, distribution, and status and on reasonably likely zebra mussel impacts. Continued operation and maintenance of the 9-Foot Channel Project will facilitate upstream transport of zebra mussels by large vessels using navigation locks, thereby continuing to replenish zebra mussels in the UMR and encompassing all UMR mainstem Higgins' eye Essential Habitat Areas. Continued operation and maintenance of the 9-Foot Channel Project also facilitates maintenance of existing populations of zebra mussels in navigation pools and lock chambers, which are more hospitable for zebra mussels than unimpounded riverine conditions.

The proposed project makes possible large-scale commercial barge transportation on the UMR. But for the project, there would be no commercial barge navigation. But for the commercial barge traffic, there would be no continuous, large-scale transport and replenishment of zebra mussels in the UMR upstream of the Illinois River. While recreational boats may transport zebra mussels on the UMR, commercial barge transportation is the predominant upstream carrier. Barges have larger submerged surface areas than recreational craft for mussel attachment; they remain for long periods in the water (exposure and attachment time); they travel long distances within the UMR, from below Lock and Dam 26 to the head of navigation in Minneapolis, Minnesota; and they travel within and downstream of the Illinois River, a constant source of zebra mussels from Lake Michigan to the UMR. Furthermore, the proposed project provides ideal habitat for zebra mussel colonization (Corps 1999). Zebra mussel colonization is restricted by water velocity. Colonization is most successful in slow-moving water. The operation and maintenance of the 9-Foot Channel Project provides these ideal slow-moving water conditions.

Zebra mussels affect native freshwater mussels like Higgins' eye by competing for food and by attaching to native mussels in such large numbers that infested mussels cannot travel or burrow. When infested by many zebra mussels, native mussels cannot open their shells to respire, feed, burrow, or move, nor can they close their shells for protection. Zebra mussels can build up on native mussels in such numbers that waves and currents can dislodge native mussels from the substrate. Any of these impacts or combination of impacts can lead to the death of the infested mussel; if enough adults die, reproduction and recruitment may be limited to the point that the mussel population and community cannot be maintained.

Thus, the Service believes it is reasonably certain that operation and maintenance of the navigation pools and project-dependent commercial barge transportation will facilitate zebra mussel persistence in the UMR to the extent that the likelihood of recovery and survival of Higgins' eye is appreciably reduced.

5.4.2 Reasonable and Prudent Alternative

Regulations (50 CFR 402.02) implementing Section 7 of the Act define reasonable and prudent alternatives as alternative actions, identified during formal consultation, that: (1)

can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) are economically and technologically feasible; and (4) would, the Service believes, avoid the likelihood of jeopardizing the continued existence of the listed species or resulting in the destruction or adverse modification of critical habitat.

The continued operation and maintenance of the 9-Foot Channel Project facilitates a continued and maintained source of zebra mussels in the UMR, and thus, appreciably reduces the likelihood of survival and recovery of Higgins' eye. To avoid jeopardizing the continued existence of the species, while continuing operation and maintenance of the 9-Foot Channel Project, guarding against further Higgins' eye population loss due to zebra mussel infestation is imperative. To achieve this, it is necessary to (1) establish, reestablish, or augment Higgins' eye populations in areas currently uninfested by zebra mussels, (2) prevent zebra mussel infestation above Lock and Dam 3 and into the Lower Wisconsin River, and (3) reverse current zebra mussel population trends in the UMR, especially downstream of Lock and Dam 3 to the confluence of the Illinois River.

Continued operation and maintenance of the 9-Foot Channel Project will facilitate zebra mussel persistence in the UMR, and is likely to decimate all Higgins' eye Essential Habitat Areas on the UMR. To insure against the eventual loss of these essential populations, Higgins' eye populations need to be relocated into areas unaffected by zebra mussels. The Wisconsin Department of Natural Resources (WIDNR) and Illinois Natural History Survey surveyed zebra mussel veligers from Lock and Dam 2 to Lock and Dam 11, and at the mouth of the St. Croix River (WI DNR unpublished 1998 data). No veligers were found coming from the St. Croix River, indicating it did not support a reproducing population of zebra mussels in 1998. During August 1999, the WIDNR conducted another veliger survey in the St. Croix River and found 17 veligers in a sample taken from the mouth of the river just downstream of the railroad bridge at the City of Prescott, Wisconsin. The veliger density was 0.18 veligers per liter with a bimodal size distribution (Benjamin per comm 1999). Veligers were found at all UMR locks and dams sampled in 1998 (Locks and Dams 2 through 11). Very few veligers, however, were found in the tailwater of Lock and Dam 3 (0.1 veligers per liter) compared to the tailwater of the downstream dams (range 18 to 487 veligers per liter; WIDNR unpublished 1998 data).

Zebra mussel densities at Corps locks and dams in the St. Paul District are substantially lower upstream of Lock and Dam 3 than downstream. Corps personnel have routinely monitored zebra mussels at locks and dams in the St. Paul District (Upper St. Anthony Falls to Lock and Dam 10) since 1992. Combined zebra mussel densities for 1993 and 1994 averaged 0.9 individuals/ sq m at upstream locks (Upper St. Anthony Falls to and including Lock and Dam 3), and 18.4 individuals/ sq m at downstream locks (Locks and Dams 4 - 10). By 1995, zebra mussel densities were so large at downstream locks that they were described as being "in layers and too numerous to count by divers;" in comparison, zebra mussel densities at upstream sites were only 3.8 and 6.6 individuals/ sq m in 1995 and 1999, respectively (Yaeger 1999).

Based on these data, we conclude that there is limited to absent zebra mussel reproduction occurring upstream of Lock and Dam 3, in the St. Croix River, Lower Wisconsin River, and in other tributaries. Thus, in protecting these currently uninfested areas from zebra mussel impacts, and mussel relocation sites per implementation of the Reasonable and Prudent Alternative (Section 5.4.2), it is also necessary to minimize the probability of zebra mussel transport upstream from Lock and Dam 3.

A Reasonable and Prudent Alternative (RPA) is for the Corps to (1) develop a Higgins' eye Pearlymussel Relocation Action Plan and (2) to conduct a reconnaissance study to control zebra mussels in the UMR. This RPA will involve the following:

1. Conduct a Higgins' eye relocation feasibility analysis and prepare a Higgins' eye Pearlymussel Relocation Plan to address the feasibility of the Reasonable and Prudent Alternative in avoiding jeopardy and reducing incidental take. This will be an interdisciplinary/interagency effort designed to determine the most efficient and cost effective combination of methods and measures to provide for relocation of Higgins' eye. The effort will follow the Corps' traditional six-step planning process and include the utilization of pilot field studies if necessary. A report on the findings of this effort will be provided to the Field Supervisor, U.S. Fish and Wildlife Service, 4101 East 80th Street, Bloomington, Minnesota, 55425-1665, by April 30, 2001, for approval. If the feasibility study concludes that relocation of Higgins' eye is not feasible, the Corps will immediately reinitiate consultation with the Service under Section 7 of the Endangered Species Act to develop an alternative RPA to avoid jeopardy. If relocation is feasible, implementation of the Higgins' eye Pearlymussel Relocation Plan is to commence by June 1, 2001. The feasibility analysis will include, but not be limited to, the following:

   Development of milestones or success criteria and time frames for achieving such goals,

   Development of a relocation site criteria plan based on political, institutional and biological parameters,

   Development of a search plan for candidate relocation sites,

   Implementation of the search plan, including pilot projects necessary to develop site suitability criteria and to evaluate candidate relocation sites,

   Preparation of a prioritized list of candidate relocation sites, with narrative evaluation,

   Evaluation of relocation methods including relocation of adult and juvenile Higgins' eye from existing populations, hatchery (*in situ*) propagation and rearing where juveniles would be used in relocation, and release of glochidia-laden host fish,

   Funding the relocation of Higgins' eye at selected site(s) and evaluating success at the site(s). The relocation plan will include a monitoring component to determine the effectiveness of the relocation program in re-establishing viable populations of *L.*

higginsi. Annual status reports of the relocation and monitoring program will be submitted for approval to the Field Supervisor, U.S. Fish and Wildlife Service, 4101 East 80th Street, Bloomington, Minnesota, 55425-1665,

Support and continuation of pilot projects to evaluate relocation techniques. Biologists from the Wisconsin and Minnesota Departments of Natural Resources and Service are planning to conduct emergency relocation efforts for Higgins' eye in fiscal year 2000, perhaps before this formal Section 7 consultation is completed. The Corps will continue to support these actions when Section 7 consultation is completed, including post-relocation monitoring of pilot projects.

2. Conduct a zebra mussel reconnaissance study to determine the necessary measures, projected costs, and likelihood of success in controlling zebra mussels in the UMR. This will be an interdisciplinary/interagency effort designed to determine the most efficient and cost effective combination of measures necessary to control zebra mussels. Based on these findings, the Corps will pursue, for those actions that fall within their perview, the appropriate project planning and other steps to implement the necessary measures. Also, the Corps and the Service will seek the assistance of other agencies in pursuing those additional actions, which are within the authorities of those agencies and deemed necessary to control zebra mussel infestation. The reconnaissance report will be provided to the Field Supervisor, U.S. Fish and Wildlife Service, 4101 East 80th Street, Bloomington, Minnesota, 55425-1665, by April 30, 2002, for approval. If the zebra mussel control program is feasible, it will include a monitoring component to determine the effectiveness of the program in controlling zebra mussel abundance and distribution. Annual status reports of the zebra mussel control and monitoring program will be submitted for approval to the Field Supervisor, U.S. Fish and Wildlife Service, 4101 East 80th Street, Bloomington, Minnesota, 55425-1665.

   If the reconnaissance report or a subsequent feasibility report concludes that zebra mussel control in the UMR is not feasible, or feasible actions under the perview of the Corps are not implemented within two years of their identification, the Corps will immediately reinitiate consultation with the Service under Section 7 of the Endangered Species Act to develop an alternative RPA to avoid jeopardy.

   Because this Biological Opinion has found jeopardy to Higgins' eye pearlymussel, the Corps is required to notify the Service of its final decision on the implementation of the reasonable and prudent alternative.

5.5 Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to Section 4(d) of the Act prohibits the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such activity. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, and sheltering. Incidental take is defined as take incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), take incidental to and not an intended part of the agency action is not considered prohibited taking under the Act, provided such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Corps for the exemption in Section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps fails to assume and implement the terms and conditions, the protective coverage of Section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement (50 CFR, 402.14(I)(3)).

5.5.1 Level of Take

The Service has developed the following incidental take statement based on the premise that the RPA will be implemented. The Service anticipates that incidental take of Higgins' eye will occur between issuance of this biological opinion and complete implementation of the RPA, as well as, for a short period following implementation of the RPA (perhaps a 5 to 10-year period). During this period, zebra mussels will continue to adversely affect Higgins' eye in the UMR mainstem, and, to a lesser extent, in the St. Croix River as well. Incidental take will occur in the form of harassment (e.g., competition for food, locomotion impairment) and harm (e.g., suffocation, starvation). Based on current zebra mussel densities, we anticipate all UMR Higgins' eye essential populations, except the Orion population, could be harassed or harmed during this interim period. In a few of these areas, adverse impacts could lead to complete loss of recruitment and substantial mortality.

Incidental take will be difficult to detect and monitor, however. The reasons for this are as follows. First, changes to fitness parameters (e.g., decreased recruitment) often are not manifested in a year or two but rather over several years (e.g., 5 to 10 years). This is especially true for species that occur at low densities. Second, detection of impaired or recently morbid specimens is unlikely given the low abundance of Higgins' eye. Third, the normal variance in Higgins' eye population trend is great, a consequence of low densities, and thus, identifying a declining trend over such a short time-frame is problematic. We believe, however, the level of take can be monitored by observing the population trends of other native freshwater mussels and zebra mussel densities. At high infestations, the differences in mussel susceptibility to mortality and stress from zebra mussels are likely minor (Corps 1999). If other native co-habitant species are reduced by zebra mussels, it is also likely true for Higgins' eye. Thus, the general level of Higgins' eye take can be determined by monitoring the trend of the co-existing mussel community and the concurrent trend of zebra mussels.

Although we suspect that nearly all reproductive potential will be lost and that mortality could be substantial in some Essential Habitat Areas during this interim period, we do not anticipate that recruitment will be impaired or that mortality will be significant in the following four Essential Habitat Areas: Interstate Park, Hudson, Prescott, and Orion. Based on population monitoring at Prairie du Chien (at Prairie du Chien, natural density fluctuations in the native mussel community were typically less than 50 percent of mean values), we anticipate that the native mussel diversity and density should not decline by more than 40 percent and that zebra mussel density in these four areas will not exceed $6000/m^2$, a density at which native mussel impacts have been observed (Cope *et al* 1997), within the next 8 to 10 years in any of the four Essential Habitat Areas identified above.

We believe that this anticipated interim level of take due to zebra mussel infestation is unlikely to jeopardize the continued existence of Higgins' eye. Zebra mussels obtain greater abundance in areas of high native mussel densities. Thus, zebra mussel occurrence (and consequently, adverse impacts) is likely to be greater in areas supporting high density mussel beds, i.e., Essential Habitat Areas. It is, therefore, unlikely that residual populations occurring outside these Essential Habitat Areas will be substantially impacted during this 8 to 10-year period. Although the majority of take will be concentrated in Essential Habitat Areas in the UMR and this take is likely to include a substantial reduction in recruitment, it is unlikely that all individuals within these areas will be lost during this interim period. Hence, throughout the implementation phase of the RPA, Higgins' eye populations in the UMR are likely to persist and future reproductive potential will likely be maintained. Furthermore, based on recent surveys, zebra mussel densities are much lower in the upper pools (above Lock and Dam 3) and are unlikely to have significant adverse impacts to Higgins' eye populations in such areas during this time-frame. Thus, an upstream source for re-colonization and augmentation will persist. Lastly, following implementation of the RPA, relocated populations will provide additional sources of specimens to replenish once infested Essential Habitat Areas. In short, the impact of the anticipated take will be marked but the effects will be short-term and mitigated following implementation of the RPA.

In addition to impacts associated with zebra mussels, continued operation and maintenance of the project may result in the take of Higgins' eye from specific channel maintenance activities such as dredging and modification of channel control structures. However, this programmatic biological opinion does not authorize any incidental take associated with such channel maintenance activities that may occur. These actions will require further Section 7 review. Although the level of anticipated incidental take from these actions is currently unknown, we believe such take will not rise to the level of jeopardy. The reasons for this are (1) in most instances, such projects will occur in the main navigation channel, and thus, will not affect Essential Habitat Areas, (2) such projects will have localized effects affecting only a few individuals, and (3) as the specific locations and project descriptions are developed and undergo Section 7 review, measures further minimizing the impacts of any such incidental take will be required and implemented.

5.5.2 Reasonable and Prudent Measures

The measures described below are non-discretionary, and must be implemented by the agency for the exemption in Section 7(o)(2) to apply. The Corps has a continuing duty to implement the activity covered by this incidental take statement. If the Corps fails to adhere to the terms and conditions of the incidental take statement, the protective coverage of Section 7(o)(2) may lapse.

The Service believes the following Reasonable and Prudent Measures (RPM) are necessary and appropriate to minimize take of Higgins' eye:

1. Implement a monitoring program for Higgins' eye and other unionids in the UMR,

2. Investigate and implement opportunities to protect live Higgins' eye individuals within Essential Habitat Areas in the UMR during the interim period between issuance of the biological opinion and implementation of the RPA,

3. Develop and implement an action plan to monitor abundance and distribution of zebra mussels on the Upper Mississippi River System (UMRS; navigable portions of the UMR, Illinois, Black, Lower Minnesota and Lower St. Croix Rivers, Lower Wisconsin River, and the Upper St. Croix River upstream of Taylors Falls, Minnesota). This should include continuing the monitoring of zebra mussel impacts to Higgins' eye at the Prairie du Chien Essential Habitat Area. These studies are currently being conducted by personnel from the Corps of Engineers Waterways Experiment Station (WES) and are critical to understanding zebra mussel impacts to native species.

5.5.3 Terms and Conditions

To be exempt from the prohibitions of Section 9 of the Act, the Corps must comply with the following terms and conditions which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. In monitoring Higgins' eye and other native mussel populations, assessments will include estimates of density, recruitment and genetic variability among populations in Essential Habitat Areas as well as secondary habitats identified in the Higgins' Eye Pearlymussel Recovery Plan (Hornbach 1999). Annual reports on the findings of this effort will be provided for approval to the Field Supervisor, U.S. Fish and Wildlife Service, 4101 East 80th Street, Bloomington, Minnesota, 55425-1665.

2. In developing and implementing the feasible provisions of a plan to protect live Higgins' eye individuals within Essential Habitat Areas, the Corps may involve an interdisciplinary/interagency effort designed to determine the most efficient and cost effective combination of methods and measures to protect Higgins' eye individuals at Essential Habitat Areas downstream of the St. Croix River and Wisconsin River (Hornbach 1999). Annual reports on the findings of this effort shall be provided for approval to the Field Supervisor, U.S. Fish and Wildlife Service, 4101 East 80th Street, Bloomington, Minnesota, 55425-1665.

3. The zebra mussel monitoring effort will also include assessing the ongoing effects of zebra mussel densities on Higgins' eye and other native mussels in the 10 Essential Habitat Areas and secondary habitats (Hornbach 1999). The plan will also evaluate dispersal of zebra mussel veligers, and develop models to determine source populations and population dynamics of zebra mussels on the UMRS. The action plan will include a specific plan for the Lower St. Croix River and Lower Wisconsin River that would avoid or minimize colonization by zebra mussels. Annual reports on the findings of this effort shall be provided for approval to the Field Supervisor, U.S. Fish and Wildlife Service, 4101 East 80th Street, Bloomington, Minnesota, 55425-1665.

4. The Service believes that all Higgins' eye essential populations may experience some incidental take as a result of the proposed action. However, this incidental take will be difficult to detect and monitor. As an indicator of Higgins' eye take, we believe that no more than a 40 percent decline in the native mussel densities will occur and that zebra mussel densities will not exceed 6000/m^2 in any of the four currently uninfested Essential Habitat Areas during the interim period. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable an prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

5.6 Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. Conduct a feasibility analysis using the traditional Corps planning process to enhance the opportunity for fish passage at locks and dams for species of fish that are hosts of the *L. higginsi* glochidia. Implement feasible measure(s). Existing locks and dams are semi-permeable barriers to fish movement between navigation pools on the UMR. Water control gates at Lock and Dam 5 are raised out of the water less frequently than other navigation dams on the UMR in the St. Paul District. There has been only one live *L. higginsi* found in the UMR upstream of Lock and Dam 6 (Pool 1 in 1993; Cawley 1996). Since upstream expansion of *L. higginsi* is dependent on transport of glochidia by host fish species, existing locks and dams are restricting the upstream distribution of *L. higginsi*. Priority should be given to locks and dams in the St. Paul District. Existing data indicate the majority of the population of *L. higginsi* in the UMR occurs in Pool 10 and downstream areas (Cawley 1996). Enhancing fish passage at Locks and Dams 9, 10 and upstream sites may increase the number of host fish

carrying glochidia to the upper navigation pools.

2. Implement a public outreach effort, in coordination with the Service and other resource agencies, as a means to disseminate information on life history and distribution of zebra mussels, ecological importance of native mussels to include Higgins' eye, control measures to limit the spread of zebra mussels on the UMR and tributaries, and status of mussel relocation efforts.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

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6.0 Winged mapleleaf mussel

6.1 Status of the Species

The winged mapleleaf was listed in 1991 as endangered because (1) the species has been eliminated from nearly all of its original 11-state range and at listing was known from only one population along a 13-mile segment of the St. Croix River, (2) its population was small and therefore vulnerable to catastrophic stochastic events, such as toxic spills or low water levels, (3) its reproductive success was threatened by its low population, and (4) changes in land use practices in the watershed were anticipated because the watershed is close to a growing metropolitan area (USFWS 1997). The plan recognized zebra mussels as a grave potential threat. Zebra mussels are repeatedly found on recreational boats entering the St. Croix River from the Mississippi River and the reduction of the threat of zebra mussel invasion is a priority to the Winged Mapleleaf Recovery Team (USFWS 1997); for these reasons zebra mussels is a major concern to the well-being of the winged mapleleaf.

Little is known of the details of winged mapleleaf reproduction, feeding ecology, and specific habitat requirements (USFWS 1997). The brooding period for winged mapleleaf was presumed to be late May to the middle of July (Baker 1928). Recent investigation, however, revealed the brooding period of winged mapleleaf extended from about mid-September to mid-October in the St. Croix River (Heath *et al*. 1999). Hove *et al*. 1999 have begun laboratory studies to determine the host fish species for winged mapleleaf. In 38 trials on 29 fish species and on one species of mudpuppy, no species were found to provide complete winged mapleleaf glochidial metamorphosis. Recently, two glochidia successfully were released from a channel catfish in the laboratory (Hove 2000). However, the host glochidial species for winged mapleleaf remains unknown.

Much research on habitat requirements of the remnant St. Croix River population has been done during the last decade. Winged mapleleaf occurs in riffles with clean gravel, sand, and rubble substrates in rivers with clear water (USFWS 1997). It was found to be most abundant in shallow areas with fast current. Hornbach *et al.* (1995a) reported winged mapleleaf occur at an average depth of 3.0 ft (0.93 m), ranging from 1.4 to 6.2 ft (0.42 to 1.9 m). Winged mapleleaf are associated with three mussel species, deertoe (*Truncilla truncata*), monkeyface (*Quadrula metanevra*), and fawnsfoot (*Truncilla donaciformis*) (Hornbach *et al.* 1996). Hornbach *et al.* (1995b) concludes winged mapleleaf is only found in habitats that are generally high quality habitats for other mussel species. They also found considerable variation in flow conditions where winged mapleleaf occurred. Water velocity ranged from 0.13 ft/s (0.04 m/s) to 1.12 ft/s (0.34 m/s) with a mean of 0.58 ft/s (0.178 m/s) (Hornbach *et al.* 1995a).

Historically, winged mapleleaf was found in 34 rivers across 12 states from Ohio in the east to Kansas in the west and south to Oklahoma (USFWS 1997). There is uncertainty over its occurrence in Oklahoma due to unresolved taxonomic classification; however, it has been reported as a new state record in the Ouachita River, Arkansas (Posey *et al.* 1996). The range of the winged mapleleaf has been reduced by more than 90 percent. Factors that may have contributed to its decline include predators (e.g., muskrat, mink, raccoons, turtles, and waterbirds), disturbances (e.g., illegal harvest for consumption or bait, swimming, wading, physical disturbance of substrate from recreational and commercial boating), competitors (e.g., interspecific competition for resources), parasites, and disease. The winged mapleleaf, due to its single, small geographically extant population in the St. Croix River, is particularly vulnerable to stochastic events such as low water levels, toxic spills, or climatic episodes (USFWS 1997).

Currently, the winged mapleleaf population is known only in a 12.4 mile (20km) stretch of the St. Croix River from the hydropower dam at St. Croix Falls south to Osceola, Wisconsin (RM 44 to RM 52) (Hornbach *et al.* 1998; USFWS 1997).

The St. Croix River, bounded along part of its length by the states of Minnesota and Wisconsin, begins in Wisconsin and flows in a southerly direction for 154 miles until it joins the Mississippi River at Prescott, Wisconsin. The river forms part of the St. Croix National Scenic Riverway, administered by the National Park Service, and the Lower St. Croix National Scenic Riverways, administered by the Minnesota and Wisconsin Departments of Natural Resource in partnership with the National Park Service. The river is unique because it has its complete native mussel fauna of 40 species; which includes 13 Wisconsin and 17 Minnesota threatened and endangered mussels (Hornbach *et al.* 1995a).

In recent years, recruitment to the population has been low and the last large cohort recruitment was in 1987 (Heath 1999). On September 24, 1997, one gravid female was found among approximately 250 winged mapleleafs collected and examined in biweekly surveys in summer and fall of 1997. The glochidia in the female were immature, suggesting late September was the beginning of winged mapleleaf's brooding period. Winged mapleleaf would be unusual in having a September-October brooding period as almost all other members of the winged mapleleaf's subfamily brood in spring and early summer (Corps 1999). The glochidial host fish for winged mapleleaf is unknown, but may be a member of the catfish family, based on known glochidial host fish of other *Quadrula* species (USFWS

1997).

A recent threat to winged mapleleaf comes from zebra mussels (*Dreissena polymorpha*), freshwater mussels native to the Black and Caspian Seas. Zebra mussels were introduced into Lake Erie in the late 1980s from ship ballast water discharge (Benson and Boydstun 1995). The species is now reproducing and invading North America's lakes and rivers, including the Mississippi River.

6.2 Environmental Baseline

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and ecosystem within the action area. The purpose is to analyze the effects on the species at the action level. Factors affecting the species include recreation and exotic species.

Currently, the species is known from one locality, the St. Croix River between St. Croix Falls and Osceola, Wisconsin.

6.2.4 Recreation

There is evidence that recreational boats (paddlewheel boats and smaller motorboats) may have caused significant local disturbance to mussel beds by physical disturbance of the substrate and by enabling boaters access to otherwise isolated mussel beds (USFWS 1997). There has also been considerable wading and swimming activity in the vicinity of the mussel beds where winged mapleleaf are known to occur. People have been observed collecting mussels at some beach sites; indiscriminate collections may have included winged mapleleafs at some locations (Whiting 2000). Currently, the NPS is consulting with the Service during the development of the *Draft Cooperative Management Plan Environmental Impact Statement; Lower St. Croix National Scenic Riverway* (National Park Service1999).

6.2.5 Exotic Species

Of major concern to the well being of mussels in general, and winged mapleleaf in particular, was the introduction of zebra mussels to the Mississippi River. Zebra mussels have been found throughout the Mississippi River and have the potential to kill or otherwise eliminate native mussels, including winged mapleleaf.

Adult zebra mussels attach themselves by byssal threads to hard substrates including rocks, native mussels, wood, aquatic plants, and other zebra mussels. Zebra mussels may also colonize soft substrates, such as aquatic vegetation or soft mud (Whitney *et al.* 1996). They also attach to man-made materials including fiberglass, iron, plastic, concrete, and other surfaces (Corps 1992). Male zebra mussels release sperm directly into the water to fertilize eggs released by the female zebra mussels. Large females can release up to one million eggs per season (Corps 1992). Eggs are released when water temperatures reach 52-54 ^{o}F. Immature zebra mussels (veligers) spread via passive drift on water currents.

Adults and veligers attach to boat hulls, lower power drives, trim tabs, wet compartments, containers, and submerged boat equipment.

Zebra mussels affect other mussels by competing for food and by attaching to mussels in such numbers that infested mussels cannot travel or burrow. When infested by approximately 100 or more zebra mussels, native mussels can neither open their shells to properly respire, feed, burrow, or move, nor can they close their shells for protection. Zebra mussels can build up on native mussels in such numbers that waves and currents can dislodge native mussels from the substrate. Recent observations suggest infested native mussels may remove themselves from the substrate to escape zebra mussels (Miller 1995). Any of these impacts, singly or in combination, can kill the infested mussel. Recreational and commercial water craft are the main vectors of this species throughout inland waters, while passive drift of veligers and juveniles facilitates downstream dispersal.

Zebra mussels reach a maximum length of about two inches, and hundreds of thousands can colonize a square meter. Up to 10,000 zebra mussels have been counted on a single native mussel (Corps 1992). In Michigan's Lakes Erie and St. Clair, where zebra mussels have existed for several years, native mussel populations have been devastated, and in some areas eradicated (Masteller and Schloesser 1991, Gillis and Mackie 1991). Gillis and Mackie (1991) found a positive correlation between large increases in the average number of zebra mussels attached to native mussel shells and a decline in live native mussel numbers in Lake St. Clair. They also found approximately 2,000 zebra mussels on a native mussel shell occluded the siphon region completely, affecting the infested mussel's ability to filter. Colonization rates of approximately 0.4 to 1.0 g of zebra mussels per g of native mussel (dry mass) were recorded in native mussels immediately before extirpation of native mussels from the Canadian side of the Detroit River (Ohnesorg *et al.* 1993).

Zebra mussels may have greater impact on some native mussel species than others, although this is not conclusive. Haag *et al.* (1993), in a test of six species, found species in the Anodontinae subfamily to be the most sensitive to zebra mussels, followed by Lampsilinae and Ambleminae. Winged mapleleaf is a member of the subfamily Ambleminae. Hunter *et al*. (1997 and references within) also found some species to be more sensitive than others. Giant floater (*Anodonta grandis*) was the most sensitive, followed by fragile papershell (*Leptodea fragilis*), fatmucket (*Lampsilis siliquoidea*), pink heelsplitter (*Potamilus alatus*), and black sandshell (*Ligumia recta*).

Zebra mussels were first discovered in Lake St. Clair in 1988 and in all the Great Lakes in 1989. The first zebra mussel collected from the Mississippi River was taken in 1991, south of La Crosse, Wisconsin (Corps 1999). The first discovery of zebra mussels on recreational boats in the St. Croix River was in 1994. Every year since 1994, boats have been observed with zebra mussels attached. During dive surveys in 1999, 32 boats checked had zebra mussels attached (Karns 2000). During the same sampling period, 51 live zebra mussels were found in the St. Croix River. Zebra mussels have been found attached to native mussels, rip rap, rock, refuse, and bridge piers. Currently, the St. Croix

River remains uninfested by zebra mussels despite these incidents of zebra mussels on the river substrate, on native mussels, or on boats.

The Wisconsin Department of Natural Resources (WI DNR) and Illinois Natural History Survey have conducted surveys of zebra mussel veligers from the mouth of the St. Croix River (Benjamin per comm 1999). In 1998, no veligers were found coming from the St. Croix River, indicating it did not support a reproducing population of zebra mussels in 1998. During August 1999, the WI DNR conducted another veliger survey in the St. Croix River and found 17 veligers in a sample taken from the mouth of the river just downstream of the railroad bridge at the City of Prescott. The veliger density was 0.189 veligers per liter with a bimodal size distribution (Benjamin per comm 1999). Few veligers, however, were found upstream of Lock and Dam 3 compared to downstream areas. Surveys by Corps and Service biologists in 1998 and 1999 confirmed the presence of significantly fewer adult zebra mussels upstream of Lock and Dam 3 (Yager 1999).

Once firmly attached, adult zebra mussels can withstand water velocity up to approximately 6 ft/sec (1.8 m/s) (Claudi and Mackie 1994). They appear adapted to lotic conditions, but when the complete life history of zebra mussels is considered, its lotic (flowing water) adaptability is doubtful. Successful lotic mussels have internal fertilization, the females holding eggs in marsupial chambers in their gills, where the eggs are fertilized, and where development proceeds to the glochidial stage. The glochidia are released, attach to fish, develop, metamorphose, and drop from the fish to the river bottom. Reliance on external fertilization and planktonic larvae is not typical of mussels in lotic environments. Native mussels have possible advantages over zebra mussels in their ability to bury into the substrate: longer life span, possibly greater energy reserves, thicker shells, and reproductive strategy suited for lotic habitats. The concern for the negative effects of zebra mussels on native riverine mussels may not be fully realized, as was the case with the Asian clam (Miller and Payne 1996), but this is by no means clear.

Strayer (1991) concluded zebra mussels do not exist in rivers less than 30 m (98.4 ft) wide. Lakes and run-of-river-reservoirs along large rivers are the primary habitats of zebra mussels. Hunter *et al.* (1997 and references within) showed zebra mussel settlement is restricted by water velocity. Settlement is most successful in slow-moving water (<10 cm/s) (3.9 in/s), and, within velocity refuges from even such slow-moving water. Successful colonization of smaller river systems by zebra mussels may depend in part on lakes, large pools, and impoundments along the river's course where reproducing groups of zebra mussels can establish (Hunter *et al.* 1997). Impoundments along a smaller river enhance conditions for successful zebra mussel colonization, but the overall susceptibility of such a river to heavy infestation by zebra mussels is lower than for lakes and for long, low-velocity sections of large rivers. However, S.J. Nichols (date unavailable) reported that zebra mussel adults are attracted to water current and will colonize areas with water velocities up to 6.6 ft/s (2 m/s). He also reported that water velocities over 6.6 ft/s (2 m/s) discourage the settling of veligers.

Zebra mussels disperse by three natural mechanisms (water currents, birds, and other animals) and 20 human-related mechanisms (Carlton 1993, Schneider *et al*. 1998).

Johnson *et al.* (1994) reported that although waterfowl can transport zebra mussels, the actual numbers of zebra mussels moved by ducks were quite low (0 to 0.25 zebra mussels/duck) and thus waterfowl do not represent a rapid means of spreading zebra mussels between bodies of water.

Human mechanisms are preponderantly important in the upstream and overland transport of zebra mussels and larvae. Carlton (1993) suggests zebra mussels on boats and other movable substrates leads to rapid "hopscotching" over suitable habitat, with “backfilling” likely to occur later. It is uncertain to what extent these introductions lead to infestation. Johnson and Carlton (1992) state: 1) the introduction of only a few zebra mussels creates a low probability that a self-sustaining population will develop, 2) repeated introductions into a water body could be required for an outbreak, 3) overland transport requiring extended survival of mussels out of water is rarely successful, and 4) it is difficult to predict when invasion will occur, despite the high likelihood of eventual zebra mussel invasion -- it could require decades. Schneider *et al.* (1998) developed a transportation model for use in Illinois and found that the risk of spread of zebra mussels depends on the number of boat trips from infested waters, which in turn depends on the distance from an infested water, boat use at the site, and the position of a lake within a river system. They determined that the invasion of inland lakes and reservoirs in Illinois was predicted to occur first at areas of high boat use close to currently infested waters.

Zebra mussels have been documented to spread via divers through their gear (Kraft 1995, 1996). He found three inland lakes known to be colonized by zebra mussels in quarries frequented by divers. Kraft (1994) also reported that a 20-acre quarry, only few miles overland from Lake Michigan and frequented by divers near Racine, Wisconsin, had been infested with zebra mussels. The quarry has no public boat launch.

Native mussels vary by species and size in their susceptibility to mortality and stress from zebra mussels, but these distinctions probably do not matter at high infestations. Winged mapleleaf is rare and sparsely distributed and may, therefore, be more vulnerable to harm from high zebra mussel infestations than are more common mussel species. Potential zebra mussel affect on winged mapleleaf reproduction was addressed in winged mapleleaf population and habitat viability report (Kjos, *et al*. 1998). The report, in discussing computer simulated zebra mussel infestation, stated that the most profound risk faced by this remnant population appears to be an infestation by zebra mussels. Direct impacts on female fecundity and adult mortality of this [simulated] infestation cause affected populations to decrease rapidly toward extinction following the introduction of zebra mussels into winged mapleleaf habitat.

6.2.7 Summary

The range of the winged mapleleaf has been reduced by more than 90 percent; the species is presently known only in the St. Croix River. In 1991, the species was listed as endangered because it had been eliminated from nearly all of its original range, its population is vulnerable to catastrophic stochastic events, its reproductive success is threatened by its low population numbers, and anticipated changes in land use practices within in the watershed are anticipated. Recreational activities, such as tour-boating, wading, and direct handling, are having minor adverse effects to winged mapleleaf. A recent threat to native mussels comes from zebra mussels. Dense zebra mussel colonization on native mussels has severely impacted native mussel communities in the Mississippi River. Consequently, zebra mussels are a major concern to the well-being of the winged mapleleaf.

6.3 Effects of the Proposed Action

This section includes an analysis of the direct and indirect effects of the proposed action on the species and its interrelated and interdependent activities.

6.3.1 Direct Effects

The Biological Assessment (Corps 1999) was used in our assessment of project effects on winged mapleleaf. We also used information and observations of the Winged Mapleleaf Recovery Team in determining effects of the Proposed Action on the species (Hornbach 1999). Our assessment of direct effects to winged mapleleaf from continuing operation and maintenance of the 9-Foot Channel Project for an additional 50 years included the following parameters.

6.3.1.2 Maintenance of the 9-Foot Channel Project

6.3.1.2.3 Clearing and Snagging

Clearing and snagging could affect winged mapleleaf through disturbance of bottom substrate and by stimulating premature release of glochidia. Snag removal on the St. Croix River, however, is conducted only when requested by the National Park Service because of its wild and scenic river status (Corps 1996) and has not been performed in the past 20 years. In 1972 the Lower St. Croix National Scenic Riverway was established on the St. Croix. The Corps does not anticipate snag removal on the St. Croix during the next 50 years (Corps 1999); we therefore do not anticipate major adverse impacts. Should the National Park Service request snag removal, consultation would be initiated with the Fish and Wildlife Service prior to any snag removal.

6.3.2 Indirect Effects

6.3.2.1 Navigation Related Indirect Effects

6.3.2.1.1 Tow Traffic

Commercial barge traffic is involved in the transport and replenishing of zebra mussel populations at upstream locations (Carlton 1993, Keevin *et al.* 1992). Recently, commercial barge traffic has occurred during the I-94 bridge construction project, the construction of the City of Stillwater levee project, and for the Lake Mallalieu dam rehabilitation project. For all of these projects, the action agencies have consulted with the Service regarding the impacts to Higgins' eye and winged mapleleaf. The impact of zebra mussels on winged mapleleaf is discussed under exotic species.

6.3.2.1.3 Port Facilities

There is one commercial port facility on the St. Croix River. Northern States Power Company (NSP) owns and operates the King generating plant near the City of Stillwater, approximately 22 miles downriver of winged mapleleaf area. The port facility is no longer active and NSP is considering removing the barge docking and unloading facility as part of a bridge project being funded by the Minnesota Department of Transportation. Except as a possible zebra mussel infestation source for further spread, the port facility and port operations should have no affect on winged mapleleaf.

6.3.2.1.4 Exotic Species

The proposed project makes possible large-scale commercial barge transportation on the Mississippi River. But for the project, there would be no commercial barge navigation. But for the barge traffic, there would be no continuous, large-scale transport and replenishment of zebra mussels in the Mississippi River mainstem. Furthermore, the proposed project also provides ideal habitat for zebra mussel colonization (Corps 1999). Zebra mussel colonization seems most successful in slow-moving water. The operation and maintenance of the 9-foot channel project provides these ideal slow-moving water conditions. Thus, the proposed project ensures the zebra mussel's persistence in the UMR-mainstem.

Currently, zebra mussels have not infested the St. Croix River, although they continue to be found on rock and artificial substrate at extremely low densities. Zebra mussels are brought into the St. Croix River via recreational boats from the Mississippi River despite Minnesota and Wisconsin state laws prohibiting the transport of zebra mussels into the St. Croix River. Thus, but for the continued persistence of zebra mussels in the UMR-mainstem, continued transport of zebra mussels into the St. Croix River would not likely occur.

Although commercial barges are the overwhelmingly preponderant carrier of zebra mussels in the Mississippi River mainstem, recreational traffic also facilitates the spread of zebra mussels throughout the system and to other tributaries. Barges have larger submerged surface areas than recreational craft for mussel attachment; they remain for long periods in the water (exposure and attachment time), they travel long distances within the Mississippi River, from below Lock and Dam 26 to the head of navigation in Minneapolis, Minnesota; and they travel within and downstream of the Illinois River, a constant source of zebra mussels from Lake Michigan to the Mississippi River. For these reasons, commercial barge traffic appears more important than recreational vessel traffic in the transport and maintenance of zebra mussels in the Mississippi River.

As there is no regular commercial barge traffic on the St. Croix River, the most likely vector for zebra mussel occurrence in the St. Croix River is recreational boat traffic. Although the recreational boat traffic is not as effective as commercial barge traffic in facilitating zebra mussel spread, a transportation model risk assessment of zebra mussel spread (Schneider *et al.* 1998) suggested that the St. Croix River may still be at risk of zebra mussel spread. Given the persistence of zebra mussels in the Upper Mississippi River mainstem and the movement of recreational traffic between the Upper Mississippi River mainstem and the St. Croix River, we believe it is likely that recreational traffic will continue to spread zebra mussels into the St. Croix River, but it is not likely that this vector alone will result in zebra mussel infestation. In addition to a lack of a continuous source of zebra mussels from barge traffic, the National Park Service's boater check station at RM 30 will greatly minimize the likelihood of zebra mussel infestation in the St. Croix River. The low densities of zebra mussel occurrence in the St. Croix River to date, relative to the recent zebra mussel trends in the Upper Mississippi River mainstem, support this contention.

As previously explained, exotic species infestations resulting from human introduction could impact winged mapleleaf by direct mortality and by chronic impacts.

The likelihood for another exotic species invading the Mississippi and St. Croix rivers is high and the degree of impact upon the native fauna is impossible to determine, but it is probably negative. One species that could impact winged mapleleaf in the same fashion as the zebra mussel is the quagga mussel (*Dreissena bugensis*).   Quagga mussels have been spread into Lakes St. Clair, Lake Ontario, and Lake Erie in a similar way to the zebra mussel. Morton (1997) predicted zebra mussels will spread to the uninfested rivers of North America having suitable water quality and substrate, the only question being how soon.

6.3.4 Interdependent Effects

An interdependent activity is an activity, not part of the proposed project, that has no independent utility apart from the proposed action under consideration.

6.3.4.2 U.S. Coast Guard (USCG) Buoy Tending

A potential impact of buoy placement and maintenance by USCG is the transport of zebra mussels into previously unoccupied habitat; USCG buoy tending vessels entering the St. Croix River from the Mississippi River would very likely carry zebra mussels from the Mississippi into the St. Croix. This could facilitate the establishment of a zebra mussel population in the St. Croix River. However, on September 31, 1999, a Service representative met with representatives of the U.S. Coast Guard and other Federal, State, and local stakeholders regarding the maintenance of navigation aids in the St. Croix River. The USCG agreed to replace the existing heavy metal buoys with lighter easy-to-service buoys and with on-shore daymarkers. This action will preclude the USCG having to bring zebra mussel-infested cutters and work barges into the St. Croix River. Thus, buoy tending is unlikely to greatly influence zebra mussel densities in the St. Croix River, and therefore, is unlikely to adversely affect winged mapleleaf.

6.3.5 Cumulative Effects

Cumulative effects include the effect of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Biological Opinion. Future Federal actions unrelated to the proposed action are not considered in this section because they will undergo separate consultation pursuant to Section 7 of the Act.

Cumulative effects will not be subject to future Section 7 review because no Federal action is associated with them. The Service knows of no projects reasonably certain to occur in the action area that will produce cumulative effects. Residential, industrial, and recreational uses will likely continue to increase on the St. Croix River and may negatively change habitat conditions for winged mapleleaf but the extent of this change is unknown.

6.3.6 Summary of Effects

The current conservation status of winged mapleleaf is critical. As only one small population persists, the species is vulnerable to even small perturbations. Although there are other adverse effects associated or concurrently occurring with the proposed action, including recreational effects and effects from the operation of the NSP dam upstream, the primary concern of the proposed project is continuation of the threat of zebra mussel infestation into the St. Croix River. The proposed action ensures a continued source of zebra mussels at the confluence of the St. Croix and Mississippi rivers. Although the primary vector (barge traffic) of zebra mussel spread will not occur, recreational traffic will continue to transport zebra mussels into the St. Croix. This is particularly more likely in the future as zebra mussel densities continue to increase in the Upper Mississippi River mainstem.

As explained previously, zebra mussels are maintained in the Mississippi River by the conditions created from the operation and maintenance of the 9-foot channel project. The proposed project's purpose is continued enablement of commercial barge travel on the Mississippi River. Continued operation and maintenance of the 9-Foot Channel Project will facilitate upstream transport of zebra mussels by large vessels using navigation locks, thereby continuing to replenish zebra mussels in the Mississippi River mainstem and continuing to be a source of zebra mussels for the St. Croix River. Continued operation and maintenance of the 9-foot channel project also facilitates maintenance of existing populations of zebra mussels in navigation pools and lock chambers, which are more hospitable for zebra mussels than unimpounded riverine conditions.

Zebra mussels may affect winged mapleleaf by competing for food and impairing locomotion, respiration, and feeding. Thus, we believe that the continued operation and maintenance of the 9-Foot Channel project will adversely affect individual winged mapleleaf mussels through the indirect effects of zebra mussel spread into the St. Croix River.

6.4 Conclusion

After reviewing the current status of winged mapleleaf mussel, the environmental baseline for the action area and range of the species, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the action, as proposed, is not likely to jeopardize the continued existence and recovery of winged mapleleaf mussel. No critical habitat has been designated for this species, therefore, none will be affected.

As explained above, the primary concern to the well being of the winged mapleleaf, is the introduction of zebra mussels to the St. Croix River. Zebra mussels have been found throughout the Mississippi River, including the St. Croix River, and thus, have and will continue to threaten winged mapleleaf mussels. However, the St. Croix River remains uninfested despite ongoing incidents of zebra mussels on the river substrate, on native mussels, and on boats. Undoubtably, zebra mussel infestation into the St. Croix River would substantially threaten the survival and recovery of the winged mapleleaf. This is unlikely to occur, however

The upstream colonization of zebra mussels in rivers depends on an upstream vector. As there is no regular commercial barge traffic on the St. Croix River, the most likely vector for zebra mussel infestation of the St. Croix River is recreational boat traffic. Although a definite factor, recreational traffic is not an efficient vector in the spread of zebra mussels. Furthermore, the distance between the confluence with the Mississippi River and the winged mapleleaf population in the St. Croix River, and the zebra mussel check stations greatly reduce the likelihood of zebra mussel infestation occurring in the upper St. Croix River. The steady rate of occurrence of zebra mussels into the St. Croix River relative to the Mississippi River mainstem supports this contention.

Based on the above, we believe it is reasonably certain that navigation pools and project-dependent commercial barge transportation will perpetuate zebra mussels persistence in the Mississippi River mainstem, but it is unlikely that zebra mussel densities will reach infestation levels in the St. Croix. Thus, the proposed project will not appreciably reduce the likelihood of recovery and survival of winged mapleleaf.

6.5 Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to Section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such activity. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, and sheltering. Incidental take is defined as take incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), take incidental to and not an intended part of the agency action is not considered prohibited taking under the Act, provided such take is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Corps for the exemption in Section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps fails to assume and implement the terms and conditions, the protective coverage of Section 7(o)(2) may lapse. To monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(I)(3)].

6.5.1 Level of Take

The Service anticipates that incidental take of winged mapleleaf mussel from the proposed action will be harassment and harm of winged mapleleaf from zebra mussels occurring in the St. Croix River or its tributaries. Continued operation and maintenance of the 9-Foot Channel Project, which includes the St. Croix River, for an additional 50 years, will facilitate commercial navigation for that time period. Commercial navigation will facilitate continued transport, replenishment, and maintenance of zebra mussels in the Mississippi River mainstem up to the confluence of the St. Croix River. Although commercial barge traffic does not regularly occur in the St. Croix River, recreational watercraft or other vessels entering and navigating the St. Croix River from the Mississippi River provide an upstream vector for zebra mussels. As there is a likelihood that zebra mussels will be deposited near the winged mapleleaf population over the next 50 years, incidental take will occur in the form of harassment (i.e., competition for food, locomotion impairment) and harm (i.e., suffocation and starvation).

Incidental take will be difficult to detect and monitor, however. The reasons for this are as follows. First, changes to fitness parameters (e.g., decreased recruitment) often are not manifested in a year or two but rather over several years (e.g., 5 to 10 years). This is especially true for species that occur at low densities. Second, detection of impaired specimens is unlikely given the low abundance of winged mapleleaf. Third, the normal variance in population size may be great, due to the low densities, and thus, identifying a declining trend over a short time-frame is problematic. We believe, however, the level of take can be monitored by observing the population trend of zebra mussel densities.

Despite probable zebra mussel occurrence in winged mapleleaf habitat, we believe population densities will not reach infestation levels as observed in the mainstem of the Mississippi River. As such, we do not anticipate persistence of zebra mussel veligers in the water column or adult zebra mussel densities exceeding 10/m2 in the St. Croix River upstream of the Highway 10 bridge at Prescott, Wisconsin. The occurrence of either of these parameters would indicate the presence of a reproducing population of zebra mussels in the St. Croix River. If this were to occur, incidental take of winged mapleleaf mussels would greatly increase. Conversely, the lack of veligers and a low density of adult zebra mussels indicate that a reproducing zebra mussel population is not established in the St. Croix River. Under this scenario, we anticipate incidental take of a small number of individuals but not to the extent that population level effects would occur.

In addition to impacts associated with zebra mussels, continued operation and maintenance of the project may result in the take of winged mapleleaf from specific channel maintenance activities such as dredging and modification of channel control structures. As the Corps does not anticipate any such activities to occur and as this is a programmatic biological opinion, incidental take associated with future channel maintenance activities is not authorized. These actions will require further Section 7 review.

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

6.5.2 Reasonable and Prudent Measures

The measures described below are non-discretionary, and must be implemented by the agency for the exemption in Section 7(o)(2) to apply. The Corps has a continuing duty to implement the activity covered by this incidental take statement. If the Corps fails to adhere to the terms and conditions of the incidental take statement, the protective coverage of Section 7(o)(2) may lapse.

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of winged mapleleaf mussel.

1. Develop and implement an action plan to monitor and control the abundance and distribution of zebra mussels on the St. Croix River.

2. Conduct a winged mapleleaf mussel relocation feasibility analysis and prepare a Winged Mapleleaf Mussel Relocation Plan to address the feasibility of reducing incidental take.

6.5.3 Terms and Conditions

To be exempt from the prohibitions of Section 9 of the Act, the Corps must comply with the following terms and conditions which implement the reasonable and prudent measure described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. The action plan will include monitoring and controlling the abundance and distribution

of zebra mussels on the St. Croix River. The action plan shall be provided for approval to Field Supervisor, U.S. Fish and Wildlife Service, 4101 East 80th Street, Bloomington, Minnesota, 55425-1665 by April 30, 2002.

2. In developing and implementing the feasible provisions of a plan to protect live winged mapleleaf individuals in the St. Croix River, the Corps may involve an interdisciplinary - interagency effort designed to determine the most efficient and cost effective combination of methods and measures. Annual reports on the findings of this effort shall be provided for approval to Field Supervisor, U.S. Fish and Wildlife Service, 4101 East 80th Street, Bloomington, Minnesota, 55425-1665.

The Service believes that a few winged mapleleaf mussels will be incidentally taken as a result of the proposed project. However, this incidental take will be difficult to detect and monitor. As an indicator of winged mapleleaf incidental take, adult zebra mussel densities will not exceed 10/m2, and zebra mussel veligers will not persist in the water column upstream of the Highway 10 bridge at Prescott, Wisconsin. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

6.6 Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are activities to be conducted at your agency's discretion. They are designed to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. Implement public outreach effort, in coordination with the Service and other resource agencies, as a means to disseminate information on life history and distribution of zebra mussels, ecological importance of native mussels including winged mapleleaf, control measures to limit the spread of zebra mussels on the Mississippi River and tributaries, and status of mussel relocation efforts.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

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7.0 Bald Eagle

7.1 Status of the Species

This section presents the biological or ecological information relevant to formulating the biological opinion. Appropriate information on the species' life history, its habitat and distribution, and other data on factors necessary to its survival, is included to provide background for analysis in later sections. This analysis documents the effects of all past human and natural activities or events that have led to the current range-wide status of the species. This information is presented in listing documents, the Northern States Bald Eagle Recovery Plan (USFWS 1983), a proposal to delist the bald eagle (64 FR 36454), and the Biological Assessment (USACE 1999).

The bald eagle (*Haliaeetus leucocephalus*) was first listed as endangered under the Endangered Species Protection Act of 1966 on March 11, 1967 (32 FR 4001). On February 14, 1978 (43 FR 6233), the species was listed as endangered under the Endangered Species Act of 1973 in 43 states except Washington, Oregon, Minnesota, Wisconsin, and Michigan, where it was listed as threatened. On July 12, 1995 (60 FR 36000) the eagle was reclassified as threatened in all 48 conterminous states. On July 6, 1999 (64 FR 36454), the Service proposed to delist the species in the 48 conterminous states. The bald eagle also occurs in Alaska and Canada, where it is not at risk and is not protected under the Act; and in small numbers in northern Mexico.

Shortly after World War II, the use of DDT and other organochlorine pesticides became widespread. Initially, DDT was sprayed extensively along coastal and other wetland areas to control mosquitos. Later it was used as a general insecticide. Eagles ingested DDT by eating contaminated fish. The pesticide caused the shells of the bird's eggs to thin and resulted in nesting failures. Loss of nesting habitat also contributed to the population decline. In 1972, the Environmental Protection Agency banned the use of DDT in the United States. This was the first step on the road to recovery for the bald eagle.

At its low point in 1963, there were an estimated 487 nesting pairs of bald eagles in the lower 48 states. In 1998, due to the recovery efforts of the Service in partnership with other federal agencies, tribes, state and local governments, conservation organizations, universities, corporations and thousands of individual Americans, this number has risen to nearly 6000 nesting pairs with close to 7000 young produced.

The recovery goal for the northern states recovery region, which includes the project area, is to re-establish a self-sustaining population and to have 1,200 occupied breeding areas by the year 2000 (USFWS 1983). In 1998, there were over 2000 occupied territories in this region, far exceeding the delisting goal.

7.2 Environmental Baseline

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and ecosystem within the action area. The purpose is to describe the current status of the species within the action area and those factors that have contributed to this state.

7.2.1 Status of the Species in the Action Area

The UMRS is a significant winter use area for the bald eagle. Winter use is highest where the river is ice-free and adequate perch sites are available. These areas are important, providing stable feeding sites during high caloric demand periods. Large concentrations of eagles often are associated with open water areas bordered by suitable perch trees. High use areas within the project area include many of the tailwaters below the locks and dams, constrictions in the river which remain free of ice, mouths of large tributary rivers or the heated effluent discharged by power plants. During most winters, winter feeding sites are not limiting, as there is much open water. Known winter roost sites are located in

Mississippi River pools 2, 3, 4, 5, 9, 14, 16 and 19.

There are basically three habitat components to winter management of bald eagles: feeding areas, daytime perching areas, and night roosts. Martell (1992) describes these components and provides management recommendations. The availability of food will dictate bald eagle use of an area during winter. They will congregate where open water conditions or other factors provide a food base. Daytime perching areas are near their foraging areas and are used to hunt from, eat in, or rest on. Trees within 100 feet of the shore are preferred.

Winter communal roosting behavior is found in a wide variety of habitats and is important for winter survival. Roost sites probably are selected because they offer bald eagles special advantages such as proximity to feeding areas, protection from the wind and cold, favorable sun exposure, and isolation. Removal or disturbance of roost sites could cause abandonment of a wintering area, causing stress during a critical period of the year and potentially affecting survival. Protection of roost sites is therefore important. Communal roosts receive high bald eagle use during the winter, with some sites supporting up to 50 eagles at a time. Roost sites are commonly used during evenings, but may be used during the day in inclement weather. There are two types of roosts: critical and secondary (Martell 1992). The critical roosts are those used more than 14 nights per season by local breeding eagles, or used more than 14 nights per season by more than 15 eagles per night, or one that has been documented as active for more than 5 years. Secondary roosts do not meet the above criteria and may form temporary foraging areas.

The UMRS is becoming more important for bald eagle nesting which is known to occur within the St. Croix, Minnesota, Upper Mississippi, and Illinois River corridors. In general, nesting activity has increased dramatically in recent years. As an example, in 1988 there were 6 occupied territories in Iowa with 7 young produced. A decade later in 1998, there were 83 occupied territories and 80 young produced. In Illinois in 1988 there were 6 occupied territories with 7 young produced. In 1998 there were 43 occupied territories with 55 young produced. Not all of these territories were within the UMRS corridor but many were. Eagle production is steadily climbing as eagles are nesting in previously unoccupied areas. At the present time, there are 167 known eagle nest sites in the UMRS corridor (USFWS/USGS 2000).

7.2.2 Factors Affecting the Species

7.2.2.1 Impoundment and Water Level Regulation

The construction of navigation dams in the 1930's altered the hydrology of the river system. The lower two-thirds of each navigation pool became more reservoir like, while the upper one-third remains most similar to pre-impoundment. This pooling of the river raised water levels and inundated portions of the floodplain. Impoundment directly impacted floodplain forest and has been implicated in long-term changes. While altered hydrology has contributed to the alteration of species diversity and composition of the floodplain forest, other factors also played important roles. These include extensive logging and conversion to agriculture in the 19th century, as well as urban development. Estimates from 1989 satellite data indicate that approximately 304,000 acres of the UMR floodplain remains forested. This is subdivided into bottomland forests covering 18.6% of the land surface of the UMR and 17.6% of the Illinois River. Species composition is estimated to be 80% silver maple, 10% oak-hickory, 5% willow and cottonwood, and 5% other (USACE 1999).

The effects of water level changes on floodplain forests have been discussed and documented in various publications. Reviews of Government Land Office (GLO) survey records have estimated the pre-settlement landscape of the floodplain in the area of the confluence of the Illinois and Mississippi Rivers (Nelson *et al.* 1994). Estimates indicate that approximately 56% of the floodplain was forested and 41% was prairie. GLO records from Pool 17 indicate that 57% of the floodplain was prairie and 26% was forested. The forest described in the records, however, was less dense than what we know today, and forests were mainly restricted to river banks and islands, with prairies and savanna dominating the floodplain (Nelson *et al* 1998). Historic surveys of the forest do show that silver maple was a co-dominant species by 1817 and prior to impoundment in 1938 had become dominant in the area between the Illinois and Mississippi Rivers (Nelson and Sparks 1997). Additionally, Moore (1988) found by reconstructing GLO records from 1837 that silver maple, elm, and ash were dominant species in the Effigy Mounds area in northeast Iowa and continued to be so in 1983 (Yin *et al.* 1997).

Water levels were most severely altered in the areas immediately upstream of each dam. Yeager (1949) found that after 6 years of completion of Lock and Dam 26 in 1938, the trees on the lowest and thus permanently inundated floodplain were nearly eliminated. Where the groundwater level was raised, only the most flood-tolerant species remained, and on higher elevation areas species such as pin oak showed heavy mortality (Yin and Nelson 1995). Changes in forest composition within the open river reach also occurred. Where oak *(Quercus* spp.), American beech *(Fagus grandifolia),* walnut *(Juglans* spp.), and hickory *(Carya* spp.) were once found adjacent to the river on higher elevation areas, they have largely disappeared and have been replaced by silver maple and willow *(Salix* spp.) (Yin and Nelson 1995). Silver maple and willow were historically found on river fronts, islands, and low-lying floodplain areas and continue to be found there (Yin 1999).

Mississippi River Pools 11-22 (Rock Island Corps District) have been inventoried through stand mapping and entered into a Geographic Information System (GIS). That system provides detailed data on the forest resources of the Mississippi River Project. A summary of that data shows an example of species composition change. Table 7-1 below summarizes the forest composition of areas that had been cruised (20,000-25,000 ac) in 1943.

TABLE 7.1. Mississippi River forest composition in 1943, percent of tree species (based on merchantable timber that had been cruised).	
Silver Maple	50%
Cottonwood	15%
Elm	15%
Oak	10%
Green Ash	3%
River Birch	2%
Other *	5%

* Includes Locust, Pecan, Hickory, Sycamore, Hackberry, Willow, Kentucky Coffee Tree, Walnut, and Basswood.

Table 7-2 shows the percent composition of the roughly 50,000 acres in the current inventory. Though the two tables are not directly comparable, they provide a picture of the change in forest composition and current species composition in Pools 11 through 22. The increase in stands with silver maple and cottonwood as dominant components is clear. What the tables do not show, however, is that the 25,000-30,000 acres not considered to be merchantable timber in 1943 has all grown to be forest.

TABLE 7-2. Mississippi River forest composition in the 1980's-1990's, percent of forest stands with named species as a dominant or co-dominant component.

Silver Maple	87%
Cottonwood	36%
Green Ash	33%
Black Willow	22%
Hackberry	12%
Elm	20%
River Birch	10%
Pin Oak	8%
Sycamore	3%
Pecan	2%
NOTE: stands can, and do, include more than one species and therefore this table is not additive.	

In addition to, and perhaps more significant than, the species composition is the size class of existing forest. Generally, Mississippi River forests are aging and not regenerating in a smooth transition. As can be seen from Table 7-3 below, approximately 41 % of the 52,818 acres in the database is 18.1 inches dbh or greater. Following are 11.8-18.1 inches dbh (34%), 4.7-11.8 inches (22%), and 1.0-4.7 inches dbh (3%) size classes. Size class is nearly a direct relationship to age (USACE 1999) and, therefore, it appears that much of the forest is aging and not regenerating in a smooth transition. Though not extensive, regeneration is occurring in some areas of the floodplain. The Rock Island District has been doing regeneration surveys at clear-cut sites for approximately 10 years. Data show that silver maple, ash, cottonwood, mulberry, willow, and elm are regenerating when there is sufficient light (USACE 1999). Regeneration after the flood of 1993 has also been shown on the open river reach. Yin (1999) found that the mortality caused by the flood of 1993 allowed cottonwood and willow to regenerate.

Table 7-3. Size class (dbh) distribution, Pools 11-22.

Size Class	Percent
>18.1 in.	41
11.8-18.1 in.	34
4.7-11.8 in.	22
1.0-4.7 in.	3

The 9-Foot Channel Navigation Project has contributed to hydrological changes of the river floodplain and initially caused the conversion of some bottomland forest to aquatic and wetland habitat. However, on the positive side, many acres of farmed lands were purchased as part of the project and allowed to grow to forest. Were it not for the 9-Foot Channel Navigation Project and acquisition of lands by the Federal Government, much of the remaining forest would most likely have been cleared and would not exist today. Much of this remaining bottomland forest is managed for natural resource benefits in the St. Paul and Rock Island Corps Districts, and efforts are under way to maintain forest age class and diversity. The St. Louis District does not directly manage any of its forest lands; rather, it oversees the management of its fee title lands managed by state and federal agencies such as the Fish and Wildlife Service.

In addition, impoundment has enhanced winter feeding opportunities for the eagle. Prior to lock and dam construction, the rivers would freeze over leaving few, if any, areas of open water for eagles to feed in. The navigation dams created a turbulent tailwater area for some distance downstream that results in open water throughout the winter. Consequently, during particularly cold weather, eagles tend to congregate near the dams to feed.

While it is obvious that impoundment has contributed to hydrological changes in the floodplain of the project area and has affected forest composition, the magnitude of this impact cannot be evaluated due to lack of historical data. In total, however, the 9-Foot Navigation Project has been beneficial to the eagle.

7.2.2.2 Dredging and Disposal

Dredging not only affected the main channel of the river, but also affected side channels, sloughs and backwater lakes and ponds through increased turbidity levels and resuspension of pollutants. This may have affected the bald eagles' food source. Deepening of the channel may have resulted in changes in species composition from shallow-water fish to deep-water species, making them less available as prey. The local fish base is the main staple diet item to bald eagles. Fish are susceptible to local extermination, and can be affected by turbidity, intake of resuspended pollutants, and reduced oxygen levels. Suspended solids and sedimentation due to dredging can cause clogging and abrasion of gills and other respiratory surfaces in fish, can affect spawning beds, and feeding. This may have affected bald eagle feeding patterns during the dredging operations. However, the magnitude of this impact cannot be determined due to a lack of historical data.

Dredging occurs during the open water season and, therefore, no disturbance to wintering bald eagles has occurred. Dredging operations can begin in April during the critical nesting period, which may have disturbed bald eagle nesting activities. Dredging in the vicinity of a nest may have caused nest failures or abandonment due to disturbance, depending upon the time of year, duration of dredging, and proximity of the nest to dredging activity. However, the average date of first dredging is mid-May, after the most critical period. Dredging operations may add an incremental increase to the disturbance of eagles, although dredging operations are typically of short duration, usually lasting only a couple of days. The magnitude of this impact cannot be determined due to a lack of historical data.

Disposal of dredged material may have affected bald eagles in two ways: (1) causing sufficient disturbance during placement activities to have an impact on nesting, feeding or perching; or (2) changing the conditions of habitat.

Disturbance can result from increased human activity within 0.6 mile of an active nest site. Human disturbance has been shown to negatively affect bald eagle nesting. Eagles are most sensitive to disturbance during the critical nesting period when they are involved with courtship, egg-laying, and incubation. The critical nesting period for the study area is generally from March 15 to May 15. The moderately critical period is one month before and after the critical nesting period. From February 15 to March 15, the eagles are becoming physiologically conditioned for breeding. From May 15 to June 15, the newly hatched eagles require frequent brooding and feeding. Eagles tolerate moderate amounts of human presence during the low critical period from June 15 to October 1, when young are in the post-fledgling stage. The magnitude of this impact cannot be determined due to a lack of historical data.

Historically, dredged material has been placed on islands, in backwaters, wetlands, side channels, and along shorelines in the Rock Island and St. Paul Districts. In some instances a temporary in-water rehandling site was used. In-water disposal is a normal method of handling dredge material in the St. Louis District. Destruction or modification of habitat may have included removal of nesting, perching and roosting trees, or changes in the suitability of feeding areas. Sediment quality in terms of contaminants may also have been a factor in the effects to bald eagles. In areas with sediment contamination problems, effluent discharge from disposal sites may have affected the fisheries downstream of the discharge through reduced water quality, both in fish densities and contaminant buildup in fish tissue. This may have affected bald eagles by decreasing the food supply and through bioaccumulation of contaminants in the food chain. The magnitude of this impact cannot be determined due to a lack of historical data.

7.2.2.3 Clearing and Snagging

Removal of trees or other obstructions from the navigation channel may have affected bald eagles by removing nesting, perching, or roosting trees along the shoreline. However, the magnitude of this impact cannot be determined due to a lack of historical data.

7.2.2.4 Channel Structures/Revetment

Channel structures are designed to concentrate flows in the main channel and, therefore, primarily affect flow patterns along with sedimentation patterns. Construction related impacts of channel control structures may have occurred in areas near nesting or roosting sites. Closing dams were constructed to reduce flows into side-channel areas. Impacts such as reduced volume of flow, reduced current velocities, reduced sediment input, and increased water residence time in backwaters would have occurred in these habitats and may have affected the fish species inhabiting side channel areas. Subsequently, the increased flows in the main channel resulting from side channel closure may have affected main channel and channel border habitats as well. Changes in the dynamics of side channels may have altered the local fishery, thereby affecting bald eagle feeding opportunities. Placement of stone protection on shoreline areas may have affected bald eagles if bank reshaping, including tree removal, was included in the plan, especially if the project is within nesting or roosting zones. The magnitude of these impacts cannot be determined due to a lack of historical data.

7.2.2.5 Tow Traffic

Bald eagles may have been impacted by tow traffic resulting from either disturbance around activity areas or by destruction/modification of bald eagle habitat. Eagles are more tolerant of vehicular traffic than they are of humans and they have become accustomed to tow traffic in the project area, as evidenced by the steady increase in nesting numbers. The magnitude of these impacts cannot be determined due to a lack of historical data.

Shoreline erosion may have resulted from propeller wash as tows pass by eagle activity areas or while tows are awaiting lockage. As a result of this erosion, trees may have toppled and certain backwater habitats may have been affected by increased sediment transport. However, the magnitude of these impacts cannot be determined due to a lack of historical data.

7.2.2.6 Fleeting

Development of fleeting areas may have affected bald eagles in two ways: (1) causing sufficient disturbance to have an impact on nesting, feeding or perching; or (2) changing the conditions of habitat. The discussion above regarding dredging and disposal (Section 7.2.1.2.1) is applicable here. In addition, barges have been tied off to shoreline trees in the past which may have resulted in their being girdled and killed representing a loss of potential perch trees. The magnitude of these impacts cannot be determined due to a lack of historical data.

7.2.2.7 Port Facilities

Terminal or port facilities have typically been constructed in urban or industrial areas, usually within floodplain habitat. There are two Corps of Engineers port facilities within the range of the bald eagle: one in the St. Paul District (Fountain City, MN) and one in the Rock Island District (LeClaire Service Base, IA), and numerous private facilities. In non-urban situations, eagle habitat has likely been destroyed or modified in the construction of port facilities. It is likely that eagle use of these areas would have been avoided due to disturbance from the high level of human activity. The magnitude of these impacts cannot be determined due to a lack of historical data.

7.2.2.8 Exotic Species - not applicable

7.2.2.9 Contaminants

There have been numerous studies linking declines in productivity and complete nesting failures with exposure to a range of environmental contaminants. Most of the contaminants responsible for the long-term decline of the bald eagle are no longer used in the U.S. However, due to their widespread use and persistent nature, some may still be a contributing factor impacting eagle survival and productivity. Many organisms have been shown to be sensitive to a wide range of contaminants including ammonium, pesticides, and petroleum products, all of which are commonly transported on the UMR. On the positive side, water quality in the UMRS is improving and should continue to improve in the future.

Contaminants can enter the system via a spill, or those already in river sediments can be resuspended by towboat propellers or by dredging activities. Contaminants then enter the eagle through ingestion of contaminated prey, as was the case with DDT. There is no historical information available by which to analyze the effects of project-related contamination on the bald eagle.

7.2.2.10 Recreation Related Indirect Effects

Development and use of recreational facilities such as campgrounds, boat launch facilities, marinas, and beaches, have impacted bald eagles in two ways: 1) modification of habitat and 2) disturbance. Habitat modification would include loss of shoreline trees which may have been used by eagles for perching and roosting. Human activity or recreational boat traffic may have disturbed eagles resulting in their abandoning such areas or aborting nesting activities. The magnitude of this impact cannot be evaluated due to a lack of historical information.

7.2.2.11 Cabin Leases

Development and use of cabin lease sites has impacted bald eagles in two ways: 1) modification of habitat and 2) disturbance. Habitat modification includes loss of shoreline trees which may have been used by eagles for perching and roosting. Human activity may have disturbed eagles resulting in their abandoning such areas or aborting nesting activities. The magnitude of this impact cannot be evaluated due to a lack of historical information.

7.2.2.12 General Plan Lands Management

The Corps has the responsibility and authority to manage the natural resources on fee title lands. The goals of the Corps' forest management in the project area are described in section 1.2.3 of this document.

As with most habitat management projects, the prescribed forest management practices may have caused temporary adverse impacts, but provided long-term benefits to the habitat (i.e. forest regeneration). All forest management prescriptions are evaluated for presence of threatened or endangered species, or species of special concern and actions are taken to avoid impacts to species. This includes designation of special management zones, observance of seasonal restrictions and provision of buffers. Forest management practices are carried out through close coordination with state and federal resource agencies including the U.S. Fish and Wildlife Service. Forestry practices diversify the habitat and strive to maintain size class diversity. Specific actions are described in the operating management plan (OMP) and five year plan and environmental assessment prepared for forestry, fish and wildlife management within the St. Paul and Rock Island Districts. Forest management practices that maintain forest age class and diversity have contributed to the conservation of the species through provision and maintenance of suitable habitat into the future.

Management of General Plan lands by the U.S. Fish and Wildlife Service and state natural resource agencies may have resulted in changes to bald eagle habitat. Within the range of the bald eagle, these areas include the Illinois River National Wildlife and Fish Refuge, Mark Twain National Wildlife Refuge, Upper Mississippi National Wildlife & Fish Refuge, Minnesota Valley National Wildlife Refuge, and various areas managed by state agencies. Detailed descriptions of the Refuges are included in their respective refuge Master Plans. In general, the management practices on General Plan lands that have maintained forest age class and diversity have contributed to the conservation of bald eagle habitat. However, those activities that have increased human activity near nesting sites during critical periods, or cleared bottomland forest may have negatively impacted the bald eagle.

The magnitude of this impact cannot be evaluated due to a lack of historical information.

7.3 Effects of the Action

This section includes an analysis of the anticipated direct and indirect effects of the proposed action on the species and its interrelated and interdependent activities.

7.3.1 Direct Effects

7.3.1.1 Operation of the 9-Foot Channel Project

7.3.1.1.1 Impoundment and Water Level Regulation

The long-term impact of impoundment and water level regulation upon the bottomland forest and species composition is not yet fully understood. However, trees will continue to produce seeds as they have in the past, so the reproductive potential of the bottomland species is present as long as there are mature trees. As mentioned in Section 7.2.1, it appears that much of the forest is aging and not regenerating in a smooth transition. If forests are allowed to undergo natural succession, bald eagle habitat could decline over the 50-year life of the project. However, the St. Paul and Rock Island Corps Districts have operational management plans which incorporate forest management practices that will benefit the eagle. In addition, the Corps' Conservation Measure for the Indiana bat (section 1.3.1) wherein "forest management efforts within the range of the bat will be carried out to establish and maintain forest species and size class diversity in order to ensure a long-term supply of potential Indiana bat roost trees", should benefit the bald eagle as well. Yin (1999) concluded that the composition of the present day forest will be sustained over the next 50 years.

Impoundment also affects the geomorphology of the river system. Island habitat has declined since impoundment, and will likely continue to decline in the future. In a change assessment of the aquatic guilds in pools 4 through 26 (USACE 1999), it was estimated that island habitat would decrease from 107,135 acres in 1998 to 104,940 acres in 2050 (-2%). This assessment predicted out of the 2,195 acres of island habitat lost in the 50-year period, 1,942 acres (88.5%) would be from pools 4-10. Island habitat in pools 4-10 is currently estimated at 46,588 acres and it is predicted to decline by 8.5% by 2050. In pools 11-26, island habitat is predicted to increase by nearly 3% to 62,315 acres by 2050.

The general habitat needs for the bald eagle include mature trees for nesting, perching and roosting. Assuming that the island habitat that is being lost mostly consists of suitable habitat for the bald eagle, a 2% decline will impact bald eagle nesting, perching, and roosting in the project area. However, bald eagle numbers in the project area have increased dramatically in the past two decades despite the continual loss of bottomland forest and island habitat. Flooding will continue to be the most significant factor affecting bottomland hardwood forest, as it has been for centuries, and that forest should continue to support bald eagle habitat.

While impoundment and water level regulation will continue to contribute to hydrological changes in the floodplain of the project area which, in turn, will affect forest composition and extent, that impact will be mitigated by the Corps' operational management plans for forest management. Therefore, impacts to individual birds will be offset and will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual birds or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival and recovery of the species within the action area will not be threatened.

7.3.1.2 Maintenance of the 9-Foot Channel Project

7.3.1.2.1 Dredging and Disposal

Channel dredging and disposal will continue over the life of the project and may affect bald eagles through disturbance of nesting birds. Both the St. Paul and Rock Island Districts currently have dredged material placement coordination processes in place. Prior to the discharge of any dredged material, representatives of the Corps and state and federal resource agencies meet to determine the preferred placement site for the dredged material. Consideration of endangered species impacts is a part of this process. Potential impacts of dredged material placement can be minimized or avoided and, if necessary, Tier II Section 7 Consultation will be conducted while the species is still listed. All dredged material in the St. Louis District is disposed of in the water and does not affect bald eagle habitat. Therefore, while dredging and disposal may affect individual birds through disturbance, it will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual birds or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

7.3.1.2.2 Clearing & Snagging

The majority of snagging presently occurs on the Minnesota River and is performed on the St. Croix River upon request of the National Park Service. The future need for snagging on these rivers is unknown. However, given appropriate coordination with the Service in all Corps Districts, any potential impacts can be minimized or avoided. Therefore, while clearing and snagging may affect individual birds through disturbance, it will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual birds or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

7.3.1.2.3 Channel Structure/Revetment

The planning and design of regulatory structures includes consideration of environmental impacts and compliance with various regulations. The process varies within each Corps district, but involves coordination with other agencies. In St. Paul District, the process includes project review by the River Resources Forum which is composed of Federal and State representatives of agencies with management or regulatory responsibilities along the Mississippi River. The Rock Island District has the Committee to Assess Regulatory Structures (CARS), which consists of representatives from the engineering, operations, and environmental offices and the U.S. Fish and Wildlife Service. Consideration of endangered species impacts is a part of this process. In addition, a document produced by the St. Louis District describes their environmental river engineering project in which biologists and engineers cooperate to improve navigation and habitat diversity through the use of river structures (USACE 1999).

Given appropriate coordination, impacts to the bald eagle in all Districts can be minimized or avoided. Tier II Section 7 Consultation will be conducted where necessary while the species is still listed. Therefore, while construction and maintenance of river structures and revetment may affect individual birds through disturbance, it will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual birds or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

7.3.1.2.4 Lock and Dam Rehabilitation

The main impact of future rehabilitation work for the lock and dams within the project area would be mainly through disturbances resulting from increased human activity and associated construction equipment. Depending upon the scope and/or timing of the proposed work, rehabilitation of the locks and dams could affect bald eagle nesting, feeding, or winter roosting. Changes in habitat conditions would not result because rehabilitation entails repair of the existing structures currently in place, not increasing the footprint of the project area. In these cases, there would be negligible disturbance to areas outside the existing disturbed area so no additional bald eagle habitat would be impacted.

Bald eagle nests are not likely to be located near a lock and dam because of high human activity. Rehabilitation activities during winter may impact feeding activities of eagles downstream of the structure in the open water areas. However, this impact is expected to be minor because eagles are somewhat tolerant of human activity during the winter at feeding areas. Since rehabilitation occurs at only one lock and dam at a time, additional feeding areas would be available at structures upstream and downstream, as well as other open water areas in the vicinity of the lock and dam being rehabilitated.

A Progammatic Environmental Impact Statement on major rehabilitation of Locks and Dams 2-22 was completed by the Rock Island District, Corps of Engineers was completed in 1989 (USACE 1989b). The biological opinion rendered by the U.S. Fish and Wildlife Service concluded that rehabilitation would have no effect on the bald eagle (USFWS 1989) and is incorporated herein by reference.

7.3.2 Indirect Effects

7.3.2.1 Navigation Related Indirect Effects

7.3.2.1.1 Tow Traffic

Tow traffic is projected to increase over the life of the project. The impact of this increase on bald eagle nesting, or nesting habitat, within the project area is unknown. However, due to the fact that eagles have demonstrated some tolerance of passing tows, and the number of nests in the UMRS has increased dramatically in the last decade, it is apparent that any impacts to the bald eagle due to tow traffic are likely to be negligible and will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual birds or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

7.3.3.1.2 Fleeting

The future need for fleeting areas will likely increase as tow traffic increases over the life of the project. However, potential impacts of development of fleeting areas will be minimized or eliminated through appropriate coordination with the Service. The States of Minnesota, Wisconsin, and Iowa regulate barge-fleeting activities through their own regulations and Illinois and Missouri regulate it through review of the Federal permitting process (Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act). Given appropriate coordination, potential impacts can be minimized or avoided. Tier II Section 7 Consultation will be conducted as necessary while the species is still listed. Therefore, while fleeting may affect individual birds through disturbance, it will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual birds or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

7.3.2.1.3 Port Facilities

The two Corps of Engineers port facilities within the range of the bald eagle will continue to operate which could potentially disturb bald eagle nesting, feeding, and roosting behavior. However, neither base has plans for expansion, so no additional habitat would be impacted. There are no known nests near the bases, which are located within urban areas of high human use. Operational activities at each service base do not increase human activity at either site substantially. Any future expansion at these facilities would have to be determined on a case by case basis to determine potential impact upon the bald eagle.

The future need for private port facilities is unknown although it will likely increase as tow traffic increases. If construction requires the removal of trees suitable for bald eagle perching or nesting, it may adversely affect the species. However, construction of terminals would be subject to floodplain regulations and environmental review. Given appropriate coordination, potential impacts can be minimized or avoided. Tier II Section 7 Consultation will be conducted as necessary while the species is still listed. Therefore, while construction and operation of port facilities may affect individual birds through disturbance, it will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual birds or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

7.3.2.1.4 Exotic Species - not applicable

7.3.2.1.5 Contaminants

The potential impacts of contaminants from navigation related effects include mortality and reduced nesting success. Navigation has been made safer on the UMR and the potential for a hazardous spill has been greatly reduced. However, there are still accidents occurring which may result in a spill. Due to the nature of these spills, most organisms would be acutely exposed to contaminants where there would be less bio-accumulation than in a chronic situation. If concentrations of the spilled material are high enough, many aquatic organisms would be killed through acute exposure. A bald eagle preying on a fish killed by an acute exposure, would ingest less of the material but could be affected to some degree up to and including death. Due to the low frequency of spills on the UMRS, impacts to the bald eagle due to contamination may affect individual birds to a minor extent but will not threaten the survival and recovery of the species in the action area.

7.3.2.2 Recreation Related Indirect Effects

Considering current population trends, human use of, and demand for recreational facilities in the UMRS corridor will likely increase, which will increase the potential for impact on the bald eagle. Human activity at public use sites has the potential to disrupt bald eagle nesting, feeding, and roosting behavior depending upon the level and timing of activity and the location of bald eagle use sites. Based upon recent trends of bald eagles using habitats near areas of human disturbance, however, the overall impact may not have the same consequence as previous research has speculated (Mathieson *et al*. 1977).

Operation of Corps' recreational facilities includes routine maintenance, such as mowing, but there is no plan to expand or increase the number of such facilities (USACE 1999). The future need for private or local government facilities is unknown but could impact eagles through loss of habitat and an incremental increase in disturbance. Recreational boat traffic and beach use could impact bald eagles through disturbance during the nesting season.

Development of recreational facilities would be subject to floodplain regulations and environmental review. Given appropriate coordination, potential impacts can be avoided. Tier II Section 7 consultation will be conducted as necessary while the species is listed. Based on the dramatic increase of bald eagle nesting in the UMRS corridor in the last two decades, recreational impacts appear to be negligible. Therefore, while construction of recreational facilities and recreational use of the UMRS may affect individual eagles through disturbance, it will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual birds or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

7.3.3 Interrelated Effects

7.3.3.1 Timber Management - see 7.3.3.3 below

7.3.3.2 Cabin Leases

The lease of cabin sites by the Corps of Engineers has the potential to impact bald eagle nesting, roosting and feeding through disturbance and habitat loss in the Rock Island and St. Louis Districts, although eagles will likely avoid areas of human activity. There are no cabin lease agreements in the St. Paul District. Private recreational and residential leases within both districts affect approximately 700 acres. There will be no new leases issued, but those in existence will be maintained. All leases returned to the Corps are released and natural resource management prescriptions are implemented. This usually includes closure or removal of the access road and conversion to natural habitat (USACE 1999). All new maintenance actions taken by lessees are subject to review and therefore impacts to bald eagles would be considered at that time. Therefore, while continued maintenance of cabin leases may affect individual birds through disturbance, it will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual birds or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area.

7.3.3.3. Management of General Plan Lands

Management of General Plan Lands will follow existing prescriptions of the responsible federal and state agencies, although the Service's Refuges are currently in the process of revising their management goals and objectives. In general, those prescriptions that provide for maintenance of forest age class and diversity will be of benefit to the eagle. Therefore, any adverse impacts associated with General Plan Land management will not rise to the level of harm or harassment; i.e. will not cause death or injury of individual birds or significantly disrupt normal behavior patterns including breeding, feeding or sheltering. The survival of the species will not be threatened in the action area..

7.3.3.4 Public Use Sites - see 7.3.2.2 above.

7.3.3.5 Corps Port Facilities - see 7.3.2.1.3 above.

7.3.4 Interdependent Effects - none

7.3.5 Cumulative Effects

Cumulative effects include the effects of future State, local or private actions that are reasonably certain to occur in the action area considered in, this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of ESA.

The Service is unaware of any non-Federal actions that are reasonably certain to occur which may affect the bald eagle. However, most activities within the UMRS corridor are regulated under the Clean Water Act or River and Harbors Act or other floodplain regulations. Given appropriate environmental coordination, impacts to the bald eagle can be avoided. Therefore, any cumulative effects due to non-Federal actions will not threaten the survival and recovery of the species and are considered negligible.

7.3.6 Summary of Effects

In summary, on-going project impacts to the bald eagle may result from continued operation and maintenance of the 9-Foot Navigation Project in the form of disturbance and minor habitat alteration. However, as explained previously, these impacts are likely to be negligible or offset by habitat management activities. Furthermore, all the above activities, with the exception of continued impoundment and water level regulation, will be subject to environmental review by the Service, and, if necessary, additional measures to further minimize potential impacts will be implemented via a Tier II Section 7 consultation as long as the species is listed.

Similarly, indirect and interrelated activities such as tow traffic and fleeting, construction and operation of port facilities, release of environmental contaminants, river recreation, and General Plan Land management may affect individual eagles through disturbance and minor habitat alteration. These impacts are likely to be negligible or offset by habitat management activities. Any activities requiring authorization under the Clean Water Act or River and Harbors Act will be reviewed by the Service and, if necessary, undergo a Tier II Section 7 consultation as long as the species is listed.

7.4 Conclusion

After reviewing the current status of the bald eagle, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the Northern population of the species.

Potential impacts will be negligible, offset by forest management prescriptions, or will be avoided or minimized through appropriate environmental coordination. As any adverse effects will be minimized, the long-term persistence of the bald eagle within the action area will not be threatened. Thus, the proposed action is also unlikely to appreciably reduce the likelihood of survival and recovery of the species rangewide. No Critical Habitat has been designated for the bat within the action area.

7.5 Incidental Take

Section 9 of the Act and Federal regulation pursuant to Section 4(d) of the Act prohibits the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such activity. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, and sheltering. Incidental take is defined as take incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), take incidental to and not an intended part of the agency action is not considered prohibited taking under the Act, provided such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Corps for the exemption in Section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps fails to assume and implement the terms and conditions, the protective coverage of Section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement (50 CFR, 402.14(I)(3)).

The Service does not anticipate that the proposed action will incidentally take any bald eagles.

7.6 Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The following conservation measures are recommended:

1. Initiate and continue forest management practices on Corps managed lands that will preserve species diversity and maintain size-class structure for roosting and nesting. This measure will address the aging and regeneration of eagle habitat.

2. Implement nesting and wintering management guidelines in the course of all operations. This measure will protect eagles from disturbance and harassment.

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8.0 Pallid Sturgeon

8.1 Status of the Species

8.1.1 Species Description

The pallid sturgeon, *Scaphirhynchus albus*, was originally described as a species by Forbes and Richardson in 1905. The type specimens for identification were collected at or near Grafton, Illinois, on the lower Illinois and Mississippi Rivers (Forbes and Richardson 1905). The species is described as having a flattened, shovel-shaped snout; long, slender, and completely armored caudal peduncle; and lacks a spiracle (Smith 1979). The mouth is toothless, protrusible, and ventrally positioned under the snout, as with other sturgeon. Pallid sturgeon are similar in appearance to the more common and darker shovelnose sturgeon (*S. platyrhynchus*). Pflieger (1975) reported the principal features distinguishing pallid sturgeon from shovelnose sturgeon as the paucity of dermal ossifications on the belly, 24 or more anal fin rays and 37 or more dorsal fin rays.

8.1.2 Historic and Current Rangewide Distribution

The historic range of the pallid sturgeon as described by Bailey and Cross (1954) encompassed the middle and lower Mississippi River, the Missouri River and the lower reaches of the Platte, Kansas and Yellowstone Rivers. The type specimens utilized by Forbes and Richardson (1905) were caught at or near Grafton, Illinois, which is approximately 22 miles above the mouth of the Missouri River. Bailey and Cross (1954) noted a pallid sturgeon captured at Keokuk, Iowa at the Iowa and Missouri state border. Duffy, *et al*. (1996) stated that the historic range of pallid sturgeon once included the Mississippi River upstream to Keokuk, Iowa, before the river was converted into a series of locks and dams for commercial navigation (Coker 1930).

Carlson and Pflieger (1981) stated that pallid sturgeon are rare, but widely distributed in the Missouri River and in the Mississippi River downstream from the mouth of the Missouri River. According to USFWS (1993), since 1980, reports of most frequent occurrence are from the Missouri River between the Marias River and Ft. Peck Reservoir in Montana; between Ft. Peck Dam and Lake Sakakawea (near Williston, North Dakota); within the lower 113 km of the Yellowstone River to downstream of Fallon, Montana; in the headwaters of Lake Sharpe in South Dakota; and from the Missouri River near the mouth of the Platte River near Plattsmouth, Nebraska. Areas of most recent and frequent occurrence on the Mississippi River are near Chester, Illinois; Caruthersville, Missouri; and in both the Mississippi and Atchafalaya Rivers in Louisiana at the Old River Control

Complex where the Atchafalaya diverges from the Mississippi River. Of 622 pallid sturgeon sightings prior to 1994, 70.7% were reported from the Missouri River, 12.6% from the Atchafalaya River, 10.8% from the Mississippi River, 5% from the Yellowstone River, and less than 1% from the St. Francis, Platte, Ohio, Kansas, and Big Sunflower Rivers (Constant *et al*. 1997). The total present range of the pallid sturgeon is 5635 km (3500 miles).

8.1.3 Life History

8.1.3.1 Reproductive Biology

Little is known about reproduction or spawning activities of pallid sturgeon. Even basic parameters such as spawning locations, substrate preference, water temperature, or time of year have not been well documented. No spawning beds have been located, although Bramblett (1996) speculated that potential spawning areas were in the Yellowstone River from about river km 6 to river km 14. Breder and Rosen (1966) report that as a group, sturgeon exhibit uniform spawning behavior; and thus, such information can be used to make inferences about pallid sturgeon behavior. All sturgeon species spawn in the spring or early summer, are multiple spawners, and release their eggs at intervals. The adhesive eggs are released in deep channels or rapids and are left unattended (Gilbraith *et al*. 1988). The larvae of Acipenserids are pelagic, becoming buoyant or active immediately after hatching (Moyle and Cech 1982). Although the downstream migration and behavior of young sturgeon is poorly understood, recent work by Kynard *et al*. (1998) indicates that the migration period for young pallid sturgeon begins day-0 at hatching and continues up to day-13, with a decline after day-8. With this information it has been possible to estimate that larval pallid sturgeon may drift in the water column for a distance of over 400 miles (Steve Krentz, USFWS, pers. comm.).

Time of spawning has not been well documented, but is believed to occur sometime between March through July depending on location (Forbes and Richardson 1905, Gilbraith *et al*. 1988; Keenlyne and Jenkins 1993). Females collected in June and July in Lake Sharpe, a reservoir on the Missouri River in South Dakota, contained mature ova and presumably were ready to spawn. However, there has been no evidence of successful reproduction during 10 years of sampling for young-of-the-year fish in Lake Sharpe (Kallemeyn 1983).

Kallemeyn (1983) reported that pallid sturgeon males reach sexual maturity at 53.3-58.4 cm, however, size and age of females at sexual maturity were unknown at that time. Conte *et al*. (1988) indicated that females of most sturgeon in North America do not mature until 7 years of age and typically require several years for eggs to mature between spawnings. The age of sexual maturity and intervals between spawning were estimated for nine pallid sturgeon by recording what were interpreted to be spawning events from pectoral fin ray cross sections. Sexual maturity for males was estimated to be 7 to 9 years, with 2 to 3 year intervals between spawning years. Females were estimated to reach sexual maturity in 15 to 20 years, with 3 to 10 year intervals between spawning years (Keenlyne and Jenkins 1993). Time of sexual maturity and the age intervals between spawning years is likely to be influenced by available forage, environmental conditions and other factors (USFWS 1993), and thus, likely varies to some degree between river reaches.

Keenlyne *et al*. (1992) estimated fecundity for a female pallid sturgeon taken from the upper Missouri River. The authors found the mass of mature eggs weighed 1,952 g, which represented 11.4 percent of total body weight. Total fecundity was estimated at 170,000 eggs for this female. Females may take up to 10 years between spawnings depending on the quality and quantity of food available in their natural habitat (Keenlyne and Jenkins 1993). Therefore, fecundity of a female may vary considerably, with an individual female spawning only a few times during her normal life span (Duffy *et al*. 1996).

8.1.3.2 Food and Feeding Habits

Carlson *et al*. (1985) determined composition of food categories, by volume and frequency of occurrence, in the diet of shovelnose sturgeon (n=234), pallid sturgeon (n=9), and presumed hybrids (n=9). Although benthic macroinvertebrates characteristic of lotic habitats are important dietary components (Modde and Schmulbach 1977, Carlson *et al*. 1985), the occurrence of lentic and terrestrial invertebrates in sturgeon stomachs suggest that drifting invertebrates may also be important forage organisms (Modde and Schmulbach 1977, Contant *et al*. 1997). Aquatic invertebrates (principally the immature stages of insects) compose most of the diet of shovelnose sturgeon, while pallid sturgeon and presumed hybrids consume a greater proportion of fish (mostly cyprinids). Other researchers also reported a higher incidence of fish in the diet of pallid sturgeon than in the diet of shovelnose sturgeon (Cross 1967, Held 1969). Most piscivorous Missouri River species eat large quantities of aquatic insect larvae in early life and even as adults (Modde and Schmulback 1977).

8.1.3.3 Age and growth

Little is known about age and growth of pallid sturgeon. The total length of pallid sturgeon was significantly greater than that of shovelnose in the lower Missouri and Mississippi Rivers for each age group in which comparable data were available (Carlson *et al*. 1985). Fogle (1963) estimated growth rates using cross sections of pectoral fin rays from six pallid sturgeon from Lake Oahe in South Dakota. He estimated that growth of these fish was relatively rapid during the first 4 years, but that growth decreased to approximately 70 mm per year between ages 5 and 10. Carlson and Pflieger (1981) presented data (n=8) from the Missouri and Mississippi Rivers in Missouri, which showed slightly slower growth than from pallid sturgeon in South Dakota.

It should be noted that recent efforts to validate pallid sturgeon age estimates from pectoral fin rays have questioned the accuracy and precision of this aging technique. Hurley (1999) documented that the majority of pallid sturgeon age estimates based on pectoral fin rays were incorrect, with the most frequent error being three years. He noted a tendency to underage, rather than overage pallid sturgeon samples. Large variations between first and second age estimates for the same fish by each reader (within reader variation) were noted. Hurley (1999) found only 28% accuracy and up to four years of variation utilizing pectoral fin rays for aging. Precision between readers was also low with estimates of the same fish by both readers differing by up to two years (Hurley 1999). However, a 3 to 4 year variation in age estimates may not be significant given the long life span of pallid sturgeon (40-50 years).

8.1.3.4 Movements

Pallid sturgeon exhibit seasonal variation in movement patterns based upon temperature and discharge (Bramblett 1996, Constant *et al*. 1997, Sheehan *et al*. 1998). Movement patterns also vary between spawning versus non-spawning years (Bramblett 1996). Bramblett (1996) reported an average home range of 48.8 miles in the Yellowstone and Upper Missouri Rivers while Sheehan *et al*. (1998) reported a home range of 21.2 miles in the MMR. Sheehan *et al*. (1998) speculated that because habitat in the MMR is relatively uniform, large movements and home ranges may not be a beneficial in the MMR, as in Bramblett's area, as it is unlikely that study fish may happen across new habitats.

As a large river fish, pallid sturgeon are capable of moving large distances in search of favorable habitat. Sheehan *et al*. (1998) noted one study fish moving along a 60.3 mile stretch of river. Bramblett (1996) noted a maximum home range as large as 198.6 miles.

8.1.4 Population Status and Trends

Because the pallid sturgeon was not recognized as a distinct species until 1905, it was not listed in early commercial fishery reports, so little is recorded about its abundance prior to this time. Even as late as the mid-1900's, it was common for pallid sturgeon to be tallied in commercial catch records as either shovelnose or lake sturgeon (Keenlyne 1995). Correspondence and notes of researchers suggest, however, that the pallid sturgeon was still fairly common in many parts of the Mississippi and Missouri River systems as late as 1967 (Keenlyne 1989). Review of the literature indicates that declines in populations has occurred in recent years coincidental with development of the Missouri and Mississippi River systems for flood control and navigation (Deacon *et al*. 1979, Keenlyne 1989). [Excerpt from Duffy *et al*. 1996].

Pallid sturgeon were proposed for listing as an endangered species on August 30, 1989 (54 FR 35901-35904). The species was listed as endangered on October 9, 1990 (55 FR 36641-36647). The reasons for listing were habitat modification, apparent lack of reproduction, commercial harvest and hybridization in parts of its range. Most authors attribute the decline of pallid sturgeon to the massive habitat alterations that have taken place over virtually all of its range (Kallemeyn 1983, Gilbraith *et al*. 1988, Keenlyne 1989, USFWS 1993).

Since 1988, pallid sturgeon researchers have collaborated on studies to gather information about the species including estimates of fish numbers (Keenlyne 1995). This has allowed workers to identify where populations still remain and to obtain rough estimates of present abundance of the species. Tag and recapture data have allowed researchers to estimate that 50 to 100 pallid sturgeon remain in the Missouri River above Ft. Peck Dam in Montana and between 200 and 300 pallid sturgeon remain between the Garrison Dam in North Dakota and Fort Peck Dam which also includes the lower Yellowstone River (Steve Krentz, U.S. Fish and Wildlife Service, pers. comm.). One to five sightings per year have been made of pallid sturgeon between the headwaters of Oahe Reservoir in South Dakota to the Garrison Dam and from the riverine reach in the Missouri River above Gavins Dam to Fort Randall Dam suggesting that, perhaps as many as 25 to 50 fish may remain in each of these areas. A small population also exists between Oahe Dam and Big Bend Dam on the Missouri River in South Dakota with perhaps 50 to 100 fish remaining in this riverine section. Unfortunately, no evidence has been obtained that any of these upper Missouri River system populations are reproducing for only large individuals are being reported (Keenlyne 1989). [Excerpt from Duffy *et al*. 1996]

Obtaining estimates of abundance in the channelized Missouri River downriver from Sioux City, Iowa, to the mouth and the Mississippi River downstream from the mouth of the Missouri River is complicated by the difficulties of sampling rapidly flowing river sections. Abundance estimates by Duffy *et al*. (1996) were not considered reliable due to the lack of mark/recapture data. A comparison of pallid sturgeon and shovelnose sturgeon catch records provide an indication of the rarity of pallid sturgeon. Of 4355 sturgeon collected by Carlson *et al*. (1985) at 12 sampling stations on the Missouri and Mississippi Rivers from 1978-1979, 11 (0.25%) were identified as pallid sturgeon, 12 hybrids and the remainder shovelnose sturgeon. During systematic sampling on the Missouri and Yellowstone Rivers in 1995, the Montana Department of Game, Fish and Parks collected 10 (2.2%) pallid sturgeon compared to 444 shovelnose sturgeon (Liebelt 1995). Reed and Ewing (1993) collected 11 (11%) pallid sturgeon, 18 hybrids and 74 shovelnose sturgeon in the vicinity of the Old River Control Complex in Louisiana. Watson and Stewart (1991) noted one (0.29%) pallid sturgeon out of 350 sturgeon from the lower Yellowstone River in Montana.

Glen Constant, at Louisiana State University, estimated the pallid sturgeon population in the Atchafalaya River to range from 2750 to 4100 fish. This is based on tag returns and telemetry studies. However, a high incidence of hybridization is occurring in the Atchafalaya River and Mississippi Rivers (Keenlyne *et al*. 1994) which makes estimation of the number of pure pallid sturgeon in these river systems difficult (Duffy *et al*. 1996).

In recent years, pallid sturgeon populations have been augmented by release of hatchery reared fish. In 1994, the Missouri Department of Conservation (MoDOC) released approximately 7000 fingerlings in the Missouri and Mississippi Rivers and an additional 3000 fingerlings were stocked in 1997 (Graham 1997, 1999). Since stocking in 1994, approximately 86 pallid sturgeon returns have been reported, mostly in the Mississippi

River downstream of St. Louis (Graham 1999). Thirty-five 12 to 14-inch fish raised at Natchitoches National Fish Hatchery were stocked in the Lower Mississippi River in 1998 (Kilpatrick 1999). Also in 1998, 745 hatchery-reared yearling pallid sturgeon were released at three sites in the Missouri River above Ft. Peck Reservoir (Gardner 1999).

Despite stocking efforts, pallid sturgeon remain rare compared to the shovelnose sturgeon. In 1997 and 1998, the MoDOC, LTRM Station at Cape Girardeau collected 7 pallid sturgeon (0.45%) compared to 1549 shovelnose sturgeon in the MMR (Petersen 1999). Constant *et al*. (1997) noted that in surveys of commercial catch, shovelnose sturgeon accounted for between 52% and 98% of the total sturgeon catch, with the remainder composed of similar portions of hybrids (2% to 21%) and pallid sturgeon (0% to 26%).

Evidence of successful pallid sturgeon reproduction and recruitment is rare throughout the range of the species, and is believed to be the primary limiting factor. In 1998, the MoDOC collected a young-of-the-year pallid sturgeon at approximate river mile 49.5(L) south of Cape Girardeau in the MMR (Petersen and Herzog 1999). More recently, in August 1999, one confirmed and two probable pallid sturgeon larvae were collected from the Lower Missouri River (Jim Milligan, USFWS, pers. comm.). These two instances represent the first evidence of successful pallid sturgeon reproduction in recent years and indicate that some suitable spawning habitat remains in the Lower Missouri River and, potentially, the MMR.

Recent work in the Atchafalaya River has revealed fish of several age groups suggesting that some reproduction and recruitment may occur in the Atchafalaya River. However, the only physical evidence of reproduction was the observation of three gravid females (Constant *et al*. 1997). According to their data, pallid sturgeon collected in the Atchafalaya River and other areas of the Mississippi River have averaged less than 3 kg and length-at-age estimates calculated according to Fogle (1963) indicated that even the smallest fish were over age 6, with the oldest perhaps over age 14. The age of fish in their study indicates the most recent recruitment of pallid sturgeon to be from 1988 year class (Constant *et al*. 1997).

Larval sturgeon of any species rarely have been collected from within the range of pallid sturgeon. This may be due to low reproductive success or the inability of standard sampling gear to capture larval sturgeon. Hesse and Mestl (1993) collected two sturgeon larvae from the Missouri River adjacent to Nebraska between 1983 and 1991. These larvae were among 147,000 fish larvae collected during filtration of 519,400 cubic meters of river water. Gardner and Stewart (1987) collected no sturgeon larvae in 339 samples from the Missouri River or in 77 samples from tributary streams where 3,124 and 5,526 fish larvae were collected, respectively. In three years of sampling in/near Lisbon Chute on the Missouri River, the Service’s Columbia Missouri Fishery Resources Office collected over 10,000 small fish utilizing seines, benthic trawls and fyke nets. In processing 9855 of these fish, 1 confirmed and 2 probable larval pallid sturgeon have been identified (Joanne Grady, USFWS, pers. comm.). These data suggest that spawning success and larval sturgeon abundance are low.

Although Mayden and Kuhajda (1997) contend that there is no empirical evidence indicating that hybridization between shovelnose sturgeon and pallid sturgeon is common, they present no evidence to support this contention. Based on meristic and morphological characters, Carlson *et al*. (1985) noted hybrids as being prevalent in their samples, suggesting that hybridization between the species of *Scaphirhynchus* may occur frequently. Field surveys of *Scaphirhynchus* stocks suggest a relatively high incidence of hybridization between shovelnose sturgeon and pallid sturgeon in the MMR (Sheehan *et al*. 1997a, 1997b, 1998). Sheehan *et al*. (1997b) and Carlson and Pflieger (1981) noted a 3:2 ratio of hybrid sturgeon to pallid sturgeon. Sheehan *et al*. (1997b) speculated that if this is representative of the sturgeon population in the MMR, hybridization may pose a significant threat to pallid sturgeon as the species continues to introgress with shovelnose sturgeon.

Sturgeons exhibit unusual combinations of morphology, habits, and life history characteristics, which make them highly vulnerable to impacts from human activities (Boreman 1997). Sturgeons generally have low mortality rates, long life spans and are K strategists with a relatively low capacity for population increase (Boreman 1997). As such, pallid sturgeon are well adapted to living in large rivers, where fluctuating environmental conditions, such as discharge, can affect reproductive success. However, these characteristics also make sturgeon species more sensitive to additional mortality factors, particularly human activities. Many anthropogenic impacts, such as those resulting in diminished spawning and nursery habitat, primarily affect the production and survival of age-0 fish (Dr. Robert Sheehan, Southern Illinois University at Carbondale (SIUC), pers. comm.). Sturgeon populations worldwide have declined because of anthropogenic influences. The structure and magnitude of genetic diversity of natural populations of sturgeon serves to buffer these fish against environmental variation and should be maintained (Wirgin *et al*. 1997).

8.1.5 Habitat Requirements

Forbes and Richardson (1905), Schumulbach *et al*. (1975), Kallemeyn (1983), and Gilbraith *et al*. (1988) describe pallid sturgeon as being a fish well adapted to life on the bottom in swift waters of large, turbid, free-flowing rivers. Pallid sturgeon evolved in the diverse environments of the Missouri and Mississippi Rivers. Floodplains, backwaters, chutes, sloughs, islands, sandbars, and main channel waters formed the large-river ecosystem that provided macrohabitat requirements for pallid sturgeon and other native large-river fish. These habitats were historically in a constant state of change. Mayden and Kuhajda (1997) describe the natural habitats to which the pallid sturgeon is adapted as: braided channels, irregular flow patterns, flooding of terrestrial habitats, extensive microhabitat diversity and turbid waters. Today, these habitats and much of the once functioning ecosystem has been changed by human developments.

The historic floodplain habitat of the Missouri and Mississippi Rivers provided important functions for the native large-river fish. Floodplains were the major source of organic matter, sediments and woody debris for the mainstem rivers when floodflows crested the river’s banks. The transition zone between the vegetated floodplain and the main channel included habitats with varied depths described as chutes, sloughs, or side channels. The chutes or sloughs between the islands and shore were shallower and had less current than the main channel. These areas provided valuable diversity to the fish habitat and probably served as nursery and feeding areas for many aquatic species (Funk and Robinson 1974). The still waters in this transition zone allowed organic matter accumulations, important to macroinvertebrate production. Both shovelnose sturgeon and pallid sturgeon have a high incidence of aquatic invertebrates in their diet (Carlson *et al*. 1985, Gardner and Stewart 1987). Floodflows connected these important habitats and allowed fish from the main channel to utilize these habitat areas to exploit available food sources.

Floodflows also stimulated spawning migrations. Both shovelnose sturgeon and paddlefish spawning migrations occur in response to increased flows in June (Berg 1981). Although there is no information on pallid sturgeon spawning migrations, it is assumed these migrations would similarly occur in response to increased June flows.

Carlson *et al*. (1985) captured both pallid sturgeon and shovelnose sturgeon in gear-sets along sandbars on the inside of riverbends, and in deeply scoured pools behind wing dams, indicating overlap of habitat use by the two species. However, 4 of 11 pallids were captured in gear-sets in swifter currents where shovelnose sturgeon were less numerous. Although pallid sturgeon and shovelnose sturgeon habitat use and movements are similar in certain aspects, important differences were noted by Bramblett (1996). Pallid sturgeon showed significant preferences for sandy substrates, particularly sand dunes and avoided gravel and cobble substrate (Bramblett 1996). In contrast, shovelnose sturgeon significantly preferred gravel and cobble substrates and avoided sand.

Pallid sturgeon were also more specific and restrictive in their use of macrohabitat selection than shovelnose sturgeon (Bramblett 1996). According to this study, pallid sturgeon were found most often in sinuous channels with islands or alluvial bars present. Straight channels, and channels with irregular patterns or irregular meanders were only rarely used by pallid sturgeon. Seral stage of islands or bars near pallid sturgeon was most often subclimax (Bramblett 1996).

Bramblett (1996) noted that because macrohabitats utilized by pallid sturgeon were more specific and restrictive than shovelnose sturgeon, features in these macrohabitats may be more important to pallid sturgeon than to shovelnose sturgeon. Bramblett (1996) found macrohabitats used by pallid sturgeon were diverse and dynamic. For example, pallid sturgeon utilized river reaches with sinuous channel patterns and islands and alluvial bars which generally have more diversity of depths, current velocities, and substrates than do relatively straight channels without islands or alluvial bars. The diversity of channel features such as backwaters and side channels was also higher. The subclimax riparian vegetational seres in these areas are indicative of a dynamic river channel and riparian zone (Johnson 1993).

In telemetry studies of pallid sturgeon on the MMR, Sheehan *et al*. (1998) found a positive selection for main channel border and downstream islands tips and also for depositional areas between wingdams and deep holes off of wingdam tips. This seems to correlate well with Carlson *et al*. (1985). Sheehan *et al*. (1998) speculated that between wingdam areas and downstream island tips may be used as velocity refugia and/or feeding stations. Study sturgeon were found most often in main channel habitat, however, they exhibited selection against this habitat type. Their occurrence in such habitat was not surprising considering main channel comprised approximately 65% of the available habitat in the study reach (Sheehan *et al*. 1998).

Constant *et al*. (1997) reported that sturgeon were most frequently found in low slope areas and that such areas were used in proportion to their availability. No sturgeon were observed on extremely steep slopes. They found that sand made up over 80% of the substrate in low slope areas where over 90% of pallid sturgeon were located. Constant *et al*. (1997) stated that the preference for sand substrates in low slope areas suggests that pallid sturgeon use such areas as current refugia. Sand substrates were found to have lower invertebrate densities than substrates of silt-clay which were generally located on areas of steep slope which were exposed by swift currents. As such, it would have been energetically costly for pallid sturgeon to remain near these substrates for extended periods of time. However, telemetry observations showed 55% of sturgeon locations occurred within 10m of steep slopes, suggesting that pallid sturgeon remained near areas of high food abundance (Constant *et al*. 1997).

Some caution must be utilized in evaluating the results of habitat preference studies conducted in the highly altered river environments of today as there is no way to measure pallid sturgeon preference for habitats that no longer exist (Dr. Robert Sheehan, SIUC, pers. comm.). The results of studies by Sheehan *et al*. (1998), Constant *et al*. (1997) and Bramblett (1996) are indicative of the habitats being utilized by pallid sturgeon in the altered environment of today.

8.1.5.1 Microhabitat Characteristics

Microhabitat characteristics of pallid sturgeon are just recently being described. Much of the microhabitat research to date is being located in the significantly altered environments of today. This research does not necessarily indicate preferred or required habitats; instead it may only indicate which habitats of those presently available are used by the pallid sturgeon. Also, capture locations may have conditions representing seasonal habitat preferences.

8.1.5.1.1 Current Velocity

Findings from a study on the Missouri River in South Dakota indicate that pallid sturgeon most frequently occupy river bottoms where velocity ranges from 0 to 0.73 m/s (Erickson 1992). Other studies in Montana found that they are most frequently associated with water velocities ranging from 0.46 to 0.96 m/s (Clancey 1990). Bramblett (1996) noted pallid sturgeon occupying bottom velocities ranging from 0.0 to 1.37 m/s. These velocities are commonly found throughout the species' range.

Pallid sturgeon collected from the Missouri River above Garrison Reservoir in North Dakota during spring and fall seasons of 1988 to 1991 were found in deep pools at the downstream end of chutes and sandbars, and in the slower currents of near-shore areas. These areas may have been providing good habitat for energy conservation and feeding (USFWS 1993). Sheehan *et al*. (1998) indicated that there were no shifts in habitat selection and avoidance by MMR pallid sturgeon under three different velocity regimes (low, medium and high discharge ranges of 0 - 165,000, 165,001 - 270,000 and >270,000 cfs). Data collected by Constant *et al*. (1997) support observations that shovelnose sturgeon tolerate lower current velocities than pallid sturgeon (Carlson *et al*. 1985, Ruelle and Keenlyne 1994, Bramblett 1996). They found that pallid sturgeon catch-per-unit-effort (CPUE) declined following shutdown of the Old River Control Structure and that no pallid sturgeon were collected when current velocity was reduced to zero, although shovelnose sturgeon CPUE was highest at this time.

8.1.5.1.2 Turbidity

Pallid sturgeon historically occupied turbid river systems. Turbidity levels where pallid sturgeon have been found in South Dakota range from 31.3 Nephelometric turbidity units (NTU) to 137.6 NTU (Erickson 1992). Pallid sturgeon avoid areas without turbidity and current (Bailey and Cross 1954, Erickson 1992) which may help explain why pallid sturgeon are no longer found in the Upper Mississippi River slackwater pools and the Missouri River reservoirs, and have not expanded into other rivers in the Mississippi drainage, even though access is available (Duffy *et al*. 1996).

8.1.5.1.3 Water Depth

The range of water depths where pallid sturgeon were frequently found in South Dakota are 2 to 6 m (Erickson 1992). In Montana, pallid sturgeon were captured from depths that ranged from 1.2 to 3.7 m in the summer, but they were captured in deeper waters during winter (Clancey 1990). Other pallid sturgeon collected in the upper Missouri, Yellowstone and Platte Rivers were captured in depths ranging from 1 to 7.6 m (Watson and Stewart 1991, USFWS 1993). Bramblett (1996) found pallid sturgeon in depths ranging from 0.6 to 14.5 m. This contrasts with Constant *et al*. (1997) which found pallid sturgeon at mean depths of 15.2 m and observed pallid sturgeon at depths of 7 and 21 m with greater frequency than such areas were available. They also found pallid sturgeon almost completely avoiding areas <7m in depth.

8.1.5.1.4 Substrate

Pallid sturgeon are most frequently caught over a sand bottom, which is the predominant bottom substrate within the species' range on the Missouri and Mississippi Rivers. Constant *et al*. (1997) noted that pallid sturgeon spent considerable time associated with sand substrates. They noted that preference for sand substrates in low slope areas suggests that pallid sturgeon use such areas as current refugia (e.g., utilize sand-wave troughs created as bed-material moves along the river bottom (Gordan *et al*. 1992)). The pallid sturgeon collected on the Yellowstone River in July 1991 by Watson and Stewart (1991) was over a bottom of mainly gravel and rock, which is the predominant substrate at that capture site. Reed and Ewing (1993) found sturgeon occurring in the man-made rip-rap lined outfall channels of the Old River Control Complex in Louisiana. Bramblett (1996) found that pallid sturgeon preferred sandy substrates, particularly sand dunes and avoided substrates of gravel and cobble. Pallid sturgeon have adhesive eggs. Thus, spawning is thought to occur over hard substrates of gravel or cobble with moderate flow (Dr. Robert Sheehan, SIUC, pers. comm.).

8.1.5.1.5 Temperature

Pallid sturgeon inhabit areas where the water temperature ranges from 0° C to 30°C, which is the range of water temperature on the Missouri and Mississippi Rivers. Sheehan *et al*. (1998) noted that sturgeon habitat use in the MMR did not change with changes in temperature regimes and stated that temperature would not seem to have an affect on either habitat use or habitat selection by MMR pallid sturgeon. Curtiss (1990) found no relation between surface water temperatures and depth used by shovelnose sturgeon on the Mississippi River and no indication that shovelnose sturgeon were moving into deeper, cooler water (if available) as water temperature increased. Current research, however, indicates that pallid sturgeon spawning is directly linked to water temperature. As water temperature increases to 62-65°F, pallid sturgeon initiate spawning activity (Steve Krentz, USFWS, pers. comm.).

8.1.6 Rangewide Distribution and Abundance of Habitat

The historic range of the pallid sturgeon as described by Bailey and Cross (1954) encompassed the middle and lower Mississippi River, the Missouri River and the lower reaches of the Platte, Kansas and Yellowstone Rivers. Duffy, *et al*. (1996) stated that the historic range of pallid sturgeon once included the Mississippi River upstream to Keokuk, Iowa, before the river was converted into a series of locks and dams for commercial navigation (Coker 1930). Pallid sturgeon evolved in the diverse environments of these river systems. Floodplains, backwaters, chutes, sloughs, islands, sandbars, and main channel waters formed the large river ecosystem that provided the macrohabitat requirements for pallid sturgeon. These habitats were historically in a constant state of change. Today, natural fluvial processes have been altered by human modification of the river systems which have anchored the river channels in place. Such modifications have affected the abundance and distribution of pallid sturgeon habitat.

The current range of the pallid sturgeon includes the Mississippi River from its mouth upstream to Melvin Price Locks and Dam (river mile 202.0), the Missouri River, the lower Yazoo/Big Sunflower and St. Francis Rivers, the lower Kansas and Yellowstone Rivers and the Atchafalaya River. The total length of the species range is approximately 3500 miles. However, approximately 51% of this area has been channelized for navigation and

28% has been impounded. The remaining 21% of the range is below dams and, therefore, has altered temperature, flow and sediment dynamics (Keenlyne 1989, Bramblett 1996). Approximately 49% of the species' current range is considered unsuitable habitat due to impoundments. The remaining 51% of the species range has been significantly affected by channelization. The amount of potentially suitable pallid sturgeon habitat remaining within this area is currently unknown.

The 1993 Pallid Sturgeon Recovery Plan indicates six recovery-priority management areas. These areas provide the greatest probability for recovering the species, and include: (1) the Missouri River from the mouth of the Marias River to the headwaters of Ft. Peck Reservoir; (2) the Missouri River from Ft. Peck Dam to the headwaters of Lake Sakakawea, including the Yellowstone River upstream of the mouth of the Tongue River; (3) the Missouri River from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake; (4) the Missouri River below Gavins Point Dam to its confluence with the Mississippi River; (5) the Mississippi River from its confluence with the Missouri River to the Gulf of Mexico; and (6) the Atchafalaya River distributary system of the Gulf of Mexico.

8.1.7 Factors Affecting Pallid Sturgeon Rangewide

8.1.7.1 Habitat Loss and Degradation

Alteration of habitat has been a major factor in the decline of pallid sturgeon populations. Approximately 51% of its range has been channelized, 28% impounded and the remaining 21% affected by upstream impoundments by altering flow regimes, temperatures and sediment dynamics. All of these factors have adversely affected the fish by blocking movements to spawning and/or feeding areas, destroying spawning habitats, altering conditions or flows of potential remaining spawning areas, reducing food sources and/or the ability to obtain food, or altering remaining substrates and conditions necessary for the fish's survival (Keenlyne 1989).

8.1.7.2 Commercial Harvest

Historically, pallid, shovelnose, and lake sturgeon (*Acipenser fulvescens*) were commercially harvested on the Missouri and Mississippi Rivers (Helms 1974). The larger lake and pallid sturgeon were sought for their eggs which were sold as caviar, whereas shovelnose sturgeon were destroyed as a by catch.

Commercial harvest of all sturgeon has declined substantially since record keeping began in the late 1800's. Most commercial catch records for sturgeon have not differentiated between species. Combined harvests as high as 195,450 kg (430,889 lbs) were recorded in the Mississippi River in the early 1890's, but had declined to less than 9,100 kg (20,062 lbs) by 1950 (Carlander 1954). Lower harvests reflected a decline in shovelnose sturgeon abundance since the early 1900's (Pflieger 1975).

8.1.7.3 Pollution/Contaminants

Although more information is needed, pollution is a likely threat to the species over much of its range. Pollution of the Missouri River by organic wastes from towns, packing houses, and stockyards was evident by the early 1900's and continued to increase as populations grew and additional industries were established along the river (Whitely and Campbell 1974). Due to the identified presence of a variety of pollutants, numerous fish-harvest and consumption advisories have been issued over the last decade or two from Kansas City, Missouri, to the mouth of the Mississippi River. This represents about 45% of the pallid sturgeon's range.

Polychlorinated biphenyls (PCB's), cadmium, mercury, and selenium have been detected at elevated concentrations in tissue of three pallid sturgeon collected from the Missouri River in North Dakota and Nebraska. Detectable concentrations of chlordane, DDE, DDT, and dieldrin also were found (Ruelle and Keenlyne 1993). Abandoned landfills, mines, sewage treatment plants, and industries have a high potential to contaminate pallid sturgeon habitats in several states. The prolonged egg maturation cycle of the pallid sturgeon, combined with an inclination for certain contaminants to be concentrated in eggs, could make contaminants a likely agent adversely affecting developing eggs, development of embryos, or survival of fry, and thereby, reduce reproductive success.

8.1.7.4 Hybridization

Carlson *et al*. (1985) studied morphological characteristics of 4,332 sturgeon from the Missouri and Middle Mississippi Rivers. Out of this group, he identified 11 pallid sturgeon and 12 pallid/shovelnose sturgeon hybrids. Suspected hybrids have been noted in commercial fish catches on the lower Missouri and middle and lower Mississippi Rivers. Bailey and Cross (1954) did not report hybrids, which may indicate that hybridization is a recent phenomenon resulting from environmental changes caused by human-induced reductions in habitat diversity and measurable changes in environmental variables such as turbidity, flow regimes, and substrate types (Carlson *et al*. 1985). A study by Keenlyne *et al*. (1994) concluded that hybridization may be occurring in half of the river reaches within the range of pallid sturgeon and that hybrids may represent a high proportion of remaining sturgeon stocks. Hybridization could present a threat to the survival of pallid sturgeon, through genetic swamping if the hybrids are fertile, and through competition for limited habitat (Carlson *et al*. 1985). Keenlyne *et al*. (1994) noted few hybrids showing intermediacy in all characteristics as would be expected in a first generation cross. This provides some indication the hybrids are fertile and reproducing.

Campton *et al*. (1995) collected data that support the hypothesis that pallid and shovelnose sturgeon are reproductively isolated in less-altered habitats, such as the Upper Missouri River. Bramblett (1996) found substantial differences in habitat use and movements between adult pallid and shovelnose sturgeon. Presumably, the loss of habitat diversity caused by human induced environmental changes inhibits naturally occurring reproductive isolating mechanisms (Campton *et al*. 1995). Sheehan *et al*. (1997b) noted that hybridization points to the fact that similar areas are being used by both species for spawning.

Hubbs (1955) indicated that the frequency of natural hybridization in fish was a function of the environment, and the seriousness of consequences of hybridization was dependent on hybrid viability. Hybridization can occur in fish if spawning habitat is limited, if many individuals of one potential parent species lives in proximity to a limited number of the other parent species, if spawning habitat is modified and rendered intermediate, if spawning seasons overlap, or where movement to reach suitable spawning habitat is limited (Hubbs 1955). All of these conditions exist to some extent within the range of pallid and shovelnose sturgeon. Any of these conditions, or a combination of them, could be causing the apparent breakdown of isolating mechanisms which prevented hybridization between these species in the past (Keenlyne *et al*. 1994).

Sheehan *et al*. (1997b) speculated that incidental harvest of pallid sturgeon by the commercial shovelnose sturgeon fishery may be a factor in hybridization between the two species. Male pallid sturgeon reach sexual maturity at 5-7 years while females reach sexual maturity at approximately 15 years (Keenlyne and Jenkins 1993, Keenlyne *et al*. 1992). For this reason, females are at a greater risk of mortality before maturity and, as such, incidental or illegal harvest of female pallid sturgeon may skew the sex ratios. This would then possibly increase the incidence of hybridization as mature male pallid sturgeon, unable to find mature females, spawn with shovelnose sturgeon (Sheehan *et al*. 1997b). Sheehan *et al*. (1997b) and Carlson and Pflieger (1981) noted a 3:2 ratio of hybrid sturgeon to pallid sturgeon. Sheehan *et al*. (1997b) speculated that if this is representative of the sturgeon population in the MMR, hybridization may pose a significant threat to pallid sturgeon as the species continues to introgress with shovelnose sturgeon.

8.1.8 Summary

Pallid sturgeon distribution and abundance have drastically declined. In various studies, pallid sturgeon have represented from 0.29% to 11% of total sturgeon collected. In commercial catch surveys, pallid sturgeon have composed 0 to 26% of sturgeon collected. Habitat modification is considered the primary factor affecting pallid sturgeon populations. Approximately 49% of the pallid sturgeon’s historical range has been modified to the extent that it is no longer suitable. All remaining habitat has been substantially impacted by channelization. The species is now relegated to three genetically isolated sub-populations (Upper Missouri River, Lower Missouri River-MMR-Lower Mississippi River, Atchafalaya River). Within these sub-populations are even smaller, perhaps non-viable and isolated populations. The populations have little opportunity for genetic exchange. Evidence of successful reproduction is rare and documentation of recent recruitment is non-existent.

As habitat loss continues, other factors affecting pallid sturgeon, such as incidental/illegal harvest and hybridization, become more problematic. Further, habitat modification exacerbates the effects of these factors, such as hybridization.

Although specific microhabitat data are limited, we know the general habitat needs of the species. These include braided channels, irregular flow patterns, flood flows, turbidity, and extensive microhabitat diversity. Further, it is reasonable to draw inferences from data collected for other large river fish which evolved under similar river conditions.

8.2 Environmental Baseline

The Section 7 environmental baseline for this biological opinion is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and ecosystem, within the action area. Along with a discussion of the past and present impacts associated with construction, operation and maintenance of the 9-Foot Channel Project, the baseline includes the following: 1) State, local and private actions already affecting the species or that will occur contemporaneously with this consultation; 2) unrelated Federal actions affecting pallid sturgeon that have completed formal or informal consultations; and 3) Federal and other actions within the action area that may benefit pallid sturgeon.

8.2.1 Status of the species in the action area

The action area for this analysis encompasses the Mississippi River from the confluence of the Ohio River (river mile 0.0) to Minneapolis-St. Paul, Minnesota (river mile 854.0) and portions of the Lower Missouri River and Lower Mississippi River. It also includes the navigable portions of the Illinois, Kaskaskia, Minnesota, Black and St. Croix Rivers.

8.2.1.1 Historic and current distribution in the action area

The current range of pallid sturgeon in the action area includes the Mississippi River from the confluence of the Ohio River to the mouth of the Missouri River (river mile 196.0), locally referred to as the Middle Mississippi River (MMR), the mouth of the Missouri River to Melvin Price Locks and Dam (river mile 202.0), the Lower Missouri River and the Lower Mississippi River. The historic range of pallid sturgeon within the action area also included the Mississippi River upstream to Keokuk, Iowa, (UMR mile 364.0) (Duffy *et al*. 1996).

8.2.1.2 Population status and trends in the action area

Little is known about historic abundance of pallid sturgeon in the MMR. As late as the mid-1900's, it was common for pallid sturgeon to be tallied in commercial catch records as either shovelnose or lake sturgeon (Keenlyne 1995). However, correspondence and notes of researchers suggest that pallid sturgeon was still fairly common in many parts of the Mississippi and Missouri River systems as late as 1967 (Keenlyne 1989). Declines of pallid sturgeon populations in the MMR appears to have occurred in recent years coincidental with the development of the river for flood control and navigation (Deacon *et al*. 1979, Keenlyne 1989).

Pallid sturgeon have been captured in the MMR in the vicinity of Ste. Genevieve, Missouri, Chester, Illinois, and Cape Girardeau, Missouri. While population estimates are lacking, recent collection efforts indicate that pallid sturgeon are now rare in the MMR. Carlson *et al*. (1985), for example, collected 1 pallid sturgeon, 7 hybrids and 1897 shovelnose sturgeon at two MMR sampling stations during 1978-1979. Similarly, sampling in 1997 and 1998, by the MoDOC, collected 7 pallid sturgeon compared to 1549 shovelnose sturgeon (Petersen 1999). Significantly, however, in 1998, they also collected a young-of-the-year pallid sturgeon. This is one of only two instances in recent years, throughout the range of the species, indicating successful pallid sturgeon reproduction.

In response to obvious declines in pallid sturgeon numbers, MoDOC began an augmentation effort by releasing fingerlings raised at Blind Pony State Fish Hatchery. Approximately 7000 fingerlings were released in the Missouri and Mississippi Rivers in 1994 and an additional 3000 fingerlings were released in 1997 (Graham 1997, 1999). Since the release, approximately 86 tagged pallid sturgeon have been reported. Most of these fish are being reported below St. Louis likely due to higher numbers of commercial fisherman in the Mississippi River (Graham 1999).

Field surveys of *Scaphirhynchus* stocks suggest a relatively high incidence of hybridization between shovelnose sturgeon and pallid sturgeon in the MMR (Sheehan 1997a, 1997b, 1998). Sheehan *et al*. (1997b) and Carlson and Pflieger (1981) noted a 3:2 ratio of hybrid sturgeon to pallid sturgeon. Sheehan *et al*. (1997b) speculated that if this is representative of the sturgeon populations in the MMR, hybridization may pose a significant threat to pallid sturgeon as the species continues to introgress with shovelnose sturgeon.

The MMR constitutes approximately 5% of the pallid sturgeon's total range. However, approximately 49% of the species' range has been affected by impoundments and is currently considered unsuitable pallid sturgeon habitat. Therefore, the MMR represents approximately 10% of the species' range which is unaffected by impoundments and which may potentially provide suitable habitat.

According to the recovery plan, the MMR is part of recovery-priority area #5 which consists of the Mississippi River from its confluence with the Missouri River to the Gulf of Mexico. Recovery-priority areas were selected based upon most recent pallid sturgeon records of occurrence and the probability that the areas still provide suitable habitat for restoration and recovery of the species. These areas are typically the least degraded and have the highest habitat diversity, and in some reaches still exhibit a natural channel configuration of sandbars, side channels, and varied depths.

Little is also known about the historic abundance of pallid sturgeon in the Lower Missouri River and the Lower Mississippi River. The current population size in both areas is unknown, however, records indicate that pallid sturgeon in these river segments remain rare and widely scattered. Carlson *et al*. (1985) collected 5 pallid sturgeon and 4 hybrids from the Lower Missouri River and 5 pallid sturgeon and 1 hybrid from the

Lower Mississippi River from 1978-1979. Constant *et al*. (1997) collected 2 hybrids from the Lower Mississippi River from 1993-1995. Hybridization with shovelnose sturgeon appears prevalent in both river segments. Evidence of successful reproduction has been lacking until recently. In August 1999, one confirmed and two probable pallid sturgeon larvae were collected from the Lower Missouri River (Jim Milligan, USFWS, pers. comm.).

As previously discussed (see Status Section), the pallid sturgeon range has become reproductively fragmented. Some remnants of its historical connectedness, however, persist with genetic exchange still likely among the Lower Missouri River, MMR, and the Lower Mississippi River. As such, the MMR serves as an important genetic conduit for the pallid sturgeon populations occurring in the Lower Missouri and Lower Mississippi Rivers. Pallid sturgeon movements can occur over great distances. Bramblett (1996) noted a maximum home range on the Yellowstone River of approximately 199 miles. Other studies indicate movements of 60 or more miles (Sheehan *et al*. 1998). In addition, larval pallid sturgeon may drift in the water column up to 13 days (Kynard *et al*. 1998). Calculations of velocities, therefore, indicate that larval sturgeon may drift for a distance of potentially over 400 miles (Steve Krentz, USFWS, pers. comm.). These particular life history characteristics underscore the importance of the interconnectedness of the Missouri and Mississippi Rivers in terms of pallid sturgeon population biology. For example, adult pallid sturgeon in the MMR may migrate upstream to the Lower Missouri River to spawn. Larval sturgeon may then drift only a short distance over a period of a couple of days and settle out in the Lower Missouri River. Alternatively, these larval fish may drift over a long distance over a period of 8 or more days and settle out in the MMR. The areas where larval sturgeon settle out are likely dependent upon a number of factors including habitat availability. This same scenario is possible for pallid sturgeon in the Lower Mississippi River which may migrate to the MMR to spawn.

The interconnectedness of these river systems helps maintain the genetic connectivity and continuity of pallid sturgeon by ensuring that genetic material is dispersed throughout the population and genetic diversity is maintained. According to Wirgin *et al*. (1997), the structure and magnitude of genetic diversity of natural populations of sturgeons serves to buffer these species against environmental variation and should be maintained.

8.2.1.3 Distribution and abundance of habitat in the action area

The MMR historically had a meandering pattern and shifted its course over the years, leaving oxbow lakes and backwaters (Theiling 1999). The undeveloped river was shallow and characterized by a series of runs, pools and channel crossings that provided a diversity of depth (Theiling 1999). In 1824, the MMR surface area totaled 109 mi^2 (87.2% riverbed, 12.8% islands) (Simons *et al*. 1974). In 1796, Collot (1826) surveyed the river and mapped 55 side channels. His historical account describes a very dynamic system with the capability to create and maintain a diversity of habitat types. In describing the great potential for change in the system, Collot (1826) wrote:

"The Mississippi River has not only the inconvenience of being of an immense extent, of winding in a thousand different directions, and of being intercepted by numberless islands; its current is likewise extremely unequal, sometimes gentle, sometimes rapid; at other times motionless; which circumstances will prevent, as long as both sides remain uninhabited, the possibility of obtaining just data with respect to distances. But an insurmountable obstacle will always be found in the instability of the bed of this river, which changes every year; here a sharp point becomes a bay; there an island disappears altogether. Further on, new islands are formed, sand-banks change their spots and directions, and are replaced by channels; the sinuosities of the river are no longer the same; here where it once made a bend it now takes a right direction, and there the straight line becomes a curve; here ravages and disorders cannot be arrested or mastered by the hand of man, and it would be extreme folly to undertake to describe them, or pretend to give a faithful chart of this vast extent of waters, as we have done for the course of the Ohio, since it would not only be useless but dangerous."

Today, the natural meandering processes of the MMR have been altered through channelization. Wingdams, revetments, closing structures and bendway weirs have fixed the channel in place, disrupting the dynamic processes that create and maintain pallid sturgeon habitat. As a result, the diverse habitats to which pallid sturgeon are adapted (e.g., braided channels, irregular flow patterns, flood cycles, extensive microhabitat diversity and turbid waters) continue to decline in quality and quantity. By 1968, the river surface area had declined to 100 mi^2 and the river width to an average 3200 feet (Simons *et al*. 1974). Today only 25 side channels remain (USACE 1999b). Recent studies by Theiling *et al*. (1999) indicate that river surface area and width continues to decline and side channels continue to be lost.

According to the Corps' biological assessment (USACE 1999a), there are 16,966 acres of sandbar below the LWRP+10 feet on the MMR. This habitat is available to the pallid sturgeon depending upon river stage. Of this amount, approximately 11,699 acres occur below the LWRP and is available to pallid sturgeon approximately 97% of the time. It is unknown how much sandbar habitat occurring at shallow water elevations historically occurred in the MMR. Trends in the Lower Mississippi River provide some indication of the amount of sandbar habitat which may have been lost. According to information provided by the Corps, 85,165 acres of sandbar habitat occurred below the LWRP in 1948. The amount of habitat has fluctuated over time and totaled 81,414 acres in 1994. This reflects a 4.4% decline in sandbar habitat occurring below the LWRP. Sandbar area below the LWRP +10 elevation declined by 13.7% from 1948 (151,796 acres) to 1994 (131,008 acres). Sandbar area below LWRP +20 declined by 25% from 1948 (209,082 acres) to 1994 (156,904 acres). The amount of sandbar habitat below LWRP +20 has declined steadily from 1948 to 1994 including a 21.1% decline from 1965 to 1994 and a 10.7 % decline from 1988 to 1994.

The natural meandering processes of the Lower Missouri River and Lower Mississippi River have also been altered through channelization. Such alteration has affected the distribution and abundance of habitat in these river segments in much the same way the MMR has been affected.

8.2.2 Factors affecting the species environment within the action area

8.2.2.1 Channel Training Structures

Channel training structures have adversely affected pallid sturgeon by affecting the quality and quantity of habitats in the MMR to which the species is adapted (e.g., braided channels, irregular flow patterns, flood cycles, extensive microhabitat diversity and turbid waters). This loss of habitat has reduced pallid sturgeon reproduction, growth and survival by (1) decreasing the availability of spawning habitat; (2) reducing larval and juvenile pallid sturgeon rearing habitat; (3) reducing the availability of seasonal refugia; and (4) reducing the availability of foraging habitat. In addition, loss of habitat is believed to have contributed to the hybridization of pallid and shovelnose sturgeon (Carlson *et al*. 1985, Keenlyne *et al*. 1993, Campton *et al*. 1995). These habitat changes have also reduced the natural forage base of the pallid sturgeon, which is another likely contributing factor in its decline (Mayden and Kuhajda 1997).

The MMR historically had a meandering pattern and shifted its course many times over the years, leaving oxbow lakes and backwaters (Theiling 1999). The undeveloped river was shallow and characterized by a series of runs, pools and channel crossings that provided a diversity of depth along the main channel (Theiling 1999). Currently the MMR channel is fixed as a result of channel training structures and no longer allowed to meander across the floodplain. In 1824, the MMR surface area totaled 109 mi^2 (87.2% riverbed, 12.8% islands), and in 1888, surface area increased to 163 mi^2 (78.5% riverbed, 21.5% islands). Average river width increased from 3600 feet in 1824 to 5300 feet in 1888 (Simons *et al*. 1974). This increase in surface area and width is thought to have been caused by a series of floods between 1844 and 1888 and by changes in land use (e.g., clearing of floodplain timber for steamboat fuel and lumber and conversion of floodplain to agricultural use) (Simons *et al*. 1974, Strauser 1993). These examples are an indication of the river's surface area and width at particular points in time. However, the magnitude of the change from 1824 to 1888 is indicative of the dynamic nature of the MMR and the great potential for change described by Collot (1826), indicating that river surface area and width has probably never been static. In 1968, due to the construction of channel training structures (dikes/revetments), the river surface area had decreased to 100 mi^2 and the river width to an average of 3200 feet. From 1888 to 1968 there was a 38.7% decrease in river surface area and a 39.6% decrease in average river width (Simons *et al*. 1974, Fremling *et al*. 1986). Fixing the river channel in place and reducing river surface area and width have affected natural river processes that create and maintain aquatic habitats over time and the quantity of those habitats.

The effect of channel training structures in reducing channel width and surface area, and thereby habitat diversity, was most apparent within a few years of construction. However, although occurring at a slower rate, the effects are ongoing. For example, in evaluating side channel sedimentation and land cover change in the MMR, Theiling *et al*. (1999) found that main channel habitat decreased by 1667 acres in the six study reaches during the period 1950 to 1994. Of this amount, approximately 412 acres were lost from 1975 to 1994. In addition, dikes and revetments have not only narrowed the river channel, but deepened it as well (Chen and Simons 1986, Nielson *et al*. 1984). Simons *et al*. (1974) gave the following example of riverbed degradation in a 14-mile reach of the MMR due to channel constriction:

> *"By 1966 the river had been contracted to an average width of 1800 feet. The riverbed had lowered about 8 feet between 1889 and 1966. In July 1967, the Corps of Engineers selected this 14-mile reach as a test reach to develop design criteria on obtaining and maintaining a dependable 9-foot deep navigation channel. [Degenhardt 1973]. Between 1967 and 1969, this test reach narrowed from 1800 feet to 1200 feet in width. In 1971, the riverbed was resurveyed. The contraction from 1800 feet to 1200 feet had resulted in a 3-foot lowering of the riverbed [Degenhardt 1973]. In 1971 the low-water riverbed in the 14-mile reach between mile 140 and 154 was on the average 11 feet lower than in 1889."*

Channel training structures have also altered the natural hydrograph of the MMR by contributing to higher water surface elevations at lower discharges than in the past and to a downward trend in annual minimum stages (Simons *et al*. 1974, Wlosinski 1999). Wlosinski (1999) found water-surface elevations have decreased at the same low discharge of 60,000 cfs during the period from 1880 to present. The downward shift of annual minimum stages can be partially attributed to the degradation of the low-water channel by wingdams (Simons *et al*. 1974). River stages fluctuate as much as 15 m annually, effectively dewatering some secondary channels during low stages (Fremling *et al*. 1989). As a result, previously aquatic habitats are now dry at low discharges (Wlosinski 1999). This has potentially reduced the availability of pallid sturgeon spawning habitat through the loss of habitat complexity.

Side channels serve as important nursery areas and as refugia from the swift currents and harsh environments of the thalweg (Environmental Sci. and Eng. 1982, Fremling *et al*. 1989). Recent evidence suggests that side channels may be important rearing areas for larval pallid sturgeon. In 1999, one confirmed and two probable larval pallid sturgeon were collected from a large sandbar complex at the lower end of Lisbon Chute, a reconnected side channel of the Missouri River (Missouri River mile 214.7) (Jim Milligan and Joanne Grady, USFWS, pers. comm.). In addition, adult pallid sturgeon have been captured in MMR side channels (Mike Peterson, MoDOC, LTRM Station, pers. comm.). Furthermore, side channels are an integral component of the habitat complexity of the MMR ecosystem. These areas not only provide nursery areas and refugia for fish, but serve an important role in the cycling of nutrients and in the production of food organisms for many species.

In its natural state, an alluvial river divides itself into two or more channels by the processes of either erosion or deposition. Side channels which are obliterated by deposition are replaced by new side channels caused by floods and/or river migrations. In the MMR, the river is no longer free to migrate and produce new side channels (Simons *et al*. 1974) due to channel training structures (e.g., wingdams, revetments, closing structures). Side channels in the MMR have been closed off and others have sedimented in (Simons *et al*. 1975, Theiling 1999). The loss of side channels is well documented. In 1797 there were 55 side channels (Collot 1826), 35 in 1860 (Simons *et al*. 1974), 27 in 1968 (Simons *et al*. 1974), and only 25 today (USACE 1999b). Many of those that remain are degraded and much smaller than in the past (Theiling *et al*. 1999). For example, within the six study reaches analyzed, Theiling *et al*. (1999) noted that approximately 918 acres of secondary channel habitat was lost during the period 1950 to 1994 due to closing structures and resulting sediment accumulation and terrestrial encroachment. Of this amount, approximately 275 acres were lost from 1975 to 1994. In the absence of further human-induced changes in hydrology or geomorphology of the MMR, most of the remaining side channels may disappear (Theiling 1999). The loss of side channels has reduced larval and juvenile rearing habitat, reduced the availability of seasonal refugia, reduced the availability of foraging habitat and reduced the natural forage base of pallid sturgeon by reducing the nutrient cycling ability of the MMR.

Just as changes in river processes have eliminated channel meandering that creates new side channels, development of new sand bar habitat (aquatic and terrestrial) is also inhibited. Bendway weirs were developed to inhibit point-bar establishment in bends and channel crossings and to reduce the need for dredging in these areas. They consist of a series of submerged dikes (>3m below the LWRP) generally constructed around the outer edge of a river bend. In recent years, bendway weirs have also been utilized in other depositional areas in the MMR. Each dike is angled 30 degrees upstream of perpendicular to divert flow, in progression, towards the inner bank. The result is hydraulically controlled point bar development and reduced channel downcutting throughout the bend.

Resource agencies have expressed concern over the effect bendway weirs have on the aquatic environment. As a result, a Bendway Weir Fish Sampling Team was established and various studies have been conducted to document the effects of bendway weirs. Hydroacoustic surveys of fishes were conducted in August 1994 and September 1995 in four river bends in the MMR (Kasul and Baker 1995, 1996). In 1994, two of the four river bends had bendway weirs. In 1995, all four bends had bendway weirs. An additional bend without weirs was also sampled in 1995. According to the Corps' biological assessment, based on the 1994 data, the two bends with weirs (Dogtooth and Price) had a 2.2x higher density of fishes than the two bends without weirs. This is accurate for the data collected on the outside bank. However, the mean number of fish per hectare for the entire bend was higher for bends without weirs (1894) than for the bends with weirs (1402). In addition, the bends without weirs had a significantly higher number of fish per hectare located on the inside bank than the bends with weirs (Kasul and Baker 1995).

A comparison of 1994 and 1995 data for Greenfield and Cape bend provides between year information for bends without weirs (1994) and bends with weirs (1995). The mean number of fish in Greenfield bend increased for the entire bend area from 1994 to 1995. Much of this increase occurred along the outside bank. Fish numbers along the inside bank declined from 2599 in 1994 to 1506 in 1995 indicating a redistribution of fish across the cross-section of the channel from the inside bank to the outside bank. The mean number of fish per hectare within the entire bend and both the outside bank and inside bank also increased in Cape bend from 1994 to 1995. The mean number of fish per hectare also increased between 1994 and 1995 for Dogtooth and Price bends (with weirs). There was a significant increase in the mean number of fish occurring along the inside bank of Dogtooth bend from 1994 (287) to 1995 (1138). This may reflect the re-establishment of channel equilibrium following bendway weir construction and recovery of the benthic macroinvertebrate community. Scutters bend is the only bend without weirs analyzed in 1995. The mean number of fish per hectare for this bend was higher than the numbers for Price and Cape bends, but lower than Greenfield and Dogtooth bends. [Data from Kasul and Baker 1995 and 1996]

In addition, the effects of bendway weirs on point-bar fishery habitat were studied on the Lower Mississippi River (Schramm *et al*. 1997, 1998) by comparing the changes in late-falling and low-river stage electrofishing catch rates of prevalent fishes before (1994) and after (1996 and 1997) installation of bendway weirs at Victoria Bend relative to the changes in catch rates of the same fishes at Rosedale Bend, a nearby reference site without bendway weirs. Large interyear variation in catch rates were observed and, for most prevalent species, catch rates declined from 1994 to 1996 in sandbar habitats. However, significant declines in catch rates of prevalent species at Victoria Bend relative to changes in catch rates at the reference site were only noted for gizzard shad. Conversely, catch rates for goldeye, channel catfish, and flathead catfish at sandbar habitat during late-falling river stage significantly declined from 1994 to 1996 at Rosedale Bend while catch rates remained similar at Victoria Bend. [excerpt from USACE 1999a]

No data for pallid sturgeon were collected for the above referenced study. However, pallid sturgeon fall within a guild of fishes referred to as rheophilic. Rheophilic fish are found in swift-flowing main and secondary channel habitats. These species are adapted to live at the bottom of the river where currents are slower and to seek shelter in flow refugia such as dike fields and snags (USACE 1999b). Blue catfish and channel catfish are also rheophilic fish. Therefore, data from Schramm *et al*. (1997, 1998) concerning blue catfish and channel catfish may provide insight regarding the effects of bendway weirs on pallid sturgeon. According to Schramm *et al*. (1997, 1998), catch rates for channel catfish during late-falling river stages at sandbar habitat declined from 1994 (16.00 +/- 5.0SE) to 1996 (0.20 +/- 0.20SE) at Rosedale Bend in 1997. No channel catfish were collected in sandbar habitat at Rosedale Bend during late-falling river stages. Channel catfish also declined in sandbar habitat during late-falling river stages at Victoria Bend from 1994 (1.86 +/- 0.51SE) to 1996 (0.25 +/- 0.25SE) and from 1994 to 1997 (1.50 +/- 0.87SE). Blue catfish declined at sandbar habitat during late-falling river stages at both Rosedale Bend and Victoria Bend from 1994 to 1996 and 1997.

During low river stages in sandbar habitat blue catfish increased at both Victoria Bend and Rosedale Bend from 1994 to 1996. Blue catfish numbers increased slightly in 1997 (2.0 +/- 1.15SE) at Victoria Bend compared to 1994 (0.2 +/- 0.20SE) and decreased slightly in Rosedale Bend from 1994 (1.0 +/- 1.0SE) to 1997 (0.0). According to Schramm *et al*. (1997), channel catfish increased during low river stages on sandbar habitat at Victoria Bend from 1994 (0.0) to 1997 (5.25 +/- 2.59). A slight increase in channel catfish was also noted at Rosedale Bend. However, it should be noted that Schramm *et al*. (1998) did not report catch rates for channel catfish during low river stages for 1994 and 1996. Similar trends for both blue catfish and channel catfish were noted for revetted habitat. These data indicate some interyear variation in catch rates for channel catfish and blue catfish. However, the data do not present sufficient information to develop conclusions concerning the effects of bendway weirs on rheophilic fish.

In general terms, the results of various studies indicate that fish redistribute across the channel cross-section from the inside bank to the outside bank as a result of bendway weirs. This is most likely in response to increases in macroinvertebrate abundance (Ecological Specialists, Inc. 1997a) and the low velocity fields that develop behind each weir. Bendway weirs also cause channel bottom aggradation along the outside bend, which may have some benefit by reducing water level fluctuations in adjacent side channels. This benefits pallid sturgeon by (1) increasing the availability of larval and juvenile rearing habitat; (2) increasing the availability of seasonal refugia; and (3) increasing substrate diversity, which influences macroinvertebrate production, thus, increasing the natural forage base of pallid sturgeon.

While the above beneficial effects of bendway weirs is noted, the effect of bendway weirs on inside bend point bar habitat is unclear. As stated previously, bendway weirs control point bar development and are also being utilized to address other depositional areas. Bendway weirs also increase water velocities along the inside bend by redirecting channel flow. Shallow water, low slope, sandbar habitat is thought to be important to juvenile pallid sturgeon, and perhaps, other life stages. This is the habitat type in which a young-of-the-year pallid sturgeon has recently been captured in the MMR (Petersen and Herzog 1999) and larval pallid sturgeon were recently collected from a large sandbar complex on the Missouri River (Jim Milligan, USFWS, pers. comm.). According to Sheehan *et al*. (1998) pallid sturgeon exhibited a positive selection for downstream island tips (depositional areas) in terms of habitat use versus availability. As existing sandbar habitat continues to accrete and revert to woody vegetation, aquatic sandbar habitat will continue to decline in quantity. Thus, bendway weirs likely reduce larval and juvenile rearing habitat and feeding habitat for all life stages.

According to the Corps' biological assessment (USACE 1999a), there are approximately 16,966 acres of sandbar habitat below the LWRP+20 elevation in the MMR. Of this amount, 11,699 acres occurs below the LWRP and is available to pallid sturgeon approximately 97% of the time The remainder is available to pallid sturgeon depending on river stage. However, much of this sandbar habitat occurs in relatively straight reaches of the main channel where current velocities are most extreme. Although pallid sturgeon are adapted to high velocity habitats, they typically seek out lower velocity refugia within these high velocity areas. Therefore, much of the existing sandbar habitat is not likely suitable habitat for pallid sturgeon.

Although it is unknown how much sandbar habitat, at shallow water elevations, historically occurred in the MMR, the loss of channel surface area and width, riverbed degradation, past dredging practices and sediment accretion suggest that much of this habitat type has been lost. Existing sandbar habitat continues to accrete and revert to woody vegetation, affecting the quantity of aquatic sandbar habitat in the MMR. As an example, during the period 1950 to 1994, Theiling *et al*. (1999) found that approximately 293 acres of aquatic habitat had transitioned to terrestrial sand/mud habitat and approximately 1300 acres converted to wooded terrestrial habitat within the six study reaches analyzed. Much of this change can be attributed to sedimentation induced by channel training structures. This has adversely affected pallid sturgeon by reducing larval and juvenile rearing habitat and feeding habitat for all life stages.

Aquatic habitats, such as backwaters, side channels and channel border eddies, have been described as hydraulic retention devices (Bhowmik and Adams 1990). They slow the movement of water through a river reach, which concentrates nutrients and primary productivity. In low current areas with high water clarity, algae and submersed aquatic plants can greatly increase riverine productivity. Backwaters with permanent connections to the river can shunt energy to the channel environment. Flood flows can connect isolated backwaters and distribute pulses of energy to other environments (Theiling *et al*. 1999). Channel training structures have disrupted natural geomorphic processes and affected natural hydrologic variability in the MMR. This has reduced riverine productivity by destroying and/or isolating important floodplain features (Theiling *et al*. 1999) and other aquatic habitats. This has reduced the natural forage base of pallid sturgeon.

Furthermore, large woody debris alters channel morphology by influencing sediment routing, thus creating pools, gravel bars and depositional sites (Bilby and Ward 1991). Bilby and Likens (1980) suggested that a large part of stream organic matter is associated with woody debris. Trees of all types and sizes were essential as aquatic insect substrate, and they provided localized zones of reduced velocity for fish. Snags reduced mean stream velocity, increased the stream top width, provided long-term organic matter supplies, and aided in fine organic matter retention (Benke *et al*. 1985, Hesse *et al*. 1988, Hesse *et al*. 1993). The disruption of natural geomorphic processes (e.g., meandering, erosion) has also eliminated much of the woody debris from the MMR. This has reduced overall habitat diversity and organic matter input. This has reduced microhabitat diversity for pallid sturgeon and reduced the natural forage base of pallid sturgeon.

Lastly, channel training structures have influenced the incidence of hybridization between pallid and shovelnose sturgeon. Approximately 114 species of fish inhabit the MMR and they exhibit a wide range of habitat requirements (Pitlo *et al*. 1995, Fremling *et al*. 1989). Each species is adapted to particular river conditions and many species' habitat requirements change seasonally. Quiet waters may be required for spawning or for juvenile rearing habitat, while adults may inhabit swifter waters of the main channel (Pflieger 1975, Welcomme 1979, Becker 1983). Different habitats may also be required under different temperature conditions (Sheehan *et al*. 1990a and 1990b, Bodensteiner *et al*. 1990, Bodensteiner and Lewis 1992). The distribution, availability, and quality of aquatic habitats in the UMR (including the MMR), have been altered by the construction of channel training structures, dikes, and dredging (Theiling 1999).

Hubbs (1955) indicated that the frequency of natural hybridization in fish was a function of the environment, and the seriousness of consequences of hybridization were dependent on hybrid viability. Hybridization can occur in fish if spawning habitat is limited, if many individuals of one potential parent species live in proximity to a limited number of the other parent species, if spawning habitat is modified and rendered intermediate, if spawning seasons overlap, or where movement to reach suitable spawning habitat is limited (Hubbs 1955). Channel training structures have altered the distribution, availability and quality of aquatic habitats required for pallid sturgeon. Therefore, channel training structures have contributed to pallid sturgeon hybridization with shovelnose sturgeon by altering/eliminating spawning habitat and potentially limiting the movement of sturgeon species to spawning habitat.

8.2.2.2 Locks and Dams

Impoundment and water level regulation due to construction of locks and dams have adversely affected pallid sturgeon by (1) impeding seasonal migration and elimination of the species from a portion of its historic range, thus decreasing the availability of spawning habitat; (2) reducing the quantity and quality of habitat in the MMR, thus decreasing the availability of spawning habitat, reducing larval and juvenile rearing habitat and reducing the availability of seasonal refugia; (3) increasing hybridization with shovelnose sturgeon through reduced substrate diversity; (4) increasing the risk of predation with other fish; and (5) increasing competition with other fish and decreasing pallid sturgeon foraging capability.

The historic range of the pallid sturgeon included the UMR upstream to Keokuk, Iowa (Duffy *et al*. 1996, Bailey and Cross 1954). The upstream movement of pallid sturgeon to this area was eliminated as the river was converted into a series of locks and dams (Coker 1930). Although Coker's 1916 record of a pallid sturgeon taken near Keokuk dam has been disputed, the sturgeon group's potadromy and affinity for rock riffle or coarse substrate during the spawning period are well known. The completion of the power dam at Keokuk in 1913 resulted in the loss of spawning habitat suitability by impoundment of Keokuk rapids, in conjunction with physically blocking spawning runs of all sturgeon species. Therefore, we believe, impoundment has eliminated the pallid sturgeon from a portion of its former range and has decreased the availability of spawning habitat, and thus, reproductive potential.

Dams were constructed on the UMR for the specific purpose of increasing low and moderate flow water surface elevations to maintain a continuous nine-foot navigation channel from St. Louis, Missouri to Minneapolis, Minnesota (USACE 1999a). Dams on the UMR have affected the MMR by affecting the hydrologic cycle and sediment inputs. The MMR receives 60% of its flow from the Mississippi River basin (Fremling *et al*. 1989). Thus, impoundment of the UMR through dam construction has likely contributed in some part to the downward shift in annual minimum stages in the MMR, which affected the quality and availability of pallid sturgeon habitat.

One of the effects of impoundment of the UMR is a reduction in suspended sediment load in the MMR. MMR sediment load has declined 66% from pre-1935 levels mainly due to sediment entrapment in Missouri River impoundments (Fremling *et al*. 1989). However, as the UMR presently contributes approximately 20% of the average suspended sediment load to the MMR (Tuttle and Pinner 1982), UMR dams have also contributed to the sediment load reductions. This lack of sediment delivery upset the natural channel equilibrium and was replaced by a variety of nonequilibrium processes such as hydraulic sorting and bed paving, which eventually will eliminate all sediment movement (USFWS 1993). This has already occurred to some extent and has resulted in reduced bed roughness, and therefore, reduced substrate diversity (USFWS 1993). Although little is known about the specific spawning requirements of pallid sturgeon, they have adhesive eggs, which means that a firm substrate with moderate flow is required for spawning. Reductions in substrate diversity have likely eliminated pallid sturgeon spawning habitat, and may have lead to an increased incidence of hybridization with the closely related shovelnose sturgeon.

The associated turbidity caused by suspended sediment also provided the pallid sturgeon and other native fish, adapted to living in a nearly sightless world, with cover while moving from one snag or undercut bank to another. Today, water clarity has increased dramatically due to reduced suspended sediment loads, and this essential cover is gone. Under such conditions, predation by sight-feeding predators can be expected to significantly impact native species not equipped with good eyesight (USFWS 1993). For this reason larval and juvenile pallid sturgeon are subject to increased probability of predation.

It is also suspected that reduced turbidity has affected food availability by changing species composition and by making it more difficult for pallid sturgeon, and other native species, to capture prey in the clearer water environment. In the Missouri River, pelagic planktivores and sight-feeding carnivores have increased in abundance, whereas species specialized for life in the turbid, predevelopment river (like pallid sturgeon) have decreased in abundance (Pflieger and Grace 1987). Similar changes in species composition are also occurring in the MMR (Bob Hrabik, MoDOC, LTRM Station, pers. comm.). This change in community structure is less apparent where changes in the natural hydrograph, temperature regime, and turbidity are less pronounced (USFWS 1993). Therefore, pallid sturgeon have increased competition for available food resources and their ability to capture prey has been adversely affected.

8.2.2.3 Dredging/Disposal

Dredging and disposal of dredged material have adversely affected pallid sturgeon by (1) reducing the availability and quantity of the natural forage base of pallid sturgeon; (2) reducing the quantity and availability of juvenile and adult habitat; and (3) contributing to the transference of contaminants, potentially affecting pallid sturgeon reproductive success.

Dredging occurs in depositional areas and channel crossings to maintain a nine-foot navigation channel with disposal occurring in the adjacent main channel border areas near shore. From 1978 to 1998, the St. Louis District dredged an average of 6.0 million cubic yards (mcy) of material per year in the MMR. This ranged from a low of 0.5 mcy in 1993 to a high of 20.5 mcy in 1988 (USACE 1998). The amount of material dredged varies from year to year depending on river stages. In addition, there has been no consistent pattern in the locations of dredging activities as this also varies depending on river conditions.

Dredging disturbs main channel habitat, killing the resident benthic macroinvertebrates and temporarily leveling the dune and swale bed forms. The bed forms re-form rapidly, but macroinvertebrate recolonization may take at least one growing season (USACE 1999b). Sheehan *et al*. (1998) found pallid sturgeon utilizing main channel habitat more than any other type. This was not surprising since approximately 65% of the study area consisted of main channel habitat. This indicates that past dredging may have affected pallid sturgeon food resources. The extent of the adverse affect is unknown at this time as there has never been a quantification of the areal extent of aquatic habitat affected by dredging and disposal activities.

In recent years, the St. Louis District has been following general dredge disposal guidelines developed to protect important aquatic habitat, such as side channels. However, implementation of disposal guidelines for the beneficial use of dredge material is virtually non-existent in the MMR. Material has been deposited in the adjacent main channel border area. Recovery times for these sites have not been well documented, but may take a year or longer. Researchers for the Illinois Natural History Survey found no recolonization of sand dredged material disposal sites within one year following disposal on the Illinois River (Stevenson and Koel 1999). This is consistent with information from Lake Erie which indicated that more than a year was required to reestablish a community structure similar to unaffected areas (Flint 1979). Studies conducted by Sheehan *et al*. (1998) indicated pallid sturgeon exhibited a positive selection for main channel border habitat. In addition, a recent collection of a young-of-the-year pallid sturgeon near Cape Girardeau, Missouri, occurred in main channel border habitat on an inside bend point bar (Petersen and Herzog 1999). This indicates that both rearing and/or feeding areas for adult and juvenile pallid sturgeon, and potentially larval pallid sturgeon, have been adversely affected by past dredge disposal practices.

Dredging disturbs bottom sediments and associated contaminants. Main channel dredge cut sediment is periodically sampled and analyzed to determine bulk chemical concentrations of contaminants for use in assessing the water quality effects of dredging. However, concentrations of some contaminants (e.g., PCB's chloradane, dieldrin and DDE) occur below detection levels in sediment, but accumulate in fish (Mike Coffey, USFWS, pers. comm.). Although dredge material consists mainly of sand, some amount of silts are disturbed during the dredging process. In addition, some contaminated materials exist as sand-sized particles and can be transported in the bed load (Mike Coffey, USFWS, pers. comm.). The concentrations of some contaminants, such as PCB's, have been homogenized in the Mississippi River due to repeated deposition and resuspension of contaminated silts (Rostad *et al*. 1995). No analysis of the effects of dredging on the mass balance of contaminant mobilization and transport in the UMR has been conducted (USACE 1999b). It is likely that dredging contributed to some degree to the homogenization of contaminant concentrations in the Mississippi River and potentially contributed to the transference of contaminants downstream.

A recent sturgeon health assessment in the MMR suggests that pallid sturgeon are at risk from exposure to contaminants present in their habitat (Coffey *et al*. 1999). This study found evidence of possible endocrine disruption, which has the potential to cause reproductive impairment (USGS 1998). Coffey *et al*. (1999) also noted a significant difference between reference site sturgeon and MMR sturgeon for some organochlorine chemicals. This has likely resulted in reduced fish health and reproductive impairment.

8.2.2.4 Commercial Navigation Traffic

Commercial navigation traffic has adversely affected pallid sturgeon directly through entrainment mortality. However, the degree of impact is uncertain. Studies have been conducted to determine the impacts of commercial navigation on aquatic resources as a result of the current Navigation Systems Study for the Upper Mississippi River and Illinois Rivers. Gutreuter *et al*. (1998) developed a method for estimation of tow-induced mortality of adult fishes in commercially navigated waterways. However, the results of the study to estimate entrainment mortality of adult fish are indeterminate due to high variance. Based on their results, they cannot determine whether towboat entrainment is an important source of mortality for fish species that utilize the main channel. However, they state that a prudent interim conclusion is that entrainment mortality of certain larger fishes, such as shovelnose sturgeon, may be an important factor influencing their abundance and dynamics in the Upper Mississippi River System. In addition, the ancillary estimates of kills of 'adult' shovelnose sturgeon were 2.4 fish/km of tow travel. As pallid sturgeon and shovelnose sturgeon exhibit similar life history characteristics, pallid sturgeon may have been significantly affected by entrainment mortality, however, as yet there have been no studies to determine the effect on pallid sturgeon populations. It should be noted that according to the Corps, independent statisticians that reviewed the Gutreuter *et al*. (1998) draft report indicated that the use of ancillary estimates of fish kills was inappropriate.

8.2.2.5 Commercial and Sport Fishing for Sturgeon

Mortality of pallid sturgeon occurs as a result of illegal and incidental harvest from both sport and commercial fishing activities. In addition, such illegal and incidental harvest may skew pallid sturgeon sex ratios such that hybridization with shovelnose sturgeon is exacerbated.

Historically, pallid, shovelnose and lake sturgeon were commercially harvested on the Mississippi and Missouri Rivers (Helms 1974). The larger lake and pallid sturgeon were sought for their eggs which were sold for caviar, whereas, shovelnose sturgeon were destroyed as a bycatch. Commercial harvest of all sturgeon has declined substantially since record keeping began in the late 1800's. Most commercial catch records for sturgeon have not differentiated between species. Combined harvests as high as 195,450 kg were recorded in the Mississippi River in the early 1890's, but had declined to less than 9,100 kg by 1950 (Carlander 1954). Lower harvests reflected a decline in shovelnose sturgeon abundance since the early 1900's (Pflieger 1975).

Currently, only a sport and/or aboriginal fishery exists for lake sturgeon due to such low population levels (Todd 1998). Shovelnose sturgeon is commercially harvested in eight states, including Illinois and Missouri (Todd 1998) and a sport fishing season exists in a number of states (Mosher 1998). Although information on the commercial harvest of shovelnose sturgeon is limited, Illinois reported the commercial harvest of shovelnose sturgeon was 19,689 kg of flesh and 106 kg of eggs in 1997 and Missouri reported harvest of 3,700 kg of flesh and an unknown quantity of eggs (Todd 1998). Missouri also has a sport fishery for shovelnose sturgeon but has limited data on the quantities harvested (Mosher 1998).

Sturgeon species, in general, are highly vulnerable to impacts from fishing mortality due to unusual combinations of morphology, habits and life history characteristics (Boreman 1997). In 1990, the head of a pallid sturgeon was found at a sport-fish cleaning station in South Dakota, and in 1992 a pallid sturgeon was found dead in a commercial fisherman’s hoop net in Louisiana. In 1997, four pallid sturgeon were found in an Illinois fish market (Sheehan *et al*. 1997b). Currently, there are no methods to differentiate between pallid and shovelnose sturgeon eggs. It is probable that pallid sturgeon are significantly affected by the illegal take of eggs for the caviar market.

Sheehan *et al*. (1997b) speculated that incidental harvest of pallid sturgeon by the commercial shovelnose sturgeon fishery may be a factor in hybridization between the two species. Male pallid sturgeon reach sexual maturity at 5-7 years while females reach sexual maturity at approximately 15 years (Keenlyne and Jenkins 1993, Keenlyne *et al*. 1992). For this reason, females are at a greater risk of mortality before maturity and, as such, incidental or illegal harvest of female pallid sturgeon may skew the sex ratios. This would then possibly increase the incidence of hybridization as mature male pallid sturgeon, unable to find mature females, spawn with shovelnose sturgeon (Sheehan *et al*. 1997b). Sheehan *et al*. (1997b) and Carlson and Pflieger (1981) noted a 3:2 ratio of hybrid sturgeon to pallid sturgeon. Sheehan *et al*. (1997b) speculated that if this is representative of the sturgeon population in the MMR, hybridization may pose a significant threat to pallid sturgeon as the species continues to introgress with shovelnose sturgeon.

8.2.2.6 Commercial Sand and Gravel Dredging

Commercial sand and gravel dredging operations adversely affect pallid sturgeon due to (1) reduced quantity and availability of spawning habitat; (2) reduced availability and quantity of forage organisms; and (3) by contributing to the transference of contaminants, potentially affecting pallid sturgeon reproductive success.

The Service has completed a number of informal Section 7 consultations with the St. Louis District, Corps of Engineers on the effects of reissuing commercial sand and gravel dredging permits in the MMR. As a result of these consultations, permit conditions restrict dredging operations to defined river reaches within the channel to avoid impacts to aquatic habitats, which may be important to pallid sturgeon (e.g., side channels, tributary mouths, point bars, shallow water). These conditions have been implemented for many years to protect aquatic habitats. Currently, permit conditions also prohibit dredging of gravel during the pallid sturgeon spawning season. However, dredging of gravel outside the spawning season may affect the quantity and availability of spawning habitat.

Commercial dredging principally occurs in the main channel border area. Dredging in these areas destroys the benthic macroinvertebrate community. Macroinvertebrate recolonization of dredged areas may take a year or longer. According to Sheehan *et al*. (1998), pallid sturgeon exhibited a positive selection for main channel border habitat, indicating this is possibly a preferred habitat type. Commercial dredging operations typically dredge in the same locations regularly, which tend to be depositional areas. Locally, such operations may increase short-term turbidity and affect the availability of food resources for pallid sturgeon.

Dredging disturbs bottom sediments and associated contaminants. Although the dredged material consists mainly of sand, some amounts of silts are disturbed during the dredging process. The concentrations of some contaminants, such as PCB's, have been homogenized in the Mississippi River due to repeated deposition and resuspension of contaminated silts (Rostad *et al*. 1995). It is likely that commercial sand and gravel dredging has contributed to some degree to the homogenization of contaminant concentrations in the Mississippi River, and potentially, contributed to the transference of contaminants downstream.

A recent sturgeon health assessment in the MMR suggests that pallid sturgeon are at risk from exposure to contaminants present in their habitat (Coffey *et al*. 1999). This study found evidence of possible endocrine disruption, which has the potential to cause reproductive impairment (USGS 1998). Coffey *et al*. (1999) also noted a significant difference between reference site sturgeon and MMR sturgeon for some organochlorine chemicals. This may result in reduced fish health and reproductive impairment.

8.2.2.7 Flood Control Projects

Flood control projects in the MMR have adversely affected pallid sturgeon by (1) decreasing the availability of habitat for all life stages, including the loss of seasonal refugia and feeding areas; and (2) reducing riverine productivity, thereby, affecting the natural forage base of pallid sturgeon.

Approximately 80% of the floodplain in the MMR (approximately 500,000 acres) has been isolated from the main channel due to levee construction. Interior drainage ditches and large pumps drain groundwater seepage (Theiling 1999) and interior floodflows. This has allowed the conversion of floodplain habitats to agriculture and other land uses. Isolated backwaters, side channels and wetlands have been degraded due to incompatible agricultural practices, poor stormwater management and sedimentation. Destruction and isolation of these important floodplain features has reduced riverine productivity (Theiling *et al*. 1999) by decreasing energy inputs (organic matter, carbon) into the main channel. Isolation of wetlands reduces their habitat value to riverine fish, which make seasonal movements to backwaters and floodplains (USACE 1999b). Levees also contribute to increased flood heights and increased water level variability because floodwaters are confined in a smaller cross-sectional area (Belt 1975, Chen and Simons 1986, Bellrose *et al*. 1983). As a result, flood control projects in the MMR may have affected the production of forage food organisms for pallid sturgeon (macroinvertebrates and fish) and may have isolated pallid sturgeon from important rearing/feeding areas and seasonal refugia.

8.2.2.8 Fleeting

Fleeting has adversely affected pallid sturgeon by (1) reducing the natural forage base of pallid sturgeon; (2) resuspending sediments that may be contaminated, thus, affecting pallid sturgeon reproduction; and (3) potentially causing direct mortality due to towboat entrainment.

Fleeting areas are typically constructed within main channel border habitats. Towboats maneuvering within fleeting areas cause resuspension of sediments. In addition, fleeting areas may occasionally require dredging, which also disturbs bottom sediments. As such, fleeting operations likely affect macroinvertebrate production on a local scale. According to the work of Sheehan *et al*. (1998), pallid sturgeon exhibited a strong preference for main channel border habitat. It is difficult to determine to what degree fleeting may have affected pallid sturgeon. However, fleeting adversely affects the natural forage base of pallid sturgeon, and may cause resuspension of contaminated sediments, thereby, potentially reducing pallid sturgeon reproductive capacity.

Towboats maneuver and reconfigure barges in fleeting areas. Gutreuter *et al*. (1998) could not determine whether towboat entrainment is an important source of mortality of fish species that utilize the main channel as the results of the study to estimate tow-induced mortality of adult fish are indeterminate due to high variance. The results of this study indicate that main channel fish are susceptible to mortality due to propeller strikes. Therefore, it is likely that fleeting has caused some degree of fish mortality. However, the effect of this mortality on pallid sturgeon is unknown.

8.2.2.9 Missouri River Impoundments

Missouri River impoundments have adversely affected pallid sturgeon in the MMR due to (1) reduced substrate diversity, and therefore, reduced reproductive success; (2) increased predation; (3) increased competition with other species due to species composition shifts; and (4) reduced pallid sturgeon foraging success.

The MMR currently receives about 80% of its average suspended sediment load from the Missouri River and 20% from the UMR watershed. The sediment load is 109.8 million tons/year. This represents a 66% decline from pre-1935 levels, mainly due to retention by Missouri River reservoirs (Fremling *et al*. 1989). This lack of sediment delivery upset the natural channel equilibrium and was replaced by a variety of nonequilibrium processes such as hydraulic sorting and bed paving, which eventually will eliminate all sediment movement (USFWS 1993). This has already occurred to some extent and resulted in reduced bed roughness, and therefore, reduced substrate diversity (USFWS 1993). Little is known about the specific spawning requirements of pallid sturgeon; however, they have adhesive eggs, which means that a firm substrate with moderate flow is required for spawning. Reduction in substrate has likely eliminated or reduced pallid sturgeon spawning habitat and may have lead to hybridization with the closely related shovelnose sturgeon.

The associated turbidity caused by suspended sediment also provided the pallid sturgeon and other native fish, adapted to living in a nearly sightless world, with cover while moving from one snag or undercut bank to another. Today, as a result of decreased sediment load, water clarity has increased dramatically, and this essential cover is gone. Under such conditions, predation by sight-feeding predators can be expected to significantly impact native species not equipped by evolution with good eyesight. For this reason larval and juvenile pallid sturgeon are subject to increased probability of predation.

It is also suspected that reduced turbidity has affected food availability by changing species composition and by making it more difficult for pallid sturgeon, and other native species, to capture prey in the clearer water environment. In the Missouri River, pelagic planktivores and sight-feeding carnivores have increased in abundance, whereas species specialized for life in the turbid, predevelopment river (like pallid sturgeon) have decreased in abundance (Pflieger and Grace 1987). Similar changes in species composition are also occurring the MMR (Bob Hrabik, MoDOC, LTRM Station, pers. comm.). This change in community structure is less apparent where changes in the natural hydrograph, temperature regime, and turbidity are less pronounced (USFWS 1993). Therefore, pallid sturgeon are subjected to increased competition for available food resources and their ability to capture prey has been impaired.

8.2.2.10 Avoid and Minimize Program

In October 1992, the St. Louis District issued Design Memorandum No. 24, “Avoid and Minimize Measures” developed as a result of commitments made in the Record of

Decision of the Environmental Impact Statement for the Second Lock at Melvin Price Locks and Dam. The purpose of the Avoid and Minimize Program is to implement various measures to avoid and minimize impacts associated with operation and maintenance of the 9-Foot Channel Project.

The Avoid and Minimize Program is beneficially affecting pallid sturgeon by restoring/enhancing habitat in the MMR. Projects completed to date have improved habitat complexity in the MMR and potentially have benefitted pallid sturgeon due to (1) increasing access to a side channel; (2) increasing seasonal refugia diversity; and (3) increasing the forage base of pallid sturgeon by improving the nutrient cycling ability of a side channel.

In 1997, six short stub dikes and bank revetment were placed in Santa Fe Chute between river miles 35-40(L). The purpose of the structures was to restore habitat diversity by creating a meandering channel and restoring water depth diversity in the side channel. Physical monitoring thus far indicates the upper two dikes have created scour holes approximately 20 feet in depth and hydroacoustic soundings also suggest the desired thalweg meander was forming (USACE 1997). However, the stub dikes were not built to micro-model specifications. Bed material in the sidechannel has been redistributed, and as a result, has exacerbated filling of the lower end of the side channel (Jenney Frazier, MoDOC LTRM Station, pers. comm.). Currently, there is insufficient data to assess the project's impact on biological communities and the chute's limnology (Frazier 1998).

Also in 1997, hard points were placed in the side channel between the mainland and the sandbar at Owl Creek, river miles 84-86(R). Although the purpose of this project was to isolate an existing sandbar to improve nesting habitat for least terns; the hardpoints create a flow in the side channel that induces scour and creates a deeper channel; which contributes to overall aquatic habitat diversity (USACE 1997). This project has benefitted pallid sturgeon by increasing seasonal refugia diversity.

In 1998, the upper closing structure of Marquette Chute, river mile 51.0(R), was modified by placing a series of shallow notches in the structure. The idea was to create a "string of pools" which may someday connect to each other downstream of the closing structure. Two of the notches were designed to enhance an existing half-acre, shallow pool located on the adjacent sand bar. The intent was to increase the wetted edge of this seasonal, temporary habitat for wading birds and to provide more water for amphibians and reptiles (Frazier and Hrabik 1998). This project has benefitted pallid sturgeon by increasing access to the side channel, increasing seasonal refugia diversity and increasing the nutrient cycling ability of the side channel, thereby, increasing the forage base of pallid sturgeon.

The Avoid and Minimize Program was originally proposed for implementation from 1994 to 2000 with an estimated cost of approximately 14 million dollars (2 million/year). After 2000, the program is to be completely absorbed into the normal operation and maintenance program or become a part of the Integrated River

Management Program (USACE 1992). Due to recovery efforts from the Great Flood of 1993, program construction did not become active until 1995 (USACE 1995). Since that time, the program has been extended to 2002 but funding has been reduced to 1-1.5 millions dollars/year (USACE 1997). Funding for the Avoid and Minimize Program is currently divided between the impounded reaches of the St. Louis District (Pools 24, 25 and 26) and the MMR with work in the MMR beginning in 1997.

The projects constructed by the Avoid and Minimize Program have served to increase aquatic habitat diversity in the MMR. This is a benefit to the pallid sturgeon, which is adapted to a dynamic environment with diverse habitat components. In addition, physical and biological monitoring has provided data that may be used to further refine structures for environmental benefits. However, the Avoid and Minimize Program can only implement small-scale improvements given funding limitations and the necessity to distribute those resources over a large area of river (approximately 300 miles).

8.2.2.11 Refuge Land Acquisition and Management

Refuge land acquisition and management is beneficially affecting pallid sturgeon by restoring/enhancing habitat in the MMR. Benefits include improved access to off-channel habitat during flood stages and increasing the natural forage base of pallid sturgeon by improving the nutrient cycling ability of the MMR.

Prior to the Flood of 1993, public land ownership in the MMR was virtually nonexistent. However, following the Flood of 1993, many private landowners and levee and drainage districts expressed the desire to sell their flood prone property. In response, Congress appropriated funding for the Emergency Wetland Reserve Program of the Department of Agriculture and for the Fish and Wildlife Service (Service) to assist with purchasing property from landowners who had been plagued by flooding and wanted to dispose of their flood prone property.

The Service completed an Environmental Assessment in 1995 that evaluated four locations (totaling 11,400 acres) of floodplain habitat in the MMR which contained unprotected wetlands, cropland and aquatic areas. The four specific areas identified included:

1) Meissner Island, 1,650 acres in Monroe County, Illinois at river miles 153 - 156;
2) Harlow Island, 1,050 acres in Jefferson County, Missouri at river miles 141 - 145;
3) Wilkinson Island, 2,700 acres in Jackson County, Illinois and Perry County, Missouri at river miles 88 - 94, and;
4) Powers Island, 6,000 acres in Scott County, Missouri at river miles 34 - 39 (USFWS 1995).

To date the Service has purchased 1,224 acres on Harlow Island, 2,532 acres on Wilkinson Island and less than 100 acres on Meissner Island. These areas are part of the Mark Twain National Wildlife Refuge (MTNWR) for management and administrative purposes. The purchased lands contribute to MTNWR goals and objectives by restoring habitat conditions on lands that will also increase floodplain functionality and the ecological integrity of the river. Acquisition of the properties has allowed flood-damaged agricultural lands to return to a more natural state by minimizing the reliance on levees and restoring the natural functions of the Mississippi River floodplain through re-connection with the river. This re-connection improves riverine fish access, including pallid sturgeon, to off-channel areas during flood stages. Restoration of habitat and improved floodplain function will increase organic matter and carbon inputs into the river locally while reducing nitrate input. This nutrient cycling function will benefit aquatic resources, including pallid sturgeon, in this portion of the river.

8.2.2.12 Land-Use Changes

Land-use changes in the UMR basin have affected channel morphology in the MMR and thus have contributed to changes in quantity, quality and diversity of aquatic habitat. Due to the incredibly complex nature of how these land-use changes interact to affect channel morphology, the long time period which must be considered and the various changes in land-use and land management practices during that time that have affected the movement of sediment and water throughout the system, it is unclear how land-use change may have affected pallid sturgeon.

River channel morphology is formed by the movement of sediment and water in relation to the material locally available in the bed and banks (Brookes 1996). A natural channel is neither straight nor uniform (Brookes 1996). Hydraulic and morphological variability through space and time determine the different habitats found both within a given river channel and also in the adjacent riparian and floodplain zones (Brookes 1996). A number of hydraulic factors determine the cross-sectional shape, pool-riffle formation and meander shape of alluvial river channels. This includes depth, slope and velocity which produce bank erosion and sediment transport (Brookes 1996).

Land-use changes in the drainage basin (e.g., agriculture, forestry, mining, grazing and urbanization) alter runoff and sediment yield relationships (Brookes 1996). These land-use changes have an indirect effect on channel characteristics by altering depth, slope and velocity. Land-use change in the central portion of the UMR basin was accelerated with development of the moldboard plow in 1837, and, after World War II with the shift toward intensive mechanized row crop farming (Theiling 1999).

Theiling (1999) noted that land-use and land management practices within the basin have increased the rates of upland erosion and discharge of sediment from tributaries to the UMR over presettlement rates (Knox *et al*. 1975, Knox 1977, Demissie *et al*. 1992). Upland erosion and UMR tributary sediment yields in Wisconsin were highest during periods of intensive farming and runoff during the 1850's through the 1920's, with erosion rates declining since then because of improved land-management practices (Knox *et al*. 1975, Trimble and Lund 1982; Trimble 1983).

However, large amounts of sediment has been stored in the banks and beds of tributaries during the past century (Knox 1977, Demissie *et al*. 1992). According to Demissie *et al*. (1992) it may take 100-200 years for these sediments to be transported from tributary streams. Even so, the discharge of sediment from many tributaries to the UMR, exclusive of the Missouri River, has increased substantially over presettlement rates (Knox *et al*. 1975, Knox 1977, Demissie *et al*. 1992, Soballe and Wiener 1999). Much of this sediment is being held in the impoundments of the UMR.

These land-use changes work in combination with a number of other factors in highly altered river environments. Dam construction and channelization also affect the movement of sediment and water through river systems, affecting channel morphology (Brookes 1996). For this reason, the effect of land-use change on MMR channel morphology, and therefore, aquatic habitat, is incredibly complex. It is not possible to quantify the effect land-use changes have had on the quantity, quality and diversity of habitat in the MMR, and therefore, pallid sturgeon. However, we can say that those changes have contributed to some degree to changes in channel morphology, and therefore, aquatic habitat composition.

8.2.3 Summary

As explained in the status section, pallid sturgeon were historically more abundant. The decline in pallid sturgeon numbers and distribution were coincidental with flood control and navigation projects. Since such projects, pallid sturgeon collection has been rare. Despite this rarity, there is recent evidence of reproduction in MMR. Successful recruitment appears rare, and thus, the extent to which MMR currently provides suitable spawning and larval rearing habitat is unknown.

Many factors have influenced pallid sturgeon habitat availability and abundance in the MMR, with the most pervasive effect being a decrease in habitat quantity and quality as a result of channel training structures, lock and dams, dredging and disposal, commercial sand and gravel dredging, fleeting operations, and impoundment of the Missouri River. An apparent secondary effect caused by this habitat loss is hybridization between pallid and shovelnose sturgeon. Similarly, changes in habitat quality has also impaired the pallid sturgeon's ability to compete for food resources and rendered the species more vulnerable to predation.

As a result of these factors, pallid sturgeon numbers and distribution within the action area have appreciably declined.

8.3 Effects of the Action

8.3.1 Direct Effects

Aquatic features in rivers and floodplains are transient (Leopold *et al*. 1964, Shields and Abt 1989, Salo 1990, Amoros 1990). Natural river systems are subject to high and low flow events and biological processes that can cause rapid changes in successional stage of a particular river feature (Theiling *et al*. 1999). A natural channel is neither straight nor uniform (Brookes 1996). Hydraulic and morphologic variability through space and time determine the different habitats found both within a given river channel and also in the adjacent riparian and floodplain zones (Brookes 1996).

The proposed project (operation and maintenance of the 9-Foot Channel Project) will continue to arrest some of the natural processes that provide dynamic physical change in rivers (Theiling 1999). As explained previously, the dynamic equilibrium of the MMR has been interrupted and replaced by unstable processes and hydraulic and morphologic variability has declined as the result of past operation and maintenance activities. This disruption will have continuing, ongoing effects. The result will be continued homogenization of the river system and degradation of aquatic habitat.

Since pallid sturgeon require diverse and dynamic habitats, it is likely that this species will be extirpated from the MMR. The elimination of this genetic conduit between the Lower Missouri River and the Lower Mississippi River will significantly reduce the survival, growth and recovery of the species throughout its range.

8.3.1.1 Operation of the 9-Foot Channel Project

8.3.1.1.1 Water Level Regulation

Water level regulation will continue to affect pallid sturgeon by affecting the quantity and quality of aquatic habitat in the MMR, thus, (1) reducing larval and juvenile rearing habitat; (2) reducing the availability of seasonal refugia; and (3) reducing the natural forage base of pallid sturgeon by reducing nutrient cycling in the MMR.

During previous discussions with the Corps for preparation of the biological assessment, we concluded that water level regulation effects were not applicable to pallid sturgeon. However, in further reviewing this issue, we believe this is not the case. Dams were constructed on the UMR for the specific purpose of increasing low and moderate flow water surface elevations to maintain a continuous nine-foot navigation channel. Wlosinski (1999) found that water surface elevations in the MMR decreased at the same low discharge of 60,000 cfs during the period 1880 to present. This downward trend is likely to continue as a result of the proposed project. This downward shift in annual minimum stages has been attributed primarily to the degradation of the low water channel due to channel constriction by wingdams and levees (Simons *et al*. 1974). The MMR receives 60% of its flow from the Mississippi River basin (Fremling *et al*. 1989). It is likely that holding water to maintain a 9-Foot Channel in the pools contributes to the low water surface elevations in the MMR at low discharges. Therefore, water level regulation contributes to water level fluctuations in aquatic habitats in the MMR. This can affect the availability of larval and juvenile rearing habitat and the availability of seasonal refugia. In addition, loss of aquatic habitat will reduce the nutrient cycling ability of the MMR, therefore, reducing the natural forage base of pallid sturgeon.

8.3.1.1.2 Impoundment

Impoundment due to construction of dams on the UMR will continue to affect pallid sturgeon by (1) blocking migration routes; (2) reducing substrate diversity, therefore, reducing the availability of spawning habitat; (3) increasing hybridization with shovelnose sturgeon through reduced substrate diversity (e.g., spawning habitat); (4) increasing the risk of predation by other fish; (5) increasing competition with other fish; and (6) decreasing pallid sturgeon foraging capability.

Impoundment of the UMR has effectively converted much of the free-flowing, lotic river habitat to a lentic, pooled condition which is unsuitable for pallid sturgeon. The dams are physical barriers which potentially inhibit upstream migration of riverine fish, including pallid and/or shovelnose sturgeon. Gravel bars and other habitats have filled with sediment due to the lotic conditions. It is uncertain to what degree pallid sturgeon may have historically utilized the UMR above the mouth of the Missouri River. However, to some degree operation of UMR dams continues to reduce the availability of pallid sturgeon spawning habitat, and potentially, block pallid sturgeon migration routes. Operation of UMR dams may also block the migration of shovelnose sturgeon leading to increased instances of hybridization as the two species compete for suitable spawning habitat (Steve Krentz, USFWS, pers. comm.).

The UMR contributes approximately 20% of the suspended sediment load to the MMR (Tuttle and Pinner 1982). Impoundment due to UMR dams will continue to contribute to the reduction of sediment to the MMR. Theiling (1999) found that navigation pools may continue to accumulate this sediment. The lack of sediment delivery upset the natural channel equilibrium. This has been replaced by a variety of nonequilibrium processes, such as, hydraulic sorting and bed paving, which will eventually eliminate all sediment movement (USFWS 1993). This has already occurred to some extent and has resulted in reduced bed roughness, and therefore, reduced substrate diversity (USFWS 1993). Because the system is not at equilibrium, substrate diversity will continue to decline. Reduced substrate diversity will reduce pallid sturgeon spawning habitat, thereby, reducing reproductive success and/or result in increased hybridization with the closely related shovelnose sturgeon.

Impoundments will continue to contribute to reduced suspended sediment (i.e., turbidity), which provides essential cover for pallid sturgeon. Under such conditions, predation by sight-feeding predators can be expected to significantly impact native species not equipped with good eyesight. This effect of impoundment is ongoing. For this reason, pallid sturgeon continue to be subject to increased probability of predation.

As explained previously, it is suspected that reduced turbidity affects food availability by changing species composition and by making it more difficult for pallid sturgeon, and other native species to capture prey in the clearer water environment. Therefore, it is expected that species composition in the MMR will continue to change with a shift to species adapted to clear water environments. This will lead to an increase in competition for species less adapted to this altered environment (clear water). That is, pallid sturgeon will likely face increased competition for available food resources and their ability to capture prey will continue to be adversely affected.

8.3.1.2 Maintenance of the 9-Foot Channel Project

Maintenance of the 9-Foot Channel Project consists of channel maintenance dredging and disposal, maintenance of existing channel training structures and construction of new channel training structures. These activities will work in combination to significantly alter the natural processes that provide dynamic physical change in the MMR (Theiling 1999). Such changes will continue to affect the pallid sturgeon in numerous ways.

a. Changes in river processes result in continued habitat loss and modification.

The environmental baseline section of this biological opinion describes how channel training structures/revetments have altered the MMR and its aquatic environments. Humans have manipulated the UMR system and arrested some of the natural processes that provided dynamic physical changes in the rivers (Theiling 1999). Early snag removal destroyed the structural complexity of the channel environment. In the natural river, snags and log jams would cause scour and filling that provided a highly variable river bottom. Bank stabilization has largely arrested meander cuts and bank erosion. Wingdams have constrained the river width (Shields 1995) and incised the channel (Simons *et al*. 1975a, Wlosinski 1999). Closing structures have isolated side channels and accelerated their rate of filling. This is a significant change in the habitats to which the pallid sturgeon is adapted (e.g., braided channels, irregular flow patterns, flood cycles, extensive microhabitat diversity and turbid waters). Continued maintenance of the 9-Foot Channel Project will result in further homogenization of the river environment, and thus, cause further declines in habitat quality, quantity and diversity.

As explained in the Status and Environmental Baseline sections, the implications of such loss include: (1) reduced substrate diversity, thus, reduced availability of spawning habitat; (2) reduced availability of larval and juvenile rearing habitat; (3) reduced availability of seasonal refugia; (4) reduced quantity and availability of forage food; (5) increased incidence of hybridization with shovelnose sturgeon; and (6) continued transference and homogenization of contaminants in the river system, which may reduce fish health and impair reproduction.

This has great implications for the pallid sturgeon, since the MMR represents one of only two areas within the range of the species in which evidence of successful reproduction has been noted in recent years.

b. Loss of habitat quality, quantity and diversity will likely result in extirpation of pallid sturgeon from the MMR, thus reducing the genetic continuity of the species.

The MMR represents an important genetic conduit between the Lower Missouri River and the Lower Mississippi River. The sturgeons, as a group, exhibit potadromy and occupy different habitats throughout their life cycle. Adult pallid sturgeon may range over distances of 60 or more miles (Bramblett 1996, Sheehan *et al*. 1998) in search of suitable habitat. In addition, larval sturgeon may drift for distances of over 400 miles depending on current velocity (Steve Krentz, USFWS, pers. comm.). These particular life history characteristics underscore the importance of the interconnectedness of the Missouri and Mississippi Rivers in terms of pallid sturgeon population biology. The interconnectedness of these river systems helps maintain the genetic connectivity and continuity of pallid sturgeon by ensuring that genetic material is dispersed throughout the population and genetic diversity is maintained.

Continued maintenance of the 9-Foot Channel Project is expected to result in homogenization of the MMR, essentially making the MMR unsuitable to pallid sturgeon. Hence, pallid sturgeon are likely to be extirpated from this area. Therefore, important spawning and larval/juvenile rearing habitat will be eliminated and the genetic conduit between the Lower Missouri River and the Lower Mississippi River will be impaired. Furthermore, as the MMR is interconnected with the Lower Missouri and Lower Mississippi rivers, any adverse impact to the MMR population will undoubtably influence the viability of the populations occurring in these river reaches as well.

c. Altered environments may lead to increased hybridization with shovelnose sturgeon, thus altering the genetic integrity of the species.

As explained previously, data suggest that hybridization between pallid and shovelnose sturgeon is a recent phenomenon as a result of human-induced reductions in habitat diversity and measurable changes in variables such as turbidity, flow regimes, and substrate types (Carlson *et al*. 1995). Data also suggest that pallid sturgeon and shovelnose sturgeon are reproductively isolated in less-altered habitats, such as portions of the Upper Missouri River (Campton *et al*. 1995). Based on these data, we believe that as maintenance activities degrade and eliminate habitat, pallid and shovelnose sturgeon will be forced to further share spawning habitats, which would not have occurred under non-degraded conditions. Thus, continued maintenance will exacerbate degradation of present habitat conditions to the extent that we believe the incidence of hybridization will increase. This not only decreases reproductive success but could also lead to genetic swamping and loss of the MMR pallid sturgeon population.

d. Nutrient cycling disruption due to changes in river processes that inhibit or reduce floodplain inputs into the river, affecting the forage base of pallid sturgeon.

As explained in the environmental baseline section, channel training structures (e.g., wingdams, revetments) cause the disruption of natural geomorphic processes (e.g., channel meandering, erosion, deposition) and hydrologic variation in the MMR, which will reduce riverine productivity. This loss of nutrient inputs reduces invertebrate and fish production which are the primary forage foods of pallid sturgeon. Channel training structures are typically constructed of rock which adds microhabitat/substrate diversity and complexity leading to increases in macroinvertebrate production on a local scale but do not contribute organic matter or carbon to the riverine system. In addition, different types of insects grow on different types of substrates. The declines in insect abundance and diversity may be linked to changes in fish abundance (Hesse *et al*. 1993). For example, flathead chubs primarily use terrestrial insects which fall into the river from woody debris protruding from the water or along the bank (Hesse *et al*. 1993). Flathead chubs are thought to be extirpated from the MMR.

Maintenance of existing channel training structures and future construction of such structures will contribute further to the disruption of the natural geomorphic processes that inhibit channel meandering. This will likely decrease the availability and diversity of forage food for pallid sturgeon.

8.3.1.2.1 Dredging

Dredging will continue to adversely affect pallid sturgeon by (1) reducing the availability and quantity of the natural forage base of pallid sturgeon; (2) reducing the quantity and availability of larval/juvenile and adult habitat; and (3) contributing to the transference and homogenization of contaminants, potentially affecting pallid sturgeon health and reproductive success. In addition, dredging may result in mortality of juvenile pallid sturgeon.

Dredging occurs in depositional areas and channel crossings to maintain a nine-foot navigation channel. As explained previously, the amount of material dredged in the MMR will vary from year to year depending on river stages, and based on past data, there does not appear to be a consistent pattern in the locations of dredging activities (USACE 1998).

Sheehan *et al*. (1998) documented pallid sturgeon utilizing water depths ranging from 1.82 to 19.17 m with 87.7% of all relocations occurring in water with maximum depths of 6 to 12 m. This compares favorably with the results of other studies, which indicate pallid sturgeon may occur in a variety of water depths (Constant *et al*. 1997, Bramblett 1996, Erickson 1992). The study sturgeon were primarily found in the main channel and main channel border habitats with depths in this range. This was not surprising since main channel habitat comprised approximately 65% of the available habitat in the study reach. Significantly, however, the analysis of habitat data indicated a negative selection against main channel habitat more than any other habitat. Dredging disturbs main channel habitat, killing the resident benthic macroinvertebrates and temporarily leveling the dune and swale bed forms. The bed forms re-form rapidly, but macroinvertebrate recolonization may take at least one growing season (USACE 1999b). Thus, dredging will likely affect the natural forage base of pallid sturgeon.

Currently, dredging does not occur during the presumed window of pallid sturgeon spawning from 12 April to 30 June (USACE 1999a). However, dredging occurs in depositional areas and channel crossings to maintain the nine-foot navigation channel. Sheehan *et al*. (1998) noted that pallid sturgeon exhibited a strong preference for downstream island tips (Sheehan *et al*. 1998), which are typically depositional areas, and thus, possibly prime dredging locations. In addition, the young-of-the-year pallid sturgeon collected in trawling surveys near Cape Girardeau was collected in main channel border habitat located on an inside bend sandbar in water depth of approximately 2.7 m (Petersen and Herzog 1999). Therefore, dredging in depositional areas may also affect the quality and availability of larval/juvenile rearing habitat and/or the availability of feeding habitat for all age classes.

Dredging also disturbs bottom sediments and associated contaminants as discussed in the Environmental Baseline section. Dredging in the MMR will likely further contribute to the homogenization of contaminant concentrations in the Mississippi River, and potentially, exacerbate the transference of contaminants downstream. This may result in reduced fish health and reproductive impairment.

Finally, dredging may cause direct larval or juvenile pallid sturgeon mortality. Adams *et al*. (1999) found that juvenile pallid sturgeon have the capability of occupying habitat that contains water velocities ranging from 15-30 cm/sec for extended periods depending on size. Adams *et al*. (1999) documented speeds of 55 and 40 cm/sec as representing burst swimming speeds for large and small size fish, respectively. However, they were unable to measure the entire range of burst speeds. Bramblett (1996) and Constant *et al*. (1997) found adult pallid sturgeon associated with sand substrate, where fish presumably find refuge from currents within deep scour holes or behind sand dunes and islands. Adams *et al*. (1999) stated that despite lower relative performance, juvenile pallid sturgeon may inhabit high velocity macrohabitats by taking advantage of low velocity microhabitats. No information has been developed concerning flow fields created by dredging in the MMR, therefore, it is unknown if juvenile sturgeon, which may be utilizing depositional areas affected by dredging, can effectively escape dredging activities.

8.3.1.2.2 Disposal

Disposal of dredged material will continue to affect pallid sturgeon by (1) reducing the quantity and availability of the natural forage base of pallid sturgeon; (2) reducing the availability of juvenile and adult feeding areas; and (3) reducing the quality and availability of juvenile and adult habitat. In addition, disposal activities may result in mortality of juvenile pallid sturgeon.

Dredge disposal in the MMR generally occurs in the main channel border area. Characteristic water depths utilized by pallid sturgeon is variable (Constant *et al*. 1997, Bramblett 1996, Sheehan *et al*. 1998). As stated earlier, pallid sturgeon exhibited a positive selection of main channel border habitat in terms of use versus availability (Sheehan *et al*. 1998). Pallid sturgeon also exhibited a strong preference for downstream island tips, which are typically depositional areas. Main channel border areas tend to have higher concentrations of benthic macroinvertebrates than the main channel due to the presence of more favorable substrate (Solomon *et al*. 1974). These areas have been found to have higher fish species richness than deep water habitats (Tibbs 1995). We believe that these areas also provide juvenile rearing habitat (see Status Section). For this reason, disposal activities in the main channel border will likely reduce the natural forage base of pallid sturgeon, reduce the availability of juvenile/adult feeding areas and reduce the availability of juvenile rearing habitat.

It is unclear whether juvenile pallid sturgeon occupying main channel border or depositional areas have the burst swimming speeds necessary to escape disposal activities (Adams *et al*. 1999). Therefore, disposal activities may also result in mortality of juvenile pallid sturgeon.

8.3.1.2.3 Snagging and Clearing

A well defined navigation channel has been established in the MMR as a result of various channel training structures and is maintained by dredging operations. As a result, snagging and clearing operations no longer occur in the MMR.

8.3.1.2.4 Channel Structures/Revetment

8.3.1.2.4.1 Wingdams

Wingdams are designed to direct flow towards the middle of the channel, thus reducing the natural meandering capability of the river. Dike systems (wingdams) may cause localized flattening of the channel slope, increased roughness, vertical accretion of bars, increases in main channel volume, and stage reductions at low discharges (Elliot *et al*. 1991). Existing wingdams have the ongoing effect of altering natural river processes, thereby, reducing the quality, quantity and diversity of habitat in the MMR (see Environmental Baseline section). Continued disruption of natural processes will affect pallid sturgeon by (1) reducing substrate diversity; (2) reducing the availability of larval and juvenile rearing habitat; (3) reducing the availability of seasonal refugia; and (4) reducing the nutrient cycling ability of the MMR, and therefore, reduce the natural forage base of pallid sturgeon. However, wingdams also add substrate diversity to the MMR which influences benthic macroinvertebrate production. This may affect macroinvertebrate production locally. However, by reducing the channel migrational capability, floodplain input (e.g., nutrients and substrates) is reduced, and thus, overall macroinvertebrate abundance and species richness are reduced.

Wingdam systems in the MMR are maintained for the purpose of maintaining the nine-foot navigation channel. As such, they continue to reduce the natural meandering capability of the river. Thus, the river remains constricted and the channel bottom degraded. River migrations that would naturally create new habitat no longer occur. In addition, there is evidence that wingdams in the MMR continue to accrete sediment and revert to woody habitat, further constricting the channel.

Further, wingdams are frequently constructed near the mouths of side channels which modifies river hydraulics and hastens side channel filling. From 1950 to 1994, Theiling *et al*. (1999) noted the loss of approximately 918 acres of secondary channel habitat in the six study reaches. Of this amount, approximately 275 acres were lost from 1975 to 1994. Construction of wingdams near the mouths of side channels is at least partially responsible for this loss of habitat. This trend in side channel habitat loss is likely to continue as existing structures are maintained and new structures are developed.

As a result, wingdams will contribute to further declines in habitats to which the pallid sturgeon are adapted (e.g., braided channels, irregular flow patterns, flood cycles, extensive microhabitat diversity, and turbid waters). That is, wingdams will continue to reduce substrate diversity, reduce larval and juvenile rearing habitat and the availability of seasonal refugia. Also, continued bed degradation and side channel filling is expected to occur in the MMR. This affects the connectivity of aquatic habitats to the main channel, affecting the availability of seasonal refugia. It also reduces the nutrient cycling capability of the MMR which reduces the natural forage base of pallid sturgeon.

However, wingdams are constructed of rock riprap. These structures contribute to substrate diversity and are colonized by macroinvertebrates (Beckett *et al*. 1983, Bingham 1982, Nord Schmulbach 1973, Payne *et al*. 1989). This in turn attracts fish (Farabee 1986, Pennington *et al*. 1983). Thus, to some degree, wingdams contribute to the production of pallid sturgeon forage food. In addition, shovelnose sturgeon spawn on wingdams in the main stem of larger rivers (Christiansen 1975, Elser *et al*. 1977, Moos 1978, Helms 1974). The effect on the reproductive success of pallid sturgeon is unclear. Pallid sturgeon may also utilize these areas, due to the absence of other substrate types, thus, increasing the incidence of hybridization with shovelnose sturgeon. Alternatively, wingdams may provide shovelnose sturgeon with additional substrates away from pallid sturgeon spawning sites, thus reducing hybridization potential.

According to Shields (1995) and Smith (1986) wingdams are currently constructed to avoid accretion of land and constriction of the channel; after an initial period of sandbar accretion, the habitat stabilizes. A Lower Mississippi River study found that within a short period of wingdam construction, aquatic volume and the area of associated low-velocity habitats declined. However, after initial adjustment, habitat area and volume fluctuated about a condition of dynamic equilibrium (Shields 1995). Smith (1986) noted similar behavior in MMR dike fields. Over 800 wingdams have been constructed in the MMR

(Simons *et al*. 1974). Approximately 150 of these have been modified to provide better aquatic habitat conditions (Claude Strauser, USACE, pers. comm). However, the affect is minimal compared to the overall cumulative effects of wingdams in disrupting dynamic natural river processes, such as, channel meandering. In addition, the results of Theiling *et al*. (1999) indicate that wingdams in the MMR continue to accumulate sediment and further reduce channel width.

8.3.1.2.4.2 Bendway Weirs

Bendway weirs are designed to reduce dredging requirements in river bends by controlling point bar development (Davinroy 1990). Bendway weirs affect pallid sturgeon by reducing larval and juvenile rearing habitat and feeding habitat for all life stages. However, bendway weirs also have beneficial effects for pallid sturgeon. These include: (1) reducing channel degradation which may reduce water level fluctuations in adjacent side channels, thus, increasing the availability of larval and juvenile rearing habitat and seasonal refugia; (2) increasing substrate diversity which influences macroinvertebrate production which in turn increases the natural forage base of pallid sturgeon; and (3) reducing the amount of dredging needed to maintain the navigation channel.

Based on information collected to date, the effect of bendway weirs on pallid sturgeon are inconclusive or may reflect a trade off in terms of habitat effects (see Environmental Baseline). Bendway weirs add microhabitat/substrate diversity locally, increasing the natural forage base of pallid sturgeon, and cause channel aggradation along the outside bend which may have some benefit by reducing water level fluctuations in adjacent side channels. However, bendway weirs were developed to inhibit and control point-bar development in bends and depositional areas in channel crossings. These types of habitats are thought to be important to pallid sturgeon, particularly larval and juvenile life stages. As bendway weirs contribute to inhibiting natural processes over time, existing sandbar habitats are likely to accrete to woody terrestrial habitat, further reducing habitat complexity. In addition, bendway weirs increase flow velocities toward the inside bank. It is unclear what impact this may have on fishery utilization of these inside bends, although there is a general trend for fish to redistribute across the cross-section of the channel. Although fish abundance may remain unchanged, it is probable that fish species richness is reduced. Tibbs (1995) found that small-fish abundance was higher in shallow-water habitats compared to deep-water habitats. He also found that small fish species richness was higher in shallow-water than in deep-water (Tibbs 1995).

8.3.1.2.4.3 Bank Revetment/Off-Bank Revetment

Bank revetments are used to eliminate the tendency for the main channel to migrate within the floodplain. Revetments alter the sinuosity of the river channel and alter natural alluvial processes, such as erosion. This can affects pallid sturgeon by (1) reducing substrate diversity, thus, reducing the availability of spawning habitat; (2) reducing the availability of larval and juvenile rearing habitat; (3) reducing the availability of seasonal refugia; and (4) reducing the natural forage base of pallid sturgeon.

Revetments located on outside river bends led to channel downcutting and riverbed degradation. Thus, revetments, in conjunction with wingdams, are responsible for MMR channel constriction and degradation that has reduced river surface area/width and has resulted in a downward shift of annual minimum stages resulting in degradation of aquatic habitats by dewatering (Simons *et al*. 1974, Fremling *et al*. 1989, Wlosinski 1999). Revetments prohibit natural channel migrations that would result in establishment of new side channels as old side channels fill in with sediment or are cut-off from the main channel. By prohibiting natural channel migrations, revetments also reduce the input of organic matter and nutrients (e.g., woody debris) to the river and contribute to reductions in suspended sediment loads.

Thus, revetments will continue to contribute to declines in habitats to which the pallid sturgeon are adapted (e.g., braided channels, irregular flow patterns, flood cycles, extensive microhabitat diversity, turbid waters). Therefore, bank revetments reduce substrate diversity, reduce the availability of larval and juvenile rearing habitat, reduce the availability of seasonal refugia and reduce the natural forage base of pallid sturgeon.

Although revetments contribute to the decline in aquatic habitat, these structures add to substrate diversity that allows colonization of macroinvertebrates (Beckett *et al*. 1983, Bingham 1982, Nord and Schmulbach 1973, Payne *et al*. 1989) which in turn attract fish (Farabee 1986, Pennington *et al*. 1983). In the Lower Mississippi River, Pennington *et al*. (1983), found that numbers of species collected on revetted banks and natural banks are similar. In this study, sport and commercial species were more abundant by weight on revetted banks. Mean catch per effort in numbers and weight were greater on natural banks during June but greater on revetted banks at other times. Farabee (1986) reported that 70% of fish collected were taken on revetted sites and also reported no difference in numbers of species between natural and revetted banks.

It is evident from these two studies that large numbers of fish, but not necessarily different species of fish, generally utilize revetted banklines versus natural banklines. Given the degree to which banklines have been revetted and the lack of woody debris within the system, it is likely that fish redistribute within the system to take advantage of the macroinvertebrate community that develops along revetted banklines. For example, during 1994 hydroacoustic surveys of Greenfield bend, in excess of 29,000 fish per hectare were detected from a protected area near the downstream end of the bend where submerged trees provided inwater structure along a caved-in bank on the inside of the bend (Kasul and Baker 1995). Different species of insects utilize different types of substrates.

Changes in fish abundance can partially be attributed to changes in abundance and diversity of insects (Hesse *et al*. 1993). For example, flathead chubs primarily utilize terrestrial insects, which fall into the river from woody debris protruding from the water or along the bank (Hesse *et al*. 1993). Flathead chubs are thought to be extirpated from the MMR. By prohibiting channel migrations, revetments reduce woody debris inputs into the river.

Off-bankline revetments were designed to reduce bank stabilization costs and increase habitat diversity in main channel environments. They differ from standard revetment in that the riprap is placed several meters away from the bank in areas where there is a gradually sloping river bed. The result is the creation of artificial backwaters adjacent to the main channel. Fish movement is allowed through notches in the revetment. Recent fish work suggests that off-bank revetment provides useful and valuable habitat for a large variety of riverine fishes (Atwood 1996).

Currently, there are no off-bankline revetments constructed in the MMR. Therefore, these structures are not effecting pallid sturgeon. Future construction of these structures in the MMR would increase off-channel habitat, therefore, increasing habitat diversity which would benefit pallid sturgeon. However, MMR banklines are already extensively revetted, therefore, the need for future revetment is uncertain. In addition, use of this type of revetment would generally be restricted to low velocity and gently sloping areas of the river (Rob Davinroy, USACE, pers. comm.), which may adversely affect larval and juvenile rearing habitat.

8.3.1.2.4.4 Chevron Dikes

Chevron dikes were designed to divert flow into a portion of the navigation channel impacted by sediment accumulation on the point bar at a river bend where the river channel splits. The dikes divert flow into the main channel by presenting the hydraulic appearance of a solid object without isolating the side channel with a closing structure. Flow between the structures maintains a permanent side channel connection, which provides important off-channel habitat for fishes. The rock dike substrate provides habitat for epilithic macroinvertebrates that are capable of colonizing in very high densities and providing an important food source for fish. Chevron dikes also create habitat heterogeneity and appear to increase invertebrate abundance and diversity (Ecological Specialist, Inc. 1997b) and provide useful and valuable habitat for a large variety of riverine fishes (Atwood 1997).

No chevrons have been constructed in the MMR. Therefore, these structures are not currently affecting pallid sturgeon. According to Sheehan *et al*. (1998), pallid sturgeon exhibit a strong preference for downstream island tips. Any future construction of chevrons in the MMR would likely benefit pallid sturgeon by improving habitat diversity, including restoration of shallow water sandbar habitat.

8.3.1.2.4.5 Closing Structures

Closing structures for side channels were constructed to divert flow towards the main channel to maintain sufficient depth for the navigation channel. Thus, these structures have reduced flow into side channels causing the channel to fill with sediment. Recently, low dissolved oxygen and high ammonia levels have been documented in side channels isolated from the river (Bob Hrabik, MoDOC, LTRM Station, pers. comm.). Side channel closing structures also inhibit fish ingress/egress in side channels. Although Sheehan *et al*. (1998) did not note pallid sturgeon use of side channels, two of the study fish provided by the LTRM station at Cape Girardeau were collected from MMR side channels (Marquette and Santa Fe) (Mike Petersen, MoDOC, LTRM Station, pers. comm.). In addition, larval pallid sturgeon were recently collected at the lower end of a reconnected side channel on the Missouri River (Joanne Grady, USFWS, pers. comm.). This indicates pallid sturgeon utilize side channels to some degree. Therefore, closing structures continue to affect pallid sturgeon by (1) reducing the availability of spawning habitat; (2) reducing the availability of larval and juvenile rearing habitat; and (3) reducing the availability of seasonal refugia.

As previously discussed, closing structures disrupt natural geomorphic processes by isolating/destroying important side channel and backwater habitat, thereby, reducing riverine productivity (Theiling *et al*. 1999). Closing structures are likely to contribute to ongoing declines in habitats to which pallid sturgeon are adapted (e.g., braided channels, irregular flow patterns, flood cycles, extensive microhabitat diversity, turbid waters) and reduce the quantity and availability of the natural forage food base of pallid sturgeon.

8.3.2 Indirect Effects

8.3.2.1 Navigation Related Indirect Effects

8.3.2.1.1 Tow Traffic

Studies have been conducted to determine the impact of commercial navigation on aquatic resources as a result of the current Navigation Systems Study of the Upper Mississippi River and Illinois River. Gutreuter *et al*. (1998) developed a method for estimation of tow-induced mortality of adult fishes in commercially navigated waterways. The results of this study indicate that main channel fish are susceptible to mortality due to propeller strikes; although estimates adult entrainment mortality are indeterminate due to high variance. However, if their estimates are approximately correct, potentially large losses throughout the Upper Mississippi River System are possible.

The ancillary estimates of kills of ‘adult’ shovelnose sturgeon were 2.4 fish/km of tow travel (Gutreuter *et al*. 1998). The effect of entrainment mortality on pallid sturgeon populations is unknown; although pallid sturgeon and shovelnose sturgeon exhibit similar life history characteristics, and thus, it is likely that pallid sturgeon will also be killed as a result of entrainment mortality. It should be noted that according to the Corps, independent statisticians that reviewed the Gutreuter *et al*. (1998) draft report indicated that the use of ancillary estimates of fish kills was inappropriate.

In addition, tow traffic also contributes to the resuspension of bottom sediments in the main channel depending upon water depths. As such, tow traffic may contribute to the transference and homogenization of contaminants in the UMR as discussed previously. This may result in reduced pallid sturgeon health and reproductive impairment.

8.3.2.1.2 Fleeting

Fleeting adversely affects pallid sturgeon by (1) reducing the quality of habitat in the MMR; (2) reducing the natural forage base of pallid sturgeon; (3) resuspending sediments that may be contaminated, thus, affecting pallid sturgeon health and reproduction; and (4) potentially causing direct mortality due to towboat entrainment.

Fleeting areas are typically constructed within main channel border habitats. Towboats maneuvering within fleeting areas cause resuspension of sediments. In addition, fleeting areas may occasionally require dredging, which also disturbs bottom sediments. As such, fleeting operations likely affect macroinvertebrate production on a local scale. According to the work of Sheehan *et al*. (1998), pallid sturgeon exhibited a strong preference for main channel border habitat. It is difficult to determine to what degree fleeting will continue to affect pallid sturgeon. However, future fleeting will contribute to the overall continued decline in habitat quality, adversely affecting the natural forage base of pallid sturgeon and may cause resuspension of contaminated sediments, thereby, potentially reducing pallid sturgeon health and reproductive success.

Towboats maneuver and reconfigure barges in fleeting areas. Although Gutreuter *et al*. (1998) could not determine whether towboat entrainment is an important source of mortality of fish species, the results of this study indicate that main channel fish are susceptible to mortality due to propellor strikes. Therefore, it is also likely that fleeting will cause some degree of fish mortality, including pallid sturgeon as they utilize main channel border habitats.

8.3.2.1.3 Port Facilities

Development of port facilities requires various levels of habitat modification (USACE 1999a). It is unknown to what degree future development of port facilities may contribute to loss of habitat for pallid sturgeon.

8.3.2.1.4 Exotic Species

There are no exotic species currently known to be affecting pallid sturgeon.

8.3.2.1.5 Contaminants

As previously discussed, Ruelle and Keenlyne (1993) identified several contaminants in Missouri River pallid sturgeon that may adversely impact reproduction. A recent sturgeon health assessment in the MMR indicates that there appears to be sufficient evidence to suggest that pallid sturgeon are at risk from exposure to contaminants present in their habitat (Coffey *et al*. 1999). This study found evidence of possible endocrine disruption, which has the potential to cause reproductive impairment (USGS 1998). Coffey *et al*. (1999) also noted a significant difference between reference site sturgeon and MMR sturgeon for some organochlorine chemicals. This has likely resulted in reduced fish health and reproductive impairment. There are currently no data available for contaminant concentrations in pallid sturgeon ovaries. However, data for the shovelnose sturgeon indicate that values of organic compounds may be of concern for developing embryos (USACE 1999a).

An indirect effect of maintaining the 9-Foot Channel is the spillage of hazardous materials or substances. An analysis of reported oil spills in a portion of the MMR indicates that these types of spills are quite common (from 11/26/98 to 7/26/99 there were 45 spills reported for the area between UMR miles 170.0 - 202.0) (Stan Smith, USFWS, pers. comm.). Most of the spills were small quantities of oil and/or diesel. The potential for such future spills to have direct or chronic effects on pallid sturgeon is unknown. However, such spills contribute to the accumulation of contaminants in the MMR which may impair reproduction or result in reduced fish health.

8.3.2.2 Recreation Related Indirect Effects

Unlike the pooled portion of the UMR where the Corps maintains lake-like conditions and recreational facilities that are conducive to boating, no recreation facilities are maintained or planned for the MMR. Recreation activity in the MMR is not affected by maintenance of the 9-Foot Channel Project. Therefore, recreation related indirect effects to pallid sturgeon are not anticipated.

8.3.3 Interrelated Effects

8.3.3.1 Management of Corps Lands

The Corps does not own nor manage any lands in the MMR. Therefore, interrelated effects to pallid sturgeon due to management of Corps lands are not anticipated.

8.3.3.2 Open River Habitat Enhancement Project

The Corps recognizes that the degradation and loss of side channel habitat is of particular concern within the MMR. These habitats not only supply important nursery and overwintering areas, they are an extremely important carbon energy generating machine for the entire river system (USACE undated). As such, the St. Louis District is in the process of developing the Open River Habitat Enhancement Project to enhance and/or create side channel habitat in the MMR. In addition, the project proposes other activities, such as sandbar creation, riparian corridor restoration and restoring woody debris. These activities are thought to be beneficial for pallid sturgeon.

While the Corps proposes to utilize some operation and maintenance and construction general funds to implement this program, much of the work is proposed under various cost-sharing mechanisms (e.g., Environmental Management Program, Section 1135, Section 206). As a result, the Corps cannot guarantee how much of this program will be implemented, therefore, the amount of habitat that will be restored or enhanced is unknown at this time.

8.3.4 Interdependent Effects

8.3.4.1 Missouri River Bank Stabilization and Navigation Project

As the MMR and the Lower Missouri River are interconnected in terms of pallid sturgeon reproduction, the Missouri River Bank Stabilization and Navigation Project (Missouri River Project) will continue to affect pallid sturgeon survival and reproduction in the MMR by (1) reducing substrate diversity, including spawning habitat; (2) reducing the availability of seasonal refugia; and (3) reducing riverine productivity, thereby, reducing the natural forage base of pallid sturgeon.

The Missouri River Project has restricted the Missouri River to a serpentine, self-cleaning navigation channel characterized by high water velocities. This has been accomplished through the use of wingdams and revetments which confine the river. Before the Missouri River was channelized and impounded, it annually eroded 3.1 hectares/km of its floodplain (USACE 1981). Most of this erosion has stopped due to channelization and impoundment. Erosion was a natural function of the river system, and through erosion, inorganic sediments, organic matter, and large woody debris were introduced into the river. This material import was essential to the habitat dynamics and nutrient cycling of the river system. Such sediment and nutrient discharge are the raw materials for habitat development in the Missouri and Mississippi River system. By reducing erosion in the Missouri River, and thereby reducing suspended sediment load, the Missouri River Project contributes to the decline of pallid sturgeon in the MMR by reducing substrate diversity and reducing the natural forage base of pallid sturgeon.

As a result of the Missouri River Project, wide bends in the river were cut off by rock revetments or physically separated from the main channel by cuts (USFWS 1980). Just as the 9-Foot Channel Project has reduced and continues to reduce habitat quality, quantity and diversity in the MMR, the Missouri River Project has a similar effect in the Missouri River. From 1912 to 1980 approximately 100,000 acres of aquatic habitat and approximately 65,000 acres of island/sandbar habitat was lost due to the Missouri River Project (USFWS 1980). As discussed previously, the Lower Missouri River and the MMR are interconnected in terms of pallid sturgeon population biology. Therefore, Missouri River Project contributes to the decline in pallid sturgeon survival and reproduction in the MMR by reducing substrate diversity, and therefore, spawning habitat, and reducing the availability of seasonal refugia for pallid sturgeon which may migrate during various seasons from the MMR to the Lower Missouri River.

8.3.4.2 USCG Buoy Tending

USCG buoy tending activities are not known to affect pallid sturgeon.

8.3.5 Cumulative Effects

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Mortality of pallid sturgeon occurs as a result of illegal and incidental harvest from both sport and commercial fishing activities. Sturgeon species, in general, are highly vulnerable to impacts from fishing mortality due to unusual combinations of morphology, habits and life history characteristics (Boreman 1997). In 1990, the head of a pallid sturgeon was found at a sport-fish cleaning station in South Dakota, and in 1992 a pallid sturgeon was found dead in a commercial fisherman's hoop net in Louisiana. In 1997, four pallid sturgeon were found in an Illinois fish market (Sheehan *et al*. 1997b). Currently there are no methods to differentiate between pallid and shovelnose sturgeon eggs; however, it is believed that pallid sturgeon are significantly affected by the illegal take of eggs for the caviar market.

Sheehan *et al*. (1997b) speculate that incidental commercial harvest of pallid sturgeon may indirectly lead to greater hybridization with shovelnose sturgeon as a result of skewed sex ratios. Pallid sturgeon males mature at 5-7 years of age while female pallid sturgeon first spawn at approximately 15 years (Keenlyne and Jenkins 1993). Once mature, pallid sturgeon may not spawn every year, but may take several years between spawning (Keenlyne and Jenkins 1993, Keenlyne *et al*. 1992). Due to its late maturity, pallid sturgeon may be exposed to many years of commercial fishing before they have a chance to spawn and contribute to the recruitment of the population. For those that do survive long enough to spawn once, they may have to survive multiple years of commercial fishing danger in order to spawn again. Being at great risk of being removed before maturity, incidental commercial harvest of females may skew the sex ratio of the mature sturgeon population. This could indirectly lead to greater hybridization rates as male pallid sturgeon, unable to find mature females to mate with, spawn with shovelnose sturgeon instead. [excerpt from Sheehan *et al*. 1997b]

8.3.6 Summary of Effects

Operation and maintenance of the 9-Foot Channel Project will continue to disrupt and arrest some of the natural processes that provide dynamic physical change in the UMR. The dynamic equilibrium of the MMR has been interrupted and replaced by unstable processes that have continuing, ongoing effects. The result will be continued homogenization of the river system and degradation of aquatic habitat, which in turn affects the quantity, quality and diversity of aquatic habitats available to pallid sturgeon.

Specific effects to pallid sturgeon are varied. The most important affect is the loss and degradation of aquatic habitat which reduces spawning substrate, larval and juvenile rearing habitat and seasonal refugia. The loss of habitat is believed to be a factor in increased incidences of hybridization with shovelnose sturgeon. Reduced suspended sediment transport is a factor in increased predation, competition with other species and reducing the foraging capability of pallid sturgeon. A number of operation and maintenance activities work in combination to reduce the quantity and quality of the natural forage base of pallid sturgeon. Migration routes are blocked by locks and dams which affects reproductive success. Operation and maintenance activities also contribute to the transference and homogenization of contaminants in the UMR, which may reduce fish health and impair reproduction. As a result of the above, it is likely that the MMR will become so homogenized that pallid sturgeon are likely to be extirpated from this area and/or hybridization will become so prevalent that genetic swamping will occur. Furthermore, because this action also influences pallid sturgeon in the Lower Missouri and Lower Mississippi Rivers, the viability of the Lower Missouri-MMR-Lower Mississippi population unit is also affected by continued operation and maintenance.

8.4 Conclusion

8.4.1 Jeopardy Analysis

After reviewing the current status of pallid sturgeon, the environmental baseline for the MMR, the effects of continued operation and maintenance of the 9-Foot Channel Project and the cumulative effects, it is the Service’s biological opinion that the continued operation and maintenance of the 9-Foot Channel Project, as proposed, is likely to jeopardize the continued existence of the pallid sturgeon. No critical habitat has been designated for this species, therefore, none will be affected.

As discussed in the status section of this biological opinion, pallid sturgeon populations are declining throughout the range of the species. Although spawning is known to occur, there is little evidence of successful reproduction and no indication of recent recruitment. Upper Missouri River populations are reproductively isolated and aging. Hybridization appears to be prevalent throughout much of the species’ range. The Atchafalaya River population has a diverse age structure, but is also hybridizing with shovelnose sturgeon and is reproductively isolated from the remainder of the species’ range.

The MMR is important to the survival and recovery of pallid sturgeon for a number of reasons. The MMR represents a significant portion of 1 of 6 designated recovery priority management areas identified in the recovery plan (USFWS 1993). It is 1 of 3 areas in which we believe some natural reproduction may be occurring and it is believed to be an important juvenile rearing area. Furthermore, it is 1 of only 2 areas where we have evidence of reproduction in recent years. The MMR is approximately 5% of the pallid sturgeon's total current range of approximately 3500 miles. However, it represents approximately 10% of the range that is believed to have suitable habitat (e.g., somewhat unaffected by impoundments on the Upper Missouri River).

Finally, the MMR represents an important genetic conduit between the Lower Missouri River and the Lower Mississippi River. Impacts to the MMR influence pallid sturgeon the populations in both of these river sections (i.e., the area of impact to pallid sturgeon is much greater than just the MMR). Changes in the MMR are likely to affect the population viability in the Lower Missouri River and the Lower Mississippi River, and thus, influence the likelihood of survival and recovery of the entire Lower Missouri River-MMR-Lower Mississippi River population. In other words, the effects of the project compromise not only the persistence of the MMR pallid population but also the viability of pallid populations in the Lower Missouri and Lower Mississippi Rivers.

The proposed project, continued operation and maintenance of the 9-Foot Channel for the next 50 years, will result in habitat loss and degradation, and perhaps more importantly, will continue to disrupt and alter dynamic natural river processes (e.g., channel meandering, erosion, deposition), leaving little opportunity for the reestablishment of important aquatic habitats. The most evident effect is the continued loss and degradation of existing aquatic habitat which reduces pallid sturgeon spawning substrate, larval and juvenile rearing habitat and seasonal refugia. This loss of habitat will likely lead to further reductions in the productivity of pallid sturgeon and increased incidences of hybridization with shovelnose sturgeon. Furthermore, the disruption and alteration of dynamic river processes also inhibits the creation and reestablishment of aquatic habitats which are important to pallid sturgeon. This effect will not only lead to further reductions in pallid sturgeon productivity, but also will prevent the increases in productivity that are necessary to ensure the continued survival and recovery of the species.

In addition to these two primary effects, continued operation and maintenance will also result in a series of secondary effects that are also of importance. These include:

- Reductions in suspended sediment transport.
- Reductions in the quantity, quality and availability of the natural forage base.
- Continued disruption of migration routes.
- Transference and homogenization of contaminants.

Reductions in suspended sediment transport is a factor in increased predation, competition with other species, and reducing the foraging capability of pallid sturgeon. Similarly, operation and maintenance activities will reduce the quantity, quality and availability of the natural forage base of pallid sturgeon. While past operation and maintenance activities have reduced this important resource, continuation of these activities will prevent its recovery. Migration routes will continue to be potentially blocked by locks and dams, which affects reproductive success. Lastly, operation and maintenance activities will contribute to the transference and homogenization of contaminants in the UMR, which may reduce fish health and impair reproduction. As a result of the above, it is likely that the MMR will become so homogenized that pallid sturgeon are likely to be extirpated from this area and/or hybridization will become so prevalent that genetic swamping will occur.

These effects will have the greatest influence on the MMR, which is an important portion of the species range. However, as alluded to above, continued operation and maintenance will also substantially impact pallid sturgeon populations in both the Lower Missouri River and the Lower Mississippi River. That is, continued operation and maintenance will affect the core of the pallid sturgeon's contiguous range, and hence, appreciably reduce the likelihood of both survival and recovery of the species.

8.4.2 Reasonable and Prudent Alternative

Regulations (50 CFR §402.02) implementing section 7 of the Act define reasonable and prudent alternatives as alternative actions, identified during formal consultation, that: (1) can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) are economically and technologically feasible; and (4) would, the Service believes, avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat.

As stated previously, habitat loss and alteration, as well as disruption and alteration of the dynamic processes that create, restore, and maintain habitat, resulting from the continued operation and maintenance of the 9-Foot Channel Project are likely to jeopardize the continued existence of the pallid sturgeon. To avoid jeopardizing the continued existence of pallid sturgeon, it is necessary to (1) prevent further reductions in the total amount of habitat and (2) provide for the reestablishment of pallid sturgeon spawning, rearing, and refugia habitat to compensate for the curtailment of the dynamic processes that create and maintain such habitat. To achieve this, while continuing operation and maintenance of the 9-Foot Channel, it is necessary to: (1) implement a concurrent habitat restoration program with the goal of restoring habitat quality, quantity, and diversity so that the benefits of the dynamic natural river processes are restored, and, (2) conduct a comprehensive pallid sturgeon habitat study to better characterize spawning habitat and seasonal and various life stage use in the MMR to facilitate habitat restoration. We believe that these actions will assist in restoring and maintaining a functional ecosystem that is needed to ensure that the likelihood of survival and recovery of the pallid sturgeon is not appreciably reduced.

A Reasonable and Prudent Alternative (RPA) is for the Corps to (1) conduct a pallid sturgeon habitat study in the MMR, (2) facilitate development of a pallid sturgeon conservation and restoration plan, (3) implement a long-term program of aquatic habitat restoration in the MMR that will mitigate future adverse effects of operation and maintenance of the 9-Foot Channel Project on pallid sturgeon habitat, including the adverse effects of curtailment of the dynamic processes that create and maintain such habitat, and (4) begin short-term implementation of aquatic habitat restoration measures that may reasonably be expected to benefit pallid sturgeon in the MMR during the interim period between issuance of the biological opinion and implementation of component #3 (e.g. restoration of side channels, wingdam notching, chevron dike construction, etc.). This RPA involves the following:

1. Conduct a pallid sturgeon habitat study in the MMR. The goal of this effort is to develop a comprehensive study of pallid sturgeon habitat to identify the habitat variables and related factors that are limiting population growth and distribution in the MMR. Although much data have been collected in recent years, more information relative to pallid sturgeon life history, particularly spawning and larval/juvenile life stages, is needed. Such studies would (1) help to better establish the connection between specific impacts of operation and maintenance of the 9-Foot Channel (and mitigatory actions needed on the part of the Corps to offset these impacts) and actual loss of sturgeon habitat, and (2) serve to help focus the implementation efforts of the pallid sturgeon conservation and restoration plan (described below).

An interdisciplinary team composed of Service staff, biologists familiar with the pallid sturgeon, and potamologists or hydrologists familiar with the MMR will be organized to assist the Corps with developing the scope-of-work(s) for this study. This scope-of-work(s) will be completed and submitted to the Service for approval within 1 year of issuance of this biological opinion. Implementation of the study will begin within 2 years of issuance of this biological opinion. A progress report describing the results of this study will be provided to the Service annually, beginning with the first report in June 2002. If an approved scope-of-work or implementation of such study does not occur by this date, the Corps must promptly reinitiate section 7 consultation with the Service.

2. Facilitate development of a pallid sturgeon conservation and restoration plan (Plan). The goal of this effort is to develop a comprehensive plan (subject to periodic revision as new information becomes available) directed at mitigation of the adverse impacts of operation and maintenance of the 9-Foot Channel project occurring after the baseline year. This Plan may also identify additional sturgeon habitat restoration needs in the MMR that can be implemented by the Corps, the Service, the states of Illinois and Missouri and the private sector. This may include related issues such as a stocking program and means of regulating illegal or incidental take of pallid sturgeon by sport and commercial fishermen. As the Plan will include not only Corps mitigatory actions but may also include other restoration opportunities, it could become the “blueprint” guiding the overall pallid sturgeon habitat restoration and population recovery effort in the MMR.

An interdisciplinary team (similar to that described in item 1 above) will be established to assist in drafting the Plan. The primary responsibility of this team is to provide guidance to the Corps on the habitat and ecological needs of the pallid sturgeon in the MMR. The Corps should also solicit the assistance of the team to review and apply new data as it becomes available. The Corps must submit the Plan to the Service for approval by June 2004. Should the Corps fail to obtain an approved Plan by this date, section 7 consultation must be reinitiated immediately with the Service. The Plan will include, but not limited to, the following:

a. A habitat restoration plan for each river compartment (or reach). As the Mississippi River is ecologically diverse, the various river reaches within the MMR are likely to have differing data collection and habitat restoration needs. Thus, the Plan will identify and prioritize distinct river compartments throughout the MMR, and will describe the restoration needs for each river compartment. Each river compartment plan will specifically identify those actions to be taken to mitigate the effects of continued operation and maintenance of the Nine Foot Channel Project. The Service supports the identification of other actions within the compartment plans which may be undertaken voluntarily by the Corps of Engineers or other agencies/groups that are in support of pallid sturgeon recovery. The Corps must submit, upon completion, each river compartment plan to the Service for approval to ensure the overall objective of the RPA is met.

b. A population and habitat restoration monitoring plan. Monitoring the effect of habitat restoration on sturgeon population reproduction, growth and survival and on the status and trends of habitat quality, quantity and diversity will be critical in measuring the success of the program and in guiding future decision making. Thus, the Plan must include a monitoring protocol. The monitoring plan will be developed and submitted to the Service <u>within one year</u> of issuance of the biological opinion in order to expedite the collection of baseline data.

3. Implement, as described in the Plan, a long-term aquatic habitat restoration program in the MMR that will mitigate future adverse effects of operation and maintenance of the 9-Foot Channel Project on pallid sturgeon habitat. The Corps must implement those actions identified in the approved Plan to mitigate for the adverse effects of operation and maintenance of the 9-Foot Channel in the far term. As indicated in item 2 above, the Plan will include restoration plans for each river compartment. Each of these plans will identify specific timelines and benchmarks for its particular river reach, in addition to the benchmarks described below. Thus, an annual report describing progress the Corps has made toward meeting the timelines and benchmarks and the results of monitoring will be provided to the Service by <u>30 June</u> of each year beginning with the first report in <u>June 2001.</u> Should the Corps fail to meet the benchmarks described below or those identified in the river compartment plans, section 7 consultation must be reinitiated immediately with the Service. As more pallid sturgeon life history data and monitoring data are collected, the timelines and benchmarks of the plans may be modified with approval by the Service. The long-term habitat restoration work will continue until such time as additional work is no longer warranted (due to the cumulative beneficial impacts of all pallid sturgeon conservation and restoration work completed in the MMR through implementation of the conservation and restoration plan) as determined in the Plan.

4. During the interim period between issuance of the biological opinion and implementation of the Plan, the Corps will implement short-term aquatic habitat restoration measures and studies that may reasonably be expected to benefit sturgeon in the MMR. There is sufficient information available to enable biologists who are familiar

with pallid sturgeon to identify where initial habitat restoration should be focused. This element of the RPA requires the Corps to immediately begin proactively implementing certain habitat restoration measures (e.g., side channel restoration, wing dam notching, chevron dike construction) while habitat studies are underway and while the Plan is finalized and implemented. Habitat restoration measures and studies selected for implementation will be determined by the Corps, in consultation with biologists from the Service and the states of Illinois and Missouri. These short-term aquatic habitat restoration measures will be identified within six months of issuance of the biological opinion and submitted to the Service for approval. Should the Corps fail to meet this deadline, section 7 consultation must be reinitiated immediately with the Service.

Several habitat restoration and enhancement measures (see table below) are critical to restoring habitat quantity, quality and diversity in the MMR, and will be used as a guide for both short-term and long-term restoration efforts until more information regarding pallid sturgeon habitat needs is obtained. The following habitat restoration and enhancement measures have been classified (by the Corps and FWS) according to priority needs and expected benefits to pallid sturgeon, and thus, will be used by the Corps to guide their restoration efforts:

Priority	**Measure**	**Expected Benefit**
High	Restore gravel bars	spawning, early life history
High	Restore sand bars	larval/juvenile habitat
High	Restore side channels	all life stages, seasonal refugia
Medium	Restore floodplain connectivity	nutrient cycling/productivity for forage food
Medium	Restore woody debris	trophic and habitat diversity
Medium	Modify training structures	all life stages, habitat diversity
Low	Restore the riparian corridor	nutrient cycling

Benchmarks and Timelines

To ensure expeditious progress is made in complying with the various elements of the RPA, the following benchmarks have been developed. The timeline for these benchmarks begins with the date of issuance of this biological opinion.

Year 1 (2000) Establish the interdisciplinary team to assist with developing the Plan, monitoring plan(s), and scope(s)-of-work for the pallid sturgeon habitat study

Identify and prioritize river compartments

Develop the scope(s)-of-work for the pallid sturgeon habitat study

Develop a monitoring plan for both habitat and sturgeon populations

Identify short-term restoration measures and submit to the Service for approval (within 6 months of issuance of the biological opinion)

Begin implementation of short-term restoration measures

Year 2 (2001) Begin developing the Plan, including developing habitat restoration plans for 1/3 to 1/2 of the top ranked compartments

Continue implementation of short-term restoration measures

Begin pallid sturgeon habitat study

Begin monitoring (e.g., collection of baseline data)

Year 3 (2002) Continue developing the Plan, including developing plans for the next 1/3 to 1/2 of river compartments

Continue implementation of short-term habitat restoration measures

Continue pallid sturgeon habitat study

Continue monitoring (e.g., finish baseline data collection)

Year 4 (2003) Finish the Plan, including developing plans for the remainder of the river compartments as necessary

Continue implementation of short-term habitat restoration measures

Continue pallid sturgeon habitat study

Year 5 (2004) Begin Plan implementation

Continue monitoring as specified in the monitoring plan

A yearly report describing progress the Corps has made toward meeting the timelines and benchmarks and the results of monitoring will be provided to the Service by June 30 of each year beginning with the first report in June 2001. Should any of the above benchmarks be unobtainable, the Corps must promptly reinitiate section 7 consultation with the Service.

Because this biological opinion has found jeopardy, the Corps is required to notify the

Service of its final decision on the implementation of the reasonable and prudent alternative.

8.5 Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any contract, grant, or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the contract, permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in this incidental take statement. [50 CFR §402.14(i)(3)]

While the overall effect of new construction projects (e.g., bendway weirs, wingdams, etc.) are considered programmatically in this incidental take statement, it is not possible to determine the site-specific effects of these actions at this time. Therefore, all new construction projects will require a Tier II level of review to determine if formal section 7 consultation is necessary. A biological assessment that incorporates measures to further minimize incidental take and that contains pre-project physical and biological data, an analysis of predicted post-project effects and monitoring of post-project physical and biological effects will be developed for each project and provided to the Service for review.

8.5.1 Amount or Extent of Take

The Service has developed the following incidental take statement based on the premise that the reasonable and prudent alternative will be implemented.

The Service anticipates that incidental take of pallid sturgeon will occur between issuance of this biological opinion and complete implementation of the RPA, as well as, for a short period following implementation of the RPA (approximately 10 years).

1. During the interim period between issuance of this biological opinion and implementation of the reasonable and prudent alternative, continued operation and maintenance of the 9-Foot Channel Project will result in continued declines in pallid sturgeon habitat and continued disruption and alteration of the processes that create and maintain such habitat, and therefore, result in incidental take.

   The Service anticipates that incidental take of pallid sturgeon due to continued operation and maintenance activities will be difficult to detect and monitor for the following reasons: (1) pallid sturgeon are wide ranging, (2) occur in habitats and at densities that make detection difficult and finding a dead or impaired specimen is unlikely, and (3) changes to fitness parameters (e.g., decreased recruitment) are difficult to assess in small populations. We believe, however, the level of take can be detected by monitoring habitat loss and disturbance. Recent studies by Theiling, *et al*. (1999) indicate that main channel habitat in the six study reaches analyzed is currently being lost at a rate of approximately 1.2 acres/mile/year (1975-1994). Secondary channel (side channel) habitat is being lost at a rate of approximately 0.8 acres/mile/year (1975-1994). Thus, during this interim period, a maximum of 1.2 acres/mile/year of main channel habitat and a maximum of 0.8 acres/year/mile of side channel habitat is anticipated to be lost due to the on-going effects of continued operation and maintenance (including existing channel training structures and the dredging program).

   Adverse impacts will occur over the next 50 years, and as we have determined, will cause an appreciable reduction in the likelihood of survival and recovery of pallid sturgeon. Although the RPA provides a 4-year planning period, some short-term habitat restoration activities will occur within this interim period. The benchmarks for the first 4 years following issuance of this biological opinion includes primarily planning and baseline monitoring with implementation not beginning until year 5. This is necessary in order to meet the needs of Corps' budgetary planning cycles. Also, as this is a programmatic biological opinion, future site-specific projects will undergo further section 7 review, and as such, adverse affects will be minimized to the extent possible. Furthermore, we anticipate that some amount of habitat restoration/enhancement will occur within the 4-year planning period under the Avoid and Minimize Program and, potentially, the Environmental Management Program and/or Section 1135. Thus, we believe the adverse effects that may occur during the planning phase of the RPA will be minimized to the extent that an appreciable reduction in the likelihood of survival and recovery will not occur during this time.

2. During the period following implementation of the RPA, pallid sturgeon habitat is likely to continue to decline as a result of continued operation and maintenance of the 9-Foot Channel Project and the processes that create and maintain such habitat will continue to be disrupted and altered. This is because the habitat restoration program is long-term and immediate trends in increasing habitat quality, quantity and diversity are not likely in the short-term (e.g., the amount of habitat restored is not initially likely to off-set the amount lost due to operation and maintenance activities). Therefore,

incidental take, in the form of habitat loss and alteration due to operation and maintenance of channel training structures, is likely to continue for some time (approximated at 10 years) following implementation of the RPA. In addition, incidental take in the form of habitat alteration due to the dredging program is likely to continue for the next 50 years.

As explained above, we believe that incidental take of pallid sturgeon due to continued operation and maintenance activities will be difficult to detect. Although it is difficult to estimate the rate of habitat loss that will occur, we anticipate that habitat loss and the associated incidental take will not exceed the current rate of loss. Thus, during the first 10 years following implementation of the RPA, a maximum of 1.2 acres/mile/year of main channel habitat and a maximum of 0.8 acres/year/mile of side channel habitat is anticipated to be lost due to the on-going effects of continued operation and maintenance (including existing channel training structures and the dredging program). After this initial 10 year period, habitat quality, quantity and diversity are expected to increase as a result of implementation of the RPA.

3. Implementation of a monitoring program for sturgeon in the MMR is likely to result in incidental take of pallid sturgeon as an artifact of sampling gears (e.g., trawling for young-of-the-year, hoop netting, gill netting). Similarly, monitoring efforts for specific operation and maintenance activities may also result in incidental take of pallid sturgeon. The Service anticipates that 10 young-of-the-year pallid sturgeon/year and 1 juvenile/adult pallid sturgeon/year could be taken as a result of sturgeon monitoring. This incidental take is expected to be in the form of death of individual pallid sturgeon. This level of anticipated incidental take is based on current information. This level of anticipated incidental take may require revision once the monitoring plan for the RPA has been completed.

8.5.2 Effect of the Take

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat when the reasonable and prudent alternative is implemented.

8.5.3 Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures (RPM's) are necessary and appropriate to minimize take of pallid sturgeon:

1. Channel training structure maintenance projects will incorporate modifications to improve aquatic habitat diversity (e.g, notching of wingdams, incorporating woody debris, etc.). This RPM addresses incidental take anticipated in 1 and 2 discussed above.

2. Dredge material disposal in the MMR will be conducted in a manner to restore habitat

or other beneficial use. To minimize impacts to pallid sturgeon habitat, dredge material will be disposed of in the thalweg of the channel, unless material is otherwise utilized in association with habitat restoration or other beneficial uses. This RPM addresses incidental take anticipated in 1 and 2 discussed above.

3. Maintenance dredging will not occur during the presumed window of pallid sturgeon reproduction (12 April - 30 June). These dates may require revision as more information becomes available regarding pallid sturgeon spawning and larval stage development. This RPM addresses incidental take anticipated in 1 and 2 discussed above.

4. All live pallid sturgeon caught in sampling gear and remaining in good condition will be released immediately following recording of relevant population/species data and collection of tissue samples. This RPM addresses incidental take anticipated in 3 discussed above.

5. Data collected with implementation and monitoring of the RPA will be reviewed by the habitat restoration implementation team in order to further develop measures that minimize incidental take. The proposed measures will be incorporated into future operation and maintenance activities. This RPM addresses incidental take in 1 and 2 discussed above.

8.5.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. At the beginning of each fiscal year, the Corps will provide the Service a list of new construction projects for which Tier II evaluations are anticipated. This term and condition addresses incidental take in 1 and 2 discussed above.

2. Channel training structure maintenance projects will be submitted to the Service for a 30 day review period. Service recommendations for aquatic habitat improvement will be incorporated into project construction plans. This term and condition addresses incidental take in 1 and 2 above.

3. Monitoring will be conducted to measure the loss of main channel and side channel habitat. Such monitoring can be included in the monitoring plan developed for the RPA. This term and condition addresses incidental take in 1 and 2 discussed above.

4. Dredging and disposal activities will continue to be coordinated with the Service, Illinois Department of Natural Resources and the Missouri Department of Conservation. This term and condition addresses incidental take in 1 and 2 discussed above.

5. Should it become necessary for the Corps to dredge during the presumed window of pallid sturgeon reproduction (12 April - 30 June), reinitiation of formal section 7 consultation will be necessary to address further incidental take of pallid sturgeon. A Tier II biological assessment will be required to evaluate the effects of dredging during this time frame on pallid sturgeon. This term and condition addresses incidental take in 3 discussed above.

6. A monitoring program will be implemented to monitor the effects of thalweg disposal on the aquatic environment and the navigation channel. This term and condition addresses incidental take in 1 and 2 discussed above.

7. An annual dredge material management report will be provided to the Service at the end of each dredging season. The report should include information concerning dredging/disposal locations, quantities of material, the results of sediment size analysis and methods of disposal. This term and condition addresses incidental take in 1 and 2 discussed above.

8. All dead pallid sturgeon encountered during sampling and monitoring activities will be preserved on ice and provided to the University of Alabama per the Service's cooperative agreement. This term and condition addresses incidental take in 3 discussed above.

8.5.5 Closing Paragraph

The Service believes that no more than 16.8 acres/mile (1.2 acres/mile/year X 14 years) of main channel habitat and 11.2 acres/mile (0.8 acres/mile/year X 14 years) of side channel habitat will be incidentally taken as a result of the continued operation and maintenance of the 9-Foot Channel Project. The Service also believes that no more than 11 pallid sturgeon per year will be incidentally taken as a result of monitoring activities. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the on-going effects of continued operation and maintenance activities. If, during the course of continued operation and maintenance of the 9-Foot Channel Project, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

8.6 Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. Lock and dam operations and other structures may impede shovelnose sturgeon migrations, thus contributing to hybridization between pallid sturgeon and shovelnose sturgeon. This may be a factor of concern with operations at both Melvin Price Locks and Dam and Kaskaskia Lock and Dam and with the low water rock weir in the Chain of Rocks. Therefore, we recommend the completion of a feasibility study to evaluate the effects of these structures on sturgeon spawning migrations and to recommend alternatives to enhance sturgeon passage should the study find that the structures are impeding spawning migrations.

2. Provide funding to complete a sturgeon stock assessment in the MMR to obtain population information to assist in future management and recovery.

3. Provide funding in support of pallid sturgeon reintroduction/augmentation programs being implemented by the Service and state resource agencies.

4. Implement an education and outreach program for fisherman on identifying sturgeon species.

5. Provide funding to develop and validate a sturgeon aging technique.

6. Provide funding to determine the extent and management implications of hybridization between sturgeon species.

7. Provide funding to conduct a Population Viability Analysis to determine appropriate recovery numbers.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

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REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the action(s) outlined in the (request/reinitiation request). As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.