4.0 Higgins eye pearlymussel (*Lampsilis higginsii*)

4.1 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. Portions of this information are also presented in listing documents, the recovery plan (USFWS 2004), , the Final Biological Opinion for the Operation and Maintenance of the 9-Foot Navigation Channel on the Upper Mississippi River System (USFWS 2000), and the Biological Assessment of the Upper Mississippi River-Illinois Waterway System Navigation Study (USACE 2004).

4.1.1 Species /critical habitat description

The Higgins Eye Pearlymussel Recovery Plan identifies ten Essential Habitat Areas (EHAs) that are important for the recovery of the species (U.S. Fish and Wildlife Service 2004). The ten Essential Habitat Areas are: 1) the St. Croix River near Interstate (River Mile 47.5 - 48.5), 2) the St. Croix River at Hudson, Wisconsin (River Mile 16.2 - 17.6), 3) the St. Croix River at Prescott, Wisconsin (River Mile 0 – 0.2), 4) the Wisconsin River near Muscoda, Wisconsin (Orion), 5) the UMR at Whiskey Rock, at Ferryville, Wisconsin, Pool 9 (River Mile 655.8 - 658.4), 6) the UMR at Harpers Slough, Pool 10 (River Mile 639.0 - 641.4), 7) the UMR Main and East Channels at Prairie du Chien, Wisconsin, and Marquette, Iowa, Pool 10 (River Mile 633.4 - 637), 8) the UMR at McMillan Island, Pool 10 (River Mile 616.4 - 619.1), 9) the UMR at Cordova, Illinois, Pool 14 (River Mile 503.0 - 505.5), and 10) the UMR at Sylvan Slough, Quad Cities, Illinois, Pool 15 (River Mile 485.5 - 486.0). In addition, the original recovery plan described the following nine secondary habitats: 1) Guttenberg, Iowa, Pool 11 (River Mile 613), 2) Cassville, Wisconsin, Pool 11 (River Mile 607), 3) Dubuque, Iowa, Pool 12 (River Mile 580); (4) Adam Island (vicinity), Iowa, Pool 14 (River Mile 507); (5) Rapids City, Illinois, Pool 14 (River Mile 496); (6) Lower Sylvan Slough, Illinois, Pool 16 (River Mile 482); (7) Andalusia Slough, Illinois, Pool 16 (River Mile 473); (8) Barkis Island, Illinois, Pool 17 (River Mile 444); and (9) Jonas Johnson Island, Illinois, Pool 17 (River Mile 439) (U.S. Fish and Wildlife Service 2004).

4.1.2 Life history

Higgins eye occurs most frequently in medium to large rivers with current velocities of 0.5 to 1.5 feet per second and in depths of 2 to 20 feet (U.S. Fish and Wildlife Service 2004). It tends to be found in water with dissolved oxygen greater than 5 parts per million (ppm) and calcium carbonate levels greater than 50 ppm. The species is correlated with a firm, coarse sand substrate (Hornbach *et al.* 1995). Higgins eye usually is found in large, stable mussel beds with relatively high species and age diversity. Hornbach *et al.* (1995) concluded Higgins eye seemed 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 into 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 the posterior shell resembles a small swimming fish that is postulated to attract predator fish. Gill tissue containing glochidia protrudes between the mantle flaps. When a fish attacks the gill tissue, 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. Glochidia are carried in the gill marsupia through winter and released the following spring or summer (Baker 1928, Holland-Bartels and Waller 1988).

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 host fish for Higgins eye, as determined by glochidial persistence and maturation to juvenile stage on the fish. Subsequent studies (Gordon 2001) found smallmouth bass (*Micropterus dolomieui*) to be a suitable host as well.

4.1.3 Population dynamics

Population dynamics are described below under Status and distribution.

4.1.4 Status and distribution

The Higgins eye pearlymussel (*Lampsilis higginsii*) was listed as an endangered species by the U.S. Fish and Wildlife Service (Service) on June 14, 1976 (Federal Register, 41 FR 24064). The major reasons for listing Higgins eye were the decrease in both the abundance and range of the species. As stated in the recovery plan (U.S. Fish and Wildlife Service 2004), Higgins eye was never abundant, and Coker (1919) indicated it was becoming increasingly rare around the turn of the last 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 (U.S. Fish and Wildlife Service 2004).
A variety of factors have been listed as affecting Higgins eye over time including commercial harvest; impoundment from the federal 9-Foot Channel 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 (U.S. Fish and Wildlife Service 2004).

Distribution

The historical distribution of Higgins eye is not known with certainty. While never considered an abundant species, it is believed to have been distributed widely, inhabiting the Upper Mississippi River (UMR) main stem from just north of St. Louis, Missouri, to Minneapolis-St. Paul, Minnesota (Coker 1919). It also was found in several UMR tributaries including the Ohio, Illinois, Sangamon, Iowa, Cedar, Wapsipinicon, Rock, Wisconsin, Black, Minnesota, and St. Croix Rivers (U.S. Fish and Wildlife Service 2004). The range of Higgins eye has been reduced significantly from its historical distribution and now includes the UMR upstream of Lock and Dam 22 near Hannibal, Missouri, the lower St. Croix River between Wisconsin and Minnesota,

the lower Wisconsin River, Wisconsin, and the lower Rock River in Illinois (U.S. Fish and Wildlife Service 2004). Based on work done by Cawley (1996), the known range of Higgins eye has been extended 98 miles to the south and 82 miles to the north of the range described in the 1983 recovery plan, based solely on the collection of dead specimens. However, since 1980, live Higgins eye have not been collected on the UMR downstream of Lock and Dam 19, though a single fresh dead specimen was collected in Pool 22 in the late 1980s (U.S. Fish and Wildlife

Major Threats

The single most significant threat to Higgins eye appears to come from zebra mussels (*Dreissena polymorpha*), a nonindigenous species introduced into the United States from the Black and Caspian Seas (U.S. Fish and Wildlife Service 2000). Zebra mussels were introduced into Lake St. Clair in the mid 1980s from discharge of ship ballast water. The species is now reproducing and invading North America's lakes and rivers. Zebra mussels invaded the Illinois River from Lake Michigan through the Chicago Sanitary and Ship Canal; once in the Illinois River, they quickly invaded the UMR. The invasion from Lake Michigan probably resulted from zebra mussel veligers drifting downstream through the canal system to the Illinois River. However, because zebra mussels attach to hard objects/substrates, they readily attach to the hulls of boats including commercial tows and recreational boats navigating on the Illinois and Mississippi Rivers and are consequently transported by these vessels. Unfortunately, the ability of zebra mussels to attach to boat hulls and associated equipment provided the critical vector for upstream transport on the UMRS by large commercial and recreational boats. All EHAs for Higgins eye are located in the UMR and tributaries upstream of the confluence of the Illinois River (U.S. Fish and Wildlife Service 2004). Today, zebra mussels are found in all EHAs, with the exception of the Interstate EHA on the St. Croix River.

Zebra mussels can decimate native mussels in waters where they become establish and reach high densities (U.S. Fish and Wildlife Service 2000). They affect native mussels directly by attaching to the shells of the native species and impairing feeding and filtering functions, preventing valve closure, and causing shell deformation. Zebra mussels may also indirectly harm native mussels by competing for food resources and changing the water chemistry, i.e., decreasing dissolved oxygen levels and increasing ammonia levels (U.S. Army Corps of Engineers 2004a). Furthermore, zebra mussels can prevent recolonization of native mussels in formerly suitable habitats and prevent their burrowing into substrate by forming an impenetrable layer on the bottom (U.S. Fish and Wildlife Service 2000).

Concerning potential impacts to Higgins eye, a reconnaissance study by the U.S. Army Corps of Engineers predicted that zebra mussels may adversely affect approximately 1,700 acres of prime Higgins eye habitat and eventually eliminate 573,000 individuals, or 83 percent of the total known population in EHAs and secondary habitat areas (U.S. Army Corps of Engineers 2003). A loss of this magnitude occurred at the Prairie du Chien EHA, Wisconsin, in UMR Pool 10. Studies by the Corps of Engineers in the East Channel reference site found the native mussel community decimated by zebra mussels (U.S. Army Corps of Engineers 2004a). Zebra mussels were first collected in 1993, averaging two individuals per square meter. Density increased to over 10,000 individuals per square meter by 1996 (Figure 4-1), and a precipitous decline in native mussels followed (Figure 4-2). In particular, catch per unit effort of Higgins eye declined from nearly 1.0 individual per minute in 1995 to less than 0.1 individual per minute in 2000 through 2003 (Figure 4-3).

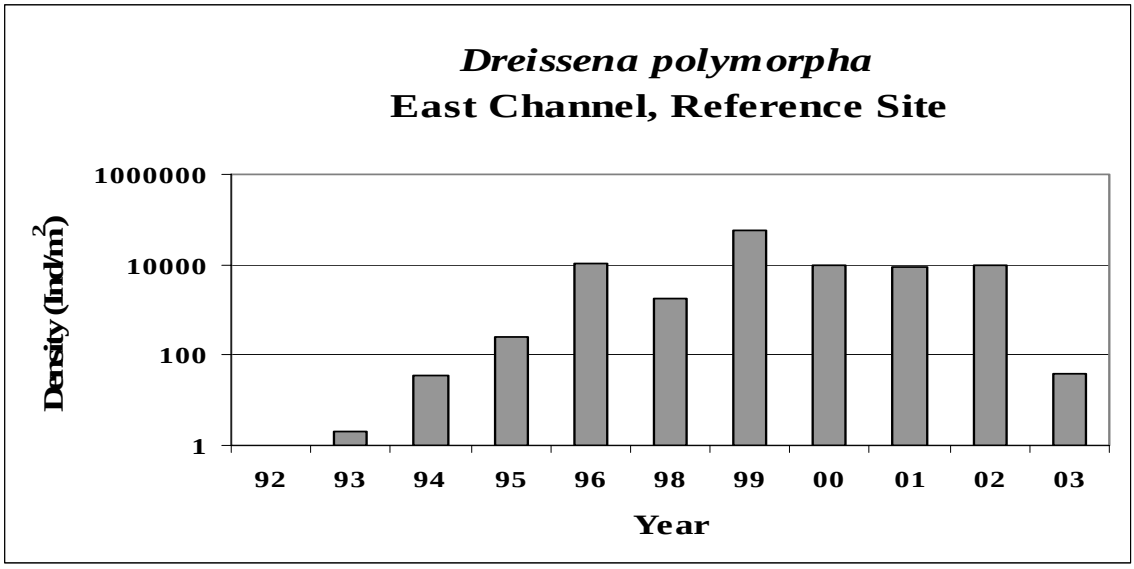

Figure 4-1. Zebra mussel abundance in the East Channel at Prairie du Chien, Wisconsin. Source: U.S. Army Corps of Engineers (2004a).

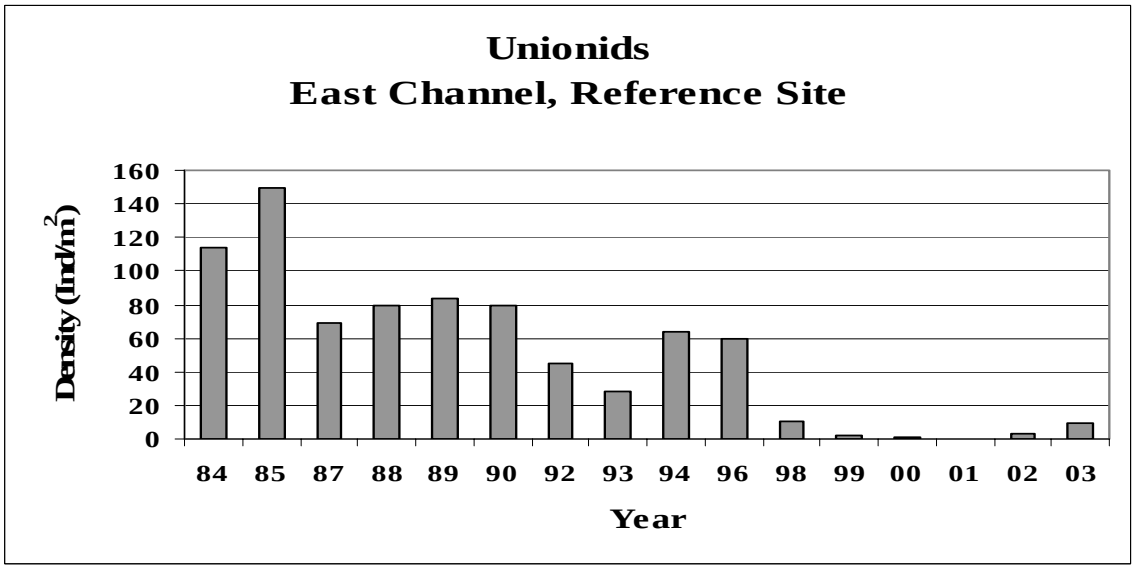

Figure 4-2. Native mussel densities in the East Channel at Prairie du Chien, Wisconsin. Source: U.S. Army Corps of Engineers (2004a).

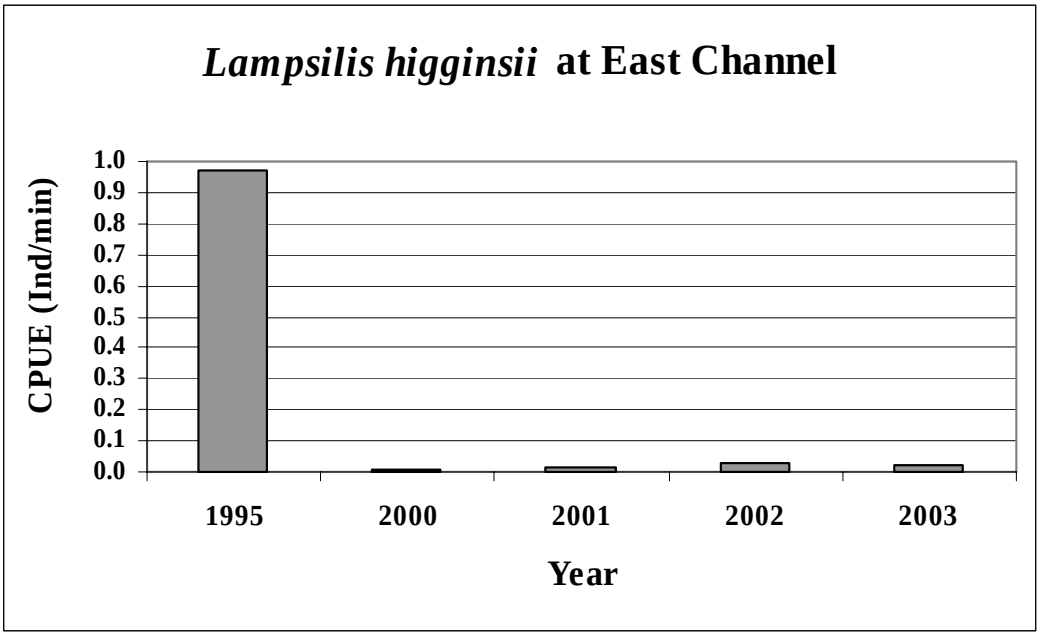

Figure 4-3. Catch per unit effort of Higgins eye pearlymussels (*Lampsilis higginsii*) at the East Channel Reference Site within the Prairie du Chien Essential Habitat Area, Pool 10, Upper Mississippi River, Wisconsin. Source: Unpublished 2003 data from the U.S. Army Corps of Engineers.

A major factor contributing to zebra mussel distribution and abundance on the UMR, and consequently the current status of Higgins eye, is the operation and maintenance of the 9-Foot Channel project authorized by Congress in the Rivers and Harbors Act of 1927. In April 2000, the Service issued a final Biological Opinion for the Operation and Maintenance of the 9-Foot Navigation Channel Project on the Upper Mississippi River System (UMRS) in Illinois, Iowa, Minnesota, Missouri, and Wisconsin (U.S. Fish and Wildlife Service 2000). In that biological opinion, we concluded that continued operation and maintenance of the 9-Foot Channel Project for an additional 50 years is likely to jeopardize the continued existence of Higgins eye due to upstream transport of zebra mussels by commercial barge transportation using the project. Our jeopardy opinion included a Reasonable and Prudent Alternative (RPA) to avoid jeopardizing the species. The RPA required the Corps of Engineers to:

1 Conduct a Higgins eye relocation feasibility analysis and prepare a Higgins eye Relocation Plan.

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.

The biological opinion also included the following Reasonable and Prudent Measures (RPMs) to minimize incidental take:

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

2. Investigate opportunities to protect live Higgins eye individuals with essential habitat areas in the UMR during the interim period between issuance of the biological opinion and implementation of the relocation phase.

3. Minimize upriver distribution of zebra mussels by commercial navigation through locks and dams in the UMRS.

The Corps of Engineers is implementing the reasonable and prudent alternatives and measures identified in the biological opinion (U.S. Army Corps of Engineers 2004a). To assist in their effort, the Corps of Engineers established an interagency Mussel Coordination Team (MCT) with a Partnership Agreement signed by agency heads of the U.S. Army Corps of Engineers, St. Paul and Rock Island Districts; the U.S. Fish and Wildlife Service; the U.S. Geological Survey; the National Park Service; the U.S. Coast Guard; and the Departments of Natural Resources from Minnesota, Wisconsin, Iowa, and Illinois. The purpose of the MCT is to work cooperatively with the Corps of Engineers to coordinate and plan relevant mussel studies and projects, share information on the management of native mussel resources, and control nonindigenous mussels. The status of these efforts is summarized below (U.S. Army Corps of Engineers 2004a):

1. Zebra Mussel Management – The Corps of Engineers conducted a reconnaissance study to evaluate potential zebra mussel management measures (U.S. Army Corps of Engineers 2003). The study concluded that there are potentially feasible zebra mussel control alternatives, which may be in the federal interest to pursue, and recommended a $2.1 million feasibility study be undertaken.

2. The Corps of Engineers and the MCT are conducting pilot projects to protect adult Higgins eye within EHAs by annually removing zebra mussels from individuals. The pilot projects are being conducted at the following locations in the UMR: Pool 10 (Harpers Slough), Pool 11 (Cassville), and Pool 14 (Cordova). Over 600 Higgins eye have been collected and annually cleaned of zebra mussels.

3. The Corps of Engineers developed a Higgins eye relocation action plan in collaboration with the MCT (U.S. Army Corps of Engineers 2002). The objective of this relocation effort is to establish a minimum of five new and viable populations of Higgins eye with a minimum of 500 individuals in the UMR and/or tributaries un-infested or with low-level infestations of zebra mussels. With the goal of achieving five viable populations, relocation efforts are being attempted at 10 UMR sites: Pools 2, 3, 4 and 17; Rock River in Illinois; Cedar, Iowa, and Wapsipinicon Rivers in Iowa; Wisconsin River in Wisconsin, and a site to be determined. A variety of relocation methods are being employed including adult relocation, release of glochidia inoculated free-ranging wild and hatchery fish, direct release of juveniles, and raising subadults in cages for 2 to 3 years prior to placement at a final relocation site. Over 500 age 3 subadults grown in cages have been placed in Pools 3 and 4 at their final relocation site, and approximately 8,500 age 1 and 2 subadults presently are being grown in cages. Nearly 500 adults have been moved to relocation sites in UMR Pools 2 and 3. Over 17,000 fish, each capable of producing around 70 juvenile Higgins eye, have been held in open bottom cages or released at the relocation sites from 2000 to 2004 The stocking should be completed by 2007, with augmentation thereafter. The plan includes a long-term monitoring program to assess the viability of these new populations.

4. A long-term program to monitor trends in abundance and distribution of Higgins eye and other native mussels in EHAs and secondary habitats has been ongoing since 2000. Seven to eight areas are sampled annually. Trends in abundance and distribution of zebra mussels in

the UMRS are also being collected at these areas. Zebra mussel veliger densities are being monitored on the UMR main stem from above the head of navigation in Minneapolis, Minnesota, to Pool 24 and all major tributaries.

Since 2000, there are also positive observations on the status of Higgins eye. In 2003, a significant drop in zebra mussel densities was observed at the Prairie du Chien EHA; less than 100 individuals per square meter were found in quantitative samples (Figure 4-1). Conversely, the abundance of native mussels increased slightly in 2002 and 2003 (Figure 4-2). With respect to Higgins eye at the Prairie du Chien EHA, only one live individual was collected in each year in 1999 and 2000 (U.S. Army Corps of Engineers 2004a). However, in 2003, six Higgins eye were collected resulting in slightly higher catch per unit effort (Figure 4-3). Equally important in 2002 and 2003, the percentage of individuals and species collected that were less than 30 millimeters long increased, showing evidence of recent recruitment (Figure 4-4).

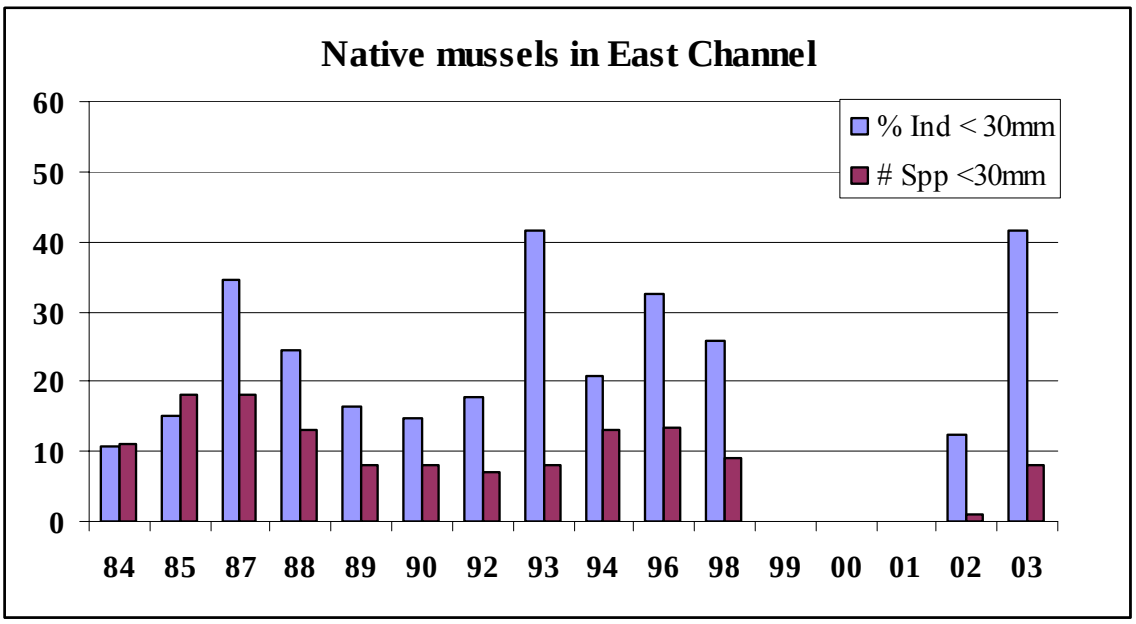

Figure 4-4. Native mussel recruitment in the East Channel at Prairie du Chien, Wisconsin. Source: U.S. Army Corps of Engineers (2004a).

Conservation Status

The range of Higgins eye has been reduced significantly from its historical distribution and now includes the UMR upstream of Lock and Dam 22 near Hannibal, Missouri, the St. Croix River between Wisconsin and Minnesota, the Wisconsin River, Wisconsin, and the lower Rock River in Illinois (U.S. Fish and Wildlife Service 2004). In the 1990s, the total population of Higgins eye in EHAs and secondary habitats was estimated to be 697,758 before the zebra mussel invasion; today, the population may have declined to 182,611 Higgins eye based on adverse effects from zebra mussels (U.S. Army Corps of Engineers 2003).

We are cautiously optimistic that the status of Higgins eye reproduction, numbers and distribution improved since 2000 due to (1) a decrease in abundance of zebra mussels in many areas of the UMRS; (2) an increase in recruitment at the Prairie du Chien EHA (U.S. Army Corps of Engineers 2004a); and (3) observed recruitment of Higgins eye in UMR Pool 16

(Helms 2000). Our optimism since 2000 is also based on successful Higgins eye propagation and relocation activities of the Corps of Engineers and MCT (Mussel Coordination Team 2003). Furthermore, we remain hopeful that funding will be provided to the U.S. Army Corps of Engineers to initiate the Zebra Mussel Management Feasibility Study, and implement feasible measures in a timely manner (U.S. Army Corps of Engineers 2003).

Conservation Needs

Clearly, the immediate conservation needs for Higgins eye focus on reducing adverse effects from zebra mussels. Priority Task 1.1 of the revised recovery plan is to assess and limit the impact of zebra mussels on Higgins eye (U.S. Fish and Wildlife Service 2004). In order to achieve the immediate goal of reclassifying Higgins eye to threatened status and long term goal of species recovery, at least five identified EHAs must contain reproducing, self-sustaining populations of Higgins eye that are not threatened by zebra mussels. The five EHAs must include the Prairie du Chien HHA and at least one EHA each in the St. Croix River and in UMR Pool 14 (U.S. Fish and Wildlife Service 2004). To achieve these goals, it is critical that the Corps of Engineers initiate the Zebra Mussel Management Feasibility Study and implement feasible control measures in a timely manner (U.S. Army Corps of Engineers 2003). It is likewise critical for the Corps of Engineers and MCT to continue their efforts to propagate and relocate Higgins eye.

4.2 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.

4.2.1 Status of the Higgins eye pearlymussel within the action area

As the action area overlaps completely the range of Higgins eye, thus its status in the action area is similar to that described in the Status of the Species section. Currently, the greatest threats to Higgins eye and other native mussels of the UMRS are from nonindigenous species. Zebra mussels must be effectively managed, or their abundance and distribution controlled by natural forces (i.e. predation, diseases, habitat limitations), so that their effects no longer threaten the survival and recovery of Higgins eye. It is critical that the Corps of Engineers initiate the Zebra Mussel Management Feasibility Study and implement feasible control measures in a timely manner (U.S. Army Corps of Engineers 2003).

We are seriously concerned that additional nonindigenous species like the quagga mussel and back carp may become established in the UMRS over the next 50 years. However, we remain cautiously optimistic for the survival and recovery of Higgins eye. Our optimism is directly related to both the decreasing abundance of zebra mussels in some portions of the UMRS since 2000, and recent evidence of recruitment of Higgins eye at the Prairie du Chien EHA and in UMR Pool 16. We are also optimistic that implementation of the Reasonable and Prudent Alternative from the previous biological opinion will establish five new and viable populations of Higgins eye in the UMRS outside the threat of zebra mussels, and control upstream transport of zebra mussels (and potentially quagga mussels) over the next 50 years. In addition, construction of habitat restoration projects under EMP and other authorities to restore the

ecological health of the UMRS will improve habitat conditions for Higgins eye and other native mussels. Likewise, efforts to conserve native mussels and facilitate public education and outreach will provide positive benefits to Higgins eye and other species. Therefore, reproduction, numbers and distribution of Higgins eye should continue to improve over the next 50 years if zebra mussels and other harmful noninvasive species can be managed, or fail to reach harmful densities.

Distribution

The range-wide distribution of Higgins eye is contained within the action area for the Upper Mississippi River-Illinois Waterway System Navigation Study and is described in the preceding section on Status of the Species.

4.2.2 Factors affecting the Higgins eye pearlymussel environment within the action area

Historically, the commercial harvest of native freshwater mussels in the UMRS peaked during the pearl button period of the 1920s and later during the cultured pearl era in the late-1980s and early 1990s (U.S. Fish and Wildlife Service 2004). 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 (U.S. Fish and Wildlife Service 2004). Commercial harvest of mussels could result in some accidental mortality of Higgins eye. Incidental extraction from the substrate, sorting, and return of Higgins eye, especially for nondiscriminating collection methods such as brailing, could produce some Higgins eye mortality and/or abortion of the glochidia. In addition, misidentification of Higgins eye with similarly appearing commercially allowed species such as hickory nut (*Obovaria olivaria*) could result in mortality of Higgins eye. The five Upper Mississippi River States (Iowa, Illinois, Minnesota, Missouri, and Wisconsin) have regulated mussel harvest since the latter portion of the pearl button era in the late 1930s (Waters 1980) and are continuing to revise the regulations to strive for uniformity among the States, and protect species of state and federal concern such as Higgins eye (U.S. Fish and Wildlife Service 2004).

Since construction of the 9-Foot Channel Project approximately 70 years ago, the UMR continues to adjust from a riverine to a reservoir system. It is likely that adverse impacts to Higgins eye and other native mussels occurred from construction, operation and maintenance of the original 9-Foot Channel Project, and the thousands of channel training structures preceding it for commercial navigation purposes; however, the extent and magnitude of the impacts are largely unknown and occurred nearly a century ago (U.S. Fish and Wildlife Service 2000). Although effects of the original navigation projects likely reduced the reproduction, numbers and distribution of Higgins eye to some degree, the species seemed to be stabilizing by 1993 and discussions by the Higgins Eye Recovery Team focused on revising the recovery plan and recovering the species (U.S. Fish and Wildlife Service 2004).

Unfortunately, the recent invasion of the exotic zebra mussel significantly changed this scenario. Due to upstream transport by commercial barge traffic and recreational craft, zebra mussels are now found throughout the UMR and have had significant adverse impacts on Higgins eye and other native freshwater mussels (U.S. Fish and Wildlife Service 2000). The crash of native

mussels at the Prairie du Chien EHA, and observations of native mussel declines elsewhere, unequivocally indicate that zebra mussels are a significant threat to native freshwater mussels in the UMRS, including Higgins eye (U.S. Fish and Wildlife Service 2004).

It is likely that zebra mussels will continue to adversely affect Higgins eye in the foreseeable future until adequate control measures are implemented, or their abundance and distribution are significantly reduced by natural forces (i.e. predation, diseases, habitat limitations). The Corps of Engineers predicted that without implementing measures to effectively manage zebra mussels on the UMRS, the population of Higgins eye at EHAs and secondary habitats may decline from 697,758 in the 1990s before zebra mussels invaded the UMRS to 120,227 by 2015 (U.S. Army Corps of Engineers 2003).

Lake Pepin (UMR Pool 4) was one of the first areas in the upper reaches of the UMR to become infested with zebra mussels, probably due to its natural lake-like character; it is now a major source population of zebra mussels and their veligers. In addition to the UMR, zebra mussels have developed a self-sustaining population within the lower St. Croix River (R. Rowse, U.S. Fish and Wildlife Service, 2004, personal communication). Recreational boat traffic using these and other infested waters may transport zebra mussels to uninfested headwater lakes of the UMR, the St. Croix River, the Wisconsin River, or any of the other tributary watersheds (U.S. Army Corps of Engineers 2004a).

Currently, a critical area for Higgins eye and other native mussels is the segment of the UMR upstream of the middle of Lake Pepin (UMR Pool 4) to the head of navigation in Minneapolis, Minnesota. Currently, this reach contains few zebra mussels, has no known upstream source of veligers (with the exception of the lower St. Croix River which enters in UMR Pool 3), has a diverse native mussel community that is recovering from previous water quality impacts from the Twin Cities metro area, and contains several propagation and relocation sites for Higgins eye (Mussel Coordination Team 2003). In 2003, zebra mussels were discovered in Lake Ossawinnamakee in central Minnesota. This lake is less than 10 miles from the Mississippi River near Brainerd, Minnesota, an area of heavy recreational boat use (U.S. Army Corps of Engineers 2004a). From this location, zebra mussels may eventually find their way into one of the headwater lakes of the UMR, establishing a critical source population of zebra mussels and their veligers for the UMR including the Twin Cities metro area. The risk-based zebra mussel modeling that will be done as part of the Zebra Mussel Feasibility Study will provide a better understanding of zebra mussel population dynamics in the UMRS, including risks from overland transport.

Unfortunately, it is likely that another nonindigenous species harmful to native mussels will invade the UMRS over the next 50 years such as the quagga mussel (*Dreissena bugensis*). Quagga mussels are similar to zebra mussels in appearance, reproductive strategy, ability to attach to objects in the water, and adverse effects to native mussels. They are well established in the lower Great Lakes and the St. Lawrence Seaway; a specimen was found in the UMR near St. Louis, Missouri (see Internet site www.entryway.com/seagrant/feb97q.jpg). Like zebra mussels, quagga mussels could invade the UMRS from Lake Michigan through the Chicago Sanitary and Ship Canal and be transported upstream on commercial tows and recreational craft to important Higgins eye habitats. Another nonindigenous species that could affect Higgins eye in the future is the black carp (*Mylopharyngodon piceus*), an Asian species that was recently found in the UMR at River Mile 273 below Lock and Dam 24 (R. Maher, Illinois Department of Natural

Resources, 2004, personal communication). The primary foods of black carp are mollusks and crustaceans.

On a more positive note, since the mid 1980s construction of habitat restoration/enhancement projects has been active on the UMRS. The goals of these projects are to reverse the decline of habitat and species since the 9-Foot Channel Project was constructed nearly 70 years ago. These projects include island construction, fish passage, floodplain restoration, water level management, backwater restoration, side channel restoration, wing dam/dike alteration, island and shoreline protection, increases in topographic diversity, forest management, and other ecosystem restoration.

Currently, the largest habitat restoration/enhancement program on the UMRS is the Upper Mississippi River System Environmental Management Program (EMP); it is anticipated that 132,804 acres of habitat will be restored over the next 10 years (U.S. Army Corps of Engineers 2004b, in press). Overall, the goal of these projects is to enhance/restore habitat for a variety of species, including native freshwater mussels. Conservation measures to avoid and minimize impacts to Higgins eye have been implemented on these site-specific projects in the past. These conservation measures included employing best management practices during project construction, modifying project features, or abandoning the project. We assume that these measures will be used for future projects under EMP and other authorities to avoid impacts to Higgins eye. To date, no habitat projects constructed under EMP have adversely affected Higgins eye. However, given the large number of habitat projects proposed for construction in the future, it is likely that a few Higgins eye may be adversely affected by one or more of these habitat projects. However, we believe that there is a net benefit to Higgins eye and other native mussels from restoration of the UMRS ecosystem through construction of habitat enhancement/restoration projects over the next 50 years.

Actions to conserve Higgins eye dramatically increased since 2000. Activities and accomplishments of the Corps of Engineers and the MCT in propagation and relocation of Higgins eye has led to similar conservation activities for other native mussels including the federally endangered winged mapleleaf (*Quadrula fragosa*). In 2004, the Upper Mississippi River Conservation Committee released a Conservation Plan for Freshwater Mussels of the Upper Mississippi River System (Upper Mississippi River Conservation Committee 2004). Public outreach efforts have also increased since 2000 with the development of the Internet web site Freshwater Mussels of the Upper Mississippi River System (http://midwest.fws.gov/mussel), and numerous news articles and releases on mussel conservation activities. A partnership of state and federal biologists recently revised and reprinted the popular booklet Freshwater Mussels of the Upper Mississippi River (Bob Hay, Wisconsin Department of Natural Resources, 2004 personal communication). Activities to conserve native mussels, and efforts to educate the public on the importance of our native mussels, controlling nonindigenous species, and maintaining/restoring aquatic habitats will continue in the foreseeable future and benefit Higgins eye and other native mussels of the UMRS.

4.3 Effects of the Action

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

The Upper Mississippi River-Illinois Waterway System Navigation Study proposes to implement both navigation improvement and ecosystem restoration actions. The navigation improvement program also contains a mitigation component for unavoidable adverse impacts to natural resources of the UMRS.

This Tier I biological opinion for Higgins eye evaluates the effects of these actions from a programmatic scale. Site-specific impacts will be evaluated during the Tier II planning process for specific projects and Tier II biological opinions provided to the U.S. Army Corps of Engineers for those projects that are likely to adversely affect Higgins eye. As no recent records of live Higgins eye have been recorded below Lock and Dam 19 (U.S. Fish and Wildlife Service 2004), any site-specific actions on the UMR downstream of Lock and Dam 19 are not likely to affect the species.

The following Standards and Guidelines were proposed by the Corps of Engineers in their Tier I Biological Assessment (Corps of Engineers 2004a) for use in avoiding/minimizing adverse impacts to Higgins eye and developing subsequent Tier II Assessments for specific projects. This process essentially follows the current Section 7 consultation process between the Corps and the Service. As a result of continued consultation, the Corps of Engineers and Service modified the original Standards and Guidelines as follows:

1. The suitability of aquatic habitat for Higgins eye, including consideration of current range, and existing mussel surveys in the project area will be reviewed to assess the presence of and impacts to Higgins eye in the direct and secondary impact zones of site-specific actions.

2. Site-specific mussel surveys will be completed where there is insufficient information on habitat suitability and mussel distribution in the impact zone to make presence/impact determinations.

3. If the preliminary Biological Assessment concludes that the proposed action is likely to adversely affect Higgins eye, conservation measures will be incorporated, to the extent feasible, into the proposed action to avoid (no effect determination) impacts, or minimize impacts so that the anticipated effects will be insignificant or discountable. Conservation measures may include employing best management practices during project construction, modifying project features, or abandoning the project. In the case of water level management, specific conservation measures have been identified in the section on water regulation.

If the final Tier II Biological Assessment concludes that project actions are likely to adversely affect Higgins eye despite the conservation measures identified in 3 above, formal consultation will be initiated and a Tier II biological opinion will be issued.

4.3.1 Direct effects

4.3.1.1 Navigation improvements

Potential effects to Higgins eye from navigation improvements are summarized in Table 1 of the Tier I BA (USACE 2004b). At the programmatic scale, adverse effects to Higgins eye from navigation improvements are anticipated to be similar to those described in the biological opinion for the 9-Foot Channel Project (U.S. Fish and Wildlife Service 2000).

A major issue with navigation improvements is the resulting increase in tow traffic on the UMRS over the next 50 years and subsequent environmental effects. Two approaches were used by the Corps of Engineers to address potential impacts of increased navigation traffic on native mussels (U.S. Army Corps of Engineers 2004a). In the first approach, laboratory studies were conducted to determine the effects of navigation traffic-induced changes in velocity and suspended solids on a variety of freshwater mussel physiological parameters. In the second approach, a bioenergetics model was developed to predict the effects of increased sediment loads on the threeridge mussel (*Amblema plicata*). The threeridge is a heavy-shelled species with similar life history to Higgins eye, and hence, is an appropriate surrogate for determining potential impacts to the species. The results of both the physiological study and the bioenergetics model indicate that the effects of increased tow traffic resulting from the proposed action would likely have minimal effects on native mussels (U.S. Army Corps of Engineers 2004a). Thus, we anticipate that reproduction, numbers and distribution of Higgins eye within the action area will not be appreciably altered by the expected increase in tow traffic.

Numerous fleeting and terminal facilities are located in the action area. Fleeting areas are typically constructed within main channel border habitats. Towboats maneuvering within fleeting areas cause resuspension of sediments, or direct contact with the bottom in shallow areas. In addition, fleeting areas and terminals often require periodic dredging, which disturbs bottom sediments. In addition, contaminated sediments may be resuspended and transferred downstream. Consequently, fleeting activities may adversely affect Higgins eye located in the action area of new fleeting/terminal facilities through direct contact with propellers/hulls, from dredging and disposal activities, or from increased sedimentation and resuspension of contaminants.

The Corps completed a Fleeting Analysis (USACE 2000) as part of the Navigation Study in order to determine if fleeting is likely to increase as a result of increased navigation traffic. The Corps concluded that no new fleeting areas are expected as a result of improvements to the navigation system. The Service disagrees with this assessment. While it is uncertain as to whether construction of additional fleeting areas will be necessary, there will be more barges moving throughout the UMRS (U.S. Army Corps of Engineers 2004a). In addition, with implementation of navigation improvements, tow lockage will become more efficient. For these reasons, there will likely be increased movement of barges into and out of some existing fleeting and terminal areas, or expansion of existing facilities to accommodate increased usage, either of which could adversely affect Higgins eye in the action area. However, although we anticipate that a few individuals may be harmed, we do not expect the reproduction, numbers or distribution of Higgins eye populations within UMRS will be appreciably reduced.

The Corps has proposed to develop a Systemic Barge Fleeting Plan for the UMRS (U.S. Army Corps of Engineers 2004a). However, the details of this plan remain unknown, and therefore, it is uncertain as to the extent it will address impacts associated with fleeting, including impacts to Higgins eye. The Service supports development of the Systemic Barge Fleeting Plan for the UMRS in a timely manner

Nonindigenous Species

The purpose of the navigation improvements is to accommodate and facilitate increased tow traffic within UMRS (U.S. Army Corps of Engineers 2004a). Additional tows resulting from

proposed navigation improvements will transport additional zebra mussels upstream on the UMRS to Higgins eye populations and habitats unless effective control measures are implemented. As discussed in the Status and Environmental Baseline sections, the Corps of Engineers is implementing the Reasonable and Prudent Alternative (RPA) described in the biological opinion for the 9-Foot Channel Project (U.S. Fish and Wildlife Service 2000, U.S. Army Corps of Engineers 2003, 2004a). At this time, we assume, that (1) the Corps of Engineers will initiate the Zebra Mussel Management Feasibility Study; (2) the study will develop one or more feasible control measures; and (3) these measures will be implemented in a timely manner to prevent upstream transport of zebra mussels (and potentially quagga mussels) by commercial navigation on the UMRS, including any projected increases in navigation traffic as a result of the proposed action. The feasibility study will also address recreational craft using the 9-Foot Channel Project, a much more likely vector of transport to the St. Croix River and other tributaries.

As discussed in the Environmental Baseline section, a critical area for Higgins eye and other native mussels is the segment of the UMR upstream of the middle of Lake Pepin (UMR Pool 4) to the head of navigation in Minneapolis, Minnesota. Currently, this reach contains few zebra mussels, has no known upstream source of veligers (with the exception of the lower St. Croix River which enters in UMR Pool 3), has a diverse native mussel community that is recovering from previous water quality impacts from the Twin Cities metro area, and contains several propagation and relocation sites for Higgins eye (Mussel Coordination Team 2003). As a result of the proposed navigation improvements, the current traffic level of 5 tows per day at Lock and Dam 3 will increase to 8 tows per day; however, any increase in tow traffic will not occur before 2030 (U.S. Army Corps of Engineers 2004a). Considering the small incremental increase in tow traffic, that any increase in tow traffic is not projected to occur before 2030 above Lock and Dam 3, and efforts to control zebra mussel distribution and abundance over the next 10 to 15 years, we anticipate that the status of zebra mussels in the UMRS over the next 50 years will not be detectably influenced by navigation improvements proposed in the Upper Mississippi River-Illinois Waterway System Navigation Study. Hence, further impacts on Higgins eye from zebra mussels are not anticipated to result from the navigation improvement program. However, it is critical that the Corps of Engineers initiate the Zebra Mussel Management Feasibility Study and implement feasible control measures in a timely manner (U.S. Army Corps of Engineers 2003).

4.3.1.2 Mitigation

Mitigation planning for impacts associated with incremental increases in navigation traffic fall into four major biological areas – fishery, submersed aquatic plants, bank erosion, and backwater-side channel sedimentation. Fishery mitigation measures include large woody debris anchors, backwater improvements, dike alterations, and fish passage. Submerged aquatic plant mitigation measures include modification of river regulation to improve habitat conditions, backwater/side channel habitat protection and restoration and revegetation. Bank erosion mitigation measures include such structural measures as offshore revetments, bank protection, or vegetative/bioengineered protection. Mitigation for backwater/side channel sedimentation measures includes offshore revetment, drop structures, closure structures, bank protection, barrier island construction, and dredging. The level and schedule of mitigation will be commensurate with the level and schedule of navigation improvements.

At the programmatic scale, most of the mitigation measures identified above have the potential for long-term beneficial impacts to Higgins eye by improving habitat conditions for the species and/or habitat conditions for fish host species. One mitigation measure that would be beneficial to the species is providing offshore lock waiting areas, therefore keeping waiting traffic away from mussel beds. This may include either mooring cells or buoys. However, it is likely that a few mitigation projects will be constructed on the UMRS over the next 50 years that adversely affect a few Higgins eye by burial from disposal of dredged material, rip rap or other construction materials, by contact with dredging equipment during construction, or changes to existing habitat conditions (flow velocity, scour and erosion). Per the proposed Standards and Guidelines, the Corps of Engineers will coordinate with State, and Federal resource agencies to develop site-specific project plans, including the placement of the structures, location of dredging and material placement, and evaluating expected changes in velocity, scour, and sediment patterns on Higgins eye. We anticipate that only in a very few instances will adverse effects be unavoidable. In these situations, it is unlikely that an entire bed or population of Higgins will be affected. Furthermore, it is extremely unlikely that any such project would be implemented if the viability of an EHA were to be threatened. Thus, although we anticipate that a few individuals may be harmed, we do not expect the reproduction, numbers or distribution of Higgins eye populations within UMRS will be appreciably reduced from mitigation activities.

Because mitigation measures proposed to date are similar to the ecosystem restoration component of the Upper Mississippi River-Illinois Waterway System Navigation Study, these actions are evaluated in greater detail in the Ecosystem Restoration section of this biological opinion.

4.3.1.3 Ecosystem restoration

Implementation of the Upper Mississippi River – Illinois Waterway System Navigation Study would result in a variety of navigation and ecosystem actions. From a habitat perspective, the combined effect of implementing the ecosystem restoration component of the study would benefit approximately 400,000 acres of UMRS floodplain habitat and 2,500 miles of main stem and tributary channels resulting in significant improvements to the quality and sustainability of the ecological health of the UMRS (U.S. Army Corps of Engineers 2004a). From a programmatic scale, improving the ecological health of the UMRS will also significantly benefit native mussels including Higgins eye from water quality improvements, reduction in erosion/sedimentation and increased opportunities for movement of host fish between navigation pools, reaches and tributaries of the UMRS.

The Upper Mississippi River – Illinois Waterway System Navigation Study includes ecosystem management actions that are intended to reverse the decline of habitat and species within the UMRS proposed in these documents and studies. Specific actions include island construction, fish passage, floodplain restoration, water level management, backwater restoration, side channel restoration, wing dam/dike alteration, island and shoreline protection, topographic diversity improvements, forest management, and other ecosystem restoration measures. Overall, the goal of these actions is to enhance/restore habitat on the UMSR for a variety of species, including native freshwater mussels.

Table 9 of the Tier I BA summarizes the potential impacts to Higgins eye from ecosystem restoration actions (USACE 2004b). Conservation measures to avoid and minimize impacts to Higgins eye have been implemented on similar projects in the past. These conservation measures included employing best management practices during project construction, modifying project features, or abandoning the project. To date, resource agencies have successfully eliminated adverse effects in all but one instance[1]. However, given the large number of habitat projects proposed for construction in the future under the Upper Mississippi River – Illinois Waterway System Navigation Study, it is likely that Higgins eye may be adversely affected in the future by one or more habitat projects depending on where the specific project is located and if Higgins eye are in the action area. The anticipated effect associated with these restoration actions are described below.

Island Building

Many islands were present when the lock and dam system was completed (U.S. Army Corps of Engineers 2004a). In some areas islands have been lost to erosion, and in other areas they have grown as a result of sedimentation. Island building includes constructing islands from sediment (sand, clay, or silt) dredged from the bottom of the river to replace islands eroded by waves and river current. Islands may also be constructed in open water areas to create sheltered off-channel habitat to promote backwater communities. Past experience has led to designs that can protect large areas (>1,000 acres) with as little as 30 acres of island. Island building can have an added benefit of protecting and establishing deepwater habitat, which provides important habitat for fish and mussels.

Island restoration is most needed in the upper pooled reaches where island erosion is most pronounced, but will apply system-wide to create wave breaks, protect bank lines, store dredged sediments, and create new side channels or off-channel habitat elsewhere, but particularly in the middle Mississippi River.

Construction of islands will improve habitat for Higgins eye and other native mussels by reducing wind fetch and waves which will decrease sediment resuspension and increase water quality in the project area. Islands will also facilitate environmental conditions in the project area that promote the growth and abundance of aquatic vegetation. Beds of aquatic vegetation also decrease sediment resuspension in the project area. However, it is likely that a few islands will be constructed on the UMRS over the next 50 years that adversely affect a few Higgins eye by burial from disposal of dredged material, rip rap or other construction materials, by contact

[1] Until recently, Higgins eye was considered a deep water species, not occurring in water depths less than 3 feet (U.S. Fish and Wildlife Service 2004). However, numerous Higgins eye have been collected by the MCT in water depths of 1.5 to 3 feet at the Cassville mussel bed (Pool 11) and the Cordova EHA (Pool 14) (Mussel Coordination Team 2003). However, the chance of Higgins eye inhabiting very shallow water (< 1.5 feet) during normal pool elevations is highly unlikely due to the extreme environmental conditions associated with these areas (i.e., freezing, ice damage, wave action, extreme heat). In 2001, a 1.5-foot drawdown at the dam was conducted in Pool 8, and some mussels were found stranded or in very shallow water, including two Higgins eye (M. Havlik, Malacological Consultants, La Crosse, Wisconsin, 2001, personal communication). In 2001, river discharges and water levels were high most of the spring and early summer, and mussel tracks and stranded mussels were observed in floodplain forest areas after the water receded in other UMR pools as well (M. Davis, Minnesota Department of Natural Resources, 2001, personal communication). During approximately a 30-day period from April 13 to May 13, 2001, Pool 8 water elevation was more than 2 feet above the secondary control pool elevation, and exceeded 6 feet for a few days. These conditions probably contributed to the number of stranded mussels observed during the 2001 Pool 8 drawdown. It is not known if mussels actively moved to these areas or were carried there by the excessive flows, but it is often the case that mussels will be displaced outside their normal distribution during high water events by either mode (Tucker 1996, Coker *et al.* 1921). For future pool level drawdowns, Conservation Measures were developed by the Corps of Engineers in their Tier I BA to avoid impacts to Higgins eye from stranding (U.S. Army Corps of Engineers 2004a).

with dredging equipment during construction, or changes to existing habitat conditions (flow velocity, scour, erosion). Per the proposed Standards and Guidelines, the Corps of Engineers will coordinate with State, and Federal resource agencies to develop site-specific project plans, including the placement of the structures, location of dredging and material placement, and evaluating expected changes in velocity, scour, and sediment patterns on Higgins eye. We anticipate that only in a very few instances will adverse effects be unavoidable. In these situations, it is unlikely that an entire bed or population of Higgins will be affected. Furthermore, it is extremely unlikely that any such project would be implemented if the viability of an EHA were to be threatened. Thus, although we anticipate that a few individuals may be harmed, we do not expect the reproduction, numbers or distribution of Higgins eye populations within UMRS will be appreciably reduced from island building activities.

Fish Passage

Native mussels like Higgins eye require a host fish for glochidia transformation (Mussel Conservation Team 2003). Prior to construction of navigation locks and dams with the 9-Foot Channel Project, host fish for native mussels had relatively unimpeded access to the entire basin stream network (U.S. Army Corps of Engineers 2004a). Natural barriers such as rapids and falls were the primary determinant of the distribution of fish stocks at that time. Now, navigation dams on the UMRS restrict upstream fish movement during most portions of a given year. Technical fishways, such as fish ladders, and naturalistic bypass channels through spillways are the primary techniques considered as ecosystem restoration measures under the Upper Mississippi River – Illinois Waterway System Navigation Study, although some benefits may be gained from modified dam operation as well. The major benefit to Higgins eye and other native mussels is increased opportunity for seasonal movement of host fish between navigation pools and reaches of the UMRS, and hence, allowing genetic exchange and population reestablishments in currently unoccupied areas.

Improved fish passage may facilitate more rapid upward movement of nonindigenous species such as the black carp, which might prey on small Higgins eye and other native mussels. However, the current navigation system is not a complete barrier to upstream migration and even if the proposed fish passage actions do not occur, nonindigenous black carp will probably disperse upstream and adversely affect mussels over the next 50 years.

The overall effect of improving fish passage, and improved system connectivity, has the potential to greatly improve the overall fishery of the UMRS and distribution of native mussels including Higgins eye. Increased movement of fish throughout the system increases both the probability of host fish availability, especially walleye, a preferred host species for Higgins eye (Holland-Bartels and Waller, 1988), and improves the opportunity for dispersal of Higgins eye throughout the Upper Mississippi River (U.S. Army Corps of Engineers 2004a). However, it is likely that a few fish passage projects constructed on the UMRS over the next 50 years may adversely affect a few Higgins eye by burial from disposal of dredged material, rip rap or other construction materials, by contact with dredging or other equipment during construction, or changes to existing habitat conditions (flow velocity, scour, erosion). Per the proposed Standards and Guidelines, the Corps of Engineers will coordinate with State, and Federal resource agencies to develop site-specific project plans, including the placement of the structures, location of dredging and material placement, and evaluating expected changes in velocity, scour, and sediment patterns on Higgins eye. We anticipate that only in a very few

instances will adverse effects be unavoidable. In these situations, it is unlikely that an entire bed or population of Higgins will be affected. Furthermore, it is extremely unlikely that any such project would be implemented if the viability of an EHA were to be threatened. Thus, although we anticipate that a few individuals may be harmed, we do not expect the reproduction, numbers or distribution of Higgins eye populations within UMRS will be appreciably reduced from fish passage activities.

Floodplain Restoration

Floodplain habitats throughout the UMRS have been altered for many reasons (U.S. Army Corps of Engineers 2004a). In northern river reaches, dams spread water across low elevation floodplain areas and greatly increase aquatic habitat connectivity in the floodplain. Floodplain restoration in the north includes a mix of protecting some areas with islands, connecting isolated backwaters, and restoring tributary channels. In southern river reaches, the floodplain is much more developed for crop production and flood protection and is thus much more isolated from the river. Floodplain restoration in southern reaches will include a mixture of water level manipulation in management areas, wetland/habitat management in leveed areas (e.g., Wetlands Reserve Program, Conservation Reserve Program, etc.), and restoration of agricultural areas to aquatic, floodplain forest, and prairie habitats.

Providing connectivity to previously isolated floodplain areas will increase flowing secondary channel habitat suitable for Higgins eye and other native mussels. However, it is likely that a few floodplain restoration projects constructed on the UMRS over the next 50 years may adversely affect a few Higgins eye by burial from disposal of dredged material, rip rap or other construction materials, by contact with dredging or other equipment during construction, or changes to existing habitat conditions (flow velocity, scour, erosion). Per the proposed Standards and Guidelines, the Corps of Engineers will coordinate with State, and Federal resource agencies to develop site-specific project plans, including the placement of the structures, location of dredging and material placement, and evaluating expected changes in velocity, scour, and sediment patterns on Higgins eye. We anticipate that only in a very few instances will adverse effects be unavoidable. In these situations, it is unlikely that an entire bed or population of Higgins will be affected. Furthermore, it is extremely unlikely that any such project would be implemented if the viability of an EHA were to be threatened. Thus, although we anticipate that a few individuals may be harmed, we do not expect the reproduction, numbers or distribution of Higgins eye populations within UMRS will be appreciably reduced from floodplain restoration activities.

Water Level Management Activities

Large river ecosystems such as the UMRS are characterized by seasonal cycles of flood and drought (or low flow) (U.S. Army Corps of Engineers 2004a). A variety of ecological functions and processes are linked to this cycle. Development of water resources for hydropower or navigation typically alters and disrupts these natural cycles. In the UMRS, the flood stage of the hydrograph is relatively unaltered, but low flows have been eliminated to support commercial navigation. Water level management has the potential to be a powerful ecosystem restoration measure to improve the long-term habitat quality of the UMR for a variety of species, including Higgins eye. Pool-wide and/or system-wide drawdowns are being proposed in the Upper Mississippi River – Illinois Waterway System Navigation Study to promote aquatic vegetation,

consolidate sediments, improve water quality, and modify flow distribution. These actions will enhance habitat conditions for Higgins eye by improving water quality, cleaning substrate through scouring, improving overall productivity, improving conditions for host fish species, and other ecological benefits. However, these drawdowns could adversely affect Higgins eye during the drawdown phase primarily by stranding individuals.

For pool level drawdowns, the following Conservation Measures are proposed by the Corps of Engineers in their Tier I BA to avoid impacts to Higgins eye from stranding (U.S. Army Corps of Engineers 2004a):

1. A drawdown will not be implemented that would result in lowering normal water levels more than 1.5 feet at any of the essential, secondary, or relocation habitat areas.

2. A drawdown will not be implemented if pool elevation at the dam is greater than two feet above the secondary control pool elevation in excess of 20 days from April 1 to June 15 in the proposed drawdown year.

3. During the drawdown, water levels will be lowered slowly (0.1 to 0.2 foot per day), allowing the escape of native mussels from the dewatered zone. The rate of drawdown will be commensurate with the proposed level of drawdown and the location of the drawdown.

4. Studies may be completed to evaluate the distribution of Higgins eye in relationship to water depths, the ability of Higgins eye to escape the dewatered zone, and evaluation of the stranding of mussels with ongoing pilot pool drawdowns. As additional information is obtained, the preceding conservation measures will be reviewed and revised, in coordination with the Service. For example, a study may find that Higgins eye are found at depths greater than 1.5 feet at a particular EHA, thereby facilitating a deeper drawdown at that location.

We believe that the following water level management scenarios may affect but are not likely to adversely affect Higgins eye: 1) drawdowns outside the current range of Higgins eye (i.e. UMR downstream of Lock and Dam 19); 2) minor drawdowns within existing Corps operational constraints (i.e., current drawdown zone during operation of the 9-Foot Channel Project); and, 3) drawdowns implemented with the above Conservation Measures. Other drawdowns of larger scope may adversely affect a few Higgins eye and other native mussels by stranding. In addition, drawdowns will likely involve dredging to maintain recreational and/ commercial navigation access during the event. Depending on the location of these dredge cuts, a few Higgins eye and other mussels may be adversely affected by burial from disposal of dredged material, rip rap or other construction materials, by contact with dredging or other equipment during construction, or changes to existing habitat conditions (flow velocity, scour, erosion). Per the proposed Standards and Guidelines, the Corps of Engineers will coordinate with State, and Federal resource agencies to develop site-specific project plans, including the placement of the structures, location of dredging and material placement, and evaluating expected changes in velocity, scour, and sediment patterns on Higgins eye. We anticipate that only in a very few instances will adverse effects be unavoidable. In these situations, it is unlikely that an entire bed or population of Higgins will be affected. Furthermore, it is extremely unlikely that any such project would be implemented if the viability of an EHA were to be threatened. Thus, although we anticipate that a few individuals may be harmed, we do not expect the reproduction, numbers

or distribution of Higgins eye populations within UMRS will be appreciably reduced from water level management activities.

Backwater Restoration

Many UMRS backwaters have been degraded by excessive amounts of sediment emanating from the basin, tributaries, and main stem sources (U.S. Army Corps of Engineers 2004a). The degradation results from loss of depth, poor sediment quality, poor water quality, and sediment resuspension that blocks sunlight required by aquatic plants. Remedial action can be in the form of backwater dredging, or water level management actions discussed above. Backwater dredging typically consists of dredging channels with fingers extending from the main dredge cut to a depth of 6 to 8 feet deep. Earlier projects have dredged about 20 acres, which provides enough habitat for fish from larger areas to concentrate during winter and other harsh climate conditions. The sediment resulting from the dredging portion of the project can be used to enhance aquatic areas with islands or to augment terrestrial areas with increased topographic diversity and elevation, which promotes the growth of oaks and other mast tree species.

The overall effect of backwater restoration will improve habitat for Higgins eye and other native mussels through increased plant growth, which in turn will result in decreased sediment resuspension and increased water quality in the project area (U.S. Army Corps of Engineers 2004a). However, some backwater restoration measures may adversely affect a few Higgins eye in the project area from placement of structures on individuals; dredging in backwaters, and hence digging up, injuring and killing specimens found in these locations; drawdowns to consolidate sediments and increase plant growth; and from resulting changes in velocity, scour, and sediment patterns. Per the proposed Standards and Guidelines, the Corps of Engineers will coordinate with State, and Federal resource agencies to develop site-specific project plans, including the placement of the structures, location of dredging and material placement, and evaluating expected changes in velocity, scour, and sediment patterns on Higgins eye. We anticipate that only in a very few instances will adverse effects be unavoidable. In these situations, it is unlikely that an entire bed or population of Higgins will be affected. Furthermore, it is extremely unlikely that any such project would be implemented if the viability of an EHA were to be threatened. Thus, although we anticipate that a few individuals may be harmed, we do not expect the reproduction, numbers or distribution of Higgins eye populations within UMRS will be appreciably reduced from backwater restoration activities.

Side Channel Restoration

Side channels provide off-channel habitat that shields fish and other animals from the harsh conditions of the main channel. In braided channel habitats of the northern river reaches, side channels are numerous and provide an assortment of habitat conditions. Farther south, side channels are typically larger and more uniform in their configuration.

Side channels have been degraded by sedimentation and channelization. Where sedimentation is the issue, restoration includes dredging the upper and lower connections similar to what is done in backwaters. Restoration in response to channelization typically involves modifying channel regulating structures to increase connectivity between the main and secondary channels. In both cases, work within the side channel may include constructing barbs to alter flow patterns or

augmenting woody debris piles or other structures. Side channel restoration will be common throughout the UMRS.

The overall effect of side channel restoration will be to increase and improve available habitat for both Higgins eye and fish species that serve as glochidial hosts for the mussel. However, construction of these projects over 50 years may adversely affect a few Higgins eye. The direct and secondary impacts of side channel restoration activities on Higgins eye and other native mussels can be grouped into three categories – impacts from direct structure placement to restore side channels; impacts of dredging to restore side channels; and impacts of changes in velocity, scour, and sediment patterns resulting from side channel restoration actions. Per the proposed Standards and Guidelines, the Corps of Engineers will coordinate with State, and Federal resource agencies to develop site-specific project plans, including the placement of the structures, location of dredging and material placement, and evaluating expected changes in velocity, scour, and sediment patterns on Higgins eye. We anticipate that only in a very few instances will adverse effects be unavoidable. In these situations, it is unlikely that an entire bed or population of Higgins will be affected. Furthermore, it is extremely unlikely that any such project would be implemented if the viability of an EHA were to be threatened. Thus, although we anticipate that a few individuals may be harmed, we do not expect the reproduction, numbers or distribution of Higgins eye populations within UMRS will be appreciably reduced from side channel restoration activities.

Wing Dam and Dike Alteration

Wing dams and dikes are prominent channel regulating structures common in main channel habitats. In northern river reaches, most wing dams are artifacts of earlier channel management efforts for the navigation project. Wing dams provide important habitat in channel border areas. In southern river reaches, and especially the middle Mississippi River reach, wing dikes are very prominent features of the channel environment. These structures are used to concentrate flow in the main channel in order to reduce the need for dredging. They were often constructed in groups called dike fields. These areas are depositional zones that often fill from the bank outward toward the channel. Notching, lowering their profile, or altering their angle to the channel are some actions that can be used to increase habitat diversity through the creation of new scour holes, sandbars, and flow refugia. When wing dike alteration is done on the dike field level, or in association with new structure placements, new side channels, islands, and off-channel areas can be created. The practice has met with great success in the middle Mississippi River.

Dike alteration will be an important component of the restoration of the middle Mississippi River reach and will have beneficial application elsewhere in the system. The overall effect of channel regulating structure alteration will be to increase and improve available habitat for both Higgins eye and fish species that serve as hosts for the species. However, construction of these projects over 50 years may adversely affect a few Higgins eye. The direct and secondary impacts of channel regulating structure alteration activities on Higgins eye and other native mussels can be grouped into two categories – impacts from direct structure placement and impacts of changes in velocity, scour, and sediment patterns resulting from channel structure alterations. Per the proposed Standards and Guidelines, the Corps of Engineers will coordinate with State, and Federal resource agencies to develop site-specific project plans, including the placement of the structures, location of dredging and material placement, and evaluating expected changes in

velocity, scour, and sediment patterns on Higgins eye. We anticipate that only in a very few instances will adverse effects be unavoidable. In these situations, it is unlikely that an entire bed or population of Higgins will be affected. Furthermore, it is extremely unlikely that any such project would be implemented if the viability of an EHA were to be threatened. Thus, although we anticipate that a few individuals may be harmed, we do not expect the reproduction, numbers or distribution of Higgins eye populations within UMRS will be appreciably reduced from wing dam and dike alterations.

Island and Shoreline Protection

Island and shoreline erosion are natural processes that characterize dynamic rivers. In the UMRS, shoreline erosion may also in some areas, be affected by commercial and recreational boats and by wind-generated waves in the impounded system. Shoreline erosion may affect Higgins eye by burial of individuals and beds over time from eroded material, or changing habitat conditions as existing islands and shorelines are eroded that may have provided or protected mussel habitat.

Island and shoreline protection includes measures to protect the existing aquatic and terrestrial features of the river. Typical measures include riprapped shorelines, but more environmentally compatible measures including offshore revetments, plantings (bioengineering), low gradient slopes, rock groins, and others are being incorporated along with traditional measures. These measures may also be used to alter the overflow portions of the dams. Priority erosional areas have been mapped and can be targeted for protection. This measure is viewed as a habitat protection measure that maintains existing conditions to the extent possible.

The overall effect of protecting islands and shorelines from erosion will be to increase and improve available habitat for both Higgins eye and fish species that serve as glochidial hosts. However, construction of these projects over 50 years may adversely affect a few Higgins eye. The direct and secondary impacts to Higgins eye from island and shoreline protection activities can be grouped into three categories – impacts from direct placement of dredged material, rip rap, vanes, groins, revetment, and bioengineering material on individuals; dredging for construction material and access to the site and hence digging up, injuring and killing specimens found in these locations; and from resulting changes in velocity, scour, and sediment patterns. Per the proposed Standards and Guidelines, the Corps of Engineers will coordinate with State, and Federal resource agencies to develop site-specific project plans, including the placement of the structures, location of dredging and material placement, and evaluating expected changes in velocity, scour, and sediment patterns on Higgins eye. We anticipate that only in a very few instances will adverse effects be unavoidable. In these situations, it is unlikely that an entire bed or population of Higgins will be affected. Furthermore, it is extremely unlikely that any such project would be implemented if the viability of an EHA were to be threatened. Thus, although we anticipate that a few individuals may be harmed, we do not expect the reproduction, numbers or distribution of Higgins eye populations within UMRS will be appreciably reduced from island and shoreline protection measures.

Topographic Diversity

When the dams were put into operation, the floodplain water table elevation was increased in many areas. The result in the terrestrial plant communities was the elimination of flood

intolerant tree species that require a dry root zone. Improving topographic diversity simulates the ridge and swale topography of the natural floodplain by using material dredged from the channel. This newly elevated land area is then planted with oaks and other mast producing trees.

Measures to increase topographic diversity include the placement of dredged material, typically in ridges, on the floodplain to raise the root zone of flood intolerant mast trees, or the creation of isolated floodplain potholes or scour holes. These measures are frequently complementary to channel maintenance and other restoration measures.

Topographic diversity is similar to dike alteration in that the measure is very localized in a relatively small area, but may have wider benefits. The measure is important to restore terrestrial plant species diversity that has been impacted by impoundment and inundation.

Most of the specific ecosystem restoration actions would occur in terrestrial settings and would not affect aquatic areas, and as such are not likely to adversely affect reproduction, numbers or distribution of Higgins eye.

Forest Management

Most forest management would occur in terrestrial settings and would not have an impact on aquatic areas. Furthermore, standard forestry practices to minimize secondary erosion and impacts to the adjacent aquatic environment will be used. As such, forestry management actions are not likely to adversely affect reproduction, numbers, or distribution of Higgins eye.

4.3.1.4 Summary

Major changes that affected Higgins eye from operation and maintenance of the 9-Foot Channel Project and prior navigation improvements occurred in the years following construction and are described in the previous biological opinion (U.S. Fish and Wildlife Service 2000). Additional impacts to Higgins eye from the proposed navigation improvements and associated incremental increase in tow traffic are not likely to appreciably affect reproduction, numbers or distribution of Higgins eye in the action area. Although some risk to individuals is possible from implementation of specific navigation improvement projects, we believe that the most significant risks to Higgins eye are from zebra mussels' persistence in the UMRS. However, for reasons explained within, we anticipate that the associated increases in commercial traffic are not likely to increase the likelihood of zebra mussel persistence. Hence, we do not expect any appreciable effects to reproduction, numbers, or distribution of Higgins eye within the action area from navigation improvements.

To date, habitat restoration/enhancement projects constructed on the UMRS have not—in all but one instance--adversely affected Higgins eye due to implementation of conservation measures during project planning to avoid impacts (see footnote on Page 17). Although the Corps and the Service fully expect this success to continue, there may be a few instances where adverse effects will be unavoidable. Given the large number and variety of habitat projects proposed for construction in the future under the Upper Mississippi River – Illinois Waterway System Navigation Study, it is likely that a few individual Higgins eye will be adversely affected by one or more habitat projects. We anticipate that the majority of these cases will be when short-term adverse effects are necessary in order to achieve long-term benefits for Higgins eyes. As such,

we anticipate that over the term of the project, ecosystem restorations actions will improve the reproduction, numbers or distribution of Higgins eye within the action area.

4.4 Cumulative Effects

Cumulative effects are 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 ESA. The Service knows of no projects reasonably certain to occur in the action area that will produce cumulative effects.

4.5 Conclusion

The conclusion section presents the Service's opinion regarding whether the aggregate effects of the factors analyzed under the environmental baseline, effects of the action, and cumulative effects in the action area .After reviewing the current status of the Higgins eye pearlymussel, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's opinion that implementation of the recommended plan as proposed is not likely to jeopardize the continued existence of the Higgins eye pearlymussel. No critical habitat has been designated for this species; therefore, none will be affected.

The action area encompasses the range of Higgins eye. Programmatic benefits to Higgins eye and other native mussels will occur from implementation of the ecosystem restoration component of the Upper Mississippi River – Illinois Waterway System Navigation Study. While site-specific adverse impacts to Higgins eye are likely for a small number of actions (navigation improvements and ecosystem restoration measures), we believe that the proposed action will not appreciably reduce reproduction, numbers, or distribution of Higgins eye within the action area, or appreciably reduce the likelihood of survival and recovery of the species over 50 years.

4.6 Incidental Take Statement

4.6.1 Introduction

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)].

4.6.2 Extent of take anticipated

The Service anticipates that direct incidental take of Higgins eye from the proposed action will be in the form of harassment and harm from both navigation and ecosystem restoration components of the Upper Mississippi River – Illinois Waterway system Navigation Study. However, as the proposed action is at a programmatic scale, site- and project-specific information is lacking. Without such detailed information, it is difficult to quantify incidental take for specific projects with any degree of certainty over the next 50 years. In other words, although we are reasonably certain that adverse effects, and more specifically incidental take, will occur during implementation of the proposed action over the next 50 years, we do not have the information needed to precisely quantify the amount we anticipate will occur. Nonetheless, based on the Standards and Guidelines proposed by the Corps of Engineers, we are able to estimate a maximum level of take that could occur through implementation of the proposed action.

Very few (less than ten) navigation and habitat projects constructed on the UMRS adversely affected Higgins eye since the species was listed in 1976. This is due to successful planning efforts by the Corps of Engineers and resource agencies to avoid adverse impacts to the species. To continue these planning efforts, the Corps of Engineers proposed Standards and Guidelines to avoid and minimize impacts to Higgins eye from actions proposed in the Upper Mississippi River – Illinois Waterway system Navigation Study. Per the proposed Standards and Guidelines, the Corps of Engineers will coordinate with State, and Federal resource agencies to develop site-specific project plans to avoid and minimize impacts to Higgins eye. We anticipate that only in a very few instances will adverse effects be unavoidable. In these situations, it is unlikely that an entire bed or population of Higgins will be affected. Furthermore, it is extremely unlikely that any such project would be implemented if the viability of an EHA were to be threatened.

Based on past experience, we believe that less than 5 percent of actions (up to 50 projects) proposed under the Upper Mississippi River – Illinois Waterway system Navigation Study may adversely affect Higgins eye over 50 years. With one exception, incidental take of Higgins eye for similar projects constructed in the past on the UMRS was less than ten individuals per

project.[2] Therefore, we believe the maximum incidental take that is likely to occur over the 50 year term of the proposed action is 500 individuals.

4.6.3 Effect of the take

The Corps of Engineers (2003) predicted that the population of Higgins eye in EHAs and secondary habitats will decline from 698,000 in the 1990s to 183,000 in the 2000s due to adverse effects of zebra mussels. Using the estimate of 183,000 as representing the current population of Higgins eye at these locations, an incidental take of 500 individuals represents a loss of 0.27 percent over 50 years, or 0.005 percent per year. Other studies have shown that populations of mussels having a long life span like Higgins eye are viable when annual total mortality is less than 5 percent (D. Heath, Wisconsin Department of Natural Resources, 2004, personal communication).

Regarding effects on the distribution of Higgins eye, it is unlikely that an entire bed or population of Higgins will be affected by proposed actions and thus incidentally taken. Furthermore, it is extremely unlikely that any navigation or ecosystem project would be implemented if the viability of an EHA for Higgins eye were to be threatened. Therefore, we believe that the maximum incidental take of 500 Higgins eye is not likely to reduce the reproduction, numbers, or distribution of Higgins eye, result in jeopardy to the species, or destruction or adverse modification of critical habitat (critical habitat has not been designated for Higgins eye).

4.6.4 Reasonable and prudent measures

To ensure that the anticipated level of incidental take is commensurate with the take that occurs per the proposed action, the Corps of Engineers (Corps) and the Service is implementing a tiered programmatic consultation approach. This approach utilizes a tiered consultation framework with the subject consultation resulting in this Tier I biological opinion. All subsequent projects will be Tier II consultations with Tier II biological opinions issued as appropriate (i.e., whenever the proposed project will result in unavoidable adverse effects to threatened and endangered species).

[2] That exception was past dredging activities in the East Channel of the UMR at Prairie du Chien, Wisconsin. Havlik and Marking (1980) examined dredged material deposited on an upland site after maintenance dredging by the Corps of Engineers in 1976. They documented the presence of an extremely rich mussel assemblage in the East Channel including 175 Higgins eye that were killed by dredging activities (they did not estimate total mortality). The East Channel was subsequently included within the larger Prairie du Chien EHA for Higgins eye (U.S. Fish and Wildlife Service 1983). In a 1993 biological opinion to the Corps of Engineers, the Service concluded that future channel maintenance and commercial navigation activities in the East Channel would jeopardize the continued existence of Higgins eye (U.S. Fish and Wildlife Service 1993). The Service provided protective measures to avoid the likelihood of jeopardy to Higgins eye including suspending navigation channel maintenance dredging in the East Channel between the Highway 18 Bridge and the turning basin, hazardous material spill prevention and response measures, and reinitiation of formal section 7 consultation if commercial transportation exceeded established limits. These measures reduced the likelihood that a significant number of Higgins eye would be killed from future dredging and navigation activities. Also, the invasion of zebra mussels decimated the Higgins eye population at the Prairie du Chien EHA since 1993 (U.S. Army Corps of Engineers 2004a).

As individual projects are proposed under the recommended plan, the Corps shall provide, for any action that may affect Indiana bats, project-specific information to the Service that (1) describes the proposed action and the specific area to be affected, (2) identifies the species that may be affected, (3) describes the manner in which the proposed action may affect listed species, and the anticipated effects, (4) specifies whether the anticipated effects from the proposed project are similar to those anticipated in the programmatic BO, (5) estimates a cumulative total of take that has occurred thus far under the tier I BO, and (6) describes any additional effects, if any, not considered in the tier I consultation. If it is determined that the proposed project may affect the Higgins eye pearlymussel, the Corps will provide this information in a tier II BA to document anticipated effects of the subject action.

The Service will review the information provided by the Corps for each proposed project. If it is determined during this review that a proposed project is not likely to adversely affect listed species, the Service will complete its documentation with a standard concurrence letter and specifies that the Service concurs that the proposed project is not likely to adversely affect listed species or designated critical habitat.. If it is determined that the action is likely to adversely affect listed species or designated critical habitat and these effects are commensurate with those contemplated in the programmatic BO, then the Service will complete a tier II BO with a project-specific incidental take statement within the annual allotted programmatic incidental take, and project specific Reasonable and Prudent Measures and Terms and Conditions, if appropriate..

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 impacts of incidental take of Higgins eye. The RPMs are a modification of the Standards and Guidelines found on Page 123 of the Corps of Engineers Tier I Biological Assessment, and proposed Systemic Barge Fleeting Plan (U.S. Army Corps of Engineers 2004a):

1. Implement the Higgins Eye Planning Guidelines listed below for design and implementation of navigation and ecosystem restoration actions.

2. Complete the Systemic Barge Fleeting Plan for the UMRS (U.S. Army Corps of Engineers 2004a) in a timely manner.

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. The Service's points of contact for coordination on all terms and conditions are Mr. Dan Stinnett, Field Office Supervisor, U.S. Fish and Wildlife Service, Twin Cities ES Field Office, 4101 East 80th Street, Bloomington, Minnesota, 55425-1665 for St Paul District projects; and Mr. Richard C. Nelson, Field Supervisor, U.S. Fish and Wildlife Service, Rock Island Field Office, 4469-48th Avenue Court, Rock Island, Illinois 61201-9213 for Rock Island District projects:

1. Incorporate the following Higgins Eye Planning Guidelines as an integral part of the planning process for actions proposed under the Upper Mississippi River – Illinois Waterway System Navigation Study:

   a. Review the suitability of aquatic habitat for Higgins eye site-specifically for individual projects, including consideration of current range, and existing mussel surveys in the action area to assess the presence of and impacts to Higgins eye from site-specific actions.

   b. Conduct site-specific mussel surveys for Higgins eye where there is insufficient information on habitat suitability and/or mussel distribution in the individual project area to make presence/impact determinations. If Higgins eye are not found in the mussel survey, use the decision criteria proposed by Wilcox et al. (1993) to determine the likelihood of occurrence of Higgins eye in the individual project area.

   c. If Higgins eye are likely to be adversely affected in the individual project area, coordinate with the U.S. Fish and Wildlife Service in accomplishing the following:

      1. Develop and incorporate Conservation Measures into individual project plans to minimize take of Higgins eye. Conservation measures may include but are not limited to employing best management practices during project construction, or modifying project features, locations or timing of construction.

         For water level management projects within a pool or reach known to contain Higgins eye, evaluate the following Conservation Measures for implementation during the planning phase to minimize take of Higgins eye:

         a. Limit the depth of drawdown at any of the 10 Essential Habitat Areas described in the revised recovery plan (U.S. Fish and Wildlife Service 2004), secondary habitats that are important to Higgins eye (U.S. Fish and Wildlife Service 2004), or locations on the UMR and tributaries where Higgins eye have been relocated in accordance with the Biological Opinion for Operation and Maintenance of the 9-Foot Channel Project (U.S. Fish and Wildlife Service 2000). Studies may be conducted to define the appropriate depth for a particular location(s) to minimize impacts to Higgins eye (see Item 1d below). In the absence of studies, a drawdown should not exceed 1.5 feet at any of the above habitat areas or locations.

b. Defer the drawdown if the pool elevation at the dam is greater than two feet above the secondary control pool elevation in excess of 20 days from April 1 to June 15 in the proposed drawdown year[3].

c. Lower water levels slowly (around 0.2 foot per day) during the drawdown to facilitate the escape of native mussels from the dewatered zone. The rate of drawdown should be commensurate with the proposed level of drawdown and the location of the drawdown.

d. Conduct studies to evaluate the distribution of Higgins eye in relationship to water depths in the action area, the ability of Higgins eye to escape the dewatered zone, and stranding of mussels with ongoing water level management projects. As additional information is obtained, the preceding Conservation Measures may be reviewed and revised, in coordination with the U.S. Fish and Wildlife Service. For example, a study for a proposed drawdown may find that Higgins eye are found at depths greater than 1.5 feet at a particular EHA or other habitat area, thereby facilitating a deeper drawdown at that location while minimizing impacts to Higgins eye.

2. After conservation measures have been incorporated to minimize take of Higgins eye, coordination with the U.S. Fish and Wildlife Service, evaluate the feasibility of relocating Higgins eye from the impact area of navigation and ecological restoration actions that are likely to adversely affect Higgins eye. Factors to consider in determining feasibility include the size of the collection site (i.e. project "footprint"), substrate, water depth and flow conditions at the collection site, estimated number of Higgins eye and other mussels potentially relocated, and the availability of suitable relocation sites in the project area. If feasible, develop and implement a Higgins Eye Relocation Plan as part of the specific action and incorporate it into the Tier II Biological Assessment.

2. When appropriate, incorporate Higgins eye habitat restoration into the planning and implementation of ecosystem restoration projects within the range of the species. Implementing mussel habitat restoration as a part of the ecosystem restoration program will contribute to the restoration/enhancement of Higgins eye habitat on the UMRS in general for conservation of the species, and replace unavoidable habitat losses from specific navigation and ecosystem restoration actions, in particular.

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[3] In April and May 2001, the maximum elevation above normal water levels in Pool 8 was approximately 6 feet. Water levels remained 2 feet above normal pool for greater than 30 days during April through June 15, 2001. During this period, mussels moved into shallower habitats. The high waters occurring for an extended period of time prior to the Pool 8 drawdown, combined with an unusual period of drought immediately after the drawdown was initiated, greatly contributed to observed stranding of mussels during the 2001 drawdown. Stranded mussels were observed in Pool 5 and other navigation pools that did not experience a drawdown, suggesting a strong correlation between mussel stranding and the severe flooding/drought conditions of 2001 (M. Davis, Minnesota Department of Natural Resources, 2001, personal communication). This flooding scenario is rare. From 1970 to 2003, there were only 4 years (1975, 1986, 1997 and 2001) where water levels remained high (greater than 2 feet) in Pool 8 for an extended period of time (greater than 20 days) during the period April 1 through June 15. The above restriction, because of the rarity of these events, should provide an opportunity for drawdowns to occur in navigation pools while avoiding/minimizing impacts to Higgins eye.

3. During the planning process for fish passage facilities at Lock and Dam 19, study the risks to Higgins eye and other native mussels from nonindigenous black carp. The study should be conducted in coordination with the U.S. Fish and Wildlife Service and other appropriate federal and state natural resource agencies. This information will be useful in determining the feasibility of fish passage facilities at Lock and Dam 19 which currently limits upstream movement of fish on the UMR.

4. In coordination with the U.S. Fish and Wildlife Service and other appropriate federal and state natural resource agencies, initiate development of the Systemic Barge Fleeting Plan for the UMRS in Funding Year One of the Upper Mississippi River – Illinois Waterway System Navigation Capacity Improvement Project. Information from the plan will assist in locating future actions to avoid and minimize effects to Higgins eye. The fleeting plan should be completed within three years of initiation and identify (1) important Higgins eye habitat areas that should be avoided; (2) areas that are suitable for fleeting and have no or minimal impacts on Higgins eye; and (3) other measures to avoid/minimize the impacts of fleeting on Higgins eye.

Requirements for Monitoring and Reporting of Incidental Take of Higgins eye pearlymussels

Federal agencies have a continuing duty to monitor the impacts of incidental take resulting from their activities [50 CFR 402.14(i)(3)]. In doing so, the Federal agency must report the progress of the action and its impact on the species to the Service as specified below.

1. Supply the Service with an annual report, due by January 31 of each following year, that specifies:

   a. the progress and results of implementing the Reasonable and Prudent Measures and their terms and conditions,

   b. the location and number of live and dead Higgins eye pearlymussels handled during mussel surveys or other activities identified by specific project, date and location including River Mile, and

   c. the length, height, and if possible sex and age, of each Higgins eye pearlymussel handled during mussel surveys or other activities identified by specific project, date and location including River Mile.

Closing

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.

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. Participate in the implementation of the Conservation Plan for Freshwater Mussels of the Upper Mississippi River System (Upper Mississippi River Conservation Committee 2004).

2. Participate in public outreach efforts, 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 Higgins eye and winged mapleleaf (*Quadrula fragosa*), control measures to limit the spread of zebra mussels on the UMR and tributaries, and status of mussel propagation and relocation efforts.

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

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