November 2005

STATUS OF IMPLEMENTATION OF HIGGINS EYE PEARLYMUSSEL (*Lampsilis higginsii*) REASONABLE AND PRUDENT ALTERNATIVES AND REASONABLE AND PRUDENT MEASURES AND WINGED MAPLELEAF (*Quadrula fragosa*) REASONABLE AND PRUDENT MEASURES

US Army Corps of Engineers®

MUSSEL COORDINATION TEAM

U.S. FISH & WILDLIFE SERVICE

DNR

WISCONSIN DEPT. OF NATURAL RESOURCES

PARTNERS FOR THE CONSERVATION OF NATIVE MUSSELS

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

USGS

NATIONAL PARK SERVICE

Minnesota DEPARTMENT OF NATURAL RESOURCES

BACKGROUND

The USFWS biological opinion listed a Reasonable and Prudent Alternative (RPA) believed necessary to avoid jeopardy for *Lampsilis higginsii*. An RPA was for the Corps to:

(1) conduct a reconnaissance study to control zebra mussels in the Upper Mississippi River (UMR) and
(2) develop an *L. higginsii* Relocation Action Plan

The USFWS biological opinion listed reasonable and prudent measures (RPM) believed necessary to minimize impacts of incidental take of Higgins' eye pearlymussel including the following:

(1) Develop and implement an action plan to monitor abundance and distribution of zebra mussels in the UMRS.
(2) Develop and implement a monitoring program for Higgins' eye and other mussels in the Upper Mississippi River System (UMRS).
(3) Investigate and implement opportunities to protect live Higgins' eye individuals within Essential Habitat Areas (EHA) in the UMRS.

INTERAGENCY COORDINATION

A Mussel Coordination Team (MCT) was established with a Partnership Agreement signed by agency heads of the Corps of Engineers (Corps) St. Paul (CEMVP) and Rock Island (CEMVR) Districts; the U.S. Fish and Wildlife Service (USFWS); the U.S. Geological Survey (USGS); the National Park Service (NPS); the U.S. Coast Guard; and the Departments of Natural Resources from Minnesota, Wisconsin, Iowa and Illinois. The MCT is assisting in the planning, development and implementation of the recommended actions identified in the Biological Opinion for winged mapleleaf and Higgins eye pearlymussel. The CEMVP, CEMVR, USFWS, NPS and the States have jointly conducted/funded the accomplishments discussed below. A complete list of publications that have been generated as result of this interagency effort is contained in attachment 1.

HIGGINS' EYE PEARLYMUSSEL RPA ACTION ITEM 1. Zebra Mussel Control

As stated in the biological opinion, the Corps was to:

"Conduct a zebra mussel reconnaissance study to determine the necessary measures, projected costs, and likelihood of success in controlling zebra mussels in the UMR. This will be an interdisciplinary/interagency effort designed to determine the most efficient and cost effective combination of measures necessary to control zebra mussels. Based on these findings, the Corps will pursue, for those actions that fall within their purview, the

appropriate project planning and other steps to implement the necessary measures. Also, the Corps and the Service will seek the assistance of other agencies in pursuing those additional actions, which are within the authorities of those agencies and deemed necessary to control zebra mussel infestation. The reconnaissance report will be provided to the Field Supervisor, U.S. Fish and Wildlife Service, 4101 East 80th Street, Bloomington, Minnesota, 55425-1665, by April 30, 2002, for approval…. If the reconnaissance report or a subsequent feasibility report concludes that zebra mussel control in the UMR is not feasible, or feasible actions under the purview of the Corps are not implemented within two years of their identification, the Corps will immediately reinitiate consultation with the Service under Section 7 of the Endangered Species Act to develop an alternative RPA to avoid jeopardy."

STATUS:

- Reports:

St. Paul District, U.S. Army Corps of Engineers. August 2000. Letter Report - Determination of Federal Interest in Conducting a Reconnaissance Study of Measures for Controlling Zebra Mussels in the 9-Foot Navigation Channel of the Upper Mississippi River. U.S. Army Corps of Engineers, St. Paul, Minnesota.

Miller, A., B. Payne and J. Miller. February 2001. A preliminary Evaluation of Possible Strategies to reduce or Eliminate Zebra Mussels, and their Associated Impacts to *Lampsilis higginsii*, from the Upper Mississippi River Navigation System. Engineer Research and Development Center, Vicksburg Mississippi.

St. Paul District, U.S. Army Corps of Engineers. August 2003. Final Reconnaissance Study. Mississippi River Between the Missouri River and Minneapolis, 9-Foot Channel Project Measures to Manage Zebra Mussels. U.S. Army Corps of Engineers, St. Paul, Minnesota.

- Approved Reconnaissance Study recommending $2.1 million Feasibility Study
- Requested funds for Feasibility Study
- Not funded in 2004-2005
- Initiated a St. Croix River Watershed Reconnaissance Study. The study will evaluate a broad range of issues within the watershed, potentially including zebra mussel management on the St. Croix River and winged mapleleaf and Higgins eye protection and restoration. However, any subsequent feasibility study and implementation of any resulting feasible alternative(s) may require cost sharing.
- Feasibility Study is having hard time competing with larger scale projects like NESP, Everglades, and other Ecosystem Restoration projects
- In the FY 06 Budget Conference Report, there is $250,000 listed for "St. Croix River Relocation of Endangered Mussels, WI".

HIGGINS EYE PEARLYMUSSEL RPA 2. *L. higginsii* Relocation Plan

As stated in the biological opinion and as modified in a letter to the Corps from the USFWS, dated May 21, 2001, the Corps was to:

> "Conduct a Higgins' eye relocation feasibility analysis and prepare a Higgins' eye Pearlymussel Relocation Plan to address the feasibility of the Reasonable and Prudent Alternative in avoiding jeopardy and reducing incidental take. This will be an interdisciplinary/interagency effort designed to determine the most efficient and cost effective combination of methods and measures to provide for relocation of Higgins' eye. The effort will follow the Corps' traditional six-step planning process and include the utilization of pilot field studies if necessary"

STATUS

- Higgins eye relocation action plan: A "Definite Project Report/Environmental Assessment - Relocation Plan for the Endangered Higgins' Eye Pearlymussel (*Lampsilis higginsii*) Upper Mississippi River and Tributaries; Minnesota, Wisconsin, Iowa, and Illinois" was signed July 2002.
- Major features of the Relocation Plan include:
  - Ten year plus plan.
  - Goal is to establish 5 populations of Higgins eye with a minimum of 500 adults in areas with low or no zebra mussel infestation.
  - Relocating mussels to 10 sites using a variety of relocation techniques (see figure 1 for locations).
  - Relocation techniques include adult relocation, release of free-ranging infested fish, fish held in cages with open bottoms, and sub-adults being grown in closed bottom cages for 3 years.
  - Includes a long-term monitoring plan to assess viability of new populations.

KEY RESULTS:

Propagation results:

- Genetic studies
  - Higgins eye has a lot of genetic diversity, but no differences between northern and southern populations
  - Microsatellite to track progeny still in developmental stage
- See Table 1 and key results below for status of relocation efforts at the 10 sites. Stocking goals should be met or exceeded at all sites.
- 471 adults relocated to UMR Pools 2 and 3
- 7,400 sub-adults reintroduced to UMR Pools, 2, 3, 4, and Wisconsin River

- 10,000 – 20,000 sub-adults being grown out in cages (UMR Pool 4 - Lake Pepin)
- Potentially >1.4 million transformed juveniles from >24,000 glochidia infested fish free released or placed in open bottom cages (see Table 2).
- All propagation goals should be met by 2007 – placement of sub-adults, augmentation, and monitoring thereafter.

Relocation Site Monitoring

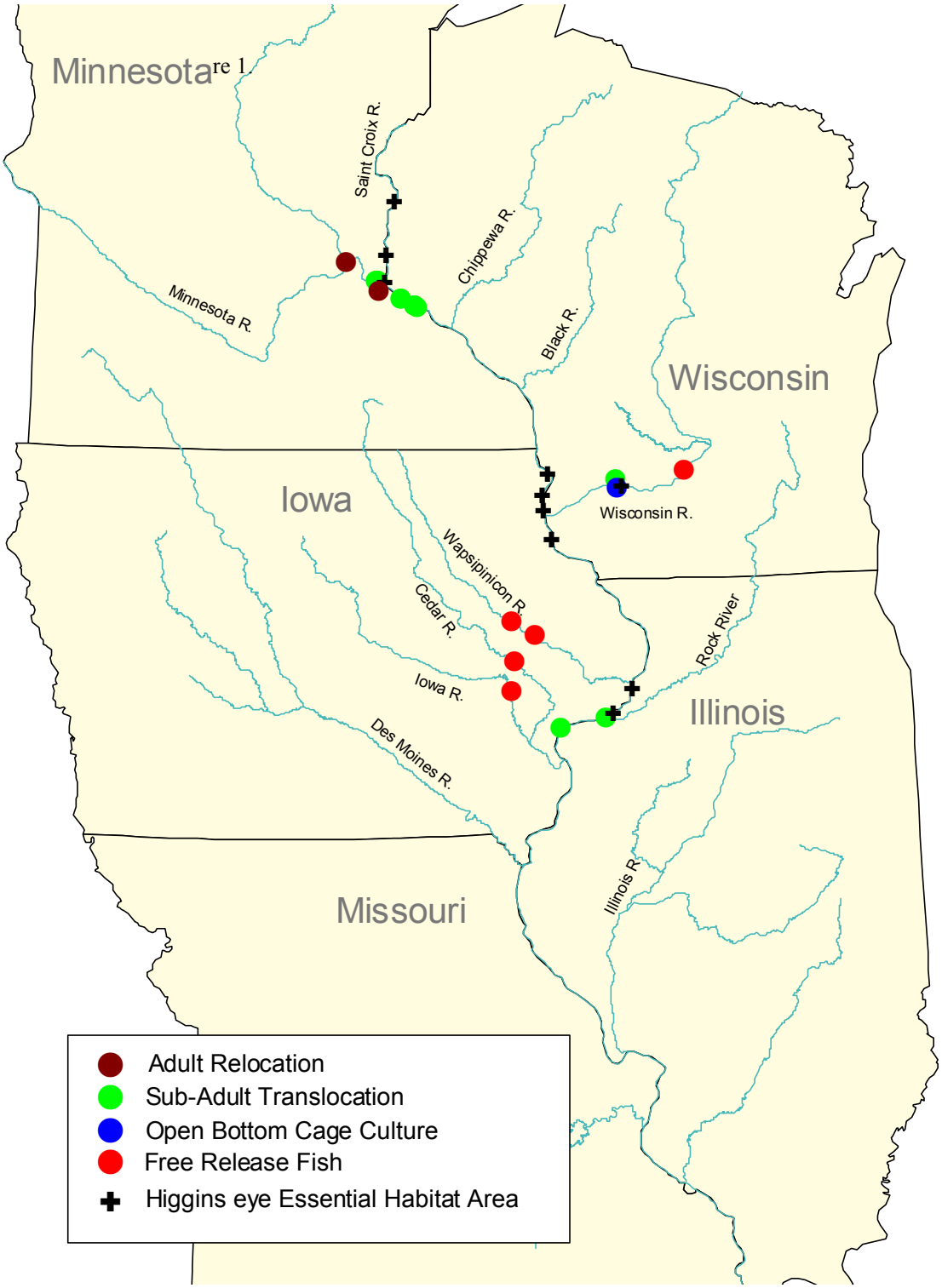
- Adult relocation in pools 2 and 3 complete.
  - Good survival.
  - Females have been gravid.
  - Looking for evidence of recruitment (no evidence yet).
- Open bottom Cages on the Wisconsin River at Orion
  - 4 juveniles have been found near and downstream of cages
- Free release of fish on Iowa, Cedar, Wapsipinicon, and Wisconsin rivers
  - In 2004: radio-tagging study of released fish on Cedar to identify likely areas to search for juvenile Higgins eye.
  - Searched Cedar, Iowa, Wapsipinicon this summer.
    - Cedar – found few species and no Higgins eye
    - Iowa – large number of species (20) but no Higgins eye
    - Wapsipinicon River – good number of species and 1 Higgins eye female.
- Sub-adults in pools 2, 3, 4.
  - Sub-adults are measured, uniquely marked, and placed in grids.
  - Monitoring of relocated sub-adults in pools 3 and 4 was completed in 2003. A subset of grids were checked in 2004 (see table 3). Good recovery was found in pool 3. However, only 5% of mussels were recovered at the relocation site in pool 4. The individuals placed in pool 4 were generally smaller and may have been more susceptible to predation. We believe that fish predation (probably carp) is a problem at least at the pool 4 site. Blankets (aluminum or plastic mesh) were placed over the mussels in 2004. A check this spring found one of the blankets partially buried. The remainder of blankets were intact. A spot-check of the 2002 cohort not placed under blankets had good recovery at the pool 2 site and one of the pool 4 sites (Goose Lake), but extremely poor recovery at the other pool 4 site (4^{th} Cut). Found shell fragments including shells with tags at the 4^{th} Cut pool 4 site. Predation is a major concern that we need to address.

FUTURE PLANS:

- Propagation to be completed in 2007, placement of sub-adults at the relocation sites and augmentation thereafter
- Survey for Higgins eye recruits
- Continue to monitor sub-adults
  –Survival, growth, etc.

–Evaluate protection and rearing technique

- Develop and implement long term monitoring strategy to evaluate long-term viability of populations.


Minnesota
Saint Croix R.
Chippewa R.
Minnesota R.
Black R.
Wisconsin
Wisconsin R.
Iowa
Wapsipinicon R.
Cedar R.
Iowa R.
Des Moines R.
Rock River
Illinois
Illinois R.
Missouri
Adult Relocation
Sub-Adult Translocation
Open Bottom Cage Culture
Free Release Fish
Higgins eye Essential Habitat Area

re 1.

Figure 2. Photos of Closed Bottom Cage Propagation at Lake Pepin

Figure 3. 2003 Sub-adult Propagation in Closed Bottom Cages

7,400 + *L. higginsii*
2003 cage effort - Lake Pepin

Figure Location of adult and sub-adult relocation efforts

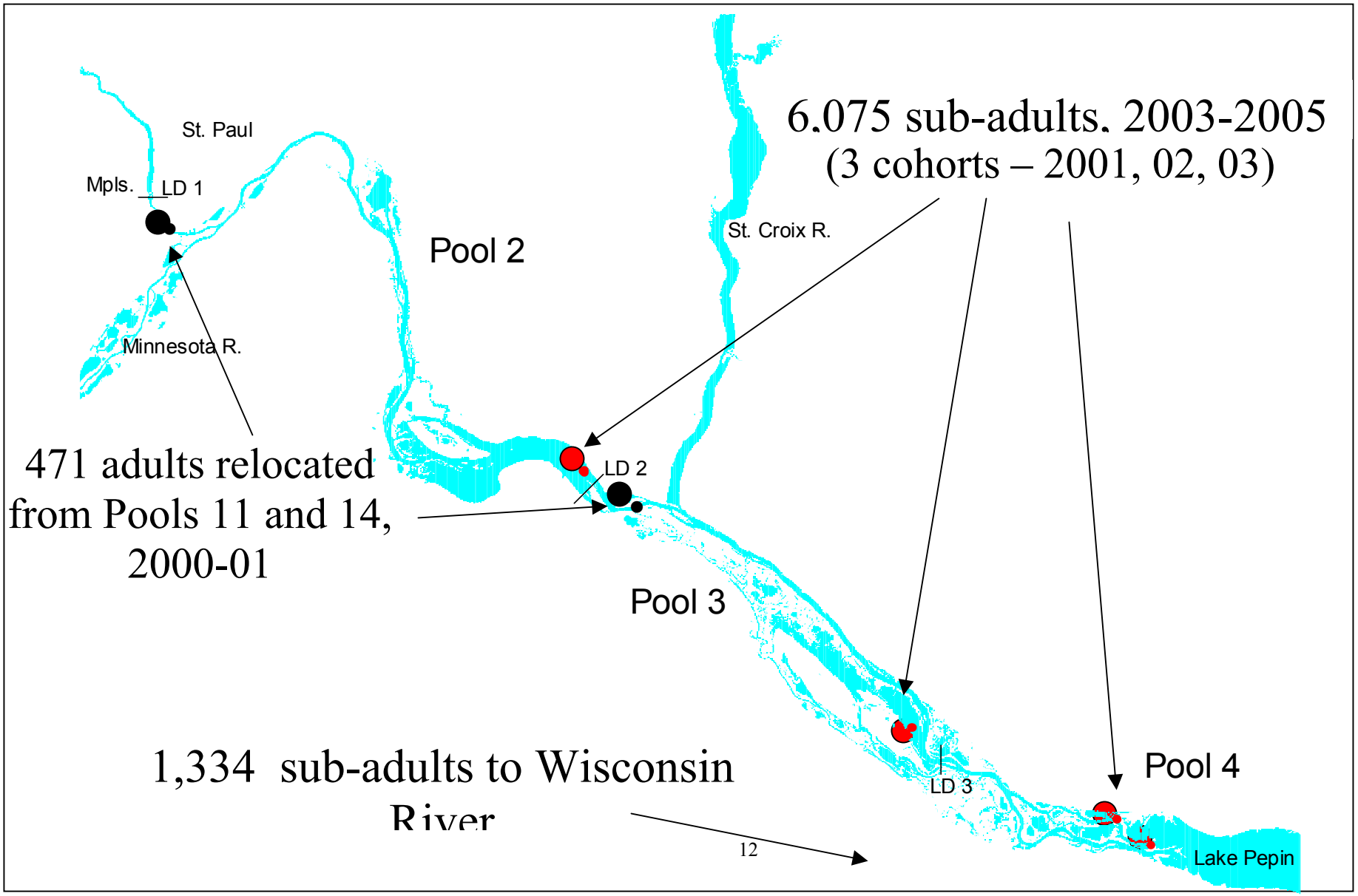


Table 1. Status of relocation efforts at the 10 sites.

Year Placed	Cohort	Site 1		Site 2	Site 3		Site 4		Site 5
		Pool 2 - Hidden Falls		Lower pool 2	Pool 3 - Main channel border	Pool 3 - Sturgeon Lake	Pool 4 - Goose Lk.	Pool 4 - 4th Cut	Rock River
		adults	sub-adults	sub-adults	adults	sub-adults	sub-adults	sub-adults	sub-adults
2000	Many	100			101				
	2000								
2001	Many	271							
	2001								
2002	2002								
2003	2000						3		
	2001					195	346		
	2003								
2004	2001			5			5	5	
	2002		5	334			264	300	
	2003[1]			506			308	300	
	2004								
2005	2003[1]			800		1,400	500	500	0
	2005								
2006	2003[1]						200	200	
	2004[2]			750		750	250	250	400
	2006								
2007	2005[3]			1,000		1,000	500	500	1,000
2008	2006[3]			1,000		1,000	500	500	1,000
2009	2007[3]								1,000
	Total	371	5	4,395	101	4,345	2,876	2,555	3,400
	Target	300	0	420	100	420	210	210	420

[1] Around 7,500 sub-adults were produced of which 1,100 were placed in 2004. Around 4,500 were placed in 2005, with around 600 remaining in cages until 2006, when they would be placed in 2006 at one for the sites to.

[2] Around 2,000 St. Croix strain sub-adults were produced in 10 cages (200/cage) and around 1,000 Cassville/Cordova strain in 50 cages - Lake Pepin and floating cages (production rate of around 20/cage)

[3] Production rates of sub-adults based on 2004 numbers ~ 3,000 St. Croix Strain in 15 cages and 2,500 Cassville/Cordova strain in 110 cages. Production rate for juveniles from free release and open bottom cages based on 2004 rates - 18% transformation rate.

Red Font = St. Croix strain. Blue Font = Cassville/Cordova and a few WS River strain

Year Placed	Cohort	Site 6 Pool 17 sub-adults	Site 7 Wisconsin River - Orion sub-adults	Site 7 Wisconsin River - Orion Juv - cage	Site 7 Wisconsin River - Prairie du Sac Juv - free	Site 8 Iowa River - Iowa City Juv - free	Site 9 Cedar River Juv - free	Site 10 Wapsi River Central City Juv - free	Site 10 Wapsi River Anamosa Juv - free
2000	Many								
	2000			1,100					
2001	Many								
	2001			34,042	13,485		69,200		
2002	2002				16,500	131,551	35,615	71,000	69,700
2003	2000								
	2001								
	2003			59,952	51,748	13,359	38,657	21,084	21,117
2004	2001								
	2002								
	2003[1]								
	2004			29,471	26,101	93,721	87,888	45,198	45,198
2005	2003[1]		1,334						
	2005			54,786	27,527	41,358	41,291	258,536	
2006	2003[1]		200						
	2004[2]	400	200						
	2006			70,497	26,856	63,783	Abandone	16,785	111,452
2007	2005[3]	1,000	500						
2008	2006[3]	1,000	500						
2009	2007[3]	1,000	500						
	Total	3,400	3,234	249,848	162,217	343,772	272,651	412,603	247,467
	Target	420	420	183,500	104,000	312,500	312,500	156,250	156,250

[1] Around 7,500 sub-adults were produced of which 1,100 were placed in 2004. Around 4,500 were placed in 2005, with around 600 remaining in cages until 2006, when they would be placed in 2006 at one for the sites to.

[2] Around 2,000 St. Croix strain sub-adults were produced in 10 cages (200/cage) and around 1,000 Cassville/Cordova strain in 50 cages - Lake Pepin and floating cages (production rate of around 20/cage)

[3] Production rates of sub-adults based on 2004 numbers ~ 3,000 St. Croix Strain in 15 cages and 2,500 Cassville/Cordova strain in 110 cages. Production rate for juveniles from free release and open bottom cages based on 2004 rates - 18% transformation rate.

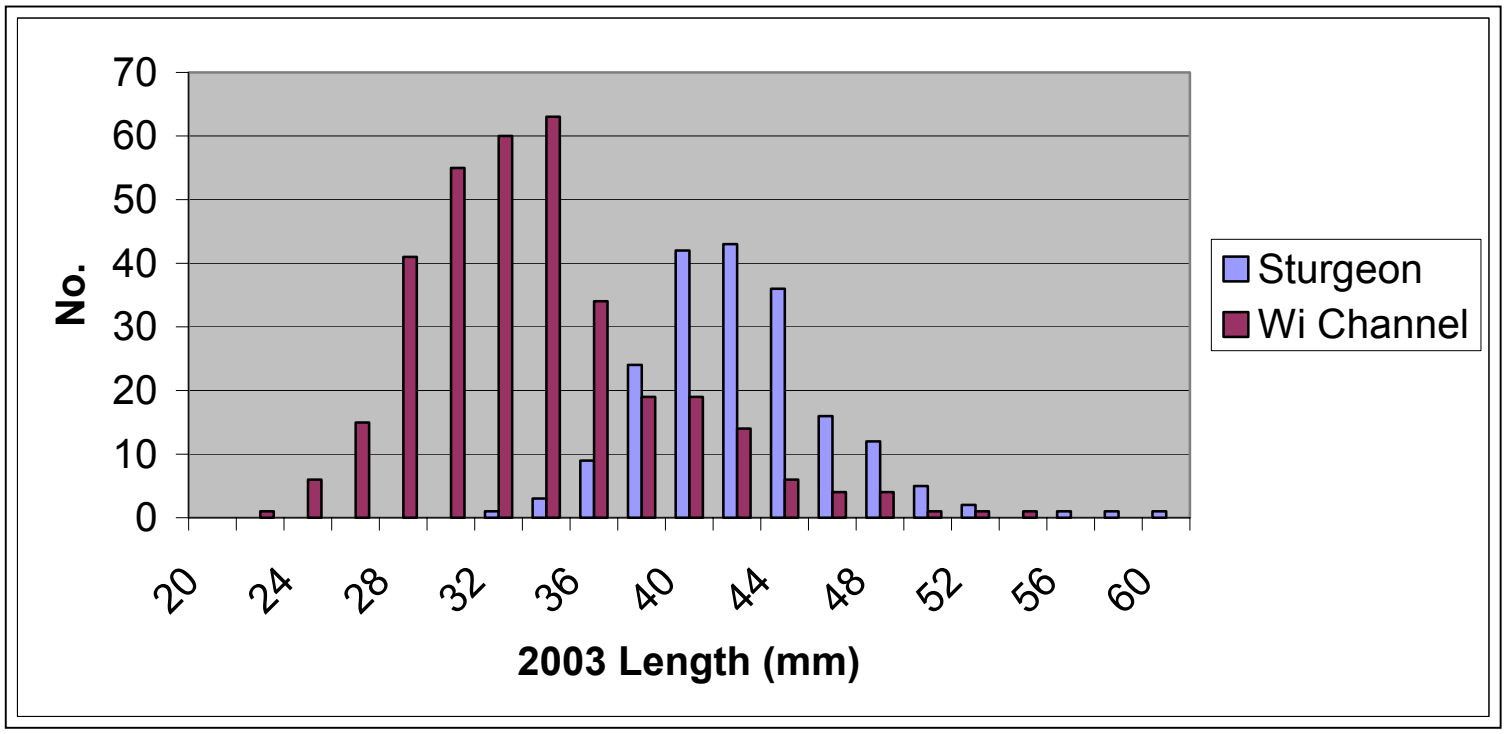
Red Font = St. Croix strain. Blue Font = Cassville/Cordova and a few WS River strain

TABLE 2. NUMBER OF FISH - FREE RELEASE AND OPEN CAGES

Site	Method	No. fish released since 2001	Potential transformed Higgins eye
Cedar River	free release	4,915	264,450
Iowa River	free release	6,160	213,833
Wapsipinicon River	free release	7,660	535,195
Wisconsin River - Prairie du Sac	free release	2,114	133,779
Wisconsin River - Orion	open bottom cages	3,043	224,630
Total		23,892	1,371,887

Total including closed bottom cages **37,233**

Length Distribution of Sub-Adults
(2001 Cohort) Placed in 2003



HIGGINS' EYE PEARLYMUSSEL RPM 1. Develop and implement an action plan to monitor abundance and distribution of zebra mussels on the Upper Mississippi River System

STATUS

- Compilation of past and ongoing zebra mussel monitoring efforts on the UMRS Inland Waterways (Ecological Specialists, Inc. 2001 and **Stefanik 2005)**

- A zebra mussel monitoring program was developed. The zebra mussel monitoring program focuses on improving our understanding of the current and future distribution and population status of zebra mussels (*Dreissena polymorpha*) on the UMR. The two tasks are 1) longitudinal and tributary distribution of zebra mussel veligers and 2) examination of temporal and spatial dynamics of adult zebra mussels in selected river reaches or pools.

  Task 1: Veliger zebra mussels. WDNR/IDNR have been collecting monthly veliger samples since 1998 from Locks and Dams 2 through 12, St. Croix, Wisconsin, Black, and Chippewa Rivers. An expanded veliger-sampling program was initiated in July 2001 and has been repeated in 2002-2005. Quantitative water samples were collected by MDNR, ILDNR, NPS, WDNR, IDNR, CEMVP, and CEMVS monthly (July, August, September) from above the head of Navigation and below each lock and dam from Lock and Dam 1 down to Lock and Dam 19 and in all major tributaries including the St. Croix, Chippewa, Black, Wisconsin, Upper Iowa, Turkey, Wapsipinicon, Yellow, Maquoketa, Skunk, Des Moines, Cedar, and Rock Rivers. In 2004, 3 sites were added on the Illinois River. In 2004, additional sites were added on the upper St. Croix River and basin, including the Snake and Sunrise rivers. The Illinois Natural History Survey performed the sample analysis in 2001 and Engineering Research and Development Center in 2002-4 (Farr and Alley, 2003; Far and Alley, 2003; and Far and Antwine, 2005).

  Task 2: Juvenile and adult zebra mussels. Quantitative samples were collected in 2000 through 2004 as part of essential and secondary habitat monitoring, to determine density, size demography, and evidence of recent recruitment of *D. polymorpha* (Miller and Payne, 2002; Farr et al., 2002; Farr et al., 2003; Farr et al., 2004; Farr et al., 2005). The 1996/1997 quantitative sampling of Lake Pepin was selectively repeated in 2003 and 2004 (Davis, 2003 and Davis, 2003). NPS, along with St. Croix Aquatic Nuisance Task Force, has been collecting qualitative and semi-quantitative information on zebra mussels in the St. Croix River since 2000. In 2004, stations were established for obtaining quantitative sampling to determine density, size demography, and evidence of recent recruitment of *D. polymorph* (National Park Service, 2004)**.**

KEY RESULTS:

- Veligers
  - Veliger concentrations have decreased in upper pools since 2002, but have remained the same in lower pools (Figure 9).
  - Tributaries - low level veliger concentrations were found in Cedar, Iowa, and lower St. Croix.
  - Only low levels of veligers (< 5/L) were found at the 3 sites on the Illinois River in 2004.
- Zebra mussel densities in selected native mussel beds.
  - Zebra mussel densities highly variable between and within designated sampling areas (Figure 10 and Table 8).
  - Significant declines in zebra mussel densities in 2003 and 2004 sampling efforts.
- Lake Pepin zebra mussels
  - Densities were generally comparable between 1996/7 and 2003/4 (figure 11).
  - Lower Lake Pepin has highest densities.
  - Significant differences in length distribution between sampling efforts (Figure 12) – in 1996/7 a wide distribution of lengths was observed, whereas in 2003 and 2004 smaller specimens dominated. May be related to heavy zebra mussel mortality in 2001.
- St. Croix River
  - No detects in veliger or quadrat samples above Stillwater (figure 12).
  - Very low densities in quadrats at Hudson and Lake St. Croix. Low/moderate densities at sites in lower 10 miles ~ 100/m^2
  - Quantitative sampling (veligers and quadrats) initiated in 2004 on St. Croix River should provide a good basis for assessing status of zebra mussels on St. Croix River.
  - 2005 Data unavailable at present.

FUTURE PLANS:

- Continue monitoring program as funding allows

Figure 9. Longitudinal Distribution of Zebra Mussel Veligers 2001-2004.

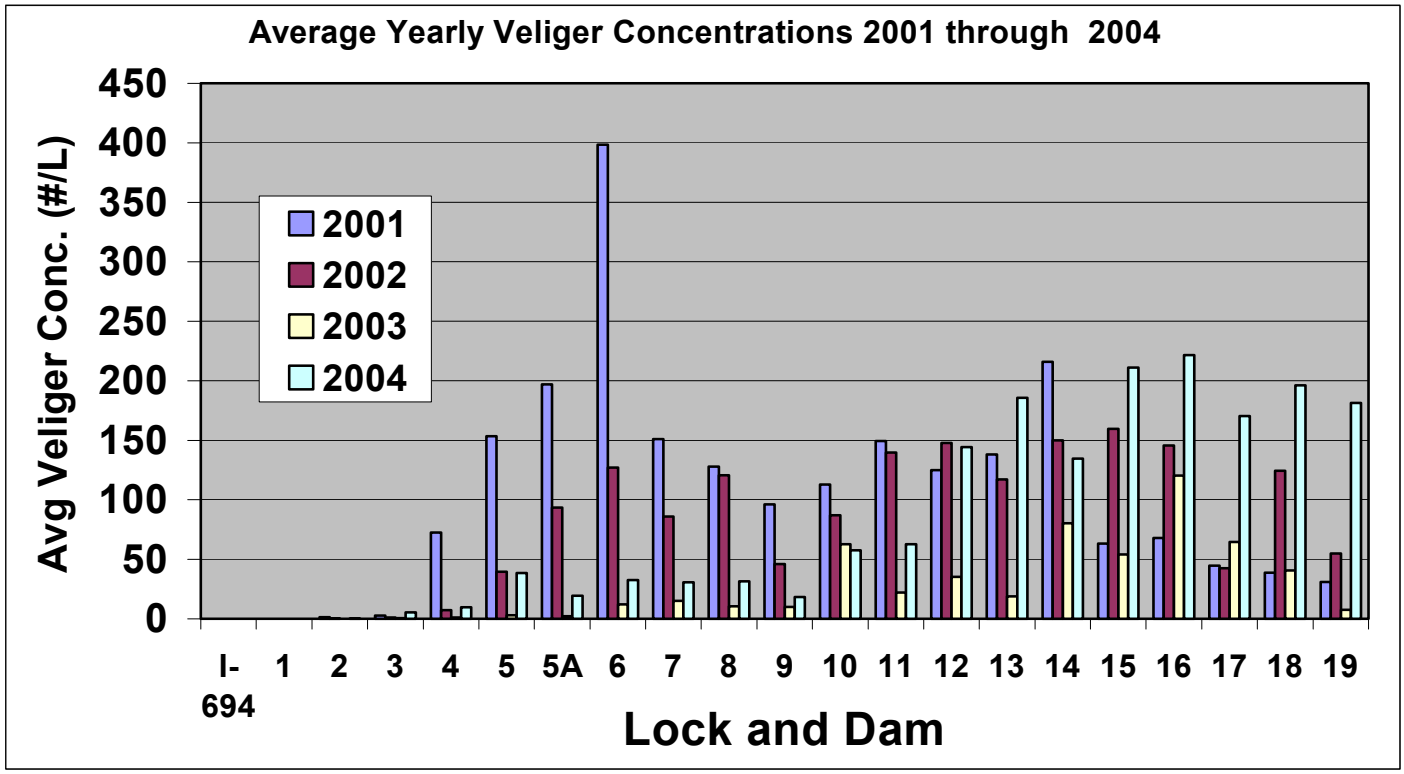


Figure 10. Zebra Mussel Densities in Selected Mussel Beds on Upper Mississippi River

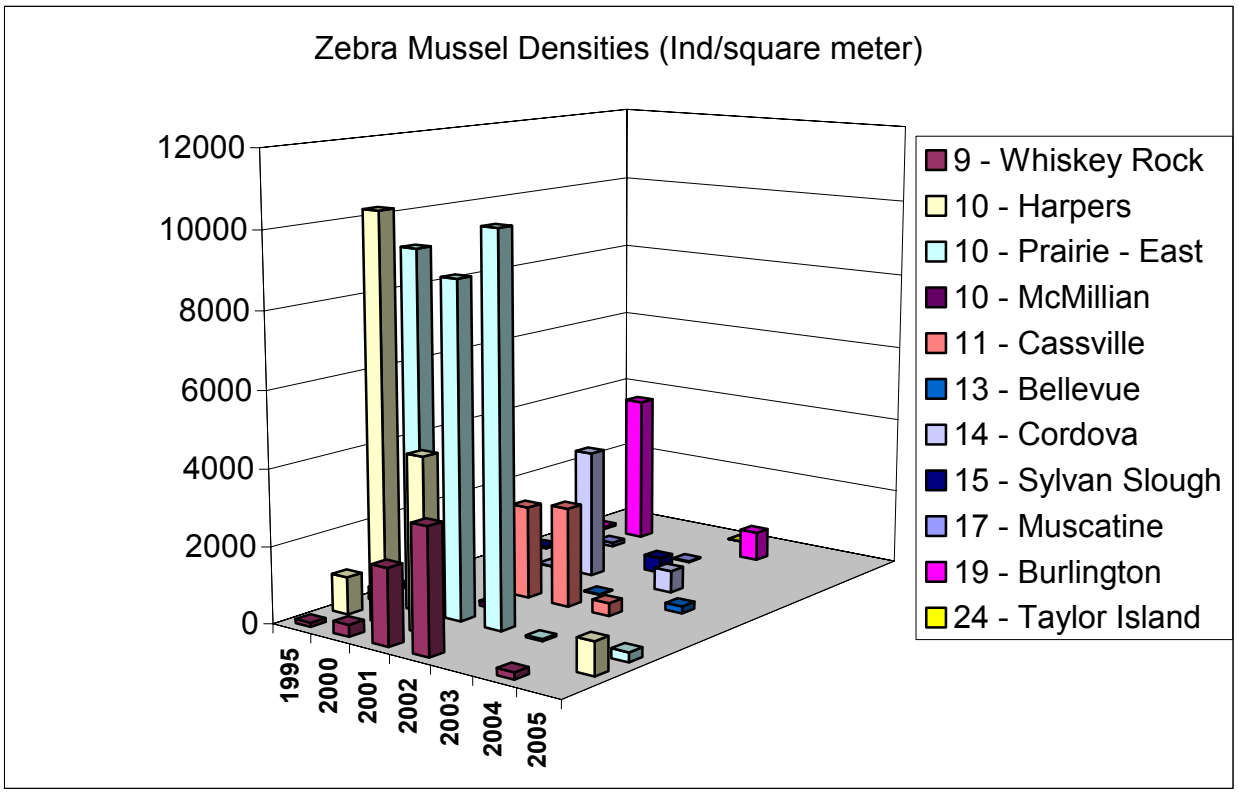


Figure 12. Zebra mussel densities in Lake Pepin 1996/7, 2003 and 2004

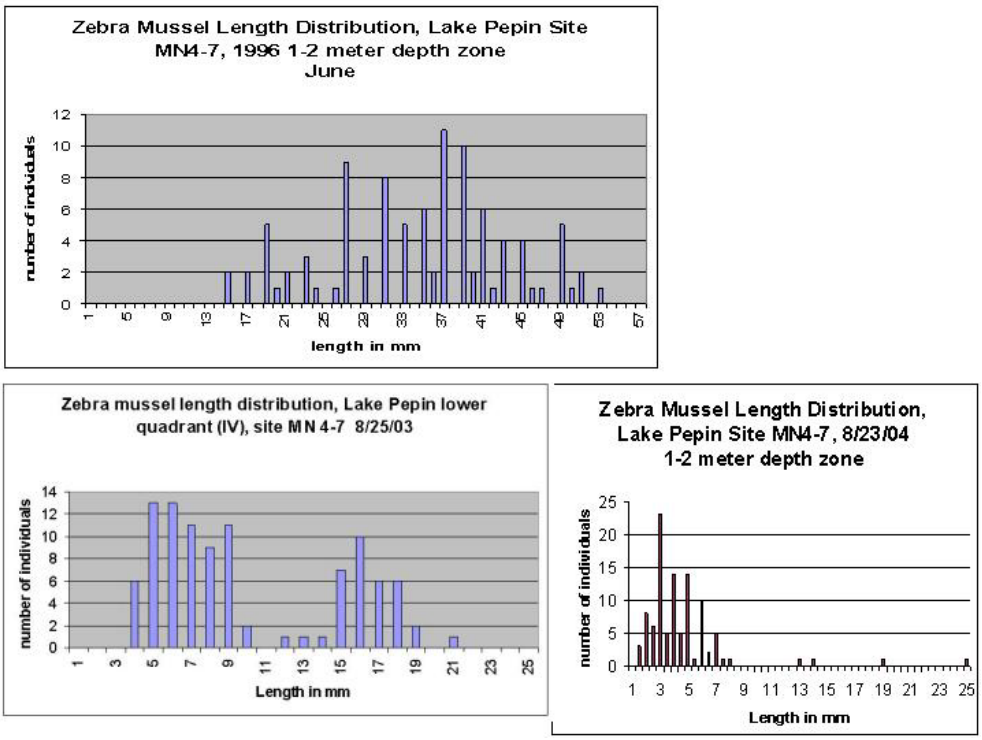


Figure 13. Zebra Mussel Densities at Selected Sites in the St. Croix River

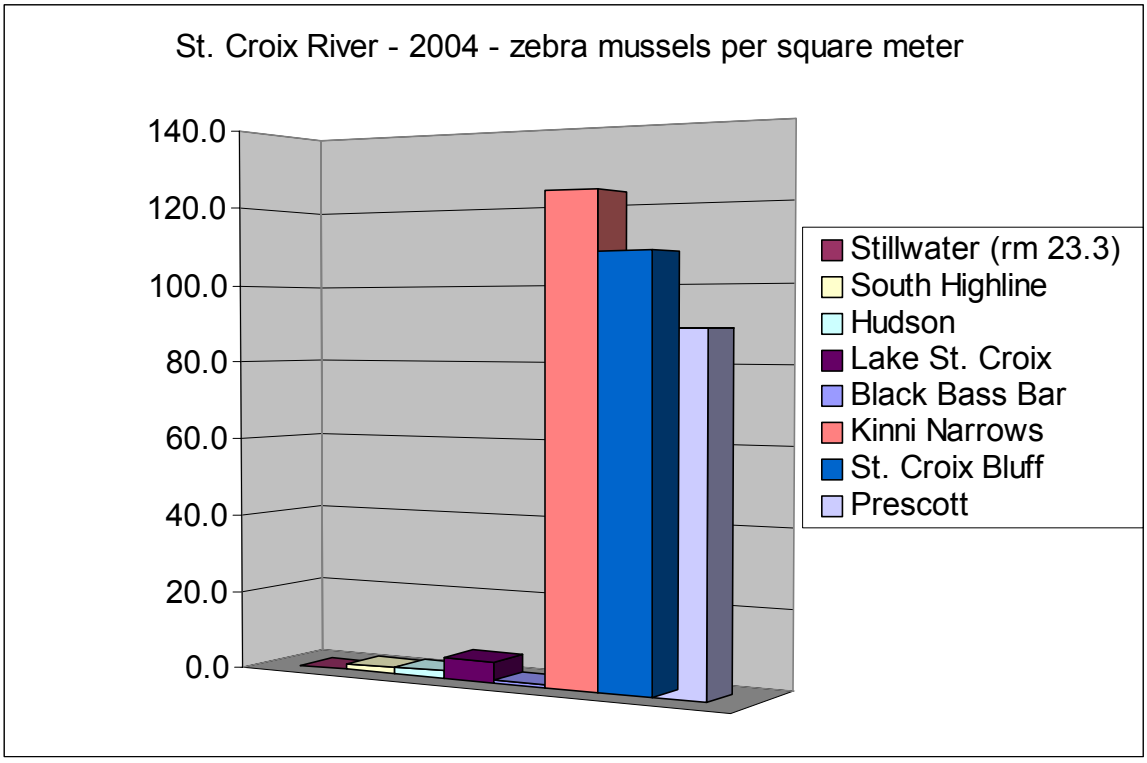


Table 8. Zebra Mussel Density (individuals/square meter)

Pool and area	1995	2000	2001	2002	2003	2004	2005
9 - Whiskey Rock	108	309	2003	3266		179	
10 - Harpers	986	10470	4520				861
10 - Prairie - East	332	9390	8760	10126	56		251
10 - McMillian	177	461	134				
11 - Cassville			2425	2605	339		
13 - Bellevue		90		15		183	
14 - Cordova		13	3373		578		
15 - Sylvan Slough	47	30		409			
17 - Muscatine	49	105		23			
19 - Burlington	63	3948			775		
24 - Taylor Island				3			

HIGGINS EYE PEARLYMUSSEL RPM 2. Develop and implement a monitoring program for Higgins' eye and other mussels in the UMRS

STATUS:

- A long-term monitoring plan has been developed and monitoring has been occurring since 2000. Population and community parameters in freshwater mussel beds are monitored each year or every 2 to 5 years at selected essential and secondary habitat areas. Qualitative and quantitative sampling is being conducted to obtain information on community composition, species diversity, species richness, and evenness. A new sampling technique was added in 2004, mapping the extent of the mussel beds. Semi-quantitative information
- The schedule of what has been completed in 2000-2005 and what is proposed for future years, subject to funding availability, is contained in Attachment 1.

KEY RESULTS:

- Geospatial web-based mussel database
  - Being developed by Cold Regions research Laboratory – NESP funded
  - All ERDC historic data being put into format for porting into the geospatial database – NESP funded.
  - MVP and MVR working on getting historical data ready for input.
- Mussel densities in the East Channel at Prairie du Chien in pool 10 significantly declined after invasion by zebra mussels, to all time lows in 1999-2001 (Figure 4). Slight improvements in mussel densities were found in 2002 and 2003. Densities were significantly higher in 2005. Heavy zebra mussel mortality in late 2001 may have contributed.
- Mussel densities declined at most of the mussel beds surveyed (Figure 6). Places like East Channel and Harpers Slough in pool 10 showed the greatest decline. Less dramatic declines were observed in many of the other mussel beds, especially areas like Whiskey Rock in pool 9. All mussel beds that have been sampled since 2002 have had slightly higher densities than previous sampling.
- Recruitment as measured by percent of individuals less than 30 mm was not observed from 1999-2001 at the East Channel (Figure 5). Juvenile mussels, including Higgins eye, were found at the East Channel in 2003 and 2005.
- Some of the study areas, especially areas like Whiskey Rock in pool 9 and Cassville in pool 11, have continued to show some level of recruitment even during the heavy zebra mussel infestations. Percent of individuals less than 30 mm increased in 2003 and 2004.
- Higgins eye essential habitat areas on St. Croix and Wisconsin River (Figure 7)
  - St. Croix River - Prescott and Hudson mussel populations have remained relatively stable.
  - St. Croix River – Interstate mussel densities declined from 2000 to 2004. The flood of 2001 may have contributed to this decline. The Interstate bed also contains the majority of winged mapleleaf found in the St. Croix River.
  - Wisconsin River at Orion – Continued decline in mussel densities. Casual factor is unknown.

FUTURE PLANS:

- Continue monitoring, as funding allows.

Figure 4. Mussel Density in East Channel Reference Site - Prairie du Chien, Pool 10.

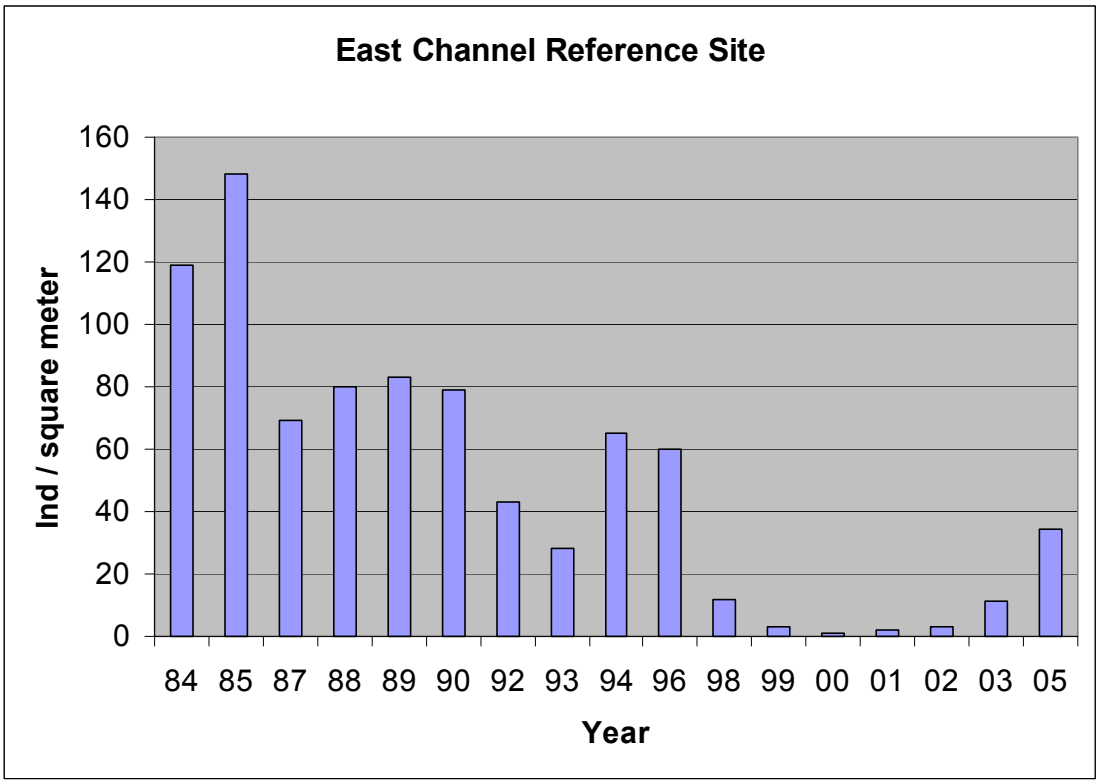


Figure 5. Recruitment in East Channel Reference Site - Prairie du Chien, Pool 10.

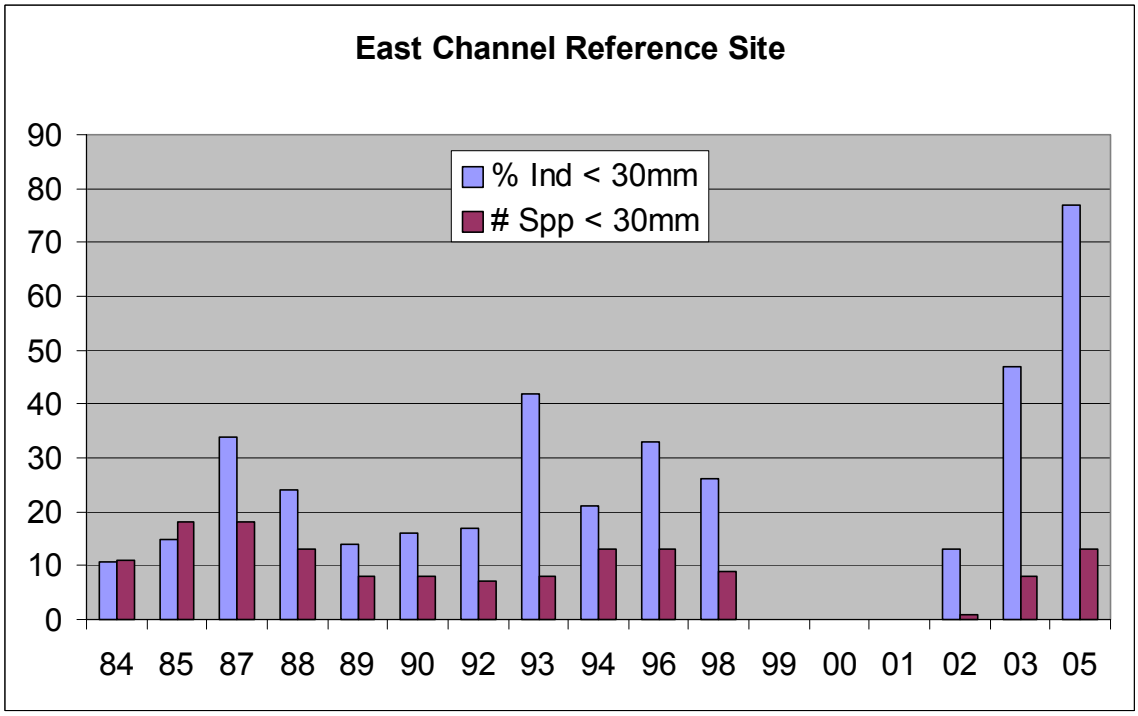


Figure 6. Mussel Density at Various Mussel Beds 1995-2005

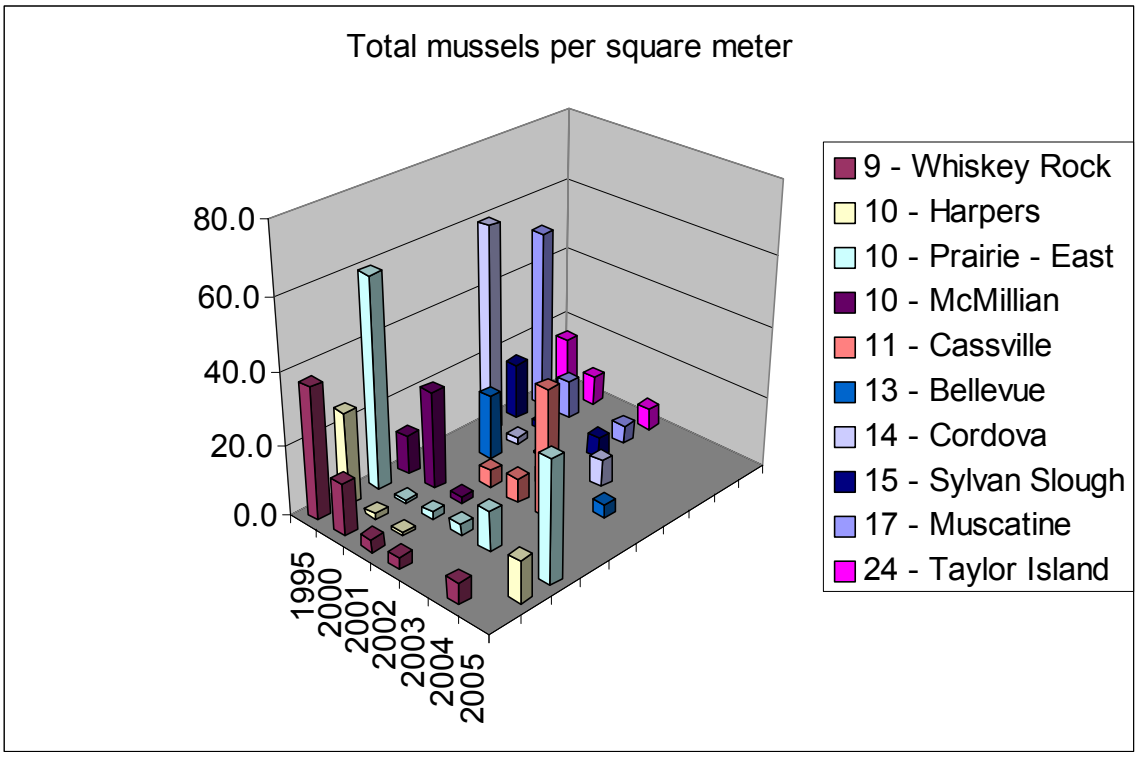


Figure 7. Percent of Individuals Less than 30mm at Various Mussel Beds 1995-2005

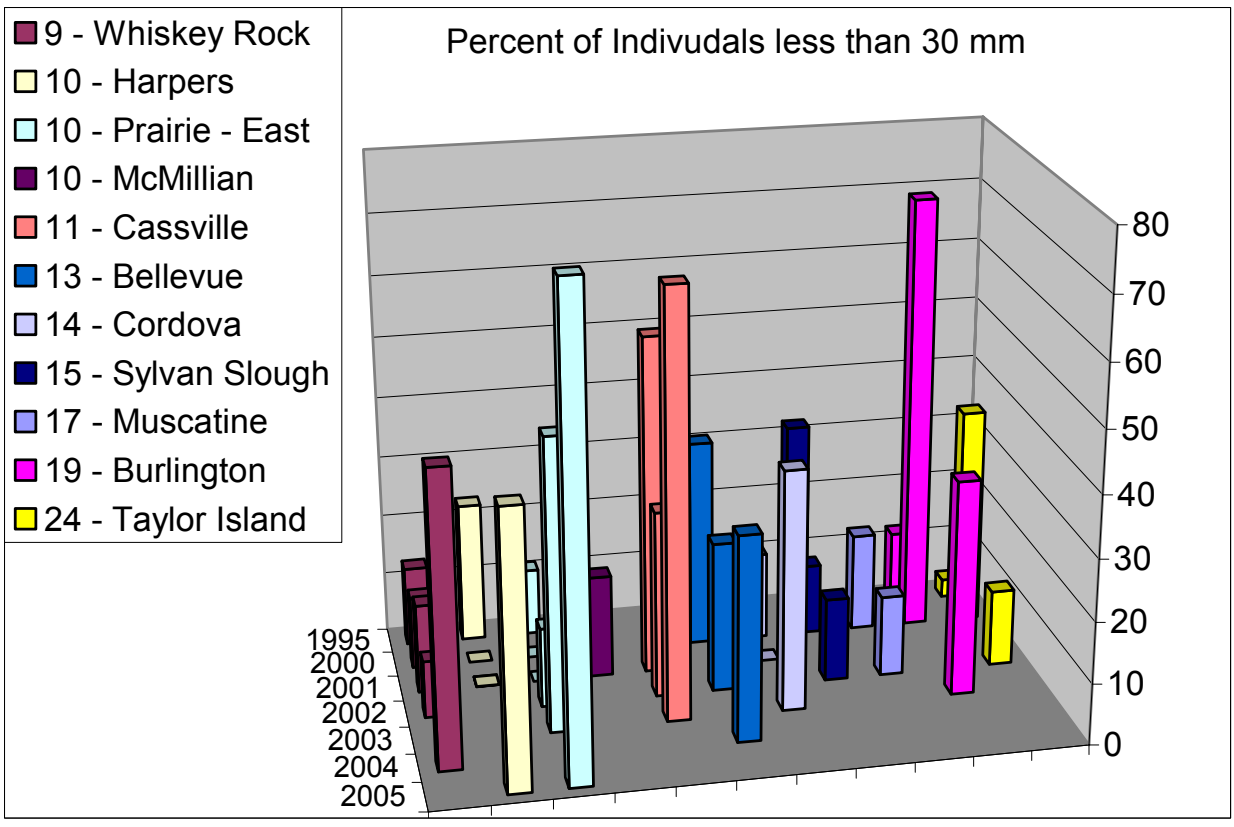


Figure 8. Native Mussel Densities at Selected Sites in Wisconsin and St. Croix Rivers

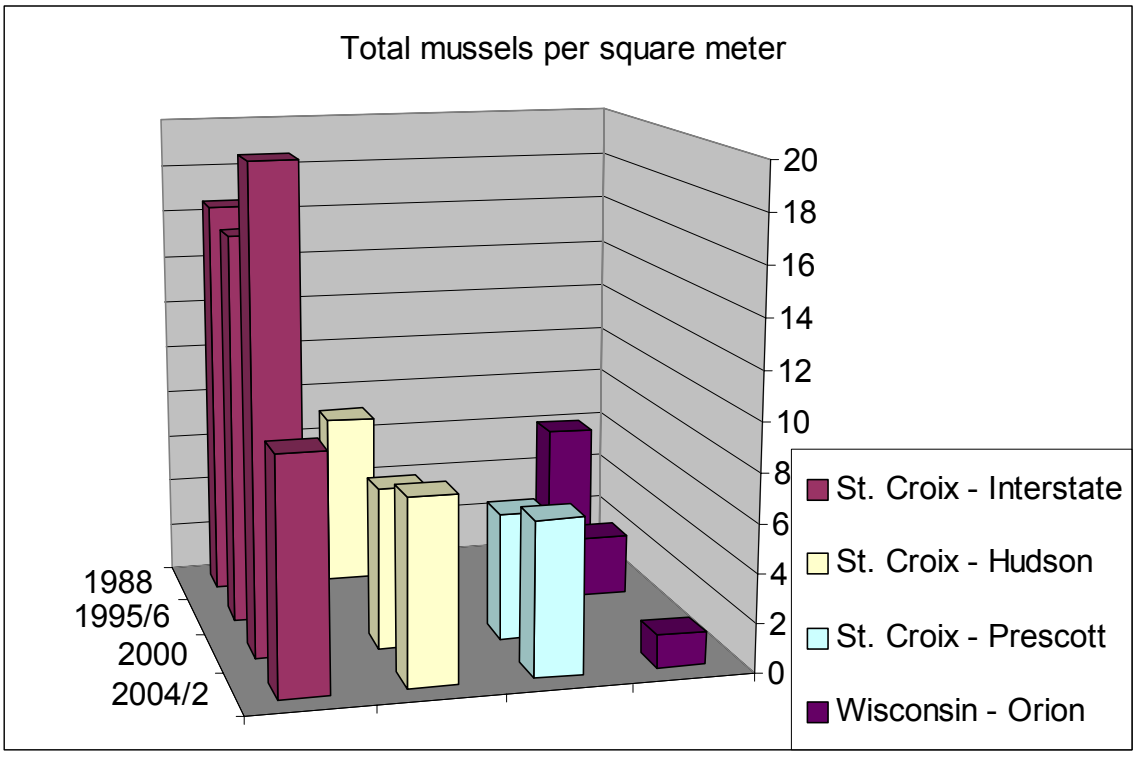


Table 4. Mussel densities (Ind/meter^2) for selected years

Pool and area	1995	2000	2001	2002	2003	2004	2005
9 - Whiskey Rock	37.6	14.8	3.7	3.4		6.0	
10 - Harpers	26.2	1.7	1.0				12
10 - Prairie - East	60.0	1.1	2.0	3.2	11.4		34.6
10 - McMillian	11.2	28.0	1.9				
11 - Cassville			5.1	6.9	36.4		
13 - Bellevue		18.6		4.2		3.7	
14 - Cordova	60.2	2.0	0.6		7.7		
15 - Sylvan Slough	16.2	2.2		5.9			
17 - Muscatine	51.5	10.7		5.3			
19 - Burlington		48.7			23.6		
24 - Taylor Island	16.2	8.5		6.4			

Table 5. Percent of Individuals Less than 30 mm

Pool and area	1995	2000	2001	2002	2003	2004	2005
9 - Whiskey Rock	13	12	15	9		48	
10 - Harpers	23	0	0				45
10 - Prairie - East	11	0	0	13	47		77
10 - McMillian		0	17				
11 - Cassville			55	30	69		
13 - Bellevue		34		25		33	
14 - Cordova		14	0		39		
15 - Sylvan Slough	32	12		14			
17 - Muscatine		16		13			
19 - Burlington	12	71			35		
24 - Taylor Island	3	36		13			

Table 6. Percent of Species with Individuals Less than 30 mm

Pool and area	1995	2000	2001	2002	2003	2004	2005
9 - Whiskey Rock	55	33	33	20		68	
10 - Harpers	39	0	0				56
10 - Prairie - East	54	0	17	25	65		50
10 - McMillian		0	50				
11 - Cassville			78	41	74		
13 - Bellevue		82		31		75	
14 - Cordova		25	0		47		
15 - Sylvan Slough	56	20		29			
17 - Muscatine		33		44			
19 - Burlington	55	71			67		
24 - Taylor Island		6		20			

Table 7. Quantitative (1/4 meter^2) 2005 Sampling in Harpers and East Channel Essential Habitat Areas in Pool 10

Sample Area	# of samples	Native mussel density #/m^2	Zebra / unionid	Zebra densities #/m^2	% of mussels from 1 - 5 years old	% less than 30mm	% of species with 1-5 year old	% of species less than 30 mm	Total # of native species
Harpers Lower	20	12.6	0.6	1065	68%	37%			
Harpers Upper	10	10.8	1.3	450	93%	63%			
Harpers Total	30	12.0	0.5	861	76%	44%	69%	56%	16
East Channel Turning Basin	11	6.2	2.2	32	82%	82%			
East Channel Reference	20	34.6	3.0	251	87%	77%			
East Channel Downstream	10	3.6	5.2	5180	89%	33%	81%	50%	26

HIGGINS' EYE PEARLYMUSSEL RPM 3. Investigate and implement opportunities to protect live Higgins' eye individuals within Essential Habitat Areas in the UMRS

STATUS:

- Development of and implementation of a plan to protect Higgins' eye pearlymussels. A limited pilot cleaning and stockpiling effort (3 sites) is being conducted, as a trial, to determine overall survival and the extent of zebra mussel re-infestation and subsequent maintenance cleaning required. A minimum of 300 Higgins' eye individuals will be collected at each of the sites and cleaned and monitored annually.
    2. Cassville in pool 11: A pilot mussel cleaning and stockpiling effort was conducted at Cassville in 2001, 2002, and 2004.
    3. Cordova in pool 14: A pilot mussel cleaning and stockpiling effort was conducted 2002, 2003, and 2004.
    4. Harpers Slough in pool 10: A pilot mussel cleaning and stockpiling effort was conducted in 2003.

- Habitat protection, restoration, or creation. The Zebra Mussel Control Reconnaissance and Feasibility Studies being conducted to address RPA Action Item 2 will address alternatives for managing habitat to control zebra mussels in the UMRS. However, site-specific recommendations/proposals for mussel habitat enhancement or creation will be incorporated into the Corps' ongoing Natural Resource Management Program, Habitat Rehabilitation and Enhancement Projects under the Environmental Management Program and the Navigation and Environmental Sustainability Program, if authorized and funded.

KEY RESULTS:

- Harpers – pool 10
    - Only found 11 live in 2003. However, 19 additional specimens were found in 2005. Low numbers make it of questionable value.
- Cassville – pool 11
    - Collected and cleaned 346 since 2002
- Cordova - pool 14
    - Collected and cleaned 801 since 2002
- Good survival (~ 5% mortality)
- No difference in growth & mortality between donor and non-donor females
- 2005 data has not been analyzed yet.

FUTURE PLANS:

- Evaluate results from this year to determine if continuation is warranted

WINGED MAPLELEAF (*Quadrula fragosa*)

BACKGROUND

The USFWS biological opinion listed reasonable and prudent measures (RPM) believed necessary to minimize impacts of incidental take of winged mapleleaf including the following:

(1) Develop and implement an action plan to monitor and control zebra mussels on the St. Croix River.

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

WINGED MAPLELEAF RPM 1. Zebra Mussel Control

This item has been incorporated under the Higgins' eye pearlymussel RPA 2.

WINGED MAPLELEAF RPM 2. Winged Mapleleaf Relocation

- Identification of winged mapleleaf host species. Studies completed in 2003/2004 identified channel catfish and blue catfish as suitable host (Steingrabber et al. 2005).

- Trigger for reinitiation of consultation was revised.

- Genetic studies. Contracted with Jeanne Serb from Iowa State University to develop a genetic library for winged mapleleaf to assist in the relocation feasibility study. USFWS is pursuing funding for comparing the genetic differences between southern populations (Saline, Ouachita, Bourbuse rivers) versus northern populations (St. Croix River).

- Pilot propagation efforts were initiated by the FWS and others in 2004. Some limited additional pilot propagation efforts to evaluate propagation techniques scheduled for fall/winter 2005/6.

- Zebra mussel monitoring was increased.

- Relocation Feasibility Study. Final Project Management Plan July 2005. A draft Definite Project Report and Environmental Assessment is to be completed by August 2006.

HIGGINS EYE AND WINGED MAPLELEAF CONSERVATION MEASURE - Public outreach

- Special session at Freshwater Mollusc Conservation Society 2005 Symposium
- Presentations at numerous other meetings
- FWS Mussel Web page
- Web Page in development for MCT activities and publications for posting to Corps internet site

HIGGINS EYE CONSERVATION MEASURE - Fish passage

- Draft Report in 2004 – Purpose was to provide information as it relates to mussels for consideration into ongoing NESP Fish Passage Study

PERIODIC SYNTHESIS REPORTS

- **Scheduled for every 3 years**
- **Zebra Mussels**
  - Ecological Specialists, Inc. January 2001. Zebra Mussel Monitoring in the Inland Waterways: Synthesis of Current Research and Recommendations for the Development of Population Dynamics Models. St. Peters, Missouri.
  - Stefanik, E.L. 2004. Summary of Zebra Mussel Monitoring Efforts For the Upper Mississippi River, 2000 through 2003. U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.
- **Native Mussels**
  - Mussel Coordination Team. 2003. Saving the Higgins' Eye Pearlymussel (Lampsilis higginsii) from Extinction: 2002 Status Report on the Accomplishments of the Mussel Coordination Team. U.S. Fish and Wildlife Service, Twin Cities Field Office, Bloomington, Minnesota and U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.
  - Update scheduled for this winter

ATTACHMENT 1
Mussel Coordination Team Publications
Updated July 2005

Anderson, D.D. and M. Farr. 2003. Report of 2002 collecting, cleaning, and stockpiling of adult Lampsilis higginsii from the Mississippi River in pool 11 near Cassville, Wisconsin. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Bowen, B. 2002. Progress report on genetic study of Lampsilis higginsii. Department of Animal Ecology, Iowa State University, Ames, Iowa.

Bowen, B. 2004. Genetic variability and geographic structure of Lampsilis higginsii mussels in the upper Mississippi River and tributaries. Department of Animal Ecology, Iowa State University, Ames, Iowa.

Bowen, B. and T.J. Kelley. 2003. Progress report on population genetics of Lampsilis higginsii using microsatellite DNA. Department of Animal Ecology, Iowa State University, Ames, Iowa.

Bowen, B. and T.J. Kelley. 2004. Assessment of nuclear DNA microsatellites for genetic studies of Lampsilis higginsii mussels. Department of Animal Ecology, Iowa State University, Ames, Iowa.

Corgiat, D., B. Schanzle, B. Atwood, and T. Kelley. 2002. Report on 2002 placement and monitoring of Lampsilis higginsii inoculated fish in cages into pool 24, Illinois

Davis, M. 2001. Emergency conservation relocation and reintroduction of Higgins' eye pearlymussel (Lampsilis higginsii) and other mussel species from zebra mussel infested areas in the Upper Mississippi River. Section 6 Grant Project Final Report, 2001. Minnesota Department of Natural Resources, Lake City, Minnesota.

Davis, M. 2002. Clam Chronicles. An account of activities associated with efforts to propagate and repatriate Lampsilis higginsii in the Mississippi River, Minnesota – 2002 Field Season. Minnesota Department of Natural Resources, Lake City, Minnesota.

Davis, M. 2003. Clam Chronicles. An account of activities associated with efforts to propagate and repatriate Lampsilis higginsii in the Mississippi River, Minnesota – 2003 Field Season. Minnesota Department of Natural Resources, Lake City, Minnesota.

Davis, M. 2004. Clam Chronicles. An account of activities associated with efforts to propagate and repatriate Lampsilis higginsii in the Mississippi River, Minnesota – 2004 Field Season. Minnesota Department of Natural Resources, Lake City, Minnesota.

Delphey, P., D.D. Anderson, D. Sallee, and M. Davis. 2002. Report of 2001 relocation of adult Lampsilis higginsii from the Mississippi River in pool 14 near Cordova, Illinois to Pool 2, Minnesota. U.S. Fish and Wildlife Service, Twin Cities Field Office, Bloomington,

Minnesota; U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota; Illinois Department of Natural Resources, Sterling, Illinois; and Minnesota Department of Natural Resources, Lake City, Minnesota.

Delphey, P. and D.D. Anderson. 2002. Report of 2001 collecting, cleaning, and stockpiling of adult Lampsilis higginsii from the Mississippi River in pool 11 near Cassville, Wisconsin. U.S. Fish and Wildlife Service, Twin Cities Field Office, Bloomington, Minnesota; U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.

Ecological Specialists, Inc. January 2001. Zebra Mussel Monitoring in the Inland Waterways: Synthesis of Current Research and Recommendations for the Development of Population Dynamics Models. St. Peters, Missouri.

Farr, M.D., A.C. Miller, and B.S Payne. Draft – 2002. Ecological aspects of native and non-native bivalves at selected sites in the Upper Mississippi River, 2001 Studies. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Farr, M.D., A.C. Miller, and B.S Payne. Draft – 2003. Ecological aspects of native and non-native bivalves at selected sites in the Upper Mississippi River, 2002 Studies. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Farr, M.D., A.C. Miller, and B.S Payne. 2005. Ecological aspects of native and non-native bivalves at selected sites in the Upper Mississippi River, 2003 Studies. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Farr, M.D., A.C. Miller, and B.S Payne. 2005. Ecological aspects of native and non-native bivalves at selected sites in the Upper Mississippi River, 2004 Studies. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Farr, M.D. and V.E. Alley. 2003. Distribution and Abundance of Zebra Mussel Veligers in the Upper Mississippi River and its Major Tributaries, 2002. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Farr, M.D. and V.E. Alley. March 2004. Distribution and Abundance of Zebra Mussel Veligers in the Upper Mississippi River and its Major Tributaries, 2003. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Farr, M.D. and M. Antwine . 2005. Distribution and Abundance of Zebra Mussel Veligers in the Upper Mississippi River and its Major Tributaries, 2004. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Farr, M.D., V.E. Alley, and N.M. McVay. Draft March 2004. Distinguishing between live and recently dead zebra mussel veligers associated with the Chicago Sanitary and Ship Canal electrical barrier, 2003. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Gordon, R. 2001. Zebra mussel (Dreissena polymorpha) control protocol associated with culture of freshwater mussels. U.S. Fish and Wildlife Service. Genoa National Fish Hatchery, Genoa, WI.

Gordon, R. 2001. Operational procedures and techniques for the artificial infestation of Lampsilis higginsi. U.S. Fish and Wildlife Service. Genoa National Fish Hatchery, Genoa, WI.

Gordon, R. 2001. Lampsilis higginsi recovery project Genoa National Fish Hatchery, 2001. U.S. Fish and Wildlife Service. Genoa National Fish Hatchery, Genoa, WI. Prepared for U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.

Gordon, R. 2002. Lampsilis higginsi recovery project Genoa National Fish Hatchery, 2002. U.S. Fish and Wildlife Service. Genoa National Fish Hatchery, Genoa, WI. Prepared for U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.

Gordon, R. and T. Brady. 2003. Lampsilis higginsi recovery project Genoa National Fish Hatchery, 2003. U.S. Fish and Wildlife Service. Genoa National Fish Hatchery, Genoa, WI. Prepared for U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.

Gordon, R. and T. Brady. 2004. Lampsilis higginsi recovery project Genoa National Fish Hatchery, 2004. U.S. Fish and Wildlife Service. Genoa National Fish Hatchery, Genoa, WI. Prepared for U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.

Gritters, S. 2001. Letter Report on Iowa River Inoculations in 2001. Iowa Department of Natural Resources, Guttenberg, Iowa.

Heath, D.J. December 2001. Letter Report on May 2001 collection of Lampsilis higginsii from the St. Croix R., Minnesota for use as brood stock for mussel propagation at the Genoa National Fish Hatchery. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Heath, D.J. January 2001. Letter Report on placement of juveniles of Lampsilis higginsii into the lower Black River, Jackson County, Wisconsin. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Heath, D.J. 2001. Report on placement of L. higginsi inoculated fish in cages and free-ranging fish, lower Wisconsin R., 2001. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Heath, D.J. January 2002. Progress report on: Mussel surveys to identify potential relocation sites for the Endangered Higgins' eye pearlymussel (Lampsilis higginsii) Black and Chippewa Rivers, Wisconsin. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Heath, D.J. 2003. Results of 2002 Monitoring of Freshwater Mussel Communities of the Wisconsin River near Orion, Richland County, Wisconsin. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Heath, D.J. 2003. Report on July 2002 monitoring of Lampsilis higginsii placed in cages in the Wisconsin River near Orion in 2001. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Heath, D.J. 2003. Report on May 2002 collection of Lampsilis higginsi from the St. Croix R., Minnesota for use as brood stock for mussel propagation at the Genoa National Fish Hatchery. Wisconsin Department of Natural Resources, Minnesota Department of Natural Resources and the U. S. Fish and Wildlife Service.

Heath, D.J. 2003. Report on 2002 Lampsilis higginsii Brood Stock Collection and Stockpiling in the Wisconsin River near Prairie du Sac, Wisconsin. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Heath, D.J. 2003. Report on May 2002 collection of Lampsilis higginsi from the Mississippi R. near Cassville, Wisconsin for use as brood stock for mussel propagation at the Genoa National Fish Hatchery. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Heath, D.J. 2004. Report on April 2003 collection of Lampsilis higginsii from the St. Croix R., Minnesota for use as brood stock for mussel propagation at the Genoa National Fish Hatchery. Wisconsin Department of Natural Resources, Minnesota Department of Natural Resources and the U. S. Fish and Wildlife Service.

Heath, D.J. 2004. Report on March 2003 collection of Lampsilis higginsii from the Mississippi River, near Cassville, Wisconsin for use as brood stock for mussel propagation at the Genoa National Fish Hatchery. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Heath, D.J. 2004. Report on 2003 Monitoring of the Lampsilis higginsii Relocation Site on the Wisconsin River near Prairie du Sac, Wisconsin. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Heath, D.J., R. Benjamin, and M. Endris. 2001. Results of Monitoring of Freshwater Mussel Communities of the Saint Croix National Scenic Riverway, Minnesota and Wisconsin. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Heath, D.J., R. Benjamin, K. Von Ruden, and J. Janvrin. Draft March 2004. A survey of Freshwater Mussel Aggregations on the Lower Black River, Wisconsin. Wisconsin Department of Natural Resources, La Crosse, Wisconsin. 25 pp and appendices.

Heath, D.J., R. Benjamin, K. Von Ruden, and J. Janvrin. 2004. A survey of Freshwater Mussel Aggregations on the Lower Chippewa River, Wisconsin. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Hove, M. 2004. Recovery information needed to prevent extinction of the federally endangered winged mapleleaf: early life history of select upper Mississippi River mussels. Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota, Saint Paul, Minnesota

Howard, C.S. and H.L. Dunn. 2003. Final Report, Qualitative Surveys of Unionid Mussels and Associated Habitat in Four Mississippi River Tributaries of Iowa to Identify Potential Relocation Areas for the Endangered Higgins' Eye Pearly Mussel (Lampsilis higginsii). Harding ESE, Inc. St. Louis, MO and Ecological Specialists, Inc., O'Fallon, MO. Prepared for U.S. Army Corps of Engineers, Rock Island District, Rock Island, Illinois

Kelner, D.E. and M. Davis. 2002. Final Report: Mussel (Bivalvia: Unionidae) survey of the Mississippi National River and Recreation Area Corridor, 2000-01. Minnesota Department of Natural Resources, Ecological Services Division, St. Paul, Minnesota.

Kelner, D.E. and S. Gritters. 2003. Report of 2003 collecting and stockpiling of adult Lampsilis higginsii from the Mississippi River in pool 10 near Harpers Ferry, Iowa. U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota and Iowa Department of Natural Resources, Guttenberg, Iowa.

Kelner, D.E. 2005. Report of 2004 collecting and stockpiling of adult Lampsilis higginsii from the Mississippi River in Pool 14 near Cordova, Illinois and in Pool 11 near Cassville, Wisconsin. U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.

Kelner, D.E. Draft- February 2004. Phase 1 - Higgins' eye relocation site monitoring plan for Biological Opinion for the endangered Higgins' eye pearlymussel (Lampsilis higginsii) Upper Mississippi River and tributaries, Minnesota, Wisconsin, Iowa, Illinois, and Missouri. U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.

Kelner, D.E., M. Davis, G. Wege. 2004. Report of 2003 relocation of sub-adult Lampsilis higginsii reared in cages from the Mississippi and St. Croix rivers. U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota; Minnesota Department of Natural Resources, Ecological Services Division, St. Paul, Minnesota; and U.S. Fish and Wildlife Service, Twin Cities Field Office, Bloomington, Minnesota.

Lance, R.F. and E. P. Perkins, Ph.D. January 2002. Population Genetic Diversity within Lampsilis higginsi as Determined by Amplified Fragment Length Polymorphisms. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Lee, J., H. Dunn, and W.J. Elzinga. December 2003. Draft Report: Qualitative surveys of unionids and associated habitats within the Rock, Illinois, and Kankakee Rivers, Illinois to identify potential relocation areas for the endangered Higgins' eye pearly mussel (Lampsilis higginsii). MACTEC, Inc. St. Louis, Missouri and Ecological Specialists, Inc., O'Fallon, MO. Prepared for U.S. Army Corps of Engineers, Rock Island District, Rock Island, Illinois.

Miller, A.C., B.S. Payne and J. Miller. February 2001. A preliminary Evaluation of Possible Strategies to Reduce or Eliminate Zebra Mussels, and their Associated Impacts to Lampsilis higginsii, from the Upper Mississippi River Navigation System. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Miller, A.C. and B.S. Payne. Draft March 2001. Effects of Zebra Mussels (Dreissena polmorpha) at Essential Habitat Areas for Lampsilis higginsii in the Upper Mississippi River System, 2000. Technical Report EL-200- , U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Minnesota Department of Natural Resources. February 2002. Final Report: Mussel (Bivalvia: Unionidae) Surveys 2001: Lower St. Croix River from Stillwater, Minnesota (RM 23.7) to Prescott, Wisconsin (RM 1.7), Mississippi River Pool 7, Mississippi River Lock and Dame 3 tailwaters mussel bed mapping, and Higgins' eye gravid female collection. Minnesota Department of Natural Resources, Ecological Services Division, St. Paul, Minnesota.

Mussel Coordination Team. March 2001. Draft Higgins' eye Pearlymussel Conservation Plan. U.S. Fish and Wildlife Service, Twin Cities Field Office, Bloomington, Minnesota and U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.

Mussel Coordination Team. 2002. Report of 2001 Mussel Coordination Team Activities, Endangered Species Permit TE 023308-1. U.S. Fish and Wildlife Service, Twin Cities Field Office, Bloomington, Minnesota and U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.

Mussel Coordination Team. 2003. Saving the Higgins' Eye Pearlymussel (Lampsilis higginsii) from Extinction: 2002 Status Report on the Accomplishments of the Mussel Coordination Team. U.S. Fish and Wildlife Service, Twin Cities Field Office, Bloomington, Minnesota and U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.

Mussel Coordination Team. Long-term monitoring protocol for native mussels, including the endangered Higgins eye (Lampsilis higginsii), Upper Mississippi River and tributaries; Minnesota, Wisconsin, Iowa, Illinois, and Missouri. U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota, U.S. Army Corps of Engineers, St. Paul District, and U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

National Park Service. 2004. Annual Report: Quantitative Assessment of Zebra Mussels (Dreissena polymorpha, Pallas, 1771) in the Lower St. Croix River at Native Mussels Beds. National Park Service, St. Croix National Scenic Riverway, St. Croix Falls, WI.

Pritchard, J. 2001. An Historical Analysis of Mussel Propagation and Culture: Research Performed at the Fairport Biological Station. Clear Creek Research Center, Ames, Iowa. Prepared for U.S. Army Corps of Engineers, Rock Island District, Rock Island, Illinois. 151 pp.

Sallee, D. 2003. Mussel surveys to identify potential relocation sites for the endangered Higgins eye (Lampsilis higginsii) on the Rock River, Illinois. Illinois Department of Natural Resources, Sterling, Illinois.

Sallee, D. and B. Schanzle. 2004. Report on 2004 propagation efforts of Lampsilis higginsii (inoculated fish in closed bottoms cages) in pool 12 of Upper Mississippi River. Illinois Department of Natural Resources, Sterling, Illinois.

St. Paul District, U.S. Army Corps of Engineers. August 2000. Letter Report - Determination of Federal Interest in Conducting a Reconnaissance Study of Measures for Controlling Zebra Mussels in the 9-Foot Navigation Channel of the Upper Mississippi River. U.S. Army Corps of Engineers, St. Paul, Minnesota.

St. Paul District, U.S. Army Corps of Engineers. August 2003. Final Reconnaissance Study. Mississippi River Between the Missouri River and Minneapolis, 9-Foot Channel Project Measures to Manage Zebra Mussels. U.S. Army Corps of Engineers, St. Paul, Minnesota.

St. Paul District, U.S. Army Corps of Engineers. July 2002. Final Definite Project Report and Environmental Assessment for Relocation Plan for the Endangered Higgins' Eye Pearlymussel (Lampsilis higginsii) Upper Mississippi River and Tributaries; Minnesota, Wisconsin, Iowa, and Illinois. U.S. Army Corps of Engineers, St. Paul District, in cooperation with the interagency Mussel Coordination Team.

Stefanik, E.L. 2004. Summary of Zebra Mussel Monitoring Efforts For the Upper Mississippi River, 2000 through 2003. U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.

Steingrabber, M. 2004. Laboratory Study Jump-Starts Winged Mapleleaf Recovery Efforts. LaCrosse Fisheries Resource Office, U.S. Fish and Wildlife Service, Onalaska, Wisconsin.

Stengraeber, M., M. Bartsch, J. Kalas, and T. Newton. April 2005. Winged Mapleleaf Mussel Early Life History Investigations Conducted by the U.S. Department of the Interior in FY 2004. U.S. Fish and Wildlife Service, Fishery Resources Office, Onalaska, WI and U.S. Geological Survey, Upper Midwest Environmental Science Center, La Crosse, WI. 14 pages plus figures.

Stoekel, J. 2002. Evaluation of Zebra Mussel Veliger Abundances in the Upper Mississippi River, 2001. Illinois River Biological Station, Illinois Natural History Survey, Havana, Illinois.

U.S. Fish and Wildlife Service. June 2002. Propagation and Restoration of Higgins' Eye Pearlymussels in the Upper Mississippi River Basin – Partnership Efforts and Achievements in 2000-2001, Fish and Wildlife Service, La Crosse Fishery Resource Office, Onalaska, Wisconsin.

Wege, G., D. Anderson, E. Stefanik, and D. Sallee. 2002. Report of 2002 collecting and stockpiling of adult Lampsilis higginsii from the Mississippi River in pool 14 near Cordova, Illinois. U.S. Fish and Wildlife Service, Twin Cities Field Office, Bloomington, Minnesota; U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota; and Illinois Department of Natural Resources, Sterling, Illinois.

Welke, K., T. Turner, R. Gordon, V. Hyde, and P. Thiel. 2000. Propagation of the Federally Endangered Higgins' Eye Pearlymussel (Lampsilis higginsii) at the Genoa National Fish Hatchery as a Survival Strategy. Interim Report. October 25, 2000. 5 pp.

Wisconsin Department of Natural Resources. 2004. Report on 2004 Placement of Cages Containing Lampsilis higginsii in the Wisconsin River near Orion. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Wisconsin Department of Natural Resources. 2004. Results of 2004 Monitoring of Freshwater Mussel Communities of the Saint Croix National Scenic Riverway, Minnesota and Wisconsin. By Wisconsin Department of Natural Resources, U. S. National Park Service and U. S. Fish and Wildlife Service. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.

Wisconsin Department of Natural Resources. 2005. Report on 2004 Monitoring of Lampsilis higginsii Released into the Wisconsin River near Orion and Prairie du Sac, Wisconsin. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.