U.S. Fish & Wildlife Service

Saving the Higgins' Eye Pearlymussel

Propagation at Genoa National Fish Hatchery
May 2001

Background

The Higgins' eye pearlymussel is native to the Mississippi River and some of its northern tributaries. It is usually found in areas of swift current and buries itself in mud-gravel bottoms in water up to 15 feet deep with only the edge of its shell and its feeding siphons exposed. Higgins' eyes measure 3 to 4 inches and have thick, round, olive-brown shells with dark rings.

The Higgins' eye was listed as endangered under the federal Endangered Species Act in 1976. Under the Act, an endangered species is one likely to become extinct in the foreseeable future. At the time the Higgins' eye was listed, major threats included its diminished range and numbers, and loss and degradation of habitat. In recent years, a more immediate threat is the presence of the non-native zebra mussel.

The exotic zebra mussel attaches to any hard surface and is so prolific that it smothers native mussels like the Higgins' eye.

The Zebra Mussel Threat

Zebra mussels are small mussels native to Eastern Europe and Asia. They are believed to have arrived in the United States in the ballast of ocean-going vessels which emptied their tanks in Great Lakes ports. Zebra mussels were discovered in Lake St. Clair (between Lake Huron and Lake Erie) in 1988; since then, these prolific mussels have spread to most major river systems in the Midwest, as well as all the Great Lakes. They move from one area to another by attaching to boats and barges. Zebra mussels established themselves in the Upper Mississippi River by 1992 and have continued to spread.

The increase in zebra mussel populations has been matched by a decline among many native mussels. Zebra mussels compete with native species for oxygen and food, and are so prolific that they can virtually smother native mussel beds. One section of the Upper Mississippi River once supported one of the upper river's most diverse and dense mussel beds, with more than 30 species reported in 1996. By 1999, only seven species were reported, no Higgins' eyes were found, and the native mussel bed was covered by a carpet of zebra mussels several inches thick.

One contributing factor to the spread of zebra mussels in the Upper Mississippi River is the operation of the navigation system of locks and dams on the river to facilitate barge traffic and other river users. In an Endangered Species Act consultation with the Corps of Engineers on the navigation system, the Service determined that operation of the system would jeopardize the existence of the Higgins' eye pearlymussel. As a result of that consultation, the Service and Corps agreed to measures that would lessen the impacts on the Higgins' eye. Measures included relocation and propagation of mussels threatened by the presence of zebra mussels.

The Propagation Project

Higgins' eye populations are in immediate danger of being

eliminated in the Upper Mississippi River. If that occurs, the only remaining Higgins' eyes will be found in small populations in the St. Croix and Wisconsin Rivers. One of the strategies to save the species is the propagation of the Higgins' eye at Genoa National Fish Hatchery. The project is a partnership effort among the Service and the states of Minnesota and Wisconsin.

As with other freshwater mussels, Higgins' eye pearlymussels need host fish in order to complete their life cycles. Tiny larval mussels, released by the female, must attach to the gills of a host fish, where the microscopic larvae – called glochidia – spend several weeks before dropping to the streambed. Mussels use different species of host fish; Higgins' eyes are thought to use sauger, freshwater drum, largemouth bass, smallmouth bass and walleye.

The propagation process for Higgins' eye begins in the spring with the collection of adult females from the St. Croix River. Divers trained to identify female Higgins' eye pearlymussels collect about 15 gravid females, or those that contain glochidia within them. The adult mussels are taken to Genoa National Fish Hatchery, where hatchery workers carefully remove the glochidia using a syringe. The microscopic glochidia are then placed with host fish in a bucket where the glochidia attach to the host's gills. The infected fish are then placed in aquariums or raceways.

After 2 or 3 weeks, some of the infected fish are taken to sites in suitable habitat where they are either released directly into the river, or held in underwater cages over suitable mussel habitat. Fish remaining in the hatchery are checked periodically, and hatchery staff collect glochidia once they have matured enough to leave the host fish. These juvenile mussels remain at the hatchery until mid-summer when many are released into areas where zebra mussels are not a threat.

The propagation project began in 2000, using funding from a grant from the National Fish and Wildlife Foundation. Work is done at Genoa National Fish Hatchery in Genoa, Wisconsin, in a specially constructed facility known as the "Clam Palace." In 2000, workers released 3,750 juvenile Higgins' eye pearlymussels in the Wisconsin River, and placed another 1,100 juveniles in special screened trays in the river to be monitored periodically.

National Fish Hatcheries and Endangered Species

Genoa is one of 69 fish hatcheries in the National Fish Hatchery System, administered by the U.S. Fish and Wildlife Service. The system also includes seven fish technology centers, and nine fish health centers. Hatcheries and technical centers are working with 44 aquatic species federally listed as endangered or threatened. Among them are fish, five species of freshwater mussels, as well as toads, salamanders, and horseshoe crabs. These facilities play an important role in conservation and recovery through the development of state-of-the-art captive propagation techniques and by providing genetic refugia for listed species.

U.S. Fish & Wildlife Service
1 Federal Drive
Fort Snelling, Minnesota 55111
612/713-5350
http://midwest.fws.gov/endangered

Genoa National Fish Hatchery and Freshwater Mussels

Mississippi River Note 2

There are lots of places in the Upper Mississippi where fish can breed and grow, but the Genoa National Fish Hatchery south of Genoa, Wisconsin, offers a controlled environment for fish research and production. This 200-plus-acre federal facility raises everything from bluegills in ponds to Great Lake sturgeons in indoor tanks. In 1995, Genoa became the first federal hatchery where researchers attempted moving native mussels out of zebra mussel-infested waters.

The hatchery, which is bisected by Highway 35, is a series of ponds laid out along the final mile of the Bad Axe River before it empties into the Mississippi. It was established in 1932, on former farmland, and began producing fingerling bass and bluegills in 1934. The hatchery provides eggs and fry (young fish) free to state and federal stocking projects.

Collecting Eggs

Genoa is one of only three federal facilities that collects eggs from wild walleye and sauger. Early each spring, hatchery workers gather eggs and milt (sperm) from fish that spend their entire lives in the river. After netting a fish, workers stun it with a small electric shock. Walleye eggs and milt can be stripped (gently squeezed out) on the boat, then someone from the Wisconsin Department of Natural Resources (DNR) weighs and records data before adult fish are returned to the river.

Northern pike, sometimes called "slimers," are harder to handle because of a thick layer of slime on their skin, a mouth full of sharp teeth and an aggressive nature. Northerns are held at the hatchery for an average of three to four days, until the time is right to gather their eggs and milt. They are then returned to the river.

Specially designed jars hold the fertilized eggs while flowing wellwater keeps the eggs loose and free of algae. After 11 to 21 days, the fry hatch and wash into long tanks where they absorb their yolk sacs. Then they're moved to ponds until they're one-and-a-half to six inches long. Ten percent of the hatched fish are returned to the area where the eggs were collected.

Most of the walleyes hatched at Genoa are used to stock tribal waters, although occasionally some go to wildlife refuges. Northern pike fry and eggs usually go to states for stocking areas disturbed by Army Corps of Engineers projects.

Protecting Threatened Fish

The Genoa hatchery has evolved from simply raising sport fish to protecting threatened fish and helping with environmental management projects. Managers at Horicon Refuge in central Wisconsin hope northern pikes from Genoa will stop a growing carp population.

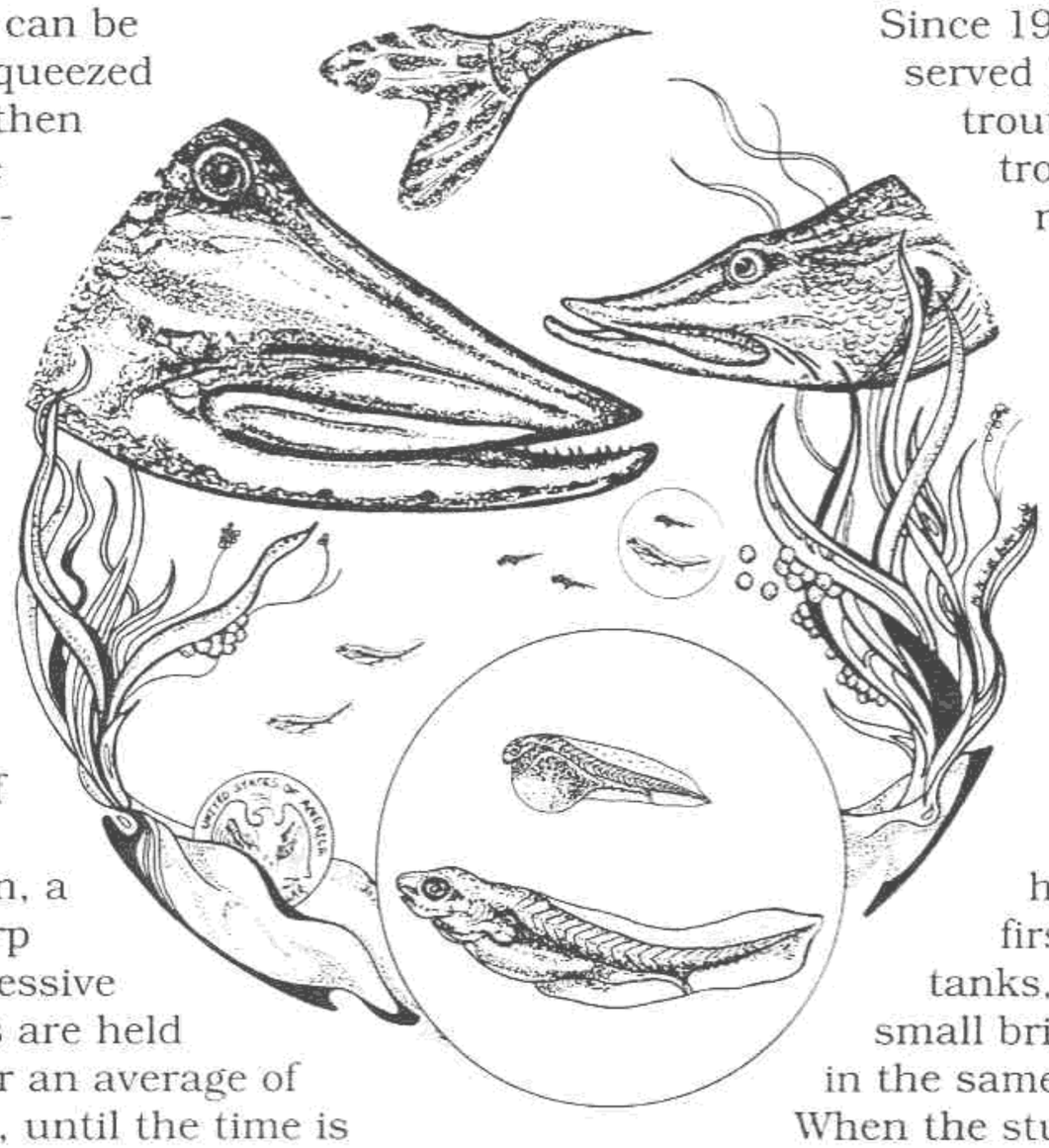
Fisheries managers use the hatchery to maintain brood stocks of fish threatened by disease and pollution. Fish are held in isolation for about two years and inspected for disease three times, before the hatchery can ship their eggs and fry.

Since 1996, Genoa has preserved brood stocks of lake trout and coastal brook trout. These fish are native to the Great Lakes, where disease makes it impossible to safely gather uncontaminated eggs.

The hatchery has raised about 6,000 lake sturgeons each year since 1994.

Sturgeons will not eat pelleted food like most other hatchery fish. When first hatched in indoor tanks, sturgeons eat small brine shrimp hatched in the same tanks.

When the sturgeons get bigger they're fed zooplankton seined from the hatchery's ponds. Eventually, they eat



The illustration at left shows five stages of northern pike development: eggs clinging to the underside of vegetation; newly hatched fry retaining yolk sacs; older larvae that have nearly used up their yolk supply; an immature pike; and an adult.

Northern pike eggs are about 3.4 mm long, slightly more than one eighth the diameter of a quarter (diagrammed in the lower left corner). The remaining stages of pike are also shown to scale.

Illustration by Mi Ae Lipe-Butterbrodt.

adult brine shrimp from another facility.

Genoa is helping to reintroduce sturgeons to the Wolf River. Two dams built near Shawano, Wisconsin, in the early 1900s cut off the sturgeons from the headwaters, effectively eliminating them in the area that is now the Menominee Reservation.

Protecting Native Mussels

In 1995, the Genoa hatchery began research to help save the Upper Mississippi's native mussels from being destroyed by invasive zebra mussels.

Zebra mussels, native to Europe, probably arrived in the Great Lakes in the ballast water of trans-Atlantic ships. The zebras spread to the Mississippi through the human-created canals and rivers that connect the river with Lake Michigan.

Zebra mussels cripple native mussels by attaching to their shells, and compete for food and oxygen.

Researchers from the Upper Mississippi Resource Conservation Committee (UMRCC) collected several species of native mussels from an infested spot in the river, scrubbed them clean of visible zebras, then quarantined them for 35 days.

Mussels were placed in four kinds of structures, or treatments, and returned to the river (the control set) or put into a quarter-acre pond at the hatchery.

The first test treatment, called "shoe-bag" structures, are nylon mesh bags with an individual pocket for each mussel. They were placed upright about an inch above the bottom. The second and third treatments used metal trays filled with dredge material. The mussels were placed inside, and the trays were either buried or suspended a few feet above the bottom. The final treatment used a metal barrier, or corral, on the bottom to prevent the mussels from wandering away.

The experiment had four goals: (1) develop a method to move healthy native mussels without transporting zebra mussels; (2) compare growth and survival of mussels in artificial ponds and in the river; (3) determine whether some species survive and grow better after moving; and (4) decide which treatment gives the best survival and growth rates.

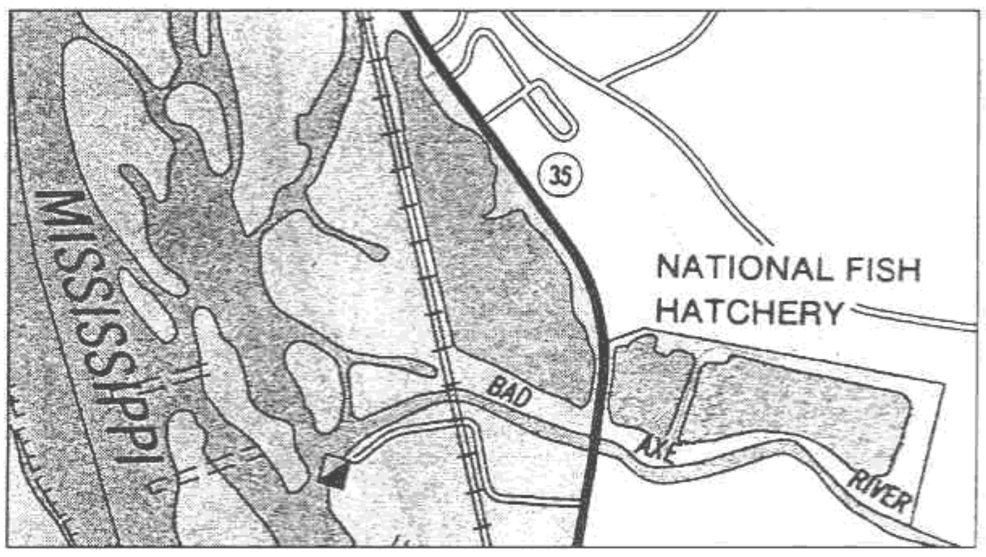
Results suggest that mussels such as the mapleleaf (*Quadrula quadrula*), pigtoe (*Fusconaia flava*) and threeridge (*Amblema plicata*) can be moved with some success. Others, such as the fragile papershell (*Leptodea fragilis*) and threehorned wartyback (*Obliquaria reflexa*), cannot. Of the four treatments, mussels in the suspended trays seemed to grow best.

Finally, the pond environment at the hatchery appears less productive than the river. Future research will study how best to feed mussels in artificial environments.

While the project did not create an ideal home for native mussels, it succeeded in several ways.

"We showed that it is possible to move natives without transplanting zebras," says Kurt Welke, fisheries biologist for the Wisconsin DNR. "And we developed a set of protocols — or handling procedures — that will make it possible for us to move mussels in the event that somebody decides we need to in order to save them."

Projects at other national hatcheries, which began after the Genoa project broke the ice, have pushed the research further, and have even hatched new mussels in artificial environments.



Things to Do & See

Tours

The Genoa National Fish Hatchery does not currently have a visitor's center, but can accommodate group tours arranged in advance. For information contact Todd Turner, hatchery manager, at (608) 689-2605.

River Aquarium

You can see some native fish and a display of native mussel shells at the Iowa State Aquarium located in Guttenberg, Iowa. The Aquarium is usually open for visitors from May to October. Call (319) 252-1156 to check the hours.

Fisheries Schools

According to Todd Turner, the University of Wisconsin-Stevens Point offers one of the finest schools for fisheries biology. Bemidji (Minn.) State University and the University of Arkansas-Pine Bluff also offer fisheries programs.

For Your Information

An excellent handout describing the life cycle of mussels is available from the James Ford Bell Museum of Natural History at the University of Minnesota. Write to the James Ford Bell Museum, 10 Church Street SE, Minneapolis, MN 55455.

While not specific to the Upper Mississippi, the Virginia Polytechnic Institute and State University offers a poster of America's Pearly Mussels. You can order a copy for $5.00, plus $2.50 shipping and handling from Extension Distribution Center, 112 Landsdowne Street, Blacksburg, VA 24061-0512. Checks should be made out to "Treasurer, Virginia Tech."

Todd Turner, manager of the Genoa Fish Hatchery, provided information about hatchery history and practices.

Kurt Welke, biologist for the Wisconsin DNR in Prairie du Chien, Wis., and Rhonda Kenyon, of the La Crosse, Wis., office of the DNR provided information about the mussel relocation project.

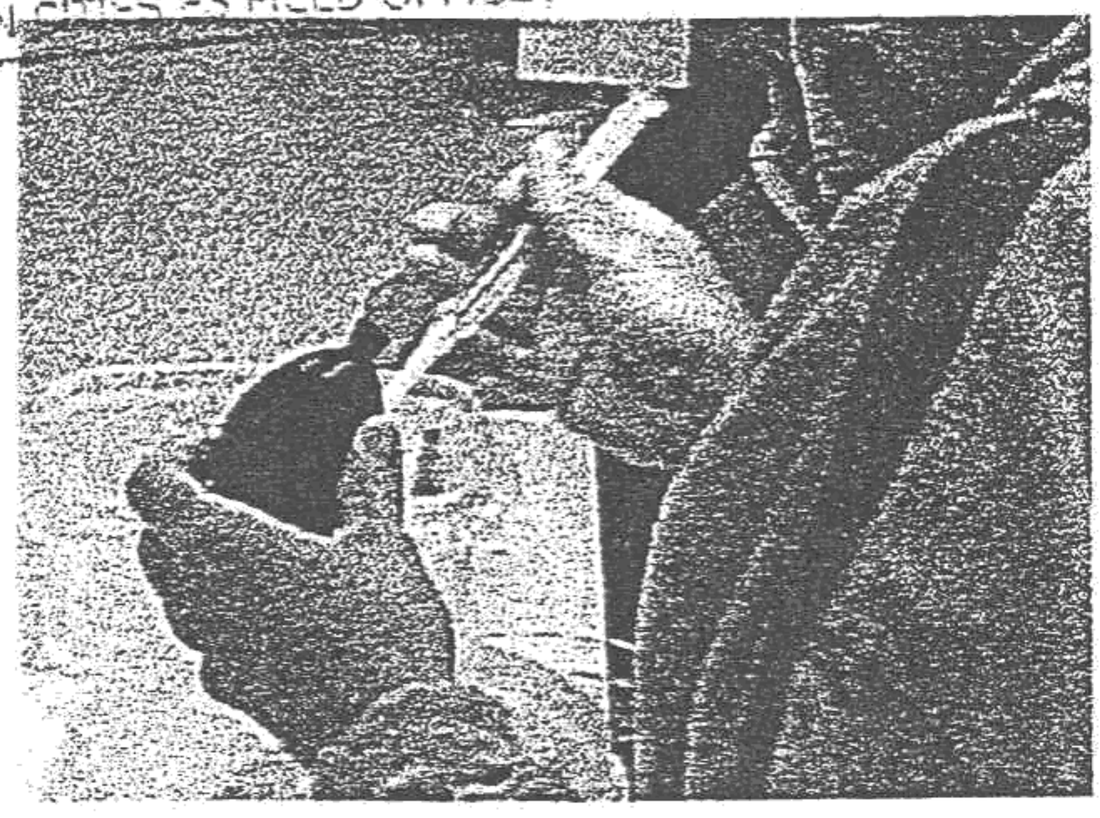
This and other River Notes are available on the Big River World Wide Web site (www.big-river.com) or from the Minnesota-Wisconsin Boundary Area Commission, 619 Second St., Hudson, WI 54016-1576; (612) 436-7131 or (715) 386-9444.

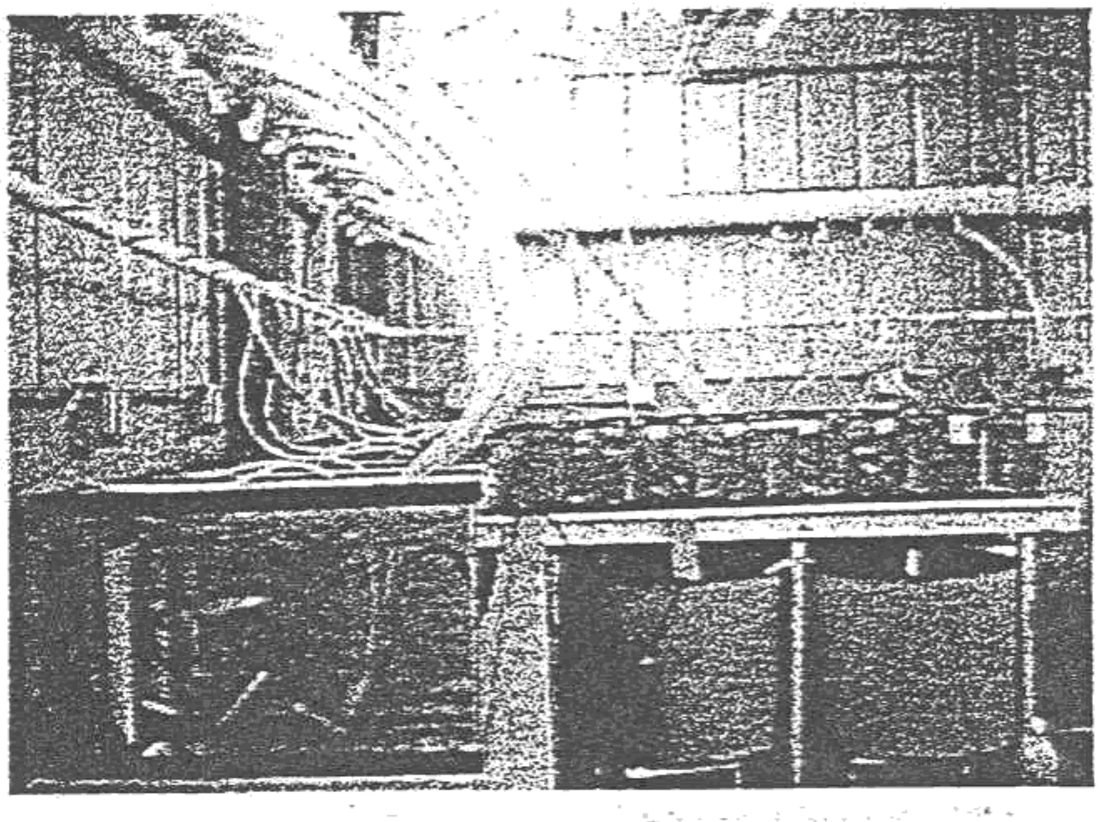
Mississippi River Notes are created by Riverwise, Inc. (P.O. Box 204, Winona, MN 55987) for the Minnesota-Wisconsin Boundary Area Commission, with support from the McKnight Foundation.

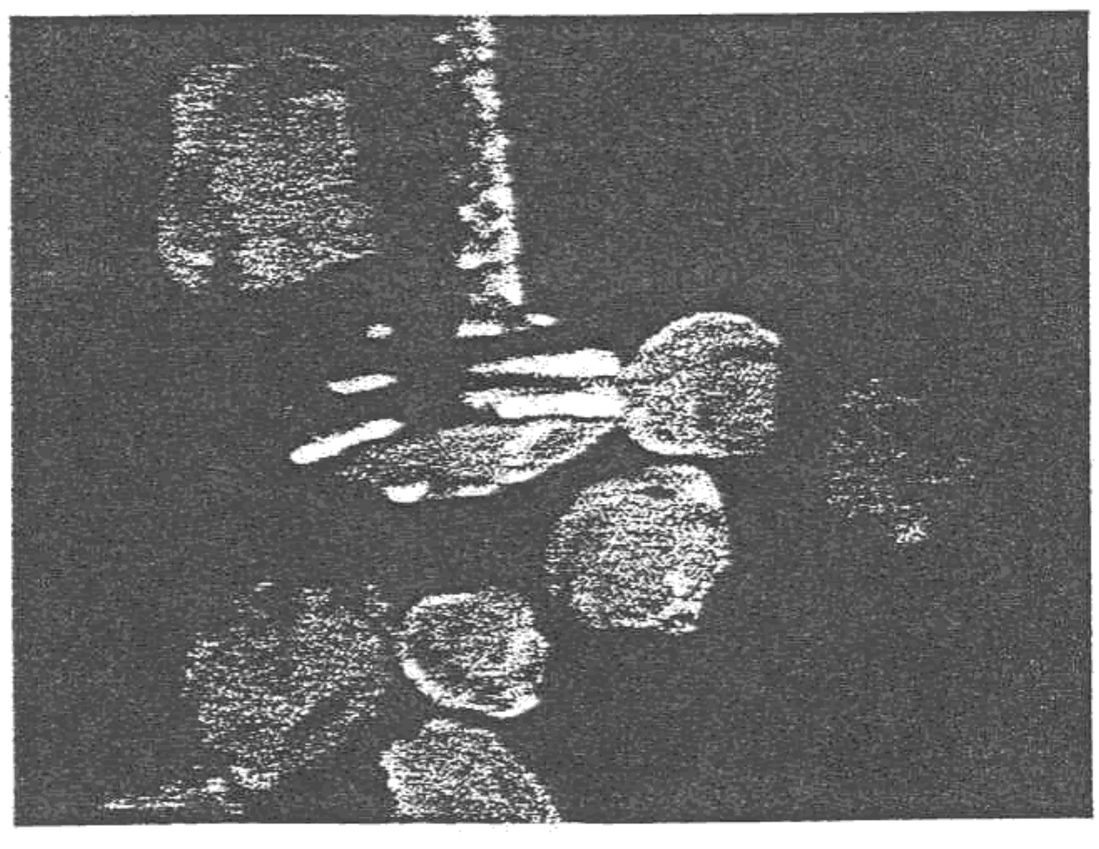
January 1998

Propagation of the Federally Endangered Higgins' Eye Pearlymussel (*Lampsilis higginsi*) at the Genoa National Fish Hatchery as a Survival Strategy

Interim Report
October 25, 2000







Kurt Welke
Wisconsin Department of Natural Resources

Todd Turner, Roger Gordon, Valerie Hyde, and Pam Thiel
U.S. Fish and Wildlife Service

INTRODUCTION

The Higgins' eye pearlymussel (*Lampsilis higginsi*) is endemic to the Mississippi River basin fauna (Becker 1928). Found in the gravel and sand of the main channel borders (Duncan 1981) of the Mississippi River and some of its northern tributaries (Cummings 1992), the Higgins' eye pearlymussel has a thick valve suitable for commercial exploitation. This occurred first as material for buttons (Becker 1928) and later as the nucleus of high quality cultured pearls (Lopinot 1967).

The Higgins' eye pearlymussel was placed on the Federal Endangered Species List in 1976, based primarily upon its relative scarcity in the Upper Mississippi River (UMR) and the diminished extent of its range. Today, zebra mussels (*Dreissena polymorpha*) exacerbate the original justification for that listing. Stress induced by zebra mussels weakens the physiological condition of vulnerable native mussel species, ultimately causing increased mortality and diminished recruitment of native mussels. Zebra mussel densities, infestation rates upon native unionids, and the areal extent of zebra mussel colonization are at peak levels of observation at many UMR locations.

Zebra mussels became established in the UMR in 1991-1992 and have continued to increase in numbers and extent. The physical habitat of some UMR mussel beds has experienced general deterioration (e.g., decreased dissolved oxygen, increased biological oxygen demand, and reduced or altered plankton communities) synchronous with zebra mussel proliferation. While zebra mussels have recently flourished, members of native unionid communities have suffered marked declines in density and diversity. The east channel of the UMR in navigation Pool 10 (near Prairie du Chein, Wisconsin) historically contained one of the most dense and diverse mussel beds in the UMR, with an abundance of Higgins' eye pearlymussels. Over 30 mussel species have been collected in this area. With equal sampling effort in 1996, 1998, and 1999, only 27, 20, and 7 species of native mussels were collected here, respectively. No Higgins' eye pearlymussels and no recruitment of any native mussel species were detected in the 1999 sampling, however, a carpet of zebra mussels several inches thick covered the mussel bed. Higgins' eye pearlymussel populations in the Mississippi River are at imminent danger of extirpation by zebra mussels. Should that occur, the gene pool would be fragmented and survival of the Higgins' eye pearlymussel would depend on two small, less-than-robust populations: one in the St. Croix River and the other in the Wisconsin River.

The documented declines experienced by UMR native mussel communities are attributed to the continuing population explosion of zebra mussels. Agencies actively monitoring adult and larval zebra mussel populations have found very high zebra mussel concentrations in navigation Pools 5-11, where Higgins' eye pearlymussels presently occur. Conversely, navigation Pools 1-4 are located upstream of Lake Pepin (part of the historical range of Higgins' eye pearlymussels) and have low densities of zebra mussels despite having been continuously inoculated with zebra mussel veligers. Furthermore, no zebra mussels have been reported in the Chippewa and Wisconsin Rivers, two large tributaries of the UMR. Recent investigations have established a

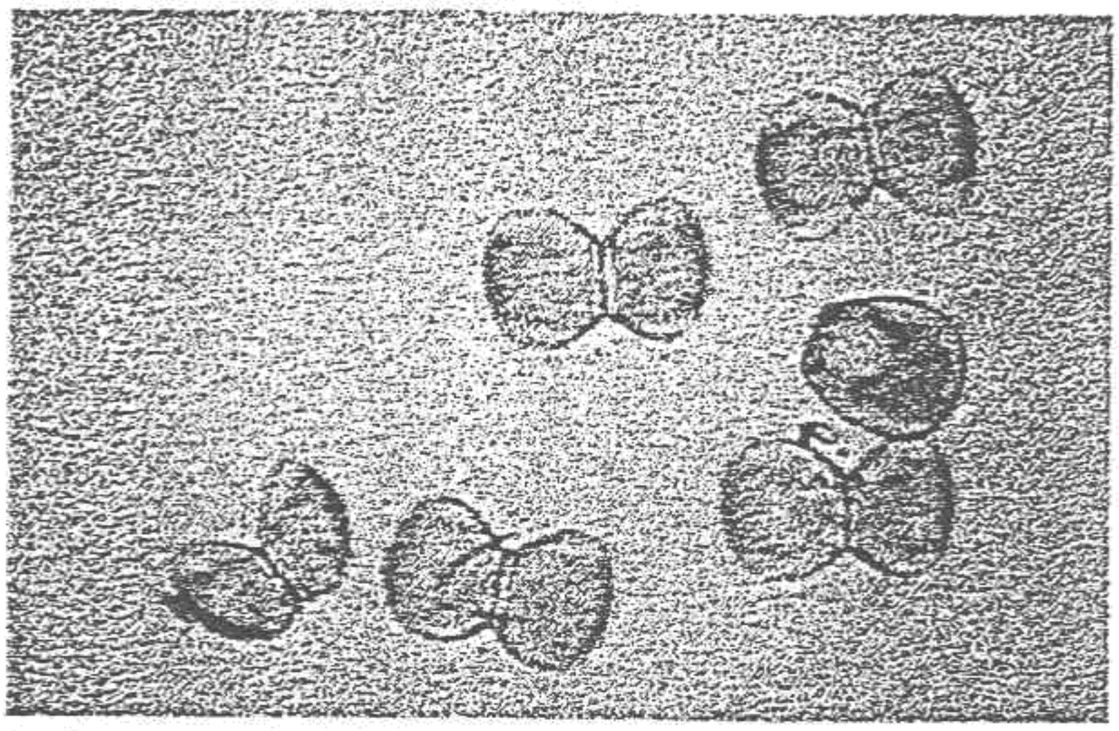
dependable and accurate compilation of native mussel community dynamics, as well as locations and characteristics of suitable habitats, and techniques for relocation of native mussels.

To salvage, protect, and enhance UMR populations of Higgins' eye pearlymussels, a suite of complimentary efforts are needed. The Genoa National Fish Hatchery (NFH) has a record of successful partnerships and was the first NFH to obtain U.S. Fish and Wildlife Service authorization to house native mussels. The mission and infrastructure of the Genoa NFH makes this facility a unique and logical site for holding and propagating Higgins' eye pearlymussels.

The purpose of this project is to prevent zebra mussel-induced extinction of the Higgins' eye pearlymussel through propagation at the Genoa NFH and the subsequent stocking into refugia habitats with no or low zebra mussel densities.

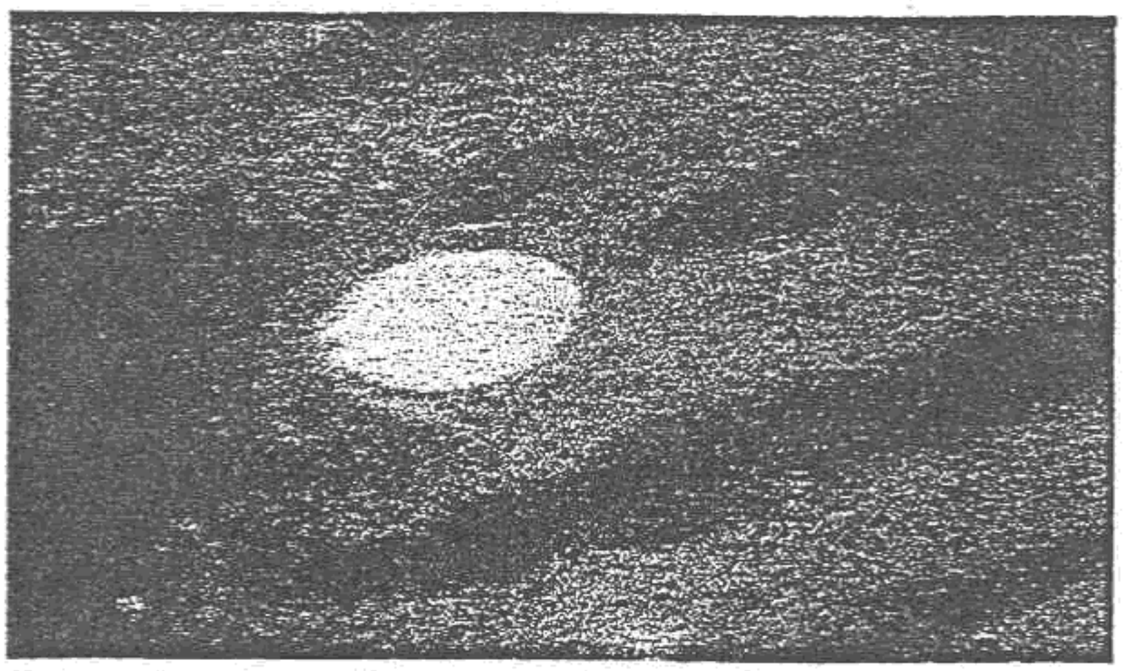
DEFINITIONS

Glochidia: Larval form flushed from the marsupial gill of the female mussel.



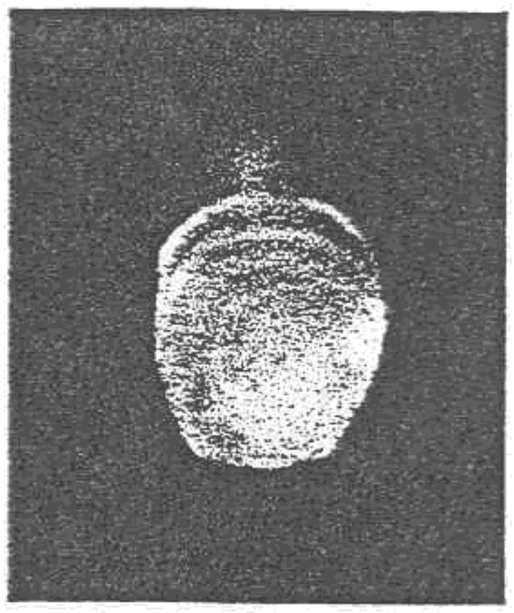
L. higginsi glochidia.

Encysted juvenile: Parasitic form encysted in fish tissue and undergoing organogenesis transformation.



L. higginsi juvenile encysted on a gill lamella.

Juvenile: Excysted form, having dropped from the host fish and actively pedal feeding with foot movement.



L. higginsi juvenile.

ACCOMPLISHMENTS

Fall 1999

- Obtained and reared walleye and largemouth bass for use as host fish.
- Initiated modification of hatchery building for mussel culture.

Winter 1999-2000

- Conducted a literature review on *Lampsilis higginsi* and methods of mussel propagation and relocation.
- Interviewed with and toured the facilities of (* = in person)
  Dr. Tom Watters, Ohio State University
  Scott O'Dee Ohio State University (*)
  Dr. Mark Hove, University of Minnesota (*)
  Dr. Jim Layzer, Tennessee Technical University (*)
  Dr. Dick Neves, Virginia Polytechnic Institute and State University (*)
  Dr. Teresa Newton, USGS Upper Midwest Environmental Science Center (*)
  Dr. Diane Waller, Western Wisconsin Technical College (*)
  Dr. Chris Barnhart, Southwestern Missouri State University
  Monte McGregor, Mike Pinder, Virginia Department of Game and Fisheries (*)
  Joe Ferraro Buller State Fish Hatchery, Virginia (*)
  Don Hubbs Tennessee Wildlife Resources Agency
- Applied for endangered species collection permits from state and federal agencies.

Spring 2000

- Obtained five gravid *Lampsilis higginsi* females from the St. Croix River for use in infecting host fish.
- Obtained two gravid *Lampsilis cardium* females from the St. Croix River for use as surrogates while establishing infection procedures.
- Infected 592 largemouth bass (LMB) yearlings at an average rate of 185 glochidia per fish and 752 walleye (WAE) yearlings at an average rate of 100 glochidia per fish on May 9-10. After infection, 482 LMB were placed in a 500-gal tank and 110 LMB were placed in 10-gal aquaria at a rate of 11 fish per aquarium. Similarly, 608 WAE were placed in a separate 500-gal tank and 144 WAE were placed in 10-gal aquaria at a rate of ten, eleven, or twenty fish per aquaria, depending on the fish size. Water temperature in the large flow-through tanks was that of the ambient pond water supply and while recirculated water supplied to the aquaria was heated to 20°C.
- Aquaria were quantitatively monitored, every other day, for premature sloughing of encysted juveniles and for the presence of transformed juveniles. The first transformed juveniles were collected from LMB in aquaria on May 31 (22 days post-infection). The first transformed juveniles were collected from WAE in aquaria on June 2 (24 days post-infection).
- On LMB hosts, 28% of the encysted juveniles were transformed into juveniles.

Spring 2000 (*continued*)

- Aquaria with WAE experienced a serious ectoparasite infection (Ichthyophthirius multifilis) that resulted in total fish mortality within 48 hours (May 31- June 1). In response, we excised the encysted gill tissues from dead WAE for continued incubation in a separate recirculating water system. This system consisted of a five-inch length of four- inch diameter polyvinyl chloride (PVC) pipe fitted at both ends with 150 μm Nytex® nylon screening and three air stones that were oriented inside the pipe to create a circular "surf" of highly oxygenated water in which many of the encysted juveniles were able to excyst from the gill tissue. Gill tissue was removed and separated into individual arches before placement in this system where they were held 48-60 hours in water heated to 21°C. Thirty nine percent of the WAE encysted juveniles (22-23 days post-infection) placed into this treatment were recovered as transformed juveniles. Overall, WAE hosts transformed 6% of the encysted juveniles into transformed juveniles.
- Some LMB also died from Ich infections. Recovery of transformers from LMB gill arches (22-27 days post-infection) placed in the circulating housings averaged 55%.
- The project employed three different holding/culturing treatments for transformed juveniles.
- Two lots of mussels (one lot hosted on WAE and one lot hosted on LMB) excysted directly from the host fish into the receiving treatment. These treatments consisted of standard hatchery flow-through fiberglass raceways measuring 15 ft long by 3 ft wide by 2 ft deep and lined with 3 to 5 inches of 1-3 mm diameter crushed rock.

Transformed juveniles which excysted from host fish held in aquariums were collected by siphoning aquarium floors. These mussels were placed into either:

A. Miniature raceways constructed from PVC rain gutters lined with 0.5-inch of 1-3 mm diameter crushed rock and measuring 10 ft long by 3 inches wide by 3 inches deep. Three gutters were embedded into the bottom of a standard hatchery raceway (see above). Two raceways were established in this manner for a total of six gutters.

B. Suspended filter baskets, constructed by fixing 150μm Nitex® nylon screening to the bottom of an 8-inch diameter PVC pipe. Each filter basket measured 6 inches deep and was submerged 4 inches below the water surface in the runway. Filter baskets were lined with 2 inches of 1-3 mm diameter crushed rock. Baskets were individually supplied with inflow from an obligate spigot.

All holding-culture treatments received pond surface water at a flow rate of approximately 10 cm/sec. All treatments accreted sediment that was suspended in the inflow.

Summer 2000

- Established a 300-gal algal culture tank to produce plankton for feeding juvenile mussels. All treatments received a daily ration of concentrated algal solution. Each raceway and miniature-raceway gutter treatment received a three gallon drip of algal solution which took approximately 0.5-hour to administer. Basket treatments were drained then filled with 2 L of algal solution per basket. Water flow into the baskets was resumed after one hour.
- Continued to monitor transformed juveniles; photographing and video taping their development.
- Identified potential refugia locations on the Wisconsin, Chippewa and Upper Mississippi Rivers.
- Released 3750 juveniles, which were approximately 250μm in diameter, into the Wisconsin River on July 10.
- Collected 30 adult mussels of 11 species from the Wisconsin River and maintained them in tanks to assess holding mortality.
- Placed 1100 juveniles, averaging 510μm in diameter, into four screened trays that were placed at three sites in the Wisconsin River on August 1. Growth and survival of these mussels will be monitored periodically beginning in spring 2001.

PRESS COVERAGE

- Fox News May 31, 2000
- La Crosse Tribune June, 2000
- Courier Press, Prairie du Chien, WI June 7, 2000
- Coulee News June 22, 2000
- Minnesota Public Radio July 14, 2000
- Wisconsin State Journal July 20, 2000
- Wisconsin State Journal July 23, 2000
- Upper Mississippi River Conservation Committee Newsletter July/August 2000
- Wisconsin Council of Sport Fishing Organizations "Newsline" July/August 2000
- La Crosse Tribune August 24, 2000
- Ellipsaria (Freshwater Mollusk Conservation Society newsletter) August, 2000
- Arcadia News-Leader August 2000

LITERATURE CITED

Becker F. C. 1928. The fresh water mollusca of Wisconsin. Bulletin of the University of Wisconsin, Madison, WI.

Duncan R. E. and P. A. Thiel 1983. A survey of the mussel densities in Pool 10 of the upper Mississippi River. Technical bulletin 139, Wisconsin Department of Natural Resources, Madison, WI.

Cummings K. S. and C. A. Mayer. 1992. Field guide to freshwater mussels of the midwest. Illinois Natural History Survey, Champaign, IL.

Lopinot, A. C. 1967. The Illinois mussel. Outdoor Illinios 6:8-15.