

Final
Restoration Plan and Environmental Assessment
for the
Hegeler Zinc Smelter Site and
Lyondell Chemical Company Bankruptcy
Hegeler, Illinois

August 29, 2012



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Fish and Wildlife Service
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**Restoration Plan and Environmental Assessment
Hegeler Zinc Smelter Site and Lyondell Chemical Company Bankruptcy**

1.0 Introduction

1.1 Purpose

The purpose of this assessment is to consider and evaluate various alternatives available to the action agency to help restore the natural resources that were injured as a result of exposure to hazardous substances released into Grape Creek and the Vermilion River. The hazardous substances included a variety of inorganic and organic compounds. These contaminants were released into the Grape Creek and the Vermilion River from a hazardous waste site located along Grape Creek in Hegeler, Illinois. Grape Creek flows into the Vermilion River a few miles downstream of the hazardous waste site. The hazardous waste site was used for a variety of activities over its long history including for a zinc smelter, mixing and distribution of pesticide chemicals.

The Comprehensive Environmental Compensation and Liability Act (CERCLA) (Title 42 United States Code Sections 9601 to 9675), the Clean Water Act (Title 33 United States Code Section 1251 *et seq.*), and the Natural Resource Damage Assessment and Restoration (NRDAR) regulations (Title 43 Code of Federal Regulations Part 11) are laws and rules that direct the restoration of natural resources that have been injured by such a release. According to the laws, government Trustees for natural resources ensure that the public is fairly compensated for these kinds of injuries to natural resources.

The Federal Natural Resource Trustee received a small damages payment for the environmental contamination from the hazardous waste site in Hegeler, Illinois as part of a bankruptcy settlement against Lyondell Chemical Company. Lyondell Chemical Company was a related company to one or some of the previous operators at the hazardous waste site.

The U.S. Fish and Wildlife Service is representing the Federal Trustee. The injured natural resources included creek and river surface water, aquatic sediments, and aquatic life including mussels, other invertebrates, fishes, and aquatic dependent wildlife such as migratory birds and endangered bats that depend on the aquatic life for food and drinking water. Future injury assessments may be used to determine the rehabilitation and replacement needs for the resulting environmental condition once the remediation of the hazardous waste site is completed and there are viable responsible parties available to support the restoration.

The Federal Trustee is now required to use the bankruptcy settlement money for a restoration action. The Trustee is obligated to develop and adopt a Restoration Plan before the restoration money can be used for a project, and that in doing so, there must be adequate public notice, opportunity for public comment, and consideration of available restoration alternatives. In addition, the Federal government must balance engineering and economic decisions with the environmental consequences of its actions according to the National Environmental Policy Act (NEPA). Therefore, this Restoration Plan was developed as an integrated Environmental Assessment under NEPA to facilitate public involvement and to be in compliance with agency environmental decision-making requirements.

1.2 Needs

There is the need to compensate the public for injuries from contamination to the natural resources due to the release of hazardous substances into Grape Creek and the Vermilion River. Furthermore, the Trustee is responsible for satisfying the requirements in the bankruptcy consent decree. The compensation is not intended to replace all past lost natural resources, because it was a small settlement amount and investigations continue to determine the cleanup of the hazardous waste site. The Trustee intends to use the available restoration funds in such a manner as to provide the maximum benefits as soon as possible. To accomplish this, the Trustee sought out partnership opportunities to leverage the settlement funds to be part of existing, appropriate, and larger scale restoration projects. Partnerships will also be needed to monitor and help protect the restored natural resources on into the future.

There is an active mussel restoration and monitoring project in the Vermilion River System by the Illinois Natural History Survey and the Illinois Department of Natural Resources. Mussels are a highly imperiled faunal group in North America (Williams *et al.* 1993). Mussels are declining at an alarming rate with up to 1.2% of the North American species becoming extinct every decade (Ricciardi and Rasmussen 1999). There is a variety of National and Regional plans that identify needs to help conserve native mussel species especially endangered and threatened species (Williams *et al.* 1993).

1.3 Background

Grape Creek flows through the hazardous waste site in Hegeler, Illinois before emptying into the Vermilion River. Heavy metals especially from the smelter slag piles along with pesticide chemicals from storage and mixing operations were released into Grape Creek. Contaminants in the surface water and in some circumstances the sediments of Grape Creek would have flowed into the Vermilion River. Grape Creek was listed as an impaired stream by the Illinois Environmental Protection Agency in accordance to Section 303(d) of the Clean Water Act due to in part by zinc contamination (ILEPA, 2004).

Grape Creek is a small stream that also flows through an urban area and reclaimed coal mine areas. Grape Creek has supports aquatic life including invertebrates and fishes. The Vermilion River supports aquatic life including invertebrates and fishes. The aquatic life in these systems provide food for wildlife.

Mussels also occur in Grape Creek and the Vermilion River (ILNHS, 2012). Mussels provide ecological services that benefit the public. They filter water and contribute to the biological diversity in river ecosystems. High biological diversity provides resilience that helps system rebound from natural and man-made impacts to rivers. Mussels help stabilize river substrates and mussels beds actually act as a substrate, colonized by a variety of other aquatic invertebrate species. These invertebrate species are attractive to bait fish and game fish that feed on the bait fish. The insects and fish are food for wildlife that dependent on aquatic habitats such as migratory birds and bats.

2.0 The Alternatives

The Trustee considered the various types of restoration alternatives that are defined in the NRDAR regulations (Title 43 Code of Federal Regulations Part 11.81) for developing the Restoration Plan. Restoration is defined as an action or group of actions taken to either: 1) rehabilitate the injured natural

resource if cleanup or remediation was sufficient to prevent future problems; 2) replace the injured natural resource by creating new resources or enhancing existing resources; or 3) acquisition of equivalent natural resources to those that were injured.

Two broad categories of restoration actions include in-kind and out-of-kind. In-kind means that the project focuses on the restoration of natural resources that are comparable to those that were lost. Out-of-kind means that the project focuses on restoration of natural resources that are different than those that were lost. Out-of-kind projects are usually considered if in-kind projects are not available or feasible.

The Trustees prefer to locate the restoration action in the vicinity or same system of the natural resource loss. However, it is often necessary to locate restoration actions further away, but as close as possible, based on the restoration opportunities available.

2.1 Alternatives Eliminated from Analysis

The Trustee did not consider the restoration alternative of on-site rehabilitation of Grape Creek or other affected habitats for the following reason. The on-site rehabilitation alternative was deemed risky because soil and sediment contamination exists or potentially exists in the environment and along Grape Creek and Vermilion River.

The contamination is expected to attenuate naturally over time through sediment scour and dilution, and burial with clean sediments being transported in Grape Creek and Vermilion River. It is expected that over time, aquatic life will re-colonize the affected parts of Grape Creek with greater diversity once sediment quality improves. Our restoration action is intended to help compensate for the past lost use of the ecological services provided by the aquatic natural resources.

Other alternatives that were considered for this action included the creation of rock riffle structures or other fish and mussel habitat in Grape Creek or the Vermilion River. Riffle structures include gravel and cobble substrates that are used by fish for spawning and allow mussels to colonize, because of the lack of sedimentation due to the higher flow over shallow rocky bars.

The creation of new gravelly substrate areas may be feasible with the right partners to complete the engineering analysis, help with the costs to find, transport, and shape the materials in the river. Creation of new riffle structures and gravelly substrates was not considered further due to the limited amount of funding available and the timing for any new partnerships. The construction of riffle structures and creation of new gravelly substrates will require Clean Water Act permits and a more detailed cultural resource review which is beyond the scope of this Restoration Plan and Environmental Assessment given the alternatives carried forward for analysis.

2.2 The Alternatives Carried Forward for Analysis

In our review for the Restoration Plan, we were able to identify and develop the following timely and inexpensive alternatives to meet the restoration purpose and need to compensate the public for the past losses of aquatic natural resources. The available alternatives include adult translocation of mussel species, release of artificially propagated mussels, stocking of cultured fish, and natural recovery.

2.2.1 Alternative A: Mussel Translocation (preferred alternative)

Under the mussel translocation alternative (Alternative A), injuries to natural resources would be compensated by stocking rivers with adult wild caught mussels from other source locations. The objective for Alternative A is to augment the endangered mussel populations in the Vermilion River ecosystem.

The augmentation strategy includes transporting adult northern riffleshell (*Epioblasma rangiana*) and clubshell (*Pleurobema clava*) collected from the Allegheny River in Pennsylvania to the Vermilion River System in Illinois. Both of these species are listed as endangered by the States of Pennsylvania and Illinois and the U.S. Fish and Wildlife Service. There is a bridge on the Allegheny River that has to be dropped into the River for dismantling and construction of a new bridge. The river below the bridge construction zone contains tens of thousands of northern riffleshell and clubshell. These mussels are being moved out of the way for the construction project and then put back into the area once the construction is complete and the area has been rehabilitated. Partners and the U.S. Fish and Wildlife Service decided to use some of these adult mussels for reintroduction and conservation projects in other States to ensure recovery and survival of the species. These species currently has recruitment in only a few streams in the eastern United States. The northern riffleshell was extirpated from the Vermilion River System and the clubshell was known from only one individual in the Vermilion River System (Szafoni, Cummings, & Mayer, 2000)

The Illinois Natural History Survey and Illinois Department of Natural Resources completed a pilot study by translocating 136 adult northern riffleshell from the Allegheny River into two mussel beds in the Vermilion River System. Research for determining the locations for the suitable and protected mussel beds to receive the incoming mussels was completed as part of the pilot study. Suitable and protected mussel beds included those in public lands or suitable private property, within the range of the host fishes, and at existing mussel beds with high species diversity. Several other suitable and protected mussel beds were found in the Vermilion River System. The survivorship of the relocated mussels for the pilot study was around 80%. The translocation was deemed successful and now the partners wish to continue the recovery and restoration for these Illinois mussel populations.

The method for Alternative A is the translocation of an additional 1,000 (or more) Northern riffleshell and 300 (or more) clubshell in the Vermilion River system. The organisms will be quarantined at a qualified facility to ensure that the transport water or the organisms do not carry any mussel or fish diseases or exotic species into Illinois waters. Each organism will be fitted with a tag to determine its origin. The organisms will be stocked into Illinois waters in batches spread out between several locations. The performance of the translocation will be monitored for a number of years as part of other mussel survey activities.

This alternative is desirable because it meets the purpose and the needs for the action. The implementation of this alternative would contribute to other larger scale mussel restoration projects by the State of Illinois and Federal agencies. There are a variety of partners for the preferred alternative (see list of agencies outlined in Section 5 below). There is additional funding or in-kind services available from the partners to help with the translocation, quarantine operations, and monitoring for Alternative A.

2.2.2 Alternative B: Release of Artificially Propagated Mussels (secondary option for preferred alternative)

Under the mussel propagation alternative (Alternative B), injuries to natural resources would be compensated by stocking rivers with juvenile artificially propagated mussels from qualified hatcheries. The objective for Alternative B is to augment the endangered mussel populations in the Vermilion River ecosystem.

The augmentation strategy includes transporting adult northern riffleshell (*Epioblasma rangiana*) or clubshell (*Pleurobema clava*) collected from the Allegheny River in Pennsylvania to qualified State or Federal hatcheries. These hatcheries have the capability to collect glochidia from gravid adult mussels and inoculate them onto the gills of host fishes. The glochidia infested host fishes may be placed in cages (typically several cages with a dozen or so fish per cage) at locations that are upstream of mussel beds in the Vermilion River System so that the newly transformed mussels may drop off at target locations, or the glochidia infested host fishes may be free released into the Vermilion River System

The fish hosts will be certified as disease free by a qualified facility to ensure that the transport water or the organisms do not carry any mussel or fish diseases or exotic species into Illinois waters. The organisms will be stocked into Illinois waters in batches spread out between several locations. The performance of the augmentation will be monitored for a number of years as part of other mussel survey activities. The new mussels may be identified by the age structure since there are not any known natural recruitment of these species in the Vermilion River System and genetic markers that have been determined for the Allegheny River populations.

This alternative is desirable because it meets the purpose and the needs for the action. The implementation of this alternative would contribute to other larger scale mussel restoration projects by the State of Illinois and Federal agencies. There are a variety of partners for the preferred alternative (see list of agencies outlined in Section 5 below). There is additional funding or in-kind services available from the partners to help with the translocation, quarantine operations, and monitoring for Alternative A.

Alternative B may be used to supplement Alternative A outlined above since both alternative have the same outcome, objective, and fulfill the purpose and the needs for the action.

2.2.3 Alternative C: No Action

Under the no action alternative (Alternative C), some of the past natural resource losses would be uncompensated. Given sufficient time, natural processes should enable the affected natural resources recover to conditions that existed prior to the release of hazardous substances.

2.2.4 Alternative D: Fish Stocking

Under the fish stocking alternative (Alternative D), some of past natural resource losses would be compensated for by purchasing fish available from commercial or government sources. The objectives for Alternative D are to augment fish populations and to speed up the natural recovery of ecological services through augmentation of the fish populations. The fish species could include game or non-game species that are available from regional hatcheries. Fish stocking could include multiple

species and occur over multiple years at multiple locations. This alternative is less desirable, because fish reproduction is presumed to be more resilient compared to mussel reproduction and survival. The fish species for stocking must be carefully chosen as not to impact the darter and minnow diversity through predation since many of the mussel species depend on these species as hosts for their life cycle.

3.0 Affected Environment

3.1 Alternatives A and B: Mussel Translocation and Augmentation

Project Areas: The target mussel beds are in the Vermilion River System including North Fork, Middle Fork, Salt Fork, and their tributaries. There are about eight known mussel beds that are within protected areas, have the host fishes present as part of the aquatic species assemblage, and contain high mussel species diversity. The Middle Fork of the Vermilion River is a component of the Wild and Scenic Rivers System in the United States and Scenic River for the State of Illinois. As such, activities in the Middle Fork require coordination with the State of Illinois and the National Park Service pursuant to Section 7(a) of the Wild and Scenic Rivers Act. This coordination was initiated in 2005 as part of the Environmental Assessment for the original stocking of northern riffleshell. The coordination will be reinitiated should the cooperating agencies elect to target augmentation at mussel beds within the protected reach of the Middle Fork.

Geologic Resources: The proposed project sites are located in the modern main channel and main channel border areas of the Vermilion River System with underlying sands and gravels (fluvial deposition) that have been deposited more recently by riverine processes.

Cultural Resources: We reviewed the cultural resources spatial databases and maps maintained by the Office of State Archeologist for the State of Illinois. The database and maps indicates that there are prehistoric and historic sites along the Vermilion River System. None of these resources are in the main channel or channel border of the rivers and streams of the Vermilion River system.

Habitat Resources: The proposed project sites include coarse sand and gravel shoal and bar habitats. Gravelly shoals and bars are created in the river by hydraulic conditions that promote scouring of fine sands, silt, and clay sized sediment particles leaving behind the coarser sand and gravel materials. The gravel size particles are moved more slowly along the bottom by river currents.

Biological Resources: Gravelly aquatic habitats support an assemblage of benthic macroinvertebrates including mussels, and fishes. Fish eating wildlife such as turtles, mammals, and birds forage over gravelly bars. Gravelly bars do not typically support major beds of aquatic plants.

Endangered Species: The cooperating agencies reviewed the federally listed species database for the Vermilion River System maintained by the U.S. Fish and Wildlife Service. The review indicated that there are two federally listed aquatic species found in the Vermilion River system including the endangered northern riffleshell and endangered clubshell. The northern riffleshell are those individuals relocated by the State of Illinois discussed above. The clubshell is currently found in the Middle Branch of the North Fork (Szafoni, Cummings, & Mayer, 2000). The handling, transport, and release of the endangered mussel species for this project require coordination with the State of Illinois and the U.S. Fish and Wildlife Service pursuant to Section 7(a) of the Endangered Species Act.

Surrounding Land Use: The shoreline, floodplain, and uplands around the project sites include native habitats, agricultural land cover, and developed urban areas.

3.2 Alternative B: No Action

Resources and land use will remain in the reduced baseline conditions under the no action alternative until natural recovery is completed which is expected to take up to decades.

3.3 Alternative C: Fish Stocking

Project Area: The proposed fish stocking location is at the boat access points along the rivers and streams of the Vermilion River System.

Geologic Resources: The proposed project sites are located in the modern main channel and main channel border areas of the Vermilion River System with underlying sands and gravels (fluvial deposition) that have been deposited more recently by riverine processes.

Cultural Resources: The cooperating agencies reviewed the cultural resources spatial databases and maps maintained by the Office of State Archeologist for the State of Illinois. The database and maps indicates that there are prehistoric and historic sites along the Vermilion River System. None of these resources are in the main channel or channel border of the Vermilion River system.

Habitat Resources: The proposed project sites include coarse sand and gravel shoal and bar habitats. Gravelly shoals and bars are created in the river by hydraulic conditions that promote scouring of fine sands, silt, and clay sized sediment particles leaving behind the coarser sand and gravel materials. The gravel size particles are moved more slowly along the bottom by river currents.

Biological Resources: Gravelly aquatic habitats support an assemblage of benthic macroinvertebrates including mussels, and fishes. Fish eating wildlife such as turtles, mammals, and birds forage over gravelly bars. Gravelly bars do not typically support major beds of aquatic plants.

Endangered Species: We reviewed the federally listed species database for the Vermilion River System maintained by the U.S. Fish and Wildlife Service. The review indicated that there are two federally listed aquatic species found in the Vermilion River system including the endangered northern riffleshell and endangered clubshell.

Surrounding Land Use: The shoreline, floodplain, and uplands around the project sites include native habitats, agricultural land cover, and developed urban areas.

Table 2. Summary of current environmental conditions for the action alternatives considered in the alternative analysis.

Attribute	Alternatives A & B Mussel Stocking	Alternative D Fish Stocking
Project Area	Vermilion River System	Vermilion River System
Surrounding Land Use	Native habitats, cropfields, urban areas	Native habitats, cropfields, urban areas
Cultural Resources	In vicinity	In vicinity
Habitat	Riverine	Riverine
Wetlands	Yes	Yes
Aquatic Resources	Warm water fishery	Warm water fishery
Resident Wildlife	Foraging Use	Foraging Use
Migratory Birds	Foraging Use	Foraging Use
Federally Listed Endangered (E), Threatened (T) and Candidate (C) Species	Northern riffleshell (E), clubshell (E)	Northern riffleshell (E), clubshell (E)

4.0 Environmental Consequences

4.1 Effects Common to All

Archeological Resources: The restoration actions would not affect any prehistoric resources because there are not any physical disturbances associated with stocking of aquatic species into the Vermilion River System by using existing car and boat access points.

Historical Resources: The restoration actions would not affect any historical resources because there are not any physical disturbances associated with stocking of aquatic species into the Vermilion River System by using existing car and boat access points.

Habitat Resources: The proposed project would not cause adverse effects to habitats because the action is only the release of native aquatic species back into the wild to augment existing populations that are already found in the project area.

Drainage: The projects would not cause any additional artificial increase of the natural level of surface water or groundwater. Thus, this project would not have any impact to drainage on neighboring lands.

Socioeconomic Impacts: No loss of local taxes will occur due to this project.

Environmental Justice: Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, 59 Federal Register 7629 (1994), directs Federal agencies to incorporate environmental justice in their decision making process. Federal agencies are directed to identify and address as appropriate, any disproportionately high and adverse environmental effects of their programs, policies and activities on minority or low-income populations.

No environmental justice issues exist for any of the action alternatives. None of the alternatives would create environmental pollution. No minority or low-income populations would be displaced or negatively affected in any other way by the proposed action or any alternative.

There may be benefits to any low-income communities near the project areas by the action alternatives through improvements to environmental conditions and biological diversity.

Cumulative Impacts: The phrase “cumulative impacts” refers to the overall effect of the proposed action or a series of similar actions in a landscape or regional setting. Enhancing aquatic populations is considered to have positive environmental consequences. Native habitats, fish, and wildlife populations will all benefit on a regional basis by the action alternatives.

4.2 Alternatives A and B: Mussel Translocation and Augmentation

Biological Resources: There will be beneficial effects from the augmentation of existing mussel populations by the translocation of mature and potentially juvenile mussels. The benefits include increase of mussel abundance, stabilization of river substrates, enhanced production of other benthic macroinvertebrate species that use mussel beds, and attraction for fish species.

The northern riffleshell is extirpated from the Vermilion Rivers system and from many other eastern United States stream so there are not any significant and immediate genetic diversity considerations since few source areas exist. The clubshell is known from one isolated population in the Middle Branch of the North Fork. The cooperating agencies can avoid affects to the genetic diversity of the clubshell in the Vermilion River System by not stocking any mussels of this species originating from Pennsylvania at locations above the Lake Vermilion Dam that may become part of the North Fork clubshell population.

The Lake Vermilion Dam is a fish barrier and prevents host fishes from releasing newly transformed clubshell in contact with the Middle Branch population. Clubshell populations established from stocking efforts in the other forks and their tributaries of the Vermilion River System are isolated from the North Fork clubshell population by this dam.

Endangered Species: There may be take of federally listed and State listed endangered species. The take will be in the form of removal of stock from the Allegheny River in Pennsylvania for transport to the State of Illinois or to the cooperating hatcheries. The probability of mortality due to capture, handling, and transportation will be avoided and minimized with special care considerations. A consultation was completed with the U.S. Fish and Wildlife Service and with the Illinois Department of Natural Resources to determine that the level of anticipated take (in this case harassment) of several to tens of organisms of the two listed species would not jeopardize the continued existence of these species.

Regulatory Considerations: The collection, transportation, and release into the wild of endangered mussels are subject to Federal and State permits. The augmentation of listed mussel species would not cause any new endangered species consultation or permitting beyond what is required now for the project area because federally listed and State listed endangered mussel species already exist in the project area at this time.

Partnership Considerations: The mussel propagation alternative has partnership opportunities including Federal agencies, State agencies, and local governments of the adjacent communities. There is the ability to leverage existing funding with outside funding and in-kind services to expand the scale of the mussel stocking alternative and complete the monitoring goals.

4.3 Alternative B. No Action

Under the no action alternative, injuries to natural resources would be uncompensated. Given sufficient time, natural processes should enable the affected natural resources to recover to pre-injury levels also known as the baseline condition. The public would not be compensated for its interim lost use of the natural resources during this recovery period. No additional natural resources impacts are expected from implementing the no action alternative.

4.4 Alternative C. Fish Stocking

Biological Resources: There will be beneficial effects from the augmentation of the existing fishery by recruitment of new young into population. None of the selected fish species with proper disease free certification at the numbers targeted for reintroduction can cause adverse effects to the local fishery.

Endangered Species: No negative responses are predicted for federally listed species because only selected fish species will be reintroduced into the wild that do not directly impact the listed species or indirectly adversely impact the listed mussel host species.

Regulatory Considerations: The propagation, transportation, and release of artificially cultured fish into the wild are subject to State approvals.

Partnership Considerations: No partnership opportunities with sources of outside funding identified during the scoping process.

Table 2. Summary of environmental consequences by alternative.

Impacts	Alternatives A & B Mussel Stocking	Alternative C No Action	Alternative D Fish Stocking
Geology or Soils	No change	No change	No change
Cultural Resources	No adverse effects	No adverse effects	No adverse effects
Habitat Resources	No adverse effects	Recovery over time	No adverse effects
Wetlands	No change	No change	No change
Aquatic Life	Ecological benefits	Recovery over time	Ecological and recreational
Resident Aquatic or Wetland Dependent Wildlife	Benefits	Recovery over time	Benefits
Migratory Birds	Benefits	Recovery over time	Benefits
Federally Listed Endangered, Threatened Species	Benefits with minimal take	Recovery over time	No change
Hydrology/Drainage	No changes	No changes	No changes
Socioeconomic Issues	No changes	No changes	No changes
Part of larger restoration effort	Yes	No	No

5.0 List of Preparers

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6.0 References, Consultation, and Coordination

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7.0 Public Review and Comment

The Restoration Plan and Environmental Assessment report was posted on the Rock Island, IL Ecological Services web site starting on June 27, 2012 at <http://www.fws.gov/midwest/RockIsland/ec/Restoration/index.html>.

A legal notice of availability was published in the Danville, IL Commercial News by the U.S. Fish and Wildlife Service on July 3, 2012 to solicit comment, issues, or concerns from the public. The public comment period was open between the dates of June 27, 2012 and August 3, 2012. There were no comments received on the Restoration Plan and Environmental Assessment during or after the public review and comment period.

8.0 Literature Cited

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FRESHWATER MUSSELS - WATER QUALITY COORDINATION VERMILION RIVER SYSTEM

Other federally listed mussel species historically found in the Vermilion River:
Other locations for clubshell shown as open circles (<1980)
Northern riffleshell (x)

Federal candidate species historically found in the Vermilion River system:
Sheepnose
See Mississippi River
Ohio River
Wabash River
Kankakee River
Rayed bean (x)

x = state extirpated (<1986)

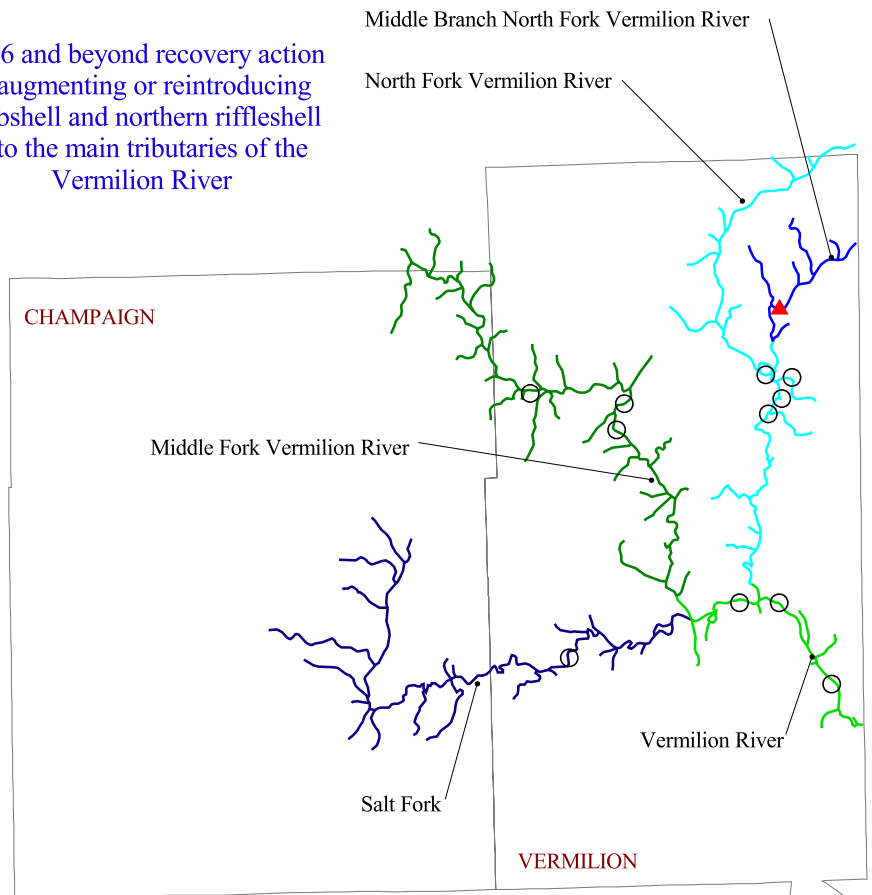
**Vermilion River System
Illinois general
location of extant (after 1986)
clubshell mussel populations**

Data from:

Cummings, K.S., C.A. Mayer and R.E. Szafofi. 1997. Endangered freshwater mussels (Mollusca: Unionidae) in the North Fork Vermilion River, IL with comments on the federally endangered clubshell, *Pleurobema clava* (Lamarck, 1819). Transactions of the Illinois State Academy of Science. 91(1&2):91-102

Szafofi, R.E. 2000. Freshwater mussels (Mollusca: Unionidae) of the Middle Branch, North Fork Vermilion River, Illinois/Indiana. Transactions of the Illinois State Academy of Science. 93(3):229-237

2006 and beyond recovery action is augmenting or reintroducing clubshell and northern riffleshell into the main tributaries of the Vermilion River



Map by
U.S. Fish and Wildlife Service
Rock Island, IL Ecological Services Field Office
September 09, 2005

NOTES: