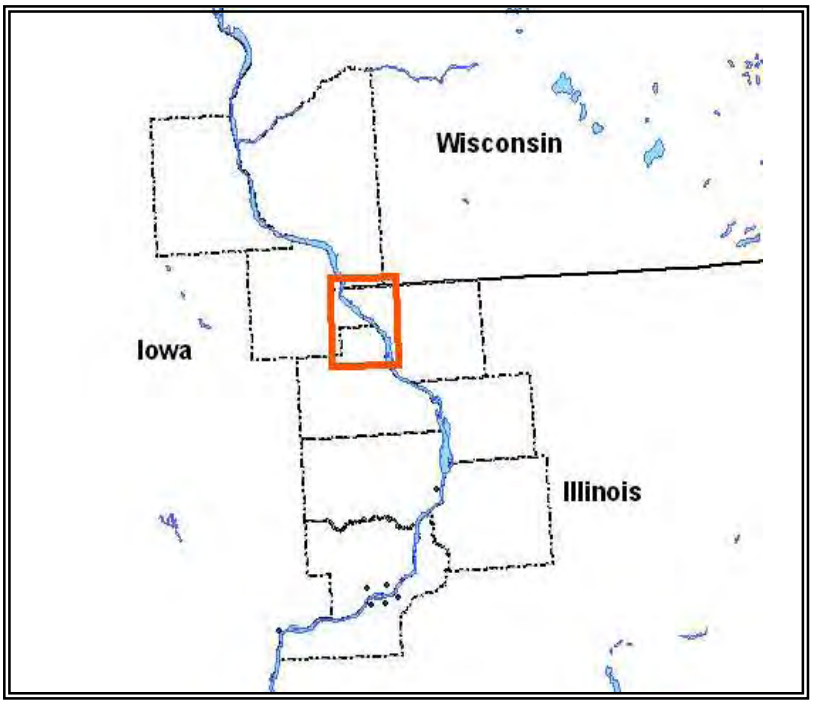
Net Environmental Benefits Analysis

Upper Mississippi River, Pool 12

March 8-9, 2006

Savanna, Illinois

REPORT



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Executive Summary

Background
In March of 2006, the US Environmental Protection Agency Region 5, in collaboration with the U.S. Fish and Wildlife Service, sponsored a workshop along the Upper Mississippi River to evaluate the relative risk to natural resources from an oil spill and response options. The workshop was held in Savanna, Illinois within the Upper Mississippi National Wildlife and Fish Refuge. Workshop participants examined a spill scenario from a ruptured pipeline that released diesel fuel into Pool 12 of the Upper Mississippi River.

Workshop Discussion and Findings
This exercise was assumed to occur in the fall, so a primary concern was the protection of migratory waterfowl. There were also concerns about effects on protected species of mussels, impacts on productive backwater areas, and diesel mixing into the water column if it passed over (or through) Lock and Dam 12. Given these concerns, protection priorities were identified at Molo Slough, Hires Lake, Harris Slough, open water just above Lock and Dam 12, and the spillway off the dam.

To develop a baseline of potential impacts for comparison purposes, participants discussed what would happen to priority resources if no response or active cleanup action were taken. This baseline comparison helped establish priorities, and highlighted the importance of employing protection strategies. The participants identified rapid deployment of protective boom as an important response strategy. Traditional deflection booming, and innovative barge booming were considered as ~~p~~protection methods~~.~~ Recovery points were limited, but Scott Island and Bellevue Slough were identified as two possible collection points. Barges were also identified for potential use as on-water staging areas for boom deployment and oil recovery.

Although a number of high value natural resources are present in Pool 12, participants determined that spill response capability – in terms of both personnel and equipment – is very limited in this area. No spill response contractors could be readily identified in the area to respond to a spill; with the closest identified contractor being located in the Quad Cities, approximately two hours away. The participants discussed training of local personnel, such as Refuge staff, as a potential method of increasing local spill response capability.

Recommendations
The following are key recommendations resulting from the Pool 12 NEBA:

- Pool-specific plans should be created to identify protection strategies on the Upper Mississippi River. The plans can help to coordinate timely and effective responses by private industry, local and state officials and various federal agencies to minimize damage resulting from releases of oil or hazardous materials in an identified sub-area.

Recommendations (continued)

- To facilitate the establishment of pool-specific plans, a series of NEBA workshops at Mississippi River Pools 4-14, within the Upper Mississippi River National Wildlife Refuge should be conducted. As needed, carry out field verification of the location and viability of proposed response strategies.
- Pool-specific plans should be annexed to the Upper Mississippi River Spill Response Plan.
- An equipment cache containing boom should be acquired and maintained for use on Pool 12; and/or contractors should be identified who can reach Pool 12 for response in a timely fashion.
- Training for FWS Refuge staff and other interested local parties in OSHA safety and river boom deployment should be provided so these local personnel can be notified and respond if a spill occurs.
- For Pool 12 specifically, additional collection points should be identified.
- The NEBA process and relative risk matrix for freshwater environments should be refined and possibly made specific to Upper Mississippi River pools.

1. Introduction

On March 8-9, 2006 a Net Environmental Benefit Analysis (NEBA) workshop was held in Savanna, Illinois to evaluate possible response actions and potential environmental impacts in the event of a 90,000-gallon diesel release from a pipeline leak in Pool 12 of the Mississippi River. Twenty-three responders and resource managers from federal, state, local private and non-profit agencies participated (see Appendix A for a complete list of participants). This workshop was a continuation of efforts (including NEBAs performed at Pool 7 and 19 in 2004) to examine sensitive resources in or near the Upper Mississippi River National Wildlife and Fish Refuge (UMR NW&FR), focusing on the prevention and response options applicable to this type of natural resource area.

This NEBA is one of several exercises that have been conducted for freshwater environments. With each exercise, processes and documentation are modified to get the most out of the NEBA in the least amount of time. Following is a detailed reporting of:

- A description of the NEBA process,
- A summary of discussions held during this NEBA,
- Findings of this NEBA
- Recommendations regarding preparedness and response efforts on the Upper Mississippi River and UMR NW&FR.

2. Background: Net Environmental Benefit Analysis (NEBA)

NEBA is a tool for identifying and comparing environmental benefits of alternative management options in the removal of spilled oil and oil products. By evaluating environmental issues before an emergency, response decision makers can improve the quality and results of environmental decision-making by incorporating protection for priority resources, and considering impacts on resources from both the spill itself and recovery efforts.

Net environmental benefits are the gains in environmental services or other ecological properties attained by the removal of the oil or ecological restoration minus the environmental injuries caused by those actions. A NEBA for oiled sites typically involves the comparison of the following management alternatives:

1) Leaving contamination in place for natural attenuation,
2) Removing the contaminants through traditional removal techniques,
3) Remediating contamination with alternative removal techniques.

NEBA is a risk-benefit analysis applied to environmental management options. To do this, a group including both resource managers and emergency responders must participate together in forming opinion, guiding discussion and educating each other in

processes of importance and concern. NEBA places value on ecological services or other properties, assesses adverse impacts and evaluates removal actions.

NEBA has the potential to assist resources managers in avoiding the possibility that the real-time removal alternative will provide no net environmental benefit over natural attenuation of contaminants and ecological recovery. A removal option may provide no net environmental benefit because:

1) The removal action is ineffective or inappropriate (the action does not substantially change the risk); or,
2) The removal alternative causes environmental injuries greater than the damage associated with the contamination because:
    a. The need for remediation has been driven by human health risk, not ecological risk;
    b. The ecological injury from contamination has been overestimated;
    c. Injuries associated with removal were not properly addressed; or,
    d. The need for remediation is driven by human considerations not related to health or ecologic concerns.

NEBA has the potential to help resource managers plan a removal that provides a positive net environmental benefit over the hypothetical state that would prevail in the absence of contamination. NEBA is recommended if any of the removal alternatives potentially have significant negative ecological effects or minimal ecological benefits.

3. NEBA Approach for Pool 12 of the Upper Mississippi River

A modified NEBA approach was taken in the Pool 12 workshop, in order to most efficiently move the conversation forward to a point where specific priorities for protection and response strategies could be discussed. These modifications resulted from both pre-workshop planning that took into account the nature of the resource, and adaptations to the agenda as the workshop proceeded.

The major modifications made to the NEBA process for Pool 12 were as follows:

- A "Relative Risk Matrix" was only completed for natural attenuation. Although additional response options would certainly be employed during an actual spill, this approach helped simplify the discussion and allowed the group to establish a "baseline" for comparison of potential impacts to species and habitats. For the purposes of this workshop, a "baseline" situation was considered to mean the following:
    - No protection, containment, or collection of spill.
    - No active cleanup of spill, only natural attenuation.
- Although the scenario initiated discussion, participants were not tied to the particulars of the scenario in their discussions or in making decisions regarding response options.

- Once general consensus was reached regarding protection priorities for species and habitats, the workshop proceeded to discussion of response and protection strategies.
- A specific discussion took place regarding the operation of locks and dams on the Upper Mississippi River, and the resulting implications for spill response and spill containment.

4. Geographic Area and Scenario Description

The Upper Mississippi River Pool 12 NEBA focused on the pool's 25-mile stretch, between Dubuque and Bellevue, Iowa. This navigational pool is located upstream of Lock and Dam 12 at Bellevue, and within the U.S. Fish and Wildlife Service's Upper Mississippi National Wildlife and Fish Refuge (UMR NW&FR), Savanna District. The refuge and critical resources dominate the Illinois side; while the Iowa side has steep river bluffs, which could be a hazard during response.

Figure 1. Upper Mississippi River, Pool 12

Upper Mississippi River, Pool 12 was selected for this NEBA because it was within close proximity of a fixed spill source, and there are numerous environmental resources in need of protection at the refuge including endangered mussel species and migratory waterfowl. Also, it was anticipated that working through a NEBA at Pool 12 might provide a model for other pools on the Upper Mississippi River.

The spill scenario was designed around a pipeline located at Dubuque, Iowa at the north end of Pool 12 (see Appendix B, Inland Sensitivity Atlas). According to the scenario, a 10" petroleum product pipeline ruptured in late October at approximately 0200 hours, continuously releasing 3,000 to 4,000 gallons of diesel fuel per hour. The spill was not discovered until the following morning, resulting in approximately 90,000 gallons of diesel released into the river above Lock and Dam 12.

The Lock and Dam system on the Mississippi River presents unique challenges for spill responders. The locks and dams are used to regulate water depth for navigation, and are not designed for flood control. As a result, closure of the dam's gates would quickly result in flow of oil and water over the dam's spillway. Additionally, if the gates are not closed, oil would travel through the gate structures. In either case, oil would be mixed into the water column, becoming more difficult to recover. Therefore, a slick traveling downstream should be diverted and collected above the dam to prevent the fuel from spilling over, or traveling through, the dam.

DIESEL & HOME HEATING OIL, AKA NO. 2 OIL

- Moderately volatile (≥ 40% evaporation in 24 hours), evaporates to no residue or stain
- Distinctive and strong odor (concern in areas of human populations)
- Combustible (not flammable)
- Low viscosity; spreads rapidly to a sheen
- Specific gravity of 0.80-0.85; API gravity of 35-45
- Moderate to high acute toxicity to biota; product specific toxicity related to type and concentration of aromatic compounds
- Tend to penetrate substrate; fresh spills are non-adhesive
- Can "taint" commercial and/or recreational fish catches

Figure 2. Properties of Diesel Fuel

Diesel fuel spilling over or passing through Lock and Dam 12 is primarily a concern for sensitive resources located downstream in Pool 13. However, the primary and immediate concern for this NEBA was the impact to Pool 12 resources, especially within sensitive backwater habitats and the open water above Lock and Dam 12 where migratory waterfowl congregate.

5. Relative Risk Ranking, Priority Species and Habitats

NEBA participants identified flora and fauna that are typically found in six Pool 12 ecosystems; terrestrial, wetland, shoreline, nearshore, submerged structure and open water. The potential impact on these species and resources was evaluated by completing a relative risk matrix (see Table 1), a ranking system that has been developed to focus these types of discussions. This system assigns priorities to species based on environmental and economic value, where a high priority signifies species that should be protected first.

In brief, a ranking of "1A" represents a catastrophic resource impact with a probable population collapse. A ranking of "4D" represents negligible impact to the population with full recovery anticipated by the following year. So-called "driver" species can define response and removal methods employed or planned. These "drivers" are critical species (e.g., Higgens Eye mussel) that are most sensitive to spills and/or removal techniques, and therefore help dictate the selection of response techniques. They are typically identified as having the highest sensitivity and greatest likelihood for irreparable harm due to their low population numbers, status as threatened or endangered, or location with respect to the spill scenario.

Table 1. Risk Ranking Matrix

		Potential Length of Recovery			
		Probable Population Collapse	**Long-term (4-7 years)**	**Intermediate (2-3 years)**	**Short (1 year)**
Degree of Resource Impact	**Catastrophic**	**1A**	**2A**	**3A**	**4A**
	Critical	**1B**	**2B**	**3B**	**4B**
	Marginal		**2C**	**3C**	**4C**
	Negligible		**2D**	**3D**	**4D**

Legend: Cells that are dark grey represent a **high** level of concern, cells that are shaded light grey represent a **moderate** level of concern, and cell not shaded represent a **limited** level of concern.

Ranking Process
It can be useful to evaluate each resource category's response to the various removal techniques using the risk-ranking matrix. However, as previously discussed, natural attenuation was the only response option thoroughly discussed and documented using this method for Pool 12. Participants used the scenario and risk-ranking matrix as a method of initiating discussion, but quickly advanced the discussion to response and protection options. The matrix still proved helpful because it illustrated areas that would recover quickly on their own, and other areas that would benefit from removal techniques. The Relative Risk Matrix Summary for the Pool 12 NEBA is presented in Appendix D.

Priority Species
In the Pool 12 workshop, fish (e.g., Bass and Paddle Fish) and mussels (e.g., federally endangered Higgens Eye and candidate species Spectacle Case) were viewed as high priority, especially in wetland, nearshore, submerged, and open water habitats. In addition, migrant birds were perceived as a high and moderate priority in open water and along the shoreline, respectively. See Appendix D for details of prioritization.

Priority Habitats
In order to protect high priority species in an efficient manner, priority habitats were specified in Pool 12 (see map in Appendix C). Resource experts identified these areas as locations where a high number of priority resources are found: Molo Slough, Hires Lake, Harris Slough, open water above Lock and Dam 12, and the spillway at the lock and dam. Group consensus was that if oil were spilled over or through Lock and Dam 12, it would threaten high value resources downstream in Pool 13. The identification of priority species and their general locations along the river drove a discussion about protection and removal techniques.

6. Response Options

A response to an oil spill consists of containment & protection, recovery, and cleanup phases as described below:

- Containment & Protection: The main objective of containment & protection is to keep oil out of priority habitats or to reduce the amount that enters, minimizing the impact on those habitats.
- Recovery (Collection): Recovery consists of removing floating oil from the water surface.
- Cleanup: The cleanup phase consists of removing stranded oil from shoreline habitats via physical, chemical and enhanced biological means.

In most spill response situations, protection and oil recovery are the immediate goals. In an actual response to an oil spill, it is likely that a combination of removal techniques, including no action, would be employed. This NEBA focused primarily on containment & protection and (oil) recovery phases, with the implication that considering natural attenuation as a "baseline" cleanup approach would facilitate further discussions about other possible response methods and their effectiveness against a spill in Pool 12 (see Figure 3 for details about natural attenuation).

Containment and Protection Strategies
In this scenario, protection and diversion with boom (common response techniques) were proposed as primary methods to be employed during the containment and protection phases of the response. The use of barges as boom (a more innovative approach) was also considered. As described earlier, habitats to be protected in this phase of the response were identified as: Molo Slough, Hires Lake, Harris Slough, open water above Lock and Dam 12, and the spillway at the dam (see Appendix C).

Recovery and Oil Collection Strategies
Relating response options to priority species on the river helped to derive the location of possible staging and collection areas. For example, endangered species (e.g., mussels and resident birds) can avoid physical trauma during cleanup when the species location is known. For Pool 12, a staging area was identified just above of Lock and Dam 12, collecting oil using existing buoys as anchor points to attach boom. This area has the least opportunity to harm priority resources, and it is the last location to divert oil away from the dam. Collection could be performed using existing buoys as anchor points for boom. Recovery points were limited, but Scott Island and Bellevulle Slough were identified as two possible collection points.

NATURAL ATTENUATION OF OIL SPILLS

- When no attempt is made to remove any stranded oil
- Used to minimize the impact of cleanup activities, particularly to sensitive habitats
- Used when recovery is impractical in the face of the environmental threat
- Occurs to throughout the impact area to some degree
- Manual removal of all the contaminant is virtually impossible; some amount of oil is always left to naturally biodegrade.
- In all cases, gross oiling and oil with the potential to remobilize in significant amounts are removed.
- In some case, extraordinary efforts are taken to minimize the threat of wildlife contamination, particularly when endangered species are concerned.
- Environmental injury associated with natural attenuation is a function of the type of oil, the amount unrecovered, the ambient environmental conditions (exposure, flushing, etc.) and the habitat involved.

Figure 3. Description of Natural Attenuation

7. Findings

Findings from the Pool 12 NEBA are summarized in the following paragraphs and grouped into the following categories:

(1) Protection priorities

(2) Threats

(3) Personnel

(4) Training

(5) Equipment

(6) Protection Methods

(7) Structure and Content of the NEBA

Most of the findings relate specifically to Pool 12, but may also be generally applicable to other Mississippi River pools within the Upper Mississippi River National Wildlife and Fish Refuge, such as Pools 13 and 14.

(1) PROTECTION PRIORITIES

Priority Areas that need to be protected by booming in Pool 12 are:

1. Molo Slough
2. Hires Lake
3. Harris Slough
4. Open water above Lock and Dam 12
5. The spillway on Lock & Dam 12

(2) THREATS

- Most of the oils that are transported across the river are located in product pipelines, which carry diesel, gasoline and asphalt (no crude oil). The most likely source of a spill would be diesel. See Figure 2 for a summary of diesel properties.
- Spills could result from accidents involving barges or towboats (i.e. navigational river traffic) and the railroad, in addition to an oil pipeline.

(3) PERSONNEL

- Savanna has 2 to 3 paid Fire Department personnel. These personnel could be of assistance in the event of a spill to provide initial on-scene intelligence, but would require some training.
- The UMR NW&FR staff are closest in proximity to a spill that occurs in the Refuge.
- There are no identified response contractors in the area. The closest contractor is located in the Quad Cities (approximately two hours away).
- If a cooperative group is formed for Pool 12, it must identify appropriate personnel to be involved in response actions.
- The lockmaster tracks cargo on the river and can be a resource for this type of information in spill response planning.
- Point of contact (POC) for pipelines needs to be clearly established.

(4) TRAINING

- Training for boom deployment is usually involves at least a days worth of on-water training.
- Safety and/or boom deployment training is needed for FWS refuge staff and Savanna Fire Department personnel.

(5) EQUIPMENT

- There is no existing pre-staged boom or other response equipment for Pool 12.
- Barges can potentially be used as protection boom, serving as a barrier individually or “strung” together.
- Barges could be used as a platform for an on-water staging area. It may be possible to deploy boom and use vacuum trucks from here.

- Self-inflating boom, which is stored on a wheel, could work well in this area.
- The FWS could store boom, but probably couldn't deploy it at this time because personnel do not have training.
- Existing river buoys (or pre-deployed buoys) could be used as boom anchoring points at appropriate locations.
- Low pressure flushing could be used to get the oil out of vegetation.
- US EPA Region 5 has a water treatment trailer that could be used during a spill.

(6) PROTECTION METHODS

- Deflection and collection boom would be needed for primary protection and containment activities.
- Areas of low sensitivity may need to be sacrificed in order to protect areas of greater sensitivity.
- Because of river level fluctuation, equipment cannot be pre-deployed on site in many locations on Pool 12.
- Ferry Landing has a small point ramp, which could be accessed during a response.
- Island 241, which is used for sand disposal, could be a good working area.
- Potentially, a work barge can be launched at Dubuque or Savanna, which could be used as a staging area for a spill. Various sizes of barges may be available. Marinas out of Dubuque have work barges. USACE has work barges at Lock and Dam 14.
- Collection Points: Scott Island and Bellevue Slough would be a good deep-water access and collection points. There is a shallow point that would aid in collection. The bank south of the boat access would be a good access point. The problem with this collection point is that the oil might start splitting off and spreading.
- In-Situ Burning might be an option in backwater areas, after oil has been collected by boom. It should not be used without proper authority's permission, or with oil that is moving with the main river current.
- For Pool 13, try to keep oil out of the spillway at Lock and Dam 12. In Pool 13, Pleasant Creek can be protected by a levee. Close off Lanesville. Running Slough would protect areas south. Try to keep oil out Plum River marina. Elk River has half a dozen access points that can be used.

(7) STRUCTURE & CONTENT OF THIS NEBA

- A primary benefit of the NEBA workshop is the training the participants get in planning and, to some extent, responding to a spill.
- Use the Inland Sensitivity Atlas (ISA) and the UMR Spills plan more prominently by emphasizing the applicable maps from the ISA, as well as the location of response equipment and the lists of products shipped, pipelines, and dischargers from the UMR plan. There could be a mini-section on "Tools & Resources" (including excerpts from the ISA and Plan, as well as a review of the species and habitat fact sheets) that could be presented up front. It would also be a good way to ground truth the ISA and the Spills Plan.
- Introduce the risk-ranking matrix after all the background material has been covered (about resources, response options, etc.), possibly on the morning of the second day.

- Standardize the risk-ranking matrix and consider using a different presentation of the matrix.
- Perform a site/field visit at one or more of the key areas involved in the NEBA. For example, visiting the Lock and Dam structure and the associated wetland area below the spillway.
- In the future, it would be preferable for UMRBA to help facilitate the NEBAs on the UMR and GLC to help facilitate NEBAs in the Great Lakes basin. Background and follow-up work would also be much smoother if done by staff in the same region that already has ongoing communication with the affected parties.

8. Recommendations

- Pool-specific plans should be created to identify protection strategies on the Upper Mississippi River. The plans can help to coordinate timely and effective responses by private industry, local and state officials and various federal agencies to minimize damage resulting from releases of oil or hazardous materials in an identified sub-area.
- To facilitate the establishment of pool-specific plans, a series of NEBA workshops at Mississippi River Pools 4-14, within the Upper Mississippi River National Wildlife Refuge should be conducted. As needed, carry out field verification of the location and viability of proposed response strategies.
- Pool-specific plans should be annexed to the Upper Mississippi River Spill Response Plan.
- An equipment cache containing boom should be acquired and maintained for use on Pool 12; and/or contractors should be identified who can reach Pool 12 for response in a timely fashion.
- Training for FWS Refuge staff and other interested local parties in OSHA safety and river boom deployment should be provided so these local personnel can be notified and respond if a spill occurs.
- For Pool 12 specifically, additional collection points should be identified.
- The NEBA process and relative risk matrix for freshwater environments should be refined and possibly made specific to Upper Mississippi River pools.
- Research grants can be identified to formally write this and successive NEBA reports.
- Response strategy documentation should be integrated from this NEBA into the update of the Illinois Inland Sensitivity Atlas.

Appendix A: NEBA Participants List

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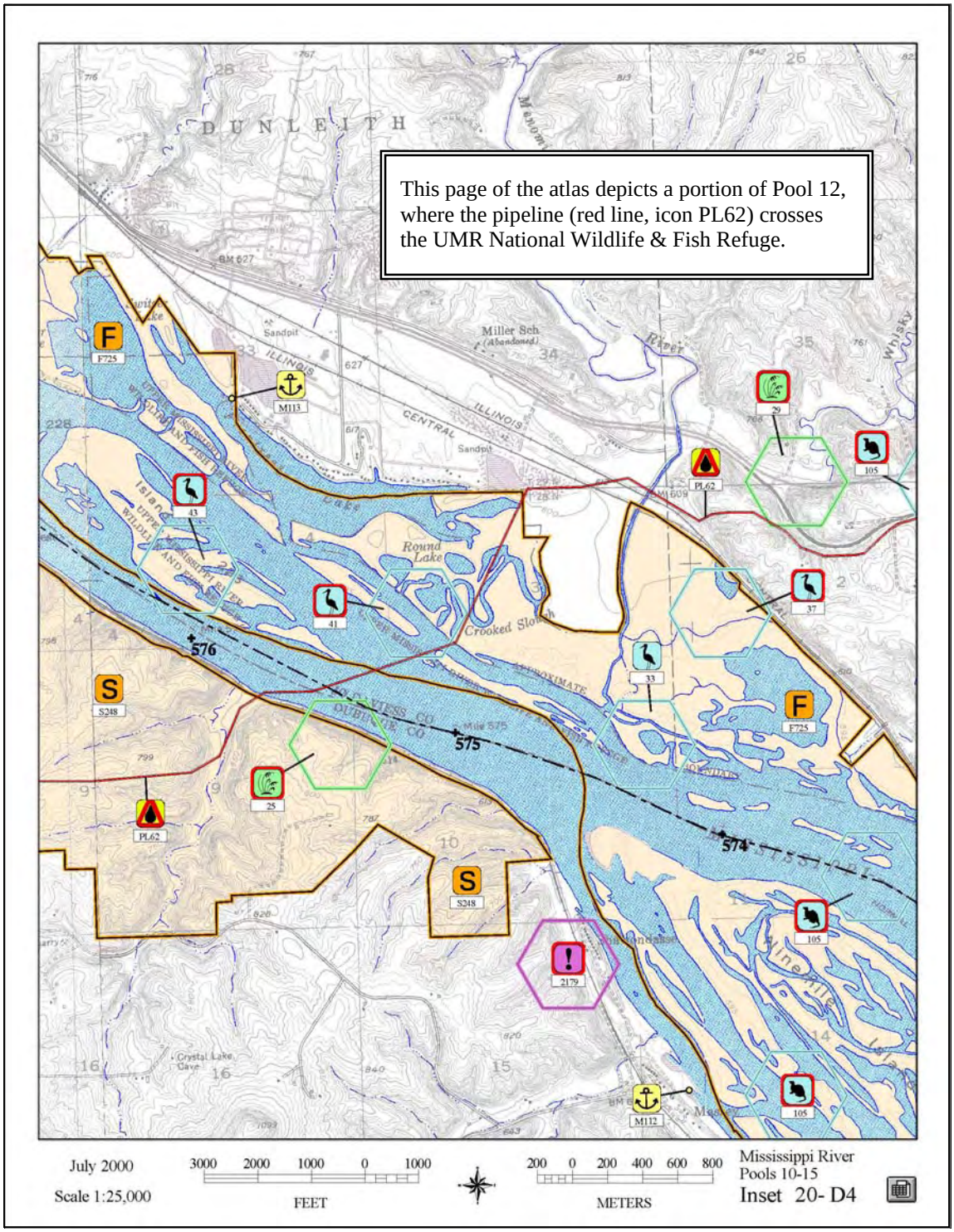
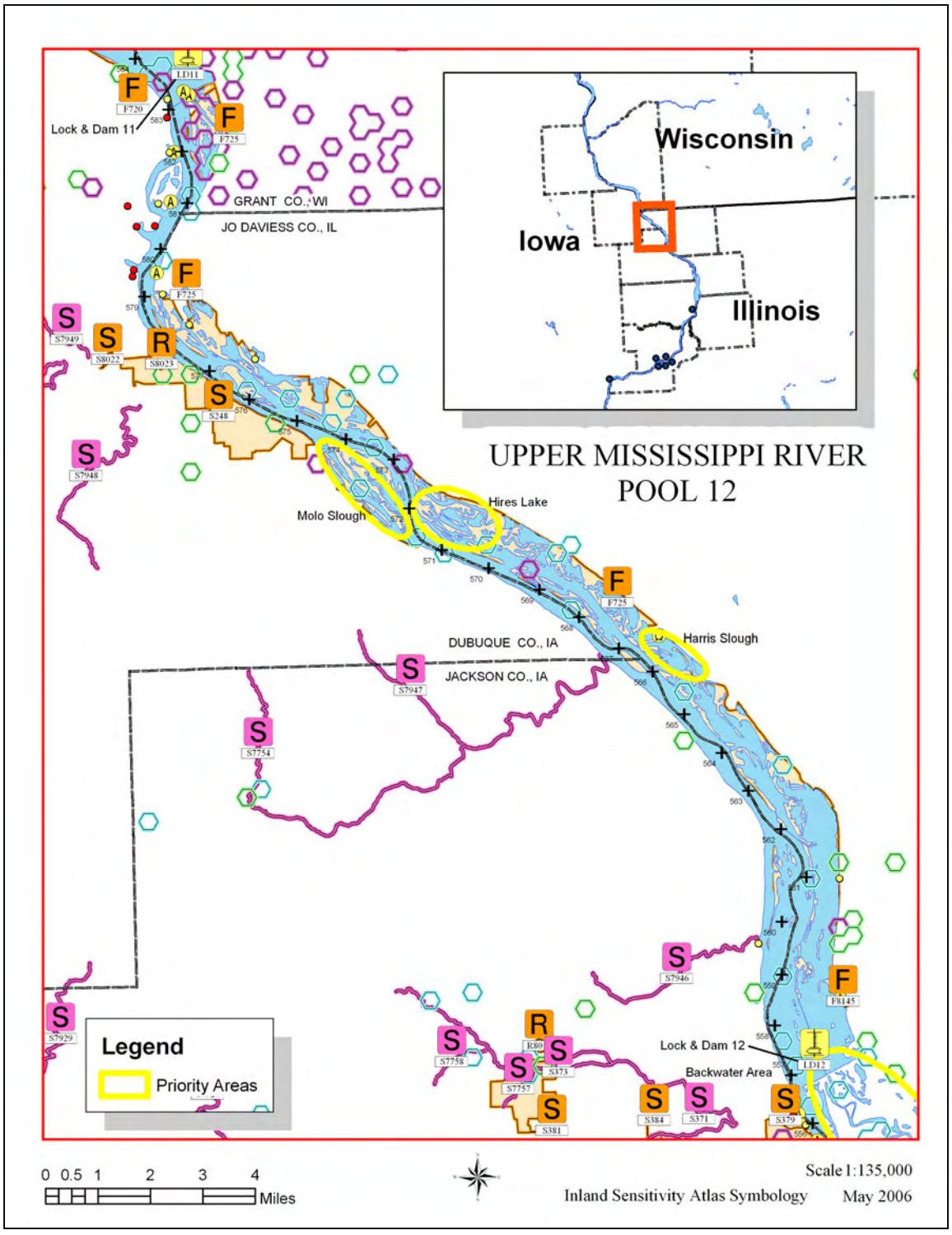
Appendix B: Inland Sensitivity Atlas



Pipelines

Icon	Company Name, Route Name
PL62	**BP,** Whiting - Moorhead

Appendix C: Pool 12 Priority Areas



Priority Areas: Molo Slough, Hires Lake, Harris Slough, Backwater Area above Lock & Dam 12

Appendix D: Upper Mississippi River Pool 12 Priority Species

Ecosystem	Description
Terrestrial	Inland habitat beyond the high water mark and/or splash zone
Wetlands/Marsh	Emergent vegetation and wetland habitat hydrodynamically linked to Mississippi River waters
Shoreline	From the normal waterline to the limit of the high water mark/splash zone
Nearshore	Shallow waters (approximately 4–10 ft. depth) from the limit of emergent vegetation line outward
Reef/Submerged Structure	Supporting specific plant and animal life beyond the nearshore, includes wing dams
Open Water (Open Channel)	Beyond the limit of the near shore and not including reef structures

Ecosystem	Category	Species Discussion
Terrestrial	Vegetation	Forest
	Mammals	Beaver, River Otter, deer, mice
	Birds - Resident	Cardinal, Grackle, Jay, Geese, Woodpecker, turkeys
	Birds - Migrant	N/A
	Herptiles	turtle
	Macroinvertebrates	N/A
	Microinvertebrates	N/A
Wetlands/Marsh	Vegetation	Localized impact to an abundant species. The edge habitat is important. It is one of the components of the system we are loosing.
	Mammals	Beaver, Otter, Muskrat. Localized population. These mammals have a large home range. Short recovery.
	Birds - Resident	Eagle, Heron. Localized population.
	Birds - Migrant	Heavy migrating season.
	Herptiles	Common, localized population. Many offspring.
	Fish	Bass. Backwaters serve as wintering grounds.
	Macroinvertebrates	Fingernail Clam
	Microinvertebrates	Zooplankton
Shoreline	Vegetation	Vegetated shoreline and trees. The root systems tend to spread out rather than down. Nutrients are at the 1-2 foot level.

Ecosystem	Category	Species Discussion
	Mammals	Muskrat, Beaver. 1/3 of muskrat huts are found in the bank. Critical area for Raccoon.
	Birds - Resident	Not many resident birds on the shoreline. Few rare birds are found on the shoreline.
	Birds - Migrant	Geese and Mallard Duck. Loafing habitat for these birds in October. 20,000 – 30,000 birds flying through every week during migration.
	Herptiles	Transition and basking area for snakes and turtles. Assuming water temp is 45 and turtles and frogs might be in hibernation.
	Macroinvertebrates	N/A
	Microinvertebrates	N/A
Nearshore	Vegetation	Submerged vegetation (seasonally dying)
	Mammals	Muskrat, Beavers, Otter
	Birds - Resident	Bald Eagle
	Birds - Migrant	Dabblers, Divers
	Herptiles	Water is cold enough that they are in hibernation.
	Fish	Mino
	Macroinvertebrates	Higgens Eye mussel – federally endangered species
	Microinvertebrates	N/A
Reef/Submerged Structure	Vegetation	Algae (may exist)
	Birds - Resident	N/A
	Birds - Migrant	Zebra mussel (which attach to the dam) attract birds as food.
	Fish	Riverine fish. Live deeper in the river where there is not a large oxygen demand. These fish more apt to move, but are attracted to the food.
	Macroinvertebrates	Spectacle Case mussel, other mussels. 90% found at winged dams. Long lived. The Spectacle Case mussel is a candidate for the endangered species list.
	Microinvertebrates	N/A
Open Water (Open Channel)	Vegetation	N/A
	Mammals	White Tail Deer sometimes swim across
	Birds - Resident	Eagle

Ecosystem	Category	Species Discussion
	Birds - Migrant	Could be thousands of birds present (High number = 80,000 birds). Canvasbacks can be present (early).
	Fish	Paddle fish and filter feeders. Long lived (spawn every third year), filter feeders, low in numbers and highly migratory. Feed through the entire water column.
	Macroinvertebrates	Endangered mussels found by the winged dams. Higgens Eye (long lived).
	Microinvertebrates	N/A

Appendix E: Relative Risk Matrix Summary

Contaminant: Diesel Fuel

Ecosystems	Terrestrial							Wetlands/Marsh							
Resources / Resources Options	Vegetation	Mammals	Birds - Resident	Birds - Migrant	Herptiles	Macroinvertebrates	Microinvertebrates	Vegetation	Mammals	Birds - Resident	Birds - Migrant	Herptiles	Fish	Marcoinvertebrates	Microinvertebrates
Natural Recovery	**4D**	**4D**	**4D**	**4D**	**4D**	**4D**	**4D**	**3C**	**3C**	**4C**	**4C**	**3B**	**2B**	**3B**	**4A**

Ecosystems	Shoreline							Nearshore							
Resources / Resources Options	Vegetation	Mammals	Birds - Resident	Birds - Migrant	Herptiles	Macroinvertebrates	Microinvertebrates	Vegetation	Mammals	Birds - Resident	Birds - Migrant	Herptiles	Fish	Marcoinvertebrates	Microinvertebrates
Natural Recovery	**4D**	**3C**	**4D**	**4B**	**4D**	**4D**	**4D**	**4C**	**3C**	**4C**	**4D**	**4C**	**3C**	**1A**	**4D**

Ecosystems	Reef/Submerged Structure (75 wing dams)						Open Water (Open Channel)						
Resources / Resources Options	Vegetation	Birds - Resident	Birds - Migrant	Fish	Macroinvertebrates	Microinvertebrates	Vegetation	Mammals	Birds - Resident	Birds - Migrant	Fish	Marcoinvertebrates	Microinvertebrates
Natural Recovery	**4D**	**N/A**	**4C**	**3B**	**1B**	**4D**	**N/A**	**4D**	**4C**	**3A**	**2B**	**1A**	**4D**

Water Quality				
Resources / Resource Options	Nearshore	Reef	Open Water	Coastal Wetland
Natural Recovery	**4C**	**4C**	**4C**	**4C**

		Potential Length of Recovery			
		Probable Population Collapse	Long-term (4-7 years)	Intermediate (2-3 years)	Short (1 year)
Degree of Resource Impact	Catastrophic	1A	2A	3A	4A
	Critical	1B	2B	3B	4B
	Marginal		2C	3C	4C
	Negligible		2D	3D	4D

Legend: Cells that are dark grey represent a **high** level of concern, cells that are shaded light grey represent a **moderate** level of concern, and cell not shaded represent a **limited** level of concern.

Ecosystem Description:

Terrestrial – Inland habitat beyond the high water mark and/or splash zone.

Wetlands/Marsh – Emergent vegetation and wetland habitat hydrodynamically linked to Mississippi River waters.

Shoreline – From the normal waterline to the limit of the high water mark/splash zone.

Nearshore – Shallow waters (approximately 4–10 ft. depth) from the limit of emergent vegetation line outward.

Reef/Submerged Structure – Supporting specific plant and animal life beyond the nearshore, includes wing dams.

Open Water (Open Channel) – Beyond the limit of the near shore and not including reef structures.