

## **1.0 Introduction**

The University of Wisconsin-Green Bay Graduate Seminar in Environmental Science and Policy, by design, links local government issues with public policy and attempts to create a bridge of understanding between science and public policy. “Fox River Restoration: Review and Recommendations” connects the community to the Lower Fox River and Green Bay Restoration Plan, with suggestive criteria for future restoration proposals that bring attention to the issue, as well as encourage community involvement in the restoration efforts.

The Fox River restoration effort comes about as a result of industry practices that affected the river, most of which date back to the 1950s through the 1970s. The manufacturing and/or recycling of carbonless copy paper from several paper mills released polychlorinated biphenyls (PCBs) into the river via discharge water. PCBs are man-made compounds that attach to sediments, entering the food chain when bottom-dwelling aquatic life ingest the sediment. Eventually, PCB movement into humans is a result of contaminated fish consumption as PCBs are a bioaccumulating agent stored in the fatty tissue of game fish and waterfowl. The United States Environmental Protection Agency (EPA) has designated PCBs as known human carcinogens with non-carcinogenic effects on the nervous and reproductive systems of some mammals.

Despite the ban of PCB production in 1976 and dredging of the Lower Fox River, over 60,000 pounds of PCBs remain present in the river sediment. As a direct result of the release of PCBs, the Lower Fox River and Green Bay ecosystems have sustained substantial injuries, or adverse biological, chemical, or physical effects on natural resources, such as death, decreased population, or lost services. Impaired uses attributable to the existence of PCBs along the Fox River and Lower Green Bay Assessment Area include consumptive advisories on fish and waterfowl, reduced fecundity and reproductive performance for a number of bird species, and restrictions of dredging for hazardous waste transportation purposes.

In 1994 the United States Fish and Wildlife Service (U.S.FWS) proposed a Natural Resource Damage Assessment (NRDA) that would investigate, evaluate and quantify the injuries sustained to natural resources, with a goal of calculating monetary damages to be used in restoration of the lost resources. The NRDA was established

under the authority of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) [42 USC § 9601, *et seq*] and the Water Pollution Control Act [33 USC § 1251 *et seq*] with goals to restore the habitats and resources to the condition they would have been had the polluters not released hazardous substances, and to compensate the public for the loss of their use or enjoyment of natural resources (Charbonneau, 2003). The polluters are required to pay for these activities under federal laws and some state laws. The NRDA outlines restoration planning and provides a criterion for Trustees to evaluate and select possible projects to restore or replace injured natural resources.

Restoration has been defined as returning an ecosystem to a close approximation of its condition prior to disturbance. Successful restoration pinpoints both structure and function to ensure that the natural ecosystem will operate effectively. In the case of stream or river restoration, natural restoration may begin immediately with a change in land management practices such as, erosion control, removal of unnecessary dikes and levees, and reconnecting riparian zones and floodplains to the systems.

The Fox River Joint Restoration Project is one of the most highly funded NRDA efforts of its type. Negotiations are still being made with responsible parties, requiring the restoration funding to occur over an extended time frame. The assessment area of the restoration plan is the 39-mile stretch of the Lower Fox River, adjacent floodplains and ecologically associated uplands, all of Green Bay and adjacent coastal wetlands, and tributaries upstream to the first impoundment for both the River and the Bay, including the adjacent floodplains and ecologically associated uplands.

The improvements in the water quality of the assessment area is reflective of the framework created by the Clean Water Act, which limited overall point-source pollutants along the 39-mile stretch of the Fox River (Kraft and Johnson, 1999). Although PCB contamination will pose a major concern for the future, it will take decades of commitment to pollution prevention, cleanup of contaminants, habitat enhancement, and better land use management (Kraft and Johnson, 1999). However, the majority of water quality issues are related to nonpoint-sources such as agricultural runoff, which is attributed to nutrient loading and depleted coastal ecosystems. The cleanup of the

assessment area will be conducive with effective and efficient restoration efforts that seek to restore the water quality of the Lower Fox River and Green Bay area.

As a class, our purpose was to review the Joint Restoration Plan (§2.0), prepare recommendations regarding the future success of restoration projects, help to ensure the wise distribution of funding, initiate community involvement, and encourage a greater diversity of restoration project proposals. Specifically, this document addresses current restoration efforts and proposed projects (§3.0), develops criteria for project/proposal selection (§4.0), provides a methodology to monitor the success of restoration by use of indicators and internet based data display (§5.0), and defines the role of land acquisition in restoration (§6.0), which is accompanied by a land acquisition proposal.

**Figure 1.1: Restoration and Assessment Area**

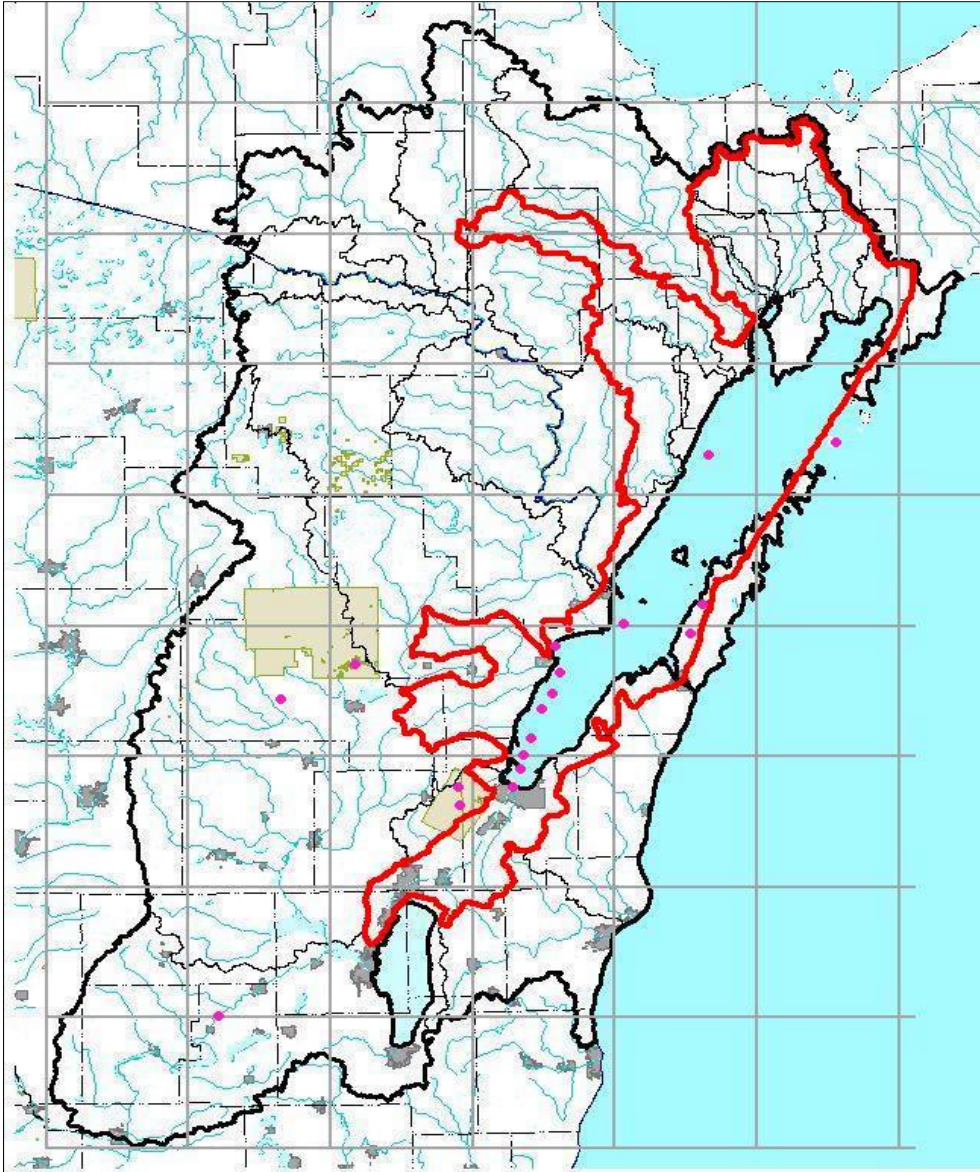


Figure 1.1: Adapted from Figures 1 and 2 of the Joint Restoration Plan.

## **2.0 Summary of the Joint Restoration Plan and Environmental Assessment for the Lower Fox River and Green Bay Area**

Federal legislation, including the Comprehensive Environmental Response, Compensation and Liability Act [42 USC § 9601, *et seq*] and the Water Pollution Control Act [33 USC § 1251 *et seq*], authorize states, federally recognized tribes, and certain federal agencies that manage or control natural resources, to act as trustees of the public within an affected region to restore, rehabilitate, replace, and/or acquire natural resources equivalent to those harmed by hazardous substance release. The assessment area for the Lower Fox River and Green Bay includes the 39-mile stretch of the Lower Fox River, all adjacent floodplains and associated uplands, all of Green Bay and the adjacent coastal wetlands, and tributaries upstream to the first impoundment for both the Fox River and Green Bay, including the associated uplands and floodplains.

The Trustees, who have collaborated to determine the measures necessary to address the natural resource injuries caused by the past releases of polychlorinated biphenyls (PCBs) into the affected region, include:

- Wisconsin Department of Natural Resources
- Oneida Tribe of Indians of Wisconsin
- Michigan Attorney General
- Michigan Department of Environmental Quality
- Menominee Indian Tribe of Wisconsin
- Department of the Interior: Fish and Wildlife Service (U.S. FWS), Bureau of Indian Affairs
- Department of Commerce: National Oceanic and Atmospheric Administration

The affected environment supports a diverse number of species including birds, fish, and mammals, some of which are rare, threatened, and/or endangered species. The Joint Restoration Plan summarizes the physical characteristics and biological environment necessary for sustaining wildlife.

Within the Joint Restoration Plan several alternatives for action were discussed to determine the priority of projects. Alternative A acts as the baseline scenario with which

to compare all other plans, which involves the Trustees taking no action. Alternative B is the Natural Resource Based Restoration, involving projects within the assessment area that will directly restore injured natural resources and provide enhanced ecosystem services or compensation for losses caused by the release of PCBs. Alternative B includes a variety of environments found within the assessment area to ensure a mix of natural resource restoration projects. To provide an array of ecosystem services throughout the Lower Fox River and Green Bay environment, four activities were highlighted:

- Wetland and Associated Upland Habitat Preservation
- The initiation of Fishery Resource Enhancement Projects
- The development of Aquatic, Near Shore, and Riparian Habitat Quality Improvement Projects
- The use of Natural Resource Based Public Use Enhancement Projects

Alternative C, Natural Resource Based Restoration within and beyond the assessment area, includes all activities outlined in Alternative B, as well as actions whose effects lie beyond the assessment area.

Project Proposals submitted to the Trustees for review will be given preference based upon the following criteria:

- Are not currently implemented
- Have no planned funding under other programs
- Provide long-term benefits that begin immediately
- Have a broad scope of measurable benefits
- Have a proportionate cost to benefit ratio
- Benefit more than one injured natural resource
- Use reliable, proven methodologies as opposed to experimental, unproven methods
- Have Tribal importance
- Avoid/minimize additional natural resource damage

The actions must be consistent with state and federal mandates and processes which mean that projects should be completed in a feasible, safe, and cost effective manner, address injured natural resources, consider actual and anticipated conditions, and

have likelihood for success. First priority of project proposals will be granted to those project within the 39-mile stretch of the Lower Fox River, second priority to the adjacent floodplain and ecologically associated uplands, third priority to all of Green Bay and its adjacent coastal wetlands and tributaries upstream to the first impoundment for both the river and the bay, and fourth priority to all those areas outside the assessment area of the river and bay.

The full Joint Restoration Plan, including information about how to contact the Trustees, plans for consultation and coordination with the public and others, and public comments, can be found at: [www.dnr.state.wi.us/org/water/wm/lowerfox/nrda.html](http://www.dnr.state.wi.us/org/water/wm/lowerfox/nrda.html).

### **3.0 Restoration Projects**

Restoration is a critical element of the Lower Fox River/Green Bay project. Restoration involves restoring, rehabilitating, replacing, and/or acquiring natural resources equivalent to those lost through release of PCB contaminants. Specific restoration projects have been selected to perform this function and are discussed in this section. We comment on the origins of restoration projects as well as review current restoration projects. The review of current projects includes an analysis of project locations, an evaluation of project categories, a cost comparison of projects, and a brief discussion restoration projects. In addition, proposed restoration projects under consideration are summarized.

#### **3.1 Origins of Selected Restoration Projects**

The *Restoration and Compensation Determination Plan (RCDP), Lower Fox River/Green Bay Natural Resource Damage Assessment*, published in October 2000, provides an extensive summary of the Trustees' initial planned approach for compensating the public for losses caused by the release of PCBs and restoring injured natural resources. Among other things, the RCDP served to formally merge previous natural resource injury determinations, complete economic valuations for damages, and present an assessment of the types and scales of restoration activities required to make the environment and public whole (Stratus, 2000). The RCDP was considered a significant milestone in the restoration process, as it culminated over six years of work on the U.S. Fish and Wildlife Service's Green Bay NRDA (Dean, 2000).

During the development of the RCDP, the Trustees conducted an extensive search to identify existing restoration-based planning efforts already conducted for the lower Fox River and Green Bay area. The search identified a broad range of documents providing numerous project proposals. Of the published sources identified during that literature review, the *Lower Green Bay Remedial Action Plan for the Lower Fox River and Lower Green Bay Area of Concern* and the *Green Bay Habitat Restoration Workshop: Summary 1994* were considered the most essential, as they included a significant number of proposed restoration projects, solicited input from a variety of

experts, and considered problems that affect the entire Green Bay ecosystem (Stratus, 2000).

In addition to published reports, the Habitat Restoration Workgroup, associated with the Science and Technical Advisory Committee, which has worked for over a decade to advise the Wisconsin Department of Natural Resources (WDNR) and others about conditions in the river and bay, provided substantial input in the identification of potential restoration projects. The workgroup consisted of professionals from several different agencies and organizations such as the WDNR, the City of Green Bay, the Green Bay Metropolitan Sewerage District, the University of Wisconsin-Green Bay, and the Oneida and Menominee Indian Tribes. The workgroup met through 1997 and 1998 and developed lists of potential restoration project proposals. The group also created a compilation of restoration project reviews, which summarized select projects, but also allowed members of the workgroup to recognize potential projects that had not yet been considered. The proposals and reviews were expected to provide the basis for the selection of future restoration projects (Stratus, 2000).

Restoration project proposals were also solicited from at least eighteen potential cooperating organizations, which are presented in Table 3.1.

**Table 3.1:**

<b>Agencies/organizations Contacted for Potential Restoration Project Proposals</b>	
Brown County Land Conservation Department	Oconto County Office of Land Conservation
Brown County Park Department	Oneida Tribe of Indians of Wisconsin
Clean Water Action Council	Outagamie County Land Conservation Department
Fox River Group of paper companies	University of Wisconsin-Green Bay
Fox-Wolf Basin 2000	U.S. Army Corps of Engineers
Menominee Tribe of Wisconsin	U.S. Fish and Wildlife Service
Michigan Department of Environmental Quality	Winnebago County Land Conservation Department
The Nature Conservancy	Wisconsin Department of Natural Resources
Northeast Wisconsin Land Trust	Wisconsin Waterfowl Association

Table 3.1; Adapted from *Restoration and Compensation Determination Plan (RCDP), Lower Fox River/Green Bay Natural Resource Damage Assessment*, Table 3.2, Pages 3-9, prepared by Stratus Consulting Inc., October 25, 2000.

After compiling all identified potential restoration projects in an electronic database, and removing duplicate efforts, the database contained a total of 621 distinct

resource-based restoration projects. The database provided project-specific information such as project location, project description, project goals, actions, and information sources (Stratus, 2000).

In April 1998, the 621 projects compiled in the project database were evaluated and ranked according to a process developed by the Trustees. The established criteria were based on existing NRDA regulations set forth in 43 C.F.R. §11.82 (d). The evaluation criteria were grouped into the following general evaluation categories (Hagler, 1998):

- Project acceptability
- Project focus
- Project implementation
- Project benefits

Of the original 621 identified projects, 471 projects received one of the following acceptability rankings; score of pass (P), more information/pass (MI/P), or more information required (MI) (Hagler, 1998). The remaining projects that did not receive a designation were removed from further consideration (Stratus, 2000).

To apply the remaining evaluation criteria (e.g., focus, implementation, benefits) a smaller set of “summary” projects was developed by grouping into three classes: nonpoint-source pollution control, habitat restoration, and water related human services (Hagler, 1998). These project categories were then scored against further Trustee ranking criteria, which produced a final set of restoration projects that constituted a preferred restoration alternative. At the time, project ideas included: restoration of select lost wetlands around Green Bay; preservation of select existing wetlands, and reduction of nonpoint-source pollution into Green Bay. Lastly, the Trustees developed a strategy for project implementation based on the type, number, size, and distribution of sites (Stratus, 2000). The development of a suite of restoration projects, distilled from the “Potential Restoration Projects Database,” was considered the starting point for the Trustees’ subsequent restoration planning steps (Hagler, 1998; Stratus, 2000), outlined in the previously discussed *Final Joint Restoration Plan and Environmental Assessment for the Lower Fox River and Green Bay Area* (Restoration Plan).

In the months prior to finalization of the Restoration Plan by U.S. FWS in 2003, the Restoration Technical Representatives Team (RT2), a subgroup of the Fox River/Green Bay Natural Resource Trustee Council, toured portions of the restoration area to evaluate the suitability of project proposals for restoration using NRDA funds. Project ideas reportedly under consideration at the time included protection of properties that provide habitat for a variety of native fish and wildlife species (including walleye, mallards, scaup, otter, and mink), and for a variety of rare plants, insects, and other bird species. The RT2 also evaluated project ideas with a focus on existing natural resource areas, which contribute to the overall environmental health of the restoration area (Nelson, 2003).

On June 3, 2003, when the Trustees met publicly for the first time, the implementation of seventeen restoration projects already underway was discussed (Fox River, 2003) and the projects were formally approved (Katers, 2003), along with the finalization of the Restoration Plan by the U.S. FWS (Katers, 2003; Swanson, 2003). The finalization of the Restoration Plan provided a formal outline, describing project categories “in which restoration projects must fit and the geographic area the plan covers: wetland reestablishment or preservation to provide habitat (homes) for fish and wildlife; aquatic quality improvement projects to restore and enhance habitat and recreational services; and direct resource restoration projects, such as those designed to improve fish reproduction and improvements to outdoor recreational facilities associated with the river banks or coastal habitat recreation, appreciation of education” (Swanson, 2003, p. 3).

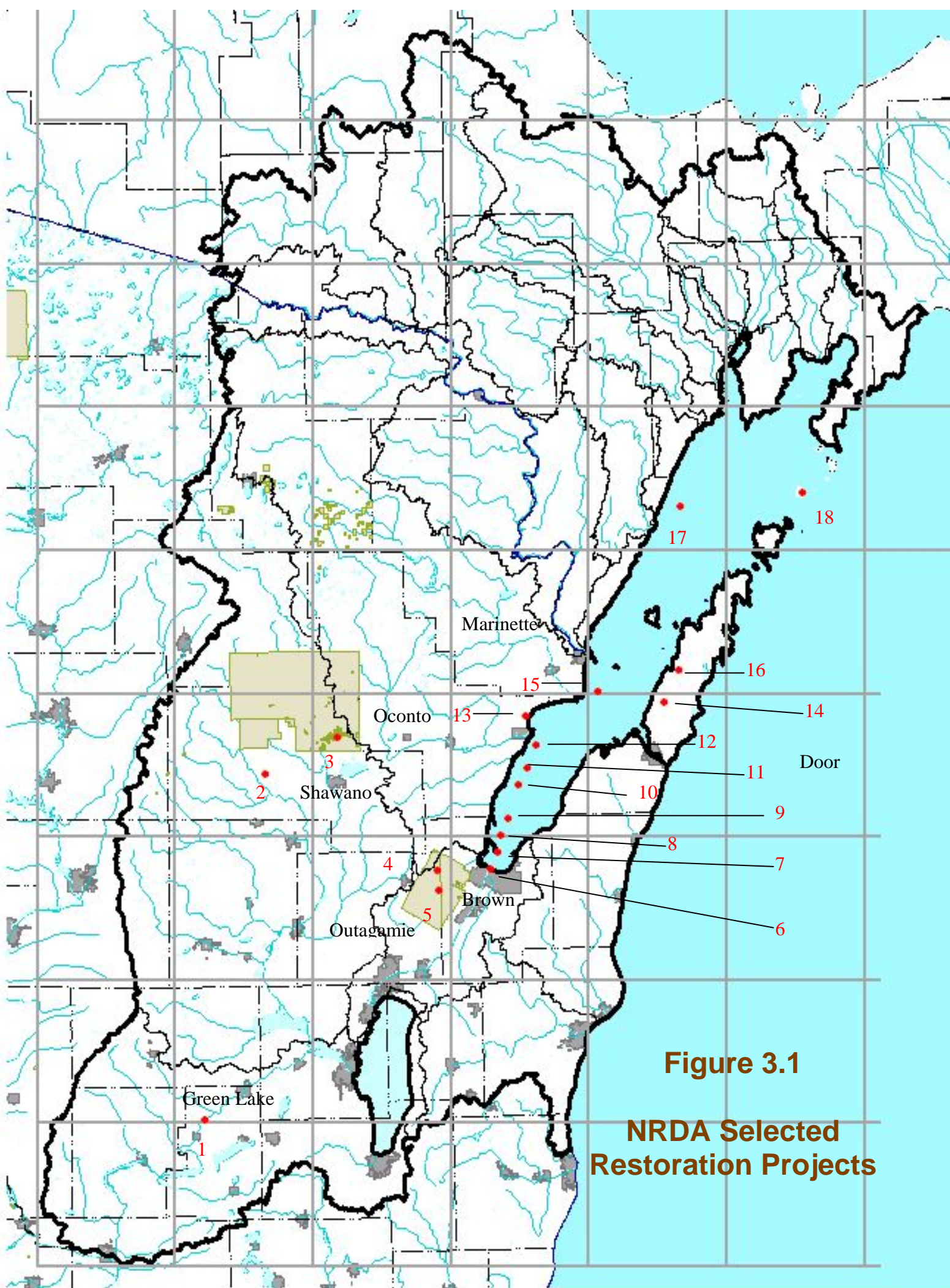
The formal finalization and approval of the Restoration Plan also established which restoration action (Alternative C) was to be implemented, and the distinct geographical region where restoration projects can occur. The geographical area defined in Alternative C includes the entire Lower Fox River and Green Bay watershed, including headwaters of all tributaries that flow into the system. The area includes portions of six Michigan counties, and twenty-three counties in Wisconsin, encompassing an area of approximately 6,349 square miles (Swanson, 2002).

### **3.2 Current Restoration Project Activities**

The Trustee Council has roughly \$20 million available from the interim partial NRDA settlement with Appleton Paper and NCR Corporation in 2003 (Katers, 2003). Approximately \$11 million from this interim settlement has been dedicated to current restoration activities. This \$11 million has funded eighteen restoration projects as summarized in Table 3.2; the project locations are indicated in Figure 3.1. Many of these projects were proposed a decade ago as part of the Green Bay Remedial Action Plan that reflected upon ecosystem health and social and economic conditions within the area (Kraft and Johnson, 1999).

**Table 3.2  
Summary of the Eighteen Funded Restoration Projects**

Map #	Title	Summary	Category	Location/ Location Ranking	Benefits	Schedule	Funds Requested	Contact
13	CARA Grant Match - West Shore Habitat Acquisition	Matching Grant to obtain northern pike spawning properties	Wetlands	West Shore of Green Bay	To preserve spawning and rearing habitat for fish	Not Listed	\$125,000 (CARA grant matching funds = \$500,000)	WDRN - Tom Penning
			Aquatic, Near-Shore & Riparian	#2 Green Bay and coastal wetlands				
2	Wolf River/Green Bay Habitat Preservation	Protect, preserve & enhance unique & threatened habitats - land acquisitions	Wetlands	Wolf River Basin, Door County & West Shore of Green Bay	Protect unique & threatened habitats.	Closings - 6/03	\$3,000,000	WDRN - Tom Penning
			Aquatic, Near-Shore & Riparian	#3 tributaries to the lower Fox River and Green Bay up to the headwaters				
8	Lower Green Bay Purple Loosestrife and Phragmites Control	Control purple loosestrife & phragmites	Aquatic, Near-Shore & Riparian	Lower Green Bay and associated shorelines #2 Green Bay and coastal wetlands	Control this evasive, exotic vegetative species that competes with native species	June - August 2003	\$100,000	Fish Wildlife Services Janet Smith
5	Duck Creek Watershed Model	Develop a strategy for restoring wetlands in the Duck Creek Watershed	Wetlands	Northeast WI, within the Duck Creek Watershed	Compensation of Oneida Tribe. Overall project goal is to create a sustainable fishery for the tribe	Not Listed	\$100,000	Oneida Tribe Tom Nelson
			Fisheries Resource Enhancement	#2 Green Bay and coastal wetlands				
4	Design of the 40-Acrea Lake Within the Exterior Boundaries of the Oneida Tribe	Design for the creation of a lake on Oneida Reservation	Fisheries Resource Enhancement	Northeast WI, within the Exterior Boundaries of the Oneida Tribe #2 Green Bay and coastal wetlands	Compensation to the Oneida Tribe. The lake will provide an uncontaminated fish source for the tribe.	In Progress	\$100,000	Oneida Tribe Tom Nelson
1	Fox River National Wildlife Refuge Native Grassland Restoration	Remove red pine trees & reestablish native grasslands	Wetlands	Upper Fox River, Marquette County #3 tributaries to the lower Fox River and Green Bay up to the headwaters	Reestablish native habitat for grassland birds, waterfowl & water bird (sandhill crane)	Tree Removal - 1/3 to 3/3 Grass planting - 6/3 to 9/3	\$150,000	Fish Wildlife Services Patti Meyers
3	Wild Rice Reintroduction Sustainability Study	Determine if a suitable habitat exists for reintroduction of wild rice	Aquatic, Near-Shore & Riparian	Menominee Indian Reservation #3 tributaries to the lower Fox River and Green Bay up to the headwaters	May provide wild rice production to the tribe. Also, general habitat benefits.	2003 -2004	Phase 1 = \$50,000 Phase 2 = \$30,000	Menominee Indian Tribe Douglas Cox
18	Green Bay National Wildlife Refuge Island Habitat Restoration Project	Study habitat and species on islands, develop management plan, remove exotic species & plant native species	Wetlands	Green Bay and Lake Michigan	Improve habitat for colonial bird nesting site & habitat of migratory birds.	Study Habitat - 5/3 to 9/4 develop plan - 9/4 to 3/5 remove exotic species & plant native species - 5/5 to 8/5	\$170,000	Fish Wildlife Services Patti Meyers
			Aquatic, Near-Shore & Riparian	#2 Green Bay and coastal wetlands				
14	Door County Habitat Preservation	Land acquisition of threaten lands	Wetlands	Door County	Preserved threatened lands that provide habitat for emerald dragon fly, shorebirds, bald eagles ...	Closing - 6/03	\$650,000 (\$694,000 in matching funds from TNC)	Fish Wildlife Services Colette Charbonneau
			Aquatic, Near-Shore & Riparian	#2 Green Bay and coastal wetlands				
16	Door County Fish & Wildlife Habitat Preservation	Land acquisition of threaten lands	Wetlands	Door County	Protect spring fed wetlands & possible bald eagle nesting area.	Closing - 10/03	\$1,459,000	Fish Wildlife Services Colette Charbonneau
7	Cat Island Chain Restoration Project - Modeling and Design Work for Project Construction	Modeling & Construction design for restoring the Cat Island Chain	Aquatic, Near-Shore & Riparian	Lower Green Bay	Restore barrier island chain that protect coastal wetlands. Migratory bird and other species are expected to benefit.	Modeling & design - 3/3 to 7/3 Construction - 2004	\$300,000	Fish Wildlife Services Janet Smith
			Wetlands	#2 Green Bay and coastal wetlands				
6	South Bay Marina - Habitat Enhancement Project	Install headland groin base structures	Aquatic, Near-Shore & Riparian	South Bay Marina	Provide valuable spawning habitat for walleyes & other predator species	Complete	\$98,000 (\$22,000 in matching funds from Walleyes for tomorrow)	WDRN George Boronow
			Fisheries Resource Enhancement	#2 Green Bay and coastal wetlands				
17	Lake Trout Population Enhancement	Provide funding to address maintenance and construction needs of fisheries.	Fisheries Resource Enhancement	Lake Michigan, Northern Green Bay #2 Green Bay and coastal wetlands	Ensure continued stocking of lake trout	Design - 1/3 to 6/3 Construction - 6/3	Phase 1 = \$300,000 Phase 2 = \$3,700,000	Fish Wildlife Services Mark Holey
15	Lake Sturgeon Habitat Restoration Limiting Factors	Study available options for improving spawning habitat	Fisheries Resource Enhancement	Tributaries to the Green Bay Watershed	Improve spawning habitat for Lake Sturgeon	Design - 1/3 to 6/3 Finalize study - 6/3 to 12/6	Phase 1 = \$50,000 Phase 2 = \$230,000	Fish Wildlife Services Mark Holey
			Aquatic, Near-Shore & Riparian	#2 Green Bay and coastal wetlands				
9	Great Lakes (Spotted) Musky Restoration Management	Restore spotted musky to the Fox & Green Bay	Fisheries Resource Enhancement	Lower Fox River & Green Bay #2 Green Bay and coastal wetlands	Increase spotted Musky population	Stocking - Fall 2003	\$75,000	WDNR Al Niebur
12	Great Lakes Musky Reintroduction and Enhancement	Restore native musky population	Fisheries Resource Enhancement	Waters of Green Bay #2 Green Bay and coastal wetlands	Restore native predator fish. Provide fish for sport fishing.	1/2003 to 6/2013	Phase 1 = \$50,000 Phase 2 = 200,000	Fish Wildlife Services Mark Holey
11	Assessment of Yellow Perch in Green Bay - Phase 1 - Workshop	Workshops on Yellow Perch	Fisheries Resource Enhancement	Bay of Green Bay #2 Green Bay and coastal wetlands	Provide information needed to reach a self-sustaining yellow perch population	Through 9/3	\$30,000	Fish Wildlife Services Mark Holey
10	Perch Management Options Evaluation	Evaluate white perch management plans. Monitor PCB concentrations in white perch.	Fisheries Resource Enhancement	Bay of Green Bay	Increase White perch populations	3-May	\$100,000	WDRN - Al Niebur WDRN - Bill Horns
				#2 Green Bay and coastal wetlands				



**Figure 3.1**  
**NRDA Selected**  
**Restoration Projects**

### **3.2.1 Restoration Project Locations and Categories**

The Joint Restoration Plan requires projects to meet certain location criteria. The location criteria are based on a ranking system, which gives preference to projects located in the Lower Fox River. The ranking system is outlined below, along with the breakdown of the current 18 projects.

- First priorities are the 39 miles of the Lower Fox River, adjacent floodplain and ecologically associated uplands (no official projects, but there are some being reviewed)
- Second priorities are Green Bay and adjacent coastal wetlands (15 projects)
- Third priorities are the tributaries to the lower Fox River and Green Bay up to the headwaters, including adjacent floodplains and ecologically associated uplands (3 projects)
- Fourth priorities are watersheds adjacent to the river systems in the first three priorities (0 projects)

Although the top priority was given to the Lower Fox River, no official projects from this area have been approved. One reason for the inability to find projects in this area may be related to the current use of this region. Most of the Lower Fox River is highly developed and sites in this area are not good candidates for restoration since they may be impacted by local industry.

Under CERLCA regulations, natural resource damage settlement funds can only be utilized for “restoration” (i.e., restoration, rehabilitation, replacement, or acquisition of the equivalent) of injured resources under trusteeship. Injured natural resources include surface waters, sediment, wildlife and associated ecosystems, fish, and cultural aspects of affected Indian Tribes (U.S. FWS, 2003).

The Trustees prefer to implement a blend of restoration projects that will provide an array of natural resource services throughout the Lower Fox River and Green Bay ecosystem, and those that may enhance a targeted group of outdoor recreational activities for local communities. Therefore, the Trustees endorse a variety of goals, which allows for the selection of a mixture of restoration project proposals from pre-defined categories. It is assumed that this approach will allow for greater flexibility for the selection of more feasible and cost-effective actions (U.S. FWS, 2003).

The Restoration Plan requires proposed restoration projects to fall under at least one of the following four broad categories.

- Wetland and Associated Upland Habitat Preservation, Reestablishment or Enhancement Projects
- Fishery Resource Enhancement Projects
- Aquatic, Near Shore and Riparian Habitat Quality Projects
- Natural Resource-Based Public Use Enhancement Projects

*Wetland and Associated Upland Habitat Preservation, Reestablishment or Enhancement*

Wetlands and associated upland areas provide a variety of habitat types depending on the vegetative and hydrologic characteristics present. Wetlands demonstrate a great deal of biological richness and diversity, and are an essential feature of the environment. In the natural state, wetlands provide a range of habitat for a great variety of wildlife species, including threatened and endangered species. Numerous bird species use wetland features for food, cover, nesting, and loafing habitat, along with reptiles, amphibians, and insects. Wetlands also serve as habitat for a range of fish species, including not only important game and predatory species, but also smaller forage species on which multitudes of wildlife species are dependent (Hey, 2000).

Acquisition, preservation, and enhancement of existing wetlands; restoration of wetlands; and creation of new wetlands are some important projects identified in the preliminary NRDA phases, and are currently being implemented or considered to restore lost habitat in the restoration area. In preliminary proposal rankings, projects designed to preserve, enhance, or create wetlands received high relative rankings among participants (Hey, 2000). Although not necessarily intrinsically linked to ecological functions damaged by the release of PCBs, wetlands and associated upland habitat restoration activities will provide similar services to those lost by improving spawning, nesting, nursery, and loafing habitat for a variety of fish, birds, and other wildlife (U.S. FWS, 2003).

The Trustees' preliminary wetland goals are to preserve approximately 9,900 acres, and enhance or reestablish approximately 3,300 acres in the defined Lower Fox River and Green Bay restoration area. To preserve wetlands, the Trustees intend the focus on acquiring and managing select coastal wetlands, wetlands in densely populated areas, and wetlands of high quality. Preservation will be achieved primarily through fee

title purchase or conservation easements, with acquired property deeded to various governmental entities, non-governmental organizations, or land trusts. To reestablish and enhance wetlands and associated uplands, the Trustees intend to concentrate effort where ecological modifications have destroyed or impaired such areas. Degraded wetlands and associated habitats located in bay coastal areas, within floodplains, and in the vicinity of other natural areas will be given priority. Reestablishment and enhancement goals may be achieved through the closing or disrupting drainage features (i.e., ditches, tile systems), and the establishment of native wetland and upland vegetation (U.S. FWS, 2003).

Although the Restoration Plan places restoration projects into one of four explicit categories, most projects meet multiple category criteria (dual category projects). Currently, one (1) formally accepted restoration project proposes wetland and associated upland habitat reestablishment exclusively – the *Fox River National Wildlife Refuge Native Grassland Restoration*. Seven of the selected projects address wetlands and associated upland habitat to varying degrees, in conjunction with at least one other primary project category.

#### *Fishery Resource Enhancement*

The restoration area encompasses one of the most productive fishery resources in the Great Lakes region, and is of central importance to the Trustees, as this resource is a primary food base for numerous avian and terrestrial wildlife species in the Green Bay area. Nationally, as defined by the *Great Lakes Fish and Wildlife Restoration Act*, the restoration area holds significant fish stocks, including lake trout, yellow perch, walleye, and lake sturgeon (Stratus, 2000). However, the abundance and variety of fish species that historically inhabited the region has changed significantly due to a variety of human impacts. Impacts to regional fish communities is evidenced by the scarcity of top predatory species and reduction of native forage species, in conjunction with the influx of invasive and exotic species such as carp, alewife, and white perch (U.S. FWS, 2003).

The primary goal of the Trustees for fishery resource enhancement projects is the establishment of self-sustaining and healthy fish populations in the Lower Fox River and Green Bay environment (Swanson, 2002; U.S. FWS, 2003). According to the

Restoration Plan, “Top fish predators are important components of a fish community to maintain stability and integrity of the fish community. The loss of top predators in Lake Michigan allowed exotic alewife to increase in abundance to the point where they are considered a nuisance and liability to society”. As such, the Trustees place high value on predator enhancement restoration projects designed to increase the diversity and population of top predatory species, and promote fish community integrity. Projects that aim to effectively control aquatic nuisance species will also be given priority (U.S. FWS, 2003).

A total of six approved projects are explicitly related to fisheries resource enhancement. Three additional projects are related to fisheries to some degree, which are considered dual category projects.

#### *Aquatic, Near Shore and Riparian Habitat Quality*

Hazardous substances, encroachment, and fragmentation of habitat due to human activities have all contributed to the impairment of aquatic and riparian habitat of tributaries of the Lower Fox River and Green Bay. The RCDP, remedial action plans, and other primary research documents highlight the importance of water quality to the overall health of the region, and provide suggestions to improve water quality, such as implementation of nonpoint source pollution control programs (Stratus, 2000; U.S. FWS, 2003).

The Trustees recognize and acknowledge the importance of water quality in the environment; however they intend to limit the use of restoration funds to protecting, reestablishing, or enhancing critical aquatic habitats, such as spawning and nursery habitats for native species, wildlife barrier islands, stream island oak savanna habitats, stream bank corridors with native vegetation, and stream bank stabilization. The Trustees do not intend to supplement existing extensive nonpoint source pollution programs as a means of restoration (U.S. FWS, 2003), although the Restoration and Compensation Determination Plan (RCDP) suggested specific restoration activities include promoting conservation tillage and the installation of buffer strips along tributaries (Stratus, 2000). The Trustees’ logic for ignoring actions directly related to nonpoint-source pollution appears to be based on an understanding that existing agricultural runoff, storm water,

and urban nonpoint-programs currently coordinated by the WDNR's Office of Water are adequate, and restoration funding is not justified in these project areas. Therefore, preference will be given to habitat projects not otherwise funded.

For aquatic, near-shore, and riparian restoration projects, the Trustees overall goal is "the protection, reestablishment, or enhancement of approximately 12,000 acres of aquatic, near shore, and riparian habitat in the Lower Fox River and Green Bay environment" (U.S. FWS, 2003). The goals for this category are in addition to goals set forth in the other restoration categories, and are subject to change as the availability of restoration funds, restoration opportunities, and costs will vary over time (U.S. FWS, 2003).

Currently, two project proposals dedicated to aquatic, near-shore, and the Trustees have formally accepted riparian restoration projects. An additional eight accepted projects are related to this category to some degree, in conjunction with at least one other project category.

#### *Natural Resource-Based Public Use Enhancement*

The natural resource-based public use enhancement project category includes "improvements of outdoor recreational facilities at existing parks or the development of new parks associated with river or coastal habitat recreation, appreciation or education" (Swanson, 2002, pp.7). Projects in this category may include improvements to (U.S. FWS, 2003):

- Boat ramps/shore fishing
- Biking and hiking trails along waterfront
- Educational signage, kiosks, or other construction promoting environmental education

The types of improvements listed above are intended to compensate the public for aquatic habitat services that are similar to, but not the same as, those lost or impaired by the release of PCBs in the Lower Fox River and Green Bay area. The Trustees will not support public use enhancement projects that do not provide for ecological benefit; rather, projects proposals designed to divert high intensity public use activities away from

ecologically sensitive areas will be considered. Projects aimed to develop new parks in the area are not omitted from consideration, but would require additional documentation evaluating environmental impacts (U.S. FWS, 2003).

The Trustees intend to designate less than ten percent of the total restoration funding to improvements of park facilities in the restoration area (Swanson, 2002; U.S. FWS, 2003). The limited resources dedicated to this category may be based on the premise that the public will be sufficiently compensated by the implementation of projects residing in other categories. According to the RCDP, “The value to the public of the improvement in the environment that will be attained through wetland preservation, wetland restoration, and nonpoint source pollution reductions is balanced with the value of the resources and services lost to the public because of the PCB injuries” (Stratus, 2000, pp. 1-6). Currently, there are no natural resource-based public use enhancement restoration projects approved by the Trustees.

### **3.2.2 Evaluation of Restoration Categories for Funded Projects**

The Joint Restoration Plan requires that projects fit into the four different categories previously described. Some projects emphasize activities that fall into more than one category. The four different categories and dual categories are listed below:

- Wetland and associated upland habitat preservation, reestablishment or enhancement projects (1 project)
- Fisheries resource enhancement (6 projects)
- Aquatic, near-shore and riparian habitat quality improvement projects (2 projects)
- Natural resource-based public use enhancement projects (0 projects)
- Wetland and associated upland habitat preservation, reestablishment or enhancement projects/fisheries resource enhancement (1 project)
- Wetland and associated upland habitat preservation, reestablishment or enhancement projects/aquatic, near-shore and riparian habitat quality improvement projects (6 projects)
- Aquatic, near-shore and riparian habitat quality improvement projects/ fisheries resource enhancement (2 projects)

The breakdown indicates that fishery projects and a combination of wetland and associated upland habitat preservation, reestablishment or enhancement projects/aquatic, near-shore and riparian habitat quality improvement projects were the most prevalent

categories accepted. This may imply that the Trustees favor projects that accomplish multiple goals and supply multiple benefits. After analyzing the benefits and summaries of the projects within a specific category, they also indicate similarities. For example, out of the six fishery projects, two were intended to restore a certain fish population, two were designed to complete a specific study about a certain fish population, and the other two emphasized the construction and maintenance of fishery facilities. The wetland and associated upland habitat preservation, reestablishment or enhancement projects/aquatic, near-shore and riparian habitat quality improvement projects showed a tendency toward the preservation/protection and restoration of certain habitats or species. The other categories indicated similar goals and benefits: restoration, protection, and preservation of habitats and species.

There have been no projects selected from the natural resource-based public use enhancement projects. Since the goal of the Joint Restoration Plan is to provide a broad range of projects, future projects should target this category. In addition, as part of the proposed Georgia-Pacific settlement, the following projects would be funded which fall under this recreation category (Balas, 2003):

- The acquisition of a designated 30-acre parcel off a park in the Village of Allouez
- Construction of a 1,000-foot-long scenic trail along the west side of the East River (it would serve as the Allouez portion of the East River Trail Development Project)
- Construction of a one-mile-long scenic trail along the west side of the Fox River, which will be known as the Fox River Riverwalk
- Improvement of an existing trailhead facility at the north end of the East River Parkway Trail in the town of Bellevue
- Acquisition of river frontage along the East River and construction of a twelve-foot-wide pedestrian/bike trail in the town of Bellevue

### **3.2.3 Restoration Project Cost Comparison**

The eighteen projects were reviewed to determine what types of projects have received the most funding. The distribution of funds is summarized in Table 3.3

**Table 3.3** Distributions of Funds

Land Acquisition	\$5,234,000
Construction (fisheries projects)	\$4,098,000
Models, designs, and studies related to future restoration construction projects	\$665,000
Studies and workshops (fisheries projects)	\$410,000
Remove exotic species/ Restore native species	\$335,000
Fish Stocking	\$325,000

As evident from the Table 3.3, land acquisition is the most funded type of restoration project to date. Most land acquisitions target properties that would otherwise be sold to developers; therefore, the high costs may be due to developers' pricing. In addition, the Joint Restoration Plan has a high goal of preserving 9,900 acres, to be completed mostly through land acquisition. Construction projects are also very costly. One of the fisheries construction projects, The Lake Trout Population Enhancement Project, has a total cost of \$4 million. This project involves construction and maintenance at four national fisheries in the restoration area. In addition, roughly \$440,000 is being funded for studies and workshops related to fish management. Projects dedicated to removing exotic species, restoring native species, and stocking fish have received less funding. This is most likely due to the uncertain long term benefits, since exotic species may return, restored native species may be overrun by non-native species, and fish populations are not guaranteed to increase through restocking.

Three of the funded projects have matching funds from the government or special interest groups. Through funding the CARA [Conservation and Reinvestment Act] Grant Match project, the restoration project is providing local cost share of a federal project (2). The matching funds from special interest groups shows that these groups support the restoration effort.

### **3.3 Select Restoration Project Descriptions**

Restoration projects are selected and implemented through a collaborative effort between the Trustees and cooperating partners, such as local municipalities, county and local governments, tribal governments, select private nonprofit organizations, and other state and federal governmental programs promoting restorative-type actions. The Trustees have all established work planning and project management capabilities, routinely used for their base work efforts (U.S. FWS, 2003), and have also developed a broad network of relationships with potential partners. To that end, “It is the desire of the Trustee Council to utilize existing management processes within trustee agencies for implementing restoration projects. The Trustee Council does not intend to create an NRDA-specific bureaucracy for the implementation of restoration projects” (WDNR, 2003). Furthermore, the Trustees expect that the partners will work through existing resource management programs and professional resource managers, and cooperative projects designed to utilize these resources are highly encouraged (U.S. FWS, 2003).

Several projects formally approved by, and directly “sponsored” by, various Trustees are discussed in the following section. As the restoration projects were only approved in June 2003, information regarding project implementation and status is not readily available. Additionally, there are currently no reporting requirements for the recipients of restoration damages, limiting the amount and type of project information currently available. It is anticipated that as restoration projects near completion, comprehensive reports will be generated and made available to the public.

General information regarding the currently funded restoration projects can be accessed from the *Lower Fox River – Natural Resource Damage Assessment* website, located at <http://www.dnr.state.wi.us/org/water/wm/lowerfox/nrda.html>. The website provides a variety of information and other links regarding the current status of the NRDA, with a special emphasis on public education. According to Greg Hill, NRDA coordinator for the WDNR, “one extremely valuable part of the page is that it gives the public the opportunity to examine projects that have been funded so far. It also provides organizations with instructions and examples of how they may submit restoration project proposals to the trustees for consideration” (WDNR, 2003).

### 3.3.1 Sample Projects Sponsored by the Oneida and Menominee Indian Nations

Both avian and fishery resources of the Lower Fox River and Green Bay ecosystems provide essential food and cultural significance to the Oneida Tribe of Indians of Wisconsin and the Menominee Indian Tribe of Wisconsin. Upon relocation of the Oneida people from New York to a reservation near Green Bay, most of their animal protein was obtained from local game including waterfowl, wild turkey, and other small game animals. Additionally, many local bird species played an important spiritual role in the lives of both the Oneida and Menominee people. Annual fish migrations were historically a center for cultural and community gatherings for the Oneida people, and also provided a means for supplemental income. Likewise, the lake sturgeon is a valuable resource for the Menominee, providing both a food source and a strong cultural and spiritual symbol (Stratus, 2000).

The *Design of the 40-acre Lake within the Exterior Boundaries of the Oneida Reservation* is one of three Tribal related projects currently funded by legal agreements between the Fox River/Green Bay Natural Resource Trustee Council. The overall intent of this project is to design a self-sustaining lake ecosystem that will provide the Oneida Tribe with environmental and cultural services that have been lost due to the release of PCBs to the environment, most specifically related to losses associated with Fish Consumption Advisories (Nelson, 2003b; WDNR, 2003).

Initial time estimates for completion of the design and subsequent construction of the lake are four to five years, with the establishment of a sustainable fishery within ten years. The establishment of this fishery will provide compensation to the Oneida community decades before a safe Green Bay fishery is established. To date, a third party consultant has identified and assessed five potential sites, two of which have been eliminated because of groundwater issues. The remaining three sites are currently under consideration. Additional sites are also being investigated, with the collection of groundwater, soil, and land use data. Community meetings and listening sessions with elders, schools, the Oneida Land Commission, and Oneida Nation Environmental Resource Board (ONERB) have also yielded additional cultural and recreational preferences, which the consultant may incorporate into a final location and lake design

(Nelson, 2003c). The final design is expected to be complete in approximately three years (Balas, 2003).

Another project sponsored by the Oneida Tribe is the *Duck Creek Watershed Model*. The overall goal of the project is to develop a strategy to augment the flow of Duck Creek and associated wetlands to improve the injured river fishery. Prior to the construction of upstream dams, draining of wetlands, and land-use impacts, the Oneida Tribe utilized the entire length of Duck Creek for a fishery and cultural gatherings. Restoration of affected wetlands and associated riparian habitats is anticipated to increase flow to the river, reduce sedimentation and nutrient influx, and reduce water temperatures, while restoring lost habitat for culturally significant fish and wildlife (Nelson, 2003).

Initial time estimates to full restoration of Duck Creek vary from five to twenty years, contingent on available funding and implementation of restoration efforts; however, progress on the project has been slower than anticipated due to lack of staffing and internal politics. Modeling efforts that have been completed to date indicate that land-use in the Duck Creek corridor has been significantly impacted, and wetland restoration alone will not adequately restore base flow to a level that will sustain a viable fishery (Nelson, 2003). A previous wetland model generated by the University of Wisconsin indicated that approximately 750 acres of wetland restoration would be necessary to stabilize flows leading to a sustainable fishery (WDNR, 2003). The restoration strategy now reportedly includes the possibility of the construction of flow control structures on select river tributaries (Nelson, 2003).

The third Tribal project currently funded is the *Wild Rice Reintroduction Suitability Study*, a multi-phase venture proposed by the Menominee Indian Reservation. The proposed study aims to assess the general decline of wild rice habitats on fifteen to twenty lakes that have remnants of wild rice, or are known to have sustained wild rice in the past, and to identify potential reseeding efforts. Both natural and human impacts to wild rice will be assessed in an effort to determine suitable habitat for wild rice reintroduction. Subsequent phases include purchasing and planting seed and the application of the selective herbicide 2,4-dichlorophenoxy acetic acid (WDNR, 2003).

In addition to initiating wild rice production on the reservation, expected benefits include increased habitat for waterfowl and other wildlife species (e.g., otter, beaver, mink, song birds, and raptors), and cultural, spiritual, and educational benefits to the community (WDNR, 2003)

### **3.3.2 Sample Projects Sponsored by the WDNR and/or U.S. FWS**

As discussed, the WDNR and the U.S. FWS are currently implementing numerous fisheries, wetland, and aquatic habitat projects in the Lower Fox River and Green Bay. Fisheries related efforts include examination of various fish populations and enhancement or reintroduction activities directed toward the Great Lakes (spotted musky, lake trout, yellow perch, and lake sturgeon (WDNR, 2003; Balas, 2003). Wetlands and aquatic habitat related activities include restoration and preservation through land acquisitions. Examples of WDNR and U.S. FWS projects are discussed below.

#### *Assessment of Yellow Perch in Green Bay; and Perch Management Options Evaluation*

Yellow perch populations in Lake Michigan, including Green Bay, have significantly declined in the past decade (Charbonneau, 2003), a phenomenon that has continued to puzzle local fishermen, scientists, and conservationists (Balas, 2003). Although some have speculated that the underlying cause for poor recruitment of young fish is due to a combination of the invasive zebra muscle and white perch (Balas, 2003), the true cause remains unknown.

In a June, 2001 correspondence, the Lake Michigan Fisheries Forum (Forum) was informed by the WDNR Secretary Darrel Bazzell that \$200,000 had been committed to future yellow perch restoration efforts and general fisheries management in the Green Bay area (UWSG, 2003). At the request of the Secretary Bazzell, the Forum, undertook the task of planning a series of workshops “that would bring together North American experts and interested citizens with a goal of identifying potential causes of the decline in yellow perch populations in Green Bay and developing management or study projects to begin to address the problems” (UWSG, 2003). With the assistance of a third party facilitator, the Forum determined that a three-workshop format would be most

appropriate to address the challenge, allowing for the transition from a broad to narrow focus as the meetings progressed. The resulting series of yellow perch workshops were conducted by the Forum on March 16, April 20, and May 18, 2002 (UWSG, 2003), and were “open to anyone interested in the fate of the yellow perch” (Charbonneau, 2003, pp. 4).

In general, the three workshops determined that participants desired to conserve existing yellow perch stocks through improved management programs and expanded understanding of habitat and predatory influences. Additionally, both Forum members and workshop participants expressed the importance of reexamining methods employed to assess yellow perch abundance (WDNR, 2003). In response, with a focus toward assessing the non-human factors affecting yellow perch, the U.S. FWS and WDNR submitted restoration project proposals to the Trustees to investigate yellow perch assessment and gather data from the mouth of the Fox River and southern Green Bay (Charbonneau, 2003). The projects accepted and currently funded include the *Assessment of Yellow Perch in Green Bay* (sponsored by U.S. FWS) and the *Perch Management Options Evaluation* (sponsored by the WDNR).

In cooperation with the WDNR, the U.S. FWS have proposed to develop an updated statistical “catch-at-age” model of yellow perch in Green Bay, review the temporal and spatial scale of current yellow perch assessment methods, and assist in the review and consolidation of yellow perch data into an electronic format (WDNR, 2003). The agencies have begun to compile twenty-five years of yellow perch assessment and harvest data, with the U.S. FWS consolidating available information into an electronic database. With the electronic available data, the U.S. FWS is developing statistical population models to analyze the information (Charbonneau, 2003). According to Mark Holey, project leader of the U.S. FWS Green Bay Fisheries Office, “The modeling results should help the DNR better identify which of the many potential factors are most limiting to yellow perch in Green Bay and focus management efforts to overcome them” (Charbonneau, 2003, p. 5). Recommendations from the Forum workshops will be further addressed (Charbonneau, 2003).

According to a recent article appearing in the *Fox River Current*, “Thanks to information gathered from projects supported by the Lower Fox River/Green Bay natural

resource damage assessment, fishery regulations will be reviewed this year and next” (Charbonneau, 2003, p. 4). Other anticipated benefits include providing for better management decisions relating to future NRDA damages, as well as improved fisheries management decisions directly related to yellow perch, in the interest of meeting the overall goal of achieving self-sustaining fish populations (WDNR, 2003).

*Great Lakes Spotted Musky Reintroduction and Enhancement Project; and the Great Lakes (Spotted) Musky Restoration Management Project*

A primary goal of the Trustees, in terms of fishery resource enhancement projects, is the establishment of self-sustaining and healthy fish populations in the Lower Fox River and Green Bay environment, with a special emphasis toward top predatory species (U.S. FWS, 2003; Swanson, 2002). According to the Restoration Plan, “Top fish predators are important components of a fish community to maintain stability and integrity of the fish community. The loss of top predators in Lake Michigan allowed exotic alewife to increase in abundance to the point where they are considered a nuisance and liability to society” (p. 11). The *Great Lakes Spotted Musky Reintroduction and Enhancement* (sponsored by U.S. FWS) and *Great Lakes (Spotted) Musky Restoration Management* (sponsored by WDNR) are two restoration actions currently underway, focusing on the restoration of native and top-level predators to the Green Bay aquatic environment (WDNR, 2003).

The WDNR currently has a program in place for the enhancement of the Great Lakes (spotted) Musky into the Fox River and Green Bay. Through past fish stocking efforts the WDNR has observed some level of success demonstrated by the increasing presence of spotted musky in the fishery. Based on the positive results observed after initial stocking efforts, the WDNR intends to “focus more funding and effort toward obtaining appropriate brood stock and enhancing the reintroduction efforts for Great Lakes spotted musky” (WDNR, 2003). With damage funds dedicated to the *Great Lakes (Spotted) Musky Restoration Management* project, the WDNR is enhancing their brood stock sampling and egg collection, along with hatchery rearing at the Wild Rose Hatchery for release into the Green Bay ecosystem. An initial goal of rearing 15,000 to 20,000 large musky fingerlings has been established (WDNR, 2003).

The *Great Lakes Spotted Musky Reintroduction and Enhancement* project is also enabling the U.S. FWS Green Bay Fishery Resources Office to cooperate with the WDNR in efforts to restore the spotted musky by planning the collection and transport of muskellunge eggs from wild donor populations. Potential donor populations include the St. Lawrence River, Lake Huron, and Lake St. Clair in Michigan. All U.S. FWS project work would be performed in cooperation with the WDNR (WDNR, 2003).

An additional U.S. FWS predator species project, *Lake Trout Population Enhancement*, is designed to address maintenance and construction needs of National Fish Hatcheries located in Iron River, Wisconsin and Jordan River and Pendill's Creek, Michigan. Funds will provide for engineering design work, replacement of raceway covers, construction of new rearing facilities, and installation of liquid oxygen equipment for increased water quality. The project "will ensure future benefits to both restoration and harvest in the waters of Lake Michigan and northern Green Bay" (WDNR, 2003).

#### *South Bay Marina-Habitat Enhancement Project*

The *South Bay Marina-Habitat Enhancement Project*, a dual aquatic habitat improvement and fisheries enhancement project, is near completion. Sponsored by the WDNR in partnership with Walleyes for Tomorrow and the owner of the South Bay Marina, the project aims to provide for habitat protection and improvements along degraded waterfront along in the South Bay of Green Bay. Structures known as "headland groin base structures" were installed as part of new construction at the South Bay Marina. Installation of these structures is expected to provide valuable spawning habitat for walleye and other predatory species, consistent with the Trustees' restoration priorities. Funds were used for the installation of groin structure fill, and for stone and boulders to armor and enhance spawning habitat (WDNR, 2003). Once fill material is tied into the groin base from shore, the project will be complete.

#### *Fox River National Wildlife Refuge Native Grassland Restoration*

The Fox River National Wildlife Refuge (NWR) is a 1,004-acre satellite wildlife refuge located ten miles north of Portage in Marquette County, Wisconsin. Established in 1979, the refuge is primarily administered by staff located at the Horicon NWR near

Mayville, Wisconsin. The Fox River NWR consists primarily of wetland features such as shallow marshes, sedge meadow, fens, and wet prairie wetlands, intermingled with associated upland habitat along the riparian floodplain of the Upper Fox River. This matrix of wetland and upland areas provides essential habitat for a variety of wildlife, such as the greater sandhill crane, herons, rails, ducks, songbirds, whitetail deer, wild turkey, and bobwhite quail. Migrant waterfowl and other migratory birds also use the area for nesting and loafing habitat, feeding, and as a rest area during annual migrations (U.S. FWS, n.d.; WDNR, 2003.).

The refuge was originally established to protect nesting habitat for the sandhill crane (WDNR, 2003), and today, it provides summer harborage for over fifty greater sandhill cranes and a staging area for over 300 cranes during the fall migration (U.S. FWS, n.d.). However, prior to ownership by the federal government, a segment of the land area was established as a red pine plantation. This type of artificially created ecosystem is not conducive for use by sandhill cranes, migratory grassland birds, or waterfowl. In an effort to restore the Fox River NWR, the U.S. FWS requested funds to remove the red pine trees and reestablish native grassland species, to create a habitat similar to what was historically available (WDNR, 2003).

The *Fox River National Wildlife Refuge Native Grassland Restoration Project* is currently funded and under implementation. The refuge is formally managed for the first time since inception, five acres of pine trees have been logged, baseline wildlife surveys are in progress, wetlands are being restored via ditch modification, and efforts to reestablish Oak Savannah uplands and Sedge Meadow wetlands are underway. Funding is also expected to provide a full-time Wildlife Biologist dedicated to the facility for the next three years (U.S. FWS, n.d.).

#### *Wolf River Basin, Door County, and the West Shore of Green Bay Preservation*

The WDNR “has numerous project boundaries established for the purpose of protecting, preserving and enhancing the unique and threatened habitat of fisheries and wildlife resources within the restoration area of the Lower Fox River/Green Bay project area” (WDNR, 2003). Project boundaries are areas of land that have been identified for potential acquisition in a feasibility study or master plan. Boundaries are established on a

map to highlight areas that are likely to contain valuable natural resources, may improve public access to natural areas, or may provide for education or further recreational opportunities (WDNR, 2000).

Property within these formally established boundaries are then further targeted by the WDNR for purchase over an extended period of time (WDNR, 2000). Properties of interest in the restoration area, for the purpose of preservation through management, are located within the Green Bay West Shores Wildlife Area, the Lower Wolf River Bottomlands Natural Resource Area, and the Washington Island Wetlands (WDNR, 2003). Land acquired through this process will ultimately be deeded to federal, state, tribal or local governments, non-governmental organizations, or land trusts (U.S. FWS, 2003). The Natural Resources Board must approve establishment of new project boundaries, and new properties must receive Governor approval. In both cases, public interests are considered (WDNR, 2000).

The WDNR is currently funded through restoration damages and is actively working toward acquiring coastal wetlands, wetlands in highly populated areas, and wetlands of high natural value (WDNR, 2003). Properties within the project boundaries will be obtained through fee title purchase, and will be solicited from willing sellers only (U.S. FWS, 2003). The U.S. FWS is also working in collaboration with The Nature Conservancy's Door Peninsula staff to obtain significant habitat in Door County, primarily in the Mink River and Bay Shore Bluff Lands project areas. To date, over \$5,000,000 of restoration funds has been granted to the WDNR, and over \$2,000,000 to the U.S. FWS, for the purpose of land acquisitions. Due to the delicate nature of property transactions, the status of the WDNR and U.S. FWS land acquisitions is unknown. To date, the Trustees have only discussed specific properties or property contract negotiations in executive sessions not open to the public (Nelson, 2003d).

### **3.4 Potential Restoration Projects**

Fifty-four additional project proposals have been submitted. They have not been approved for funding, and most do not contain sufficient information. The meeting minutes of the trustee council indicate that the sponsors of these proposals will be contacted for further development of their projects (Fox River, 2003).

Thirty-four out of the fifty-four proposed projects have been reviewed to determine the category in which the proposed project. As found with the funded projects, many of the proposed projects fall under more than one category. The breakdown of thirty-four projects is outlined as follows as well as in Table 3.4:

- Fisheries resource enhancement (11 projects)
- Wetland and associated upland habitat preservation, reestablishment or enhancement projects(14 projects)
- Wetland and associated upland habitat preservation, reestablishment or enhancement projects/aquatic, near-shore and riparian habitat quality improvement projects (1 project)
- Aquatic, near-shore and Riparian habitat quality improvement projects/ fisheries resource enhancement (2 projects)
- Natural resource-based public use enhancement (2 projects)
- Wetland and associated upland habitat preservation, reestablishment or enhancement projects/natural resource-based public use enhancement (2 projects)
- Natural resource-based public use enhancement / fisheries resource enhancement (2 projects)

**Table 3.4**

<b>Proposed Projects</b>	<b>Project Categories</b>
Bay Beach Wildlife Sanctuary Surface Water and Shoreline Habitat Restoration Project	Fishery Resource/Natural Resource-based Public Use
Wolf River sturgeon trail	Fishery Resource/Natural Resource-based Public Use
Installation of accessible fishing pier at Potowatomi State Park in Sturgeon Bay	Natural resource-based Public-use
Building removal from Cattail Marsh, Delta City, Michigan	Natural resource-based Public-use
Prairie restoration of upland sites near wetlands, waterways and rivers near Calumet and Manitowoc	Wetlands
Snake Hibernacula restoration & creation in the Brillon WA	Wetlands
Wetland restoration on Killsnake WA & enhancement on Brillon WA	Wetlands
Oconto Marsh Pump and Water replacement	Wetlands
Wolf River Bottoms WA-K&S Unit	Wetlands

Terrel's Island Habitat Restoration Area Waterfowl Product and Shorebird Enhancement	Wetlands
Common Tern nesting island	Wetlands
Managing the source-High quality state Natural Areas in Upper Fox/Wolf River basins	Wetlands
Brillon WA Waterfowl Enhancement Project	Wetlands
Common Tern nesting habitat enhancement project	Wetlands
Uihlein Waterfowl Prod. Area Restoration	Wetlands
Rush Lake Restoration Project	Wetlands
Peterson Pond impoundment reconstruction and recreational development	Wetlands
Restore sturgeon spawning habitat on Wolf River and Wolf River Bottomlands recreational area	Wetlands
Replacement Of R/V Barney Devine	Fishery Resource Enhancement
Construction Of walleye rearing ponds In Door County, Wisconsin	Fishery Resource Enhancement
Strawberry Creek Chinook salmon egg collection facility & water flow enhancement	Fishery Resource Enhancement
Thunder River trout rearing station rearing house repair	Fishery Resource Enhancement
Wild Rose Hatchery renovation	Fishery Resource Enhancement
Northern Pike habitat inventory and needs assessment	Fishery Resource Enhancement
Lake Sturgeon population enhancement	Fishery Resource Enhancement
Assessment of Yellow perch limiting factors	Fishery Resource Enhancement
Aquatic ecosystem restoration with Branch Wolf river	Fishery Resource Enhancement
Clark's mill Dam removal project	Fishery Resource Enhancement
White River Lock and dam removal project	Fishery Resource Enhancement
Outagamie water Pump replacement	Wetlands/ Natural resource-based Public-use
Dike repair for Outagamie WA	Wetlands /Natural resource-based Public-use
Foster's Tern nesting Enhancement Project	Fishery Resource Enhancement/Aquatic, Near-shore & Riparian
Page's Slough Carp barrier	Fishery Resource Enhancement/Aquatic, Near-shore &

	Riparian
Monitoring, Protection and Captive rearing of the Great Lakes population of the Piping Plover	Fishery Resource Enhancement /Aquatic, Near-shore & Riparian

Table 3.4: Thirty-four proposed projects and their corresponding categories.

## **4.0 Ranking Criteria**

We have created a ranking form for the technical team and the trustees to have a more structured system for approving projects. This can provide a documented rationale by which projects are approved or denied. The original intent was to have two groups of users: those who review and rank the proposals, and those who use the rankings to decide which proposals will be approved. The ranking form can be used in many variations of this theme including as guidance for those groups who wish to submit proposals. Points can be assigned to each question and each section is addressed below, followed by the ranking form itself.

### **4.1 Sections of the Ranking Form**

#### **4.1.1 Applicant Information Summary**

This section is intended to keep track of which project is being evaluated, who is applying to do the project, how much money is being requested, and if and when the project is funded. It is also possible to include the reviewer's name and the date reviewed in this section. This section will be important for record keeping.

#### **4.1.2 Minimum Project Characteristics**

A number of characteristics for restoration projects were outlined in the 2003 Joint Restoration Plan (U.S. FWS, 2003). These begin the ranking sheet as criteria that every project should fulfill. Ten criteria are provided and are to be evaluated on a yes/no basis: either the project proposal satisfies the question (check the box) or it does not (leave the box empty). These questions could be used to reject projects immediately if they do not fulfill any of the requirements. Alternatively, the number of characteristics a project displays can be used as a measure relative to an ideal project that has all ten characteristics (e.g. project A is better than project B because A has nine out of ten Minimum Characteristics and B only has six of ten Minimum Characteristics). The latter is our suggestion for the use of this section on the ranking sheet, and most of the other sections follow this pattern.

### **4.1.3 Environmental Considerations**

The set of environmental questions deals specifically with the environmental aspects of the proposed projects as well as the relationship to the losses or “injuries” to natural resources that were caused by the release of PCBs in the Fox River. The first three questions in this section deal with how the proposed project will benefit injured natural resources. The Trustees prefer “restoration actions [that] are effective in providing the public with similar services and values to those lost because of the release of PCBs into the environment” (U.S.FWS, 2003). A definition of “injury” is included in the ranking form so those evaluating proposals (or submitting proposals, if this form is made available to the public) will be aware of this definition and its importance to the restoration activities. It is important to directly relate the environmental aspects of a project to these injuries because restoration funds are to be used specifically to remedy those losses. The third question relates the idea of restoring the ecological integrity of the ecosystem as compensation for the injured natural resources. This underscores the importance of taking an ecosystem approach that will provide as many benefits as possible. The fourth and fifth questions deal with the importance of restoring or maintaining habitat that is critical to the future success of the project. Areas that are adjacent to the proposed project should be considered for opportunities to expand upon current or past restoration projects, because continuous natural habitat is generally more beneficial than fragmented habitats. The last question in this section focuses on any potential future changes (ecological or societal) that may occur within or adjacent to the proposed project. These factors must be considered in order to determine the future condition of the proposed project area, and ultimately, the success of the project.

### **4.1.4 Economic Considerations**

Overall, the economic portion of the criteria for the NRDA restoration funding is important in establishing baseline dollar amounts requested for the specific projects rounded to the nearest hundred. This allows the trustees to see exactly what amount of money is needed and to compare among multiple projects and their objectives. This estimate should be broken down into specific categories that could include salaries and benefits, equipment costs, labor, technical assistance, and long-term maintenance, which

allow the trustees to evaluate the cost categories to make sure a project proposal is mainly focused on the restoration of the Fox River.

This first question represents the need to establish how many miles or acres are restored in a given area and the associated costs. This estimate can be directly related back to the baseline dollar estimates to determine how many acres are going to be restored and the associated dollar amounts. Preferred projects should incorporate reliable and proven methods rather than focusing on experimental and untested methods (FWS, 2003). This allows for less speculation about the feasibility of the project.

The second question relates to the “relative” cost effectiveness of the project. By determining the overall costs and the established area of restoration, a group can establish the main costs related to the benefits of their project. If the benefit to cost ratio is high, a project will be more acceptable. Also, restoration projects should provide a broad scope of measurable benefits to a wide area or population (FWS, 2003).

Cost effectiveness of projects is an important goal to the trustees and is included in the ranking form described earlier. While costs are relatively easy to determine, benefits often do not have market value, or they are perceived rather than concrete and therefore it is difficult to assign even estimated dollar values. Some costs and benefits that should be considered by those submitting proposals are summarized in Table 4.1. Many of these values are difficult to estimate, but there are a number of sources on the Internet that may be helpful (Appendix 9.2).

**Table 4.1 Cost Benefit Analysis**

<b>Category</b>	<b>Description</b>
Recreation and Tourism Benefits	How much money would be generated if the project were implemented?
Watershed Protection Benefits	Value of erosion control, flood reduction, regulation of stream flow
Ecological Processes Benefits	Value of nutrient cycling, soil formation, water cleansing (especially wetlands)
Biodiversity Benefits	Value of continued genetic resource, species protection, ecosystem health
Education and Research Benefits	Value of increasing the number and diversity of areas where these can occur
Consumptive Benefits	If the water is cleaner, it will be cheaper - less treatment is necessary
Other Benefits	Value of cultural resource, aesthetic value
Direct Costs	Establishment (the actual project), Maintenance (ensuring success)
Indirect Costs	Will there be costs outside the restoration area?
Opportunity Costs	Forgone outputs (preventing development and benefits from alternative uses)

Table 4.1: Examples of some benefits and costs that should be considered in environmental projects.

Information from Dixon and Sherman (1990) and National Research Council (1992).

The third question refers to whether matching grants are contributed to a specific project. This may make a higher priced proposal look more acceptable because full funding is not required from the Trustees, and it shows that the project has already been viewed and accepted by other funding agencies.

The last question in this section refers back to the overall budget that categories need to be identified for funding to be allocated. Equipment, salaries and benefits, and other cost categories should be detailed in the proposal so the trustees understand how much money will be spent and allocated for what parts of the restoration. By identifying these aspects within a proposal, the trustees can establish how, when, and where the restoration funds will be spent if the proposal is accepted.

#### **4.1.5 Cultural Resource Considerations**

Cultural and social affects of a restoration project, both positive and negative, must be considered when approving these projects. Applicants should demonstrate that they have done some exploration into the broader impacts of the restoration that they are proposing. This may include cultural resource assessments or some evidence of public support.

#### **4.1.6 Project Outcome Criteria**

The outcome of a restoration project is ultimately what the public and many involved parties look forward to seeing. These criteria assess the time and space constraints on the proposed project. The Joint Restoration Plan emphasizes that preference will be given to projects for which the benefits are achieved within a short time span and are long-lasting. Also, the geographic areas in which the restoration projects are to take place are clearly stated (U.S. FWS, 2003).

#### **4.1.7 Conclusion**

Similar to the Applicant Information Summary at the beginning of the ranking form, this is a section for users to provide summary information. A table of point totals for each section is provided. The reviewer can use this summary to make a final recommendation. Space is provided for comments if the proposal is not recommended or

if changes are suggested. Decision makers (i.e., the Trustees) can use this section from several ranking forms to decide which proposals to fund. If copies of ranking forms are sent to applicants who have not been funded, this section will assist them in revising their proposals for re-submission.

**4.2 Criteria for Project Selection: NRDA Restoration Funding**

**Applicant Information Summary**

Project Title: \_\_\_\_\_

Applicant: \_\_\_\_\_

Amount Requested: \_\_\_\_\_

Amount Funded: \_\_\_\_\_

Date Funded: \_\_\_\_\_

**Minimum Project Characteristics**

- Does the project use reliable, proven methods?
- Is the project based on valid assumptions?
- Is the project technically feasible?
- Will the proposed budget be sufficient for project completion?
- Have the appropriate permits been obtained and/or applicable regulations been followed to proceed with the project?
- Has a cultural resources assessment been done to identify existing cultural resources that could be affected by the project?
- Can the benefits of the project be measured and quantified?
- Does the project proposal include a timeline for the implementation of the project?
- Can the project timeline be used to determine completion and success of the project?
- Does the project have other funding that would allow the project be completed without NRDA funding?

\_\_\_ /10 Minimum Criteria (Checkboxes) Fulfilled

**Quality of Restoration Opportunities:**

**Environmental Considerations/ Relationship to Losses**

1. Does the project avoid or minimize additional natural resource injury or degradation?  
Yes \_\_\_ (preference given)  
No \_\_\_

2. Does the project directly restore injured\* natural resources?  
Yes \_\_\_ (preference given)  
No \_\_\_

How many injured natural resources does the project benefit?  
One \_\_\_\_\_  
More than one \_\_\_\_\_ (preference given)

List the natural resources that would benefit:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**\*Definition: "Injury" as defined in 43 CFR 11.14(v) means a measurable adverse change, either short or long-term, in the chemical or physical quality of the viability of a natural resource resulting either directly or indirectly from exposure to a discharge of oil or release of a hazardous substance. Encompasses the phrases "injury", "destruction", and "loss."**

3. Does the project restore the ecological integrity \*of the degraded ecosystem as compensation for losses caused by PCBs?  
Yes \_\_\_ (preference given)  
No \_\_\_

**\*Definition: "Ecological integrity" refers to the condition of an ecosystem- particularly the structure, composition, and natural processes of its biotic communities and physical environment.**

4. Does the project sustain or restore natural habitat functions or structures that are self-sustaining and essential to maintain habitat?  
Yes \_\_\_ (preference given)  
No \_\_\_

5. Is the project adjacent to existing natural habitat (preserved or restored), or related to other efforts in the watershed that would be further enhanced by the proposed project?  
Yes \_\_\_ (preference given)  
No \_\_\_

6. Does the proposed project plan for any foreseeable ecological and/or societal changes that may affect future success of the project?  
Yes \_\_\_ (preference given)  
No \_\_\_



2. How long will the benefits last? \_\_\_\_\_ years

3. What is the geographic location of the project?

Within the 39 miles of the Lower Fox River,  
adjacent floodplain, and ecologically associated uplands \_\_\_\_\_(1<sup>st</sup> priority)

Within Green Bay and adjacent coastal wetlands \_\_\_\_\_(2<sup>nd</sup> priority)

Within tributaries to the Lower Fox River and Green Bay  
upstream to the first impoundment, including adjacent  
floodplains and ecologically associated uplands \_\_\_\_\_(3<sup>rd</sup> priority)

Within watersheds adjacent to river systems in the  
first three priorities \_\_\_\_\_(4<sup>th</sup> priority)

### Conclusion

Point totals:

Category	Points Given	Points Possible
Minimum Project Characteristics		
Quality of Restoration Opportunities		
Economic Considerations		
Cultural Resource Considerations		
Project Outcome Criteria		

I recommend this project for funding.

I recommend this project for funding if the following changes are made:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

I do not recommend this project for funding.

Main reason for denial:

\_\_\_\_\_

\_\_\_\_\_

## **5.0 Monitoring the Success of a Basin Wide Restoration Project**

One of the most difficult components of the Fox River restoration effort will be determining the success of implemented restoration projects. Achievable and measurable goals are a requirement of any project and must be taken seriously. In the case of the Fox River restoration project, this is especially important because of the large sum of available funding, complexity of the restoration plan, determining if the extensive area in which restoration is possible, and the extended period of time funding is available for such efforts. A significant amount of organization and effort is spent on the restoration project, with an expectation for a high degree of success. Understanding and determining the success of restoration projects can be achieved through several measures, most notably monitoring. The monitoring of projects allows funding organizations and the groups conducting restoration projects to adjust and improve restoration efforts and to determine the long-term effectiveness of their efforts. Donna Meyers (1999), Executive Director of the Coastal Watershed Council, addresses why a fundamental understanding for the success or failure of restoration projects is necessary:

Over the last decade, restoration techniques have become more sophisticated. “Old school” techniques, such as installing riprap or cement retaining walls along streams, are increasingly being replaced with bioengineering methods that use natural materials such as large woody debris and willows. How well are the new techniques working; unfortunately, the answer in most cases is; we don’t know. We don’t know because projects aren’t being monitored to determine their long-term effectiveness. Without monitoring, our understanding of what actually works remains poor. We aren’t learning from our mistakes, because we don’t know we made them (Meyers, 1999)

Recognizing mistakes and instituting methods of improving them are essential in a long-term restoration effort like this one. This is especially important since it is the largest and most highly funded environmental improvement project of this type to date. Monitoring the successes and failures of the initial restoration efforts will result in improvements and a higher degree of success in subsequent restoration projects administered through the restoration plan.

A number of past restoration attempts have resulted in failure, in part due to a lack of monitoring and observation of completed projects once restoration is completed. Underlying the lack of monitoring is the notion that restoration projects are “completed” once they have been installed. The truth is quite different: adjustments to restoration work may be necessary for months or even years following installation (Meyers, 1999).

Attempts in Chesapeake Bay to transfer submerged aquatic vegetation (SAV) showed a high failure rate. In Chesapeake Bay, scientist and other professional have attempted SAV planting at nearly fifty sites. While many sites showed growth after one year, fewer than ten percent still had plants two or three years later (Bergstrom, 1999). Through monitoring efforts it was found that careful choice of sites and species improves the chances for planting success. Without appropriate monitoring, even for such short time periods, the success of SAV projects in this region may have never been assessed, and unsuccessful restoration efforts may have continued to be funded.

Many reasons for holding back monitoring have been cited. People fear finding that a project is not performing as well as expected, but like all complex projects, including scientific measures, success can only be achieved by learning from failure. Another common perception of monitoring, by funding agencies in particular, is that monitoring is a waste of time and money. The return on investment for monitoring and auditing efforts is more difficult to quantify than physical and visual observations of manipulative habitat improvements. Funding agencies would rather see funds go to a direct alteration and improvement of the environment and habitat, rather than in auditing and monitoring efforts. Furthermore, in many cases for which monitoring is included in the original budget of, unexpected costs during the construction phase often consume the money earmarked for monitoring, possibly because monitoring is seen as secondary and relatively expendable (Meyers, 1999).

The efficacy of the continual implementation of questionable restoration projects begs the question; is funding failing restoration efforts less desirable than conducting monitoring to improve future efforts? Studies in Alberta, Canada surveyed 400 instream habitat enhancement structures and found that one-third was characterized by low or zero effectiveness. Another study of 161 aquatic habitat enhancement structures on fifteen streams in western Oregon and Washington found that eighteen percent had failed outright and sixty percent were damaged or ineffective (Meyers, 1999). The results of short-term and long-term monitoring for projects like these can have an immediate payback. A more efficient allocation of funds will increase the future availability of funding. Increasing efficient use of funds is especially important in the Fox River joint restoration project, where funding may be available for a number of years. Optimizing

the future use of funding is dependent on monitoring the efficiency and equity of current restoration efforts.

### **5.1 Properties of Monitoring**

The successful implementation of monitoring efforts is dependent on many properties. The most criticized property of monitoring is the cost. Traditionally, monitoring by agencies such as the EPA has been very costly. Professionals conducting environmental monitoring are often over-extended with numerous job responsibilities and limited time. Monitoring efforts must also be conducted for each of many actions to provide pertinent information, which further extends professional duties. Lastly, monitoring must be conducted extensively for a desired location and extended to multiple locations to provide pertinent information, further extending professional duties. This is especially necessary in projects utilizing entire watersheds like the Fox River Restoration project where monitoring must occur throughout an extensive area.

Cost is the first issue that must be addressed for the implementation of successful monitoring efforts. The trustees have shown their concern for the extensive costs associated with environmental and habitat monitoring, especially if these costs are drawn-out into the future. As government-funded monitoring programs continue to decline, there is an increasing opportunity for volunteer monitoring and other community projects to decrease monitoring costs. New, innovative policies and actions have been tested and implemented throughout the United States and globally to address this issue. In order to address complex environmental concerns, measures like “community science” and “volunteer monitoring efforts” have provided professionals, scientists, and government agencies the necessary information and data to make quality environmental decisions at little cost. According to a Gallup poll conducted by Independent Sector (1999), fifty-six percent of the nation’s citizens volunteered for an average of a three and a half hour workweek during 1998. Of these volunteers, five and a half percent reported volunteering in the environmental realm. Utilizing this free labor in a collective and organized effort can greatly reduce the cost of monitoring.

Another addition to the cost of monitoring is the extensive land coverage necessary to complete a watershed analysis. Efficiently covering an extensive area can

be difficult for one or a handful of professionals, as is often the case. The most commonly cited reason for volunteer or community monitoring, is that more people covering a greater area allows for economics of scale. The economic feasibility and practicality of community science is hard to beat (Carr, 2003). In many cases citizens have a vested interest in protecting and preserving the environment in which they live. These same individuals are often likely to invest time in volunteer monitoring efforts to improve the environmental conditions around them. An example of this is Pennsylvania's program, Alliance for Acid Rain Monitoring (ALLARM), which initiated local angler's concerns for water quality in the streams they fished. Since 1986, the program has grown from anglers monitoring fifty stream and lake locations to more than 600 sites currently.

## **5.2 Monitoring Indicators**

A wide range of indicators can provide volunteers a number of opportunities to monitor environmental conditions that may interest them. Integrating volunteers to monitor a variety of indicators can significantly improve environmental monitoring efforts necessary for a watershed-based monitoring effort like that necessary for the Fox River restoration effort. If a volunteer monitoring effort was successfully organized, a number of indicators could be measured in areas where restoration efforts are taking place, as well as in the surrounding areas to include the entire Green Bay watershed.

Different types of environmental indicators are used to determine the health of ecosystems. Many watersheds monitoring efforts have focused on water indicators in streams like pH, conductivity, dissolved oxygen, turbidity, and nutrient concentrations. In the ALLARM example, field-monitoring kits were used to measure the pH of water bodies as an indicator of acid rain deposition due to air pollution. Recently efforts in biological monitoring have increased. Biological indicators are often a reliable source of information for localized monitoring, and benthic macroinvertebrate, fish, and periphyton (algal) assemblages are used most often in that order. Benthic macroinvertebrates are fairly sedentary ensuring exposure to a pollutant or stress that reliably conveys local conditions (Engel 2002).

### **5.2.1 Organized Volunteer Monitoring**

The EPA has taken a proactive stance in utilizing volunteer monitoring. The EPA Office of Water has encouraged volunteer monitoring efforts through a number of programs. The Volunteer Monitoring Program, volunteer biological assessment, and similar programs can be viewed at <http://www.epa.gov/owow/monitoring/vol.html>. Recognizing the success of a number of grass-roots efforts for environmental monitoring, the EPA has decided to facilitate new and interested organizations by providing a top-down methodology of information and streamlined monitoring procedures to improve the efficiency of their sampling. This has helped streamline monitoring efforts and provide volunteer groups with a template to begin monitoring actions. Volunteer groups appreciate the assistance because it gives them the chance to do what they want to do, get their hands dirty, rather than organize and prepare methods for analysis.

Historically, there have been many organized volunteer monitoring efforts. The Audubon Society has been conducting organized volunteer bird counts for over 100 years, with 1900 marking the first all-volunteer Audubon Christmas Bird Count. Since this time volunteering efforts have grown significantly and are caring projects with greater complexity. Popularity of organized efforts like ALLARM and the National Water Monitoring Day show the public's interest in taking an active role in understanding and investigating the environment around them.

### **5.2.2 Case Study: Student Watershed Research Project**

One of the most extensively organized volunteer efforts is now being conducted in the Portland/Vancouver, Oregon watershed region by an organization call the Student Watershed Research Project (SWRP). The success of the SWRP program can be a guide for any groups interested in volunteer monitoring.

The basis of this case study is from the Student Watershed Research Project (SWRP) [[www.swrp.org](http://www.swrp.org)]. SWRP was started by Saturday Academy with funds from the National Science Foundation. A core group of individuals developed a framework where 8-12<sup>th</sup> grade students could work directly with scientists to collect, interpret, and communicate data that would be useful to resource managers making policy decisions related to the watershed. Since its beginning in 1991, SWRP continues to provide needed

baseline data in the watershed, while increasing the basic scientific knowledge and commitment of the next generation. Since the program's inception, SWRP has trained 147 teachers, directly impacting 8,000 students, while focusing for eight years on ninety stream locations. SWRP and Saturday Academy are committed to being catalyst for additional cooperative projects that leverage a broad base of support for water-quality related efforts, which focus on long-term public education.

The SWRP Project Goals are:

- Collaboration among science teachers, students, and practicing scientists
- Provision of training, equipment, and materials for watershed monitoring
- Sharing of data with participating agencies and community groups
- Fostering stewardship of natural areas and resources by students

The SWRP Mission is:

To develop awareness, knowledge, skills, and commitment leading to responsible behavior and constructive actions with regard to water quality and watershed resources; fulfilled by the cooperative efforts of local scientists, businesses, government agencies, teachers, and students with the collection of high quality data and watershed education.

The SWRP program places a high degree of importance on quality of data. The implementation of a rigorous quality assurance/quality control (QA/QC) program is coordinated and supervised by SWRP staff. The program requires sample training prior to field sampling, duplicate sample analysis by laboratories, as well as several sample checks to ensure the highest degree of quality. Regardless of how effective a volunteer biological monitoring protocol proves to be in a validation study, there must be an adequate quality assurance/quality control plan to guarantee that the protocol is consistently adhered to by all participating volunteer groups. The SWRP program has also taken the measures necessary to produce reliable and valid data from its volunteer monitoring efforts.

The importance of QA/QC in volunteer monitoring efforts was researched by Engel (2002). After assessing a volunteer monitoring protocol prepared by the Izaak Walton League's "Save Our Streams" (SOS) initiative, Engel found that it was necessary for the protocol to be modified by professionals to adjust for regional conditions. Protocols for the SOS program were initially set up as an education tool for students to

give them insight on stream biology, chemistry, and ecology. By transforming SOS's simple protocol, Engel (2002) proved that volunteers can reliably assess whether the ecological condition of a stream is impaired or not, when a sound protocol is developed by professionals.

The SWRP program continues to improve the efficiency of its monitoring efforts through constant revisions and adding more monitoring opportunities in its manual of field and lab procedures. The SWRP protocol provides a reliable foundation for all volunteer monitoring efforts, and suggests the possibility of using such an approach in the Green Bay and Fox River watersheds.

### **5.2.3 Green Bay Watershed Research Project**

The Fox River restoration effort provides a great opportunity for the implementation of the SWRP program on the entire watershed basin. Dr. Kevin Fermanich, assistant professor of Natural and Applied Sciences at the University of Wisconsin-Green Bay, has taken advantage of the SWRP protocol in the Green Bay area by organizing high school students to monitor tributaries of the Fox River. This effort provides the framework for a model that can be spread across the entire Green Bay watershed. Monitoring of the restored areas will provide valuable information. The data will help determine the effects of restoration as well as the success or failure of certain projects. These results could prove to be very beneficial in supplying information for the assignment of future projects. To make a success of such a volunteer monitoring effort in the Green Bay Fox River watershed, close coordination between local school groups, universities, environmental and conservation organizations, WDNR, and tribal groups will be necessary. As pointed out in the literature, a mutuality arrangement between volunteers and professionals would seem to be the only way that watersheds are going to receive appropriate environmental stewardship (Engel, 2002). Together, small volunteer efforts can provide a great environmental monitoring service.

### **5.3 Indicators for Fox River Restoration Projects**

Projects to restore the environmentally damaged land and polluted river are underway and proposals are being accepted according to standards previously set by the

Trustees. A concern, however, lies in how the projects will be measured for success or failure after an approved project is completed. A possible way to quantify project achievement is to apply the use of indicators and set standards within the project areas. Possible indicators include biological indicators, water quality and resources, land use and cover, and social indicators. Assessments of projects can be made through the monitoring of area-specific indicators.

### **5.3.1 Evaluating Indicators in the Fox River Watershed**

The University of Wisconsin – Green Bay's 2002 Graduate Seminar in Environmental Science and Policy students prepared a series of research papers identifying acceptable indicators. The class project, titled “States of the Fox/Wolf River Basin: Assessing Environmental Indicators,” placed the indicators into four major categories: land use/land cover, water quality and resources, biological indicators, and social indicators.

#### *Land Use/Land Cover Indicators*

Indicators of land use and land cover can include habitat and wetlands monitoring, as well as activity on the landscape. For example, the amount of agricultural acreage in a reserve program can be used to indicate how the area around the river is being used. Other pertinent agricultural data includes the number of farms, and the size and the location of each farm (Herrick, 2002).

Habitat monitoring involves historical land cover and other pertinent data. Wetland monitoring can be accomplished by determining the total acreage of wetlands, wetland history (the change of wetland to farmland or farmland to wetland), wetland protection within the studied area, and the number of dams and locks (Potokar, 2002). Wetland loss can relate to the loss of ecological diversity, flood control, and water filtration (Gibson, 2002).

The amount of wetland and forested acreage can be related significantly to another indicator, water quality. For example, wetlands act as sinks for sediments and nutrients while forests hold soils from erosion. Forested land, like some wetlands, can

increase ecological diversity (including threatened and endangered species protection), corridor connections for wildlife, and protection of water quality (Gibson, 2002).

Finally, land cover can indicate how the land in the studied area is currently (or previously) being used. Land use changes involve patterns in human activity, such as changes in settlement, and cultivation and agricultural practices (Gibson, 2002). Land cover includes developed areas (residential and business districts), point discharges, and forest cover (Graduate Seminar in Environmental Science and Policy, 2002). Table 5.1 is a list of possible indicators that can be monitored when studying the land around the Fox River Basin.

**Table 5.1:**

<b>Forests</b>	<b>Landscapes</b>
Foliar Chemistry	Flood Indicator
Dendrochemistry	Riparian Zones
Lichen Chemistry	Loss of Wetlands
Bio-Indicator Zone	Agriculture Near Water
Visible Plant Damage	Watershed/Quality Indicator
Branch Evaluations	Miles of Roads
Regeneration	Amount of Agriculture and Urban Area
Lichen Communities	Recovery Time
Overstory Diversity	Edge Amount/Patch Size
Mortality	Corridors Between Patches
Root Ecology	Diffusion Rates
Vegetation Structure	Actual v. Potential Vegetation
Tree Growth	Loss of Rare Land Cover
Wildlife Habitat	Habitat for Endangered Species
Scenic Beauty	Wildlife Potential
Crown Condition	Change of Habitat

**Table 5.1:** Fox River Basin Indicators for forests and landscapes. (Modified from EPA Environmental Monitoring and Assessment Program (EMAP) on EPA website)

### *Water Quality and Resource Indicators*

To determine the water quality in lakes or streams, measurements of dissolved oxygen, toxic substances, dissolved materials; suspended solids, water clarity, nutrient levels, and observations of a lake trophic status can be made.

Studies show that many of the Lower Fox River Basin streams and lower bay experience large loadings of sediment, nutrients, heavy metals, and bacteria (Vasiliev, 2002). Measurements of the above parameters can be taken to determine to what degree the loadings are happening. Table 5.2 lists indicators possible water quality.

**Table 5.2:**

<b>Indicator</b>	<b>Indicates</b>
Phosphorus	Negative fertilizer uses, domestic/industrial discharges
Nitrogen	Negative fertilizer uses, domestic/industrial discharges
Chlorophyll a	Amount of phytoplankton biomass
Secchi disk depth	Water clarity
Dissolved Oxygen	Amount of air introduced into water
Total Suspended Solids	Particles from plankton, soils, erosion, and wastes

**Table 5.2:** Water Quality Indicators Available for the Fox River Basin (Modified from Vasiliev 2002)

### *Biological Indicators*

A biological indicator, as defined by the U.S. EPA, is a “sign or signal that relays a complex message, potentially from numerous sources, in a simplified useful manner, and may reflect biological, chemical, or physical attributes of ecological conditions” (U.S. EPA 2003). These signals and signs can then be measured and analyzed through the use of indexes such as the Index of Biological Integrity (IBI). Interpretations can then be made and necessary steps to improve failing projects or duplicate successful ones can be defined and put into action.

**Table 5.3:**

<b>ELEMENTS</b>	<b>OBSERVATIONS</b>
Genetics	Mutation, recombination
Individual	Metabolism, growth, reproduction
Population/species	Age specific birth and death rates Evolution/speciation
Assemblage (community and ecosystem)	Interspecific interactions Community size Energy flow
Landscape	Water cycle, water clarity Nutrient cycles Population sources and sinks Migration and dispersal

**Table 5.3:** Various components of integrity to be measured and observed in determined indicators. Modified from Karr (1990).

Indicators can be assessed in numerous ways, often through observations made on a system's biological integrity (see Table 5.3). Biological integrity is described as "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region" (Karr and Dudley, 2003). Assessments made with biological indicators are supported by the U.S. EPA and can yield the condition of local ecological health (U.S. EPA 2003). This bioassessment can be done through the study of pre-determined indicators, specific to the Fox River Watershed.

Birds make ideal indicators because of their mobility, frequency of travel, multiple travel sites, and sensitivity to larger scale factors such as landscape and habitat degradation (Haig et al., 1998, Neimi et al., 2001). Data and surveys of birds are easily accessible and therefore increase the likelihood of being suitable indicators. An indicator is most ideal when it meets the following criteria (ASU Research, 2000):

- Taxonomically well known and stable (species should be easy to identify and distinguish from other species)
- Biology and general life history well known and understood (must be able to understand habitat, and active period)
- Species population is easy to survey and observe

- Species have a breadth of habitats and a wide geographical range (species must be able to be compared to populations in other parts of the world)
- Specialization of species in a narrow habitat (more specialization typically means more sensitivity to pollution)
- Data about the species is applicable to other species in the area
- Species have economic importance (to better receive the community's attention)

A species that is important to the community is also a sign that it will make a good indicator. This is true for birds in the assessment area. Birds are popularly viewed as recreational: people find birds worthy to study as a pastime more so than they would study other creatures. This makes volunteerism high and observations and studies can be completed more thoroughly. Many bird species found in the Great Lakes region cannot be found anywhere else in the Midwest and this makes it is an important reason to monitor how they react to the changes within their habitat. Key indicator species to consider include the Bald Eagle, Black-Crowned Night Heron, Common Tern, and the Red-Breasted Merganser (Marks, 2002). Available data sources include Wisconsin Breeding Bird Atlas, Audubon Christmas Bird Count, and the North American Breeding Bird Survey.

Fish are indicators to test for polluted waters. Fish live in water for their entire life span and species differ in their tolerance to polluted waters, and they have a relatively long life span (U.S.EPA, 2003). Data from surveys of area fish are plentiful. Fish also meet many of the criteria mentioned above. They are of economic importance, easily identifiable and somewhat easy to observe, their histories are well known and their habitat and biology are well understood and published.

The WDNR is currently underway in compiling a fish Index of Biotic Integrity in Wisconsin waterways (Marks, 2002). Data can also be found within the *Lower Fox River Basin Integrated Management Plan*, which indicates the number of fish species caught in both game and non-game fish species. Amphibians and reptiles are both sensitive to the effects of water pollution and are therefore good indicators to use in the judgment of a project (Herrick, 2002). Both spend a majority of their lives in and around the water, hence polluted waters are bound to influence amphibians and reptiles first. The possibility of early indication makes amphibians and reptiles ideal indicators. Other

organisms, such as birds and mammals, feed on herptiles so a direct link between these and other possible indicators.

Existing studies and maps that give the range, trends, and status of herptiles are available, though not for the immediate area of concern (for further reference see the Wisconsin Frog and Toad Survey and Wisconsin Herpetological Atlas Program). These allow for easier observations of population sizes and habitats to be made. Wood Turtles are example indicator because they are specific to an area that contains clear, clean water and are sensitive to habitat fragmentation.

Benthic macroinvertebrates are good indicators of watershed health because they spend their lives in the water, easily collectable, differ in tolerance given type and amount of pollution, easy to study in a laboratory setting, have limited mobility, integrators of environmental conditions, and can live for more than one year (USEPA, 2002). Besides water pollution, zebra mussels can threaten macroinvertebrates and can also be studied using various methods.

The WDNR reports that there currently are no technical reports available on macroinvertebrates for the Lower Fox River Sub-basin, though studies have been conducted in many other watershed rivers (WDNR, 2002). Data on the studied macroinvertebrates can be found on the University of Wisconsin-Stevens Point aquatic entomology lab website

[http://biology.uwsp.edu/gacilities/vertebrates/mammals\\_of\\_Wisconsin\\_database.htm](http://biology.uwsp.edu/gacilities/vertebrates/mammals_of_Wisconsin_database.htm).

Instructions on how macroinvertebrates can be used to make as indicators can be found on the *Wetland Invertebrate Communities* website and the *Biological Assemblages and Protocols for Benthic Macroinvertebrates* website, both accessible through the EPA website ([www.epa.gov/bioindicators](http://www.epa.gov/bioindicators).)

Macrophytes (emerged, submerged or floating aquatic plants living in or near water) and periphyton (benthic algae) are both often used as signs indicating water quality (U.S. EPA, 2003). A lack of macrophytes would indicate that a water source is lacking sport and forage fish and waterfowl. An overabundance can be a sign that the water source is exposed to high nutrient levels (U.S. EPA, 2003). Macrophytes make good indicators because they respond to changing nutrient levels, toxic contaminants, and metals; they are easily sampled, do not require laboratory work, and they are integrators

of environmental conditions. Periphytons are good indicators because of their diverse number of species, rapid responses to pollution, and ease of sampling (U.S.EPA, 2003).

### *Social Indicators*

Social indicators for the Fox River Basin include measurements of population, education, employment/income, local government capacity, number of environmental organizations (such as the WDNR's Urban Forestry Program), and civic capacity, or the willingness of citizens to join organizations and participate in community affairs (Graduate Seminar in Environmental Science and Policy, 2002). The degree of involvement of the environmental organization, for example, can be used to determine the importance and social relevance of a species or habitat. For instance, the measure of hunting and fishing licenses related to the Fox River Basin can also be used to determine the degree of recreation which can then be related to the health and population of local species. Specific indicators could include the number of licenses sold, hunting/fishing counts, and the number of violations.

## **5.4 Ideas for Local Community Involvement**

Creating involvement at the local level is to create an institutional structure to implement the plan, which is considered one of the top priorities for the Green Bay Remedial Action Plan. This portion of the document explores the current involvement of four local Green Bay area schools, two local universities and two local organizations to restore and monitor the Fox River. In an effort to implement the plan, there is initiative to "increase public awareness of, participation in, and support for the river and bay cleanup" (WDNR, 1993). In order to coordinate public participation, the purpose of this section is to establish a network of local schools, colleges and groups to maintain and submit data to an online service.

Four local northeastern Wisconsin high schools (Green Bay Southwest, Appleton East, Markesan, and Luxemburg-Casco), two local organizations (Green Bay Metropolitan Sewerage District and the U.S. Geological Society), and two universities (UW-Green Bay and UW-Milwaukee) created a program to measure runoff pollution in the Lower Fox River Watershed (Rebhahn, 2003). This five-year program, known as the

Fox River Monitoring Project, began during the summer of 2003 and will extend through the summer of 2007. The Fox River Monitoring Project is funded by a \$1.5 million grant from Arjo-Wiggin Appleton.

The schools "...turn it [data] into the university for important environmental decisions" (Rebhahn, 2003). Lynn Hudock is the current biology teacher at Green Bay Southwest and is enthusiastic about the potential to assist with an institutional plan to involve other local schools in the surrounding area. Channeling effective communication is essential with respect to the restoration efforts of the Fox River.

#### **5.4.1 Create a Fox River Network Design**

At the present time, Fox River Monitoring Project is an example of an initiative to create proactive change. This could be considered Phase I of an institutional plan, in which the initial goals and objectives are outlined. The partnership of UW-Green Bay, UW-Milwaukee, and the four high schools is only the initial start to such a project. Involving other local schools for participation is crucial in order to design an adequate network for change and a proactive approach to restore the Fox River.

Phase II for this proposed project would be to expand the local participation and include other area high schools, especially those along the river such as in the Village of Ashwaubenon and the City of Appleton. The project could also be expanded to include local tributaries that flow into the Fox River. The current focus is on the Duck Creek, Baird Creek, and Apple Creek watersheds, but in the future could include Trout Creek or Bower Creek. The Fox River Network could include the following participants: Green Bay, Appleton and other area schools, the Oneida Tribe of Indians of Wisconsin, the Environmental Resources Board of the Oneida Tribe, UW-Green Bay, UW-Milwaukee, UW-Stevens Point, Northeast Technical College, Fox Valley Technical College, and the Menominee Tribe, among many other possible groups.

#### **5.4.2 Curriculum Design for High School Monitoring**

Class structure should be in a three-hour block to ensure time for fieldwork, analysis, and synopsis. Classes for the high school curriculum would include Biology, Chemistry, or Environmental Science. In order to create incentive for high school

students to participate and enroll in environmental classes, instructors could include a one-half credit allowance for research conducted within the course. The course should be a yearlong investment so students can learn research methods for future college courses and for use on their resumes (Frisk, 2003). The local schools would then submit the data to the universities for analysis.

The plan could include a Phase III, to move from gaining local participation to implementation. Phase III is intended to create a friendly learning environment for high school students and high school teachers to unite with university professors to share their knowledge and findings of their research into an annual Environmental Summit. The Summit could include a weeklong camping experience at UW-Green Bay or the other universities to reassess and reevaluate the findings each year. This would allow interaction for students and teachers to formally present their data.

Phase III is based upon a project titled Project Field Research for Science Teachers (FIRST) (Frisk, 2003). Project FIRST includes over one hundred teachers to brainstorm on environmental issues such as water quality or prairie restoration. The teachers would review the best way to set objectives and implement a plan to accomplish the task.

Once the duration of the Fox River monitoring project comes to a close in the summer of 2007, Phase IV would include a decision-making and assessment process. This is the time to evaluate the program its advantages. Tholke recommends groups should “Assess programs periodically using regularly scheduled checkpoints. Checkpoints provide a formalized opportunity to reaffirm commitment, address/correct emerging conflicts or, if appropriate; evaluate alternatives or options for exit” (Tholke, 2002). Tholke also suggests “employing a mix of hard and soft measurements that allow parties to assess performance and to highlight expectations, opportunities and challenges for the collaboration to go forward” (Tholke, p. 25).

Checkpoints could be on a yearly basis based upon feedback from the high school students, high school teachers, and university professors. Key questions to answer would include: What is the overall picture of monitoring from the first year to the last year? What changes occurred with relation to environmental indicators and what could be changed to include a more encompassing analysis of data? How has the condition of the

water quality or restoration efforts affected the ecosystem? Both students and the data they collect should also be evaluated.

Students could be assessed on a quarterly basis based on their performance, what they valued, and what they measured. In context, the individual assessment and evaluation is based on what they learned and how they can apply what they have learned to everyday concepts.

### **5.4.3 Funding Sources**

The schools and universities are collaborating to create change to restore the Fox River. Funding is currently supplied by the Department of Natural Resources for buses to transport students to local sites to study and monitor water quality and benthic macroinvertebrates. In addition to current federal funding initiatives and a grant from Arjo-Wiggins Appleton, future funding should include an expansive multi-agency approach to bridge the communication gap and to design a participatory process. In terms of environmental policy, companies should create a “synergy,” or a relationship that considers both the business and environmental “objectives” (Hart, 2002). Once the company considers both objectives of business and environment, a portfolio can be created to design a future outlook.

### **5.5 Non Profit Organizations involved in Restoration**

There are numerous organizations that may be willing to engage in monitoring and indicator projects. Appendix 9.1 lists organizations that exist within the Fox/Wolf Watershed and within the state of Wisconsin. The list is an example of the many organizations that exist, the mission each organization strives for, and contact information. It is important to note that this list serves only as an example of many existing organizations. If a monitoring and indicator project is desired, it may be useful to contact one of these organizations, explain the objective, and continue with the organization’s assistance.

## **5.6 Sharing Information to Make Better Decisions**

This section proposes a way to engage local stakeholders from across the community in the restoration process and to provide them with easy-to-understand information about their community so they might become involved in the important environmental decisions made the Fox River Restoration Project. Questions and concerns need to be addressed regarding how the public gives input during the restoration process. It is unclear how well the public understands the issues surrounding the restoration project and the Fox River cleanup in general. There is also a perception that the public avoids getting more involved because of the technical and political nature of the effort.

“Citizen movements for environmental sustainability are an important and visible force in society” (Gasteyer and Flora, 2000); however, it has been suggested, in order for citizens to band together for a common cause, they need to have identified a problem that takes them from being satisfied with the status quo. Is this part of the reason why more community members are not aware of, involved with, or concerned with the restoration project? While it is difficult to answer this question, the Trustees could attempt to design a more inclusive and public process for making the environmental decisions associated with the restoration projects.

### **5.6.1 Overview of Interactive GIS-Based Website**

We propose the development of a GIS-based interactive website to increase public access to and involvement in the restoration process and to provide a centralized warehouse of data necessary for making better environmental decisions within the Lower Fox and Green Bay Assessment Area. This website would serve as a conduit for all spatial and attribute data related to all monitoring efforts. Indicator data, collected by agency staff, citizen volunteers, student groups, and non-profit groups, would be accessible and easily queried and displayed by all citizens and groups via the internet.

In order to use a sophisticated tool of this kind within a low-cost environment, several issues need to be addressed. First, an initial project development grant would be needed to support additional planning and the implementation of the concept. Second, maintenance and access issues would need to be addressed. The network of K-12 and

university students and teachers and scientists involved in the Fox River Monitoring Project could share some responsibility for the effort. Likewise, the Trustees would have to support the effort and could significantly benefit from the additional public input and attention that could result from such an endeavor.

Figure 5.1 provides an overview of how the interactive website could work. The diagram includes information on the four dimensions of the project: Indicators, Participants, Technology Overview, and End Users. Indicator data would be provided by volunteer groups, through efforts like the University of Wisconsin-Green Bay's outreach efforts engaging local high school groups in the SWRP. The interactive website would provide a forum for discussion about regional resource management issues in addition to the Fox River restoration effort. It could allow multiple applications of data submitted by numerous local, regional, statewide, and nationally sponsored groups to be viewed simultaneously by the entire community and other participants involved in the project. According to ESRI, "Organizations around the world are leveraging their information technology investments by integrating mapping and geographic information system (GIS) technology" ([www.esri.com](http://www.esri.com)). This project would likely have very high payoffs in terms of documented outcomes and increased public involvement.

Using new web-based technology, the integration of geographic data from multiple sources will allow localized query and analysis based on geographic location or type of indicator ([www.esri.com](http://www.esri.com)). Using a simple browser interface, regional users will be able to display and interact with data generated from the network of monitoring projects. Users may have varying levels of access, depending upon the type of data sought. The Trustees, regional agency staff and government officials may need to rely on some sensitive datasets that requires more security. The public at large could have access to as much indicator data as possible and as necessary for providing input into environmental decisions. A system of unique user identification and passwords could be developed by the database manager and requested by the users via email.

### **5.6.2 Rationale for Constructing the GIS-based Web Tool**

The website would not only provide an intelligent mapping component, but also a dynamic database that could be updated by agency staff, volunteer groups and local

citizens, and other interested stakeholders engaged in regional monitoring activities. Several examples of this kind of technology in use exist within other monitoring project efforts around the world: GLIFWC's EPICENTER [www.glifwc.org](http://www.glifwc.org) is one such example. GLIFWC has an ongoing effort to monitor exotic species that affect the 1837 Ceded Territory in northern Wisconsin. They have developed several ways for citizen volunteers and state agency staff to participate in this program. First, they make their survey tool available via their organization's homepage. Second, they collaborate with an educational institution to host an ARCIMS (ArcInfo Internet Map Server) server containing a dynamic user interface that allows for the entry of geographically referenced locations of purple loosestrife.

### **5.6.3 Benefits of Interactive Websites**

Incorporating GIS into a web-based tool will allow better communication between different groups like planners, decision makers and the public. According to the National Center for Geographic Information and Analysis (NCGIA, 1996), the "implementation of web-based GIS could provide interactive mapping and spatial analyses capabilities for enhancing public participation and collaborative decision-making processes." It can help answer and document answers to questions like "How open are planning and decision making processes? What information is released to the public? How can genuine communication between planners, decision makers, and the public be achieved? And, is the public willing to participate?" (NCGIA, 1996)

### **5.6.4 Public Participation GIS**

A growing area of study is Public Participation GIS (PPGIS). PPGIS can be "conceived broadly as an integrative and inclusive process-based set of methods and technologies amenable to public participation, multiple viewpoints, and diverse forms of information" (Krygier, 1997). PPGIS can include many different types of information:

- Graphic snapshots of pre-generated maps
- Spatial database catalogs and libraries
- Map generators
- Real-time map browsers

- Real-time maps and images

PPGIS can be used in environmental dispute resolution, participatory planning, and other activities involving public collaboration. According to NCGIA (1996), “A public participation approach would situate GIS analytical tools within an expanded framework of communication and discourse, opening opportunities for public participation across the processes of problem definition and problem resolution.”

An interactive GIS-based website will fully support the goals of SWRP by providing a forum for:

- Collaboration among science teachers, students, and practicing scientists
- Provision of training, equipment, and materials for watershed monitoring
- Sharing of data with participating agencies and community groups
- Fostering stewardship of natural areas and resources by students

This tool will expand upon the current spatial location snapshots of the funded restoration projects,

[http://www.dnr.state.wi.us/org/water/wm/lowerfox/NRDA\\_Selected/index.html](http://www.dnr.state.wi.us/org/water/wm/lowerfox/NRDA_Selected/index.html). In assessing the current site, we found it to be slow loading and void of well-referenced geographic locations. While maneuvering among the range of views it becomes even more difficult to identify with an exact location within the Green Bay Assessment Area. Once oriented within the overall view, the user must click on a second tier of snapshots that provide an even poorer frame of reference.

### **5.6.5 Public Input Access Accomplished**

The use of a GIS-based online database will allow the Trustees to more fully meet their obligations to the public by sharing information so others can make better informed decisions, and know where, when, why, and how to take action. As ESRI notes, “GIS allows us to view, understand, question, interpret, and visualize data in ways simply not possible in the rows and columns of a spreadsheet ([www.esri.com](http://www.esri.com)).

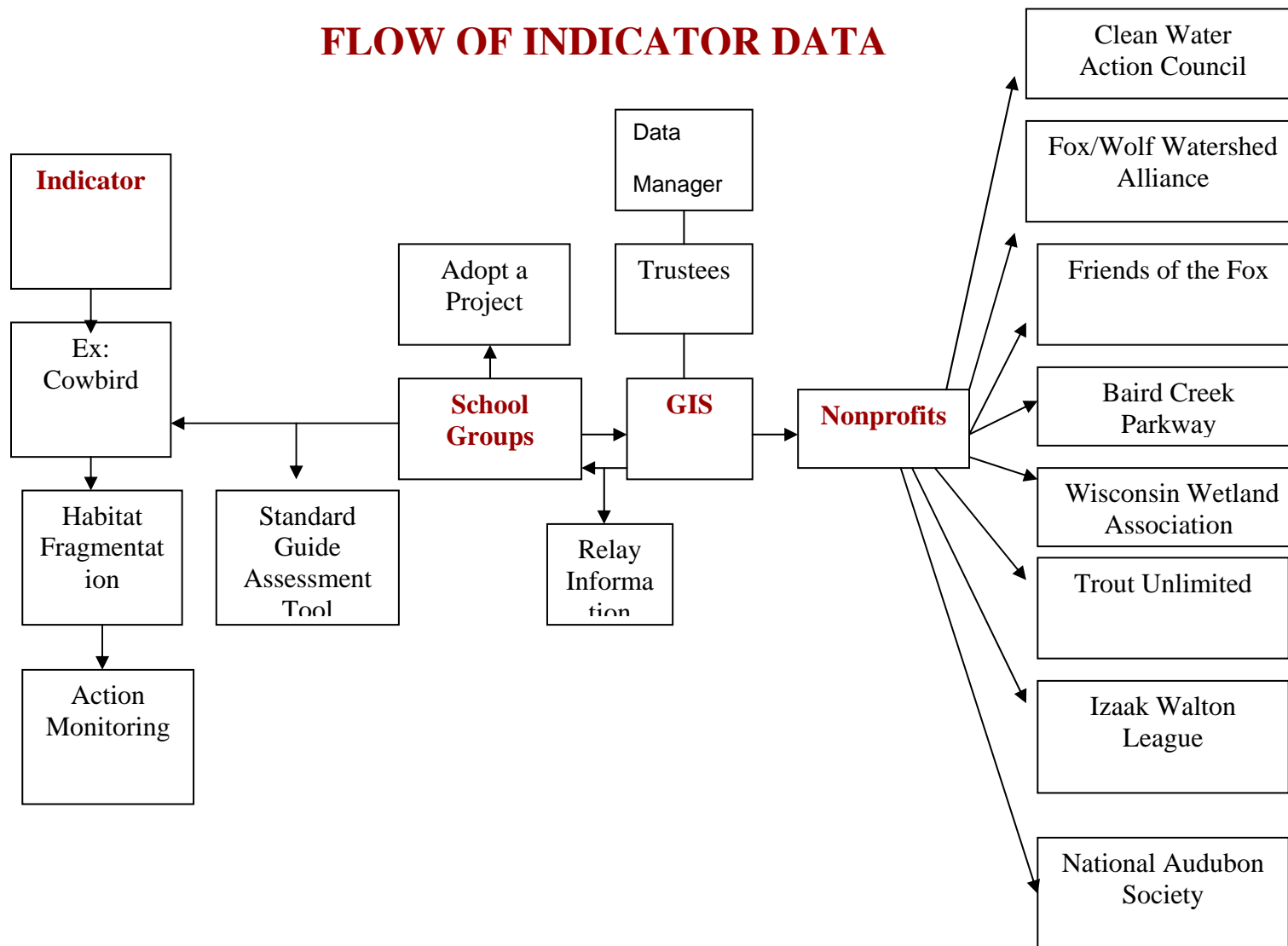
## **5.7 Conclusions**

Consistent with the goals of the programs reviewed above, we want to offer the opportunity to participate to community members and school groups with the ability to take part in collecting indicator data that will contribute to better environmental management decisions. This project will allow for community participation in monitoring specific sites, and will offer the community a chance to provide input into the decisions made regarding restoration and the continued success or failure of each restoration project.

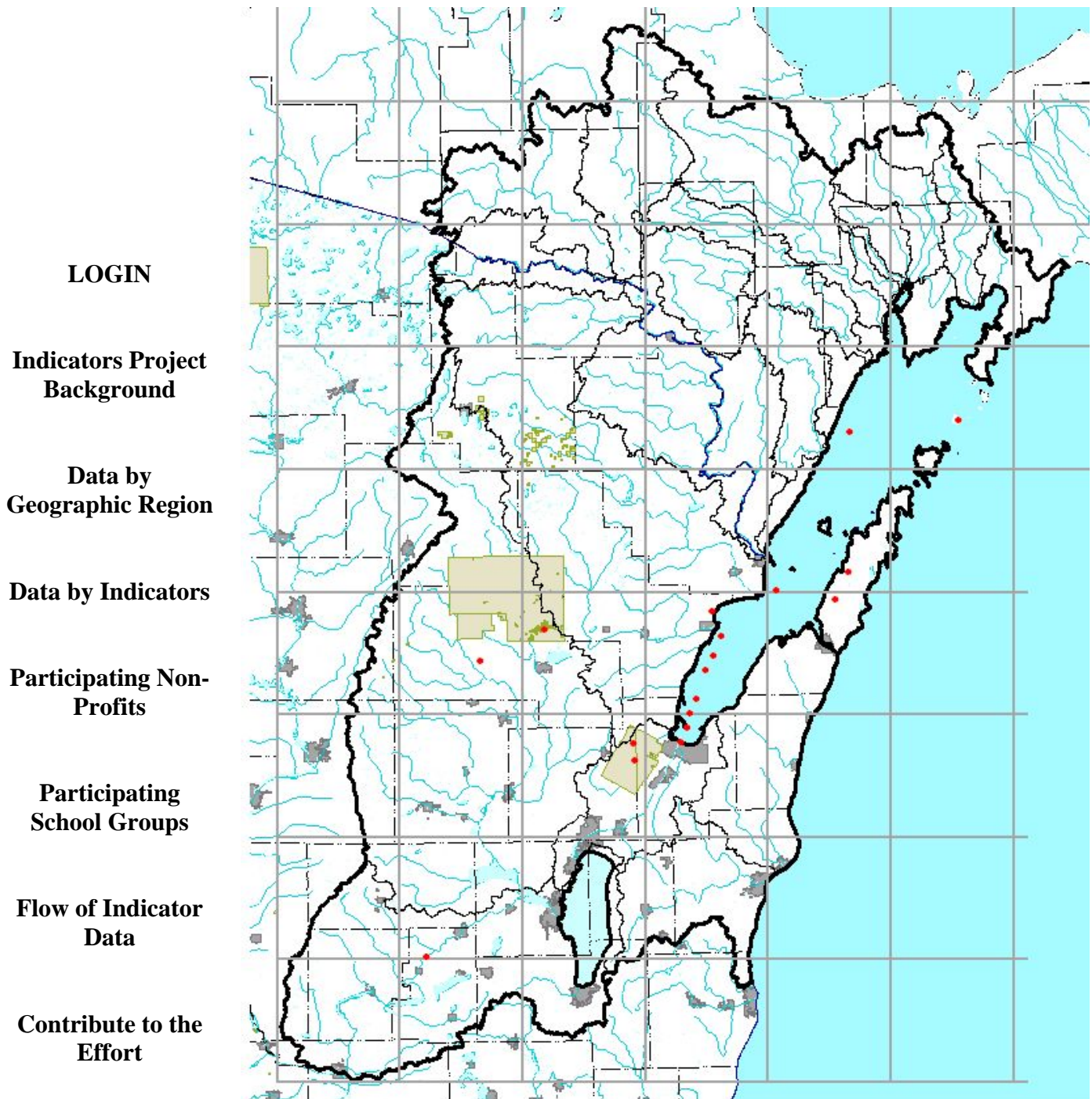
The website containing an interactive GIS-based database will offer a one-stop, easily accessible mapping and data management tool containing environmental datasets. These datasets will include all information available from local citizens, school groups, non-profit organizations, and tribal, local, regional, state, and federal environmental staff members.

The website will support collaborative efforts among agencies who strive to protect and restore the habitat along the Fox River. Users will be provided with the choice of environmental datasets (maps and database excerpts) that span the entire Green Bay Restoration Area. Mapping capabilities will be developed for a range of users with varying levels of access and ease with the technology.

Figure 5.1. Flow of indicator data within GIS-based interactive website.



**Figure 5.2: Layout for the GIS-based Interactive Website**



The Trustees could take the following steps to immediately improve the existing restoration website hosted by the DNR, and develop the platform and layout of information necessary for putting the GIS-based interactive website into place by following the steps outlined below:

- Gather GIS data layers from regional planning commissions, the Department of Natural Resources Geographic Data Services Section, and the Wisconsin Department of Administration's Office of Land Information Services to improve the geographic references for the restoration project sites. The symbols used to identify the restoration project sites could be more descriptive and provide the community with a spatial distribution of restoration projects by category.
- Tie geographic data to more detailed attribute information about each restoration project. Recognizing the proposed changes in the application process and the proposed monitoring scheme, we suggest this information includes specific intended outcomes of each project. Measurable outcomes will lead to indicators that can be measured by the volunteer groups and then entered into the interactive GIS-based website's database.
- Develop the GIS-based interactive website to be linked to the homepages of the agencies overseeing the restoration project. Keep the following set of issues and opportunities in mind during the development process:
  - Use a graduated color scheme appropriate to the priority of each restoration category.
  - Tie descriptions of restoration projects to type of indicator data collected to allow for easy thematic display. Query tools can be more fully developed over time as resources permit.
  - Develop a website administration plan: Who will serve as the database manager or "keeper of the data?" What type of security system is needed? What type of equipment is required for the effort?
  - Determine funding sources for the concept – The Trustees or a non-profit organization or school group may wish to pursue a grant to fund this entire concept. Outlined here is much of the information necessary for doing so.
  - Develop a public inquiry or comment button to serve as a mechanism for the public to submit questions, concerns, and suggestions on the restoration process, program and/or specific projects to trustees. The

button would prompt a dialog box where questions are submitted to a database that can report information to the Trustees via a secure discussion board. The Trustees would be able to log into the discussion board at their convenience to monitor public comments. They could discuss among themselves how to reply and take opportunity to prepare a response via a call up box that could email a response to the initial inquiring party—secure area where trustees could have discussion utilizing a discussion board for how they envision a response.

## **6.0 Land Acquisition**

### **6.1 A Rationale for Preservation: Alternatives for Conserving Biodiversity**

A fundamental environmental concern is the conservation of biodiversity in the most undisturbed and natural forms possible. When biodiversity is damaged at the ecosystem level, there are two main options for dealing with this problem: acquisition of undisturbed land to replace the damaged habitat or physical restoration of the degraded habitat itself. Both options concentrate on the key objective of preserving high levels of biodiversity. Physical restoration aims to improve biodiversity by habitat modification techniques while land acquisition relies on the purchase of healthy ecosystems and their accompanying services.

Czech (2002) and Main et al. (1999) emphasize that land acquisition is key to conserving appropriate levels of biodiversity. Czech recommends that higher levels of biodiversity can be achieved by means of land acquisition in comparison to restoration efforts; purchasing land parcels that include relatively intact ecosystems should be a priority for restoration efforts. Assigning priority to land parcels is a challenge, especially when the objective is to “replace” numerous damaged resources that are provided by the target property. Mittermeier et al. (1998) suggest that land acquisition projects should focus their efforts on parcels encompassing largely intact pristine wilderness habitat with low human population densities and/or disturbance.

Connectivity must be considered if a land acquisition project is to successfully achieve biodiversity preservation. Haig et al. (1998) review connectivity for the purpose of conserving avian species. The authors note that wetlands, particularly, are a priority for conservation biologists because of high levels of naturally occurring species that utilize the resources offered by the ecosystem. Preserving the connectivity of large wetlands through targeted land acquisition ensures the protection of numerous species because of the high levels of biodiversity associated with these habitat types. Acquiring land parcels surrounded by currently protected habitats (in this case, Nicolet National Forest) guarantees high connectivity and reduces the threat of future degradation (Haig et al. 1998).

The most important challenge for ecologists is to protect representative ecosystems and maintain their ecological functions. The area protected must be large

enough to retain the diversity and array of species present; the larger the site, the more species will be protected. Preservation of large areas has two crucial objectives: maintain large mobile predators and increase the probability that natural ecosystem processes can continue to generate habitat diversity.

Protection of a system alone will not ensure future success. As previously indicated, it is essential for these areas to be highly connected to accommodate dispersal. The benefits are compounded when land acquisition occurs in an area where the surrounding land is already protected. The surrounding area then acts as a buffer to the newly acquired property. The region around the newly protected acreage should have a high standard of land use practices to ensure that nutrients, pollution, and exotic species have minimal or no impact. With these considerations taken into account, the property of Long Lake is clearly a large, intact representative ecosystem (Figure 6.1) that should be protected in order to maintain its ecological function and services.

Restoration projects, on the other hand, are based on the same objective of obtaining the highest level of biodiversity for a previously damaged resource through various means. Restoration, as defined by Geist and Galatowitsch (1999), is the return of an ecosystem to its pre-disturbed condition, or an approximate condition. The authors deliberately advise against restoration efforts when the option of conserving existing biodiversity, such as land acquisition, is open. In fact, the record for restoration efforts reflects a paucity of success (Geist & Galatowitsch, 1999). The authors explain that this is due to several factors involved in restoration projects: inherent complexity of the components, uncertainty, vague definitions, controversy, and ultimately societal limitations. In addition to the aforementioned limitations, the presence of already contaminated soils or restricted plant availability, for example, presents yet another barrier that cannot be feasibly modified by human means. It has become obvious that numerous hindrances must be faced and resolved in order to create a successful restoration effort.

Another complication when taking on the challenges of ecosystem restoration is the lack of clear operational definitions of restoration, its success, and the clarification of when an outcome is reached. A definition of good restoration ecology rests on several criteria and societal contexts (Higgs, 1997). Since ecosystems are natural environments,

shifting and changing over time is expected and inevitable. Therefore, a definition of good restoration will be unique to the site or project and will reflect the characteristics of that habitat. Higgs (1997) also discusses the fidelity of restoring a degraded ecosystem. Fidelity includes the ability to replicate the ecosystem's structure, functional success, and durability or stability through time. Historically, the Society for Ecological Restoration has published several working definitions to clarify good ecological restoration; the most current definition (1995) indicates that "the process of renewing and maintaining ecosystem health" is crucial for quality restoration efforts (Higgs, 1997).

### **6.1.1 Wetland Restoration and Complexities**

There is no substitute for a naturally occurring wetland, and what remains of these threatened systems should be conserved at all costs. Natural wetland ecosystems are endangered because their importance is not well understood, and not easily quantified. Increasingly, we are satisfied with inferior human constructed wetlands that fail to provide adequate services for people or wildlife. Wetland restoration is indeed a challenge and poses many obstacles for which scientists do not have all the answers. Like other ecosystems of the biome, wetlands are highly complex and, at best, understood at only an elementary level.

### **6.1.2 Restoration Limitations**

Race and Fonseca (1996) describe the serious limitations faced by biologists and ecologists when taking on wetland restoration projects. The function and value of these little understood habitats are difficult to fully comprehend in a naturally established ecosystem and nearly impossible to replicate via constructional restoration. In order to create a successful wetland, three requirements must be met: understanding wetland function, giving the system time to generate, and appreciating the idea of self-design.

Most attempts to measure and achieve success of created and restored wetlands caused by a lack of application of good wetland science to the problem and compounded by the existing construction-schedule driven process are flawed because of misunderstandings or misapplication of these factors (Mitsch and Wilson 1996). Given the obvious difficulties of recreating wetlands through

physical restoration, funding for land acquisition projects aimed at preserving natural wetlands is becoming increasingly important.

### **6.1.3 Restoration Examples**

The evaluation of restored ecosystems compared to their natural counterparts presents less than ideal results. According to Geist and Galatowitsch (1999), the comparison of natural and human constructed salt marshes in southern California resulted in lower quality conditions in the constructed marsh; specifically, the restored site had low soil nitrogen despite soil amendments. Recreating a functioning ecosystem or restoring a damaged ecosystem to its original state is beyond our understanding simply because of nature's complexity and multifaceted connectivity.

Another example of the difficulties associated with constructing ecosystems is the restoration of ninety kilometers of the Kissimmee River in Florida. This restoration includes a time span of ten to fifteen years and involves a cost of more than \$370 million. These riparian restoration efforts, compared to more pristine areas of the Kissimmee River, required enormous time and financial commitments that not all organizations are willing to invest. In addition, Geist and Galatowitsch (1999) point out that restoration of forest habitat can take from several decades up to a century, depending on soil conditions and plant availability.

In a study of prairie pothole restoration, Galatowitsch and van der Valk studied areas that had been drained for twenty-five years or more. A comparison of ten restored sites and ten natural sites showed that, in natural ecosystems a mean number of forty-six species were present compared to twenty-seven species for constructed systems. Analysis of seed banks revealed a significant difference between natural sites, with fifteen species present, and restored sites, with eight species present. In the created wetlands submersed aquatics, wet prairie, and wet meadow seeds were all absent. In accordance with the results of the study, the hypothesis (when hydrology is restored, vegetation will reestablish) was rejected. These results were strengthened by another discovery that after fifty years, seed densities were less than 1,000/m<sup>2</sup> in created wetlands compared to 3,000-7,000/m<sup>2</sup> for natural sites. This study confirms that, in addition to restoration of hydrology, organisms with poor dispersal might have to be re-introduced.

Restoration of degraded ecosystems poses many difficulties, and although they apply to all ecosystems, they are especially true for wetlands. Wetlands are extremely complex systems and are inherently difficult to understand. In addition, restoration efforts become even more challenging due to the mobility of the species that inhabit the area. Despite efforts, if the natural dynamics of wetland ecosystems are not accounted for, the resulting community might differ significantly from a natural one. The literature shows dramatic differences in wildlife usage, community composition, hydrology, and soil factors between natural and constructed wetlands. Effective restoration needs to address all these issues to achieve optimal, natural function. Rarely do scientists fully understand the vital interactions among species and the environment; this lack of knowledge often predetermines failure for physical restoration projects. It is absolutely vital that restoration projects allow for natural dynamics, most importantly, hydrology and natural disturbance.

#### **6.1.4 Wetland Mitigation**

Wetland mitigation is the construction of new wetlands to replace wetlands destroyed by agriculture or other construction. Scientists studying mitigation in the mid-1980s believed it was an effective option to consider, while others argued that more intense research must first be completed; “if not properly conducted, a wetlands mitigation project could easily fail,” suggest Mitsch and Wilson (1996). Failures of mitigation wetlands are far more common than successes. Studies in Virginia found that only 50 percent of 23 projects could be considered successful, while 60 percent of mitigation projects in Florida were either incomplete or failed projects (Mitsch and Wilson, 1996). Examples of mitigation failure are numerous, and it is certain that there is a need for more effective mitigated wetland management. This type of ecological restoration should provide clear predictions for these ecological communities and the specific steps that will be taken to evaluate the success of the project. If criteria are not met, not only has a significant quantity of funding been misspent, but also, damage to the system may actually increase despite the intent to effectively restore the landscape.

Restoration ecology requires only two tools in order to achieve success: first, the ability to recreate desired communities; second, the ability to evaluate whether the

manipulation has produced the desired change. However, these two components have produced one of the greatest challenges for scientists. All restoration projects must include some degree of monitoring, from an applied perspective, using diverse variables and methods (not just measuring) to determine if the restoration is effective. If dollars are spent without any form of evaluation of the restoration, the success will be unknown and the entire project could result in a potential waste of funds.

Cost is a highly relevant element to funding restoration or land acquisition projects since, as it is evident, some projects require extensive funding, time commitments, and workers. Even if a restoration project was sufficiently funded and implemented, it will be difficult to measure the success of efforts on a temporal scale that most organizations consider reasonable. The literature reveals few standardized and cost-effective measures of success (not to mention how to define a successful project) with regard to environmental and ecological restoration efforts (Salafsky and Margoluis, 1999). The authors recommend a different approach, threat reduction, which can be advantageous due to its sensitivity to small changes when measuring biodiversity over relatively short periods of time. It also allows comparison between projects implemented in diverse settings, a type of standardization that is ideal for measures of project success.

### **6.1.5 Conclusions**

True wilderness possesses great inherent value in its ability to contribute to the preservation of existing biodiversity in a natural state (Cole, 2000). Cole (2000) describes “wilderness” as a land in its natural condition, which is pristine (or which lacks human influence) and is therefore undeveloped. If large-scale physical restoration projects are pursued without thought of conservation, there will no longer be a natural ecosystem reference point for future restoration efforts. A manipulated and modified environment might soon be the reference point to which future projects compare when evaluating their success. In spite of difficulties, physical restoration projects are necessary to return highly degraded environments to a more natural state. However, these types of habitat manipulations require ongoing restoration efforts and long term monitoring to truly evaluate success. Conservation through land acquisition, on the other hand, preserves naturally functioning systems that can be used to evaluate the success of

physically restored sites and conserved sites do not require the same long-term commitment to restoration and monitoring.

Land acquisition and restoration efforts are important resolutions to the loss of biodiversity. Both options are critical steps in replacing damaged resources and habitat, and in creating and maintaining a diverse environment despite human influences. However, given that there are always time and financial limitations, land acquisition is a more prudent solution. Restoration through conservation will result in the protection of an established, functioning ecosystem and existing biodiversity. Degraded or contaminated ecosystems are expensive and time-consuming candidates for restoration, if they can be successfully restored at all. Land acquisition offers an opportunity to conserve healthy ecosystems without time and financial requirements beyond purchasing the land. Monitoring, a crucial component of physical restoration success and fidelity, is a minimum necessity in land acquisition projects.

From a local perspective, as the Fox/Wolf River watershed continues to experience degradation, great efforts are required to preserve what remains of the undamaged habitat through land acquisition projects, and to rehabilitate degraded areas through restoration. The clean up of contaminants and the removal of contaminated input to the system are also vital steps in returning the basin to a more natural state. The Fox River restoration project is making great strides to protect, restore, and enhance ecosystems within the watershed, and if carried out correctly, with a balanced approach of restoration and conservation, will likely be looked back upon as one of the great environmental success stories of our time.

Figure 6.1:

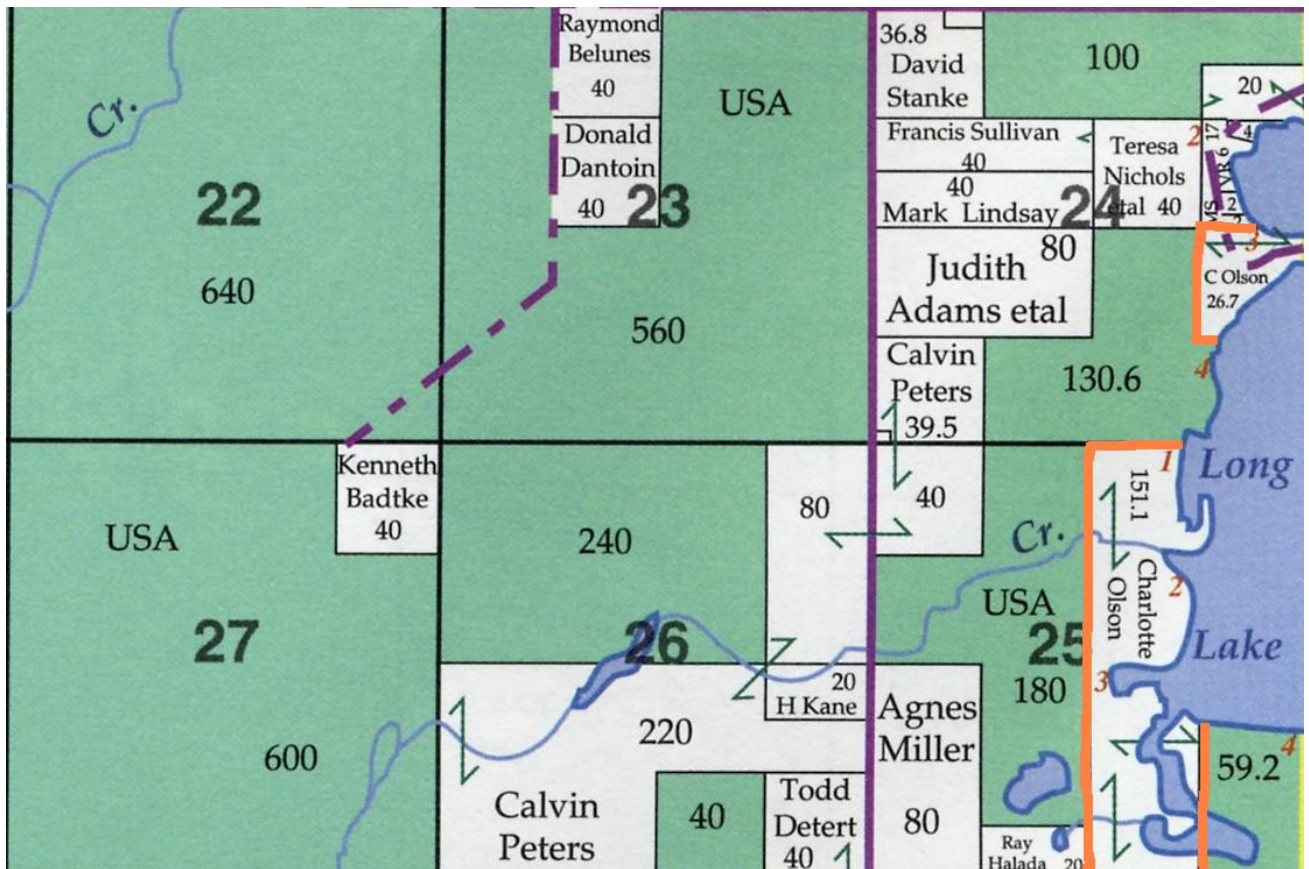


Figure 6.1: Long Lake Property Boundaries for Land Acquisition Proposal (Forest County Wisconsin Land Atlas and Plat Book 1995)

## **6.2 Rationale for Protection of Riparian Zones**

Riparian zones are the terrestrial areas immediately adjacent to streams, rivers and lakes. Though evidence supports a variety of riparian zone widths, one rule suggests one to two tree lengths, which in the Great Lakes states is approximately 23 m and 46 m, respectively (Verry 1992). The riparian zone plays an influential role in energy cycling of both terrestrial and aquatic ecosystems and is now considered vital habitat to protect.

Riparian corridors provide essential habitat for wildlife in several ways. Perhaps most importantly, they contribute large woody debris (LWD) to aquatic systems. It has been calculated that in some regions, "...over 70 percent of the LWD in streams flowing through mature and old growth riparian zones in western Washington and Oregon originated within 20 m of the stream bank" (McDade et al. 1990). Trees enter the water from the riparian zone as a result of erosion, windfall and catastrophic events such as floods and tornadoes. These trees become LWD, which not only increases biodiversity among aquatic species, but asserts its influence over the terrestrial ecosystem as well. Many terrestrial species occupying the riparian zone directly use LWD snags. "Cranes, herons, kingfishers, dippers, otters, mink, snakes, and salamanders are among the animals that use stream and lake-associated debris for hunting and resting" (Bragg & Kershner, 1999).

From the perspective of LWD contribution to stream systems, the value of riparian zones is clearly seen. However, their importance ranges much farther than a mere physical contribution of biomass to waterways. According to Naiman et al. (1993), riparian corridors that remain intact and undisturbed contribute biophysical habitats that are highly diverse, dynamic, and complex critical ecosystems for the Earth's terrestrial environment. Riparian corridors help to regulate the environment of both streams and the surrounding terrestrial system and can produce a great amount of biodiversity.

The utilization of riparian zones is prevalent among numerous vertebrate species, not just birds. According to Raedeke (1989), "...nearly 70 percent of vertebrate species in a region will use riparian corridors in some significant way during their lifecycle." In fact, studies have even shown widespread use of riparian corridors by mammalian predators such as coyotes, bobcats, red foxes, pine martin and fishers (Hunter, 1990).

Despite the importance of these biologically crucial habitats, they were attacked with a vengeance during the 1800s in the name of logging. It has been estimated that more than 80 percent of riparian areas have disappeared in North America and Europe in the last 200 years (Naiman et al., 1993). Riparian zones were negatively affected in two main ways: direct logging and channel clearing. Because of certain logging practices, the proximity of the trees to the transport system imperiled these delicate ecosystems. When the practice of logging first began, transporting logs using stream systems was the most efficient manner of moving timber harvests; this practice led to the second major negative impact on fragile riparian areas and streams: channel clearing. Large-scale efforts to remove all debris from shipping channels may have made the waterways more navigable, but greatly reduced much-needed habitat for wildlife. Sedell et al. (1991) sums this up clearly by suggesting that a significant majority of our larger streams, rivers, and lakes have, historically (over approximately 300 years), provided a waterway to move logs to their sawmill destination.

Fortunately, the attitudes of the past are changing and management practices regarding preservation of riparian zones and LWD are vastly improving. The turnaround on thinking regarding the importance of riparian debris really began in the late 1960s. There has been increasing emphasis on returning riparian areas to their natural states and this has been accomplished in many areas. In 1995, the Environmental Protection Agency (EPA) declared that “the reestablishment of natural riparian forests (i.e., forest buffers) is now considered ‘best management practice’ for restoring stream and river ecosystems to their natural or quasi-natural states” (Sweeny, Czapka & Yerkes 2002).

As attitudes about riparian debris shift from excess fiber resource to a critical environmental component, Bragg and Kershner (1999) explain that this debris, once considered a riparian obstacle, is now key to ecosystem functionality. This shift in attitude has also caused management styles to be modified as a new mindset evolves. Education of the public will remain a high priority as we look towards reestablishing quality LWD levels in streams and the riparian zones that contribute to them. Getting the public involved in large ecological projects gives them input instead of having them feel put upon. However, the new wave of interdisciplinary decision-making is arriving:

Rivers are being viewed as watersheds, not as individual reaches. Efforts are underway to correct the errors of the past. Scientists and decision makers alike are starting to see the benefit of protecting intact habitats and biodiversity, while working to restore areas that have already been damaged. Perhaps we are coming full circle in our quest to do what is best for the streams, rivers and lakes.

### **6.3 Watershed Connections of Long Lake**

A watershed is defined by the Wisconsin Department of Natural Resources (WDNR) as an interconnected area of land draining from surrounding ridge tops to a common point, such as a lake or stream. All lands and waterways can be found within one watershed or another. Watersheds fit together and, like pieces of an interdependent puzzle, they drain into one another. Thus, it is important to grasp the concept that individual drainage basins are not self-contained entities; stream systems are a part of larger surrounding watersheds that represent only a small portion of the greater hydrologic cycle.

Long Lake is part of a region known as the Headwaters geographical management unit. The Headwaters basin includes portions of the Upper Wisconsin, Upper Green Bay and Wolf River Basins. Headwater areas are the upper reaches of a basin or watershed, and thus contain smaller streams and rivers that are tributaries of larger water bodies (WDNR). The Headwaters geographic management unit contains some of the state's most beautiful waters and includes the counties of Florence, Forest, Vilas, Oneida, Lincoln, and Langlade (Figure 6.2).

Glacial abrasion in the region, typically identified as the Northern Highlands, has left igneous and metamorphic rock exposed and has only been thinly concealed by glacial drift and newly formed soils. Partially filled valleys, glacial gouges and moraines create a landscape of thousands of lakes, ponds, swamps, bogs, fens and marshes. This complex hydrology makes this region essential to the quality of all the surrounding watershed basins, including the Wolf Basin, the Upper Green Bay basin, and as a result, the Lower Fox Basin.

Not well suited to most farming and industrial activities, the Headwaters Region supports extensive forestlands. Approximately 70 percent of the land supports forest

cover (USFS survey, 1996)—varying from about 85 percent in the northern counties to about 40 percent in the southern counties. Timber and wildlife management are the principle land use activities in the region, with both private timber concerns and State and National Forest ownership important to the local economies. The natural vegetation of the region is predominantly classified as Northern Mesic Forest. Dominant species are maple, hemlock, yellow birch and the distinctive white birch. Prominent areas of Pine Forest, dominated by white and red pine, are next in importance. Nearly as extensive are the Conifer Swamps, which are composed of northern white cedar, black spruce and tamarack. Much of this latter type also tends toward open sedge fens and true leather leaf bogs. The Pine Barren cover-type is also common on poor, dry soils on granite outcrops. Jack and sometimes red pine are scattered among stands of prairie grasses (WDNR). The Long Lake property encompasses many of these cover types, including high quality forested wetlands and valuable riparian forests.

The Headwaters Region is home to over a third of Wisconsin's 15,057 lakes. Connections between these waters are sometimes concealed by rocky rubble, or by organic accumulations. Youthful streams often connect water bodies. Such streams, often steeply graded with coarse, rocky substrate and frequent waterfalls, typically support high water quality and coldwater fisheries. Coldwater Creek, which flows through the Long Lake property, is one of these streams.

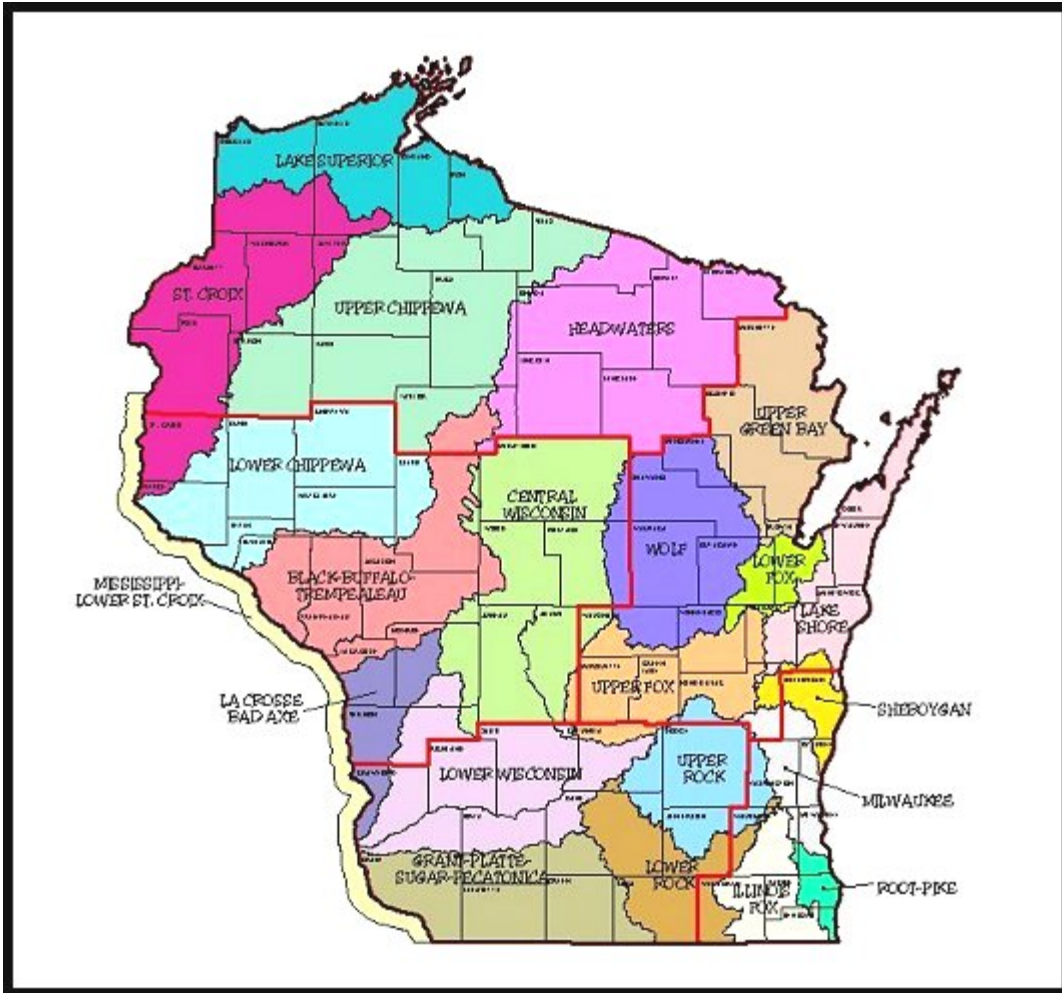


Figure 6.2: Wisconsin Watershed Basins

(<http://www.dnr.state.wi.us/org/gmu/gmu.html>)

#### **6.4 Lower Fox River and Green Bay Restoration Project Proposal**

**Date Submitted:** December 2003

**Project Title:** Long Lake Conservation Project: Preserving a Unique Ecological Area Consisting of Diverse Habitats and Rich Biodiversity

**Group Submitting Proposal:** University of Wisconsin — Green Bay's Graduate Seminar in Environmental Science and Policy Capstone Course.

*Project Coordinators:*

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**Amount of Request:** \$1,850,000.00

**Location:**

*State:* Wisconsin

*County:* Forest County

*Township:* FO Popple River

*Range:* T.39N. - R.14E.

*Section:* NE ¼, SE ¼ 24 and W ½ 25

*City/Municipality:* Popple River

*Address:* 13090-6 Highway 139

*Zip:* 54542

*Area:* 8

*Lake Name:* Long Lake

**Restoration Project Category:** (1) Wetland and associated upland habitat preservation project

**Project Description:** Many options exist for conservation, and sometimes choosing the best route can be a daunting task. The Fox River Restoration Project presents the rare opportunity to make powerful and lasting contributions to conservation efforts in Wisconsin and Michigan. The project is aimed at correcting the errors of the past, a difficult but plausible goal. This effort encompasses a vast array of choices to aid in the recovery of ecological systems in the Fox/Wolf River watersheds. Projects involving restoration in the lower Fox River region have a logical precedence over more distant areas, yet the distant areas warrant an equal amount of consideration. Areas in the outer watershed should be seriously considered for the following reasons: conservation of higher quality ecological systems, preservation of headwater areas that contribute to the Fox River, and protection of areas with higher biodiversity.

Numerous properties in the watershed management area have been examined and the site we have selected should be considered a high conservation priority. The Long Lake property consists of 177.8 acres in northern Wisconsin. This property has remained relatively undisturbed over the last three decades and borders Long Lake on one side and the Nicolet National Forest on the other. It is actually two parcels of land that are joined by Nicolet National Forest. It has an astounding 6,600 feet of lake frontage, with an active trout stream running through the property. A low-lying wetland area surrounds Coldwater Creek (See *Appendix 9.5*) while mixed deciduous and coniferous forests occupy the higher areas. In total, there are seven distinct habitat types located within the property, making it an excellent choice for preservation.

A sponsor will take over ownership of the land once the land is purchased, depending on the amount granted. The United States Forest Service (USFS) has expressed interest in a bargain-purchase of the Long Lake Property and will integrate the property into the surrounding Nicolet National Forest landscape.

**Maintenance Requirements:** One of the benefits of the Long Lake Land Acquisition Proposal is the immediate preservation of high quality ecosystems and high levels of biodiversity without long-term restoration, financial, or management commitments. Due

to the land's proximity to Nicolet National Forest and its relatively undisturbed habitats, little to no active management should be required once the property is purchased.

**Compliance with Applicable Laws & Regulations:** Since land acquisition does not involve habitat alteration, construction, or land manipulation, the project is in compliance with all applicable laws and regulations. All applicable real estate transaction laws will be followed.

**Timeline:** Completion date is largely dependent upon the decisions of the Trustees. Once the property is purchased and protected in perpetuity, immediate benefits for fish and wildlife will be established, largely as a consequence of preventing future development. The restoration project will offer immediate substitution for damages done to the Lower Fox River and will be completed in a period of fewer than 5 years. The land will be protected with a conservation easement preventing development, in effect protecting vital habitat forever. No long-term management efforts will be required after purchase.

*Phase 1: Review of Proposal by Trustees*

*Phase 2: Purchase of Property*

*Phase 3: Turn over Property to Managing Entity (Sponsor)*

**Proposed Budget:**

Budget Breakdown: All funds will be applied to the purchase of the property.

**Project Benefits:** The overriding goal of the Fox River Restoration Project is to help repair damages sustained by the lower Fox River due to the release of polychlorinated biphenyls (PCBs). The goal of this land acquisition proposal is to preserve an area that will replace ecosystems damaged by this tragedy. Though some physical distance from the lower Fox River, the selected property is certainly not removed in function. Protection of the habitat on this property will provide much needed preservation of a headwaters area that ultimately connects to the lower Fox River (see Watershed

Connections of Long Lake, following). Protection at the source prevents the possibility of upstream damage that could destroy an otherwise pristine stretch of water.

Recognizing that waterways more distant from the root of the problem receive lower priority, a rationale has been established for why there should be a mix of funding priorities that range from large scale ecological restoration near the lower Fox, to preservation of habitat (especially waterways) farther away (please see Rationale for Preservation versus Restoration, following).

The direct benefits of protecting the Long Lake property are numerous. It is an instant success; a high quality, fully functioning ecosystem can be preserved immediately, without worry of long-term financial or management issues. Sadly, often-great amounts of time and money are expended on restoration projects that simply cannot return highly degraded systems to the level of functioning at which undisturbed systems operate. In this particular case, a vital piece of lakefront property destined for development would be protected. Lakes in northern Wisconsin continue to experience greater and greater pressure. Here is an opportunity to reverse this trend by preserving 6,600 feet of frontage, alleviating an astonishing amount of potential stress to the lake. Preserving the riparian corridor benefits a remarkable amount of wildlife and may provide breeding grounds for ducks, loons, and perhaps even Bald Eagles.

In all, there are seven diverse and distinct habitats on the property and this alone should make it a high priority for preservation. There are several different types of forests, including coniferous (White Spruce and Red Pine), mixed broad-leaf deciduous, and mixed conifer/deciduous. In addition to these forest types, there are three different types of wetlands, including emergent wetland, forested wetland and lowland shrub. These wetlands support a great diversity of birds and other wildlife. Furthermore, Coldwater Creek begins at Long Lake and flows through the property. It is considered a pristine trout stream, which adds strength to the argument for protecting the surrounding property.

Overall, the site has a great possibility for rich biodiversity, including a number of species that were directly affected by PCBs in the Lower Fox River. We have put together several potential species lists for wildlife that could be found on the property. The diversity of habitat types creates a very heterogeneous landscape (Appendix 9.6).

This, in addition to the high connectivity to Nicolet National Forest, will allow for a large tract of land to be protected from development. Though riparian corridors may be among the most vital habitats to protect for wildlife, they are often the most threatened by recreational development (see Rationale for Protection of Riparian Zones, following). Most importantly, a single act of preservation today will provide a lifetime of conservation benefits for wildlife and humanity.

**Measures of Success:** The simple fact that 177.8 acres of diverse and pristine habitat along with 6600 feet of undeveloped Northwoods lake shoreline will be preserved is testament enough to the success of this project.

The success of physical restoration is difficult to measure (Cole, 2000). Scientists and researchers often cannot agree on what the goal of the restoration should be, or when it is achieved. Ultimately, Higgs (1997) explains that a critical end product has been reached when scientists cannot distinguish the restored ecosystem from the natural ecosystem. In other words, the restored ecosystem must mimic the natural system in composition and function to a significant degree. Unfortunately, incomplete understanding of ecosystem complexities, connectivity, and functions often thwarts the success of physical restoration projects. A large number of implemented restoration projects fail to meet previously established project goals (Higgs, 1997). A successful restoration must renew or recreate ecosystem services and provide a stable, functioning structure over a considerable length of time.

## **7.0 Conclusions**

We would like to express our support of the Trustees for undertaking the daunting task of coordinating such a large-scale restoration effort. By reviewing the Joint Restoration Plan and the current activities associated with it, we hope to improve the process and outcome of this important endeavor. First, we encourage the Trustees to continue to fund and implement an appropriate mix of projects from all possible categories. Currently, there is an uneven distribution of accepted projects throughout the categories, but this may be due to the type of proposals that were available. Also, there are no projects underway in the area of first priority (along the Lower Fox River), and no public use enhancement projects, two areas that could be given more consideration when reviewing future proposals. Second, we recommend the use of a uniform ranking system to aid in choosing proposals for implementation. The ranking form we created could be used by the Trustees to easily review each proposal based on the criteria they included in the Joint Restoration Plan. Groups that are writing proposals, so they can be sure they consider all aspects of their project before submitting the proposal could also use the form. Third, we propose ideas for ensuring the success of these projects through monitoring. While funding is usually not given for monitoring specifically, options such as a coordinated volunteer monitoring effort through schools or non-profit organizations could be used in this case. We also outline a way to store and share information gathered on a number of indicators through a GIS-based interactive website. We do not expect the Trustees to create or manage such an innovation, but it would be ideal if an organization would implement this idea for the benefit of the restoration area, or larger region, as a whole. Finally, we ask the Trustees to thoroughly consider land acquisition proposals as an alternative in the overall restoration effort. A number of land acquisitions have been funded so far, and because there is no possibility for failure and no need for monitoring, this trend should continue as more money is committed to projects in the future. It is our hope that the review of this project will be helpful to the Trustees and the community and will generate more discussion and more high-quality proposals to make this restoration project a great success.

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