PATHWAY FOR DELISTING THREE BENEFICIAL USE IMPAIRMENTS IN GREAT LAKES AREAS OF CONCERN

Assessment of the
U.S. Michigan and Binational Areas of Concern
with regard to:

- **Degraded Fish and Wildlife Populations**
- **Loss of Fish and Wildlife Habitat**
- **Degradation of Benthos**

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INTRODUCTION

Three beneficial use impairments—Degraded Fish and Wildlife Populations, Loss of Fish and Wildlife Habitat, and Degradation of Benthos—have been identified in most of the United States Areas of Concern (AOC). These impairments are caused by chemical, physical and biological degradation resulting from human activities. Although anecdotal narratives tell of fish and wildlife bounty throughout the Great Lakes in pre-European settlement times, little scientific information about the landscape from that time exists with the exception of surveyors' notes from the 1800s. Nevertheless, of all the fourteen beneficial use impairments, these three are perhaps the most visible acknowledgments of how much the landscape has been changed by human activities.

In the early history of the Areas of Concern and Remedial Action Plans (RAP), the direct and indirect causes of fish and wildlife population declines or habitat loss were unclear. In some instances, the demarcation line that delineated an Area of Concern included the most polluted areas but may not have taken into consideration upstream activities contributing to degradation. Early RAP documents, therefore, while clearly stating chemical pollution sources of degradation, are not as descriptive about physical or biological changes to fish and wildlife populations or their habitats. With the help of many individuals and organizations, today we have a more complete understanding of the causes of degradation and the effects of such changes on fish and wildlife populations and habitats.

Fish and wildlife and benthos Beneficial Use Impairments (BUIs) have been particularly vexing with regard to delisting. In 2003, the Great Lakes National Program Office (GLNPO) began to develop a systematic approach to delisting. GLNPO staff decided to assess the progress of all US and binational AOCs with regard to delisting these three BUIs. One major finding is that local citizens with government entities have done tremendous work to characterize problems and implement change.

In general, however, we found no common pathway toward delisting of the three BUIs. We found little guidance or suggestions or information that would lead from restoration to delisting, and thus, Great Lakes ecosystem health.

Based on a cursory review of thousands of pages—and no doubt not all—from RAP documents developed over the years, we found we could not visualize each AOC in a restored state. We couldn't state with certainty what habitat types or populations needed to be restored in each AOC. And very often we couldn't find the connection between what restoration is presently occurring and stated RAP goals.

This paper is intended to establish a restoration pathway to delisting and assess Michigan AOC progress along that pathway. Appendices A and B contain sources of additional information about ecological restoration and restoration resources.

THE DESIGNATION OF HABITAT- RELATED BUIs AT AOCs

While there are many sites where the environment has been impacted in the Great Lakes basin and that are a cause for local concern, the Areas of Concern designated by U.S. – Canadian *Great Lakes Water Quality Agreement* are locations where significant environmental degradation is likely to cause continuing impacts on the Great Lakes.

At each of these locations, site conditions were assessed to determine if existing conditions supported fourteen beneficial uses of the resource. Based on criteria provided by the International

Joint Commission (IJC), the three habitat-related uses were listed as impaired, i.e. there were "beneficial use impairments" (BUIs), if the following criteria were met:

> *Degraded Fish and Wildlife Populations*
> When fish and wildlife personnel have identified degraded fish or wildlife populations due to a cause within the watershed as part of fish and wildlife management programs.
>
> *Loss of Fish and Wildlife Habitat*
> When fish and wildlife personnel have identified loss of fish and wildlife habitat due to water quality contamination as part of fish and wildlife management programs.
>
> *Degradation of Benthos*
> When the benthic macroinvertebrate community structure significantly diverges from un-impacted control sites of comparable physical and chemical characteristics. Benthic invertebrate community structure and composition are good integrators of ecosystem status. Three examples of utility include: 1) developing an endpoint using species diversity; 2) quantifying divergence from an expected community, given quantifiable physical and chemical habitat descriptors; and, 3) developing an ecosystem objective using benthic community structure. Further, benthic invertebrates are effective for bioassessment of sediment-associated contaminants. It is recommended that both field and laboratory bioassay data and historical information be used to define endpoints for toxicity and bioavailability of sediment-associated contaminants. A site will be listed when toxicity or bioavailability of sediment-associated contaminants is significantly (95% probability level) higher than controls.

Most of the Michigan AOCs have listed all three beneficial uses as impaired.

THE CHALLENGE OF DELISTING

Unlike toxicity driven BUIs, it is difficult to establish universal goals or endpoints for the habitat-related BUIs. There is a direct relationship between the landscape and the fish and wildlife populations that can be supported: the quantity and quality of available habitat determines the fish and wildlife population capacity of the AOC. While this relationship is easily understood, it begs the question, how much and what kind of habitat is enough? Answering this question is the major challenge faced by AOCs with habitat-related BUIs.

Each AOC has its own set of specific challenges that result from the location and history of the site. Most AOCs are "working landscapes" which have a significant degree of industrialization. Many sites contain features that are unique to the AOC and should be protected, such as the rapids within the St. Marys River or the river delta at the southern end of the St. Clair River. Other sites are important migration corridors, such as the two major migration pathways supported by the Detroit River. Because of these site-specific features, it is difficult to develop universally applied goals for delisting habitat related BUIs. This is not a barrier to delisting the AOC, but it is something that needs to be considered in developing AOC goals and site-specific targets.

Further, while environmental protection and natural resource management agencies have an important role in managing public lands, land-use decisions are fundamentally under the authority of local municipalities and governments. State and Federal agencies can offer expertise and help communities ensure that rules and regulations are met, but the most significant decisions are in the

hands of local communities. Capacity at the local level varies and the work of restoring sites within AOCs may require hiring additional staff or consultants.

Fortunately, the approach that each AOC needs to take to develop goals and site-specific targets can be consistent across all the AOCs. We are suggesting the following pathway to ensure that restoration is successful and results in a clearly articulated and defensible delisting process for the three habitat-related BUIs.

PATHWAY TO DELISTING

The following pathway to delisting is based on an ecological restoration approach (see Appendix A) and is comprised of five steps: vision and goals; inventory and assessment; project design; implementation; and monitoring and re-assessment. Opportunities may present themselves out of sequence. The pathway should not hinder progress in these cases, but should provide a commonly understood road map. For example, a site that would provide good habitat might be available for acquisition by a public entity before the full project design is completed. The pathway, then, is a guide to use when pursuing restoration of an AOC and delisting the three BUIs.

Step 1

Vision and goals: **the mental picture of the AOC and the components needed to improve it.**

- Organize staff from appropriate fish and wildlife agencies, academic institutions and the public who understand the issues and have the expertise, as an AOC committee who will oversee the restoration pathway to delisting.
- Research pre-European settlement habitat and species in order to understand the magnitude of changes and the range of improvement possibilities.
- Determine what natural resource values and features are important in the AOC, the reasons for listing the beneficial uses as impaired, and how restoration will improve water and ecosystem quality.
- With as many AOC local interests involved as practical, develop the vision for the entire AOC that balances protection and restoration of natural resource values with economic considerations.
- State restoration goals for the AOC. Be realistic and practical. When setting goals for aquatic habitats, determine the status of sediment remediation work and other remediation activities. What remediation work has to proceed prior to restoration?

This first step in the pathway is complete when the local community:

1. Acknowledges competing interests and values regarding land use, standards of cleanup and natural resources, and works toward acceptable compromises;
2. Shares a vision of the present AOC and what it will look like post-restoration;
3. Articulates AOC habitat-related goals;
4. Understands what is involved to get the work done; and,
5. Is committed to doing the work and preventing future degradation.

Step 2

***Inventory and assessment:* a listing of the plants, animals, and habitats currently in the AOC as well as the problems that are causing the impairments to them and what is needed for them to recover.**

- Enlist an ecological restoration expert familiar with local ecosystem types to inventory habitats and species and compare it to both historical conditions and the vision. This is the present benchmark between the past and the future.
- Determine the important or unique features that need to be preserved.
- Articulate the specific impairments to fish and wildlife populations and habitats and their causes.
- Determine land ownership and ability to influence land management.
- Map the AOC and each potential restoration or protection site, evaluating site conditions and needs.
- Revisit and refine AOC goals in light of the inventories. Points to consider are whether there are areas that do not lend themselves to immediate restoration because they are still under heavy human use (i.e. shipping channel); or whether there is a need for additional open space or public access; or what sites have the greatest potential to contribute to ecosystem recovery.

The second step in the pathway is complete when:

1. Major ecological components in the AOC, as well as the causes of impairments to those components, are known and mapped;
2. Work that needs to be done to restore is broadly known and consistent with the vision and goals; and,
3. The environmental goals for the AOC are reasonable given the potential for restoration.

Step 3

***Project design:* the detailed work plan to restore and manage all sites in the AOC.**

- Develop a comprehensive budget and assemble a working team that includes a restoration ecologist experienced working with native plants and local ecotypes, land managers of sites to be restored, and other appropriate specialists such as hydrologists or soil scientists, to design restoration plans for AOC sites.
- Choose reference sites for each habitat type to be restored. A reference site serves as a model for planning the restoration project. It is normally selected for its well-developed expression of biodiversity. In several AOCs, such as the St. Mary's River, reference sites surround the AOC. In others, such as the Buffalo River, reference sites must be pieced together from historic records and nearby sites.
- At each of the sites to be restored, and based on current inventories, identify habitat targets, the types and quantity of habitat to be restored.
- Given the type and quantity of habitat available, determine species targets, the fish, wildlife, or benthos species or community types and quantities each habitat type can support.
- Incorporate indicators into the work plan to be able to assess when the targets have been reached at each site. These key measures will describe how success will be communicated throughout the effort.
- Develop a timeline for implementation including: contaminant removal, point source pollution monitoring or prevention, non-point source best management practices upstream, and habitat restoration at each site.

Step three in the pathway is complete when:

1. A work plan is in place for each site within an AOC to be restored and/or managed;
2. Site targets (habitat and species) support the environmental goals for the AOC.
3. The project timetable is reasonable; and,
4. There is a common understanding of how project progress will be tracked and communicated.

Step 4

***Implementation:* initiating the work plan activities that will accomplish the goals and objectives leading to the fulfillment of the vision.**

- Secure finances for the project components.
- Begin restoration at each site. Often contractors are hired for major components of the effort. Consider including volunteers for some of the restoration activities.
- Ensure that quality protocols are clearly stated and corrective actions are taking place, if appropriate.

The success of restoration activities may not be evident for years. Therefore, the fourth step in the pathway may be considered complete if:

1. Finances have been secured and work has been started at all sites according to the work plan developed in the project design step; and,
2. The indicators (track record) show that demonstrable progress toward reaching targets at each site is being made.

Step 5

***Monitoring and re-assessment:* keeping track of each site over a long period of time.**

- Develop a long term, feasible and economical monitoring plan and program to monitor progress of restoration indicators as well as the overall AOC goals.
- Organize a partnership to oversee progress, implement long term monitoring of the indicators established in Step 3, assess the results of monitoring, and respond or adapt management actions. This partnership will likely include agency staff and local residents.
- Maintain a tracking and reporting system.

Step five is complete when:

1. Restoration is completed or well underway at all sites. Consistent monitoring shows that the restoration trajectory is on track to meet all site targets within the work plan timeframe;
2. The restoration trajectory also demonstrates that the restoration of site targets is leading to the achievement of AOC environmental goals.
3. Resources to complete the work, manage the sites, and monitor over the long term (20+ years) are assured; and,
4. Protections are in place to prevent future degradation from recurring.

DELISTING PRINCIPLES AND CRITERIA

AOCs were designated because they were problematic, major contributors to the degradation of the Lakes. Restoration of degraded fish and wildlife populations, habitats, and benthos will contribute positively to the health of the AOC and also to the greater ecosystem. For example, today there are few mayflies in Saginaw Bay. Restoration of aquatic habitats and benthos in the bay will create a robust nursery area that would benefit the entire lake.

The following three principles underlie the pathway to delisting:

1. Delisting of habitat-related BUIs is likely to be dependent on the delisting of other BUIs. For example, in order to restore macroinvertebrates, it may be necessary to remediate contaminated sediments. The work plan timetable needs to take this into consideration.

2. An AOC that's ready for delisting will not only have restored sites, but will have a connection with its surrounding landscape. For example, the St. Mary's River is a migratory corridor for fish and birds. Restoration of AOC habitats will help to maintain the continuity of those routes. In an urban setting such as the Buffalo River, restoration of sites will provide much needed and scarce habitat for many different species.

3. It is appropriate for delisting to occur prior to full ecological restoration as long as it can be demonstrated that the ecosystem is on a trajectory toward full recovery. For example, wetlands take a long time to recover. It is appropriate to consider delisting a restored wetland when water flows have been restored and major categories of emergent vegetation are in place, but prior to restoration of full biodiversity and ecosystem processes, which can take as long as decades.

The following are criteria for delisting the three BUIs:

- The restoration trajectory is moving measurably toward the environmental AOC goals.
- It is demonstrated that the restoration pathway has been followed, including monitoring and reporting systems in place to track and guide recovery.
- Target habitat quantities are sufficient to support desired fish, wildlife and benthos populations.
- The quality of habitat for desired species is physically, chemically, and biologically suitable.
- The desired fish, wildlife, and benthic communities are showing signs of sustainable recovery.
- The benthic macroinvertebrate community structure resembles control sites of comparable physical and chemical characteristics.
- Fish and wildlife are beginning to migrate freely in and through AOCs to utilize essential habitats.
- Land use plans and zoning laws are protecting habitats from future development, physical degradation and contamination.

Please refer to the document "Restoring Great Lakes Areas of Concern: Principles and Guidelines", found on the GLNPO website at http://www.epa.gov/glnpo/aoc/delist.html, for more information about the process of delisting any BUI.

Getting the Help You Need

GLNPO is committed to efforts leading to delisting. In Appendix B we list contract and nursery resources. In addition, for fiscal year 2005, beginning October 1, 2004, our Funding Guidance will devote a portion of our habitat and Coastal Environmental Management funds toward one or more of the five pathway categories.

ASSESSMENT OF THE PATHWAY IN MICHIGAN AOCs

When assessing each Michigan AOC according to the pathway, we found that seven of the Michigan AOCs have a vision and broad goals. Four AOCs have stated goals but the vision for the AOC post-restoration is not clear. Three AOCs do not have a clearly stated clearly articulated vision or broad goals that we could find in the RAP documents.

All of the AOCs have assessed AOCs problems well. It was easy to understand why the three BUIs were originally listed. All have also done a fair number of plant and animal inventories. In most cases, however, these inventories are listings that appear disconnected from an AOC-wide vision or goals or have not been used to establish site targets. Inventories can be useful both in establishing the values the community wants to retain and as the basis for any project design.

Only Torch Lake has a well-defined restoration design, although the Kalamazoo River appears close and the Detroit River has a partial design that is evolving with the Heritage Corridor and International Wildlife Refuge. Project design maps for each AOC are largely absent. We had difficulty picturing what a restored AOC would look like. We feel it's necessary to provide a picture of the vision for an AOC so that there is a common understanding within the community.

All AOCs have implemented restoration projects. However, project connections to vision and goals. Indicators to track success are often missing. Also missing are long-term monitoring plans. It is not possible to gauge the success of ecological restoration at each site or for an AOC without monitoring over a long period of time.

Table 1, summarizing Michigan AOC pathway progress, and the assessments of each of the Michigan AOCs in terms of natural resource values, BUIs listed, reasons for the listing, and actions needed, follows.

Table 1: Summary of Michigan AOC Pathway Progress

✔ = completed
\+ = in progress

	Vision & Goals	Inventory and Assessment	Project Design	Implementation	Monitoring and Re-Assessment
Clinton River	+	+		+	
Deer Lake		+		+	
Detroit River	✔	+	+	+	
Kalamazoo River	✔	✔	+	+	
Manistique River	+	+		+	
Menominee River	+	+		+	
Muskegon Lake	✔	+		+	
River Raisin		+		+	
Rouge River	✔	+		+	
Saginaw River	✔	+		+	
St. Clair River	+	+		+	
St. Mary's River	✔	+		+	
Torch Lake	✔	✔	✔	✔	+
White Lake		+		+	

Assessment of Michigan AOC Habitat-Related BUIs

Clinton River

Natural Resource Values/Unique Features:
Although degraded, warm water fisheries, mussel populations, Chinook salmon and wetlands/floodplains are of significant value in the AOC.

BUIs:
Degradation of fish and wildlife populations
Degradation of Benthos
Loss of fish and wildlife habitat

Reasons for BUI Listing:
Increased sedimentation, contaminated groundwater, poor habitats, low dissolved oxygen, partially blocked river flows combined with little topographical relief, PCBs and heavy metals contamination of river water and sediments, eutrophic conditions and impoundment have all contributed to degraded habitats, fish and wildlife, and benthos. The sources of stress include municipal and industrial point source pollution, non-point source pollution from agricultural runoff, stream channelization, poor land use practices, changes in hydrogeology, and development. Studies have also shown that salinity levels may be a source of stress on Clinton River biota.

Suggested actions:

1. Specify the vision, goals and objectives for the entire AOC that includes habitat and species to be restored.
2. As the AOC now appears to encompass the entire watershed, inventory and assess potential sites for their restoration potential.
3. Develop a restoration plan that includes target habitat acreage and species composition as well as a timetable for sediment remediation.

Deer Lake

Natural Resource Values/Unique Features:
Deer Lake is a 906-acre impoundment, connected to Lake Superior by the Carp River. The drainage basin is relatively small, covering only 36 square miles of primarily forested area (96%). For decades, the lake's water level was manipulated through a dam on the Carp River by a local electrical utility; consequently, a goal of the RAP is a stable lake level. No county or municipal beaches or parks surround the lake and since the lake is not publicly owned, MDNR does not manage it. However, the lake has been stocked with yellow perch from time to time in the past. The Carp River is a designated trout stream. Deer Lake's wetlands are important; in fact, a 1981 survey found 103 species passing through them during spring migration. The surrounding forests have a typical mix of animals and plant species.

BUIs:
Degradation of fish and wildlife populations

Reasons for BUI listing:
Fish had been contaminated with high levels of mercury in excess of the MDPH's action level of 0.5 mg/kg-wet weights, which resulted in fish consumption advisory for Carp Creek, Deer Lake, and the Carp River. Sources of mercury include both point and non-point sources. Point sources included the

old sewage treatment plant and CSOs from the City of Ishpeming. (Fortunately, the new treatment plant began operating in 1986.) Sediment throughout Deer Lake has been contaminated with mercury and some metals. The area was the site of gold mining since the 1880's and mercury amalgamation was used. Tailings were deposited in several tributary creeks.

Bald eagles are sighted and a few have tried to nest; unfortunately, the mercury uptake from fish in the lake may have resulted in elevated mercury readings from sample eagle feathers.

Finally, concentrated nutrient loadings, probably from the sewage treatment plants, have hastened eutrophication.

Suggested Actions:

1. Develop a comprehensive map of the AOC.
2. Establish baseline inventories of habitat, plants, and animals. Include detailed analysis of both eagle population and desired fisheries.
3. Design a restoration plan: identify reference sites, i.e. biodiversity investment areas. Include surrounding forested areas and possibly extrapolate loadings given various development scenarios. Consider future land use patterns: zoning, etc.
4. Implementation: identify restoration leaders, implementers, and desired local involvement, including the PAC.
5. Establish a timeline for implementing restoration plan with the goal of delisting. Include long-term monitoring in the plan.

Detroit River

Natural Resource Values/Unique Features:

Detroit River coastal wetlands provide habitat for over 300 threatened and endangered species. Fish habitats are critical, particularly for species such as the lake sturgeon, various mussel species, and colonial waterbirds. Two migratory waterfowl and raptor corridors converge over the Detroit River, which is also an important walleye migration route. For humans, the Detroit River is a source of drinking water and recreational opportunities such as duck hunting.

BUIs:

Degradation of Fish and Wildlife Populations— The status of this BUI has long been disputed. Some reviewers of the Detroit Stage I RAP felt that data cited in the Stage I did not support a "no impairment" conclusion for fish or wildlife. In 1996, the Detroit River Update Report changed the wildlife impairment conclusion to "unknown," but continued to regard fish as "unimpaired." In a November 1999 Detroit River Update Report, the Detroit River Canadian Cleanup Committee considered both fish and wildlife populations to be impaired.
Loss of Fish and Wildlife Habitat—"Sediment toxicity results in violations of water quality objectives suggest impairment due to contaminants." *(from the RAP Phase I document)*

Degradation of Benthos—"Based on analyses of benthic community structure, moderately large portions of the system exhibit severely impacted benthic communities" (1996 Detroit River Update Report, pg. 62).

Reasons for BUI listing:

Sediment contamination, exotic species, and changes in habitat structure have impacted fish and wildlife populations and community structure. The river bottom is degraded and pollution

tolerant organisms dominate. Riparian wetlands have been lost. Bird species such as bald eagles have lost reproductive capacity due to contamination. The sources of these problems include point source pollution from industrial discharges such as petrochemical plants, sewage treatment plants, and leachates from waste disposal sites. Spills of chemicals, oils, and other products along the shoreline or from cargo ships have contributed to pollution. Shipping lane dredging has had an impact on harbor sediments. Non-point source pollution is from urban, agriculture and in-stream sediment discharges.

Actions Needed:
A vision for the AOC has been completed. Goals for the AOC include zero loss of wetlands, no net loss of productive capacity of fish habitats and protection and restoration of habitats where possible. Mapping, characterization and protection of wetlands and island habitats has been completed. Compliance with Michigan water quality standards is the stated target. Numerous actions have begun cleanup, including sediment remediation of the Trenton Channel, numerous habitat acquisitions and restoration projects, a designation as a Heritage River and International Wildlife Refuge. Additional actions are needed as follows:

1. In addition to meeting Michigan water quality standards, determine the community and species targets for each site to be protected and restored. Targets need to take into account bird and walleye migrations, and wetland and mussel species.
2. Determine goals and objectives, as well as targets for fish and wildlife habitats and species.
3. Design a habitat protection and restoration plan that includes a timetable for acquisition and restoration. Incorporate Great Lakes Fisheries Commission fish community goals and objectives, 1996 Detroit River Update Report habitat goals, Essex Regional Conservation Authority Biodiversity Conservation Strategy, Lower Detroit River Conservation Vision and USFWS Comprehensive Conservation Plan for the Detroit International Wildlife Refuge, into the plan.
4. Since zero loss of wetlands is one goal, set up a long-term monitoring program to measure health and extent.
5. In addition to monitoring wetlands set up a long-term monitoring program to measure aquatic and terrestrial habitats.

Kalamazoo River

Natural Resource Values/Unique Features:
The Kalamazoo River drains approximately 2,020 square miles through ten counties. It is 162 miles long and varies in width from 11 to 29 miles. The entire watershed is contained within the Michigan/Indiana till plains ecoregion. For our purposes, it may be easiest to divide the river into four sections:

1. The North Branch above Concord is a small, clear-water stream.
2. The South Branch from Homer to Albion is a larger river, averaging 40 feet wide and 18 inches deep. There are some quality marshes in this area.
3. Between Albion and Cereso, half of this length is impounded and it is heavily developed. There is an area around Battle Creek that has several scenic areas and some islands.

4. Finally, the river widen to an average of 100 feet with a four-foot depth. Generally, there is very little development along this section, save for a constructed channel where the river flows into Lake Michigan at Saugatuck.

BUIs:
Degradation of fish and wildlife populations
Loss of fish and wildlife habitat
Degradation of benthos

Reasons for BUI listing:
Myriad Superfund sites dot this Area of Concern; and decades of manufacturing have taken their toll on this river. Each of these contributors are outlined in detail in the RAP document. Much of the information is site specific.

Suggested Actions: (Measured against our ecological restoration pathway, this RAP appears to have covered all of the areas.)

1. Develop a comprehensive map of the AOC. (*Generally done, although some more work on biodiversity investment areas may be needed.)*
2. Establish baseline inventories of habitat, plants, and animals. (*Most of this has been planned.)*
3. Design a restoration plan (*Generally done)*
4. Implementation: identify restoration leaders, implementers, and desired local involvement, including the PAC. (*Generally done.)*
5. Establish a timeline for implementing restoration plan with the goal of delisting. Include long-term monitoring in the plan. (*More emphasis on long term monitoring is needed for delisting.)*

Manistique River

Natural Resource Values/Unique Features:
The Manistique River is located in Michigan's Upper Peninsula. The Area of Concern begins at the dam and extends through the harbor to Lake Michigan. Low sandy or gravely ridges alternating with swales and swamps characterize it. Aquatic habitat downstream of the dam supports a variety of sport fish, e.g. northern pike, several varieties of salmon, and trout. One specific point in the river where the elevation quickly drops forming rapids is considered to be an excellent spawning location. Bald eagles forage along the shoreline in the vicinity of the AOC and many types of waterfowl have been observed. "There is little available wildlife habitat elsewhere in the AOC, since the entire site lies within the City of Marquette and the shoreline and nearby areas are relatively developed."

BUIs:
Degradation of fish and wildlife populations
Loss of fish and wildlife habitat
Degradation of benthos

Reasons for BUI listing:
There are three basic problems that led to the listings: (1.) PCB-impacted sediment; (2.) effects of the dam and paper mill flume on fisheries management goals; and (3.) combined sewer overflows discharging directly to the river and harbor. Most actions called for in the RAP document deal directly with these problems.

Suggested Actions:

1. Develop a comprehensive map of the AOC. Pay special attention to special critical biodiversity areas, such as the rapids that are critical to spawning activity. Perhaps dividing the river into segments including the city's parcel would be helpful in setting goals.
2. Establish baseline inventories of habitat, plants, and animals in each segment.
3. Given that the concentrated development had already greatly affected the habitat, consider what can realistically be achieved.
4. Design a restoration plan: identify reference sites, i.e. biodiversity investment areas.
5. Implementation: identify restoration leaders, implementers, and desired local involvement, including the PAC.
6. Establish a timeline for implementing restoration plan with the goal of delisting. Include long-term monitoring in the plan.

Menominee River

Natural Resources Values/Unique Features:
Wetlands and fisheries are the primary natural resources values/features.

BUIs:
Degradation of Fish and Wildlife Populations
Loss of Fish and Wildlife Habitat
Degradation of Benthos

Reasons for BUI listing:
Past lumber and logging activities, urbanization, water fluctuations, waste disposal, and sediment and groundwater contamination has led to birth defects and reproductive problems in fish eating species, the elimination of wetlands, arsenic contamination, habitat loss, accumulation of waste from lumbering activities, contaminated sediments, and poor water quality.

Suggested Actions:

1. Develop a comprehensive map of the AOC.
2. Establish baseline inventories of habitat, plants, and animals.
3. Design a restoration plan: identify reference sites, i.e. biodiversity investment areas.
4. Implementation: identify restoration leaders, implementers, and desired local involvement, including the PAC. Given the pronounced nutrient loading problem, consider outreach to the agricultural community.
5. Establish a timeline for implementing restoration plan with the goal of delisting. Include long-term monitoring in the plan.

Muskegon Lake

Natural Resource Values/Unique Features:
A warm water fishery and unique shoreline and wetland areas, especially sand dunes and marshes, are the major natural resource values and features.

BUIs:
Degradation of Fish and Wildlife Populations
Loss of Fish and Wildlife Habitat
Degradation of Benthos

Reasons for BUI listing:
Degraded fish habitats, loss of shallow littoral zone, excessive nutrient loadings, invasive species, erosion, alteration of shoreline, and contaminated sediments and groundwater are the result of many impacts. Impacts include sediment and habitat problems associated with urban runoff, dredging and filling at the shoreline, the historical discharges of polluted wastewater, localized groundwater contamination moving toward the lake and its tributaries have impacted fish, wildlife and benthos. Historically, lumbering, industrial growth related to foundries, metal finishing facilities, petrochemical production and shipping, have contributed to degradation..

Suggested Actions:

1. Develop a comprehensive map of the AOC.
2. Establish baseline inventories of habitat, plants, and animals.
3. Design a restoration plan: identify reference sites, i.e. biodiversity investment areas.
4. Implementation: identify restoration leaders, implementers, and desired local involvement, including the PAC.
5. Establish a timeline for implementing restoration plan with the goal of delisting. Include long-term monitoring in the plan.

River Raisin

Natural Resource Values/Unique Features:
The River Raisin and remaining coastal marshes are habitat for mussel and fish species as well as special plants such as the water lotus.

BUIs:
Degradation of Fish and Wildlife Populations
Loss of Fish and Wildlife Habitat
Degradation of Benthos

Reasons for BUI listing:
A 1997 study showed that Ford Marsh bald eagles are deformed, probably due to residual DDT and PCBs. A 1976-1978 study found only four species of mussels compared to twenty species historically. The remaining mussel species are considered endangered or threatened. Water lotus is endangered and decreasing in the lower river marshes. There has been a reduction in the reproduction and growth of benthic organisms, a decrease in prey species available for sport fish, and a lack of pollution intolerant species. Streams lack vegetative cover for fish habitat, water temperature has increased, sedimentation is high and sediments are contaminated, diversity of depth, velocity and bottom substrates has decreased, and eutrophic conditions are caused by high turbidity and phosphorus. Fish population movement is restricted due to blocked fish migration routes. These impairments are due to municipal and industrial point source pollution, non-point source pollution from agricultural runoff, destruction of wetlands, entrainment, dams, stream channelization, and poor land use practices.

Suggested Actions:
1. Concur on an AOC-wide vision that includes habitats and species.
2. State concrete goals and objectives for the different habitat types and species identified in the vision that are coordinated with sediment remediation goals.

3. Inventory and assess the habitat remnants in a manner similar to the Sterling State Park work.
4. Design a restoration plan for each site that includes reference sites and quantitative species and habitat targets. Set targets for delisting that include warm water fishery upstream of the turning basin, benthic organisms, mussel habitats that supports the remaining species, restored and functioning wetlands, bald eagle resting or nesting habitats, and lotus beds that are maintained and not decreasing.
5. In the area from the shipping canal to the turning basin, determine the value of restoring fish habitat.
6. Upstream of the shipping channel area, map and assess warmwater fish habitats, wetlands, lotus beds, mussel habitats; inventory species utilizing these habitats.
7. Upstream of the AOC, assess non-point source contributions to sedimentation and implement non-point source controls and best management practices (in addition to the filter strips installed in 1994.)
8. Map and assess the nearshore aquatic habitats and wetlands along the shoreline outside of the shipping area (if outside of Sterling State Park).

Rouge River

Natural Resource Values/Unique Features:
Trout streams, wetlands and river corridors are the main unique features in the AOC.

Contrary to popular belief not all areas of the watershed are degraded. Much of the public parkland floodplain remains intact and many of the headwaters areas and tributary streams are in good condition. There have been significant water quality improvements as well.

BUIs:
Degradation of Fish and wildlife populations
Loss of fish and wildlife habitat
Degradation of benthos

Reasons for BUI Listing:
Declines in game fish populations and sensitive fish species are the result of many factors, including pollution from salvage yards going into the river, non-point source pollution, point source stormwater discharges, combined/separated sewer overflows, contaminated sediments, altered stream flows, fragmentation of floodplain and river corridors, rivers channelized and encased in concrete, and urbanization-development.

Suggested Actions:
1. Develop a comprehensive map of the AOC. Pay special attention to special critical biodiversity areas.
2. Establish baseline inventories of habitat, plants, and animals in each segment of the river.
3. Given that the concentrated development had already greatly affected the habitat, consider what can realistically be achieved.
4. Design a restoration plan: identify reference sites, i.e. biodiversity investment areas.
5. Implementation: identify restoration leaders, implementers, and desired local involvement, including the PAC.
6. Establish a timeline for implementing restoration plan with the goal of delisting. Include long-term monitoring in the plan.

Saginaw River and Bay

Natural Resource Values/Unique Features:
The Saginaw River watershed is Michigan's largest (8,709 square miles in size), draining approximately 15% of Michigan's total land area. The Saginaw Bay is the second largest bay in the Great Lakes system and historically contained the largest wetland/lake prairie complex in the Great Lakes region. The watershed contains what is said to be America's largest contiguous freshwater coastal wetland system, with more than 175 inland lakes and 7,000 miles of rivers. It is home to 138 endangered or threatened species.

BUIs:
Degradation of Fish and Wildlife Populations
Loss of Fish and Wildlife Habitat
Degradation of Benthos

Reasons for BUI listing:
Many changes in the fish populations of the bay and river began to occur in the early 1900s. Fish numbers were affected by water pollution, the introduction or invasion of exotic species like carp, rainbow smelt, and (later) alewife, and dams blocking major spawning tributaries in both the Saginaw River watershed and other tributaries to the bay. There is also evidence that excessive commercial harvest exacerbated the drastic decline recorded for several species on into the mid-late 20th century. Extensive fish stocking (over 80% of the walleye, the top predatory species in the bay) is required to maintain a healthy fishery due to a lack of suitable tributary/reef spawning habitat in the watershed. The manufacture, use, and subsequent discharge of persistent toxic chemicals into the waters of the area have had a significant negative impact on the growth and survival of a number of fish-eating wildlife species.

Saginaw Bay historically contained the largest wetland/lake prairie complex in the Great Lakes region. Massive land use changes since the mid-1800s have significantly altered the quantity, diversity, and quality of habitat available to support wildlife. Of the estimated 115,000 acres of coastal wetlands that fringed the inner Saginaw Bay prior to settlement, only about 40,000 acres remained as of the early 1970s. Dams and other barriers, as well as the burial of historic near-shore reefs by sediments, have severely decreased spawning habitat for native fish species. Other habitat degradation includes the sedimentation of fish spawning reefs in Saginaw Bay, human development of riparian lands along Saginaw Bay and River, removal of bottom substrates by dredging, numerous impacts from exotic species, and anoxic bottom conditions. This habitat loss and degradation has impaired the reproductive success and growth of numerous aquatic and wildlife species.

Saginaw Bay is a shallow region that once supported a rich riverine invertebrate bottom fauna, but underwent drastic changes in response to increased inputs of pollutants, primarily during the period from 1956 to 1978. High sediment oxygen demands eliminated many species of invertebrates that were replaced by pollution tolerant forms. The benthic species composition changed from a mesotrophic to a eutrophic assemblage.

Suggested Actions:
The overall natural resource values have been described:
Yellow perch
Walleye
Sturgeon

Bald eagles
Coastal wetlands
Tributary/wetland spawning areas
Mayflies

Overall restoration goals have been established:

Target: (F2) Critical coastal marsh areas are adequately protected.

Target: (F3) There is an increase in abundance of walleye in the bay, ultimately through natural reproduction, such that growth rates approximate more closely statewide averages for this species and reflect improved use of available forage in the bay.

Target: (F4) There is a sustained annual harvest of 750,000 pounds of yellow perch per year with increasing abundance of larger, faster growing individuals.

Target: (F5) There is documented evidence of natural reproduction of Lake Sturgeon in the Saginaw River.

Target: (W1) At least 60 percent of the coastal marsh areas (below the 585-foot contour) and adequate upland buffers representing essential fish and wildlife habitat is preserved through public ownership, covered under conservation easements, or otherwise protected under agreements with landowners.

Target: (W2) The most vulnerable portions of the remaining 40 percent of the essential coastal marsh areas have been identified so that governmental agencies, local conservation/environmental organizations, and concerned citizens can monitor their status, enforce existing laws, and conduct public educational programs to better protect these areas.

Target: (W3) The reproductive success of bald eagles in the Saginaw Bay area is equivalent to that found in other Lake Huron costal areas in Michigan.

Target: (BE2) Samples of mayfly nymphs collected in the open waters of Saginaw Bay exceed 30/m^2 for two consecutive years, based upon established sampling methods.

While key natural resource values and measures of success have been identified, more detailed implementation plans are needed to guide restoration efforts.

1. Map the AOC. Because of the size of the AOC, separate maps will need to be generated for each issue: coastal wetlands, tributary/wetland spawning areas, sediment erosion/transport, bald eagle nesting site distribution, sturgeon spawning site distribution, historic spawning reefs, benthic substrate-mayfly distribution.
2. The RAP is largely silent on the restoration of Saginaw River, which may be appropriate given the remedial measures (floodplain soils or contaminated sediment isolation/dredging) still needed before restoration efforts are initiated. However baseline information should also be mapped.
3. The RAP is largely silent on how to address the to 138 endangered or threatened species found in the watershed. Consideration of the distribution of these species and their habitat associations might also guide restoration efforts. Baseline information should be mapped.
4. Determine the status of the remediation effort for each one of the above issues. Is the damage reversible? To what extent? Are demonstration projects needed? What work has to proceed and at what sites?

5. Develop a restoration plan for each of the individual issues mentioned above. What key actions need to be accomplished by when? How will success be determined? These are more detailed goals than the overall "measures of success".
6. Develop a timeline for the collective remediation/restoration, considering interactions between plans for each individual issue. Prioritize actions so that actions are implemented in proper sequence, especially:
   Contaminated sediment removal,
   Non-point source control (agricultural best management practices upstream and streambank restoration to reduce downstream transport of sediment)

   Note that activities in the Saginaw Bay region or along the Bay shoreline need not be delayed by activities in the Saginaw River region. In other words, the protection/restoration of coastal wetlands and the enhancement of spawning access to tributaries/wetlands can proceed concurrently with Saginaw River remediation.
7. Organize government-local partnerships to oversee program implementation and monitor progress for each issue.
8. Periodically assess progress toward overall "measures of success" targets.

St. Clair River

Natural Resource Values/Unique Features:

The fish community of the St. Clair River is diverse consisting of almost 100 sport and forage species. At least 91 species of fish have been recorded as resident or migrants in the river and its delta, with at least 46 species utilizing the area for spawning and nursery habitat. Species that were important historically include large runs of lake trout, lake whitefish and lake herring that entered the St. Clair River from lakes Erie and Huron to spawn (Goodyear et al. 1982).

Unique St. Clair delta region provides habitat for amphibians and reptiles, birds other than waterfowl, and mammals including a number of rare species. The Lake St. Clair marshes of which the delta forms a major component, ranked as the second most important staging area in southern Ontario.

The Area of Concern provides habitat for at least 20 species of amphibians, 25 species of reptiles, 250 species of birds and 60 species of mammals.

An extensive park network provides substantial recreational amenities along both shores of the St. Clair River. These include campgrounds, day use parks, marinas and a limited number of beaches.

Two Native Indian reserves situated along the Canadian shore of the St. Clair River include the Chippewa of Sarnia Band Reserve and the Walpole Island First Nations Indian Reserve. Tribal members rely on hunting, fishing and trapping for food and income.

At least 179 benthic faunal species are known to occur in the St. Clair River.

BUIs:

[Degradation of Fish and Wildlife Populations – not identified as impaired]
Loss of Fish and Wildlife Habitat
Degradation of Benthos

Reasons for BUI listing:

[The St. Clair River provides diverse and extensive fish and wildlife habitat. At least 91 species of fish have been recorded as resident or migrants in the river and its delta, with at least 46 species utilizing the area for spawning and nursery habitat. The coldwater fish community is largely composed of exotic species (rainbow and brown trout, chinook and coho salmon and rainbow smelt)

which have filled the niche left absent by native species such as lake trout, lake whitefish and lake herring. This beneficial use is not identified as impaired.]

Fish and wildlife habitat on both sides of the St. Clair River have been altered considerably over the last century due to industrialization, urban development, diking, drainage for agricultural purposes, and the development of navigational channels. Extensive bulkheading and infilling has occurred along much of the river resulting in the loss of spawning, rearing and feeding sites for many fish species. Many of the wetlands of the St. Clair system have been lost, primarily because of drainage of large tracts of land for agriculture. The loss of wetlands from Lake St. Clair, including portions of the AOC lying within the delta, has been well documented and include at least 5,252 ha (12,972 acres) in Michigan and 1,064 ha (2,628 acres) in Ontario. Most of this occurred in the area of the delta. Considerable wetland acreage was also lost due to dredging or filling related to navigation, marina and housing developments. In addition, dykes that hydrologically separate them from the main channel have seriously impaired many wetlands. Present day development pressures continue to threaten fish and wildlife habitat. Impacts related to the loss of habitat as a consequence of water and sediment quality issues have not been well documented. This beneficial use is impaired due to physical habitat losses.

Benthic community health along the Michigan shore is good. On the Ontario side, the benthic community has been impacted downstream from the head of the river, near Sarnia's industrial complex. The zone of benthic impairment extended in the reach between the Sarnia WPCP and Dow Chemical and extending downstream past Stag Island to approximately Novacor Chemical (Canada) at Mooretown. Conditions were unsuitable for a number of pollution-intolerant benthic species including indicator organisms, such as, mayfly nymphs and freshwater scud. The "severely degraded" zone was not found in the 1990 survey. This beneficial use is impaired.

Suggested Actions:
Remediation work in the St. Clair River AOC has appropriately focused on chemical contamination. However, habitat remediation efforts have taken place at several locations in the AOC. In addition, Michigan Department of Natural Resources and the Ontario Ministry of Natural Resources have initiated the development of fishery goals. Additional work is needed to address ecosystem objectives in support of the fishery, as well as management goals for other components of the ecosystem. As noted in the AOC documents, fish and wildlife management goals are needed to help further determine the degree of impairment and guide rehabilitation strategies. Delisting targets need to be identified as part of the long-term management plan for the AOC.

1. Develop an overall vision for the fish and wildlife resources in St. Clair River corridor. What features where historically present? Where are the key current sites that support resident species? What needs to be in place to support migrating species? What is (and could be) the St. Clair River's role in the overall functioning of the Great Lakes basin ecosystem? Much of the components of this vision are already in the AOC documents.
2. Establish baseline information, including the compilation of historic and current ecosystem information.
3. Prioritize potential protection and restoration sites within the AOC. The river delta will be one area of focus. What other habitat types are essential? What quantity of habitat is required to achieve overall vision? What can be realistically achieved?

4. Design: Identify reference sites and create design for each restoration site. Consider timetable, budget. How will success be determined? The measures of success are one aspect of delisting, along with long-term management plans.
5. Implementation: Identify restoration leaders, implementers, and local involvement.
6. Establish schedule, method, and responsibility for monitoring recovery against delisting criteria. Develop plan for evolving from the goal of delisting to long-term management in perpetuity.

St. Marys River

Natural Resource Values/Unique Features:

At the 2000 State of the Lakes Ecosystem Conference (SOLEC 2000), the St. Mary's River was given the highest biodiversity rating in the Great Lakes.

Approximately 83 percent of the lands within 5 km (3 miles) of the St. Mary's River consist of undeveloped forest and wetlands. Forestland consists of mostly northern conifer-hardwood forests and boreal forests in poor to very poorly drained sites Extensive areas of emergent marsh wetlands border the lower river.

Diverse riparian bird habitat. One hundred and eighty-six species of waterfowl, colonial waterbirds, shorebirds, passerines and raptors inhabit the area, as residents or as temporary inhabitants. When water levels are low for extended periods, 'openland/grassland' terrestrial species can be found using the large expanses of sedge meadow adjacent to the river.

Riparian areas of the St Mary's River also support a number of big and small game animals and fur bearing mammals.

Unique rapids habitat.

The fish community in the St. Mary's River is diverse and includes 74 species of warm, cool and coldwater fish. Open waters and embayments, emergent wetlands, sand and gravel beaches, and the rapids area provide spawning, nursery, and feeding grounds for a number of native and introduced species. Pacific salmonine, namely pink, Coho, and Chinook salmon, and rainbow trout are seasonally abundant in the river and provide for a popular sport fishery. Commercial fishing by Native Americans occurs in Whitefish Bay and in the upper reaches of the St. Mary's River.

In open water phytoplankton and zooplankton populations are low in terms of abundance and relatively diverse in terms of community structure and reflect the oligotrophic characteristics of Lake Superior waters.

Diverse benthic macroinvertebrate community (over 300 taxa recorded).

BUIs:

Degradation of Fish and Wildlife Populations
Loss of Fish and Wildlife Habitat
Degradation of Benthos

Reasons for BUI listing:

Populations of native fish have been reduced due to habitat alteration, over fishing, pollution, exotic species, and stocking. The St. Mary's River is also the major contributor of sea lamprey infestation to northern Lake Huron, which accounts for an annual mortality of 54% of adult lake trout. Zebra mussels have also been discovered in the St. Mary's River. Extensive development on both sides of the river has resulted in the degradation and loss of aquatic and terrestrial habitat. The potential effect of this development on birds, mammals, and other animals has not been well documented. Wildlife populations appear to be stable or increasing, but assessment criteria are required.

Significant loss of fish and wildlife habitat has occurred as a result of shoreline alteration, industrialization, urbanization, and shipping activities, particularly within and immediately above and below the St. Mary's rapids. While agreements on water use have guaranteed minimum amounts of water for the rapids it is a significant change in flow that existed pre 1985 that has resulted in both a reduction in size of the rapids habitat and a reduction in discharge over the rapids. Loss of wetlands and rapids habitat due to urban/industrial development and operation of navigational structures are also a concern. Fish spawning and rearing habitat in both Michigan and Ontario have been lost due to the construction of structures for navigation and power generation, as well as from dredging and filling activities. Specific habitats throughout the river are now threatened by colonization of exotic species such as purple loosestrife, Eurasian fish species, zebra mussels, and other exotic invertebrates.

Pollutant loadings from industrial and municipal discharges and urban runoff affects benthic habitat along sites along the river.

Suggested Actions:
St. Mary's River is a site of extremely high ecological richness. As previously noted, at the 2000 State of the Lakes Ecosystem Conference (SOLEC 2000), the St. Mary's River was given the highest biodiversity rating in the Great Lakes. In a sense, it is its own reference site. The main focus of most restoration efforts will likely be ensuring that there is "no net loss of existing habitat", as outlined in the initial delisting criteria of the Stage 2 document.

1. Map the AOC. Rather than mapping species distribution across the entire corridor and then developing a management plan for each species, consider dividing the AOC into functional use sections (geozones as described in the Stage 2 document): shipping lanes, industrial areas and their impact zones, riverside parks, natural sites of a given type (forested sections, riparian corridors, wetland systems, open water fishery, tributary/nearshore spawning areas, etc.). Focusing on restoring ecosystem values at specific sites will help focus activities on the ground. In most cases, by improving habitat, the desired improvement in wildlife populations will be achieved.
2. Determine the status of the possible remediation effort for each one of the sections. How impacted are the areas? Is the damage reversible? To what extent? Be realistic.
3. Prioritize the above areas, if appropriate. The total number of sites/sections to address must be reasonable. Some sites may not benefit from additional remedial work (e.g., scour in shipping channels may negate restoration activities.) These areas may have a lower priority for resources.
4. Develop a protection/restoration plan for each of the selected sections. How will success be determined? Restoration activities at impaired sites should have specific goals. Set targets for restoration endpoints. A riverside park in a city will have different endpoints (walkways, piers, viewing platforms, landscaping with selected native plants) than a natural site (protection/restoration of native plant and animal community assemblages). Not every location needs to be measured, for example if the benthic community at an area that is directly impacted by an industrial outfall is restored; it is reasonable to assume the rest of the area is healthy. Success in high quality habitat areas might simply be defined as having establishing protection measures (purchase, easements, stewardship/management plans).
5. Consider the net effect of protection/restoration efforts in the entire corridor. Will activities bring a net increase in a given species/habitat type? Will current populations/habitat be

maintained? Because of the biodiversity in the area, consider using "keystone" species as indicators, rather than developing targets for every organism.
6. Delisting criteria will be the endpoints for individual sites, plus any overall "keystone" indicator species/habitat targets.
7. Develop a timeline for remediation and restoration actions. Prioritize actions so that actions are implemented in proper sequence, especially making sure that industrial outfall clean-up and contaminated sediment removal precedes habitat restoration.
8. Organize government-local partnerships to oversee site restorations.
9. Periodically assess progress toward site protection/restoration and overall delisting targets.

Torch Lake

Natural Resource Values/Unique Features:
Torch Lake has a viable sport fishery.

BUIs:
Loss of Fish and Wildlife Habitat
Degradation of Benthos

Reasons for BUI listing:
Deposits of slag and contaminated sediments, as well as high copper concentrations, have degraded the benthic macroinvertebrate community. When present, benthic organism populations consist of pollution tolerant species. Deposits of tailings from historic mining and milling operations have covered shoreline and wetland areas. The entire area is a Superfund site and under Superfund authority.

Suggested Action:
A fish spawning reef and artificial wetland were installed and Superfund remediation is underway, however, an additional action is needed as follows:
1. Continue to monitor the new fish spawning reef and wetland for improved habitat conditions, use by species, as specified by Superfund.

White Lake

Natural Resource Values/Unique Features:
White Lake is a drowned river-mouth lake at the end of the White River. It is thousands of years old, covers 2,571 acres, is approximately five and a half miles long, averages a mile in width, and a mean depth of 23 feet, and a maximum depth of 70 feet. The White River continues to contribute about 95% of the lake's water.

BUIs:
Degradation of fish and wildlife populations
Loss of fish and wildlife habitat
Degradation of benthos

Reasons for BUI listing:
Dredging and hardening of the shoreline, mechanical removal of vegetation, marina development, and seawall construction has changed the shoreline and led to depleted oxygen levels, altered shoreline habitats, exotic species introductions, and contaminated sediments. The shoreline is quickly becoming encircled by residential development or altered for commercial and recreational

use. Habitat loss is a major concern as extensive shoreline development in recent years had led to the elimination of riparian and submergent plants, while isolating upland habitats that still remain. People are building ever-larger homes in smaller spaces along steep hillsides, in ravines, and altering unique habitats like wetlands. Overall, development is eliminating important breeding areas and habitat corridors for fish and wildlife. While cultural eutrophication has slowed since this RAP was first listed, nutrient loading from the White River remains a concern.

Actions needed according the RAP documents: "Determine nutrient loading for the lake and establish 5 and 10–year nutrient management plans.

1. Establishment of a formalized master plan between all municipalities around White Lake that provides habitat conservation, preservation, and restoration for fish and wildlife.
2. Acquire conservation easements at Dupont, Occidental, and Genesco sites for habitat protection and pubic land preservation. Utilize sites to give back to the community that has already had so many negatives associated with their health, and the health of their environment."

Suggested actions:
General goals have been developed for the habitat-related BUIs.

1. Develop a comprehensive map of the AOC. Rather than concentrate on private, remedial sites, establish a baseline for restoration that includes, but is not limited to, industrial sites.
2. Establish baseline inventories of habitat, plants, and animals.
3. Given that concentrated riparian development greatly affects the habitat, consider including zoning and other land use goals in the plan, considering what can realistically be achieved.
4. Design a restoration plan: identify reference sites, i.e. biodiversity investment areas.
5. Implementation: identify restoration leaders, implementers, and desired local involvement, including the PAC. Given the pronounced nutrient loading problem, consider outreach to the agricultural community.
6. Establish a timeline for implementing restoration plan with the goal of delisting. Include long-term monitoring in the plan.

APPENDIX A: Primer on Ecological Restoration

Available online from the Society for Ecological Restoration at:

http://www.ser.org/content/ecological_restoration_primer.asp

APPENDIX B: Resources to Get Started

Ecological Restoration-Natural Landscaping Design Consultants

Questions to ask when selecting a consultant:
Does the type of project you are considering fit the mission of the design consultant?
What is the scope of their services?
Has the consultant worked on similar landscapes successfully?
What is their training, expertise, knowledge?
Are their plant materials native and/or non-invasive?
Are their references satisfactory?
What is the extent of their insurance coverage?

Consultants:
Disclaimer: *Below is a list of ecological restoration-natural landscaping design consultants. This is not a complete list nor is it an endorsement.*

Andropogon and Associates
10 Shurs Lane
Philadelphia, PA
215-487-0700; fax: 215-483-7520; www.andropogon.com

Applied Ecological Services, Inc.
17921 Smith Road, P.O. Box 256,
Brodhead, WI 53520-0256
609-897-8641; fax: 608-897-8486; www.aeserv.com

Biohabitats, Inc.
15 W. Aylesbury Road
Timonium, Maryland 21093
410-337-3659; fax: 410-583-5678; www.biohabitats.com

Conservation Design Forum
375 W. First Street
Elmhurst, IL 60126
630-559-2000; fax: 559-2030;
www.cdfinc.com

David Borneman
1123 Mixtwood
Ann Arbor, MI 48103
E-mail:
davidborneman@yahoo.com
734-994-3475; Mobile: 734-645-8476

Earth Art Landscape Design
3319 Eloc Drive
Swartz Creek, MI 48473
E-mail: vchatfield@comcast.net
810-655-6580

Ecological Restoration and Management, Inc.
15 W. Aylesbury Road
Timonium, Maryland 21093
410-337-4899; fax: 410-583-5678; www.biohabitats.com

Ecothink
2271 Rochester Road
Oakland, MI 48363
E-mail: ecothink@comcast.net
248-652-4004

Heritage Farm
600 South Hurd Road
Oxford, MI 48371
E-mail:
prairiesmoke@earthlink.net
248-969-9200;
www.home.earthlink.net/~prairiesmoke

J.F. New and Associates
708 Roosevelt Road
Walkerton, Indiana 46574
574-586-3400; fax: 574-586-3446; www.jfnew.com

Pizzo and Associates, Ltd.
10729 Pine Road
Leland, IL 60531
815-495-2300; 815-498-4406;
www.Pizzo1.com

Plantwise Native Landscapes
224 Charles Street
Ann Arbor, MI 48103
E-mail: plantwise@aol.com
734-665-7168

Wild Thymes
8070 Perry Lake Road
Clarkston, MI 48348
248-625-7240

Native Plant Resources

Questions to consider before buying native plants for restorations:

Q: Is it true that I should only buy plants or seeds that originated from my local area?

A: Another way to phrase this question is "how native is native"? Though a particular species of plant may exist in prairies in both Michigan and Illinois, over time that species adapted in slightly different ways, adjusting to the different conditions in each of those areas. Utilizing plants that originated in a local area builds upon this unique adaptation, and is geared toward maintaining the integrity of the local gene pool.

"How native is native", or how far away can a plant or seed come from and still be considered native to a local area, is a tough question. There is a range of opinions about what the answer should be.

One line of thought is that plants and seeds introduced or planted in an area need to come from very close to the area being planted. For instance, the North Branch Prairie Project in the Chicago area requires that the seeds used in prairie restoration originate from native plants within fifteen miles of the restoration site.

Others believe that it is important to look at how each particular plant species naturally spreads their seeds. Following this reasoning, if a plant's seeds are naturally disbursed through the wind, plant/seed sources from a relatively wide geographic range are acceptable. If the plant's seeds are eaten and then deposited by animals with a limited range, sources for the plants/seeds would need to originate from a closer geographic area.

Still others believe that as long as the native variation species originated in a specific type of ecosystem (e.g. prairie), the genetic variation is inconsequential. In their opinion, it is appropriate to use the plant/seeds in other similar ecosystems no matter where the geographic location.

Most of these "how native is native" seed source issues have surfaced around designing the restoration work for degraded natural areas. And while the scale for restoring ecosystems and planting wild gardens is certainly different, there are many similarities. Both are improving the environment. A restoration ecologist can help figure out where, as stewards of your AOC, you should along on this spectrum of opinions. As a practical matter, you may find that there are not enough local seed sources to fill the demand. As a rule of thumb, buy plants or seeds from garden centers or nurseries with seed sources that originated as close as possible to the area where you want to plant them.

Q: Should the native plants be raised in nurseries? Can they come directly from natural areas?

A: As important as it is to use plant stock from your local area, it is important that the native plants and seeds themselves do not come directly from the natural areas, unless collected as part of the restoration effort. Poaching of plants and seeds from wild areas will eventually deplete these areas of the seed stock they need to be self-sustaining. Responsible nurseries and garden centers raise the native plants themselves, or otherwise ensure that the plants that they sell were not stolen from the wild. Often nurseries will receive seed stock from the stewards of natural areas. Plants from this wild seed are crossed with the nursery plants of the same species to ensure that the native plants sold remain strong and hardy. Many of these reinvigorated plants are returned to the natural areas where they originated. Others are sold for native landscaping.

Disclaimer: *Below are lists of potential sources where you may obtain further information. The following lists of publications, nurseries, seed sources, landscape architects, ecologists, organizations, consultants, and contractors does not imply any endorsement or recommendation by the Federal Government. This is not a complete list of resources. It is intended to be an aid to those seeking initial guidance on ecological restoration and native landscaping. Additional information can be found at: http://www.epa.gov/greenacres/*

Literature

Ann Arbor Department of Parks and Recreation, Natural Area Preservation, 1831 Traver Road, Ann Arbor, MI 48105 ; (313) 996-3266 (Series of pamphlets on native trees, shrubs, wildflowers, vines, grasses, sedges, ferns, and landscaping.)

Floristic Quality Assessment with Wetland Categories and Computer Application Programs for the State of Michigan. Lansing, Michigan: Michigan Department of Natural Resources, Wildlife Division, Natural Heritage Program. 21 pp. plus appendices. Herman, K.D., L.A. Masters, M.R. Penskar, A.A. Reznicek, G.S. Wilhelm, and W.W. Brodwicz.

Living with Michigan Wetlands: A Landowners Guide, Wilfred Cwikiel, Tip of the Mitt Watershed Council, Conway, MI, 1996. [Voluntary wetland protection, enhancement and restoration, wetland regulation, getting help. (616) 347-1181)]

Michigan Flora: A Guide to the Identification and Occurrence of the Native and Naturalized Seed-Plants of the State. Part I. Gymnosperms and Monocots, E.G. Voss, Cranbrook Institute of Science, Bloomington Hills, MI, 1972.

Michigan Flora: A Guide to the Identification and Occurrence of the Native and Naturalized Seed-Plants of the State. Part II. Dicots (Saururaceae-Cornaceae), E.G. Voss, Cranbrook Institute of Science, Bloomington Hills, MI, 1985.

Michigan Flora. A Guide to the Identification and Occurrence of the Native and Naturalized Seed-Plants of the State. Part III. Voss. E.G. (To be published.)

Organizations with Information on Native Plants

Beal Botanical Garden, Michigan State University, East Lansing, MI 48824; Tel: (517)355-7750; http://www.cpp.msu.edu/beal/beal.htm . (Systematic display of native species.)

Northland College , Sigurd Olson Environmental Institute, 1411 Ellis Ave., Ashland, WI, 715-682-1481

Society of Ecological Restoration International, 285 W. 18th Street, Suite 1, Tucson, Arizona, 85701, 520.622.5485 phone / 520.622.5491 fax / info@ser.org

University of Michigan, School of Natural Resources and Environment, 430 East University,Ann Arbor, MI; Tel: (313) 764-2376

University of Nebraska, Department of Horticulture, 377K Plant Science Hall, Lincoln, NE 68583 (402) 472-2854 (Information about PrairieScapes: landscapes and gardens that help prevent pollution; environmentally sound landscaping for prairie region.)

Wildflower Association of Michigan, P.O. Box 80527, Lansing, MI 48908-0527

The Wild Ones -Ann Arbor Chapter, P.O. Box 23576, Milwaukee, WI 53223 (Natural landscaping organization.)

U.S. Department of Agriculture, Natural Resources Conservation Service, Rose Lake Plant Materials Center, 7472 Stoll Road, East Lansing, MI 48823-9420, Phone: (517) 641-6300, Fax: (517) 641-4421

Nurseries, Landscape Architects, Ecologists, Consultants, Contractors:

Arrowhead Alpines
PO Box 857
Fowlerville, MI 48836
517-223-3581; fax: 517-223-8750

Autumn Glade Botanicals
46857 W. Ann Arbor Trail
Plymouth, MI 48170
fax: 313-459-2604

Bordine Nursery
8600 Dixie Highway
Clarkston, MI 48348-4236
248-625-9100; fax: 248-625-9109

David Borneman
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Ann Arbor, MI 48103
E-mail:
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734-994-3475; Mobile: 734-645-8476

Earth Art Landscape Design
3319 Eloc Drive
Swartz Creek, MI 48473
E-mail: vchatfield@comcast.net
810-655-6580

Ecothink
2271 Rochester Road
Oakland, MI 48363
E-mail: ecothink@comcast.net
248-652-4004

Far North Gardens
P.O. Box 126
New Hudson, MI 48165

Grass Roots, Inc.
Tom Smith
PO Box 4001
East Lansing, MI 48826
E-mail: grassroots@voyager.net
Phone: 517-337-2405
Fax: 517-337-2430

Hartmann's Plantation, Inc.
P.O. Box E, 310 60th Street
Grand Junction, MI 49056
Tel: (616) 253-4281

Heritage Farm
600 South Hurd Road
Oxford, MI 48371
E-mail:
prairiesmoke@earthlink.net
248-969-9200;
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Hortech, Inc.
PO Box 533
Spring Lake, MI 49456-0533
Phone: 616-842-1392
Fax: 616-842-3273

International BioEnt Enterprises
14174 Hoffman Road
Three Rivers, MI 49093
Tel: (616) 278-3075

Kalamazoo Wildflower Nursery
922 Grant
Kalamazoo, MI 49008
Tel: (616) 342-4910

Michigan Habitat Design, Inc.
2935 Flint
Ortonville, MI 48462
Phone/Fax: 248-627-8733

Michigan Wildflower Farm
11770 Cutler Rd.
Portland, MI 48875
E-mail: wildflowers@voyager.net
517-647-6010; fax: 517-647-6072;
www.michiganwildflowerfarm.com

Native Plant Nursery
PO Box 7841
Ann Arbor, MI 48107
734-677-3260; E-mail:
plants@nativeplant.com
www.nativeplant.com

Nesta Prairie Perennials
1019 Miller Rd.
Kalamazoo, MI 49001
800-233-5025 or 616-343-1669;
fax: 616-343-0768

Needlefest Evergreens
4075 W. Hansen Road
Ludington, MI 49431

Oikos Tree Crops
PO Box 19425
Kalamazoo, MI 49019-0425
E-mail: oak24@aol.com
Phone: 616-624-6233
Fax: 616-624-4019

Plantwise Native Landscapes
224 Charles Street
Ann Arbor, MI 48103
E-mail: plantwise@aol.com
734-665-7168

Sand Hill Farm
11250 Ten Mile Rd, NE
Rockford, MI 49341
E-mail: cherylt@iserv.net
616-691-8214; fax: 616-691-7872

Wetlands Nursery, Inc.
PO Box 14553
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Wildtype Native Plants
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