MIDWEST GLACIAL LAKES Partnership

A Fish Habitat Partnership

Strategic Plan for Fish Habitat Conservation in Midwest Glacial Lakes

September 30, 2009

This page intentionally left blank.

TABLE OF CONTENTS

APPENDICES

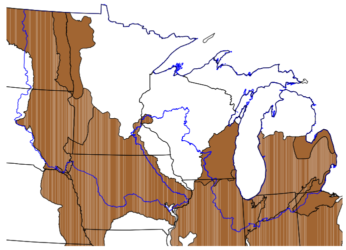
Contact Information: Pat Rivers, Midwest Glacial Lakes Project Manager
1601 Minnesota Drive
Brainerd, MN 56401
Telephone 218-327-4306
pat.rivers@dnr.state.mn.us
www.midwestglaciallakes.org

Executive Summary

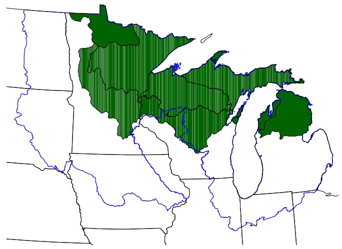
OUR MISSION
The mission of the Midwest Glacial Lakes Partnership is to work together to protect, rehabilitate, and enhance sustainable fish habitats in glacial lakes of the Midwest for the use and enjoyment of current and future generations.

Glacial lakes (lakes formed by glacial activity) are a common feature on the midwestern landscape. From small, productive potholes to the large windswept walleye "factories", glacial lakes are an integral part of the communities within which they are found and taken collectively are a resource of national importance. Despite this value, lakes are commonly treated more as a commodity rather than a natural resource susceptible to degradation. Often viewed apart from the landscape within which they occupy, human activities on land—and in water—have compromised many of these systems. These threats can be grouped as the three C's: Corn, Cabins, and Concrete.

Corn (Agriculture)
Agriculture is a dominant land use in much of this partnership's geography. The graphic at right depicts all ecoregions that are dominated by agricultural land use. Lakes can be found in all eight states that are still suffering from the poor soil conservation practices of an earlier time. Further, previous soil and water conservation gains are being lost as lands once retired to perennial vegetation are being tilled again with today's favorable biofuel economics.



Cabins (Development)
Much of the development in the Midwest is focused on lakes. While some areas of the region actually lost population in recent years, lake-rich counties, especially in forested ecoregions (see graphic at right) are seeing dramatic increases both in terms of year-round and seasonal residents. Projections for future growth show this trend will continue. As building occurs around lakes, the footprint of development and the activities that go with them (e.g., native vegetative buffers replaced with "city-scaped" lawns, water activities including shallow-water boating, the use of large docks and the removal of fish habitat) combine to have adverse impacts to fish habitats and water quality.



Concrete (Urban impervious surfaces)
Impervious surfaces in this region's urban areas have dramatic impacts on lakes. Direct discharge of storm water into lakes carries nutrients and other pollutants into these systems. As algae blooms become more common, rooted aquatic plants—fish habitat—become scarcer. The Central Conrbelt Plains ecoregion exceeds 9 percent impervious surface and certainly is much higher when considering specific lakesheds.

Many good conservation efforts are occurring in the respective states, however, the coordination of programs and exchange of information and successful actions does not occur to the fullest extent possible. This partnership is developing a regional strategy for addressing aquatic habitat protection and restoration in glacial lakes. Benefits of such an approach are many, not the least of which will be the first regionally based assessment of glacial lakes. This assessment will focus conservation activities and resources in areas that make the greatest use of limited funds. The partnership provides a forum for sharing programs, strategies, and techniques that have proven their worth but have not yet been applied at a larger, regional scale.

MIDWEST GLACIAL LAKES PARTNERSHIP

GOALS

Protect and maintain intact and healthy lake systems and fish habitats, including fishable populations of game (sport) fish, with an emphasis on native, naturally sustaining populations.

Prevent further degradation of fish habitats that have been adversely affected.

Reverse declines in the quality and quantity of aquatic habitats in lakes to improve the overall health of fish and other aquatic organisms.

Increase the quality and quantity of fish habitats in lakes that support a broad natural diversity of fish and other aquatic species.

OBJECTIVES and TARGETS

Conduct a condition analysis and identify priority glacial lake fish habitats by 2010.

Prepare a "Status of Fish Habitats in Midwestern Glacial Lakes" report in 2010 and every five years thereafter.

Implement a Communications Strategy that effectively uses Outreach and Education by 2011.

Protect 10,000 acres of intact and healthy lake habitats and 40,000* acres of intact watersheds by 2012*.

Restore natural variability in 1,000 acres of lake surface elevations and reconnect 10,000 acres of fragmented lake habitats by 2015*.

Reduce and maintain sedimentation, phosphorus and nitrogen runoff to lake habitats to a level within 10 percent of the expected natural variance in these factors or above numeric State Water Quality Criteria in 1,000 acres of affected lakes by 2020*.

DEFINITIONS

Protect:
The removal of a threat to, or preventing the decline of, aquatic habitat by an action in or near a waterbody

Restore:
The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic attributes or functions to degraded aquatic habitat

Enhance:
The manipulation of the physical, chemical, or biological characteristics of a waterbody that heighten, intensify, or improve specific function(s) or for a purpose such as water quality improvement, flood water retention or increased fish production/habitat.

Source: Final Interim Strategies and Targets for National Fish Habitat Action Plan, November 8, 2007

*Interim target. Future coordination with partners will determine actual target upon completion of the resource assessment.

MIDWEST GLACIAL LAKES PARTNERSHIP OVERVIEW

GUIDING PRINCIPLES

-Habitat protection is the most cost-effective long-term conservation strategy.

-The Partnership will help local and regional efforts acquire the necessary resources and provide decision analysis and other evaluation tools necessary to succeed.

-Money spent on restoration, if done strategically, is a wise investment and will result in a positive return on that investment.

-Our lake conservation efforts are most likely to succeed when we evaluate progress toward clear and measurable goals, adapting our methods as new information becomes available.

PARTNERSHIP PROCESS

Inventory

Conduct an inventory and classification of the lakes resource using existing data.

Prioritize

Work with partners to identify priority areas for each system type:

- Healthy and intact fish habitats in lakes
- Impaired lake habitats
- Engineered systems (with control structures)

Identify System Influences

What are the processes, condition factors, and stressors affecting the state of the resource (hydrology, connectivity, bottom form, material recruitment, energy flow)?

- Hydrology
- Land use (watershed)
- In-lake use (riparian, shore land, in-lake structures, surface use)
- Climate change (affects policy and priorities)
- Organizational capacity, precipitating interest and social barriers

Improve

Provide guidance to partners for implementing lake protection and conservation strategies by focusing on the process and underlying system influences. Address the system influence that is negatively impacting the resource.

Evaluate

Measure the social, ecological, and economic response and benefits. In the event of failure, determine why the project did not meet expectations.

Adapt

Based on project evaluation, change strategies as warranted.

The State's many lakes and ponds, forested hills and ridges, and gently rolling farmlands remind us of the glacier's visit and beckon us to come, explore, and enjoy! —From the National Park Service Ice Age National Scenic Trail website
http://www.nps.gov/archive/iatr/expanded/history.htm

Photo courtesy of Steve Heiskary MPCA

I. BACKGROUND

Glacial lakes are an abundant and recognizable feature of the landscape over much of the upper Midwest. Retreating and melting of the the Wisconsin Glacial Episode—the last major advance of continental glaciers in the North American Laurentide ice sheet—formed the Midwestern glacial lakes. This episode began about 110,000 years ago and ended 10,000-15,000 years ago (Morton and Gawboy 2000). The resulting landscape features a diverse collection of lakes that range from the small fishless basins that are important to wildlife and waterfowl to the grand sizes of Winnebago, Mille Lacs and Lake of the Woods. Glacial lakes—40,000 by one count—occur in multiple ecoregions in the upper Midwest ranging from the Northern Glaciated Plains and Eastern Corn Belt Plains, which are now dominated by agriculture, to the Northern Lakes and Forests which is as its name implies (Omernik, 1987). The Prairie Pothole Region of the country constitutes portions of Iowa, Minnesota, and North and South Dakota and is an important waterfowl production area for North America.

Not long after the retreat of the glaciers this lakes region became home to numerous Native American tribes that relied on the area's abundant fish, wildlife and other natural resources for their sustenance. Spring and fall fish runs proved to be a reliable food source. Harvesting fish by torchlight during these runs was practiced on many lakes and on the aptly named Lac du Flambeau (Lake of the Flames) located in central Wisconsin. Lakes provided travel routes throughout the year for Ojibwe to hunt, fish, trade, and seasonally gather wild rice and travel "from berry patch to beaver meadow" (Morton and Gawboy 2000). Lakes and rivers in the 1836, 1837, 1842 and 1854 ceded territories remain important for tribal subsistence harvest today. French Voyageurs began their Midwest lake travels in the early 1600's opening up the fur trade with Native Americans and helping to establish towns such as Grand Portage and International Falls (Treur 1979). As territories became states and counties and towns developed, lakes continued to be focal points in the citing of communities and local economies. Logging companies used lakes—first taking those stately pines that could be felled directly onto the ice of a lake or driving stream (Rector 1953) — to transport their product to sawmills. As angling opportunities were discovered, resorts that catered to the fishing desires of city dwellers from the likes of Chicago, Minneapolis, and Detroit sprang up on thousands of lakes. Lake water provided—and still does today—a cost-effective water supply for many communities.

Today, lakeshore development fuels another economy. Lakeshore that once was deemed not suitable for development—perhaps due to a wetland shoreline instead of the oft-desired sand beach—is now the "best of the rest." For a variety of reasons, resorts are being subdivided and sold for single-family homes and more commonly today as fractional ownership communities. With the advent of web-based workplaces, stay at home telecommuters are able to live full-time at their lake home (be it newly acquired or one that spans generations). Many small cottages from eras gone by are being remodeled or replaced with homes that are larger and reminiscent of city homes. This changing nature of lakeshore ownership demonstrates our continued reliance on our glacial lakes for social, cultural, and economic needs.

II. VALUES OF GLACIAL LAKES

Glacial lakes have important economic, social and ecological values. And just as the three legged stool requires all legs to function, so too it is that effective lakes management requires all three value types be addressed.

Economics-

It is well known that lake-based angling in the Midwest has a significant effect on local, regional and national economies. Southwick Associates (2008) estimated that freshwater fishing creates 115,000 jobs in the eight Partnership states, generating $875 million in fishing-related federal tax revenue. Nonresident anglers traveling to Wisconsin and Minnesota spend more than $1 billion per year on fishing. At the local level, anglers fishing for black crappie on Upper Red Lake, MN spent an estimated $4 million in 2004 alone (Welle 2005). Lakeshore property values are related to the water quality and available recreational opportunities as well. When the walleye fishery on Upper Red Lake collapsed and the season was closed indefinitely, lakeshore values dropped dramatically. However as the fishery recovered, culminating with the re-opening of walleye harvest in 2006, property values tripled over the course of seven years (Welle 2005). The clarity of lake water has also been shown to affect the price of lakeshore (Michael et all. 2000; Boyle et al., 1998; Krysel et al., 2003). Tribal subsistence harvests provide many tribal families with nutrition throughout the year.

Social-

Lakeshore property is in demand because of the amenities or benefits it provide its owners, such as water-based recreation, an aesthetic setting for a home, tranquility away from urban and commercial life, and perhaps the privilege or esteem of owning an increasingly scarce and valuable resource (Krysel et al. 2003). For many in the Midwest, renting a lake cabin or spending time at their lake cottage is the highlight of summer months and anticipated throughout the year. Riparian and littoral zones of lakes have an aesthetic appeal when the shoreline is naturally vegetated. Lake associations and fishing clubs are important social networks that bring lake users together to share their passions. Winter is no time to sleep as ice fishing, cross-country skiing, riding snowmobiles, and numerous festivals (e.g., Eelpout Festival in Walker, MN: Kites on Ice in Madison, WI; pond hockey tournaments in many cities) utilize the "hard water." For many that live close to lakes, weekly use is a cherished reason for living where they do. Whatever the reason, millions of people

choose to spend their time on, in, or around these glacial lakes.
Ecological-

The geographic focus area for the Midwest Glacial Lakes Partnership encompasses nearly 270,000 square miles in all or part of eight states and includes approximately 40,000 lakes and tens of thousands of miles of shoreline. This collection of lakes range from the relatively infertile systems of the Canadian Shield to the highly productive lakes of the prairie landscape. It would be difficult to overestimate the ecological value and benefits of any of these functioning lakes and their corresponding lakesheds. Ecological processes of lakes occur at different scales—from the site specific processing of chemicals to the geographic position of a lake within a landscape (e.g., seepage vs. drainage lake)—and all play a role in maintaining high quality environments. It is no wonder humans are attracted to riparian or near shore areas since they are considered one of the richest habitats for aquatic and land based life (Castelle et al. 1992). Functioning riparian areas maintain water quality through filtration and nutrient processing. Vegetation—from periphyton found on submerged logs to emergent aquatic plants, to the towering trees that one day will become food for aquatic animals when they too fall—support the fundamental requirements of all animal life. Aquatic vegetation provides cover for invertebrates that are keys to healthy food webs and can inhibit algae production in fertile waters. Plant structure serves as spawning substrate for many species and as a nursery for young-of-the-year fish, providing abundant food and sheltering them from predators. Both plants and associated invertebrates are food for many wildlife species as well. Tree-falls create complex habitat in glacial lakes with forested lakeshores. Fish grow at faster rates along areas containing woody cover than areas without such complex habitat (Sass et al. 2006). When these and a myriad of other ecological processes come together, the complex systems that are our glacial lakes function in a sustainable fashion, much as they have for thousands of years. When human behaviors intercept/disturb one or more of these ecological processes, the dynamic equilibrium that has been maintained is interrupted and the consequences and impacts soon become readily apparent.

III. OVERVIEW OF IMPACTS TO GLACIAL LAKES-- IDENTIFIED THREATS AND STRESSORS

Natural shorelines and inlake structure (aquatic plants, coarse woody habitat) provide many benefits for fish, wildlife, and water quality. Many people take these benefits for granted and alterations to aquatic habitats and water quality caused by development and other land use changes are increasingly affecting the sustainability of healthy glacial lakes in the Midwest. Indeed, Weitzell et al. (2003) concluded, "… glacial lakes [in Minnesota and Wisconsin] are among the most endangered of aquatic systems, currently threatened with a multitude of anthropogenic disturbances." These disturbances operate within an historical, spatial, and geographic context.

The Legacy of Past Actions- Agricultural Setting

As European settlement began in the mid-1800s, land use changed. Declines in water quality occurred coincident with wide-scale conversion of the landscape from prairie and transitional forest to today's familiar row crop agriculture, primarily in the Partnership's southern geography. Many shallow lakes and wetlands were drained to aid in this pursuit, taking with the water the ability to filter and hold precipitation and snow melt. For many lakes, these land use changes increased nutrient inputs and shifted them from a clear water state with abundant aquatic plants to a turbid state with fewer aquatic macrophytes. For other lakes, the changes simply compromised their resiliency or ability to withstand further perturbations (Scheffer and Carpenter 2003; Figure 1). The legacy of these land use changes on lakes is long lasting. As Carpenter et al. (2007) note for the Yahara lake district in southern Wisconsin, "While some progress has been made in reducing nonpoint-source phosphorus [commonly a limiting nutrient in aquatic systems] inputs to the lakes, dealing with the legacy of intensive nutrient use is a challenge. Future water quality is constrained by nutrient overuse a generation ago." Currently, we are seeing our previous gains in conservation practices in this landscape (e.g., Conservation Reserve Program) threatened anew with rising commodity prices brought on by the demand for ethanol, food demand, and meat production (Carpenter et al. 2007).

The Legacy of Past Actions- Forested Setting

While such a broad water quality change has not been documented in northern-forested landscapes, a similar and long-lasting habitat legacy has occurred in this region. White and red pine stands were harvested in the late-1800s and early-1900s, creating measurable coarse woody habitat deficits for northern lakes that will linger for a century or more. Coarse woody habitat can make a very long contribution to the near shore ecology of lakes in the form of carbon budgets, physical habitat, and energy transfer (Guyette and Cole 1999), providing benefits to many generations of invertebrates, fish, turtles, birds, and other species from a single piece of coarse woody habitat in a lake. Guyette and Cole (1999) reconstructed a chronology of woody habitat from littoral zone pine boles of an Ontario lake that spanned eight centuries. Fortunately, forests in this region of the Midwest have mostly regenerated and watersheds have returned to an undeveloped state in many areas, factors that mimic pre-settlement conditions.

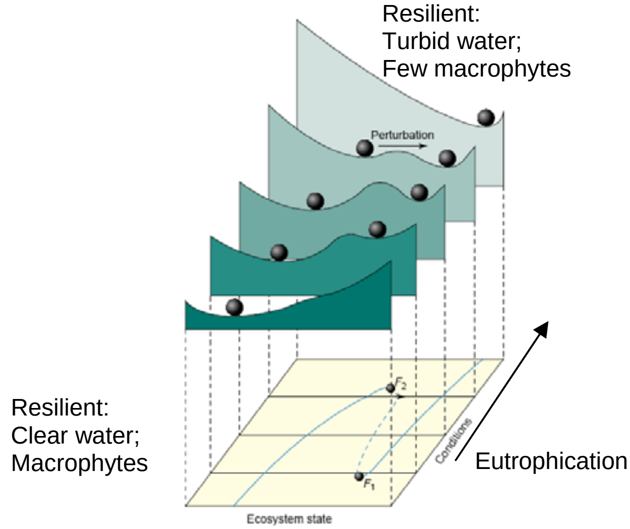


Figure 1. The loss of resiliency and resulting shift in plant communities. Reprinted by permission from Macmillan Publishers Ltd: Nature, Scheffer, M. et al. Catastrophic shifts in ecosystems. Copyright 2001.

From Lakeshore to Lakeshore Drive

One trend that is not as clearly reversible is conversion of lakeshore to residential development and redevelopment, a trend that has greatly accelerated over the past 30 years. This trend is driven by convergent factors of changing population demographics, an increasingly mobile society, and various economic forces. Patterns of growth tend to be away from agriculture and urban core areas and toward suburbs and lake rich areas. Over the past 20 years, the states of Michigan, Minnesota, and Wisconsin, each rich in glacial lakes, have experienced extremely high increases in population while surrounding states have grown much more slowly or have even lost population. A Wisconsin study found housing development increased an average of 216% since 1965 on lakes greater than 10 ha in northern Wisconsin. Further, glacial lakes are not uniformly abundant across the region, which creates a type of lake “supply and demand” for these resources in states like Indiana relative to other “lake rich” states - development pressures are perhaps even greater due to lakes’ relative scarcity. Carpenter et al. (2007) report that fish habitats and growth rates of fishes in the northern, forested region were primarily affected by shoreline development and, to a lesser extent, movement of invasive plant and animal species, which increases with increasing travel and lakeshore development.

Additionally, many people are traveling across the region from their main residence in one state to their lake cabin in another, making it difficult for Best Management Practices education and outreach efforts to reach their intended targets.

70 years and counting!

Forgoing a more formal wedding, Ray and Peggy Lemmerman of Austin, MN spent their wedding money on lake property (Rush Lake, Crow Wing County) in 1938. Some family members thought this a foolish move by these newlyweds. Now, 70 years later, Peg watches her three great-grandchildren enjoy the lake and cabin where she and Ray raised their four children. "As teachers, we spent much of our summers at the lake. The kids would fish, find frogs, and the best days were known as the Two Swim Days." Now 92 years old, Peg still enjoys summer pontoon boat rides and crappie fishing which has been a rite of spring for those 70 years.

As residential development increases around lakes, human behaviors and activities in the immediate riparian area lead to physical alteration of aquatic habitats and increased nutrient inflow from fertilizers, septic tanks and storm water run-off from imperviousness. The attendant loss of near shore habitat, primarily reductions in native vegetation, coarse woody habitat from fallen trees, and physical reshaping of the shoreline and shallow areas, is well documented in the scientific literature as is the correlation between these human-caused changes and reductions in fish species diversity, densities and growth rates. These changes also create new, compromised habitats that in turn aid in the establishment of nonnative species, further disturbing and competing for native game fish habitat (Weitzell 2003). Studies have also documented the negative effects of lakeshore alteration caused by housing development on the composition of breeding birds, reptile and amphibian abundance. Common loons, the signature species of the northern glacial lakes, osprey and eagles avoid lakes with a high level of human disturbance.

Direct Removal of Fish Habitat

Physically complex lakeshores provide superior habitat while human activities work to simplify such conditions. Developed shorelines can change the composition of bottom materials that can alter aquatic vegetation patterns, favoring shifts towards more luxuriant growth and "taller" plant forms. Lakeshore property owners then pursue physical removal or chemical control through herbicides (Figure 2), in response to a perceived interference with their use of the near shore lake area or simply to try and create their ideal of a "clean" lake. As homes become denser, tree-falls dwindle due to thinning and removal of trees along the lakeshore—sometime to better the lake view—and the removal of downed trees from the water. Construction and placement of shoreline erosion control structures, usually needed to compensate for the stability lost from native vegetation removal, reduces complex natural habitat elements. Riprap and sea walls result in less habitat diversity and lack woody debris and overhanging cover. The combined practice of hardening shores with rocks or walls and removing native plants on either side is the ultimate in lakeshore urbanization creating a look and feel similar to that of a curb and gutter suburban subdivision. Lakes and lakeshores cannot simultaneously function as swimming pools, boat storage areas and a place for fish and wildlife production.

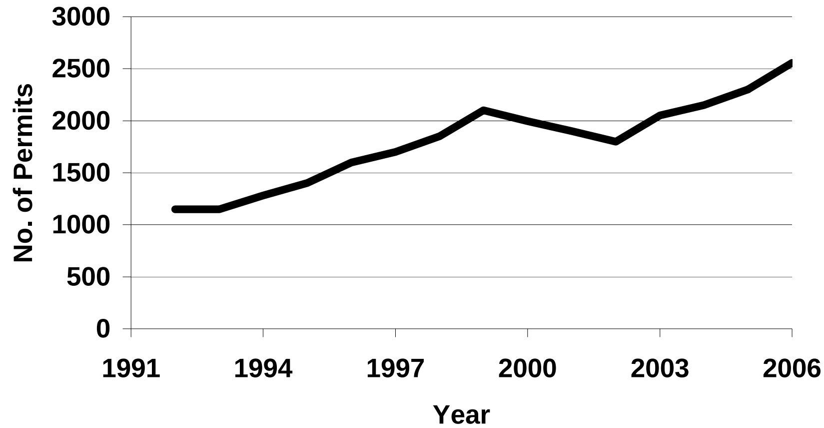


Figure 2. Number of aquatic plant management permits issued by the MN DNR, 1991-2006 (Enger and Hanson 2008).

Cumulative Effects

Taken individually, a small removal of vegetation (or a downed tree) by a shoreline owner is inconsequential. However, the accumulation of relatively small habitat changes can have lakewide consequences for fish and fish habitats (Jennings et al. 1999). Sass et al. (2006) observed diet shifts in largemouth bass and a decline in yellow perch abundance following a large-scale experimental removal of woody habitat from a northern Wisconsin lake, demonstrating that changes in coarse woody habitat abundance can cause complex and lasting effects to lake ecosystems. Whole-lake estimates of largemouth bass nesting success were found to be negatively associated with dwelling density in a suite of Michigan lakes (Wagner et al. 2006). Piers or docks occurred on average every 100 feet and covered nearly 10% of the nearshore littoral zone of one Wisconsin lake (Garrison et al. 2005), while an estimated 20% of the shoreline of lakes in Crow Wing County, Minnesota was impacted (Minnesota Dept. of Natural Resources, unpublished data). Clearly, fish need more than water to support abundant and diverse populations.

While the details vary from state to state, shoreline property ownership conveys a suite of property rights unique to riparian owners that govern lake bottom ownership, in-lake habitat removal, and general recreational surface water access and use. State resource management agencies attempt to balance these riparian rights with their fiduciary responsibilities for the commons. In exercising their riparian rights, lakeshore residents may and often do adversely alter lake habitats. Lakeshore residents generally recognize the consequences of certain detrimental behaviors, but many also knowingly conduct activities that adversely impact lake water quality and fish habitats for reasons including personal aesthetics, peer pressure, perceived and real economics of lakeshore property, and lack of understanding for cumulative impacts.

With limited supply, there is increasing market pressure to add density to lakeshore areas (i.e., condominiums and second tier development within the near shore watershed). Further, the remaining lakeshore lots that have not been developed do not lend themselves well to the ideal lakeshore envisioned above. Rather, they tend to have wetland fringe, shallow water and abundant aquatic vegetation. It is not surprising then when these new homes are built that requests for aquatic plant removal, boardwalk installation, and in some cases channel creation via dredging soon follow. These effects will be devastating to fisheries habitat in coming years unless riparian landowners change behaviors and protect, preserve and restore shoreland and near-shore habitats.

Multiple Use Conflicts

The essence of multiple use conflicts is really one of conflicting uses and expectations. With increased human densities on lakeshores comes increased diversity in the ways and means by which people recreate on our waters and shores. The same development that has led to increasingly urbanized lakeshores has also increased the level of non-lake shore owner demand to use the Midwest's glacial lakes. Public access sites on many lakes are at capacity each weekend of the summer. Tournament fishing has increased dramatically in number and scope and scale. This all creates competition for a finite space and inevitably leads to conflict and diminished recreation experiences as well as biological health. Increased crowding of our surface waters and especially the shallow water areas negatively impacts fisheries production and lake ecosystem health.

What is at stake?

To someone visiting a Midwest glacial lake for the first time, he or she might conclude that the resource is in an intact—if not pristine—condition. And while this is the case in many lakes in the northern portion of the partnership area, it certainly is not true in the central and southern areas. This creates difficulty in conveying what is at stake or perhaps what has already been lost. Stuck in "The Invisible Present" (Magnuson 1990), some current users simply are unaware of this loss. But for the angler or person with a long, storied history in one location, the negative changes are apparent and not of an incipient nature (see Leech Lake at right). It is this gradual decline we hope to prevent, stop, and in some cases, reverse.

If glacial lake habitats continue to decline in quality, we can expect to see further erosion in our aquatic ecosystems. There will be more lakes listed as "impaired", meaning water quality or other environmental standards are not met—already at 40 percent of lakes tested in Minnesota. We will see more algal blooms that hamper recreation and compromise aquatic communities. Management agencies will see their list of lakes needing immediate action increase at a time when agency resources are increasingly limited. Lakes that currently support intolerant species such as northern cisco and trout will cease doing so. Popular sport fish populations will decrease and potentially no longer be self-sustaining. Property values are tied directly to water clarity, so negative changes in that metric will mean lowered values. Wildlife populations that are so dependent on riparian corridors—from amphibians to raptors– will become but a memory, much as the chorus of springtime frogs already has in some locations.

Where are the Leech Lake muskellunge plants?

Leech Lake in Cass Co., MN, is by most accounts in good condition. Waters are clear, a diverse gamefish assemblage is self-sustaining, and much of the shoreline is protected through public ownership. However, some anglers have noted a significant decline in the lake's aquatic plant beds. In a recent article, Chris Niskanen (2007) writes: "*When Al Maas, who has fished for muskies on Leech Lake for 40 years, talks about the disappearance of "lake weeds", his voice reflects a personal loss. A Leech Lake bed of native vegetation is a treasured muskie haunt for Maas; when one disappears, it's as if a familiar neighborhood has been razed for a freeway expansion. "The Big Pelican Island weedbed is gone…the Gull Island weedbed is gone…the Cedar Point weedbed is gone…several small weedbeds by Bear Island—they're gone too. They've all disappeared since I started fishing.""*

Whatever the reason for their loss, areas that once were abundant with aquatic plants such as large-leaf pondweed and the muskies that frequent them are now devoid of both. To the casual boater or one in the "invisible present," nothing seems out of place. It is only through the temporal view that one detects the loss of habitat.

> "So subtle has been its progress that few residents of the region are aware of it. It is ***quite invisible*** to the tourist who finds this wrecked landscape colorful and charming."
>
> -Aldo Leopold in The Land Ethic

Fortunately, our partnership is committed to working together to attain desired common goals, which are to protect our quality lake resources and rehabilitate those that require active management. Our partners have extensive experience developing natural resource strategic plans and implementing programs and projects that seek to achieve planning objectives. State agencies each administer federal, state, and private grant dollars under a number of programs. The state partners each have programs and/or initiatives that engage private partners in lake management and natural resource activities to various degrees. Our tribal partners bring their own suite of expertise and storied histories to aid in glacial lake conservation. It is under the umbrella of this partnership that we choose to work together for the betterment of glacial lakes.

IV. AN ECOREGIONAL APPROACH

We believe the best way to manage lakes in our partnership geography is by looking at the collection of eleven distinct ecoregions in lieu of eight states with many similar lakes and landscapes (Figure 3). Ecoregions-- by definition—are regions defined by their unique ecology. Likewise, lakes within a given ecoregion often have similar physical characteristics, water chemistry, and biological communities. The number, appearance, and condition of lakes vary among ecoregions because of the local glacial history, geology, soil type, land use, and climate, many of the same reasons that make each ecoregion unique.

Managing natural resources based on ecoregions is not new. The U.S. Environmental Protection Agency's National Nutrient Strategy considers water quality using the same ecoregional context described below. The State Wildlife Action Plans are organized around ecoregions as a systematic way to assess and manage species of greatest conservation need. The North American Bird Conservation Initiative, which refers to "Biological Conservation Regions" or BCRs as the fundamental biological units through which they promote delivery of landscape scale bird conservation (UMRGL JV 2007). Each ecoregion provides context useful to understanding where anthropogenic changes to aquatic habitats have occurred most intensely and predicting where future impact or opportunity may arise. They also keep management goals and options in perspective. It is not realistic or even desirable, for example, to expect a shallow Central Corn Belt Plains lake to have similar water clarity or productivity as a Northern Lakes and Forests lake. Ecoregions help people understand and appreciate these differences. Further, baseline or reference conditions can be established by looking at lakes in each ecoregion that have been minimally impacted, measuring changes in project lakes relative to these reference lakes (Table 1).

Ducks Unlimited's Living Lakes Initiative (LLI) is an example of ecoregional management. Waterfowl need quality habitat all along their respective flyway. Under the LLI, shallow lakes and wetlands in Iowa and Minnesota are managed. But waterfowl also use lakes in northern Minnesota and rely on wild rice to provide an energy source critical during spring and fall migrations. Using the LLI ecoregional approach ensures waterfowl have the resources they need along key points, or "stepping stones," on that travel path.

An ecoregional approach also facilitates a nested or hierarchical approach. Nested within the Midwest Glacial Lakes Partnership are the eight states (or portions thereof), eleven "lake" ecoregions and the state/ecoregion polygons that make up the smallest of these management units. Within these smaller polygons are the lakeshed locations where projects occur. Conservation actions can be geared at any of these scales.

PARAMETER	NLF	NCF	WCP	NGP	CCP	HEP	LAP	NMW	STP	SMP	ECP
TKN (mg/L)	0.32 (262)	0.65 (355)	0.957 (81)	1.41 (66)	0.62 (102)	0.5 (9)	0.62 (8)	0.49 (13)	0.54 (62)	0.43 (107)	0.525 (47)
NO2 + NO3 (mg/L)	0.003 (154)	0.008 (215)	0.0065 (79)	0.022 (58)	0.015 (167)	0.535 (9)	0.007 (8)	0.009 (13)	0.04 (15)	0 (106)	0.257 (47)
TN (mg/L) - calculated	0.323 (NA)	0.66 (NA)	0.9635 (NA)	1.43 (NA)	0.63 (NA)	1.04 (NA)	0.63 (NA)	0.499 (NA)	0.58 (NA)	0.43 (NA)	0.782 (NA)
TN (mg/L) - reported	0.40 zz (17)	0.81 (22)	- (NA)	1.83 (2z)	- (-)	- (-)	2.14 zz (1 z)	- (-)	- (-)	- (-)	- (-)
TP (*ug*/L)	9.69 (406)	20 (469)	55 (92)	90 (69)	20 (165)	10 (9)	51.25 (11)	10 (22)	12.19 (125)	10.0 (111)	35 (47)
Secchi (meters)	4.2 (581)	3.20 (559)	1.23 (108)	1.46 (55)	1.44 (197)	2.6 zz (1 z)	1.98 (6)	4.0 (28)	3.19 (108)	3.35 (95)	0.87 (20)
Chlorophyll *a* (*ug*/L) - F	1.38 (2)	2.02 (20)	18.8 (1 z)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
Chlorophyll *a* (*ug*/L) - S	2.46 (128)	5.0 (273)	14.6 (57)	6.5 (24)	7.85 (133)	- (-)	4 (3 z)	2.70 (21)	19.44 (12)	- (-)	5.27 (7)
Chlorophyll *a* (*ug*/L) - T	- (-)	5.51 (234)	14 (16)	19 zz (1z)	7.64 (133)	- (-)	- (-)	- (-)	4.77 (106)	- (-)	5.45 (14)

Table 1. Reference condition for Level III Ecoregion Lakes (US EPA, 2000 [a, b, c]). Number in parentheses is the number of lakes used to calculate the reported value.

NLF- Northern Lakes and Forests
NCF- North Central Hardwood Forest
WCP- Western Corn Belt Plains
NGP- Northern Glaciated Plains
CP- Central Corn Belt Plains
HEP- Huron/Erie Lake Plain
LAP- Lake Agassiz Plain
NMW- Northern Minnesota Wetlands
STP- Southeastern Wisconsin Till Plains
SMP- Southern Michigan/Northern Indian Till Plains
ECP- Eastern Corn Belt Plains

TKN- Total Kjeldahl Nitrogen
TN- Total nitrogen
TP- Total Phosphorus
F- Chlorophyll *a* measured by Fluorometric method with acid correction.
S- Chlorophyll *a* measured by Spectrophotometric method with acid correction.
T- Chlorophyll *a b c* measured by Trichromatic method.
NA- Not Applicable-
z- denotes median calculated with less than three seasons of data
zz- denotes value calculated with less than four lakes

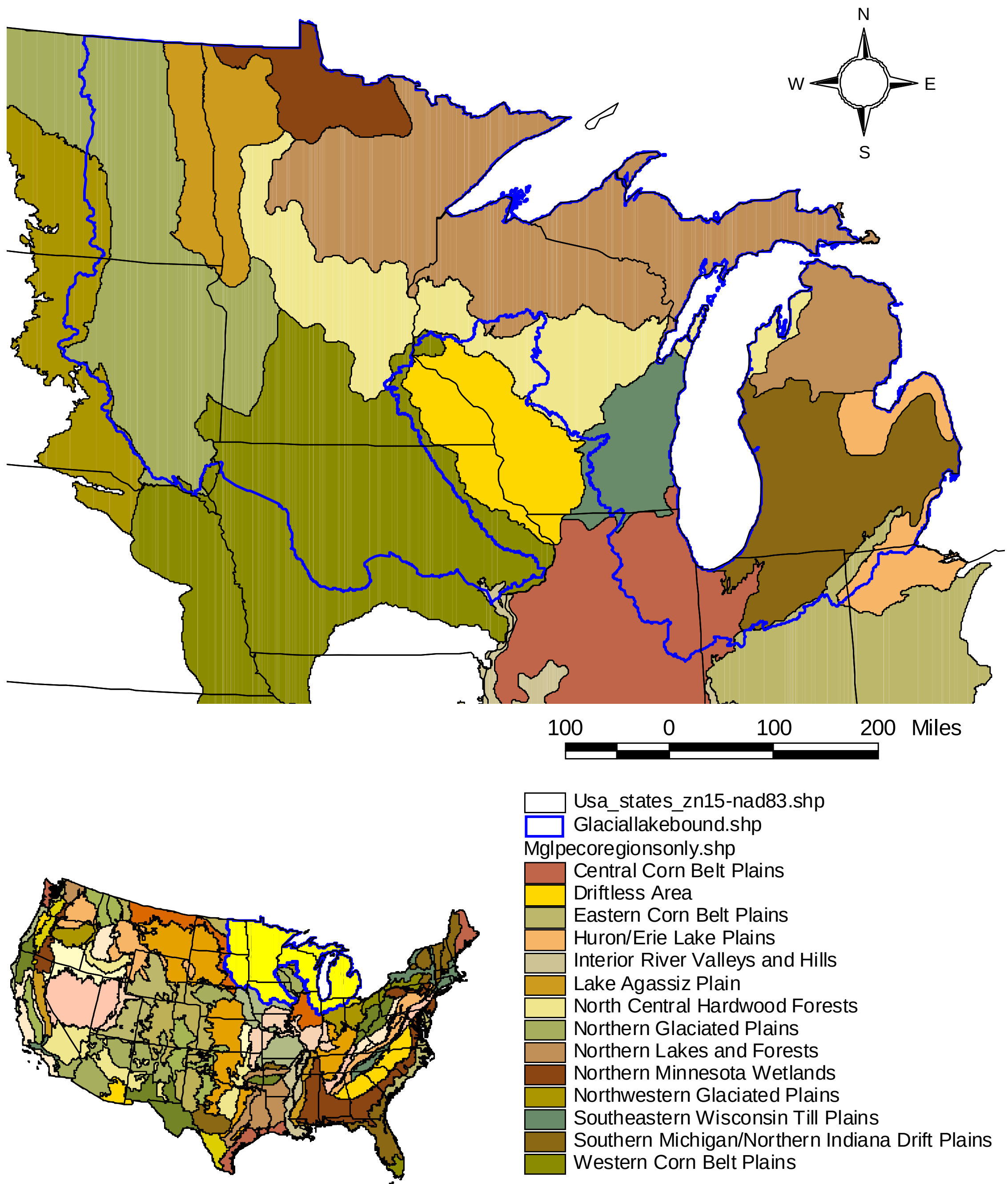
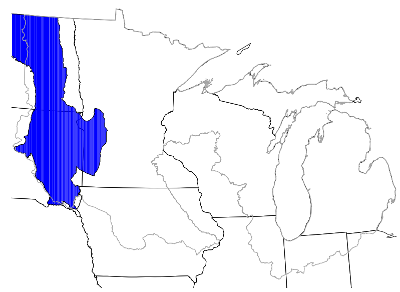


Figure 3. Level III Ecoregions of the Midwest Glacial Lakes Partnership Area (Omernick 1987).

ECOREGIONAL DESCRIPTIONS

Of the 120 Level III ecoregions in the continental United States, there are eleven in the Midwest Glacial Lakes Partnership area that have abundant lakes (Omernick 1987). Below is a description of these ecoregions (US EPA, 2002), the natural fish communities and specific statistics for the partnership area.

NORTHERN GLACIATED PLAINS
Primary states: South Dakota and North Dakota
Area: 43,944 square miles
Number of lakes >10 acres: 8,219
Population Density: 7/sq. mile
No. of Dams: 388
Human Influence Index (Range of 0-64): 18.6
Dominant land use: Agriculture (41%)

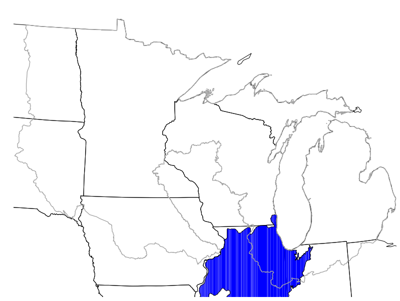


Notable Fish Species of Greatest Conservation Need:
Pallid sturgeon, Topeka shiner, American brook lamprey, Flathead catfish, Paddlefish.

A flat to gently rolling landscape composed of glacial till characterizes the Northern Glaciated Plains ecoregion. The sub humid conditions foster transitional grassland containing tallgrass and shortgrass prairie. High concentrations of temporary and seasonal wetlands create favorable conditions for waterfowl nesting and migration. Though the till soils are very fertile, agricultural success is subject to annual climatic fluctuations. Lakes within the tall grass prairie ecoregion of South Dakota are primarily situated in the Coteau des Prairie, a plateau formed by glacial action in the eastern part of the state. Most of these natural lakes are classified as outwash lakes, formed when material from glacier ice melt was deposited over ice at the lower elevations. Subsequently, melting of the outwash-covered ice formed many closed depressions forming what we know today as the prairie pothole region. These lakes are typically relatively shallow (<25 ft.) and are wind-swept in nature creating well mixed waters lacking extensive submerged vegetation beds. Most prairie coteau lakes do not stratify during open water periods.

The most common fish species present within this region is a mix of cool and warm water species including walleye, northern pike, yellow perch, black crappie, bluegill, black bass, common carp, catfish and bullhead. The primary management species of the larger lakes within this region are walleye and yellow perch. Walleye is by far the most sought after species by anglers in the region. Black bass and bluegill populations have become more common within the region through stocking efforts as well as lake-habitat shifts resulting in more submerged aquatic vegetation becoming established. Natural walleye reproduction within the region is not consistent and populations are largely maintained through stocking efforts. Natural reproduction is more consistent for species such as yellow perch, northern pike, bluegill and black bass.

CENTRAL CORN BELT PLAINS
Primary state: Illinois
Area: 11,118 square miles
Number of lakes >10 acres: 1,887
Population Density: 536/sq. mile
No. of Dams: 165
Human Influence Index (Range of 0-64): 34.5
Dominant land use: Agriculture (63%)

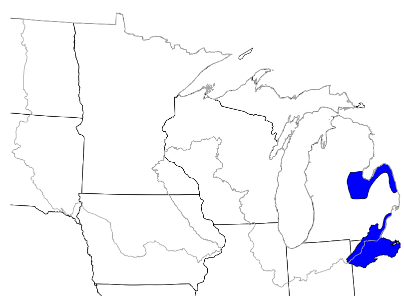


Notable Fish Species of Greatest Conservation Need:
Blackchin shiner, Greater redhorse, Banded pygmy sunfish, Walleye, Yellow perch.

Extensive prairie communities intermixed with oak hickory forests were native to the glaciated plains of the Central Corn Belt Plains; they were a stark contrast to the hardwood forests that grew on the drift plains of ecoregions to the east. Ecoregions to the west were mostly treeless except along larger streams. Beginning in the nineteenth century, the natural vegetation was gradually replaced by agriculture. Farms are now extensive on the dark, fertile soils of the Central Corn Belt Plains and mainly produce corn and soybeans; cattle, sheep, poultry, and especially hogs are also raised, but they are not as dominant as in the drier Western Corn Belt Plains to the west. Agriculture has affected stream chemistry, turbidity, and habitat.

Most glacial lakes in this ecoregion contain a variety of native fish taxa, but they tend to be managed as diversified cool-warm water sport fisheries. Sport species typically include: largemouth bass, smallmouth bass, walleye, northern pike, muskellunge, channel catfish, black crappie, white crappie, bluegill, pumpkinseed, and yellow perch. White bass, yellow bass, and freshwater drum are common in some lakes. Non-game species found in many lakes include: lake chubsucker, warmouth, black bullhead, yellow bullhead, white sucker, golden shiner, brook silversides, emerald shiner, and bluntnose minnow. Less common species include bowfin, longnose gar, brown bullhead, grass pickerel, log perch, brook stickleback, and central mudminnow, whereas imperiled species include the State threatened Iowa darter (Illinois), banded killifish, and blackchin shiner and the State endangered blacknose shiner and pugnose shiner. Lakes that support self-sustaining populations of imperiled species contain abundant and diverse aquatic macrophyte communities that are managed by mechanical harvesting rather than chemical herbicide applications. The Kankakee basin in northwest Indiana is home to at least 82 fish species, over 18 of which occur in the glacial lakes that are perched among the morainal hills separating the Lake Michigan and Kankakee River drainages and along the meandering river corridors in this region. For the most part, a few large shallow and highly productive lakes are found in historical prairie areas with unique plant diversity occurring in several smaller lakes along the watershed divide. Yellow perch, bluegill, largemouth bass, walleye, and black crappie tend to be the most abundant game fish collected. Channel catfish, muskellunge, hybrid tiger muskie, walleye, and northern pike are stocked in some lakes. Nongame and introduced species include golden shiner, alewife, white bass, white perch, white sucker, quillback, bigmouth buffalo, bluntnose minnow, goldfish, grass pickerel, lake chubsucker, gizzard shad, and longnose gar.

HURON/ERIE LAKE PLAIN



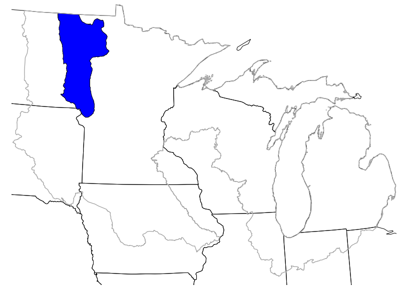
Primary state: Michigan
Area: 5,572 square miles
Number of lakes >10 acres: 483
Population Density: 218/sq. mile
No. of Dams: 37
Human Influence Index (Range of 0-64): 32
Dominant land use: Agriculture (63%)

Notable Fish Species of Greatest Conservation Need:
Black redhorse, Brindled madtom, Grass pickerel, Ohio River muskellunge, Pirate perch, Sauger

The Huron/Erie Lake Plain is a broad, fertile, nearly flat plain punctuated by relic sand dunes, beach ridges, and end moraines. Originally, soil drainage was typically poorer than in the adjacent Eastern Corn Belt Plains, and elm-ash swamp and beech forests were dominant. Oak savanna was typically restricted to sandy, well-drained dunes and beach ridges. Today, most of the area has been cleared and artificially drained and contains highly productive farms producing corn, soybeans, livestock, and vegetables; urban and industrial areas are also extensive. Channelization, ditching, and agricultural activities have degraded stream habitat and quality.

In Michigan, there are relatively few natural lakes in the Huron Erie Lake Plain. The majority of these waters are reservoirs, wildlife floodings, borrow pits, and quarries and tend to be relatively small. These waters likely support warmwater fish species but because of the lakes' small size they have limited fishery potential and are not actively managed or routinely surveyed. In addition, many of these waters are susceptible to winterkill. Fish species likely to occur in these waters include bluegill, pumpkinseed, largemouth bass, black crappie, bullheads, and a number of minnow species.

LAKE AGASSIZ PLAIN
Primary state: Minnesota
Area: 16,008 square miles
Number of lakes >10 acres: 552
Population Density: 14/sq. mile
No. of Dams: 128
Human Influence Index (Range of 0-64): 20
Dominant land use: Agriculture (83%)

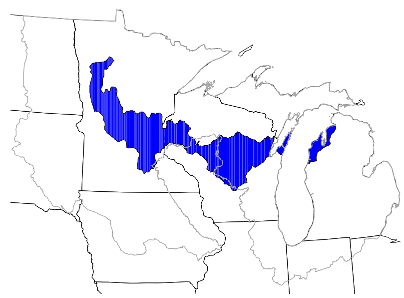


Notable Fish Species of Greatest Conservation Need:
Blacknose shiner, Blue sucker, Flathead catfish, Lake sturgeon, Trout perch, Yellow bullhead

Glacial Lake Agassiz was the last in a series of proglacial lakes to fill the Red River valley in the three million years since the beginning of the Pleistocene. Thick beds of lake sediments on top of glacial till create the extremely flat floor of the Lake Agassiz Plain. The historic tallgrass prairie has been replaced by intensive row crop agriculture. The preferred crops in the northern half of the region are potatoes, beans, sugar beets and wheat; soybeans, sugar beets, and corn predominate in the south.

Rivers, notably the Red River, dominate this region's water resources. Lakes in this ecoregion are more important for waterfowl than for fish

NORTH CENTRAL HARDWOOD FORESTS
Primary states: Minnesota and Wisconsin
Area: 30,959 square miles
Number of lakes >10 acres: 6,307
Population Density: 82/sq. mile
No. of Dams: 536
Human Influence Index (Range of 0-64): 25
Dominant land use: Agriculture/forested (47% / 30%)

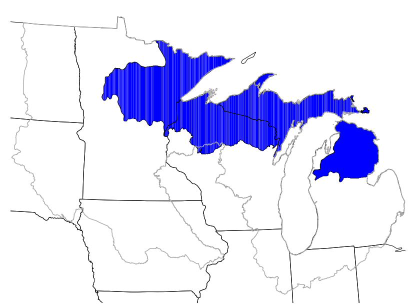


Notable Fish Species of Greatest Conservation Need:
American eel, Black buffalo, Skipjack herring, Bluntnose darter, Gilt darter, Chestnut lamprey, Warmouth

The North Central Hardwood Forests is transitional between the predominantly forested Northern Lakes and Forests to the north and the agricultural ecoregions to the south. Land use/land cover in this ecoregion consists of a mosaic of forests, wetlands and lakes, cropland agriculture, pasture, and dairy operations.

This is a diverse region in terms of fish assemblages and can be characterized primarily as bass/panfish lakes. Walleye stocking is common in this ecoregion with some lakes supporting natural populations. Mukellunge introductions have been successful in numerous lakes, producing fishable populations that are now self sustaining.

NORTHERN LAKES AND FORESTS
Primary states: Michigan, Minnesota, and Wisconsin
Area: 69,715 square miles
Number of lakes >10 acres: 13,603
Population Density: 12/sq. mile
No. of Dams: 1,021
Human Influence Index (Range of 0-64): 15
Dominant land use: Forested (62%)

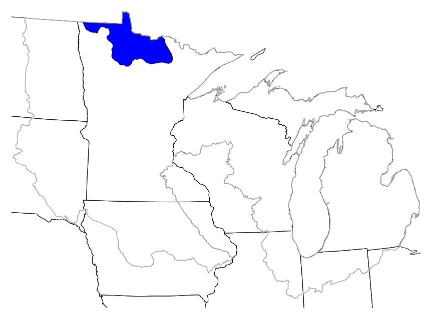


Notable Fish Species of Greatest Conservation Need:
Pygmy whitefish, Deepwater sculpin, Bloater, Nipigon cisco, Shortjaw cisco, Pugnose shiner

The Northern Lakes and Forests is a region of nutrient poor glacial soils, coniferous and northern hardwood forests, undulating till plains, morainal hills, broad lacustrine basins, and extensive sandy outwash plains. Soils in this ecoregion are thicker than in those to the north and generally lack the arability of soils in adjacent ecoregions to the south. The numerous lakes that dot the landscape are clearer and less productive than those in ecoregions to the south. This eco-region includes a large portion of the territory ceded by the Ojibwe to the United States through treaties signed in 1836, 1837, 1842, and 1854. In these treaties the signatory Tribes reserved the right to hunt, fish, and gather in the territories ceded. Tribal off-reservation aquatic resource management and harvest in this ecoregion focuses on walleye, muskellunge, lake sturgeon, and wild rice. These aquatic resources are of immense importance to the Ojibwe for subsistence, medicinal, cultural, spiritual, and economic purposes, as they have been for many generations.

Fish management in this region includes coldwater fisheries that support naturally reproducing populations of lake trout and cisco and some lakes stocked with stream trout. Natural walleye lakes are common which also support natural populations of northern pike and white sucker. Centrarchids (black crappie, bluegill, pumpkinseed sunfish and smallmouth bass) and yellow perch are also managed for in this ecoregion, however are not a primary management assemblage in much of the area. Most of Minnesota's natural muskellunge waters occur in this ecoregion. Resource protection is a key component of tribal off-reservation resource management. This includes annual surveys of important wild rice and naturally reproducing walleye waters. These surveys provide long-term trend information for relative abundance and could provide a means to detect changes that indicate habitat degradation. This approach is consistent with the goal to "protect and maintain intact and healthy lake systems and fish habitats, including fishable populations of game fish, with an emphasis on native, naturally sustaining populations". In addition, habitat protection is an important component of tribal wild rice management.

NORTHERN MINNESOTA WETLANDS
Primary state: Minnesota
Area: 9,307 square miles
Number of lakes >10 acres: 322
Population Density: 2/sq. mile
No. of Dams: 27
Human Influence Index (Range of 0-64): 9
Dominant land use: Forest (58%)



Notable Fish Species of Greatest Conservation Need:
Greater redhorse, Lake sturgeon, Northern brook lamprey,

Much of the Northern Minnesota Wetlands is a vast and nearly level marsh that is sparsely inhabited by humans and covered by swamp and boreal forest vegetation. Formerly occupied by broad glacial lakes, most of the flat terrain in this ecoregion is still covered by standing water.

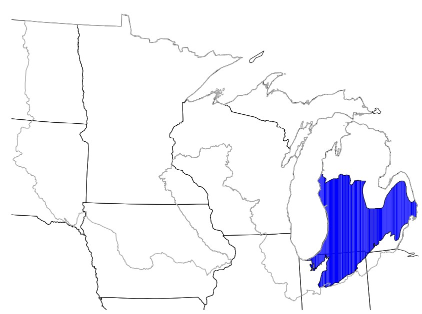
Natural lakes are not abundant in this ecoregion, however two of the largest—Lake of the Woods and the Red Lakes—are located here. Walleye, yellow perch and sauger are the primary game fish and both lakes support coregonids. Lake of the Woods supports a harvestable population of lake sturgeon, a population still recovering from over harvest and pollution in the early 20th century.

SOUTHEASTERN WISCONSIN TILL PLAINS
Primary state: Wisconsin
Area: 9,934 square miles
Number of lakes >10 acres: 1,179
Population Density: 196/sq. mile
No. of Dams: 185
Human Influence Index (Range of 0-64): 31
Dominant land use: Agriculture (61%)

Notable Fish Species of Greatest Conservation Need:
Lake sturgeon.

The Southeastern Wisconsin Till Plains supports a mosaic of vegetation types, representing a transition between the hardwood forests and oak savannas of the ecoregions to the west and the tall-grass prairies of the Central Corn Belt Plains to the south. Like the Corn Belt Plains, land use in the Southeastern Wisconsin Till Plains is mostly cropland, but the crops are largely forage and feed grains to support dairy operations, rather than corn and soybeans for cash crops. This ecoregion is made up of glacial till plains and moraines, but the southwest portion consists of older, pre-Wisconsin till with a more dissected topography. Soils are lime-rich tills overlain in most areas by a silt-loam loess cap. Most riparian zones have been degraded through forest clearing, urban development, and intensive agricultural practices. Watershed pollution is about average according to rankings by Wisconsin DNR, but groundwater pollution is worse than average compared to the rest of the state. Nonetheless the Southeastern Wisconsin Till Plains has the highest aquatic productivity for plants, insects, invertebrates, and fish, of any Ecoregion in the state.

The Southeastern Wisconsin Till Plains contains several large lakes, including those in the Madison area and in the Lake Winnebago Pool system. These lakes are important to many aquatic species including the lake sturgeon. Kettle lakes are common on end moraines and in outwash channels. In addition to Horicon Marsh, this Ecoregion contains important fens, tamarack swamp, wet prairies, and wet-mesic prairies that contain rare plants and animals. However, most wetlands have experienced widespread ditching, grazing, and infestation by invasive plants. Significant river systems include the Mukwonago, Wolf, Sheboygan, Milwaukee, Rock, Sugar, and Fox.



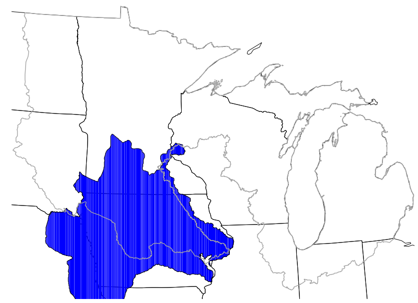
SOUTHERN MICHIGANI/NORTHERN INDIANA DRIFT PLAINS
Primary state: Michigan
Area: 27,724 square miles
Number of lakes >10 acres: 6,945
Population Density: 187/sq. mile
No. of Dams: 543
Human Influence Index (Range of 0-64): 30
Dominant land use: Agriculture (48%)

Notable Fish Species of Greatest Conservation Need:
Bantam sunfish, Bigmouth shiner, Cypress darter, Goldeye, Greater redhorse, Tippecanoe darter

Bordered by Lake Michigan on the west, this ecoregion is less agricultural than those to the south, it is better drained and contains more lakes than the flat agricultural lake plain to the east, and its soils are not as nutrient poor as the region to the north. The region is characterized by many lakes and marshes as well as an assortment of landforms, soil types, soil textures, and land uses. Broad till plains with thick and complex deposits of drift, paleobeach ridges, relict dunes, morainal hills, kames, drumlins, meltwater channels, and kettles occur. Feed grain, soybean, and livestock farming as well as woodlots, quarries, recreational development, and urban-industrial areas are common

Although 67 fish species are known to occur in glacial lakes, fisheries management focuses on prominent sport fish groups. They include bluegill, crappie, largemouth and smallmouth bass, walleye, yellow perch, northern pike, muskellunge, trout, and cisco. Walleyes and muskies are stocked where predator numbers are low and ample prey is available, even though reproduction may not occur. Some lakes in northeast Indiana have coldwater habitat suitable for stocked rainbow and brown trout. Potential may exist to reintroduce ciscoes in the same ecoregion, if water quality improves in some of the 42 lakes where they were originally documented. Glacial lake habitats are especially critical to lesser-known and unique species, such as blackchin, blacknose, pugnose and spottail shiners, least darter, Iowa darter, banded killifish, brook stickleback, northern starhead topminnow and lake sturgeon. Range and population stability of many of these species are unknown.

WESTERN CORN BELT PLAINS



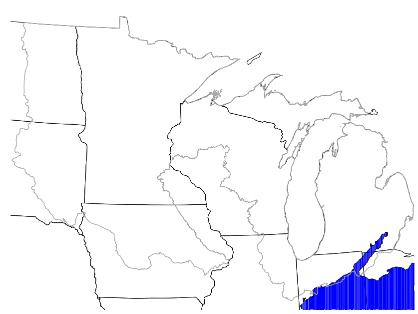
Primary states: Iowa and Minnesota
Area: 40,200 square miles
Number of lakes >10 acres: 1,410
Population Density: 36/sq. mile
No. of Dams: 593
Human Influence Index (Range of 0-64): 26
Dominant land use: Agriculture (83%)

Notable Fish Species of Greatest Conservation Need:
Pallid sturgeon, Topeka shiner, Banded killifish, Black redhorse, Blue sucker, Longnose gar

Once covered with tallgrass prairie, over 75 percent of the Western Corn Belt Plains is now used for cropland agriculture and much of the remainder is in forage for livestock. A combination of nearly level to gently rolling glaciated till plains and hilly loess plains, an average annual precipitation of 63 - 89 cm, which occurs mainly in the growing season, and fertile, warm, moist soils make this one of the most productive areas of corn and soybeans in the world. The region is also one of major environmental concern regarding surface and groundwater contamination from fertilizer and pesticide applications as well as livestock concentrations

The Western Cornbelt Plains contains warmwater fish communities that are dominated by tolerant species. Fisheries management in this region must account for shallow and productive lakes, flashy streams on account of accelerated agricultural drainage, drastically changed watersheds/waterbodies and cultural eutrophication. Centrarchids (sunfishes, white and black crappie, and black bass) are the primary management group, with introduction and enhancement stocking of angler-desired predators (walleye, muskellunge, northern pike). Enhancement stockings are designed to improve waters where forage and habitat may be adequate, but spawning habitat and natural recruitment is missing or limited. Ictalurids are also important to the Cornbelt Plains region including managing for catfish (flathead and channel) and bullheads. This region's small order stream systems contain madtoms, darters, and cyprinids. Minnow species are diverse; stonerollers, shiners, chubs, and dace are used as biotic integrity indicator species. The endangered Topeka shiner is indigenous to Missouri River drainages in low-grade, slow-moving streams. A wide range of catostomids inhabit Cornbelt Plains lotic systems; buffalo, redhorse, quillback, suckers, and carpsuckers are found throughout the ecoregion.

EASTERN CORNBELT PLAINS



Primary states: Indiana and Michigan
Area:1,763 square miles
Number of lakes >10 acres: 218
Population Density: 145/sq. mile
No. of Dams: 36
Human Influence Index (Range of 0-64): 34
Dominant land use: Agriculture (72%)

Notable Fish Species of Greatest Conservation Need:
Eastern sand darter, Golden redhorse, grass pickerel, Ohio River muskellunge, Slimy sculpin

The Eastern Corn Belt Plains is primarily a rolling plain with local end moraines; it had more natural tree cover and has lighter colored soils than the Central Corn Belt Plains. The region has loamier and better drained soils than the Huron/Erie Lake Plain, and richer soils than the Erie/Ontario Hills and Lake Plain. Glacial deposits of Wisconsin age are extensive. They are not as dissected or as leached as the pre-Wisconsin till which is restricted to the southern part of the region. Originally, beech forests were common on Wisconsin soils while beech forests and elm-ash swamp forests dominated the wetter pre-Wisconsin soils. Today, extensive corn, soybean, and livestock production occurs and has affected stream chemistry and turbidity.

The ecoregion has few reservoirs or natural lakes. Both perennial and intermittent streams are common in the ecoregion. Constructed ditches and channelized streams provide artificial drainage in flat areas. At least 86 species of fish currently occur in this ecoregion, numerically dominated by cyprinid, centrarchid, and percid species. They include rock bass, crappie, largemouth, smallmouth, and spotted bass, 11 darters, walleye, northern pike, and mottled sculpin.

Benefits to an Ecoregional Approach

- Provides the best context for assessing lakes- comparing "apples to apples" and sets realistic expectations or examples for what a minimally impacted lake should be.
- Focus on key stressors for each region, stressors that differ by ecoregion.
- Set priority areas in each ecoregion, making multiple opportunities/entry points for stakeholders to get involved.
- Facilitates a strategic, objective, and "Nested Approach"
    - MLGP Area
        - Ecoregion
            - Watershed within an ecoregion
                - Individual lakeshed
                    - Project area.

V. MULTIPLE INTERESTS WITH COMMON GOALS

This effort, while focusing on fish and fish habitat, will be most effective when we satisfy multiple species' habitat needs with each conservation project. Birds, mammals, amphibian, insects, reptiles, mussels, and fish are part of larger, interconnected systems and other partners may join us to work together on improving habitats for all species. As we look to prioritize habitat projects, one criterion is the potential benefits to other species (e.g., Species of Greatest Conservation Need, Appendix III) as well as how many additional interested partners are willing to work with us. A good example of the cross-interest participation is a project that aims to restore wild rice in lakes. From fish, to frogs, to furbearers and fowl, many species benefit by the restoration of this aquatic plant. Joint Ventures may help our partnership prioritize lakes for wild rice restoration with an emphasis on the migratory needs of waterfowl.

VI. INVASIVE SPECIES AND CLIMATE CHANGE

Invasive species and global climate change provide unique challenges to glacial lakes. Below is a brief description of programs that work to minimize the effects of these two stressors. We look forward to working with those that are intimately involved in these conservation efforts.

Invasive species
Federal agencies are working together on the prevention, control, and management of invasive species. In 1999, Executive Order 13112 established the National Invasive Species Council (NISC), which is co-chaired by the Secretaries of the Interior, Agriculture, and Commerce. NISC was charged with providing coordination, planning and overall leadership for Federal invasive species programs and reaching out to State, Tribal, local and private partners. This executive order also required the Secretary of the Interior to establish the Invasive Species Advisory Committee (ISAC), a group of 30 nonfederal stakeholders from diverse constituencies (representing State, Tribal, local and private concerns) around the nation, to advise NISC on invasive species issues. In addition, the Order called

on NISC to prepare and issue the first national plan to deal with invasive species. Completed in 2001, The National Invasive Species Management Plan, Meeting the Invasive Species Challenge, served as a comprehensive management plan for Federal action on invasive species, as well as NISC's primary coordination tool. This coordination tool provided the first comprehensive national plan for invasive species action. It called for about 170 specific actions within nine categories of activity, about 100 of which have been established or completed. Actions identified in the 2001 Plan continue to be implemented. The NISC recently published their 2008 – 2012 National Invasive Species Management Plan, the first revision of their 2001 effort (http://www.invasivespeciesinfo.gov/council/mpdraft07.pdf).

To complement the federal efforts, a multitude of state, tribal, county, academic, and non-governmental organizations are working to control invasive species. In Minnesota for example, the state agency's Invasive Species Program has an annual budget of $2 million to help curb the spread and minimize the harmful effects of nonnative species. Similar to the NISC, the Indiana Legislature created an Invasive Species Task Force in October 2007. Comprised of state agency personnel, university researchers, conservation organizations, and private business, the group is tasked to study the economic and environmental impacts of invasive species in Indiana and provide findings and recommendations on strategies for prevention, early detection, control and management of invasive species to minimize these impacts. Examples like these can be found within each Midwest Glacial Lakes Partnership state. With this amount of effort focused on invasive species, it is prudent for our partnership to concentrate on fish habitat and partner with these efforts when we can.

Climate Change

Climate change has the potential to exacerbate the cumulative impacts of human activities. In north temperate lakes, much work over the past decade has focused on modeling habitat changes as a result of warming water temperatures and predicting the consequences for fish populations and communities (Stefan et al. 1996, DeStasio et al. 1996, Casselman 2002, Shuter et al. 2002, Jackson and Mandrak 2002). Stefan et al. (1996) projected seasonal average epilimnetic water temperatures will increase by approximately 3° C with a doubling of CO_2 concentrations. This could lead to a 41% reduction in coldwater habitat. The Intergovernmental Panel on Climate Change (IPCC) predicts this doubling could happen as early as 2030 under continued rates of emission and population growth (IPCC 2007). Coldwater species such as lake trout and cisco could experience the greatest reduction in inland lakes because of their narrow thermal and dissolved oxygen habitat requirements. With a temperature increase of 3° C, Casselman (2002) projected recruitment of coolwater species will decline by a factor of 18 and recruitment of warmwater species would increase approximately 15 fold. This would result in the displacement of coolwater species by warmwater species. Jackson and Mandrak (2002) project these temperature changes will result in the loss of fish biodiversity along with shifts in species assemblages.

As lakes management is being challenged by a changing climate, the Midwest Glacial Lakes Partnership aims to aid fish habitat conservation on two fronts. First, while partnership efforts do not directly address mitigation strategies (e.g., reducing energy consumption, promoting old growth forests, and "green" building techniques), research efforts may find a role for lakes to act as carbon sinks (Dean and Gorham 1998; Tranvik et al. *in review*). If such carbon sequestration is found to be an effective strategy, fish habitat stands to benefit. The second role is one of adaptation. MGLP is working to understand what contributes to ecological resiliency in lakes. For example, it is known that lakes with intact riparian areas and minimal anthropogenic eutrophication retain well-oxygenated hypolimnia deeper and/or longer than those without these attributes. Lakes with abundant native aquatic vegetation are better equipped to minimize the impacts of aquatic invasive macrophytes. Once these and other attributes are clearly understood, conservation actions focusing on these resiliency "keys" can be promoted in earnest. This is a centerpiece to the future of glacial lakes management, as lakes that are intact and resilient will have the qualities to resist the impacts of a changing climate and invasive species. As research continues to expand our knowledge on how to manage these threats, future iterations of this strategic plan will look for opportunities to more directly address them.

VII. Challenges

Ensuring sustainable fish habitats in glacial lakes is a difficult task. There are a number of challenges that need to be overcome for us to succeed in this endeavor.

Funding
As with many natural resource challenges, there will never be sufficient funding to complete all projects required to protect and restore aquatic habitats. This reality forces us to choose our priority areas for conservation carefully and maximize the conservation work per dollar spent in each and every project. This also calls for increased evaluation of projects to validate successes and learn from failures.

Limitations of biological systems
There are limits in what we can achieve. Some systems are simply beyond a condition where meaningful conservation work can take place. We need to identify these limitations and act accordingly.

Public Will and Human Behavior
Ultimately what will define the success of our partnership is how we engage and work with those that are passionate about glacial lakes and those whose activities compromise the resource. We need to permanently change behaviors that negatively impact lakes. Whether it is an educational barrier or one of perception, finances, or personal preference, our success hinges on changing these attitudes and subsequent behaviors.

> "The real substance of conservation lies not in the physical projects of government, but in the mental processes of its citizens."
>
> \- Aldo Leopold

VIII. INTERIM OBJECTIVES AND TARGETS

<u>Preamble</u>

To conserve (protect, restore, and enhance) the habitats of Midwestern glacial lake fish populations, to support a broad natural diversity of aquatic species, to promote self-sustaining fish populations, and to provide successful fishing opportunities, we adopt the following strategies:

Objective 1 – Identify and protect 10,000 acres [a] of intact and healthy lake habitats and 40,000 acres of intact watersheds [b] by 2012. [b]

a. Success measures
- i. Completion of lakes assessment.
- ii. Acreage of intact lake habitat protected.
- iii. Acreage of intact lakesheds protected.

b. Major resources available to meet targets
- i. Partner GIS resources, including existing data.
- ii. In-kind support dollars and grant funding.
- iii. Local units of government that can influence land use decision-making.

Protection Case History
Mann Lake, Minnesota

Jack and Betty Thomas of Hackensack, MN donated 13.8 acres of land, with 454 feet of shoreline on Mann Lake, to the Leech Lake Area Watershed Foundation. This undeveloped parcel was later donated to the Minnesota DNR, triggering the release of $600,000 from the state's "Reinvest in Minnesota" (RIM) program. The RIM money was then applied to the DNR purchase of 1,700 feet of sensitive lakeshore on nearby Woman Lake. In the end, more than 2,000 feet of sensitive shoreline was preserved.

Objective 2- Restore natural variability in 1,000 [a] acres of lakes surface elevations in by 2015. [b]

a. Success measures
- i. Acreage of lakes with water levels rehabilitated to within 10% of the natural pattern.
- ii. Optional measure - For the above measure, document whether key target fish populations remained constant or increased in distribution or relative abundance.

b. Major resources available to meet target
- i. Partner expertise in dam removal/modifications.
- ii. Local units of government that manage water control structures.
- iii. In-kind support dollars and grant funding.

Natural Variability Case History
Rush Lake, Wisconsin

The largest prairie pothole east of the Mississippi River, Rush Lake's aquatic plant community was negatively impacted by artificially high and stable water levels. A 15-member committee conducted monthly meetings from 1999-2005 and completed an extensive citizen involvement process. The group developed a plan to address all the significant problems facing the lake and had strong public support garnered through citizen participation. This plan is now being implemented as part of a holistic lake restoration project

[a] Identified for each partnership (as applicable) in the "Final Interim Strategies and Targets for National Fish Habitat Action Plan, November 8, 2007."

[b] Proposed as of 12/19/2008. Actual target and date are still being discussed by the partnership.

Objective 3 – Reconnect 10,000 [a] acres of fragmented lake habitats to allow access to historic spawning, nursery and rearing grounds by 2015. [b]

a. Success measures
  i. Acreage of lake habitat with restored full fish movement.
  ii. Optional measure - For the above measure, document whether the key target fish or invertebrate population increased in distribution or relative abundance.

b. Major resources available to meet targets
  i. Partner expertise in dam removal/modifications. Local units of government that manage water control structures.
  ii. In-kind support dollars and grant funding.

Reconnection Case History
White Earth Lake, MN

Lake sturgeon are known to have historically inhabited White Earth Lake. Two dams, one located at the lake outlet and another 67 miles downstream, disconnected important habitats found between Red River of the North and White Earth Lake. The MN DNR, White Earth Band of Ojibwe, and USFWS worked together to eliminate the fish passage barriers resulting from the dams, reconnecting 125 miles of high quality stream habitat between Red River of the North and White Earth Lake. Fish populations including lake sturgeon, walleye, and smallmouth bass have shown a dramatic positive response as a result of these efforts.

Objective 4 – Reduce and maintain sedimentation, phosphorus and nitrogen runoff to lake habitats to a level within 25 percent of the expected natural variance in these factors or above numeric State Water Quality Criteria in 1,000 acres [a] of affected lakes by 2020. [b]

a. Success measures
  i. Identify key degraded systems whose sediment, phosphorus or nitrogen inputs have been modified by more than 25 percent above numeric State Water Quality criteria or from the natural and expected inputs
  ii. Acreage of lakes with sediment, phosphorus or nitrogen inputs rehabilitated to within 25 percent of the natural or other desired levels such as numeric State Water Quality criteria.
  iii. Optional measure - For the above measure, document whether the key target fish or invertebrate population remained constant or increased in distribution or relative abundances.

b. Major resources available to meet targets
  i. NRCS and Farm Bill provisions for soil and water conservation
  ii. In-kind support dollars and grant funding.

Nutrient Case History
Lake Ahquabi, Iowa

Through public participation, it was determined that soil and nutrient delivery to the lake could be reduced through best management practices on pasture and cropland in the watershed and through the renovation of two existing sediment basins and development of five new wetlands above the lake. Overall, 95 percent of the cropland in the watershed is now farmed under Natural Resource and Conservation Service (NRCS) approved soil conservation practices. Visitor use has increased three-fold since water quality and angling opportunities have improved.

[a] Identified for each partnership (as applicable) in the "Final Interim Strategies and Targets for National Fish Habitat Action Plan, November 8, 2007."
[b] Proposed as of 12/19/2008. Actual target and date are still being discussed by the partnership.

Objective 5 – Implement a Communications Strategy that effectively uses Outreach and Education by 2011. [b]

a. Outreach and Education targets
  i. Identify key audiences in MGLP area
  ii. Develop communication tools, such as presentations, pamphlets and news releases to reach key audiences. Increase public awareness of natural and altered systems
  iii. Deliver the following Outreach communications annually: 20 presentations
  1,000 pamphlets
  10 news releases

b. Success measures
  i. Number of individuals contacted and/or presentations given
  ii Optional measure – Change in behaviors and beliefs about fish habitat conservation in glacial lakes.

c. Major resources available to meet targets
  i. Partner Information and Education Staff
  ii. Grant dollars.
  iii. Media- related partners (e.g., In-Fisherman, Engbretson Photography).
  iv. Other Fish Habitat Partnerships.

Communications Case History
Burnett County, Wisconsin

Through a survey of shoreline property owners, UW-Extension assessed local needs and identified interest in voluntary, incentive-based shoreline preservation. As a result, the Burnett County Shoreline Incentives Program (SIP) was developed through a partnership of UW-Extension, the Burnett County Land and Water Conservation Department and Wisconsin Department of Natural Resources (DNR-to protect and restore lake shores around the county's 500 lakes. Through 2007 the SIP had registered 610 parcels protecting over 42 miles of shoreline on 112 lakes and converting over 2.5 acres of lawn to native shoreland vegetation.

Objective 6– Increase fish habitat in priority lakes where it is lacking. [b]

a. Fish Habitat targets
  i. Identify lakes lacking a key fish habitat component(s)
  ii. Number of habitat projects

b. Success measures
  i. Percent increase of habitat
  ii Optional measure – increase in fish population

c. Major resources available to meet targets
  i. In-kind support and grant funding

Fish Habitat Case History
Bony Lake, Bayfield County, WI

Bony Lake is located in the forested region of northern Wisconsin. The legacy of logging and the direct removal of large woody habitat resulted in a lack of this important habitat type in the lake. A survey found only one piece of wood for every 200' of shoreline. In 2006, more than 50% of shoreland owners agreed to participate in a lakewide restoration plan. One component of this plan was a large woody habitat project that returned this valuable fish habitat to the lakeshore and shallow waters. The project more than doubled the amount of large woody habitat in the lake, and future projects will increase this amount, ultimately reflecting a more natural shoreline around Bony Lake.

[a] Identified for each partnership (as applicable) in the "Final Interim Strategies and Targets for National Fish Habitat Action Plan, November 8, 2007."

[b] Proposed as of 12/19/2008. Actual target and date are still being discussed by the partnership.

IX. INTERIM PRIORITY WATERSHEDS

Illinois-	Fox River, including the following sub watersheds: Sequiot Creek, Fish Lake, Squaw Creek, and the Fox Chain of Lakes. In addition, specific lakes include Defiance, Crystal, Elizabeth (partly in Illinois), and Killarney. Lower priority lakes include Lily and Griswold.
Indiana-	Lake Wawasee, Upper Tippecanoe Watershed, James/Jimmerson/Snow Lakes, Seven Sisters Lake, Cedar Lake, Koontz Lake
Iowa-	Black Hawk Lake, Carter Lake, Clear Lake, Five Island Lake, Lake Manawa, Lost Island Lake, Lower Gar Lake, Silver Lake, (Deleware), Storm Lake Shallow natural lakes: Diamond Lake, West Swan Lake, Lizard Lake, Pickeral Lake
Michigan-	Higgins and Houghton (Roscommon Co.), Glen (Leelanau Co.), Crystal (Benzie Co.) and Birch (Cass Co.).
Minnesota-	Belle Lake, Cedar Lake, Comfort/Forest Lake, Crystal-Loon-Mills Lake System, Gull Lake, Horseshoe Chain of Lakes, Lake Minnetonka, LeSeuer River, Long Prairie, Middle Fork Crow River, Mille Lacs Lake, North Fork Crow River, Otter Tail River, Pearl Lake, Pine River, Pomme de Terre River, Rainy River, Red Lake River, Rice Creek, Roseau River, St. Louis River, Sauk River, Shakopee Creek Headwaters, Shetek Lake, Sunrise River, Snake River, Two Rivers, Upper Cannon River, Wild Rice River.
North Dakota-	Pembina, Turtle, Forest, Lower Red, Park, Goose
South Dakota-	Waubay Chain of Lakes, Madison Lakes Chain, Lake Poinsett Chain, Lake Kampeska and Lake Pelican, Lake Campbell, Roy Lake, Clear Lake, Oakwood Lakes Chain
Wisconsin-	Lower Apple River, Trout Brook, Bois Brule River, Iron River, Wolf Creek, Wood River, Lower Yellow (Burnett Co.) River, Balsam Branch, Brill and Red Cedar Rivers, Beaver Brook, North Fork Clam River, Red Cedar River, Lower Namakagon River, Couderay River, Lake Chippewa, West Fork Chippewa River, White River, Totagatic River, Upper St. Croix and Eau Claire Rivers, Marengo River, Trade River, Upper Apple River, Shell Lake and Upper Yellow River, Trego Lake- Middle Namekagon River, Upper Namakagon River, Tamarack Pioneer River, Deerskin River, Flambeau Flowage, Presque Isle River, Lily River, Upper Wolf River and Post Lake, Upper Eau Clair River Prairie River, Lower/Middle/Upper Tomahawk Rivers, Noisy and Pine Creeks, Woodboro, Pelican River, Rhinelander Flowage, Sugar Camp Creek, Eagle River, Bear River, Manitowish River, St. Germain River.

NOTE: These interim priority watersheds were chosen based on best professional judgment (and great latitude) prior to a resource assessment. Priority watersheds will be revisited after the assessment is completed in 2010.

Literature Cited

Boyle, K. J., S. R. Lawson, H. J. Michael, and R. Bouchard. 1998. Lakefront Property Owners' Economic Demand for Water Clarity in Maine Lakes. Maine Agriculture and Forest Experiment Station Miscellaneous Report 410. University of Maine.

Carpenter, S. R., B. J. Benson, R. Biggs. J. W. Chipman, J. A. Foley, S. A. Golding, R. B. Hammer, P. C. Hanson, P. T. J. Johnson, A. M. Kamarainen, T. K. Kratz, R. C. Lathrop, K. D. McMahon, B. Provencher, J. A. Rusak, C. T. Solomon, E. H. Stanley, M. G. Turner, M. J. Vander Zanden, C. Wu, and H. Yuan. 2007. Understanding regional change: A comparison of two lake districts. Bioscience. 57(4):323-335.

Casselman, J. M. 2002. Effects of temperature, global extremes, and climate change on year-class production of warmwater, coolwater, and coldwater fishes in the Great Lakes basin. Pages 39-60. in N.A. McGinn, editor. Fisheries in a changing climate. American Fisheries Society Symposium 32. Bethesda.

Castelle, A. J., C. Conolly, M. Emers, E. D. Metz, S. Meyer, M. Witter, S. Mauerman, T. Erickson, and S. Cook. 1992. Wetland buffers: use and effectiveness. Washington State Department of Ecology, Olympia, Washington.

Dean, W. E., and E. Gorham. 1998. Magnitude and significance of carbon burial in lakes, reservoirs, and peatlands. Geology 26: 535-538.

DeStasio, B.T. Jr., D.K. Hill, J.M. Kleinhans, N.P. Nibbelink, and J.J. Magnuson. 1996. Potential effects of global climate change on small north-temperate lakes: physics, fish, and plankton. Limnology and Oceanography 41: 1136-1149.

Enger, S. and S. Hanson. 2008. A summary of permitted management work for aquatic vegetation, algae, leeches, swimmer's itch, 2007. Minnesota Department of Natural Resources. 41 pages.

Garrison, P. J., D. W. Marshall, L. Stremick-Thompson, P. L. Cicero, and P. D. Dearlove. 2005. Effects of pier shading on littoral zone habitat and communities in Lakes Ripley and Rock, Jefferson County, Wisconsin. Wisconsin Department of Natural Resources PUB-SS-1006 2005.

Guyette, R. P. and W. G. Cole. 1999. Age characteristics of coarse woody debris (Pinus strobes) in a lake littoral zone. Can. J. Fish. Aquat. Sci. 56: 496-505.

Intergovernmental Panel of Climate Change (IPCC). 2007. Climate change 2007: synthesis report. Valencia, Spain.

Jackson, D.A., and N.E. Mandrak. 2002. Changing fish biodiversity: predicting the loss of cyprinid biodiversity due to global climate change. Pages 89-98 in N.A. McGinn, editor. Fisheries in a changing climate. American Fisheries Society Symposium 32. Bethesda, Maryland.

Jennings, M. J., M. A. Bozek, G. R. Hatzenbeler, E. E. Emmons, and M. D. Staggs. 1999. Cumulative Effects of Incremental Shoreline Habitat Modification on Fish Assemblages in North Temperate Lakes. North American Journal of Fisheries Management 19:18–27

Krysel, C., E. Marsh Boyer, C. Parsons, and P. Welle. 2003. Lakeshore property values and water quality: evidence from property sales in the Mississippi Headwaters Region. Submitted to the Legislative Commission on Minnesota Resources by the Mississippi Headwaters Board and Bemidji State University. May 14. 59 pp.

Magnuson, J. J. 1990. Long-term ecological research and the invisible present. Bioscience 40.7: 495-501.

Michael, H. J., K. J. Boyle, and R. Bouchard. 2000. Does the Measurement of Environmental Quality Affect Implicit Prices Estimated from Hedonic Models? Land Economics 76.2: 283-298.

Morton, R. L. and C. Gawboy. 2000. Talking rocks: geology and 10,000 years of native American tradition in the lake superior region. Pfeifer-Hamilton Publishers. 224 pp.

Niskanen, C. 2007. The muskie patch. Minnesota Conservation Volunteer. July-August.

Omernik, J.M. 1987. Ecoregions of the conterminous United States. Map (scale 1:7,500,000). Annals of the Association of American Geographers 77(1):118-125.

Rector, W. G. 1953. Log transportation in the lake states lumber history 1840-1918. The Arthur H. Clark Company, Glendale, CA. 3521 pp.

Sass, G. G., J. F. Kitchell, S. R. Carpenter, T. R. Hrabik, A. E. Marburg, and M. G. Turner. 2006. Fish community and food web responses to a whole-lake removal of coarse woody habitat. Fisheries. 31(7): 321-330.

Scheffer, M. and S. R. Carpenter. 2003. Catastrophic regime shifts in ecosystems: linking theory to observation. TRENDS in Ecology and Evolution Vol. 18 No. 12: 648-656.

Shuter, B. J., C. K. Minns, N. Lester. 2002. Climate change, freshwater fish, and fisheries: case studies from Ontario and their use in assessing potential impacts. Pages 77-88 in N.A. McGinn, editor. Fisheries in a changing climate. American Fisheries Society Symposium 32. Bethesda.

Stefan, H. G., M. Hondzo, X. Fang, J. G. Eaton, and J. H. McCormick. 1996. Simulated longterm temperature and dissolved oxygen characteristics of lakes in the north-central United States and associated fish habitat limits. Limnology and Oceanography 41: 1124-1135

Southwick Associates. Sportfishing in America: an economic engine and conservation powerhouse. Produced for the American Sportfishing Association with funding from the Multistate Conservation Grant Program, 2007.

Tranvik, L.J. and others. Lakes and impoundments as regulators of carbon cycling and climate. In review.

Treur, R. 1979. Voyageur country. University of Minnesota Press, St. Paul, MN 173 pp.

UMRGL JV. 2007. Upper Mississippi Rivers and Great Lakes Region Joint Venture Implementation plan (compiled by G. J. Soulliere and B.A. Potter). U.S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA.

U.S. Environmental Protection Agency. 2000a. Ambient water quality criteria recommendations: information supporting the development of state and tribal nutrient criteria for lakes and reservoirs in nutrient ecoregion VI. Office of Water, Office of Science and Technology, Health and Ecological Criteria Division, Washington, DC. December.

U.S. Environmental Protection Agency. 2000b. Ambient water quality criteria recommendations: information supporting the development of state and tribal nutrient criteria for lakes and reservoirs in nutrient ecoregion VII. Office of Water, Office of Science and Technology, Health and Ecological Criteria Division, Washington, DC. December.

U.S. Environmental Protection Agency. 2000c. Ambient water quality criteria recommendations: information supporting the development of state and tribal nutrient criteria for lakes and reservoirs in nutrient ecoregion VIII Office of Water, Office of Science and Technology, Health and Ecological Criteria Division, Washington, DC. December.

U.S. Environmental Protection Agency. 2002. Primary distinguishing characteristics of level III ecoregions of the continental United States(Draft). U.S. Environmental Protection Agency, National Health and Environmental Effects Laboratory, Western Ecology Division, Corvallis, OR., http//www.epa.gov/wed/pages/ecoregions/level_iii.htm.

Wagner, T., A. K. Jubar, and M. T. Bremigan. 2006. Can habitat alteration and spring angling explain largemouth bass nest success? Transactions of the American Fisheries Society. 135:843-852.

Weitzell, R. E., M. L. Khoury, P. Gagnon, B. Schrears, D. Grossman, and J. Higgins. 2003. Conservation priorities for freshwater biodiversity in the Upper Mississippi River Basin. A report prepared by NatureServe and The Nature Conservancy.

Welle, P., J. Leitz, and J. Wettersten 2005. Socio-economic aspects of fishing on Upper and Lower Red Lake of Minnesota. Technical report submitted to the Minnesota Department of Natural Resources and the Red Lake Department of Natural Resources. March. 72 pages.

APPENDIX I

STEERING COMMITTEE, CONTRIBUTING PARTNERS, AND WORKING GROUPS

Steering Committee

Agency/Organization	Contact
Illinois Department of Natural Resources	Joe Ferencak for Steve Pallo
Indiana Department of Natural Resources	Bill James
IA Department of Natural Resources	Joe Larscheid
MI Department of Natural Resources	Gary Whelan for Kelley Smith
MN Department of Natural Resources	Ron Payer
North Dakota Game and Fish Department	Greg Power
South Dakota Game, Fish and Parks	John Lott
Wisconsin Department of Natural Resources	Mike Staggs
The Nature Conservancy	Tom Landwehr
Great Lakes Indian Fish and Wildlife Commission	Neil Kmiecik
U.S. Fish and Wildlife Service	Mike Weimer
U.S. Forest Service	Nick Schmal
U.S. Geological Survey	Leon Carl
Michigan United Conservation Clubs	Erin McDonough
Gathering Waters	Kate Zurlo-Cuva
Wisconsin Association of Lakes	Earl Cook
Upper Miss. And Great Lakes Joint Venture	Barbara Pardo

State and Federal Coordinators

FOND DU LAC	Brian Borkholder
IL DNR	Joe Ferencak
IN DNR	Gwen White
IA DNR	Mike McGhee, George Antoniou
MI DNR	Lizhu Wang, Jim Breck
MN DNR	Pat Rivers, Michael Duval, Grant Wilson
ND G&F	Scott Elstad
RED LAKE BAND	Shane Bowe
SD GF&P	Mark Ermer
WI DNR	Carroll Schaal, Paul Cunningham
TNC	Kristen Blann
GLIFWC	Neil Kmiecik
USFS	Nick Schmal
USGS	Jana Stewart

GIS WORKGROUP

IN DNR	Angela Grier, Stu Shipman
IA DNR	Chris Ensminger
MI DNR	Lizhu Wang, Jim Breck
MN DNR	Pat Rivers, Lyn Bergquist, Leslie Jagger
ND G&F	Brian Hosek
SD GF&P	Paul Lorenzen, Christopher Marsh, Mark Rath
WI DNR	Jennifer Filbert, Jerry Sullivan
TNC	Kristen Blann
USFS	Ted Geier, Mike Martischang
USGS	Jana Stewart

APPENDIX II

FISH HABITAT CONSERVATION STRATEGIES GROUPED BY THEMES

Classification

- Work with partners to obtain sufficient physical, biological and user information on lakes to determine fisheries potential and to set, with public involvement, lakes specific mgt. objectives.
- Evaluate current status of shorelines on natural lakes to provide baseline data for future comparisons, using boat-based and remote sensing methods.
- Classify lakes according to ecoregional, morphometric and biological considerations.
- Work with partners to gather existing data into a centralized database, especially for storage of long-term data sets.
- Support existing water quality and vegetation monitoring and assessment programs, especially efforts driven by volunteers at the local level.
- Use satellite imagery to classify current status of lakes through water clarity measurement and susceptibility to development.
- Create base map of the partnership area with delineated watersheds and associated land use layers.
- Identify and assess aquatic system targets that are already in 100% public/conservation ownership and work with owners to ensure long-term management compatible with conservation/protection.

Cumulative Impacts

- Work with zoning boards to minimize variances that harm riparian habitat
- Work with lake associations to develop support for watercraft regulations, determine the extent of areas needed for protection, and implement ecologically protective regulations.
- Require an aquatic plant management plan prior to application of herbicides in public lakes and limit treatment of waters without a permit.
- Use natural and artificial structures, including coarse woody habitat to lakes to enhance fish habitats.
- Limit non-target impacts of herbicide treatments on seasonal aquatic plant biovolume and cover of native species by conducting experimental comparisons of various chemicals and dosages to determine the most cost-effective treatment regimes.
- Revise water quality standards to include parameters that are indicative of lake eutrophication.

Riparian Buffers

- Promote riparian and shoreland protection rules through press releases and lake association presentations.
- Provide assistance to local units of government in developing county planning and zoning ordinances and building codes that protect lake shorelands.
- Increase funding of IEPA 319 Grants and C2000 projects directed toward riparian areas, shoreline stabilization, education and research.
- Examine state drainage codes and update the statutes, where necessary to protect wetlands and water quality in downstream lakes.
- Strengthen enforcement of state erosion control regulations, including stop work action at the local level.
- Implement a shoreline habitat cost share program that complements existing programs.
- Minimize damage to intact riparian corridors while allowing adequate drainage for agricultural purposes.
- Work with zoning boards to protect riparian habitats and minimize variances that harm them.
- Develop standards for greater buffer strip margins for wetlands, lakes, and ditches and increase enforcement of mandated rules.
- Develop shoreline stewardship programs for riparian property owners, modeled after similar successful initiatives.

Watershed BMPS

- Provide financial assistance to SWCDs and local government for technical assistance in implementing stormwater management plans.
- Explain conservation programs (e.g. NRCS and SWCD) to producers in targeted watersheds and assist them in enrolling in these or other conservation programs.
- Work with existing programs to increase the number of outreach efforts in priority watersheds.
- Encourage state government begin funding the NPS program at each state environmental protection agency at a minimum of $1 million per year to support lake-related programs.
- Require and enforce ordinances for minimum runoff control measures at construction sites developed by municipalities designated as MS4s.
- Provide a series of regional workshops for county surveyors and drainage boards to discuss use of the drainage handbook and permitting issues.
- Examine state drainage codes and update the statutes, where necessary to protect wetlands and water quality in downstream lakes.
- Require lake area septic systems to undergo periodic testing and/or certification by local health departments to guarantee adequate performance as an integral part of an operations and maintenance plan.
- Recommend centralized wastewater collection and treatment, rather than individual on-site systems, when alternatives for repair or replacement of aging, failing septic systems are exhausted.
- Establish a system for county funding of private onsite disposal systems to address inadequate or failing systems.
- Work with county and state officials to offer tax incentives (and low cost loans to fix non-complying) for complying septic systems.

Social Marketing and Outreach

- Create stewardship awards for lakeshore owners that demonstrate outstanding shoreland stewardship practices.
- Work to educate advocate groups to help prioritize advocacy needs.
- Promote riparian and shoreland protection rules through press releases and lake association presentations.
- Educate lake users and the public on the significance of lake habitat for supporting fish diversity and angling opportunities.
- Work with LGU's to develop and include BMPs in correspondence with their constituents.
- Work with existing programs to increase the number of outreach efforts in priority watersheds.
- Develop TV, radio, and Internet spot announcements and in-depth TV programs on lake management issues and possible solutions/strategies.
- Work with cities and counties to consolidate comprehensive plans into a regional plan.
- Develop presentations to disseminate information to lake associations about permit requirements and littoral habitat protection.
- Create aquatic habitat based NGO's to advocate for fish habitat conservation.

APPENDIX III

SPECIES OF GREATEST CONSRVATION NEED BY LEVEL III ECOREGION

(Source: State Wildlife Action Plans)

Taxa	Common name	Scientific Name	Federal Status	Lake Agassiz Plain	North Central Hardwood Forests	Northern Glaciated Plains	Northern Lakes and Forests	Northern Minnesota Wetlands	Western Corn Belt Plains	Central Cornbelt Plains	Huron/Erie Lake Plain	Southeast Wisconsin Till Plains	So. Mich./No. IN Drift Plains	Eastern Cornbelt Plains
Fishes	Pallid Sturgeon	*Scaphirhynchus albus*	END			x			x					
Fishes	Topeka Shiner	*Notropis topeka*	END			x			x					
Fishes	American Brook Lamprey	*Lampetra appendix*	NL		x	x	x		x					
Fishes	American Eel	*Anguilla rostrata*	NL		x		x		x	x		x		
Fishes	Banded Darter	*Etheostoma zonale*	NL				x		x					
Fishes	Banded Killifish	*Fundulus diaphanus*	NL		x	x	x		x	x		x		
Fishes	Banded Pygmy Sunfish	*Elassoma zonatum*	NL							x			x	
Fishes	Bantam Sunfish	*Lepomis symmetricus*	NL							x			x	
Fishes	Bigmouth Shiner	*Notropis dorsalis*	NL				x			x			x	
Fishes	Black Buffalo	*Ictiobus niger*	NL		x				x			x		
Fishes	Black Redhorse	*Moxostoma duquesnei*	NL		x		x		x	x	x		x	x
Fishes	Blackchin Shiner	*Notropis heterodon*	NL							x				
Fishes	Blacknose Dace	*Rhinichthys atratulus*	NL							x				
Fishes	Blacknose Shiner	*Notropis heterolepis*	NL	x		x			x	x				
Fishes	Blackside Darter	*Percina maculata*	NL						x					
Fishes	Blackstripe Topminnow	*Fundulus notatus*	NL						x					
Fishes	Bloater	*Coregonus hoyi*	NL				x							
Fishes	Blue Catfish	*Ictalurus furcatus*	NL						x					
Fishes	Blue Sucker	*Cycleptus elongatus*	NL	x	x	x			x					
Fishes	Bluntnose Darter	*Etheostoma chlorosoma*	NL		x				x					
Fishes	Bowfin	*Amia calva*	NL						x	x				
Fishes	Brassy Minnow	*Hybognathus hankinsoni*	NL				x				x		x	
Fishes	Brindled Madtom	*Notorus miurus*	NL								x		x	x
Fishes	Brook Stickleback	*Culaea inconstans*	NL							x				
Fishes	Brook Trout	*Salvelinus fontinalis*	NL						x					
Fishes	Brown Bullhead	*Ameiurus nebulosus*	NL		x		x		x	x	x		x	x
Fishes	Burbot	*Lota lota*	NL						x					
Fishes	Central Mudminnow	*Umbra limi*	NL			x			x	x				
Fishes	Central Stoneroller	*Campostoma anomalum*	NL	x		x								
Fishes	Channel Darter	*Percina copelandi*	NL				x				x		x	
Fishes	Chestnut Lamprey	*Ichthyomyzon castaneus*	NL	x		x			x					
Fishes	Crystal Darter	*Ammocrypta asprella*	NL		x				x					
Fishes	Cypress Darter	*Etheostoma proeliare*	NL							x			x	
Fishes	Deepwater Sculpin	*Myoxocephalus thompsoni*	NL		x		x							
Fishes	Eastern Sand Darter	*Ammocrypta pellucida*	NL								x		x	x
Fishes	Fantail Darter	*Etheostoma flabellare*	NL				x				x		x	x
Fishes	Finescale Dace	*Phoxinus neogaeus*	NL	x	x	x	x						x	
Fishes	Flathead Catfish	*Pylodictis olivaris*	NL	x		x								
Fishes	Flathead Chub	*Platygobio gracilis*	NL	x		x			x					
Fishes	Freckled Madtom	*Noturus nocturnus*	NL						x					
Fishes	Ghost Shiner	*Notropis buchanani*	NL						x					
Fishes	Gilt Darter	*Percina evides*	NL		x		x			x			x	
Fishes	Golden Redhorse	*Moxostoma erythrurum*	NL		x		x				x		x	x
Fishes	Goldeye	*Hiodon alosoides*	NL		x				x					
Fishes	Grass Pickerel	*Esox americanus*	NL				x		x		x		x	x
Fishes	Gravel Chub	*Erimystax x-punctata*	NL						x	x		x		
Fishes	Greater Redhorse	*Moxostoma valenciennesi*	NL		x		x	x	x	x		x	x	
Fishes	Highfin Carpsucker	*Carpiodes velifer*	NL							x				
Fishes	Hornyhead Chub	*Nocomis biguttatus*	NL			x								
Fishes	Iowa Darter	*Etheostoma exile*	NL							x				
Fishes	Kiyi	*Coregonus kiyi*	NL				x							
Fishes	Lake Chub	*Couesius plumbeus*	NL			x	x							
Fishes	Lake Chubsucker	*Erimyzon sucetta*	NL		x		x			x	x	x	x	x

APPENDIX III (cont'd)

Taxa	Common name	Scientific Name	Federal Status	Lake Agassiz Plain	North Central Hardwood Forests	Northern Glaciated Plains	Northern Lakes and Forests	Northern Minnesota Wetlands	Western Corn Belt Plains	Central Cornbelt Plains	Huron/Erie Lake Plain	Southeast Wisconsin Till Plains	So. Mich./ No. IN Drift Plains	Eastern Cornbelt Plains
Fishes	Lake Herring	*Coregonus artedi*	NL		x		x			x			x	
Fishes	Lake Sturgeon	*Acipenser fulvescens*	NL	x	x	x	x	x	x	x		x	x	
Fishes	Lake Whitefish	*Coregonus clupeaformis*	NL							x			x	
Fishes	Largescale Stoneroller	*Campostoma oligolepis*	NL		x	x	x		x	x				
Fishes	Least Darter	*Etheostoma microperca*	NL		x	x	x		x	x	x	x	x	x
Fishes	Logperch	*Percina caprodes*	NL	x		x			x					
Fishes	Longear Sunfish	*Lepomis megalotis*	NL		x		x			x		x		
Fishes	Longnose Dace	*Rhinichthys cataractae*	NL						x	x			x	
Fishes	Longnose Gar	*Lepisosteus osseus*	NL						x					
Fishes	Longnose Sucker	*Catastomus catastomus*	NL							x			x	
Fishes	Mississippi Silvery Minnow	*Hybognathus nuchalis*	NL		x				x					
Fishes	Mooneye	*Hiodon tergisus*	NL				x				x			
Fishes	Mottled Sculpin	*Cottus bairdi*	NL						x	x				
Fishes	Mud Darter	*Etheostoma asprigene*	NL		x				x					
Fishes	Nipigon Cisco	*Coregonus nipigon*	NL				x							
Fishes	Northern Brook Lamprey	*Ichthyomyzon fossor*	NL				x	x	x	x			x	
Fishes	Northern Madtom	*Noturus stigmosus*	NL							x			x	
Fishes	Northern Pike	*Esox lucius*	NL							x				
Fishes	Northern Redbelly Dace	*Phoxinus eos*	NL	x		x								
Fishes	Ohio River Muskellunge	*Esox masquinongy*	NL							x	x		x	x
Fishes	Orangethroat Darter	*Etheostoma spectabile*	NL						x					
Fishes	Ozark Minnow	*Notropis nubilus*	NL		x				x	x		x		
Fishes	Paddlefish	*Polyodon spathula*	NL		x	x			x			x		
Fishes	Pallid Shiner	*Notropis amnis*	NL		x				x	x			x	
Fishes	Pearl Dace	*Margariscus margarita*	NL	x		x			x					
Fishes	Pirate Perch	*Aphredoderus sayanus*	NL		x		x		x		x		x	
Fishes	Plains Minnow	*Hybognathus placitus*	NL						x		x		x	
Fishes	Plains Topminnow	*Fundulus sciadicus*	NL			x			x					
Fishes	Pugnose Minnow	*Opsopoeodus emiliae*	NL		x				x	x				
Fishes	Pugnose Shiner	*Notropis anogenus*	NL	x	x	x	x		x	x	x	x	x	
Fishes	Pygmy Whitefish	*Prosopium coulteri*	NL				x							
Fishes	Red Shiner	*Cyprinella lutrensis*	NL			x			x					
Fishes	Redfin Shiner	*Lythrurus umbratilis*	NL		x				x	x		x		
Fishes	Redside Dace	*Clinostomus elongatus*	NL		x		x		x	x		x	x	x
Fishes	River Chub	*Nocomis micropogon*	NL				x				x		x	x
Fishes	River Darter	*Percina shumardi*	NL	x			x		x		x			
Fishes	River Redhorse	*Moxostoma carinatum*	NL		x		x		x		x	x	x	
Fishes	Rosyface Shiner	*Notropis rubellus*	NL			x				x				
Fishes	Sauger	*Stizostedion canadense*	NL				x			x	x		x	
Fishes	Shortjaw Cisco	*Coregonus zenithicus*	NL				x							
Fishes	Shovelnose Sturgeon	*Scaphirhynchus platorynchus*	NL		x				x					
Fishes	Sicklefin Chub	*Macrhybopsis meeki*	NL			x			x					
Fishes	Silver Chub	*Macrhybopsis storeiana*	NL	x		x							x	
Fishes	Silver Lamprey	*Ichthyomyzon unicuspis*	NL	x					x					
Fishes	Silver Shiner	*Notropis photogenis*	NL								x		x	x
Fishes	Skipjack Herring	*Alosa chrysochloris*	NL		x	x			x			x		
Fishes	Slender Madtom	*Noturus exilis*	NL						x			x		
Fishes	Slenderhead Darter	*Percina phoxocephala*	NL						x					
Fishes	Slimy Sculpin	*Cottus cognatus*	NL		x				x	x			x	x
Fishes	Smallmouth Bass	*Micropterus dolomieu*	NL							x				
Fishes	Southern Brook Lamprey	*Ichthyomyzon gagei*	NL		x		x							
Fishes	Southern Redbelly Dace	*Phoxinus erythrogaster*	NL			x			x	x	x		x	x
Fishes	Speckled Chub	*Macrhybopsis aestivalis*	NL		x				x			x		
Fishes	Spoonhead Sculpin	*Cottus ricei*	NL		x		x							
Fishes	Spottail Shiner	*Notropis hudsonius*	NL						x					

APPENDIX III (cont'd)

Taxa	Common name	Scientific Name	Federal Status	Lake Agassiz Plain	North Central Hardwood Forests	Northern Glaciated Plains	Northern Lakes and Forests	Northern Minnesota Wetlands	Western Corn Belt Plains	Central Cornbelt Plains	Huron/Erie Lake Plain	Southeast Wisconsin Till Plains	So. Mich./ No. IN Drift Plains	Eastern Cornbelt Plains
Fishes	Spotted Darter	*Etheostoma maculatum*	NL							x			x	
Fishes	Spotted Gar	*Lepisosteus oculatus*	NL						x				x	
Fishes	Spotted Sucker	*Minytrema melanops*	NL				x		x		x		x	x
Fishes	Starhead Topminnow	*Fundulus dispar*	NL		x					x		x	x	
Fishes	Stonecat	*Noturus flavus*	NL				x				x		x	x
Fishes	Striped Shiner	*Luxilus chrsocephalus*	NL								x		x	x
Fishes	Sturgeon Chub	*Macrhybopsis gelida*	NL			x			x					
Fishes	Suckermouth Minnow	*Phenacobius mirabilis*	NL		x				x					
Fishes	Tadpole Madtom	*Noturus gyrinus*	NL		x		x		x		x		x	x
Fishes	Tippecanoe Darter	*Etheostoma tippecanoe*	NL							x			x	
Fishes	Trout Perch	*Percopsis omiscomaycus*	NL	x		x			x	x			x	
Fishes	Variegate Darter	*Etheostoma variatum*	NL							x			x	
Fishes	Walleye	*Stizostedion vitreum*	NL							x				
Fishes	Warmouth	*Lepomis gulosus*	NL		x									
Fishes	Weed Shiner	*Notropis texanus*	NL						x					
Fishes	Western Creek Chubsucker	*Erimyzon claviformis*	NL								x		x	
Fishes	Western Sand Darter	*Ammocrypta clara*	NL		x		x		x	x		x	x	
Fishes	Western Silvery Minnow	*Hybognathus argyritis*	NL						x					
Fishes	Yellow Bullhead	*Ameiurus natalis*	NL	x		x								
Fishes	Yellow Perch	*Perca flavescens*	NL							x				
Birds	Least Tern	*Sterna antillarum*	END			x			x	x			x	
Birds	Piping Plover	*Charadrius melodus*	END		x	x	x	x	x	x		x	x	
Birds	Whooping Crane	*Grus americana*	END		x	x			x			x		
Birds	Bald Eagle	*Haliaeetus leucocephalus*	THR	x	x	x	x	x	x	x		x	x	
Birds	Yellow-billed Cuckoo	*Coccyzus americanus*	CAND		x		x		x	x		x		
Birds	Acadian Flycatcher	*Empidonax virescens*	NL		x	x			x	x		x		
Birds	American Avocet	*Recurvirostra americana*	NL	x	x	x	x	x	x					
Birds	American Bittern	*Botaurus lentiginosus*	NL	x	x	x	x	x	x	x		x		
Birds	American Black Duck	*Anas rubripes*	NL		x		x	x				x		
Birds	American Golden-plover	*Pluvialis dominica*	NL	x	x	x	x	x	x			x		
Birds	American White Pelican	*Pelecanus erythrorhynchos*	NL		x	x	x	x	x					
Birds	American Woodcock	*Scolopax minor*	NL	x	x	x	x	x	x	x		x		
Birds	Baird's Sparrow	*Ammodramus bairdii*	NL	x		x								
Birds	Barn Owl	*Tyto alba*	NL		x				x	x		x		
Birds	Bay-breasted Warbler	*Dendroica castanea*	NL				x	x						
Birds	Bell's Vireo	*Vireo bellii*	NL		x	x			x	x		x		
Birds	Bewick's Wren	*Thryomanes bewickii*	NL						x					
Birds	Black Tern	*Chlidonias niger*	NL	x	x	x	x	x	x	x		x	x	
Birds	Black-and-white Warbler	*Mniotilta varia*	NL						x					
Birds	Black-backed Woodpecker	*Picoides arcticus*	NL		x		x	x						
Birds	Black-billed Cuckoo	*Coccyzus erythropthalmus*	NL	x	x	x	x	x	x	x		x		
Birds	Black-crowned Night-heron	*Nycticorax nycticorax*	NL	x	x	x			x					
Birds	Black-throated Blue Warbler	*Dendroica caerulescens*	NL		x		x		x	x		x		
Birds	Blue-winged Teal	Anas discors	NL		x		x		x	x		x		
Birds	Blue-winged Warbler	*Vermivora pinus*	NL		x	x			x	x		x		
Birds	Bobolink	*Dolichonyx oryzivorus*	NL	x	x	x	x	x	x	x		x		
Birds	Boreal Chickadee	*Poecile hudsonica*	NL		x		x	x						
Birds	Boreal Owl	*Aegolius funereus*	NL				x	x						
Birds	Broad-winged Hawk	*Buteo platypterus*	NL						x					
Birds	Brown Creeper	*Certhia americana*	NL						x					
Birds	Brown Thrasher	*Toxostoma rufum*	NL	x	x	x	x	x	x	x		x		
Birds	Buff-breasted Sandpiper	*Tryngites subruficollis*	NL	x	x	x	x	x	x	x		x		
Birds	Burrowing Owl	*Speotyto cunicularia*	NL	x		x			x					
Birds	Canada Warbler	*Wilsonia canadensis*	NL		x		x	x	x	x		x		
Birds	Canvasback	*Aythya valisineria*	NL	x	x	x	x		x	x		x		

APPENDIX III (cont'd)

Taxa	Common name	Scientific Name	Federal Status	Lake Agassiz Plain	North Central Hardwood Forests	Northern Glaciated Plains	Northern Lakes and Forests	Northern Minnesota Wetlands	Western Corn Belt Plains	Central Cornbelt Plains	Huron/Erie Lake Plain	Southeast Wisconsin Till Plains	So. Mich./ No. IN Drift Plains	Eastern Cornbelt Plains
Birds	Cape May Warbler	*Dendroica tigrina*	NL				x	x						
Birds	Caspian Tern	Sterna caspia	NL							x		x		
Birds	Cerulean Warbler	*Dendroica cerulea*	NL		x	x	x		x			x		
Birds	Chestnut-collared Longspur	*Calcarius ornatus*	NL	x		x								
Birds	Common Loon	*Gavia immer*	NL	x	x	x	x	x	x					
Birds	Common Moorhen	*Gallinula chloropus*	NL		x	x			x					
Birds	Common Nighthawk	*Chordeiles minor*	NL	x	x	x	x	x	x					
Birds	Common Tern	*Sterna hirundo*	NL		x		x	x				x		
Birds	Connecticut Warbler	*Oporornis agilis*	NL	x	x		x	x						
Birds	Dickcissel	*Spiza americana*	NL	x	x	x	x		x	x		x		
Birds	Dunlin	*Calidris alpina*	NL	x	x	x	x	x	x	x		x		
Birds	Eared Grebe	*Podiceps nigricollis*	NL	x	x	x			x					
Birds	Eastern Meadowlark	*Sturnella magna*	NL		x		x		x	x		x		
Birds	Eastern Towhee	*Pipilo erythrophthalmus*	NL						x					
Birds	Eastern Wood-pewee	*Contopus virens*	NL	x	x	x	x	x	x					
Birds	Ferruginous Hawk	*Buteo regalis*	NL	x		x								
Birds	Field Sparrow	*Spizella pusilla*	NL	x	x	x	x		x	x		x		
Birds	Forster's Tern	*Sterna forsteri*	NL	x	x	x	x	x	x	x		x		
Birds	Franklin's Gull	*Larus pipixcan*	NL	x	x	x			x					
Birds	Golden-winged Warbler	*Vermivora chrysoptera*	NL		x		x	x	x			x		
Birds	Grasshopper Sparrow	*Ammodramus savannarum*	NL	x	x	x	x		x	x		x		
Birds	Great Egret	Ardea alba	NL		x				x			x		
Birds	Greater Prairie Chicken	*Tympanuchus cupido*	NL	x	x	x	x		x			x		
Birds	Greater Yellowlegs	*Tringa melanoleuca*	NL	x	x	x	x	x	x					
Birds	Henslow's Sparrow	*Ammodramus henslowii*	NL	x	x	x	x		x	x		x		
Birds	Hooded Warbler	*Wilsonia citrina*	NL		x		x		x			x		
Birds	Horned Grebe	*Podiceps auritus*	NL	x	x	x	x		x	x		x		
Birds	Hudsonian Godwit	*Limosa haemastica*	NL	x	x	x	x	x	x	x		x		
Birds	Kentucky Warbler	*Oporornis formosus*	NL		x				x			x		
Birds	King Rail	*Rallus elegans*	NL		x	x			x	x		x		
Birds	Kirtland's Warbler	Dendroica kirtlandii	Nl		x		x							
Birds	Lark Bunting	*Calamospiza melanocorys*	NL	x		x								
Birds	Lark Sparrow	*Chondestes grammacus*	NL		x		x		x			x		
Birds	Le Conte's Sparrow	*Ammodramus leconteii*	NL	x	x	x	x	x	x			x		
Birds	Least Bittern	*Ixobrychus exilis*	NL	x	x	x	x	x	x					
Birds	Least Flycatcher	*Empidonax minimus*	NL	x	x	x	x	x	x	x		X		
Birds	Lesser Scaup	*Aythya affinis*	NL	x	x		x		x	x		x		
Birds	Lesser Yellowlegs	*Tringa flavipes*	NL						x					
Birds	Loggerhead Shrike	*Lanius ludovicianus*	NL	x	x	x	x		x	x		x		
Birds	Long-billed Curlew	*Numenius americanus*	NL	x		x								
Birds	Long-eared Owl	*Asio otus*	NL						x					
Birds	Louisiana Waterthrush	*Seiurus motacilla*	NL		x		x		x					
Birds	Marbled Godwit	*Limosa fedoa*	NL	x	x	x	x	x	x	x		x		
Birds	Marsh Wren	*Cistothorus palustris*	NL	x	x	x	x	x	x					
Birds	Nelson's Sharp-tailed Sparrow	*Ammodramus nelsoni*	NL	x	x	x	x	x	x					
Birds	Northern Bobwhite	*Colinus virginianus*	NL		x				x			x		
Birds	Northern Goshawk	*Accipiter gentilis*	NL		x		x	x				x		
Birds	Northern Harrier	*Circus cyaneus*	NL	x	x	x	x	x	x	x		x		
Birds	Northern Mockingbird	*Mimus polyglottos*	NL						x					
Birds	Northern Pintail	*Anas acuta*	NL	x	x	x			x					
Birds	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	NL	x	x	x	x	x	x					
Birds	Olive-sided Flycatcher	*Contopus cooperi*	NL	x	x		x	x						
Birds	Osprey	*Pandion haliaetus*	NL		x		x		x	x		x	x	
Birds	Ovenbird	*Seiurus aurocapilla*	NL	x	x	x	x	x	x					
Birds	Peregrine Falcon	*Falco peregrinus*	NL	x	x	x	x		x	x		x	x	

APPENDIX III (cont'd)

Taxa	Common name	Scientific Name	Federal Status	Lake Agassiz Plain	North Central Hardwood Forests	Northern Glaciated Plains	Northern Lakes and Forests	Northern Minnesota Wetlands	Western Corn Belt Plains	Central Cornbelt Plains	Huron/Erie Lake Plain	Southeast Wisconsin Till Plains	So. Mich./ No. IN Drift Plains	Eastern Cornbelt Plains
Birds	Prothonotary Warbler	*Protonotaria citrea*	NL		x	x			x			x		
Birds	Red Crossbill	Loxia curvirostra	NL		x					x		x		
Birds	Redhead	*Aythya americana*	NL	x	x	x			x			x		
Birds	Red-headed Woodpecker	*Melanerpes erythrocephalus*	NL	x	x	x	x	x	x	x		x		
Birds	Red-necked Grebe	*Podiceps grisegena*	NL	x	x	x	x	x	x	x		x		
Birds	Red-shouldered Hawk	*Buteo lineatus*	NL		x		x		x	x		x		
Birds	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	NL	x	x	x	x	x	x					
Birds	Ruddy Turnstone	*Arenaria interpres*	NL	x	x	x	x	x	x					
Birds	Ruffed Grouse	*Bonasa umbellus*	NL						x					
Birds	Rusty Blackbird	*Euphagus carolinus*	NL		x		x		x	x		x		
Birds	Sandhill Crane	*Grus canadensis*	NL						x					
Birds	Sedge Wren	*Cistothorus platensis*	NL	x	x	x	x	x	x					
Birds	Semipalmated Sandpiper	*Calidris pusilla*	NL	x	x	x	x	x	x					
Birds	Sharp-tailed Grouse	*Tympanuchus phasianellus*	NL	x	x	x	x	x	x			x		
Birds	Short-billed Dowitcher	*Limnodromus griseus*	NL	x	x	x	x	x	x	x		x		
Birds	Short-eared Owl	*Asio flammeus*	NL	x	x	x	x	x	x	x		x		
Birds	Snowy Egret	*Egretta thula*	NL		x							x		
Birds	Solitary Sandpiper	*Tringa solitaria*	NL		x		x		x	x		x		
Birds	Sprague's Pipit	*Anthus spragueii*	NL	x		x								
Birds	Spruce Grouse	*Falcipennis canadensis*	NL		x		x	x						
Birds	Stilt Sandpiper	*Micropalama himantopus*	NL						x					
Birds	Swainson's Hawk	*Buteo swainsoni*	NL	x		x			x					
Birds	Swamp Sparrow	*Melospiza georgiana*	NL	x	x	x	x	x	x					
Birds	Trumpeter Swan	*Cygnus buccinator*	NL	x	x	x	x	x	x	x		x	x	
Birds	Upland Sandpiper	*Bartramia longicauda*	NL	x	x	x	x	x	x	x		x		
Birds	Veery	*Catharus fuscescens*	NL	x	x	x	x	x	x	x		x		
Birds	Vesper Sparrow	Pooecetes gramineus	NL		x		x		x	x		x		
Birds	Virginia Rail	*Rallus limicola*	NL	x	x	x	x	x	x					
Birds	Western Grebe	*Aechmophorus occidentalis*	NL	x	x	x			x					
Birds	Western Meadowlark	Sturnella neglecta	NL		x		x		x	x		x		
Birds	Whimbrel	*Numenius phaeopus*	NL	x	x	x	x	x	x	x		x		
Birds	Whip-poor-will	*Caprimulgus vociferus*	NL	x	x	x	x	x	x			x		
Birds	White-eyed Vireo	*Vireo griseus*	NL						x					
Birds	White-rumped Sandpiper	*Calidris fuscicollis*	NL	x	x	x	x	x	x					
Birds	White-throated Sparrow	*Zonotrichia albicollis*	NL	x	x		x	x						
Birds	Willet	*Catoptrophorus semipalmatus*	NL	x		x								
Birds	Willow Flycatcher	*Empidonax traillii*	NL	x	x	x	x		x	x		x		
Birds	Wilson's Phalarope	*Phalaropus tricolor*	NL	x	x	x	x	x	x			x		
Birds	Winter Wren	*Troglodytes troglodytes*	NL	x	x	x	x	x	x					
Birds	Wood Thrush	*Hylocichla mustelina*	NL		x	x	x	x	x	x		x		
Birds	Worm-eating Warbler	*Helmitheros vermivorus*	NL		x				x					
Birds	Yellow Rail	*Coturnicops noveboracensis*	NL	x	x	x	x	x	x			x		
Birds	Yellow-bellied Sapsucker	*Sphyrapicus varius*	NL	x	x	x	x	x	x					
Birds	Yellow-breasted Chat	*Icteria virens*	NL						x					
Birds	Yellow-crowned Night Heron	*Nyctanassa violacea*	NL		x				x	x		x		
Birds	Yellow-throated Warbler	Dendroica dominica	NL		x							x		
Herpetiles	Copperbelly Water Snake	*Nerodia erythrogaster neglecta*	THR						x	x			x	
Herpetiles	Eastern Massasauga Rattlesnake	*Sistrurus catenatus catenatus*	CAND		x		x		x	x	x	x	x	x
Herpetiles	Alligator Snapping Turtle	*Macrochelys temminckii*	NL						x	x			x	
Herpetiles	Black Rat Snake	*Elaphe obsoleta*	NL								x		x	x
Herpetiles	Blanchard's Cricket Frog	Acris crepitans blanchardi	NL		x						x		x	x
Herpetiles	Blanding's Turtle	*Emydoidea blandingii*	NL		x	x	x		x	x	x	x	x	x
Herpetiles	Blue-spotted Salamander	*Ambystoma laterale*	NL						x	x			x	
Herpetiles	Boreal Chorus Frog	Pseudacris maculata	NL		x		x		x					
Herpetiles	Bull snake	*Pituophis catenifer sayi*	NL		x		x		x			x		

APPENDIX III (cont'd)

Taxa	Common name	Scientific Name	Federal Status	Lake Agassiz Plain	North Central Hardwood Forests	Northern Glaciated Plains	Northern Lakes and Forests	Northern Minnesota Wetlands	Western Corn Belt Plains	Central Cornbelt Plains	Huron/Erie Lake Plain	Southeast Wisconsin Till Plains	So. Mich./ No. IN Drift Plains	Eastern Cornbelt Plains
Herpetiles	Butler's Garter Snake	*Thamnophis butleri*	NL		x					x		x		
Herpetiles	Canadian Toad	*Bufo hemiophrys*	NL	x		x								
Herpetiles	Central Newt	*Notophthalmus viridescens*	NL						x					
Herpetiles	Common Mudpuppy	*Necturus maculosus*	NL	x	x	x	x	x	x	x		x	x	
Herpetiles	Common Musk Turtle	*Sternotherus odoratus*	NL						x					
Herpetiles	Common Snapping Turtle	*Chelydra serpentina*	NL	x	x	x	x	x	x					
Herpetiles	Cope's Grey Treefrog	*Hyla chrysoscelis*	NL			x								
Herpetiles	Copperhead	*Agkistrodon contortix*	NL						x					
Herpetiles	Cottonmouth	*Agkistrodon piscivorus*	NL							x			x	
Herpetiles	Crawfish Frog	*Rana areolata*	NL						x					
Herpetiles	Diamondback Water Snake	*Nerodia rhombifera*	NL						x					
Herpetiles	Eastern Box Turtle	*Terrapene carolina*	NL		x		x				x		x	x
Herpetiles	Eastern Fox Snake	*Elaphe vulpina*	NL		x	x	x		x			x	x	
Herpetiles	Eastern Hognose Snake	*Heterodon platirhinos*	NL		x	x	x							
Herpetiles	Eastern Mud Turtle	*Kinosternon subrubrum*	NL							x			x	
Herpetiles	Eastern Racer	*Coluber constrictor*	NL		x				x			x		
Herpetiles	Eastern Red-backed Salamander	*Plethodon cinereus*	NL				x	x						
Herpetiles	False Map Turtle	*Graptemys pseudogeographica*	NL	x		x								
Herpetiles	Five-lined Skink	*Eumeces fasciatus*	NL		x	x			x					
Herpetiles	Four-toed Salamander	*Hemidactylium scutatum*	NL		x		x		x	x		x	x	
Herpetiles	Gopher Snake	*Pituophis catenifer*	NL		x	x			x					
Herpetiles	Gray Ratsnake	Pantherophis spiloides	NL		x									
Herpetiles	Great Plains Skink	*Eumeces obsoletus*	NL						x					
Herpetiles	Great Plains Toad	*Bufo cognatus*	NL						x					
Herpetiles	Hellbender	*Cryptobranchus alleganiensis*	NL							x			x	
Herpetiles	Kirtland's Snake	*Clonophis kirtlandii*	NL										x	x
Herpetiles	Lined Snake	*Tropidoclonion lineatum*	NL			x			x					
Herpetiles	Marbled Salamandar	*Ambystoma opacum*	NL										x	
Herpetiles	Milk Snake	*Lampropeltis triangulum*	NL		x	x	x		x					
Herpetiles	Mink Frog	*Rana septentrionalis*	NL		x		x							
Herpetiles	Northern Cricket Frog	*Acris crepitans*	NL		x	x	x		x			x		
Herpetiles	Northern Prairie Skink	*Eumeces septentrionalis*	NL	x	x	x	x		x					
Herpetiles	Northern Redbelly Snake	*Storeria occipitomaculata*	NL	x		x								
Herpetiles	Northern Ribbon Snake	Thamnophis sauritus	NL		x		x					x		
Herpetiles	Ornate Box Turtle	*Terrapene ornata*	NL		x				x			x		
Herpetiles	Pickerel Frog	*Rana palustris*	NL		x		x		x	x		x		
Herpetiles	Plains Leopard Frog	*Rana blairi*	NL							x			x	
Herpetiles	Plains Spadefoot	*Spea bombifrons*	NL	x		x								
Herpetiles	Prairie Kingsnake	*Lampropeltis calligaster*	NL						x					
Herpetiles	Prairie Rattlesnake	*Crotalus viridis*	NL						x					
Herpetiles	Prairie Ringneck Snake	Diadophis punctatus arnyi	NL		x									
Herpetiles	Queen Snake	Regina septemvittata	NL		x					x		x		
Herpetiles	Six-lined Racerunner	*Cnemidophorus sexlineatus*	NL		x				x					
Herpetiles	Smallmouth Salamander	*Ambystoma texanum*	NL						x		x		x	x
Herpetiles	Smooth Earth Snake	*Virginia valeriae*	NL						x					
Herpetiles	Smooth Green Snake	*Liochlorophis vernalis*	NL	x	x	x	x		x					
Herpetiles	Smooth Softshell Turtle	*Apalone mutica*	NL		x	x						x		
Herpetiles	Speckled Kingsnake	*Lampropeltis getulus*	NL						x					
Herpetiles	Spotted Salamander	*Ambystoma maculatum*	NL				x		x					
Herpetiles	Spotted Turtle	Clemmys guttata	NL		x		x			x	x		x	x
Herpetiles	Timber Rattlesnake	*Crotalus horridus*	NL		x				x					
Herpetiles	Western Hognose Snake	*Heterodon nasicus*	NL	x	x	x	x		x					
Herpetiles	Western Ribbon Snake	*Thamnophis proximus*	NL		x							x		
Herpetiles	Western Slender Glass Lizard	*Ophisaurus attenuatus*	NL		x				x			x		
Herpetiles	Western Worm Snake	*Carphophis amoenus*	NL		x				x					

APPENDIX III (cont'd)

Taxa	Common name	Scientific Name	Federal Status	Lake Agassiz Plain	North Central Hardwood Forests	Northern Glaciated Plains	Northern Lakes and Forests	Northern Minnesota Wetlands	Western Corn Belt Plains	Central Cornbelt Plains	Huron/Erie Lake Plain	Southeast Wisconsin Till Plains	So. Mich./ No. IN Drift Plains	Eastern Cornbelt Plains
Herpetiles	Wood Turtle	*Clemmys insculpta*	NL		x		x		x		x	x	x	
Herpetiles	Yellow Mud Turtle	Kinosternon flavescens	NL		x		x		x			x		
Herpetiles	Yellowbelly Water Snake	*Nerodia erythrogaster flavigaster*	NL						x					
Insects	Dakota Skipper	*Hesperia dacotae*	CAND	x		x			x					
Insects	American Burying Beetle	*Nicrophorus americanus*	END			x								
Insects	Karner Blue	*Lycaeides melissa samuelis*	END		x		x							
Insects	Silvery Blue	*Glaucopsyche lygdamus*	END						x					
Insects	A Caddisfly	*Agapetus tomus*	NL		x		x							
Insects	A Caddisfly	*Asynarchus rossi*	NL		x									
Insects	A Caddisfly	*Ceraclea brevis*	NL				x							
Insects	A Caddisfly	*Hydroptila metoeca*	NL				x							
Insects	A Caddisfly	*Hydroptila novicola*	NL				x							
Insects	A Caddisfly	*Hydroptila tortosa*	NL				x							
Insects	A Caddisfly	*Oxyethira ecornuta*	NL		x		x							
Insects	A Caddisfly	*Oxyethira itascae*	NL		x		x	x						
Insects	A Caddisfly	*Polycentropus milaca*	NL				x							
Insects	A Caddisfly	*Protoptila talola*	NL				x							
Insects	A Caddisfly	*Setodes guttatus*	NL				x							
Insects	A Tiger Beetle	*Cicindela denikei*	NL				x	x						
Insects	A Tiger Beetle	*Cicindela fulgida fulgida*	NL			x			x					
Insects	A Tiger Beetle	*Cicindela fulgida westbournei*	NL	x										
Insects	A Tiger Beetle	*Cicindela hirticollis rhodensis*	NL				x							
Insects	A Tiger Beetle	*Cicindela limbata nympha*	NL		x									
Insects	A Tiger Beetle	*Cicindela macra macra*	NL		x									
Insects	A Tiger Beetle	*Cicindela patruela patruela*	NL		x		x							
Insects	Acadian Hairstreak	*Satyrium acadica*	NL						x					
Insects	Alkali Bluet	*Enallagma clausum*	NL						x					
Insects	Arogos Skipper	*Atrytone arogos*	NL	x	x	x			x					
Insects	Assiniboia Skipper	*Hesperia comma assiniboia*	NL	x										
Insects	Baltimore Checkerspot	*Euphydryas phaeton*	NL						x					
Insects	Blazing Star Stem Borer	*Papaipema beeriana*	NL	x	x	x			x					
Insects	Blue-eyed Darner	*Aeshna multicolor*	NL						x					
Insects	Blue-faced Meadowhawk	*Sympetrum ambiguum*	NL						x					
Insects	Bog Copper	*Lycaena epixanthe michiganensis*	NL		x		x	x						
Insects	Boreal Bluet	*Enallagma boreale*	NL						x					
Insects	Brimstone Clubtail	*Stylurus intricatus*	NL						x					
Insects	Broad-winged Skipper	*Poanes viator*	NL						x					
Insects	Byssus Skipper	*Problema byssus*	NL						x					
Insects	Canada Darner	*Aeshna canadensis*	NL						x					
Insects	Carolina Saddlebags	*Tramea carolina*	NL						x					
Insects	Columbine Duskywing	*Erynnis lucilius*	NL						x					
Insects	Common Ringlet	*Coenoympha tullia*	NL						x					
Insects	Cyrano Darner	*Nasiaeschno pentacantha*	NL						x					
Insects	Disa Alpine	*Erebia disa mancinus*	NL				x	x						
Insects	Dreamy Duskywing	*Erynnis icelus*	NL						x					
Insects	Dusted Skipper	*Atrytonopsis hianna*	NL						x					
Insects	Ebony Boghauter	*Williamsonia fletcheri*	NL		x		x						x	
Insects	Edward's Hairstreak	*Satyrium edwardsii*	NL						x					
Insects	Elegant Spreadwing	*Lestes inaequalis*	NL						x					
Insects	Emma's Dancer	*Argia emma*	NL						x					
Insects	Extra-striped Snaketail	*Ophiogomphus anomalis*	NL				x							
Insects	Four-spotted Skimmer	*Libellula quadrimaculata*	NL						x					
Insects	Garita Skipper	*Oarisma garita*	NL	x										
Insects	Green-faced Clubtail	*Gomphus viridifrons*	NL		x		x							
Insects	Green-striped Darner	*Aeshna verticalis*	NL						x					

APPENDIX III (cont'd)

Taxa	Common name	Scientific Name	Federal Status	Lake Agassiz Plain	North Central Hardwood Forests	Northern Glaciated Plains	Northern Lakes and Forests	Northern Minnesota Wetlands	Western Corn Belt Plains	Central Cornbelt Plains	Huron/Erie Lake Plain	Southeast Wisconsin Till Plains	So. Mich./ No. IN Drift Plains	Eastern Cornbelt Plains
Insects	Grey Petaltail	*Tachopteryx thoreyi*	NL										x	
Insects	Grizzled Skipper	*Pyrgus centaureae freija*	NL				x	x						
Insects	Headwater Chilostigman	*Chilostigma itascae*	NL				x							
Insects	Hines Emerald	*Somatochlora hineana*	NL				x							
Insects	Hickory Hairstreak	*Satyrium caryaevorum*	NL						x					
Insects	Incurvate Emerald	*Somatochlora incurata*	NL				x							
Insects	Iowa Skipper	*Atrytone arogos iowa*	NL			x								
Insects	Laura's Snaketail	*Stylurus laurae*	NL				x				x		x	
Insects	Leonard's Skipper	*Hesperia leonardus leonardus*	NL		x		x	x	x					
Insects	Little White Tiger Beetle	*Cicindela lepida*	NL		x	x			x					
Insects	Mocha Emerald	*Somatochlora linearis*	NL						x					
Insects	Mulberry Wing	*Poanes massasoit*	NL						x					
Insects	Nabokov's Blue	*Lycaeides idas nabokovi*	NL				x	x						
Insects	Olympia White	*Euchloe olympia*	NL						x					
Insects	Ottoe Skipper	*Hesperia ottoe*	NL			x			x					
Insects	Paiute Dancer	*Argia alberta*	NL						x					
Insects	Pawnee Skipper	*Hesperia leonardus pawnee*	NL	x		x			x					
Insects	Pepper and Salt Skipper	*Amblyscirtes hegon*	NL						x					
Insects	Persius Duskywing	*Erynnis persius*	NL		x		x							
Insects	Phlox Moth	*Schinia indiana*	NL			x			x					
Insects	Pipevine Swallowtail	*Battus philenor*	NL						x					
Insects	Powesheik Skipper	*Oarisma powesheik*	NL	x		x			x					
Insects	Prairie Bluet	*Coenagrion angulatum*	NL						x					
Insects	Purplish Copper	*Lycaena helloides*	NL						x					
Insects	Pygmy Snaketail	*Ophiogomphus howei*	NL				x							
Insects	Rapids Clubtail	*Gomphus quadricolor*	NL				x		x				x	
Insects	Red Tailed Prairie Leafhopper	*Aflexia rubranura*	NL	x	x	x			x					
Insects	Regal Fritillary	*Speyeria idalia*	NL	x	x	x			x					
Insects	Riverine Snaketail	*Stylurus amnicola*	NL				x				x		x	
Insects	Royal River Cruiser	*Macromia taeniolata*	NL						x					
Insects	Rusty Snaketail	*Ophiogomphus rupinsulensis*	NL						x					
Insects	Sand Snaketail	*Ophiogomphus sp.*	NL						x					
Insects	Sedge Skipper	*Euphyes dion*	NL						x					
Insects	Skillet Clubtail	*Gomphus ventricosus*	NL				x							
Insects	Slaty Skimmer	*Libellula incesta*	NL						x					
Insects	Sleepy Duskywing	*Erynnis brizo*	NL						x					
Insects	Smoky Shadowdragon	*Neurocordulia molesta*	NL						x					
Insects	Spangled Skimmer	*Libellula cyanea*	NL						x					
Insects	Splendid Clubtail	*Gomphus lineatifrons*	NL				x						x	
Insects	Spotted Spreadwing	*Lestes congener*	NL						x					
Insects	St. Croix Snaketail	*Ophiogomphus susbehcha*	NL		x		x							
Insects	Striped Hairstreak	*Satyrium liparops*	NL						x					
Insects	Stygian Shadowdragon	*Neurocordulia yamaskanensis*	NL						x					
Insects	Sulphur-tipped Clubtail	*Gomphus militaris*	NL						x					
Insects	Swamp Metalmark	*Calephelis muticum*	NL						x					
Insects	Sweetflag Spreadwing	*Lestes forcipatus*	NL						x					
Insects	Tawny Crescent	*Phyciodes batesii*	NL				x	x						
Insects	Two-spotted Skipper	*Euphyes bimacula illinois*	NL		x		x		x					
Insects	Uhler's Arctic	*Oeneis uhleri varuna*	NL	x										
Insects	Uncas Skipper	*Hesperia uncas*	NL		x				x					
Insects	Variable Darner	*Aeshna interrupta*	NL						x					
Insects	Vertrees's Ceraclean Caddisfly	*Ceraclea vertreesi*	NL				x							
Insects	Vesper Bluet	*Enallagma vesperum*	NL						x					
Insects	Wild Indigo duskywing	*Erynnis baptisiae*	NL						x					
Insects	Zabulon Skipper	*Poanes zabulon*	NL						x					

APPENDIX III (cont'd)

Taxa	Common name	Scientific Name	Federal Status	Lake Agassiz Plain	North Central Hardwood Forests	Northern Glaciated Plains	Northern Lakes and Forests	Northern Minnesota Wetlands	Western Corn Belt Plains	Central Cornbelt Plains	Huron/Erie Lake Plain	Southeast Wisconsin Till Plains	So. Mich./No. IN Drift Plains	Eastern Cornbelt Plains
Insects	Zebra Swallowtail	*Eurytides marcellus*	NL						x					
Land Snail	Iowa Pleistocene Snail	*Discus macclintocki*	END						x					
Land Snail	Bluff Vertigo	*Vertigo occulta*	NL						x					
Land Snail	Briarton Pleistocene Snail	*Vertigo brierensis*	NL						x					
Land Snail	Frigid Ambersnail	*Catinella gelida*	NL						x					
Land Snail	Hubricht's Vertigo	*Vertigo hubrichti*	NL						x					
Land Snail	Iowa Pleistocene Succinea	*Novasuccinea n. Sp. Minnesota b*	NL						x					
Land Snail	Iowa Pleistocene Vertigo	*Vertigo iowaensis*	NL						x					
Land Snail	Minnesota Pleistocene Succinea	*Novasuccinea n. Sp. Minnesota a*	NL						x					
Mammals	Bobcat	*Lynx rufus*	END						x					
Mammals	Canada Lynx	*Lynx canadensis*	THR				x	x						
Mammals	Gray Wolf	*Canis lupus*	THR	x		x	x	x	x			x		
Mammals	Indiana Bat	*Myotis sodalis*	END						x					
Mammals	Northern Swift fox	*Vulpes velox*	END			x								
Mammals	Red-backed Vole	*Clethrionomys gapperi*	END						x					
Mammals	American Badger	*Taxidea taxus*	NL	x	x	x	x	x	x					
Mammals	American Marten	*Martes americana*	NL		x		x							
Mammals	Arctic Shrew	*Sorex arcticus*	NL	x		x								
Mammals	Eastern Pipistrelle	*Pipistrellus subflavus*	NL		x	x	x		x					
Mammals	Eastern Red Bat	Lasiurus borealis	NL		x					x		x		
Mammals	Eastern Spotted Skunk	*Spilogale putorius*	NL	x	x	x	x		x					
Mammals	Elk	*Cervus elaphus*	NL	x				x						
Mammals	Evening Bat	*Nycticeius humeralis*	NL						x					
Mammals	Franklin's Ground Squirrel	*Spermophilus franklinii*	NL	x	x	x	x	x	x	x		x		
Mammals	Hayden's Shrew	*Sorex haydeni*	NL						x					
Mammals	Heather Vole	*Phenacomys intermedius*	NL				x							
Mammals	Hoary Bat	Lasiurus cinereus	NL		x		x		x	x		x		
Mammals	Least Shrew	*Cryptotis parva*	NL						x					
Mammals	Least Weasel	*Mustela nivalis*	NL	x	x	x	x	x	x					
Mammals	Moose	*Alces alces*	NL		x		x							
Mammals	Northern Bog Lemming	*Synaptomys borealis*	NL				x	x						
Mammals	Northern Flying Squirrel	Glaucomys sabrinus	NL		x		x					x		
Mammals	Northern Grasshopper Mouse	*Onychomys leucogaster*	NL	x		x			x					
Mammals	Northern Myotis	*Myotis septentrionalis*	NL		x	x	x		x	x		x		
Mammals	Northern Pocket Gopher	*Thomomys talpoides*	NL	x										
Mammals	Plains Pocket Mouse	*Perognathus flavescens*	NL	x	x	x			x					
Mammals	Prairie Vole	*Microtus ochrogaster*	NL	x	x	x	x		x	x		x		
Mammals	Pygmy Shrew	*Sorex hoyi*	NL	x		x								
Mammals	Red Squirrel	*Tamiasciurus hudsonicus*	NL						x					
Mammals	Richardson's Ground Squirrel	*Spermophilus richardsonii*	NL	x		x			x					
Mammals	River Otter	*Lutra canadensis*	NL	x		x			x	x			x	
Mammals	Rock Vole	*Microtus chrotorrhinus*	NL				x							
Mammals	Short-tailed Shrew	*Blarina hylophaga*	NL						x					
Mammals	Silver-haired Bat	Lasionycteris noctivagans	NL		x		x		x	x		x		
Mammals	Smoky Shrew	*Sorex fumeus*	NL				x							
Mammals	Southern Bog Lemming	*Synaptomys cooperi*	NL						x					
Mammals	Southern Flying Squirrel	*Glaucomys volans*	NL						x					
Mammals	Water Shrew	Sorex palustris	NL		x		x		x	x		x		
Mammals	Western Harvest Mouse	*Reithrodontomys megalotis*	NL		x	x			x					
Mammals	White-tailed Jackrabbit	*Lepus townsendii*	NL		x		x		x					
Mammals	Woodland Vole	*Microtus pinetorum*	NL		x				x	x		x		
Mammals	Wooldand Jumping Mouse	Napaeozapus insignis	NL		x		x					x		
Mollusks	Clubshell	*Pleurobema clava*	END							x			x	
Mussels	Bullhead (Sheepnose)	*Plethobasus cyphus*	CAND						x					
Mollusks	Rayed Bean	*Villosa fabalis*	CAND							x	x		x	

APPENDIX III (cont'd)

Taxa	Common name	Scientific Name	Federal Status	Lake Agassiz Plain	North Central Hardwood Forests	Northern Glaciated Plains	Northern Lakes and Forests	Northern Minnesota Wetlands	Western Corn Belt Plains	Central Cornbelt Plains	Huron/Erie Lake Plain	Southeast Wisconsin Till Plains	So. Mich./ No. IN Drift Plains	Eastern Cornbelt Plains
Mussels	Spectacle case	*Cumberlandia monodonta*	CAND						x					
Mollusks	Fanshell	*Cyprogenia stegaria*	END							x			x	
Mollusks	Fat Pocketbook	*Potamilus capax*	END							x			x	
Mollusks	Higgins Eye	*Lampsilis higginsii*	END		x		x		x					
Mollusks	Northern Riffleshell	*Epioblasma torulosa rangiana*	END							x	x		x	
Mollusks	Orangefoot Pimpleback	*Plethobasus cooperianus*	END							x			x	
Mollusks	Pink Mucket	*Lampsilis abrupta*	END							x			x	
Mollusks	Rabbitsfoot	*Quadrula cylindrica*	END							x			x	
Mollusks	Tubercled Blossom	*Epioblasma torulosa torulosa*	END							x			x	
Mollusks	White Catspaw	*Epioblasma obliquata perobliqua*	END							x	x		x	
Mollusks	White Wartyback	*Plethobasus cicatricosus*	END							x			x	
Mollusks	Winged Mapleleaf	*Quadrula fragosa*	END		x		x							
Mollusks	Pink Papershell	*Potamilus ohiensis*	END/THR	x										
Mollusks	Black Sandshell	*Ligumia recta*	NL	x	x	x	x	x	x					
Mollusks	Butterfly	*Ellipsaria lineolata*	NL		x		x		x					
Mollusks	Creek Heelsplitter	*Lasmigona compressa*	NL	x	x	x	x	x	x					
Mussels	Cylinder	*Anodontoides ferussacianus*	NL						x					
Mollusks	Ebonyshell	*Fusconaia ebena*	NL		x		x		x					
Mollusks	Elephant-ear	*Elliptio crassidens*	NL		x									
Mollusks	Elktoe	*Alasmidonta marginata*	NL		x	x	x		x		x		x	
Mollusks	Ellipse	*Venustaconcha ellipsiformis*	NL		x	x			x	x	x		x	
Mollusks	Fawnsfoot	*Truncilla donaciformis*	NL		x	x			x					
Mussels	Flat floater	*Anodonta suborbiculata*	NL						x					
Mollusks	Fluted-shell	*Lasmigona costata*	NL	x	x	x		x	x					
Mollusks	Hickorynut	*Obovaria olivaria*	NL		x	x	x		x		x			
Mollusks	Kidneyshell	*Ptychobranchus fasciolaris*	NL							x			x	
Mussels	Lilliput	*Toxolasma parvus*	NL						x					
Mollusks	Little Spectaclecase	*Villosa lienosa*	NL							x			x	
Mollusks	Long Solid	*Fusconaia subrotundra*	NL							x			x	
Mollusks	Mapleleaf	*Quadrula quadrula*	NL	x		x								
Mollusks	Monkeyface	*Quadrula metanevra*	NL		x	x	x		x					
Mollusks	Mucket Mussel	*Actinonaias ligamentina*	NL		x	x	x		x					
Mollusks	Ohio Pigtoe	*Pleurobema cordatum*	NL							x			x	
Mussels	Ozark Pigtoe	*Fusconaia ozarkensis*	NL						x					
Mussels	Paper Pondshell	*Utterbackia imbecillis*	NL						x					
Mollusks	Pink Heel Splitter	*Potamilus alatus*	NL	x		x								
Mollusks	Pistolgrip	*Tritogonia verrucosa*	NL		x	x	x		x					
Mollusks	Pointed Campeloma	*Campeloma decisum*	NL							x			x	
Mussels	Pondhorn	*Uniomerus tetralasmus*	NL						x					
Mussels	Pondmussel	*Ligumia subrostrata*	NL						x					
Mollusks	Purple Lilliput	*Toxolasma lividus*	NL							x	x		x	
Mollusks	Purple Wartyback	*Cyclonaias tuberculata*	NL		x		x		x		x		x	
Mollusks	Pyramid Pigtoe	*Pleurobema rubrum*	NL							x			x	
Mollusks	Rainbow	*Vilosa iris*	NL				x				x		x	
Mollusks	Rock Pocketbook	*Arcidens confragosus*	NL		x	x			x					
Mollusks	Rough Pigtoe	*Pleurobema plenum*	NL							x			x	
Mollusks	Round Hickorynut	*Obovaria subrotunda*	NL							x	x		x	x
Mollusks	Round Pigtoe	*Pleurobema coccineum*	NL		x		x		x				x	x
Mollusks	Salamander Mussel	*Simpsonaias ambigua*	NL		x	x	x		x	x	x		x	
Mussels	Slippershell	*Alasmidonta viridis*	NL				x		x		x		x	
Mussels	Slough Sandshell	*Lampsilis teres teres*	NL						x					
Mollusks	Snuffbox	*Epioblasma triquetra*	NL		x		x			x	x		x	
Mollusks	Spike	*Elliptio dilatata*	NL		x	x	x		x					
Mussels	Strange Floater (Squawfoot)	*Strophitus undulatus*	NL						x					
Mollusks	Swamp Lymnaea	*Lymnaea stagnalis*	NL							x			x	

APPENDIX III (cont'd)

Taxa	Common name	Scientific Name	Federal Status	Lake Agassiz Plain	North Central Hardwood Forests	Northern Glaciated Plains	Northern Lakes and Forests	Northern Minnesota Wetlands	Western Corn Belt Plains	Central Cornbelt Plains	Huron/Erie Lake Plain	Southeast Wisconsin Till Plains	So. Mich./No. IN Drift Plains	Eastern Cornbelt Plains
Mollusks	Three Ridge	*Amblema plicata*	NL	x		x								
Mollusks	Wabash Pigtoe	*Fusconaia flava*	NL	x		x								
Mollusks	Wartyback	*Quadrula nodulata*	NL		x		x		x					
Mollusks	Washboard	*Megalonaias nervosa*	NL		x									
Mollusks	Wavyrayed Lampmussel	*Lampsilis fasciola*	NL							x	x		x	x
Mollusks	Yellow Sandshell	*Lampsilis teres*	NL		x				x					
Snails	Acorn Ramshor	*Planorbella multivolvis*	NL				x							
Snails	Brown Walker	*Pomatiopsis cincinnatiensis*	NL		x						x		x	x
Snails	Deepwater Pondsnail	*Stagnicola contracta*	NL		x		x							
Snails	Gravel Pyrg	*Pyrgulopsis letsoni*	NL								x		x	
Snails	Spindle Lymnaea	*Acella haldemani*	NL								x		x	
Snails	Watercress Snail	*Fontigens nickliniana*	NL								x		x	
Spiders	A Jumping Spider	*Habronattus texanus*	NL		x				x					
Spiders	A Jumping Spider	*Marpissa grata*	NL	x	x	x	x		x					
Spiders	A Jumping Spider	*Metaphidippus arizonensis*	NL	x	x									
Spiders	A Jumping Spider	*Paradamoetas fontana*	NL		x	x	x		x					
Spiders	A Jumping Spider	*Phidippus pius*	NL		x	x			x					
Spiders	A Jumping Spider	*Tutelina formicaria*	NL		x									