

The State of the Upper Fox River Basin

October, 2001
WT-665-2001



Fox River at Eureka, Winnebago County, Bureau of Watershed Management

A Report by the
Wisconsin Department of Natural Resources in
Cooperation with the Upper Fox River Basin
Partnership Team and Stakeholders



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October 2001

To: Recipients of the Upper Fox River Basin State of the Basin Report

We are pleased to present the *Upper Fox River Basin State of the Basin Report*. The primary purpose of this report is to: provide background information about the basin; articulate land, air, and water quality concerns; present management objectives; and serve as a tool for the improvement and protection of the resources of the basin. This is a working document that will evolve over time as ecological and social changes occur and as resource management evolves and progresses in the future.

This report was prepared using an Integrated Ecosystem Management approach that emphasizes the interconnectedness of ecological components. The Upper Fox River Basin Team better serves the land, water, air, and people of the basin by using this approach.

As resource managers, one of our greatest challenges is addressing resource issues in an integrated manner -- one that mimics the connectedness of nature -- while maintaining needed accountability to our individual programs. On the positive side, new relationships developed through our partnership efforts continue to bolster our enthusiasm and effectiveness in the realm of resource management. We believe that by establishing joint efforts on truly integrated projects, we can make tangible progress toward improving, maintaining, and/or protecting our natural resources.

We look forward to communicating our management philosophy, goals, and objectives to you through personal meetings and discussions, electronic media and in paper format, through updates to this and other public documents in the future.

Sincerely,

Ellen Barth, Leader
Upper Fox River Basin Land Team

Robin McLennan, Leader
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The State of the Upper Fox Basin

November 2001

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with the Upper Fox River Basin Partnership Team

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This report can also be found on the DNR website at <http://www.dnr.state.wi.us/org/gmu/upfox/index.htm>

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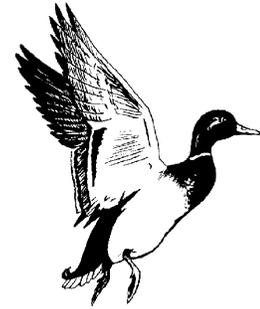
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MISSION STATEMENT OF THE DEPARTMENT OF NATURAL RESOURCES

The Mission of the Department of Natural Resources is provided below. It establishes the over-arching purpose and philosophy guiding the Department's management of the state's natural resources. It recognizes the value of our resources to the people of Wisconsin and the need of the Department to work with the public as partners in resource management.

Mission:

*To protect and enhance our natural resources:
our air, land, and water;
our wildlife, fish, and forests;
and the ecosystems that sustain all life.
To provide a healthy, sustainable environment
and a full range of outdoor opportunities.
To ensure the right of all people
to use and enjoy these resources
in their work and leisure.
To work with people
to understand each other's views
and to carry out the public will.
And in this partnership
consider the future
and generations to follow.*



The Mission guides the management of the Upper Fox River Basin. Our responsibility is to be stewards of the ecosystem and to work with the public to ensure adequate protection of the resources of the basin in a manner consistent with the Department's Mission.

STATEWIDE STRATEGIC PLAN

The Department's Strategic Plan was developed to provide a framework to achieve the Department's Mission. Management within the Upper Fox Basin is consistent with the Strategic Plan. The four major elements of the plan are: I) Making People Our Strength; II) Sustaining Ecosystems; III) Protecting Public Health and Safety; and IV) Providing Outdoor Recreation. Each major element of the Strategic Plan is listed below along with an example of how the plan is being supported with activities in the Upper Fox River Basin.

I. MAKING PEOPLE OUR STRENGTH

The intent of this element of the Strategic Plan is to ensure that the public has an opportunity to participate in the management of the basin's resources. The Department is working with numerous local governments, clubs, interest groups, and the public to manage the resources of basin. Maintaining good relationships with our partners is crucial to the success and realization of our management goals. Many of our partners are listed on the following page:

Adams County LWCD	Otter Street Fishing Club
Audubon Society	Payne's Point Hook & Spear Club
Brickyard Fishing Club	Pheasants Forever
Brothertown Fishing Club	Quinney Fishing Club
Butte des Morts Conservation Club	Ripon College
Calumet County LWCD	Stockbridge Fishing Club
Central Wisconsin Trout Unlimited	Sturgeon for Tomorrow
Citizens At-Large	The National Wild Turkey Federation
City and Village Governments	The Nature Conservancy
Columbia County LCD	The Wild Ones
County Health Departments	Town Governments
County Planning and Zoning Offices	Twin City Rod & Gun Club
Ducks Unlimited	United States Fish and Wildlife Service
Eagle Anglers	Upper Cliff Fishing Club
Farm Service Agency	UW-Extension
Fisherman's Road Fishing Club	UW-Extension Basin Educators
Fond du Lac County LWCD	UW-Extension Master Gardeners
Fox Valley Technical College	UW-Oshkosh Walleyes for Tomorrow
Fox-Wolf Basin 2000	Waterfowl USA
Friends of High Cliff State Park	Waushara County Lakes Association
Glacierland LC&D	Waushara County LWCD
Green Lake LWCD	Wings Over Wisconsin
Green Lake Sanitary District	Winnebago Catfish Advisory Committee
Horicon National Wildlife Refuge	Winnebago County LWCD
Lake Poygan Sportsman's Club	Winnebago Sturgeon Advisory Committee
Lake Puckaway Rehabilitation District	Winnebago Walleye Advisory Committee
Leopold Wetland Management District	Winnebagoland Conservation Alliance
Lighthouse Anglers	Winnebagoland Musky Club
Marquette County LWCD	Wisconsin Conservation Congress
Montgomery Beach Sportsmen's Club	Wisconsin Farm Bureau
Natural Resources Conservation Service	Wisconsin Waterfowl Association
N.A. Wetlands Conservation Act Fund	Wisconsin Wildlife Federation
Northeast Wisconsin Land Trust	Wisconsin Woodland Owners Association

County Land and Water Conservation Committees have identified issues of concern for their region of the Upper Fox River Basin. The committees have outlined goals and implementation strategies to effectively manage these issues. This information is presented in each county's Land and Water Resource Management Plan. A summary of the priorities for each county located partially or entirely in the Upper Fox River Basin is listed below:

County Land and Water Plan Priorities

Adams County

- Potential groundwater contamination from nitrate, pesticides, and volatile organic compounds at levels above safe drinking water standards as well as contamination of surface waters.
- Soil erosion above "T" – Tolerable Soil Loss and soil quality.
- Need for increased and improved wildlife habitat.
- Less than optimal management and sustainable utilization of woodland resources.
- Lack of funding for technical assistance and cost sharing.

Calumet County

- Funding sources for implementation of Land and Water Resource Plan improvement programs/projects.
- Cropland and construction site erosion.
- Protection of groundwater recharge areas.
- Repair and maintenance of grassed waterways.
- Nutrient runoff management.

Columbia County

- Balance between preservation of farmland and development of housing and businesses.
- Sedimentation and phosphorus loading to surface water sources.
- Soil erosion on cropland and grazing land exceeding “T” – Tolerable Soil Loss.
- Groundwater pollution.

Fond du Lac County

- Nutrient (i.e., phosphorus and nitrogen) and sediment loading to surface waters from agricultural and urban sources.
- Threat of groundwater contamination.
- Disproportionate use of fertilizers and pesticides in urban communities.
- Wildlife habitat destruction and fragmentation.

Green Lake County

- Sediment and phosphorus delivery to streams, lakes, and rivers.
- Decline and fragmentation of natural habitat.
- Groundwater contamination, with special concern regarding improperly abandoned wells.
- Encroachment of urban land onto farmland.

Marquette County

- Sediment delivery and phosphorus loading from all sources.
- Destruction and alteration of wetlands.
- Cropland areas above “T” – Tolerable Soil Loss.
- Lack of a Construction Site Erosion Control Plan for shoreland zoning areas and need to educate riparian owners on water quality issues.

Waushara County

- Degradation of surface water and groundwater quality.
- Excessive soil erosion and nutrient runoff.
- Habitat destruction/loss.
- Ineffective management of fish and wildlife populations.
- Development stress resulting from population growth.

Winnebago County

- Cropland and urban construction soil erosion and nutrient runoff.
- Shoreline and streambank erosion and wetland destruction.
- Inadequate coordination between rural and urban areas within watersheds.
- Maintenance of existing drainage infrastructures.
- Lack of information/education on water quality issues, inadequate enforcement of existing regulations, and inadequate regulations.

II. SUSTAINING ECOSYSTEMS

This element of the Strategic Plan recognizes the need to maintain the health of all components of our diverse ecosystem. Humans and their needs are part of the ecosystem. The Upper Fox River Basin Teams are committed to using management methods that address the connectivity of land and water resources with the socioeconomic culture of the basin. The teams recognize that the health of each individual part of the ecosystem is essential for the health of the entire ecosystem. The Upper Fox Basin Teams base their management activities on the following philosophy in order to sustain healthy ecosystems:

Elements of an Ecosystem Based Management Philosophy

1. Manage for a biologically diverse, balanced, and healthy ecosystem that meets fishable and swimmable goals and the need for biodiversity.
2. Use planning and management methods that maintain, protect, and enhance productive and sustainable forests, fisheries, wildlife, and other natural resources.
3. Provide information and education to protect habitat and endangered species; protect sensitive ecosystems through acquisition or easements.
4. Management decisions must recognize biological needs while being aware of socioeconomic and institutional constraints.

III. PROTECTING PUBLIC HEALTH AND SAFETY

We are fortunate in Wisconsin to have high quality natural resources. We obtain large quantities of drinking water from groundwater and surface water sources, we grow food crops on our lands, many people consume fish and game from the basin, and we have an abundance of surface waters for recreation. These resources are utilized by millions of people each year. Therefore, it is appropriate that we protect and manage these resources for public health and safety. We are committed to ensuring that the resources of the basin can be used for the enjoyment of all. To achieve our goal we utilize the following objectives while following appropriate Natural Resource Codes:

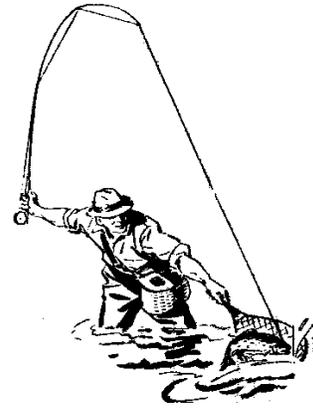
1. Monitor contaminant levels in fish and wildlife as directed through biennial guidance.
2. Regulate the discharge of wastewater and stormwater to groundwater and surface water.
3. Regulate land application of industrial, municipal, septic system, and holding tank waste materials.
4. Work with local governments and the public to protect surface water and groundwater quality and quantity.
5. Conduct dam inspections to maintain safety for human health and property.
6. Regulate municipal and other public drinking water systems. Work with landowners and well drillers to ensure safe drinking water.
7. Pursue enforcement against violators when needed.

IV. PROVIDING OUTDOOR RECREATION

There are many benefits resulting from the protection and management of our natural resources. Providing high quality outdoor recreational opportunities is a year-round benefit to all people who use the resources of the basin.

Upper Fox Basin Public Recreation Goals

1. Enhance sport fishing by protecting, maintaining, and restoring critical habitat for natural sport fish stocks and their associated aquatic communities.
2. Provide public access to lakes and rivers for fishing, boating, and other forms of water recreation.
3. Manage and enhance habitat to support healthy wildlife populations for quality hunting opportunities.
4. Provide public lands for hunting, hiking, photography, bird watching, and other forms of recreation.
5. Pursue management and resolution of user conflicts.
6. Follow the recommendations of the Land Legacy study to guide Department purchases of fee and easement parcels in the basin.



Public Lands in the Upper Fox Basin

State Ownership-Major Public Lands

Swan Lake Wildlife Area- Columbia County- 1,679 acres
 French Creek Wildlife Area- Columbia and Marquette Counties- 3,176 acres
 Eldorado Marsh Wildlife Area- Fond du Lac County- 6,371 acres
 White River Marsh Wildlife Area- Green Lake County- 11,093 acres
 Grand River Marsh Wildlife Area- Green Lake and Marquette Counties- 6,931 acres
 Caves Creek Fisheries Area- Marquette County- 650 acres
 Germania Marsh Wildlife Area- Marquette County- 2,393 acres
 Lawrence Creek Wildlife Area- Marquette County- 961 acres
 John Lawton Fisheries Area- Marquette County- 206 acres
 Mecan River Fisheries Area- Marquette and Waushara Counties- 6,007 acres
 Mecan River Wildlife Area- Marquette County- 740 acres
 Wedde Creek Fisheries Area- Waushara County- 430 acres

Scattered Glacial Habitat Restoration Area (GHRA) Parcels-
 Winnebago and Fond du Lac Counties- 3,550 acres

High Cliff State Park- Calumet County- 1,145 acres

State Natural Areas-

High Cliff Escarpment- Calumet County
 Ripon Prairie- Fond du Lac County
 Berlin Fen- Green Lake County
 Fountain Creek Wet Prairie- Green Lake County
 Puchyan Prairie- Green Lake County
 Snake Creek Fen- Green Lake County
 Comstock Bog- Marquette County
 Lawrence Creek- Marquette County
 Observatory Hill- Marquette County
 Summerton Bog- Marquette County

Bass Lake Fen- Waushara County

U.S. Fish & Wildlife Service Public Lands

Fox River National Wildlife Refuge- Marquette County- 1000 acres

Leopold Wetland Management District Waterfowl Production Areas (WPA)-

New Chester WPA- Adams County- 344 acres

Becker WPA- Columbia County- 279 acres

Lamartine WPA- Fond du Lac County- 204 acres

Duffy's Marsh WPA- Marquette County- 182 acres

Wilcox WPA- Waushara County- 232 acres

Uihlein WPA- Winnebago County- 1,926 acres

Nature Conservancy Lands

Owen Gromme Preserve- Fond du Lac and Winnebago Counties- 608 acres

FISHERIES, WILDLIFE, AND HABITAT MANAGEMENT PLAN FOR WISCONSIN

The Fisheries, Wildlife, and Habitat Management Plan for Wisconsin (FWH) was completed in June of 2000 (WDNR, 2000a). This plan is intended to guide Department staff and partners in the work that we do to protect, improve, and manage habitat, game animals, sport fish, and non-game wildlife. It is a six-year plan, for 2001 through 2007. Beginning on July 1, 2001, work plans, priorities, and budget allocations will be based on this plan. Many of the goals and objectives of the FWH Plan have been incorporated into the basin goals and objectives. This plan can be viewed at <http://www.dnr.state.wi.us/org/water/fhp/fish/management/fwhplan.pdf>.



OVERVIEW OF THE UPPER FOX RIVER BASIN

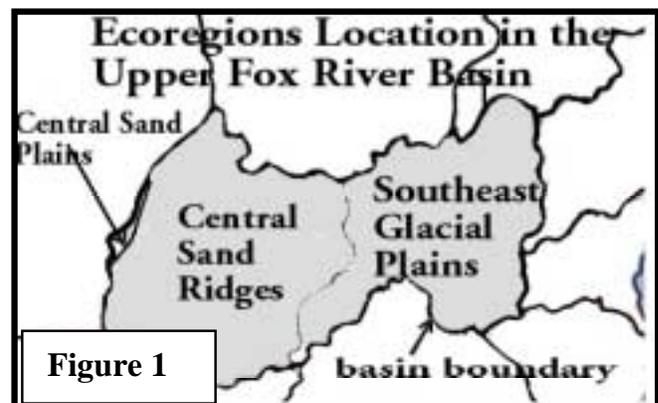
LOCATION

The Upper Fox River Basin is located in east central Wisconsin. It includes all of Marquette County. Portions of Adams, Calumet, Columbia, Fond du Lac, Green Lake, Winnebago, and Waushara Counties make up the remainder of the basin. The total area of the basin is 2,090 mi². All streams draining to Lake Winnebago, with the exception of those in the Wolf River Basin, are located in the Upper Fox River Basin boundary.

The basin is very diverse in its land use, geomorphology, and biology. All of these aspects are affected by socioeconomic impacts of the fast growing communities found in the basin. Land use is diverse and very dynamic. Agriculture, urban, recreational land, and forests are major land uses that affect the basin's ecology.

ECOREGIONS

The diversity of ecosystems in the basin is largely attributed to its complex geomorphology. Ecological change associated with this landscape has produced two distinct ecoregions -- the Central Sand Ridges and the Southeast Glacial Plains (see Figure 1). A small portion of a third ecoregion, the Central Sand Plains Region, is also present in the western edge of the basin. WDNR is using information about the ecological potential of these distinct ecoregions to develop appropriate management goals and objectives for better resource management.



GEOMORPHOLOGY

The Upper Fox River Basin is comprised of glacial drift over Cambrian sandstone in the western 2/3 of the basin and Ordovician dolomite, limestone, and sandstone in the eastern 1/3. One prominent geologic feature located in the eastern portion of the basin is the Niagra Escarpment. The escarpment is a bedrock ridge that forms the eastern boundary of the Upper Fox Basin. The escarpment provides a habitat that supports rare plants and animals.

During the most recent glacial period, the Green Bay lobe deposited glacial drift varying in thickness from zero to several hundred feet over the existing bedrock. This drift is comprised mostly of till, outwash, and lacustrine deposits from the Horicon Formation. There is some drift associated with the Kewaunee Formation in the northeast portion of the basin. Till and alluvial deposits are the chief parent materials for the soil types found in the basin. This area is unique due to the diversity in material that comprises the glacial drift.

Glaciers influenced the basin by creating lateral moraines, ground moraines, glacio-fluvial landforms, outwash plains, and lake sediments. This assortment of landforms shaped by glacial processes has molded the landscape. The diversity of the landscape and soil plays an important role in drainage patterns and water quality. The most beneficial approach is to consider all aspects of the ecosystem together to properly manage our natural resources.

SOILS

Soils range from sandy to clayey soil types. The sandy soils are generally located in the western side of the basin. Naturally, these are associated with the Central Sand Ridges Ecoregion. Typically, the sandy soils are found on pitted outwash plains over the lateral and ground moraines of the Elderon and Almond phase. This area is undulating with rolling hills and is the primary aquifer material associated with the headwaters of many tributaries to the Fox River (see Figure 2 for general locations of glacial drift patterns). Along this moraine, there are also a large number of kettle lakes formed in the pitted outwash areas. Most of these are groundwater seepage lakes that receive their recharge via groundwater flow. Thus, the aquifer material determines the water type and ultimately affects aquatic vegetation and the quality of surface water.

After determining the boundaries of a watershed in the basin, it is possible to relate the parent material of the soils of that watershed to the relative landforms they are found in. Figure 3 outlines the location of each watershed in the basin. The soil association data can be used to identify areas that may be prone to erosion or areas that are susceptible to groundwater contamination when combined with certain land uses. The soil data can also be used to give an estimation of groundwater contribution to streamflow. Generally, streams located in sandy soil aquifers have more streamflow derived from groundwater, which ultimately gives rise to cooler temperature streams. Streams in heavier clayey type soils have less groundwater input and more runoff, which tends to be warmer in temperature. Temperature differences play a significant role in the biological potential of these streams.

East of the sandy till and outwash plains, the topography becomes less undulating. The soils become more fine and eventually the clayey and silty textured soils become predominant. The soil associations are mostly composed of finer texture soils commonly found with lacustrine deposits. This area also has thick organic soils found with wetlands and old lake basins. Agriculture is the primary land use in this area as a result of the abundance of rich soils and flat topography. Much of this land is drained by a network of ditches that eventually discharge to natural waterways.

Southern Winnebago County, northern Fond du Lac County, and the east side of Green Lake County are also comprised of till. However, it is not the same till found in the western side of the basin. The till is from the Valders and Cary ages. The younger Valders overlies the older Cary till and is the primary parent material for the soils in the ground moraines and glacio-lacustrine deposits found in the eastern and southern region of the basin. Soils from the Valders age are primarily reddish brown clay and silt. This area is also widely used for agriculture. The soils associations for each watershed within the basin are listed in Table 1.

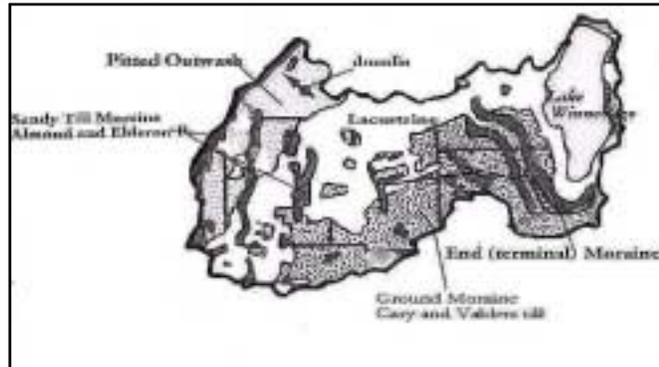


Figure 2. Glacial drift patterns – Upper Fox River Basin. The sandy till and pitted outwash in the west is separated from clayey till in the east by lacustrine deposits. Adapted from Mickelson et al., 1984.

Soils and Watersheds

The Upper Fox Basin is divided into 15 different watersheds. A watershed is an area of land that drains to a specific waterbody or reach of river (Figure 3). These watersheds cross ecoregion boundaries. The following table indicates the predominant soils of each watershed in the basin.

Table 1. Common Soil Associations by Upper Fox Basin Watershed

Watershed Name	Watershed Number	Common Soil Associations ¹
Lake Winnebago North and West	UF-01	Kewaunee-Manawa-Poygan, Loam, Silt Loam, Silty Clay Loam; Granby-Oakville-Tedrow, Loamy fine Sand; Kewaunee-Manawa-Hortonville, Silt Loam, Silty Clay Loam
Lake Winnebago East	UF-02	Kewaunee-Manawa-Poygan, Loam, Silt Loam, Silty Clay Loam; Wasepi-Plainfield-Boyer, Loamy Sand; Channahon-Whalan-Kolberg, Peat; Theresa-Pella-Lamartine, Silt Loam
Fond du Lac River	UF-03	Lomira-Virgil, Silt Loam; Kewaunee-Manawa-Poygan, Loam, Silt Loam, Silty Clay Loam; Beecher-Elliot, Silt Loam; Houghton-Palms, muck
Lake Butte des Morts	UF-04	Kewaunee-Manawa-Poygan, Loam, Silt Loam, Silty Clay Loam; Zittau-Poy, Silty Clay Loam, Silt Loam; Houghton-Willete, Peat
Fox River – Rush Lake	UF-05	Kewaunee-Manawa-Poygan, Loam, Silt Loam, Silty Clay Loam; Zittau-Poy, Silty Clay Loam, Silt Loam; Houghton-Willete, Peat; LeRoy-Ossian-Lomira, Silt Loam; Kidder-McHenry, Silt Loam; Plano, Silt Loam
Fox River – Berlin	UF-06	Kidder-Rotamer-Grellton, fine Sandy Loam, Sandy Loam; Lapeer-Mecan-Okee, Loamy fine Sand; Oakville-Brems-Granby, Loamy fine Sand, fine Sand; Boyer-Oshtemo-Gotham, Loamy fine Sand; Willete-Poy-Poygan, muck, Silty Clay Loam; Adrian-Houghton-Zittau, muck, Clay; Morocco-Kingsville-Keowns, fine Sand, Loamy fine Sand
Big Green Lake	UF-07	Plano-Mendota-St. Charles, Silt Loam; Kidder-Rotamer-Grellton, fine Sandy Loam, Sandy Loam; Boyer-Oshtemo-Gotham, Loamy fine Sand
White River	UF-08	Plainfield-Okee-Richford, steep Loamy Sand; Plainfield-Richford-Boyer-Gotham, Sand, Loamy Sand; Kingsville-Meehan, Loamy Sand; Delton-Briggsville-Mundelein, Silty Clay Loam, Silty Clay; Houghton-Adrian, Peat; Oshtemo-Gotham, fine Sandy Loam
Mecan River	UF-09	Gotham-Mecan, Loamy Sand; Plainfield-Gotham, Loamy Sand; Delton-Briggsville-Mundelein, Silty Clay Loam, Silty Clay; Granby-Tedrow-Moundville, fine Sandy Loam; Houghton-Adrian, Peat; Oshtemo-Gotham, fine Sandy Loam
Buffalo and Puckaway Lakes	UF-10	Lapeer-Pardeeville-Metea, fine Sandy Loam; Gotham-Mecan, Loamy Sand; Delton-Briggsville-Mundelein, Silty Clay Loam, Silty Clay; Granby-Tedrow-Moundville, fine Sandy Loam; Houghton-Adrian, Peat; Oshtemo-Gotham, fine Sandy Loam
Lower Grand River	UF-11	Lapeer-Pardeeville-Metea, fine Sandy Loam; Houghton-Adrian, Peat; Oshtemo-Gotham, fine Sandy Loam; Plano-Mendota-St. Charles, Silt Loam; Kidder-Rotamer-Grellton, fine Sandy Loam, Sandy Loam; Houghton-Adrian, Peat
Upper Grand River	UF-12	Plano-Mendota-St. Charles, Silt Loam; Kidder-Rotamer-Grellton, fine Sandy Loam, Sandy Loam; Lomira-Virgil, Silt Loam
Montello River	UF-13	Plainfield-Gotham, Loamy Sand; Delton-Briggsville-Mundelein, Silty Clay, Silty Clay Loam; Houghton-Adrian, Peat
Neenah Creek	UF-14	Coloma-Wyocena-Okee, Sand, Loamy Sand; Kewaunee Poygan, Silt Loam, Silty Clay Loam; Plainfield-Gotham, Loamy Sand; Delton-Briggsville-Mundelein, Loamy fine Sand, Loam; Houghton-Adrian, Peat
Swan Lake	UF-15	Plano-Griswold-Saybrook, Silt Loam; Lapeer-Wyocena, fine Sandy Loam; Grellton-Gilford-Friesland, Silt Loam; Houghton-Adrian-Palms, muck

¹ These are the most predominant soil associations in the watersheds of the Upper Fox River Basin.

INSERT UPPER FOX WATERSHEDS FIGURE

Soils and Water Quality

The physical characteristics of soils in relation to the slope have an impact on runoff and infiltration capacities, ultimately affecting erosion. Erosion due to runoff decreases natural soil fertility, decreases groundwater recharge, and increases sediment discharge to streams and lakes. The decrease of natural soil fertility not only decreases yields for agriculture, but also decreases natural flora production in the ecosystem. Decreased yields for agriculture is often countered with application of fertilizers. Fertilizers and pesticides can migrate to groundwater, which can contaminate drinking water supplies. They can also enter streams and lakes through shallow groundwater flow or through overland runoff. The same fertilizers that help crops to grow lush and green can also, when discharged to lakes and streams, make algae bloom lush and green.

The unwanted addition of nutrients, particularly phosphorus, has become a concern for lake managers and users. Nearly 90% of the lakes in Wisconsin are phosphorus limited; meaning only a small quantity of phosphorus is needed to trigger an algae bloom. Increased algae blooms decrease water quality and increase stress to aquatic organisms. About 66% of Wisconsin soils contain more phosphorus than needed for crop production. Despite the great strides the Department and partner agencies have made, reducing phosphorus loading to the basin's waters continues to be an important goal.

GROUNDWATER

Groundwater quantity and quality varies considerably throughout the basin. The diversity of aquifer materials ranges from high yielding sand and gravel to low yielding bedrock aquifers. Each type of aquifer material influences groundwater's chemical and physical properties. According to University of Wisconsin-Green Bay (1997), there are four primary aquifers in the Upper Fox River Basin. One aquifer is the crystalline aquifer from the Precambrian period, which is the deepest in the basin. Only two communities utilize the water from this aquifer for a municipal supply. The second is the Cambrian-Ordovician aquifer. This is the principal aquifer for the basin and serves 18 communities. The third aquifer is a Silurian (Niagara) dolomite aquifer. This is generally low yielding and is susceptible to contamination; thus only one community utilizes this aquifer. The fourth is a sand and gravel aquifer. This lies in the west and is associated with the Central Sand Ridges Ecoregion. This is a thick aquifer and is utilized by two communities. It is important to properly manage groundwater because of the significant role it plays in the ecosystem and to the public.

Quantity

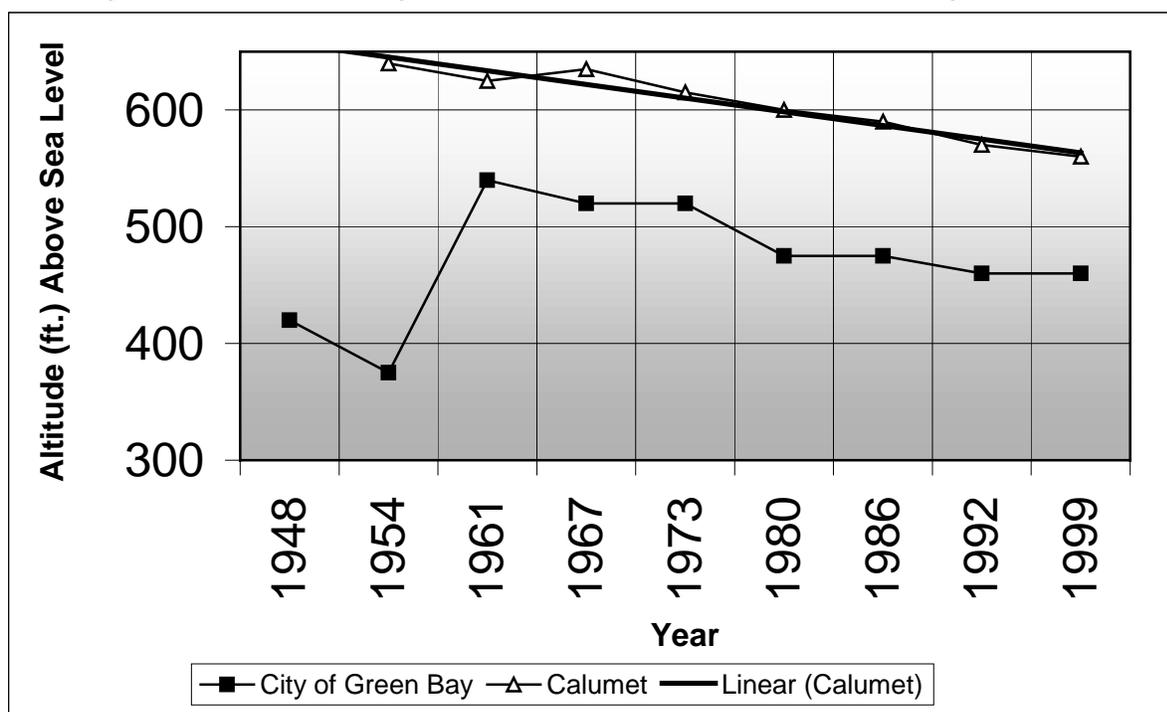
Many streams and lakes in the basin depend on groundwater recharge for their source of fresh water. This is especially true in low flow periods and during the winter months when channel precipitation and natural runoff is minimal. Thus, maintaining the elevation of the water table is an important aspect of ecosystem management.

The Upper Fox River Basin has both confined and unconfined aquifers. Each type of aquifer is very different and will respond to recharge and discharge differently. These variations in hydrology are important to stream flows and lake levels. Management of groundwater recharge and discharge areas is imperative to allow for the effective management of all types of aquatic ecosystems.

There are about 390 high capacity wells in the basin. A high capacity well is one that is capable of pumping more than 70 gallons per minute. This does not include private residential

wells. High capacity wells near groundwater discharge areas (wetlands, springs, streams, etc.) can present risks. High capacity wells have the potential to intercept enough groundwater to diminish water flow from springs and reduce stream flow volume. Over time, these groundwater dependent areas can eventually become dehydrated. This can alter the ecology of wetlands, which are the headwaters of many streams. A high concentration of private wells may have similar ecological impacts. For example, the City of Green Bay converted from groundwater to surface water for a drinking water supply around 1958. Figure 4 displays the sharp increase in the water table elevation as a response to that conversion. In comparison, the water table elevation in Calumet County is still declining due to the continual withdrawal of groundwater for drinking water. The lack of wetlands in urban areas, the increase of runoff from impervious structures, and the addition of many private wells all have an impact on groundwater quantity that ultimately affects surface water quantity (i.e., stream flows, lake levels, and wetland volumes).

Figure 4. Water Table Elevations in the Fox Valley from 1948 to 1999. The sharp increase in the City of Green Bay water table elevations between 1954 and 1961 represents the response following the conversion from groundwater to surface water as a drinking water source.



The addition of impervious structures such as roofs, roads, and parking lots on the landscape will increase runoff. Increasing runoff decreases groundwater recharge. Rapid runoff does not percolate through the soil and recharge groundwater. Instead, it flows overland to surface water drainage areas resulting in very high flows of short duration in streams and rivers.

As development continues to grow, runoff and the demand for more wells will increase. Land use planning must take potential ecological impacts from groundwater alterations into consideration. A decrease in the water table elevation could cause decreases in natural stream flows and result in the need for a drinking water supply to come from deeper sources.

Quality

Groundwater quality varies considerably in the basin. Natural and man-made pollution sources can have detrimental effects on groundwater quality. Some natural threats to groundwater quality are hardness, iron, manganese, radium/radon, and arsenic. These naturally exist at high concentrations in certain portions of the basin. Arsenic is generally found where wells penetrate the St. Peters Sandstone in Winnebago and Fond du Lac Counties. The Department of Natural Resources spearheaded a program in the Town of Algoma in Winnebago County to determine the prevalence of arsenic in home drinking water. The Town Based Sampling Program tested 754 private wells (about half of the private wells in the town). Of the wells tested, 8% were above the current EPA standard of 50 ug/l and 49% were above the proposed EPA Safe Drinking Water Act standard of 5 ug/l (WDNR, 2000b).

Arsenic has always been present in groundwater, but has become more common in private drinking water supplies in the last decade at some locations. Due to consumption of groundwater in the eastern portion of the basin, some portions of the regional water table have fallen in elevation. It is believed that drawing down of the water table allows minerals in the aquifer to react with oxygen. This reaction causes the release of arsenic. It is difficult at this time to accurately determine the distribution of natural arsenic concentrations. As more wells are drilled and more testing is completed, the Department will be better able to serve the public through education and management. At this time, the areas most susceptible to arsenic contamination are located in a band that stretches from just west of Lake Winnebago north through Outagamie County into Brown County.

Figure 5 displays Leaking Underground Storage Tank (LUST) and Environmental Repair and Response Program (ERRP) Sites in the Upper Fox River Basin.

WETLANDS

Wetlands play a crucial role for many reasons including, but not limited to, enhancing water quality, flood protection, fish and wildlife habitat, and aesthetics. They are important to water quality because they filter nutrients and sediments before they reach lakes and streams, preventing degradation of surface water quality. Wetlands serve as water detention areas during large storm events, storing water and releasing it slowly -- preventing flooding. Wetland ecology is very diverse, which attracts wildlife and enhances species richness. They also play an aesthetic role on the landscape as undeveloped "green space". Therefore, it is important to protect these areas.

The Upper Fox River Basin is relatively rich with wetlands. About 145,428 acres or 10.5% of the basin is covered with wetlands greater than 40 acres in size (UWGB, 1997). The total area is actually greater if all wetlands, regardless of size, are included in the calculations. Approximately 31% of all wetlands in the basin are forested and about 69% are non-forested. Total surface water area is about 12%. Aquatic habitat covers nearly a quarter of the basin when surface water and wetland areas are combined. The numerous small wetland complexes, usually next to streams and lakes in the watershed, contribute to the relatively high water quality present in many of the streams in the Upper Fox River Basin. Some of the larger wetland complexes in the basin are the Eldorado Marsh in Fond du Lac County, the White-Puchyan wetlands complex in Marquette and Green Lake Counties, Germania Marsh in Marquette County, Grand River Marsh in Green Lake County, and the Rush Lake wetlands in Winnebago County.

Historically, the greatest threat to wetlands in Wisconsin has been from agricultural drainage and urban development. Nationally, more than 87% of wetland losses have been due to

INSERT UPPER FOX LUST AND ERRP SITES FIGURE

agricultural development (Tiner, 1984). The case is much the same in the Upper Fox River Basin. A look at the U.S. Department of Agriculture soil survey maps for any of the counties in the basin shows thousands of acres of hydric soils which have been drained and converted to farmland. Other areas of hydric soils have been either drained or filled for roads and urban development, particularly near Lake Winnebago.

In coming years, wetland destruction will continue to be an increasing threat as development continues and land uses change. This will be especially true in areas where urban growth is occurring, such as in the Fond du Lac River Watershed and the Lake Winnebago North and West Watershed. These watersheds are near the highly populated areas of Oshkosh and Fond du Lac.

A study by Hey and Wickencamp (1998) found that watersheds with low wetland areas, 6 - 10%, experienced greater peak flows during floods and a larger number of high flow events. This relationship was more pronounced when the percent wetland area was less than 6%. Table 2 presents the percent wetlands in our urban areas. Urban wetland loss is most prevalent in the populated areas of the Upper Fox River Basin. According to this study, this region is prone to the increased runoff and ultimately increased peak flows that typically occur in urban streams.

Table 2. Percent Wetlands in Urban Watersheds

Urban Watershed Name	Watershed #	Percent of Watershed Area with Wetlands
Lake Winnebago North and West	UF-01	0.25%
Lake Winnebago East	UF-02	0.34%
Fond du Lac River	UF-03	3.7%
Lake Butte des Morts	UF-04	1.6%

High flow events are expected in urban areas due to increased runoff from impervious structures and the loss of wetlands. Wetland loss decreases the storage of floodwaters, thus peak flows are larger and the number of high flow events increase. Figure 6 displays the increase of peak flow (flooding potential) relative to the decrease in wetland percentage.

A loss of wetlands is much more than a loss of wildlife habitat. Figure 7 highlights the lack of wetland areas near larger urban areas compared to the more common presence of wetland areas in more rural watersheds. The net result of wetland losses include a general degradation of water quality, loss of groundwater recharge, and alteration of stream and lake biology.

Information and education for the public is needed to increase awareness that all wetland types provide important functions on the landscape of the basin. Changing wetland habitat types from one to another, such as changing a sedge meadow to an open water marsh is not necessarily an improvement in the wetland function. While it is still a wetland, it may have fewer functional values than the original wetland. The landscape benefits from a diversity of wetland types.

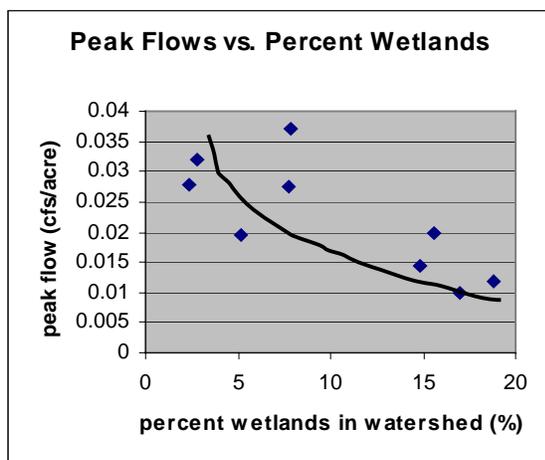


Figure 6. Peak Flows vs. Percent Wetlands. Graph adapted from Hey and Wickencamp (1998). A decrease in wetlands is related to the increase of instream flow. A watershed with 5% wetlands had greater instream flow than a watershed with 15% wetlands.

INSERT UPPER FOX URBAN AREAS AND WETLANDS FIGURE

SOCIOECONOMICS

Socioeconomic factors play a role on the health of a living ecosystem. A growing human population requires more buildings, roads, and vehicles. Every aspect of population growth disrupts the balance slightly. For every man-made structure the natural landscape is altered; thus affecting drainage, vegetation, and animal behavior. The landscape will continue to be altered as the population continues to grow. This will inevitably create more social and economic strains on the natural resources of the basin.

Land Use

Land use is the most important factor that impacts the natural landscape. Like the diversity of the natural entities, land use is equally diverse. The total area of the Upper Fox River Basin is 2090 mi². The primary land uses are; agriculture (61.1%), forests (13.7%), water (12%), wetlands (10.5%), urban (3%), and barren (0.2%) (UWGB, 1997). The population of the Upper Fox River Basin was estimated to be 276,377 in 2000. Figure 8 exhibits the land uses in the Upper Fox River Basin.

SURFACE WATER

Approximately 12% or 160,512 acres of the Upper Fox River Basin is surface water (UWGB, 1997). The surface waters of the basin are important for many thousands of people. Our lakes and rivers provide drinking water for several communities, recreation, and support the basin's plants and animals. Since the implementation of the Clean Water Act (CWA) in 1972, there has been great progress made in the basin to curb pollution from municipal and industrial discharges. However, even after implementation of the CWA and other programs, surface water is still subject to sedimentation, nutrient loading, and other unwanted constituents from nonpoint pollution. Nonpoint pollution is generated from widespread runoff from the landscape of the basin. It is believed that runoff from nonpoint sources contributes more pollutants into the waters of the basin each year than discharges from municipal and industrial sources.

Streams

The basin has significant mileage of high quality streams, particularly in the Marquette, Waushara, and Adams County portions of the basin. These streams include Chaffee, Tagatz, and Neenah Creeks and the Mekan River. There are 1,257 miles of rivers and streams in the basin. This includes 202 miles of rivers, 602 miles of named creeks, 293 unnamed creeks, and 170 miles of intermittent streams. There are 164 miles of cold water trout streams, 310 miles warm water sport fish streams, and 20 miles of warm water forage fish streams (UWGB, 1997). Most of the cold water streams are located in the western portion of the basin near the Sandy Ridges Ecoregion. The soil associations are those related to sandy soils in the pitted outwash and sand moraines, which permits high quantities of cold, high quality groundwater to discharge to the streams. This portion of the basin contains the headwaters of many small streams that are tributaries to the Fox River. Groundwater discharge to streams provides excellent spawning habitat for brook, brown, and rainbow trout. The stream corridors have many areas of wetlands associated with the streams such as: alder thickets, shrub carrs, and open water marshes. Many of the streams, namely Chaffe, Wedde, and Mekan Creek and the White River, contain good spawning areas for trout. The Department's Fish Management staff has revealed that these areas

INSERT UPPER FOX LAND USE FIGURE

are utilized for spawning by trout from the larger tributaries miles downstream. Trout habitat is a primary focus of the Department, which has formed partnerships with organizations such as Trout Unlimited to aid in habitat restoration. Attempts to enhance the quality of stream habitat are often limited due to the presence of dams on these streams in smaller urban areas.

Progressing eastward, streams change in morphology due to a change in aquifer material and landscape. This change coincides with the transition from the Central Sand Ridges Ecoregion to the Southeast Glacial Plains Ecoregion. The streams in this ecoregion tend to be slower moving streams through agricultural lands that do not have the same groundwater baseflow component as the western streams. Many of these streams are subject to flashy flows from runoff and carry more silt and clay during runoff events. Warm water fish species are common here with very little opportunity for cold water species. Nonetheless, these streams play a crucial role in the character of the Upper Fox River Basin. They provide habitat for fish and wildlife and often have open water marshes and sedge meadows associated with them. Agriculture is the predominant land use in this area that has affected surface water quality and wetland loss.

There are other streams in the eastern portion of the basin that flow directly to Lake Winnebago. These are often small streams that are recharged by runoff and some groundwater. Groundwater contributes flow from the Niagara Escarpment, but the baseflow component is typically not sufficient to support cold water fish species. The groundwater recharge area is comprised of fractured bedrock and is very close to the discharge areas by the streams. This means that groundwater has low residence times before discharging to the streams and the discharge volume is low due to the small watershed size. The streams in this area receive a great deal of runoff from agriculture. In fact, there were several fish kills in some of these streams from manure and fertilizer runoff during the 1980's. Most streams in the Upper Fox River Basin are either fully or partially meeting their biological use.

Most of the streams and lakes in the basin are affected by nonpoint sources of pollution. Nonpoint sources are primarily from rural or agricultural sources, although urban sources are an increasing factor in certain areas. Other problems affecting water quality are due to stream alterations, particularly channelization of smaller streams and excessive populations of rough fish. These problems are a reflection of the intense agricultural land use in the basin.

Lakes

The lakes in the basin range in quality and type as much as the streams do. The range of lake types, similar to the variation in stream types, is based on the characteristics of the underlying aquifer and the type and volume of runoff they receive. Each lake may respond differently to land uses. The Upper Fox Basin contains 154 lakes (larger than 10 acres in size). There are a large number of small kettle lakes that formed in the pitted outwash and sandy moraines following the last glaciation in the west. These generally possess good water quality and exhibit favorable water clarity. Some of these lakes such as: Parker, Deep, and Wood exceed 30 feet in depth and range between oligotrophic (high water quality) and mesotrophic (medium water quality). They also support two-story fisheries (warm and cold water species). Green Lake in Green Lake County is the premier deep-water lake in the basin and supports trout. It is the deepest natural lake in Wisconsin (236 feet). These lakes have long residence times compared to the shallower lakes in the east, which retain nutrients for shorter periods of time. Lawrence Lake, Harrisville Millpond, Montello Lake, and Oxford Millpond are all impoundments on streams. Most of these smaller lakes are heavily developed and have lake associations that actively participate in lake monitoring.

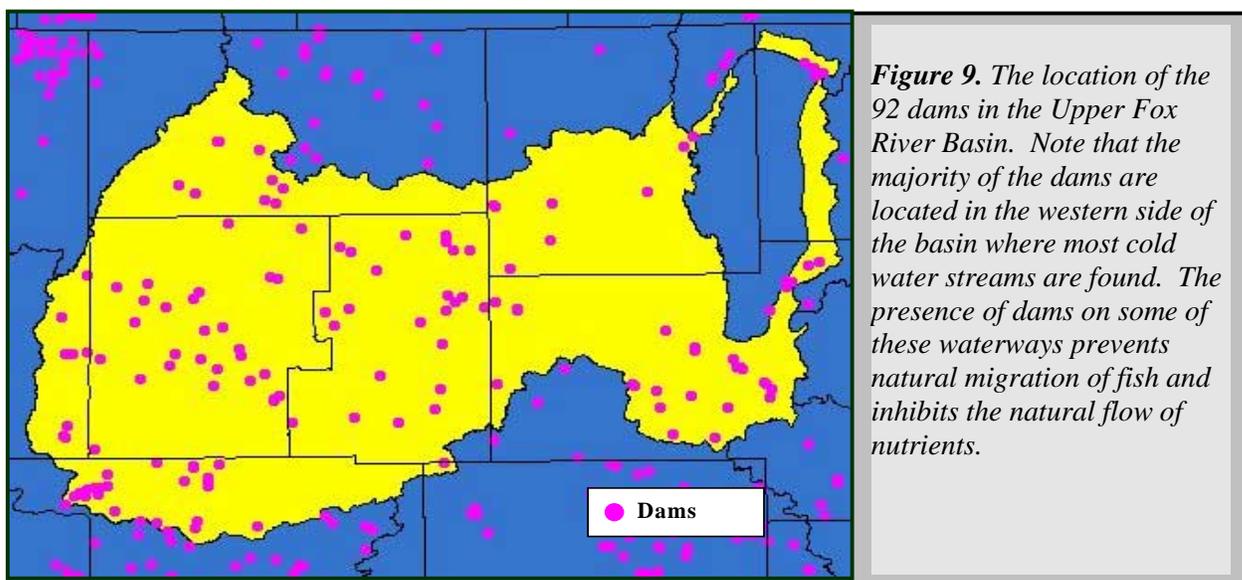
Similar to the streams, lake morphology and biology change significantly as one moves eastward. Many of these lakes in the basin are very fertile, eutrophic, or hypereutrophic shallow

lakes. They are either very turbid or suffer from excessive aquatic plant growth or algae blooms. The high fertility of these lakes is due, in part, to sediment and nutrients entering the lakes from nonpoint sources of pollution. The largest lake in the basin -- and in the state -- is Lake Winnebago. The Winnebago Pool Lakes (Winnebago, Winneconne, Poygan, and Butte des Morts) are well known and receive tremendous use from lake enthusiasts. Research designed to understand the impacts of the area's rapid population growth and increasing human demands on the resource is needed. These lakes sustain a healthy fishery of walleye, northern, sturgeon, panfish, and rough fish. These lakes are the subject of a comprehensive management plan, the goal of which is to improve water quality and aquatic habitat in and near the lakes, which will help improve fisheries and support a more diverse waterfowl population.

HYDROLOGIC MODIFICATIONS

Dams

The Upper Fox River Basin's extensive surface water bodies have been prone to modification since settlement. The placement of dams, locks, channel modifications, and the formation of drainage districts have altered the natural movement of water and changed water quality. Currently, there are 92 dams in the basin (Figure 9). The Department owns and maintains 10 dams throughout the basin.



Many of these dams were constructed for power, milling, water transportation, and/or recreation. Some have surpassed their permit expiration date and must be inspected and re-licensed. Many others are in need of repair. Several dams have failed, leading to downstream flooding. Dams have been proven to be detrimental to natural riverine organisms.

Historically, dams were constructed to provide a variety of uses. Some have produced negative environmental impacts that persist today. Dams have been proven to limit the natural and historical migration of spawning fish including: sturgeon, walleye, smallmouth bass, and trout. They also increase the temperature of the water allowing rough fish such as carp to flourish, while eliminating habitat for native cold water species such as trout. Changes in local hydrology lead to changes in the habitat in and around the stream. Habitat changes can have negative impacts on many species of plants and animals.

A number of dam removal projects have taken place in other parts of the state. On the Baraboo River, two dams have been removed. Data collected following the removal have demonstrated that historical fish species have returned and populations of exotic species, such as carp, have declined. Although it has been demonstrated that dams can negatively impact organisms, in certain instances, dams have been used to create and maintain wildlife habitat.

Drainage Districts

The Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) has given authority to County Circuit Courts to form and maintain drainage districts. Drainage districts are a government agency, with the power to tax. Drainage districts provide a service to property owners by maintaining ditch networks in areas throughout the basin. These ditches were designed to drain marginal land so agriculture could be permissible on otherwise wet soils. The Upper Fox River Basin has 18 drainage districts (see Table 3 for drainage district data). Most of these were formed decades ago from 1926 to 1949. Many of these are still active and participate in routine maintenance such as dredging.

Table 3. Drainage Districts in the Upper Fox River Basin.

County	Name	Functioning
Green Lake	District #1	Yes
Green Lake	District #2	Yes
Green Lake	District #3	Yes
Green Lake	District #4	Yes
Green Lake	District #5	Yes
Green Lake/Waushara	Seneca-Warren	Yes
Waushara	Marion-Warren	Yes
Waushara	Warren	Yes
Waushara	Lohrville-Warren	Now part of Marion-Warren
Waushara	Aurora	Yes
Marquette	Marquette #1 Hamilton/Robinson	Yes
Marquette	Marquette #2 Russel/Flats	Yes
Marquette	Marquette #4 Harris/Chickering	Yes
Marquette	Marquette #5 Duffy's Marsh (D.O.T. owned)	No
Marquette	Montello Drainage District #1	Yes
Fond du Lac	Fond du Lac County Farm Drainage District #1	No
Fond du Lac	Fond du Lac County Farm Rosendale Drainage District #1	No
Fond du Lac	Fond du Lac County Farm Drainage District #3	No

The intention of these ditches is to drain agricultural land to allow for greater yield on marginal land. Unfortunately, they have caused the impairment of certain resources. These ditches have lowered water table elevations. This has led to the disappearance of native ecosystems. Ditching can alter the hydrology and vegetation, destroying natural wetlands and important wildlife habitat. Areas with drainage ditches that are no longer actively farmed represent an altered ecosystem that prevents the re-establishment of the natural ecosystem. The reduction of wetlands leads to many other consequences that affect society on a much larger scale.

Other modifications such as channel straightening have proven to be detrimental to water quality and habitat. Straightening stream channels increases stream velocity. Increasing stream velocity will ultimately contribute to enhanced erosion as a result of increased stream energy.

MAJOR PROGRAM AREAS

Partnering

Each basin in the state has established a partnership team. The Upper Fox River Basin Partnership is a group of concerned individuals from around the basin who are working together to improve and protect the ecosystem of the Upper Fox Basin. The partnership is self-directed and accountable to the public and the natural resources of the basin.

An important partnering effort undertaken by the team was the development of a Mediated Model for the resources of the Upper Fox Basin. This effort involved the development of a model to illustrate how management changes for a specific purpose also result in changes throughout the ecosystem. For example, the model can compare existing rural residential development patterns with cluster subdivisions and show the environmental consequence of either approach projected into the future. It is clear that if all future rural development was in cluster subdivisions there would be an improvement in water quality and wildlife habitat within the basin. The model serves as a wonderful educational tool to illustrate the connectivity between the social and ecological elements of the basin.

Another activity the partnership undertook was an identification of priority issues in the basin. In April of 1998, a workshop was held to identify concerns and issues facing the natural resources of the Upper Fox River Basin. Nineteen people from a variety of professional and vocational backgrounds participated with the Department in developing an Ecological Risk Assessment. The core of the effort was a survey and several workshops where participants identified uses of the environment and impaired ecological values. The factors causing impairment were designated as stressors. Development of the risk assessment was facilitated through the University of Wisconsin – Green Bay (Harris and Wenger, 1998). The results were mathematically analyzed through a matrix and the stressors were ranked.

The stressors impacting the greatest number of ecological values and resource uses were considered to be the most significant priorities in the Upper Fox Basin. Establishing priorities helps the Department, and our partners in resource management, focus efforts on the most significant issues facing the basin. The three priorities listed below are not ranked against each other, but rather, they rose to the top when compared to all of the other stressors affecting the natural resources of the basin and the uses of those resources by the public.

- 1) Wetland filling/loss
- 2) Habitat loss and fragmentation
- 3) Nutrient loading/Nonpoint source pollution

The management of the resources of the Upper Fox Basin by the Department is consistent with these priorities.

The Department has been working on wetland restoration projects on public and private lands throughout the basin. Other agencies and organizations have also made great progress toward restoring wetlands in the basin.

The Natural Resources Conservation Service (NRCS) administers the Wetland Reserve Program (WRP). Through the WRP, private landowners can restore and preserve wetlands that have been previously drained for agricultural land. NRCS purchases a conservation easement and reimburses the cost of construction and seeding to make it affordable for the landowner to retire the wetland from crop production. Benefits of the program include: 1) ecological-restored wetlands revert quickly to fully functioning wetlands that provide flood water retention, filtration of sediment and pollutants, and habitat for waterfowl and wildlife; 2) family farms-in some instances, WRP has allowed farmers to retire and keep the land in the family, allowing the family to continue to enjoy the recreational aspects of the land; and 3) impact on the local community-the return of wetland areas often means an increase in tourism and recreational opportunities such as hunting and bird watching and because the land remains privately owned, the property tax base is not reduced.

The Upper Fox Basin is home to the state's largest WRP wetland restoration project. Duffy's Marsh is a 1,732 acre wetland restoration project in Marquette County. It covers about 1,000 acres of open water and 700 acres of grassy wetland and upland. Nine neighboring landowners have worked together with the NRCS to restore the marsh to its former beauty and wetland value. The land remains privately owned, with permanent easements to protect it in the future.

There are a total of 64 WRP contracts in the Upper Fox Basin restoring wetland complexes on 9,198 acres. Marquette County has 30 contracts on 5,112 acres; Columbia County has 12 contracts on 2,060 acres; Green Lake County has 12 contracts on 833 acres; Fond du Lac County has 7 contracts on 800 acres; and Winnebago County has 3 contracts on 393 acres.

The U.S. Fish and Wildlife Service is another agency that has made major contributions towards the restoration, enhancement, and protection of wetland ecosystems in the Upper Fox Basin.

The Fox River National Wildlife Refuge, located in Buffalo Township, Marquette County, is a 1,000 acre refuge established in 1978 as a Greater Sand Hill Crane Refuge. The area consists of 800 acres of wetlands and 200 acres of associated upland habitat.

Leopold Wetland Management District also works in the Upper Fox Basin. The District was established in 1993 and manages Waterfowl Production Areas (WPA) in 14 southeastern counties. WPA's provide waterfowl production habitat, restore wetland and grassland habitat, and provide habitat critical for many migratory water and songbirds. Public use opportunities include hunting, fishing, trapping, wildlife observation, and environmental education. There are 6 WPA's in the Upper Fox Basin. The largest WPA in the basin is Uihlein WPA in the Fox River Watershed. It encompasses 1,926 acres. Other WPA's in the basin include: New Chester (344 acres) in the Neenah Creek Watershed; Wilcox WPA (232 acres) in the White River Watershed; Duffy's Marsh WPA (182 acres) in the Lower Grand River Watershed; Lamartine WPA (204 acres) in the Fond du Lac River Watershed; and Becker WPA (279 acres) in the Swan Lake Watershed.

The U.S. Fish and Wildlife Service also works with private landowners through their Partners for Fish and Wildlife project. Staff work on private lands restoring wetlands and grasslands. Wetland restorations performed in the Upper Fox Basin by staff are as follows: Columbia County- 205.7 acres in 23 projects; Fond du Lac County- 174.2 acres in 59 projects; Green Lake County- 38.1 acres in 23 projects; Marquette County- 113 acres in 22 projects; Waushara County- 2.6 acres in 8 projects; and Winnebago County- 30 acres in 19 projects. This equates to a total of 563.6 acres restored in 154 individual projects across the Upper Fox River Basin.

Private organizations such as: Ducks Unlimited, Wisconsin Waterfowl Association, Pheasants Forever, and Wings Over Wisconsin work with private landowners to restore wetlands and associated uplands in the Upper Fox Basin.

The work of the Department and other agencies and organizations is making a positive contribution to the restoration and enhancement of wetland ecosystems in the Upper Fox Basin.

LAND TEAM RESPONSIBILITIES

Within the Department of Natural Resources, staff from the Upper Fox Basin Land and Water Teams handle primary management of the basin's resources. The Land Team includes a variety of functional areas related to management of terrestrial resources. Functional areas within the Land Team include: Wildlife Management, Forestry, Parks and Recreation, and Facilities and Lands.

Land Division Priorities

- ❖ Maintain Department properties.
- ❖ Manage outdoor recreation areas to provide our citizens and visitors with the highest quality state parks, forests, trails, educational experiences, resources stewardship, and services in their pursuit of a full range of nature based outdoor recreational opportunities.
- ❖ Implement Deer Management for 2000 and Beyond recommendations and aggressive harvest management strategies to lower deer populations in most areas of the state.
- ❖ Work to protect all types of aquatic and terrestrial communities and other significant natural features native to the state for education and research and to secure the long term protection of the state's biological diversity in line with the Department's Land Legacy Study.
- ❖ Effectively utilize available Stewardship 2000 land acquisition funding to purchase additional lands for Department properties.
- ❖ Follow guidance from Land Legacy Study to develop master plans and feasibility studies in the basin.
- ❖ Continue to screen proposed management actions for impacts on state and federally listed species. Ensure all projects comply with the National Environmental Protection Act, the Wisconsin Environmental Protection Act, and the State and Tribal Historic Preservation Acts.
- ❖ Continue to implement the Karner Blue Habitat Conservation Plan.
- ❖ Monitor contaminant levels in urban goose populations to facilitate harvest for consumption as a population management alternative.
- ❖ Assist with research on wildlife species, wildlife health issues, and the use of wildlife resources.
- ❖ Manage lands for multiple uses according to the property master plan, which may include outdoor recreation, aesthetics, native biological diversity, terrestrial and aquatic wildlife, soil and water protection, and sustainable growth of forest products.
- ❖ Maintain viable populations of rare species and assure the sustainability of native aquatic and terrestrial species and natural communities through leadership and involvement in research, management, recovery, and monitoring efforts.
- ❖ Continue activities associated with the collection, management, interpretation, use, and sharing of Natural Heritage Inventory (NHI) data. NHI data play a significant role in decision-making, including the Department's ecosystem management decision model.

- ❖ Continue development and maintenance of a broad-based constituency that will encourage stronger political and financial support for Land Division issues.
- ❖ Assist partners and private landowners with wetland and grassland restoration efforts in the basin.
- ❖ Plan and develop activities, special events, and publications to interpret the natural and cultural environment of the basin.
- ❖ Provide information to the public about Land Division programs and opportunities.
- ❖ Assess the impacts of dams or hydro facilities on wildlife and endangered resources in the basin in cooperation with the Water Division.
- ❖ Respond to requests for assistance from local governments undertaking comprehensive planning by providing and interpreting natural resource and outdoor recreation information.

Forestry Division Priorities

- ❖ Find and suppress forest fires.
- ❖ Be prepared to immediately coordinate and conduct fire suppression activities.
- ❖ Provide general forest management information to private landowners.
- ❖ Administer Forest Tax Law programs.
- ❖ Advise landowners about tree and shrub planting projects.
- ❖ Provide assistance to landowners with Wisconsin Forest Landowner Grant Program.
- ❖ Continue educational activities such as landowner workshops and school programs.
- ❖ Work with other partners to control the spread of the gypsy moth.
- ❖ Work with Land Division staff to promote healthy, sustainable forests on state owned and managed properties.

MAJOR LAND DIVISION WORK ITEMS

High Cliff State Park

High Cliff State Park is a 1,145 acre property located 8 miles east of Appleton in Calumet County. It is situated on the Niagara Escarpment overlooking the northeast shore of Lake Winnebago, the largest lake in the state. High Cliff is an all season park, providing facilities for picnicking, swimming, boating, hiking, horseback riding, biking, fishing, skiing, and snowmobiling.

Development consists of 300 feet of swimming beach, a 95-slip marina on Lake Winnebago, a 112-unit family campground, an 8-unit group camp, 16 miles of trails, and 46 acres of picnic area. Park buildings include a park entrance and visitor station, shop storage building, pavilion, shelters, bathhouse, and harbor house.

Year round attendance at the park is over 700,000. This makes High Cliff the third busiest park in the state park system. The park is close to a large population base since it is located near the Fox Valley. The park is within 20 minutes of the Fox Cities, 45 minutes from Green Bay and Manitowoc, and 2 hours from Milwaukee and Madison.

Wisconsin's Glacial Habitat Restoration Area

In the 1940's, Wisconsin's landscape was a diverse patchwork of agricultural fields and wildlife habitats. Many wildlife species were able to survive quite adequately, if not flourish, in this mixed environment. As time passed, the balance shifted towards agriculture as farmers

brought previously unfarmed, marginal lands into production. The conversion process involved farming practices such as the drainage of wetlands and intensive row cropping that were less kind to wildlife. The degradation of habitat has contributed to the decline of wildlife populations dependent on what had been an optimum mix of wetlands, grasslands, and agriculture. Since European settlement, southeast-central Wisconsin has lost 99% of its prairie and savanna and over 50% of its wetlands. A recent Wisconsin DNR analysis of statewide grassland bird population changes from 1966-1987 shows that the numbers of 11 grassland bird species likely to be found in the area are declining significantly. These species include meadowlarks, upland sandpipers, bobolinks, and four species of sparrows. Similarly, 22 wetland bird species likely to be found in the same area are exhibiting declining populations. These species include pintails, blue and green-winged teal, and spotted sandpipers.

Wisconsin's Glacial Habitat Restoration Area (GHRA) is an attempt to turn the clock back by restoring a patchwork of grasslands and wetlands over a large rural landscape so that wildlife can thrive side-by-side with agriculture. The GHRA designation resulted from 1990 Wisconsin legislation that created a ten-year, \$250 million Stewardship Fund for land conservation and protection. In 1991, the GHRA became the first major project to receive money from the Stewardship Fund. An annual allocation of \$1.5 million was earmarked for the restoration and protection of wetlands and grasslands in a four county area of southeast-central Wisconsin including part of the Upper Fox Basin in Fond du Lac and Winnebago Counties.

Located entirely within Wisconsin's Southeast Focus Area of the Upper Mississippi River and Great Lakes Region Joint Venture, the GHRA's boundary encompasses 530,000 acres. It lies within the historic center of the state's best duck producing range. A GHRA staff composed of 3 full-time Wisconsin DNR wildlife biologists hopes to restore 38,600 acres of grasslands and 11,000 acres of wetlands scattered throughout the agricultural community in this area. This will be accomplished by purchasing perpetual conservation easements, cost sharing desirable conservation practices with willing landowners, and acquiring parcels in fee title.

When completed, the GHRA will result in a mosaic of habitat. The goal of the program is to transform 10% of available upland into grassland nesting cover and to restore 10% of drained wetlands. Habitat models are being used to focus efforts onto lands that will most effectively support wildlife populations. WDNR researchers have developed three different habitat models (duck, grassland bird, and pheasant) for the entire GHRA using Geographic Information Systems (GIS) technology. These models are used in restoration evaluations to identify the best habitat or potential habitat for the different species. GHRA biologists concentrate their work on those parcels of land that meet quality habitat criteria for all three models and ignore those lands that do not fit the criteria for at least two of the models. The habitat protection and restoration efforts will also provide benefits for 12 threatened and endangered animal species and 6 similarly classified plant species. In addition, the quality of the soil and water resources within the GHRA will be enhanced.

Results of the GHRA acquisition efforts as of the fall of 1999 include 4,393 acres placed in perpetual easement and 6,380 acres in fee-title for a total of 10,773 acres. Of this land, 2,136 acres have been restored to native prairie and 637 acres to wetlands, with more conversion in progress.

The objectives of this first of its kind, landscape scale effort in Wisconsin will not be achieved without the help of many partners. Most important is the cooperation of landowners within the project boundaries that realize that the project's goals of restoration and protection are in their best interest. Many agencies and organizations have also found the GHRA goals and methods attractive and are contributing time and money. Ducks Unlimited has contributed \$50,000 towards wetland restorations on private lands, The Nature Conservancy has acquired

287 acres of land within the boundaries of the GHRA, Pheasants Forever is providing \$20,000 annually for grassland restorations, and the Wisconsin Waterfowl Association has spent \$57,000 on wetland improvement projects since 1987, with another \$20,000 to come in the next two years. Various government agencies are also involved, including U.S. Fish and Wildlife Service, Natural Resources Conservation Service, and others, all contributing toward GHRA habitat goals.

Other Wildlife Management Programs

Grassland Restoration

The Upper Fox Basin is primarily in the Southeastern Ridges and Lowlands natural division with the western most portions in the Central Plains natural division. In presettlement times, the basin was dominated primarily by prairie, oak savanna, and pine and oak barren with a mosaic of extensive sedge meadows and southern dry and mesic forest. Almost all prairie, many sedge meadows, and numerous oak savannas were converted to agriculture because of the flat topography and rich soils. Because of the intensive agriculture and urban/rural residential land uses, grassland bird habitat is largely restricted to idle grassland habitat on publicly owned properties and on un-farmed, privately owned grasslands such as wet meadows. A few of the grassland landscape scale sites within the basin include: White River Marsh Complex, Rush Lake Grasslands and Sedge Meadows, and Coloma Barrens and Savannas.

Due to its location within the State of Wisconsin, many common local resident or neotropical migrant songbirds may be found in the Upper Fox Basin. Many species are transient that utilize the basin during annual fall and spring migrations, while others migrate specifically to the basin for winter or breeding habitat. The basin has a unique mixture of open grassland/agricultural habitat (found predominately in the east-end of the basin) and more contiguous wooded habitat in the west. In addition, the basin is near the north/south tension zone of Wisconsin, which provides an interesting mix of habitat and the songbirds associated with northern and southern Wisconsin.

Although much attention has been given to the decline of forest-interior songbirds, grassland-dependent birds have actually experienced a more precipitous population decline. Between 1966 and 1994 the populations of ten grassland bird species declined significantly in Wisconsin according to the Federal Breeding Bird Survey (Sauer, 2001). These declines were not only evident in Wisconsin, but were widespread throughout the Midwest and the continent as a whole (Sample and Mossman, 1997).

Native grasslands have been almost completely lost since European settlement. Agricultural land has undergone many changes, from the era of wheat farming in the late 1800's, to the dominance of dairy farming in the mid-1900's, to the growth of row cropping in recent decades (Sample, 1989). Some bird species adapted well to agricultural land use in the early to mid-1900's, but since the late 1950's large acreages of pasture and small grain crops have been converted to row crops, which decreased the useable agricultural habitat for grassland bird species (Graber and Graber, 1963).

The Upper Fox Basin wildlife management personnel have been very active in grassland restoration and enhancement on both public and private lands. Approximately 600 acres were established in the year 2000. Other partners have contributed to the grassland restoration effort in the basin. The U.S. Fish and Wildlife Service-Leopold Wetland Management District established another 175 acres. The Conservation Reserve Program is the largest contributor to

the basin's grassland restoration effort with more than 2,250 acres put into the 10 year set-aside program.

It is theorized that to realize a positive impact on grassland dependent bird populations on a landscape scale, we need to convert 10% of the active cropland to permanent nesting cover. We are on our way toward this goal.

Wetland Restoration

Common wetland communities in the Upper Fox River Basin include shrub-carr, sedge meadow, and emergent aquatic communities. Wet prairies and wet-mesic prairies were once common wetland types within the basin, but are now rare. Thousands of acres of wetlands have been lost primarily due to agricultural drainage and urban development. Many of Wisconsin's threatened and endangered plant and animal species are wetland dependent. Wetlands provide important wildlife habitat for waterfowl, shorebirds, songbirds, furbearers, reptiles, amphibians, and other species.

The Wisconsin DNR is currently working with many partners to restore wetlands on public and private lands within the basin. Partners include the Natural Resources Conservation Service (Conservation Reserve Program and Wetland Reserve Program), U.S. Fish and Wildlife Service (Partners for Fish and Wildlife Program), private organizations (Ducks Unlimited, Pheasants Forever, Wisconsin Waterfowl Association), and private landowners. One WDNR project, the Glacial Habitat Restoration Area, has a goal of restoring 11,000 acres of wetlands inside the project boundaries within the Upper Fox River and Upper Rock River Basins. Plugging of ditches and breaking of tiles are the most common methods used to restore wetlands. Invasion of wetlands by exotic species, primarily reed canary grass and purple loosestrife, pose new problems for management of wetlands.

Waterfowl Management

A variety of waterfowl use the wetlands and surface waters of the Upper Fox River Basin. Many of the most abundant breeding waterfowl in Wisconsin are found in the watershed including wood ducks, mallards, blue-winged teal, and giant Canada geese. Spring and fall migrants observed in the watershed can include any waterfowl commonly found within the Mississippi Valley Flyway of North America. The basin includes many marshes and/or lakes that have been long known as famous waterfowl areas including: Lake Winnebago, Rush Lake, Lake Puckaway, Grand River Marsh, and Eldorado Marsh. Lake Puckaway and Rush Lake are probably the most famous within the basin and have been long identified with waterfowl hunting.

The watershed itself is located within the Southeast, Winnebago System, and Marquette-Waupaca Focus Areas of the Upper Mississippi River and Great Lakes Region Joint Venture of the North American Waterfowl Management Plan (NAWMP) signed by the United States and Canada. The goal of this program is to restore wildlife habitat including the restoration of wetlands and prairies, the preservation of current habitat, and the purchase of land. In addition, the Wisconsin Department of Natural Resources has embarked on a large scale project within the basin, the Glacial Habitat Restoration Area (GHRA), that will protect, restore, and enhance critical waterfowl habitat within a 530,000 acre area in Columbia, Dodge, Fond du Lac, and Winnebago Counties. With the use of several models, the Department has identified critical areas and habitat for waterfowl, much of which is in the Upper Fox Basin, for protection through fee title acquisition, conservation easements, and cooperative agreements.

Deer Management

The number of deer in the Upper Fox Basin varies widely from the predominately agricultural areas of the east to the wooded recreational lands in the west. The established over-winter goals vary from 20-35 deer/square mile, although recent over-winter estimates have been well above established goals. This has triggered several years of Special and Zone T antlerless only deer seasons. Several Deer Management Units are found within the basin (54A, 54C, 66, 67A, 67B, 68A, and 70E and small portions of 63B, 64, 65A, and 65B). The smallest non-metro deer management unit (70E) and three of four with the highest over-winter goal of 35 deer/square mile (67A, 67B, and 70E) are found within the basin.

The high over-winter goals in much of the basin (>25 deer/square mile) has resulted in extremely high agricultural deer damage and high deer/vehicle accidents. The Department has attempted to combat these problems with liberal hunting seasons with unlimited antlerless deer permits and with Agricultural Deer Damage Shooting Permits. Marquette and Green Lake Counties, despite their relatively small size, have lead the state with the amount of assessed deer damage claims (\$113,000 in Marquette County and \$64,000 in Green Lake County for 1999) as well as the greatest number of shooting permits issued for several years.

Deer Management for 2000 and Beyond (commonly referred to as Deer 2000), a cooperative project between the Wisconsin Department of Natural Resources, the Conservation Congress, and the public, has identified many of the Deer Management Units in the basin for an over-winter goal reduction. These changes should help alleviate the problems associated with high deer density. Lower deer population densities would reduce the number of deer/vehicle accidents and the amount of agricultural deer damage. None the less, deer management is probably the most controversial issue related to wildlife in the Upper Fox River Basin.

Pheasant Management

The ring-necked pheasant (*Phasianus colchius*) is not native to Wisconsin, but was introduced as a game bird in Waukesha County in 1916. This area was opened to hunting in 1927. This occurred due to declining populations of native game birds, primarily sharp-tailed grouse (*Pedioecetes phasianellus*) and greater prairie chicken (*Tympanuchus cupido*). Wild pheasant populations reached their peak in the 1940's and have been declining ever since then.

The Upper Fox Basin is in the heart of the best historical pheasant range in Wisconsin and thus has a large number of State Wildlife Areas and other publicly owned lands that are managed in part for grassland nesting habitat. Winnebago, Fond du Lac, Green Lake, and Columbia Counties are the primary pheasant management counties in the basin.

Statewide 2000 crowing count results show a decline of 12% in crowing indices from 1999. However, the Glacial Habitat Restoration Area (GHRA) which is a habitat improvement program initiated in 1990 focused on purchasing, easing, and improving wildlife habitat through scattered parcels of property in the eastern portion of the Upper Fox Basin resulted in crowing indices 13% greater than in 1999.

Habitat work that is being completed in the Upper Fox Basin includes wetland restoration and planting of prairie grasses and forbs that will benefit wild pheasants. This habitat work (funded in part with pheasant stamp revenues) along with the Conservation Reserve Program has had a positive impact on Wisconsin's pheasants.

Canada Goose Management

The Upper Fox Basin is the fall Canada goose mecca of Midwest United States. The interior Canada goose race (*Branta canadensis interior*) is the most common race in the Mississippi Valley Population of the Mississippi Valley Flyway of North America. The fall migration of 200,000+ Canada geese provides excellent viewing and hunting opportunity in the basin. The mosaic of agricultural fields (grain corn, alfalfa, and winter wheat), seasonally flooded basins, and shallow and deep-water lakes provide the ideal habitat for Canada geese.

The high Canada goose population has resulted in increased crop depredation and nuisance problems. Management of damage caused by these birds usually involves the use of pyrotechnic devices, traps, mechanical scare devices, and agricultural damage shooting permits. The basin is located in parts of both the Horicon and Exterior Zones. In 1999, Fond du Lac and Green Lake Counties ranked second and third respectively, in total Canada goose harvest.

The Canada goose is one of Wisconsin's wildlife success stories, especially the giant Canada goose race (*Branta canadensis maxima*). This program has been so successful that there now are urban Canada goose nuisance and damage problems in the Fox Valley urban areas. In 2000, the City of Fond du Lac was the site of the first adult Canada goose round up in Wisconsin. A total of 120 adult geese were captured, transported to a processing plant, and delivered to local food pantries for human consumption. Another 88 juvenile geese were translocated to northern WDNR properties.

Many more cities will be implementing similar programs to achieve some control of the overpopulation of giant Canada geese in the urban areas in the near future. A task force has been formed including all of the Fox Valley Cities, respective WDNR wildlife biologists, and U.S. Fish & Wildlife Service personnel to develop an eastern Upper Fox Basin specific strategy for addressing the overpopulation of giant Canada geese.

Turkey Management

There are primarily three Wild Turkey Management Zones in the Upper Fox Basin (units 23, 17, and 24). The spring 2000 harvest for each zone was 2,589, 1,466, and 280, respectively. Turkeys are extremely abundant and increasing in the western half of the Upper Fox Basin, but the population is smaller in the eastern half of the basin. This variation in the turkey population is due primarily to the differences in habitat. The western half of the watershed consists of oak woodlands and savannas, pine plantations, prairies, open fields, and farm fields, all interspersed with high quality streams and other smaller water sources. The eastern half has less savannas and oak woodlands and more open water wetlands, mesic tall grass prairies, and farm fields.

Optimal turkey habitat provides ample cover for ground nesting, trees (oaks and pines) for roosting, and prairies and fields for foraging. Consideration must be given to the different food preferences of polts and adults. Polts feed primarily on insects, whereas adults eat mostly plant material and fewer insects. Restoring prairies having a diverse mixture of grasses and forbs provides for all of these foraging requirements.

The rest of the basin works mostly on State Wildlife Areas or State Fisheries Areas to restore diverse prairies and create beneficial oak savannas and woodlands with the help of the National Wild Turkey Federation and Turkey Stamp Funds. Also, biologists work together with the U.S. Fish & Wildlife Service to help private landowners in the rest of the basin to create prairies and oak savannas.

The recent increase in the turkey population has led to a rise in turkey hunting. Many WDNR employees help conduct Turkey Education clinics to promote safe hunting ethics and to give the public an opportunity to experience the enjoyment and exhilaration of a turkey hunt.

Amphibian and Reptile Monitoring

It typically is difficult to obtain population estimates for amphibians and reptiles because they are not easily observed. However, frogs and toads become very vocal during the breeding season. Biologists and other knowledgeable volunteers run three frog and toad surveys during the breeding season each year in April, in late May through early June, and in July. The goal is to do two surveys in each county of the state and several of the surveys are done by biologists in this basin. The goal is to obtain population statistics that can be compared from year to year as an indicator of population health.

Property managers and biologists of the basin consider requirements of amphibians and reptiles when developing management plans. The Natural Heritage Inventory (NHI) lists where sensitive species are known to exist and this inventory is reviewed prior to establishing management plans. The Blanding's turtle is a threatened reptile of the state and is documented in several waterways of our watershed. This turtle is found in river bottoms and marshes, habitat types present throughout the watershed. The slender glass lizard is endangered in the state and resides within the sandy region of this basin. This region is home to oak savannas and prairies, where insects and the eggs of ground nesting species are readily available.

Threatened and Endangered Species in the Upper Fox River Basin

The Upper Fox Basin is home to many of Wisconsin's threatened and endangered species. The Wisconsin Natural Heritage Inventory documents endangered, threatened, and special concern species for the entire state. Endangered species are those species for which continued existence in the state is in jeopardy. Threatened species are those species that appear likely to become endangered within the foreseeable future. Special concern species are those for which a problem of abundance or distribution is suspected, but not yet proven. Major problems for the at risk species within the basin include habitat loss, habitat fragmentation, and pollution.

The wildlife management staff is responsible for a variety of actions aimed at helping populations of at risk species within the basin. Property acquisition is a valuable tool that allows staff to permanently protect critical habitats. Biologists acquire land as Natural Areas, Wildlife Areas, and Glacial Habitat Restoration Areas throughout the basin. Habitat restoration, modification, and maintenance are the other tools used to provide the necessary elements needed by threatened and endangered species. Practices such as prairie and wetland restoration, prescribed burning, water level management, and invasive species control are combined with knowledge about species' life history to insure that their needs are being met. Surveys are conducted in conjunction with these activities to learn of the outcome of habitat management practices and to focus efforts on areas that have the potential to realize the greatest benefit.

A complete listing of the endangered and threatened species found within the counties of the Upper Fox Basin (Adams, Calumet, Columbia, Fond du Lac, Green Lake, Marquette, Waushara, and Winnebago) follows (Tables 4 and 5).

Common Name	Species Name	Wisconsin Status¹
Dwarf Umbrella-Sedge	<i>Fuirena pumila</i>	Endangered
Harbinger-Of-Spring	<i>Erigenia bulbosa</i>	Endangered
Purple Milkweed	<i>Asclepias purpurascens</i>	Endangered
Sand Dune Willow	<i>Salix cordata</i>	Endangered

Soft-Leaf Muhly	<i>Muhlenbergia richardsonis</i>	Endangered
Lake Cress	<i>Armoracia lacustris</i>	Endangered*
Fassett's Locoweed	<i>Oxytropis campestris var chartacea</i>	Endangered**
Prairie White-Fringed Orchid	<i>Platanthera leucophaea</i>	Endangered**
Brittle Prickly-Pear	<i>Opuntia fragilis</i>	Threatened
Long-Beaked Baldrush	<i>Psilocarya scirpoides</i>	Threatened
Pale Green Orchid	<i>Platanthera flava var herbiola</i>	Threatened
Prairie Milkweed	<i>Asclepias sullivantii</i>	Threatened
Prairie Parsley	<i>Polytaenia nuttallii</i>	Threatened
Roundstem Foxglove	<i>Agalinis gattingeri</i>	Threatened
Slender Bush-Clover	<i>Lespedeza virginica</i>	Threatened
Small White Lady's-Slipper	<i>Cypripedium candidum</i>	Threatened
Sticky False-Asphodel	<i>Tofieldia glutinosa</i>	Threatened
Tussock Bulrush	<i>Scirpus cespitosus</i>	Threatened
Woolly Milkweed	<i>Asclepias lanuginosa</i>	Threatened
Bog Bluegrass	<i>Poa paludigena</i>	Threatened*
Forked Aster	<i>Aster furcatus</i>	Threatened*
Low Nutrush	<i>Scleria verticillata</i>	Special Concern
Many-Headed Sedge	<i>Carex sychnocephala</i>	Special Concern
Northeastern Bladderwort	<i>Utricularia resupinata</i>	Special Concern
One-Flowered Broomrape	<i>Orobanche uniflora</i>	Special Concern
Pale Beardtongue	<i>Penstemon pallidus</i>	Special Concern
Purple Bladderwort	<i>Utricularia purpurea</i>	Special Concern
Purple Clematis	<i>Clematis occidentalis</i>	Special Concern
Robbins Spikerush	<i>Eleocharis robbinsii</i>	Special Concern
Rock Stitchwort	<i>Minuartia dawsonensis</i>	Special Concern
Rock Whitlow-Grass	<i>Draba arabisans</i>	Special Concern
Showy Lady's-Slipper	<i>Cypripedium reginae</i>	Special Concern
Slender Bog Arrow-Grass	<i>Triglochin palustre</i>	Special Concern
Slim-Stem Small-Reedgrass	<i>Calamagrostis stricta</i>	Special Concern
Small Yellow Lady's-Slipper	<i>Cypripedium parviflorum</i>	Special Concern
Tufted Hairgrass	<i>Deschampsia cespitosa</i>	Special Concern
Virginia Meadow-Beauty	<i>Rhexia virginica</i>	Special Concern
Wax Meadowrue	<i>Thalictrum revolutum</i>	Special Concern
Whip Nutrush	<i>Scleria triglomerata</i>	Special Concern
White Adder's-Mouth	<i>Malaxis brachypoda</i>	Special Concern
Yellow Evening Primrose	<i>Calylophus serrulatus</i>	Special Concern
Deam's Rockcress	<i>Arabis missouriensis var deamii</i>	Special Concern*
Prairie Fame-Flower	<i>Talinum rugospermum</i>	Special Concern*

¹Wisconsin Status:

Endangered: continued existence in Wisconsin is in jeopardy.

Threatened: appears likely to become endangered within the foreseeable future.

Special Concern: species for which some problem of abundance or distribution is suspected, but not yet proven.

Rule: protected or regulated by state or federal legislation or policy; neither endangered nor threatened.

* indicates: a candidate for federal listing.

** indicates: Federally Endangered or Threatened.

Table 5. Threatened and Endangered Animals of the Counties within the Upper Fox Basin			
Common Name	Species Name	Wisconsin Status¹	Taxa
Caspian Tern	<i>Sterna caspia</i>	Endangered	Bird
Forster's Tern	<i>Sterna forsteri</i>	Endangered	Bird
Red-Necked Grebe	<i>Podiceps grisegena</i>	Endangered	Bird
Powesheik Skipperling	<i>Oarisma powesheik</i>	Endangered	Butterfly
Swamp Metalmark	<i>Calephelis mutica</i>	Endangered	Butterfly
Striped Shiner	<i>Luxilus chrysocephalus</i>	Endangered	Fish
Blanchard's Cricket Frog	<i>Acris crepitans blanchardi</i>	Endangered	Frog
Western Slender Glass Lizard	<i>Ophisaurus attenuatus</i>	Endangered	Lizard
Queen Snake	<i>Regina septemvittata</i>	Endangered	Snake
Common Tern	<i>Sterna hirundo</i>	Endangered*	Bird
Midwest Pleistocene Vertigo	<i>Vertigo hubrichti</i>	Endangered*	Snail
Acadian Flycatcher	<i>Empidonax virescens</i>	Threatened	Bird
Bell's Vireo	<i>Vireo bellii</i>	Threatened	Bird
Great Egret	<i>Casmerodius albus</i>	Threatened	Bird
Greater Prairie-Chicken	<i>Tympanuchus cupido</i>	Threatened	Bird
Osprey	<i>Pandion haliaetus</i>	Threatened	Bird
Red-Shouldered Hawk	<i>Buteo lineatus</i>	Threatened	Bird
Spatterdock Darner	<i>Aeshna mutata</i>	Threatened	Dragonfly
Longear Sunfish	<i>Lepomis megalotis</i>	Threatened	Fish
Pugnose Shiner	<i>Notropis anogenus</i>	Threatened	Fish
Redfin Shiner	<i>Lythrurus umbratilis</i>	Threatened	Fish
Buckhorn	<i>Tritogonia verrucosa</i>	Threatened	Mussel
Ellipse	<i>Venustaconcha ellipsiformis</i>	Threatened	Mussel
Wood Turtle	<i>Clemmys insculpta</i>	Threatened	Turtle
Cerulean Warbler	<i>Dendroica cerulea</i>	Threatened*	Bird
Greater Redhorse	<i>Moxostoma valenciennesi</i>	Threatened*	Fish
Blanding's Turtle	<i>Emydoidea blandingii</i>	Threatened*	Turtle
Green-Striped Darner	<i>Aeshna verticalis</i>	Special Concern	Dragonfly
Slender Bluet	<i>Enallagma traviatum</i>	Special Concern	Dragonfly
Swamp Spreadwing	<i>Lestes vigilax</i>	Special Concern	Dragonfly
Banded Killifish	<i>Fundulus diaphanus</i>	Special Concern	Fish
Creek Chubsucker	<i>Erimyzon oblongus</i>	Special Concern	Fish
Lake Chubsucker	<i>Erimyzon sucetta</i>	Special Concern	Fish
Lake Herring	<i>Coregonus artedi</i>	Special Concern	Fish
Least Darter	<i>Etheostoma microperca</i>	Special Concern	Fish
Pugnose Minnow	<i>Opsopoeodus emiliae</i>	Special Concern	Fish

Redside Dace	<i>Clinostomus elongatus</i>	Special Concern	Fish
Weed Shiner	<i>Notropis texanus</i>	Special Concern	Fish
Bullfrog	<i>Rana catesbeiana</i>	Special Concern	Frog
Prairie Vole	<i>Microtus ochrogaster</i>	Special Concern	Mammal
An Owlet Moth	<i>Macrochilo bivittata</i>	Special Concern	Moth
Liatris Borer Moth	<i>Papaipema beeriana</i>	Special Concern	Moth
Newman's Brocade	<i>Meropleon ambifusca</i>	Special Concern	Moth
Round Pigtoe	<i>Pleurobema sintoxia</i>	Special Concern	Mussel
Black Tern	<i>Chlidonias niger</i>	Special Concern *	Bird
Sylvan Hygrotus Diving Beetle	<i>Hygrotus sylvanus</i>	Special Concern*	Beetle
Wisconsin Well Amphipod	<i>Stygobromus putealis</i>	Special Concern*	Crustacean
Lake Sturgeon	<i>Acipenser fulvescens</i>	Special Concern*	Fish
Karner Blue Butterfly	<i>Lycaeides melissa samuelis</i>	Special Concern**	Butterfly

¹Wisconsin Status:

Endangered: continued existence in Wisconsin is in jeopardy.

Threatened: appears likely to become endangered within the foreseeable future.

Special Concern: species for which some problem of abundance or distribution is suspected, but not yet proven.

Rule: protected or regulated by state or federal legislation or policy; neither endangered nor threatened.

* indicates: a candidate for federal listing.

** indicates: Federally Endangered or Threatened.

Statewide Karner Blue Butterfly Habitat Conservation Plan

The Karner blue butterfly (*Lycaeides melissa samuelis*) is a federally listed endangered species. Wisconsin supports the largest widespread Karner blue butterfly population in the world. This species has been extirpated from much of its historic range; thus, the status of the species in Wisconsin is critical to its continued survival. The species occurs in Adams, Green Lake, Marquette, and Waushara counties (and other counties) and is known to exist at many sites in the western portion of the Upper Fox River Basin. Karner blue butterflies are found in close association with wild lupine (*Lupine perennis*), the only known host plant for their larvae. Natural habitats that Karner blue butterflies occupy include sandy pine and oak barrens, pine prairies, oak savannas, and some lakeshore dunes.

Current Karner blue butterfly habitat in Wisconsin and the Upper Fox River Basin includes abandoned agricultural fields, mowed utility and road rights-of-way, and managed forests and barrens. Potential habitat at the specific site level can only occur where conditions exist to support wild lupine. This butterfly species specializes on wild lupine and other food plants that are found primarily in early successional habitats that are dependent on ecosystem disturbance. Thus, suitable habitat can be a shifting and increasingly smaller fraction of a greater landscape mosaic that results in local species extinction events that are frequent and inevitable. Therefore, the availability – or absence – of suitable habitat mosaics plays a key role in the long term survival of this species.

In 1999, the State of Wisconsin Department of Natural Resources (WDNR) entered into an agreement with the U.S. Fish & Wildlife Service to administer and participate as a partner in the *Wisconsin Statewide Karner Blue Butterfly Habitat Conservation Plan* (HCP). The HCP was developed by WDNR and other state partners including utilities, county forests, industrial forest companies, trade organizations, non-profit conservation organizations, and Wisconsin state

agencies. WDNR administers the federal incidental take permit aspects of the HCP. The HCP is an innovative approach designed to move regulated communities (partners) beyond compliance and into efforts to proactively apply conservation measures on the land while engaging in normal land management activities. Additional entities, such as town and county highway departments who manage lupine sites along roadsides, will be added as participating partners in the HCP over time. New HCP partners, concerned individuals and experts, and interested organizations will be sought and nurtured in the western Upper Fox River Basin to assist in moving forward with the conservation of Karner blue butterflies and their habitat.

The HCP utilizes two approaches to land management by partners:

- 1) Management with consideration for Karner blue butterflies such that the long-term goal on these lands is that the butterfly habitat gains equal or exceed losses occurring through natural succession or otherwise.
- 2) Management to feature, protect, or enhance Karner blue butterflies which has the same goal on lands as stated above, plus measures are taken to promote viable Karner blue butterfly populations despite potential economic costs.

These management strategies are also applied by WDNR, a participating partner, in managing state lands in the Upper Fox River Basin. Upper Fox River Basin state lands listed in the HCP for such management include: Bass Lake Fen State Natural Area; Germania, Greenwood, and White River Marsh Wildlife Areas; and Mecan River and Wedde Creek Fisheries Areas. Acreage at some of these sites is included in federal recovery efforts for Karner blue butterflies. Prairie and savanna restoration activities underway on several of these areas will expand lupine containing habitat for this butterfly.

WATER TEAM RESPONSIBILITIES

The Water Team includes a variety of functional areas related to management of aquatic resources. The Water Team addresses: Fisheries and Habitat - fish management, aquatic habitat management, and water regulation permitting for activities below the ordinary high water mark; Watershed Management - wastewater permitting, septage management, animal waste permitting, stormwater management, and water quality; and Drinking and Groundwater - public and private water supply systems.

Fisheries and Habitat

Fish Management

This functional area is responsible for management of the fishery resource in the Upper Fox River Basin. This includes acquiring information about the fishery, making management decisions, and ensuring proper habitat is available for all stages of life.

Priorities:

- ❖ Complete an evaluation of optimum rock size and type for sturgeon spawning and sac fry survival by 2005.

- ❖ Create/enhance 6000 feet of lake sturgeon spawning habitat in the Upper Fox River and 8000 feet in the Wolf River by 2010.
- ❖ Initiate and complete construction of the Lake Poygan Breakwall by 2006 and institute an assessment program to determine biological response.
- ❖ Actively participate on the steering committee that is developing a management plan for Rush Lake and initiate restoration activities by 2004.
- ❖ Conduct five water regulation permitting training sessions by 2007 for local governments, agencies, contractors, and developers.
- ❖ Complete walleye spawning marsh habitat improvements on 8 marshes associated with the Upper Fox and Wolf Rivers by 2006.
- ❖ Develop creel-based exploitation rates for walleye on the Winnebago System by 2007.
- ❖ Sign a new Cooperative Spawning Marsh Agreement for both the Wolf River and Fox River by 2006.
- ❖ Continue implementation of the Winnebago Comprehensive Management Plan.
- ❖ Continue the Lake Winnebago Fisheries Community Assessment through trawling, seining, shocking, and netting to characterize the Lake Winnebago fish community and assess year-class strength.
- ❖ Continue lake sturgeon management in the Winnebago-Fox-Wolf System. Conduct population and harvest assessments; continue public involvement and education; work closely with the Winnebago Citizens Sturgeon Advisory Committee; pursue Upper Fox River long term sturgeon spawning stock rehabilitation, spawning, and nursery habitat protection and enhancement; cooperate with other regional, statewide, national, and international sturgeon management and research programs; and prepare the annual Winnebago System Sturgeon Management report, direct sturgeon registration, and determine harvest cap for the annual sturgeon spearing season.
- ❖ Coordinate arrangements for the 4th International Symposium on Sturgeon, 8-13 July 2001; conduct follow-up activities including publication of peer reviewed proceedings.
- ❖ Continue walleye management in the Winnebago-Fox-Wolf System. Conduct population and harvest assessments; pursue spawning habitat protection and enhancement; work closely with the Winnebago Walleye Citizens Advisory Committee; continue to provide public information and education; participation in the Midwest Walleye Technical Committee; and continue to provide the annual Winnebago System Walleye Management report.
- ❖ Conduct expanded population and harvest assessment on catfish in the Winnebago-Fox-Wolf System; work closely with the Winnebago System Catfish Advisory Committee; pursue habitat enhancement and development, and promote setline monitoring.
- ❖ Continue stream restoration and enhancement activities – Restore 10,000 feet of trout stream habitat on the Chaffee Creek, Wedde Creek, Tagatz Creek, Lawrence Creek, and the Mecan River.
- ❖ Continue cold water fisheries management through assessment of population dynamics and habitat enhancement throughout the basin – Categorize Green Lake.
- ❖ Continue warm water fisheries management through assessment of population dynamics and habitat enhancement on waters throughout the basin.
- ❖ Cooperate with the Wolf River Basin to evaluate flathead catfish populations using various set and bank line techniques. Gather length, sex, and age data on released and harvested fish. Tag catfish with floy and pit tags and use all information to formulate a flathead management plan and recommend changes to current regulations.
- ❖ Provide stocking of wild strains of trout where appropriate; decrease stocking of hatchery fish.

- ❖ Continue the contaminant monitoring program and the distribution of fish consumption advisories established from monitoring data.

Shallow Lake Management

Shallow water lakes are lakes that are generally less than 20 feet in depth or are lakes that do not stratify. The Upper Fox River Basin is rich in shallow lakes. In fact, approximately 15% of the state's surface water area is located in the shallow lakes of the Upper Fox River Basin. Rush Lake, Buffalo Lake, Lake Puckaway, Mason Lake, and the Winnebago Pool Lakes (Winneconne, Poygan, Winnebago, and Butte des Morts) are examples of shallow water lakes that are found in or bordering on the basin boundaries. These lakes exhibit unique characteristics that differentiate them from deep-water lakes. Many are also flowage lakes with water levels controlled by a dam.

The manipulation of lake levels has caused serious damage to their ecology. Most of them once teemed with plants and animals. However, years of lake level manipulation has disrupted natural high and low water cycles shallow lakes depend on to maintain their natural habitat. The unnatural constant water elevations during the summer have decreased aquatic plant generation. In turn, this allows sediment to be easily re-suspended in the water, releasing nutrients to grow huge amounts of algae. This further decreases water quality and clarity. These shallow lake systems are also further disrupted by carp. This non-native fish creates a notable impact on the natural vegetation by uprooting plants needed for fish and wildlife as it disturbs the sediment in search of food. The disturbed sediment can bury spawning grounds of other fish species, stressing the natural fish populations and increasing the availability of nutrients for algae. When algae blooms occur, they produce wide swings in the amount of dissolved oxygen aquatic organisms depend on. Murky water also favors rough fish that are taste-feeders rather than predatory game fish that must see their food to find it. More research on carp control methods is needed to help manage these problems.

While shallow lakes are naturally rich in nutrients, additional loading from sediments and runoff from their watersheds often causes these lakes to become highly nutrient enriched with poor water quality and clarity. This often results in declining public recreational opportunities. Information and education for the public is necessary to explain the importance of maintaining

Unique Fishery Resource: Winnebago System Lake Sturgeon Management

The Lake Winnebago System is home to the largest self-reproducing lake sturgeon population in North America. The Winnebago lake sturgeon population and fishery has been intensively managed since 1903 when the first protection laws were passed. Today's Winnebago System lake sturgeon program is looked at as a world model for effective sturgeon population and fishery management.

The current spawning population of lake sturgeon in the Winnebago-Fox-Wolf System is estimated to be composed of 40,000 adult males and 8000 adult females, which support an annual average combined harvest of over 1300 fish through the winter spear fishery. Sturgeon spearing is deeply woven into the cultural fabric of the Winnebago region. European settlers adopted the harvest technique from Native Americans in the mid to late 1800's. Following a harvest ban from 1915 to 1931, the first modern day spearing season was held on Lake Winnebago in 1932.

An estimated 10,000 individuals actively spear for sturgeon each winter. Men, women, and children participate in the activities, although only persons over the age of 14 are allowed to spear.

Many active spearkers are members of *Sturgeon for Tomorrow*, a local non-profit conservation organization founded in 1977 and dedicated to the long term sustenance and management of sturgeon stocks and their associated fisheries. Through their annual banquets and other activities over the last 23 years, *Sturgeon for Tomorrow* has raised and donated nearly a half a million dollars to various organizations to help fund a wide range of sturgeon research and management projects including the spring Sturgeon Guard program, as well as many sturgeon spawning and nursery habitat development projects.

Due to strong public interest and conservative management strategies, the Winnebago System sturgeon population has grown more than fourfold in numbers over the last 40 years despite a matching fourfold increase in the number of active spearkers. The keys to the success of the Winnebago sturgeon management program are:

- ❖ Sound, consistent long term sturgeon population and fishery assessment
- ❖ Aggressive habitat protection, development, and management
- ❖ Progressive public involvement and law enforcement

natural fluctuations of lake levels for healthy lake ecology rather than manipulating water elevations solely for recreation.

The perception that a lake must be deep and “weed” free has led to additional demands to increase lake elevations. Increasing lake elevations also has some potentially negative impacts on shoreline homeowners. Higher water elevations reduce flood storage capacity and may result in more frequent flooding. A local groundwater rise in response to the increased lake elevation can increase the risk of groundwater contamination from septic systems. Shoreline development along water bodies also leads to habitat fragmentation and destruction. Along the shoreline, areas with shallow water plants are often converted to plant free swimming areas and shoreline habitat is commonly replaced by lawns and long piers, further increasing the loss of fish and wildlife habitat. While this problem is not unique to shallow lakes, it is a significant issue on the shallow lakes of the Upper Fox River Basin.

Addressing shallow lake issues is commonly very expensive and/or socially distressing. It is generally very difficult for lake users to consider other water level management alternatives once they have become accustomed to artificially maintained higher water levels. A management strategy that would result in seasonally lower water levels may produce a more healthy lake ecology. While water level management is a relatively inexpensive method of regenerating lost shallow water habitat, it carries the baggage of low social acceptability. When water levels cannot be properly addressed, it becomes very expensive to restore shallow lake ecology. For instance, on Lake Butte des Morts, the Department instituted a project known as the Terrells Island Breakwall. This project enclosed more than 600 acres within a rock breakwall to reduce the erosive effects of wave action, limit carp access, and thereby restore aquatic habitat. This effort, while successful, cost almost \$2 million and the ecological response is much less than what could be achieved with proper water level management. The best management option to restore habitat and fish and wildlife populations on these very valuable shallow lakes is to restore natural fluctuations in water elevations, or at a minimum, manage water levels in a manner that mimics natural fluctuations.

Priorities:

- ❖ Continue implementation of the Winnebago Comprehensive Management Plan.
- ❖ Pursue Lake Poygan Breakwall construction.
- ❖ Continue assessment of the ecological response in the Terrells Island Habitat Restoration Area in Lake Butte des Morts.
- ❖ Continue to support local efforts for shoreline protection and restoration on the Winnebago Pool Lakes.
- ❖ Pursue ecologically sound water level management on shallow lakes.
- ❖ Provide information and education to the public on the importance of shallow lake ecology for fish and wildlife.
- ❖ Pursue strategies to reduce carp induced destruction of aquatic plant communities and water quality impacts.
- ❖ Provide information and education on the impact of shoreline development on aquatic and terrestrial ecology.
- ❖ Pursue restoration of shoreline habitat on the Winnebago Pool and other lakes.
- ❖ Provide information and education on habitat loss and impacts on fish and wildlife populations.
- ❖ Continue monitoring shallow lakes to document changes in water quality.

Water Regulation and Zoning

Waters of the state are held in trust for all members of the public. The state legislature has charged the Department with regulating activities that occur below the ordinary high water mark of lakes, wetlands, and streams. The Department administers a permitting program that ensures activities do not have negative consequences on public use and enjoyment of the state's waters.

Priorities:

- ❖ Provide information and education for lake management organizations and local officials to help them identify critical wetlands and sensitive areas that should be protected.
- ❖ Pursue the development of a Memorandum of Understanding (MOU) with developers, realtors, and lending institutions for the use of restrictive covenants to protect wetlands and shoreland areas.
- ❖ Provide educational programs for local governments and agencies on proper management and permitting of shoreland activities.
- ❖ Protect littoral zone habitat.

Watershed Management

This functional area covers a diverse set of responsibilities including the regulation of municipal, industrial, and some stormwater discharges to the state's surface and ground waters, regulation of the land application of septic system waste and solid materials remaining after wastewater processing, regulation of manure at farms considered to be large confined animal feeding operations, assessment of water quality, and regulation of dams and activities that can impact regional flood elevations.

Priorities:

- ❖ Continued implementation of the Winnebago Comprehensive Management Plan.
- ❖ Limit nutrient, sediment, and organic loading to waterways from point and nonpoint sources.
- ❖ Update formal stream classifications (NR 104).
- ❖ Provide information and education on animal waste management to the agriculture industry.
- ❖ Conduct habitat evaluation on dredged streams.
- ❖ Participate in the Smart Growth Initiative with local governments.
- ❖ Properly regulate land spreading of septage.
- ❖ Reduce the discharge of untreated stormwater to waters of the state.
- ❖ Provide information and education to the construction industry on sediment control techniques and requirements.
- ❖ Reduce stream habitat fragmentation by constructing fish passage structures on three dams by 2003.
- ❖ Remove Governor's Bend, Grand River, and White River dams on the Fox River by 2004.
- ❖ Remove an additional three dams in the basin by 2006.
- ❖ Develop a protocol for alternatives analysis for new dam construction by 2001.

- ❖ Provide information and education on aquatic exotic species that currently exist in the basin as well as those that may be introduced to the basin. For more information on exotic species, visit <http://www.dnr.state.wi.us/org/water/wm/glwsp/exotics/index.html>.

Drinking and Groundwater

This functional area provides regulation of drinking water supply systems. It addresses municipal water supplies, well water supplies for schools and other public and commercial facilities, and the residential wells for home water systems to protect public health.

Four of the five largest municipalities located in the basin receive their drinking water supply from surface water. The Cities of Oshkosh, Neenah, Menasha, and Appleton receive their drinking water from Lake Winnebago. Each municipality treats the water through different methods that include a combination of the following: settling, sand filtration, softening, and chlorination. Oshkosh also utilizes ozone and micro-filtration. Appleton will soon be operating similar technologies. These methods have proven to be successful.

Unique Resource Issue: Town-Based Arsenic Sampling Program

The Town-Based Arsenic Sampling Program was created in response to the increasing detection of high arsenic levels, from naturally occurring sources, in private wells in Winnebago County. The Department cooperated with local town governments to recruit volunteers from the public to participate in the sampling program. The State Laboratory of Hygiene analyzed each sample for arsenic and reported the results to Department staff who evaluated and presented the data in an educational program. At each program, residents of the town received their results and asked questions about their results. This program has been very successful. It has helped the Department better understand the distribution of areas affected by arsenic and it enables us to better protect people who depend on groundwater for their source of domestic water. It is now believed that as more wells are installed in the areas where arsenic is present, the resulting draw down of the water table increases the amount of soluble arsenic. This information is very useful for towns and counties involved in land use planning. The program has now been expanded to towns in Outagamie County outside of the Upper Fox Basin.

The City of Fond du Lac receives their municipal drinking water from groundwater from 16 municipal wells. One of the 16 wells has a history of radium concentrations in excess of the federal enforcement standard of 5 pico curies/liter. Although detects have been recorded at concentrations of at least 8.26 pc/l, residents have not been encouraged to seek other drinking water sources.

Arsenic is also a concern in the Oshkosh, Neenah, Menasha, and Appleton area for private wells (see Unique Resource Issue: Town-Based Arsenic Sampling Program). Municipal supplies do not exceed federal enforcement standards because the source of drinking water in these locations is Lake Winnebago. Private wells that are drilled near the St. Peters Sandstone formation have exceedingly high arsenic concentrations. The current federal enforcement standard is 50 micrograms/liter (ug/l or ppb). It is currently proposed that the enforcement standard be reduced from 50 ug/l to 5 ug/l.

Priorities:

- ❖ Provide information and education on arsenic, nitrates, and bacteria to the public and local governments.
- ❖ Ensure the public has a safe, secure source of potable water.
- ❖ Protect groundwater recharge areas.
- ❖ Nutrient and pest management.
- ❖ Proper abandonment of unused wells.
- ❖ Problem assessment monitoring of private wells.

LAKES, NONPOINT SOURCE, AND STREAMS TABLES

The following sections of this report summarize information pertaining to the lakes, nonpoint sources, and streams for each of the 15 watersheds of the Upper Fox River Basin. This information is required by the United States Environmental Protection Agency for each basin in the State of Wisconsin.

LAKES TABLE

How to Use the Lakes Table

The following explains the information enclosed in the subsequent lakes table. *Note: A blank space anywhere in the table means that data is unassessed or unavailable.*

LAKE NAME: All named and unnamed lakes are listed. Lake names are those found on U.S. Geological Survey quadrangle maps unless the Wisconsin Geographic Names Council has established a different name. Some lakes are known locally by other names; where available, local names have been listed with the official name.

COUNTY (CO): Indicates the county in which the lake is located. Waterbodies in the lakes table are listed in alphabetical order by county.

WATERBODY IDENTIFICATION CODE (WBIC): All waterbodies have been assigned a waterbody identification code by the state to help in identifying streams and stream locations. [Find the WBIC in the Register of Waterbodies]

WATERSHED NUMBER: The watersheds are identified for each lake listed using the WDNR Master Waterbody File in conjunction with U.S. Geological Survey seven minute topographic maps. The watershed number begins with a two letter abbreviation correlating to the basin in which the watershed is located and ends with the designated number of the watershed within the basin (i.e., UF-01).

TOWNSHIP, RANGE, SECTION: Lake locations are identified by township, range, and section.

SURFACE AREA: The surface area is the size of the lake, in acres, as listed in the WDNR Master Waterbody File and in Wisconsin Lakes (WDNR, 2001).

MAX/MEAN DEPTH: Maximum and mean depths are those listed in Wisconsin Lakes (WDNR, 2001).

LAKE TYPE: Each lake type displays unique limnological characteristics based on physical and chemical properties. Production of plant and animal life generally varies in accordance with lake type. Basic classifications and qualifying criteria are:

Drainage lake (DG): Impoundment or natural lake with the main water source from stream drainage; has at least one inlet and one outlet.

Drained lake (DR): Natural lake with the main water source dependent on the groundwater table and seepage from adjoining wetlands. Seldom has an inlet, but will have an outlet of very little flow similar to a seepage lake, except for the outlet.

Seepage lake (SE): Landlocked. Water level maintained by groundwater table and basin seal. Intermittent outlet may be present.

Spring lake (SP): Seldom has an inlet, but always has an outlet of substantial flow. Water supply is dependent upon groundwater rather than surface water drainage.

WINTERKILL: Winterkill (winter oxygen depletion) is a common problem in many shallow Wisconsin lakes. A kill can occur when at least four inches of snow cover the lake, which prevents sunlight from reaching the water. All photosynthesis stops and plants begin to die and decompose. The extent of oxygen loss depends on the total amount of plant, algae, and animal matter that decays. Drought increases the chance of winterkill by reducing the volume of water in the lake. A YES response indicates the lake has experienced a winterkill at least once, while a NO response indicates that a winterkill is not known to have occurred.

ACCESS:

BR = Boat Ramp

BF = Barrier-free boat ramp (boating dock and/or wheelchair access)

P = Barrier-free pier (wheelchair access)

T = Walk-in trail

R = Roadside

W = Wilderness

BW = Barrier-free wilderness access (wheelchair access)

NW = Navigable water access to lake

X = Some type of access available, but not specified

SELF-HELP MONITORING (SH): This column identifies existing or recommended Self-Help monitoring. The following letters in each column signify that Self-Help monitoring is:

R = recommended

X = completed

C = currently being done

LAKE MANAGEMENT ORGANIZATION (LMO): Indicates whether or not a lake management organization (LMO) exists for the lake. An LMO can range from a small, loosely organized group of lake property owners to an association to a district, complete with by-laws and taxing authority. In the lakes table, the following letters are used to indicate whether the LMO is an association or district. If the type of organization is not known, but one does exist, a Y is used.

Y = Indicates that a LMO does exist

ASSC = Indicates that a lake management association exists

DIST = Indicates that a lake management district exists

R = Recommends that a LMO be developed; this recommendation is usually accompanied by a narrative recommendation in the watershed analysis section.

LAKE PLAN OR PROT.: This column refers to whether the lake has been the recipient of a lake planning or lake protection grant in the past or if either of these grants are recommended for the lake. If a lake planning or protection grant is recommended, a narrative in the lake's respective watershed section will describe the recommended purpose of the grant.

PLAN = Lake has received a Lake Management Program Planning Grant in the past.

PROT = Lake has received a Lake Management Program Protection Grant in the past.

PLAN-R = A Lake Management Planning Grant is recommended for a specific purpose identified in the lake's individual narrative in the Surface Water Quality Report watershed section.

PROT-R = A Lake Management Protection Grant is recommended for a specific purpose identified in the lake's individual narrative in the Surface Water Quality Report watershed section.

FISH MERCURY (Hg): Because all fish contain some mercury, the state gives general statewide advice about how much fish to eat. This advice can be used for most inland (i.e., non-Great Lakes) waters of the state. Certain lakes contain fish with higher levels of mercury for which special advice is given. These consumption advisories are issued annually for lakes with fish mercury levels of 1.0 parts per million (ppm) or greater. Generally, predator fish from soft water, poorly buffered, low pH lakes have the highest concentrations of mercury. The most updated listing of waterbodies with fish consumption advisories can be obtained by writing to: Fish Advisory, Wisconsin Department of Natural Resources, P.O. Box 7921, Madison, WI 53707.

Groups:

R = Fish mercury monitoring is recommended.

SA (special advisory) = Monitoring has been conducted and a special advisory exists for fish consumption on this waterbody due to mercury contamination.

GA (general advisory) = Monitoring has been conducted and this waterbody falls under a general statewide fish consumption advisory for mercury.

MACROPHYTES (MAC): This column identifies the status of exotic aquatic plants in the lake. Specifically, it indicates if the lake possesses Eurasian water milfoil and/or purple loosestrife. These two invasive, non-native species can impair a lake's aesthetic, ecological, and recreational value.

EM = indicates that Eurasian water milfoil is present in the lake and may be a problem.

EM-W = specifies that the lake is part of a research project to study the effectiveness of a Eurasian water milfoil weevil in reducing and/or eradicating this plant from the lake.

PL = indicates that purple loosestrife is present in the lake and may be a problem.

SECCHI DEPTH (SD) TROPHIC STATUS INDEX (TSI): Trophic status index determined from secchi disk readings.

TROPHIC STATUS INDEX (TSI) CLASS: Lakes can be divided into three classes based on trophic state: oligotrophic, mesotrophic, or eutrophic. These categories are general indicators of lake productivity.

Oligotrophic (OLIG): lakes are generally clear, cold, and free of many rooted aquatic plants or large blooms of algae. Because they are low in nutrients, oligotrophic lakes generally do not support large fish populations. However, they often have an efficient food chain with a very desirable fishery of large predator fish.

Mesotrophic (MESO): lakes are in an intermediate stage of lake succession between oligotrophic and eutrophic stages. The bottom of these lakes is often devoid of oxygen in late summer months, limiting cold water fish and resulting in phosphorus cycling from sediments.

Eutrophic (EUTR): lakes are high in nutrients. They are likely to have excessive aquatic vegetation or experience algae blooms, sometimes both. They often support large fish populations, but are also susceptible to oxygen depletion. Shallow lakes that are small in size are especially vulnerable to a winterkill, which can reduce the density and taxonomic richness of fish species in the lake.

Lakes with a TSI less than or equal to 39 are generally considered oligotrophic, those with a TSI of 40-49 are considered mesotrophic, and those with a TSI equal to or greater than 50 are generally considered eutrophic.

All lakes naturally age, or progress from being oligotrophic to eutrophic. People have accelerated this process in many places by allowing nutrients from agriculture, lawn fertilizers, streets, septic systems, and urban storm drainage to enter lakes.

PHOSPHORUS SENSITIVITY (P SENS): This analysis classifies lakes according to their relative sensitivity to phosphorus loading and existing trophic condition. The screening identifies high quality lakes that should receive highest priority for nutrient management. The analysis first separates lakes into two major categories; lakes that are sensitive to increased phosphorus loading (Class I) and lakes less responsive to changes in phosphorus loading (Class II). Lakes in each general classification are then subdivided into management groups based on data needs or existing water quality conditions.

Class I:

A = existing water quality fair to excellent; potentially most sensitive to increased phosphorus loading.

B = existing water quality poor to very poor; less sensitive to increased phosphorus loading than Group A.

Ins = data is inadequate or insufficient to assess trophic condition; classification monitoring recommended.

Class II:

A = existing water quality fair to excellent; may not be as sensitive to phosphorus loading as Class I lakes.

B = existing water quality poor to very poor; low sensitivity to increased phosphorus loading.

Ins = data inadequate or insufficient to assess trophic condition.

These classification groups are used to establish appropriate management recommendations and priorities.

COMMENTS: Additional information that was available for the lakes has been included in the comments column. Abbreviations were used to conserve space as follows:

Source - sources are the facilities or activities that contribute pollutants or stressors, resulting in impairment of designated uses in a waterbody.

AGSPR - Agricultural land spreading site

HM - Hydrological modification (dam, ditching, wetland drainage)

NPS - Unspecified nonpoint sources

CL - Cropland erosion
SB - Streambank erosion
PSB - Streambank pasturing
PWL - Woodlot pasturing
BY - Barnyard or exercise lot runoff (animal operations)
CE - Building construction site erosion
RS - Roadside construction erosion
SEP - Septic systems are or may be causing water quality problems
URB - Urban storm water runoff
DEV - Intense development pressure
WLF - Water level fluctuations
PSM - Point source, municipal treatment plant discharge
PSI - Point source, industrial discharge

Causes/Stressors - causes are those pollutants or other conditions that contribute to the impairment of designated uses in a lake. Stressors are factors or conditions - other than specific pollutants - that cause impairment of designated uses in a lake.

ACC - Access problems relate to the general public's inability to access the lake, which as a navigable waterbody is considered a water of the state.
ALG - Undesirable algae growth
BAC - Bacteriological contamination
CARP - High carp (*Ctenopharyngodon idella*) population density
CL - Chlorine toxicity
DO - Low dissolved oxygen
HAB - Habitat
MAC - Undesirable macrophyte
NUT - Nutrient enrichment
SED - Sedimentation
TEMP - Temperature (fluctuations or extremely high or low readings)
TOX - General toxicity problems
TURB - Turbidity
VEG - Excessive vegetation
ZM - Zebra mussels (*Dreissena polymorpha*) present

Table 6. Lakes Table for All Lakes >25 Acres in the Upper Fox River Basin.

LAKE NAME	WBIC	WATER SHED #	TOWN/ RANGE/ SECTION	SURFACE AREA (ACRES)	MAX DEPTH (FEET)	MEAN DEPTH (FEET)	LAKE TYPE	WINTER-KILL	ACCESS	SH	LMO	LAKE PLAN OR PROT.	FISH MERCURY (Hg)	MAC	SD TSI	TSI CLASS	P SENS	COMMENTS	
ADAMS COUNTY																			
AMEY POND	176000	UF-14	14N/07E/36	56	7	NA	SE	YES	R				R				II	INS	
CROOKED LAKE	102600	UF-14	15N/07E/24	48	56	14	SE	NO	BR				R				I	B	
DEEP LAKE	102800	UF-14	15N/07E/15	35	47	NA	SE	NO	T				R				I	B	
FENNER LAKE	103400	UF-13	16N/07E/13	47	18	5	SE	YES	BR	C	ASSC		R		45	MESO	I	B	
GOOSE LAKE	103600	UF-14	15N/07E/11	81	18	NA	SE	YES	BR		ASSC		R	EM			II	B	WLF, VEG
JORDAN LAKE (LONG)	104000	UF-14	15N/07E/34	213	79	NA	SE	NO	BF	C	ASSC		GA	EM	42	MESO	I	A	
MCGINNIS LAKE	179100	UF-14	16N/07E/27	33	28	9	SP	NO	BR		ASSC		R				II	B	
PARKER LAKE	106500	UF-14	15N/07E/14	59	30	13	SE	NO	R	C			R	EM	36	OLIG	I	INS	
PATRICK LAKE	106600	UF-14	16N/07E/09	50	10	NA	SE	YES	BR	C	DIST		R		49	MESO	II	A	WLF, VEG
PEPPERMILL LAKE (BEAVER POND)	178700	UF-14	15N/07E/15	100	9	NA	DN	NO	BR	C	ASSC		R	EM	44	MESO	II	INS	
ROLLERS LAKE	107000	UF-14	16N/07E/12	27	5	NA	SE	YES	NA				R				II	INS	
WOLF LAKE	117500	UF-14	15N/07E/11	49	47	NA	SE	NO	BR	C			R	EM	39	OLIG	I	B	
COLUMBIA COUNTY																			
BECKER LAKE (PAYNES POND)	101400	UF-15	13N/10E/14	30	8	NA	SE	YES	NA				R				II	B	WLF
DATES MILLPOND	173300	UF-10	13N/09E/01	96	6	NA	DG	YES	BR				R				II	B	NPS
FRENCH CREEK WLA POOL NO. 1	172600	UF-10	13N/09E/11	56	5	NA	DG	NO	BR				R				II	INS	
FRENCH CREEK WLA POOL NO. 2	172300	UF-10	13N/09E/03	815	5	NA	NA	NO	BR				R				II	INS	
PARK LAKE	180300	UF-15	12N/10E/03	312	27	7	DG	NO	BR, P		DIST		R	EM, PL			II	B	HM, NPS, HAB, TURB
SILVER LAKE	107700	UF-10	12N/09E/06	74	42	16	SP	NO	BR	C			R	EM	44	MESO	I	A	NPS, URB, HAB
SWAN LAKE	179800	UF-15	12N/09E/11	406	82	32	DG	NO	BF	C	ASSC		R	PL	51	EUTR	II	A	
WEETING LAKE	176200	UF-14	13N/07E/02	34	4	NA	DG	YES	NA				R				II	INS	
DODGE COUNTY																			
EMILY LAKE	161600	UF-11	13N/13E/05	268	14	NA	SP	YES	BF	C			R		65	EUTR	II	B	HM, NPS, HAB, TURB, DO

LAKE NAME	WBIC	WATER SHED #	TOWN/RANGE/SECTION	SURFACE AREA (ACRES)	MAX DEPTH (FEET)	MEAN DEPTH (FEET)	LAKE TYPE	WINTER-KILL	ACCESS	SH	LMO	LAKE PLAN OR PROT.	FISH MERCURY (Hg)	MAC	SD TSI	TSI CLASS	P SENS	COMMENTS	
FOND DU LAC COUNTY																			
DENEVEU LAKE	139300	UF-03	15N/18E/30	79	67	NA	SE	NO	NA				R				I	B	ACC
GREEN LAKE COUNTY																			
BIG TWIN LAKE	146500	UF-07	15N/13E/05	78	46	17	DG	NO	BR				R				I	B	NPS
GRAND LAKE (MILLPOND)	161100	UF-11	14N/12E/07	234	8	3	DG	NO	BR				R				II	B	HM, NPS, HAB, TURB, DO, CARP
GRAND RIVER MARSH	159900	UF-11	14N/10E/01	3000	7	NA	DG	NO	BR				R				II	INS	NPS, HAB, TURB, DO, CARP
GREEN LAKE (BIG GREEN)	146100	UF-07	16N/13E/21	7346	236	104	DG	NO	BR, P	C	ASSN	PROT.	GA	EM, PL	E= 41,	MESO	I	A	NPS, TOX, HAB
										C	ASSN	PROT.	GA	EM, PL	W= 38	OLIG	I	A	NPS, TOX, HAB
LITTLE GREEN LAKE	162500	UF-12	15N/13E/32	466	28	10	SE	NO	BR	C	ASSC, DIST	PLAN, PROT.	R	EM	71	EUTR	II	B	NPS, HAB, TURB
LITTLE TWIN LAKE	146400	UF-07	15N/13E/05	33	10	4	DG	NO	NW				R				II	B	HM, NPS
MANCHESTER MILLPOND	162200	UF-12	14N/12E/15	30	5	NA	DG	NO	NW				R				II	B	NPS, HAB, TURB
MARIA LAKE	161900	UF-11	14N/12E/25	596	6	NA	SE	YES	BR				R				II	B	NPS
PUCKAWAY LAKE	158700	UF-10	15N/12E/18	5039	5	3	DG	NO	BR	C	DIST	PROT.	R	EM	66	EUTR	II	B	
SPRING LAKE	160600	UF-11	14N/11E/14	67	54	16	SP	NO	BR				R				I	B	
SPRING LAKE (SPIRIT)	148100	UF-07	15N/12E/12	75	42	14	DG	NO	BR				R				I	A	
MARQUETTE COUNTY																			
BIRCH LAKE (MOON)	101700	UF-13	15N/09E/01	73	12	5	SE	YES	BR				R	EM			II	B	
BUFFALO LAKE	168000	UF-10	15N/10E/16	2210	8	5	DG	NO	BF		ASSC, DIST		GA	EM			II	B	NPS, HM, CARP, DO, HAB, TURB, TOX
COMSTOCK LAKE	155570	UF-09	16N/10E/11	26	29	12	SE	NO	BR	C			R	EM	43	MESO	I	B	
CRYSTAL LAKE	157300	UF-09	17N/10E/06	124	60	NA	SP	NO	T				R				I	A	ACC, CARP
EMERY LAKE (EMERALD, RICHARDS)	168800	UF-10	15N/09E/17	35	7	3	DG	NO	BR		DIST		R	EM			II	B	NPS
EMRICK LAKE	103300	UF-14	15N/08E/07	37	79	NA	SE	NO	NA				R				I	INS	
ENNIS LAKE (MUIR)	171000	UF-10	14N/09E/14	25	31	13	SE	NO	BR				R	EM			I	A	
HARRIS POND (HARRISVILLE)	165700	UF-13	16N/09E/11	245	10	NA	DG	NO	BR, P				GA				II	B	HM, NPS, HAB, TURB

LAKE NAME	WBIC	WATER SHED #	TOWN/ RANGE/ SECTION	SURFACE AREA (ACRES)	MAX DEPTH (FEET)	MEAN DEPTH (FEET)	LAKE TYPE	WINTER-KILL	ACCESS	SH	LMO	LAKE PLAN OR PROT.	FISH MERCURY (Hg)	MAC	SD TSI	TSI CLASS	P SENS	COMMENTS
KILBY LAKE	104200	UF-13	15N/10E/06	46	29	12	SE	NO	BR	C	DIST		R		39	OLIG	I B	
KNIGHTS LAKE	104300	UF-10	14N/10E/31	25	32	12	SE	NO	R				R				I INS	
LAWRENCE POND	167000	UF-13	16N/08E/09	221	14	8	DG	NO	BF	C	DIST		R		48	MESO	II B	HM, NPS
MADDEN LAKE NO.1 (THOMPSON)	105700	UF-10	14N/10E/17	29	7	NA	SE	YES	NA				R				II INS	ACC
MASON LAKE	175700	UF-14	14N/08E/31	855	9	7	DG	NO	BR	C			R	EM	65	EUTR	II B	NPS, HAB, TURB, DO
MONTELLO LAKE	164300	UF-13	15N/10E/08	286	17	NA	DG	NO	BR		ASSN, DIST		R	EM, PL			II A	
MUD LAKE (MYERS)	106200	UF-13	16N/08E/18	45	5	NA	SE	YES	NA				R				II INS	
MUD LAKE	155700	UF-09	16N/10E/08	61	4	NA	SE	YES	NA				R				II B	
MUD LAKE	155200	UF-09	16N/10E/34	34	2	NA	DG	YES	NA				R				II B	
NEENAH LAKE (OXFORD MILLPOND)	178000	UF-14	15N/08E/17	61	15	NA	DG	NO	BR		DIST		R	EM			II INS	NPS
NESHKORO MILLPOND	149800	UF-08	17N/11E/08	184	9	3	DG	NO	BR				R				II B	HM
PETERS LAKE (ECHO)	106700	UF-13	15N/10E/06	27	18	NA	SE	NO	NA				R				I B	ACC
PINE LAKE	106800	UF-13	17N/08E/20	37	30	NA	SE	NO	NA	C			R		32	OLIG	I B	ACC
SCHOOL SECTION LAKE	107500	UF-13	17N/08E/09	34	12	7	SE	YES	BR				R	EM			II B	DO, WLF
SHARON LAKE	104700	UF-09	17N/09E/01	58	30	10	SE	NO	BR		DIST		R	EM			I B	
SILVER LAKE	107800	UF-13	16N/10E/07	52	10	NA	SE	YES	NA				R				II B	ACC
SPRING LAKE, EAST	155300	UF-09	15N/10E/03	25	49	NA	SE	NO	NA				R	EM			I A	
TUTTLE LAKE	108200	UF-09	17N/10E/22	155	33	7	SE	NO	BR	C	DIST		R		42	MESO	I A	BOATING OVERUSE
WESTFIELD POND	166700	UF-13	16N/08E/12	32	8	NA	DG	NO	R				R				II B	HM
WHITE LAKE	163970	UF-10	15N/10E/01	92	43	NA	SE	NO	NA	C	ASSC, DIST	PLAN-R	R	EM	32	OLIG	I A	ACC, WLF
WILLIAMS LAKE	168300	UF-10	15N/09E/24	62	6	4	DG	YES	R	C	DIST		R	EM	54	EUTR	II INS	NPS, TURB, DO
WOOD LAKE	117600	UF-09	17N/08E/02	91	53	22	SP	NO	BR	C	ASSC		R		32	OLIG	I B	BOATING OVERUSE
WAUSHARA COUNTY																		
CURTIS LAKE	156300	UF-09	18N/09E/28	33	45	NA	DG	NO	BR	C			R		43	MESO	I B	NPS
LUCERNE LAKE (EGANS)	104600	UF-08	18N/11E/20	48	33	NA	SE	NO	BR				R				I B	NPS, WLF
MARL LAKE	105800	UF-08	19N/09E/23	41	34	16	SE	NO	BR	C	DIST	PLAN	R		37	OLIG	I B	NPS

LAKE NAME	WBIC	WATER SHED #	TOWN/RANGE/SECTION	SURFACE AREA (ACRES)	MAX DEPTH (FEET)	MEAN DEPTH (FEET)	LAKE TYPE	WINTER-KILL	ACCESS	SH	LMO	LAKE PLAN OR PROT.	FISH MERCURY (Hg)	MAC	SD TSI	TSI CLASS	P SENS	COMMENTS
MECAN SPRINGS	158600	UF-09	18N/09E/08	41	20	4	SP	NO	BR				R				II B	NPS
WEST BRANCH MILL POND (WHITE R.)	152200	UF-08	19N/09E/25	64	29	NA	SP	NO	NA		DIST		R				II A	ACC
PICKEREL LAKE	151000	UF-08	18N/10E/27	28	51	NA	SE	NO	NA				R				I	INS
PLEASANT LAKE	106900	UF-09	18N/08E/33	127	30	15	SE	NO	BR	C	Y	PLAN	GA		37	OLIG	I B	NPS, WLF, USE CONFLICT
ROUND LAKE	107100	UF-08	19N/10E/19	26	14	NA	SE	YES	NA		ASSC		R				I B	ACC, WLF
SPRING LAKE	149000	UF-08	18N/11E/23	40	37	22	SP	NO	BR				R	EM			I B	NPS, SB
WAUTOMA POND	152700	UF-08	19N/10E/34	35	12	NA	DG	YES	T				R	PL			II	INS NPS
WHITE RIVER FL (LOWER POND)	151500	UF-08	18N/10E/24	133	20	6	DG	NO	BR	C	ASSC		R		41	MESO	II	INS HM, NPS
WITTERS LAKE	117400	UF-08	18N/10E/15	51	18	4	SE	YES	BR	C	ASSC		R		41	MESO	I A	WLF
WINNEBAGO COUNTY																		
BUTTE DES MORTS LAKE	139900	UF-04	18N/16E/10	8857	9	NA	DG	NO	BR	C	Y	PLAN-R	GA	EM, PL	69	EUTR	II B	NUT, SED, ZM
HOGERS BAYOU (MARTIN)	140500	UF-05	18N/14E/12	51	4	NA	DG	NO	NW				R				II	INS
RUSH LAKE	141400	UF-05	17N/14E/13	3070	5	NA	DG	YES	BR			PLAN-R	R				II	INS DO, TEMP, HM, CARP
UNNAMED LAKE	139600	UF-08	18N/16E/23	28	5	NA	DG	YES	NW				R				II	INS

NONPOINT SOURCE RANKING

Each watershed has been provided a nonpoint source ranking based on the importance of nonpoint source pollution in the watershed and whether it is likely that water quality could improve with control of the sources. The ranking criteria are listed below:

- Nonpoint sources of pollution exist.
- The nonpoint source pollution impacts water quality.
- The problem can be controlled and/or corrected through best management practices.

Table 7 lists the nonpoint ranking for the watersheds of the Upper Fox River Basin and which watersheds had a Priority Watershed Project initiated to control nonpoint pollution. The Priority Watershed Program is no longer selecting new watershed projects. Those currently in existence are being permitted to complete their ten-year life cycle. Three of the four watersheds selected as priority watershed projects in the basin are still active.

Groundwater contamination potential ranking by watershed is also included in Table 7. The rankings were calculated by land coverage and groundwater quality based on sampling. Groundwater contaminants used for the ranking included nitrates and pesticides, as these are common non-point source contaminants. A score of 20 or more is considered medium. At 30 or greater, the score is considered high for groundwater contamination potential. Accordingly, all watersheds in the basin are considered to be high for groundwater contamination potential.

Table 7. Rankings for Nonpoint Sources

Watershed Code	Watershed Name	Overall Rank	Ranking			Priority Watershed Status	Watershed Drains To:	
			Streams	Lakes	Groundwater		TMDL Sites Full/Partial	Surface Drinking Water
UF-01	Lake Winnebago North/West	High	High	NA	92.04			X
UF-02	Lake Winnebago East	High	High	NA	89.59	Active		X
UF-03	Fond du Lac River	High	High	NA	81.15	Active	Partial	X
UF-04	Lac Buttes des Morts South	High	High	NA	81.25			X
UF-05	Fox River/Rush Lake	High	High	High	76.57			X
UF-06	Fox River/Berlin	Medium	Medium	NA	56.09			X
UF-07	Big Green Lake	High		NR	73.73	Closed	Partial	X
UF-08	White River	Medium	NR	NR	33.73			X
UF-09	Mecan River	Medium	NR	NR	35.89			X
UF-10	Buffalo and Puckaway Lakes	High	Medium	NR	40.75			X
UF-11	Lower Grand River	High	NR	NR	60.64			X
UF-12	Upper Grand River	Medium	Medium	NR	77.09			X
UF-13	Montello Creek	Medium	Medium	NR	39.34			X
UF-14	Neenah Creek	High		NR	47.67	Active		X
UF-15	Swan Lake	Medium	Medium	NR	65.71			X

* = Small scale watershed project recommended.

NA = Not Applicable, NR = Not Ranked

STREAMS NARRATIVES AND TABLES

Watershed tables are an excellent tool to locate background data on a particular stream in a specific watershed. These tables summarize what is currently known about each stream and whether it is meeting its biological potential. An explanation of the streams tables is included below.

How to Use the Streams Tables

The following explains the information used in the stream tables. *Note: A blank space anywhere in the table means that data is unassessed or unavailable.*

Stream Name: All named streams and some unnamed streams are listed. Stream names are those found on U.S. Geological Survey (USGS) quadrangle maps unless the Wisconsin Geographic Names Council has established a different name. Unnamed streams are identified by location of the stream mouth as indicated by township, range, section, and quarter-quarter section.

Waterbody Identification Code (WBIC): All waterbodies have been assigned a waterbody identification code by the state to help in identifying streams and stream locations. [Find the WBIC in the Register of Waterbodies]

Length: The stream length is either the total length of the stream or the starting and ending mile of the portion of the stream described based on the Master Waterbody System, developed from a Fish Distribution Study conducted by the Bureau of Research (WDNR Research Report 126, 1984). The stream mile at the stream mouth is zero ("0") and increases as one moves upstream.

Existing Use: This column indicates the biological use that the stream or stream segment currently supports. This is not a designation or classification; it is based on the current condition of the surface water and the biological community living in that surface water. Information in this column is not designed for, and should not be used for, regulatory purposes. In cases where the existing use is unknown, "UNK" was entered. The biological use categories are defined in NR102(04)(3) under fish and aquatic life uses, which are the same categories used to describe the stream's codified use. The following abbreviations for existing stream uses are used in the table. See also *Guidelines for Designating Fish and Aquatic Life Uses for Wisconsin Surface Waters (6/98 Draft)*. *This draft guidance should be used for determining existing and potential use for Cold (generally), WWSF, WWFF, LFF, and LAL. Until this draft is formally adopted, the categories listed below will be used, as opposed to the proposed revisions incorporating CWT-1-3, CWF, and GLM waters.*

COLD Cold Water Community; includes surface waters that are capable of supporting a community cold water fish and other aquatic life or serving as a spawning area for cold water fish species. The cold water community may be indicated by a trout class based on the document, *Wisconsin Trout Streams* (DNR Publ. 6-3600[80]). The approximate length or portion of stream meeting each of the use classes is indicated.

CLASS I high-quality stream where populations are sustained by natural reproduction;

CLASS II stream has some natural reproduction, but may need stocking to maintain a desirable fishery;

Class III stream has no natural reproduction and requires annual stocking of legal-size fish to provide sport fishing.

WWSF Warm Water Sport Fish Communities; includes waters capable of supporting a community of warm water sport fish or serving as a spawning area for warm water sport fish.

WWFF Warm Water Forage Fish Communities; includes surface waters capable of supporting an abundant, diverse community of forage fish and other aquatic life.

LFF Limited Forage Fishery (intermediate surface waters); includes surface waters of limited capacity due to low flow, naturally poor water quality or poor habitat. These surface waters are capable of supporting only a limited community of tolerant forage fish and aquatic life.

LAL Limited Aquatic Life (marginal surface waters); includes surface waters severely limited because of low flow and naturally poor water quality or poor habitat. These surface waters are capable of supporting only a limited community of aquatic life.

Potential (Attainable) Use: This column indicates the biological use that the investigator believes the stream or stream segment could achieve through proper management of "controllable" pollution sources. Beaver dams, hydroelectric dams, low gradient streams, and naturally occurring low flows are generally not problems that can be controlled. The potential (or attainable) use may be the same as the existing use or it may be higher. Abbreviations for "potential use" are the same as those used in the "existing use" column. Information sources used to determine stream potential are indicated by footnotes in each table. Unless otherwise noted, the source for trout streams was *Wisconsin Trout Streams* (DNR Publ. 6-3600[80]), Wis. Adm. Code NR102.10 and NR102.11, and the professional judgment of WDNR personnel.

Codified Use: This is the waterbody's classification that is formally and legally recognized by Wis. Adm. Code NR102 and 104. This column shows the classification that will be used to determine water quality criteria and effluent limits. A stream can obtain a codified use by applying formal stream classification procedures, which were revised in 1996. Classifications in this column are derived from:

1. Streams classified in NR102 and NR104.
2. Trout streams as defined by *Wisconsin Trout Streams* (1980) and listed in NR 104.
3. ORW and ERW streams officially approved as such by the WDNR board and listed in NR102.10 and NR102.11. [In addition, a stream's fish and aquatic life use designation is in this column. Officially, ORW/ERW waterbodies are not fish and aquatic life use designations, but are a separate category for the WDNR antidegradation program. These waterbodies also receive a fish and aquatic life use designation for the purpose of determining water quality criteria.] *All other waters will be codified **Warm Water Sport Fishery (WWSF) which is the default (DEF) classification.***

Streams that are listed in a wastewater permit as "cold," that are not codified as a cold water fish and aquatic life use should not be listed as cold in the codified classification column. The codified class for these streams should be the "default."

Streams classified as trout streams under 1.02(7) by the Bureau of Fisheries Management since publication of *Wisconsin Trout Streams* (1980), are not formally classified as trout waters.

These streams must appear in NR102 and/or NR104 to formally be classified as trout waters. Streams and stream segments not yet added to the code, however, are classified with the "default" code used for streams and stream segments (WWSF).

Streams classified as ORW and ERW in NR102.10 and NR102.11:

Outstanding Resource Waters have excellent water quality and high-quality fisheries. They do not receive wastewater discharges; these point source discharges will not be allowed in the future unless the quality of such discharges meets or exceeds the quality of the receiving water. This classification includes national and state wild and scenic rivers and the highest quality CLASS I trout streams.

Exceptional Resource Waters have excellent water quality and valued fisheries, but may already receive wastewater discharges or may receive future discharges necessary to correct environmental or public health problems.

Supporting Potential Use: This column indicates whether a stream is threatened or is fully, partially, or not meeting its potential biological use. An entry in this column shows the relationship between the stream's current and potential biological use. To determine if a waterbody or segment supports a potential use, one or more of the following is used: chemical, physical (habitat, morphology, etc.), or biological information, direct observation and/or best professional judgment. When biological data contrary to chemical or physical data exists, the biological data overrides the other data.

Fully Supporting "FULLY"

A stream or stream segment's existing biological use is the same as its potential biological use (E = P). This includes stream or stream segments that are *not affected* and stream or stream segments that have *culturally irreversible* impacts. An example of culturally irreversible impacts are those effects in a river system with an "optimally operating" dam--a dam that operates with minimal to no effect on the fish and aquatic life community assemblage, productivity, and diversity. Note that fairly to poorly operating dams are not considered "culturally irreversible" and their effect on biological resources is factored into the use support designation (see partially supporting).

Fully Supporting/Threatened "FULLY-THR"

A stream or stream segment's existing biological use is the same as its potential biological use (E = P), but there is a *clear and imminent* "threat" to the existing use remaining at its current level of biological productivity and ecological health. This threat could be due to actions likely to occur on or to the stream and/or in the watershed, such as:

- Rapid commercial, residential, and/or industrial development in the watershed,
- The advent of large-scale industrial operations in the watershed,
- Planned or active channel modifications that have been, or will be permitted, or cannot be regulated under existing state or federal rules (i.e., drainage districts).

Partially Supporting "PART"

A stream or stream segment's existing biological use is the same as its potential biological use, except that implementation of management practices could enhance the overall ecological health of the biological community. Management practices in this category include modification of hydro-regimes to reduce the impact of dam operations on the biological community.

Thus, E = P, but the potential use assessment is below the stream or stream segment's maximum biological potential and this "less than optimal" condition is reversible.

Not Supporting "NOT"

When a stream or stream segment's existing biological use is less than its potential biological use by a factor of 1 or more of the following codified use classifications:

Cold (includes Cold I, II, IIN, and III in one group);

WWSF

WWFF

LFF

LAL

Thus, $E < P$, with problems considered reversible by implementation of management actions.

Miles Assessed -- Monitored, Evaluated, or Unassessed: To substantiate the Use Support designation of "fully," "partially," "not," or "threatened," the terms monitored, evaluated, or unassessed are defined as the following:

Monitored: A stream has been "monitored" for the purposes of Wisconsin water quality management plans and/or Wisconsin's Water Quality Assessment Report to Congress (305[b]) if:

- Site-specific data has been collected on that stream or stream segment in the past five years; For the purposes of this document, data is defined as structured information gathered to assess the quality or integrity of a resource. Data from outside the WDNR can be used to help determine the quality or integrity of waters in the State of Wisconsin.
- The data are adequate to develop a best professional judgment about the existing and potential biological use of that stream or stream segment;
- The data should be adequate to judge the difference between the "existing" versus "potential" biological use for that stream or stream segment. This information is used to determine if the Existing Biological Use matches or supports the Potential Biological Use "fully," "partially," or "not:"--and if that use is "threatened."

Evaluated: A stream has been "evaluated" if information other than site-specific data is adequate to determine a Potential Biological Use and to determine if the stream is currently meeting that level of biological use.

Sources of "evaluated" information include:

- Site-specific data that is more than five years old,
- Information on file provided by the public or others,
- Best professional judgment of a WDNR biologist or a WDNR fish manager.

Unassessed: A stream has been not been assessed.

Use Problems, Source/Impact: This column indicates probable sources of pollution in the stream and types of water quality problems present (impact). All streams other than FULLY or UNKNOWN will show use problems and impacts in this column. These situations are usually explained in the narrative. Following is a key to abbreviations in the stream tables:

Source (cause of problem) - This is the source of threat or impairment. Be as specific as possible.

ACC - No or limited access

CM - Cranberry marsh

BDAM - Beaver dam

DRDG - Dredging
EX - Introduced species
F - Forestry activities (logging, logging roads, stream crossings)
HM - Hydrological modification (dam, ditching, wetland drainage)
LF - Landfill
NMM - Non-metallic mining
NPS - Unspecified nonpoint sources
Specified Nonpoint sources:
CL - Cropland erosion
SB - Streambank erosion
PSB - Streambank pasturing
PWL - Woodlot pasturing
BY - Barnyard or exercise lot runoff
CE - Construction site erosion
RS - Roadside erosion
URB - Urban storm water runoff
DEV - Intense development pressure
PSM - Point source, municipal treatment plant discharge
PSI - Point source, industrial discharge
MS - Mine wastes and/or roaster piles

Impact (effect or impact of source on a stream) - Variously known as the cause, impact or stressor, this column lists the effect on the stream as a result of the source.

Ad - Animal deformity
Bac - Bacteriological contamination
Cl - Chlorine toxicity
Com - Competition (i.e, encroachment by introduced species)
DO - Dissolved oxygen
Fad-Sa - Waters with special fish consumption advisories
Flow - Stream flow fluctuations caused by unnatural conditions
Hab - Habitat (in-stream sedimentation, scouring, etc.)
Hm - Heavy metal toxicity
Mac - Undesirable rooted aquatic plant (macrophyte) or algal growth
Mig - Fish migration interference
NH₃ - Ammonia toxicity
Nut - Nutrient enrichment
Org- Organic chemical toxicity or bioaccumulation
PCB - PCB bioaccumulation
pH - pH (fluctuations or extreme high or low)
Pst - Pesticide/herbicide toxicity
Sc - Sediment contamination
Temp - Temperature (fluctuations or extreme high or low)
Tox - General toxicity problems
Turb - Turbidity

Trend: This column is based upon best professional judgment or by comparing data from past plans to find that a waterbody has improved or declined in relation to previous assessments. This decline/improvement should not be the result of gaining data, but a relative assessment of

changes occurring on the waterbody. The stream may be improving (I), stable (S), declining (D) or unknown (U).

Comments: This column contains a "N" if there is a narrative for the stream, and/or a "R" if there is a management or monitoring recommendation. A detailed recommendation is included in the narrative section for the watershed. Any recommendation specific to a stream should be addressed with a narrative. Overall narratives for a watershed can sufficiently cover general recommendations such as for watershed wide data collection. Other comments may be included in this column and will be described in footnotes at the bottom of the table, such as the stream's inclusion in a priority watershed project (PW), listing as a critical habitat (CH), or a site containing endangered species (ES), etc.

Data Level: This column indicates what level of data was used to make decisions on this stream/segment. Ideally, the number is a composite of physical, chemical, biological and habitat data. United States Environmental Protection Agency provided additional guidance on how to fill out this column.

References: The reference material used to complete the table for each stream is indicated by a number. A numeric list of references is provided for each watershed. Streams for which there are recommendations or identified water quality impairments should have at least one reference listed in this column.

LAKE WINNEBAGO NORTH AND WEST WATERSHED (UF-01)

This watershed is located along the west and north shore of Lake Winnebago from Oshkosh to just west of High Cliff State Park. It includes portions of the Cities of Oshkosh, Neenah, and Menasha. The watershed has approximately 15 miles of frontage on Lake Winnebago. Land use is best characterized as urban commercial, industrial, and residential land uses with limited agricultural uses.

There is considerable established urban area in the watershed. Additional development is also occurring, particularly along the U.S. Highway 41 corridor. Numerous urban stormwater outfalls discharge to Lake Winnebago from portions of the Cities of Oshkosh, Neenah, and Menasha. Storm event runoff from commercial, industrial, and residential construction sites and from plat developments in rapidly developing sections of Oshkosh, Neenah, and Menasha are also nonpoint source pollution problems. These sites produce substantial amounts of runoff during snowmelt and storm events. The runoff carries sediment, nutrients, and other pollutants via intermittent drainageways and roadside ditches to Lake Winnebago. Both agricultural and urban runoff may be negatively affecting water quality of this lake. Critical soil erosion from agricultural sources has been estimated as being 3 or more tons per acre per year (Bruch, 1988). Additional modeling or monitoring may be needed to fully assess the extent of this problem.

Table 8. Lake Winnebago North and West Watershed (UF-01) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Oshkosh, City WWTF	0025038 3/31/2006	Fox River	LAL	840 cfs	Municipal	
Mercury Marine	0047619 3/31/2002	Lake Winnebago	WWSF	NA	Outboard Motors	

Water quality modeling done by Northeast Wisconsin Waters of Tomorrow (NEWWT) have indicated this watershed to be a major contributor of phosphorus and suspended solids to Lake Winnebago (WDNR, 1994). This watershed was ranked "High" for streams prior to the watershed boundary changes. Since data were collected on streams outside the current boundary, the watershed and streams are similar in nature, the rank of "High" will remain.

Table 9. Lake Winnebago North and West Watershed (UF-01)

Area (sq. miles): 61.1

Counties: Winnebago and Calumet

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Unnamed Tributary 21-1	131200	2	LAL ^e	2	UNK		DEF			HM	Mig		N		
Unnamed Streams (-)		3													

Total Stream Miles: 5

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/0	COLD/0
	WWSF/0	WWSF/0
	WWFF/0	WWFF/0
	LFF/0	LFF/0
	LAL/2	LAL/2
	UNK/3	UNK/3

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (WDNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104 but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

LAKE WINNEBAGO EAST WATERSHED (UF-02)

The Lake Winnebago East watershed extends along the east shore of Lake Winnebago in Calumet and Fond du Lac Counties. It is predominately an agricultural watershed, but does include more than 1/3 of the City of Fond du Lac as well as the rapidly developing area to the east of Fond du Lac on the west slope of the Niagara Escarpment. Most of the streams originate from springs along the Niagara Escarpment. These streams are generally short with steep gradient until just before they reach Lake Winnebago. Critical animal waste and soil erosion problems are intensified by the steep slopes along the Niagara escarpment in this watershed. Average soil loss in all of Calumet County is estimated to be 2.7 tons per acre. These factors accelerate nutrient and sediment delivery to Lake Winnebago. Both the Winnebago Comprehensive Management Plan (Bruch, 1998) and the Lower Green Bay Remedial Action Plan identified this watershed as a high priority for the control of nonpoint sources of pollution.

Table 10. Lake Winnebago East Watershed (UF-02) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Eden WWTF	0030716 3/31/2004	Trib. to Deneveu Cr.	LFF	0.04 cfs*	Municipal	
Chiquita Processed Foods	0000485 3/31/2003	Trib. to Deneveu Cr.	LFF	0.04 cfs	Canning	
Stockbridge WWTF	0021393 9/30/2004	Mud Creek	LAL	0 cfs	Municipal	

(* = Q_{7,10} is estimate from 1979 Low-Flow Characteristics of Wisconsin Streams at Sewage Treatment Plants. The 1992 edition of this publication makes no flow estimate because flow is primarily effluent.)

The City of Fond du Lac suffers stormwater peak flow problems. This is primarily due to its location; set in a topographical depression next to a lake. The flatness of the terrain does not allow water to drain quickly. This problem is magnified by continued development along the eastern and southern fringe of the city in the watershed. Increasing amounts of impermeable surfaces such as new roads, parking lots, and driveways may be increasing peak flows in the city as well as areas outside the city. The City of Fond du Lac received a grant through the priority watershed project in 1996 to develop a comprehensive stormwater management plan. Other information regarding the City of Fond du Lac will be found in the narrative section of the next watershed, the Fond du Lac River watershed (UF-03).

The watershed was selected as a nonpoint source priority watershed project in 1989. The primary goals of this watershed project are to reduce Phosphorus and sediment loading to Lake Winnebago and decrease the loading of heavy metals from urban nonpoint sources. For a more detailed description of the project, including water quality goals and existing water quality conditions for all surface waters in the watershed, please see A Nonpoint Source Control Plan for the Lake Winnebago East Priority Watershed Project (Blake and Prey, 1994).

REFERENCES

1. Wisconsin Department of Natural Resources. Water Resources Management Files - Northeast Region. 1996.
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3. Blake, Tom and Jeff Prey. A Nonpoint Source Control Plan for the Lake Winnebago East Priority Watershed Project. Wisconsin Department of Natural Resources. 1994.
4. Bruch, Ronald. Winnebago Comprehensive Management Plan. Wisconsin Department of Natural Resources. 1988.
5. Fox-Wolf Basin Nonpoint Source Pollution Abatement Initiative (Draft). Wisconsin Department of Natural Resources. 1994.
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7. Fond du Lac County Erosion Control Plan. Fond du Lac County Land Conservation and Planning Departments. 1989.
8. Fix, Steven M. and Lloyd Lewis Eagan. Upper Fox River Water Quality Management Plan. Wisconsin Department of Natural Resources. 1990.
9. Johnson, Brad. Basin Assessment Report (Draft). Wisconsin Department of Natural Resources. 1996.

Table 11. Lake Winnebago East Watershed (UF-02)

Area (sq. miles): 143

Counties: Fond du Lac and Calumet

Stream Name	WBIC	Length (mile)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
De Neveu Creek	138700	0-4.8	WWSF ^e	4.8	WWSF ^e	4.8	DEF	PART 4.8	M	NPS, HM	Hab, Sed, Turb, Mig				1, 3, 6, 8 1, 3, 6, 8
		4.8-11	WWFF ^e	6.2	WWFF ^e	6.2	DEF	PART 6.2	M						
		11-12	LAL ^e	1.0			DEF								
Johnson Creek	131900	1.0	WWFF ^e	1.0	WWFF ^e	1.0	DEF	PART 1.0	M	NPS	Hab, Sed, Turb				3, 6
Mill Creek	131500	4.0	WWSF ^a	4.0	WWSF ^a	4.0	WWSF	PART 4.0	M	NPS	Hab, Sed, Turb				3, 6
Mud Creek	131600	1.5	WWFF ^e	1.5	WWFF ^e	1.5	DEF	PART 1.5	M	NPS	Hab, Sed, Turb				3, 6
		1.5	WWSF ^e	1.5	WWSF ^e	1.5	LFF	PART 1.5	M						
Pipe Creek	132800	0-0.5	WWSF ^e	0.5	WWSF ^e	0.5	DEF	PART 0.5	E, M	NPS	Hab, Sed, Turb				3, 6, 8
		0.5-3	WWFF ^e	2.5	WWFF ^e	2.5		PART 2.5							
Roberts Creek	131700	2.0	WWFF ^e	2.0	WWFF ^e	2.0	DEF	PART 2.0	M	NPS	Hab, Sed, Turb				3, 6
Stockbridge Trib. To Mud Creek		0.6	LFF ^{e,f}	0.6	LFF ^{e,d}	0.6	LAL	PART 0.6	M	NPS, PSM	Hab, Sed, Turb, DO				
Taycheedah Creek	138400	10	WWSF ^e	10.0	WWSF ^a	10.0	DEF	PART 10.0	E, M	NPS,	Hab, Sed, Turb				1, 3, 6, 8
Unnamed Streams		29.4								NPS, HM ^h	Hab, Sed, Turb, Mig ^h				
Unnamed 2-11		3.0	LFF ^e	3.0	UNK		DEF								8

Total Stream Miles: 68

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/0	COLD/0
	WWSF/20.8	WWSF/20.8
	WWFF/13.2	WWFF/13.2
	LFF/3.6	LFF/3.6
	LAL/1	
	UNK/29.4	UNK/29.4

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (WDNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

^fRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is stream is seasonal WWSF March-April.

^hRecent research has revealed the presence of dams that are limiting fish migration and potentially raising water temperatures.

FOND DU LAC RIVER WATERSHED (UF-03)

The Fond du Lac River watershed is the second largest watershed in the Upper Fox River Basin with an area of about 225 square miles. It is located along the southern and southwestern shore of Lake Winnebago and includes all the streams flowing to the lake between Oshkosh and Fond du Lac in Fond du Lac and Winnebago Counties.

The predominant land use in the watershed is agriculture, with cash crop and dairy farming being the principle types of agriculture. Many water quality and instream habitat problems in the watershed are attributable to agricultural practices. Barnyards adjacent to streams, grazing and trampling of stream banks, and fall tillage practices appear to be the main problems. Wetland areas have been ditched and drained. Many of the streams have been also been ditched to facilitate field drainage.

There are large and growing urban areas in the watershed. Major urban areas in the watershed include large parts of the Cities of Fond du Lac and Oshkosh and a corridor along the lakeshore and USH 41 between Oshkosh and Fond du Lac. Other urban areas in the watershed include North Fond du Lac, Oakfield, and Rosendale. Erosion from road construction and commercial and residential construction sites delivers significant amounts of sediment to surface waters.

Table 12. Fond du Lac River Watershed (UF-03) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Fond du Lac WWTF	0023990 3/31/2004	Lake Winnebago	WWSF	NA	Municipal	
Oakfield WWTF	0024988 12/31/2005	Campground Creek	COLD Class II	1.8 cfs	Municipal	
Rosendale WWTF	0028428 6/30/2002	Rosendale Trib. to W. Br. Fond du Lac River	WWFF	<0.01 cfs	Municipal	
Saputo Cheese USA - Fond du Lac	0000132 9/30/2002	W. Br. Fond du Lac R.; Groundwater	WWSF; NA	0 cfs; NA	Dairy Processing	
Saputo Cheese USA - Fond du Lac	0056120 12/31/2006	Lake Winnebago (Lakeside Park Lagoon)	WWSF	NA	Cheese Processing	
Power Packaging - Rosendale	0069965 9/30/2005	Groundwater	NA	NA	Juice Processing/Packaging	
Friday Canning - Oakfield	0002267 9/30/2004	Campground Cr.; Groundwater	WWSF; NA	1.8 cfs; NA	Canning	N

This watershed became a nonpoint source pollution abatement priority watershed project in 1996. Many of the nonpoint source water quality problems in the watershed are being addressed through this project. A nonpoint source appraisal monitoring report was completed in early 1997. The nonpoint source priority watershed plan was completed shortly afterward. That plan contains more detail on nonpoint source related water resources problems and includes specific recommendations to address these problems.

Fond du Lac - The City of Fond du Lac has a population of 42,203 according to the 2000 census. About two-thirds of the city is in the Fond du Lac River watershed, with the rest being in the Lake Winnebago East watershed (see above). The city sits in the lowest part of its surrounding watershed. Increasing urbanization increases impermeable surface areas leading to increased stormwater flows in streams and channels. Fond du Lac officials believe that part of their problem is due in part to increased stormwater peak flows in developing parts of the city and its environs. Construction site erosion is a problem in the developing parts of the city. The

city received a grant from the Lake Winnebago East Priority Watershed project to begin to address stormwater management (WDNR SCR-Files, 1996).

The Fond du Lac Wastewater Treatment Facility (WWTF) is a regional facility discharging treated effluent to Lake Winnebago. The city has a stormwater quantity and quality problem in that the existing storm sewer system cannot fully handle peak flows during major rain events. Both the storm sewer and sanitary sewer systems are old and located in close proximity, particularly in the older parts of the city. Because of the age and proximity of the systems, it is thought that water leaking from one system gets into the other. The city's wastewater treatment system has a history of bypassing sewage into Lake Winnebago and sewage backing up into basements during wet weather (Roemer, 1996). This is a concern as Lake Winnebago is a drinking water source for about 100,000 people. Fond du Lac has made significant strides in upgrading its sewer systems and identifying problem areas. They have budgeted over 1 million dollars a year for sewer replacement and bypassing occurs much less frequently as a result. Fond du Lac has initiated a program to upgrade both sewer systems and to improve treatment (WDNR SCR-Files, 1996).

WATER QUALITY DESCRIPTIONS

Campground (Byron) Creek - Campground Creek rises from several springs at the base of the Niagara escarpment in southeast Fond du Lac County (Weber et al., 1969). It is considered a Class II trout stream from Fond du Lac CTH Y to a point near its headwaters, approximately 3.3 miles upstream (WDNR, 1980). The stream has a good gradient through this reach. The gradient flattens and the stream is dominated by a warm water forage fishery downstream of CTH Y. Nonpoint sources of pollution, particularly bank erosion due to cattle grazing, are the main water quality problem in the trout waters reach. Sedimentation from farm tillage practices is also a problem in the downstream reach. Runoff due to excessive stray irrigation by a canning company near Oakfield has occasionally reached the stream and caused water quality problems. There are also some unnamed tributaries to the creek which have intensive agricultural operations on land adjacent to them. Some of these operations may be affecting water quality in Campground Creek (WDNR SCR-Files, 1996).

Fond du Lac River - The Fond du Lac River is formed by the juncture of the East and West Branches of the Fond du Lac River in the City of Fond du Lac. It flows approximately 2 miles to Lake Winnebago. It is a totally urban waterway whose pollutant load includes the urban and rural loading of the East and West Branches. There are a number of industries either along the stream or nearby which contribute stormwater runoff to the river. Fond du Lac River water was used as background control water during bioassay monitoring done at the Galloway West Company (currently Saputo Cheese USA, Inc.) facility in Fond du Lac. Organisms in the control water failed the chronic toxicity test indicated there may be some problem with water quality in the river. Additional monitoring will be done to try to determine if this "failure" of the chronic toxicity test was an anomaly or if nonpoint sources of pollution are causing the problem (WDNR SCR-Files, 1996).

Fond du Lac River, East Branch - The East Branch of the Fond du Lac River rises in south central Fond du Lac County and flows northeasterly to its junction with the West Branch in the City of Fond du Lac. There is intense agriculture throughout much of the watershed. Runoff from plowed fields and barnyards and erosion of heavily grazed and exposed stream banks along the East Branch and its tributaries are adding tons of sediment and nutrients to the river and to Lake Winnebago. Critical soil erosion rate from agricultural lands has been estimated as being 6

tons per acre per year. The East Branch is the largest single sediment contributor to Lake Winnebago (Bruch, 1988).

Fond du Lac River, West Branch - The West Branch of the Fond du Lac River rises in northwest Fond du Lac County and flows generally southeast to its confluence with the East Branch. Historically, flow in the river has been a problem. The West Branch has four distinct reaches. The first reach is the upper headwater reach, including all its tributaries above Eldorado Marsh. The second reach is contained within Eldorado Marsh. The third reach is from Eldorado Marsh to the City of Fond du Lac, while the fourth reach is in the City of Fond du Lac.

The reach above Eldorado Marsh has a relatively flat gradient. There are numerous small wetland complexes and areas of drained wetlands. Many of the unnamed tributaries and drainageways have been ditched or straightened. There are areas of very intensive farming, but there are also large areas of farmland which have been set aside as part of the Conservation Reserve Program (CRP). The seemingly large CRP lands in the sub-watershed of this reach act as buffers to the stream in many areas. Water quality is good enough to allow wild rice to be present in the stream channel at at least one location above Eldorado Marsh (WDNR SCR-Files, 1996). All the CRP land also reduces the amount of sediment and nutrients that would otherwise find their way into Eldorado Marsh. There is a dam on the river at the Community of Eldorado. Ownership of the dam is unclear according to WDNR records. As a result, it is unknown how the dam is being managed or ought to be managed.

The Eldorado Marsh reach of the river is within the boundaries of the Eldorado State Wildlife Area. There is a water control structure that is used to manipulate water levels and control flow out of the marsh. The marsh acts as a sediment and nutrient sink, where much of the incoming sediment is deposited.

The reach of the river from State Highway 23 at the south edge of the wildlife area downstream to U.S. Highway 41 has a steeper gradient and possesses a series of runs and riffles. Instream habitat looks very good and perhaps may be capable of supporting a smallmouth bass fishery (WDNR SCR-Files, 1996). There is not as much intensive agriculture in this reach and there is rural, low density residential development along portions of the river that may be offering even more buffer from agricultural nonpoint source impacts. Macroinvertebrate monitoring indicate fair to good water quality conditions (Sorge, 1996).

The reach from USH 41 to its confluence with the East Branch is an urban stream. There are urban nonpoint sources of pollution which affect the water quality of the stream.

Parsons Creek - Parsons Creek is a small tributary to the East Branch of the Fond du Lac River. The stream, originating along the Niagara escarpment, is designated as Class I trout water for 1.9 miles of its length and is an Exceptional Resource Water. An additional 2.4 miles of the stream is classified as Class II trout waters (WDNR, 1980). The reach above Hickory Road flows through a wetland and a small county park and appears to have good water quality. There is an unnamed tributary from the east that joins Parsons below the wetland. This tributary had good water quality at one time (Weber et al., 1965). Recent macroinvertebrate monitoring indicating poor water quality conditions (Sorge, 1996). Below Hickory Road, the stream is heavily affected by agricultural practices, particularly barnyard runoff and excessive grazing along the stream's banks.

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1. Wisconsin Department of Natural Resources. Water Resources Management Files - South Central Region. 1996.

2. Wisconsin Department of Natural Resources. Wastewater Management Files - South Central Region. 1996.
3. Wisconsin Trout Streams. Wisconsin Department of Natural Resources. 1980.
4. Bruch, Ronald. Winnebago Comprehensive Management Plan. Wisconsin Department of Natural Resources. 1988.
5. Fox-Wolf Basin Nonpoint Source Pollution Abatement Initiative (Draft). Wisconsin Department of Natural Resources. 1994.
6. Fond du Lac County Erosion Control Plan. Fond du Lac County Land Conservation and Planning Departments. 1989.
7. Weber, John J., Paul T. Schultz, Lee T. Kern, and C.W. Threinen. Surface Water Resources of Fond du Lac County. Wisconsin Department of Natural Resources. 1969.
8. Fix, Steven M. and Lloyd Lewis Eagan. Upper Fox River Water Quality Management Plan. Wisconsin Department of Natural Resources. 1990.
9. Sorge, Michael. Unpublished Appraisal Monitoring Data. Wisconsin Department of Natural Resources. 1996.
10. Sorge, Michael. Personal Communication. Wisconsin Department of Natural Resources. 1996.
11. Roemer, William. Personal Communication. City of Fond du Lac. 1996.
12. Webster, Mary Jo. Personal Communication. Wisconsin Department of Commerce. 1996.

Table 13. Fond du Lac Watershed (UF-03)

Area (sq. miles): 225.6

Counties: Fond du Lac and Winnebago

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Anderson Creek	133300	0-0.2 0.2-5.0	WWSF ^e LFF ^e	0.2 4.8	WWSF ^e LFF ^e	0.2 4.8	DEF DEF	PART 0-0.2 PART 4.8	M M	NPS	Hab, Sed, Turb				1, 7, 8, 9
Campground Creek	137400	0-5.0 5.0-8.3	WWSF ^e COLD ^b CLASS II	5.0 3.3	WWSF ^e COLD ^b CLASS II	5.0 3.3	WWSF COLD	PART 5.0 PART 3.0	M M	NPS, HM ^h	Hab, Sed Mig ^h		N, R		1, 2, 3, 7, 8, 9
E. Br. Fond du Lac River	135900	14.5	WWSF ^e	14.5	WWSF ^e	14.5	DEF	PART 14.5	M	NPS, HM ^h	Hab, Sed, Turb, Mig ^h		N		1, 7, 8, 9
Fond du Lac River	133700	2.0	WWSF ^a	2.0	WWSF ^a	2.0	WWSF	PART 2.0	M	PSI, SS, URB, HM	Hab, Sed, Turb, Mig		N, R		1, 2, 7, 8, 9
Mosher Creek	133500	0-0.2 0.2-3.0	WWSF ^e LFF ^e	0.2 2.8	WWSF ^e LFF ^e	0.2 2.8	DEF DEF	PART 0.2 PART 2.8	E M	NPS	Hab, Sed, Turb				1, 7, 8, 9
Parsons Creek	136000	0-2.4 2.4-4.3 4.3-6.0	COLD ^b COLD ^b LFF ^e	2.4 1.9 1.7	COLD ^b COLD ^b UNK	2.4 1.9 1.7	COLD ERW DEF	NOT 2.4 PART 1.9	M M E	NPS	Hab, Sed, Turb		N		1, 3, 7, 8, 9
Sevenmile Creek	136800	11	LFF ^e	11	LFF ^e	11	DEF	PART 11	M	NPS, HM ^h	Hab, Sed, Turb, Mig ^h				1, 7
Van Dyne Creek	132600	0-1.0 1.0-8.0	WWSF ^e LFF ^e	1.0 7.0	WWSF ^e LFF ^e	1.0 7.0	DEF DEF	PART 1 PART 7	M M	NPS	Hab, Sed, Turb				1, 7, 8, 9
W. Br. Fond du Lac River	134000	26.0	WWSF ^e	26.0	WWSF ^e	26.0	DEF	PART 26.0	M	NPS	Hab, Sed		N		1, 7, 8, 9
Unnamed Creek (Rogersville)		2.5	LFF ^e	2.5	LFF ^e	2.5	DEF	PART 2.5	M	NPS	Hab, Sed				1, 2, 7, 8, 9
Unnamed Creek (Rosendale)		0-1.0 1.0-6.0	WWFF ^e LFF ^e	1.0 5.0	WWFF ^e LFF ^e	1.0 5.0	LFF ^d LFF	PART 1.0 PART 5.0	M M	NPS	Hab, Sed				1, 2, 7, 8, 9
Unnamed Tributary to Parsons Creek		0-1.0 1.0-1.9	COLD ^b WWF ^e	1.0 0.9	COLD ^b WWF ^e	1.0 0.9	COLD DEF	PART 1.0 PART 0.9	M M	NPS, HM	Hab, Sed Mig				1, 7, 8, 9

Total Stream Miles: 164.6

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/8.6	COLD/8.6
	WWSF/48.9	WWSF/48.9
	WWFF/1.9	WWFF/1.9
	LFF/34.8	LFF/22.1
	LAL/0	LAL/0
	UNK/71	UNK/83.7

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (WDNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

^hRecent research has revealed the presence of dams that are limiting fish migration and potentially raising water temperatures.

LAKE BUTTE DES MORTS SOUTH WATERSHED (UF-04)

The Lake Butte des Morts South Watershed lies in east central Winnebago County. It includes approximately the southwest 1/3 of the City of Oshkosh and the southern shore of Lake Butte des Morts to where the Fox River empties into the lake. Agriculture is the primary land use, but there is a very sizable urban area in the watershed.

The Town of Algoma has been experiencing significant growth. The town's population increase 15% between 1990 and 1993 (DOA, 1993). The town has requested numerous sewer service area amendments in the past several years. One of the primary concerns raised as a result of this growth has been the management of storm water (ECWRPC, 1994). East Central Wisconsin Regional Planning Commission conducted a needs identification session to assess development issues in 1994 (ECWRPC, 1994). The commission inventoried demographic characteristics, environmental resources, and land uses in the town. The commission staff is currently preparing a land use strategy for the town.

Monitoring recommendations have been made to conduct fixed station (ambient) monitoring on the Upper Fox River to assess long-term water quality data in the Upper Fox River Basin. Fixed station monitoring consists of the collection of physical, chemical, and biological parameters on a monthly basis for an unlimited number of years.

Table 14. Lake Butte des Morts/South Watershed (UF-04) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Edison Estates Mobile Home Park	Scheduled to be annexed to Oshkosh in 2001; will be served by Oshkosh WWTF.	Trib. to Lake Butte des Morts	WWSF	NA	Municipal	
Michaels Materials	0058564 3/31/2004	Trib. to Lake Butte des Morts			Quarry Dewatering	

WATER QUALITY DESCRIPTIONS

Sawyer Creek - Sawyer Creek is classified as supporting a limited aquatic life community. The stream is a clear, hardwater tributary to the Fox River. The stream is intermittent except for the lower one mile, which contains water, but has no measurable flow during low water stages. This portion lies within the City of Oshkosh and is a catch-all for trash. The fishery is minimal but bullheads and panfish are known to exist. Even though much of the stream is intermittent, Sawyer Creek carries tremendous volumes of water during peak runoff periods. It is also a major source of sediment to Lake Winnebago from both rural and urban areas (Bruch, 1988).

Spring Brook - Spring Brook is a clear, hardwater stream divided into two distinct segments. The lower two miles comprise a bayou off Lake Butte des Morts. This area is popular for hunting and fishing. This stream is classified as supporting a warm water sport fish community. The bottom substrate consists of mainly silt. Portions of the stream are intermittent, although it carries large volumes of water during peak runoff periods.

The DNR recently started contacting landowners to negotiate purchasing easements along Sawyer Creek in Oshkosh and Spring Brook near Omro to protect area water quality as well as fish and wildlife habitat (Lovette, 1992). Easements provide continuous protective corridors along streams and rivers by maintaining existing streambank vegetation buffers and wetlands. These areas maintain natural water retention, slow down stream flow, and prevent erosion to some extent. The easement program is part of the DNR's Stewardship Program; it is strictly

voluntary. The state will pay fair market values, determined through an appraisal process, for the easements (WDNR NER-Files, 1996).

Lake Butte des Morts - Lake Butte des Morts is an 8,857 acre lake with a maximum depth of 9 feet. The lake is one of the Winnebago Pool Lakes, which includes Lake Winnebago, Lake Winneconne, and Lake Poygan. The lake is considered to have a very good sport fishery. It also provides significant habitat for nesting and migratory waterfowl. Over the years, the lake has lost large areas of wetlands along its shoreline. This has led to increased shoreline erosion in addition to loss of fisheries and wildlife habitat. Sediment and nutrient delivery to the lake has also degraded the lake. Blue-green algae blooms have been common on the lake. The Winnebago Comprehensive Management Plan (Bruch, 1988) made recommendations to improve habitat and water quality of the lake. The DNR is currently working with other public and private sector partners to implement recommendations of the plan. Being selected as a nonpoint source priority watershed project would provide more impetus to improve water quality and habitat of the lake.

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5. Bruch, Ronald. Winnebago Comprehensive Management Plan. Wisconsin Department of Natural Resources. 1988.
6. Fox-Wolf Basin Nonpoint Source Pollution Abatement Initiative (Draft). Wisconsin Department of Natural Resources. 1994.
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8. Bougie, Cheryl. Personal Communication. Wisconsin Department of Natural Resources. 1996.

Table 15. Lac Buttes des Morts/South Watershed (UF-04)

Area (sq. miles): 83.7

Counties: Winnebago

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Campbell Creek	139700	1.0	WWSF ^e	1.0	WWSF ^e	1.0	DEF	PART 1.0	E	CON, SS, URB	Sed, Hab				3, 7
Sawyer Creek	139800	0-5.0	WWSF ^e	5.0	UNK	5.0	DEF		E	CON, SS, HM, URB	Sed, Hab, Mig		N, R		3, 4, 6, 7
		5.0-9.0	LAL ^e	4.0	LAL ^e	4.0									
Spring Brook	140300	0-2.0	WWSF ^e	2.0	WWSF ^e	2.0	DEF	PART 2.0	E	NPS	Hab, Sed		N, R		3, 4, 6, 7
		2.0-5.0	LFF ^e	3.0	LFF ^e	3.0	DEF	PART 3.0	E						
Unnamed Streams		3													

Total Stream Miles: 18

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/0	COLD/0
	WWSF/8	WWSF/3
	WWFF/0	WWFF/0
	LFF/3	LFF/3
	LAL/4	LAL/4
	UNK/3	UNK/8

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (DNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

FOX RIVER - RUSH LAKE WATERSHED (UF-05)

The Fox River - Rush Lake watershed is located in southern Winnebago County and small portions of Fond du Lac and Green Lake Counties. Agriculture is the dominant land use in the watershed with cash crop and dairy farming utilizing the greatest acreage. There are many wetland complexes in the watershed with the Rush Lake complex being the largest and most important. Water quality modeling done by Northeast Wisconsin Waters of Tomorrow (NEWWT) identified this watershed as a major contributor of phosphorus and suspended solids to Lake Winnebago (DNR, 1994). The Villages of Eureka, Omro, and Waukau are in the watershed.

Table 16. Fox River/Rush Lake Watershed (UF-05) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Chiquita Processed Foods, LLC.	0070700 3/31/2005	Groundwater	NA	NA	Food Processing	
Omro WWTF	0025011 6/30/2002	Fox River	WWSF	340 cfs*	Municipal	

* = Q_{7,10} flow estimate for Fox River at Berlin.

WATER QUALITY DESCRIPTIONS

Eightmile Creek (Fisk or Rush Creek) - Eightmile Creek is classified as supporting a limited forage fish community. The lower half of the stream lies in a portion of the Rush Lake marsh complex. A large percentage of the watershed is agricultural land. Nonpoint source pollution is the limiting factor for water quality of this stream. The soil erosion rate has been estimated as being 3 tons per acre per year (Bruch, 1988).

Henderson Creek - Henderson Creek has an unknown classification. The small stream drains into Rush Lake in southwestern Winnebago County. Muck is the predominant substrate with traces of other gravel material. Nonpoint source pollution is the limiting factor for water quality of this stream.

Hoger's Bayou - Hoger's Bayou is a very turbid, hard water bayou located adjacent to the Fox River west of Omro. Water levels are directly dependent on levels of the Fox River. It has a navigable outlet to the Fox River and an inlet from lake 14-4. The major bottom material is muck. Most of the shoreline is an open cattail marsh with a small portion of hardwood upland and agricultural lands. Carp spawning and feeding activity keep the water turbid throughout most of the year. In addition to carp, natural water level fluctuation and dense growths of aquatic vegetation limit recreational use (WDNR NER-Files, 1996).

Rush Lake - Rush Lake is a shallow (5 feet maximum depth), 3070 acre, marshy basin. It is subject to winterkill yearly. Water is supplied through seepage, drainage, and spring flow. Water levels are maintained in part by a dam located on Waukau Creek, the outlet stream. It is a major wildlife area serving as a resting point for migratory waterfowl and as an important breeding place for many other waterfowl species. Local landowners have noted that population densities of nine waterfowl species have declined or that those species no longer nest there. Lead shot in bottom sediments is a problem. Waterfowl deaths due to lead shot poisoning have occurred. Poisoning is caused by ingestion of lead shot during bottom feeding and grit gathering.

A study was conducted in 1992 by the Wisconsin Department of Natural Resources' Bureau of Wildlife Management and Bureau of Research to assess lead shot contamination in the sediments of Rush Lake. Students from the University Wisconsin-Oshkosh and Ripon College also assisted with the study. The results demonstrated that lead was heavily and significantly concentrated in the upper 16.5 cm of the soft sediment (Jolin, et al. 1992). Mallards (*Anas platyrhynchos*) have the ability to feed in water and sediment as deep as 40 cm from the water surface. This confirms that lead is accessible to mallards as well as other species of waterfowl. Management techniques should be researched and developed to decrease the rate of ingestion of lead by waterfowl.

Average critical soil erosion rates in the drainage area are in excess of 3 tons per acre per year. Although vast wetland areas surround the lake, pollutants have direct access through a series of old drainage ditches that drain large, historic wetland areas. This problem should be addressed when selected as a priority lake project. The lake's watershed is about 40.5 square miles.

REFERENCES

1. Wisconsin Department of Natural Resources. Watershed Rankings. Water Resource Management Files - Lake Michigan District. 1995.
2. Fox-Wolf Basin Nonpoint Source Pollution Abatement Initiative (Draft). Wisconsin Department of Natural Resources. 1994.
3. Fix, Steven M. and Lloyd Lewis Eagan. Upper Fox River Water Quality Management Plan. Wisconsin Department of Natural Resources. 1990.
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5. Rasman, Tim. Personal Communication. Wisconsin Department of Natural Resources - Green Bay. 1995.
6. Fassbender, Ron. Surface Water Resources of Winnebago County. Wisconsin Department of Natural Resources. 1995.
7. Bruch, Ronald. Winnebago Comprehensive Management Plan. Wisconsin Department of Natural Resources. 1988.
8. Bougie, Cheryl. Personal Communication. Wisconsin Department of Natural Resources. 1996.
9. Sasing, Mark. Personal Communication. Wisconsin Department of Natural Resources. 1996.

Table 17. Fox River/Rush Lake Watershed (UF-05)

Area (sq. miles): 122.5

Counties: Winnebago

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Eight-Mile Creek	140900	0-4.0	LFF ^e	4.0	LFF ^e	4.0	DEF	PART 4.0	E	NPS	Had, Sed, Turb		N		1, 2, 3, 6
		4.0-13.0	UNK	9.0	UNK	9.0	DEF								
Fox River	142400	7.5	WWSF ^a	7.5	WWSF ^a	7.5	WWSF	PART 7.5	E	NPS, HM	Hab, Sed, Mig				1, 2, 3, 6
Henderson Creek	141600	3	UNK	3			DEF		E	NPS	Hab, Sed		N		1, 2, 3
Waukau Creek	140700	0-5	WWSF ^a	5.0	WWSF ^a	5.0	DEF	PART 5.0	E	NPS, HM	Hab, Sed, Mig				1, 3
		5-10	UNK	5.0	UNK	5.0	DEF								
Unnamed Creek (17-14)		3	LFF ^e	3.0	LFF ^e	3.0	DEF	UNK	E						1, 6
Unnamed Streams		14								HM ^h	Mig ^h				

Total Stream Miles: 50.5

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/0	COLD/0
	WWSF/12.5	WWSF/12.5
	WWFF/0	WWFF/0
	LFF/7	LFF/7
	LAL/0	LAL/0
	UNK/31	UNK/31

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (DNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

^hRecent research has revealed the presence of dams that are limiting fish migration and potentially raising water temperatures.

FOX RIVER - BERLIN WATERSHED (UF-06)

This large watershed lies in northern Green Lake, southeastern Waushara and southwestern Winnebago Counties. Agriculture is the primary land use. The only urban area in the watershed is the City of Berlin. Phosphorus modeling done by NEWWT indicated this watershed is a major contributor of phosphorus to Lake Winnebago. Field reconnaissance did not locate severe nonpoint source pollution sources or sites in the watershed (WDNR SCR-Files, 1996). There are not the intense agricultural practices immediately adjacent streams in this watershed as there are in many of the other watersheds in the basin. There may be adverse nonpoint source sites located on uplands away from surface water. Further evaluation is necessary to obtain a complete assessment of nonpoint sources.

There are many wetland complexes in the watershed, particularly those adjacent to streams. A calcareous fen, a rare groundwater driven wetland type of regional importance, is located in this watershed near Berlin. There appears to be a significant amount of acreage in the federal Conservation Reserve Program (CRP). Land set aside from this program provides additional buffering to surface waters. Should the CRP program be eliminated, much of the land currently in CRP will revert back to cropland. That would likely increase sediment and nutrient loading to surface waters.

Table 18. Fox River/Berlin Watershed (UF-06) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Berlin WWTF	0021229 6/30/2002	Fox River	WWSF	340 cfs	Municipal	
Berlin Soft Water	0057746 9/30/2002	Puchyan River; Green Lake	WWSF	*	Water Softener Regeneration	
Green Lake, City WWTF	0021776 3/31/2005	Puchyan River	WWSF	*	Municipal	
Green Lake Sanitary District WWTF	0036846 6/30/2004	Fox River	WWSF	90**	Municipal	
Marks Bros. Pickles	0055212 9/30/2006	Groundwater	NA	NA	Pickle Processor	
National By-Products	0038038 12/31/2005	Harrington Cr. Trib. To Fox River; Groundwater	LFF; NA	None; NA	Animal Processing	N
Princeton WWTF	0022055 6/30/2003	Fox River	WWSF	90**	Municipal	

* = No Q_{7,10} flow estimate due to upstream dam.

** = Q_{7,10} flow estimate for Fox River upstream at Montello.

Berlin - Berlin is the largest municipality in the Fox-Berlin watershed. The city is bisected by the Fox River. Berlin operates an activated sludge type wastewater treatment facility that discharges to the Fox River. Berlin is experiencing growth in its industrial park and housing. The new prison located in Redgranite is drawing more people to the city. Construction site erosion control may be a problem on occasion (WDNR SCR-Files, 1996).

Green Lake Sanitary District - The Green Lake Sanitary District (GLSD) encompasses a large percentage of Green Lake, a large deepwater high quality water body. Providing sanitary sewers completely around the lake continues to be a contentious issue. The sanitary district constructed a wastewater treatment facility in 1995. It is an aerated lagoon system with a discharge to the Fox River. This facility provides service to parts of the north shore including the American Baptist Assembly facility and to the western shore. The remainder of residences and structures in the sanitary district are connected to septic systems or holding tanks. All septage from the

septic and holding tanks are hauled to the GLSD facility for treatment (WDNR SCR-Files, 1996).

WATER QUALITY DESCRIPTIONS

Puchyan River - This stream comes out of Green Lake and flows approximately 15 miles to the Fox River. There are wetlands adjacent the river over much of its length. These wetlands act as a buffer for the stream. There appear to be few significant nonpoint sources of pollution along this stream. The stream has a sport fishery that is limited perhaps more by natural conditions than by cultural alteration. Instream habitat evaluations done in 1994 at two sites indicated the stream possessed "good" habitat (WDNR SCR-Files, 1996). The City of Green Lake's WWTF discharges to the Puchyan River.

Barnes Creek - Barnes Creek rises in Waushara County and flows easterly to the Fox River at Berlin. Portions of the creek have been channelized, particularly in Waushara County. The area has been intensely farmed and there are large muck farms that drain to the creek. It does appear that significant acreage has been put into CRP. There are some larger wetland complexes in the Barnes Creek sub-watershed. These wetlands may serve as a buffer for the creek as well as having a wildlife benefit. One dissolved oxygen grab sample done in October of 1994 at the STH 49 bridge in Berlin was below the state water quality standard for dissolved oxygen. Habitat assessments at two locations indicates the stream having "fair" habitat (WDNR SCR-Files, 1996). Fish and macroinvertebrate surveys are required before this stream can be classified.

Snake Creek - Snake Creek is a smaller tributary to the Puchyan River in Green Lake County. The upper 1.3 miles of the stream is a Class I trout stream (WDNR, 1980) as well as an Exceptional Resource Water (ERW). There is little recent information on the fishery or water quality of the stream. The stream goes through a wetland complex that provides it with good protection from agricultural nonpoint source impacts, although there is grazing at one location in the wetland. There is a non-metallic mine operation near the creek. It is not known whether or not this facility affects the creek. An instream habitat assessment done at St. Marie Road indicated habitat conditions as being "fair" (WDNR SCR-Files, 1995).

Harrington Creek - This is a small tributary to the Fox River in section 10 of T17NR13E on the south edge of Berlin. The stream flows through a larger wetland complex that includes a calcareous fen. Calcareous fens are a unique type of wetland complex. They are dependent on upwelling of groundwater rich in calcium and magnesium bicarbonates. They often have plants that are uncommon or rare plants. Preliminary fisheries monitoring in 1992 indicated the stream to be a Limited Forage Fishery (LFF) stream (WDNR SCR-Files, 1995).

Fox River - The Fox River in this watershed is characterized as a larger stream with a low gradient. An 1855 account of the Fox River in what is now Green Lake County talks about clear flowing water that supported small-mouth bass and wild rice. The water is turbid due to erosion from farm fields and the drainage of wetlands. The river still has an impressive warm water sport fishery, but the abundance of carp is a problem (Fassbender, 1971). The DNR is doing long term monitoring on the Fox River at Berlin and there is also a USGS river flow station at Berlin.

REFERENCES

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3. Fox-Wolf Basin Nonpoint Source Pollution Abatement Initiative (Draft). Wisconsin Department of Natural Resources. 1994.
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5. Fassbender, Ronald, A., John J. Weber, and Linden M. Nelson. Surface Water Resources of Green Lake County. Wisconsin Department of Natural Resources. 1971.
6. Bruch, Ronald. Winnebago Comprehensive Management Plan. Wisconsin Department of Natural Resources. 1988.
7. Sessing, Mark. Personal Communication. Wisconsin Department of Natural Resources. 1996.

Table 19. Fox River/Berlin Watershed (UF-06)

Area (sq. miles): 139

Counties: Green Lake, Waushara, and Winnebago

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Barnes Creek	143300	13.0	UNK	13	UNK	13	DEF		M	NPS, HM	Hab, Sed		N, R		1, 4
Black Creek	15400	13.0	WWSF ^e	13	WWSF ^e	13	DEF	PART 13	E	NPS	Hab, Turb				4, 5
Fox River	143900	31.0	WWSF ^a	31	WWSF ^a	31	WWSF	PART 31	M	NPS, HM	Hab, Sed, Mig		N		1, 4, 5
Harrington Creek	143700	3.0	LFF ^e	3.0	UNK	3.0	DEF	PART 3	M	PSI, NPS	Hab, Sed		N		1
Mill Race	154400	6.0	UNK	6.0			DEF			HM	Mig				
Puchyan River	145200	15.0	WWSF ^a	15.0	WWSF ^a	15.0	WWSF	PART 15.0	M	NPS	Hab, Sed		N		1, 5
Snake Creek	145300	0-3.0 3.0-4.3 4.3-7.0	WWSF ^e COLD ^b UNK	3.0 1.3 2.7	WWSF ^e COLD ^b UNK	3.0 1.3 2.7	DEF ERW	PART 3.0 PART 3.1	M E E	PSI, NPS NPS	Hab, Sed Hab, Sed		N		1, 2, 5
Town Drain	144400	5.0	UNK	5.0	UNK	5.0	DEF								
Unnamed Streams		39.0								HM ^h	Mig ^h				

Total Stream Miles: 132

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/1.3	COLD/1.3
	WWSF/62	WWSF/62
	WWFF/0	WWFF/0
	LFF/3	LFF/0
	LAL/0	LAL/0
	UNK/65.7	UNK/68.7

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (DNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

^hRecent research has revealed the presence of dams that are limiting fish migration and potentially raising water temperatures.

BIG GREEN LAKE WATERSHED (UF-07)

This watershed was a priority watershed under the Wisconsin Nonpoint Source (NPS) Water Pollution Abatement Program. This project began in 1981 and concluded in latter part of 1992. The primary role of this program was to provide cost-sharing and technical assistance to local agencies for the control of nonpoint source pollution. A nonpoint source pollution abatement plan was developed and implementation of best management practices (BMPs) was established throughout much of the watershed. Installation and implementation of BMPs throughout the watershed began in the spring of 1985. The completion date for installation of BMPs was readjusted to December 1992 to accommodate added cost-share projects acquired through a second sign-up period offered in 1988.

The goals of the Big Green Lake Priority Watershed Project were designed to protect existing high water quality areas, to rehabilitate areas degraded by nonpoint source pollution, and to halt or reverse (where possible) the declining water quality trend in Big Green Lake. These goals were further expanded to include:

1. Reduce the concentrations of bacteria to "acceptable" levels.
2. Reduce the nutrient loading levels to streams from nonpoint sources by 40% on a yearly basis.
3. Increase the average transparency (secchi disk) readings within Big Green Lake during the open water times.
4. Halt the trend of increasing littoral zone establishment as a result of sediment loading to the lake.

A mid-project review was performed by the Department in 1988. One of the review findings was that upland soil loss occurred at rate equal to 41% of the watershed plan's goal, an overall soil loss reduction of 18%. The reduction in phosphorus loading from barnyard runoff was calculated as 75%. This exceeded the goal of 40% established in the watershed plan. The evaluation concluded that, although the project did not attain all the goals of the plan, it did result in a significant improvement in the level of nonpoint source control. By 1988, five sub-watersheds had fully achieved or exceeded their nonpoint source pollution reduction goals.

The DNR conducted monitoring studies to evaluate the success of the Big Green Lake Priority Watershed Project. The evaluation's focus was two-fold; first, the evaluation of water quality and habitat improvement resulting from the implementation of BMPs and secondly, determine to what extent the original objectives of the project were met.

The Big Green Lake Priority Watershed Project evaluation concluded that, although all of the cost-share projects had not been completed, nonpoint source pollution derived from agricultural origin has been adequately controlled by best management practices where they have been installed and properly maintained. With the additional projects gained through the supplementary sign-up period in 1988, participation levels will be within the projected 75% success rate.

The habitat assessment and soil analysis revealed additional sources of nutrients and sediments, including bare forest floors resulting from dense forest canopies, extensive intermittent gully systems, and downcutting through the rich silt loam topsoil causing streambank erosion. These problems should be addressed in the future.

The Big Green Lake Priority Watershed Project original goals were to improve conditions that had been degraded and maintain areas with high water quality. Evidence from 1988 suggests these goals were met. This includes improvement in transparency readings (secchi disk), bacterial levels, sedimentation, macroinvertebrate analysis, and nutrient analysis.

Analysis of data collected since 1988 needs to be done to determine if water quality has improved, remained static, or declined.

While all BMPs were installed by the fall of 1992, it will take time for the installed practices to become stabilized and for the sediment already in transport toward Big Green Lake (i.e. gullies, ditches, and streams) to be "flushed" out of the system. Another factor that must be considered is that water entering Big Green Lake has an estimated residence time of 21 years. Clear trends and conclusions may not be apparent for perhaps 20 years or longer. This is due to the size and depth of the lake and the residence time. Climatic and land use variability also can have dramatic effects on water quality and must be considered in the overall evaluation. Any major change in water quality will be affected by these and perhaps additional factors, making it very difficult to accurately assess water quality unless years are compared that have similar rainfall duration and intensity or the data is normalized.

A major problem with this priority watershed project was the extremely low landowner participation in the Silver Creek sub-watershed, particularly in Fond du Lac County. Ongoing monitoring of phosphorus in Silver Creek indicates significant phosphorus loading to Green Lake (see below).

Water quality descriptions of some of the creeks in the Big Green Lake watershed are below. For a more detailed description consult [Big Green Lake Priority Watershed Project/Final Evaluation Monitoring Report](#).

Table 20. Big Green Lake Watershed (UF-07) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Chiquita Processed Foods-Ripon	0001163 3/31/2006	Silver Creek; Groundwater	WWSF; NA	0.84 cfs; NA	Canning	
Ripon WWTF	0021032 6/30/2004	Silver Creek	WWSF	0.84 cfs	Municipal	N

Ripon - The City of Ripon operates an activated sludge sewage treatment facility that discharges to Silver Creek, a tributary to Green Lake. The WPDES permit for the facility has wasteload allocated discharge limits including phosphorus limits (1 mg/l). Phosphorus loading to Green Lake is a concern of the Department. With the treatment plant having phosphorus limits already, there may be a need to look at other measures in the city to reduce phosphorus and sediment loading to Silver Creek.

WATER QUALITY DESCRIPTIONS

Dakin Creek - Dakin Creek is a tributary to Green Lake that enters on the southeast end of the lake. Historically, it was a spring fed, Class II trout stream (WDNR, 1980). It supported a good aquatic macroinvertebrate population that sustained a native brook trout population (Fassbender et al., 1971). There is no recent water quality or fisheries information for the stream. It was not identified as a trout stream in the state's 1996-97 trout fishing regulations (WDNR, 1996).

Spring Creek - Spring Creek originates at Spring Lake and flows through the county park marshlands before it empties into the southwest end of Big Green Lake. Spring Creek is 2.2 miles long and receives water from open meadows, gullies, and agricultural croplands. Heavy silt accumulation is the main factor for a poor stream habitat rating upstream of Highway K. A steep gradient in the reach of the stream downstream of Highway K allows for swift sediment transport to Green Lake. The sediment source is difficult to pinpoint. However, numerous gullies in road ditches and wooded areas are undoubtedly major contributors to the sediment accumulation problem.

Silver Creek - Silver Creek rises in northwestern Fond du Lac County and flows west to Green Lake. It drains the largest of Green Lake's sub-watersheds. This sub-watershed is heavily agricultural, but includes the City of Ripon.

Silver Creek was not assessed during the priority watershed project for the following reasons:

- ⊗ The City of Ripon contributes a substantial amount of point and nonpoint source pollution.
- ⊗ Silver Creek is Big Green Lake's largest sub-watershed and has a very low level of participation.
- ⊗ Due to the above points, any changes in Silver Creek's water quality would be difficult to correlate to the Priority Watershed Program (Kroner et al., 1992).

Phosphorus monitoring done since the completion of the priority watershed project indicates that Silver Creek carries a significant phosphorus load to Green Lake (WDNR¹, 1995). This is an ongoing problem that may undo the efforts and progress of the priority watershed project. This sub-watershed would be a good candidate for a phosphorus total maximum daily load (TMDL) study. Such a study would determine where the phosphorus is coming from and establish phosphorus loading goals. While the stream is not officially classified as a trout stream, trout fishing regulations do apply from Green Lake to the first upstream dam at Ripon (WDNR, 1996).

White Creek - White Creek is a spring fed creek and is classified as a Class I trout stream (WDNR, 1980). White Creek originates from a spring at the end of Craig Road and flows approximately 0.9 miles before it enters Big Green Lake. An intermittent branch enters White Creek approximately ½ mile from its mouth. White Creek receives drainage from woodlands, cash cropping, barnyards, and feedlots. Agricultural impacts to White Creek have been minimized through BMP implementation. Soil loss resulting from agricultural practices has been controlled to tolerable levels, although some soil loss through wind, sheet, and rill erosion is inevitable. Insufficient forest floor vegetation resulting in gully and streambank erosion is the main factor contributing to sediment entering White Creek.

Green Lake - Green Lake is the deepest inland lake in Wisconsin with a maximum depth of 236 feet. It is classified as a mesotrophic lake. It has both a cold and warm water sport fishery. Water quality analyses of Green Lake indicate a slight trend toward improved water quality. Both secchi disk and bacteria concentration readings have shown improvement since 1984. Secchi disk measurements in 1989-1991 are now comparable to the levels commonly found before the mid-1970s. Nutrient and chlorophyll concentrations have essentially remained stable over the duration of the priority watershed project. Due to the long hydraulic residence time of Green Lake and the nutrient sink associated with such a large body of water, consistent trends exhibiting water quality improvements may not fully manifest themselves in Green Lake for decades to come (WDNR, 1995¹).

Habitat assessments indicate that best management practices have substantially reduced sediment and nutrient loadings to Green Lake. The Green Lake Priority Watershed project experienced a high level of participation in much of the Green Lake County part of the watershed that has resulted in control of cropland soil erosion and a high reduction of nutrient runoff from barnyards. Habitat assessments also identified two prevailing sources of nonpoint source

pollution: serious sheet, rill, and streambank erosion in densely wooded areas and gully erosion found in numerous roadside ditches.

The evaluation concludes that, although some of the projects have yet to be completed, water quality in Green Lake has been maintained throughout the duration of the project and BMPs have reduced sediment and nutrient loss associated with agricultural practices to tolerable levels. This evaluation also concludes that nonpoint sources of pollution associated with dense forests and roadside gullies continue to significantly impact Big Green Lake and should be the focus of future nonpoint source reduction efforts (Kroner et al., 1992).

Green Lake still receives a significant phosphorus load from Silver Creek (WDNR¹, 1995). This phosphorus loading from the Silver Creek sub-watershed will continue to degrade the lake unless action is taken. The Silver Creek sub-watershed had very poor participation during the priority watershed project. Reasons for the poor participation need to be evaluated.

A 1992 macrophyte survey of Green Lake found 20 species growing in the lake, with the most growth at a depth of 6 feet and tapering off sharply after 15 feet. Sensitive areas, areas particularly important to fish spawning and rearing, or having a significant plant diversity, have been identified for Green Lake. Aquatic plant management will be limited in these areas (WDNR, 1992).

Past bacteria monitoring has found bacteria levels above water quality standards. At least some of this has been attributed to all of the individual septic systems and holding tanks for residences around the lake. The Green Lake Sanitary District provides wastewater treatment for residences as well as municipal and industrial buildings around the lake, except for those located within the City of Green Lake. This should reduce some of the pollutant loading to the lake (WDNR, 1995⁷).

Land use is a problem around Green Lake. Much of the shoreline is already developed and the remaining undeveloped areas are under extreme development pressure. One of the last undeveloped parcels with a good expanse of undeveloped shoreline was recently sold. Erosion control, particularly from larger and plat developments may add excessive sediments and nutrients to the lake. A condominium project has been proposed for a bay on the southwest corner of the lake. This project would affect a wetland complex with important functional values. Another residential development is proposed along the steep forested southern shoreline of the lake.

A concern is that continued urban growth around the lake will result in other problems. These problems include a significant increase in piers and boat slips, resuspension of sediments due to boat motors in shallow areas of the lake, and possible use conflicts between various groups of potential lake users.

Green Lake County received a lake management protection grant in early 1995 from the Department of Natural Resources. The project's ultimate goal was to improve protection of water quality and watersheds for Green Lake, Puckaway Lake, and Little Green Lake. The grant was used to fund a study of existing land uses and ordinances on and near these lakes. The information will be used to update existing ordinances and to assess the need for a county stormwater management ordinance. Work on this project was completed in December, 1996.

Issues that continue to exist on Green Lake are:

1. increased pressure for more piers and docks,
2. increasing shoreland development pressure,
3. inconsistent land management decisions,
4. continued nonpoint source pollution concerns, particularly from Silver Creek,
5. aquatic plant management,
6. carp control,

7. shallow water habitat restoration in County Park Marsh and the Silver Creek estuary,
8. relatively poor understanding of lake hydrology dynamics, nutrient history, and long term trends, and
9. state and local management units need to focus on building partnerships, establishing goals, identifying issues, and defining strategies to address water resources related problems.

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Table 21. Big Green Lake Watershed (UF-07)

Area (sq. miles): 13

Counties: Green Lake and Fond du Lac

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Assemble Creek		0.3	COLD ^b	0.3	COLD ^b	0.3	COLD	FULL 0.3	E						1, 2, 3, 7
Dakin Creek	146700	0-3.4	COLD ^b	3.4	COLD ^b	3.4	COLD	UNK 3.4	E				N		2, 3, 4, 9
Hill Creek	146200	2.0	LFF ^e	2.0	LFF ^e	2.0	DEF	PART 2.0	M	NPS, HM	Hab, Sed, Mig				3, 4, 9
Roy Creek	148200	8.0	LFF ^e	8.0	LFF ^e	8.0	DEF	PART 3	M	NPS	Hab, Sed				3, 4, 9
Silver Creek	146800	14.0	WWSF ^a	14.0	WWSF ^a	14.0	WWSF	PART 14.0	M	NPS, HM	Hab, Sed, Mig		N, R		1, 3, 4, 5, 8
Spring Creek	148000	3.0	WWFF ^e	3.0	WWFF ^e	3.0	DEF	PART 3.0	M	NPS	Hab, Sed		N		3, 4, 9
White Creek	146600	1.0	COLD ^b	1.0	COLD ^b	1.0	COLD	PART 1.0	M	NPS	Hab, Sed		N		2, 3, 4, 9
Wurchs Creek		6.0	LFF ^e	6.0	WWSF ^e	6.0	DEF	NOT 6.0	E	NPS	Hab, Sed				3, 4, 9
Unnamed Streams		13.0								HM ^h	Mig ^h				

Total Stream Miles: 50.7

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/4.7	COLD/4.7
	WWSF/14	WWSF/20
	WWFF/3	WWFF/3
	LFF/16	LFF/10
	LAL/0	LAL/0
	UNK/13	UNK/13

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (DNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

^hRecent research has revealed the presence of dams that are limiting fish migration and potentially raising water temperatures.

WHITE RIVER WATERSHED (UF-08)

The White River watershed is located in northwest Green Lake, northeast Marquette, and southern Waushara Counties. The two municipal wastewater dischargers in the watershed are Neshkoro and Silver Lake Sanitary District (includes Wautoma). Land use in the watershed is predominately agricultural with a significant amount of woodland and wetlands. The larger wetland complexes in the watershed are the White River Marsh State Wildlife Area, Wautoma Swamp, and Lunch Creek Wetlands. There are a number of high quality streams, particularly in the Waushara County portion of the watershed. Portions of the following streams are Exceptional Resource Waters: Bird Creek, Bowers Creek, Lunch Creek, Soules Creek, the West Branch of the White River, and the White River. There are some smaller drainage and seepage lakes in the watershed. These lakes are assumed to have good water quality, but specific data is lacking for most of them. The following lakes located in Waushara County have self-help lake monitoring volunteers: Marl Lake, White River Flowage (lower pond), and Witters Lake. Volunteers observe and document water quality changes over time by measuring water clarity. This simple procedure can provide valuable information for long-range planning.

Table 22. White River Watershed (UF-08) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Neshkoro WWTF	0060666 9/30/2005	White River; Groundwater	WWSF; NA	12 cfs; NA	Municipal	
Silver Lake S.D. WWTF (includes Wautoma)	0061301 12/31/2005	White River	WWSF	40 cfs	Municipal	

* = Q_{7,10} flow estimate for White River upstream at Wautoma.

Silver Lake Sanitary District - A post-operational study was conducted to determine what, if any, impact the Silver Lake Sanitary District's wastewater treatment facility discharge was having on the White River. The study was conducted on the river below the hydropower dam in August of 1991. The water chemistry results were indicative of a normal and healthy river system. All test result values for the parameters listed in their WPDES wastewater permit were below the permit levels (Szymanski, 1991).

WATER QUALITY DESCRIPTIONS

Lunch Creek - Lunch Creek is a trout stream tributary to the White River at the Neshkoro Millpond. About 5.5 miles of the stream above STH 22 is a Class I trout stream and Exceptional Resource Water. Another 11.2 miles is Class II trout waters (WDNR, 1980). Water quality and resources are threatened by nonpoint sources of pollution. There is little recent information on existing water quality conditions in the stream.

White River - The White River above the White River Flowage is a Class I trout stream (WDNR, 1980) and an Exception Resource Water. The river is considered to have good water quality although little recent information is available. There are some potential nonpoint source threats to the stream from agricultural practices near the stream. Below the flowage, the river is considered a warm water sport fishery (Poff and Threinen, 1963). The river flows through large wetland complexes below the Neshkoro Millpond, including the White River Marsh State Wildlife Area.

A post-operational study was conducted on the White River below North American Hydro, Inc.'s power generating dam in August, 1991. The purpose of the survey was to assess the impact of effluent discharged from the Silver Lake Sanitary District Wastewater Treatment

Facility (WWTF) on the White River. The water chemistry results were indicative of a normal and healthy river system. All WWTF outfall values were below permit levels (Szymanski, 1992).

Overall, it appears the White River is able to assimilate the discharge of the Silver Lake Sanitary District WWTF without any adverse impacts. In addition, the Village of Neshkoro constructed a new WWTF in 1998. The village abandoned its previous system that discharged to groundwater via seepage cells. The new WWTF discharges to the White River on the southwest side of Neshkoro.

Bass Lake - Bass Lake is a moderately fertile lake that forms the headwaters of Little Lunch Creek. This lake has numerous springs around its shoreline and has been classified as a State Natural Area. The lake has a good warm water sport fishery and is utilized by migratory waterfowl.

Lake Lucerne - Lake Lucerne has been designated as an Outstanding Resource Water (ORW) under the state's antidegradation policy. The lake is a 48 acre land-locked seepage lake that possesses good water quality. The lake provides good panfish fishing and is popular with bird-watchers because it is used as a resting place for migratory waterfowl.

Marl Lake - Historical water quality data reveals increased levels of nitrogen and phosphorus and decreased dissolved oxygen levels in Marl Lake. Waushara County Land Conservation Department Staff observed significant sedimentation entering the lake from surrounding agricultural and non-agricultural lands. A lake district (Marl Lake Protection & Rehabilitation District) was formed in 1988 to address declining water quality in the lake. The organization received a lake planning grant in 1995 to develop an aquatic plant management plan (WDNR NER-Files, 1996).

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Table 23. White River Watershed (UF-08)

Area (sq. miles): 160.5

Counties: Green Lake, Marquette, and Waushara

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Bird Creek	152300	0-4.0	COLD ^b	4.0	COLD ^b	4.0	ERW	FULLY-THR 4	E	NPS	Hab, Sed				1, 4, 5, 6
		4.0-5.0	UNK	1.0	UNK	1.0	DEF								
Bowers Creek	152400	0-2.4	COLD ^b	2.4	COLD ^b	2.4	ERW	FULLY 2.4	E						1, 4
		2.4-3.0	UNK	0.6	UNK	0.6	DEF								
Little Lunch Creek	150300	0-0.6	COLD ^e	0.6	COLD ^e	0.6	COLD	FULLY 0.6	E	HM	Mig				5
Lunch Creek	149900	0-11.2	COLD ^b	11.2	COLD ^b	11.2	COLD	FULLY-THR 11.2	E	NPS	Hab, Sed		N		4, 5
		11.2-16.7	COLD ^b	5.5	COLD ^b	5.5	ERW	FULLY-THR 5.5	E	NPS	Hab, Sed				
		16.7-20.0	UNK		UNK										
Mud Creek	151800	0-0.6	COLD ^b	0.6	COLD ^b	0.6	ERW								4
		0.6-1	UNK	0.4	UNK	0.4	DEF								
Soules Creek	152800	5.5	COLD ^b	5.5	COLD ^b	5.5	ERW	FULLY 5.5	E						4, 5
Sucker Creek	148600	0-11.0	LFF ^e	11	LFF ^e	11	DEF	PART 11.0	E	NPS, HM	Hab, Sed, Hab				7 4, 5, 8 4
		11-14.6	COLD ^b	3.6	COLD ^b	3.6	COLD	PART 3.6	E	NPS	Sed				
		14.6-16.4	COLD ^b	1.8	COLD ^b	1.8	ERW	FULLY-THR 1.8	E	NPS	Hab, Sed				
		16.4-20.0	UNK	3.6	UNK	3.6	DEF								
W. Br. White River	151700	0-5.4	COLD ^b	5.4	COLD ^b	5.4	ORW	FULLY-THR 5.4	E	NPS, HM	Hab, Mig				4, 5, 8
		5.4-6.0	UNK	0.6	UNK	0.6	DEF								
White River	148500	0-18.9	WWSF ^a	18.9	WWSF ^a	18.9	ERW	FULLY-THR 18.9	E, M	NPS, HM	Hab, Sed, Mig		N		2, 3, 4, 5, 7, 8
		18.9-25.2	WWSF ^a	6.3	WWSF ^a	6.3	WWSF	PART 6.3	E, M	NPS, HM	Hab, Sed, Mig				
		25.2-27.8	COLD ^b	2.6	COLD ^b	2.6	ERW	FULLY-THR 2.6	E	NPS	Hab, Sed				
		27.8-32	UNK	4.2	UNK	4.2	DEF								
Unnamed Streams		33	UNK							HM ^h	Mig ^h				

Total Stream Miles: 126.1

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/43.2	COLD/43.2
	WWSF/25.2	WWSF/25.2
	WWFF/0	WWFF/0
	LFF/11	LFF/11
	LAL/0	LAL/0
	UNK/46.7	UNK/46.7

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (DNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

^hRecent research has revealed the presence of dams that are limiting fish migration and potentially raising water temperatures.

MECAN RIVER WATERSHED (UF-09)

The Mecan River watershed is located in southwestern Waushara and north central Marquette Counties. Many of the tributary streams of the Mecan River support high quality cold water fisheries. The land use in the watershed is primarily agricultural. There are no municipal WPDES permitted wastewater dischargers to surface water in the watershed. Most wetlands are confined to stream corridors in the upper reaches of the watershed. Larger wetland complexes occur in the Marquette County part of the watershed. The largest wetland complex in the watershed is the Germania Marsh in east central Marquette County. There are some smaller drainage and seepage lakes in the watershed.

Table 24. Mecan River Watershed (UF-09) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Coloma WWTF	0060861 3/31/2003	Groundwater	NA	NA	Municipal	

WATER QUALITY DESCRIPTIONS

Chaffee Creek - Chaffee Creek is a spring fed creek that supports a very good cold water fishery. It is a Class I trout stream for just over 8 miles of its length and a Class II trout stream for another 4 miles (WDNR, 1980). Chaffee Creek is considered an Outstanding Resource Water stream. The United States Geological Survey (USGS) monitored one reach of the stream as part of its benchmark streams project in the western Lake Michigan drainage basin. The water quality of the monitored reach was considered "good" using the Hilsenhof Biotic Index (HBI) (Rheaume et al., 1996). Little is known about current water quality conditions or potential outside of the monitored reach or actual nonpoint sources of pollution to the stream.

Mecan River - The Mecan River originates at the Mecan Springs as a cold water stream. It supports about 6.6 miles of Class I trout fishery and another 10 miles of Class II trout fishery (WDNR, 1980). Below the STH 22 bridge in Marquette County it is considered a warm water sport fishery. The reach above the Community of Richford is an Outstanding Resource Water with the remainder being an Exceptional Resource Water. One reach of the Mecan River was monitored by USGS in 1993 as part of its benchmark streams project in the western Lake Michigan drainage basin. The water quality of the monitored reach was considered "very good" using the Hilsenhof Biotic Index (HBI) (Rheaume et al., 1996). As with Chaffee Creek, little is known about current water quality conditions or potential or actual nonpoint sources of pollution to the stream in the remainder of its length.

Pleasant Lake - Pleasant Lake is a large, hardwater seepage lake located four miles southwest of Coloma. The littoral bottom materials are primarily sand and marl. Recent secchi disk readings indicate the lake has good water quality. The lake is a heavily used recreational resource with perceived acceleration of nutrient problems. A lake district (Pleasant Lake Improvement Corp.) was formed to address declining water quality in the lake. The organization received a lake planning grant in 1993 to develop a water quality database, determine water quality problems, increase landowner participation, and develop a comprehensive lake management plan for long term lake protection (WDNR NER-Files, 1996).

Crystal Lake - Crystal Lake is a 124 acre spring fed lake with a maximum depth of 60 feet. Historical information indicates very good water clarity although no recent information exists. The lakeshore is extensively developed and public access is minimal. Carp may be a problem affecting water quality and habitat (WDNR SCR-Files, 1996).

Tuttle Lake - Tuttle Lake is a 167 acre seepage lake with a maximum depth of 36 feet. There are cottages around much of the shoreline. Recent secchi disk readings indicate the lake has good water quality. There is no other water quality or fisheries monitoring data to better assess water quality of the lake (WDNR SCR-Files, 1996).

Wood Lake - Wood Lake is a 92 acre seepage lake in northwest Marquette County. It has a maximum depth of 55 feet. Water quality is generally very good to excellent based on secchi disk readings taken by a volunteer in the Self-Help Program (WDNR SCR-Files, 1996). The data collected to date needs to be analyzed in depth to determine if there is a trend developing toward declining water quality. Additional monitoring and watershed assessment may be needed.

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Table 25. Mecan River Watershed (UF-09)

Area (sq. miles): 148

Counties: Marquette and Waushara

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Chaffee Creek	155900	0-10.5 10.5-14	COLD ^b UNK	10.5 3.5	COLD ^b UNK	10.5 3.5	ORW DEF	FULLY-THR 10.5	E, M	NPS	Hab, Sed		N		1, 3, 4, 6
E. Br. Little Pine Creek	157800	2.0	UNK	2.0			DEF								
Little Pine Creek	157400	6.0	COLD ^b	6.0	COLD ^b	6.0	ERW	FULLY 6.0	E	HM	Mig				3, 4, 6
Mecan River	155000	0-18.0 18.0-34.2 34.2-40.0	WWSF ^e COLD ^b UNK	18.0 16.2 5.8	WWSF ^e COLD ^b UNK	18.0 16.2 5.8	ERW ERW DEF	FULLY 18.0 FULLY-THR 16.2	E M	HM NPS	Mig Hab, Sed		N		3, 4, 6
Mud Lake Outlet	155100	4	WWSF ^e	4.0	WWSF ^e	4.0	DEF								6
N. Br. Wedde Creek	156100	2.6	COLD ^b	2.6	COLD ^b	2.6	ERW	FULLY-THR 2.6	E	NPS	Hab, Sed				3, 4, 5
Schmudluck Creek	158400	0-1.0 1.0-3.0	COLD ^b COLD ^b	1.0 2.0	COLD ^b COLD ^b	1.0 2.0	COLD ERW	FULLY-THR 1.0 FULLY-THR 2.0	E E	NPS NPS	Hab, Sed Hab, Sed				3, 5 2, 3, 5
S. Br. Wedde Creek	156600	4.9	COLD ^b	4.9	COLD ^b	4.9	ERW	FULLY-THR 4.9	E	NPS	Hab, Sed				1, 3, 4, 6
Wedde Creek	15600	3.6	COLD ^b	3.6	COLD ^b	3.6	COLD	FULLY-THR 3.6	E	NPS	Hab, Sed				1, 3, 4, 5
W. Br. Little Pine Creek	157900	0-2.9 2.9-4.0	COLD ^b UNK	2.9 1.1	COLD ^b UNK	2.9 1.1	ERW DEF	FULLY-THR 2.9	E	NPS	Hab, Sed				3, 4, 6
Unnamed Streams		13.0	UNK				DEF								

Total Stream Miles: 97.1

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/49.7	COLD/49.7
	WWSF/22	WWSF/22
	WWFF/0	WWFF/0
	LFF/0	LFF/0
	LAL/0	LAL/0
	UNK/25.4	UNK/25.4

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (DNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

BUFFALO AND PUCKAWAY LAKES WATERSHED (UF-10)

The Buffalo and Puckaway Lakes watershed is a large 232 square mile watershed that covers parts of Columbia, Marquette, and Green Lake Counties. It includes all streams going into Buffalo and Puckaway lakes as well as reaches of the Fox River from Swan Lake downstream to the dam at Lake Puckaway. Agriculture is the dominant land use in the watershed. There are many wetland complexes in the watershed. There are large wetland complexes on the east and west ends of Puckaway Lake, on the upstream end of Buffalo Lake, the French Creek wetlands in the French Creek State Wildlife Area, and the wetlands associated with the Swan Lake State Wildlife Area. Other smaller wetland complexes exist throughout the watershed.

Communities in the watershed are Endeavor, Marquette, and Packwaukee as well as portions of the Cities of Portage and Montello. Montello's wastewater treatment plant discharges to the Fox River. The Endeavor and the Packwaukee Sanitary District Wastewater Treatment Facilities both have a history of discharging by landspreading. The final fate of landspread discharge is in groundwater. Prior to reaching the groundwater, the nutrients and contaminants contained in the discharge are filtered by physical and biological processes in the soil. The Endeavor system was updated in 1998 with a new re-circulating sand filter treatment system. The Packwaukee Sanitary District completed construction of a new treatment system in 1999. It is a re-circulating sand filter that discharges to a wetland.

Table 26. Buffalo and Puckaway Lakes Watershed (UF-10) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Endeavor WWTF	0031488 9/30/2003	Groundwater	NA	NA	Municipal	N
Montello WWTF	0024813 3/31/2005	Fox River	WWSF	90	Municipal	
Packwaukee S.D. WWTF	0060933 3/31/2003	Groundwater	NA	NA	Municipal	N

The population of the City of Portage grew approximately 3.2% between 1990 and 1995. While this is not as dramatic an increase as other municipalities in the basin, it is significant. The continued growth may cause local water quality and quantity problems if the city does not adequately address them. The population of the City of Montello grew approximately 7.5% between 1990 and 1995, faster than the state average. If that level of growth continues, Montello may also face the water quality and quantity problems that other growing municipalities face.

WATER QUALITY DESCRIPTIONS

Fox River - The Fox River is the principle stream in the watershed. The river and its two large impoundments, Buffalo Lake and Lake Puckaway, have a diverse warm water sport fishery. The river also flows through two state wildlife areas, French Creek and Swan Lake. There is a fish consumption advisory for a reach of the Fox River between Swan Lake and Portage. Elevated levels of PCB's and/or pesticides have been found in carp in this reach.

Ox Creek (Laing Creek) - Ox Creek is a tributary to the Fox River at Buffalo Lake. There is no recent water quality information for this stream. The reach of the stream above Lake Emery is considered to be a Class II trout stream (WDNR, 1980).

Buffalo Lake - Buffalo Lake is a 2,210 acre shallow lake on the Fox River in central Marquette County. Historically, it was a natural lake on the river which was increased in size when a 3 foot head dam was constructed on the lower end (Esser, 1991). The lake is a very popular fishing lake with significant seasonal and year-round homes around it. Boating is sometimes difficult due to the shallowness and excessive aquatic plant growth. It is an eutrophic lake and suffers from excessive aquatic plant growth. The lake has a wide variety of aquatic plants, both emergent and submergent. Eurasian water milfoil has been identified in vegetation samples collected from the lake (Esser, 1991). Mechanical aquatic plant harvesting is being used to manage the aquatic plant problem. The plant harvesting has resulted in other problems involving loose plant fragments, nutrients, and sediment being transported downstream in the Fox River and into Lake Puckaway.

In 1991, the Department of Natural Resources, U.S. Army Corps of Engineers, and the Buffalo Lake Protection and Rehabilitation District initiated a water quality and vegetation study on both Buffalo and Puckaway lakes. One of the conclusions of the study was that aquatic plant nuisance conditions are likely to happen on the Fox River below Montello "with or without" mechanical plant harvesting near Montello (Dreher and Sessing, 1991). Water quality seems to decline going from upstream to downstream areas of the lake. Phosphorus, chlorophyll a, and suspended solids attained their highest levels in mid-summer. This is also when water clarity was at its poorest level (Dreher and Sessing, 1991). Additional monitoring done in 1993 and 1994 showed similar results. It was concluded that Buffalo Lake is currently a stable and healthy shallow lake system with a plant dominated, clear water ecological state. This stability could be adversely affected by a massive aquatic plant loss, higher nutrient loadings over time, and/or destabilization of the diverse fish community occurring with subsequent increase in carp populations (Van Norman, 1995). The lake has gone through a cycle from a highly turbid, carp dominated lake to a clearer, aquatic plant dominated lake (Dreher and Sessing, 1991). The report "Buffalo and Puckaway Lakes Water Quality and Vegetation Survey" (Dreher and Sessing, 1991) and follow-up report "Buffalo Lake Water Quality Survey Addendum for 1993 and 1994" offer more detail on conditions of Buffalo Lake. There is a fish consumption advisory for Buffalo Lake. Elevated levels of mercury have been found in northern pike taken from the lake.

Puckaway, Lake - Puckaway is another shallow, drainage lake on the Fox River. It has an area of 5039 acres and a maximum depth of 5 feet. Wild rice, a sign of good water quality, once was the dominant plant on the lake (Dreher and Sessing, 1991). The long term impacts of agriculture and urbanization in the basin above the lake have altered the lake. A large variety of aquatic plants were identified in Lake Puckaway during a recent aquatic plant study (Esser, 1991). The lake still has a healthy and diverse aquatic plant community. The lake is eutrophic with elevated phosphorus and nitrogen levels. Water clarity in the lake is poorer than in Buffalo Lake (Dreher and Sessing, 1991).

White Lake - White Lake is a 92 acre seepage lake east of Montello. The lake has good water quality. It is thought to be in the oligotrophic to early mesotrophic phase in terms of its ecological age. The major water quality concern for the lake is phosphorus and other nutrient loading to the lake. Such loadings will alter conditions in the lake and allow increased aquatic plant growth and/or increased algae problems. There is self-help monitoring on the lake and this information will assist any lake association and others in what lake management measures need to be taken. A lake planning grant may be needed to assist in the evaluation of the extent of the nutrient problem and recommendations for how to deal with it.

REFERENCES

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Table 27. Buffalo and Puckaway Lakes Watershed (UF-10)

Area (sq. miles): 139

Counties: Columbia and Marquette

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Allen Creek	169900	3.0	WWSF ^e	3.0	WWSF ^e	3.0	DEF	PART 3.0	E	NPS, HM	Hab, Sed, Mig				2, 3
Chapman Creek	170200	3.0	WWSF ^e	3.0	WWSF ^e	3.0	DEF	PART 3.0	E	NPS, HM	Hab, Sed, Mig				2, 3
Fox River	170650	45.0	WWSF ^a	45.0	WWSF ^a	45.0	WWSF	PART 45.0	E	NPS, PSM, HM	Mig		N		1, 2, 3, 5
French Creek	172100	12.0	WWSF ^e	12.0	WWSF ^e	12.0	DEF	PART 12.0	E	NPS, PSM, HM	Hab, Sed, Mig				2
Good Earth Creek	171400	7.0	WWSF ^e	7.0	WWSF ^e	7.0	DEF	PART 7.0	E	NPS, PSM	Hab, Sed				2, 3
Mad River	169600	2.0	WWSF ^e	2.0	WWSF ^e	2.0	DEF	PART 2.0	E	NPS, HM	Hab, Sed, Turb, Mig				2, 3
Ox (Laing) Creek	168600	0-3.0	WWSF ^e	3.0	WWSF ^e	3.0	DEF	PART 2.0	E	NPS, PSM	Hab, Sed	N			2, 3
		3.0-5.8	COLD ^b	2.8	COLD ^b	2.8	COLD	PART 2.8	E	NPS, HM	Hab, Sed, Mig				2, 3, 4
		5.8-7.0	UNK	1.2	UNK	1.2	DEF								
Page Creek	169100	5.0	WWSF ^e	5.0	WWSF ^e	5.0	DEF	PART 5.0	E	NPS, HM	Hab, Sed, Mig				2, 3
Spring Creek	172400	6.0	WWFF ^e	6.0	WWFF ^e	6.0	DEF	PART 6.0	E	NPS, HM	Hab, Sed, Mig				2, 3
Unnamed Streams		70.0	UNK												

Total Stream Miles: 160

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/2.8	COLD/2.8
	WWSF/80	WWSF/80
	WWFF/6	WWFF/6
	LFF/0	LFF/0
	LAL/0	LAL/0
	UNK/71.2	UNK/71.2

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (DNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

LOWER GRAND RIVER WATERSHED (UF-11)

The Lower Grand River includes the Grand River and its tributaries from its confluence with the Fox River in Marquette County to the dam at Manchester. The watershed is rural in nature, with agriculture being the primary land use. The three small communities in the watershed are Dalton, Kingston, and Manchester. There are extensive wetland complexes in the watershed, the most notable being the Grand River Marsh and State Wildlife Area.

Table 28. Lower Grand River Watershed (UF-11) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Friesland WWTF	0031780 12/31/2005	Friesland Trib. to Grand River	LAL	0	Municipal	
Kingston WWTF	0036421 6/30/2005	Grand River	WWSF	2.3' cfs	Municipal	

* = Q_{7,10} flow estimate upstream at Markesan.

WATER QUALITY DESCRIPTIONS

Belle Fountain Creek - This stream is a tributary to the Grand River in Green Lake County. There is no recent fisheries or water resources information for the stream. The stream is clear with little sediment build up based on observations of the stream near the Community of Dalton. The fishery of the stream includes forage fish, suckers, and carp. Walleye and northern pike may migrate into lower reaches of the stream to spawn. Caddisfly and mayflies were mentioned in a 1971 document (Fassbender et al., 1971) as being present. This would indicate good water quality in at least some reaches of the stream.

Grand River - This is another stream for which there is little recent fisheries or water resources information. The 1991 version of the Upper Fox River Basin Plan identified wetland drainage, agricultural nonpoint source pollution, and an overabundance of carp as the primary water quality problems (Fix and Eagan, 1990). The entire river system above the Kingston dam was chemically treated to remove carp. It was identified that chemical treatment successfully decreased carp the population (Fassbender et al., 1971).

This reach of the Grand River has two dams, which forms an impoundment. One dam creates the flowage that is the main water feature of the Grand River Marsh State Wildlife Area. The other dam on this reach forms Grand Lake at Kingston.

Grand Lake - Grand Lake is an impoundment of the Grand River at Kingston. Although the lake supported a good fishery at one time, it has been degraded due to sediment accumulation and the presence of carp. These problems are not uncommon to millponds in southern Wisconsin. The millpond was chemically treated to eliminate the carp in the late 1960's, but that project was only partially successful. The dam was drawn down in the early 1990's to allow reconstruction of the dam. The drawdown allowed cattails to become established in the shallower areas of the pond. The significant increase of cattails in the millpond has resulted in recreational use problems.

REFERENCES

1. Wisconsin Department of Natural Resources. Water Resources Files - South Central Region. 1995.
2. Fix, Steven M. and Lloyd Lewis Eagan. Upper Fox River Water Quality Management Plan. Wisconsin Department of Natural Resources. 1990.
3. Fassbender, Ronald L., John J. Weber, and Linden M. Nelson. Surface Water Resources of Green Lake County. Wisconsin Department of Natural Resources. 1971.
4. Poff, Ronald J. and C.W. Threinen. Surface Water Resources of Marquette County. Wisconsin Department of Natural Resources. 1963.
5. Bruch, Ronald. Winnebago Comprehensive Management Plan. Wisconsin Department of Natural Resources. 1988.

Table 29. Lower Grand River Watershed (UF-11)

Area (sq. miles): 109

Counties: Green Lake and Marquette

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Belle Fountain Creek	160000	2.0	WWSF	2.0	WWSF ^e	2.0	DEF	FULLY 2.0	E	HM	Mig		N		1, 2, 3, 4
Graham Creek	160130	2.0	UNK	2.0	COLD	2.0	DEF	NOT 2.0	E	NPS, HM	Hab, Sed, Mig				2, 4
Grand River	159300	21.0	WWSF ^a	21.0	WWSF ^a	21.0	WWSF	PART 21.0	E	NPS, PSM, HM	Hab, Sed Mig		N		1, 2, 3, 4
N. Br. Belle Fountain	160170	3.0	LFF ^e	3.0	LFF ^e	3.0	DEF	FULLY 3.0	E						2, 3
S. Br. Belle Fountain	160160	3.0	LFF	3.0	LFF ^e	3.0	DEF	PART 3.0	E	NPS, PSM	Hab, Sed				2, 3
Spring Creek	167300	2.0	LFF ^e	2.0	LFF ^e	2.0	DEF	PART 2.0	E	NPS, HM	Hab, Sed, Turb				2, 3
Welch Creek	159400	5.0	UNK	5.0											
Unnamed Stream 17-3C T14N R12E		0-5.0	WWFF ^e	5.0	WWFF ^e	5.0	DEF								3
		5-13.0	UNK	8.0	UNK	8.0	DEF								
Unnamed Streams		25.0	UNK	25.0			DEF								

Total Stream Miles: 76

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/0	COLD/2
	WWSF/23	WWSF/23
	WWFF/5	WWFF/0
	LFF/8	LFF/8
	LAL/0	LAL/0
	UNK/40	UNK/38

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (DNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

UPPER GRAND RIVER WATERSHED (UF-12)

The Upper Grand River watershed includes all water draining to the Grand River above the Manchester dam in southeast Green Lake County and a part of western Fond du Lac County. As with most of the watershed in the Upper Fox River Basin, land use is predominately agricultural.

The Upper Grand River watershed has an erosion rate of 8 tons of sediment per acre per year. The Green Lake County conservationist considers this watershed a likely candidate for a possible nonpoint source pollution abatement priority watershed project (Hebbe, 1990). Assessment monitoring will be done in this watershed. If the results of the monitoring indicate there are water resource use impairments due to nonpoint sources of pollution, which could be corrected through a NPS priority watershed project, the Department will make the appropriate amendment to the basin plan.

There are two communities with municipal wastewater treatment facilities in the watershed, Markesan and Fairwater. Fairwater operates a stabilization pond wastewater treatment system that discharges to an effluent ditch tributary to the Grand River. The 1995 Compliance Maintenance Annual Report indicated the facility was having some problems, particularly with influent loading. The problems are being addressed at this time. Markesan operates an oxidation ditch wastewater treatment facility that discharges to the Grand River. There are also two larger canning factories at Markesan, Del Monte and Chiquita Processed Foods. Both canning facilities discharge process wastewater to groundwater via spray irrigation on farm fields. Del Monte discharges non-contact cooling water directly to the Grand River. Non-contact cooling water at Chiquita's operation is discharged to a seepage lagoon next to the Grand River (WDNR SCR-Files, 1996). There is some question as to whether this discharge is actually seeping into the Grand River. Chiquita Processed Foods had also received a Notice of Noncompliance (NON) while the facility was owned by Friday Canning regarding exceeding WPDES permit loading rates for their spray irrigation fields (WDNR SCR Files, 1996). They are working on resolving the situation.

Table 30. Upper Grand River Watershed (UF-12) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Fairwater WWTF	0021440 9/30/2005	Trib to Grand River	LAL/ WWSF	0/ 0.37	Municipal	
Markesan WWTF	0024619 3/31/2002	Grand River	WWSF	2.3 cfs	Municipal	N
Chiquita Processed Foods- Markesan	0027529 6/30/2004	Groundwater	NA	NA	Food Canning	
Del Monte Foods-Plant 116	0027448 12/31/2005	Grand River; Groundwater	WWSF; NA	2.3; NA	Food Canning	N

WATER QUALITY DESCRIPTIONS

Grand River - Little is known about current water quality, instream habitat, or fisheries conditions of the Grand River in this watershed. Observations made by DNR staff indicate the stream may have reaches of good water quality and habitat (WDNR, 1995). However, agricultural practices may be affecting the river. Older biotic index information taken below Markesan indicates only fair water quality (Fix and Eagan, 1990). There is a dam on the river at Manchester that forms a small impoundment. The dam is in poor condition and the impoundment is drawn down. The dam is an impediment to fish migration and may have an adverse impact on downstream water quality. There is no public access to the impoundment. The dam is in poor condition and should be repaired or removed (Josheff, 1996).

Little Green Lake - Little Green Lake is a 466 acre lake with a maximum depth of 28 feet. The lake has a diverse warm water sport fishery. It has a drainage area of about 3.33 square miles. The watershed surrounding the lake is used primarily for agricultural purposes. Non-point sources of pollution include severe soil erosion problems in the watershed which are negatively affecting water quality of the lake (Bruch, 1988). There are seasonal cottages and year-round homes around much of the lake. The lake has a history of excessive algae and/or aquatic weed growth. Chemical treatment has been used to control aquatic vegetation (WDNR SCR-Files, 1995). The lake association received a planning grant to document water quality problems in the lake. The preliminary findings of the study, done by the U.S. Geological Survey, are that the lake: is eutrophic and has poor water quality; algal growth is dependent on available phosphorus and nitrogen; large amounts of phosphorus are released from bottom sediment during the summer; and chlorophyll a concentrations are declining and clarity seems to be improving (Field, 1995).

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4. Wisconsin Department of Natural Resources. Wastewater Management Files - South Central Region. 1996.
5. Josheff, Susan. Personal Communication. Wisconsin Department of Natural Resources. 1996.
6. Hebbe, James. Personal Communication. Green Lake County Land Conservation Department. 1990-1996.
7. Field, Stephen J. "Letter to the Little Green Lake Protection and Rehabilitation District." U.S. Geological Survey. 1995.
8. Bruch, Ronald. Winnebago Comprehensive Management Plan. Wisconsin Department of Natural Resources. 1988.
9. Sessing, Mark. Personal Communication. Wisconsin Department of Natural Resources. 1996.

Table 31. Upper Grand River Watershed (UF-12)

Area (sq. miles): 62

Counties: Green Lake

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Grand River	159300	21-43	WWSF	22.0	WWSF ^e	22.0	WWSF	PART 22.0	E	NPS	Hab, Sed		N		1, 2, 3, 4, 5
Unnamed Streams		22.0	UNK	22.0			DEF			HM ^h	Mig ^h				

Total Stream Miles: 44

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/0	COLD/0
	WWSF/22	WWSF/22
	WWFF/0	WWFF/0
	LFF/0	LFF/0
	LAL/0	LAL/0
	UNK/22	UNK/22

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (DNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

^hRecent research has revealed the presence of dams that are limiting fish migration and potentially raising water temperatures.

MONTELLO RIVER WATERSHED (UF-13)

The Montello River watershed is a 152 square mile watershed in northwestern Marquette County. The primary land use in the watershed is agricultural, but it is not as intensive agricultural as watersheds in the eastern and southern parts of the basin. There are large forested and woodlot areas in the watershed. The two larger lakes in the watershed are both impoundments and show some of the water quality problems that most impoundments in southern Wisconsin. All the lakes in the watershed are experiencing increased recreational use and development pressure. There are numerous wetland complexes in the watershed, most associated with the streams. Some wetland areas have been drained for agriculture. There are a number of Class I and Class II trout streams in the watershed.

The only municipal wastewater discharge in the watershed is the Village of Westfield. The Community of Harrisville and most of the City of Montello are also in the watershed. Montello's wastewater discharge is in a different watershed (UF-06). The population of the City of Montello grew approximately 7.5% between 1990 and 1995, faster than the state average. If that level of growth continues, Montello may also face the water quality and quantity problems growing municipalities have encountered.

Table 32. Montello River Watershed (UF-13) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Westfield WWTF	0022250 3/31/2005	Westfield Creek	WWSF	23	Municipal	
Brakebush Bros., Inc.	0051527 6/30/2005	Groundwater	NA	NA	Food Processing	

WATER QUALITY DESCRIPTIONS

Caves Creek - Caves Creek is a tributary to Westfield Creek east of Westfield. It is a Class I trout stream (WDNR, 1980) and is also an Exceptional Resource Water of the state. There is little recent water quality information for the stream. The stream is assumed to have good water quality based on recent visual observation (WDNR SCR-Files, 1995)

Lawrence Creek - Lawrence Creek is a Class I trout stream (WDNR, 1980) which rises in eastern Adams County and empties into Lawrence Lake in Marquette County. Approximately 50% of the watershed is agricultural, with most of the remainder forested. The stream is characterized as 75% run versus 25% riffle areas (Rheaume et al., 1996). It is considered to have good water quality based on recent observations (WDNR SCR-Files, 1995) and a recent U.S Geological Survey study (Rheaume et al., 1996). There is little intensive agriculture in its sub-watershed and the stream is buffered in many reaches by wetlands or woods. Portions of the stream are in public ownership as part of the Lawrence Creek Public Hunting Grounds.

Montello River - There is some question as to exactly where the Montello River begins. Hydrologically, it could be considered to begin at the confluence of Westfield and Tagatz creeks, about a mile upstream of Harris Pond. Surface Water Resources of Marquette County (Poff and Threinen, 1963) considers the river to begin at the Harrisville dam and continue downstream to the Fox River. This report will consider the river to begin at the confluence of Westfield and Tagatz creeks. There has been no recent water quality information collected for the river. Recent observations have lead Department staff to consider water quality to be generally good as there is good water clarity and wild rice has been observed growing in the stream (WDNR SCR-Files, 1995). Instream habitat may be limited as the bottom seems to primarily consist of sand in

numerous spots. However, there are also reaches with gravel bottom. The stream appears to be well buffered by woods or shrub-carr wetlands (WDNR SCR-Files, 1995). There are two dams on the river. The dam at Harrisville forms the Harris Pond and is still used to generate electricity. The dam at Montello creates Montello Lake.

Tagatz Creek - Tagatz Creek is a Class I trout stream (WDNR, 1980) which rises in the northwest corner of Marquette County. It is also considered a Wisconsin Outstanding Resource Water. It is considered to have very good water quality. Instream habitat may be limited in its lower reaches by sand (WDNR SCR-Files, 1995). The stream does appear to be well buffered and there is little intensive agriculture in its sub-watershed.

Westfield Creek - Westfield Creek starts at the Lawrence Lake dam and flows easterly. Above Lawrence Lake it is known as Lawrence Creek. There is a second dam on the creek at Westfield. Although the stream is not formally classified as a trout stream, it is managed for trout (WDNR, 1996). The operation of the Lawrence Lake dam and the dam at Westfield are the likely limiting factors for the trout fishery in the creek by warming the water in the creek. A sandy substrate habitat may also be limiting (WDNR SCR-Files, 1995).

Montello Lake - Montello Lake is a 286 acre impoundment of the Montello River. It has a maximum depth of 17 feet (WDNR, 1995⁶). The lake appears to be suffering water quality problems generally associated with impoundments in southern Wisconsin. The lake is enriched with nutrients which encourages excessive aquatic plant growth during the summer (Aron, 1995). There does not appear to be the animal density, number of barnyards adjacent streams, or other poor agricultural practices in the watershed when compared to other watersheds in the basin. It is likely that much of the nutrient loading to the lake is naturally occurring (WDNR SCR-Files, 1995¹). Additional monitoring, land use assessment, and modeling would be necessary to determine what percent of total nutrient loading to the lake is due to nonpoint source pollution and what is naturally occurring.

Lawrence Lake - Lawrence Lake is formed by a small hydropower dam on Lawrence Creek. The lake is 221 acres in size with a maximum depth of 14 feet and an average depth of 8 feet. The dam partially failed several years ago and the lake was drawn down while repairs were done. The Department of Natural Resources and the lake district have had an ongoing dialog regarding appropriate management and operation of the dam. The Department's position has been that a bottom draw discharge would be best for downstream water quality and instream habitat consideration while the lake association prefers a top draw.

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1. Wisconsin Department of Natural Resources. Water Resources Files - South Central Region. 1995.
2. Wisconsin Trout Streams. Wisconsin Department of Natural Resources. 1980.
3. Fix, Steven M. and Lloyd Lewis Eagan. Upper Fox River Water Quality Management Plan. Wisconsin Department of Natural Resources. 1990.
4. Poff, Ronald J. and C.W. Threinen. Surface Water Resources of Marquette County. Wisconsin Department of Natural Resources. 1963.

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8. Rheume, S.J., J.S. Stewart, and Bernard N. Lenz. Environmental Setting of Benchmark Streams in Agricultural Areas Of Eastern Wisconsin. U.S. Geological Survey. Water-Resources Investigations Report 96-4038-A. 1996.

Table 33. Montello River Watershed (UF-13)

Area (sq. miles): 109

Counties: Marquette

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Caves Creek	166100	12.1	COLD ^b	12.1	COLD ^b	12.1	ERW	FULLY-THR 12.1	E	NPS	Hab, Sed		N		1, 2, 3, 4
Klawitter Creek	164900	0-3.9 3.9-13.0	COLD ^b WWFF ^e	3.9 9.1	COLD ^b UNK	3.9 9.1	COLD	FULLY 3.9	E	HM	Mig				2, 3, 4 4
Lawrence Creek	167100	4.4	COLD ^b	4.4	COLD ^b	4.4	ORW	FULLY 4.4	M				N		1, 2, 3, 4, 8
Montello River	164100	14.0	WWSF ^e	14.0	WWSF ^e	14.0	DEF	PART 14.0	E	NPS, HM	Hab, Sed, Mig		N		1, 3, 4
Tagatz Creek	165800	16.2 16.2-17.0	COLD ^b UNK	16.2 0.8	COLD ^b UNK	16.2 0.8	ORW DEF	FULLY 16.2	E				N		1, 2, 3, 4
Spring Creek	167300	2.0	WWFF ^e	2.0	UNK	2.0	DEF								4
Westfield Creek	166000	11.0	WWSF ^e	11.0	COLD	11.0	DEF	NOT 11.0	E	NPS, HM	Hab, Sed, Mig		N		1, 3, 4, 5
Unnamed Streams		26.0	UNK	26.0			DEF			HM ^h	Mig ^h				

Total Stream Miles: 99.5

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/36.6	COLD/47.6
	WWSF/25	WWSF/14
	WWFF/11.1	WWFF/0
	LFF/0	LFF/0
	LAL/0	LAL/0
	UNK/26.8	UNK/37.9

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (DNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

^hRecent research has revealed the presence of dams that are limiting fish migration and potentially raising water temperatures.

NEENAH CREEK WATERSHED (UF-14)

The Neenah Creek watershed is a 169 square mile watershed located in southeastern Adams County, southwestern Marquette County and northwest Columbia County. Approximately 42% of the watershed is agricultural, 27% of the watershed is forested, and about 14% of the watershed is composed of wetlands (Rahmeier, 1994). The only incorporated municipality in the watershed is the Village of Oxford. Wastewater from this village is discharged to surface water. The only other wastewater treatment facility in the watershed is the Oxford Federal Correctional Institute.

Table 34. Neenah Creek Watershed (UF-14) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Oxford WWTF	0032077 6/30/2004	Neenah Creek	COLD Class III	26	Municipal	

The watershed has a number of smaller glacial pot-hole or kettle lakes, lakes characterized as having no outlets. There are some impoundments on some streams in the watershed. There are some large wetland complexes, as well as drained wetlands, in the Columbia County part of the watershed. There are some smaller wetland complexes along streams in the watershed, including one very high quality wetland along Widow Green Creek.

Neenah Creek watershed was selected in 1994 as a priority watershed project under the state's nonpoint source pollution abatement program. This project is currently in implementation and will end in 2004. The 1990 edition of this water quality management plan specified the water quality problems surface waters in the watershed were experiencing (Fix and Eagan, 1990). Watershed appraisal monitoring done in 1994 more completely document the extent of the water quality problems and threats to surface waters in the priority watershed project plan (Rahmeier, 1994). The areas of primary concern due to nonpoint source pollution are at the Columbia-Marquette county line and southward and in the Mason Lake area (Rahmeier, 1994).

Appraisal work done as part of the beginning of the priority watershed project led to the conclusion that groundwater quality in the watershed is generally good (Rahmeier, 1994).

For a more detailed discussion of the nonpoint source priority watershed project, see the publication Nonpoint Source Control Plan for the Neenah Creek Priority Watershed Project, (Rahmeier, 1994).

WATER QUALITY DESCRIPTIONS

Big Spring Creek - Big Spring Creek is a small tributary to Mason Lake. It is a Class I trout stream (WDNR, 1980) above a small millpond at the Community of Big Spring. The dam creating the millpond has been removed and the millpond has been drawn down as a result. Nonpoint sources of pollution have affected instream habitat and the fishery.

Neenah Creek - Neenah Creek above Neenah Lake (Oxford Millpond) is a Class I trout stream (WDNR, 1980). It is considered the finest brown trout stream in Adams County. Macroinvertebrate biotic indices indicate "very good" to "excellent" water quality (Rahmeier, 1994). The reach from the Neenah Lake dam downstream to Marquette County Highway P is considered a Class III trout stream indicating a put and take fishery. It is apparent that the dam has a considerable affect on Neenah Creek; it is Class I trout water above the lake and Class III below. Water coming out of the lake warms the stream, thus reducing optimum conditions for trout. Improving the classification from Class III trout to Class II is considered realistic

through the nonpoint source priority watershed program (Rahmeier, 1994). From Marquette CTH P downstream to its mouth, Neenah creek is considered a warm water sport fishery (Rahmeier, 1994). Stream gradient in this reach is lower than in upstream portions of the stream. Agricultural land uses also change in this part of the watershed. There are several large muck farms (farms on drained wetland soils) located in watershed. Drainage ditches from these farms likely deliver large loads of sediment and nutrients to Neenah Creek and the Fox River.

Peppermill Creek - Peppermill Creek is a short tributary to Neenah Creek in Adams County. It has a diverse cold and warm water fishery. Both the macrophyte indices and instream habitat assessments were good. Water quality is generally good except in some of the impoundments (Rahmeier, 1994).

Peppermill Creek was declassified as trout water years ago because the numerous small impoundments have increased water temperatures above the optimum trout range. The priority watershed plan recommends removing the impoundments to improve water temperature and to minimize the effects of nonpoint source pollution on water quality and the stream's fishery (Rahmeier, 1994).

Widow Green Creek - Widow Green Creek is a tributary to Neenah Creek. The lower six plus miles are considered warm water sport fishery (Rahmeier, 1994). The upper 5.3 miles are Class II trout water. There are extensive marshes and wetlands in this sub-watershed. The nonpoint source priority watershed plan recommends preserving these wetlands because of their ecological significance.

Jordan Lake - Jordan Lake is a 213 acre lake with a maximum depth of 79 feet. It is the second largest lake in the watershed and can be considered typical of many of the rest in that it is a glacial pothole type of seepage lake. Water quality is considered to be "very good" based on secchi disk water clarity readings. The shoreline of the lake is extensively developed except on the east shore. There is a wetland complex on the east shore which provides some additional habitat as well as other wetlands functions. The priority watershed plan recommends protecting this wetland (Rahmeier, 1994). The lake has a diverse fishery and is a stop-over site from migratory waterfowl.

Mason Lake - Mason Lake is the largest lake in the watershed with an area of 855 acres. It is an impoundment of the South Branch of Neenah Creek and has a maximum depth of 10 feet. It suffers from water quality problems generally associated with shallow impoundments. Those problems include turbidity, high sediment and nutrient loading, nuisance growth of aquatic vegetation, and algal blooms. The lake has a diverse sport fishery and is popular year round. The lake is a major stopping point for migratory waterfowl, particularly Canada geese that can reach nuisance levels. The lake association has been very active in trying to manage the lake.

Neenah Lake (Oxford Millpond) - Neenah Lake is an impoundment of Neenah Creek at Oxford in Marquette County. The impoundment covers 61 acres with a maximum depth of 15 feet. The impoundment suffers many of the water quality problems found in other impoundments in southern Wisconsin including: sedimentation, nutrient loading, excessive aquatic plant, and/or algae growth. The dam also is a barrier to fish migration. Neenah Creek upstream of the impoundment is a high quality Class I trout stream while downstream of the dam it is only considered Class III trout water.

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Table 35. Neenah Creek Watershed (UF-14)

Area (sq. miles): 173

Counties: Adams, Columbia, and Marquette

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Big Slough	174500	10.0	WWSF ^e	10.0	WWSF ^e	10.0	DEF	PART 10.0	M	NPS, HM	Hab, Sed, Turb, Mig				3, 8
Big Spring Creek	176400	0-1.0 1.0-3.0	UNK COLD ^b	1.0 2.1	UNK COLD ^b	1.0 2.1	DEF ERW	PART 2.0	M	HM NPS	Mig Hab, Sed		N		8 1, 2, 3, 8
Neenah Creek	173800	0-19.0 19.0-29.9 29.9-37.3	WWSF ^e COLD ^b CLASS III COLD ^b	19.9 10.9 7.4	WWSF ^e COLD ^b CLASS III COLD ^b	19.9 10.9 7.4	DEF COLD ERW	PART 19.0 PART 10.9 FULLY-THR 7.4	M M	NPS, HM NPS, HM NPS	Hab, Sed, Mig Hab, Sed, Temp, Mig Hab, Sed				1, 2, 3, 7, 8
Peppermill Creek	178400	2.0	WWFF ^e	2.0	COLD	2.0	DEF	NOT 2.0	M	NPS, HM	Hab, Sed, Temp, Mig		N, PW		3, 8
S. Br. Neenah Creek	175500	3.2	WWSF ^e	3.2	WWSF ^e	3.2	DEF	PART 3.2	M	NPS, HM	Hab, Sed, Temp, Mig				8
Widow Green Creek	176800	0-6.7 6.7-12.0	WWSF ^e COLD ^b	6.7 5.3	WWSF ^e COLD ^b	6.7 5.3	DEF COLD	PART 6.7 PART 5.3	M M	NPS NPS	Hab, Sed Hab, Sed		N, PW		1, 2, 3, 8
Unnamed Trib to Mason Lake		6.0	LFF ^e	6.0	COLD	3.3	DEF	NOT 3.3	M	NPS	Hab, Sed				8
Unnamed Streams		43.0	UNK	43.0			DEF			HM ^h	Mig ^h				

Total Stream Miles: 116.5

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/25.6	COLD/30.9
	WWSF/38.9	WWSF/38.9
	WWFF/2	WWFF/0
	LFF/6	LFF/2.7
	LAL/0	LAL/0
	UNK/44	UNK/44

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (DNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

^hRecent research has revealed the presence of dams that are limiting fish migration and potentially raising water temperatures.

SWAN LAKE WATERSHED (UF-15)

The Swan Lake Watershed is an 81 square mile watershed that includes the headwaters of the Fox River. It is located in north-central Columbia County and a small part of southern Green Lake County. The topography of the watershed is composed of rolling drumloidal hills. The soils range from well drained on the hill slopes to very poorly drained soils on land possessing little to no slope. Agriculture is the dominant land use in the watershed.

There are agricultural nonpoint source pollution problems in the watershed. These problems include animal waste management problems, stream bank trampling as well as farm field runoff (Fix and Eagan, 1990). All of these problems add sediment and nutrients to the Fox River and the two principle lakes in the watershed, Park Lake and Swan Lake. There are wetland complexes in the watershed. The larger ones are adjacent to the Fox River and Swan Lake.

Pardeeville is the only municipality in the watershed. Its wastewater treatment plant discharges treated wastewater to a land disposal system. The discharge is filtered by physical and biological processes contained in the soil before reaching groundwater. There is some concern regarding the facility's ability to meet groundwater limits for nitrates and chlorides. This is a general concern for most wastewater facilities discharging to groundwater. The wastewater treatment facility is operating at 80-90% capacity. Pardeeville's population grew by 13% between 1990 and 1995. With this growth rate, the community should be looking at a major upgrade of this facility in the near future.

Table 36. Swan Lake Watershed (UF-15) Point Sources

FACILITY NAME	PERMIT # EXP. DATE	RECEIVING WATER	CLASS	Q _{7,10}	ACTIVITIES	N/R
Pardeeville WWTF	0021644 3/31/2004	Groundwater	NA	NA	Municipal	
Tuscarora, Inc.	0055328 6/30/2006	Spring Lake; Groundwater	WWSF; NA	NA; NA	Plastic Packaging	

WATER QUALITY DESCRIPTIONS

Fox River - The headwaters of the Fox River are in southern Green Lake County. There is little water quality information for the Fox River in this watershed. The USGS has done some monitoring just above Park Lake to help estimate nutrient loading to the lake. The data generated by the USGS study indicates that phosphorus loading to the lake from the Fox River was six times the threshold amount considered excessive (Kammerer, 1995). There is also little recent fisheries information for the river above Pardeeville.

Park Lake - Park Lake is a 312 acre impoundment of the Fox River at Pardeeville. It has a maximum depth of 27 feet, but its average depth is 7 feet. The lake is used by many people for recreation and fishing. However, it suffers from many of the same water quality problems found in impoundments in southern Wisconsin. The primary problems are from excessive aquatic plant growth and algae blooms. Secchi disk monitoring data has been used to classify the lake as highly eutrophic (WDNR, 1996¹). Monitoring of the Fox River above Park Lake indicates that the watershed above the lake contributes excessive amounts of sediment and nutrients to the lake (Kammerer, 1995). If sediment and nutrient loading to Park Lake from its watershed were reduced, water quality conditions would improve. This would also help water quality conditions of Swan Lake, which is located just downstream from Park Lake.

Swan Lake - Swan Lake is a natural, 406 acre lake on the Fox River. It has a maximum depth of 82 feet and an average depth of 32 feet. The lake is developed on its north and south shores with summer cottages, year-round homes, condominiums, and a golf course. These developments are all sewered by septic systems. No evaluation of how well these septic systems are functioning has been conducted.

The lake is considered to have a good warm water sport fishery. Recently, an over population of gizzard shad has occurred which has affected the overall fishery of the lake. The overpopulation may also be affecting water quality in the lake because the shad are feeding on zooplankton instead of feeding on algae in the lake.

Water quality is considered to be good. The lake is considered to be mesotrophic to borderline mesotrophic-eutrophic. Secchi disk water clarity readings collected between 1991 and 1994 showed a range of water quality conditions between fair and very good. The worst year was 1993 when a secchi disk reading of only 3 feet was obtained. That year was also a year of heavier than usual precipitation in the watershed. Fish from Swan Lake have been tested for mercury with no detects recorded.

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Table 37. Swan Lake Watershed (UF-15)

Area (sq. miles): 81

Counties: Columbia and Green Lake

Stream Name	WBIC	Length (miles)	Existing		Potential		Codified Use	Supporting Potential Use	Miles Assessed	Use Problems		Trend	Comments	Data Level	References
			Use	Miles	Use	Miles				Source	Impact				
Fox River	170650	34.0	WWSF ^e	34.0	WWSF ^e	34.0	DEF	PART 34.0	E, M	NPS, HM	Hab, Nut, Sed, Mig		N		1, 3, 5
Rock Spring Creek	180400	3.0	UNK	3.0	UNK	3.0	DEF								
Sand Spring Creek	180500	5.0	UNK	5.0	UNK	5.0	DEF								
Unnamed Streams		13	UNK	13.0	UNK	13.0	DEF			HM ^h	Mig ^h				

Total Streams Miles: 55

	<u>Existing Use Miles</u>	<u>Potential Use Miles</u>
Subtotals:	COLD/0	COLD/0
	WWSF/34	WWSF/34
	WWFF/0	WWFF/0
	LFF/0	LFF/0
	LAL/0	LAL/0
	UNK/21	UNK/21

^aA formal use classification (COLD, WWSF, WWFF) published by the department. (Note: this is the legal use classification even though it does not appear in the codes at this time.)

^bTrout stream identified in the "blue" Wisconsin Trout Streams book (DNR, 1980).

^cA formal variance use classification published by the department and correctly listed in NR 104.

^dA formal variance use classification published by the department and incorrectly or not listed in NR 104. (Note: these are the stream which no longer should be listed in NR 104 or ones that belong in NR 104, but are waiting for code update).

^eRecent studies or the professional judgment of a fish manager or aquatic biologist familiar with the water indicates this is the biological use the stream is now meeting or has the potential to meet.

^hRecent research has revealed the presence of dams that are limiting fish migration and potentially raising water temperatures.

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