

Lake Management Plan  
for  
East and West Fox Lakes

Crow Wing County, Minnesota

Sponsored by Fifty Lakes Property Owners Association and  
Fifty Lakes Foundation

Emailed: \_\_\_\_\_

Reviewed by FLPOA Board: \_\_\_\_\_

Reviewed by Initiative Foundation: \_\_\_\_\_

Final Adoption: \_\_\_\_\_

Subject to on-going improvements and updates

Healthy Lakes & Rivers Partnership Committee

Special thanks to Don Hickman of the Initiative Foundation

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## **I. Introduction**

### **Summary of Healthy Lakes & Rivers Partnership Program**

This document is intended to create a record of historic and existing conditions and influences on East and West Fox Lakes, and to identify the goals of the East and West Fox Lakes community. Ultimately it is meant to also help prioritize goals, and guide citizen action and engagement in the priority action areas. Clearly state agencies, local units of government, and the U.S. Corps of Engineers have a vital role and responsibility in managing surface waters and other natural resources, but above all else this Lake Management Plan is intended to be an assessment of what we as citizens can influence, what our desired outcomes are, and how we will participate in shaping our own destiny.

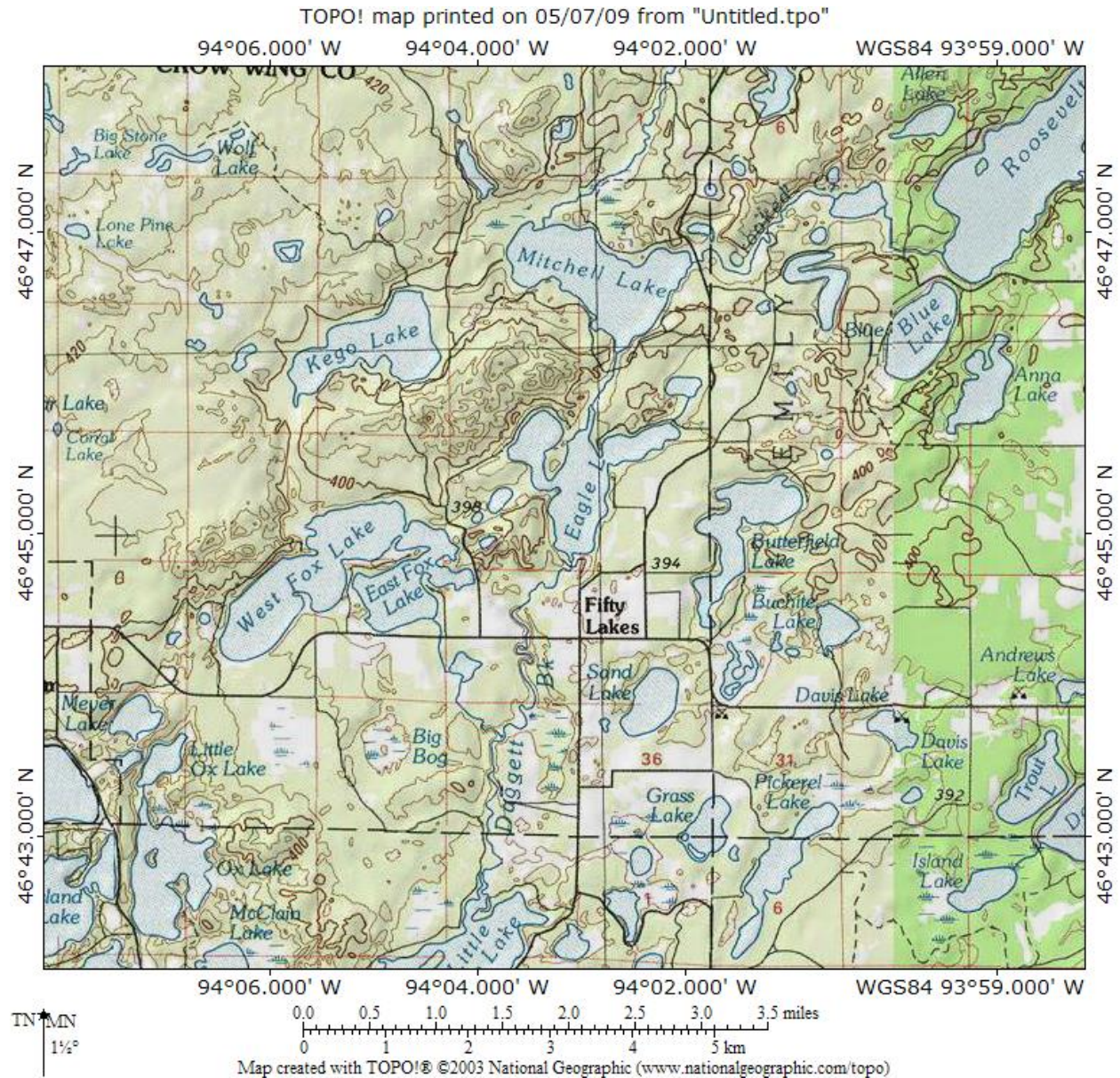
This Lake Management Plan is also intended to be a “living document;” as new or better information becomes available, as we accomplish our goals or discover that alternative strategies are needed, it is our intent to update this plan so that it continues to serve as a useful guide to future leaders.

In discussing lake management issues, it is impossible to avoid all scientific or technical terms. We have tried to express our goals, measures of success, and other themes as simply and clearly as possible, but have included a glossary of common limnological terms at the end of the plan to assist the reader. Limnology is the state of lake conditions and behavior.

Finally, we would like to thank the funders of the Healthy Lakes & Rivers Partnership program for Crow Wing County, including the McKnight Foundation, Laura Jane Musser Trust, Xcel Energy, U.S. Environmental Protection Agency, McDowall Company, the Cass County Water Plan, Lake Hubert Conservation Association, Portage-Crooked Lakes Association, and the Sibley Lake Association of Crow Wing County, the Ann Lake Sportsmen’s Club of Kennebec County, various staff from the Initiative Foundation, and over thirty generous individuals.

## Physical Description of East and West Fox Lakes Drainage Basin

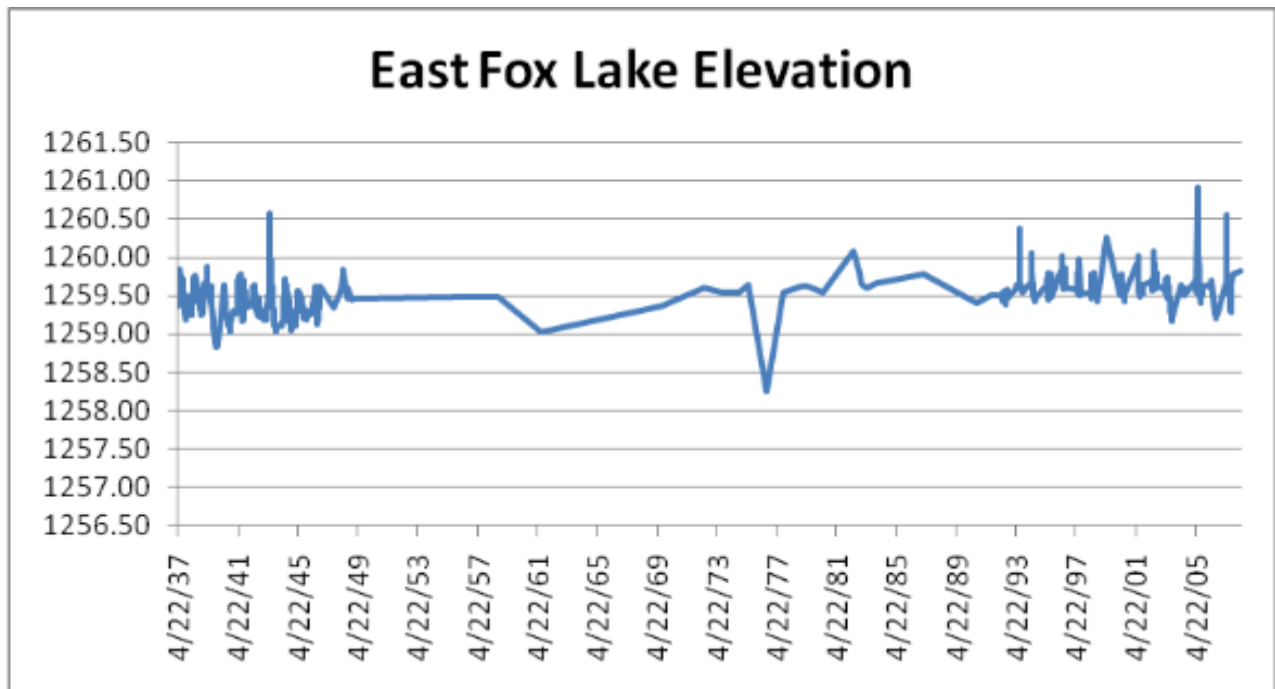
East Fox Lake (#18-0298) and West Fox Lake (#18-0297) are located in northern Crow Wing County, approximately one mile west of the City of Fifty Lakes, MN. East Fox Lake has a surface area of 239 acres, while West Fox has a surface area of 472 acres. East Fox has a maximum depth of 65 feet, and West Fox is 55 feet at its deepest point. Approximately 101 acres (42.3 percent) of East Fox Lake is within the littoral zone (having a depth of less than 15 feet), and 138 acres (29.2 percent) fit this classification. Water clarity averages 18.0 feet on East Fox, and 17.0 on West Fox Lake.



## 1. Watershed Size

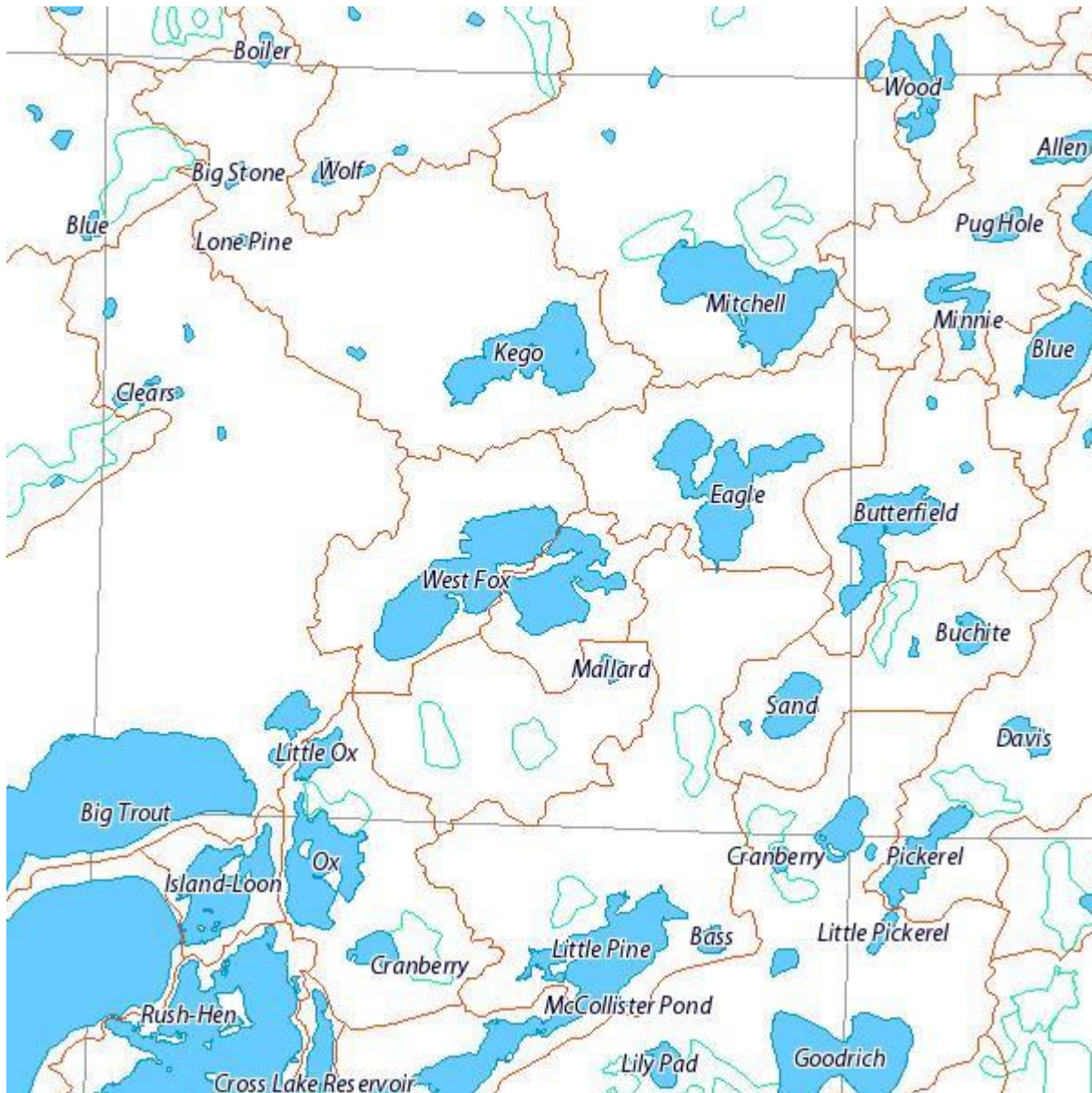
The Minnesota Department of Natural Resources, Division of Waters has monitored lake elevation (lake levels) on East Fox Lake in cooperation with volunteer readers since 1937. During the period of record the lake level has varied 2.67 feet based on 2,445 readings (through May 2008). In general, water levels decline from May through September, with the exception of a slight increase in mid-July in response to several storms.

Highest Recorded (feet/date)	Lowest Recorded (feet/date)	Ordinary High Water (feet)
1,260.92 ft  (June 9, 2005)	1,258.25 ft  (Aug. 10, 1976)	1,260.4 feet*



Elevations have only been recorded on four dates (between 1982 and 1984) on West Fox Lake, and were either identical or within 0.01 feet (higher) than those at East Fox Lake.

## 2. Watershed Hydrology



West Fox Lake watershed catchment acres = 1538

East Fox Lake watershed catchment acres = 711

## **Minor Watersheds**

**This data source has been recently updated. The newer minor watershed or "catchment" lines may show small discrepancies with the major watershed boundaries.**

### **West Fox Lake**

HUC 12 Minor Name: Fox Lake

HUC 12 Number: 070101050303

Catchment ID:1103302

Catchment Acres: 1538

Catchment Area (sq\_m): 6223005.9

Contributing Area to this Catchment (in Acres): 7639

Major Watershed Number: 11

### **East Fox Lake**

HUC 12 Minor Name: Fox Lake

HUC 12 Number: 070101050303

Catchment ID:1103303

Catchment Acres: 711

Catchment Area (sq\_m): 2876428.3

Contributing Area to this Catchment (in Acres): 8350

Major Watershed Number: 11

## **3. Precipitation**

In this part of the state average annual precipitation ranges between 28 and 30 inches and evaporation averages around 30 inches. Summer (May to September) precipitation averages about 17 inches.

## **4. Soils**

According to the 1965 Crow Wing County Soil Survey, the majority of soils within the immediate Fox Lake drainage are of the Brainerd-Chetek Association or the Chetek-Onamia Association. Brainerd series soils are moderately well drained soils that developed from brown, non-calcareous, glacial till. Chetek series soils are well-drained to excessively drained, weakly developed soils that formed from non-calcareous, sandy and gravelly outwash and drift containing many crystalline rocks.



## **5. Land Use**

The water quality of our lakes and rivers is directly impacted by the land uses within the watershed. How we use and develop our land can have a positive or negative impact on the watershed water quality. The City of Fifty Lakes has zoning regulations that are designed to protect and preserve our Lakes and Rivers and the DNR has established setbacks that are supported and enforced by the City of Fifty Lakes.

The lakes are classified as General Development and the Development density is considered Heavy.

### **History of Development/Impacts on East and West Fox Lakes**

#### **Organizational History**

##### **FIFTY LAKES PROPERTY OWNERS ASSOCIATION**

The association had its' beginning in 1991 as the Fox Lakes Association. On August 10, 1991 a meeting was called for all the property owners on East and West Fox Lakes. The meeting was held at the Fifty lakes Sportsmen Club building. That building is now known as the Fifty Lakes Foundation.

Seventy-five to eighty property owners attended the first meeting and voted to form the association. A board was elected and began the process of organizing the association. Monthly board meetings were held and at a meeting in October 1991, committees were formed to address issues that were identified. The first set of by-laws was approved at a general meeting May 21, 1994.

In 1996 the board began talking about expanding the association to include property owners on all the lakes in Fifty Lakes and all property owners in Fifty Lakes. A vote was taken at the annual meeting in 1996 to approve expanding the association to include ALL property owners in Fifty Lakes. The name was changed to The Fifty Lakes Property Owners Association and a new set of by-laws was adapted August 23, 2003.

#### **a) Mission**

##### **THE PURPOSE OF THE ASSOCIATION**

- A. Disseminate information to the membership regarding governmental and technical development affecting the area.

- B. Serve as the voice of the membership in matters under consideration by federal, state or local governmental bodies and other agencies.
  - C. Promote and support enforcement of laws, which affect lakes and watersheds.
  - D. Represent the best interest of members in areas of real estate use and development, taxation and road development and maintenance.
  - E. Maintain the natural beauty of the area.
  - F. Promote home and property security.
  - G. Promote and support good lake management in order to maintain or improve:
    - 1. Water Quality.
    - 2. Fish population and wildlife habitat.
    - 3. Environmental sound lakeshore.
  - H. Disseminate information to the members on good lake and shoreline Management.
  - I. Promote the welfare of lake and watershed management interests in any other ways, which may be deemed appropriate by the Board of Directors.
- The above purpose was taken from section 3 of the by-laws that were adopted August 23, 2003.*

**b) Structure**

FLPOA is a Minnesota non-profit public organization and we follow Robert’s Rule of order for our meetings.

Board structure

- President
- Vice President
- Secretary
- Treasurer
- Board Members
- Members

**c) Accomplishments**

**PROGRAMS AND ACTIVITIES THE ASSOCIATION IS INVOLVED WITH EVERY YEAR**

- A. Monitor the water quality of the lakes in the city.
- B. Monitor the invasive species surveys that are conducted at the public boat accesses.
- C. Coordinate and exchange information with other associations and organizations.
- D. Monitor the activities of the city, county and state.
- E. Participate in Fifty Lakes Days.
- F. Conduct meetings as required.
- G. Develop lake management plans for our lakes. This project was started in 2009.

- H. Education program for the membership and anyone else that is using our lakes and the watersheds around them.

**SOME ISSUES AND DISCUSSION TOPICS THAT HAVE COME BEFORE THE BOARD OVER THE NINETEEN YEAR HISTORY OF THE ASSOCIATION**

Shoreline restoration	Tulebee gill netting
Timber Harvest	Aquatic vegetation
Fire pits near the lake	ATVs
Aquatic Invasive Species	Power Line Tree Trimming
Planned Unit Developments	Construction site dumpsters
Membership	Newsletter
Photographs of shoreline	Water ski school
Daggett Brook	Hay Creek
Golf courses	Code enforcement
PCA Lake Monitor Program	WAPOA Water Quality Testing Program
Annual Dues	Grants
Association Web Site	Water quality flyovers
Crow Wing County Timber Harvesting	

The success of the association, over the last nineteen years, can be attributed to the many volunteers who did and continue to donate their time to the many activities and projects the association has and is involved in. Thank you to all the volunteers who have participated.

**Web Site** <http://minnesotawaters.org/group/fiftylakes/welcome>

In Q1 of 2011 FLPOA developed a web site hosted by Minnesota Waters.

**II. Review of Historical and Existing Conditions for Focus Areas**

**1. Water Quality**

Since 1981, citizen volunteers from East and West Fox Lakes have participated in the Minnesota Pollution Control Agency’s (MPCA) Citizen Lake Monitoring Program (CLMP), recording secchi disc transparency – a measure of water clarity. Bob Stancer has been responsible for these efforts in recent years on both lakes, and has been supported by Dave and Marion Sundquist on West Fox Lake.

On the MPCA’s web-site link, “Lake Water Quality Database,” additional water chemistry data is reported. The MPCA’s “Environmental Database Access” system also provides additional water chemistry data which includes total phosphorus concentrations, as well as other data.

One application of secchi disc transparency data is to convert the clarity measurements into a Carlson Trophic Status Index (TSI) score. The Carlson Trophic Status Index (TSI) is a tool used to summarize several measurements of water quality into one index value, which can be used to compare a lake to other lakes, or to historic/future data as a measure of degradation or improvement. In many ways, the index can be viewed as a measure of the potential for algal productivity. Since most people value lakes with low algae productivity, the lower the TSI value, the healthier the lake. Specifically:

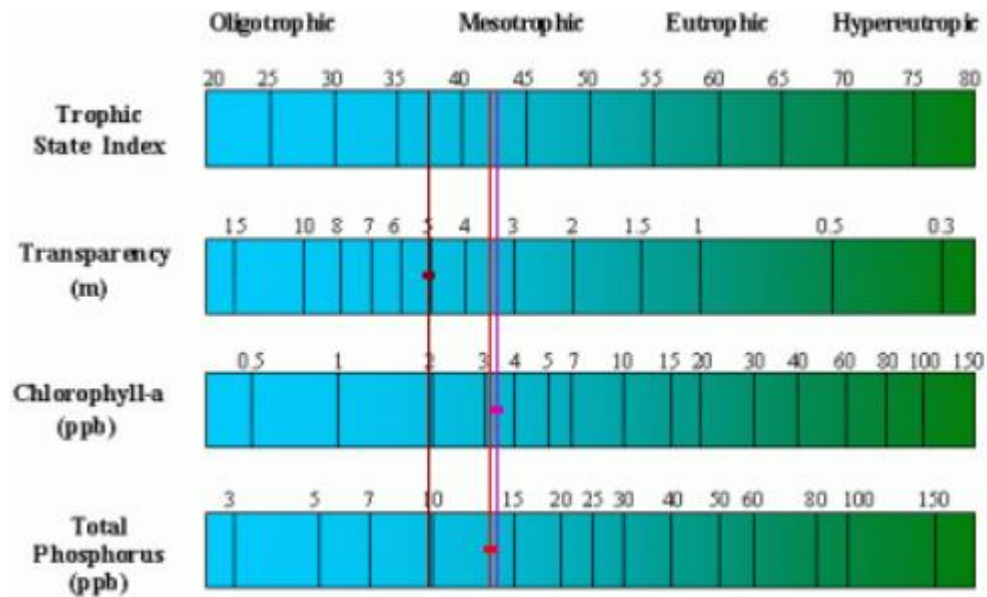
<b><u>TSI Range</u></b>	<b><u>Trophic Status</u></b>	<b><u>Characteristics</u></b>
0-40	Oligotrophic	Clean Lake
41-50	Mesotrophic	Temporary algae & aquatic plant problems
50-70	Eutrophic	Persistent algae & aquatic plant problems
Greater than 70	Hypereutrophic	Extreme algae & aquatic plant problems

Based on the data provided on the MPCA website, an average concentration (or depth) for the key TSI parameters can be determined, and the associated TSI score calculated.

### Average TSI Measurements for East Fox Lake, 1982-2010.

Year	Chlorophyll <i>a</i> (µg/L)	Total Phosphorus (µg/L)	Secchi Depth (feet)	Average TSI
1982	3.04	13	---	41.3
1992	---	---	19.6	34.2
1993	---	---	19	34.8
1996	---	---	14.2	38.9
1997	---	---	17.5	36
1998	---	---	15.5	37.6
1999	---	---	12.7	40.5
2000	---	---	---	---
2001	---	---	17.7	35.8
2002	---	---	14.5	38.7
2003	3.76	14	16.4	39.7
2004	1.68	13.8	17.1	37.3
2005	5.46	15.2	15.4	39.3
2006	---	---	16	37.2
2007	3.56	17.2	17.1	37.8
2008	4.40	17.2	20.2	34.5
2009	1.8	13.0	16.3	38.2
2010	3.0	14.4	15.0	41.2

These data suggest that water quality in East Fox Lake routinely exhibits conditions in the Oligotrophic Range range (a score below 40) or lower “meso-eutrophic” range (a TSI score above 40 but below 50). The higher scores associated with total phosphorus and chlorophyll *a* suggest that the potential for nutrient inputs could degrade transparency. A graph of all TSI data on record is presented on page 14.



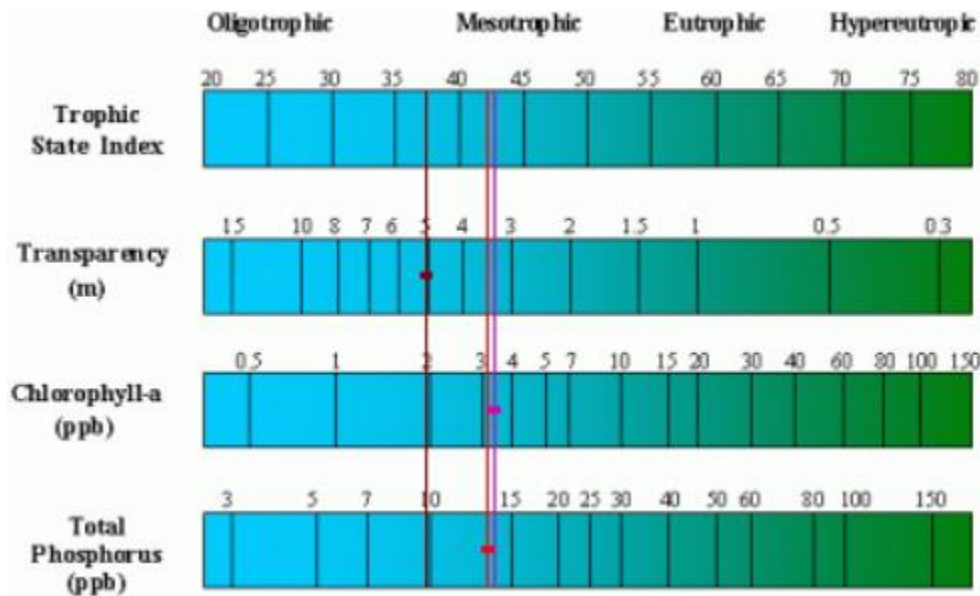
The graph above shows the long-term trend in Trophic Status Index values the years for which data are available for **East Fox Lake**. The variation observed within a single year reflects naturally occurring impacts of temperature, precipitation and water level; the important ‘take home message’ of this graph is that the data suggests range within oligotrophic conditions since data were first collected in 1981.

Based on the data provided on the MPCA website, an average concentration (or depth) for the key TSI parameters can be determined, and the associated TSI score calculated

for West Fox Lake.

**Average TSI Measurements for West Fox Lake, 1976-2008**

Year	Chlorophyll <i>a</i> (µg/L)	Total Phosphorus (µg/L)	Secchi Depth (feet)	Average TSI
1976	---	---	12.8	40.6
1977	---	---	17.5	36.2
1986	---	---	14.1	39.3
1987	---	---	16.8	36.5
1988	---	---	16.3	37
1989	---	---	17.2	36.2
1990	---	---	16.4	37
1991	---	---	15.1	38
1992	---	---	18.4	35.2
1993	---	---	14.9	38.3
1994	---	---	17.2	36.3
1995	---	---	17.1	36.3
1996	---	---	14	39.6
1997	---	---	18.5	35.5
1999	---	---	13.2	40.2
2001	---	---	15.9	37.4
2002	---	---	12	41.6
2003	6.9	14.6	13.5	43.1
2004	4.3	19.2	12.9	43.1
2005	4	19	13.2	10.9
2006	---	---	15.1	38.1
2007	5.8	18.3	16.9	38.3
2008	4.5	18.4	18.4	37.5
2009	3.4	12.8	14.9	40.6
2010	3.5	18.8	14.8	42.0



The graph above shows the long-term trend in Trophic Status Index values the years for which data are available for **West Fox Lake**. The variation observed within a single year reflects naturally occurring impacts of temperature, precipitation and water level; the important ‘take home message’ of this graph is that the data suggests range within oligotrophic conditions since data were first collected in 1976.

A second method of assessing water quality and determining whether your water body is the “best that it can be” is to compare it to other lakes of similar morphology, geology, and land uses. The table below is adapted from the MN Pollution Control Agency “Environmental Data Access” database, and compares observed surface water results in East and West Fox Lakes to common water quality ranges for lakes within the Northern Lakes & Forests Eco-region.

#### Average Summer Water Quality and Trophic Status Indicators



Parameter	Typical Range:	East Fox Lake	West Fox Lake
	Northern Lakes & Forests	(#18-0298)	(#18-0297)
	Eco-region		
Total Phosphorus (µg/L)	14 – 27	15.4 + 2.9	17.9 + 5.6
Chlorophyll a (µg/L) mean	4 – 10	3.8 + 2.5	5.1 + 3.8
Chlorophyll a (µg/L) maximum	<15	9.0	19.3
Secchi disc (feet)	8 – 15	17.4 + 3.1	15.9 + 3.3
Total Kjeldahl Nitrogen (mg/L)	0.4 – 0.75	0.56	ND
Nitrite + Nitrate Nitrogen (mg/L)	<0.01	<0.01	ND
Alkalinity (mg/L)	40-140	90	ND
Color (Pt-Color units)	10 – 35	5	ND
pH	7.2 – 8.3	8.7 + 0.4	8.1 + 0.7
Chloride (mg/L)	0.6 – 1.2	0.76	ND
Total Suspended Solids (mg/L)	<2	ND	ND
Conductivity (µmhos/cm)	50 – 250	215.7 +30.4	226.0 + 29.7

ND = No data

Absence of standard deviation indicates single value

A third application of these data is to compare phosphorus concentrations to the Minnesota Pollution Control Agency water quality criterion for swimming and other recreational contact.

The Northern Lakes and Forests Ecoregion phosphorus criteria level of 30 micrograms per liter (µg/L) serves as the upper threshold for full-support for swimmable use. This concentration corresponds to Carlson's TSI values of 54 or lower.

For the Northern Lakes and Forests ecoregion, summer-mean total phosphorus concentrations above 35 µg/L were associated with nonsupport of aquatic recreational use. At concentrations above about 35 µg/L mild blooms occur over 50 percent of the summer, nuisance blooms (> 20 µg/L of chlorophyll *a*) about 15 percent of the summer.

Phosphorus concentrations above criteria levels would result in greater frequencies of nuisance algal blooms and increased frequencies of "impaired swimming."

The MPCA uses a summary based on available summer (June through September) data in STORET (STORET is the national water quality data repository developed by the United States Environmental Protection Agency to calculate achievement in this area. All water quality data collected by MPCA or received from external groups is placed in STORET) collected between 1997 and 2006. The following summary is presented on the MPCA website:

Name	Mean Total Phosphorus (µg/l)	Carlson's Trophic Stratus Index (phosphorus)	MPCA Swimming Criterion'
------	------------------------------	--	--------------------------

East Fox Lake  
West Fox Lake

14.0  
17.0

42  
45

Full Support  
Full Support

## WAPOA Tests of Area Lake Water -- Latest Results

### INDIVIDUAL LAKE TSI VALUES

- 36-40 O'Brien, Big Trout, Star, Ox, Island, Ossawinnamakee, Clear, Kimble
- 40-42 East Fox, Rush, Butterfield
- 42-44 Middle Whitefish, Crosslake, West Fox, Lower Whitefish, Lower Hay, Goodrich, Bertha, Clamshell, Velvet, S. Roosevelt
- 44-46 Ruth, Lawrence, Leavitt, Smokey Hollow, N. Roosevelt
- 46-48 Eagle, Mitchell, U. Whitefish, Little Pine, Pine
- 48-50 Daggett
- 50+ Arrowhead, Upper Hay, Mary, Kego, Emily

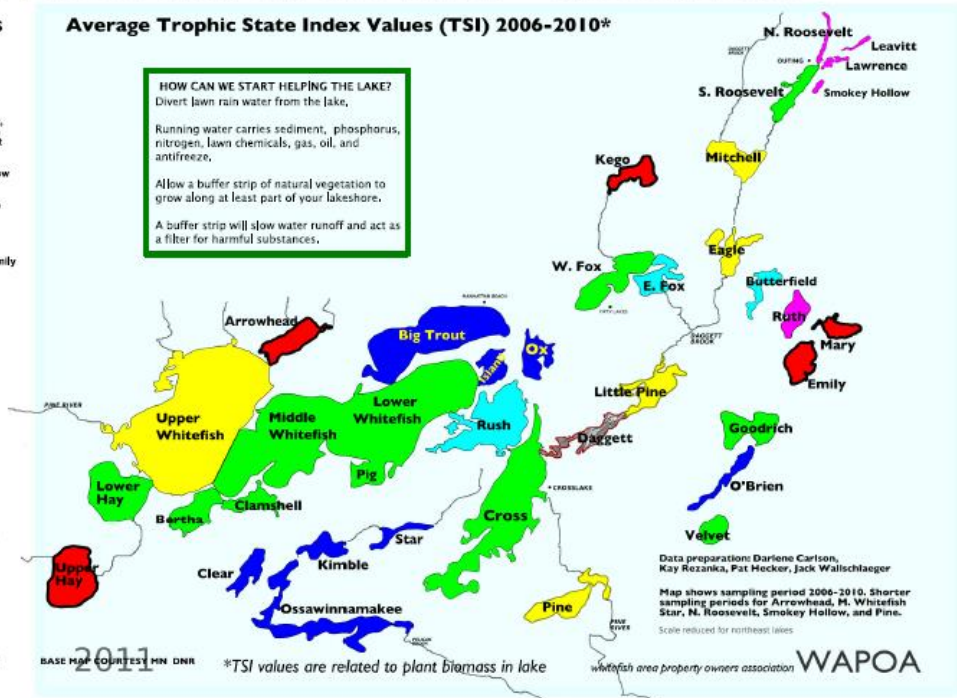
**↑ LOWER TSI**  
clearer water  
less algae  
desirable for swimming  
more oxygen in water  
game fish like this water

**↓ HIGHER TSI**  
cloudier water  
more green algae  
less/no swimming  
less oxygen in water  
rough fish tendency

WAPOA tests water on over 30 lakes. The result is a "TSI number."  
A higher TSI number (unfavorable) means more algae in the water.  
For every 1 point increase in TSI there is a 10% increase in algae in the water.  
Water with a high TSI may be unsuitable for swimming, clogged with plants, have green algae blooms, and be supportive of rough fish.  
Development along a lakeshore leads to phosphorus and sediment getting into the lake with degradation of water quality and increased plant and algal growth.

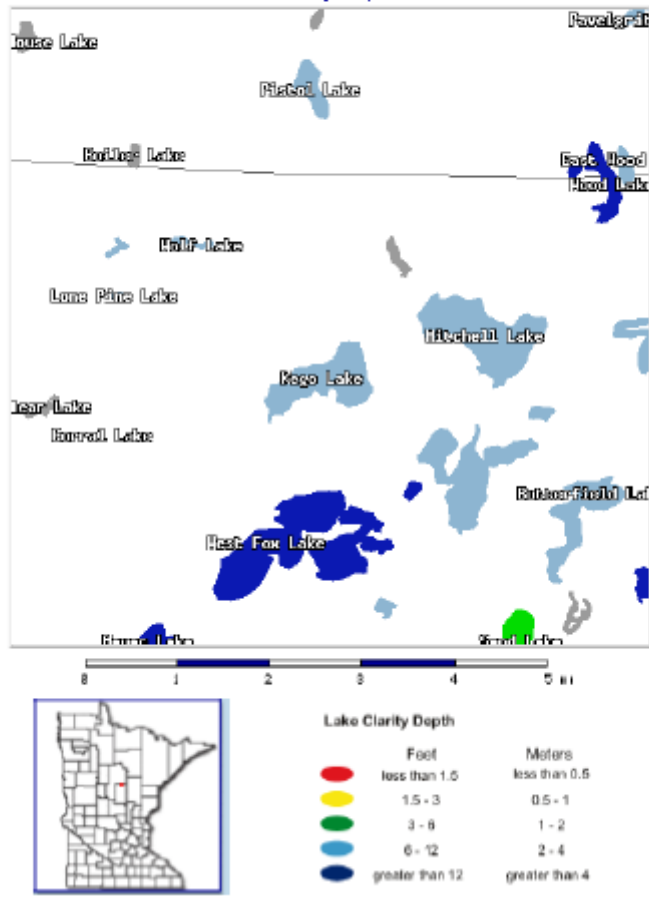
### Average Trophic State Index Values (TSI) 2006-2010\*

**HOW CAN WE START HELPING THE LAKE?**  
Divert lawn rain water from the lake.  
Running water carries sediment, phosphorus, nitrogen, lawn chemicals, gas, oil, and antifreeze.  
Allow a buffer strip of natural vegetation to grow along at least part of your lakeshore.  
A buffer strip will slow water runoff and act as a filter for harmful substances.



<http://water.umn.edu/cgi-bin/mapserv>

Water Clarity Map of 2005



<http://www.dnr.state.mn.us/lakefind/index.html>

<http://www.dnr.state.mn.us/lakefind/results.html>

## 2. Fisheries Management Plan

### *Status of the Fox Lake fishery (as of August 4, 2008) according to the MN Dept. of Natural Resources fisheries summary:*

Walleye fingerlings are currently stocked into West Fox every third year. The 2008 walleye catch rate was average when compared to similar lakes (1.2/gill net). All of the fish were over 18" with the average size measuring 21.8".

Northern pike numbers were average (8.3/gill net). Size averaged 18.8" and 1.6 lbs., with 10% of the fish measuring 24" or larger.

Largemouth bass numbers were high in gill nets (2.8/gill net) and low in trap nets (0.4/trap net). With both sampling gears combined, 29% of the fish were 12" or larger.

Black crappies were caught in average numbers both in gill nets (0.8/gill net) and trap nets (0.8/trap net). With both sampling gears combined, 75% of the fish were 8" or larger.

The bluegill catch rate was low (4.3/trap net). The average size was 6.2" and 36% of the fish were 7" or larger.

Other fish species sampled included black bullhead, bowfin (dogfish), brown bullhead, green sunfish, hybrid sunfish, pumpkinseed, rock bass, tullibee (cisco), yellow bullhead, and yellow perch.

See appendix I DNR Fisheries Managements Plan for East Fox and West Fox Lakes

For Crow Wing County the DNR Area Fisheries Manager is Tim Brastrup, Area Fisheries Manager, 1601 Minnesota Drive, Brainerd, MN 56401, phone: (218) 833-8636, e-mail: [tim.brastrup@dnr.state.mn.us](mailto:tim.brastrup@dnr.state.mn.us). The long range fisheries goal of the DNR plans for both lakes is to:

Maintain northern pike net catches within lake class 23 quartiles (2.2-8.7 per lift).  
Increase yellow perch catch rates to at least 3.0 per lift and tullibee net catches to at least 2.0 per lift. Maintain walleye net catches within lake class 23 quartiles (1.0-5.0 per lift).

The DNR plan also notes the following limiting factors:

Continued low net catches of yellow perch and tullibee raises concern about the forage base for walleye and northern pike.

The entire DNR Fisheries Management Plans for East (Appendix I) and West Fox Lakes (Appendix II) are included at the end of this Lake Management Plan.

### **3. Aquatic Vegetation**

Results of WAPOA Public Access Survey 2010 on East Fox Lake taken in 3' of water.

**No invasive plants found.**

Beneficial plants identified.

Chara  
Richardsons  
Robbins  
Sago  
Wild Celery  
Water Lily

### **4. Wildlife**

The "Blue Book," *Developing a Lake Management Plan* notes that:

"Minnesota's lakes are home to many species of wildlife. From our famous loons and bald eagles to muskrats, otters, and frogs, wildlife is an important part of our relationship with lakes. In fact, Minnesota's abundant wildlife can be attributed largely to our wealth of surface water. From small marshes to large lakes, these waters are essential to the survival of wildlife.

The most important wildlife habitat begins at the shoreline. The more natural the shoreline, with trees, shrubs and herbaceous vegetation, the more likely that wildlife will be there. Just as important is the shallow water zone close to shore. Cattail, bulrush, and wild rice along the shoreline provide both feeding and nesting areas for wildlife. Loons, black terns and red-necked grebes are important Minnesota birds that are particularly affected by destruction of this vegetation. Underwater vegetation is also important to wildlife for many portions of their life cycle, including breeding and rearing of their young.

The primary agency charged with the management of Minnesota's wildlife is the Department of Natural Resources, Division of Fish and Wildlife, Wildlife Section. For Pelican Lake, the DNR Area Wildlife Manager is Gary Drotts, 1601 Minnesota Drive, Brainerd MN 56401. His phone number is 218-828-2314. His e-mail is [gary.drotts@dnr.state.mn.us](mailto:gary.drotts@dnr.state.mn.us). Pam Perry is the Non-Game Wildlife Specialist, and can be reached at (218) 828-2228, [pam.perry@dnr.state.mn.us](mailto:pam.perry@dnr.state.mn.us).

The Minnesota County Biological Survey has completed the survey for Crow Wing County.

Specific Interests or concern for East and West Fox Lakes.

- Maintain and add Loon nesting locations
- Control of Beaver population in West Fox Lake
- West Fox Lake has family of 4 to 6 Otters, maintain habitat.
- Respect and protect Bald Eagle nesting locations.

## **5. Exotic Species**

### **Background**

"Exotic" species -- organisms introduced into habitats where they are not native -- are severe world-wide agents of habitat alternation and degradation. A major cause of biological diversity loss throughout the world, they are considered "biological pollutants."

Introducing species accidentally or intentionally, from one habitat into another, is risky business. Freed from the predators, parasites, pathogens, and competitors that have kept their numbers in check, species introduced into new habitats often overrun their new home and crowd out native species. In the presence of enough food and favorable environment, their numbers will explode. Once established, exotics rarely can be eliminated.

Most species introductions are the work of humans. Some introductions, such as carp and purple loosestrife, are intentional and do unexpected damage. But many exotic introductions are accidental. The species are carried in on animals, vehicles, ships, commercial goods, produce, and even clothing. Some exotic introductions are ecologically harmless and some are beneficial. But other exotic introductions are harmful to recreation and ecosystems. They have been caused the extinction of native species -- especially those of confined habitats such as islands and aquatic ecosystems.

The recent development of fast ocean freighters has greatly increased the risk of new exotics in the Great Lakes region. Ships take on ballast water in Europe for stability during the ocean crossing. This water is pumped out when the ships pick up their loads in Great Lakes ports. Because the ships make the crossing so much faster now, and harbors are often less polluted, more exotic species are likely to survive the journey and thrive in the new waters.

Many of the plants and animals described in this guide arrived in the Great Lakes this way. But they are now being spread throughout the continent's interior in and on boats and other recreational watercraft and equipment. This guide is designed to help water recreationalists recognize these exotics and help stop their further spread.

### **Eurasian watermilfoil (*Myriophyllum spicatum*)**

Eurasian watermilfoil was accidentally introduced to North America from Europe. Spread westward into inland lakes primarily by boats and also by waterbirds, it reached Midwestern states between the 1950s and 1980s.

In nutrient-rich lakes it can form thick underwater stands of tangled stems and vast mats of vegetation at the water's surface. In shallow areas the plant can interfere with water recreation such as boating, fishing, and swimming. The plant's floating canopy can also crowd out important native water plants.

A key factor in the plant's success is its ability to reproduce through stem fragmentation and runners. A single segment of stem and leaves can take root and form a new colony. Fragments

clinging to boats and trailers can spread the plant from lake to lake. The mechanical clearing of aquatic plants for beaches, docks, and landings creates thousands of new stem fragments. Removing native vegetation creates perfect habitat for invading Eurasian watermilfoil.

Eurasian watermilfoil has difficulty becoming established in lakes with well established populations of native plants. In some lakes the plant appears to coexist with native flora and has little impact on fish and other aquatic animals.

Likely means of spread: Milfoil may become entangled in boat propellers, or may attach to keels and rudders of sailboats. Stems can become lodged among any watercraft apparatus or sports equipment that moves through the water, especially boat trailers.

### **Purple loosestrife (*Lythrum salicaria*)**

Purple loosestrife is a wetland plant from Europe and Asia. It was introduced into the East Coast of North America in the 1800s. First spreading along roads, canals, and drainage ditches, then later distributed as an ornamental, this exotic plant is in 40 states and all Canadian border provinces.

Purple loosestrife invades marshes and lakeshores, replacing cattails and other wetland plants. The plant can form dense, impenetrable stands which are unsuitable as cover, food, or nesting sites for a wide range of native wetland animals including ducks, geese, rails, bitterns, muskrats, frogs, toads, and turtles. Many are rare and endangered wetland plants and animals and are also at risk.

Purple loosestrife thrives on disturbed, moist soils, often invading after some type of construction activity. Eradicating an established stand is difficult because of an enormous number of seeds in the soil. One adult plant can disperse 2 million seeds annually. The plant is able to re-sprout from roots and broken stems that fall to the ground or into the water.

A major reason for purple loosestrife's expansion is a lack of effective predators in North America. Several European insects that only attack purple loosestrife are being tested as a possible long-term biological control of purple loosestrife in North America.



Likely means of spread: Seeds escape from gardens and nurseries into wetlands, lakes, and rivers. Once in aquatic system, moving water and wetland animals easily spreads the seeds.

### **Other Midwestern Aquatic Exotics**

**Curly-leaf pondweed** (*Potamogeton crispus*) is an exotic plant that forms surface mats that interfere with aquatic recreation. The plant usually drops to the lake bottom by early July. Curly-leaf pondweed was the most severe nuisance aquatic plant in the Midwest until Eurasian watermilfoil appeared. It was accidentally introduced along with the common carp.

**Flowering rush** (*Botumus umbellatus*) is a perennial plant from Europe and Asia that was introduced in the Midwest as an ornamental plant. It grows in shallow areas of lakes as an emergent, and as a submersed form in water up to 10 feet deep. Its dense stands crowd out native species like bulrush. The emergent form has pink, umbellate-shaped flowers, and is 3 feet tall with triangular-shaped stems.

**Round goby** (*Neogobius melanostomus*) is a bottom-dwelling fish, native to Eastern Europe that entered the eastern Great Lakes in ballast water. They can spawn several times per year, grow to about 10 inches, are aggressive, and compete with native bottom-dwellers like sculpins and log perch. They are expected to be harmful to Great Lakes and inland fisheries.

**Rusty crayfish** (*Orconectes rusticus*) are native to streams in the Ohio, Kentucky, and Tennessee region. Spread by anglers who use them as bait, rusty crayfish are prolific and can severely reduce lake and stream vegetation, depriving native fish and their prey of cover and food. They also reduce native crayfish populations.

**White perch** (*Morone americana*) are native to Atlantic coastal regions and invaded the Great Lakes through the Erie and Welland canals. Prolific competitors of native fish species, white perch have the potential to cause declines of Great Lakes walleye populations.

## **6. Land Use and zoning**

The water quality of a lake or river is ultimately a reflection of the land uses within its watershed. While the specific impacts to a lake from various land uses vary as a function of local soils, topography, vegetation, precipitation, and other factors, it is ultimately the land uses which citizens have the most control over through prudent zoning

Many zoning regulations are based upon the Shoreland Management Act and/or the Minnesota Department of Natural Resources (DNR) classification of a given lake. The DNR has classified all lakes within Minnesota as General Development (GD), Recreational Development (RD), or Natural Environmental (NE) lakes, and assigned a unique identification number to the lake for ease of reference. Counties in turn have used these classifications as a tool to establish minimum lot area (width and setbacks) that is intended to protect and preserve the character reflected in the classification. Similar classifications exist for rivers; in Crow Wing County the Mississippi River is considered Class II. Clearly any local municipal jurisdiction may have additional (and usually more restrictive) standards as well.

On any shoreland the permissible density and setbacks for virtually all new uses are determined by the lake or river classification standards established by the Department of Natural Resources. **East and West Fox Lakes** (DNR Lake ID#18-0298 and 18-0297) are General Development (GD) Lakes.

**Natural Environment** lakes are generally small, often shallow lakes with limited capacities for assimilating the impacts of development and recreational use. They often have adjacent lands with substantial constraints for development such as high water tables, exposed bedrock, and unsuitable soils. These lakes, particularly in rural areas, usually do not have much existing development or recreational use. In Crow Wing County, an NE management district is “established to preserve and enhance high quality waters by protecting them from pollution and to protect shorelands of waters which are unsuitable for development; to maintain a low density of development; and to maintain high standards of quality for permitted development.”

**Recreational Development** lakes are generally medium-sized lakes of varying depths and shapes with a variety of landform, soil, and ground water situations on the lands around them. They often are characterized by moderate levels of recreational use and existing development. Development consists mainly of seasonal and year-round residences and recreationally-oriented commercial uses. Many of these lakes have capacities for accommodating additional development and use. In Crow Wing County the RD management district is established to “managed proposed development treasonable consistent with existing development and use; to

provide for the beneficial use of public waters by the general public, as well as the riparian owners; to provide for multiplicity of lake uses; and to protect areas unsuitable for residential and commercial uses from development.”

**General Development** lakes are generally large, deep lakes or lakes of varying sizes and depths with high levels and mixes of existing development. These lakes often are extensively used for recreation and, except for the very large lakes, are heavily developed around the shore. Second and third tiers of development are fairly common. The larger examples in this class can accommodate additional development and use. Crow Wing County’s Shoreland Ordinance notes that “the GD management district is established to provide minimum regulations in areas presently developed as high density, multiple use areas; and to provide guidance for future growth of commercial and industrial establishments which require locations on protected waters.”

In Crow Wing County the zoning standards associated with each water body class are:

Class	Minimum Lot Size (sq ft)	Minimum Lot Width (feet)	Structure Setback (feet)	Maximum impervious coverage
GD	20,000	100	75	25 percent
RD	40,000	150	100	25 percent
NE	80,000	200	200	25 percent
II	5 acres	330	150	---

Most lakes have numerous properties that are “grand fathered,” or developed prior to the establishment of these restrictions. In general, these pre-existing uses are allowed to remain unless they are identified as a threat to human health or environment, or are destroyed by natural, accidental causes or in association with significant renovation.

**State of Minnesota Regulations Part 6120.3300**

<https://www.revisor.mn.gov/rules/?id=6120.3300>

Subp. 3.

Minimum setbacks for each class of public waters apply to all structures, except water-oriented accessory structures and facilities. East and West Fox lakes are both classed as General Development Lakes.

<u>Class</u>	<u>Ordinary high water level in feet</u>	<u>Setback from top of bluff in feet</u>
General dev.	75	30

The Crow Wing County Planning Department can assist with details on shoreland standards and restrictions, and answers to “frequently asked questions” regarding best management practices, resources of education or information, and additional assistance. The County website is [www.co.crow-wing.mn.us](http://www.co.crow-wing.mn.us), and additional assistance is provided through the County Planning and Zoning Department, 200 South 4th Street, Brainerd, MN 56401-3565, Phone: (218) 824-1125, Fax: (218)824-1126, Email:[cwcpz@co.crow-wing.mn.us](mailto:cwcpz@co.crow-wing.mn.us)

## **The Alternative Shoreland Management Standards**

### **A Product of Minnesota's North Central Lakes Pilot Project**

Existing statewide minimum shoreland standards affect nearly all of Minnesota's lakes and rivers. These standards address issues of shoreland development and use like sewage treatment, stormwater management, minimum lot size and water frontage, building and septic system setbacks, building heights, subdivisions and alterations of land and vegetation close to the shore. By statute and rule, local governments with priority shorelands are required to adopt and manage the statewide minimum shoreland standards through their local land use controls and zoning ordinances. Many have also adopted stricter standards to deal with their own emerging land development issues.

Increased development and new development trends have raised concerns about impacts on water quality and lake use. The Governor's Clean Water Initiative pilot project in the five county north central lakes area around Brainerd raised these concerns through its stakeholders group. This led to the development of the alternative shoreland management standards through an advisory committee of the group. The alternative shoreland management standards provide options that a local government may use to address specific shoreland issues identified in the five county area. Other local governments outside the pilot area are either considering or in the process of adapting certain elements of the alternative shoreland standards for use in their own shoreland ordinances. The alternative shoreland standards are voluntary standards that present a

"tools in the toolbox" approach to shoreland management that any local government may choose to consider to address their own development issues.

The alternative standards developed through this pilot project will be considered during the rulemaking process as the Shoreland Rules Update Project proceeds with updating the statewide shoreland management standards.

For additional information on how these might be used in your community visit:

[http://www.dnr.state.mn.us/waters/watermgmt\\_section/shoreland/shoreland\\_rules\\_update.html](http://www.dnr.state.mn.us/waters/watermgmt_section/shoreland/shoreland_rules_update.html)

## **7. Managing water surface use conflicts**

The goal of lake management is to ensure that the lake can continue to provide the benefits that attract homeowners and users. However, conflicts among uses arise almost invariably. Successful resolution of conflicts lies in the ability of the users to work collaboratively to arrive at acceptable compromises.

The primary agency responsible for managing surface water use conflicts is the Minnesota Department of Natural Resources, Bureau of Information and Education. The Boat and Water Safety Section within the Bureau oversees surface water use and is in charge of administering the Water Surface Use Management (WSUM) program. The goal of this program is to enhance the recreation use, safety and enjoyment of the water surfaces in Minnesota and to preserve these water resources in a way that reflects the state's concern for the protection of its natural resources.

Within this context, any governmental unit may formulate, amend or delete controls for water surface use by adopting an ordinance. Submit the ordinance for approval by the MDNR Boat and Water Safety Coordinator by calling 1 (800) 766-6000 or (651) 296-3336. To gain approval the ordinance must:

- Where practical and feasible accommodate all compatible recreational uses;
- Minimize adverse impacts on natural resources
- Minimize conflicts between users in a way that provides for maximum use, safety and enjoyment, and
- Conform to the standards set in WSUM Rules.

From a practical standpoint, any community considering this action should also consult with their local law enforcement agency (that will largely enforce the local ordinance) to ensure that any restrictions can be effectively enforced.

An alternative or complementary approach is to encourage education and a “community standard” of acceptable behavior. Annual distribution of state standards for hours of operation, setbacks from shorelands, loon nests, swimming areas, and other hazards or sensitive areas helps create “peer pressure” to minimize the types of behavior that tend to lead to the most conflicts.

## **8. Public water access**

Research has shown that Minnesotans rely heavily upon public access sites to access lakes and rivers. A 1988 boater survey conducted by the University of Minnesota showed that three-fourths of the state’s boat owners launch a boat at a public water access site at least once a year. In addition, over 80 percent of boat owners report using public water access sites for recreation activities other than boating.

The primary agency responsible for public water accesses in Minnesota is the Minnesota Department of Natural Resources, Trails and Waterways Unit. They are responsible for the acquisition, development and management of public water access sites. The DNR either manages them as individual units or enters into cooperative agreements with county, state, and federal agencies, as well as local units of government such as townships and municipalities. The DNR’s efforts to establish and manage public water access sites are guided by Minnesota Statutes and established written DNR policy. The goal of the public water access program is free and adequate public access to all of Minnesota’s lake and river resources consistent with recreational demand and resource capabilities to provide recreation opportunities.

According to the 2006 Minnesota Department of Natural Resources Fisheries Survey, there is one public access on East and West Fox Lakes, as shown below:

### ***Public Access Information***

<b>Ownership</b>	<b>Type</b>	<b>Description</b>
DNR	Concrete	South side of long point between East and West Fox on the

northwest shore of East Fox Lake. Access is via channel into West Fox.



- Red dots are public access locations

## 9. Organizational Development and Communication

### III. Summary/Conclusion

#### 1. Outcome of Visioning/Planning Session

##### Listening/Visioning Sessions

We have had two listening or visioning sessions for the property owners to provide information to the Lake Management Teams. The LMP teams will use this information to develop the lake management plans for our lakes.

The first session was held August 22, 2009 at the association annual meeting. There were 75-80 association members that participated.

The members broke into groups by their lake. They were asked to prioritize the top five topics or issues from the list below.

1. Water Quality.
2. Aquatic Vegetation.
3. Fisheries Management.

4. Invasive Species.
5. Shoreline Restoration and Natural Shoreline.
6. Wildlife.
7. Land Use and Zoning.
8. Water Surface Use and Conflicts.
9. Public Access and/or Navigation.
10. Septic Systems.

## 2. Lakeshore Owners Survey Results

Individual lake lists with one being the most important.

### **Eagle**

1. Water Quality
2. Invasive Species
3. Shoreline Rest. & Nat. Shoreline
4. Land Use and Zoning
5. Aquatic Vegetation

### **East Fox**

1. Invasive Species
2. Shoreline Rest. & Nat. Shore.
3. Septic Systems
4. Water Surface Use & Conflicts.
5. Water Quality

### **Kego**

1. Water Quality
2. Invasive Species
3. Water Surface Use & Conflicts
4. Fisheries Management
5. Land Use & Zoning

### **Mitchell**

1. Aquatic Vegetation
2. Water Quality
3. Public Access & Navigation
4. Fisheries Management
5. Shoreline Rest. & Nat. Shore.

### **West Fox**

1. Invasive Species
2. Water Quality
3. Land Use and Zoning
4. Dam and Information to New Owners
5. Water Surface Use & Conflicts

## Prioritized Goals and Action Plan

The second listening or visioning session was held a year later at the 2011 annual meeting August 21, 2010. Approximately 40 members attended this meeting.

At that meeting members were asked to respond to two questions:

1. What will our lakes look like in five years? What changes should we anticipate?
2. In the next five years, what actions could property owners and people who use our lakes take to maintain or improve the condition of our lakes?



We broke into small groups to discuss and respond to the two questions.  
After much discussion each group recorded their responses and turned them in.

The responses were broke into three categories:

1. General comments and observations:
  - a. Will see more boat and jet ski traffic.
  - b. Increased recreational use of the lakes with more noise.
  - c. More aquatic vegetation.
  - d. Oil and other pollution from increased boat traffic.
  
2. Questions. Four questions were raised.
  - a. How much natural shoreline will still be in place in five years?
  - b. What is the status of Daggett Brook that flows into Mitchell Lake?
  - c. What can be done to control erosion that is caused by muskrats and other organisms?
  - d. What is the status of the dams on Eagle and East Fox Lakes?
  
3. Actions. The following actions were listed.
  - a. More shoreline restoration projects to include buffer zones.
  - b. Close public boat accesses.
  - c. Lakes that are infected with invasive species should be quarantined.
  - d. If you have grass, don't use fertilizer or fertilizer that has phosphate in it.
  - e. Contact county and state officials and ask them to take more positive actions to protect our land and aquatic environments.
  - f. The association should develop a better education program.
  - g. Consider no wake zones in certain areas of our lakes that need special protection.
  - h. Involve more people in association projects and education program.
  - i. Conduct aquatic vegetation surveys.
  - j. Establish an invasive species inspection program at our public boat accesses.
  - k. Improve septic system inspections.
  - l. Provide information to property owners who are renting their property.

# Appendix I

## DNR Fisheries Management Plan for East Fox Lake

### Fish Sampled for the 2008 Survey Year

Species	Gear Used	Number of fish per net		Average Fish Weight (lbs)	Normal Range (lbs)
		Caught	Normal Range		
<i>Black Bullhead</i>	Gill net	0.33	0.3 - 1.9	1.04	0.3 - 0.9
<i>Black Crappie</i>	Trap net	0.78	0.5 - 2.2	0.34	0.3 - 0.5
	Gill net	0.83	0.3 - 1.7	0.50	0.2 - 0.5
<i>Bluegill</i>	Trap net	4.33	7.7 - 43.4	0.20	0.1 - 0.2
	Gill net	4.50	N/A	0.10	N/A
<i>Bowfin (dogfish)</i>	Trap net	1.22	0.3 - 1.0	5.11	2.6 - 4.9
	Gill net	0.50	0.2 - 0.3	4.30	3.0 - 5.3
<i>Brown Bullhead</i>	Gill net	1.17	0.3 - 1.8	1.16	0.5 - 1.1
<i>Hybrid Sunfish</i>	Trap net	3.11	N/A	0.26	N/A
<i>Largemouth Bass</i>	Trap net	0.44	0.4 - 1.5	0.37	0.2 - 0.7
	Gill net	2.83	0.5 - 1.7	0.88	0.5 - 1.2
<i>Northern Pike</i>	Trap net	0.56	N/A	0.69	N/A
	Gill net	8.33	2.2 - 8.7	1.60	1.5 - 3.2
<i>Pumpkinseed</i>	Trap net	0.11	1.4 - 5.9	0.16	0.1 - 0.2
	Gill net	2.17	N/A	0.24	N/A
<i>Rock Bass</i>	Trap net	1.11	0.8 - 3.7	0.33	0.2 - 0.4
	Gill net	4.00	0.7 - 4.4	0.54	0.2 - 0.4
<i>Tullibee (cisco)</i>	Gill net	0.83	1.3 - 10.4	1.95	0.3 - 1.0
<i>Walleye</i>	Gill net	1.17	1.0 - 5.0	3.75	1.2 - 3.0
<i>Yellow Bullhead</i>	Trap net	1.00	1.0 - 5.3	0.58	0.5 - 0.9
	Gill net	2.00	1.0 - 6.0	0.80	0.4 - 0.7
<i>Yellow Perch</i>	Trap net	0.11	0.4 - 2.3	0.18	0.1 - 0.2

## Appendix II

### DNR Fisheries Management Plan for West Fox Lake

#### Fish Sampled for the 2008 Survey Year

Species	Gear Used	Number of fish per net		Average Fish Weight (lbs)	Normal Range (lbs)
		Caught	Normal Range		
<i>Black Crappie</i>	Trap net	0.78	0.5 - 2.2	0.43	0.3 - 0.5
	Gill net	1.78	0.3 - 1.7	0.38	0.2 - 0.5
<i>Bluegill</i>	Trap net	23.67	7.7 - 43.4	0.12	0.1 - 0.2
	Gill net	6.22	N/A	0.08	N/A
<i>Bowfin (dogfish)</i>	Trap net	1.67	0.3 - 1.0	4.89	2.6 - 4.9
<i>Brown Bullhead</i>	Trap net	0.22	0.3 - 1.0	0.94	0.7 - 1.0
	Gill net	0.33	0.3 - 1.8	1.06	0.5 - 1.1
<i>Hybrid Sunfish</i>	Trap net	10.44	N/A	0.21	N/A
	Gill net	0.56	N/A	0.28	N/A
<i>Largemouth Bass</i>	Trap net	1.67	0.4 - 1.5	0.60	0.2 - 0.7
	Gill net	2.22	0.5 - 1.7	0.59	0.5 - 1.2
<i>Northern Pike</i>	Trap net	0.22	N/A	1.29	N/A
	Gill net	10.33	2.2 - 8.7	2.28	1.5 - 3.2
<i>Pumpkinseed</i>	Trap net	2.78	1.4 - 5.9	0.09	0.1 - 0.2
	Gill net	1.56	N/A	0.17	N/A
<i>Rock Bass</i>	Trap net	2.33	0.8 - 3.7	0.27	0.2 - 0.4
	Gill net	2.11	0.7 - 4.4	0.43	0.2 - 0.4
<i>Smallmouth Bass</i>	Trap net	0.11	0.2 - 0.8	1.58	0.2 - 0.7
<i>Tullibee (cisco)</i>	Gill net	2.11	1.3 - 10.4	1.61	0.3 - 1.0
<i>Walleye</i>	Gill net	1.44	1.0 - 5.0	3.80	1.2 - 3.0
<i>Yellow Bullhead</i>	Trap net	1.44	1.0 - 5.3	0.88	0.5 - 0.9
	Gill net	1.11	1.0 - 6.0	0.65	0.4 - 0.7
<i>Yellow Perch</i>	Trap net	0.44	0.4 - 2.3	0.10	0.1 - 0.2
	Gill net	0.22	1.5 - 13.8	0.10	0.1 - 0.2

## Glossary

**Aerobic:** Aquatic life or chemical processes that require the presence of oxygen.

**Algal bloom:** An unusual or excessive abundance of algae.

**Alkalinity:** Capacity of a lake to neutralize acid.

**Anoxic:** The absence of oxygen in a water column or lake; can occur near the bottom of eutrophic lakes in the summer or under the ice in the winter.

**Benthic:** The bottom zone of a lake, or bottom-dwelling life forms.

**Best Management Practices:** A practice determined by a state agency or other authority as the most effective, practicable means of preventing or reducing pollution.

**Bioaccumulation:** Build-up of toxic substances in fish (or other living organism) flesh. Toxic effects may be passed on to humans eating the fish.

**Biological Oxygen Demand:** The amount of oxygen required by aerobic microorganisms to decompose the organic matter in sample of water. Used as a measure of the degree of water pollution.

**Buffer Zone:** Undisturbed vegetation that can serve as to slow down and/or retain surface water runoff, and assimilate nutrients.

**Chlorophyll *a*:** The green pigment in plants that is essential to photosynthesis.

**Clean Water Partnership (CWP) Program:** A program created by the legislature in 1990 to protect and improve ground water and surface water in Minnesota by providing financial and technical assistance to local units of government interested in controlling nonpoint source pollution.

**Conservation Easement:** A perpetual conservation easement is a legally binding condition placed on a deed to restrict the types of development that can occur on the subject property.

**Cultural eutrophication:** Accelerated “aging” of a lake as a result of human activities.

**Epilimnion:** Deeper lakes form three distinct layers of water during summertime weather. The epilimnion is the upper layer and is characterized by warmer and lighter water.

**Eutrophication:** The aging process by which lakes are fertilized with nutrients.

**Eutrophic Lake:** A nutrient-rich lake – usually shallow, “green” and with limited oxygen in the bottom layer of water.

**Exotic Species:** Any non-native species that can cause displacement of or otherwise threaten native communities.

**Fall Turnover:** In the autumn as surface water loses temperature they are “turned under” (sink to lower depths) by winds and changes in water density until the lake has a relatively uniform distribution of temperature.

**Feedlot:** A lot or building or a group of lots or buildings used for the confined feeding, breeding or holding of animals. This definition includes areas specifically designed for confinement in which manure may accumulate or any area where the concentration of animals is such that a vegetative cover cannot be maintained. Lots used to feed and raise poultry are considered to be feedlots. Pastures are not animal feedlots.

**Groundwater:** water found beneath the soil surface (literally between the soil particles); groundwater is often a primary source of recharge to lakes.

**Hardwater:** Describes a lake with relatively high levels of dissolved minerals such as calcium and magnesium.

**Hypolimnion:** The bottom layer of lake water during the summer months. The water in the hypolimnion is denser and much colder than the water in the upper two layers.

**Impervious Surface:** Pavement, asphalt, roofing materials or other surfaces through which water cannot drain. The presence of impervious surfaces can increase the rates and speed of runoff from an area, and prevents groundwater recharge.

**Internal Loading:** Nutrients or pollutants entering a body of water from its sediments.

**Lake Management:** The process of study, assessment of problems, and decisions affecting the maintenance of lakes as thriving ecosystems.

**Littoral zone:** The shallow areas (less than 15 feet in depth) around a lake's shoreline, usually dominated by aquatic plants. These plants produce oxygen and provide food, shelter and reproduction areas for fish & animal life.

**Local Unit of Government:** A unit of government at the township, city or county level.

**Mesotrophic Lake:** A lake that is midway in nutrient concentrations (between a eutrophic and oligotrophic lake). Characterized by periodic problems with algae blooms or problem aquatic vegetation.

**Native Species:** An animal or plant species that is naturally present and reproducing.

**Nonpoint source:** Polluted runoff – nutrients or pollution sources not discharged from a single point. Common examples include runoff from feedlots, fertilized lawns, and agricultural fields.

**Nutrient:** A substance that provides food or nourishment, such as usable proteins, vitamins, minerals or carbohydrates. Fertilizers, particularly phosphorus and nitrogen, are the most common nutrients that contribute to lake [eutrophication](#) and nonpoint source pollution.

**Oligotrophic Lake:** A relatively nutrient-poor lake, characterized by outstanding water clarity and high levels of oxygen in the deeper waters.

**Nutrient:** A substance that provides food or nourishment, such as usable proteins, vitamins, minerals or carbohydrates. Fertilizers, particularly phosphorus and nitrogen, are the most common nutrients that contribute to lake [eutrophication](#) and non-point source pollution.

**pH:** The scale by which the relative acidity or basic nature of waters are assessed,

**Photosynthesis:** The process by which green plants produce oxygen from sunlight, water and carbon dioxide.

**Phytoplankton:** Algae – the base of the lake’s food chain, it also produces oxygen.

**Point Sources:** Specific sources of nutrient or pollution discharge to a water body, i.e., a stormwater discharge pipe.

**Riparian:** The natural ecosystem or community associated with river or lake shoreline.

**Secchi Disc:** A device measuring the depth of light penetration in water.

**Sedimentation:** The addition of soils to lakes, which can accelerate the “aging” process by destroying fisheries habitat, introducing soil-bound nutrients, and filling in the lake.

**Spring turnover:** After ice melts in the spring, warming surface water sinks to mix with deeper, colder water. At this time of year all water is the same temperature.

**Thermocline:** During summertime deeper lakes stratify by temperature to form three discrete layers; the middle layer of lake water is known as the thermocline.

**Trophic Status:** The level of growth or productivity of a lake as measured by phosphorus, content, algae abundance, and depth of light penetration.

**Watershed:** The surrounding land area that drains into a lake, river, or river system.

**Zooplankton:** Microscopic animals.

## **Common Biological or Chemical Abbreviations**



BOD	Biological Oxygen Demand
°C	degree(s) Celsius
cfs	cubic feet per second (a common measure of rate of flow)
cfu	colony forming units (a common measure of bacterial concentrations)
chl <i>a</i>	Chlorophyll <i>a</i>
cm	centimeter
COD	Chemical Oxygen Demand
Cond	conductivity
DO	dissolved oxygen
FC	fecal coliform (bacteria)
ft	feet
IR	infrared
l	liter
m	meter
mg	milligram
ml	milliliter
NH <sub>3</sub> -N	nitrogen as ammonia
NO <sub>2</sub> -NO <sub>3</sub>	nitrate-nitrogen
NTU	Nephelometric Turbidity Units, standard measure of turbidity
OP	Ortho-phosphorus
ppb	parts per billion
ppm	parts per million
SD	Standard Deviation (statistical variance)

TDS	total dissolved solids
TN	total nitrogen
TP	total phosphorus
TSI	trophic status index
TSI (C)	trophic status index (based on chlorophyll <i>a</i> )
TSI (P)	trophic status index (based on total phosphorus)
TSI (S)	trophic status index (based on secchi disc transparency)
TSS	total suspended solids
mg/l	micrograms per liter
mmhos/cm	micromhos per centimeter, the standard measure of conductivity
UV	Ultraviolet

### **Guide to common acronyms**

#### *State and Federal Agencies*

BWSR	Board of Soil & Water
COE	U.S. Army Corps of Engineers
CRP program	Conservation Reserve Program - A federal government conservation
DNR	Department of Natural Resources
DOJ	United States Department of Justice
DOT	Department of Transportation
DTED	Department of Trade and Economic Development

EPA	U.S. Environmental Protection Agency
EQB	MN Environmental Quality Board
LCCMR	Legislative-Citizen Commission on Minnesota Resources
MDH	Minnesota Department of Health
MPCA	Minnesota Pollution Control Agency
OEA	MN Office of Environmental Assistance
OSHA	Occupational Safety and Health Administration
RIM	Reinvest In Minnesota - a State of Minnesota Conservation Program
SCS	Soil Conservation Service
SWCD	Soil & Water Conservation District
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USFWS	United States Fish & Wildlife Service

***Regional, watershed, community development, trade and advocacy groups***

AMC	Association of Minnesota Counties
APA	American Planning Association
COLA	Coalition of Lake Associations
IF	Initiative Foundation
LMC	League of Minnesota Cities
MAT	Minnesota Association of Townships
MCIT	Minnesota Counties Insurance Trust

MSBA	Minnesota School Board Association
Mid-MnMA	Mid-Minnesota Association of Builders
MnSCU	Minnesota State Colleges and Universities
MW	Minnesota Waters
TIF	Tax Increment Financing

***Codes and Regulations***

110B	The Minnesota law that regulates non-metro county water plans
ADA	American Disabilities Act
B & B	Bed and Breakfast
BOA	Board of Adjustment
Chapter 70/80	Individual Sewage Treatment Standards
CIC Plat	Common Interest Community Plat
Class V	Class Five “Injection” well; any well which receives discharge
CSAH	County State Aid Highway
CUP	Conditional Use Permit
CWA	Clean Water Act
EAW	Environmental Assessment Worksheet
EIS	Environmental Impact Statement
EOA	Equal Opportunity Act
FOIA	Freedom of Information Act
GD	General Development (lake)
GLAR	Greater Lakes Area Association of Realtors
IAQ	Indoor Air Quality

ISTS	Individual Sewage Treatment System
LMP	Lake Management Plan
LQG	Large Quantity Generator (of hazardous waste)
MAP	Minnesota Assistance Program
OHW	Ordinary High Water
PUD	Planned Unit Development
RD	Recreational Development (lake)
ROD	Record of Decision
ROW	Right-of-Way
SBC	State Building Code
SDWA	Safe Drinking Water Act
SF	Square feet
SIZ	Shoreland Impact Zone
SQG	Small Quantity Generator (of hazardous waste)
SWMP	Stormwater Management Plan
UBC	Universal Building Code