SHERWOOD LAKE

LAKE CLASSIFICATION REPORT

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SHERWOOD LAKE
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EXECUTIVE SUMMARY

Background Information about Sherwood Lake

Sherwood Lake is located in the Town of Rome, Adams County, WI, in the south central part of Wisconsin. The impoundment of 14-Mile Creek is slightly over 243 surface acres in size. Maximum depth is 24', with an average depth of 8'. Both Upper and Lower Camelot Lakes flow through dams into Sherwood Lake. Sherwood Lake flows through a dam into Arrowhead Lake. All the Tri-Lakes dams are owned and operated by Adams County. There is a public boat launch on Sherwood Lake on the southwest edge of the lake owned by the Parks Department of Adams County. Heavy residential development around the lake is found along most of the lakeshore. Sherwood Lake is managed by the Tri-Lakes Management District. There is also an active Sherwood Property Owners Association.

The primary soil type in both the surface and ground watersheds is loamy sand. The second most common soil type in both watersheds is muck. The most common soil right around the lake is sand.

Loamy sands tend to be well-drained, with water, air and nutrients moving through them at a rapid rate. Runoff, when it occurs, tends to be slow. Loamy sands have little water-holding capacity and low natural fertility, although they usually have more organic matter present than do sandy soils. Both wind and water erosion are potential hazards with loamy sands, as is drought. There are difficulties with waste disposal and vegetation establishment because of slope and seepage.

Sandy soil tends to be excessively drained, no matter what the slope. Water, air and nutrients move through sandy soils at a rapid rate, so that little runoff occurs unless the soil becomes saturated. Although water erosion can be a problem, wind erosion may be more of a hazard with sandy soils, especially since these soils dry out so quickly. There are also draught hazards with sandy soils. Getting vegetation started in sandy soils is often difficult due to the low available water capacity, as well as low natural fertility and organic material. Onsite waste disposal in sandy soils is also a problem because of slope and seepage; mound systems are usually required.

Land Use in Sherwood Lake Watersheds

Although the ground watershed for Sherwood Lake is fairly small, the surface watershed is quite large. The two most common land uses in the ground watershed are woodlands and residential. The two most common land uses in the surface watershed are woodlands and irrigated agriculture.

Sherwood Lake has a total shoreline 7.8 miles (41,184 feet) Most of the lakeshore is in residential or beach club use. According to a 2004 shore survey, some of the areas near the shore are steeply sloped; some are also soft and/or not well–vegetated. Only 12.84% of the Sherwood Lake shore has native vegetation. 77.54% of the shore has been disturbed and is currently covered by mowed lawn, rock riprap, some kind of seawall, hard structures (piers, etc.), erosion and/or sand.

A 2004 shore survey showed that very little of Sherwood Lake's shore had an "adequate buffer." An "adequate buffer" is a native vegetation strip at least 35 feet landward from the shore. Most of the "inadequate" buffer areas were those with rock or seawall, hard structures, beach, active erosion or mowed lawns. In a few instances, those with insufficient native vegetation at the shoreline to cover 35 feet landward from the water line were also called "inadequate." A vegetated shore is especially important when shores are steep and soft, as are many of Sherwood Lake shores.

Adequate buffers on Sherwood Lake in some places could be easily installed on the inadequate areas by either letting the first 35 feet landward from the water just grow without mowing it, except for a path to the water, or by planting native seedlings sufficient to fill in the first 35 feet or using biologs to protect the shore that are vegetated. Where areas are deeply eroded, shaping, revegetating and protecting the shores will be necessary to prevent further erosion.

Water Testing Results

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information on Sherwood Lake. Overall, Sherwood Lake was determined to be a mildly eutrophic lake with fair to poor water quality and poor water clarity.

Measuring the phosphorus in a lake system provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excess plant growth. The 2004-2006 summer average phosphorus concentration in Sherwood Lake was 37.7 micrograms/liter. This average is over the 30 micrograms/liter level recommended to avoid nuisance algal blooms. This concentration suggests that Sherwood Lake is likely to have nuisance algal blooms from excessive phosphorus.

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity is measured with a Secchi disk. Average summer Secchi disk clarity in Sherwood Lake in 2004-2006 was 4.36 feet. This is poor water clarity.

Chlorophyll-a concentration provides a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth, as well as result in unpleasing odor and appearance. The 2004-2006 growing season (June-September) average chlorophyll-a concentration in Sherwood Lake was 20.7 micrograms/liter, lower than the state average of 65 micrograms/liter for impoundments.

Sherwood Lake water testing results showed "hard" water with an average of 178 milligrams/liter CaCO3. Hard water lakes tend to produce more fish and aquatic plants than soft water lakes because they are often located in watersheds with soils that load phosphorus into the lake water.

A lake with a neutral or slightly alkaline pH like Sherwood Lake is a good lake for fish and plant survival. Natural rainfall in Wisconsin averages a pH of 5.6. This means that if the rain falls on a lake without sufficient alkalinity to buffer that acid water coming in by rainfall, the lake's fish cannot reproduce. That is not a problem at Sherwood Lake, since its surface water alkalinity averages 125.6 milliequivalents/liter. The pH levels from the bottom of the lake to the surface hovered between nearly 7 and 8, alkaline enough to buffer acid rain.

Some of the water quality testing at Sherwood Lake showed areas of concern. The presence of a significant amount of chloride over a period of time indicates there may be negative human impacts on the water quality present from septic system failure, the presence of fertilizer and/or waste, deposition of road-salt, and other nutrients. An increased chloride level is thus an indication that too many nutrients are entering the lake, although the level has to be evaluated compared to the natural background data for chloride. The average chloride level found in Sherwood Lake during the 2004-2006 testing period was 11.73 milligrams/liter, elevated substantially above the natural level of 3 milligrams/liter for chloride in this area of Wisconsin. Prior studies also found elevated chloride levels in Sherwood Lake. In fact, substantially elevated chloride levels have been found at Sherwood Lake since records were kept (1985). The source of this ongoing elevation needs to be identified and the elevation reduced.

The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 milligrams/liter in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). Sherwood Lake combination spring levels from 2004 to 2006 averaged .99 milligrams/liter, above the .3 milligrams/liter predictive level for nitrogen-related algal blooms. These elevations suggest that some of the algal blooms on Sherwood Lake may be at least partly nitrogen-related. This issue should be further investigated.

In low-oxygen waters (hypoxic), sulfate can combine with hydrogen and becomes the gas hydrogen sulfate, which smells like rotten eggs and is toxic to most aquatic organisms. Sulfate levels can also affect the metal ions in the lake, especially iron and mercury, by binding them up, thus removing them from the water column. To prevent the formation of hydrogen sulfate, levels of 10 milligrams/liter are best. A health advisory kicks in at 30 milligrams/liter. Sherwood Lake sulfate levels averaged 29.01 milligrams/liter during the testing period, above the level for hydrogen sulfate formation, but still slightly below the health advisory level. However, the overall average for the years in which sulfate testing was done is 30.84, above the health advisory level. This is also an area of concern to be further investigated.

The average calcium level in Sherwood Lake's water during the testing period was 41.36 milligrams/liter. The average Magnesium level was 17.7 milligrams/liter. Both of these are low-level readings. Both sodium and potassium levels in Sherwood Lake are very low: the average sodium level was 3.4 milligrams/liter; the average potassium reading was 2.55 milligrams/liter.

Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Turbid water may mask the presence of bacteria or other pollutants because the water looks murky or muddy. In general, turbidity readings of less than 5 NTU are best. Very turbid waters may not only smell, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. Turbidity levels for Sherwood Lake's waters were low in the 1980s, but have risen substantially since, with one reading over the 5 TU mark.

Phosphorus

Like most lakes in Wisconsin, Sherwood Lake is a phosphorus-limited lake: of the pollutants that end up in the lake, the one that most affects the overall quality of the lake water is phosphorus. The amount of phosphorus especially affects the frequency and density of aquatic vegetation and the frequency and density of various kinds of algae, as well as water clarity and other water quality aspects.

The total phosphorus (TP) concentration in a lake is considered a good indicator of a lake's nutrient status, since the TP concentration tends to be more stable than other types of phosphorus concentration. For a man-made lake like Sherwood Lake, a total phosphorus concentration below 30 micrograms/liter tends to result in few nuisance algal blooms. Sherwood Lake's growing season (June-September) surface average total phosphorus level of 37.7 micrograms/liter is over that limit, suggesting that phosphorus-related nuisance algal blooms may occur.

Land use plays a major role in phosphorus loading. The land uses around Sherwood Lake that contribute the most phosphorus are irrigated and non-irrigated agriculture. Some phosphorus deposition cannot be controlled by humans. However, some phosphorus (and other nutrient) input can be decreased or increased by changes in human land use patterns. Practices such as shoreland buffer restoration along waterways; infiltrating stormwater runoff from roof tops, driveways and other impervious surfaces; using no phosphorus lawn fertilizers; and reducing phosphorus input to and properly managing septic systems will minimize phosphorus inputs into the lake. Such practices need to be implemented in all of the Tri-Lakes Watersheds in order for a significant impact on phosphorus reduction to occur.

Reducing the amount of input from the surface and ground watersheds results in less nutrient loading into the lake itself. Under the modeling predictions, reducing phosphorus inputs from human-based activities even 10% would improve Sherwood Lake water quality by 1 to 8.6 micrograms/liter. A 25% reduction would save 2.5 to 21.5 micrograms/liter and could reduce the overall eplimnetic growing season total phosphorus to around the 30 micrograms/liter level to avoid nuisance algal blooms. These predictions make it clear that reducing current phosphorus inputs to the lake are essential to improve, maintain and protect Sherwood Lake's health for future generations.

Aquatic Plant Community

The aquatic plant community is characterized by below average quality for Wisconsin lakes, poor species diversity and impacted by high levels of disturbance. Sherwood Lake is within the 25% of lakes in the state most tolerant of disturbance and furthest from an undisturbed condition. Disturbances include invasions of exotic species, boat traffic, shoreline development, harvesting and past herbicide treatments.

Of the 29 species found in Sherwood Lake, 25 were native and 4 were exotic invasives. In the native plant category, 14 were emergent, 1 was a free-floating plant, and 10 were submergent species. Four exotic invasives, *Myriophyllum spicatum* (Eurasian Watermilfoil), *Nasturtium microphyllum* (watercress), *Phalaris arundinacea* (Reed Canarygrass), and *Potamogeton crispus* (Curly-Leaf Pondweed) were found. Filamentous algae were found at 22.76% of the sample sites in 2006 and at 38.33% of the sites in 2000.

Potamogeton pectinatus, an aquatic plant favored by drawdowns, was the most frequently-occurring plant in Sherwood Lake in 2006. In 2000, the most frequent species was *Chara* spp. No species but *Potamogeton pectinatus* reached a frequency of 50% or greater in the lake overall in 2006, although *Chara spp* and *Potamogeton crispus* were not far under 50%, with occurrence frequencies of 45.53% and 42.28%

respectively. In 2000, no aquatic species reached an overall occurrence frequency of over 50%.

Potamogeton pectinatus was also the densest plant in 2006 in Sherwood Lake. In the lake overall, none of the aquatic plant species had a mean density of over 2.0, meaning none occurred at more than average, in 2006. In 2006, the only species occurring at more than average density in any of the depth zones was *Potamgeton pectinatus* in the second (1.5 feet-5 feet) and third (5 feet-10 feet) depth zones. Densest in Depth Zone 1 (0 to 1.5 feet) was *Chara spp*; densest in the other three zones was *Potamogeton pectinatus.* No species occurred at more than average density in the lake overall in 2000, either. The only depth zone with more than average density of growth was Depth Zone 3, where *Chara spp* grew at more than average density.

Relative frequency and relative density are combined into a dominance value that demonstrates how dominant a species is within its aquatic plant community. Based on dominance value, *Chara* spp was the dominant aquatic "plant" species in Sherwood Lake in 2000. Sub-dominant was *Elodea canadensis.* However, in 2006, *Potamogeton pectinatus* dominated the aquatic plant community, with *Potamogeton crispus* and *Chara* spp next most dominant.

Looking at the results from the 2000 survey and those from 2006 shows some changes in the aquatic plant community. There were more species found in 2006, and the structure of the aquatic plant community has changed with more emergent species present, but only one free-floating plant. No floating-leaf plants, which provide habitat and cover for fish and invertebrates, were found in either year. Further, when calculating the coefficient of similarity between the 2000 and 2006 surveys, they score as statistically dissimilar both in terms of frequency of occurrence and relative frequency. Based on frequency of occurrence, the aquatic plant communities of the two years are just over 45% similar. Using relative frequency, the score is only 53% similar. Similarity percentages of 75% or more are considered statistically similar. Obviously, the figures for Sherwood Lake are far below that figure.

It is worth noting that the report on the 2000 aquatic plant surveys mentioned the low level of emergent plants in Sherwood Lake. The 2006 survey shows that emergent plants were still scarce in Sherwood Lake than they were in 2000, but there were more increased coverage from emergent plants in 2006.

Sherwood Lake has five known invasive aquatic plant species: Curly-Leaf Pondweed (submergent); Eurasian Watermilfoil (submergent); Purple Loosestrife (emergent); Reed Canarygrass (emergent) and Watercress (floating-leaf). The lake gets a significant amount of transient boat traffic due to its location (right off a main highway) and large public boat ramp. The Tri-Lakes Management District has a lake

management plan that includes management of aquatic invasives. The lake has been using targeted harvesting for Eurasian Watermilfoil, emphasizing the harvesting of that plant in May and September, while harvesting the summer months for navigation, rather than control of Eurasian Watermilfoil. In 2007, some lake citizens were trained to monitor the aquatic invasives and participate in the Clean Boats, Clean Waters boater education program.

Fish/Wildlife/Endangered Resources

WDNR stocking and fishery inventories go back to 1968, when the lake was stocked after a chemical eradication of fish in 1967 to get rid of the rough fish population. Stocking in 1968 consisted of bluegills, largemouth bass, northern pike and walleye. A follow-up inventory in 1969 found that bluegills and pumpkinseeds were abundant; largemouth bass, northern pike, walleye and yellow perch were common; and shiners and white suckers were scarce. The most recent survey, done in 2002, found that bluegills and largemouth bass were abundant; black crappie, walleye and yellow perch were common; and northern pike was scarce. Between 1970 and 2000, thirteen other fish inventories were performed by the WDNR. In addition to those fish already mentioned, various fish surveys through the years also found brown bullheads, black bullheads, yellow bullheads, yellow suckers, golden shiners, and emerald shiners.

In 1999, the local WDNR fishery biologist reported that a recent survey of Sherwood Lake showed that the largemouth bass and northern pike populations were good and that those fish were healthy. However, although the panfish numbers were sufficient, he found them to be small and thin. He expressed concern about loss of invertebrate habitat that the fish fed on, about the chemicals killing zooplankton, and about the effects of the winter drawdown on the aquatic plant community.

There are several endangered resources in the Sherwood Lake surface watershed. Natural communities reported here include northern sedge meadow, northern wet forest, pine barrens and shrub-carr. Endangered plants known in the area include *Polygala cruciata* (crossleaf milkwort), *Juncus marginata* (grassleaf rush), and *Bartonicia virginica* (yellow screwstem).

Conclusion

Sherwood Lake is currently impoundment impacted substantially by its position in the large surface watersheds of the Tri-Lakes, as well as significant disturbances. It is approaching the threshold of passing from an aquatic plant-dominated system to a turbid algae-dominated system. The Tri-Lakes Management District will need to regularly review and update its lake management plan in order to address its management issues in a logical, cohesive manner.

RECOMMENDATIONS

Lake Management Plan

- When the Tri-Lakes Management District revises the lake management plan, it needs to make sure the plan includes at least the following aspects concerning the management of the lake: integrated aquatic species management; control/management of invasive species; wildlife and fishery management; nutrient budgeting; shoreland protection; water quality protection.
- The Sherwood Property Owner's Association should participate in the revision process and implementation of the lake management plan.

Watershed Recommendations

- Since computer modeling results suggest that input of nutrients, especially phosphorus, are a factor that needs to be explored for Sherwood Lake, it is recommended that both the surface and ground watersheds be inventoried, documenting any of the following: runoff from any livestock operations that may be entering the surface water; soil erosion sites; agricultural producers not complying with nutrient management plans and/or irrigation water management plans.
- If such sites are documented, a statement outlining the Sherwood Lake Association and Tri-Lake Management District's encouragement to Adams County Land & Water Conservation Department and landowners to design and implement practices to address the sites.

Water Quality Recommendations

- All lake residents should practice best management on their lake properties, including keeping septic systems maintained in proper condition and pumped every three years, eliminating the use of lawn fertilizers, cleaning up pet wastes and not composting near the water.
- Reducing the amount of impervious surface around the lake and management of stormwater runoff will also help maintain water quality.
- Residents should become involved in the Citizen Lake Water Monitoring Program. This program includes water quality monitoring, invasive species monitoring, and Clean Boats, Clean Waters.
- Broad-scale restoration of native vegetation at the shore is needed to help improve water quality. Studies show that the frequency and density of the most sensitive plant species is less at disturbed shores than at those with native vegetation. These sensitive plants are indicators of changing water quality.

- Further investigation of the sources of the elevated chloride, nitrogen and sulfate needs to be made to identify such sources and develop a plan to reduce those elevated levels.

Aquatic Plant Recommendations

- All lake users should protect the aquatic plant community in Sherwood Lake by assisting in revising implementing an integrated aquatic plant management plan that uses multiple methods of control.
- The Tri-Lakes Management District should maintain exotic species signs at the boat landings and contact DNR if the signs are missing or damaged.
- The Tri-Lakes Management District should continue monitoring and control of Eurasian Watermilfoil and Curly-Leaf Pondweed, maintaining the most effective methods and modifying if necessary. The Sherwood Property Owners Association should assist in these efforts. Residents may need to hand-pull scattered plants.
- Lake residents should get involved in the county-sponsored Citizen Aquatic Invasive Species Monitoring Program. This will allow not only noting changes in the Eurasian Watermilfoil pattern and Curly-Leaf Pondweed, but also for other invasives, including the zebra mussels already known to be present in Arrowhead Lake. Noting the presence and density of invasives early is the best way to take preventive action to keep them from becoming a bigger problem.
- Emergent vegetation, which is very sparse in Sherwood Lake, should not be removed. In fact, removal of aquatic plants and shore plants should be kept to the maximum 30' wide viewing/access corridor and navigation purposes. Leave as much vegetation as possible to protect water quality and habitat.
- Natural shoreline should be restored and eroded areas repaired. Disturbed shoreline covers too much of the shore and mowed lawn alone covers nearly half of the shore.
  a) Unmowed native vegetation reduces shoreline erosion and run-off into the lake and filters the run-off that does enter the lake thus reducing nutrient inputs.
  b) Shoreline restoration could be as simple as leaving a band of natural vegetation around the shore by discontinuing mowing.
  c) Restoration could be as ambitious as extensive plantings of attractive native wetland species in the water and native grasses, flowers, shrubs and trees on the near shore area.

LAKE CLASSIFICATION REPORT FOR SHERWOOD LAKE, ADAMS COUNTY

INTRODUCTION

In 2003, The Adams County Land & Water Conservation Department (Adams County LWCD) determined that a significant amount of natural resource data needed to be collected on the lakes with public access in order to provide it and the public with information necessary to manage the lakes in a manner that would preserve or improve water quality and keep it appropriate for public use. In some instances, there was significant historical data about a particular lake; in that instance, the study activities concentrated on combining and updating information. In other instances, there was no information on a lake, so study activities concentrating on gathering data about that lake. Further, it was discovered that information was scattered among various citizens, so often what information was actually available regarding a particular lake was unknown. To assist in updating some information and gathering baseline information, plus centralize the data collected, so the public may access it. The Adams County LWCD received a series of grants from the Wisconsin Department of Natural Resources (WDNR) from the Lake Classification Grant Program.

Objectives of the study were:

- collect physical data on the named lakes to assist in assessing the health of Adams County lake ecosystems and in classifying the water quality of the lakes.
- collect chemical and biological data on the named lakes to assist in assessing the health of Adams County lake ecosystems and in classifying the water quality of the lakes.
- develop a library of lake information that is centrally located and accessible to the public and to City, County, State and Federal agencies.
- make specific recommendations for actions and strategies for the protection, preservation and management of the lakes and their watersheds.
- create a baseline for future lake water quality monitoring.
- Provide technical information for the development of comprehensive lake management plans for each lake
- provide a basis for the water quality component of the Adams County Land and Water Resource Management Plan. Components of the plan will be incorporated into Adams County's "Smart Growth Plan".
- develop and implement educational programs and materials to inform and educate lake area property owners and lake users in Adams County.

METHODS OF DATA COLLECTION

To collect the physical data, the following methods were used:

- delineation & mapping of ground & surface watersheds using topographic maps, ground truthing and computer modeling;
- identification of flow patterns for both the surface & ground watersheds using known flow maps and topographic maps;
- inventory & mapping of current land use with orthographic photos and collected county information;
- inventory & mapping of shoreline erosion and buffers using county parcel maps and visual observation;
- inventory & mapping for historical and cultural sites using information from the local historical society and the Wisconsin Historical Society;
- identification & mapping of critical habitat areas with WDNR and Adams County LWCD staff;
- identification & mapping of endangered or threatened natural resources (including natural communities, plant & animal species) using information from the Natural Heritage Inventory of Wisconsin;
- identification & mapping of wetland areas using WDNR and Natural Resource Conservation Service wetland maps;
- preparation of soil maps for each of the lake watersheds using soil survey data from the Natural Resource Conservation Service.

To collect water quality information, different methods were used:

- for three years, lakes were sampled during late winter, at spring and fall turnover, and several times during the summer for various parameters of water quality, including dissolved oxygen, relevant to fish survival and total phosphorus, related to aquatic plant and algae growth;
- random samples from wells in each lake watershed were taken in two years and tested for several factors;
- aquatic plant surveys were done on all 20 lakes and reports prepared, including identification of exotics, identifying existing aquatic plant community, evaluation of community measures, mapping of plant distribution, and recommendations;
- all lakes were evaluated for critical habitat areas, with reports and recommendations being made to the respective lakes and the WDNR;
- lake water quality modeling was done using data collected, as well as historical data where it was available.

WATER QUALITY COMPUTER MODELING

Wisconsin developed a computer modeling program called WiLMS (Wisconsin Lake Modeling Suite) to assist in determining the amount of phosphorus being loaded annually into a lake, as well as the probable source of that phosphorus. This suite has many models, including Lake Total Phosphorus Prediction, Lake Eutrophic Analysis Procedure, Expanded Trophic Response, Summary Trophic Response, Internal Load Estimator, Prediction & Uncertainty Analysis, and Water & Nutrient Outflow. The models that various types of data inputs: known water chemistry; surface area of lake; mean depth of lake; volume of lake; land use types & acreage. This information is then used in the various models to determine the hydrologic budget, estimated residence time, flushing rate, and other parameters.

Using the data collected over the course of the studies, various models were run under the WiLMS Suite. These water quality models are computer-based mathematical models that simulate lake water quality and watershed runoff conditions. They are meant to be a tool to assist in predicting changes in water quality when watershed management activities are simulated. For example, a model might estimate how much water quality improvement would occur if watershed sources of phosphorus inputs were reduced. However, it should be understood that these models predict only a relative response, not an exact response. Modeling results will be incorporated into topic discussions as appropriate.

DISSEMINATION OF PROJECT DELIVERABLES

The results of this study will be distributed to various agencies, organizations and the public as previously described. Based on the classification information, the Adams County Land and Water Conservation Department will identify assistance requests and determine the appropriate future activities, based on the classification determinations. To provide the requested assistance, Adams County Land and Water Conservation Department will incorporate the lake management plans goals, priorities and action items into its Annual Plan of Operations. Goals, priorities and action items may include educational programs, formation of lake districts, further development of lake management plans and implementation of lake management plans.

ADAMS COUNTY INFORMATION

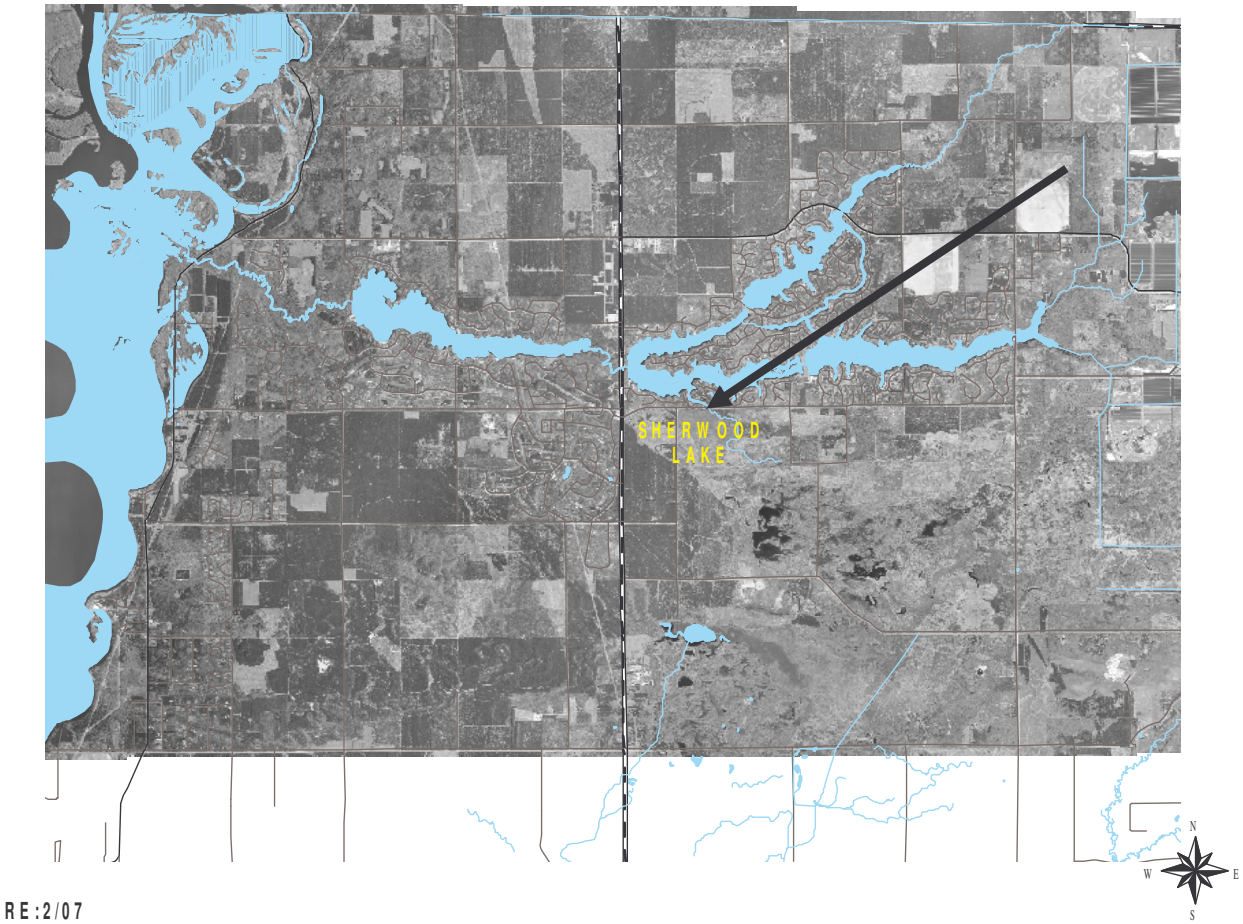
Adams County lies in south central Wisconsin, shaped roughly like the outline of Illinois. Adams County is a small rural county with a full-time population of about 20,000. Between 1980 and 2000, Adams County's population grew by more than 20%, with most of the population increase being located upon the lakes and streams. The population increase has resulted in a greater need for facilitation, technical assistance and education, including information on the lakes and streams.

Figure 1: Adams County Location in Wisconsin

SHERWOOD LAKE BACKGROUND INFORMATION

Sherwood Lake is located in the Town of Rome, Adams County, WI, in the south central part of Wisconsin. The impoundment of 14-Mile Creek is slightly over 243 surface acres in size. Maximum depth is 24', with an average depth of 8'. Both Upper and Lower Camelot Lakes flow through dams into Sherwood Lake. Sherwood Lake flows through a dam into Arrowhead Lake. All the Tri-Lakes dams are owned and operated by Adams County. There is a public boat launch on Sherwood Lake on the southwest edge of the lake owned by the Parks Department of Adams County. Heavy residential development around the lake is found along most of the lakeshore. Sherwood Lake is managed by the Tri-Lakes Management District. There is also an active Sherwood Property Owners Association.

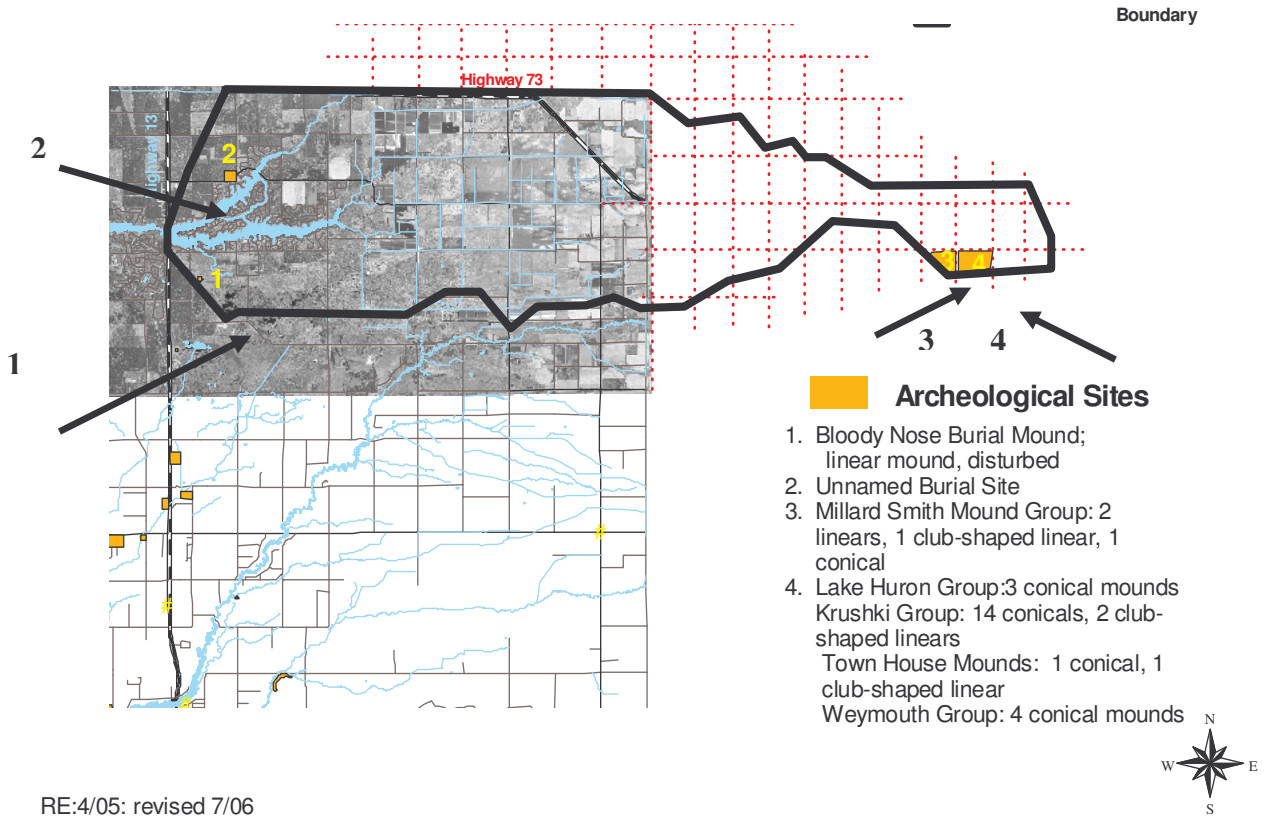
Figure 2: Sherwood Lake location



The Central Sand Plains, which contain Sherwood Lake, are found in the Driftless Area of Wisconsin. The area is characterized by varying elevations, with numerous, usually flat-topped ridges & hills sometimes called "mounds." Deposits made by streams from the melting ice sheet cover large areas and usually consist of sand, clay and gravel.

Archeological Sites

Figure 3: Sherwood Lake Archeological Sites



There are many Native American archeological sites in Adams County, with several being located right around in the Tri-Lakes watersheds. These mounds can be conical, linear or effigy (animal shapes) shapes. In order to preserve Native American heritage, federal and state laws on Native American burials require permission of the federal government and input from the local tribes before further disturbance.

Bedrock and Historical Vegetation

Bedrock around Sherwood Lake is mostly sandstone, both weak and resistant, formed in the Cambrian Period of Geology (542 to 488 millions years ago). Bedrock may be 200 or more feet below the sand/clay/gravel deposits left by melting ice cover.

Original upland vegetation of the area included extensive wetlands of many types (including open bogs, shrub swamps & sedge meadows), as well as prairies, oak forests, savannahs and barrens. Mesic white pine & hemlock forests were found in the northwest portion of the region. Most of the historic wetlands were drained in the 1900s and used for cropping. The current forested areas are mostly oak-dominated, followed by aspen and pines. There are also small portions of maple-basswood forest and lowland hardwoods.

Soils in the Sherwood Lake Watersheds

The primary soil type in both the surface and ground watersheds is loamy sand. The second most common soil type in both watersheds is muck. The most common soil right around the lake is sand.

Loamy sands tend to be well-drained, with water, air and nutrients moving through them at a rapid rate. Runoff, when it occurs, tends to be slow. Loamy sands have little water-holding capacity and low natural fertility, although they usually have more organic matter present than do sandy soils. Both wind and water erosion are potential hazards with loamy sands, as is drought. There are difficulties with waste disposal and vegetation establishment because of slope and seepage.

Sandy soil tends to be excessively drained, no matter what the slope. Water, air and nutrients move through sandy soils at a rapid rate, so that little runoff occurs unless the soil becomes saturated. Although water erosion can be a problem, wind erosion may be more of a hazard with sandy soils, especially since these soils dry out so quickly. There are also draught hazards with sandy soils. Getting vegetation started in sandy soils is often difficult due to the low available water capacity, as well as low natural fertility and organic material. Onsite waste disposal in sandy soils is also a problem because of slope and seepage; mound systems are usually required.

The soil and soil slopes around lakes and streams are very important to water quality. They affect amount of infiltration of surface precipitation into the ground and the amount of contaminants that may reach the groundwater, as well as the amount of

surface stormwater runoff. In addition, these two factors affect the amount and content of pollutants and particles (including soil) that may wash into a water body, affecting its water quality, its aquatic plant community and its fishery. Further, soil types and soil slopes help determine the appropriate private sewage system and other engineering practices for a particular site, since they affect absorption, filtration and infiltration of contamination from engineering practices.

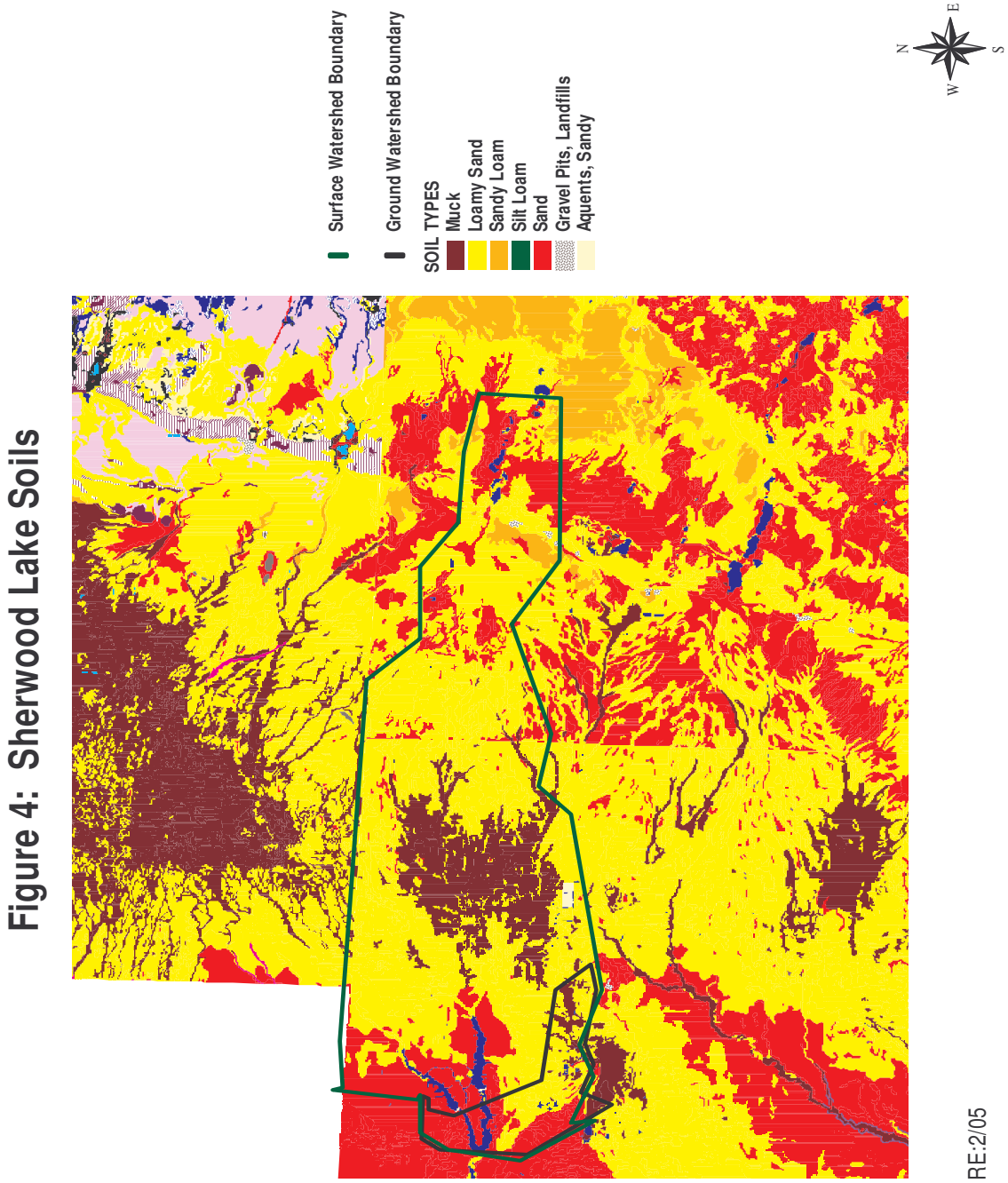


Figure 4: Sherwood Lake Soils

RE:2/05

PRIOR STUDIES OF THE TRI-LAKES AREA

The Tri-Lakes Area, including Sherwood Lake, has been the subject of several different studies. In 1978, a "water management study" report, Fourteenmile Creek Watershed, was published by the University of Wisconsin-Madison, This summarized the results of a study done during the summer of 1978. The report noted that the first lake constructed in the system was Sherwood Lake, on which construction started in 1967. By 1978, all of the Tri-Lakes had been constructed. The upper watershed was used mostly for agriculture and commercial forest. 70% of the agricultural fields were irrigated. Because of the concerns expressed by the landowners in the lower watershed (around the lakes), the report concentrated on studying that area.

A survey of lakeshore owners indicated that water weeds were seen as the most severe problem, followed by erosion, algal blooms and oil slicks from boat motors. There were also complaints about water "muddiness." Over one-half of the respondents thought that contributors to these problems included leaking septic systems, oil from boat motors, silt & sand from shoreline erosion, construction erosion and fertilizers from lawns and fields. Researchers saw lakes Camelot and Sherwood as more vulnerable to eutrophy because of their shallowness, relative clarity and abundant nutrients to encourage dense aquatic plant and algal growth. Sherwood Lake was determined to be fed by water over Camelot Lake dams and groundwater. Because Sherwood Lake waters mixed frequently, nutrients from the bottom of the lake was made available to algae and plants in the surface waters. Sherwood Lake also had a high flushing rate, with its total volume of water being replaced about 15 times per year. High flushing rates often bring greater loads of nutrients. The researchers noted that substantial shoreline erosion was occurring on Sherwood Lake. They indicated that the main causes of erosion were waves stirred up by winds or boat wakes. Further study revealed that wind was responsible for three times as many waves as boat wakes, but that boat wakes created many more large waves.

Recommendations from this report included: (1) installation of shoreline protection practices to reduce erosion; (2) lakeside vegetation planting to reduce soil loss and help control erosion; (3) amendment of the Town of Rome boating ordinance to reduce the incidence of high energy, boat-generated waves by specifying speeds without certain distances from shores; (4) better enforcement of the current town boating ordinance to control boat speeds and water skiing issues; (5) continued stocking of game fish like pike & walleye, as well as fish habitat improvement within the lakes; (6) establishing a lake management district that included all the lakes.

In 1993, another report called Tri-Lakes, Adams County, Wisconsin: Lakes and Watershed Characterization was published. This study was funded by the WDNR and the Tri-Lakes Management District and performed by Blue Water Science of St Paul, Minnesota. Parameters researched during this study include collection of flow & total phosphorus data for the creek and ditches feeding into the Tri-Lakes; collecting lake water chemistry sample for one summer (1991); and estimating phosphorus load from various land uses and contribution sources. Runoff was estimated at 6.3 inches per year. Secchi disk readings for Sherwood Lake ranged from 10.5 feet (June 1991) to 4 feet (August 1991). Hypoxia in the water column increased as the summer went on. In June, hypoxia was present only at 25 feet or more; by August, hyopoxia started at about 8 feet in depth. Total phosphorus for summer 1991 ranged from 20 to 32 micrograms/liter. Chlorophyll-a readings ranged from 6 to 21 micrograms/liter. Although total phosphorus levels were generally low, nitrate levels were always very high. An overall trophic state index of 52 was calculated for Sherwood Lake. These researchers calculated an overall total phosphorus load of nearly 3740 pounds per year to Sherwood Lake.

The report made several recommendations; (1) to continue efforts to reduce wind erosion through practices such as tree planting, snow fence planting, residue management, etc.; (2) to continue monitoring incoming stream water and lake water, examining at least total phosphorus, nitrate-nitrite, total Kjeldahl nitrogen and total suspended solids; (3) conduct bioassays on the 14-Mile Creek bedloads, since it was estimated that their phosphorus level was considerably higher than that of the creek surface water; (4) to continue a lake and watershed information & education program using activities such as newsletters, lake fair picnics, underwater video, demonstration projects, appointment of lake captains responsible for information distribution on their lakes; (5) to conduct plan surveys & monitor the amount of plant removal by monthly analyzing plants mechanically harvested for total phosphorus on each lake; (6) to install demonstration projects for aquatic plant control nearshore by methods other than herbicides; (7) to landscape lake shores for wildlife, shore protection & erosion control; and (8) to perform an on-site waste system evaluation and conductivity study, taking samples that were analyzed for fecal coliform & fecal streptococcus bacteria.

In April, 1999, Mid-State Associates Professional Services published the results of a septic study it had done. 45% if the properties around Sherwood Lake were developed at that time. Houses tended to be within 100 feet of the waterfront, with lakeshores narrow and houses close together. MSA inspected 20% of the septic sites. It found that 18% of the septic systems around Sherwood Lake were failing. While the overall average age of Sherwood Lake's septic systems was 18 years, the average age of the failing systems was 27 years. The report indicated that up to 31% of the septic systems over 20 years old would up expected to fail, with effects most obvious in localized

sections of the lake. It also noted that the sandy soils in the drainfields had a low capacity to retain phosphorus. According to this report, previous studies in 1979 and 1993 had overestimated the sandy soils' ability to retain phosphorus. The report also indicated that septic systems phosphorus input was likely to grow as development increased and the sandy soils reached their phosphorus saturation point. The report recommended four alternatives to be considered in place on continuing to use many individual private septic systems: (1) centrally collect wastewater and discharge it outside the Tri-Lakes watersheds; or (2) centrally collect wastewater and pump it into an existing municipal sewage system; or (3) use cluster type wastewater collection with nutrient removal and discharge of treated water; or (4) use nutrient removal techniques in the individual on-site waste systems.

The results of a study of the algae in Sherwood Lake were outlined in a report titled Phytoplankton Community Composition and Distribution in the Tri-Lakes Area, written by Dr. Robert Bell, UWSP-Biology Department, published in 2000. He found that Sherwood Lake had the most taxonomically diverse algae of all the Tri-Lakes. However, the taxa were generally unremarkable and were seen as typical of a mesotrophic of slightly eutrophic lake. Dr. Bell felt that at that time, heavy aquatic plant growth was more of a problem than seasonal algal blooms, but that he expected the levels of cyanobacteria (blue-green algae) to increase as the algal community shifted from one roughly equally spot of cyanobacteria, ochrophytes (pigmented algae) and green algae to one of predominately cyanobacteria. He made the following recommendations: (1) reduce the upstream input of pesticides & growth-promoting nutrients by using sediment traps or lagoons; (2) remove in-lake nutrients via sediment and/or plant biomass removal; (3) reduce residential nutrient input by improved septic/ sanitation systems and shoreline vegetation filter strips.

In December 2001, a report titled Assessment of Shallow Groundwater Flow & Chemistry & Interstital Water Sediment, Aquatic Macrophyte and Chemistry for the Tri-Lakes, Adams County, WI, was published. It was written by B. Shaw, C. Sparacio, J. Stelzer and N. Turyk of UWSP. Objectives of this study were: (1) to compare groundwater flow patterns during full & drawn-down conditions; (2) to examine water quality after heavy summer use; (3) to monitor groundwater entering back bays in Camelot & Sherwood Lakes for local impacts such as septics and/or lawns; (4) to determine nutrients & biomass of aquatic macrophytes as they relate to nutrients in interstitial water & lake sediments; and (5) to determine quantity of phosphorus and nitrogen held by plant tissues to estimate harvest removal. This study found that during non-drawdown conditions, 47% if Sherwood Lake sites showed upwelling, i.e., showed that groundwater was entering the lake. The main downwelling was found near the dam, which is typical. During a drawdown, even more of the sample sites were upwelling, raising the potential for effect on water quality by the water being drawn into the lake. 15.2% of the upwelling sites showed

evidence of septic contamination. 27.3% of these sites showed evidence of negative impacts from land use. 6.1% showed evidence of contamination from road-salt. When the study looked at aquatic plants (macrophytes) and the harvesting done by the Tri-Lakes Management District, it noted that 44% of the harvested tonnage came from Sherwood, with July being the peak month. The study concluded that the fall drawdown & spring refill of Sherwood Lake and the Camelot Lakes resulted in nutrients being released from anaerobic sediments and negatively impacted lake water quality. The high reactive phosphorus and ammonium levels suggested that nutrient transport to the lake was significant, especially from the fall drawdown, which increased groundwater discharge to the lake. The report stated that there was nutrient availability from several sources, including (1) the anaerobic release of ammonium and phosphorus from high organic matter sediments; (2) the nutrient flux from groundwater inflow; and (3) the cycling of nutrients from lake to sediment to groundwater and back again.

A survey was done of Tri-Lakes property owners during 2001. Although 72% of the respondents felt that the lakes' water quality was "good" or "fair", 74% felt the water quality had declined since they started coming to the lake. The top three causes attributed by respondents were input from cranberry growers, fertilizer use and heavy recreational use. The presence of algal scum and reduced water clarity were cited as the top two water quality problems, with aquatic plant growth scoring near the bottom. Nearly 66% of the respondents fertilized their lawn, with only 25% using non-phosphorus fertilizer. 74% mowed over 25% of their lawn at their lakefront. 83.8% if the houses had 2 or 3 bedrooms. Main activities on the lake included swimming, boating and fishing. The three most common boat types were pontoon, fishing and skiing, with 56.7% of the respondents having a boat motor 50 horsepower or larger.

A report titled Limnological Investigations of Camelot, Sherwood and Arrowhead Lakes, WI, was written by W.F. James, J. Barko & H. Eaken of the U.S. Army Corps of Engineers in 2002. Field work for this report included evaluating total sediment, total nitrogen and total phosphorus loads in the lakes. This was done by sediment collecting & testing, as well as water quality monitoring and computer modeling. The report noted that total phosphorus and chlorophyll-a levels increased as one went west in the lake chain, with the Camelot Lakes having the lowest levels and Arrowhead Lake having the highest level, with Sherwood Lake between the two. Summer anoxia in the lower levels of the lake was noted in July and August, especially near the Sherwood Dam. Secchi disk readings were lowest in August and September. The average summer Secchi disk reading was 7.2 feet. Average total phosphorus was 15 micrograms/liter and average chlorophyll-a was 14.8 micrograms/liter. The report indicated that Sherwood had an intermediate algal bloom frequency. Report authors determined Sherwood Lake to be susceptible to declining water quality as phosphorus loading increased.

CURRENT LAND USE

Although the ground watershed for Sherwood Lake is fairly small, the surface watershed is quite large. The two most common land uses in the ground watershed are woodlands and residential. The two most common land uses in the surface watershed are woodlands and irrigated agriculture. (See Figures 5 through 8).

Figure 5: Sherwood Lake Watersheds Land Use in Acres and Percent of Total

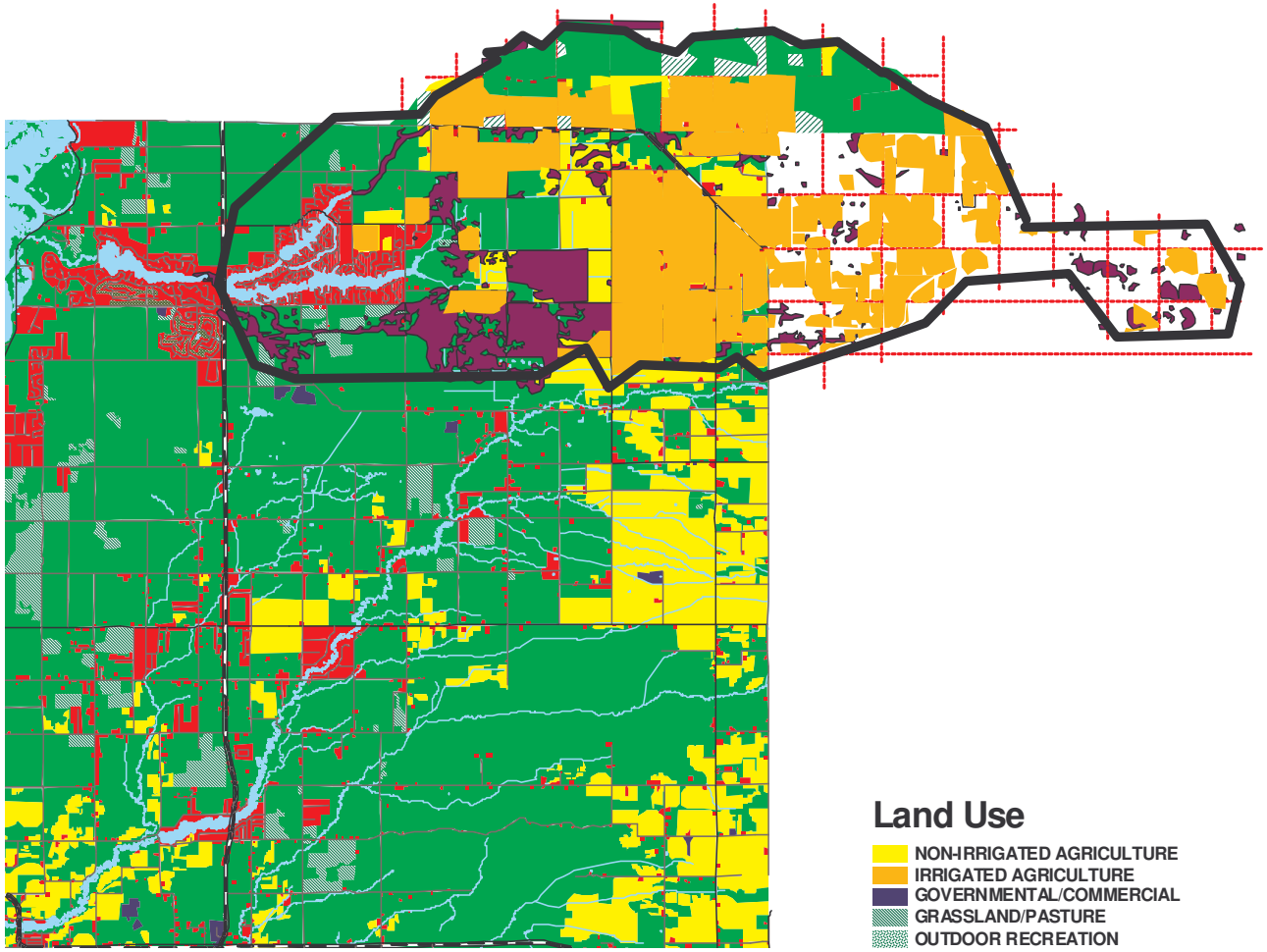
	Ground		Surface		Total	
Sherwood Lake	**Acres**	**% of Total**	**Acres**	**% of Total**	**Acres**	**% of Total**
Agriculture--Non Irrigated	0	0.00%	8598.14	16.93%	8598.14	16.11%
Agriculture--Irrigated	0	0.00%	14,712.35	28.97%	14712.35	27.57%
Grassland/Pasture	173.89	6.73%	3983.82	7.85%	4157.71	7.79%
Residential	819.83	31.73%	2,627.44	5.17%	3447.27	6.46%
Water	347.78	13.46%	603.9	1.19%	951.68	1.78%
Woodland	1242.2	48.08%	20,252.97	39.89%	21495.17	40.28%
total	2583.7	100.00%	50778.62	100.00%	53362.32	100.00%

Prior information on the watersheds shows how land use has changed over the years. After a substantial increase in agricultural land use between 1978 and 1986, agricultural changes appear to have leveled off and are no longer increasing in acreage. Residential use in the watersheds has decreased overall, although residential use directly around the Tri-Lakes has increased. Woodlands have increased slightly.

Figure 6: Prior Land Use Data for Sherwood Lake Watersheds

Land Use Type	1978	1986	1998	2004
Agricultural (both types)	31.1%	48.6%	48.9%	43.7%
Pasture/Grassland	17.1%	11.3%	11.1%	7.8%
Residential	12.4%	7.8%	9.3%	6.5%
Woodland	37.8%	30.7%	29.1%	40.3%
Water	1.6%	1.6%	1.6%	1.8%

Studies have shown that land use around a lake has a great impact on the water quality of that lake, especially in the amount and content of surface runoff. (James, T., 1992, I-10; Kibler, D.F., ed. 1982. 271) For example, while natural woodland may (on the average) absorb 3.5" out of a 4" rainfall, leaving only .5" as runoff, a residential area with quarter-acre lots may absorb only 2.3" of the 4", leaving 1.7" to run off the land into the lake—the same amount as may be expected to run off from a corn or soybean field. 1.7" of runoff translates into 46,200 gallons per acre ending up in the lake! Percentage of impervious surface, the soil type, vegetation present and slope of the site can all affect runoff volume. (Frankenberger, J, ID-230). The changes in the Sherwood watershed land use are therefore likely to significantly increase the runoff in volume and content unless protection steps are taken.



Land Use--Sherwood Lake Surface Watershed

RE:2004

Land Use

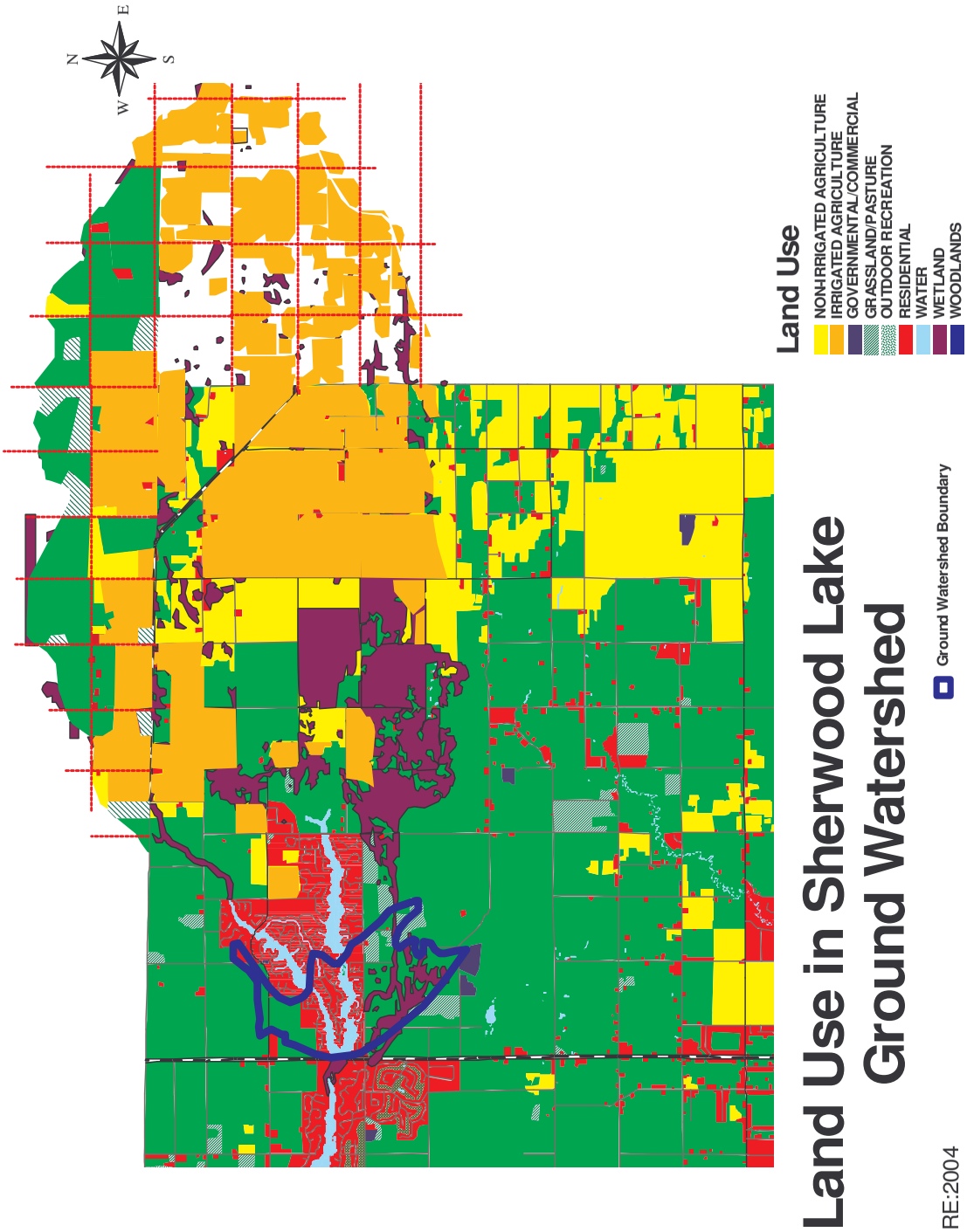
- NON-IRRIGATED AGRICULTURE
- IRRIGATED AGRICULTURE
- GOVERNMENTAL/COMMERCIAL
- GRASSLAND/PASTURE
- OUTDOOR RECREATION
- RESIDENTIAL
- WATER
- WETLANDS
- WOODLANDS

Surface Watershed Boundary

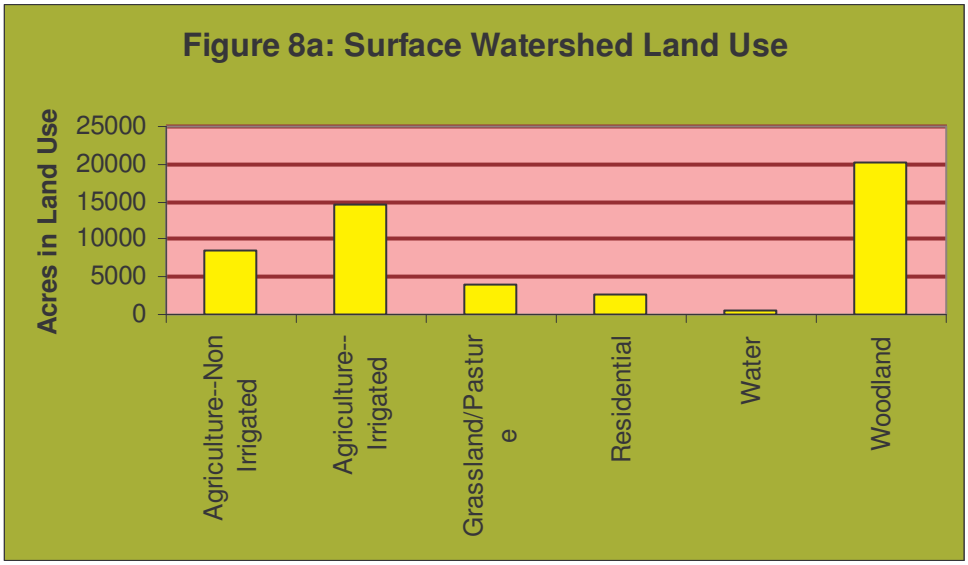
N
W E
S

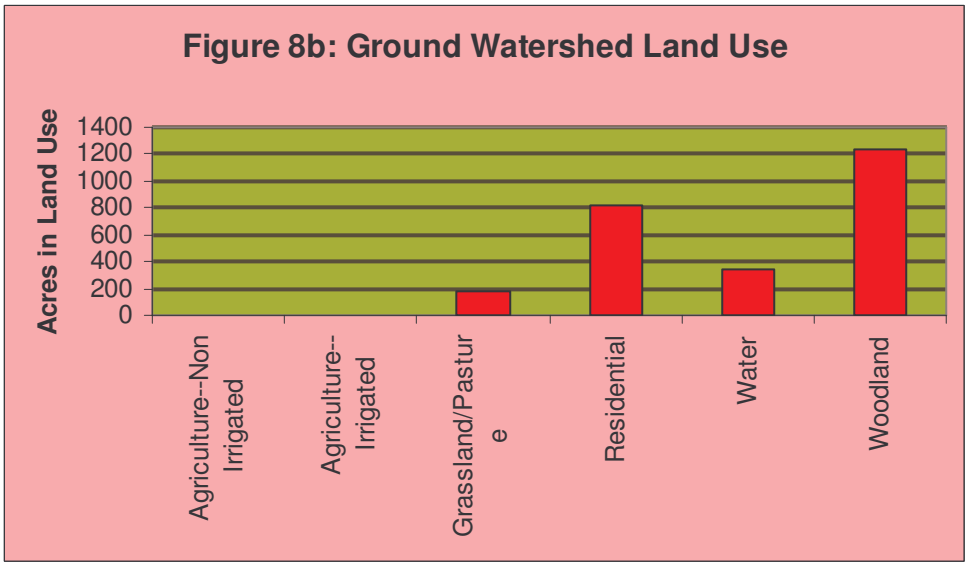
Figure 7a: Land use in Sherwood Lake Surface Watershed

Figure 7b: Land Use in Sherwood Lake Ground Watershed



When water runs over a surface, it picks up whatever loose pollutants—sediment, chemicals, metals, exhaust gas, etc—are present on that surface and takes those items with it into the lake. Increased development around a lake tends to increase the amount of pollutants being carried into the lake, thus negatively affecting water quality. Residential development areas with lots of one-quarter acre or less may deliver as much as 2.5 pounds of phosphorus per year to the lake for each acre of development.





There are two specific kinds of land use—wetlands and shorelands--that are so important to water quality that they will be separately discussed.

WETLANDS

A number of wetlands are located in the Sherwood Lake surface and ground watersheds. In the past, wetlands were seen as "wasted land" that only encouraged disease-transmitting insects. Many wetlands were drained and filled in for cropping, pasturing, or even residential development. In the last few decades, however, the importance of wetlands has become evident, even as wetlands continue to decline in acreage.

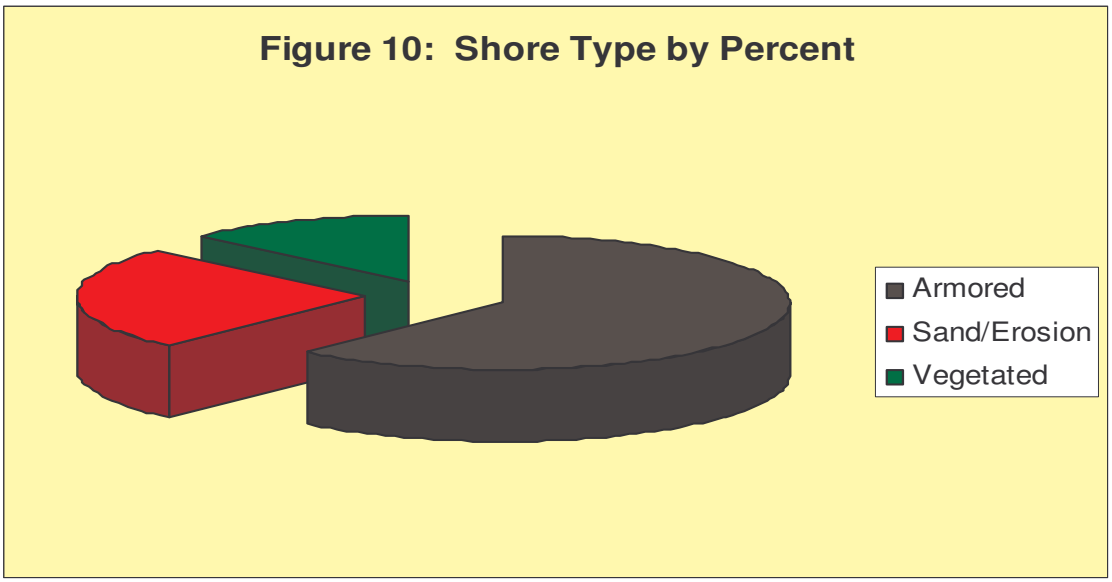
Wetlands play an important role in maintaining water quality by trapping many pollutants in runoff and flood waters, thus often helping keep clean the water they connect to. They serve as buffers to catch and control what would otherwise be uncontrolled water and pollutants. Wetlands also play an essential role in the aquatic food chain (thus affecting fishery and water recreation), as well as serving as spaces for wildlife habitat, wildlife reproduction and nesting, and wildlife food.

The large areas of wetlands in the Sherwood Lake watersheds serve as filters and traps that help keep Sherwood Lake as clean as it is. It is essential to preserve these wetlands for the health of all the Tri-Lakes.

Figure 9: Example of lake end wetland

SHORELANDS

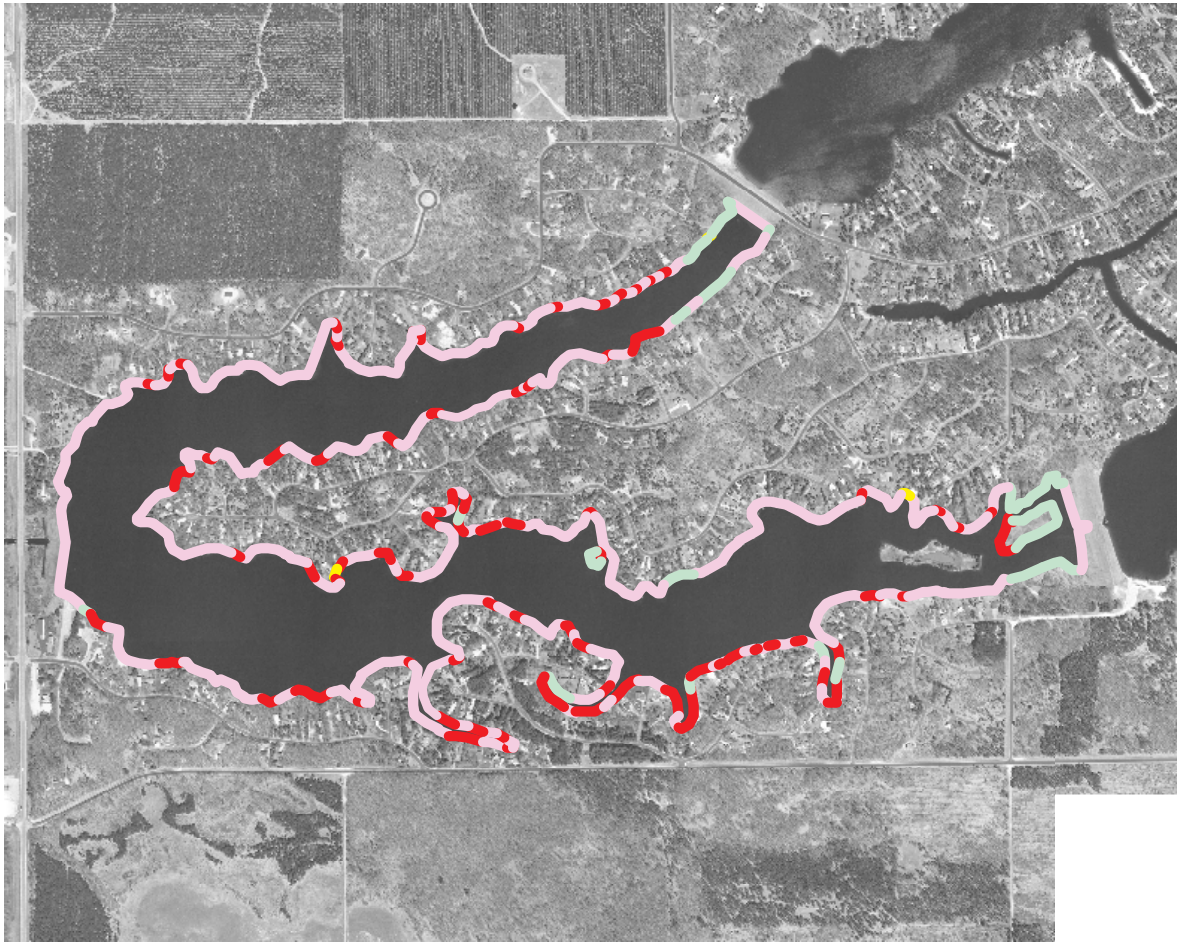
Sherwood Lake has a total shoreline 7.8 miles (41,184 feet) Most of the lakeshore is in residential or beach club use. According to a 2004 shore survey, some of the areas near the shore are steeply sloped; some are also soft and/or not well–vegetated. Only 12.84% of the Sherwood Lake shore has native vegetation. 77.54% of the shore has been disturbed and is currently covered by mowed lawn, rock riprap, some kind of seawall, hard structures (piers, etc.), erosion and/or sand.



Some of the Sherwood Lake shores were heavily eroded, as shown in Figure 11.

Figure 11: Example of Erosion on Sherwood Lake

Sherwood Lake Shoreline



Active Erosion

Beach or Sand

Rock or Seawall

Vegetated Shore

N
W E
S

RE:2004

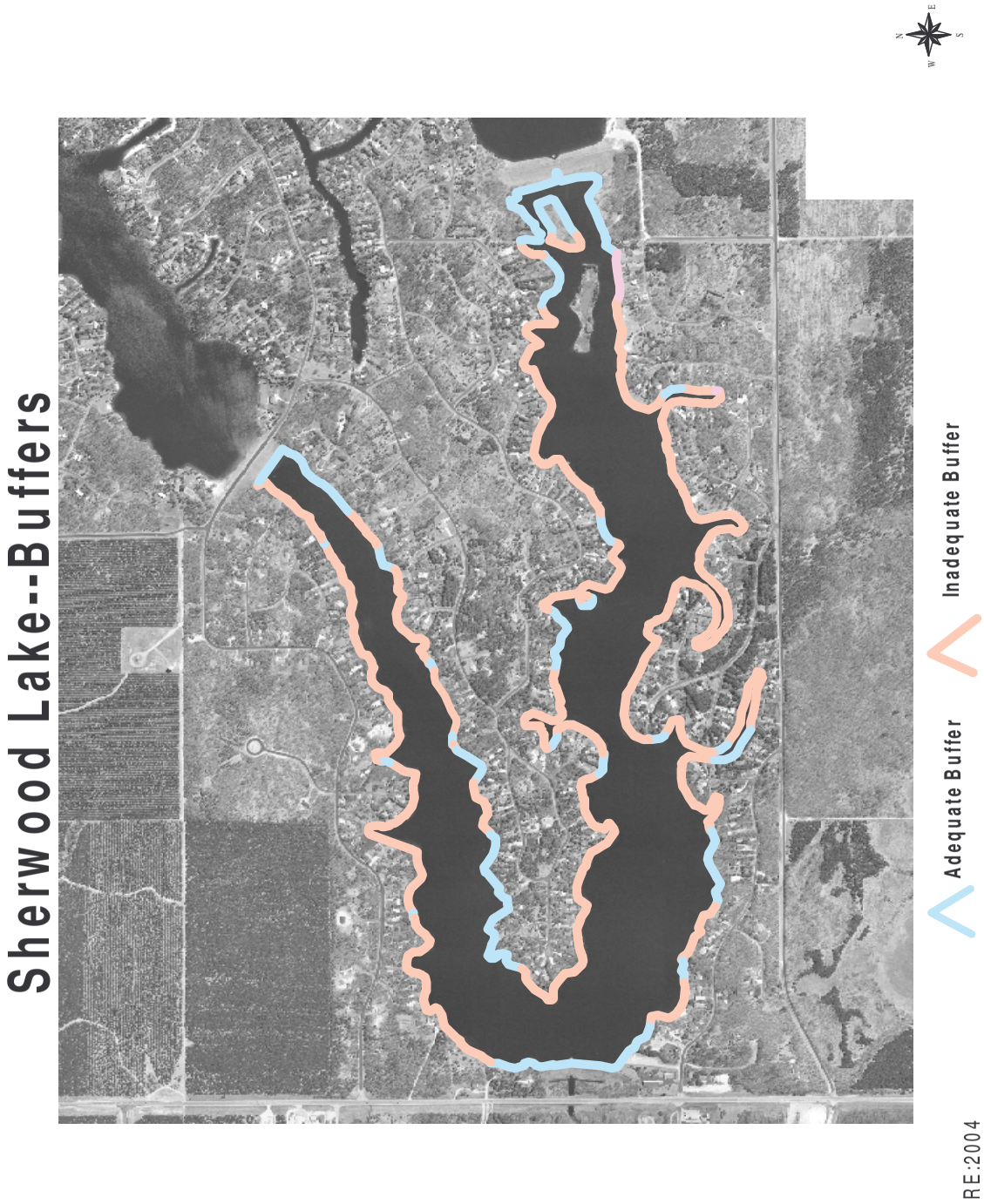
Figure 12: Shoreland Map of Sherwood Lake (2004)

The Adams County Shoreline Ordinance defines 1000' landward from the ordinary high water mark as "shoreland". Under the ordinance, the first 35 feet landward from the water is a "buffer." Shoreland buffers are an important part of lake protection and restoration. These buffers are simply a wide border of native plants, grasses, shrubs and trees that filter and trap soil & similar sediments, fertilizer, grass clippings, stormwater runoff and other potential pollutants, keeping them out of the lake. A 1990 study of Wisconsin shorelines revealed that a buffer of native vegetation traps 5 to 18 times more volume of potential pollutants than does a developed, traditional lawn or hard-armored shore.

A 2004 shore survey showed that very little of Sherwood Lake's shore had an "adequate buffer." An "adequate buffer" is a native vegetation strip at least 35 feet landward from the shore. Most of the "inadequate" buffer areas were those with rock or seawall, hard structures, beach, active erosion or mowed laws. In a few instances, those with insufficient native vegetation at the shoreline to cover 35 feet landward from the water line were also called "inadequate."

Vegetated shoreland buffers help stabilize shoreline banks, thus reducing bank erosion. The plant roots give structure to the bank and also increase water infiltration and decrease runoff. A vegetated shore is especially important when shores are steep and soft, as are many of Sherwood Lake shores. Figure 13 maps the adequate and inadequate buffers on Sherwood Lake.

Figure 13: Sherwood Lake Buffer Map (2004)



Lakeside buffers also serve as important habitat. Lake edges usually contain aquatic and wetland plants, grading into drier groundcover, then shrubs and trees as one moves inland towards drier land. Buffers provide habitat for many species of water-dependent wildlife, including furbearers, reptiles, birds and insects. Many wildlife species, including birds, small mammals, fish & turtles breed, nest, forage and/or perch in shore buffer areas. Further, 80% of the endangered and threatened species listed spend part of their life in this near-lake buffer area. (Wagner et al, 2006)

When the natural shoreline is replaced by traditional mowed turf-grass lawns, rock, wooden walls or similar installments, bird and animal life, land-based insects, and aquatic insects that hatch or winter on natural shore are negatively impacted. For example, on many Adams County lakes, the non-native aquatic plant, Eurasian Watermilfoil has invaded. There is a weevil native to Wisconsin that weakens Eurasian Watermilfoil by burrowing into and developing within its stems, but that weevil depends on a native-plant shore to overwinter. If the shore is instead covered by rock, seawall or traditional lawn, these weevils will be unavailable for the lake to use as Eurasian Watermilfoil control.

The filtering process and bank stabilization that buffers provide help improve a lake's water quality, including water clarity. Studies in Minnesota, Maine and Michigan have shown that waterfront property value increases for every foot the water clarity of a lake increases. (Krysel et al, 2003).

Figure 14: Example of Inadequate Vegetative Buffer

Figure 15: Example of Adequate Buffer

Natural shoreland buffers serve important cultural functions. They enhance the lake's aesthetics. Studies have shown that aesthetics rank high as one of the reasons people visit or live on lakes. Shore buffers can provide visual & audio privacy screens for homeowners from other neighbors and/or lake users.

Adequate buffers on Sherwood Lake in some places could be easily installed on the inadequate areas by either letting the first 35 feet landward from the water just grow without mowing it, except for a path to the water, or by planting native seedlings sufficient to fill in the first 35 feet or using biologs to protect the shore that are vegetated. Where areas are deeply eroded, shaping, revegetating and protecting the shores will be necessary to prevent further erosion.

Figure 16: Heavily-eroded Shore on Sherwood Lake that would need installation of shoreland protection practices

WATER QUALITY

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information on Sherwood Lake. Historic information about water testing on Sherwood Lake was also obtained from the studies discussed earlier in this report.

Phosphorus

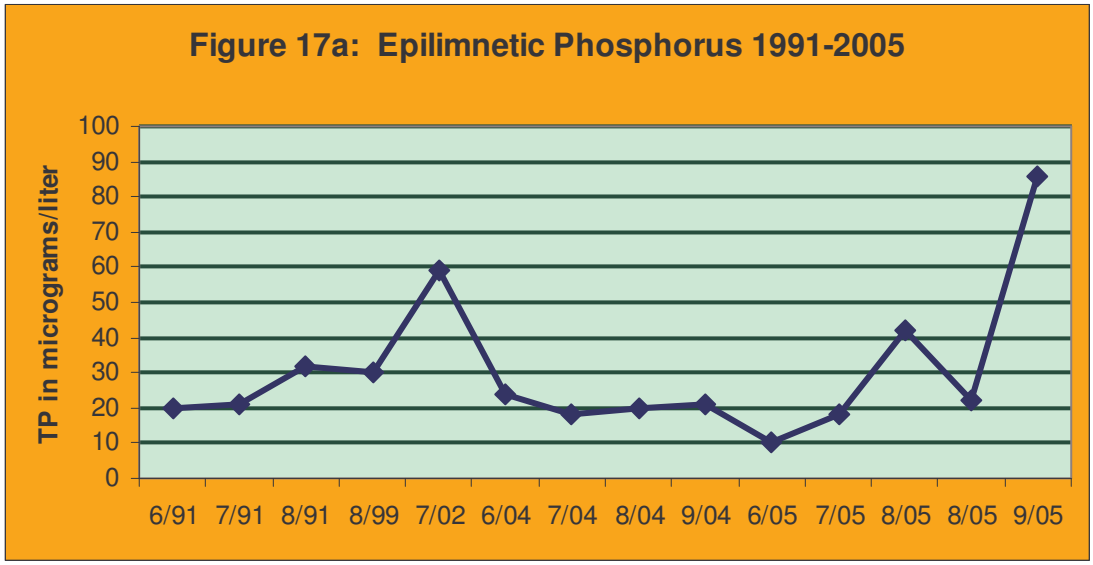
Most lakes in Wisconsin, including Sherwood Lake, are phosphorus-limited lakes: of the pollutants that end up in the lake, the one that most affects the overall quality of the lake water is phosphorus. The amount of phosphorus especially affects the frequency and density of aquatic vegetation and the frequency and density of various kinds of algae, as well as water clarity and other quality aspects. One pound of phosphorus can produce as much as 500 pounds of algae.

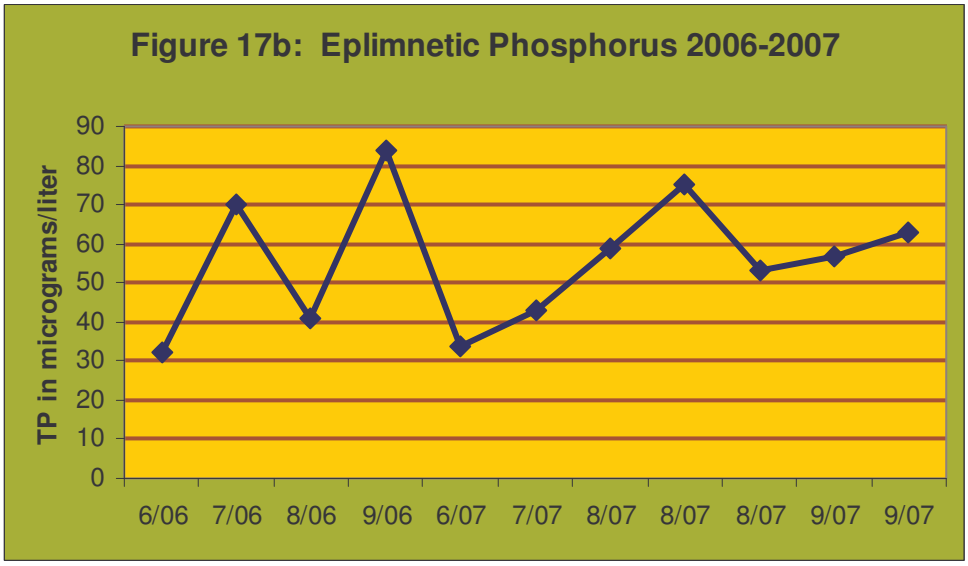
Phosphorus is not an element that occurs in high concentration naturally, so any lake that has significant phosphorus readings must have gotten that phosphorus from outside the lake or from internal loading. Some phosphorus is deposited onto the lake from atmospheric deposition, especially from soil or other particles in the air carrying phosphorus. A lake that includes a flooded wetland area may have a significant amount of phosphorus being released during the flushing of the wetland area. Phosphorus may accumulate in sediments from dying animals, dying aquatic plants and dying algae. If the bottom of the lake becomes anoxic (oxygen-depleted), chemical reactions may cause phosphorus to be released to the water column.

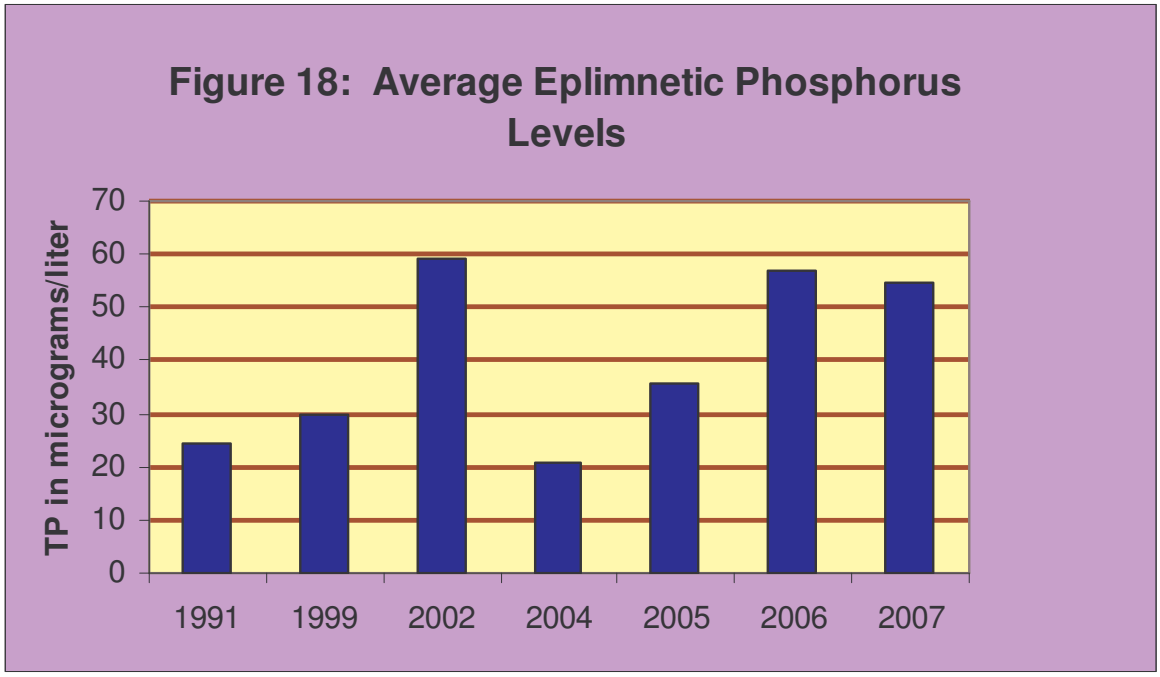
Although there are several forms of phosphorus in water, the total phosphorus (TP) concentration is considered a good indicator of a lake's nutrient status, since the TP concentration tends to be more stable than other types of phosphorus concentration. For an impoundment lake like Sherwood Lake, a total phosphorus concentration below 30 micrograms/liter tends to prevent nuisance algal blooms. Sherwood Lake's growing season (June-September) surface average total phosphorus level of 37.7 micrograms/liter is slightly over to the level at which nuisance algal blooms can be expected. And areas of Sherwood Lake do have nuisance-level algal blooms, especially in the shallower back bays.

Since phosphorus is usually the limited factor, measuring the phosphorus in a lake system thus provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excess plant growth.

The 2004-2006 summer average phosphorus concentration in Sherwood Lake places Sherwood Lake in the "fair" water quality section for impoundments, and in the "mesotrophic" level for phosphorus. The total epilimnetic phosphorus level has been creeping up in Sherwood Lake. In 1991, average eplimnetic total phosphorus was 24.33 micrograms/liter. By 2005, it averaged 35.6 micrograms/liter. The most recent figures, from summer 2007, show an average eplimnetic phosphorus level of 54.86 micrograms/liter, although the overall average for 2004-2007 is 41.99 micrograms/liter. These levels show that nutrients are accumulating in the lake as time goes on.







As the Figure 18 indicates, the average growing season total phosphorus levels have varied and often registered above the level recommended to avoid nuisance algal blooms. However, the eplimnetic total phosphorus levels have stayed below the state impoundment average of 65 micrograms/liter. Especially due to the increasing epilimnetic total phosphorus levels, phosphorus should continue to be monitored and steps should be taken to reduce the phosphorus levels in the lake.

Groundwater testing of various wells around Sherwood Lake was done by Adams County LWCD and included a test one year for total phosphorus levels in the groundwater coming into the lake. The average TP level in the wells was 22.75 micrograms/liter, considerably lower than the lake surface water results.

Land use plays a major role in phosphorus loading. A key component of the computer models used is the phosphorus budget, that is, the estimated amount of phosphorus delivered to the lake from each land use type annually. The land uses that contribute the most phosphorus are non-irrigated agriculture and residences. Using the current land use data, as well as phosphorus readings from 2004 through 2006 water sampling, a phosphorus loading prediction model was run for Sherwood Lake. The current results are shown in Figure 19a.

Figure 19a: Current Phosphorus Loading by Land Use

MOST LIKELY ANNUAL PHOSPHORUS LOADING--Current		
	% Loading	Lbs/acre/yr
Grassland/Pasture	0.7%	8.03
Residential	5.2%	59.78
Water	1.7%	18.74
Woodland	2.0%	22.31
Septics	5.2%	58.89
Greater Surface Watershed	85.2%	917.52
Total		1085.27

In the prior studies, phosphorus loading was somewhat different than the current estimates (see figure 19b).

Figure 19b: Prior Phosphorus Loading Estimates

Land Use Phosphorus Contributions in lbs/acre/yr	1991	current
Grassland/Pasture	0.00	8.03
Residential	47.29	59.78
Water	0.00	18.74
Woodland	83.87	22.31
Septics	0.00	58.89
Greater Surface Watershed	1571.16	917.52
Total in pounds/acre/year	1702.32	1085.27

These figures reveal that overall phosphorus loading in the watershed is now less than it was in the early-1990s. This may be due to the installation of agricultural runoff practices in the upper watershed. However, contribution percentages by land use have changed. For example, contribution (not including septics) from residential areas was nearly twice as much in 2004 than it was in 1991, while contribution from the greater watershed (which includes agriculture) has gone down nearly 10%.

Figure 19c: Contribution Percentage by Land Use

MOST LIKELY ANNUAL PHOSPHORUS LOADING--Current		
	% Loading	lb/yr
Grassland/Pasture	0.7%	19.8
Residential	5.2%	147.4
Other Water	0.5%	13.2
Woodland	2.0%	55
Septics	5.2%	145.2
Lake Surface	1.2%	33
Greater Surface Watershed	85.2%	2395.58
Total in pounds/year	100.0%	2809.18

Currently, the most phosphorus loading is coming from the greater watershed, including irrigated agriculture, non-irrigated agriculture and upstream septic systems. Although phosphorus deposits such as that from flooded wetlands or from atmospheric deposition cannot be controlled by humans, phosphorus loads from human activities such as agriculture, residential development and septic systems can be partly controlled by changes in human land use patterns. Practices such as agricultural buffers, nutrient management, shoreland buffer restoration; infiltrating stormwater runoff from roof tops, driveways and other impervious surfaces; using no phosphorus lawn fertilizers; and reducing phosphorus input to and properly managing septic systems will minimize phosphorus inputs into the lake. Circumstances such as increased impervious surface, lawns mowed to water's edge, disturbance of shore areas, improperly-functioning septic systems and removal of native vegetation can greatly increase the volume and content of runoff—and thus increase the volume of phosphorus entering the lake. Many of these practices can also increase the concentration of phosphorus entering the lake, by runoff or other methods of entry.

The models were run using not only the current known phosphorus readings in the lake, but also representing decreases or increases of human-controlled phosphorus input by 10%, 25%, and 50%. Just a 10% reduction of the human-impacted phosphorus would reduce the overall load by 276.3 pounds/year. This figure may not seem like much---until you calculate that one pound of phosphorus can result in up to 500 pounds of algae. A 10% reduction in these three areas could result in up to 138,150 pounds less of algae per year!

Figure 20: Impact of Increase/Decrease on P Loading

LAND USE	lb/yr	-10%	-25%	-50%
Grassland/Pasture	19.8	17.82	14.85	9.90
Residential	147.4	132.66	110.55	73.70
Other Water	13.2	13.20	13.20	13.20
Woodland	55	49.50	41.25	27.50
Septics	145.2	130.68	108.90	72.60
Lake Surface	33	33.00	33.00	33.00
Greater Surface Watershed	2395.58	2156.02	1796.69	1197.79
Total	2809.18	2532.88	2118.44	1427.69

Reducing the amount of input from the surface and ground watersheds results in less nutrient loading into the lake itself. Under the modeling predictions, reducing phosphorus inputs from human-based activities even 10% could improve Sherwood Lake water quality by up to 8.6 micrograms/liter. A 25% reduction could save up to 21.5 micrograms/liter and could reduce the overall eplimnetic growing season total phosphorus to around the 30 micrograms/liter level to avoid nuisance algal blooms. These predictions make it clear that reducing current phosphorus inputs to the lake are essential to improve, maintain and protect Sherwood Lake's health for future generations.

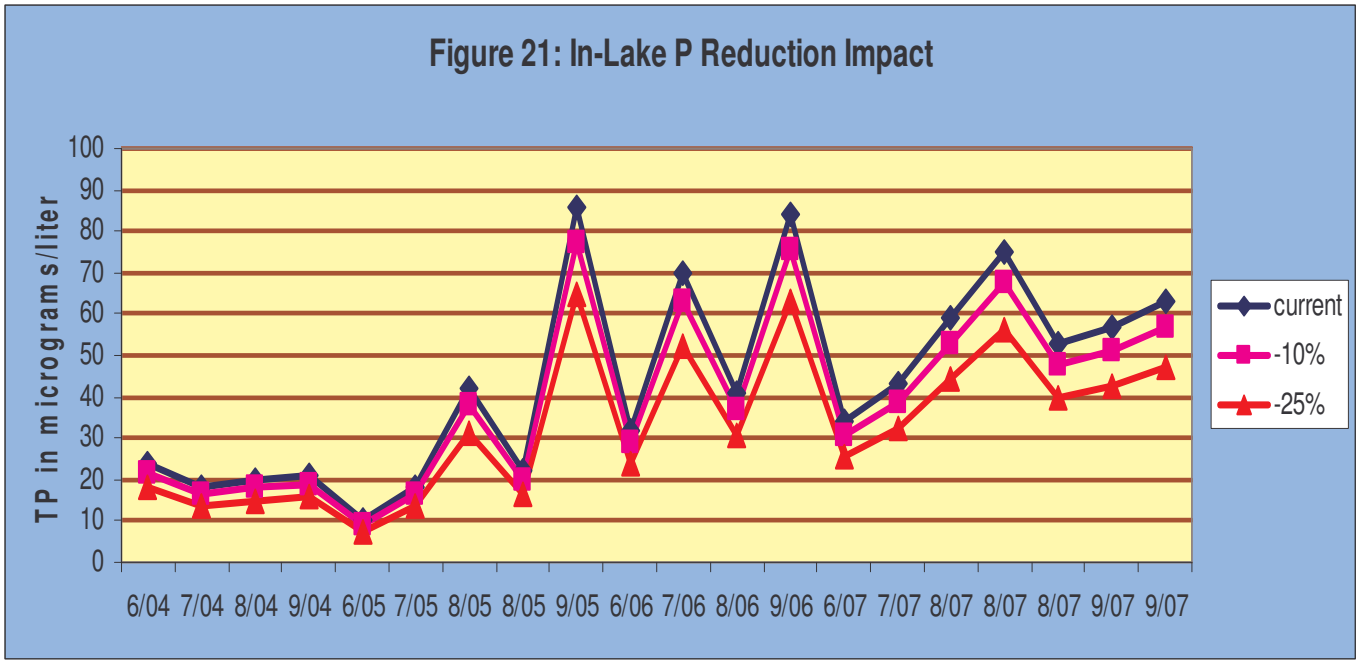
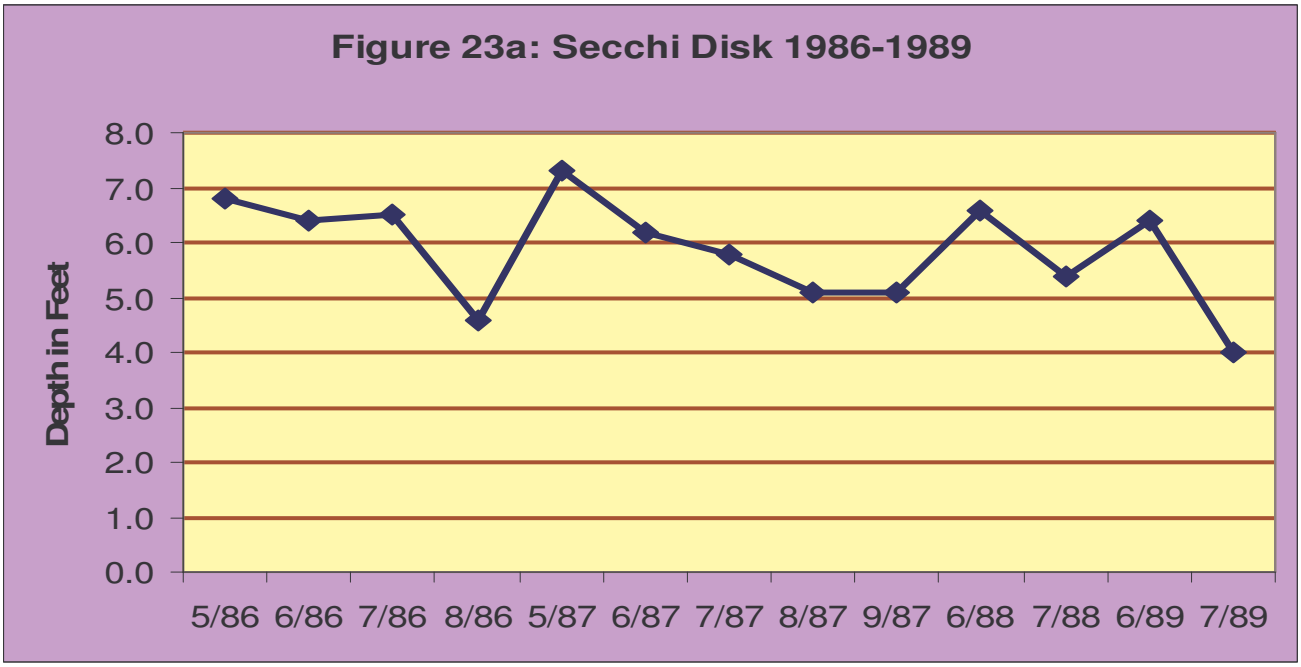
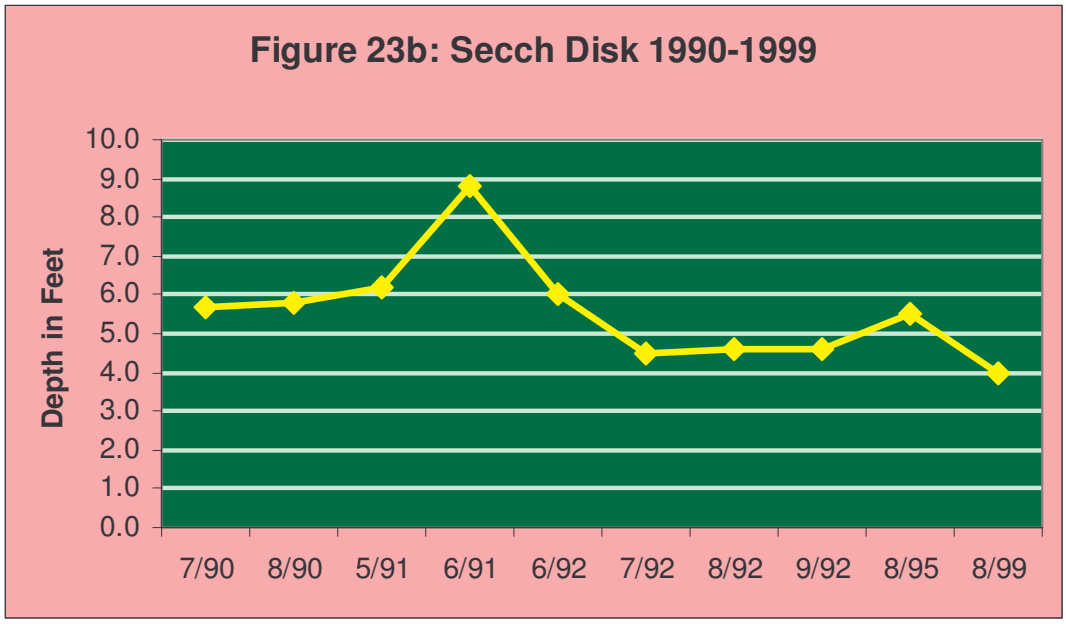


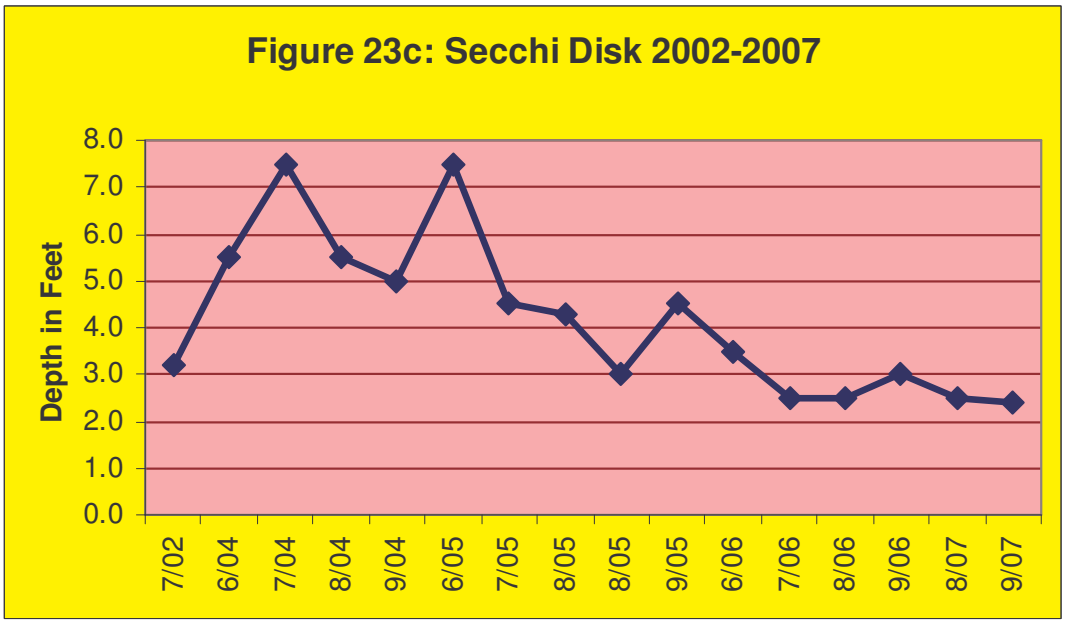
Figure 22: Photo of a Lake in Algal Bloom

Water Clarity

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity can be reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color or cloud the water. Water clarity is measured with a Secchi disk. Average summer Secchi disk clarity in Sherwood Lake in 2004-2006 was 4.36 feet. This is poor water clarity, putting Sherwood Lake into the "eutrophic" category for water clarity.







Sherwood Lake has a considerable history of Secchi disk readings in a number of years. A look at the average Secchi depth for the growing season in each year since 1986, Secchi disk depth readings on Sherwood Lake have generally decreased over the years (see figure 24). The overall average depth for the fourteen years for which there are records is 5.0 feet.

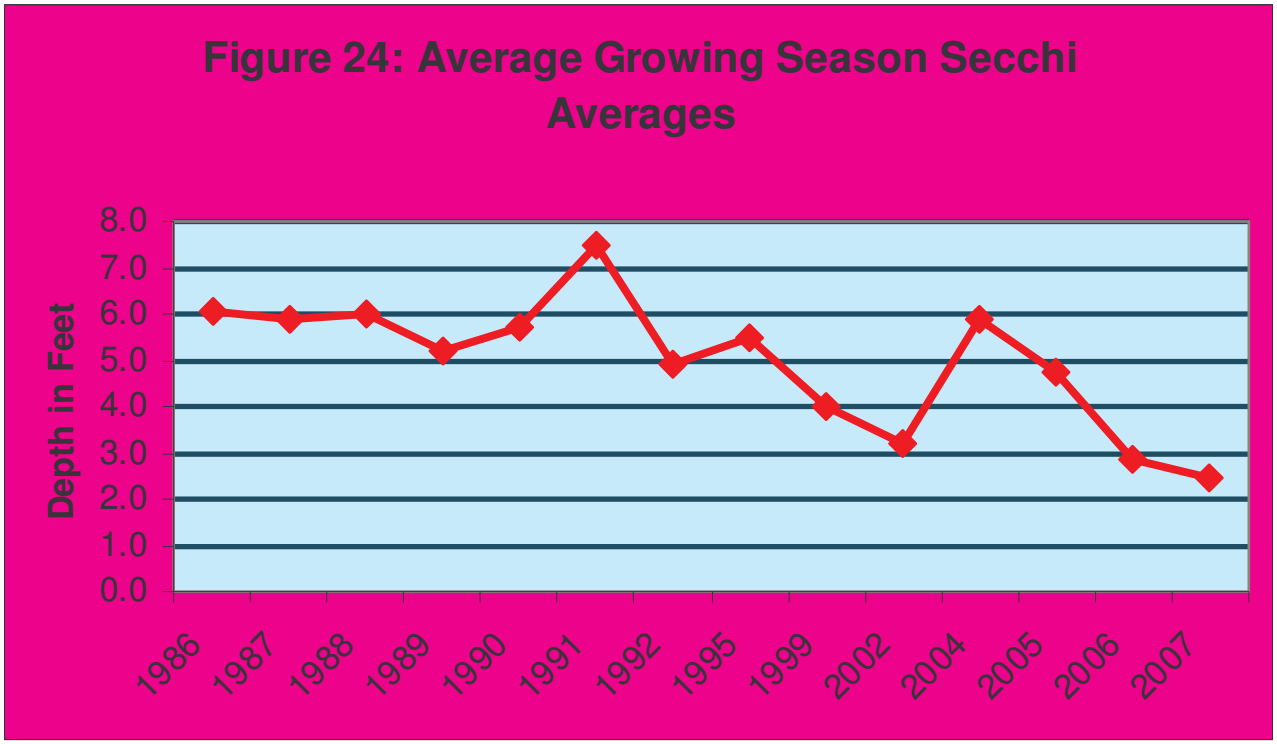
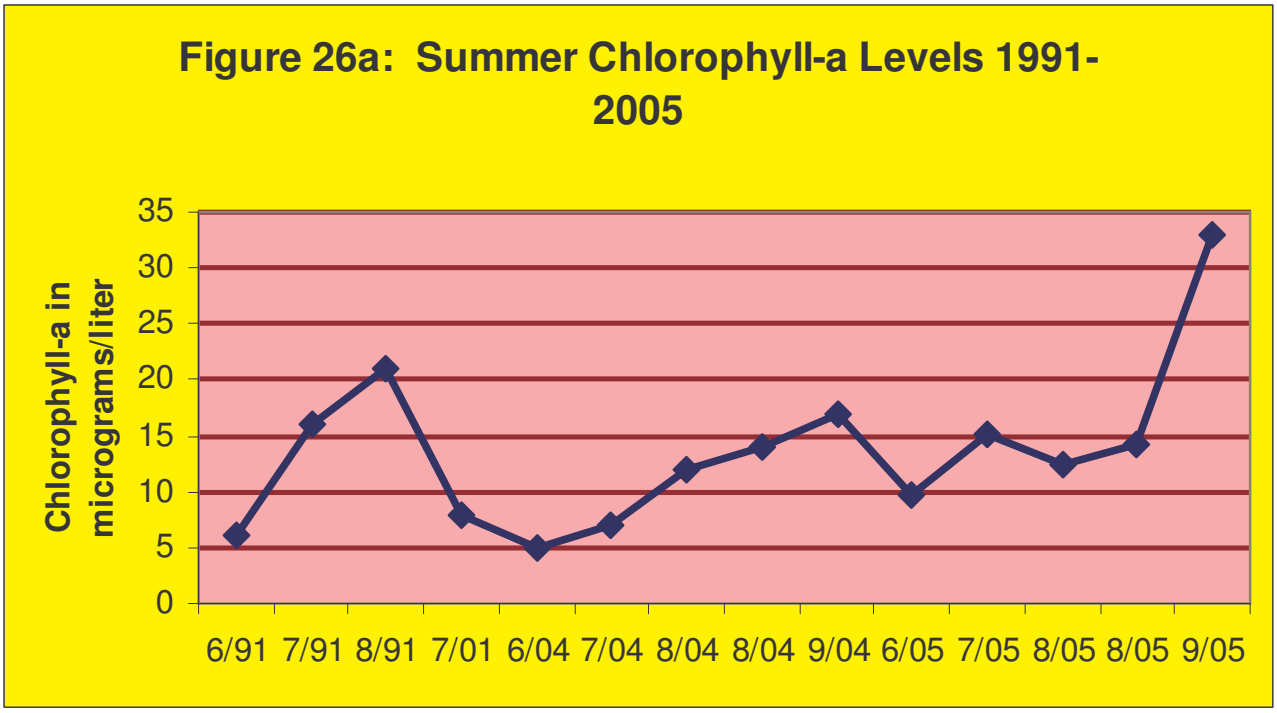


Figure 25: Photo of Testing Water Clarity with Secchi Disk

Chlorophyll a

Chlorophyll-a concentrations provide a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth, as well as result in unpleasing odor and appearance. Studies have shown that the amount of chlorophyll a in lake water depends greatly on the amount of algae present; therefore, chlorophyll-a levels are commonly used as a water quality indicator. The 2004-2006 growing season (June-September) average chlorophyll concentration in Sherwood Lake was 20.7 micrograms/liter. Such an algae concentration places Sherwood Lake at the "poor" level for chlorophyll a results.



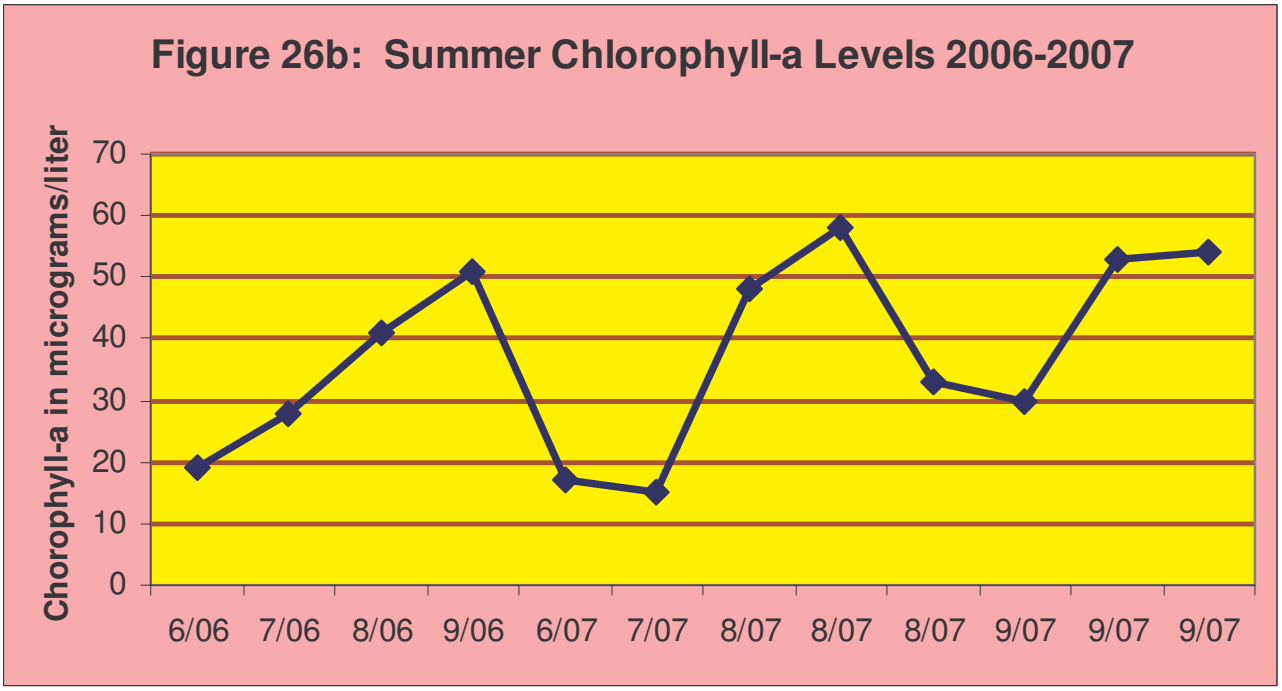
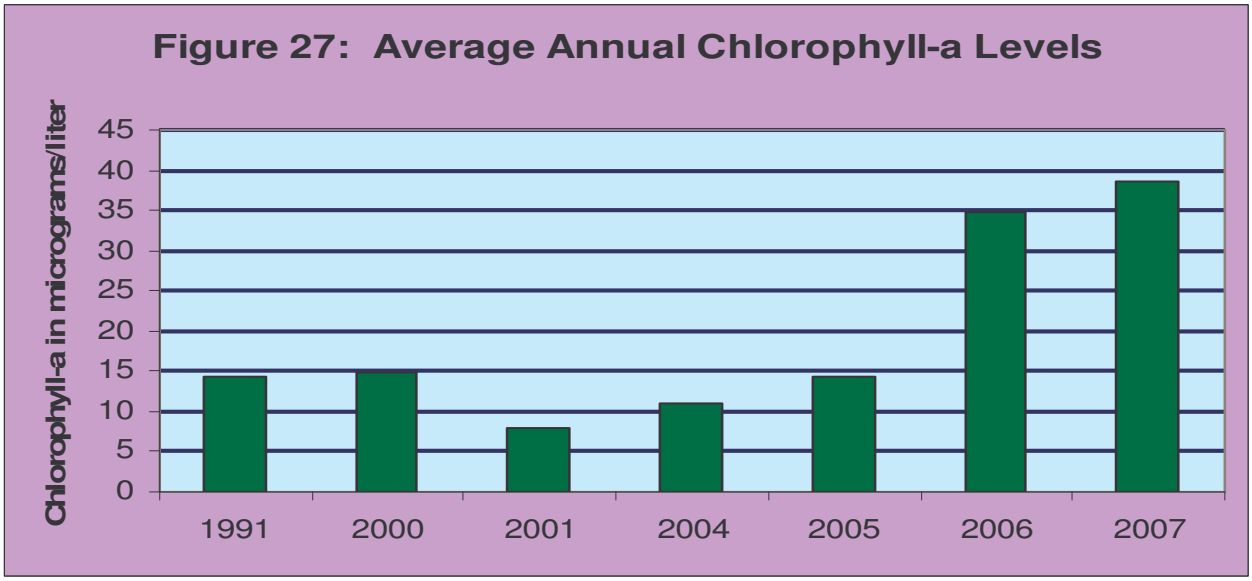


Figure 27 shows that summer chlorophyll-a averages stayed fairly steady from 1991 through 2005, staying in the "fair" category. However, in 2006 and 2007, chlorophyll-a levels shot up substantially. These two years coincide with many days of very hot and still weather. Such weather tends to encourage algal growth. Continued monitoring of chlorophyll-a will need to occur to determine if these high levels were the result of weather or are part of an ongoing trend.



Dissolved Oxygen

Oxygen dissolved in the water is essential to all aerobic aquatic organisms. The oxygen in a lake comes from the atmosphere and from the process of photosynthesis. Aquatic plants and algae consume carbon dioxide and respirate oxygen back into the lake water. The distribution of oxygen within a lake is affected by many factors, including water circulation, water stratification, winds or storms, air temperature; water temperature, nutrient availability, and the density and location of algae and/or aquatic plants.

Prior studies of Sherwood Lake have found anoxic (no oxygen) or hypoxic (low oxygen) in Sherwood near the dam (also the location of the deepest water in Sherwood Lake) and in the south "arm" of the lake. However, during the 2004-2006 study, no anoxia was found and hypoxia of just of 5 milligrams/liter occurred only in June 2005. Generally, dissolved oxygen levels didn't usually go below levels 5 milligrams/liter, the appropriate level for good fish survival. The charts (Figures 28) show the annual variations in dissolved oxygen levels in milligrams/liter, depth in feet and months of the years.

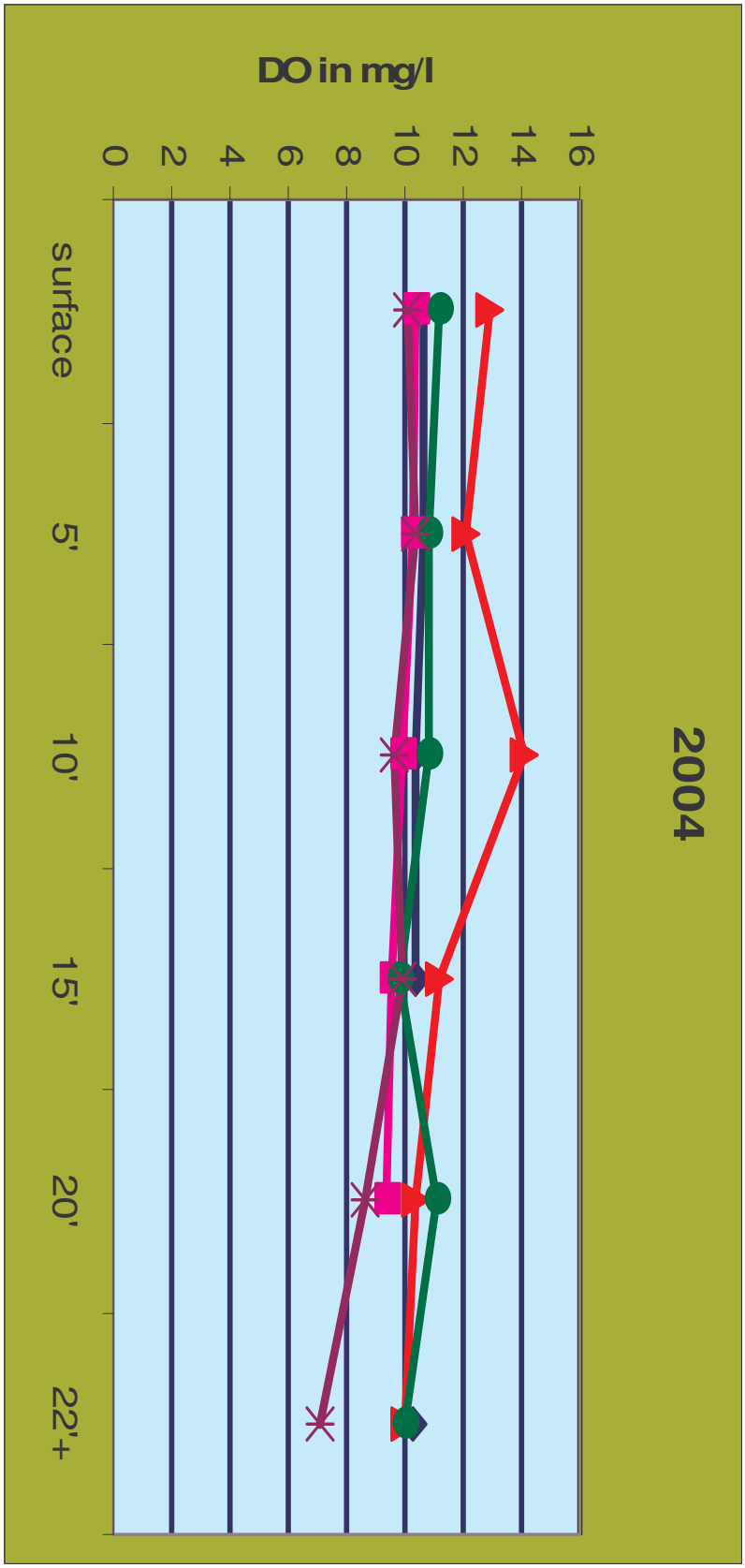


Figure 28a: Dissolved Oxygen Levels 2004 in milligrams/liter

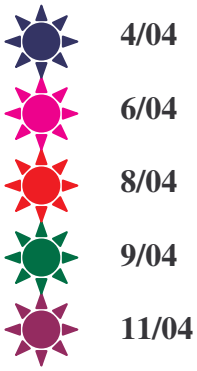


Figure 28b: Dissolved Oxygen Levels During 2005 Water Testing in milligrams/liter

2/05

4/05

6/05

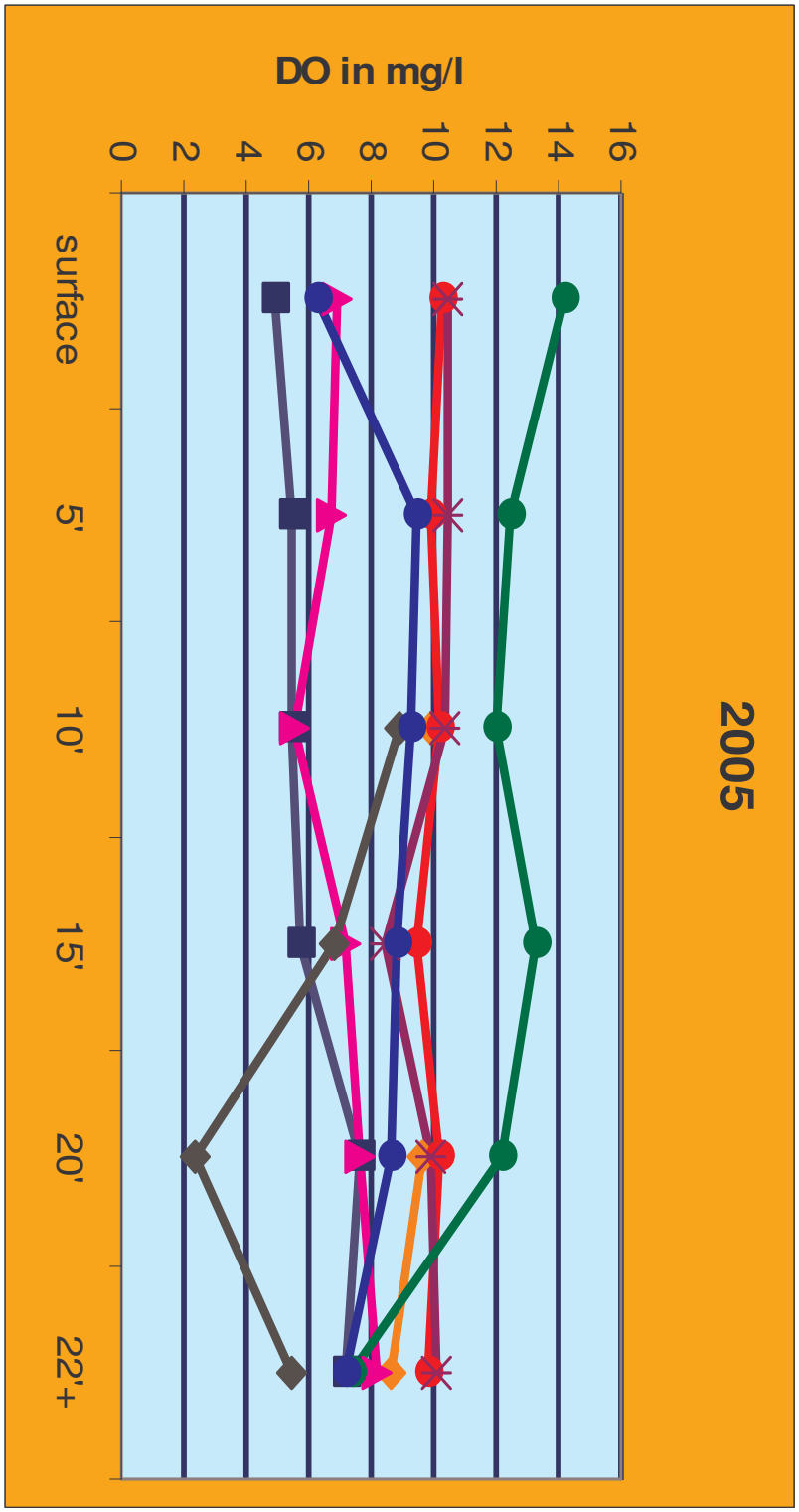
7/05

8/05

8/05

9/05

11/05



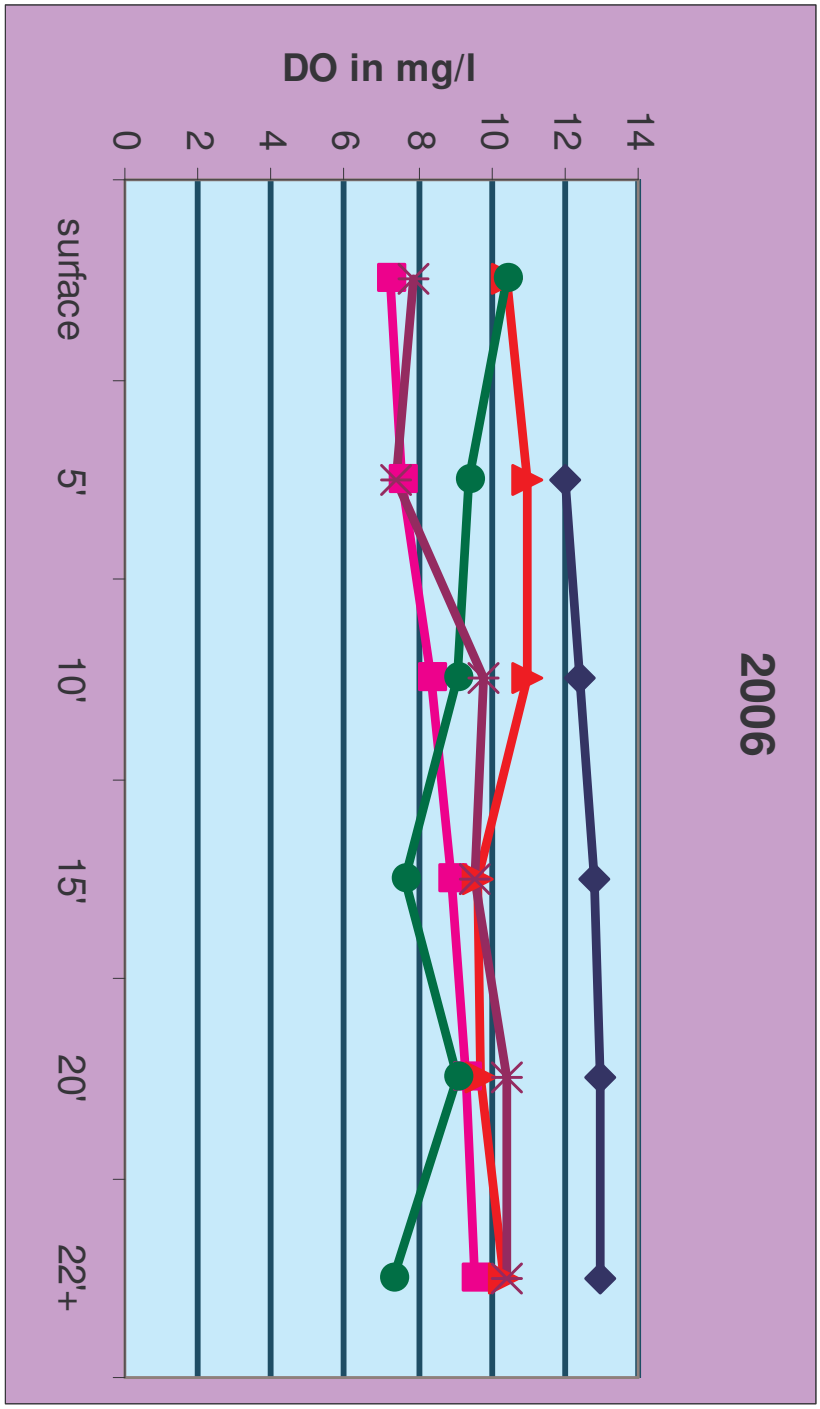
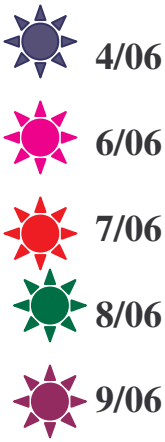


Figure 26c: Dissolved Oxygen Levels During 2006Water Testing in milligrams/liter



In deeper lakes, when the surface waters have cooled in autumn and water density throughout the water column is the same, the water column mixes vertically, a process known as "fall turnover." Most of Sherwood Lake is shallow and does not stratify. However, the west end of the lake, where depths exceed 22 feet deep, does stratify and turns over in the spring or fall.

Further, since flowing stream goes through the lake from east to west through Sherwood Lake, some open water is common throughout the winter on part of the lake. This probably allows oxygen levels to stay elevated—even the winter, most of the dissolved oxygen readings over the amount needed by fish (over 5 milligrams/liter).

Figure 29a: One of the abundant fish in Sherwood Lake—Bluegill (*Lepomis macrochirus*)

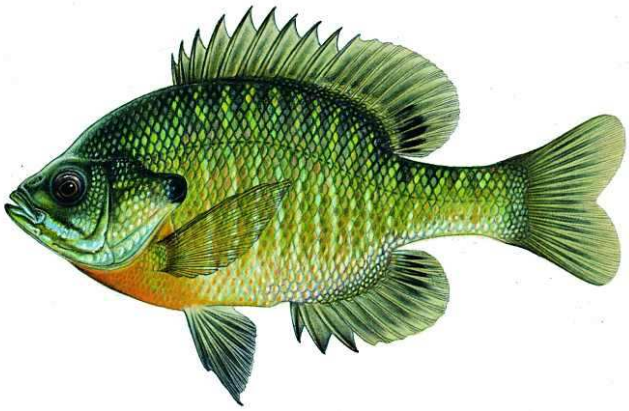


Figure 29b: One of the common Fish in Sherwood Lake—Largemouth Bass (*Micropterus salmoides*)

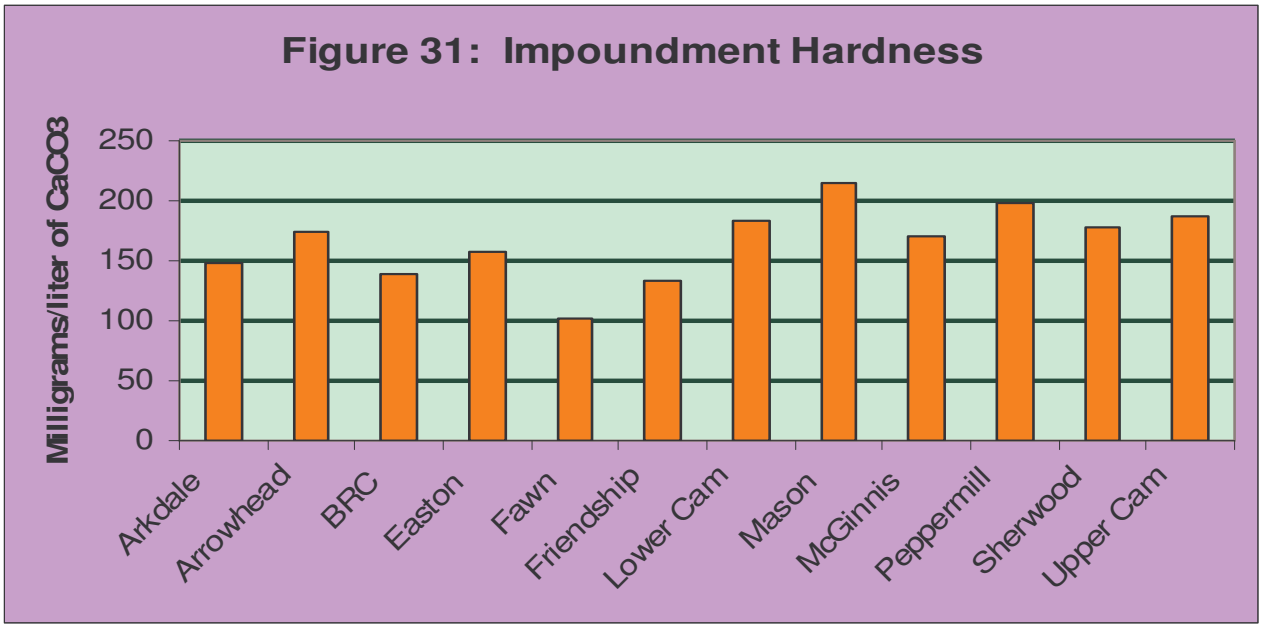
Water Hardness, Alkalinity and pH

Testing done by Adams County LWCD on Sherwood Lake included annual testing for water alkalinity and water hardness. Hardness and alkalinity levels in a lake are affected by the soil minerals, bedrock type in the watershed, and frequency of contact between lake water & these materials.

Level of Hardness	Milligrams/liter CaCO3
SOFT	0-60
MODERATELY HARD	61-120
HARD	121-180
VERY HARD	>180

Figure 30: Hardness Table

One method of evaluating hardness is to test the water for the amount of calcium carbonate (CaCO3) it contains. The surface water of all of the public access lakes in Adams County have water that is moderately hard to very hard, whether they are impoundments (man-made lakes) or natural lakes. In 2005 and 2006, random samples were also taken of wells around Sherwood Lake to measure the hardness of the water coming into the lake through groundwater. Hardness in the groundwater ranged from 180 (hard) to 208 (very hard), with an average of 187.2 milligrams/liter. Surface water hardness averaged 178 milligrams/liter, slightly lower than the groundwater hardness. The hardness in both surface and groundwater is likely due to the underlying bedrock in Adams County, which is mostly sandstone with pockets of dolomite and shale.



As the graph (Figure 31) shows, Sherwood Lake surface water testing results showed "hard" water (average 178 milligrams/liter CaCO3), slightly more than the overall hardness average impoundments in Adams County of 166 milligrams/liter of Calcium Carbonate. Hard water lakes tend to produce more fish and aquatic plants than soft water lakes because they are often located in watersheds with soils that load phosphorus into the lake water.

Alkalinity is important in a lake to buffer the effects of acidification from the atmosphere. "Acid rain" has long been a problem with lakes that had low alkalinity level and high potential sources of acid deposition.

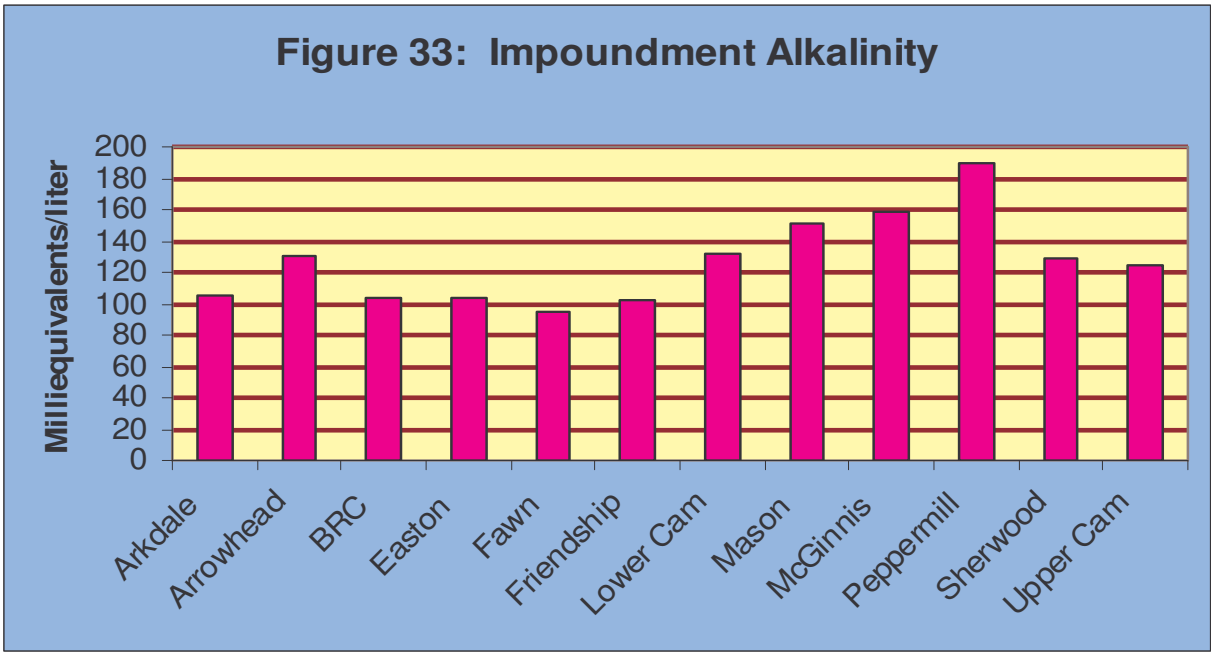
Acid Rain Sensitivity	ueq/l CaCO3
High	0-39
Moderate	49-199
Low	200-499
Not Sensitive	>500

Figure 32: Acid Rain Sensitivity

Well water alkalinity testing results ranged from 132 milliequivalents/liter to 180 milliequivalents/liter in alkalinity, with an average of 152 milliequivalents/liter. This is higher than the surface water average of 125.6 milliequivalents/liter. Sherwood Lake's potential sensitivity to acid rain is moderate, but luckily for Adams County, the acid deposition rate is very low, probably due to the little industrialization in the county.

Alkalinity also affects the pH level of lake water. The acidity level of a lake's water regulates the solubility of many minerals. A pH level of 7 is neutral. The pH level in Wisconsin lakes ranges from 4.5 in acid bog lakes to 8.4 in hard water, marl lakes.

Some of the minerals that become available under low pH, especially the metals aluminum, zinc and mercury, can inhibit fish reproduction and/or survival. Even what seems like a small variance in pH can have large effects because the pH scale is set up so that every 1.0 unit change increases acidity tenfold, i.e., water with a pH of 7 is 10 times more acid than water with pH of 8. Mercury and aluminum are not only toxic to many kinds of wildlife; they can also be toxic to humans, especially those that eat tainted fish.



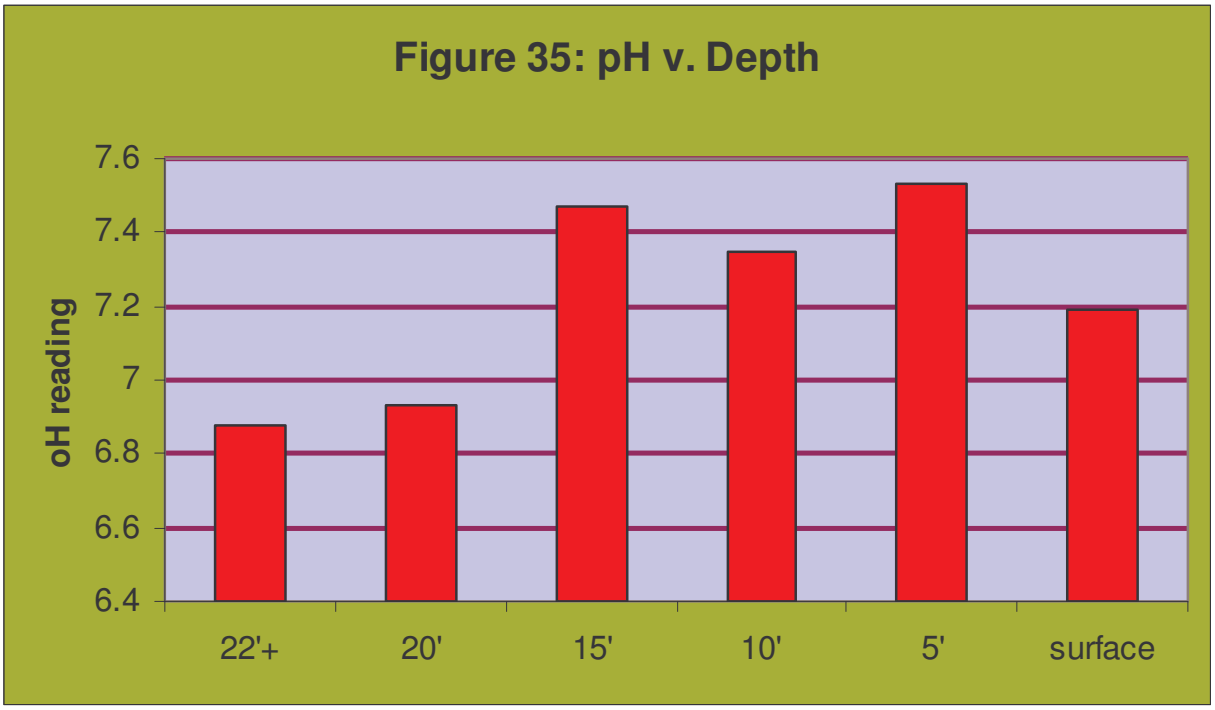
The testing occurring from 2004-2006 also included regular monitoring of the pH at several depths in Sherwood Lake. As is common in the lakes in Adams County, Sherwood Lake has pH levels starting at just under neutral (6.88) at over 22 feet depth and increasing in alkalinity as the depth gets less. By 15 feet deep, the pH had risen to 7.47and at 5 feet below the surface, the pH reached 7.53. A lake's pH level is important for the release of potentially harmful substances and also affects plant growth, fish reproduction and survival. Most plants grow best at pH levels between 5.5 and 8.

More importantly for many lakes, fish reproduction and survival are very sensitive to pH levels. The chart below indicates the effect of pH levels under 6.5 on fish (Figure 34):

Figure 34: Effects of pH Levels on Fish

Water pH	Effects
6.5	walleye spawning inhibited
5.8	lake trout spawning inhibited
5.5	smallmouth bass disappear
5.2	walleye & lake trout disappear
5	spawning inhibited in most fish
4.7	Northern pike, sucker, bullhead, pumpkinseed, sunfish & rock bass disappear
4.5	perch spawning inhibited
3.5	perch disappear
3	toxic to all fish

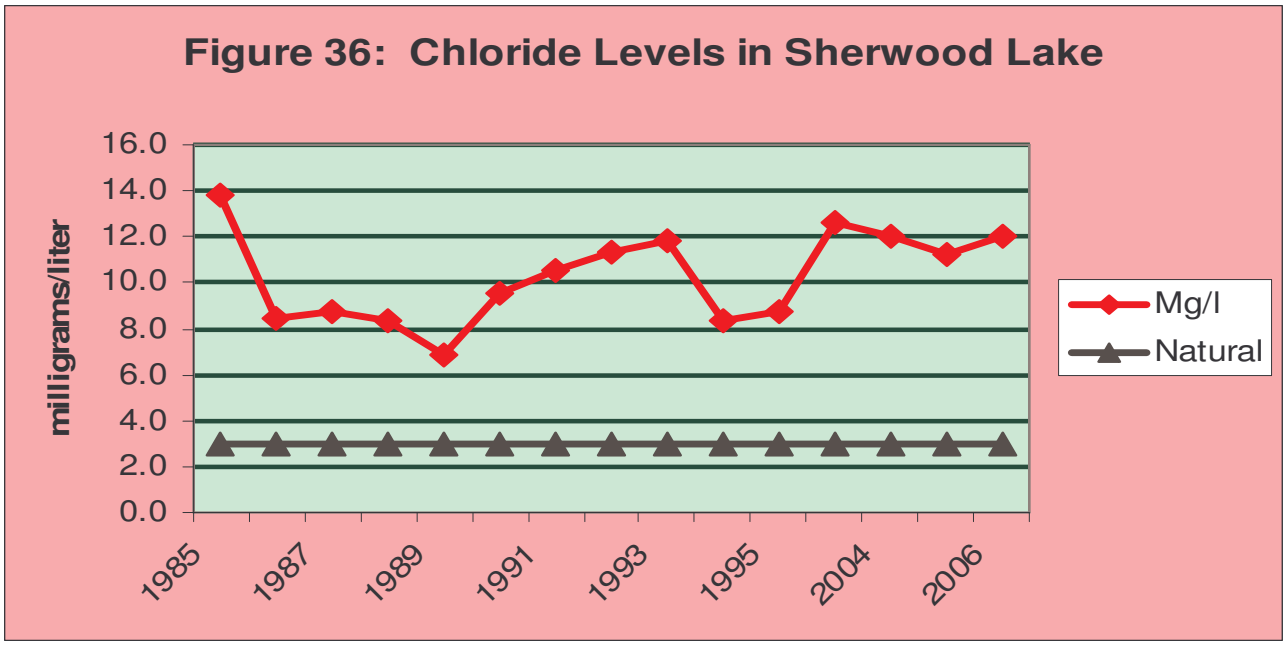
No pH levels taken in Sherwood Lake between 2004-2006 fell below the pH level that inhibits walleye reproduction. A lake with a neutral or slightly alkaline pH like Sherwood Lake is a good lake for fish and plant survival. Natural rainfall in Wisconsin averages a pH of 5.6. This means that if the rain falls on a lake without sufficient alkalinity to buffer that acid water coming in by rainfall, the lake's fish cannot reproduce. That is not a problem at Sherwood Lake. Sherwood Lake has a good pH level for fish reproduction and survival.



Other Water Quality Testing Results

CHLORIDE: Chloride does not affect plant and algae growth and is not known to be harmful to humans. It isn't common in most Wisconsin soils and rocks, so is usually found only in very low levels in Wisconsin lakes. However, the presence of a significant amount of chloride over a period of time indicates there may be negative human impacts on the water quality present from septic system failure, the presence of fertilizer and/or waste, deposition of road-salt, and other nutrients. An increased chloride level is thus an indication that too many nutrients are entering the lake, although the level has to be evaluated compared to the natural background data for chloride. The average chloride level found in Sherwood Lake during the 2004-2006 testing period was 11.73 milligrams/liter, elevated substantially above the natural level of 3 milligrams/liter for chloride in this area of Wisconsin.

Prior studies also found elevated chloride levels in Sherwood Lake. In fact, substantially elevated chloride levels have been found at Sherwood Lake since records were kept (1985). Further investigation as to the causes of such continued chloride elevations needs to be performed.



NITROGEN: Nitrogen is necessary for plant and algae growth. A lake receives nitrogen in various forms, including nitrate, nitrite, organic, and ammonium. In Wisconsin, the amount of nitrogen in a lake's water often corresponds to the local land use. Although some nitrogen will enter a lake through rainfall from the atmosphere, that coming from land use tends to be in higher concentrations in larger amounts,

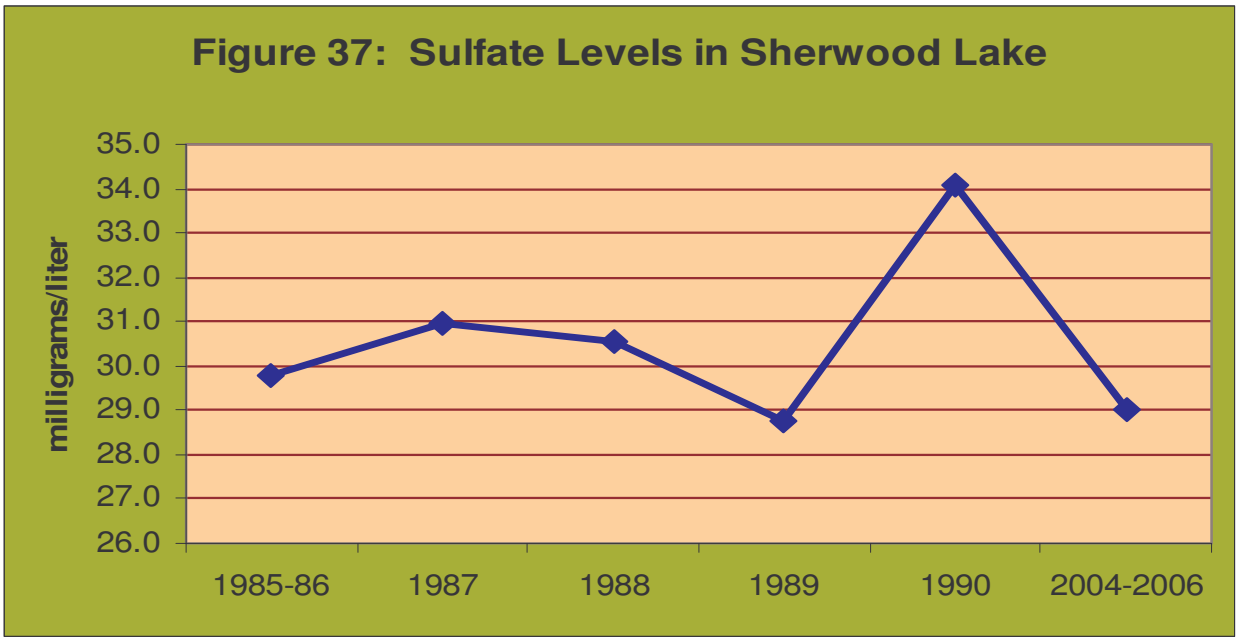
coming from fertilizers, animal and human wastes, decomposing organic matter, and surface runoff. For example, the growth level of the exotic aquatic plant, Eurasian Watermilfoil (*Myriophyllum spicatum*) has been correlated with fertilization of lake sediment by nitrogen-rich spring runoff.

Nitrogen levels can affect other aspects of water quality. The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 milligrams/liter in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). Sherwood Lake combination spring levels from 2004 to 2006 averaged .99 milligrams/liter, above the .3 milligrams/liter predictive level for nitrogen-related algal blooms. These elevations suggest that some of the algal blooms on Sherwood Lake may be at least partly nitrogen-related.

CALCIUM and MAGNESIUM: Calcium is required by all higher plants and some microscopic lifeforms. Magnesium is needed by chlorophyllic plants and by algae, fungi and bacteria. Both calcium and magnesium are important contributors to the hardness of a lake's waters. Magnesium elevated about 125 milligrams/liter may have a laxative effect on some humans. Otherwise, no health hazards to humans and wildlife are known from calcium and magnesium. The average Calcium level in Sherwood Lake's water during the testing period was 41.36 milligrams/liter. The average Magnesium level was 17.7 milligrams/liter. Both of these are low-level readings.

SODIUM AND POTASSIUM: These elements occur naturally only in low levels in Wisconsin waters and soils. Their presence may indicate human-caused pollution. Sodium is found with chloride in many road salts and fertilizers and is also found in human and animal waste. Potassium is found in many fertilizers and also found in animal waste. The level of these two is generally not useful as a specific pollution indicator, but increasing levels or one or both of these elements can indicate possible contamination from damaging pollutants. High levels of sodium have also been found to influence the development of a large population of cyanobacteria, some of which can be toxic to animals and humans. Some health professionals have suggested that sodium levels over 20 milligrams/liter may be harmful to heart and kidney patients if ingested. From 2004-2006, the average sodium level was 3.4 milligrams/liter. Prior sodium levels, taken in the mid-1980's, were slightly lower at 2.1 milligrams/liter. The sodium level average from 1985 to 2006 was 2.14 milligrams/liter. The average potassium reading from 2004 to 2006 was 2.55 milligrams/liter. This is slightly higher than the potassium levels from the mid-1980s, which averaged 1.5 milligrams/liter. However, both of these reading remain low on the overall scale of potential problems.

SULFATE: In low-oxygen waters (hypoxic), sulfate can combine with hydrogen and becomes the gas hydrogen sulfate, which smells like rotten eggs and is toxic to most aquatic organisms. Sulfate levels can also affect the metal ions in the lake, especially iron and mercury, by binding them up, thus removing them from the water column. To prevent the formation of hydrogen sulfate, levels of 10 milligrams/liter are best. A health advisory kicks in at 30 milligrams/liter. Sherwood Lake sulfate levels averaged 29.01 milligrams/liter during the testing period, above the level for hydrogen sulfate formation, but still slightly below the health advisory level. However, the overall average for the years in which sulfate testing was done is 30.84, above the health advisory level.



TURBIDITY: Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Turbid water may mask the presence of bacteria or other pollutants because the water looks murky or muddy. In general, turbidity readings of less than 5 NTU are best. Very turbid waters may not only smell, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. Turbidity levels for Sherwood Lake's waters were low in the 1980s, but have risen substantially since, with one reading over the 5 TU mark.

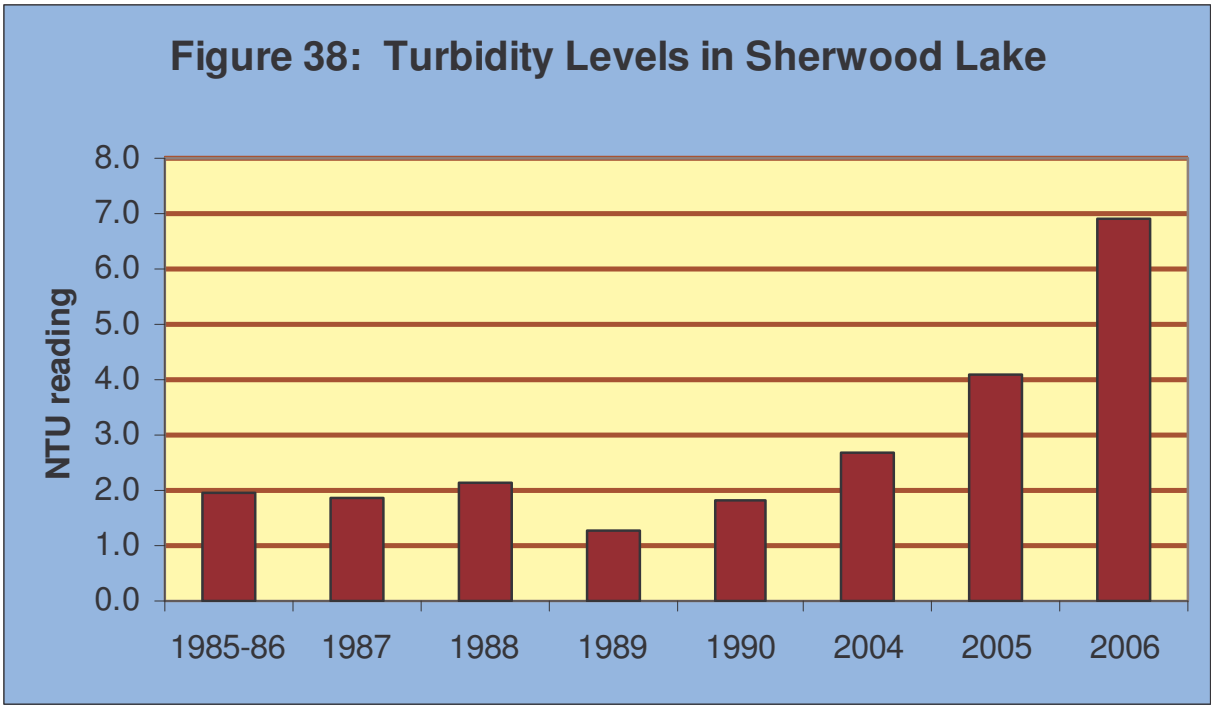


Figure 39: Examples of Very Turbid Water

HYDROLOGIC BUDGET

According to date in a 1971 WDNR bathymetric (depth) map, Sherwood Lake has 246 surface acres, and the volume of the lake is 2516 acre-feet. At that time, 7.5% of the lake was less than 3 feet deep and 8% was over 20 feet deep. The maximum depth was 27 feet.

A "hydrologic budget" is an accounting of the inflow to, outflow from and storage in a hydrological unit (such as a lake). "Residence time" is the average length of time particular water stays within a lake before leaving it. This can range from several days to years, depending on the type of lake, amount of rainfall, and other factors. "Flushing rate" is the time it takes a lake's volume to be replaced. "Annual runoff volume", as used in WiLMS, is the total water yield from the drainage area reaching the lake. The "drainage area" is the amount of area (in acres) contributing surface water runoff and nutrients to the lake. The "areal water load" is the total annual flow volume reaching the lake divided by the surface area of the lake. "Hydraulic loading" is the total annual volume of all water sources (including precipitation, non-point sources & point sources) loading into the lake.

Using the data gathered from historical testing and that done by the Adams County LWCD from 2004-2006, the WiLMS model calculated the tributary drainage area for Sherwood Lake as 2337.7 acres. The average unit runoff for Adams County in the Sherwood Lake area is 9.4 inches. WiLMS determined the expected annual runoff volume as 1831.2 acre-feet/year. Anticipated annual hydraulic loading is 5840.8 acre-feet/year. Areal water load is 23.7 feet/year. In an impoundment lake like Sherwood Lake, a significant portion of the water and its nutrient load running through it from the impounded creek tend to flush through the lake and continue downstream—in Sherwood Lake's case, modeling estimates a water residence of 0.43 year. The calculated lake flushing rate is 2.32 1/year. Water and its load flow through Sherwood Lake fairly quickly.

Figure 40: Example of Hydrologic Budget

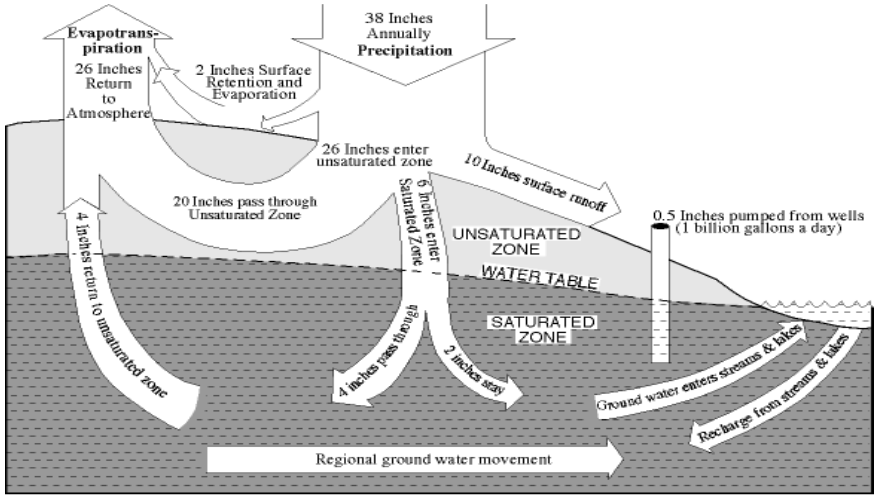
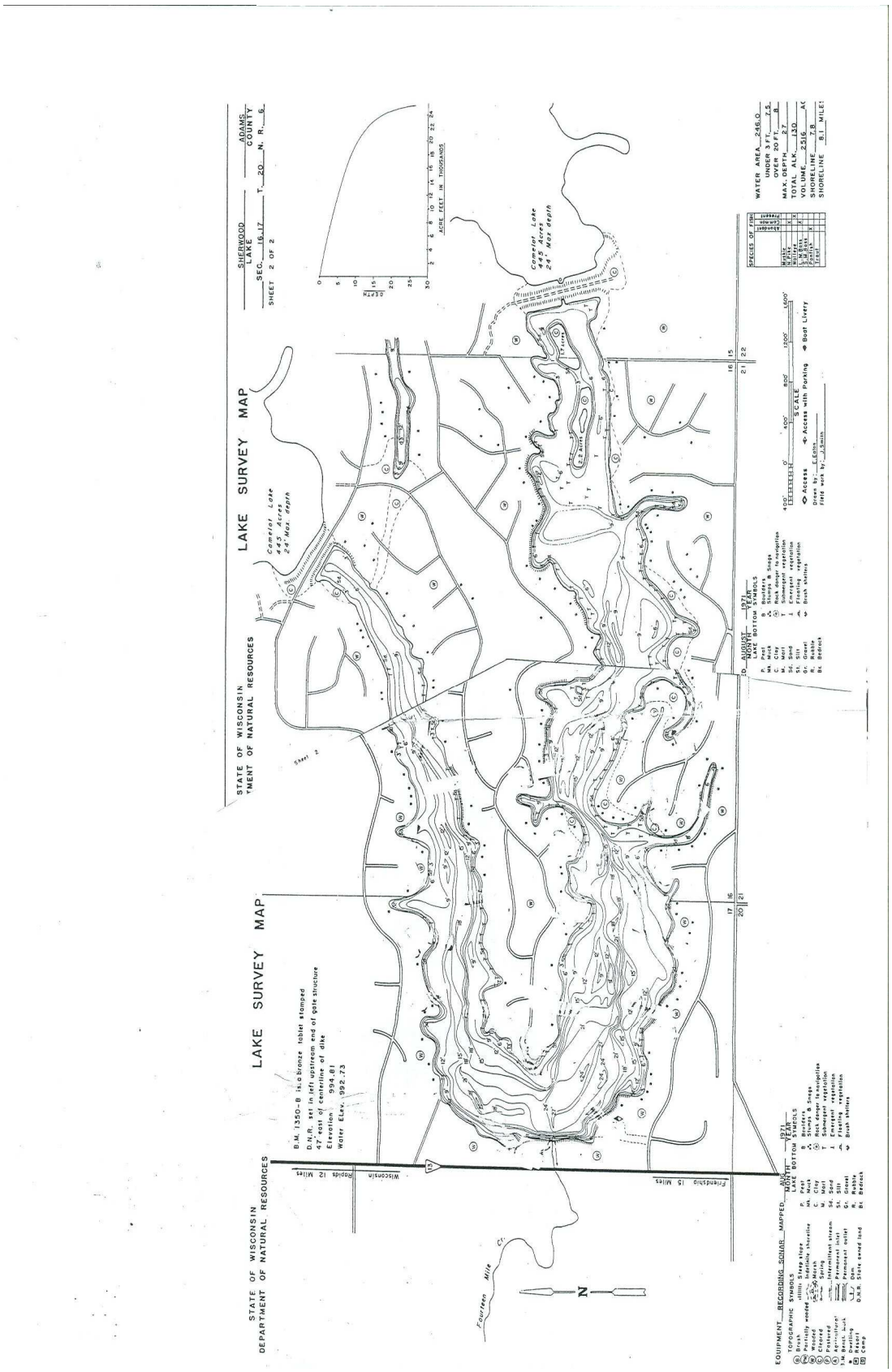


Figure 41: Sherwood Lake Bathymetric Map



TROPHIC STATE

The trophic state of a lake is one measure of water quality, basically defining the lake's biological production status (see Figure 42). **Eutrophic lakes** are very productive, with high nutrient levels, frequent algal blooms and/or abundant aquatic plant growth. **Oligotrophic lakes** are those low in nutrients with limited plant growth and small populations of fish. **Mesotrophic lakes** are those in between, i.e., those which have increased production over oligotrophic lakes, but less than eutrophic lakes; those with more biomass than oligotrophic lakes, but less than eutrophic lakes; often with a more varied fishery than either the eutrophic or oligotrophic lakes. In comparing water quality testing results with the prediction from the computer modeling of this modeling with the actual figures outlined above, the actual Trophic State of Sherwood Lake is what was predicted from the modeling. Modeling results predicted that the overall TSI for Sherwood Lake would be **57**. This score places Sherwood Lake's overall TSI at above average for impoundment lakes in Adams County (52.83).

Figure 42: Trophic Status Table

Score	TSI Level Description
30-40	**Oligotrophic:** clear, deep water; possible oxygen depletion in lower depths; few aquatic plants or algal blooms; low in nutrients; large game fish usual fishery
40-50	**Mesotrophic:** moderately clear water; mixed fishery, esp. panfish; moderate aquatic plant growth and occasional algal blooms; may have low oxygen levels near bottom in summer
50-60	**Mildly Eutrophic:** decreased water clarity; anoxic near bottom; may have heavy algal bloom and plant growth; high in nutrients; shallow eutrophic lakes may have winterkill of fish; rough fish common
60-70	**Eutrophic:** dominated by blue-green algae; algae scums common; prolific aquatic plant growth; high nutrient levels; rough fish common; susceptible to oxygen depletion and winter fishkill
70-80	**Hypereutrophic:** heavy algal blooms through most of summer; dense aquatic plant growth; poor water clarity; high nutrient levels

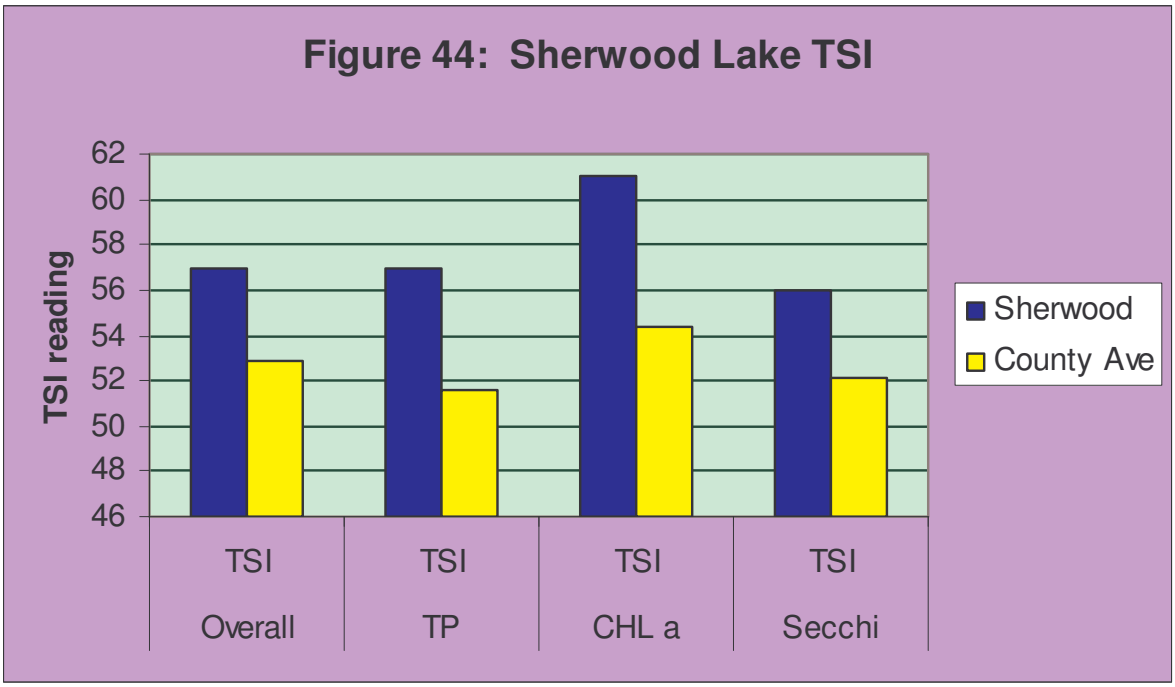
Sherwood Lake = 57

Phosphorus concentration, chlorophyll-a concentration and water clarity data are collected and combined to determine a trophic state. As discussed earlier, the average growing season epilimnetic total phosphorus for Sherwood Lake was 37.7 micrograms/liter. The average growing season chlorophyll-a concentration was 20.7 micrograms/liter. Growing season water clarity averaged a depth of 4.36 feet. Figure 39 shows where each of these measurements from Sherwood Lake falls in trophic level.

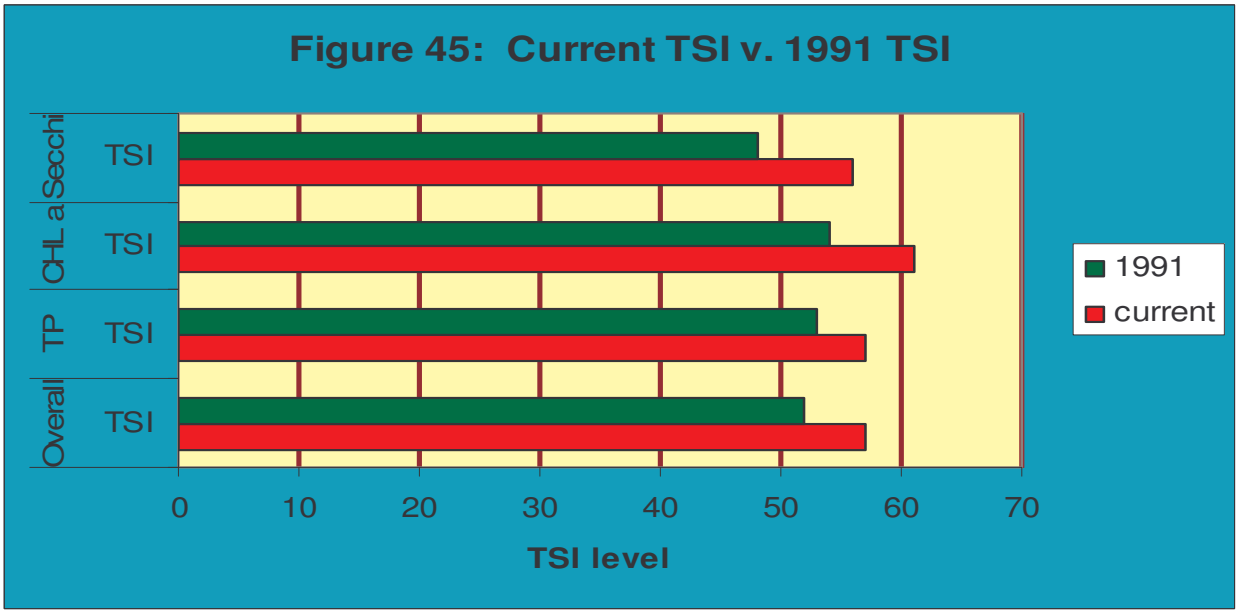
Figure 43: Sherwood Lake Trophic Status Overview

Trophic State	Quality Index	Phosphorus	Chlorophyll a	Sechhi Disk
		(ug/l)	(ug/l)	(ft)
Oligotrophic	Excellent	<1	<1	>19
	Very Good	1 to 10	1 to 5	8 to 19
Mesotrophic	Good	10 to 30	5 to 10	6 to 8
	Fair	**30 to 50**	10 to 15	5 to 6
Eutrophic	Poor	50 to 150	**15 to 30**	**3 to 4**
Sherwood Lake		**37.7**	**20.7**	**4.36**

These figures show that Sherwood Lake has poor to fair levels overall for the three parameters often used to describe water quality: Secchi disk depths; average TP for the growing season; and chlorophyll a levels. It is normal for all of these values to fluctuate during a growing season. However, they can be affected by human use of the lake, by summer temperature variations, by algae growth & turbidity, and by rain or wind events. Sherwood Lake is above the county impoundments average for overall TSI levels—which is negative, since with TSI levels, the lower the better.



During the 1991 study, water chemistry samples were taken and TSI levels were calculated. Figure 45, which compares the current TSI levels to those from 1991, shows that all the parameters for TSI calculations have increased, indicating that the lake nutrient levels have risen substantially.



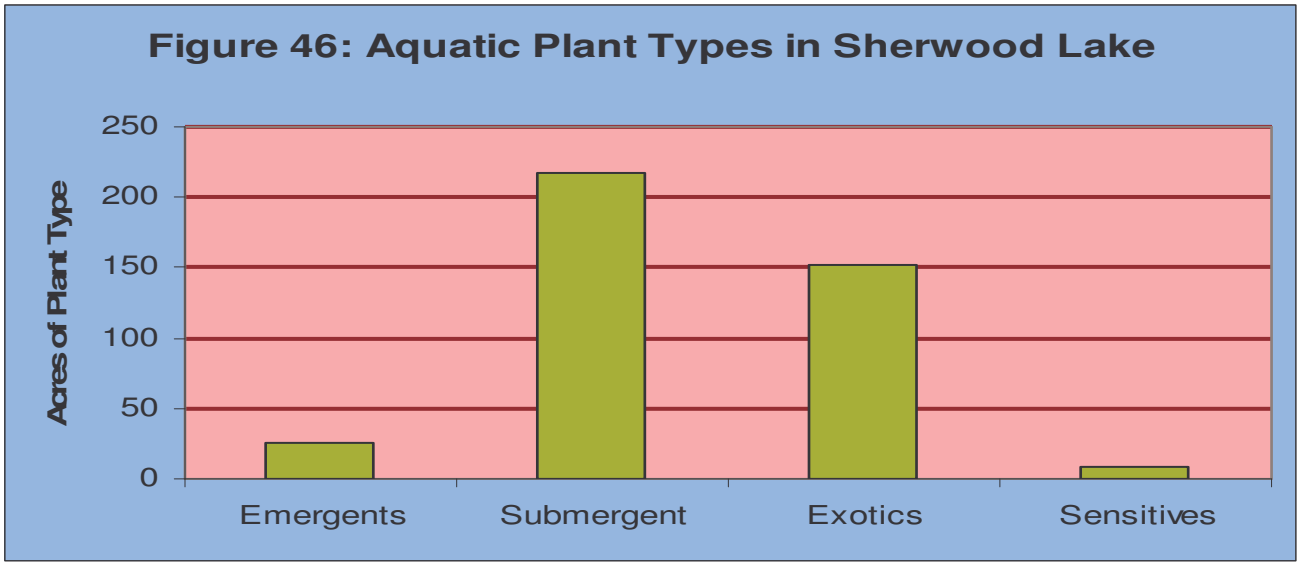
IN-LAKE HABITAT

Aquatic Plants

A healthy aquatic plant community plays a vital role within the lake community. This is due to the role plants play in improving water quality, providing valuable habitat resources for fish and wildlife, resisting invasions of non-native species and checking excessive growth of the most tolerant species.

An aquatic plant survey was performed in 2006 by staff from the Adams County Land & Water Conservation Department and a Tri-Lakes property owner. The aquatic plant community in Sherwood Lake is characterized by below average quality for Wisconsin lakes, poor species diversity and impacted by high levels of disturbance. Sherwood Lake is within the 25% of lakes in the state most tolerant of disturbance and furthest from an undisturbed condition. Disturbances include invasions of exotic species, boat traffic, shoreline development, harvesting and past herbicide treatments.

Of the 29 species found in Sherwood Lake, 25 were native and 4 were exotic invasives. In the native plant category, 14 were emergent, 1 was a free-floating plant, and 10 were submergent species. Four exotic invasives, *Myriophyllum spicatum* (Eurasian Watermilfoil), *Nasturtium microphyllum* (watercress), *Phalaris arundinacea* (Reed Canarygrass), and *Potamogeton crispus* (Curly-Leaf Pondweed) were found. Filamentous algae were found at 22.76% of the sample sites in 2006 and at 38.33% of the sites in 2000.



Of the plants on this list, several are species likely to increase in frequency and/or density in the case of regular drawdowns: *Lemna minor* (free-floating); *Najas flexilis* (submergent); *Potamogeton crispus* (submergent exotic); *Potamogeton pectinatus* (submergent); *Scirpus validus* (emergent) and *Potamogeton zosteriformis* (submergent). Some also tend to decrease with regular drawdowns: *Chara* spp (submergent); *Myriophyllum sibiricum* (submergent); *Myriophyllum spicatum* (submergent exotic); and *Vallisneria americana* (submergent). In general, regular drawdowns will tend to encourage the increase of plants that can survive frequent disturbances and will also tend to reduce the diversity of the aquatic plant community.

Figure 47. Sherwood Lake Aquatic Plant Species, 2006

Scientific Name	Common Name	Type	Found in 2000
Calamagrostis canadensis	Blue-Joint Grass	Emergent	
Carex crawfordii	Crawford's Sedge	Emergent	
Carex comosa	Longhair Sedge	Emergent	
Ceratophyllum demersum	Coontail	Submergent	x
Chara spp	Muskgrass	Submergent	x
Eupatorium purpureum	Sweetscented Joe Pye Weed	Emergent	
Hypericum canadense	Large St. John's Wort	Emergent	
Iris versicolor	Blue-Flag Iris	Emergent	
Juncus spp	Rush	Emergent	x
Lathyris palustris	Marsh Pea	Emergent	
Lemna minor	Small Duckweed	Free-Floating	x
Myriophyllum sibiricum	Northern Milfoil	Submergent	x
Myriophyllum spicatum	Eurasian Watermilfoil	Submergent	x
Najas flexilis	Bushy Pondweed	Submergent	x
Nasturtium microphyllum	Watercress	Floating-Leaf	
Phalaris arundinacea	Reed Canarygrass	Emergent	
Potamogeton crispus	Curly-Leaf Pondweed	Submergent	x
Potamogeton illinoensis	Illinois Pondweed	Submergent	
Potamogeton pectinatus	Sago Pondweed	Submergent	x
Potamogeton pusillus	Small Pondweed	Submergent	x
Potamogeton zosteriformis	Flat-Stem Pondweed	Submergent	x
Renaunculus recurvatus	Hooked Buttercup	Emergent	
Sagittaria spp	Arrowhead	Emergent	x
Salix spp	Willow	Emergent	
Scirpus validus	Soft-Stem Bulrush	Emergent	
Thelypteris palustris	Marsh Fern	Emergent	
Typha latifolia	Wide-Leaf Cattail	Emergent	x
Vallisneria americana	Water Celery	Submergent	x
Zosterella dubia	Water Stargrass	Submergent	x

Comparing the species found in 2006 to those reported in 2000, some changes are evident. Several plants found in 2006 were not found in 2000, especially emergents: *Carex crawfordii* (emergent); *Carex comosa* (emergent); *Eupatorium purpureum* (emergent); *Hypericum canadense* (emergent); *Iris versicolor* (emergent); *Lathyris palustris* (emergent); *Potamogeton illinoensis* (submergent); *Rancunculus recurvatus* (emergent); *Salix* spp (emergent); and *Scirpus validus* (emergent).

Potamogeton pectinatus, an aquatic plant favored by drawdowns, was the most frequently-occurring plant in Sherwood Lake in 2006. In 2000, the most frequent species was *Chara* spp. No species but *Potamogeton pectinatus* reached a frequency of 50% or greater in the lake overall in 2006, although *Chara spp* and *Potamogeton crispus* were not far under 50%, with occurrence frequencies of 45.53% and 42.28% respectively. In 2000, no aquatic species reached an overall occurrence frequency of over 50%.

Potamogeton pectinatus was also the densest plant in 2006 in Sherwood Lake. In the lake overall, none of the aquatic plant species had a mean density of over 2.0, meaning none occurred at more than average, in 2006. In 2006, the only species occurring at more than average density in any of the depth zones was *Potamgeton pectinatus* in the second (1.5 feet-5 feet) and third (5 feet-10 feet) depth zones. Densest in Depth Zone 1 (0 to 1.5 feet) was *Chara spp*; densest in the other three zones was *Potamogeton pectinatus.* No species occurred at more than average density in the lake overall in 2000, either. The only depth zone with more than average density of growth was Depth Zone 3, where *Chara spp* grew at more than average density.

However, when looking at the "mean density where present", three plants in addition to *Potamogeton pectinatus* had a more than average "density where present" in 2006: *Chara spp; Eupatorium purpureum;* and *Potamogeton crispus.* This is lower than the seven species beside *Chara* spp that had more than average "density where present" in 2000: *Elodea canadensis; Juncus spp; Myriophyllum sibiricum; Nitella spp; Potamogeton foliosus; Potamogeton pusillus* and *Vallisnera americana.* These figures indicate some species in the lake have higher than average density that can interfere with fish habitat and recreational use.

Relative frequency and relative density are combined into a dominance value that demonstrates how dominant a species is within its aquatic plant community. Based on dominance value, *Chara* spp was the dominant aquatic "plant" species in Sherwood Lake in 2000. Sub-dominant was *Elodea canadensis.* However, in 2006, *Potamogeton pectinatus* dominated the aquatic plant community, with *Potamogeton crispus* and *Chara* spp next most dominant. The exotics found Sherwood Lake, were not present

in high frequency, high density or high dominance in either year although *Myriophyllum spicatum* had a greater frequency in 2000.

In 2006, *Potamogeton pectinatus* was dominant in Depth Zones 1 and 2, with *Chara* spp subdominant in each. *Potamogeton pectinatus* also dominated in Depth Zone 3, with *Potamgeton crispus* and *Cerataphyllum demersum* subdominant. *Potamgeton pectinatus* dominated Depth Zone 4 in 2006. In 2000, *Chara* spp dominated all four depth zones

Aquatic plants occurred at 84.6% of the sample sites in Sherwood Lake to a maximum rooting depth of 14 feet. This increased coverage from the 79.2% figure of 2000, when the maximum rooting depth was 12 feet. Filamentous algae were found in the three shallowest zones in both 2006 and 2000.

In 2006, the 1.5 feet-5 feet depth zone (Zone 2) produced the highest total occurrence of plant growth, followed closely by Depth Zone 3. There was then a slight drop in occurrence to Zone 1, then a sharp drop to Zone 4. The pattern was slightly different in 2000: Depth Zone 3 had the highest total occurrence, then a drop in frequency in Depth Zone 2. Depth Zone 1 was lower than Depth Zone 2, with Zone 4 having the lowest total occurrence of all. For plant density in 2006, Depth Zone 2 had the greatest total density, with Depth Zone 3 having slightly less. A sharp drop in density characterized Depth Zone 1 and even lower to Depth Zone 4. In 2000, the same pattern was followed.

Species richness increased slightly between 2000 and 2006, with the biggest increase in richness found in Depth Zone 1 (0-1.5 feet).

	2006	2000
Zone 1	5.38	2.35
Zone 2	2.94	2.58
Zone 3	2.8	3.56
Zone 4	1.95	1.69
Overall	2.98	2.93

Figure 48: Aquatic Plant Species Richness Table

The Simpson's Diversity Index for Sherwood Lake in 2006 was .84, indicating poor species diversity. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable). This places it in the lowest quartile for Simpson's Diversity Index readings for both North Central Hardwood Forest and all Wisconsin lakes. This is lower than the Simpson's Diversity Index for 2000, which was .89. The 2006 AMCI for Sherwood Lake is 49, placing its quality below the

average for North Central Wisconsin Lakes and all Wisconsin Lakes. The AMCI value for 2000, 47, is also below average range for quality of aquatic plant community.

Figure 49: Aquatic Macrophyte Community Index-2006 & 2000

AMCI	2006	2006	2000	2000
Category	Result	Value	Result	Value
Max. Rooting Depth	14'	8	12'	6
% Littoral Zone Veg.	84.6%	10	79.2%	10
% Submersed Species	88%	9	95%	6
% Exotic Species	24%	3	8%	4
% Sensitive Species	4%	4	6%	5
Taxa #	23	9	16	8
Simpson's Index	0.84	6	0.89	8
		49		47

Using the AMCI index, some change has occurred in Sherwood Lake between 2000 and 2006, not necessarily for the better.

The presence of four invasive, exotic species could be a significant factor in the future. In 2006, *Potemogeton crispus* had the highest occurrence of any of the exotics found in Sherwood Lake, but *Myriophyllum spicatum* had an occurrence frequency of over 13% in 2006, despite the long history of both chemical and mechanical control efforts and despite this plant survey being done early in the summer, before some *Myriophyllum. spicatum* has reached its maximum growth. These plants must continue to be monitored, since their tenacity and ability to spread to large areas fairly quickly could make them a danger to the already low diversity of Sherwood Lake's current aquatic plant community.

The Average Coefficient of Conservatism and Floristic Quality Index calculation were performed on the field results. Technically, the Average Coefficient of Conservatism measures the community's sensitivity to disturbance, while the Floristic Quality Index measures the community's closeness to an undisturbed condition. Indirectly, they measure past and/or current disturbance to the particular community.

Previously, a value was assigned to all plants known in Wisconsin to categorize their probability of occurring in an undisturbed habitat. This value is called the plant's Coefficient of Conservatism. A score of 0 indicates a native or alien opportunistic invasive plant. Plants with a value of 1 to 3 are widespread native plants. Values of 4 to 6 describe native plants found most commonly in early successional ecosystem. Plants scoring 6 to 8 are native plants found in stable climax conditions. Finally,

plants with a value of 9 or 10 are native plants found in areas of high quality and are often endangered or threatened. In other words, the lower the numerical value a plant has, the more likely it is to be found in disturbed areas.

The Average Coefficient of Conservatism in Sherwood Lake in 2006 was 4.6, up slightly from 4.00 in 2000. This puts this lake in the lowest quartile for Wisconsin Lakes (average 6.0) and for lakes in the North Central Hardwood Region (average 5.6). The aquatic plant community in Sherwood Lake is in the category of those very tolerant of disturbance, probably due to selection by a series of past disturbances and heavy shoreline development.

The Floristic Quality Index of the aquatic plant community in Sherwood Lake of 16.85 in 2006 is in the lowest quartile for Wisconsin Lakes and the North Central Hardwood Region. This suggests that the plant community in Sherwood Lake is within the group of lakes farthest from an undisturbed condition in Wisconsin overall and in the North Central Hardwood Region. The 2000 figure of 16.97 was also in the lowest quartile. The Floristic Quality Index has decreased slightly between 2000 and 2006, suggesting more disturbance progress to the lake. Using either the Average Coefficient of Conservatism or the Floristic Quality Index scales, the aquatic plant community in Sherwood Lake apparently has been impacted by a high amount of disturbance.

"Disturbance" is a term that covers many disruptions to a natural community. It includes physical disturbances to plant beds such as boat traffic, plant harvesting, chemical treatments, dock and other structure placements, shoreline development and fluctuating water levels. Indirect disturbances like sedimentation, erosion, increased algal growth, and other water quality impacts will also negatively affect an aquatic plant community. Biological disturbances such as the introduction of non-native and/or invasive species (such as the Eurasian Watermilfoil, Reed Canarygrass and Curly-Leaf Pondweed found here), destruction of plant beds, or changes in aquatic wildlife can also negatively impact an aquatic plant community. Shore development and sediment deposition can also reduce the quality of the aquatic plant community.

Out of the 36 transects sampled on Sherwood Lake, only one site was entirely naturally vegetated. Therefore, no statistical evaluation comparing the aquatic macrophyte communities at disturbed vs. natural shores was appropriate.

Based on water clarity, chlorophyll and phosphorus data, Sherwood Lake is a eutrophic/mesotrophic impoundment with poor water clarity and fair to poor water quality. This trophic state should support substantial plant growth and several algal blooms.

Sufficient nutrients (trophic state), shallow lake, and nutrient input from heavy shore development on Sherwood Lake favor plant growth. Despite the sometime limiting effect of poor water clarity and sand sediments on aquatic plant growth, over 84% of the lake is vegetated, suggesting that even the heavily-sandy sediments in Sherwood Lake hold sufficient nutrients to maintain aquatic plant growth.

The very few shore areas of natural vegetation and wetlands on the lake should be preserved as they are to maintain habitat and to serve as a buffer for that area. Studies have suggested that runoff from naturally-buffered land is substantially less than that of developed areas. There are also some areas of deep erosion on steep banks that need to be addressed to prevent tree fall (and related root ball removal from bank) and bank preservation. Shoreline restoration of native vegetation is badly needed on Sherwood Lake and has actually decreased since 2000.

Some type of native vegetated shoreline covered only 21.46% of the lake shoreline in 2006, down from 30% in 2000. Disturbed shorelines—including bare sand, traditional cultivated lawn, hard structure (piers, decks, seawalls, etc.) and rock riprap--were the most frequently-occurring shore, covering 78.54% of the shore of Sherwood Lake in 2006, up from 70% of the shore in 2000.

Looking at the results from the 2000 survey and those from 2006 shows some changes in the aquatic plant community. There were more species found in 2006, and the structure of the aquatic plant community has changed with more emergent species present, but only one free-floating plant. No floating-leaf plants, which provide habitat and cover for fish and invertebrates, were found in either year. Further, when calculating the coefficient of similarity between the 2000 and 2006 surveys, they score as statistically dissimilar both in terms of frequency of occurrence and relative frequency. Based on frequency of occurrence, the aquatic plant communities of the two years are just over 45% similar. Using relative frequency, the score is only 53% similar. Similarity percentages of 75% or more are considered statistically similar. Obviously, the figures for Sherwood Lake are far below that figure.

It is worth noting that the report on the 2000 aquatic plant surveys mentioned the low level of emergent plants in Sherwood Lake. The 2006 survey shows that emergent plants were still scarce in Sherwood Lake, but there were more increased coverage from emergent plants in 2006.

Figure 50: Changes in the Aquatic Plant Community 2000 to 2006

	Changes in the Macrophyte Community			
Sherwood Lake	2000	2006	Change	%Change
Number of Species	18	25	7	38.89%
Maximum Rooting Depth	12.0	14.0	2	16.67%
% of Littoral Zone Unvegetated	20.80%	15.40%	-0.054	-25.96%
%Emergents	5.26%	12.50%	0.1	137.64%
%Free-floating	2.11%	0.00%	0.0	-100.00%
%Submergents	100.00%	100.00%	0.0	0.00%
%Floating-leaf	0.00%	0.00%	0.0	0.00%
Simpson's Diversity Index	0.89	0.84	-0.05	-5.51%
Species Richness	3.72	2.94	-0.78	-20.97%
Floristic Quality Index	16.97	16.85	-0.12	-0.71%
Average Coefficient of Conservatism	4	4.6	0.60	15.00%
AMCI Index	47	49	2.00	4.26%

The following aquatic species decreased between 2000 and 2006: *Ceratophyllum demersum, Chara* spp., *Myriophyllum spicatum, Najas flexilis, Potamogeton pusillus, Zosterella dubia, Sagittaria* spp, *Eleocharis acicularis, Nitella* spp., *Potamogeton foliosus,* and *Spirodela polyrhiza.* Species that increased included: *Myriophyllum spicatum* (an exotic invasive); *Potamogeton crispus* (an exotic invasive); *Potamogeton pectinatus, Potamogeton zosteriformis;* and *Vallisneria americana.* New species found in 2006 were mostly emergents, although two new invasives were also found: *Phalaris arundinacea* and *Nasturtium microphyllum.*

Figure 51a: Distribution of Emergent Plants in Sherwood Lake

Figure 51b: Distribution of Submergent Plants in Sherwood Lake

There was a long history of chemical use for treating aquatic plant growth and algae in Sherwood Lake, 1970-2000. Some chemical products that are now banned because of their toxicity were used. Broad-spectrum chemicals were also used. Two chemicals that do not biodegrade, but build up in the sediment, resulting in toxic sediment were used. .

Figure 52: Chemical Aquatic Plant Treatments in Sherwood Lake

Year	Copper	Cutrine	Aquathol	Hydrothol	Diaquat	Rodeo	2,4-D	Silvex	AV-70
	(lbs)	(gal)	(gal)	(gal)	(gal)	(gal)	(gal)		
1970	250		10		5				
1971	305		17		14			3	
1972	293		9		20.5				
1973	620				12				
1974	1220				12		22		
1975	620		8.9		6.6		2		
1976	600		9.5		26				
1977	910		215	100	6				30
1978				550	8				8
1979	400								
1980	60			855					
1981	60			1200					
1982	450								
1983	500								
1984	200		27	1					
1985	70		56		8				
1986	900		38		6				
1987	430								
1988	605				6				
1989	50		7		5.5				
1990	400		20		22.5				
1991	200		3.5		18				
1992	250		10		8				
1993		15	9.5		10.5				
1994	360		17.5		10.5				
1995	425		13.25		5.25				
1996		32	14			14			
1997		72.5	2.5		2.5				
1999			6		6				
2000			35		35				
total	10178	119.5	528.65	2706	253.85	14	24	3	38

The problems with the herbicides that were used included the following:

1) One toxic compound used in Sherwood Lake was Silvex (2,2,4,5-TP). Silvex is now banned as a possible carcinogen.
2) The broad-spectrum chemical Diquat was used. This compound killed all plant species and inadvertently opened up areas for the introduction of exotic and invasive species. Over 253 gal of Diquat compounds were used over the 30-year span.
3) The Hydrothol formulation is toxic to young fish.
4) Cutrine and CuSO4 are copper products that were used to kill algae and reduce swimmer's itch. Since copper is an element, it does not biodegrade further, building up the sediments. The drawbacks of copper treatments are: (a) the very short effective time; (b) the toxicity of copper to aquatic insects, an important part of the food chain in a lake; (c) the build up of copper in the sediments, resulting in sediments that are toxic to mollusks that are the natural consumers of algae in a lake.

Mechanical harvesting of aquatic plants in Sherwood Lake started in 1995 and has continued through 2006. The chart below shows the pounds of aquatic plant removed through mechanical harvesting through 2006. For 2005 and 2006, plant samples were taken to a laboratory to be tested for the amount of phosphorus in milligrams per kilogram of aquatic plants. This is also shown on the chart below.

Figure 53: Mechanical Harvesting on Sherwood Lake

Year	Lbs Harvested	Phosphorus Removed (lbs)
1995	58,000	NA
1996	204,000	NA
1997	340,000	NA
1998	195,600	NA
1999	317,000	NA
2000	652,000	NA
2001	496,000	NA
2002	491,600	NA
2003	519,000	NA
2004	582,000	NA
2005	709,200	2147.81
2006	307,500	117.83
total	4,871,900	2,266

Ceratophyllum demersum
(Coontail)

Potamogeton pectinatus
(Sago Pondweed)

Figure 54: Some Common Native Aquatic Species in Sherwood Lake

Chara **spp**
(Muskgrass)

Aquatic Plant Management Recommendations

(1) Because the plant cover in the littoral zone of Sherwood Lake is at the top of the ideal (25%-85%) coverage for balanced fishery, continued harvesting to open fishing lanes could occur in some areas. Removal should occur by hand in the shallower areas to be sure that entire plants are removed and to minimize the amount of disturbance to the sediment.

(2) Natural shoreline restoration and erosion control in many areas is needed, especially on some bare steep banks. If trees fall at the eroded sites due to continued erosion, large portions of the banks will fall with them. Natural shoreline has decreased since 2000 and disturbed shoreline has increased, especially in hard structure and rock riprap.

(3) To protect water quality, a buffer area of native plants needs to be restored on those many sites that now have seawalls or have traditional lawns mowed to the water's edge. Most areas of the lake shoreline are unnatural and prone to erosion & runoff of nutrients & toxics. Unmowed native vegetation reduces runoff into the lake and filters runoff that enters the lake.

(4) The Tri-Lakes Management District and the Sherwood Lake Association should continue to cooperate with the WDNR to monitor for zebra mussel introduction to protect the aquatic plant community in Sherwood Lake.

(5) Studies indicate that properties around the lakeshore are putting nutrients into the lake, rather than most of the nutrients coming from the watershed. To improve the quality of the lake water and prevent further degradation:

   (a) Stormwater management of the many impervious surfaces around the lake is essential to improve the quality of the lake water and prevent further degradation.
   (b) No lawn chemicals should be used on properties around the lake. If they must be used, they should be used no closer than 50' to the shore. Green grass tends to equal green lake.
   (c) The few sites where there is undisturbed shore should be maintained and left undisturbed.
   (d) Sherwood Lake residents should identify, cooperate with and participate in watershed programs that will reduce nutrient and sediment inputs.

(6) The aquatic plant management plan should be reviewed annually. Mechanical harvesting plans should continue target harvesting for Eurasian Watermilfoil

(EWM) and include target harvesting for Curly-Lead Pondweed to prevent further spread.

(7) The Sherwood Lake Association may want to continue to apply for grants from the Wisconsin Department of Natural Resources to help defray the cost of aquatic plant management.

(8) No broad-scale chemical treatments of aquatic plant growth are recommended due to the undesirable side-effects of such treatments, including increased nutrients from decaying plant material and decreased dissolved oxygen and opening up more areas to the invasion of EWM.

(9) Any fallen trees should be left at the shoreline in the water for habitat.

(10) The Tri-Lakes Management District conducted limited water quality monitoring for several years, but has decreased its involvement during 2004-2006 when Adams Land & Water Conservation Department was doing more intense monitoring as part of a Lake Classification Grant. Monitoring by the Lake District or through the DNR Self-Help Monitoring Program should be restarted.

(11) No drawdowns of water level except for DNR-approved purposes should occur. Several of the plants found in Sherwood Lake in 2006 are those encouraged by drawdowns. In addition, water drawdowns are increasing the inflow of nutrient-rich groundwater into the lake.

(12) The Tri-Lakes Management District should make sure that its lake management plan takes into account all inputs from both the Sherwood Lake surface ground watershed and inputs from Camelot & Sherwood Lakes, and addresses the concerns of this larger lake community.

(13) Natural shoreline restoration should occur on disturbed sites.

(a) Unmowed native vegetation reduces shoreline erosion and run-off into the lake and filters the run-off that does enter the lake thus reducing nutrient inputs.

(b) Shoreline restoration could be a as simple as leaving a band of natural vegetation around the shore by discontinuing mowing.

(c) Restoration could be as ambitious as extensive plantings of attractive native wetland species in the water and native grasses, flowers, shrubs and trees on the near shore area.

(14) The Sherwood Property Owners Association & Tri-Lakes Management District should cooperate with programs in the watershed to reduce nutrient inputs to the lake. Currently nearly half of the relatively large watershed is in agriculture.

Aquatic Invasives

Sherwood Lake has five known invasive aquatic plant species: Curly-Leaf Pondweed (submergent); Eurasian Watermilfoil (submergent); Purple Loosestrife (emergent); Reed Canarygrass (emergent) and Watercress (floating-leaf). The lake gets a significant amount of transient boat traffic due to its location (right off a main highway) and large public boat ramp. The Tri-Lakes Management District has a lake management plan that includes management of aquatic invasives. The lake has been using targeted harvesting for Eurasian Watermilfoil, emphasizing the harvesting of that plant in May and September, while harvesting the summer months for navigation, rather than control of Eurasian Watermilfoil. In 2007, some lake citizens were trained to monitor the aquatic invasives and participate in the Clean Boats, Clean Waters boater education program.

Figure 55: Distribution of Exotic Aquatic Plants in Sherwood Lake

RE:11/06

Curly-Leaf Pondweed

Eurasian Watermilfoil

Figure 56: Invasive Aquatic Plants in Known at Sherwood Lake

Reed Canarygrass and Purple Loosestrife

Watercress

FISHERY/WILDLIFE/ENDANGERED RESOURCES

WDNR stocking and fishery inventories go back to 1968, when the lake was stocked after a chemical eradication of fish in 1967 to get rid of the rough fish population. Stocking in 1968 consisted of bluegills, largemouth bass, northern pike and walleye. A follow-up inventory in 1969 found that bluegills and pumpkinseeds were abundant; largemouth bass, northern pike, walleye and yellow perch were common; and shiners and white suckers were scarce. The most recent survey, done in 2002, found that bluegills and largemouth bass were abundant; black crappie, walleye and yellow perch were common; and northern pike was scarce. Between 1970 and 2000, thirteen other fish inventories were performed by the WDNR. In addition to those fish already mentioned, various fish surveys through the years also found brown bullheads, black bullheads, yellow bullheads, yellow suckers, golden shiners, and emerald shiners.

In 1999, the local WDNR fishery biologist reported that a recent survey of Sherwood Lake showed that the largemouth bass and northern pike populations were good and that those fish were healthy. However, although the panfish numbers were sufficient, he found them to be small and thin. He expressed concern about loss of invertebrate habitat that the fish fed on, about the chemicals killing zooplankton, and about the effects of the winter drawdown on the aquatic plant community.

Muskrat are also known to use Tri-Lakes shores for cover, reproduction and feeding. Seen during the field survey were various types of waterfowl and songbirds. Frogs and salamanders are known, using the lake shores for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nested and fed in this area. Upland wildlife feed and nest here as well.

There are several endangered resources in the Sherwood Lake surface watershed. Natural communities reported here include northern sedge meadow, northern wet forest, pine barrens and shrub-carr. Endangered plants known in the area include *Polygala cruciata* (crossleaf milkwort), *Juncus marginata* (grassleaf rush), and *Bartonicia virginica* (yellow screwstem).

Figure 57: Photos of some of the species of concern in Sherwood Lake Watersheds*

YELLOW SCREWSTEM

CROSSLEAF MILKWORT

*information courtesy of Wisconsin Department of Natural Resources

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Figure 58: Photo of Watercress on Sherwood Lake in Summer 2006