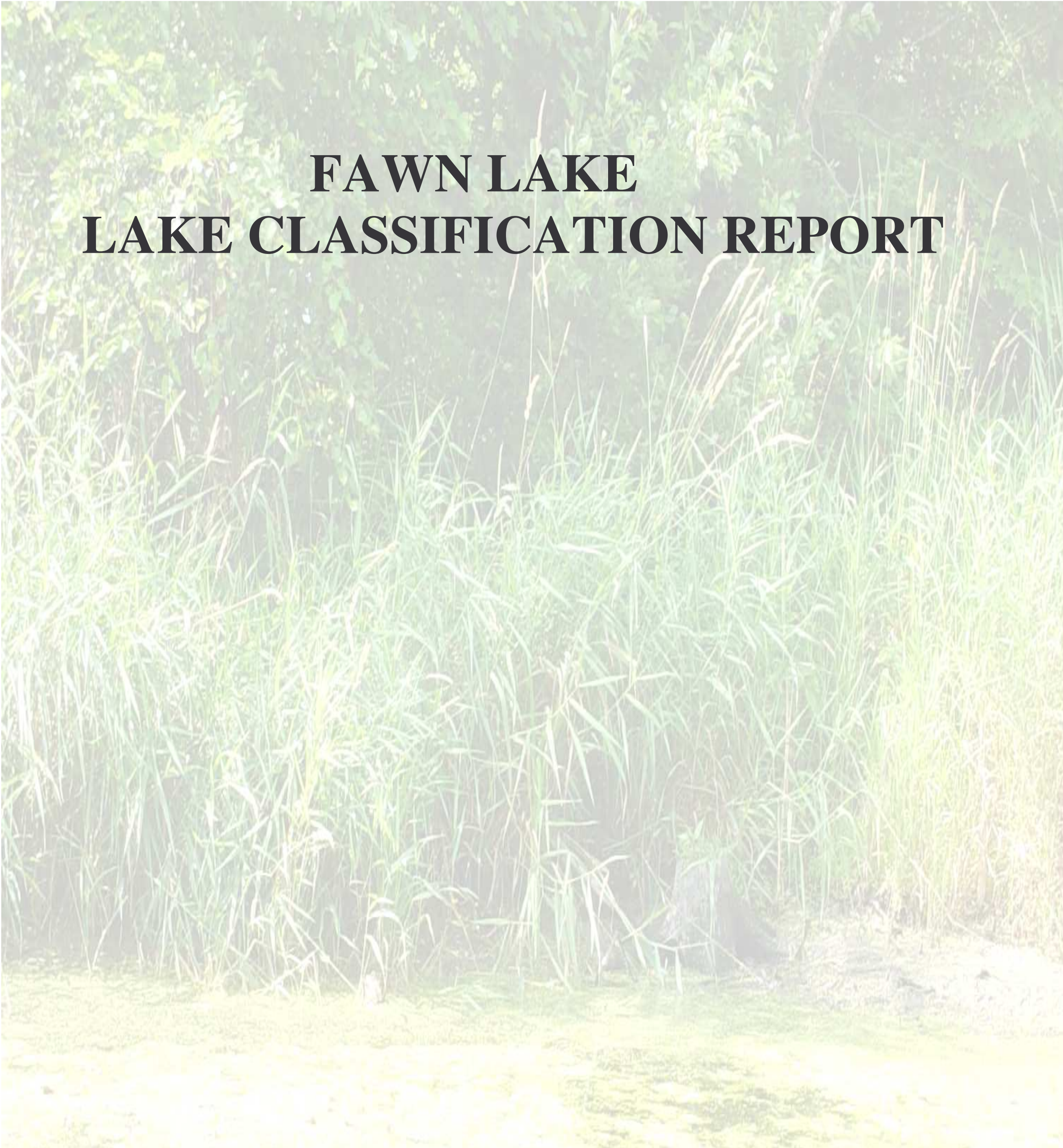
FAWN LAKE
LAKE CLASSIFICATION REPORT



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EXECUTIVE SUMMARY

Background Information about Fawn Lake

Fawn Lake is located in Adams County in south central Wisconsin and is a 17.65-acre impoundment (man-made) lake located in the Dell Prairie, Adams County, in the Central Sand Plains of Wisconsin. This lake is formed by an impoundment of Trout Creek, which eventually empties into the Wisconsin River. Fawn Lake has a public boat ramp and fishing dock. The dam is owned and operated by Adams County. No archeological or historical sites have been reported in either the surface or ground watersheds of Fawn Lake.

Except for some small pockets of silt loam and loamy sand, the soils in the surface and ground watersheds for Fawn Lake are sand, with slopes from very flat up to 20% (see Figure 3). Sandy soils occupy 89% of the ground watershed and 90.6% of the surface watershed. These soils tend to be well or excessively drained, whatever the slope. Water, air and nutrients move through these soils at a rapid rate, so that little runoff occurs unless the soil becomes saturated. Wind erosion, water erosion and draught are common hazards of these soil types.

Land Use in Fawn Lake Watersheds

Both the surface and ground watersheds of Fawn Lake are very small. The two largest land uses in the surface watershed are Woodlands (45.91%) and Residential (35.31%). In the ground watershed, Woodlands dominate (82.99%).

Fawn Lake has a total shoreline of 2.08 miles (10976 feet). In 2004, a visual inventory of the lakeshore was done by Adams County Land & Water Conservation Department. One of the purposes of the inventory was to determine shoreline status around the lake Most of Fawn Lake's shore is cattail marsh (a type of wetland). 90.53% of Fawn Lake's shoreline is vegetated; only 9.47% was armored or other shore cover. Most of the shore is in residential development, except for two areas. There is WDNR-owned land on the northwest side of the lake. The dam/boat ramp area on the east and northeast side of the lake are owned by the county. The dam area is protected by rock riprap. Some emergent vegetation (mostly cattails) has grown in front of the rocks. No active erosion at the shore was noted in the 2004 survey. Most of the houses are set more than 70' back from the shore, even in those places where there is mowed lawn. Most of the shore is fairly flat.

The 2004 inventory included classifying areas of the Fawn Lake shorelines as having "adequate" or "inadequate" buffers. 68.26% (about 7492 feet) of Fawn Lake's shoreline had an "adequate buffer", leaving 31.74% (3484 feet) as "inadequate." Most of the "inadequate" buffer areas were found with mowed lawns and/or insufficient native vegetation at the shoreline to cover 35 feet landward from the water line. Adequate buffers on Fawn Lake could be easily installed on most of the lake by either letting the first 35 feet landward from the water grow without mowing it, except for a path to the water, or by planting native seedlings sufficient to fill in the first 35 feet.

Water Testing Results

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information on Fawn Lake. Overall, Fawn Lake was determined to be a mildly eutrophic lake with fair to good water quality and fair 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 Fawn Lake was 31.9 micrograms/liter. This average is over the 30 micrograms/liter recommended to avoid algal blooms. This concentration suggests that Fawn Lake is likely to have nuisance algal blooms.

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 Fawn Lake in 2004-2006 was 5.05 feet. This is fair 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 summer (June-September) average chlorophyll-a concentration in Fawn Lake was 16.4 micrograms/liter, a fairly low algal level for an impoundment.

Fawn Lake water testing results showed "hard" water average of 101.33 mg/l $CaCO_3$). 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 Fawn 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 Fawn Lake, since its alkalinity in the surface water averages 96.8 milliequivalents/liter. The pH levels from the bottom of the lake to the surface hovered between 6.82 and 7.82, alkaline enough to buffer any acid rain.

Most of the other water quality testing at Fawn Lake showed no areas of concern. The average calcium level in Fawn Lake's water during the testing period was 17.18 mg/l. The average Magnesium level was 11.54 mg/l. Both of these are low-level readings. Both sodium and potassium levels in Fawn Lake are low: the average sodium level 8.65 mg/l; the average potassium reading was 0.7 mg/l. To prevent the formation of H2S, levels of 10 mg/l are best. A health advisory kicks in at 30 mg/l. Sulfalte level for Fawn Lake was 10.17 mg/l. 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. Very turbid waters may not only smell and mask bacteria & other pollutants, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. Turbidity levels for Fawn Lake's waters were at low levels between 2004-2006.

The presence of a significant amount of chloride over a period of time may indicate that there are 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. Chloride levels found in Fawn Lake during the testing period were 2 mg/l, below the natural level of 3 mg/l in this area of Wisconsin. This is not a level of concern.

Nitrogen levels can affect other aspects of water quality. The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 mg/l in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). Fawn Lake combination spring levels from 2004 to 2006 were .23 mg/l, under the limit that might produce a nitrogen-related algal bloom. This is good, because a raised level in this area could increase the growth level of Eurasian watermilfoil, an invasive plant that has occurred in Fawn Lake.

Also, in some instances, sulfate can combine with hydrogen to become the gas hydrogen sulfalte (H2S), which smells like rotten eggs and is toxic to most aquatic organisms. To avoid such formation, levels of sulfate lower than 10 mg/l are best. Fawn Lake sulfate levels averaged 10.17 mg/l during the testing period, just above the recommended 10 mg/l level, but still lower than the health advisory level of 30 mg/l.

Phosphorus

Like most lakes in Wisconsin, Fawn Lake is a phosphorus-limited lake. Of the pollutants that end up in a 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 Fawn Lake, a total phosphorus concentration below 30 micrograms/liter tends to result in few nuisance algal blooms. Fawn Lake's growing season (June-September) surface average total phosphorus level of 31.9 micrograms/liter is over that limit.

Land use plays a major role in phosphorus loading. The land uses around Fawn Lake that contribute the most phosphorus are non-irrigated agriculture and woodlands. 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.

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 by 25% would save 6 to 16 micrograms/liter. Such reductions of phosphorus inputs could put the lake low enough in total phosphorus levels that algal blooms would be greatly reduced. These predictions make it clear that reducing current phosphorus inputs to the lake are essential to improve, maintain and protect Fawn Lake's health for future generations.

Aquatic Plant Community

An aquatic plant survey was done on Fawn Lake in 2006 by staff of the Adams County Land & Water Conservation Department. 92% of Fawn Lake's bottom is vegetated, suggesting that even the sand sediments in the lake have sufficient nutrients to sustain aquatic plant growth. Due to the shallow depth, sunlight also encourages plant growth at nearly all depths in the lake.

Of the 24 aquatic species found, ten were emergent, two were rooted floating leaf, three were free-floating and nine species were submergent. The aquatic plant community does contain a variety of plant structure: emergent plants, rooted plants, free-floating plants and rooted plants with floating leaves. However, the community is characterized by plants that tolerate a high amount of disturbance and abundant filamentous algae. The 0 to 1.5 foot depth zone was the highest in frequency of growth. Submergent and free-floating species were especially abundant.

The presence of the three invasives *Myriophyllum spicatum* (Eurasian Watermilfoil), *Potomegeton* crispus (Curly-Leaf Pondweed) and *Phalaris arundinacea* (Reed Canarygrass) are significant factors. Currently, their density and relative frequency don't establish them as dominant among Fawn Lake's aquatic plant community, but their tenacity and ability to spread to large areas fairly quickly make it a danger to the already poor diversity of Fawn Lake's aquatic plant community. The Fawn Lake District has chemically treated the lake for Eurasian Watermilfoil. In 2006, some of the areas formerly occupied by Eurasian Watermilfoil were occupied instead by *Elodea canadensis*, a native aquatic plant species.

Using several scientific indices, Fawn Lake has spoor aquatic plant species diversity. The indices established that Fawn Lake is in the lowest quartile for Central Wisconsin Hardwood Lakes and Impoundments, with an aquatic plant community of below average quality and highly tolerant of disturbance.

<u>Critical Habitat Area</u>

Wisconsin Rule 107.05(3)(i)(I) defines a "critical habitat areas" as: "areas of aquatic vegetation identified by the department as offering critical or unique fish & wildlife habitat or offering water quality or erosion control benefits to the body of water. Thus, these sites are essential to support the wildlife and fish communities. They also provide mechanisms for protecting water quality within the lake, often containing high-quality plant beds. Finally, critical habitat areas often can provide the peace, serenity and beauty that draw many people to lakes. One area on Fawn Lake was determined by a team of lake professionals to be appropriate for critical habitat designation.

This area, FL1 extends along approximately 500 feet of the shoreline and has an average water depth of 3 feet. Maximum rooting depth of aquatic vegetation in FL1 was 6 feet. Sediment includes marl, muck, peat, sand, silt and mixtures thereof. 75% of the shore is native herbaceous cover and 25% is wooded. Some woody cover is available for habitat. Human disturbance impact on this area is currently limited. Aquatic vegetation found at FL1 includes emergent plants such as bulrush, cattails, rushes and sedges. Emergents provide important fish habitat and spawning areas, as well as food and cover for wildlife. One floating-leaf rooted plant was also found in FL1. Floating-leaf vegetation provides cover and dampens waves, protecting the shore. Seven species of submergent aquatic plants were also found here, including two invasives. Most of these plants are used by a variety of fish and wildlife. Filamentous algae were found at this site as well.

Fish/Wildlife/Endangered Resources

Historic fishery inventory indicate that bluegill are abundant, with largemouth bass and pumpkinseed common, in Fawn Lake. Also present are yellow perch, yellow bullhead and black crappie.

Muskrat are also known to use Fawn Lake shores for cover, reproduction and feeding. Seen during the field survey were various types of waterfowl, songbirds, and turkey. 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. In 2006, a pair of Egyptian geese made a summer home at Fawn Lake. Endangered resources known in the Fawn Lake watersheds are Blanding's turtle and the western slender glass lizard.

Conclusion

Fawn Lake is currently a small impoundment impacted substantially by its surface and ground watersheds. The Fawn Lake District has an approved lake management plan which is reviewed annually for needed changes in best management of the lake. It is hoped that the recommendations on the following pages and the information in this report will help in these aims.

RECOMMENDATIONS

Lake Management Plan

The Fawn Lake District should continue to operate under its approved Lake Management Plan and make sure that it at least annually reviews the plan for any needed changes. Some issues to be considered in the next review might be the decreasing depth of some parts of the lake, protection of the critical habitat, buffer restoration of areas that are currently inadequate, management of the invasives, and involvement of the lake residents in a Citizen Monitoring Program that includes Clean Boats, Clean Waters boater education program.

Watershed Recommendations

Although both Fawn Lake's watersheds are small, computer modeling suggests that non-irrigated agriculture may be contributing substantially to phosphorus loading in the lake. Inputs of nutrients, especially phosphorus, are factors that need to be explored for Fawn Lake. Therefore, 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, steps for dealing with these issues can be incorporated into the lake management plan.

Shoreland Recommendations

All lake residents should practice best management on their lake properties, including keeping septic systems cleaned and in proper condition, eliminating the use of lawn fertilizers, cleaning up pet wastes and not composting near the water.

Aquatic Plant/Invasive Species Recommendations

1) Residents should continue involvement in the Citizen Lake Water Monitoring, Invasive Species Monitoring and Clean Boats, Clean Waters Programs. This will allow not only noting changes in the current three known invasives, but will also help discover any other invasions. Noting the presence and density of such species is the best way to take action to keep them from becoming bigger problems.

2) Lake residents should protect and restore natural shoreline around Fawn Lake. Studies have shown that there is lower frequency and density of the most sensitive plant species in disturbed shoreline areas. Disturbed shoreline sites support an aquatic plant community that is generally less able to resist invasions of exotic species and show impacts from nutrient enrichment.

3) All lake users should protect the aquatic plant community in Fawn Lake.

4) The Fawn Lake Association should maintain exotic species signs at the boat landings and contact DNR if the signs are missing or damaged.

5) The Fawn Lake Association should continue monitoring and control of Eurasian Watermilfoil and Curly-Leaf Pondweed, using the most effective methods, with modification if necessary. For Eurasian Watermilfoil, another early-season chemical spot treatment might be necessary. Residents should also be encouraged to hand-pull any scattered EWM plants. Curly-Leaf Pondweed, if treat chemically, also requires an early season treatment.

6) The lake management plan should include a multi-pronged approach for the management and control of aquatic invasives.

Critical Habitat Recommendations

There are also several recommendations appropriate for the critical habitat areas:

(1) Maintain current habitat for fish and wildlife.
(2) Do not remove any fallen trees along the shoreline.
(3) No alteration of littoral zone unless to improve spawning habitat.
(4) Seasonal protection of spawning habitat.
(5) Maintain any snag/cavity trees for nesting.
(6) Install nest boxes.
(7) Maintain or increase wildlife corridor.
(8) Maintain no-wake lake designation.
(9) Protect emergent vegetation.
(10) Seasonal control of Eurasian Watermilfoil, Curly-Leaf Pondweed, and any other exotics identified, using methods selective for control of exotics.
(11) Minimize aquatic plant and shore plant removal to maximum 30' wide viewing/access corridor and navigation purposes. Leave as much vegetation as possible to protect water quality and habitat.
(12) Use best management practices.

(13) No use of chemical lawn products.
(14) No bank grading or grading of adjacent land.
(15) No pier placement, boat landings, development or other shoreline disturbance in the shore area of the wetland corridor.
(16) No pier construction or other activity except by permit using a case-by-case evaluation and only using light-penetrating materials.
(17) No installation of pea gravel or sand blankets.
(18) No bank restoration unless the erosion index scores moderate or high.
(19) If the erosion index does score moderate or high, bank restoration only using biologs or similar bioengineering, with no use of riprap or retaining walls.
(20) Placement of swimming rafts or other recreational floating devices only by permit.
(21) Maintain aquatic vegetation buffer in undisturbed condition for wildlife habitat, fish use and water quality protection.
(22) Post exotic species information at public boat landing.

LAKE CLASSIFICATION REPORT FOR FAWN 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 education 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 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. The lake management plans will also be incorporated into the Adams County Land and Water Conservation Management Plan.

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

FAWN LAKE BACKGROUND INFORMATION

Fawn Lake is located in the Town of Dell Prairie, Adams County, WI, in the south central part of Wisconsin. Fawn Lake is a mildly eutrophic impoundment with good water quality and fair water clarity. According to bathymetric mapping done in 2005, Fawn Lake has 17.65 surface acres, with a maximum depth of 14.1 feet and an average depth of 6 feet. Water level is controlled by a dam owned and maintained by Adams County. There is a public boat ramp on the northeast end of the lake. A public fishing dock is located near the boat ramp.

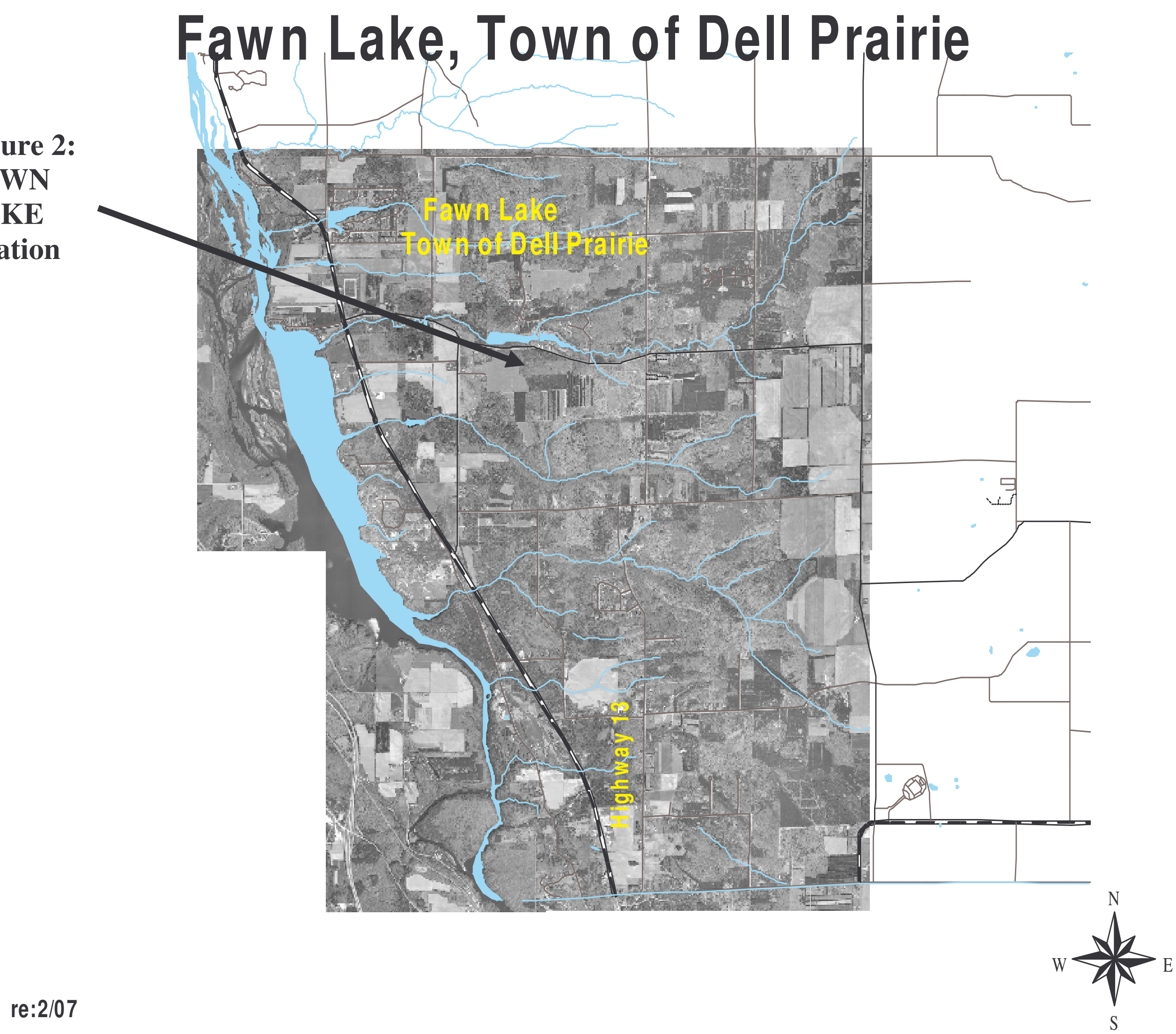


Figure 2: FAWN LAKE location

Fawn Lake is part of the Plainville sub-watershed, from which water flows eventually into the Wisconsin River. The Central Sand Plains, which contain Fawn Lake, are found in the Driftless Area of Wisconsin, in and around what was once Glacial Lake Wisconsin. The area is characterized by varying elevations, with numerous, usually flat-topped ridges & hills sometimes called "mounds." These sandstone buttes were carved by rapid drainage of the glacial lake or by wave action. Deposits made by streams from the melting ice sheet cover large areas and usually consist of sand, clay and gravel.

Bedrock and Historical Vegetation

Bedrock around Fawn 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.

Historic vegetation of the area included extensive wetlands of many types, including open bogs, shrub swamps & sedge meadows. Prairie, oak forests, savannas and barrens also occurred in the Central Sand Plains. Small pockets of mesic forest with white pine and hemlock were found in the northwest portion.

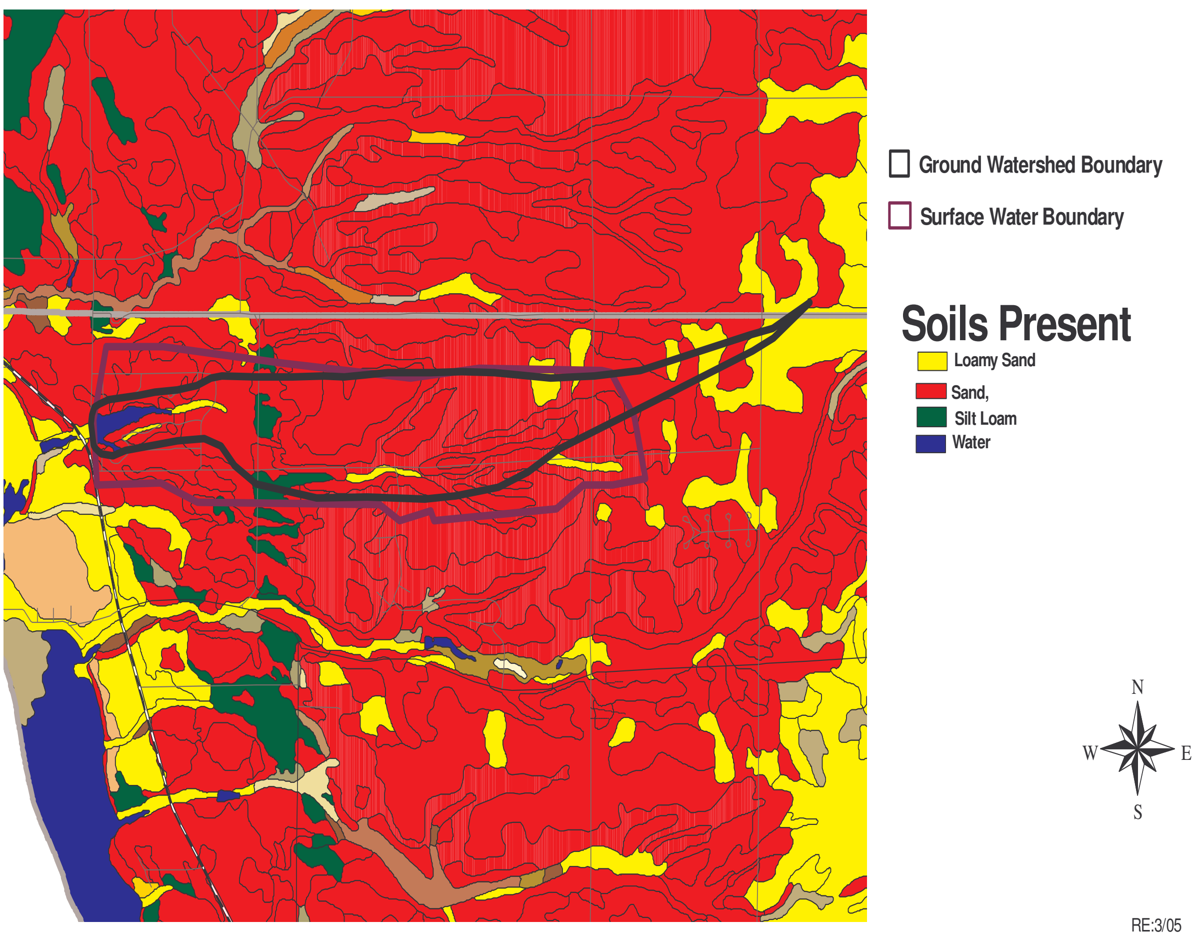
Soils in the Fawn Lake Watersheds

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.

Except for some small pockets of silt loam and loamy sand, the soils in the surface and ground watersheds for Fawn Lake are sand, with slopes from very flat up to 20% (see Figure 3). Sandy soils occupy 89% of the ground watershed and 90.6% of the surface watershed.

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.

Figure 3: Fawn Lake Watersheds Soils



CURRENT LAND USE

Both the surface and ground watersheds of Fawn Lake are very small. (See Figures 4, 5a, 5b & 6). The two largest land uses in the surface watershed are Woodlands (45.91%) and Residential (35.31%). In the ground watershed, Woodlands dominate (82.99%).

Figure 4: Fawn Lake Watersheds Land Use in Acres and Percent of Total

	Surface		Ground		Total	
Fawn Lake						
Agriculture--Non Irrigated	208.93	16.77%	17.38	13.48%	226.31	16.46%
Residential	440.05	35.31%	3.15	2.45%	443.2	32.23%
Water	25.02	2.01%	1.39	1.08%	26.41	1.92%
Woodland	572.05	45.91%	106.98	82.99%	679.03	49.39%
total	1246.05	100.00%	128.9	100.00%	1374.95	100.00%

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).

Fawn Lake Surface Watershed Land Use

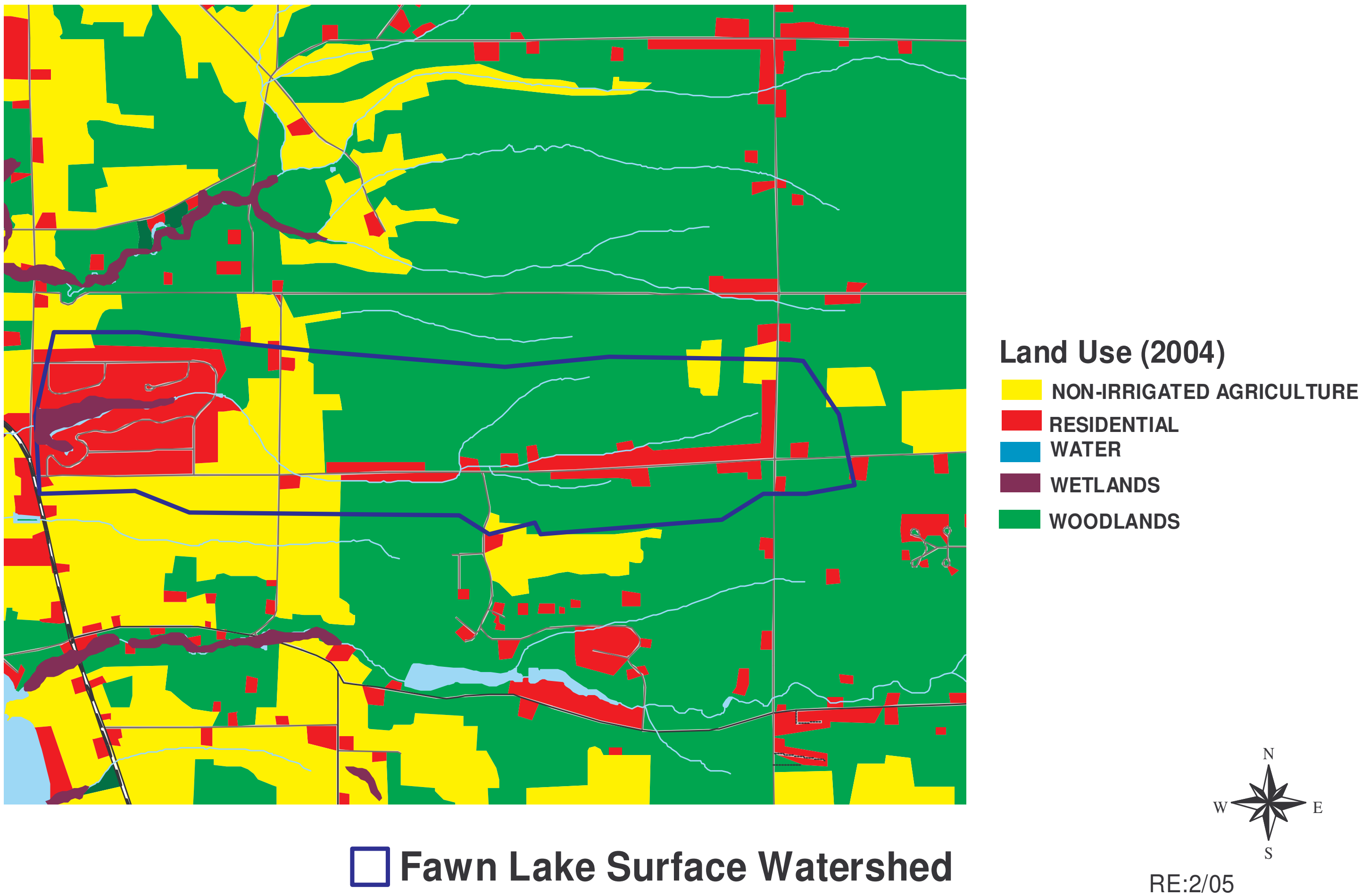


Figure 5a: Land Use in Fawn Lake Surface Watershed

Ground Watershed Land Use--Fawn Lake

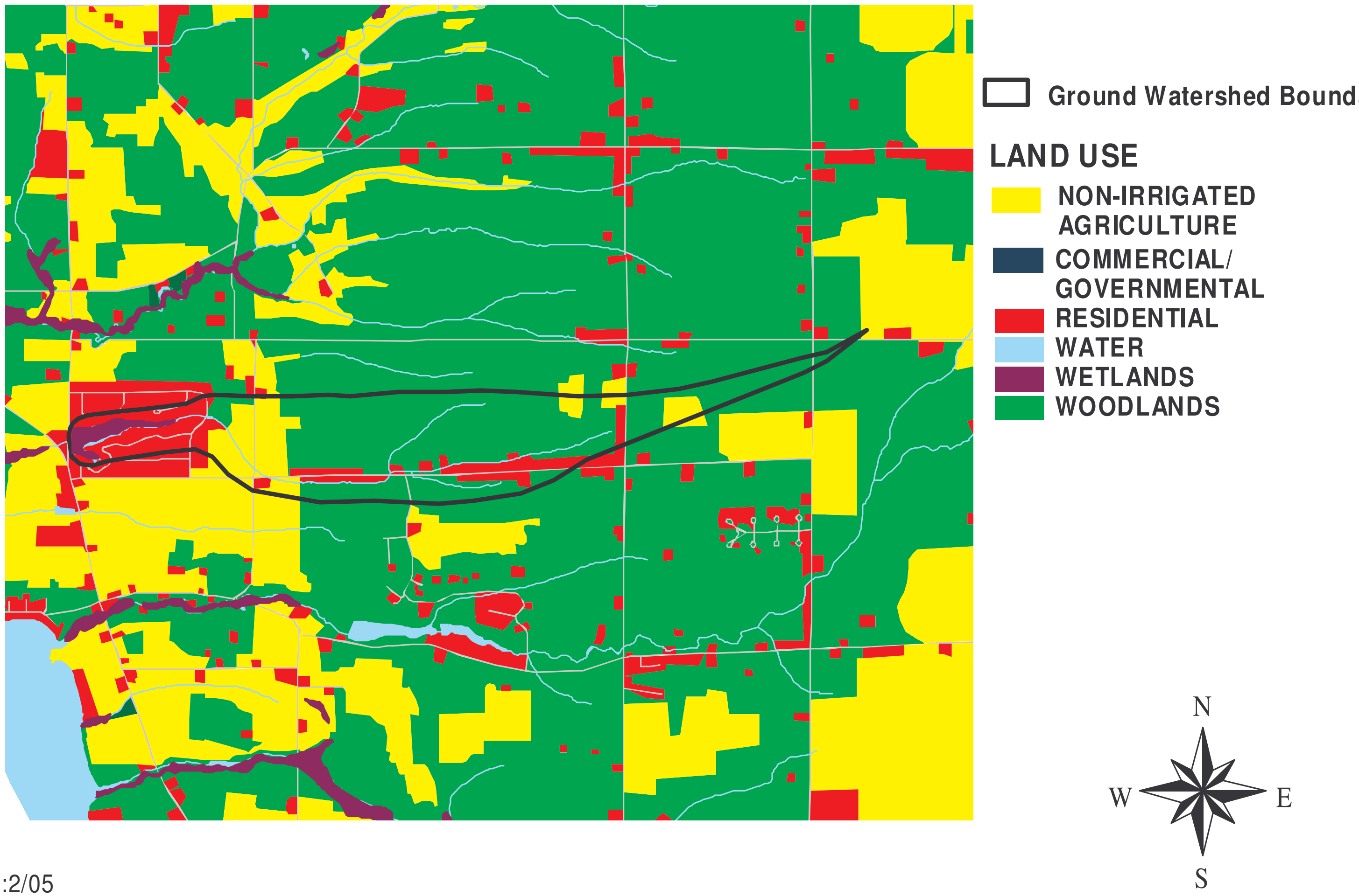


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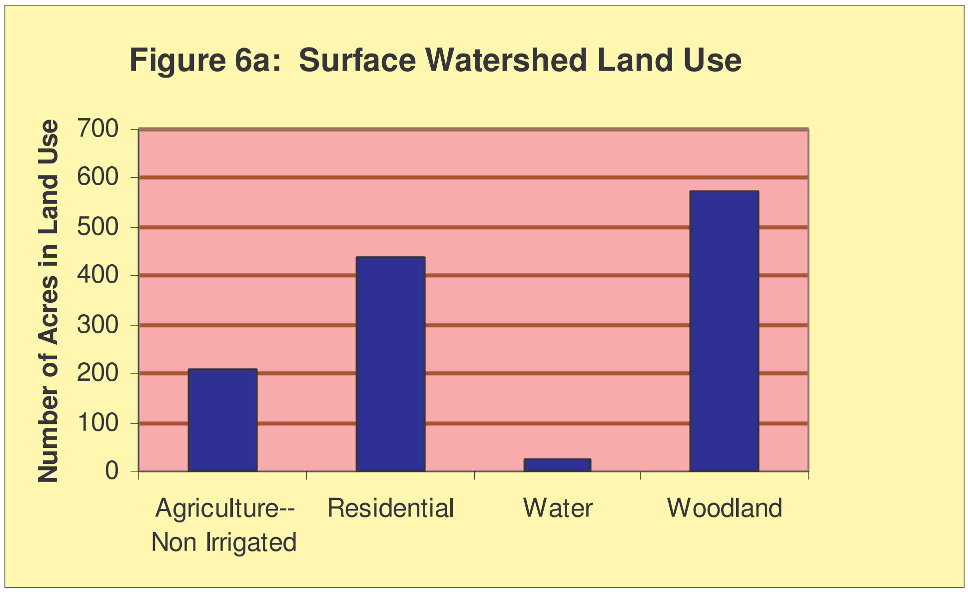
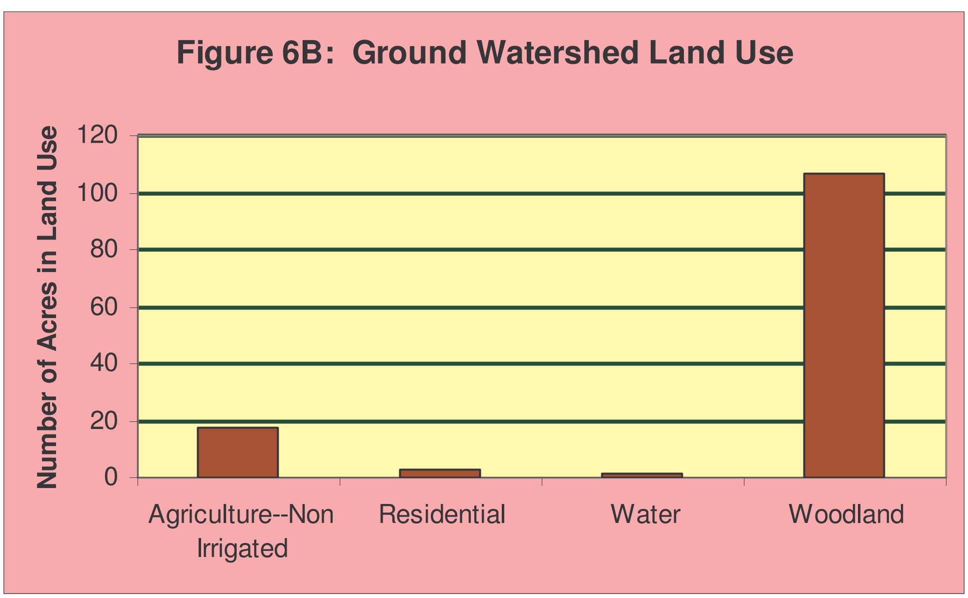
Figure 5b: Land use in Fawn Lake Ground Watershed

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.





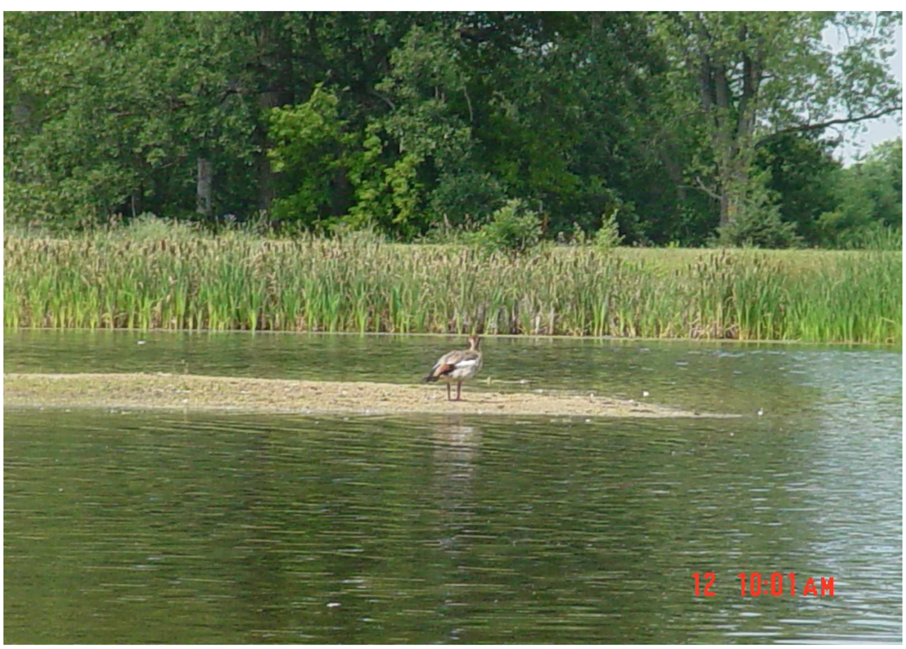
There are two specific kinds of land use—wetlands and shorelands--that are so important to water quality that they will be separately discussed.

WETLANDS

The wetlands in the Fawn Lake Watersheds are primarily around the lake itself (Figures 5a & 5b). Much of the immediate shore of Fawn Lake is a cattail-dominated wetland. 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.

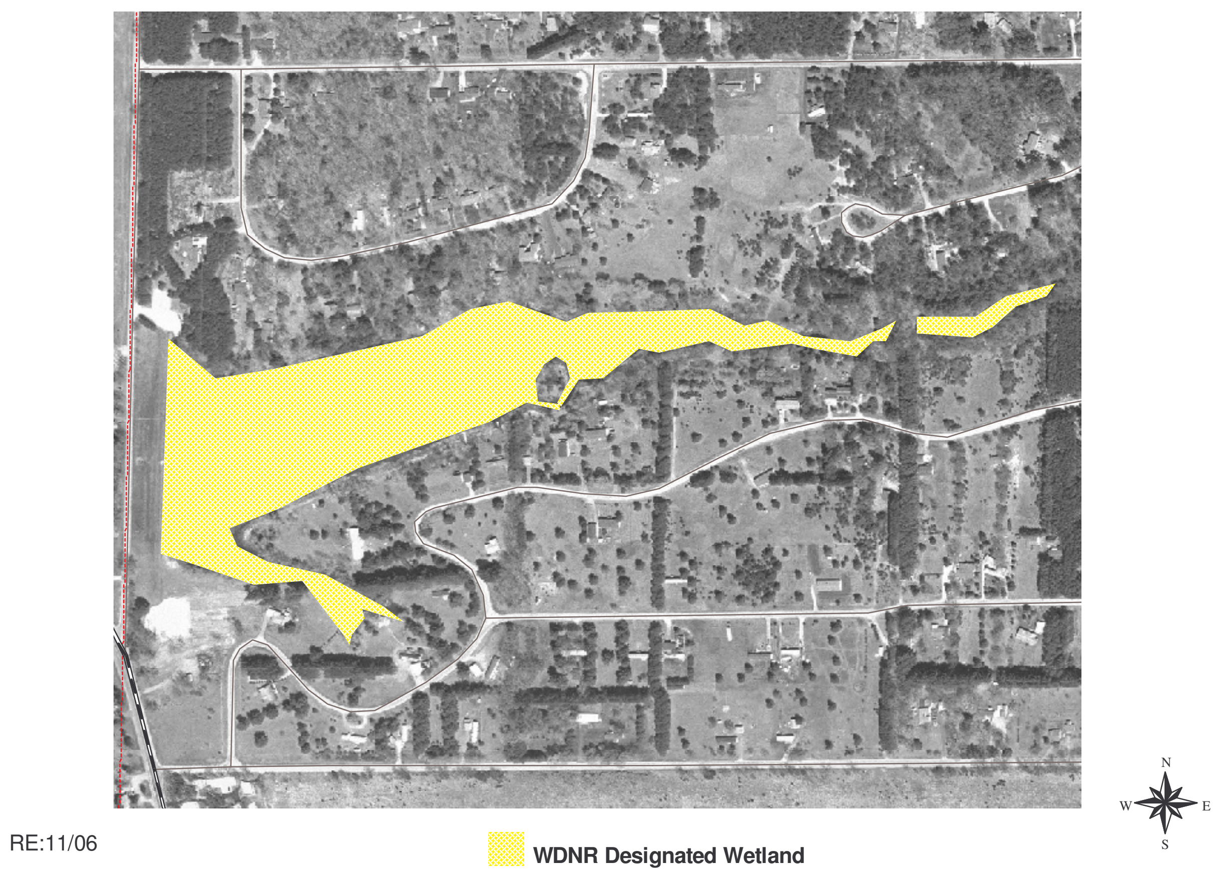
Wetlands play an important role in maintaining water quality by trapping many pollutants in runoff and flood waters, thus often helping keep clean the water they connect to. They serve as buffers to catch and control what would otherwise be uncontrolled water and pollutants. Wetlands also play an essential 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.

Figure 7: Fawn Lake cattail wetland with Egyptian Goose



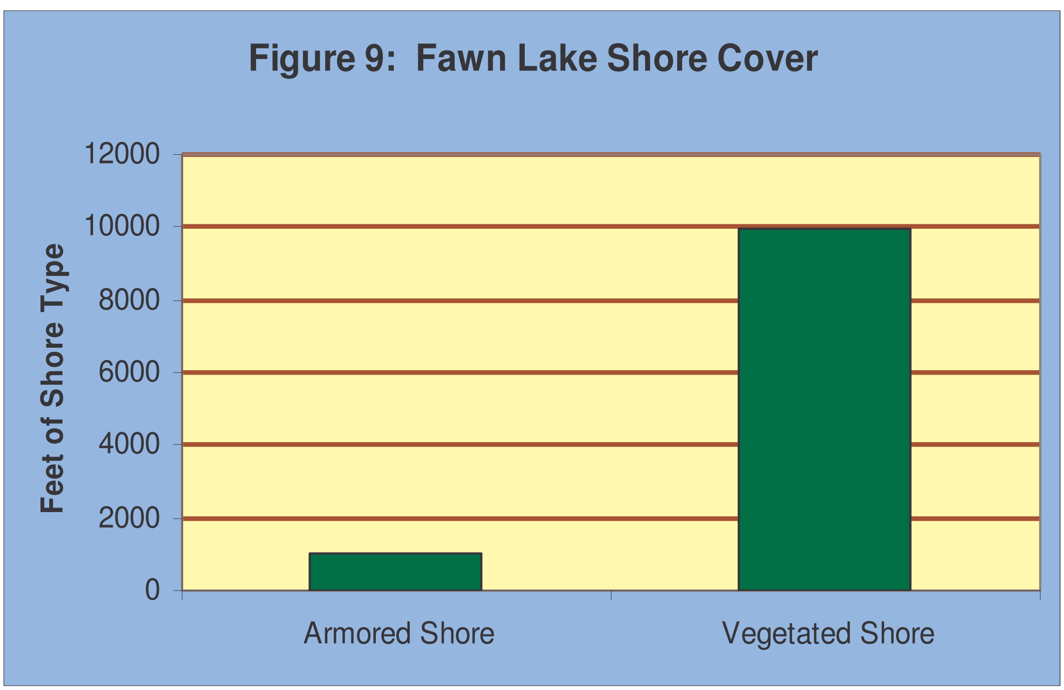
The photo above (Figure 7) shows one of the wetlands along the shores of Fawn Lake. According to the WDNR, Fawn Lake and its immediate surroundings are various categories of wetlands. Figure 8 makes it evident how important these wetlands are to Fawn Lake…much of the lake has wetlands at or near the shore that serve as filters and trappers that help keep the lake as clean as it is. It is essential to preserve these wetlands for the health of Fawn Lake.

Figure 8: Wetlands in Fawn Lake

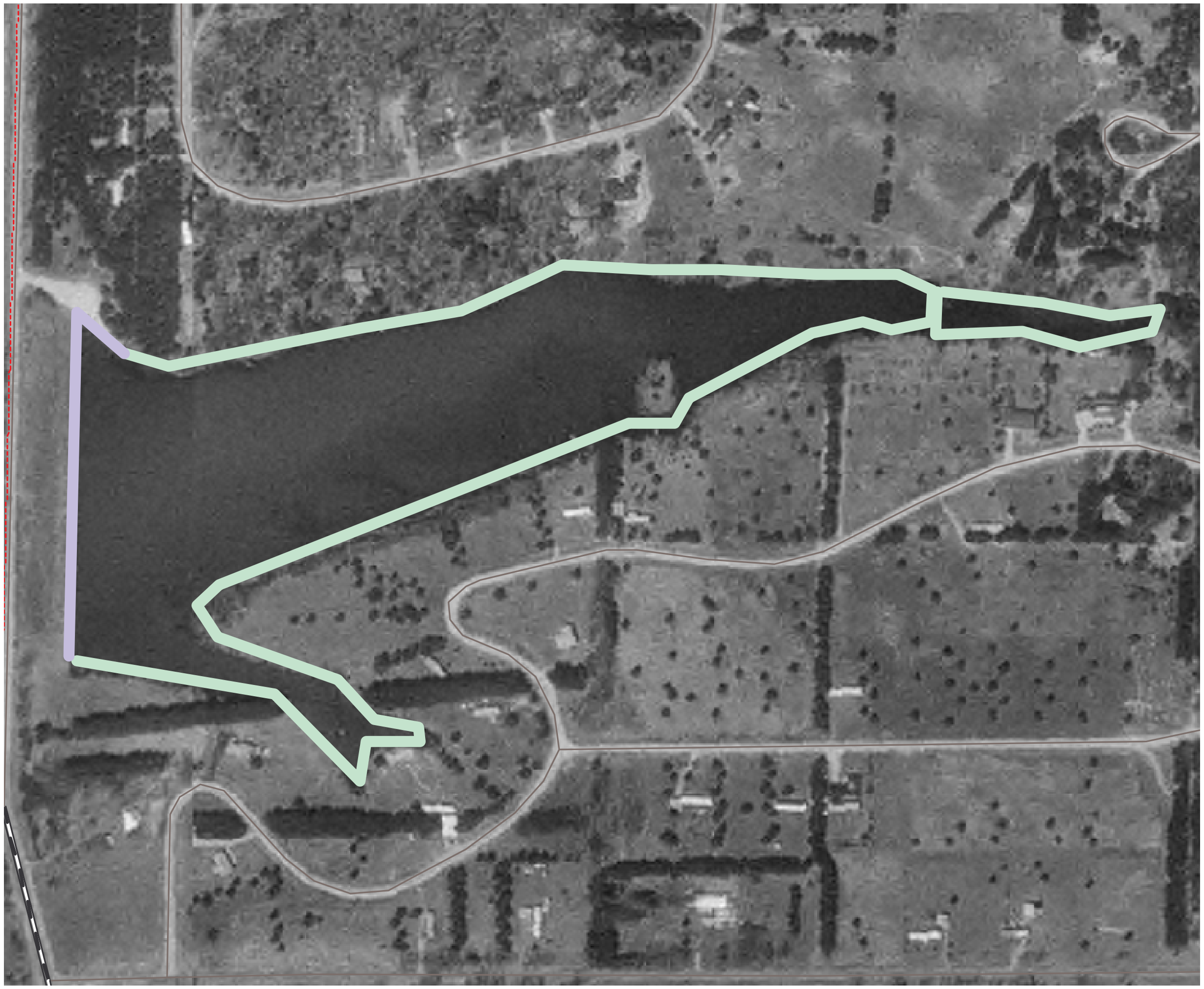


SHORELANDS

Fawn Lake has a total shoreline of 2.08 miles (10976 feet). In 2004, a visual inventory of the lakeshore was done by Adams County Land & Water Conservation Department. One of the purposes of the inventory was to determine shoreline status around the lake Most of Fawn Lake's shore is cattail marsh (a type of wetland). 90.53% of Fawn Lake's shoreline is vegetated; only 9.47% was armored or other shore cover. Most of the shore is in residential development, except for some WDNR-owned land on the northwest side of the lake and the dam/boat ramp area, owned by the county, on the east and northeast sides of the lake. The dam area is protected by rock riprap. Some emergent vegetation (mostly cattails) has grown in front of the rocks. As one enters the boat ramp, to the left is a willow thicket at the shore. No active erosion at the shore was noted in the 2004 survey. Most of the houses are set more than 70' back from the shore, even in those places where there is mowed lawn. Most of the shore is fairly flat.



Fawn Lake Shoreline



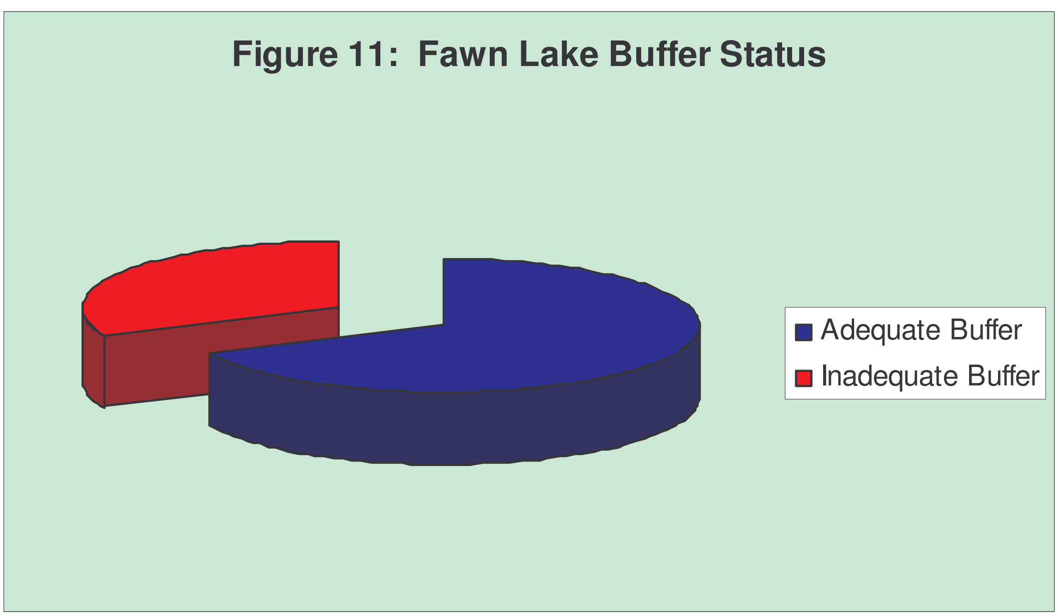
Hard Structure/Rock
Vegetated Shore

RE:9/05

Figure 10: Fawn Lake Shoreline Map

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.

The 2004 inventory included classifying areas of the Fawn Lake shorelines as having "adequate" or "inadequate" buffers (see Figure 11). An "adequate" buffer was defined as one having the first 35 feet landward covered by native vegetation. An "inadequate" buffer was anything that didn't meet the definition of "adequate buffer", including native vegetation strips less than 35 feet landward. Using these definitions, 68.26% (about 7492 feet) of Fawn Lake's shoreline had an "adequate buffer", leaving 31.74% (3484 feet) as "inadequate." Most of the "inadequate" buffer areas were found with mowed lawns and/or insufficient native vegetation at the shoreline to cover 35 feet landward from the water line.



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 the Fawn Lake shores. Figure 12 maps the adequate and inadequate buffers on Fawn Lake.

Figure 12: Fawn Lake Buffer Map

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.

Figure 13: Example of Inadequate Vegetative Buffer

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 Adequate Buffer

Natural shoreland buffers serve important cultural functions. They enhance the lake's aesethics. Studies have shown that aeshetics 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.

In the few spots where there are inadequate buffers on Fawn Lake, just letting that natural vegetation, including cattails, grow without more than necessary interruption would result in adequate buffers on the rest of the lake. If something more controlled or aesthetically pleasing was desired—by planting native seedlings sufficient to populate in the first 35 feet or using biologs to protect the shore that are vegetated.

WATER QUALITY

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information on 20 lakes in Adams County with public access. Fawn Lake was one of these lakes. Part of the information was gained from periodic water sampling done by Adams County LWCD. Historic information about water testing on Fawn Lake was also obtained from the WDNR in a series of 1994 tests.

Phosphorus

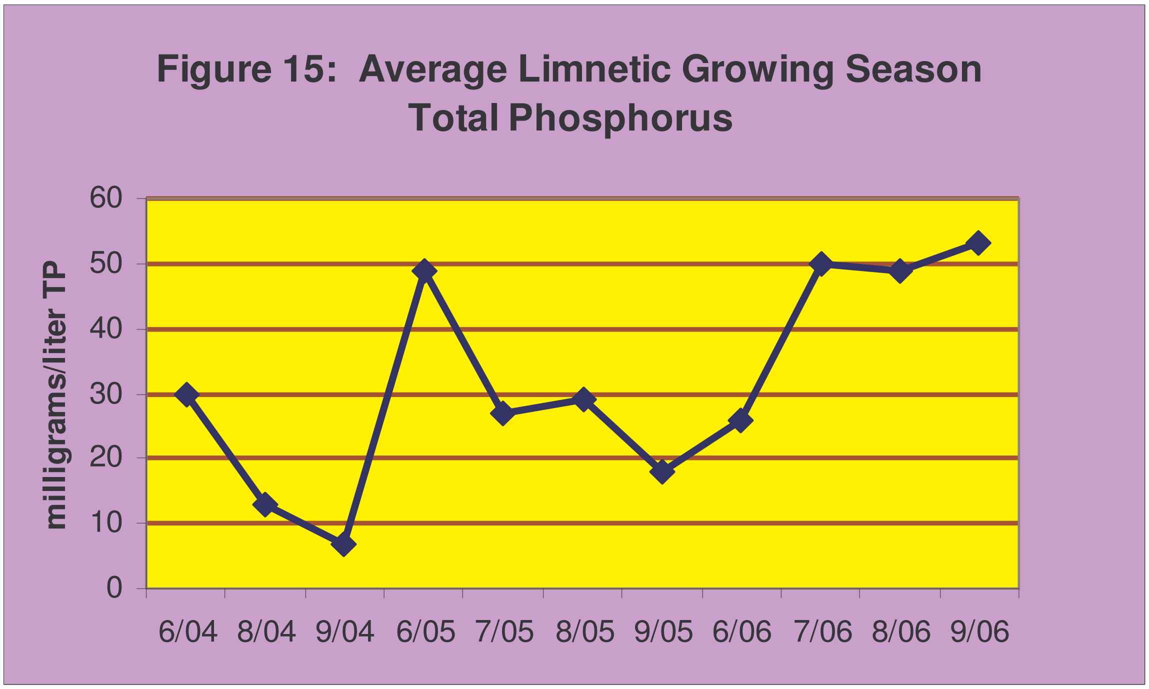
Most lakes in Wisconsin, including Fawn Lake, are phosphorus-limited lakes: of the pollutants that end up in the lake, the one that most affects the overall quality of the lake water is phosphorus. The amount of phosphorus especially affects the frequency and density of aquatic vegetation and the frequency 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 Fawn Lake, a total phosphorus concentration below 30 micrograms/liter tends to prevent nuisance algal blooms. Fawn Lake's growing season (June-September) average total phosphorus level of 34.67 micrograms/liter for the entire water column is over the level to avoid nuisance algal blooms.

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 epilemnetic (top layer, not entire water column) phosphorus concentration in Fawn Lake was 31.9 micrograms, lower than the water column average for the growing season. This is not unexpected because total phosphorus is commonly higher in the lower depths of a lake. This places Fawn Lake in the "fair" water quality section for impoundments, and in the "mesotrophic" level for phosphorus.



As the above graph (Figure 15) indicates, the summer epilemnetic growing season total phosphorus levels have varied and usually registered above the level recommended to avoid nuisance algal blooms. No historical total phosphorus information is available for Fawn Lake. But since current average is above levels recommended to avoid algal blooms, 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 Fawn 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 tested 19 micrograms/liter, considerably lower than the lake surface water results. This suggests that groundwater may not be contributing much of a load in phosphorus to Fawn Lake.

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 woodlands. 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 Fawn Lake. The current results are shown in the table below:

Figure 16: Current Phosphorus Loading by Land Use

MOST LIKELY CURRENT PHOSPHORUS LOADING		
BY LAND USE	%	Current
Agriculture--Non Irrigated	50.3%	74.8
Residential	2.7%	4.4
Other Water	0.5%	0.5
Woodland	31.0%	46.2
Groundshed	3.9%	6.6
Lake Surface	1.8%	2.2
Septic	9.8%	14.52
total in pounds/year	100.0%	149.22

Phosphorus deposits such as that from flooded wetlands or from atmospheric 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, especially with tri-levels of growth; 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.

Figure 17: Photo showing Tri-Level Vegetative Growth: Trees; Shrubs; Emergents

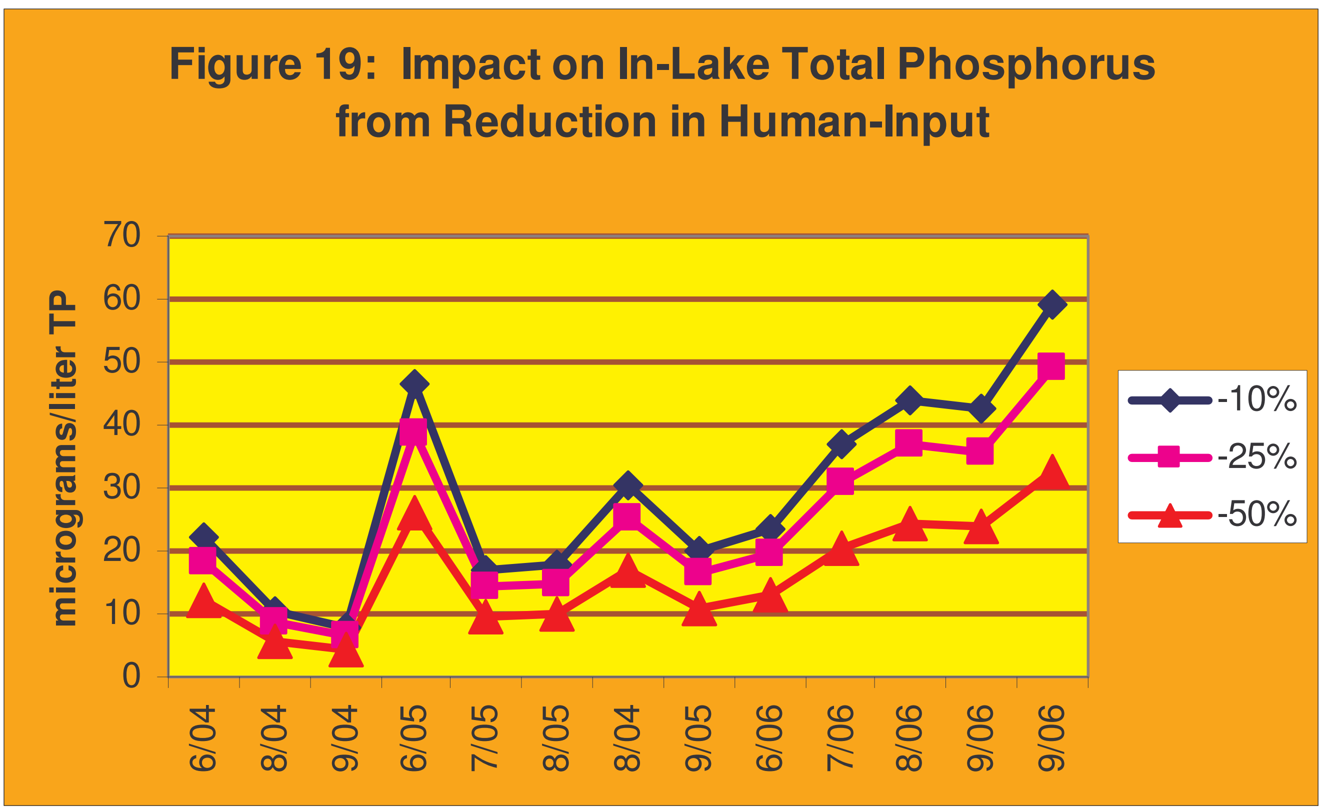
The models were run using not only the current known phosphorus readings in the lake, but also representing decreases or increases of human-controlled phosphorus input by 10%, 25%, and 50%. The figures may not seem like much---until one calculates that one pound of phosphorus can result in up to 500 pounds of algae. A 10% reduction in these three areas could result in up to 5016 pounds of algae less per year! Figure 18 shows the impact on phosphorus loading per acre per year by decreases or increases in human-related total phosphorus loading.

Figure 18: Impact of Changes in Phosphorus Loading by Human Activities

Land Use	Current	-10%	-25%	-50%
Agriculture--Non Irrigated	74.8	67.32	56.10	37.40
Residential	4.4	3.96	3.30	2.20
Other Water	0.5	0.50	0.50	0.50
Woodland	46.2	46.20	46.20	46.20
Groundshed	6.6	5.94	4.95	3.30
Lake Surface	2.2	2.20	2.20	2.20
Septic	14.52	13.07	10.89	7.26
total	149.22	139.188	124.14	99.06

Looking at this issue in terms of how much phosphorus readings in the lake might change in-lake levels, based on the computer modeling, perhaps makes it clearer. Figure 15 showed the surface summer (June-September) epilemnetic mean phosphorus levels for Fawn Lake since 2004. The overall average for those 3 years was 31.9 micrograms/liter.

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 Fawn Lake in-lake water quality by up to 8 micrograms of phosphorus/liter; a 25% reduction could save up to 16 micrograms/liter (see Figure 19). These predictions make it clear that reducing current phosphorus inputs to the lake are essential to improve, maintain and protect Fawn Lake's health for future generations.



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 Fawn Lake in 2004-2006 was 5.05 feet. This is fair water clarity, putting Fawn Lake into the "mesotrophic" category for water clarity.

Figure 20: Secchi Disk Readings from 6/03 through 9/06

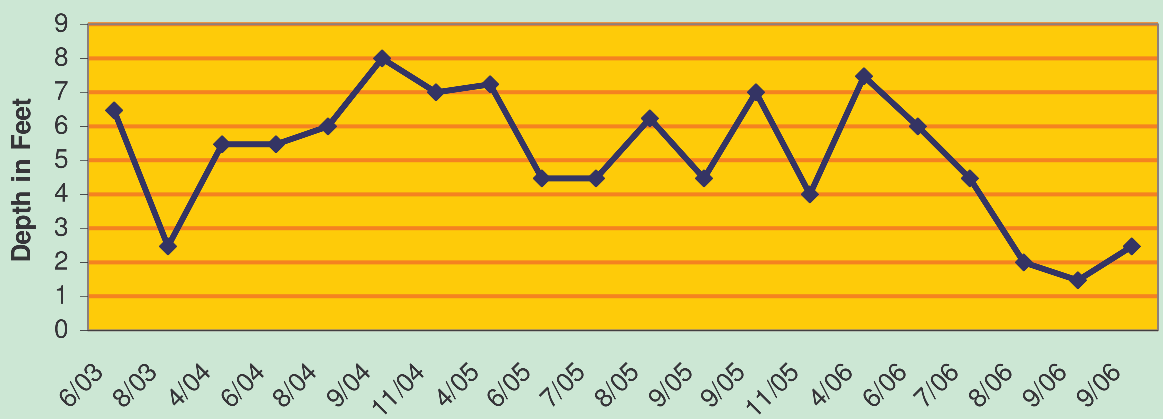
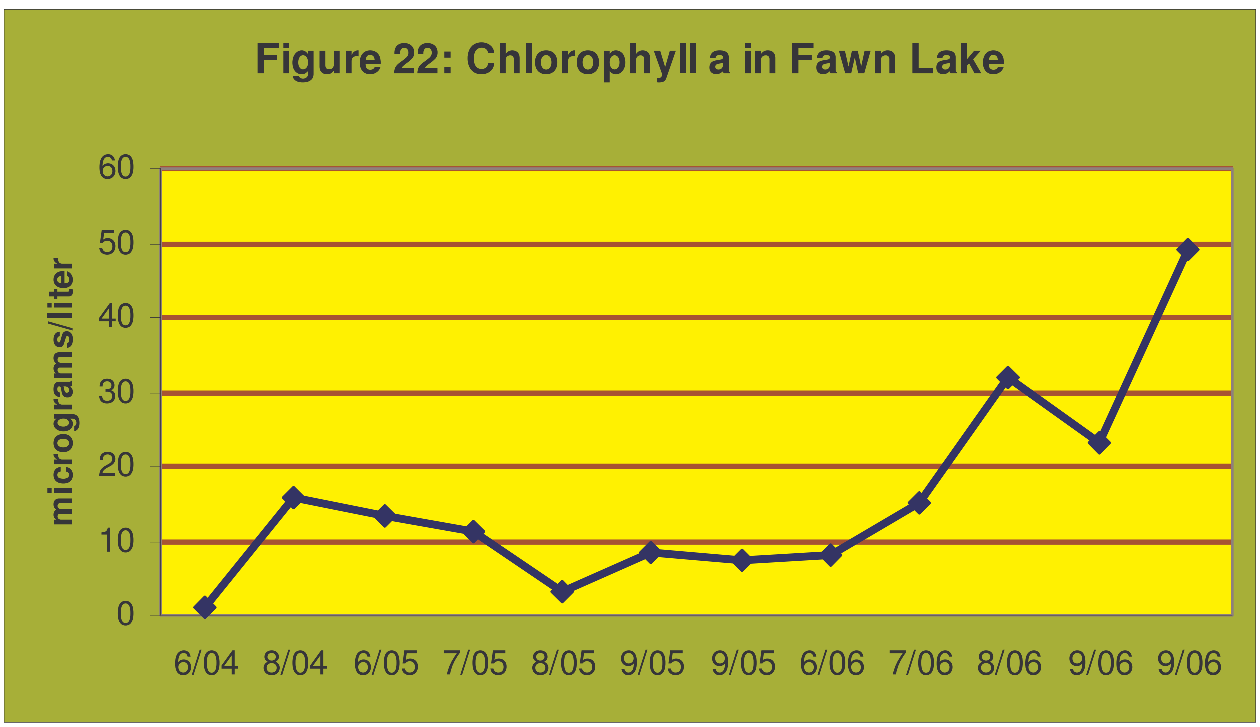


Figure 21: Photo of Testing Water Clarity with Secchi Disk

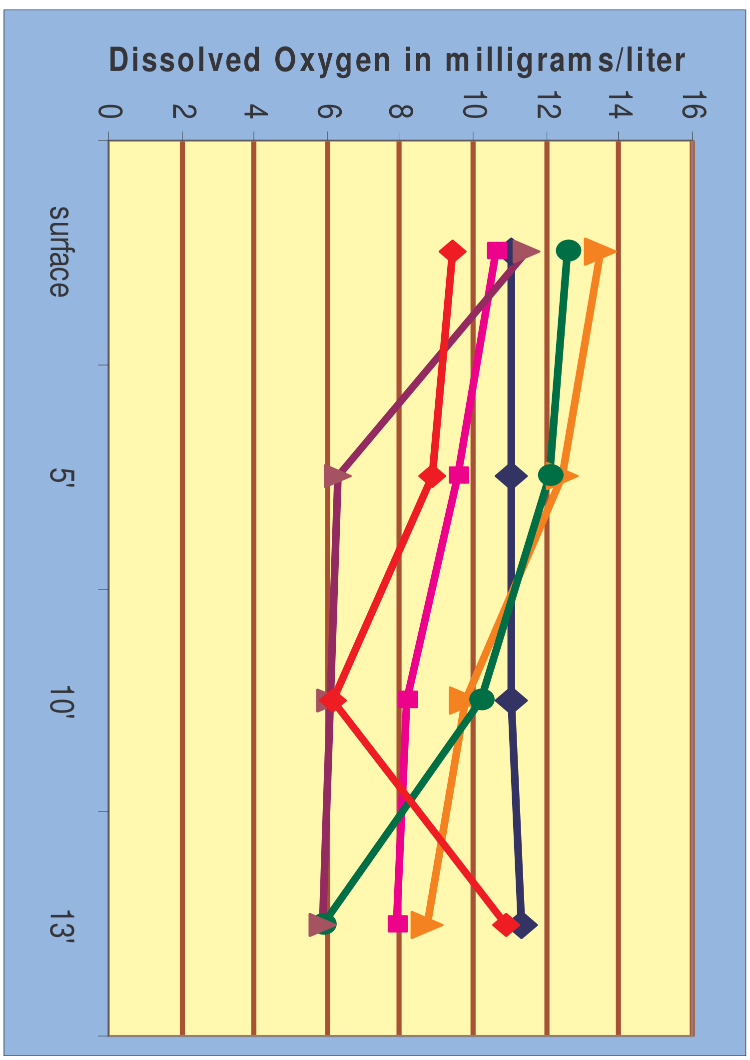
Chlorophyll a

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 summer (June-September) average chlorophyll concentration in Fawn Lake was 16.4 micrograms/liter Such an algae concentration places Fawn Lake at the "poor" level for chlorophyll a results, suggesting that algal blooms are likely to be frequent in Fawn Lake. A look at Figure 21 clearly shows that chlorophyll-a has steadily risen in Fawn Lake from 2004 through 2006. The summer of 2006 was especially hot and dry, which may account for the leap in chlorophyll-a levels that year. Further monitoring is essential to determine if the increase is temporary, or a sign of developing problems.



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. Low oxygen during the summer in the bottom waters of a lake can occur, but is not common in lakes as shallow as Fawn Lake. During the summers of 2004, 2005 and 2006, dissolved oxygen levels didn't go below levels 5 mg/l, the appropriate level for good fish survival. The charts (Figures 23a, b, c) below show the annual (2004-2006) variations in dissolved oxygen levels in milligrams/liter, depth in feet and months of the year:



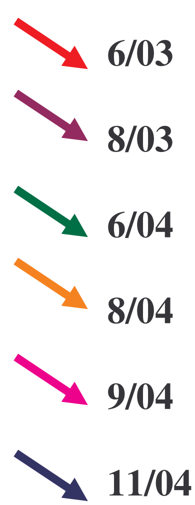
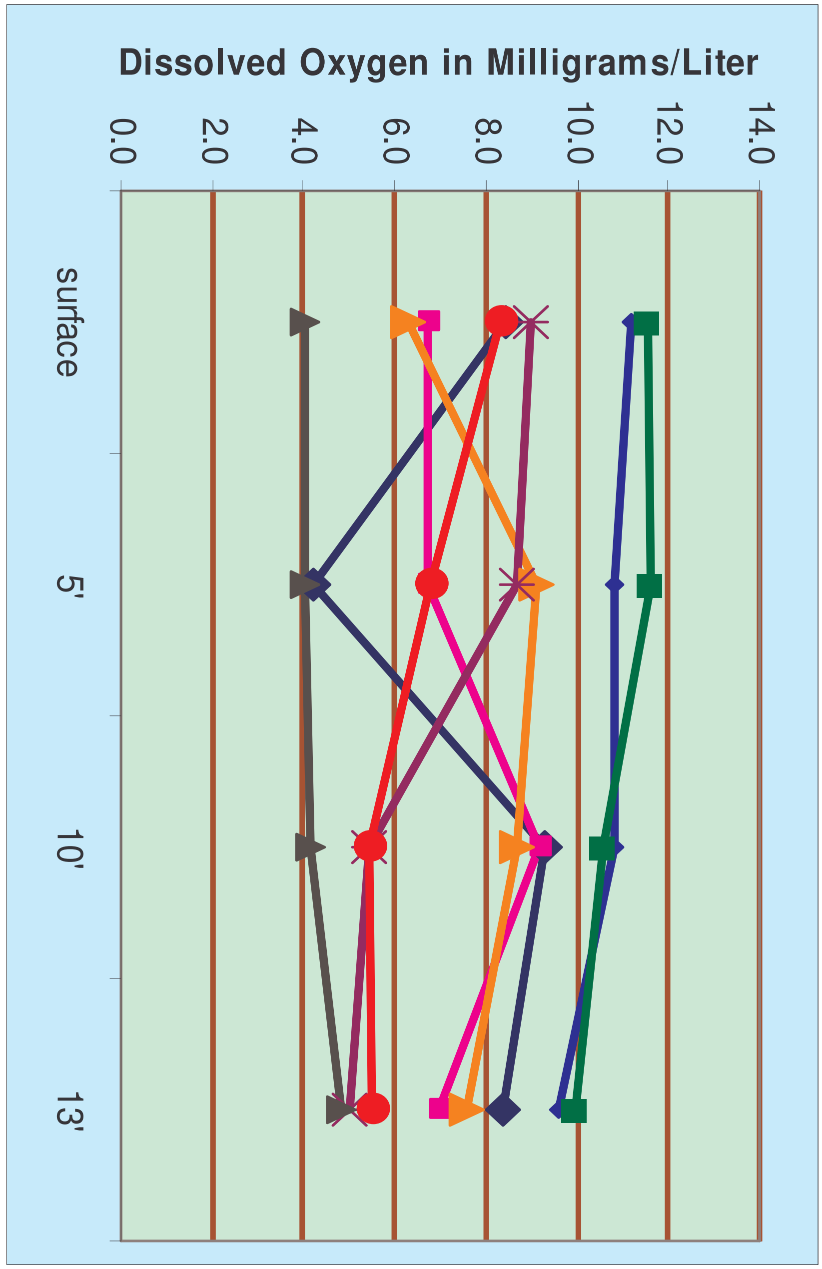


Figure 23a: Dissolved Oxygen Levels During 20043-2004 Water Testing in milligrams/liter

Figure 23b: Dissolved Oxygen Levels During 2005 Water in milligrams/liter



2/05

4/05

6/05

78/05

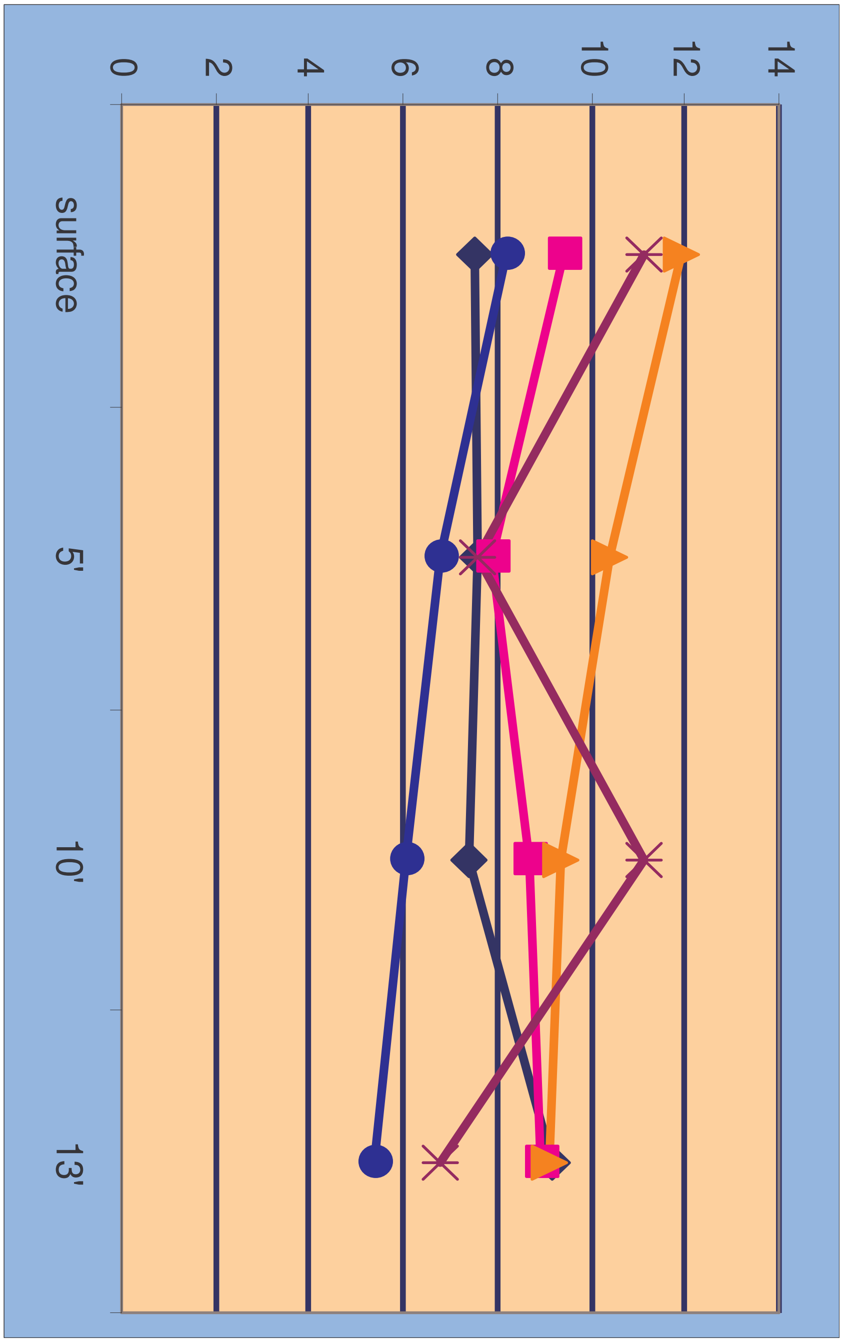
8/05

9/05

9/05

11/05

Figure 23c: Dissolved Oxygen Levels During 2006 Water 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." Since Fawn Lake is such a shallow lake, it does not stratify and thus does not turnover in either the spring or fall.

Figure 24: Photo of a Lake with Algal Bloom

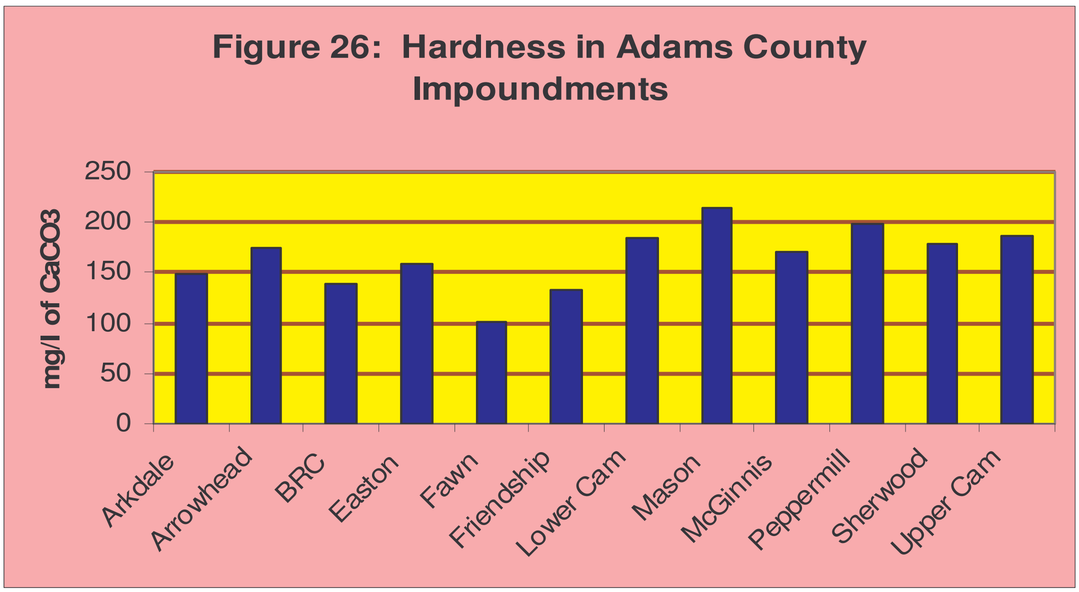
Water Hardness, Alkalinity and pH

Testing done by Adams County LWCD on Fawn 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	Mg/l CaCO3
SOFT	0-60
MODERATELY HARD	61-120
HARD	121-180
VERY HARD	>180

Figure 25: Levels of Hardness in Mg/l of Calcium Carbonate

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 Fawn Lake to measure the hardness of the water coming into the lake through groundwater. Hardness in the groundwater averaged 120.88 mg/l of CaCO3, right at the line between "moderately hard" and "hard." The hardness in the 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 26) shows, Fawn Lake surface water testing results showed "moderately hard" water (average 101.33 mg/l CaCO3), and Fawn Lake's hardness is considerably less than the overall hardness average impoundments in Adams County of 166 mg/l 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

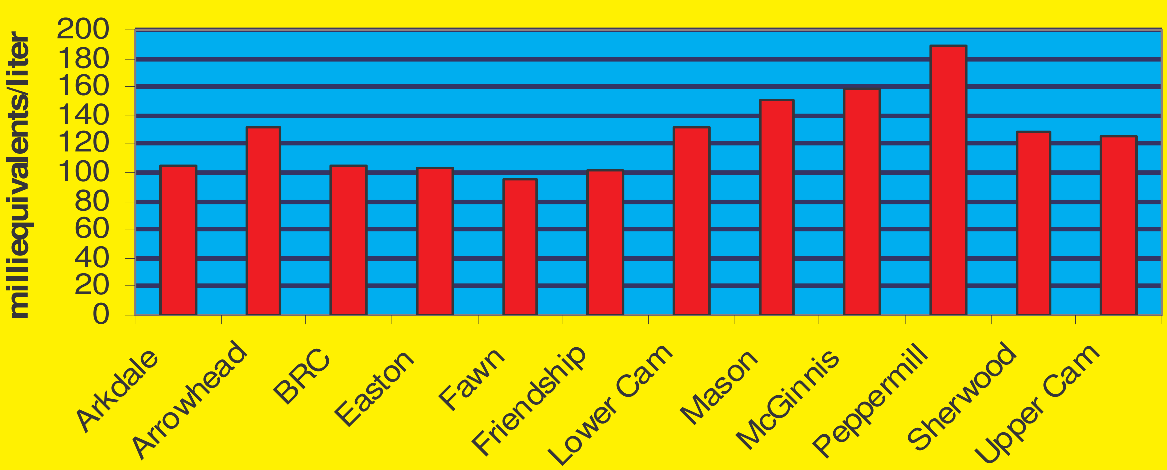
Figure 27: Acid Rain Sensitivity

Well water testing results for Fawn Lake averaged 113.25 ueq/l. This is higher than the surface water average of 96.8. Fawn 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.

Figure 28: Alkalinity Adams County Impoundments



The testing occurring from 2004-2006 also included regular monitoring of the pH at several depths in Fawn Lake. As is common in the lakes in Adams County, Fawn Lake has pH levels starting at just under neutral (6.82) at 13' depth and increasing in alkalinity as the depth gets less, until the surface water pH averages 7.82. 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. Fawn Lake's pH falls right into this range.

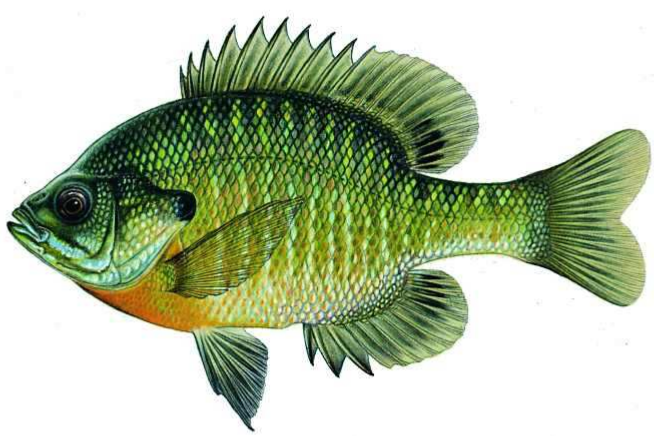
More importantly for many lakes, fish reproduction and survival are very sensitive to pH levels. The chart below indicates the effect of pH levels under 6.5 on fish (Figure 29):

Figure 29: 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 Fawn Lake in 2004-2006 fell below the pH level that inhibits walleye reproduction. A lake with a neutral or slightly alkaline pH like Fawn 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 Fawn Lake. Fawn Lake has a good pH level for fish reproduction and survival.

Figure 30: Most Abundant Fish in Fawn Lake: Bluegill (*Lepomis macrochirus)*



Other Water Quality Testing Results

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 mg/l 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 Fawn Lake's water during the testing period was 17.18 mg/l. The average Magnesium level was 11.54 mg/l. Both of these are low-level readings.

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 Fawn Lake during the testing period was 2 mg/l, around the natural level of chloride in this area of Wisconsin.

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 mg/l in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). Fawn Lake combination spring levels from 2004 to 2006 averaged .23 mg/l, below the .3 mg/l predictive level for algal blooms caused by nitrogen levels. Fawn Lake's significant ongoing problem with frequent algal blooms during the growing season is likely due to its total phosphorus levels.

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 mg/l may be harmful to heart and kidney patients if ingested.

Both sodium and potassium levels in Fawn Lake are low: the average sodium level was 8.65 mg/l; the average potassium reading .7 mg/l.

SULFATE: In low-oxygen waters (hypoxic), sulfate can combine with hydrogen and becomes the gas hydrogen sulfate (H2S), 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 H2S, levels of 10 mg/l are best. A health advisory kicks in at 30 mg/l. Fawn Lake sulfate levels averaged 10.17 mg/l during the testing period, above the level for H2S formation, but below the health advisory level.

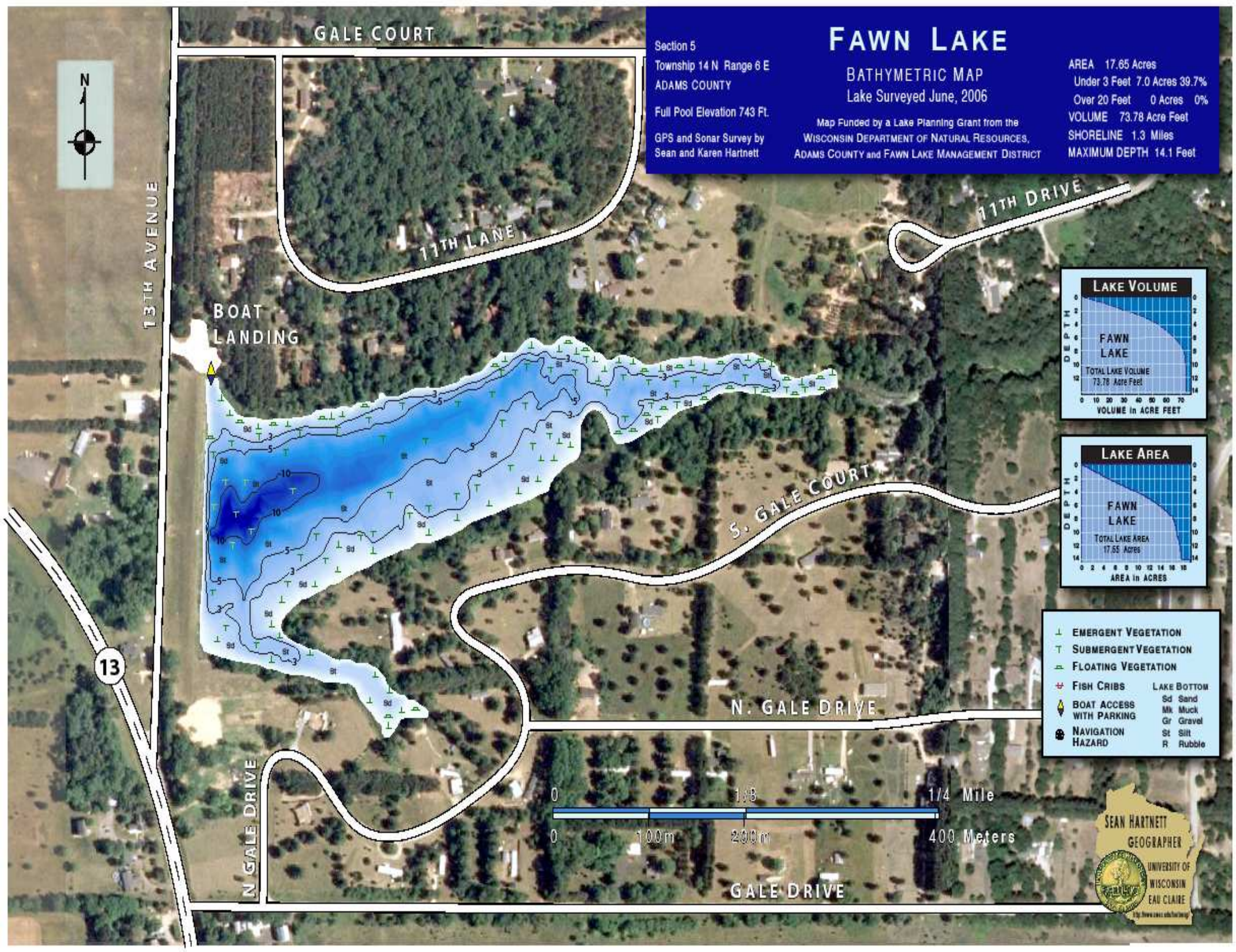
TURBIDITY: Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Turbid water may mask the presence of bacteria or other pollutants because the water looks murky or muddy. In general, 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 Fawn Lake's waters were 1.9 NTU in 2004, 2.8 NTU in 2005, and 3.8 NTU in 2006—all below the 5 NTU level of concern.

Figure 31: Examples of Very Turbid Water

HYDROLOGIC BUDGET

According to data gathered for a recent bathymetric (depth) map, Fawn Lake is 17.65 surface acres, and the volume of the lake is 73.78 acre-feet. The mean depth is 6 feet. The maximum depth is 14.1 feet.

Figure 32: Bathymetric Map of Fawn Lake

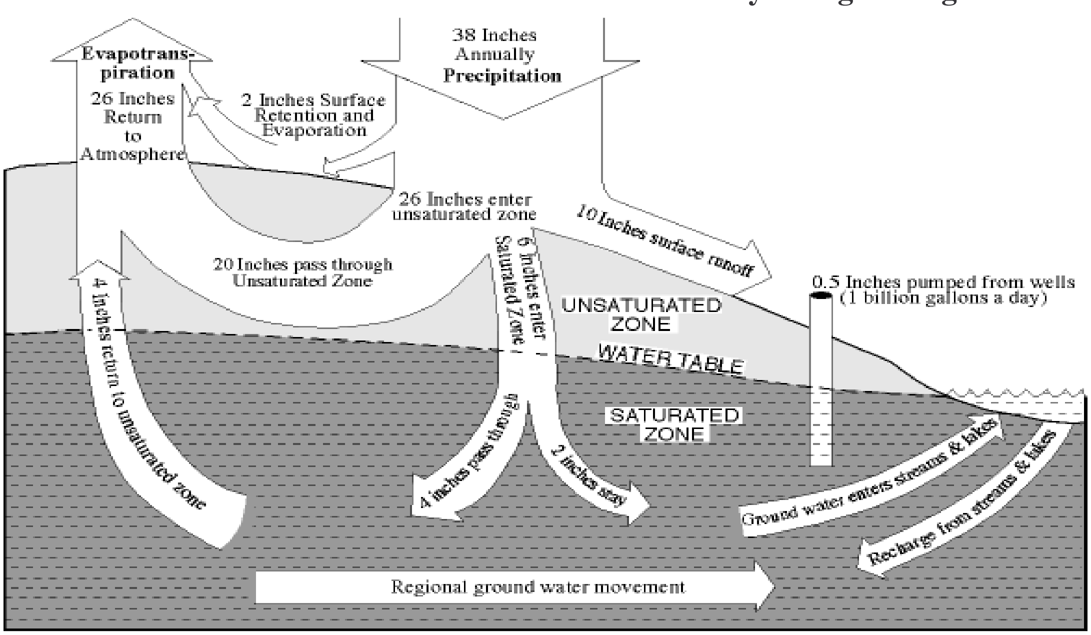


A "hydrologic budget" is an accounting of the inflow to, outflow from and storage in a hydrological unit (such as a lake). "Residence time" is the average length of time particular water stays within a lake before leaving it. This can range from several days to years, depending on the type of lake, amount 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 Fawn Lake as 1355 acres**.** The average unit runoff for Adams County in the Fawn Lake area is 9.4 inches. WiLMS determined the expected annual runoff volume as 1061.4 acre-feet/year. Anticipated annual hydraulic loading is 1065.2 acre-feet/year. Areal water load is 60.4 feet/year. Lake flushing rate is 8.88 1/year, and water residence time was calculated as 0.07 year.

In an impoundment lake like Fawn 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 Fawn Lake's case, modeling estimates a water residence of 60.4 feet 1/years**.** The calculated lake flushing rate is .07 feet per year. Water and its load flow through Fawn Lake fairly quickly.

Figure 33: Example of Hydrologic Budget



TROPHIC STATE

The trophic state of a lake is one measure of water quality, basically defining the lake's biological production status (see Figure 34). 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 Fawn Lake is what was predicted from the modeling. Modeling results predicted that the overall TSI for Fawn Lake would be 56. This score places Fawn Lake's overall TSI above the average for impoundment lakes in Adams County (52.83). In TSI, the lower the score, the less disturbed the lake is.

Figure 34: 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

Fawn Lake = 56 → (50-60)

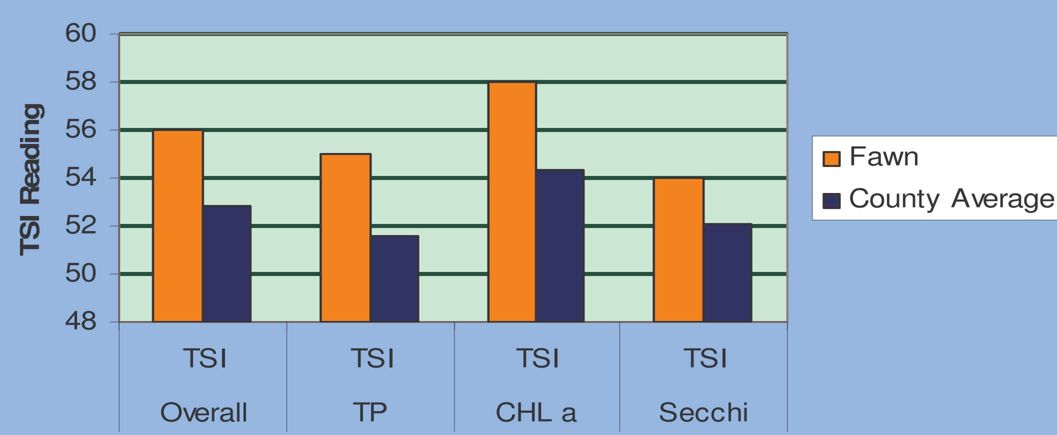
Phosphorus concentration, chlorophyll-a concentration and water clarity data are collected and combined to determine a trophic state. As discussed earlier, the average summer epilimnetic total phosphorus for Fawn Lake was 31.9 micrograms/liter. The average summer chlorophyll-a concentration was 16.4 milligrams/liter. Growing season water clarity averaged a depth of 5.05 feet. Figure 35 shows where each of these measurements from Fawn Lake fall in trophic level.

Figure 35: Fawn Lake Trophic Status Overview

Trophic State	Quality Index	Phosphorus	Chlorophyll a	Sechhi Disk
		(ug/l)	(mg/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
Fawn Lake		**31.9**	**16.4**	**5.06**

These figures show that Fawn Lake has fair to good levels overall for the three parameters often used to described 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.

Figure 36: Trophic State Index for Fawn Lake



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 done on Fawn Lake in the summer of 2006 by staff from the Adams County LWCD. Its trophic state should support moderate to dense plant growth and occasional algal blooms. The aquatic plant survey was generally in keeping with this prediction. Filamentous algae were abundant in Fawn Lake, present at least 86.2%, of the sites and found even in the over 5 foot depth zone. Despite the sometime limiting effect of sand sediments on aquatic plant growth, 92% of Fawn Lake's bottom was vegetated, suggesting that even the sand sediments there hold sufficient nutrients to maintain aquatic plant growth. Due to the shallow depth, sunlight can encourage plant growth at all depths in the lake.

Figure 37: Sediments in Fawn Lake

Of the 24 aquatic species found, ten were emergent, two were rooted floating leaf, three were free-floating and nine species were submergent. The aquatic plant community does contain a variety of plant structure: emergent plants, rooted plants, free-floating plants and rooted plants with floating leaves. However, the community is characterized by plants that tolerate a high amount of disturbance and abundant filamentous algae. The 0 to 1.5 feet depth zone was the highest in frequency of growth. Submergent and free-floating species were especially abundant.

The dominant plant in the lake was *Elodea canadensis* (common waterweed), a submergent plant. *Lemna minor* (small duckweed, a free-floating plant) was sub-dominant. No other aquatic plants came close to these two in dominance. Three of the four depth zones had rooted aquatic plants, and all four depth zones had free-floating plants and filamentous algae present. Of the 24 species found in Fawn Lake in 2006, ten had higher than average density of growth where they were found.

The only two plants found in all four depth zones were *Lemna minor* and *Wolffia* spp. (common watermeal). *Lemna minor* and *Typha latifolia* were dominant in the 0-1.5 foot depth zone, with *Elodea canadensis* sub-dominant. *Elodea canadensis* dominated the 1.5 foot-5 foot depth zone, with *Lemna* minor and *Wolffia columbiana* sub-dominant. *Wolffia columbiana* was dominant in 5 foot-10 foot depths; *Elodea canadensis* and *Lemna minor* were sub-dominant.

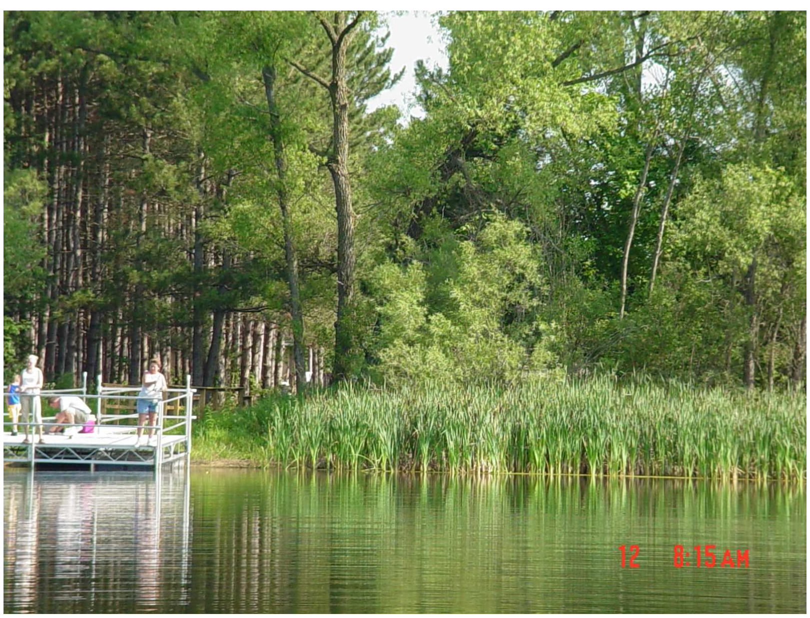


Figure 38: Photo of public fish dock on Fawn Lake

Figure 39: Fawn Lake Aquatic Plant Species Found 2006

Scientific Name	Common Name	Type
Agalinus paupercula	Small-Flowered False Foxglove	Emergent
Bidens vulgatus	Tall Beggar's Tick	Emergent
Ceratophyllum demersum	Coontail	Submergent
Chara sp	Muskgrass	Submergent
Cicuta bulbifera	Water Hemlock	Emergent
Eleocharis acicularis	Needle Spike-Rush	Emergent
Elodea canadensis	Common Waterweed	Submergent
Lemna minor	Small Duckweed	Free-Floating
Leersia oryzoides	Rice Cut-Grass	Emergent
Myriophyllum spicatum	Eurasian Watermilfoil	Submergent
Najas flexlis	Bushy Pondweed	Submergent
Nymphaea odorata	White Water Lily	Rooted Floating-Leaf
Phalaris arundinacea	Reed Canarygrass	Emergent
Polygonum hyudropiperoides	Waterpepper	Rooted Floating-Leaf
Potamogeton crispus	Curly-Leaf Pondweed	Submergent
Potamogeton nodosus	Long-Leaf Pondweed	Submergent
Potamogeton pectinatus	Sago Pondweed	Submergent
Ranunculus sceleratus	Cursed Crowfoot	Submergent
Rumex spp	Water Dock	Emergent
Salix spp	Willow spp	Emergent
Spirodela polyrhiza	Greater Duckweed	Free-Floating
Typha angustifolia	Narrow-Leaf Cattail	Emergent
Typha latifolia	Wide-Leaf Cattail	Emergent
Wolffia columbiana	Common Watermeal	Free-Floating

The Simpson's Diversity Index for Fawn Lake was .81, suggesting poor species diversity. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable). The Aquatic Macrophyte Community Index (AMCI) for Fawn Lake is 40. This is in the lowest quartile for Central Wisconsin Hardwood Lakes and Impoundments, suggesting an aquatic plant community of below average quality. The aquatic plant community in Fawn Lake is in the category of those most tolerant of disturbance, likely from a high amount of disturbance compared to other Wisconsin lakes.

The presence of the three invasives *Myriophyllum spicatum* (Eurasian Watermilfoil), *Potomegeton* crispus (Curly-Leaf Pondweed) and *Phalaris arundinacea* (Reed Canarygrass) are significant factors. Currently, their density and relative frequency don't establish them as dominant among Fawn Lake's aquatic plant community, but their tenacity and ability to spread to large areas fairly quickly make it a danger to the already poor diversity of Fawn Lake's aquatic plant community. The Fawn Lake District has chemically treated the lake for Eurasian Watermilfoil; in 2006, some of the areas formerly occupied by Eurasian Watermilfoil were occupied instead by *Elodea canadensis.*

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 Conservation for Fawn Lake was 4. 1. This puts it 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 Fawn Lake is in the category of those most tolerant of disturbance, probably due to selection by a series of past disturbances.

The Floristic Quality Index of the aquatic plant community in Fawn Lake of 18.77 is below average for Wisconsin Lakes (average 22.2) and the North Central Hardwood Region (average 20.9). This again indicates that the plant community in Fawn Lake is farther from an undisturbed condition than the average lake in Wisconsin overall and in the North Central Hardwood Region. In other words, the aquatic plant community in Fawn Lake has been impacted by a high amount of disturbance.

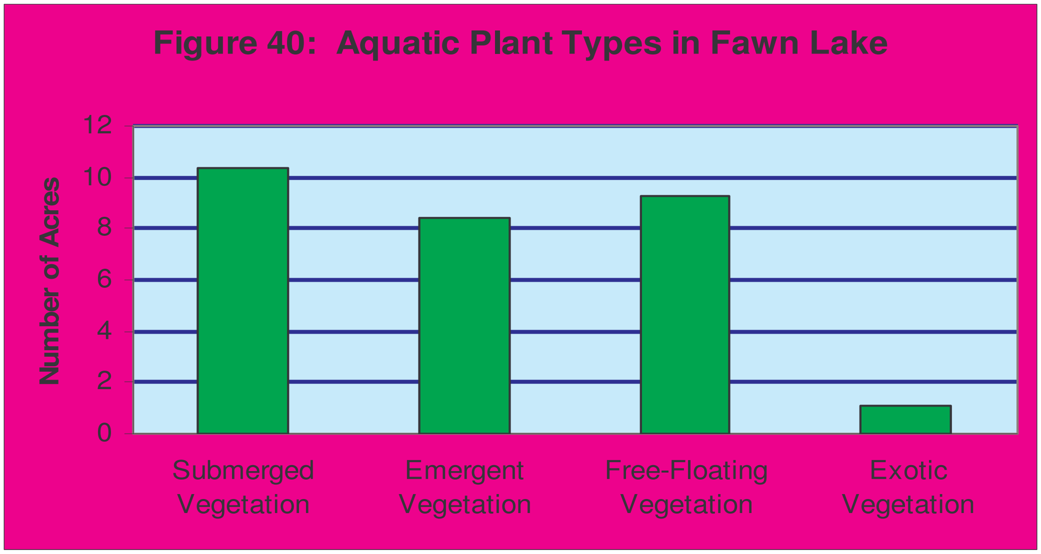


Figure 41a: Distribution of Emergent Plants in Fawn Lake 2006

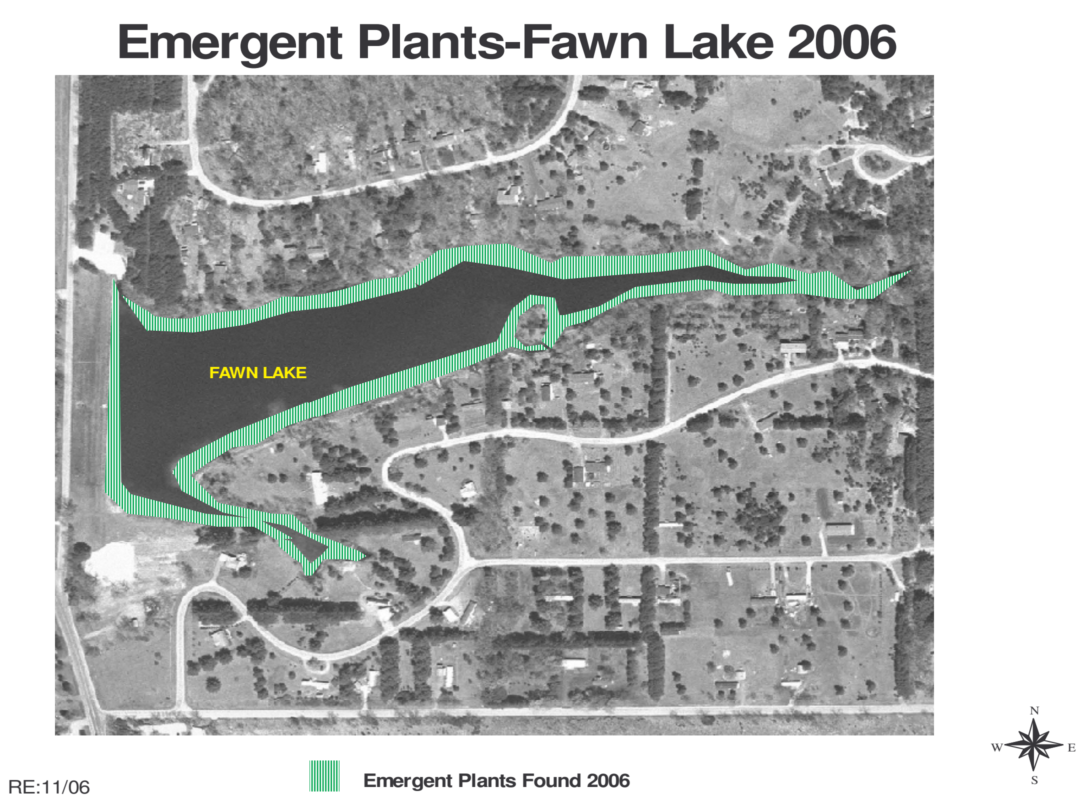


Figure 41b: Free-Floating & Floating-Leaf Rooted Plants Distribution

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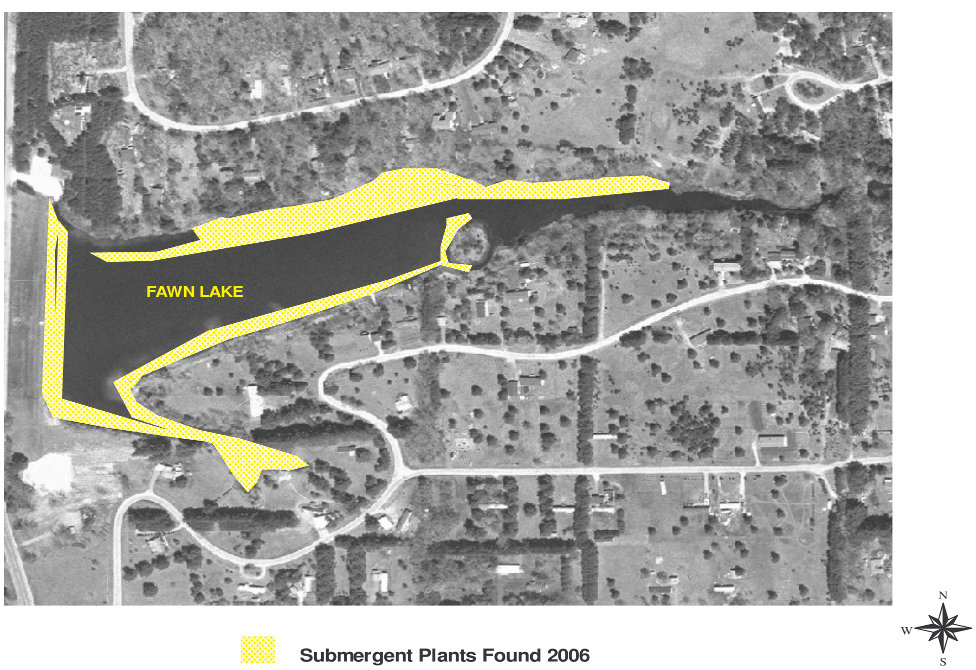
Floating Plants Found 2006

Figure 41c: Submergent Aquatic Plants Distribution 2006



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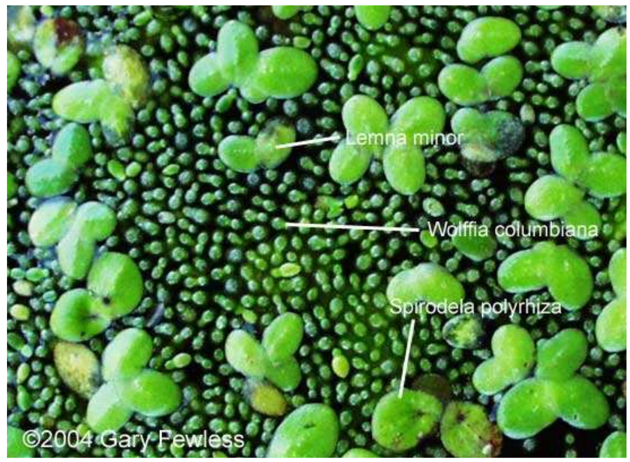
Submergent Plants Found 2006

Figure 42: Most Common Aquatic Species in Fawn Lake

Elodea canadensis
(Common waterweed)

Lemna minor
(Small Duckweed)

Wolffia columbiana
(Common watermeal)



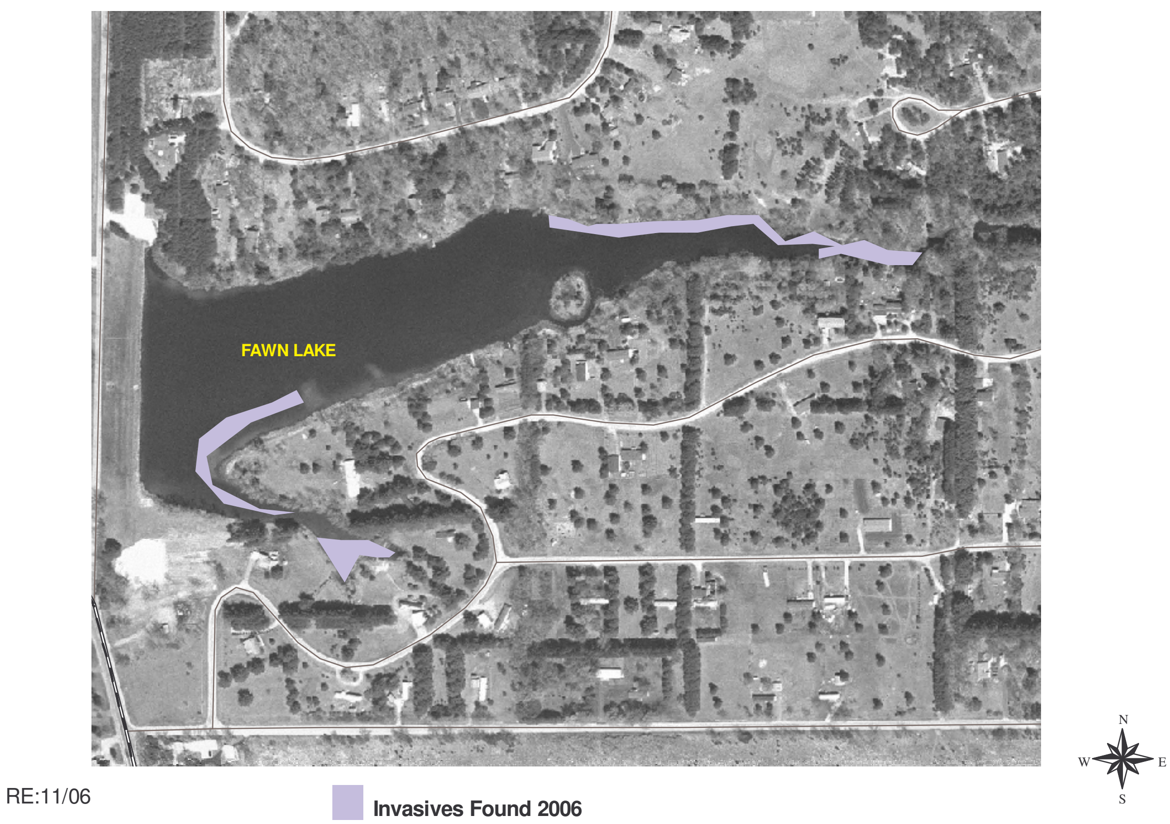
Typha angustifolia
(Wide-leaved Cattail)

Typha latifolia
Narrow-leaved Cattail

Aquatic Invasives

Eurasian Watermilfoil was introduced in Fawn Lake at an unknown time, probably through the public boat ramp. In the early 2000s, Fawn Lake Association (now District) used spot chemical treatments to knock the EWM back. In July 2006, little Eurasian Watermilfoil was found. Areas formerly covered with EWM tended to be populated with *Elodea canadensis.* The Fawn Lake District has a lake management plan with specific management plan for dealing with aquatic invasives. Starting in 2008, a citizen monitoring group will be trained to monitoring aquatic invasives, including Eurasian Watermilfoil, Curly-Leaf Pondweed and Reed Canarygrass (the three aquatic invasives found at Fawn Lake in 2006).

Figure 43: Distribution of Invasive Aquatic Species in Fawn Lake 2006



Myriophyllum spicatum
(Eurasian Watermilfoil)

Potamgeton crispus
(Curly-Leaf Pondweed)

Phalaris arundinacea
(Reed Canarygrass)
And
Lythrum salicaria
(Purple Loosestrife—
not found at Fawn
Lake)

Figure 44: Invasive Aquatic Plants in Fawn Lake

Critical Habitat

Designation of critical habitat areas within lakes provides a holistic approach for assessing the ecosystem and for protecting those areas in and near a lake that are important for preserving the qualities of the lake. Wisconsin Rule 107.05(3)(i)(I) defines a "critical habitat areas" as: "areas of aquatic vegetation identified by the department as offering critical or unique fish & wildlife habitat or offering water quality or erosion control benefits to the body of water. Thus, these sites are essential to support the wildlife and fish communities. They also provide mechanisms for protecting water quality within the lake, often containing high-quality plant beds. Finally, critical habitat areas often can provide the peace, serenity and beauty that draw many people to lakes.

Protection of critical habitat areas must include protecting the shore area plant community, often by buffers of native vegetation that absorb or filter nutrient & stormwater runoff, prevent shore erosion, maintain water temperature and provide important native habitat. Buffers can serve not only as habitats themselves, but may also provide corridors for species moving along the shore.

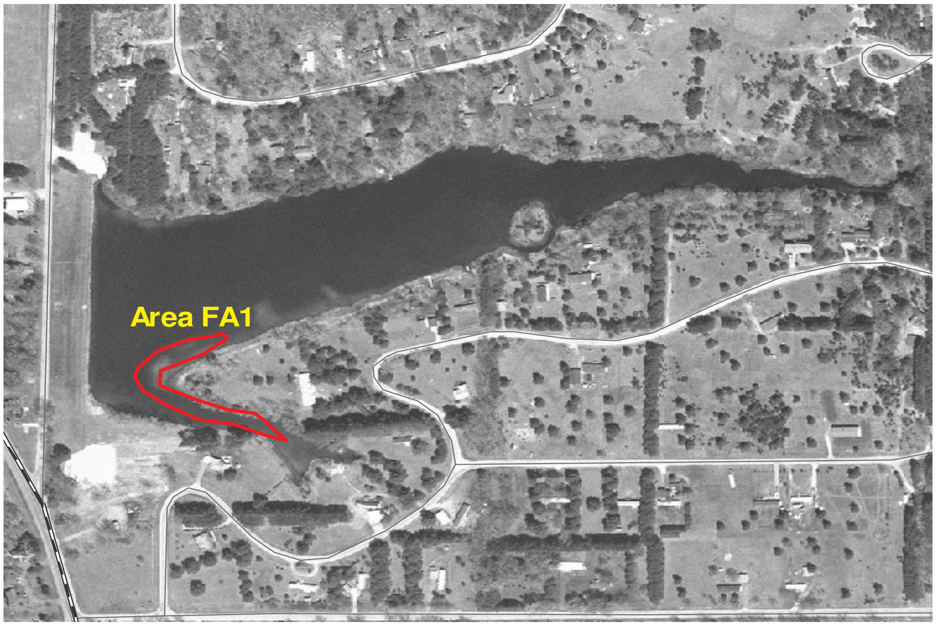
Besides protecting the landward shore areas, preserving the littoral (shallow) zone and its plant communities not only provides essential habitat for fish, wildlife, and the invertebrates that feed on them, but also provides further erosion protection and water quality protection.

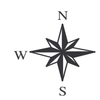
Field work for a critical habitat area study was performed on September 19, 2006, on Fawn Lake, Adams County. The study team included: Scot Ironside, DNR Fish Biologist; Deborah Konkel, DNR Aquatic Plant Specialist; and Reesa Evans, Adams County Land & Water Conservation Department. Areas were identified visually, with GPS readings and digital photos providing additional information. Input was also gained from Terence Kafka, DNR Water Regulation; James Keir, DNR Wildlife Biologist; and Patrick (Buzz) Sorge, DNR Lakes Manager. Areas were identified visually, with GPS readings and digital photos providing additional information.

Critical Habitat Area FL1

This area extends along approximately 500 feet of the shoreline and has an average water depth of 3 feet. Maximum rooting depth of aquatic vegetation in FL1 was 6 feet. Sediment includes marl, muck, peat, sand, silt and mixtures thereof. 75% of the shore is native herbaceous cover and 25% is wooded. Some woody cover is available for habitat. Human disturbance impact on this area is currently limited.

Figure 45: Critical Habitat Area on Fawn Lake





RE:9/06

Figure 46: North Side of FL1

Fishery in this area includes largemouth bass and several types of panfish, including bluegills, pumpkinseed and crappie. Geese and songbirds are known at this site, as are amphibians and reptiles.

Aquatic vegetation found at FL1 includes emergent plants such as bulrush, cattails, rushes and sedges. Emergents provide important fish habitat and spawning areas, as well as food and cover for wildlife. White water lily, floating-leaf rooted plant, was also found in FL1. Floating-leaf vegetation provides cover and dampens waves, protecting the shore. Submergent aquatic vegetation at this site were *Ceratophyllum demersum* (Coontail), *Chara* spp (Muskgrass), *Elodea canadensis* (Waterweed), *Potamgeton crispus* (Curly-Leaf Pondweed), *Potamgeton nodsosus* (Long-Leaf Pondweed), *Potamogeton pectinatus* (Sago Pondweed) and *Potamogeton pusillus* (Small Pondweed). A diverse submergent community provides many benefits. Most of these plants are used by a variety of fish and wildlife. Filamentous algae were found at this site as well.

This area of some woody cover, emergent aquatic vegetation, submergent and a little floating vegetation provides spawning and nursery areas for many types of fish: largemouth bass; bluegill; pumpkinseed; yellow perch; crappie; and other panfish. All of these fish also feed and take cover in these areas. No exotic aquatic wildlife was noted in this area, i.e, no carp, smelt or rusty crayfish were seen.

Figure 47: South Side of FL1

RECOMMENDATIONS FOR AREA FL1

(1) Maintain current habitat for fish and wildlife.
(2) Do not remove any fallen trees along the shoreline or in the water.
(3) No alteration of littoral zone unless to improve spawning habitat.
(4) Seasonal protection of spawning habitat.
(5) Maintain any snag/cavity trees for nesting.
(6) Install nest boxes.
(7) Maintain or increase wildlife corridor.
(8) Maintain no-wake zone.
(9) Protect emergent vegetation.
(10) Minimize aquatic plant and shore plant removal to maximum 30' wide viewing/access corridor. Leave as much vegetation as possible to protect water quality and habitat.
(11) Use best management practices on shoreline properties.
(12) No use of lawn products on nearby shores.
(13) No bank grading or grading of adjacent land.
(14) No pier placement, boat landings, development or other shoreline disturbance in the shore area of the wetland corridor.
(15) No pier construction or other activity except by permit using a case-by-case evaluation.
(16) No installation of pea gravel or sand blankets.
(17) No bank restoration unless the erosion index scores moderate or high.
(18) If the erosion index does score moderate or high, bank restoration only using biologs or similar bioengineering, with no use of riprap or retaining walls.
(19) Placement of swimming rafts or other recreational floating devices only by permit.
(20) Maintain aquatic vegetation buffer in undisturbed condition for wildlife habitat, fish use and water quality protection.
(21) Post exotic species information at public boat landing.
(22) No chemical treatments in area except specific spot-treatment for non-native invasive species.

FISHERY/WILDLIFE/ENDANGERED RESOURCES

In 1982, after an inventory of the lake, the WDNR determined that Fawn Lake was best managed for largemouth bass and bluegills. The most recent fishery inventory indicated that bluegills are abundant, with largemouth bass and pumpkinseed common. Also present are yellow perch, yellow bullhead and black crappie.

Muskrat are also known to use Fawn Lake shores for cover, reproduction and feeding. Seen during the field survey were various types of waterfowl, songbirds, and turkey. 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. In 2006, a pair of Egyptian geese made a summer home at Fawn Lake.

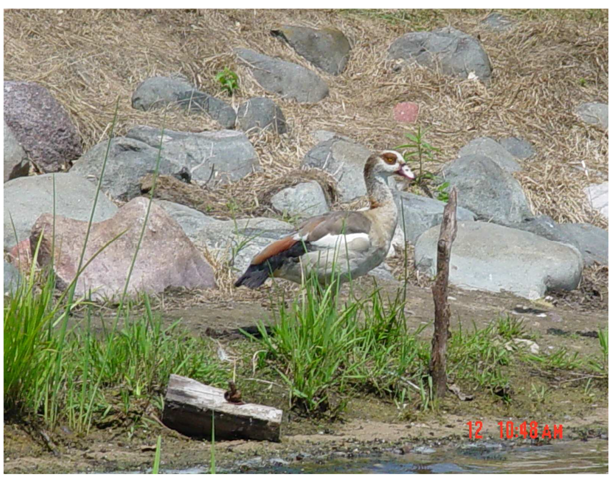


Figure 48: Eygyptian Goose at Fawn Lake 2006

Endangered resources known in the Fawn Lake watersheds are Blanding’s turtle and the western slender glass lizard.

Emydoidea blandingi
(Blanding’s Turtle)

Figure 49: Endangered Resources Reported in Fawn Lake Watersheds*

Ophisaurus attenuatus
(Western Slender Glass Lizard)

*information courtesy of Wisconsin Department of Natural Resources

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