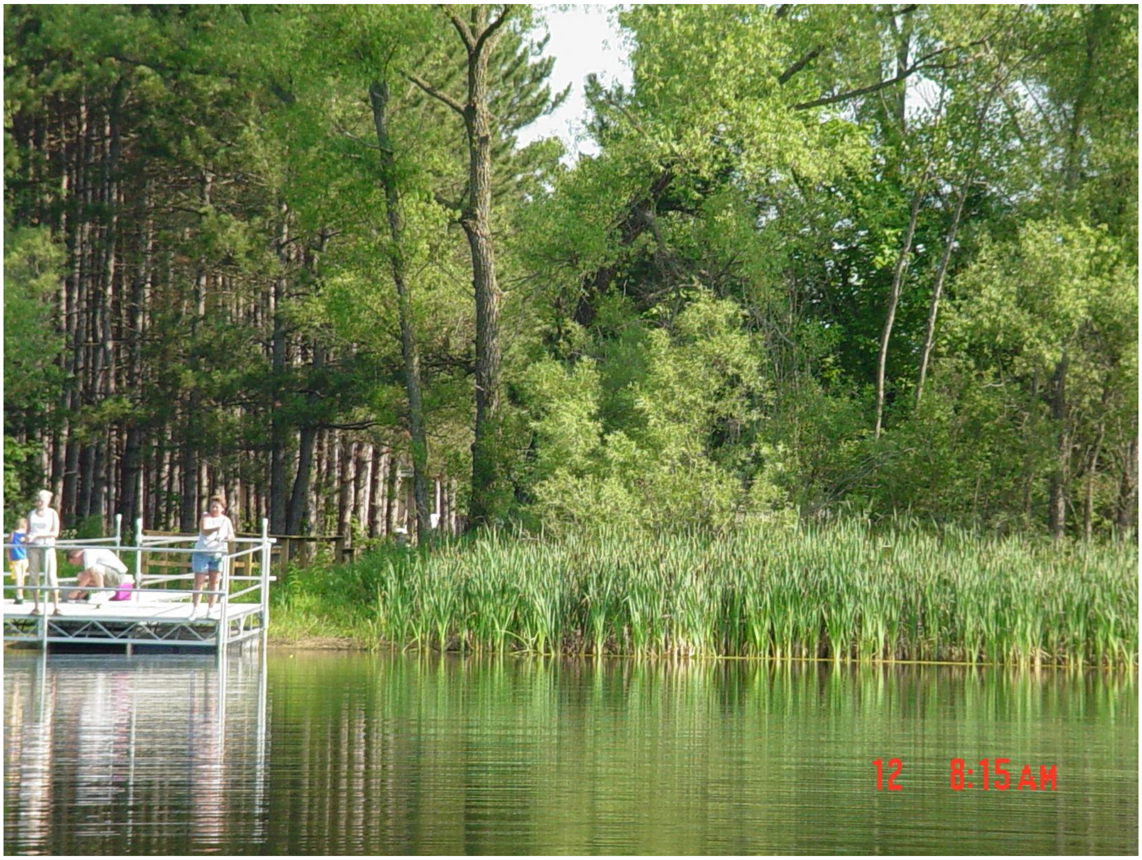

THE AQUATIC PLANT COMMUNITY OF FAWN LAKE, ADAMS COUNTY 2002-2015

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EXECUTIVE SUMMARY

Fawn Lake is a 19-acre impoundment on Trout Creek in southwest Adams County, Wisconsin. Both its surface and ground watersheds are small. The dam for Fawn Lake was authorized in 1970-71, and is maintained and operated by the Adams County Land & Water Conservation Department. There is a public boat launch, operated by the Adams County Parks & Recreation Department, at the upper western "corner" of the lake. There is also a public fishing dock a short walk from the boat launch. The maximum depth of the lake is about 15 feet, with the deepest areas occurring near the dam. Much of the shore is covered by thick cattails.

Phosphorus concentration, chlorophyll-a concentration and water clarity data are collected and combined to determine a trophic state, i.e., the nutrient status of a lake. The 2004-2015 summer average phosphorus concentration in Fawn Lake was 25.7 micrograms/liter (good). The 2005-2015 summer average chlorophyll-a concentration for Fawn Lake 8.5 micrograms/liter (very good). Average summer (May-September) Secchi disk clarity in Fawn Lake in 2003 to 2015 was 8.3 feet (very good). Both the total phosphorus and chlorophyll-a averages are in the "good" category, while the water clarity average scores in the "very good" category.

Aquatic plants occurred at 97.4% of the transect sample sites in Fawn Lake during the 2015 survey to a maximum rooting depth of 13.4 feet. 32 species were found, three of which were invasives, *Myriophyllum spicatum* (Eurasian Water Milfoil) and *Potamogeton crispus* (Curly-Leaf Pondweed), and *Phalaris arundinacea* (Reed Canarygrass). Of the native species, 15 were submergent species; 13 were emergent species; 3 were free-floating species; and 1 was a rooted floating-leaf plant.

Based on dominance value, Common Waterweed *(Elodea canadensis*) dominant in the 2015 PI survey, while Coontail *(Ceratophyllum demersum)* was sub-dominant. Chemical treatment occurred early in the summer to knock back Curly-Leaf Pondweed *(Potamogeton crispus)* and Eurasian Watermilfoil/hybrid *(Eurasian watermilfoil)*. In this survey, which was conducted at least a month after the chemical treatment, these two invasive species were only 5% of the aquatic macrophyte population.

The Simpson's Diversity Index for Fawn Lake was .89 for the 2015 survey, suggesting good species diversity. The Aquatic Macrophyte Community Index (AMCI) for Fawn Lake is 53 for the 2015 survey. These figures place Fawn Lake in the averagerange for all Wisconsin lakes (45 to 57) and the North Central Hardwood region (48 to 57). The Average Coefficients of Conservatism in 2015 put Fawn Lake in the group of lakes most tolerant of disturbance in Wisconsin lakes and lakes in the North Central Hardwood Region. This suggests that the aquatic plant community in Fawn Lake has been impacted by some disturbances, although the amount of that disturbance may depend on the area of the lake being examined.

MANAGEMENT RECOMMENDATIONS

1) Fawn Lake does have a lot of native vegetated shoreline, but some of the buffers need to be wider landward to get maximum benefit to the water quality. In the few places where there is bare soil, vegetation should be planted.

2) Further, the shore area previously cleared down to the bare soil needs to be restored as soon as possible to prevent soil erosion and degradation of the water quality in that area. This is particularly urgent since the property is located directly across from the designated critical habitat in Fawn Lake. The area in the water in front of this lot also should not be cleared, except the 30 foot wide corridor allowed to be hand-cleared.

3) The Fawn Lake District needs to update its aquatic plant management plan to aggressively manage the increasing populations of Eurasian Watermiilfoil and Curly-Leaf Pondweed. This should include varied approaches, not just the chemical treatment it has traditionally relied upon.

4) A EWM weevil survey should be performed at Fawn Lake to determine if the lake provides suitable habitat for the native weevils that attack EWM. If it does, the Fawn Lake District should consider participating in propagating these weevils as one of the methods to attack the EWM in its lake.

5) No lawn chemicals should be used on properties around the lake or in the water without a permit. If they must be used, they should be used no closer than 50 feet to the shore. The clearing of one shore area in 2011 happened so quickly that chemicals were obviously used, right at the shore, both in and out of the water. Since it has stayed non-vegetated, it is likely that chemicals are being used at that spot both in and out of the water to inhibit regrowth of plants.

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

7) Fallen trees should be left at the shoreline. They should not be removed unless they block access to the lake. The Fawn Lake District could pursue the addition of fallen trees as habitat. It might consider pursuing a Health Lakes Initiative grant for fish habitat installation.

8) Fawn Lake residents should continue to be involved in the Wisconsin Self-Help Monitoring Program to permit on-going monitoring of the lake trends for basically no cost. This should include regular monitoring for known invasives and invasives known to be nearby.

9) Fawn Lake residents should identify, cooperate with and participate in watershed programs that will reduce nutrient and sediment inputs.

10) Emergent vegetation and rooted floating-leaf beds should be protected where they are currently present and re-established where they are not. These not only provide habitat, but also help stabilize the shores in some area where the shores are exposed.

11) Shore areas where there is undisturbed wooded shore should be maintained &
left undisturbed.

12) Since one critical habitat area has been determined on Fawn Lake, care should be taken to reduce any disturbance in those areas. Posting a map of this area by the boat ramp might help lake users to avoid disturbing these areas.

THE AQUATIC PLANT COMMUNITY FOR FAWN LAKE
ADAMS COUNTY 2002-2015

I. INTRODUCTION

A survey of the aquatic macrophytes (plants) in Fawn Lake were conducted during the summer of 2015 by the Adams County Land and Water Conservation Department and the Wisconsin Department of Natural Resources. Previous full aquatic macrophyte surveys were done in 2002, 2006, and 2011. More limited surveys for the presence of the invasive Curly-Leaf Pondweed and Eurasian Watermilfoil (or its hybrid) were conducted during the years of chemical treatment.

Ecological Role: Information about the diversity, density and distribution of aquatic plants is an essential component in understanding the lake ecosystem due to the integral ecological role of aquatic vegetation in the lake and the ability of vegetation to impact water quality (Dennison et al, 1993). Lake plant life is the beginning of the lake's food chain, the foundation for all other lake life. Aquatic plants and algae provide food and oxygen for fish and wildlife, as well as cover and food for the invertebrates that many aquatic organisms depend on. Plants provide habitat and protective cover for aquatic animals. They also improve water quality, protect shorelines and lake bottoms, add to the aesthetic quality of the lake, and impact recreation.

This study will provide further information useful for effective management of Fawn Lake, including fish habitat improvement, protection of sensitive areas, aquatic plant management, and water resource regulation. Part of the Fawn Lake District's management plan is to repeat aquatic macrophyte surveys every four to five years.

Characterization of Water Quality: Aquatic plants can serve as indicators of water quality because of their sensitivity to water quality parameters such as clarity and nutrient levels (Dennison et al, 1993).

Background and History: Fawn Lake is a 19-acre impoundment on Trout Creek in southwest Adams County, Wisconsin. Both its surface and ground watersheds are small. The dam for Fawn Lake was authorized in 1970-71, and is maintained and operated by the Adams County Land & Water Conservation Department. Fawn Lake is located just off of State Highway 13 in the Town of Dell Prairie. There is a public boat launch, operated by the Adams County Parks & Recreation Department, at the upper western "corner" of the lake. There is also a public fishing dock a short walk from the boat launch. The maximum depth of the lake is about fifteen (15) feet, with the deepest areas occurring near the dam. Much of the shore is covered by thick cattails.

Complaints concerning heavy aquatic plant growth were recorded as early as 1974. Investigations at that time found heavy growth of sago pondweed (*Stuckenia* *pectinata*) and leafy pondweed (*Potamogeton foliosus*). Some coontail (*Ceratophyllum demersum*) was also found.

The first recorded chemical treatments were in 1981. Between 1981 and 2002, several different chemicals were used to treat aquatic plants and algae. Up to 10 acres had been treated in some years (more than half the lake), and multiple treatments were conducted many of the years. There was a break for several years, then chemical treatment resumed when large colonies of a hybrid Eurasian-Northern Watermilfoil and significant Curly-Leaf Pondweed were found.

Figure 1: Depth Map of Fawn Lake

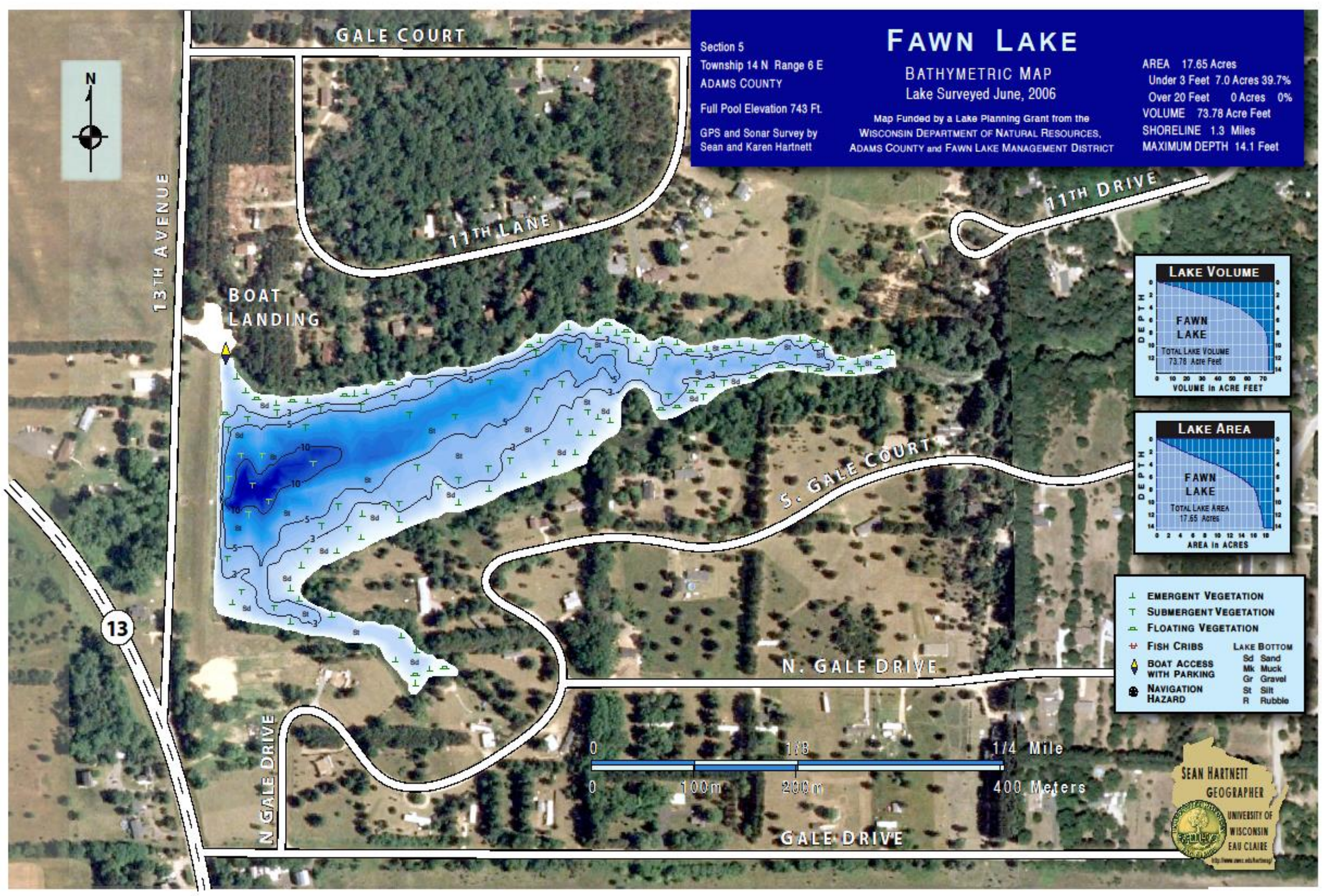


Figure 2: Chemical Treatment History for Fawn Lake

Year & # treatments	Diquat (gal)	Aquathol (gal)	AS-70 (gal)	CuSO4 (lbs)	2,4-D (gal)	Acres
1981(3)	3.75	14.5	6.5			4
1982 (3)	4		6.5	11	5	7
1989 (2)	3	2.5		14		8
1990	5			50		10
1991 (2)	2	5		75		5
1992 (2)	3.5	2		20		4
1993	2	2.5				4
1994 (3)				150		5
1994 (3)	5			100		5
1996 (3)	3			100		7
1999					270 lb	3
2001					297 lb	3
2002					750 lb	5
total	31.25 gal	26.5 gal	13 gal	521 lbs	5 gal	
					1317 lbs	

Diquat and Aquathol are broad-spectrum chemicals that kill all plant species. DNR Fish Management reported that chemical treatments were removing nearly all the plant material in the lake (1995, internal memo). Removing large portions of the aquatic plant community left little habitat for fish, augmented the algae problem and set up an ideal situation for the introduction and colonization of the two exotic plant species in the lake. Treatment with 2,4-D, considered more target-specific for Eurasian Watermilfoil, resumed in about 2010. Chemical treatment to address Curly-Leaf Pondweed was resumed at the same time. Specifics of those treatments have not been made available.

No other management methods, such as mechanical harvesting, hand-pulling or diver-assisted harvesting have been tried in Fawn Lake as of 2015.

Land Use: Both the surface and ground watersheds of Fawn Lake are fairly small. The two largest land uses in the surface watershed are Woodlands (45.9%) and Residential (35.3%). In the ground watershed, Woodlands dominate (83.0%).

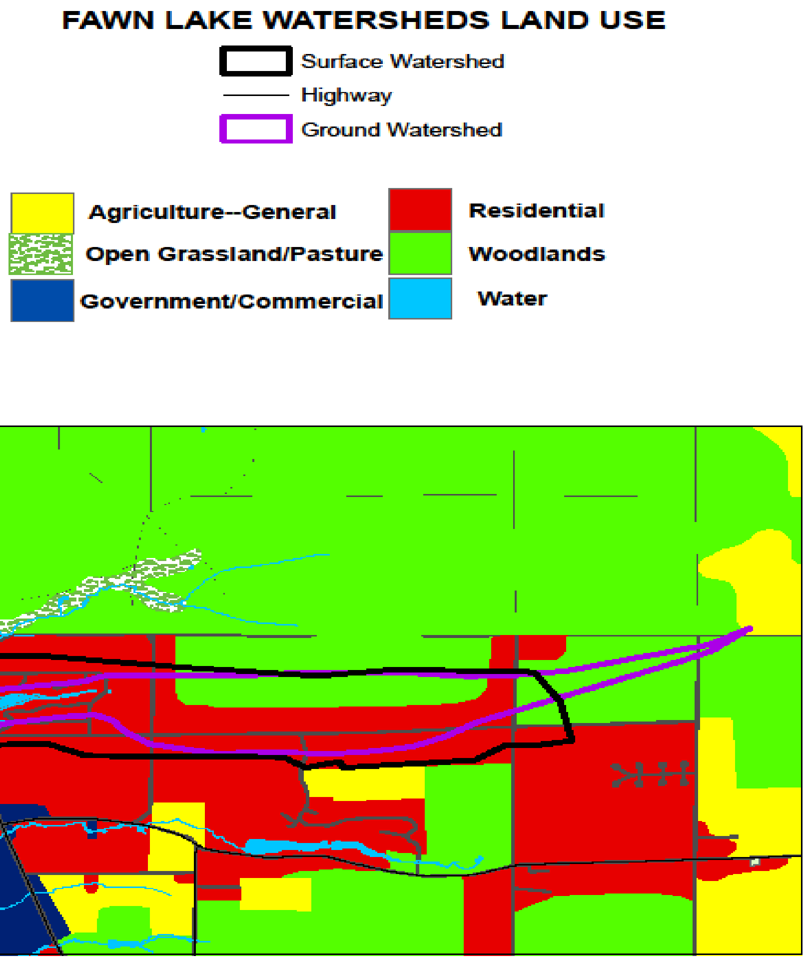
Soils: Except for some small pockets of silt loam and loamy sand, the soils in the surface and ground watersheds for Fawn Lake are sand, with slopes from very flat up to 20%. Sandy soils occupy 89% of the ground watershed and 90.6% of the surface watershed. These soils tend to be well or excessively 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.

Fish and Wildlife: 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 nesting and feeding. In 2006, a pair of Egyptian geese made a summer home at Fawn Lake, but they have not returned.

Critical Habitat Area: 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.

Figure 3: Land Use Map of Fawn Lake Watersheds



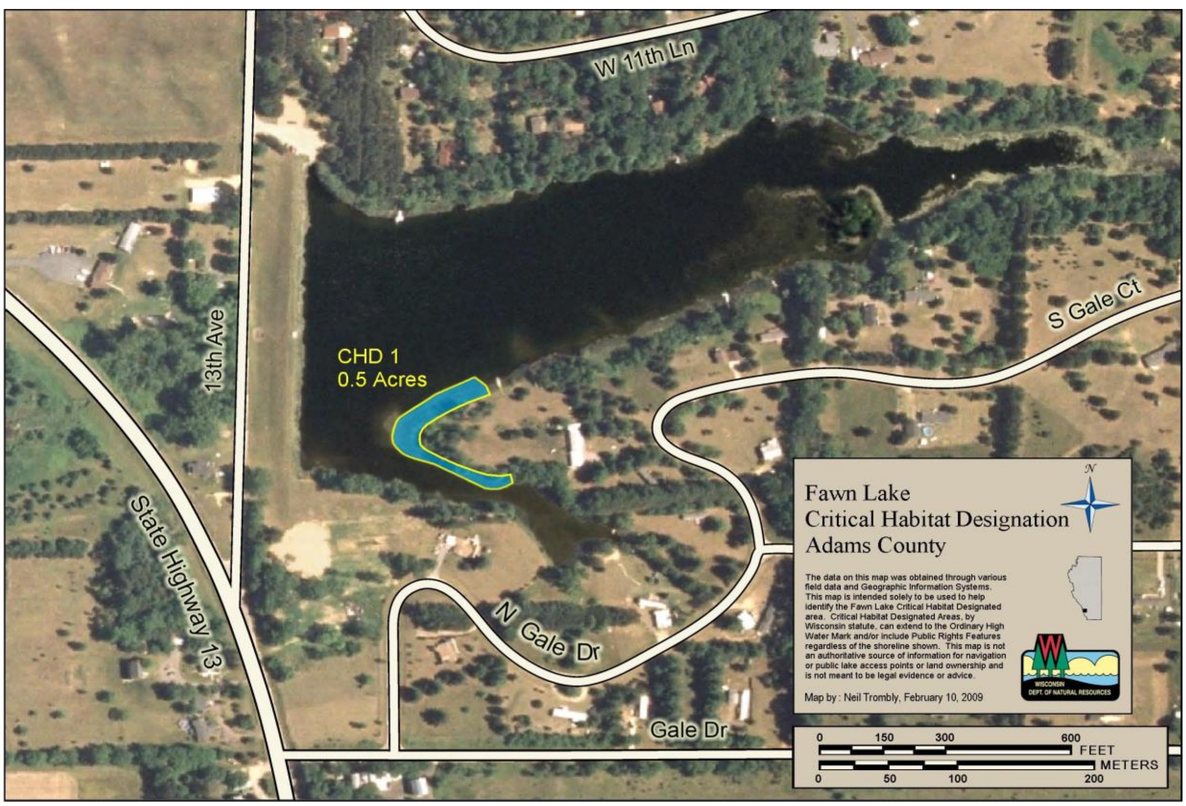
One area on Fawn Lake was designated as "critical habitat" by the Wisconsin Department of Natural Resources. This area extends along approximately 500 feet of the shoreline and has an average water depth of 3 feet. Maximum rooting depth of aquatic vegetation in FL1 was 6 feet. Sediment includes marl, 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.

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 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, a floating-leaf rooted plant, was also found in CHD1. Floating-leaf vegetation provides cover and dampens waves, protecting the shore. Seven species of submergent aquatics were found at this site as well. A diverse submergent community provides many benefits. Most of these plants are used by a variety of fish and wildlife.

Figure 4: Map of Fawn Lake Critical Habitat Area

Figure 2. Critical Habitat Designated Areas



This area of some woody cover, emergent aquatic vegetation, submergent plants, 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.

II. METHODS

Field Methods

The 2002, 2006, and one 2011 aquatic plant survey studies were based on the rake-sampling method developed by Jessen and Lound (1962), using stratified random transects. The shoreline was divided into 12 equal sections, with one transect placed randomly within each segment, perpendicular to the shoreline. This method takes samples only in areas of 20 feet in depth or less (littoral zone).

Surveys starting in 2010 used the Point Intercept Method. This method involves calculating the surface area of a lake and dividing it (using a formula developed by the WDNR) into a grid of several points, always placed at the same interval from the next one(s). These points are related to a particular latitude and longitude reading. At each geographic point, the depth is noted and one rake is taken, with a score given between 1 and 3 to each species on the rake.

A rating of 1 = a small amount present on the rake;
A rating of 2 = moderate amount present on the rake;
A rating of 3 = large amount present on the rake.

A visual inspection was done between points to record the presence of any species that didn't occur at the raking sites. Gleason and Cronquist (1991) nomenclature was used in recording plants found.

Data Analysis:

The percent frequency (number of sampling sites at which it occurred/total number of sampling sites) of each species was calculated. Relative frequency (number of species occurrences/total all species occurrences) was also determined. The mean density (sum of species' density rating/number of sampling sites) was calculated for each species. Relative density (sum of species' density/total plant density) was also determined. Mean density where present (sum of species' density rating/number of sampling sites at which species occurred) was calculated. Relative frequency and relative density results were summed to obtain a dominance value. Species diversity was measured by Simpson's Diversity Index.

The Average Coefficient of Conservation and Floristic Quality Index were calculated as outlined by Nichols (1998) to measure plant community disturbance. A coefficient of conservation is an assigned value between 0 and 10 that measures the probability that the species will occur in an undisturbed habitat. The Average Coefficient of Conservationism is the mean of the coefficients for the species found in the lake. The coefficient of conservatism is used to calculate the Floristic Quality Index, a measure of a plant community's closeness to an undisturbed condition within its respective ecoregion.

An Aquatic Macrophyte Index was determined using the method developed by Nichols et al (2000). This measurement looks at the following seven parameters and assigns each of them a number on a scale of 1-10: maximum depth of plant growth; percentage of littoral zone vegetated; Simpson's diversity index; relative frequency of submersed species; relative frequency of sensitive species; taxa number; and relative

frequency of exotic species. The average total for the North Central Hardwoods lakes and impoundments is between 48 and 57. The maximum score for this scale is 70.

III. RESULTS

Chemical & Physical Data

The aquatic plant community can be impacted by several physical parameters. W water quality, including nutrients, algae and clarity, influence the plant community; the plant community in turn can modify these boundaries. Lake morphology, sediment composition, and shoreline use also affect the plant community.

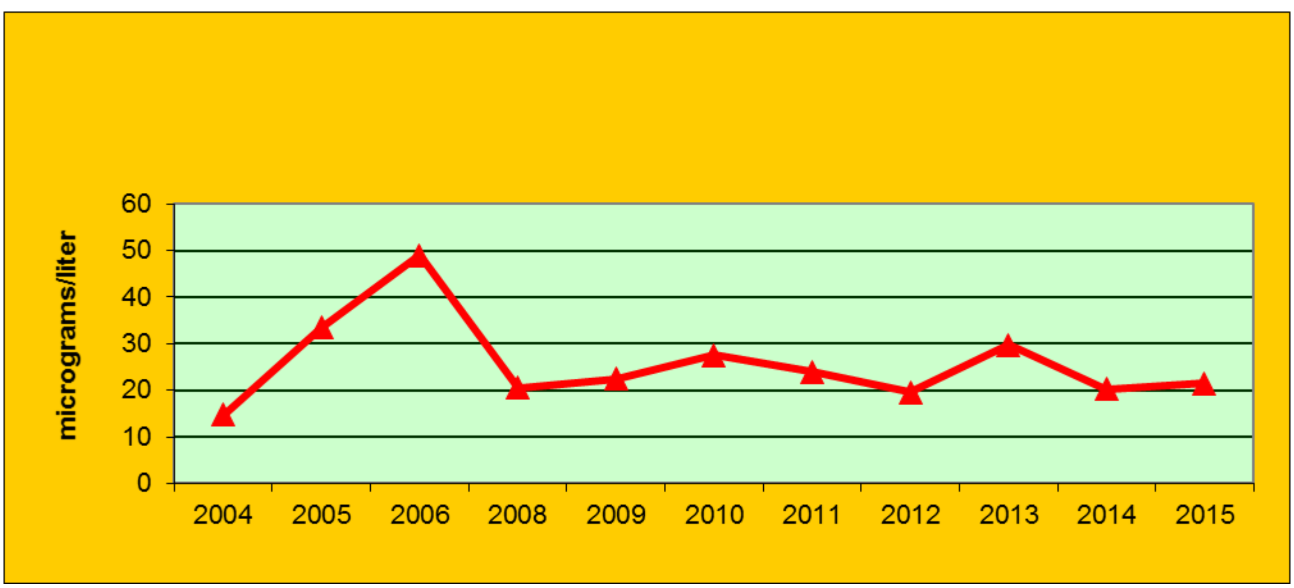
The trophic state of a lake is a classification of water quality. Total phosphorus concentration, chlorophyll-a concentration, and water clarity data are collected and combined to determine a trophic state. Eutrophic lakes are very productive, with high nutrient levels and large biomass presence. Oligotrophic lakes are those low in nutrients with limited plant growth and small fisheries. 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; those with a good and more varied fishery than either the eutrophic or oligotrophic lakes. The most diversity tends to occur in mesotrophic lakes.

Measuring the total 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 2004-2011 summer average phosphorus concentration in Fawn Lake was 25.7 micrograms/liter (good). Fawn Lake's average total phosphorus is below the recommended 40 micrograms/liter for impoundments like Fawn Lake under the Wisconsin Phosphorus Index and below the Wisconsin average for impoundments of 65 micrograms/liter

Figure 5: Trophic State Parameters

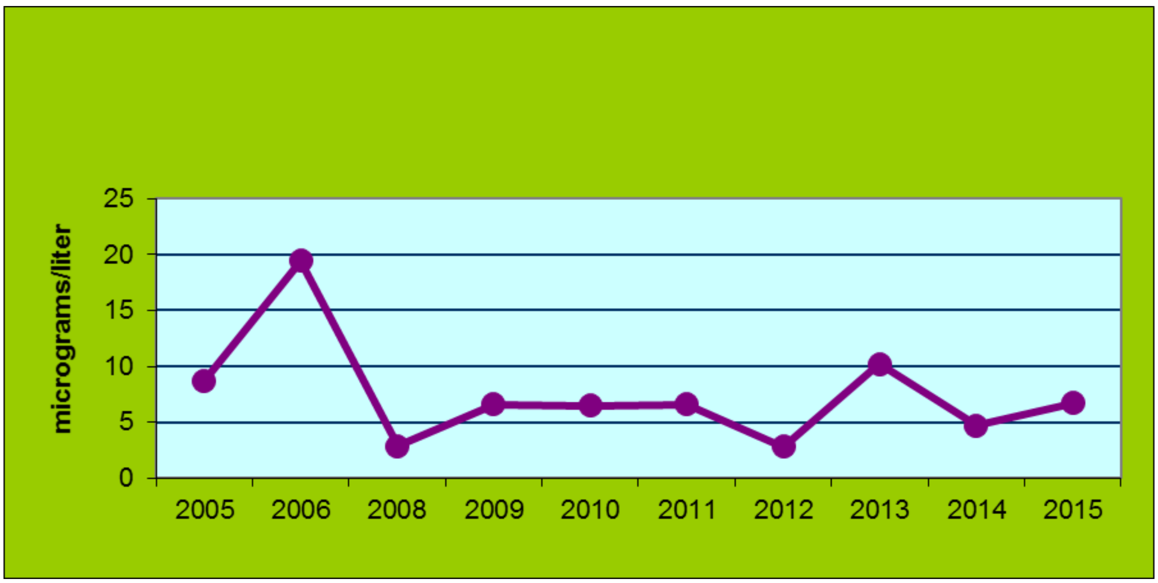
Trophic State	Quality Index	Phosphorus (ug/l)	Chlorophyll-a (ug/l)	Sechhi Disk (ft)
Oligotrophic	Excellent	<1	<1	>19
	Very Good	1 to 10	1 to 5	**8 to 19**
Mesotrophic	Good	**10 to 30**	**5 to 10**	6 to 8
	Fair	30 to 50	10 to 15	5 to 6
Eutrophic	Poor	50 to 150	15 to 30	3 to 4
Fawn Lake		**25.7**	**7.5**	**8.3**

Figure 6: Total Phosphorus Averages in Fawn Lake



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. The 2005-2015 summer average chlorophyll concentration for Fawn Lake 7.5 micrograms/liter (good). This is fairly low, especially for an impoundment, placing Fawn Lake at the meostrophic level for chlorophyll-a results.

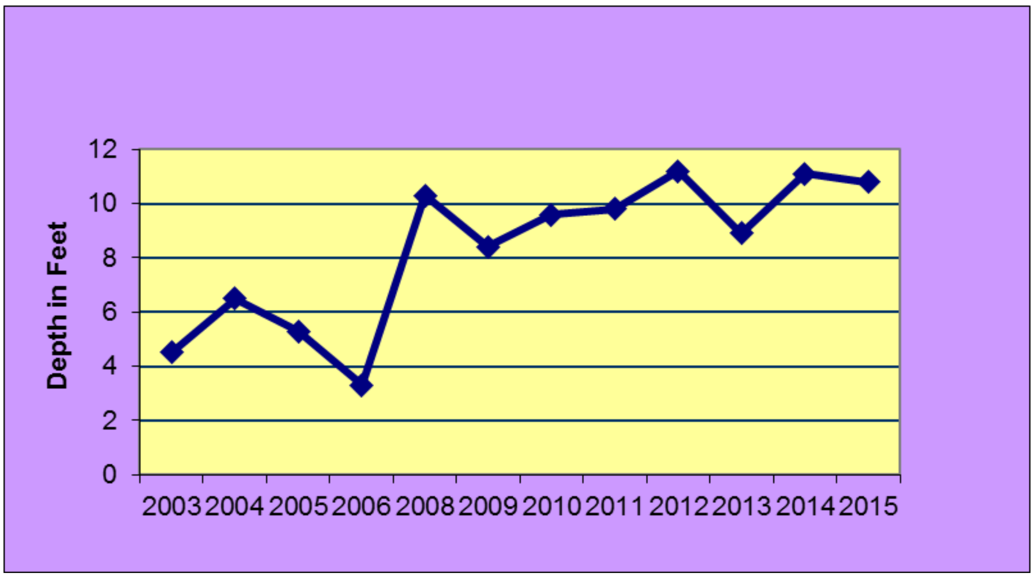
Figure 7: Chlorophyll-a Averages in Fawn Lake.



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. Secch readings have been kept on Fawn Lake continuously since 2003. Average summer (May-September) Secchi disk clarity in Fawn Lake in 2003 to 2015 was 8.3 feet. This is very good water clarity.

It is normal for all of these values to fluctuate during a growing season. They can be affected by human use of the lake, by summer temperature variations, by algae growth & turbidity, and by rain or wind events. Phosphorus tends to rise in early summer, than decline as late summer and fall progress. Chlorophyll-a tends to rise in level as the water warms, then decline as autumn cools the water. Water clarity also tends to decrease as summer progresses, probably due to algae and plant growth, then declines as fall approaches.

Figure 8: Average Water Clarity on Fawn Lake



Lake Morphology: Lake morphology is an important factor in distribution of lake plants. Duarte & Kalff (1986) determined that the slope of a littoral zone could explain up to 72% of the observed variability in the growth of submerged plants. Gentle slopes support higher plant growth than steep slopes (Engel 1985).

Fawn Lake is a narrow, shallow impoundment with gradually sloped littoral zone and very shallow east end. The gradually slopes and shallow depths would favor plant growth.

SEDIMENT COMPOSITION - Many species of plants depend on the sediment in which they are rooted for their nutrients. The richness or sterility and texture of the sediment will determine the type and abundance of macrophyte species that can survive in a particular lake.

Based on prior surveys, silt, an intermediate density sediment, was the predominant sediment in Fawn Lake, especially at depths greater than 5 feet. The availability of mineral nutrients for growth is highest in sediments of intermediate density, such as silt (Barko and Smart 1986). Sand and silt mixtures were predominant in the 0-5 feet depth zone; while sand sediment was common at depths less than 5 feet. Although sand sediment may limit growth, almost all sites in Fawn Lake were vegetated. It appears that sandy sediment is not a limiting factor at Fawn Lake.

Shoreland: Shoreline land use often strongly impacts the aquatic plant community and thus the entire aquatic community. Impacts can be caused by increased erosion and sedimentation and higher run-off of nutrients, fertilizers, and toxins applied to the land. Such impacts occur in both rural and residential settings.

Shores at Fawn Lake tend to have good herbaceous cover, almost 100% occurrence frequency. Although trees and shrubs are less common, trees were found at about

75% of the shores and shrubs at 15%. Small areas of cultivated lawn are not uncommon. Hard structures at shores tend to be docks only.

Macrophyte Data

SPECIES PRESENT

Aquatic plants occurred at 97.4% of the transect sample sites in Fawn Lake during the 2015 survey to a maximum rooting depth of 13.4 feet. 32 species were found, three of which were invasives, *Myriophyllum spicatum* (Eurasian Water Milfoil) and *Potamogeton crispus* (Curly-Leaf Pondweed), and *Phalaris arundinacea* (Reed Canarygrass). Of the native species, 15 were submergent species; 13 were emergent species; 3 were free-floating species; and 1 was a rooted floating-leaf plant.

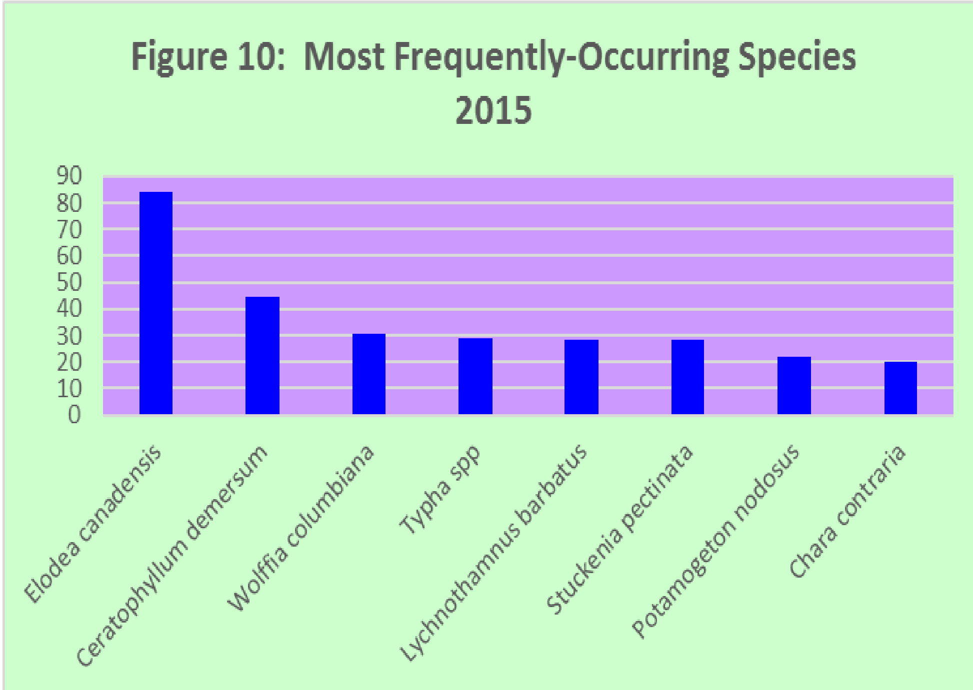
Figure 9—Plants in Fawn Lake, 2002-2015

Scientific Name	Common Name	2002T	2006T	2011T	2011PI	2015PI
Agalinus paupercula	Purple False Foxglove		x		x	
Bidens connatus	Purple--Stemmed Beggar's Tick					x
Bidens frondosus	Common Beggar's Tick			x	x	
Bidens vulgatux	Tall Beggar's Tick		x	x	x	
Carex spp	Sedge	x			x	x
Carex utriculata	Common Yellow Lake Sedge				x	
Ceratophyllum demersum	Coontail	x	x	x	x	x
Chara contraria	Opposite Stonewort	x	x	x	x	x
Cicuta bulbifera	Bulb-Bearing Water Hemlock		x			
Eleocharis acicularis	Needle Spikerush		x			
Eleocharis palustris	Common Spikerush					x
Elodea canadensis	Common Waterweed	x	x	x	x	x
Juncus effusus	Soft Rush	x				
Leersia oryzoides	Rice-Cut Grass		x		x	x
Lemna minor/triscula/turionifera	Small Duckweed	x	x	x	x	x
Lychnothamnus barbatus	Bearded Stonewort					x
Ludwigia palustris	Marsh Purslane					x
Myriophyllum heterophyllum	Various-Leaved Milfoil			x	x	x
Myriophyllum sibiricum	Northern Milfoil	x	x	x	x	x
Myriophyllum spicatum/hybrid	Eurasian Water Milfoil	x	x	x	x	x

Myriophyllum verticillatum	Whorled Milfoil					x
Najas flexlis	Bushy Pondweed	x	x			x
Najas guadelupensis	Southern Naiad			x	x	x
Nymphaea odorata	White Water Lily		x			
Phalaris arundinacea	Reed Canary Grass	x	x	x	x	x
Polygonum amphibium	Water Smartweed			x	x	x
Polygonum hydropiperoides	Swamp Smartweed		x			
Polygonum lapthifolium	Dock-Leaved Smartweed					x
Polygonum persicaria	Heart's Ease				x	
Potamogeton amplifolius	Large Pondweed				x	x
Potamogeton crispus	Curly-Leaf Pondweed	x	x	x	x	x
Potamogeton foliosus	Leafy Pondweed				x	
Potamoeton friesii	Fries' Pondweed				x	
Potamogeton nodosus	Long-Leaf Pondweed	x	x	x	x	x
Potamogeton pusillus	Small Pondweed	x	x	x	x	x
Potamogeton strictifolius	Stiff Pondweed					x
Potamogeton zosteriformis	Flat-Stemmed Pondweed		x		x	
Ranunculus sceleratus	Cursed Crowfoot		x		x	x
Rorippa aquatica	Yellow Cress					x
Rumex spp	Dock		x			
Salix spp	Willow	x	x		x	x
Salix bebbiana	Bebb's Willow			x	x	
Salix discolor	Pussy Willow					x
Salix exigua	Sandbar Willow			x	x	
Salix periolaris	Meadow Willow			x	x	
Schoenoplectus tabernaemontani	Soft-Stemmed Bulrush	x	x	x	x	x
Solanum dulcamara	Bittersweet Nightshade			x	x	x
Spirodela polyrhiza	Large Duckweed		x	x	x	x
Stuckenia pectinata	Sago Pondweed		x	x	x	x
Typha spp	Cattail	x	x	x	x	x
Wolffia columbiana	Watermeal		x	x	x	x
Zosterella dubia	Water Stargrass			x	x	x

FREQUENCY OF OCCURRENCE

The most frequently-occurring plant in the 2015 survey by far was Common Waterweed. It was found at over 84% of the sample sites. Coontail was the next most frequently-occurring plans. Other commonly-found species included Watermeal, Cattail, Bearded Stonewort, Sago Pondweed, Long-Leaf Pondweed, and Muskgrass.



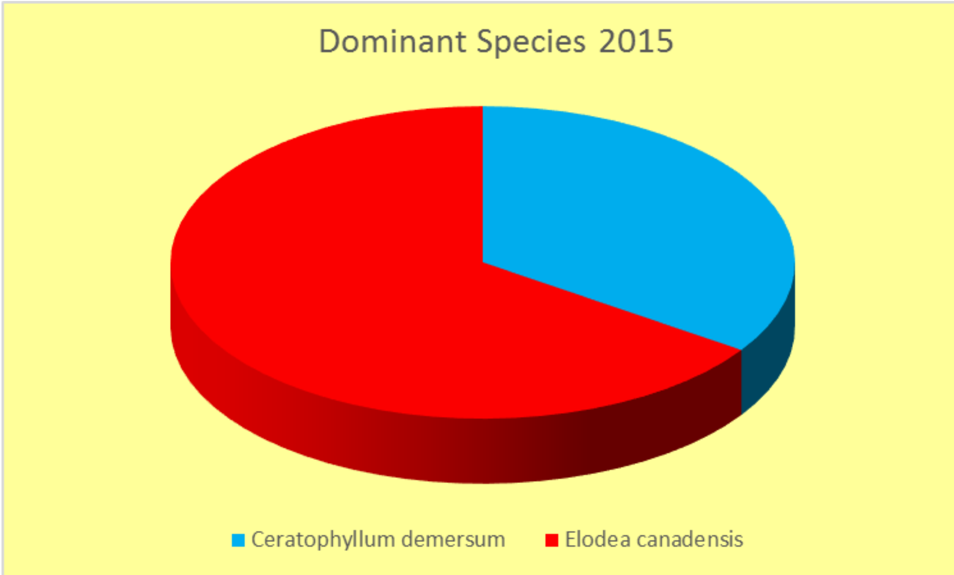
DENSITY OF GROWTH

Common waterweed was the species with the highest mean density of growth in Fawn Lake in the 2015 survey. However, it did not occur throughout the lake in high density, but instead was only densely-growing in just over 17% of the sample sites.

DOMINANCE

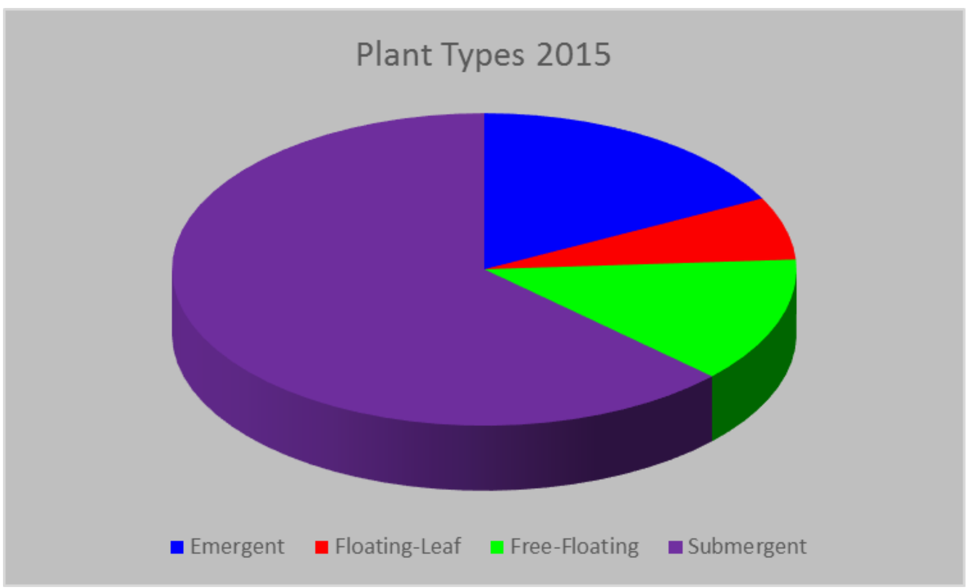
Relative frequency and relative density are combined into a dominance value that demonstrates how dominant a species is within its aquatic plant community. Based on dominance value, Common Waterweed dominated the aquatic macrophyte community in Fawn Lake in 2015, with Coontail subdominant.

Figure 11: Dominance in 2015 in Fawn Lake



The community was also evaluated for the difference in the type of plants. Like many lakes in Adams County, Fawn Lake was dominated by submergent plants. The plant type it had the least of was rooted floating-leaf plants, such as water lily.

Figure 12: Dominance re Plant Types in Fawn Lake 2015



IV. DISCUSSION

Aquatic plants occurred at over 97% of the sample sites in Fawn Lake during the 2015 survey to a maximum rooting depth of 13.2 feet. This is consistent with results of prior surveys; vegetation is generally high, sometimes up to 100% vegetated.

Overall species richness (number of species per sample site) for the 2015 PI survey was 4.48 per site. This is slightly higher than the PI figure for 2011, when species richness was 4.15 per site. For the transect surveys conducted earlier, the species richness figure for 2002 was 3.85; for 2006, it was 3.96; and for 2011, it was 4.8.

Maps on the following pages outline the approximate areas of the lake where different species types were found during the 2015 survey.

Figure 13: Location of Emergent Plants in Fawn Lake in 2015

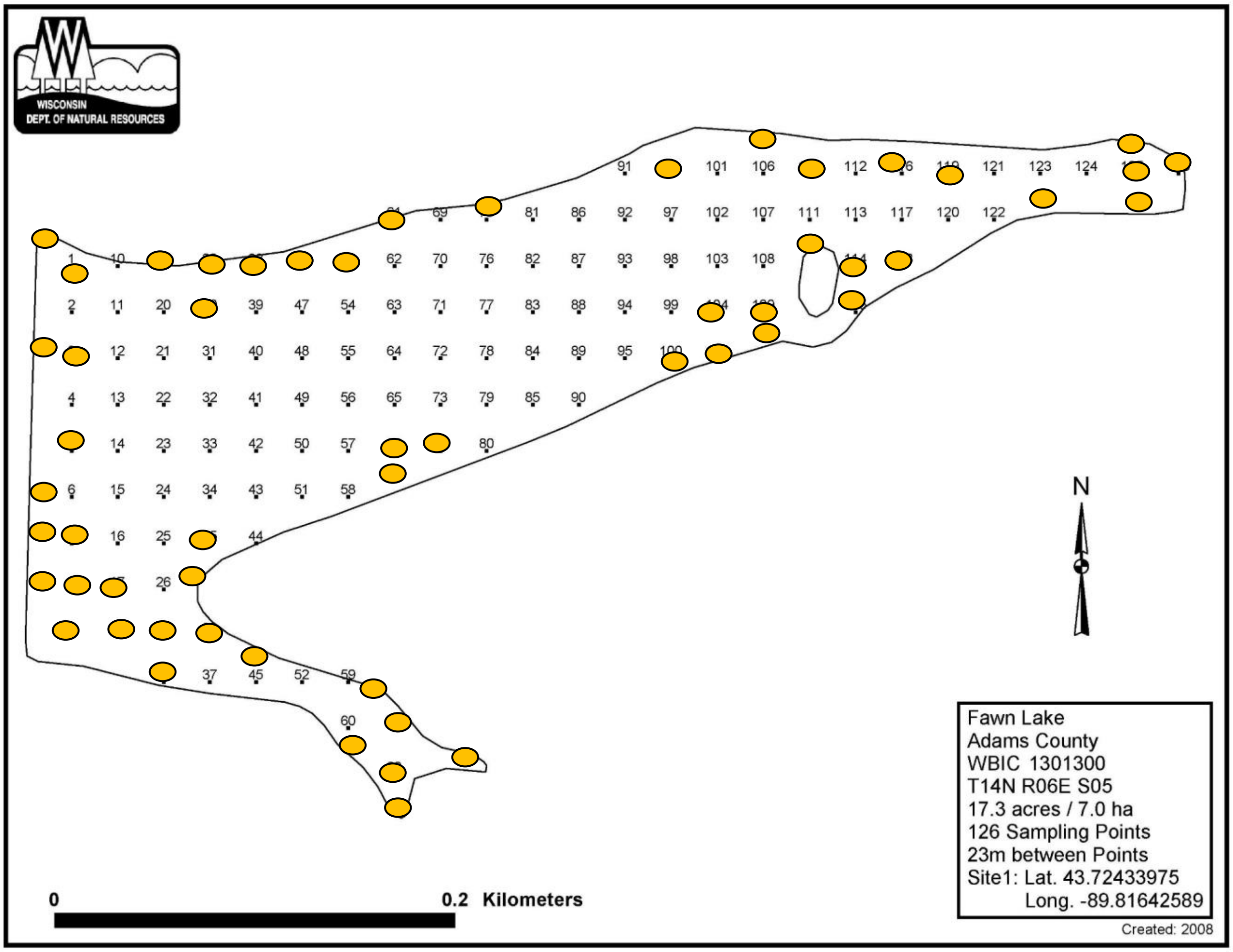
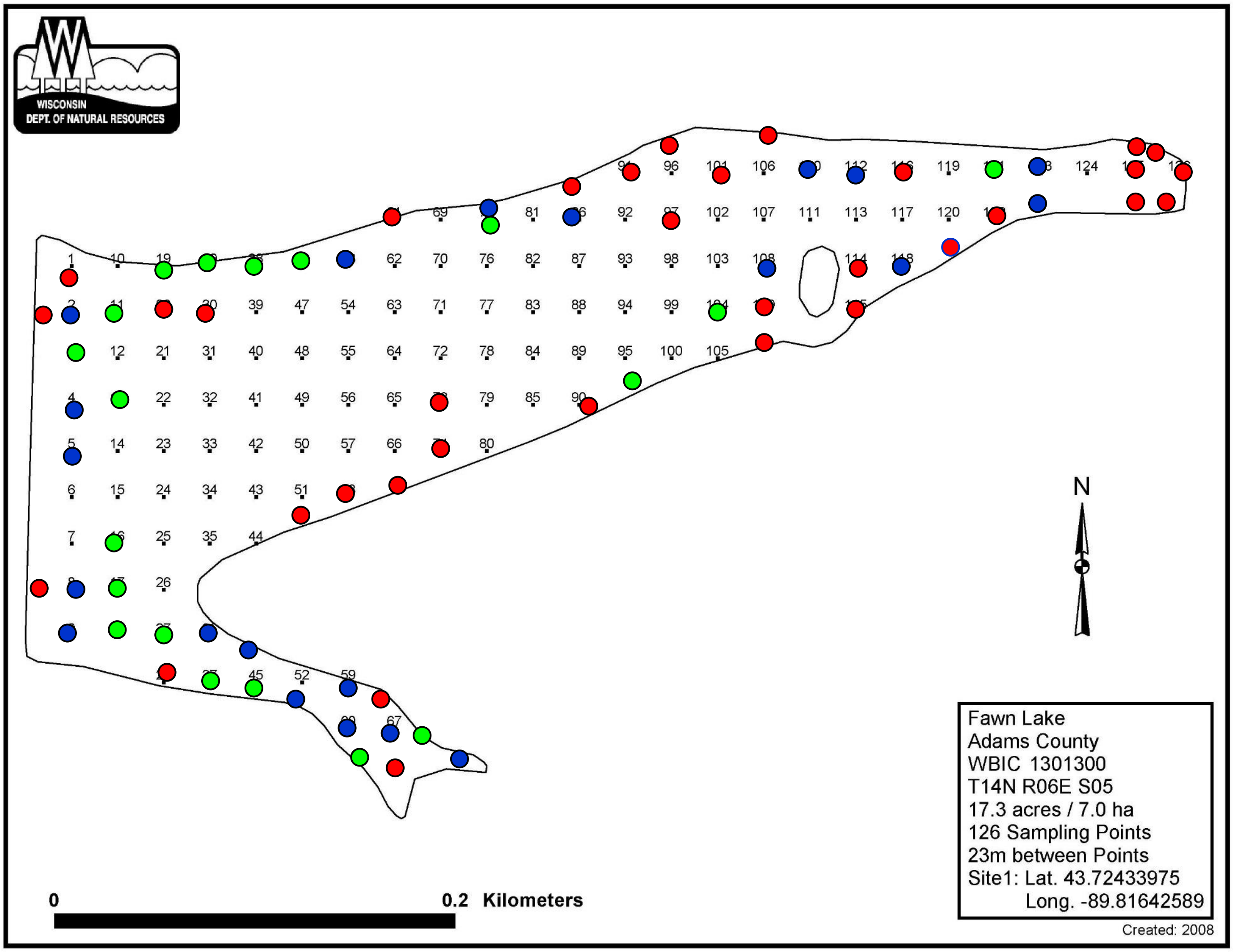
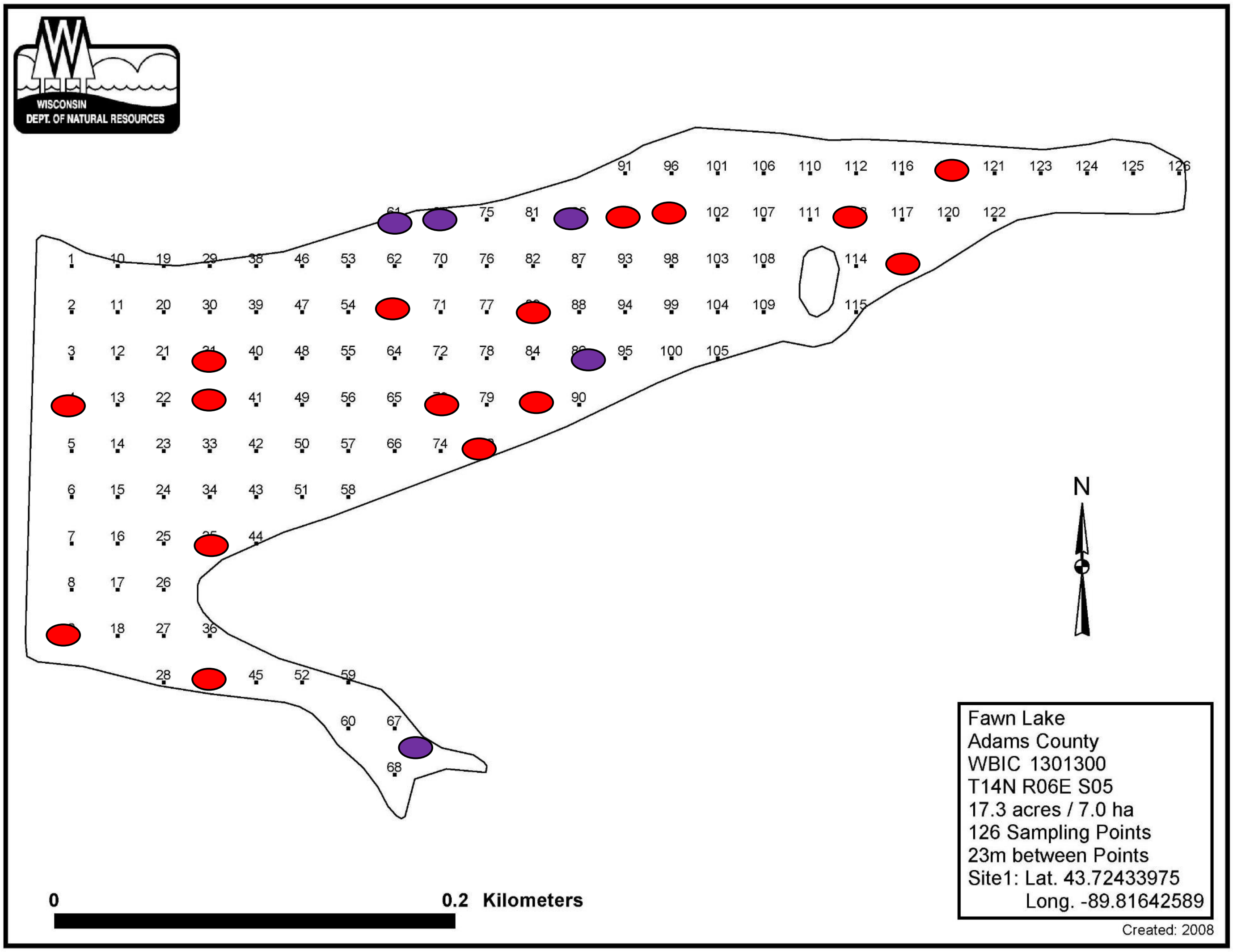

WISCONSIN
DEPT. OF NATURAL RESOURCES
N
Fawn Lake
Adams County
WBIC 1301300
T14N R06E S05
17.3 acres / 7.0 ha
126 Sampling Points
23m between Points
Site1: Lat. 43.72433975
Long. -89.81642589
0
0.2 Kilometers
Created: 2008

Figure 14: Location of Free-Floating & Floating-Leaf Plants in 2015



Floating Leaf only
Floating-Leaf & Free-Floating
Free-Floating only

Figure 15: Location of Eurasian Watermilfoil & Curly-Leaf Pondweed



Curly-Leaf Pondweed   Eurasian Watermilfoil/Hybrid

Lychnothamnus barbatus was noted in Fawn Lake in 2010, after it was found in some other lakes in Adams County. Until then, this most-endangered *Charophyte* had never been found in the Western Hemisphere. The species was marked separately during the 2015 survey in order to gain specific information about its locations in Fawn Lake. *Charophytes* (including *L. barbatus)* were found at about 24% of the vegetated sites in various densities during the 2015 survey.

Charophytes play important roles in aquatic ecosystems in the food web, in providing habitat, and in increasing water quality. They do not thrive in murky, turbid or dirty water. Many ducks, amphibians & reptiles directly use these species as food. *Charophytes* also serve as a location for insects that provide food for fish and other wildlife. In particular, insects that provide food for game fish like bluegills, smallmouth and largemouth bass are often found on *Charophytes.* In the winter, *Charophytes* provide shelter for overwintering insects.

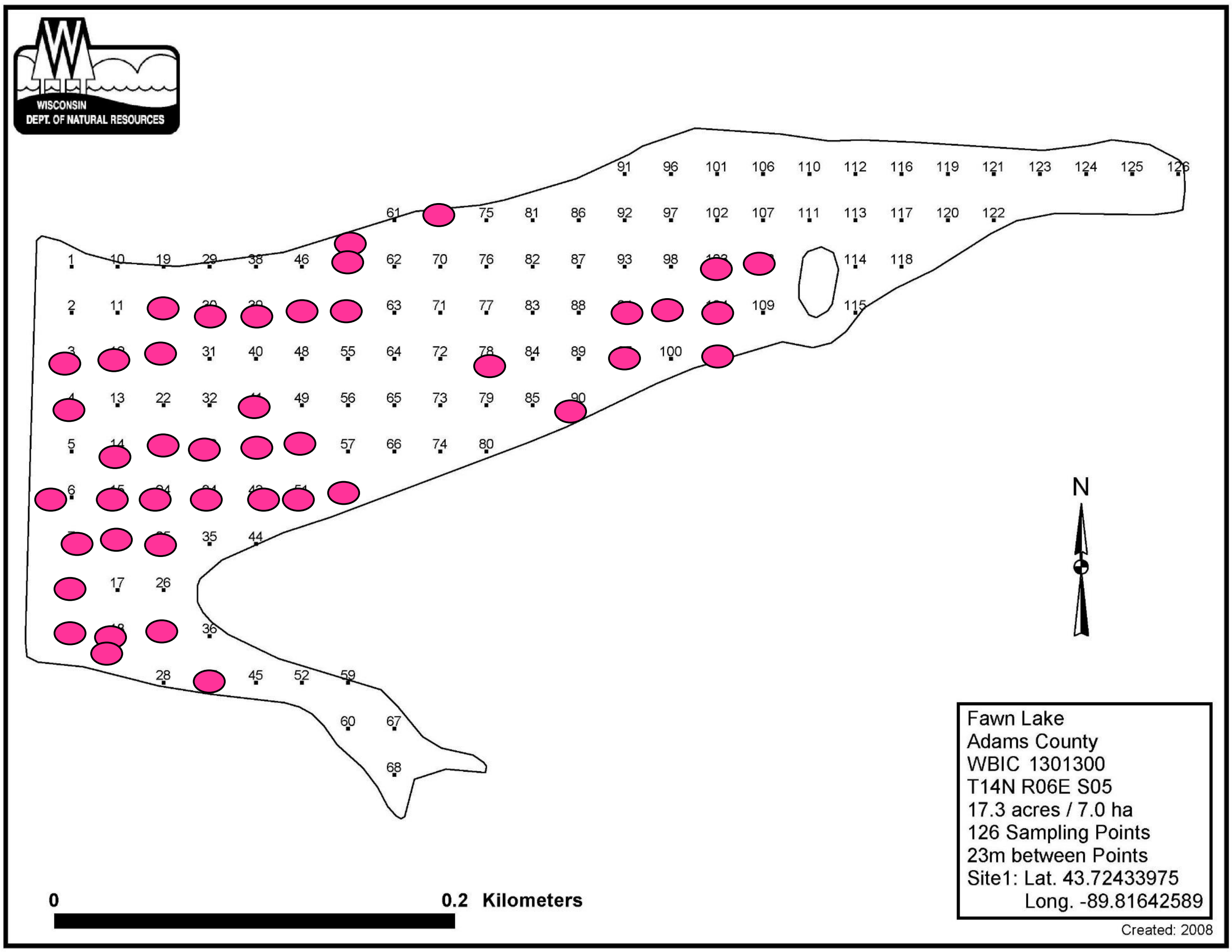
In addition to providing habitat for important invertebrates and food for fish and wildlife, *Charophytes* serve as protection and cover for young fish. They are important in the predator-prey ratio. Their presence has even been known to inhibit the survival of mosquito larvae. Studies in Europe suggest *Charophyte* beds are important for northern pike and walleye spawning.

Perhaps the most important role in an aquatic ecosystem that *Charophytes* serve is in water quality. They naturally filter the water and play an important part in nutrient cycling. They hold massive amounts of phosphorus that might otherwise be available for less attractive algae or nuisance aquatic plant growth. In hard water lakes like Parker Lake, the calcification on the *Charophytes* ties up even more phosphorus.

They are known to play important roles in forming and shaping an aquatic environment, influencing both abiotic (pH, water clarity) and biologic (structure of phytoplankton) factors. Besides holding phosphorus, they also hold a lot of nitrogen, which is the second most influential factor in the presence of nuisance aquatics. They deliver oxygen to sediments, enhancing the nitrogen cycle and preventing iron-bound phosphorus from being released into the water column.

Charophytes also stabilize bottom sediments, reducing resuspension of sediment particles (which are often laden with nutrients) into the water column. Studies have shown that they reduce resuspension up to 100 times more than aquatic plants.

Figure 16: Location of *Lychnothamnus barbatus* in Fawn Lake 2015



Three same three invasive plants have been found on Fawn Lake since 2002: *Myriophyllum spicatum* (Eurasian Watermilfoil); *Phalarais arundinacea* (Reed Canarygrass); and *Potamogeton crispus* (Curly-leaf Pondweed). All of them have varied considerably in each aquatic plant survey. They have sometimes been a significant part of the aquatic plant community, but sometimes not. In 2002, the three invasives together were 33.5% of the overall aquatic community. By 2006, after a few years of chemical treatment for Eurasian Watermilfoil, it was down to 7.5%, but climbed back up in 2011 to a little over 20%. In 2015, after several years of resumed chemical treatment, they were 5% of the overall community.

THE COMMUNITY

The 2015 Simpson's Diversity Index (SI) score for Fawn Lake was .89, suggesting good species diversity. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable). The average SI range for all Wisconsin lakes is .80 to .90. The SI diversity score for Fawn Lake thus places it in the median of all lakes in Wisconsin. The North Central Hardwood Region, which includes Fawn Lake, has an average SI range is .82 to .90, so Fawn Lake is again in the median range for diversity for its ecological region too (Nichols et al, 2000).

The Aquatic Macrophyte Community Index (AMCI) for the 2015 survey of Fawn Lake is 53, the same score as in 2011. The median AMCI range for all Wisconsin Lakes is 45 to 57; the median for the North Central Hardwood Lakes Region is 48 to 57. Fawn Lake again scores squarely in the average range for both all lakes in Wisconsin and lakes in the North Central Hardwoods region.

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

Figure 17: AMCI Calculations 2011 PI and 2015 PI

	2011	2011	2015	2015
	parameter	value	parameter	value
Max. Rooting Depth (ft)	13.3	8	13.2	8
% Littoral Vegetated	97.6	10	97.4	10
% Submerged Species	86	10	64	6
% Exotic Species	21	3	5	6
% Sensitive Species	3	4	4	5
SI Index	0.90	8	0.89	8
# taxa	32	10	31	10
TOTAL		53		53

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 2015 Average Coefficient of Conservatism was 4.35, about the same as the 2011 figure for the PI survey at 4.4. These figures put Fawn Lake below the median, in the lowest quartile for Wisconsin Lakes (average 6.0) and for lakes in the North Central Hardwood Region (average 5.6). Using the criteria of the average coefficient of conservatism, 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.

Figure 18: Floristic Quality and Coefficient of Conservatism of Fawn Lake,
Compared to Wisconsin Lakes and North Central Hardwood Lakes.

	Average Coefficient of Conservatism †	Floristic Quality ‡
Wisconsin Lakes	5.5, 6.0, 6.9 *	16.9, 22.2, 27.5
NCHR	5.2, 5.6, 5.8 *	17.0, 20.9, 24.4
Fawn Lake	**4.35**	**25.25**

***** - Values indicate the highest value of the lowest quartile, the mean and the lowest value of the upper quartile.
† - Average Coefficient of Conservatism for all Wisconsin lakes ranged from a low of 2.0 (the most disturbance tolerant) to a high of 9.5 (least disturbance tolerant).
‡ - lowest Floristic Quality was 3.0 (farthest from an undisturbed condition) and the high was 44.6 (closest to an undisturbed condition).

However, using the Floristic Quality Index of 25.25, Fawn Lake scores near the top of the average range for the North Central Hardwoods Region and in the median range for all Wisconsin Lakes.

The Floristic Quality Index is also a tool that can be used to identify areas of high conservation value, monitor sites over time, assess the anthropogenic (human-caused) impacts affecting an area and measure the ecological condition of an area (M. Bourdaghs, 2006). The FQI for the 2011 PI survey was 23.9, which also falls into the median range. This indicates that the plant community in Fawn Lake is as removed from an undisturbed condition at about the same level as average lake in Wisconsin overall and in the North Central Hardwood Region.

Looking at these figures, it's obvious that Fawn Lake has been impacted by at least an average 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, Curly-Leaf Pondweed, and Reed Canarygrass found here), destruction of plant beds, or changes in aquatic wildlife can also negatively impact an aquatic plant community.

V. COMPARISON TO PRIOR YEARS

Since the early surveys were done using the transect method, their results can't be compared to the PI results in 2011 and 2015. However, the PI surveys in 2011 and 2015 can be compared using statistical calculation. The results of the 2011 and 2015 surveys were compared using Jaccard's coefficient of similarity. This procedure allows two communities to be compared for similarity and dissimilarity. A coefficient of .75 or more suggests that the communities are statistically similar. When these calculations were performed using actual frequency of occurrence and relative frequency of occurrence, the 2011 and 2015 aquatic plant communities scored as 78.0% similar on the basis of actual frequency of occurrence and 91.2% on the basis of relative frequency. Thus, even though some of the details may vary, the aquatic plant community appears to be relatively stable.

Figure 19: Comparison of Plant Communities 2011 and 2015

FAWN LAKE	2011	2015
Number of Species Found	30	31
Maximum Rooting Depth (feet)	13.3	13.2
% of Littoral Zone Unvegetated	2	2.6
%Sites/Emergents	10.48%	39.22%
%Sites/Free-floating	15.32%	27.25%
%Sites/Submergents	97.6%	95.42%
%Sites/Floating-leaf	20.45%	28.1%
Simpson's Diversity Index	0.90	0.88
Species Richness	4.01	4.36
Floristic Quality	23.92	24.24
Average Coefficient of Conservatism	4.78	4.09
AMCI Index	53	53

Some of the "details" have varied, some have not. Eleven species have been found in all aquatic plant surveys since 2002. These include Coontail, Muskgrass, Common Waterweed, various types of Duckweed, Northern Milfoil, Eurasian Watermilfoil (or its hybrid), Curly-Leaf Pondweed, Long-Leaf Pondweed, Small Pondweed, Soft-Stemmed Bulrush, and Cattails.

There were some new species found during the 2015 survey; whether they continue to thrive in Fawn Lake or on its shores remains to be seen. The new species documented for the first time in Fawn Lake in 2015 were: Purple-Stemmed Beggar's Tick; Common Spikerush; Bearded Stonewort; Marsh Purslane; Whorled Milfoil; Dock-Leaved Smartweed; Stiff Pondweed; Yellow Cress; and Pussy Willow. Beggar's Tick, Spikerush, Marsh Purslane, Dock-Leaved Smartweed, Yellow Cress and Pussy Willow are all emergent. Bearded Stonewort, Whored Milfoil, and Stiff Pondweed are submergent species.

VI. CONCLUSION

Based on water clarity, chlorophyll-a, and phosphorus data, Fawn Lake is amesotrophic impoundment lake with very good water clarity and good water quality. This trophic state should support moderate plant growth and localized algal blooms.

Sufficient nutrients (trophic state), lake morphology, and soil substrates at Fawn Lake favor plant growth. Although sometimes sand sediment may limit aquatic plant growth, this does not seem to be the case in Fawn Lake. In all surveys, no matter what the method, nearly all of the lake had aquatic vegetation, suggesting that all the sediments in Fawn Lake hold sufficient nutrients to maintain aquatic plant growth.

The lake is starting to have a more varied structure, now having submergent, emergent, free-floating, and rooted floating-leaf plants. Rooted floating-leaf plants remain rare in the lake. Since the 2015 survey was done after chemical treatment, it is unclear whether that treatment negatively affected any native species, which can occur.

Emergents provide important fish habitat and spawning areas, as well as food and cover for wildlife. Floating-leaf plants provide cover for fish and invertebrates, as well as help dampen waves to protect the shore. A diverse submergent community provides many benefits. Because this lake provides all structural types of vegetation, the aquatic plant community has a diversity of structure and species that supports even more diversity of fish and wildlife.

Figure 20: Comparison of Aquatic Plant Community Structure 2002-2015

	2002 (T)	2006(T)	2011 (T)	2011 (PI)	2015 (PI)
Emergent	18%	41%	18%	6%	16.5%
Free-Floating	7%	23%	18%	9%	13.0%
Rooted Floating-Leaf			1%		6.5%
Submergent	75%	36%	63%	85%	63.0%

Aquatic plants occurred at 97.4% of the transect sample sites in Fawn Lake during the 2015 survey to a maximum rooting depth of 13.4 feet. 32 species were found, three of which were invasives: *Myriophyllum spicatum* (Eurasian Water Milfoil) and *Potamogeton crispus* (Curly-Leaf Pondweed), and *Phalaris arundinacea* (Reed Canarygrass). Of the native species, 15 were submergent species; 13 were emergent species; 3 were free-floating species; and 1 was a rooted floating-leaf plant.

Based on dominance value, Common Waterweed dominant in the 2015 PI survey, while Coontail was sub-dominant. Chemical treatment occurred early in the summer to knock back Curly-Leaf Pondweed and Eurasian Watermilfoil/hybrid. In this survey, which was conducted at least a month after the chemical treatment, these two invasive species were only 5% of the overall aquatic macrophyte population.

Many of the species found at Fawn Lake have multiple uses for wildlife.

FIGURE 21: BENEFITS OF SOME AQUATIC PLANTS

	Fish	Water Fowl	Shore Birds	Upland Birds	Muskrat	Beaver	Deer
Ceratophyllum demersum	F,I,C,S	F,I,C			F		
Chara spp	F,S	F,I,C					
Elodea canadensis	F,I,C	F,I,C			F		
Lemna minor	F,I,C,S	F	F		F	F	
Myriophyllum heterophyllum	F,I,C,S	F,I	F		F		
Myriophyllum sibiricum	F,I,C,S	F,I	F		F		
Najas flexilis	F.C	F	F				
Phalaris arundinacea	C	C					
Potamogeton amplifolius	F,I,C,S	F,I	F		F	F	F
Potamogeton richardsonii	F,I,C,S	F,I	F		F	F	F
Potamogeton zosteriformis	F,I,C,S	F,I	F		F	F	F
Schoenoplectus tabernaemontani	F,C,I	F,C	F,C,N	F	F	F	F
Stuckenia pectinata	F,I,C,S	F,I	F		F	F	F
Typha spp	I,C,S	F	F,C,N		F,C,N	F	

F = Food; I = Shelters Invertebrates; C = Cover; S = Spawning; N = Nesting

The Simpson's Diversity Index for Fawn Lake was .89, similar to the 2011 SI of .90. This is good species diversity. The Aquatic Macrophyte Community Index

(AMCI) for 2015 is 53, as it was in 2011. These figures place Fawn Lake mostly in the median average for all Wisconsin lakes and the North Central Hardwood region. These suggests that the aquatic plant community in Fawn Lake has been impacted by some disturbances, although the amount of that disturbance may depend on the area of the lake being examined.

Much of Fawn Lake's shoreline offers relatively good protection for water quality due to the thick beds of cattails. Some of buffers present in other areas were only a few feet wide landward and could add greater protection to the water quality if they were expended.

Fawn Lake is a mesotrophic lake with good water quality and water clarity. The quality of the aquatic plant community in Fawn Lake is low average for Wisconsin lakes and for lakes in the North Central Hardwood region. Structurally, it is starting to contain emergent plants, rooted plants with floating leaves, free-floating plants, and submergents.

The most frequently-occurring and dominant plant in the lake in the 2015 survey was the native plant, Coontail, while in the PI survey in 2011, that place was held by the invasive Eurasian Watermilfoil. The several years of chemical treatment have knocked the invasive back to a small part of the overall aquatic community.

A healthy and diverse aquatic plant community plays a vital role within the lake ecosystem. Plants help improve water quality by trapping nutrients, debris and pollutants in the water body; by absorbing and/or breaking down some pollutants; by reducing shore erosion by decreasing wave action and stabilizing shorelines and lake bottoms; and by tying-up nutrients that would otherwise be available for algae blooms. Aquatic plants provide valuable habitat resources for fish and wildlife, often being the base level for the multi-level food chain in the lake ecosystem, and also produce oxygen needed by animals.

Further, a healthy and diverse aquatic plant community can better resist the invasion of species (native and non-native) that might otherwise "take over" and create a lower quality aquatic plant community. A well-established and diverse plant community of natives can help check the growth of more tolerant (and less desirable) plants that would otherwise crowd out some of the more sensitive species, thus reducing diversity.

Vegetated lake bottoms support larger and more diverse invertebrate populations that in turn support larger and more diverse fish and wildlife populations (Engel, 1985). Also, a mixed stand of aquatic macrophytes (plants) supports 3 to 8 times more invertebrates and fish than do monocultural stands (Engel, 1990). A diverse plant community creates more microhabitats for the preferences of more species.

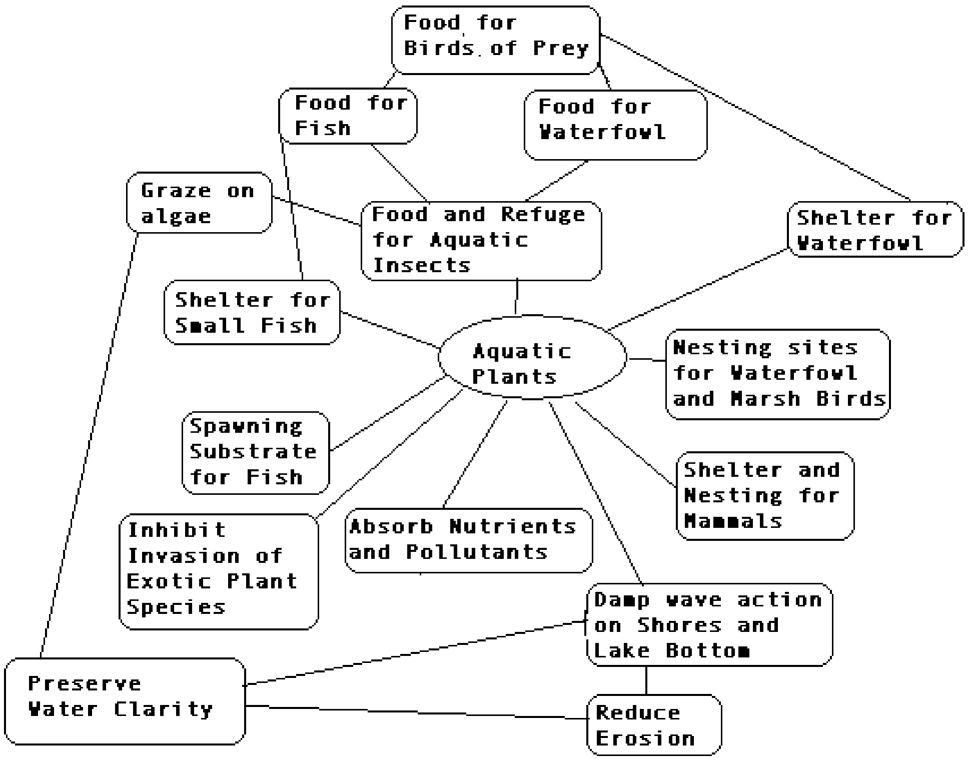


Figure 24: Aquatic Ecosystem Web

MANAGEMENT RECOMMENDATIONS

(1) Fawn Lake does have a lot of native vegetated shoreline, but some of the buffers need to be wider landward to get maximum benefit to the water quality. In the few places where there is bare soil, vegetation should be planted.

(2) Further, the shore area previously cleared down to the bare soil needs to be restored as soon as possible to prevent soil erosion and degradation of the water quality in that area. This is particularly urgent since the property is located directly across from the designated critical habitat in Fawn Lake. The area in the water in front of this lot also should not be cleared, except the 30 foot wide corridor allowed to be hand-cleared.

3) The Fawn Lake District needs to update its aquatic plant management plan to aggressively manage the increasing populations of Eurasian Watermiilfoil and Curly-Leaf Pondweed. This should include varied approaches, not just the chemical treatment it has traditionally relied upon.

4) A EWM weevil survey should be performed at Fawn Lake to determine if the lake provides suitable habitat for the native weevils that attack EWM. If it does, the Fawn Lake District should consider participating in propagating these weevils as one of the methods to attack the EWM in its lake.

5) No lawn chemicals should be used on properties around the lake or in the water without a permit. If they must be used, they should be used no closer than 50 feet to the shore. The clearing of one shore area in 2011 happened so quickly that chemicals were obviously used, right at the shore, both in and out of the water. Since it has stayed non-vegetated, it is likely that chemicals are being used at that spot both in and out of the water to inhibit regrowth of plants.

6) No broad-scale chemical treatments of native aquatic plant growth are recommended due to the undesirable side-effects of such treatments, including

increased nutrients from decaying plant material, destruction of fish and wildlife habitat, and decreased dissolved oxygen and opening up more areas to the invasion of EWM.

7) Fallen trees should be left at the shoreline. They should not be removed unless they block access to the lake. The Fawn Lake District could pursue the addition of fallen trees as habitat. It might consider pursuing a Health Lakes Initiative grant for fish habitat installation.

8) Fawn Lake residents should continue to be involved in the Wisconsin Self-Help Monitoring Program to permit on-going monitoring of the lake trends for basically no cost. This should include regular monitoring for known invasives and invasives known to be nearby.

9) Fawn Lake residents should identify, cooperate with and participate in watershed programs that will reduce nutrient and sediment inputs.

10) Emergent vegetation and rooted floating-leaf beds should be protected where they are currently present and re-established where they are not. These not only provide habitat, but also help stabilize the shores in some area where the shores are exposed.

11) Shore areas where there is undisturbed wooded shore should be maintained left undisturbed.

12) Since one critical habitat area has been determined on Fawn Lake, care should be taken to reduce any disturbance in those areas. Posting a map of this area by the boat ramp might help lake users to avoid disturbing these areas.

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