Town Of Saint Germain Lakes

Vilas County, Wisconsin

Town-wide Lake Management Plan

April 2013

Sponsored by:

Town of Saint Germain

WDNR Grant Program

LPL-1319-10, LPL-1320-10, LPL-1321-10, LPL-1322-10, LPL-1323-10, LPL-1324-10, LPL-1326-10, LPL-1327-10, & LPL-1328-10

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Onterra, LLC
Lake Management Planning

Town of Saint Germain

Vilas County, Wisconsin

Town-wide Lake Management Plan

April 2013

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Funded by: Town of Saint Germain
Wisconsin Dept. of Natural Resources

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Town of Saint Germain Lakes Committee

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Todd Wiese	D. Zelinski	D. Kloepfer	L. Peil
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Wisconsin Dept. of Natural Resources

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APPENDICES

1.0 INTRODUCTION

The Town of Saint Germain board in 2003, created the Town of Saint Germain Lakes Committee (TSGLC) as a standing advisory committee to the town government. The purpose of this committee is to coordinate a proactive community approach to the prevention and management of aquatic invasive species (AIS) in the town's lakes. The committee's goal is to enable the lake organizations representing the town's primary lakes to address the various lake management issues in a common and united manner. The committee has in the past, and will continue to address a broad scope of awareness, education and lake monitoring on a town-wide scale. The committee is not to be confused with lake associations and P&R districts, which oversee individual or several lakes within the Town of Saint Germain. These entities and the lakes they represent (and are involved in this project) can be viewed in Table 1.1-1.

In 2004 the Town of Saint Germain launched a town-wide lake management planning project aimed at assessing the plant communities of eight of the town's largest and most utilized lakes. The Town of Saint Germain Aquatic Plant Management Plan (Onterra, LLC 2006) was completed during the summer of 2006 and stood as the first town-wide management planning effort in Wisconsin. In 2009, the Town Lakes Committee again teamed with Onterra to reassess the town's lakes. The current project includes seven of the eight lakes originally studied by the town (Table 1.1-1 and Map 1). Little Saint Germain Lake was not included in this project as it has recently updated its management plan to include actions dealing with water quality and AIS-related issues.

The project reported on here is essentially an update of the town's 2006 aquatic plant management plan. However, in this effort, funded through nine Wisconsin Department of Natural Resources (WDNR) Management Planning Grants, the Town Lakes Committee elected to expand the scope of the assessments beyond that of aquatic plants. This expanded project includes reassessments of each lakes aquatic plant communities as well as assessments of their water quality, watershed, and shorelands. Additionally, this project includes a compilation of available fisheries data and a written stakeholder survey that was provided to each shoreland property owner.

Table 1.1-1. Town of Saint Germain project lakes and pertinent lake information.

			Lake Morphometric Data			Lake Use Characteristics		
Lake Organization	Lake(s) Representing	WBIC	Acres	Max Depth (feet)	% Littoral	Number of Boat Landings	Number of Parking Spaces	Number of Resorts
Big St. Germain Area Lakes District	Big St. Germain Lake	1591100	1617	42	32	1	12 spaces	10
Big St. Germain Area Lakes District	Content Lake	1592000	244	14	100	*Through Big Saint Germain Lake*		1
Big St. Germain Area Lakes District	Fawn Lake	1591000	22	10	100	*Through Big Saint Germain Lake*		0
Found Lake Association	Found Lake	1593800	326	21	98	1	12 spaces	0
Lost Lake Association	Lost Lake	1593400	544	20	100	1	5 spaces	7
Alma/Moon P&R District	Alma Lake	967900	58	19	100	1	5 spaces	0
Alma/Moon P&R District	Moon Lake	1005800	131	40	54	*Through Alma Lake*		0

To create a full understanding of the project on both a town-wide and individual lake basis, this report is divided into several sections:

Saint Germain Lakes Management Plan – This section outlines the results of the studies as they pertain to all of the lakes studied within the project. By reading this section, the reader will gain an overall knowledge of the project and its results on a more general, town-wide basis.

Lake-specific Results and Conclusions – These sections outline the results of each lake's studies and the analysis of those results. They also describe the conclusions drawn based upon those results. Finally, these sections include the lake-specific maps. By reading this document, the reader gains an understanding of the lake in particular and how that information pertains to the management of that lake. Please note that it is necessary to read the Saint Germain Lakes Management Plan section previous to reading the Lake-specific sections.

Lake-group Specific Implementation Plan – These sections contain an implementation plan outlining the specifics on how the management goals and actions for that lake would be completed. Duplications of management goals and actions of course exist between different lakes. However, lake-specific management goals and actions are also included to assure that each lake's particular management needs are met. By reading this section, the reader will understand not only the steps that will be taken to meet the management goals of the lake, but also who will be facilitating those steps and when they will be initiated.

2.0 STAKEHOLDER PARTICIPATION

Stakeholder participation is an important part of any management planning exercise. During this project, stakeholders were not only informed about the project and its results, but also introduced to important concepts in lake ecology. The objective of this component in the planning process is to accommodate communication between the planners and the stakeholders. The communication is educational in nature, both in terms of the planners educating the stakeholders and vice-versa. The planners educate the stakeholders about the planning process, the functions of their lake ecosystem, their impact on the lake, and what can realistically be expected regarding the management of the aquatic system. The stakeholders educate the planners by describing how they would like the lake to be, how they use the lake, and how they would like to be involved in managing it. All of this information is communicated through multiple meetings that involve the lake group as a whole or a focus group called a Planning Committee, the completion of a stakeholder survey, and updates within the lake group's newsletter.

The highlights of this component are described below in chronological order. Materials used during the planning process can be found in Appendix A.

Kick-off Meeting

On August 11, 2010, a project kick-off meeting was held at the Town of Saint Germain Community Center to introduce the project to the general public. The meeting was announced through a mailing and personal contact by the Town of Saint Germain board members. The approximately 30 attendees observed a presentation given by Tim Hoyman, an aquatic ecologist with Onterra. Mr. Hoyman's presentation started with an educational component regarding general lake ecology and ended with a detailed description of the project including opportunities for stakeholders to be involved. The presentation was followed by a question and answer session.

Stakeholder Survey

During June 2010, a six-page, 28-question survey was mailed to 868 riparian property owners in association with the Town of Saint Germain project waters. Overall, 52 percent of the surveys were returned and those results were entered into a spreadsheet by members of the individual lake group Planning Committees. The data were summarized and analyzed by Onterra for use at the planning meetings and within the management plan. The full survey and results can be found in Appendix B, while discussion of those results is integrated within the appropriate sections of the management plan.

Informational Booth at the Saint Germain Flea Market and other Town Functions

At the highly-popular town flea markets and at other town functions, the TSGLC has a booth displaying information related to their lakes, often highlighting AIS issues. Prior to Memorial Day Weekend 2010, a large-format color poster was created by Onterra and provided to the TSGLC that displayed information regarding the management planning project that had just gotten under way. Prior to this weekend in 2011, a new poster was created that displayed some of the project study results from the previous summer.

Planning Committee Meeting I

On August 23rd, 2011, Tim Hoyman, Eddie Heath and Dan Cibulka of Onterra met with members of the Town of Saint Germain Lakes Planning Committee for nearly 3.5 hours. The primary focus of this meeting was the delivery of the study results and conclusions to the committee. All study components including, native and non-native aquatic plant inventories, water quality analysis, and watershed modeling were presented and discussed. Many concerns were raised by the committee, including nuisance levels of aquatic plants, low water levels, and potential introduction of invasive plant species.

Project Wrap-up Meeting

On September 17th, 2011, Tim Hoyman held a special meeting regarding the completion of the Town of Saint Germain Lakes Management Planning Project. During the meeting, Mr. Hoyman presented the results of the many studies that had been completed on the lake since 2010. He also answered many questions about the lakes and how they should be managed.

Management Plan Review and Adoption Process

Prior to the Planning Committee Meeting (August 23, 2011), an early draft of the Results Sections (i.e. Water Quality, Watershed, Aquatic Plants, and Fisheries Data Integration Sections) of the Lake Management Plan were provided to meeting attendees to enhance the productivity of the meeting. In March 2012, an official first draft of the Town of Saint Germain Lake Management Plan was supplied to the WDNR and the TSGLC for review.

A short list of additional comments was provided by the WDNR in April of 2013. This report reflects the integration of WDNR and TSGLC comments. The final report will be reviewed by the TSGLC Board of Directors and a vote to adopt the management plan will be held during the next annual meeting.

3.0 RESULTS & DISCUSSION

3.1 Lake Water Quality

Primer on Water Quality Data Analysis and Interpretation

Reporting of water quality assessment results can often be a difficult and ambiguous task. Foremost is that the assessment inherently calls for a baseline knowledge of lake chemistry and ecology. Many of the parameters assessed are part of a complicated cycle and each element may occur in many different forms within a lake. Furthermore, not all chemical attributes collected may have a direct bearing on the lake's ecology, but may be more useful as indicators of other problems. Finally, water quality values that may be considered poor for one lake may be considered good for another because judging water quality is often subjective. However, focusing on specific aspects or parameters that are important to lake ecology, comparing those values to similar lakes within the same region and historical data from the study lake provides an excellent method to evaluate the quality of a lake's water.

Many types of analysis are available for assessing the condition of a particular lake's water quality. In this document, the water quality analysis focuses upon attributes that are directly related to the ecology of the lake. In other words, the water quality that impacts and controls the fishery, plant production, and even the aesthetics of the lake are related here. Specific forms of water quality analysis are used to indicate not only the health of the lake, but also to provide a general understanding of the lake's ecology and assist in management decisions. Each type of available analysis is elaborated on below.

As mentioned above, chemistry is a large part of water quality analysis. In most cases, listing the values of specific parameters really does not lead to an understanding of a lake's water quality, especially in the minds of non-professionals. A better way of relating the information is to compare it to lakes with similar physical characteristics and lakes within the same regional area. In this document, a portion of the water quality information collected on the Town of Saint Germain lakes is compared to other lakes in the state with similar characteristics as well as to lakes within the northern region (Appendix C). In addition, the assessment can also be clarified by limiting the primary analysis to parameters that are important in the lake's ecology and trophic state (see below). Three water quality parameters are focused upon in the Town of Saint Germain lake's water quality analysis:

> **Phosphorus** is the nutrient that controls the growth of plants in the vast majority of Wisconsin lakes. It is important to remember that in lakes, the term "plants" includes both algae and macrophytes. Monitoring and evaluating concentrations of phosphorus within the lake helps to create a better understanding of the current and potential growth rates of the plants within the lake.
>
> **Chlorophyll-*a*** is the green pigment in plants used during photosynthesis. Chlorophyll-*a* concentrations are directly related to the abundance of free-floating algae in the lake. Chlorophyll-*a* values increase during algal blooms.
>
> **Secchi disk transparency** is a measurement of water clarity. Of all limnological parameters, it is the most used and the easiest for non-professionals to understand. Furthermore, measuring Secchi disk transparency over long periods of time is one of the best methods of monitoring the health of a lake. The measurement is conducted by

lowering a weighted, 20-cm diameter disk with alternating black and white quadrates (a Secchi disk) into the water and recording the depth just before it disappears from sight.

The parameters described above are interrelated. Phosphorus controls algal abundance, which is measured by chlorophyll-*a* levels. Water clarity, as measured by Secchi disk transparency, is directly affected by the particulates that are suspended in the water. In the majority of natural Wisconsin lakes, the primary particulate matter is algae; therefore, algal abundance directly affects water clarity. In addition, studies have shown that water clarity is used by most lake users to judge water quality – clear water equals clean water (Canter et al. 1994, Dinius 2007, and Smith et al. 1991).

Trophic State

Total phosphorus, chlorophyll-*a*, and water clarity values are directly related to the trophic state of the lake. As nutrients, primarily phosphorus, accumulate within a lake, its productivity increases and the lake progresses through three trophic states: oligotrophic, mesotrophic, and finally eutrophic. Every lake will naturally progress through these states and under natural conditions (i.e. not influenced by the activities of humans) this progress can take tens of thousands of years. Unfortunately, human influence has accelerated this natural aging process in many Wisconsin lakes. Monitoring the trophic state of a lake gives stakeholders a method by which to gauge the productivity of their lake over time. Yet, classifying a lake into one of three trophic states often does not give clear indication of where a lake really exists in its trophic progression because each trophic state represents a range of productivity. Therefore, two lakes classified in the same trophic state can actually have very different levels of production.

Trophic states describe the lake's ability to produce plant matter (production) and include three continuous classifications: Oligotrophic lakes are the least productive lakes and are characterized by being deep, having cold water, and few plants. Eutrophic lakes are the most productive and normally have shallow depths, warm water, and high plant biomass. Mesotrophic lakes fall between these two categories.

However, through the use of a trophic state index (TSI), an index number can be calculated using phosphorus, chlorophyll-*a*, and clarity values that represent the lake's position within the eutrophication process. This allows for a more clear understanding of the lake's trophic state while facilitating clearer long-term tracking. Carlson (1977) presented a trophic state index that gained great acceptance among lake managers.

Limiting Nutrient

The limiting nutrient is the nutrient which is in shortest supply and controls the growth rate of algae and some macrophytes within the lake. This is analogous to baking a cake that requires four eggs, and four cups each of water, flour, and sugar. If the baker would like to make four cakes, he needs 16 of each ingredient. If he is short two eggs, he will only be able to make three cakes even if he has sufficient amounts of the other ingredients. In this scenario, the eggs are the limiting nutrient (ingredient).

In most Wisconsin lakes, phosphorus is the limiting nutrient controlling the production of plant biomass. As a result, phosphorus is often the target for management actions aimed at controlling plants, especially algae. The limiting nutrient is determined by calculating the nitrogen to phosphorus ratio within the lake. Normally, total nitrogen and total phosphorus values from the surface samples taken during the summer months are used to determine the ratio. Results of this ratio indicate if algal growth within a lake is limited by nitrogen or phosphorus. If the ratio is greater than 15:1, the lake is considered phosphorus limited; if it is less than 10:1, it is considered nitrogen limited. Values between these ratios indicate a transitional limitation between nitrogen and phosphorus.

Temperature and Dissolved Oxygen Profiles

Temperature and dissolved oxygen profiles are created simply by taking readings at different water depths within a lake. Although it is a simple procedure, the completion of several profiles over the course of a year or more provides a great deal of information about the lake. Much of this information relates to whether the lake thermally stratifies or not, which is determined primarily through the temperature profiles. Lakes that show strong stratification during the summer and winter months need to be managed differently than lakes that do not. Normally, deep lakes stratify to some extent, while shallow lakes (less than 17 feet deep) do not.

Lake stratification occurs when temperature gradients are developed with depth in a lake. During stratification the lake can be broken into three layers: The epiliminion is the top layer of water which is the warmest water in the summer months and the coolest water in the winter months. The hypolimnion is the bottom layer and contains the coolest water in the summer months and the warmest water in the winter months. The metalimnion, often called the thermocline, is the middle layer containing the steepest temperature gradient.

Dissolved oxygen is essential in the metabolism of nearly every organism that exists within a lake. For instance, fishkills are often the result of insufficient amounts of dissolved oxygen. However, dissolved oxygen's role in lake management extends beyond this basic need by living organisms. In fact, its presence or absence impacts many chemical process that occur within a lake. Internal nutrient loading is an excellent example that is described below.

Internal Nutrient Loading*In lakes that support strong stratification, the hypolimnion can become devoid of oxygen both in the water column and within the sediment. When this occurs, iron changes from a form that normally binds phosphorus within the sediment to a form that releases it to the overlaying water. This can result in very high concentrations of phosphorus in the hypolimnion. Then, during the spring and fall turnover events, these high concentrations of phosphorus are mixed within the lake and utilized by algae and some macrophytes. This cycle continues year after year and is termed "internal phosphorus loading"; a phenomenon that can support nuisance algae blooms decades after external sources are controlled.

The first step in the analysis is determining if the lake is a candidate for significant internal phosphorus loading. Water quality data and watershed modeling are used to screen non-candidate and candidate lakes following the general guidelines below:

Non-Candidate Lakes

- Lakes that do not experience hypolimnetic anoxia.
- Lakes that do not stratify for significant periods (i.e. months at a time).
- Lakes with hypolimnetic total phosphorus values less than 200 μg/L.

Candidate Lakes

- Lakes with hypolimnetic total phosphorus concentrations exceeding 200 μg/L.
- Lakes with epilimnetic phosphorus concentrations that cannot be accounted for in watershed phosphorus load modeling.

Specific to the final bullet-point, during the watershed modeling assessment, the results of the modeled phosphorus loads are used to estimate in-lake phosphorus concentrations. If these estimates are much lower than those actually found in the lake, another source of phosphorus must be responsible for elevating the in-lake concentrations. Normally, two possibilities exist; 1) shoreland septic systems, and 2) internal phosphorus cycling.

If the lake is considered a candidate for internal loading, modeling procedures are used to estimate that load.

*Lack of hypolimnetic phosphorus data prevents these analyses from being performed. The explanation provided under this heading is strictly for the information of the reader.

Comparisons with Other Datasets

The WDNR publication *Implementation and Interpretation of Lakes Assessment Data for the Upper Midwest* (PUB-SS-1044 2008) is an excellent source of data for comparing water quality from a given lake to lakes with similar features and lakes within specific regions of Wisconsin. Water quality among lakes, even among lakes that are located in close proximity to one another, can vary due to natural factors such as depth, surface area, the size of its watershed and the composition of the watershed's land cover. For this reason, the water quality of the Town of Saint Germain lakes will be compared to lakes in the state with similar physical characteristics. The WDNR groups Wisconsin's lakes into 6 classifications (Figure 3.1-1).

First, the lakes are classified into two main groups: **shallow (mixed)** or **deep (stratified)**. Shallow lakes tend to mix throughout or periodically during the growing season and as a result, remain well-oxygenated. Further, shallow lakes often support aquatic plant growth across most or all of the lake bottom. Deep lakes tend to stratify during the growing season and have the potential to have low oxygen levels in the bottom layer of water (hypolimnion). Aquatic plants are usually restricted to the shallower areas around the perimeter of the lake (littoral zone). An equation developed by Lathrop and Lillie (1980), which incorporates the maximum depth of the lake and the lake's surface area, is used to predict whether the lake is considered a shallow (mixed) lake or a deep (stratified) lake. The lakes are further divided into classifications based on their hydrology and watershed size:

Seepage Lakes have no surface water inflow or outflow in the form of rivers and/or streams.

Drainage Lakes have surface water inflow and/or outflow in the form of rivers and/or streams.

Headwater drainage lakes have a watershed of less than 4 square miles.

Lowland drainage lakes have a watershed of greater than 4 square miles.

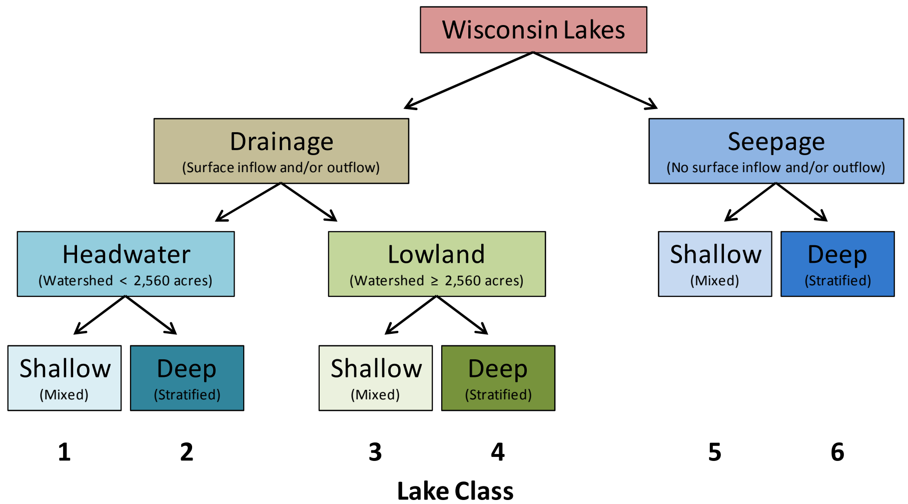

Figure 3.1-1. Wisconsin Lake Classifications. Adapted from WDNR PUB-SS-1044 2008.

Lathrop and Lillie developed state-wide median values for total phosphorus, chlorophyll-*a*, and Secchi disk transparency for each of the six lake classifications. Though they did not sample sufficient lakes to create median values for each classification within each of the state's ecoregions, they were able to create median values based on all of the lakes sampled within each ecoregion (Figure 3.1-2). Ecoregions are areas related by similar climate, physiography, hydrology, vegetation and wildlife potential. Comparing ecosystems in the same ecoregion is sounder than comparing systems within manmade boundaries such as counties, towns, or states. The Town of Saint Germain is within the Northern Lakes and Forests ecoregion.

The Wisconsin 2010 Consolidated Assessment and Listing Methodology (WisCALM), created by the WDNR, is a process by which the general condition of Wisconsin surface waters are assessed to determine if they meet federal requirements in terms of water quality under the Clean Water Act. It is another useful tool in helping lake stakeholders understand the health of their lake compared to others within the state. This method incorporates both biological and physical-chemical indicators to assess a given waterbody's condition. One of the assessment methods utilized is Carlson's Trophic State Index (TSI). They divided the phosphorus, chlorophyll-*a*, and Secchi disk transparency data of each lake class into ranked categories and assigned each a "quality" label from "Excellent" to "Poor". The categories were based on pre-settlement conditions of the lakes inferred from sediment cores and their experience.

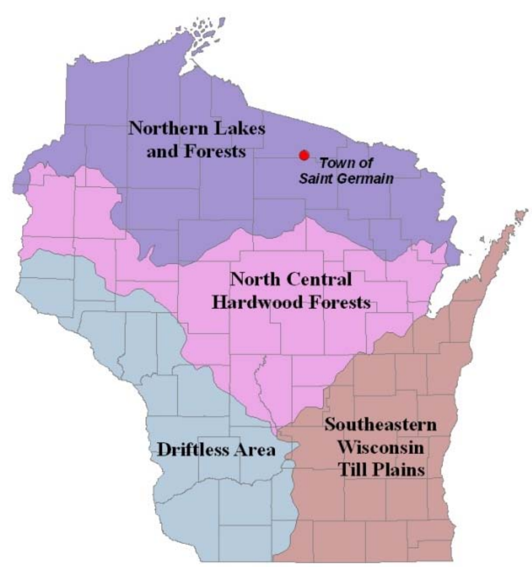

Figure 3.1-2. Location of the Town of Saint Germain within the ecoregions of Wisconsin. After Nichols 1999.

These data along with data corresponding to statewide natural lake means, historic, current, and average data from the Town of Saint Germain lakes are displayed within each respective lake section. A cursory look at the data on all project lakes is presented below in Figures 3.1-3 through 3.1-7. Please note that the data in these graphs represent concentrations and depths taken only during the 2010 growing season (April-October) or summer months (June-August). Furthermore, the phosphorus and chlorophyll-a data represent only surface samples. Surface samples are used because they represent the depths at which algae grow and depths at which phosphorus levels are not greatly influenced by phosphorus being released from bottom sediments.

Town of Saint Germain Lakes Water Quality Analysis

While detailed discussion takes place regarding the water quality of the individual Town of Saint Germain lakes within their respective sections, it is both interesting and worthwhile to compare these lakes side-by-side. As presented in the Watershed section, the geographical setting of a lake can influence its water chemistry and biota greatly. Although close in proximity, the Town of Saint Germain lakes vary in their geography and local geology – some of the Town of Saint Germain lakes receive water only through groundwater and surface runoff while others have one or more tributary streams feeding into the lake. Additionally, as discussed in the Aquatic Plant section and Fisheries section, the substrate of each lake is different as well. Many of these lakes have nutrient-rich, organic sediments. Within other lakes, the lake bottom is covered primarily by a sandy substrate. These elements, as well as others, play a key role in determining the water quality of any lake.

Average summer 2010 total phosphorus values ranged between 9.4 μg/L in Moon Lake and 29.7 μg/L in Fawn Lake (Figure 3.1-3). The two deep seepage lakes, Moon and Alma, had the lowest total phosphorus average concentrations of all the lakes studied. The mean total phosphorus value for lakes within the Northern Lakes and Forests ecoregion is 21 μg/L. All of the Town of Saint Germain lakes studied in this project are relatively close to this mean value. Although Fawn Lake is the smallest of the Town of Saint Germain lakes, it had the highest total phosphorus value in 2010. This likely occurs because of its geographical setting (falling downstream of Big St. Germain) and is discussed further within its individual lake section.

In the Town of Saint Germain lakes, chlorophyll-*a* concentrations varied much during the summer of 2010 (Figure 3.1-4). The two deep seepage lakes, Moon and Alma, had the lowest average chlorophyll-*a* concentrations while Lost Lake, a lowland shallow drainage lake, had the highest concentration. Fawn Lake, which had the highest average phosphorus concentration of the studied lakes, had an average chlorophyll-*a* concentration less than half that of Lost Lake. Although phosphorus is among the primary nutrients that feed algal growth, this parameter is interrelated with other factors that contribute to algal production, or non-production. Some lakes become dominated by macrophytes quickly in the year, and utilize the available nutrients greatly. In a system such as Fawn Lake, which is held by a dam, it is likely that the recharge of water is relatively rapid because of the large watershed draining to it. This rapid change of water within the lake flushes out nutrient before they can be fully utilized by algae.

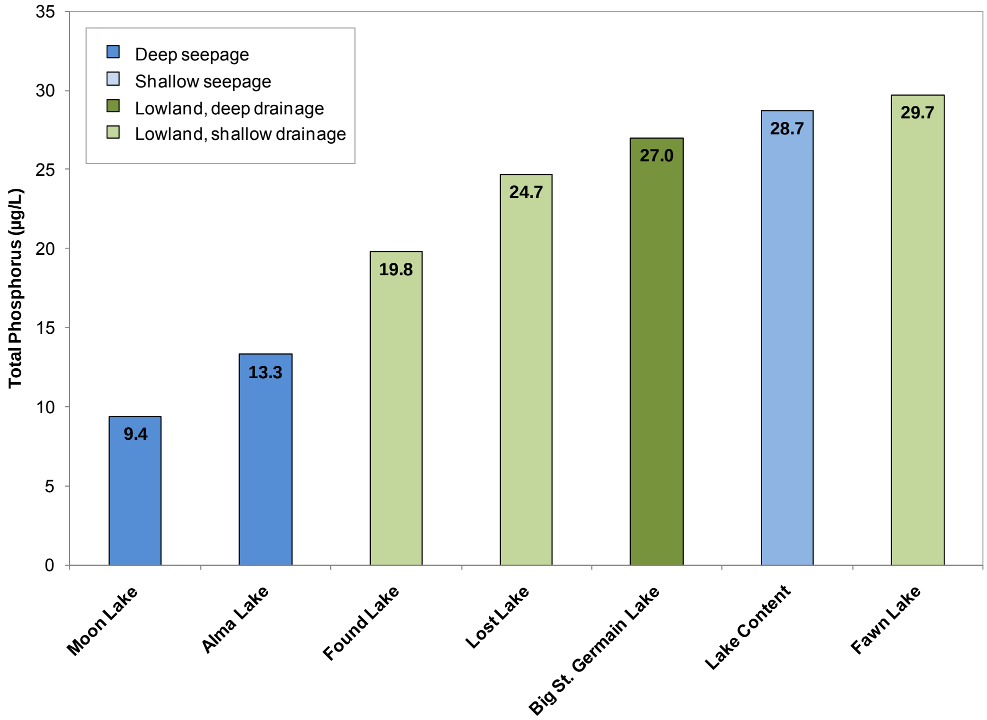

Figure 3.1-3. Town of Saint Germain lakes' total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

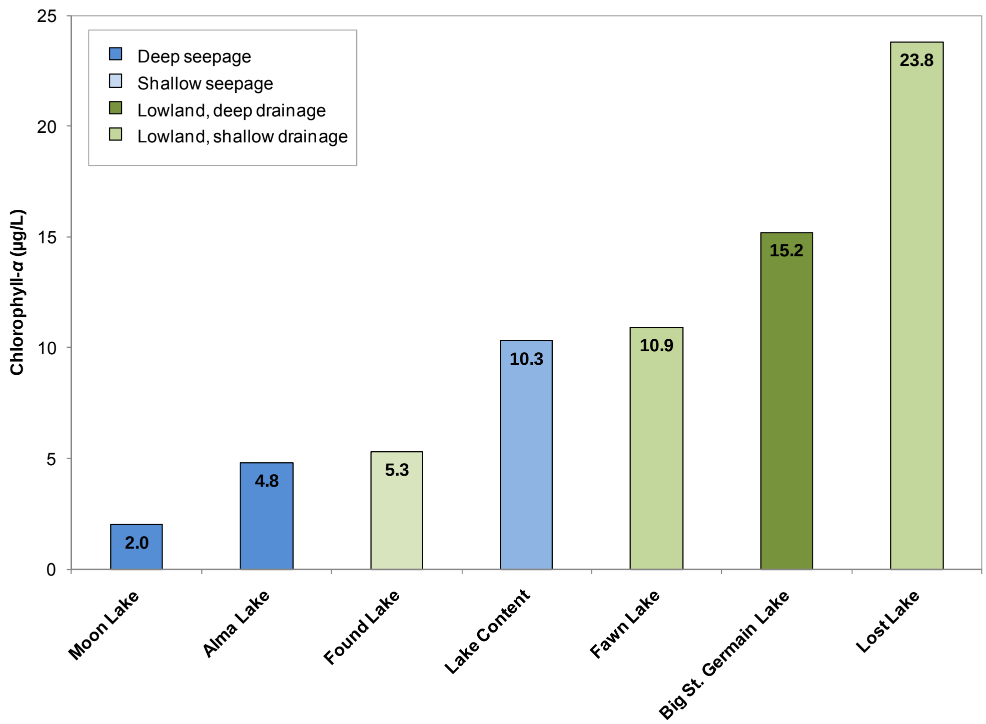

Figure 3.1-4. Town of Saint Germain lakes' chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from Lillie and Mason (1983).

As with the chlorophyll-*a* data, the average Secchi depth varied between the Town of Saint Germain lakes in 2010 (Figure 3.1-5). Secchi disk depth is a parameter that is easily and cheaply measured, and is also a good indicator of trophic status. It is linked highly to chlorophyll-*a* concentrations in a lake – with more algae (and thus chlorophyll-*a*) in the water column, the water clarity and Secchi disk depth should decrease. This parameter is, however, influenced by other environmental factors.

Moon Lake, which had the lowest 2010 phosphorus and chlorophyll-*a* concentrations, had the highest average Secchi disk value (Figure 3.1-5). Lost Lake, which had the highest average chlorophyll-*a* concentration in 2010, had the smallest Secchi disk value. Big St. Germain Lake, which had the second highest average chlorophyll-*a* concentration in 2010, had the second highest Secchi disk value. As previously mentioned, Secchi disk clarity can be influenced by other factors besides chlorophyll-*a*. Discoloration of the water might occur from wetland runoff and terrestrial plant decomposition. Further, as discussed in Alma Lake's individual section, the clarity values measured at the lake during 2006-2010 were shallower than measured in previous years. This is likely brought on by increased water color due to dissolved organic acids as opposed to algal particulates in the water column. On the other hand, Big St. Germain's clarity values are similar to those measured in past years; therefore, it is likely that in the long-term, Alma Lake will likely have greater water clarity than Big St. Germain Lake as would be expected based upon algal content.

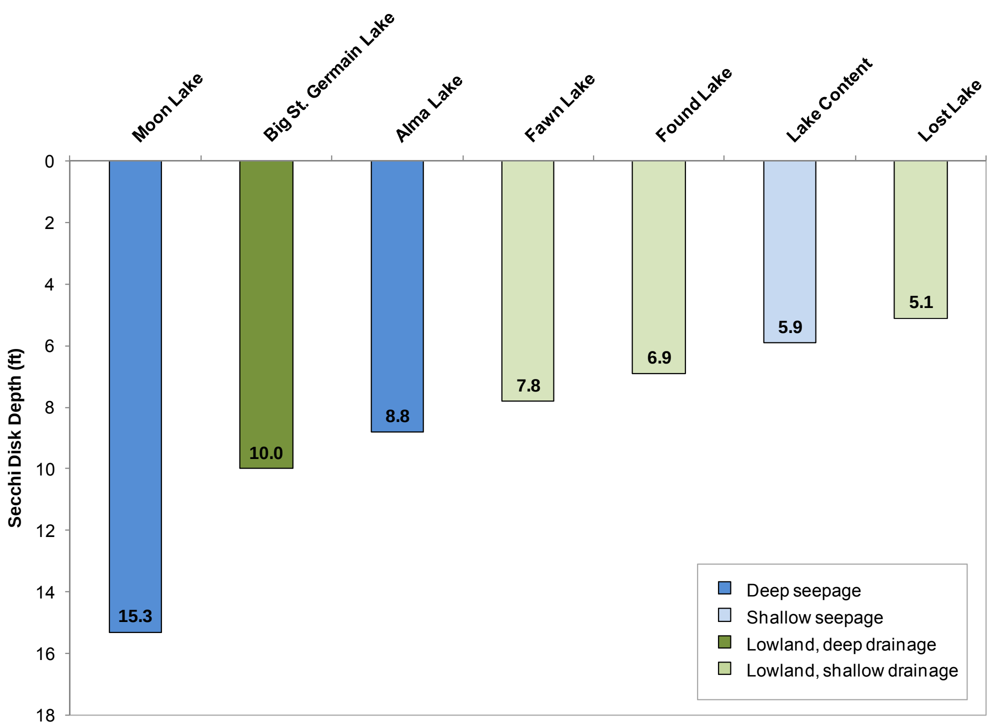

Figure 3.1-5. Town of Saint Germain lakes' Secchi disk clarity values. Mean values calculated with 2010 summer month surface sample data. Water Quality Index values adapted from Lillie and Mason (1983).

Limiting Plant Nutrient of Town of Saint Germain Lakes

Using 2010 average nitrogen and phosphorus concentrations from all lakes included in the Town of Saint Germain lakes study, a nitrogen:phosphorus ratio was calculated for each lake (Table 3.1-1). In all lakes, the ratio weighed heavily in favor of nitrogen, rather than phosphorus. This finding indicates that all of the Town of Saint Germain lakes are phosphorus limited as are the vast majority of Wisconsin lakes. In general, this means that cutting phosphorus inputs may limit plant growth within the lakes.

Table 3.1-1. Town of Saint Germain lakes nitrogen and phosphorus values and N:P ratios. Ratios calculated from surface samples taken in summer of 2010 from each lake.

Lake Name	Avg. Summer Nitrogen (µg/L)	Avg. Summer Phosphorus (µg/L)	N:P Ratio
Alma Lake	590.0	13.7	41:1
Big St. Germain Lake	550.0	26.3	21:1
Lake Content	786.7	31.3	25:1
Fawn Lake	550.0	29.7	19:1
Found Lake	470.0	17.7	27:1
Lost Lake	673.3	31.3	21:1
Moon Lake	406.7	8.3	49:1

Town of Saint Germain Lakes Trophic State

Figure 3.1-6 contain the TSI values for the Town of Saint Germain lakes. The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values range in values spanning from upper oligotrophic to eutrophic. In general, the best values to use in judging a lake's trophic state are the biological parameters. Using these data, it is apparent that the Town of Saint Germain lakes vary greatly in their trophic status. Within these seven waterbodies, examples can be seen of clear, low nutrient oligotrophic lakes (Moon), highly productive eutrophic lakes (Found, Big St. Germain, Fawn, Content and Lost Lakes) and moderately productive lakes (Alma Lake).

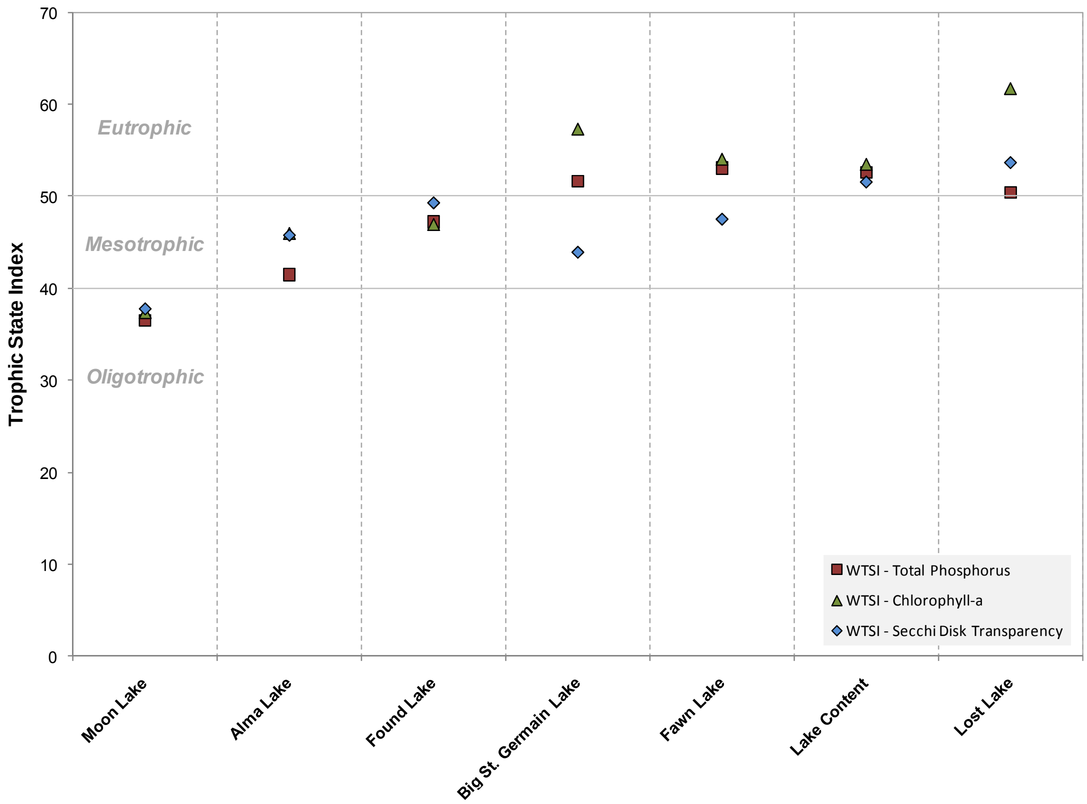

Figure 3.1-6. Town of Saint Germain lakes' Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Additional Water Quality Data

The above discussed water quality parameters are very helpful in characterizing a lake in terms of it trophic state. There are more water quality parameters that can be used to describe other conditions of a lake's health, such as its suitability for invasive species infestation. Calcium concentration can be used to characterize a lake in terms of its likeliness to allow AIS, such as zebra mussels (*Dreissena polymorpha*) or quagga mussels (*Dreissena bugensis*) to proliferate in the lake. Calcium is considered to be a key limiting factor for Dreissenid species, as the mineral is required for basic metabolic function as well as shell building. Researchers believe that a calcium concentration of at least 12 mg/L is required for zebra mussel colonization (Whittier et al 2008). It is theorized by some in the scientific community that similar concentrations may be required for quagga mussel colonization. However, there has been much less research conducted on quagga mussels and so calcium suitability for this species is still inconclusive at this point.

The calcium concentrations for all of the project lakes fall within the very low susceptibility category for zebra mussel establishment and survivability (Figure 3.1-7). Though all of these project lakes do not contain optimal calcium levels for zebra mussels, Lake Content, Lost Lake, Fawn and Big St. Germain Lake have conditions closer to optimal relative to the other project lakes. Zebra mussel monitoring in the future should be focused on the project lakes with relatively higher calcium concentrations.

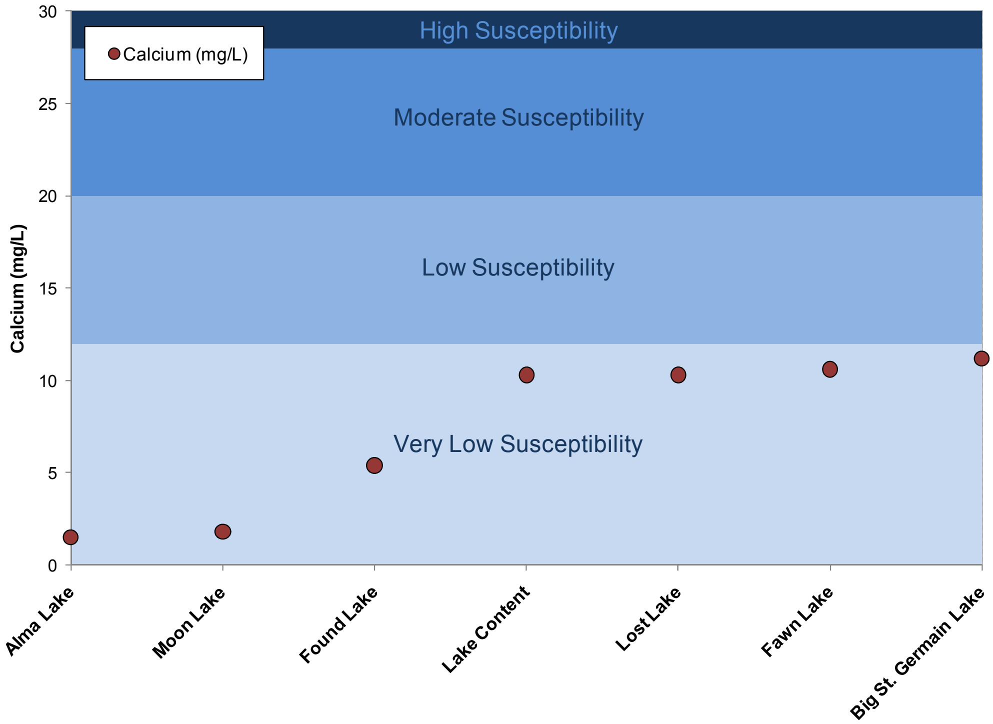

Figure 3.1-7. Town of Saint Germain lakes susceptibility to zebra mussel survivability and establishment based on calcium concentration. Created using surface calcium values. Calcium susceptibility range adapted from Whittier et al. 2008. .

Researchers at the University of Wisconsin - Madison have developed an AIS suitability model called smart prevention (Vander Zanden and Olden 2008). In regards to zebra mussels, this model relies on measured or estimated dissolved calcium concentration to indicate whether a given lake in Wisconsin is suitable, borderline suitable, or unsuitable for sustaining zebra mussels. Within this model, suitability was estimated for approximately 13,000 Wisconsin waterbodies and is displayed as an interactive mapping tool (www.aissmartprevention.wisc.edu). Based upon this analysis, all project waters were considered unsuitable except for Lake Content which was considered borderline suitable for mussel establishment.

On each of the lakes studied within the Town of Saint Germain, plankton tows were completed by Onterra staff during the August of 2010 and these samples were processed by the WDNR for larval zebra mussels. All samples came back negative, meaning that the larval form of zebra mussels was not found in any of the Town of Saint Germain lakes.

3.2 Watershed Assessment

Watershed Modeling

A lake's flushing rate is simply a determination of the time required for the lake's water volume to be completely exchanged. Residence time describes how long a volume of water remains in the lake and is expressed in days, months, or years. The parameters are related and both determined by the volume of the lake and the amount of water entering the lake from its watershed. Greater flushing rates equal shorter residence times.

Two aspects of a lake's watershed are the key factors in determining the amount of phosphorus the watershed exports to the lake; 1) the size of the watershed, and 2) the land cover (land use) within the watershed. The impact of the watershed size is dependent on how large it is relative to the size of the lake. The watershed to lake area ratio (WS:LA) defines how many acres of watershed drains to each surface-acre of the lake. Larger ratios result in the watershed having a greater role in the lake's annual water budget and phosphorus load.

The type of land cover that exists in the watershed determines the amount of phosphorus (and sediment) that runs off the land and eventually makes its way to the lake. The actual amount of pollutants (nutrients, sediment, toxins, etc.) depends greatly on how the land within the watershed is used. Vegetated areas, such as forests, grasslands, and meadows, allow the water to permeate the ground and do not produce much surface runoff. On the other hand, agricultural areas, particularly row crops, along with residential/urban areas, minimize infiltration and increase surface runoff. The increased surface runoff associated with these land cover types leads to increased phosphorus and pollutant loading; which, in turn, can lead to nuisance algal blooms, increased sedimentation, and/or overabundant macrophyte populations.

In systems with lower WS:LA ratios, land cover type plays a very important role in how much phosphorus is loaded to the lake from the watershed. In these systems the occurrence of agriculture or urban development in even a small percentage of the watershed (less than 10%) can unnaturally elevate phosphorus inputs to the lake. If these land cover types are converted to a cover that does not export as much phosphorus, such as converting row crop areas to grass or forested areas, the phosphorus load and its impacts to the lake may be decreased. In fact, if the phosphorus load is reduced greatly, changes in lake water quality may be noticeable, (e.g. reduced algal abundance and better water clarity) and may even be enough to cause a shift in the lake's trophic state.

In systems with high WS:LA ratios, like those exceeding 10-15:1, the impact of land cover may be tempered by the sheer amount of land draining to the lake. Situations actually occur where lakes with completely forested watersheds have sufficient phosphorus loads to support high rates of plant production. In other systems with high ratios, the conversion of vast areas of row crops to vegetated areas (grasslands, meadows, forests, etc.) may not reduce phosphorus loads sufficiently to see a change in plant production. Both of these situations occur frequently in impoundments.

Regardless of the size of the watershed or the makeup of its land cover, it must be remembered that every lake is different and other factors, such as flushing rate, lake volume, sediment type, and many others, also influence how the lake will react to what is flowing into it. For instance, a deeper lake with a greater volume can dilute more phosphorus within its waters than a less voluminous lake and as a result, the production of a lake is kept low. However, in that same lake, because of its low flushing rate (high residence time, i.e., years), there may be a buildup of phosphorus in the sediments that may reach sufficient levels over time that internal nutrient loading may become a problem. On the contrary, a lake with a higher flushing rate (low residence time, i.e., days or weeks) may be more productive early on, but the constant flushing of its waters may prevent a buildup of phosphorus and internal nutrient loading may never reach significant levels.

A reliable and cost-efficient method of creating a general picture of a watershed's affect on a lake can be obtained through modeling. The WDNR created a useful suite of modeling tools called the Wisconsin Lake Modeling Suite (WiLMS). Certain morphological attributes of a lake and its watershed can be entered into WiLMS along with the acreages of different types of land cover within the watershed to produce useful information about the lake ecosystem. This information includes an estimate of annual phosphorus load and the partitioning of those loads between the watershed's different land cover types and atmospheric fallout entering through the lake's water surface. WiLMS also calculates the lake's flushing rate and residence times using county-specific average precipitation/evaporation values or values entered by the user. Predictive models are also included within WiLMS that are valuable in validating modeled phosphorus loads to the lake in question and modeling alternate land cover scenarios within the watershed. Finally, if specific information is available, WiLMS will also estimate the significance of internal nutrient loading within a lake and the impact of shoreland septic systems. Although watershed modeling was not as a part of this project, this program could be utilized in future studies on the Town of Saint Germain lakes.

As described within this document, the Town of Saint Germain lakes studied as part of this project are diverse in terms of their ecology; much of these differences stem from the characteristics of each lake's watershed. These watersheds cover 45,020 acres of land, both within and extending beyond the township's borders. The watersheds cover 72% of the township's total acreage (25,600 acres) and 41% of the watersheds are found within the township, while the majority of the acreage (59%) are found outside of the township. As indicated in Figure 3.2-1, the size of these watersheds ranged greatly - Alma with 182 acres is the smallest and Big St. Germain Lake's 44,324-acre watershed is the largest. Please refer to Map 2 to view each watershed and its respective land cover.

Fawn Lake is interesting in regards to its watershed. Big St. Germain Lake drains into Fawn Lake through a narrow channel. Fawn Lake's watershed consists of two areas, the first being all the land that drains into Big St. Germain Lake, and a much smaller second area that drains directly into Fawn Lake without first passing through Big St. Germain Lake. Because Big St. Germain Lake is so large, it acts as a sink for much of the nutrients and sediment it receives from its watershed, and likely passes only a portion of these nutrients along to the smaller Fawn Lake. Therefore, Fawn Lake's 44,399 acre watershed probably does not affect the lake as it would under other circumstances.

As with most watersheds located in northern Wisconsin, the primary land cover type surrounding the Town of Saint Germain lakes is forest and forested wetlands. Wetlands constitute a portion of most individual watersheds, and in the smaller watersheds the lake surface actually represents a substantial portion of the "land" cover type. Agricultural land and pasture/grass land is located in nearly all the watersheds, though to a minor degree.

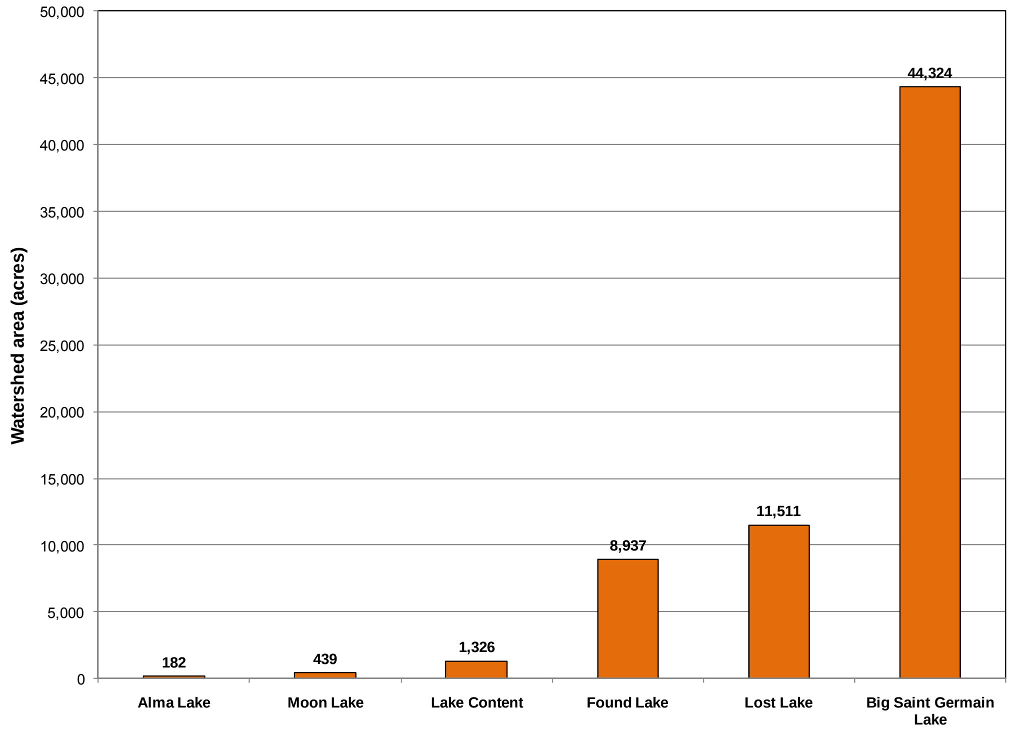

Figure 3.2-1. Town of Saint Germain lakes watershed size in acres. Fawn Lake is not included here for the reasons discussed in the above text.

As discussed above, the size of the watershed in relation to the size of the lake can have a considerable impact on the lake's water quality. The watershed to lake area ratios of the Town of Saint Germain lakes range from 2:1 to 26:1 (Figure 3.2-2). Under normal circumstances, Fawn Lake would have a watershed to lake area ratio of 2,017:1, however, as discussed above, the position of Big St. Germain likely reduces the affect of this ratio greatly. The differences in water quality can be observed between the watersheds with small ratios versus watersheds with large ratios. Although special circumstances overruled these observations in some cases, in general, the lakes with smaller watershed to lake area ratios had lower phosphorus concentrations, lower chlorophyll-*a* concentrations, and higher Secchi depth readings. The role of phosphorus, chlorophyll-*a* and Secchi disk depth on water quality are discussed further in the Water Quality section, while specifics about each lakes' watershed is discussed in their individual sections.

Lakes with larger watersheds have a greater amount of land from which to receive nutrients and water. These lakes tend to have higher phosphorus and chlorophyll-*a* concentrations, and normally fare better against drought conditions. In addition to holding larger watersheds, several of these lakes are classified as drainage lakes because they have an inlet. Seepage and spring lakes, which draw water from groundwater, direct precipitation and surface runoff only, tend to be more sensitive to climatic conditions and may experience lower water levels during times of drought conditions. Changing water levels, while causing negative recreational and short-term ecological impacts, are part of a naturally occurring cycle and have likely happened many times within the lifespan of the lakes in the Northwoods of Wisconsin. While these natural fluctuations may have their drawbacks, these relatively short-term changes may actually benefit the lake ecosystem in the long-term by increasing the level of habitat diversity.

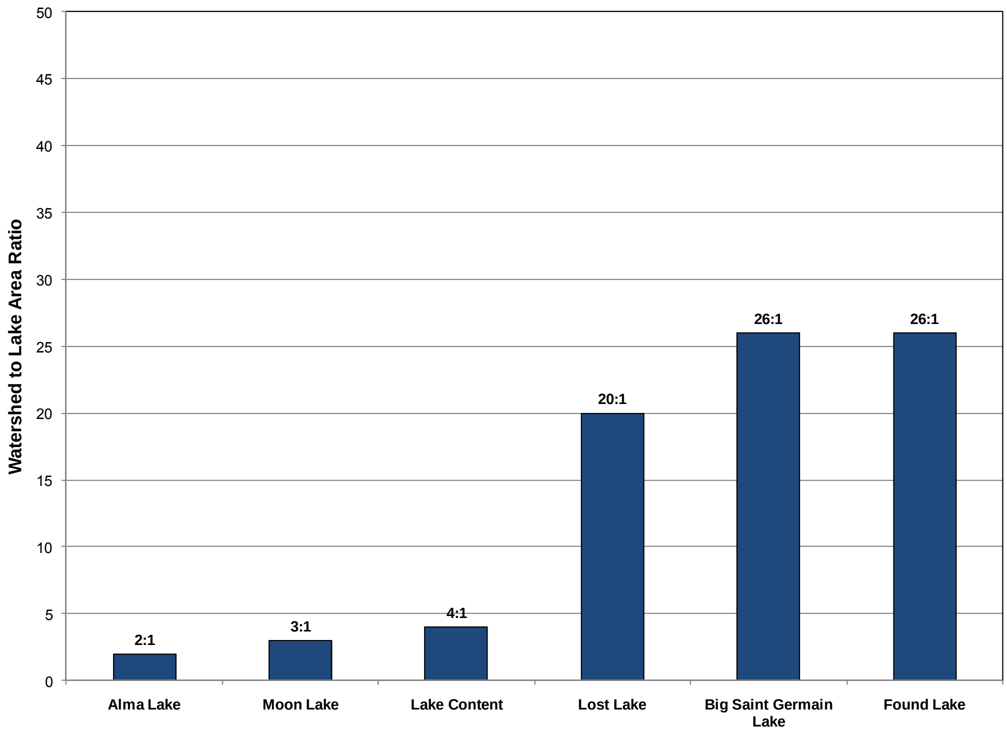

Figure 3.2-2. Town of Saint Germain lakes watershed to lake area ratio. Please note that Fawn Lake is not displayed due to the circumstances described in the above text.

3.3 Shoreland Condition

The Importance of a Lake's Shoreland Zone

One of the most vulnerable areas of a lake's watershed is the immediate shoreland zone (approximately from the water's edge to at least 35 feet shoreland). When a lake's shoreland is developed, the increased impervious surface, removal of natural vegetation, and other human practices can severely increase pollutant loads to the lake while degrading important habitat. Limiting these anthropogenic (man-made) affects on the lake is important in maintaining the quality of the lake's water and habitat. Along with this, the immediate shoreland area is often one of the easiest areas to restore.

The intrinsic value of natural shorelands is found in numerous forms. Vegetated shorelands prevent polluted runoff from entering lakes by filtering this water or allowing it to slow to the point where particulates settle. The roots of shoreland plants stabilize the soil, thereby preventing shoreland erosion. Shorelands also provide habitat for both aquatic and terrestrial animal species. Many species rely on natural shorelands for all or part of their life cycle as a source of food, cover from predators, and as a place to raise their young. Shorelands and the nearby shallow waters serve as spawning grounds for fish and nesting sites for birds. Thus, both the removal of vegetation and the inclusion of development reduces many forms of habitat for wildlife.

Some forms of development may provide habitat for less than desirable species. Disturbed areas are often overtaken by invasive species, which are sometimes termed "pioneer species" for this reason. Some waterfowl, such as geese, prefer to linger upon open lawns near waterbodies because of the lack of cover for potential predators. The presence of geese on a lake resident's beach may not be an issue; however the feces the geese leave are unsightly and pose a health risk. Geese feces may become a source of fecal coliforms as well as flatworms that can lead to swimmers itch. Development such as rip rap or masonary, steel or wooden seawalls completely remove natural habitat for most animals, but may also create some habitat for snails; this is not desirable for lakes that experience problems with swimmers itch, as the flatworms that cause this skin reaction utilize snails as a secondary host after waterfowl.

In the end, natural shorelines provide many ecological and other benefits. Between the abundant wildlife, the lush vegetation, and the presence of native flowers, shorelands also provide natural scenic beauty and a sense of tranquility for humans.

Shoreland Zone Regulations

Wisconsin has numerous regulations in place at the state level which aim to enhance and protect shorelands. Additionally, counties, townships and other municipalities have developed their own (often more comprehensive or stronger) policies. At the state level, the following shoreland regulations exist:

Wisconsin-NR 115: Wisconsin's Shoreland Protection Program

Wisconsin's shoreland zoning rule, NR 115, sets the minimum standards for shoreland development. First adopted in 1966, the code set a deadline for county adoption of January 1, 1968. By 1971, all counties in Wisconsin had adopted the code and were administering the shoreland ordinances it specified. Interestingly, in 2007 it was noted that many (27) counties had recognized inadequacies within the 1968 ordinance and had actually adopted more strict shoreland ordinances. Passed in February of 2010, the final NR 115 allowed many standards to remain the same, such as lot sizes, shoreland setbacks and buffer sizes. However, several standards changed as a result of efforts to balance public rights to lake use with private property rights. The regulation sets minimum standards for the shoreland zone, and requires all counties in the state to adopt shoreland zoning ordinances of their own. County ordinances may be more restrictive than NR 115, but not less so. These policy regulations require each county to amend ordinances for vegetation removal on shorelands, impervious surface standards, nonconforming structures and establishing mitigation requirements for development. Minimum requirements for each of these categories are as follows (Note: counties must adopt these standards by February 2014, counties may not have these standards in place at this time):

- Vegetation Removal: For the first 35 feet of property (shoreland zone), no vegetation removal is permitted except for: sound forestry practices on larger pieces of land, access and viewing corridors (may not exceed the lesser of 30 percent of the shoreline frontage), invasive species removal, or damaged, diseased, or dying vegetation. Vegetation removed must be replaced by replanting in the same area (native species only).

- Impervious surface standards: The amount of impervious surface is restricted to 15% of the total lot size, on lots that are within 300 feet of the ordinary high-water mark of the waterbody. A county may allow more than 15% impervious surface (but not more than 30%) on a lot provided that the county issues a permit and that an approved mitigation plan is implemented by the property owner.

- Nonconforming structures: Nonconforming structures are structures that were lawfully placed when constructed but do not comply with distance of water setback. Originally, structures within 75 ft of the shoreline had limitations on structural repair and expansion. New language in NR-115 allows construction projects on structures within 75 feet with the following caveats:
    - No expansion or complete reconstruction within 0-35 feet of shoreline
    - Re-construction may occur if no other build-able location exists within 35-75 feet, dependent on the county.
    - Construction may occur if mitigation measures are included either within the footprint or beyond 75 feet.
    - Vertical expansion cannot exceed 35 feet

- Mitigation requirements: New language in NR-115 specifies mitigation techniques that may be incorporated on a property to offset the impacts of impervious surface, replacement of nonconforming structure, or other development projects. Practices such as buffer restorations along the shoreland zone, rain gardens, removal of fire pits, and beaches all may be acceptable mitigation methods, dependent on the county.

- Contact the county's regulations/zoning department for all minimum requirements.

Wisconsin Act 31

While not directly aimed at regulating shoreland practices, the State of Wisconsin passed Wisconsin Act 31 in 2009 in an effort to minimize watercraft impacts upon shorelines. This act prohibits a person from operating a watercraft (other than personal watercraft) at a speed in excess of slow-no-wake speed within 100 feet of a pier, raft, buoyed area or the shoreline of a lake. Additionally, personal watercraft must abide by slow-no-wake speeds while within 200 feet of these same areas. Act 31 was put into place to reduce wave action upon the sensitive shoreland zone of a lake. The legislation does state that pickup and drop off areas marked with regulatory markers and that are open to personal watercraft operators and motorboats engaged in waterskiing/a similar activity may be exempt from this distance restriction. Additionally, a city, village, town, public inland lake protection and rehabilitation district or town sanitary district may provide an exemption from the 100 foot requirement or may substitute a lesser number of feet.

Shoreland Research

Studies conducted on nutrient runoff from Wisconsin lake shorelands have produced interesting results. For example, a USGS study on several Northwoods Wisconsin lakes was conducted to determine the impact of shoreland development on nutrient (phosphorus and nitrogen) export to these lakes (Graczyk et al. 2003). During the study period, water samples were collected from surface runoff and ground water and analyzed for nutrients. These studies were conducted on several developed (lawn covered) and undeveloped (undisturbed forest) areas on each lake. The study found that nutrient yields were greater from lawns than from forested catchments, but also that runoff water volumes were the most important factor in determining whether lawns or wooded catchments contributed more nutrients to the lake. Ground-water inputs to the lake were found to be significant in terms of water flow and nutrient input. Nitrate plus nitrite nitrogen and total phosphorus yields to the ground-water system from a lawn catchment were three or sometimes four times greater than those from wooded catchments.

A separate USGS study was conducted on the Lauderdale Lakes in southern Wisconsin, looking at nutrient runoff from different types of developed shorelands – regular fertilizer application lawns (fertilizer with phosphorus), non-phosphorus fertilizer application sites, and unfertilized sites (Garn 2002). One of the important findings stemming from this study was that the amount of dissolved phosphorus coming off of regular fertilizer application lawns was twice that of lawns with non-phosphorus or no fertilizer. Dissolved phosphorus is a form in which the phosphorus molecule is not bound to a particle of any kind; in this respect, it is readily available to algae. Therefore, these studies show us that it is a developed shoreland that is continuously maintained in an unnatural manner (receiving phosphorus rich fertilizer) that impacts lakes the greatest. This understanding led former Governor Jim Doyle into passing the Wisconsin Zero-Phosphorus Fertilizer Law (Wis Statue 94.643), which restricts the use, sale and display of lawn and turf fertilizer which contains phosphorus. Certain exceptions apply, but after April 1 2010, use of this type of fertilizer is prohibited on lawns and turf in Wisconsin. The goal of this action is to reduce the impact of developed lawns, and is particularly helpful to developed lawns situated near Wisconsin waterbodies.

Shorelands provide much in terms of nutrient retention and mitigation, but also play an important role in wildlife habitat. Woodford and Meyer (2003) found that green frog density was negatively correlated with development density in Wisconsin lakes. As development increased, the habitat for green frogs decreased and thus populations became significantly lower. Common loons, a bird species notorious for its haunting call that echoes across Wisconsin lakes, are often associated more so with undeveloped lakes than developed lakes (Lindsay et al. 2002). And studies on shoreland development and fish nests show that undeveloped shorelands are preferred as well. In a study conducted on three Minnesota lakes, researchers found that only 74 of 852 black crappie nests were found near shorelines that had any type of dwelling on it (Reed, 2001). The remaining nests were all located along undeveloped shoreland.

Emerging research in Wisconsin has shown that coarse woody habitat (sometimes called "coarse woody debris"), often stemming from natural or undeveloped shorelands, provides many ecosystem benefits in a lake. Coarse woody habitat describes habitat consisting of trees, limbs, branches, roots and wood fragments at least four inches in diameter that enter a lake by natural or human means. Coarse woody habitat provides shoreland erosion control, a carbon source for the lake, prevents suspension of sediments and provides a surface for algal growth which important for aquatic macroinvertebrates (Sass 2009). While it impacts these aspects considerably, one of the greatest benefits coarse woody habitat provides is habitat for fish species.

Coarse woody habitat has shown to be advantageous for fisheries in terms of providing refuge, foraging area as well as spawning habitat (Hanchin et al 2003). In one study, researchers observed 16 different species occupying coarse woody habitat areas in a Wisconsin lake (Newbrey et al. 2005). Bluegill and bass species in particular are attracted to this habitat type; largemouth bass stalk bluegill in these areas while the bluegill hide amongst the debris and often feed upon in many macroinvertebrates found in these areas, who themselves are feeding upon algae and periphyton growing on the wood surface. Newbrey et al. (2005) found that some fish species prefer different complexity of branching on coarse woody habitat, though in general some degree of branching is preferred over coarse woody habitat that has no branching.

With development of a lake's shoreland zone, much of the coarse woody habitat that was once found in Wisconsin lakes has disappeared. Prior to human establishment and development on lakes (mid to late 1800's), the amount of coarse woody habitat in lakes was likely greater than under completely natural conditions due to logging practices. However, with changes in the logging industry and increasing development along lake shorelands, coarse woody habitat has decreased substantially. Shoreland residents are removing woody debris to improve aesthetics or for recreational opportunities (boating, swimming, and, ironically, fishing).

National Lakes Assessment

Unfortunately, along with Wisconsin's lakes, waterbodies within the entire United States have shown to have increasing amounts of developed shorelands. The National Lakes Assessment (NLA) is an Environmental Protection Agency sponsored assessment that has successfully pooled together resource managers from all 50 U.S. states in an effort to assess waterbodies, both natural and man-made, from each state. Through this collaborative effort, over 1,000 lakes were sampled in 2007, pooling together the first statistical analysis of the nation's lakes and reservoirs.

Through the National Lakes Assessment, a number of potential stressors were examined, including nutrient impairment, algal toxins, fish tissue contaminants, physical habitat, and others. The 2007 NLA report states that "*of the stressors examined, poor lakeshore habitat is the biggest problem in the nations lakes; over one-third exhibit poor shoreline habitat condition*" (USEPA 2009). Furthermore, the report states that "*poor biological health is three times more likely in lakes with poor lakeshore habitat*".

The results indicate that stronger management of shoreline development is absolutely necessary to preserve, protect and restore lakes. This will become increasingly important if development on lakes continues to steadily grow.

Native Species Enhancement

The development of Wisconsin's shorelands has increased dramatically over the last century and with this increase in development a decrease in water quality and wildlife habitat has occurred. Many people that move to or build in shoreland areas attempt to replicate the suburban landscapes they are accustomed to by converting natural shoreland areas to the "neat and clean" appearance of manicured lawns and flowerbeds. The conversion of these areas immediately leads to destruction of habitat utilized by birds, mammals, reptiles, amphibians, and insects (Jennings et al. 2003). The maintenance of the newly created area helps to decrease water quality by considerably increasing inputs of phosphorus and sediments into the lake. The negative impact of human development does not stop at the shoreland. Removal of native plants and dead, fallen timbers from shallow, near-shore areas for boating and swimming activities destroys habitat used by fish, mammals, birds, insects, and amphibians, while leaving bottom and shoreland sediments vulnerable to wave action caused by boating and wind (Jennings et al. 2003, Radomski and Goeman 2001, and Elias & Meyer 2003). Many homeowners significantly decrease the number of trees and shrubs along the water's edge in an effort to increase their view of the lake. However, this has been shown to locally increase water temperatures, and decrease infiltration rates of potentially harmful nutrients and pollutants. Furthermore, the dumping of sand to create beach areas destroys spawning, cover and feeding areas utilized by aquatic wildlife (Scheuerell and Schindler 2004).

In recent years, many lakefront property owners have realized increased aesthetics, fisheries, property values, and water quality by restoring portions of their shoreland to mimic its unaltered state. An area of shore restored to its natural condition, both in the water and on shore, is commonly called a shoreland buffer zone. The shoreland buffer zone creates or restores the ecological habitat and benefits lost by traditional suburban landscaping. Simply not mowing within the buffer zone does wonders to restore some of the shoreland's natural function.

Enhancement activities also include additions of submergent, emergent, and floating-leaf plants within the lake itself. These additions can provide greater species diversity and may compete against exotic species.

Cost

The cost of native, aquatic, and shoreland plant restorations is highly variable and depends on the size of the restoration area, the depth of buffer zone required to be restored, the existing plant density, the planting density required, the species planted, and the type of planting (e.g. seeds, bare-roots, plugs, live-stakes) being conducted. Other sites may require erosion control stabilization measures, which could be as simple as using erosion control blankets and plants and/or seeds or more extensive techniques such as geotextile bags (vegetated retaining walls), geogrids (vegetated soil lifts), or bio-logs (see above picture). Some of these erosion control techniques may reduce the need for rip-rap or seawalls which are sterile environments that do not allow for plant growth or natural shorelines. Questions about rip-rap or seawalls should be directed to the local Wisconsin DNR Water Resources Management Specialist. Other measures possibly required include protective measures used to guard newly planted area from wildlife predation, wave-action, and erosion, such as fencing, erosion control matting, and animal deterrent sprays. One of the most important aspects of planting is maintaining moisture levels. This is done by watering regularly for the first two years until plants establish themselves, using soil amendments (i.e., peat, compost) while planting, and using mulch to help retain moisture.

Most restoration work can be completed by the landowner themselves. To decrease costs further, bare-root form of trees and shrubs should be purchased in early spring. If additional assistance is needed, the lakefront property owner could contact an experienced landscaper. For properties with erosion issues, owners should contact their local county conservation office to discuss cost-share options. In general, a restoration project with the characteristics described below would have an estimated materials and supplies cost of approximately $1,400. The more native vegetation a site has, the lower the cost. Owners should contact the county's regulations/zoning department for all minimum requirements. The single site used for the estimate indicated above has the following characteristics:

- Spring planting timeframe.
- 100' of shoreline.
- An upland buffer zone depth of 35'.
- An access and viewing corridor 30' x 35' free of planting (recreation area).
- Planting area of upland buffer zone 2- 35' x 35' areas
- Site is assumed to need little invasive species removal prior to restoration.
- Site has only turf grass (no existing trees or shrubs), a moderate slope, sandy-loam soils, and partial shade.
- Trees and shrubs planted at a density of 1 tree/100 sq ft and 2 shrubs/100 sq ft, therefore, 24 native trees and 48 native shrubs would need to be planted.
- Turf grass would be removed by hand.
- A native seed mix is used in bare areas of the upland buffer zone.
- An aquatic zone with shallow-water 2 - 5' x 35' areas.
- Plant spacing for the aquatic zone would be 3 feet.

- Each site would need 70’ of erosion control fabric to protect plants and sediment near the shoreland (the remainder of the site would be mulched).
- Soil amendment (peat, compost) would be needed during planting.
- There is no hard-armor (rip-rap or seawall) that would need to be removed.
- The property owner would maintain the site for weed control and watering.

Advantages	***Disadvantages***
• Improves the aquatic ecosystem through species diversification and habitat enhancement. • Assists native plant populations to compete with exotic species. • Increases natural aesthetics sought by many lake users. • Decreases sediment and nutrient loads entering the lake from developed properties. • Reduces bottom sediment re-suspension and shoreland erosion. • Lower cost when compared to rip-rap and seawalls. • Restoration projects can be completed in phases to spread out costs. • Once native plants are established, they require less water, maintenance, no fertilizer; provide wildlife food and habitat, and natural aesthetics compared to ornamental (non-native) varieties. • Many educational and volunteer opportunities are available with each project.	• Property owners need to be educated on the benefits of native plant restoration before they are willing to participate. • Stakeholders must be willing to wait 3-4 years for restoration areas to mature and fill-in. • Monitoring and maintenance are required to assure that newly planted areas will thrive. • Harsh environmental conditions (e.g., drought, intense storms) may partially or completely destroy project plantings before they become well established.

Town of St. Germain Shoreland Zone Condition

Shoreland Development

A lake's shoreland zone can be classified in terms of its degree of development. In general, more developed shorelines are more stressful on a lake ecosystem, while definite benefits occur from shorelines that are left in their natural state. Figure 3.3-1 displays a diagram of shoreline categories, from "Urbanized", meaning the shoreland zone is completely disturbed by human influence, to "Natural/Undeveloped", meaning the shoreline has been left in its original state.

As a part of this project, the development stage of the Town of Saint Germain project lakes' entire shoreline was surveyed during late summer of 2010, except for Alma and Moon Lakes, which were assessed as part of another study. Onterra staff only considered the area of shoreland 35 feet inland from the water's edge, and did not assess the shoreline on a property-by-property basis. During the survey, Onterra staff examined the shoreline for signs of development and assigned areas of the shoreland one of the five descriptive categories in Figure 3.3-1.

Table 3.3-1 displays the shoreline condition of each Town of Saint Germain lake, expressed as a percentage of the total shoreline. Of the lakes studied, Lake Content had the highest percentage of undisturbed shoreline, followed closely by Found Lake. As far as lakes with disturbed shorelines, Big St. Germain Lake has the highest percentage followed closely by Lost Lake. The shoreline condition of each lake will be discussed further in each individual lake section, while the Shoreline Condition Map for each lake illustrates the locations of these shoreline categories.

Table 3.3-1 Town of Saint Germain lakes shoreland condition. Numbers are based on a percentage of the total shoreline length. Data from 2010 surveys.

Classification	Big St. Germain Lake	Lake Content	Fawn Lake	Found Lake	Lost Lake
Natural/Undeveloped	7%	46%	6%	30%	21%
Developed-Natural	11%	2%	10%	7%	3%
Developed-Semi-Natural	35%	28%	58%	47%	45%
Developed-Unnatural	26%	24%	21%	14%	16%
Urbanized	21%	0%	4%	2%	16%

Two of the project lakes, Found Lake and Moon Lake, are involved in WDNR research projects in which the ecological benefits of shoreland restoration are being measured through before-and-after restoration efforts. On Found Lake, 14 neighboring properties agreed to participate in restoration efforts in which erosion and unsuitable wildlife habitat issues were addressed by control structures and vegetative plantings. This project began in 2007. Similar efforts were conducted in 2008 on 1,300 lineal feet of shoreline along the Moon Beach Camp on Moon Lake. Both of these locations will receive post-project monitoring and comparison to control sites in an effort to examine the change in relative abundance and diversity of native vegetation, herptiles (reptiles and amphibians), birds, and small mammals.

Urbanized: This type of shoreline has essentially no natural habitat. Areas that are mowed or unnaturally landscaped to the water's edge and areas that are rip-rapped or include a seawall would be placed in this category.

Developed-Unnatural: This category includes shorelines that have been developed, but only have small remnants of natural habitat yet intact. A property with many trees, but no remaining understory or herbaceous layer would be included within this category. Also, a property that has left a small (less than 30 feet), natural buffer in place, but has urbanized the areas behind the buffer would be included in this category.

Developed-Semi-Natural: This is a developed shoreline that is mostly in a natural state. Developed properties that have left much of the natural habitat in state, but have added gathering areas, small beaches, etc within those natural areas would likely fall into this category. An urbanized shoreline that was restored would likely be included here, also.

Developed-Natural: This category includes shorelines that are developed property, but essentially no modifications to the natural habitat have been made. Developed properties that have maintained the natural habitat and only added a path leading to a single pier would fall into this category.

Natural/Undeveloped: This category includes shorelines in a natural, undisturbed state. No signs of anthropogenic impact can be found on these shorelines. In forested areas, herbaceous, understory, and canopy layers would be intact.

Figure 3.3-1. Shoreline assessment category descriptions.

3.4 Aquatic Plants

Introduction

Although the occasional lake user considers aquatic macrophytes to be "weeds" and a nuisance to the recreational use of the lake, the plants are actually an essential element in a healthy and functioning lake ecosystem. It is very important that lake stakeholders understand the importance of lake plants and the many functions they serve in maintaining and protecting a lake ecosystem. With increased understanding and awareness, most lake users will recognize the importance of the aquatic plant community and their potential negative effects on it.

Diverse aquatic vegetation provides habitat and food for many kinds of aquatic life, including fish, insects, amphibians, waterfowl, and even terrestrial wildlife. For instance, wild celery (*Vallisneria americana)* and wild rice (*Zizania aquatica* and *Z. palustris*) both serve as excellent food sources for ducks and geese. Emergent stands of vegetation provide necessary spawning habitat for fish such as northern pike (*Esox lucius*) and yellow perch (*Perca flavescens*) In addition, many of the insects that are eaten by young fish rely heavily on aquatic plants and the periphyton attached to them as their primary food source. The plants also provide cover for feeder fish and zooplankton, stabilizing the predator-prey relationships within the system. Furthermore, rooted aquatic plants prevent shoreline erosion and the resuspension of sediments and nutrients by absorbing wave energy and locking sediments within their root masses. In areas where plants do not exist, waves can resuspend bottom sediments decreasing water clarity and increasing plant nutrient levels that may lead to algae blooms. Lake plants also produce oxygen through photosynthesis and use nutrients that may otherwise be used by phytoplankton, which helps to minimize nuisance algal blooms.

Under certain conditions, a few species may become a problem and require control measures. Excessive plant growth can limit recreational use by deterring navigation, swimming, and fishing activities. It can also lead to changes in fish population structure by providing too much cover for feeder fish resulting in reduced predation by predator fish, which could result in a stunted pan-fish population. Exotic plant species, such as Eurasian water-milfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*) can also upset the delicate balance of a lake ecosystem by out competing native plants and reducing species diversity. These invasive plant species can form dense stands that are a nuisance to humans and provide low-value habitat for fish and other wildlife.

When plant abundance negatively affects the lake ecosystem and limits the use of the resource, plant management and control may be necessary. The management goals should always include the control of invasive species and restoration of native communities through environmentally sensitive and economically feasible methods. No aquatic plant management plan should only contain methods to control plants, they should also contain methods on how to protect and possibly enhance the important plant communities within the lake. Unfortunately, the latter is often neglected and the ecosystem suffers as a result.

Aquatic Plant Management and Protection

Important Note:
Even though most of these techniques are not applicable to the Town of St. Germain Lakes, it is still important for lake users to have a basic understanding of all the techniques so they can better understand why particular methods are or are not applicable in their lake. The techniques applicable to the Town of St. Germain Lakes are discussed in Summary and Conclusions section and the Implementation Plan found

Many times an aquatic plant management plan is aimed at only controlling nuisance plant growth that has limited the recreational use of the lake, usually navigation, fishing, and swimming. It is important to remember the vital benefits that native aquatic plants provide to lake users and the lake ecosystem, as described above. Therefore, all aquatic plant management plans also need to address the enhancement and protection of the aquatic plant community. Below are general descriptions of the many techniques that can be utilized to control and enhance aquatic plants. Each alternative has benefits and limitations that are explained in its description. Please note that only legal and commonly used methods are included. For instance, the herbivorous grass carp (*Ctenopharyngodon idella*) is illegal in Wisconsin and rotovation, a process by which the lake bottom is tilled, is not a commonly accepted practice. Unfortunately, there are no "silver bullets" that can completely cure all aquatic plant problems, which makes planning a crucial step in any aquatic plant management activity. Many of the plant management and protection techniques commonly used in Wisconsin are described below.

Permits

The signing of the 2001-2003 State Budget by Gov. McCallum enacted many aquatic plant management regulations. The rules for the regulations have been set forth by the WDNR as NR 107 and 109. A major change includes that all forms of aquatic plant management, even those that did not require a permit in the past, require a permit now, including manual and mechanical removal. Manual cutting and raking are exempt from the permit requirement if the area of plant removal is no more than 30 feet wide and any piers, boatlifts, swim rafts, and other recreational and water use devices are located within that 30 feet. This action can be conducted up to 150 feet from shore. Please note that a permit is needed in all instances if wild rice is to be removed. Furthermore, installation of aquatic plants, even natives, requires approval from the WDNR.

Permits are required for chemical and mechanical manipulation of native and non-native plant communities. Large-scale protocols have been established for chemical treatment projects covering >10 acres or areas greater than 10% of the lake littoral zone and more than 150 feet from shore. Different protocols are to be followed for whole-lake scale treatments (≥160 acres or ≥50% of the lake littoral area). Additionally, it is important to note that local permits and U.S. Army Corps of Engineers regulations may also apply. For more information on permit requirements, please contact the WDNR Regional Water Management Specialist or Aquatic Plant Management and Protection Specialist.

Manual Removal

Manual removal methods include hand-pulling, raking, and hand-cutting. Hand-pulling involves the manual removal of whole plants, including roots, from the area of concern and disposing them out of the waterbody. Raking entails the removal of partial and whole plants from the lake by dragging a rake with a rope tied to it through plant beds. Specially designed rakes are available from commercial sources or an asphalt rake can be used. Hand-cutting differs from the other two manual methods because the entire plant is not removed, rather the plants are cut similar to mowing a lawn; however Wisconsin law states that all plant fragments must be removed. One manual cutting technique involves throwing a specialized "V" shaped cutter into the plant bed and retrieving it with a rope. The raking method entails the use of a two-sided straight blade on a telescoping pole that is swiped back and forth at the base of the undesired plants.

In addition to the hand-cutting methods described above, powered cutters are now available for mounting on boats. Some are mounted in a similar fashion to electric trolling motors and offer a 4-foot cutting width, while larger models require complicated mounting procedures, but offer an 8-foot cutting width. Please note that the use of powered cutters may require a mechanical harvesting permit to be issued by the WDNR.

When using the methods outlined above, it is very important to remove all plant fragments from the lake to prevent re-rooting and drifting onshore followed by decomposition. It is also important to preserve fish spawning habitat by timing the treatment activities after spawning. In Wisconsin, a general rule would be to not start these activities until after June 15th.

Cost

Commercially available hand-cutters and rakes range in cost from $85 to $150. Power-cutters range in cost from $1,200 to $11,000.

Advantages	*Disadvantages*
• Very cost effective for clearing areas around docks, piers, and swimming areas. • Relatively environmentally safe if treatment is conducted after June 15th. • Allows for selective removal of undesirable plant species. • Provides immediate relief in localized area. • Plant biomass is removed from waterbody.	• Labor intensive. • Impractical for larger areas or dense plant beds. • Subsequent treatments may be needed as plants recolonize and/or continue to grow. • Uprooting of plants stirs bottom sediments making it difficult to conduct action. • May disturb benthic organisms and fish-spawning areas. • Risk of spreading invasive species if fragments are not removed.

Bottom Screens

Bottom screens are very much like landscaping fabric used to block weed growth in flowerbeds. The gas-permeable screen is placed over the plant bed and anchored to the lake bottom by staking or weights. Only gas-permeable screen can be used or large pockets of gas will form under the mat as the result of plant decomposition. This could lead to portions of the screen becoming detached from the lake bottom, creating a navigational hazard. Normally the screens are removed and cleaned at the end of the growing season and then placed back in the lake the following spring. If they are not removed, sediments may build up on them and allow for plant colonization on top of the screen.

Cost

Material costs range between $.20 and $1.25 per square-foot. Installation cost can vary largely, but may roughly cost $750 to have 1,000 square feet of bottom screen installed. Maintenance costs can also vary, but an estimate for a waterfront lot is about $120 each year.

Advantages	*Disadvantages*
• Immediate and sustainable control. • Long-term costs are low. • Excellent for small areas and around obstructions. • Materials are reusable. • Prevents fragmentation and subsequent spread of plants to other areas.	• Installation may be difficult over dense plant beds and in deep water. • Not species specific. • Disrupts benthic fauna. • May be navigational hazard in shallow water. • Initial costs are high. • Labor intensive due to the seasonal removal and reinstallation requirements. • Does not remove plant biomass from lake. • Not practical in large-scale situations.

Water Level Drawdown

The primary manner of plant control through water level drawdown is the exposure of sediments and plant roots/tubers to desiccation and either heating or freezing depending on the timing of the treatment. Winter drawdowns are more common in temperate climates like that of Wisconsin and usually occur in reservoirs because of the ease of water removal through the outlet structure. An important fact to remember when considering the use of this technique is that only certain species are controlled and that some species may even be enhanced. Furthermore, the process will likely need to be repeated every two or three years to keep target species in check.

Cost

The cost of this alternative is highly variable. If an outlet structure exists, the cost of lowering the water level would be minimal; however, if there is not an outlet, the cost of pumping water to the desirable level could be very expensive. If a hydro-electric facility is operating on the system, the costs associated with loss of production during the drawdown also need to be considered, as they are likely cost prohibitive to conducting the management action.

Advantages	*Disadvantages*
• Inexpensive if outlet structure exists. • May control populations of certain species, like Eurasian water-milfoil for a few years. • Allows some loose sediment to consolidate, increasing water depth. • May enhance growth of desirable emergent species. • Other work, like dock and pier repair may be completed more easily and at a lower cost while water levels are down.	• May be cost prohibitive if pumping is required to lower water levels. • Has the potential to upset the lake ecosystem and have significant effects on fish and other aquatic wildlife. • Adjacent wetlands may be altered due to lower water levels. • Disrupts recreational, hydroelectric, irrigation and water supply uses. • May enhance the spread of certain undesirable species, like common reed (*Phragmites australis*) and reed canary grass (*Phalaris arundinacea*). • Permitting process may require an environmental assessment that may take months to prepare. • Unselective.

Mechanical Harvesting

Aquatic plant harvesting is frequently used in Wisconsin and involves the cutting and removal of plants much like mowing and bagging a lawn. Harvesters are produced in many sizes that can cut to depths ranging from 3 to 6 feet with cutting widths of 4 to 10 feet. Plant harvesting speeds vary with the size of the harvester, density and types of plants, and the distance to the off-loading area. Equipment requirements do not end with the harvester. In addition to the harvester, a shore-conveyor would be required to transfer plant material from the harvester to a dump truck for transport to a landfill or compost site. Furthermore, if off-loading sites are limited and/or the lake is large, a transport barge may be needed to move the harvested plants from the harvester to the shore in order to cut back on the time that the harvester spends traveling to the shore conveyor. Some lake organizations contract to have nuisance plants harvested, while others choose to purchase their own equipment. If the latter route is chosen, it is especially important for the lake group to be very organized and realize that there is a great deal of work and expense involved with the purchase, operation, maintenance, and storage of an aquatic plant harvester. In either case, planning is very important to minimize environmental effects and maximize benefits.

Costs

Equipment costs vary with the size and features of the harvester, but in general, standard harvesters range between $45,000 and $100,000. Larger harvesters or stainless steel models may cost as much as $200,000. Shore conveyors cost approximately $20,000 and trailers range from $7,000 to $20,000. Storage, maintenance, insurance, and operator salaries vary greatly.

Advantages	***Disadvantages***
• Immediate results. • Plant biomass and associated nutrients are removed from the lake. • Select areas can be treated, leaving sensitive areas intact. • Plants are not completely removed and can still provide some habitat benefits. • Opening of cruise lanes can increase predator pressure and reduce stunted fish populations. • Removal of plant biomass can improve the oxygen balance in the littoral zone. • Harvested plant materials produce excellent compost.	• Initial costs and maintenance are high if the lake organization intends to own and operate the equipment. • Multiple treatments are likely required. • Many small fish, amphibians and invertebrates may be harvested along with plants. • There is little or no reduction in plant density with harvesting. • Invasive and exotic species may spread because of plant fragmentation associated with harvester operation. • Bottom sediments may be re-suspended leading to increased turbidity and water column nutrient levels.

Chemical Treatment

There are many herbicides available for controlling aquatic macrophytes and each compound is sold under many brand names. Aquatic herbicides fall into two general classifications:

1. Contact herbicides act by causing extensive cellular damage, but usually do not affect the areas that were not in contact with the chemical. This allows them to work much faster, but does not result in a sustained effect because the root crowns, roots, or rhizomes are not killed.
2. Systemic herbicides spread throughout the entire plant and often result in complete mortality if applied at the right time of the year.

Both types are commonly used throughout Wisconsin with varying degrees of success. The use of herbicides is potentially hazardous to both the applicator and the environment, so all lake organizations should seek consultation and/or services from professional applicators with training and experience in aquatic herbicide use.

Applying herbicides in the aquatic environment requires special considerations compared with terrestrial applications. WDNR administrative code states that a permit is required if "you are standing in socks and they get wet." In these situations, the herbicide application needs to be completed by an applicator licensed with the Wisconsin Department of Agriculture, Trade and Consumer Protection. All herbicide applications conducted under the ordinary high water mark require herbicides specifically labeled by the United States Environmental Protection Agency.

Aquatic herbicides can be classified in many ways. Organization of this section follows Netherland (2009) in which mode of action (i.e. how the herbicide works) and application techniques (i.e. foliar or submersed treatment) group the aquatic herbicides. The table below provides a general list of commonly used aquatic herbicides in Wisconsin and is synthesized from Netherland (2009).

The arguably clearest division amongst aquatic herbicides is their general mode of action and fall into two basic categories:

1. Contact herbicides act by causing extensive cellular damage, but usually do not affect the areas that were not in contact with the chemical. This allows them to work much faster, but in some plants does not result in a sustained effect because the root crowns, roots, or rhizomes are not killed.
2. Systemic herbicides act slower than contact herbicides, being transported throughout the entire plant and disrupting biochemical pathways which often result in complete mortality.

General Mode of Action		Compound	Specific Mode of Action	Most Common Target Species in Wisconsin
Contact		Copper	plant cell toxicant	Algae, including macro-algae (i.e. muskgrasses & stoneworts)
		Endothall	Inhibits respiration & protein synthesis	Submersed species, largely for curly-leaf pondweed; Eurasian water milfoil control when mixed with auxin herbicides
		Diquat	Inhibits photosynthesis & destroys cell membranes	Nusiance natives species including duckweeds, trageted AIS control when exposure times are low
Systemic	Auxin Mimics	2,4-D	auxin mimic, plant growth regulator	Submersed species, largely for Eurasian water milfoil
		Triclopyr	auxin mimic, plant growth regulator	Submersed species, largely for Eurasian water milfoil
	In Water Use Only	Fluridone	Inhibits plant specific enzyme, new growth bleached	Submersed species, largely for Eurasian water milfoil
	Enzyme Specific (ALS)	Penoxsulam	Inhibits plant-specific enzyme (ALS), new growth stunted	New to WI, potential for submergent and floating-leaf species
		Imazamox	Inhibits plant-specific enzyme (ALS), new growth stunted	New to WI, potential for submergent and floating-leaf species
	Enzyme Specific (foliar use only)	Glyphosate	Inhibits plant-specific enzyme (ALS)	Emergent species, including purple loosestrife
		Imazapyr	Inhibits plant-specific enzyme (EPSP)	Hardy emergent species, including common reed

Both types are commonly used throughout Wisconsin with varying degrees of success. The use of herbicides is potentially hazardous to both the applicator and the environment, so all lake organizations should seek consultation and/or services from professional applicators with training and experience in aquatic herbicide use.

Herbicides that target submersed plant species are directly applied to the water, either as a liquid or an encapsulated granular formulation. Factors such as water depth, water flow, treatment area size, and plant density work to reduce herbicide concentration within aquatic systems. Understanding concentration and exposure times are important considerations for aquatic herbicides. Successful control of the target plant is achieved when it is exposed to a lethal concentration of the herbicide for a specific duration of time. Much information has been gathered in recent years, largely as a result of an ongoing cooperative research project between the Wisconsin Department of Natural Resources, US Army Corps of Engineers Research and Development Center, and private consultants (including Onterra). This research couples quantitative aquatic plant monitoring with field-collected herbicide concentration data to evaluate efficacy and selectivity of control strategies implemented on a subset of Wisconsin lakes and flowages. Based on their preliminary findings, lake managers have adopted two main treatment strategies; 1) whole-lake treatments, and 2). spot treatments.

Spot treatments are a type of control strategy where the herbicide is applied to a specific area (treatment site) such that when it dilutes from that area, its concentrations are insufficient to cause significant affects outside of that area. Spot treatments typically rely on a short exposure time (often hours) to cause mortality and therefore are applied at a much higher herbicide concentration than whole-lake treatments. This has been the strategy historically used on most Wisconsin systems.

Whole-lake treatments are those where the herbicide is applied to specific sites, but when the herbicide reaches equilibrium within the entire volume of water (entire lake, lake basin, or within the epilimnion of the lake or lake basin); it is at a concentration that is sufficient to cause mortality to the target plant within that entire lake or basin. The application rate of a whole-lake treatment is dictated by the volume of water in which the herbicide will reach equilibrium. Because exposure time is so much longer, target herbicide levels for whole-lake treatments are significantly less than for spot treatments.

Cost

Herbicide application charges vary greatly between $400 and $1000 per acre depending on the chemical used, who applies it, permitting procedures, and the size of the treatment area.

Advantages	*Disadvantages*
• Herbicides are easily applied in restricted areas, like around docks and boatlifts. • If certain chemicals are applied at the correct dosages and at the right time of year, they can selectively control certain invasive species, such as Eurasian water-milfoil. • Some herbicides can be used effectively in spot treatments.	• Fast-acting herbicides may cause fishkills due to rapid plant decomposition if not applied correctly. • Many people adamantly object to the use of herbicides in the aquatic environment; therefore, all stakeholders should be included in the decision to use them. • Many herbicides are nonselective. • Most herbicides have a combination of use restrictions that must be followed after their application. • Many herbicides are slow-acting and may require multiple treatments throughout the growing season. • Overuse may lead to plant resistance to herbicides

Biological Controls

There are many insects, fish and pathogens within the United States that are used as biological controls for aquatic macrophytes. For instance, the herbivorous grass carp has been used for years in many states to control aquatic plants with some success and some failures. However, it is illegal to possess grass carp within Wisconsin because their use can create problems worse than the plants that they were used to control. Other states have also used insects to battle invasive plants, such as waterhyacinth weevils (*Neochetina spp.*) and hydrilla stem weevil (*Bagous spp.*) to control waterhyacinth (*Eichhornia crassipes*) and hydrilla (*Hydrilla verticillata)*, respectively. Fortunately, it is assumed that Wisconsin's climate is a bit harsh for these two invasive plants, so there is no need for either biocontrol insect.

However, Wisconsin, along with many other states, is currently experiencing the expansion of lakes infested with Eurasian water-milfoil and as a result has supported the experimentation and use of the milfoil weevil (*Euhrychiopsis lecontei*) within its lakes. The milfoil weevil is a native weevil that has shown promise in reducing Eurasian water-milfoil stands in Wisconsin, Washington, Vermont, and other states. Research is currently being conducted to discover the best situations for the use of the insect in battling Eurasian water milfoil. Currently the milfoil weevil is not a WDNR grant-eligible method of controlling Eurasian water milfoil.

Cost

Stocking with adult weevils costs about $1.20/weevil and they are usually stocked in lots of 1000 or more.

Advantages	***Disadvantages***
• Milfoil weevils occur naturally in Wisconsin. • Likely environmentally safe and little risk of unintended consequences.	• Stocking and monitoring costs are high. • This is an unproven and experimental treatment. • There is a chance that a large amount of money could be spent with little or no change in Eurasian water-milfoil density.

Wisconsin has approved the use of two species of leaf-eating beetles (*Galerucella calmariensis* and *G. pusilla*) to battle purple loosestrife. These beetles were imported from Europe and used as a biological control method for purple loosestrife. Many cooperators, such as county conservation departments or local UW-Extension locations, currently support large beetle rearing operations. Beetles are reared on live purple loosestrife plants growing in kiddy pools surrounded by insect netting. Beetles are collected with aspirators and then released onto the target wild population. For more information on beetle rearing, contact your local UW-Extension location.

In some instances, beetles may be collected from known locations (*cella* insectaries) or purchased through private sellers. Although no permits are required to purchase or release beetles within Wisconsin, application/authorization and release forms are required by the WDNR for tracking and monitoring purposes.

Cost

The cost of beetle release is very inexpensive, and in many cases is free.

Advantages	***Disadvantages***
• Extremely inexpensive control method. • Once released, considerably less effort than other control methods is required. • Augmenting populations many lead to long-term control.	• Although considered “safe,” reservations about introducing one non-native species to control another exist. • Long range studies have not been completed on this technique.

Analysis of Current Aquatic Plant Data

Aquatic plants are an important element in every healthy lake. Changes in lake ecosystems are often first seen in the lake's plant community. Whether these changes are positive, such as variable water levels or negative, such as increased shoreland development or the introduction of an exotic species, the plant community will respond. Plant communities respond in a variety of ways. For example, there may be a loss of one or more species. Certain life forms, such as emergents or floating-leaf communities, may disappear from specific areas of the lake. A shift in plant dominance between species may also occur. With periodic monitoring and proper analysis, these changes are relatively easy to detect and provide very useful information for management decisions.

As described in more detail in the methods section, multiple aquatic plant surveys were completed on Town of St. Germain Lakes; the first looked strictly for the exotic plant, curly-leaf pondweed, while the others that followed assessed both native and non-native species. Combined, these surveys produce a great deal of information about the aquatic vegetation of the lake. These data are analyzed and presented in numerous ways; each is discussed in more detail below.

Primer on Data Analysis & Data Interpretation

Species List

The species list is simply a list of all of the species that were found within the lake, both exotic and native. The list also contains the life-form of each plant found, its scientific name, and its coefficient of conservatism. The latter is discussed in more detail below. Changes in this list over time, whether it is differences in total species present, gains and losses of individual species, or changes in life-forms that are present, can be an early indicator of changes in the health of the lake ecosystem.

Frequency of Occurrence

Frequency of occurrence describes how often a certain species is found within a lake. Obviously, all of the plants cannot be counted in a lake, so samples are collected from pre-determined areas. In the case of Town of St. Germain Lakes, plant samples were collected from plots laid out on a grid that covered the entire lake. Using the data collected from these plots, an estimate of occurrence of each plant species can be determined. In this section, two types of data are displayed: littoral frequency of occurrence and relative frequency of occurrence. Littoral frequency of occurrence is used to describe how often each species occurred in the plots that are less than the maximum depth of plant growth (littoral zone). Littoral frequency is displayed as a percentage. Relative frequency of occurrence uses the littoral frequency for occurrence for each species compared to the sum of the littoral frequency of occurrence from all species. These values are presented in percentages and if all of the values were added up, they would equal 100%. For example, if water lily had a relative frequency of 0.1 and we described that value as a percentage, it would mean that water lily made up 10% of the population.

In the end, this analysis indicates the species that dominate the plant community within the lake. Shifts in dominant plants over time may indicate disturbances in the ecosystem. For instance, low water levels over several years may increase the occurrence of emergent species while decreasing the occurrence of floating-leaf species. Introductions of invasive exotic species may result in major shifts as they crowd out native plants within the system.

Floristic Quality Assessment

The floristic quality of a lake is calculated using its species richness and average species conservatism. Species richness is simply the number of species that occur in the lake, for this analysis, only native species are utilized. Average species conservatism utilizes the coefficient of conservatism values for each of those species in its calculation. A species coefficient of conservatism value indicates that species' likelihood of being found in an undisturbed (pristine) system. The values range from one to ten. Species that are normally found in disturbed systems have lower coefficients, while species frequently found in pristine systems have higher values. For example, cattail, an invasive native species, has a value of 1, while common hard and softstem bulrush have values of 5, and Oakes pondweed, a sensitive and rare species, has a value of 10.

Ecoregions are areas related by similar climate, physiography, hydrology, vegetation and wildlife potential. Comparing ecosystems in the same ecoregion is sounder than comparing systems within manmade boundaries such as counties, towns, or states.

On their own, the species richness and average conservatism values for a lake are useful in assessing a lake's plant community; however, the best assessment of the lake's plant community health is determined when the two values are used to calculate the lake's floristic quality. The floristic quality is calculated using the species richness and average conservatism value of the aquatic plant species that were solely encountered on the rake during the point-intercept survey and does not include incidental species or those encountered during other aquatic plant surveys.

In this section, the floristic quality of the Town of Saint Germain Lakes will be compared to median values from lakes in the same ecoregion and in the state as calculated by Nichols (1999). The same ecoregions used in the water quality comparison are utilized for this purpose (Water Quality section, Figure 3.1-2). However, the comparative data within this ecoregion has been divided into two groupings: Northern Lakes and Forest Lakes (NLFL) and Northern Lakes and Forest Flowages (NLFF). The Town of Saint Germain Lakes are natural systems and therefore will be compared to other natural lakes within the NLFL ecoregion.

Median Value This is the value that roughly half of the data are smaller and half the data are larger. A median is used when a few data are so large or so small that they skew the average value to the point that it would not represent the population as a whole.

Species Diversity

Species diversity is probably the most misused value in ecology because it is often confused with species richness. As discussed above, species richness is simply the number of species found within a system or community. Although these values are related, they are far from the same because diversity also takes into account how evenly the species occur within the system. A lake with 25 species may not be more diverse than a lake with 10 if the first lake is highly dominated by one or two species and the second lake has a more even distribution.

A lake with high species diversity is much more stable than a lake with a low diversity. This is analogous to a diverse financial portfolio in that a diverse lake plant community can withstand environmental fluctuations much like a diverse portfolio can handle economic fluctuations. For example, a lake with a diverse plant community is much better suited to compete against exotic infestation than a lake with a lower diversity.

One factor that influences species richness is the “development factor” of the shoreline. This is not the degree of human development or disturbance, but rather it is a value that attempts to describe the nature of the habitat a particular shoreline may hold. This value is referred to as the shoreline complexity. It specifically analyzes the characteristics of the shoreline and describes to what degree the lake shape deviates from a perfect circle. It is calculated as the ratio of lake perimeter to the circumference of a circle of area equal to that of the lake. A shoreline complexity value of 1.0 would indicate that the lake is a perfect circle. The further away the value gets from 1.0, the more the lake deviates from a perfect circle. As shoreline complexity increases, species richness increases, mainly because there are more habitat types, bays and back water areas sheltered from wind.

Between 2005 and 2009, WDNR Science Services conducted point-intercept surveys on 252 lakes within the state. In the absence of comparative data from Nichols (1999), the Simpson’s Diversity Index values of the lakes within the WDNR Science Services dataset will be compared to the Saint Germain Lakes. Comparisons will be displayed using boxplots that showing median values and upper/lower quartiles of lakes in the same ecoregion (Water Quality section, Figure 3.1-2) and in the state. Please note for this parameter, the Northern Lakes and Forests Ecoregion data includes both natural and flowage lakes.

Box Plot or box-and-whisker diagram graphically shows data through five-number summaries: minimum, lower quartile, median, upper quartile, and maximum. Just as the median divides the data into upper and lower halves, quartiles further divide the data by calculating the median of each half of the dataset.

Community Mapping

A key component of the aquatic plant survey is the creation of an aquatic plant community map. The map represents a snapshot of the important plant communities in the lake as they existed during the survey and is valuable in the development of the management plan and in comparisons with surveys completed in the future. A mapped community can consist of submergent, floating-leaf, or emergent plants, or a combination of these life-forms. Examples of submergent plants include wild celery and pondweeds; while emergents include cattails, bulrushes, and arrowheads, and floating-leaf species include white and yellow pond lilies. Emergents and floating-leaf communities lend themselves well to mapping because there are distinct boundaries between communities. Submergent species are often mixed throughout large areas of the lake and are seldom visible from the surface; therefore, mapping of submergent communities is more difficult and often impossible.

Exotic Plants

Because of their tendency to upset the natural balance of an aquatic ecosystem, exotic species are paid particular attention to during the aquatic plant surveys. Two exotics, curly-leaf pondweed and Eurasian water milfoil are the primary targets of this extra attention.

Eurasian water-milfoil is an invasive species, native to Europe, Asia and North Africa, that has spread to most Wisconsin counties (Figure 3.4-1). Eurasian water-milfoil is unique in that its primary mode of propagation is not by seed. It actually spreads by shoot fragmentation, which has supported its transport between lakes via boats and other equipment. In addition to its propagation method, Eurasian water-milfoil has two other competitive advantages over native aquatic plants, 1) it starts growing very early in the spring when water temperatures are too cold for most native plants to grow, and 2) once its stems reach the water surface, it does not stop growing like most native plants, instead it continues to grow along the surface creating a canopy that blocks light from reaching native plants. Eurasian water-milfoil can create dense stands and dominate submergent communities, reducing important natural habitat for fish and other wildlife, and impeding recreational activities such as swimming, fishing, and boating.

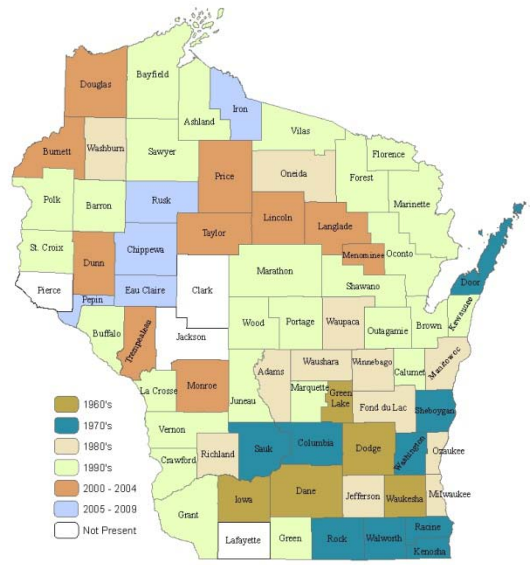

Figure 3.4-1. Spread of Eurasian water milfoil within WI counties. WDNR Data 2009 mapped by Onterra.

Curly-leaf pondweed is a European exotic first discovered in Wisconsin in the early 1900's that has an unconventional lifecycle giving it a competitive advantage over our native plants. Curly – leaf pondweed begins growing almost immediately after ice-out and by mid-June is at peak biomass. While it is growing, each plant produces many turions (asexual reproductive shoots) along its stem. By mid-July most of the plants have senesced, or died-back, leaving the turions in the sediment. The turions lie dormant until fall when they germinate to produce winter foliage, which thrives under the winter snow and ice. It remains in this state until spring foliage is produced in early May, giving the plant a significant jump on native vegetation. Like Eurasian water-milfoil, curly-leaf pondweed can become so abundant that it hampers recreational activities within the lake. Furthermore, its mid-summer die back can cause algal blooms spurred from the nutrients released during the plant's decomposition.

Because of its odd life-cycle, a special survey is conducted early in the growing season to inventory and map curly-leaf pondweed occurrence within the lake. Although Eurasian water milfoil starts to grow earlier than our native plants, it is at peak biomass during most of the summer, so it is inventoried during the comprehensive aquatic plant survey completed in mid to late summer.

Aquatic Plant Survey Results

As mentioned above, numerous plant surveys were completed as a part of this project. In June 2010, surveys were completed on the seven Town of Saint Germain project lakes that focused upon locating any possible occurrences of curly-leaf pondweed. These meander-based surveys did not locate this exotic plant within any of the project lakes. It is believed that curly-leaf pondweed either does not occur within these project lakes or exists at an undetectable level.

However, an established population of curly-leaf pondweed does exist in Little Saint Germain Lake, which was not included in this project.

The point-intercept surveys were conducted on the Town of Saint Germain project lakes in July and August of 2010 by Onterra. Additional surveys were completed by Onterra on these lakes to create the emergent and floating-leaf aquatic plant community maps (See "Aquatic Plant Community Map" after each individual lake section) during July and August of 2010.

From the seven project lakes surveyed, a total of 86 aquatic plant species were identified. Forty submergent plants were located within the waterbodies (Table 3.4-1), as well as 39 emergent or variation of emergent life form species (Table 3.4-3). Three free-floating and four floating-leaf species were also identified from the seven project lakes (Table 3.4-2).

As discussed in the previous sections, the seven Town of Saint Germain project lakes vary widely in their physical attributes (surface area, depth, watershed to lake area ratio, etc.). These differences in morphology generate variances in water quality and trophic state, which in turn influence aquatic plant species composition and abundance creating very different, but high quality plant communities among the Town of Saint Germain project lakes.

The seven Town of Saint Germain project lakes can be divided into two essentially distinct types based on the aquatic plant community composition: 1) lakes that are dominated by plants of the isoetid growth form, and 2) lakes dominated by plants of the elodeid growth form. Aquatic plant species of the isoetid growth form are small, stiff, slow-growing, evergreen, inconspicuous submersed plants usually found growing in sandy substrates within shallower areas of a lake (Boston and Adams 1987, Vestergaard and Sand-Jensen 2000). Some common isoetid species found in the Town of Saint Germain project lakes include quillwort species, dwarf water milfoil, water lobelia, and brown-fruited rush. Isoetid plants are often referred to by residents as "grasses" or "turf-species." Conversely, submersed species of the elodeid growth form have leaves on tall, slender, erect stems which grow tall up into the water column. These leafy submergent plants are often referred to by residents as "lake weeds."

One of the primary factors in determining whether or not a lake's plant community will be dominated by elodeids or isoetids is the availability of carbon within the water, specifically the amount of bicarbonate (Vestergaard and Sand-Jensen 2000). Bicarbonate will be present in a lake if surface or groundwater entering the lake comes into contact with minerals such as calcite and dolomite within the lake's watershed. Lakes with larger watersheds will generally have higher bicarbonate levels than lakes with smaller watersheds.

Elodeids cannot solely meet their carbon demand for photosynthesis through dissolved carbon dioxide in the water and require supplemental carbon from bicarbonate. Thus, in lakes with little to no bicarbonate most species of elodeids are unable to grow. Isoetids, on the other hand, have unique adaptations including the ability to access carbon dioxide within the sediment allowing them to thrive in carbon-limited systems. While isoetids are physically able to grow in lakes with higher bicarbonate levels, their short stature makes them susceptible to shading from the much taller elodeid species, which often restricts their growth to shallow, wave-exposed sites with course sediments (Vestergaard and Sand-Jensen 2000).

Table 3.4-1. Submergent aquatic plant species located in Town of St. Germain Lakes during summer 2010 surveys.

Species	Common Name	C Value	Growth Form	Alma	Moon	BSG	Content	Fawn	Found	Lost
Bidens beckii	Water marigold	8	S			X				X
Ceratophyllum demersum	Coontail	3	S		X	X	X	X	X	X
Chara sp.	Muskgrasses	7	S	X	X	X	X		X	X
Elatine minima	Waterwort	9	S	X	X		X		X	
Elodea canadensis	Common waterweed	3	S	X	X	X	X	X	X	X
Eriocaulon aquaticum	Pipewort	9	S	X	X		X			
Gratiola aurea	Golden pert	10	S		X					
Heteranthera dubia	Water stargrass	6	S		X	X	X			
Isoetes echinospora	Spiny-spored quilwort	8	S				X		X	
Isoetes lacustris	Lake quillwort	8	S	X	X	X			X	X
Lobelia dortmanna	Water lobelia	10	S	X	X	X	X		X	X
Myriophyllum sibiricum	Northern water milfoil	7	S			X	X	X	X	X
Myriophyllum tenellum	Dwarf water milfoil	10	S	X	X		X		X	
Myriophyllum verticillatum	Whorled water milfoil	8	S							X
Najas flexilis	Slender naiad	6	S			X	X	X	X	X
Nitella sp.	Stoneworts	7	S	X	X	X		X	X	X
Potamogeton alpinus	Alpine pondweed	9	S							X
Potamogeton amplifolius	Large-leaf pondweed	7	S	X	X	X	X	X	X	X
P. amplifolius x P. praelongus	Large-leaf x White-stem pondweed	0	S			X	X		X	
Potamogeton epihydrus	Ribbon-leaf pondweed	8	S		X					
Potamogeton friesii	Fries' pondweed	8	S			X	X			
Potamogeton gramineus	Variable pondweed	7	S			X			X	X
Potamogeton haynesii	Stiff x Flat-stem pondweed	NA	S							X
Potamogeton illinoensis	Illinois pondweed	6	S			X	X		X	
Potamogeton natans	Floating-leaf pondweed	5	S						X	X
Potamogeton praelongus	White-stem pondweed	8	S			X	X	X	X	X
Potamogeton pusillus	Small pondweed	7	S	X	X	X	X		X	X
Potamogeton richardsonii	Clasping-leaf pondweed	5	S			X	X	X	X	X
Potamogeton robbinsii	Fern pondweed	8	S			X	X	X	X	X
Potamogeton spathuliformis	Illinois x Variable pondweed	NA	S							X
Potamogeton spirillus	Spiral-fruited pondweed	8	S		X	X		X		
Potamogeton strictifolius	Stiff pondweed	8	S							X
Potamogeton vaseyi	Vasey's pondweed	10	S					X	X	X
Potamogeton zosteriformis	Flat-stem pondweed	6	S			X	X	X	X	X
Ranunculus aquatilis	White water-crowfoot	8	S			X	X	X	X	
Ranunculus flammula	Creeping spearwort	9	S	X	X	X				
Stuckenia pectinata	Sago pondweed	3	S			X				X
Utricularia resupinata	Small purple bladderwort	9	S	X	X					
Utricularia vulgaris	Common bladderwort	7	S			X			X	
Vallisneria americana	Wild celery	6	S	X	X	X	X	X	X	X

C value = Coefficient of Conservatism; BSG = Big St. Germain; S = Submergent

Unfortunately, the only available historic alkalinity data from the project lakes is from Alma Lake, which has quite low alkalinity values (6-7 mg/L). In light of this information, it is not a surprise that of the seven project lakes, Alma and Moon Lakes have the highest abundance of isoetid species. Only Fawn Lake did not contain isoetid species. As indicated above, occurrences of isoetid species outside of Alma and Moon Lakes were limited to areas that were unsuitable for elodeid species to thrive, such as wave-washed, sandy near-shore areas.

Two species of bladderworts were located within the Town of Saint Germain project lakes: common bladderwort and small purple bladderwort. Like isoetid plants, bladderworts have an advantage in low nutrient and low pH systems where other native plants have difficulty obtaining their required nutrients. As their name suggests, these plants contain small bladders that trap and digest small aquatic organisms, utilizing nutrients unavailable to other plants. Both Alma and Moon Lakes contained small purple bladderwort, which until recently was listed as a species of special concern in Wisconsin by the Natural Heritage Inventory (NHI) Program (WDNR 2010a). Vasey's pondweed, which has been and still is an NHI listed species of special concern, was located within three of the project waters (Photo 3.3-1).

Photo 3.4-1 Special concern species Vasey's pondweed (*Potamogeton vaseyi*).

Three elodeid species were found within all seven lakes: common waterweed, large-leaf pondweed, and wild celery. Large-leaf pondweed, sometimes called musky cabbage by anglers, provides valuable habitat for ambush predator fish. Wild celery is a turbidity-tolerant species that is a premiere food source for ducks, marsh birds, shore birds and muskrats. Common waterweed and coontail (found in all but Alma Lake) are largely un-rooted and their locations can be largely a product of water movement. However, these species sometimes possess structures that function similar to roots (rhizoids) or become partially buried in the sediment which greatly limits their ability to move around the lake as rapidly as do duckweeds, which will be discussed below.

Northern water milfoil was found in all project waters except Alma and Moon Lakes. This species is usually found in soft sediments and its feathery foliage traps filamentous algae and detritus, providing valuable invertebrate habitat. Because northern water milfoil prefers high water clarity, its populations are declining state-wide as lakes are becoming more eutrophic. Northern water milfoil is often falsely identified as Eurasian water milfoil, especially since it is known to take on the 'reddish' appearance of Eurasian water milfoil as the plant reacts to increased sun exposure as the growing season progresses and is exacerbated by lowering water levels. No Eurasian water milfoil or any other submergent exotic invasive species were located within the project waters during the 2010 aquatic plant surveys.

Increases in alkalinity and sedimentation from residential development around a lake may result in creating a more suitable habitat for the taller elodeids, displacing isoetid species. As a result, many of the isoetid species have higher conservatism values as they are intolerant of disturbance and are indicators of high quality lake environments. Isoetid dominated lakes tend to be lower in species richness than elodeid dominated lakes.

As indicated in Table 3.4-2, three species of free-floating plants were found in the project waters. These very small, flowering plants belonging to the duckweed family (Lemnaceae) may resemble algae to the untrained eye. Forked duckweed can often be found floating just below the water's surface or aggregating along the bottom. The other two species present within the project waters are generally referred to as floating duckweeds. Floating duckweeds are only found at the surface and accumulate amongst flowering or canopied vegetation and other debris that is at the water's surface. Water movement caused by flow or wind can greatly alter the locations of these species in a short timeframe. While these species are known for their high food value to the waterfowl community, they are also known for their rapid growth and ability to cause nuisance conditionals for lake users. The greatest occurrences of duckweeds were in Fawn Lake.

Photo 3.4-2. White-water crowfoot flower amongst floating duckweed species.

White water lily and spatterdock are floating-leaf plants that were located in all seven of the project lakes (Table 3.4-2). Commonly referred as "lily-pads," these species provide invaluable aquatic habitat that helps support the lake ecosystem. Floating-leaf and emergent species are particularly vulnerable to ecosystem perturbations and closely monitoring the expanse or retraction of these communities may signal changes in a lake before they are apparent in other environmental aspects, such as water quality. As indicated above, a separate community mapping survey was conducted to document the emergent and floating-leaf communities of the project lakes. This survey was also conducted in 2004-2005 on the project waters and comparisons of these datasets will be discussed within each individual lake section.

Table 3.4-2. Free-floating and floating-leaf aquatic plant species located on Town of St. Germain Lakes during summer 2010 surveys.

Species	Common Name	C Value	Growth Form	Alma	Moon	BSG	Content	Fawn	Found	Lost
Lemna trisulca	Forked duckweed	6	FF				X	X		
Lemna turionifera	Turion duckweed	2	FF			X	X	X		
Spirodela polyrhiza	Greater duckweed	5	FF			X		X		X
Brasenia schreberi	Watershield	7	FL	X	X		X	X	X	
Nuphar variegata	Spatterdock	6	FL	X	X	X	X	X	X	X
Nymphaea odorata	White water lily	6	FL	X	X	X	X	X	X	X
Polygonum amphibium	Water smartweed	5	FL						X	

C value = Coefficient of Conservatism; BSG = Big St. Germain; FF = Free-floating; FL = Floating-leaf

Table 3.4-3 shows that of the 39 emergent species located within the seven project waterbodies, none were found in all. One emergent species located during the plant surveys is considered a non-native, invasive species: purple loosestrife. This plant was located on the shoreline of Found Lake. Due to its importance, this species and its locations will be discussed in depth within the individual lake vegetation section for Found Lake.

Table 3.4-3. Emergent aquatic plant species located on Town of St. Germain Lakes during summer 2010 surveys.

Species	Common Name	C Value	Growth Form	Alma	Moon	BSG	Content	Fawn	Found	Lost
Bolboschoenus fluviatilis	River bulrush	5	E							X
Calla palustris	Water arum	9	E	X	X	X	X	X		
Carex comosa	Bristly sedge	5	E			X	X			
Carex crawfordii	Crawford's sedge	5	E	X		X				
Carex cryptolepis	Small yellow sedge	8	E	X						
Carex lacustris	Lake sedge	6	E			X				
Carex lasiocarpa	Wooly-fruit sedge	9	E	X					X	
Carex pellita	Broad-leaved woolly sedge	4	E	X						
Carex utriculata	Northwest Territory sedge	7	E							X
Carex vesicaria	Blister sedge	8	E						X	
Decodon verticillatus	Water-willow	7	E					X		
Dulichium arundinaceum	Three-way sedge	9	E		X				X	
Eleocharis acicularis	Needle spike-rush	5	S/E	X	X	X	X		X	X
Eleocharis obtusa	Blunt spike-rush	3	E		X					
Eleocharis palustris	Creeping spike-rush	6	E	X	X	X	X		X	X
Equisetum fluviatile	Water horsetail	7	E						X	
Glyceria canadensis	Rattlesnake grass	7	E	X						
Iris versicolor	Northern blue flag	5	E					X		
Juncus effusus	Soft rush	4	E					X		
Juncus pelocarpus	Brown-fruited rush	8	E	X	X		X		X	X
Lythrum salicaria	Purple loosestrife	Exotic	E						X	
Pontederia cordata	Pickerelweed	9	E				X	X	X	X
Sagittaria cristata	Crested arrowhead	9	S/E			X				X
Sagittaria graminea	Grass-leaved arrowhead	9	S/E	X	X		X	X		X
Sagittaria latifolia	Common arrowhead	3	E			X	X	X		X
Sagittaria rigida	Stiff arrowhead	8	E			X				
Sagittaria sp. (rosette)	Arrowhead sp. rosette	NA	S/E	X	X	X	X			
Schoenoplectus acutus	Hardstem bulrush	5	E		X	X	X			X
Schoenoplectus subterminalis	Water bulrush	9	E		X					
Schoenoplectus tabernaemontani	Softstem bulrush	4	E						X	X
Scirpus cyperinus	Wool-grass	4	E			X				
Scirpus pedicellatus	Stalked wool-grass	6	E	X						
Sium suave	Water-parsnip	5	E			X				
Sparganium angustifolium	Narrow-leaf bur-reed	9	FL/E	X	X		X			
Sparganium eurycarpum	Common bur-reed	5	FL/E				X	X		X
Sparganium fluctuans	Floating-leaf bur-reed	10	FL/E					X	X	
Typha angustifolia	Narrow-leaved cattail	1	E					X		
Typha latifolia	Broad-leaved cattail	1	E				X	X		X
Zizania palustris	Northern wild rice	8	E	X	X	X				

C value = Coefficient of Conservatism; BSG = Big St. Germain; E = Emergent; FL/E = Floating-leaf emergent; S/E = Submergent emergent

Wild rice, found in Alma, Moon and Big St. Germain lakes, is an emergent aquatic grass that grows in shallow water of lakes and slow-moving rivers. Wild rice has cultural significance to the Chippewa Tribal Communities where the grain historically was an important component of Native American diets. Wild rice is also an important diet component of waterfowl, muskrats, deer, and many other species. Established wild rice plant communities can provide valuable nursery and brooding habitat for wetland bird and amphibian species as well as spawning habitat for various fish. Perhaps one of the most overlooked benefits of having established wild rice communities is their ability to utilize excessive plant nutrients, stabilize soils, and form natural wave breaks to protect shoreland areas.

In the Town of Saint Germain Project lakes, the number of plant species observed per lake varied from 29 species in Alma Lake to 44 species in Big St. Germain Lake, with an average of 37 species per lake in 2010 (Figure 3.4-2). These numbers include incidental species, or species that were not sampled directly during the point-intercept survey but were discovered either during this survey or the community mapping surveys. As discussed previously, the calculations used for the Floristic Quality Index (FQI) for a lake's aquatic plant community are based on the aquatic plant species that were encountered on the rake during the point-intercept survey and does not include incidental species. For example, while 41 native aquatic plant species were located in Lost Lake during the 2010 surveys, only 28 were encountered on the rake during the point-intercept survey. Figure 3.4-2 shows that the native species richness values for the Town of Saint Germain Lakes are above the regional and state medians.

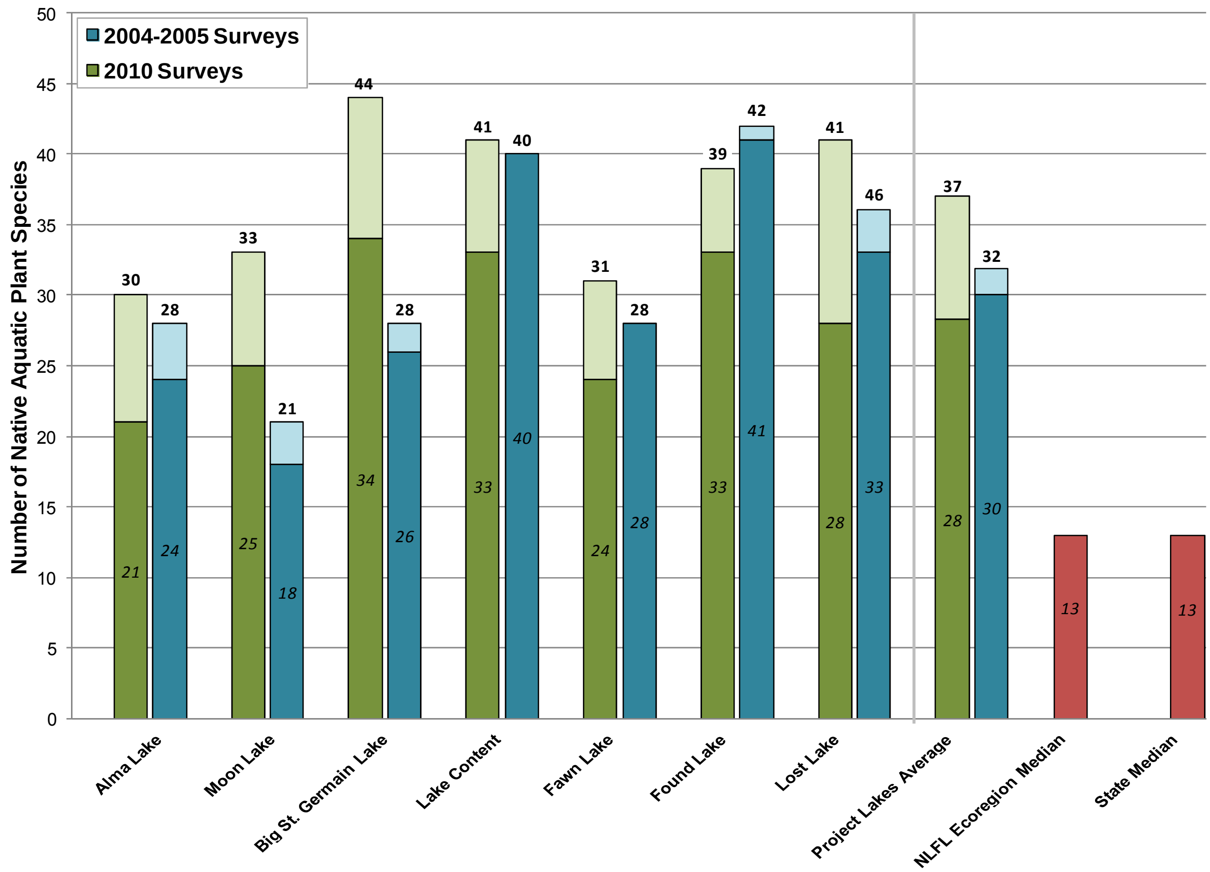

Figure 3.4-2. Town of St. Germain Lakes native species richness. Created using data from 2004-2005 and 2010 aquatic plant surveys. Chart includes incidental species (light colored bars) observed during sampling surveys.

Although comparisons between the 2004/2005 and 2010 surveys are displayed on the following figures, it is important to note that the survey methodologies were different during the two time periods. In 2004 and 2005, the aquatic plant surveys were conducted using transect-based methods, the commonly accepted methodology at that time. Since then, a new methodology developed by the WDNR using a grid of evenly spaced sample locations covering the entire lake emerged and has now become the accepted method of assessing the lake's aquatic plant community. The 2004/2005 transect-based surveys target the near-shore areas of the lake more so than the point-intercept surveys that were performed in 2010. The increase in native species richness in many of the 2010 surveys is likely a result of more of the lake being covered by the point-intercept survey and that survey's increased focus on deeper areas of the lakes.

Like species richness, the Town of Saint Germain project lakes had a wide range of plant species diversity. An ecological tool called Simpson's diversity index (1-D) is commonly used to determine a habitat's diversity. Simpson's diversity is calculated as:

$$D = \sum (n/N)^2$$

D is a value between 0 and 1 where:
n = the total number of instances of a particular species
N = the total number of instances of all species

For example, a Simpson's Diversity Index of 0.9 means that there is a 90% chance that the next species encountered is different from the previous. As discussed earlier, how evenly the species are distributed throughout the system and species richness together influence species diversity.

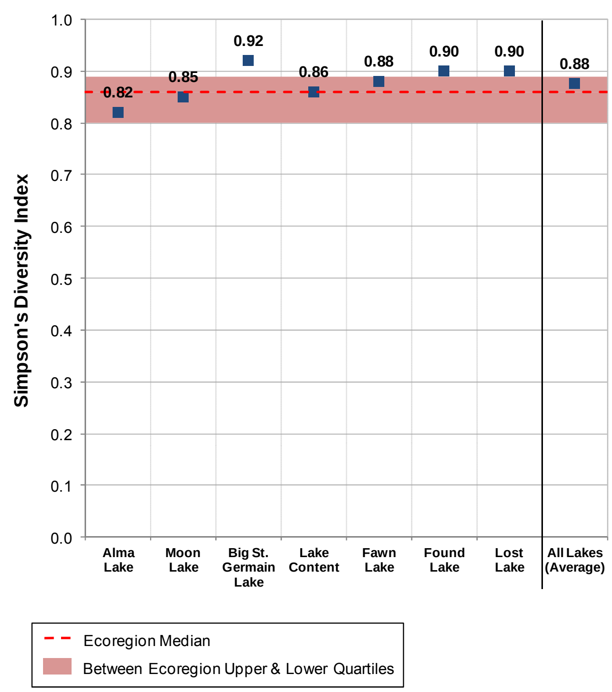

Figure 3.4-3 Town of St. Germain Lakes species diversity index. Created using data from 2010 aquatic plant surveys.

Simpson's Species diversity ranged from 0.82 in Alma Lake to 0.92 in Big St. Germain Lake, showing that some lakes were dominated by one or two species, while others had a more even distribution of plant species. Larger lakes tend to have a larger suite of habitat types (e.g. calm back water bays, sand bars) that can support many different species. While a method of characterizing diversity values as "Fair" or "Poor", etc. does not exist, lakes within the same ecoregion may be compared to provide an idea of how the Town of Saint Germain project lakes' scores rank. Using data obtained from WDNR Science Services, median values and upper/lower quartiles were calculated for 109 lakes within the Northern Lakes and Forests ecoregion (Figure 3.4-3). Four of the seven lakes rank above the median for the ecoregion, while the remaining three lakes are slightly below this median and still within the lower quartile.

Data collected from the 2010 aquatic plant surveys indicated that five of the seven project lakes met or exceeded the Northern Lakes Ecoregion median and all seven lakes surveyed exceeded the state median for average plant species' conservatism values (Figure 3.4-4). This shows that the aquatic plants within the project waters are more indicative of a pristine condition than those found in most lakes in the state. The Northern Lake and Forest Ecoregion contains some of the most pristine lakes within the state and although some lakes within the Town of Saint Germain contain averages below the ecoregion median, the data needs to be understood within this context.

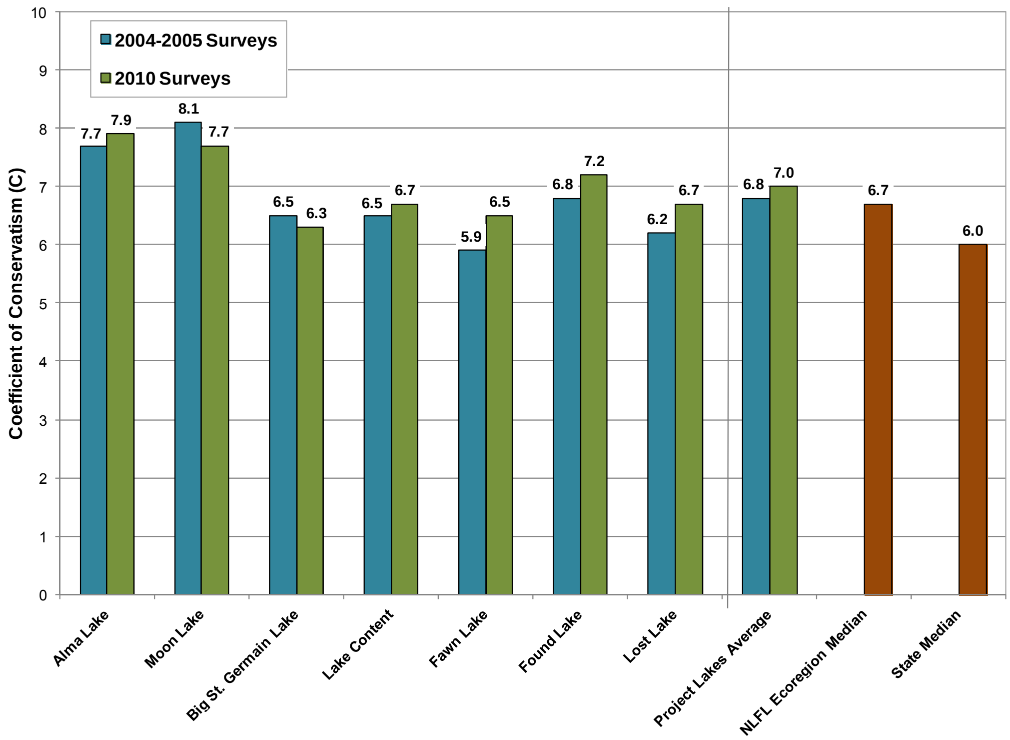

Figure 3.4-4. Town of St. Germain Lakes average native species' coefficients of conservatism. Created using data from 2004-2005 and 2010 aquatic plant surveys.

It is true that the many of these lakes are popular recreation destinations and endures considerable use which has potential to negatively impact plant communities. Of the 1,454 respondents to the stakeholder survey, 22% indicated that they use a motor boat with greater than a 25 hp motor, and 18% indicate that they have used a pontoon boat (Appendix B, Question #12). Figure 3.4-5 shows how this question was answered by lake. Also, the lakes that fell below the ecoregion median had higher nutrient levels and reduced light availability, supporting mainly disturbance-tolerant plant species (e.g., coontail, flat-stem pondweed) and fewer sensitive species.

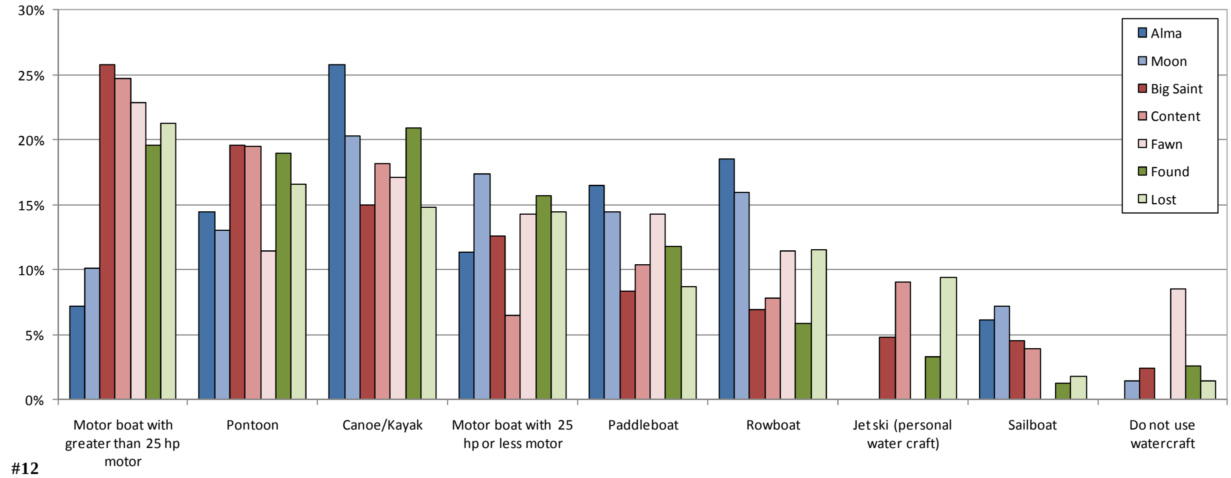

Figure 3.4-5. Watercraft use of Town of Saint Germain stakeholders. Question #12 indicated as percent response of stakeholders. Data collected through the Town of Saint Germain Stakeholder Survey (Appendix B).

Even though some of the lakes have moderate coefficient of conservatisms values, combining the high species richness of the aquatic plants within the system, the floristic quality of the Town of Saint Germain Lakes (Figure 3.4-6) is excellent, especially when compared to median values for the state and ecoregion. As described above, floristic quality utilizes average conservatism value for all of the native species found in the lake and the total number of those species.

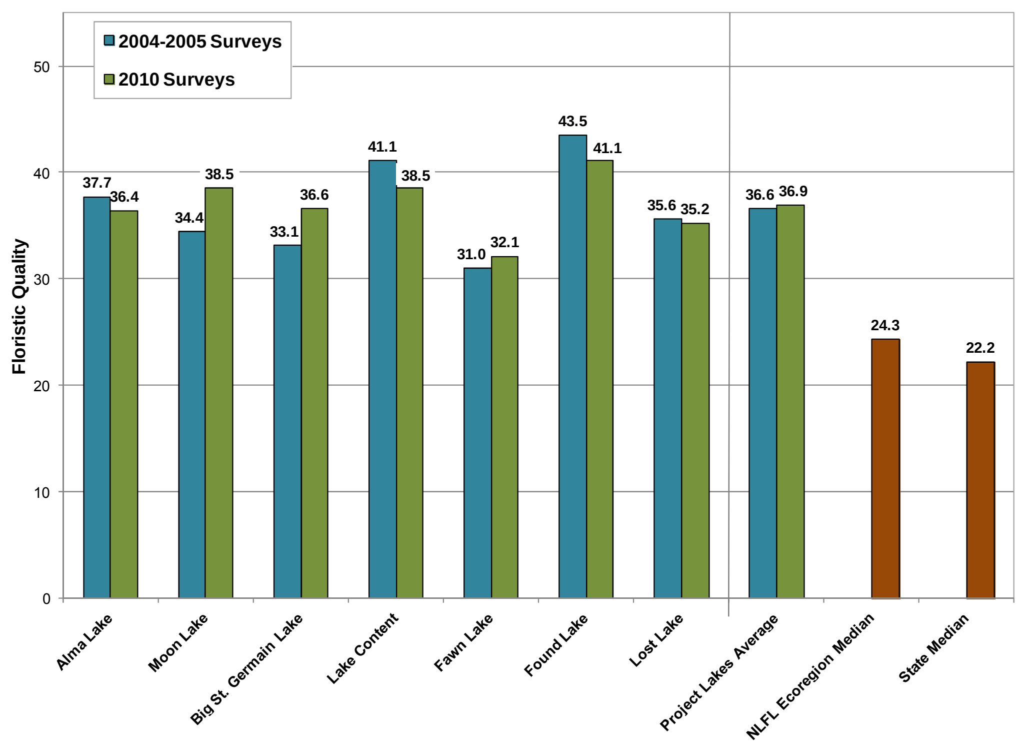

Figure 3.4-6. Town of St. Germain Lakes floristic quality index values. Created using data from 2004-2005 and 2010 aquatic plant surveys.

3.5 Fisheries Data Integration

Fishery management is an important aspect in the comprehensive management of a lake ecosystem; therefore, a brief summary of available data is included here as reference. The following section is not intended to be a comprehensive plan for the lake's fishery, as those aspects are currently being conducted by the numerous fisheries biologists overseeing the Town of Saint Germain lakes. The goal of this section is to provide a partial overview of some of the data that exists, particularly in regards to specific issues (e.g. spear fishery, fish stocking, angling regulations, etc) that were brought forth by the TSGLA stakeholders within the stakeholder survey and other planning activities. Although current fish data were not collected, the following information was compiled based upon data available from the WDNR and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) (WDNR 2011 & GLIFWC 2011A and 2011B).

Table 3.5-1. Twenty common gamefish present in Northwoods Wisconsin lakes with corresponding biological information (Becker, 1983)**.** Species may or may not be found in Town of Saint Germain lakes.

Common Name	Scientific Name	Max Age (yrs)	Spawning Period	Spawning Habitat Requirements	Food Source
Black Bullhead	*Ictalurus melas*	5	April - June	Matted vegetation, woody debris, overhanging banks	Amphipods, insect larvae and adults, fish, detritus, algae
Black Crappie	*Pomoxis nigromaculatus*	7	May - June	Near *Chara* or other vegetation, over sand or fine gravel	Fish, cladocera, insect larvae, other invertebrates
Bluegill	*Lepomis macrochirus*	11	Late May - Early August	Shallow water with sand or gravel bottom	Fish, crayfish, aquatic insects and other invertebrates
Brook Trout	*Salvelinus fontinalis*	6	October - December	Streams or spring-fed tributaries, gravel bottom	Aquatic insects, terrestrial insects, crustaceans, fish and worms
Green Sunfish	*Lepomis cyanellus*	7	Late May - Early August	Shelter with rocks, logs, and clumps of vegetation, 4 - 35 cm	Zooplankton, insects, young green sunfish and other small fish
Largemouth Bass	*Micropterus salmoides*	13	Late April - Early July	Shallow, quiet bays with emergent vegetation	Fish, amphipods, algae, crayfish and other invertebrates
Longear Sunfish	*Lepomis megalotis*	9	June - Early August	Water 0.25 - 0.36 m, with gravel, sand, or hard mud bottom	Aquatic insects, fish eggs, terrestrial foods, crustacea and other invertebrates
Muskellunge	*Esox masquinongy*	30	Mid April - Mid May	Shallow bays over muck bottom with dead vegetation, 6 - 30 in.	Fish including other muskies, small mammals, shore birds, frogs

Table 3.5-1 cont.

Common Name	Scientific Name	Max Age (yrs)	Spawning Period	Spawning Habitat Requirements	Food Source
Northern Pike	*Esox lucius*	25	Late March - Early April	Shallow, flooded marshes with emergent vegetation with fine leaves	Fish including other pike, crayfish, small mammals, water fowl, frogs
Orangespotted Sunfish	*Lepomis humilis*	4	Late May - August	Shallow water with sand or gravel bottom	Crustaceans, copepods, mites and aquatic insects
Pumpkinseed	*Lepomis gibbosus*	12	Early May - August	Shallow warm bays 0.3 - 0.8 m, with sand or gravel bottom	Crustaceans, rotifers, mollusks, flatworms, insect larvae (terrestrial and aquatic)
Rainbow Trout	*Oncorhynchus mykiss*	11	March - May	Stream for spawning and large lake for development	Aquatic and terrestrial insects and other invertebrates, zooplankton, fish
Rock Bass	*Ambloplites rupestris*	13	Late May - Early June	Bottom of course sand or gravel, 1 cm - 1 m deep	Crustaceans, insect larvae, and other invertebrates
Smallmouth Bass	*Micropterus dolomieu*	13	Mid May - June	Nests more common on north and west shorelines over gravel	Small fish including other bass, crayfish, insects (aquatic and terrestrial)
Walleye	*Sander vitreus*	18	Mid April - Early May	Rocky, wavewashed shallows, inlet streams on gravel bottoms	Fish, fly and other insect larvae, crayfish
Warmouth	*Lepomis gulosus*	13	Mid May - Early July	Shallow water 0.6 - 0.8 m, with rubble slightly covered with silt	Crayfish, small fish, odonata, and other invertebrates
White Bass	*Morone chrysops*	8	Late April - June	Running water of streams, windswept shorelines, sand, gravel, or rock	Crustaceans, insect larvae and other invertebrates, and fish
White Crappie	*Pomoxis annularis*	13	May - June	Within 10 m from shore, over hard clay, gravel, or roots	Crustaceans, insects, small fish
Yellow Bullhead	*Ameiurus natalis*	7	May - July	Heavy weeded banks, beneath logs or tree roots	Crustaceans, insect larvae, small fish, some algae
Yellow Perch	*Perca flavescens*	13	April - Early May	Sheltered areas, emergent and submergent veg	Small fish, aquatic invertebrates

Table 3.5-1 is a list of popular game fish that are present in many northern Wisconsin lakes. When examining the fishery of a lake, it is important to remember what "drives" that fishery, or what is responsible for determining its mass and composition. The gamefish in the Town of Saint Germain lakes are supported by an underlying food chain. At the bottom of this food chain are the elements that fuel algae and plant growth – nutrients such as phosphorus and nitrogen, and sunlight. The next tier in the food chain belongs to zooplankton, which are tiny crustaceans that feed upon algae and plants, and insects. Smaller fish called planktivores feed upon zooplankton and insects, and in turn become food for larger fish species. The species at the top of the food chain are called piscivores, and are the larger gamefish that are often sought after by anglers, such as bass and walleye.

A concept called energy flow describes how the biomass of piscivores is determined within a lake. Because algae and plant matter are generally small in energy content, it takes an incredible amount of this food type to support a sufficient biomass of zooplankton and insects. In turn, it takes a large biomass of zooplankton and insects to support planktivorous fish species. And finally, there must be a large planktivorous fish community to support a modest piscivorous fish community. Studies have shown that in natural ecosystems, it is largely the amount of primary productivity (algae and plant matter) that drives the rest of the producers and consumers in the aquatic food chain. This relationship is illustrated in Figure 3.5-1.

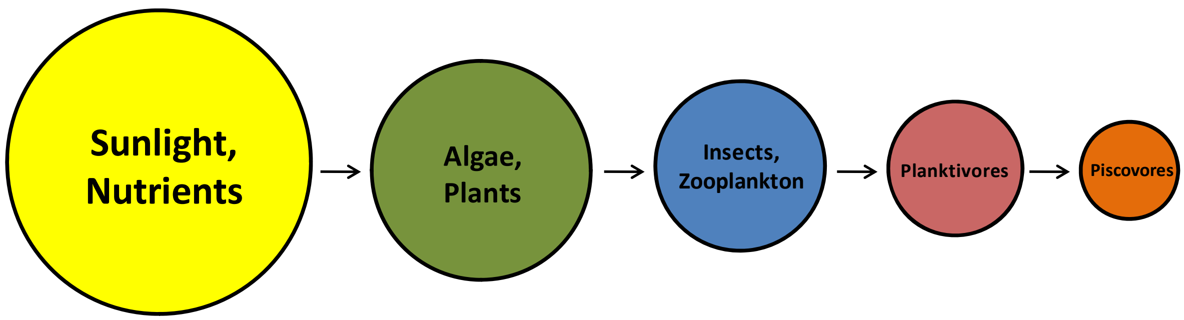

Figure 3.5-1. Aquatic food chain. Adapted from Carpenter et. al 1985.

As discussed in the Water Quality section, the Town of Saint Germain lakes vary in their trophic status, meaning there is a difference in the water chemistry and biomass of each lake. This in turn determines the level of primary productivity, or production at the bottom end of the food chain. Simply put, this means it is difficult for a low nutrient lake to support a large population of predatory fish (piscovores) because the supporting food chain is relatively small. On the other hand, lakes that have higher nutrient contents can support a larger biomass at the opposite end of the food chain – planktivorous and piscivorous fish.

Town of Saint Germain Lakes Fishing Activity

Based on data collected from the stakeholder survey (Appendix B), fishing was ranked fairly high when compared to other enjoyable activities on Town of Saint Germain lakes, particularly for Fawn Lake, Big St. Germain Lake, Lake Content, Found Lake, and Lost Lake (Table 3.5-2, Question #13). Many anglers who participated in the survey have been fishing these lakes for greater than 10 years (Question #8). With Lake Content as the only exception, stakeholders described the fishing on their lakes as fair or good, though respondents on all lakes believe the fishing has either stayed the same or gotten worse since they began fishing the lake (Question

#10 and #11). Stakeholders listed "loss of fish habitat" and/or "excessive fishing pressure" as either within their top three lake concerns or as a factor negatively effecting the lake for several of the Town of Saint Germain lakes (Questions #19 and #20).

Table 3.5-2. Fishing activities and perceptions of Town of Saint Germain stakeholders. Questions #8 - #11 indicated as percent response of stakeholders. Data collected through the Town of Saint Germain Stakeholder Survey (Appendix B).

Lake	Question #8 How many years have you fished the lake?	Question #9 Have you fished the lake in the past 3 years?	Question #10 How would you describe the current quality of fishing on the lake?	Question #11 How has the quality of fishing changed since you started fishing the lake?	Question #13 Importance of "fishing" compared to other activities.	Question #19 & #20 Concerns regarding fishery*
Alma	10+ years *71%*	Yes *87%*	Fair / Good *83%*	Worse / Stayed Same *90%*	4th	Loss of fish habitat (#19 & #20)
Big Saint Germain	10+ years *57%*	Yes *72%*	Fair *66%*	Much / Somewhat worse *54%*	2nd	Escessive fishing pressure (#19) Loss of fish habitat (#20)
Content	10+ years *82%*	Yes *91%*	Very Poor to Fair *77%*	Much / Somewhat worse *68%*	2nd	-
Fawn	10+ years *77%*	Yes *77%*	Fair *54%*	Much / Somewhat worse *85%*	1st	Excessive fishing pressure (#19 & #20)
Found	10+ years *67%*	Yes *87%*	Fair / Good *82%*	Much worse to Same *62%*	2nd	Loss of fish habitat (#20)
Lost	10+ years *69%*	Yes *87%*	Fair / Good *85%*	Worse / Stayed Same *68%*	2nd	-
Moon	10+ years *48%*	Yes *59%*	Fair *59%*	Worse / Stayed Same *73%*	4th	Loss of fish habitat (#19)

** Fishing related concerns listed if included as one of top 3 responses.*

Approximately 22,400 square miles of northern Wisconsin was ceded to the United States by the Lake Superior Chippewa tribes in 1837 and 1842 (Figure 3.5-2). The Town of Saint Germain lakes fall within the ceded territory based on the Treaty of 1842. This allows for a regulated open water spear fishery by Native Americans on specified systems. This highly structured process begins with an annual meeting between tribal and state management authorities. Reviews of population estimates are made for ceded territory lakes, and then an "allowable catch" is established, based upon estimates of a sustainable harvest of the fishing stock (age 3 to age 5 fish). This figure is usually about 35% of a lake's fishing stock, but may vary on an individual lake basis. In lakes where population estimates are out of date by 3 years, a standard percentage is used. The allowable catch number is then reduced by a percentage agreed upon by biologists that reflects the confidence they have in their population estimates for the particular lake. This number is called the "safe harvest level". The safe harvest

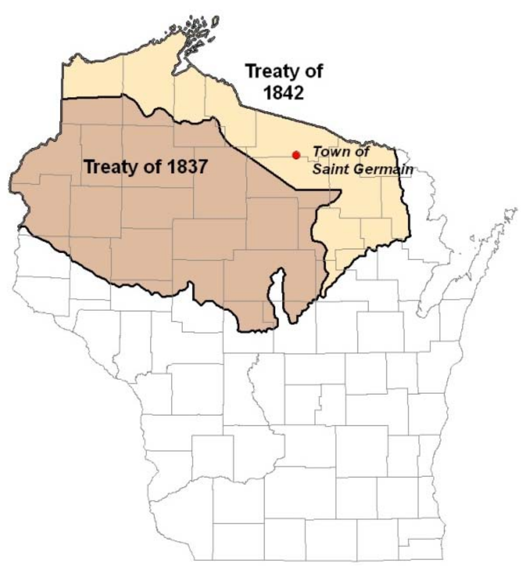

Figure 3.5-2. Location of Town of Saint Germain lakes within the Native American Ceded Territory (GLIFWC 2011A). This map was digitized by Onterra; therefore it is a representation and not legally binding.

is a conservative estimate of the number of fish that can be harvested by a combination of tribal spearing and state-licensed anglers. The safe harvest is then multiplied by the Native American communities claim percent, or declaration. This result is called the quota, and represents the maximum number of fish that can be taken by tribal spearers (Spangler, 2009). Daily bag limits for walleye are then reduced for hook-and-line anglers to accommodate the tribal quota and prevent over-fishing. Bag limits reductions may be increased at the end of May on lakes that are lightly speared. The tribes have historically selected a percentage which allows for a 2-3 daily bag limit for hook-and-line anglers (USDI 2007).

Spearers are able to harvest muskellunge, walleye, northern pike, and bass during the open water season. The spear harvest is monitored through a nightly permit system and a complete monitoring of the harvest (GLIFWC 2011B). Creel clerks and tribal wardens are assigned to each lake at the designated boat landing. A catch report is completed for each boating party upon return to the boat landing. In addition to counting every fish harvested, the first 100 walleye (plus all those in the last boat) are measured and sexed. An updated nightly quota is determined each morning by 9 a.m. based on the data collected from the successful spearers. Harvest of a particular species ends once the quota is met or the season ends. In 2011, a new reporting requirement went into effect on lakes with smaller quotas. Starting with the 2011 spear harvest season, on lakes with a harvestable quota of 75 or fewer fish, reporting of harvests may take place at a location other than the landing of the speared lake.

Since 1998, a spring spear harvest has only occurred on Big St. Germain Lake with walleye and muskellunge comprising the vast majority of the open water spear fish harvest. On three other Town of Saint Germain lakes – Lake Content, Fawn Lake and Lost Lake, a quota has been established in past years however no harvest has occurred.

Walleye open water spear harvest records for Big St. Germain Lake are provided in Figure 3.5-3. One common misconception is that the spear harvest targets the large spawning females. Figure 3.5-3 clearly show that the opposite is true with only 10.8% of the total walleye harvest (241 fish) since 1998 comprising of female fish on Big St. Germain Lake. Tribal spearers may only take two walleyes over twenty inches per nightly permit; one between 20 and 24 inches and one of any size over 20 inches (GLIWC 2011B). This regulation limits the harvest of the larger, spawning female walleye.

Because Big St. Germain Lake is located within ceded territory and experiences an annual spear harvest, special fisheries regulations may occur, specifically in terms of walleye. An adjusted walleye bag limit pamphlet is distributed each year by the WDNR which explains the more restrictive bag or length limits that may pertain to Big St. Germain Lake. In 2011, the daily bag limit was set at 2 walleyes with a minimum length limit of 15 inches.

The Town of Saint Germain is located within Vilas County. Unless otherwise specified, the minimum length limit on walleye within this county is 15" and the daily bag limit is 3 fish. On Found Lake, the minimum length limit is 18". For bass species, after the beginning of the season the minimum length limit is 14" and a daily bag limit is limited to 5 fish. The Town of Saint Germain lakes are within the northern half of the muskellunge and northern pike management zone. Muskellunge must be 34" to be harvested, with a daily bag limit of one fish, while no minimum length limit exists for northern pike and only 5 pike may be kept in a single day. Statewide regulations apply for all other fish species.

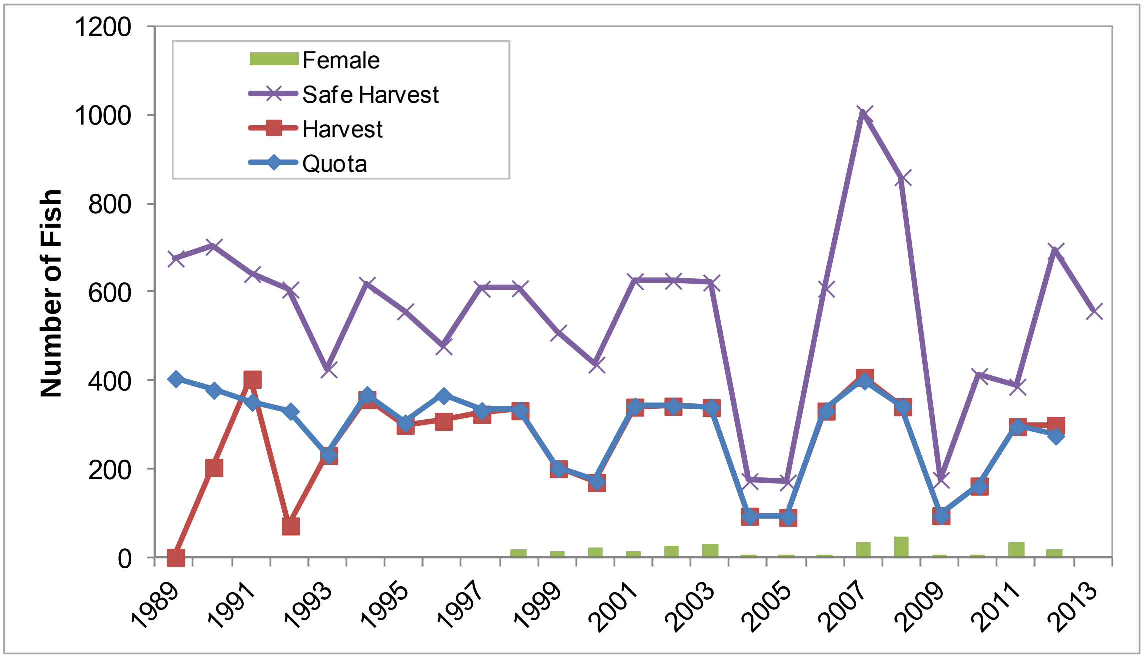

Figure 3.5-3. Open water spear harvest data of walleye for Big St. Germain Lake. Annual walleye spear harvest statistics are displayed since 1989 (T. Cichosz, personal communication).

In addition to walleye, muskellunge have been spear harvested on Big St. Germain as well. Figure 3.5-4 displays the open water muskellunge spear harvest since 1998. Since 1998, an average of 7 muskellunge have been harvested per year during the open water spear fishery. Annual quotas range from 12 to 16 fish, however during most years the quota is either 12 or 13 fish. The annual quota has only been reached on two occasions – in 1998 and 2002.

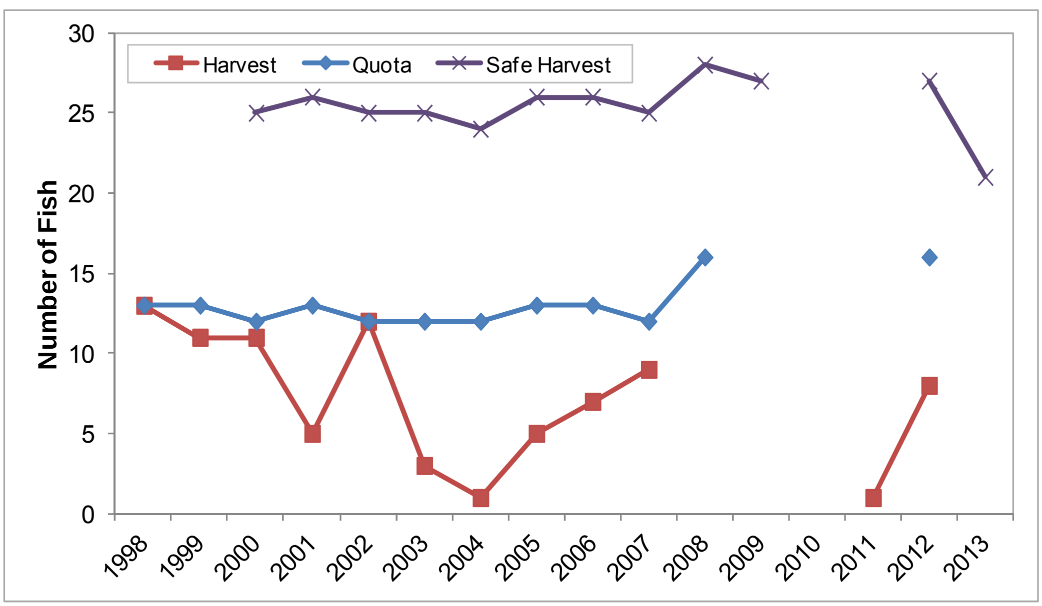

Figure 3.5-4. Open water spear harvest data of muskellunge for Big St. Germain Lake. Annual muskellunge spear harvest statistics are displayed since 1988 (T. Cichosz, personal communication).

Town of Saint Germain Lakes Fish Stocking

To assist in meeting fisheries management goals, the WDNR may stock fish in a waterbody that were raised in nearby permitted hatcheries. Stocking of a lake is sometimes done to assist the population of a species due to a lack of natural reproduction in the system, or to otherwise enhance angling opportunities. Fish can be stocked as fry, fingerlings or even as adults.

Fish have been actively stocked in Alma Lake, Big St. Germain Lake, Found Lake, Lost Lake and Moon Lake. The stockings have consisted primarily of muskellunge and walleye, although largemouth and smallmouth bass have been stocked historically as well. Stocking history for these lakes can be found within Appendix E.

Town of Saint Germain Lakes Substrate Type

Just as forest wildlife require proper trees and understory growth to flourish, fish prefer certain substrates and habitat types to nest, spawn, escape predators, and search for prey. Indeed, lakes with primarily a silty/soft substrate and much aquatic plants and coarse woody debris may produce a completely different fishery than lakes that are largely sandy and contain few aquatic plant species or coarse woody habitat.

As seen in Figure 3.5-5, substrate type within the littoral zone of the Town of Saint Germain lakes varied much from lake to lake. Alma Lake, Lake Content, Fawn Lake and Lost Lake are dominated by a mucky substrate, while Big St. Germain and Moon Lake contain more of a sandy substrate. Found Lake was very evenly mixed between muck and sand. Substrate and habitat are critical to fish species that do not provide parental care to their eggs, in other words, the eggs are left after spawning and not tended to by the parent fish. Muskellunge is one species that does not provide parental care to its eggs (Becker 1983). Muskellunge broadcast their eggs over woody debris and detritus, which can be found above sand or muck. This organic material suspends the eggs above the substrate, so the eggs are not buried in sediment and suffocate as a result. Walleye is another species that does not provide parental care to its eggs. Walleye preferentially spawn in areas with gravel or rock in places with moving water or wave action, which oxygenates the eggs and prevents them from getting buried in sediment. Fish that provide parental care are less selective of spawning substrates. Species such as bluegill tend to prefer a harder substrate such as rock, gravel or sandy areas if available, but have been found to spawn in muck as well.

As discussed in the Shoreland Condition Section, the presence of coarse woody habitat is important for many stages of a fish's life cycle, including nesting or spawning, escaping predation as a juvenile, and hunting insects or smaller fish as an adult. Unfortunately, as development has increased on Wisconsin lake shorelines in the past century, this beneficial habitat has often been the first to be removed from the natural shoreland zone.

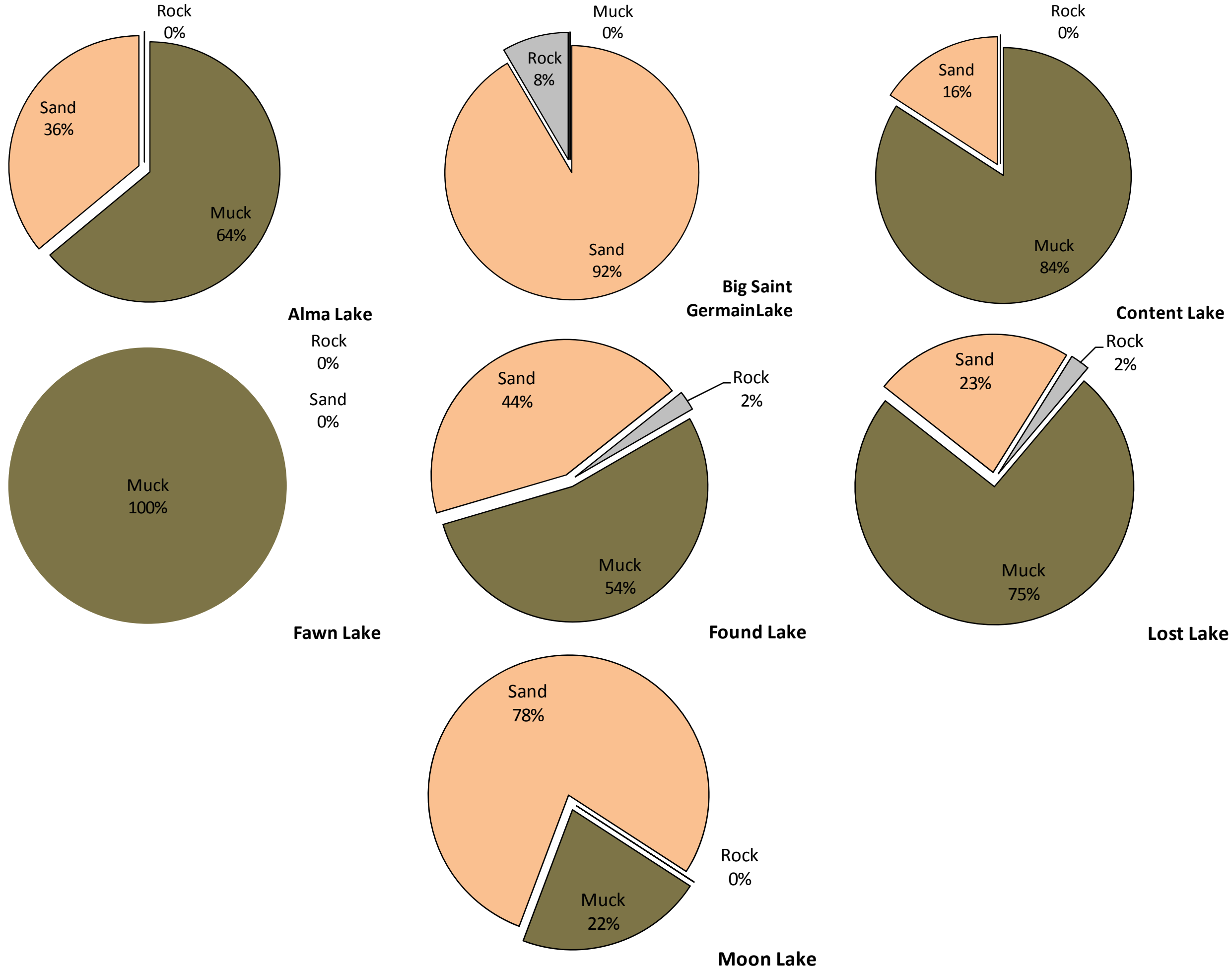

Figure 3.5-5. Substrate types for the Town of Saint Germain lakes. Data collected during point intercept surveys by Onterra (2010).

4.0 SUMMARY & CONCLUSIONS

The design of this project was intended to fulfill several objectives;

1) Update the aquatic plant management plans that were created in 2006, and expand upon these plans to include numerous other components (water quality sampling, watershed, stakeholder survey, etc.)
2) Have professional ecologists search the lakes for invasive plant species, and collect spatial information if such species were encountered.

These objectives were fulfilled during the project and have led to a good understanding of the Town of Saint Germain project lakes, the folks that care about these lakes, and what needs to be completed to protect and enhance them. In 2006, it was learned that the Town of Saint Germain project lakes were unique and exceptional ecosystems. This was determined by their aquatic plant communities, which are excellent indicators of the health of a lake ecosystem. More can be said about these diverse ecosystems now that a comprehensive study has been completed.

The water quality varied greatly between each of these lakes. This is to be expected, as each of these lakes also varies in their hydrology and geology as well. Alma and Moon Lakes, for example, are classified as deep seepage lakes. Seepage lakes often have clear water, but are subject to fluctuating water levels because they don't receive as much runoff water from their watersheds.

Drainage lakes such as Big St. Germain, Fawn, Lost, and Found Lakes have larger watersheds and thus receive water through surface runoff and also stream inputs. Because of this, these lakes are less likely to experience large fluctuations in water level. Additionally, drainage lakes may have higher nutrient concentrations because of their increased water input. With increased nutrient content, algae as well as aquatic plants will increase in their abundance. Examining these lakes confirms this relationship – Alma and Moon lakes have low nutrients, low chlorophyll-*a*, and are characterized by low growing plant species that carry little biomass. Contrarily, the drainage lakes studied as a part of this project have higher nutrients, higher algal abundance, and aquatic plant communities that have substantial biomass.

While the town-wide portion of this report compares the lakes side-by-side, this information should be used as a point of reference and not to rate the relative health of each lake. Again, these lakes are similar only in terms of their geographical location – not in terms of their hydrology, geology, biology, etc. So, within the individual lake sections, each lake is compared to similar lakes across the state and within the ecoregion. This allows an "apples to apples" comparison to be made.

As seen within each lake section, the Town of Saint Germain project lakes are fairly healthy when compared to similar lakes across the state and ecoregion. Many of the lakes boast water quality parameters that are of greater value than or fairly similar to their comparable counterparts in the state and ecoregion. Because the condition of each lake's water quality is average or better, there are no pressing concerns with any of the Town of Saint Germain project lakes in terms of this ecological aspect.

As discussed briefly above, the plant communities vary greatly between the Town of Saint Germain project lakes. A number of factors contribute to determining a lake's aquatic plant community, including the water quality and substrate type. As explained within the Town-wide Aquatic Plant Section, there were a total of 86 species observed during the 2010 plant surveys that were conducted on the seven Town of Saint Germain project lakes. The species richness by lake varied from 29 species (including incidental occurrences) in Alma Lake to 43 species in Big St. Germain Lake. All seven of the project lakes hold exceptionally high quality plant communities, as indicated by each lake's floristic quality index value. Furthermore, no submersed aquatic invasive plant species (e.g. Eurasian water milfoil or curly-leaf pondweed) were discovered within the project lakes. It is strongly believed by invasive plant researchers and lake management personnel that having a healthy aquatic plant community assist in safeguarding a lake against infestation from these exotic species. However, an infestation is still possible in lakes with even the healthiest, most dense plant population. Because of this, the Town of Saint Germain Lakes Committee has been diligent in their efforts to keep these bothersome exotic species out of these project lakes.

Though the lakes are largely in good condition, one element of the suite of scientific studies that were conducted indicates moderate to poor health in several lakes – the condition of the shoreland zone. Studies continue to show the link between developed shorelands and the loss of natural habitat, impacts to water quality and overall poor biological health of the lake ecosystem. As determined through the Shoreland Condition Assessment, several project lakes show much developed shoreland surrounds them. The Town of Saint Germain Planning Committee recognizes the fact that these areas should be examined for potential restoration efforts. While not specified as the result of this project, shoreland restoration has to be a major focus of a planning update which will happen five years following this project. Within this management plan update, the Town of Saint Germain Lakes Committee will host a study design that aims to identify and prioritize areas for shoreland restoration, and will commit towards remediating developed areas of the lakes. The current management goal, as specified in the Implementation Plan below, is to focus on educational measures and voluntary procedures for discussing shoreland restoration as a viable strategy to reduce pollution and increase habitat and buffering capacity to the Town of Saint Germain project lakes.

In summary, the Town of Saint Germain project lakes are healthy ecosystems with many positive qualities about them. The difficulty that lies ahead for the Town of Saint Germain Lakes Committee is not in fixing the lakes, per se, but in ensuring the lakes do not degrade from their current state. This is often a difficult undertaking as there is not a concrete issue for volunteers to engage upon. The vague mission of protecting the lakes is not as exciting as rallying against a defined threat, such as an invasive species introduction or faulty septic system problem. The Implementation Plan that follows this section outlines the necessary steps to protect these lakes, and also provides opportunities to educate others. After all, educating stakeholders on the high quality of these lakes is the best way to show them what truly is at stake.

5.0 TOWN-WIDE IMPLEMENTATION PLAN

The Implementation Plan presented below was created through the collaborative efforts of the TSGLC and ecologist/planners from Onterra. It represents the path the TSGLC will follow in order to meet their lake management goals. The goals detailed within the plan are realistic and based upon the findings of the studies completed in conjunction with this planning project and the needs of the Town of Saint Germain lakes stakeholders as portrayed by the members of the Planning Committee, the returned stakeholder surveys, and numerous communications between Planning Committee members and the lake stakeholders. The Implementation Plan is a living document in that it will be under constant review and adjustment depending on the condition of the township lakes, the availability of funds, level of volunteer involvement, and the needs of the stakeholders. While the TSGLC is listed as the facilitator of the majority of management actions listed below, many of the actions may be better facilitated by a sub-committee of the TSGLC (e.g. Education & Communication Committee, Water Quality Committee, Invasive Species Committee). The TSGLC will be responsible for deciding whether the formation of sub-committees is needed to achieve the various management goals.

Management Goal 1: Promote Lake Protection and Enjoyment through Stakeholder Education

Management Action: Support the Lakes Committee to promote safe boating, water quality, public safety, and quality of life on the Town of Saint Germain project lakes.

Timeframe: Continuation of current efforts

Facilitator: Town of Saint Germain Lakes Committee

Description: Education represents an effective tool to address issues that impact water quality such as lake shore development, lawn fertilization, and other issues such as air quality, noise pollution, and boating safety. The TSGLC can be utilized to continue to promote lake protection through a variety of educational efforts.

Currently, the Alma/Moon P&R District operates a website (http://www.almamoonlake.org/) which allows for exceptional communication within the lake group. The other project lakes currently do not have websites devoted to operations on their lake. The Town of Saint Germain does, however, have space dedicated to the Lakes Committee. The town website is an excellent place to disseminate information to stakeholders about these lakes.

This level of communication is important within a management group because it builds a sense of community while facilitating the spread of important district news, educational topics, and even social happenings. It also provides a medium for the recruitment and recognition of volunteers. Perhaps most importantly, the dispersal of a well written newsletter can be used as a tool to increase awareness of many aspects of lake ecology and management among district members. By doing this, meetings can often be conducted more efficiently and misunderstandings based upon misinformation can be avoided. Educational pieces within the newsletter may contain monitoring results, management history, as well as other educational topics listed below.

Many educational activities have already been conducted by the TSGLC. For example, as a part of this planning project informative newsletters describing the threat of AIS were distributed to all Saint Germain property owners. In a display of more direct action, all project lakes were periodically surveyed by volunteers for AIS. This effort was conducted in addition to Clean Boats Clean Waters watercraft inspections. Additionally, the message of invasive species was spread to people outside of the lake as well, through printed messages that were placed upon plastic grocery bags, bait containers at local retailers, placemats and beverage coasters at area restaurants, and an informational booth that was placed at the Saint Germain Flea Market. One of the more impressive displays of this message came in the form of a portable trailer which bears a sign informing readers of the threat of invasive species. This sign was placed at strategic locations (high traffic areas, boat landings, etc.) throughout the duration of the project.

In addition to these efforts, a variety of new educational efforts will be initiated by the Lakes Committee. These may include educational materials, awareness events and demonstrations for lake users as well as activities which solicit local and state government support.

Example Educational Topics:

- Specific topics brought forth in other management actions
- AIS monitoring updates
- Boating safety and ordinances (slow-no-wake zones and hours)
- Catch and release fishing
- Littering (particularly on ice)
- Noise, air, and light pollution
- Shoreland restoration and protection
- Septic system maintenance
- Fishing Rules

Action Steps:

Please see description above.

Management Goal 2: Maintain Current Water Quality Conditions

Management Action: Monitor water quality through WDNR Citizens Lake Monitoring Network.

Timeframe: Begin Summer 2012

Facilitator: Town of Saint Germain Lakes Committee

Description: Monitoring water quality is an import aspect of every lake management planning activity. Collection of water quality data at regular intervals aids in the management of the lake by building a database that can be used for long-term trend analysis. The lack of this type of historical information hampered the water quality analysis for some of the lakes during this project. Early discovery of negative trends may lead to the reason as to why the trend is developing.

The Citizens Lake Monitoring Network (CLMN) is a WDNR program in which volunteers are trained to collect water quality information on their lake. Water quality data collection through the CLMN has or currently is occurring on five of the Town of Saint Germain project lakes. Volunteers trained by the WDNR as a part of the CLMN program begin by collecting Secchi disk transparency data for at least one year, then if the WDNR has availability in the program, the volunteer may enter into the advanced program and collect water chemistry data including chlorophyll-*a*, and total phosphorus. Currently only three of the Town of Saint Germain project lakes are collecting water chemistry data as a part of the advanced program. The Secchi disk readings and water chemistry samples are collected three times during the summer and once during the spring. Note: as a part of this program, these data are automatically added to the WDNR database and available through their Surface Water Integrated Monitoring System (SWIMS).

The Town of Saint Germain Lakes Committee will promote all lakes within the township to at a minimum; have CLMN volunteers collecting Secchi disk data on all lakes. Currently, the advanced CLMN program is not accepting additional lakes to participate in the program. However, a benefit of having all the lakes on board with the base Secchi disk data CLMN program is that when additional spots open in the advanced monitoring program, volunteers from the Town of Saint Germain project lakes will be ready to make the transition into more advanced monitoring.

Action Steps:

Please see description above.

Management Action: Reduce phosphorus and sediment loads from shoreland watershed to the Town of Saint Germain project lakes.

Timeframe: Begin Spring 2012

Facilitator: Town of Saint Germain Lakes Committee and/or Individual Lake Groups

Description: As indicated within the stakeholder survey for each of the Town of Saint Germain project lakes, many stakeholders ranked issues related to lakeshore development within their top three concerns for their lake (Appendix B, Question 20). These issues include structural concerns (loss of fish habitat) and issues resulting from degraded shorelines (e.g. water quality degradation, algae blooms, septic system discharge, etc.). These issues were brought up and discussed during a meeting with the Town of Saint Germain Lakes Planning Committee and Onterra staff. In conjunction with an educational campaign aimed at raising awareness about shoreline condition (discussed above), each lake committee (individual associations or district) may choose to work towards restoration of specific shoreline areas. The shoreline assessment associated with this project identified areas of highly disturbed and moderately disturbed shoreland on all of the project lakes, with the exception of Alma and Moon Lake in which a shoreland assessment was not conducted. This indicates that the opportunity for improvements do exist in terms of restoring the shoreline on each of these lakes.

For each lake, the shoreland assessment map indicates the locations of highly disturbed shoreland (Urbanized and Unnatural/Developed areas). If restoration of any of the Town of Saint Germain project lakes shoreland is to occur, these areas should be considered a priority. A volunteer from the TSGLC will work to research grant programs, shoreland restoration techniques, and other pertinent information that will aid the lake committee in making enhancements to the project lake's shorelines if so desired. Several valuable resources for this type of conservation work include the WDNR, UW-Extensions and Vilas County Lakes and Rivers Association. Several websites of interest include:

- Wisconsin Lakes website: www.wisconsinlakes.org/shorelands)
- Conservation easements or land trusts: (www.northwoodslandtrust.org)
- UW-Extension Shoreland Restoration: (http://www.uwex.edu/ces/shoreland/Why1/whyres.htm)
- WDNR Shoreland Zoning website: (http://dnr.wi.gov/topic/ShorelandZoning/)

There are two appropriate working models to show to property owners interested in shoreland restoration projects. These two projects took place on 14 individual properties on Found Lake and the Moon Beach Camp property on Moon Lake. In this project, native species enhancements, littoral habitat and erosion control structures were put in place to ultimately enhance the shoreland area and lake.

Action Steps:

1. Recruit facilitator.
2. Facilitator gathers appropriate information from sources described above. This includes biological research as well as grant/funding opportunities.
3. Facilitator assists residents that are interested in shoreland restoration with process of contacting shoreland restoration specialists (public or private) and carrying out restoration plan.
4. Retain Moon Beach Camp and Found Lake locations as a demonstration model for other residents who may be interested in restoration work.

Management Goal 3: Prevent Aquatic Invasive Species Introductions to the Town of Saint Germain Project Lakes

Management Action: Maintain boater education, boat inspection and boat cleaning operations at boat landings.

Timeframe: Begin 2012

Facilitator: Town of Saint Germain Lakes Committee and/or Individual Lake Groups

Description: Although the concern about AIS expressed by property owners in recent surveys was focused on species such as Eurasian water milfoil and curly-leaf pondweed, no known control procedures are available for other species such as Viral Hemorrhagic Septicemia (VHS) and zebra mussels. These and other species may be expected to be introduced and become established at present levels of preventative activities. Establishment of these species will be devastating to the lakes, water use, property values and the regional economy. To minimize the chance that other species will become established, the TSGLC will continue to work to continue the boater education, boat inspection and boat cleaning operations that currently occur on the town lakes. In addition, an Education Committee comprised of stakeholder volunteers will develop materials and programs that will promote clean boating and responsible use of these waters (See Education Goal).

Action Steps: See description above.

Management Action: Coordinate annual volunteer monitoring of Aquatic Invasive Species

Timeframe: Continuation of current effort

Facilitator: Town of Saint Germain Lakes Committee and/or Individual Lake Groups

Description: In lakes without Eurasian water milfoil, early detection of pioneer colonies commonly leads to successful control and in cases of very small infestations, possibly even eradication. Even in lakes where these plants occur, monitoring for new colonies is essential to successful control.

Specific to the Town of Saint Germain project lakes, the group already performs a considerable amount of Eurasian water milfoil and curly-leaf pondweed monitoring on its own; therefore, the framework for such a volunteer network is essentially in place. The lakes committee has also produced newsletters and other material which educates lake users on the threat of invasive species. This management action will also provide benefits to the Town of Saint Germain project lakes by providing monitoring of other invasive species such as purple loosestrife, giant reed, etc. The use of GPS by volunteers is recommended, as specific locations of exotic plants can be accurately marked and then re-visited.

In addition to volunteer-based aquatic invasive species surveys, professional monitoring may be warranted once every 5 years, particularly on the high access lakes.

Action Steps:

1. Recruit volunteers to conduct field surveys.
2. Retain consultant to coordinate monitoring strategy.
3. Obtain WDNR grant.
    a. Purchase GPS unit for the TSGLC.
    b. Consultant trains volunteers on GPS use and data collection.
    c. Consultant or qualified public sector coordinator trains volunteers on native/non native species identification.
    d. Volunteers transfer data to consultant for integration and graphical representation to develop control plan.

6.0 METHODS

Lake Water Quality

Baseline water quality conditions were studied to assist in identifying potential water quality problems in the Town of Saint Germain project lakes (e.g., elevated phosphorus levels, anaerobic conditions, etc.). Water quality was monitored at the deepest point on each of the Town of Saint Germain project lakes that would most accurately depict the conditions of the lake (Map 1). Samples were collected using WDNR Citizen Lake Monitoring Network (CLMN) protocols which occurred three times during the summer. Professional water quality samples were collected at subsurface (S). Along with Secchi disk transparency, we would collect data reflecting temperature, dissolved oxygen, pH, and conductivity profiles at each sample location during each time period.

All samples that required laboratory analysis were processed through the Wisconsin State Laboratory of Hygiene (SLOH). The parameters measured, sample collection timing, and designated collector are contained in the table below.

	June	July	August
Parameter	**S**	**S**	**S**
Total Phosphorus	●	●	●
Chlorophyll-*a*	●	●	●
Total Kjeldahl Nitrogen	●	●	●
Nitrate-Nitrite Nitrogen	●	●	●
Ammonia Nitrogen	●	●	●
Calcium		●	

Watershed Analysis

Land cover

The watershed analysis began with an accurate delineation of the each Town of Saint Germain project lake's drainage area using U.S.G.S. topographic survey maps and base GIS data from the WDNR. The watershed delineation was then transferred to a Geographic Information System (GIS) and a map was created to reference during the management planning project discussions. Land use information was obtained through the Multi-Resulution Land Characteristics Consortium (MRLC) and their 2006 National Land Cover Database (Fry et. al. 2011).

Shoreland Assessment

Using a GPS data collector with sub-meter accuracy, the immediate shoreline of the project lakes were surveyed and classified based upon its potential to negatively impact the system. Examples of these negative qualities include shoreland areas that are maintained in an unnatural manner and impervious surfaces. The maps created attempt to prioritize areas for restoration that would likely have a benefit to the ecosystem of each of the project lakes.

Alma and Moon Lakes underwent a shoreland restoration project with the help of Mike Meyers, WDNR. Therefore a shoreland assessment was not conducted on these lakes, as areas for restoration have already been established. Found Lake has also been involved in a shoreline restoration project, but the lake as a whole had not been assessed. A survey was conducted as a part of this project.

Aquatic Vegetation

Curly-leaf Pondweed Survey

Surveys of curly-leaf pondweed were completed on the Town of Saint Germain project lakes during the month of June, 2010 in order to correspond with the anticipated peak growth of the plant. Visual inspections were completed throughout the lake by completing a meander survey by boat.

Comprehensive Macrophyte Surveys

Comprehensive surveys of aquatic macrophytes were conducted on the system to characterize the existing communities within each lake and included inventories of emergent, submergent, and floating-leaved aquatic plants within them. The point-intercept method as described in the Wisconsin Department of Natural Resource document, Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design, Field and Laboratory Procedures, Data Entry, and Analysis, and Applications (WDNR PUB-SS-1068 2010) was used to complete the studies. Based upon advice from the WDNR, the following point spacing and resulting number of points comprised the surveys:

Lake	Point-intercept Resolution (meters)	Number of Points	Survey Dates
Alma Lake	35	184	Aug. 4, 2010
Moon Lake	40	328	Aug. 3, 2010
Big St. Germain Lake	75	1163	July 26-28, 2010
Lake Content	56	304	July 27, 2010
Fawn Lake	30	83	July 27, 2010
Lost Lake	75	384	July 27-28, 2010
Found Lake	53	484	July 28-29, 2010

Community Mapping

During the species inventory work, the aquatic vegetation community types within each lake (emergent and floating-leaved vegetation) were mapped using a Trimble GeoXT Global Positioning System (GPS) with sub-meter accuracy. Furthermore, all species found during the point-intercept surveys and the community mapping surveys were recorded to provide a complete species list for each of the lakes.

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8.0 INDIVIDUAL LAKE SECTIONS

8.1 ALMA LAKE

8.1.1 An Introduction to Alma Lake

Alma Lake, Vilas County, is a seepage lake with a maximum depth of 19 feet and a surface area of 55 acres. This mesotrophic lake has a relatively small watershed when compared to the size of the lake. Alma Lake contains 29 native plant species, of which stoneworts were the most common plant. No exotic plant species are known to exist in Alma Lake.

Field Survey Notes

Due to the low water levels, we were not able to use the public boat landing on Alma Lake. Using a private access location on Moon Lake, we would push our boat through the narrow channel that connects the two lakes. Arriving at this beautiful hideaway was always a treat for us. The small emergent flowers of water lobelia and small purple bladderwort were a welcomed sight.

Photo 8.1.1-1 Alma Lake, Vilas County

Lake at a Glance – Alma Lake

Morphology	
Acreage	55.0
Maximum Depth (ft)	19.0
Mean Depth (ft)	11.1
Volume (acre-feet)	608.0
Shoreline Complexity	1.0
Vegetation	
Curly-leaf Survey Date	June 29, 2010
Comprehensive Survey Date	August 4, 2010
Number of Native Species	21 + 9 incidental = 30
Threatened/Special Concern Species	*none*
Exotic Plant Species	-
Simpson's Diversity	0.82
Average Conservatism	7.6
Water Quality	
Wisconsin Lake Classification	Class 6 (deep, seepage lake)
Trophic State	Mesotrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	2:1

8.1.2 Alma Lake Watershed Assessment

Alma Lake's 183-acre watershed is the smallest of all the Town of Saint Germain lakes studied. The watershed consists primarily of forested land (43% or 78 acres) and forested wetland (16% or 29 acres) with rural open space and wetlands making up 7% and 4% of the watershed land cover types, respectively (Figure 8.1.2-1). The Alma Lake surface occupies the remaining 30% or 55 acres. The watershed to lake area ratio is 2:1, which indicates that the lake would be sensitive to changes in land cover. Map 2 of the Town-Wide report displays the Alma Lake watershed and its land cover.

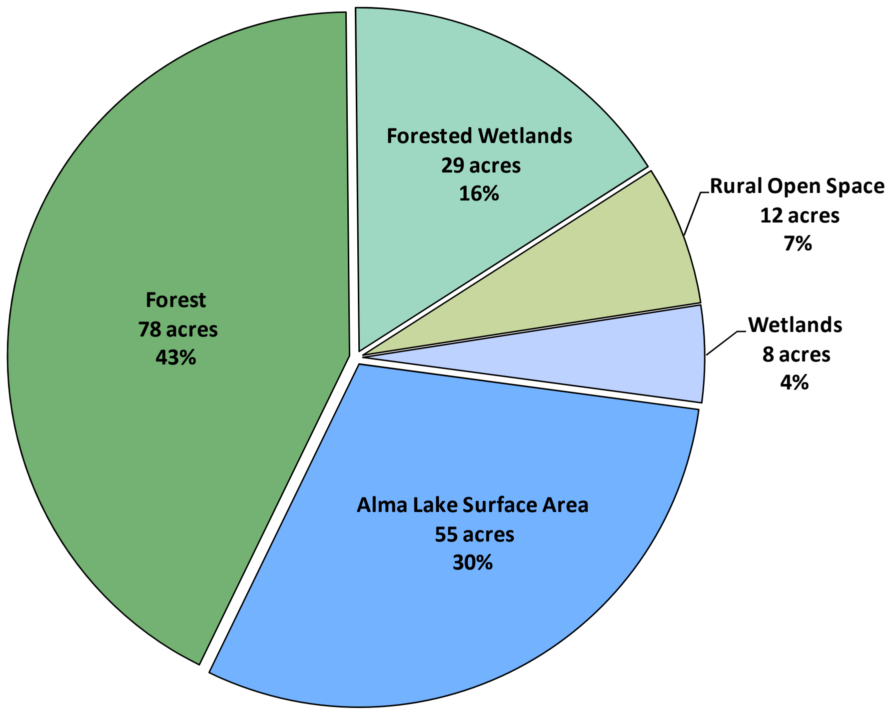


Figure 8.1.2-1. Alma Lake watershed land cover types in acres. Based upon landcover classifications from the Multi-Resolution Land Characteristics Consortium (MRLC, 2006).

The land use within Alma Lake's watershed is that which exports little pollution to the lake. Forested lands allow water to seep into the ground, and thus reduce the amount of overland flow which might carry sediments and pollutants into nearby lakes and streams. Additionally, with the help of Mike Meyers from the WDNR, the Alman/Moon Lake Protection and Rehabilitation District has restored areas of disturbed shoreland in an effort to reduce pollution to the lake from this particularly sensitive area of the watershed.

Alma Lake is classified as a seepage lake. While some lakes have streams that carry water to them, seepage lakes receive water only through groundwater inputs, surface runoff, and precipitation; of which groundwater is normally the most important. Drought conditions in northern Wisconsin have greatly reduced the amount of regional precipitation in the past 8 – 10 years. Without adequate precipitation, seepage lakes will collect water only from the ground. The lake water level, also a reflection of the groundwater level, will slowly lower as precipitation fails to "recharge" depleted groundwater stocks. And as evaporation occurs, the water levels in the lake will continue to decrease. While these changing water levels may have negative recreational and short-term ecological impacts, it is important to remember that lake water level fluctuations are part of a naturally occurring cycle and may actually benefit the lake ecosystem in the long-term by increasing the level of habitat diversity.

8.1.3 Alma Lake Water Quality

Water quality data was collected from Alma Lake on three occasions in summer of 2010. Onterra staff sampled the lake for a variety of water quality parameters including total phosphorus, chlorophyll-*a*, Secchi disk clarity, temperature, and dissolved oxygen.

Citizens Lake Monitoring Network (CLMN) volunteers have monitored water quality through an advanced monitoring program for quite some time. These efforts provide a considerable amount of historical data, which may be compared against recent data in an effort to detect any trends that may be occurring in the water quality of the lake. The summer average total phosphorus concentrations of the years have remained fairly constant, ranging between 10 and 17 µg/L and bordering a category of excellent and good (Figure 8.1.3-1). A weighted value across all years is slightly lower than the average for deep, seepage lakes in the state of Wisconsin.

Average chlorophyll-*a* concentrations have also shown very little variation within the past 11 summers (Figure 8.1.3-2). Although the weighted average of all data is slightly higher than the average for similar (deep seepage) lakes, there is little reason for concern as the chlorophyll-*a* concentrations still rank in a category of good for this parameter.

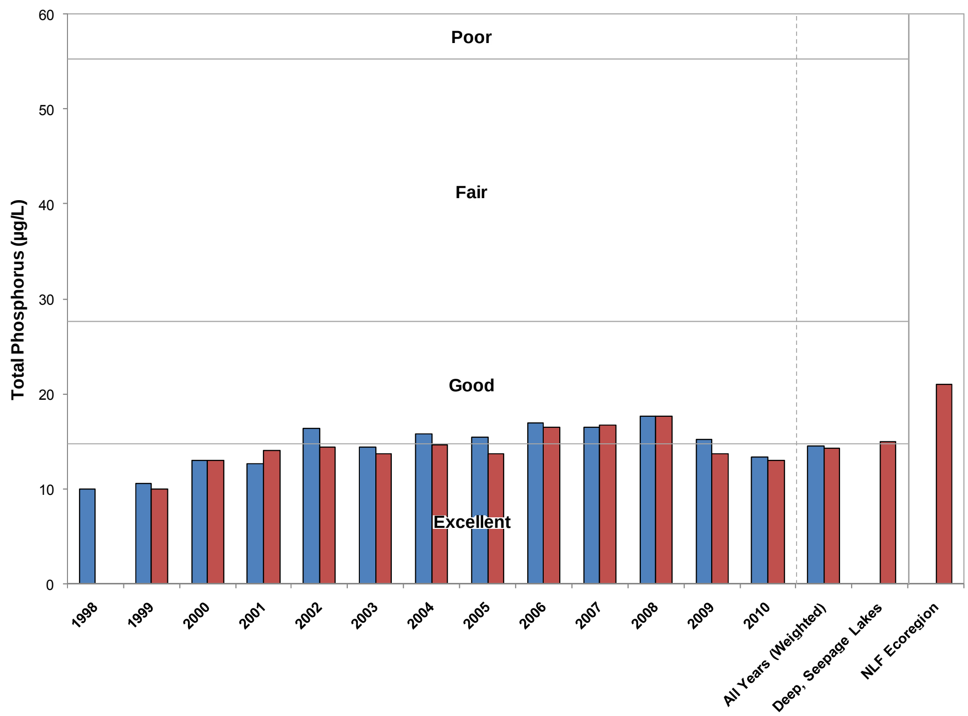


Figure 8.1.3-1. Alma Lake, state-wide deep, seepage lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

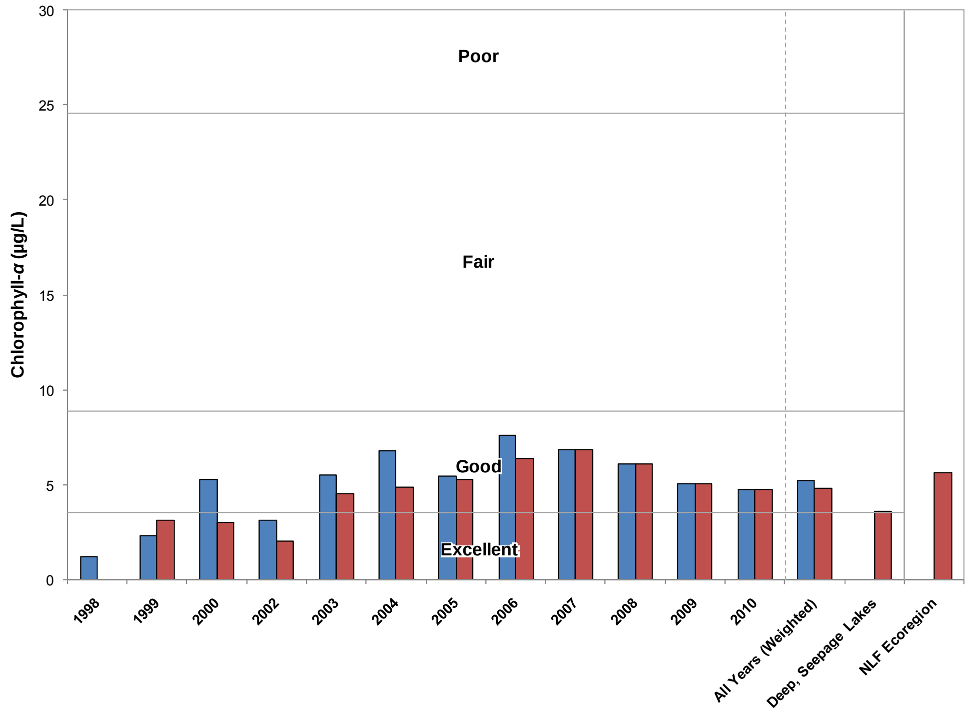


Figure 8.1.3-2. Alma Lake, state-wide deep, seepage lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Measurements of Secchi disk clarity span more than two decades on Alma Lake (Figure 8.1.3-3). Some of the highest recorded values on the lake include measurements of 12, 13, 14, and even 15 feet. All summer averages range between categories of good and excellent, and a weighted average across all years is greater than the average for deep seepage lakes statewide. Interestingly, there is an apparent decrease in water clarity from years 2005-2006 through 2010. It is unlikely that this is due to an increase in nutrients and thus algae, because as explained above, a noticeable trend was not observed in these parameters. The noticeable decrease in Secchi disk depth may be due to other environmental factors, such as decreasing water levels. As seen in the stakeholder survey (Appendix B – Alma Lake comments) water levels have been a major concern with lake residents. Since 2002, the connected Moon Lake's water levels have been monitored and these data can be found on the district's website (www.almamoonlake.org). Water clarity is a function of many factors, include algae, suspended sediment or other particles, and water color. With the shallower water, it is possible that factors that influence the apparent color of the water may have a stronger presence at this time. Lake water levels are often cyclic, so there is a good chance that water levels will rise to ordinary high water mark (OHWM) in the near future. Although the observed decrease in Secchi disk clarity is not thought to be troublesome at this time, continued monitoring of both water levels and water clarity is recommended to see if conditions change as the water levels eventually rise.

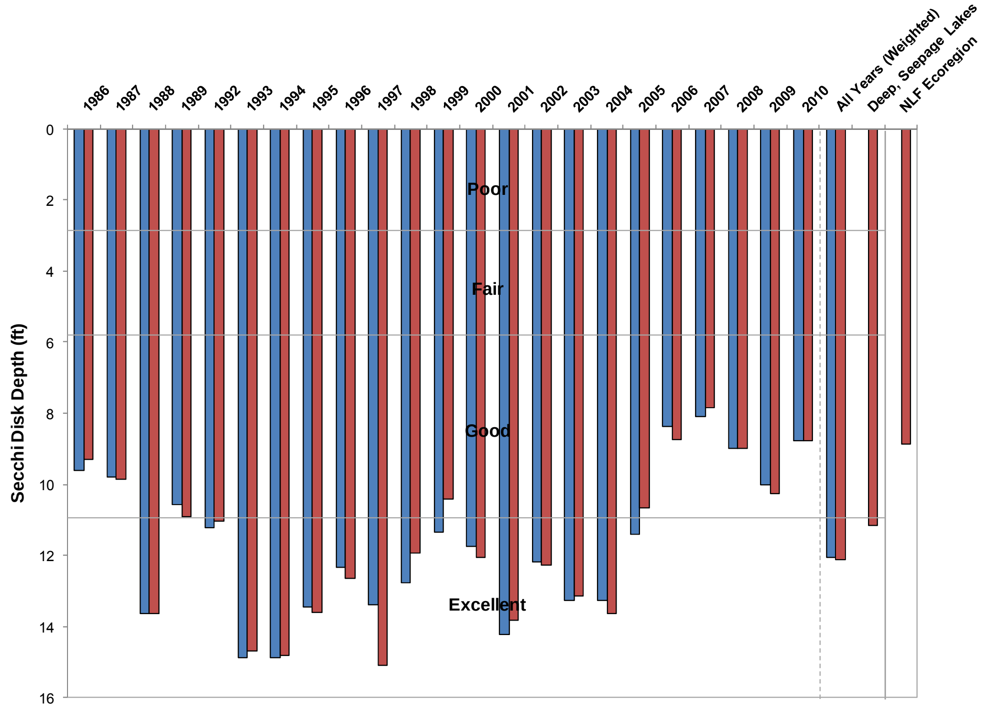


Figure 8.1.3-3. Alma Lake, state-wide deep, seepage lake, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

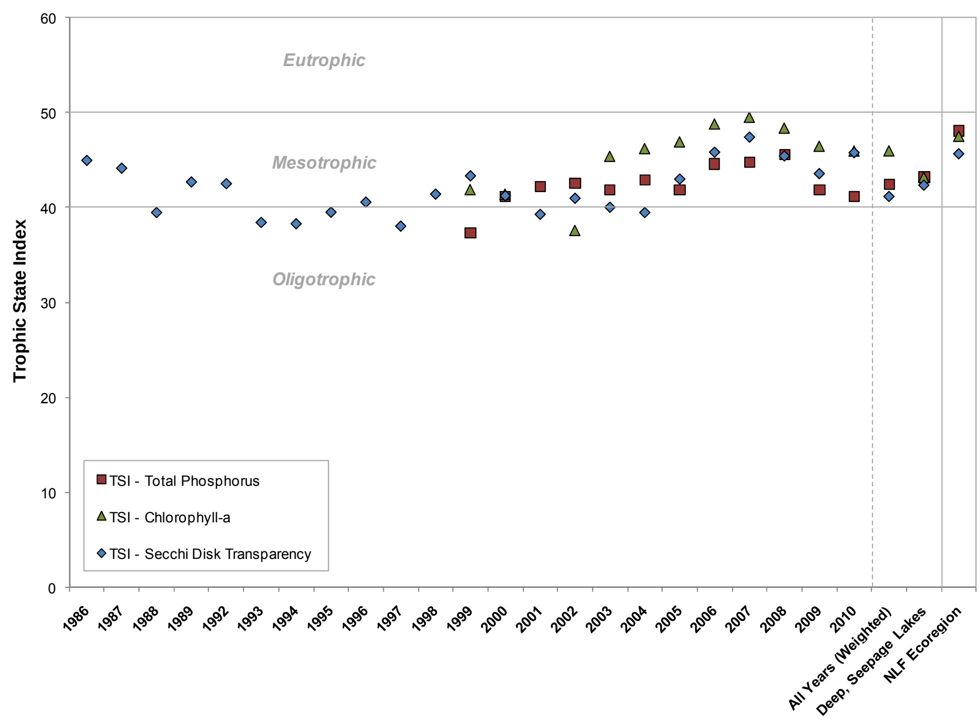


Figure 8.1.3-4. Alma Lake, state-wide deep, seepage lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Alma Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Alma Lake by Onterra staff. Graphs of those data are displayed in Figure 8.1.3-5 for all three sampling events.

Alma Lake remained thoroughly mixed throughout most of the summer months in 2010, though a small amount of stratification likely occurs periodically in the deeper portions of the lake as seen in the June and July profile. This is not uncommon in lakes that are small and moderately deep. Energy from the wind is sufficient to mix the lake from top to bottom, distributing oxygen throughout the epilimnion and hypolimnion and keeping water temperatures fairly constant within the water column. Decomposition of organic matter along the lake bottom is likely the cause of the slight decrease in dissolved oxygen observed in June and July. Despite this late summer dip, dissolved oxygen levels remained sufficient to support most aquatic life found in northern Wisconsin lakes.

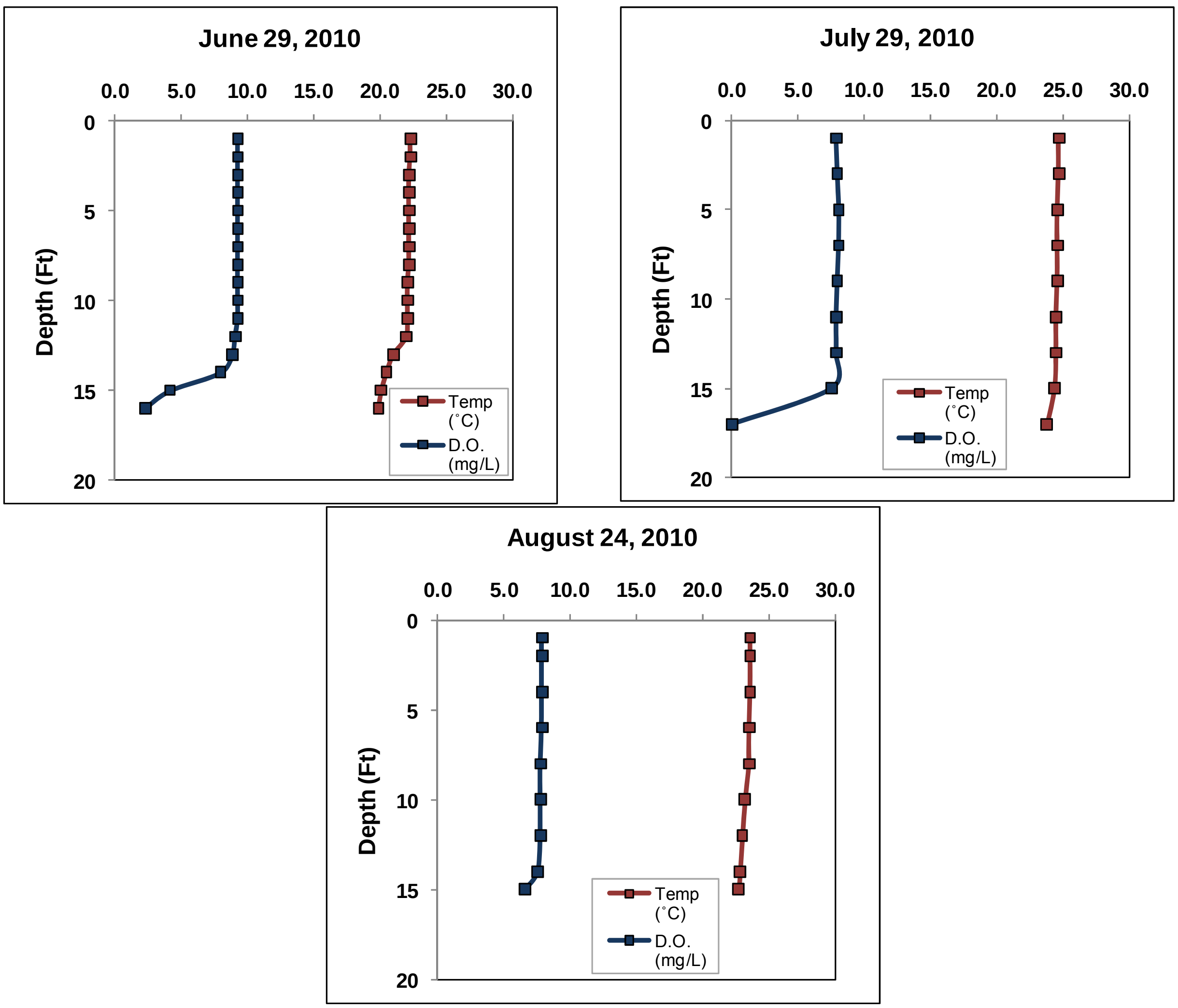


Figure 8.1.3-5. Alma Lake dissolved oxygen and temperature profiles.

8.1.4 Alma Lake Aquatic Vegetation

The curly-leaf pondweed survey was conducted on Alma Lake on June 29, 2010. This meander-based survey did not locate any occurrences of this exotic plant, and it is believed that this species either does not currently exist in Alma Lake or is present at an undetectable level. Eurasian water milfoil, also an aquatic invasive plant, was not located in Alma Lake during any of the 2010 surveys.

The aquatic plant point-intercept survey was conducted on Alma Lake on August 4, 2010 by Onterra. The floating-leaf and emergent plant community mapping survey was also completed to create the aquatic plant community map (Alma Lake Community Map) during this time. During these surveys, 30 species of native aquatic plants were located in Alma Lake; 21 of these species were sampled during the point-intercept survey (Table 8.1.4-1 and Figure 8.1.4-1). This species richness greatly exceeds the Northern Lakes Ecoregion and Wisconsin State medians.

A testament to the high water clarity in Alma Lake, aquatic plants were found growing to a depth of 17 feet. Of the 183 point-intercept locations sampled within the littoral zone, approximately 97% contained aquatic vegetation. Sixty-four percent of the point-intercept sampling locations where sediment data was collected at contained fine, organic substrate (muck) while the remaining 36% contained sand (Town-Wide Fisheries Section, Figure 3.4-5).

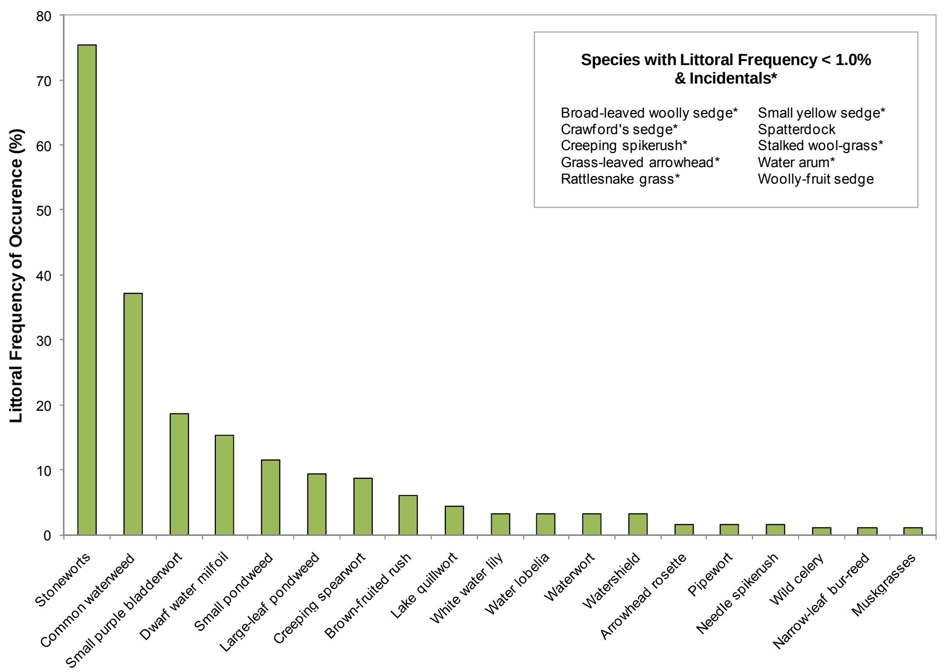


Figure 8.1.4-1. Alma Lake aquatic plant littoral frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

The most frequently encountered aquatic plants during the survey were stoneworts, common waterweed, and small purple bladderwort (Figure 8.1.4-1). Stoneworts appear to be rooted vascular plants, but they are in fact a type of macro-algae which provides valuable structural habitat for invertebrates and sources of food for waterfowl, muskrats, and other wildlife. The stoneworts in Alma Lake were most prevalent at depths from 6 to 17 feet. Common waterweed is a widespread species inhabiting water bodies throughout North America and also provides structural habitat and sources of food to various species of wildlife.

Table 8.1.4-1. Aquatic plant species located in the Alma Lake during the 2010 aquatic plant surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)
Emergent	*Calla palustris*	Water arum	9
	Carex crawfordii	Crawford's sedge	5
	Carex cryptolepis	Small yellow sedge	8
	Carex pellita	Broad-leaved woolly sedge	4
	Carex lasiocarpa	Woolly-fruit sedge	9
	Eleocharis palustris	Creeping spikerush	6
	Glyceria canadensis	Rattlesnake grass	7
	Scirpus pedicellatus	Stalked wool-grass	6
	Zizania palustris	Northern wild rice	8
FL	*Brasenia schreberi*	Watershield	7
	Nuphar variegata	Spatterdock	6
	Nymphaea odorata	White water lily	6
FL/E	*Sparganium angustifolium*	Narrow-leaf bur-reed	9
Submergent	*Chara spp.*	Muskgrasses	7
	Eriocaulon aquaticum	Pipewort	9
	Elatine minima	Waterwort	9
	Elodea canadensis	Common waterweed	3
	Isoetes lacustris	Lake quillwort	8
	Lobelia dortmanna	Water lobelia	10
	Myriophyllum tenellum	Dwarf water milfoil	10
	Nitella spp.	Stoneworts	7
	Potamogeton amplifolius	Large-leaf pondweed	7
	Potamogeton pusillus	Small pondweed	7
	Ranunculus flammula	Creeping spearwort	9
	Sagitaria sp. (rosette)	Arrowhead rosette	N/A
	Utricularia resupinata	Small purple bladderwort	9
	Vallisneria americana	Wild celery	6
S/E	*Eleocharis acicularis*	Needle spikerush	5
	Juncus pelocarpus	Brown-fruited rush	8
	Sagittaria graminea	Grass-leaved arrowhead	9

FL = Floating Leaf
FL/E = Floating Leaf and Emergent
S/E = Submergent and Emergent

Alma Lake has a relatively high number of aquatic plant species, and because of this, one may assume that the system would also have high species diversity. As discussed previously, how evenly the species are distributed throughout the system also influences the diversity. The diversity index for Alma Lake's plant community is 0.82. This means that if two individual plant specimens were randomly sampled from Alma Lake, there would be an 82% probability that the two individuals would be of different species. This value is slightly below the median value for the Northern Lakes and Forests Lakes ecoregion (0.86). Diverse aquatic plant communities with a mosaic of species provide complex structural habitat, various sources of food for wildlife, and make it more difficult for invasive plants to become established if introduced.

As explained earlier in the Primer on Data Analysis and Data Interpretation Section, the littoral frequency of occurrence analysis allows for an understanding of how often each of the plants is located during the point-intercept survey. Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while stoneworts were found at 75% of the sampling locations, its relative frequency of occurrence is 36%. Explained another way, if 100 plants were randomly sampled from Alma Lake, 36 of them would be stoneworts. As Figure 8.1.4-2 shows, together stoneworts, common waterweed, and small purple bladderwort account for 63% of the population of plants within Alma Lake, while the other 18 species account for the remaining 37%. Eight additional species were located from the lake but not from of the point-intercept survey, as indicated in Figure 8.1.4-1 as incidentals.

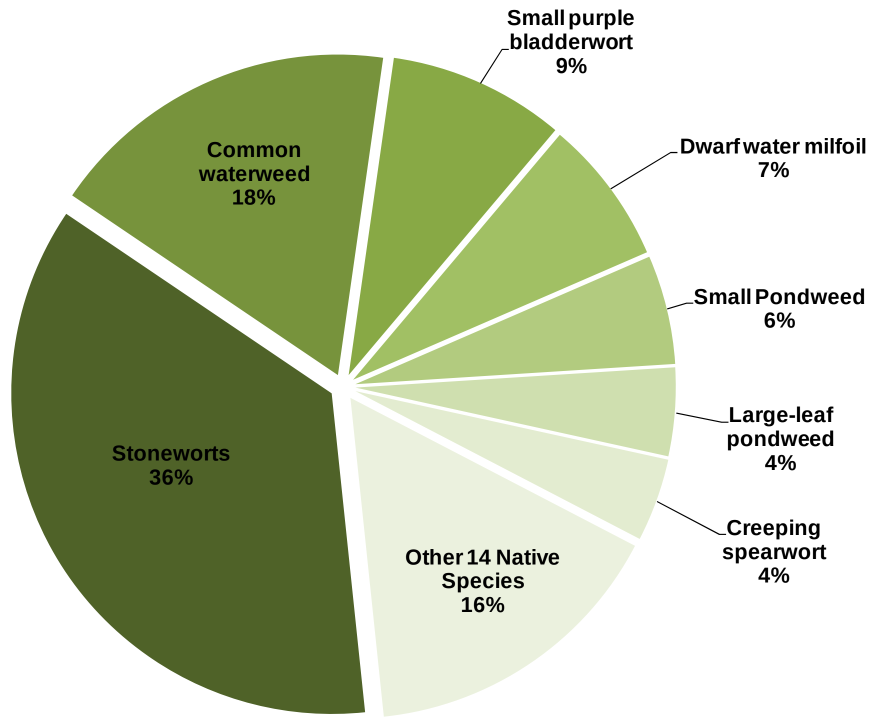


Figure 8.1.4-2 Alma Lake aquatic plant relative frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

Alma Lake had the highest average conservatism value (7.9) of the seven Town of Saint Germain project lakes sampled, and are well above the ecoregion and Wisconsin State medians.

This value indicates that the majority of the aquatic plant species present in Alma Lake are sensitive to environmental degradation, and their current presence signifies high quality environmental conditions. Declines in these species in the future may indicate potential declines in water quality or other aspect of the lake environment.

Combining Alma Lake's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in an exceptionally high value of 36.4; again, well above the median values of the ecoregion and state (Town-Wide Aquatic Plant Section, Figure 3.3-6). The quality of Alma Lake is also indicated by the incidence of emergent and floating-leaf plant communities that occur in the shallower regions of the lake. The 2010 community map indicates that approximately 6.6 acres of the lake contains these types of plant communities (Alma Community Map, Table 8.1.4-2). Twelve floating-leaf and emergent species were located on Alma Lake (Table 8.1.4-1), all of which provide valuable wildlife habitat. These communities are especially important during periods of low water levels as they provide structure when much of the woody habitat remains above the receding water line.

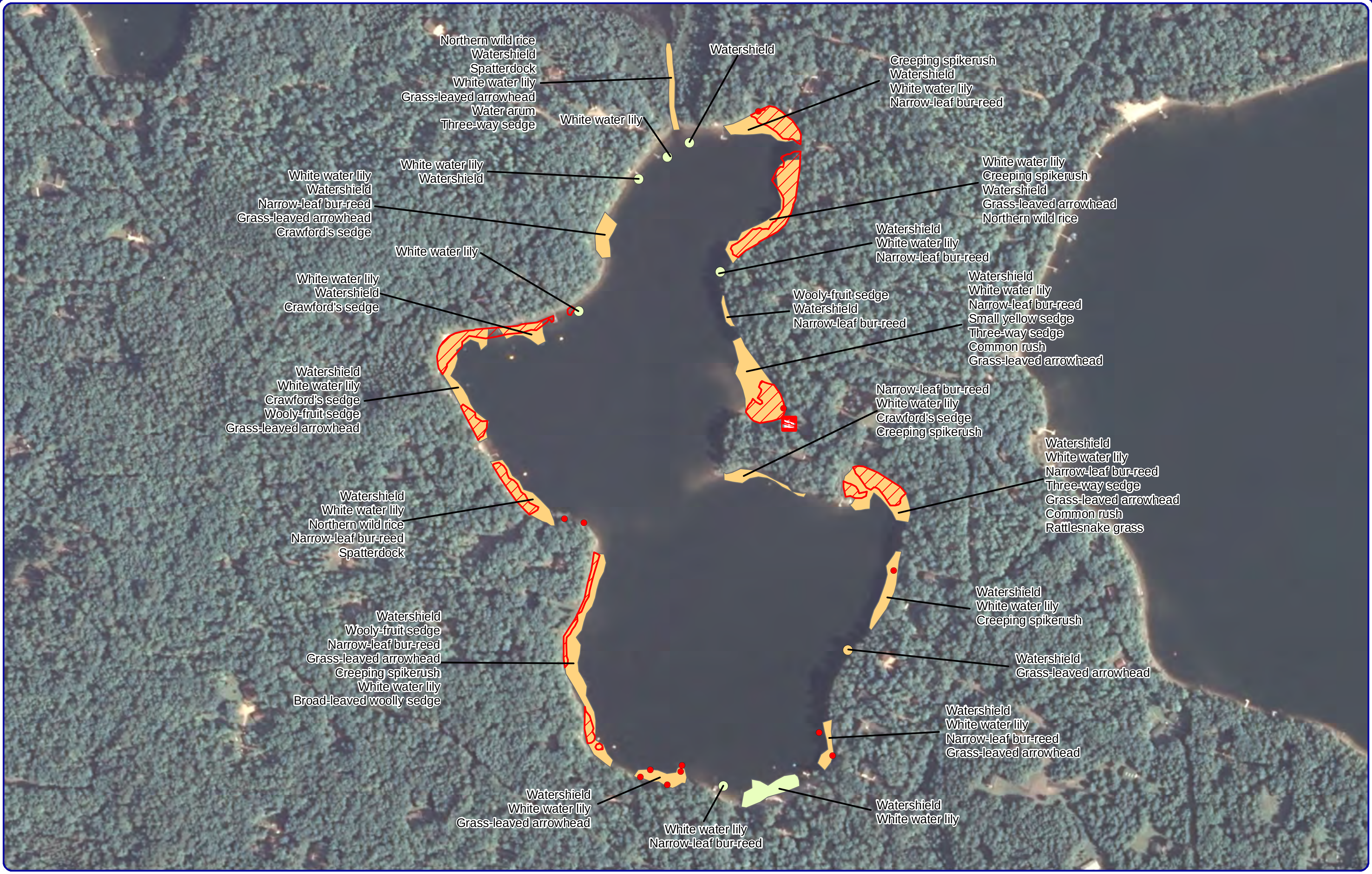
Table 8.1.4-2. Alma Lake acres of emergent and floating-leaf plant communities from the 2004 and 2010 community mapping survey.

	Acres	
Plant Community	**2004**	**2010**
Floating-leaf	2.6	0.3
Emergent	0.0	0.0
Floating-leaf/Emergent	0.1	6.3
Total	**2.7**	**6.6**

The community map represents a 'snapshot' of the emergent and floating-leaf plant communities. Replications of this survey will provide a valuable understanding of the dynamics of these communities within Alma Lake. This is important, because these communities are often negatively affected by recreational use and shoreland development. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelines when compared to undeveloped shorelines in Minnesota Lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines.

The 2010 community mapping survey was the second survey of this type to be conducted, the first being conducted by Onterra in 2004. Looking at the 2010 Alma Lake Community Map, the floating-leaf and emergent plant communities have since expanded since 2004 by almost four acres (Table 8.1.4-2). Many of these communities have expanded lakeward, likely due to the lower water levels experienced over the past years. Also, the majority of the watercraft use on the lake is from non-motorized vessels. Approximately 26% of the watercrafts used by Alma Lake stakeholder survey respondents were canoe/kayaks and 19% were rowboats (Appendix B, Question #12). These values are higher than any of the other project lakes. Only 7% of the watercrafts used by Alma Lake stakeholders were motor boats with greater than a 25 hp motor.

Note: The Alma and Moon Lakes District represents both Alma and Moon Lake. Therefore, a single Implementation Plan has been constructed for these lakes and is located following the Moon lake Section (8.2.5).



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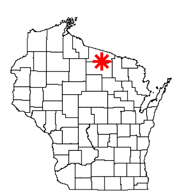
www.onterra-eco.com

Sources:
Aquatic Plants: Onterra, 2004 & 2010
Orthophotography: NAIP 2010
Map date: March 24, 2011
Filename: Map1_Alma_Comm_2010.mxd



Project Location in Wisconsin

Legend

Small Plant Communities	Large Plant Communities
Emergent	Emergent
Floating-leaf	Floating-leaf
Mixed Floating-leaf & Emergent	Mixed Floating-leaf & Emergent
2004 Small Plant Community	2004 Large Plant Community

Alma Lake - Map 1

Saint Germain Lakes

Vilas County, Wisconsin

Aquatic Plant Communities

8.2 MOON LAKE

8.2.1 An Introduction to Moon Lake

Moon Lake, Vilas County, is a deep seepage lake with a maximum depth of 40 feet and a surface area of 124 acres. This oligotrophic lake has a relatively small watershed when compared to the size of the lake. Moon Lake contains 33 native plant species, of which members of the stonewort genus were the most common plant. There were no exotic plants located within Moon Lake during the 2010 vegetation surveys.

Field Survey Notes

Dominated by turf-like isoetid plant species, Moon Lake had some of the neatest plant species encountered during the TSG project. Water bulrush lined the channel to Alma Lake and wild rice was also located during the survey.

Photo 8.2.1-1 Moon Lake, Vilas County

Lake at a Glance – Moon Lake

Morphology	
Acreage	124.0
Maximum Depth (ft)	40.0
Mean Depth (ft)	18.1
Volume (acre-feet)	2,247.0
Shoreline Complexity	1.64
Vegetation	
Curly-leaf Survey Date	June 29, 2010
Comprehensive Survey Date	August 3, 2010
Number of Native Species	25 + 8 incidental = 33
Threatened/Special Concern Species	*none*
Exotic Plant Species	-
Simpson's Diversity	0.85
Average Conservatism	7.6
Water Quality	
Wisconsin Lake Classification	Class 6 (deep seepage lake)
Trophic State	Upper oligotrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	3:1

8.2.2 Moon Lake Watershed Assessment

Moon Lake's watershed is 439 acres in size and is the second smallest of the Town of Saint Germain lakes studied. The top three land cover types within the watershed include forest (35% or 152 acres), the lake surface (28% or 124 acres) and also forested wetlands (25% or 108 acres) (Figure 8.2.2-1). Rural open space (8%) and wetlands (4%) are also Moon within the watershed to a lesser degree. The watershed to lake area ratio is 3:1, which indicates that the lake would be sensitive to changes in land cover. Map 2 of the Town-Wide report displays the Moon Lake watershed and its land cover.

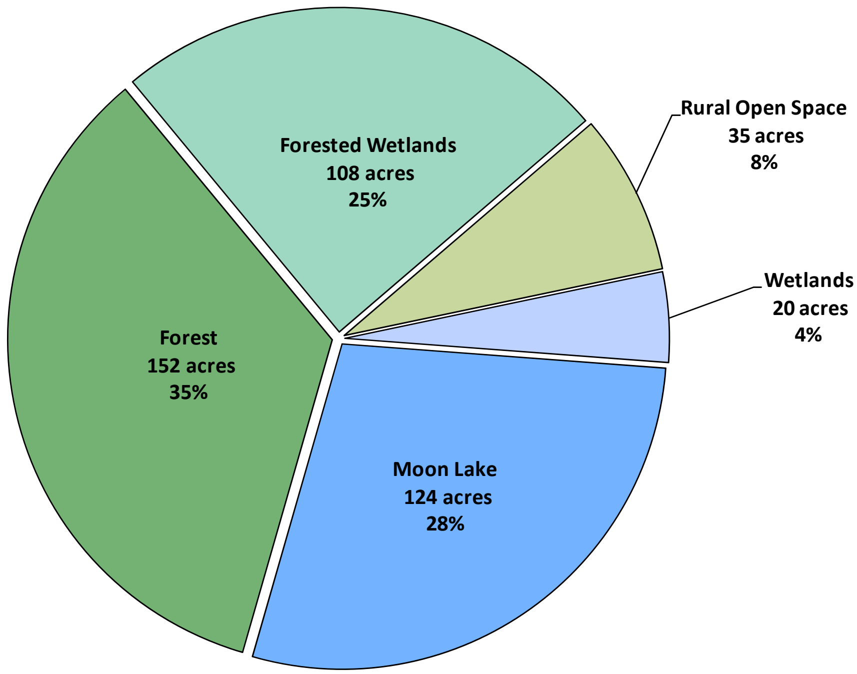


Figure 8.2.2-1. Moon Lake watershed land cover types in acres. Based upon landcover classifications from the Multi-Resolution Land Characteristics Consortium (MRLC, 2006).

Overall, the land use within Moon Lake's watershed is that which exports little pollution to the lake. Forested lands allow water to seep into the ground, and thus reduce the amount of overland flow which might carry sediments and pollutants into nearby lakes and streams. Additionally, with the help of Mike Meyers from the WDNR, the Alman/Moon Lake Protection and Rehabilitation District has restored areas of disturbed shoreland in an effort to reduce pollution to the lake from this particularly sensitive area of the watershed.

Moon Lake is classified as a deep seepage lake. While some lakes have streams that carry water to them, seepage lakes receive water only through groundwater inputs, surface runoff, and precipitation; of which groundwater is normally the most important. Drought conditions in northern Wisconsin have greatly reduced the amount of regional precipitation in the past 8 – 10 years. Moon Lake's water levels have also been impacted by drought. Since 2002, Moon Lake's water levels have been monitored and these data can be found on the district's website (www.almamoonlake.org). Without adequate precipitation, seepage lakes will collect water only from the ground. The lake water level, also a reflection of the groundwater level, will slowly lower as precipitation fails to "recharge" depleted groundwater stocks. And as evaporation occurs, the water levels in the lake will continue to decrease. While these changing water levels may have negative recreational and short-term ecological impacts, it is important to remember that lake water level fluctuations are part of a naturally occurring cycle and may actually benefit the lake ecosystem in the long-term by increasing the level of habitat diversity.

8.2.3 Moon Lake Water Quality

Water quality data was collected from Moon Lake on three occasions in summer of 2010. Onterra staff sampled the lake for a variety of water quality parameters including total phosphorus, chlorophyll-*a*, Secchi disk clarity, temperature, and dissolved oxygen. Citizens Lake Monitoring Network (CLMN) volunteers have monitored water quality through an advanced monitoring program for greater than a decade. These efforts provide a considerable amount of historical data, which may be compared against recent data in an effort to detect any trends that may be occurring in the water quality of the lake. These efforts should be continued in order to understand trends in the water quality of Moon Lake.

The summer average total phosphorus concentrations during this time period have remained fairly constant, ranging between 9.2 and 16.0 μg/L (Figure 8.2.3-1). These average values mostly fall within the TSI excellent category. A weighted value across all years is lower than the average for deep seepage lakes in the state of Wisconsin. As with the total phosphorus values, average chlorophyll-*a* concentrations have also shown very little variation within the past decade (Figure 8.2.3-2). Summer averages from 10 of the 11 years on record rank as excellent in the TSI category set. The weighted average across all years is lower than the average for other deep seepage lakes statewide. As indicated by the comparison to the TSI categories of similar lakes statewide, the total phosphorus and chlorophyll-*a* concentrations in Moon Lake are below average, which indicates great water quality.

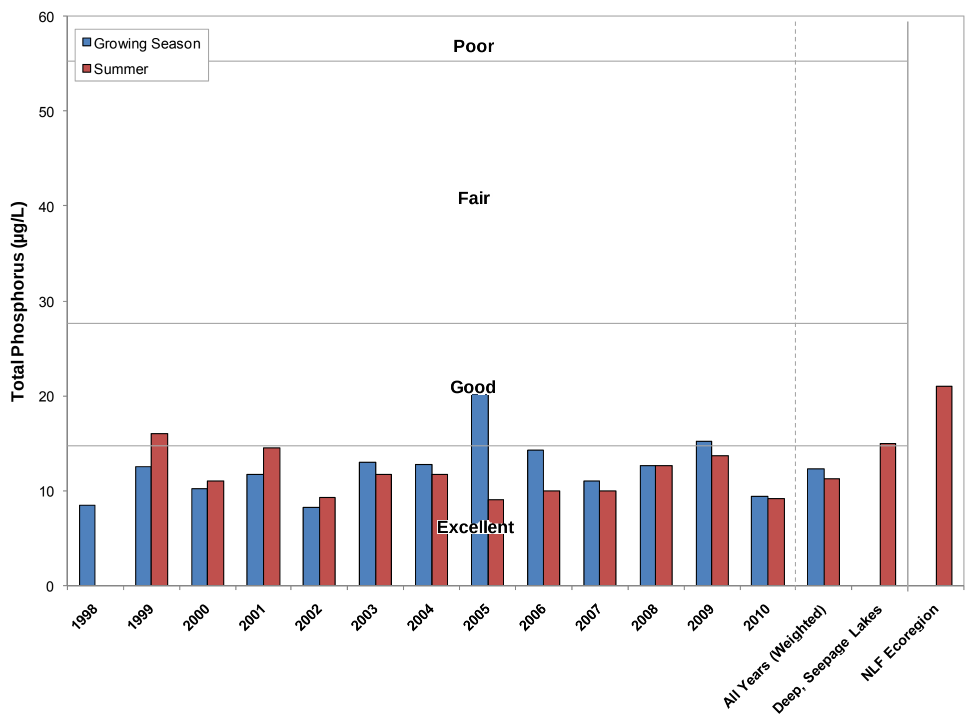


Figure 8.2.3-1. Moon Lake, state-wide shallow, lowland drainage lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Measurements of Secchi disk clarity span a larger timeframe on Moon Lake – over 2 decades of information has been collected (Figure 8.2.3-3). Some of the highest recorded values on the lake include measurements greater than 18 feet. All summer averages rank within the TSI excellent category, and a weighted average across all years is greater than the average for similar lakes statewide. This incredible water clarity is to be expected for several reasons. First, chlorophyll-*a* concentrations are typically very low within the water column. Secondly, the lake is deep yet small, which reduces the chances for large watercrafts to stir up the lake bottom. Finally, as discussed in the previous section, the small watershed contains many undisturbed land areas, which reduces the probability of pollution runoff into the lake.

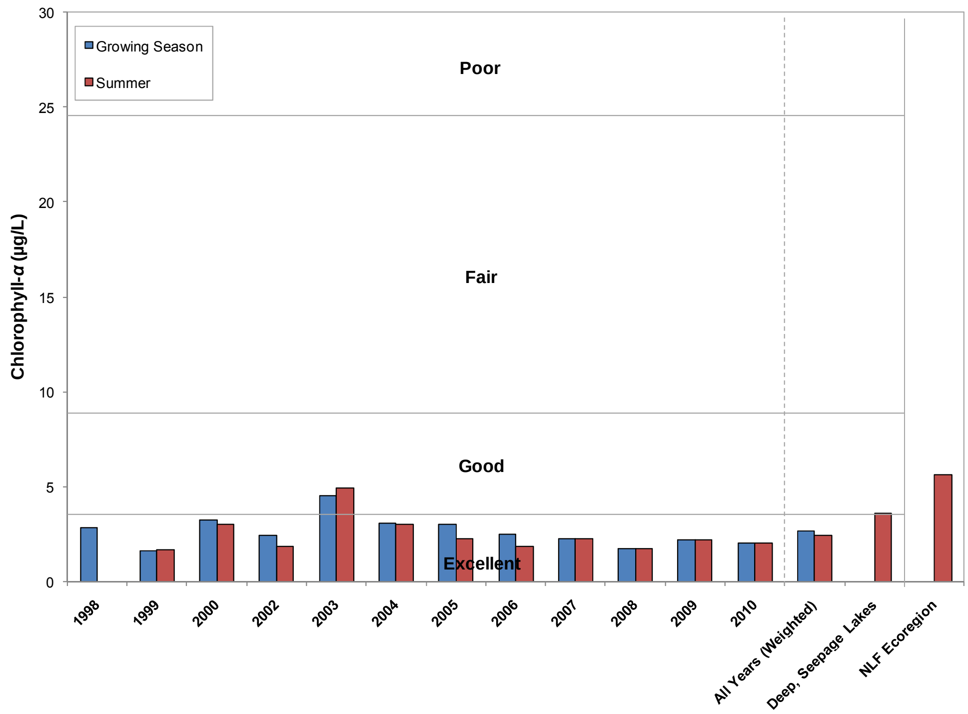


Figure 8.2.3-2. Moon Lake, state-wide shallow, lowland drainage lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Moon Lake Trophic State

The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values fall within categories of mesotrophic and oligotrophic (Figure 8.2.3-4). In general, the best values to use in judging a lake's trophic state are the biological parameters; therefore, relying primarily on the 2010 total phosphorus and chlorophyll-*a* TSI values, it can be concluded that Moon Lake is in an upper oligotrophic state.

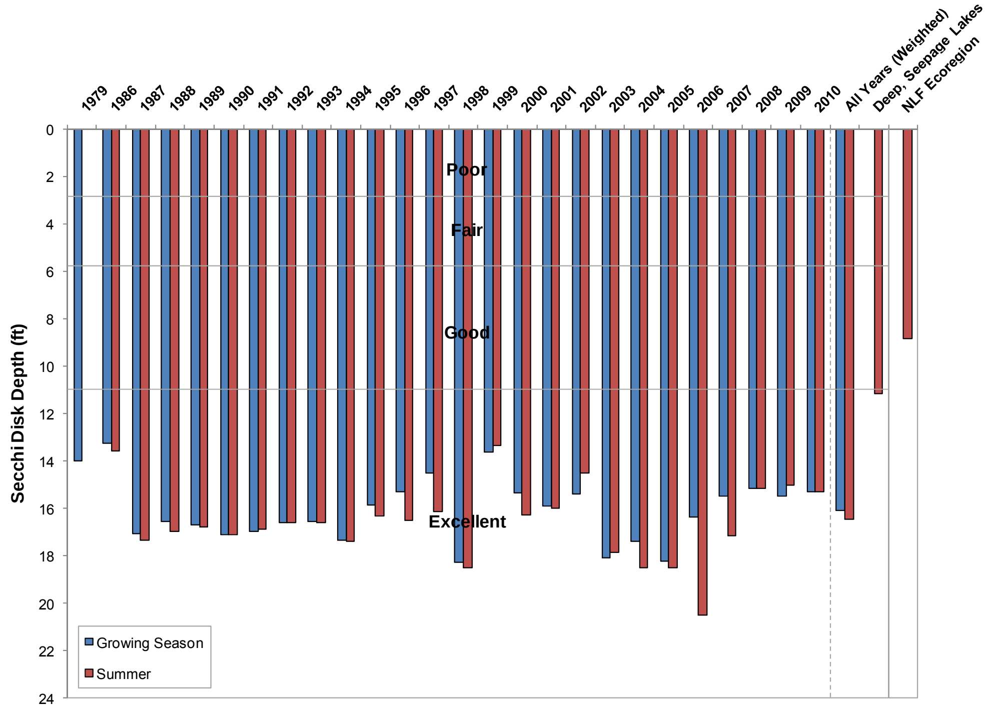


Figure 8.2.3-3. Moon Lake, state-wide shallow, lowland drainage lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

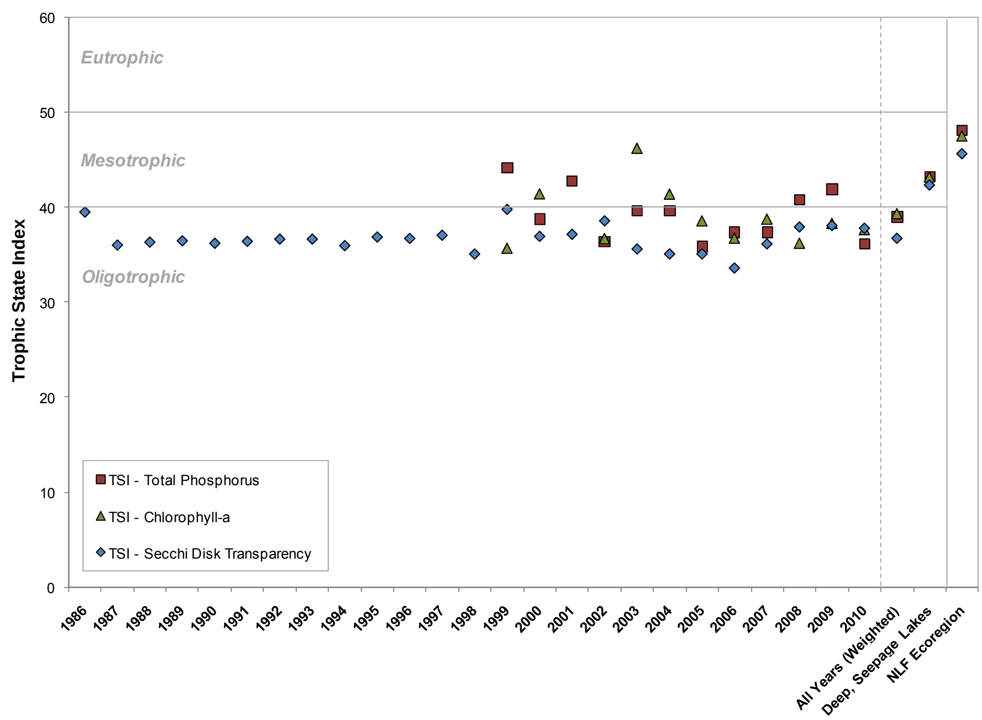


Figure 8.2.3-4. Moon Lake, state-wide shallow, lowland drainage lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Moon Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Moon Lake by Onterra staff. Graphs of those data are displayed in Figure 8.2.3-5 for all three sampling events.

Moon Lake was found to be stratified during the months of June and July, and was likely somewhat stratified in the month of August as well. In small, deep lakes such as Moon Lake, it takes an incredible amount of wind energy to mix the warmer top layer of water (epilmnion) with the colder (hypolimnion). When this does occur, temperature gradients are diminished, and dissolved oxygen is distributed evenly throughout the water column as well.

The decreasing dissolved oxygen near the bottom of the lake is the result of the decomposition of organic matter. Despite this decrease, dissolved oxygen levels remained sufficient in the upper 25 feet of the water column to support most aquatic life found in northern Wisconsin lakes.

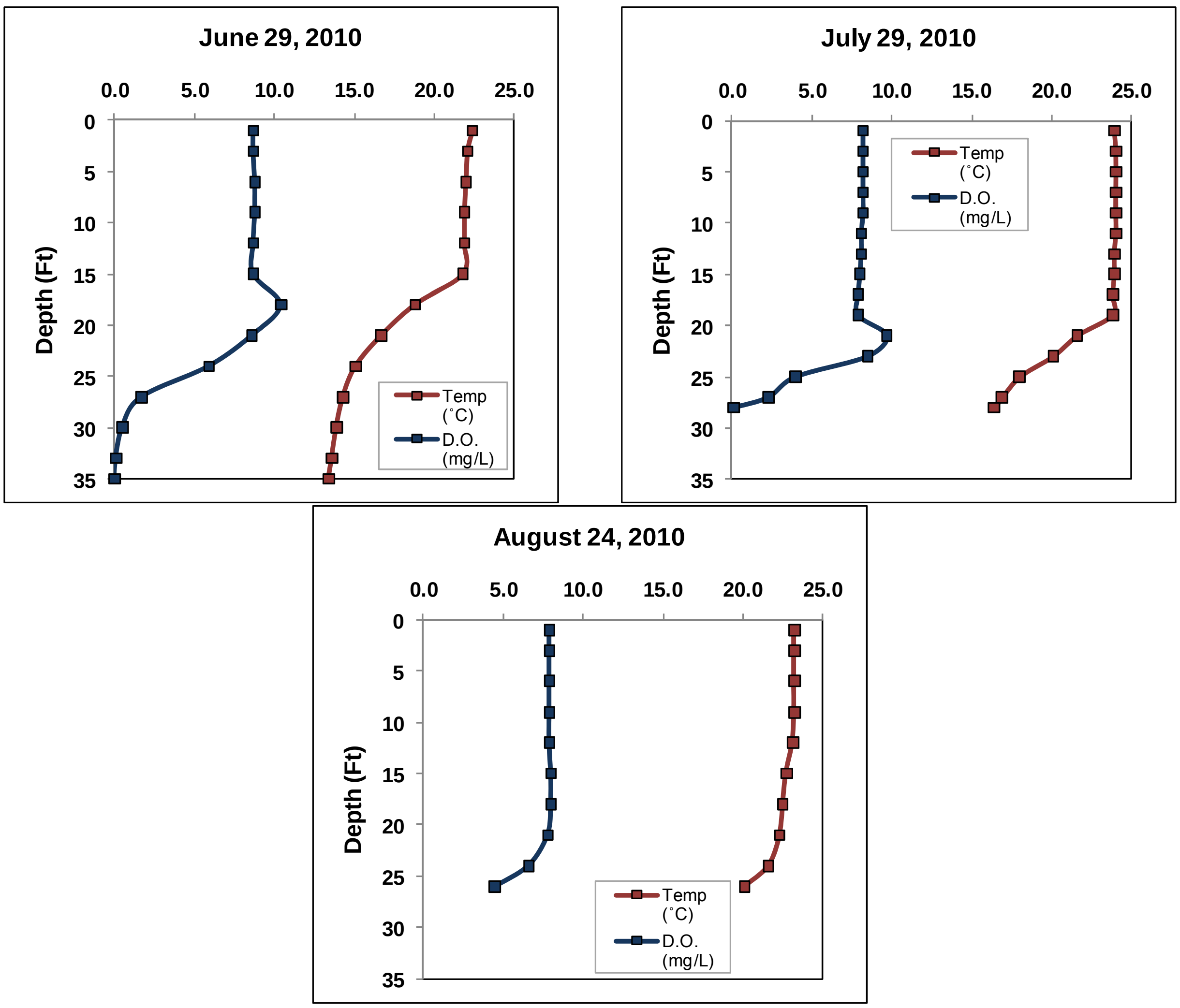


Figure 8.2.3-5. Moon Lake dissolved oxygen and temperature profiles.

8.2.4 Moon Lake Aquatic Vegetation

The curly-leaf pondweed survey was conducted on Moon Lake on June 29, 2010. This meander-based survey did not locate any occurrences of this exotic plant, and it is believed that this species either does not currently exist in Moon Lake or is present at an undetectable level. Eurasian water milfoil, also an aquatic invasive plant, was not located in Moon Lake during any of the 2010 surveys.

The aquatic plant point-intercept survey was conducted on Moon Lake on August 3, 2010 by Onterra. The floating-leaf and emergent plant community mapping survey were completed on the following day (August 4, 2011) to create the aquatic plant community map (Moon Lake Community Map). During these surveys, 33 species of native aquatic plants were located in Moon Lake; 25 of these species were sampled during the point-intercept survey (Table 8.2.4-1 and Figure 8.2.4-1). This species richness greatly exceeds the Northern Lakes Ecoregion and Wisconsin State medians.

A testament to the high water clarity in Moon Lake, aquatic plants were found growing to a depth of 29 feet. Of the 290 point-intercept locations sampled within the littoral zone, approximately 76% contained aquatic vegetation. Twenty-two percent of the point-intercept sampling locations where sediment data was collected at contained fine, organic substrate (muck) while the majority (78%) contained sand (Town-Wide Fisheries Section, Figure 3.4-5).

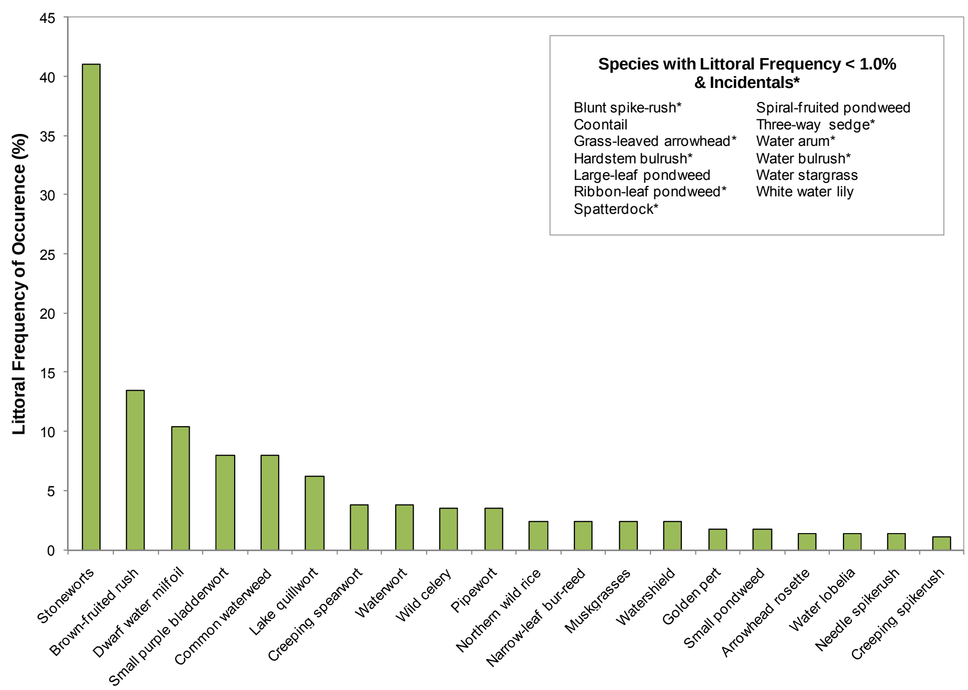


Figure 8.2.4-1 Moon Lake aquatic plant littoral frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

Moon Lake has a relatively high number of aquatic plant species, and because of this, one may assume that the system would also have high species diversity. As discussed previously, how evenly the species are distributed throughout the system also influences the diversity. The diversity index for Moon Lake's plant community is 0.85, which is just below the Northern

Lakes and Forests Lakes ecoregion median value (0.86). Figure 8.2.4-1 shows that stoneworts overwhelmingly dominate the aquatic plant community of Moon Lake. Stoneworts appear to be rooted vascular plants, but they are in fact a type of macro-algae which provides valuable structural habitat for invertebrates and sources of food for waterfowl, muskrats, and other wildlife. The stoneworts in Moon Lake were most prevalent at depths from 17 to 30 feet.

Table 8.2.4-1. Aquatic plant species located in the Moon Lake during the 2010 aquatic plant surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)
Emergent	*Calla palustris*	Water arum	9
	Dulichium arundinaceum	Three-way sedge	9
	Eleocharis obtusa	Blunt spike-rush	3
	Eleocharis palustris	Creeping spikerush	6
	Schoenoplectus acutus	Hardstem bulrush	5
	Schoenoplectus subterminalis	Water bulrush	9
	Zizania palustris	Northern wild rice	8
FL	*Brasenia schreberi*	Watershield	7
	Nuphar variegata	Spatterdock	6
	Nymphaea odorata	White water lily	6
FL/E	*Sparganium angustifolium*	Narrow-leaf bur-reed	9
Submergent	*Ceratophyllum demersum*	Coontail	3
	Chara spp.	Muskgrasses	7
	Eriocaulon aquaticum	Pipewort	9
	Elatine minima	Waterwort	9
	Elodea canadensis	Common waterweed	3
	Gratiola aurea	Golden pert	10
	Heteranthera dubia	Water stargrass	6
	Isoetes lacustris	Lake quillwort	8
	Lobelia dortmanna	Water lobelia	10
	Myriophyllum tenellum	Dwarf water milfoil	10
	Nitella spp.	Stoneworts	7
	Potamogeton epihydrus	Ribbon-leaf pondweed	8
	Potamogeton amplifolius	Large-leaf pondweed	7
	Potamogeton spirillus	Spiral-fruited pondweed	8
	Potamogeton pusillus	Small pondweed	7
	Ranunculus flammula	Creeping spearwort	9
	Sagitaria sp. (rosette)	Arrowhead rosette	N/A
	Utricularia resupinata	Small purple bladderwort	9
	Vallisneria americana	Wild celery	6
S/E	*Eleocharis acicularis*	Needle spikerush	5
	Juncus pelocarpus	Brown-fruited rush	8
	Sagittaria graminea	Grass-leaved arrowhead	9

FL = Floating Leaf
FL/E = Floating Leaf and Emergent
S/E = Submergent and Emergent

As explained earlier in the Primer on Data Analysis and Data Interpretation Section, the littoral frequency of occurrence analysis allows for an understanding of how often each of the plants is located during the point-intercept survey. Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while stoneworts were found at 41% of the sampling locations, its relative frequency of occurrence is 34%. Explained another way, if 100 plants were randomly sampled from Moon Lake, 34 of them would be stoneworts. As Figure 8.2.4-2 shows, together five species account for 66% of the population of plants within Moon Lake, while the other 20 species account for the remaining 33%. Eight additional species were located from the lake but not from of the point-intercept survey, as indicated in Figure 8.2.4-1 as incidentals.

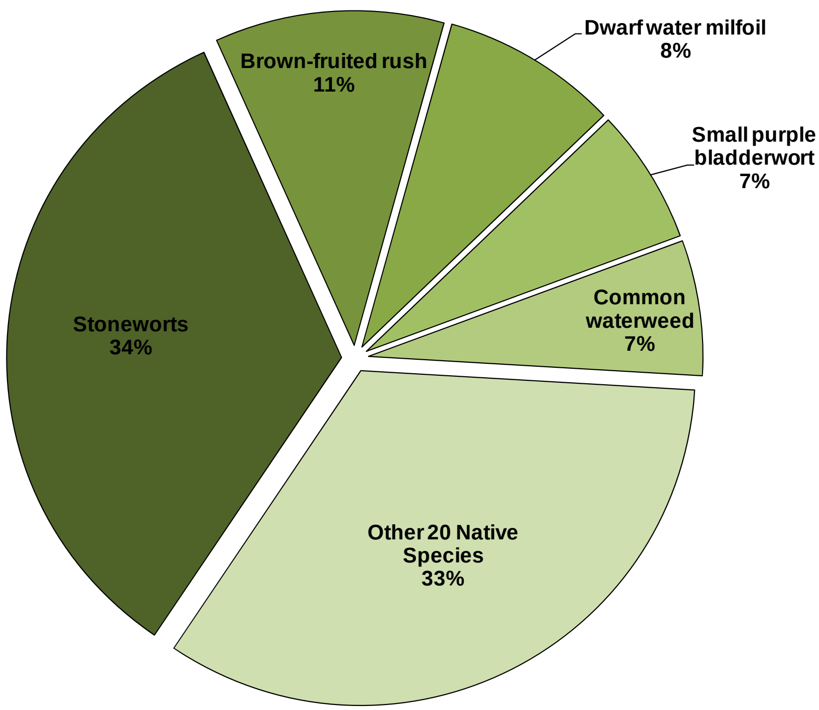


Figure 8.2.4-2 Moon Lake aquatic plant relative frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

Moon Lake had the second highest average conservatism value (7.7) of the seven Town of Saint Germain project lakes sampled in 2010, and its value well above the ecoregion and Wisconsin State medians. This indicates that the majority of the aquatic plant species present in Moon Lake are sensitive to environmental degradation, and their current presence signifies high quality environmental conditions. Declines in these species in the future may indicate potential declines in water quality or other aspect of the lake environment.

Combining Moon Lake's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in an exceptionally high value of 38.5; again, well above the median values of the ecoregion and state and second highest of the seven project lakes (Town-Wide Aquatic Plant Section, Figure 3.3-6).

The quality of Moon Lake is also indicated by the incidence of emergent and floating-leaf plant communities that occur in the shallower regions of the lake. The 2010 community map indicates that approximately 7.7 acres of the lake contains these types of plant communities (Moon Community Map, Table 8.2.4-2). Twelve floating-leaf and emergent species were located on Moon Lake (Table 8.2.4-1), all of which provide valuable wildlife habitat. These communities are especially important during periods of low water levels as they provide structure when much of the woody habitat remains above the receding water line.

Table 8.2.4-2. Moon Lake acres of emergent and floating-leaf plant communities from the 2004 and 2010 community mapping survey.

	Acres	
Plant Community	**2004**	**2010**
Floating-leaf	0.4	0.1
Emergent	0.7	0.7
Floating-leaf/Emergent	0.4	6.9
Total	**1.5**	**7.7**

Continuing the analogy that the community map represents a 'snapshot' of the emergent and floating-leaf plant communities, replications of this survey through time will provide a valuable understanding of the dynamics of these communities within Moon Lake. This is important, because these communities are often negatively affected by recreational use and shoreland development. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelines when compared to undeveloped shorelines in Minnesota Lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines.

The 2010 community mapping survey was the second survey of this type to be conducted, the first being conducted by Onterra in 2004. Looking at the 2010 Moon Lake Community Map, it is clear that the floating-leaf and emergent plant communities have expanded since 2004 by over six acres (Table 8.2.4-2). The greatest increase in area of these communities is the almost separate, southeastern basin of Moon Lake near the channel to Alma Lake. Almost no plants were observed in this location during the 2004 surveys and now contain large areas of northern wild rice, watershield, and spatterdock amongst other species. It is also interesting to note that spatterdock was not observed from Moon Lake during the 2004 surveys.

The expanse of many of these communities is likely due to the lower water levels experienced over the past years. Also, the majority of the watercraft use on the lake is from non-motorized vessels. Approximately 20% of the watercrafts used by Moon Lake stakeholder survey respondents were canoe/kayaks and 16% were rowboats (Appendix B, Question #12). Except for Alma Lake, these values were greater than those for the other project waters. Only 10% of the watercrafts used by Moon Lake stakeholders were motor boats with greater than a 25 hp motor.

8.2.5 Alma and Moon Lake Implementation Plan

The Alma and Moon Lakes District represents both Alma and Moon Lake. Therefore, a single Implementation Plan has been constructed for these lakes. The Implementation Plan below is a result of collaborative efforts between Alma and Moon Lake stakeholders, the TSGLC, and ecologists/planners from Onterra. This plan provides goals and actions created to protect the quality and integrity of Moon Lake and will serve as reference for keeping stakeholders on track and focused upon these science-driven management activities.

While the Town of Saint Germain project lakes are geographically similar, they are definitely ecologically diverse. The latter is detailed throughout this report. This diversity leads to the need for diverse plans aimed at managing the lakes. Some of the project lakes have more complicated management needs than others, but in general most of the lakes', including Alma and Moon Lake's, needs center on protecting the current quality of the lake as opposed to performing activities aimed at enhancing or resolving particular of issues. The Town-wide Implementation Plan will serve each of the project lakes well in terms of protecting their current condition; therefore, Alma and Moon Lake's implementation plan is compiled by describing how Alma and Moon Lake stakeholders should proceed in implementing applicable portions of the town-wide implementation plan for their lake.

Town-wide Implementation Plan – Specific to Moon Lake

Town-wide Management Goal 1: Promote Lake Protection and Enjoyment through Stakeholder Education

Management Action: Support the Lakes Committee to promote safe boating, water quality, public safety, and quality of life on Alma and Moon Lakes.

Timeframe: Continuation of current efforts

Facilitator: Alma/Moon Lake P&R District

Description: Moon Lake stakeholders can assist in the implementation of this action by participating in the TSGLC's town-wide initiatives. Participation may include presentation of educational topics, volunteering at local and regional events, participating in committees, or simply notifying the lakes committee of concerns involving Moon Lake and its stakeholders.

Action Steps: See description above.

Town-wide Management Goal 2: Maintain Current Water Quality Conditions

Management Action: Monitor water quality through WDNR Citizens Lake Monitoring Network (CLMN) or similar program.

Timeframe: Continuation of current efforts

Facilitator: Alma/Moon Lake P&R District

Description: Currently, Moon Lake is enrolled in the CLMN's advanced water quality monitoring program. This means that in addition to Secchi disk clarity, volunteers also monitor phosphorus and chlorophyll-*a* on the lake. Additionally, the Alma/Moon Lake P&R District has purchased a dissolved oxygen probe that is used to measure oxygen throughout the water column in both the open water and winter seasons. Although this is a great accomplishment, it must be continued in order to ensure the quality of Moon Lake is protected. Volunteers from Moon Lake must be proactive in recruiting others to participate.

When analyzing the data that has been collected on Alma Lake by CLMN volunteers over the past ~24 years, an apparent decrease in Secchi disk clarity was observed within the past five years. This apparent reduction in water clarity is likely not due to excessive nutrients and algae, as monitoring for these parameters has shown little difference in their water column concentrations during this time. It is hypothesized that the difference in water clarity is due to a stronger presence of elements that are altering the water's color. This is likely due to natural factors, and not a form of pollution. Further monitoring of Secchi disk clarity is recommended so that this observation may be scrutinized for further change.

Action Steps: See description above.

<u>Management Action:</u> Reduce phosphorus and sediment loads from shoreland watershed to the Town of Saint Germain project lakes.

Timeframe: Continuation of current efforts

Facilitator: Alma/Moon Lake P&R District

Description: The Moon Lake shoreland was visually inspected by Mike Hess, WDNR, prior to a 2008 shoreland restoration project that took place at the Moon Beach Camp. At that time, this site was determined to be the best place for shoreland restoration activities to take place between the two lakes (Alma and Moon). The location was ideal because of 1) the amount of impervious surface and compacted soil due to increased foot traffic (2,000 visitors annually), 2) the exposure to many people through the operations of the Moon Beach Camp, which creates a learning and model opportunity. This restoration project was conducted between May 2008 and August 2010, covering 1,300 lineal feet of shoreline, with participating parties including the WDNR, Vilas County Land and Water Conservation Department and Alma/Moon Lake P&R District as well as Moon Beach Camp personnel. Funding was provided through a WDNR Lake Protection Grant awarded to the Alma/Moon Lake P&R District. Erosion problems were corrected through rain garden construction, biodegradable erosion control products and native vegetation plantings. Along with the native vegetation, habitat was improved by the placement of downed trees within the littoral region.

If property owners wish to enhance their shoreline, they may work with the facilitator named by the TSGLC to look into restoration options that may provide ecological benefits to their shoreland properties. The facilitator will have cost-sharing opportunities available for the property owner as well.

Action Steps: See description above.

Town-wide Management Goal 3: Prevent Aquatic Invasive Species establishment within Alma and Moon Lakes

Management Action: Maintain and expand stakeholder education.

Timeframe: Continuation of current efforts

Facilitator: Alma/Moon Lake P&R District

Description: Alma Lake contains a public access location, however it is a fairly rugged access that is not commonly utilized by non-residents, particularly in low water years. Moon Lake access is restricted through Alma Lake because of the narrow and sometimes shallow channel that connects the two lakes, which turns larger boats away. Because of this, the threat of AIS introduction is greatly reduced from transient boaters. However, in lakes with a single, unimproved public access, often lake residents (and their friends and family) access the lake on their individual properties. This essentially creates numerous points on a lake where boats may be entering occasionally.

Alma and Moon Lake stakeholders can work together with the TSGLC to reduce the chances that AIS find their way into the lake through numerous opportunities. By working with the lakes committee, property owners can learn proper boat cleansing techniques and AIS identification. Additionally, on lakes where a property owner chooses to provide access to multiple other residents, signage may be created by the TSGLC and placed at this location which warns boaters about the AIS threat.

Additionally, Alma and Moon Lake stakeholders can monitor their lake for the presence of AIS. The TSGLC can train volunteers not only on AIS identification, but methods to monitor the lake for AIS as well. Because these lakes are low access lakes, residents may request professional field surveys at their discretion. Other Town of Saint Germain project lakes, particularly those with high public access, may have professional surveys completed once every 5 years because of the increased exposure risk.

Action Steps: See description above.

Management Goal 4: Understand Impacts of Water Levels and Wild Rice in Alma/Moon Lake and Connecting Channel

Management Action: Continue water level and emergent aquatic plant community monitoring.

Timeframe: Beginning Summer 2012

Facilitator: Alma/Moon Lake P&R District

Description: As discussed within this report, Alma and Moon Lakes are seepage lakes and are subject to water level fluctuations more so than lakes that are fed by streams or larger watersheds. In May, 2002 a water level marker was placed in Moon Lake by the United States Geological Survey (USGS). Since then, water level data has been monitored by the Alma/Moon Lake P&R District from May – October. The data is available on the Alma/Moon Lakes P&R District website (www.almamoonlake.org). Data collected during this time essentially shows a decreasing trend in water level from 2002 to 2011. However, it should be noted that the water level is quite variable also, and that relatively great fluctuations have occurred within only a year's timeframe. Northern Wisconsin has experienced moderate drought-like conditions for about a decade now, and this is evident in the lakes within this region – most of which are below ordinary high water mark (OHWM). The lower water levels in Alma and Moon Lakes have raised several issues that the residents are now facing.

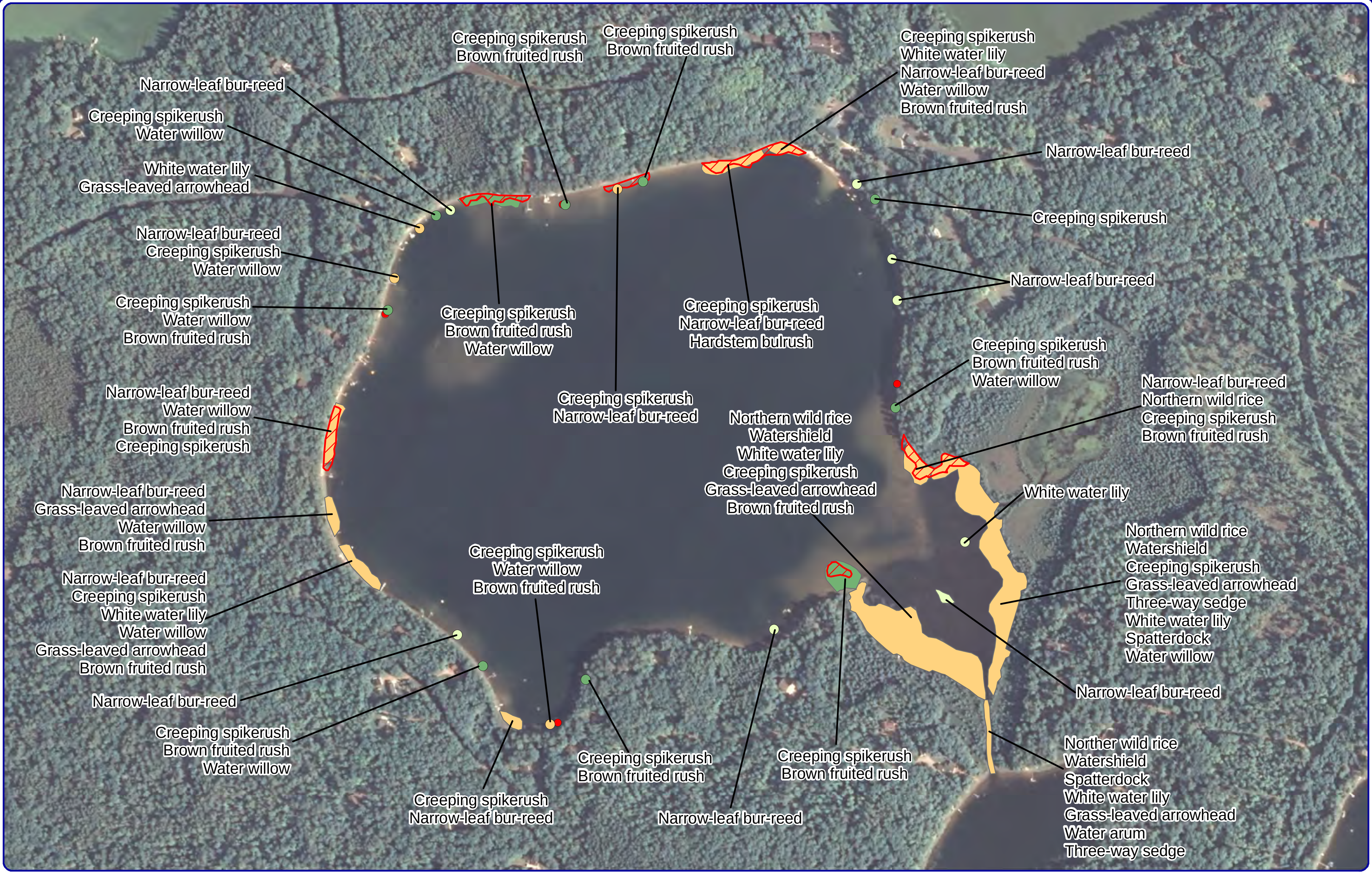
In the past few years, residents of Alma and Moon Lakes have noticed that wild rice (*Zizania sp*.) communities have increased their lake ward extent and density. Wild rice is an emergent aquatic grass that grows in shallow water of lakes and slow-moving rivers. The lower water levels in Alma and Moon Lakes have likely increased to its proliferation in the southern bay of Moon Lake. Wild rice has cultural significance to the Chippewa Tribal Communities where the grain was an important component of Native American diets. Wild rice is also an important diet component for waterfowl, muskrats, deer, and many other species. Established wild rice plant communities can provide valuable nursery and brooding habitat for wetland bird and amphibian species as well as spawning habitat for various fish. Perhaps one of the most overlooked benefits of having established wild rice communities is their ability to utilize excessive plant nutrients, stabilize soils, and form natural wave breaks to protect shoreland areas. Although this species provides numerous ecological benefits, it is known to grow to an extent that causes navigational difficulties.

During the community mapping survey (2010), areas of these communities were mapped using GPS technology with sub-meter accuracy. Wild rice communities are thought to fluctuate on a three-year rotation, with "boom" and "bust" years occurring during this time. It is recommended that these populations be visually monitored by Alma/Moon Lake P&R District members, and that a similar community mapping survey be completed in five years (or at District request) to quantify any differences in community extents. Manual cutting and raking of most aquatic plants are exempt from permit requirements (NR 107 and 109) if the area of plant removal is no more than 30 feet wide and any piers, boatlifts, swim rafts, and other recreational and water use devices are located within that 30 feet. This action can also be conducted up to 150 feet from shore. However, because of its cultural significance in northern Wisconsin, a permit is needed in all instances if wild rice is to be removed.

Another water-level related issue concerning lake residents is that of the channel between Alma and Moon Lakes, which is less navigable during times of low water depth. In 2010/2011, water levels were higher and navigation was easier, however there are still years in which this is not the case. According to Alma/Moon Lake P&R District records, this channel was dredged once in 1963. In 1985, the land bordering the channel was designated as wetlands by the WDNR, which limits the kind of dredging that can take place (hydraulic dredging only). Dredging of lake bottom sediment is an endeavor that requires numerous permits, a spoils site to dispose of the dredging sediment, and a substantial cost that is not always applicable to funding through the state or other sources. The Alma/Moon Lake P&R District is reviewing dredging options through conversations with the WDNR, to determine if a feasible approach may be reached. Because of the immense cost and permitting, a viable solution may be to enjoy access between lakes during times of high water, but realize that this may not always be an option as the Alma & Moon Lake ecosystem is highly variable, and will likely remain that way.

Action Steps:

1. Continue monitoring of staff gauge in Moon Lake.
2. Monitor wild rice populations in the lakes, utilizing professional services when deemed necessary to accurately map communities and compare to 2010 community extents/locations.



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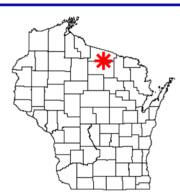
Sources:
Aquatic Plants: Onterra, 2004 & 2010
Orthophotography: NAIP 2010
Map date: March 24, 2011
Filename: Map1_Moon_Comm_2010.mxd



Project Location in Wisconsin

Legend

Small Plant Communities	Large Plant Communities
Emergent	Emergent
Floating-leaf	Floating-leaf
Mixed Floating-leaf & Emergent	Mixed Floating-leaf & Emergent
2004 Small Plant Community	2004 Large Plant Community

Moon Lake - Map 1

Saint Germain Lake
Vilas County, Wisconsin

Aquatic Plant Communities

8.3 BIG ST. GERMAIN LAKE

8.3.1 An Introduction to Big St. Germain Lake

Big St. Germain Lake, Vilas County, is a drainage lake with a maximum depth of 42 feet and a surface area of 1,617 acres. This eutrophic lake has a large watershed when compared to the size of the lake. Big St. Germain Lake contains 43 native plant species, of which wild celery is the most common plant. No exotic plant species are known to exist in Big St. Germain Lake.

Field Survey Notes

Windy conditions during point-intercept survey, but water clarity remained good. Submersed plants found growing out to a depth of 16 feet. Much boating activity during survey.

Photo 8.3.1-1 Big St. Germain Lake, Vilas County

Lake at a Glance – Big St. Germain Lake

Morphology	
Acreage	1,617.0
Maximum Depth (ft)	42.0
Mean Depth (ft)	20.8
Volume (acre-feet)	33,586
Shoreline Complexity	1.80
Vegetation	
Curly-leaf Survey Date	June 21-22, 2010
Comprehensive Survey Date	July 26-27, 2010
Number of Native Species	34 + 10 incidental = 44
Threatened/Special Concern Species	-
Exotic Plant Species	-
Simpson's Diversity	0.92
Average Conservatism	6.3
Water Quality	
Wisconsin Lake Classification	Class 4 (deep, lowland drainage lake)
Trophic State	Eutrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	26:1

8.3.2 Big St. Germain Lake Watershed Assessment

Big St. Germain Lake's watershed is approximately 44,324 acres in size. Forested lands (21,055 acres or 47% of the total) make up the largest percentage of the watershed (Figure 8.3.2-1). Forested wetlands (27%) and wetlands (14%) contribute significant portions of the watershed as well. Smaller land cover types in the watershed include rural open space (6%), the surface of Big St. Germain Lake (4%), and pasture/grass (2%). An insignificant amount of row crops, rural residential land, and medium and high density urban lands round out the remaining land cover types in the watershed. Big St. Germain Lake is indeed large, at 1,617 acres, and drains an incredible amount of land. The watershed to lake area ratio is 26:1, which indicates that the lake would not be sensitive to changes in land cover at a small or even moderate scale. Map 2 of the Town-Wide report displays the Big St. Germain Lake watershed and its land cover.

Fortunately the land use within Big St. Germain Lake's watershed is that which exports a minimum amount of pollution as possible to the lake. Forested lands allow water to seep into the ground, and thus reduce the amount of overland flow which might carry sediments and pollutants into nearby lakes and streams. Forested wetlands and traditional wetlands retain water and nutrients within moist soils and plant matter, and release both slowly to the receiving lake.

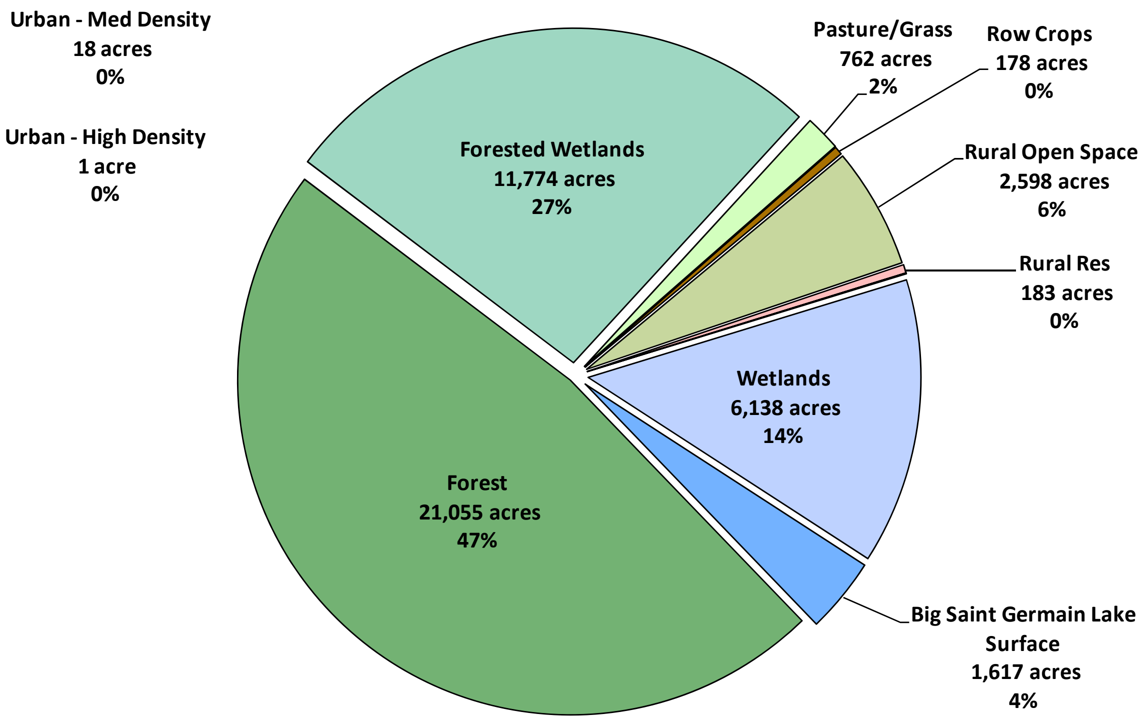


Figure 8.3.2-1. Big St. Germain Lake watershed land cover types in acres. Based upon classifications from the Multi-Resolution Land Characteristics Consortium (MRLC, 2006).

Big St. Germain Lake is considered a drainage lake due to its geographical setting and hydrology. Drainage lakes receive water primarily through streams, however surface runoff, groundwater inputs, and precipitation contribute as well. Drainage lakes also contain an outlet stream which is either continuous or intermittent. While drainage lakes tend to fair against low precipitation better than seepage or spring lakes (which do not have a stream input source), drought conditions in northern Wisconsin have greatly reduced the amount of regional precipitation in the past 8 – 10 years to the point at which impacts may even be seen on a drainage lake. While changing water levels may have negative recreational and short-term ecological impacts, it is important to remember that lake water level fluctuations are part of a naturally occurring cycle and actually benefit the lake ecosystem in the long-term by increasing the level of habitat diversity in the littoral (near shore) and shoreline zones of the lake.

Big St. Germain Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 1.3 miles of natural/undeveloped and developed-natural shoreline were observed during the survey (Figure 8.3.2-2). These shoreland types provide the most benefit to the lake and should be left in their natural state if at all possible. During the survey, 3.6 miles of urbanized and developed–unnatural shoreline (47% of the total shoreline) were observed.

Big St. Germain Lake has numerous public resorts/restaurants in operation along its shoreland. Often, resorts and restaurants have shorelands that are developed as these facilities need to accommodate a large number of people and an array of uses. The benefit is that like public beaches, these areas concentrate lake visitors into designated use areas, which allows other public areas to resist damage from foot traffic, development, etc. However, these high use areas are amongst the most degraded shoreland on the lake. While it is understandable that a business would retain a shoreland area that is developed in order to accommodate its usership, partial or full restoration of the shoreland could be initiated to serve as an educational/demonstrative tool, thereby protecting the ecology of the lake and giving the business an environmentally friendly aspect which it may advertise to its usership.

If restoration of the Big St. Germain Lake shoreline is to occur, primary focus should be placed on developed-unnatural and urbanized shoreland areas as they currently provide little benefit to, and actually may harm, the lake ecosystem. The Big St. Germain Lake Shoreline Condition Map displays the location of these shoreline lengths around the entire lake.

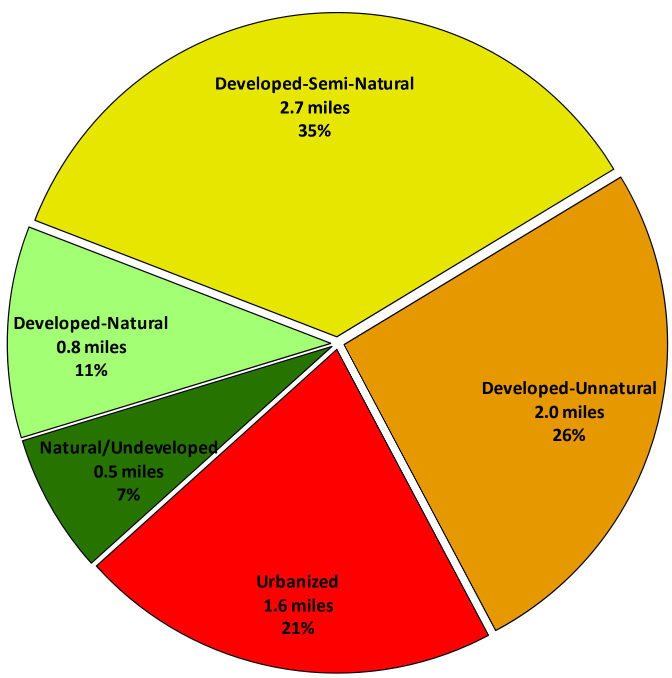


Figure 8.3.2-2. Big St. Germain Lake shoreland categories and total lengths. Based upon a late summer 2010 survey. Locations of these categorized shorelands can be found on the Big St. Germain Lake Shoreline Condition Map.

8.3.3 Big St. Germain Lake Water Quality

Water quality data was collected from Big St. Germain Lake on three occasions in summer of 2010. Onterra staff sampled the lake for a variety of water quality parameters including total phosphorus, chlorophyll-*a*, Secchi disk clarity, temperature, and dissolved oxygen.

Citizens Lake Monitoring Network (CLMN) volunteers have monitored water quality through a state-supported monitoring program for quite some time. Specifically, Secchi disk clarity has been monitored almost continuously since 1989. These efforts provide a considerable amount of historical data, which may be compared against recent data in an effort to detect any trends that may be occurring in the water quality of the lake.

For total phosphorus and chlorophyll-*a*, only a limited dataset exists. The summer average total phosphorus concentrations of the years have ranged between 21.7 and 40.3 µg/L and fall within water quality categories of fair and good (Figure 8.3.3-1). A weighted value across all years is slightly higher than the average for deep, lowland drainage lakes in the state of Wisconsin.

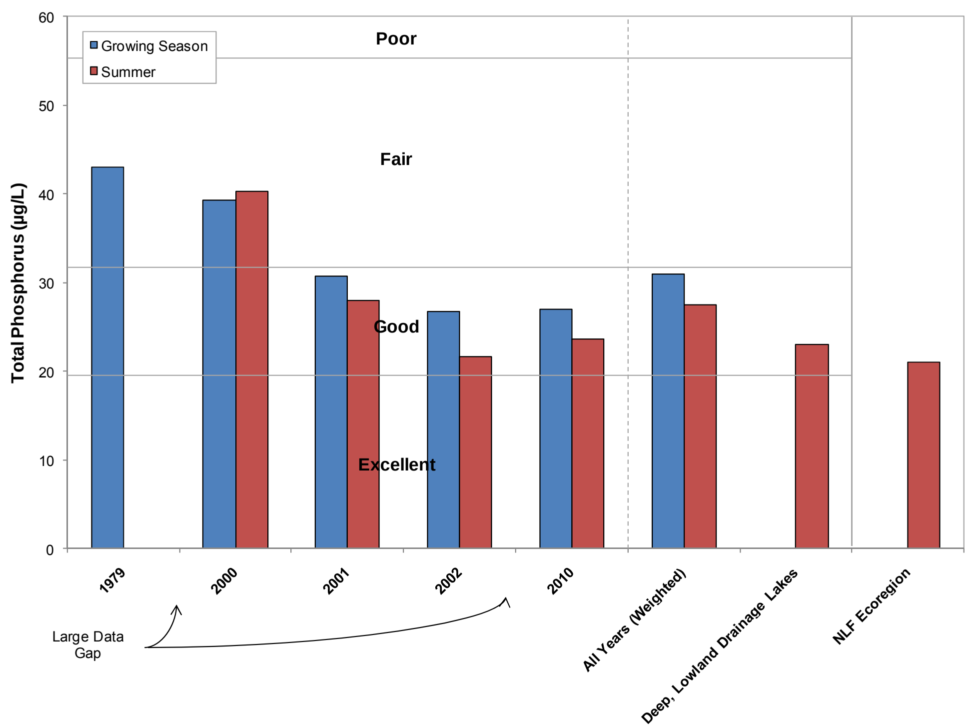


Figure 8.3.3-1. Big St. Germain Lake, state-wide deep lowland drainage lakes and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Average summer chlorophyll-*a* concentrations have ranged between 7.0 and 13.1 µg/L and span water quality categories of excellent to fair (Figure 8.3.3-2). The weighted average of all data is higher than the average for similar (deep, lowland drainage) lakes. Interestingly, an unexpected relationship is seen between phosphorus and chlorophyll-*a* during years 2000-2002 and 2010. In 2000, the summer average phosphorus concentration was at its highest, while chlorophyll-*a* was fairly low. In contrast, phosphorus values in 2010 were fairly low, while the chlorophyll-*a* values measured that summer were the highest on record. Although these two water quality parameters are closely tied to each other in a positively correlated relationship, often other factors such as available sunlight, macrophytes biomass, and zooplankton (tiny aquatic crustaceans that feed on algae) biomass may influence how much algae is found in the water column.

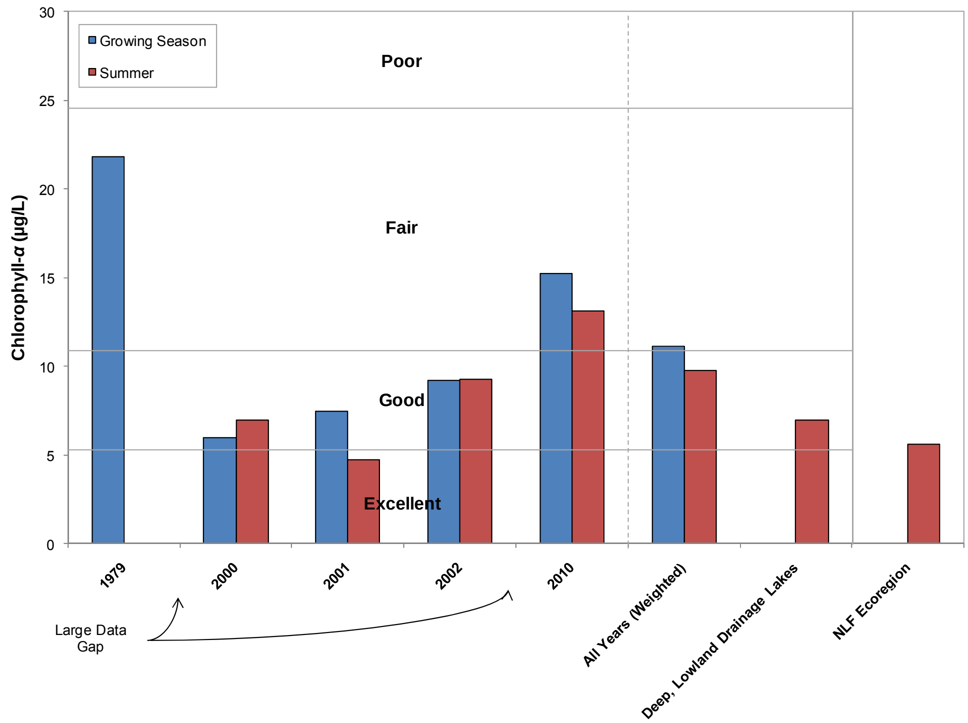


Figure 8.3.3-2. Big St. Germain Lake, state-wide deep lowland drainage lakes and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Measurements of Secchi disk clarity span more than two decades on Big St. Germain Lake (Figure 8.3.3-3). In many years the annual average summer value ranks as excellent. A weighted average across all years is greater than the average for deep, lowland drainage lakes statewide. Over the recorded time period, Secchi depths have fluctuated little, indicating that the lake not only has excellent water clarity, but has had the same water clarity for quite some time.

Big St. Germain Lake Trophic State

The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values range in values spanning from lower mesotrophic to eutrophic (Figure 8.3.3-4). In general, the best values to use in judging a lake's trophic state are the biological parameters; therefore, relying primarily on total phosphorus and chlorophyll-*a* TSI values, it can be concluded that Big St. Germain is in a lower eutrophic state.

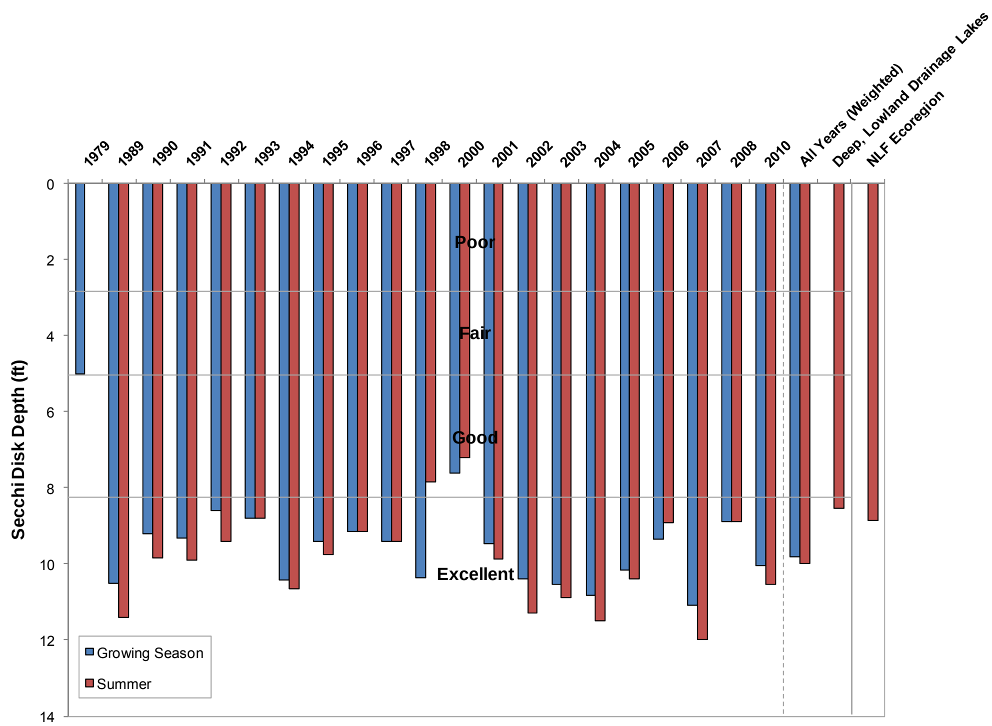


Figure 8.3.3-3. Big St. Germain Lake, state-wide deep lowland drainage lakes and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

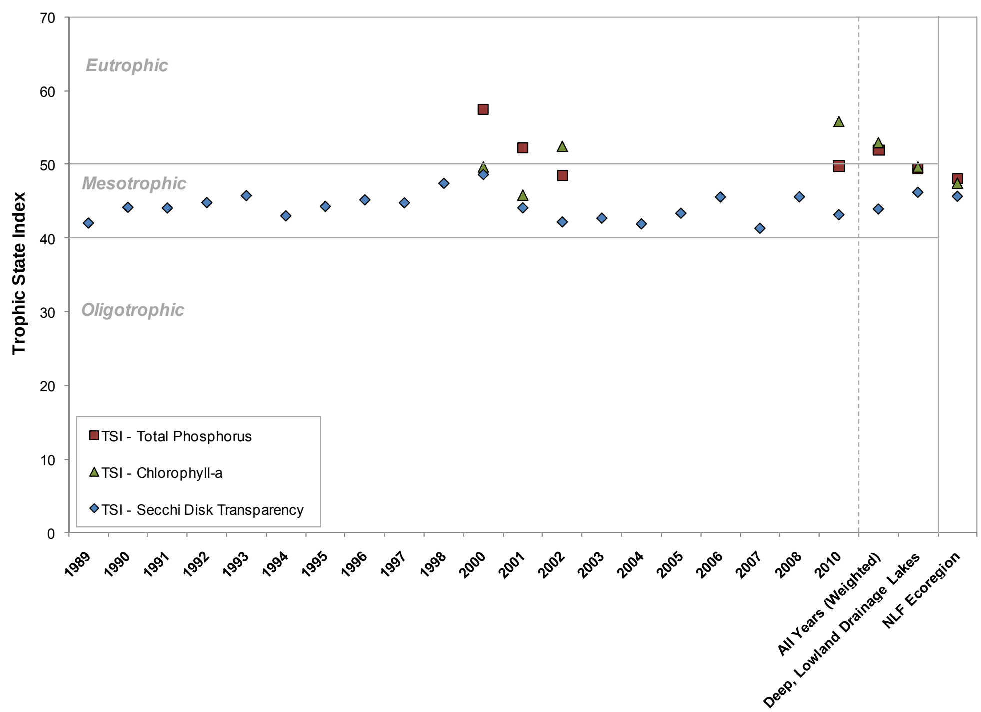


Figure 8.3.3-4. Big St. Germain Lake, state-wide deep lowland drainage lakes and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Big St. Germain Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Big St. Germain Lake by Onterra staff. Graphs of those data are displayed in Figure 8.3.3-5 for all three sampling events.

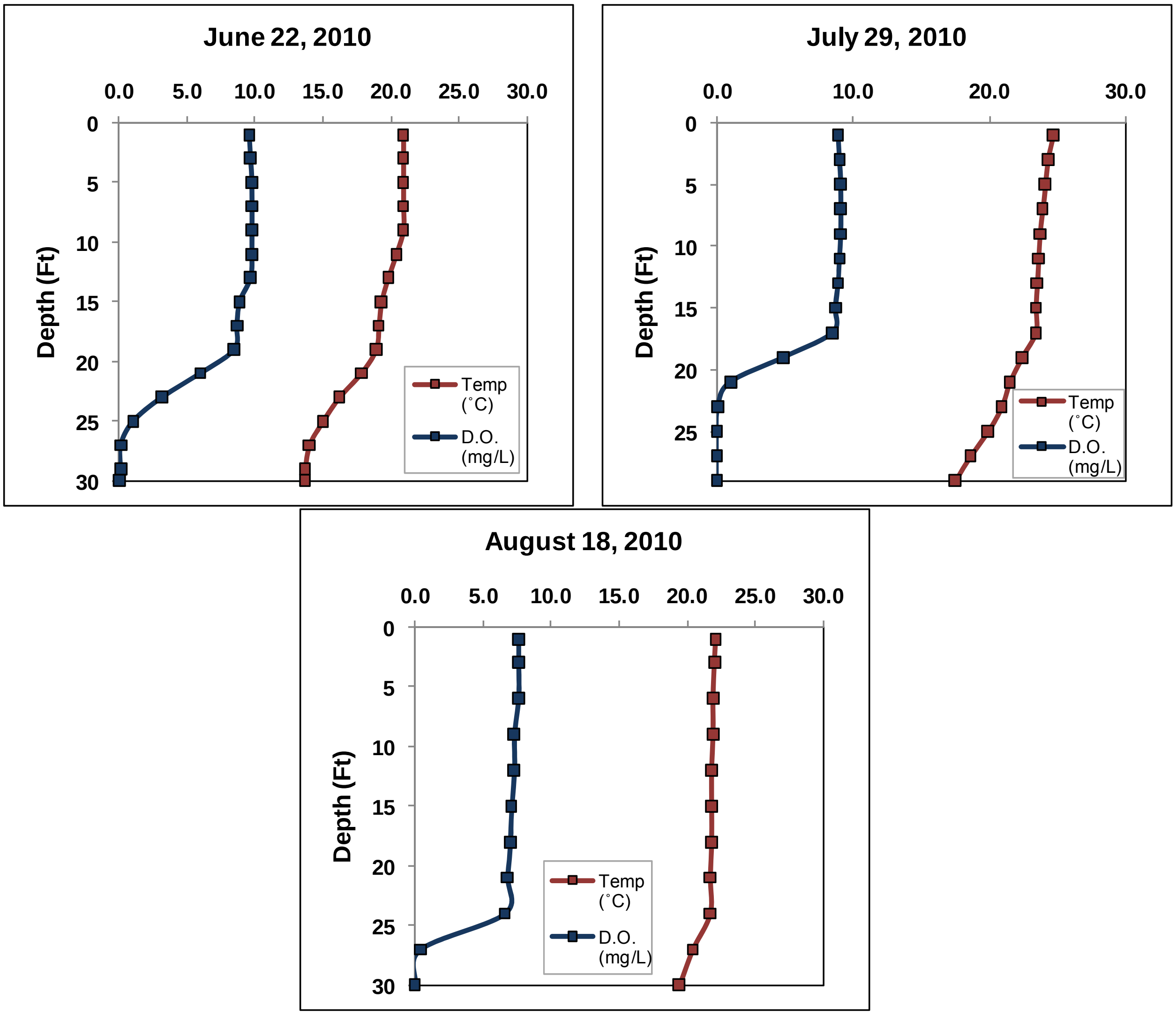


Figure 8.3.3-5. Big St. Germain Lake dissolved oxygen and temperature profiles.

Big St. Germain Lake was weakly stratified during the months of June and July in 2010, but mixed thoroughly in the month of August. This is not uncommon in lakes that are large and also relatively deep. Energy from the wind must penetrate through 42 feet of the water column if the water in the lake is going to mix thermally. Because the lake is so deep, a large amount of energy is needed to do this. However, Big St. Germain Lake is 2.5 miles at its longest length, therefore the summer winds have time to build across the long flat lake surface. When this occurs to the point that energy is sufficient enough, the lake becomes mixed from top to bottom, distributing oxygen throughout the epilimnion and hypolimnion and keeping water temperatures fairly constant within the water column. Decomposition of organic matter along the lake bottom is the cause of the decrease in dissolved oxygen observed in the summer months. Despite this decrease, dissolved oxygen levels remained sufficient in the upper and middle reaches of the water column to support most aquatic life found in northern Wisconsin lakes.

8.3.4 Big St. Germain Lake Aquatic Vegetation

The curly-leaf pondweed survey was conducted on Big St. Germain Lake on June 21-22, 2010. This meander-based survey did not locate any occurrences of this exotic plant, and it is believed that this species either does not currently exist in Big St. Germain Lake or is present at an undetectable level. Eurasian water milfoil, also an aquatic invasive plant, was not located in Big St. Germain Lake during any of the 2010 surveys. A sample of suspect northern water milfoil that exhibited morphological traits similar to Eurasian water milfoil (high leaflet count) was sent to Grand Valley State University for DNA analysis. The sample was identified as pure northern water milfoil and not Eurasian water milfoil or a hybrid variety.

The aquatic plant point-intercept survey was conducted on Big St. Germain Lake on July 26-28, 2010 by Onterra. The floating-leaf and emergent plant community mapping survey was also completed to create the aquatic plant community map (Big St. Germain Lake Community Map) during this time. During these surveys, 44 species of native aquatic plants were located in Big St. Germain Lake - more than any of the other project lakes. 34 of these species were sampled during the point-intercept survey (Table 8.3.4-1 and Figure 8.3.4-1). This species richness greatly exceeds the Northern Lakes Ecoregion and Wisconsin State medians.

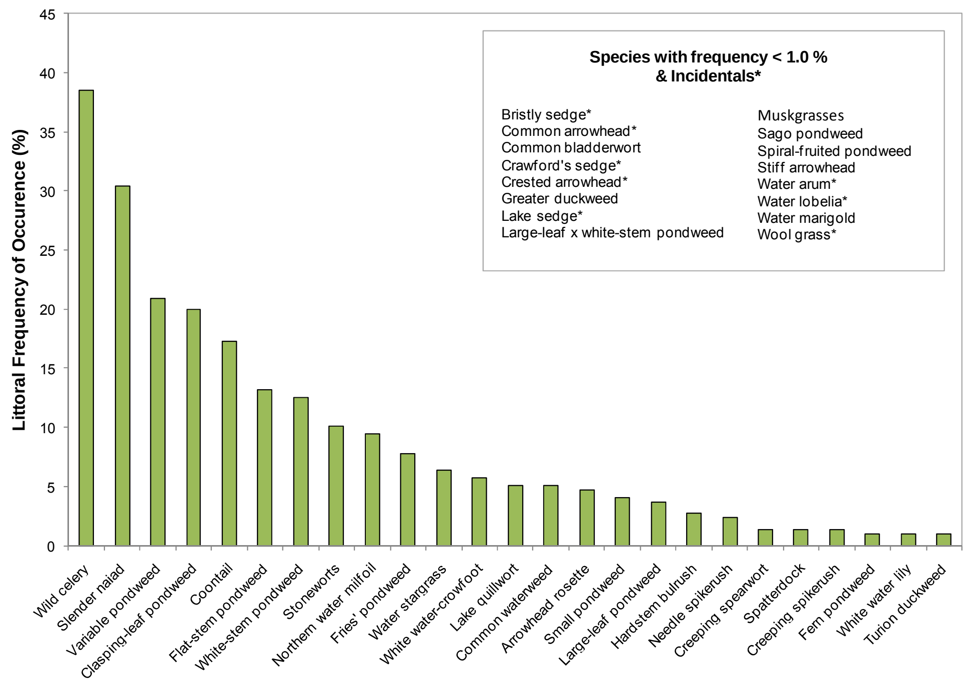


Figure 8.3.4-1 Big St. Germain Lake aquatic plant littoral frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

A testament to the high water clarity in Big St. Germain Lake, aquatic plants were found growing to a depth of 16 feet, although the majority of point-intercept locations with plants were 3-4 feet deep. Of the 296 point-intercept locations sampled within the littoral zone, approximately 83% contained aquatic vegetation. Ninety-two percent of the point-intercept sampling locations where sediment data was collected at contained sandy soils while the remaining 8% contained rock (Town-Wide Fisheries Section, Figure 3.4-5).

Table 8.3.4-1. Aquatic plant species located in the Big St. Germain Lake during the 2010 aquatic plant surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)
Emergent	*Calla palustris*	Water arum	9
	Carex comosa	Bristly sedge	5
	Carex crawfordii	Crawford's sedge	5
	Carex lacustris	Lake sedge	6
	Eleocharis palustris	Creeping spikerush	6
	Sagittaria latifolia	Common arrowhead	3
	Scirpus cyperinus	Wool grass	4
	Sium suave	Water parsnip	5
	Sagittaria rigida	Stiff arrowhead	8
	Schoenoplectus acutus	Hardstem bulrush	5
	Zizania palustris	Northern wild rice	8
FL	*Nymphaea odorata*	White water lily	6
	Nuphar variegata	Spatterdock	6
Submergent	*Chara spp.*	Muskgrasses	7
	Ceratophyllum demersum	Coontail	3
	Elodea canadensis	Common waterweed	3
	Heteranthera dubia	Water stargrass	6
	Isoetes lacustris	Lake quillwort	8
	Lobelia dortmanna	Water lobelia	10
	Megalodonta beckii	Water marigold	8
	Myriophyllum sibiricum	Northern water milfoil	7
	Nitella spp.	Stoneworts	7
	Najas flexilis	Slender naiad	6
	Potamogeton illinoensis	Illinois pondweed	6
	Potamogeton spirillus	Spiral-fruited pondweed	8
	Potamogeton amplifolius x praelongus	Large-leaf x white-stem pondweed	NA
	Potamogeton robbinsii	Fern pondweed	8
	Potamogeton amplifolius	Large-leaf pondweed	7
	Potamogeton pusillus	Small pondweed	7
	Potamogeton friesii	Fries' pondweed	8
	Potamogeton praelongus	White-stem pondweed	8
	Potamogeton zosteriformis	Flat-stem pondweed	6
	Potamogeton richardsonii	Clasping-leaf pondweed	5
	Potamogeton gramineus	Variable pondweed	7
	Ranunculus flammula	Creeping spearwort	9
	Ranunculus aquatilis	White water-crowfoot	8
	Stuckenia pectinata	Sago pondweed	3
	Sagitaria sp. (rosette)	Arrowhead rosette	N/A
	Utricularia vulgaris	Common bladderwort	7
	Vallisneria americana	Wild celery	6
SE	*Eleocharis acicularis*	Needle spikerush	5
	Sagittaria cristata	Crested arrowhead	9
FF	*Lemna turionifera*	Turion duckweed	2
	Spirodela polyrhiza	Greater duckweed	5

FL = Floating Leaf
S/E = Submergent and Emergent
FF = Free Floating

Big St. Germain Lake has a high number of aquatic plant species, and because of this, one may assume that the system would also have a high diversity. As discussed earlier, how evenly the species are distributed throughout the system also influence the diversity. The diversity index for Big St. Germain Lake's plant community (0.92) is the highest of the seven project lakes and is higher than the Northern Lakes and Forests Lakes ecoregion median value (0.86). Figure 8.3.4-1 shows that wild celery and slender naiad are the most frequently encountered plant species in the lake. These species are often found in the sandy sediments that are found in Big St. Germain Lake. Five of the top ten most frequent species are pondweeds (*Potamogeton* spp.), the favored habitat of many fish species including muskellunge.

As explained earlier in the Primer on Data Analysis and Data Interpretation Section, the littoral frequency of occurrence analysis allows for an understanding of how often each of the plants is located during the point-intercept survey. Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while wild celery was found at 38.5% of the sampling locations, its relative frequency of occurrence is 17%. Explained another way, if 100 plants were randomly sampled from Big St. Germain Lake, 17 of them would be wild celery. Together seven species account for 66% of the population of plants within Big St. Germain Lake, while the other 28 species account for the remaining 34%. Nine additional species were located from the lake but not from of the point-intercept survey, as indicated in Figure 8.3.4-1 as incidentals.

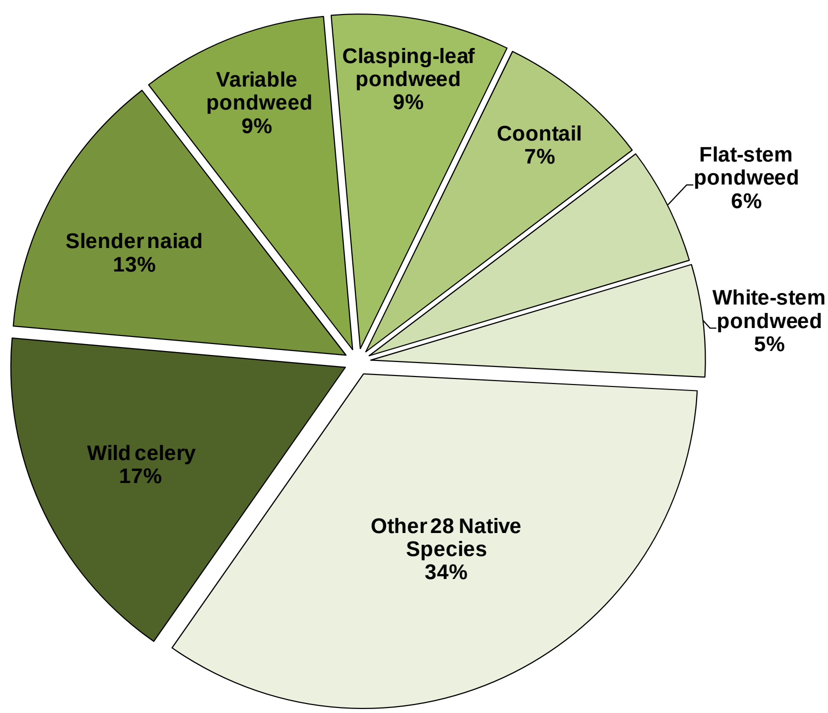


Figure 8.3.4-2 Big St. Germain Lake aquatic plant relative frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

While Big St. Germain Lake had the highest species richness of the project waters, its average coefficient of conservatism value was the lowest of the project waters (6.3). Big St. Germain

Lake's average conservatism value is still higher than the state median, but is slightly less than the ecoregion median. This indicates that the plant community of Big St. Germain is moderately indicative of a disturbed system.

Two factors measured during this project that may indicate disturbance include heavy watercraft use and the condition of the lake's shoreline. Approximately 26% of the watercrafts used by Big St. Germain Lake stakeholder survey respondents were motor boats with greater than a 25 hp motor and 20% of the watercrafts used were pontoon boats (Appendix B, Question #12). These values are higher than any of the other project waters. This is not a surprise as Big St. Germain is a large lake that offers active watercraft use opportunities. As indicated within the Watershed Sections, the two shoreland condition classifications that indicate man-made disturbance include Developed-Unnatural and Urbanized. Big St. Germain Lake contains the highest percentage of its shoreline with these classifications of the five project lakes (Alma and Moon Lakes were excluded) where this assessment was made (Town-Wide Watershed Section, Table 3.1-1). Shifting the condition of Big St. Germain Lake's shoreline towards more natural shorelines will be important to protect certain vulnerable aquatic plant species and further degradation of Big St. Germain Lake's aquatic plant community.

Combining Big St. Germain Lake's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in an exceptionally high value of 36.6; this is well above the median values of the ecoregion and state (Town-Wide Aquatic Plant Section, Figure 3.3-6).

The quality of Big St. Germain Lake is also indicated by the incidence of emergent and floating-leaf plant communities that occur in the shallower regions of the lake. The 2010 community map indicates that approximately 18.8 acres of the lake contains these types of plant communities (Big St. Germain Community Map, Table 8.3.4-2). Twelve floating-leaf and emergent species were located on Big St. Germain Lake (Table 8.3.4-1), all of which provide valuable wildlife habitat.

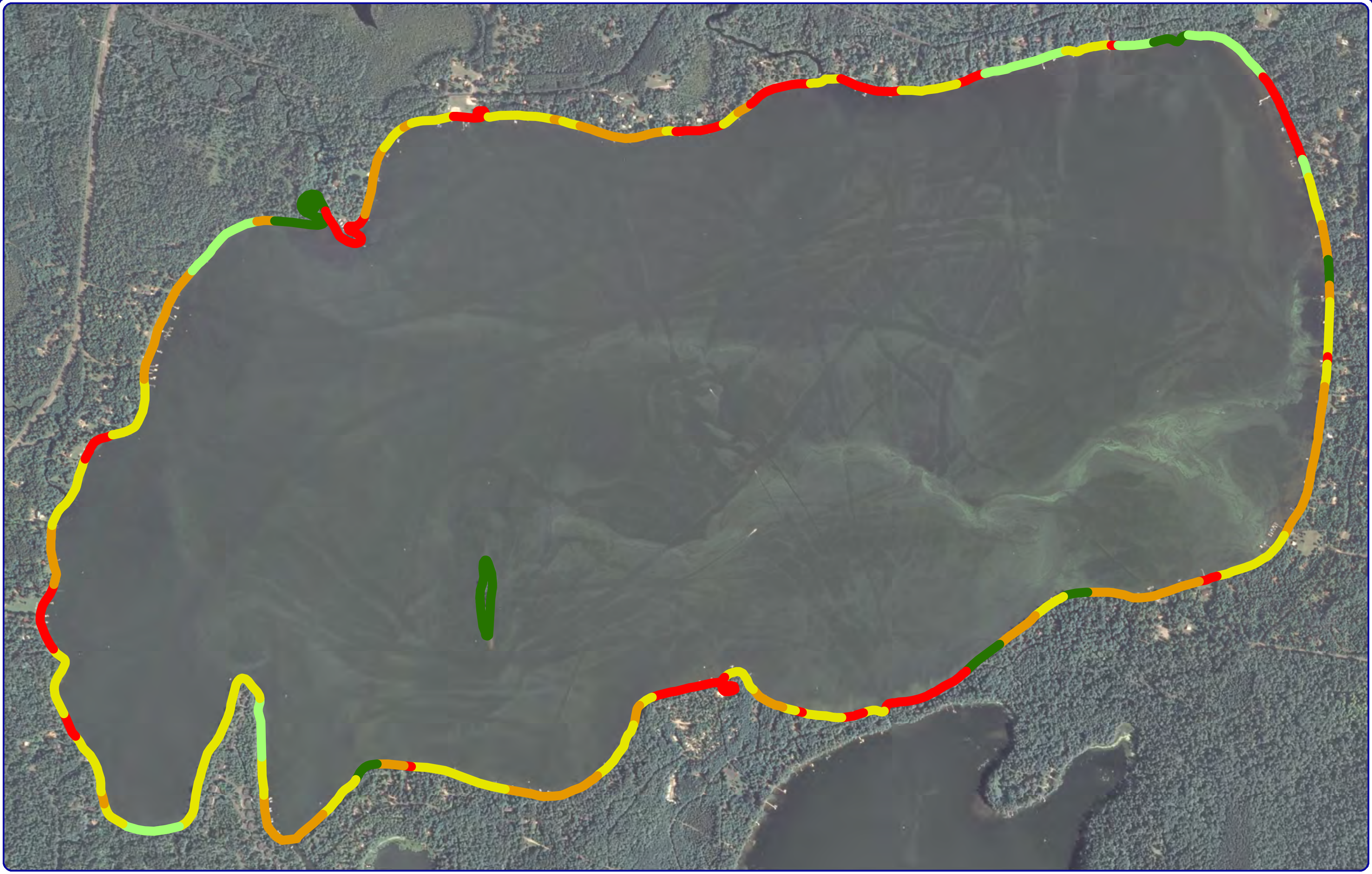
Table 8.3.4-2. Big St. Germain Lake acres of emergent and floating-leaf plant communities from the 2004 and 2010 community mapping survey.

	Acres	
Plant Community	**2004**	**2010**
Floating-leaf	2.6	3.5
Emergent	9.8	13.7
Floating-leaf/Emergent	4.4	1.6
Total	**16.8**	**18.8**

Continuing the analogy that the community map represents a 'snapshot' of the emergent and floating-leaf plant communities, replications of this survey through time will provide a valuable understanding of the dynamics of these communities within Big St. Germain Lake. This is important, because these communities are often negatively affected by recreational use and shoreland development. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelines when compared to undeveloped shorelines in Minnesota Lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines.

The 2010 community mapping survey was the second survey of this type to be conducted, the first being conducted by Onterra in 2004. Large hardstem bulrush communities can be found along the eastern margin of the lake. As the inset of the Community Map shows these communities have expanded slightly since the 2004 survey. With bulrush communities declining on many waterbodies statewide, perhaps due to increased boating activity, these bulrush communities are indicative of the good health of Big St. Germain Lake.

Note on Big St. Germain Lake's Implementation Plan: The Big St. Germain Area Lakes District represents Big St. Germain Lake, Fawn Lake, and Lake Content. Therefore, a single Implementation Plan has been constructed for these lakes and is located following the Lake Content Section (8.5.5).



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www.onterra-eco.com

Sources:
Orthophotography: NAIP, 2010
Shoreline Condition: Onterra, 2010
Map Date: August 17, 2011
Filename: BSG_Map1_SA_2010.mxd

Project location in Wisconsin

Legend

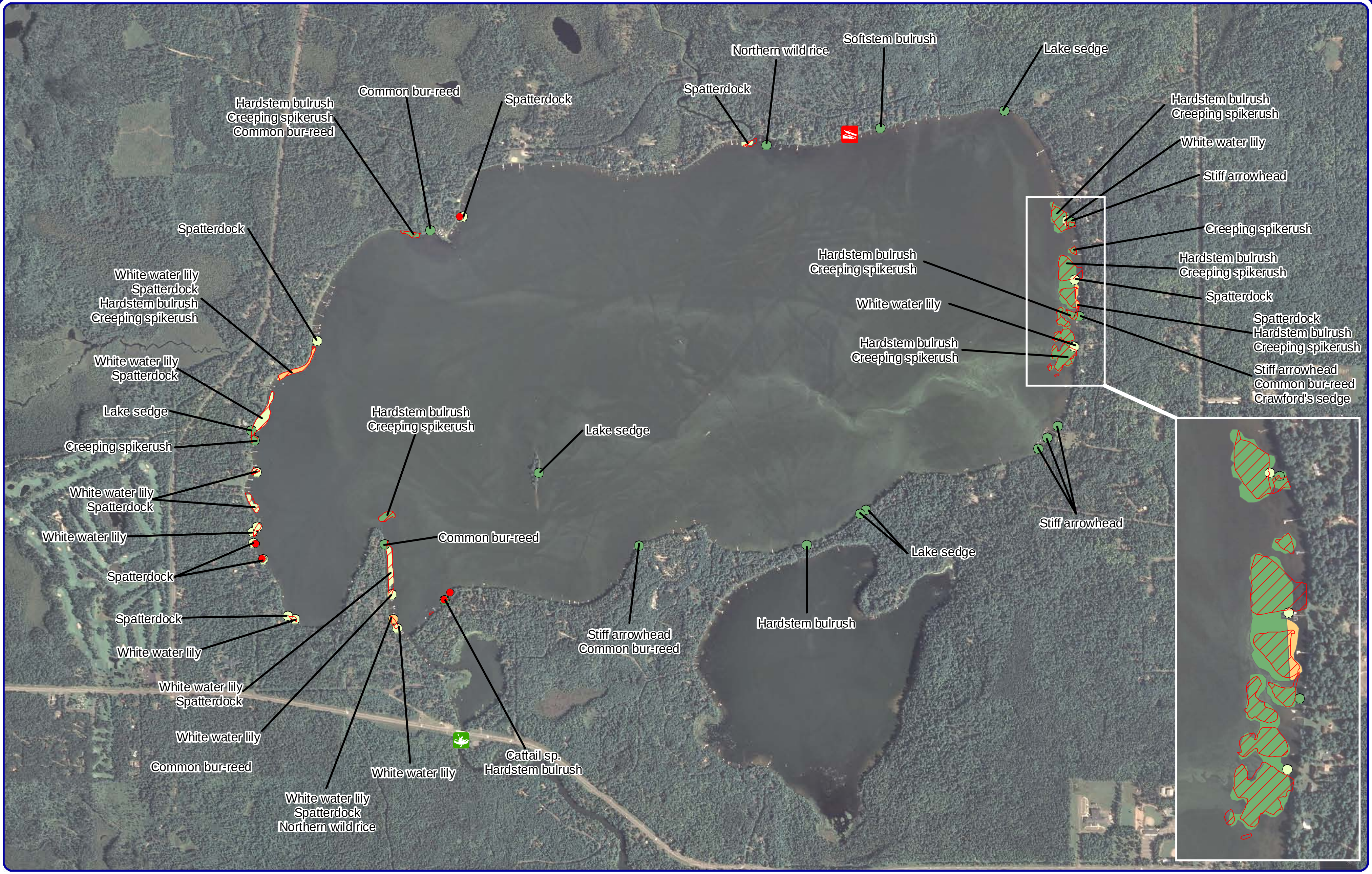
- Natural/Undeveloped
- Developed-Natural
- Developed-Semi-Natural
- Developed-Unnatural
- Urbanized

Big Saint Germain Lake - Map 1

Saint Germain Lakes

Vilas County, Wisconsin

Shoreline Condition



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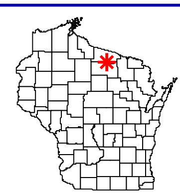
Sources:
Aquatic Plants: Onterra, 2004 & 2010
Orthophotography: NAIP 2010
Map date: March 28, 2011
Filename: Map2_BSG_Comm_2010.mxd



Project Location in Wisconsin

Legend

Small Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent
- 2004 Small Plant Community

Large Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent
- 2004 Large Plant Community

Big Saint Germain Lake - Map 2

Saint Germain Lake

Vilas County, Wisconsin

Aquatic Plant Communities

8.4 FAWN LAKE

8.4.1 An Introduction to Fawn Lake

Fawn Lake, Vilas County, is a lowland drainage lake with a maximum depth of 10 feet and a surface area of 22 acres. This eutrophic lake has a relatively small watershed when compared to the size of the lake. Fawn Lake contains 31 native plant species, of which coontail was the most common plant. There were no exotic plants located within Fawn Lake during the 2010 vegetation surveys.

Field Survey Notes

After a long day of being blown around on Big Saint, it is nice to tuck back into Fawn Lake and enjoy some quite water. Some of the largest white water lily pads that we have ever seen! Lots of painted turtles were observed on the logs and small emergent plant islands around the lake. Always a few people fishing along the shore near the outlet dam.

Photo 8.4.1-1 Fawn Lake, Vilas County

Lake at a Glance – Fawn Lake

Morphology	
Acreage	22.0
Maximum Depth (ft)	10.0
Mean Depth (ft)	5.7
Volume (acre-feet)	126.0
Shoreline Complexity	1.44
Vegetation	
Curly-leaf Survey Date	June 22, 2010
Comprehensive Survey Date	July 27, 2010
Number of Native Species	24 + 7 incidental = 31
Threatened/Special Concern Species	1 – Vasey's Pondweed
Exotic Plant Species	-
Simpson's Diversity	0.88
Average Conservatism	6.4
Water Quality	
Wisconsin Lake Classification	Class 3 (shallow, lowland drainage lake)
Trophic State	Eutrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	NA

8.4.2 Fawn Lake Watershed Assessment

As eluded to in the Town-wide Section of this report, Fawn Lake falls under a special circumstance in terms of its watershed. Big St. Germain Lake flows directly into Fawn Lake. The water then travels over the Big St. Germain Dam before flowing into the Saint Germain River. Because of this situation, Fawn Lake receives all the water that flows into Big St. Germain Lake, and therefore, its watershed includes all of Big St. Germain Lake's watershed (44,324 acres) as well as 74 more acres immediately surrounding the lake. So, technically the Fawn Lake watershed is 44,399 acres in size. However, Big St. Germain Lake is quite large and likely acts as a sink to trap nutrients and sediment within its borders. This means that the effects of the entire Big St. Germain Lake watershed are not seen within Fawn Lake.

The land cover within the immediate Fawn Lake watershed consists primarily of forest at 41% of the total acreage, or 31 acres. Because the immediate watershed is so small (74 acres), the surface of Fawn Lake comprises a large portion (30%) of the watershed as well. Forested wetlands (13%), rural open space (12%), wetlands (3%) and rural residential areas (1%) round out the remaining land cover types. Map 2 of the Town-Wide report displays the Fawn Lake watershed and its land cover.

If the watershed that includes Big St. Germain Lake is compared to Fawn Lake, the watershed to lake area ratio is 2,017:1. However, if the immediate watershed is compared to the lake size, the watershed to lake area ratio is 2:1. As indicated by its water quality (see the Water Quality Section below) Fawn Lake has characteristics of having a smaller watershed such as a relatively low nutrient content and high Secchi disk clarity. These observations provide testimony to the fact that Fawn Lake's watershed does not impact the lake as it would under normal circumstances.

Fawn Lake is classified as a shallow, lowland drainage lake. Drainage lakes receive water primarily through stream input, however surface runoff, groundwater inputs, and precipitation contribute water as well. Drainage lakes also often contain an outlet stream which is either continuous or intermittent in times of low water supply. In the case of Fawn Lake, the water discharge at the outlet stream is controlled by the Big St. Germain dam.

As mentioned previously in the Town-Wide Watershed Section, one of the most sensitive areas of the watershed is the immediate shoreland area. This area of land is the last source of protection for a lake against surface water runoff, and is also a critical area for wildlife habitat. In late summer of 2010, Fawn Lake's immediate shoreline was assessed in terms of its development. Fawn Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 0.2 miles of natural/undeveloped and developed-natural shoreline were observed during the survey (Figure 8.4.2-1). These shoreland types provide the most benefit to the lake and should be left in their natural state if at all possible. During the survey, 0.3 miles of urbanized and developed–unnatural shoreline (26% of the total shoreline) was observed. If restoration of the Fawn Lake shoreline is to occur, primary focus should be placed on these shoreland areas as they currently provide little benefit to, and actually may harm, the lake ecosystem. The majority of the lake shoreland area (58%) fit descriptions consistent with a developed-semi-natural shoreline. The Fawn Lake Shoreline Condition Map displays the location of these shoreline lengths around the entire lake.

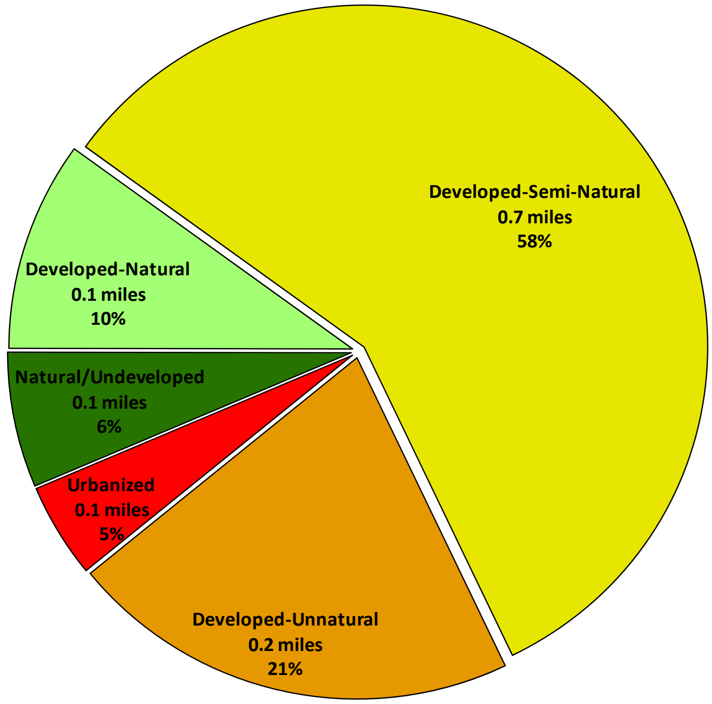


Figure 8.4.2-1. Fawn Lake shoreland categories and total lengths. Based upon a late summer 2010 survey. Locations of these categorized shorelands can be found on the Fawn Lake Shoreline Condition Map.

8.4.3 Fawn Lake Water Quality

Water quality data was collected from Fawn Lake on three occasions in summer of 2010. Onterra staff sampled the lake for a variety of water quality parameters including total phosphorus, chlorophyll-*a*, Secchi disk clarity, temperature, and dissolved oxygen.

Citizens Lake Monitoring Network (CLMN) volunteers have monitored Secchi disk clarity through a state-supported monitoring program in the past decade (2001-2008). The additional data collected in 2010 was by Onterra staff. Continuous water quality monitoring is important because it provides concrete data in which management decisions may be based upon, as opposed to anecdotal feelings about what has or has not changed in the lake. From a reliable dataset, historical data may be compared to recent data in an effort to detect any trends that may be occurring in the water quality of the lake

In particular, a very limited amount of data exists for total phosphorus and chlorophyll-*a*, with the only summer data being from the monitoring associated with this project. During 2010, the summer average total phosphorus was 29.7 µg/L and the average chlorophyll-*a* concentration was 10.9 µg/L (Table 8.4.3-1). To put these values into perspective, they both rank within the TSI category of good, and are very similar the averages seen in shallow, lowland drainage lakes statewide.

Table 8.4.3-1. Fawn Lake, state-wide shallow, lowland drainage lakes, and regional water quality parameters and means. Fawn Lake mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

	Secchi (feet)				Chlorophyll-*a* (µg/L)				Total Phosphorus (µg/L)			
	Growing Season		Summer		Growing Season		Summer		Growing Season		Summer	
Year	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean
1979	1	6.0	0		1	7.8	0		1	36.0	0.0	
2001	3	9.0	2	9.3								
2002	9	9.3	5	10.0								
2003	10	9.1	5	9.4								
2004	11	9.5	6	9.8								
2005	6	8.0	5	8.0								
2006	7	7.6	6	7.5								
2007	6	9.2	4	9.3								
2008	5	7.4	5	7.4								
2010	9	7.8	6	7.2	3	10.9	3	10.9	3	29.7	3.0	29.7
All Years (Weighted)		8.6		8.6		10.2		10.9		31.3		29.7
Shallow, Lowland Drainage Lakes				5.6				9.4				33.0
NLF Ecoregion				8.9				5.6				21.0

The Secchi disk depth dataset is more robust, allowing for more data interpretation to occur. Average measurements from the past decade have consistently fallen between 7 and 10 feet, indicating that the water clarity fluctuates little from year to year (Figure 8.4.3-1). Compared to similar lakes statewide, these measurements can be classified as being in the TSI category of excellent.

Fawn Lake Trophic State

The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values fall within categories of mesotrophic and eutrophic (Figure 8.4.3-2). In general, the best values to use in judging a lake's trophic state are the biological parameters; therefore, relying primarily on the 2010 total phosphorus and chlorophyll-*a* TSI values, it can be concluded that Fawn Lake is in a eutrophic state.

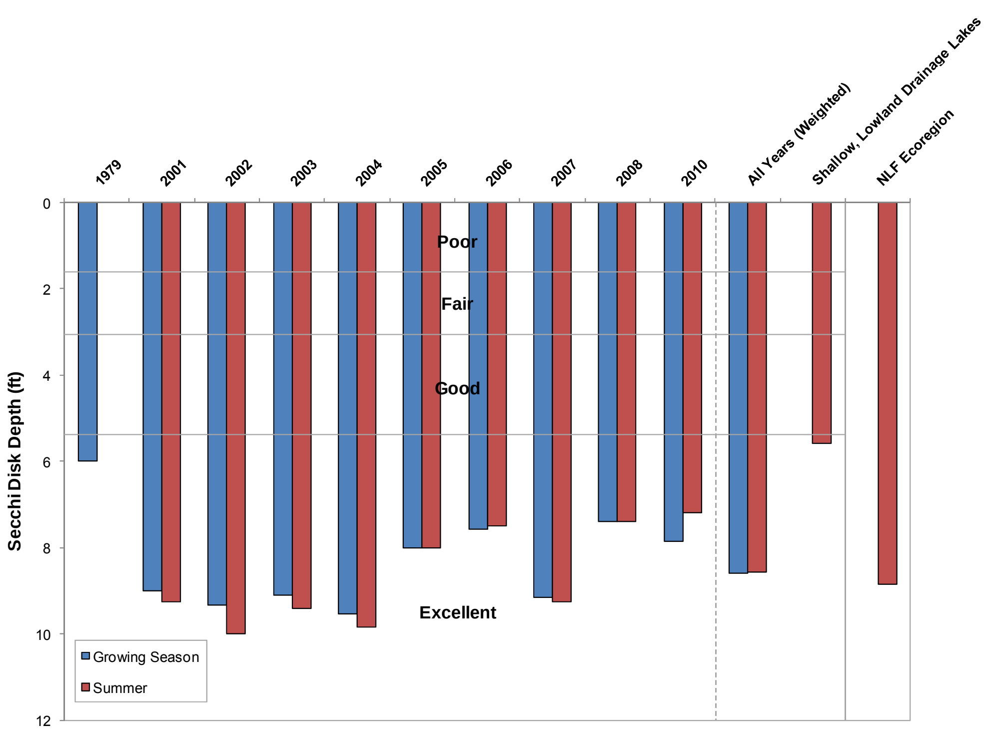


Figure 8.4.3-1. Fawn Lake, state-wide shallow, lowland drainage lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

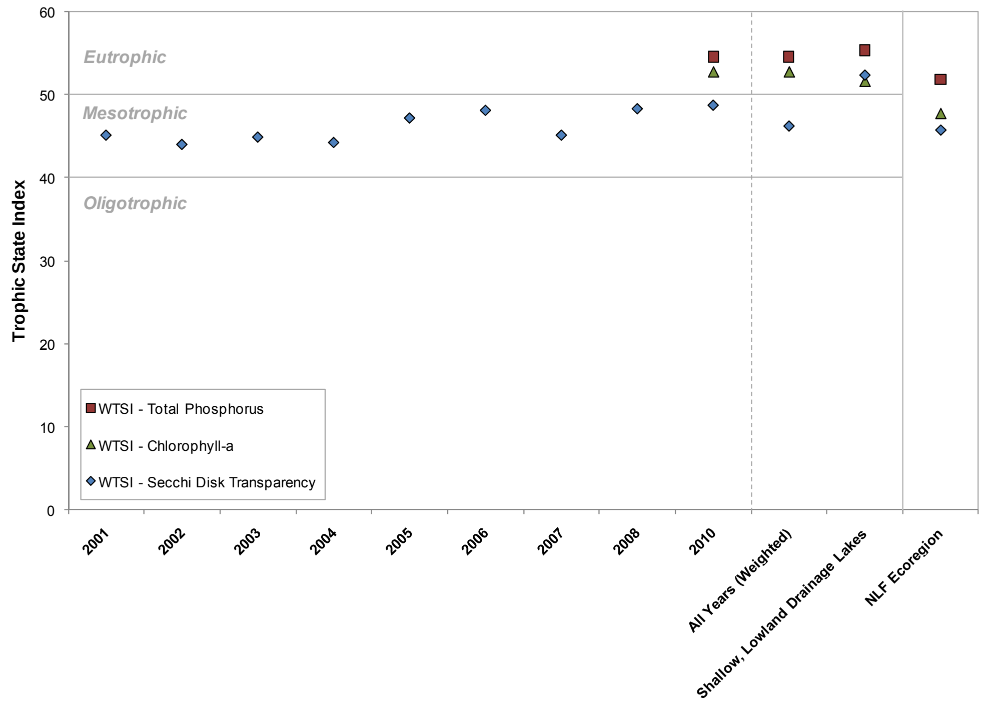


Figure 8.4.3-2. Fawn Lake, state-wide shallow, lowland drainage lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Fawn Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Fawn Lake by Onterra staff. Graphs of those data are displayed in Figure 8.4.3-3 for all three sampling events.

Fawn Lake was found to be completely mixed during the summer months. While natural lakes are mixed by energy from the wind, Fawn Lake receives flowing water from Big St. Germain Lake which assists in mixing the lake in terms of temperature and dissolved oxygen. This water flow likely keeps temperature and dissolved oxygen gradients to a minimum year-round.

Fawn Lake has abundant plant growth, and as a result, there is much plant material decomposing along the lake bottom. The decomposition of this organic matter is likely the cause of the slight decrease in dissolved oxygen observed in June and July. Despite this decrease, dissolved oxygen levels remained sufficient in the upper 8 feet of the water column to support most aquatic life found in northern Wisconsin lakes.

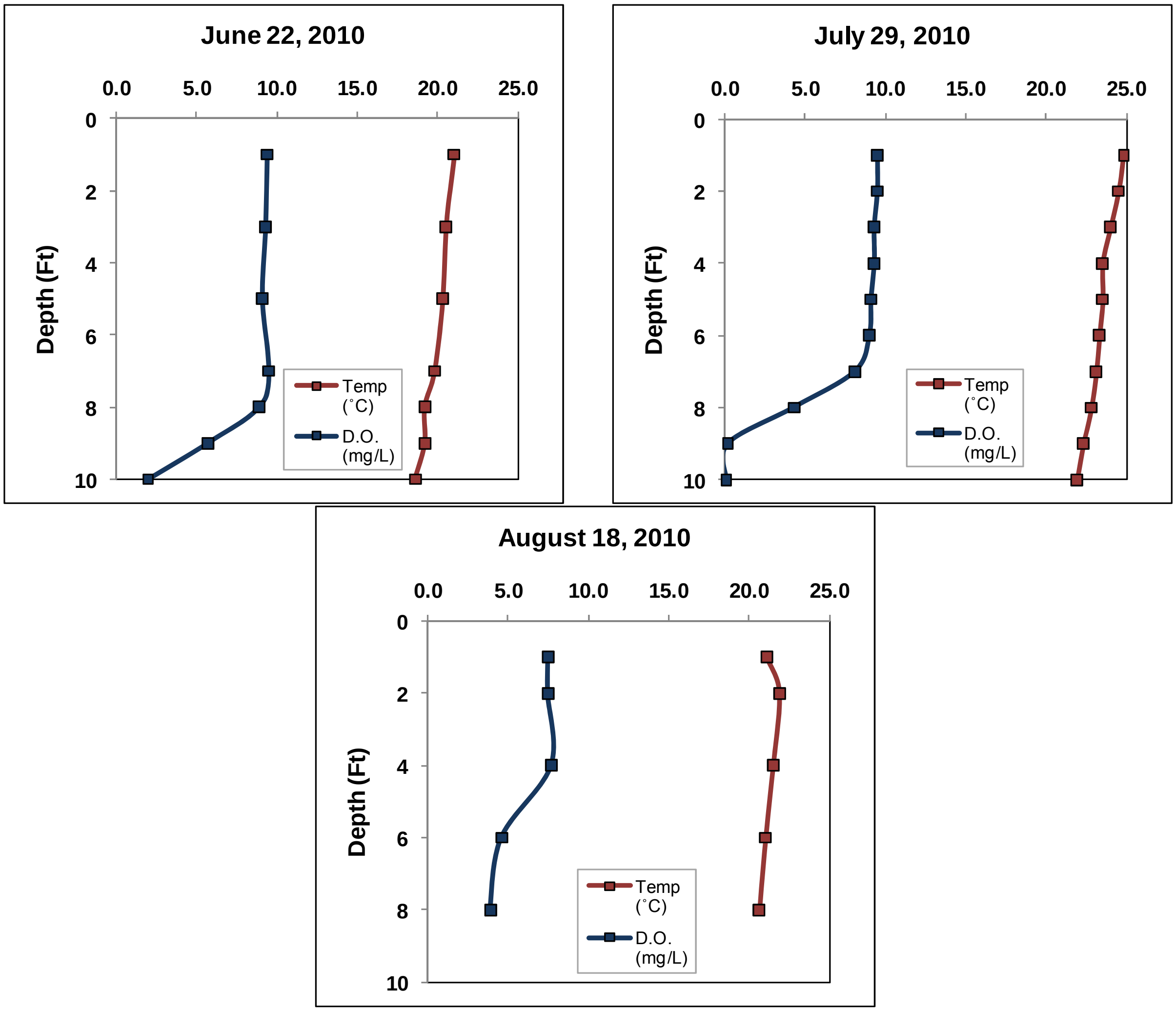


Figure 8.4.3-3. Fawn Lake dissolved oxygen and temperature profiles.

8.4.4 Fawn Lake Aquatic Vegetation

The curly-leaf pondweed survey was conducted on Fawn Lake on June 22, 2010. This meander-based survey did not locate any occurrences of this exotic plant, and it is believed that this species either does not currently exist in Fawn Lake or is present at an undetectable level. Eurasian water milfoil, also an aquatic invasive plant, was not located in Fawn Lake during any of the 2010 surveys.

The aquatic plant point-intercept survey was conducted on Fawn Lake on July 27, 2010 by Onterra. The floating-leaf and emergent plant community mapping survey was completed the following day (July 28, 2010) to create the aquatic plant community map (Fawn Lake Community Map) during this time. During these surveys, 31 species of native aquatic plants were located in Fawn Lake; 24 of these species were sampled during the point-intercept survey (Table 8.4.4-1 and Figure 8.4.4-1). This species richness greatly exceeds the Northern Lakes Ecoregion and Wisconsin State medians.

Aquatic plants were found growing in all areas of the lake which equated to a maximum depth of 12 feet. Of the 83 point-intercept locations sampled, all locations (100%) contained aquatic vegetation. 100% of the point-intercept sampling locations contained fine, organic substrate (muck) (Town-Wide Fisheries Section, Figure 3.4-5).

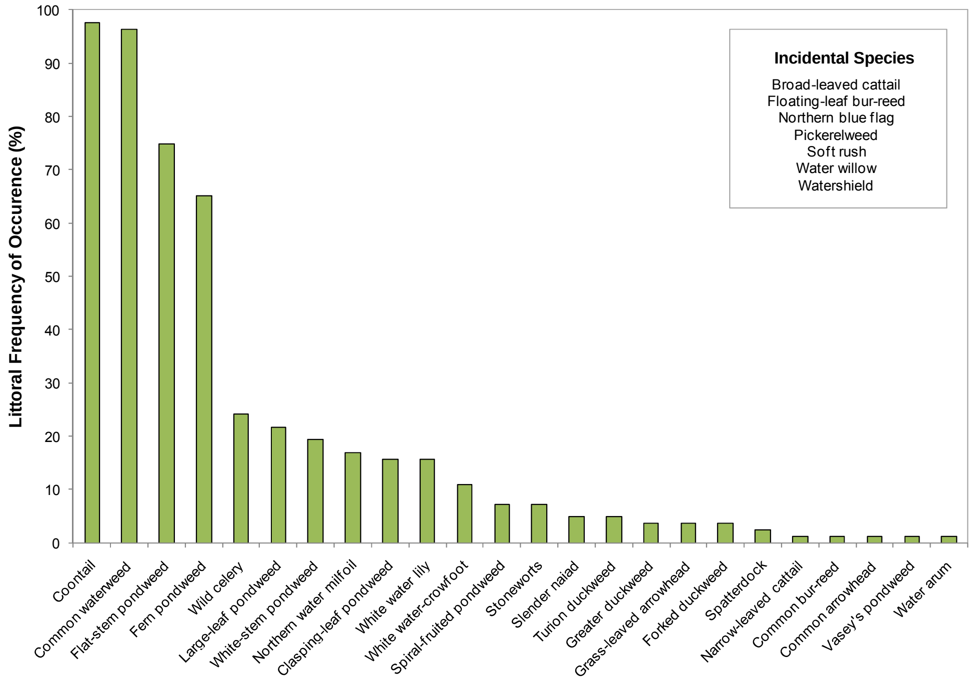


Figure 8.4.4-1 Fawn Lake aquatic plant littoral frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

It is unrealistic to quantitatively define the term "nuisance," as this designation is subjective by nature. However, WDNR Science Services researchers indicate that nuisance levels of certain plant species likely occur when their frequency of occurrences exceed 35% (Alison Mikulyuk, personal comm.). Plants that can potentially cause nuisance conditions are those that can grow to and/or near the water surface and contain a high biomass (i.e bushy appearance) at or near the surface. Figure 8.4.4-1 shows that coontail, common waterweed, flat-stem pondweed, and fern pondweed exceed this somewhat arbitrary benchmark in Fawn Lake. Actually, all five of the most commonly encountered species in the lake are indicative of waters with lower water transparency and have a higher tolerance of disturbance.

Coontail and common waterweed, at these levels, have the potential to impact navigation, especially when the plants collect into dense surface mats. Even at these frequencies, flat-stem pondweed is often not considered a nuisance due to this species' thin leaf structures; and fern pondweed is usually growing prostrate along the bottom, not interfering with recreational activities. However, these plants were noted to be especially dense in some areas during the 2010 surveys.

Table 8.4.4-1. Aquatic plant species located in the Fawn Lake during the 2010 aquatic plant surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)
Emergent	*Calla palustris*	Water arum	9
	Decodon verticillatus	Water willow	7
	Iris versicolor	Northern blue flag	5
	Juncus effusus	Soft rush	4
	Pontederia cordata	Pickerelweed	9
	Sagittaria latifolia	Common arrowhead	3
	Typha latifolia	Broad-leaved cattail	1
	Typha angustifolia	Narrow-leaved cattail	1
FL	*Brasenia schreberi*	Watershield	7
	Nuphar variegata	Spatterdock	6
	Nymphaea odorata	White water lily	6
FL/E	*Sparganium fluctuans*	Floating-leaf bur-reed	10
	Sparganium eurycarpum	Common bur-reed	5
Submergent	*Ceratophyllum demersum*	Coontail	3
	Elodea canadensis	Common waterweed	3
	Myriophyllum sibiricum	Northern water milfoil	7
	Najas flexilis	Slender naiad	6
	Nitella spp.	Stoneworts	7
	Potamogeton vaseyi	Vasey's pondweed	10
	Potamogeton spirillus	Spiral-fruited pondweed	8
	Potamogeton richardsonii	Clasping-leaf pondweed	5
	Potamogeton praelongus	White-stem pondweed	8
	Potamogeton amplifolius	Large-leaf pondweed	7
	Potamogeton robbinsii	Fern pondweed	8
	Potamogeton zosteriformis	Flat-stem pondweed	6
	Ranunculus aquatilis	White water-crowfoot	8
	Vallisneria americana	Wild celery	6
S/E	*Sagittaria graminea*	Grass-leaved arrowhead	9
FF	*Lemna trisulca*	Forked duckweed	6
	Lemna turionifera	Turion duckweed	2
	Spirodela polyrhiza	Greater duckweed	5

FL = Floating Leaf
FL/E = Floating Leaf and Emergent
S/E = Submergent and Emergent
FF = Free Floating

Of the project waters, Fawn Lake contained the second lowest number of plant species of the project waters. This is not surprising due to the small size of the lake and relatively similar habitat type throughout. Because of this, one may assume that the system would also have one of the lowest diversity indices of the project waters. As discussed earlier, how evenly the species are distributed throughout the system also influence the diversity. The diversity index for Fawn Lake's plant community (0.88) ranks in the middle of the seven project lakes and is slightly above the Northern Lakes and Forests Lakes ecoregion median value (0.86).

As explained earlier in the Primer on Data Analysis and Data Interpretation Section, the littoral frequency of occurrence analysis allows for an understanding of how often each of the plants is located during the point-intercept survey. Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while coontail was found at 98% of the sampling locations, its relative frequency of occurrence is 19%. Explained another way, if 100 plants were randomly sampled from Fawn Lake, 19 of them would be coontail. The relatively uneven distribution can be observed in Figure 8.4.4-2, where together five species account for 71% of the population of plants within Fawn Lake, while the other 19 species account for the remaining 29%. Seven additional species were located from the lake but not from of the point-intercept survey, as indicated in Figure 8.4.4-1 as incidentals.

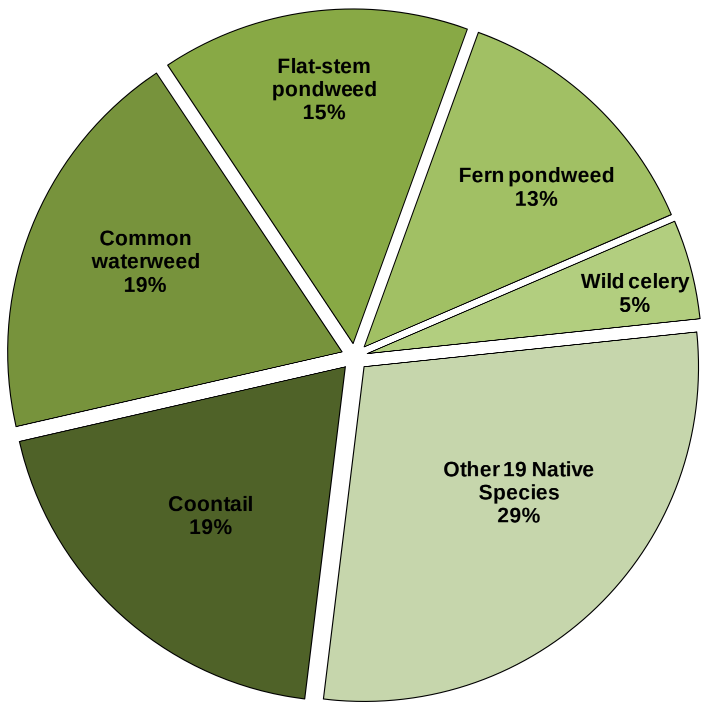


Figure 8.4.4-2 Fawn Lake aquatic plant relative frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

Fawn Lake's average conservatism value of 6.5 is higher than that state median, but slightly less than the ecoregion median. Of the Town of Saint Germain project waters, only Big St. Germain Lake had a lower average coefficient of conservatism value. This indicates that the plant community of Fawn Lake is moderately indicative of a disturbed system.

Two factors measured during this project that may indicate disturbance include heavy watercraft use and the condition of the lake's shoreline. Approximately 23% of the watercrafts used by Fawn Lake stakeholder survey respondents were motor boats with greater than a 25 hp motor and 11% of the watercrafts used were pontoon boats (Appendix B, Question #12). This is not a surprise as Fawn Lake is connected to Big St. Germain Lake, a large lake that offers active watercraft use opportunities. However, it is likely that the use of these watercrafts are limited to traveling to and from Big St. Germain Lake and the lake itself likely does not endure too much large boat traffic. Passive watercraft types like canoe/kayak, paddleboats, and row boats were also commonly used on the lake. As indicated within the Watershed Sections, the two shoreland condition classifications that indicate man-made disturbance include Developed-Unnatural and Urbanized. Approximately 25% of Fawn Lake shoreline falls within these classifications (Watershed Section, Figure 8.4.2-1). Ensuring that the condition of Fawn Lake's shoreline does not shift towards urbanized development will be important to protect certain vulnerable aquatic plant species and further degradation of Fawn Lake's aquatic plant community.

Combining Fawn Lake's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in an exceptionally high value of 32.1, albeit the lowest amongst the Town of Saint Germain project lakes but still well above the median values of the ecoregion and state (Town-Wide Aquatic Plant Section, Figure 3.3-6). The quality of Fawn Lake is also indicated by the incidence of emergent and floating-leaf plant communities that occur in shallower regions of the lake. The 2010 community map indicates that approximately 6.1 acres of the lake contains these types of plant communities (Fawn Lake Map, Table 8.4.4-2). Fourteen floating-leaf and emergent species were located on Fawn Lake (Table 8.4.4-1), all of which provide valuable wildlife habitat.

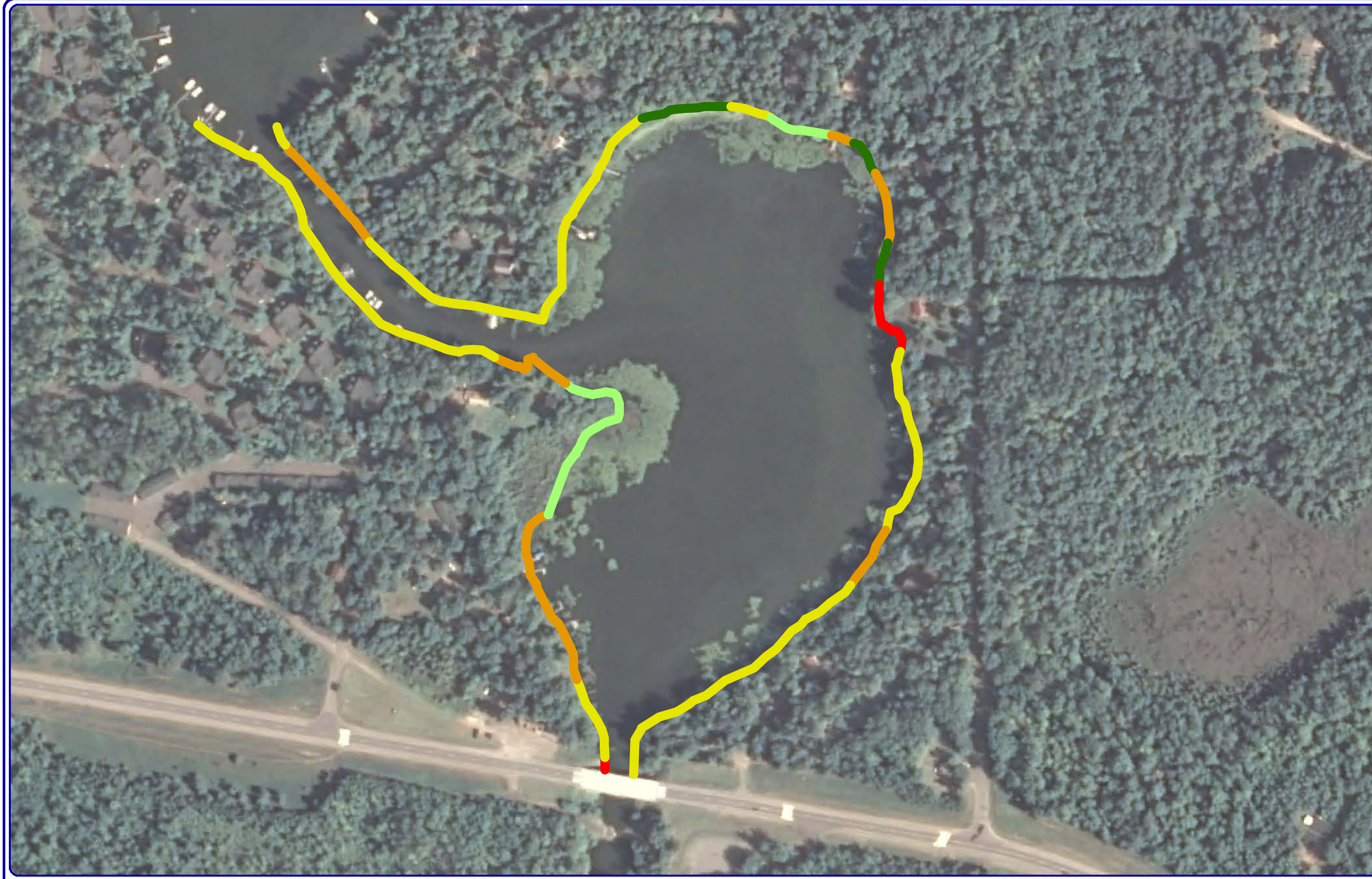
Table 8.4.4-2. Fawn Lake acres of emergent and floating-leaf plant communities from the 2005 and 2010 community mapping survey.

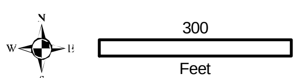
	Acres	
Plant Community	**2005**	**2010**
Floating-leaf	0.0	4.1
Emergent	0.1	0.0
Floating-leaf/Emergent	4.9	2.1
Total	**5.0**	**6.1**

The community map represents a 'snapshot' of the emergent and floating-leaf plant communities. Replications of this survey will provide a valuable understanding of the dynamics of these communities within Fawn Lake. This is important, because these communities are often negatively affected by recreational use and shoreland development. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelines when compared to undeveloped shorelines in Minnesota Lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines.

The 2010 community mapping survey was the second survey of this type to be conducted, the first being conducted by Onterra in 2005. As the Community Map shows, these communities have remained relatively similar between the two surveys. A slight expansion of floating-leaf species (e.g. white-water lily, spatterdock, and watershield) is noted on the central part of the eastern shoreline. This may be a result of reduced boating traffic in this area since 2005.

Note on Fawn Lake's Implementation Plan: The Big St. Germain Area Lakes District represents Big St. Germain Lake, Fawn Lake, and Lake Content. Therefore, a single Implementation Plan has been constructed for these lakes and is located following the Lake Content Section (8.5.5).





Onterra LLC
Lake Management Planning
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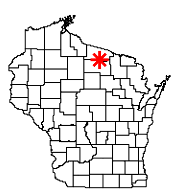
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Orthophotography: NAIP, 2010
Shoreline Condition: Onterra, 2010
Map Date: August 17, 2011
Filename: Fawn_Map1_SA_2010.mxd



Project location in Wisconsin

Legend

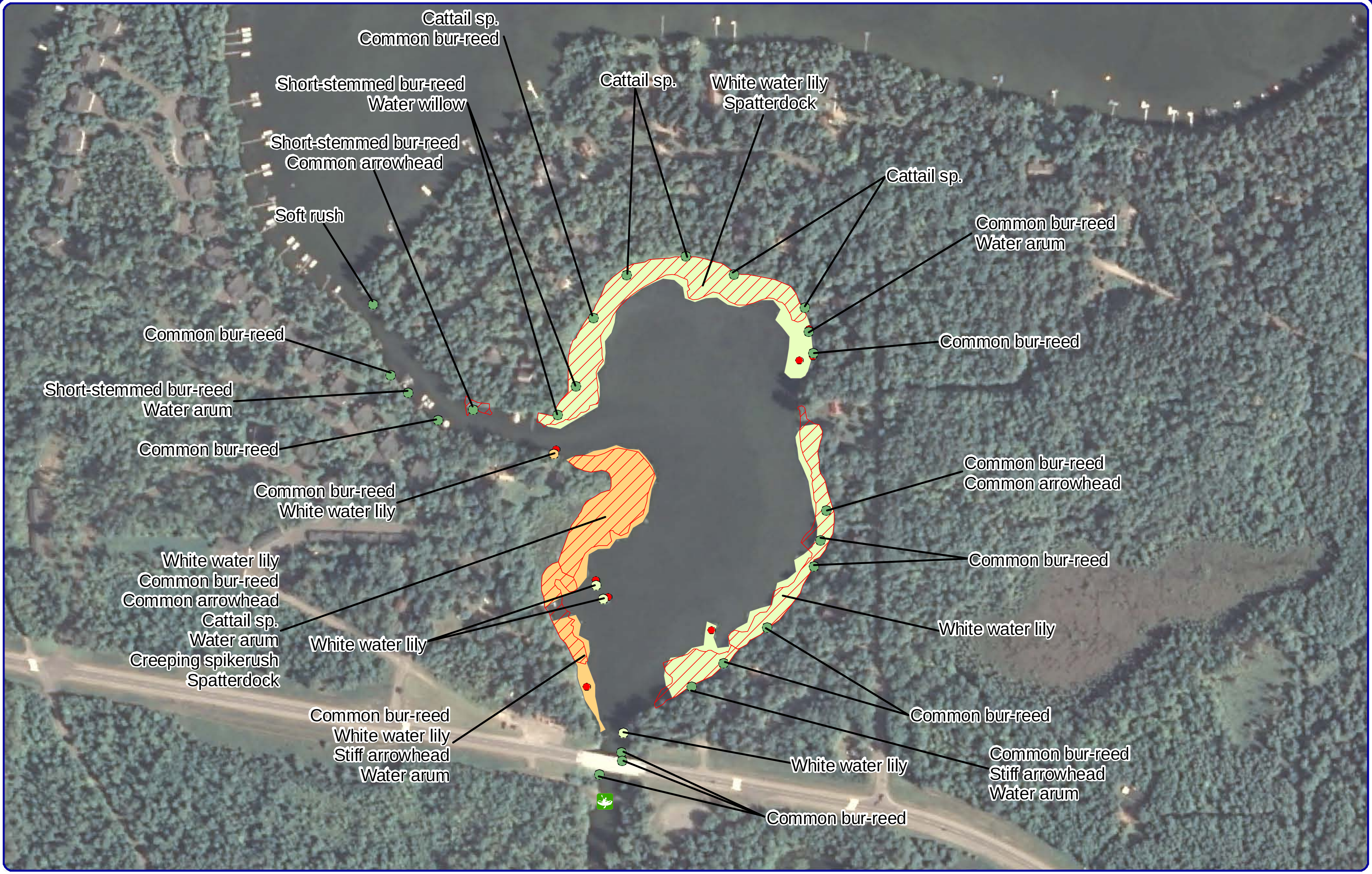
- Natural/Undeveloped
- Developed-Natural
- Developed-Semi-Natural
- Developed-Unnatural
- Urbanized

Fawn Lake - Map 1

Saint Germain Lakes

Vilas County, Wisconsin

Shoreline Condition



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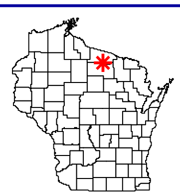
Sources:
Aquatic Plants: Onterra, 2005 & 2010
Orthophotography: NAIP 2010
Map date: March 28, 2011
Filename: Map2_Fawn_Comm_2010.mxd



Project Location in Wisconsin

Legend

Small Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent
- 2005 Small Plant Community

Large Plant Communities
- Emergent *(None found)*
- Floating-leaf
- Mixed Floating-leaf & Emergent
- 2005 Large Plant Community

Fawn Lake - Map 2

Saint Germain Lake
Vilas County, Wisconsin

Aquatic Plant Communities

8.5 LAKE CONTENT

8.5.1 An Introduction to Lake Content

Lake Content, Vilas County, is a drainage lake with a maximum depth of 14 feet and a surface area of 244 acres. This eutrophic lake has a small watershed when compared to the size of the lake. Lake Content contains 41 native plant species, of which coontail is the most common plant. No exotic plant species are known to exist in Lake Content.

Field Survey Notes

Water is fairly green. A lot of filamentous algae covering submersed plants, as well as many floating mats on the surface. White-water crowfoot observed – very dense in some areas. Be careful of the large rocks just south of the channel coming from Big St. Germain Lake!

Photo 8.5.1-1 Lake Content, Vilas County

Lake at a Glance – Lake Content

Morphology	
Acreage	244.0
Maximum Depth (ft)	14.0
Mean Depth (ft)	6.2
Volume (acre-feet)	1,507.0
Shoreline Complexity	2.0
Vegetation	
Curly-leaf Survey Date	June 23, 2010
Comprehensive Survey Date	July 27, 2010
Number of Native Species	33 + 8 incidental = 41
Threatened/Special Concern Species	-
Exotic Plant Species	-
Simpson's Diversity	0.86
Average Conservatism	6.5
Water Quality	
Wisconsin Lake Classification	Class 4 (deep, lowland drainage lake)
Trophic State	Eutrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	26:1

8.5.2 Lake Content Watershed Assessment

Lake Content's watershed is 1,326-acres in size. The land cover within this watershed is predominantly forest, with 40% (529 acres) being various types of hard and softwood forest and 25% being forested wetlands (Figure 8.5.2-1). Forested lands allow water to seep into the ground, and thus reduce the amount of overland flow which might carry sediments and pollutants into nearby lakes and streams. The lake surface comprises 18% of this watershed, and is the third largest "land" cover type. Six land cover types represent much smaller portions of the watershed: rural open space at 9%, pasture/grass, rural residential and wetlands at 2% each, and row crops and urban medium density at 1% each. The watershed to lake area ratio is 4:1, which indicates that the lake would be sensitive to changes in land cover. Map 2 of the Town-Wide report displays the Lake Content watershed and its land cover.

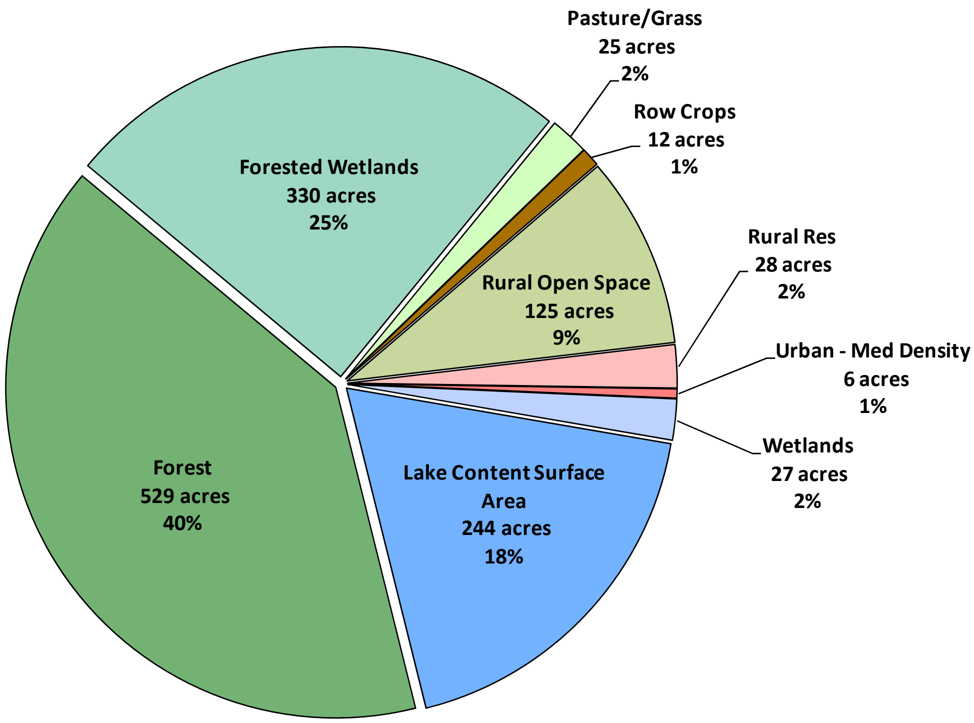


Figure 8.5.2-1. Lake Content watershed land cover types in acres. Based upon landcover classifications from the Multi-Resolution Land Characteristics Consortium (MRLC, 2006).

Most lakes that have a connection to a neighboring lake would be considered a spring or drainage lake, depending on the circumstances. However, because the channel between Big St. Germain and Lake Content is artificial, Lake Content is classified as a shallow seepage lake. While some lakes have streams that carry water to them, seepage lakes receive water only through groundwater inputs, surface runoff, and precipitation; of which groundwater is normally the most important. Drought conditions in northern Wisconsin have greatly reduced the amount of regional precipitation in the past 8 – 10 years. Without adequate precipitation, seepage lakes will collect water only from the ground. The lake water level, also a reflection of the groundwater level, will slowly lower as precipitation fails to "recharge" depleted groundwater stocks. And as evaporation occurs, the water levels in the lake will continue to decrease. While these changing water levels may have negative recreational and short-term ecological impacts, it is important to remember that lake water level fluctuations are part of a naturally occurring cycle and may actually benefit the lake ecosystem in the long-term by increasing the level of habitat diversity. Please note that during summer 2010 surveys, low water levels were not observed on Lake Content.

As mentioned previously in the Town-Wide Watershed Section, one of the most sensitive areas of the watershed is the immediate shoreland area. This area of land is the last source of protection for a lake against surface water runoff, and is also a critical area for wildlife habitat. In late summer of 2010, Lake Content's immediate shoreline was assessed in terms of its development. Lake Content has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 1.5 miles of natural/undeveloped and developed-natural shoreline were observed during the survey (Figure 8.5.2-2). These shoreland types provide the most benefit to the lake and should be left in their natural state if at all possible. During the survey, 0.8 miles of urbanized and developed–unnatural shoreline (24% of the total shoreline) was observed. If restoration of the Lake Content shoreline is to occur, primary focus should be placed on these shoreland areas as they currently provide little benefit to, and actually may harm, the lake ecosystem. The Lake Content Shoreline Condition Map displays the location of these shoreline lengths around the entire lake.

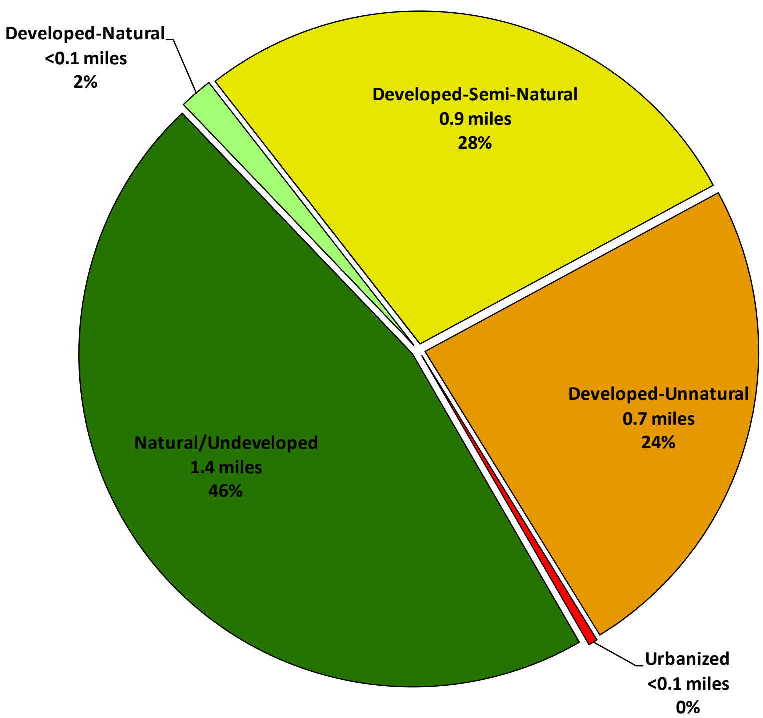


Figure 8.5.2-2. Lake Content shoreland categories and total lengths. Based upon a late summer 2010 survey. Locations of these categorized shorelands can be found on the Lake Content Shoreline Condition Map.

8.5.3 Lake Content Water Quality

Water quality data was collected from Lake Content on three occasions in summer of 2010. Onterra staff sampled the lake for a variety of water quality parameters including total phosphorus, chlorophyll-*a*, Secchi disk clarity, temperature, and dissolved oxygen.

Citizens Lake Monitoring Network (CLMN) volunteers have monitored Secchi disk clarity through a state-supported monitoring program in the past, but these efforts appear to have ended in 2003. Continuous water quality monitoring is important because it provides concrete data in which management decisions may be based upon, as opposed to anecdotal feelings about what has or has not changed in the lake. From a reliable dataset, historical data may be compared to recent data in an effort to detect any trends that may be occurring in the water quality of the lake.

For total phosphorus and chlorophyll-*a*, very little data exists. The summer average total phosphorus concentrations of the years have ranged between 17.0 and 41.7 µg/L and fall primarily within the TSI water quality categories of good (Figure 8.5.3-1). A weighted value across all years is higher than the average for shallow, seepage lakes in the state of Wisconsin. Average summer chlorophyll-*a* concentrations have ranged between 5.8 and 18.8 µg/L and fall within water quality categories of good and fair (Figure 8.5.3-2). The weighted average of all data is higher than the average for similar (shallow, seepage) lakes statewide.

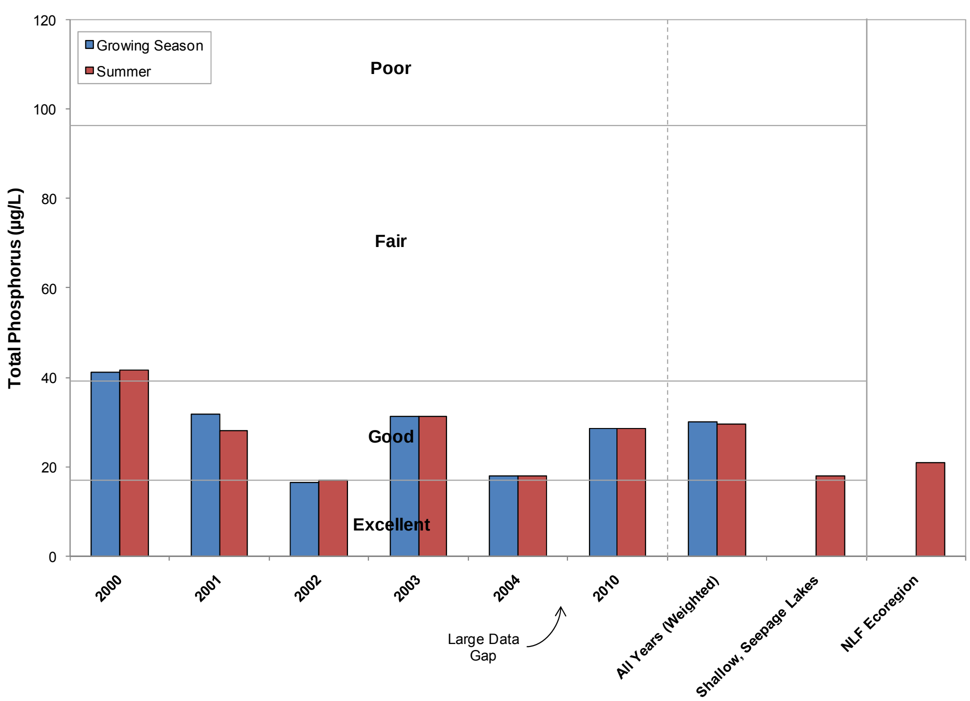


Figure 8.5.3-1. Lake Content, state-wide shallow seepage lakes and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

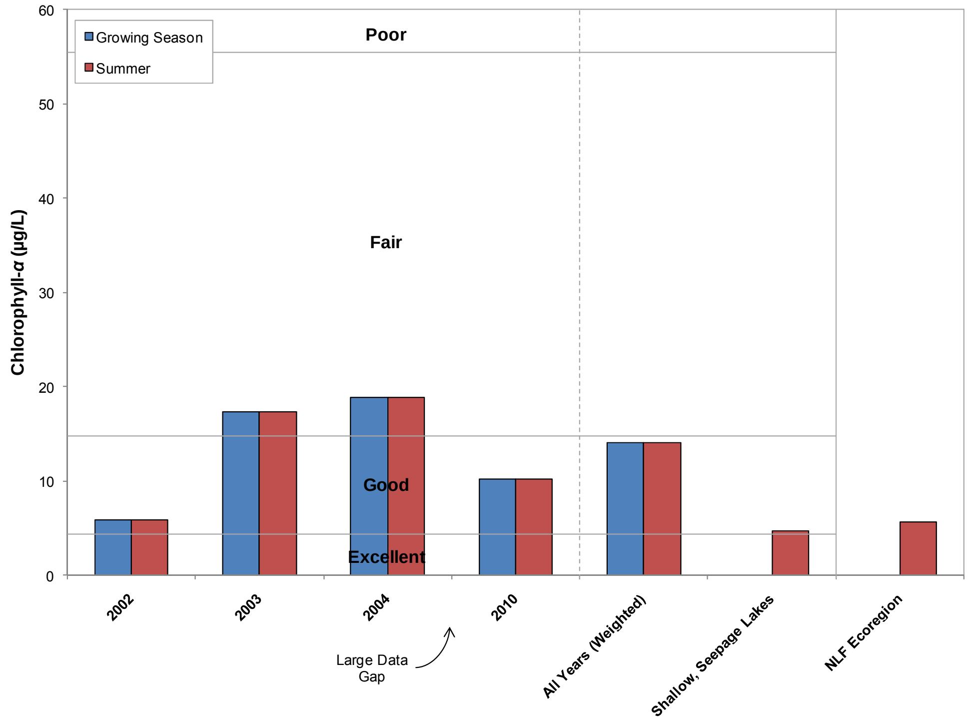


Figure 8.5.3-2. Lake Content, state-wide shallow seepage lakes and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Measurements of Secchi disk clarity span the years 1995-2003, and then include data collected in 2010 as a part of this project (Figure 8.5.3-3). In many years the annual average summer value ranks in the TSI water quality category of good, though on some years excellent water clarity was measured. A weighted average across all years is slightly lower than the average for similar lakes statewide. Over the recorded time period, Secchi depths have fluctuated often. Water clarity is the result of many different factors, such as algal and sediment concentration within the water column, but also by organic acids from the surrounding watershed that might change the water's color. These factors themselves are influenced by environmental variables such as temperature, wind velocity and precipitation. As Figure 8.5.3-3 suggests, it is not uncommon to see variations in the clarity of a lake from year to year.

Lake Content Trophic State

The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values range in values spanning from lower mesotrophic to eutrophic (Figure 8.5.3-4). In general, the best values to use in judging a lake's trophic state are the biological parameters; therefore, relying primarily on total phosphorus and chlorophyll-*a* TSI values, it can be concluded that Lake Content is in a eutrophic state.

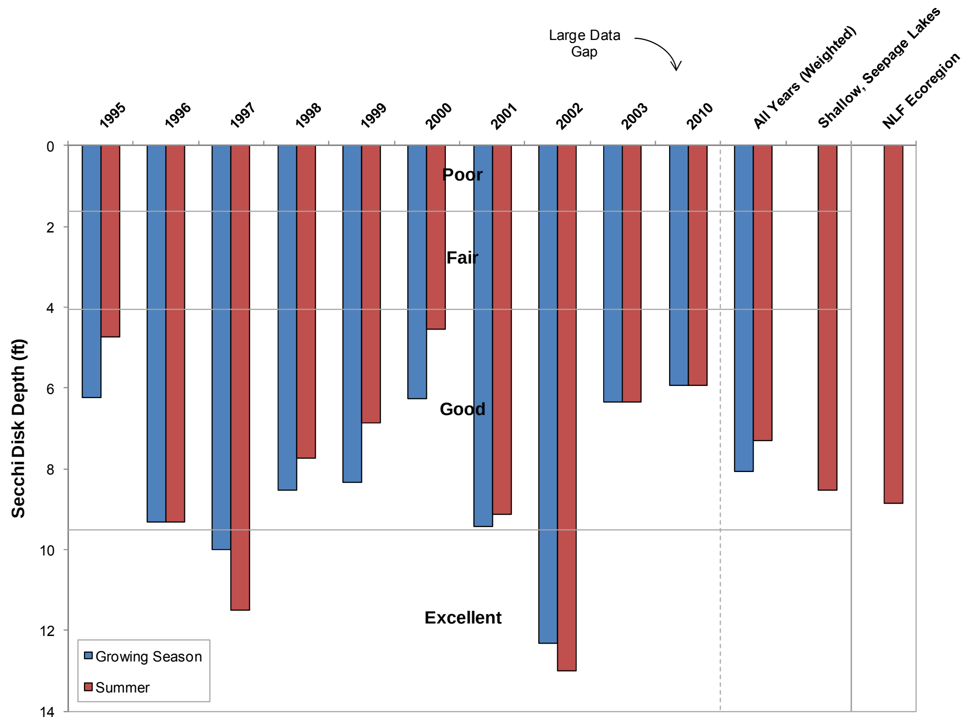


Figure 8.5.3-3. Lake Content, state-wide shallow seepage lakes and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

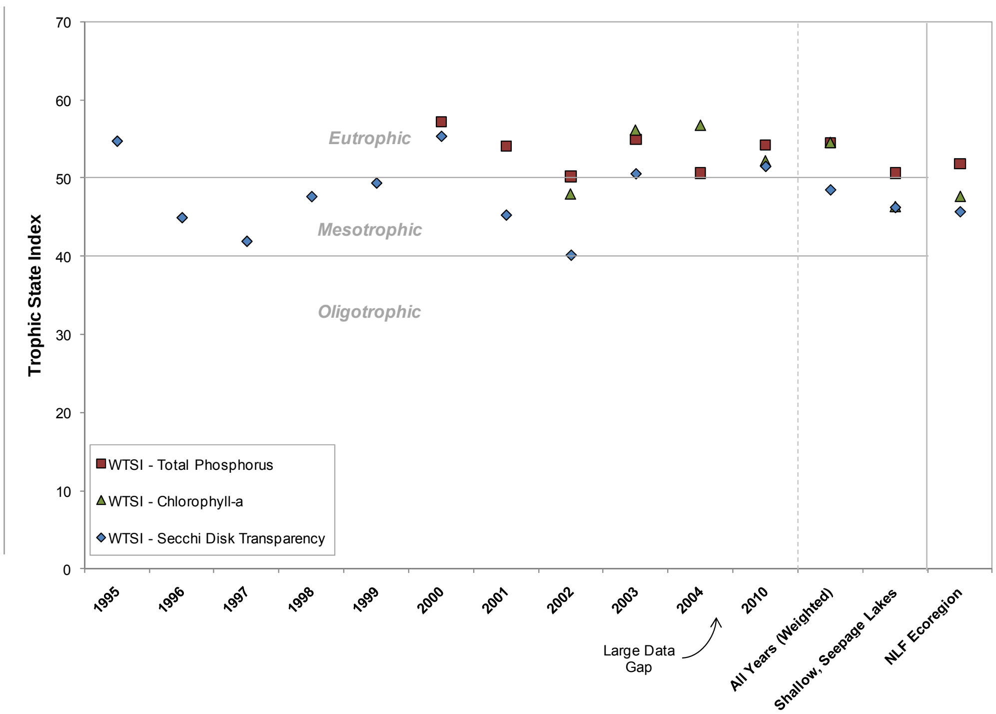


Figure 8.5.3-4. Lake Content, state-wide shallow seepage lakes and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Lake Content

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Lake Content by Onterra staff. Graphs of those data are displayed in Figure 8.5.3-5 for all three sampling events.

Lake Content was found to remain mixed through June, July and August of 2010. In shallow lakes, energy from the wind mixes the lake so that the temperature in the water column is fairly consistent from the top to the bottom. This energy also distributes dissolved chemical elements and dissolved oxygen throughout the water column. In late July, the wind may have remained light for a period of time, during which decomposition occurring near the lake bottom used up the available oxygen. Upon the wind increasing once again, the lake became thoroughly mixed, as depicted in the August profile. Despite this decrease along the bottom of the lake, dissolved oxygen levels remained sufficient in the upper 11 feet of the water column to support most aquatic life found in northern Wisconsin lakes.

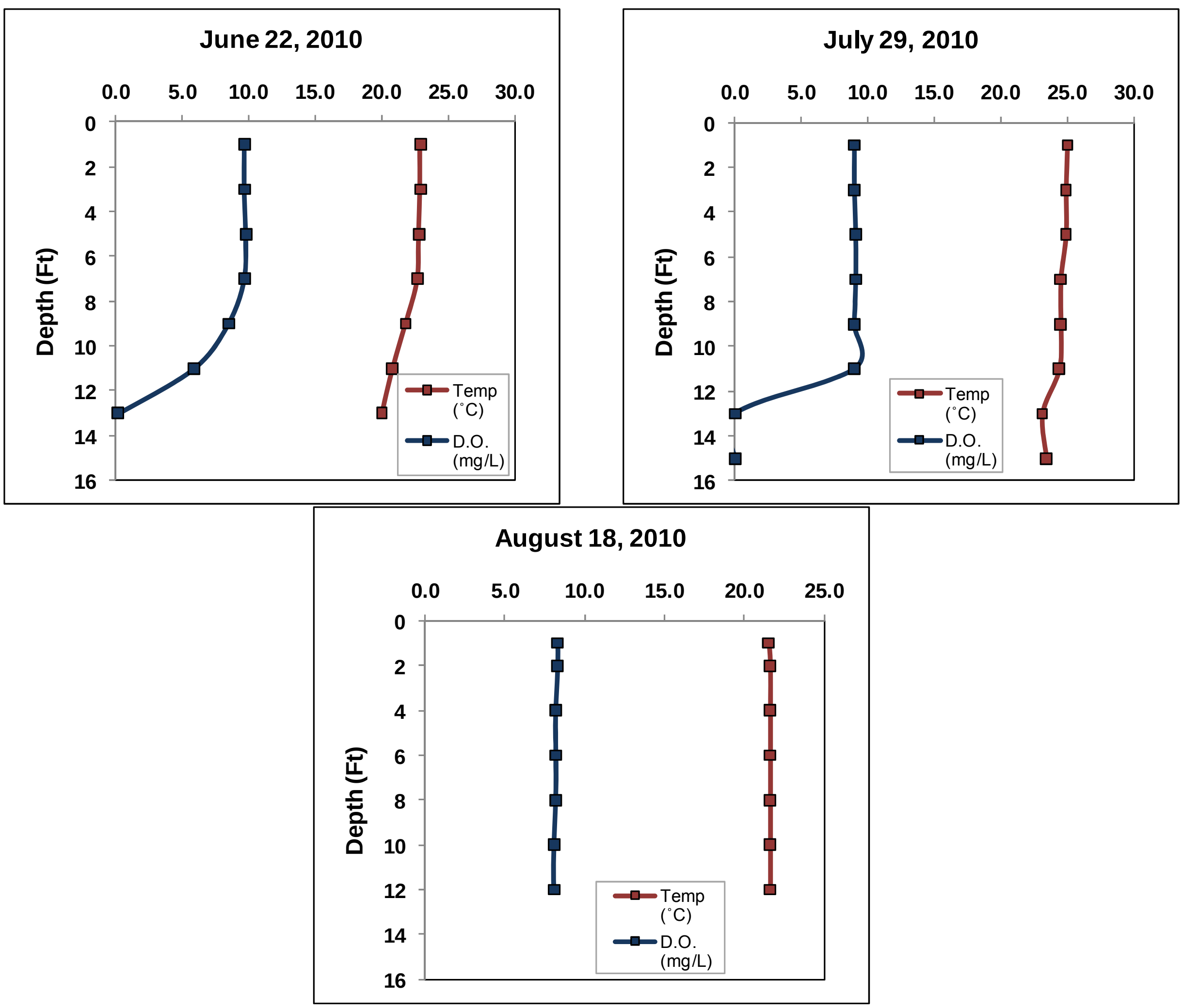


Figure 8.5.3-5. Lake Content dissolved oxygen and temperature profiles.

8.5.4 Lake Content Aquatic Vegetation

The curly-leaf pondweed survey was conducted on Lake Content on June 23, 2010. This meander-based survey did not locate any occurrences of this exotic plant, and it is believed that this species either does not currently exist in Lake Content or is present at an undetectable level. Eurasian water milfoil, also an aquatic invasive plant, was not located in Lake Content during any of the 2010 surveys.

The aquatic plant point-intercept survey was conducted on Lake Content on July 27, 2010 by Onterra. The floating-leaf and emergent plant community mapping survey was completed the following day (July 28, 2010) to create the aquatic plant community map (Lake Content Community Map). During these surveys, 41 species of native aquatic plants were located in Lake Content; 33 of these species were sampled during the point-intercept survey (Table 8.5.4-1 and Figure 8.5.4-1).

Aquatic plants were found growing in all areas of the lake which equated to a maximum depth of 13 feet. Of the 295 point-intercept locations sampled all but 2 locations (>99%) contained aquatic vegetation. Eighty-four percent of the point-intercept sampling locations where sediment data was collected at contained fine, organic substrate (muck) while the remaining 16% contained sand (Town-Wide Fisheries Section, Figure 3.4-5).

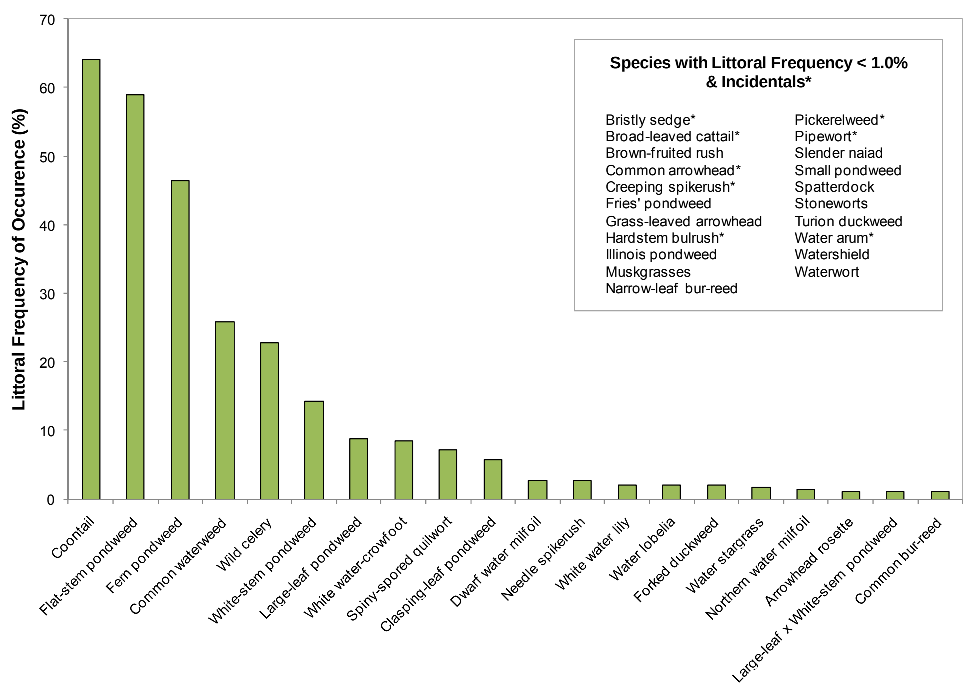


Figure 8.5.4-1 Lake Content aquatic plant littoral frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

Table 8.5.4-1. Aquatic plant species located in the Lake Content during the 2010 aquatic plant surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)
Emergent	*Calla palustris*	Water arum	9
	Carex comosa	Bristly sedge	5
	Eleocharis palustris	Creeping spikerush	6
	Pontederia cordata	Pickerelweed	9
	Sagittaria latifolia	Common arrowhead	3
	Schoenoplectus acutus	Hardstem bulrush	5
	Typha latifolia	Broad-leaved cattail	1
FL	*Brasenia schreberi*	Watershield	7
	Nuphar variegata	Spatterdock	6
	Nymphaea odorata	White water lily	6
FL/E	*Sparganium angustifolium*	Narrow-leaf bur-reed	9
	Sparganium eurycarpum	Common bur-reed	5
Submergent	*Chara spp.*	Muskgrasses	7
	Ceratophyllum demersum	Coontail	3
	Eriocaulon aquaticum	Pipewort	9
	Elatine minima	Waterwort	9
	Elodea canadensis	Common waterweed	3
	Heteranthera dubia	Water stargrass	6
	Isoetes echinospora	Spiny-spored quilwort	8
	Lobelia dortmanna	Water lobelia	10
	Myriophyllum sibiricum	Northern water milfoil	7
	Myriophyllum tenellum	Dwarf water milfoil	10
	Najas flexilis	Slender naiad	6
	Nitella sp.	Stoneworts	7
	Potamogeton illinoensis	Illinois pondweed	6
	Potamogeton pusillus	Small pondweed	7
	Potamogeton friesii	Fries' pondweed	8
	Potamogeton amplifolius x praelongus	Large-leaf x White-stem pondweed	N/A
	Potamogeton richardsonii	Clasping-leaf pondweed	5
	Potamogeton amplifolius	Large-leaf pondweed	7
	Potamogeton praelongus	White-stem pondweed	8
	Potamogeton robbinsii	Fern pondweed	8
	Potamogeton zosteriformis	Flat-stem pondweed	6
	Ranunculus aquatilis	White water-crowfoot	8
	Sagitaria sp. (rosette)	Arrowhead rosette	N/A
	Vallisneria americana	Wild celery	6
S/E	*Eleocharis acicularis*	Needle spikerush	5
	Juncus pelocarpus	Brown-fruited rush	8
	Sagittaria graminea	Grass-leaved arrowhead	9
FF	*Lemna turionifera*	Turion duckweed	2
	Lemna trisulca	Forked duckweed	6

FL = Floating Leaf
FL/E = Floating Leaf and Emergent
S/E = Submergent and Emergent
FF = Free Floating

It is unrealistic to quantitatively define the term "nuisance," as this designation is subjective by nature. However, WDNR Science Services researchers indicate that nuisance levels of certain plant species likely occur when their frequency of occurrences exceed 35% (Alison Mikulyuk, personal comm.). Plants that can potentially cause nuisance conditions are those that can grow to and/or near the water surface and contain a high biomass (i.e bushy appearance) at or near the surface. Figure 8.5.4-1 shows that coontail, flat-stem pondweed, and fern pondweed exceed this somewhat arbitrary benchmark in Lake Content. Actually, all four of the most commonly encountered species in the lake are indicative of waters with lower water transparency and have a higher tolerance of disturbance.

Coontail at these levels has the potential to impact navigation, especially when the plants collect into dense surface mats. Even at these frequencies, flat-stem pondweed is often not considered a nuisance due to this species' thin leaf structures; and fern pondweed is usually growing prostrate along the bottom, not interfering with recreational activities. However, these plants were noted to be especially dense in some areas during the 2010 surveys.

Of the project waters, only Big St. Germain Lake was found to contain more aquatic plant species (43 including incidental species) and because of this, one may assume that the system would also have a high diversity. As discussed earlier, how evenly the species are distributed throughout the system also influence the diversity. The diversity index for Lake Content's plant community (0.86) is comparable to the Northern Lakes and Forests Lakes ecoregion median value, which is also 0.86.

As explained earlier in the Primer on Data Analysis and Data Interpretation Section, the littoral frequency of occurrence analysis allows for an understanding of how often each of the plants is located during the point-intercept survey. Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while coontail was found at 64% of the sampling locations, its relative frequency of occurrence is 22%. Explained another way, if 100 plants were randomly sampled from Lake Content, 22 of them would be coontail. The relatively uneven distribution can be observed in Figure 8.5.4-2, where together six species account for 81% of the population of plants within Lake Content, while the other 27 species account for the remaining 19%. Eight additional species were located from the lake but not from of the point-intercept survey, as indicated in Figure 8.5.4-1 as incidentals.

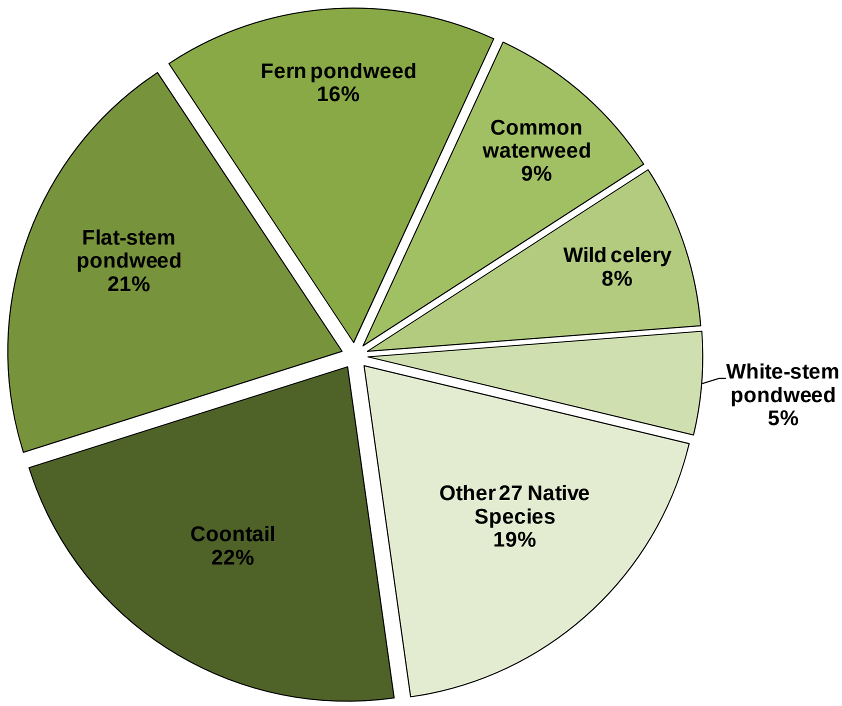


Figure 8.5.4-2 Lake Content aquatic plant relative frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

Lake Content's average conservatism value of 6.7 is higher than that state median, and equal to the ecoregion median. This indicates that the plant community of Lake Content is moderately indicative of a disturbed system. Two factors measured during this project that may indicate disturbance include heavy watercraft use and the condition of the lake's shoreline. Approximately 25% of the watercrafts used by Lake Content stakeholder survey respondents were motor boats with greater than a 25 hp motor and 19% of the watercrafts used were pontoon boats (Appendix B, Question #12). Of the project waters, only Big St. Germain Lake respondents indicated a higher level of use of these active watercraft types. This is not a surprise as Lake Content is connected to Big St. Germain Lake, a large lake that offers active watercraft use opportunities. As indicated within the Watershed Sections, the two shoreland condition classifications that indicate the least amount of man-made disturbance include Natural/Undeveloped and Developed-Natural. Lake Content's shoreline contains the highest percentage of its shoreline with these classifications of the five project lakes (Alma and Moon Lakes were excluded) where this assessment was made (Town-Wide Watershed Section, Table 3.1-1). Ensuring that the condition of Lake Content's shoreline does not shift towards urbanized development will be important to protect certain vulnerable aquatic plant species and further degradation of Lake Content's plant community.

Combining Lake Content's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in an exceptionally high value of 38.5 which is well above the median values of the ecoregion and state and slightly higher than the project lakes average (Town-Wide Aquatic Plant Section, Figure 3.3-6).

The quality of Lake Content is also indicated by the incidence of emergent and floating-leaf plant communities that occur in shallower regions of the lake. The 2010 community map indicates that approximately 15.3 acres of the lake contains these types of plant communities (Lake Content Map, Table 8.5.4-2). Thirteen floating-leaf and emergent species were located on Lake Content (Table 8.5.4-1), all of which provide valuable wildlife habitat.

Table 8.5.4-2. Lake Content acres of emergent and floating-leaf plant communities from the 2005 and 2010 community mapping survey.

	Acres	
Plant Community	**2005**	**2010**
Floating-leaf	0.7	0.1
Emergent	5.2	4.6
Floating-leaf/Emergent	6.1	10.7
Total	**12.1**	**15.3**

Continuing the analogy that the community map represents a 'snapshot' of the emergent and floating-leaf plant communities, replications of this survey through time will provide a valuable understanding of the dynamics of these communities within Lake Content. This is important, because these communities are often negatively affected by recreational use and shoreland development. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelines when compared to undeveloped shorelines in Minnesota Lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines.

The 2010 community mapping survey was the second survey of this type to be conducted, the first being conducted by Onterra in 2005. As the Community Map shows, the southern-most bay and western most bay have seen advances in the mixed floating-leaf emergent communities in these areas since the 2005 survey. For the most part, the emergent plants within these communities are tight to the shoreline and the colony expansion is by the floating-leaf species (e.g. white water lily, spatterdock, and watershield). Tucked away in the northeastern part of the lake, the emergent plant community appears to have receded from the shallow sandbar in this area. Perhaps this was due to changes in water levels.

8.5.5 Big St. Germain, Fawn Lake, and Lake Content Implementation Plan

The Big Saint Germain Area Lakes District (BSALD) represents Big St. Germain Lake, Fawn Lake, and Lake Content. Therefore, a single Implementation Plan has been constructed for these lakes. The Implementation Plan below is a result of collaborative efforts between Big St. Germain Lake, Fawn Lake, and Lake Content stakeholders, the TSGLC, and ecologists/planners from Onterra. This plan provides goals and actions created to protect the quality and integrity of Lake Content and will serve as reference for keeping stakeholders on track and focused upon these science-driven management activities.

While the Town of Saint Germain project lakes are geographically similar, they are definitely ecologically diverse. The latter is detailed throughout this report. This diversity leads to the need for diverse plans aimed at managing the lakes. Some of the project lakes have more complicated management needs than others, but in general most of the lakes', including Lake Content's, needs center on protecting the current quality of the lake as opposed to performing activities aimed at enhancing or resolving particular of issues. The Town-wide Implementation Plan will serve each of the project lakes well in terms of protecting their current condition; therefore, the following implementation plan is compiled by describing how Big St. Germain Lake, Fawn Lake, and Lake Content stakeholders should proceed in implementing applicable portions of the town-wide implementation plan for their lake.

<u>Town-wide Implementation Plan – Specific to Lake Content</u>

Town-wide Management Goal 1: Promote Lake Protection and Enjoyment through Stakeholder Education

<u>Management Action:</u> Support the Lakes Committee to promote safe boating, water quality, public safety, and quality of life on Big St. Germain Lake, Fawn Lake, and Lake Content.

Timeframe: Continuation of current efforts

Facilitator: Big Saint Germain Area Lakes District

Description: Lake Content stakeholders can assist in the implementation of this action by participating in the TSGLC's town-wide initiatives. Participation may include presentation of educational topics, volunteering at local and regional events, participating in committees, or simply notifying the lakes committee of concerns involving Big St. Germain Lake, Fawn Lake, and Lake Content as well as its stakeholders.

Action Steps: See description above.

Town-wide Management Goal 2: Maintain Current Water Quality Conditions

<u>Management Action:</u> Monitor water quality through WDNR Citizens Lake Monitoring Network (CLMN) or similar program.

Timeframe: Continuation of current efforts

Facilitator: Big Saint Germain Area Lakes District

Description: Currently, Big St. Germain Lake and Fawn Lake are enrolled in the CLMN's basic water quality monitoring program. This means that Secchi disk clarity is monitored on the lakes during the open water season. A step up from this type of monitoring is the CLMN's advanced water quality monitoring program in which phosphorus and chlorophyll-*a* are also monitored.

Currently, no volunteer water quality collection is occurring on Lake Content and has not occurred since 2004. The first step to maintaining water quality conditions on the lake is to enroll in the CLMN. The importance of this is two-fold. First, following collection, these data will automatically be entered onto SWIMS, an Internet warehouse of water quality data from Wisconsin waterbodies. This information can be accessed in future years so that comparisons can be made to historical data and changes in lake water quality can be scientifically and accurately identified. Secondly, following one year of enrollment within the basic CLMN program, Lake Content will become eligible to enroll in the CLMN's Advanced Monitoring program.

Because volunteers from Big St. Germain and Fawn Lakes have been continually enrolled within the basic CLMN program, these lakes are eligible to enroll in the advanced program. Although the CLMN is not currently accepting new lake groups into the advanced program, when the program expands the volunteers will already meet eligibility criteria and can begin monitoring other water quality parameters on the lake.

Action Steps: See description above.

<u>Management Action:</u> Reduce phosphorus and sediment loads from shoreland watershed to the Town of Saint Germain project lakes.

Timeframe: Continuation of current efforts

Facilitator: Big Saint Germain Area Lakes District

Description: As a result of the Shoreland Condition Assessment survey that took place in 2010, 47% of the Big St. Germain Lake shoreline, 26% of the Fawn Lake shoreline, and 24% of the Lake Content shoreline were classified as Developed-Unnatural. These areas may be impacting the lake in a negative manner by not filtering surface runoff water and limiting the amount of available habitat for both terrestrial and aquatic organisms.

If property owners of these areas wish to enhance their shoreline, they may work with the facilitator named by the TSGLC to look into restoration options that may provide ecological benefits to their shoreland properties. The facilitator will have cost-sharing opportunities available for the property owner as well. The Town of Saint Germain project lakes are no stranger to shoreland restoration projects. 14 properties on Found Lake and a camp on Moon Lake have both received funding to participate in WDNR studies in which ecological benefits of shoreland restoration were examined. These two locations may serve as demonstration models to present to property owners who are interested in restoring their shoreland areas.

Action Steps: See description above.

Town-wide Management Goal 3: Prevent Aquatic Invasive Species establishment within Big St. Germain Lake, Fawn Lake, and Lake Content

Management Action: Maintain and expand stakeholder education.

Timeframe: Continuation of current efforts

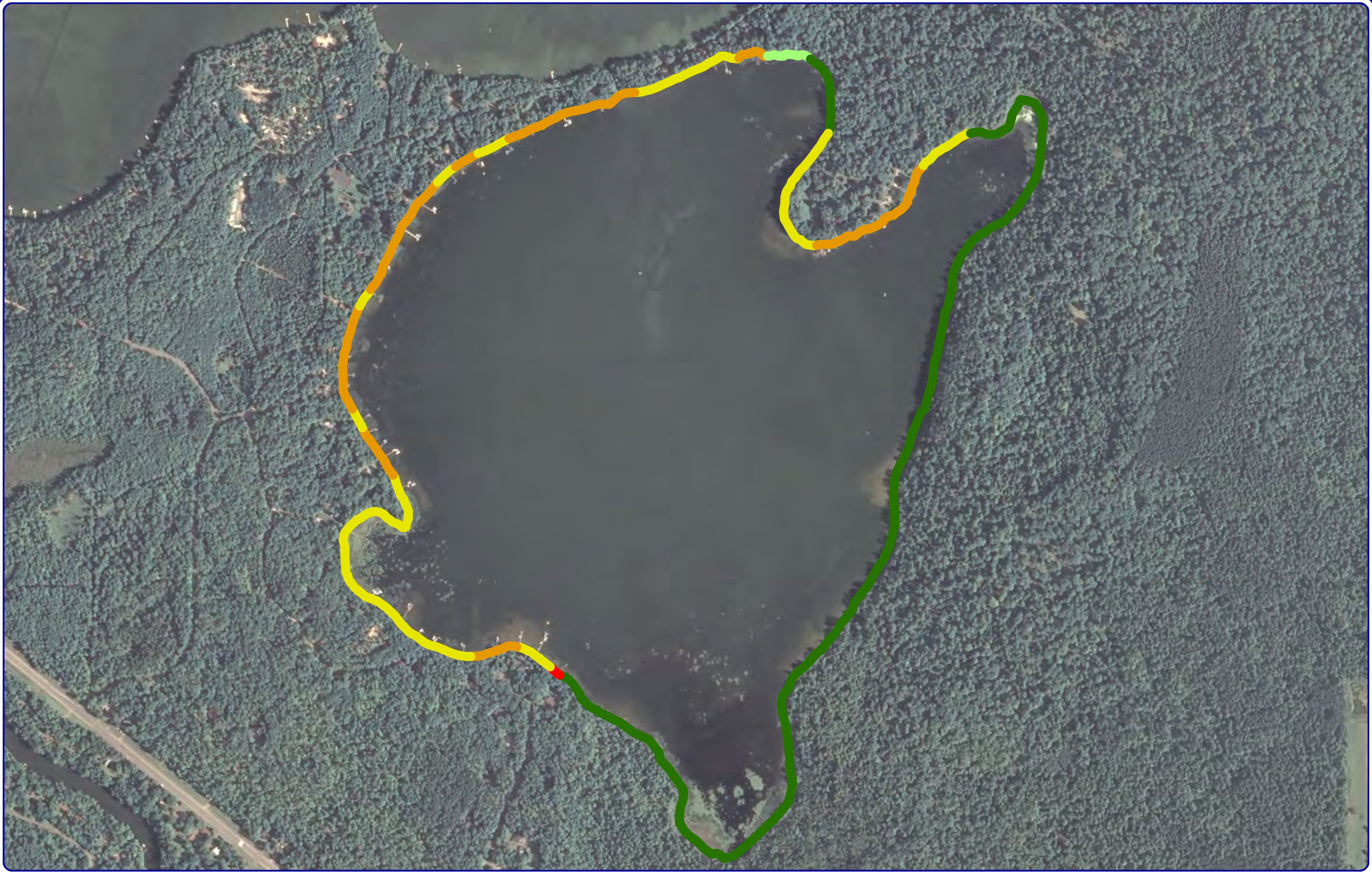
Facilitator: Big Saint Germain Area Lakes District

Description: Big St. Germain Lake has a single main public access points which can accommodate many vehicles. Although there is a carry-in access location on Fawn Lake, public access to Lake Content and Fawn Lake is primarily through Big St. Germain Lake. However, there are numerous private access points on the system (e.g. private residences, resorts, restaurants) where boats may be entering occasionally. As a result, the threat of AIS introduction is increased when compared to lakes with limited or no access.

BSALD stakeholders can work together with the TSGLC to reduce the chances that AIS find their way into the lake through numerous opportunities. By working with the TSGLC, property owners can learn proper boat cleansing techniques and AIS identification. Additionally, volunteers should continue work with the CBCW program. By monitoring the Big St. Germain public access points with CBCW volunteers, potential AIS introduction to the lake is reduced. An added benefit is that this interaction allows an opportunity to educate boaters about AIS and the importance of boat cleaning and inspection.

AIS monitoring should occur on a regular basis within the lakes. Because Big St. Germain Lake is fairly large and receives many recreationalists through several public access points, professional AIS surveys should occur once every 5 years. In between these professional surveys, the TSGLC can train volunteers not only on AIS identification, but methods to monitor the lake for AIS as well. These surveys were conducted as part of this project, but continuing them may be difficult as times of volunteerism fluctuate. It is the responsibility of the TSGLC and Big Saint Germain Area Lakes District to constantly recruit new volunteers. This will ensure that surveys are completed well into the future.

Action Steps: See description above.

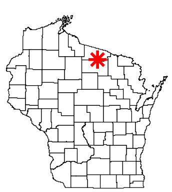


N W E S

750
Feet

Onterra LLC
Lake Management Planning
815 Prosper Rd
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Orthophotography: NAIP, 2010
Shoreline Condition: Onterra, 2010
Map Date: August 17, 2011
Filename: Content_Map1_SA_2010.mxd



Project location in Wisconsin

Legend

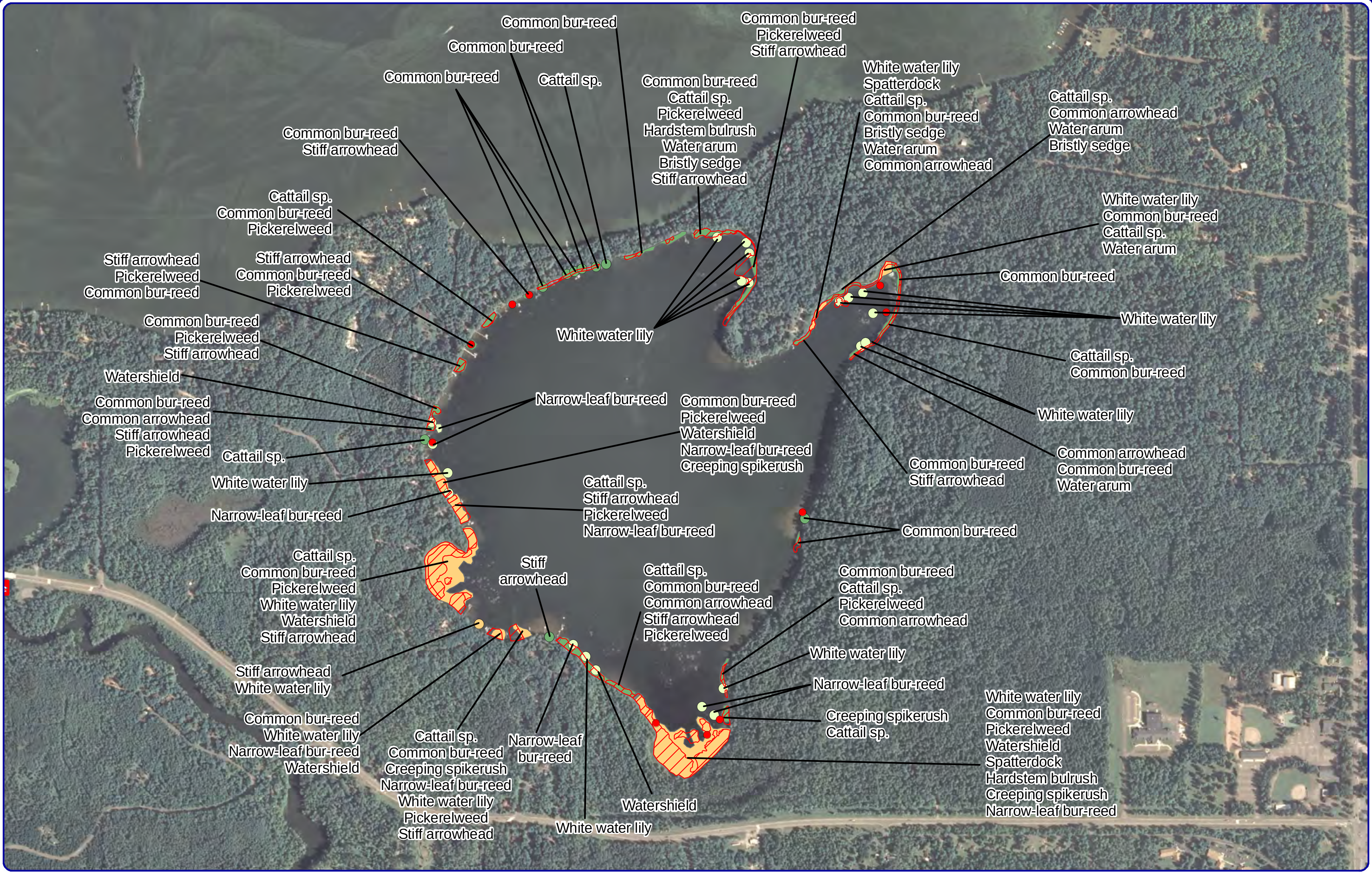
- Natural/Undeveloped
- Developed-Natural
- Developed-Semi-Natural
- Developed-Unnatural
- Urbanized

Lake Content - Map 1

Saint Germain Lakes

Vilas County, Wisconsin

Shoreline Condition



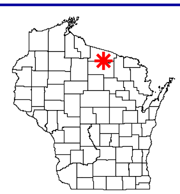
N W E S

1,100

Feet

Onterra LLC
Lake Management Planning
815 Prosper Rd
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Aquatic Plants: Onterra, 2005 & 2010
Orthophotography: NAIP 2010
Map date: March 28, 2011
Filename: Map2_Content_Comm_2010.mxd



Project Location in Wisconsin

Legend

Small Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent
- 2005 Small Plant Community

Large Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent
- 2005 Large Plant Community

Content Lake - Map 2

Saint Germain Lake
Vilas County, Wisconsin

Aquatic Plant Communities

8.6 LOST LAKE

8.6.1 An Introduction to Lost Lake

Lost Lake, Vilas County, is a lowland drainage lake with a maximum depth of 20 feet and a surface area of 544 acres. This eutrophic lake has a relatively large watershed when compared to the size of the lake. Lost Lake contains 41 native plant species, of which coontail was the most common plant. No exotic plants were observed during the 2010 lake surveys.

Field Survey Notes

Entire lake was searched for Eurasian water milfoil during vegetation surveys. No EWM was found despite intense searching. However northern water milfoil was present to a high degree and we were slightly puzzled to see many floating northern water milfoil plants on the northeastern shoreline that appear to have been uprooted as opposed to being fragments.

Photo 8.6.1-1 Lost Lake, Vilas County

Lake at a Glance – Lost Lake

Morphology	
Acreage	544.0
Maximum Depth (ft)	20.0
Mean Depth (ft)	11.3
Volume (acre-feet)	6,145.0
Shoreline Complexity	1.98
Vegetation	
Curly-leaf Survey Date	June 21, 2010
Comprehensive Survey Date	July 27 & 28, 2010
Number of Native Species	28 + 13 incidental = 41
Threatened/Special Concern Species	1 – Vasey's Pondweed
Exotic Plant Species	-
Simpson's Diversity	0.90
Average Conservatism	6.4
Water Quality	
Wisconsin Lake Classification	Class 3 (shallow, lowland drainage lake)
Trophic State	Eutrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	20:1

8.6.2 Lost Lake Watershed Assessment

Lost Lake's watershed is 11,511 acres in size. As with the other Town of Saint Germain lakes and most other lakes in the Northwoods of Wisconsin, the land cover consists primarily of forest (47% or 5,479 acres) and forested wetlands (31% or 3,542 acres) with wetlands contributing a significant portion (9% or 1,048 acres) as well (Figure 8.6.2-1). Several land cover types compose the remaining 13% of the watershed: the Lost Lake surface (5%), rural open space (5%), pasture/grass (2%), row crops (1%) and rural residential land (<1%). The watershed to lake area ratio is 20:1, which indicates that the lake would likely not be sensitive to changes in land cover because of the immense amount of land draining to the lake. Map 2 of the Town-Wide report displays the Lost Lake watershed and its land cover.

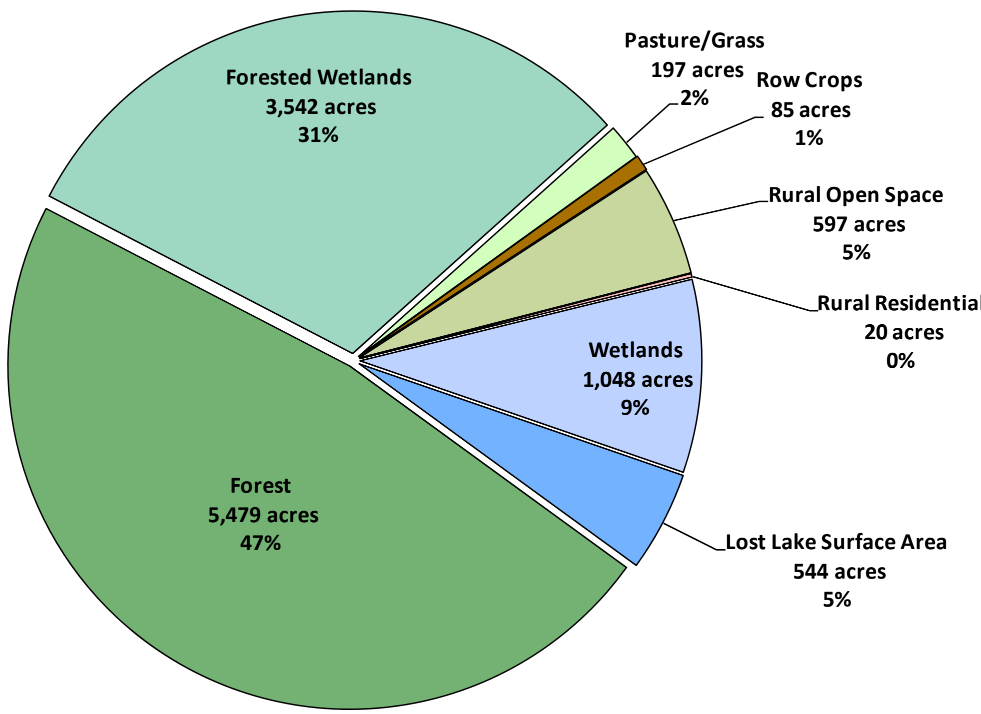


Figure 8.6.2-1. Lost Lake watershed land cover types in acres. Based upon landcover classifications from the Multi-Resolution Land Characteristics Consortium (MRLC, 2006).

Forests and forested wetlands are probably the most ideal land cover types to have in a watershed in terms of protecting a lake from surface water runoff. These land cover types allow water to seep into the ground, and thus reduce the amount of overland flow which might carry sediments and pollutants into nearby lakes and streams. Approximately 78% of the Lost Lake watershed consists of either forests or forested wetlands.

Lost Lake is classified as a shallow, lowland drainage lake. Drainage lakes receive water primarily through stream input, however surface runoff, groundwater inputs, and precipitation contribute water as well. Drainage lakes also often contain an outlet stream which is either continuous or intermittent in times of low water supply. While drainage lakes tend to fair against low precipitation better than seepage or spring lakes (which do not have a stream input source), drought conditions in northern Wisconsin have greatly reduced the amount of regional precipitation in the past 8 – 10 years to the point at which impacts may even be seen on a drainage lake such as Lost Lake. It should be noted that during 2010 field surveys, Onterra staff did not observe significantly low water levels on Lost Lake.

As mentioned previously in the Town-Wide Watershed Section, one of the most sensitive areas of the watershed is the immediate shoreland area. This area of land is the last source of protection for a lake against surface water runoff, and is also a critical area for wildlife habitat. In late summer of 2010, Lost Lake's immediate shoreline was assessed in terms of its development. Lost Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 1.2 miles of natural/undeveloped and developed-natural shoreline were observed during the survey (Figure 8.6.2-2). These shoreland types provide the most benefit to the lake and should be left in their natural state if at all possible. During the survey, 1.6 miles of urbanized and developed–unnatural shoreline (32% of the total shoreline) was observed. If restoration of the Lost Lake shoreline is to occur, primary focus should be placed on these shoreland areas as they currently provide little benefit to, and actually may harm, the lake ecosystem. The Lost Lake Shoreline Condition Map displays the location of these shoreline lengths around the entire lake.

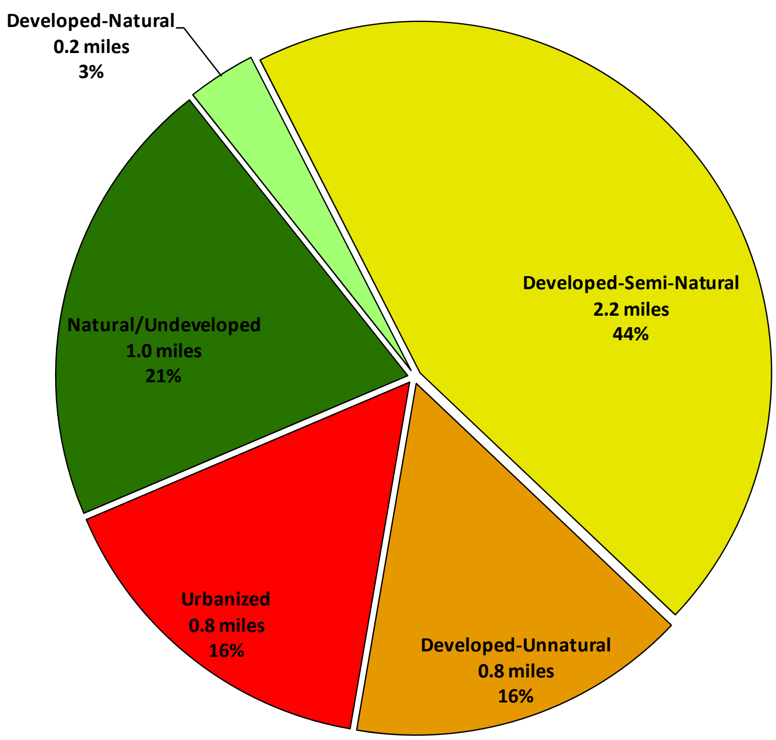


Figure 8.6.2-2. Lost Lake shoreland categories and total lengths. Based upon a late summer 2010 survey. Locations of these categorized shorelands can be found on the Lost Lake Shoreline Condition Map.

8.6.3 Lost Lake Water Quality

Water quality data was collected from Lost Lake on three occasions in summer of 2010. Onterra staff sampled the lake for a variety of water quality parameters including total phosphorus, chlorophyll-*a*, Secchi disk clarity, temperature, and dissolved oxygen.

Citizens Lake Monitoring Network (CLMN) volunteers have monitored water quality through an advanced monitoring program for greater than a decade (1997-2010). These efforts provide a considerable amount of historical data, which may be compared against recent data in an effort to detect any trends that may be occurring in the water quality of the lake. These efforts should be continued in order to understand trends in the water quality of Lost Lake.

During this time, summer average total phosphorus concentrations have fluctuated slightly, ranging between 19 and 53 µg/L (Figure 8.6.3-1). The majority of these average values rank within the TSI good category. A weighted value across all years is slightly lower than the average for shallow, lowland drainage lakes in the state of Wisconsin. As with the total phosphorus values, average chlorophyll-*a* concentrations have also shown some variation within the past decade (Figure 8.6.3-2). Most values fall within the TSI good category, though the weighted average across all years is somewhat higher than the average for other shallow, lowland drainage lakes statewide.

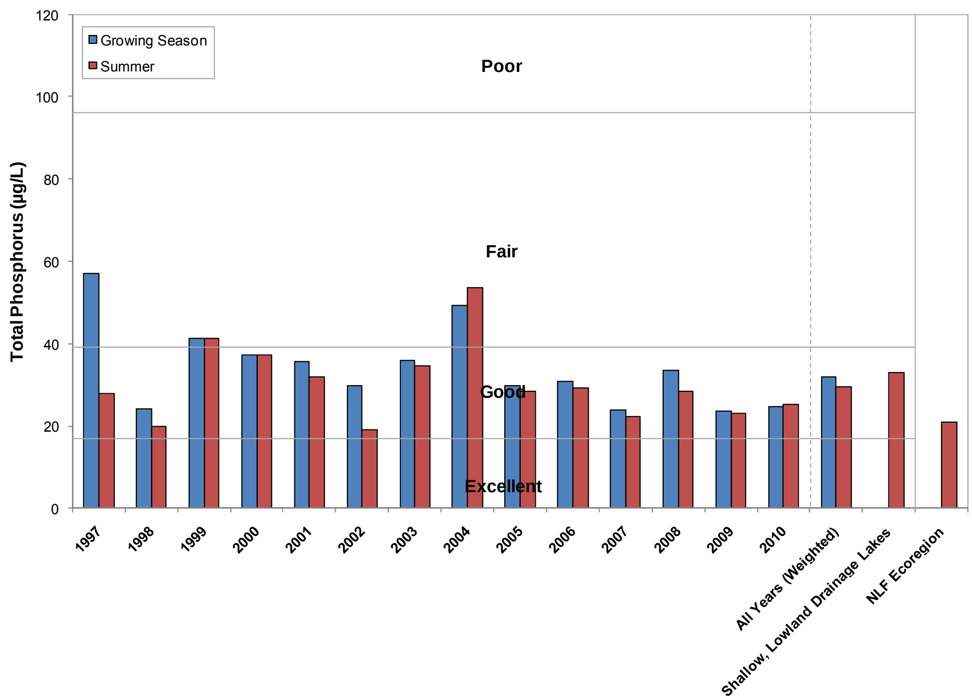


Figure 8.6.3-1. Lost Lake, state-wide shallow, lowland drainage lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Measurements of Secchi disk clarity span a longer timeframe than the other two primary water quality parameters, and show a considerable amount of annual variance (Figure 8.6.3-3). All summer averages range between categories of good and excellent, and a weighted average across all years is greater than the average for shallow, lowland drainage lakes statewide. Secchi disk clarity is often tied to algal abundance – the more algae in the water column, the less clear the water will be. Comparing the chlorophyll-*a* dataset with the Secchi disk clarity dataset, it is apparent that during most years the two parameters do indeed have an inverse relationship. For example, in years 1998, 2002, and 2004 chlorophyll-*a* concentrations were relatively low in the lake, and in those same years some of the highest Secchi disk depth averages are seen. On the other hand, in years 2000, 2006 and 2010 average chlorophyll-*a* concentrations were particularly high for Lost Lake and, as a result, the average Secchi disk depth was fairly low during those years.

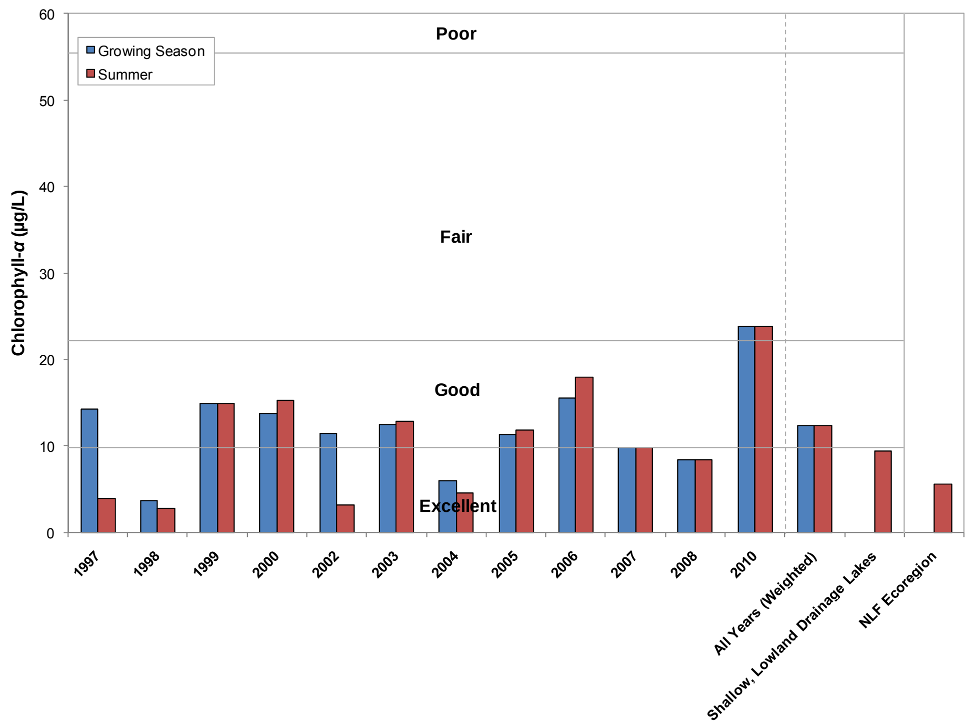


Figure 8.6.3-2. Lost Lake, state-wide shallow, lowland drainage lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Of course, other factors besides algal abundance determine the water clarity within a lake. Suspended sediments may cause turbitity within the lake, while organic acids (sometimes called "tannins") may stain the water a darker color temporarily when washed in from surrounding wetlands. These organic acids are byproducts of decomposing plant material.

Lost Lake Trophic State

The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values range in values spanning from lower mesotrophic to eutrophic (Figure 8.6.3-4). In general, the best values to use in judging a lake's trophic state are the biological parameters; therefore, relying primarily on total phosphorus and chlorophyll-*a* TSI values, it can be concluded that Lost Lake is in a eutrophic state.

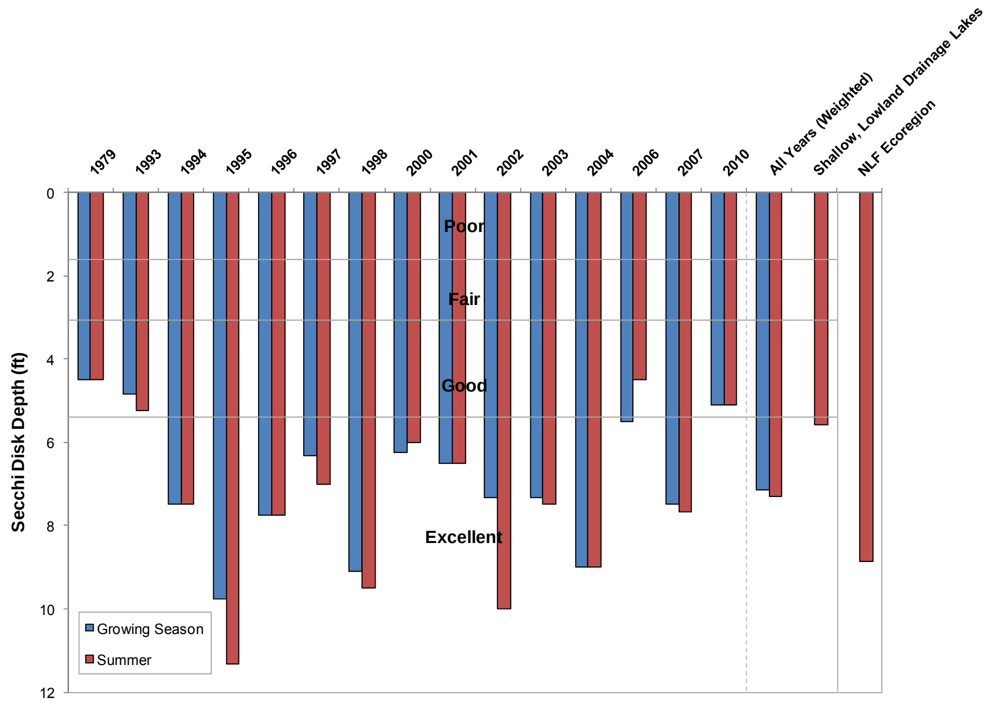


Figure 8.6.3-3. Lost Lake, state-wide shallow, lowland drainage lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

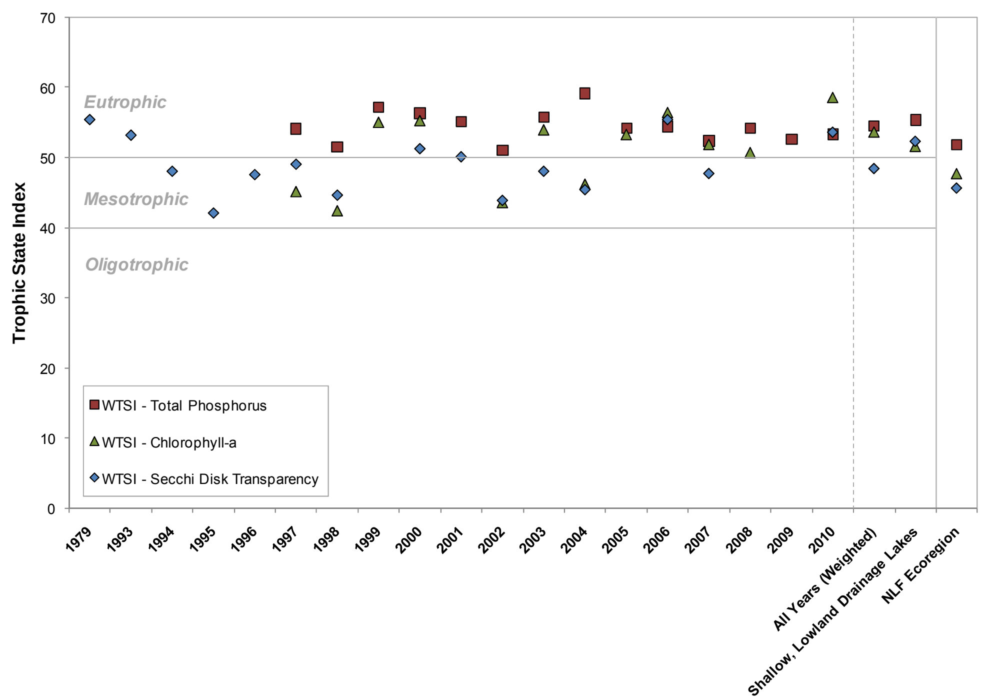


Figure 8.6.3-4. Lost Lake, state-wide shallow, lowland drainage lakes, and regional Wisconsin Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Lost Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Lost Lake by Onterra staff. Graphs of those data are displayed in Figure 8.6.3-5 for all three sampling events.

Lost Lake remained thoroughly mixed throughout most of the summer months in 2010, though a small amount of stratification likely occurs periodically in the deeper portions of the lake as seen in the June and July profile. This is not uncommon in lakes that are moderate in size and fairly deep. Energy from the wind is sufficient to mix the lake from top to bottom, distributing oxygen throughout the epilimnion and hypolimnion and keeping water temperatures fairly constant within the water column.

Decomposition of organic matter along the lake bottom is likely the cause of the slight decrease in dissolved oxygen observed in July and August. Despite this late summer dip, dissolved oxygen levels remained sufficient in the upper 15 feet of the water column to support most aquatic life found in northern Wisconsin lakes.

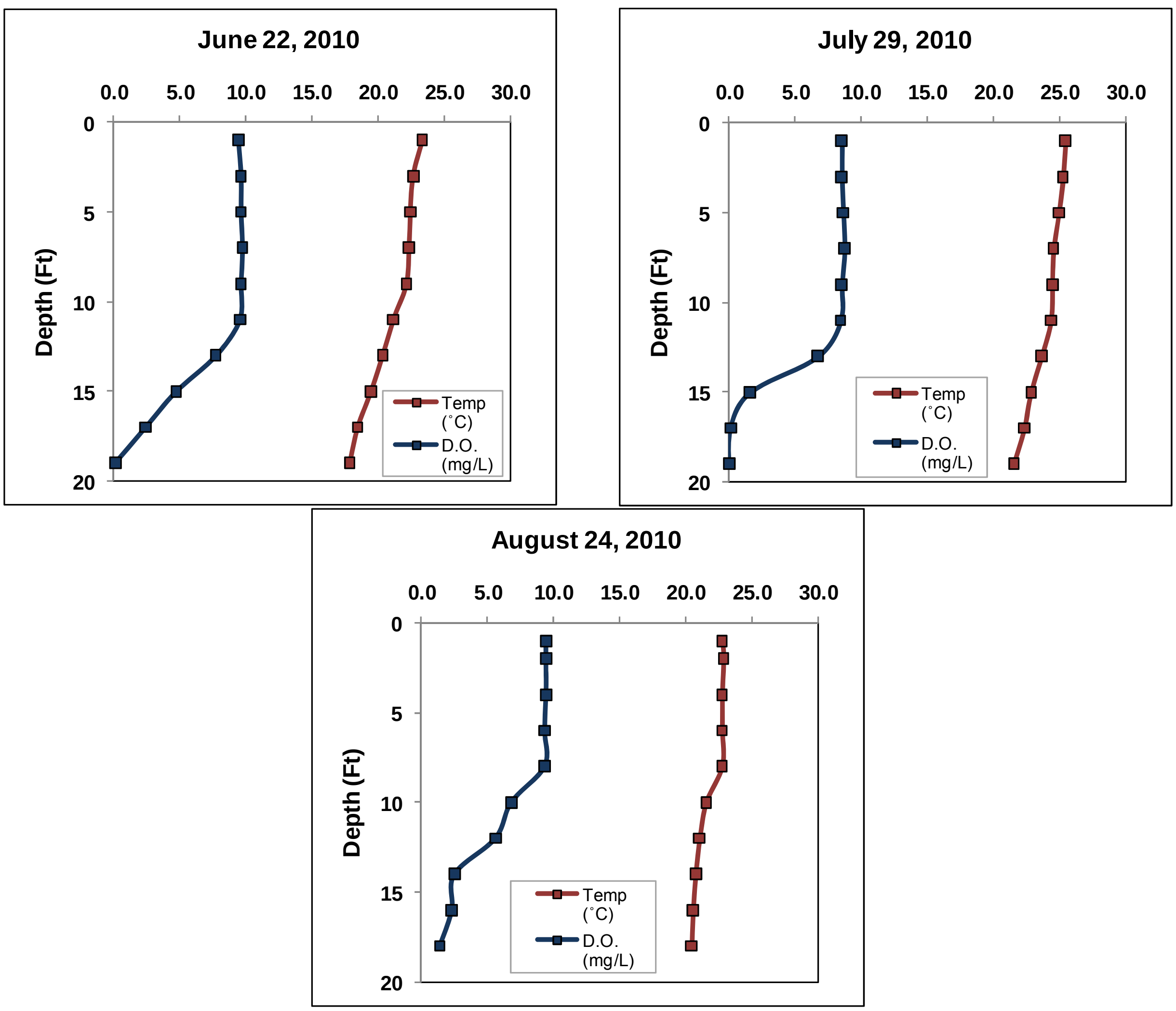


Figure 8.6.3-5. Lost Lake dissolved oxygen and temperature profiles.

8.6.4 Lost Lake Aquatic Vegetation

The curly-leaf pondweed survey was conducted on Lost Lake on June 21-22, 2010. This meander-based survey did not locate any occurrences of this exotic plant, and it is believed that this species either does not currently exist in Lost Lake or is present at an undetectable level.

The aquatic plant point-intercept survey was conducted on Lost Lake on July 27-28, 2010 by Onterra. The floating-leaf and emergent plant community mapping survey was completed the following day (July 29, 2010) to create the aquatic plant community map (Lost Lake Community Map) during this time. During these surveys, 41 species of native aquatic plants were located in Lost Lake; 28 of these species were sampled during the point-intercept survey (Table 8.6.4-1 and Figure 8.6.4-1).

A testament to the high water clarity in Lost Lake, aquatic plants were found growing to a depth of 15 feet, although the majority of point-intercept locations with plants were found growing out to 13 feet. Of the 252 point-intercept locations sampled within the littoral zone, approximately 81% contained aquatic vegetation. Approximately 75% of the point-intercept sampling locations where sediment data was collected at contained fine, organic substrate (muck), 23% contained sand, and 2% were determined to be rocky (Town-Wide Fisheries Section, Figure 3.4-5).

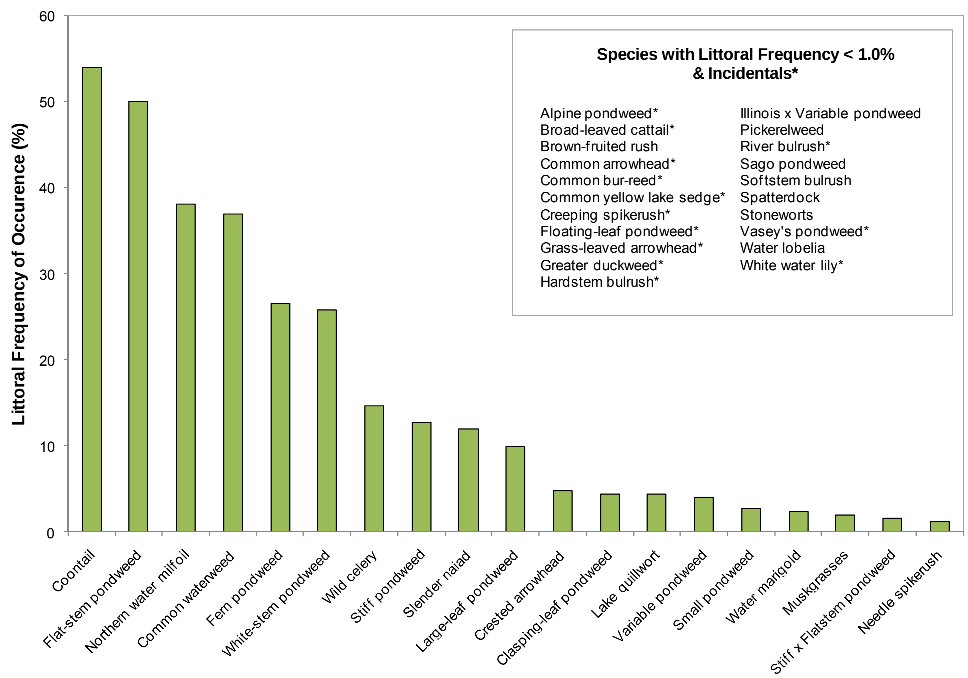


Figure 8.6.4-1 Lost Lake aquatic plant littoral frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

It is unrealistic to quantitatively define the term “nuisance,” as this designation is subjective by nature. However, WDNR Science Services researchers indicate that nuisance levels of certain plant species likely occur when their frequency of occurrences exceed 35% (Alison Mikulyuk, personal comm.). Plants that can potentially cause nuisance conditions are those that can grow to and/or near the water surface and contain a high biomass (i.e bushy appearance) at or near the surface. Figure 8.6.4-1 (above) shows that coontail, flat-stem pondweed, northern water milfoil, and common waterweed were the most frequently encountered plants within Lost Lake.

Coontail and common waterweed at these levels have the potential to impact navigation, especially when the plants collect into dense surface mats. Even at these frequencies, flat-stem pondweed is often not considered a nuisance due to this species' thin leaf structures. At times, northern water milfoil can be found forming dense monocultures similar to their exotic relative, Eurasian water milfoil. Although northern water milfoil colonies typically do not reach the surface, decreasing water levels during the summer can bring these plants into the range that can hamper navigation.

All four of these species are at levels that exceed this somewhat arbitrary benchmark. According to stakeholder respondents, excessive aquatic plant growth was the highest ranked factor negatively impacting the lake (Appendix B, Question #19 and #20) and approximately 71% of respondents indicated that aquatic plant control is either definitely or probably needed on the lake (Question #22).

In 2007, the WDNR completed a point-intercept survey on Lost Lake and believed to have found Eurasian water milfoil in a few places around the lake. Onterra visited the lake in 2008 and collected suspect northern water milfoil that exhibited morphological traits similar to Eurasian water milfoil (high leaflet count) that were then sent to a laboratory for genetic testing to determine it the plants were in fact the exotic species or possibly a hybrid variety. Unfortunately, these samples were not tested and that laboratory ceased testing milfoil DNA.

In 2009, additional samples were collected from Lost Lake and were sent to a new laboratory at Grand Valley State University in Michigan for DNA analysis. All five samples sent in were identified as pure northern water milfoil and not Eurasian water milfoil or a hybrid variety. While some level of uncertainty remains surrounding this issue, the fact is that Eurasian water milfoil was not located in Lost Lake during any of the intensive 2010 surveys. If Eurasian water milfoil does exist in Lost Lake, it is currently at population levels that are not affecting the lake ecosystem.

Of the seven milfoil species (genus *Myriophyllum*) found in Wisconsin, two (northern water milfoil and whorled water milfoil) were located from Lost Lake. Of the seven Town of Saint Germain project waters, whorled water milfoil was only observed in Lost Lake. Northern water milfoil, arguably the most common milfoil species in Wisconsin lakes, is frequently found growing in soft sediments and high water clarity. In Lost Lake, large amounts of northern water milfoil were uprooting and aggregating into large floating maps along the shoreline. Uprooting of plants, especially if exacerbated by fluctuating water levels, is often associated with heavy wave action caused by intense motor boat activity.

While it remains unclear if the uprooting of northern water milfoil is caused by motor boat activity on Lost Lake, it is true that Lost Lake's shoreline is quite developed and the lake endures a great amount of watercraft activity. Approximately 21% of the watercrafts used by Lost Lake stakeholder survey respondents were motor boats with greater than a 25 hp motor and 17% of the watercrafts used were pontoon boats (Appendix B, Question #12). As indicated within the Watershed Sections, the two shoreland condition classifications that indicate man-made disturbance include Developed-Unnatural and Urbanized. Lost Lake contains the second highest

(Big St. Germain contains the highest) percentage of its shoreline with these classifications of the five project lakes (Alma and Moon Lakes were excluded) where this assessment was made (Town-Wide Watershed Section, Table 3.1-1). Shifting the condition of Lost Lake's shoreline towards more natural shorelines will be important to protect certain vulnerable aquatic plant species and further degradation of Lost Lake's aquatic plant community.

Table 8.6.4-1. Aquatic plant species located in the Lost Lake during the 2010 aquatic plant surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)
Emergent	*Bolboschoenus fluviatilis*	River bulrush	5
	Carex utriculata	Common yellow lake sedge	7
	Eleocharis palustris	Creeping spikerush	6
	Pontederia cordata	Pickerelweed	9
	Sagittaria latifolia	Common arrowhead	3
	Schoenoplectus acutus	Hardstem bulrush	5
	Schoenoplectus tabernaemontani	Softstem bulrush	4
	Typha latifolia	Broad-leaved cattail	1
FL	*Nymphaea odorata*	White water lily	6
	Nuphar variegata	Spatterdock	6
FL/E	*Sparganium eurycarpum*	Common bur-reed	5
Submergent	*Chara spp.*	Muskgrasses	7
	Ceratophyllum demersum	Coontail	3
	Elodea canadensis	Common waterweed	3
	Isoetes lacustris	Lake quillwort	8
	Lobelia dortmanna	Water lobelia	10
	Myriophyllum verticillatum	Whorled water milfoil	8
	Megalodonta beckii	Water marigold	8
	Myriophyllum sibiricum	Northern water milfoil	7
	Nitella spp.	Stoneworts	7
	Najas flexilis	Slender naiad	6
	Potamogeton alpinus	Alpine pondweed	9
	Potamogeton natans	Floating-leaf pondweed	5
	Potamogeton vaseyi	Vasey's pondweed	10
	Potamogeton spathuliformis	Illinois x Variable pondweed	N/A
	Potamogeton haynesii	Stiff x Flatstem pondweed	N/A
	Potamogeton pusillus	Small pondweed	7
	Potamogeton gramineus	Variable pondweed	7
	Potamogeton richardsonii	Clasping-leaf pondweed	5
	Potamogeton amplifolius	Large-leaf pondweed	7
	Potamogeton strictifolius	Stiff pondweed	8
	Potamogeton praelongus	White-stem pondweed	8
	Potamogeton robbinsii	Fern pondweed	8
	Potamogeton zosteriformis	Flat-stem pondweed	6
	Stuckenia pectinata	Sago pondweed	3
	Vallisneria americana	Wild celery	6
S/E	*Eleocharis acicularis*	Needle spikerush	5
	Juncus pelocarpus	Brown-fruited rush	8
	Sagittaria graminea	Grass-leaved arrowhead	9
	Sagittaria cristata	Crested arrowhead	9
FF	*Spirodela polyrhiza*	Greater duckweed	5

FL = Floating Leaf
FL/E = Floating Leaf and Emergent
S/E = Submergent and Emergent
FF = Free Floating

An incredible 41 species of aquatic plants (including incidentals) were found in Lost Lake and because of this, one may assume that the system would also have a high diversity. As discussed earlier, how evenly the species are distributed throughout the system also influence the diversity. The diversity index for Lost Lake's plant community (0.90) ranks the second highest (tied with Found Lake) of the seven project lakes and is above the Northern Lakes and Forests Lakes ecoregion value (0.86).

As explained earlier in the Primer on Data Analysis and Data Interpretation Section, the littoral frequency of occurrence analysis allows for an understanding of how often each of the plants is located during the point-intercept survey. Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while coontail was found at 54% of the sampling locations, its relative frequency of occurrence is 17%. Explained another way, if 100 plants were randomly sampled from Lost Lake, 17 of them would be coontail. This distribution can be observed in Figure 8.6.4-2, where together six species account for 74% of the population of plants within Lost Lake, while the other 22 species account for the remaining 26%. Thirteen additional species were located from the lake but not from of the point-intercept survey, as indicated in Figure 8.6.4-1 as incidentals.

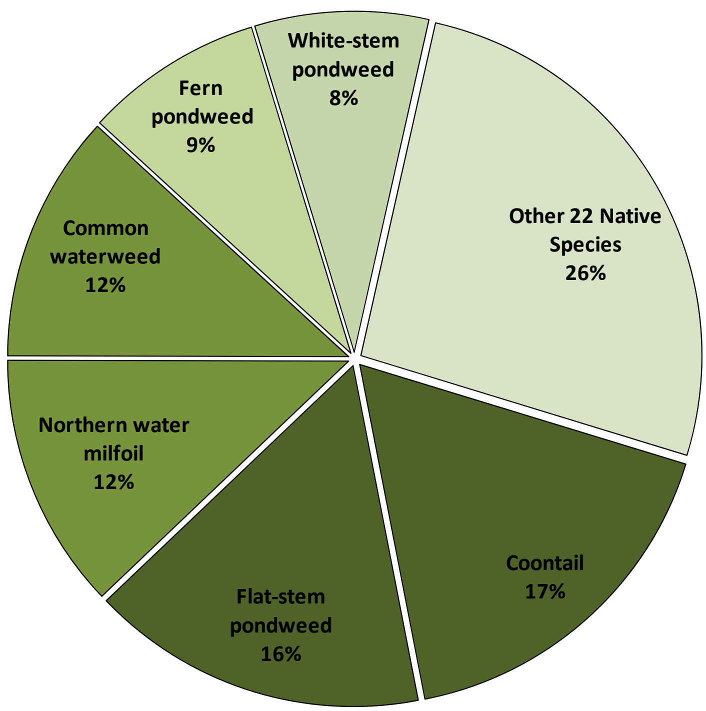


Figure 8.6.4-2 Lost Lake aquatic plant relative frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

Lost Lake's average conservatism value is higher than that state median, and is equal to the ecoregion median. Of the Town of Saint Germain project waters, only Big St. Germain Lake had a lower average coefficient of conservatism value. This indicates that the plant community of Lost Lake is moderately indicative of a disturbed system. Again, this is not surprising considering Lost Lake is the second most developed of the project waters and for a relatively shallow lake with plants growing across most of it, endures a large amount of watercraft activity.

Combining Lost Lake's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in an exceptionally high value of 35.2 which is well above the median values of the ecoregion and state but is slightly below the average of the seven project waters (Town-Wide Aquatic Plant Section, Figure 3.3-6).

The quality of Lost Lake is also indicated by the incidence of emergent and floating-leaf plant communities that occur in shallower regions of the lake. The 2010 community map indicates that approximately 8.4 acres of the lake contains these types of plant communities (Lost Lake Map, Table 8.6.4-2). Thirteen floating-leaf and emergent species were located on Lost Lake (Table 8.6.4-1), all of which provide valuable wildlife habitat.

Table 8.6.4-2. Lost Lake acres of emergent and floating-leaf plant communities from the 2004 and 2010 community mapping survey.

	Acres	
Plant Community	**2004**	**2010**
Floating-leaf	0.8	0.6
Emergent	0.7	0.5
Floating-leaf/Emergent	7.5	7.3
Total	**9.0**	**8.4**

Continuing the analogy that the community map represents a 'snapshot' of the emergent and floating-leaf plant communities, replications of this survey through time will provide a valuable understanding of the dynamics of these communities within Lost Lake. This is important, because these communities are often negatively affected by recreational use and shoreland development. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelines when compared to undeveloped shorelines in Minnesota Lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines.

The 2010 community mapping survey was the second survey of this type to be conducted, the first being conducted by Onterra in 2004. As the Community Map shows, these communities remain relative similar between the two surveys. The only notable differences appear to be related to riparian use patterns such as boat traffic coming/going from a pier and/or intentional removal of the plants in front of one's property. In most cases, there appears to be an increase of this activity but there appeared to be examples where colony expansion was related to a lack of property use. As indicated in the Primer on Data Analysis and Data Interpretation Section, riparians are allowed without a permit to remove a 30-foot width area of native aquatic vegetation in front of their property (that must include their pier) out into the lake as far as needed for access as long as all plants are removed from the lake. The use of herbicides without a permit or without being a licensed applicator in aquatic situations carries with it strict penalties and potentially great negative impacts to the ecosystem.

8.6.5 Lost Lake Implementation Plan

The Implementation Plan below is a result of collaborative efforts between Lost Lake stakeholders, the TSGLC, and ecologists/planners from Onterra. This plan provides goals and actions created to protect the quality and integrity of Lost Lake and will serve as reference for keeping stakeholders on track and focused upon these science-driven management activities.

While the Town of Saint Germain project lakes are geographically similar, they are definitely ecologically diverse. The latter is detailed throughout this report. This diversity leads to the need for diverse plans aimed at managing the lakes. Some of the project lakes have more complicated management needs than others, but in general most of the lakes', including Lost Lake's, needs center on protecting the current quality of the lake as opposed to performing activities aimed at enhancing or resolving particular of issues. The Town-wide Implementation Plan will serve each of the project lakes well in terms of protecting their current condition; therefore, Lost Lake's implementation plan is compiled by describing how Lost Lake stakeholders should proceed in implementing applicable portions of the town-wide implementation plan for their lake.

Town-wide Implementation Plan – Specific to Lost Lake

Town-wide Management Goal 1: Promote Lake Protection and Enjoyment through Stakeholder Education

Management Action: Support the Lakes Committee to promote safe boating, water quality, public safety, and quality of life on Lost Lake.

Timeframe: Continuation of current efforts

Facilitator: Lost Lake Association

Description: Lost Lake stakeholders can assist in the implementation of this action by participating in the TSGLC's town-wide initiatives. Participation may include presentation of educational topics, volunteering at local and regional events, participating in committees, or simply notifying the lakes committee of concerns involving Lost Lake and its stakeholders.

Action Steps: See description above.

Town-wide Management Goal 2: Maintain Current Water Quality Conditions

Management Action: Monitor water quality through WDNR Citizens Lake Monitoring Network (CLMN) or similar program.

Timeframe: Continuation of current efforts

Facilitator: Lost Lake Association

Description: Currently, no volunteer water quality collection is occurring on Lost Lake. Participation with the program ceased in 2008. The first step to maintaining water quality conditions on the lake is to enroll in the CLMN. Following enrollment into the program, Secchi disk clarity data will be collected during the open water season. The importance of this is two-fold. First, following collection, these data will automatically be entered onto SWIMS, an Internet warehouse of water quality data from Wisconsin waterbodies. This information can be accessed in future years so that comparisons can be made to historical data and changes in lake water quality can be scientifically and accurately identified. Secondly, following one year of enrollment within the basic CLMN program, Lost Lake will become eligible to enroll in the CLMN's Advanced Monitoring program. Although the CLMN is not currently accepting new lake groups into the advanced program, when the program expands Lost Lake volunteers will already meet eligibility criteria and can begin monitoring other water quality parameters on the lake.

Action Steps: See description above.

Management Action: Reduce phosphorus and sediment loads from shoreland watershed to the Town of Saint Germain project lakes.

Timeframe: Continuation of current efforts

Facilitator: Lost Lake Association

Description: As a result of the Shoreland Assessment survey that took place in 2010, 32% of the Lost Lake shoreline was classified as Developed-Unnatural. These areas may be impacting the lake in a negative manner by not filtering surface runoff water and limiting the amount of available habitat for both terrestrial and aquatic organisms.

If property owners of these areas wish to enhance their shoreline, they may work with the facilitator named by the TSGLC to look into restoration options that may provide ecological benefits to their shoreland properties. The facilitator will have cost-sharing opportunities available for the property owner as well. The Town of Saint Germain project lakes are no stranger to shoreland restoration projects. 14 properties on Found Lake and a camp on Moon Lake have both received funding to participate in WDNR studies in which ecological benefits of shoreland restoration were examined. These two locations may serve as demonstration models to present to property owners who are interested in restoring their shoreland areas.

Action Steps: See description above.

Town-wide Management Goal 3: Prevent Aquatic Invasive Species establishment within Lost Lake

Management Action: Maintain and expand stakeholder education.

Timeframe: Continuation of current efforts

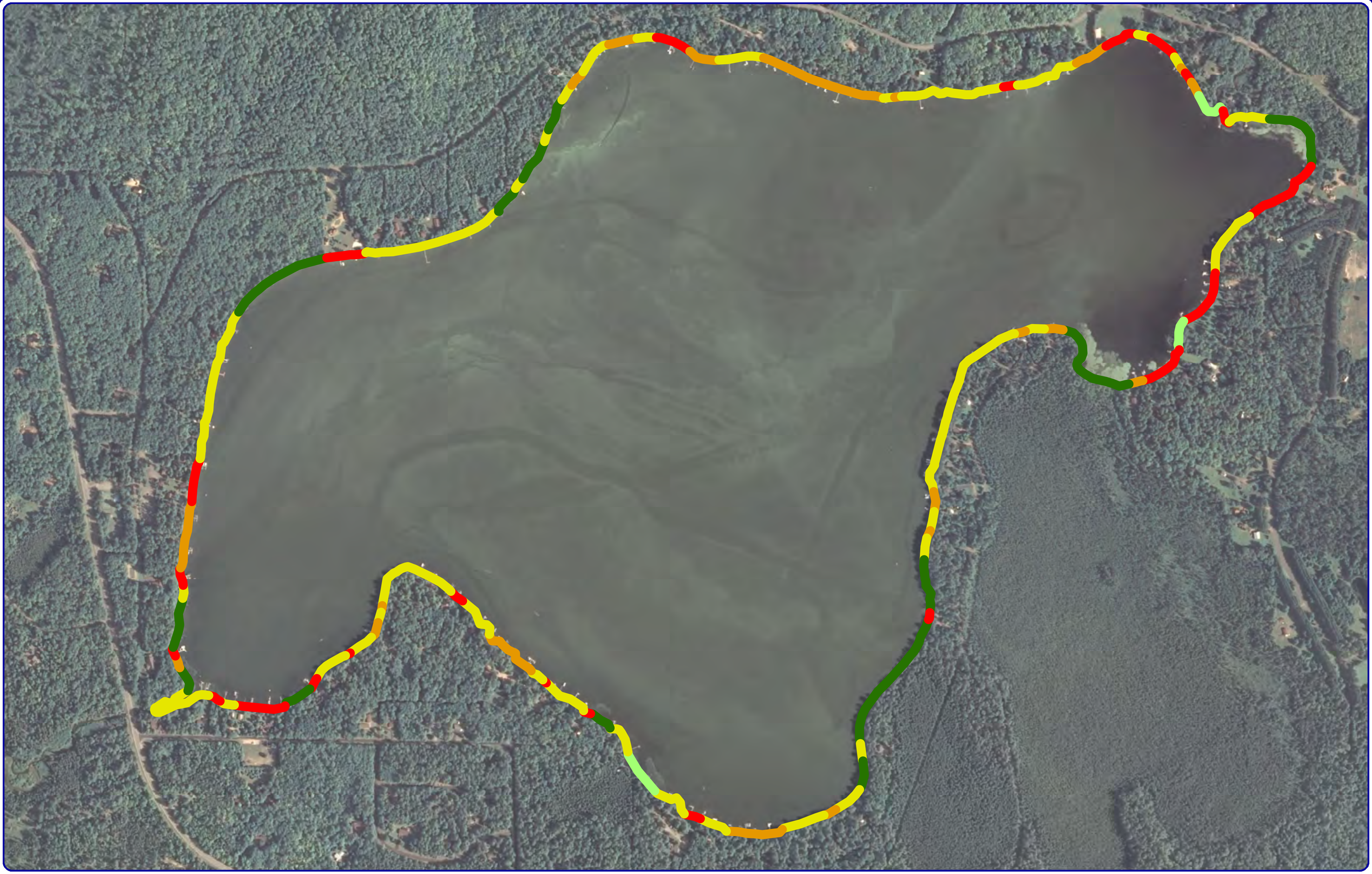
Facilitator: Lost Lake Association

Description: Lost Lake has a single public access point on the lake's southeast side. As a result, the threat of AIS introduction is increased when compared to lakes with limited or no public access.

Lost Lake stakeholders can work together with the TSGLC to reduce the chances that AIS find their way into the lake through numerous opportunities. By working with the TSGLC, property owners can learn proper boat cleansing techniques and AIS identification. Additionally, volunteers should continue work with the CBCW program. By monitoring the Lost Lake public access point with CBCW volunteers, potential AIS introduction to the lake is reduced. An added benefit is that this interaction allows an opportunity to educate boaters about AIS and the importance of boat cleaning and inspection.

AIS monitoring should occur on a regular basis within the lake. Because Lost Lake is a fairly large, heavily utilized lake, professional AIS surveys should occur once every 5 years. In between these professional surveys, the TSGLC can train volunteers not only on AIS identification, but methods to monitor the lake for AIS as well. These surveys were conducted as part of this project, but continuing them may be difficult as times of volunteerism fluctuate. It is the responsibility of the TSGLC and Lost Lake Association to constantly recruit new volunteers. This will ensure that surveys are completed well into the future.

Action Steps: See description above.



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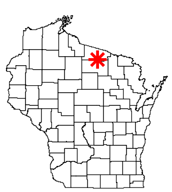
Onterra LLC
Lake Management Planning
815 Prospect Rd
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Orthophotography: NAIP, 2010
Shoreline Condition: Onterra, 2010
Map Date: August 17, 2011
Filename: Lost_Map1_SA_2010.mxd



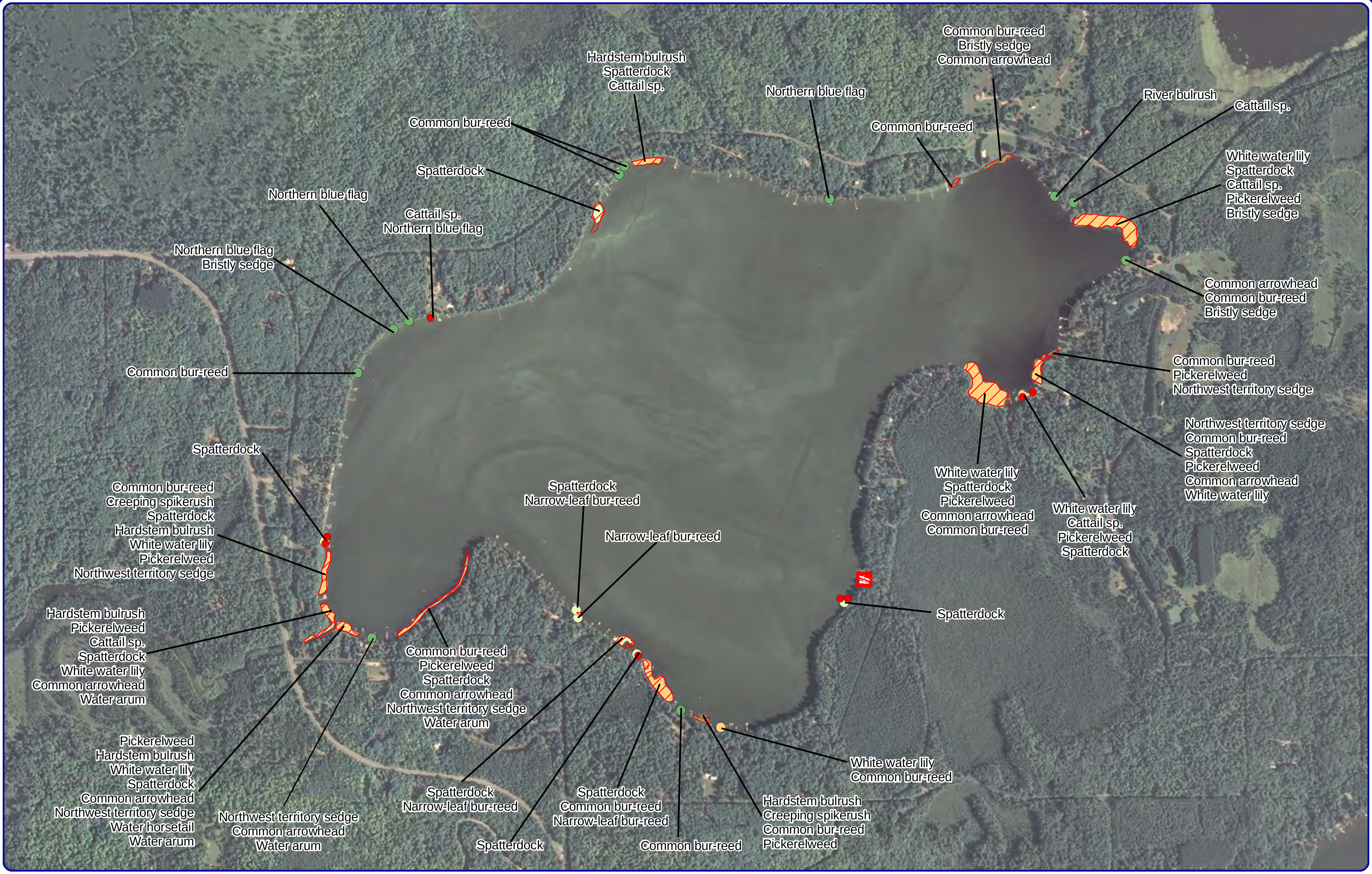
Project location in Wisconsin

Legend

- Natural/Undeveloped
- Developed-Natural
- Developed-Semi-Natural
- Developed-Unnatural
- Urbanized

Lost Lake - Map 1
Saint Germain Lakes
Vilas County, Wisconsin

Shoreline Condition



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Onterra LLC
Lake Management Planning

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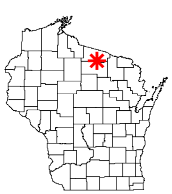
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Aquatic Plants: Onterra, 2004 & 2010
Orthophotography: NAIP 2010
Map date: March 29, 2011
Filename: Map2_Lost_Comm_2010.mxd



Project Location in Wisconsin

Legend

Small Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent
- 2004 Small Plant Community

Large Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent
- 2004 Large Plant Community

Lost Lake - Map 2

Saint Germain Lake

Vilas County, Wisconsin

Aquatic Plant Communities

8.7 FOUND LAKE

8.7.1 An Introduction to Found Lake

Found Lake, Vilas County, is a lowland drainage lake with a maximum depth of 21 feet and a surface area of 326 acres. This upper mesotrophic lake has a relatively small watershed when compared to the size of the lake. Found Lake contains 39 native plant species, of which common waterweed was the most common plant. The only exotic plant species observed in Found Lake was purple loosestrife, found along the lake's shoreline in a single location.

Field Survey Notes

Beautiful conditions for the plant survey. Much wildlife spotted along southeaster shoreline – deer, eagles, and a loon.

At one point during the community mapping survey, we had boat problems and one boat had to pull the other back to the landings. Luckily, the issue was resolved at the boat landing. And lucky there were two crews on the lake that day.

Photo 8.7.1-1 Found Lake, Vilas County

Lake at a Glance – Found Lake

Morphology	
Acreage	326.0
Maximum Depth (ft)	21.0
Mean Depth (ft)	10.5
Volume (acre-feet)	3,429.0
Shoreline Complexity	2.17
Vegetation	
Curly-leaf Survey Date	June 22, 2010
Comprehensive Survey Date	July 28 & 29, 2010
Number of Native Species	33 + 6 incidental = 39
Threatened/Special Concern Species	1 – Vasey's Pondweed
Exotic Plant Species	1 – Purple loosestrife
Simpson's Diversity	0.90
Average Conservatism	7.2
Water Quality	
Wisconsin Lake Classification	Class 3 (shallow, lowland drainage lake)
Trophic State	Upper Mesotrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	9:1

8.7.2 Found Lake Watershed Assessment

Found Lake's watershed is 3,195 acres in size. The land cover consists primarily of forested wetlands (35% or 1,110 acres) and forested land (39% or 1,229 acres) with the lake surface and rural open space making up 10% and 6% of the watershed land cover types, respectively (Figure 8.7.2-1). Three cover types make up the remaining 10% of the watershed – wetlands (5%), pasture/grass (3%) and row crops (2%). Overall, the land use within Found Lake's watershed is that which exports little pollution to the lake. Forested lands allow water to seep into the ground, and thus reduce the amount of overland flow which might carry sediments and pollutants into nearby lakes and streams. The watershed to lake area ratio is 9:1, which indicates that the lake would be moderately sensitive to changes in land cover. Map 2 of the Town-Wide report displays the Found Lake watershed and its land cover.

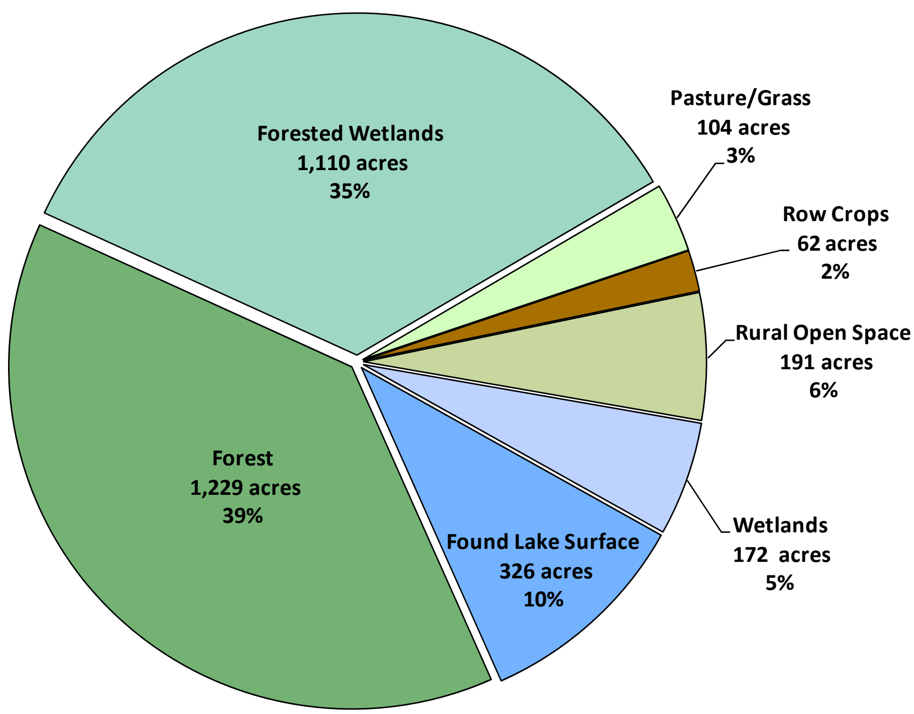


Figure 8.7.2-1. Found Lake watershed land cover types in acres. Based upon landcover classifications from the Multi-Resolution Land Characteristics Consortium (MRLC, 2006).

Found Lake is classified as a shallow, lowland drainage lake. Drainage lakes receive water primarily through stream input, however surface runoff, groundwater inputs, and precipitation contribute water as well. Drainage lakes also often contain an outlet stream which is either continuous or intermittent in times of low water supply. While drainage lakes tend to fair against low precipitation better than seepage or spring lakes (which do not have a stream input source), drought conditions in northern Wisconsin have greatly reduced the amount of regional precipitation in the past 8 – 10 years to the point at which impacts may even be seen on a drainage lake such as Found Lake. It should be noted that during 2010 field surveys, Onterra staff did not observe significantly low water levels on Found Lake.

As mentioned previously in the Town-Wide Watershed Section, one of the most sensitive areas of the watershed is the immediate shoreland area. This area of land is the last source of protection for a lake against surface water runoff, and is also a critical area for wildlife habitat. In late summer of 2010, Found Lake's immediate shoreline was assessed in terms of its development. Found Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 1.5 miles of natural/undeveloped and developed-natural shoreline were observed during the survey (Figure 8.7.2-2). These shoreland types provide the most benefit to the lake and should be left in their natural state if at all possible. During the survey, 0.7 miles of urbanized and developed–unnatural shoreline (16% of the total shoreline) was observed. If restoration of the Found Lake shoreline is to occur, primary focus should be placed on these shoreland areas as they currently provide little benefit to, and actually may harm, the lake ecosystem. The Found Lake Shoreline Condition Map displays the location of these shoreline lengths around the entire lake. As mentioned in the Town-wide portion of this plan, Found Lake has already seen restoration efforts take place on 14 neighboring properties along the lake. These areas may serve as a model for other Found Lake property owners who are interested in potentially initiating shoreland restoration projects on their properties.

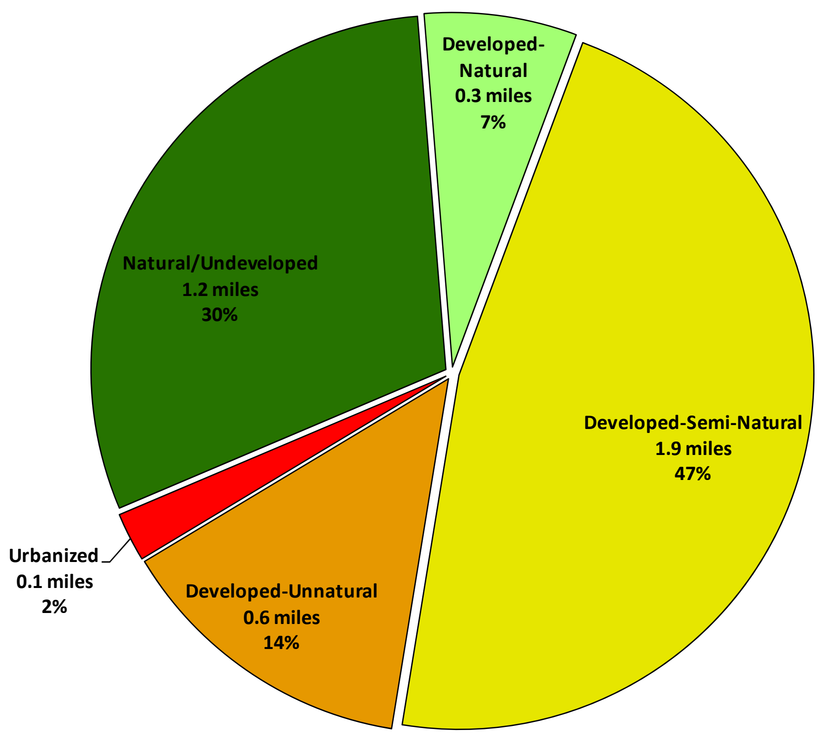


Figure 8.7.2-2. Found Lake shoreland categories and total lengths. Based upon a late summer 2010 survey. Locations of these categorized shorelands can be found on the Found Lake Shoreline Condition Map.

8.7.3 Found Lake Water Quality

Water quality data was collected from Found Lake on three occasions in summer of 2010. Onterra staff sampled the lake for a variety of water quality parameters including total phosphorus, chlorophyll-*a*, Secchi disk clarity, temperature, and dissolved oxygen.

Citizens Lake Monitoring Network (CLMN) volunteers have monitored water quality through an advanced monitoring program for greater than a decade. These efforts provide a considerable amount of historical data, which may be compared against recent data in an effort to detect any trends that may be occurring in the water quality of the lake. These efforts should be continued in order to understand trends in the water quality of Found Lake.

The summer average total phosphorus concentrations during this time period have remained fairly constant, ranging between 17.7 and 26.0 µg/L (Figure 8.7.3-1). These average values all rank within the TSI good category. A weighted value across all years is lower than the average for shallow, lowland drainage lakes in the state of Wisconsin. As with the total phosphorus values, average chlorophyll-*a* concentrations have also shown very little variation within the past decade (Figure 8.7.3-2). Most values fall within the TSI excellent category, and the weighted average across all years is lower than the average for other shallow, lowland drainage lakes statewide. As indicated by the comparison to the TSI categories of similar lakes statewide, the total phosphorus and chlorophyll-*a* concentrations in Found Lake are below average, which indicates great water quality.

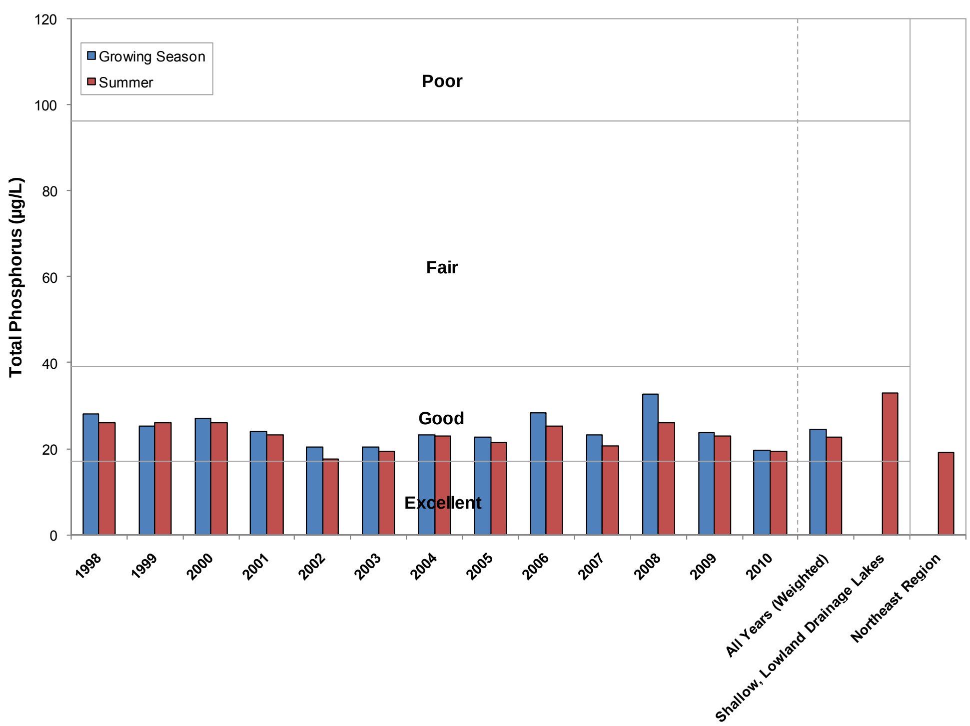


Figure 8.7.3-1. Found Lake, state-wide shallow, lowland drainage lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Measurements of Secchi disk clarity span a similar timeframe on Found Lake (Figure 8.7.3-3). Some of the highest recorded values on the lake include measurements of 6, 7, and 8 feet. All summer averages range between categories of good and excellent, and a weighted average across all years is greater than the average for shallow, lowland drainage lakes statewide. The averaged summer values are fairly consistent, though some small variations occur, particularly in years 1999, 2000, and 2008 when Secchi disk clarity averaged below 4.5 feet. It is unlikely that this is due to an increase in nutrients and thus algae, because as explained above, a noticeable difference was not noticed in these parameters during these years. The noticeable decrease in Secchi disk depth may be due to other environmental factors, such as precipitation. During years of higher precipitation, lakes receive more surface water runoff. This may include nutrients, but also sediments and natural organic acids from wetlands. Sediments may cause turbitity within the lake, while organic acids (sometimes called "tannins") may stain the water a darker color temporarily. These organic acids are byproducts of decomposing plant material in wetlands. This may be the case with Found Lake, which has significant amounts of forested wetlands within its watershed (See the Watershed Section). Heavy rainfall was experienced in much of the state during 2008, particularly in the beginning of the summer.

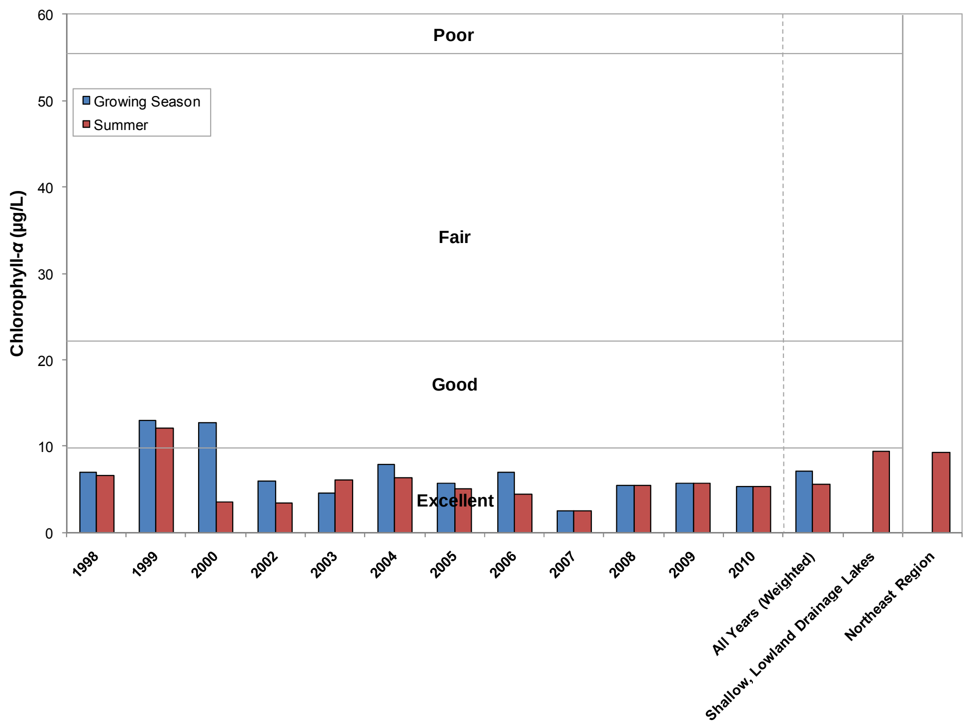


Figure 8.7.3-2. Found Lake, state-wide shallow, lowland drainage lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Found Lake Trophic State

The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values range in values spanning from lower mesotrophic to eutrophic (Figure 8.7.3-4). In general, the best values to use in judging a lake's trophic state are the biological parameters; therefore, relying primarily on total phosphorus and chlorophyll-*a* TSI values, it can be concluded that Found Lake is in an upper mesotrophic state.

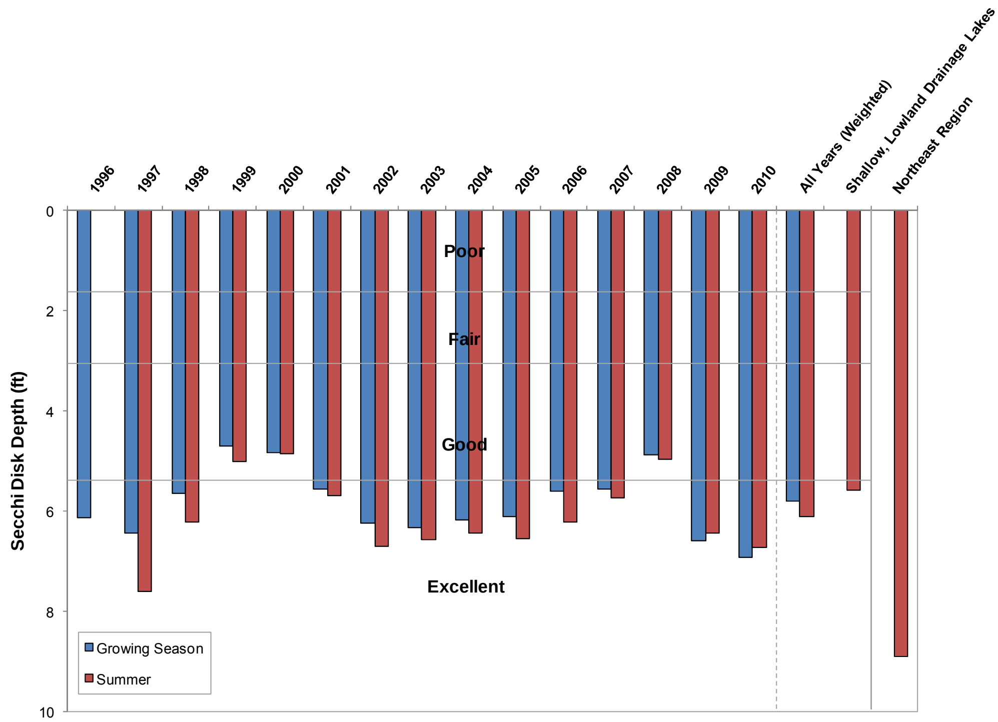


Figure 8.7.3-3. Found Lake, state-wide shallow, lowland drainage lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

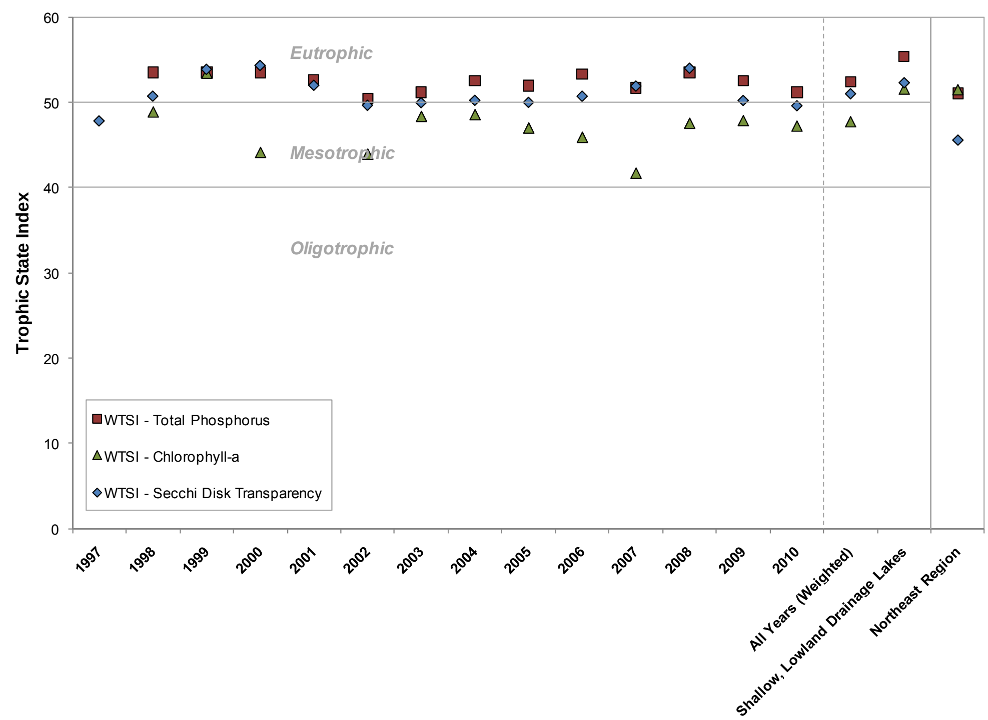


Figure 8.7.3-4. Found Lake, state-wide shallow, lowland drainage lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Found Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Found Lake by Onterra staff. Graphs of those data are displayed in Figure 8.7.3-5 for all three sampling events. Please note that in June, the lake was sampled at a pre-determined EPA (Environmental Protection Agency) sampling site. Following the June sampling event, a deeper location on the lake was identified. Because it is common in water quality monitoring to sample the deepest location of a lake, this new location was sampled in July and August.

Found Lake was weakly stratified during the summer months (July and August). In order for complete mixing of the water column to occur, the wind energy traveling over the lake must be sufficient enough to push overlying warm layers of water into the hypolimnion. This mixes the cooler waters there into the rest of the water column.

Decomposition of organic matter along the lake bottom is likely the cause of the slight decrease in dissolved oxygen observed in July and August. Despite this late summer dip, dissolved oxygen levels remained sufficient in the upper 15 feet of the water column to support most aquatic life found in northern Wisconsin lakes.

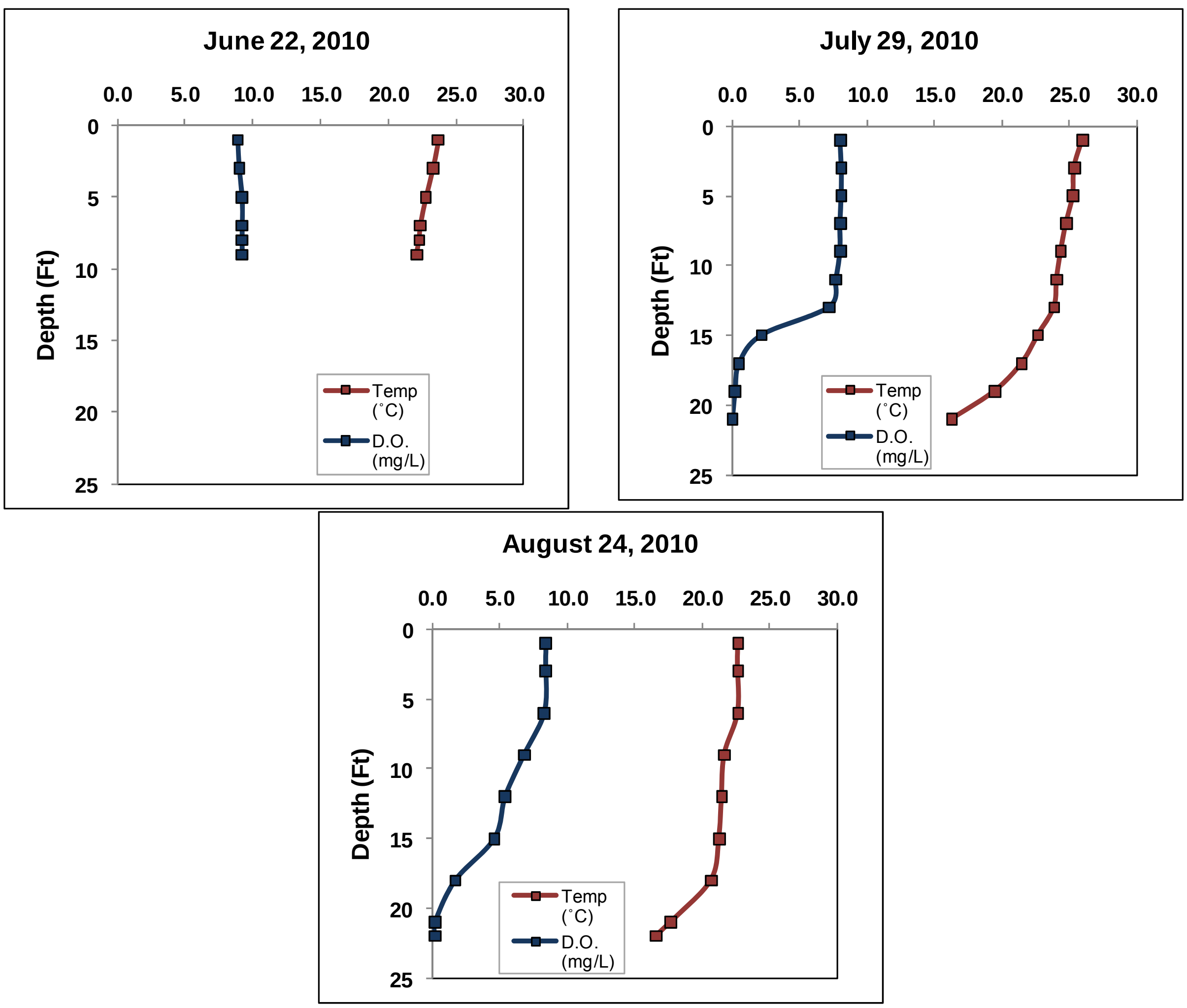


Figure 8.7.3-5. Found Lake dissolved oxygen and temperature profiles.

8.7.4 Found Lake Aquatic Vegetation

The curly-leaf pondweed survey was conducted on Found Lake on June 22, 2010. This meander-based survey did not locate any occurrences of this exotic plant, and it is believed that this species either does not currently exist in Found Lake or is present at an undetectable level. Eurasian water milfoil, also an aquatic invasive plant, was not located in Found Lake during any of the 2010 surveys.

The aquatic plant point-intercept survey was conducted on Found Lake on July 28-29, 2010 by Onterra. The floating-leaf and emergent plant community mapping survey was completed at the same time to create the aquatic plant community map (Found Lake Community Map) during this time. During these surveys, 39 species of native plants were located in Found Lake; 33 of these species were sampled during the point-intercept survey (Table 8.7.4-1 and Figure 8.7.4-1).

A testament to the high water clarity in Found, aquatic plants were found growing to a depth of 21 feet, although the majority of point-intercept locations with plants were found growing out to 15 feet or so. Of the 430 point-intercept locations sampled within the littoral zone, approximately 67% contained aquatic vegetation. Approximately 54% of the point-intercept sampling locations where sediment data was collected at contained fine, organic substrate (muck), 44% contained sand, and 2% were determined to be rocky (Town-Wide Fisheries Section, Figure 3.4-5).

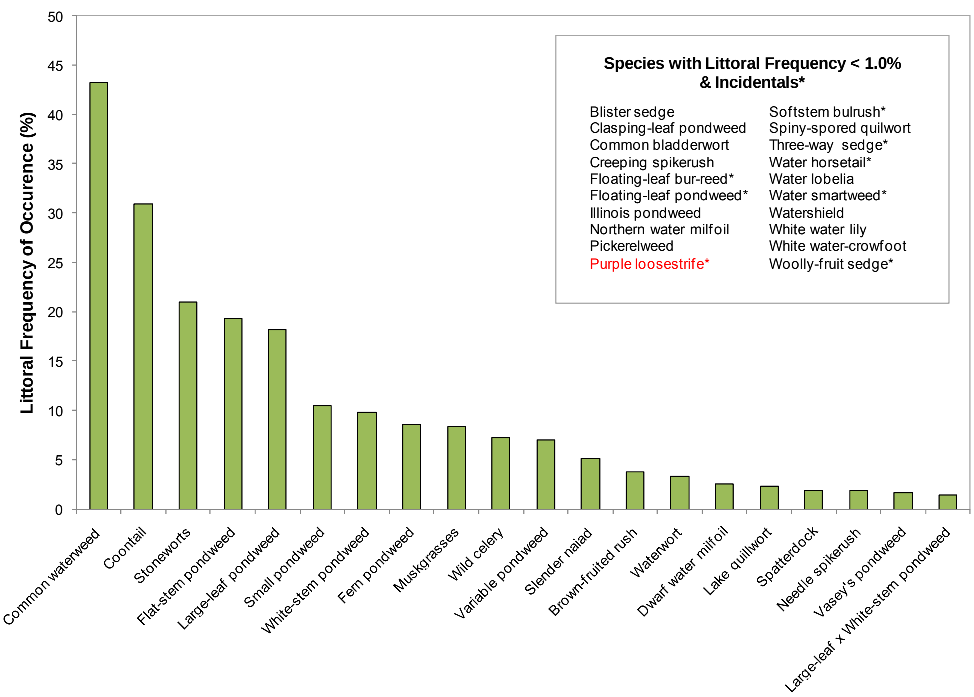


Figure 8.7.4-1 Found Lake aquatic plant littoral frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

Figure 8.7.4-1 shows that common waterweed and coontail were the most frequently encountered plants on Found Lake. As discussed in the Town-wide Aquatic Plant Section, coontail and common waterweed are largely un-rooted (although do sometimes possess structures that function similar to roots) and their locations can be largely determined by water movement.

Table 8.7.4-1. Aquatic plant species located in the Found Lake during the 2010 aquatic plant surveys. Exotic species shown in red.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)
Emergent	*Carex lasiocarpa*	Woolly-fruit sedge	9
	Carex vesicaria	Blister sedge	7
	Dulichium arundinaceum	Three-way sedge	9
	Equisetum fluviatile	Water horsetail	7
	Eleocharis palustris	Creeping spikerush	6
	Lythrum salicaria	Purple loosestrife	Exotic
	Pontederia cordata	Pickerelweed	9
	Schoenoplectus tabernaemontani	Softstem bulrush	4
FL	*Brasenia schreberi*	Watershield	7
	Nymphaea odorata	White water lily	6
	Nuphar variegata	Spatterdock	6
	Polygonum amphibium	Water smartweed	5
FL/E	*Sparganium fluctuans*	Floating-leaf bur-reed	10
Submergent	*Chara spp.*	Muskgrasses	7
	Ceratophyllum demersum	Coontail	3
	Elatine minima	Waterwort	9
	Elodea canadensis	Common waterweed	3
	Isoetes echinospora	Spiny-spored quilwort	8
	Isoetes lacustris	Lake quillwort	8
	Lobelia dortmanna	Water lobelia	10
	Myriophyllum sibiricum	Northern water milfoil	7
	Myriophyllum tenellum	Dwarf water milfoil	10
	Najas flexilis	Slender naiad	6
	Nitella spp.	Stoneworts	7
	Potamogeton natans	Floating-leaf pondweed	5
	Potamogeton illinoensis	Illinois pondweed	6
	Potamogeton richardsonii	Clasping-leaf pondweed	5
	Potamogeton amplifolius x P. praelongus	Large-leaf x White-stem pondweed	N/A
	Potamogeton vaseyi	Vasey's pondweed	10
	Potamogeton gramineus	Variable pondweed	7
	Potamogeton robbinsii	Fern pondweed	8
	Potamogeton praelongus	White-stem pondweed	8
	Potamogeton pusillus	Small pondweed	7
	Potamogeton amplifolius	Large-leaf pondweed	7
	Potamogeton zosteriformis	Flat-stem pondweed	6
	Ranunculus aquatilis	White water-crowfoot	8
	Utricularia vulgaris	Common bladderwort	7
	Vallisneria americana	Wild celery	6
S/E	*Eleocharis acicularis*	Needle spikerush	5
	Juncus pelocarpus	Brown-fruited rush	8

FL = Floating Leaf
FL/E = Floating Leaf and Emergent
S/E = Submergent and Emergent

During the community mapping survey, a few occurrences of purple loosestrife were discovered (Found Lake Community Map). Coordinated by Ted Ritter, Invasive Species Coordinator for Vilas County and Chuck Their, president of the TSGLC, access was gained to the property that these plants were growing on and were manually removed.

Purple loosestrife (*Lythrum salicaria*) is a perennial herbaceous plant native to Europe and was likely brought over to North America as a garden ornamental. This plant escaped from its garden landscape into wetland environments where it is able to out-compete our native plants for space and resources. First detected in Wisconsin in the 1930's, it has now spread to 70 of the state's 72 counties. Purple loosestrife largely spreads by seed, but also can vegetatively spread from root or stem fragments.

Found Lake contained a high number of plant species and because of this, one may assume that the system would also have a high diversity. As discussed earlier, how evenly the species are distributed throughout the system also influence the diversity. The diversity index for Found Lake's plant community (0.90) ranks the second highest (tied with Lost Lake) of the seven project lakes and is higher than the Northern Lakes and Forests Lakes ecoregion value (0.86).

As explained earlier in the Primer on Data Analysis and Data Interpretation Section, the littoral frequency of occurrence analysis allows for an understanding of how often each of the plants is located during the point-intercept survey. Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while common waterweed was found at 43% of the sampling locations, its relative frequency of occurrence is 20%. Explained another way, if 100 plants were randomly sampled from Found Lake, 20 of them would be common waterweed. This distribution can be observed in Figure 8.7.4-2, where together five species account for 62% of the population of plants within Found Lake, while the other 28 species account for the remaining 38%. Seven additional species were located from the lake but not from of the point-intercept survey, as indicated in Figure 8.7.4-1 as incidentals.

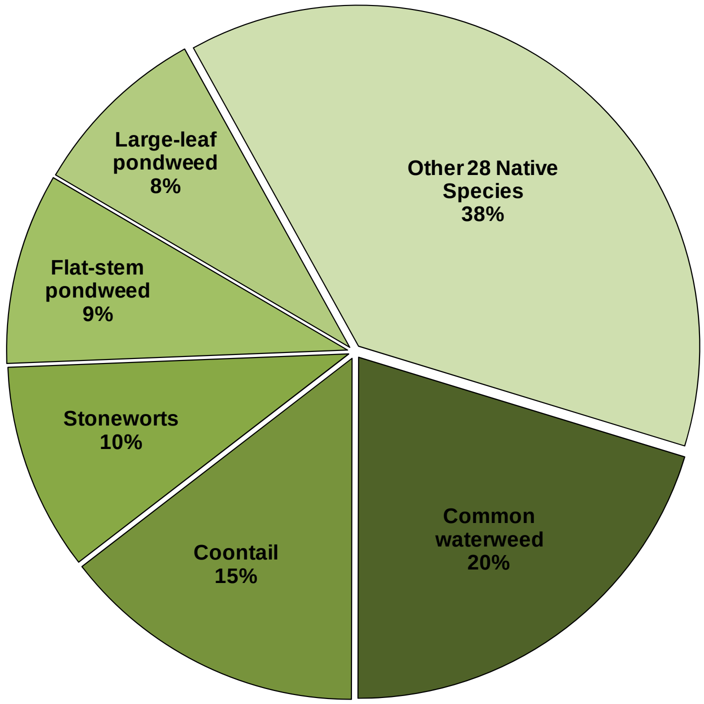


Figure 8.7.4-2 Found Lake aquatic plant relative frequency of occurrence analysis. Created using data from 2010 point-intercept survey.

Exceed only by Alma and Moon Lake, Found Lake has a relatively high average conservatism value (7.2), and is above the ecoregion and Wisconsin State medians. This value indicates that the majority of the aquatic plant species present in Found Lake are sensitive to environmental degradation, and their current presence signifies high quality environmental conditions.

Declines in these species in the future may indicate potential declines in water quality or other aspects of the lake environment, perhaps from increased shoreline development or active watercraft use. Approximately 20% of the watercrafts used by Found Lake stakeholder survey respondents were motor boats with greater than a 25 hp motor and 19% of the watercrafts used were pontoon boats (Appendix B, Question #12). This is not a surprise as Found Lake is a relatively large lake that offers active watercraft use opportunities. Passive watercraft types like canoe/kayak, paddleboats, and row boats were also commonly used on the lake at a slightly higher rate than other large lakes of the project waters. As indicated within the Watershed Sections, the shoreland condition classification that indicates the least amount of man-made disturbance is Developed-Natural. Found Lake contains the highest percentage of its shoreline within this classifications of the five project lakes (Alma and Moon Lakes were excluded) where this assessment was made (Town-Wide Watershed Section, Table 3.1-1). Protecting these areas and ensuring that the condition of Found Lake's shoreline does not shift towards urbanized development will be important to protect certain vulnerable aquatic plant species and further degradation of Found Lakes' aquatic plant community.

Combining Found Lake's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in an exceptionally high value of 41.1, which is the highest of the Town of Saint Germain project lakes and is also well above the median values of the ecoregion and state and is the highest of the seven project waters (Town-Wide Aquatic Plant Section, Figure 3.3-6).

The quality of Found Lake is also indicated by the incidence of emergent and floating-leaf plant communities that occur in shallower regions of the lake. The 2010 community map indicates that approximately 10.9 acres of the lake contains these types of plant communities (Found Lake Map, Table 8.7.4-2). Thirteen floating-leaf and emergent species were located on Found Lake (Table 8.7.4-1), all of which provide valuable wildlife habitat.

Table 8.7.4-2. Found Lake acres of emergent and floating-leaf plant communities from the 2004 and 2010 community mapping survey.

	Acres	
Plant Community	**2004**	**2010**
Floating-leaf	2.8	2.8
Emergent	0.2	0.9
Floating-leaf/Emergent	8.1	7.2
Total	**11.1**	**10.9**

Continuing the analogy that the community map represents a 'snapshot' of the emergent and floating-leaf plant communities, replications of this survey through time will provide a valuable understanding of the dynamics of these communities within Found Lake. This is important, because these communities are often negatively affected by recreational use and shoreland development. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelines when compared to undeveloped shorelines in Minnesota Lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines.

The 2010 community mapping survey was the second survey of this type to be conducted, the first being conducted by Onterra in 2004. As the Community Map shows, these communities remain relative similar between the two surveys. The only notable differences were along the northern shoreline, where small colonies of narrow-leaf bur-reed were restricted to isolated occurrences. This may be a result of fluctuating water levels or simply dynamics of the species.

8.7.5 Found Lake Implementation Plan

The Implementation Plan below is a result of collaborative efforts between Found Lake stakeholders, the TSGLC, and ecologists/planners from Onterra. This plan provides goals and actions created to protect the quality and integrity of Found Lake and will serve as reference for keeping stakeholders on track and focused upon these science-driven management activities.

While the Town of Saint Germain project lakes are geographically similar, they are definitely ecologically diverse. The latter is detailed throughout this report. This diversity leads to the need for diverse plans aimed at managing the lakes. Some of the project lakes have more complicated management needs than others, but in general most of the lakes', including Found Lake's, needs center on protecting the current quality of the lake as opposed to performing activities aimed at enhancing or resolving particular of issues. The Town-wide Implementation Plan will serve each of the project lakes well in terms of protecting their current condition; therefore, Found Lake's implementation plan is compiled by describing how Found Lake stakeholders should proceed in implementing applicable portions of the town-wide implementation plan for their lake.

Town-wide Implementation Plan – Specific to Found Lake

Town-wide Management Goal 1: Promote Lake Protection and Enjoyment through Stakeholder Education

Management Action: Support the Lakes Committee to promote safe boating, water quality, public safety, and quality of life on Found Lake.

Timeframe: Continuation of current efforts

Facilitator: Found Lake Association

Description: Found Lake stakeholders can assist in the implementation of this action by participating in the TSGLC's town-wide initiatives. Participation may include presentation of educational topics, volunteering at local and regional events, participating in committees, or simply notifying the lakes committee of concerns involving Found Lake and its stakeholders.

Action Steps: See description above.

Town-wide Management Goal 2: Maintain Current Water Quality Conditions

Management Action: Monitor water quality through WDNR Citizens Lake Monitoring Network (CLMN) or similar program.

Timeframe: Continuation of current efforts

Facilitator: Found Lake Association

Description: Currently, Found Lake is enrolled in the CLMN's advanced water quality monitoring program. This means that in addition to Secchi disk clarity, volunteers also monitor phosphorus and chlorophyll-*a* on the lake. Additionally, the Found Lake Association has purchased a dissolved oxygen probe that is used to measure oxygen throughout the water column in both the open water and winter seasons. Although this is a great accomplishment, it must be continued in order to ensure the quality of Found Lake is protected. Volunteers from Found Lake must be proactive in recruiting others to participate.

Action Steps: See description above.

<u>Management Action:</u> Reduce phosphorus and sediment loads from shoreland watershed to the Town of Saint Germain project lakes.

Timeframe: Continuation of current efforts

Facilitator: Found Lake Association

Description: As a result of the Shoreland Assessment survey that took place in 2010, 16% of the Found Lake shoreline was classified as Urbanized/Developed-Unnatural. These areas may be impacting the lake in a negative manner by not filtering surface runoff water and limiting the amount of available habitat for both terrestrial and aquatic organisms.

If property owners of these areas wish to enhance their shoreline, they may work with the facilitator named by the TSGLC to look into restoration options that may provide ecological benefits to their shoreland properties. The facilitator will have cost-sharing opportunities available for the property owner as well. The Town of Saint Germain project lakes are no stranger to shoreland restoration projects. 14 properties on Found Lake and a camp on Moon Lake have both received funding to participate in WDNR studies in which ecological benefits of shoreland restoration were examined. These two locations may serve as demonstration models to present to property owners who are interested in restoring their shoreland areas.

Action Steps: See description above.

Town-wide Management Goal 3: Prevent Aquatic Invasive Species establishment within Found Lake

<u>Management Action:</u> Maintain and expand stakeholder education.

Timeframe: Continuation of current efforts

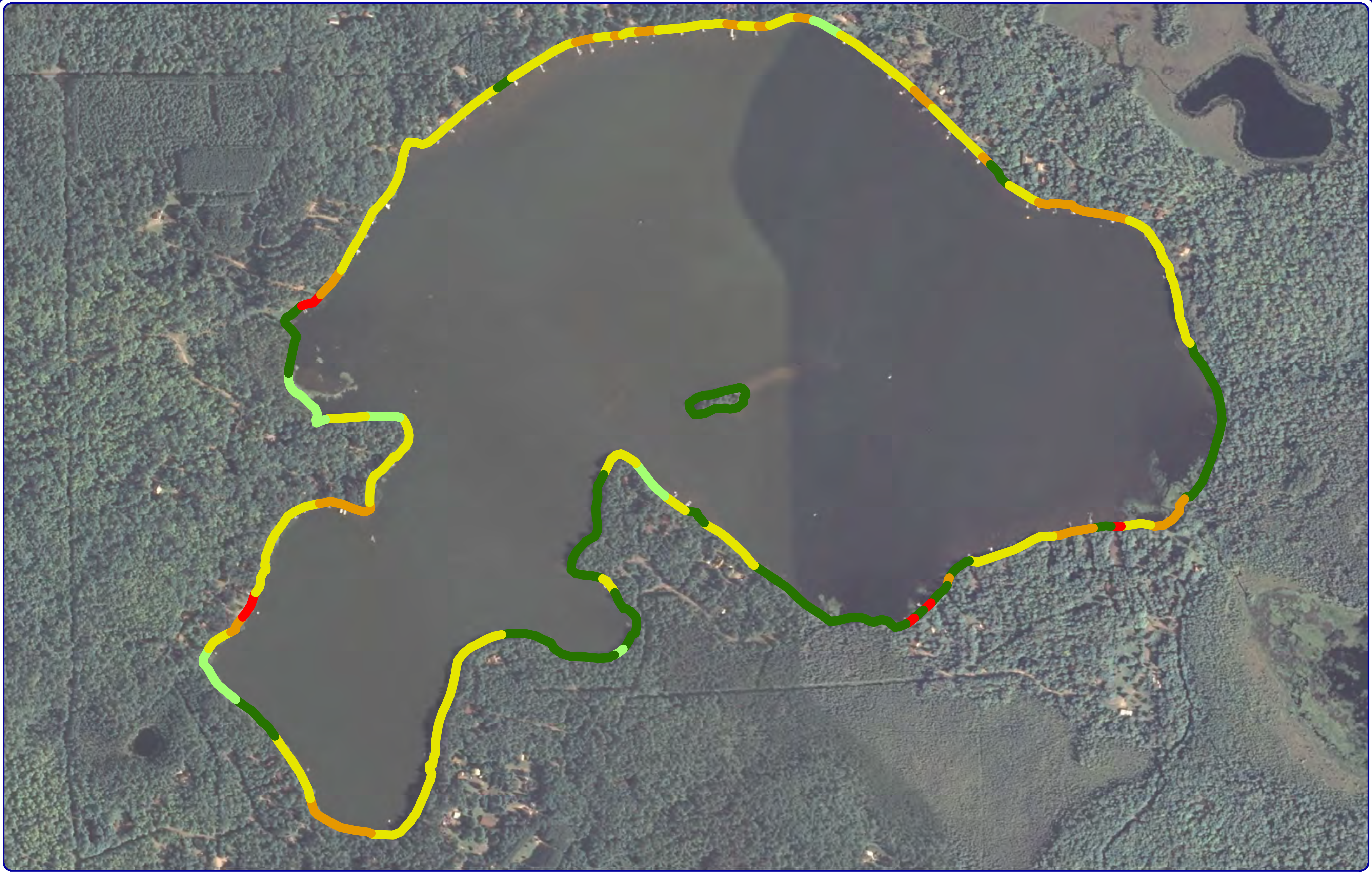
Facilitator: Found Lake Association

Description: Found Lake has a single public access point on the lake's southeast side. As a result, the threat of AIS introduction is increased when compared to lakes with limited or no public access.

Found Lake stakeholders can work together with the TSGLC to reduce the chances that AIS find their way into the lake through numerous opportunities. By working with the TSGLC, property owners can learn proper boat cleansing techniques and AIS identification. Additionally, volunteers should continue work with the CBCW program. By monitoring the Found Lake public access point with CBCW volunteers, potential AIS introduction to the lake is reduced. An added benefit is that this interaction allows an opportunity to educate boaters about AIS and the importance of boat cleaning and inspection.

AIS monitoring should occur on a regular basis within the lake. Because Found Lake is a fairly large, heavily utilized lake, professional AIS surveys should occur once every 5 years. In between these professional surveys, the TSGLC can train volunteers not only on AIS identification, but methods to monitor the lake for AIS as well. These surveys were conducted as part of this project, but continuing them may be difficult as times of volunteerism fluctuate. It is the responsibility of the TSGLC and Found Lake Association to constantly recruit new volunteers. This will ensure that surveys are completed well into the future.

Action Steps: See description above.



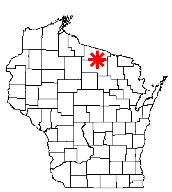
N W E S

750

Feet

Onterra LLC
Lake Management Planning
815 Prosper Rd
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Orthophotography: NAIP, 2010
Shoreline Condition: Onterra, 2010
Map Date: August 17, 2011
Filename: Found_Map1_SA_2010.mxd



Project location in Wisconsin

Legend

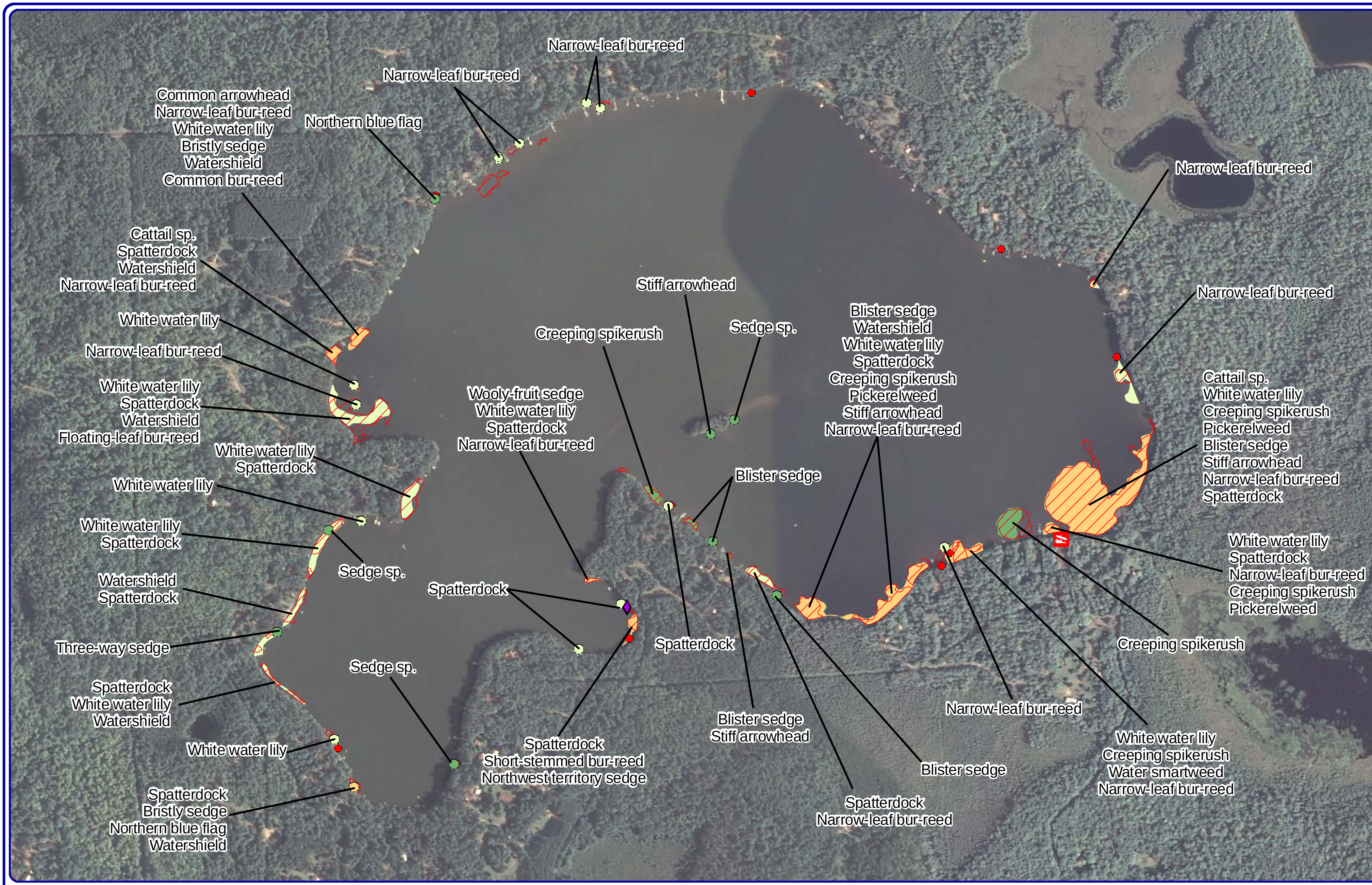
- Natural/Undeveloped
- Developed-Natural
- Developed-Semi-Natural
- Developed-Unnatural
- Urbanized

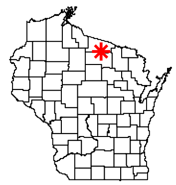
Found Lake - Map 1

Saint Germain Lakes

Vilas County, Wisconsin

Shoreline Condition





Project Location in Wisconsin

Legend

Small Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent
- Purple Loosestrife *(Exotic)*
- 2004 Small Plant Community

Large Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent
- 2004 Large Plant Community

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Sources:
Aquatic Plants: Onterra, 2004 & 2010
Orthophotography: NAIP 2010
Map date: March 29, 2011
Filename: Map2_Found_Comm_2010.mxd

Found Lake - Map 2

Saint Germain Lake
Vilas County, Wisconsin

Aquatic Plant Communities