Town of Saint Germain

Vilas County, Wisconsin

Comprehensive Management Plan Update

March 2021

Official First Draft

Alma Lake
Big St. Germain Lake
Fawn Lake
Lake Content
Lost Lake
Moon Lake

Created by: Brenton Butterfield, Josephine Barlament, Eddie Heath, Heather Lutzow, Paul Garrison, & Tim Hoyman

Onterra, LLC
De Pere, WI

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Acknowledgements

This management planning effort was truly a team-based project and could not have been completed without the input of the following individuals:

Town of Saint Germain Lakes Committee

Mary Anderson	Dave Kunelius	Kay Schultz
Don Baumann	Judy Napierala	Steve Soltwedel
Jim Guckenberg	Ted Ritter	Barbara Steinhilber
Gary Heeler	Donna Rollmann	Tony Waisbrot
Milt Klingsporn	Bob Schell	Dave Zielinski

Wisconsin Dept. of Natural Resources
Kevin Gauthier

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APPENDICES

1.0 INTRODUCTION

In 2003, the Town of Saint Germain Board 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 the individual lake associations and districts, which oversee individual or several lakes within the Town of Saint Germain.

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 TSGLC again teamed with Onterra to reassess the town's lakes with an updated *Town of Saint Germain Town-wide Lake Management Plan* (Onterra 2013) completed in 2013. To continue their efforts in protecting these lakes for current and future generations, the town was awarded two Wisconsin Dept. of Natural Resources large-scale lake management planning grants in December 2018 to reassess the town's lakes and update the management plan based on the findings of this reassessment.

This project included a reassessment of Alma Lake, Moon Lake, Big Saint Germain Lake, Lake Content, Fawn Lake, and Found Lake (Map 1). While Little Saint Germain and Lost lakes have been included in previous town-wide assessments, these lakes underwent individual lake management planning efforts in response to control and monitoring of established invasive aquatic plant populations. While assessments were not completed on Little Saint Germain and Lost lakes in 2019, data available from these lakes are included for comparison purposes.

This project was designed to reassess the lakes and update the town's 2013 lake management plan. The water quality, watershed, immediate shoreland zone, and aquatic plant communities were reassessed in each lake in 2019. In addition, updated data was collected from lake stakeholders through an anonymous stakeholder survey. This report also includes a compilation of available updated fisheries data.

The studies completed in 2019 found that the water quality in the six study lakes remains high, and they continue to support high-quality, diverse native aquatic plant communities. The aquatic plant communities of some lakes, like Alma and Moon lakes, saw some noteworthy changes between the 2009 and 2019 assessments, likely a result of a significant increase in water levels over this period. The watersheds for these lakes remain largely comprised of intact forests and wetlands which help to minimize nutrient and pollutant runoff. The degree of development in the immediate shoreland zone varies by lake, but is likely one of the largest stressors to the lakes currently. The Implementation Plan (Section 5.0) outlines actions for protection and restoring shorelines to a more natural state on these lakes.

To create an understanding from both a town-wide and individual lake perspective, this report is comprised of two primary sections. The first (Sections 1.0 – 5.0) discuss the results of the studies from a town-wide perspective, where differences in water quality, aquatic plant communities, etc. among the town's lakes are presented and discussed. This section also includes the

Implementation Plant (Section 5.0), which includes the updated management goals and associated actions. The second section (Section 8.0) includes detailed discussion surrounding the study results from each of the individual study lakes. This section only includes lakes within the scope of the project, Little Saint Germain and Lost lakes are not included in this section.

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 and the completion of a stakeholder survey. The highlights of this component are described below. Materials used during the planning process can be found in Appendix A.

General Public Meetings

The general public meetings were used to raise project awareness, gather comments, create the management goals and actions, and deliver the study results These meetings were open to anyone interested and were generally held during the summer, on a Saturday, to achieve maximum participation.

Project Wrap-up Meeting

Has not yet occurred.

Committee Level Meetings

A planning committee meeting, similar to general public meetings, was used to gather comments, create management goals and actions and to deliver study results. This meeting was open only to the planning committee (TSGLC) and was held during the week. The committee members were supplied with the draft report sections prior to the meeting and much of the meeting time was utilized to detail the results, discuss the conclusions and initial recommendations, and answer committee questions. The second half of the meeting concentrated on the development of management goals and actions that make up the framework of the implementation plan.

Planning Committee Meeting I

On August 27, 2020, Brenton Butterfield of Onterra met with members of the TSGLC virtually for approximately 3.5 hours. The primary focus of this meeting was the delivery of the study results and conclusions to the committee as well as the development of the implementation plan framework. 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 excessive watercraft traffic, shoreland development, and recent higher water levels.

Management Plan Review and Adoption Process

Has not yet occurred.

Stakeholder Survey

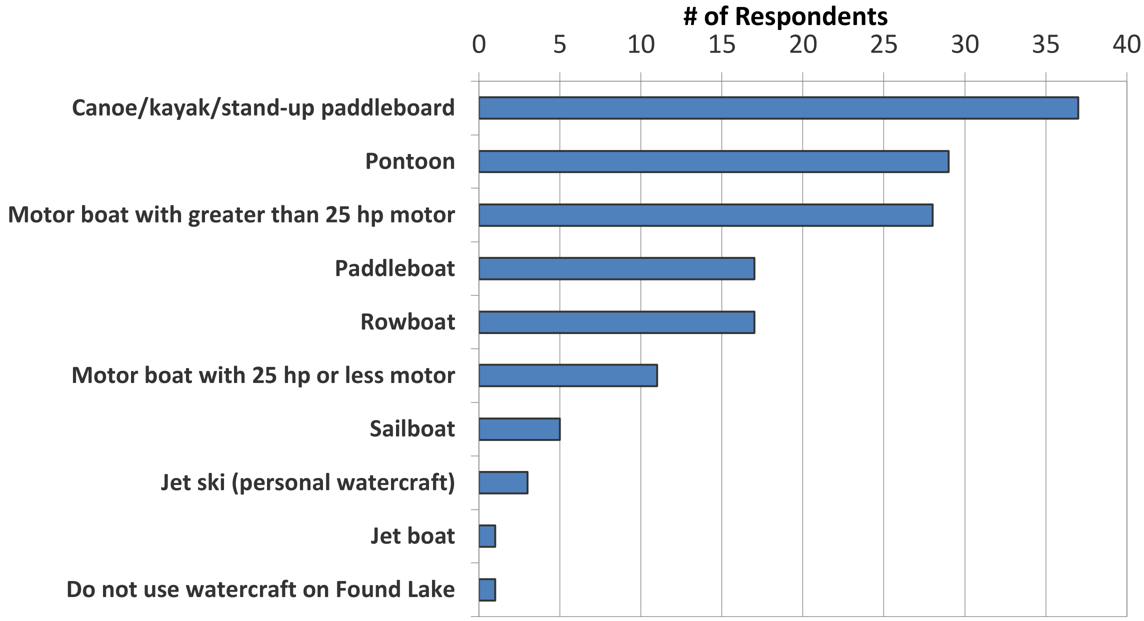
As a part of this project, two stakeholder surveys were distributed to the Town of Saint Germain Lakes; one specific to Found Lake stakeholders and another to the other five project lakes. The Found Lake stakeholder survey was distributed to all riparian property owners and Found Lake Property Owners Association (FLPOA) members surrounding Found Lake. The survey was designed by Onterra staff, the FLPOA planning committee, and reviewed by a WDNR social scientist.

In October 2019, the eight-page, 34-question survey was posted online through Survey Monkey for property owners to answer electronically. If requested, a hard copy was sent to the property owner with a self-addressed stamped envelope for returning the survey anonymously. The returned hardcopy surveys were entered into the online version by a third-party to ensure anonymity. Forty-seven percent of the surveys were returned. Please note that typically a benchmark of a 60% response rate is required to portray population projections accurately and make conclusions with statistical validity. The data were analyzed and summarized by Onterra for use at the planning meeting 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 and a general summary is discussed below.

Based upon the results of the Stakeholder Survey, much was learned about the people that use and care for Found Lake. Stakeholders (30%) utilize their property as seasonal residence (longer than summer), while 28% are a seasonal vacation home, 20% are year-round residents, and 2% have undeveloped property. Fifty-eight percent of stakeholders have owned their property for over 15 years, and 37% have owned their property for over 25 years.

The following sections (Water Quality, Watershed, Aquatic Plants, and Fisheries Data Integration) discuss the stakeholder survey data with respect to these particular topics. Figures 2.0-1 and 2.0-2 highlight a few of the other questions found within the survey. More than half of survey respondents indicate that they use either a pontoon boat, larger motor boat, canoe/kayak, or a combination of these three vessels on Found Lake (Question 12). Paddleboats were also a popular option. On a relatively small lake such as Found Lake, the importance of responsible boating activities is increased. The need for responsible boating increases during weekends, holidays, and during times of nice weather or good fishing conditions as well, due to increased traffic on the lake. As seen on Question 15, a few of the top recreational activities on the lake involve boat use. Boat traffic was listed as a factor potentially impacting Found in a negative manner and it was ranked 5th on a list of stakeholder's top concerns regarding the lake (Question 23).

Question 12: What types of watercraft do you currently use on Found Lake?



Question 15: Please rank up to three activities that are important reasons for owning your property on Found Lake, with 1 being the most important.

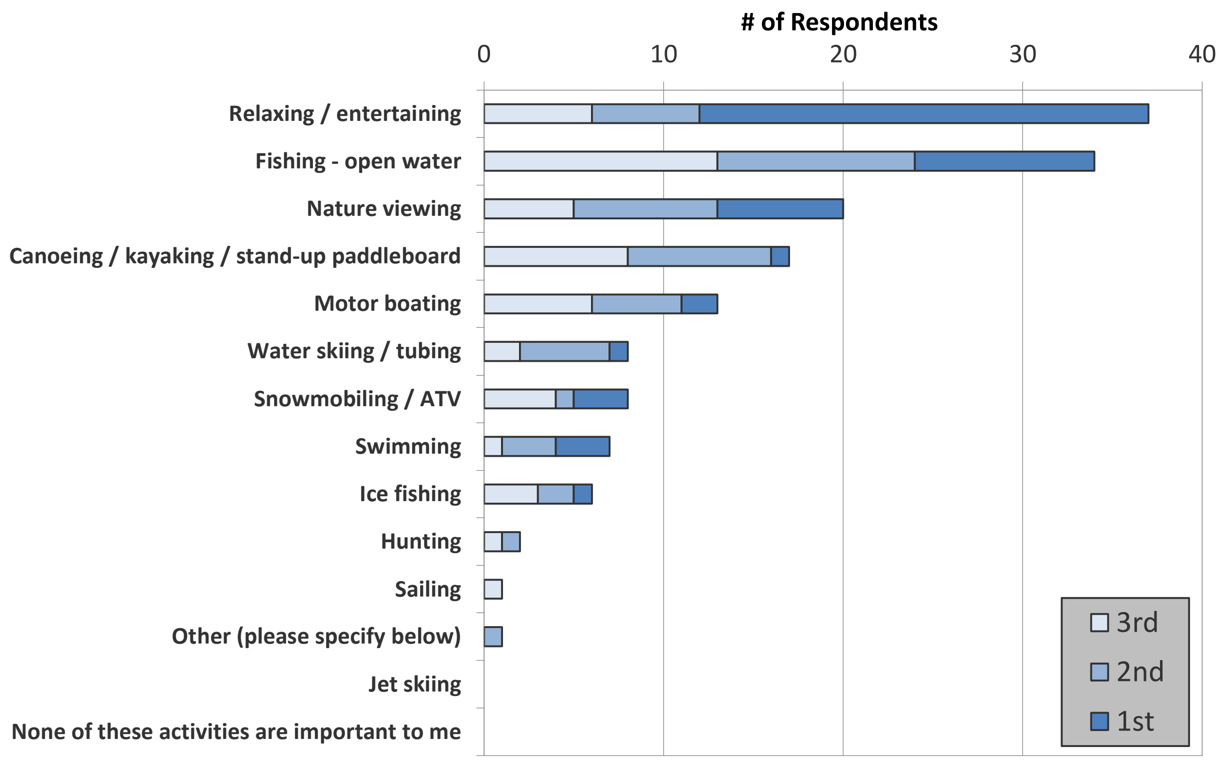


Figure 2.0-1. Select survey responses from the Found Lake Stakeholder Survey. Additional questions and response charts may be found in Appendix B.

Question 23: Please rank your top three concerns regarding Found Lake, with 1 being your greatest concern.

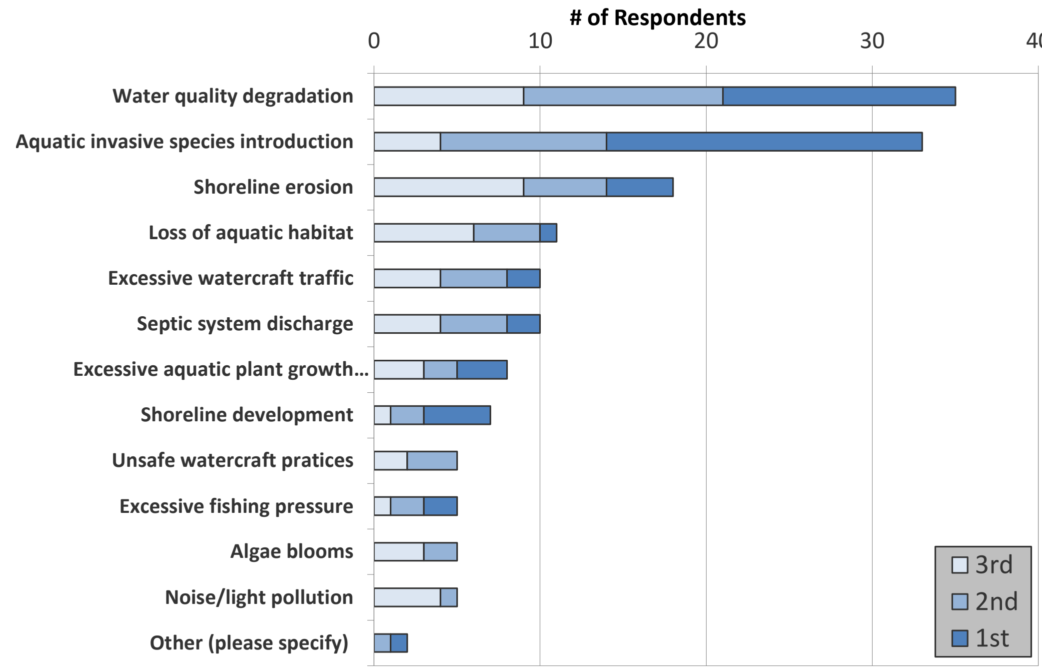


Figure 2.0-2. Select survey responses from the Found Lake Stakeholder Survey, continued. Additional questions and response charts may be found in Appendix B.

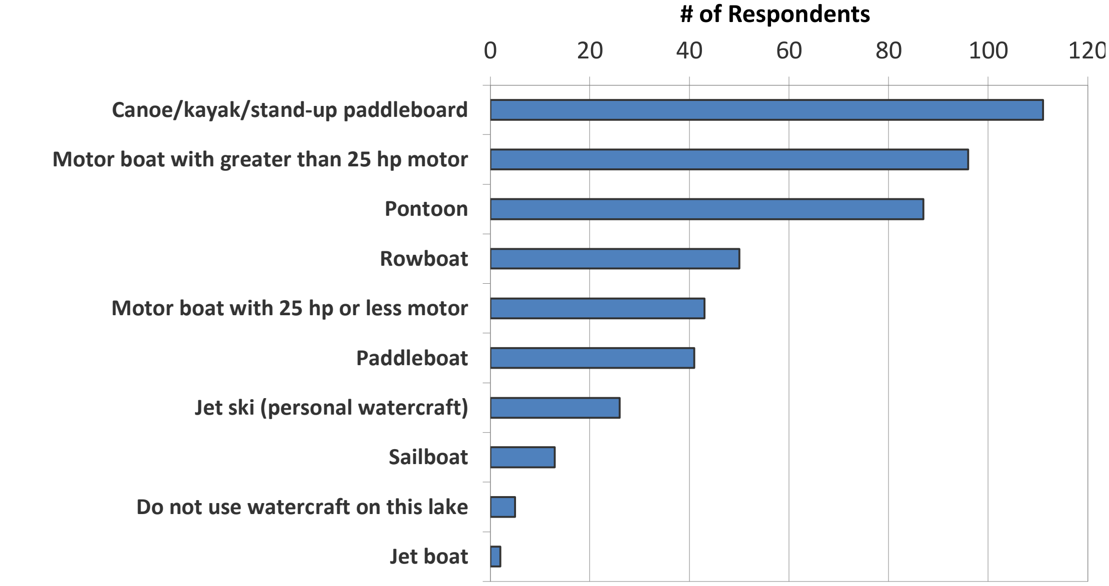
A separate stakeholder survey was also distributed to riparian property owners, and district and/or lake group members around Big Saint Germain Lake, Lake Content, Fawn Lake, Alma Lake, and Moon Lake. The survey was designed by Onterra staff, Big St. Germain Area Lakes District planning committee, Alma-Moon Lake District planning committee, and reviewed by a WDNR social scientist. In October 2019, the seven-page, 32-question survey was posted online through Survey Monkey for property owners to answer electronically, or request a hard copy.

Based upon the results of the Stakeholder Survey, much was learned about the people who use and care for the Town of Saint Germain Lakes. Stakeholders (34%) use the lake as a seasonal vacation home, while for 25% it is a year-round residence, 21% are seasonal residents (longer than summer), 3% use the property as a summer residence only, and 1% have undeveloped property. The remaining percentage includes resort property, rental property, and other use. Fifty-three percent of stakeholders have owned their property for over 15 years, and 33% have owned their property for over 25 years.

The following sections (Water Quality, Watershed, Aquatic Plants and Fisheries Data Integration) discuss the stakeholder survey data with respect to these particular topics. Figures 2.0-3 and 2.0-4 highlight a few of the other questions found within the survey. More than half of survey respondents indicate that they use either a pontoon boat, larger motor boat, canoe/kayak, or a combination of these three vessels on the Town of Saint Germain Lakes (Question 13). Paddleboats were also a popular option. The need for responsible boating is important during weekends, holidays, and during times of nice weather or good fishing conditions as well, due to increased traffic on the lake. As seen on Question 16, a few of the top recreational activities on the lakes involve boat use. Boat traffic was listed as a factor potentially impacting the Town of

Saint Germain Lakes in a negative manner and it was ranked 6th on a list of stakeholder's top concerns regarding the lake (Question 24).

Question 13: What types of watercraft do you currently use on this lake?



Question 16: Please rank up to three activities that are important reasons for owning your property on or near the lake, with 1 being the most important.

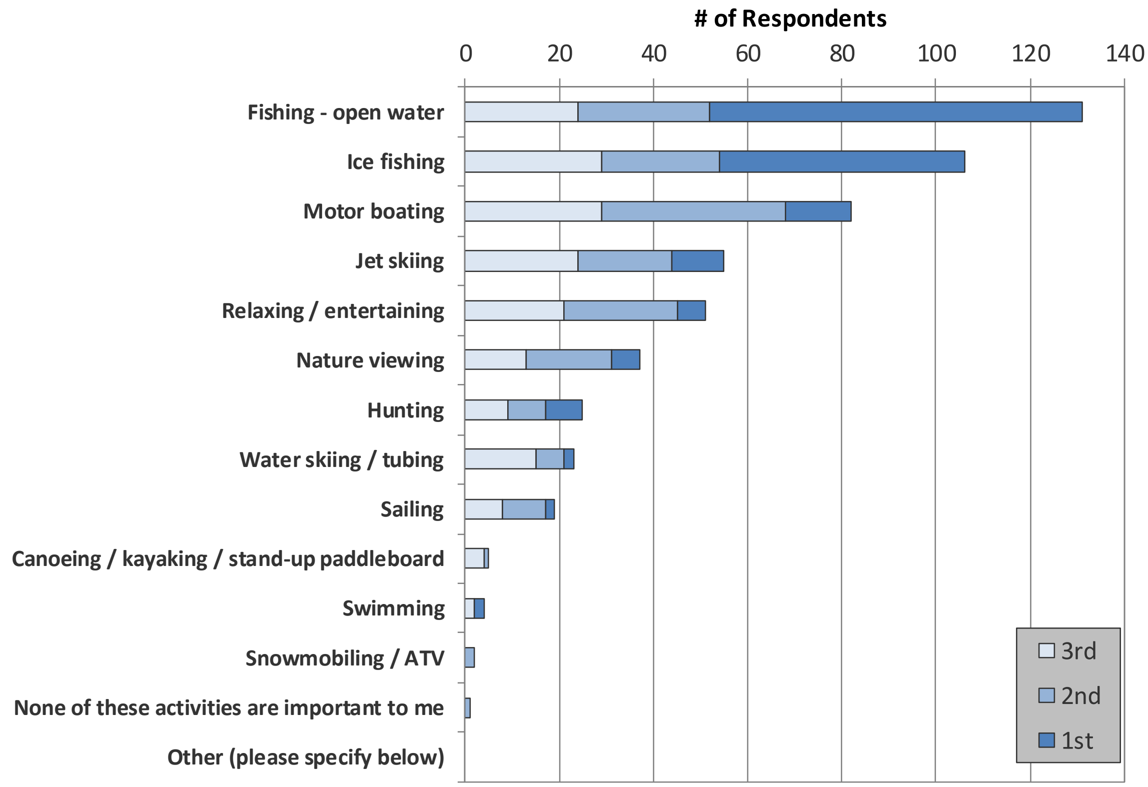


Figure 2.0-3. Select survey responses from the Town of Saint Germain Lakes Stakeholder Survey. Additional questions and response charts may be found in Appendix B.

Question 24: Please rank your top three concerns regarding your lake, with 1 being your greatest concern.

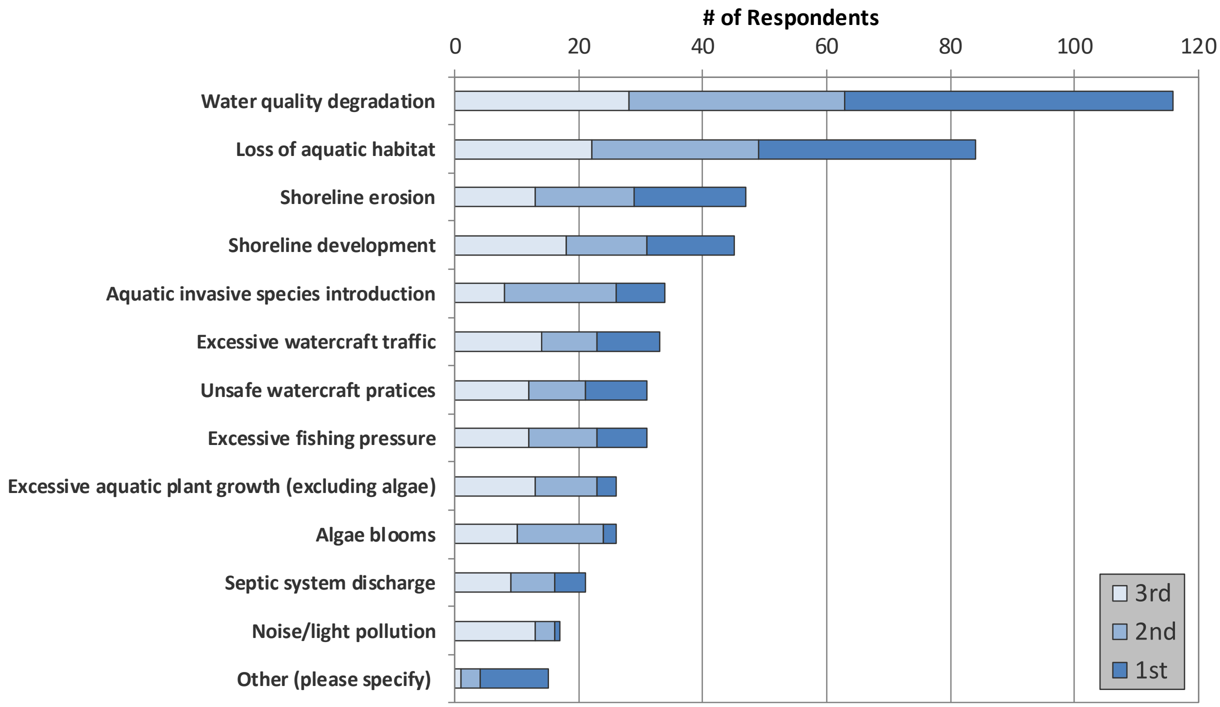


Figure 2.0-4. Select survey responses from the Town of Saint Germain Lakes Stakeholder Survey, continued. Additional questions and response charts may be found in Appendix B.

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, 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 analyses 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 productivity 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 analyses 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 from the Town of Saint Germain lakes are 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 primary water quality parameters are focused upon in the water quality analysis:

> **Phosphorus** is the primary nutrient that regulates the growth of planktonic algae and some larger, vascular plants (macrophytes) in the vast majority of Wisconsin lakes. 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 frequently employed 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 quadrants (a Secchi disk) into the water and recording the depth just before it disappears from sight.

These three parameters are often correlated with one another. 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, Nelson and Everett 1994) (Dinius 2007) (Smith, Cragg and Croker 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. Oligotrophic lakes have the lowest amounts of nutrients and biological productivity, and are generally characterized by having high water clarity and a lower abundance of aquatic plants. Mesotrophic lakes have moderate levels of nutrients and biological productivity and generally support more abundant aquatic plant growth. Eutrophic lakes have higher levels of nutrients and biological productivity, and generally have a high abundance of aquatic plants.

Most lakes will naturally progress through these states under natural conditions (i.e., not influenced by the activities of humans), but this process can take tens of thousands of years. Unfortunately, human development of watersheds and the direct discharge of nutrient-rich effluent has accelerated this natural aging process in many Wisconsin lakes. This process is termed cultural eutrophication. The excessive input of nutrients through cultural eutrophication has resulted in some lakes becoming hypereutrophic. Hypereutrophic lakes have the highest levels of nutrients and biological productivity. These lakes are typically dominated by algae, experience frequent nuisance algal blooms, have very poor water clarity, and little if any aquatic plant growth.

It is important to note that both natural factors and human activity can affect a lake's trophic state, and that some lakes can be naturally eutrophic. 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.

However, through the use of a trophic state index (TSI), an index number can be calculated using phosphorus, chlorophyll-*a*, and Secchi disk depth values that represent the lake's position within the eutrophication process. This allows for a clearer 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 larger vascular plants 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 and density gradients are developed with depth in a lake. During stratification, the lake can be broken into three layers: The ***epilimnion*** is the surface layer with the lowest density and has the warmest water in the summer months and the coolest water in the winter months. The ***hypolimnion*** is the bottom layer the highest density and has the coolest water in the summer months and the warmest water in the winter months. The ***metalimnion***, often called the thermocline, is the layer between the epilimnion and hypolimnion where temperature changes most rapidly with depth.

Dissolved oxygen is essential in the metabolism of nearly every organism that exists within a lake. For instance, fish kills 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 processes that occur within a lake. Internal nutrient loading is an excellent example that is described below.

Internal Nutrient Loading

In general, lakes tend to act as phosphorus sinks, meaning they tend accumulate phosphorus over time and export less phosphorus than the amount that is loaded to the lake from its watershed. In most lakes, there is a net movement of phosphorus from the water to bottom sediments where it accumulates over time. The retention of this phosphorus within bottom sediments depends on a number of physical, chemical, and biological factors (Wetzel 2001). If this phosphorus remains bound within bottom sediments, it is largely unavailable for biological use. However, under certain conditions, this phosphorus can be released from bottom sediments into the overlying water where it may become biologically available. This release of phosphorus (and other nutrients) from bottom sediments into the overlying water is termed *internal nutrient loading*. While phosphorus can be released from bottom sediments under a few varying conditions, it occurs most often when the sediment-water interface becomes devoid of oxygen, or anoxic.

When water at the sediment-water interface contains oxygen, phosphorus largely remains bound to ferric iron within the sediment. When the water at the sediment-water interface becomes anoxic, or devoid of oxygen, ferric iron is reduced to ferrous iron and the bond between iron and phosphorus is broken. Under these conditions, iron and phosphorus are now soluble in water and are released from the sediments into the overlying water (Pettersson 1998). Anoxia at the sediment-water interface typically first develops following thermal stratification, or the formation of distinct layers of water based on temperature and density. As surface water warms in late-spring/early summer, it becomes less dense and floats atop the colder, denser layer of water below. The large density gradient between the upper, warm layer of water (*epilimnion*) and lower, cold layer of water (*hypolimnion*) prevents these layers from mixing together and eliminates atmospheric diffusion of oxygen into bottom waters. If there is a high rate of biological decomposition of organic matter in the bottom sediments, anoxic conditions within the hypolimnion can develop as oxygen is consumed and is not replaced through mixing. The loss of oxygen then results in the release of phosphorus from bottom sediments into the hypolimnion.

The development of an anoxic hypolimnion and subsequent release of phosphorus from bottom sediments occurs in many lakes in Wisconsin. However, in deeper, dimictic lakes which remain stratified during the summer, internal nutrient loading is often not problematic as the majority of the phosphorus released from bottom sediments is confined within the hypolimnion where it is largely inaccessible to phytoplankton. Dimictic lakes are those which remain stratified throughout the summer (and winter) and experience only two complete mixing events (turnover) per year, one in spring and one in fall. In dimictic lakes, phosphorus released from bottom sediments into the hypolimnion during stratification only becomes available to phytoplankton in surface waters during the spring and fall mixing events. While these spring and fall mixing events can stimulate diatom and golden-brown phytoplankton blooms, these mixing events generally to not stimulate cyanobacterial (blue-green algae) blooms because water temperatures are cooler.

Internal nutrient loading can become problematic in lakes when sediment-released phosphorus becomes accessible to phytoplankton during the summer months when surface temperatures are at their warmest. Sediment-released phosphorus can be mobilized to surface waters during the summer in polymictic lakes, or lakes which have the capacity to experience multiple stratification and mixing events over the course of the growing season. Some polymictic lakes tend to straddle the boundary between deep and shallow lakes, and have the capacity to break stratification in summer when sufficient wind energy is generated. Consequently, phosphorus which has accumulated in the anoxic hypolimnion during periods of stratification is mobilized to the surface during partial or full mixing events where it then can spur nuisance phytoplankton blooms at the surface.

Phosphorus from bottom waters can also be mobilized to the surface in polymictic lakes through entrainment, or the continual deepening of the epilimnion and erosion of the metalimnion below (Wetzel 2001). Wind-driven water generates turbulence across the thermal barrier between the epilimnion and the metalimnion and the metalimnion is eroded, mixing sediment-released nutrients into the epilimnion above. Both periodic mixing and entrainment act as "nutrient pumps" in polymictic lakes, delivering sediment-released nutrients in bottom waters to surface waters (Orihel et al. 2015). While a continuum exists between dimictic and polymictic lakes, the Osgood

Index (Osgood 1988) is used to determine the probability that a lake will remain stratified during the summer. This probability is estimated using the ratio of the lake's mean depth to its surface area. Lakes with an Osgood Index of less than 4.0 are deemed polymictic. As is discussed further in the section and the individual lake sections, some of the Town of Saint Germain lakes experience internal nutrient loading in summer which elevates phosphorus concentrations and can fuel periodic algal blooms.

To determine if internal nutrient loading occurs and has a significant effect on a lake's water quality, the dynamics of near-surface phosphorus concentrations over the course of the growing season are examined. In dimictic lakes that experience internal nutrient loading, near-surface concentrations will often be highest in the fall following fall turnover when the phosphorus-rich bottom waters are mixed throughout the water column. In shallower lakes that experience internal loading and periodic mixing throughout the growing season, near-surface phosphorus concentrations will often increase over the course of the growing season as sediment-released phosphorus is periodically mobilized to the surface. In addition, near-bottom phosphorus concentrations are also measured during periods of stratification to determine if significant levels of phosphorus are accumulating in bottom waters.

Finally, watershed modeling was used to determine if measured phosphorus concentrations were similar to those predicted based on watershed size, land cover, and precipitation. If predicted phosphorus concentrations are significantly lower than those measured, this indicates that source(s) of phosphorus are entering the lake that were not accounted for in the model. This unaccounted source of phosphorus is often attributable to the internal loading of phosphorus.

Comparisons with Other Datasets

The WDNR document *Wisconsin 2018 Consolidated Assessment and Listing Methodology* (WDNR, Wisconsin 2018 Consolidated Assessment and Listing Methodology (WisCALM) 2018) 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 is compared to lakes in the state with similar physical characteristics.

The WDNR classifies Wisconsin's lakes into ten natural communities based on size, hydrology, and depth (Figure 3.1-1). First, the lakes are classified into three main groups: (1) lakes and reservoirs less than 10 acres, (2) lakes and reservoirs greater than or equal to 10 acres, and (3) a classification that addresses special waterbody circumstances. The last two categories have several sub-categories that provide attention to lakes that may be shallow, deep, play host to cold water fish species or have unique hydrologic patterns. Overall, the divisions categorize lakes based upon their size, stratification characteristics, and hydrology. 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.

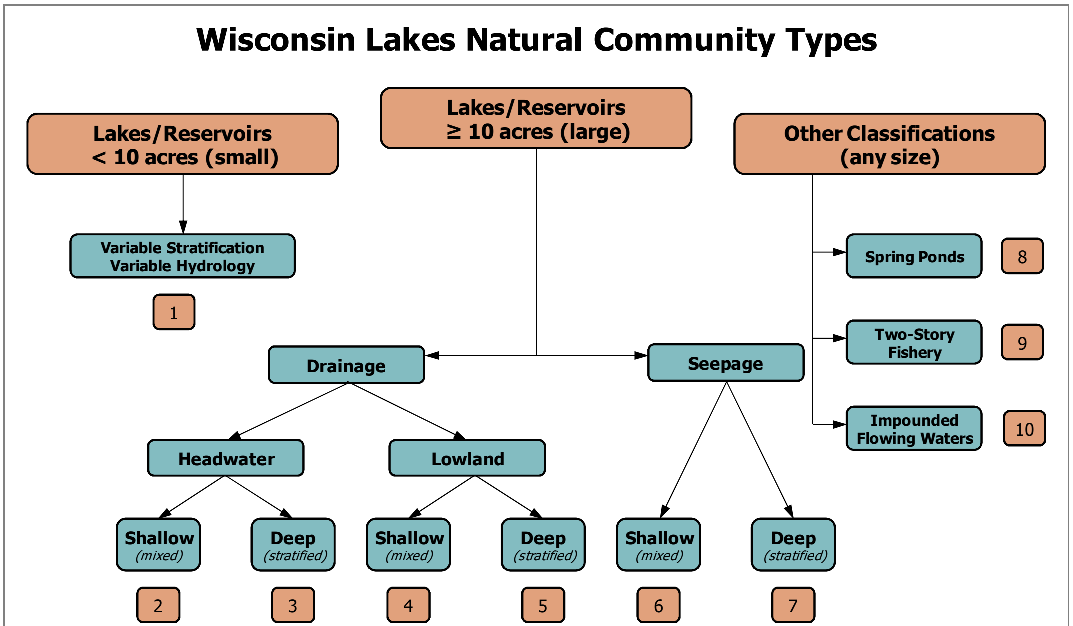


Figure 3.1-1. Wisconsin Lake Classifications. Adapted from WDNR 2013A.

The Town of Saint Germain project lakes represent a diversity of the natural lake community types that can be found in Wisconsin and include: shallow headwater drainage lakes, deep headwater drainage lakes, shallow lowland drainage lakes, two-story fishery lakes, and deep seepage lakes (Table 3.1-1). While Big Saint Germain Lake's depth and watershed size classifies it as a deep lowland drainage lake, it is classified as a two-story fishery lake given the documented presence of a cold-water fish population (cisco). As is discussed in the Big Saint Germain Lake individual water quality section (Section 8.2.1), two-story fishery lakes have more protective water quality standards when compared to the other lake communities in an effort to protect the cold-water fishery habitat.

Table 3.1-1. Community classification of project lakes within the Town of Saint Germain.

Lake Type	Town of Saint Germain Project Lakes
Deep Seepage	Alma Lake Moon Lake
Deep Headwater Drainage	West Bay - Little Saint Germain Lake
Shallow Headwater Drainage	Lake Content*
Shallow Lowland Drainage	East Bay - Little Saint Germain Lake Fawn Lake Found Lake Lost Lake South Bay - Little Saint Germain Lake
Deep Lowland Drainage/Two-Story	Big Saint Germain Lake

**Lake Content is currently classified as a deep seepage lake by the WDNR, but is currently under revision to be reclassified as a shallow headwater drainage lake.*

The WDNR currently classifies Lake Content as a deep seepage lake with a maximum depth of 42 feet. However, surveys in 2019 showed that the maximum depth of the lake is 14 feet, and the 42 feet listed is believed to be for Big Saint Germain Lake. In addition, Lake Content possesses an outlet to Big Saint Germain

Lake. Given the shallower depth and the presence of an outlet tributary, Lake Content should be classified as a shallow headwater drainage lake. For comparison purposes, Lake Content will be classified as a shallow headwater drainage lake for this analysis.

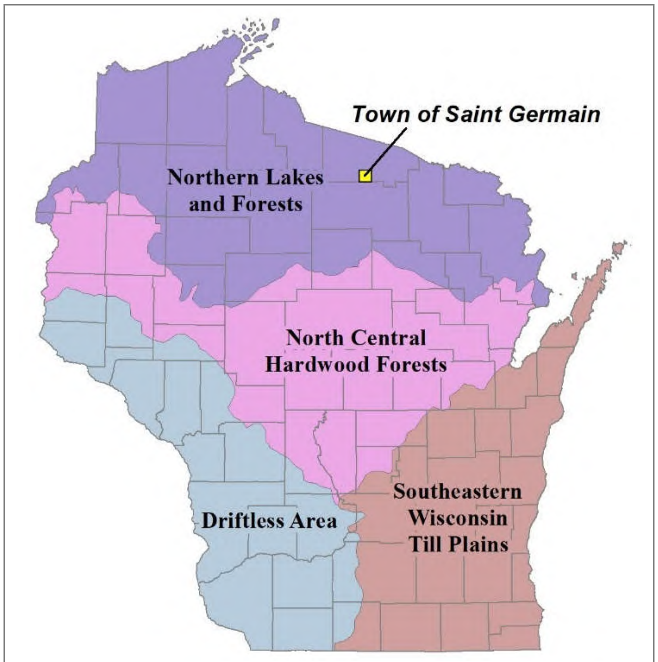


Figure 3.1-2. Location of the Town of Saint Germain within the ecoregions of Wisconsin. After Nichols 1999.

(Garrison, Jennings et al. 2008) developed state-wide median values for total phosphorus, chlorophyll-*a*, and Secchi disk transparency for six of the ten lake classifications. While 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 and its lakes fall within the Northern Lakes and Forests (NLF) ecoregion, and the water quality of the town's lakes will be compared to other lakes within the NLF ecoregion. (Figure 3.1-2).

The Wisconsin 2018 Consolidated Assessment and Listing Methodology document also helps stakeholders understand the health of their lake compared to other lakes within the state. Looking at pre-settlement diatom population compositions from sediment cores collected from numerous lakes around the state, they were able to infer a reference condition for each lake's water quality prior to human development within their watersheds. Using these reference conditions and current water quality data, the assessors were able to rank phosphorus, chlorophyll-*a*, and Secchi disk transparency values for each lake class into categories ranging from excellent to poor.

Water quality data from the Town of Saint Germain project lakes are presented along with comparable data from similar lakes throughout the state and lakes within the NLF ecoregion in the subsequent section. Please note that these data represent samples collected during the growing season (April – October) or summer months (June, July, and August) unless otherwise indicated. The chlorophyll-*a* data represent only samples collected from the near-surface because they represent the depths at which phytoplankton grow.

Wisconsin Valley Improvement Company Reservoir System

The Big Saint Germain Lake system (Fawn Lake, Big Saint Germain Lake, Lake Content) and Little Saint Germain lake are two of 21 Wisconsin Valley Improvement Company (WVIC) water storage reservoirs used to maintain a nearly uniform flow of water as practicable in the Wisconsin river by storing surplus water in reservoirs for discharge when water supply is low to improve the usefulness of the rivers of the rivers for hydropower, flood control, and public use (Figure 3.1-3).

Hydroelectric power projects are licensed by the Federal Energy Regulatory Commission (FERC). As part of the FERC operation license, the minimum and maximum water levels are set for each waterbody. Natural lake reservoir water levels, like Big Saint Germain and Little Saint Germain lakes are maintained within a relatively narrow range in comparison to the five man-made reservoirs which exhibit changes of water levels that could span 10-20 feet in a single year.

Big and Little Saint Germain lakes are two of the natural lake reservoirs in the WVIC system, and have operational ranges of less than 2 feet during the summer months. For Big Saint Germain Lake, the water levels need to be kept between 1,589.33 and 1,590.66 feet between June 1 and September 30 of each year. In Little Saint Germain Lake, water levels need to be kept between 1,612.05 and 1,613.88 feet between June 1 and September 30 of each year. Winter drawdowns cannot exceed 1,588.16 feet in Big Saint Germain Lake and 1,612.05 feet in Little Saint Germain Lake.

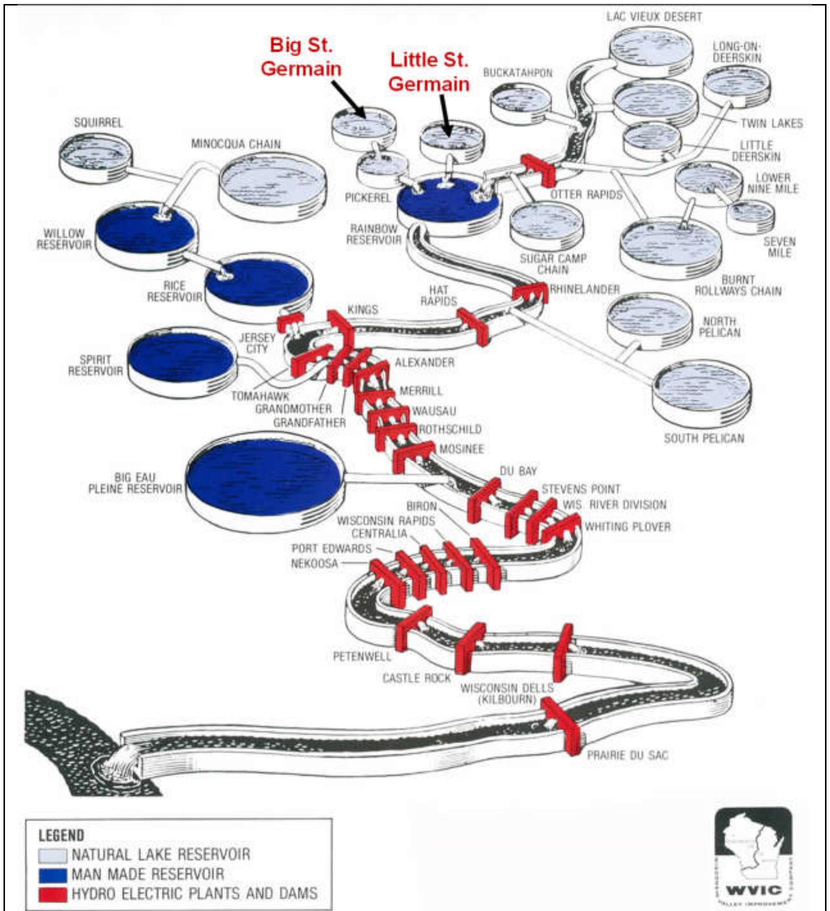


Figure 3.1-3. WVIC reservoir system. Adapted from WVIC website.

In addition to establishing a range of water levels, minimum outflows are also set to make sure the downstream riverine systems are not negatively impacted by abnormally low flows. Big Saint Germain Lake must maintain a minimum flow with a 2-inch gate opening at the dam, while Little Saint Germain Lake must maintain a minimum flow of 5.6 cubic feet per second.

Town of Saint Germain Project Lakes Water Quality Analysis

Town of Saint Germain Project Lakes Nutrients, Phytoplankton, and Water Clarity

The water quality data collected as part of this management planning update project were not as extensive as the monitoring completed during the original plan development. Onterra ecologists collected water quality data during June, July, and August of 2019 on the six lakes included in this project (Alma, Moon, Found, Big Saint Germain, Fawn, and Content). While Little Saint Germain (LSG) and Lost lakes were not included in this management update project because they have their own lake-specific management plans largely focused on aquatic invasive species management, water quality data from these lakes are also included in this section. Please note that the data for LSG are separated by basin (West Bay, East Bay, Lower East Bay, and South Bay) as these basins represent distinct natural community types. The locations of these basin locations can be found on Map 1.

The individual lake sections provide in-depth discussions of each of the six project lakes included in this project. Detailed water quality data for Little Saint Germain and Lost lakes can be found in their respective lake management plan. The data presented in this section will serve to compare the lakes within the township. While these lakes are in close proximity to one another, their differences in morphometry and watershed sizes drive large variations in water quality. Within this section, the lakes' total phosphorus concentrations, chlorophyll-*a* concentrations, and water clarity are compared.

Total Phosphorus

As discussed previously, phosphorus is the primary nutrient controlling the growth of algae (phytoplankton) in the majority of Wisconsin's lakes. To determine whether phosphorus is the limiting nutrient within a lake, the concentration of phosphorus is compared to the concentration of nitrogen. Mid-summer total phosphorus and total nitrogen concentrations from the Town of Saint Germain project lakes indicate that Moon, Alma, Content, LSG-West Bay, Found, Fawn, LSG-South Bay, and Big Saint Germain lakes are phosphorus-limited like the majority of Wisconsin lakes (Figure 3.1-4). In general, this means that phosphorus regulates algal production in these lakes – as phosphorus increases, algal production increases and vice versa.

Data from Lost Lake, LSG-Lower East Bay, and LSG-East Bay indicate that these waterbodies may transition between phosphorus and nitrogen limitation. As is discussed in detail in their individual lake management plans, these waterbodies experience internal phosphorus loading, a process by which phosphorus from bottom sediments is mobilized to surface waters. These lakes may experience nitrogen limitation when internal nutrient loading results in large inputs of phosphorus.

The average summer (June-August) near-surface total phosphorus concentration was calculated for each lake using data collected as part of this project in 2019 along with historical data. As illustrated in Figure 3.1-5, phosphorus concentrations vary widely across the Town of Saint Germain lakes, ranging from 11 µg/L in Moon Lake to 63 µg/L in LSG-East Bay. It is important to note that the variation in phosphorus concentration among these lakes is largely a result of differences in their morphology and position within the landscape.

In general, more voluminous (deep) lakes with smaller watersheds (headwater) tend to have lower phosphorus concentrations. Having a smaller watershed generally means less phosphorus is delivered to the lake, and with greater water volume, these lakes are better able to dilute incoming phosphorus which reduces in-lake concentrations. Lakes that have less water volume (shallow) with larger watersheds (lowland) tend to have the highest phosphorus concentrations. Larger watersheds deliver a higher amount of phosphorus, and phosphorus becomes more concentrated in lakes with less water volume. In addition, in shallower lakes, phosphorus in bottom sediments has the potential to be recycled back into surface waters, further elevating concentrations.

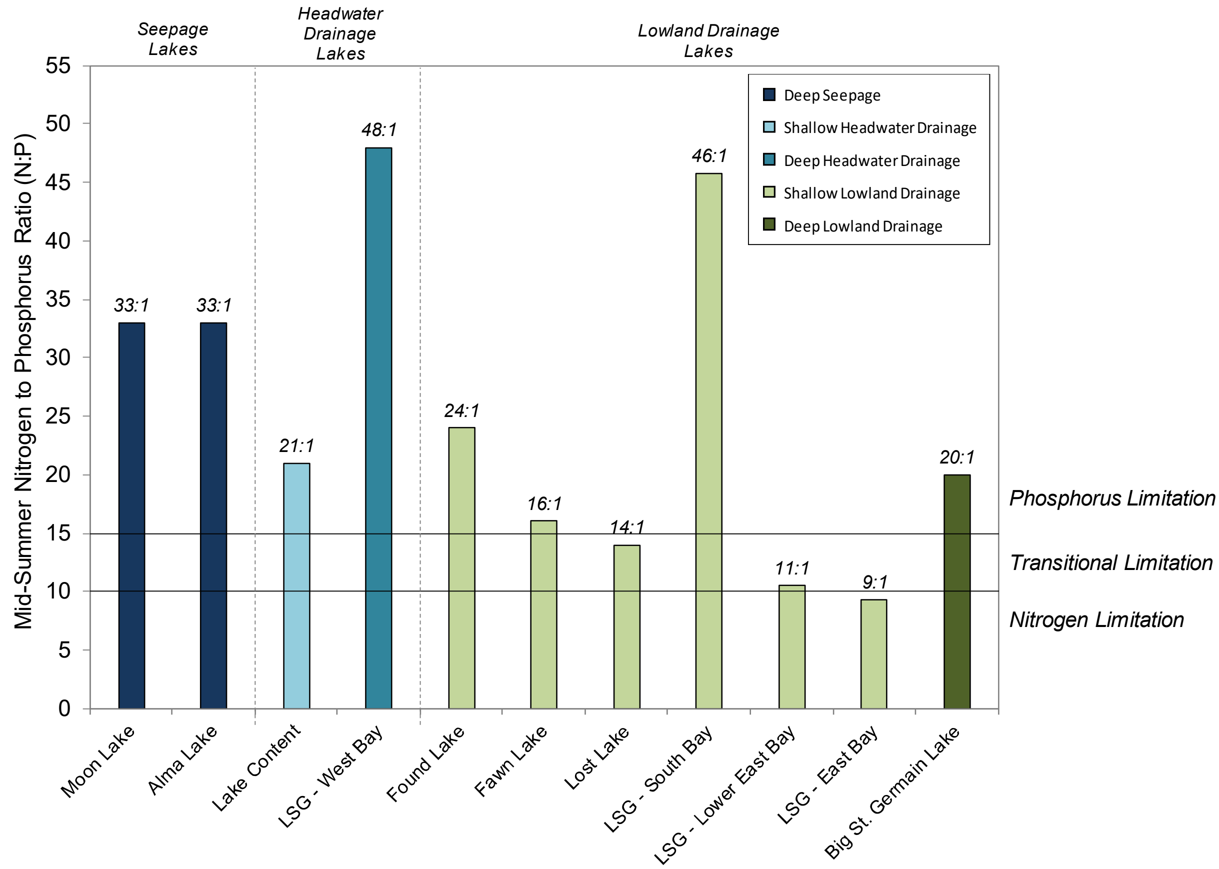


Figure 3.1-4. Town of Saint Germain project lakes 2019 mid-summer total nitrogen to total phosphorus ratios. Data represent surface samples collected during mid-summer during each respective project phase. Lost Lake data is from 2017 and data from LSG basins are from 2001 and 2003.

Wisconsin's deep seepage lakes (lakes with the smallest watersheds and higher water volume) on average have the lowest phosphorus concentrations with a median concentration of 15 µg/L. The two deep seepage lakes of Moon and Alma lakes have the lowest phosphorus concentrations of the Town of Saint Germain project lakes at 11 µg/L and 14 µg/L, respectively (Figure 3.4-5). Similarly, the project's only deep headwater drainage lake, LSG-West Bay, has lower concentrations of phosphorus at 17 µg/L. Phosphorus concentrations in Lake Content, the project's only shallow headwater drainage lake, are higher than expected at 36 µg/L. As is discussed in detail in the Lake Content Water Quality Section (Section 8.3.1), concentrations are believed to be higher due to the internal loading of phosphorus from bottom sediments.

Phosphorus concentrations among the six shallow lowland drainage lakes ranged from 22 µg/L in Found Lake to 63 µg/L in LSG-East Bay (Figure 3.1-5). East Bay and South Bay of Little Saint Germain Lake and Lost Lake experience internal phosphorus loading which elevates phosphorus concentrations. Detailed discussions surrounding internal nutrient loading in these lakes can be found in their respective individual lake management plans. The average summer phosphorus concentration in Big Saint Germain Lake was 28 µg/L, the project's only deep lowland drainage lake. This concentration is slightly higher than the median concentration for Wisconsin's deep lowland drainage lakes. Big Saint Germain Lake also experiences periodic internal phosphorus loading, which mainly results in higher phosphorus concentrations later in the summer and early fall. Internal nutrient loading in Big Saint Germain Lake is discussed in the Big Saint Germain Lake Water Quality Section (Section 8.2.1).

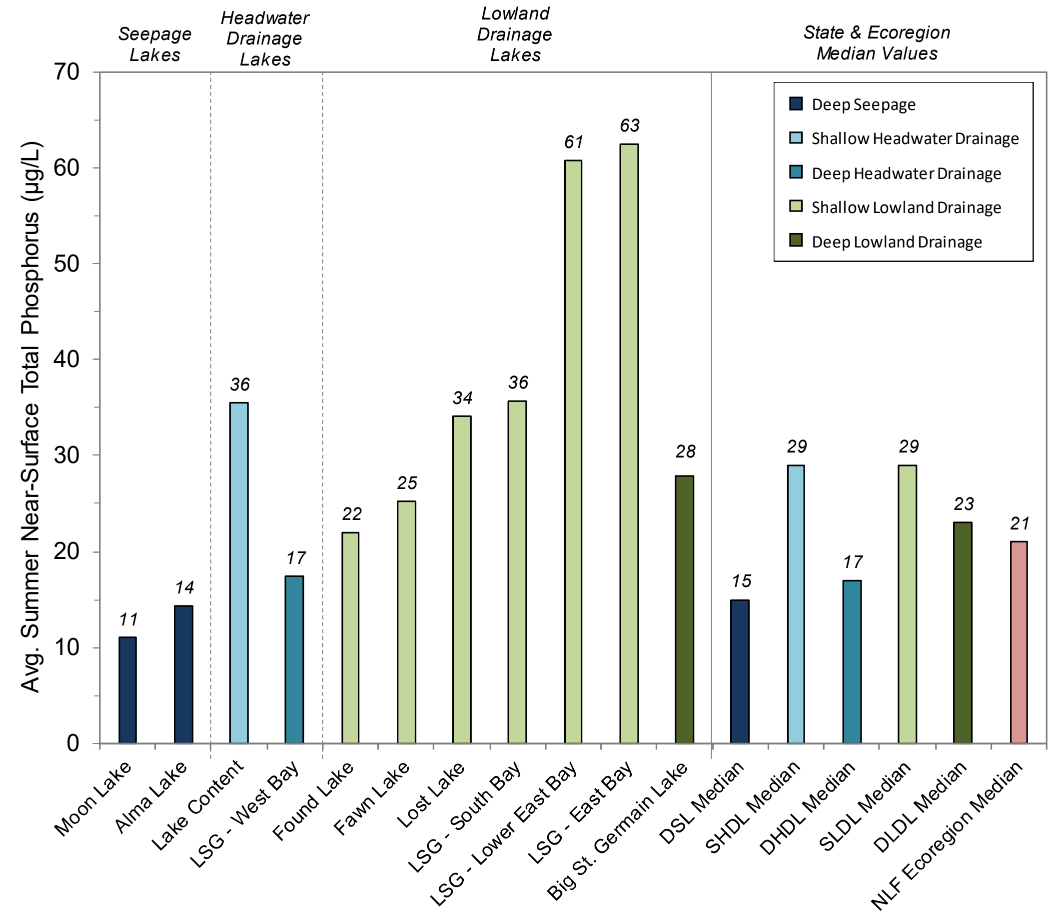


Figure 3.1-5. Town of Saint Germain project lakes summer average near-surface total phosphorus concentrations and median summer near-surface phosphorus concentrations for comparable lakes. Individual lake values calculated using all available historical and current data. DSL = deep seepage lake; SHDL = shallow headwater drainage lake; DHDL = deep headwater drainage lake; SLDL = shallow lowland drainage lake; DLDL = deep lowland drainage lake; NFL = Northern Lakes and Forests Lakes ecoregion.

Chlorophyll-α

As discussed earlier, chlorophyll-*a* is a surrogate for measuring free-floating algae abundance within the water column and is usually positively correlated with total phosphorus concentrations. While phosphorus limits the amount of algal growth in the majority of Wisconsin's lakes, other factors also affect the amount of algae produced within the lake. Water temperature, sunlight, and the presence of small crustaceans called zooplankton, which feed on algae, also influence algal abundance.

Summer average chlorophyll-*a* concentrations ranged from 2.5 µg/L in Moon Lake to 46.0 µg/L in LSG-East Bay and LSG-Lower East Bay (Figure 3.1-6). Chlorophyll-*a* concentrations for Alma and Moon lakes fall near the median concentration for Wisconsin's deep seepage lakes. Similarly, concentrations in Lake Content and LSG-West Bay fall near median values for the state's shallow headwater drainage and deep head water drainage lakes, respectively. Chlorophyll-*a* concentrations in Found and Fawn lakes fall near the median concentration for shallow lowland drainage lakes in Wisconsin, while concentrations in Lost Lake are nearly twice the median concentration. Concentrations in LSG-South Bay are nearly three times higher than median concentrations, while LSG-East Bay and LSG-Lower East Bay have concentrations over six times higher than median values. Lake users are likely to observe algal blooms when chlorophyll-*a* concentrations exceed 20 µg/L. Algal blooms occur periodically in Lost Lake, LSG South, East, and Lower East bays, and Big Saint Germain Lake and Lake Content.

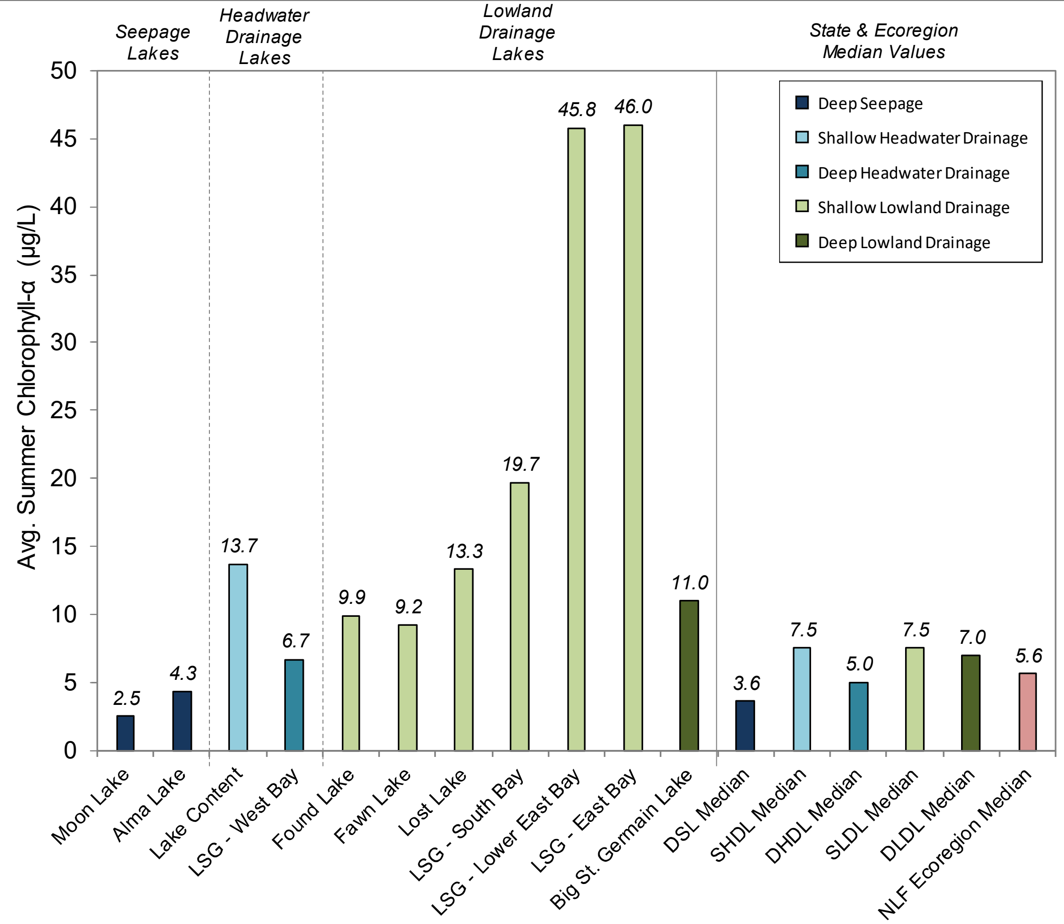


Figure 3.1-6. Town of Saint Germain project lakes summer average chlorophyll-α concentrations and median summer chlorophyll-α concentrations for comparable lakes. Individual lake values calculated using all available historical and current data. DSL = deep seepage lake; SHDL = shallow headwater drainage lake; DHDL = deep headwater drainage lake; SLDL = shallow lowland drainage lake; DLDL = deep lowland drainage lake; NFL = Northern Lakes and Forests Lakes ecoregion.

As discussed previously, chlorophyll-*a* concentrations are typically correlated with phosphorus concentrations – as phosphorus concentrations increase, chlorophyll-*a* or algal production increases. Chlorophyll-*a* concentrations in most of the Town of Saint Germain project lakes are correlated with phosphorus concentrations (Figure 3.1-7). As expected, the lakes with the lowest phosphorus concentrations (Alma and Moon lakes) also have the lowest chlorophyll-*a* concentrations, and lakes with the highest phosphorus concentrations (LSG-East Bay and LSG-Lower East Bay) have the highest chlorophyll-*a* concentrations.

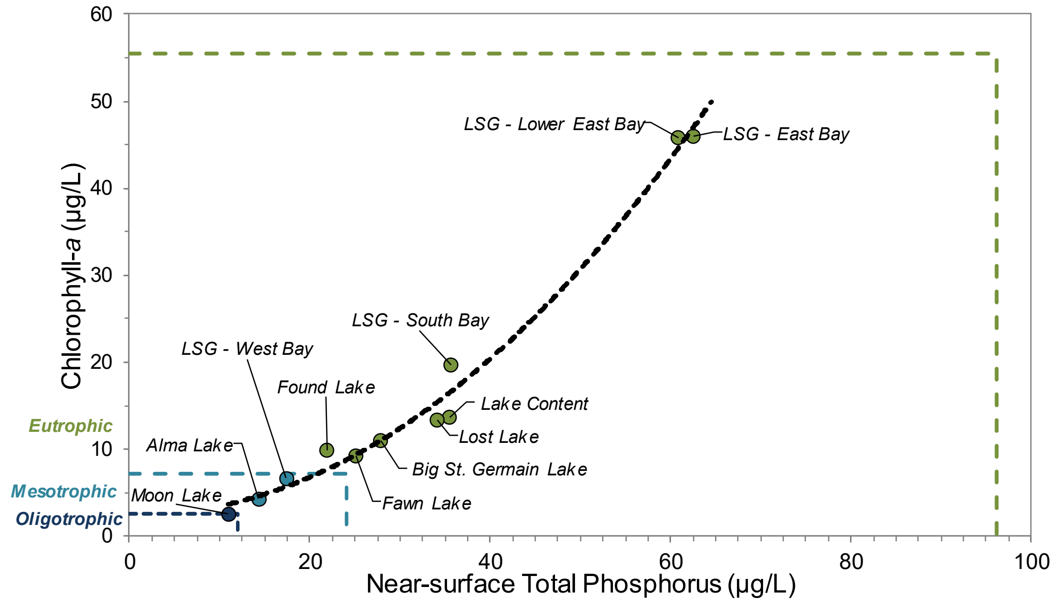


Figure 3.1-7. Town of Saint Germain project lakes average summer chlorophyll-α concentrations plotted against average summer total phosphorus concentrations. Phosphorus is a good predictor of chlorophyll in most of the project lakes.

Water Clarity

Average summer Secchi disk depth measured in the project lakes ranged from 3.4 feet in LSG-East Bay and LSG-Lower East Bay to 16.3 feet in Moon Lake (Figure 3.1-8). With the exception of LSG-East and Lower East Bay, the average summer Secchi disk depth for all of the project lakes was similar to or exceeded the median statewide value for their respective lake type. Average Secchi disk depth in the Town of Saint Germain project lakes is highly correlated with chlorophyll-*a* concentrations, indicating that free-floating algae are the primary factor regulating water clarity in these lakes (Figure 3.1-9).

Alma and Moon lakes, the lakes with the lowest chlorophyll-*a* concentrations, had the highest water clarity, while the lakes with the highest chlorophyll-*a* concentrations, LSG-East and Lower East Bay, had the lowest water clarity (Figure 3.1-9). Water clarity in Big Saint Germain Lake was slightly higher than expected given chlorophyll-*a* concentrations. This can occur in situations when the algal community is comprised of larger-bodied species, such *Aphanizomenon* or *Gloeotrichia* which allow more light to penetrate into the water column.

Apart from suspended material within the water such as algae, water clarity in Wisconsin's lakes, particularly in northern Wisconsin, can also be affected by dissolved organic matter (DOM) within the water. Many lakes in northern Wisconsin contain higher concentrations of DOM which originates from decomposing plant material within wetlands and forests in the lakes' watersheds. In higher concentrations, these dissolved compounds give the water a brown or tea-like color, decreasing water clarity. In addition, the underlying geology of northern Wisconsin is largely low in calcium, and lower concentrations of calcium within the water inhibit the breakdown of these organic compounds by bacteria allowing concentrations to be higher (Cole and Weihe 2016). Higher precipitation in recent years has resulted in higher concentrations of DOM in lakes across Wisconsin, decreasing water clarity. Higher precipitation not only causes higher runoff rates of

DOM, but the saturated soil conditions also lead to a higher production rates of DOM within the watershed.

A measure of water clarity, once all of the suspended material (i.e. phytoplankton and sediments) have been removed, is termed *true color*, and indicates the level of dissolved material within the water. In the Town of Saint Germain project lakes, average true color values ranged from 5 SU (clear) in Lake Content and LSG-West Bay to 50 SU (tea-colored) in Found Lake (Figure 3.1-10). These dissolved compounds influence water clarity to a greater extent in lakes like Found and Lost lakes. It's important to note that the presence of DOM and the tea-colored water it creates is natural.

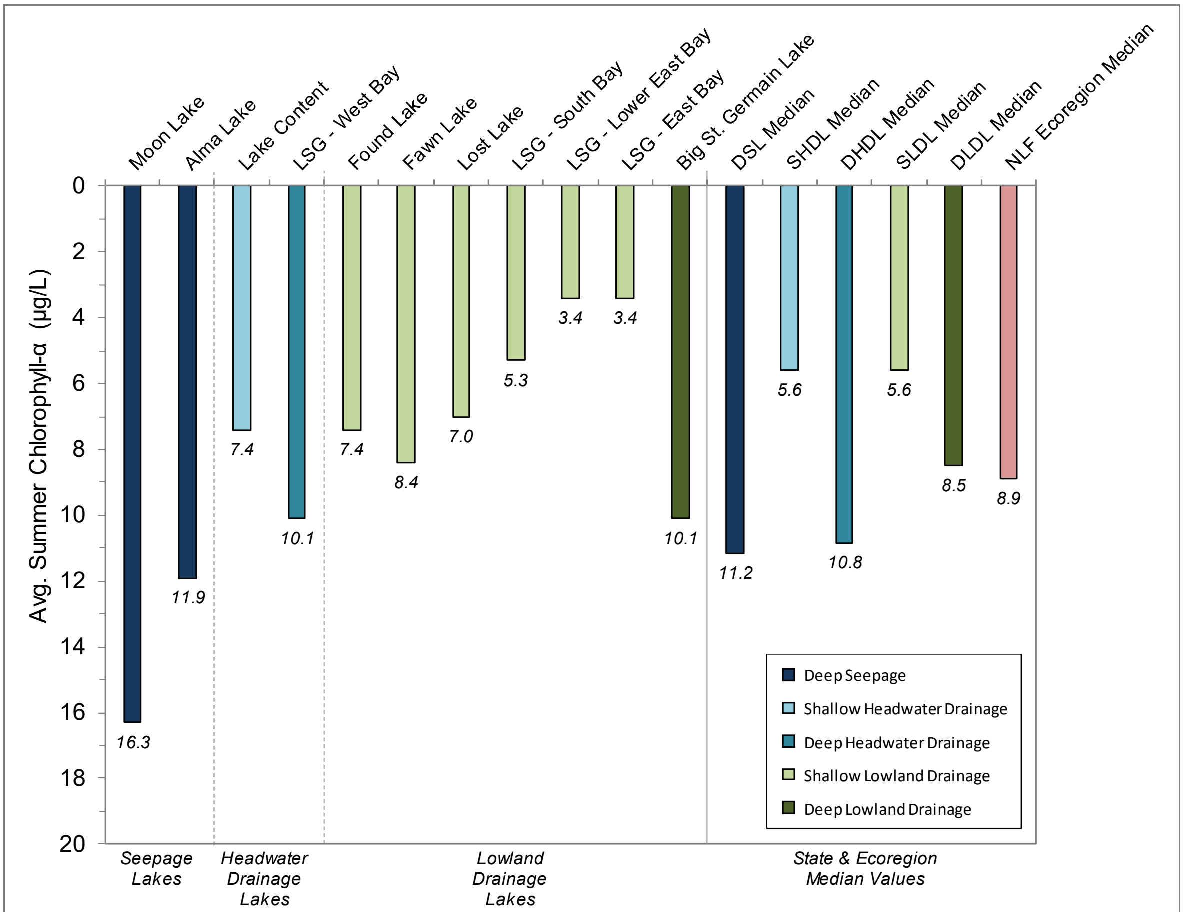


Figure 3.1-8. Town of Saint Germain project lakes summer average Secchi disk depth and median summer Secchi disk depths for comparable lakes. Individual lake values calculated using all available historical and current data. DSL = deep seepage lake; SHDL = shallow headwater drainage lake; DHDL = deep headwater drainage lake; SLDL = shallow lowland drainage lake; DLDL = deep lowland drainage lake; NFL = Northern Lakes and Forests Lakes ecoregion.

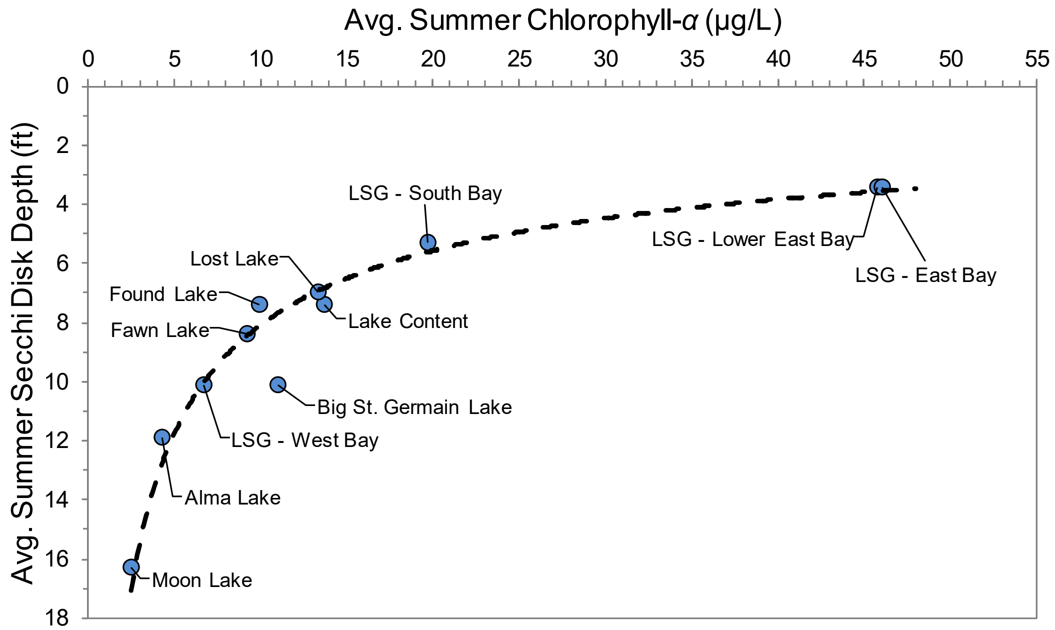


Figure 3.1-9. Town of Saint Germain project lakes average summer Secchi disk depths plotted against average summer chlorophyll-α concentrations. Chlorophyll is a good predictor of Secchi disk depth in the project lakes.

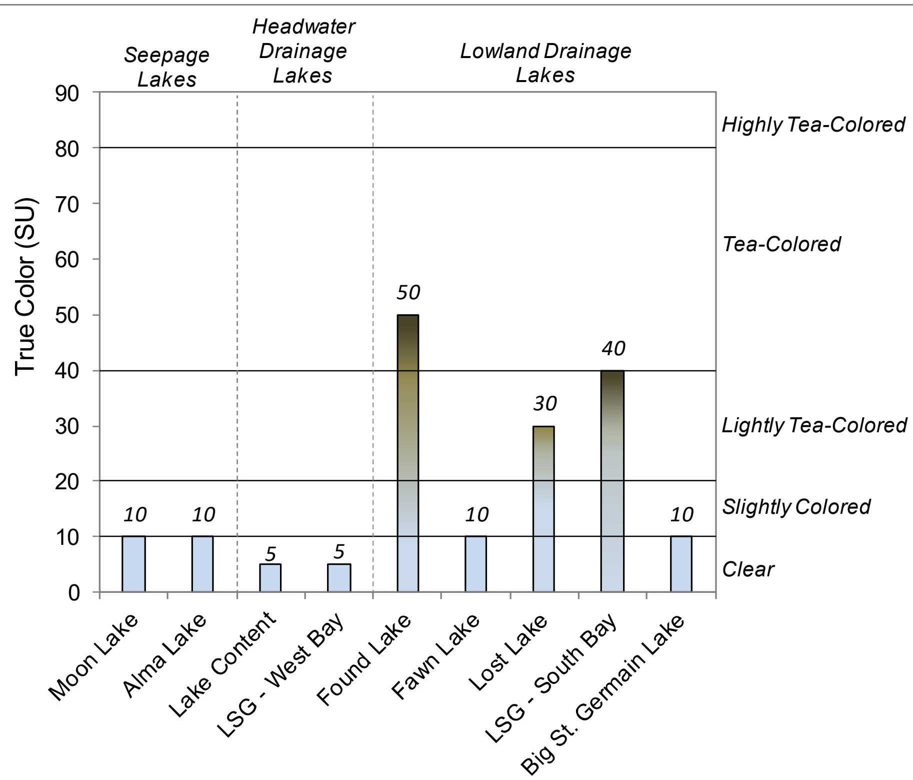


Figure 3.1-10. Town of Saint Germain project lakes average growing season true color values. Samples collected from the near-surface. Color range adapted from UNH Center for Freshwater Biology (2014).

Town of Saint Germain Project Lakes Trophic State

Figure 3.1-11 contains the weighted average Trophic State Index (TSI) values for each of the Town of Saint Germain project lakes. These TSI values are calculated using summer near-surface total phosphorus, chlorophyll-*a*, and Secchi disk transparency data collected as part of this project along with available historical data. In general, the best values to use in assessing a lake's trophic state are chlorophyll-*a* and total phosphorus as water clarity can be influenced by factors other than phytoplankton, such as DOM within the water. The closeness of the calculated TSI values for these three parameters to one another indicates a higher degree of correlation.

The Town of Saint Germain lakes span the spectrum of productivity, ranging from the oligotrophic Moon Lake to the upper eutrophic basins of LSG-East and Lower East Bay (Figure 3.1-11). Moon Lake is less productive when compared to other deep seepage lakes in Wisconsin, while Alma Lake is of comparable productivity. Lake Content is slightly more productive when compared to other shallow headwater drainage lakes in the state, and LSG-West Bay is of comparable productivity when compared to Wisconsin's deep headwater drainage lakes. Found and Fawn lakes are less productive when compared to other shallow lowland drainage lakes in the state, while Lost Lake, LSG-East Bay, and LSG-Lower East Bay are more productive. Big Saint Germain Lake is more productive when compared to other deep lowland drainage lakes in Wisconsin.

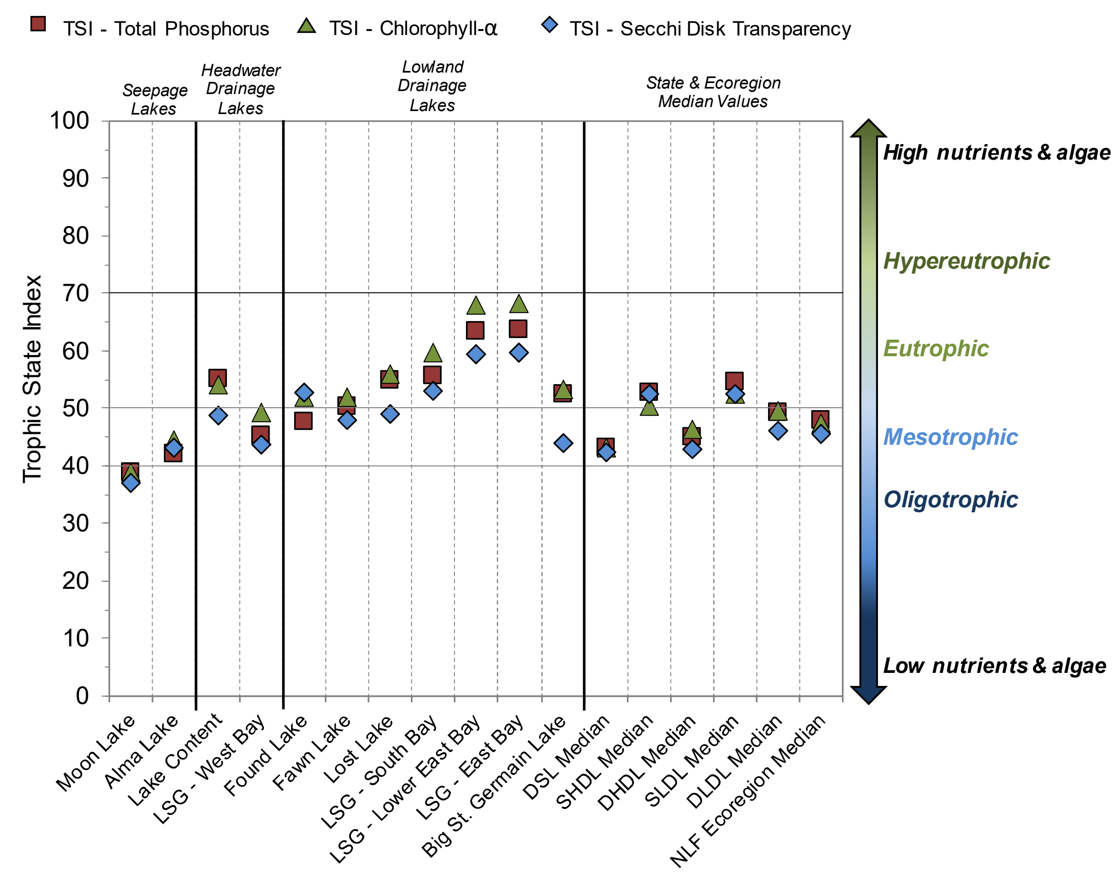


Figure 3.1-11. Town of Saint Germain project lakes Trophic State Index. Values calculated with summer month surface sample data using WDNR PUB-WT-193. DSL = deep seepage lake; SHDL = shallow headwater drainage lake; DHDL = deep headwater drainage lake; SLDL = shallow lowland drainage lake; DLDL = deep lowland drainage lake; NLF = Northern Lakes and Forests Lakes ecoregion.

For most of the project lakes, all three measures of trophic status are similar with the exception of Lake Content, Lost Lake, Big Saint Germain Lake, and LSG (South Bay, East Bay, Lower East Bay). In all of these instances, the TSI for Secchi disk depth is lower than the TSI for total phosphorus and chlorophyll-*a*, indicating water clarity is higher than expected given chlorophyll-*a* concentrations. This can occur if the algal community is comprised of large particulates, such as *Aphanizomenon* or *Gloeotrichia*, or if zooplankton are consuming more algae than is typical in most lakes. Given the data available, it is unclear which of these or both are occurring in these lakes.

Additional Water Quality Data Collected at the Town of Saint Germain Project Lakes

The previous sections were largely focused on lake eutrophication. However, parameters other than nutrients, chlorophyll-*a*, and water clarity were collected as part of the project. These other parameters were collected to increase the understanding of the Town of Saint Germain project lakes' water quality and are recommended as a part of the WDNR long-term lake trends monitoring protocol. These parameters include; pH, alkalinity, and calcium.

pH

The pH scale ranges from 0 to 14 and indicates the concentration of hydrogen ions (H^+) within the lake's water and is an index of the lake's acidity. Water with a pH value of 7 has equal amounts of hydrogen ions and hydroxide ions (OH^-) and is considered to be neutral. Water with a pH of less than 7 has higher concentrations of hydrogen ions and is considered to be acidic, while values greater than 7 have lower hydrogen ion concentrations and are considered basic or alkaline. The pH scale is logarithmic, meaning that for every 1.0 pH unit the hydrogen ion concentration changes tenfold. The normal range for lake water pH in Wisconsin is about 5.2 to 8.4, though values lower than 5.2 can be observed in some acid bog lakes and higher than 8.4 in some marl lakes and highly productive lakes. In lakes with a pH of 6.5 and lower, the spawning of certain fish species such as walleye becomes inhibited (Shaw and Nimphius 1985).

The variability in pH between lakes is most likely attributable to a number of environmental factors, most influential being the geology within the lake's surficial and ground watershed. On a smaller scale within a lake or between similar lakes, photosynthesis by phytoplankton and macrophytes can impact pH because the process uses dissolved carbon dioxide, which forms carbonic acid in water. Carbon dioxide removal through photosynthesis reduces the acidity of lake water, so pH increases. In the project lakes, summer near-surface pH values ranged from 6.8 in Alma Lake to 9.3 in LSG-East Bay (Figure 3.1-12).

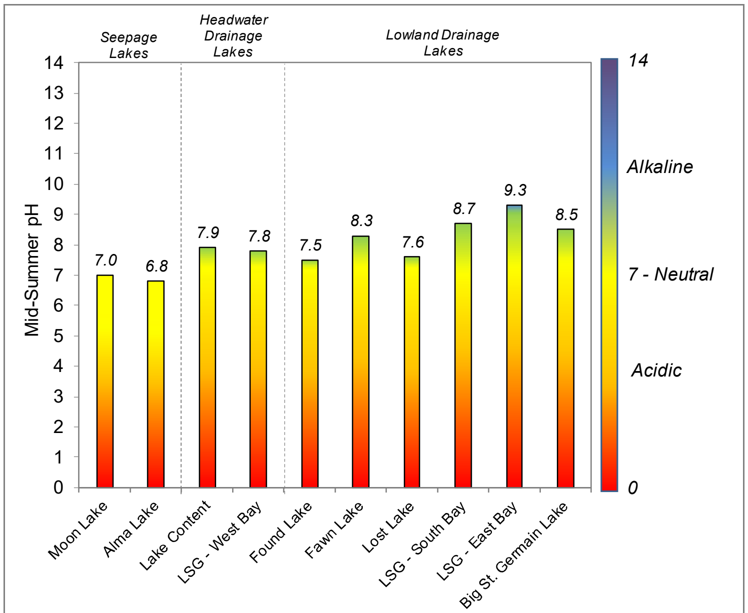


Figure 3.1-12. Town of Saint Germain project lakes mid-summer near-surface pH values.

Onterra LLC
Lake Management Planning

Alkalinity

Alkalinity is a lake's capacity to resist fluctuations in pH by neutralizing or buffering against inputs such as acid rain. The main compounds that contribute to a lake's alkalinity in Wisconsin are bicarbonate (HCO_3^-) and carbonate (CO_3^-), which neutralize hydrogen ions from acidic inputs. These compounds are present in a lake if the groundwater entering it comes into contact with minerals such as calcite ($CaCO_3$) and/or dolomite ($CaMgCO_3$). A lake's pH is primarily determined by the amount of alkalinity it contains. Rainwater in northern Wisconsin is slightly acidic naturally with a pH of around 5.0 due to dissolved carbon dioxide from the atmosphere. Consequently, lakes with low alkalinity have lower pH due to their inability to buffer against acid inputs.

Within the project lakes, alkalinity ranged from less than 2.5 mg/L as $CaCO_3$ in Alma and Moon lakes to 38.2 mg/L as $CaCO_3$ in Fawn Lake (Figure 3.1-13). Alma and Moon lakes have very low alkalinity, indicating most of their water is likely derived directly from precipitation. Drainage lakes naturally have higher alkalinity when compared to seepage lakes because they generally receive groundwater inputs and incoming streams pick up dissolved minerals such as calcium carbonate from surficial geology. Of the project lakes, only Alma and Moon lakes are considered sensitive to acid precipitation.

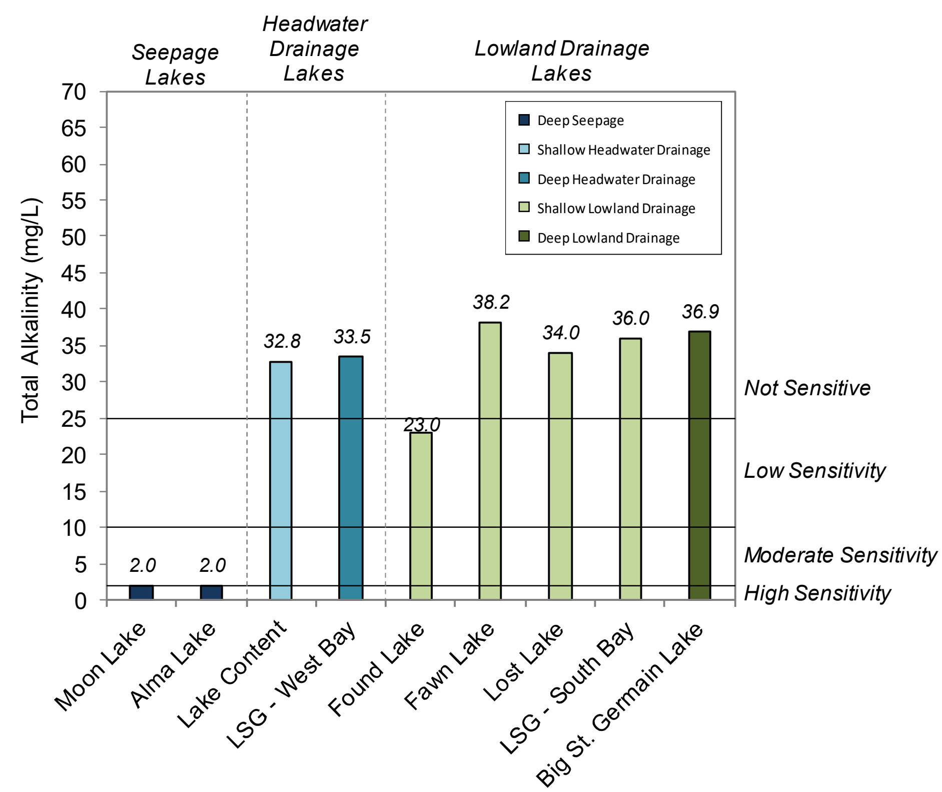


Figure 3.1-13. Town of Saint Germain project lakes average total alkalinity and sensitivity to acid rain. Samples collected from near-surface. The concentrations in Alma and Moon lakes were below the detection limit which is 2.5 mg/L.

Calcium

Like associated pH and alkalinity, the concentration of calcium within a lake's water depends on the geology of the lake's watershed. Recently, the combination of calcium concentration and pH has been used to determine which lakes can support zebra mussel populations if they are introduced. The commonly accepted pH range for zebra mussels is 7.0 to 9.0, and the pH most of the project lakes fall within this range. Lakes with calcium concentrations of less than 12 mg/L are considered to have *very low susceptibility* to zebra mussel establishment. Measured calcium concentrations ranged from 1.7 in Alma Lake to 11.6 in Lake Content (Figure 3.1-14). Calcium concentrations in all of the measured lakes fall within the *very low susceptibility* category for zebra mussel establishment. The calcium concentrations in these lakes indicate zebra mussels have a low probability of establishing if they were to be introduced.

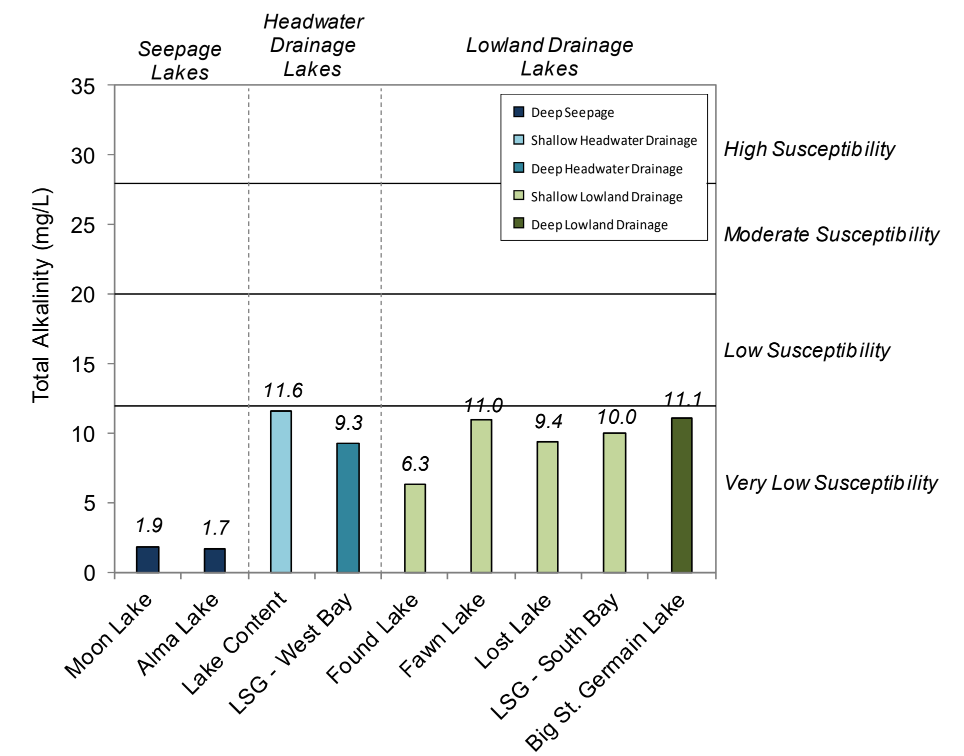


Figure 3.1-14. Town of Saint Germain project lakes average calcium concentrations and susceptibility to zebra mussel establishment. Samples collected from the near-surface.

Town of Saint Germain Lakes Water Quality Impairments

As of early 2020, Big Saint Germain Lake was on Wisconsin's 303(d) list of impaired water bodies for total phosphorus and chlorophyll-*a* concentrations which exceed listing thresholds for recreational and fish and aquatic life use. Big Saint Germain Lake is classified as a two-story lake based on the documentation of a coldwater fish population (cisco). The impairment listing thresholds are the most protective for two-story lakes in an effort to protect the oxygenated coldwater habitat that these fish populations require to survive. The listing thresholds are set at 15 µg/L for total phosphorus and 10 µg/L for chlorophyll-*a* for fish and aquatic life use in two-story lakes, and current levels of both phosphorus and chlorophyll-*a* in Big Saint Germain Lake exceed these thresholds.

As is discussed in the Paleoecology Section (Section 3.3), sediment core analysis from Big Saint Germain Lake indicate that phosphorus concentrations prior to Euro-American settlement (~150 years ago) are relatively similar to present concentrations. This indicates that attaining a phosphorus concentration of 15 μg/L is unrealistic, and site-specific water quality criteria will likely need to be developed to remove Big Saint Germain Lake from the list of impaired waterbodies.

Similarly, Lake Content is listed as impaired for total phosphorus and chlorophyll-*a* concentrations which exceed listing thresholds for recreational use. The WDNR currently classifies Lake Content as a deep seepage lake based on a maximum depth of 42 feet. However, this maximum recorded depth is from Big Saint Germain Lake, and Lake Content's actual maximum depth is 14 feet. In addition, Lake Content as a tributary connection with Big Saint Germain Lake, defining it as a drainage lake. The WDNR is reviewing the classification of Lake Content. Once the lake is reclassified and its water quality is reassessed as a shallow headwater drainage lake, it should be removed from the list of impaired waterbodies. All of the other Town of Saint Germain project lakes meet water quality criteria for their respective lake type.

Town of Saint Germain Lakes Stakeholder Perceptions of Water Quality

In 2019, a stakeholder survey was sent to 652 stakeholders with properties on or near the Town of Saint Germain project lakes of Lake Content, Big Saint Germain, Fawn, Alma, Moon, and Found lakes. Of the 652 surveys distributed, 36% (237) were returned. Given the relatively low response rate, the results of the stakeholder survey cannot be interpreted as being statistically representative of the population sampled. At best, the results may indicate possible trends and opinions about the stakeholder perceptions of the Town of Saint Germain lakes but cannot be stated with statistical confidence. The full survey and results can be found in Appendix B.

When asked how they describe water quality, the top three responses were water clarity (87%), aquatic plant growth (57%), and water color (41%) (Figure 3.1-15). When asked what was the single most important aspect when considering water quality, 52% of respondents indicated water clarity, followed by aquatic plant growth (20%), and algae blooms (13%) (Figure 3.1-15). These data indicate that Town of Saint Germain lake stakeholders believe water clarity is the most significant indicator of good water quality. As discussed previously, water clarity in the Town of Saint Germain project lakes is primarily driven by free-floating algae and dissolved organic matter (DOM). In lakes like Big Saint Germain Lake, algae are the primary factor regulating water clarity, while DOM plays a larger role in water clarity in lakes like Found and Lost lakes by creating tea-colored water.

When asked how they would describe the current water quality of these six lakes, 62% indicated the current water quality is *good*, 20% indicated *excellent*, 13% indicated *fair*, 1% indicated *poor*, 0% indicated *very poor*, and 3% were *unsure* (Figure 3.1-16). These perceptions of lake water quality agree with the water quality data collected from these lakes, with most of the parameters falling in the *good* to *excellent* categories for the respective lake type.

When asked how the water quality of these six lakes has changed since they first visited the lake, 52% indicated water quality has *remained the same*, 25% indicated it has *somewhat degraded*, 10% indicated it has *somewhat improved*, 2% indicated it has *severely degraded*, 1% indicated it has *greatly improved*, and 11% were *unsure* (Figure 3.1-16). As is discussed in the individual lake water quality sections, water quality in these lakes has largely remained the same over the period for which data are available, aligning with the majority of stakeholder responses indicating water quality has remained the same.

However, some lakes, like Alma and Found lakes, have seen measured declines in water clarity in recent years due to increases in DOM (i.e., tannins). Given water clarity was indicated as the most important aspect when considering water quality, it is likely that the 25% who indicated the water quality of these lakes have *somewhat degraded* have perceived the recent decline in water clarity in these lakes. The increase in DOM is the result of increases in precipitation, and is not an indication of degrading environmental conditions.

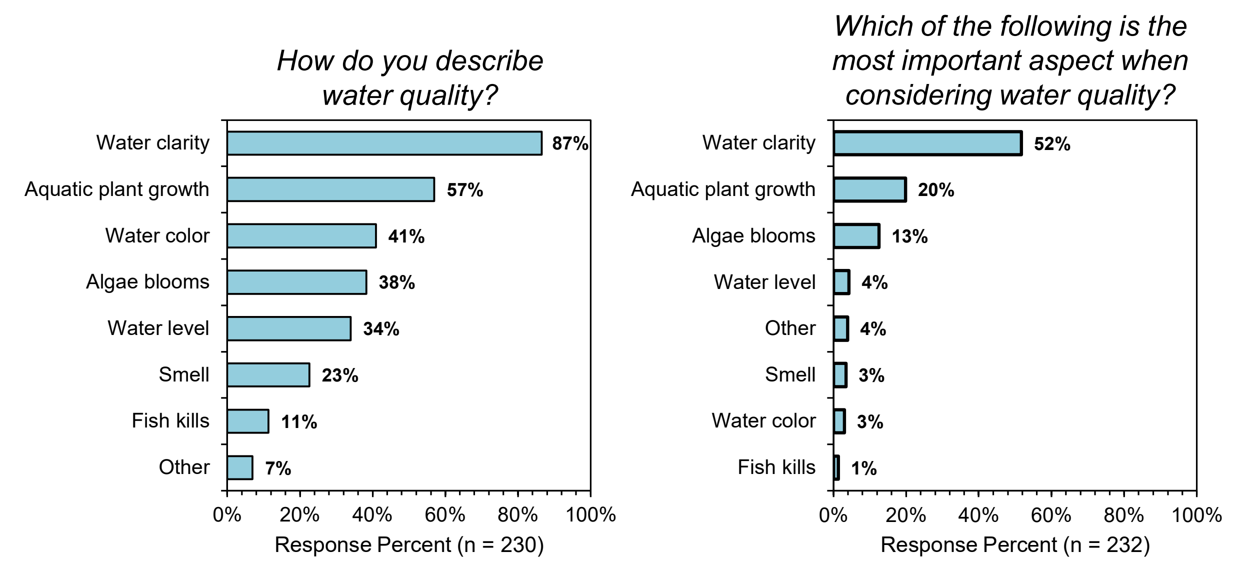


Figure 3.1-15. Town of Saint Germain stakeholder survey responses to questions regarding how stakeholders describe lake water quality.

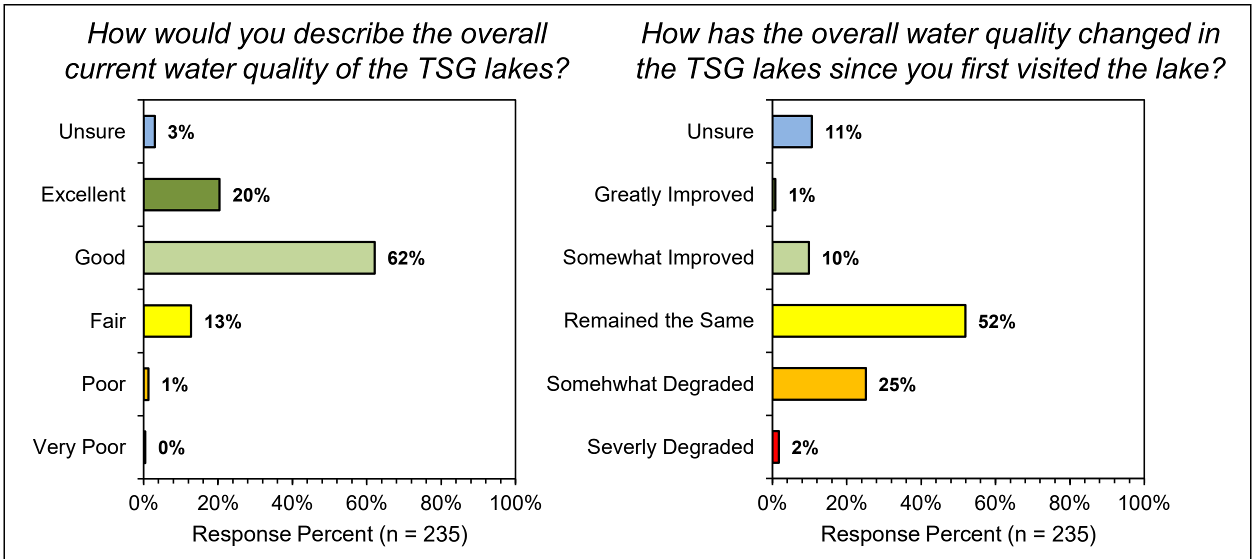


Figure 3.1-16. Town of Saint Germain stakeholder survey responses to questions regarding current and historical water quality.

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 effect 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 are 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. WiLMS does not always accurately estimate how much phosphorus loading occurs from precipitation on the lake surface. A more accurate estimate for northern Wisconsin lakes is provided from a study conducted by the USGS on Whitefish Lake, a seepage lake in northwestern Wisconsin. This revised estimate is important for seepage lakes where the phosphorus loading from precipitation is often the largest source. 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. Using the stakeholder survey sent to lake residents in 2019, the number of homes around the lake was determined. Studies conducted in Wisconsin have found that phosphorus runoff from shoreland home is higher than forested land cover. A runoff coefficient of 0.27 lbs/ac/year was used for shoreland homes. In addition, data obtained from a stakeholder survey was also used to estimate the amount of phosphorus loading to the lake from riparian septic systems.

Town of St. Germain Lakes Watershed Assessment

The Town of Saint Germain Lakes fall within the headwaters of the Wisconsin River Watershed, which drains an area of over 12,000 square miles, extending from Michigan's Upper Peninsula to south and west into the Driftless Area where the river joins the Mississippi River. The watershed for the Town of Saint Germain lakes can be separated into three primary subwatersheds: 1) the Fawn Lake Watershed which encompasses Big Saint Germain Lake, Lake Content, Lost Lake, and Found Lake, 2) the Alma and Moon Lakes Watershed, and 3) the Little Saint Germain Lake Watershed (Figure 3.2-2).

As is discussed within the Lake Water Quality Section (section 3.1), the differences in water quality among the project lakes are largely the result of differences in lake morphometry (water volume) and watershed size. However, internal nutrient loading in some of the lakes (i.e., Lost Lake and Little Saint Germain) also influence water quality. The watershed sizes among the Town of Saint Germain project lakes vary widely, ranging in size from Alma Lake's watershed of 195 acres (0.002 square miles) to Fawn Lake's watershed of 41,370 acres (65 square miles) for Fawn Lake (Figure 3.2-3). The watershed area to lake area ratios also vary, ranging from 2:1 in Lake Content, Moon, and Alma lakes, to 1,914:1 for Fawn Lake (Figure 3.2-3).

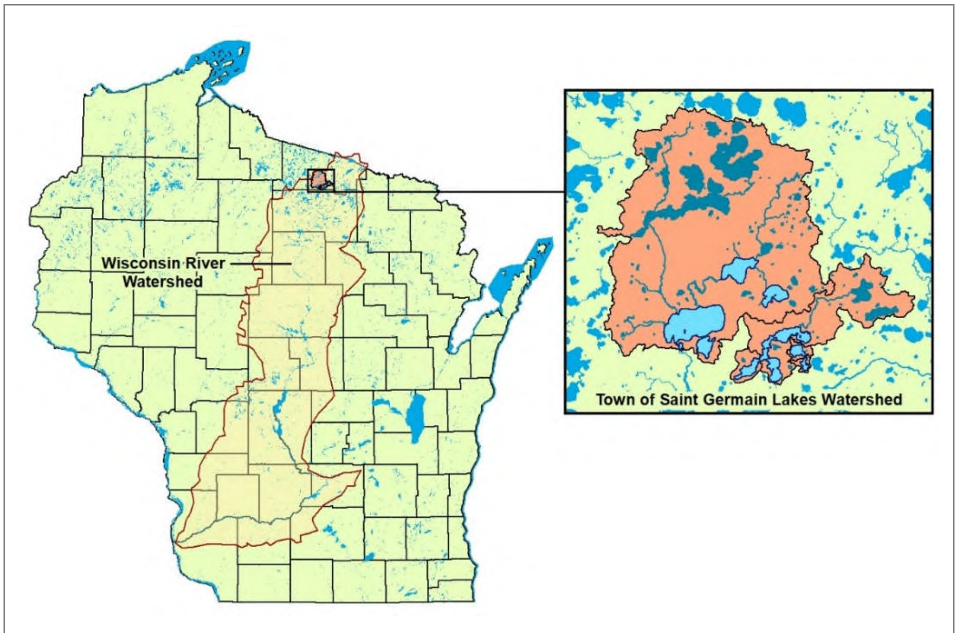


Figure 3.2-1. Town of Saint Germain project lakes' watersheds within the Wisconsin River Basin.

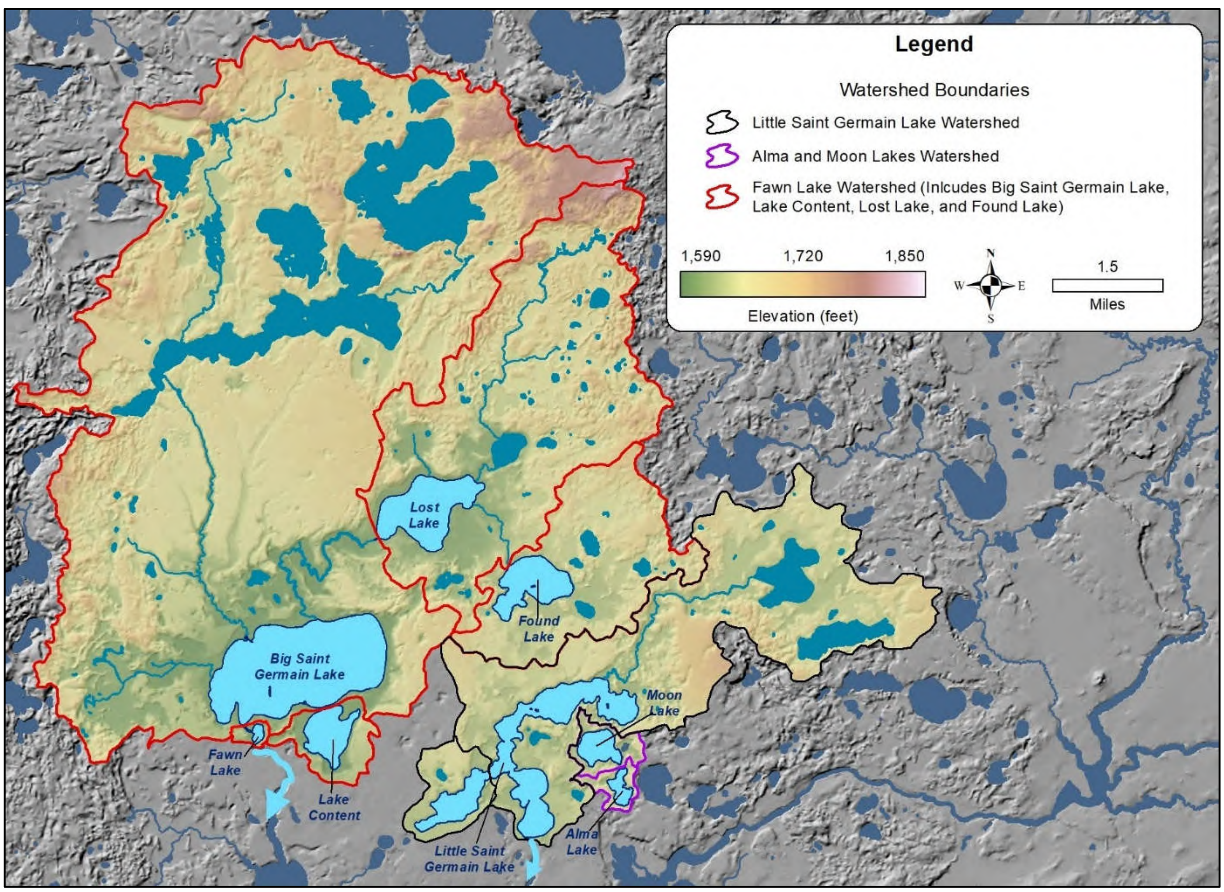


Figure 3.2-2. Town of Saint Germain project lakes watershed boundaries and land elevation.

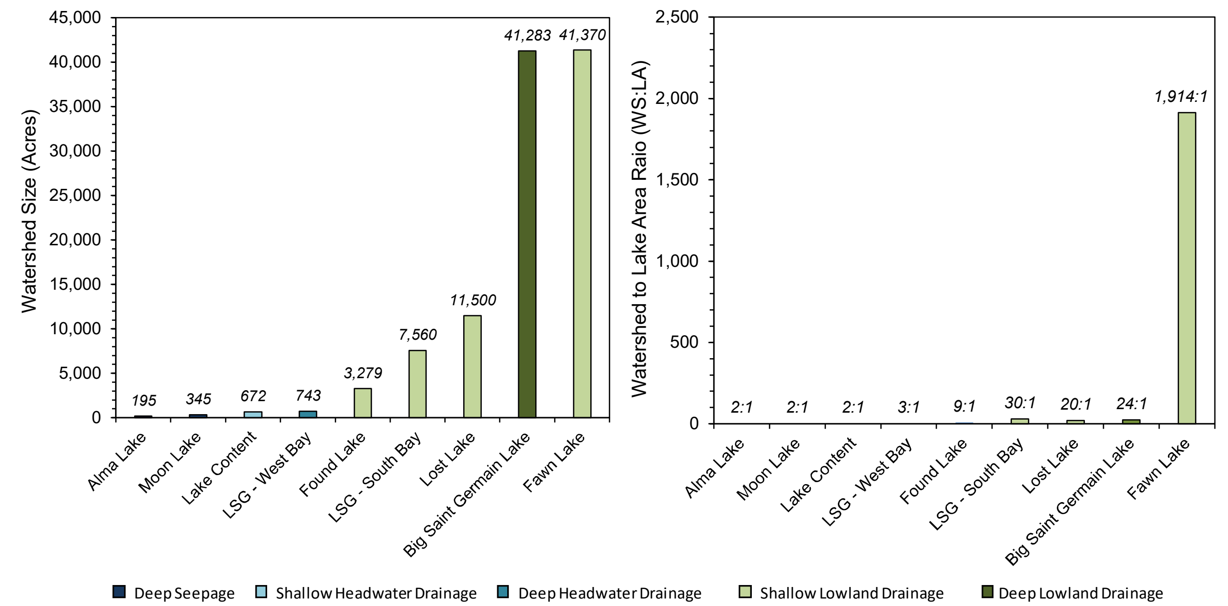


Figure 3.2-3. Town of Saint Germain lakes watershed size (left) and watershed to lake area ratios (right). Maps displaying watershed boundaries can be found within the individual lake report sections.

The 2016 land cover data indicates that the majority of land use within the Town of Saint Germain lakes' watersheds is comprised of upland forests and wetlands (both forested and non-forested), with other land use types such as rural open space and urban areas comprising small proportions (Figure 3.2-4). The lake surfaces themselves comprise larger proportions of the watersheds in the deep seepage lakes of Alma and Moon lakes and the headwater drainage lakes of Lake Content and LSG-West Bay.

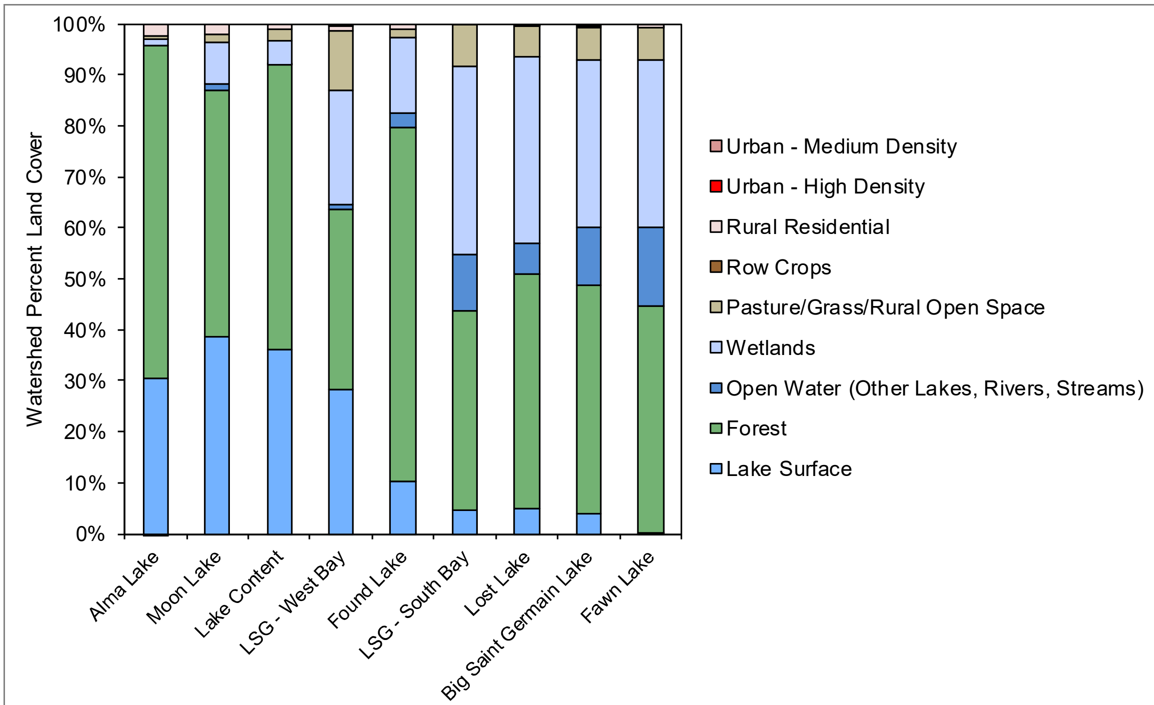


Figure 3.2-4. Town of Saint Germain lakes watershed landcover composition. Maps displaying watershed boundaries and land cover types can be found within the individual report sections.

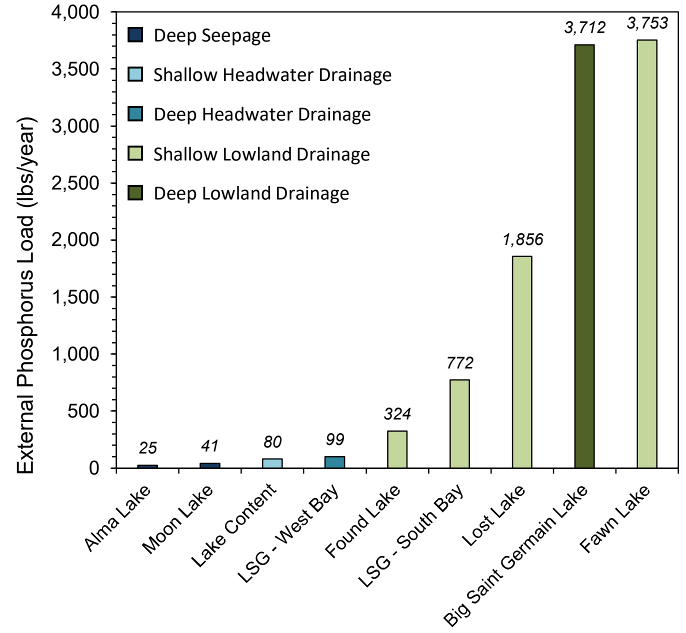


Figure 3.2-5. Town of St. Germain lakes estimated annual phosphorus loading in pounds. Calculated using Wisconsin Lakes Modeling Suite.

Watershed modeling indicates that these lakes differ greatly in terms of the estimated phosphorus delivered to them annually, ranging from 25 pounds per year in Alma Lake to 3,723 pounds per year in Fawn Lake (Figure 3.2-5). However, as discussed, lake size and volume also have to be taken into consideration when discussing phosphorus loading. Using the estimated annual phosphorus loads and the estimated volume of each lake, the annual phosphorus load per acre-foot of lake water was calculated. This analysis shows, for example, that while Moon Lake receives approximately 16 pounds of phosphorus per year more than Alma Lake, phosphorus concentrations in Moon Lake are lower because of its higher water volume. Moon Lake receives approximately 0.02 pounds of phosphorus per year per acre-foot of water, while Alma Lake receives approximately 0.04 pounds of phosphorus per year per acre-foot of water. Given Alma Lake's lower water volume, phosphorus concentrations are higher when compared to Moon Lake.

Fawn Lake receives an estimated 34 pounds of phosphorus per acre-foot of water per year. Even though phosphorus loading in Fawn Lake is very high, the lake's water residence time is less than one day, meaning water in Fawn Lake is completely replaced in less than one day on average. Given the high rate of water flow through Fawn Lake, phosphorus concentrations do not build up and they are similar to concentrations measured in Big Saint Germain Lake.

In addition to estimating the annual amount of phosphorus delivered to each lake, WiLMS also provides a predicted growing season total phosphorus concentration for each lake. The predicted phosphorus concentrations are compared against measured concentrations collected from each lake. If the measured phosphorus concentrations are higher than the model predictions, it is an indication that phosphorus may be entering the lake from a source that was unaccounted for within the model (e.g., internal nutrient loading). If the measured and predicted phosphorus concentrations are relatively similar, it is an indication that the watershed was modeled accurately and there are likely no significant sources of unaccounted phosphorus entering the lake.

Figure 3.2-6 displays the measured growing season (April-October) near-surface total phosphorus concentrations compared to WiLMS predicted concentrations for the project lakes. Measured and predicted phosphorus concentrations were relatively similar in Alma, Moon, and Fawn lakes, while predicted phosphorus concentrations were lower than measured concentrations in Lake Content, LSG-West Bay, Found, Lost, and Big Saint Germain lakes.

As mentioned within the Lake Water Quality Section (section 3.1), when measured phosphorus concentrations are higher than predicted in a lake which has a watershed largely comprised of natural land cover, internal nutrient loading is often the source of the unaccounted phosphorus. Internal nutrient loading involves the release of phosphorus (and other nutrients) from anoxic bottom sediments into the overlying water. Studies completed on Little Saint Germain and Lost Lakes indicated that internal nutrient loading occurs in these lakes. As is discussed further in the respective lakes' individual water quality sections, internal nutrient loading is also occurring in Lake Content, Big Saint Germain Lake, and to some extent in Found Lake, resulting in measured phosphorus concentrations that are higher than modeled predictions.

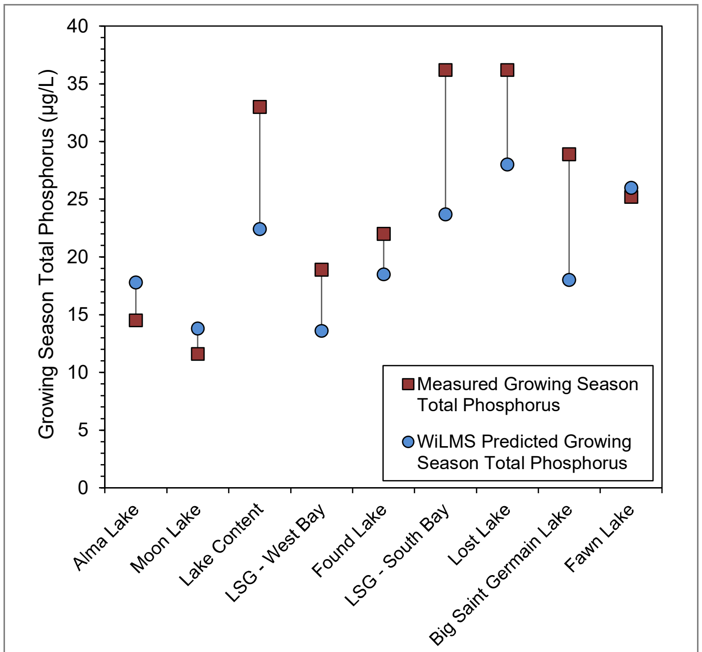


Figure 3.2-6. Town of St. Germain lakes measured versus WiLMS-predicted in-lake growing season total phosphorus concentrations. Internal phosphorus loading from bottom sediments is the primary reason why measured concentrations in some lakes are higher than predicted. Phosphorus loading from internal loading is not accounted for in WiLMS modeling.

The potential impact of septic systems on phosphorus loading to these lakes was also estimated using data collected from the stakeholder surveys. These data indicate that phosphorus originating from septic systems around the Town of Saint Germain project lakes is negligible. Please see the individual lake report sections to see estimated phosphorus loading from shoreline septic systems for each lake. Overall, the watersheds for the St. Germain project lakes are in excellent shape being primarily comprised of intact, natural land cover types. These natural land cover types decrease soil erosion and nutrient runoff into these lakes and maintain their good water quality.

3.3 Paleoecology

Photo 3.3-1. Sediment core collected from Found Lake in 2019.

Questions often arise concerning how a lake's water quality has changed through time as a result of watershed disturbances. In most cases, there is little or no reliable long-term data. They also want to understand when the changes occurred and what the lake was like before the transformations began. Paleoecology offers a way to address these issues. The paleoecological approach depends upon the fact that lakes act as partial sediment traps for particles that are created within the lake or delivered from the watershed. The sediments of the lake entomb a selection of fossil remains that are more or less resistant to bacterial decay or chemical dissolution.

These remains include frustules (silica-based cell walls) of a specific algal group called diatoms, cell walls of certain algal species, and subfossils from aquatic plants. The diatom community is especially useful in reconstructing a lake's ecological history as they are highly resistant to degradation and are ecologically diverse. Diatom species have unique features as shown in Photo 3.3-1, which enable them to be readily identified. Certain taxa are usually found under nutrient poor conditions while others are more common under elevated nutrient levels. Some species float in the open water areas while others grow attached to substrates such as aquatic plants or the lake bottom.

The chemical composition of the sediments may indicate the composition of particles entering the lake as well as the past chemical environment of the lake itself. By collecting an intact sediment core, sectioning it off into layers, and utilizing all of the information described above, paleoecologists can reconstruct changes in the lake ecosystem over any period of time since the establishment of the lake.

One often used paleoecological technique is collecting and analyzing top/bottom cores. The top/bottom core only analyzes the top (usually 1 cm) and bottom sections. The top section represents present day conditions and the bottom section is hoped to represent pre-settlement conditions by having been deposited at least 100 years ago. While it is not possible to determine the actual date of deposition of bottom samples, a determination of the radionuclide lead-210 estimates if the sample was deposited at least 100 years ago. The primary analysis conducted on this type of core is the diatom community leading to an understanding of past nutrients, pH, and general aquatic vegetation coverage.

Town of Saint Germain Lakes Paleoecological Results

Top/bottom cores were collected from four of the project lakes: Alma, Moon, Big Saint Germain, and Found Lakes (Photo 3.3-1). The cores were collected by Onterra staff on August 19 and 20, 2019. The total length of the core from Alma Lake was 39 cm and 56 cm in Moon Lake. Both cores were dark brown in color throughout the cores. In both cores the top 1 cm was kept for diatom analysis and is assumed to represent present day water quality conditions in the lakes. In

Alma Lake the section from 33 to 35 cm was kept for analysis and the section 53-55 cm in Moon Lake was kept for analysis. The total length of the core from Big Saint Germain Lake was 41 cm and it was 46 cm in Found Lake. The core from Big Saint Germain Lake was dark brown for the top 27 cm and dark gray for the remainder of the core. The Found Lake core was dark brown in color throughout the core. In both cores the top 1 cm was kept for diatom analysis and is assumed to represent present day water quality conditions in the lakes. In Big Saint Germain Lake, the section from 37 to 40 cm was kept for analysis and the section 43-45 cm in Found Lake was kept for analysis. The bottom sections are assumed to represent conditions before the arrival Euro-American settlers in the nineteenth century.

Diatom Community Changes

Multivariate Statistical Analysis

In order to make a comparison of environmental conditions between the bottom and top samples of the cores from the project lakes, an exploratory detrended correspondence analysis (DCA) was performed (CANOCO 5 software) (Ter Braak and Smilauer 2012) . The DCA analysis has been done on many Wisconsin lakes to examine the similarities of the diatom communities between the top and bottom samples of the same lake.

The results revealed two clear axes of variation in the diatom data, with 39% and 25% of the variance explained by axis 1 and axis 2, respectively (Figure 3.3-1). Sites with similar sample scores occur in close proximity reflecting similar diatom composition. The arrows symbolize the trend from the bottom to the top samples. Alma and Moon lakes cluster near each other indicating the similarity in their diatom communities. Although there are some differences in the diatom communities between the bottom and top samples, they are relatively close together suggesting small changes have occurred in these lakes over the last 100 plus years.

The samples for Big Saint Germain and Found lakes are separated from each other as well as Alma and Moon lakes, which indicates the diatom communities between these systems are different. The diatom *Aulacoseira* (Photo 3.3-2A) is a prominent part of the community in Big Saint Germain Lake but almost nonexistent in Alma, Moon, and Found lakes. Another difference is the very low amount of benthic *Fragilaria* (Photo 3.3-2C) in Found Lake. In both lakes the top

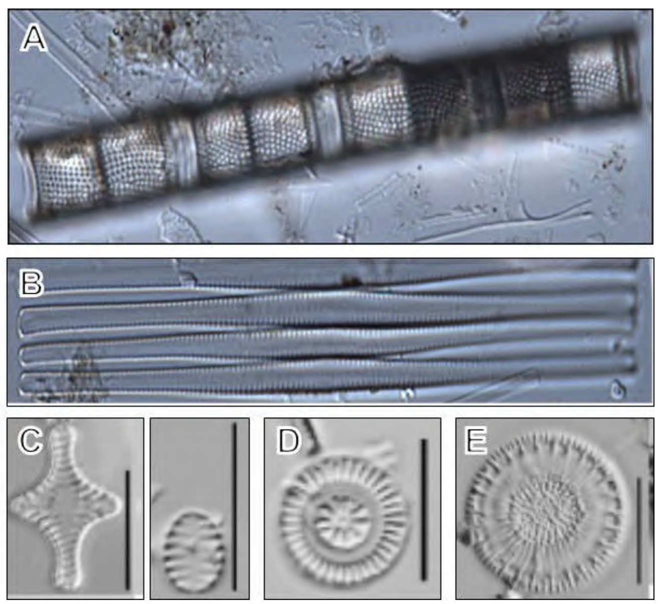


Photo 3.3-2. Photomicrographs of the diatoms commonly found in the sediment cores from these lakes. The top diatom (A) is *Aulacoseira ambigua* which is common in many Wisconsin lakes with low to moderate phosphorus concentrations. *Fragilaria crotonensis* (B) is more common with moderate phosphorus levels but also indicates higher nitrogen concentrations. This diatom is most common in the top samples of the sediment cores. *Staurosira construens* (C left) and *S. construens* var. *venter* (C right) are typically found growing on macrophytes and lake sediments. *Discostella stelligera* (D) and *Cyclotella bodanica* var. *lemanica* (E) are diatoms that float in the open water and are generally found in lakes with very good water quality.

and bottom samples cluster relatively close together indicating there has not been large changes in the diatom communities.

While it is not possible to determine which were the most important environmental variables ordering the diatom communities, one trend is apparent. Axis 1 likely represents the alkalinity of the lakes. Other studies of Wisconsin and Vermont lakes indicate that the most important variable ordering the diatom communities is alkalinity. Lakes on the right side of the DCA graph tend to have the lowest alkalinity values while the highest are on the left side. A study by (Eilers et al. 1989) of 149 lakes in north central Wisconsin found that as a consequence of lake shore development, alkalinity and conductivity concentrations increase. This is because of the sediment that enters the lake during cottage and road construction. The direction of the arrow in Alma Lake indicates may indicate slightly higher alkalinity at the present time compared to historical times, but it does not appear that the alkalinity of Moon, Big Saint Germain, and Found lakes has changed.

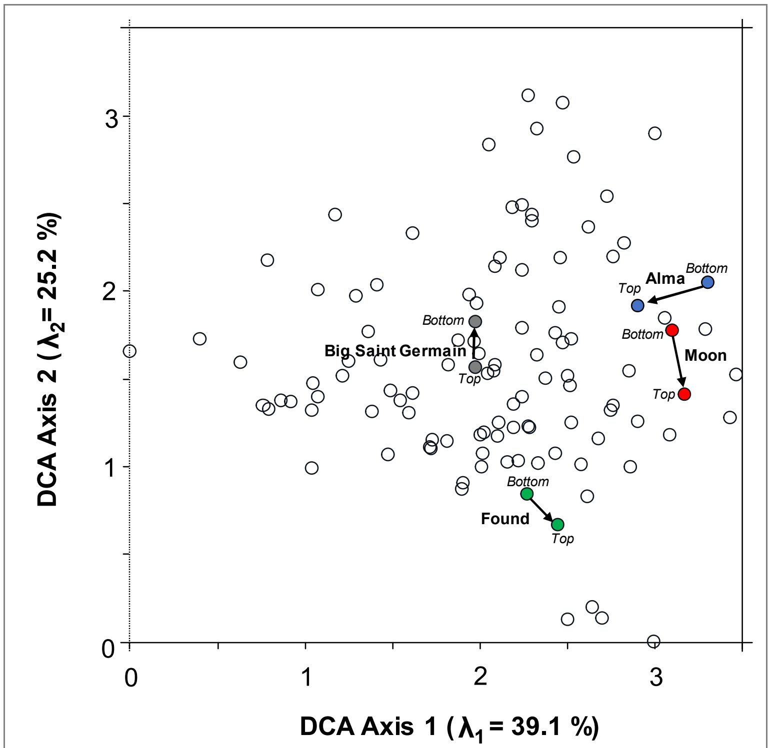


Figure 3.3-1. DCA plot of top/bottom samples from study lakes in the Town of Saint Germain. The arrows connect bottom to top samples in the same lake. The open circles are other Wisconsin lakes where top/bottom samples have been analyzed. The four project lakes have changed only a moderate amount since the arrival of Euro-American settlers over 150 years ago.

Top and Bottom Diatom Communities

The diatom communities in the top and bottom samples of the Alma Lake core were dominated by diatoms that grow attached to substrates such as macrophytes (aquatic plants) or the bottom sediments (Figure 3.3-2). This is not surprising as the lake is relatively shallow which means most of the lake bottom receives sufficient light for diatom growth. The percentage of planktonic diatoms, those that grow in the open water, is much less in the top sample compared with the bottom sample. *Discostella stelligera* was common in the bottom but was virtually absent in the top sample. This is a common diatom associated with low nutrients and grows in the open water of the lake. The decline of planktonic diatoms suggests that macrophyte coverage is greater now than it was historically.

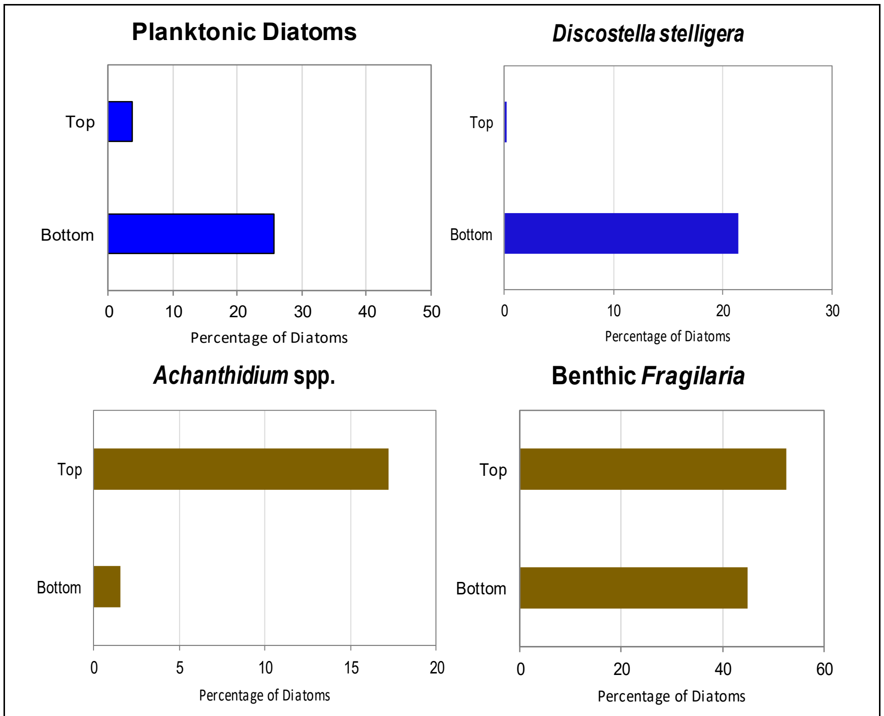


Figure 3.3-2. Changes in abundance of important diatoms found in the top and bottom of the sediment core from Alma Lake. The decline of planktonic diatoms and the increase in *Achnanthidium* suggests an increase in macrophyte coverage at the present time.

(Borman 2007) as a result of shoreline development found in northwestern Wisconsin lakes, the macrophyte community often changed in seepage lakes, from one dominated by low growing plants to a community dominated by larger macrophytes. With increased sediment runoff from near-shore construction, the structure of the macrophyte community shifts as more fine-grained sediment is deposited. This allows larger aquatic plants to become established, which trap more fine-grained sediments and facilitates additional plant growth. With larger aquatic plants, there is more surface area available for diatoms and other periphytic algae to grow.

Achnanthidium spp. grows attached to macrophytes and is often one of the first diatoms to increase production in response to shoreland disturbances (Garrison and Wakeman 2000) (Garrison, LaLiberte and Ewart 2010). The increase of this diatom in the top sample of Alma Lake compared with the bottom sample is further evidence that at the present time there is a greater macrophyte presence than historically. Benthic *Fragilaria* often grow attached to submerged aquatic plants under moderate to high nutrient levels. In Alma Lake, their numbers in the top and bottom samples were similar indicating nutrient levels at the present time are similar to prior to the arrival of Euro-Americans even though there are now more aquatic plants present.

In Moon Lake, planktonic diatoms are more common than in Alma Lake. This is because Moon Lake is deeper and a smaller portion of the lake bottom receives sufficient light for diatom growth. In addition, the lake has a larger volume of water for planktonic diatoms to grow. The portion of the total diatom community that is composed of planktonic diatoms is similar in the top and bottom samples (Figure 3.3-3). This suggests that unlike Alma Lake which has seen an increase in macrophyte coverage, the macrophyte coverage at the present time in Moon Lake is likely not significantly different than it was prior to the arrival of Euro-Americans.

The planktonic diatom *D. stelligera* is more common in the top sample of Moon Lake which may indicate either nitrogen levels have increased, or the lake has seen a warming of its surface waters. Increased growth of the planktonic diatom *Fragilaria crotonensis* is often associated with increased nutrient levels, especially nitrogen. The percentage of this diatom is similar in the bottom and top samples, indicating that nitrogen levels are likely similar today to what they were prior to Euro-American settlement (Figure 3.3-3). The most likely explanation for the increase of *D. stelligera* in the top sample is warmer surface water temperatures driven by global climate change.

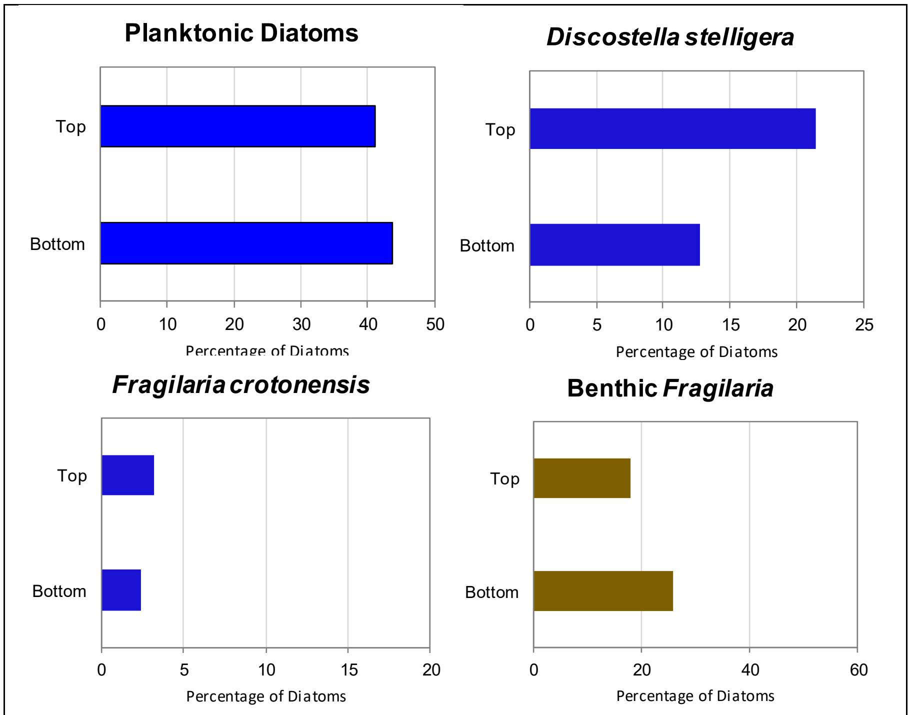


Figure 3.3-3. Changes in abundance of important diatoms found in the top and bottom of the sediment core from Moon Lake. Unlike Alma Lake, there does not appear to be an increase in macrophyte coverage and nutrient levels at the present time are similar to historical times.

In Moon Lake, benthic *Fragilaria* levels are lower when compared with Alma Lake because Moon Lake is deeper and can support more planktonic diatoms. Abundance in the bottom and top samples are similar which is further evidence that nutrient levels in Moon Lake at the present time are similar to what they were prior to the arrival of Euro-Americans in the nineteenth century (Figure 3.3-3).

In the bottom sample of Big Saint Germain Lake, planktonic diatoms dominated the diatom community (Figure 3.3-4). The most common diatom was *Aulacoseira ambigua* which is frequently the dominant diatom in large lakes in northern Wisconsin, Michigan, and Minnesota prior to the arrival of Euro-American settlers (Camburn and Kingston 1986) (Kingston et al. 1990)

(Garrison and Fitzgerald 2005). In fact, in Big Saint Germain Lake, this diatom comprised over 50% of the historical diatom community. In the top sample, the presence of *A. ambigua* was reduced to 12% and all of the planktonic diatoms only constituted just over half of the diatom community (Figure 3.3-4). In the top sample, *A. ambigua* was replaced by diatoms that prefer higher nutrient levels e.g. *Fragilaria crotonensis* and *Asterionella formosa* as well as those diatoms that grow attached to macrophytes (benthic *Fragilaria*). This indicates the nutrient levels and aquatic plant growth have likely increased somewhat in Big Saint Germain Lake since Euro-American settlement.

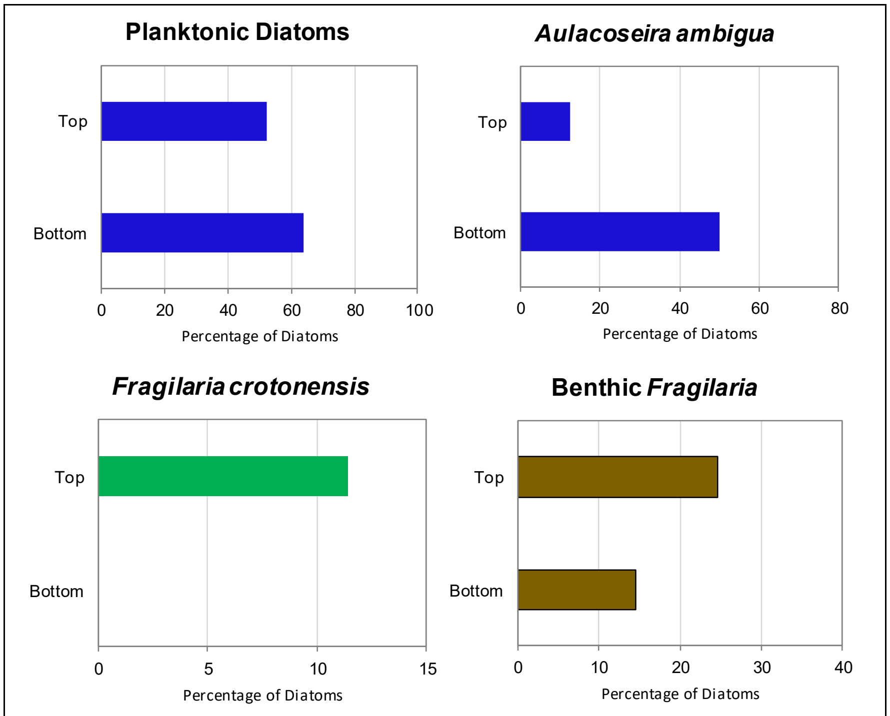


Figure 3.3-4. Changes in abundance of important diatoms found in the top and bottom of the sediment core from Big Saint Germain Lake. The diatom community at the bottom of the core was dominated by *Aulacoseira ambigua* which are generally found in low phosphorus concentrations. The increase in *F. crotonensis* the top sample indicates a small increase in nutrients, especially nitrogen.

In Found Lake, the diatom community in the bottom sample was not as well preserved as it was in the other lakes. Only 143 diatom valves were counted in the Found Lake bottom sample when 500 are typically counted per sample. However, despite the scarcity of diatoms, there were sufficient numbers present to complete the analysis. Part of this conclusion is based upon the fact the diatom community in the bottom sample is similar to the pre-settlement community of many other lakes in northern Wisconsin.

The diatom community in the bottom sample of Found Lake was nearly evenly divided between planktonic (open water) and benthic diatoms (Figure 3.3-5). Unlike Big Saint Germain Lake, the dominant planktonic taxa were *Fragilaria sepes* and *Tabellaria flocculosa*. In the top sample these diatoms have been partially replaced by *Asterionella formosa* and *F. crotonensis*, which prefer slightly higher nutrient levels, especially nitrogen.

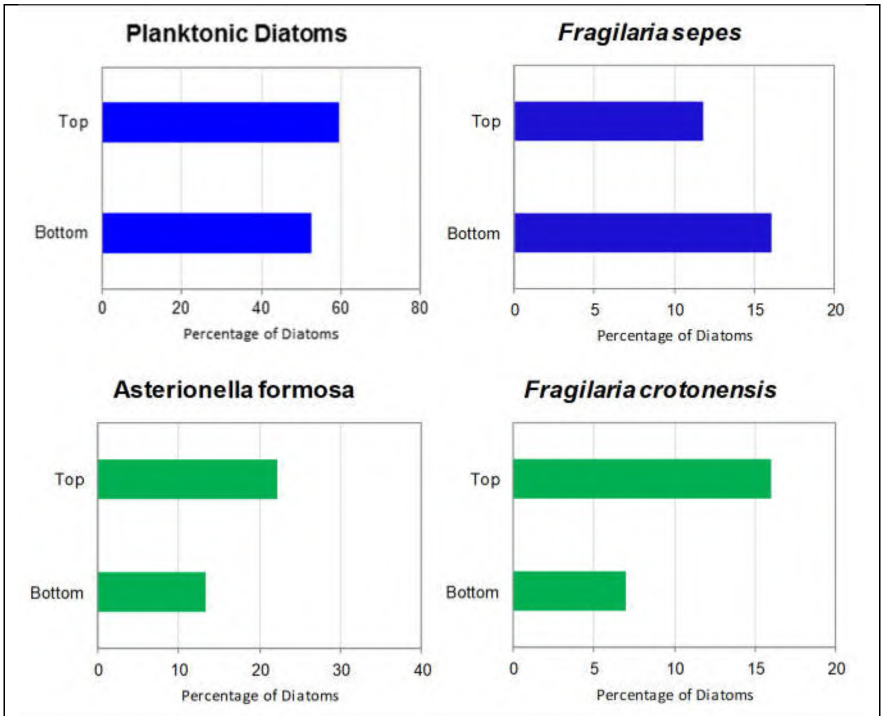


Figure 3.3-5. Changes in abundance of important diatoms found in the top and bottom of the sediment core from Found Lake. The increase in *A. formosa* and *F. crotonensis* the top sample indicates a small increase in nutrients, especially nitrogen.

Lake Diatom Condition Index

The Lake Diatom Condition Index (LDCI) was developed by Dr. Jan Stevenson, Michigan State University (Stevenson, Zalack and Wolin 2013). The LDCI uses diatoms to assess the ecological condition of lakes. The LDCI ranges from 0 to 100 with a higher score representing better ecological integrity. The index is weighted towards nutrients, but also incorporates ecological integrity by examining species diversity where higher diversity indicates better ecological condition. The index also incorporates taxa that are commonly found in undisturbed and disturbed conditions. The breakpoints (poor, fair, good) were determined by the 25th and 5th percentiles for reference lakes in the upper Midwest. The LDCI was used in the 2007 National Lakes Assessment to determine the biological integrity of the nation's lakes.

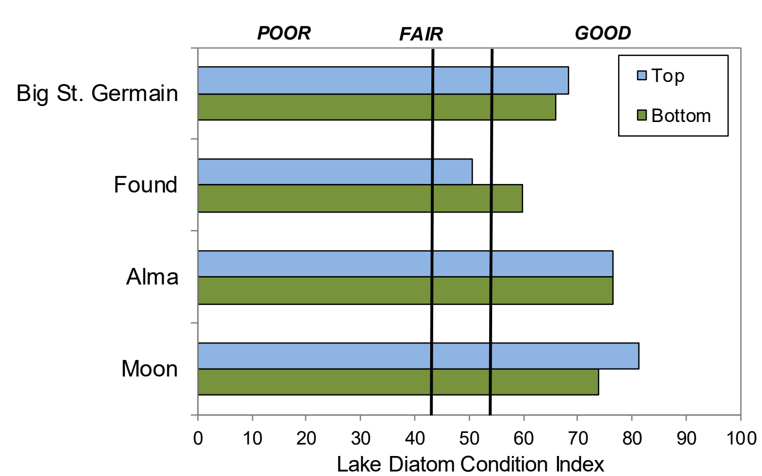


Figure 3.3-6. The Lake Diatom Condition Index (LDCI) for Alma, Big Saint Germain, Found, and Moon lakes. The biotic integrity is good and is similar in the top and bottom samples.

The bottom samples for all four lakes fell into the good category for the LDCI (Figure 3.3-6). The top samples from Alma, Moon, and Big Saint Germain lakes remained in the good category, while the top sample from Found Lake fell within the fair category. The reduction in Found Lake's LDCI value is the result of reduced diversity in its diatom community and changes in community structure.

Inference models

Diatom assemblages have been used as indicators of trophic changes in a qualitative way (Bradbury 1975) (Carney 1982) (Anderson, Rippey and Stevenson 1990), but quantitative analytical methods also exist. Ecologically relevant statistical methods have been developed to infer environmental conditions from diatom assemblages. These methods are based on multivariate ordination and weighted averaging regression and calibration (Birks et al. 1990). Ecological preferences of diatom species are determined by relating modern limnological variables to surface sediment diatom assemblages. The species-environment relationships are then used to infer environmental conditions from fossil diatom assemblages found in the sediment core.

Weighted averaging calibration and reconstruction (Birks et al. 1990) were used to infer historical water column summer average phosphorus in the sediment cores. A training set that consisted of 60 stratified lakes was used. Training set species and environmental data were analyzed using weighted average regression software (C2) (Juggins 2014).

The diatom-inferred phosphorus concentration from the top sample in Alma Lake was 15 µg/L, very similar to the average measured concentration of 14 µg/L (Table 3.3-1). Similarly, the diatom-inferred phosphorus concentration from the top sample collected from Moon Lake was 12 µg/L compared to the measured in-lake average of 11 µg/L. This indicates that the diatom-inferred phosphorus concentration from the sediment core is reliable. The diatom-inferred phosphorus concentration from the bottom section of the core collected from Alma Lake was 12 µg/L, indicating that nutrient levels have increased slightly in Alma Lake over the past 150 years. In Moon Lake, the diatom-inferred phosphorus concentration from the bottom section of the core was 13 µg/L, indicating there has been little change in nutrient concentrations over the past 150 years. Alma Lake is likely more sensitive to changes in its watershed given it has a lower water volume when compare to Moon Lake and cannot dilute incoming nutrients as readily as Moon Lake.

The diatom-inferred phosphorus concentrations in the top core section from Big Saint Germain Lake was 25 µg/L, relatively similar to the in-lake average concentration measured at 29 µg/L. The diatom-inferred phosphorus concentration for the bottom section of the core from Big Saint Germain Lake was 26 µg/L, indicating there has not been a significant change in nutrient concentrations over the last 150 years. In Found Lake, the diatom-inferred phosphorus concentration for the top section of the core was 21 µg/L, similar to the in-lake average measured at 23 µg/L. The diatom-inferred phosphorus concentration from the bottom section of the core from Found Lake was 19 µg/L, indicating that nutrient levels have increased slightly in Found Lake over the past 150 years.

The sediment core from Big Saint Germain Lake indicates that at the present time, nutrient levels, especially nitrogen are slightly higher when compared with pre-settlement times and there has also been an expansion of the density of macrophytes. Shoreland development results in more nutrient input to the lake but with increased macrophyte coverage, more surfaces are provided for diatom growth. The attached algae remove much of the increased phosphorus input from the water. This means that phosphorus levels in the open water remain unchanged. If phosphorus input increases enough, the attached algae are not able to take up all the phosphorus and concentrations in the open water increase. This has not happened yet but continued input of phosphorus from the nearshore could eventually result in higher phosphorus levels in the lake.

Table 3.3-1. Diatom-inferred phosphorus concentrations from top and bottom core sections and measured in-lake concentrations from Town of Saint Germain project lakes.

	Total Phosphorus (µg/L)		
Lake	Bottom of Core	Top of Core	Measured In-Lake
Alma Lake	12	15	14
Moon Lake	13	12	11
Big Saint Germain Lake	26	25	29
Found Lake	19	21	23

In Found Lake, there has also been a slight increase in nutrients, especially nitrogen. Phosphorus concentrations may also be slightly higher at the present time and the lake's biotic index is worse at the present time when compared with pre-settlement conditions. Unlike Big Saint Germain Lake, there does not appear to be a significant increase in macrophyte density.

3.4 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) effects on the lake is important in maintaining the quality of the lake's water and habitat.

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 swimmer's itch. Development such as rip rap or masonry, 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. Counties were previously able to set their own, stricter, regulations to NR 115 but as of 2015, all counties have to abide by state regulations. Minimum requirements for each of these categories are described below. Please note that at the time of this writing, changes to NR 115 were last made in October of 2015 (Lutze 2015).

- 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 35 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. If a property owner treats their run off with some type of treatment system, they may be able to apply for an increase in their impervious surface limit.

- 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. 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 the same type of structure is being built in the previous location with the same footprint. All construction needs to follow general zoning or floodplain zoning authority
    - Construction may occur if mitigation measures are included either within the existing footprint or beyond 75 feet.
    - Vertical expansion cannot exceed 35 feet

- Mitigation requirements: 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.

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, Gillum and Meyer 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.

Photograph 3.4-1. Example of coarse woody habitat in a lake.

Coarse woody habitat has shown to be advantageous for fisheries in terms of providing refuge, foraging area as well as spawning habitat (Hanchin, Willis and St. Stauver 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 as development pressured on lakes continue 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) (Radmoski and Goeman 2001) (Elias and 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).

Photograph 3.4-2. Example of a biolog restoration site.

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 Saint Germain Lakes Shoreland Zone Condition

Shoreland Development

The Town of Saint Germain Lake's shoreland zone can be classified in terms of its degree of development. In general, more developed shorelands are more stressful on a lake ecosystem, while definite benefits occur from shorelands that are left in their natural state. Figure 3.4-1 displays a diagram of shoreland categories, from "Urbanized", meaning the shoreland zone is completely disturbed by human influence, to "Natural/Undeveloped", meaning the shoreland has been left in its original state.

On the Town of Saint Germain Lakes, the development stage of the entire shoreland was surveyed during fall of 2019, using a GPS unit to map the shoreland. Lost Lake was surveyed in Fall of 2017 and Little Saint Germain Lake was surveyed in Fall of 2016. Onterra staff only considered the area of shoreland 35 feet inland from the water's edge, and did not assess the shoreland on a property-by-property basis. During the survey, Onterra staff examined the shoreland for signs of development and assigned areas of the shoreland one of the five descriptive categories in Figure 3.4-2.

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 3.4-1. Shoreland assessment category descriptions.

The lakes have stretches of shoreland which fit all of the five shoreland assessment categories. In all, 23.4 miles of natural/undeveloped and developed-natural shoreland were observed during the survey (Figure 3.4-2). These shoreland types provide the most benefit to the lake and should be left in their natural state if at all possible. During the surveys, 9.1 miles of urbanized and developed–unnatural shoreland were observed. If restoration of the Town of Saint Germain Lakes shoreland 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. Maps displaying the locations of these categorized shorelands can be found in the individual report sections.

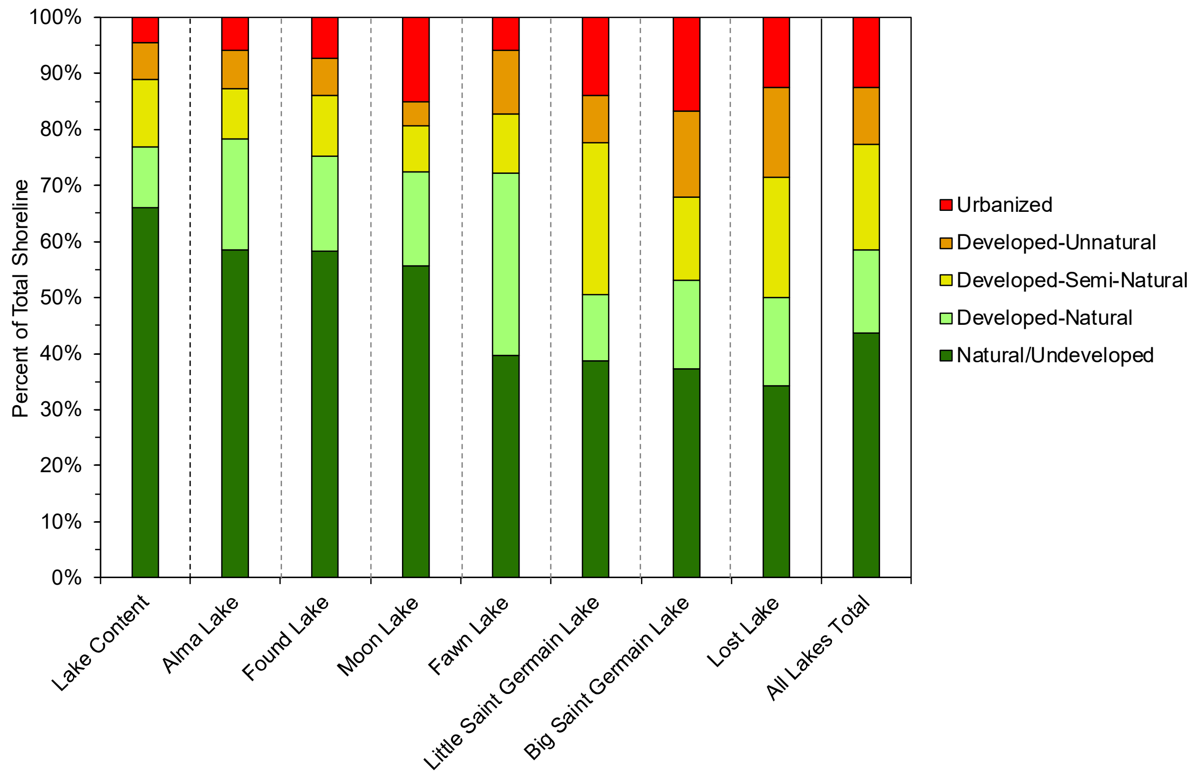


Figure 3.4-2. Town of Saint Germain Lakes shoreland categories. Surveys completed in 2019 for Lake Content, Alma, Moon, Found, Fawn, and Big Saint Germain lakes. Survey completed in 2017 on Lost Lake and 2016 on Little Saint Germain Lake. Maps displaying locations of these categorized shorelands can be found in the individual lake report sections.

While producing a completely natural shoreland is ideal for a lake ecosystem, it is not always practical from a human's perspective. However, riparian property owners can take small steps in ensuring their property's impact upon the lake is minimal. Choosing an appropriate landscape position for lawns is one option to consider. Placing lawns on flat, unsloped areas or in areas that do not terminate at the lake's edge is one way to reduce the amount of runoff a lake receives from a developed site. And, allowing tree falls and other natural habitat features to remain along a shoreline may result not only in reducing shoreline erosion, but creating wildlife habitat also.

Coarse Woody Habitat

As part of the shoreland condition assessment, the Town of Saint Germain Lakes were also surveyed to determine the extent of their coarse woody habitat. Coarse woody habitat was identified, and classified in three size categories (2-8 inches in diameter, 8+ inches in diameter, or clusters of pieces) as well as four branching categories: no branches, minimal branches, moderate branches, and full canopy. Pictures descriptions of these categories can be found in Figure 3.4-3. As discussed earlier, research indicates that fish species prefer some branching as opposed to no branching on coarse woody habitat, and increasing complexity is positively correlated with higher fish species richness, diversity and abundance (Newbrey et al. 2005).

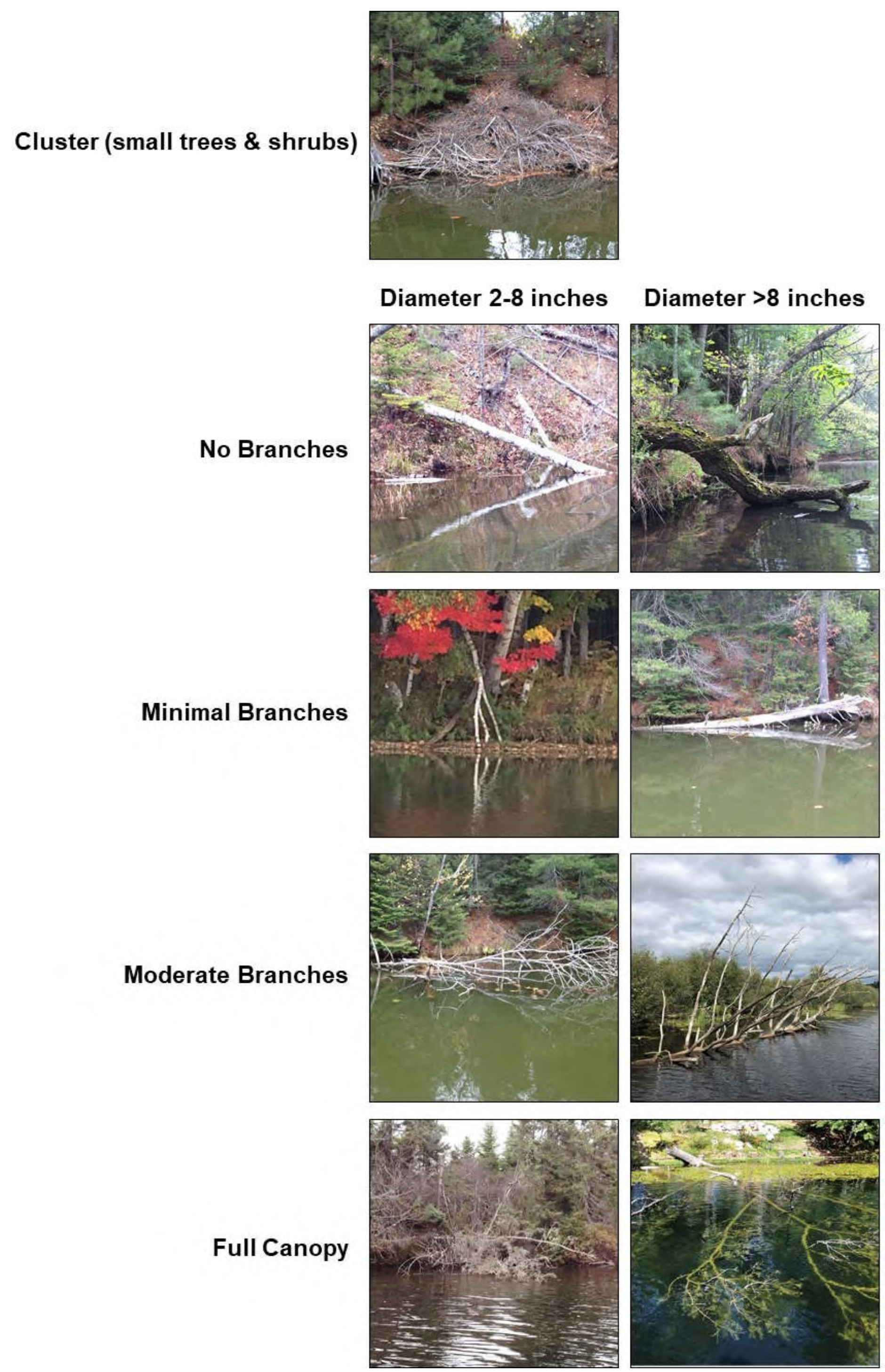


Figure 3.4-3. Coarse woody habitat classifications used during 2019 surveys on the Town of Saint Germain Lakes. Photo credit Onterra.

Between 2012 and 2018, Onterra has completed coarse woody habitat surveys on 111 lakes throughout Wisconsin. Figure 3.3-4 displays the number of coarse woody habitat pieces per shoreline mile from the Town of Saint Germain project lakes and how they compare with data from the 111 lakes surveyed. The number of coarse woody habitat pieces per mile ranged from 44 in Alma Lake to 11 in Lake Content, with an average across lakes of 25 pieces per shoreline mile. Alma Lake falls above the 75th percentile for the number of CWH pieces per shoreline mile, Moon, Found, and Little Saint Germain lakes fall between the 50th and 75th percentile, Lost Lake falls between the 25th and 50th percentile, and Lake Content, Big Saint Germain, and Fawn lakes fall below the 25th percentile (Figure 3.4-4).

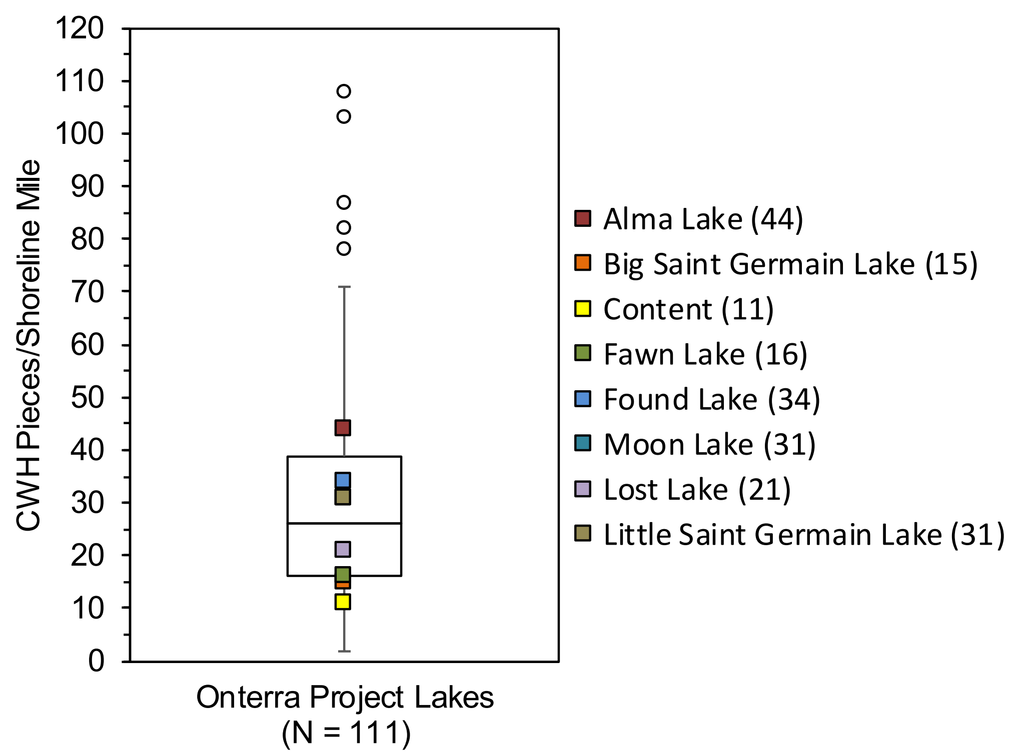


Figure 3.4-4. The Town of Saint Germain Lakes coarse woody habitat survey results. Surveys completed in 2019 for Lake Content, Alma, Moon, Found, Fawn, and Big Saint Germain lakes. Survey completed in 2017 on Lost Lake and 2016 on Little Saint Germain Lake. Maps displaying locations of CWH can be found in the individual lake report sections.

3.5 Aquatic Plants

Introduction

Although the occasional lake user considers aquatic plants (macrophytes) to be weeds and are often considered as a nuisance to the recreational use of the lake, these plants are an essential element in a healthy and functioning lake ecosystem (Photo 3.5-1). 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.

Photo 3.5-1. Native aquatic plant community. Fern pondweed (*Potamogeton robbinsii*). Photo credit Onterra.

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 sago pondweed (*Stuckenia pectinata*) 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.

Aquatic plants also provide cover for feeder fish and zooplankton, stabilizing the predator-prey relationships within the system. Furthermore, rooted aquatic plants prevent shoreland erosion and the resuspension of bottom 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 nutrient levels that may lead to phytoplankton blooms. Lake plants also produce oxygen through photosynthesis and use nutrients that may otherwise be used by phytoplankton, which helps to minimize nuisance phytoplankton blooms.

Because most aquatic plants are rooted in place and are unable to relocate in the wake of environmental change, they are often the first aquatic community to indicate that changes may be occurring within the system. For this reason, aquatic plants are used as indicators of environmental health. Aquatic plant communities can respond in variety of ways; there may be increases or reductions in the occurrence of sensitive species, or a complete loss. Or, certain growth forms, such as emergent and floating-leaf communities may disappear from certain areas of the waterbody. With periodic monitoring and proper analysis, these changes are relatively easy to detect and provide relevant information for making management decisions.

Under certain conditions, a few species may grow to levels which can interfere with the use of the lake. 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 watermilfoil and curly-leaf pondweed 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

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.

> **Important Note:**
> Even though most of these techniques are not applicable to the Town of Saint 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 Saint Germain Lakes are discussed in Summary and Conclusions section and the Implementation Plan found near the end of this document.

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

Native aquatic plants are an essential component of aquatic environments as they provide valuable habitat, improve water quality, and prevent the establishment of non-native species. Because of this, maintaining a healthy native aquatic plant community should be the priority of every lake riparian property owner. While the control of native aquatic plants is generally not recommended for the reasons previously discussed, riparian property owners can manually remove native aquatic plants in areas around their dock and/or swim area without a permit with certain restrictions (see below). If a riparian property owner feels the need to manually remove aquatic plants around their dock or within a swim area, it is strongly recommended that they first get in touch with Emily Heald at the North Lakeland Discovery Center or local WDNR staff. These professionals will be able to help identify if the plants are native or non-native, determine if any native plants present are Natural Heritage Inventory-listed species (e.g. endangered or threatened), and determine the most environmentally-sound manual removal methods that could be employed.

Photo 3.5-2. Example of aquatic plants that have been removed manually.

Manual methods for aquatic plant removal 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. 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. Wisconsin law states that all plants and plant fragments removed via manual techniques must be removed from the water (Photo 3.5-2).

Manual removal of aquatic plants can only occur within a 30-foot wide area that extends directly out from a use area which contains a dock or swim area. However, non-native species can be manually removed from any area outside of the 30-foot wide zone as long as the manual technique does not remove native species. Wild rice has special protections and may not be manually removed without a permit, even if it occurs within the 30-foot wide manual removal zone.

Cost

Commercially available hand-cutters and rakes range in cost from $85 to $150.

Advantages	*Disadvantages*
• Very cost effective for clearing areas around docks, piers, and swimming areas. • 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 removal 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.

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 watermilfoil for a few years. • Allows some loose sediment to consolidate, increasing water depth. • May enhance growth of desirable emergent species.	• 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.

• Other work, like dock and pier repair may be completed more easily and at a lower cost while water levels are down.	• May enhance the spread of certain undesirable species, like common reed and reed canary grass. • Permitting process may require an environmental assessment that may take months to prepare. • Non-selective.

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 (Photo 3.5-3). 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.

Photo 3.5-3. Aquatic plant mechanical harvester.

Cost

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.	• 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.

• 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.	• 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.

Herbicide Treatment

The use of herbicides to control aquatic plants and algae is a technique that is widely used by lake managers. Traditionally, herbicides were used to control nuisance levels of aquatic plants and algae that interfere with navigation and recreation. While this practice still takes place in many parts of Wisconsin, the use of herbicides to control aquatic invasive species is becoming more prevalent.

Resource managers employ strategic management techniques towards aquatic invasive species, with the objective of reducing the target plant's population over time; and an overarching goal of attaining long-term ecological restoration. For submergent vegetation, this largely consists of implementing control strategies early in the growing season; either as spatially-targeted, small-scale spot treatments or low-dose, large-scale (whole lake) treatments. Treatments occurring roughly each year before June 1 and/or when water temperatures are below 60°F can be less impactful to many native plants, which have not emerged yet at this time of year. Emergent species are targeted with foliar applications at strategic times of the year when the target plant is more likely to absorb the herbicide.

While there are approximately 300 herbicides registered for terrestrial use in the United States, only 13 active ingredients can be applied into or near aquatic systems. All aquatic herbicides must be applied in accordance with the product's US Environmental Protection Agency (EPA) approved label. There are numerous formulations and brands of aquatic herbicides and an extensive list can be found in Appendix F of (Gettys, Haller and (eds) 2009). 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, targeted 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 $1,500 per acre depending on the chemical used, who applies it, permitting procedures, and the size/depth of the treatment area.

Advantages	***Disadvantages***
• Herbicides are easily applied in restricted areas, like around docks and boatlifts. • Herbicides can target large areas all at once. • 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 watermilfoil. • Some herbicides can be used effectively in spot treatments. • Most herbicides are designed to target plant physiology and in general, have low toxicological effects on non-plant organisms (e.g. mammals, insects)	• All herbicide use carries some degree of human health and ecological risk due to toxicity. • 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 aquatic herbicides are nonselective. • Some herbicides have a combination of use restrictions that must be followed after their application. • Overuse of same herbicide may lead to plant resistance to that herbicide.

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 water hyacinth weevils (*Neochetina spp.*) and hydrilla stem weevil (*Bagous spp.*) to control water hyacinth (*Eichhornia crassipes*) and hydrilla (*Hydrilla verticillata)*, respectively.

However, Wisconsin, along with many other states, is currently experiencing the expansion of lakes infested with Eurasian watermilfoil 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 watermilfoil 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 watermilfoil. Currently the milfoil weevil is not a WDNR grant-eligible method of controlling Eurasian watermilfoil.

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 watermilfoil 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

Primer on Data Analysis & Data Interpretation

Three aquatic plant surveys were completed by Onterra on the Town of Saint Germain project lakes in 2019. The first, the Early-Season Aquatic Invasive Species (ESAIS) Survey, is a meander-based survey completed in June. The primary goal of this survey is to detect potential occurrences of non-native plants, primarily curly-leaf pondweed and pale-yellow iris. Curly-leaf pondweed reaches its peak growth in June before naturally dying back by July, while pale-yellow iris reaches peak bloom in June making it easier to locate.

The second survey completed was the whole-lake point-intercept survey, a quantitative survey designed to determine the frequency of occurrence of each plant species, both native and non-native, within the lake. The third and final survey was an Emergent and Floating-leaf Aquatic Plant Mapping Survey focused on mapping emergent and floating-leaf aquatic plant communities.

A specimen of each aquatic plant species that had not been located in aquatic plant surveys completed previously in 2004-05 or 2010 was collected, pressed, and sent to the University of Wisconsin-Stevens Point Herbarium for verification of correct identification. The correct identification of these plants was confirmed by Dr. Robert Freckmann. The point-intercept survey method as described Wisconsin Department of Natural Resources Bureau of Science Services, PUB-SS-1068 2010 (Hauxwell et al. 2010) was used to complete the whole-lake point-intercept surveys on the Town of Saint Germain project lakes. The sampling location spacing (resolution) and resulting total number of locations varied by lake and were created based upon guidance from the WDNR (Table 3.5-1).

Table 3.5-1. Resolution and number of point-intercept sampling locations used on the Town of Saint Germain project lakes.

Lake	Distance Between Sampling Points (meters)	Number of Sampling Locations
Alma Lake	35	184
Moon Lake	40	328
Big Saint Germain Lake	75	1,163
Lake Content	56	304
Fawn Lake	30	83
Found Lake	53	484

At each point-intercept location within the *littoral zone*, information regarding the depth, substrate type (soft sediments, sand, or rock/gravel), and the plant species sampled along with their relative abundance (Figure 3.5-1) on the sampling rake was recorded. A pole-mounted rake was used to collect the plant samples, depth, and sediment information at point locations of 14 feet or less. A rake head tied to a rope (rope rake) was used at sites greater than 14 feet. Depth information was collected using graduated marks on the pole of the rake or using an onboard sonar unit at depths greater than 14 feet. Also, when a rope rake was used, information regarding substrate type was not collected due to the inability of the sampler to accurately feel the bottom with this sampling device. The point-intercept survey produces a great deal of information about a lake's aquatic vegetation and overall health. These data are analyzed and presented in numerous ways; each is discussed in more detail the following section.

The **Littoral Zone** is the area of the lake where sunlight is able to penetrate to the sediment providing aquatic plants with sufficient light to carry out photosynthesis.

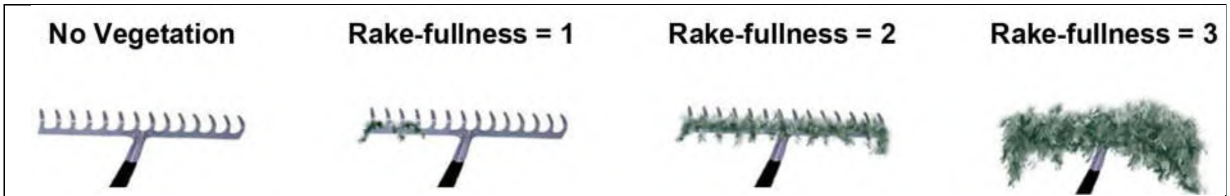


Figure 3.5-1. Aquatic plant rake fullness ratings. Adapted from (Hauxwell et al. 2010).

Species List

The species list is simply a list of all of the species, both native and non-native, that were located during the surveys completed on the Town of Saint Germain project lakes. The list indicates the species that were located in both the 2010 and 2019 surveys. The list also contains the status of each species in Wisconsin (i.e., native, non-native, endangered, etc.) its growth form (i.e., submergent, emergent, etc.), its scientific name, common 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 growth forms that are present, can be an early indicator of changes in the ecosystem.

Frequency of Occurrence

Frequency of occurrence describes how often a certain aquatic plant 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 the whole-lake point-intercept surveys completed on the Town of Saint Germain project lakes, plant samples were collected from plots laid out on a grid that covered the lake (point-intercept survey). Using the data collected from these plots, an estimate of occurrence of each plant species can be determined. The occurrence of aquatic plant species is displayed as the *littoral frequency of occurrence*. Littoral frequency of occurrence is used to describe how often each species occurred in the plots that are within the maximum depth of plant growth (littoral zone), and is displayed as a percentage.

Floristic Quality Assessment

The floristic quality of a lake's aquatic plant community is calculated using its native *species richness* and their *average conservatism*. Species richness is the number of native aquatic plant species that were physically encountered on the rake during the point-intercept survey. Average conservatism is calculated by taking the sum of the coefficients of conservatism (C-values) of the native species located and dividing it by species richness. Every plant in Wisconsin has been assigned a coefficient of conservatism, ranging from 1-10, which describes the likelihood of that species being found in an undisturbed environment. Species which are more specialized and require undisturbed habitat are given higher coefficients, while species which are more tolerant of environmental disturbance have lower coefficients.

For example, algal-leaf pondweed (*Potamogeton confervoides*) is only found in nutrient-poor, acid lakes in northern Wisconsin and is prone to decline if degradation of these lakes occurs. Because of algal-leaf pondweed's special requirements and sensitivity to disturbance, it has a C-value of 10. In contrast, sago pondweed (*Stuckenia pectinata*) with a C-value of 3, is tolerant of disturbance and is often found in greater abundance in degraded lakes that have higher nutrient concentrations and low water clarity. Higher average conservatism values generally indicate a healthier lake as it is able to support a greater number of environmentally-sensitive aquatic plant species. Low average conservatism values indicate a degraded environment, one that is only able to support disturbance-tolerant species.

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 surveys (equation shown below). This assessment allows the aquatic plant community of each lake to be compared to other lakes within the region and state.

$$FQI = \text{Average Coefficient of Conservatism} * \sqrt{\text{Number of Native Species}}$$

Species Diversity

Species diversity is often confused with species richness. As defined previously, species richness is simply the number of species found within a given community. While species diversity utilizes species richness, it also takes into account evenness or the variation in abundance of the individual species within the community. For example, a lake with 10 aquatic plant species that had relatively similar abundances within the community would be more diverse than another lake with 10 aquatic plant species were 50% of the community was comprised of just one or two species.

An aquatic system with high species diversity is more stable than a system with a low diversity. This is analogous to a diverse financial portfolio in that a diverse aquatic plant community can withstand environmental fluctuations much like a diverse portfolio can handle economic fluctuations. A lake with a diverse plant community is also better suited to compete against exotic infestations than a lake with a lower diversity. The diversity of a lake's aquatic plant community is determined using the Simpson's Diversity Index (1-D):

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

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

If a lake has a diversity index value of 0.90, it means that if two plants were randomly sampled from the lake there is a 90% probability that the two individuals would be of a different species. The Simpson's Diversity Index values from the Town of Saint Germain Project lakes are compared to data collected by Onterra and the WDNR Science Services on 212 lakes withn the Northern

Lakes and Forests ecoregion and on 392 lakes throughout Wisconsin. Comparisons are displayed in the individual lake report sections using *boxplots* that display median values and upper/lower quartiles of lakes in the same ecoregion and in the state.

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.

Emergent and Floating-leaf Community Mapping

A key component of the aquatic plant surveys is the delineation of the emergent and floating-leaf aquatic plant communities within each lake as these plants are often underrepresented during the point-intercept survey. This survey creates a snapshot of these important communities within each lake as they existed during the survey and is valuable in the development of the management plan and in comparisons with future surveys. Examples of emergent plants include cattails, rushes, sedges, grasses, bur-reeds, and arrowheads, while examples of floating-leaf species include the water lilies and watershield. Submersed aquatic plants species are often mixed throughout large areas of the lake and are often not visible from the surface, and therefore do not lend themselves well to mapping. However, the point-intercept survey allows for a general understanding of the distribution of submersed species within each lake.

Non-Native 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 watermilfoil are the primary targets of this extra attention. Eurasian watermilfoil is an invasive species, native to Europe, Asia and North Africa, that has spread to most Wisconsin counties (Figure 3.5-2). Eurasian watermilfoil 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 watermilfoil has two other competitive advantages over native aquatic plants: 1) it starts growing very early in the spring when water temperatures are cool and the majority of native plants are still dormant, and 2) in some instances once its stems reach the water surface, it does not stop growing like most native plants and instead continues to grow along the surface creating a canopy that blocks light from reaching native plants. Eurasian watermilfoil 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.

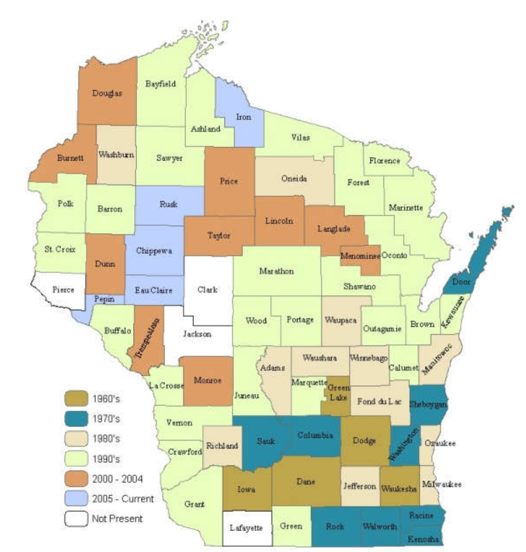


Figure 3.5-2. Spread of Eurasian watermilfoil within WI counties. WDNR Data mapped by Onterra (2011).

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 watermilfoil, curly-leaf pondweed can become so abundant that it hampers recreational activities within the lake. Furthermore, its mid-summer die back can cause phytoplankton blooms spurred from the nutrients released during the plant's decomposition.

Aquatic Plant Survey Results

In the surveys completed on Lake Content, Alma, Moon, Big Saint Germain, Fawn, and Found lakes since 2004/05, a total of 101 aquatic plant species have been located and collected by Onterra and verified by UW-Stevens Point Herbarium (Table 3.5-2). Aquatic plant information for Little Saint Germain and Lost lakes can be found in their respective individual lake management plans. Eleven species were found in all six lakes, and include water arum, muskgrasses, three-way sedge, creeping spikerush, common waterweed, slender naiad, stoneworts, spatterdock, white water lily, large-leaf pondweed, and wild celery. Growth forms included 47 submersed species, 37 emergent species, six floating-leaf species, five submersed/emergent species, five free-floating species, and one floating-leaf/emergent species.

Of the 101 species located, four are considered non-native species: Eurasian watermilfoil, purple loosestrife, narrow-leaved cattail, and green arrow-arum. Eurasian watermilfoil, purple loosestrife, and narrow-leaved cattail are considered to be aggressive, invasive species with the potential to displace native species, create dense, monotypic colonies, and alter habitat and ecosystem function. While green arrow-arum is an introduced species, as of this writing, it is considered to be *locally established*, with a sparse distribution in Wisconsin. It does not appear to be imparting negative ecological impacts at this time.

Green arrow-arum is native to the eastern United States, and there is ongoing debate as to whether or not populations in Wisconsin were introduced or are naturally-occurring disjunct populations on the western edge of the species' range. These non-native plants are discussed in detail in the subsequent Non-Native Aquatic Plants subsection. The non-native curly-leaf pondweed is found in the Town of Saint Germain lakes of Lost and Little Saint Germain lakes. The curly-leaf pondweed populations and their management in these lakes can be found in their respective individual lake management plans that were separate from this project.

Since 2004/05 surveys, three native aquatic plant species located during these studies are listed as special concern by the WDNR Natural Heritage Inventory Program due to "a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors" (WDNR 2014). These species include Oakes' pondweed in Found Lake, Vasey's pondweed in Fawn and Found lakes, and northeastern bladderwort in Alma and Moon lakes (Photo 3.5-4).

Table 3.5-2. Aquatic plant species located in the Town of Saint Germain Lakes in 2004/05, 2010, and 2018/19 surveys. Continued on subsequent page.

Scientific Name	Common Name	Status in Wisconsin	Coefficient of Conservatism	Growth Form	Alma			Moon			BSG			Content			Fawn			Found		
					2004/05	2010	2019	2004/05	2010	2019	2004/05	2010	2019	2004/05	2010	2019	2004/05	2010	2019	2004/05	2010	2018/19
Bidens beckii	Water marigold	Native	8	S								X	X	X			X		X			
Brasenia schreberi	Watershield	Native	7	FL	X	X	X	X	X	X				X	X	X		X		X	X	X
Calla palustris	Water arum	Native	9	E	X	X	X		X	X		X		X	X	X	X	X	X			X
Carex comosa	Bristly sedge	Native	5	E				X		X		X		X	X	X	X			X		
Carex crawfordii	Crawford's oval sedge	Native	5	E		X						X										
Carex cryptolepis	Northeastern sedge	Native	8	E		X																
Carex gynandra	Nodding sedge	Native	6	E																		X
Carex lacustris	Lake sedge	Native	6	E								X										
Carex lasiocarpa	Narrow-leaved woolly sedge	Native	9	E		X	X														X	
Carex pellita	Broad-leaved woolly sedge	Native	4	E		X																
Carex utriculata	Common yellow lake sedge	Native	7	E												X						X
Carex vesicaria	Blister sedge	Native	7	E																	X	
Ceratophyllum demersum	Coontail	Native	3	S					X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ceratophyllum echinatum	Spiny hornwort	Native	10	S						X												
Chara spp.	Muskgrasses	Native	7	S		X	X		X	X	X	X	X		X	X			X	X	X	X
Cicuta bulbifera	Bulbet water-hemlock	Native	7	E			X															
Comarum palustre	Marsh cinquefoil	Native	8	E						X												
Decodon verticillatus	Water-willow	Native	7	E														X	X			
Dulichium arundinaceum	Three-way sedge	Native	9	E	X		X		X	X				X		X				X	X	
Elatine minima	Waterwort	Native	9	S	X	X	X	X	X		X		X	X	X		X			X	X	
Eleocharis acicularis	Needle spikerush	Native	5	S/E		X	X		X	X	X	X	X	X	X	X				X	X	X
Eleocharis obtusa	Blunt spikerush	Native	3	E					X													
Eleocharis palustris	Creeping spikerush	Native	6	E	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X
Elodea canadensis	Common waterweed	Native	3	S		X	X		X	X	X	X	X	X	X	X	X	X	X		X	X
Elodea nuttallii	Slender waterweed	Native	7	S	X		X	X		X										X		X
Equisetum fluviatile	Water horsetail	Native	7	E																X	X	
Eriocaulon aquaticum	Pipewort	Native	9	S	X	X	X	X	X	X				X	X	X				X		
Glyceria canadensis	Rattlesnake grass	Native	7	E	X	X																
Gratiola aurea	Golden pert	Native	10	S	X			X	X											X		
Heteranthera dubia	Water stargrass	Native	6	S					X		X	X	X	X	X	X			X			
Iris versicolor	Northern blue flag	Native	5	E	X					X				X			X	X	X	X		
Isoetes echinospora	Spiny-spored quillwort	Native	8	S											X						X	
Isoetes lacustris	Lake quillwort	Native	8	S	X	X		X	X		X	X		X						X	X	
Isoetes spp.	Quillwort spp.	Native	8	S			X			X			X			X						X
Juncus effusus	Soft rush	Native	4	E	X		X			X								X		X		
Juncus pelocarpus f. submersus	Brown-fruited rush	Native	8	S/E	X	X	X	X	X	X	X			X	X	X				X	X	X
Lemna minor	Lesser duckweed	Native	5	FF			X							X		X	X			X		
Lemna trisulca	Forked duckweed	Native	6	FF									X		X	X		X	X			
Lemna turionifera	Turion duckweed	Native	2	FF								X			X			X	X			
Lobelia dortmanna	Water lobelia	Native	10	S	X	X	X	X	X	X		X	X	X	X	X					X	X
Lythrum salicaria	Purple loosestrife	Non-Native - Invasive	N/A	E																	X	
Myriophyllum heterophyllum	Various-leaved watermilfoil	Native	7	S													X					
Myriophyllum sibiricum	Northern watermilfoil	Native	7	S							X	X	X	X	X	X	X	X	X		X	
Myriophyllum tenellum	Dwarf watermilfoil	Native	10	S	X	X	X	X	X	X			X	X	X	X				X	X	X
Najas flexilis	Slender naiad	Native	6	S						X	X	X	X		X	X	X	X	X	X	X	X
Nitella spp.	Stoneworts	Native	7	S	X	X	X	X	X	X	X	X	X		X			X		X	X	
Nuphar variegata	Spatterdock	Native	6	FL	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nymphaea odorata	White water lily	Native	6	FL	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Peltandra virginica	Green arrow-arum	Non-Native - Locally Established	N/A	E						X												
Persicaria amphibia	Water smartweed	Native	5	FL	X		X													X	X	

X = Species Present; S = Submergent; E = Emergent; S/E = Submergent and/or Emergent; FL = Foating-leaf; FL/E = Floating-leaf and Emergent; FF = Free-floating

Table 3.5-2 continued. Aquatic plant species located in the Town of Saint Germain Lakes in 2004/05, 2010, and 2018/19 surveys.

Scientific Name	Common Name	Status in Wisconsin	Coefficient of Conservatism	Growth Form	Alma 2004/05	Alma 2010	Alma 2019	Moon 2004/05	Moon 2010	Moon 2019	BSG 2004/05	BSG 2010	BSG 2019	Content 2004/05	Content 2010	Content 2019	Fawn 2004/05	Fawn 2010	Fawn 2019	Found 2004/05	Found 2010	Found 2018/19
Pontederia cordata	Pickerelweed	Native	9	E									X	X	X	X		X		X	X	X
Potamogeton amplifolius	Large-leaf pondweed	Native	7	S	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Potamogeton amplifolius x P. praelongus	Large-leaf x White-stem pondweed	Native	N/A	S								X			X						X	
Potamogeton berchtoldii	Slender pondweed	Native	7	S									X						X			
Potamogeton epihydrus	Ribbon-leaf pondweed	Native	8	S				X	X													
Potamogeton foliosus	Leafy pondweed	Native	6	S													X		X	X		
Potamogeton friesii	Fries' pondweed	Native	8	S								X	X		X							
Potamogeton gramineus	Variable-leaf pondweed	Native	7	S							X	X	X			X				X	X	X
Potamogeton illinoensis	Illinois pondweed	Native	6	S			X				X	X		X	X					X	X	
Potamogeton natans	Floating-leaf pondweed	Native	5	S																	X	
Potamogeton oakesianus	Oakes' pondweed	Native - Special Concern	10	S																X		
Potamogeton praelongus	White-stem pondweed	Native	8	S							X	X	X	X	X	X		X	X	X	X	X
Potamogeton praelongus x P. richardsonii	White-stem x Clasping-leaf pondweed	Native	N/A	S									X									
Potamogeton pusillus	Small pondweed	Native	7	S	X	X	X	X	X	X	X	X	X		X	X				X	X	X
Potamogeton richardsonii	Clasping-leaf pondweed	Native	5	S							X	X	X	X	X	X	X	X	X	X	X	
Potamogeton robbinsii	Fern-leaf pondweed	Native	8	S								X	X	X	X	X		X	X	X	X	X
Potamogeton spirillus	Spiral-fruited pondweed	Native	8	S					X	X	X	X	X					X	X	X		
Potamogeton strictifolius	Stiff pondweed	Native	8	S									X									
Potamogeton vaseyi	Vasey's pondweed	Native - Special Concern	10	S														X	X		X	
Potamogeton zosteriformis	Flat-stem pondweed	Native	6	S							X	X	X	X	X	X	X	X	X	X	X	
Ranunculus aquatilis	White water crowfoot	Native	8	S							X	X	X		X			X	X		X	
Ranunculus flammula	Creeping spearwort	Native	9	S	X	X	X		X	X		X										
Sagittaria cristata	Crested arrowhead	Native	9	S/E						X		X	X			X						
Sagittaria graminea	Grass-leaved arrowhead	Native	9	S/E	X	X			X		X			X	X		X	X		X		
Sagittaria latifolia	Common arrowhead	Native	3	E								X		X	X		X	X	X	X		X
Sagittaria rigida	Stiff arrowhead	Native	8	E								X	X			X			X			
Sagittaria sp. (rosette)	Arrowhead sp. (rosette)	Native	N/A	S		X			X			X	X		X	X						
Schoenoplectus acutus	Hardstem bulrush	Native	5	E	X		X		X	X	X	X	X		X	X	X					
Schoenoplectus pungens	Three-square rush	Native	5	E										X								
Schoenoplectus subterminalis	Water bulrush	Native	9	S/E	X			X	X	X												
Schoenoplectus tabernaemontani	Softstem bulrush	Native	4	E						X				X							X	X
Scirpus atrocinctus	Black-girdled wool-grass	Native	7	E			X															
Scirpus cyperinus	Wool grass	Native	4	E			X			X		X				X			X			
Scirpus pedicellatus	Stalked woolgrass	Native	6	E		X																
Sium suave	Water-parsnip	Native	5	E								X										
Sparganium americanum	American bur-reed	Native	8	E												X						X
Sparganium angustifolium	Narrow-leaf bur-reed	Native	9	FL	X	X	X	X	X	X			X	X	X	X				X		X
Sparganium emersum var. acaule	Short-stemmed bur-reed	Native	8	FL/E										X			X		X			
Sparganium eurycarpum	Common bur-reed	Native	5	E							X		X	X	X	X	X	X				
Sparganium fluctuans	Floating-leaf bur-reed	Native	10	FL														X			X	X
Spirodela polyrhiza	Greater duckweed	Native	5	FF								X		X		X	X	X	X	X		
Stuckenia pectinata	Sago pondweed	Native	3	S								X	X							X		
Typha angustifolia	Narrow-leaved cattail	Non-Native - Invasive	N/A	E									X			X		X				
Typha latifolia	Broad-leaved cattail	Native	1	E	X					X	X		X	X	X	X	X	X	X			X
Utricularia geminiscapa	Twin-stemmed bladderwort	Native	9	S			X															
Utricularia resupinata	Northeastern bladderwort	Native - Special Concern	9	S		X	X	X	X	X												
Utricularia vulgaris	Common bladderwort	Native	7	S				X		X		X		X							X	X
Vallisneria americana	Wild celery	Native	6	S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Wolffia columbiana	Common watermeal	Native	5	FF							X			X			X					
Zizania palustris	Northern wild rice	Native	8	E		X		X	X			X	X									

X = Species Present; S = Submergent; E = Emergent; S/E = Submergent and/or Emergent; FL = Foating-leaf; FL/E = Floating-leaf and Emergent; FF = Free-floating

Oakes' pondweed in Found Lake has not been relocated since the initial 2004/05 surveys. Vasey's pondweed was located in Found Lake in 2010 but not relocated in 2019, while Vasey's pondweed was recorded in Fawn Lake in both 2010 and 2019. The occurrence these two pondweeds is low in these lakes, making the probability of finding them in any given survey difficult. Oakes' pondweed and Vasey's pondweed may still be present in Found Lake, but just at a level which is undetectable during the point-intercept survey. Northeastern bladderwort was located in Alma Lake in 2010 and 2019, while it was located across all three surveys in Moon Lake. All three of these species require high-quality conditions to survive.

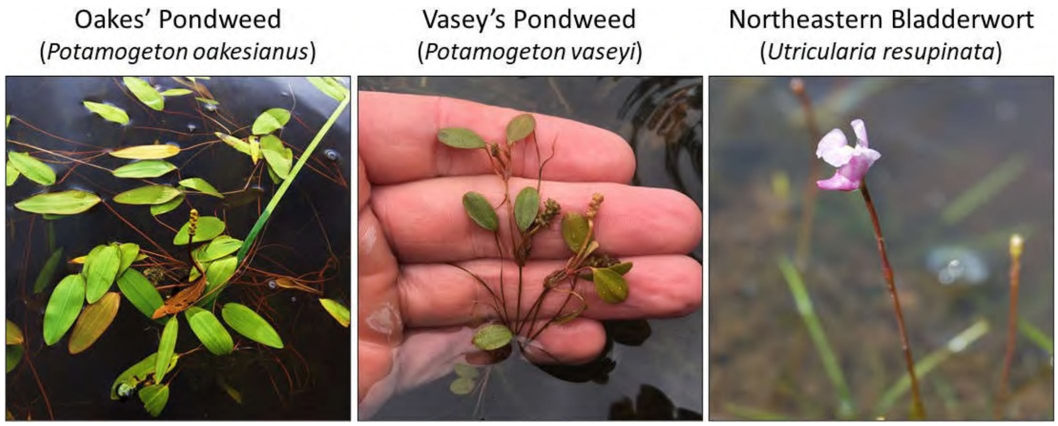


Photo 3.5-4. Rare native aquatic plant species listed as special concern in Wisconsin found in the Town of Saint Germain project lakes. Photo credit Onterra.

Lakes in Wisconsin vary in their morphometry, water chemistry, water clarity, substrate composition, and management, all of which influence aquatic plant community composition. Like terrestrial plants, aquatic plants vary in their preference for a particular substrate type; some species are usually only found growing in soft sediments, others only course substrates like sand, while some are more generalists and can be found growing in either. Lakes with varying types of substrates generally support a higher number of aquatic plant species because of the different habitat types that are available. During the whole-lake point-intercept surveys completed on the Town of Saint Germain project lakes, substrate data were also recorded at each sampling location in one of three general categories: soft sediments, sand, or rock/gravel.

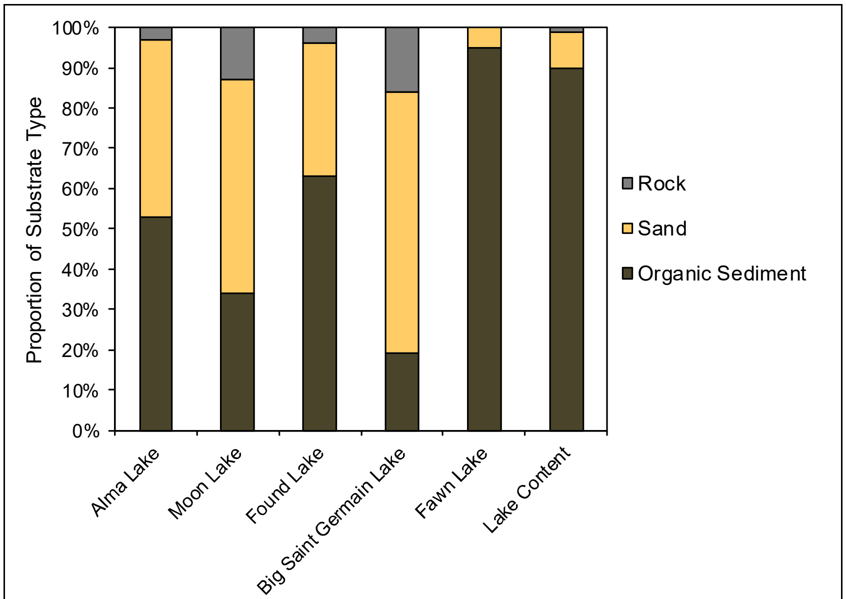


Figure 3.5-3. Town of Saint Germain project lakes proportion of substrate types. Created using data collected during the whole-lake point-intercept survey.

The project study lakes varied in terms of their substrate composition. Figure 3.5-3 illustrates the proportion of substrate types (soft sediments, sand, and rock) as determined from the whole-lake aquatic plant point-intercept surveys. Substrate composition within littoral areas ranged from being primarily comprised of harder substrates of sand and rock in Big Saint Germain Lake, to littoral areas comprised mainly of soft, organic sediments like in Fawn Lake and Lake Content. Other lakes, like Moon Lake, had a relatively even proportion of these three substrate types within the littoral zone. Like terrestrial plants, aquatic plants vary in their preference for a particular substrate type; some species are usually only found growing in soft sediments, others only course substrates like sand, while some are more generalists and can be found growing in either. Lakes with varying types of substrates generally support a higher number of aquatic plant species because of the different habitat types that are available.

The maximum depth of aquatic plant growth is largely dependent on light availability regulated by water clarity. Moon Lake, which has the highest water clarity of the six project lakes, also had the deepest recorded maximum depth of plant growth at 26 feet in 2019. Found Lake has the lowest water clarity of the six project lakes, and aquatic plants were documented growing to a maximum depth of 13 feet in 2018. The maximum depth of plants in Fawn Lake is 10 feet; however, this is also the maximum depth of the lake. Based on Fawn Lake's water clarity, if the lake were deeper, it is estimated that plants would grow to a depth of approximately 16 feet.

The littoral frequency of occurrence of aquatic vegetation in the Town of Saint Germain project lakes ranged from 100% in Fawn Lake to 44% in Found Lake (Figure 3.5-4). The proportion of aquatic plant total rake fullness (TRF) ratings varied among the six lakes, indicating lower biomass of aquatic plants in Alma, Moon, Found, and Big Saint Germain lakes, and higher biomass in Fawn Lake and Lake Content (Figure 3.5-4). The combination of higher water clarity, nutrients, and organic substrates in Fawn Lake and Lake Content lead to more abundant aquatic plant growth.

When comparing a lake's aquatic plant community to other lakes within the ecoregion and the state, only the native plant species that were directly encountered on the rake during the whole-lake point-intercept surveys are used in the analysis. For example, while a total of 41 native aquatic plant species were located in Big Saint Germain Lake in 2019, 31 were directly encountered on the rake during the point-intercept survey while 10 were located *incidentally*. An incidentally-located species means the plant was not directly sampled on the rake during the point-intercept survey at any of the sampling locations but it was observed in the lake by Onterra ecologists and was also recorded and collected.

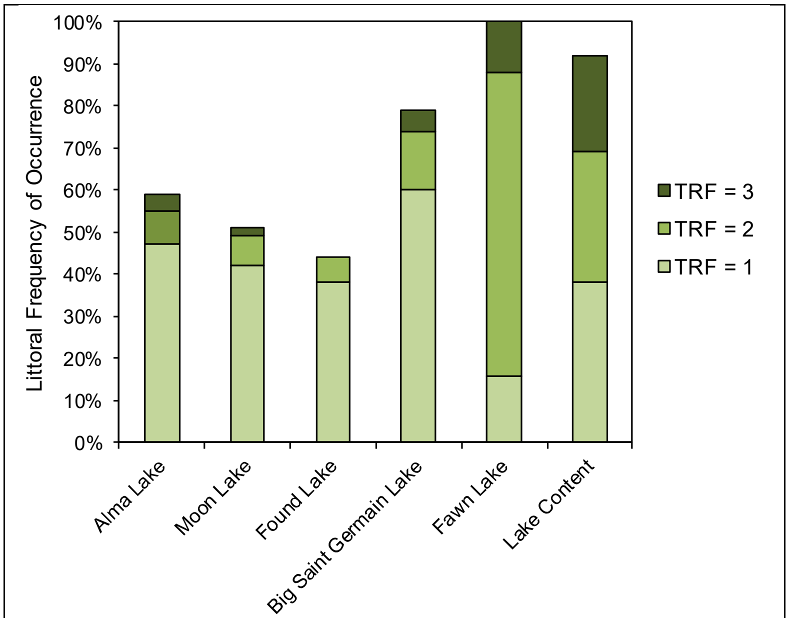


Figure 3.5-4. Town of Saint Germain lakes littoral frequency of occurrence of aquatic vegetation and total rake fullness (TRF) ratings. Created using data collected during the whole-lake point-intercept surveys.

In the surveys completed in 2018 and 2019, the number of native aquatic plant species (species richness) located on the rake per lake ranged from 31 in Big Saint Germain Lake and Lake Content to 20 in Alma and Fawn lakes (Figure 3.5-5). The majority of incidentally-located plants typically include emergent species growing along the lake's margins and submersed species that are relatively rare within the lake's plant community. Species richness for all six of the project lakes fell near or above the median value for lakes in the ecoregion and above the median value for lakes across Wisconsin. There were some larger changes in species richness values between the 2010 and 2018/19 surveys in some of the project lakes, and these changes are discussed in detail in the respective individual lake report sections.

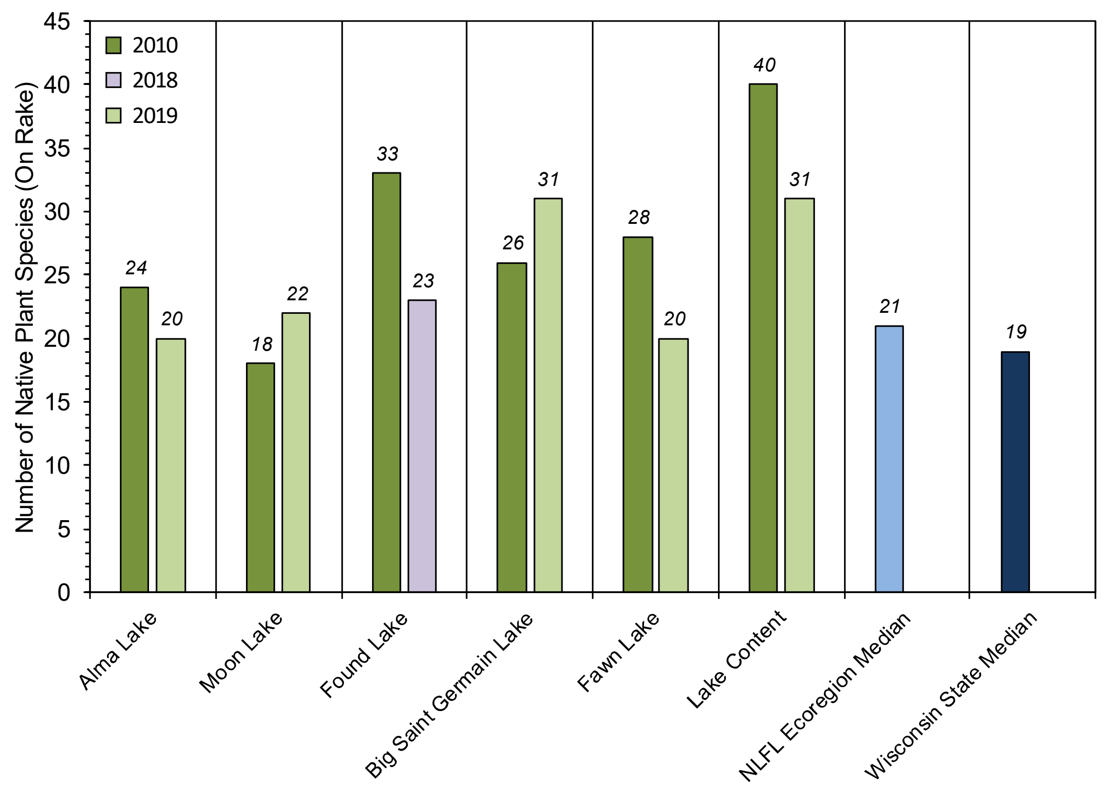


Figure 3.5-5. Town of Saint Germain Lakes native aquatic plant species richness and median species richness for Northern Lakes and Forests (NLF) ecoregion lakes and Wisconsin lakes. Values include native species only recorded on rake during point-intercept survey and do not include incidentally-located species.

Pearson correlation indicated that native plant species richness among the six Town of Saint Germain project lakes was most strongly correlated with littoral area – the greater the littoral area the higher number of species were present. Studies have shown that the number of species present tends to increase with the area of suitable habitat (Lacoul and Freedman 2006). The lake's morphometry in combination with water clarity are going to determine the size of the littoral zone. Lakes with lower water clarity have been shown to support fewer species, those which can tolerate lower-light conditions. There was a slight negative correlation with water clarity and species richness amongst the six Town of Saint Germain project lakes.

Studies have also shown that the number of aquatic plants species also tend to increase with higher water clarity and higher *shoreline complexity* (Vestergaard and Sand-Jensen 2000). Shoreline complexity is an index that relates the area of the lake to the perimeter of its shoreline. If a lake were a perfect circle, its shoreline complexity value would be 1.0. The farther a lake deviates from a perfect circle, the higher its shoreline complexity value is. Lakes with greater shoreline complexity harbor more areas that are sheltered from wind and wave action creating additional habitat types for aquatic plants. There is not a wide range in shoreline complexity among the six Town of Saint Germain project lakes, ranging from 1.5 in Fawn and Moon lakes to 2.5 in Alma Lake, and there was no significant correlation between shoreline complexity and species richness.

Studies have also shown that alkalinity as it relates to the amount of bicarbonate within the water is one of the primary factors in determining the composition of a lake's aquatic plant community (Vestergaard and Sand-Jensen 2000). Most aquatic plants cannot meet their carbon demand for photosynthesis solely from the availability of dissolved carbon dioxide within the water and require supplemental carbon from dissolved bicarbonate. As is discussed in the Water Quality Section (Section 3.1), Alma and Moon lakes have very low alkalinity (low bicarbonate) when compared to the other four project lakes. Both of these lakes have plant communities mainly comprised of plants of shorter stature which are adapted to live in these carbon-limited environments the higher alkalinity in the other four project lakes is sufficient to support taller, larger aquatic plant species which have a higher carbon demand.

Figure 3.4-6 compares the average conservatism values of the native aquatic plant species located on the rake during each of the point-intercept surveys conducted on the Town of Saint Germain Lakes. The average conservatism values from 2018/19 ranged from 6.1 in Fawn Lake to 7.4 in Alma Lake. The lakes with higher conservatism values support a higher number of environmentally-sensitive species. All of the lakes with the exception of Fawn Lake had conservatism values equal to or higher than the median values for lakes in the ecoregion and the state. While there were some fluctuations in average conservatism values between 2010 and the 2018/19 surveys, this is expected and there are no changes that are concerning.

As discussed in the primer section, the calculations used to create 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 do not include incidental species. The number of native species encountered on the rake during the whole-lake point-intercept surveys and their conservatism values were used to calculate the FQI of the Town of Saint Germain Lakes. Figure 3.4-7 displays the FQI values for the Town of Saint Germain project lakes and compares them to median values of lakes within the NLF ecoregion and lakes throughout Wisconsin. Floristic Quality Index values in 2018/19 ranged from 37.4 in Little Saint Germain Lake to 27.3 in Fawn Lake. The FQI values for all lakes with the exception of Fawn Lake fell above the median value for lakes in the ecoregion.

Lakes with diverse aquatic plant communities have higher resilience to environmental disturbances and greater resistance to invasion by non-native plants. In addition, a plant community with a mosaic of species with differing morphological attributes provides zooplankton, macroinvertebrates, fish, and other wildlife with diverse structural habitat and various sources of food. If a lake has a high number of aquatic plant species, it does not necessarily mean that the lake will also have high species diversity as diversity is also influenced by how evenly the aquatic plant species are distributed within the community.

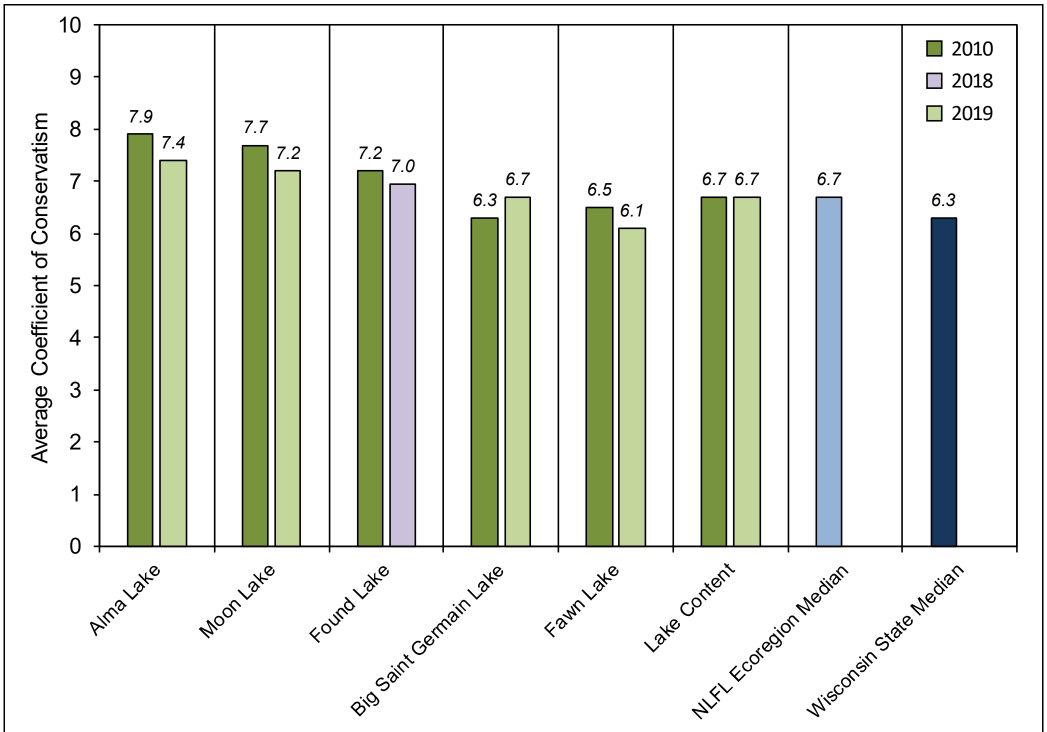


Figure 3.5-6. Town of Saint Germain Lakes native aquatic plant average coefficients of conservatism. Created using conservatism values of native aquatic plant species located on the rake during the whole-lake point-intercept surveys. Analysis follows Nichols (1999).

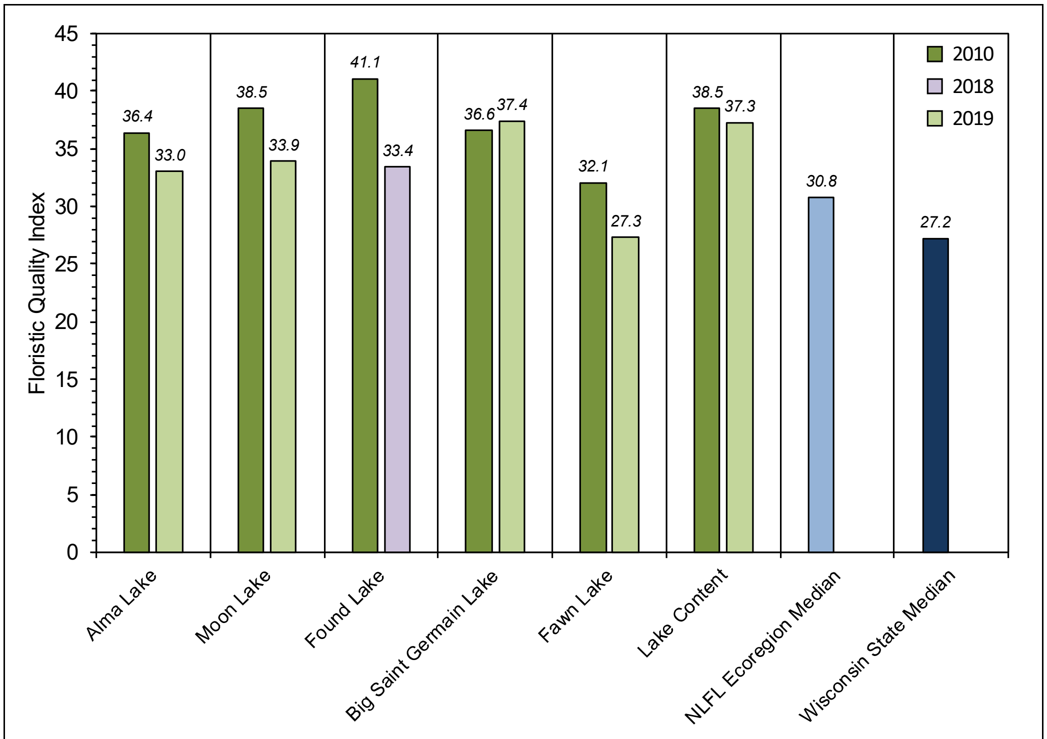


Figure 3.5-7. Town of Saint Germain Lakes Floristic Quality Index values. Created using conservatism values and number of native aquatic plant species located on the rake during the whole-lake point-intercept surveys. Analysis follows Nichols (1999).

While a method for characterizing diversity values of fair, poor, etc. does not exist, lakes within the same ecoregion may be compared to provide an idea of how the Town of Saint Germain Lakes' diversity values rank. Using data collected by Onterra and WDNR Science Services, quartiles were calculated for 212 lakes within the NLF Ecoregion (Figure 3.5-8). Simpson's Diversity Index values were calculated using data collected from the whole-lake aquatic plant point-intercept surveys. Simpson's Diversity Index values from 2018/19 ranged from 0.86 in Lake Content to 0.91 in Moon Lake (Figure 3.5-8). Diversity values for Alma and Moon lakes were higher in 2019 when compared to 2010, while diversity values for Found, Big Saint Germain, Fawn, and Lake Content were relatively similar to past surveys.

Explained another way, if aquatic plants were to be randomly sampled from two locations from Moon Lake in 2019, there would have been a 91% probability that they would be of different species. The 2018/19 diversity values for Moon, Found, and Big Saint Germain lakes exceed the median value for lakes in the NLF ecoregion. Diversity values for Alma and Fawn lakes fall near the median value, while Lake Content's diversity value fell below the ecoregion median value.

The previous analyses indicate that native the plant communities of the Saint Germain project lakes are healthy and of high quality. The aquatic plant communities within these lakes provide essential habitat and aid in maintaining the water quality of these lakes. Another important component of a lake's aquatic plant community are the emergent and floating-leaf communities which provide valuable structural habitat and stabilize bottom and shoreland sediments. These communities are even more important during periods of lower water levels when coarse woody habitat becomes exposed above the lower water line. The mapping of emergent and floating-leaf aquatic plant communities in the Town Saint Germain project lakes found that the size of these communities in 2019 ranged from 21.2 acres in Big Saint Germain Lake to 4.4 acres in Fawn Lake (Figure 3.5-9). Some lakes saw an increase in the acreage of these communities while others saw a decrease. The size of these communities often respond to changes in water levels, and discussions surrounding changes in each lake can be found in the respective individual lake report sections.

Continuing the analogy that the community map represents a 'snapshot' of the important emergent and floating-leaf plant communities, a replication of this survey in the future will provide a valuable understanding of the dynamics of these communities within the Town of Saint Germain project lakes. This is

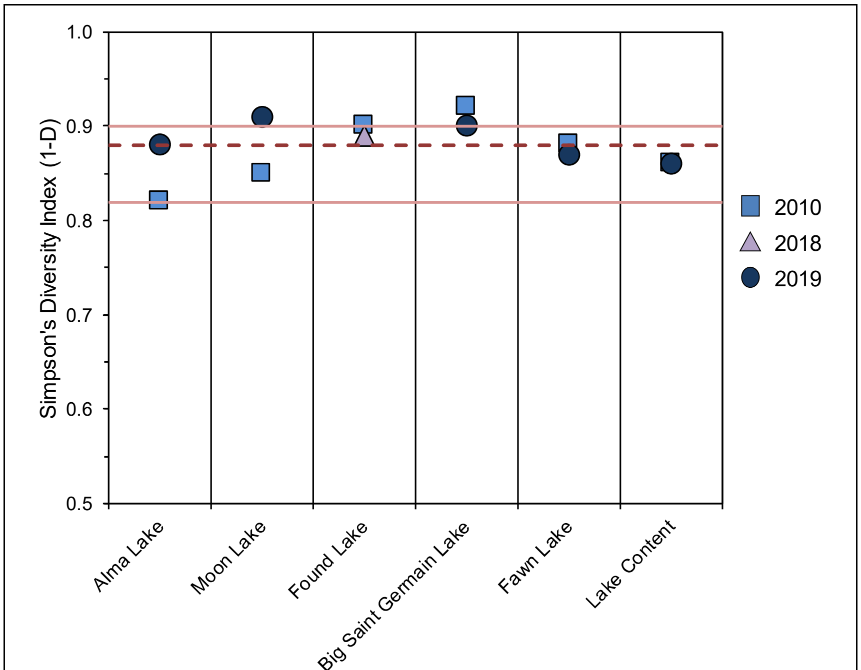


Figure 3.5-8. Town of Saint Germain Lakes Simpson's Diversity Index. Created using data collected from whole-lake point-intercept surveys. Ecoregion data calculated using Onterra and WDNR science services point-intercept survey data.

important, because these communities are often negatively affected by recreational use and shoreland development. (Radmoski 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.

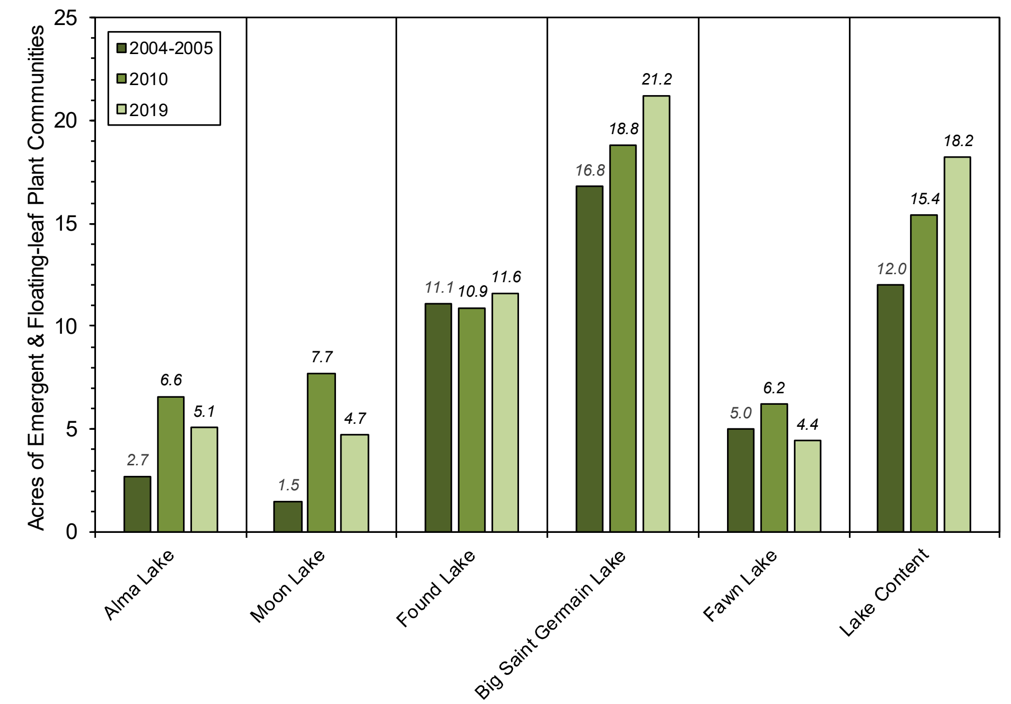


Figure 3.5-9. Town of Saint Germain Lakes acreage of emergent and floating-leaf aquatic plant communities. Locations of these aquatic plant communities are displayed on maps within the individual lake report sections.

Non-Native Aquatic Plants in the Town of Saint Germain Lakes

Eurasian watermilfoil (Myriophyllum spicatum)

Eurasian watermilfoil (EWM; Photograph 3.5-6) is a non-native, invasive aquatic plant from Eurasia. To date, populations of EWM have been found in Little Saint Germain Lake (2003), Lost Lake (2013), and Found Lake (2018). Discussions surrounding the occurrence and management of EWM in Little Saint Germain and Lost Lakes can be found in their respective individual lake management plans.

Photograph 3.5-6. Eurasian watermilfoil, a non-native invasive aquatic plant located in Found Lake. Photo credit: Onterra.

Eurasian watermilfoil was recently located in Found Lake during a June 2018 early-season aquatic invasive species survey being completed by Onterra. A few single plants were located in the bay on the west side of lake in approximately 6.0 feet of water (Figure 3.5-10). Following discussions between the Found Lake Property Owners Association (FLPOA), Onterra, and the WDNR, a hand-harvesting firm was contracted to remove the newly-discovered EWM population as well as to conduct scuba-based reconnaissance in the area around the public boat launch.

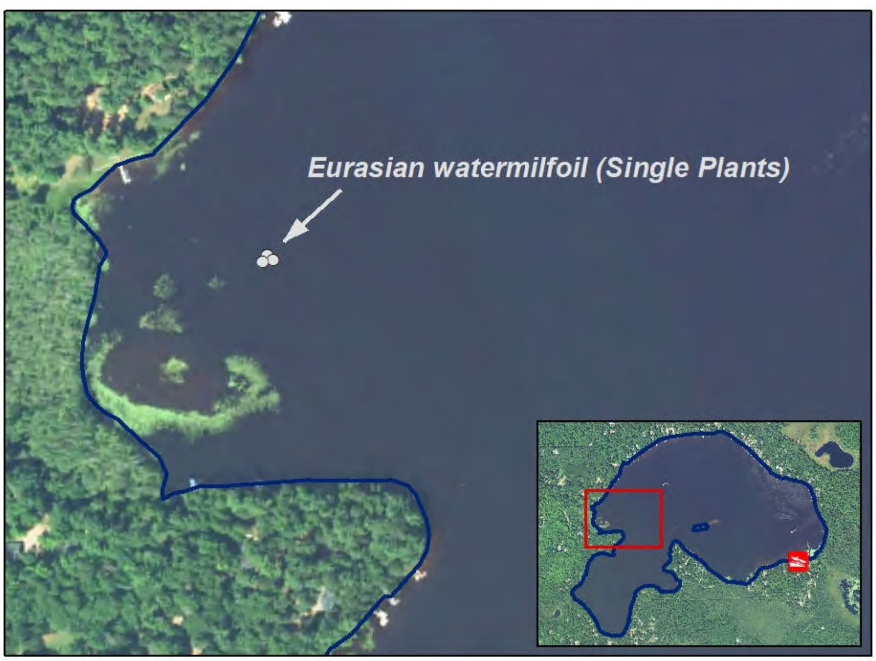


Figure 3.5-10. Found Lake June 2018 Eurasian watermilfoil locations. Extent of large map shown in red.

The FLPOA successfully received a WDNR AIS-Early Detection and Response (EDR) grant to aid in funding EWM monitoring and hand-harvesting from 2018-2020. Aquatic Plant Management, LLC (APM) conducted hand-harvesting of EWM on Found Lake on July 6, 2018.

They spend six hours on the lake and removed approximately 0.25 cubic feet of EWM. The divers noted smaller (< 6 inches) EWM plants growing in the immediate area near the mapped occurrences. No EWM was located near the public boat launch.

On June 20, 2019, Onterra ecologist completed another early-season AIS survey on Found Lake in an effort to located and map EWM and coordinate potential hand-harvesting efforts. The area where EWM had been located in 2018 was intensely surveyed from the surface and with a submersible camera and no EWM could be located in this area or anywhere else within the lake. Onterra ecologists returned to Found Lake on August 19, 2019 to conduct the late-season AIS survey. Again, no EWM could be located in the area previously mapped in 2018. Given no EWM was located in Found Lake in 2019, no hand-harvesting activities took place. An early-season AIS survey is scheduled for June of 2020 in an effort to locate any potential remaining EWM occurrences.

Purple Loosestrife (Lythrum salicaria)

Purple loosestrife is a perennial, herbaceous wetland plant native to Europe and was likely brought over to North America as a garden ornamental (Photo 3.5-7). 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 is now widespread across Wisconsin. Purple loosestrife largely spreads by seed but can also spread from root or stem fragments.

Photograph 3.5-7. The non-native weltand plant purple loosestrife. Photo credit: Onterra.

In 2010, a few purple loosestrife plants were located along the shoreline of Found Lake. Shortly thereafter, these plants were manually removed by the Vilas County AIS Coordinator and the current president of the FLPOA. During the 2019 community mapping surveys on the six Town of Saint Germain project lakes, no purple loosestrife was located. Continued monitoring for potential occurrences of purple loosestrife should continue by riparian property owners.

Narrow-leaved Cattail (Typha angustifolia)

Like purple loosestrife, narrow-leaved cattail is a perennial invasive wetland plant which invades shallow marshes and other wet areas. Like Wisconsin's native broad-leaved cattail (*T. latifolia*), narrow-leaved cattail produces tall, erect, sword-like leaves that can grow nearly 10 feet tall (Photo 3.5-8). The leaves are generally narrower than broad-leaf cattail, typically 0.15-0.5 inches wide. Unlike broad-leaf cattail in which the male and female flowers are typically touching, there is typically a gap of 0.5-4.0 inches between the male and female flowers of narrow-leaved cattail.

Colonies of narrow-leaved cattail were located in near-shore areas of Big Saint Germain Lake and Lake Content in 2019. Maps displaying the locations of these colonies can be found in the individual lake report sections. Given the isolated nature of these colonies, the best method of control is likely the cutting of stems (both green and dead) in mid- to late-summer or early fall to below the water line. The following growing season, continually cut-back emerging stems to maintain them below the water for the remainder of the growing season. This process should be repeated until the plants do not reemerge.

Photograph 3.5-8. Onterra ecologist amongst a colony of narrow-leaved cattail. Photo credit: Onterra.

Green Arrow-arum (Peltandra virginica)

Green arrow-arum is a perennial wetland plant native to wetlands in eastern and central North America (Figure 3.5-11). Its distribution in Wisconsin is sparse, and there is ongoing debate as to whether populations in Wisconsin were introduced or represent disjunct populations at the western edge of its native range. Green arrow-arum can form large clumps and colonies, but it does not appear to be behaving aggressively in the wetlands where it has been found in Wisconsin. It is similar in appearance to native arrowhead (*Sagittaria*) species, so it is possible this plant is more widespread than suggested and may be overlooked.

A population of green arrow-arum can be found growing within the emergent marsh community in Engle Bog which is connected to Moon Lake (Moon Lake – Map 5). In 2019, the population was comprised of clumps and colonies within the emergent marsh that encircles the open water. While this plant was observed in 2006, its population was not mapped at the time. Future surveys will help determine how the population in Engle Bog is behaving.

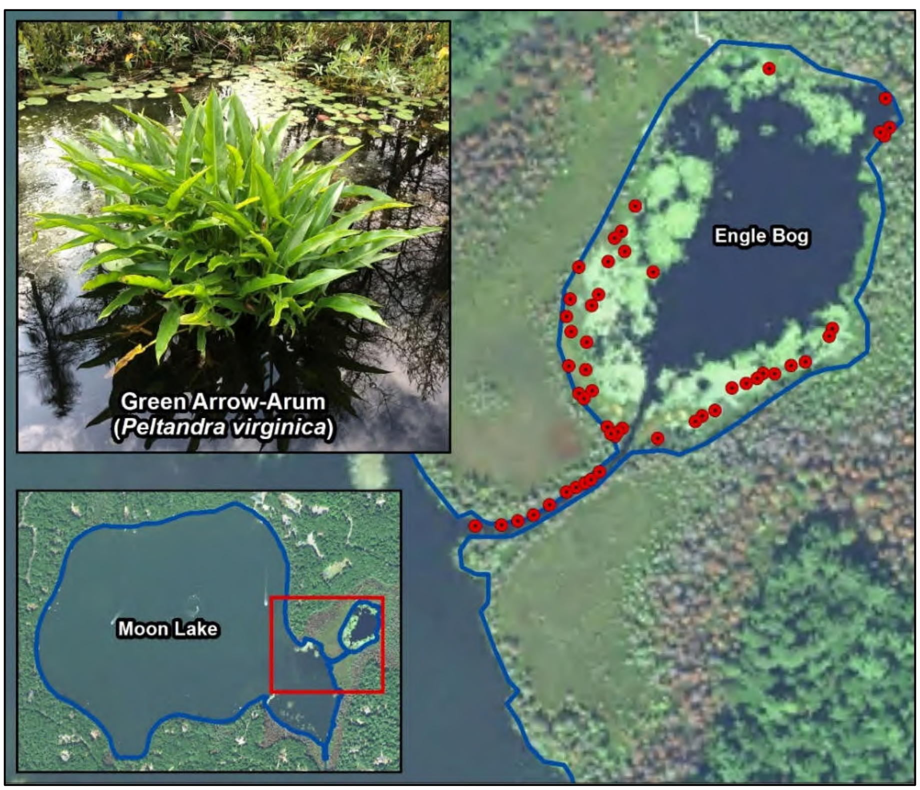


Figure 3.5-11. Engle Bog (Moon Lake) August 2019 locations of green arrow-arum. Locations indicated by red circles.

3.6 Other Aquatic Invasive Species in the Town of Saint Germain Lakes

While non-native, aquatic invasive plants (e.g., Eurasian watermilfoil) were discussed in the previous Aquatic Plant Section, a few species of aquatic invasive invertebrates have been documented within the Town of Saint Germain project lakes (Table 3.6-1). These include the Chinese mystery snail (*Cipanogopaludina chinensis*), banded mystery snail (*Viviparus georgianus*), and rusty crayfish (*Orconectes rusticus*).

Table 3.6-1. Aquatic invasive species documented to date in the Town of Saint Germain project lakes. Species presence verified by the WDNR. Updated April 2020.

Type	Scientific Name	Common Name	Location in Report	Alma Lake	Big Saint Germain Lake	Fawn Lake	Found Lake	Lake Content	Little Saint Germain Lake	Lost Lake	Moon Lake
Plants	*Iris pseudacorus*	Pale-yellow iris	LSG Lake Management Plan						X		
	Lythrum salicaria	Purple loosestrife	Section 3.5: Aquatic Plants				X				
	Myriophyllum spicatum	Eurasian w atermilfoil	Section 3.5: Aquatic Plants				X		X	X	
	Peltandra virginica	Green arrow -arum	Section 3.5: Aquatic Plants								X
	Potamogeton crispus	Curly-leaf pondw eed	LSG & Lost Lakes Management Plans						X	X	
	Typha angustifolia	Narrow -leaved cattail	Section 3.5: Aquatic Plants		X	X		X			
Invertebrates	*Cipangopaludina chinensis*	Chinese mystery snail	Section 3.6: Other Invasive Species	X	X		X	X	X	X	X
	Oronectes rusticus	Rusty crayfish	Section 3.6: Other Invasive Species		X					X	
	Viviparus georgianus	Banded mystery snail	Section 3.6: Other Invasive Species		X		X	X	X	X	

X = Verified as present by WDNR as of April 2020

One study conducted in northern Wisconsin lakes found that the Chinese mystery snail did not have strong negative effects on native snail populations (Solomon et al. 2010). However, researchers did detect negative impacts to native snail communities when both Chinese mystery snails and the rusty crayfish were present (Johnson et al. 2009).

Rusty crayfish were introduced to Wisconsin from the Ohio River Basin in the 1960's, likely via anglers' discarded bait. In addition to displacing native crayfish (*O. virilis* and *O. propinquus*), rusty crayfish also degrade the aquatic habitat by reducing aquatic plant abundance and diversity and have also been shown to consume fish eggs. While there is currently no method for completely eradicating rusty crayfish from a waterbody, aggressive trapping and removal has been shown to significantly reduce populations and minimize their ecological impact.

Figure 3.6-1 displays the aquatic invasive species that Town of Saint Germain stakeholders believe to be present in one of the six project lakes: Alma, Big Saint Germain, Fawn, Found, Lake Content, and Moon. While some respondents believe zebra mussels, spiny waterfleas, common carp, heterosporis, *Phragmites*, round goby, flowering rush, and freshwater jellyfish are present in the Town of Saint Germain lakes, none of these species have been documented in these lakes to date. Curly-leaf pondweed has been documented in Lost and Little Saint Germain lakes, but not in any of the six lakes in this project. Purple loosestrife was located on the shorelines of Found Lake in 2010 and removed and was not relocated in 2019.

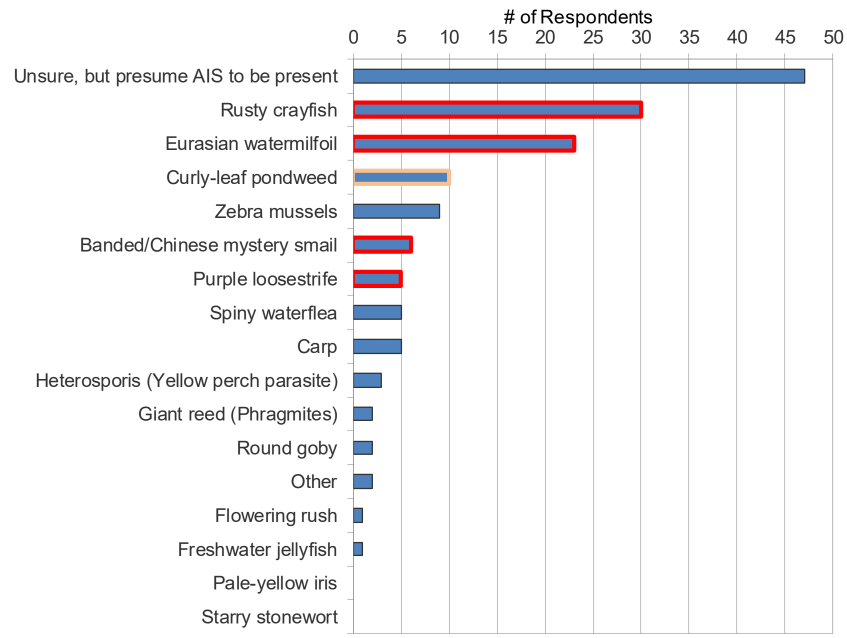


Figure 3.6-1. Stakeholder survey response Question #23. *Which aquatic invasive species do you believe are your lake?* Red outline indicates species which have been documented in one of the six project lakes. Curly-leaf pondweed (orange) is in Lost and Little Saint Germain lakes which are not included in this project.

3.7 Fisheries Data Integration

Fisheries management is an important aspect in the comprehensive management of a lake ecosystem; therefore, a brief summary of available data is included here as a reference. The following section is not intended to be a comprehensive plan for the Town of Saint Germain lakes' fishery, as those aspects are currently being conducted by the fisheries biologists overseeing the lakes. These lakes include Alma Lake, Big Saint Germain Lake, Lake Content, Fawn Lake, Found Lake, and Moon Lake. Little Saint Germain Lake and Lost Lake will also be included in compiled areas of the fisheries section. The goal of this section is to provide an overview of some of the data that exists. Although current fishery-related data were not collected as a part of this project, the following information was compiled based upon data available from the Wisconsin Department of Natural Resources (WDNR) the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) and personal communications with DNR Fisheries Biologist Eric Wegleitner (WDNR 2020 & GLIFWC 2019).

Town of Saint Germain Fishery

Energy Flow of a Fishery

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 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 3.7-1.

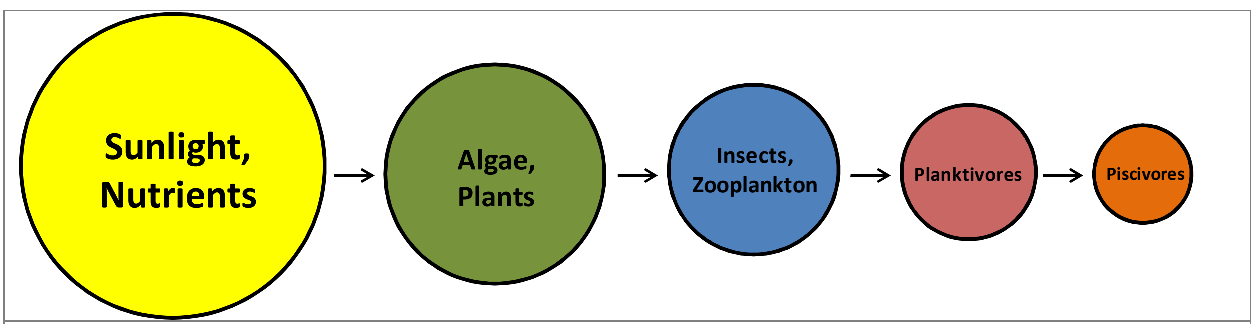


Figure 3.7-1. Aquatic food chain. Adapted from Carpenter et. al 1985.

Table 3.7-1 shows the popular game fish present within the Town of Saint Germain Lakes collectively. Although not an exhaustive list of fish species in the lakes, additional species documented in past WDNR surveys of include cisco (*Coregonus artedi*), golden shiner (*Notemigonus crysoleucas*), silver redhorse (*Moxostoma anisurum*), and white sucker (*Catostomus commersonii*).

Table 3.7-1. Gamefish present in the Town of Saint Germain Lakes with corresponding biological information (Becker, 1983).

Common Name (*Scientific Name*)	**Max Age (yrs)**	**Spawning Period**	**Spawning Habitat Requirements**	**Food Source**
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
Largemouth Bass *(Micropterus salmoides)*	13	Late April - Early July	Shallow, quiet bays with emergent vegetation	Fish, amphipods, algae, crayfish 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
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
Pumpkinseed *(Lepomis gobbosus)*	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)
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
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

Survey Methods

In order to keep the fishery of a lake healthy and stable, fisheries biologists must assess the current fish populations and trends. To begin this process, the correct sampling technique(s) must be selected to efficiently capture the desired fish species. A commonly used passive trap is a fyke net (Photograph 3.7-1). Fish swimming towards this net along the shore or bottom will encounter the lead of the net, be diverted into the trap and through a series of funnels which direct the fish further into the net. Once reaching the end, the fisheries technicians can open the net, record biological characteristics, mark (usually with a fin clip), and then release the captured fish.

The other commonly used sampling method is electrofishing (Photograph 3.7-1). This is done, often at night, by using a specialized boat fit with a generator and two electrodes installed on the front touching the water. Once a fish comes in contact with the electrical current produced, the fish involuntarily swims toward the electrodes. When the fish is in the vicinity of the electrodes, they become stunned making them easier to net and place into a livewell to recover. Contrary to what some may believe, electrofishing does not kill the fish and after being placed in the livewell fish generally recover within minutes. As with a fyke net survey, biological characteristics are recorded and any fish that has a mark (considered a recapture from the earlier fyke net survey) are also documented before the fish is released. The mark-recapture data collected between these two surveys is placed into a statistical model to calculate the population estimate of a fish species.

Fisheries biologists can then use this data to make recommendations and informed decisions on managing the future of the fishery.

Photograph 3.7-1. Fyke net positioned in the littoral zone of a Wisconsin Lake (left) and an electroshocking boat (right).

Fish Stocking

To assist in meeting fisheries management goals, the WDNR may permit the stocking of fingerling or adult fish in a waterbody that were raised in permitted hatcheries (Photograph 3.7-2). Stocking a lake may be done to assist the population of a species due to a lack of natural reproduction in the system, or to otherwise enhance angling opportunities. Lakes within the Town of Saint Germain that have received stocking are listed below along with corresponding tables with details of each stocking event.

Photograph 3.7-2. Muskellunge fingerling.

Big Saint Germain Lake has been consistently stocked with muskellunge and walleye since the early 1970's. Currently, muskellunge are being stocked on an odd year basis and walleye stocked on an even year basis (Tables 3.7-2 and 3.7-3). Largemouth bass were stocked periodically in the 1990's, but no recent stocking has occurred (Table 3.7-4). In 1994, 6,496 fingerling smallmouth bass were also stocked. Additionally, the lake district has contributed to the effort, stocking 2,100 fingerling walleye in 2019. Stocking of muskellunge and walleye are set to continue as scheduled (Personal communications, Eric Wegleitner).

Table 3.7-2. WDNR Stocking data available for Muskellunge in Big Saint Germain Lake

Year	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1973	UNSPECIFIED	FINGERLING	1,635	9
1975	UNSPECIFIED	FINGERLING	1,264	11
1978	UNSPECIFIED	FINGERLING	2,920	11.4
1979	UNSPECIFIED	FINGERLING	1,000	10
1981	UNSPECIFIED	FINGERLING	705	11
1983	UNSPECIFIED	FINGERLING	2,353	9
1985	UNSPECIFIED	FINGERLING	2,500	8
1987	UNSPECIFIED	FINGERLING	5,100	12
1988	UNSPECIFIED	FINGERLING	595	10.5
1989	UNSPECIFIED	FINGERLING	2,350	10.75
1991	UNSPECIFIED	FINGERLING	1,000	11
1992	UNSPECIFIED	FINGERLING	1,250	11
1993	UNSPECIFIED	FINGERLING	4,134	11.03
1995	UNSPECIFIED	FINGERLING	603	10.55
1997	UNSPECIFIED	LARGE FINGERLING	1,500	10.8
1999	UNSPECIFIED	FRY	143,000	0.5
1999	UNSPECIFIED	LARGE FINGERLING	1,000	12.5
2000	UNSPECIFIED	FRY	166,050	0.5
2001	UNSPECIFIED	FRY	169,550	0.5
2001	UNSPECIFIED	LARGE FINGERLING	808	10.6
2003	UNSPECIFIED	LARGE FINGERLING	808	10.6
2005	UNSPECIFIED	LARGE FINGERLING	808	10.6
2007	UPPER WISCONSIN RIVER	LARGE FINGERLING	538	12.1
2009	UPPER WISCONSIN RIVER	LARGE FINGERLING	808	9.9
2011	UPPER WISCONSIN RIVER	LARGE FINGERLING	805	9.3
2013	UPPER WISCONSIN RIVER	LARGE FINGERLING	404	9.2
2015	UPPER WISCONSIN RIVER	LARGE FINGERLING	404	11.4
2017	UPPER WISCONSIN RIVER	LARGE FINGERLING	259	10.8
2019	UPPER WISCONSIN RIVER	LARGE FINGERLING	417	NA

Table 3.7-3. WDNR Stocking data available for Walleye in Big Saint Germain Lake

Year	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1972	UNSPECIFIED	FRY	10,000,000	1
1973	UNSPECIFIED	FRY	8,000,000	
1974	UNSPECIFIED	FINGERLING	21,000	5
1974	UNSPECIFIED	FRY	8,000,000	1
1975	UNSPECIFIED	FRY	8,000,000	
1978	UNSPECIFIED	FINGERLING	42,240	2
1980	UNSPECIFIED	FINGERLING	114,266	2.14
1982	UNSPECIFIED	FINGERLING	99,040	3
1984	UNSPECIFIED	FINGERLING	80,000	2.25
1986	UNSPECIFIED	FINGERLING	80,000	2.5
1988	UNSPECIFIED	FINGERLING	77,760	2
1989	UNSPECIFIED	FINGERLING	16,660	4
1989	UNSPECIFIED	FRY	1,500,000	3
1991	UNSPECIFIED	FINGERLING	40,242	2
1992	UNSPECIFIED	FINGERLING	40,298	2
1994	UNSPECIFIED	FINGERLING	80,601	2
1994	UNSPECIFIED	FRY	1,000,000	0.2
1995	UNSPECIFIED	FRY	2,500,000	0.2
1996	UNSPECIFIED	FINGERLING	80,000	1.5
1996	UNSPECIFIED	FRY	500,000	0.3
1998	UNSPECIFIED	FRY	2,000,000	0.3
1998	UNSPECIFIED	SMALL FINGERLING	160,000	1.5
1999	UNSPECIFIED	FRY	2,800,000	0.3
2000	UNSPECIFIED	FRY	5,000,000	0.3
2000	UNSPECIFIED	SMALL FINGERLING	126,250	1.7
2001	UNSPECIFIED	FRY	7,000,000	0.3
2002	MISSISSIPPI HEADWATERS	SMALL FINGERLING	80,850	1.4
2004	MISSISSIPPI HEADWATERS	SMALL FINGERLING	81,106	1.3
2005	MISSISSIPPI HEADWATERS	FRY	696,000	0.3
2006	MISSISSIPPI HEADWATERS	SMALL FINGERLING	56,898	1.7
2008	MISSISSIPPI HEADWATERS	SMALL FINGERLING	44,940	1.65
2010	MISSISSIPPI HEADWATERS	SMALL FINGERLING	56,892	1.7
2012	MISSISSIPPI HEADWATERS	SMALL FINGERLING	46,594	1.6
2014	MISSISSIPPI HEADWATERS	SMALL FINGERLING	56,770	1.7
2016	MISSISSIPPI HEADWATERS	SMALL FINGERLING	56,583	2
2018	MISSISSIPPI HEADWATERS	SMALL FINGERLING	56,598	1.95

Table 3.7-4. Stocking data available for Largemouth Bass in Big Saint Germain Lake

Year	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1990	UNSPECIFIED	FINGERLING	2,870	4
1991	UNSPECIFIED	FINGERLING	4,185	3
1997	UNSPECIFIED	LARGE FINGERLING	550	3.4
1998	UNSPECIFIED	LARGE FINGERLING	934	5.4
1999	UNSPECIFIED	LARGE FINGERLING	775	4.8
2000	UNSPECIFIED	LARGE FINGERLING	3,000	2

Alma Lake has been consistently stocked with muskellunge and walleye since 1973. Currently, muskellunge are being stocked on an even year basis and walleye stocked on an odd year basis (Tables 3.7.5 and 3.7.6). Four largemouth bass stocking events have occurred between 1972 and 1989. In total, 4,544 fingerling largemouth bass were stocked in these events.

Table 3.7-5. Stocking data available for Muskellunge in Alma Lake

Year	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1974	UNSPECIFIED	FINGERLING	100	7
1976	UNSPECIFIED	FINGERLING	100	13
1978	UNSPECIFIED	FINGERLING	100	8
1984	UNSPECIFIED	FINGERLING	100	12
1986	UNSPECIFIED	FINGERLING	100	12
1988	UNSPECIFIED	FINGERLING	105	10.5
1990	UNSPECIFIED	FINGERLING	100	11
1991	UNSPECIFIED	FINGERLING	50	12
1992	UNSPECIFIED	FINGERLING	50	10
1993	UNSPECIFIED	FINGERLING	50	10
1996	UNSPECIFIED	FINGERLING	100	10.7
1998	UNSPECIFIED	LARGE FINGERLING	100	11.4
2000	UNSPECIFIED	LARGE FINGERLING	100	10.9
2002	UNSPECIFIED	LARGE FINGERLING	29	10.7
2004	UNSPECIFIED	LARGE FINGERLING	29	10.1
2006	UPPER WISCONSIN RIVER	LARGE FINGERLING	28	10.7
2008	UPPER WISCONSIN RIVER	LARGE FINGERLING	28	10.4
2010	UPPER WISCONSIN RIVER	LARGE FINGERLING	21	12.7
2012	UPPER WISCONSIN RIVER	LARGE FINGERLING	28	10.4
2014	UPPER WISCONSIN RIVER	LARGE FINGERLING	14	11.3
2016	UPPER WISCONSIN RIVER	LARGE FINGERLING	14	10.8
2018	UPPER WISCONSIN RIVER	LARGE FINGERLING	14	11.3

Table 3.7-6. Stocking data available for Walleye in Alma Lake

Year	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1973	UNSPECIFIED	FINGERLING	2,000	3
1975	UNSPECIFIED	FINGERLING	2,000	3
1976	UNSPECIFIED	FINGERLING	2,000	3
1977	UNSPECIFIED	FINGERLING	2,000	3
1980	UNSPECIFIED	FINGERLING	3,000	3
1981	UNSPECIFIED	FINGERLING	5,655	3.67
1983	UNSPECIFIED	FINGERLING	3,000	3
1985	UNSPECIFIED	FINGERLING	3,000	2
1987	UNSPECIFIED	FINGERLING	9,000	2
1989	UNSPECIFIED	FINGERLING	3,125	2
1991	UNSPECIFIED	FINGERLING	1,599	2
1992	UNSPECIFIED	FINGERLING	1,434	2
1993	UNSPECIFIED	FINGERLING	3,045	2.5
1995	UNSPECIFIED	FINGERLING	2,934	2.1
1999	UNSPECIFIED	SMALL FINGERLING	2,979	1.7
2001	UNSPECIFIED	SMALL FINGERLING	3,164	1.6
2003	MISSISSIPPI HEADWATERS	SMALL FINGERLING	2,992	1.8
2005	MISSISSIPPI HEADWATERS	SMALL FINGERLING	2,900	1.5
2009	MISSISSIPPI HEADWATERS	SMALL FINGERLING	1,055	1.7
2011	MISSISSIPPI HEADWATERS	SMALL FINGERLING	1,925	1.8
2013	MISSISSIPPI HEADWATERS	SMALL FINGERLING	1,925	2
2015	MISSISSIPPI HEADWATERS	SMALL FINGERLING	1,991	1.7
2017	MISSISSIPPI HEADWATERS	SMALL FINGERLING	2,021	1.68
2019	MISSISSIPPI HEADWATERS	SMALL FINGERLING	2,021	NA

Moon Lake, similar to Alma, receives muskellunge and walleye stocking in alternating years (Tables 3.7-7 and 3.7-8). Largemouth bass have also been stocked on two occasions; once in 1986 (1,000 fingerlings), and again in 1989 (1,800 fingerlings).

Table 3.7-7. Stocking data available for Muskellunge in Moon Lake

Year	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1975	UNSPECIFIED	FINGERLING	100	11
1976	UNSPECIFIED	FINGERLING	200	13
1978	UNSPECIFIED	FINGERLING	200	11
1984	UNSPECIFIED	FINGERLING	150	12
1986	UNSPECIFIED	FINGERLING	150	11
1988	UNSPECIFIED	FINGERLING	150	10.5
1990	UNSPECIFIED	FINGERLING	150	11
1991	UNSPECIFIED	FINGERLING	150	12
1992	UNSPECIFIED	FINGERLING	150	10
1993	UNSPECIFIED	FINGERLING	272	10
1995	UNSPECIFIED	FINGERLING	168	12.2
1997	UNSPECIFIED	LARGE FINGERLING	127	10
1999	UNSPECIFIED	LARGE FINGERLING	150	12.1
2002	UNSPECIFIED	LARGE FINGERLING	65	10.7
2004	UNSPECIFIED	LARGE FINGERLING	65	10.1
2006	UPPER WISCONSIN RIVER	LARGE FINGERLING	62	10.7
2008	UPPER WISCONSIN RIVER	LARGE FINGERLING	62	10.4
2010	UPPER WISCONSIN RIVER	LARGE FINGERLING	47	12.7
2012	UPPER WISCONSIN RIVER	LARGE FINGERLING	65	10.4
2014	UPPER WISCONSIN RIVER	LARGE FINGERLING	32	11.3
2016	UPPER WISCONSIN RIVER	LARGE FINGERLING	32	10.8
2018	UPPER WISCONSIN RIVER	LARGE FINGERLING	32	11.3

Table 3.7-8. Stocking data available for Walleye in Moon Lake

Year	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1973	UNSPECIFIED	FINGERLING	10,720	4
1975	UNSPECIFIED	FINGERLING	4,000	3
1976	UNSPECIFIED	FINGERLING	8,000	3
1977	UNSPECIFIED	FINGERLING	4,000	3
1980	UNSPECIFIED	FINGERLING	6,000	3
1981	UNSPECIFIED	FINGERLING	5,975	3.5
1983	UNSPECIFIED	FINGERLING	6,000	3
1985	UNSPECIFIED	FINGERLING	6,000	2
1987	UNSPECIFIED	FINGERLING	18,000	2
1989	UNSPECIFIED	FINGERLING	6,250	2
1991	UNSPECIFIED	FINGERLING	3,198	2
1992	UNSPECIFIED	FINGERLING	3,346	2
1994	UNSPECIFIED	FINGERLING	6,019	2
1996	UNSPECIFIED	FINGERLING	23,052	1.8
1998	UNSPECIFIED	SMALL FINGERLING	13,000	1.5
2003	MISSISSIPPI HEADWATERS	SMALL FINGERLING	6,732	1.8
2005	MISSISSIPPI HEADWATERS	SMALL FINGERLING	6,550	1.5
2009	MISSISSIPPI HEADWATERS	SMALL FINGERLING	4,337	1.7
2011	MISSISSIPPI HEADWATERS	SMALL FINGERLING	4,339	1.8
2013	MISSISSIPPI HEADWATERS	SMALL FINGERLING	4,340	2
2015	MISSISSIPPI HEADWATERS	SMALL FINGERLING	4,539	1.7
2017	MISSISSIPPI HEADWATERS	SMALL FINGERLING	4,340	1.68
2019	MISSISSIPPI HEADWATERS	SMALL FINGERLING	4,334	NA

Found Lake has received consistent stocking of both muskellunge and walleye since 1972 (Tables 3.7-9 and 3.7-10). Starting in 2013, Found Lake was adopted into the Wisconsin Walleye Initiative program. Between 2013 and 2019, walleye fingerlings were stocked at a rate of approximately 5 fish/ acre. Largemouth bass have also been stocked in 1974, 1986, and 1999. In total, 7,485 largemouth bass fingerlings were stocked in these events.

Provided funding is available, future stocking efforts of walleye will be consistent following Found Lake's inclusion in the Wisconsin Walleye Initiative. The Initiative was made possible by the governor's office, Department of Natural Resources and statewide partners to maintain the walleye population in Wisconsin's lakes and improve walleye fisheries in lakes capable of sustaining the sportfish (WDNR 2014). Lakes chosen to be included are selected based upon anticipated fingerling survival, natural reproduction opportunities, public access, tribal interest (for ceded territory lakes) and potential impacts to tourism (WDNR 2014). Stocking rates are randomly assigned to chosen lakes and stocked every other year to avoid competing year classes.

Table 3.7-9. Stocking data available for Muskellunge in Found Lake (1972-2018).

Year	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1972	UNSPECIFIED	FINGERLING	666	12
1975	UNSPECIFIED	FINGERLING	293	11
1976	UNSPECIFIED	FINGERLING	400	9
1980	UNSPECIFIED	FINGERLING	613	11
1986	UNSPECIFIED	FINGERLING	600	10.5
1988	UNSPECIFIED	FINGERLING	600	10
1990	UNSPECIFIED	FINGERLING	600	9
1991	UNSPECIFIED	FINGERLING	700	11
1992	UNSPECIFIED	FINGERLING	600	10.75
1993	UNSPECIFIED	FINGERLING	600	10
1995	UNSPECIFIED	FINGERLING	600	11.3
1999	UNSPECIFIED	LARGE FINGERLING	300	11.6
2006	UPPER WISCONSIN RIVER	LARGE FINGERLING	326	10.2
2008	UPPER WISCONSIN RIVER	LARGE FINGERLING	326	10.4
2010	UPPER WISCONSIN RIVER	LARGE FINGERLING	308	12.7
2012	UPPER WISCONSIN RIVER	LARGE FINGERLING	322	10.4
2014	UPPER WISCONSIN RIVER	LARGE FINGERLING	82	11.3
2016	UPPER WISCONSIN RIVER	LARGE FINGERLING	80	10.8
2018	UPPER WISCONSIN RIVER	LARGE FINGERLING	81	11.6

Table 3.7-10. Stocking data available for Walleye in Found Lake

Year	Strain (Stock)	Age Class	# Fish Stocked	Avg Fish Length (in)
1974	UNSPECIFIED	FINGERLING	10,000	3
1975	UNSPECIFIED	FINGERLING	8,000	3
1977	UNSPECIFIED	FINGERLING	15,000	3
1985	UNSPECIFIED	FINGERLING	16,000	2
1987	UNSPECIFIED	FINGERLING	48,000	2.5
1989	UNSPECIFIED	FINGERLING	22,276	2.5
1991	UNSPECIFIED	FINGERLING	8,112	3
1992	UNSPECIFIED	FINGERLING	4,795	2
1994	UNSPECIFIED	FINGERLING	15,907	2.57
1996	UNSPECIFIED	FINGERLING	2,530	5.6
1998	UNSPECIFIED	SMALL FINGERLING	32,425	2.1
2000	UNSPECIFIED	SMALL FINGERLING	28,788	1.9
2002	MISSISSIPPI HEADWATERS	LARGE FINGERLING	1,900	4.3
2002	MISSISSIPPI HEADWATERS	SMALL FINGERLING	16,300	1.7
2004	MISSISSIPPI HEADWATERS	LARGE FINGERLING	3,259	7
2006	MISSISSIPPI HEADWATERS	LARGE FINGERLING	3,260	7.9
2008	MISSISSIPPI HEADWATERS	LARGE FINGERLING	3,260	6.93
2010	MISSISSIPPI HEADWATERS	LARGE FINGERLING	1,646	7.7
2013	MISSISSIPPI HEADWATERS	LARGE FINGERLING	1,630	7.95
2015	MISSISSIPPI HEADWATERS	LARGE FINGERLING	1,677	7.9
2017	MISSISSIPPI HEADWATERS	LARGE FINGERLING	1,682	6.45
2019	MISSISSIPPI HEADWATERS	LARGE FINGERLING	1,679	NA

Fishing Activity

Two stakeholder surveys were completed on the Town of Saint Germain Lakes. Data was collected from the Saint Germain stakeholder survey (Big Saint Germain, Content, Fawn, Alma, and Moon Lakes) with Found Lake completed in a separate survey (Appendix B). Data from the Saint Germain stakeholder survey showed fishing (open-water and ice) was the first most important reason for owning property on or near the Saint Germain Lakes (Question #16). Figure 3.7-2 displays the fish that Saint Germain stakeholders enjoy catching the most, with walleye, bluegill/sunfish, and yellow perch being the most popular. Approximately 69% of these same respondents believed that the quality of fishing on the lake was either good or fair (Figure 3.7-3). Approximately 43% of respondents who fish the Saint Germain Lakes believe the quality of fishing is somewhat worse since they first started to fish the lake (Figure 3.7-4).

Data from the Found Lake stakeholder survey showed fishing (open-water) was the second most important reason for owning property on or near Found Lake (Question #15). Figure 3.7-5 displays the fish that Saint Germain stakeholders enjoy catching the most, with crappie and largemouth bass being the most popular. Approximately 89% of these same respondents believed that the quality of fishing on the lake was either good or fair (Figure 3.7-6). Approximately 55% of respondents who fish Found Lake believe the quality of fishing is somewhat worse since they first started to fish the lake (Figure 3.7-7).

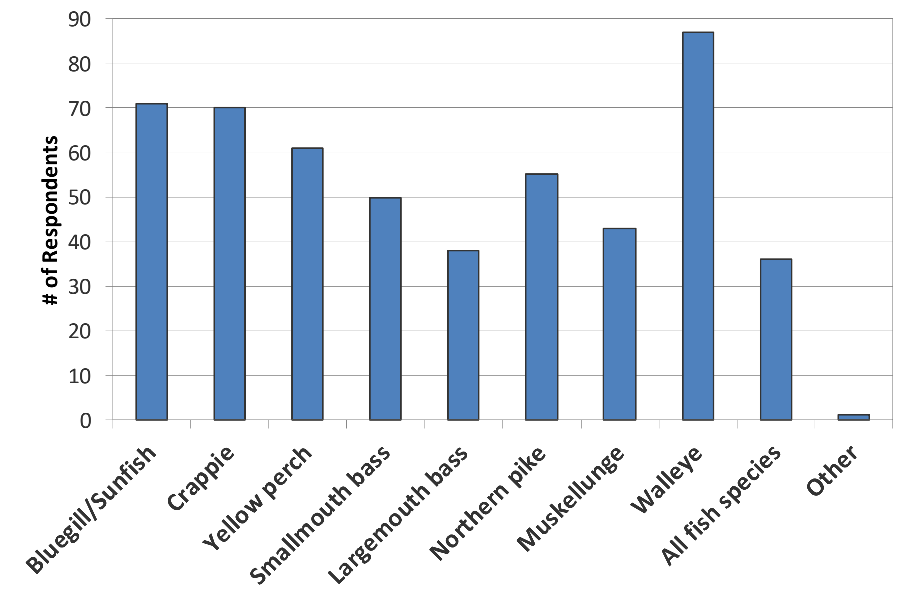


Figure 3.7-2. Stakeholder survey response Question #10. What species of fish do you like to catch on this lake?

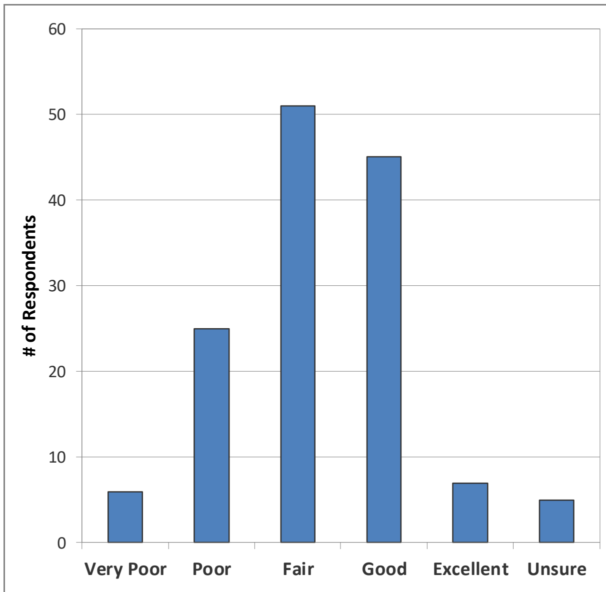


Figure 3.7-3. Stakeholder survey response Question #11. How would you describe the current quality of fishing on this lake?

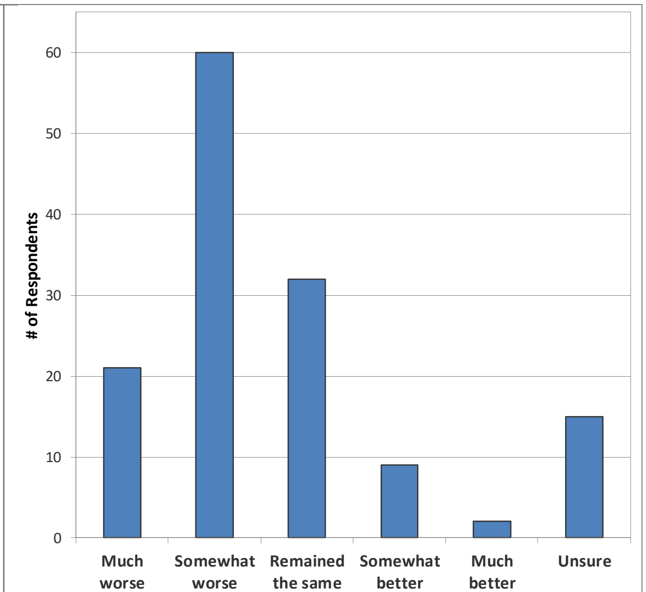


Figure 3.7-4. Stakeholder survey response Question #12. How has the quality of fishing changed on the lake since you started fishing it?

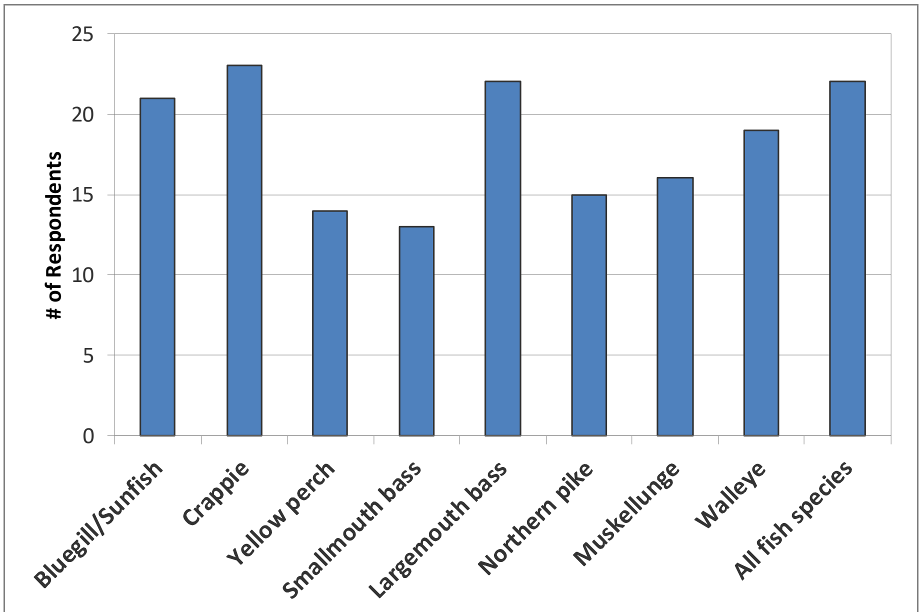


Figure 3.7-5. Stakeholder survey response Question #9. What species of fish do you like to catch on Found Lake?

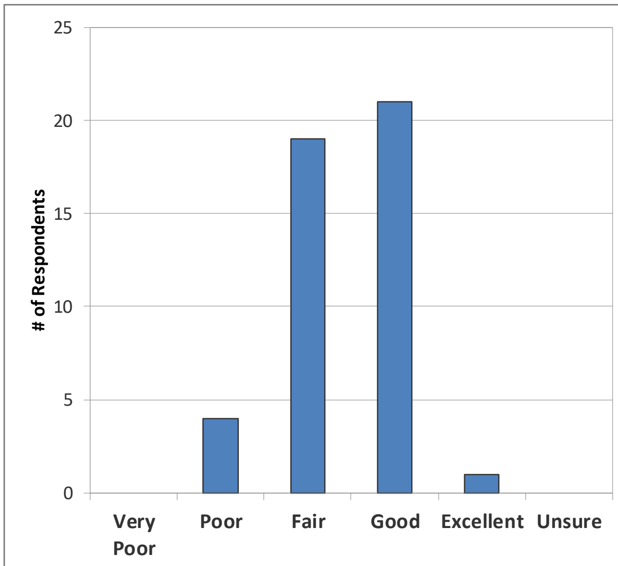


Figure 3.7-6. Stakeholder survey response Question #10. How would you describe the current quality of fishing on Found Lake?

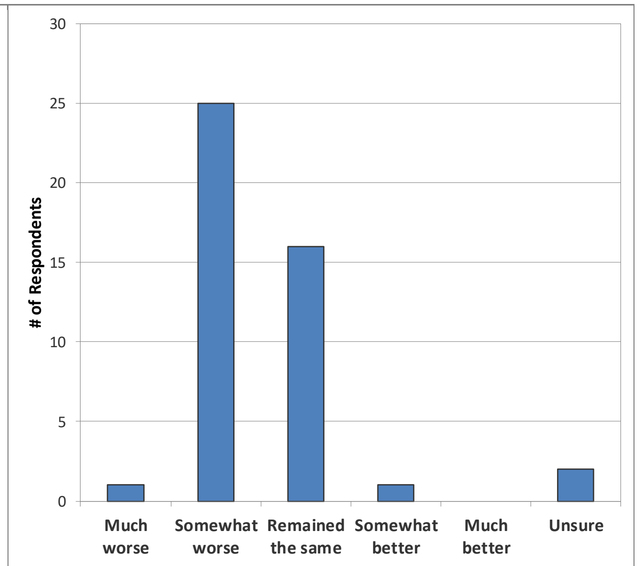


Figure 3.7-7. Stakeholder survey response Question #11. How has the quality of fishing changed on Found Lake since you started fishing the lake?

The WDNR measures sport fishing harvest by conducting creel surveys. A Creel Survey Clerk will count the number of anglers present on a lake and interview anglers who have completed fishing for the day. Data collected from the interviews include targeted fish species, harvest, lengths of harvested fish and hours of fishing effort. Creel clerks will work on randomly-selected days and shifts to achieve a randomized census of the fish being harvested. A creel survey was completed on Big Saint Germain Lake, Lake Content, and Fawn Lake during the 1994 and 2011 fishing seasons (Table 3.7-11).

Total angler effort was similar in 2011 as it was in 1994. In 1994, angler effort/acre was 41.2 hours and in 2011 it was 39.3 hours/acre. In those years, walleye and muskellunge saw the most amount of directed fishing pressure. Muskellunge harvest dropped from 80 fish in 1994, to zero fish harvested in 2011. Conversely, smallmouth bass saw an increase from 0 fish harvested in 1994 to 353 fish harvested in 2011.

Table 3.7-11. Creel Survey from Big Saint Germain, Content, and Fawn Lakes in 1994 and 2011.

Species	Year	Directed Effort/Acre (Hours)	Percent of Total	Total Catch	Specific catch rate (Hours/Fish)*	Total Harvest	Specific harvest Rate (Hours/Fish)*
Largemouth Bass	1994	0.4	1.0	135	7.3	6	107.5
	2011	1.3	3.3	1,478	3.6	44	
Muskellunge	1994	13.9	33.7	697	35.7	80	303.3
	2011	9.5	24.2	390	48.5	0	
Northern Pike	1994	8	19.4	4,421	5.3	1,043	20
	2011	5.3	12.9	3,496	8	941	18.8
Smallmouth Bass	1994	0.1	0.2	46		0	
	2011	4.2	10.7	6,175	2.4	353	25.2
Walleye	1994	21	51.0	5,646	6.1	1,391	24.4
	2011	15.4	39.2	3,506	7.5	1,588	16.2

Fish Populations and Trends

Utilizing the above-mentioned fish sampling techniques and specialized formulas, WDNR fisheries biologists can estimate populations and determine trends of captured fish species. These numbers provide a standardized way to compare fish caught in different sampling years depending on gear used (fyke net or electrofishing). Data is analyzed in many ways by fisheries biologists to better understand the fishery and how it should be managed.

Gamefish

The gamefish present in the Town of Saint Germain Lakes represent different population dynamics depending on the species. A survey was conducted by WDNR biologists in the spring of 2011 to assess gamefish populations (Appendix E). Specifically, biologists focused on walleye and muskellunge abundance on Big Saint Germain Lake, Lake Content, and Fawn Lake. The results for the Saint Germain stakeholder survey show landowners prefer to catch walleye and on Found Lake, stakeholders prefer to catch largemouth bass (Figure 3.7-2 and Figure 3.7-5).

Walleye are a valued sportfish throughout Wisconsin and the Town of Saint Germain is a destination walleye location for many Wisconsin anglers. The lakes in this area have received millions of walleyes through various stocking programs, both by the DNR and through private organizations. A 2011 survey and population estimate of Big Saint Germain Lake shows a moderately abundant adult walleye population of approximately 4,800 fish (Table 3.7-12). This equates to approximately 3 adult fish/acre. Walleye between 15-20 inches were the most common size class and walleye greater than 15 inches accounted for 89% of the fish captured. The biggest walleye captured during this survey was a 28-inch female.

Table 3.7-12. Adult Walleye Population Estimate for Big Saint Germain Lake 1994 and 2011

Year	Primary Recruitment Source	Population Estimate	Lower 95 C.I.	Number / Acre	# Adults <12 Inches / Acre	# Adults 12-15 Inches / Acre	# Adults 15-20 Inches / Acre	# Adults >20 Inches / Acre
1994	Natural	4,558	3,461	2.8	0.1	0.7	1.2	0.9
2011	Stocked	4,843	3,253	3	0	0.3	2	0.6

Muskellunge, like walleye, are another highly valued sportfish of northern Wisconsin. The lakes within the Town of Saint Germain offer great opportunity for anglers to pursue muskellunge. Listed as a Class A1 muskellunge water, Big Saint Germain Lake has the potential to produce trophy sized fish. In a 2011 survey, about 25% of muskellunge captured in fyke nets were greater than 40 inches. The largest fish was a 47.5- inch female. Although very little to no natural reproduction occurs, consistent stocking has proved successful within this lake. Little Saint Germain Lake and Lake Content, also listed as Class A1 waters, are home to trophy muskellunge as well.

Some natural reproduction has occurred in Lake Content in the past, but is more likely sustained by the extensive stocking of Big Saint Germain Lake. Listed as a Class A2 water, Lost Lake gives anglers the best chance at catching muskellunge with high numbers of adult fish, but the average size is not as large as A1 waters. Fawn Lake is listed as a Class B muskellunge water, meaning anglers can still expect good action while muskellunge fishing. The potential for a trophy-sized fish, however, is less than in Class A waters. Alma, Moon, and Found Lakes are also listed as Class B water, with no history of natural reproduction. These lakes receive consistent muskellunge stocking.

Smallmouth bass and largemouth bass are present in the Town of Saint Germain Lakes. A bycatch of the 2011 survey, 78 smallmouth bass and 70 largemouth bass were captured during sampling of Big Saint Germain Lake. The largest smallmouth bass was 19.9 inches and the largest largemouth bass was 17.9 inches long.

Northern Pike are also present in the Town of Saint Germain lakes. In 2011, 87 fish were captured in Big Saint Germain. Of these fish, 85% were less than 26 inches long. The longest fish captured measured 34.6 inches.

Panfish

Black Crappie, bluegill, pumpkinseed and yellow perch were all common during the 2011 WDNR fisheries survey. Exact numbers and lengths of these fish were not recorded. is very popular within the Saint Germain area because of the common abundance and table fare these fish provide. According to 2011-2012 creel survey results, angling effort directed towards panfish accounted for approximately 42% of all angling pressure and over 22,000 panfish harvested on Big Saint Germain Lake (WDNR 2011-2012). Results for the stakeholder surveys show anglers prefer to catch bluegill/sunfish on the Saint Germain Lakes and crappie on Found Lake (Figure 3.7-2 and Figure 3.7-5).

Fish Kill

Lake Content has experienced periodic fish kills over winter caused by a lack of dissolved oxygen in the water. Anoxic conditions can develop during the winter months when dissolved oxygen is depleted from biological processes in which oxygen is consumed. No recent WDNR fish studies have been conducted on Lake Content to evaluate the current populations of gamefish in the system. In communications with Vilas County fish biologist Eric Wegleitner, fish seem to move freely between Big Saint Germain and Lake Content, so migration between the two lakes during low dissolved oxygen periods is likely.

Town of Saint Germain Spear Harvest Records

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 3.7-8). The Town of Saint Germain falls within the ceded territory based on the Treaty of 1842. This allows for a regulated open water spear fishery by Native Americans on lakes located within the Ceded Territory. Determining how many fish are able to be taken from a lake by tribal harvest is a highly regimented and dictated process.

Figure 3.7-8. Location of Saint Germain within the Native American Ceded Territory (GLIFWC 2017). This map was digitized by Onterra; therefore, it is a representation and not legally binding.

This highly structured procedure begins with bi-annual meetings between tribal and state management authorities. Reviews of population estimates are made for ceded territory lakes, and then a "total allowable catch" (TAC) is established, based upon estimates of a sustainable harvest of the fishing stock. The TAC is the number of adult walleye or muskellunge that can be harvested from a lake by tribal and recreational anglers without endangering the population. A "safe harvest" value is calculated as a percentage of the TAC each year for all walleye lakes in the ceded territory. The safe harvest represents the number of fish that can be harvested by tribal members through the use of high efficiency gear such as spearing or netting without influencing the sustainability of the population.

This does not apply to angling harvest which is considered a low-efficiency harvest regulated statewide by season length, size and bag limits. The safe harvest limits are set through either recent population estimates or a statistical model that ensure there is less than a 1 in 40 chance that more than 35% of the adult walleye population will be harvested in a lake through high efficiency methods. By March 15th of each year the relevant Native American communities may declare a proportion of the total safe harvest on each lake; this declaration represents the maximum number of fish that can be harvested by tribal members annually.

Prior to 2015, annual walleye bag limits for anglers were adjusted in all Ceded Territory lakes based upon the percent of the safe harvest levels determined for the Native American spearfishing season. Beginning in 2015, new regulations for walleye were created to stabilize regional walleye angler bag limits. The daily bag limits for walleye in lakes located partially or wholly within the ceded territory is three. The state-wide bag limit for walleye is five. Anglers may only remove three walleye from any individual lake in the ceded territory but may fish other waters to full-fill the state bag limit (WDNR 2017).

Tribal members may harvest muskellunge, walleye, northern pike, and bass during the open water season; however, in practice walleye and muskellunge are the only species harvested in significant numbers, so conservative quotas are set for other species. The spear harvest is monitored through a nightly permit system and a complete monitoring of the harvest (GLIFWC 2017). 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.

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 (GLIFWC 2017). This regulation limits the harvest of the larger, spawning female walleye. An updated nightly declaration is determined each morning by 9 a.m. based on the data collected from the successful spearers. Spearfishing of a particular species ends once the declared harvest is reached in a given lake. In 2011, a new reporting requirement went into effect on lakes with smaller declarations. Starting with the 2011 spear harvest season, on lakes with a harvestable declaration of 75 or fewer fish, reporting of harvests may take place at a location other than the landing of the speared lake.

Big Saint Germain Lake open water walleye spear harvest records from 2000-2019 are provided in Figure 3.7-9. As many as 537 walleye have been harvested from the lake in the past (2015), but the average harvest is roughly 300 fish in a given year. Spear harvesters on average have taken 100% of the declared quota.

Open water muskellunge spear harvest records 2000-2019 are provided in Figure 3.7-10. As many as 12 muskellunge have been harvested from the lake in the past (2002, 2014), however the average harvest is 6 fish in a given year. Spear harvesters on average have taken 13% of the declared quota.

Lake Content saw walleye spear harvest for the first time in 2019. Three fish were speared, accounting for approximately 5% of the declared quota for that year. A small quota for muskellunge has been declared in previous years, but no harvest has been recorded.

Found Lake has also seen spear harvest on one occasion. In 2017, two walleye were harvested,

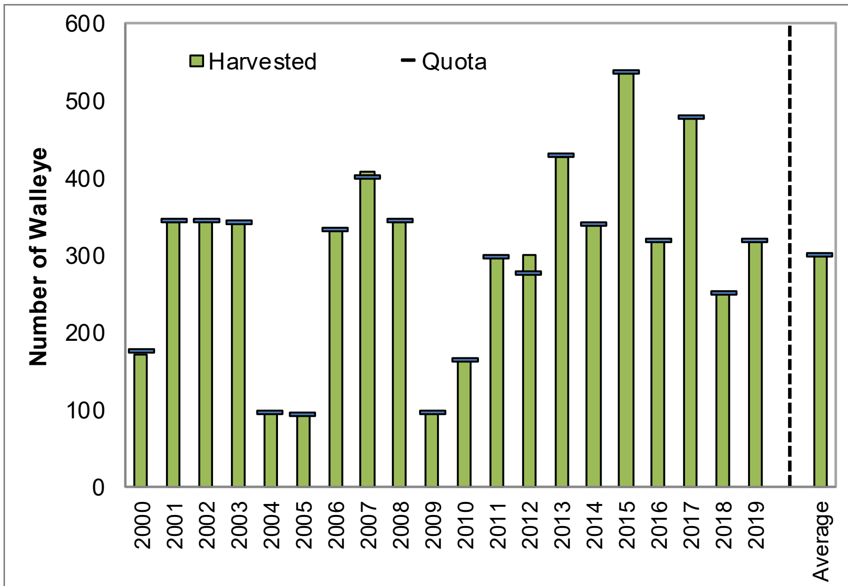


Figure 3.7-9. Walleye Spear Harvest Data for Big Saint Germain Lake 2000-2019.

accounting for approximately 5% of the declared quota for that year. A small quota for muskellunge has been declared in previous years, but no harvest has been recorded.

Alma, Fawn, and Moon Lakes have also had small quotas declared each year for both walleye and muskellunge. No harvest of either species has been recorded.

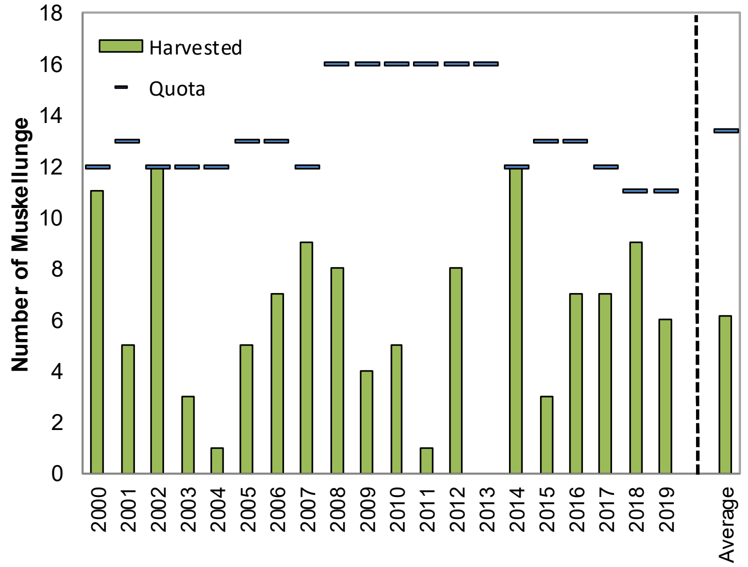


Figure 3.7-10. Muskellunge Spear Harvest Data for Big Saint Germain Lake 2000-2019.

Town of Saint Germain Lakes Fish Habitat

Substrate Composition

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

Substrate and habitat are critical to fish species that do not provide parental care to their eggs. Northern pike is one species that does not provide parental care to its eggs (Becker 1983). Northern pike 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 are 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 and care for their eggs in muck as well.

According to the point-intercept survey conducted by Onterra in 2019, 53% of the substrate sampled in the littoral zone of **Alma Lake** were soft sediments, 44% was composed of sand sediments, and 3% were composed of rock.

According to the point-intercept survey conducted by Onterra in 2019, 65% of the substrate sampled in the littoral zone of **Big Saint Germain Lake** were sand sediments, 19% was composed of soft sediments, and 16% were composed of rock.

According to the point-intercept survey conducted by Onterra in 2019, 90% of the substrate sampled in the littoral zone of **Lake Content** were soft sediments, 9% was composed of sand sediments, and 1% were composed of rock.

According to the point-intercept survey conducted by Onterra in 2019, 95% of the substrate sampled in the littoral zone of **Fawn Lake** were soft sediments and 5% was composed of sand sediments. No rock substrate was recorded.

According to the point-intercept survey conducted by Onterra in 2019, 53% of the substrate sampled in the littoral zone of **Moon Lake** were sand sediments, 34% was composed of soft sediments, and 13% composed of rock.

Woody Habitat

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. Leaving these shoreland zones barren of coarse woody habitat can lead to decreased abundances and slower growth rates in fish (Sass 2009). Fisheries biologists do not suggest a specific number of fish sticks for a lake but rather highly encourage their installation wherever possible.

A fall 2019 survey documented 74 pieces of coarse woody along the shores of **Alma Lake**, resulting in a ratio of approximately 44 pieces per mile of shoreline.

A fall 2019 survey documented 118 pieces of coarse woody along the shores of **Big Saint Germain Lake**, resulting in a ratio of approximately 15 pieces per mile of shoreline.

A fall 2019 survey documented 35 pieces of coarse woody along the shores of **Lake Content**, resulting in a ratio of approximately 11 pieces per mile of shoreline.

A fall 2019 survey documented 18 pieces of coarse woody along the shores of **Fawn Lake**, resulting in a ratio of approximately 16 pieces per mile of shoreline.
A fall 2019 survey documented 131 pieces of coarse woody along the shores of **Found Lake**, resulting in a ratio of approximately 34 pieces per mile of shoreline.

A fall 2019 survey documented 74 pieces of coarse woody along the shores of **Moon Lake**, resulting in a ratio of approximately 31 pieces per mile of shoreline.

To learn how the coarse woody habitat in the Town of Saint Germain Lakes compares to other lakes in its region please refer to section 3.3.

Fish Habitat Structures

Some fisheries managers may look to incorporate fish habitat structures on the lakebed or littoral areas extending to shore for the purpose of improving fish habitats and spawning areas. These projects are typically conducted on lakes lacking significant coarse woody habitat in the shoreland zone. The "Fish sticks" program, outlined in the WDNR best practices manual, adds trees to the shoreland zone restoring fish habitat to critical near shore areas. Typically, every site has 3 – 5 trees which are partially or fully submerged in the water and anchored to shore (Photograph 3.7-3). The WDNR recommends placement of the fish sticks during the winter on ice when possible to prevent adverse impacts on fish spawning or egg incubation periods. The program requires a

WDNR permit and can be funded through many different sources including the WDNR, County Land & Water Conservation Departments or partner contributions.

Photograph 3.7-3. Examples of fish sticks (left) and half-log habitat structures. (Photos by WDNR)

Fish cribs are a type of fish habitat structure placed on the lakebed. These structures are more commonly utilized when there is not a suitable shoreline location for fish sticks. Installing fish cribs may also be cheaper than fish sticks; however some concern exists that fish cribs can concentrate fish, which in turn leads to increased predation and angler pressure. Having multiple locations of fish cribs can help mitigate that issue.

Half-logs are another form of fish spawning habitat placed on the bottom of the lakebed (Photograph 3.7-3). Smallmouth bass specifically have shown an affinity for overhead cover when creating spawning nests, which half-logs provide (Wills, Bremigan and Haynes 2004). If the waterbody is exempt from a permit or a permit has been received, information related to the construction, placement and maintenance of half-log structures are available online.

An additional form of fish habitat structure is spawning reefs. Spawning reefs typically consist of small rubble in a shallow area near the shoreline for mainly walleye habitat. Rock reefs are sometimes utilized by fisheries managers when attempting to enhance spawning habitats for some fish species. However, a 2004 WDNR study of rock habitat projects on 20 northern Wisconsin lakes offers little hope the addition of rock substrate will improve walleye reproduction (WDNR 2004).

Placement of a fish habitat structure in a lake may be exempt from needing a permit if the project meets certain conditions outlined by the WDNR's checklists available online:

(https://dnr.wi.gov/topic/waterways/Permits/Exemptions.html)

If a project does not meet all of the conditions listed on the checklist, a permit application may be sent in to the WDNR and an exemption requested.

If interested, the Town of Saint Germain, may work with the local WDNR fisheries biologist to determine if the installation of fish habitat structures should be considered in aiding fisheries management goals for the Town of Saint Germain Lakes.

Two-Story Fishery

Big Saint German is unique compared to most lakes in Wisconsin in that it is a two-story fishery. A two-story fishery is capable of supporting both a warm-water and cold-water fishery. The top-story supports warmer water species such as bass and pike. The lower-story is colder, deeper, and well oxygenated and supports species such as cisco or trout. Cisco can prove to be a healthy forage species for other gamefish species within a lake. A 2014 survey conducted by the WDNR on Big Saint Germain Lake found Cisco (*Coregonus* spp.) in low relative abundance (Lyons et al. 2015).

Fishing Regulations

Regulations for the fish species within the Town of Saint Germain as of march 2020 are displayed in Table 3.7-13. New to 2020, the catch and release season for largemouth and smallmouth bass is open year-round, effective April 1, 2020. The regular harvest season dates for bass remain and can be found in Table 3.7-13 as well. Open water angling for muskellunge has been extended to December 31. The limit of cisco and whitefish has changed from 25 pounds plus one fish to 10 fish. For specific fishing regulations on all fish species, anglers should visit the WDNR website (*www.http://dnr.wi.gov/topic/fishing/regulations/hookline.html)* or visit their local bait and tackle shop to receive a free fishing pamphlet that contains this information.

Table 3.7-13. WDNR fishing regulations for the Town of Saint Germain Lakes 2020 (As of March 2020).

Species	Daily bag limit	Length Restrictions	Season
Panfish (bluegill, pumpkinseed, sunfish, crappie and yellow perch)	25	None	Open All Year
Largemouth bass and smallmouth bass	5	14"	June 20, 2020 to March 7, 2021
Smallmouth bass	5	14"	June 20, 2020 to March 7, 2021
Largemouth bass	5	14"	May 2, 2020 to March 7, 2021
Muskellunge and hybrids	1	40"	May 23, 2020 to December 31, 2020
Northern pike	5	None	May 2, 2020 to March 7, 2021
Walleye, sauger, and hybrids	3	The minimum length is 15", but walleye, sauger, and hybrids from 20" to 24" may not be kept, and only 1 fish over 24" is allowed.	May 2, 2020 to March 7, 2021
Bullheads	Unlimited	None	Open All Year
Cisco and whitefish	10 fish	None	Open All Year

General Waterbody Restrictions: Motor Trolling is allowed with 1 hook, bait, or lure per angler, and 2 hooks, baits, or lures maximum per boat.

Mercury Contamination and Fish Consumption Advisories

Freshwater fish are amongst the healthiest of choices you can make for a home-cooked meal. Unfortunately, fish in some regions of Wisconsin are known to hold levels of contaminants that are harmful to human health when consumed in great abundance. The two most common contaminants are polychlorinated biphenyls (PCBs) and mercury. These contaminants may be found in very small amounts within a single fish, but their concentration may build up in your body over time if you consume many fish.

Health concerns linked to these contaminants range from poor balance and problems with memory to more serious conditions such as diabetes or cancer. These contaminants, particularly mercury, may be found naturally to some degree. However, the majority of fish contamination has come from industrial practices such as coal-burning facilities, waste incinerators, paper industry effluent and others. Though environmental regulations have reduced emissions over the past few decades, these contaminants are greatly resistant to breakdown and may persist in the environment for a long time. Fortunately, the human body is able to eliminate contaminants that are consumed however this can take a long time depending upon the type of contaminant, rate of consumption, and overall diet. Therefore, guidelines are set upon the consumption of fish as a means of regulating how much contaminant could be consumed over time.

General fish consumption guidelines for Wisconsin inland waterways are presented in Figure 3.7-11. There is an elevated risk for children as they are in a stage of life where cognitive development is rapidly occurring. As mercury and PCB both locate to and impact the brain, there are greater restrictions on women who may have children or are nursing children, and also for children under 15.

Fish Consumption Guidelines for Most Wisconsin Inland Waterways

	Women of childbearing age, nursing mothers and all children under 15	Women beyond their childbearing years and men
Unrestricted*	-	Bluegill, crappies, yellow perch, sunfish, bullhead and inland trout
1 meal per week	Bluegill, crappies, yellow perch, sunfish, bullhead and inland trout	Walleye, pike, bass, catfish and all other species
1 meal per month	Walleye, pike, bass, catfish and all other species	Muskellunge
Do not eat	Muskellunge	-

**Doctors suggest that eating 1-2 servings per week of low-contaminant fish or shellfish can benefit your health. Little additional benefit is obtained by consuming more than that amount, and you should rarely eat more than 4 servings of fish within a week.*

Figure 3.7-11. Wisconsin statewide safe fish consumption guidelines. Graphic displays consumption guidance for most Wisconsin waterways. Figure adapted from WDNR website graphic (http://dnr.wi.gov/topic/fishing/consumption/)

4.0 SUMMARY AND CONCLUSIONS

The design of this project was intended to reassess the health and status of six lakes within the Town of Saint Germain and create an updated management plan based on the findings and input from town stakeholders. The reassessment of these lakes has shown that they remain in good health, with good to excellent water quality, diverse native aquatic plant communities, and overall healthy watersheds.

The water quality data indicated that Big Saint Germain and Lake Content may experience late-summer algal blooms due to the internal loading of phosphorus from bottom sediments, but this does not occur every year. More recent data also indicated that there has been a significant decline in water clarity in Found Lake, believed to be the result of higher concentrations of dissolved organic matter which darkens (stains) the water. Above average precipitation has led to increased production and delivery of dissolved organic matter to many lakes. Alma and Moon lakes have also seen a measured decline in water clarity, to a lesser extent, but also likely due to increases in dissolved organic matter.

The decline in water clarity in Found Lake resulted in a marked decline in overall aquatic plant abundance, especially in the deepest areas of its littoral zone. Similarly, aquatic plant occurrence in Alma and Moon lakes also declined markedly; however, this decline was likely due to the approximate 3-foot water level increase in recent years, resulting in less light availability in the deepest areas of the lakes. The water clarity and water levels in Big Saint Germain Lake, Lake Content, and Fawn Lake remained relatively stable since the last assessment, and their aquatic plant communities also remained more stable over this period.

Non-native aquatic plants located in 2019 included some small colonies of narrow-leaved cattail in near-shore areas of Big Saint Germain Lake and Lake Content. While Eurasian watermilfoil had been located in Found Lake in 2018, following hand-harvesting no plants were located in subsequent surveys in 2019 or 2020. No Eurasian watermilfoil or curly-leaf pondweed were found in any of the other five project lakes. Green arrow-rum was located in Engle Bog connected to Moon Lake; however, there is ongoing assessment as to whether or not this species is native to Wisconsin.

Like all lakes in Wisconsin, the Town of Saint Germain lakes face a number of challenges and threats, from the ongoing threat of invasive species introduction to increasing pressure from human use and development. The Town of Saint Germain and the individual lake organizations are taking proactive action to meet these challenges by continually monitoring the health of these lakes and initiating educational campaigns to lake stakeholders and users. The management goals outlined in the following Implementation Plan section were designed by the TSGLC and resource managers to ensure the conservation and enhancement of the Town of Saint Germain lakes for current and future generations.

5.0 IMPLEMENTATION PLAN

The Implementation Plan presented in this section was created through the collaborative efforts of the Town of Saint Germain Lakes Committee, Onterra ecologists, and WDNR staff. 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 lake stakeholders as portrayed by the members of the Lakes Committee and the communications between 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 lakes, the availability of funds, level of volunteer involvement, and the needs of the stakeholders. Please note that the listing order of these management goals is not indicative of priority.

Management Goal 1: Protect & Enhance Current Water Quality Conditions

Management Action 1a: Continue and expand monitoring of Town of Saint Germain lakes' water quality through the WDNR Citizens Lake Monitoring Network (CLMN) program.

Timeframe: Continuation of current effort.

Facilitator: Town of Saint Germain Lakes Committee & Individual Lake CLMN Volunteers

Description: Monitoring water quality is an important 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. Early discovery of negative trends will likely aid in an earlier definition of what may be causing the trend.

The Citizens Lake Monitoring Network (CLMN) is a WDNR program in which volunteers are trained to collect water quality data on their lake. Volunteers trained as a part of the CLMN program begin by collecting Secchi disk transparency data for one year, then if space is available, the lake group may enter into the *advanced program* and collect water chemistry data (chlorophyll-a and total phosphorus). The Secchi disk readings and water chemistry samples are collected three times during the summer and once during the spring. 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).

As of 2020, Big Saint Germain Lake, Found Lake, Alma Lake, and Moon Lake have designated CLMN volunteers collecting water quality on an annual basis (Table 5.0-1). Big Saint Germain, Alma, and Moon lakes are enrolled in the advanced monitoring program, collecting total phosphorus and chlorophyll-*a* in addition to Secchi disk depths. Found Lake is currently monitoring Secchi disk depth and is in need of phosphorus and chlorophyll-*a* monitoring. Data from Lake Content and Fawn Lake are not being collected on a regular basis, and annual monitoring of these three parameters is needed on these lakes.

Table 5.0-1. Town of Saint Germain Lakes' current CLMN volunteers, monitoring, and future monitoring needs.

Lake	Current Volunteer	Annual Parameter Monitored?		
		Secchi	TP	Chla
Alma	Joyce & Clyde Owens	Yes	Yes	Yes
Big Saint Germain	Marie & Don Baumann	Yes	Yes	Yes
Content	Need Volunteer	Need	Need	Need
Fawn	Need Volunteer	Need	Need	Need
Found	Jon Reuling	Yes	Need	Need
Moon	Joyce & Clyde Owens; Terrie & Ken Beier	Yes	Yes	Yes

The CLMN is supported by a grant that the WDNR provides to itself to run the program. The volunteer time used to collect, prepare, and ship the samples is used as the local match for the grant. Currently, there are more lake groups in northern Wisconsin that would like to participate than spaces existing in the program. Further, changes in the program may bring on fewer spaces and/or limit the time lakes can participate in the program. Given there is a need for expanding water quality monitoring on Lake Content, Found, and Fawn lakes, the Town of Saint Germain could consider funding the water quality sampling for these lakes. The Town could consider setting up an account with the Wisconsin State Laboratory of Hygiene to analyze water samples. With the proper set up, the data would automatically be entered into SWIMS as discussed.

Wisconsin State Laboratory of Hygiene
http://www.slh.wisc.edu/
Wisconsin State Laboratory of Hygiene
2601 Agriculture Drive, PO Box 7904
Madison, WI 53718
(800) 442-4618

Volunteers would be encouraged to share the annual reports supplied by the WDNR as a part of the CLMN program so the WTLC can update the town on the participating lakes.

Action Steps:

Please see description above.

Management Goal 2: Reduce Phosphorus & Sediment Runoff from Immediate Shoreland Areas on the Town of Saint Germain Lakes

Management Action 2a:	Conserve undeveloped and restore highly developed shoreland areas on the Town of Saint Germain lakes to protect and enhance habitat, reduce erosion, and protect water quality.
Timeframe:	Continuation of current effort.
Facilitator:	Property owner with assistance from Town of Saint Germain Lakes Committee facilitator and individual lake organization.
Potential Funding Source:	Healthy Lakes Grants; Lake Protection Grant
Description:	In the past, the Town of Saint Germain lake property owners have utilized the Healthy Lakes Program to implement best management practices on their property to reduce runoff, improve habitat, and reduce shoreland erosion. These practices include the installation of rain gardens with native plants, the planting of native plants along the lake's shoreline, and addition of coarse woody habitat. The Town of Saint Germain Lakes Committee would like to continue the implementation of best management practices along lakeshore properties of the town's lakes. The 2019 shoreland condition assessment completed by Onterra on the Town of Saint Germain project lakes found that approximately 20% of the nearly 40 miles of combined shoreline were highly developed, lacking little to no natural habitat. Over 60% of the combined shoreline areas was found to contain little to no human development with natural habitat intact. In addition, over 65 acres of near-shore emergent and floating-leaf aquatic plant communities were mapped in 2019, primarily adjacent to minimally-developed shorelands. It is important that the owners of the properties with little to no development are informed on the benefits their shoreland is providing to these lakes in terms of habitat, stabilizing shoreland soils, and protecting water quality. The conservation of these privately-owned undeveloped shorelands should be an ongoing priority for the Town of Saint Germain. It is equally important that the owners of properties with developed shorelands become educated on the lack of benefits and possible harm their shoreland imparts on these lakes in terms of habitat loss, shoreland erosion, water quality degradation, and decreased aesthetic appeal. The Town Lakes Committee facilitator will continue to work with property owners to pursue Healthy Lakes grants to restore developed shorelands and implement best management practices

(e.g., rain gardens) on their property. The committee is also highly concerned with shoreland erosion on undeveloped lands, believed to be largely due to large waves produced by motorized watercraft and recent higher water levels.

The WDNR's Healthy Lakes grants allow partial cost coverage for native plantings in transition areas. This reimbursable grant program is intended for relatively straightforward and simple projects. More advanced projects that require advanced engineering design may seek alternative funding opportunities, potentially through the county and the WDNR Lake Protection Grant Program. For a larger project that may include a number of properties, it may be more appropriate to seek funding through a WDNR Lake Protection Grant. While more funding can be provided through a Lake Protection Grant and there are no limits to where that funding is utilized (e.g., technical, installation, etc.). However, the grant does require that the restored shorelines remain undeveloped in perpetuity. The WDNR also offers fee simple land easement and acquisition grants which provide funding for permanent protection of land associated with lakes and rivers.

The Town Lakes Committee should continue to work with the WDNR's Kevin Gauthier (715.356.5211) and Vilas County's Land and Water Conservation Department (715.479.3747) to initiate new Healthy Lake projects, research ideas for larger-scale projects to address shoreland restoration and protection, other grant programs, restoration/preservation techniques, and other pertinent information that will aid lake stakeholders.

Because property owners may have little experience with or be uncertain about restoring a shoreland to its natural state, properties that have already undertaken restoration projects could serve as demonstration sites. Other lakeside property owners could have the opportunity to view a shoreland that has been restored to a more natural state, and learn about the maintenance, labor, and cost-sharing opportunities associated with these projects. Below are some resources in Wisconsin with information on shoreline restoration options. This list is not comprehensive.

- Wisconsin Healthy Lakes Program: www.healthylaeswi.com
- UW-Extension Lakes Lakeshore Restoration: https://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/resources/WiLakeshoreRestorationProWiLa/default.aspx

Action Steps:

1. Town Lakes Committee contacts WDNR and Vilas County Land and Water to gather information on initiating and conducting shoreland restoration and protection projects. Vilas County and/or WDNR staff could speak about shoreland restoration and protection at town or individual lake meetings.
2. Town Lakes Committee would encourage property owners who have restored their shorelines to serve as demonstration sites.

Management Goal 3: Continue and Expand Awareness and Education of Lake Management, Stewardship, and Navigational Safety Matters to Town of Saint Germain Riparians and General Public

Management Action 3a: The Town of Saint Germain Lakes Committee will continue to promote stakeholder involvement and inform stakeholders of various lake issues as well as the quality of life on the Town of Saint Germain Lakes.

Timeframe: Continuation of current effort

Facilitator: Town of Saint Germain Lakes Committee

Description: Education represents an effective tool to address lake issues like shoreline development, invasive species, water quality, lawn fertilizers, as well as other concerns such as community involvement and boating safety. The Town Lakes Committee has undertaken a number of efforts to increase stakeholder education and awareness surrounding lake issues including the installation of AIS signage and billboards, informational coasters and place mats at bars and restaurants, among other initiatives.

The Town Lakes Committee maintains website that provides meeting times, agendas, and minutes. The committee also launched a Constant Contact email campaign in 2017 in an effort to provide information to lake stakeholders on current projects, meeting times, volunteer opportunities, and educational topics. Approximately 58% of the stakeholder survey respondents indicated that the Town Lakes Committee keeps them very to fairly well informed regarding the town's lakes and their management. Approximately 26% of respondents indicated they were not too informed or not at all informed from the Town Lakes Committee, indicating there is a need increase the committee's capacity to reach a wider stakeholder audience.

The Town Lakes Committee is comprised of three representatives from each individual lake organization. Information from the committee is disseminated to stakeholders of each organization through their own communication method. Some organizations do not yet have an email list of their members/riparian property owners, and obtaining a mailing list for these organizations will help to expand communication and education efforts.

Education of lake stakeholders on all matters is important. The 2019 stakeholder survey indicated that respondents' top concerns regarding the town's lakes was water quality degradation, loss of aquatic habitat, shoreline erosion and development, aquatic invasive species introduction, and excessive watercraft traffic, among others (Appendix B, Question #24). Articles and information surrounding these topics can be included in Constant Contact emails website or distributed as separate educational materials. In addition, the committee and the individual lake organizations can invite professionals who work within these topics to come and speak at meetings or hold workshops if available.

Action Steps:

1. See description above.

Management Goal 4: Actively Manage Existing and Reduce the Likelihood of Future Aquatic Invasive Species Introduction in the Town of Saint Germain Lakes

Management Action 4a: Continue coordination of annual volunteer-based and periodic professional-based monitoring for aquatic invasive species in the Town of Saint Germain Lakes.

Timeframe: Continuation of current effort.

Facilitator: Town of Saint Germain Lakes Committee/Individual Lake Organizations

Description: The early detection of a newly-introduced aquatic invasive species is important because early detection and removal can often prevent establishment or prevent the population from reaching excessive levels. The Town Lakes Committee and individual lake organizations have an established monitoring network in place using a combination of volunteers for annual monitoring and professionals for periodic monitoring.

The education and monitoring by volunteers led to the discovery of Eurasian watermilfoil in Lost Lake in 2013, while periodic professional monitoring led to the discovery of curly-leaf pondweed in Lost Lake in 2014 and Eurasian watermilfoil in Found Lake in 2018. Swift action following the discovery of Eurasian watermilfoil in Found Lake has led to successful control, and it has not been observed in subsequent surveys in 2019 and 2020.

The individual lake organizations distribute information on AIS and ask their members to search for AIS on an annual basis. It is important that the lakes committee support the individual lake organizations in this effort by providing information on AIS and methods for recruiting and retaining volunteer monitors.

Professional AIS monitoring is scheduled to be completed on Found Lake in 2021 and 2022 following the extension of the AIS-Early Detection and Response Grant. It is recommended that professional AIS monitoring be completed again on Lake Content, Big Saint Germain, Fawn, Found, Alma, and Moon lakes in 2024 (5 years) if no AIS are discovered beforehand by volunteers.

Action Steps:

1. Retain volunteers and recruit new volunteers as needed to complete annual AIS monitoring.
2. Retain qualified professional to complete AIS monitoring on Found Lake in 2021 and 2022 and again on all project lakes in 2024.
3. Volunteer monitors report any findings to qualified professionals and WDNR (see next management action).

<u>Management Action 4b:</u> Initiate aquatic invasive species rapid response plan upon discovery of a new infestation.

Timeframe: Initiate upon discovery of new invasive species.

Facilitator: Town of Saint Germain Lakes Committee, individual lake organization, and/or appropriate lake stakeholder(s)

Description: In the event that a new aquatic invasive species, such as Eurasian watermilfoil, is located in one of the town's lakes by trained volunteers, the areas would be marked using GPS and the individual lake organization should contact the lakes committee and resource managers immediately. The areas marked by volunteers would serve as focus areas for professional ecologists, and these areas would be surveyed by professionals during the plant's peak growth phase. The results would be used to develop potential control strategies. The lakes committee and individual lake organizations will continue to educate lake stakeholders on how to identify Eurasian watermilfoil and other invasive species so they may recognize potential occurrences while out on the lake.

Action Steps:

1. Town of Saint Germain Lakes Committee or individual lake organization contacts WDNR upon discovery of new aquatic invasive species discovery.
2. Town of Saint Germain Lakes Committee works with WDNR and/or qualified professionals to develop management strategy for newly discovered invasive species.

Management Action 4c:	Continue Clean Boats Clean Waters watercraft inspections and education at Town of Saint Germain Lakes' public access locations.
Timeframe:	Continuation of current effort.
Facilitator:	Town of Saint Germain Lakes Committee and individual lake organizations.
Description:	All of the Town of Saint Germain project lakes with the exception of Alma and Moon lakes utilize volunteers from the University of Wisconsin-Oshkosh to complete watercraft inspections at public access locations. The public access location for Alma and Moon lakes sees little traffic, so Oshkosh inspectors are not deployed at this location. The combination of interns and volunteers spend approximately 20% of the daylight hours in summer conducting watercraft inspections. These lakes are a popular destination by recreationists and anglers, making them vulnerable to new infestations of exotic species. The intent of the boat inspections is not only be to prevent additional invasive species from entering the lakes through these public access points, but also to prevent the infestation of other waterways with invasive species that are already present in these lakes. The goal is to cover the landings during the busiest times in order to maximize contact with lake users, spreading the word about the negative impacts of AIS on lakes and educating people about how they are the primary vector of their spread. The fact that the lakes which see some of highest use, like Big Saint Germain Lake, have yet to have established populations of Eurasian watermilfoil or curly-leaf pondweed is a testament to the educational and watercraft inspection work completed thus far. Continuation of this effort is vital to minimize the probability of future AIS introductions. In addition to watercraft inspectors, Found Lake is going to trial the use of a camera at its public access point for continuous surveillance of watercraft entering and leaving the lake. If this proves to be a cost-effective method of inspection, it will be implemented at other public access points on the town's lakes.
Action Steps:	
1.	See description above.

Management Action 4d:	Monitor and control narrow-leaved cattail on Big Saint Germain Lake and Lake Content.
Timeframe:	Initiate in 2021.
Facilitator:	Don Baumann with support from the Big Saint Germain Area Lake District and Town of Saint Germain Lakes Committee.

Description: Narrow-leaved cattail, a non-native, invasive wetland plant that has the capacity to create large, monotypic colonies and displace native wetland vegetation. Colonies of narrow-leaved cattail were located in near-shore areas of Big Saint Germain Lake and Lake Content in 2019. The GPS coordinates of these colonies can be found in Table 5.0-2. Maps displaying the locations of these colonies can be found in the individual lake report sections. Given the isolated nature of these colonies, the best method of control is likely the cutting of stems (both green and dead) in mid- to late-summer or early fall to below the water line. The following growing season, continually cut-back emerging stems to maintain them below the water for the remainder of the growing season. This process should be repeated until the plants do not reemerge. It is recommended that the Big Saint Germain Area Lake District contact Catherine Higley at Vilas County Land and Water to discuss control methods and possible funding options.

Table 5.0-2. Coordinates of narrow-leaved cattail colonies mapped in 2019 on Big Saint Germain Lake and Lake Content.

Lake	Latitude	Longitude
Big Saint Germain	45.926560	-89.521766
Content	45.919537	-89.506153
Content	45.913890	-89.510185
Content	45.925778	-89.507341
Content	45.925766	-89.507435

Action Steps:

1. Big Saint Germain Lake District contacts Catherine Higley (715.479.3747) to discuss possible funding options and methods for control of narrow-leaved cattail.
2. Big Saint Germain Lake District, with assistance from Vilas County, implements control of narrow-leaved cattail on Big Saint Germain Lake and Lake Content.
3. Big Saint Germain Lake District monitors narrow-leaved cattail colonies and continues to implement annual control as necessary until colonies have been removed.

Management Goal 5: Protect Native Aquatic Plant Communities in the Town of Saint Germain Lakes

Management Action 5a: Coordinate periodic, quantitative aquatic plant monitoring on the Town of Saint Germain Lakes.

Timeframe: Whole-lake point-intercept surveys and emergent/floating-leaf community mapping surveys every 5 years.

Facilitator: Town of Saint Germain Lakes Committee

Description: Aquatic plants are a critical component to a properly functioning lake ecosystem. Over the course of the surveys completed on the town's lakes, 97 native aquatic plant species have been identified, a number of which are considered to be rare in Wisconsin. In addition to supporting a high number of native species, these lakes also support a suite of differing native aquatic plant communities. For example, the softwater seepage lakes of Alma and Moon lakes support isoetid-dominated aquatic plant communities, or plant communities dominated by small, rosette forming species such as quillworts (*Isoetes*) and dwarf watermilfoil (*Myriophyllum tenellum*). Other lakes which have slightly higher alkalinity and nutrients, like Big Saint Germain and Lake Content, support diverse communities dominated by taller and larger aquatic plant species. In addition, the project lakes support over 65 acres of emergent and floating-leaf marsh communities comprised of 26 identified species.

Conservation of these valuable native aquatic plant communities is not only important for the ecological function of these lakes, but aids in regional and statewide efforts to conserve these valuable aquatic plant communities. The isoetid communities found in Alma and Moon lakes are relatively rare in Wisconsin, and are typically found in softwater seepage lakes in northern Wisconsin. In addition to conserving water quality and immediate shoreland areas, the Town Lakes Committee could also distribute materials on how boating can impact aquatic plants in terms of direct cutting, propwash, and wave action. In an effort to maintain the integrity of these communities, it is recommended that comprehensive surveys (whole-lake point-intercept and emergent/floating-leaf community mapping surveys) be completed on these lakes every 5 years.

Action Steps:

1. Retain qualified professional to complete whole-lake point-intercept and emergent/floating-leaf aquatic plant community mapping surveys once every 5 years.
2. Work with qualified professional to develop protection/restoration strategies if warranted.
3. Update management plan to reflect changes in aquatic plant communities and aquatic plant management/monitoring needs and those of the lake ecosystem.

Management Goal 6: Conserve and Enhance the Town of Saint Germain Lakes as a Fishery Resource

Management Action 6a:	Develop a fisheries management plan for the Town of Saint Germain Lakes.
Timeframe:	Initiate in 2021
Facilitator:	Town of Saint Germain Lakes Committee
Description:	The Town of Saint Germain Lakes Committee would like the WDNR fisheries biologist to lead them through the creation of a written strategy for managing the fisheries of the towns' lakes. Each individual lake organization would encourage an open visioning session where a bidirectional flow of information and perspectives can take place. This will allow managers to understand user preferences to balance with ecosystem capability. With a formally defined strategy being in place, measurable objectives can be set to determine if the strategy is succeeding.
Action Steps:	
	See description above.

Management Goal 7: Work with Local Governmental Agencies to Increase Enforcement of Existing State, County, and Town Boating, Fishing, and Shoreland Development/Disturbance Laws on the Town of Saint Germain Lakes

Management Action 7a:	Meet with the local WDNR Warden Supervisor to develop a plan for increasing State Boat Patrol presence on the Town of Saint Germain Lakes.
Timeframe:	Initiate in 2021 and as needed
Facilitator:	Town of Saint Germain Lakes Committee
Description:	The stakeholder survey distributed to Town of Saint Germain lakes' stakeholders and communications with the TSGLC indicated that one of the primary concerns on the lakes was excessive watercraft traffic and unsafe watercraft practices. In addition, the irresponsible use of watercraft was also believed to be contributing to shoreland erosion and habitat degradation. In addition to continually educating and informing lake stakeholders on Wisconsin boating regulations, the TSGLC will work with the local WDNR Warden Supervisor for Vilas County, Stefan Fabian (920.366.2802), to develop a plan to increase law enforcement presence on the Town of Saint Germain lakes.
Action Steps:	
1.	Please see above description.

Management Action 7b:	Meet with Vilas County Zoning to discuss methods for detecting and responding to shoreland development/disturbance violations.
Timeframe:	Initiate in 2021 and as needed
Facilitator:	Town of Saint Germain Lakes Committee
Description:	The stakeholder survey distributed to Town of Saint Germain lakes' stakeholders and communications with the TSGLC indicated that one of the primary concerns on the lakes was loss of aquatic habitat, shoreline erosion, and shoreland development. In an effort to protect natural shorelines and minimize illegal shoreland development/disturbance activities, the TSGLC will contact the Vilas County Zoning and Planning Department (715.479.3620) to discuss methods for detecting and responding to shoreland development/disturbance violations.
Action Steps:	
1.	Please see above description.
Management Action 7c:	Meet with Town of Saint Germain Board to discuss what role town government might play in increasing law enforcement presence on the Town of Saint Germain lakes.
Timeframe:	Initiate in 2021 and as needed
Facilitator:	Town of Saint Germain Lakes Committee
Description:	In an effort to increase law enforcement presence on the Town of Saint Germain lakes to decrease unsafe watercraft practices and protect shoreland areas, the TGLC will work with Town of Saint Germain Board to discuss what role the town government may play in increasing law enforcement presence.
Action Steps:	
1.	Please see above description.

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 Lakes (e.g., elevated phosphorus levels, anaerobic conditions, etc.). Water quality was monitored at the deepest point on each lake that would most accurately depict the conditions of each lake. Samples were collected using WDNR Citizen Lake Monitoring Network (CLMN) protocols which occurred twice during the summer. In addition to the samples collected by CLMN volunteers, professional water quality samples were collected at subsurface (S) and near bottom (B) depths once in spring, summer, fall and winter. Winter dissolved oxygen was determined with a calibrated probe and all samples were collected with a 3-liter Van Dorn bottle. Secchi disk transparency was also included during each visit.

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. In addition, during each sampling event Secchi disk transparency was recorded and a temperature, pH, conductivity, and dissolved oxygen profile was completed.

	Spring		June		July		August		Fall		Winter	
Parameter	S	B	S	B	S	B	S	B	S	B	S	B
Dissolved Phosphorus	●	●			●	●					●	●
Total Phosphorus	●	●	●	●	●	●	●	●	●	●	●	●
Total Kjeldahl Nitrogen	●	●			●	●					●	●
Nitrate-Nitrite Nitrogen	●	●			●	●					●	●
Ammonia Nitrogen	●	●			●	●					●	●
Chlorophyll-*a*	●		●		●		●		●			
True Color	●				●							
Hardness	●				●							
Total Suspended Solids	●	●			●	●			●	●		
Laboratory Conductivity	●	●			●	●						
Laboratory pH	●	●			●	●						
Total Alkalinity	●	●			●	●						
Calcium	●				●							

Watershed Analysis

The watershed analysis began with an accurate delineation of each lakes' drainage area using U.S.G.S. topographic survey maps and base GIS data from the WDNR and Vilas County. The watershed delineation was then transferred to a Geographic Information System (GIS). These data, along with land cover data from the National Land Cover Database (NLCD – Fry et. al 2016) were then combined to determine the watershed land cover classifications. These data were modeled using the WDNR's Wisconsin Lake Modeling Suite (WiLMS) (Panuska and Kreider 2003).

Aquatic Vegetation

Curly-leaf Pondweed Survey

Surveys of curly-leaf pondweed were completed on each lake during an early summer visit in June 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 each lake to characterize the existing communities within the lake and include 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 this study in mid summer.

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 Pro6T 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 the lake. Representatives of all plant species located during the point-intercept and community mapping survey were collected, vouchered, and sent to the University of Wisconsin – Steven's Point Herbarium.

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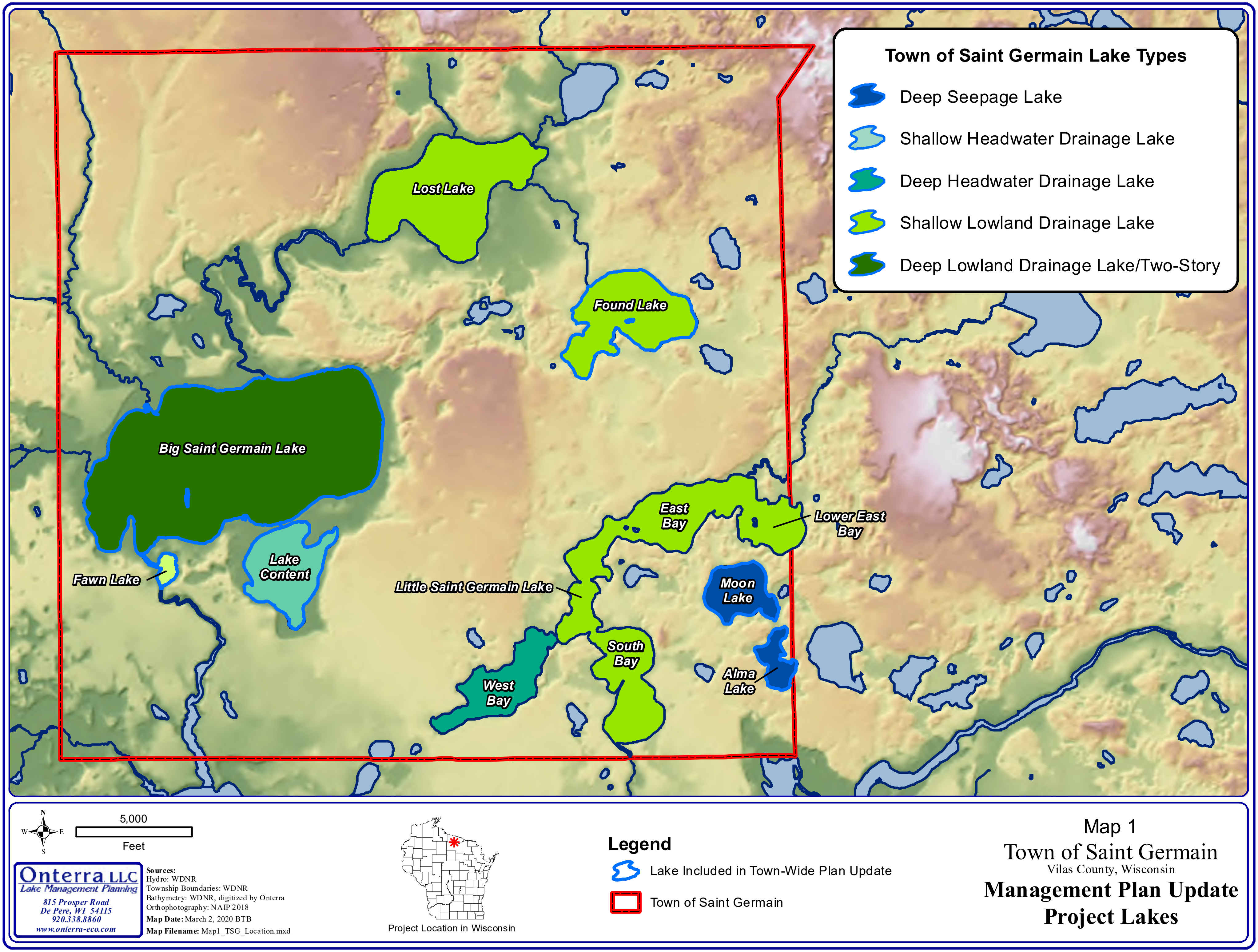
Town of Saint Germain Lake Types
Deep Seepage Lake
Shallow Headwater Drainage Lake
Deep Headwater Drainage Lake
Shallow Lowland Drainage Lake
Deep Lowland Drainage Lake/Two-Story
Lost Lake
Found Lake
Big Saint Germain Lake
East Bay
Lower East Bay
Lake Content
Fawn Lake
Little Saint Germain Lake
Moon Lake
South Bay
West Bay
Alma Lake
N
W
E
S
5,000
Feet
Onterra LLC
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com
Sources:
Hydro: WDNR
Township Boundaries: WDNR
Bathymetry: WDNR, digitized by Onterra
Orthophotography: NAIP 2018
Map Date: March 2, 2020 BTB
Map Filename: Map1_TSG_Location.mxd
Project Location in Wisconsin
Legend
Lake Included in Town-Wide Plan Update
Town of Saint Germain
Map 1
Town of Saint Germain
Vilas County, Wisconsin
Management Plan Update
Project Lakes

8.0 INDIVIDUAL LAKE REPORTS

The following section contains the individual lake reports. They contain the results of each individual lake. A better understanding of these results can be reached by first reading the Town-Wide document.

Individual Lake Table of Contents