Butternut and Franklin Lakes

Forest County, Wisconsin

Comprehensive Management Plan

February 2014

Sponsored by:

Butternut-Franklin Lakes Association.

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Onterra, LLC
Lake Management Planning

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Forest County, Wisconsin
Comprehensive Management Plan
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1.0 INTRODUCTION

Butternut Lake, Forest County, is a 1,254-acre spring lake with a maximum depth of 42 feet (Map 1). The lake is classified as oligotrophic due to its high clarity and low nutrient/algal content. Butternut Lake receives water through an intermittent stream that originates from Franklin Lake, which only flows during high or normal water conditions. Water flows from Butternut Lake eastward to form the Pine River. Butternut Lake contains 51 native plant species, with reed canary grass being the only exotic plant observed during 2012 surveys.

Field Survey Notes

The western, open basin of Butternut Lake is characterized by a sandy/rock substrate with steep drop-offs. The eastern and southern bay contain more optimal conditions for aquatic plant growth, as well as locations of coarse woody habitat, an important habitat variable for aquatic organisms. Excellent water clarity observed during field work.

Photograph 1.0-1 Butternut Lake, Forest County

Lake at a Glance - Butternut Lake

Morphology*	
Acreage	1,254
Maximum Depth (ft)	42
Mean Depth (ft)	20
Shoreline Complexity	2.9
Vegetation	
Curly-leaf Survey Date	June 7, 2012
Comprehensive Survey Date	July 18, 2012
Number of Native Species	51
Threatened/Special Concern Species	-
Exotic Plant Species	*Phalaris arundinacea*
Simpson's Diversity	0.93
Average Conservatism	34.2
Water Quality	
Trophic State	Upper oligotrophic
Limiting Nutrient	Phosphorus
Water Acidity (pH)	8.0
Sensitivity to Acid Rain	No sensitivity
Watershed to Lake Area Ratio	5:1

**Lake characteristics at ordinary high water mark (OHWM)*

Franklin Lake, Forest County, is a 843-acre drained lake with a maximum depth of 46 feet (Map 1). As with Butternut Lake, Franklin Lake contains relatively clear water and low nutrients, ranking it as oligotrophic. Though historic accounts tell of logs being transported downstream from Franklin to Butternut Lake, the stream that connects these waterbodies is thought to have been dry for some time. Franklin Lake contains 41 native plant species; no exotic plant species are known to exist in the lake.

Field Survey Notes

The lake's western lobe is primarily shallow, with organic substrates and abundant aquatic plant growth. In contrast, the northern/eastern lobe achieves depths of up to 46 feet, and is predominantly sandy in the littoral zone. Signs of lower water level apparent. Excellent water clarity observed during field work.

Photograph 1.0-2 Franklin Lake, Forest County

Lake at a Glance - Franklin Lake

Morphology*	
Acreage	843
Maximum Depth (ft)	46
Mean Depth (ft)	20
Shoreline Complexity	2.9
Vegetation	
Curly-leaf Survey Date	June 7, 2012
Comprehensive Survey Date	July 18-19, 2012
Number of Native Species	41
Threatened/Special Concern Species	-
Exotic Plant Species	-
Simpson's Diversity	0.89
Average Conservatism	36.4
Water Quality	
Trophic State	Upper oligotrophic
Limiting Nutrient	Phosphorus
Water Acidity (pH)	7.4
Sensitivity to Acid Rain	Low sensitivity
Watershed to Lake Area Ratio	3:1

**Lake characteristics at ordinary high water mark (OHWM)*

Butternut Lake and Franklin Lake are both listed as Outstanding Resource Waters, meaning they contain exceptional natural features which warrant additional protection from the effects of pollution, as determined by the State of Wisconsin. The North Branch of the Pine River, which flows out of Butternut Lake, is classified as an ORW as well as being listed as a Class 2 trout stream. The lakes are easily accessible through several public access locations. Both lakes have two watercraft access points, one of which on Franklin Lake is within a US Forest Service property and contains a large campground along with walk-in lake access, a beach and picnic area.

With the attractive clear water and great fishery coupled with many access opportunities these lakes provide, the Butternut-Franklin Lake Association, Inc. (BFLA) is concerned over the threat of aquatic invasive species. Besides rusty crayfish (in both lakes) and freshwater jellyfish (in Franklin Lake), no other aquatic invasive species are known to exist within each lake; however several nearby lakes (Kentuck, Anvil, Eagle River Chain of Lakes) are known to have established populations of curly-leaf pondweed and/or Eurasian water milfoil. With this knowledge, the BFLA has been very active in preserving the beauty of their lake ecosystem.

The BFLA has previously received Wisconsin Department of Natural Resources (WDNR) grants for a 2007 Aquatic Plant Management (APM) Plan, conducted by Northern Environmental (now Stantec). Besides this APM study and a 1997 limnology survey conducted by Northern Lake Services, the BFLA has involved themselves in numerous other actions to preserve their lake. Some other projects they have been involved with include:

- Clean Boats, Clean Waters program
- Citizens Lake Monitoring with data going back to 1986
- Building and placement of loon nesting habitat.
- Monofilament fishing line recovering program.
- Adirondack Shelter
- Warning buoys at rock bars.
- Get the lead out project.
- Building and placement of fish cribs.
- Building and placement of bass habitat half logs.
- Tree drops to improve fish habitat.
- Frog, toad monitoring
- Shoreline Restoration Project
- Comment to Forest Service and State Management Plans
- Garlic Mustard Pulls
- Wolf and bluebird monitoring
- Swan banding
- Signage for AIS
- Bridge over Pine River
- Trail Improvement

These activities are the result of a volunteer group that have dedicated time, effort and funds towards educational and physical activities to protect and preserve their lake. In 2012 their decision to further study and protect their lakes was put forth through a lake management planning effort.

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 through 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.

Kick-off Meeting
On July 21, 2012, a project kick-off meeting was held at the Town of Hiles Fire Department to introduce the project to the general public. The meeting was announced through a mailing and personal contact by Butternut-Franklin Lakes Association board members. The attendees observed a presentation given by Tim Hoyman, an aquatic ecologist with Onterra. Mr. Hoyman's presentation started with an educational component regarding general lake ecology and ended with a detailed description of the project including opportunities for stakeholders to be involved. The presentation was followed by a question and answer session.

Planning Committee Meeting I
On June 24, 2013, Dan Cibulka and Tim Hoyman of Onterra met with the Butternut-Franklin Lakes Planning Committee for over three hours. The meeting highlighted a presentation in which all project study results, including the water quality components, watershed and shoreland assessments, aquatic plant inventories and fisheries data integration were discussed in detail. Planning Committee members asked many questions regarding some of the shoreland observations and water quality parameters that were investigated, as well as general questions on aquatic invasive species.

Planning Committee Meeting II
On August 14, 2013, Dan Cibulka and Tim Hoyman of Onterra met with the Butternut-Franklin Lakes Planning Committee a second time. With the information presented at Planning Meeting I at hand, the committee discussed management goals with Onterra ecologists, including alternatives and what goals would be feasible for Butternut and Franklin Lakes. Much of this discussion is highlighted in the Summary and Conclusions Section, while the results of this meeting are presented as Management Goals and Actions within the Implementation Plan towards the end of this report.

Project Wrap-up Meeting
Yet to occur.

Management Plan Review and Adoption Process

Following the two Planning Meetings, Onterra staff drafted an Implementation Plan which highlighted the conversations and conclusions the Planning Committee had come to. A rough draft of the Implementation Plan was sent to the committee in electronic format on November 8, 2013. On January 31, 2014, the committee had completed their review and offered several suggestions on the plan content for Onterra staff to address. These suggestions were incorporated within the plan the following week, and an official first draft of the Butternut Franklin Lakes Management Plan was sent to WDNR personnel on February 4, 2014 for a review.

Stakeholder Survey

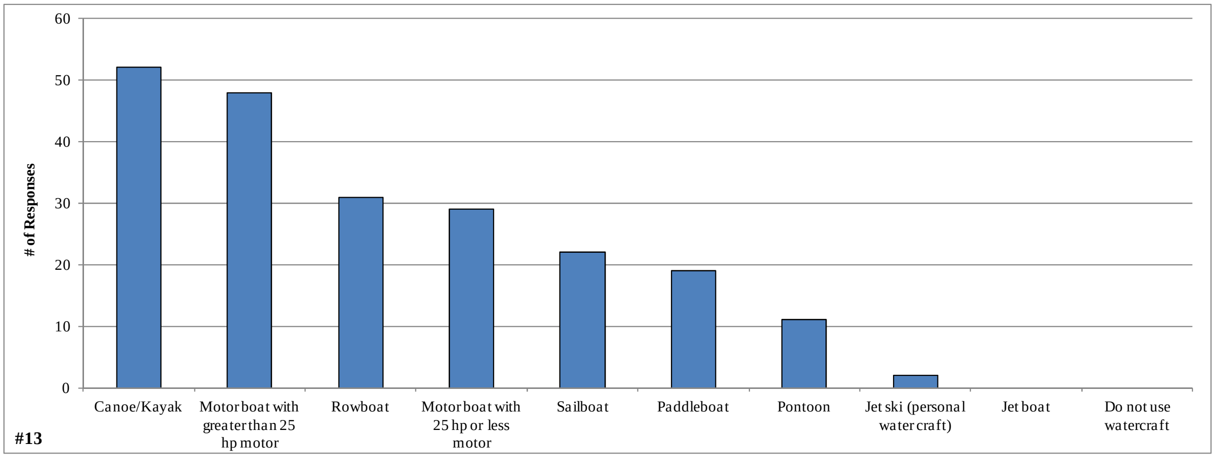
In fall of 2012, Onterra staff worked with the BFLA planning committee members to draft an anonymous stakeholder survey which would be sent to all association members and non-members living around Butternut Lake and Franklin Lake. The survey was created in September of 2012, and in October was reviewed by a social scientist from the WDNR. Following WDNR approval, an eight page, 30 question survey was sent to 128 households around Butternut Lake and Franklin Lake. Roughly 58% of the surveys were returned and those results were entered into a spreadsheet by members of the Butternut-Franklin Lakes Planning Committee. The data were summarized and analyzed by Onterra for use at the planning meetings and within the management plan. The survey and results can be found in Appendix B, while discussion is integrated within the management plan and a summary is presented below.

Based upon the results of the Stakeholder Survey, much was learned about the people that use and care for Butternut Lake and Franklin Lake. The majority of stakeholders (42%) are seasonal residents, while 25% visit on weekends through the year and 24% have a year-round residence (Appendix B, Question #2). 84% of stakeholders have owned their property for over 15 years, and 64% 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 these particular topics. Figures 2.0-1 and 2.0-2 highlight several other questions found within this survey. More than half of survey respondents indicate that they use a canoe or kayak on Butternut or Franklin Lake (Question #13). Motor boats and rowboats were popular options as well. On popular destination lakes such as Butternut and Franklin, respectful and safe boating practices are very important. 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 #14, several of the top recreational activities on the lake involve boat use. Although boat traffic was listed 2nd as a factor potentially impacting Butternut Lake and Franklin Lake in a negative manner (Question #20), it was ranked 6th on a list of stakeholder's top concerns regarding the lake (Question #21).

Survey respondents selected several issues to be of their top concern regarding Butternut Lake and Franklin Lake. These include aquatic invasive species, water quality degradation and excessive fishing pressure. The plan that follows discusses these concerns within the appropriate sections (e.g. aquatic invasives within Aquatic Plant Section, water quality within the Water Quality Section, etc.). Furthermore, the Summary & Conclusions section as well as the Implementation Plan discusses actions the BFLA will undertake to minimize the impacts of these concerns on Butternut Lake and Franklin Lake.

Question #13: What types of watercraft do you currently use on Butternut or Franklin Lake?



Question #14: Please rank up to three activities that are important reasons for owning your property on or near Butternut or Franklin Lake.

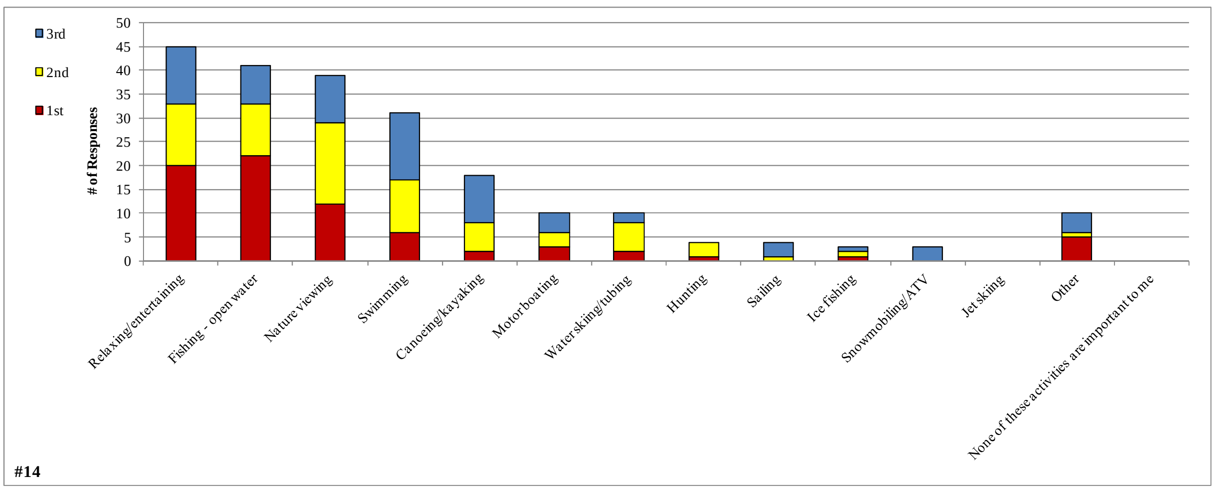
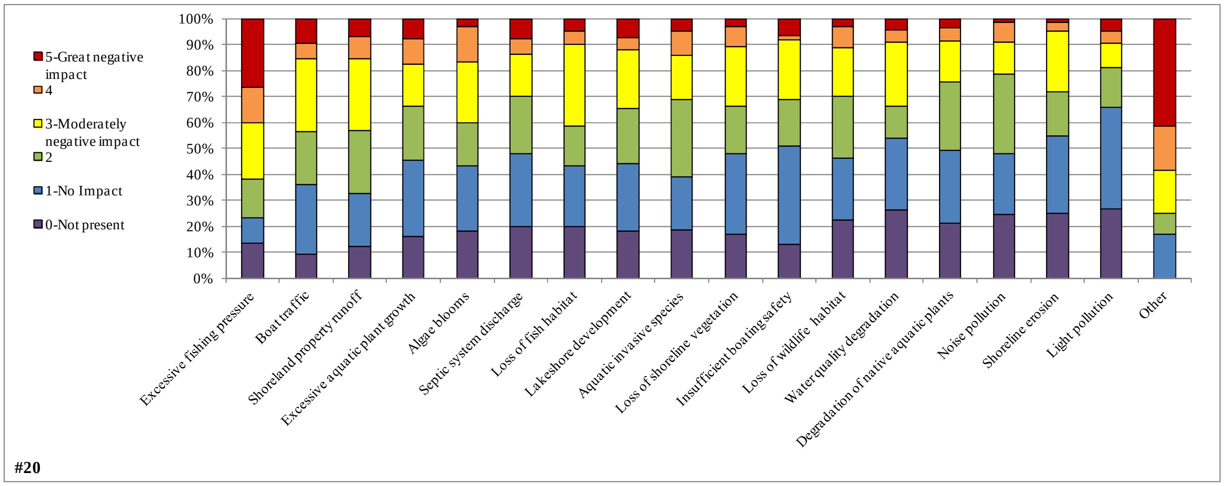


Figure 2.0-1. Select survey responses from the Butternut Lake and Franklin Lake Stakeholder Survey. Additional questions and response charts may be found in Appendix B.

Question #20: To what level do you believe these factors may be negatively impacting Butternut or Franklin Lake?



Question #21: Please rank your top three concerns regarding Butternut or Franklin Lake.

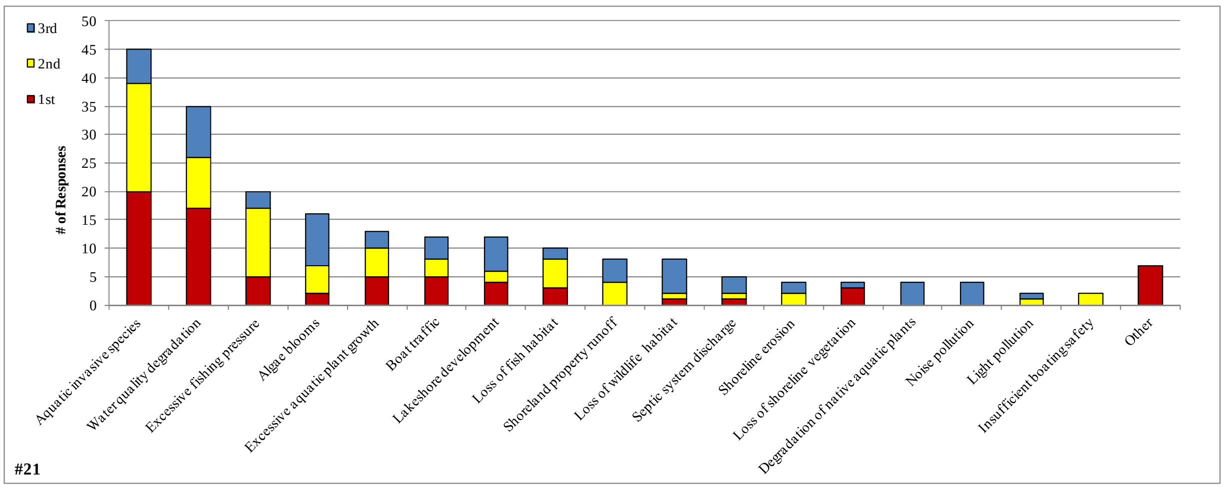


Figure 2.0-2. Select survey responses from the Butternut Lake and Franklin Lake Stakeholder Survey, continued. Additional questions and response charts may be found in Appendix B.

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 analysis are used to indicate not only the health of the lake, but also to provide a general understanding of the lake's ecology and assist in management decisions. Each type of available analysis is elaborated on below.

As mentioned above, chemistry is a large part of water quality analysis. In most cases, listing the values of specific parameters really does not lead to an understanding of a lake's water quality, especially in the minds of non-professionals. A better way of relating the information is to compare it to lakes with similar physical characteristics and lakes within the same regional area. In this document, a portion of the water quality information collected on Butternut Lake and Franklin Lake 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 water quality parameters are focused upon in Butternut and Franklin Lake's water quality analysis:

> **Phosphorus** is the nutrient that controls the growth of plants in the vast majority of Wisconsin lakes. It is important to remember that in lakes, the term "plants" includes both algae and macrophytes. Monitoring and evaluating concentrations of phosphorus within the lake helps to create a better understanding of the current and potential growth rates of the plants within the lake.
>
> **Chlorophyll-*a*** is the green pigment in plants used during photosynthesis. Chlorophyll-*a* concentrations are directly related to the abundance of free-floating algae in the lake. Chlorophyll-*a* values increase during algal blooms.
>
> **Secchi disk transparency** is a measurement of water clarity. Of all limnological parameters, it is the most used and the easiest for non-professionals to understand. Furthermore, measuring Secchi disk transparency over long periods of time is one of the best methods of monitoring the health of a lake. The measurement is conducted by lowering a weighted, 20-cm diameter disk with alternating black and white quadrates (a Secchi disk) into the water and recording the depth just before it disappears from sight.

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

Trophic State

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

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

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

Limiting Nutrient

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

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

Temperature and Dissolved Oxygen Profiles

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

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

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

Internal Nutrient Loading

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

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

Non-Candidate Lakes

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

Candidate Lakes

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

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

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

Comparisons with Other Datasets

The WDNR publication *Implementation and Interpretation of Lakes Assessment Data for the Upper Midwest* (WDNR PUB-WT-913, 2009) 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 Butternut Lake and Franklin Lake will be compared to lakes in the state with similar physical characteristics. The WDNR groups Wisconsin's lakes into 6 classifications (Figure 3.1-1).

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

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

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

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

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

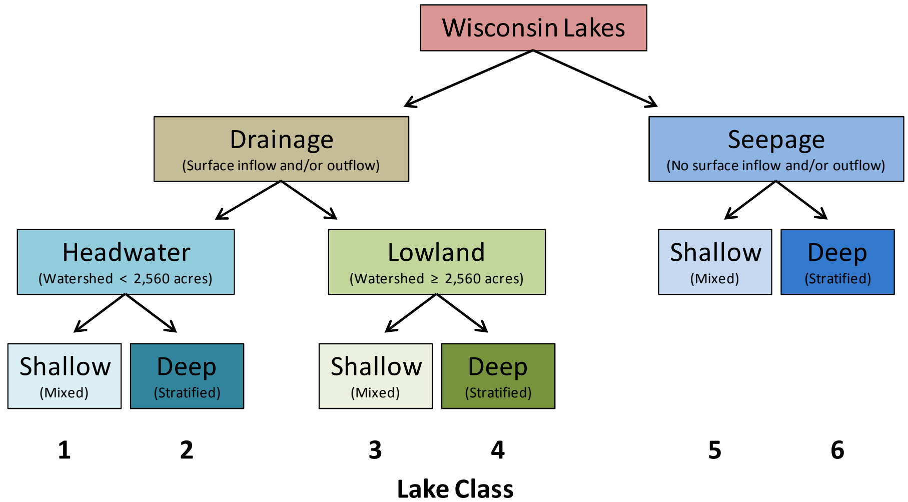


Figure 3.1-1. Wisconsin Lake Classifications. Butternut Lake and Franklin Lake are classified as deep (stratified), lowland drainage lakes (Class 4). Adapted from WDNR (2009).

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

The Wisconsin 2010 Consolidated Assessment and Listing Methodology (WisCALM), created by the WDNR, is a process by which the general condition of Wisconsin surface waters are assessed to determine if they meet federal requirements in terms of water quality under the Clean Water Act (WDNR 2009). It is another useful tool in helping lake stakeholders understand the health of their lake compared to others within the state. This method incorporates both biological and physical-chemical indicators to assess a given waterbody's condition. In the report, they divided the phosphorus, chlorophyll-*a*, and Secchi disk transparency data of each lake class into ranked categories and assigned each a "quality" label from "Excellent" to "Poor". The categories were based on pre-settlement conditions of the lakes inferred from sediment cores and their experience.

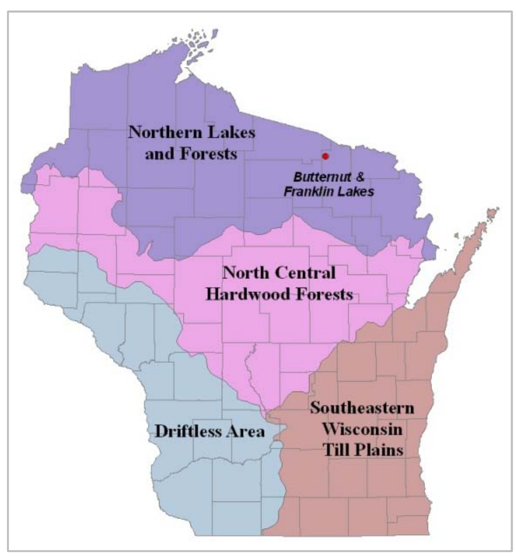


Figure 3.1-2. Location of Butternut Lake and Franklin Lake within the ecoregions of Wisconsin. After Nichols 1999.

These data along with data corresponding to statewide natural lake means, historic, current, and average data from Butternut Lake and Franklin Lake are displayed in Figures 3.1-3 - 3.1-14. Please note that the data in these graphs represent concentrations and depths taken only during the growing season (April-October) or summer months (June-August). Furthermore, the phosphorus and chlorophyll-*a* data represent only surface samples. Surface samples are used because they represent the depths at which algae grow and depths at which phosphorus levels are not greatly influenced by phosphorus being released from bottom sediments.

Butternut Lake and Franklin Lake Water Quality Analysis

As a part of this study, Butternut and Franklin Lake stakeholders were asked about their perceptions of their lake's water quality through an anonymous stakeholder survey. The majority (93%) of lake residents rated the water quality of Butternut Lake and Franklin Lake as *Good* or *Excellent* while the remaining respondents (7%) identified their lake's water quality as *Fair* (Appendix B, Question #15). Roughly 60% of survey respondents stated that the water quality had *Remained the same* since they first visited the lake, while 27% indicated the water quality had *Somewhat degraded* and 8% believe it has *Somewhat improved* (Question #16). Survey respondents indicated that shoreland property runoff, algae blooms and septic system discharge were factors that may be negatively impacting the overall health of the lake (Question #20). Water quality degradation and algae blooms were listed as the 2nd and 4th top concerns, respectively, of Butternut and Franklin Lake stakeholders (Question #21).

It is often difficult to determine the status of a lake's water quality purely through observation. Anecdotal accounts of a lake "getting better" or "getting worse" can be difficult to judge because a) a lake's water quality may fluctuate from year to year based upon environmental conditions such as precipitation or lake thereof, and b) differences in observation and perception of water quality can differ greatly from person to person. It is best to analyze the water quality of a lake through scientific data as this gives a concrete indication as to the health of the lake, as whether the lake health has deteriorated or improved. Further, by looking at data for similar lakes regionally and statewide, one can determine what the status of the lake is by comparison.

Volunteers have been and continue to be actively collecting data from both Butternut Lake and Franklin Lake through the Citizens Lake Monitoring Network (CLMN) Program. Through this WDNR-sponsored program, volunteers are trained to collect water quality data on their lake. Samples are analyzed through the State Lab of Hygiene in Madison, WI and data are entered into the Surface Water Integrated Monitoring System (SWIMS), an online database which allows for quick access to all current and historical water quality data. This process allows stakeholders to become directly engaged in protecting their lake, while producing reliable and comparable data that managers may recall through a streamlined website.

As previously mentioned, the three primary water quality parameters that are studied in lakes include total phosphorus, chlorophyll-*a* and Secchi disk clarity. Thanks to efforts of CLMN volunteers, much data has been assembled over the past two decades. Average annual phosphorus data for Butternut Lake and Franklin Lake can be viewed in Figures 3.1-3 and 3.1-4, respectively.

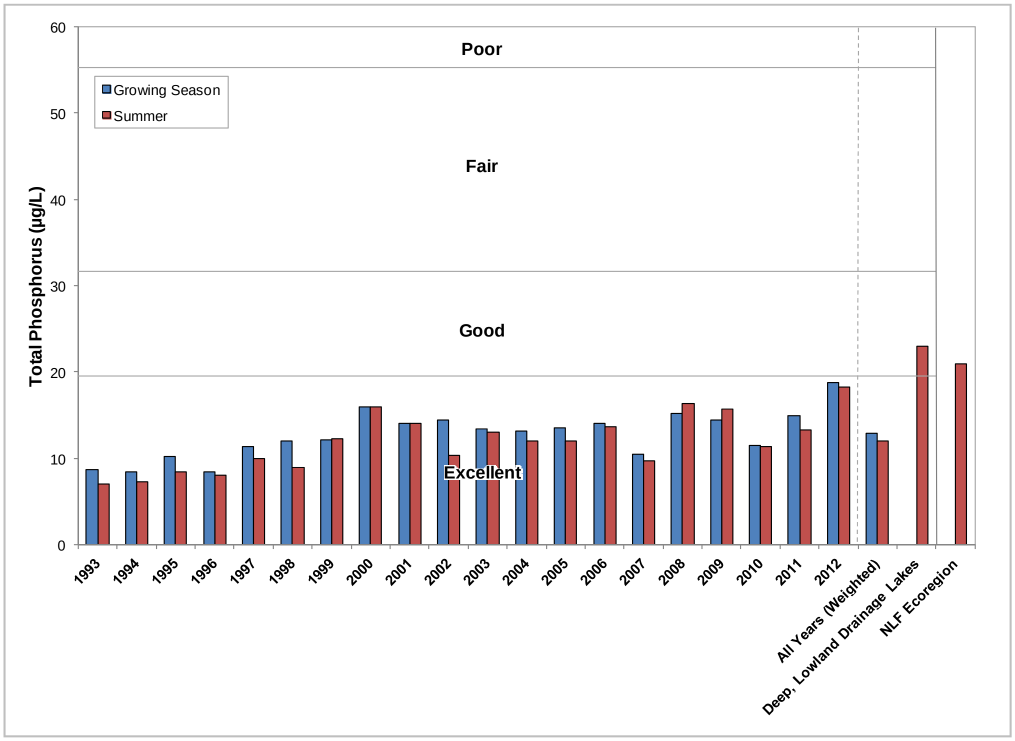


Figure 3.1-3. Butternut Lake, state-wide class 4 lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR (2009).

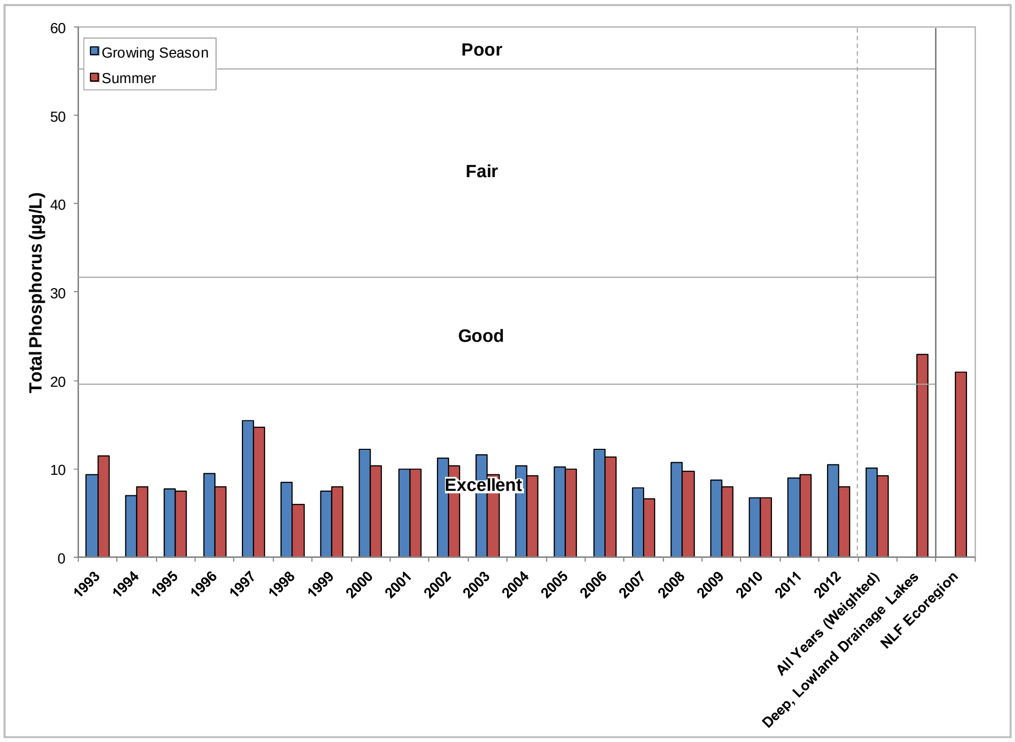


Figure 3.1-4. Franklin Lake, state-wide class 4 lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR (2009).

Since 1993, average total phosphorus concentrations have ranged between 7.0 µg/L and 18.3 µg/L on Butternut Lake, and 6.0 µg/L and 14.7 µg/L on Franklin Lake during the summer months (Figures 3.1-3 and 3.1-4). A weighted average for all summer data was calculated to be 12.0 µg/L and 9.2 µg/L for Butternut Lake and Franklin Lake, respectively. These averages fall well below the median values for other deep, lowland drainage lakes across the state of Wisconsin and all lakes within the Northern Lakes and Forests ecoregion. And when further compared against other deep, lowland drainage lakes these averages rank in a category of *Excellent* for this water quality parameter.

Upon close inspection of the data from Butternut Lake, a slight increase in annual phosphorus concentrations was observed. Annual average summer concentrations were analyzed using a Mann-Kendall test for trend detection. The resulting Mann-Kendall test statistic (S) indicates how strong the trend in the given variable is, and whether or not the variable is increasing or decreasing without the influence of chance (a statistically significant change). The results of the Mann-Kendall statistic (S statistic, α=0.05) indicate a statistically significant increasing trend in annual average summer total phosphorus concentrations. While this increase is slight, as previously mentioned phosphorus concentrations are not unexpected from what would typically be found in a lake such as Butternut Lake. As discussed further within the Watershed Section, there were no “unaccounted for” sources of phosphorus to Butternut Lake that a watershed model could pick up upon.

Often, near-surface water samples of phosphorus are analyzed because they are easy to collect and are representative of what is occurring in the littoral zone (sunlit, plant and algae growing area) of a lake. Figures 3.1-3 and 3.1-4 include only data collected from the near-surface of both Butternut Lake and Franklin Lake. However, comparing surface and bottom phosphorus samples can be advantageous to understanding other nutrient dynamics in lakes, such as internal nutrient loading as discussed above. Figures 3.1-5 and 3.1-6 display data depicting surface and bottom phosphorus concentrations on dates in which both of these data types were available. During times in which a lake is mixed, we can expect phosphorus concentrations to be similar near the surface and the bottom of the lake. During times that the lake is stratified however, the bottom phosphorus concentration may be twice or three times that which was observed in the surface waters. Under anoxic conditions, phosphorus may be released from the sediments which explains the higher concentrations. Although this occurrence can be seen on several occasions, phosphorus concentrations have not exceeded 29 µg/L on Butternut Lake and 20 µg/L on Franklin Lake. As discussed above, lakes are typically not considered candidates for significant internal nutrient loading until these levels reach 200 µg/L or greater.

In addition to total phosphorus, chlorophyll-*a*, a water quality parameter closely tied to open-water algal abundance, has been monitored since 1993. During this time, average summer concentrations have ranged between 1.2 µg/L and 4.8 µg/L on Butternut Lake, and 1.5 µg/L and 4.2 µg/L on Franklin Lake during the summer months (Figures 3.1-7 and 3.1-8). A weighted average for all summer data was calculated to be 2.3 µg/L and 2.4 µg/L for Butternut Lake and Franklin Lake, respectively. These averages fall well below the median values for other deep, lowland drainage lakes across the state of Wisconsin and all lakes within the Northern Lakes and Forests ecoregion. And when further compared against other deep, lowland drainage lakes these averages rank in a category of *Excellent* for this water quality parameter.

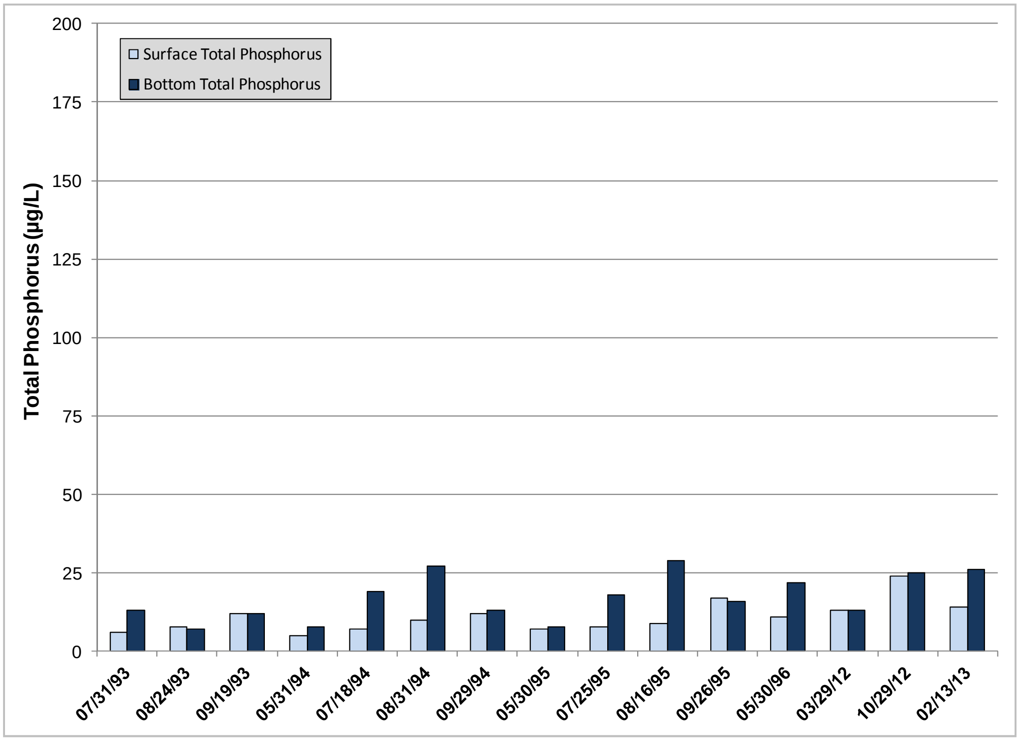


Figure 3.1-5. Butternut Lake surface and bottom total phosphorus concentrations. Data collected from historical records (WDNR SWIMS) and Onterra 2012-2013 sampling. All concentrations are actual values, not averages.

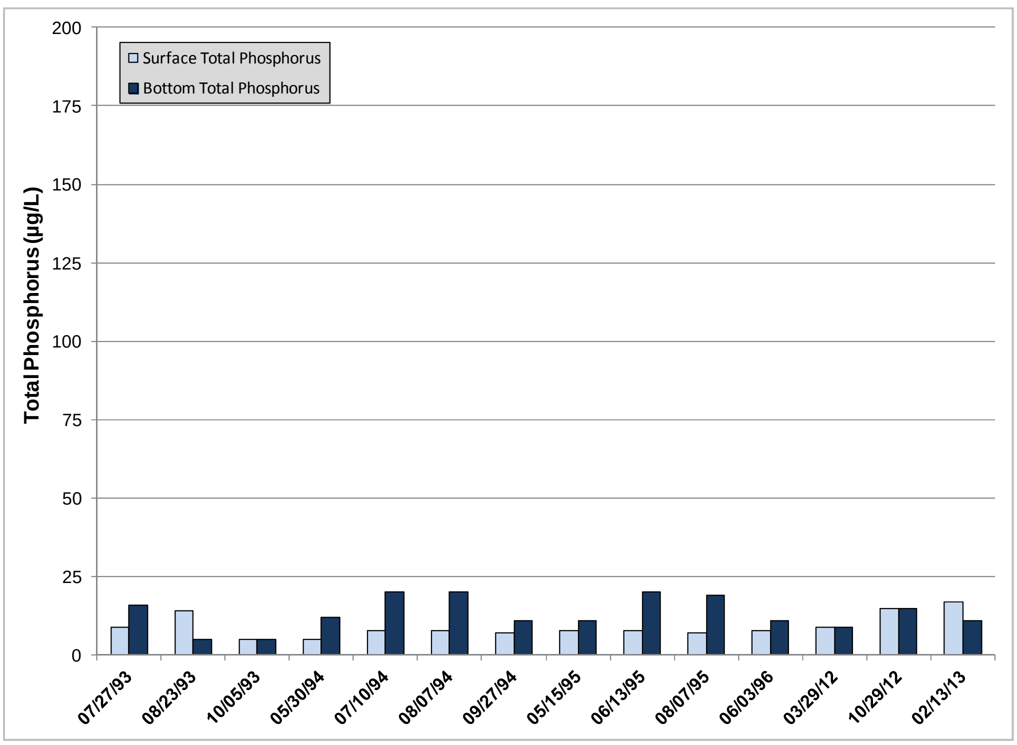


Figure 3.1-6. Franklin Lake surface and bottom total phosphorus concentrations. Data collected from historical records (WDNR SWIMS) and Onterra 2012-2013 sampling. All concentrations are actual values, not averages.

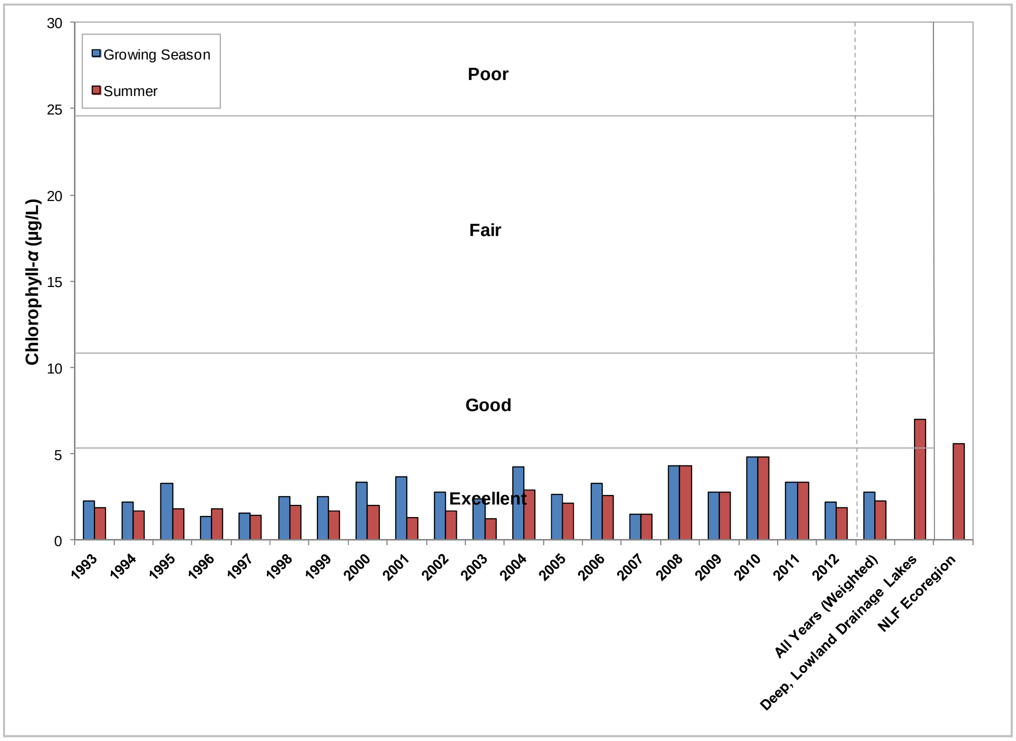


Figure 3.1-7. Butternut Lake, state-wide class 4 lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR (2009).

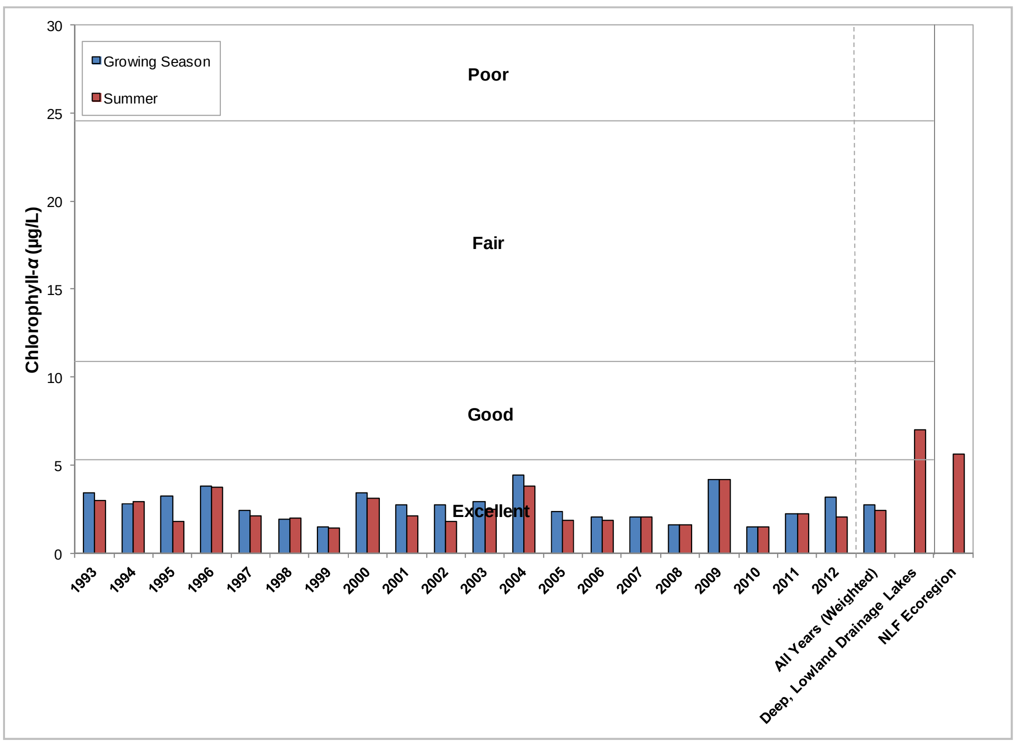


Figure 3.1-8. Franklin Lake, state-wide class 4 lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR (2009).

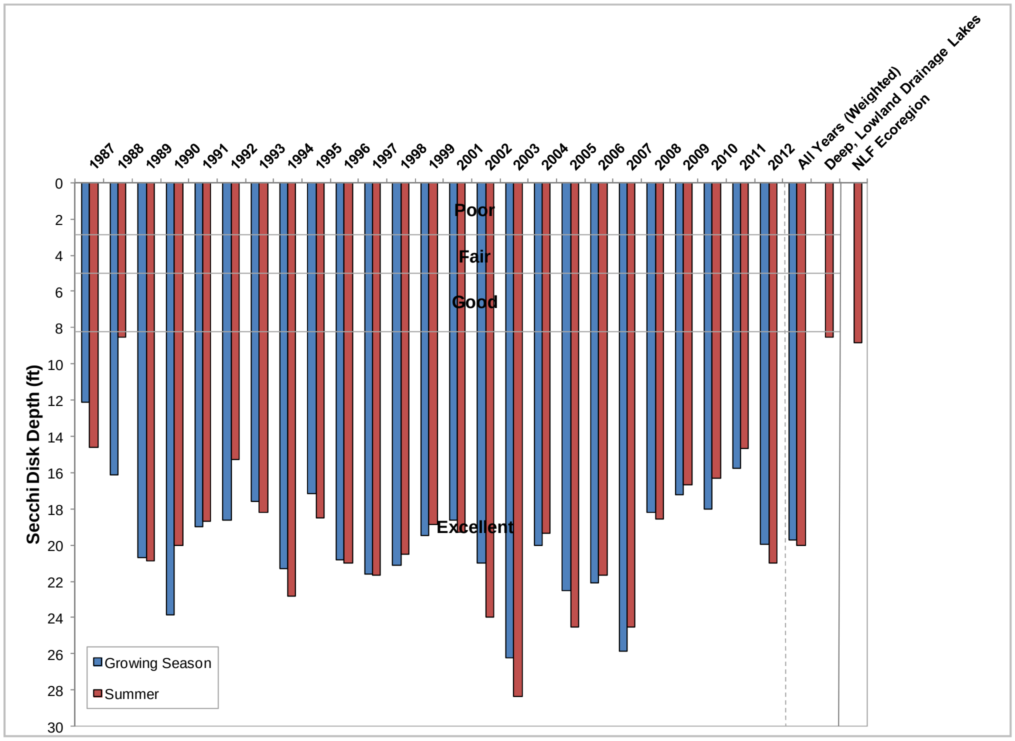


Figure 3.1-9. Butternut Lake, state-wide class 4 lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR (2009).

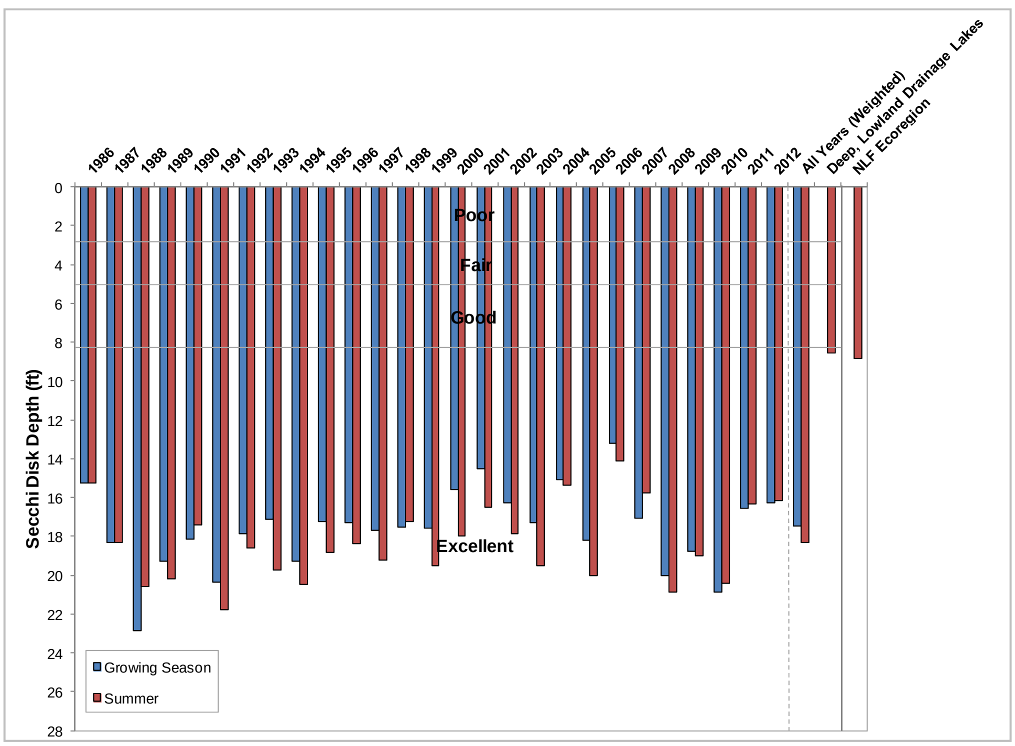


Figure 3.1-10. Franklin Lake, state-wide class 4 lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR (2009).

Secchi disk clarity has been monitored since 1987 on both Butternut Lake and Franklin Lake. The average clarity of Butternut Lake has ranged between 8.5 feet and 28.3 feet during this time (Figure 3.1-9), while in next-door Franklin Lake average clarity values have been calculated at between 14.1 feet and 21.8 feet during the summer months (Figure 3.1-10). The values for both Butternut Lake and Franklin Lake rank as Excellent when compared against similar deep, lowland drainage lakes across the state. Additionally, the weighted average is much greater than median values for similar lakes around the state and within the Northern Lakes and Forests ecoregion.

The Secchi disk dataset for Butternut Lake, and to a lesser extent Franklin Lake, displays some annual fluctuation in this clarity measurement. This is not uncommon in lakes as clarity may show much variation from year to year based upon environmental conditions. Factors such as temperature and precipitation regulate the amount of runoff and algal growth a lake receives. Water clarity is essentially how far light may penetrate into the water; this is governed by two primary factors: suspended particles (sediments, algae, etc.) and dissolved elements. As discussed earlier, algae concentrations were found to be minimal in each lake during the summer months. Dissolved elements can be measured through a "true color" analysis. True color measures the dissolved organic materials in water. Water samples collected from Butternut Lake and Franklin Lake in March of 2012 were measured for true color and were found to be at the lower threshold (<5 Platinum-cobalt units, or PCU) of detection for this analysis. Lillie and Mason (1983) categorized lakes with 0-40 PCU as having "low" color, 40-100 PCU as "medium" color, and >100 PCU as high color. Having little color to the water increases its clarity. So, because Butternut Lake and Franklin Lake have little algae and low dissolved organic materials within the water column, the clarity is quite high.

Limiting Plant Nutrient of Butternut Lake and Franklin Lake

Using midsummer nitrogen and phosphorus concentrations, a nitrogen:phosphorus ratio of 25:1 was calculated for Butternut Lake and 53:1 calculated for Franklin Lake. This finding indicates that both Butternut Lake and Franklin Lake are indeed phosphorus limited as are the vast majority of Wisconsin lakes. In general, this means that cutting phosphorus inputs may limit plant growth within the lake.

Butternut Lake and Franklin Lake Trophic State

Figure 3.1-9 and 3.1-10 contain the TSI values for Butternut Lake and Franklin Lake, respectively. The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values range in values spanning from middle oligotrophic to middle mesotrophic for both lakes. In general, the best values to use in judging a lake's trophic state are the biological parameters; therefore, relying primarily on total phosphorus and chlorophyll-*a* TSI values, it can be concluded that both Butternut Lake and Franklin Lake are in an upper oligotrophic state.

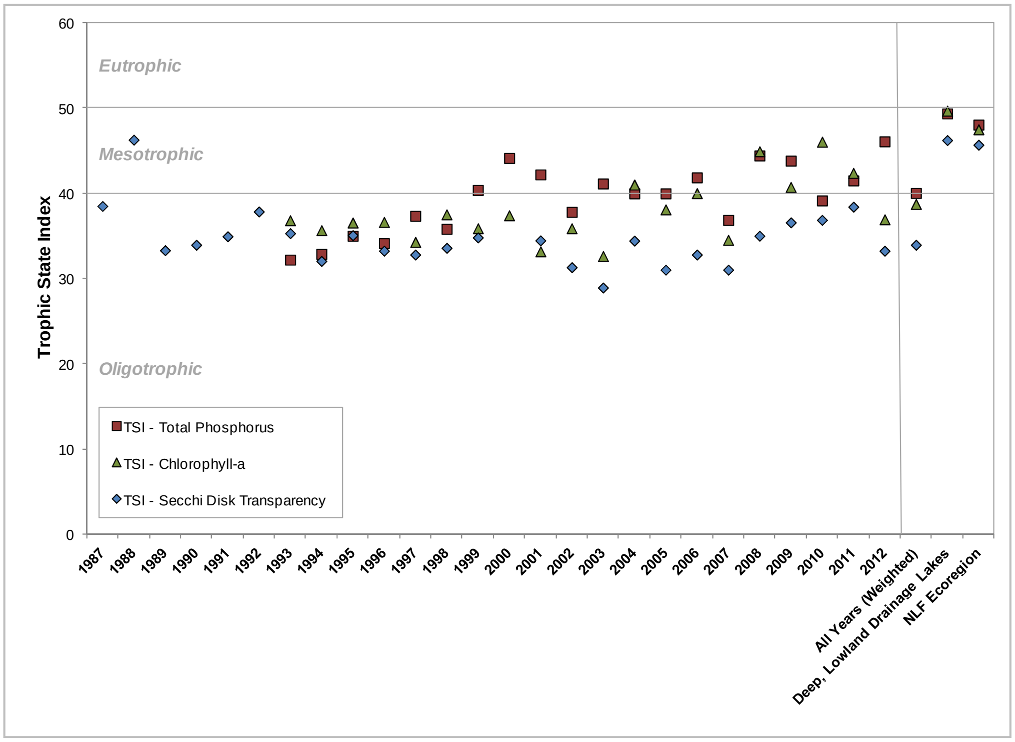


Figure 3.1-11. Butternut Lake, state-wide class 4 lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR (2009).

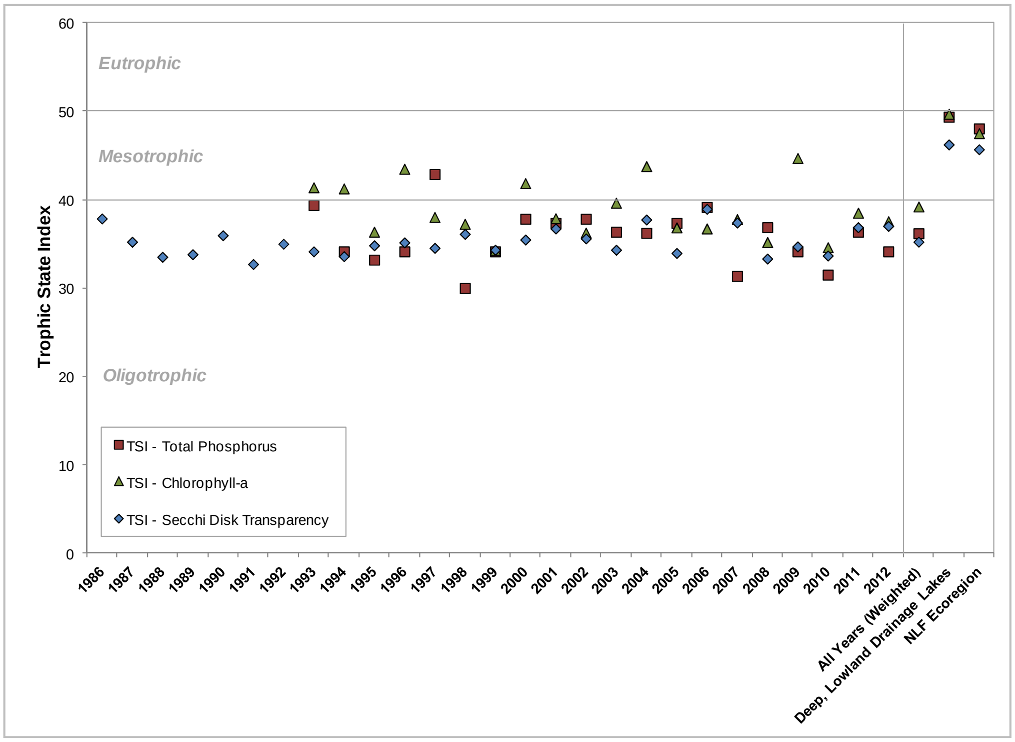


Figure 3.1-12. Franklin Lake, state-wide class 4 lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR (2009).

Dissolved Oxygen and Temperature in Butternut Lake and Franklin Lake

Dissolved oxygen and temperature were measured during water quality sampling visits to Butternut Lake and Franklin Lake by Onterra staff. Additionally, data has been collected by volunteers on each lake through the Citizens Lake Monitoring Network. Profiles depicting these data are displayed in Figure 3.1-11 and 3.1-12.

In both Butternut Lake and Franklin Lake, the entire water column was found to be completely mixed during the early spring. Once the ice leaves a lake, water temperatures are fairly consistent through the water column which allows for complete mixing of oxygen and other elements. As the open water season progresses, the top layer of water will warm, while the bottom layers may remain a bit cooler. During this time, oxygen may decrease at the bottom of the lake while bacteria break down accumulating organic material (fish, plants, algae, etc.). In August of 2012, winds were sufficient to re-mix Butternut Lake, while Franklin Lake remained slightly stratified. In October, as the surface water cooled, both lakes mixed completely as they did in the past spring.

During the winter months, a lake is covered with ice which changes the way in which temperature and oxygen gradients develop in the water column. During this time of the year, the coldest water is near the frozen ice at the surface of the lake while denser, slightly warmer water may be found at the bottom of the lake. Oxygen will deplete near the bottom of the lake at this time due to bacterial degradation of organic material. In some lakes, this winter oxygen depletion can occur to the point in which the entire water column loses oxygen and consequences such as fish kills occur. The amount of oxygen depletion experienced on Butternut Lake and Franklin Lake is not of concern as plenty of oxygen was present in February 2013 for warm water fish species.

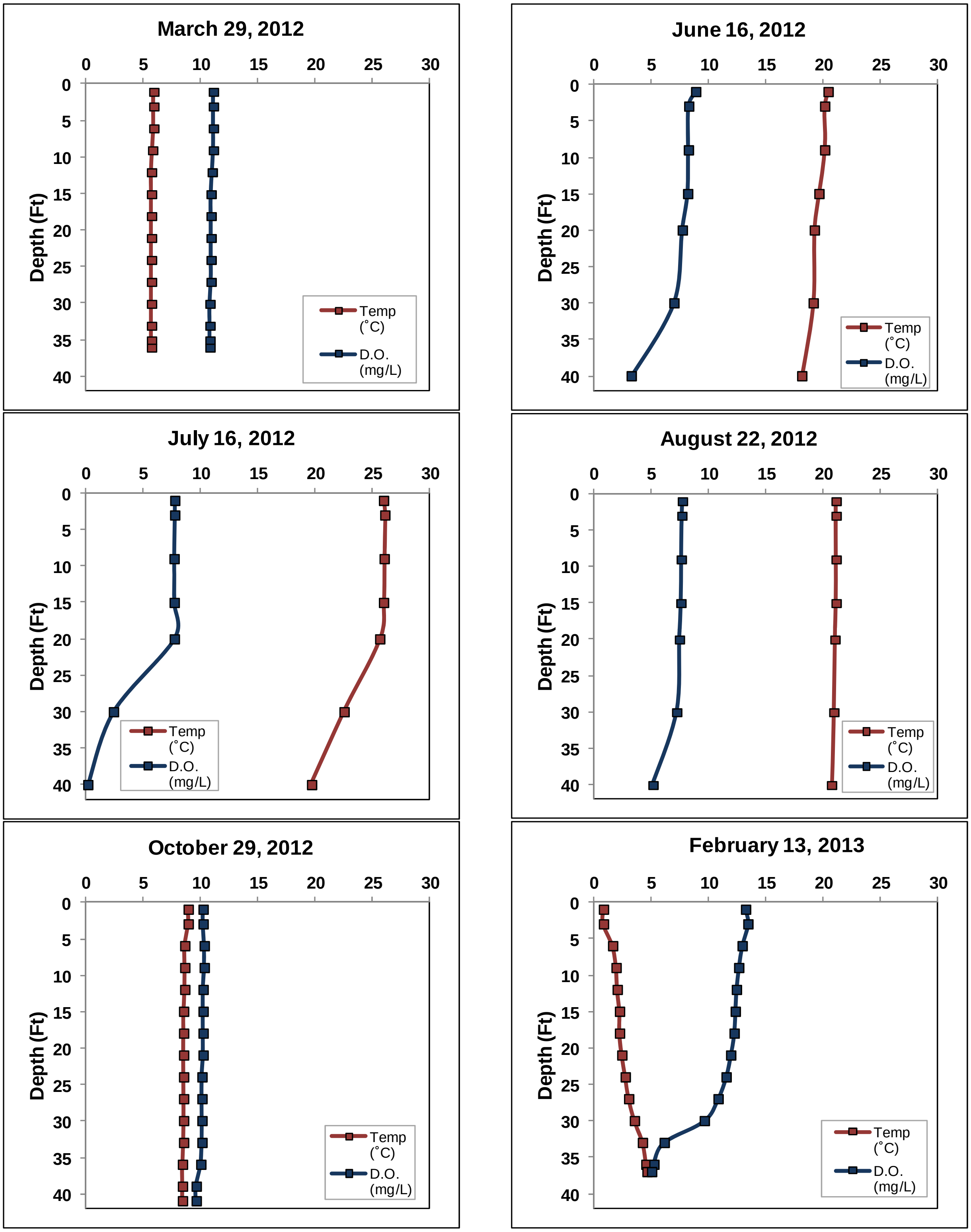


Figure 3.1-13. Butternut Lake dissolved oxygen and temperature profiles.

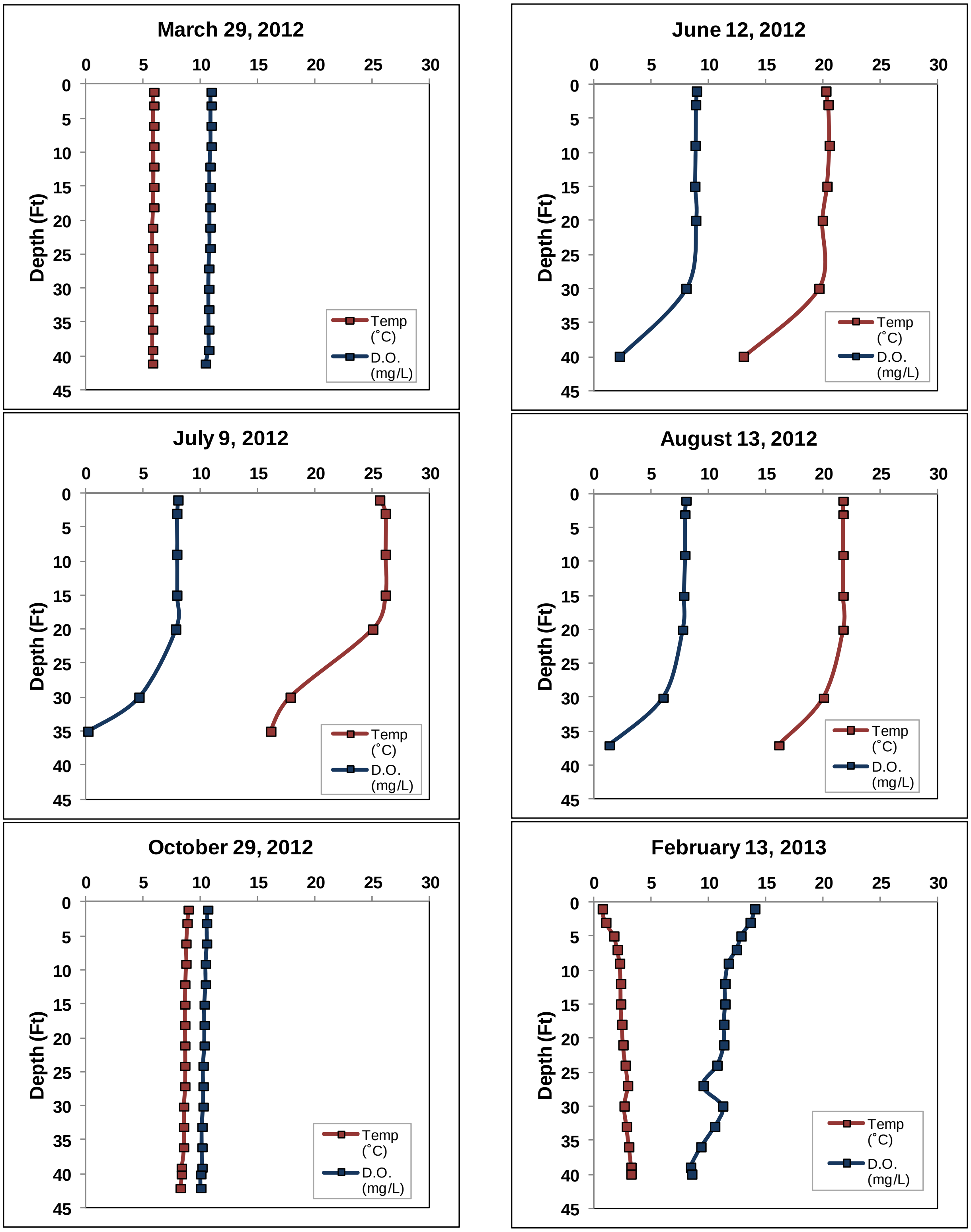


Figure 3.1-14. Franklin Lake dissolved oxygen and temperature profiles.

Additional Water Quality Data Collected in Butternut Lake and Franklin Lake

The water quality section is centered on lake eutrophication. However, parameters other than water clarity, nutrients, and chlorophyll-*a* were collected as part of the project. These other parameters were collected to increase the understanding of Butternut and Franklin Lake's water quality and are recommended as a part of the WDNR long-term lake trends monitoring protocol. These parameters include pH, alkalinity and calcium.

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. In lakes with a pH of 6.5 and lower, the spawning of certain fish species such as walleye becomes inhibited (Olszyk, 1980). The pH of the water in Butternut Lake and Franklin Lake was found to be 8.0 and 7.4, respectively, in spring of 2012. These values fall slightly above neutral and are within the normal range for Wisconsin Lakes.

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. Rainwater in northern Wisconsin is slightly acidic naturally due to dissolved carbon dioxide from the atmosphere with a pH of around 5.0. Consequently, lakes with low alkalinity have lower pH due to their inability to buffer against acid inputs. The alkalinity in Butternut Lake was measured at 52.30 mg/L as $CaCO_3$ in spring of 2012, indicating that the lake has a substantial capacity to resist fluctuations in pH and has no sensitivity to acid rain. Franklin Lake's alkalinity was measured at 21.0 mg/L as $CaCO_3$ during that same time. At this level, Franklin Lake has low sensitivity to acid rain inputs.

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 what lakes can support zebra mussel populations if they are introduced. The commonly accepted pH range for zebra mussels is 7.0 to 9.0 (Coen 2005), so Butternut Lake and Franklin Lake pH of 8.0 and 7.4 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 (Whittier et al 2008). The calcium concentration of Butternut Lake was 12.5 mg/L, lying at the lower threshold for zebra mussel establishment. Franklin Lake's calcium concentration was measured to be 44 mg/L, which puts the lake at a high risk for zebra mussels.

Plankton tows were completed by Onterra staff during the summer of 2012 and these samples were processed by the WDNR for larval zebra mussels. During analysis of these samples, no larval zebra mussels were detected.

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. For these reasons, it is important to maintain as much natural land cover (forests, wetlands, etc.) as possible within a lake's watershed to minimize the amount runoff (nutrients, sediment, etc.) from entering the lake.

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 10-15:1 or higher, 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 (a residence time of years), there may be a buildup of phosphorus in the sediments that may reach sufficient levels over time and lead to a problem such as internal nutrient loading. A lake with a higher flushing rate (low residence time, i.e., days or weeks) may be more productive early on, but the constant flushing of its waters may prevent a buildup of phosphorus and internal nutrient loading may never reach significant levels.

A reliable and cost-efficient method of creating a general picture of a watershed's affect on a lake can be obtained through modeling. The WDNR created a useful suite of modeling tools called the Wisconsin Lake Modeling Suite (WiLMS). Certain morphological attributes of a lake and its watershed 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. Predictive models are also included within WiLMS that are valuable in validating modeled phosphorus loads to the lake in question and modeling alternate land cover scenarios within the watershed. Finally, if specific information is available, WiLMS will also estimate the significance of internal nutrient loading within a lake and the impact of shoreland septic systems.

Butternut Lake and Franklin Lake Watershed

Butternut Lake and Franklin Lake are slightly different in terms of their hydrology. Butternut Lake is classified as a spring lake. Spring lakes typically have no inlet, but do have an outlet. These lakes are fed through groundwater sources and also from the immediate surface drainage area. They are the headwaters of many streams in Wisconsin; water leaves Butternut Lake to form the beginning of the North Branch Pine River. Franklin Lake is a drained lake. Drained lakes are not groundwater-fed, but receive water inputs from precipitation and the surrounding watershed. This input is not sufficient to create an inlet, but typically results in an intermittent or continuous outlet. Franklin Lake's intermittent outlet flows towards Butternut Lake in times of high water levels, which have not been observed in some time (J. Lyon, personal communication). Thus, the Franklin Lake watershed is within the larger Butternut Lake watershed as this is the primary direction of surface water flow.

The Franklin Lake watershed is roughly 3,742 acres in size, while Butternut Lake's 8,081 acre watershed encompasses the watershed that is draining to Franklin Lake (Map 2). The watershed to lake area ratios for Butternut Lake and Franklin Lake were calculated to be 5:1 and 3.1, respectively. Both watersheds are primarily forested, with this land cover type claiming 42% and 54% of the Butternut Lake and Franklin Lake direct watersheds, respectively (Figure 3.2-1 and 3.2-2). Wetlands make up a considerable portion of each watershed, as does the surface area of these relatively large lakes. Pasture/grass is found in each watershed to a minor degree. As indicated on Map 2, much of the watershed includes federally owned land (the Chequamegon-

Nicolet National Forest). This land ownership will ensure that much of the Butternut and Franklin Lake watershed remains in a natural state for years to come.

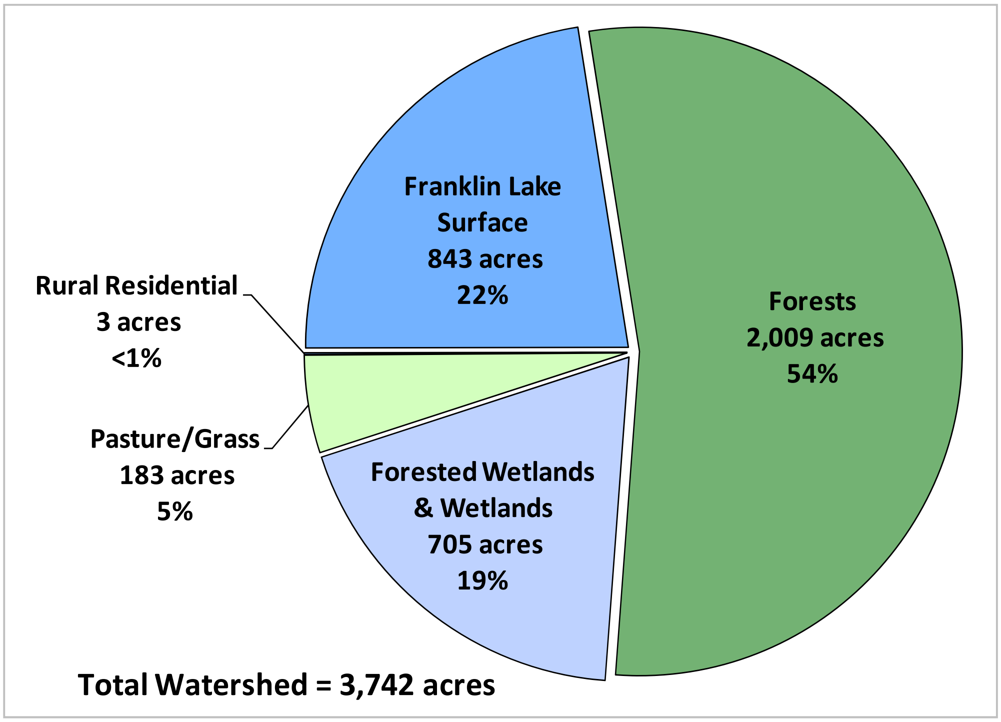


Figure 3.2-1. Franklin Lake watershed land cover types in acres. Based upon National Land Cover Database (NLCD – Fry et. al 2011).

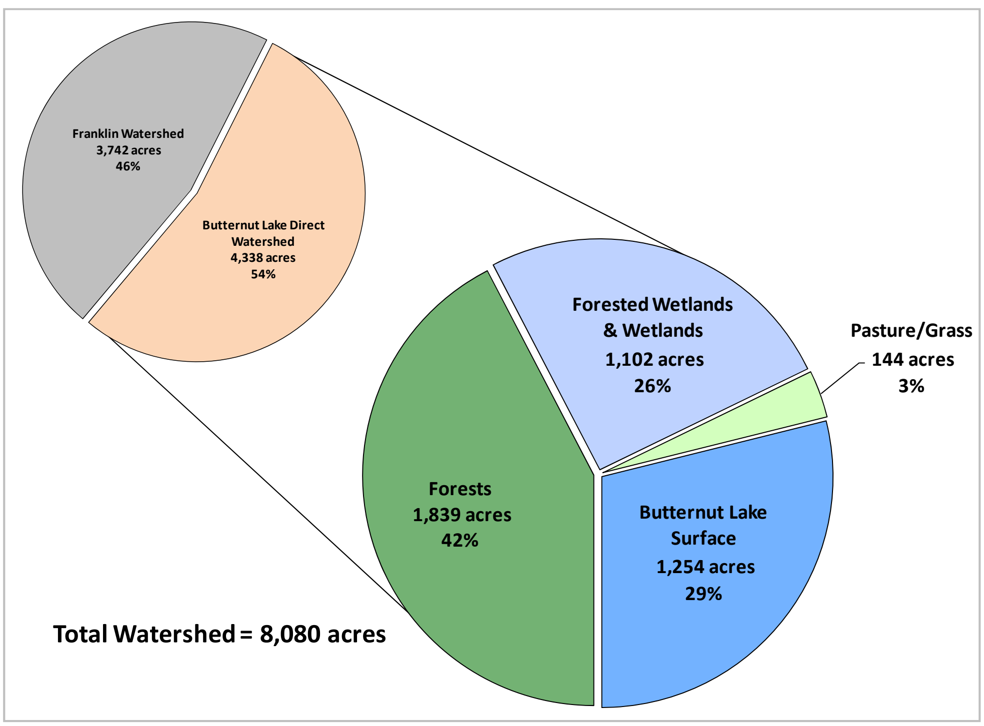


Figure 3.2-2. Butternut Lake watershed land cover types in acres. Based upon National Land Cover Database (NLCD – Fry et. al 2011).

WiLMS was utilized to estimate the annual potential phosphorus load to each lake, based upon the watershed size land cover characteristics of each watershed (model results in Appendix D). The predicted annual phosphorus load to Franklin Lake is roughly 499 lbs; while Butternut Lake's annual input is 714 lbs (Figures 3.2-3 and 3.2-4). In each modeling scenario, WiLMS determined that the lake's surface was the largest contributor to the annual phosphorus load. A lake's surface collects phosphorus through atmospheric deposition of particles; this accumulation accounts for 225 lbs (45%) on Franklin Lake and 335 lbs (47%) on Butternut Lake. The large tracts of forested land export phosphorus to each lake as well as wetlands found within the watershed; however, the amount is small considering the vast area these land cover types occupy.

Though the Franklin Lake watershed receives 499 lbs of phosphorus a year, 88 of these pounds are estimated to be sent downstream towards Butternut Lake. In turn, Butternut Lake was calculated to send 262 lbs of phosphorus downstream on the North Branch of the Pine River. Of course, these phosphorus inputs and outputs are modeled with the assumption of normal precipitation rates and water levels. With the recent drought-like conditions northern Wisconsin has experienced, water levels are down on many area lakes. Thus, the annual phosphorus load to and from each lake is likely smaller than what is projected through WiLMS modeling.

In addition to calculating annual phosphorus loads, WiLMS is able to estimate what the growing season mean phosphorus concentration should be within a lake. This value is compared to measured phosphorus concentrations to determine the model's accuracy. If the predicted (modeled) concentration is similar to the actual (measured) in-lake concentration, the model has performed accurately. If the values differ, other factors may be occurring that need to be investigated. For example, WiLMS functions best at modeling drainage systems so spring lakes, drained lakes and seepage lakes may not model well. Other reasons for an inaccurate model include high calcium carbonate systems (which bind to phosphorus) or unaccounted sources of phosphorus input (internal nutrient loading, agricultural drain tiles, point source inputs, etc.).

For Franklin Lake's model, WiLMS calculated a growing season mean phosphorus value of 16 µg/L, while an actual value was 10 µg/L in 2012. As previously mentioned, WiLMS is best suited for modeling drainage waterbodies and thus may overestimate the phosphorus load to a drained lake. So while the modeled growing season mean phosphorus value and the 2012 measured phosphorus value differ for the Franklin Lake, this is likely due to limitations of the WiLMS program and the drought-like conditions that this region is experiencing.

The regional drought-like conditions were acknowledged during the Butternut Lake modeling process. WiLMS was utilized to model this watershed with an input from Franklin Lake of 88 lbs of phosphorus per year, and also model the watershed without this input. This would allow for examination of the lake's annual phosphorus load when the unnamed creek between Butternut Lake and Franklin Lake is running, and when it is not. WiLMS predicted a growing season mean of 14 µg/L in Butternut Lake with the inclusion of the 88 lb input from Franklin Lake. In comparison to the measured value of 14 µg/L found in Butternut Lake in 2012, the conclusion is that the watershed was accurately modeled. Because of Franklin Lake's minimal contribution to the Butternut Lake annual phosphorus load (12% of 741 lbs), re-modeling the watershed with this input produced a negligible difference in the predicted vs. measured growing season mean calibration analysis. This analysis indicates that the modeled watershed load matches what is expected to be seen within the lake (e.g. there no "unaccounted for" phosphorus sources to the lake).

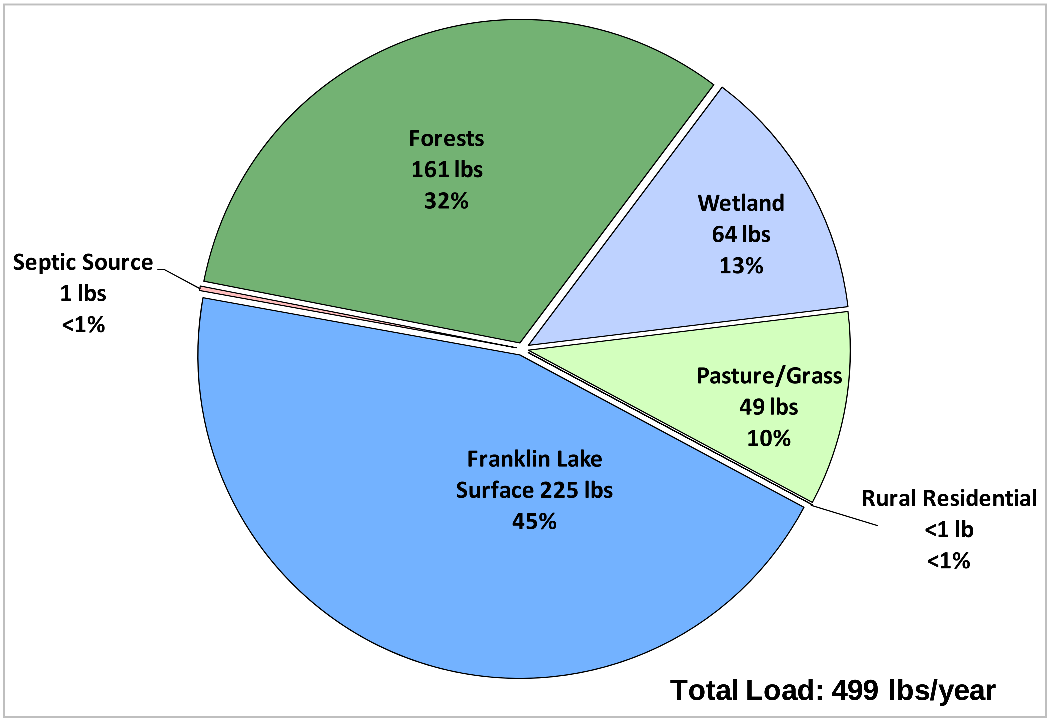


Figure 3.2-3. Franklin Lake watershed phosphorus loading in pounds. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

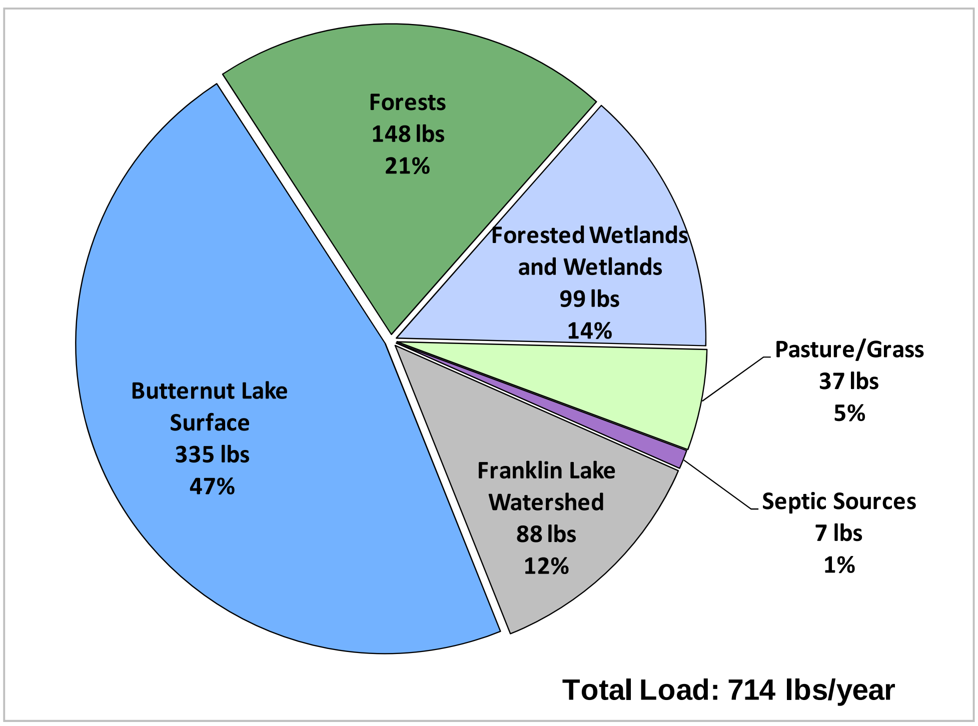


Figure 3.2-4. Butternut Lake watershed phosphorus loading in pounds. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

3.3 Shoreland Condition

The Importance of a Lake's Shoreland Zone

One of the most vulnerable areas of a lake's watershed is the immediate shoreland zone (approximately from the water's edge to at least 35 feet shoreland). When a lake's shoreland is developed, the increased impervious surface, removal of natural vegetation, and other human practices can severely increase pollutant loads to the lake while degrading important habitat. Limiting these anthropogenic (man-made) 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 swimmers itch. Development such as rip rap or masonary, steel or wooden seawalls completely remove natural habitat for most animals, but may also create some habitat for snails; this is not desirable for lakes that experience problems with swimmers itch, as the flatworms that cause this skin reaction utilize snails as a secondary host after waterfowl.

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

Shoreland Zone Regulations

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

Wisconsin-NR 115: Wisconsin's Shoreland Protection Program

Wisconsin's shoreland zoning rule, NR 115, sets the minimum standards for shoreland development. First adopted in 1966, the code set a deadline for county adoption of January 1, 1968. By 1971, all counties in Wisconsin had adopted the code and were administering the shoreland ordinances it specified. Interestingly, in 2007 it was noted that many (27) counties had recognized inadequacies within the 1968 ordinance and had actually adopted more strict shoreland ordinances. Passed in February of 2010, the final NR 115 allowed many standards to remain the same, such as lot sizes, shoreland setbacks and buffer sizes. However, several standards changed as a result of efforts to balance public rights to lake use with private property rights. The regulation sets minimum standards for the shoreland zone, and requires all counties in the state to adopt shoreland zoning ordinances of their own. County ordinances may be more restrictive than NR 115, but not less so (though Act 170 allows for less restrictive standards for existing non-conforming structures). These policy regulations require each county to amend ordinances for vegetation removal on shorelands, impervious surface standards, nonconforming structures and establishing mitigation requirements for development. Minimum requirements for each of these categories are described below. Please note that at the time of this writing, NR 115 is under review by the State of Wisconsin and updates will likely occur in February of 2014.

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

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

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

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

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

Wisconsin Act 31

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

Shoreland Research

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

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

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

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

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

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

National Lakes Assessment

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

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

The results indicate that stronger management of shoreline development is absolutely necessary to preserve, protect and restore lakes. This will become increasingly important 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, Radomski and Goeman 2001, and Elias & Meyer 2003). Many homeowners significantly decrease the number of trees and shrubs along the water's edge in an effort to increase their view of the lake. However, this has been shown to locally increase water temperatures, and decrease infiltration rates of potentially harmful nutrients and pollutants. Furthermore, the dumping of sand to create beach areas destroys spawning, cover and feeding areas utilized by aquatic wildlife (Scheuerell and Schindler 2004).

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

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

Cost

The cost of native, aquatic, and shoreland plant restorations is highly variable and depends on the size of the restoration area, the depth of buffer zone required to be restored, the existing plant density, the planting density required, the species planted, and the type of planting (e.g. seeds, bare-roots, plugs, live-stakes) being conducted. Other sites may require erosion control stabilization measures, which could be as simple as using erosion control blankets and plants and/or seeds or more extensive techniques such as geotextile bags (vegetated retaining walls), geogrids (vegetated soil lifts), or bio-logs (see above picture). Some of these erosion control techniques may reduce the need for rip-rap or seawalls which are sterile environments that do nott 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.

Butternut Lake and Franklin Lake Shoreland Zone Condition

Shoreland Development

A 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 3.3-1 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.

Urbanized: This type of shoreland 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 shorelands 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 shoreland 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 shoreland that was restored would likely be included here, also.

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

Figure 3.3-1. Shoreland assessment category descriptions.

On Butternut Lake and Franklin Lake, the development stage of the entire shoreland was surveyed during late summer of 2012 using a GPS unit to map the shoreland. 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 3.3-1.

Both Butternut and Franklin Lake have stretches of shoreland that fit all of the five shoreland assessment categories. The results of this survey show that the majority of the shorelands on these lakes are in a natural/undeveloped or developed-natural state; 78% of the Butternut Lake shoreland and 82% of the Franklin Lake shoreland were assigned these classifications in 2012 (Figures 3.3-2 and 3.3-3). These shoreland types provide the most benefit to the lake and should be left in their natural state if possible. Minimal areas were found to be highly developed, with 6% of the Butternut Lake shoreland and 5% of the Franklin Lake shoreland being classified as either urbanized or developed-unnatural. If restoration of the Butternut Lake 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 3 and 4 display the location of these shorelands.

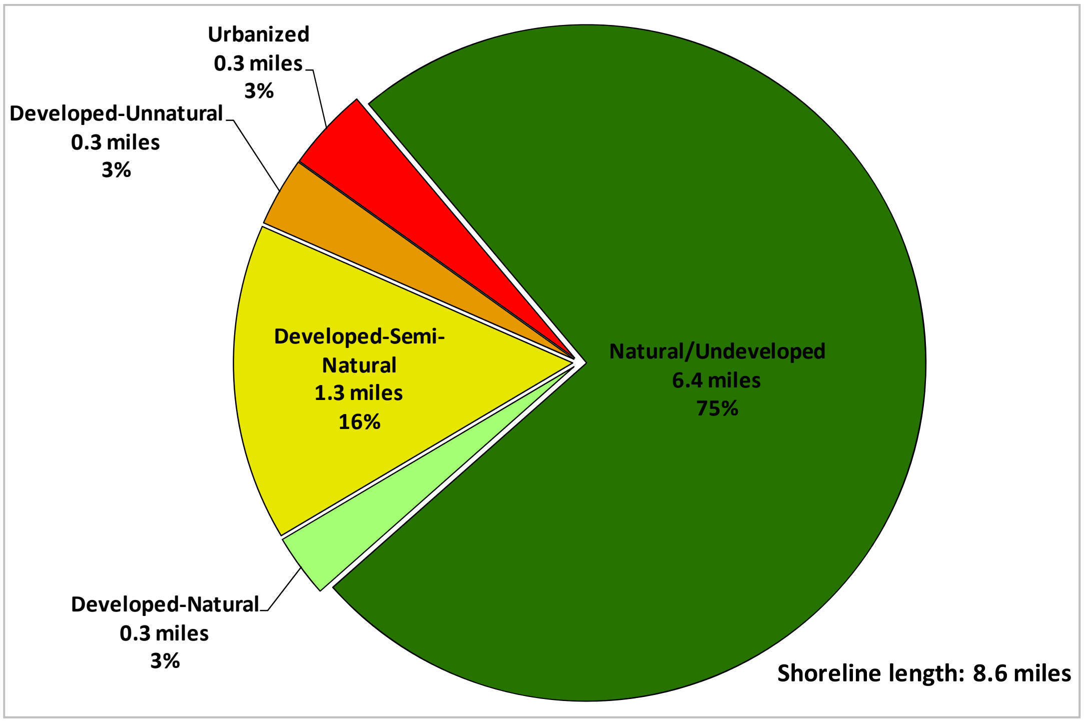


Figure 3.3-2. Butternut Lake shoreland categories and total lengths. Based upon a late summer 2012 survey. Locations of these categorized shorelands can be found on Map 3.

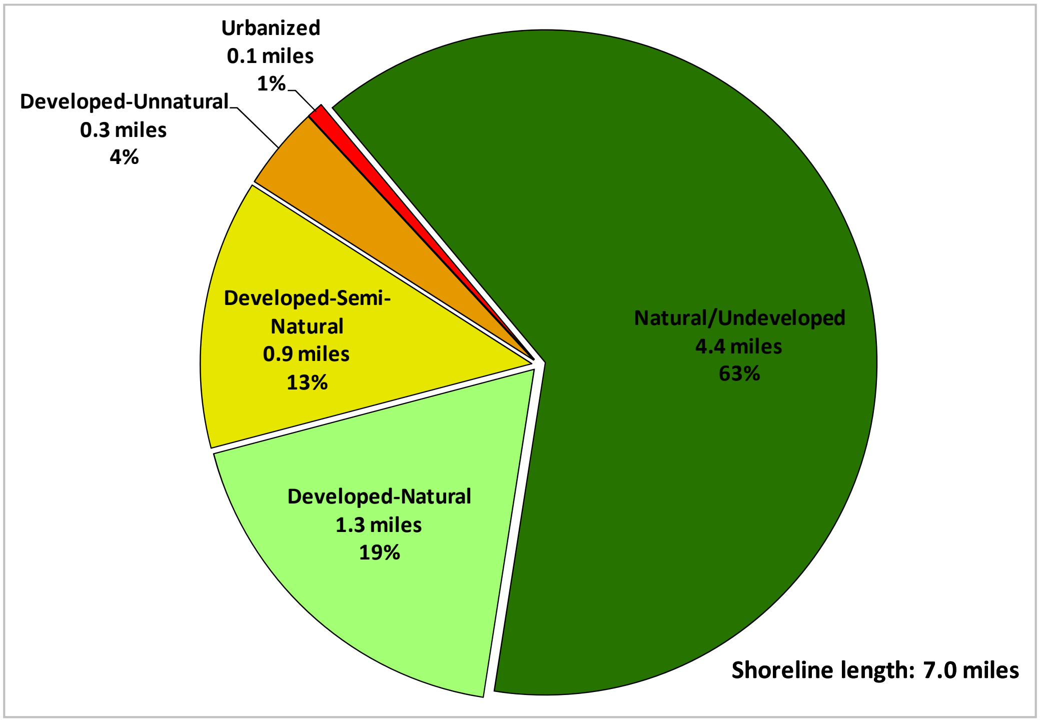


Figure 3.3-3. Franklin Lake shoreland categories and total lengths. Based upon a late summer 2012 survey. Locations of these categorized shorelands can be found on Map 4.

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. Locating 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

Butternut Lake and Franklin Lake were surveyed in 2012 to determine the extent of their coarse woody habitat. A survey for coarse woody habitat was conducted in conjunction with the shoreland assessment (development) survey. Coarse woody habitat was identified, and classified in two size categories (2-8 inches diameter, >8 inches diameter) as well as four branching categories: no branches, minimal branches, moderate branches, and full canopy. 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.

During this survey, 13 total pieces of coarse woody habitat were observed on Butternut Lake, and 9 pieces on Franklin Lake. Therefore, the ratio of coarse woody habitat to shoreline miles is 2:1 and 1:1 for Butternut and Franklin Lake, respectively. To put this into perspective, Wisconsin researchers have found that in completely undeveloped lakes, an average of 345 coarse woody habitat structures may be found per mile (Christensen et al. 1996). Locations of coarse woody habitat are displayed on Maps 5 and 6.

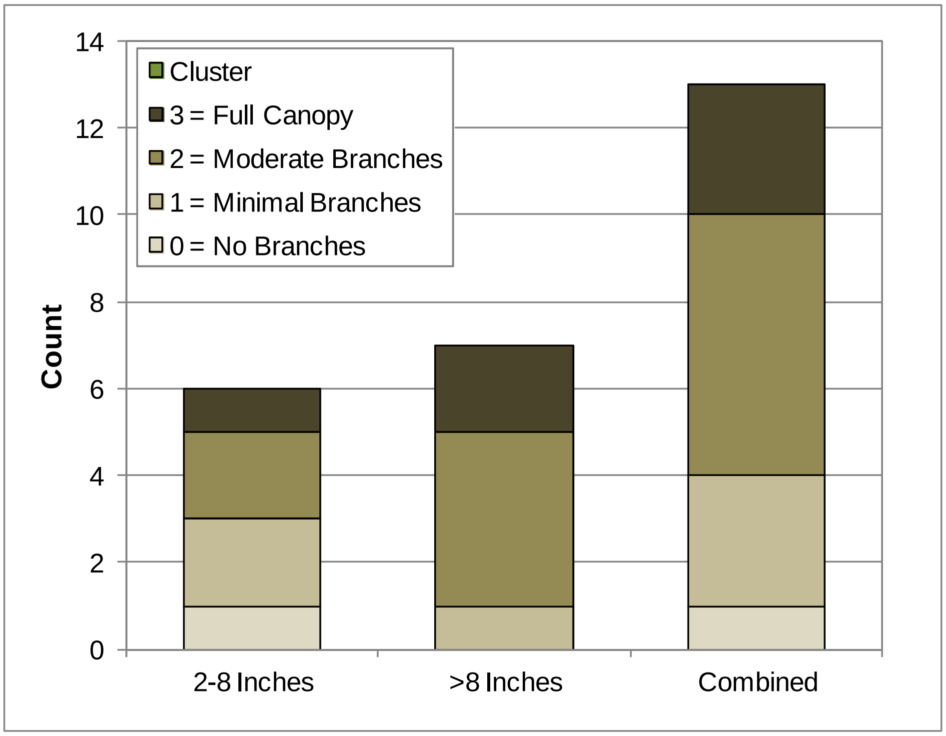


Figure 3.3-4. Butternut Lake coarse woody habitat survey results. Based upon a late summer 2012 survey. Locations of coarse woody habitat can be found on Map 5.

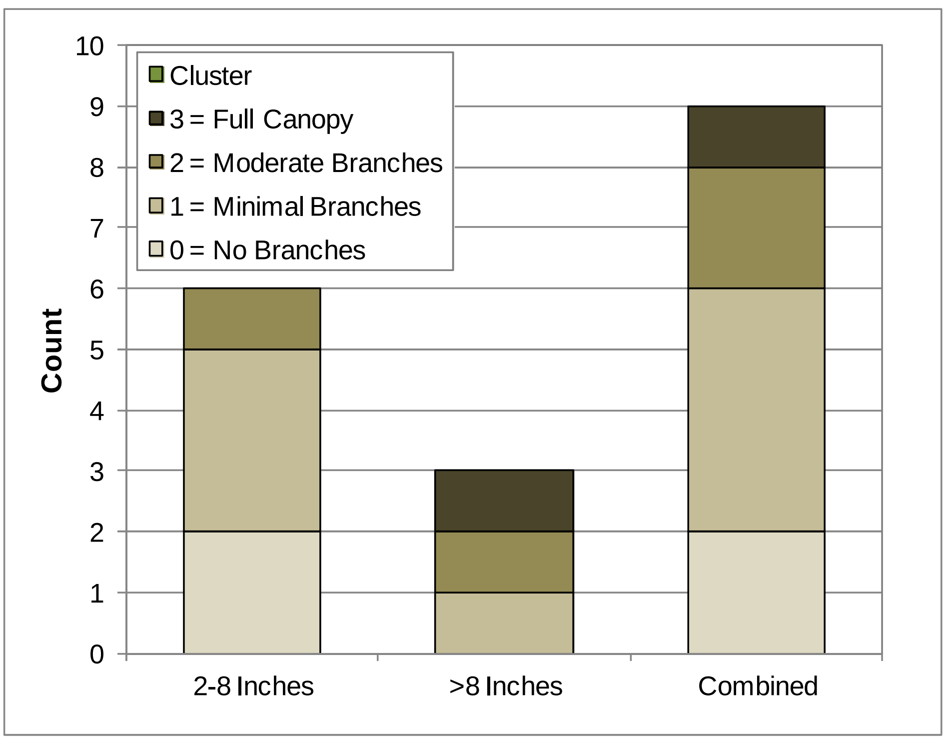


Figure 3.3-5. Franklin Lake coarse woody habitat survey results. Based upon a late summer 2012 survey. Locations of coarse woody habitat can be found on Map 6.

3.4 Aquatic Plants

Introduction

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

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

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

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

Aquatic Plant Management and Protection

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

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

Permits

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

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

Manual Removal

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

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

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

Cost

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

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

Bottom Screens

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

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

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

Water Level Drawdown

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

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

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

Mechanical Harvesting

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

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. • Opening of cruise lanes can increase predator pressure and reduce stunted fish populations. • Removal of plant biomass can improve the oxygen balance in the littoral zone. • Harvested plant materials produce excellent compost.	• Initial costs and maintenance are high if the lake organization intends to own and operate the equipment. • Multiple treatments are likely required. • Many small fish, amphibians and invertebrates may be harvested along with plants. • There is little or no reduction in plant density with harvesting. • Invasive and exotic species may spread because of plant fragmentation associated with harvester operation. • Bottom sediments may be re-suspended leading to increased turbidity and water column nutrient levels.

Chemical Treatment

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

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

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

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

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

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

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

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

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

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

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

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

Cost

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

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

Biological Controls

There are many insects, fish and pathogens within the United States that are used as biological controls for aquatic macrophytes. For instance, the herbivorous grass carp has been used for years in many states to control aquatic plants with some success and some failures. However, it is illegal to possess grass carp within Wisconsin because their use can create problems worse than the plants that they were used to control. Other states have also used insects to battle invasive plants, such as 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 water-milfoil and as a result has supported the experimentation and use of the milfoil weevil (*Euhrychiopsis lecontei*) within its lakes. The milfoil weevil is a native weevil that has shown promise in reducing Eurasian water-milfoil stands in Wisconsin, Washington, Vermont, and other states. Research is currently being conducted to discover the best situations for the use of the insect in battling Eurasian water milfoil. Currently the milfoil weevil is not a WDNR grant-eligible method of controlling Eurasian water milfoil.

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

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

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

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

Cost

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

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

Analysis of Current Aquatic Plant Data

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

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

Species List

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

Frequency of Occurrence

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

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

Species Diversity and Richness

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

A lake with high species diversity is much more stable than a lake with a low diversity. This is analogous to a diverse financial portfolio in that a diverse lake plant community can withstand environmental fluctuations much like a diverse portfolio can handle economic fluctuations. For example, a lake with a diverse plant community is much better suited to compete against exotic infestation than a lake with a lower diversity. Simpson's diversity index is used to determine this diversity in a lake ecosystem. Simpson's diversity (1-D) is calculated as:

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

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. Between 2005 and 2009, WDNR Science Services conducted point-intercept surveys on 252 lakes within the state. In the absence of comparative data from Nichols (1999), the Simpson's Diversity Index values of the lakes within the WDNR Science Services dataset will be compared to Butternut and Franklin Lakes. Comparisons will be displayed using boxplots that showing median values and upper/lower quartiles of lakes in the same ecoregion (Figure 3.4-1) 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.

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

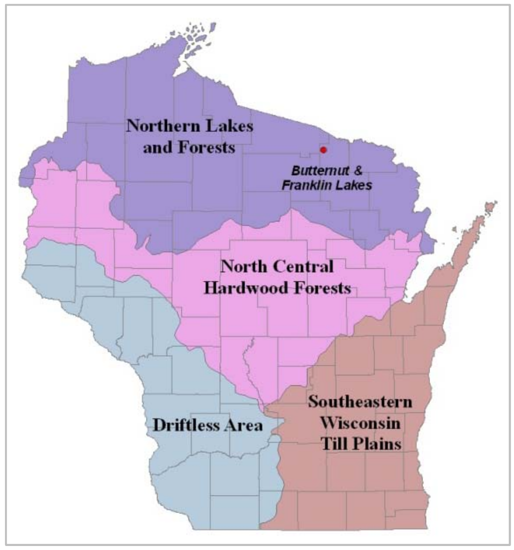


Figure 3.4-1. Location of Butternut Lake and Franklin Lake within the ecoregions of Wisconsin. After Nichols 1999.

Floristic Quality Assessment

Floristic Quality Assessment (FQA) is used to evaluate the closeness of a lake's aquatic plant community to that of an undisturbed, or pristine, lake. The higher the floristic quality, the closer a lake is to an undisturbed system. FQA is an excellent tool for comparing individual lakes and the same lake over time. In this section, the floristic quality of Butternut and Franklin Lakes will be compared to lakes in the same ecoregion and in the state (Figure 3.1-2 in the Water Quality Section).

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 floristic quality of a lake is calculated using its species richness and average species conservatism. As mentioned above, species richness is simply the number of species that occur in the lake, for this analysis, only native species are utilized. Average species conservatism utilizes the coefficient of conservatism values for each of those species in its calculation. A species coefficient of conservatism value indicates that species likelihood of being found in an undisturbed (pristine) system. The values range from one to ten. Species that are normally found in disturbed systems have lower coefficients, while species frequently found in pristine systems have higher values. For example, cattail, an invasive native species, has a value of 1, while common hard and softstem bulrush have values of 5, and Oakes pondweed, a sensitive and rare species, has a value of 10. 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 of the aquatic plant species that were sampled on the rake during the point-intercept survey and does not include incidental species.

Community Mapping

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

Exotic Plants

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

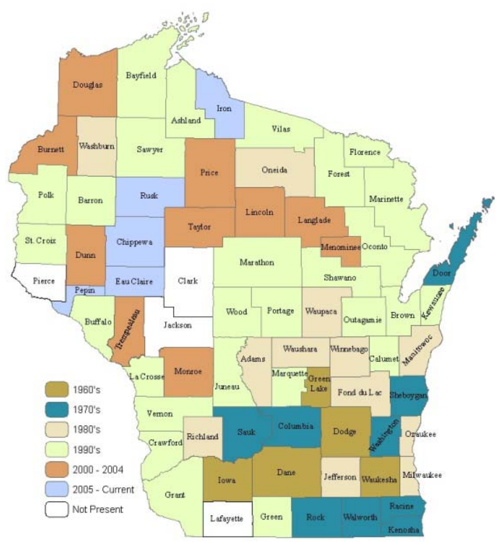


Figure 3.4-2. Spread of Eurasian water milfoil within WI counties. WDNR Data 2011 mapped by Onterra.

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

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 after ice-out and by mid-June is at peak biomass. While it is growing, each plant produces many turions (asexual reproductive shoots) along its stem. By mid-July most of the plants have senesced, or died-back, leaving the turions in the sediment.

The turions lie dormant until fall when they germinate to produce winter foliage, which thrives under the winter snow and ice. It remains in this state until spring foliage is produced in early May, giving the plant a significant jump on native vegetation. Like Eurasian water-milfoil, curly-leaf pondweed can become so abundant that it hampers recreational activities within the lake. Furthermore, its mid-summer die back can cause algal blooms spurred from the nutrients released during the plant's decomposition.

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

Aquatic Plant Survey Results

As mentioned above, numerous plant surveys were completed as a part of this project. On June 7, 2012, an early-season aquatic invasive species survey was completed on Butternut Lake and Franklin Lake. While the intent of this survey is to locate any potential non-native species within the lake, it's primarily focused on locating any occurrences of curly-leaf pondweed which should be at or near its peak growth at this time. During this meander-based survey of the littoral zone, Onterra ecologists did not locate any curly-leaf pondweed.

The point-intercept survey was conducted on Butternut Lake on July 18, 2012 and Franklin Lake on July 18-19, 2012 by Onterra (Appendix E). Note that where applicable, data collected from the Onterra 2012 point-intercept survey will be compared to a 2007 point-intercept survey conducted on Butternut and Franklin Lakes by Northern Environmental (now Stantec). These surveys were conducted on July 11-13, 2007. The point-intercept survey is conducted utilizing WDNR protocols, and is used to quantify the submersed plant community. In 2012 on Butternut Lake 424 of 660 sites were visited, with several sites being non-navigable due to shallow water or other sites being too deep for aquatic plant growth. Of these 424 sampling locations, 273 were found to be shallower than the maximum depth of plants, which was determined to be 22 feet. Aquatic plants were sampled at 28% (77 points) of these 273 locations. On Franklin Lake, 401 of 696 sampling locations were able to be visited. Of these 401 locations, 380 were within the maximum depth of plant growth (21 feet) and 51% of these locations (193 points) held aquatic vegetation.

The point-intercept survey is very efficient and quantifying the submersed aquatic plants in a lake. However, this survey methodology does not address emergent and floating-leaf plant communities as well because these species are often located in shallow hard-to-reach areas. A separate survey, the aquatic plant community mapping survey, was completed to better understand the extent of emergent and floating-leaf plant species in Butternut and Franklin Lake. This survey was conducted during the same time in which the point-intercept survey was completed (July 18-19, 2012).

During the point-intercept and aquatic plant community mapping surveys, 51 aquatic plant species were found on Butternut Lake and 41 were found on Franklin Lake (Table 3.4-1). Between the two lakes, a total of 60 aquatic plant species were found overall. Only one exotic plant, reed canary grass (*Phalaris arundinacea*) was found on Butternut Lake. This is an emergent plant that is fairly common in wetland areas around the Midwest.

Table 3.4-1. Butternut Lake and Franklin Lake aquatic plant species.

Growth Form	Scientific Name	Common Name	Coefficient of Conservatism	2007 (*Northern Environmental*)		2012 (*Onterra*)	
				Butternut Lake	Franklin Lake	Butternut Lake	Franklin Lake
Emergent	*Carex comosa*	Bristly sedge	5			I	I
	Carex crawfordii	Crawford's sedge	5			I	
	Carex gynandra	Nodding sedge	6			I	
	Carex lasiocarpa	Wooly-fruit sedge	9			I	I
	Carex rostrata	Beaked sedge	10			I	
	Carex vesicaria	Blister sedge	7			I	I
	Decodon verticillatus	Water-willow	7			I	
	Dulichium arundinaceum	Three-way sedge	9			I	X
	Eleocharis erythropoda	Bald spike-rush	3			I	
	Eleocharis palustris	Creeping spikerush	6	X	X	X	X
	Equisetum fluviatile	Water horsetail	7			I	
	Glyceria canadensis	Rattlesnake grass	7				X
	Iris versicolor	Northern blue flag	5			I	I
	Juncus effusus	Soft rush	4			I	I
	Phalaris arundinacea	Reed canary grass	Exotic			I	
	Sagittaria latifolia	Common arrowhead	3			I	
	Sagittaria rigida	Stiff arrowhead	8			I	
	Schoenoplectus acutus	Hardstem bulrush	5	X	X	X	X
	Schoenoplectus pungens	Three-square rush	5				I
	Schoenoplectus tabernaemon	Softstem bulrush	4		X	I	X
	Scirpus cyperinus	Wool grass	4			I	I
	Typha spp.	Cattail spp.	1			I	I
FL	*Brasenia schreberi*	Watershield	7		X		I
	Nuphar variagata	Spatterdock	6		I	I	I
	Nymphaea odorata	White water lily	6		X		X
FL/E	*Sparganium americanum*	Eastern bur-reed	8			I	I
	Sparganium angustifolium	Narrow-leaf bur-reed	9		X	I	I
Submergent	*Chara spp.*	Muskgrasses	7	X	X	X	X
	Elatine minima	Waterwort	9				I
	Elodea canadensis	Common waterweed	3	X	X	X	X
	Elodea nuttallii	Slender waterweed	7				X
	Eriocaulon aquaticum	Pipewort	9		X	I	X
	Heteranthera dubia	Water stargrass	6			X	
	Isoetes spp.	Quillwort spp.	8			X	X
	Lobelia dortmanna	Water lobelia	10		X		X
	Myriophyllum alterniflorum	Alternate-flowered water milfoil	10			X	
	Myriophyllum sibiricum	Northern water milfoil	7	X		X	
	Myriophyllum tenellum	Dwarf water milfoil	10	X	X	X	X
	Najas flexilis	Slender naiad	6	X	X	X	X
	Nitella sp.	Stoneworts	7	X	X	X	X
	Potamogeton amplifolius	Large-leaf pondweed	7	X	X	X	X
	Potamogeton berchtoldii	Slender pondweed	7			X	X
	Potamogeton epihydrus	Ribbon-leaf pondweed	8			X	I
	Potamogeton foliosus	Leafy pondweed	6			X	
	Potamogeton gramineus	Variable pondweed	7		X	X	X
	Potamogeton illinoensis	Illinois pondweed	6	X		X	
	Potamogeton natans	Floating-leaf pondweed	5			I	I
	Potamogeton pusillus	Small pondweed	7	X	X		
	Potamogeton richardsonii	Clasping-leaf pondweed	5			X	
	Potamogeton robbinsii	Fern pondweed	8		X	X	X
	Potamogeton strictifolius	Stiff pondweed	8			X	
	Potamogeton zosteriformis	Flat-stem pondweed	6			X	
	Ranunculus flammula	Creeping spearwort	9				X
	Utricularia geminiscapa	Twin-stemmed bladderwort	9		X		
	Utricularia intermedia	Flat-leaf bladderwort	9				X
	Utricularia vulgaris	Common bladderwort	7			I	X
	Vallisneria americana	Wild celery	6	X	X	X	X
S/E	*Eleocharis acicularis*	Needle spikerush	5	X	X	X	
	Juncus pelocarpus	Brown-fruited rush	8		X	X	
	Sagittaria cuneata	Arum-leaved arrowhead	7			I	
	Sagittaria cristata	Crested arrowhead	9	X	X	X	

FL = Floating Leaf; FL/E = Floating Leaf and Emergent; S/E = Submergent and Emergent
X = Sampled with rake during point-intercept survey; I = Incidental Species

At each point-intercept location 12 feet of depth or less, data was collected regarding the sediment type. These data indicate that both Butternut Lake and Franklin Lake have a predominately sandy substrate, though they differ slightly with Butternut including vast areas of rocky substrate and Franklin Lake having substantial organic (muck) substrate (Figure 3.4-3; Maps 7 and 8).

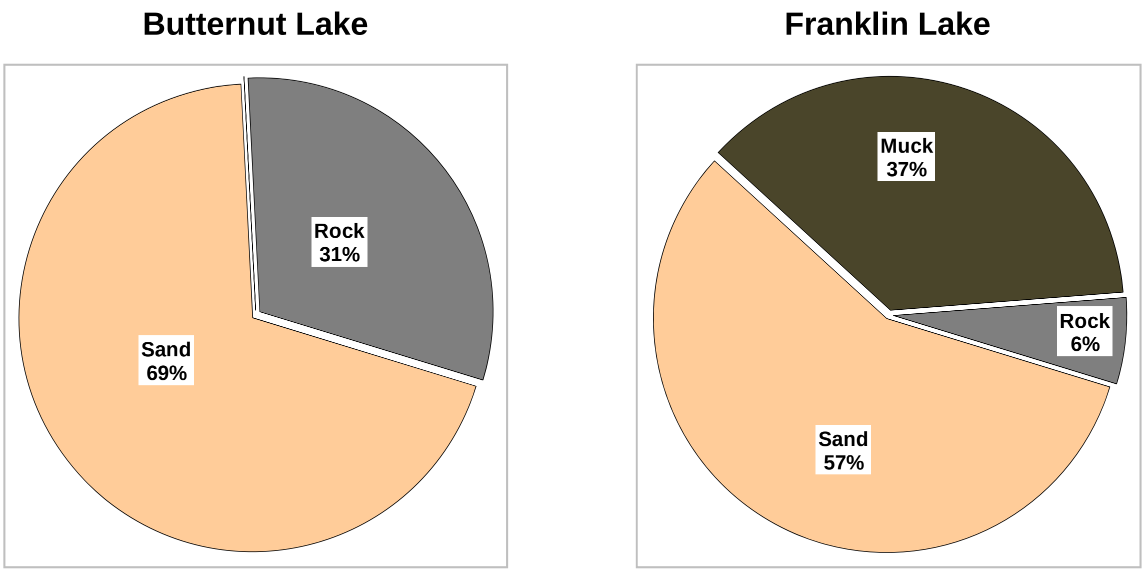


Figure 3.4-3. Butternut Lake (left) and Franklin Lake (right) proportion of substrate types within littoral areas. Created using data from July 2012 aquatic plant point-intercept survey.

Maps 9 and 10 shows that the majority of the aquatic vegetation growth in both Butternut Lake and Franklin Lake occur within the shallow bays and near-shore areas. As discussed in the water quality section, the water clarity in these lakes is very high which allows sunlight penetration deep into the water column on these lakes, allowing plants to inhabit deeper areas of the lake. Figures 3.4-4 displays steady aquatic plant growth through most depths of Butternut Lake; on Franklin Lake (Figure 3.4-5), the shallower depths held the majority of growth though plants can be observed growing in deeper water as well. As discussed further on, this trend is governed by the types of plants that are found in each lake.

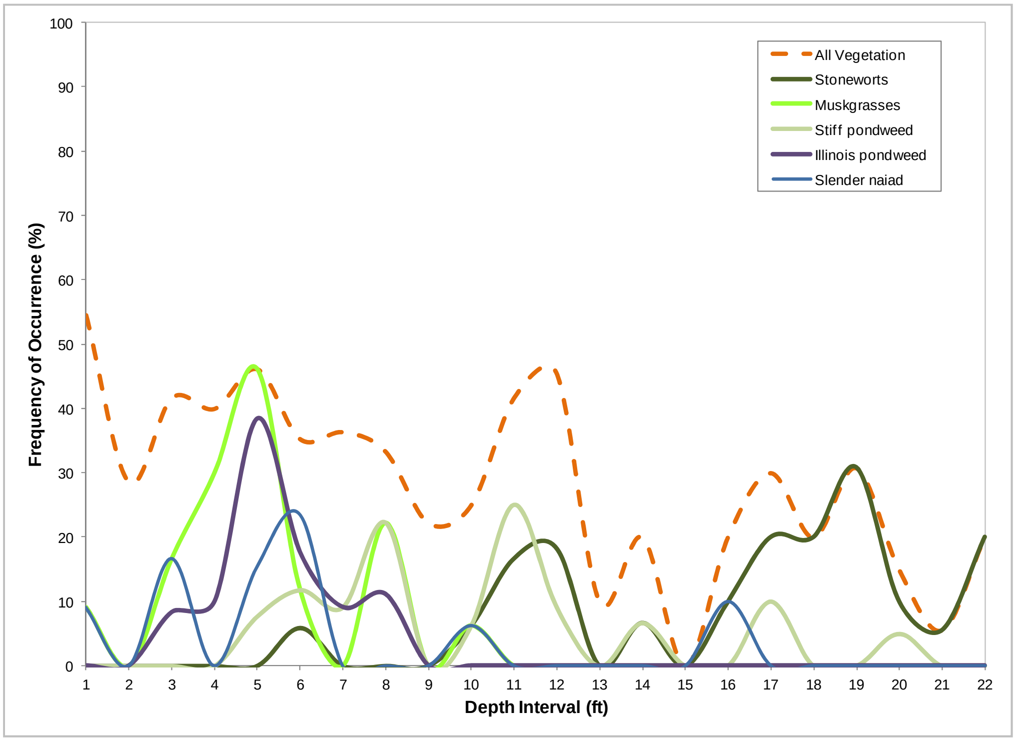


Figure 3.4-4. Frequency of occurrence at littoral depths for several Butternut Lake plant species. Created using data from July 2012 aquatic plant point-intercept survey.

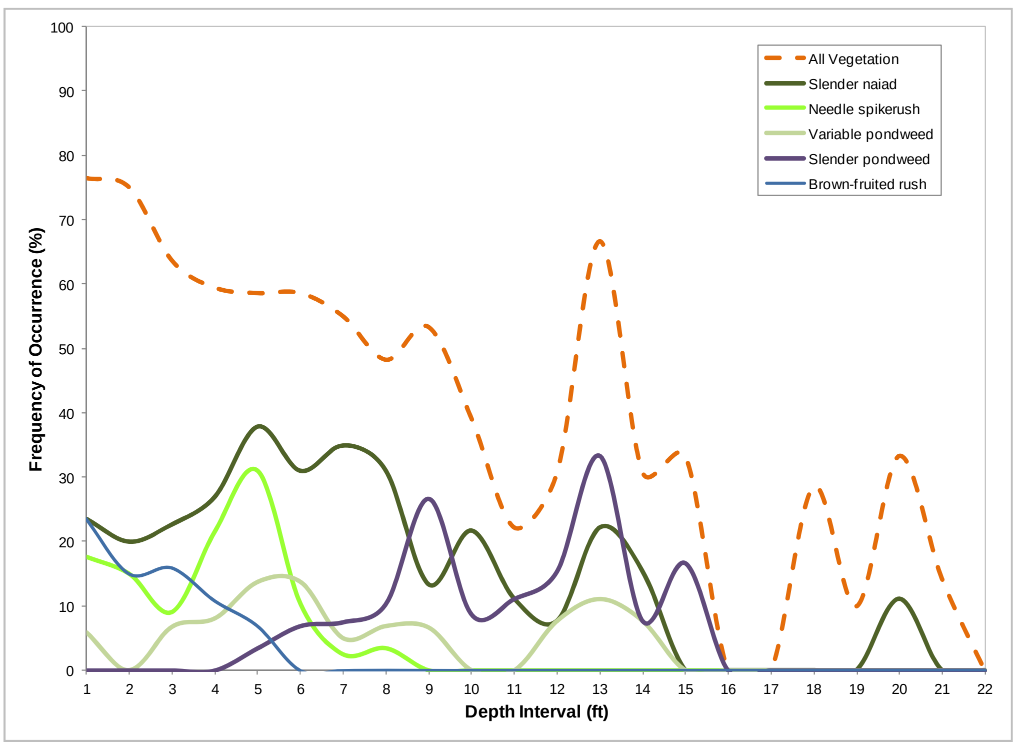


Figure 3.4-5. Frequency of occurrence at littoral depths for several Franklin Lake plant species. Created using data from July 2012 aquatic plant point-intercept survey.

Aquatic plants can be placed in one of two general groups, based upon their form of growth and habitat preferences. These groups include the isoetid growth form and the elodeid growth form. Plants of the isoetid growth form are small, slow growing, and inconspicuous submerged plants. They often have evergreen leaves located in a rosette and are usually found growing in sandy soils within the near-shore areas of a lake (Boston and Adams 1987, Vestergaard and Sand-Jensen 2000). Some common isoetid species include brown-fruited rush, needle spikerush, and spiny-spored quillwort. Submersed species of the elodeid growth form have leaves on tall, erect stems which grow upwards into the water column. Elodeid species include slender naiad, stiff pondweed, Illinois pondweed and variable pondweed.

Alkalinity is the primary water chemistry factor determining whether a lake is dominated by plant species of the isoetid or elodeid growth form (Vestergaard and Sand-Jensen 2000). Most elodeids are restricted to lakes of relatively higher alkalinity, as their carbon demand for photosynthesis cannot be met solely by the dissolved carbon dioxide (CO_2) present in the water, and they must acquire additional carbon through bicarbonate (HCO_3^-). While isoetids are able to grow in lakes of higher alkalinity, their short stature makes them poor competitors for light, and they are usually outcompeted and displaced by the taller elodeids. Thus, isoetids are most prevalent in lakes of low alkalinity. Recall from the Water Quality Section that Butternut Lake's alkalinity was determined to be 52.3 mg/L as $CaCO_3$ in 2012, while Franklin Lake's alkalinity was measured at 21.0 mg/L as $CaCO_3$. Butternut Lake, with its high alkalinity, has a plant community that is dominated by elodeid plant species. In intermediate alkalinity lakes, there exists a mixed community of isoetids inhabiting the shallow, sandy/rocky areas and elodeids thriving in the deeper areas of softer sediment. Indeed, Franklin Lake with its intermediate alkalinity, includes nearly a 50/50 mix of elodeid and isoetid plant species that are present.

On Butternut Lake, members of the stoneworts and muskgrass family were most prevalent, with stiff pondweed being found with 3rd littoral abundance in 2012 (Figure 3.4-6). Stoneworts are actually a type of macro algae rather than a vascular plant. Whorls of forked branches are attached to the "stems" of the plant, which are really just smooth-textured algae. Because they lack roots, stoneworts remove nutrients from the water. Similarly, muskgrasses are a form of macro algae. They are grey to green colored and grow in large clumps in shallow to deep water. When growing in hard, mineral rich water, muskgrasses sometimes become coated with lime, giving them a rough, "gritty" feel. They are easily identified by their strong skunk-like or garlic odor. Stiff pondweed, the third most frequently encountered species on Butternut Lake, is fairly infrequently found across Wisconsin. It prefers hard substrates and alkaline waters. The plant can be difficult to distinguish from other thin-leaved pondweeds without the presence of fruits.

On Franklin Lake, slender naiad, needle spikerush and variable pondweed were the three most encountered species during the point-intercept survey (Figure 3.4-7). Slender naiad is a submersed, annual plant that may reach lengths of eight feet. It is sometimes called bushy pondweed because its small leaves branch out in numerous directions and become stiff and recurved as it ages. The seeds form a dual purpose, as they are a delicious food source for waterfowl. Needle spikerush is a green, grass-like perennial plant that has oval-shaped, brownish-flowering spikes at the tips of its smooth round stem. This species provides food for waterfowl and mammals, while serving as habitat for amphibians and fish. Also, clusters of the plant help to stabilize shorelands. Variable pondweed is a submersed plant that produces a thin, cylindrical stem that has numerous branches. These branches produce linear leaves that grow anywhere from four to eleven centimeters long, and may produce three to seven veins per leaf.

This plant also hybridizes easily with other pondweed (*Potamogeton*) species; thus, this plant can appear quite variable in size and shape and is named appropriately.

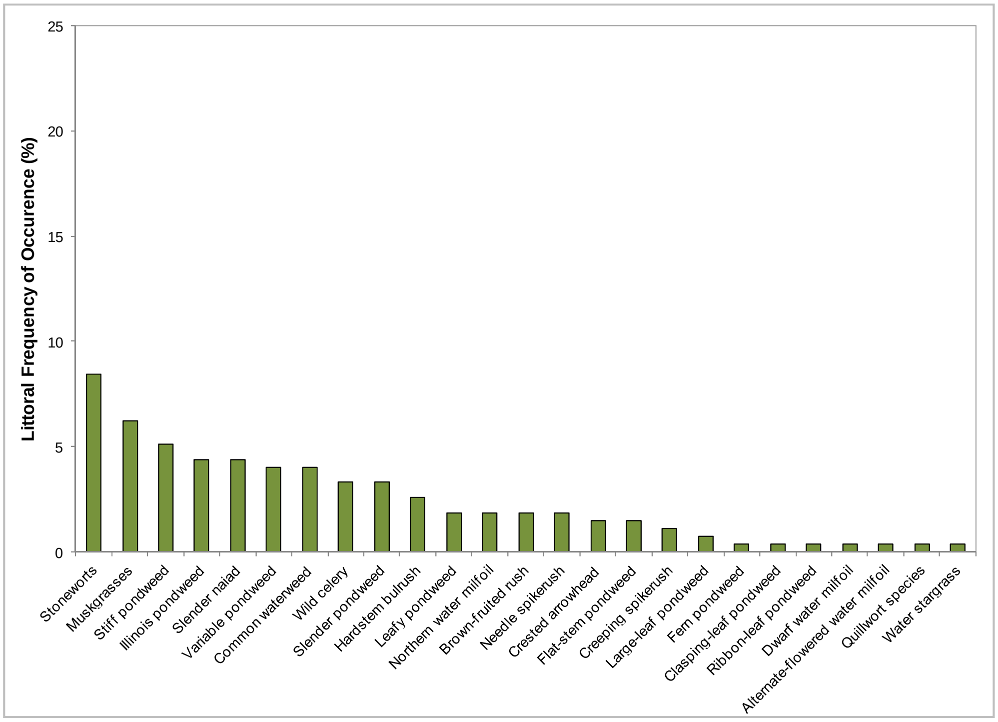


Figure 3.4-6 Butternut Lake aquatic plant littoral frequency of occurrence. Created using data from July 2012 surveys.

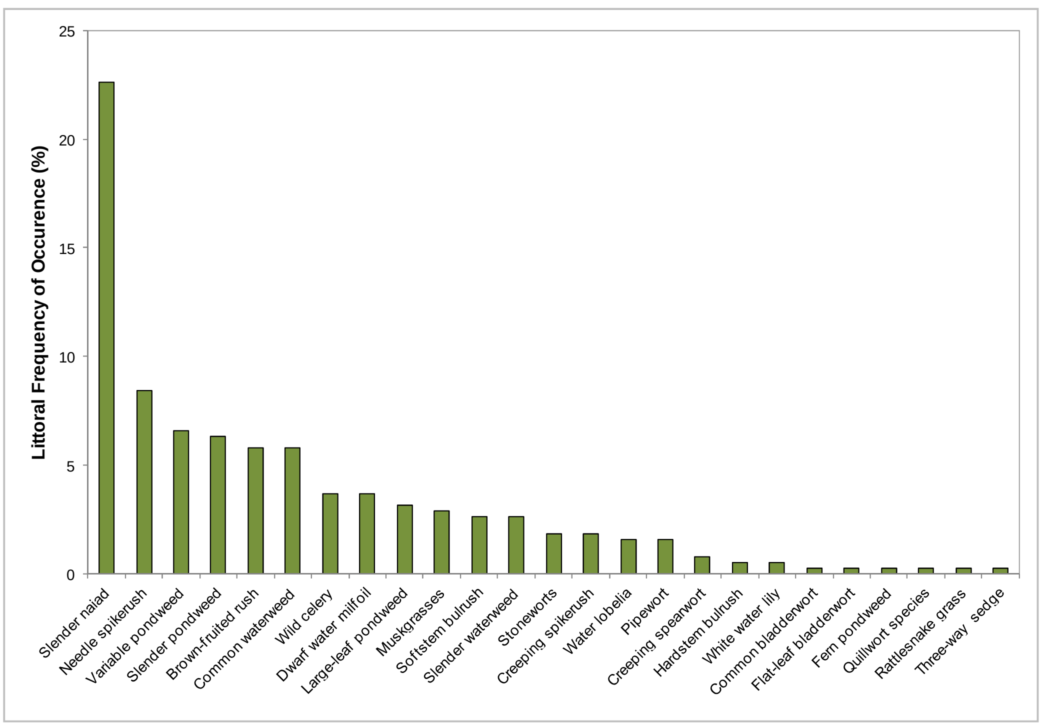


Figure 3.4-7 Franklin Lake aquatic plant littoral frequency of occurrence. Created using data from July 2012 surveys.

Data collected during 2007 and 2012 point-intercept surveys may be used to make comparisons in the aquatic plant community between these time periods. To determine if changes in the populations of native aquatic plant species had occurred, a Chi-square distribution analysis was used on these data. Aquatic plant species that had a littoral frequency of occurrence of at least 4% during both these time periods in Butternut and Franklin Lakes were used in this analysis. In Butternut Lake minor changes had occurred, though no statistically significant changes were observed within the aquatic plant community between these periods. Figure 3.4-8 indicates that within Franklin Lake, several aquatic plant species saw a statistically significant change in their frequency of occurrence between 2007 and 2012. Some of these species increased in their occurrence, others decreased. The cause of this change in frequency is likely environmentally induced; aquatic plants communities may change their composition due to factors such as temperature, growing season length, water chemistry and interspecies (amongst multiple species) competition.

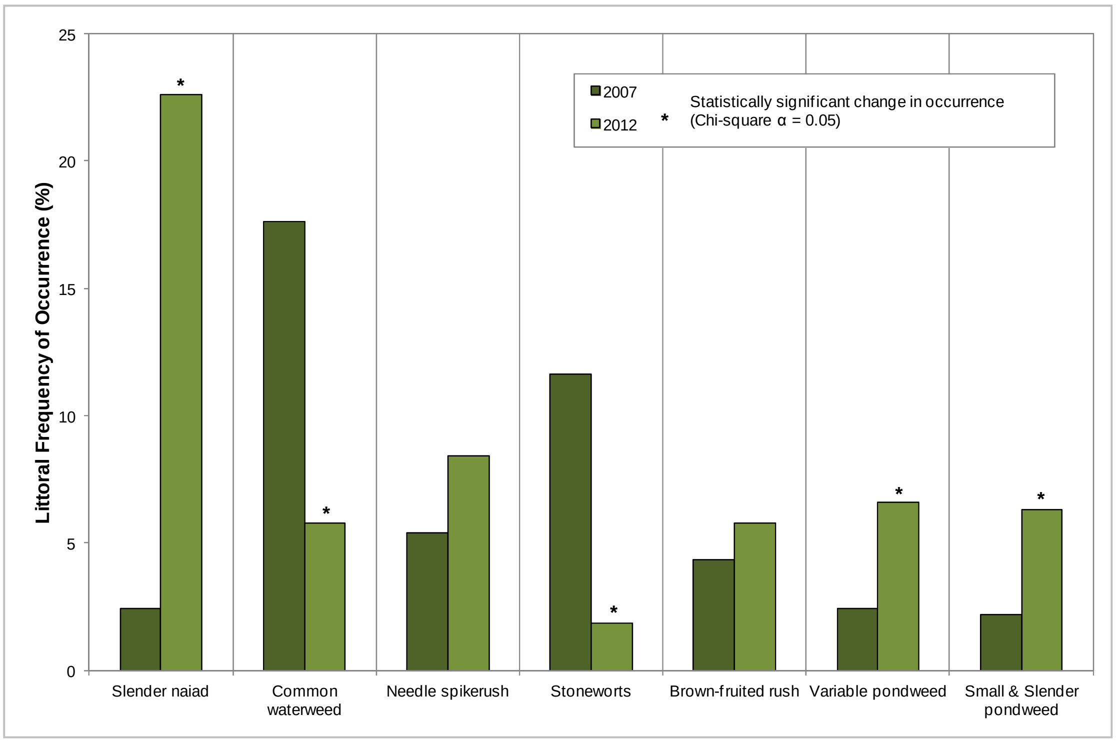


Figure 3.4-8 Franklin Lake littoral occurrence of native aquatic plants, 2007 & 2012. Species with an occurrence of at least 4% in either survey represented. Created using data from 2007 Northern Environmental (now Stantec) and 2012 Onterra point-intercept surveys..

As explained above in the Primer on Data Analysis and Data Interpretation Section, the littoral frequency of occurrence analysis allows for an understanding of how often each of the plants is located during the point-intercept survey. Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For instance, while members of the stoneworts family were found at 8% of the sampling locations in Butternut Lake, their relative frequency of occurrence is 14%. Explained another way, if 100 plants were randomly sampled from Butternut Lake, 14 of them would be slender naiad. Looking at relative frequency of occurrence (Figure 3.4-9), six species comprise approximately half of the plant community in Butternut Lake. On Franklin Lake, four species comprise half of the plant community (Figure 3.4-10).

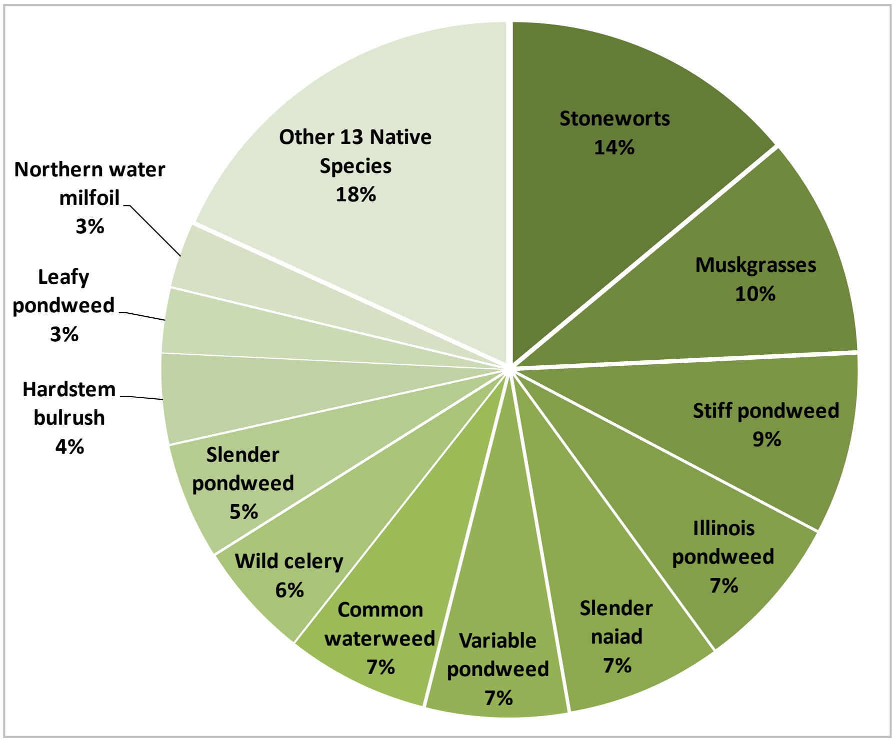


Figure 3.4-9 Butternut Lake aquatic plant relative frequency of occurrence. Created using data from July 2012 surveys.

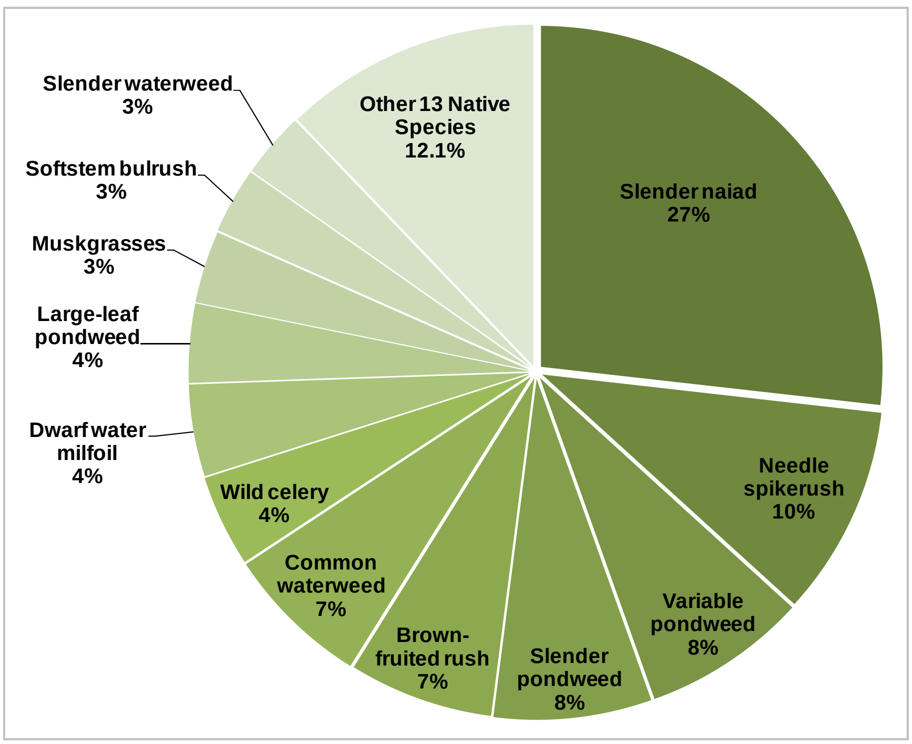


Figure 3.4-10 Franklin Lake aquatic plant relative frequency of occurrence. Created using data from July 2012 surveys.

As discussed previously, the calculations used for the Floristic Quality Index (FQI) for a lake's aquatic plant community are based on the aquatic plant species that were encountered on the rake during the point-intercept survey and does not include incidental species. For example, while 51 native aquatic plant species were located in Butternut Lake during the 2012 surveys, 25 species were encountered on the rake during the point-intercept survey. Figures 3.4-11 and 3.4-12 show that the native species richness for both Butternut Lake and Franklin Lake are above the Northern Lakes and Forests Ecoregion and Wisconsin State medians.

The species that are present in these lakes are indicative of high-quality conditions. Data collected from the aquatic plant surveys show that the 2012 average conservatism values (6.8 for Butternut Lake, 7.3 for Franklin Lake) are well above the Northern Lakes and Forest Lakes Ecoregion and Wisconsin State medians (Figure 3.4-11 and 3.4-12), indicating that the majority of the plant species found in these lakes are considered sensitive to environmental disturbance and their presence signifies excellent environmental conditions.

Combining each lake's aquatic plant species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in exceptionally high 2012 values of 34.2 for Butternut Lake and 35.4 for Franklin Lake (equation shown below). These calculated values are well above the median values for the ecoregion and state (Figure 3.4-11 and 3.4-12), as well as values calculated through 2007 aquatic plant studies. This further illustrates the quality of Butternut and Franklin Lake's plant community.

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

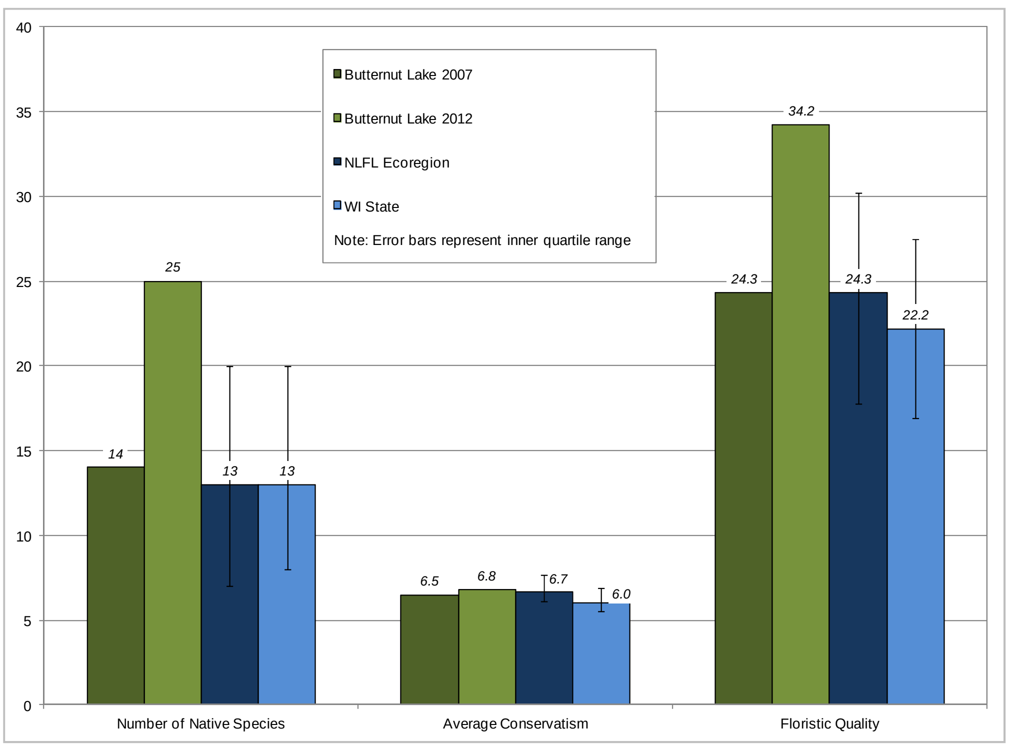


Figure 3.4-11. Butternut Lake Floristic Quality Assessment. Created using data from 2007 and 2012 surveys. Analysis following Nichols (1999) where NLFL = Northern Lakes and Forest Lakes Ecoregion.

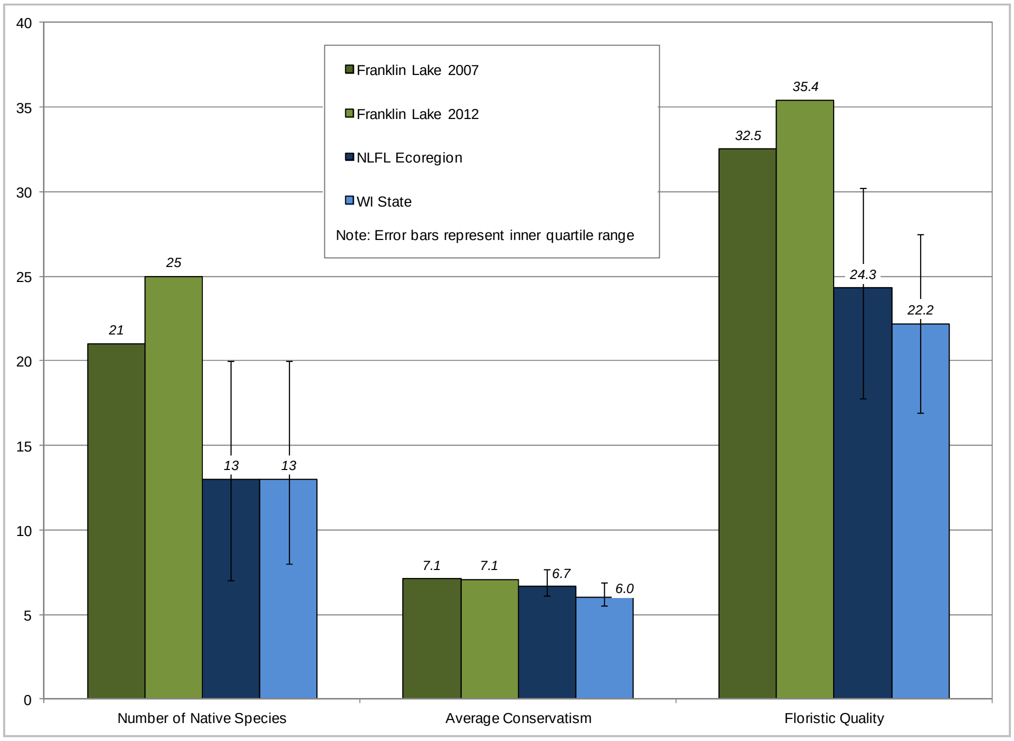


Figure 3.4-12. Franklin Lake Floristic Quality Assessment. Created using data from 2007 and 2012 surveys. Analysis following Nichols (1999) where NLFL = Northern Lakes and Forest Lakes Ecoregion.

Because both Butternut and Franklin Lake contain a high number of native aquatic plant species, one may assume their aquatic plant communities have high species diversity. However, as discussed earlier, species diversity is also influenced by how evenly the plant species are distributed within the community.

The aquatic plant community in both Butternut and Franklin Lake was found to be highly diverse, with a Simpson's diversity value of 0.93 and 0.89, respectively (Figure 3.4-13). This value ranks above state and ecoregion upper quartiles. Lakes with diverse aquatic plant communities have higher resilience to environmental disturbances and greater resistance to invasion by non-native plants. 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.

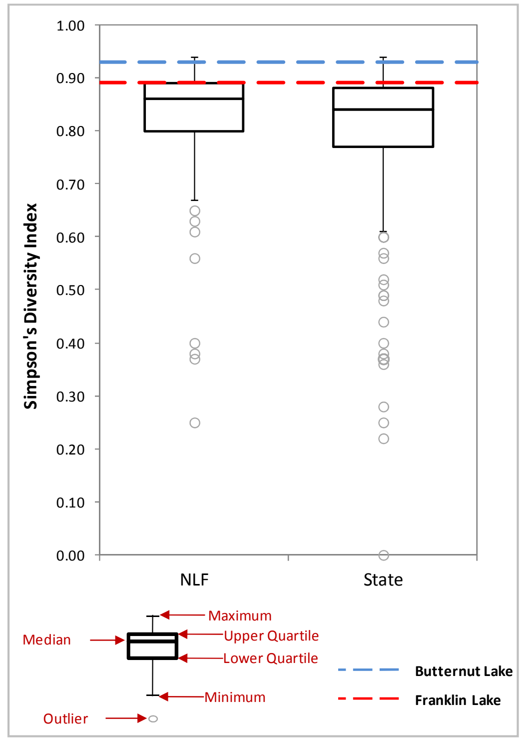


Figure 3.4-13. Butternut Lake and Franklin Lake species diversity index. Created using data from July 2012 aquatic plant surveys. Ecoregion data provided by WDNR Science Services.

The quality of each lake's plant community is also indicated by the high incidence of emergent and floating-leaf plant communities that occur in near-shore areas around the lake. The 2012 community map indicates that approximately 30.5 acres (9%) of the 335 acre Butternut Lake and 62.3 acres of the 225 acre Franklin Lake (28%) contain these types of plant communities (Table 3.4-2; Maps 11 and 12). Twenty-four floating-leaf and emergent species were located on Butternut Lake, while 18 of these species were found on Franklin Lake. These community types provide a diverse type of structural habitat for invertebrates, fish, and other wildlife. These communities also stabilize lake substrate and shoreland areas by dampening wave action from wind and watercraft.

Table 3.4-2. Butternut Lake and Franklin Lake acres of plant community types. Created from a July 2012 community mapping survey.

Plant Community	Butternut Lake Acres	Franklin Lake Acres
Emergent	30.5	43.3
Floating-leaf	-	6.1
Mixed Floating-leaf and Emergent	-	12.9
Total	**30.5**	**62.3**

Because 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 a lake ecosystem. This is important because these communities are often negatively affected by recreational use and shoreland development. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelands when compared to the undeveloped shorelands 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 shorelands.

Reed Canary Grass

Reed canary grass was found on Butternut Lake during 2012 in several locations. Reed canary grass (*Phalaris arundinacea*) is a large, coarse perennial grass that can reach three to six feet in height. Often difficult to distinguish from native grasses, this species forms dense, highly productive stands that vigorously outcompete native species. Unlike native grasses, few wildlife species utilize the grass as a food source, and the stems grow too densely to provide cover for small mammals and waterfowl. It grows best in moist soils such as wetlands, marshes, stream banks and lake shorelands.

Reed canary grass is difficult to eradicate; at the time of this writing there is no efficient control method. Small, discrete patches have been covered by black plastic to reduce growth for an entire season. However, the species must be monitored because rhizomes may spread out beyond the plastic. Chemical applications are difficult because the plant is found in moist environments and many herbicides are harmful to aquatic organisms.

At this time, populations are not excessive, though it is recommended that continued monitoring of reed canary grass takes place. During the community mapping survey of Butternut Lake in July of 2012, Onterra ecologists mapped occurrences of reed canary grass along the shoreland of the lake with sub-meter GPS technology. The spatial data is available upon request and is displayed on Map 11 of this report.

3.5 Fisheries Data Integration

Fishery management is an important aspect in the comprehensive management of a lake ecosystem; therefore, a brief summary of available data is included here as reference. The following section is not intended to be a comprehensive plan for the lake's fishery, as those aspects are currently being conducted by the numerous fisheries biologists overseeing Butternut and Franklin Lake. The goal of this section is to provide an incomplete overview of some of the data that exists, particularly in regards to specific issues (e.g. spear fishery, fish stocking, angling regulations, etc) that were brought forth by the BFLA stakeholders within the stakeholder survey and other planning activities. Although current fish data were not collected, the following information was compiled based upon data available from the WDNR and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) (WDNR 2013 & GLIFWC 2013A and 2013B).

Butternut and Franklin Lake Fishery

Fishing Activity

Based on data collected from the stakeholder survey (Appendix B), fishing was the second highest ranked important reason for stakeholders to own property on or near Butternut Lake and Franklin Lake (Question #14). Approximately 78% of these same respondents believed that the quality of fishing on both lakes was either *Fair* or *Good* (Question #11); however approximately 72% believe that the quality of fishing has gotten *Somewhat* or *Much worse* since they have obtained their property (Question #12). Overall, stakeholders indicated they prefer to catch smallmouth bass and walleye most in Butternut and Franklin Lake.

Table 3.5-1 shows the popular game fish that are present in the system. 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 a lake 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 piscovorous fish community. Studies have shown that in natural ecosystems, it is largely the amount of primary productivity (algae and plant matter) that drives the rest of the producers and consumers in the aquatic food chain. This relationship is illustrated in Figure 3.5-1.

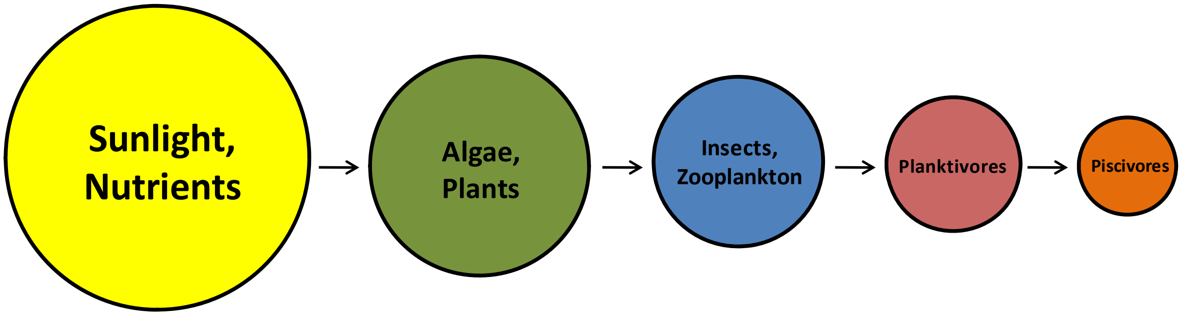


Figure 3.5-1. Aquatic food chain. Adapted from Carpenter et. al 1985.

As discussed in the Water Quality section, Butternut Lake and Franklin Lake are oligotrophic, meaning they have high water clarity, but a low amount of nutrients and thus relatively low primary productivity. Because of the cascading effort of the aquatic food chain, smaller inputs of nutrients and primary productivity at one end result in smaller proportions of predatory fish at the other end. Therefore, Butternut and Franklin Lake may not be as productive in terms of their fishery as other, more nutrient and plant rich Wisconsin lakes.

Table 3.5-1. Gamefish present in the Butternut and/or Franklin Lake with corresponding biological information (Becker, 1983)**.**

Common Name	Scientific Name	Max Age (yrs)	Spawning Period	Spawning Habitat Requirements	Food Source
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
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 gibbosus	12	Early May - August	Shallow warm bays 0.3 - 0.8 m, with sand or gravel bottom	Crustaceans, rotifers, mollusks, flatworms, insect larvae (terrestrial and aquatic)
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
Whitefish*	*Coregonus clupeaformis*	30	Early winter	Shallow rock or sand bottomed water <25 feet deep	Aquatic insect larvae, mollusks and amphipods
Yellow Perch	*Perca flavescens*	13	April - Early May	Sheltered areas, emergent and submergent veg	Small fish, aquatic invertebrates

**Small population in Butternut Lake*

Butternut Lake and Franklin Lake 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 3.5-2). Butternut and Franklin Lake fall within the ceded territory based on the Treaty of 1842. This allows for a regulated open water spear fishery by Native Americans on specified systems. Determining how many fish are able to be taken from a lake, either by spear harvest or angler harvest, is a highly regimented and dictated process. This highly structured procedure begins with an annual meeting between tribal and state management authorities. Reviews of population estimates are made for ceded territory lakes, and then a "total allowable catch" is established, based upon estimates of a sustainable harvest of the fishing stock (age 3 to age 5 fish). This figure is usually about 35% (walleye) or 27% (muskellunge) of the lake's known or modeled population, but may vary on an individual lake basis due to other circumstances. In lakes where population estimates are out of date by 3 years, a standard percentage is used. The total allowable catch number may be reduced by a percentage agreed upon by biologists that reflects the confidence they have in their population estimates for the particular lake. This number is called the "safe harvest level". Often, the biologists overseeing a lake cannot make adjustments due to the regimented nature of this process, so the total allowable catch often equals the safe harvest level. The safe harvest is a conservative estimate of the number of fish that can be harvested by a combination of tribal spearing and state-licensed anglers. The safe harvest is then multiplied by the Indian communities claim percent. This result is called the declaration, and represents the maximum number of fish that can be taken by tribal spearers (Spangler, 2009). Daily bag limits for walleye are then reduced for hook-and-line anglers to accommodate the tribal declaration and prevent over-fishing. Bag limits reductions may be increased at the end of May on lakes that are lightly speared. The tribes have historically selected a percentage which allows for a 2-3 daily bag limit for hook-and-line anglers (USDI 2007).

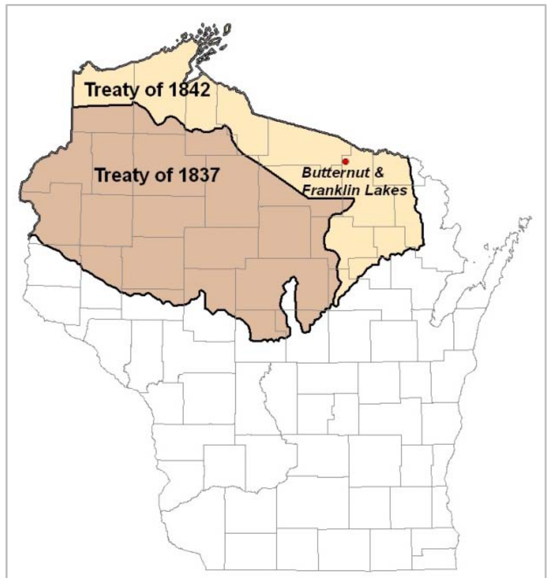


Figure 3.5-2. Location of Butternut and Franklin Lake within the Native American Ceded Territory (GLIFWC 2013A). This map was digitized by Onterra; therefore it is a representation and not legally binding.

Spearers are able to 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 2013B). Creel clerks and tribal wardens are assigned to each lake at the designated boat landing. A catch report is completed for each boating party upon return to the boat landing. In addition to counting every fish harvested, the first 100 walleye (plus all those in the last boat) are measured and sexed. An updated nightly declaration is determined each morning by 9 a.m. based on the data collected from the successful spearers. Harvest of a particular species ends once the declaration is met or the season ends. 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.

Walleye open water spear harvest records are provided in Figure 3.5-3. One common misconception is that the spear harvest targets the large spawning females. Tribal spearers may only take two walleyes over twenty inches per nightly permit; one between 20 and 24 inches and one of any size over 20 inches (GLIWC 2013B). This regulation limits the harvest of the larger, spawning female walleye.

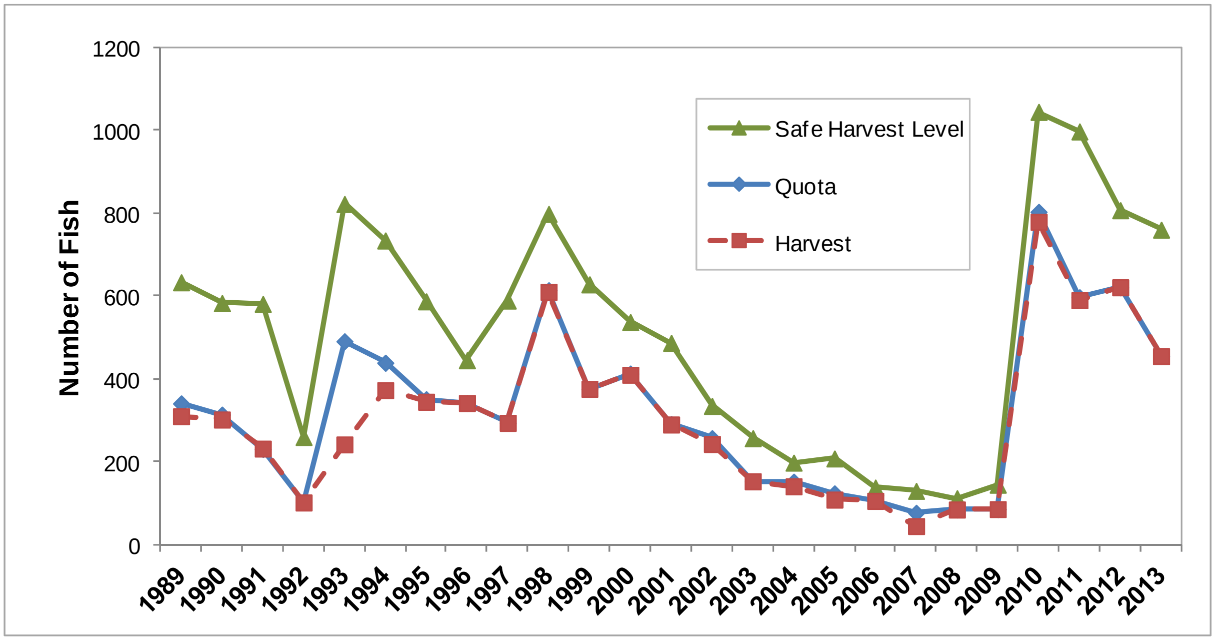


Figure 3.5-3. Butternut Lake walleye spear harvest data. Annual walleye spear harvest statistics are displayed since 1989 (T. Cichosz, personal communication).

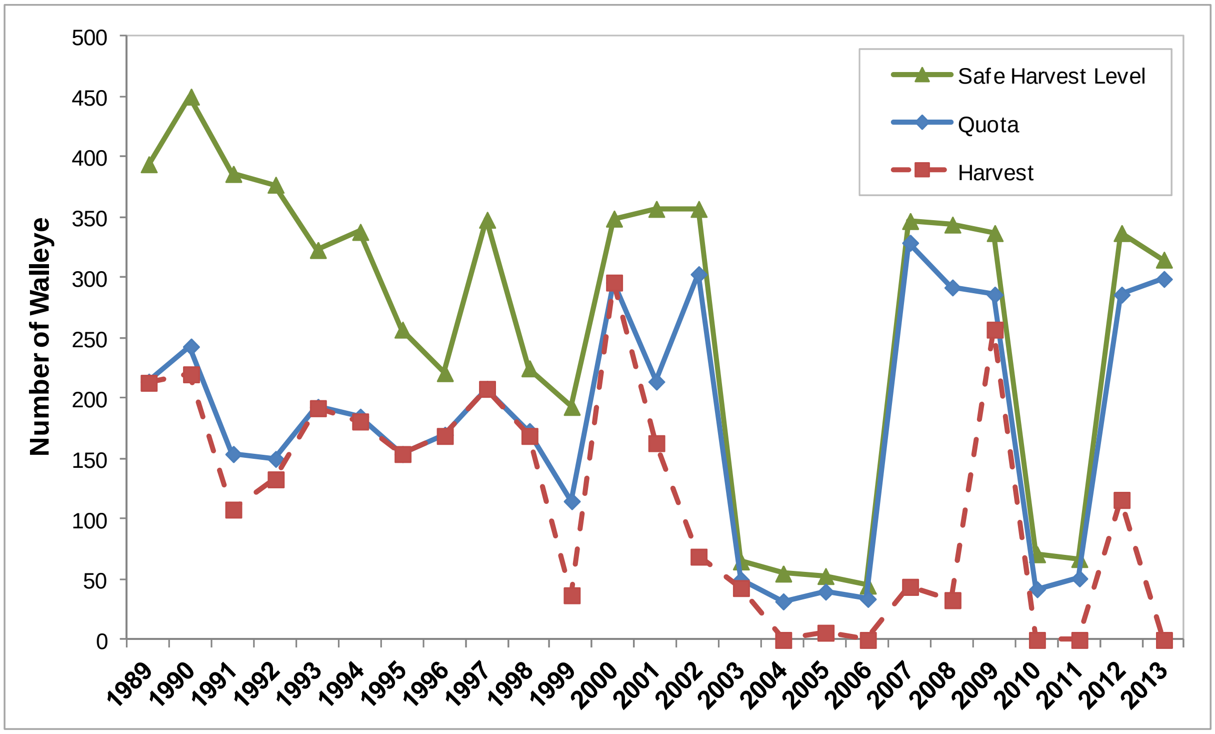


Figure 3.5-4. Franklin Lake walleye spear harvest data. Annual walleye spear harvest statistics are displayed since 1989 (T. Cichosz, personal communication).

Butternut and Franklin Lake Stocking

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

Though walleye were stocked in past years within Butternut Lake, no stocking has occurred since 2007 (Table 3.5-2). Stocking was discontinued because WDNR biologists concluded that the lake has successful, natural reproduction of walleye. In fact, the lake’s walleye fishery is so successful that eggs and sperm are taken from adult fish annually to supply a WDNR hatchery so that other waterbodies may be stocked.

Table 3.5-2. Butternut Lake walleye stocking data (WDNR 2013).

Year	Age Class	# Stocked	Avg. Length (inches)
2002	Fry	1,699,800	0.3
2003	Fry	3,500,000	0.5
2004	Fry	5,556,000	0.5
2005	Fry	1,644,000	0.3
2006	Fry	2,000,000	0.3
2007	Fry	1,174,000	0.3

Franklin Lake is currently stocked every other year with walleye, in even years (Table 3.5-3). Whereas Butternut Lake has very successful natural reproduction, stocking is necessary in Franklin Lake in order to maintain the walleye population. Currently, WDNR biologists have several ideas as to why the population is not naturally reproducing but no clear-cut reason has been found. There are hopes that the population will be able to naturally reproduce in the future, eliminating the need for stocking efforts.

Table 3.5-3. Franklin Lake walleye stocking data (WDNR 2013).

Year	Age Class	# Stocked	Avg. Length (inches)
2005	Fry	1,396,000	0.3
2006	Fry	1,500,000	0.3
2007	Fry	1,636,000	0.3
2010	Small Fingerling	31,194	1.4
2012	Small Fingerling	37,720	1.6

Butternut and Franklin Lake Substrate and Near Shore Habitat

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

According to the point-intercept survey conducted by Onterra in 2012, the majority of the substrate in Butternut Lake and Franklin Lake consist of sand (Butternut Lake – 69%, Franklin Lake – 57%). Rocky substrates can be found in both lakes, while muck was only encountered in the littoral zone in Franklin Lake (Figure 3.4-3 of the Aquatic Plant Section). Substrate and habitat are critical to fish species that do not provide parental care to their eggs, in other words, the eggs are left after spawning and not tended to by the parent fish. 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 is another species that does not provide parental care to its eggs. Walleye preferentially spawn in areas with gravel or rock in places with moving water or wave action, which oxygenates the eggs and prevents them from getting buried in sediment. Fish that provide parental care are less selective of spawning substrates. Species such as bluegill tend to prefer a harder substrate such as rock, gravel or sandy areas if available, but have been found to spawn in muck as well.

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

Butternut and Franklin Lake Regulations and Management

Because Butternut and Franklin Lake are located within ceded territory, special fisheries regulations may occur, specifically in terms of walleye. An adjusted walleye bag limit pamphlet is distributed each year by the WDNR which explains the more restrictive bag or length limits that may pertain to the lakes. In 2013-2014, the daily bag limit was adjusted to two walleye for Butternut Lake while it remained at five walleye for Franklin Lake. On each lake, there is currently no minimum length limit for walleye, but a slot limit is in effect. Fish between 14" and 18" may not be kept and only one fish over 18" is allowed. Motor trolling is permitted on both Butternut Lake and Franklin Lake.

Butternut and Franklin Lake are located within the northern region of Wisconsin, so special regulations may occur that differ from those in other areas of the state. For example, the lakes are within the northern large and smallmouth bass management zone, as well as the northern half of the muskellunge and northern pike management zone. Tables 3.5-4 and 3.5-5 display the 2013-2014 regulations for species that may be found in Butternut Lake and Franklin Lake. Please note that this table is intended to be for reference purposes only, and that anglers should visit the WDNR website (www. http://dnr.wi.gov/topic/fishing/regulations/hookline.html) for specific fishing regulations or visit their local bait and tackle shop to receive a free fishing pamphlet that would contain this information.

Table 3.5-4. WDNR fishing regulations for Butternut Lake, 2013-2014.

Species	Season	Regulation
Panfish	Open All Year	No minimum length limit and the daily bag limit is 25.
Largemouth and smallmouth bass	May 4, 2013 to June 14, 2013	Fish may not be harvested (catch and release only)
Largemouth and smallmouth bass	June 15, 2013 to March 2, 2014	The minimum length limit is 14" and the daily bag limit is 5.
Muskellunge and hybrids	May 25, 2013 to November 30, 2013	The minimum length limit is 40" and the daily bag limit is 1.
Northern pike	May 4, 2013 to March 2, 2014	No minimum length limit and the daily bag limit is 5.
Walleye, sauger, and hybrids	May 4, 2013 to March 2, 2014	No minimum length, but fish from 14" to 18" may not be kept and only 1 fish over 18" is allowed. Daily bag limit is 2 fish.
Rock, yellow, and white bass	Open All Year	No minimum length limit and the daily bag limit is unlimited.
Cisco and whitefish	Open All Year	No minimum length and the daily bag limit is 25 pounds plus one more fish of either species in total.

Table 3.5-5. WDNR fishing regulations for Franklin Lake, 2013-2014.

Species	Season	Regulation
Panfish	Open All Year	No minimum length limit and the daily bag limit is 25.
Largemouth and smallmouth bass	May 4, 2013 to June 14, 2013	Fish may not be harvested (catch and release only)
Largemouth and smallmouth bass	June 15, 2013 to March 2, 2014	The minimum length limit is 14" and the daily bag limit is 5.
Muskellunge and hybrids	May 25, 2013 to November 30, 2013	The minimum length limit is 40" and the daily bag limit is 1.
Northern pike	May 4, 2013 to March 2, 2014	No minimum length limit and the daily bag limit is 5.
Walleye, sauger, and hybrids	May 4, 2013 to March 2, 2014	No minimum length, but fish from 14” to 18” may not be kept and only 1 fish over 18” is allowed. Daily bag limit is 5 fish.
Rock, yellow, and white bass	Open All Year	No minimum length limit and the daily bag limit is unlimited.
Cisco and whitefish	Open All Year	No minimum length and the daily bag limit is 25 pounds plus one more fish of either species in total.

Greg Matzke is the WDNR fisheries biologist for inland lakes in Florence and Forest Counties. Through personal communication during this management planning project, Mr. Matzke stated that Butternut Lake holds a great walleye and smallmouth bass fishery. The lake turns out high numbers of both of these species through natural reproduction, and has trophy size potential for smallmouth bass. Because of its potential for these species, walleye and smallmouth bass are the current focus of management activities for Butternut Lake. The walleye slot limit regulation is in place to encourage consumption or harvest of walleye. With more smaller fish removed, WDNR biologists hope that the population will have more resources to increase the size quality. Currently, the fishery in Butternut Lake is meeting all goals so WDNR biologists plan to continue to monitor the populations so that if an issue arises in the future, they will have the scientific data to make further management decisions.

Mr. Matzke stated that based upon WDNR studies, Franklin Lake also has a substantial walleye and smallmouth bass population. These species are the focus of management efforts in the lake. Around 2000, the walleye population began to drop due to several years of poor natural reproduction. Current stocking efforts are intended to bolster the population, in hopes that natural reproduction increases with this species. As with Butternut Lake, Franklin Lake has a slot limit regulation for walleye. In 2014, Mr. Matzke will be surveying Franklin Lake and will be able to determine what the status of the walleye population is within the lake, and if a different regulation may be more applicable. Butternut Lake will be surveyed in 2014 as well.

4.0 SUMMARY AND CONCLUSIONS

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

1) Provide an up-to-date assessment of the ecological health of Butternut and Franklin Lakes.
2) Collect detailed information regarding invasive plant species within each lake, if any were found.
3) Collect sociological information from Butternut and Franklin Lake stakeholders regarding their use of the lake and their thoughts pertaining to the past and current condition of the lake and its management.

The three objectives were fulfilled during the project and have led to a good understanding of the Butternut and Franklin Lakes ecosystem, the folks that care about the lakes, and what needs to be completed to protect and enhance them.

As discussed throughout this report, an assessment of a lake's ecological health involves inventorying and analyzing data and observations from a variety of components. During the 2012 studies, Onterra staff and BFLA volunteers collected water samples which, when analyzed for their chemical and biological constituents, would indicate many things about the ecosystem. Phosphorus, arguably the nutrient of most concern when discussing Wisconsin lakes, was found to be in low to moderate concentrations within each lake. It is important to have ample nutrients within a lake environment to support low/moderate growth of algae and aquatic plants; however when this nutrient is found in excess it can cause impairment. Other indicators of water quality conditions, such as chlorophyll-*a*, Secchi disk clarity, dissolved oxygen and pH, all check out to be as expected for a healthy lake found in the Northwoods of Wisconsin. In fact, most of these parameters indicate exceptional health.

The surrounding watershed strongly influences many aspects of the water quality and plant community in a lake. Even in a completely natural state, large watersheds drain large quantities of water, along with nutrients and sediments, to a lake. When these watersheds are developed into agricultural or urban landscapes, further impairment often occurs. Smaller watersheds drain less surface water to a lake, but are still impacted heavily by potential development. As the Watershed Section details, the watershed surrounding Butternut and Franklin Lakes is relatively small in size, and is in largely a natural state. Furthermore, this land is protected from development as the majority of the watershed is within the Chequamegon-Nicolet National Forest.

One area of the watershed that could be considered most vulnerable is the immediate shoreland zone. Not only is this where private land lies, but as explained in the Shoreland Assessment this area is critical in terms of its buffering of surface water runoff and in its habitat potential for terrestrial and aquatic wildlife. While much of the shoreland is occupied by national forest, a good amount of the privately owned shoreline is developed to some degree. Enhancing native vegetation and minimizing further development of these areas should be a priority of the BFLA as well as private landowners.

Much like blood pressure or cholesterol counts are an indicator of the health of a human being, the aquatic plant community is an indicator of the health of a lake. Analysis of an aquatic plant community tells us if the system has seen much disturbance. This is done by examining not only how many species are present, but what species are there and what their relative abundance is. Studies have shown that a diverse, species-rich aquatic plant community provides better habitat and food for aquatic animals. An additional benefit of high-quality plant communities is the presence of natural protection from aquatic invasive species establishment.

During aquatic plant studies, 51 species of plants were found on Butternut Lake and 41 were found on Franklin Lake. As discussed in the Aquatic Plant Section, this is a tremendous number of species to find in a lake environment and is a testament to the exceptional quality of these lakes. This report goes on to discuss the diversity (even distribution) of these plants throughout the lake as well as the documentation of some species that are intolerant of disturbed conditions, meaning that Butternut and Franklin Lakes may be considered undisturbed yet.

The aquatic plant inventories identified only one non-native, emergent plant species - reed canary grass. This plant has become fairly common in wetlands and lake shorelines across Wisconsin as well as much of North America and Canada. Immediate management for this species is not required, though continued monitoring would be important. The BFLA also wishes to allocate resources towards monitoring of two aquatic invasive species that are not thought to exist in their lakes – Eurasian water milfoil and curly-leaf pondweed. So many lakes in the Northwoods now hold these invasive plants and struggle with their management. The BFLA understands the importance of preventing exposure to these plants, as well as finding an infestation early on should one occur. With an extensive history of proactive work, this is a task the BFLA is more than prepared to undertake.

When compared to lakes statewide and to the pristine lakes of the Northwoods of Wisconsin, Butternut and Franklin Lakes rank as outstanding in terms of their ecological health and rich condition. All those who visit lakes in Wisconsin do so for a variety of reason; some to bathe in crystal clear waters, some to take in the scenery or variety of flora and fauna a lake attracts, and some to partake in an angling experience few states in America can offer. Butternut and Franklin Lakes are somewhat unique in that they provide a number of these opportunities. With a proactive attitude and an incredible amount of knowledge about their lakes, the BFLA is prepared to move forward with the management goals outlined in the Implementation Plan below to protect these exceptional lakes.

5.0 IMPLEMENTATION PLAN

The Implementation Plan presented below was created through the collaborative efforts of the Butternut Franklin Lake Planning Committee and ecologist/planners from Onterra. It represents the path the BFLA will follow in order to meet their lake management goals. The goals detailed within the plan are realistic and based upon the findings of the studies completed in conjunction with this planning project and the needs of the Butternut and Franklin Lake stakeholders as portrayed by the members of the Planning Committee, the returned stakeholder surveys, and numerous communications between Planning Committee members and the lake stakeholders. The Implementation Plan is a living document in that it will be under constant review and adjustment depending on the condition of the lake, the availability of funds, level of volunteer involvement, and the needs of the stakeholders.

Management Goal 1: Optimize Efficiency of BFLA and Lake Management Activities

Management Action: Form Joint Committee to oversee lake management actions

Timeframe: Begin 2014

Facilitator: Board of Directors

Description: Many organizations create sub-committees in an effort to increase efficiency. This action divides tasks amongst a group of people, thereby increasing the amount of time and thus the quality of research and work that a task receives. Additionally, it ensures that goals are met by assigning specific tasks to individuals/committees who report upon progress until completion is achieved.

At Planning Meeting II, BFLA Planning Committee members began discussion of formation of a Butternut-Franklin Lakes Joint Committee, whose purpose would be to oversee management activities associated with the lakes. A potential name, thought of at the planning meeting, was the "Butternut Franklin Lakes Management Committee". This committee would be composed of several sub-committees to oversee specific areas. Examples of sub-committees include an AIS Monitoring Committee, Education Committee, Lake Monitoring Committee, Volunteer Recruitment Committee, etc. By having several people devoted to each committee, volunteers will be able to dedicate their time to creating new and innovative ideas with respect to one focus point, instead of many.

Action Steps:

1. Board of Directors approves of Joint Committee
2. Sub-committees selected by board based upon needs of BFLA.
3. Board of Directors will identify a base level of annual financial support.
4. Recruitment of sub-committee volunteers facilitated by Board.
5. Board investigates whether small-scale grant would be applicable for committee creation.

Management Goal 2: Increase BFLA's Capacity to Educate and Communicate with Lake Stakeholders

<u>Management Action:</u> Support an Education and Communication Committee to promote water quality, public safety, ecological responsibility and quality of life on Butternut and Franklin Lake.

Timeframe: Enhancement of existing efforts

Facilitator: Board of Directors

Description: During planning meetings between Onterra staff and the BFLA planning committee, methods of improving education and communication amongst the BFLA and other stakeholder were discussed. Two items specifically were discussed – 1) ways to focus on educational issues specific to Butternut and Franklin Lakes and 2) documentation of what communication mediums are in use and if more are necessary.

<u>Focus: Education</u>
Education represents an effective tool to address issues that impact water quality such as lake shore development, lawn fertilization, and other issues such as air quality, noise pollution, and boating safety. In coordination with Management Goal 1, an Education Committee will be created to promote lake protection through a variety of educational efforts.

Some specific educational topics the BFLA planning committee identified through this planning process include:

- Aquatic invasive species monitoring
- Boating safety and ordinances (slow-no-wake zones and hours) as well as courtesy codes
- Catch and release fishing
- Shoreland restoration and protection
- Septic system maintenance
- Fishing regulations
- Lake property values

The committee will be responsible for reaching out to state or local affiliates which can provide them with educational pamphlets, other materials or ideas. These partners may be some of those included in the table found under the table included with Management Goal 1.

<u>Focus: Communication</u>
The most important aspect of educating those involved in an organization is successful communication. Communication among lake stakeholders is important because it builds a sense of community around a lake while encouraging the spread of information regarding

association news, educational topics or social events. Communication also ensures that volunteer or other efforts are not duplicated and that resources are spent efficiently.

Communication within a lake group can be a cumbersome task, as lake residents can range from full-time, seasonal or weekend-only residents. The preferred communication medium of lake residents seems to range often as well; some may be familiar with using email and social media sources while others are not and thus prefer physical mailings or phone calls.

Communication between the BFLA and others is not ineffective at this point, as shown through results of a stakeholder survey (Appendix B, Question #28). Nevertheless, the BFLA is committed to maintaining and even improving education and open communication amongst stakeholders.

Currently, the BFLA communicates with stakeholders in the following ways:

- An annual meeting
- A newsletter that is published bi-annually
- An active website
- A Facebook® page

These four methods of communication work well because several may be considered direct (a meeting or newsletter mailing) while others, such as the website and Facebook® page, are passive in that they allow stakeholders to view information at their convenience.

Action Steps:

1. Board of Directors appoints an Education and Communication Committee in conjunction with Management Goal 1.
2. Committee creates educational materials based upon subject matter specified in text above, with additional topics added as needed.
3. Committee distributes educational material through four communication mediums above.
4. Committee determines if additional communication mediums are needed, presents to Board of Directors for approval.

Management Goal 3: Maintain Established Partnerships

Management Action: Facilitate efficient dialogue with other management entities.

Timeframe: Continuation of existing efforts

Facilitator: Board of Directors

The waters of Wisconsin belong to everyone and therefore this goal of protecting and enhancing these shared resources is also held by other entities. Some of these entities are governmental while other organizations are similar to the BFLA in that they rely on voluntary participation.

It is important that the BFLA actively engage with all management entities to enhance the association's understanding of common management goals and to participate in the development of those goals. This also helps all management entities understand the actions that others are taking to reduce the duplication of efforts. The primary management units regarding Butternut and Franklin Lakes include governmental units such as the WDNR, or Town of Hiles, but also include entities such as the Forest County Association of Lakes and Lumberjack AIS Coordinator. Each entity is specifically addressed on the next page.

Action Steps:

1. See table guidelines on next page.

Partner	Contact Person	Role	Contact Frequency	Contact Basis
United States Forest Service	Local office (7151-479-2827)	Management of Chequamegon-Nicolet National Forest	As needed	Contact regarding issues at public access, collaborating on restoration oreducational materials
Forest County Association of Lakes	Contact (Lee Lamers – 715.473.2633)	Protects Forest Co. waters through facilitating discussion and education.	Twice a year or as needed.	Training or education opportunities, partnering in special projects, or networking on other topics pertaining to Forest Co. waterways.
Vilas County Lakes & Rivers Association	President (Rollie Alger – president@vclra.us)	Protects Vilas Co. waters through facilitating discussion and education.	Twice a year or as needed.	Training or education opportunities, partnering in special projects, or networking on other topics pertaining to Vilas Co. waterways.
Oneida County Lakes & Rivers Association	Secretary (Connie Anderson – 715.282.5798)	Protects Oneida Co. waters through facilitating discussion and education.	Twice a year or as needed.	Training or education opportunities, partnering in special projects, or networking on other topics pertaining to Oneida Co. waterways.
Lumberjack Aquatic Invasives Coordinator	AIS Coordinator (John Preuss – (715) 369-9886)	Oversees AIS monitoring and prevention activities locally.	Twice a year or more as issues arise.	Spring: AIS training and ID, AIS monitoring techniques Summer: Report activities to Mr. Preuss.
Forest County Land and Water Conservation Department	County Conservationist (Cindy Gretzinger – 715-478-7796)	Oversees conservation efforts for land and water projects.	Twice a year or more as needed.	Contact for shoreland remediation techniques and cost-share procedures, wildlife damage programs, education and outreach documents.
Town of Hiles	Town Chair (Karl Tauer – 715-493-4647)	Oversees ordinances and other items pertaining to town.	As needed.	Town staff may be contacted regarding ordinance reviews or questions, and for info on community events.
Wisconsin Department of Natural Resources	Fisheries Biologist (Greg Matzke – 715.528.4400)	Manages the fishery of Butternut and Franklin Lakes.	Once a year, or more as issues arise.	Stocking activities, scheduled surveys, survey results, volunteer opportunities for improving fishery.
	Lakes Coordinator (Jim Kreitlow– 715.365.8947)	Oversees management plans, grants, all lake activities.	Every 5 years, or more as necessary.	Information on updating a lake management plan (every 5 years) or to seek advice on other lake issues.
	Warden (Bradley Dahlquist – 715.478.5610)	Oversees regulations handed down by the state.	As needed. May call the WDNR violation tip hotline for anonymous reporting (1-800-847-9367, 24 hours a day).	Contact regarding suspected violations pertaining to recreational activity on the lake, include fishing, boating safety, ordinance violations..
	Citizens Lake Monitoring Network contact (Sandra Wickman – 715.365.8951)	Provides training and assistance on CLMN monitoring & methods.	Twice a year or more as needed.	Late winter: arrange for training as needed, plan monitoring for the summer. Late fall: report monitoring activities.
Wisconsin Lakes	General staff (800.542.5253)	Facilitates education, networking and assistance WI lakes.	As needed. May check website (www.wisconsinlakes.org) often for updates.	Attend WL's annual conference. WL reps can assist on grant issues, AIS training, habitat enhancement techniques, etc.

Management Goal 4: Maintain Current Water Quality Conditions

Management Action: Continue monitoring of water quality through WDNR Citizens Lake Monitoring Network.

Timeframe: Continuation of current effort.

Facilitator: Board of Directors

Description: Monitoring water quality is an import aspect of every lake management planning activity. Collection of water quality data at regular intervals aids in the management of the lake by building a database that can be used for long-term trend analysis. In fact, within this document a more complete analysis was able to be conducted on Butternut and Franklin Lakes water quality because of the extended dataset that is available. Volunteers from the BFLA have collected Secchi disk clarities and water chemistry samples during this project and in the past through the WDNR Citizens Lake Monitoring Network (CLMN). Stability will be added to the program by selecting an individual from the BFLA to coordinate the lake's volunteer efforts and to recruit additional volunteers as needed. This volunteer will ensure that appropriate data is collected, and also entered into the WDNR's online data warehouse, SWIMS (Surface Water Integrated Monitoring System).

Action Steps:

1. Board of Directors recruits volunteer to conduct lake sampling.
2. Coordinator directs water quality monitoring program efforts and volunteers.
3. Volunteers collect data and coordinator/volunteers report results to WDNR and to association members during annual meeting.

Management Action: Investigate Butternut Lake phosphorus through advanced studies in management plan update

Timeframe: Initiate with management plan update

Facilitator: Board of Directors

Description: As discussed within the Water Quality Section, there is an increasing trend in the summer phosphorus and chlorophyll-*a* in Butternut Lake. The trend is very slight, and has not impacted the clarity of the water according to an analysis conducted on Secchi disk values. Although a trend has developed over the time in which data is available for these parameters, it is yet to be seen if this trend is due to an unaccounted for source of phosphorus or if it is due to environmental conditions that have changed over time. Nutrients and algae may fluctuate annually based upon the presence of optimal or sub-optimal conditions, often making trend detection over a relatively short period of time difficult.

Through the baseline monitoring that has happened through the Citizens Lake Monitoring Network and through this planning project, there has been detection of what may be a trend in water quality. There has not, however, been detection of what a potential source may be. Butternut Lake is surrounded by a smaller watershed which holds mostly natural land cover; the largest phosphorus loading from the watershed in fact comes from atmospheric deposition at the lake's surface. The lake also has little development with 75% of its shoreline in a completely natural state. As there are few residences bordering the large lake, septics are not thought to impact nutrient content greatly. And finally, through the modeling exercises discussed in the Watershed Section, it is believed that a predictive model accurately projected the lake's phosphorus concentrations, meaning there are not thought to be any unaccounted for phosphorus sources in the lake.

While baseline monitoring methods have answered some questions, they have in a sense spurred further questions. What is known is that despite a slight increase in phosphorus and chlorophyll-*a* trends, the lake is still in very healthy condition and its condition is not outside of what is expected for a lake of its size, its hydrology and its location in the State of Wisconsin. What is yet to be discovered is if the detected trends are real, and what the source of the elevated phosphorus may be.

During the planning meeting discussions that were held in summer of 2013, it was decided upon by the Butternut Franklin Lakes Planning Committee that during a management plan update, to take place in five to seven years, more in-depth studies would be built into the project which would serve to better quantify the phosphorus budget in the lake. Specifically, these studies would include sampling of the hypolimnion phosphorus concentration through the summer months, as well as monitoring of dissolved oxygen content in the entire water column. Other examinations such as sediment cores and an examination of groundwater flow patterns would be included if deemed necessary. At that point in time, managers would be in a better position to examine these suspected trends and proceed with a plan to investigate potential sources.

Action Steps:

1. Apply for management planning grant in 2018-2020 to update studies conducted in 2012.
2. Ensure planning update methodology includes phosphorus budgeting components.
3. Retain professional consultant to conduct studies on Butternut Lake.

Management Action: Initiate monitoring of water levels on Butternut and Franklin Lakes through Citizens Lake Monitoring Network

Timeframe: Begin with summer 2014.

Facilitator: Board of Directors

Description: Like many lakes in Wisconsin, the water levels in Butternut and Franklin Lakes have fluctuated in response to changing precipitation conditions over the past 10-15 years. Lakes that lack a tributary input (drained lakes, spring or seepage lakes) are typically impacted more so by lower precipitation levels than drainage lakes, which are tempered by the larger amount of land that drains to them.

During conversations at Planning Meeting II, BFLA members expressed interest in monitoring water levels on Butternut and Franklin Lakes. Like monitoring water quality, water level monitoring should be conducted using standardized methodology such as a calibrated staff gauge well. Additionally, measurements should be made available in a public forum so that those managing Butternut and Franklin Lakes in the future can retrieve the data.

A BFLA representative will contact Laura Herman, the Citizen Lake Monitoring Network Educator at the University of Wisconsin Extension office (715-365-8998) to discuss the beginning steps of entering Butternut and Franklin Lakes into this initiative. Efforts are currently being pursued to create a standardized methodology for lakes to monitor water levels and include these data on SWIMS, the online data warehouse that also holds water quality and Clean Boats Clean Waters monitoring data.

Action Steps:

1. Board of Directors appoints volunteer to oversee initiative
2. Volunteer contacts UW-Extension staff (Katie Hein – Catherine.Hein@Wisconsin.gov) to discuss inclusion into the water level monitoring program.

Management Goal 5: Prevent Introduction of Aquatic Invasive Species to Butternut and Franklin Lakes

Management Action: Investigate watercraft cleaning technology solutions and applicability for Butternut and Franklin Lakes.

Timeframe: Begin 2014

Facilitator: Board of Directors

Description: The battle against aquatic invasive species has been met with many "tools" by lake managers, state legislators, and lake stakeholders alike. As a result of the spread of these species, programs such as Clean Boats Clean Waters have developed, educational media such as signs, posters, billboards and television commercials have been crafted, and laws have been generated to reduce the spread of these species via boat trailers. Some programs have been developed to take another step in stopping the spread of aquatic invasives – providing either voluntary or mandatory boat and trailer washing stations at public boat landings.

This concept is not new, but has been somewhat controversial and difficult to implement. Some programs have seen opposition from watercraft operators in utilizing the washing stations. Several programs began, but lacked funding or staff to continue. Others did not meet the demand to provide complete, 24/7 coverage for a waterbody and thus were deemed ineffective.

The BFLA, determined to protect their lakes from aquatic invasive species, will prioritize researching innovative and new technologies that allow for effective watercraft decontamination. With many products being created, it is often difficult to sort through those that are functional and those that are cost effective. A volunteer of the BFLA will be appointed to research boat cleaning technologies. Assistance may be provided by the Lumberjack Aquatic Invasives Coordinator (John Preuss), the WDNR, or UW-Extension staff. Attending the Wisconsin Lakes conference or other industry conferences may expose the volunteer to up-and-coming technologies. Alternatives to this plan may be researched as well, such as Lake Champlain's program which instead of providing wash stations at boat landings provides information to boaters to find local car wash stations that can be used to wash boats, trailers and other equipment. More information on this program can be obtained on the Lake Champlain Basin Program website: http://www.lcbp.org.

Action Steps:

1. Appointed volunteer researches watercraft washing programs, determining applicability to Butternut and Franklin Lakes.
2. Volunteer provides a summary report to Board of Directors
3. Based upon findings, BFLA may decide to pursue one or several options.
4. Volunteer determines applicability of state grant funds for project.

<u>Management Action:</u> Establish annual volunteer monitoring for aquatic invasive species

Timeframe: Begin Summer 2014

Facilitator: Board of Directors

Description: Butternut and Franklin Lakes are currently not known to hold submergent aquatic invasive plant species such as curly-leaf pondweed or Eurasian water milfoil. Because of the threat these plants pose to their lakes, the BFLA wishes to develop a proactive approach to monitoring their lake and identifying recent infestations, should they occur. Also important is a monitoring design that maximizes BFLA volunteer's time as well as maximizes the amount of littoral area of the lake that is covered.

One way that lake residents can spot aquatic invasive species is through conducting "Lake Sweeps" on their lake. During a lake sweep, volunteers monitor the entire littoral zone in search of non-native plant species. This program uses an "adopt-a-shoreline" approach where volunteers survey specified, assigned areas.

In order for accurate data to be collected during these sweeps, volunteers must be able to identify non-native species such as Eurasian water milfoil and curly-leaf pondweed. Distinguishing these plants from native look-a-likes is very important. Additionally, the collection of suspected plants is important. A specimen of the plant would need to be collected for verification, and, if possible, GPS coordinates should be collected. Lumberjack Aquatic Invasives Coordinator John Preuss is an excellent resource to contact for assistance in developing monitoring techniques, identifying invasive aquatic plants and logging pertinent monitoring information.

Action Steps:

1. Volunteers from the BFLA update their skills by attending a training session conducted by Lumberjack Aquatic Invasives Coordinator John Preuss.
2. Trained volunteers recruit and train additional association members.
3. Complete lake surveys following designated protocols.
4. Report results to WDNR, Lumberjack AIS Coordinator and BFLA.

<u>Management Action:</u> Continue Clean Boats Clean Waters watercraft inspections at Butternut and Franklin Lakes public access locations.

Timeframe: Continuation of current effort

Facilitator: Board of Directors

Description: Members of the BFLA have been trained on Clean Boats Clean Waters (CBCW) protocols and complete boat inspections at the public landings on a regular basis. Because this system is currently free of exotic plant species, the intent of the boat inspections is to prevent additional invasives from entering the lake through its public access point. The goal would be to cover the landing during the busiest times in order to maximize contact with lake users, spreading the word about the negative impacts of aquatic invasive species on our lakes and educating people about how they are the primary vector of aquatic invasive species spread. In 2013, 57 boats were inspected and 124 people contacted during 68 hours of watercraft inspections on Butternut Lake. On Franklin Lake, 89 boats were inspected and 206 people contacted during 70 hours of volunteer time.

This aggressive approach to informing lake users about the dangers of aquatic invasive species has proven to be quite effective, and has likely helped to keep Butternut and Franklin Lakes free of exotic plants such as Eurasian water milfoil and curly-leaf pondweed. The BFLA will continue CBCW inspections at public landings, and will more importantly continue to pursue volunteers through its membership and partnering organizations to staff the public landing for this effort.

The BFLA can take advantage of a new streamlined CBCW application process, through the WDNR's Aquatic Invasive Species Control grant program. This program provides grant funding of 75% of total project costs no to exceed $4,000 for each boat landing with a CBCW inspection program. More information is available by contacting Jane Malischke, WDNR Environmental Grant Specialist (715)-635-4062 or visiting http://dnr.wi.gov/Aid/AIS.html.

Action Steps:

1. BFLA representative apply for program funding through online form: http://dnr.wi.gov/files/PDF/forms/8700/8700-337.pdf
2. Trained CBCW volunteer(s) conducts inspections during high-risk weekends, report results to WDNR and to association members during annual meeting.
3. Volunteer data collected are automatically added to the WDNR database and available through their Surface Water Integrated Monitoring System (SWIMS) by the volunteer.
4. Members of association periodically attend Clean Boats Clean Waters training session through Lumberjack AIS Coordinator John Preuss.
5. Promote enlistment and training of new volunteers.

Management Goal 6: Maintain as Well as Enhance Butternut and Franklin Lakes Fisheries and Fisheries Habitat

Management Action: Document and monitor fisheries and fisheries habitat.

Timeframe: Continuation of current effort

Facilitator: Board of Directors

Description: While the WDNR fisheries biologist for Forest County (Greg Matzke) and other fisheries staff oversee management of the Butternut and Franklin Lakes fishery, residents along these lakes have contributed by monitoring some aspects of the fishery. Several residents have extended records of fishing activity. Others have worked to document where fish habitat devices (fish cribs) are located within the lake. The collection and documentation of these data is beneficial because it not only involves lake residents in a management matter, but provides background information to fisheries managers who can use it to assist in management decision making.

BFLA volunteers, perhaps under the direction of a monitoring sub-committee (see Management Goal 1) will collect documentation of fisheries activity and habitat improvements and compile these materials to a single source, such as a formal report. This report may be provided to WDNR fisheries biologists, as well as published on the appropriate medium (see Management Goal 2) for lake stakeholders to learn from.

Action Steps:

1. See above description.

<u>Management Action:</u> Work with WDNR fisheries biologist to implement coarse woody habitat project.

Timeframe: Continuation of current effort

Facilitator: Board of Directors

Description: As a result of the coarse woody habitat survey, it was discovered minimal coarse woody habitat were observed along the Butternut and Franklin Lake shoreline. In fact, roughly 13 pieces of coarse woody habitat were mapped along 8.6 miles of shoreline on Butternut Lake, and nine pieces along 7.0 miles of Franklin Lake's shoreline. In contrast, some undeveloped lakes may have several hundred pieces of coarse woody habitat per mile of lake shoreland. The benefits of coarse woody habitat are well researched, and have implications for many organisms in the aquatic food web, including algae, insects, amphibians and fish.

In order to improve fishery habitat on Butternut and Franklin Lakes, the BFLA wishes to create coarse woody habitat in appropriate areas of the lake. Projects would likely include tree drops extending from shorelands into the lake – see Section 3.0, Shoreland Research, for more details on this type of habitat. This would be a coordinated effort between the BFLA, private landowners, WDNR fisheries biologists and lakes coordinator as well as the Forest County Land and Water Conservation Department. US Forest Service personnel would be an additional management entity to partner with, seeing that much of the lakes are surrounded by the Chequamegon-Nicolet National Forest.

Action Steps:

1. BFLA representative discusses potential project with WDNR fisheries biologist Greg Matzke to determine feasibility.
2. BFLA representative discusses grant funding opportunities with Forest County Land and Water Conservation Department, US Forest Service and WDNR lakes coordinator Jim Kreitlow to determine applicability.
3. BFLA solicits interest from lake residents through newsletter or association meetings. WDNR fisheries biologist must determine potential sites are suitable for introduction of coarse woody habitat structure.

6.0 METHODS

Lake Water Quality

Baseline water quality conditions were studied to assist in identifying potential water quality problems in Butternut and Franklin Lakes (e.g., elevated phosphorus levels, anaerobic conditions, etc.). Water quality was monitored at the deepest point on the lake that would most accurately depict the conditions of the lake (Map 1). Samples were collected using WDNR Citizen Lake Monitoring Network (CLMN) protocols which occurred once in spring and three times during the summer. In addition to the samples collected by BFLA members, professional water quality samples were collected at subsurface (S) and near bottom (B) depths once in spring, winter, and fall. Although BFLA members collected a spring total phosphorus sample, professionals also collected a near bottom sample to coincide with the bottom total phosphorus sample. 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. During professionally collected samples temperature, pH, conductivity and dissolved oxygen profiles were completed.

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.

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

♦ indicates samples collected as a part of the Citizen Lake Monitoring Network.
● indicates samples collected by volunteers under proposed project.
■ indicates samples collected by consultant under proposed project.

Watershed Analysis

The watershed analysis began with an accurate delineation of Butternut and Franklin Lake's drainage area using U.S.G.S. topographic survey maps and base GIS data from the WDNR. The watershed delineation was then transferred to a Geographic Information System (GIS). These data, along with land cover data from the National Land Cover Database (NLCD – Fry et. al 2011) 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 Butternut and Franklin Lake during a June 7, 2012 field visit, 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 Butternut and Franklin 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 (Hauxwell 2010) was used to complete this study on July 18-19, 2012. On Butternut Lake a point spacing of 87 meters was used resulting in 660 sampling points. On Franklin Lake, sampling points were spaced apart 70 meters which resulted in 696 locations.

Community Mapping

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

Representatives of all plant species located during the point-intercept and community mapping survey were collected and vouchered by the University of Wisconsin – Steven's Point Herbarium. A set of samples was also provided to the Butternut-Franklin Lakes Association.

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