Harpt Lake

Manitowoc County, Wisconsin

Comprehensive Management Plan

April 2012

Sponsored by:

Larrabee Sportsman's Club
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LPL-1272-09 & LPL-1273-09

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Onterra LLC
Lake Management Planning

Harpt Lake

Manitowoc County, Wisconsin

Comprehensive Management Plan

April 2012

Created by: Tim Hoyman & Dan Cibulka
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Funded by: Larrabee Sportsman's Club, Inc.
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Acknowledgements

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

Harpt Lake Planning Committee

Mike Stueck	Nick Reif	Randy Peters
Amy Stueck	Paul Tuschel	Glenn & Marlene Rezek*

**A special thanks goes out to Glenn and Marlene for all their help collecting water samples.*

Manitowoc County

Bruce Riesterer
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Manitowoc County Lakes Association, Inc.

Al Meyer	Tom Ward
Gene Weyer	

Wisconsin Dept. of Natural Resources

Mary Gansberg

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1.0 INTRODUCTION

Harpt Lake, Manitowoc County, is a seepage lake with a maximum depth of 54 feet and a surface area of 33 acres (Map 1). This eutrophic lake has a relatively large watershed when compared to the size of the lake. Harpt Lake contains 21 native plant species, of which coontail is the most common plant. One exotic plant, Eurasian water milfoil, is known to exist within Harpt Lake.

Field Survey Notes

Harpt Lake is a small productive lake with abundant plants, relatively clear water, and a well-known fishery in the area.

Photograph 1.0-1 Harpt Lake, Manitowoc County

Lake at a Glance - Harpt Lake

Morphology	
Acreage	33
Maximum Depth (ft)	54
Mean Depth (ft)	18.7
Shoreline Complexity	1.37
Vegetation	
Curly-leaf Survey Date	June 5, 2009
Comprehensive Survey Date	June 30, 2009
Number of Native Species	21
Threatened/Special Concern Species	0
Exotic Plant Species	Eurasian water milfoil
Simpson's Diversity	0.83
Average Conservatism	5.0
Water Quality	
Trophic State	Eutrophic
Limiting Nutrient	Phosphorus
Water Acidity (pH)	8.5
Sensitivity to Acid Rain	Not sensitive
Watershed to Lake Area Ratio	23:1

During the summer of 2007 residents around Harpt Lake and members of the Larrabee Sportsman's Club, Inc. (LSC) began to notice that the lake was becoming "greener". Members of the LSC contacted the Manitowoc County Lakes Association and were guided to contact a lake management consultant. During the winter of 2008, Mr. Mike Stueck contacted Onterra, LLC to discuss what could be done to help the lake. As a result of this conversation, a visit to the lake was scheduled with Mr. Stueck and Ms. Mary Gansberg of the Wisconsin Department of Natural Resources (WDNR).

During the Onterra/WDNR site visit, it was discovered that the lake supported high levels of filamentous algae, which gathered on submerged vegetation around nearly the entire margin of the lake. Talks between Onterra, the WDNR and the LSC began as to what could be fueling the growth of algae in Harpt Lake. It was decided that water quality monitoring and watershed modeling was needed on the lake, as well as an investigation as to the possibility that internal nutrient loading may be occurring. During this same visit, Eurasian water milfoil was discovered within the lake. Its identification was later verified by Dr. Robert Freckmann, UW-Stevens Point. *Note: Later in the project, it was discovered that Eurasian water milfoil had actually been discovered and vouchered in 1994 from Harpt Lake.*

Due to the upcoming challenges approaching this lake, the LSC decided to pursue a planning project that would 1) identify the extent of the exotic plants which occur in their lake, 2) help them understand the water quality and nutrient sources to their lake better, 3) to understand their overall lake ecosystem more fully, and 4) allow them to be eligible to receive additional WDNR grant funds to address AIS and other goals of lake stakeholders. The management plan that has resulted from this project is truly the combination of scientific study and the sociologic aspects of the lake and its stakeholders. The results of those studies will not only lead to better management decisions, but also act as a reference point for future studies and likely serve as groundwork for the restoration of important native habitat within and around Harpt Lake. The implementation plan found near the end of the document will act as a guide for the LSC as they continue to advocate responsible management of this resource.

2.0 STAKEHOLDER PARTICIPATION

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

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

Kick-off Meeting

On October 20, 2009, a project kick-off meeting was held at the Larrabee Sportsman's Club building to introduce the project to the general public. The meeting was announced through a mailing and personal contact by LSC board members. The approximately 30 attendees observed a presentation given by Tim Hoyman, an aquatic ecologist with Onterra. Mr. Hoyman's presentation started with an educational component regarding general lake ecology and ended with a detailed description of the project including opportunities for stakeholders to be involved. The presentation was followed by a question and answer session.

Stakeholder Survey

During September 2010 a seven-page, 28-question survey was mailed to 108 riparian property owners in the Harpt Lake watershed. 35 percent of the surveys were returned and those results were entered into a spreadsheet by members of the Harpt Lake Planning Committee. The data were summarized and analyzed by Onterra for use at the planning meetings and within the management plan. The full survey and results can be found in Appendix B, while discussion of those results is integrated within the appropriate sections of the management plan.

Planning Committee Meeting I

On June 13, 2010, Tim Hoyman of Onterra met with seventeen members of the Harpt Lake Planning Committee for nearly 3 hours. The primary focus of this meeting was the delivery of the study results and conclusions to the committee. All study components including, Eurasian water milfoil surveys, native aquatic plant inventories, water quality analysis, and watershed and internal nutrient loading modeling were presented and discussed. Many concerns were raised by the committee, including concerns about excessive algae and Eurasian water milfoil.

Planning Committee Meeting II

Several planning committee members met with Tim Hoyman and Dan Cibulka of Onterra and Mary Gansberg of the WDNR on February 27, 2012 to discuss the Harpt Lake Management Project. Specifically, nutrient loads from the watershed and Eurasian water milfoil control strategies were discussed at length. The meeting lasted about 2.5 hours. During this time, specific strategies to reduce the nutrient load to Harpt Lake were discussed, and a Eurasian water milfoil monitoring strategy was developed. Additionally, a plan to monitor the water quality of the lake was discussed. These discussions helped to formulate the goals and action steps outlined within the Implementation Section.

Project Wrap-up Meeting
On April 3, 2012, Tim Hoyman and Dan Cibulka met with the membership of the Larrabee Sportsman's Club to present the conclusion of the Harpt Lake Management Planning Project. An overview of the project results was presented, along with the management goals and actions that were developed as a result of the planning committee's work during the planning meetings.

Management Plan Review and Adoption Process
On November 16, 2011, a draft of the Management Plan was provided to the Planning Committee and WDNR for review. Based upon comments received, several modifications were made to the document over January of 2012. Several adjustments were made in light of discussions held during the February 2012 planning meeting as well. In late March/early April, the Larrabee Sportman's Club and WDNR gave their final comments to Onterra staff. The plan was accepted and finalized in early April.

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 analysis are available for assessing the condition of a particular lake's water quality. In this document, the water quality analysis focuses upon attributes that are directly related to the 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 Harpt Lake is compared to other lakes in the state with similar characteristics as well as to lakes within the northern region (Appendix C). In addition, the assessment can also be clarified by limiting the primary analysis to parameters that are important in the lake's ecology and trophic state (see below). Three water quality parameters are focused upon in the Harpt 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. As discussed further below and in the Watershed section, Harpt Lake is indeed a candidate for this situation.

Comparisons with Other Datasets

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

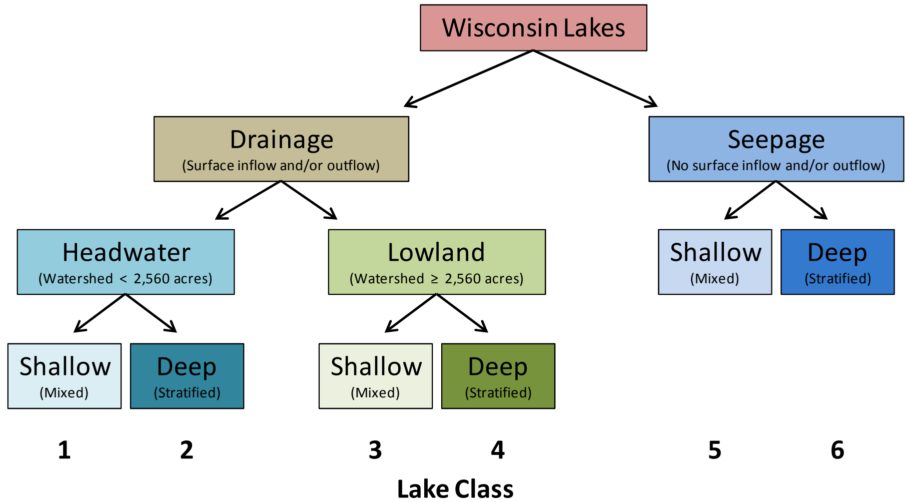

Figure 3.1-1. Wisconsin Lake Classifications. Harpt Lake is classified as a deep (stratified), seepage lake (Class 6). Adapted from WDNR PUB-SS-1044 2008.

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

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

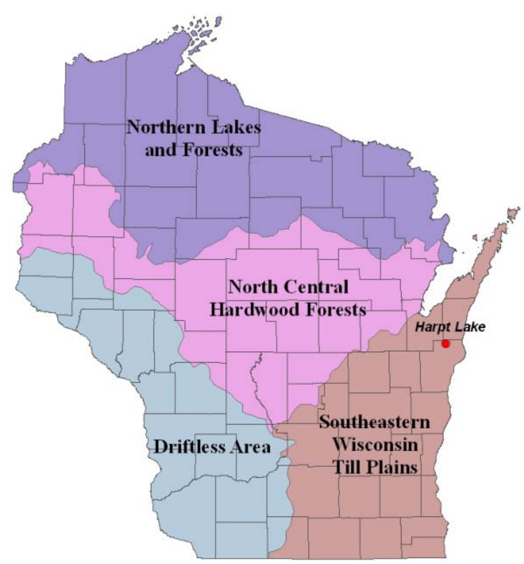

Figure 3.1-2. Location of Harpt Lake within the ecoregions of Wisconsin. After Nichols 1999.

These data along with data corresponding to statewide natural lake means, historic, current, and average data from Harpt Lake is displayed in Figures 3.1-3 - 3.1-5. 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.

Harpt Lake Water Quality Analysis

Harpt Lake Long-term Trends

The historic water quality data that exists for Harpt Lake is minimal, so it is impossible to complete a reliable long-term trend analysis. This is unfortunate because having understanding of how the lake has changed over the years is always interesting and leads to sounder management decisions. It also provides a scientific basis behind anecdotal claims of a lake "getting worse" or "getting better". As part of this study, stakeholders in the Harpt Lake watershed were asked how they perceived the water quality of the lake to be. Over 75% of the respondents indicated they believed the current water quality was Poor or Fair. (Stakeholder Survey, Appendix B, Question #13). No matter the situation now, about 78% of respondents did state that they believe the water clarity has degraded since they obtained their property near Harpt Lake (Question #14).

As described above, three water quality parameters are of most interest; total phosphorus, chlorophyll-*a*, and Secchi disk transparency. Total phosphorus data from Harpt Lake are contained in Figure 3.1-3. A weighted average across the three available years of data indicates that concentrations are higher when compared to similar lakes across the state of Wisconsin and lakes within the Southeast region (Figure 3.1-3). Overall, phosphorus levels in Harpt Lake can be described as ranking in the WQI category of *Fair*.

Chlorophyll-*a* measurements from Harpt Lake, like phosphorus data, are few and far between as well (Figure 3.1-4). Regardless, a weighted average over all years of collected data is above the average statewide and regional median values. The majority of these yearly averages fall into the WQI *Fair* category. It is important, however, to note that these values may be misleading because of the nature of the sampling process for chlorophyll-*a*. When sampling for this water quality parameter, almost all protocols call for samples to be collected at the location of the deepest point on the lake. This is done to try and receive a representative sample of the entire lakes water quality. Often, algae (which holds the chlorophyll pigment) is found free-floating and evenly distributed throughout a lake. However, on a lake such as Harpt Lake, much of the algae is a type called filamentous algae, and is found in the littoral (shallow plant growing) zone and is bound up on plants which are approaching the surface. Picture 3.1-1 illustrates this well. Notice the thick algae mats hovering over beds of native coontail, muskgrasses and other aquatic plants, while the limnetic (open water) zone is void of this filamentous algae. Currently there is no standard, inexpensive way to quantify this type of algae. Thus, it must be noted that this measurement does not account for the type of algae that is most prevalent in Harpt Lake.

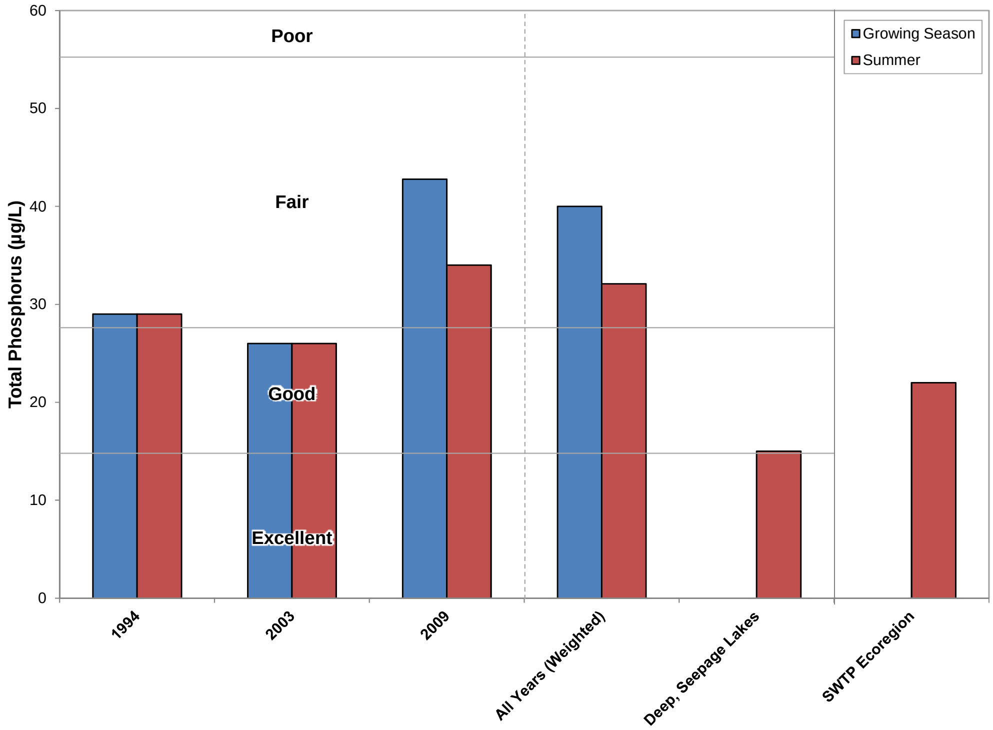

Figure 3.1-3. Harpt Lake, state-wide class 6 lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

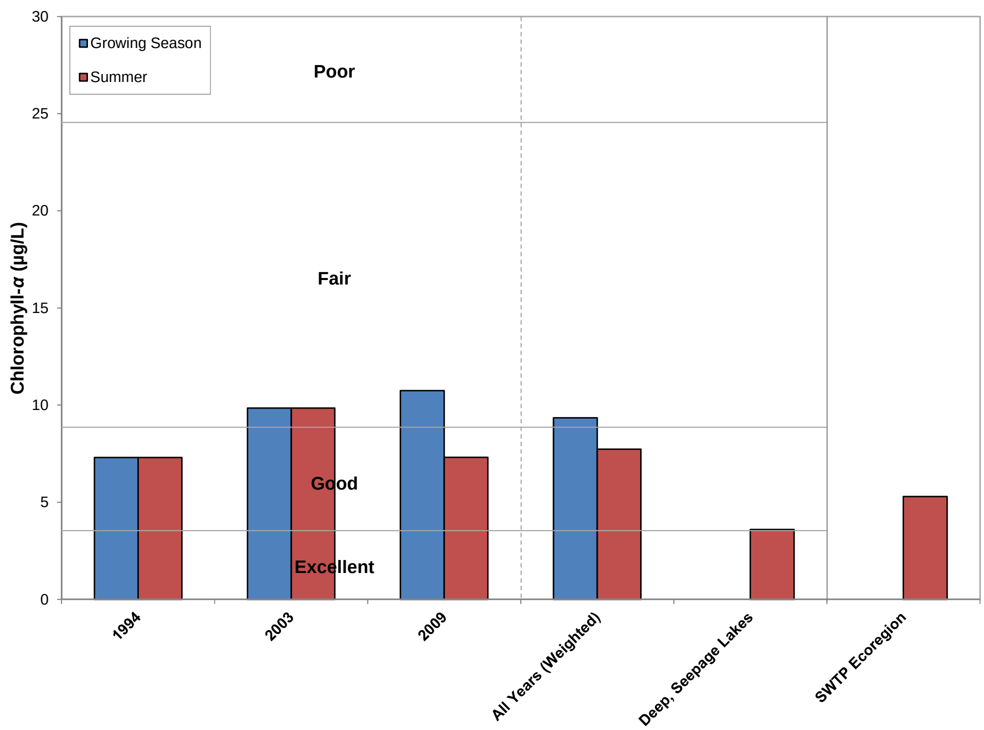

Figure 3.1-4. Harpt Lake, state-wide class 6 lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Picture 3.1-1. Harpt Lake littoral and limnetic zones, and filamentous algae extent.

Slightly more data exists for our third water quality parameter – Secchi disk clarity (Figure 3.1-5). This measurement is relatively easy to perform, very cost efficient, and provides reliable data that can be compared over time to describe potential changes that are occurring in a lake. Secchi disk clarity annual averages for Harpt Lake fall mostly within the WQI *Good* category, though as indicated by measurements taken in 1994 and 2009 variations in water clarity do exist on a yearly basis. These variations are likely due to a number of factors including environmental circumstances (precipitation, temperature, etc.) and also anthropogenic (human caused) factors. In a watershed such as Harpt Lake's watershed, annual changes to the landscape such as crop rotations or winter cover crop plantings will likely change the amount of runoff the lake sees for that year. Couple this with a seasonal weather abnormality (more or less precipitation, for example) and the opportunity for wide fluctuations exists in the lake. Overall, a weighted average for Secchi disk clarity is slightly below similar lakes within Wisconsin but slightly above lakes within the ecoregion (Figure 3.1-5).

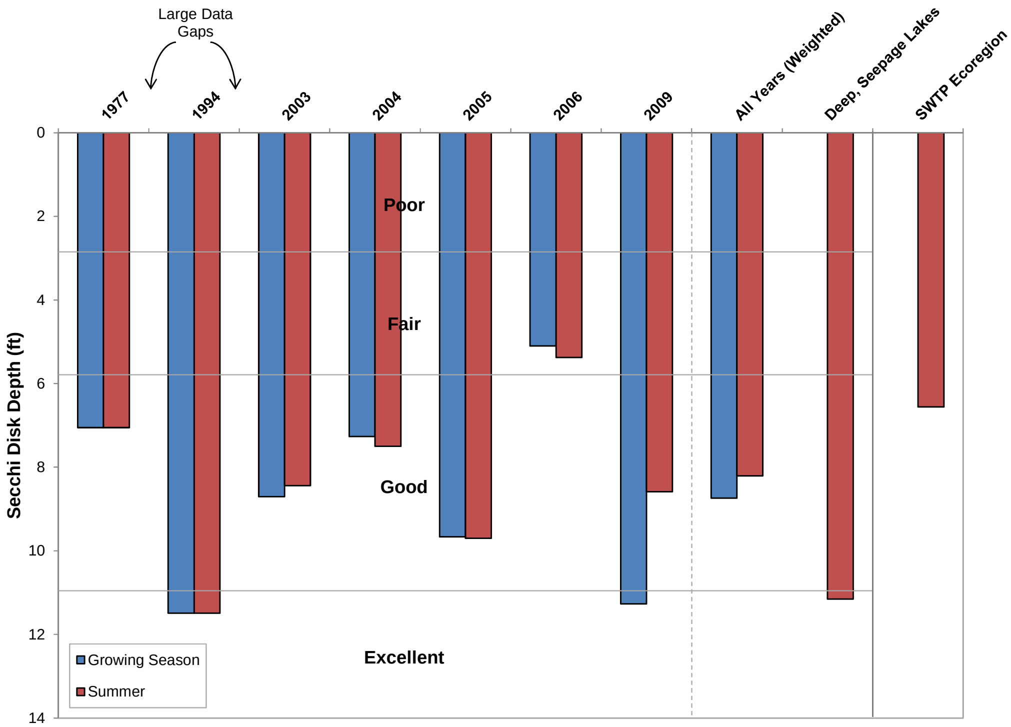

Figure 3.1-5. Harpt Lake, state-wide class 6lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Limiting Plant Nutrient of Harpt Lake

Using midsummer nitrogen and phosphorus concentrations from Harpt Lake, a nitrogen:phosphorus ratio of 39:1 was calculated. This finding indicates that Harpt Lake is 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.

Harpt Lake Trophic State

Figure 3.1-6 contain the WTSI values for Harpt Lake. The WTSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values range in values spanning from lower eutrophic to lower mesotrophic. 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* WTSI values, it can be concluded that Harpt Lake is in a eutrophic state.

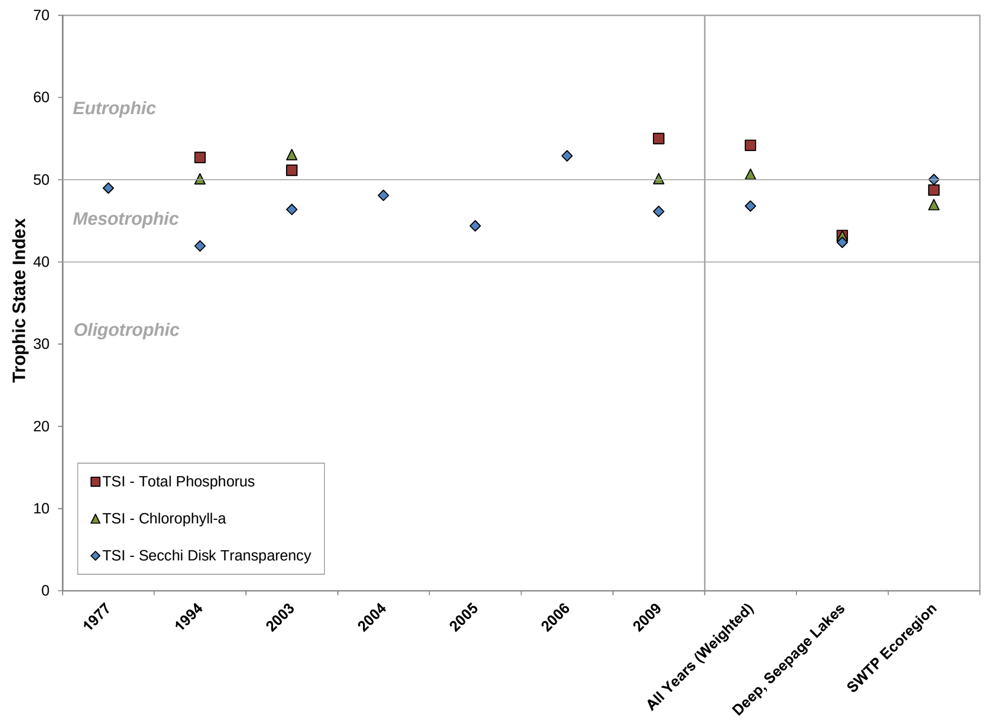

Figure 3.1-6. Harpt Lake, state-wide class 6 lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Harpt Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling event at Harpt Lake during 2009 and 2010. Because studies were completed to investigate internal nutrient loading in the lake, these profiles were taken about every other week throughout this time period. These data are available in Appendix B; while select profiles are displayed in Figure 3.1-7 to represent yearly conditions in the lake.

The profiles indicate that the lake stratifies strongly following spring mixing, and continues to remain stratified until late fall when the lake mixes again. In winter, the lake is inversely stratified, with the warmer (denser) water falling to the lake bottom and the colder (near-frozen) water located near the surface. In the summer and winter months following mixing, an anoxic (little to no oxygen) zone forms in the lower two-thirds of the lake. Through most of the summer, this anoxic zone can be found beginning at around 15 feet of depth. Oxygen is depleted due to the decomposition of organic materials, which settle in the lower areas of the lake. Although this process is naturally occurring, it may be accelerated through inputs of additional nutrients. The excess nutrients spur more plant and algae growth, which in turn requires more oxygen to complete the decomposition process. This anoxic zone also plays a role in the release of nutrients from the bottom of the lake.

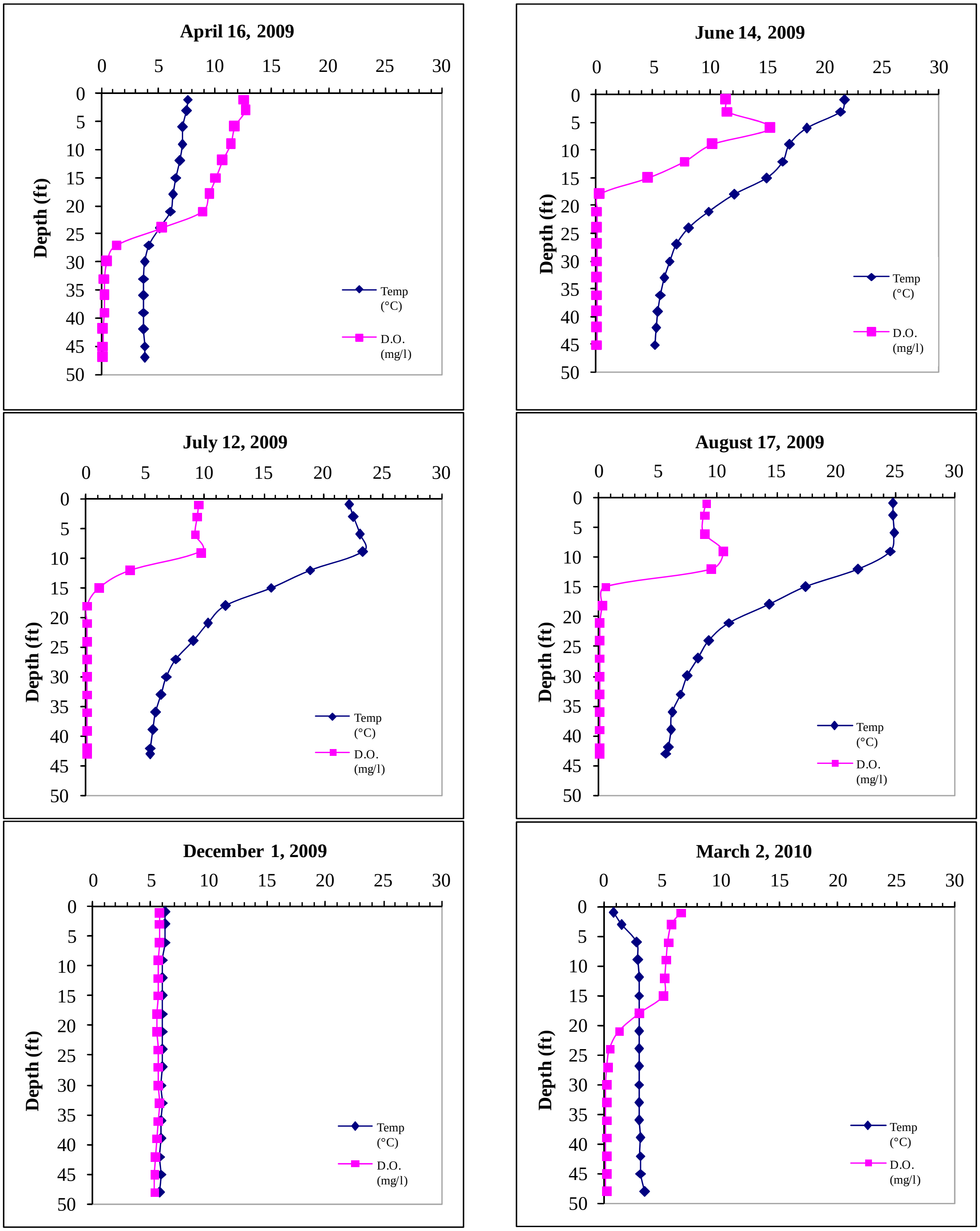

Figure 3.1-7. Harpt Lake dissolved oxygen and temperature profiles.

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Internal Nutrient Loading

As part of this study, Onterra staff and Larrabee Sportsman's Club Inc. volunteers collected epilimnion and hypolimnion phosphorus samples, temperature and dissolved oxygen profiles about every two weeks throughout the 2009 open water season and several times while the lake was ice-covered in 2010. The purpose of this monitoring schedule was to collect the necessary information to run an internal nutrient loading model, the WDNR's Wisconsin Internal Load Estimator (WINTLOAD), on Harpt Lake. As seen in Figure 3.1-8, total phosphorus concentrations within the oxygenated epilimnion remained fairly consistent throughout the summer, but rose during mixing events. In the largely anoxic hypolimnion, however, concentrations rose throughout the open water season as more and more phosphorus was released from the bottom sediments. These concentrations exceeded 200 μg/L with the exception of the fall and likely the spring mixing period, and even rose as high as 1,000 μg/L in late summer of 2009. Once mixing of the lake occurred on December 1st of 2009, phosphorus concentrations were at approximately 140 μg/L throughout the entire water column. To put this concentration into perspective, please compare 140 μg/L with the scale and WQI ratings on Figure 3.1-2.

As discussed in the Watershed section of this report, this internal source accounts for an annual input of roughly 99 lbs. of phosphorus. This is an exceptional amount when compared to the total (internal and external) annual phosphorus load. The implications of this phosphorus source on management of Harpt Lake are touched upon in the Watershed section, but discussed more thoroughly in the Summary & Conclusions and Implementation Plan.

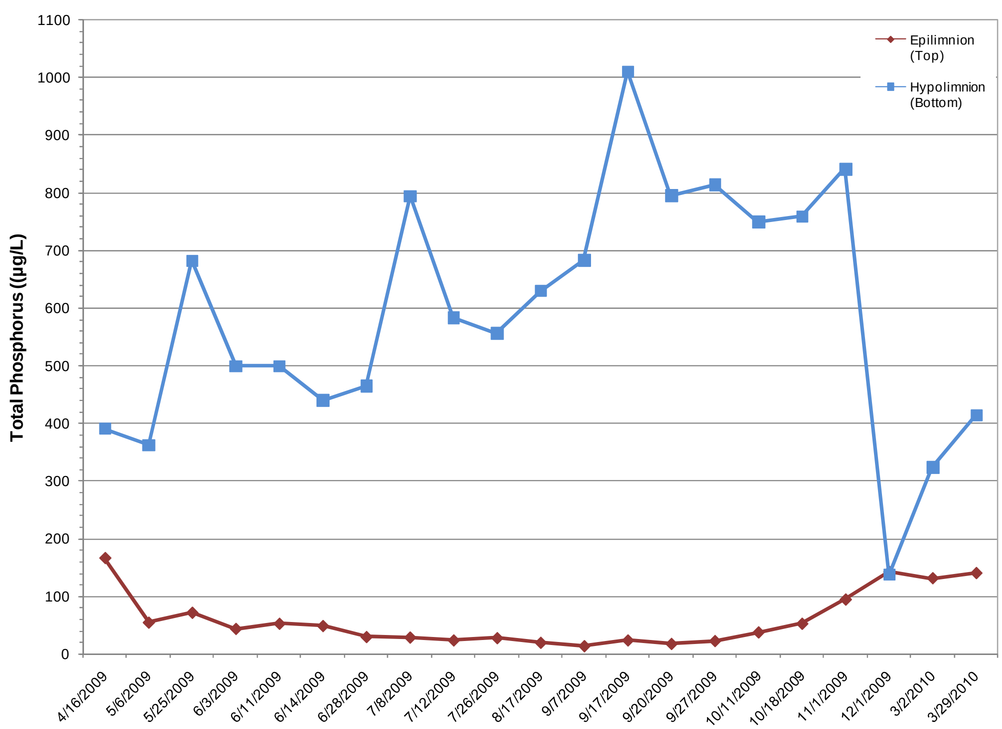

Figure 3.1-8. Harpt Lake epilimnetic and hypolimnetic total phosphorus concentrations, 2009-2010.

Additional Water Quality Data Collected at Harpt 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 Harpt 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 (Shaw et al. 2004). The pH of surface water in Harpt Lake ranged from 6.8 to 8.8 in 2009.

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 of surface water in Harpt Lake was measured at 144.5 (mg/L as $CaCO_3$), indicating that the lake has a substantial capacity to resist fluctuations in pH and has a low sensitivity to acid rain.

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, so Harpt Lake's pH values 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. The calcium concentration of Harpt Lake was found to be 40.9 mg/L, indicating that in combination with the lake's pH range, Harpt Lake has a *high susceptibility* to zebra mussel establishment if they were ever introduced. Plankton tows were completed by Onterra staff during the summer of 2010 and these samples were processed by the WDNR for larval zebra mussels. Their analysis did not locate any larval zebra mussels in the 2009 samples. However, English Lake contains optimal conditions for supporting zebra mussels and with its close proximity to Lake Michigan, lake residents should periodically inspect their docks and bottoms of boats for mussels and report any findings to the WDNR or Onterra. Cleaning, removal of water, and inspecting of boats entering and leaving English Lake is especially important for this reason.

3.2 Watershed Assessment

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

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

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

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

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

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

A reliable and cost-efficient method of creating a general picture of a watershed's affect on a lake can be obtained through modeling. The WDNR created a useful suite of modeling tools called the Wisconsin Lake Modeling Suite (WiLMS). Certain morphological attributes of a lake and its watershed can be entered into WiLMS along with the acreages of different types of land cover within the watershed to produce useful information about the lake ecosystem. This information includes an estimate of annual phosphorus load and the partitioning of those loads between the watershed's different land cover types and atmospheric fallout entering through the lake's water surface. WiLMS also calculates the lake's flushing rate and residence times using county-specific average precipitation/evaporation values or values entered by the user. Predictive models are also included within WiLMS that are valuable in validating modeled phosphorus loads to the lake in question and modeling alternate land cover scenarios within the watershed. Finally, if specific information is available, WiLMS will also estimate the significance of internal nutrient loading within a lake and the impact of shoreland septic systems.

Harpt Lake's watershed is 787 acres in size, and is largely dominated by row crop agriculture (374 acres or 47%), pasture / grass land (272 acres or 35%) and wetland (95 acres or 18%) (Figure 3.2-1 and Map 2). The remaining 6% is classified either as open water (4%) or forest (2%). The watershed is much larger than Harpt Lake itself, as indicated by a high watershed to lake area ratio of 23:1. As discussed above, in watersheds with a relatively large ratio, it is often difficult to improve water quality through land use changes because the large amount of land is a factor that overshadows the actual land type. Of the land types that may contribute excessive pollutants to the lake, the row crop agriculture and pasture / grassland is of the most concern. However, as discussed below, there are likely several factors affecting the water quality of Harpt Lake, not just land cover type alone.

WiLMs was utilized to model the land cover types in the Harpt Lake watershed and quantify the nutrient runoff into the waterbody. WiLMs uses modeling coefficients to estimate runoff from a specific land type. When multiplied by the amount of land this land cover type holds in a watershed, a nutrient load specific to the watershed for that land type is estimated. Original modeling of the Harpt Lake watershed yielded an annual phosphorus load of 423 lbs. Based upon this information, WiLMs predicted a mixed in-lake phosphorus concentration of 84 µg/L. However, due to the intense sampling regime that was initiated on Harpt Lake during 2009 – 2010 (See the Water Quality section for more details), it is known that the actual in-lake phosphorus concentration during mixing is 50.4 µg/L. This indicates that the initial modeling estimate was much too high to coincide with actual field measurements, which is an accuracy check of sorts. There may be several reasons for this is observed difference. The few wetlands in the watershed may be more influential than estimated due to their location (around the immediate shoreline) which would allow them to filter nutrients better. Additionally, there have been many conservation initiatives such as buffer strips and nutrient management plans implemented within the watershed, particularly within areas of row crop agriculture. According to the Manitowoc County Soil and Water Conservation Department, nutrient management and erosion control plans have been put in effect on 451 acres within the watershed, grassed waterways have been installed on 5,100 lineal feet of land, and winter wheat has been included in crop rotations on some fields to be used as a cover crop.

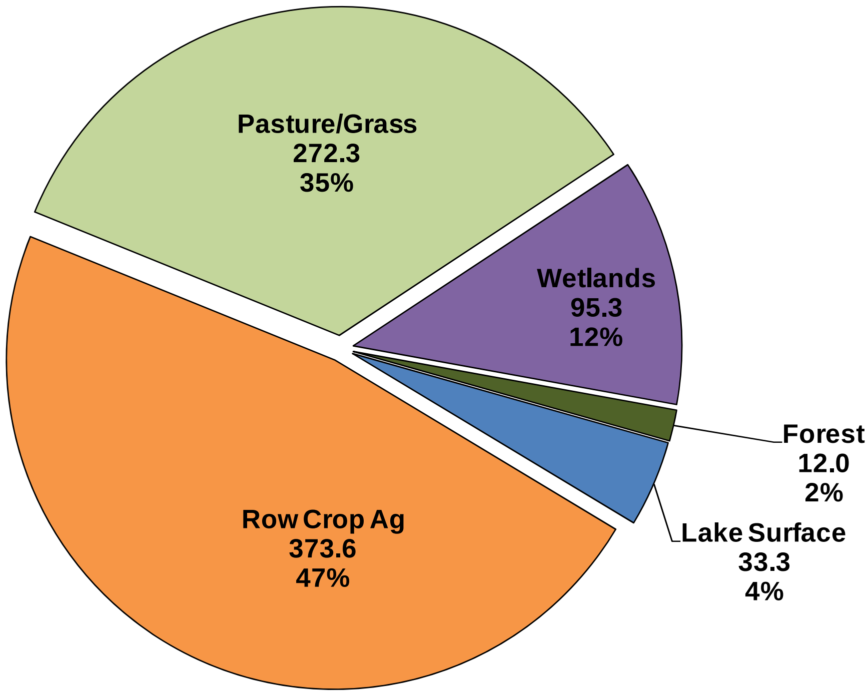

Figure 3.2-1. Harpt Lake watershed land cover types in acres. Based upon Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND) (WDNR, 1998).

Due to this discrepancy between predictive estimates and actual in-field measurements, the watershed variables (land cover types) were adjusted so that WiLMs' predictive measurements more closely resembled the actual in-field measurements. In this adjusted scenario, 200 acres was modified from row crop agriculture to mixed agriculture, which has a lower export coefficient and thus more accurately represents conditions occurring in this watershed (Figure 3.2-2). These new land cover type acres were entered into WiLMs and modeled once again.

The modeling efforts produced a predictive in-lake phosphorus concentration (53 µg/L) that is more accurate when compared to actual measured concentrations (50 µg/L). This model produced a total annual phosphorus load of 165 lbs (Figure 3.2-3). Row crop agriculture was still the highest exporting land cover type, at 77 lbs (47%), followed by mixed agriculture (53 lbs or 32%), and pasture/grass (24 lbs or 15%). Wetlands and the actual lake surface produced only small parts (5% and 1%, respectively) of the annual load, while the small amount of forested land in the watershed produces a negligible amount of phosphorus. Although some of the land types surrounding Harpt Lake produce large parts of the annual phosphorus load, remember from the water quality section discussion there is more to the picture than these external phosphorus sources. As stated in the Water Quality section, the WDNR modeling program WINTLOAD calculates the Harpt Lake internal nutrient load to be roughly 99 lbs annually, which brings the new total annual phosphorus load to 264 lbs (Figure 3.2-4).

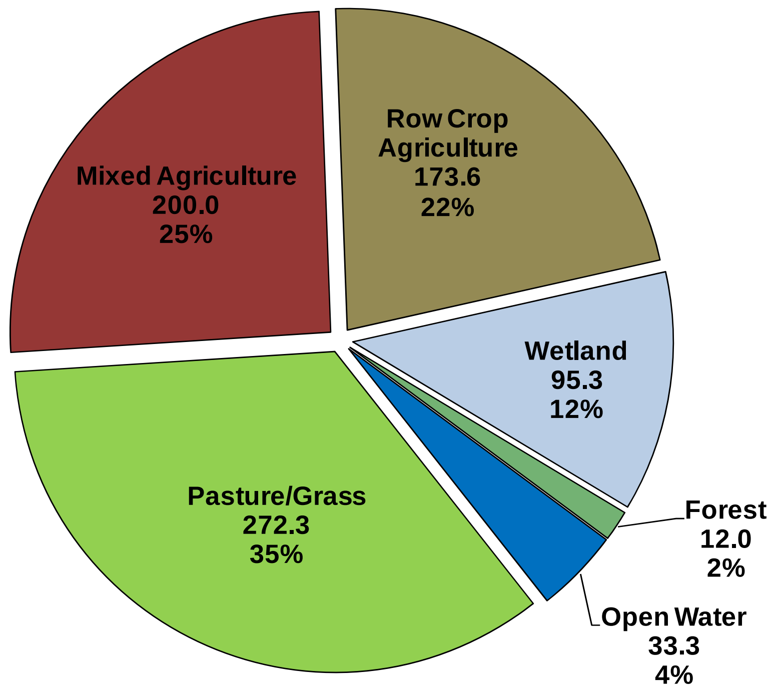

Figure 3.2-2. Adjusted Harpt Lake watershed land cover types in acres. Based initially upon Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND) (WDNR, 1998), then adjusted to accommodate Best Management Practice implementations within the Harpt Lake watershed.

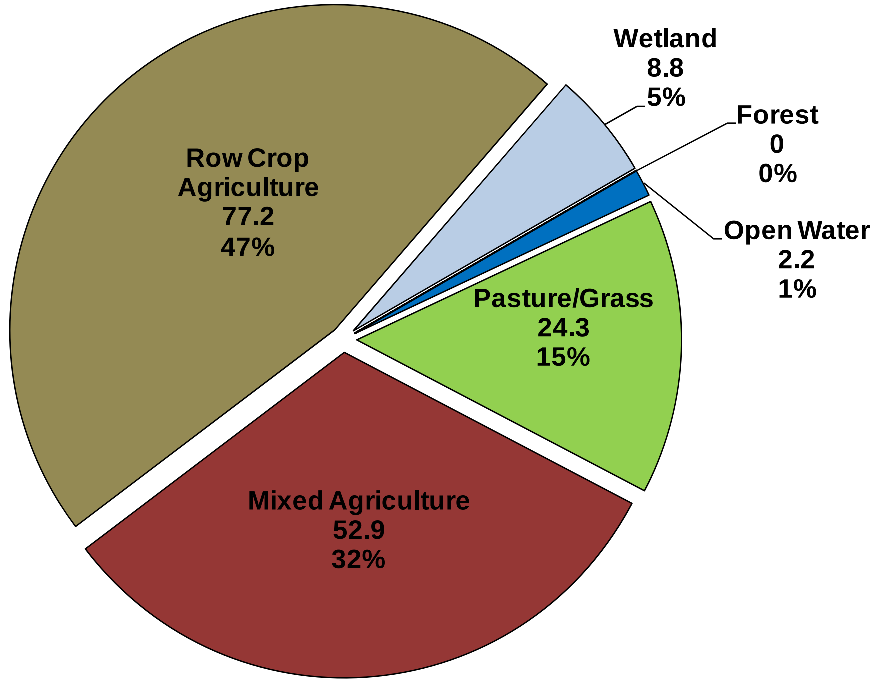

Figure 3.2-4. Adjusted Harpt Lake watershed phosphorus loading in pounds. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

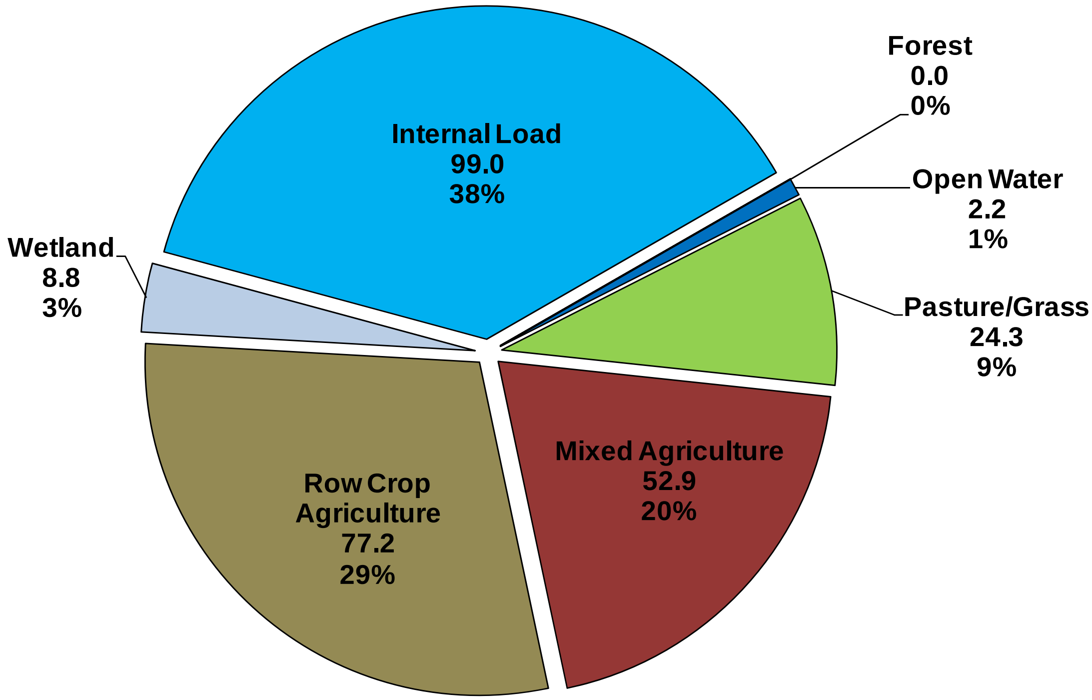

Figure 3.2-5. Adjusted Harpt Lake watershed phosphorus loading in pounds, with internal loading. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

Knowing the internal and external phosphorus loads to Harpt Lake is very helpful in evaluating restoration plans for this lake, or if restoration in even possible. As stated in the Water Quality section, Harpt Lake is an eutrophic lake. It is very likely that this has been the case for quite some time, perhaps even dating back before settlement of the area. Before European settlement of the area, it was likely 100% forested in this region. However, the watershed area was still much larger than the lake surface area. Further WiLMs scenario modeling evaluated the watershed under various conditions to determine the difference in annual phosphorus load. Additionally, the WTSI Phosphorus Value was determined from this information to declare what Trophic State the lake would be in under these scenarios. As pictured in Figure 3.2-6, even if the entire watershed was forested (a rather unachievable scenario depicting pre-settlement conditions), the phosphorus load would still be substantial, though the lake may reach a mesotrophic state. Under all other scenarios involving conversion of row crop (RC) lands to pasture/grass (PG) or mixed agriculture (MA) lands, the annual load changes very little and the lake would remain eutrophic.

Although it seems conservation measures implemented on the surrounding watershed may be in vain, it is important to remember that these measures may assist in keeping Harpt Lake from becoming *more* eutrophic. It is true that internal nutrient loading is a considerable phosphorus source to the lake. However while there are actions that can be taken to reduce this internal source, it is uncertain that the costs of these actions (which can be substantial) would result in significant changes in the water quality of the lake. The pros and cons of addressing internal nutrient loading is further discussed in the Summary & Conclusions and Implementation Plan sections.

Individual Harpt Lake property owners may help with nutrient runoff by implementing small changes on lakeshore zones. Installation and maintenance of shoreland buffer areas, use of phosphorus-free fertilizers, reductions in impervious surfaces area all important aspects in minimizing the amount of phosphorus entering the lake. Watershed protection may be achieved through larger scale projects as well. Recent discussions between riparian property owners and farmers within the watershed have been had regarding the implementation of conservation practices in several specific locations. Watershed conservation practices and their potential funding sources are discussed further below, while site-specific locations for conservation work are discussed within the Implementation Plan.

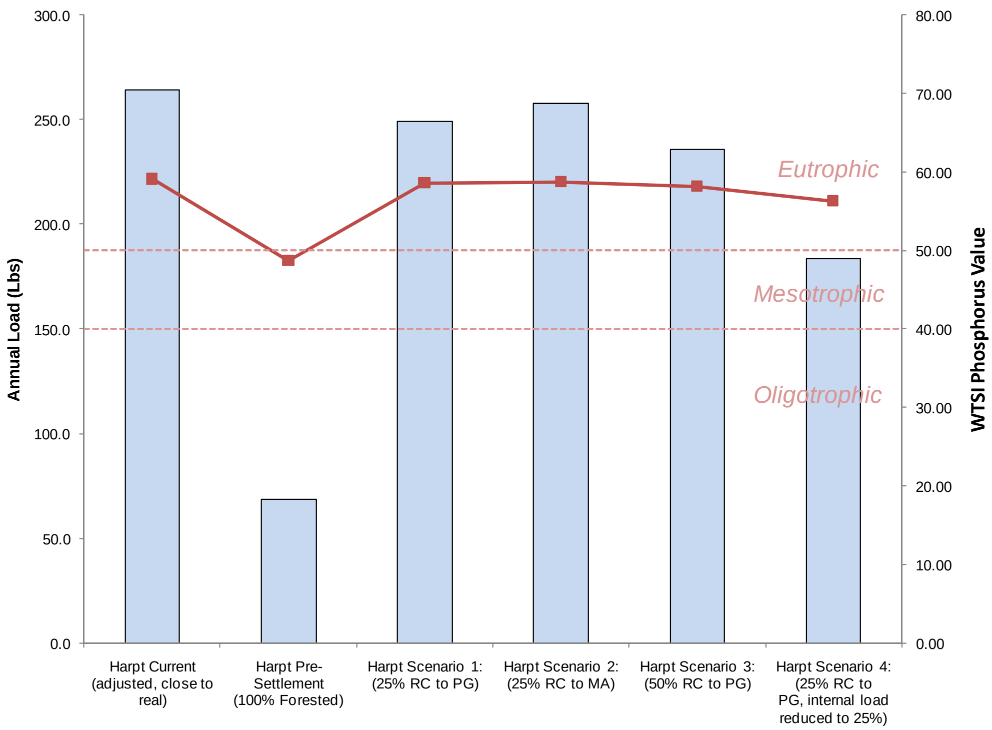

Figure 3.2-5. Harpt Lake watershed phosphorus loading in pounds and WTSI phosphorus values, under various modeling scenarios. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

Agriculture's Impacts on Water Quality

In Wisconsin, agriculture is a way of life and substantial contributor to our economy, agricultural lands and practices pose a significant threat to our waterways. Because of their size, large, open tracts of land catch large quantities of precipitation. This water is able to run off of the land, carrying with it sediment, nutrients, and agricultural-related chemicals, which when transported to waterbodies, can impact the environmental quality of the resource. When the velocity increases due to large volumes of water being moved, the potential for gully formation and streambank erosion occurs, further transporting pollutants and degrading habitat for both terrestrial and aquatic life. In a receiving waterbody, such as a lake, sediment accumulation can reduce the depth of the system, while causing reduced water clarity as well. Nutrient accumulation can spur algal blooms or plant growth. In the end, the impacts of agricultural practices have the ability to age a lake more quickly than the naturally aging process lakes undergo (*cultural eutrophication*).

Agricultural lands can typically be found near waterways because often a water source is needed for crops or grazing animals. Fortunately, there are a number of Best Management Practices (BMP's) that can reduce the impact that agriculture has on water quality. Some often utilized BMP's include buffer strips, grassed waterways, sediment retention basins, livestock exclusion fencing and winter cover crops. These conservation projects protect waterways by filtering runoff water, allowing infiltration of water into the soil, and sometimes even help by simply slowing down the velocity of surface runoff water. Some practices include projects occurring between a farm/grazing field and a waterway, while other practices include a change in how the farm/grazing field is managed. While these conservation projects can often be time consuming, scientifically complicated, and costly, there are a number of local, state, and Federal programs designed to ease the implementation of BMP's in agricultural watersheds. Many of these programs also supply financial assistance.

Excessive nutrient and aquatic plants within a Manitowoc County, WI lake.

Nutrient Management

Many agricultural landowners can benefit from a series of planning and maintenance steps that can be found in a Nutrient Management Plan (NMP). A NMP is a science-driven strategy for obtaining maximum return from on- and off-farm fertilizer resources. It serves a double purpose in protecting the quality of nearby water resources. This plan has several components which include soil nutrient testing, assessment of on-farm nutrient resources, identification of critical areas (close proximity to waterways, high slope, etc.), and most likely a manure spreading plan. A NMP is governed by Natural Resources Conservation Service (NRCS) code 590. This standard sets the minimum requirements and components of an acceptable nutrient management plan. Through meeting the "590 standard", farms should reach efficiency with regards to nutrient application, while also increasing net profit by reducing over-application of nutrients.

Regulations and Guidelines

NR 115

Wisconsin's Shoreland Protection Program (Wis. Admin. Code NR 115) was drafted to provide protection of fish and wildlife habitat, natural scenic beauty and water quality of waterways through the enhancement and protection of the shoreland zone. More specifically, NR 115 calls certain provisions to keep human disturbances near the immediate shoreline minimal, while enhancing natural vegetation and habitat. These shoreland zoning standards (expectations) were updated in February of 2010 and now include the following:

- New homes must be set back 75 feet from the water
- Minimum lot size requirements remain at 20,000 square feet and 10,000 square feet
- Expansion of an existing home closer than 75 feet from the water is allowed if the owner adds-on vertically. Horizontal expansions of existing homes more than 75 feet from the water is allowed.
- Property owners expanding the physical footprint of a non-conforming structure are required to offset the environmental impact by choosing from several counter practices,
- The amount of hard or "impervious" surfaces such as roofs, pavement and decks is now limited on properties within 300 feet of waterways. This cap only affects existing structures if owners make changes to the amount of impervious surface on their property, and only affects additions or new buildings if the amount of new impervious surface exceeds the total lot size by 15%.

While these are the minimum standards set by the state, local counties may adopt similar or more stringent standards, so long as they are in compliance with statewide minimum development standards. As mentioned before, owners of existing homes and other structures are not required to modify anything. Modification only comes when major changes occur, and, in most cases, these changes are allowed so long as a county approved environmental impact offset project is completed. These projects may include reducing the amount of lawn mowed, installing rain-gardens to absorb runoff water, or re-planting native vegetation near the shoreline.

NR 151

Wis. Admin. Code NR 151 contains runoff pollution performance standards and prohibitions, along with implementation and enforcement provisions, for the state of Wisconsin. The chapter includes provisions for agriculture (Subchapter II), non-agricultural standards (such as construction sites - Subchapter III), and transportation facility standards (Subchapter IV). Of primary concern to Harpt Lake would likely be the content held in Subchapter II. Here, standards, processes and guidelines for various agricultural activities (field phosphorus index performance, manure storage and management, clean water diversion, nutrient management, livestock operation ordinances) are explained. Additionally, cost sharing opportunities are discussed in detail. NR 151 is operated in conjunction with ATCP 50 (see below), which offers assistance to property owners seeking compliance with NR 151. While this is a regulatory rule, compliance is contingent on state or local agencies being able to provide at least 70% (and sometimes 90%) financial assistance with techniques enacted to reach compliance.

NR 243

Wis. Admin. Code NR 243 is a set of regulatory guidelines for the handling, storage, and utilization of manure from livestock operations. This rule also defines Concentrated Animal

Feedlot Operations (CAFOs), as well as sets standards to be used when issuing permits to these large livestock operations. Currently, NR 243 defines a CAFO as a livestock operation consisting of 1,000 or more animal units. As outlined in the chapter, a conversion factor is used for each different animal type to determine the total number of animal units a farm has. For example, dairy cows, pigs, and turkeys produce different amounts of waste. So with the current conversion factor, 1,000 animal units equals about 700 dairy cows, 2,500 pigs, or 55,000 turkeys.

All CAFO farms must obtain a Wisconsin Pollutant Discharge Elimination System (WPDES) CAFO permit from the WDNR. Essentially, this permit is an approved plan that outlines the construction plans of a facility, plans for collecting land spreading and inspection records, controlling feedlot runoff, and also when, where, and how much manure and nutrients can be spread on fields. NR 243 sets guidelines for manure spreading. For example, these large operations are prohibited from applying manure and wastewater to saturated soils, or when precipitation capable of producing runoff is forecast within 24 hours of the planned application. Additionally, manure cannot be applied when snow is actively melting and water is flowing off of a field. Some exceptions apply, based upon snow depth, frozen ground depth, the condition of the manure (frozen, liquid, solid) and other factors.

Although it is common practice to label large CAFOs as the primary agricultural polluters of Wisconsin's lakes and streams, smaller operations are often overlooked as having an impact on our waterways. The Program on Agricultural Technology Studies (PATS) have studied this topic extensively and have found that dairy farms with larger herd sizes are more likely to follow recommended manure management practices, and are more likely to operate with a nutrient management plan. On smaller operations, often these conservation techniques are optional or otherwise not regulated. Regardless of size, the following situations are prohibited from all livestock operations:

- Overflowing of manure storage facility
- Unconfined manure piles within 300 ft of a stream or 1,000 ft of a lake or areas susceptible to groundwater contamination
- Direct runoff from a feedlot or stored manure into state waters
- Unlimited access by livestock to state waters, except where properly maintained livestock crossings exist.

\- *NR 151.08*

NR 153 and NR 154

Wis. Admin. Code NR 153 contains the policies and procedures for directing funds awarded through the Targeted Runoff Management (TRM) Grant Program. This grant may be awarded to governmental units and state agencies to reduce nonpoint source pollution. Governmental units may forward monies onto private landowners and operators through a cost-share agreement. Wis. Admin. Code NR 154 contains technical standards for BMPs and cost-sharing conditions applicable to TRM (NR 153) and Urban Nonpoint Source Grants (NR 155). Some of the BMPs included in NR 154 include:

- Manure storage systems
- Livestock fencing
- Riparian buffers

- Roofs and roof runoff systems
- Sediment basins and underground outlets
- Shoreland habitat restoration
- Wetland development / restoration

ATCP 50

While NR 151 sets the performance standards to control farm and other runoff, Wis. Admin. Code ATCP 50 is the Department of Agriculture, Trade, and Consumer Protection's (DATCP) companion rule which provides the tools to help meet these standards. DATCP is authorized by NR 92.14 to award grants to eligible county Land Conservation Committees and other approved groups who are committed to carry out approved land conservation projects. These grants pay for conservation staff and provide landowner cost-sharing to implement Land and Water Resource Management plans. ATCP 50 may be referenced to determine BMPs that crop and livestock producers may use to comply with NR 151, as well as identify how the practices are to be installed.

ATCP 51

Wis. Admin. Code ATCP 51 was the result Wisconsin Act 235 (2003), which directed DATCP to create rules specifying standards for siting and expanding livestock operation. While NR 243 applies directly to CAFO's (1,000 or more animal units), the rules contained in ATCP 51 are directed towards new or expanding operations with 500 or more animal units. The document contains standards for:

- Setbacks (minimum distance from public roads, waterways, etc.)
- Odor and air emissions
- Nutrient management plans (in accordance with NRCS 590)
- Waste storage facilities
- Runoff management

It is important to note that many operations exceeding 500 animal units may be "grandfathered" in which ATCP 51 compliance may not be required. However, if significant expansions occur (expansion of 20%) on these properties, ATCP 51 compliance will be necessary. Also, these conditions only apply to areas in which local approval is required.

Grant Programs and Technical Assistance

Targeted Runoff Management (TRM) Grant Programs

This grant is available through the WDNR and NR 153, and its purpose is to assist agricultural and urban nonpoint source control projects with funding. Generally, these grants assist areas that are site-specific and smaller in size than a sub-watershed. There are four categories:

- Large-scale TMDL Projects
- Large-scale non-TMDL Projects
- Small-scale TMDL Projects
- Small-scale non-TMDL Projects

A TMDL (Total Maximum Daily Load) is a regulatory term describing the maximum amount of a pollutant a body of water can receive while still meeting water quality standards. As the titles suggest, the TMDL grants provide support for actions taken to assist in the pollution reduction associated with an EPA approved TMDL project. If a project area is not connected to a TMDL project, a non-TMDL project grant would apply. This grant program only supports steps taken to reduce non-point source pollution, so activities to reduce pollution from a large livestock feeding operation (as defined in NR 243) or construction sites would not be funded in this program.

TRM Grants can be reimbursed up to 70 percent of eligible costs associated with installing Best Management Practices (BMP's) to target nonpoint source pollution. The grants have a 2-year implementation timeframe, and may benefit projects such as barnyard, feedlot, and livestock waste projects, stream bank protection projects, or wetland construction.

CREP (Conservation Reserve Enhancement Program)
CREP provides assistance to landowners who choose to implement conservation practices on agricultural land bordering water resources. In addition to providing financial assistance towards BMP implementation, landowners can receive payments that vary with either a 15-year contract or perpetual conservation easement agreement. Some of the more common BMP's that result from implementation of this program are filter strips, riparian buffers, and wetland restorations.

Manitowoc County has partnered with the DATCP to provide cost share assistance to landowners within the county. These contracts have since been enhanced with Great Lakes Protection Funds through the WDNR to improve participation. As of 2007, over 438 acres of buffers have been installed in the county, protecting about 190,000 feet of streams.

More information about the CREP program can be found on the USDA's website at: http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=grp.

Conservation Reserve Program
Similar to CREP, the Conservation Reserve Program (CRP) offers payments to landowners for taking their land out of production and planting grasses or trees in place of crops. This USDA sponsored program selects potential properties / projects based upon and Environmental Benefits Index (EBI) comprised of five factors plus cost. The five factors include wildlife enhancement, water quality, soil erosion, enduring benefits, and air quality.

As of September 2010, the 25th anniversary of the program, there were over 473,000 contracts signed in with the program which provided environmental benefits to over 31.3 million acres of land. Acceptance is high in the program; in Wisconsin alone 93.8% of offers from landowners have been funded.

More information about the CRP program can be found on the USDA's website at: http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=grp.

Grassland Reserve Program

The Grassland Reserve Program (GRP) provides financial incentives to landowners who agree to voluntarily limit future development and cropping practices on their land. The landowner retains the right to conduct grazing practices, with some restrictions during nesting seasons of bird species that are in decline or protected under Federal or State law. The landowner benefits by receiving USDA payments that vary depending on optional 10, 15, 20 or perpetual easement contracts. In turn, the surrounding landscape benefits from the ecological benefits which include providing diverse wildlife habitat, carbon sequestration, and water storage and flood protection.

More information about the GRP program can be found on the USDA's website at: http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=grp.

Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) began in 1997 as a voluntary conservation program offered through the NRCS of the USDA. EQIP offers contracts that range from 1-10 years for implementation. These contracts are competitive and are based upon a ranked scoring system that selects those projects that would provide the greatest positive environmental impact. EQIP is able to provide financial and technical help with structural and management conservation practices dealing with nutrient management, manure management, integrated pest management, or wildlife habitat management.

More information about the EQIP can be found on the NRCS' website at http://www.wi.nrcs.usda.gov/programs/eqip.html

Soil and Water Resource Management Program

The Soil and Water Resource Management (SWRM) Program is administered through the Wisconsin DATCP and supports locally-led conservation efforts. Essentially, DATCP offers grants to counties to pay for conservation staff and provide landowner cost-sharing for Land and Water Resource Management Plans. Additionally, funds can be used to support cooperators and other contractors to carry out approved SRWM activities. These funds are given out in accordance with ATCP 50 and Wis. Stats. Ch. 92.

More information about the SWRM program can be found on the DATCP's website at http://datcp.wi.gov/Environment/Land_and_Water_Conservation/SWRM_Grant_Program_Working_Manual/index.aspx

Protecting Harpt Lake as a Community

While agriculture and livestock production comprise a large part of Wisconsin's economy, it is important to consider the impacts on Wisconsin's natural resources and see to it that these impacts are minimized. While lake stakeholders are often quick to "point the finger" and demand immediate mitigation of harmful farming practices, it must be remembered that these corrective measures are both time consuming and costly to landowners.

The best course of action in managing a watershed is to first establish working relationships amongst the stakeholders and landowners there. It is important for agricultural property owners to work *with* lake stakeholders because of an agreement through mutual respect, not due to a complaint or lack of regulatory compliance. Some lake stakeholders have approached landowners with incentive-offering programs that may assist in the financing and technical selection of BMP's, and volunteered their time and talents to implement them. Some lake groups have made signs for "lake friendly farmers" to display in their yards. Other lake groups have raised money to acquire lands near waterways, and then manage then appropriately.

Lake stakeholders may direct agricultural landowners towards their local County Land Conservation Department (LCD). LCDs serve as the link between landowners and federal or state cost-share programs. They also oversee County based ordinances, which may or may not be more strict than state-wide ordinances. A LCD representative should be able to determine which program is best suited for a landowner, based upon the situation, and then follow through with a plan of action. Towns may have local ordinances that regulate agriculture and livestock operations in addition to state and county requirements. Both Towns and LCDs may require landowners to comply with standards listed in NR 151, as long as cost-share funds are obtainable.

The Manitowoc County Soil and Water Conservation Department (MCSWCD) has been very active in helping area landowners with conservation practices, as well as securing financial assistance for their implementation. Currently, some cropland owners are planting a cover crop such as winter wheat within the Harpt Lake watershed. Winter wheat is a type of wheat that is planted in fall of the calendar year, and then harvested in early summer. The plant sprouts before freezing occurs, then becomes dormant until the following spring when the soil warms. In addition to providing wind and water erosion protection of fields, winter wheat often requires less input than a spring planted wheat, and can have a higher yield potential. As an added bonus, winter wheat planting and harvesting is done during a time in which there are few other field activities going on, making for a more efficient use of labor and machinery. Winter wheat is an ideal cover crop for a no-till cropping system; when seeding winter wheat into a standing crop residue, the standing crop traps snow and reduces winter kill by insulating the wheat from lethal winter air temperatures. Bruce Riesterer of the MCSWCD also recommends incorporating winter rye as a cover crop, particularly on fields that previously held corn crops.;

In addition to winter wheat being used as a vegetative cover, there are about 5,100 lineal feet of grassed waterways being utilized as a vegetative buffer and for soil stabilization within the Harpt Lake watershed. Grassed waterways are strips of land that contain tall grass species. They are usually placed the deepest continuous line along a valley or where the water flows to from surrounding land. This conservation method helps to trap sediment carried in surface water runoff. Additionally, the root structures of the plants hold soil intact, preventing the formation of gullies. Figure 3.2-6 displays their location within the Harpt Lake watershed.

Although WiLMs modeling (using 1992 land cover data) calculated about 374 acres of crop land, more recent figures from the MCSWCD calculate 477 total crop acres within the watershed. Of these 477 acres, there are nutrient management and erosion control plans in place on 451 acres. These are complete plans meeting NRCS Standard 590. These plans address actions to determine on-site nutrient content, manure spreading quantities and timing, and to identify problematic areas on the site which may lead to nutrient loss or sediment erosion. In addition to this, the MCSWCD has adopted ordinances and nutrient management restrictions which govern nutrient and manure incorporation times and restricted area boundaries. This information is available to the general public in the form of online maps on the Manitowoc County's Geographic and Land Information website (http://webmap.manitowoc-county.com/website/pasystem/). These ordinances, as well as others, are in accordance with and further elaborated upon in the County's Land and Water Resource Management Plan (2008-2012).

Further actions that can be taken to address soil erosion and nutrient loss in the Harpt Lake watershed are discussed in the Summary / Conclusions Section and Implementation Plan. These

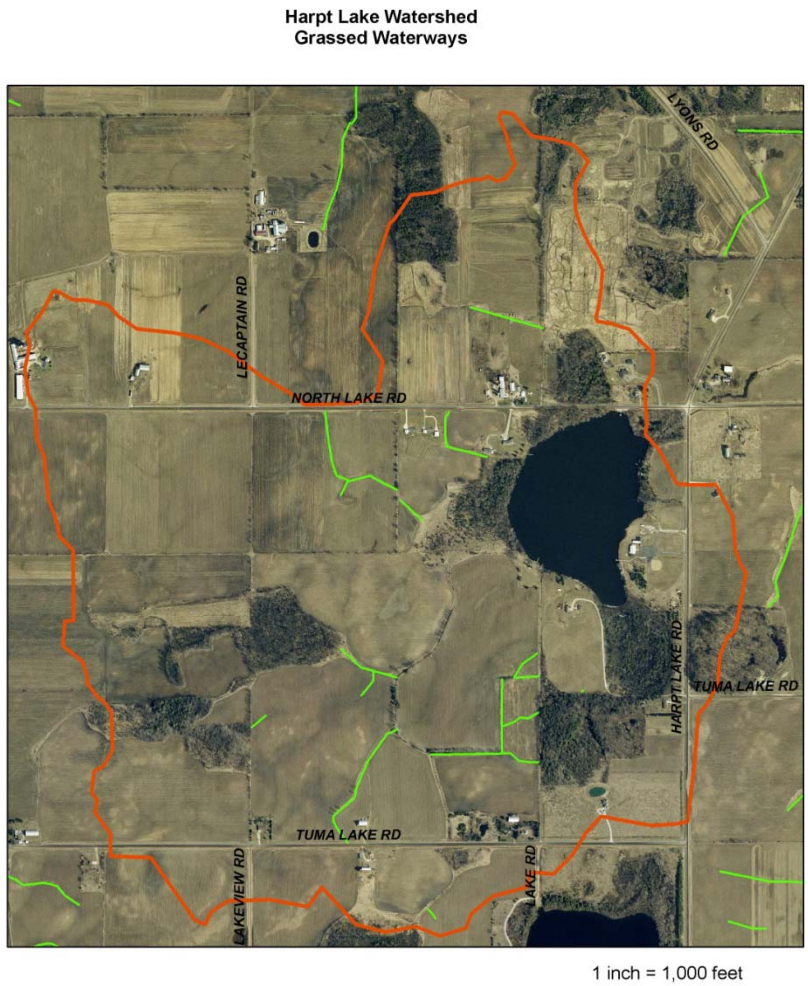

Figure 3.2-6. Locations of grassed waterways within the Harpt Lake watershed. Map created by the MCSWCD.

3.3 Aquatic Plants

Introduction

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

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

Under certain conditions, a few species may become a problem and require control measures. Excessive plant growth can limit recreational use by deterring navigation, swimming, and fishing activities. It can also lead to changes in fish population structure by providing too much cover for feeder fish resulting in reduced numbers of predator fish and 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 Harpt Lake, 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 Harpt Lake 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.

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 shoreline. 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 shoreline 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 depend on the size of the restoration area, planting densities, the species planted, and the type of planting (e.g. seeds, bare-roots, plugs, live-stakes) being conducted. Other factors may include extensive grading requirements, removal of shoreland stabilization (e.g., rip-rap, seawall), and protective measures used to guard the newly planted area from wildlife predation, wave-action, and erosion. In general, a restoration project with the characteristics described below would have an estimated materials and supplies cost of approximately $4,200.

- The single site used for the estimate indicated above has the following characteristics:
  - An upland buffer zone measuring 35’ x 100’.
  - An aquatic zone with shallow-water and deep-water areas of 10’ x 100’ each.
  - Site is assumed to need little invasive species removal prior to restoration.
  - Site has a moderate slope.
  - Trees and shrubs would be planted at a density of 435 plants/acre and 1210 plants/acre, respectively.
  - Plant spacing for the aquatic zone would be 3 feet.
  - Each site would need 100’ of biolog to protect the bank toe and each site would need 100’ of wavebreak and goose netting to protect aquatic plantings.
  - Each site would need 100’ of erosion control fabric to protect plants and sediment near the shoreline (the remainder of the site would be mulched).
  - 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 shoreline erosion. • Lower cost when compared to rip-rap and seawalls. • Restoration projects can be completed in phases to spread out costs. • 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.

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 affects on fish and other aquatic wildlife. • Adjacent wetlands may be altered due to lower water levels. • Disrupts recreational, hydroelectric, irrigation and water supply uses. • May enhance the spread of certain undesirable species, like common reed (*Phragmites australis*) and reed canary grass (*Phalaris arundinacea*). • Permitting process may require an environmental assessment that may take months to prepare. • Unselective.

Mechanical Harvesting

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

Costs

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

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

Chemical Treatment

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

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

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

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

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 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. Some herbicides are applied at a high dose with the anticipation that the exposure time will be short. Granular herbicides are usually applied at a lower dose, but the release of the herbicide from the clay carrier is slower and increases the exposure time.

Below are brief descriptions of the aquatic herbicides currently registered for use in Wisconsin.

<u>Fluridone</u> (Sonar®, Avast!®) Broad spectrum, systemic herbicide that is effective on most submersed and emergent macrophytes. It is also effective on duckweed and at low concentrations has been shown to selectively remove Eurasian water-milfoil. Fluridone slowly kills macrophytes over a 30-90 day period and is only applicable in whole lake treatments or in bays and backwaters were dilution can be controlled. Required length of contact time makes this chemical inapplicable for use in flowages and impoundments. Irrigation restrictions apply.

<u>Diquat</u> (Reward®, Weedtrine-D®) Broad spectrum, contact herbicide that is effective on all aquatic plants and can be sprayed directly on foliage (with surfactant) or injected in the water. It is very fast acting, requiring only 12-36 hours of exposure time. Diquat readily binds with clay particles, so it is not appropriate for use in turbid waters. Consumption restrictions apply.

<u>Endothall</u> (Hydrothol®, Aquathol®) Broad spectrum, contact herbicides used for spot treatments of submersed plants. The mono-salt form of Endothall (Hydrothol®) is more toxic to fish and aquatic invertebrates, so the dipotassium salt (Aquathol®) is most often used. Fish consumption, drinking, and irrigation restrictions apply.

<u>2,4-D</u> (Navigate®, DMA IV®, etc.) Selective, systemic herbicide that only works on broad-leaf plants. The selectivity of 2,4-D towards broad-leaved plants (dicots) allows it to be used for Eurasian water-milfoil without affecting many of our native plants, which are monocots. Drinking and irrigation restrictions may apply.

<u>Triclopyr</u> (Renovate®) Selective, systemic herbicide that is effective on broad leaf plants and, similar to 2,4 D, will not harm native monocots. Triclopyr is available in liquid or granular form, and can be combined with Endothal in small concentrations (<1.0 ppm) to effectively treat Eurasian water-milfoil. Triclopyr has been used in this way in Minnesota and Washington with some success.

<u>Glyphosate</u> (Rodeo®) Broad spectrum, systemic herbicide used in conjunction with a surfactant to control emergent and floating-leaved macrophytes. It acts in 7-10 days and is not used for submergent species. This chemical is commonly used for controlling purple loosestrife (*Lythrum salicaria*). Glyphosate is also marketed under the name Roundup®; this formulation is not permitted for use near aquatic environments because of its harmful effects on fish, amphibians, and other aquatic organisms.

Imazapyr (Habitat®) Broad spectrum, system herbicide, slow-acting liquid herbicide used to control emergent species. This relatively new herbicide is largely used for controlling common reed (giant reed, *Phragmites*) where plant stalks are cut and the herbicide is directly applied to the exposed vascular tissue.

Cost

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

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

Biological Controls

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

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

Cost

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

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

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

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

Cost

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

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

Analysis of Current Aquatic Plant Data

Aquatic plants are an important element in every healthy lake. Changes in lake ecosystems are often first seen in the lake's plant community. Whether these changes are positive, like variable water levels or negative, like increased shoreland development or the introduction of an exotic species, the plant community will respond. Plant communities respond in a variety of ways; there may be a loss of one or more species, certain life forms, such as emergents or floating-leaf communities may disappear from certain areas of the lake, or there may be a shift in plant dominance between species. 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 Harpt Lake; the first looked strictly for the exotic plant, curly-leaf pondweed, while the others that followed assessed both native and non-native species. Combined, these surveys produce a great deal of information about the aquatic vegetation of the lake. These data are analyzed and presented in numerous ways; each is discussed in more detail below.

Primer on Data Analysis & Data Interpretation

Species List

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

Frequency of Occurrence

Frequency of occurrence describes how often a certain species is found within a lake. Obviously, all of the plants cannot be counted in a lake, so samples are collected from pre-determined areas. In the case of Harpt Lake, 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

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.

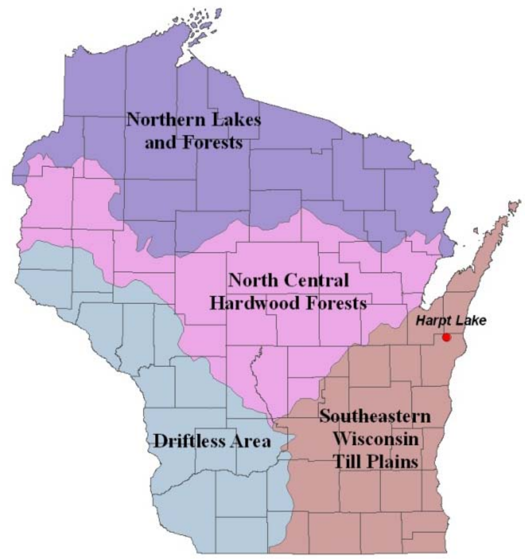

Figure 3.3-1. Location of Harpt Lake within the ecoregions of Wisconsin. After Nichols 1999.

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

One factor that influences species diversity 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.

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 Harpt Lake will be compared to lakes in the same ecoregion and in the state (Figure 3.3-1).

> **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.

Community Mapping

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

Exotic Plants

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

Eurasian water-milfoil is an invasive species, native to Europe, Asia and North Africa, that has spread to most Wisconsin counties (Figure 3.3-2). 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

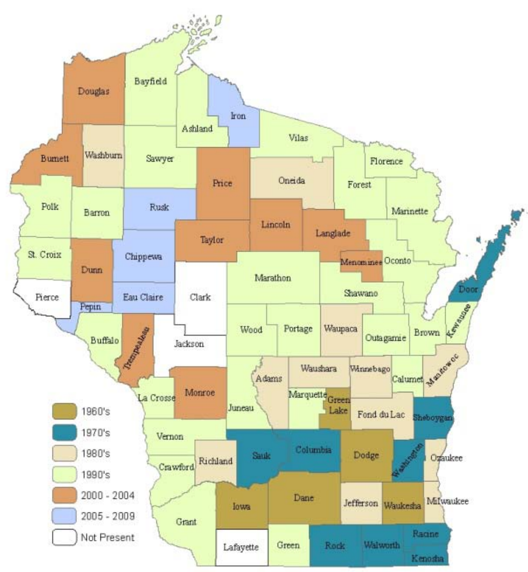

Figure 3.3-2. Spread of Eurasian water milfoil within WI counties. WDNR Data 2009 mapped by Onterra.

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

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

Aquatic Plant Survey Results

As mentioned above, numerous plant surveys were completed as a part of this project. On June 5, 2009, a survey was completed on Harpt Lake that focused upon curly-leaf pondweed. This meander-based survey did not locate any occurrences of curly-leaf pondweed. It is believed that this aquatic invasive species either does not occur in Harpt Lake or exists at an undetectable level.

The point intercept survey was conducted on Harpt Lake on June 30 of 2009 by Onterra. Additional surveys were completed by Onterra on Harpt Lake to create the aquatic plant community maps (Map 3) on June 29, 2009.

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

During the point-intercept and aquatic plant mapping surveys, 22 species of plants were located in Harpt Lake (Table 3.3-1). 17 of these species were sampled with a rake during the point-intercept survey, 3 species were located incidentally and therefore not quantified, and one of these is considered a non-native species: Eurasian water milfoil. The results of a stakeholder survey sent to members of the Larrabee Sportsman's Club, Inc. in 2010 indicate that approximately 58% of respondents are aware that aquatic invasive species are present in Harpt Lake (Appendix B, Question #16). When asked what factors may be negatively impacting Harpt Lake, aquatic invasive species ranked 7th, falling behind other factors such as algae blooms, excessive aquatic plant growth and water quality degradation / pollution.

Along with Eurasian water milfoil, a native milfoil plant, northern water milfoil was seen quite often during the point intercept survey. In fact, this was the fourth most frequently occurring plant in Harpt Lake during the survey (Figure 3.3-3). Northern water milfoil is often falsely identified as Eurasian water milfoil, especially since it is known to take on the 'reddish' appearance of Eurasian water milfoil as the plant reacts to increased sun exposure as the growing season progresses and is exacerbated by lowering water levels. The feathery foliage of northern water milfoil traps filamentous algae and detritus, providing valuable invertebrate habitat.

The top three common species found in Harpt Lake include coontail, muskgrass, and sago pondweed. Coontail was the most abundant species observed in Harpt Lake, being found on almost 60% of the sampling locations during the June 2009 point-intercept survey, and composing 25% of the aquatic plant population (Figures 3.3-4 and 3.3-5). Coontail lacks true root structures and its locations are often subject to water movement and their tendency to become entangled in plants, rocks, or debris. Muskgrass (sometimes referred to by its scientific genus, Chara) is often identified by its distinct musky or garlic-like odor. This plant is actually dissimilar from vascular plants and actually falls into a category of algae called a macroalgae. Despite its rough touch and smell, this low-growing plant is a preferred food source by waterfowl and provides excellent cover for young fish and invertebrates. Sago pondweed is a plant of worldwide importance as a food source for waterfowl, who will eat not only the foliage and seeds of the plant, but also the nutrient rich tubers. The plant is usually identified by its very thin, threadlike leaves that come off of a sheath surrounding the main stem at a distinctive angle. This arrangement gives the plant a fan-like appearance. Submersed aquatic plants were found growing to a maximum depth of 11 feet.

Table 3.3-1. Aquatic plant species located on Harpt Lake during late June 2009 surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)
Emergent	*Eleocharis palustris*	Creeping spikerush*	6
	Iris versicolor	Northern blue flag*	5
	Schoenoplectus acutus	Hardstem bulrush	5
	Typha latifolia	Broad-leaved cattail*	1
	Typha angustifolia	Narrow-leaved cattail	1
FL	*Nymphaea odorata*	White water lily	6
	Nuphar variegata	Spatterdock	6
FL/E	*Sparganium eurycarpum*	Common bur-reed	5
Submergent	*Chara sp.*	Muskgrasses	7
	Ceratophyllum demersum	Coontail	3
	Elodea canadensis	Common waterweed	3
	Myriophyllum spicatum	Eurasian water milfoil	Exotic
	Myriophyllum sibiricum	Northern water milfoil	7
	Nitella sp.	Stoneworts	7
	Potamogeton amplifolius	Large-leaf pondweed	7
	Potamogeton illinoensis	Illinois pondweed	6
	Potamogeton zosteriformis	Flat-stem pondweed	6
	Potamogeton foliosus	Leafy pondweed	6
	Stuckenia pectinata	Sago pondweed	3
FF	*Lemna minor*	Lesser duckweed	5
	Lemna trisulca	Forked duckweed	6
	Spirodela polyrhiza	Greater duckweed*	5

FL = Floating Leaf
FL/E = Floating Leaf and Emergent
FF = Free Floating
* Incidental Species

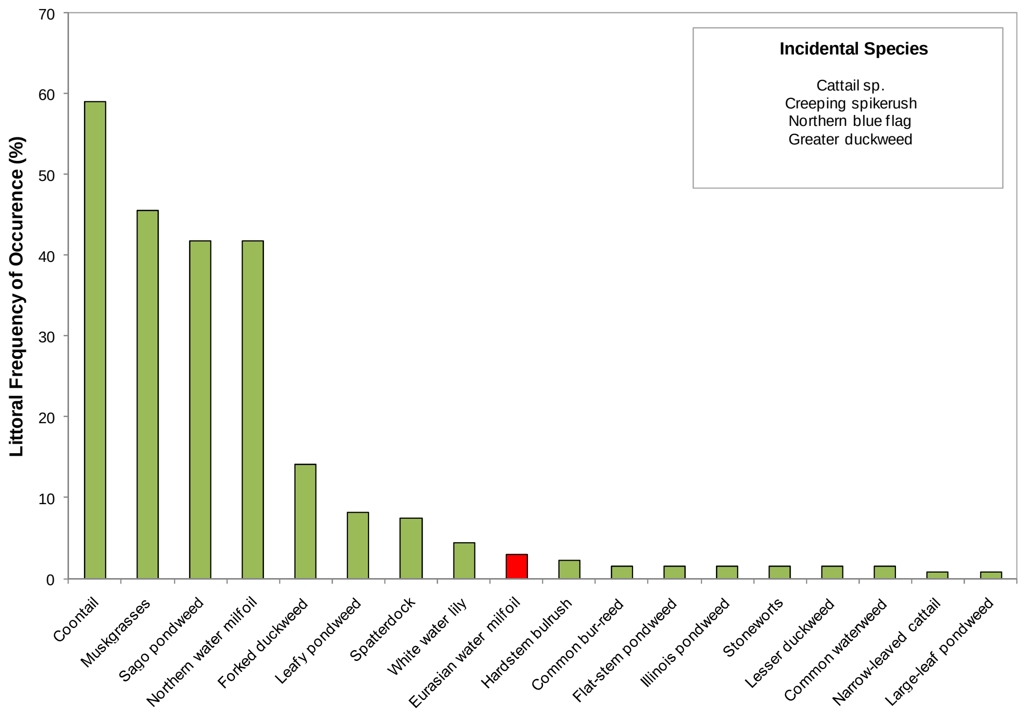

Figure 3.3-3 Harpt Lake aquatic plant littoral frequency of occurrence. Created using data from late June 2009 surveys. Exotic species indicated with red.

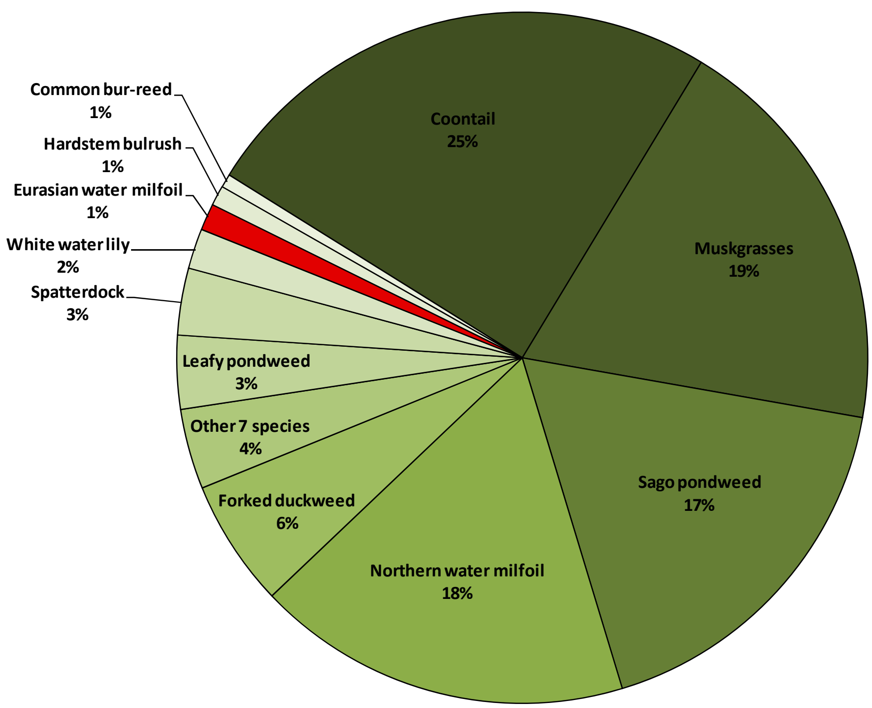

Figure 3.3-3 Harpt Lake aquatic plant relative frequency of occurrence. Created using data from late June 2009 surveys. Exotic species indicated with red.

Harpt Lake contains a relatively high number of native species when compared to other lakes in the state of Wisconsin and lakes within the Southeastern Wisconsin Till Plains (Figure 3.3-4). As discussed earlier, how evenly the species are distributed throughout the system also influences the diversity. The diversity index for Harpt Lake's plant community (0.83) indicates that the lake has a relatively uneven distribution (relative frequency) of plant species throughout the lake. In other words, because 4 species (coontail, muskgrass, sago pondweed, and northern water milfoil) make up almost 80% of the total aquatic plant frequency of occurrence (Figure 3.3-3), their dominance lowers the diversity of the plant community in the lake.

Data collected from the 2009 aquatic plant surveys indicate that the average conservatism value in Harpt Lake (4.8) is much lower than the median value for the state and Southeastern Wisconsin Till Plains (Figure 3.3-4). This indicates that many of the species present in the lake are indicative of a disturbed system. The establishment of aquatic invasive species can be viewed as a disturbance as well, and may likely cause a further shift in the aquatic plant community, particularly in respect to those species with higher coefficients of conservatism (Table 3.3-1).

Combining the number of species with the average conservatism, the Floristic Quality Index indicates that the aquatic plant populations of Harpt Lake are of moderate quality (calculation shown below). This value is slightly lower than median values seen both statewide and regionally. (Figure 3.3-4).

FQI = Average Coefficient of Conservatism (*4.8*) * √ Number of Native Species (not including incidental species) (*17*)

FQI = *19.8*

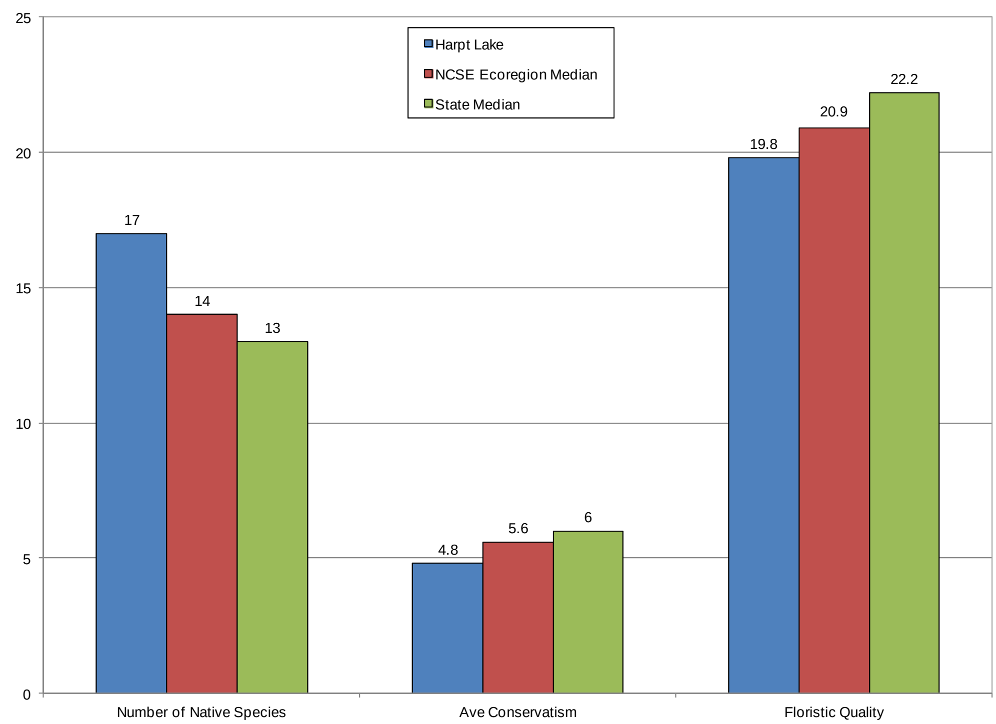

Figure 3.3-4. Harpt Lake Floristic Quality Assessment. Created using data from late June 2009 surveys. Analysis following Nichols (1999).

The quality is also indicated by the moderate incidence of emergent and floating-leaf plant communities that occur in areas surrounding the lake. A total of 8 emergent and floating-leaf species are known to exist in Harpt Lake (Table 3.3-1). The 2009 community map indicates that about 10% of the surface area (3.2 acres) of the lake contains these types of plant communities (Table 3.3-3, Map 3). Each of these areas provides valuable fish and wildlife habitat important to the ecosystem of the lake, particularly since structural habitat of fallen trees and other forms of coarse-woody debris are quite sparse along the shoreline of Harpt Lake.

Table 3.3-3. Harpt Lake acres of plant community types from the 2008 community mapping survey.

Plant Community	Acres
Floating-leaf	0.1
Mixed Floating-leaf and Emergent	3.1
Total	3.2

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

Eurasian Water Milfoil

In summer of 2007, Onterra ecologists visited Harpt Lake to investigate algae blooms which, according to lake residents and LSC members, had gotten progressively worse. During this initial visit, Eurasian water milfoil was discovered by Onterra staff and later verified by Dr. Robert Freckmann, UW-Stevens Point. Initially, this was thought to be the first occurrence of the exotic plant within the lake. It was later learned that the plant had actually been collected from the lake and vouchered in 1994.

During a late June peak biomass survey in 2009, Eurasian water milfoil was mapped throughout the lake. As Map 4 indicates, the plant was observed throughout the entire littoral zone of the lake, with some dense areas occurring on along the east shoreline. Following conversations with the WDNR and Larrabee Sportsman's Club, it was decided that the group would not pursue a 2010 herbicide treatment on the Eurasian water milfoil in the lake. Instead, the plant's abundance would be monitored.

In September of 2011, Onterra ecologists visited the lake again to map the locations of Eurasian water milfoil. The plant was found only sporadically along the western, northern and south-western shorelines. However, along the east side of the lake two denser colonies could be found between 2 and 6 feet of water (Map 5). In winter of 2012, Onterra ecologists, WDNR and members of the Harpt Lake Planning Committee discussed their options concerning the Eurasian water milfoil infestation. Because the plant had been present within the system for a considerable amount of time, and had not grown in density to a point in which navigation or other recreational activities were impacted, the LSC elected to pursue a monitoring strategy as opposed to more aggressive control efforts (e.g. herbicide treatments). The Implementation Plan outlines this monitoring strategy, to take place beginning in 2012.

3.4 Harpt Lake Fishery

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. Although current fish data were not collected, the following information was compiled based upon data available from the WDNR (WDNR 2010).

Table 3.4-1. Gamefish present in the Harpt Lake with corresponding biological information (Becker, 1983)**.**

Common Name	Scientific Name	Max Age (yrs)	Spawning Period	Spawning Habitat Requirements	Food Source
Black Bullhead	*Ictalurus melas*	5	April - June	Matted vegetation, woody debris, overhanging banks	Amphipods, insect larvae and adults, fish, detritus, algae
Black Crappie	*Pomoxis nigromaculatus*	7	May - June	Near *Chara* or other vegetation, over sand or fine gravel	Fish, cladocera, insect larvae, other inverts
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 pikes, 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 (ter. and aq.)
Rock Bass	*Ambloplites rupestris*	13	Late May - early June	Bottom of course sand or gravel, 1cm-1m deep	Crustaceans, insect larvae, and other inverts
Walleye	*Sander vitreus*	18	mid April - early May	Rocky, wavewashed shallows, inlet streams on gravel bottoms	Fish, fly and other insect larvae, crayfish
Yellow Perch	*Perca flavescens*	13	April - early May	Sheltered areas, emergent and submergent veg	Small fish, aquatic invertebrates

Harpt Lake Fishing Activity

Based on data collected from the stakeholder survey (Appendix B), fishing was the highest ranked important or enjoyable activity on Harpt Lake (Question #12). Approximately 67% of these same respondents believed that the quality of fishing on the lake was either fair or poor (Question #9); and approximately 77% believe that the quality of fishing has remained the same or gotten worse since they have obtained their property (Question #10).

Table 3.4-1 (above) shows the popular game fish that are present in the system. Management actions that will likely take place on Harpt Lake according to this plan include herbicide applications to control Eurasian water milfoil. In the future, these applications will occur in May when the water temperatures are below 60°F. It is important to understand the effect the chemical has on the spawning environment which would be to remove the submergent plants that are actively growing at these low water temperatures. For example, yellow perch is a species that could potentially be affected by early season herbicide applications, as the treatments could eliminate nursery areas for the emerged fry of these species.

Harpt Lake's location places it within two categories of species-specific management zones. The lake falls within the southern boundary of the largemouth and smallmouth bass management zone. These lakes do not have a catch and release season as their northern counterparts do. From May 1 to March 6, the minimum length limit on bass species is 14" with a daily bag limit of 5 fish total. However, Harpt Lake falls just above the boundary line dividing the northern and southern zone for muskellunge and northern pike management. In the northern zone the northern pike season runs from May 1 to March 6. For walleye, the rules follow general inland regulations with a season that runs from May 1 through March 6 with a minimum size limit of 15" and a daily bag limit of 5 walleye.

Harpt Lake Fish Stocking and Management

To assist in meeting fisheries management goals, the WDNR may stock fish in a waterbody that were raised in nearby permitted hatcheries. Stocking of a lake is sometimes done to assist the population of a species due to a lack of natural reproduction in the system, or to otherwise enhance angling opportunities. Fish can be stocked as fry, fingerlings or even as adults. Table 3.1-2 highlights recent stocking efforts in the lake. In a 2004 memorandum (Appendix F), WDNR biologist Steve Hogler wrote that walleye were stocked in the lake in odd years (2001, 2003, 2005 etc.). In years that DNR doesn't stock (even years) the local sportsmen's club may stock if they obtain a DNR stocking permit. During a fall 2003 electroshocking survey, only 3 walleye were netted and landed. As a result, it is believed by WDNR biologists that walleye survival appears to be poor within the lake.

Table 3.4-2. Walleye stocking data available from the WDNR from 1975 to 2011 (WDNR 2012).

Year	Age Class	# Stocked	Avg. Length (inches)
1975	Fingerling	1,500	5
1980	Fry	50,000	
1982	Fingerling	1,500	3
1984	Fingerling	1,500	3
1985	Fingerling	1,500	4
1989	Fry	1,500	3
1992	Fingerling	1,599	3
1994	Fingerling	740	2.5
1995	Fingerling	780	2.8
1997	Large Fingerling	775	2.7
1999	Fry	50,000	
1999	Small Fingerling	3,100	1.5
2001	Small Fingerling	3,100	1.6
2003	Small Fingerling	3,100	2.1
2005	Small Fingerling	1,525	1.4
2011	Small Fingerling	1,192	1.9

Although walleye are having difficulty surviving in Harpt Lake, bass and bluegill were reported to be doing well in the 2004 memorandum. The WDNR is managing the lake for both fish species. Besides the habitat being preferable by bass and bluegill, historical accounts describe the lake being dominated these fish. According to WDNR biologists, the fisheries goal for Harpt Lake is to develop self sustaining populations that provide fishing opportunities for recreational anglers. In the 2003 fall survey, largemouth bass were the most dominant fish captured in the lake. While survival seems to be good, the growth rate of these fish was fairly slow when compared to state averages. Similarly, the length of aged bluegills at each age was less than state averages. Angler harvest was reported to likely be a major factor in the size structure of both the bass and bluegill populations in Harpt Lake (Appendix F).

During Planning Meeting II in February of 2012, members of the Harpt Lake Planning Committee expressed concern over the presence of common carp within Harpt Lake. This species of fish originated in the Caspian Sea, and has since spread globally. It was likely introduced to the Hudson River in New York in the early 1800's for commercial purposes. It now has spread throughout the continental United States. This species feeds upon decaying plant matter and benthic (lake bottom) organisms. While feeding, the fish may uproot aquatic vegetation, while increasing turbidity, suspended solids and nutrients into the water column as well.

WDNR biologists did not capture any carp in their 2003 survey of the lake; therefore, it is believed that if carp are present within the lake it is a new introduction. A one-night WDNR fisheries survey is expected to occur in late spring of 2012. During that time, WDNR biologists will aim efforts at bass and bluegill but also note any occurrences of carp. Anglers who come across carp in Harpt Lake may remove the fish from the lake; however, WDNR biologists recommend that the fish be used for something (e.g. fertilizer) as opposed to being left on the shoreline or within a nearby trash can.

Harpt Lake Substrate Type

According to the point-intercept survey conducted by Onterra, 100% of the substrate sampled in the littoral zone on Harpt Lake was muck. 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. For example, 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 they do not get buried in sediment and suffocate. 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.

4.0 SUMMARY & CONCLUSIONS

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

1) Collect baseline data to increase the general understanding of the Harpt Lake ecosystem.
2) Collect detailed information regarding invasive plant species within the lake, with the primary emphasis being on Eurasian water milfoil.
3) Develop an accurate understanding of the sources of nutrient loading to the Harpt Lake ecosystem.
4) Collect sociological information from Harpt 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 four objectives were fulfilled during the project and have led to a good understanding of the Harpt Lake ecosystem, the people that care about the lake, and what needs to be completed to protect and enhance it.

Beginning with a single visit to Harpt Lake in September of 2009, it was apparent that this little lake was experiencing some difficulties. Thick mats of filamentous algae covered the native vegetation, which was the primary reason for Onterra's visit. Eurasian water milfoil was discovered to be spread throughout much of the lake. An understanding of the ecosystem was critical if managers were to develop strategies to deal with the problems that were concerning the residents around Harpt Lake.

Analysis of the water chemistry and clarity in Harpt Lake confirms what was suspected previously – the water quality of Harpt Lake is not ideal. Phosphorous levels are not terribly high considering the geographical setting (agricultural land) of the lake. The algae content in the lake is considerable, though it is confined primarily to the littoral region, where it becomes bound upon vegetation, rocks and downed timber. The open water of the lake holds small to moderate amounts of free floating algae, which in turn impacts the clarity of the water only moderately. Secchi disk clarity averages are consistent with similar lakes in the state. In fact, light is able to penetrate fairly well into the waters of Harpt Lake, as during the course of the study Onterra ecologists found plants growing out to 11 ft of depth.

The plant community of Harpt Lake shows signs of stress from anthropogenic sources. While the number of native species found in the lake is greater than similar lakes regionally and statewide, the quality of the plants is moderate, and the average conservatism and diversity scores the plant community received indicates an unevenly distributed, highly disturbed ecosystem. The presence of an invasive plant also is a tell-tale sign of negative human influence on a lake. From the community mapping survey, approximately 10% of the lake holds areas of floating-leaf and emergent plant species. These are important areas to preserve because of the natural habitat, shoreline protection and aesthetic value they provide.

The presence of Eurasian water milfoil is a challenge the LSC faces. First discovered in 1994, the plant was found scattered around the littoral region of the lake in 2009 (Map 4). In 2011 when Onterra ecologists mapped the invasive plant again, the plant had subsided in some areas but increased in others (Map 6). Presently, the plant itself is not limiting navigation or causing other significant nuisance conditions on the lake. The area of dominant Eurasian water milfoil indicated on Map 6 outside of the LSC is a bit concerning, as it is a sign of what the plant is capable of doing when the conditions are right. However, the plant has been present within the system for quite some time (1994). At this point in time, Onterra ecologists, the WDNR and members of the LSC believe continued monitoring by professionals is the best course of action. Should larger, denser colonies be discovered in subsequent years, a control strategy will be developed. This plan is outlined in Goal 2 of the Implementation Plan

Probably the most pressing issue concerning the LSC is the increased nutrient content of the water, which spurs nuisance conditions of filamentous algae growth in the littoral region. The algae and aquatic plants are fueled primarily by phosphorus. Knowing the problems that existed in Harpt Lake, this study was designed to incorporate testing of the water quality near the surface and bottom of the lake in order to analyze phosphorus dynamics in these zones. Through the course of this study, it was discovered that internal nutrient loading accounted for 38% of the total annual phosphorus contribution to the lake. This is a significant amount, though agricultural lands surrounding the lake are responsible for significant inputs of phosphorus as well.

While remediation strategies such as an alum treatment may be suitable to reduce the internal nutrient loading in Harpt Lake, they may not be cost effective given the potential outcome. As discussed in the Watershed Section, even if internal nutrient loading was reduced along with external loading, the changes in water quality would likely be minimal. The reality is that Harpt Lake is a small body of water, with large amounts of disturbed landscape surrounding it. Harpt Lake will likely always have a certain amount of filamentous algae, and fairly low to moderate water clarity. However, this should not deter managers, the LSC, and lake residents from doing their part to ensure that the lake does not become *more* eutrophic. With continued efforts to reduce nutrient export to the lake, these individuals can make Harpt Lake enjoyable for generations to come. In the next section, the Implementation Plan, specific tasks are outlined which when enacted will carry out a plan protect and partially restore Harpt Lake.

5.0 IMPLEMENTATION PLAN

The intent of this project was to complete a *comprehensive* management plan for Harpt Lake. As described in the proceeding sections, a great deal of study and analysis were completed involving many aspects of the ecosystem. This section stands as the actual "plan" portion of this document as it outlines the steps the Larrabee Sportsman's Club (LSC) will follow in order to manage Harpt Lake, its watershed, and the club itself.

The implementation plan is broken into individual *Management Goals*. Each management goal has one or more management actions that if completed, will lead to the specific management goal in being met. Each management action contains a timeframe for which the action will be taken, a facilitator that will initiate or carry out the action, a description of the action, and if applicable, a list of prospective funding sources and specific actions steps.

Management Goal 1: Maintain Current Water Quality Conditions

Management Action: Address manure and milkyard runoff from North Farm.
Category: Pollution Prevention
Timeframe: Begin 2012
Facilitator: Larrabee Sportsman's Club in coordination with the Manitowoc County Soil and Water Conservation Department (MCSWCD).
Description: Through conversations with conservationists at the MCSWCD and field observations during numerous visits to Harpt Lake, Onterra ecologists became concerned about possible nutrient loading to the lake stemming from a farm located northwest of the lake on North Lake Rd. Specifically, there is reason to suspect that milkyard wastes and manure may be making its way into the lake. This is a critical area due to its proximity to the lake. While there is no reason to believe that any ordinances are in violation, an opportunity to go "above and beyond" exists in which proper storage facilities could be constructed to hold the waste. There is no reason to "point the finger" at this landowner for not constructing a storage facility, as this type of project can be incredibly costly.

Funding sources such as several of those described in the Watershed Section are available to assist land owners with projects such as this. Bruce Riesterer, a resource conservationist with the MCSWCD (920.683.4163), is a tremendous source of information regarding the specifics of these funding sources, and has been successful in overseeing projects all across Manitowoc County. Bruce has discussed possibilities for conservation work on the farm with Onterra staff on several occasions; however, it is now up to the LSC and the landowner to pursue the next step.

Action Steps:

1. Members of the LSC should contact Bruce Riesterer regarding their interest in having the MCSWCD pursue conservation work on this property.
2. Members of the LSC may wish to hold a conversation with this property owner, to explain that although they are not concerned about an ordinance violation, they are concerned about impacts of the farm on Harpt Lake.

3. Mr. Riesterer will contact the property owner to discuss willingness to have conservation work done, followed by discussions of potential strategies for work along with cost-sharing options such as EQIP.

Management Action: Install buffer strips along select intermittent waterways in Harpt Lake watershed.

Category: Pollution Prevention

Timeframe: Begin 2012

Facilitator: Larrabee Sportsman's Club in coordination with the Manitowoc County Soil and Water Conservation Department (MCSWCD).

Description: Currently, there are grassed waterways covering 5,100 lineal feet within the Harpt Lake watershed. These efforts have reduced nutrient and sediment from entering Harpt Lake during rain events. At this time, the MCSWCD believes there are several key areas in which buffer strips could be grown that would further reduce nutrient and sediment loads to Harpt Lake. These areas are indicated in Figure 5.0-1 below.

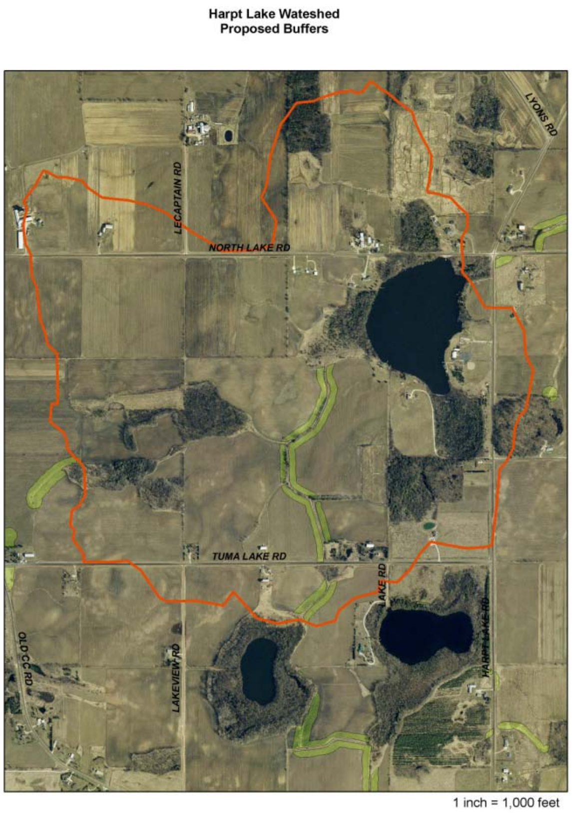

Figure 5.0-1. Locations proposed buffers within the Harpt Lake watershed. Map created by the MCSWCD.

Funding sources such as several of those described in the Watershed Section are available to assist land owners with projects such as this. Again, Bruce Riesterer, a resource conservationist with the MCSWCD (920.683.4163), would be available to streamline this process.

Action Steps:

1. Members of the LSC should contact Bruce Riesterer regarding their interest in having the MCSWCD pursue the incorporation of these buffer strips.
2. Mr. Riesterer will contact the property owner(s) either in person or by mail with information regarding the areas of proposed work, potential costs, and cost-sharing opportunities such as SWRM, CREP or EQIP.

<u>Management Action:</u> Promote winter cover crop usage within the Harpt Lake watershed.
Category: Pollution Prevention
Timeframe: Begin 2012
Facilitator: Larrabee Sportsman's Club in coordination with the Manitowoc County Soil and Water Conservation Department (MCSWCD).
Description: Although there are a number of agricultural landowners that are incorporating use of winter cover crops already within this watershed, the use of this conservation practice could be increased further.

Funding sources are not as available for this type of conservation effort as much as others. EQIP funds may be available through a grant written by the MCSWCD. Another possibility to assist landowners in utilizing this conservation practice would be for the LSC to provide financial incentive. For example, the Diamond Lake Association, in Atwater, Minnesota, offsets the landowner's costs of establishing conservation projects by paying the difference in the cost share portion paid by the Federal government. The Association also provides a one-time incentive payment to landowners for participating in this program. For more information, please consult the Diamond Lake Association website at: (http://www.diamondlakemn.com/dlanews200301.html).

While this type of financial incentive program may not be feasible for a group the size of the LSC, a similar program may be initiated. For example, some lake associations are paying landowners a flat price per acre that they place into winter cover crops. Again, Bruce Riesterer (920.683.4163) is a good source of information to consult for assistance on an effort such as this.

Action Steps:

1. See above.

<u>Management Action:</u> Monitor water quality through WDNR Citizens Lake Monitoring Network.

Timeframe: Begin 2012

Facilitator: Larrabee Sportsman's Club volunteers

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. Early discovery of negative trends may lead to the reason as of why the trend is developing.

The Citizens Lake Monitoring Network (CLMN) is a WDNR program in which volunteers are trained to collect water quality information on their lake. Volunteers trained by the WDNR as a part of the CLMN program begin by collecting Secchi disk transparency data for at least one year, then if the WDNR has availability in the program, the volunteer may enter into the advanced program and collect water chemistry data including chlorophyll-a, and total phosphorus. At a minimum, Harpt Lake volunteers should be collecting Secchi disk transparency data several times throughout the open water season. After a year's time of enrollment, volunteers may move forward with advanced monitoring if the WDNR budget allows enrollment in this program at that time. Note: as a part of this program, these data are automatically added to the WDNR database and available through their Surface Water Integrated Monitoring System (SWIMS).

During Planning Meeting II, Harpt Lake Planning Committee members expressed interest in monitoring water chemistry within the lake (nutrients, chlorophyll*a*, etc.). While no outside funding source is available for 2012, an AIS-EPP grant (discussed within Goal 2), if successfully obtained in August 2012, could provide partial funding for monitoring activities in 2013-2015. Furthermore, Harpt Lake Planning Committee members expressed interest in paying for monitoring expenses out-of-pocket in order to continue data collection on the lake. Labs such as the State Lab of Hygiene in Madison, WI can be contracted to perform laboratory analyses on samples that are sent to them. If the LSC elects to pay for 2012 samples out-of-pocket, it is recommended that the person/persons conducting the sampling discuss the matter with WDNR water resource management specialist Mary Gansberg (920.662.5489). Sampling volunteers should be trained in sampling methodology and intensity, as well as advised on what parameters should be sampled in the lake.

Action Steps:

Please see description above

Management Goal 2: Monitor Eurasian Water Milfoil and Prevent Additional AIS from Entering Harpt Lake.

Management Action: Professional monitoring of Eurasian water milfoil (3 years).
Timeframe: Begin 2012
Facilitator: Larrabee Sportsman's Club
Funding Source: WDNR Aquatic Invasive Species Education, Prevention and Planning grant
Description: During the initial surveys (2009) associated with this project, Eurasian water milfoil existed in much of the littoral zone around Harpt Lake (Map 4). In late summer 2011, Onterra ecologists mapped the extent of Eurasian water milfoil in the lake once again and found that its occurrence was greatly diminished along the western shoreline, but that several dense areas continued to thrive along the eastern shoreline of the lake (Map 5). It is not uncommon to see Eurasian water milfoil, or any aquatic plant for that matter, densities fluctuate from year to year because of the dynamics of the aquatic environment. It is unknown what course the aquatic invasive plant followed from 1994, when it was first discovered in the lake, through the time in which it was first mapped (2007).

The current density and extent of Eurasian water milfoil in Harpt Lake is slightly concerning because a). the colonies provide a source population for new plants and b). the threat of transfer of this AIS from Harpt Lake to neighboring waterbodies exists. However, at this time the plant is not causing considerable problems within Harpt Lake; navigation and recreational activities are not hindered by its presence, and the native aquatic plant community is relatively healthy.

Onterra ecologists, WDNR lakes specialist Mary Gansberg, and members of the Harpt Lake Planning Committee agreed during Planning Meeting II that the best course of action in examining Eurasian water milfoil within Harpt Lake would be to professionally monitor the plant over the course of the next four years. Specifically, the LSC will pay for professional monitoring during 2012, and prepare a proposal for an Aquatic Invasive Species Education, Prevention and Planning (AIS-EPP) grant due at the August 1st, 2012 grant cycle. If received, this grant would provide 75% of the total project cost.

The monitoring project will include peak-biomass surveys of Eurasian water milfoil, followed by a letter resport depicting explaining survey results to the LSC and WDNR. The peak biomass survey, as its name implies, will assess the plant at its peak growth (conducted during mid-July to mid-September). The letter report will be drafted the following fall/winter. This process will occur during 2012 – 2015. In 2015, a point-intercept survey would be completed on the lake, using the same methodology used in 2009. This would give managers acomparable data on the abundance of both native and non-native (Eurasian water milfoil) species within the lake. Within the 2015 letter report, an analysis of the aquatic plant survey as well as a comparison between 2009 and 2015 would be included. At this time, a Eurasian water milfoil strategy would be developed based upon what was learned in the previous three years of surveys/studies.

If a grant were obtained in August 1, 2012, the grant-funded project would last 3 years (2013-2015). Each year's peak-biomass survey and letter report would be partially funded through this grant. The grant would also include line items for potential spring pre-treatment surveys, which would be necessary should the results of the previous year's surveys warrant an herbicide treatment on Eurasian water milfoil. This control action will be initiated only if peak-biomass surveys determined that Eurasian water milfoil had increased in density to a more concerning level, or if the LSC felt that the plant was becoming a recreational or navigational hazard.

To reduce the cash cost that the LSC would incur as a result of applying for this grant, in-kind donated time will be incorporated within the proposal of this grant. For example, LSC members could be "paid" per hour for activities such as monitoring the lake's public access, attending training sessions on invasive plant identification, conducting volunteer surveys on the lake, or monitoring water quality. The August 1st grant would include line items for water quality monitoring, as well as sample processing costs at the State Lab of Hygiene.

Action Steps:

1. Retain qualified professional assistance to develop a specific project designed to implement and monitor the monitoring strategy outlined above.
2. Apply for an AIS-EPP grant for submittal to the WDNR (August 1st, 2012 deadline) with the project design described above.
3. Initiate monitoring plan.
4. Based upon monitoring results, develop further Eurasian water milfoil strategy (herbicide treatments, continued monitoring, etc.).

Management Action: Initiate volunteer-based monitoring of aquatic invasive species.
Timeframe: Start 2012
Facilitator: Larrabee Sportsman's Club
Description: In lakes with small amounts of Eurasian water milfoil, early detection of pioneer colonies commonly leads to successful control and in cases of very small infestations, possibly even eradication. Using trained volunteers is a feasible method to monitor for the occurrence of these unwanted species. The keys to success are proper training and persistence by the lake group.

Following a training session by the WDNR, UW-Extension or Manitowoc County Lakes Association, volunteers would monitor Eurasian water milfoil occurrences within the lake. Initial training would include identification of Eurasian water milfoil and curly-leaf pondweed as well as native look-a-likes and expand to proper use of GPS for recording aquatic plant occurrences, note taking, and transfer of spatial data. If this form of training is not available through the organizations listed above, the LSC may seek professional training on these tasks.

Action Steps:

1. Volunteers from LSC attend training session conducted by WDNR, UW-Extension or Manitowoc County Lakes Association.

2. Trained volunteers recruit and train additional Club members.
3. Complete lake surveys following protocols.
4. Report results to WDNR and LSC.

<u>Management Action:</u> Initiate Clean Boats Clean Waters watercraft inspections at Harpt Lake public access location.

Timeframe: Start 2012

Facilitator: Larrabee Sportsman's Club

Description: Harpt Lake is a popular destination by recreationists and anglers, making the lake vulnerable to new infestations of exotic species. The intent of the boat inspections would not only be to prevent additional invasives from entering the lake through its public access point, but also to prevent the infestation of other waterways with invasives that originated in Harpt Lake. The goal would be to cover the landings during the busiest times in order to maximize contact with lake users, spreading the word about the negative impacts of AIS on our lakes and educating people about how they are the primary vector of its spread.

Often it is difficult for lake associations to recruit and maintain a volunteer base to oversee Clean Boats Clean Waters (CBCW) inspections throughout the summer months. Recruitment outside of the LSC may be necessary in order to have sufficient coverage of the Harpt Lake public access. Education efforts outside of the lake community help to not only raise awareness about the threat of AIS, but also potentially recruit new volunteers to participate in activities such as CBCW.

Members of the LSC, as well as other volunteers, will need to be trained on CBCW protocols in order to participate in public boat landing inspections. Fully understanding the importance of CBCW inspections, paid watercraft inspectors may be sought to ensure monitoring occurs at the public boat landing. These paid inspectors may be purchased alone or in conjunction with volunteers through the LSC or in the community.

Action Steps:

1. Members of association periodically attend CBCW training session through the WDNR or Manitowoc County Lakes Association (Tom Ward – 920.588.0047) to update their skills to current standards.
2. Training of additional volunteers completed by those previously trained.
3. Begin inspections during high-risk weekends
4. Report results to WDNR and LSC
5. Promote enlistment and training of new of volunteers to keep program fresh.

6.0 METHODS

Lake Water Quality

Baseline water quality conditions were studied to assist in identifying potential water quality problems in Harpt Lake (e.g., elevated phosphorus levels, anaerobic conditions, etc.). Water quality was monitored at the deepest point in the lake that would most accurately depict the conditions of the lake (Map 1). Samples were collected with a 3-liter Van Dorn bottle at the subsurface (S) and near bottom (B). Sampling occurred once in spring, fall, and winter and three times during summer. Samples were kept cool and preserved with acid following standard protocols. All samples were shipped to the Wisconsin State Laboratory of Hygiene for analysis. The parameters measured included the following:

Parameter	Spring		June		July		August		Fall		Winter	
	S	B	S	B	S	B	S	B	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	●											

In addition, during each sampling event Secchi disk transparency was recorded and a temperature, pH, conductivity, and dissolved oxygen profile was be completed using a Hydrolab DataSonde 5.

As a part of the internal load modeling component, total phosphorus samples were collected from near-surface and near bottom depths from the lake every two weeks from mid April through October by Harpt Lake volunteers (Glenn & Marlene Rezek). A dissolved oxygen/temperature profile was also created during each of the 16 sample events. The collection of these samples was combined with the collection of the samples described above in order to make the collection as efficient as possible.

Watershed Analysis

The watershed analysis began with an accurate delineation of Harpt 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 Wisconsin initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND) 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)

Annual internal phosphorus loading was modeled for the lake through the use of the Wisconsin Internal Load Estimator (WINTLOAD). This model utilizes temperature and dissolved oxygen profiles along with seasonal phosphorus concentrations to estimate the extent of internal phosphorus loading – a major source of the annual phosphorus load in some lakes.

Aquatic Vegetation

Curly-leaf Pondweed Survey

Surveys of curly-leaf pondweed were completed on Harpt Lake during a June 5th, 2009 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 Harpt 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 "Appendix D" of the Wisconsin Department of Natural Resource document, Aquatic Plant Management in Wisconsin, (April, 2007) was used to complete this study on June 30th, 2009. A point spacing of 30 meters was used resulting in approximately 154 points.

Community Mapping

During the species inventory work, the aquatic vegetation community types within Harpt 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 LSC.

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