Jersey Flowage

Lincoln County, Wisconsin

Comprehensive Management Plan

April 2014

Sponsored by:

Friends of the Jersey Flowage
WDNR Grant Program

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Onterra, LLC
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Onterra LLC
Lake Management Planning

Jersey Flowage
Lincoln County, Wisconsin
Comprehensive Management Plan
April 2014

Created by: Dan Cibulka, Brenton Butterfield and Tim Hoyman
Onterra, LLC
De Pere, WI

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Acknowledgements

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

Jersey Flowage Planning Committee

Marv Krueger	Barbara Martin	Steve Martin
Dale Knapp	Naomi Hipler	Scott Jennejohn
Dennis Hintenlinter	Don Hipler	Robert Eisenen

Organization

Lumberjack Aquatic Invasives Coordinator – John Preuss
Wisconsin Public Service – Darrin Johnson

Wisconsin Dept. of Natural Resources

Jim Kreitlow
David Seibel

TABLE OF CONTENTS

FIGURES

TABLES

PHOTOS

MAPS

APPENDICES

1.0 INTRODUCTION

The Jersey Flowage, Lincoln, is a 423-acre shallow drainage lake with a maximum depth of 20 feet and a mean depth of 4 feet (Map 1). This eutrophic lake has a relatively large watershed when compared to the size of the lake. The Jersey Flowage contains 53 native plant species, of which wild celery is the most common plant. Two exotic plant species are known to exist in the Jersey Flowage.

Field Survey Notes

Heavily stained water within flowage. Shallow depth throughout most of the lake. The Jersey Flowage is surrounded mostly by forested wetlands and wetlands, offering exceptional wildlife habitat.

Photograph 1.0-1 Jersey Flowage, Lincoln County

Lake at a Glance - Jersey Flowage

Morphology	
Acreage	423
Maximum Depth (ft)	20
Mean Depth (ft)	4
Shoreline Complexity	20.5
Vegetation	
Curly-leaf Survey Date	06/06/2012
Comprehensive Survey Date	06/27/2012
Number of Native Species	53
Threatened/Special Concern Species	Vasey's pondweed (Potamogeton vaseyi)
Exotic Plant Species	Eurasian water milfoil and Curly-leaf pondweed
Simpson's Diversity	0.94
Average Conservatism	6.7
Water Quality	
Trophic State	Eutrophic
Limiting Nutrient	Phosphorus
Water Acidity (pH)	7.4
Sensitivity to Acid Rain	Not sensitive
Watershed to Lake Area Ratio	13:1

The Jersey Flowage is located directly north of the city of Tomahawk and is within the Wisconsin River drainage basin. Water enters the Jersey Flowage first by flowing over the Rice Dam, which impounds Lake Nokomis and the Rice River Reservoir. Water flows over this dam at an annual average of 505 cubic feet per second (cfs). After flowing through the Jersey Flowage, water empties through the Jersey Dam, a hydroelectric dam operated by Wisconsin Public Service (WPS). This dam holds lake elevations between 1,449.95 and 1,450.55 ft NGVD (National Geodetic Vertical Datum). Then, water enters Lake Mohawksin, where it joins water from the Somo River (to the west) and the Wisconsin River (to the east) and continues flowing south as the Wisconsin River.

The Friends of the Jersey Flowage, Inc. (FOJF) was *"…established in 2010 to create awareness around the need to protect the Jersey from Aquatic Invasive Species (AIS)"*. While the initial drive to organize a membership-based management body was spurred by the discovery of Eurasian water milfoil in 2009, the FOJF has concerned themselves with other aquatic invasive species such as Chinese mystery snail, rusty crayfish and curly-leaf pondweed. In 2011, the FOJF contracted Onterra, LLC to conduct initial monitoring of Eurasian water milfoil and curly-leaf pondweed on the flowage. These studies were completed that summer. With an abundance of these exotic plants found in the system, the FOJF elected to proceed with further studies to understand the Jersey Flowage and impacts that may come about from management of aquatic invasive species.

In August 2011, the FOJF submitted a grant application to the Wisconsin Department of Natural Resources (WDNR) for consideration under their lake management planning grant program. That grant application was approved for funding in October of 2011, and studies began on the lake that following spring to collect the necessary data to create this management plan.

2.0 STAKEHOLDER PARTICIPATION

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

Kick-off Meeting

On June 30, 2012, a project kick-off meeting was held at the Town of Bradley Town Hall to introduce the project to the general public. The meeting was announced through a mailing and personal contact by FOJF board members. The attendees observed a presentation given by Dan Cibulka, an aquatic ecologist with Onterra. Mr. Cibulka's presentation started with an educational component regarding general lake ecology and ended with a detailed description of the project including opportunities for stakeholders to be involved. The presentation was followed by a question and answer session.

Planning Committee Meeting I

On June 6, 2013, Dan Cibulka and Eddie Heath of Onterra met with the FOJF planning committee members to discuss the results of the scientific studies that had occurred on the Jersey Flowage in 2012. John Preuss, Lumberjack Aquatic Invasive Species Coordinator, was also present. During the meeting, many discussions were held on the water quality, aquatic plants, watershed and fisheries of the Jersey Flowage as well as the perceptions of stakeholders around the lake. Management of aquatic invasive species was discussed at length.

Planning Committee Meeting II

On August 27, 2013, Dan Cibulka met with the FOJF planning committee members a second time. This time, management goals and actions pertaining to preserving the water quality, shoreland habitat and native plants were discussed. Also, a plan was developed to continue monitoring aquatic invasive species within the lake. The discussions held at this meeting were integrated into the Implementation Plan, found near the end of this document.

Project Wrap-up Meeting

The project Wrap-Up Meeting is scheduled for summer 2014. During this meeting, Onterra staff will deliver a presentation detailing the final study results and management goals that were created as a result of the management planning process. The entire FOJF membership, as well as the general public, will be invited to participate in this meeting.

Management Plan Review and Adoption Process

The Implementation Plan was created largely from Onterra oversight of the comments and discussions amongst the FOJF planning committee. A draft of the plan was sent to the FOJF committee in January of 2014. This draft was passed before the Board of Directors, who approved of the document unanimously in March of 2014. The draft was then sent to the WDNR on March 14, 2014 for review.

Stakeholder Survey

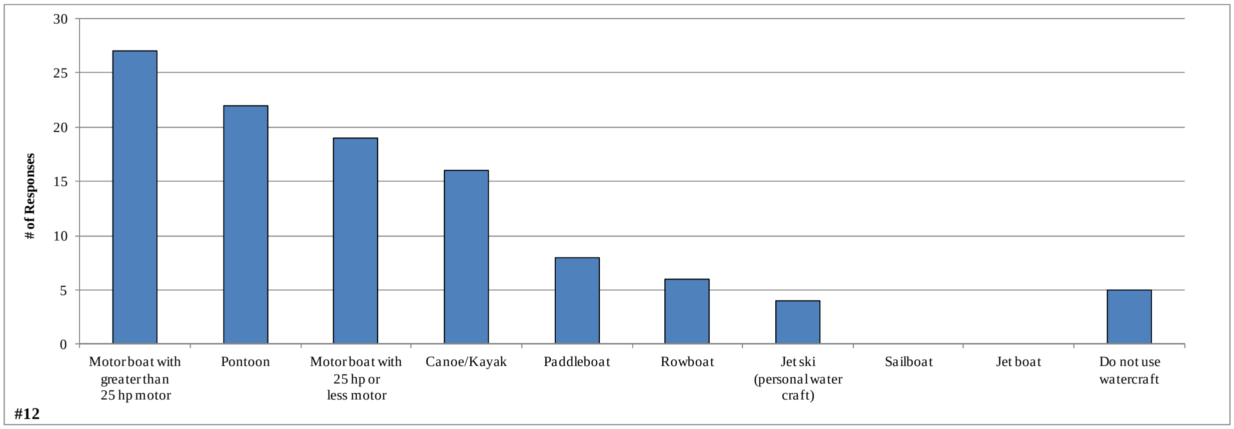
During the winter of 2012/2013, an anonymous stakeholder survey was developed by the FOTJF with oversight by Onterra staff. This survey was submitted to a WDNR social scientist for review in March of 2013. Following WDNR approval that same month, the seven-page, 32-question survey was mailed to 150 riparian property owners in the Jersey Flowage watershed. 39 percent of the surveys were returned and those results were entered into a spreadsheet by members of the Jersey Flowage 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 and a general summary is discussed below.

Based upon the results of the Stakeholder Survey, much was learned about the people that use and care for the Jersey Flowage. The majority of stakeholders (46%) are year-round residents, while 29% live on the lake during the summer months only and 13% visit on weekends through the year (Appendix B, Question #1). 61% of stakeholders have owned their property for over 15 years, and 32% have owned their property for over 25 years.

The following sections (Water Quality, Watershed, Aquatic Plants and Fisheries Data Integration) discuss the stakeholder survey data with respect these particular topics. Figures 2.0-1 and 2.0-2 highlight several other questions found within this survey. The majority of survey respondents indicated that they use a motor boat or pontoon on the Jersey Flowage (Question 10). Canoes and kayaks were also a popular option. On a shallow, sometimes constricted waterbody such as the Jersey Flowage, the importance of responsible boating activities is increased. The need for responsible boating increases during weekends, holidays, and during times of nice weather or good fishing conditions as well due to increased traffic on the lake. As seen on Question #15, several of the top recreational activities on the lake involve boat use. Although boat traffic did not rank highly as a factor potentially impacting the Jersey Flowage in a negative manner (Question #21), or highly on a list of stakeholder's top concerns regarding the lake (Question #22), there were concerns expressed by the Planning Committee during this project regarding the matter. Additionally, several comments in the survey were addressed at boat and personal water craft traffic. However, in two questions posed within the survey, it was discovered that the majority of stakeholders feel that the level of safety exhibited by watercraft users is *Fair* to *Good* and that law enforcement presence on the Jersey Flowage is sufficient (Questions #13 and #14).

Several stakeholder concerns were noted throughout the stakeholder survey (see Question #21 and #22 and survey comments – Appendix B); specifically including excessive aquatic plant growth and aquatic invasive species. These topics are discussed at length within the Summary & Conclusions section as well as within the Implementation Plan.

Question #12: What types of watercraft do you currently use on the lake?



Question #15: Please rank up to three activities that are important reasons for owning your property on or near the lake.

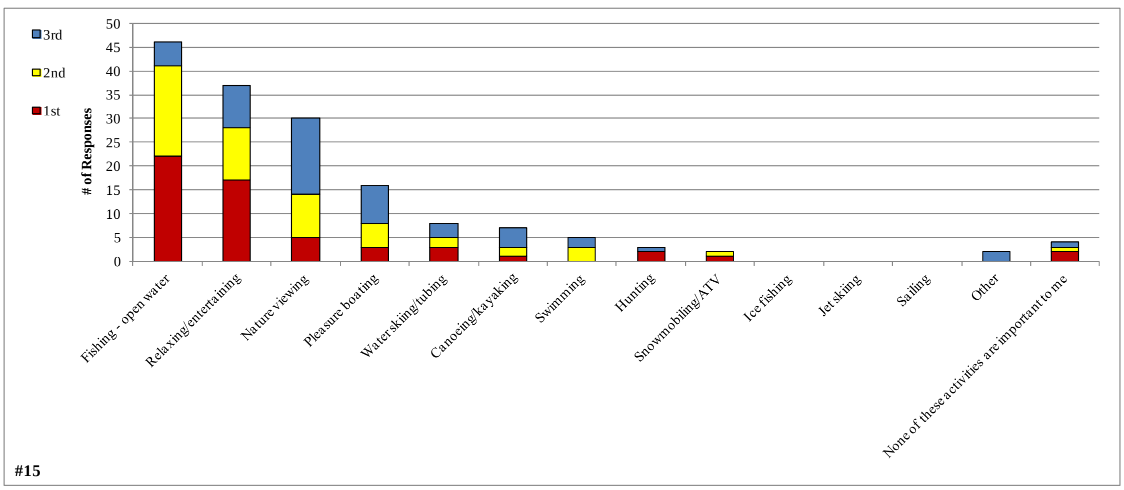
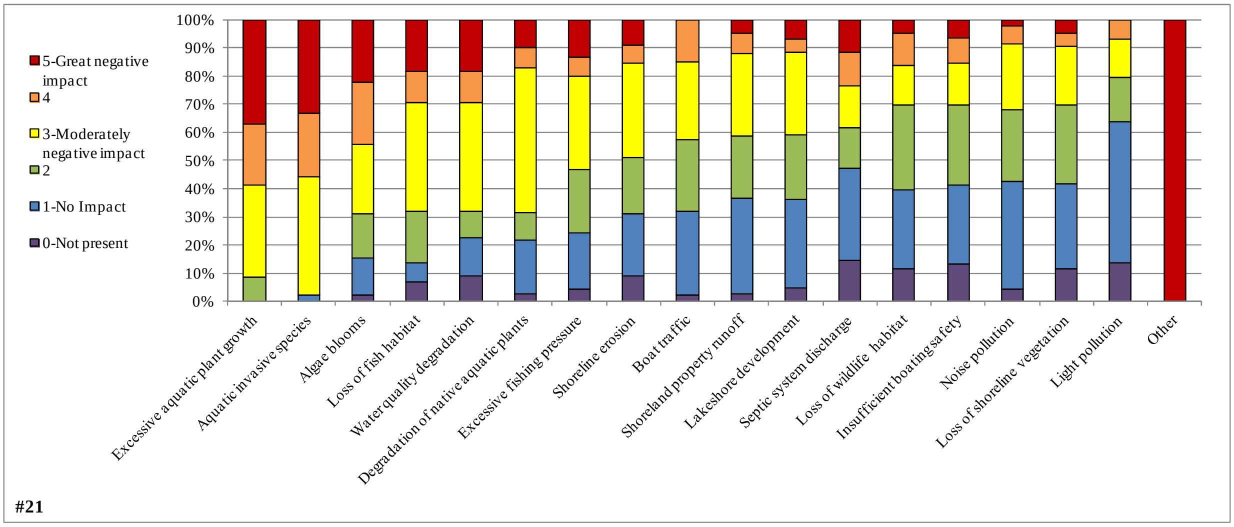


Figure 2.0-1. Select survey responses from the Jersey Flowage Stakeholder Survey. Additional questions and response charts may be found in Appendix B.

Question #21: To what level do you believe these factors may be negatively impacting Jersey Flowage?



Question #22: Please rank your top three concerns regarding Jersey Flowage.

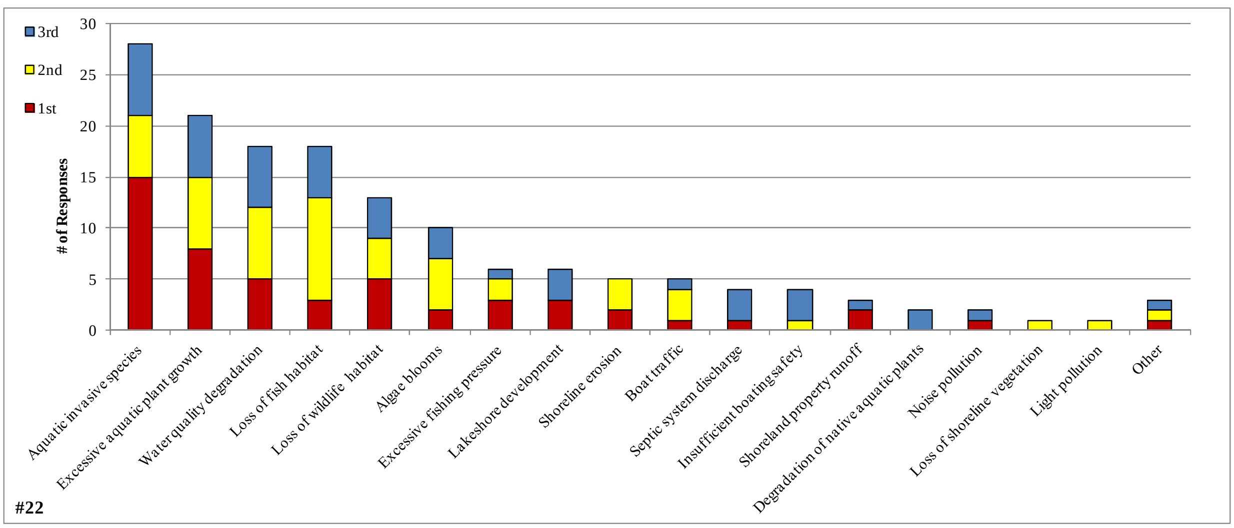


Figure 2.0-2. Select survey responses from the Jersey Flowage Stakeholder Survey, continued. Additional questions and response charts may be found in Appendix B.

3.0 RESULTS & DISCUSSION

3.1 Lake Water Quality

Primer on Water Quality Data Analysis and Interpretation

Reporting of water quality assessment results can often be a difficult and ambiguous task. Foremost is that the assessment inherently calls for a baseline knowledge of lake chemistry and ecology. Many of the parameters assessed are part of a complicated cycle and each element may occur in many different forms within a lake. Furthermore, water quality values that may be considered poor for one lake may be considered good for another because judging water quality is often subjective. However, focusing on specific aspects or parameters that are important to lake ecology, comparing those values to similar lakes within the same region and historical data from the study lake provides an excellent method to evaluate the quality of a lake's water.

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

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

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

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

Trophic State

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

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

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

Limiting Nutrient

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

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

Temperature and Dissolved Oxygen Profiles

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

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

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

Internal Nutrient Loading

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

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

Non-Candidate Lakes

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

Candidate Lakes

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

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

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

Comparisons with Other Datasets

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

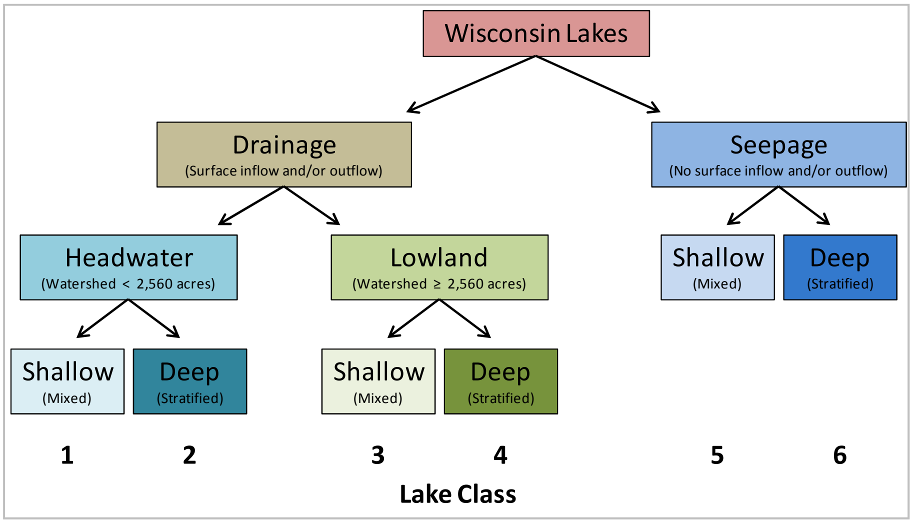


Figure 3.1-1. Wisconsin Lake Classifications. The Jersey Flowage is classified as a shallow (mixed), lowland drainage lake (Class 3). Adapted from WDNR 2009.

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

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

Figure 3.1-2. Location of the Jersey Flowage within the ecoregions of Wisconsin. After Nichols 1999.

These data along with data corresponding to statewide natural lake means, historic, current, and average data from the Jersey Flowage is displayed in Figures 3.1-3 - 3.1-7. 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.

Jersey Flowage Water Quality Analysis

Jersey Flowage Long-term Trends

The historic water quality data that exists for the Jersey Flowage is minimal and has been collected sporadically. This being said, it is difficult to complete a reliable long-term trend analysis. Having an understanding of how a lake's water quality has changed (or not changed) over time is always interesting and leads to sounder management decisions. Anecdotal reports, while valid to a certain extent, are not reliable in determining if an actual difference in a lake's water quality has occurred. Concrete, measurable scientific variables are used to ascertain this distinction.

Public perception of water quality, while not useful to guide management decisions, is nonetheless interesting to examine. In the stakeholder survey distributed through this project, the majority of Jersey Flowage residents (74%) indicated they believe the water quality in the lake is *Fair* or *Good* (Appendix B – Question #16). A number of survey respondents (46%), however, indicated that they believe the water quality has degraded somewhat since they first visited the lake (Question #17). Roughly 30% of survey respondents believe the water quality has remained the same. Water quality degradation was ranked 3rd on a list of top concerns respondents have regarding the Jersey Flowage (Question #22).

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

One of the most important aspects of monitoring a lake's water quality is having a reliable data set that spans multiple years. This is in fact the only way in which trends may be detected. Unfortunately, there is only a minimal amount of water quality data from past years on the Jersey Flowage. Data was collected in the deep hole location of the lake (Map 1) in 1979 and 2003 as part of periodic baseline data collection efforts by the WDNR. Data collected in 2012 was done so as a part of this management planning project. Data collected in 2011 as a result of volunteer monitoring efforts was done so in a different location than that depicted on Map 1; therefore, these data were removed from the overall dataset in order to keep the data truly comparable.

Average annual summer total phosphorus concentrations range between 30 µg/L and 47.3 µg/L for this dataset, falling with a category of *Good* for shallow, lowland drainage lakes (Figure 3.1-3). The weighted average over all years remains within this *Good* category, and is slightly higher than the median value for similar lakes within the state and all lakes in the Northern Lakes and Forests ecoregion. Given the size of the watershed draining into the Jersey Flowage (discussed thoroughly within the Watershed Section), it would be expected for the lake to have slightly higher phosphorus concentrations. However, the available phosphorus data indicate that the system is not excessively nutrient rich.

Chlorophyll-*a*, a measurement of algae abundance in the water column, may fluctuate from year to year based upon the nutrient content of the water, the amount of summer sunlight, water temperatures, etc. The abundance of algae is correlated highly with nutrient content, often phosphorus particularly. The available chlorophyll-*a* data for the Jersey Flowage indicates concentrations are in the *Good* category for shallow, lowland drainage lakes (Figure 3.1-4). Summer annual averages have ranged between 13.2 µg/L and 18.8 µg/L. A weighted average over all years is higher than the median value for similar lakes within the state and all lakes in the Northern Lakes and Forests ecoregion.

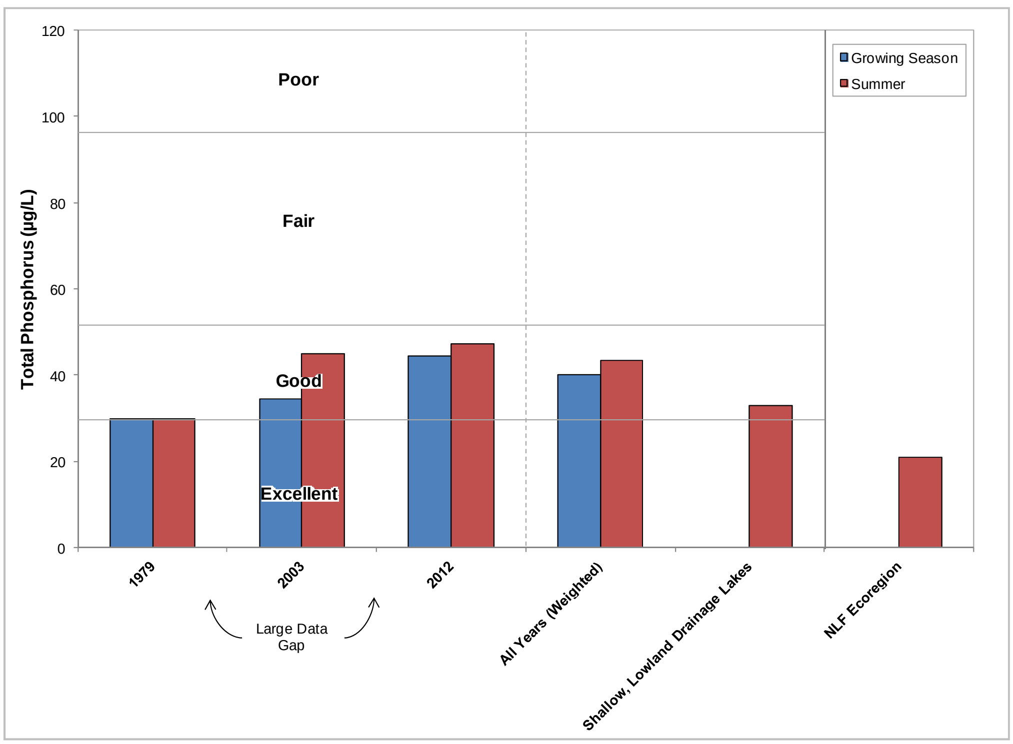


Figure 3.1-3. Jersey Flowage, state-wide class 3 lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

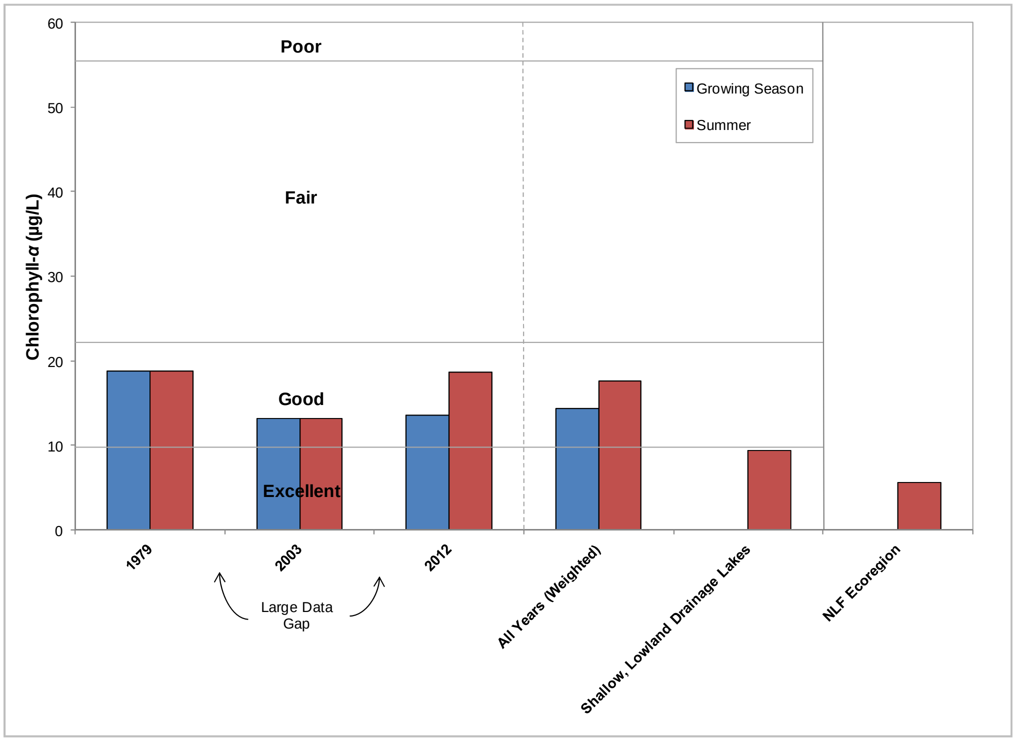


Figure 3.1-4. Jersey Flowage, state-wide class 3 lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

The third primary water quality parameter, water clarity, is measured through the use of a Secchi disk. Essentially, the circular black and white disk is lowered into the water column until it disappears from sight, and this depth is recorded. The water clarity of a lake is heavily influenced by many characteristics. For example, water clarity is influenced by algal concentration; the more algae in the water column, the less visibility there is. This is an example of a non-dissolved substance that alters water clarity. As discussed further below, dissolved organic substances may reduce the clarity by changing the color of the water in a lake.

Summer average Secchi disk depths in the Jersey Flowage have ranged between 2.5 and 4.0 feet, while a weighted summer average over all years was calculated to be 3.4 feet (Figure 3.1-5). This value ranks as *Good* for shallow, lowland drainage lakes in Wisconsin, but is lower than the median value for this lake type and lower than the median for lakes in the Northern Lakes and Forests ecoregion. Because algal concentrations are generally not excessive in the Jersey Flowage (Figure 3.1-4), the clarity of the water is likely influenced by dissolved organic acids that are transported to the lake from the area's wetlands. These weak, natural acids (sometimes called "tannins") are the byproduct of decomposition of organic matter, particularly debris from pine trees. This is the cause of the reduced clarity and root beer color of the water in the Jersey Flowage.

"True color" is a water quality parameter that measures the dissolved organic materials in water. Water samples collected in April of 2012 were measured for this parameter, and were found to be at 60 Platinum-cobalt units (Pt-co units, or PCU). Lillie and Mason (1983) categorized lakes with 0-40 PCU as having "low" color, 40-100 PCU as "medium" color, and >100 PCU as high color.

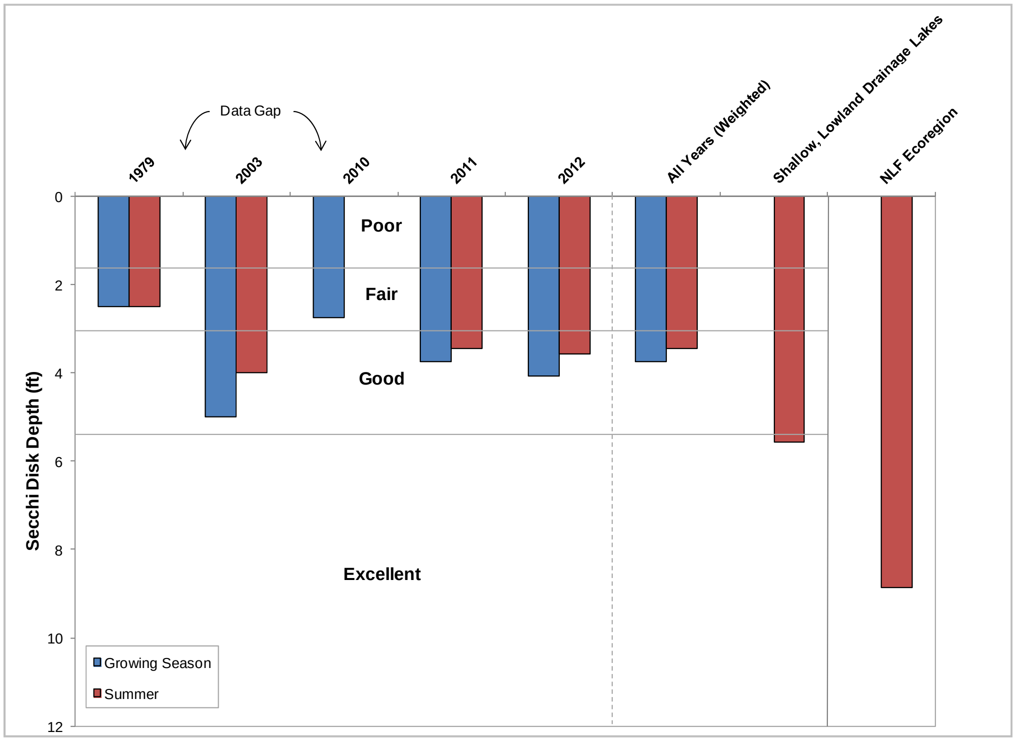


Figure 3.1-5. Jersey Flowage, state-wide class 3 lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Limiting Plant Nutrient of the Jersey Flowage

Using midsummer nitrogen and phosphorus concentrations from the Jersey Flowage, a nitrogen:phosphorus ratio of 13:1 was calculated. Typically, Wisconsin lakes have greater than a 15:1 ratio which indicates the limiting nutrient in the lake is phosphorus. A few lakes have ratios lower than 10:1, indicating nitrogen is the limiting nutrient. A ratio between 10-15:1 is considered transitional between nitrogen and phosphorus.

Jersey Flowage Trophic State

Figure 3.1-6 contain the TSI values for the Jersey Flowage. The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values fall within the eutrophic category on the TSI scale. As discussed previously, eutrophic lakes may have lower water clarity, more organic sediments, and greater algae and aquatic plants than their mesotrophic or oligotrophic counterparts. As discussed in the Fisheries Section (3.5), eutrophic lakes may also have a better fishery due to the increased productivity of the system.

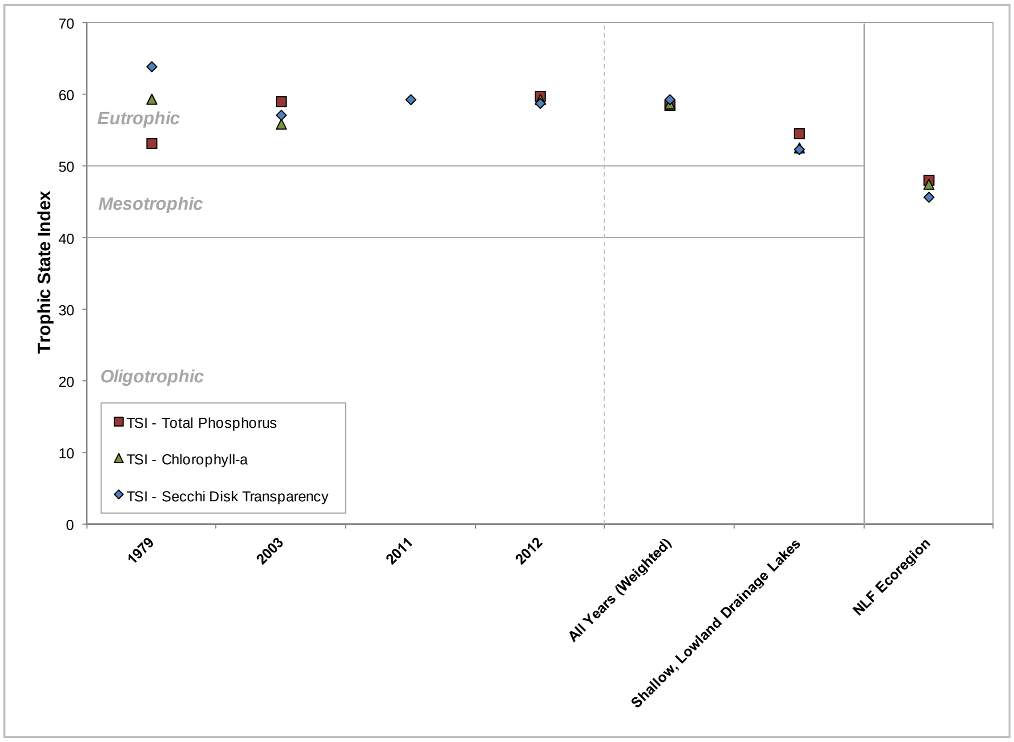


Figure 3.1-6. Jersey Flowage, state-wide class 3 lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in the Jersey Flowage

Dissolved oxygen and temperature were measured during water quality sampling visits to the Jersey Flowage by Onterra staff. Profiles depicting these data are displayed in Figure 3.1-7. In flowage systems such as the Jersey Flowage, it is not uncommon to see little difference in the temperature and dissolved oxygen from the top to the bottom of the water column. This is due to the constant flow of water, which mixes the water column completely. In lakes where this riverine type flow is not present, a gradient of warmer water/higher dissolved oxygen on the surface and colder water/lower dissolved oxygen near the bottom may develop. Without replenishment from overlying, well oxygenated waters from the surface, water near the bottom of the lake may become depleted of dissolved oxygen due to the presence of bacteria decomposing organic material. All profiles in Figure 3.1-7 indicate that the water in the Jersey Flowage is oxygenated sufficiently for warm water fish species that are found in Wisconsin.

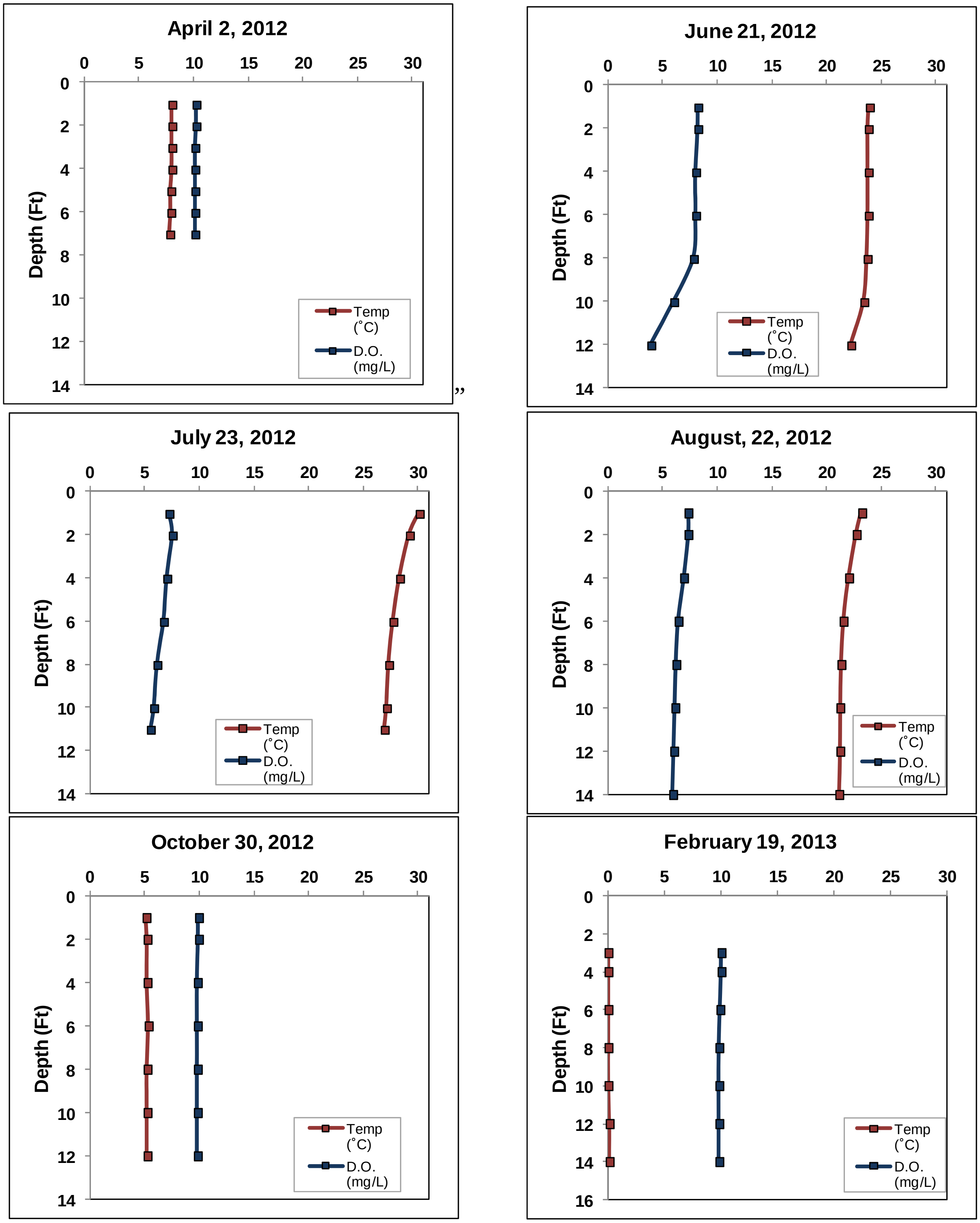


Figure 3.1-7. Jersey Flowage dissolved oxygen and temperature profiles.

Additional Water Quality Data Collected at the Jersey Flowage

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 the Jersey Flowage'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 and Nimphius 1985). The pH of the water in the Jersey Flowage was found to be slightly above neutral with a value of 7.4, and falls within the normal range for Wisconsin Lakes.

Alkalinity is a lake's capacity to resist fluctuations in pH by neutralizing or buffering against inputs such as acid rain. The main compounds that contribute to a lake's alkalinity in Wisconsin are bicarbonate (HCO_3^-) and carbonate (CO_3^-), which neutralize hydrogen ions from acidic inputs. These compounds are present in a lake if the groundwater entering it comes into contact with minerals such as calcite ($CaCO_3$) and/or dolomite ($CaMgCO_3$). A lake's pH is primarily determined by the amount of alkalinity. Rainwater in northern Wisconsin is slightly acidic naturally due to dissolved carbon dioxide from the atmosphere with a pH of around 5.0. Consequently, lakes with low alkalinity have lower pH due to their inability to buffer against acid inputs. The alkalinity in the Jersey Flowage was measured at 31.0 (mg/L as $CaCO_3$), indicating that the lake has a substantial capacity to resist fluctuations in pH and is not sensitive 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 the Jersey Flowage's pH of 7.4 falls 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 the Jersey Flowage was found to be 9.4 mg/L, falling below the optimal range for zebra mussels.

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

Based upon this analysis, the Jersey Flowage was considered not suitable for mussel establishment.

Plankton tows were completed by Onterra staff during the summer of 2012 and these samples were processed by the WDNR for larval zebra mussels. Plankton tows were completed by Onterra staff during the summer of 2012. These samples were processed by the WDNR for larval zebra mussels in 2013, and did not detect any larval zebra mussels within them.

3.2 Watershed Assessment

Watershed Modeling

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

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

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

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

In systems with high WS:LA ratios, like those 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 are entered into WiLMS along with the acreages of different types of land cover within the watershed to produce useful information about the lake ecosystem. This information includes an estimate of annual phosphorus load and the partitioning of those loads between the watershed's different land cover types and atmospheric fallout entering through the lake's water surface. WiLMS also calculates the lake's flushing rate and residence times using county-specific average precipitation/evaporation values or values entered by the user. Predictive models are also included within WiLMS that are valuable in validating modeled phosphorus loads to the lake in question and modeling alternate land cover scenarios within the watershed. Finally, if specific information is available, WiLMS will also estimate the significance of internal nutrient loading within a lake and the impact of shoreland septic systems.

The Jersey Flowage watershed consists of two sub-watersheds; a watershed that drains surface water into the Rice River Reservoir and a watershed that drains surface water directly into the Jersey Flowage (Map 2). The Rice River Reservoir drains roughly 347,615 acres of land in northern Wisconsin – a very large amount of land for an inland lake. This water flows over the Rice Dam into the Jersey Flowage; therefore, this large watershed is a part of the Jersey Flowage's watershed. In fact, the Rice River Reservoir's watershed accounts for 98% of the land that drains to the Jersey Flowage, while an additional 2% (6,222 acres) drains directly to the Jersey Flowage (Figure 3.1-2). Within the Jersey Flowage's direct watershed, forested wetlands and wetlands as well as traditional forests are the primary land cover types, at 48% and 35% of the entire watershed, respectively. Pasture/grass land covers 9% of the watershed, the Jersey Flowage's surface covers 7% of the watershed, and row crops and varying degrees of residential and urban cover make up very small portions of this direct watershed.

Overall, the watershed to lake area ratio of the Jersey Flowage's entire watershed is 816:1. With this amount of land draining towards the lake, WiLMS calculated that the Jersey Flowage is able to completely exchange its volume of water over 206 times per year (lake flushing rate).

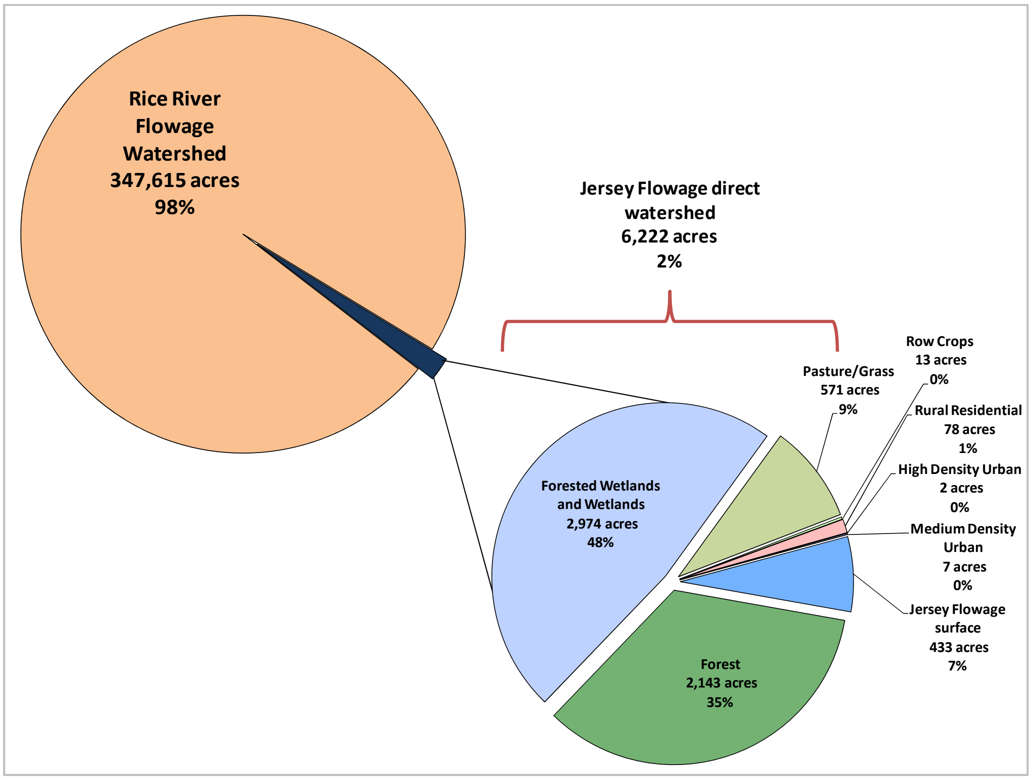


Figure 3.2-1. Jersey Flowage watershed land cover types in acres. Based upon data from the National Land Cover Database (NLCD – Fry et. al 2011).

To determine the annual phosphorus load to the Jersey Flowage, the Rice River Reservoir watershed was modeled first, as it is a substantial part of the Jersey Flowage watershed. WiLMS was utilized to determine 1) the phosphorus load to the Rice River Reservoir, 2) the water discharge from the Rice River Reservoir to the Jersey Flowage and 3) the annual average phosphorus concentration and subsequent annual load from the Rice River Reservoir to the Jersey Flowage. These parameters were calculated utilizing hydrologic information for Lincoln County that was built within WiLMS as well as the Rice River Reservoir's volume and phosphorus data obtained from SWIMS. Discharge values from the Rice Dam (computed by WiLMS) were verified with data provided by the Wisconsin Valley Improvement Company (WVIC), who oversees the dam's operations. WilMS determined that about 38,111 lbs of phosphorus is delivered to the Rice River Reservoir on an annual basis. While a portion of this is delivered to the lake, a large amount (92% or 34,941 lbs) flows over the Rice Dam into the Jersey Flowage. This source accounts for roughly 96% of the phosphorus load to the Jersey Flowage (Figure 3.2-2).

Annually, about 728 lbs of phosphorus enter the Jersey Flowage through its direct watershed. (Figure 3.2-2 and Appendix D). Forested wetlands and wetlands contribute 36% of this phosphorus load, while forests, pasture/grass land, and the Jersey Flowage surface contribute 24%, 21%, and 16%, respectively. Agricultural and developed lands provide minimal phosphorus inputs comparatively, due to the smaller area they cover.

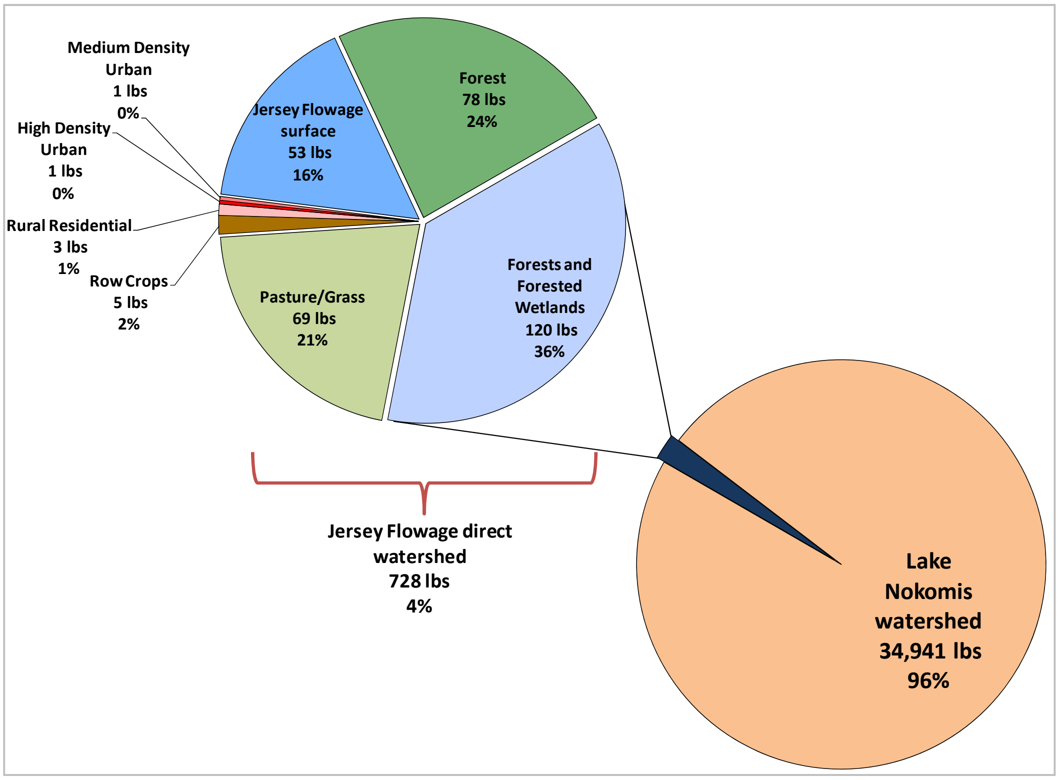


Figure 3.2-2. Jersey Flowage watershed phosphorus loading in pounds. Based upon Wisconsin Lake Modeling Suite (WiLMS) estimates.

Overall, the Jersey Flowage receives a rather large phosphorus input on an annual basis. However, this is not to be unexpected as this once riverine system has been impounded, yet still receives water from a large watershed. Fortunately, the amount of water this flowage receives helps to temper the effects of a large phosphorus load by "flushing" the lake often. Additionally, the vast majority of the Rice River and Jersey Flowage watersheds are comprised of natural landscapes such as forests and wetlands. This reduces the amount of phosphorus that is transported into the streams and rivers that drain to the Rice River Reservoir and eventually into the Jersey Flowage.

3.3 Shoreland Condition

The Importance of a Lake's Shoreland Zone

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

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

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

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

Shoreland Zone Regulations

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

Wisconsin-NR 115: Wisconsin's Shoreland Protection Program

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

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

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

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

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

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

<u>Wisconsin Act 31</u>

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

Shoreland Research

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

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

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

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

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

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

National Lakes Assessment

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

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

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

Native Species Enhancement

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

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

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

Cost

The cost of native, aquatic, and shoreland plant restorations is highly variable and depends on the size of the restoration area, the depth of buffer zone required to be restored, the existing plant density, the planting density required, the species planted, and the type of planting (e.g. seeds, bare-roots, plugs, live-stakes) being conducted. Other sites may require erosion control stabilization measures, which could be as simple as using erosion control blankets and plants and/or seeds or more extensive techniques such as geotextile bags (vegetated retaining walls), geogrids (vegetated soil lifts), or bio-logs (see above picture). Some of these erosion control techniques may reduce the need for rip-rap or seawalls which are sterile environments that do nott allow for plant growth or natural shorelines. Questions about rip-rap or seawalls should be directed to the local Wisconsin DNR Water Resources Management Specialist. Other measures possibly required include protective measures used to guard newly planted area from wildlife predation, wave-action, and erosion, such as fencing, erosion control matting, and animal deterrent sprays. One of the most important aspects of planting is maintaining moisture levels. This is done by watering regularly for the first two years until plants establish themselves, using soil amendments (i.e., peat, compost) while planting, and using mulch to help retain moisture. Most restoration work can be completed by the landowner themselves. To decrease costs further, bare-root form of trees and shrubs should be purchased in early spring. If additional assistance is needed, the lakefront property owner could contact an experienced landscaper. For properties with erosion issues, owners should contact their local county conservation office to discuss cost-share options.

In general, a restoration project with the characteristics described below would have an estimated materials and supplies cost of approximately $1,400. The more native vegetation a site has, the lower the cost. Owners should contact the county's regulations/zoning department for all minimum requirements. The single site used for the estimate indicated above has the following characteristics:

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

- Plant spacing for the aquatic zone would be 3 feet.
- Each site would need 70’ of erosion control fabric to protect plants and sediment near the shoreland (the remainder of the site would be mulched).
- Soil amendment (peat, compost) would be needed during planting.
- There is no hard-armor (rip-rap or seawall) that would need to be removed.
- The property owner would maintain the site for weed control and watering.

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

Jersey Flowage Shoreland Zone Condition

Shoreland Development

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

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

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

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

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

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

Figure 3.3-1. Shoreland assessment category descriptions.

On the Jersey Flowage, the development stage of the entire shoreland was surveyed during late summer of 2012, using a GPS unit to map the immediate shoreland (~35 feet inland from the water's edge). During the survey, Onterra staff examined the shoreland for signs of development and assigned areas of the shoreland one of the five descriptive categories in Figure 3.3-2.

The Jersey Flowage has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 7.9 miles (60%) of natural/undeveloped and developed-natural shoreland were observed during the survey (Figure 3.2-4). These shoreland types provide the most benefit to the lake and should be left in their natural state if at all possible. During the survey, 3.4 miles (26%) of urbanized and developed–unnatural shoreland were observed. If restoration of the Jersey Flowage shoreland is to occur, primary focus should be placed on these shoreland areas as they currently provide little benefit to, and actually may harm, the lake ecosystem. Map 3 displays the location of these shoreland lengths around the entire lake.

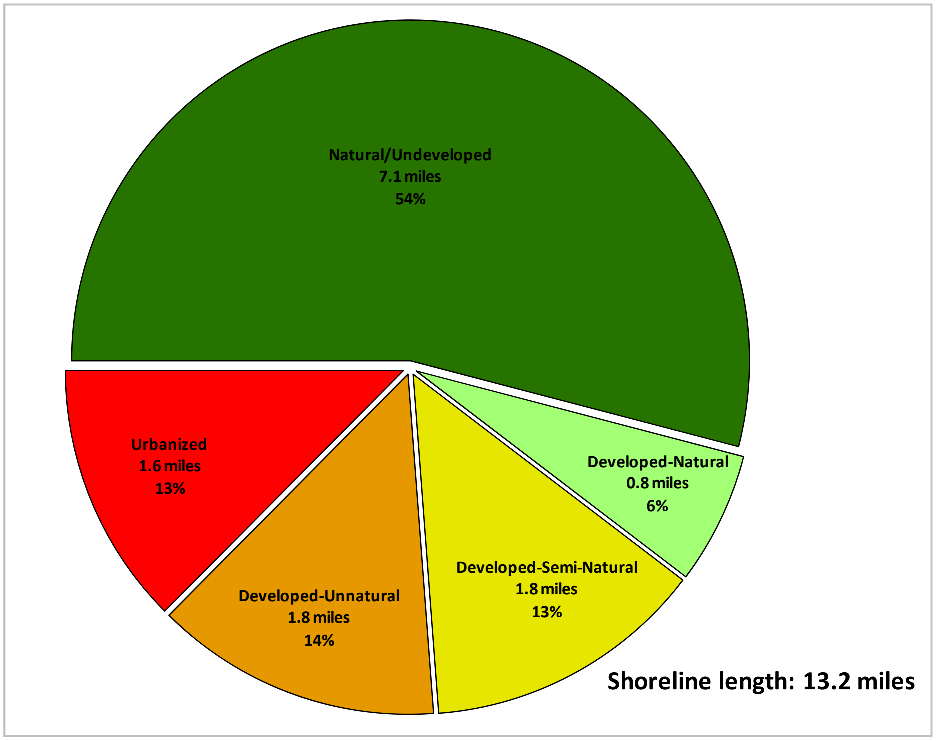


Figure 3.3-2. Jersey Flowage shoreland categories and total lengths. Based upon a late summer 2012 survey. Locations of these categorized shorelands can be found on Map 3.

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

Coarse Woody Habitat

The Jersey Flowage was surveyed in 2012 to determine the extent of its coarse woody habitat. This survey was conducted in conjunction with the shoreland assessment (development) survey. Coarse woody habitat was identified, and classified in two size categories (2-8 inches diameter, >8 inches diameter) as well as four branching categories: no branches, minimal branches, moderate branches, and full canopy. As discussed earlier, research indicates that fish species prefer some branching as opposed to no branching on coarse woody habitat, and increasing complexity is positively correlated with higher fish species richness, diversity and abundance.

During this survey, 98 total pieces of coarse woody habitat were observed along 13.2 miles of shoreline, which gives the Jersey Flowage a coarse woody habitat to shoreline mile ratio of 7:1. Locations of coarse woody habitat are displayed on Map 4. To put this into perspective, Wisconsin researchers have found that in completely undeveloped lakes, an average of 345 coarse woody habitat structures may be found per mile (Christensen et al. 1996).

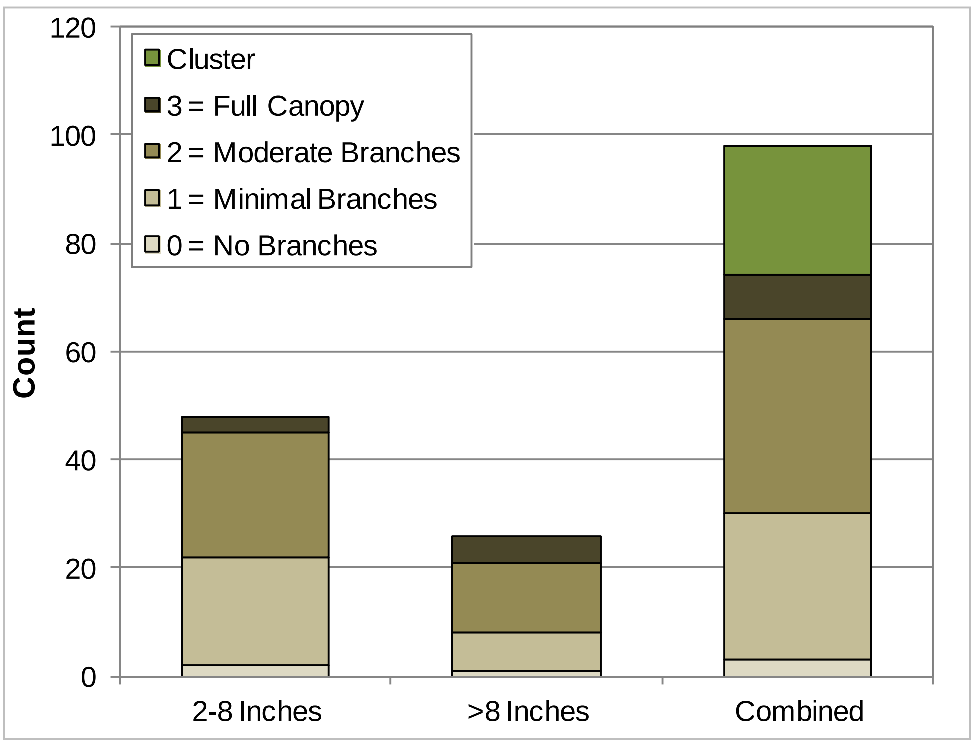


Figure 3.3-3. Jersey Flowage coarse woody habitat survey results. Based upon a late summer 2012 survey. Locations of Jersey Flowage coarse woody habitat can be found on Map 4.

3.4 Aquatic Plants

Introduction

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

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

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

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

Aquatic Plant Management and Protection

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

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

Permits

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

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

Manual Removal

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

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

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

Cost

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

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

Bottom Screens

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

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

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

Water Level Drawdown

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

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

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

Mechanical Harvesting

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

Cost

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

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

Herbicide Treatment

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

While there are approximately 300 herbicides registered for terrestrial use in the United States, only 13 active ingredients can be applied into or near aquatic systems. All aquatic herbicides must be applied in accordance with the product's US Environmental Protection Agency (EPA) approved label. There are numerous formulations and brands of aquatic herbicides and an extensive list can be found in Appendix F of Gettys et al. (2009).

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

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

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

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

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

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

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

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

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

Cost

Herbicide application charges vary greatly between $400 and $1,500 per acre depending on the chemical used, who applies it, permitting procedures, and the size/depth of the treatment area.

Advantages	***Disadvantages***
• Herbicides are easily applied in restricted areas, like around docks and boatlifts. • Herbicides can target large areas all at once. • If certain chemicals are applied at the correct dosages and at the right time of year, they can selectively control certain invasive species, such as Eurasian water-milfoil. • Some herbicides can be used effectively in spot treatments. • Most herbicides are designed to target plant physiology and in general, have low toxicological effects on non-plant organisms (e.g. mammals, insects)	• All herbicide use carries some degree of human health and ecological risk due to toxicity. • Fast-acting herbicides may cause fishkills due to rapid plant decomposition if not applied correctly. • Many people adamantly object to the use of herbicides in the aquatic environment; therefore, all stakeholders should be included in the decision to use them. • Many aquatic herbicides are nonselective. • Some herbicides have a combination of use restrictions that must be followed after their application. • Overuse of same herbicide may lead to plant resistance to that herbicide.

Biological Controls

There are many insects, fish and pathogens within the United States that are used as biological controls for aquatic macrophytes. For instance, the herbivorous grass carp has been used for years in many states to control aquatic plants with some success and some failures. However, it is illegal to possess grass carp within Wisconsin because their use can create problems worse than the plants that they were used to control. Other states have also used insects to battle invasive plants, such as water hyacinth weevils (*Neochetina spp.*) and hydrilla stem weevil (*Bagous spp.*) to control water hyacinth (*Eichhornia crassipes*) and hydrilla (*Hydrilla verticillata)*, respectively.

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

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

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

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

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

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

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

Analysis of Current Aquatic Plant Data

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

As described in more detail in the methods section, multiple aquatic plant surveys were completed on the Jersey Flowage; 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 the Jersey Flowage, plant samples were collected from plots laid out on a grid that covered the entire lake. Using the data collected from these plots, an estimate of occurrence of each plant species can be determined. In this section, two types of data are displayed: littoral frequency of occurrence and relative frequency of occurrence. Littoral frequency of occurrence is used to describe how often each species occurred in the plots that are less than the maximum depth of plant growth (littoral zone). Littoral frequency is displayed as a percentage. Relative frequency of occurrence uses the littoral frequency for occurrence for each species compared to the sum of the littoral frequency of occurrence from all species. These values are presented in percentages and if all of the values were added up, they would equal 100%. For example, if water lily had a relative frequency of 0.1 and we described that value as a percentage, it would mean that water lily made up 10% of the population.

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

Species Diversity and Richness

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

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

Simpson's diversity index is used to determine this diversity in a lake ecosystem. Simpson's diversity (1-D) is calculated as:

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

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

If a lake has a diversity index value of 0.90, it means that if two plants were randomly sampled from the lake there is a 90% probability that the two individuals would be of a different species. Between 2005 and 2009, WDNR Science Services conducted point-intercept surveys on 252 lakes within the state. In the absence of comparative data from Nichols (1999), the Simpson's Diversity Index values of the lakes within the WDNR Science Services dataset will be compared to the Jersey Flowage. Comparisons will be displayed using boxplots that showing median values and upper/lower quartiles of lakes in the same ecoregion (Water Quality section, Figure 3.1-2) and in the state. Please note for this parameter, the Northern Lakes and Forests Ecoregion data includes both natural and flowage lakes.

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

As previously stated, species diversity is not the same as species richness. One factor that influences species richness is the "development factor" of the shoreland. 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 shoreland may hold. This value is referred to as the shoreland complexity. It specifically analyzes the characteristics of the shoreland 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 shoreland 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 shoreland 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 the Jersey Flowage will be compared to lakes in the same ecoregion and in the state (Figure 3.4-1).

> 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. The floristic quality is calculated using the species richness and average conservatism value of the aquatic plant species that were solely encountered on the rake during the point-intercept survey and does not include incidental species or those encountered during other aquatic plan surveys.

Community Mapping

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

Exotic Plants

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

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

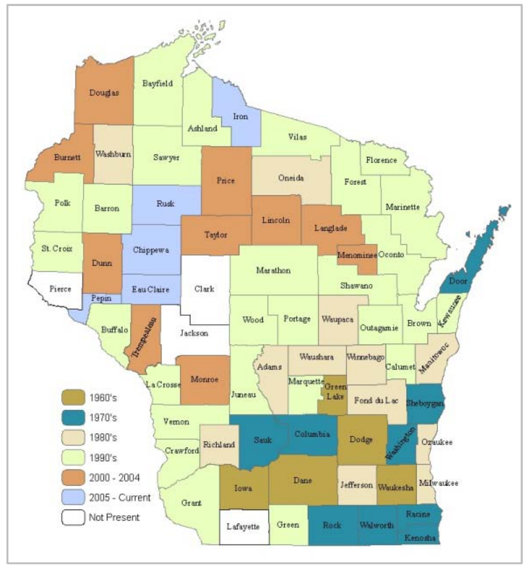


Figure 3.4-1. Spread of Eurasian water milfoil within WI counties. WDNR Data 2011 mapped by Onterra.

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

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

Aquatic Plant Survey Results

As mentioned above, numerous plant surveys were completed as a part of this project. On June 6, 2012, an early-season aquatic invasive species (AIS) survey was completed on the Jersey Flowage. While the intent of this survey is to locate any potential non-native species within the lake, it is primarily focused on locating curly-leaf pondweed which should be at its peak growth at this time. During this meander-based survey, Onterra ecologists mapped locations of curly-leaf pondweed within the lake. Preliminary data was also collected on Eurasian water milfoil, though this invasive plant was mapped thoroughly during its peak growth period in late summer. Discussions of invasive species within the Jersey Flowage occur near the end of this section.

The comprehensive aquatic plant point-intercept and aquatic plant community mapping surveys were conducted on the Jersey Flowage on June 26 and July 27, 2012, respectively, by Onterra. Point intercept survey results can be viewed in Appendix E. During these surveys, 57 species of aquatic plants were located in the Jersey Flowage, four of which are considered to be invasive species: curly-leaf pondweed, Eurasian water milfoil, purple loosestrife, and pale-yellow iris. One native aquatic plant species, Vasey's pondweed (*Potamogeton vaseyi*), is listed by the Wisconsin Natural Heritage Inventory as a species of special concern in Wisconsin due to uncertainty regarding its distribution and abundance in Wisconsin. A point-intercept survey was also conducted in the summer of 2010 by the WDNR; Table 3.3-1 provides a list of the aquatic plant species located in both the 2010 and 2012 surveys.

Sediment data were collected at each sampling location that was less than 15 feet in depth during the point-intercept survey. The data gathered shows that the majority of these areas (69.4%) are comprised of soft sediments, 28.2% contained sand, and 2.4% contained rock (Figure 3.4-2). Map 5 illustrates that most of the point-intercept sampling locations containing sand were located in the upstream-most portion of the system, areas of soft sediments dominated the central portion of the lake, and a mix of substrates were found in the southern portion. Like terrestrial plants, different aquatic plant species are adapted to grow in certain substrate types; some species are only found growing in mucky substrates, others only in sandy areas, and some can be found growing in either. Lakes that have varying substrate types generally support a higher number of plant species because the different habitat types that are available.

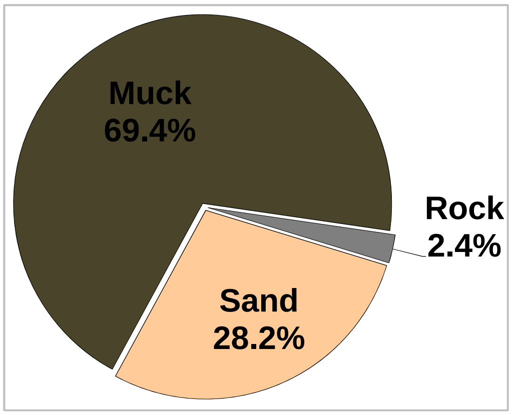


Figure 3.4-2. Jersey Flowage proportion of substrate types within littoral areas. Created using data from 2012 point-intercept survey.

During the 2012 point-intercept survey, aquatic plants were found growing to a maximum depth of seven feet. As previously discussed, the water in the Jersey Flowage is heavily stained with dissolved organic compounds which limit the depth to which sunlight can penetrate. Thus, the growth of aquatic plants in the Jersey Flowage is restricted to shallower areas where they can receive enough light to photosynthesize. Of the 533 point-intercept sampling locations that fell at or below the maximum depth of plant growth, 67% contained aquatic vegetation. Map 6 illustrates that the growth of aquatic vegetation is widespread throughout the flowage

Table 3.4-1. Aquatic plant species located in the Jersey Flowage during WDNR July 2010 and Onterra 2012 surveys.

Growth Form	Scientifc Name	Common Name	Coefficient of Conservatism (C)	2010 WDNR	2012 Onterra
Emergent	*Acorus americanus*	Sweetflag	7		I
	Calla palustris	Water arum	9		I
	Carex pseudocyperus	Cypress-like sedge	8		I
	Carex rostrata	Beaked sedge	10		I
	Carex vesicaria	Blister sedge	7		I
	Comarum palustre	Marsh cinquefoil	8		I
	Dulichium arundinaceum	Three-way sedge	9		I
	Eleocharis palustris	Creeping spikerush	6	X	I
	Equisetum fluviatile	Water horsetail	7	X	X
	Glyceria canadensis	Rattlesnake grass	7		I
	Iris pseudacorus	Pale-yellow iris	Exotic		I
	Iris versicolor	Northern blue flag	5		I
	Juncus effusus	Soft rush	4		I
	Lythrum salicaria	Purple loosestrife	Exotic		I
	Pontederia cordata	Pickerelweed	9	X	X
	Sagittaria latifolia	Common arrowhead	3		I
	Sagittaria rigida	Stiff arrowhead	8		X
	Sagittaria sp.	Arrowhead sp.	N/A	X	
	Schoenoplectus pungens	Three-square rush	5	X	
	Schoenoplectus tabernaemontani	Softstem bulrush	4		X
	Scirpus cyperinus	Wool grass	4		I
	Sparganium sp.	Bur-reed species	N/A	X	X
	Typha spp.	Cattail spp.	1	X	X
	Zizania palustris	Northern wild rice	8		X
FL	*Brasenia schreberi*	Watershield	7	X	X
	Nuphar variegata	Spatterdock	6	X	X
	Nymphaea odorata	White water lily	6	X	X
	Polygonum amphibium	Water smartweed	5	X	
FL/E	*Sparganium androcladum*	Shining bur-reed	8		I
	Sparganium eurycarpum	Common bur-reed	5		X
	Sparganium fluctuans	Floating-leaf bur-reed	10	X	X
	Sparganium sp.	Bur-reed species	N/A		X
Submergent	*Bidens beckii*	Water marigold	8	X	X
	Ceratophyllum demersum	Coontail	3	X	X
	Ceratophyllum echinatum	Spiny hornwort	10		X
	Elodea canadensis	Common waterweed	3	X	X
	Elodea nuttallii	Slender waterweed	7	X	X
	Myriophyllum sibiricum	Northern water milfoil	7	X	X
	Myriophyllum spicatum	Eurasian water milfoil	Exotic	X	X
	Najas flexilis	Slender naiad	6	X	X
	Nitella spp.	Stoneworts	7	X	X
	Potamogeton amplifolius	Large-leaf pondweed	7	X	X
	Potamogeton crispus	Curly-leaf pondweed	Exotic		X
	Potamogeton diversifolius	Water-thread pondweed	8	X	
	Potamogeton epihydrus	Ribbon-leaf pondweed	8	X	X
	Potamogeton foliosus	Leafy pondweed	6	X	
	Potamogeton natans	Floating-leaf pondweed	5		X
	Potamogeton obtusifolius	Blunt-leaf pondweed	9		X
	Potamogeton praelongus	White-stem pondweed	8	X	X
	Potamogeton pusillus	Small pondweed	7	X	X
	Potamogeton richardsonii	Clasping-leaf pondweed	5	X	X
	Potamogeton robbinsii	Fern pondweed	8	X	X
	Potamogeton spirillus	Spiral-fruited pondweed	8	X	X
	Potamogeton strictifolius	Stiff pondweed	8	X	
	Potamogeton vaseyi	Vasey's pondweed	10	X	
	Potamogeton zosteriformis	Flat-stem pondweed	6	X	X
	Ranunculus aquatilis	White water-crowfoot	8	X	X
	Utricularia vulgaris	Common bladderwort	7	X	X
	Vallisneria americana	Wild celery	6	X	X
S/E	*Sagittaria cristata*	Crested arrowhead	9		X
	Schoenoplectus subterminalis	Water bulrush	9	X	
FF	*Lemna trisulca*	Forked duckweed	6	X	X
	Lemna turionifera	Turion duckweed	2	X	X
	Spirodela polyrhiza	Greater duckweed	5	X	X

FL = Floating Leaf; FL/E = Floating Leaf and Emergent; S/E = Submergent and Emergent; FF = Free-floating
X = Located on rake during point-intercept survey; I = Incidental Species

While a total of 57 aquatic plant species were located during the 2012 surveys on the Jersey Flowage, 40 were physically recorded on the rake during the point-intercept survey while the remaining 17 were incidentally located. Of the 40 aquatic plant species located in the rake, wild celery, coontail, common waterweed, and Vasey's pondweed were the four-most frequently encountered (Figure 3.4-3). Wild celery, or tape grass, has bundles of long submersed leaves that are flat and ribbon-like which emerge from a basil rosette and provide excellent structural habitat for aquatic organisms. Spreading rapidly via rhizomes, wild celery is often found growing in large colonies where their extensive root systems stabilize bottom sediments. In mid to late summer, the coiled flower stalks of wild celery can be observed at or near the surface, and following pollination, large banana-shaped seed pods can also be seen. These seed pods have been shown to be an important food source for waterfowl.

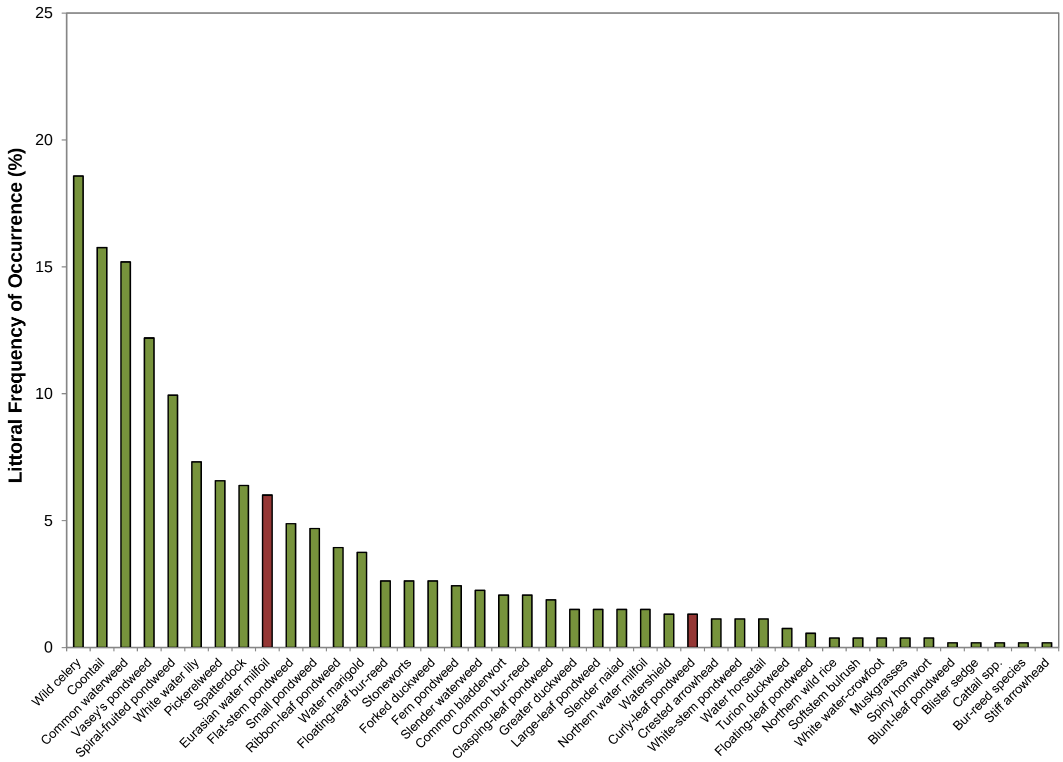


Figure 3.4-3. Jersey Flowage aquatic plant littoral frequency of occurrence. Created using data from 2012 point-intercept survey.

Coontail was the second-most frequently encountered aquatic plant species in 2012, and is a common native aquatic plant that can be found throughout North America and around the world. It produces long stems that contain whorls of stiff leaves, and as its name suggests, resemble the tail of a raccoon. The dense leaves and stems produced by coontail offer excellent structural habitat for a number of aquatic organisms. However, under certain conditions, it can often grow to nuisance levels where it can inhibit recreation. Coontail lacks true roots, and derives all of its nutrients directly from the water. Because of this, and its tolerance of low-light conditions, coontail thrives in more productive lakes like the Jersey Flowage that contain higher nutrient levels within the water. While it may grow to nuisance levels, its ability to uptake nutrients directly from the water can prevent these nutrients from being utilized by free-floating algae and prevent algae blooms.

Common waterweed, the third most abundant plant in the Jersey Flowage in 2012, can be found in lakes throughout Wisconsin and North America. It is usually found growing in mucky substrates, and possesses long stems with whorls of three, slender leaves. Like coontail, common waterweed can tolerate and thrive in lakes with lower water clarity, and can often grow to nuisance levels forming large mats on the water's surface. However, when not growing to nuisance levels, common waterweed provides excellent structural habitat for aquatic organisms and is an important food source for animals such as muskrats.

Vasey's pondweed, a state-listed special concern species, was the fourth-most abundant plant in the Jersey Flowage in 2012. This species is of special interest because it is relatively rare and its population and distribution in Wisconsin is not well known. The locations of Vasey's pondweed are currently being tracked by the Wisconsin Natural Heritage Inventory to determine if it requires further listing as either threatened or endangered. Vasey's pondweed has very fine and slender leaves which alternate on the stem (Photo 3.4-1). Upon reaching the surface, the plant produces small oval-shaped floating-leaves which aid in holding the flower stalk above the surface. It prefers water with lower alkalinity and a moderate pH range, and the Jersey Flowage contains optimal conditions for this species (Nichols 1999). Large, dense areas of Vasey's pondweed were observed in the Jersey Flowage. This abundant growth of Vasey's pondweed has been observed on upstream Lake Nokomis as well as other flowages in northern Wisconsin (Photo 3.4-1). The abundance of Vasey's pondweed in the Jersey Flowage is an indicator if high-quality conditions.

Photo 3.4-1. Vasey's pondweed. Photographs include a large bed of Vasey's pondweed (*Potamogeton vaseyi*) on a northern Wisconsin flowage (left) and close-up of floating leaves and flower stalks (right).

Because whole-lake point-intercept surveys were conducted on the Jersey Flowage in 2010 and 2012, a statistical comparison of aquatic plant species' littoral occurrences can be made. A Chi-square distribution analysis ($\alpha = 0.05$) was used to determine of any statistically valid changes in aquatic plant species' littoral frequency of occurrences have occurred from 2010-2012. Figure 3.4-4 displays the littoral frequency of occurrences of non-native aquatic plants and the native aquatic plants from 2010 and 2012 that had an occurrence of at least 5% in one of the two surveys. As illustrated, six native aquatic plant species exhibited statistically valid changes in their littoral frequency of occurrence from 2010 to 2012. Vasey's pondweed, stoneworts, leafy pondweed, slender naiad, and forked duckweed exhibited statistically valid reductions in their occurrence between the two surveys, while spiral-fruited pondweed exhibited a statistically valid increase in occurrence. The occurrence of Eurasian water milfoil between 2010 and 2012 was not found to be statistically different, while curly-leaf pondweed exhibited a statistically valid increase in occurrence.

Aquatic plant communities are dynamic and annual changes in the occurrences of certain species are expected given changes in growing conditions from year to year. The large reduction in the occurrence of leafy pondweed is believed to be due to a misidentification error during the 2010 survey. When lacking floating leaves, Vasey's pondweed is often mistaken for leafy pondweed, and this is what is believed to have occurred. However, an attempt to verify if leafy pondweed was recorded in the Jersey Flowage will be made and will be included in the final report.

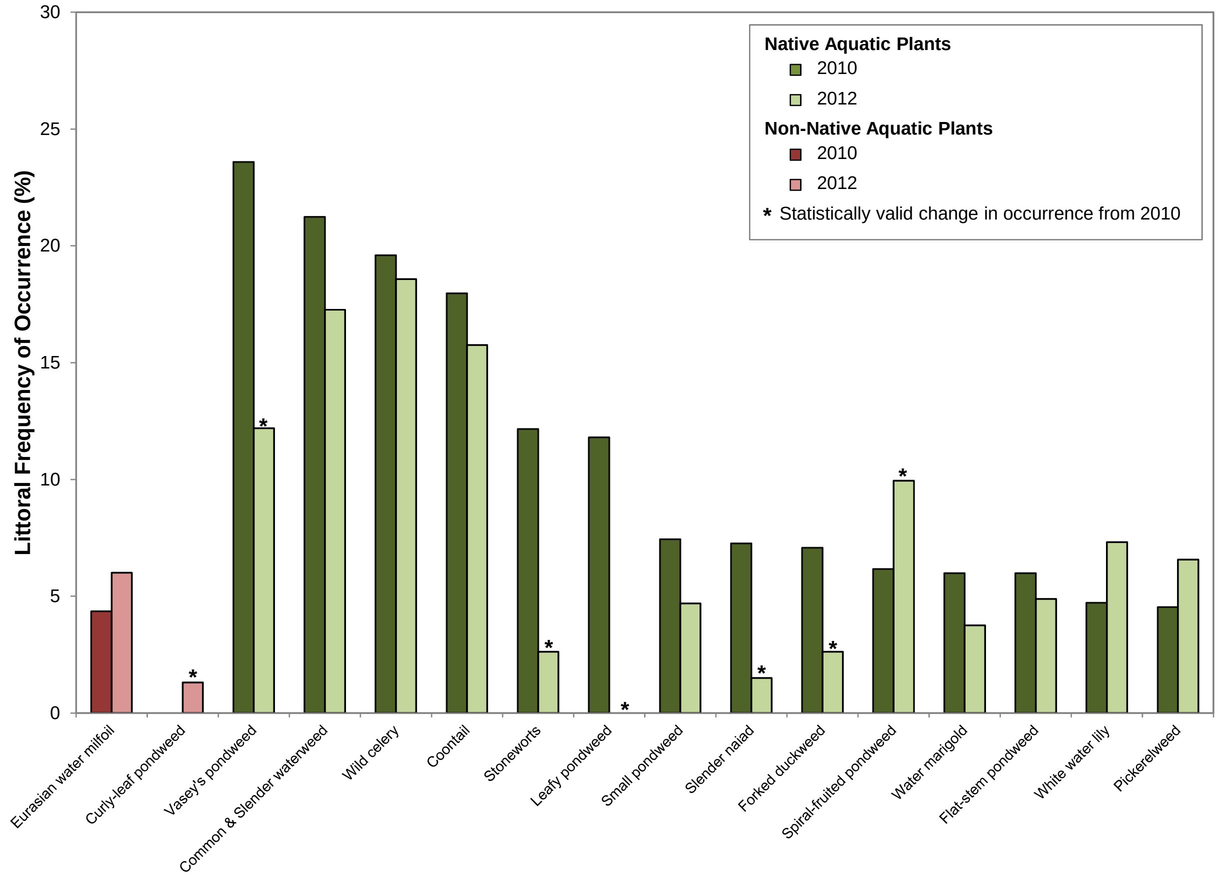


Figure 3.4-4. Littoral frequency of occurrence of select aquatic plant species in the Jersey Flowage from the WDNR 2010 and Onterra 2012 point-intercept surveys. Note: only those native species with a littoral occurrence of at least 5% in one of the two surveys are displayed. Created using data from WDNR 2010 and Onterra 2012 point-intercept surveys.

While only the most dominant aquatic plant species encountered in the Jersey Flowage in 2012 were discussed, all of the native aquatic plant species encountered on the rake in 2012 are used in calculating the Jersey Flowage's Floristic Quality Index (FQI). These calculations do not include species that were located "incidentally" during the 2012 surveys. For example, as discussed, while a total of 57 aquatic plant species were located in the Jersey Flowage during the 2012 surveys, 40 were physically encountered on the rake during the 2012 point-intercept survey. These 40 native species encountered on the rake and their conservatism values were used to calculate the FQI of the Jersey Flowage's aquatic plant community (equation below).

FQI = Average Coefficient of Conservatism * √ Number of Native Species

Figure 3.4-5 compares the FQI components of the Jersey Flowage from the 2010 and 2012 point-intercept surveys to median values of other flowages within the Northern Lakes and Forests Flowages (NLFF) Ecoregion as well as the entire State of Wisconsin. The number of native aquatic plant species, located on the rake during the point-intercept surveys, or native species richness, increased from 38 in 2010 to 40 in 2012. The number of native aquatic plant species located in both surveys is substantially higher than the median values for lakes in the NLFF Ecoregion and for lakes throughout Wisconsin.

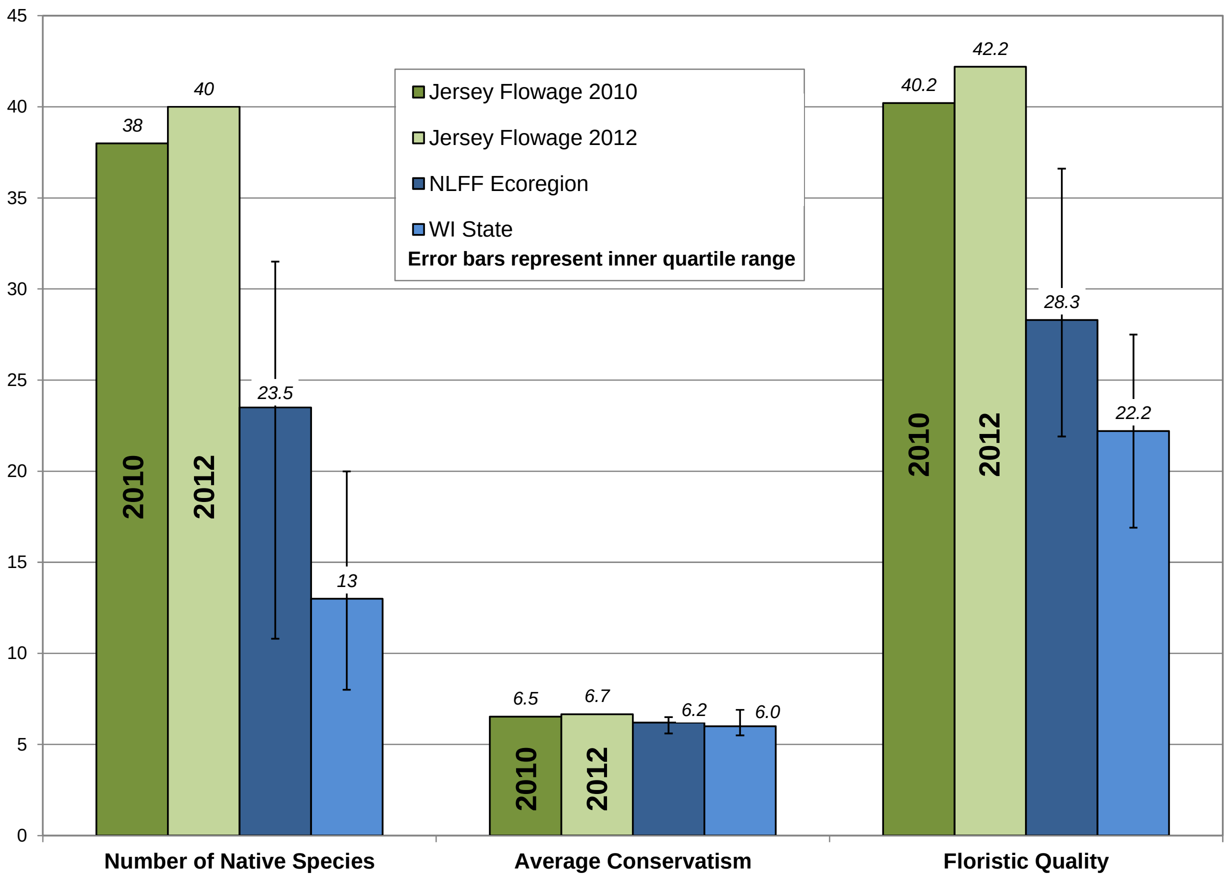


Figure 3.4-5. The Jersey Flowage Floristic Quality Assessment. Created using data from WDNR 2010 and Onterra 2012 point-intercept surveys. Analysis following Nichols (1999) where NLFF = Northern Lakes and Forest Flowages Ecoregion.

The Jersey Flowage's average conservatism value increased slightly from 6.5 in 2010 to 6.7 in 2012. The Jersey Flowage's average conservatism in 2012 is higher than the median value for flowages in the NLFF Ecoregion and higher than the median value for lakes state-wide, indicating it has a higher number of sensitive aquatic plant species when compared to other lakes. Combining the Jersey Flowage's native species richness and average conservatism values yields exceptionally high values that exceed both the NLFF Ecoregion and state median values. Overall, this analysis indicates that Jersey Flowage's aquatic plant community is of higher quality than most of the flowages in the NLFF Ecoregion and lakes throughout the entire State of Wisconsin. This analysis indicates that the quality of the Jersey Flowage's aquatic plant community has not changed from 2010 to 2012.

As explained earlier, lakes with diverse aquatic plant communities have higher resilience to environmental disturbances and greater resistance to invasion by non-native plants. In addition, a plant community with a mosaic of species with differing morphological attributes provides zooplankton, macroinvertebrates, fish, and other wildlife with diverse structural habitat and various sources of food. Because the Jersey Flowage contains a high number of native aquatic plant species, one may assume the aquatic plant community also has high species diversity. However, species diversity is also influenced by how evenly the plant species are distributed within the community.

While a method for characterizing diversity values of fair, poor, etc. does not exist, lakes within the same ecoregion may be compared to provide an idea of how the Jersey Flowage's diversity value ranks. Using data obtained from WDNR Science Services, quartiles were calculated for 109 lakes within the NLFF Ecoregion (Figure 3.4-6). Using the data collected from the WDNR's 2010 point-intercept survey and Onterra's 2012 survey, the Jersey Flowage was found to have exceptionally high species diversity with a Simpson's Diversity Index value of 0.94 in both surveys (Figure 3.4-6).

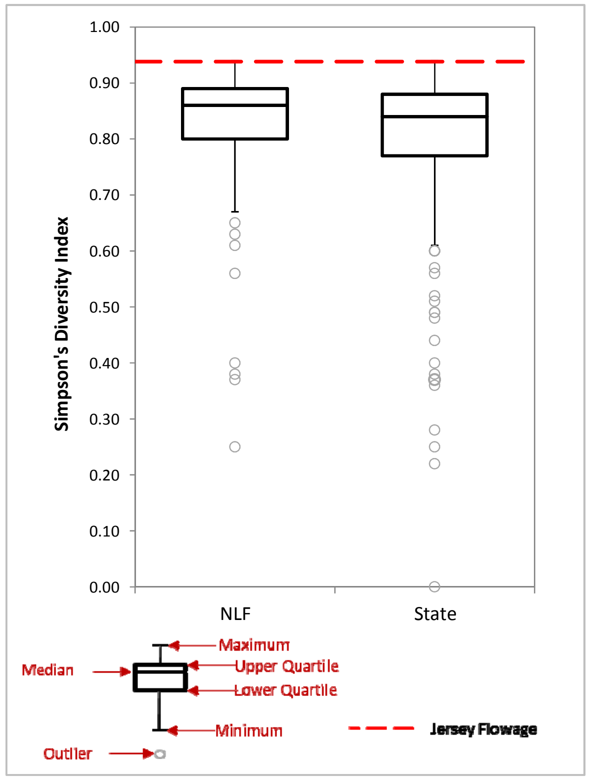


Figure 3.4-6. The Jersey Flowage Simpson's Diversity Index. Created using data from WDNR 2010 and Onterra 2012 point-intercept surveys. Ecoregion data provided by WDNR Science Services.

Figure 3.4-7 displays the relative frequency of occurrence of aquatic plant species in the Jersey Flowage from the 2012 point-intercept survey and illustrates relative abundance of species within the community to one another. For example, wild celery has a relative occurrence of 12%. This means that if 100 aquatic plants were randomly sampled from the Jersey Flowage, it would be expected that 12 of them would be wild celery. As illustrated, the aquatic plant community is not overly dominated by a single or few species, yielding high diversity.

The 2012 aquatic plant community mapping survey revealed that approximately 114 acres (26%) of the Jersey Flowage's 433 acres contains emergent and/or floating-leaf aquatic plant communities (Table 3.4-2, Maps 7-9). Twenty-eight native emergent and floating-leaf aquatic plant species were recorded in the Jersey Flowage during the 2012 surveys (Table 3.4-1). These communities provide valuable structural habitat for invertebrates, fish, and other wildlife, and also stabilize bottom sediments and shoreline areas by dampening wave action from wind and watercraft.

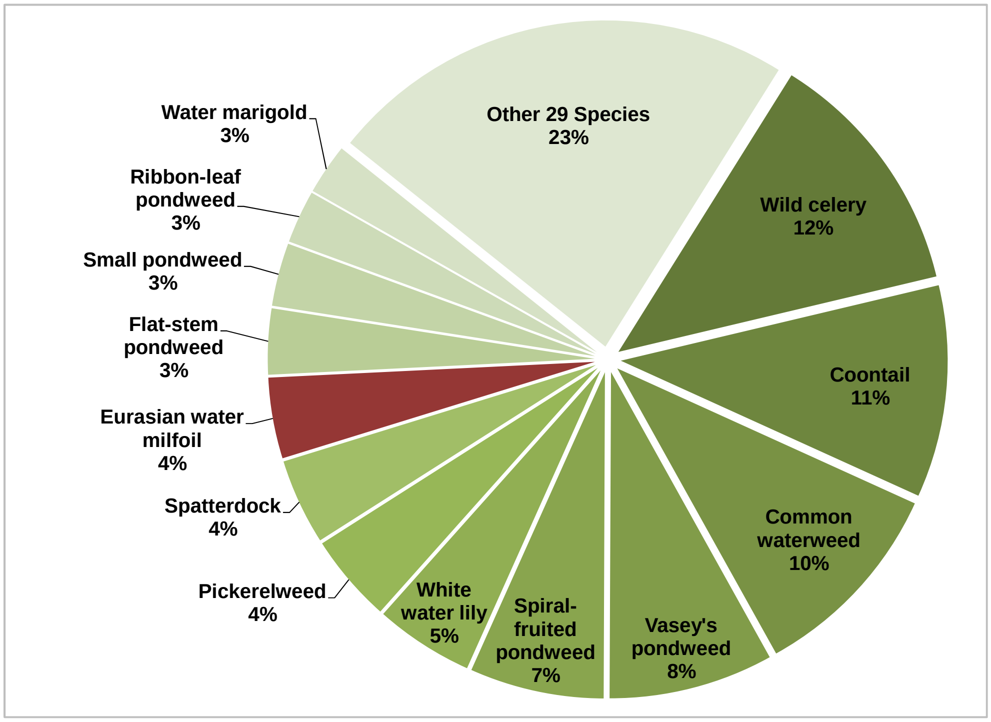


Figure 3.4-7. 2012 relative frequency of occurrence of aquatic plant species in the Jersey Flowage. Created using data from Onterra 2012 point-intercept survey. Non-native species indicated with red.

Table 3.4-2. Jersey Flowage acres of plant community types. Created from a July 2012 community mapping survey.

Plant Community	Acres
Emergent	19.5
Floating-leaf	35.9
Mixed Floating-leaf and Emergent	58.3
Total	113.7
Adjacent Wetland Area	113.5
Grand Total	227.2

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

Non-native Aquatic Plants in the Jersey Flowage

Curly-leaf Pondweed

Curly-leaf pondweed was mapped both in June 2011 as part of an Aquatic Invasive Species Early Detection and Response Grant and in June 2012 as part of this Lake Management Planning project. Map 10 displays the 2011 results, while 2012 results can be viewed in Map 11. These maps display both point-based and polygon based mapping data. The polygon based data changed little from 2011 to 2012; a total of 3.2 acres of curly-leaf pondweed was mapped each year, and densities changed little (Table 3.4-3). However, point-based curly-leaf pondweed data changed considerably between 2011 and 2012. During 2011, many single/few plants were observed primarily in the central section of the flowage. The following summer, in 2012, many of these single/few plant occurrences were rated either as clumps or small plant colonies by Onterra ecologists. This is an indication that curly-leaf pondweed, which is well-adapted to and prefers flowing water conditions, will likely increase in its density and distribution throughout the Jersey Flowage over time.

Table 3.4-3. Jersey Flowage curly-leaf pondweed survey results, 2011 and 2012. Created from June 2011 and June 2012 early season aquatic invasive species surveys.

Density Category	2011 Acres	2012 Acres
Highly Scattered	*n/a*	*n/a*
Scattered	2.90	2.66
Dominant	*n/a*	*n/a*
Highly Dominant	*n/a*	0.32
Surface Matted	0.31	0.28
Total	3.21	3.26

Eurasian water milfoil

As with curly-leaf pondweed, Eurasian water milfoil was mapped both in June 2011 as part of an Aquatic Invasive Species Early Detection and Response Grant, and in June 2012 as part of this Lake Management Planning project. Map 12 displays the 2011 results, while 2012 results can be viewed in Map 13 and Map 14. These maps display both point-based and polygon based mapping data. Unlike the changes observed in the curly-leaf pondweed population from 2011 to 2012, Eurasian water milfoil experienced a great increase in both distribution and density throughout the Jersey Flowage. Polygon based mapping summaries are provided in Table 3.4-4.

Table 3.4-4. Jersey Flowage Eurasian water milfoil survey results, 2011 and 2012. Created from June 2011 and June 2012 early season aquatic invasive species surveys.

Density Category	2011 Acres	2012 Acres
Highly Scattered	6.28	96.05
Scattered	15.16	37.36
Dominant	*n/a*	14.46
Highly Dominant	*n/a*	*n/a*
Surface Matted	*n/a*	0.57
Total	21.44	148.44

Pale Yellow Iris

Pale-yellow iris (*Iris pseudacorus*) is a large, showy iris with bright yellow flowers. Native to Europe and Asia, this species was sold commercially in the United States for ornamental use and has since escaped into Wisconsin's wetland areas forming large monotypic colonies and displacing valuable native wetland species. This species was observed flowering in numerous areas of the Jersey Flowage shoreline during the June early season aquatic invasive species survey (Maps 7, 8 & 9). At the time of this report, the abundance of pale yellow iris on the Jersey Flowage is minimal, and is not impacting the ecosystem. While the plant is in low abundance, it is best that the FOTJF work aggressively to discontinue its spread along the shoreland.

Purple Loosestrife

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

Purple loosestrife populations were located primarily in the southern portion of the Jersey Flowage (Map 9) in 2012. The abundance of this plant is of concern; it clearly has taken a liking to the shoreland around the Jersey Flowage and may spread further throughout the system if management of its population is not conducted. There are a number of effective control strategies for combating this aggressive plant, including herbicide application, biological control by native beetles, and manual hand removal.

3.5 Fisheries Data Integration

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

Jersey Flowage Fishery

Jersey Flowage Fishing Activity

Based on data collected from the stakeholder survey (Appendix B), fishing was the highest ranked important or enjoyable activity on the Jersey Flowage (Question #15). Approximately 49% of these same respondents believe that the current quality of fishing on the lake is *Fair* (Question #10). However, the majority (67.3%) believe that the quality of fishing has gotten *Much worse* or *Somewhat worse* since they began fishing on the lake (Question #11).

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

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

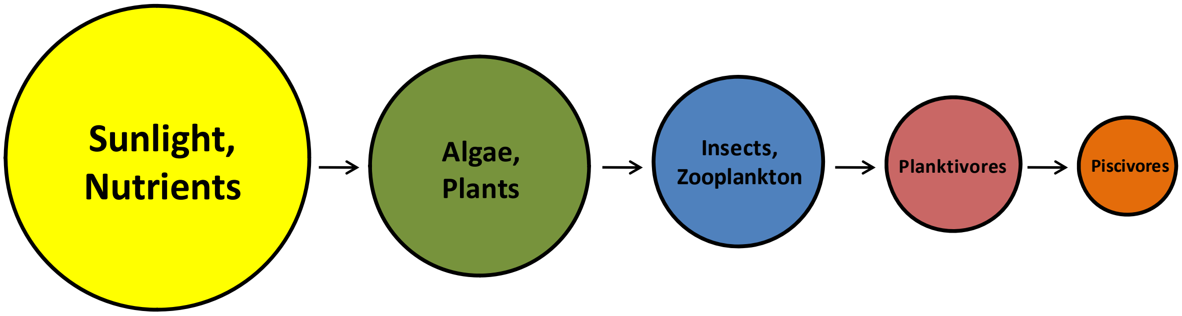


Figure 3.5-1. Aquatic food chain. Adapted from Carpenter et. al 1985.

As discussed in the Water Quality section, the Jersey Flowage is a eutrophic system, meaning it has high nutrient content and thus relatively high primary productivity. Simply put, this means the Jersey Flowage should be able to support sizable populations of predatory fish (piscivores) because the supporting food chain is relatively robust.

Table 3.5-1. Gamefish present in the Jersey Flowage 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 invertebrates
Bluegill	*Lepomis macrochirus*	11	Late May - Early August	Shallow water with sand or gravel bottom	Fish, crayfish, aquatic insects and other invertebrates
Bowfin	*Amia calva*	30	Late April - Early June	Vegetated areas from 2 - 5 ft with soft rootlets, sand or gravel	Fish, crayfish, small rodents, snakes, frogs, turtles
Largemouth Bass	*Micropterus salmoides*	13	Late April - Early July	Shallow, quiet bays with emergent vegetation	Fish, amphipods, algae, crayfish and other invertebrates
Muskellunge	*Esox masquinongy*	30	Mid April - Mid May	Shallow bays over muck bottom with dead vegetation, 6 - 30 in.	Fish including other muskies, small mammals, shore birds, frogs
Northern Pike	*Esox lucius*	25	Late March - Early April	Shallow, flooded marshes with emergent vegetation with fine leaves	Fish including other pike, crayfish, small mammals, water fowl, frogs
Pumpkinseed	*Lepomis gibbosus*	12	Early May - August	Shallow warm bays 0.3 - 0.8 m, with sand or gravel bottom	Crustaceans, rotifers, mollusks, flatworms, insect larvae (terrestrial and aquatic)
Rock Bass	*Ambloplites rupestris*	13	Late May - Early June	Bottom of course sand or gravel, 1 cm - 1 m deep	Crustaceans, insect larvae, and other invertebrates
Smallmouth Bass	*Micropterus dolomieu*	13	Mid May - June	Nests more common on north and west shorelines over gravel	Small fish including other bass, crayfish, insects (aquatic and terrestrial)
Walleye	*Sander vitreus*	18	Mid April - early May	Rocky, wavewashed shallows, inlet streams on gravel bottoms	Fish, fly and other insect larvae, crayfish
Yellow Perch	*Perca flavescens*	13	April - Early May	Sheltered areas, emergent and submergent veg	Small fish, aquatic invertebrates
Yellow Bullhead	*Ameiurus natalis*	7	May - July	Heavy weeded banks, beneath logs or tree roots	Crustaceans, insect larvae, small fish, some algae

Jersey Flowage Spear Harvest Records

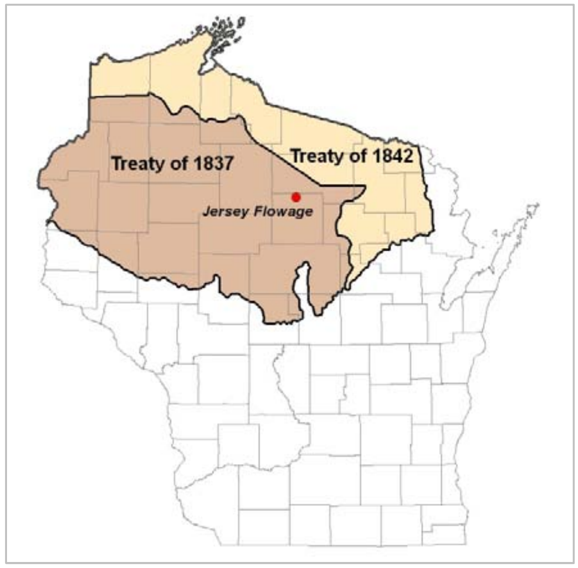


Figure 3.5-2. Location of the Jersey Flowage within the Native American Ceded Territory (GLIFWC 2013A). This map was digitized by Onterra; therefore it is a representation and not legally binding.

Approximately 22,400 square miles of northern Wisconsin was ceded to the United States by the Lake Superior Chippewa tribes in 1837 and 1842 (Figure 3.5-2). The Jersey Flowage falls within the ceded territory based on the Treaty of 1837. This allows for a regulated open water spear fishery by Native Americans on specified systems. Determining how many fish are able to be taken from a lake, either by spear harvest or angler harvest, is a highly regimented and dictated process. This highly structured procedure begins with an annual meeting between tribal and state management authorities. Reviews of population estimates are made for ceded territory lakes, and then a "total allowable catch" is established, based upon estimates of a sustainable harvest of the fishing stock (age 3 to age 5 fish). This figure is usually about 35% (walleye) or 27% (muskellunge) of the lake's known or modeled population, but may vary on an individual lake basis due to other circumstances. In lakes where population estimates are out of date by 3 years, a standard percentage is used. The total allowable catch number may be reduced by a percentage agreed upon by biologists that reflects the confidence they have in their population estimates for the particular lake. This number is called the "safe harvest level". Often, the biologists overseeing a lake cannot make adjustments due to the regimented nature of this process, so the total allowable catch often equals the safe harvest level. The safe harvest is a conservative estimate of the number of fish that can be harvested by a combination of tribal spearing and state-licensed anglers. The safe harvest is then multiplied by the Indian communities claim percent. This result is called the declaration, and represents the maximum number of fish that can be taken by tribal spearers (Spangler, 2009). Daily bag limits for walleye are then reduced for hook-and-line anglers to accommodate the tribal declaration and prevent over-fishing. Bag limits reductions may be increased at the end of May on lakes that are lightly speared. The tribes have historically selected a percentage which allows for a 2-3 daily bag limit for hook-and-line anglers (USDI 2007).

Spearers are able to harvest muskellunge, walleye, northern pike, and bass during the open water season. The spear harvest is monitored through a nightly permit system and a complete monitoring of the harvest (GLIFWC 2013B). Creel clerks and tribal wardens are assigned to each lake at the designated boat landing. A catch report is completed for each boating party upon return to the boat landing. In addition to counting every fish harvested, the first 100 walleye (plus all those in the last boat) are measured and sexed. An updated nightly declaration is determined each morning by 9 a.m. based on the data collected from the successful spearers. Harvest of a particular species ends once the declaration is met or the season ends. In 2011, a new reporting requirement went into effect on lakes with smaller declarations. Starting with the 2011 spear harvest season, on lakes with a harvestable declaration of 75 or fewer fish, reporting of harvests may take place at a location other than the landing of the speared lake.

In 1989 and 1993 and since 2001, a safe harvest has been calculated each year and a declaration determined by tribal spearers. This safe harvest level, again, roughly 35% of the lake's estimated population, has ranged between 147 and 204 fish. The declaration has ranged between 86 and 153 fish, or 54% to 85% of the safe harvest. However, a spear harvest has only occurred in one year, in 2012. It is possible that spearing efforts have been concentrated on other larger lakes in the region, which would potentially have a higher estimated safe harvest for both walleye and muskellunge. Spear harvest totals for walleye and muskellunge in 2012 are provided in Figure 3.5-3.

One common misconception is that the spear harvest targets the large spawning females. Tribal spearers may only take two walleyes over twenty inches per nightly permit; one between 20 and 24 inches and one of any size over 20 inches (GLIWC 2013B). This regulation limits the harvest of the larger, spawning female walleye. In 2012, out of the 44 walleye that were harvested, six were female, 35 were male and three were not sexed (WDNR personal communication).

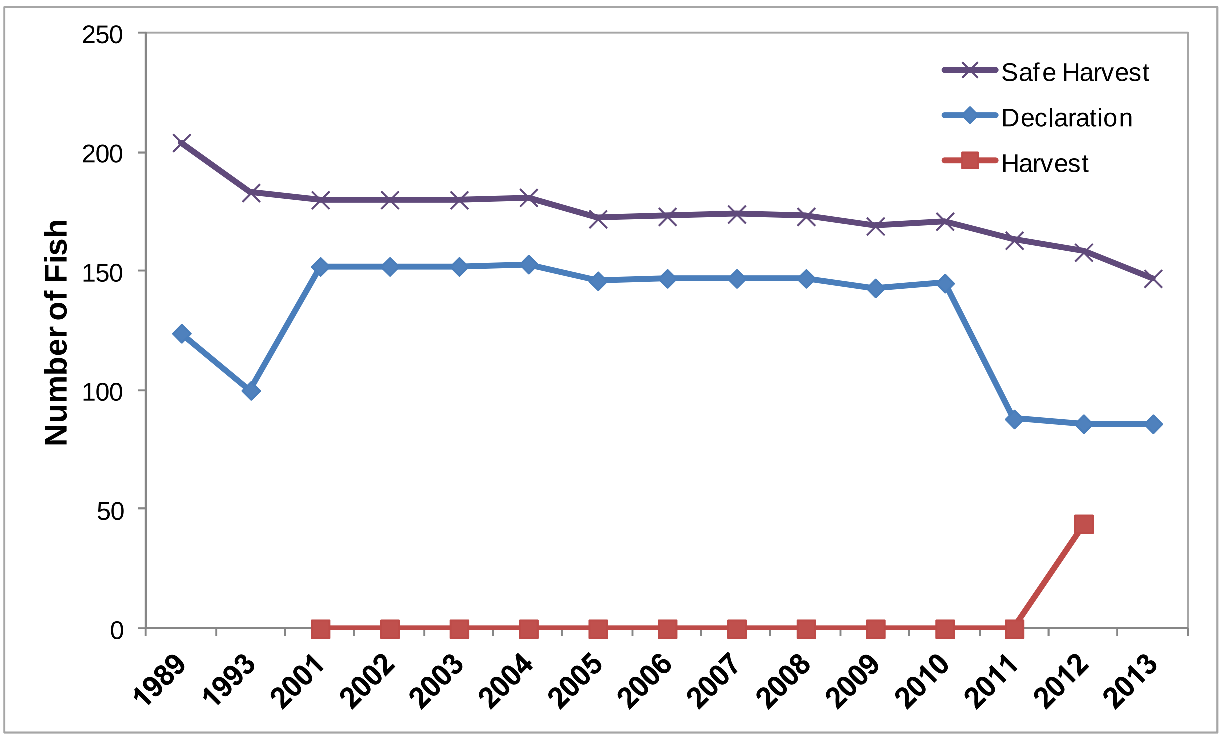


Figure 3.5-3 Jersey Flowage open water walleye spear harvest data. Annual total walleye harvest statistics are displayed since 1989 (data provided by T. Cichosz, WDNR).

In 2012, a muskellunge spear harvest occurred after years of tribes declaring a quota, but not harvesting any fish. A single muskellunge was harvested from the Jersey Flowage in that year (Figure 3.5-4). Dave Seibel, WDNR fisheries biologist, has indicated that muskellunge sampling will occur in 2014 and 2015 on the Jersey Flowage as part of a comprehensive study and population estimate for this species.

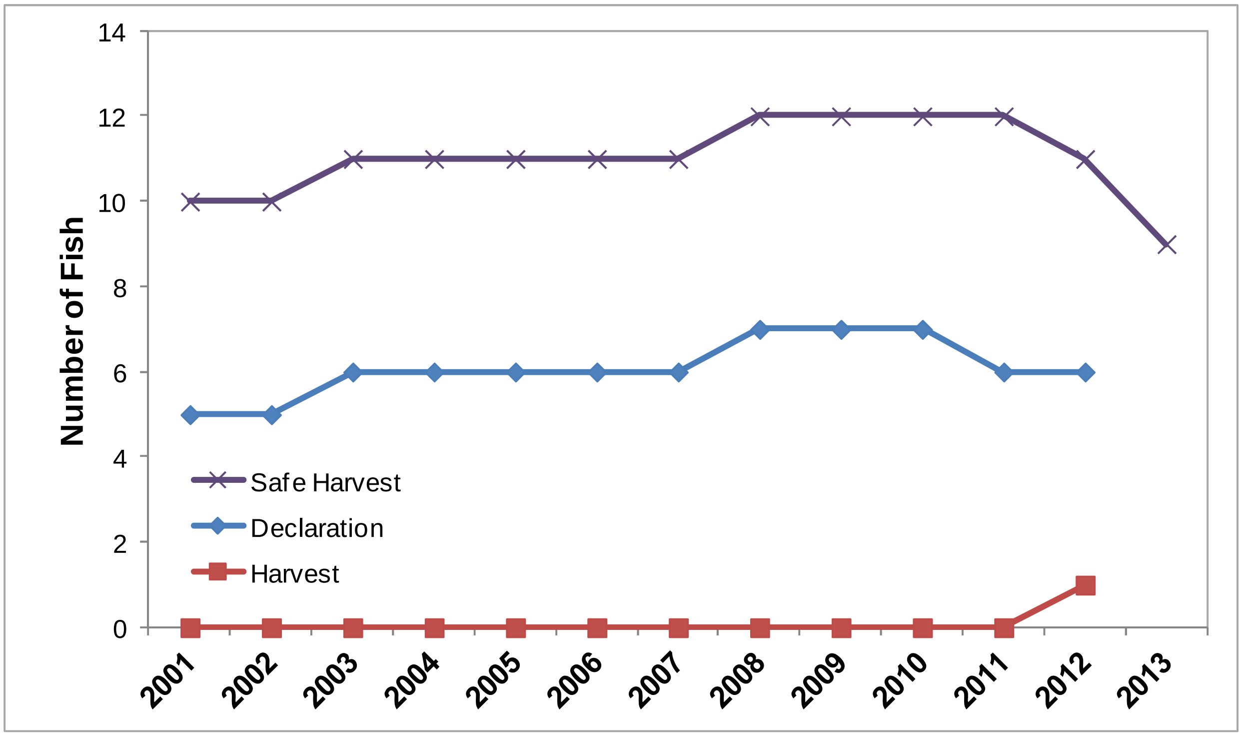


Figure 3.5-4 Jersey Flowage open water muskellunge spear harvest data. Annual total muskellunge harvest statistics are displayed since 2001 (data provided by T. Cichosz, WDNR).

Jersey Flowage Angling Regulations

Because the Jersey Flowage is located within ceded territory, special fisheries regulations may occur, specifically in terms of walleye. An adjusted walleye bag limit pamphlet is distributed each year by the WDNR which explains the more restrictive bag or length limits that may pertain to the Jersey Flowage. In 2012-2013, the daily bag limit remained at three for the lake. There is currently a minimum length limit of 15" for walleye. The Jersey Flowage is in the northern management zone for large and smallmouth bass as well as muskellunge and northern pike. Table 3.5-2 displays the 2013-2014 regulations for species that may be found in the Jersey Flowage. Please note that this table is intended to be for reference purposes only; anglers should visit the WDNR website (www. http://dnr.wi.gov/topic/fishing/regulations/hookline.html) for specific fishing regulations or visit their local bait and tackle shop to receive a free fishing pamphlet that would contain this information.

Table 3.5-2. WDNR fishing regulations for the Jersey Flowage, 2013-2015.

Species	Season	Regulation
Panfish	Open All Year	No minimum length limit and the daily bag limit is 25.
Largemouth bass	May 3, 2014 – March 1, 2015	The minimum length limit is 14" and the daily bag limit is 5.
Smallmouth bass	May 3, 2014 to June 20, 2014	Fish may not be harvested (catch and release only)
	June 21, 2014 to March 1, 2015	The minimum length limit is 14" and the daily bag limit is 5.
Muskellunge and hybrids	May 24, 2013 to November 30, 2014	The minimum length limit is 40" and the daily bag limit is 1.
Northern pike	May 3, 2014 to March 1, 2015	No minimum length limit and the daily bag limit is 5.
Walleye, sauger, and hybrids	May 4, 2013 to March 31, 2014	The minimum length limit is 15" and the daily bag limit is 3.
Bullheads	Open All Year	No minimum length limit and the daily bag limit is unlimited.
Rock, yellow, and white bass	Open All Year	No minimum length limit and the daily bag limit is unlimited.
Catfish	Open All Year	No minimum length limit and the daily bag limit is 10.

Jersey Flowage Substrate and Near Shore Habitat

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

According to the point-intercept survey conducted by Onterra, 69% of the substrate sampled in the littoral zone on the Jersey Flowage was muck, while 28% was classified as sand and 2% classified as rock (Map 5). Substrate and habitat are critical to fish species that do not provide parental care to their eggs, in other words, the eggs are left after spawning and not tended to by the parent fish. Muskellunge is one species that does not provide parental care to its eggs (Becker 1983). Muskellunge broadcast their eggs over woody debris and detritus, which can be found above sand or muck. This organic material suspends the eggs above the substrate, so the eggs are not buried in sediment and suffocate as a result. Walleye is another species that does not provide parental care to its eggs. Walleye preferentially spawn in areas with gravel or rock in places with moving water or wave action, which oxygenates the eggs and prevents them from getting buried in sediment. Fish that provide parental care are less selective of spawning substrates. Species such as bluegill tend to prefer a harder substrate such as rock, gravel or sandy areas if available, but have been found to spawn in muck as well.

As discussed in the Shoreland Condition Section, the presence of coarse woody habitat is important for many stages of a fish's life cycle, including nesting or spawning, escaping predation as a juvenile, and hunting insects or smaller fish as an adult. Unfortunately, as development has increased on Wisconsin lake shorelines in the past century, this beneficial habitat has often been the first to be removed from the natural shoreland zone. Protecting valuable shoreland habitat and coarse woody debris is a way in which lake residents can enhance the fishery of the Jersey Flowage, in addition to working with WDNR fisheries biologists to create new habitat structure within the lake.

Jersey Flowage Bullhead Concerns

In the 2013 anonymous stakeholder survey sent during this management project, several residents indicated their concern over what was perceived as an increasing bullhead population in the lake. In personal communication with Onterra staff, Dave Seibel, WDNR fisheries biologist, stated that bullhead numbers had increased in other area flowages within recent years. This is likely due to environmental conditions that favor this species. Although this is an undesirable species for many anglers, Mr. Seibel stressed the importance of this species for the balance of the overall fishery. Young bullhead are an important forage species for larger gamefish species, therefore their presence can aid the fishery of a lake. Bullheads often are observed to increase in their population numbers until they reach maturity at 5-7 years of age, and then begin to die of natural causes. Currently, no recent data exists on bullhead populations in the Jersey Flowage; however, a WDNR comprehensive survey is scheduled for 2015. At this time, WDNR fisheries biologists will be able to estimate the abundance of this species, as well as others, in the Jersey Flowage and make management decisions based upon this information.

4.0 SUMMARY AND CONCLUSIONS

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

1) Collect baseline data to increase the general understanding of the Jersey Flowage ecosystem.
2) Collect detailed information regarding invasive plant species within the lake, with the primary emphasis being on Eurasian water milfoil and curly-leaf pondweed.
3) Collect sociological information from Jersey Flowage stakeholders regarding their use of the lake and their thoughts pertaining to the past and current condition of the lake and its management.

The three objectives were fulfilled during the project and have led to a good understanding of the Jersey Flowage ecosystem, the folks that care about the lake, and what needs to be completed to protect and enhance it.

One item of interest to the FOJF planning committee was the immense size of the Jersey Flowage's watershed – 347,000+ acres or over 540 square miles. Having a large watershed means that land management occurring miles away may impact the water quality within the Jersey Flowage. This is a relationship that when realized can help others examine their stewardship practices not only for the immediate lake they live on, but also with downstream waterbodies in mind. With that, protecting natural lands and shoreland zones becomes increasingly important.

Through multiple parameters, it was determined that the water quality in the Jersey Flowage is in good shape and expected for a lake of this size, with this hydraulic pattern, and this immense of a watershed. Phosphorus levels, expected to be higher due to the large watershed, are not considerably larger than what is typically seen in shallow, lowland drainage lakes across the state. In turn, algae concentrations are at a healthy level as well – not excessive where impairment issues arise, but present enough that a full aquatic food chain is supported.

The clarity of the lake's water, as discussed within the report, is a function of many factors. These include particulates due to algae or suspended sediments that act to deflect sunlight as it enters the water, as well as dissolved components such as minerals or organics that discolor the water itself. As a result, the average Secchi disk clarity of ~4 ft. is lower than what is typically seen in lakes found in the Northwoods of Wisconsin. However, this is a typical characteristic of flowages, which transport nutrients and dissolved substances from large areas of land. It is a characteristic that may be considered unique, and not detrimental to the lake's ecosystem.

Another unique characteristic of flowages is their aquatic plant community richness. In 2012, Onterra ecologists found 53 species of native plants (along with four non-native) in the Jersey Flowage. While this is an incredible number of plant species for a Wisconsin lake, it is not necessarily a large number with respect to a Wisconsin flowage. Flowages often have a diverse array of habitat types for aquatic plants: isolated bays, open water areas, deep channels, steep or gently-sloped shoreline areas, islands, organic sediments, sandy regions, rocky reefs, large flats, irregular shorelines, etc. The diversity of habitat attracts different plant species that have their own preferences for where they grow. Thus, flowages hold some of the most species rich and unique aquatic plant communities. Two elements measured in the aquatic plant analysis, relative plant occurrence and species diversity, suggest that the aquatic plant community is well disbursed throughout the lake and while several species are found in higher abundance, no species are overwhelmingly present above others.

The studies conducted on Jersey Flowage show that the lake is a healthy ecosystem, albeit with several pressing issues that are of concern to lake residents. As discussed in many of the sections above, the lake is host to many aquatic plants. The abundance of plants found in the Jersey Flowage is troublesome to some residents as they sometimes impede recreational opportunities, such as swimming and fishing, and are a nuisance to clean off of boat motor props. Interestingly one of the common species in the lake, that is causing navigational impairment in some areas, is a state-listed special concern species – Vasey's pondweed. The conditions in the Jersey Flowage – shallow, organic substrate, murky water, low alkalinity and moderate pH – all fit the optimal growing range for this species.

Curly-leaf pondweed and Eurasian water milfoil now pose as the greatest threat to recreational enjoyment and the ecological state of the Jersey Flowage. During discussions with the FOJF planning committee, management alternatives were considered. Hand-harvesting is the simplest and least costly of all options for active management. Unfortunately, this method is only applicable in small-scale, early infestation scenarios and the presence of curly-leaf pondweed and Eurasian water milfoil is beyond this.

Some have tried mechanical harvesting aquatic invasive species. While this proves to be a short-term solution, it is a method that caters only to navigation enhancement, not restoration towards the natural state of the lake. Also, it may be an action that works against curly-leaf pondweed management in another way. Some projects have been developed on Wisconsin lakes where curly-leaf pondweed plants were removed via harvester in late spring, before turion production began. However, additional research by the United States Army Corps of Engineers (USACE) indicates that injured curly-leaf pondweed plants are still able to produce turions, and these stressed plants may produce even more turions in this condition (John Skogerboe, personal comm.). While harvesting may appear to be effective at removing the upper and middle portions of the plant, turions are still produced low on the plant and on the rhizome. Furthermore, the use of a harvester in the Jersey Flowage would prove to be difficult as much of the flowage is shallow and often depths greater than 3 feet are required.

Herbicide use for control of aquatic invasive species is discussed extensively within Management Goal 2 of the Implementation Plan. Aquatic herbicides can be effective at controlling invasive species, however their use is regulated and is not without cost – both monetary and sometimes environmentally. It is important to plan carefully anytime aquatic herbicides are used in a waterbody, and ensure that proper precautions and monitoring of the environment are covered. While an herbicide application is not recommended for the Jersey Flowage at this time (see more in Management Goal 2), it may be a tool utilized in the future. Moving forward the FOJF need to be prepared, both financially and mentally, to address issues such as aquatic invasive species that threaten the lake that is so near and dear to them.

5.0 IMPLEMENTATION PLAN

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

Management Goal 1: Maintain Current Water Quality Conditions

Management Action: Continue monitoring of Jersey Flowage's water quality through WDNR Citizens Lake Monitoring Network.

Timeframe: Continuation of current effort.

Facilitator: Board of Directors

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

The Citizen Lake Monitoring Network (CLMN) is a WDNR program in which volunteers are trained to collect water quality information on their lake. Volunteers from the FOJF have collected Secchi disk clarity data since 2010 in the Jersey Flowage. In 2013, the group began sampling for total phosphorus and chlorophyll-*a* as part of an advanced monitoring program. The FOJF realizes the importance of continuing this effort, which will supply them with valuable data about their lake. Moving forward, it is the responsibility of the Board of Directors to coordinate new volunteers as needed. When a change in the collection volunteer occurs, it will be the responsibility of the Board of Directors to contact Sandra Wickman or the appropriate WDNR/UW-Extension staff to ensure the proper training occurs and the necessary sampling materials are received by the new volunteer. It is also important to note that as a part of this program, the data collected are automatically added to the WDNR database and available through their Surface Water Integrated Monitoring System (SWIMS) by the volunteer.

Action Steps:

1. Board of Directors recruits volunteer coordinator
2. Volunteer contacts Sandra Wickman (715.365.8951) as needed.
3. Coordinator reports results to WDNR and FOJF members during annual meeting.

Management Action: Monitor dissolved oxygen in Jersey Flowage.

Timeframe: Begin in 2014.

Facilitator: Board of Directors

Description: As a part of the effort to document lake conditions as well as learn more about their lake ecosystem, the FOJF became interested in monitoring other water quality parameters. In 2013, FOJF began conversations with WDNR/UW-Extension staff member Sandra Wickman about monitoring dissolved oxygen within the lake. Dissolved oxygen is crucial to a variety of aquatic fish species and also plays an important role in nutrient interactions within a lake. In some Wisconsin lakes, utilization of dissolved oxygen through bacterial processes can lead to anoxic (no oxygen) conditions, resulting in fish kills or nutrient release from bottom sediments.

While dissolved oxygen conditions were deemed to be as expected and adequate for warm water aquatic species throughout 2012, the FOJF members would like to continue monitoring this parameter into the future. FOJF volunteers have worked out a plan with Sandra Wickman to borrow a dissolved oxygen probe that will be used to collect profile data on the Jersey Flowage. Sampling will be done in the summer and winter to monitor dissolved oxygen, with data recorded into SWIMS for permanent and public storage.

Action Steps:

1. Board of Directors recruits volunteer coordinator (may be CLMN volunteer)
2. Coordinator directs water quality monitoring program efforts.
3. Coordinator reports results to WDNR and FOJF members during annual meeting.

Management Goal 2: Monitor and Control Aquatic Invasive Species within the Jersey Flowage

Management Action: Develop monitoring and control strategy for curly-leaf pondweed and Eurasian water milfoil within the Jersey Flowage.

Timeframe: Begin summer 2015.

Facilitator: Board of Directors

Description: Curly-leaf pondweed and Eurasian water milfoil have arguably become the most troublesome and concerning of all of Wisconsin's aquatic invasive species, due to their rapid spread across the state and impact on prime recreational areas. According to the WDNR website (accessed Nov. 2013) curly-leaf pondweed can now be found in 525 lakes and rivers throughout Wisconsin, while Eurasian water milfoil has been documented in 653 of these waterbodies. While these species have been found in the Midwest for decades, much is still being learned about their distribution, environmental preferences/tolerances, interaction with native species and overall management.

During 2011 and 2012, Onterra ecologists mapped the locations and densities of curly-leaf pondweed and Eurasian water milfoil within the Jersey Flowage (Maps 10-14). In lakes without aquatic invasive species, early detection of pioneer colonies commonly leads to successful control and, in cases of very small infestations, possibly even eradication. When the level of invasive plant colonization reaches a whole-lake level, the "fix" is far beyond a rapid and aggressive management action. At this point in time the levels of curly-leaf pondweed and Eurasian water milfoil have surpassed the point by which hand-removal or small herbicide treatment methodologies would be beneficial in management of these species. For curly-leaf pondweed, 3.3 acres of the invasive plant were mapped during its peak growth period in 2012. However, many areas of point-based data were identified within the lake (Map 11). In late summer, 148.4 acres of Eurasian water milfoil were mapped in the lake (Maps 13 and 14).

Treatments using United States Environmental Protection Agency (USEPA) approved herbicides have been used on Wisconsin lakes to control aquatic invasive species such as curly-leaf pondweed and Eurasian water milfoil. 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 dilute 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. Much information has been gathered in recent years, largely as a result of a joint research project between the WDNR and the US Army Corps of Engineers (USACE). Based on their preliminary findings, lake managers have adopted two main treatment strategies; 1) whole-lake treatments, and 2). spot treatments.

Spot treatments are a type of treatment strategy where the herbicide is applied to a specific area (treatment site) such that when it dilutes from that area, its concentrations are insufficient to cause significant affects outside of that area. Spot treatments typically rely on a short exposure time (often hours) to cause mortality and therefore are applied at a much higher herbicide concentration than whole-lake treatments. For Eurasian water milfoil, 2,4-D is typically applied between 2.25 and 3.0 ppm acid equivalent (a.e.). in spot treatment scenarios. Micro-treatments are small spot treatments (working definition is less than 5 acres) and because of their small size, are extremely difficult to predict if they will be effective because of the rapid dilution of the herbicide. Larger treatment areas tend to be able to hold effective concentrations for a longer time.

Whole-lake treatments are those where the herbicide is applied to specific sites, but when the herbicide reaches equilibrium within the entire volume of water (of the lake, lake basin, or within the epilimnion of the lake or lake basin); it is at a concentration that is sufficient to cause mortality to the target plant within that entire lake or basin. The application rate of whole-lake treatments is dictated by the volume of water which the herbicide will reach equilibrium within. For Eurasian water milfoil, the target herbicide concentration is typically between 0.225 and 0.325 ppm a.e. when exposed to the target plants for 7-14 days or longer. However, these same rates have been shown to impact some native plant species, particularly dicot species, some thin-leaved pondweeds, and naiad species.

During the planning meetings associated with this project, the curly-leaf pondweed and Eurasian water milfoil situations in the Jersey Flowage were discussed extensively. One of the aspects that was focused upon was the approaches to managing these invasives through herbicides. Traditionally, curly-leaf pondweed control consists of numerous annual herbicide treatments conducted in May/June of each year. This will kill each year's plants before they are able to produce reproductive turions (asexual seed-like structures). After multiple years of treatment, the turion base in the sediment becomes exhausted and the curly-leaf pondweed population decreases significantly. Normally a control strategy such as this includes 3-5 years of treatments of the same area, sometimes longer if there a large base of turions has built up within the sediments.

Eurasian water milfoil functions somewhat differently, biologically speaking, than curly-leaf pondweed and thus requires a different approach to its management. This invasive plant, like curly-leaf pondweed, grows rapidly after ice-off on a lake and is often spotted from the surface ahead of the native plants. Eurasian water milfoil spreads rapidly through auto-fragmentation, a process where the plant produces shoots from its structure that break off and float into the water. These shoots have the ability to start new plants when they reach the lake bottom. Though auto fragmentation is thought to be the primary means of reproduction, Eurasian water milfoil is also known to reproduce through seed production and through horizontal connections called stolons. Eurasian water milfoil is treated in the early spring with herbicides to kill the plant before it is able to auto fragment.

Theoretical treatment scenarios were created in order to understand potential costs with treating aquatic invasive species, and serve as an educational tool. In order to treat curly-leaf pondweed on the Jersey Flowage, a 40-acre site would be situated over the areas of densest colonial growth. The cost of this treatment would be $20,000 - $25,000. However, because curly-leaf pondweed management requires several years of treatment in a row, this cost would be anticipated for 3-5 years in a row, with smaller treatments likely occurring afterwards to treat smaller areas of regrowth. For an Eurasian water milfoil treatment on the Jersey Flowage, a likely treatment scenario would consist of 400 acres being targeted and whole-lake dispersal of the herbicide assumed. The cost of a single treatment would be roughly $70,000 - $80,000. Depending on treatment efficacy, smaller treatments may be required in subsequent years. For each treatment, additional costs would be necessary for professional monitoring of the native and non-native plant species, project logistics, reporting, etc.

Realizing that treating either curly-leaf pondweed or Eurasian water milfoil is a costly endeavor, further discussions took place on the use of using herbicides on the Jersey Flowage. 56.1% of respondents in a stakeholder survey were supportive of their use on the Jersey Flowage, while 19.5% were neutral, 24% were unsupportive and 31% are unsure about their use (Appendix B, Question #25). The conversation then turned to the necessity of herbicide use. While curly-leaf pondweed is present with some high density in the lake, it is confined to a relatively small area. And while Eurasian water milfoil can be found colonized throughout much of the lake, its density is not such that it is impacting the ecology of the lake. Additionally, the FOJF planning committee indicated that the non-native plants are not impacting recreation more so than native plants are. This comment was supported by the stakeholder survey results, in which the majority (40.7%) of respondents indicated that aquatic plant growth negatively impacts their enjoyment of the lake “sometimes” (Question #23). However, 81% of respondents did indicate they believed aquatic plant control is needed on the Jersey Flowage (Question #24).

On this topic, researchers through the University of Wisconsin have recently found that often, overabundance of invasive species is not the case. In fact, in most cases invasives exist in moderate to low numbers, sometimes mixing in within native species and often in similar abundances to native species (Hansen et al, 2013). The study suggests that on a large scale, it is in a minority of cases that invasives increase their abundance greatly and impose ecological threat to native ecosystems. This circumstance has been documented in Wisconsin lakes with respect to curly-leaf pondweed and Eurasian water milfoil. Essentially, managers are finding that sometimes these species, though non-native, do not always act as "invasive". Given the right conditions, it is possible for non-native and native species to co-exist.

Curly-leaf pondweed and Eurasian water milfoil monitoring and control strategy

The FOJF have elected to continue watching curly-leaf pondweed and Eurasian water milfoil in the Jersey Flowage. During 2014, FOJF members will observe plant conditions in the lake and provide anecdotal observations to a professional consultant. The following year, in 2015, assessments of curly-leaf pondweed and Eurasian water milfoil would occur. Two types of assessments would be included: 1) quantitative monitoring using WDNR point-intercept protocols, and 2) qualitative monitoring using point-based and polygon-based mapping methodologies as employed through 2011 and 2012 mapping.

Following the 2015 summer studies and conversations with the FOJF, the professional consultant would produce a report describing the results. From these survey results, one of two decisions will be made regarding further actions on the curly-leaf pondweed or Eurasian water milfoil colonies. 1) If the colonies have expanded little or have changed in density very little, the FOJF may elect to continue monitoring and forgo an herbicide treatment until the presence of the species in this lake warrant a treatment. 2) If expansion or density increases are observed, the FOFJ may elect to proceed with herbicide treatments on either curly-leaf pondweed or Eurasian water milfoil – whichever is causing ecological or recreational impairment. The results of the 2015 survey would be used to determine areas for treatment. These herbicide treatments would occur the following summer using the methodology outlined below.

Pre-treatment Survey (Curly-leaf Pondweed and Eurasian water milfoil)

In April/May, professional ecologists would visit areas marked through previous years' mapping survey to verify the growth of aquatic invasive species. This survey would determine if expansion had occurred from the previous year and would be utilized to determine the final treatment areas. Herbicide treatments would then be conducted in late May/early June by a certified applicator.

Curly-leaf Pondweed Post-treatment Survey

In June, when curly-leaf pondweed is at or near its peak growth, professional ecologists would again survey known areas of curly-leaf pondweed to qualitatively assess the effectiveness of the treatment. Because of curly-leaf pondweed's unique lifecycle, quantitative assessments following the treatment would not be able to differentiate mortality caused by the herbicide and the natural senescence of the plant at that time of year.

Eurasian water milfoil Post-treatment Survey

Eurasian water milfoil peak-biomass surveys would be conducted in August/September following herbicide treatments. During this survey, data would be collected to determine the treatment's effectiveness as well as map remaining and new areas of infestation. If whole-lake treatments were to occur, a whole-lake point-intercept survey would be conducted. Comparison of data prior to and following the whole-lake treatment would allow for a quantitative comparison of the native and non-native aquatic plant communities before and after treatment.

Herbicide Concentration Monitoring (Curly-leaf Pondweed and Eurasian water milfoil)

If invited to participate within a WDNR's herbicide monitoring program, trained FOJF volunteers would collect water samples from treatment areas at set intervals to understand the nature of herbicide concentration in these areas. Samples would be collected following a study design determined by the USACE. Following collection, properly preserved samples will then be sent to the USACE laboratory for analysis. The information obtained from this monitoring will tell the FOJF if target concentrations were reached, how long the herbicide resided in the water column, how long it took to diffuse, etc. In short, this information would be useful for future decision making.

Control Project Applicable Funding

Prior to 2015, the FOJF will submit a grant to the WDNR Aquatic Invasive Species Grant Program. Specifically, an Education, Prevention and Planning Grant would be sought to fund 2015 monitoring and reporting, as well as planning for 2016. Should a 2016 herbicide treatment program be the outcome of 2015 surveys, an Established Population Control grant would be applied for to fund a multi-year project, including treatments and further monitoring.

Action Steps:

1. Board of Directors retain professional consultant to conduct 2015 monitoring studies.
2. Board of Directors submit an AIS-EPP grant application to the WDNR by February 1, 2015 to prepare for 2015 studies.
3. At the completion of 2015 studies, prepare AIS-EPC grant application if herbicide treatments are warranted.

<u>Management Action:</u> Reduce occurrence of purple loosestrife and pale yellow iris on Jersey Flowage shorelands.

Timeframe: Continuation of current effort.

Facilitator: Board of Directors.

Description: Purple loosestrife and pale yellow iris are two wetland species that have migrated from Europe and Asia to the United States, where they can aggressively outcompete native shoreland and wetland species for space and resources. Both of these species were observed flowering along the Jersey Flowage shorelands in several areas (Maps 7-9).

Manually removing pale yellow iris or purple loosestrife plants is likely the best control strategy for isolated occurrences. The FOJF is planning a volunteer recruitment campaign to assist with monitoring and hand removing both of these species from the Jersey Flowage shorelands. In addition to internal efforts, they have expanded and will continue to expand their efforts to coincide with the actions of other management entities. Discussions took place at the second meeting about what efforts the Wisconsin Valley Improvement Corporation (WVIC) was participating in on purple loosestrife management on their property. In addition to this partner, the FOJF has worked with Lumberjack Aquatic Invasive Species Coordinator John Preuss in beetle rearing program. In this program, *Galerucella sp.* beetles are raised, which are then released to feed upon purple loosestrife. The FOJF volunteers involved with pale yellow iris and purple loosestrife management are encouraged to continue communication and collaboration with these partners. Another partner may be Wisconsin Public Service (WPS). Darrin Johnson, an environmental consultant who works with WPS, assists in a similar beetle rearing program and would be happy to provide materials and coordination for Jersey Flowage landowners to manage purple loosestrife on their property. Mr. Johnson's contact information is included within Management Goal #3

Important aspects of this management action will be the monitoring and record keeping that will occur in association with the control efforts. These records will include maps indicating infested areas and associated documentation regarding the actions that were used to control the areas, the timing of those actions, and the results of the actions. These maps and records will be used to track and document the successfulness of the program and to keep the FOJF and other management entities updated.

Action Steps:

1. See description above.

Management Action: Continue Clean Boats Clean Waters watercraft inspections at Jersey Flowage public access locations.

Timeframe: Continuation of current effort

Facilitator: Board of Directors

Description: Members of the FOJF have been trained on Clean Boats Clean Waters (CBCW) protocols and complete boat inspections at the public landings on a regular basis. Because this system holds several aquatic invasive species, the intent of the boat inspections is to prevent additional invasives from entering the lake and also to keep watercraft users from transporting these species to other lakes from the Jersey Flowage. The goal is to cover the landing during the busiest times in order to maximize contact with lake users, spreading the word about the negative impacts of aquatic invasive species on our lakes and educating people about how they are the primary vector of aquatic invasive species spread. Though no inspections were recorded in 2012, 83 boats were inspected and 155 people contacted during 110 hours of watercraft inspections on the Jersey Flowage in 2011.

This aggressive approach to informing lake users about the dangers of aquatic invasive species has proven to be quite effective on a statewide basis. The FOJF will continue CBCW inspections at its public access location, and will more importantly continue to pursue volunteers through its membership and partnering organizations to staff the public landing for this effort.

The FOJF can take advantage of a new streamlined CBCW application process, through the WDNR's Aquatic Invasive Species Control grant program. This program provides grant funding of 75% of total project costs not to exceed $4,000 for each boat landing with a CBCW inspection program. More information is available by contacting Jane Malischke, WDNR Environmental Grant Specialist (715)-635-4062 or visiting http://dnr.wi.gov/Aid/AIS.html.

Action Steps:

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

Management Goal 3: Develop and Maintain Partnerships

Management Action: Facilitate efficient dialogue with other management entities.

Timeframe: Continuation of existing efforts

Facilitator: Board of Directors

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

It is important that the FOJF actively engage with all management entities to enhance the association's understanding of common management goals and to participate in the development of those goals. This also helps all management entities understand the actions that others are taking to reduce the duplication of efforts. The primary management units regarding the Jersey Flowage include governmental units such as the WDNR, but also include entities such as the Lincoln County Lakes and Rivers Association and Lumberjack Aquatic Invasive Species Coordinator. Each entity is specifically addressed below.

Action Steps:

1. See table guidelines on next page.

Partner	Contact Person	Role	Contact Frequency	Contact Basis
Lincoln County Lakes and Rivers Association	President (Peter Lloyd – 715.453.0965)	Protects Lincoln County waters through facilitating discussion and education.	Once a year or as needed.	Become aware of training or education opportunities, partnering in special projects, or networking on other topics pertaining to Lincoln County lakes.
Lumberjack Aquatic Invasives Coordinator	AIS Coordinator (John Preuss – 715.369.9886)	Oversees AIS monitoring and prevention activities locally.	Twice a year or more as issues arise.	Spring: AIS training and ID, AIS monitoring techniques Summer: Report activities to Mr. Preuss.
Wisconsin Public Service	Environmental Consultant (Darrin Johnson – 715.345.7509)	Oversees environmental aspects of WPS operations.	Twice a year or more as needed.	Contact for collaboration on purple loosestrife management, and for general questions on WPS dam.
Town of Nokomis	Town Chairman (John Bowman – 715.966.6062)	Oversees ordinances and other items pertaining to town.	As needed.	Town staff may be contacted regarding ordinance reviews or questions, and for information on community events.
Wisconsin Department of Natural Resources	Fisheries Biologist (David Seibel – 715.623.4190)	Manages the fishery of the Jersey Flowage.	Once a year, or more as issues arise.	Stocking activities, scheduled surveys, survey results, volunteer opportunities for improving fishery.
	Lakes Coordinator (Jim Kreitlow– 715.365.8947)	Oversees management plans, grants, all lake activities.	Annually, or more as necessary.	Information on lake management plans, AIS management or to seek advice on other lake issues.
	Warden (Ronald Nerva – 715.456.2188)	Oversees regulations handed down by the state.	As needed. May call the WDNR violation tip hotline for anonymous reporting (1-800-847-9367, 24 hours a day).	Contact regarding suspected violations pertaining to recreational activity on the lake, include fishing, boating safety, ordinance violations, etc.
	Citizens Lake Monitoring Network contact (Sandra Wickman – 715.365.8951)	Provides training and assistance on CLMN monitoring, methods, and data entry.	Twice a year or more as needed.	Late winter: arrange for training as needed, in addition to planning out monitoring for the open water season. Late fall: report monitoring activities.
Wisconsin Lakes	General staff (800.542.5253)	Facilitates education, networking and assistance on all matters involving WI lakes.	As needed. May check website (www.wisconsinlakes.org) often for updates.	FOJF members may attend WL's annual conference to keep up-to-date on lake issues. WL reps can assist on grant issues, AIS training, habitat enhancement techniques, etc.

Management Action: Increase volunteerism within FOJF.

Timeframe: Begin Summer 2014

Facilitator: Board of Directors

Description: Even through lake associations consist of individuals who are passionate about the lake they reside upon, it is often difficult to recruit volunteers to complete the tasks that are necessary to protect that lake. Many lake association members are elderly and retired, so sometimes labor intensive volunteer jobs are difficult to perform. Other residents may only visit the lake several times during the year, often on weekends to "get away" from the pressures of the work-week back home. Some have cut back on volunteering because of recent economic downturns, have concerns over the time commitment involved with various volunteer tasks, while others may simply have not been asked to lend their services.

Those that have volunteered in the past and have had a poor experience may be hesitant to volunteer again. Without good management, volunteers may become underutilized. Some may have been turned off by an impersonal, tense or cold atmosphere. Volunteers want to feel good about themselves for helping out, so every effort must be made by volunteer managers to see to it that the volunteer crews enjoy their tasks and their co-volunteers.

The FOJF is proud of their active role in preserving the Jersey Flowage for all stakeholders; however, they are in constant need of volunteers to continue this high level of commitment. As a result of this lake management planning project, the association is now in need of additional help to increase the level of protection the FOJF wishes to provide for the lake. In order to retain volunteer help and recruit more volunteers for these tasks, the FOJF will undertake a volunteer recruitment strategy as outlined below. While volunteer recruitment for a lake association may be difficult, the following tips will be helpful in the FOJF's efforts to solicit help for lake-related efforts.

Action Steps:

1. Board of directors appoints a volunteer coordinator. This should be a friendly, outgoing person who is able to engage people they may know or not know. The volunteer coordinator's duties are to recruit, train, supervise and recognize volunteers. Building and maintaining a volunteer database with names, contact information, tasks, hours completed, etc. will be necessary.
2. Coordinator will initially recruit volunteers through personal means, not via telephone, email or newsletter notification. Engaging a person in a friendly atmosphere through a personal invitation is more likely to result in a successful recruitment than through an impersonal email.

3. Coordinator will have duties outlined prior to recruiting volunteers. A volunteer's time should not be wasted! Work descriptions, timeframes and other specifics should be known by each worker prior to their shift.
4. Coordinator will be flexible in allowing volunteers to contribute towards project designs and implementation. Recruiting new leaders through delegating tasks will empower volunteers and give them reason to continue volunteering.
5. The board of directors will recognize volunteers through incentives and appreciation. Snacks, beverages, public acknowledgement and other means of expressing appreciation are encouraged.

Management Action: Increase membership enrollment through website.

Timeframe: Continuation of current effort

Facilitator: Board of Directors

Description: The Friends of the Jersey Flowage have a strong sense of commitment not only towards their lake, but also towards the principles of representation within the volunteer-based organization. The responsibility of managing a large lake such as the Jersey Flowage is becoming more complicated as issues such as development and aquatic invasive species become more prevalent. Decisions must be made, input sought from all stakeholders, and most importantly many volunteers are needed to maintain this resource.

As of spring 2014, the FOJF had 50 participating members in the organization. Coupled with the previous action of increasing their volunteer base, the Friends of the Jersey Flowage is interested in increasing their membership as well. This would provide a source for volunteers, as well as the additional input of stakeholders around the lake on management-based and other decisions that need to be made.

With many turning to the Internet as a source of information and as a general resource, the Friends of the Jersey Flowage have created a website to broadcast their organization and its happenings to a broader audience. New in 2013 is an option for individuals to sign up for membership within the organization. The FOJF plans to highlight this feature to prospective members, as well as advertise it wherever applicable to generate more interest in the organization.

Action Steps:

1. See above.

Management Goal 4: Expand Awareness of Lake Management and Stewardship Matters

Management Action: Communicate specifics of FOJF management issues and document resources for continued management efforts.

Timeframe: Develop in 2014

Facilitator: Board of Directors

Like many organizations, it is a core group of individuals who bear most of the responsibility of managing the FOJF. In an entirely volunteer-based organization, turnaround of officers and those with great influence can happen quickly. In addition to listing partners (Management Goal 3), the FOJF wishes to document resources that may be used to provide financial assistance, recruitment potential, and educational or volunteer opportunities. These resources can be passed on for all members to review, but more importantly, this list can be passed on to future generations of FOJF leaders. Listed below are several resources the FOJF should have on record:

Grant opportunities

Lake Planning Grants:

- Small/Large Scale Lake Planning Grant opportunities
- Lake Protection and Classification Grants

Aquatic Invasive Species Grants

- Education, Planning and Prevention Grants
- Early Detection and Response Grants
- Established Population Control Grants
- Maintenance and Containment Grants

Specifics on WDNR Lake Grants may be obtained at http://dnr.wi.gov/lakes/grants/

Outlets for Education and Recruitment

FOJF website
Facebook ® or other social media
Wisconsin Lakes Convention
Other events hosted by partners listed in Management Goal 3
Local events deemed appropriate by the FOJF

Volunteer activities

Pale yellow iris and purple loosestrife control efforts
Clean Boats Clean Waters
Citizens Lake Monitoring Network
Annual meeting preparation
FOJF Board of Directors or officer position

Action Steps:

1. Board of Directors documents resources for continued management, presents material in public setting, such as FOJF website.

Management Action: Engage stakeholders on priority education items

Timeframe: Develop in 2014

Facilitator: Board of Directors

Education of lake stakeholders on all matters is important, however during conversations with the FOJF Planning Committee it became apparent that certain topics require additional time and focused effort. These topics have direct implication on the ecology and health of the lake, as well as its navigational safety.

1. Shoreland buffers: The FOJF realizes the important role that shoreland buffers play in maintaining the water quality and habitat within the Jersey Flowage. The FOJF will make shoreland buffer education a priority for all lake residents. In addition to educational tools, the FOJF will provide access to the expertise of local and state professionals for further information on shoreland restoration and protection projects should property owners request it.

2. Navigational safety: The FOJF acknowledges that a variety of recreational activities take place on the Jersey Flowage. While allowing all stakeholders to enjoy the lake, the FOJF wishes to ensure that all recreationalists are displaying a high level of safety and awareness at all times, and are obeying all boating regulations. The FOJF will work to keep all lake residents and visitors aware of navigational hazards and regulations that exist on Jersey Flowage. This will be done through appropriate postings on the FOJF website, announcements at association meetings, signage at the lake's public access point, etc. Map 15 may serve as an educational tool for Wisconsin Act 31, which restricts watercraft speed in near shore areas.

3. Aquatic invasive species management: Aquatic invasive species pose a serious threat to lake ecosystems. Additionally, their management can be incredibly expensive (as outlined in Management Goal 2). The FOJF will work to increase stakeholder input on invasive species matters, increase a support base for funding invasive species management, and increase the knowledge of FOJF members and other riparian owners on the specifics of this unique form of lake management. Information for this educational campaign will be obtained through many of the partners identified in Management Goal 3.

Action Steps:

1. Board of Directors establishes educational committee or representative to prepare materials for specific issues, such as those defined above.
2. Material presented at annual meetings, within newsletter, on website, etc.

6.0 METHODS

Lake Water Quality

Baseline water quality conditions were studied to assist in identifying potential water quality problems in Jersey Flowage (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.

Watershed Analysis

The watershed analysis began with an accurate delineation of Jersey Flowage's drainage area using U.S.G.S. topographic survey maps and base GIS data from the WDNR. The watershed delineation was then transferred to a Geographic Information System (GIS). These data, along with land cover data from the National Land Cover Database (NLCD – Fry et. al 2011) were then combined to determine the watershed land cover classifications. These data were modeled using the WDNR's Wisconsin Lake Modeling Suite (WiLMS) (Panuska and Kreider 2003)

Aquatic Vegetation

Curly-leaf Pondweed Survey

Surveys of curly-leaf pondweed were completed on Jersey Flowage during a June 6 2012 field visit, in order to correspond with the anticipated peak growth of the plant. Visual inspections were completed throughout the lake by completing a meander survey by boat.

Comprehensive Macrophyte Surveys

Comprehensive surveys of aquatic macrophytes were conducted on Jersey Flowage to characterize the existing communities within the lake and include inventories of emergent, submergent, and floating-leaved aquatic plants within them. The point-intercept method as described in the Wisconsin Department of Natural Resource document, Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design, Field and Laboratory Procedures, Data Entry, and Analysis, and Applications (WDNR PUB-SS-1068 2010) was used to complete this study on June 26 and 27, 2012. A point spacing of 53 meters was used resulting in 615 sampling points.

Community Mapping

During the species inventory work, the aquatic vegetation community types within Jersey Flowage (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 – Stevens Point Herbarium. A set of samples was also provided to the FOJF.

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