DRAFT

Big Sand Lake

Vilas County, Wisconsin

Aquatic Plant Management Plan

July 2023

Official First Draft

Created by: Eddie Heath, Josephine Barlament, Todd Hanke, Tim Hoyman
Onterra, LLC
De Pere, WI

Funded by: Big Sand Lake Property Owners Association
Wisconsin Dept. of Natural Resources
(AEPP68222 & AEPP68122)

Acknowledgements

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

Big Sand Lake Planning Committee

Kenneth Musial - Chair	Nancy Mansavage	Doug Jehle
Matt Garni – BSLPOA President	Nicholas Garni	Joe Robinson
Tom O'Connell	William Sachse, Jr.	Dru Claar
Sean Murphy	Patrick Stemper	

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1.0 INTRODUCTION

According to the 1962 WDNR Lake Survey Map, Big Sand Lake is 1,418 acres. The WDNR website lists the lake as 1,427 acres. At the time of this report, the most current orthophoto (aerial photograph) was from the *National Agriculture Imagery Program* (NAIP) collected in 2022. Based on heads-up digitizing of the water level from that photo, the lake was determined to be 1,433 acres. Big Sand Lake, Vilas County, is a drainage lake with a maximum depth of 56 feet and a mean depth of 16 feet (Map 1).

The *Comprehensive Management Plan* (2017) investigated Big Sand Lake's water quality condition, analyzed the influence of the watershed on the lake, inventory and assessed the aquatic plant community, and integrated relevant information on the lake's fishery. Further, the *Comprehensive Management Plan* (2017) outlined five management goals and nine management actions to help guide the Big Sand Lake Property Owners Association in protecting and enhancing Big Sand Lake.

According to the 2017 Comprehensive Management Plan, the Big Sand Lake watershed is approximately 5,893 acres (including the lake's surface area), which yields a watershed to lake area ratio of 3:1 (Figure 1.0-1). The watershed to lake area ratio is small and means the watershed would be the dominating factor in determining the lake's water quality. The majority of Big Sand Lake's direct watershed is comprised of land cover types which deliver the least amount of phosphorus and sediments to the lake such as forests, wetlands, and the lake surface itself.

Figure 1.0-1. Big Sand Lake, Vilas County, WI. Watershed outline in red.

Almost 80% of Big Sand Lake's shoreland is in a natural/undeveloped, or developed-natural condition. These are the shoreland types that provide the largest nutrient buffering capabilities, as well as providing the greatest habitat for aquatic and terrestrial wildlife.

Big Sand Lake was one of the first lakes in the area to contain EWM (1990) and in the mid 2000s, had one of the largest populations of EWM in the area. After a series of herbicide controls, the population was driven down to a level where small herbicide spot treatments were ineffective. At that low EWM population level, the Big Sand Lake ecosystem is likely not being heavily impacted by EWM, nor are the lake users being hampered of their activities. The BSLPOA took an approach many area lakes have also taken; tolerate the EWM population until it reaches levels that are more likely impacting the integrity of the ecosystem and interfering with lake user's ability to recreate and enjoy the lake.

As EWM populations have increased, particularly in 2021, the BSLPOA positioned themselves for future active management of the EWM population. With changes in technologies and what is considered a Best Management Practice (BMP) for EWM management, the BSLPOA is in the process of investigating options outside of a whole-lake treatment that may have more direct benefit with fewer whole-lake negative impacts.

As discussed in previous reports, curly-leaf pondweed was recorded during the WDNR's 2006 whole-lake point-intercept survey. However, a CLP specimen was never collected/vouchered and it is likely that the presence of CLP was recorded in error on the field data sheet. Curly-leaf pondweed has not been observed in Big Sand Lake during any of the subsequent surveys since 2006, including a survey completed by Onterra in June of 2014 with a specific goal of locating potential occurrences of CLP. The recent 2022 field surveys did not find any CLP either.

Because the science and understanding of aquatic plant management is constantly evolving, the WDNR recommends that lake organizations update these aspects of their *Plan* approximately every 5 to 10 years. Working with Onterra, the BSLPOA commenced a project aimed to update to their Aquatic Plant Management (APM) Plan in 2022-23.

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.

2.1 Strategic Planning Committee Meetings

Planning committee meetings, similar to general public meetings, were used to gather comments, create management goals and actions and to deliver study results. These two meetings were open only to the planning committee and were held during the week. The first, following the completion of the draft report sections of the management plan. The planning committee members were supplied with the draft report sections prior to the meeting and much of the meeting time was utilized to detail the results, discuss the conclusions and initial recommendations, and answer committee questions. The objective of the first meeting was to fortify a solid understanding of their lake among the committee members. The second planning committee meeting was held a few weeks after the first and concentrated on the development of management goals and actions that make up the framework of the implementation plan.

Planning Committee Meeting I

The ALA planning committee meeting attendees were supplied with the draft report sections prior to the meeting and much of the meeting time was utilized to detail the results, discuss the conclusions and initial recommendations, and answer committee questions.

On May 25, 2023, Eddie Heath met with the eight-member planning committee for approximately three hours at the Big Sand Lake Club. This meeting largely consisted of a presentation of the available data from the system and the latest science and perspective on aquatic plant management activities.

Planning Committee Meeting II

On June 13, 2023, Eddie Heath again met with the eight-member planning committee for approximately two hours at the Big Sand Lake Club. This meeting concentrated on the development of management goals and actions that make up the framework of the implementation plan by the planning committee. Eurasian watermilfoil management was the focus of these discussions.

2.2 Management Plan Review and Adoption Process

Summary to be included in Final Version

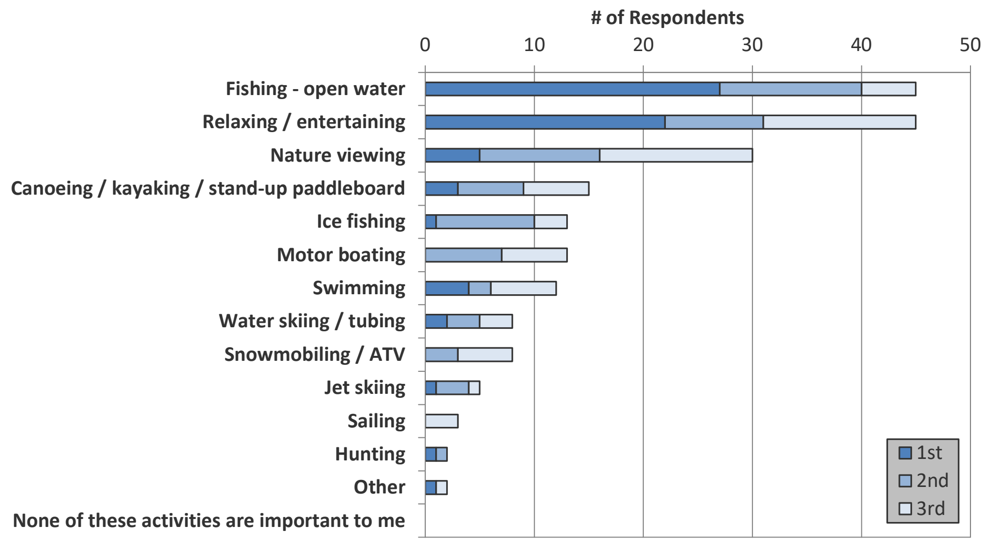
2.3 Stakeholder Survey

As a part of this project, a stakeholder survey was distributed to all members of the Big Sand Lake Property Owners Association and riparian property owners around Big Sand Lake. The survey was designed by Onterra staff and the Big Sand Lake Property Owners Association planning committee and reviewed by a WDNR social scientist. During September and October of 2022, the nine-page, 37-question survey was posted online through Survey Monkey for survey-takers to answer electronically. If requested, a hard copy was sent with a self-addressed stamped envelope for returning the survey anonymously. The returned hardcopy surveys were entered into the online version by a third-party for analysis. Twenty-eight percent of the surveys were returned. Please note that typically a benchmark of a 60% response rate is required to portray population projections accurately, and make conclusions with statistical validity. The data were analyzed and summarized by Onterra for use at the planning 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 who use and care for Big Sand Lake. 34% of respondents indicated they use their property as a weekend, vacation and/or holiday residence only, while 31% visit their property seasonally, and 34% are year-round residents. 54% of respondents have owned their property for over 25 years, and 22% have owned their property between 11 and 15 years.

The Aquatic Plants section will discuss the stakeholder survey data with respect to that particular topic. Figures 2.0-1 and 2.0-2 highlight several other questions found within this survey. Nearly 70% of survey respondents indicate that they use a motor boat with greater than 25 hp motor, and almost half of respondents use a canoe/kayak/ or stand-up paddleboard on Big Sand Lake (Question 13). Pontoon boats were also a popular option at 46%. The importance of responsible boating activities is imperative to protecting the shoreline of Big Sand Lake. 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 8, many of the top recreational activities on the lake involve boat use.

Question 8: Please rank up to three activities that are important reasons for owning your property on or near Big Sand Lake, with 1 being the most important.



Question 13: What types of watercraft do you currently use on Big Sand Lake?

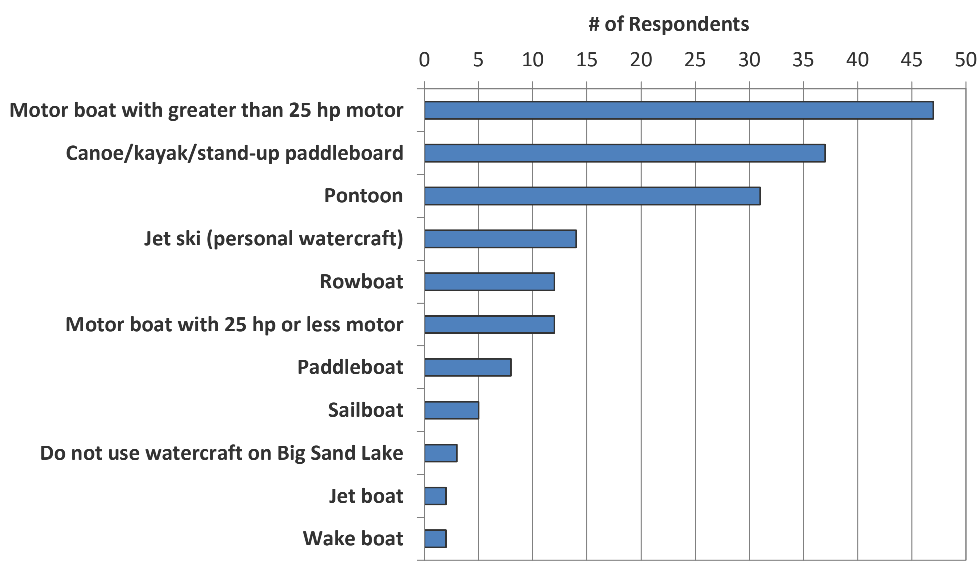


Figure 2.0-1. Select survey responses from the Big Sand Lake Stakeholder Survey. Additional questions and response charts may be found in Appendix B.

3.0 AQUATIC PLANTS

3.1 Primer on Aquatic Plant Data Analysis & Interpretation

Native aquatic plants are an important element in every healthy aquatic ecosystem, providing food and habitat to wildlife, improving water quality, and stabilizing bottom sediments. Because most aquatic plants are rooted in place and are unable to relocate in wake of environmental alterations, they are often the first community to indicate that changes may be occurring within the system. Aquatic plant communities can respond in a variety of ways; there may be increases or declines in the occurrences of some species, or a complete loss. Or, certain growth forms, such as emergent and floating-leaf communities may disappear from certain areas of the waterbody. With periodic monitoring and proper analysis, these changes are relatively easy to detect and provide relevant information for making management decisions.

Point-Intercept Survey

The point-intercept method as described Wisconsin Department of Natural Resources Bureau of Science Services, PUB-SS-1068 2010 (Hauxwell et al. 2010) have been conducted on Big Sand Lake in 2006, 2010, 2011, 2014-2019, and 2022. Each point within the survey is spaced 80 meters apart for a total of 872 points. At each point-intercept location within the *littoral zone*, information regarding the depth, substrate type (soft sediment, sand, or rock), and the plant species sampled along with their relative abundance on the sampling rake was recorded.

A pole-mounted rake was used to collect the plant samples, depth, and sediment information at point locations of 15 feet or less. A rake head tied to a rope (rope rake) was used at sites greater than 15 feet. Depth information was collected using graduated marks on the pole of the rake (at depths < 15 ft) or using an onboard sonar unit (at depths > 15 feet). Also, when a rope rake was used, information regarding substrate type was not collected due to the inability of the sampler to accurately "feel" the bottom with this sampling device. At each point that is sampled the surveyor records a total rake fullness (TRF) value ranging from 0-3 as a somewhat subjective indication of plant biomass. The point-intercept survey produces a great deal of information about a lake's aquatic vegetation and overall health. These data are analyzed and presented in numerous ways; each is discussed in more detail the following section.

Community Mapping Survey

Emergent and floating-leaf plant communities are wetland community types dominated by species such as cattails, bulrushes, and water lilies. These community types are not properly assessed with the point-intercept survey method, so a dedicated *Community Mapping Survey* was completed as a part of this project. During this survey, the floating-leaf and emergent vegetation community types were mapped using a Trimble Pro6T Global Positioning System (GPS) receiver with sub-meter accuracy.

Like submersed aquatic plant communities, these communities also provide valuable habitat, shelter, and food sources for organisms that live in and around the lake. In addition to those functions, floating-leaf and emergent plant communities provide other valuable services such as erosions control and nutrient filtration. These communities also lessen the force of wind and waves before they reach the shoreline which serves to lessen erosion. Their root systems also stabilize bottom sediments and reduce sediment resuspension. In addition, because they often occur in near-shore areas, they act as a buffer against nutrients and other pollutants in runoff from upland areas.

Species List

The species list is simply a list of all of the aquatic plant species, both native and non-native, that were located during the surveys completed on Big Sand Lake. The list also contains each species' scientific name, common name, status in Wisconsin, and coefficient of conservatism. The latter is discussed in more detail below. Changes in this list over time, whether it is differences in total species present, gains and losses of individual species, or changes in growth forms that are present, can be an early indicator of changes in the ecosystem.

Frequency of Occurrence

Frequency of occurrence describes how often a certain aquatic plant species is found within a lake from the point-intercept survey. Obviously, all of the plants cannot be counted in a lake, so samples are collected from pre-determined areas. In the case of the whole-lake point-intercept surveys that have been completed; plant samples were collected from plots laid out on a grid that covered the lake. Using the data collected from these plots, an estimate of occurrence of each plant species can be determined. The occurrence of aquatic plant species is displayed as the *littoral frequency of occurrence*. Littoral frequency of occurrence is used to describe how often each species occurred in the plots that are within the maximum depth of plant growth (littoral zone), and is displayed as a percentage.

Littoral Zone is the area of a lake where sunlight is able to penetrate down to the sediment and support aquatic plant growth.

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.

Floristic Quality Assessment

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

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

On their own, the species richness and average conservatism values for a lake are useful in assessing a lake's plant community; however, the best assessment of the lake's plant community health is determined when the two values are used to calculate the lake's floristic quality. The floristic quality is calculated using the species richness and average conservatism value of the aquatic plant species that were solely encountered on the rake during the point-intercept surveys (equation shown below). This assessment allows the aquatic plant community of Big Sand Lake to be compared to other lakes within the region and state.

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

Big Sand Lake falls within the Northern Lakes and Forests (NLF) *ecoregion* (Figure 3.1-1), and the floristic quality of its aquatic plant community will be compared to other lakes within this ecoregion as well as the entire State of Wisconsin. Ecoregions are areas related by similar climate, physiography, hydrology, vegetation and wildlife potential. Comparing ecosystems within the same ecoregion is sounder than comparing systems within manmade boundaries such as counties, towns, or states. Ecoregional and state-wide medians were calculated from whole-lake point-intercept surveys conducted on 392 lakes throughout Wisconsin by Onterra and WDNR ecologists.

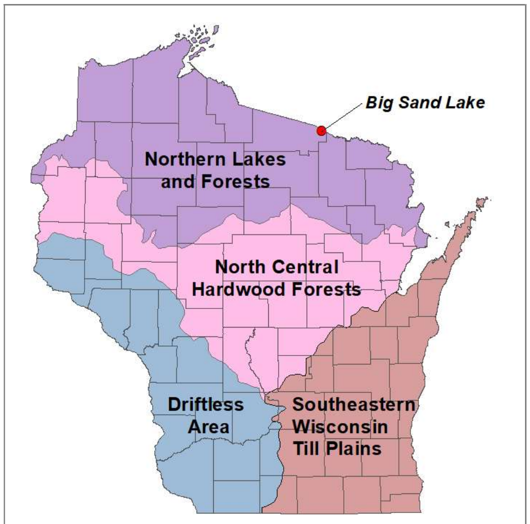


Figure 3.1-1. Location of Big Sand Lake within the ecoregions of Wisconsin. After (Nichols 1999).

Species Diversity

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

An aquatic system with high species diversity is more stable than a system with a low diversity. This is analogous to a diverse financial portfolio in that a diverse aquatic plant community can withstand environmental fluctuations much like a diverse portfolio can handle economic fluctuations. Some managers believe a lake with a diverse plant community is also better suited to compete against exotic infestations than a lake with a lower diversity. However, in a recent study of 1,100 Minnesota lakes, researchers concluded that more diverse communities were not more resistant or resilient to invaders (Muthukrishnan et al. 2018).

The diversity of a lake's aquatic plant community is determined using the Simpson's Diversity Index (1-D):

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

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

If a lake has a diversity index value of 0.90, it means that if two plants were randomly sampled from the lake there is a 90% probability that the two individuals would be of a different species. The Simpson's Diversity Index value from Big Sand Lake is compared to data collected by Onterra and the WDNR Science Services on 212 lakes within the Northern Lakes and Forests (lakes only, does not include flowages) Ecoregion and on 392 lakes throughout Wisconsin.

3.2 Big Sand Lake Aquatic Plant Survey Results

The whole-lake point-intercept survey was conducted on Big Sand Lake on August 9, 2022. The late-season AIS survey was completed on August 22, 2022. During these surveys, a total of 35 aquatic plant species were located, 34 of which are considered native to Wisconsin and one of which are considered to be a non-native invasive species (Table 3.3-1). The populations of non-native plants in Big Sand Lake are discussed specifically in the subsequent Non-Native Aquatic Plants subsection. The species documented in Big Sand Lake during surveys completed in 2006, 2010, 2011, 2014-2019, and 2022 are also included in Table 3.3-1. The species recorded historically between the 2006 and 2019 were relatively similar. The completion of an emergent and floating-leaf plant mapping survey in 2014 documented additional species growing in near-shore areas that are typically not captured in point-intercept surveys. In total, 35 species have been recorded from Big Sand Lake over the course of these surveys.

Table 3.2-1 is organized by growth form which separates out species based on whether they are emergent species, floating-leaf species, submergent species, or free-floating species. Species with an "X" on the table indicate that the species was physically encountered on the rake during the point-intercept survey. Additional species observed visually, and not on the rake, are noted on the table as an incidental and marked with an "I". Examples of incidental species that are known to be present in the waterbodies, but were not sampled on the survey rake often include species growing on the shoreline of the lake such as purple loosestrife or iris species. Species that are present in low amounts in the system can also sometimes not be detected by the point-intercept survey methodology.

Total rake fullness values from the 2022 point-intercept survey are displayed on Figure 3.2-1. These data represent the aquatic plant biomass at each sampling location and does not differentiate between native or non-native vegetation. Some of the greatest amount of plant biomass in the 2022 survey was found along the southwestern shoreline of the lake and near the thoroughfare creek outlet. Extensive beds of Eurasian watermilfoil on the south and north shorelines contribute to the plant biomass at these locations.

Aquatic plants have been found growing to a maximum depth ranging from 18 feet in 2010 to 21 feet in 2017 and 2019. Big Sand Lake has high water clarity which allows sunlight to penetrate further into the water column and support aquatic plant growth at deeper depths. Of the 623 point-intercept sampling locations that were shallower than the maximum depth of plant growth (the littoral zone), approximately 81% contained aquatic vegetation in 2022 (Figure 3.2-1).

Table 3.2-1. Aquatic plant species located in Big Sand Lake.

Growth Form	Scientific Name	Common Name	Status in Wisconsin	Coefficient of Conservatism	2006	2010	2011	2014	2015	2016	2017	2018	2019	2022
Emergent	*Calla palustris*	Water arum	Native	9				I						
	Dulichium arundinaceum	Three-way sedge	Native	9				I						
	Eleocharis palustris	Creeping spikerush	Native	6	X	X	X	X	X	X	X	X	X	I
	Equisetum fluviatile	Water horsetail	Native	7			X							
	Phragmites australis subsp. americanus	Common reed	Native	5				I						
	Sagittaria latifolia	Common arrowhead	Native	3		X		I				X		
	Schoenoplectus acutus	Hardstem bulrush	Native	5	X	X	X	X	X	X	X	X	X	X
	Schoenoplectus pungens	Three-square rush	Native	5						X				
	Schoenoplectus tabernaemontani	Softstem bulrush	Native	4	X			X	X					X
	Typha spp.	Cattail spp.	Unknown (Sterile)	N/A		X		I			X		X	
FL	*Brasenia schreberi*	Watershield	Native	7	X	X	X	X	X	X	X	X	X	X
	Nuphar variegata	Spatterdock	Native	6	X	X	X	X	X	X	X		X	
	Nymphaea odorata	White water lily	Native	6	X	X	X	X	X	X	X	X	X	X
	Persicaria amphibia	Water smartweed	Native	5				I						
	Sparganium angustifolium	Narrow-leaf bur-reed	Native	9		X		I		X	X			
	Sparganium fluctuans	Floating-leaf bur-reed	Native	10				X			X			
Submergent	*Bidens beckii*	Water marigold	Native	8	X	X	X	X	X	X	X	X	X	X
	Ceratophyllum demersum	Coontail	Native	3	X	X	X	X	X	X	X	X	X	X
	Ceratophyllum echinatum	Spiny hornwort	Native	10								X		
	Chara spp.	Muskgrasses	Native	7	X	X	X	X	X	X	X	X	X	X
	Elatine minima	Waterwort	Native	9		X	X		X	X	X	X	X	X
	Elodea canadensis	Common waterweed	Native	3	X	X	X	X	X	X	X	X	X	X
	Elodea nuttallii	Slender waterweed	Native	7	X		X							
	Eriocaulon aquaticum	Pipewort	Native	9			X	X	X	X	X		X	X
	Heteranthera dubia	Water stargrass	Native	6	X			X		X	X		X	X
	Isoetes spp.	Quillwort spp.	Native	8	X	X	X	X	X	X	X	X	X	X
	Lobelia dortmanna	Water lobelia	Native	10		X				X	X	X		X
	Myriophyllum heterophyllum	Various-leaved watermilfoil	Native	7		X								
	Myriophyllum sibiricum	Northern watermilfoil	Native	7	X	X	X	X	X	X	X	X	X	
	Myriophyllum spicatum	Eurasian watermilfoil	Non-Native - Invasive	N/A	X	X	X	X	X	X	X	X	X	X
	Myriophyllum tenellum	Dwarf watermilfoil	Native	10	X	X	X	X	X	X	X	X	X	X
	Najas guadalupensis & N. flexilis	Southern & Slender naiad	Native	0	X	X	X	X	X	X	X	X	X	X
	Nitella spp.	Stoneworts	Native	7	X	X	X					X	X	X
	Potamogeton alpinus	Alpine pondweed	Native	9	X									
	Potamogeton amplifolius	Large-leaf pondweed	Native	7	X	X	X	X	X	X	X	X	X	X
	Potamogeton amplifolius x praelongus	Large-leaf x White-stem pondweed	Native	N/A			X	X	X	X	X	X	X	X
	Potamogeton berchtoldii & P. pusillus	Small & Slender pondweed	N/A	0	X	X	X	X	X	X	X	X	X	X
	Potamogeton crispus	Curly-leaf pondweed	Non-Native - Invasive	N/A	X									
	Potamogeton epihydrus	Ribbon-leaf pondweed	Native	8						X	X	X		
	Potamogeton foliosus	Leafy pondweed	Native	6	X			X	X	X				
	Potamogeton gramineus	Variable-leaf pondweed	Native	7	X		X	X	X	X	X	X	X	X
	Potamogeton illinoensis	Illinois pondweed	Native	6	X	X	X	X	X	X	X	X	X	X
	Potamogeton praelongus	White-stem pondweed	Native	8	X	X	X	X	X	X	X	X	X	X
	Potamogeton praelongus x richardsonii	White-stem x clasping-leaf pondweed	Native	N/A				X		X				
	Potamogeton richardsonii	Clasping-leaf pondweed	Native	5	X	X	X	X	X	X	X	X	X	X
	Potamogeton robbinsii	Fern-leaf pondweed	Native	8	X	X	X	X	X	X	X	X	X	X
	Potamogeton spirillus	Spiral-fruited pondweed	Native	8			X	X			X		X	
	Potamogeton strictifolius	Stiff pondweed	Native	8	X			X	X	X		X		
	Potamogeton zosteriformis	Flat-stem pondweed	Native	6	X	X	X	X	X	X	X	X	X	X
	Ranunculus aquatilis	White water crowfoot	Native	8	X				X	X	X		X	X
	Ranunculus flammula	Creeping spearwort	Native	9								X		
	Sagittaria sp. (rosette)	Arrowhead sp. (rosette)	Native	N/A				X		X	X		X	X
	Stuckenia pectinata	Sago pondweed	Native	3	X									
	Utricularia intermedia	Flat-leaf bladderwort	Native	9				X	X	X	X	X	X	
	Utricularia vulgaris	Common bladderwort	Native	7	X	X		X	X	X	X	X	X	X
	Vallisneria americana	Wild celery	Native	6	X	X	X	X	X	X	X	X	X	X
S/E	*Eleocharis acicularis*	Needle spikerush	Native	5	X		X	X	X	X	X	X	X	X
	Juncus pelocarpus	Brown-fruited rush	Native	8	X	X	X	X	X	X	X	X	X	X
	Sagittaria cuneata	Arum-leaved arrowhead	Native	7				I						
	Schoenoplectus subterminalis	Water bulrush	Native	9				I						

X = Located on rake during point-intercept survey; I = Incidentally located; not located on rake during point-intercept survey
FL = Floating-leaf; F/L = Floating-leaf & Emergent; S/E = Submergent and/or Emergent; FF = Free-floating

Of the 34 native aquatic plant species were sampled during the 2022 point-intercept survey in Big Sand Lake with fern-leaf pondweed (49.6%), flat-stem pondweed (15.6%), and slender & southern naiad (15.2%), being the most commonly encountered native species (Figure 3.2-3). Eurasian watermilfoil was the seventh-most frequently encountered species within the lake with an occurrence of 9.8%. A total of 19 native aquatic plant species exhibited a littoral frequency of occurrence of at least 2% in Big Sand Lake in the 2022 survey, while another 16 species were present in lesser amounts and not displayed on Figure 3.2-2.

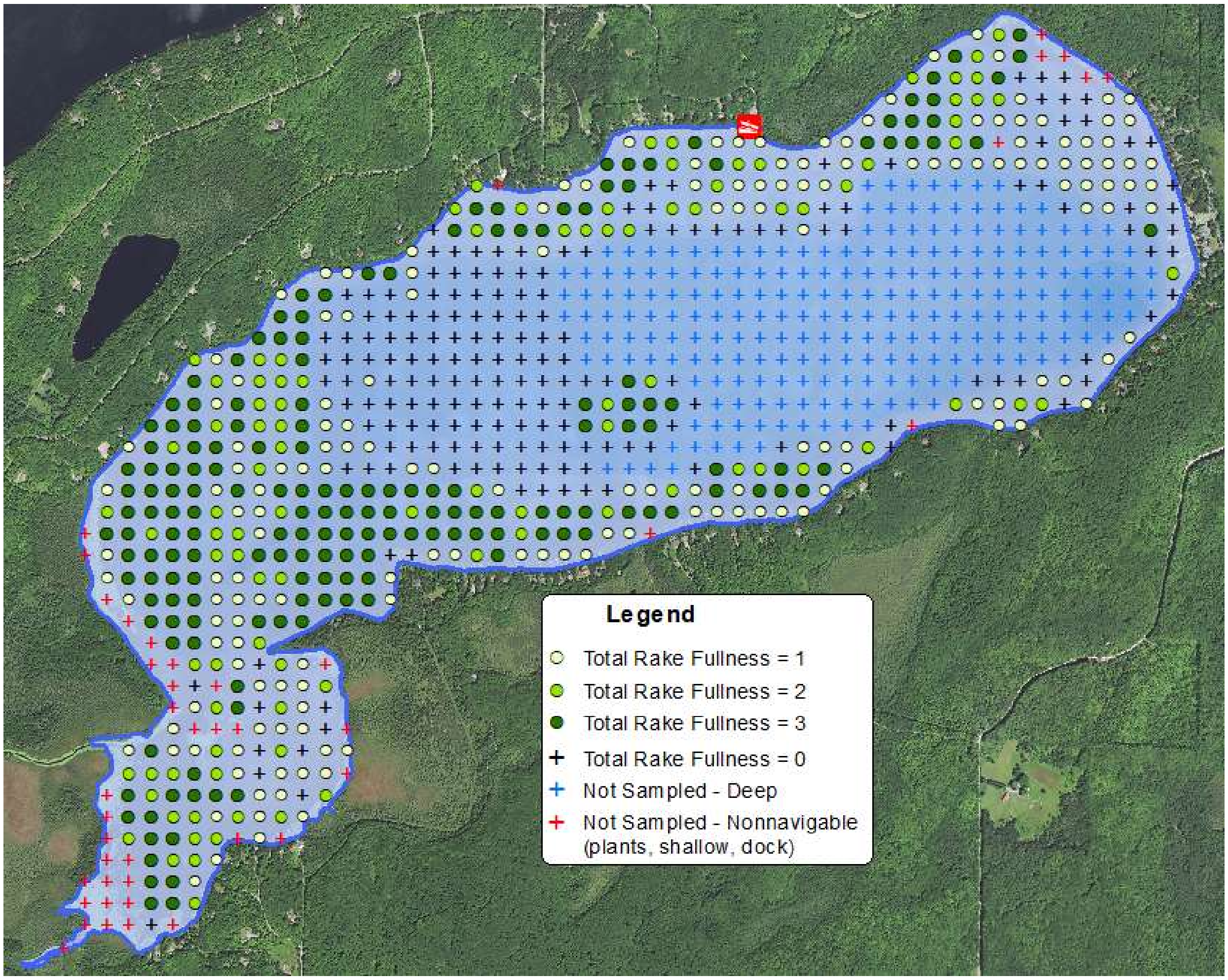


Figure 3.2-1. Big Sand Lake aquatic plant total rake fullness (TRF) ratings. Created using data from August 2022 point-intercept survey.

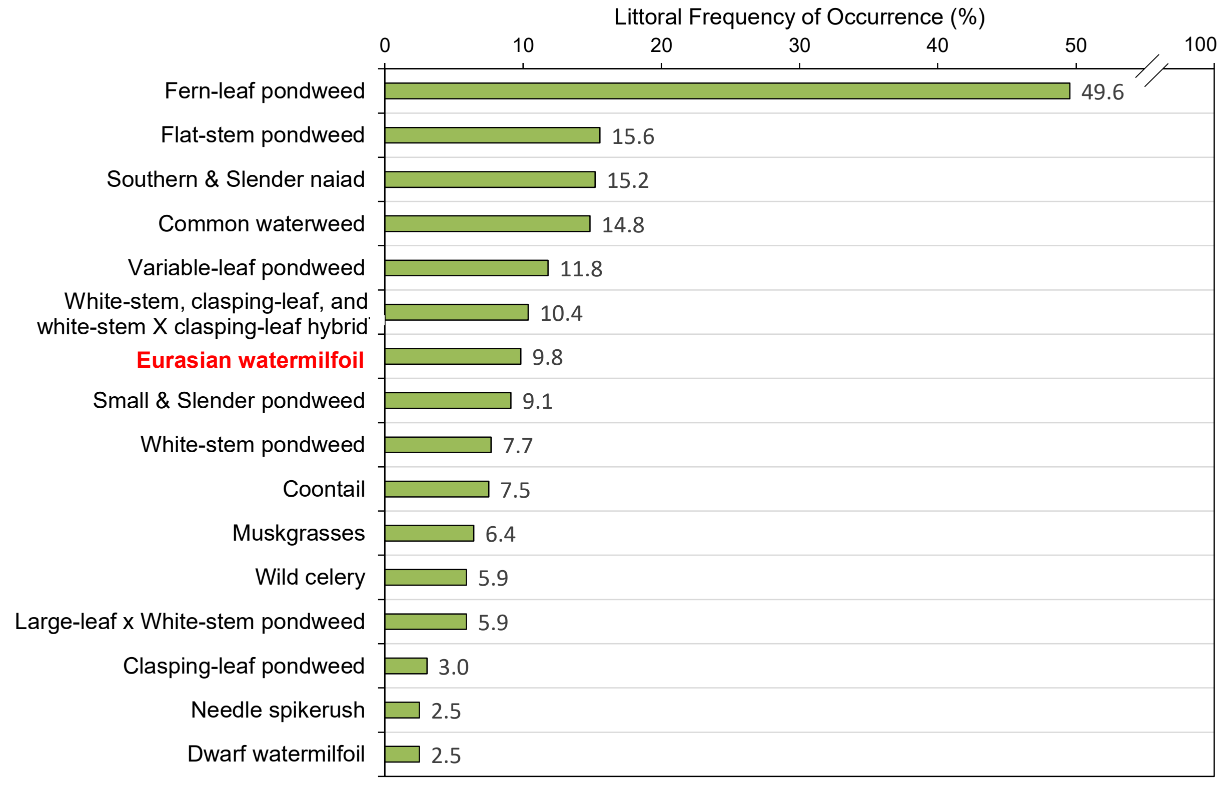


Figure 3.2-2. Big Sand Lake aquatic plant littoral frequency of occurrence. Created using data from August 2022 point-intercept survey. Only species with an occurrence >2% are displayed.

Point-intercept surveys have also taken place in Big Sand Lake during 2006, 2010, 2011, 2014-2019 and these data are comparable to the 2022 survey. A comparison of these surveys allows for detecting changes in the aquatic plant community over time. The average number of native species per sampling location within the littoral zone of the lake was greatest in 2015 at 2.29 species per sampling point. The 2022 survey found 1.68 species per site which was slightly lower than the average of all the surveys (1.95) (Figure 3.2-3). Map 2 shows areas on Big Sand Lake where the highest plant species per site exist. These locations are primarily along the southern shoreline and within the lower bay where the Thoroughfare Creek outlet is located.

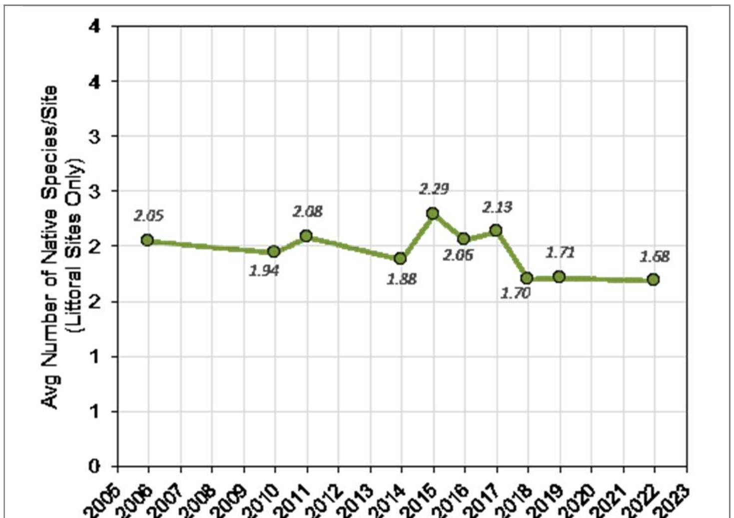


Figure 3.2-3. Average number of native aquatic plant species per littoral sampling site.

Figures 3.2-4 to 3.2-7 compare the littoral frequency of occurrence of select aquatic plant species in Big Sand Lake from the 10 point-intercept surveys. A statistically valid change in occurrence from one survey to the next is indicated with an open circle on the figure. Many species saw statistically valid changes in occurrence between the 2019 and 2022 surveys. Six species saw valid increases in occurrence including EWM, small & slender pondweed, clasping-leaf pondweed, stoneworts, and large-leaf x white-stem pondweed while three native species exhibited statistically valid decreases in occurrence from 2019 to 2022 including southern & slender naiad and white-stem pondweed. The occurrence of EWM increased from 3.5% occurrence in 2019 to 9.8% in 2022. In the field, it is often difficult to distinguish between certain species of aquatic plants that are very similar morphologically, especially when flowering/fruiting material is not present. Because of this, the littoral occurrences of the following morphologically-similar species were combined for this analysis: small pondweed (*Potamogeton pusillus*) and slender pondweed (*P. berchtoldii*), slender naiad (*Najas flexilis*) and southern naiad (*N. guadalupensis*), as well as white-stem pondweed (*Potamogeton praelongus*) and clasping-leaf pondweed (*P. richardsonii*) and white-stem X clasping-leaf hybrid (*P. praelongus, P. richardsonii & P. praelongus X P. richardsonii hybrid*).

Fern pondweed was the most abundant aquatic plant in Big Sand Lake in 2022 with a littoral frequency of occurrence of approximately 49%. As its name indicates, this plant resembles a terrestrial fern frond in appearance (Figure 3.2-4), and is often a dominant species in plant communities of northern Wisconsin lakes. Fern pondweed is generally found growing in thick beds over soft substrates, where it stabilizes bottom sediments and provides a dense network of structural habitat for aquatic wildlife. In 2022, fern pondweed was abundant throughout littoral areas of Big Sand Lake, and was only absent from near-shore areas with sandy substrates. This plant historically has been the dominant species in Big Sand Lake and continues to show that trend (Figure 3.2-4).

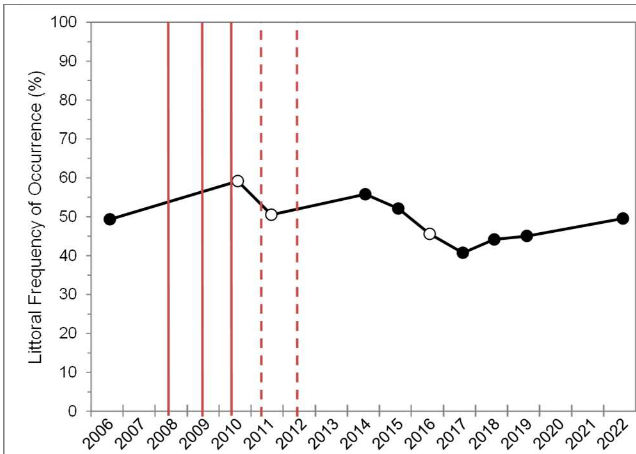


Figure 3.2-4. Fern-leaf pondweed in Big Sand Lake from 2006-2022. Open circle indicates a statistically valid change in occurrence from the previous survey (Chi-Square α = 0.05). Red solid lines indicate large-scale 2,4-D treatment and red dashed lines indicate small-scale 2,4-D treatment.

Flat-stem pondweed was the second most abundant plant in 2022 at 15.6% littoral frequency of occurrence. This pondweed is often more abundant in productive lakes with soft sediments like Big Sand Lake. Flat-stem pondweed, as its name implies, can be distinguished from other thin-leaved pondweeds by its conspicuously flattened stem. Flat-stem pondweed can attain heights of 10 feet or greater in the water column, and provides excellent structural habitat for aquatic wildlife. It has been shown to be susceptible to 2,4-D treatments, but in Big Sand Lake there was not a detectable effect on this population. Flat-stem pondweed has slowly increased in littoral frequency occurrence over time 4.7% in 2006, to 15.6% in 2022 (Figure 3.2-5).

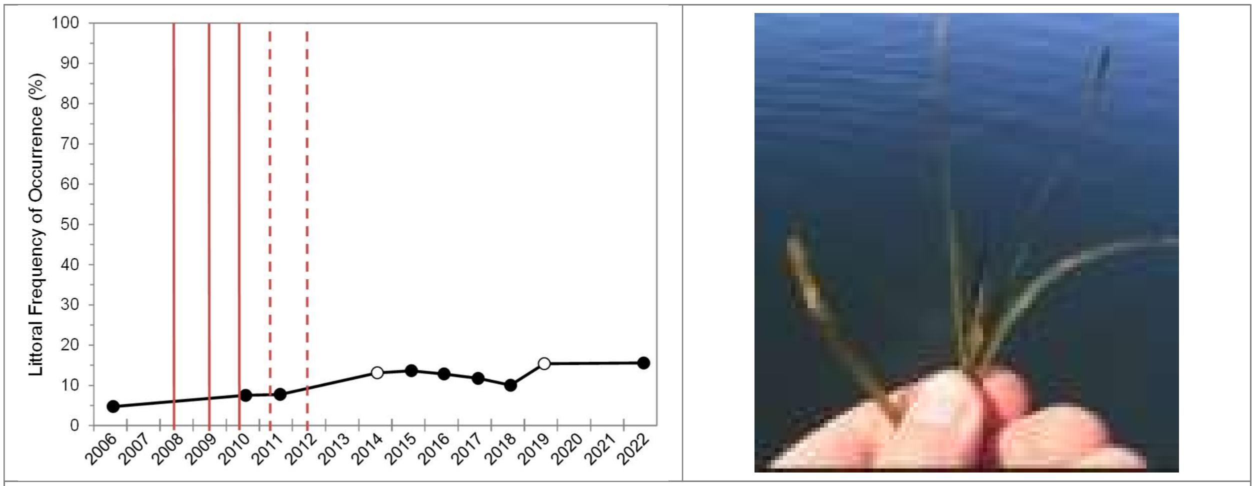


Figure 3.2-5. Flat-stem pondweed in Big Sand Lake from 2006-2022. Open circle indicates a statistically valid change in occurrence from the previous survey (Chi-Square α = 0.05). Red solid lines indicate large-scale 2,4-D treatment and red dashed lines indicate small-scale 2,4-D treatment.

Slender and southern naiad combined were the third most abundant plants in Big Sand Lake in 2022 with a littoral frequency of occurrence of approximately 15% (Figure 3.2-6). Slender and southern naiads are a slender, low-growing species with narrow, short greenish-brown leaves. These submerged plants provide habitat for small aquatic organisms and is a food source of waterfowl. As discussed in the *2015 Big Sand Lake Comprehensive Management Plan,* it was suspected southern naiad was introduced to the lake and exhibited invasive nuisance behavior between 2010 and 2016. Since the 2016 survey, both slender and southern naiad species have declined to its lowest littoral frequency of occurrence since 2016. In 2022, these plants were abundant throughout littoral areas of Big Sand Lake varying in depths between 2 – 18 feet of water.

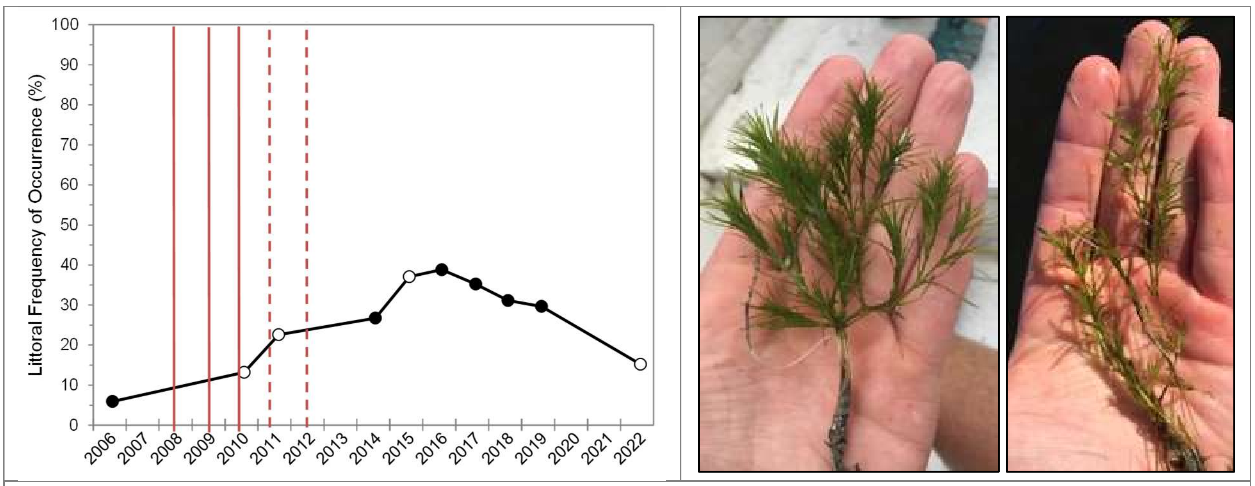


Figure 3.2-6. Slender and southern naiad in Big Sand Lake from 2006-2022. Slender naid (left picture); southern naiad (right picture). Open circle indicates a statistically valid change in occurrence from the previous survey (Chi-Square α = 0.05). Red solid lines indicate large-scale 2,4-D treatment and red dashed lines indicate small-scale 2,4-D treatment.

Common waterweed was the fourth most abundant aquatic plant in Big Sand Lake in 2022 with a littoral frequency of occurrence of approximately 15% (Figure 3.2-7). Common waterweed is an interesting plant in that although it sometimes produces root-like structures that bury themselves into the sediment, it is largely an unrooted plant that can obtain nutrients directly from the water. As a result, this plant's location in a lake can be dependent upon water movement. Similar to slender and southern naiads, common waterweed has slowly declined since surveys began in 2006 (Figure 3.2-7). In 2022, common waterweed was found abundant throughout littoral areas of Big Sand Lake varying in depths between 2 – 16 feet of water.

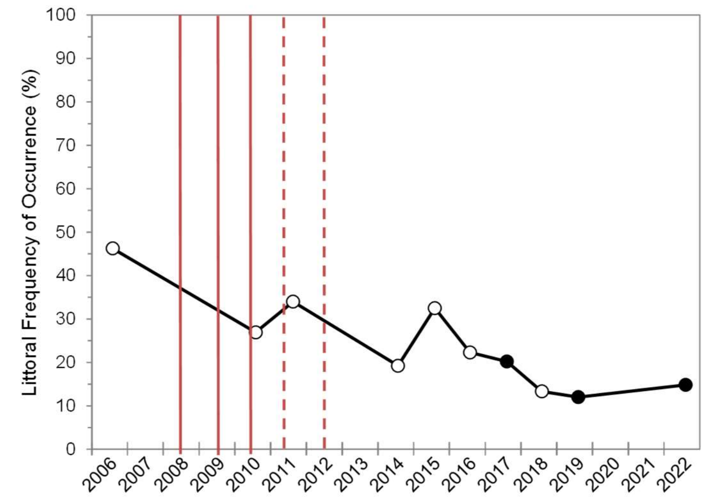


Figure 3.2-7. Common waterweed in Big Sand Lake from 2006-2022. Open circle indicates a statistically valid change in occurrence from the previous survey (Chi-Square α = 0.05). Red solid lines indicate large-scale 2,4-D treatment and red dashed lines indicate small-scale 2,4-D treatment.

One way to visualize the diversity of a lake's plant community is to examine the relative frequency of occurrence of aquatic plant species (Figure 3.2-8). Relative frequency of occurrence is used to evaluate how often each plant species is encountered in relation to all the other species found. Figure 3.2-8 displays the relative frequency of occurrence of aquatic plant species from each of the 10 point-intercept surveys completed on Big Sand Lake. These data indicate that some species such as common waterweed and Eurasian watermilfoil comprised a higher portion of the relative frequency in 2006 as compared to 2022.

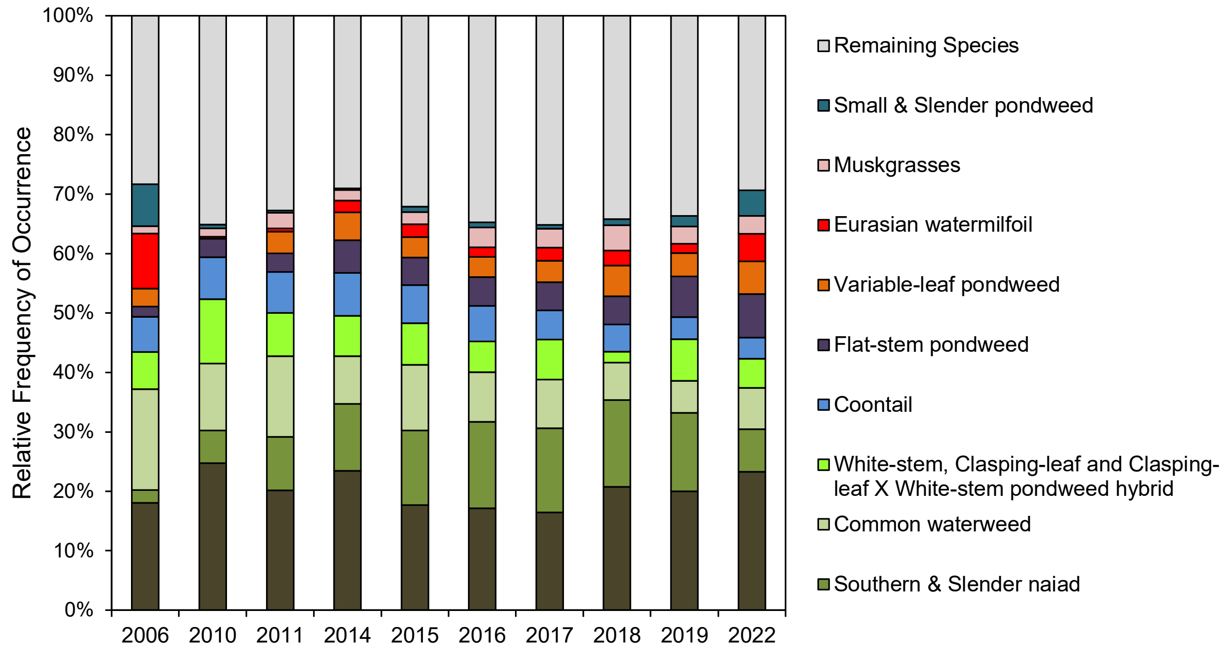


Figure 3.2-8. Relative frequency of occurrence of aquatic vegetation in Big Sand Lake. Created using data from 2006 - 2022 point-intercept surveys.

A comparison of the species richness, average conservatism, and floristic quality from each of the 10 point-intercept surveys in Big Sand Lake is displayed on Figure 3.2-9. In the 2022 point-intercept survey, the total richness was 34 compared to 42 in 2016 and 2017. Average conservatism values have remained stable compared to previous years at 6.8 in 2022. The floristic quality in Big Sand Lake has declined since peaking at 45.2 in 2017 and was measured at 39.7 in 2022. All values in 2022 are well above the ecoregion and state median values.

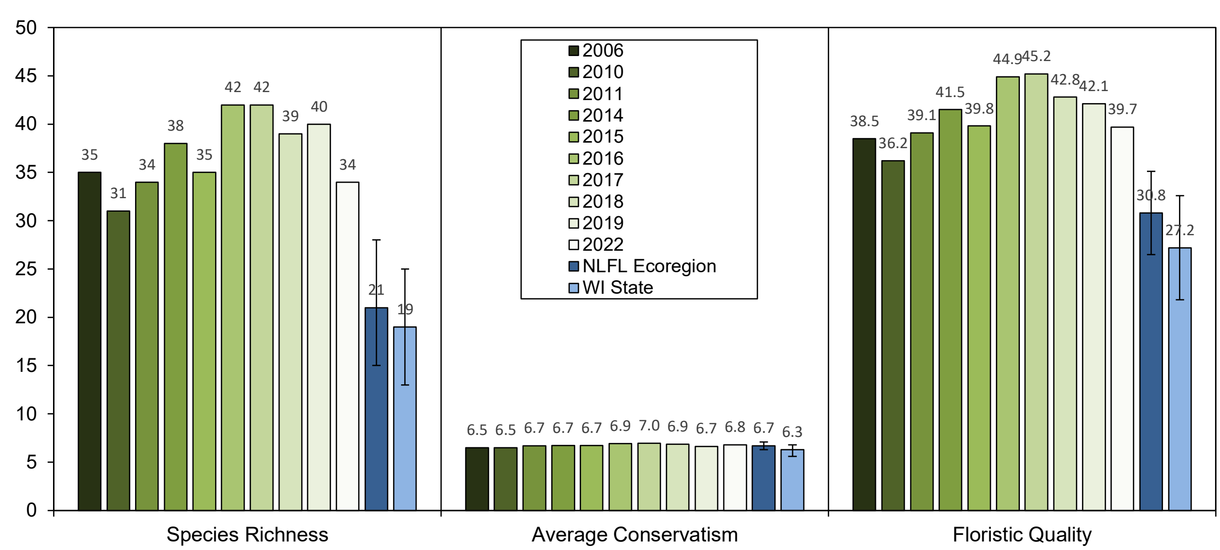


Figure 3.2-9. Big Sand Lake Floristic Quality Index. Analysis follows (Nichols 1999).

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

The aquatic plant community in Big Sand Lake was found to be diverse throughout all previous surveys, with a Simpson's diversity value variation of 0.87 in 2010/2014 and 0.89 in 2011 and 2015-2017 (Figure 3.2-10). Lakes with diverse aquatic plant communities have higher resilience to environmental disturbances and greater resistance to invasion by non-native plants. The aquatic plant community in 2022 was found to have a Simpson's diversity value of 0.88 which is at the ecoregion median. These diversity values indicate the lake continues to be dominated by a variety of plant species. A plant community with a mosaic of species with differing morphological attributes would provide zooplankton, macroinvertebrates, fish and other wildlife with diverse structural habitat and various sources of food.

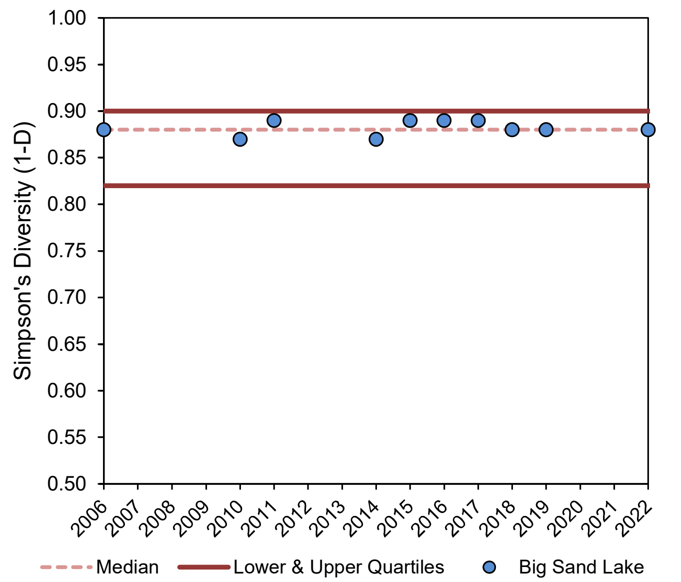


Figure 3.2-10. Big Sand Lake species diversity index. Created using data from Onterra 2011 and 2022 aquatic plant surveys. Ecoregion data provided by WDNR Science Services.

3.3 Non-native Aquatic Plants in Big Sand Lake

All the aquatic plant data discussed so far was collected as part of point-intercept surveys. The subsequent materials will also incorporate data from AIS mapping surveys. Additional explanation about how these two surveys differ is discussed below.

The point-intercept survey provides a standardized way to gain quantitative information about a lake's aquatic plant population through visiting predetermined locations and using a rake sampler to identify all the plants at each location (Photograph 3.3-1). The point-intercept survey can be applied at various scales. Most commonly, the point-intercept survey is applied at the whole-lake scale to provide a lake-wide assessment of the overall plant community. More focused point-intercept surveys, called sub-sample point-intercept surveys, may be conducted over specific areas to monitor an active management strategy such as herbicide treatments or mechanical harvesting. These types of sub-sample point-intercept survey may be used for future herbicide treatment monitoring.

Photograph 3.3-1. Conducting a point-intercept survey. Photo credit Onterra.

While the point-intercept survey is a valuable tool to understand the overall plant population of a lake, it does not offer a full account (census) of where a particular species exists in the lake. During the EWM mapping survey, the entire littoral area of the lake is surveyed through visual observations from the boat (Photograph 3.3-2). Field crews supplemented the visual survey by deploying a submersible camera along with periodically doing rake tows. The EWM population is mapped using sub-meter GPS technology by using either 1) point-based or 2) area-based methodologies. Large colonies >40 feet in diameter are mapped using polygons (areas) and are qualitatively attributed a density rating based upon a five-tiered scale from *highly scattered* to *surface matting*. Point-based techniques were applied to AIS locations that were considered as *small plant colonies* (<40 feet in diameter), *clumps of plants*, or *single or few plants*.

Photograph 3.3-2. EWM mapping survey. Photo credit Onterra.

Overall, each survey has its strengths and weaknesses, which is why both are utilized in different ways as part of this project.

Eurasian watermilfoil (Myriophyllum spicatum)

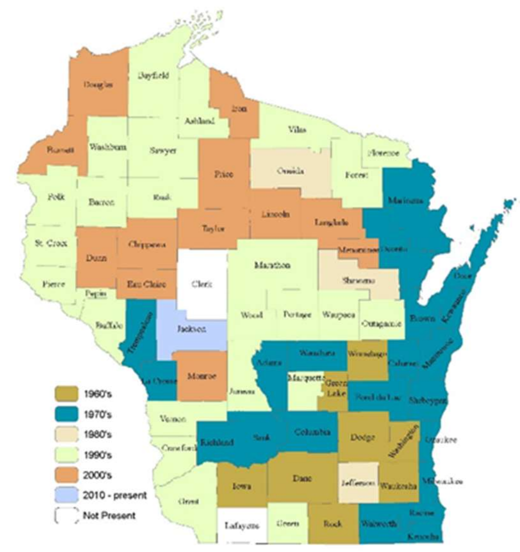


Figure 3.3-1. Spread of EWM within WI counties. WDNR Data 2022 mapped by Onterra.

Eurasian watermilfoil is an invasive species, native to Europe, Asia and North Africa, that has spread to most Wisconsin counties (Figure 3.3-1). Eurasian watermilfoil is unique in that its primary mode of propagation is not by seed. It actually spreads by shoot fragmentation, which has supported its transport between lakes via boats and other equipment. In addition to its propagation method, Eurasian watermilfoil has two other competitive advantages over native aquatic plants, 1) it starts growing very early in the spring when water temperatures are 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 watermilfoil can create dense stands and dominate submergent communities, reducing important natural habitat for fish and other wildlife, and impeding recreational activities such as swimming, fishing, and boating. However, in some lakes, EWM appears to integrate itself within the community without becoming a nuisance or having a measurable impact to the ecological function of the lake.

The non-native plant that is of primary concern in Big Sand Lake is Eurasian watermilfoil. In 201, Onterra sent in invasive watermilfoil samples from the system to Montana State University (Dr. Ryan Thum) for genetic testing using a Rapid Assay Method (ITS). This test indicates whether the sample is northern watermilfoil, EWM, or a hybrid of the two (HWM). A limited number of individual plants have been confirmed as pure-strain EWM.

The concept of heterosis, or hybrid vigor, is important in regards to EWM management in Lost Lake. The root of this concept is that hybrid individuals typically have improved function compared to their pure-strain parents. In general, hybrid watermilfoil (*M. spicatum* x *sibiricum*) typically has thicker stems, is a prolific flowerer, and grows much faster than pure-strain EWM (LaRue et al. 2012). These conditions may likely contribute to this plant being particularly less susceptible to chemical control strategies (Glomski and Nehterland 2010), (Poovey et al. 2007), (Nault et al. 2018). In lakes that contain both EWM and hybrid watermilfoil (HWM), concern exists that the more-easily controlled EWM component of a lake's invasive milfoil population may be controlled by herbicide treatment, but the slightly less-susceptible HWM component will survive, rebound in a short period of time, and then comprise a larger proportion of the invasive milfoil population. A single sample from downstream Long Lake tested positive as being HWM in 2016.

WDNR Long-Term EWM Trends Monitoring Research Project

Starting in 2005, WDNR Science Services began conducting annual point-intercept aquatic plant surveys on a set of lakes to understand how EWM populations vary over time. This was in response to commonly held beliefs of the time that once EWM becomes established in a lake, its population would continue to increase over time.

Like other aquatic plants, EWM populations are dynamic and annual changes in EWM frequency of occurrence have been documented in many lakes, including those that are not being actively managed for EWM control (no herbicide treatment or hand-harvesting program). The data are clearest for unmanaged lakes in the Northern Lakes and Forests Ecoregion (NLF) and the North Central Hardwood Forests Ecoregion (NCHF) (Figure 3.3-2).

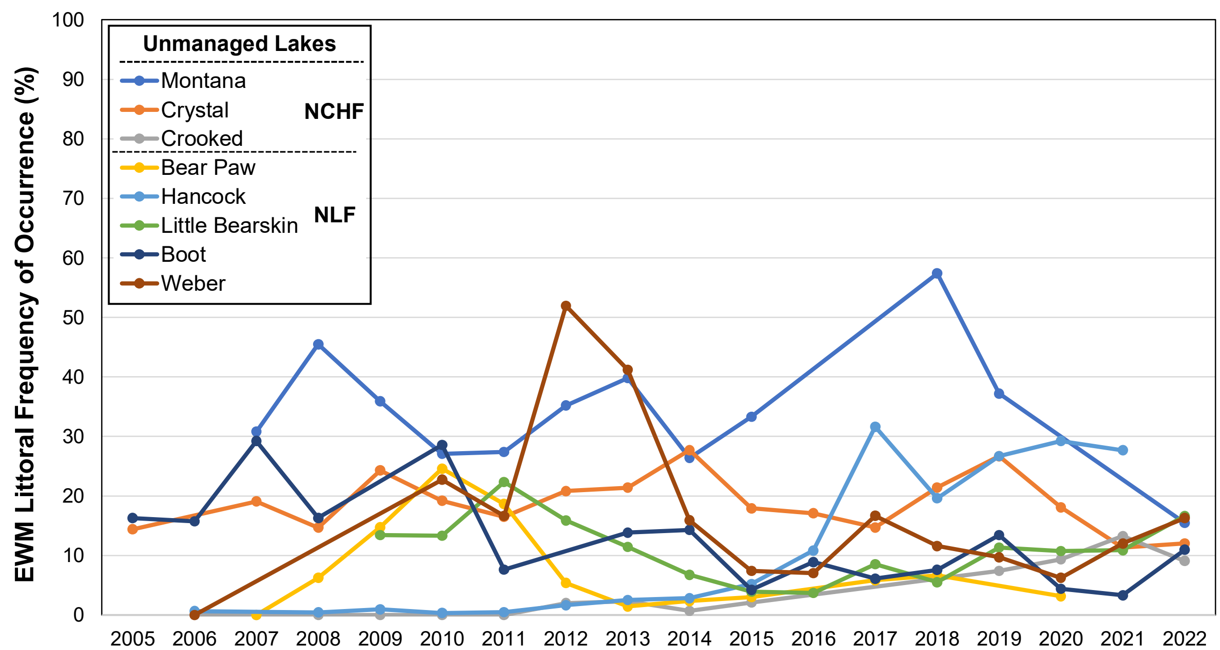


Figure 3.3-2. EWM LFOO in the NLF and NCHF Ecoregions without management. Data provided by and used with permission from WDNR.

The results of the study clearly indicate that EWM populations in unmanaged lakes can fluctuate greatly between years. Following initial infestation, EWM expansion was rapid on some lakes, but overall was variable and unpredictable (Nault 2016). On some lakes, the EWM populations reached a relatively stable equilibrium whereas other lakes had more moderate year-to-year variation. Regional climatic factors also seem to be a driver in EWM populations, as many EWM populations declined in 2015 even though the lakes were at vastly different points in time following initial detection within the lake.

EWM population of Big Sand Lake

Using data from the point-intercept surveys that have been completed over the years, the littoral frequency of occurrence of EWM can be compared over time (Figure 3.3-3). The frequency of occurrence of EWM saw a statistically valid increase in occurrence in 2022 compared to the previous surveys on Big Sand Lake. The 2022 littoral frequency of occurrence (9.8%) is the highest since the first point-intercept survey conducted in 2006 (25.3%).

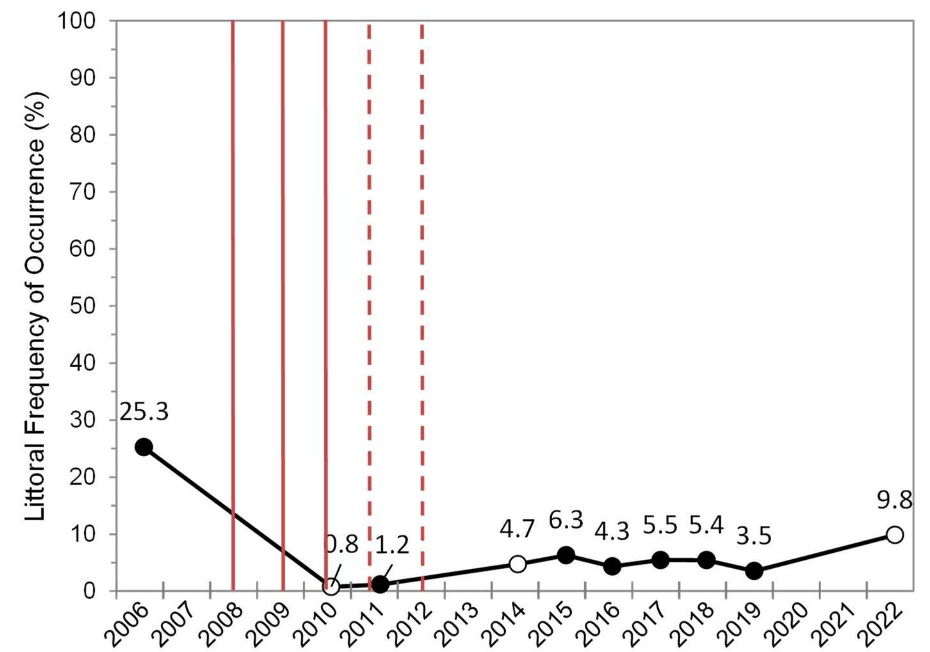


Figure 3.3-3. EWM littoral frequency of occurrence within Big Sand Lake. Data from available point-intercept surveys.

The EWM population in Big Sand Lake was mapped during an August 22, 2022 survey by Onterra ecologists. A total of 64.6 acres of colonized EWM was mapped throughout the lake in 2022 of which 2.8 acres was matting on the surface, 16.3 acres was of a highly dominant density, and another 25.9 acres was described as dominant density (Figure 3.3-4). Lower density colonies include those mapped as highly scattered (4.3 acres) or scattered density (15.2) acres. It is important to note that Figure 3.3-4 displays only those EWM occurrences that were mapped with area-based (polygons) mapping methodologies. Many additional EWM occurrences were mapped with point-based methodologies throughout the system and are described as either single or few plants, clumps of plants, or small plant colonies. Any EWM mapped with point-based methods do not contribute to the acreages displayed on Figure 3.3-4.

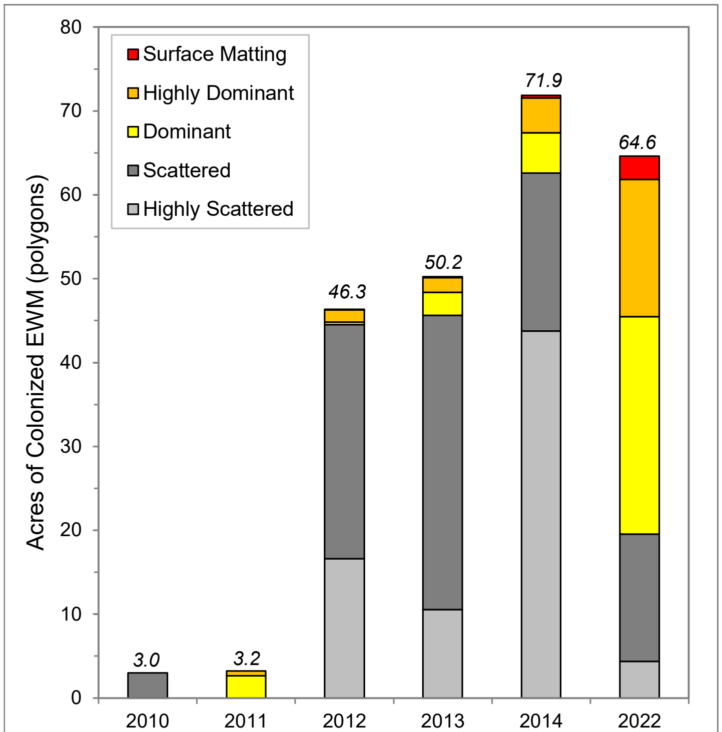


Figure 3.3-4. Big Sand Lake acreage of colonized EWM (polygons) from 2010-2014 and 2022. Created using data from Onterra late-summer EWM mapping surveys.

Most of the EWM population was found to be growing between approximately 2-10 feet of water; however, EWM was recorded out to a depth of 13 feet on the point intercept survey in Big Sand Lake. The results of the mapping survey are displayed on Maps 3-11. Large and dense colonies of EWM were mapped in many areas around off shore areas of Big Sand Lake.

Big Sand Lake Historic EWM Management

The term *Best Management Practice (BMP)* is often used in environmental management fields to represent the management option that is currently supported by that latest science and policy. When used in an action plan, the term can be thought of as a placeholder with anticipation of having an evolving definition over time. During the 2000s, the BMP for managing EWM was through 2,4-D spot treatments (Figure 3.3-5) 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 to cause mortality as the herbicide dissipates out of the spots rapidly.

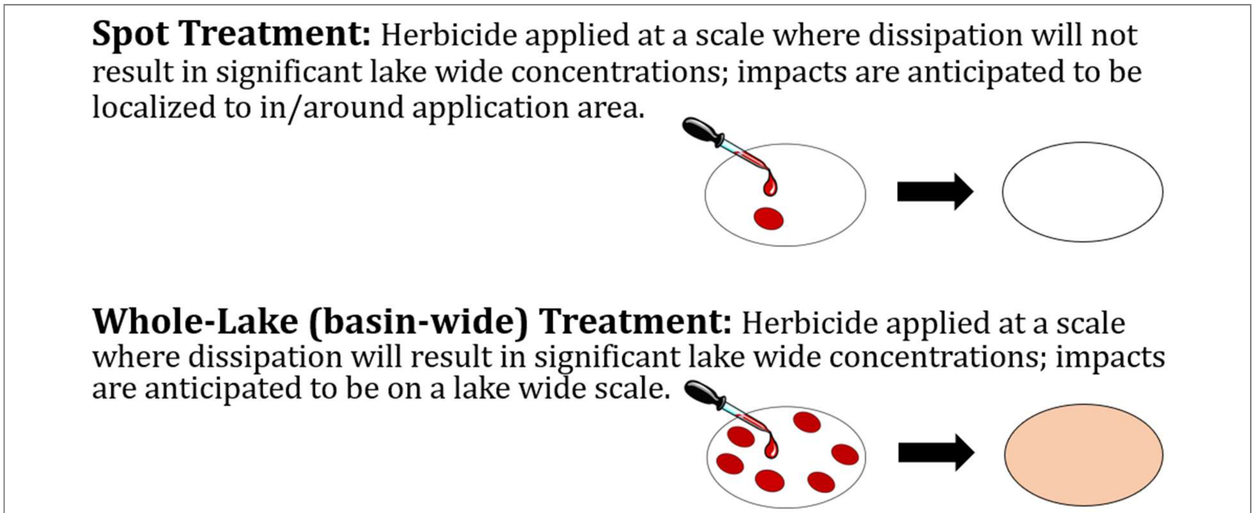


Figure 3.3-5. Ecological definitions of herbicide treatment. Graphics created in conjunction with WDNR.

Whole-lake treatments are a collective of spot-treatments around that lake that are expected to mix into a uniform lake-wide concentration that is sufficient to impact EWM. The 2008, 2009, 2011, and 2012 treatments that occurred on Big Sand Lake were designed using the spot-treatment strategy where specific areas of EWM were targeted for control. However, in 2008, the idea of whole-lake treatments was not yet on the radar of lake managers. As will be discussed, approximately 130 acres of Big Sand Lake were applied with either liquid or granular 2,4-D in 2008, and with the knowledge gained since then, it is believed this treatment functioned as a whole-lake treatment, with herbicide dissipating throughout the entire epilimnion of the water body (Figure 3.3-6).

Over the winter of 2009-2010, Onterra designed a treatment strategy for 2010 where approximately 115 acres were targeted with a 2,4-D at 2.1 ppm acid equivalent (ae), a standard spot-treatment use rate at the time. The application of 2.1 ppm over the treatment areas was hypothesized to only result in 0.073 ppm ae lake-wide. This would be too low to have whole-lake implication and the success of the 2010 treatment on Big Sand Lake was theorized to be reliant on the first few days of higher concentration within the treatment areas. Herbicide monitoring following the 2010 treatment found the initial concentration was closer to 0.205 ppm ae. While all the factors that resulted in this higher herbicide concentration are unknown, it is suspected that a weak thermocline at approximately 12-13 feet may have been present which limited the vertical dissipation of the herbicide only within this layer. Post-treatment surveys found this treatment to be highly effective at reducing EWM, with the occurrence of EWM decreasing by 96% when compared to 2006,

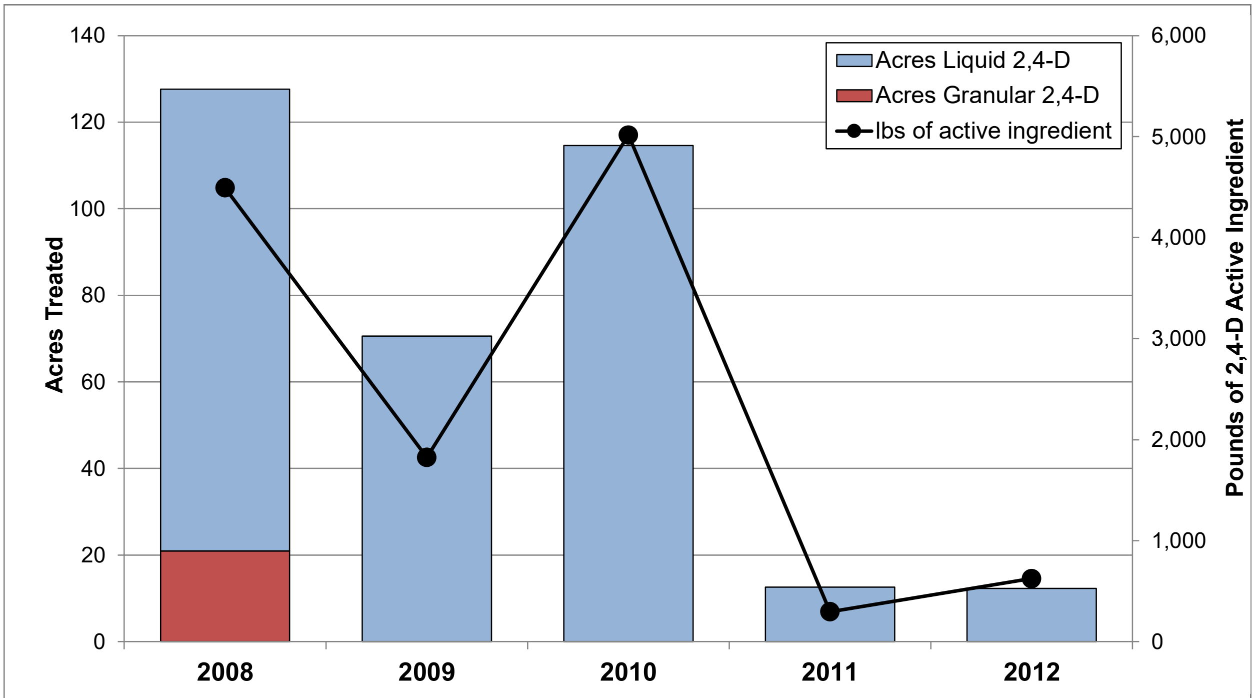


Figure 3.3-6. Historical aquatic plant herbicide management activities on Big Sand Lake.

During the previous *Comprehensive Management Planning* project in 2015-2017, predicting success (EWM control) and native plant impacts from whole-lake treatments was better understood than for spot treatments. Therefore, the BSLPOA developed an Implementation Plan that discouraged spot treatments due to concern for effectiveness. Instead, the BSLPOA would tolerate the EWM condition of the lake until it reached a specified level to consider implementing a whole-lake treatment.

Big Sand Lake Future EWM Management Discussions

During the upcoming Planning Committee meeting, Onterra will outline three broad EWM population management perspectives for consideration, including a generic potential action plan for each (Figure 3.3-7). Onterra has extracted relevant chapters from the WDNR's *APM Strategic Analysis Document* to serve as an objective baseline for the BSLOA to weigh the benefits of the management strategy with the collateral impacts each management action may have on Big Sand Lake ecosystem. These chapters are included as Appendix D. The BSLOA Planning Committee will also review these management perspectives in the context of perceived riparian stakeholder support, which is discussed in the subsequent sub-section.

1. **No Coordinated Active Management (Let Nature Take its Course)**
    - Focus on education of manual removal methods for property owners
    - Lake organization does not oppose contracted manual removal efforts, but does not organize or pay for them
2. **Reduce EWM Population on a lake-wide level (Lake-Wide Population Management)**
    - Would rely on herbicide treatment strategies (risk assessment)
    - Will not eradicate EWM
    - Set triggers (thresholds) of implementation and tolerance
    - May be inconsistent with regulatory framework
3. **Minimize navigation and recreation impediment (Nuisance Control)**
    - Manual removal alone is not able to accomplish this goal, with herbicides or a mechanical harvester being required

Figure 3.3-7. Potential EWM Management Perspectives

Let Nature Take its Course: In some instances, the EWM population of a lake may plateau or reduce without conducting active management, as shown in the WDNR Long-Term EWM Trends Monitoring Research Project on Figure 3.3-2. Some lake groups decide to periodically monitor the EWM population, typically through a semi-annual point-intercept survey, but do not coordinate active management (e.g., hand-harvesting or herbicide treatments). This requires that the riparians tolerate the conditions caused by the EWM, acknowledging that some years may be problematic to recreation, navigation, and aesthetics. Individual riparians may choose to hand-remove the EWM within their recreational footprint, but most often the lake group chooses not to assist financially or with securing permits (only necessary if Diver Assisted Suction Harvest [DASH] is used). In some instances, the lake group may select this management goal, but also set an EWM population threshold or management *trigger* where they would revisit their management strategy if the population reached that level. Said another way, the lake group would let nature take its course up until populations reached a certain lake-wide level or site-specific density threshold. At that time, the lake group would investigate whether active management measures may be justified.

Lake-Wide Population Management: Some believe that there is an intrinsic responsibility to correct for changes in the environment that are caused by humans. For lakes with EWM populations, that may be to manage the EWM population at a reduced level with the perceived goal to allow the system to function as it had prior to EWM establishment. It must also be acknowledged that some lake managers and natural resource regulators question whether that is an achievable goal as management actions have unintended collateral impacts.

In early EWM populations, the entire population may be targeted through hand-harvesting or spot treatments. On more advanced or established populations, this may be accomplished through large-scale control efforts such as water-level drawdowns or whole-lake herbicide treatment strategies. In areas of the state that contain highly established and prevalent EWM populations, lake-wide population management is often considered too aggressive by local WDNR regulators. In these instances, the nuisance conditions are targeted for management and other areas are tolerated or avoided.

Nuisance Control: Some lake groups acknowledge that the most pressing issue with the EWM population on their lake is the reduced recreation, navigation, and aesthetics compared to before EWM became established in their lake. Particularly on lakes with large EWM populations that may be impractical or unpopular to target on a lake-wide basis, the lake group would coordinate (secure permits and financially support the effort) a strategy to improve these cultural ecosystem services.

There has been a change in preferred strategy amongst many lake managers and regulators when it comes to established EWM population in recent years. Instead of chasing the entire EWM population with management, focusing on the areas that are causing the largest impacts can be more economical and cause less ecological stress. The majority of EWM management in Wisconsin would be considered nuisance management, where dense areas that are causing navigation or recreation issues are prioritized for management and dense areas not meeting these criteria being left unmanaged. Mechanical harvesting and herbicide spot treatments are most typically employed to reach nuisance management goals, although hand-harvesting/DASH is sometimes employed to target small footprints.

ProcellaCOR

The active ingredient florpyrauxifen-benzyl is sold exclusively by SePRO under the tradename ProcellaCOR™. ProcellaCOR™ has been the state's most popular spot-treatment strategy for EWM management in recent years. This herbicide has largely been used in spot treatment scenarios, but has recently been adopted as a whole-lake treatment option on a number of Wisconsin lakes. Onterra has monitored over 50 ProcellaCOR™ treatments in Wisconsin since 2019 with data analysis related to herbicide concentration monitoring and native aquatic plant impacts being investigated in the majority of treatments. Analysis of these data have allowed lake managers to better understand the ways in which the herbicide dissipates or mixes within a lake in the hours and days after application. Additionally, aquatic plant monitoring data provides insights as to which native species are typically impacted with ProcellaCOR™ treatments. The UKPOA is encouraged to investigate this chemistry for possible adoption into an herbicide rotation program. The WDNR's fact sheet on this chemistry can be found here: *https://dnr.wi.gov/water/wsSWIMSDocument.ashx?documentSeqNo=332109305*

Lake managers continue to learn how to successfully implement this form of treatment after being registered for use in Wisconsin only a few years ago. ProcellaCOR™ is in a new class of synthetic auxin mimic herbicides (arylpicolinates) with short concentration and exposure time (CET) requirements compared to other systemic herbicides. Uptake rates of ProcellaCOR™ into EWM were two times greater than reported for triclopyr (Haug 2018) (Vassios et al. 2017). The active ingredient of ProcellaCOR™, florpyrauxifen-benzyl, is primarily degraded by photolysis (light exposure), with some microbial degradation. The active ingredient is relatively short-lived in the environment, with half-lives of 4-6 days in aerobic environments and 2 days in anerobic environments (WSDE 2017). Preliminary research suggests that florpyrauxifen-benzyl may have a different or quicker breakdown pattern in waters with high pH and high biomass of aquatic plants. Based upon limited historical data, Upper Kaubashine Lake's mid-summer pH is around 8.5.

The primary breakdown product of florpyrauxifen-benzyl is florpyrauxifen acid. Florpyrauxifen acid has been shown to persist in the lake longer than the active ingredient. This chemical metabolite is reported to have activity as an herbicide on aquatic plants, albeit to a lower degree than the active ingredient. It is unclear at this time the exact role that the acid metabolite may play in contributing to EWM reductions, particularly in areas not located directly within the herbicide application area.

Onterra's experience monitoring ProcellaCOR™ treatments indicates that EWM control has been high with almost no EWM being located during the summer post treatment surveys. Some treated sites have shown EWM population recovery two-years after treatment, while most other sites have demonstrated three years and counting of continued EWM reductions to-date.

Native aquatic plant monitoring data indicates that northern watermilfoil is highly susceptible to ProcellaCOR™ with frequency of occurrences typically reduced to 0% in the year of treatment with little to no sign of recovery during the year after treatment. Other species that have shown a degree of susceptibility to this chemical include water marigold (*Bidens beckii*), coontail, and potentially water stargrass. In many of the treatments that Onterra has monitored, coontail occurrence has been reduced by approximately 50% during the year of treatment, but is not typically reduced to 0%.

Pondweed species appear to be largely unaffected by this herbicide, with some lakes having large increases in species, such as clasping-leaf pondweed, during the years following treatment. Onterra's experience is that adjacent populations of floating-leaf species (i.e. water lilies) may initially shows signs of herbicidal stress such as leaf twisting (epinasty), but typically rebound a few weeks after treatment including in intentional whole-lake treatment scenarios.

Stakeholder Survey Responses to Eurasian Watermilfoil Management

As discussed in Section 2.0, the stakeholder survey asks many questions pertaining to perception of the lake and how it may have changed over the years. Stakeholders were defined as a member of the BSLOA (with property on or off the lake) and riparian property owners who were not a member of the BSLOA. Surveys asking similar questions have been distributed to Big Sand Lake stakeholders in 2014 and 2022. The return rate of the 2022 survey was 28% and the response rate of an earlier 2014 survey was 35%. Because the response rate was below 60% in both instances, it is important to reiterate that the stakeholder survey results need to be understood in the context of the respondents to the survey, not to the overall population sampled.

In the 2022 survey, stakeholders were asked to if they supported or opposed previous EWM management in 2008-2012. Management during this time was whole-lake and spot herbicide treatments and 88% of respondents supported this management technique at the time (Figure 3.3-8).

Queston 29 (2022): How do you feel about the past actions taken to manage EWM between 2008-2012?

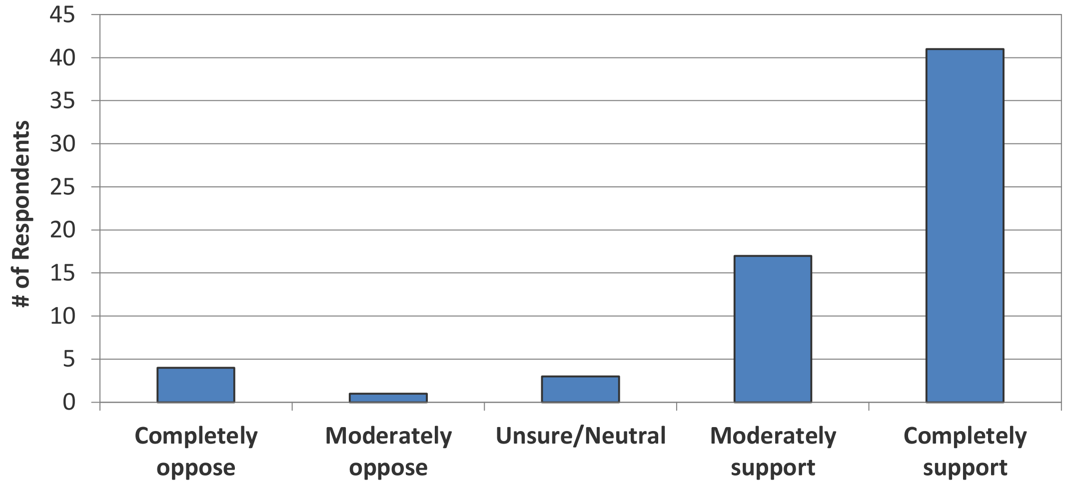


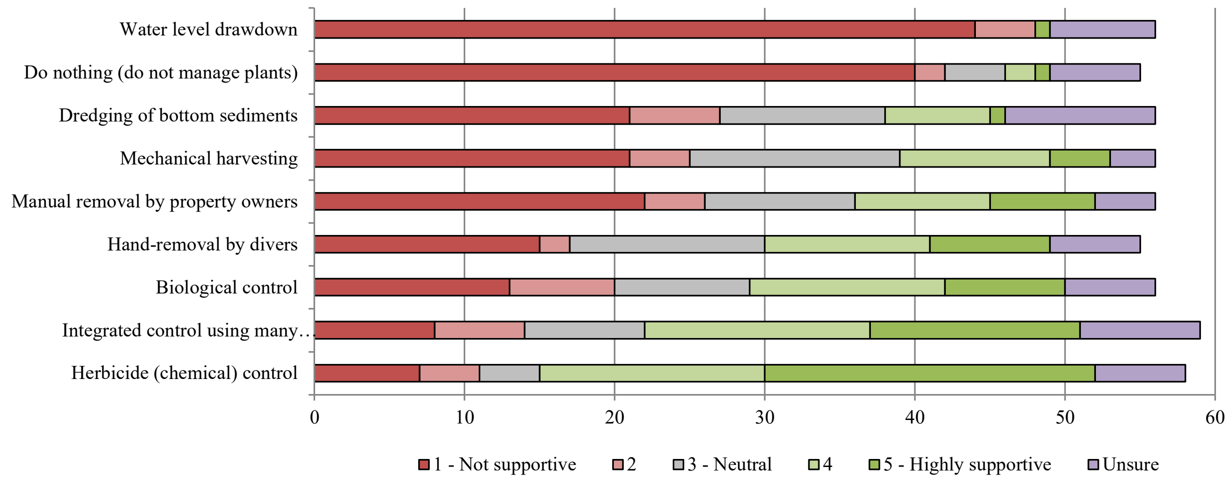
Figure 3.3-8. Select survey responses from the BSLOA 2022 Stakeholder Survey. Additional questions and response charts may be found in Appendix B.

In both 2014 and 2022, riparian property owners and BSLOA members were asked about a number of management techniques for the future management of EWM on Big Sand Lake. It is important to note that these questions were worded a little differently between surveys, and the 2014 survey provided more response options. Figure 3.3-9 highlights the responses for common EWM management techniques. The level of support amongst stakeholder respondents has overall remained the same, with stronger support for herbicide management in both years and a strong opposition to do nothing for both years as well.

Question 24 (2014): Aquatic plants can be professionally managed using many techniques. What is your level of support for the responsible use of the following techniques on Big Sand Lake?

Queston 30 (2022): What is your level of support for the future use of the following EWM management techniques in Big Sand Lake?

2014



2022

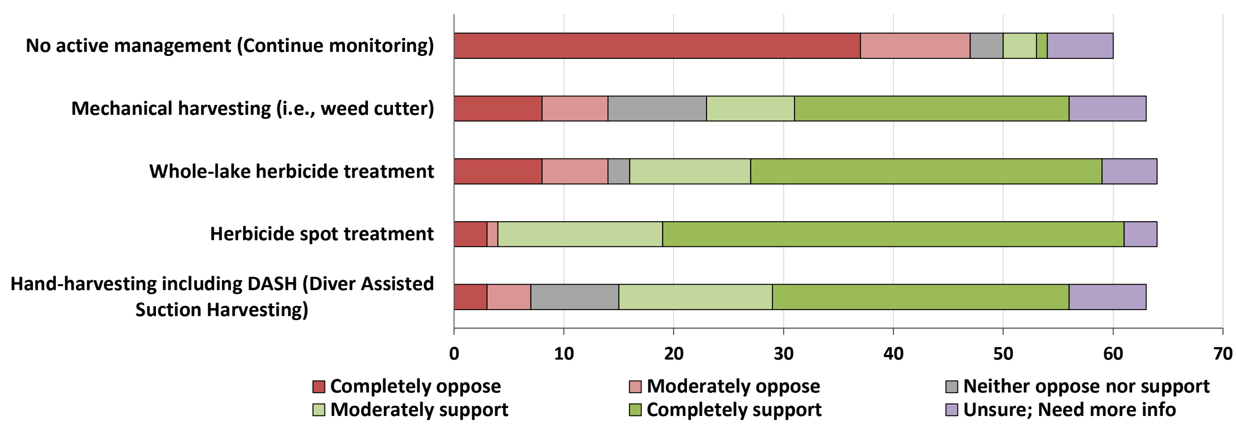


Figure 3.3-9. Select survey responses from the BSLOA Stakeholder Survey. Additional questions and response charts may be found in Appendix B.

Within the 2022 survey, stakeholders were also asked about their level of concern for hand-harvesting including DASH (Diver assisted suction harvesting), whole-lake herbicide treatment, herbicide spot treatment, and mechanical harvesting (Figure 3.3-810). Respondents largely favored herbicide management for the control of EWM but showed many concerns with its use such as impacts to native species (insects, plants, fish, etc.) as well as impacts to human health and other unknown impacts (Figure 3.3-8). The 2022 respondents also expressed concerns for hand-harvesting such as high cost and ineffectiveness of the management technique (Figure 3.3-10). The top concern regarding mechanical harvesting was ineffectiveness of technique strategy. The largest number of concerns overall were indicated under the use of aquatic herbicides.

Queston 31 (2022): What concerns, if any, do you have for the future use of aquatic herbicide treatments, traditional hand harvesting/Diver Assisted Suction Harvesting (DASH), and/or mechanical harvesting to target EWM in Big Sand Lake?

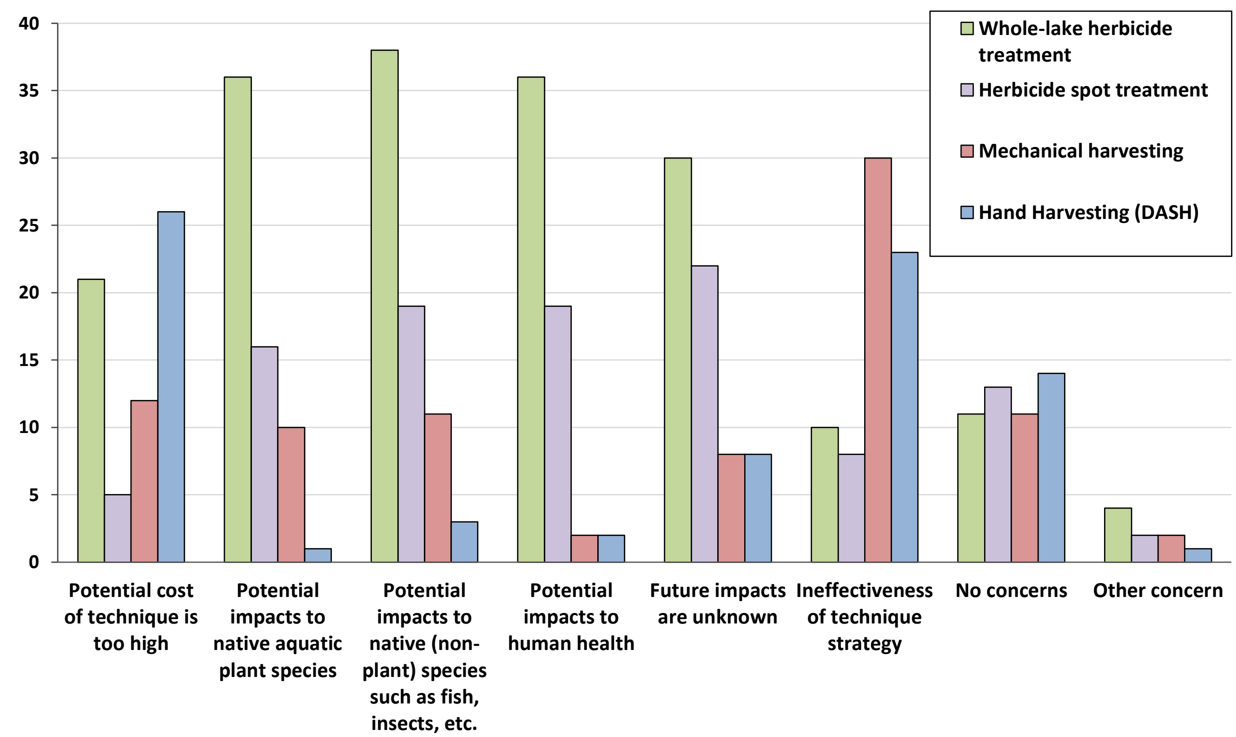


Figure 3.3-10. Select survey responses from BSLPOA Stakeholder Survey. Additional questions and response charts may be found in Appendix B.

Big Sand Lake Prevention & Containment

Big Sand Lake is an extremely popular destination by recreationists and anglers, making the lake vulnerable to new infestations of exotic species. The intent of a watercraft inspection program is not only be to prevent additional invasive species from entering the system through its public access locations, but also to prevent the infestation of other waterways with invasive species that originated in the system. The goal is typically to cover the landings during the busiest times in order to maximize contact with lake users, spreading the word about the negative impacts of AIS on lakes and educating people about how they are the primary vector of its spread.

Table 3.3-1. Watercraft inspections conducted on Big Sand Lake 2012-2022. Data from WDNR, SWIMS.

2012-2022		
Boats Inspected	Monitor Hours	Boats Inspected/ Hrs Spent
5,544	2,383	2.3

The BSLOA utilizes WDNR grant funding to sponsor watercraft inspections through the WDNR's Clean Boats Clean Waters (CBCW) program at the public boat launch. Like many Vilas County Lakes, the CBCW inspection is conducted by the University of Wisconsin – Oshkosh (UW-O). UW-O recruits the student intern boat inspectors, sets up schedules and housing, handles all payroll, and reports all the interns' hours to the WDNR"s online database (SWIMS). UW-O charges a per-hour fee every year to cover all costs with intern payroll and other associated costs. The LLPRD contracts UW-O to conduct roughly 200 hours of inspections each year. The BSLOA's Clean Boats Clean Waters program has been well organized, with numerous watercraft inspections occurring annually (Table 3.3-1 showing history summary). Any given year, an average of 504 boats are inspected at the Big Sand Lake boat launch (Figure 3.3-11).

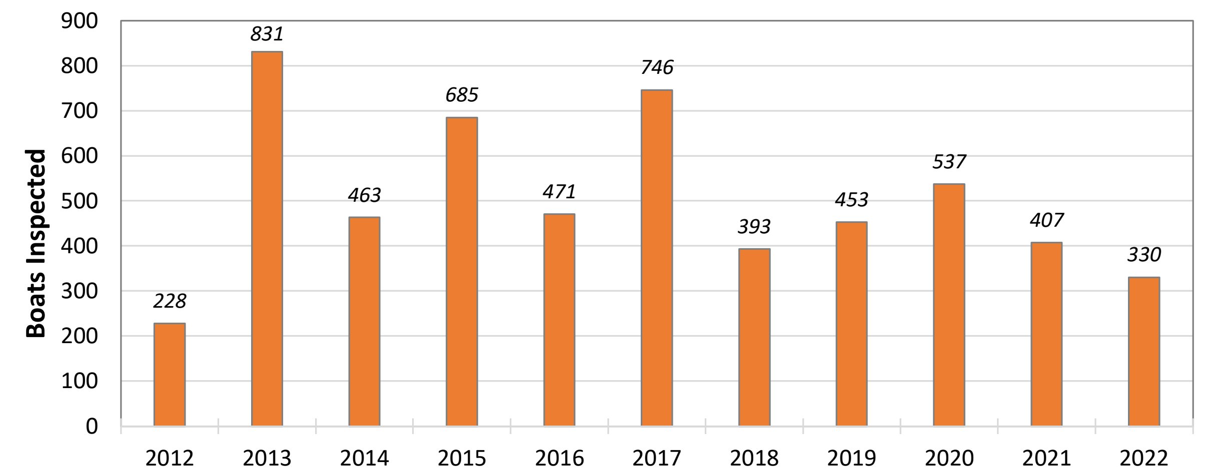


Figure 3.3-11. Watercraft inspections completed on Big Sand Lake boat launch from 2012 to 2022. Data from WDNR, SWIMS.

Based upon modeling by the University of Wisconsin Center for Limnology, Big Sand Lake is one of the state's top 300 AIS Prevention Priority Waterbodies. This means that Big Sand Lake has a high number of boats arriving from lakes that have AIS (receiving) and a high number of boats moving from Big Sand Lake to uninvaded waters (sending). Therefore, the WDNR encourages additional supplemental prevention efforts above just watercraft inspections, offering additional grant funds for these activities for applicable lakes. Supplemental prevention efforts such as decontamination stations (e.g., pressure washer) and remote video surveillance (e.g., I-Lids™) could be funded through this program.

4.0 SUMMARY & CONCLUSIONS

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

1) Collect detailed information regarding invasive plant species within Big Sand Lake, with the primary emphasis being on Eurasian watermilfoil.
2) Collect sociological information from Big Sand Lake riparians & BSLPOA members regarding their use of the lake and their thoughts pertaining to the past and current condition of the lake and its management.
3) Create an updated aquatic-plant management plan for the BSLPOA considering the evolution of BMPs and changes on regulatory support for various techniques since the previous management planning effort.

The three objectives were fulfilled during the project and have led to a good understanding of Big Sand Lake's aquatic plant community, the lake in general, and the folks that care about the lake.

The native aquatic plant community of Big Sand Lake has been monitored fairly consistently since 2006. Whole-lake point-intercept surveys indicate that many aquatic plant species have been fairly stable over this time period, whereas others have been more dynamic. Many of the broad-leaved plant species (dicots), like coontail and native watermilfoils, have been stable over time

Most of the pondweed species, such as variable-leaf, fern-leaf, flat-stem, large-leaf, and white-stem, have been stable over time. The exception is a species called small pondweed. This finer-leaved pondweed can be found growing in shallow or deep depths of Big Sand Lake. Whole-lake 2,4-D treatments in 2008-2010 reduced the population of small pondweeds for a number of years. The latest point-intercept survey in 2022 has shown a marked rebound of this species in Big Sand Lake.

Naiad populations trended up and peaked in 2016, only to steadily decline each year since. Common waterweed has also slowly trended down from 2015 to 2019, but remained relatively stable between 2019 and 2022. Changes in aquatic plant populations are normal aspects of an aquatic ecosystem, just as they are on a terrestrial landscape. Climactic conditions may favor some species over others, underscoring the importance of having a diverse aquatic plant community. As some species decline, others will take advantage of the reduced competition and increase.

Big Sand Lake was one of the first lakes in the Eagle River/Phelps area to contain EWM and at one point, had one of the largest populations of EWM in the area. After a series of aggressive herbicide treatments, the EWM population was greatly reduced. As that population rebounded, the BSLPOA attempted a series of annual 2,4-D spot treatments in an effort to preserve gains made from the earlier large treatments. These treatments were largely ineffective, with EWM rebounding either later that season or by early the following year. The herbicide from these small spot treatments dissipates too quickly for the herbicide to be effective. The BSLPOA pivoted toward a new approach; to tolerate the EWM population until it reaches levels that are more likely impacting the integrity of the ecosystem and interfering with lake user's ability to recreate and enjoy the lake.

As EWM populations have increased, particularly in 2021, the BSLPOA positioned themselves to resume active management of the EWM population. The BSLPOA planning committee has spent hours discussing the benefits and risks of conducting various forms of EWM management, particularly ProcellaCOR™ spot treatments and mechanical harvesting (i.e. weed cutter).

At this time, the BSLPOA does not believe mechanical harvesting is a good fit for Big Sand Lake. The BSLPOA has concerns of increasing the spread of EWM through fragmentation, the high cost of implementation vs the short-term gain of the effort, and the collateral impacts of bi-catch, especially small fish and invertebrates attached to the removed plants. Following this updated planning process, the BSLPOA has expressed slightly more interest in this technique, particularly if herbicide options are not permitted and the association is able to manage blocks of EWM vs narrow navigation lanes

The BSLPOA intends on targeting large and dense EWM colonies that are in high use and traffic areas, specifically those EWM colonies that are impeding navigation and recreation in the lake. With a new tool in the management toolbox, ProcellaCOR™ applications can likely produce effective spot treatments in scenarios other herbicides could not. The BSLPOA would like to pursue a trial treatment in spring 2024, carefully monitoring the results for efficacy and non-target impacts to aquatic plants. If those results were favorable, both in terms of high EWM efficacy and low native plant impacts, expansion of the effort would occur in subsequent years but still only aimed at targeting dense EWM colonies in high use areas. Lower density EWM populations and those that are not of high riparian interest will not be actively managed.

5.0 AQUATIC PLANT IMPLEMENTATION PLAN SECTION

The association's *Comprehensive Management Plan* for Big Sand Lake was finalized and approved by the WDNR in 2017. This *Plan* can be found on the WDNR website located here:

https://dnr.wi.gov/lakes/grants/project.aspx?project=98949968

The Implementation Plan Section of the *2017 Plan* includes the following management goals along with specific management actions developed to help reach those goals.

1. Increase BSLPOA's Capacity to Communicate with Lake Stakeholders and Facilitate Partnerships with Other Management Entities
   - Use education to promote lake protection and enjoyment through stakeholder education
   - Continue BSLPOA's involvement with other entities that have responsibilities in managing (management units) Big Sand Lake
2. Maintain Current Water Quality Conditions
   - Monitor water quality through WDNR Citizens Lake Monitoring Network
3. Control Existing and Prevent Further Aquatic Invasive Species Infestations within Big Sand Lake
   - Manage EWM Population on Big Sand Lake with Herbicide Control Strategies
   - Continue Clean Boats Clean Waters watercraft inspections at Big Sand Lake public access location
4. Enhance the Walleye Fishery on Big Sand Lake
   - Continue to work with WDNR fisheries managers to enhance the walleye population on Big Sand Lake
5. Improve Lake and Fishery Resource by protecting and restoring the shoreland condition of Big Sand Lake
   - Investigate restoring highly developed shoreland areas around Big Sand Lake
   - Protect natural shoreland zones around Big Sand Lake
   - Coordinate with WDNR and private landowners to expand coarse woody habitat in Big Sand Lake

Figure 5.0-1. BSLPOA management goals from 2017 CLMP. From *Big Sand Lake Comprehensive Management Plan* (2017)

The objective of this project was to revisit the aquatic plant-related goals and actions of the *Big Sand Lake Comprehensive Management Plan* and adjust them appropriately based upon current best management practices (BMPs), the lessons learned during the years since the last plan was developed, and the information gathered during the studies completed in 2022 As a result, this project largely updates the Implementation Plan Management Goals #3 of the BSLPOA's *Comprehensive Management Plan* (Figure 5.0-1). The BSLPOA will continue to follow the remaining goals outlined in the 2018 *Comprehensive Management Plan.*

The updated Implementation Plan presented below was created through the collaborative efforts of BSLPOA Board of Directors, planning committee members, and ecologist/planners from Onterra. The Implementation Plan represents the path the BSLPOA 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 Big Sand Lake stakeholders as portrayed by the members of the Board of Directors. The

Implementation Plan is a living document that will be under constant review and adjustment depending on the condition of the lake, availability of funds, level of volunteer involvement, and needs of the stakeholders.

Management Goal 1: Ensure the BSLPOA has a Functioning and Up-to-Date Management Plan

Management Action:	Periodically update lake management plan
Timeframe:	Periodic
Facilitator:	Board of Directors
Description:	The term *Best Management Practice (BMP)* is often used in environmental management fields to represent the management option that is currently supported by that latest science and policy. When used in an action plan, the term can be thought of as a placeholder with anticipation of having an evolving definition over time. ***Comprehensive Management Plan*** The WDNR recommends *Comprehensive Lake Management Plans (CLMP)* generally get updated every 10 years. Implementation projects require a completion data of "no more than 10 years prior to the year in which an implementation grant application is submitted." This allows a review of the available data from the lake, as well as to consider changing BMPs for water quality, watershed, and shoreland management. Although the BSLPOA is not pursuing grant for implementing water quality or watershed management activities, they will roughly adhere to the 10-year recommended interval of investigations into these parameters to ensure the health of Big Sand Lake. The BSLPOA will consider updating aspects of their CLMP in roughly 2028. ***Aquatic Plant Management Plan*** BMPs for aquatic plant management change rapidly, as new information about effectiveness, non-target impacts, and risk assessment emerges. To be eligible to apply for grants that provide cost share for AIS control and monitoring, "a current plan has a completion date of no more than 5 years prior to submittal of the recommendation for approval. The department may determine that a longer lifespan is appropriate for a given management plan if the applicant can demonstrate it has been actively implemented and updated during its lifespan. However, a [whole-lake] point-intercept survey of the aquatic plant community conducted within 5 years of the year an applicant applies for a grant is required." It is important to work with the regional WDNR Lakes Biologist to understand what is required at this time, as it is more subjective in comparison to the requirements of a *CLMP* as it relates to the specific management actions being considered. As discussed above, the BSLPOA will consider commencing a comprehensive planning effort in 2028 which would have an *Aquatic Plant Management Plan* component built into the overall plan.

	Annual Control & Monitoring Plan It is important to note that the management plan provides a framework to guide the management action, but does not include the specific control plan for a given year. If the action being considered does not fall within the framework of the overall management plan, it is likely that an updated plan is needed regardless of its relative age. If the BSLPOA intends to conduct active management towards aquatic plants, a proceeding written control and monitoring plan, consistent with the *Management Plan*, would be produced typically January-March prior to its implementation. The control plan is useful for WDNR and other regulators when considering approval of the action, as well as to convey the control plan to BSLPOA members for their understanding.
Action Steps:	
	See description above.

Management Action:	Conduct periodic riparian stakeholder surveys
Timeframe:	Periodic: every 5 years, corresponding with management plan updates
Facilitator:	Board of Directors
Description:	Formal riparian stakeholder user surveys have been performed by the association in 2014 and 2022. Approximately once every 5-6 years, potentially at the time of a Plan update or prior to a large management effort, an updated stakeholder survey would be distributed to the BSLPOA members and Big Sand Lake riparians. Periodically conducting an anonymous stakeholder survey would gather comments and opinions from lake stakeholders to gain important information regarding their understanding of the lake and thoughts on how it should be managed. This information would be critical to the development of a realistic plan by supplying an indication of the needs of the stakeholders and their perspective on the management of the lake. The stakeholder survey could partially replicate the design and administration methodology conducted during 2022, with modified or additional questions as appropriate. The survey would again need to receive approval from a WDNR Research Social Scientist, particularly if WDNR grant funds are used to offset the cost of the effort.

Management Goal 2: Monitor Aquatic Vegetation on Big Sand Lake

Management Action:	Periodically monitor the Eurasian watermilfoil population
Timeframe:	Periodic: full system at least once every 3 years, focused survey as needed; Timing: during latter part of growing season
Facilitator:	Board of Directors
Description:	As the name implies, the Late-Season EWM Mapping Survey is a professionally contracted survey completed towards the end of the growing season when the plant is at its anticipated peak growth stage, allowing for a true assessment of the amount of this exotic within the lake. For the Big Sand Lake, this survey would likely take place in late-August to the end of September, dependent on the growing conditions of the particular year. This survey would include a complete or focused meander survey of the system's littoral zone by professional ecologists and mapping using GPS technology (sub-meter accuracy is preferred). In 2010-2014, late-season EWM mapping surveys occurred on the Big Sand Lake using a consistent density rating system, largely as a monitoring aspect of the herbicide management program occurring at that time. Following less-than-successful 2,4-Dspot treatments, the BSLPOA pivoted in 2015 towards allowing the EWM population to be unmanaged until a level determined by the point-intercept survey (15%) triggered the consideration of a whole-lake 2,4-D treatment. As a new herbicide with spot treatment potential emerged (i.e. ProcellaCOR™), the BSLPOA conducted a late-season EWM mapping survey in 2022 to help develop and direct potential management actions in future years. Because of the large size of Big Sand Lake and the corresponding costs of conducting lake-wide mapping surveys, the BSLPOA intends to periodically conduct full late-season EWM mapping assessments of Big Sand Lake, likely at 3-year intervals. Between intervals, especially with the goal of directing management, the BSLPOA would consider conducting focused late-season EWM mapping surveys.

Management Action:	Coordinate periodic point-intercept aquatic plant surveys
Timeframe:	Periodic: at least once every 5 years, Timing: during July-August
Facilitator:	Board of Directors
Description:	The point-intercept aquatic plant monitoring methodology as described Wisconsin Department of Natural Resources Bureau of Science Services, PUB-SS-1068 2010 (Hauxwell et al. 2010) has been used on the Big Sand Lake 2006, 2010, 2011, 2014-2019, and 2022. As discussed in the previous management action, the BSLPOA conducted point-intercept surveys in 2014-2019 to see if the EWM population exceeded the 15% littoral threshold for considering another whole-lake 2,4-D treatment. The 2022 point-intercept survey provided

	updated information for this planning effort, with the EWM population being just under 10%. This survey provides quantitative population estimates for all aquatic plant species within the lake and is designed to allow comparisons with past surveys in Big Sand Lake as well as to other waterbodies throughout the state. At each point-intercept location within the *littoral zone,* information regarding the depth, substrate type (soft sediment, sand, or rock), and the plant species sampled along with their relative abundance (rake fullness) on the sampling rake is recorded. The BSLPOA will ensure the point-intercept surveys is conducted at least once every five years to maintain eligibility for WDNR AIS Control Grants, or potentially more frequently if prompted by a specific rationale.

Management Goal 3: Prevent Establishment of New Aquatic Invasive Species

Management Action:	Monitor Big Sand Lake entry points for aquatic invasive species
Timeframe:	Continuation of current effort
Facilitator:	Board of Directors – Joe Robinson
Description:	The intent of this program is not only be to prevent additional invasive species from entering the Big Sand Lake through its public access locations, but also to prevent the infestation of other waterways with invasive species that originated in Big Sand Lake. The BSLOA utilizes WDNR grant funding to sponsor watercraft inspections through the WDNR's Clean Boats Clean Waters (CBCW) program at the public boat launch. Like many Vilas County Lakes, the CBCW inspection is conducted by the University of Wisconsin – Oshkosh (UW-O). UW-O recruits the student intern boat inspectors, sets up schedules and housing, handles all payroll, and reports all the interns' hours to the WDNR"s online database (SWIMS). UW-O charges a per-hour fee every year to cover all costs with intern payroll and other associated costs. The LLPRD contracts UW-O to conduct roughly 200 hours of inspections each year. The BSLPOA will continue to seek cost share assistance through the WDNR's streamline Clean Boats Clean Waters (CBCW) program: *https://dnr.wi.gov/Aid/documents/SurfaceWater/CleanBoatsCleanWatersFactSheet.pdf*

Management Action:	Investigate supplemental aquatic invasive species prevention and containment methods.
Timeframe:	Ongoing
Facilitator:	Board of Directors
Description:	The Big Sand Lake is an extremely popular regional destination, especially from anglers, making the lake vulnerable to new infestations of exotic species. In addition to its watercraft inspection program, the BSLPOA would like to investigate supplemental prevention steps it can take to project Big Sand Lake from new aquatic invasive species. Volunteerism for this task has waned in recent years. The BSLPOA finds the opportunity of including supplemental prevention efforts appealing, particularly as is would relieve pressure of their exhausted volunteer base while continuing to provide protective actions for the lake. Supplemental prevention efforts such as decontamination stations (e.g., pressure washer), water-less cleaning stations (e.g. CD3 systems), and remote video surveillance (e.g., I-Lids™) have been taken on a few waterbodies throughout the state. The BSLPOA will research these options and determine applicability for Big Sand Lake.

Management Goal 4: Actively manage EWM to keep the population from negatively affecting recreation, navigation, and aesthetics of Big Sand Lake.

Management Action:	Conduct Integrated Pest Management Program towards EWM
Timeframe:	Ongoing
Facilitator:	AIS Committee
Description:	The objective of this action will be to minimize the periodic nuisance conditions that EWM causes on Big Sand Lake by restoring navigation, recreation, and aesthetics. The BSLPOA understands the importance of their native aquatic plant community, and would strive to understand any collateral native plant impacts surrounding any management actions it takes. In order to reach this objective, the BSLPOA has developed a multi-pronged approach as part of this Integrated Pest Management (IPM) Program. Each management technique described below is discussed in regards to site selection and corresponding monitoring strategy. The following bullets are a general guide to the IPM Program, with more specific information contained below. **General IPM Program** • ***Herbicide Treatment*** It would be the BSLPOA's preference to gain multi-year control of problematic areas through the use of spatially-targeted herbicide spot treatments.

- ***Mechanical Harvesting*** The BSLPOA has historically had reservations about contracting mechanical harvesting efforts on the lake, due to concerns of increasing the spread of EWM through fragmentation, the high cost of implementation vs the short-term gain of the effort, and the collateral impacts of bi-catch, especially small fish. Following this updated planning process, the BSLPOA has expressed slightly more interest in this technique, particularly if herbicide options are not permitted and the association is able to manage blocks of EWM vs narrow navigation lanes
- ***Manual Removal*** The current size and scale of the EWM population is beyond what is applicable for manual removal efforts. The BSLPOA is not averse to applying manual removal efforts, but struggles to find applicability at this time.

IPM Program Details

1. ***Herbicide Treatment*** The BSLPOA believes that dense areas of EWM that are impacting navigation, recreation, and aesthetics of the system can have these qualities restored for multiple years by conducting ProcellaCOR™ spot treatments using BMPs for implementation. Specifically, the BSLPOA would consider targeting EWM colonies of *dominant, highly dominant*, or *surface matting* that are in high use areas or in front of high riparian frontage. At the current time, broad treatment areas of 5 acres or greater would be considered BMPs for ProcellaCOR™ spot treatment in uncontained, offshore situations. While the BSLPOA largely conducted risk assessment efforts during this project on ProcellaCOR™, they would be open to considering future herbicides shown to be effective in short concentration and exposure time scenarios.

   If the BSLPOA decides to pursue future herbicide management towards EWM, the following set of bullet points would occur:

   - Early consultation with WDNR would occur. The BSLPOA strives to work with the WDNR early in their planning stages to be alerted of any concerns that may be resolved or mitigated.
   - The preceding annual *EWM Control & Monitoring Report* would outline the precise control and monitoring strategy.
   - EWM efficacy would occur by comparing annual late-summer EWM mapping surveys. Specifically, these would be conducted during the *year prior to treatment*, *year of treatment*, and *year after treatment*.
   - If grant funds are being used, large areas are being targeted, and/or new-to-the-region herbicide strategies are being considered, the WDNR may request a quantitative evaluation monitoring plan be constructed that is consistent with the *Draft Aquatic Plant Treatment Evaluation Protocol (October 1, 2016):*
     https://dnrx.wisconsin.gov/swims/downloadDocument.do?id=158140137

     This generally consists of collecting quantitative point-intercept data the *late-summer prior to treatment* (pre) and the summers following the treatment (*year of treatment and year after treatment*) within the application area. While the logistical challenges of collecting data during the *year prior to treatment* have resulted in some managers opting for pretreatment data collection during the late-spring of the *year of treatment*, the WDNR strongly prefers following the timing outlined in the protocol referenced above as pre and post data collected at the same time of the year is the most comparable.

- Herbicide concentration monitoring may also occur surrounding the treatment if grant funds are being used or the BSLPOA believes important information would be gained from the effort.
- An herbicide applicator firm would be selected in late-winter and a permit application would be applied to the WDNR as early in the calendar year as possible, allowing interested parties sufficient time to review the control plan outlined within the annual report as well as review the permit application.
- Unless specified otherwise by the manufacturer of the herbicide, an early-season use-pattern would likely occur. This would consist of the herbicide treatment occurring towards the beginning of the growing season (typically in early- to mid-June), active growth tissue is confirmed on the target plants, and is after sensitive fish species of concern, like walleye, have outgrown their most-sensitive life stage to herbicide exposure (first 14 days after hatching). A focused pretreatment survey would take place approximately a week or so prior to treatment. This site visit would evaluate the growth stage of the EWM (and native plants) as well as to confirm the proposed treatment area extents and water depths. This information would be used to finalize the permit, potentially with adjustments and dictate approximate ideal treatment timing. Additional aspects of the treatment may also be investigated, depending on the use pattern being considered, such as the role of stratification.

2. ***Mechanical Harvesting*** The BSLPOA would consider contracting a mechanical harvesting firm to restore navigation and recreational access in areas of high density EWM (*dominant* or greater densities), and not able to be part of an herbicide treatment in a given year. If herbicide treatments become unsupported by the BSLPOA or WDNR, this tool may play a greater role in EWM management on Big Sand Lake. The BSLPOA would first start with a trial effort before adopting on a wide-scale basis.

   Mechanical harvesting operations would have the following guidelines:

   - Harvesting locations are limited to areas on the permit map.
   - The harvester would not be permitted in waters less than 3-feet to minimize sediment disturbance.
   - Cut no more than half the water depth.
   - Harvesting operations shall not disturb spawning or nesting fish. Harvesting shall be done in a manner to minimize accidental capture of

	fish. An attempt would be made to return all gamefish, panfish, amphibians, and turtles to the water immediately. • Submerged plants, specifically EWM, would be the target for this permit. Removal of emergent (e.g. bulrushes) and floating-leaf (e.g. water lilies) species needs to be avoided because of their ecological value and niche occupation. • A reasonable effort must be made to capture all aquatic plant fragments during operation. The WDNR may consider allowing "floaters" to be picked up even if they occur outside the areas delineated on the permit map. • Reports summarizing harvesting activities shall be given to the WDNR by November 30, each harvesting season. The report shall include a map showing the areas harvested, the total amount of plant material removed from each site, and amount of effort (time) spent at each site. The report shall also include a summary of the composition and quantity of plants removed by species (rough percent of each species from each operation). *Short-Term EWM Control Plan:* Following the management plan outlined above, the BSLOPOA aims to conduct a trial ProcellaCOR™ treatment(s) in 2024 and seek AIS Control Grant funding to offset the costs of the management and monitoring. Pretreatment point-intercept sub-sample data would be collected during the summer of 2023 in preparation of this project. The project will be monitored as outlined above, including post treatment sub-sample point-intercept surveys, volunteer-based herbicide concentration monitoring, and comparative EWM mapping surveys. This grant program has an application deadline of November 15 of each year, with intent materials being due 60 days prior (September 15).

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