DRAFT

Sturgeon Bay

Door County, Wisconsin

Aquatic Plant Management Plan

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Official First Draft of Agency and Public Review

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Funded by: City of Sturgeon Bay.

Acknowledgements

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

Sturgeon Bay Planning Committee

Organization

DRAFT

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1.0 INTRODUCTION

Sturgeon Bay spans approximately 4,945 acres within Green Bay, extending across the Door County Peninsula. The bay is artificially linked to Lake Michigan through the Sturgeon Bay Ship Canal (Figure 1.0-1 and Map 1). The bay hosts shipyards, numerous marinas, and sees substantial annual activity from both commercial and recreational watercraft.

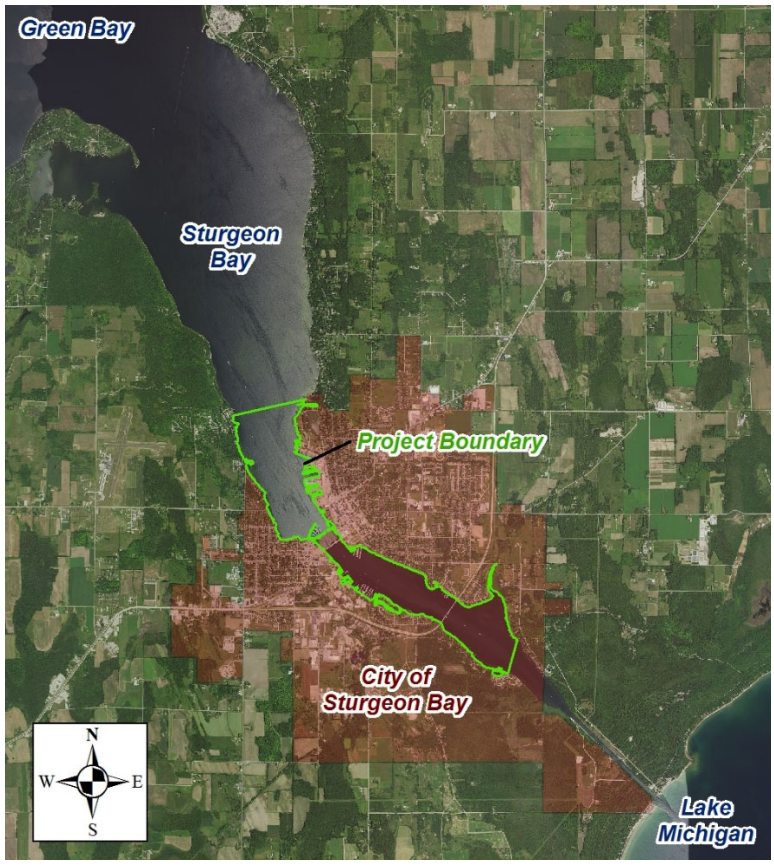


Figure 1.0-1. Project boundaries within Sturgeon Bay, Door County, Wisconsin.

Since the mid-1980s, the City of Sturgeon Bay, in conjunction with private individuals, have collaborated to address excessive aquatic plant growth in the bay. They employ a dual strategy, utilizing mechanical harvesting and herbicide applications to maintain unimpeded navigation. The city presently owns and manages three mechanical harvesters dedicated to preserving open water spaces for navigation. Furthermore, herbicides are used to control excessive plant growth in and around the docking slips at marinas.

The first aquatic plant management plan for Sturgeon Bay was finished in 2003 and called for the combined use of mechanical harvesting and herbicide treatments to control nuisance native and non-native species. The City of Sturgeon Bay implemented that plan for over a decade and a half with only minor updates occurring over that span.

In 2016, the City of Sturgeon Bay enlisted the services of Onterra, LLC to collaborate on the update of the 2003 aquatic plant management plan. The project was structured to span two years, with aquatic plant studies conducted in 2016 and a stakeholder participation component scheduled for completion in 2017. The baseline aquatic plant surveys were completed in 2016; however, during the 2017 planning process, the decision was made to extend the project to include additional surveys and staff training. The updated aquatic plant management plan was accepted by the Wisconsin Department of Natural Resources (WDNR) in December 2019. The 2019 update included expanded harvest areas and refined herbicide treatment areas. Further, the herbicide treatment areas were divided into 22 sites to accommodate accurate dosing based upon water volume, allow for better determinations of the areas that needed treatment and those that did not, and to facilitate oversight by city staff.

The WDNR requires aquatic plant management plans to be updated every five years on systems with consistent active management occurring. With Onterra's assistance, the City of Sturgeon Bay began the process of updating their plan with the same plant surveys conducted in 2016 as well as a stakeholder survey occurring during the 2023 field season. The surveys completed in 2023 included a point-intercept survey, community mapping survey, as well as a stakeholder participation survey. The methodology of these surveys replicated what was completed during the 2016 management plan with the exception of the stakeholder participation survey. This report presents the outcomes of Onterra's aquatic plant studies in 2023, and a comprehensive final report containing the updated aquatic plant management plan.

2.0 STAKEHOLDER PARTICIPATION

Stakeholder participation is an important part of any management planning exercise. 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 waterbody, their impact on the system, 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 waterbody to be, how they use it, and how they would like to be involved in managing it. All of this information is communicated through multiple meetings that involve the management entity as a whole and 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 Project Meetings

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

Kick-off Meeting

During the April 26, 2023, City of Sturgeon Bay Joint Parks and Recreation Committee/Board Meeting, Tim Hoyman, an aquatic ecologist with Onterra, LLC made a presentation describing the project's process and objectives. Tim's presentation included descriptions of the surveys that would be completed on Sturgeon Bay and Bradley Lake during the summer of 2023, an introduction to the public participation components, and an explanation of the planning process that would be used to develop the final aquatic plant management plan. Tim also described the bay user poll that had been developed for the project and displayed a QR code leading to the online survey.

Following the presentation, Tim and Ryan Lando, City of Sturgeon Bay Harbor Master/Aquatic Water Weeds Manager, left the council chambers and went to the community room to answer questions and accept comments. No one entered the room and after 25 minutes, Tim and Ryan closed the public comment session.

Project Wrap-up Meeting

To be completed in final draft.

Committee Level Meetings

This will include a description of the make-up of the committee and objectives of the committee meetings.

Planning Committee Meeting I

The first planning meeting was held on March 5, 2024 in the Community Room at the City of Sturgeon Bay City Hall. A 5-member ad hock committee of the Parks and Recreation Committee met with Tim Hoyman, Aquatic Ecologist, Onterra, LLC for over two hours. During the meeting, Tim presented the results of the surveys completed on Sturgeon Bay during 2023, as well as several comparisons with data collected by Onterra in 2016. One public comment was also recorded. Potential changes and updates to the 2019 Sturgeon Bay Aquatic Plant Management Plan were discussed in detail and include minor changes to the mechanical harvesting description, adding harvesting near Bullhead Point and in the Lama Wamah Channel, and the addition of a second herbicide application later in the growing season on an as-needed basis in the designated treatment areas. Minutes were taken during the meeting's discussions and during the public comment period.

Planning Committee Meeting II

The ad hoc committee once again met with Tim on March 21, 2024 to review the changes and updates to the 2019 Sturgeon Bay Aquatic Plant Management Plan. All changes made in the draft 2024 plan document were accepted by the committee. Two public comments were recorded during the meeting. The meeting closed with a presentation of the results from the 2024 aquatic plant surveys that Onterra completed on Bradley Lake. Minutes were taken during the meeting's discussions and during the public comment period.

2.2 Management Plan Review and Adoption Process

To be completed in final draft.

2.3 Riparian Stakeholder Survey

As a part of this project, a stakeholder survey was offered to anyone who utilizes Sturgeon Bay. Created through collaboration between Onterra staff and the City of Sturgeon Bay, the survey was customized to meet the needs of the diverse users within the system. During July 2023, the online survey was posted through Survey Monkey for stakeholders to answer online using a computer, tablet, or phone. City staff displayed posters advertising the survey at the Sawyer and Sunset boat launches. A QR code was displayed on the poster for easy access to the survey (Appendix X). Additionally, paper surveys were mailed to owners and management teams of marina or other businesses located on Sturgeon Bay. City staff also created a mailing list of 217 individual property owners to which an announcement was mailed. The survey was also announced on the city's Facebook page three times over the summer (Appendix X). In total, 404 survey responses were recorded over the open period of July 24, 2023 to September 25, 2023. 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 this report 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 Sturgeon Bay. Forty percent of respondents indicated access Sturgeon Bay via a public or private boat landing, 31% use a private slip or pier on owned or leased property, 28% use a seasonal or transient marina, business slip, or city-maintained mooring, and 2% own or manage a marina or business that offers seasonal or transient slips (Figure 2.3-1). Each of these groups were asked a unique set of questions which can be viewed in full in Appendix X.

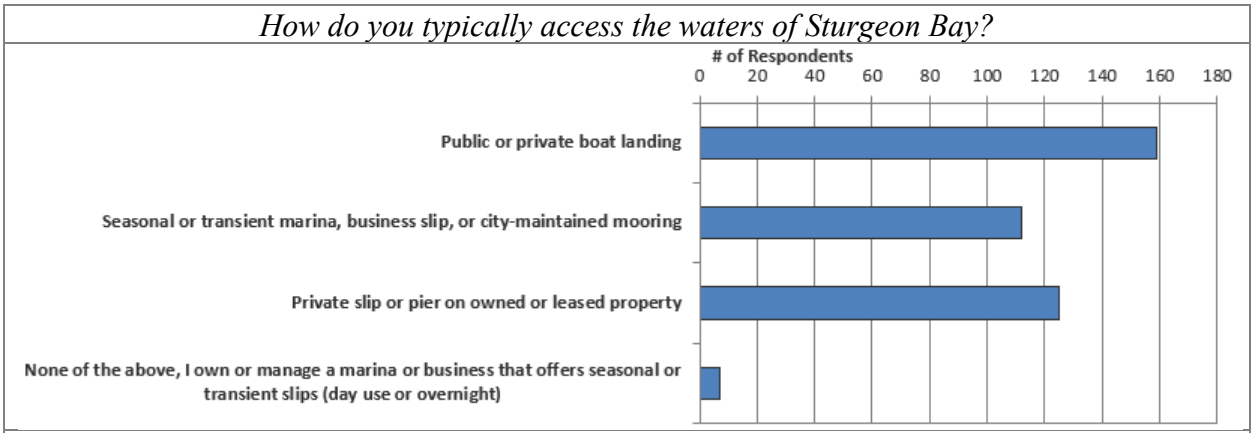


Figure 2.3-1. Select survey responses from the Sturgeon Bay Stakeholder Survey. Additional questions and response charts may be found in Appendix X.

After the survey was completed, an error was identified in the questionnaire that impacted the data collected for one question. Seasonal and transient marina users, were asked *Where do you have issues with aquatic plants while using your watercraft on Sturgeon Bay* (Appendix B). Various locations were provided (*marinas, businesses, navigation channel,* etc.) and stakeholders were asked to indicate if they *Always* experience issues with aquatic plants or *Usually, Sometimes, Rarely, or Never* in these areas. The survey questionnaire did not allow respondents to select more than one *Always* or *Never* option, thereby limiting their ability to choose all areas where they consistently experience aquatic plant conditions, either in abundance or absence. Ultimately this question was not used in the report but can still provide some information as to where these stakeholders experience the most and least issues with aquatic plants.

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.

Three aquatic plant surveys were completed by Onterra ecologists in Sturgeon Bay in 2023: two whole-lake aquatic plant point-intercept surveys (June 20-23 and August 25) and an emergent and floating-leaf aquatic plant community mapping survey (August). The same three surveys were completed in 2016. All aquatic plant species located during the 2023 surveys which were not recorded in the 2016 surveys, were collected, pressed, and sent to the University of Wisconsin-Stevens Point herbarium for confirmation of correct identification. The aquatic plant point-intercept survey method as developed by the Wisconsin Department of Natural Resources (WDNR) Bureau of Science Services (Hauxwell, et al., 2010) was used in Sturgeon Bay in 2016 and 2023. Based upon guidance from the WDNR, sampling locations were spaced 73 meters apart resulting in a total of 772 sampling locations (Map 1).

A pole-mounted rake was used to collect 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.

A key component of any aquatic plant community assessment is the delineation of the emergent and floating-leaf aquatic plant communities. because these plants are often underrepresented during the point-intercept survey. This survey creates a snapshot of these important communities within each waterbody as they existed during the survey and is valuable in the development of the management plan and in comparisons with future surveys. Examples of emergent plants include cattails, rushes, sedges, grasses, bur-reeds, and arrowheads, while examples of floating-leaf species include the water lilies. This survey was completed on July 27, 2023 on Sturgeon Bay.

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 in Sturgeon Bay during 2016 and 2023. 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. 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*. 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 Sturgeon Bay to be compared to other lakes within the region and state.

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

Sturgeon Bay falls within the Southeastern Wisconsin Till Plains (SWTP) *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 77 lakes throughout Wisconsin by Onterra and WDNR ecologists.

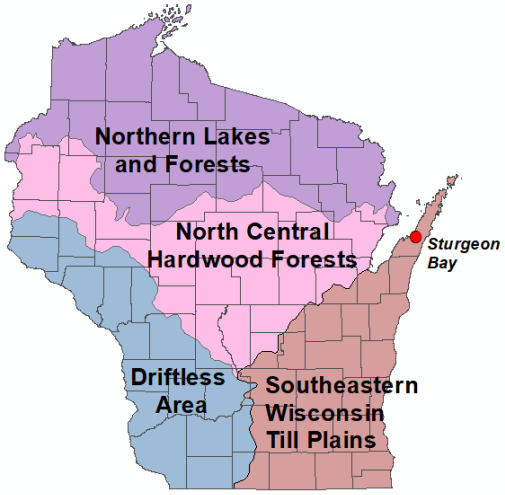


Figure 3.1-1. Location of Sturgeon Bay within the ecoregions of Wisconsin. After (Nichols, 1999)

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, Davis, Jordan, & Forester, 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 Sturgeon Bay is compared to data collected by Onterra and the WDNR Science Services on 77 lakes within the SWTP Ecoregion and on 392 lakes throughout Wisconsin.

3.2 Native Aquatic Plants

During all aquatic plant surveys completed by Onterra ecologists in Sturgeon Bay in 2016 and 2023, a total of 44 aquatic plant species were located. 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 indicates the species was physically encountered on the rake during the point-intercept survey. Aquatic plant species encountered on the rake and recorded during the 2016 and 2023 surveys on Sturgeon Bay yielded 17 and 20 native aquatic plant species, respectively. Examples of other species that were observed but were not sampled on the survey rake are referred to as incidentals and are listed with an "I" on Table 3.2-1. Often these species are found growing on the shoreline or in shallow areas of the lake. Incidental aquatic plant species were recorded during the 2016 and 2023 surveys on Sturgeon Bay which yielded 12 and 11 aquatic plant species, respectively. Five of these species are considered to be non-native, invasive species: Eurasian watermilfoil, curly-leaf pondweed, starry stonewort, purple loosestrife, and giant reed (Table 3.2-1). Due to their importance, these invasive species will be discussed in further detail in the subsequent *Non-Native Aquatic Plants Section*.

Two point-intercept surveys were completed as a part of this project to develop a full picture of the aquatic plant community of the bay during the growing season. Typically, a single point-intercept survey is completed during July or August because most native and non-native plants are at their peak biomass. Curly-leaf pondweed, a non-native plant often found in abundance in Sturgeon Bay, starts to grow very early in the spring, reaches its peak-biomass in June, and then dies back in early July. An early point-intercept survey was completed in June of 2016 and 2023 to record curly-leaf pondweed abundance during its peak growth. Other species encountered during the June surveys were also recorded; however, these data will only be used for observational differences and will not be statistically analyzed because these species were not at peak growth due to survey timing.

Table 3.2-1. Aquatic plant species located in all 2016 and 2023 point-intercept surveys.

Growth Form	Scientific Name	Common Name	Status in Wisconsin	Coefficient of Conservatism	2016	2023
Emergent	*Bolboschoenus fluviatilis*	River bulrush	Native	5	I	I
	Iris spp. (sterile)	Iris spp. (sterile)	Unknown (Sterile)	N/A		I
	Juncus arcticus	Arctic rush	Native	N/A	I	
	Juncus effusus	Soft rush	Native	4		I
	Lythrum salicaria	Purple loosestrife	Non-Native - Invasive	N/A	I	I
	Phragmites australis subsp. australis	Giant reed	Non-Native - Invasive	N/A	I	I
	Schoenoplectus acutus	Hardstem bulrush	Native	5	I	
	Schoenoplectus pungens	Three-square rush	Native	5		I
	Schoenoplectus tabernaemontani	Softstem bulrush	Native	4		I
	Sparganium eurycarpum	Common bur-reed	Native	5	I	
	Typha latifolia	Broad-leaved cattail	Native	1		I
FL	*Nuphar variegata*	Spatterdock	Native	6		I
	Nymphaea odorata	White water lily	Native	6	I	I
	Persicaria amphibia	Water smartweed	Native	5	I	
FL/E	*Sparganium emersum var. acaule*	Short-stemmed bur-reed	Native	8	I	
Submergent	*Ceratophyllum demersum*	Coontail	Native	3	X	X
	Chara spp.	Muskgrasses	Native	7	X	X
	Elodea canadensis	Common waterweed	Native	3	X	X
	Elodea nuttallii	Slender waterweed	Native	7		X
	Heteranthera dubia	Water stargrass	Native	6	X	X
	Myriophyllum sibiricum	Northern watermilfoil	Native	7	I	
	Myriophyllum spicatum	Eurasian watermilfoil	Non-Native - Invasive	N/A	X	X
	Najas flexilis	Slender naiad	Native	6	X	X
	Najas guadalupensis	Southern naiad	Native	7	X	X
	Nitella spp.	Stoneworts	Native	7		X
	Nitellopsis obtusa	Starry stonewort	Non-Native - Invasive	N/A	X	X
	Potamogeton berchtoldii	Slender pondweed	Native	7		X
	Potamogeton berchtoldii & pusillus	Slender & small pondweeds	Native	7		X
	Potamogeton crispus	Curly-leaf pondweed	Non-Native - Invasive	N/A	X	X
	Potamogeton foliosus	Leafy pondweed	Native	6		X
	Potamogeton friesii	Fries' pondweed	Native	8	X	X
	Potamogeton gramineus	Variable-leaf pondweed	Native	7	X	X
	Potamogeton praelongus	White-stem pondweed	Native	8	X	X
	Potamogeton pusillus	Small pondweed	Native	7		X
	Potamogeton richardsonii	Clasping-leaf pondweed	Native	5	X	X
	Potamogeton zosteriformis	Flat-stem pondweed	Native	6	X	X
	Ranunculus aquatilis	White water crowfoot	Native	8	X	X
	Sagittaria sp. (rosette)	Arrowhead sp. (rosette)	Native	N/A		I
	Stuckenia pectinata	Sago pondweed	Native	3	X	X
	Utricularia vulgaris	Common bladderwort	Native	7	X	
	Vallisneria americana	Wild celery	Native	6	X	X
	Zannichellia palustris	Horned pondweed	Native	7	X	
S/E	*Sagittaria cuneata*	Arum-leaved arrowhead	Native	7	X	X
FF	*Spirodela polyrhiza*	Greater duckweed	Native	5	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

Lakes in Wisconsin vary in their morphology, water chemistry, substrate composition, and recreational use, and all of these factors influence aquatic plant community composition. Like terrestrial plants, different aquatic plant species are adapted to grow in certain substrate types; some species are only found growing in soft substrates, others only in sandy/rocky areas, and some can be found growing in either. The combination of both soft sediments and areas of harder substrates creates different habitat types for aquatic plants, and generally leads to a higher number

of aquatic plant species within the lake. During the August 2023, whole-lake point-intercept survey, information regarding substrate type was collected at locations sampled with a pole-mounted rake (less than 15 feet). These data indicate that the majority (55%) of the point-intercept locations less than 15 feet deep contained soft sediments, 39% contained sand, and 6% were found to contain rock. Areas with harder substrates were primarily located near shore or northcentral of the study area.

During the August 2023 point-intercept survey, aquatic plants were found growing to a maximum depth of 19 feet, a testament to the high water clarity within the bay. Of the 586 point-intercept locations that fell within the maximum depth of plant growth (the littoral zone), approximately 58% contained aquatic vegetation. Approximately 58% of the point-intercept sampling locations that contained vegetation were within 2 to 12 feet of water. Figure 3.2-1 displays the distribution of aquatic vegetation in Sturgeon Bay as determined from the August 2016 and 2023 point-intercept surveys. In 2023, approximately 27% of the littoral point-intercept locations contained aquatic vegetation with a rake fullness rating of 1, 10% contained a rake fullness rating of 2, and 21% contained a rake fullness rating of 3. The higher proportion of sampling locations with a total rake fullness rating of 2 and 3 indicates that where vegetation is present, it is relatively dense. Between the 2016 and 2023 surveys, biomass has largely remained consistent, showing a slight decrease in density and distribution, especially noticeable in TRF ratings 1 and 2.

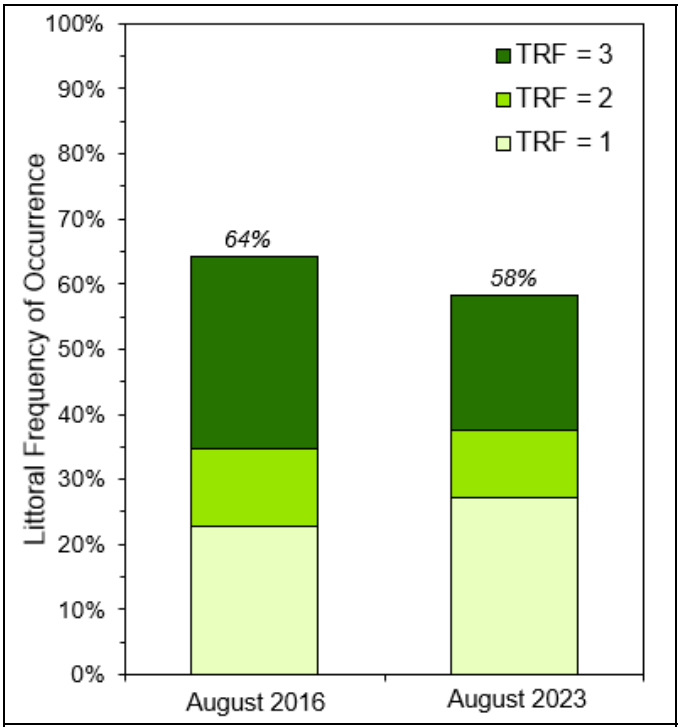


Figure 3.2-1. Distribution of vegetation and total rake fullness ratings (TRF).

Of the 34 aquatic plant species located during the 2023 surveys, 23 species were physically sampled on the rake during the August point-intercept survey and the remaining 11 species were located *incidentally*. An incidentally-located species means the plant was not directly sampled on the rake during the point-intercept survey but was observed in the lake by Onterra ecologists and was recorded/collected. The majority of incidentally-located plants typically include emergent species growing along the lake's margins and submersed species that are relatively rare within the lake's plant community. Of the 23 species encountered on the rake in August 2023, wild celery, common waterweed, muskgrasses, and coontail were the four most frequently encountered (Figure 3.2-2).

With a littoral frequency of occurrence of approximately 26.6%, wild celery was the most frequently encountered aquatic plant in Sturgeon Bay in 2023 (Figure 3.2-2). The long, tapering leaves of wild celery provide excellent structural habitat for numerous aquatic organisms while its extensive root systems stabilize bottom sediments. Additionally, the leaves, fruit, tubers, and

winter buds are food sources for numerous species of waterfowl and other wildlife. Wild celery was found growing between 3 and 18 feet of water.

Common waterweed, the second most frequently encountered aquatic plant, with a littoral frequency of occurrence of approximately 16.7%, is found throughout lakes in Wisconsin and North America. It prefers growing in soft sediments and can often grow in dense beds that mat on the surface. In Sturgeon Bay, it was encountered between 2 and 19 feet of water. Its dense foliage provides valuable aquatic habitat while its ability to derive nutrients directly from the water improves water quality.

Muskgrasses, the third most frequently encountered aquatic plants in Sturgeon Bay had a littoral frequency of occurrence of approximately 15.9% (Figure 3.2-2) and were abundant primarily between 2 and 10 feet of water. A genus of macroalgae, muskgrasses are not true vascular plants, and are often abundant in waterbodies that are clear with higher alkalinity. While several species of muskgrasses occur in Wisconsin, the muskgrasses in Sturgeon Bay were not identified to the species level. Often growing in dense beds, muskgrasses stabilize bottom sediments, provide excellent structural habitat for aquatic organisms, and are sources of food for fish, waterfowl, and other wildlife (Borman, 2007).

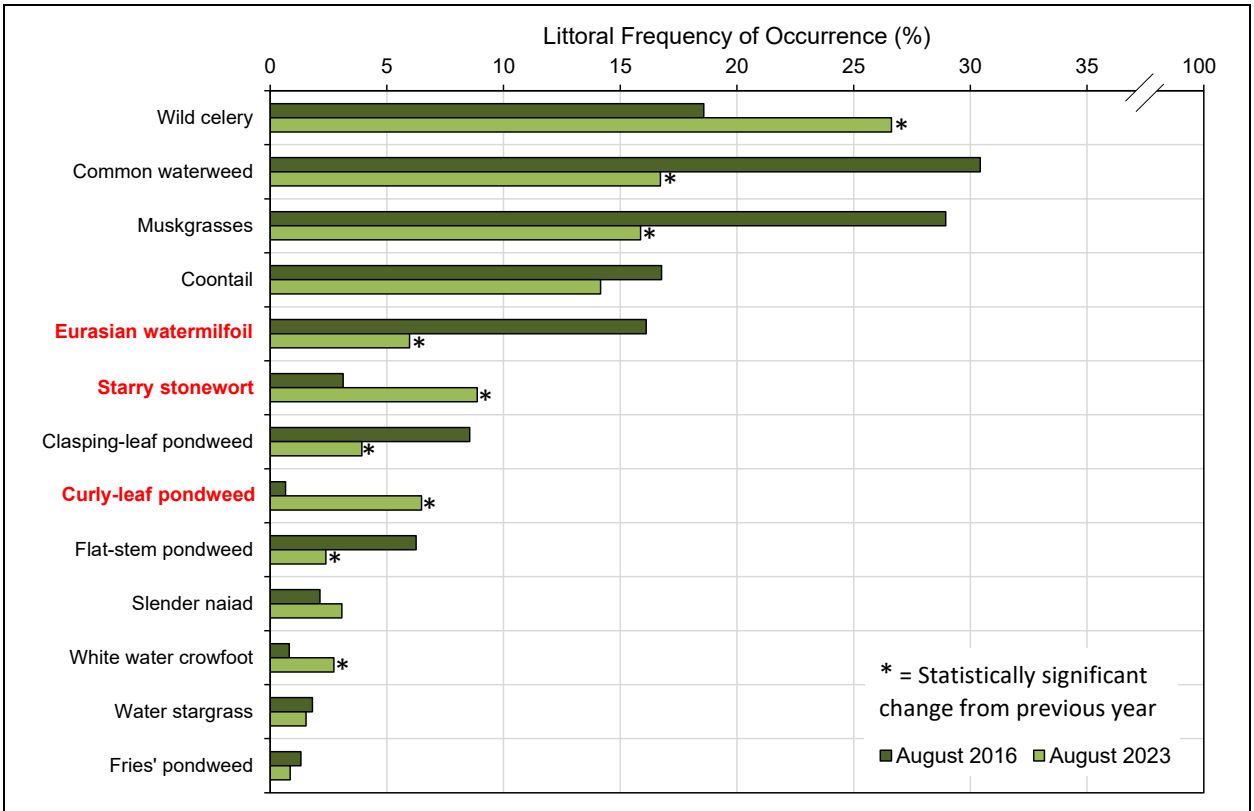


Figure 3.2-2. Littoral frequency of occurrence of aquatic plant species in August 2016 and 2023. Exotic species indicated with red.

Coontail, arguably the most abundant aquatic plant in Wisconsin, was the fourth-most frequently encountered aquatic plant in Sturgeon Bay with a littoral frequency of occurrence of approximately 14.2% (Figure 3.2-2). Unlike most of the submersed plants found in Wisconsin, coontail does not produce true roots and is often found growing entangled amongst other aquatic plants. Because it

lacks true roots, coontail derives most of its nutrients directly from the water (Gross, Erhard, & Ivanyi, 2003). This ability in combination with a tolerance for low-light conditions allows coontail to become more abundant in waterbodies with higher nutrients. While coontail as the capacity to form dense beds which mat on the surface and can hinder recreation, the majority of the coontail located in Sturgeon Bay was found growing in 2 to 16 feet of water.

The four most abundant species in the bay were made up of the same species during the 2016 and 2023 surveys; however, two of those species, common waterweed and muskgrasses saw statistically significant decreases in abundance in the 2023 survey (Figure 3.2-2). Comparison of the frequencies of occurrence of curly-leaf pondweed during the June 2016 and 2023 surveys, which sample curly-leaf pondweed at its peak growth, indicate a 41.7% increase in 2023 over 2016. Curly-leaf pondweed starts growing early in the season and by the time the June 2023 survey was completed, many areas of the bay had dense stands in them (see discussion in next section). While it is impossible to determine the extent of the impact the 2023 expanded population had on other plants, like common waterweed and muskgrasses, it is likely there was some impact. Further the factors that allowed curly-leaf pondweed to expand may have caused the most dominant plants in the bay to retract in 2023. One such factor may have been water levels. NOAA's Great Lakes Environmental Research Laboratory tracks Great Lakes water levels and displays start-of-the-month levels with long-term averages. (NOAA, 2024). During August 2016, Lake Michigan water levels were 580.18' above mean sea-level, while in August 2023, the levels were about a half of foot lower at 579.72. That is not much of a difference, but in July 2020, the lake's level was nearly 2.5 higher than in 2016 and 2023, which also plays a role in the abundancies of aquatic plants.

As discussed in the primer section, the calculations used to create the Floristic Quality Index (FQI) for a lake's aquatic plant community are based on the aquatic plant species that were encountered on the rake during the point-intercept survey and does not include incidentally located species. The native species encountered on the rake during the August 2023 point-intercept survey and their conservatism values were used to calculate the FQI of Sturgeon Bay's aquatic plant community.

Figure 3.2-3 compares the FQI components of Sturgeon Bay to median values of lakes within the Southeastern Wisconsin Till Plains (SWTP) ecoregion and to lakes throughout Wisconsin. The number of native aquatic plant species sampled on the rake was 20, which exceeds the median value for lakes in the SWTP ecoregion (15) but is slightly higher than the median for lakes state-wide (19). This is similar to the species richness value in 2016 of 17. Likewise, Sturgeon Bay's average conservatism value of 6.2 exceeds the SWTP ecoregion median value of 5.4 but falls slightly below the state median value of 6.3. Sturgeon Bay's average conservatism value indicates that when compared to other lakes within the ecoregion, it contains a larger number of aquatic plant species with higher coefficients of conservatism. The 2016 conservatism value was 6.1 which also is above the average value for lakes in the SWTP ecoregion.

Using Sturgeon Bay's native species richness and average conservatism, its FQI was calculated to be 27.7 (Figure 3.2-3). This FQI value is higher than the median value for lakes within the SWTP ecoregion (21.1) and slightly higher than the median value for lakes throughout Wisconsin (27.2). Similarly, the FQI in 2016 was 25.2 which is also above the median value for lakes with the SWTP ecoregion. This analysis indicates that Sturgeon Bay's aquatic plant community is of higher quality than the majority of waterbodies within the SWTP ecoregion in terms of native aquatic

plant species composition. Its aquatic plant community is also of comparable quality when compared against waterbodies throughout Wisconsin.

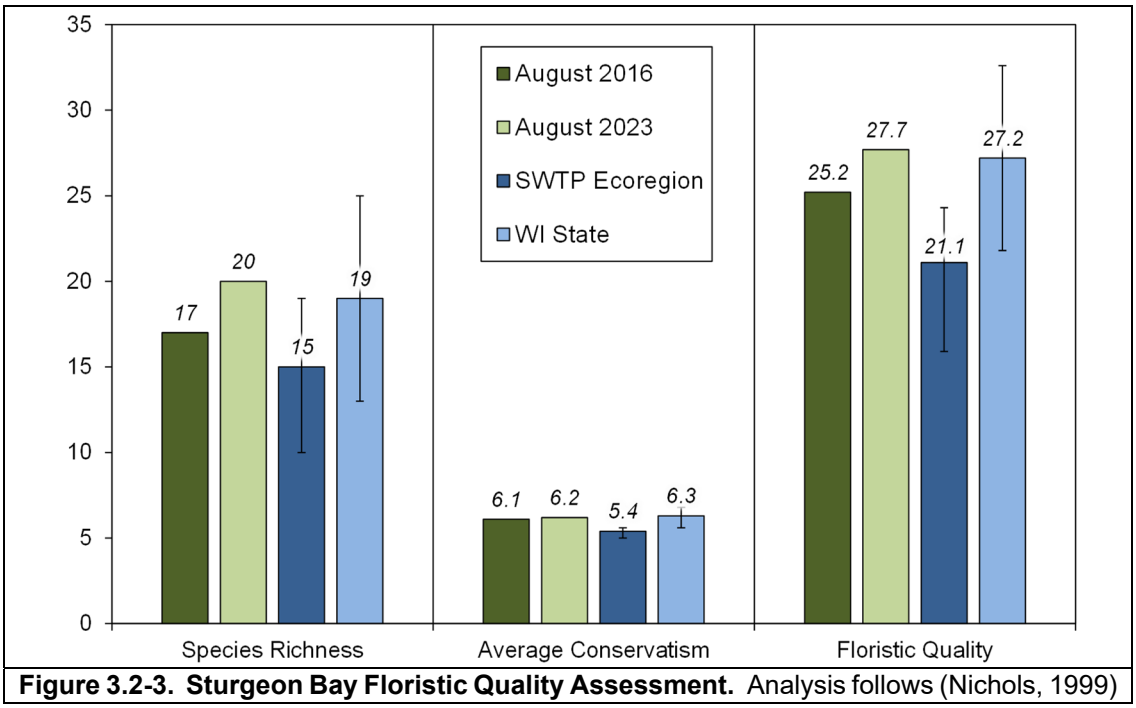


Figure 3.2-3. Sturgeon Bay Floristic Quality Assessment. Analysis follows (Nichols, 1999)

While a method for characterizing diversity values of fair, poor, etc. does not exist, lakes within the same ecoregion may be compared to provide an idea of how Sturgeon Bay's diversity value ranks. Using data collected by Onterra and WDNR Science Services, quartiles were calculated for 77 lakes within the SWTP Ecoregion (Figure 3.2-4). Using the data collected from the August 2023 point-intercept survey, Sturgeon Bay's aquatic plant community was found to have a Simpson's Diversity Index value of 0.87. In other words, if two individual aquatic plants were randomly sampled from Sturgeon Bay in 2023, there would be an 87% probability that they would be different species. Sturgeon Bay's species diversity value exceeds the median value for lakes within the SWTP ecoregion and is even with the median diversity value for lakes throughout Wisconsin.

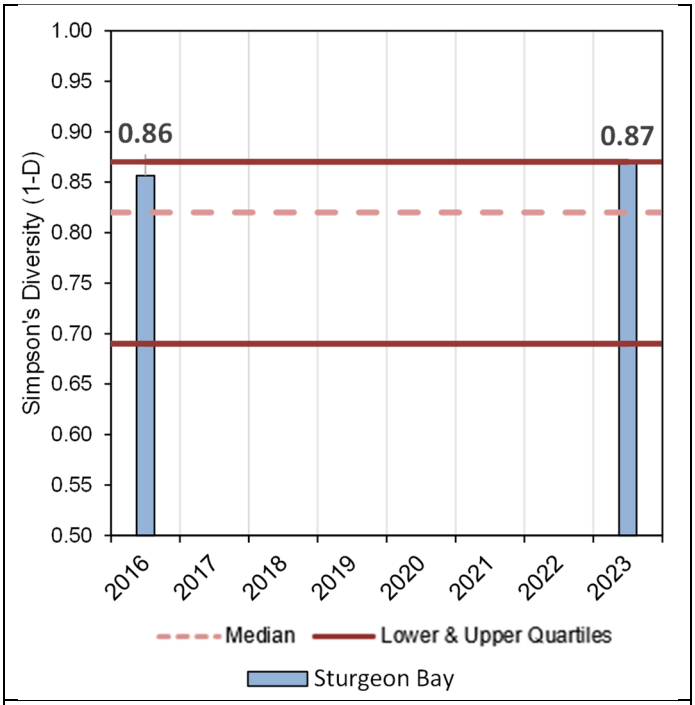


Figure 3.2-4. Sturgeon Bay aquatic plant community Simpson's Diversity Index.

As explained earlier, the littoral frequency of occurrence analysis allows for an understanding of how often each of the plants is located during the point-intercept survey. Since each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is

found in relation to all other species found (composition of population). For instance, while wild celery was found at 26.6% of the littoral sampling locations in Sturgeon Bay, its relative frequency of occurrence was 45.6% (Figure 3.2-5). Explained another way, if 100 plants were randomly sampled from Sturgeon Bay, 46 would be wild celery. As illustrated in Figure 3.2-5, in 2016 approximately 80% of Sturgeon Bay's aquatic plant community is comprised of the top five most abundant species. The most abundant five species in 2023 comprise 67% of the aquatic plant community which contributes to the slightly higher diversity found in 2023.

In 2023, Onterra ecologists also conducted a survey aimed at re-mapping emergent and floating-leaved plant communities in Sturgeon Bay (Map 2). Emergent and floating-leaf plant communities are a wetland community type dominated by species such as cattails, bulrushes, and water lilies. 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.

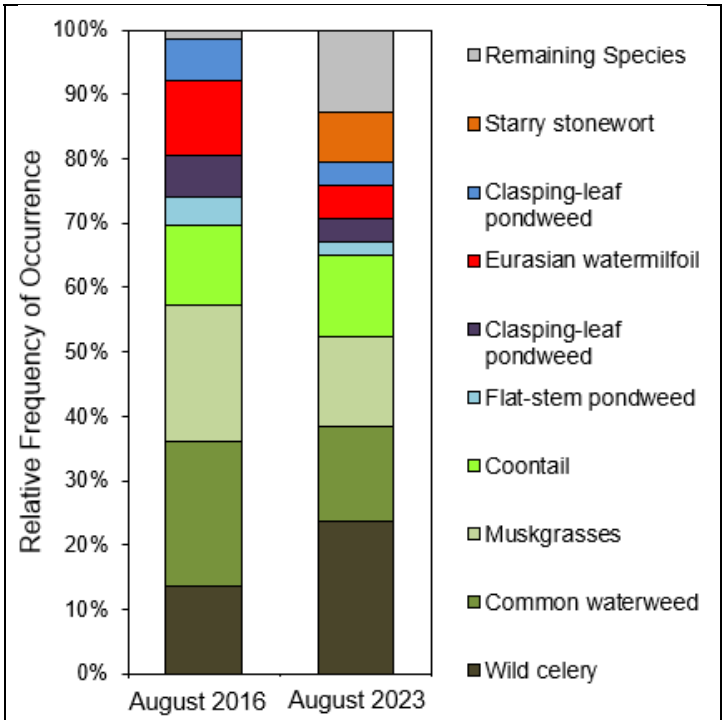


Figure 3.2-5. Sturgeon Bay relative frequency of occurrence.

This is important to note because these communities are often negatively affected by recreational use and shoreland development (Radomski & Goeman, 2001; Radomski & Goeman, 2001) found a 66% reduction in vegetation coverage on developed shorelands when compared to the undeveloped shorelands in Minnesota lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox lucius*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelands.

Analyzing the data from 2016 and 2023 reveals the majority of emergent communities retracted shoreward between the two surveys (Map 3). Emergent and floating-leaf plant communities tend to contract or expand in response to fluctuations in water levels. When water levels increase, these communities retract as the water at their lakeward extent becomes too deep for growth. Conversely, during periods of lower water levels, these communities often expand. An instance of retraction was observed at the location where Big Creek flows into Sturgeon Bay (Photograph 3.2-1). Although there was no satellite imagery available for 2016, the imagery from 2015 is likely a close representation. Over the past eight years, the images and Onterra's 2023 community mapping indicate a clear retraction of the emergent community in this area. This decline in acreage

appears to be in communities that were dominated by broad-leaved cattail (*Typha latifolia*), a native cattail species. Based on the 2008 satellite imagery, this retraction has likely been occurring for many years prior to Onterra's first community mapping survey in 2016. This retraction appears to have occurred in most communities throughout the bay, and it does not appear that one area of the bay in particular accounts for this loss in acreage.

In 2008, Lake Michigan experienced notably low water levels. By 2015, the water levels resembled those observed in 2023, although there was a peak approximately 2.5 feet higher in 2019. Throughout this period, water levels exhibited significant variability. The elevated water levels in 2019 likely led to a retraction of the emergent species that may still be recovering.

Summer 2008	Summer 2015	Summer 2022
		

Photograph 3.2-1. Evolving emergent aquatic plant communities between 2008, 2015, and 2022. The blue outline represents the 2022 channel boundary on all images.

3.3 Non-native & Nuisance Aquatic Plants

Curly-leaf Pondweed (Potamogeton crispus)

Curly-leaf pondweed (CLP) (Photograph 3.3-1) is a European exotic first discovered in Wisconsin in the early 1900's that has an unconventional lifecycle giving it a competitive advantage over our native plants. Curly–leaf pondweed begins growing almost immediately after ice-out and by mid-June is at peak biomass. While it is growing, each plant produces many turions (asexual reproductive shoots) along its stem. By mid-July most of the plants have senesced, or died-back, leaving the turions in the sediment.

Photograph 3.3-1. Curly-leaf pondweed, a non-native, invasive aquatic plant. Photo credit Onterra.

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

Due to its odd life-cycle, point-intercept surveys were conducted early in the growing season on June 20, 2016 and June 20, 2023 to gain an understanding of the distribution of curly-leaf pondweed within the study area of Sturgeon Bay when it was at its peak growth. Curly-leaf pondweed was the second-most and most frequently encountered plant in 2016 and 2023, respectively. Figure 3.3-1 and Map 4 illustrates the distribution of CLP in Sturgeon Bay as determined from the point-intercept survey. This plant is widespread and abundant throughout most of the study area, with the exception of deeper areas and the northeastern portion of the study area. It was most abundant between 2 and 19 feet of water, but was also observed growing in some of the marinas and in deeper water of 25 feet. In June of 2016, the majority (78%) of the point-intercept locations containing CLP had a CLP rake fullness rating of 1, indicating that in most areas it was not overly dense. In June of 2023, the CLP distribution expanded and densities increased as shown in Figure 9 with the increase in the CLP total rake fullness rating of 3. The June 2023 data suggests the CLP population was likely causing

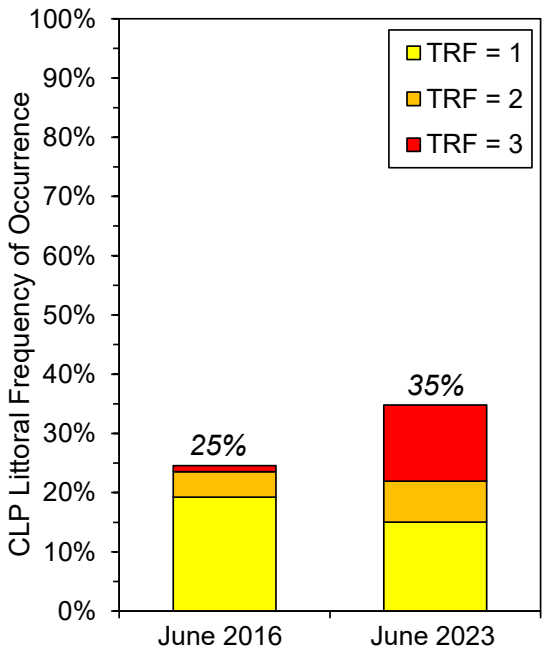


Figure 3.3-1. Distribution of curly-leaf pondweed in June 2016 and 2023.

navigation issues to boats coming into and out of the channel. During the August 2016 and 2023 point-intercept surveys, CLP had a littoral frequency of occurrence of <1% and 7%, respectively, indicating most of the population had died back by this time. While the curly-leaf pondweed population was high, this population growth is most likely a cycle and not a trend. Many environmental factors impact curly-leaf pondweed growth including but not limited to water levels, snow cover on ice, and water clarity.

Eurasian watermilfoil (Myriophyllum spicatum)

One of the submersed non-native aquatic plants known to be present within Sturgeon Bay Eurasian watermilfoil (EWM). Eurasian watermilfoil is an invasive species, native to Europe, Asia and North Africa, that has spread to most counties in Wisconsin (Photograph 3.3-2). Eurasian watermilfoil is unique in that its primary mode of propagation is not by seed. It actually spreads by shoot fragmentation, which has supported its transport between lakes via boats and other equipment. In addition to its propagation method, EWM 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 sometimes does not stop growing like most native plants and instead continues to grow along the surface creating a canopy that blocks light from reaching native plants.

Photograph 3.3-2. Eurasian watermilfoil, a non-native, invasive aquatic plant. Photo credit Onterra.

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.

Unlike CLP, EWM reaches its peak growth in mid- to late-summer, and assessments are usually completed in July through September to capture populations at their peak. Figure 3.3-2 and Map 5 illustrates the distribution of EWM in the study area of Sturgeon Bay as determined from the point-intercept surveys in August of 2016 and 2023 completed by Onterra. During these surveys, EWM had a littoral frequency of occurrence of approximately 16% in 2016 and 6% in 2023. It was most abundant between 4 and 14 feet of water. Total rake fullness data indicates the majority of the point-intercept sampling locations that contained EWM had an EWM total rake fullness rating of 1 for both years. Onterra ecologists did note EWM growing within some of the marinas. While EWM is widespread throughout the study area, in most locations it is not overly dense and likely not creating any navigational issues.

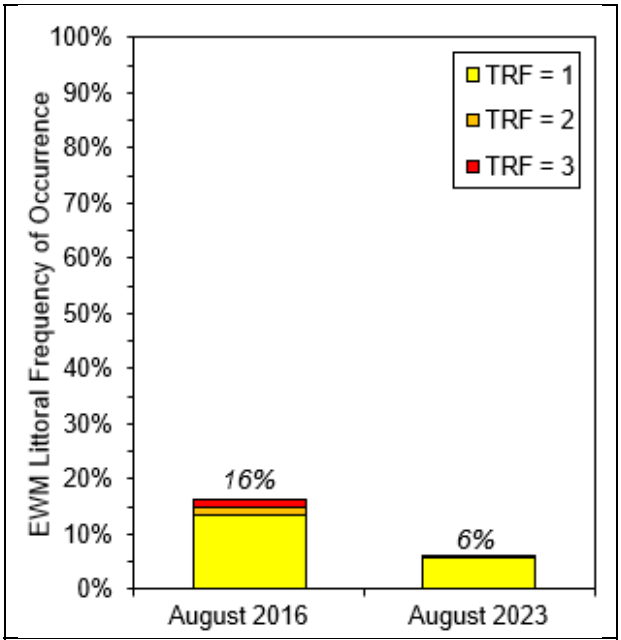


Figure 3.3-2. Distribution of Eurasian watermilfoil in August 2016 and 2023.

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.

The findings of the research demonstrate significant fluctuations in EWM populations across unmanaged lakes from year to year. After the initial infestation, EWM expansion occurred rapidly in certain lakes, but the overall pattern was characterized by variability (Nault, 2016). Some lakes achieved a relatively stable equilibrium in EWM populations, while others experienced more moderate year-to-year variations. Additionally, regional climatic factors appear to play a role in driving EWM populations.

Sturgeon Bay Historic EWM Management

In some waterbodies, EWM is a sever hindrance to recreation and may even impact the ecology of the system. In Sturgeon Bay, EWM is present and in some areas becomes quite dense. But overall, as shown by the 2016 and 2023 point-intercept survey results, this exotic is not one of the dominant plants in the bay. EWM can be a localized issue, but the population changes significantly from year-to-year in the bay, so targeting EWM with specific herbicides is not appropriate. Overall, Sturgeon Bay does not have an AIS issue, it has a nuisance plant issue made up of mostly native plants and some AIS.

During the early days of management on the system, EWM management included 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. Due to the size and shape of Sturgeon Bay, all previous herbicide applications have been spot treatments. Since 2016, EWM spot treatments have been minimal because the usefulness of these treatments do not warrant the extra cost and effort to delineate the sites for treatment, seek permits, and apply the herbicides. In 2019, a 25.7-acre ProcellaCOR treatment was completed in the bay. At the time, ProcellaCOR was a new herbicide used in Wisconsin for EWM control. Studies completed by Onterra since 2017 have found that ProcellaCOR is largely affective at controlling EWM for approximately 3 years in sites over 10 acres. However, as mentioned above, EWM specific spot treatments on Sturgeon Bay are not considered applicable due to the fact that EWM only plays a partial role in the bay's nuisance plant issue.

Starry stonewort

Starry stonewort (*Nitellopsis obtusa*; SSW; Photograph 3.3-3) is a non-native, invasive macrolagae that was first observed in the United States in 1978 within the St. Lawrence River. It was recently discovered in a southeastern Wisconsin lake in 2014, and has since spread to approximately two dozen inland lakes within 10 counties in Wisconsin. The discovery of starry stonewort in Sturgeon Bay in 2016 marks the first record of its occurrence in Lake Michigan.

Photograph 3.3-3. Starry stonewort, a non-native, invasive macroalgae. Photo credit Onterra.

Like other invasive species, starry stonewort has been shown to quickly dominate aquatic plant communities, in some cases growing to nuisance levels and hindering recreation. During the August 2016 point-intercept survey on Sturgeon Bay, SSW had a relatively low littoral frequency of occurrence of approximately 3%. The 2023 survey showed a statistically significant increase to 9%. Map 6 illustrates that SSW is widespread within the study area, but it was most frequently encountered in both surveys within the southern portion of the bay. Starry stonewort was most abundant between 2 to 12 feet in Sturgeon Bay. Since its discovery in Sturgeon Bay, the WDNR has verified the presence of Starry Stonewort in Green Bay near Brussels, Fish Creek, Little Tail Point, Ellison Bay, and Little Sturgeon Bay.

Purple Loosestrife (Lythrum salicaria)

Purple loosestrife is a perennial, herbaceous wetland plant native to Europe and was likely brought over to North America as a garden ornamental (Photograph 3.3-4). This plant escaped from its garden landscape into wetland environments where it is able to out-compete our native plants for space and resources. First detected in Wisconsin in the 1930's, it has now spread to nearly the entire state. Purple loosestrife largely spreads by seed, but can also spread from root or stem fragments.

Photograph 3.3-4. The non-native wetland plant, purple loosestrife. Photo credit Onterra.

Numerous purple loosestrife occurrences were located growing along portions of Sturgeon Bay's shoreline (Map 2. All of these occurrences were comprised of a single or few plants, and no large monotypic colonies were observed. There are a number of effective control strategies for combating this aggressive plant, including herbicide application, biological control by native beetles, and manual hand removal.

Giant Reed (Phragmites australis subsp. australis)

Giant reed (*Phragmites australis* subsp. *australis*) is a tall, perennial grass that was introduced to the United States from Europe. While a native strain (*P. australis* subsp. *americanus*) of this species exists in Wisconsin, the plants located along the shorelines and in shallow water in Sturgeon Bay are the non-native, invasive strain. Giant reed forms towering, dense colonies that overtake native vegetation and replace it with a monoculture that provides inadequate sources of food and habitat for wildlife.

Giant reed was found growing in multiple locations in Sturgeon Bay in 2016 (Map 2). Because this species has the capacity to displace the valuable wetland plants along the exposed shorelines, it is recommended that these plants be removed by cutting and bagging the seed heads and applying herbicide to the cut ends. This management strategy is most effective when completed in late summer or early fall when the plant is actively storing sugars and carbohydrates in its root system in preparation for over-wintering. A permit issued by the WDNR will likely be needed to place herbicide on plants that are located within the water.

Nuisance Aquatic Plant Management in Sturgeon Bay

As discussed above, Sturgeon Bay does not have an AIS plant issue, it has a nuisance aquatic plant issue made up of native and non-native species. An exception is during the late spring and early summer when curly-leaf pondweed is at peak biomass. This changes from year-to-year depending on environmental factors. As water levels have receded from a recent peak in 2020, curly-leaf pondweed has expanded and as a result, it has been the primary aquatic plant harvested from the start of the season through late-June for the past two years. It is important to note that curly-leaf pondweed is only managed with mechanical harvesting in the main throughfare of Sturgeon Bay. In the herbicide areas, curly-leaf pondweed may be managed with herbicides, but is not specifically targeted; it is treated along with the other nuisance plants in those areas.

Much of the harvesting time each summer is spent picking up floaters. This is not surprising considering that two of the five most abundant plants, coontail and common waterweed, may begin the season loosely rooted, but by early summer are freely floating on the surface. Further Eurasian watermilfoil auto-fragments at least twice each season. And finally, wild celery is often up-rooted later in the summer forming floating mats. Many bay users complain that the mechanical harvesting activities cause excessive amounts of floating fragment mats. While it is true that mechanical harvesting does produce fragments, much more of the bay is left unharvested than harvested, so the bulk of the floating plant material is likely naturally occurring.

Mechanical harvesting is completed on the bay on an as-needed basis. The city's three harvesters are used to maintain navigation in one of Wisconsin's most used waterbodies. They work on an as-needed basis and are directed daily by the harvesting supervisor. Figure 3.3-3 displays the number of loads removed from Sturgeon Bay from 2013 through 2023. Many environmental factors, such as ice out timing, ice snow cover, air/water temperature, and water levels impact the abundance and biomass of aquatic plants. During years of higher biomass, many loads are removed, as were in 2021-2023 when the curly-leaf pondweed population was expanding. In years like 2018-2020 when water levels were high, less harvesting is needed to maintain navigation and less loads are removed.

The city's ability to remove aquatic plant biomass is controlled by cost of equipment and its maintenance, and by the availability of staffing. The city struggles to maintain harvester operators, so purchasing additional equipment is not the answer as the new equipment may sit unused because operators are not available. The city has worked in recent years to increase harvesting efficiency by rehiring experienced operators and utilizing two primary offload sites. The city is also planning to install better GPS units with larger screens to allow for better and more efficient navigation while harvesting. The transport barge once operated by the city was sold because they frequently did not have an operator for it.

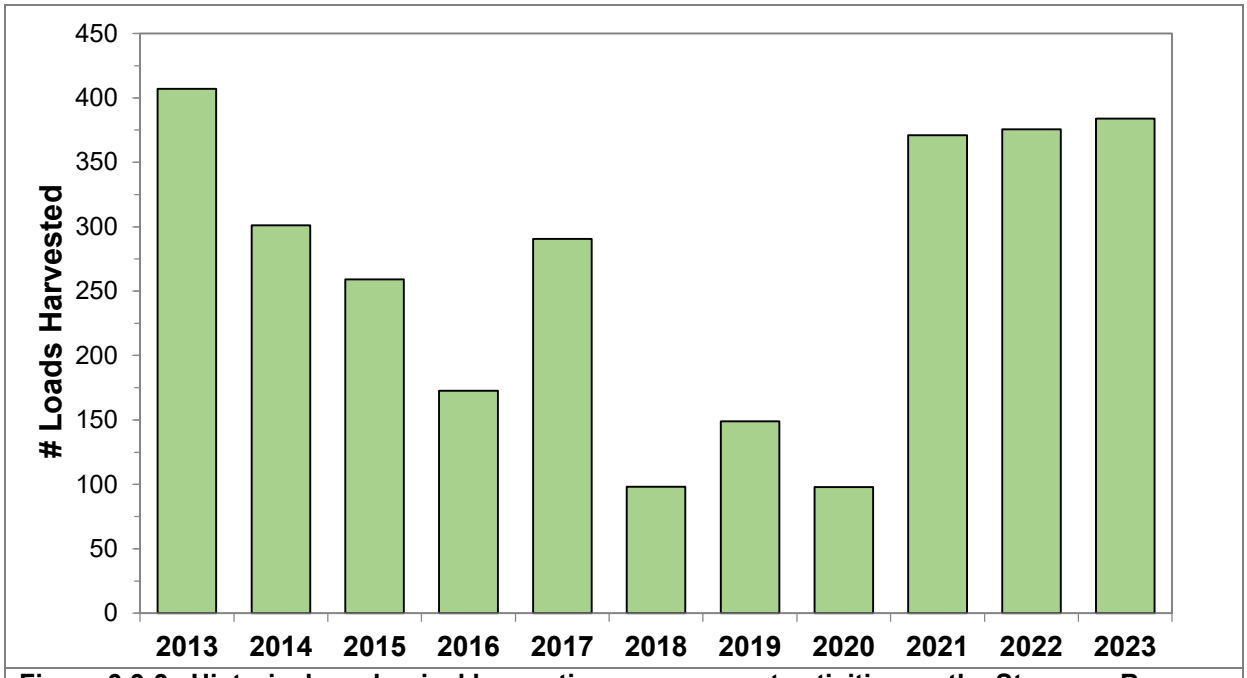


Figure 3.3-3. Historical mechanical harvesting management activities on the Sturgeon Bay.

The mechanical harvesting plan contained in Section 5.0 is very similar to the plan that has been implemented since 2019; however, two harvest areas have been added. The Lama Wamah channel, north of Bradley Lake on the east side of the bay will be harvested up to twice each year. Harvesting will consist of a 20-foot-wide channel looping through the channel. A second addition is a 10-foot-wide channel extending from the kayak launch at Bullhead Point on the west side of the bay. This area is popular among paddlers, so it will be maintained as needed.

As a part of the effort to create the 2019 management plan was spent refining treatment area spatial data and mapping to allow for more precise treatments, both in terms of surface area and in volume. This facilitates accurate dosing of herbicides leading to more efficient use. Further, the mapping was refined to allow for more effective and accurate pretreatment inspections by the city. As a result, only the sites requiring attention each year are treated. The city has been effective in selecting the areas requiring treatment and as shown in the historical treatment data displayed in Figure 3.3-4, only areas needing treatment are included in the application. The city has also been effective in managing the treatments, so the department is not inundated with many permit applications from individual property owners and marinas.

However, marina owners/managers/users and riparian property owners, via the Bay User Poll (see below and Appendix B) and direct contact with Parks and Recreation Department staff and committee members, are dissatisfied with the longevity of the treatment effects. During some years, biomass returns to nuisance levels well before the end of the season. Therefore, the option of a second herbicide treatment, following the same pretreatment inspection by city staff, is included in the updated aquatic plant management plan found in Section 5.0. Other than the addition of a second treatment option and one site being dropped (Site O) and one being added (Site K2), the herbicide strategy remains the same as the 2019 plan.

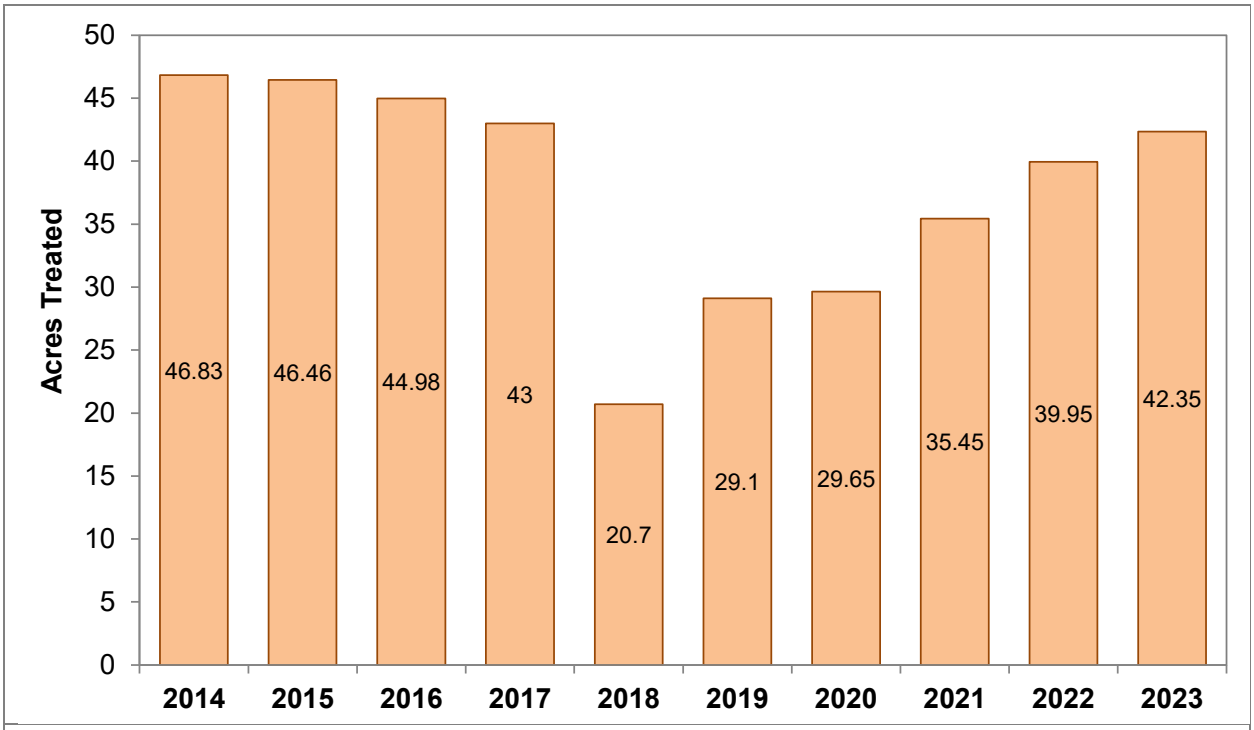


Figure 3.3-4. Historical herbicide and algaecide management activities on the Sturgeon Bay.

Stakeholder Survey Responses to Nuisance Aquatic Plant 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. All survey respondents were asked the below set of questions as it pertains to current and future aquatic plant management. When asked about previous aquatic plant management, the majority of respondents felt unsatisfied with the overall management strategy (Figure 3.3-5). Stakeholders were also asked about their views on the future use of mechanical harvesting and herbicide treatments, which are the two current management strategies employed on Sturgeon Bay (Figure 3.3-6). Respondents were highly supportive of both management techniques with mechanical harvesting receiving slightly more support between the two options.

The City of Sturgeon Bay has been utilizing mechanical harvesting and herbicides for management of aquatic plants. How satisfied are you with the current aquatic plant management strategy?

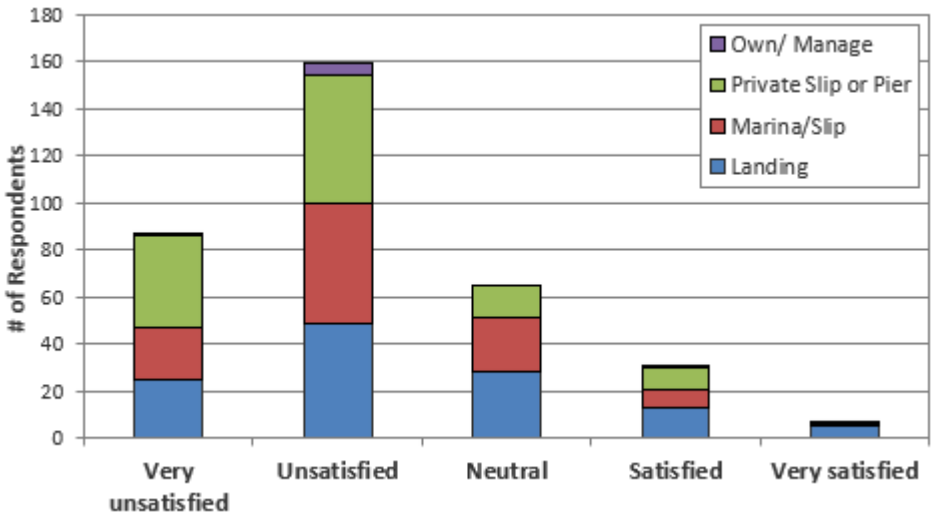
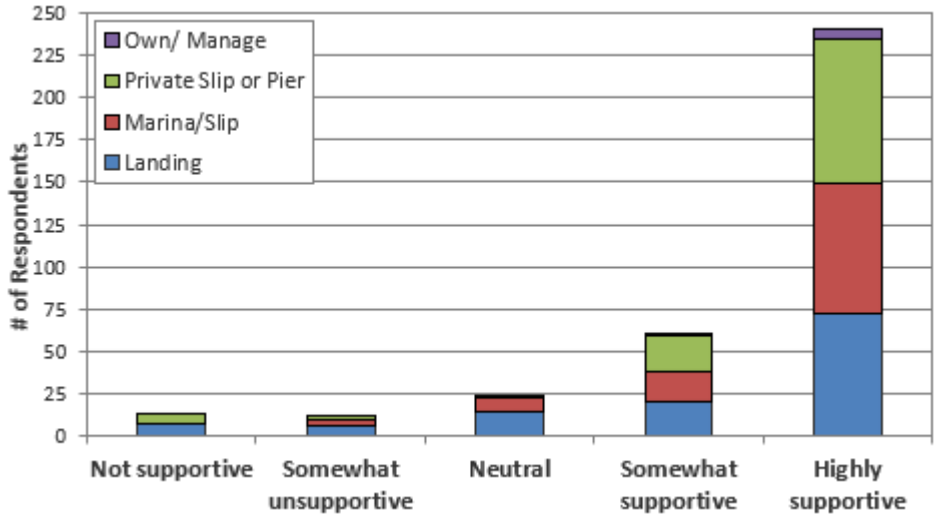


Figure 3.3-5. Select survey responses from the Sturgeon Bay Stakeholder Survey. Respondents per category: Own/Manage – 7, Private Slip or Pier – 125, Marina/Slip – 112, Landing – 159. Additional questions and response charts may be found in Appendix B.

What is your level of support for the future use of mechanical harvesting (i.e. weed cutter) techniques in Sturgeon Bay?



What is your level of support for the future use of herbicide treatment techniques in Sturgeon Bay?

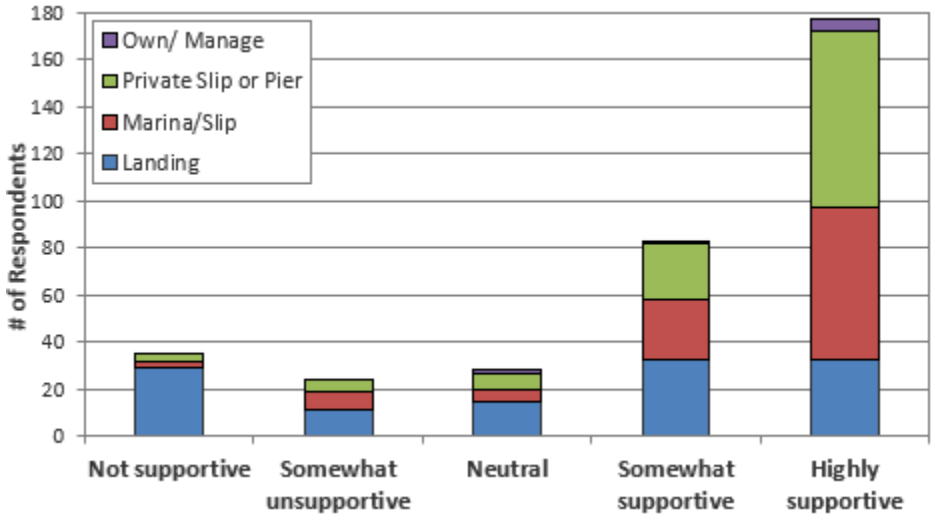


Figure 3.3-6. Select survey responses from the Sturgeon Bay Stakeholder Survey. Respondents per category: Own/Manage – 7, Private Slip or Pier – 125, Marina/Slip – 112, Landing – 159. Additional questions and response charts may be found in Appendix B.

In an effort to understand how aquatic plants impact stakeholders, the 2023 stakeholder survey asked, "How do aquatic plants negatively impact your time on the water." It is important to note, the survey respondents were also offered the options of *high negative impact, moderate negative impact, no impact,* and *neutral/unsure.* To easily interpret the results from all stakeholder categories (public landing, marina/slip, private slip or pier), the results of only *high negative impact* and *moderate negative impact* are shown and also combined. The category with the highest number of respondents was *aquatic plant growth makes it difficult to navigate my watercraft* (Figure 3.3-7). Additional information can be found in Appendix B where the responses are reported based upon respondent category.

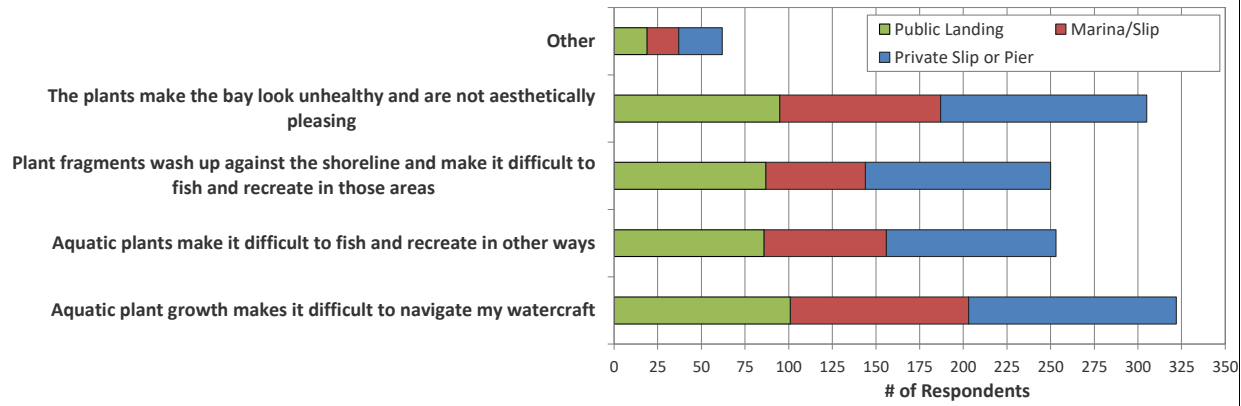


Figure 3.3-7. Select survey responses from the Sturgeon Bay Stakeholder Survey. Respondents per category: Private Slip or Pier – 125, Marina/Slip – 112, Landing – 159. Additional questions and response charts may be found in Appendix B.

Prevention & Containment

Sturgeon Bay is a highly popular destination for recreationists and anglers, making the waterbody 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.

The City of Sturgeon Bay utilizes WDNR grant funding to sponsor watercraft inspections through the WDNR's Clean Boats Clean Waters (CBCW) program at two public boat launches (Sunset Park and Sawyer Park). CBCW inspection is provided on Fridays, Saturdays, Sundays, and holidays. The City of Sturgeon Bay's Clean Boats Clean Waters program has been well organized, with numerous watercraft inspections occurring annually (Figure 3.3-8 showing recent history). The WDNR also conducts CBCW efforts on other waterbodies near the bay such as Little Sturgeon Bay, Clark Lake, and Sawyer Harbor (Potawatomi State Park Access).

Based upon modeling by the University of Wisconsin Center for Limnology, Sturgeon Bay is listed as one of the state's top 300 AIS Prevention Priority Waterbodies. This means that Sturgeon Bay has a high number of boats arriving from lakes that have AIS (receiving) and a high number of boats moving from Sturgeon Bay 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.

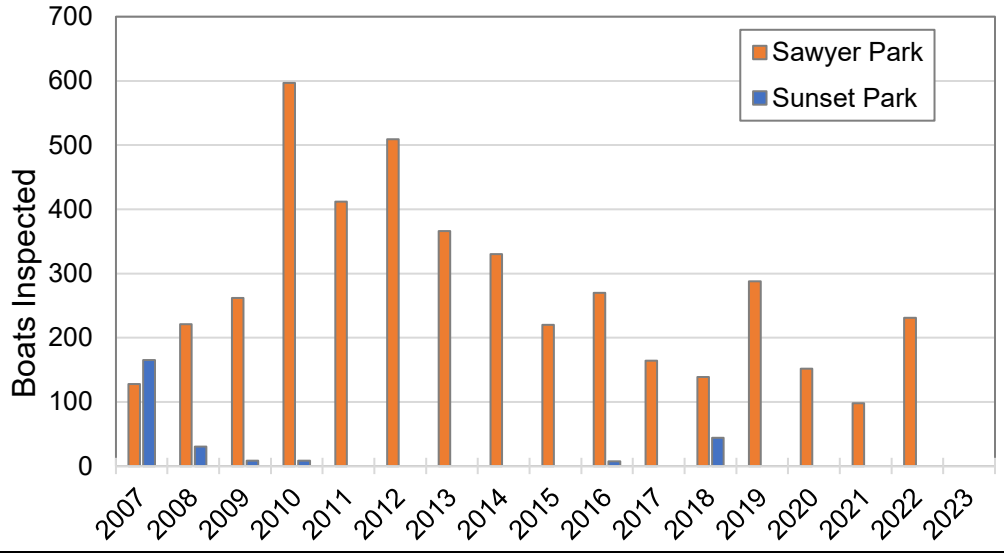


Figure 3.3-8. Watercraft inspections conducted on Sturgeon Bay 2007-2023. Data from WDNR, SWIMS.

4.0 SUMMARY & CONCLUSIONS

The 2023 aquatic plant studies in Sturgeon Bay aimed to evaluate the aquatic plant community in the study area and update the 2019 Aquatic Plant Management Plan. The findings from these surveys illustrate Sturgeon Bay hosts a greater diversity of native aquatic plant species compared to inland lakes in the ecoregion. In addition, the surveys indicate Sturgeon Bay's aquatic plant community has higher floristic quality when compared to inland lakes within the ecoregion and the state. However, signs of disturbance to the plant community are evident, demonstrated by the presence of five non-native species and a continued low occurrence of emergent and floating-leaf plant communities.

Curly-leaf pondweed and Eurasian watermilfoil were found to be widespread throughout the study area. In the case of Eurasian watermilfoil, the species was not overly dense in the locations it was found. Curly-leaf pondweed; however, had a banner year of growth which most likely inhibited recreational and commercial boat traffic in and around Sturgeon Bay. While the curly-leaf pondweed population was high, this population growth is most likely a cycle and not a trend. Many environmental factors impact curly-leaf pondweed growth including but not limited to water levels, snow cover on ice, and water clarity. The discovery of starry stonewort in Sturgeon Bay in 2016 represented the first documented occurrence of this plant in Lake Michigan. Continued monitoring in 2023 has shown this species has expanded but not to levels that would cause nuisance conditions. Purple loosestrife and giant reed were also found to be widespread along the shorelines of the study area in 2023.

Information pertaining to stakeholder use, perceptions, and concerns was gathered in the summer of 2023 to further aid in the development of an updated management plan for the City of Sturgeon Bay. Following the collection of this information, much was learned about the stakeholder perceptions regarding the existing and prospective aquatic plant management approach. Overall, most respondents to the survey were dissatisfied with the results of the current aquatic plant management activities and were in support of more mechanical harvesting and herbicide use.

Many of the comments received via the bay user survey echo those received by the city on a regular basis and those received by Onterra staff during the project. Unfortunately, some of the comments are based upon misinformation or a misunderstanding of the bay and its plant community. For instance, many comments are received complaining about plant fragments from mechanical harvesting piling up against the shore, in channels, and in marinas. While a definite disadvantage of mechanical harvesting is the creation of plant fragments, the bulk of fragments causing issues on Sturgeon Bay are actually naturally occurring due to the make-up of the bay's aquatic plant community. Two of the four most abundant plants in the bay, common waterweed and coontail, may start off the growing season being lightly rooted in the sediment, but soon into the season they break free and float to the surface. These plants spend the remainder of the season floating around in masses with each plant essentially growing on one end and dying on the other. The fifth most common species, Eurasian watermilfoil, evolved to auto-fragment at least once or twice each season as its primary method of spread. The bay's most abundant plant, wild celery, for an unknown reason, often breaks free of the sediment near the end of the season and creates large floating mats. Much of the city's active management time is spent harvesting the naturally occurring floating mats brought on by all of these species.

Many other comments called for increasing herbicide treatments, doing the herbicide treatments earlier, and conducting more mechanical harvesting. At the surface all of these ideas seem to make sense, but in practice they may not be practical or are not feasible. First, treating small areas of less than 10 acres in the open areas of the bay would likely result in incomplete treatments and be an inefficient and irresponsible use of herbicides. Even an area as large as 30 acres would be impacted by the bay's open water and fluctuating flows, which would limit effectiveness.

The city works to time the herbicide treatment to provide the longest last results. This is difficult because several factors impact aquatic plant growth in the early part of the growing season. Even a successful application only knocks the growth back, so there will be regrowth later in the season. To relieve late-season issues brought on by regrowth in the application areas, the city has included a potential second treatment, later in the season, if needed.

The City of Sturgeon Bay staffs three mechanical harvesters each season. The harvest plan contains over 160-acres of harvesting, plus additional areas are available for floater harvesting. Each year, the city struggles to hire and train the staff needed to operate the equipment. They are always looking into new methods and sources of hires. If sufficient staff is available in the future, the city may consider additional harvesting hours and equipment.

Some property owners believe individual treatments around their piers would reduce nuisance plants for the summer. As described above, small treatment areas in large waterbodies with fluctuating currents, do not perform well making these types of treatments short-lived and infeasible. Further, even if the application did work to kill the plants, the results would likely disappear when additional floating matts would accumulate in the area. The best method for keeping private properties clear is raking the plants out the area by hand. It is legal to clear 30% of a property's shoreline up to 30' wide. The area can extend as deep as needed, but is typically limited by depth. The cleared area must include any piers and boat lifts. The property owner can do the work themselves or pay others to do it. All plants must be removed from the lake – they cannot be left to float away. If a property owner does rake plants from their shoreline, the city will pick them up from the pier if they are notified.

Ultimately, the users of Sturgeon Bay, in and around the City of Sturgeon Bay, must remember that the city's goal is to maintain navigation by providing lanes to the open water areas of the bay. When managing aquatic plants on Sturgeon Bay, the city must always consider what they can do, what they are allowed to do, and what they can afford to do.

5.0 AQUATIC PLANT MANAGEMENT STRATEGY

As a part of the 2016 project that produced the 2019 Aquatic Plant Management Plan, the City of Sturgeon Bay and the WDNR requested that the updated management plan be shorter and easier to use than the previous plan created in the early 2000s, which was hundreds of pages long. This 2024 updated plan follows the same format for a clear understanding.

Mechanical Harvesting (Maps 7 & 8)

Harvest Areas

- Cut to half the water depth or 4', whichever is shallower.
- All harvest areas end at the pier face and no cutting can be completed between piers or within the City of Sturgeon Bay Pierhead Line, with the exception of the access lanes harvested in Purves and Ashers Lagoon.
- All gamefish and yellow perch should be returned to the water immediately.
- If moderate numbers of gamefish or young-of-year perch are encountered while harvesting, harvest operations in that area will cease for at least 24 hours. After 24 hours, the area will be checked for presence of fish before harvesting resumes.
- Purves and Ashers Lagoons will be cut to create a 20' wide lane, if needed for navigation.

Mooring Areas

- These areas will be harvested following the same guidelines as above.

Access Lanes

- 30' wide access lanes will be maintained following the same harvesting guidelines as above.
- The access lanes may not be needed in all years.

Lama Wamah Navigation Lane

- The 20' wide access lane will be cut up to twice each summer.
- The harvester will cut as close to the wall as possible on the south side of the channel and just off the pierheads in the remaining portions.
- The harvester will steer clear of floating-leaf and emergent vegetation in the channel.
- During these harvest operations, the Sunset Boat Launch will be used to offload.

Bullhead Point Kayak Navigation Lane

- The 10' wide access lane will be maintained as needed throughout the summer.

Floater Harvesting

- Floaters can be harvested in all areas of the bay, including marinas, public boat launches, Purves Lagoon, and Ashers Lagoon.
- Floaters cannot be harvested in No Harvest Areas or within the City of Sturgeon Bay Pierhead Line, except for the areas designated above.
- During floater harvesting, the cutter head will not be lower than 2' below the surface unless the floating mass extends deeper than 2'.

Business and Residential Dockside Pick Up

- Harvesting crews will pick up aquatic plants harvested by business and private pier owners.
- Harvested plants should be placed on the dock furthest away from shore to allow easiest access for harvesting crew.
- If residents place aquatic plants at the end of their docks, please contact the Municipal Services office to ensure the crews are notified of the pile.

No Harvest Area

- This area would not be harvested without permission from the WDNR.

Herbicide Control in Marina Areas (Map 9)

Herbicide Treatment Areas & Timing

- Marina treatment areas extend from shore to approximately 10' of water depth.
- Prior to each herbicide treatment, the city will inspect the treatment areas to determine if a treatment is warranted depending on the abundance of target species present.
    - The inspector would use a combination of printed maps from this plan and GPS tracking to identify blocks available for treatment.
    - The inspector would indicate if the average condition of the block is a 1) *current nuisance*, 2) *anticipated nuisance*, or 3) *not current issue*. The first two categories would be slated for treatment.
- The treatment areas are small; therefore, to assure the best opportunity to obtain necessary concentration and exposure times, either the entirety of the area will be treated, or it will not be treated at all. There would NOT be an option to only treat part of the site block.
- Treatments will occur when wind speeds at the Door County/Cherryland Airport are 10 mph or less.
- Up to two herbicide treatments may occur each growing season.

  - The second treatment (if required) would follow the same pretreatment inspection procedure as the first treatment.

- Herbicides requiring short exposure times would be used to target Eurasian watermilfoil, curly-leaf pondweed, and nuisance natives.
  - The contracted applicator will select the herbicides and dosages.
  - Diquat, copper, flumioxazin, and other fast-acting herbicides will be utilized.
    - Flumioxazin is appropriate for open and deeper areas due to the surface area, as opposed to volume, dosing requirement on diquat.
- If starry stonewort is found to be a *current nuisance* or an *anticipated nuisance*, the treatment strategy would also integrate best management practices (BMPs) for this non-native, macro-algae (currently involving the use of copper herbicide/algaecide).
- Treatments would occur in mid-June to early-July and late-July to mid-August (if required).

6.0 LITERATURE CITED (NOT COMPLETE)

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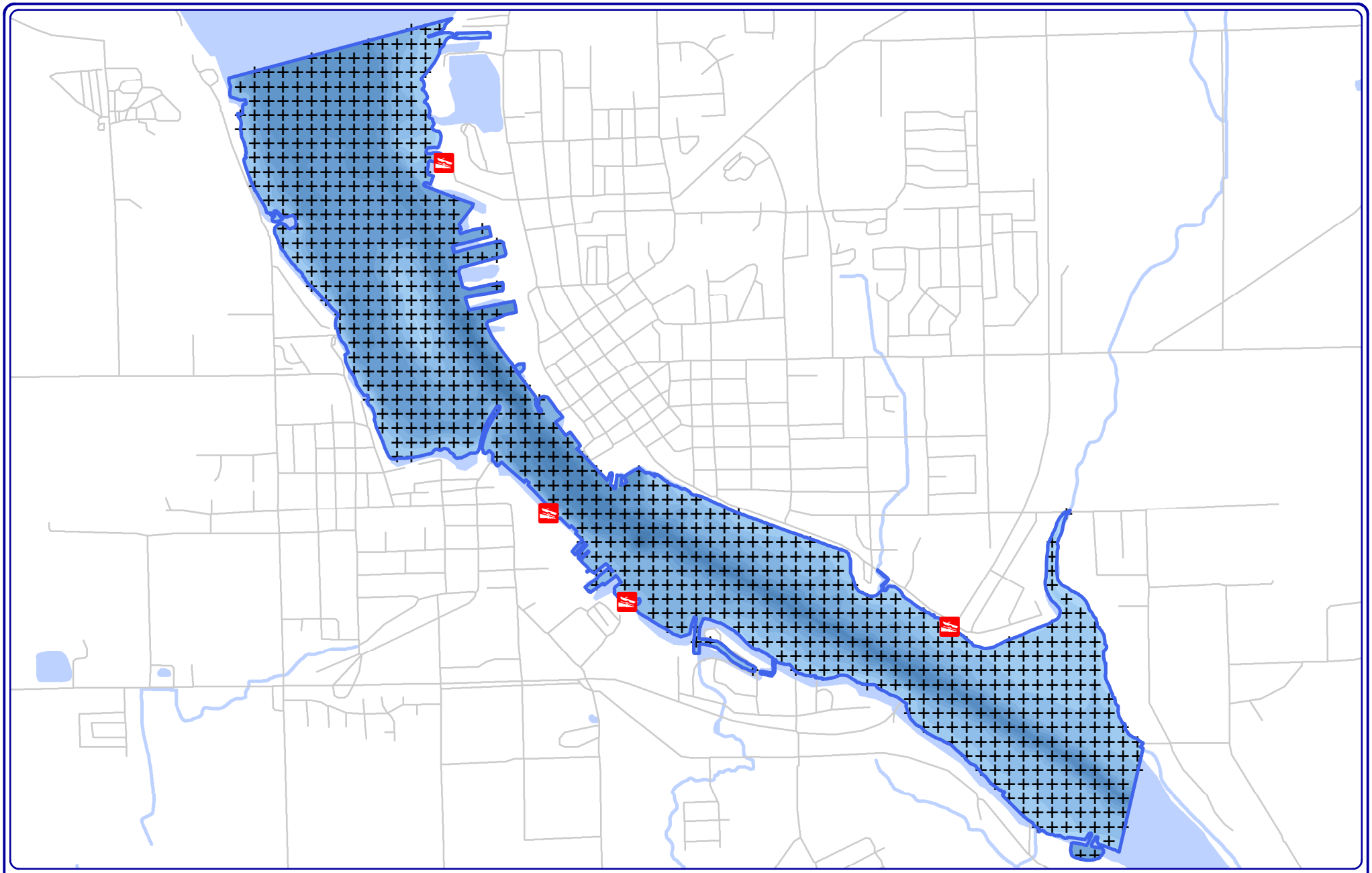
Nault. (2016). The science behind the "so-called" super weed. *Wisconsin Natural Resources*, 10-12.

Nichols, S. (1999). Floristic quality assessment of Wisconsin lake plant communities with example applications. *Journal of Lake and Reservoir Management*, 15(2): 133-141.

Radomski, P., & Goeman, T. J. (2001). Consequences of Human Lakeshore Development on Emergent and Floating-leaf Vegetation Abundance. *North American Journal of Fisheries Management*, 21: 46-61.



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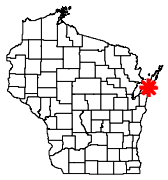
Sources:
Orthophotography: NAIP, 2015
Bathymetry: Onterra, 2016
Map Date: November 30, 2023
Filename: Map1_SturgeonBay_Location.mxd



Project Location in Wisconsin

Legend

- Project Boundary (~1,013 acres)
- Public Boat Launch Locations
- \+ Point Intercept Location

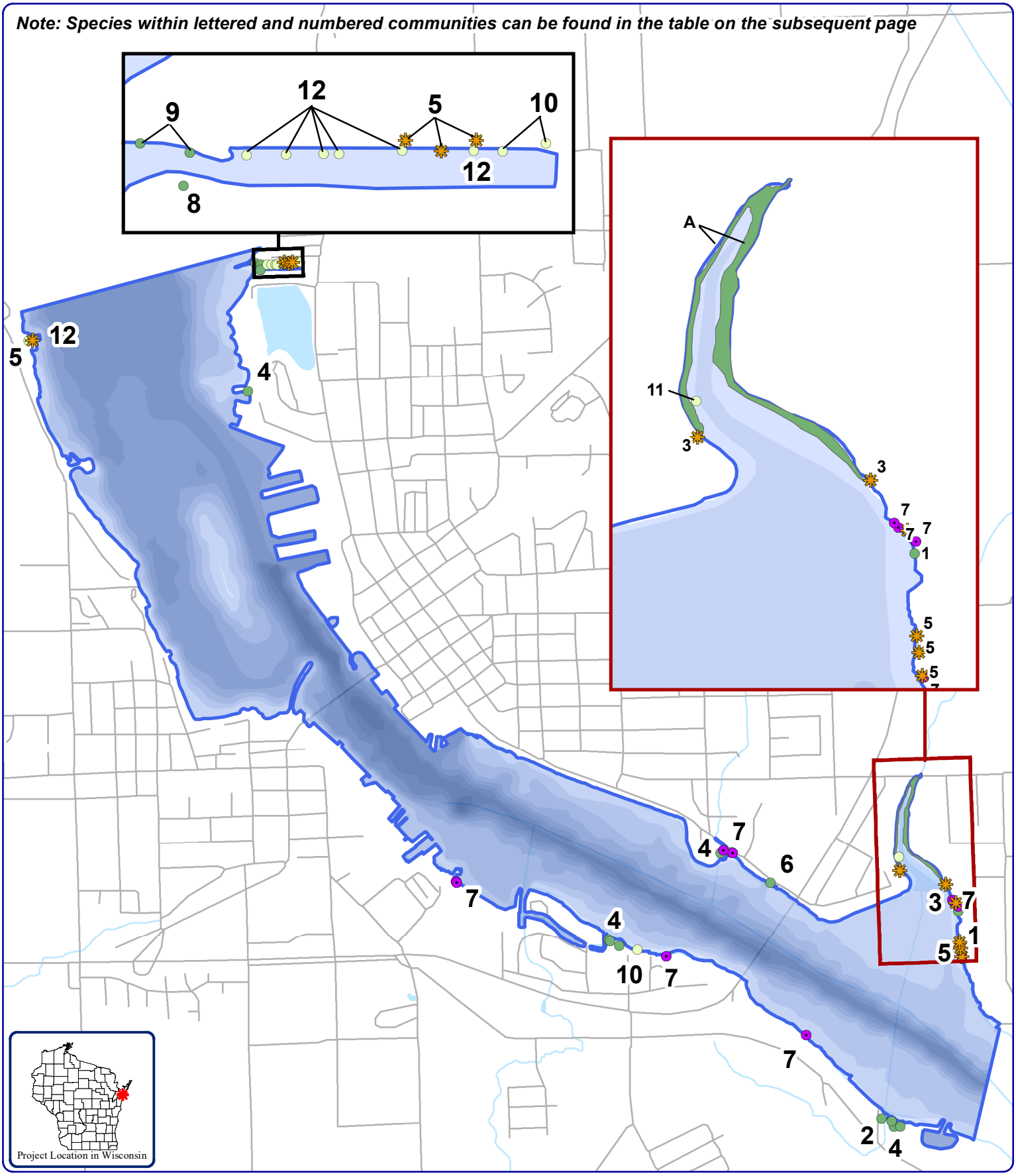
Map 1

Sturgeon Bay

Door County, Wisconsin

Project Location & Boundaries

Note: Species within lettered and numbered communities can be found in the table on the subsequent page



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Sources
Hydro: WDNR
Aquatic Plants: Onterra, 2023
Orthophotography: NAIP, 2022
Map date: November 11, 2023 KLW

Legend

Small Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent

Large Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent

Invasive Emergent Plants
- Purple Loosestrife
- Phragmites

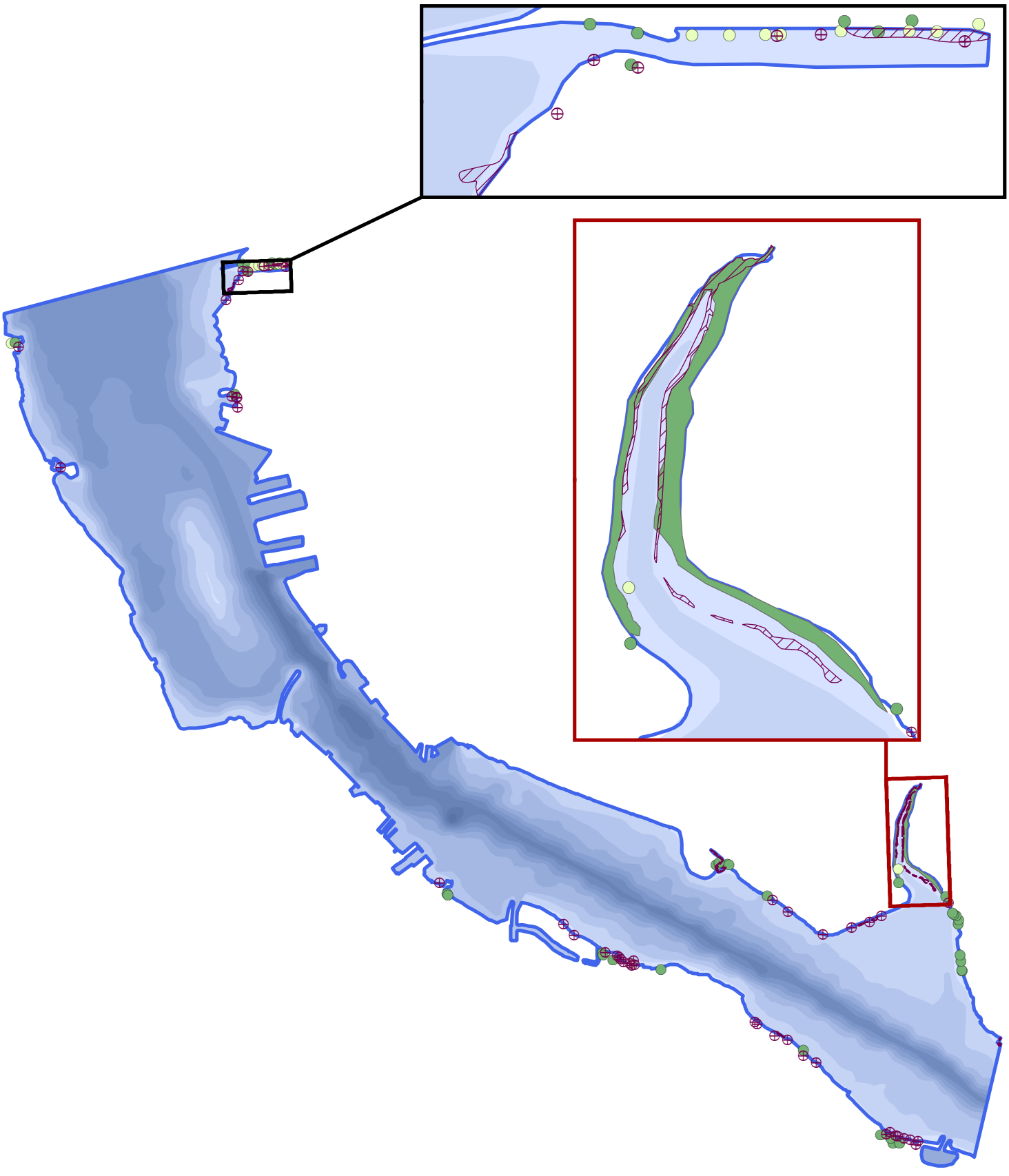
Map 2
Sturgeon Bay
Door County, Wisconsin
Aquatic Plant Communities

Sturgeon Bay 2023 Emergent & Floating-Leaf Plant Species
Corresponding Community Polygons and Points are displayed on Sturgeon Bay - Map 2

Large Plant Community (Polygons)									
Emergent	**Species 1**	**Species 2**	**Species 3**	**Species 4**	**Species 5**	**Species 6**	**Species 7**	**Species 8**	**Acres**
A	Giant reed	Broad-leaved cattail							1.79

Small Plant Community (Points)								
Emergent	**Species 1**	**Species 2**	**Species 3**	**Species 4**	**Species 5**	**Species 6**	**Species 7**	**Species 8**
1	Arrowhead sp. (sterile)	Softstem bulrush						
2	Broad-leaved cattail							
3	Broad-leaved cattail	Giant reed						
4	Cattail sp.							
5	Giant reed							
6	iris sp.							
7	Purple loosestrife							
8	Soft rush							
9	Three-square rush							
Floating-leaf	**Species 1**	**Species 2**	**Species 3**	**Species 4**	**Species 5**	**Species 6**	**Species 7**	**Species 8**
10	River bulrush							
11	Spatterdock							
12	White water lily							

Species are listed in order of dominance within the community; Scientifc names can be found in the species list in Table 3.2-1



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Sources
Hydro: WDNR
Aquatic Plants: Onterra, 2023
Orthophotography: NAIP, 2022
Map date: January 18, 2023 RMF

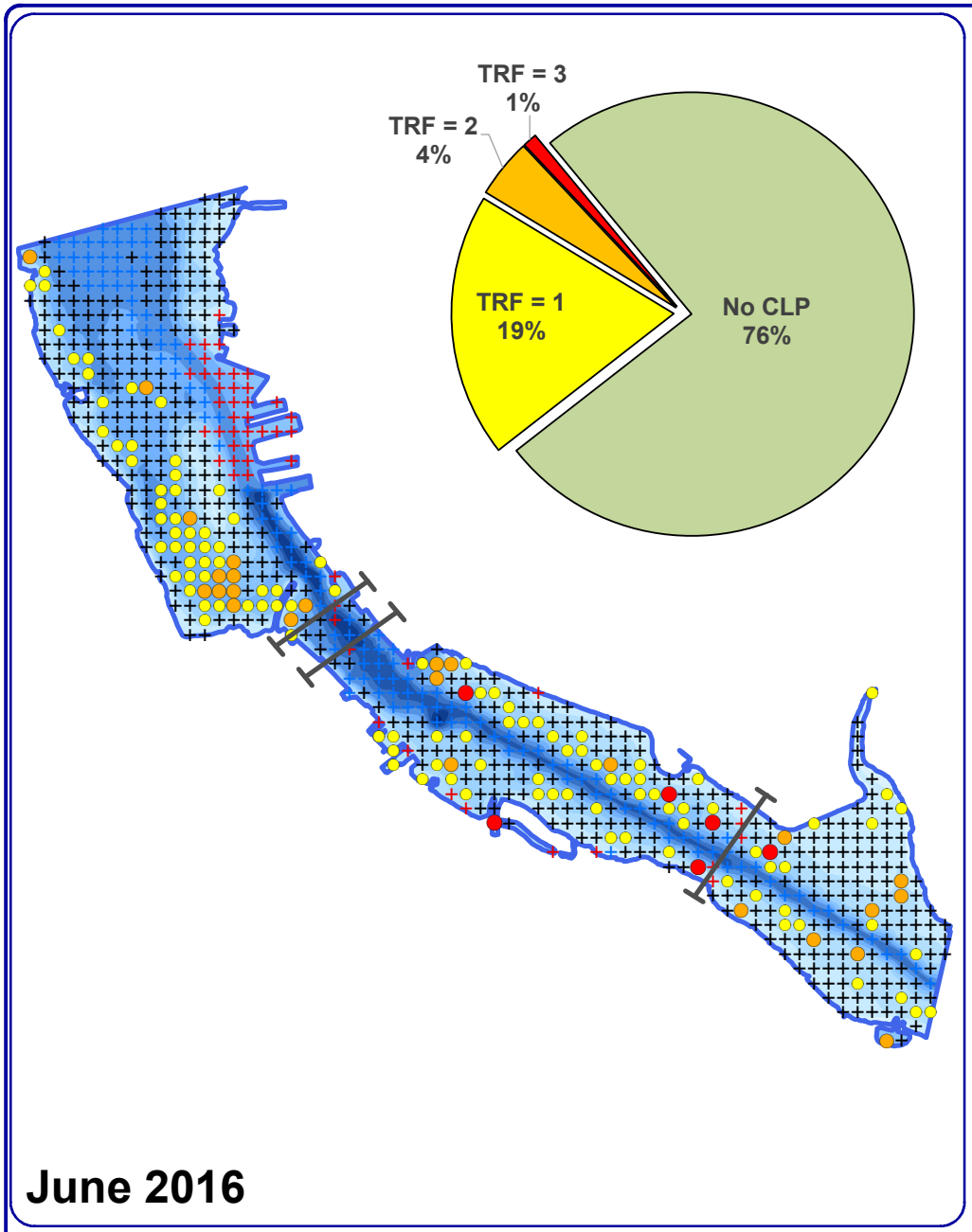
Legend

Small Plant Communities
- Emergent
- Floating-leaf
- Mixed Floating-leaf & Emergent (None)

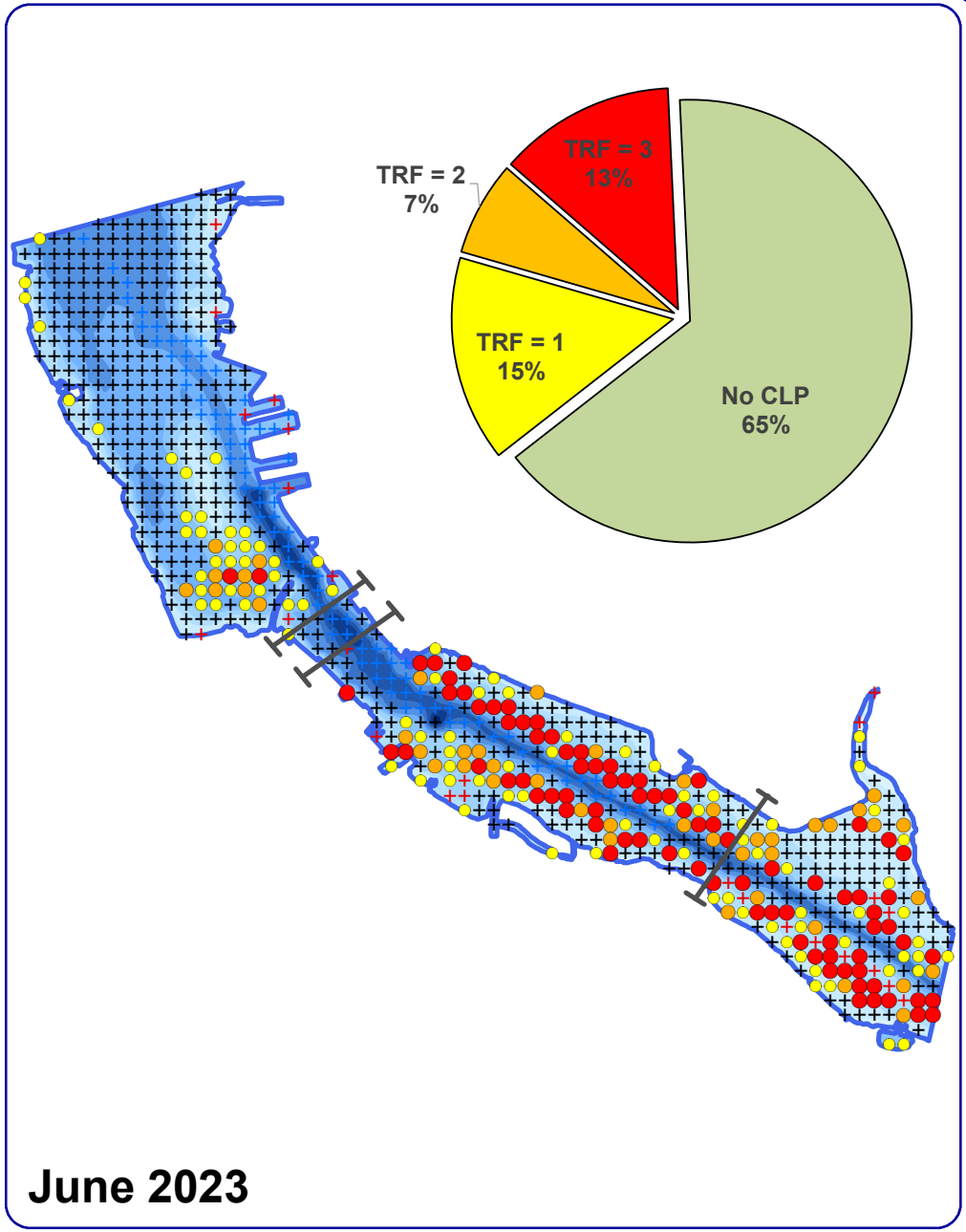
Large Plant Communities
- Emergent
- Floating-leaf (None)
- Mixed Floating-leaf & Emergent (None)

- 2016 Small Community
- 2016 Large Community

Map 3
Sturgeon Bay
Door County, Wisconsin
Aquatic Plant Communities



June 2016



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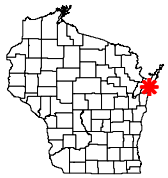
Sources:
Aquatic Plants: Onterra, 2023
Hydro: WDNR, Digitized by Onterra
Map Date: January 18, 2024 JMB



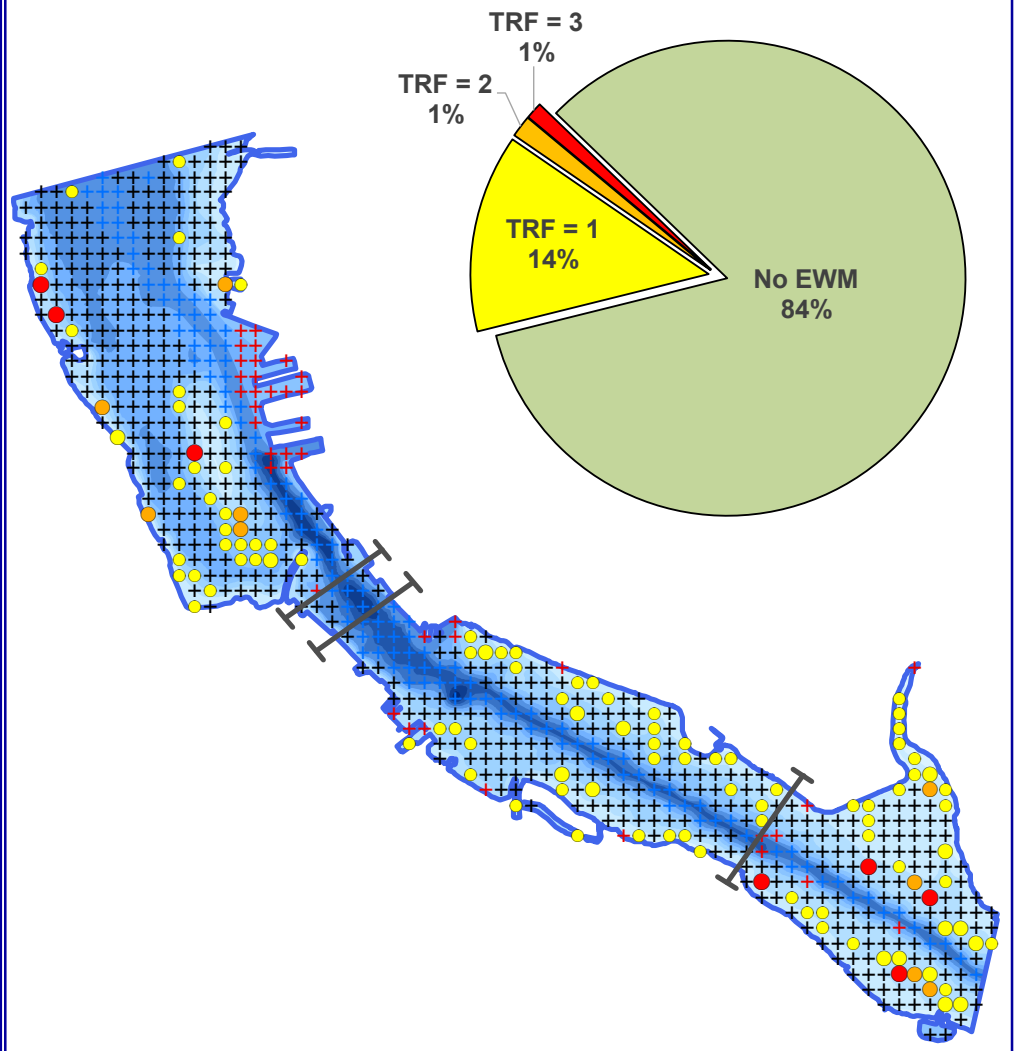
Project Location in Wisconsin

Legend

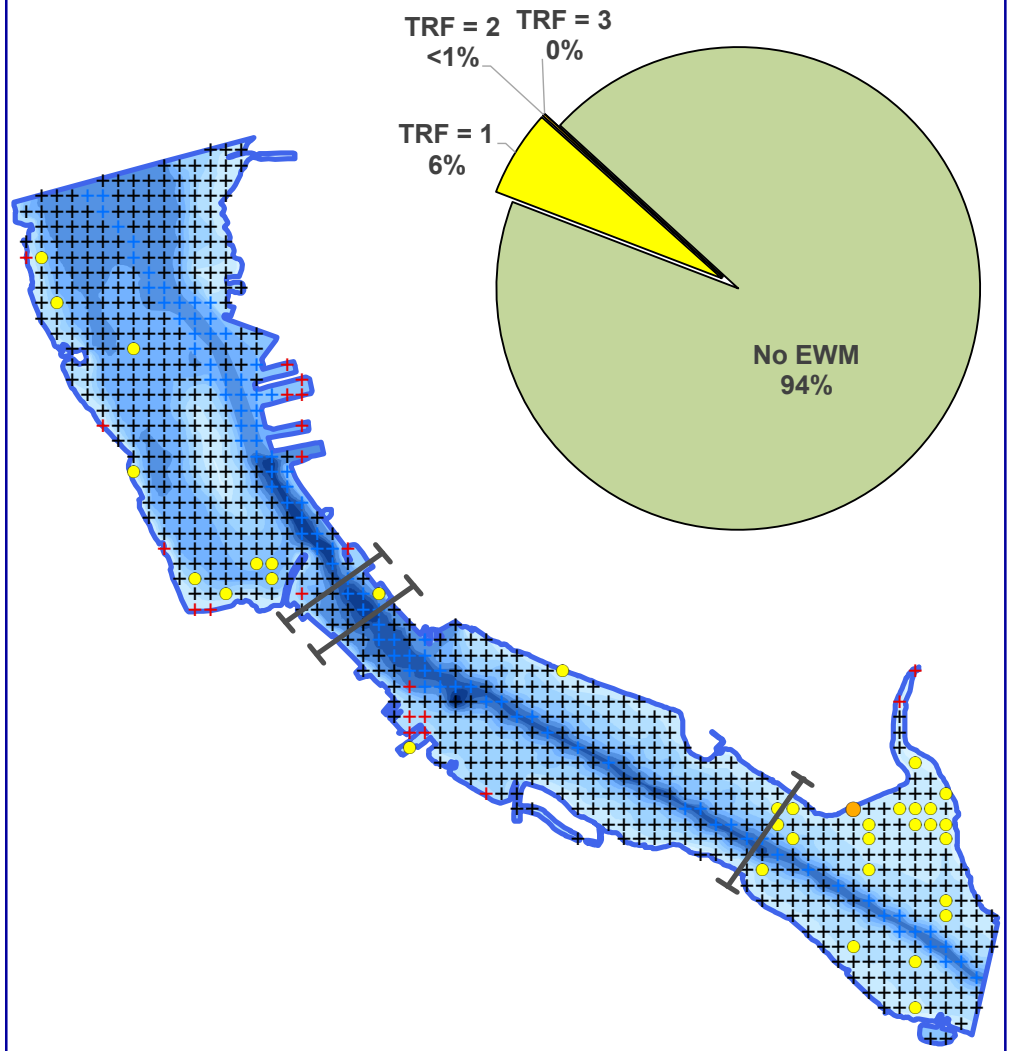
- Total Rake Fullness = 1
- Total Rake Fullness = 2
- Total Rake Fullness = 3
- \+ No curly-leaf pondweed found
- \+ Deeper than Max Depth of Plants
- \+ Non-Navigable/Obstacle
- Sturgeon Bay Bridge

Map 4
Sturgeon Bay
Door County, Wisconsin

Curly-leaf Pondweed
June 2016 & 2023



August 2016



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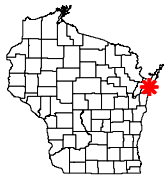
Sources:
Aquatic Plants: Onterra, 2023
Hydro: WDNR, Digitized by Onterra
Map Date: January 18, 2024 JMB



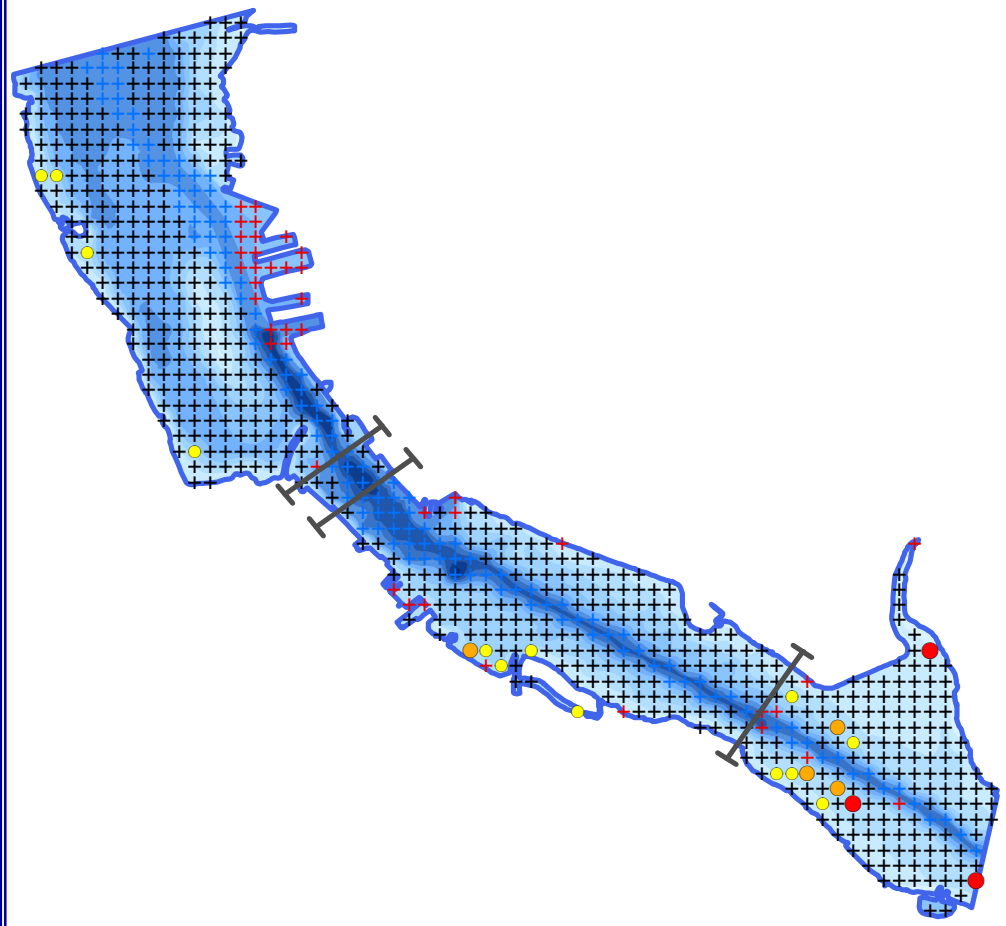
Project Location in Wisconsin

Legend

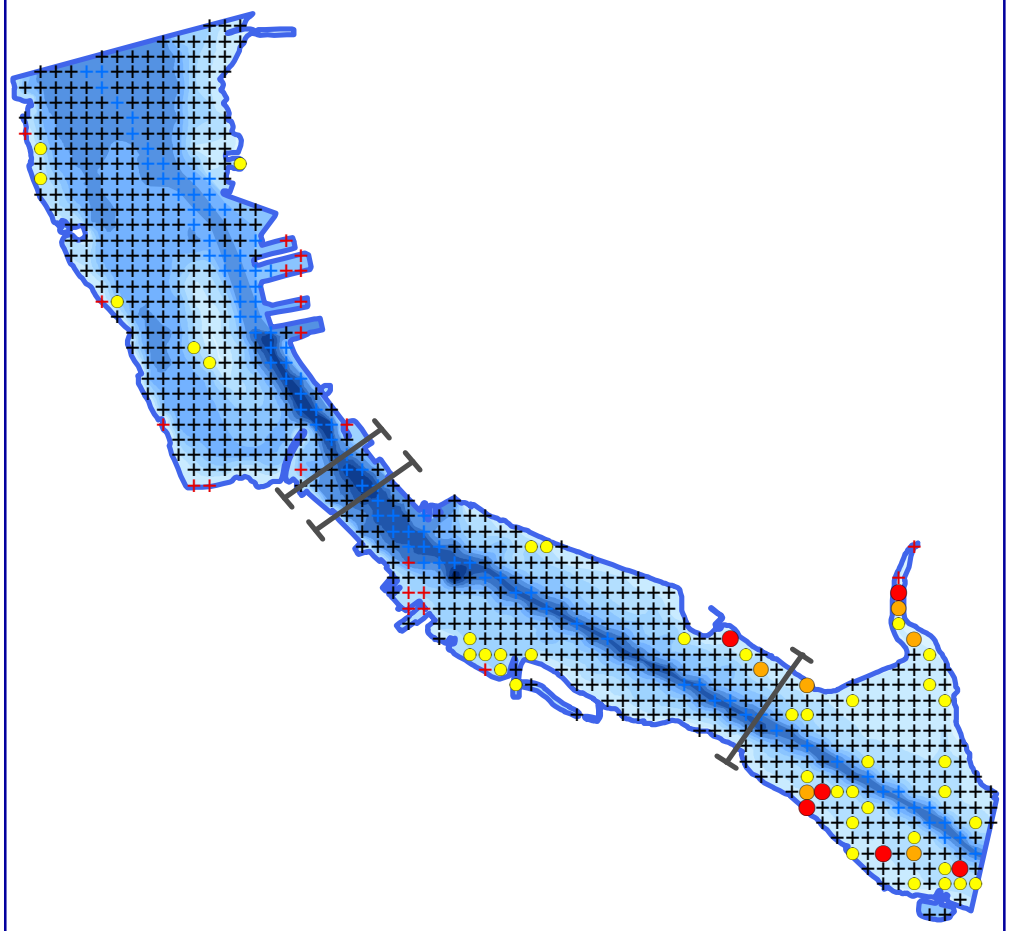
- Total Rake Fullness = 1
- Total Rake Fullness = 2
- Total Rake Fullness = 3
- \+ No Eurasian watermilfoil found
- \+ Deeper than Max Depth of Plants
- \+ Non-Navigable/Obstacle
- Sturgeon Bay Bridge

Map 5
Sturgeon Bay
Door County, Wisconsin

Eurasian watermilfoil
August 2016 & 2023



August 2016



August 2023

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Sources:
Aquatic Plants: Onterra, 2023
Hydro: WDNR, Digitized by Onterra
Map Date: January 18, 2024 JMB

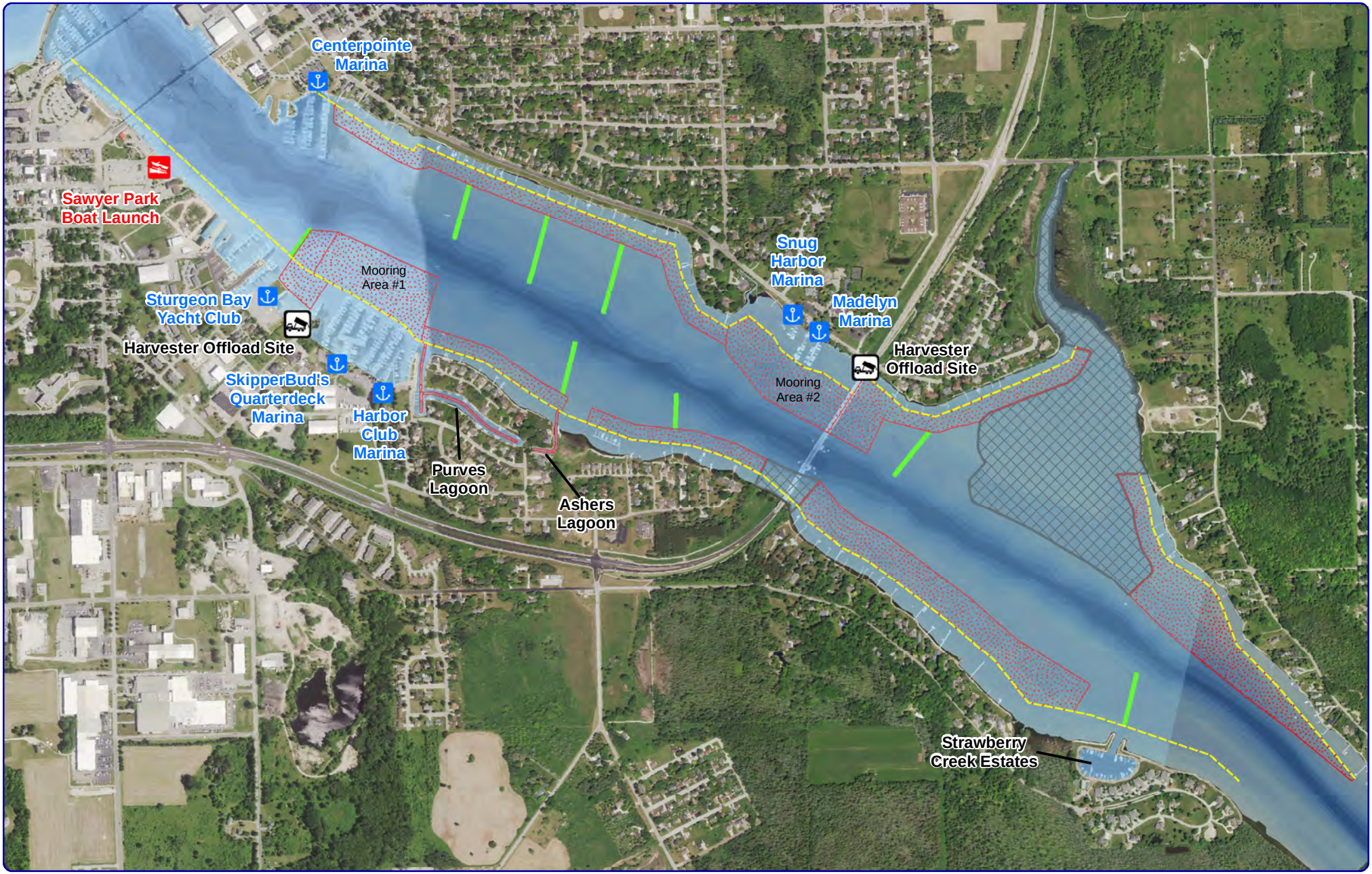
Project Location in Wisconsin

Legend

- Total Rake Fullness = 1
- Total Rake Fullness = 2
- Total Rake Fullness = 3
- \+ No starry stonewort found
- \+ Deeper than Max Depth of Plants
- \+ Non-Navigable/Obstacle
- Sturgeon Bay Bridge

Map 6
Sturgeon Bay
Door County, Wisconsin

Starry Stonewort
August 2016 & 2023



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Sources:
Hydro and Roads: WDNR
Orthophotography: NAIP, 2022
Bathymetry: Modeled by Onterra, 2016
Pierhead Line: City of Sturgeon Bay
Map Date: 3-13-2024 TWH
Filename: SturgeonBay_HarvestingLocations_2024.mxd

Project Location in Wisconsin

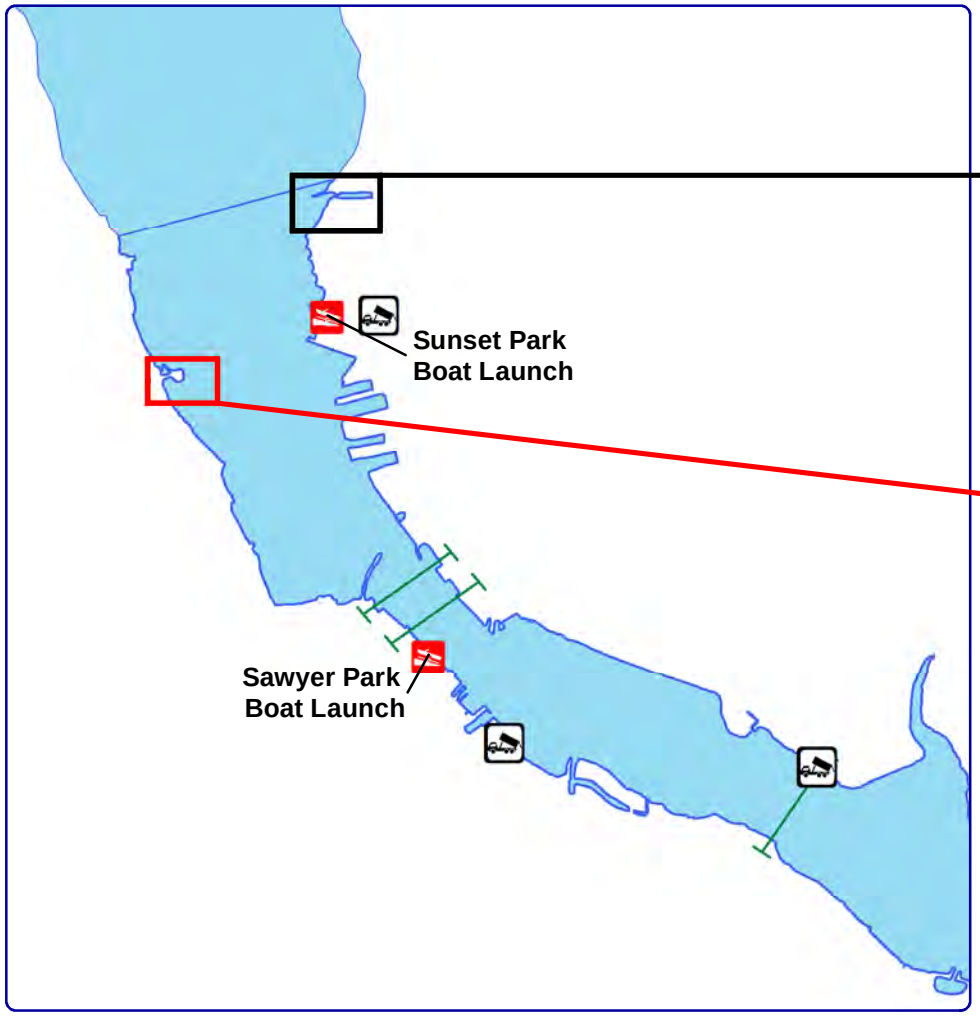
Legend

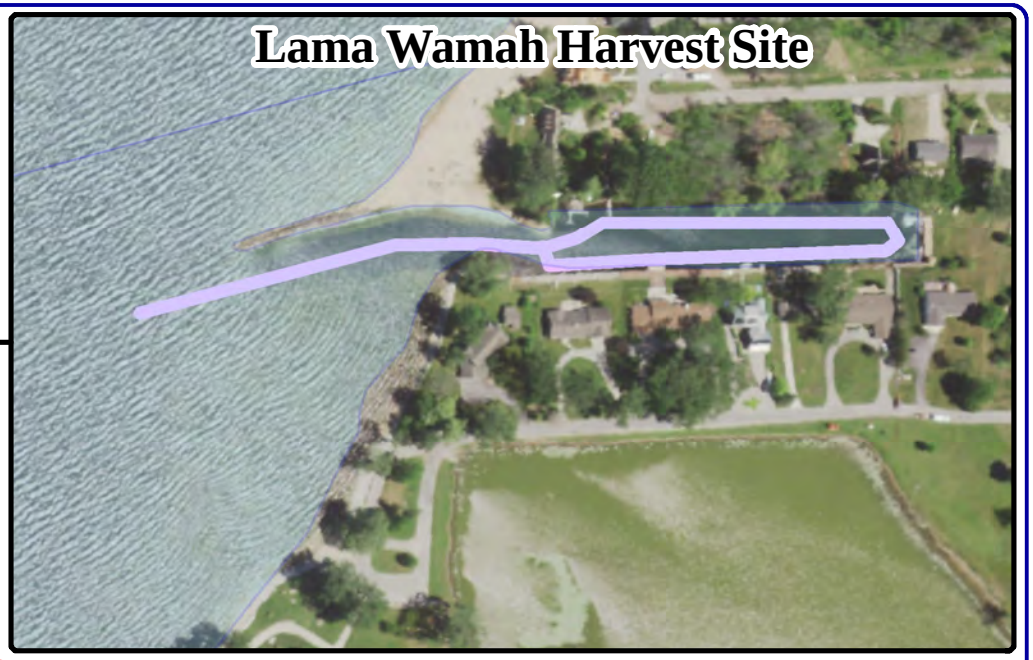
- Pierhead Line
- Harvest Area *(~121 Acres)*
- Access Lane *(30 ft wide, ~3 Acres)*
- No Harvest Area *(~64 Acres)*
- Harvester Offload Site
- Boat Launch

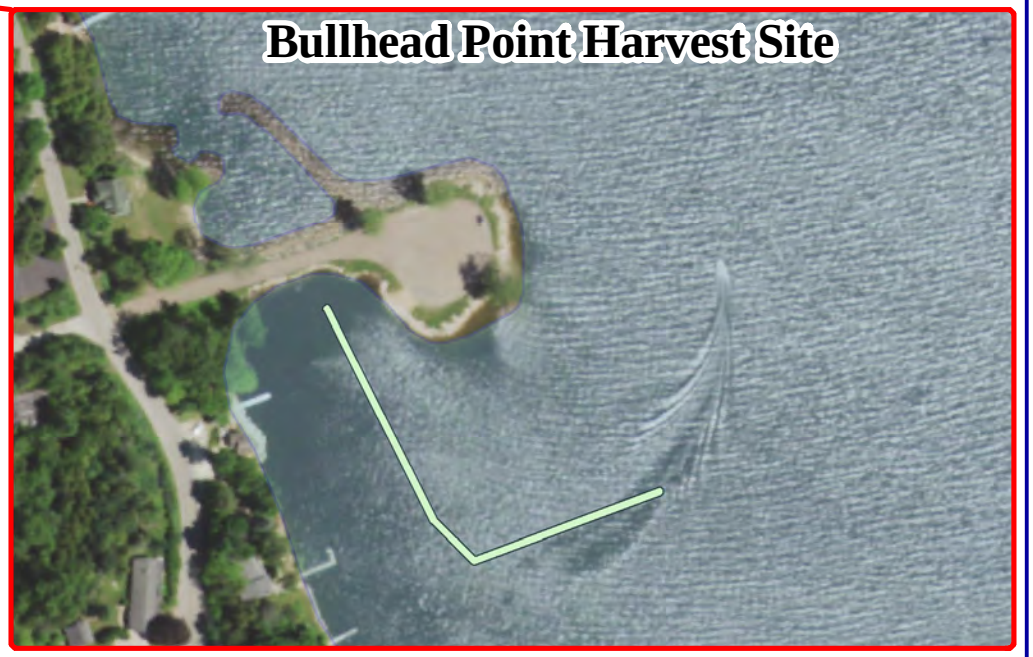
Map 7

Sturgeon Bay
Door County, Wisconsin

Mechanical Harvesting Strategy







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Sources:
Hydro and Roads: WDNR
Orthophotography: NAIP, 2022
Bathymetry: Modeled by Onterra, 2016
Pierhead Line: City of Sturgeon Bay
Map Date: 3-14-2024 TWH
Filename: SturgeonBay_HarvestingLocations_2024.mxd


Project Location in Wisconsin

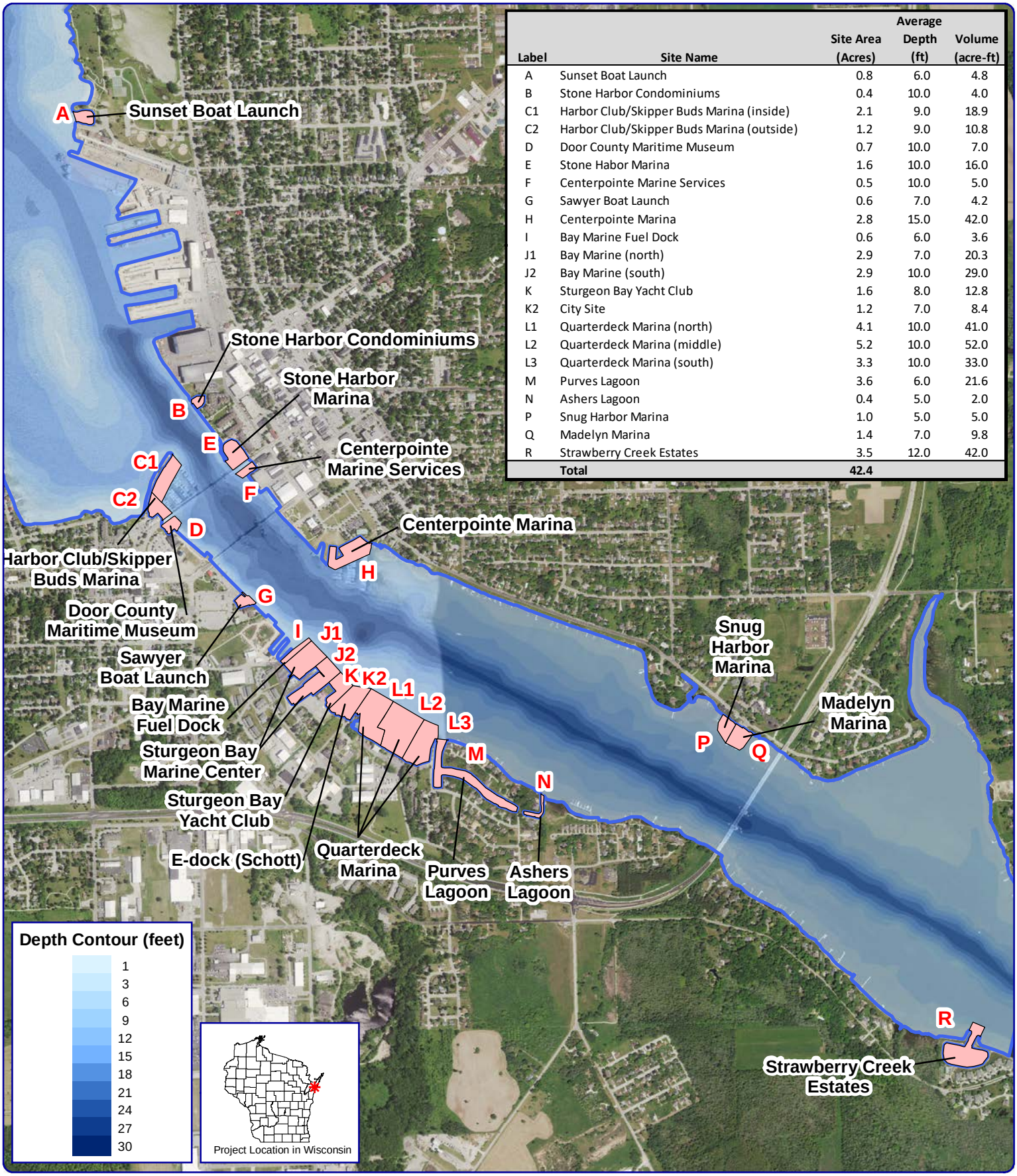
Legend

- Lama Wamah Harvest Lane
  20 ft wide, ~0.8 acres
- Bullhead Point Harvest Lane
  10 ft wide, ~0.1 acres
- Harvester Offload Site
- Boat Launch

Map 8

Sturgeon Bay
Door County, Wisconsin

Mechanical Harvesting Strategy - North



Label	Site Name	Site Area (Acres)	Average Depth (ft)	Volume (acre-ft)
A	Sunset Boat Launch	0.8	6.0	4.8
B	Stone Harbor Condominiums	0.4	10.0	4.0
C1	Harbor Club/Skipper Buds Marina (inside)	2.1	9.0	18.9
C2	Harbor Club/Skipper Buds Marina (outside)	1.2	9.0	10.8
D	Door County Maritime Museum	0.7	10.0	7.0
E	Stone Habor Marina	1.6	10.0	16.0
F	Centerpointe Marine Services	0.5	10.0	5.0
G	Sawyer Boat Launch	0.6	7.0	4.2
H	Centerpointe Marina	2.8	15.0	42.0
I	Bay Marine Fuel Dock	0.6	6.0	3.6
J1	Bay Marine (north)	2.9	7.0	20.3
J2	Bay Marine (south)	2.9	10.0	29.0
K	Sturgeon Bay Yacht Club	1.6	8.0	12.8
K2	City Site	1.2	7.0	8.4
L1	Quarterdeck Marina (north)	4.1	10.0	41.0
L2	Quarterdeck Marina (middle)	5.2	10.0	52.0
L3	Quarterdeck Marina (south)	3.3	10.0	33.0
M	Purves Lagoon	3.6	6.0	21.6
N	Ashers Lagoon	0.4	5.0	2.0
P	Snug Harbor Marina	1.0	5.0	5.0
Q	Madelyn Marina	1.4	7.0	9.8
R	Strawberry Creek Estates	3.5	12.0	42.0
	Total	**42.4**		

N
W E
S
1,500
Feet

Onterra LLC
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920.338.8860
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Sources:
Roads & Hydro: WDNR
Orthophotography: NAIP, 2022
Bathymetry: Onterra, 2016
Map Date: 3-14-2024TWH
Filename:StugeonBay_Potential Herbicide 2024mxd

Legend

Potential Herbicide Control Block

Map 9
Sturgeon Bay
Door County, Wisconsin
Potential Herbicide Control Blocks: Updated 2024