INTRODUCTION

Photo 1. Winslow Lake, Oconto County.

Winslow Lake, Oconto County, is a 68 acre drainage lake with a maximum depth of 34 feet (Photo 1). The lake's water levels are artificially elevated by a dam of the outlet which leads to the First South Branch of the Oconto River. Eurasian water milfoil (EWM) was first observed in Winslow Lake in 2012. It was later determined, through genetic testing completed by Grand Valley State University to be hybrid water milfoil (*Myriophyllum spicatum x M. sibiricum*, HWM). The Wisconsin Department of Natural Resources (WDNR) completed a point-intercept survey in 2014 and confirmed its presence within the lake. In early 2015, the Winslow Shores Property Owners Association (WSPOA) partnered with the Town of Riverview to apply for an Aquatic Invasive Species Early Detection and Response grant (AIS-EDR). With the help of Onterra, LLC, they were able to secure funding for 2015-2017 to monitor and control HWM within Winslow Lake. The goals of the project include determining the extent of the HWM population in the lake and creating a control strategy.

Based on the HWM population observed in 2015, a professional hand-harvesting control strategy was determined to be the most appropriate method for HWM control. Professional hand-harvesting efforts conducted in 2015 and 2016 on Winslow Lake were met with encouraging results with reductions of HWM being observed in the targeted areas and little change in the overall lake-wide population. A professional HWM removal strategy was once again recommended in 2017 on Winslow Lake. This report discusses the HWM control and monitoring activities conducted during the final year (2017) of this three year project.

MONITORING METHODOLOGIES

A set of HWM mapping surveys were used within this project to coordinate and qualitatively monitor the hand-harvesting efforts (Figure 1). The first monitoring event on Winslow Lake in 2017 was the Early Season Aquatic Invasive Species Survey (ESAIS). This late-spring/early-summer survey provides an early look at the lake to help guide the hand-harvesting management to occur on the system. Following the hand-harvesting, Onterra ecologists completed the Late-Summer HWM Peak-Biomass Survey, the results of which serve as a post-treatment assessment of the hand-harvesting. The hand-removal

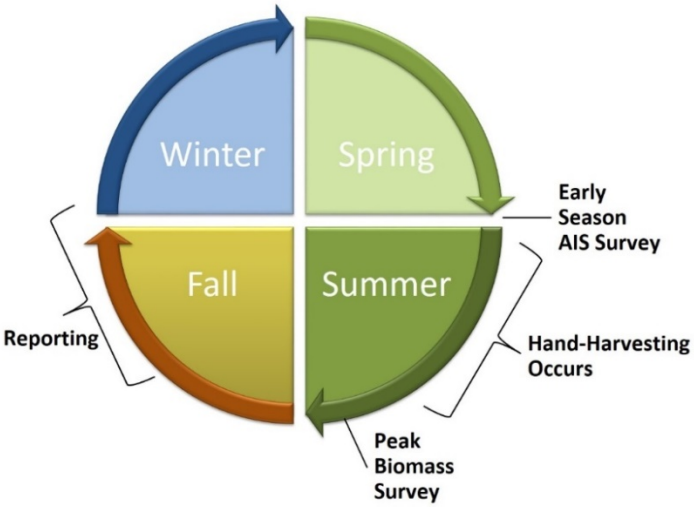


Figure 1. Project timeline diagram.

program would be considered successful if the density of HWM within the hand-removal areas was found to have decreased from the ESAIS Survey to the Late-Summer Peak-Biomass Survey.

EARLY SEASON AIS SURVEY RESULTS (PRE-HAND-HARVESTING)

Onterra ecologists completed the Early-Season AIS Survey on June 5, 2017. The HWM population was mapped by using either 1) point-based or 2) area-based methodologies. Large colonies >40 feet in diameter are mapped using polygons (areas) and were qualitatively attributed a density rating based upon a five-tiered scale from *Highly Scattered* to *Surface Matting*. Point-based techniques were applied to HWM locations that were considered as *Small Plant Colonies* (<40 feet in diameter), *Clumps of Plants*, or *Single or Few Plants*.

While HWM is usually not at its peak growth at this time of year, the water is typically clearer during the early summer allowing for more effective viewing of submersed plants, and HWM is often growing higher in the water column than many of the native aquatic plants at that time of year. The HWM mapped during the Early-Season AIS Survey is refined during the Late-Summer Peak-Biomass survey. In addition, the locations of HWM occurrences located during early summer are provided to professionals or volunteers to aid in their hand-removal efforts. Additionally, two other exotic plants commonly found in Wisconsin, Curly-leaf pondweed (CLP, *Potamogeton crispus*) and Pale Yellow Iris (*Iris pseudacorus*), are usually at their peak growth stage (or bloom) in early summer.

The field crew noted good survey conditions with sunny skies during the survey. A secchi disk reading of 16 feet was taken during the survey indicating good water clarity. Colonized areas of HWM were located near the private access location and dam as well as in the northernmost bay of the lake (Map 1). Other areas along the near shore stretches of the southern and western shoreline also contained *highly scattered* or *scattered* colonies. Additional point-based HWM occurrences comprised of *single or few plants*, *clumps of plants* or *small plant colonies* were located in several other areas of the lake (Map 1).

HAND-HARVESTING MANAGEMENT ACTIONS

The WSPOA contracted with Aquatic Plant Management, LLC (APM) to conduct professional hand-harvesting of HWM in 2017. APM utilizes Diver Assisted Suction Harvest (DASH) allowing for HWM to be suctioned out of the lake creating minimal fragmentation and spread of the plant. The DASH system is considered a form of mechanical harvesting and thus requires a WDNR permit prior to being implemented. Multiple divers from APM conducted hand-harvesting activities on July 24-26 & August 18, 2017 spending a total of 21 hours and 50 minutes (96 combined diver hours) actively hand-harvesting. Divers from APM removed a total of approximately 177.5 cubic feet of vegetation of which approximately 158.5 cubic feet was HWM. Additional harvest of incidental by-catch of native vegetation including pondweeds, muskgrasses and lily pads were documented (Table 1, Appendix A). Additional details of the hand-harvesting efforts as reported by APM are included as an appendix to this report (Appendix A).

Table 1. Winslow Lake, 2017 professional hand-harvesting activities.

Site Location	Hours Underwater	Vegetation removed (cubic feet)
Near Landing/dam	9.26	84.50
Northern bay	10.92	79.00
Other sites	1.66	14.00
Total	21.84	177.50

Volunteer based efforts to remove HWM from known locations throughout the lake totaling approximately 35 hours were undertaken by WSPOA members in 2017. These efforts were focused in shallow waters near docks and along the shoreline near the riparian owners' properties.

LATE-SUMMER HWM PEAK BIO-MASS SURVEY RESULTS (POST-HAND-HARVESTING)

The Late-Summer HWM Peak Bio-mass Survey was conducted on September 26, 2017 to qualitatively assess the professional hand-harvesting efforts as well as to understand the peak growth (peak-biomass) of the HWM population. Conditions for the survey were favorable with cloudy skies and calm winds. Much like during the ESAIS survey, HWM was searched for within the entire littoral zone of the lake during the meander survey.

Prior to hand-harvesting, a *dominant* and *scattered* colony of HWM was present near the dam and access location on Winslow Lake. Professional harvesting efforts at this location included the use of DASH and approximately 9.26 hours of effort with multiple divers yielded 84.5 cubic feet of vegetation removed. Following the harvesting efforts, the HWM population in this site was reduced to a smaller and much less dense *highly scattered* colony along with a few *clumps of plants* or *single or few plants* in the vicinity (Figure 2).

In the northernmost bay of the lake, several pockets of dense HWM colonies have historically been documented including in June 2017 when a highly dominant, dominant and highly scattered colony was delineated (Figure 2). Professional harvesting efforts undertaken in this part of the lake included 10.92 hours underwater actively harvesting approximately 79 cubic feet of vegetation (Table 1). Some reduction in the HWM population was observed in this part of the lake during the late-summer survey, most notably in the northeastern corner of the bay where a highly dominant colony previously mapped was reduced to a smaller colony that was scattered in density (Figure 2).

Additional HWM harvesting efforts were spent by divers from APM in known areas including along portions of the western shoreline of the lake. These efforts totaled approximately 14 cubic feet of vegetation harvested over 1.66 hours underwater (Table 1).

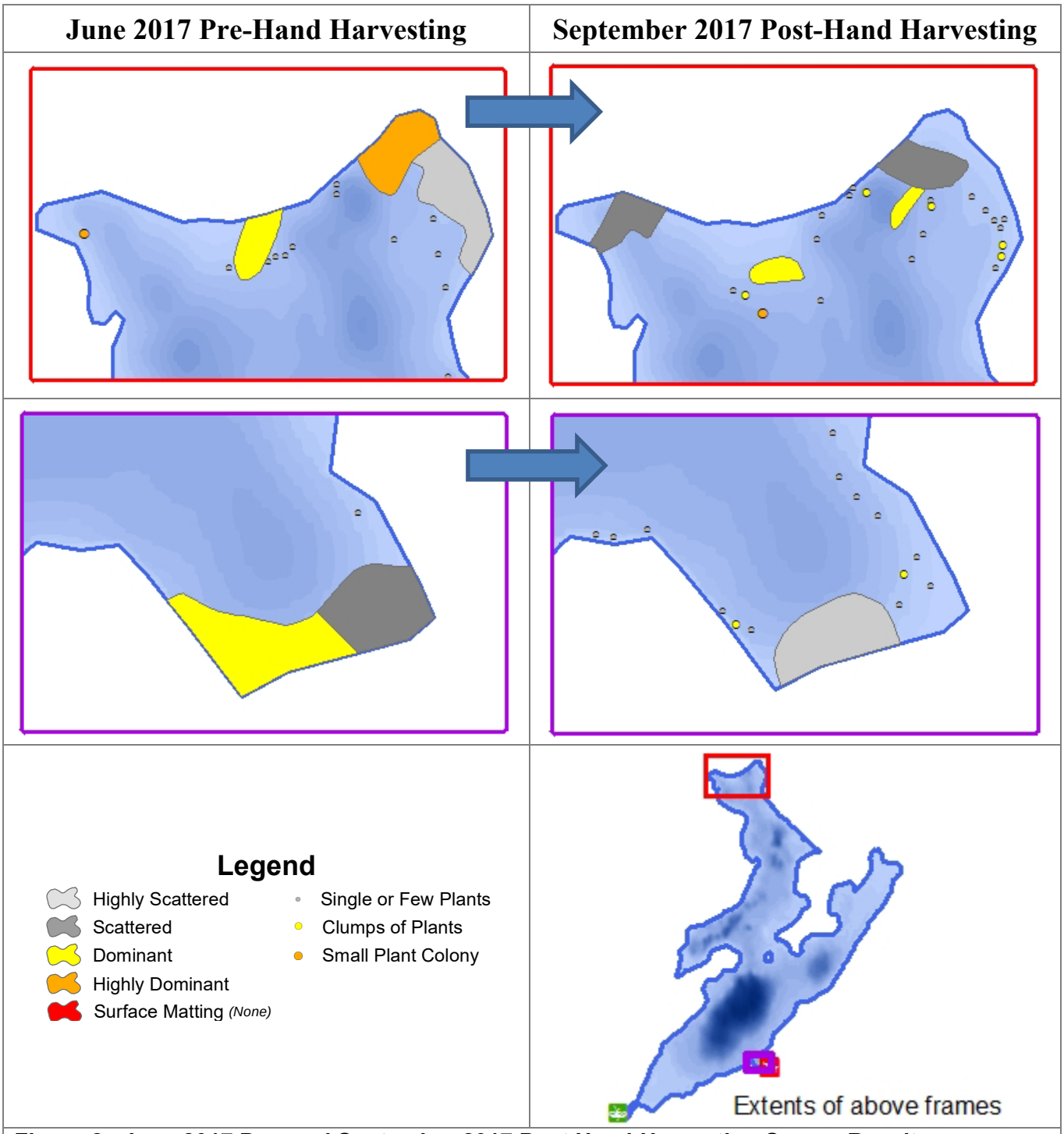


Figure 2. June 2017 Pre- and September 2017 Post Hand-Harvesting Survey Results on Winslow Lake.

During the September peak-biomass survey, low density HWM occurrences were found to be widely spread around the perimeter of the lake (Map 2). The densest colonized areas of HWM were once again located in the northern bay of the lake where several relatively small *scattered* or *dominant* colonies were identified (Map 2). The amount of HWM was found to be slightly greater than in

surveys conducted in 2016 with most of the increase in HWM consisting of point-based occurrences including numerous *single or few plants* and *clumps of plants* found in shallow waters along the southern and western shores of the lake (Map 3).

POINT INTERCEPT SURVEY RESULTS

The whole-lake point-intercept method as described by the WDNR Bureau of Science Services (PUB-SS-1068 2010) was used to complete a quantitative evaluation of the occurrences of non-native and native aquatic plant species. The 2017 survey is a replication of the point-intercept surveys conducted on the lake in 2014 by the WDNR and thus are comparable allowing for a better understanding of the plant dynamics over time. The littoral frequency of occurrence (LFOO) of HWM was found to be 0.8% in 2017, compared to 2.8% in 2014 which is not statistically different between the two surveys.

In 2017, aquatic plants were found growing to a depth of 27 feet, whereas the previous survey in 2014 found plants out to 29 feet. Of the 17 aquatic plant species recorded on the rake during the 2017 point-intercept survey, muskgrasses, white water lily and floating-leaf pondweed were the three-most frequently encountered species (Figure 3).

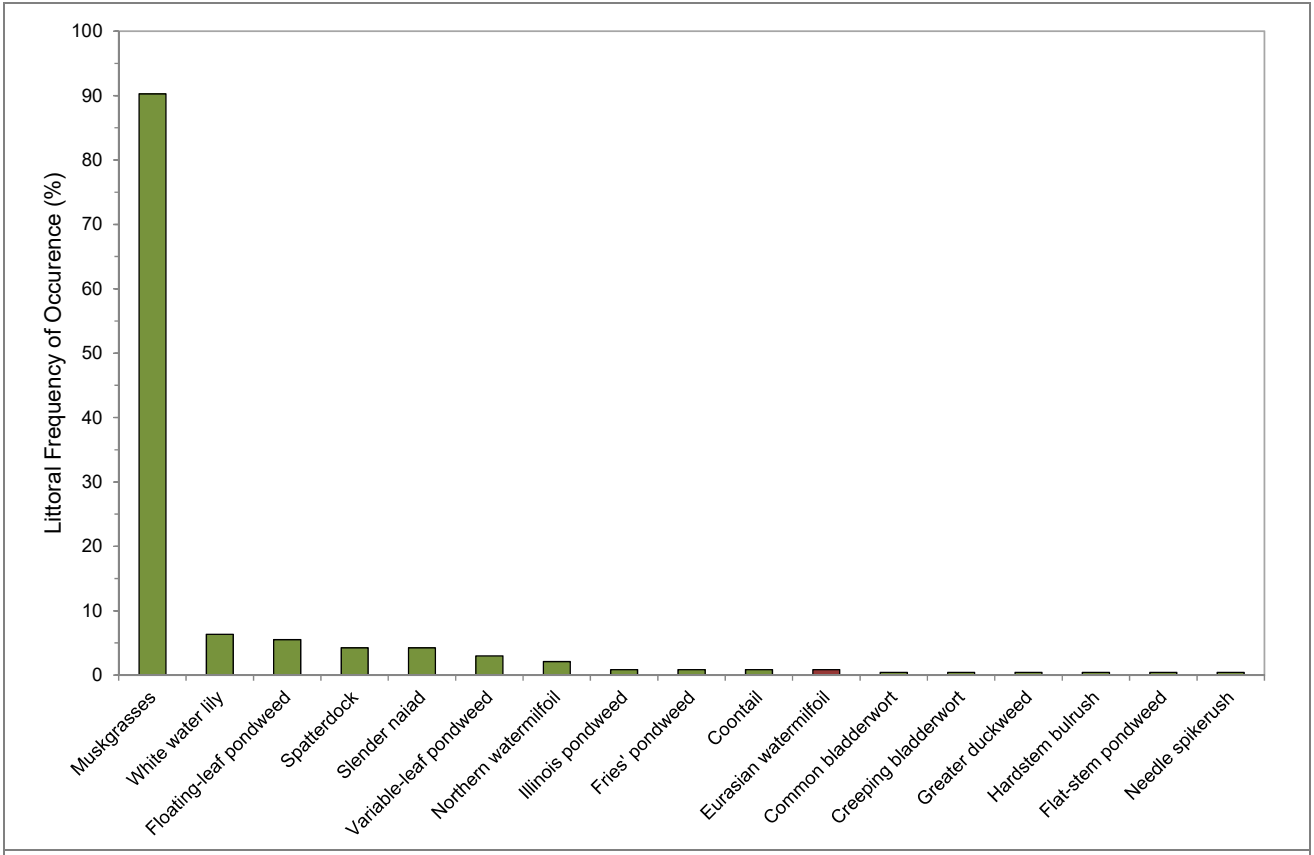


Figure 3. 2017 Littoral frequency of occurrence of Aquatic Plants in Winslow Lake.

Muskgrasses, by far the most commonly encountered species during the point-intercept surveys on Winslow Lake, are genera of macroalgae. Muskgrasses had a LFOO of 90.3% in 2017 which is similar to the 88.8% LFOO observed in 2014. These macroalgae require lakes with good water clarity,

and their large beds stabilize bottom sediments. Studies have also shown that muskgrasses sequester phosphorus in the calcium carbonate incrustations which from on these plants, aiding in improving water quality by making the phosphorus unavailable to phytoplankton (Coops 2002).

Northern watermilfoil (Myriophyllum sibericum) is a native aquatic plant species that has similar morphological characteristics to HWM. The 2017 point-intercept survey found the northern watermilfoil population to have a LFOO of 2.1% as compared to 0.8% for HWM (Table 2). Distinguishing between these two species can be difficult at times to an untrained eye, and often times a closer inspection of the plant may be required to tell the two species apart. A chi-square analysis for all species identified in the point-intercept surveys on Winslow Lake is displayed on Table 2.

Table 2. Chi-Square analysis of Winslow Lake Aquatic Plant Surveys.

	Scientific Name	Common Name	LFOO (%)		2014-2017	
			2014	2017	% Change	Direction
Dicots	*Myriophyllum spicatum*	Eurasian water milfoil	2.8	0.8	-69.7	▼
	Nymphaea odorata	White water lily	5.6	6.4	13.5	▲
	Nuphar variegata	Spatterdock	1.2	4.2	253.1	▲
	Myriophyllum sibiricum	Northern water milfoil	0.4	2.1	429.7	▲
	Ceratophyllum demersum	Coontail	1.2	0.8	-29.4	▼
	Utricularia vulgaris	Common bladderwort	0.0	0.4		▲
	Utricularia gibba	Creeping bladderwort	0.0	0.4		▲
Non-Dicots	*Chara spp.*	Muskgrasses	88.8	90.3	1.6	▲
	Potamogeton natans	Floating-leaf pondweed	4.8	5.5	14.8	▲
	Najas guadalupensis	Southern naiad	7.6	0.0	-100.0	▼
	Freshwater sponge	Freshwater sponge	0.4	5.9	1383.1	▲
	Najas flexilis	Slender naiad	0.0	4.2		▲
	Potamogeton gramineus	Variable-leaf pondweed	0.4	3.0	641.5	▲
	Potamogeton zosteriformis	Flat-stem pondweed	1.2	0.4	-64.7	▼
	Potamogeton illinoensis	Illinois pondweed	0.0	0.8		▲
	Potamogeton friesii	Fries' pondweed	0.0	0.8		▲
	Spirodela polyrhiza	Greater duckweed	0.0	0.4		▲
	Schoenoplectus acutus	Hardstem bulrush	0.0	0.4		▲
	Filamentous algae	Filamentous algae	0.0	0.4		▲
	Elodea canadensis	Common waterweed	0.4	0.0	-100.0	▼
	Eleocharis acicularis	Needle spikerush	0.0	0.4		▲

▲ or ▼ = Change Statistically Valid (Chi-square; α = 0.05)
▲ or ▼ = Change Not Statistically Valid (Chi-square; α = 0.05)

CONCLUSIONS & DISCUSSION

The professional hand-harvesting efforts conducted in 2017 on Winslow Lake were met with positive results with reductions of HWM being evident in the targeted areas. A noticeable reduction in HWM was evident after the harvesting efforts near a high priority site near the dam and access location. Volunteer removal efforts likely slowed the rate of HWM expansion within the areas targeted. Hybrid water milfoil continues to be present at relatively low densities in several locations of the lake with a few areas containing small, dense colonies.

Professional and volunteer based HWM removal efforts conducted in 2015-2017 have likely slowed the expansion or spread of HWM in the lake and have helped to maintain the HWM population at a

relatively low population (Map 3). At current levels, the HWM population is likely not causing a significant negative impact on the ecology of the lake and likely is not degrading the aesthetic or recreational services the lake provides.

Professional harvesting summary 2015-2017

The amount of effort spent through professional hand-harvesting of HWM has increased incrementally each year from 2015-2017. A total of 248 combined diver hours have been spend over the past three year and has yielded approximately 290.9 cubic feet of HWM harvest during that time span (Table 3). Harvest totals in 2017 were greater than the previous two years as a result of utilizing Diver Assisted Suction Harvesting in part of the lake which can increase the yield of HWM harvested compared to traditional diving methods alone.

Table 3. Winslow Lake, 2015-2017 professional hand-harvesting activities.

Year	Combined Dive Time (Hours)	HWM Removed (Cubic Feet)
2015	65.7	63.9
2016	86.6	68.5
2017	96	158.5
Total	**248.3**	**290.9**

WSPOA Volunteer harvesting activities summary 2015-2017

During the course of this project, the WSPOA has devoted at least 152 documented hours of efforts to remove HWM within the lake. Volunteer based efforts to remove HWM from known locations throughout the lake totaled 85.5 hours in 2015, 31.5 hours in 2016, and 35 hours in 2017 (Table 4). These efforts were focused in shallow waters near docks and along the shoreline near the riparian owners' properties.

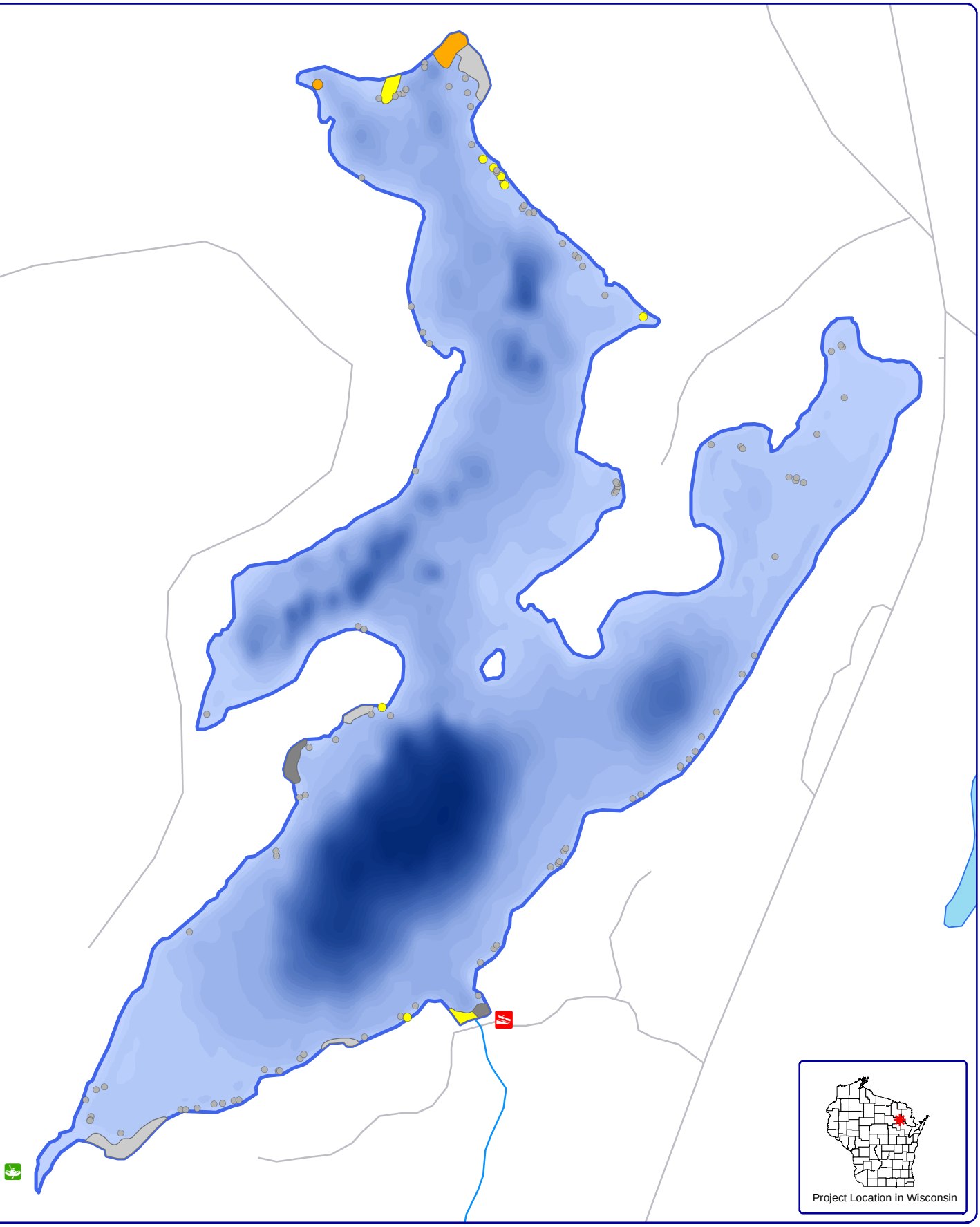
Table 4. 2015-2017 WSPOA HWM hand-harvesting activities in Winslow Lake.

Year	WSPOA HWM Hand Pulling Efforts (Hours)
2015	85.5
2016	31.5
2017	35
Total	**152**

Based on the current known HWM population in Winslow Lake, herbicide control is not warranted. The most appropriate control method for the current HWM population in the lake is likely through a coordinated hand removal effort utilizing both professional and volunteer based methods. The WSPOA was recently awarded a WDNR AIS-EDR grant which provides funding for HWM monitoring and control from 2018-2020. This three-year project is designed similar to the previous project competed in 2017 in that a coordinated hand-harvesting control strategy will be implemented during each year with professional monitoring surveys before and after the harvesting efforts (Figure

1). A point-intercept survey is scheduled for the summer of 2020 to assess the native plant population in the lake for comparison to past surveys.

Surveys scheduled for 2018 include an early-season AIS survey, which Onterra recommends to occur as early in the growing season spectrum as possible (late-May or early June) in order to provide for a larger window for hand-harvesting activities. Following the conclusion of the hand-harvesting control actions, a late-summer HWM peak biomass survey will be conducted in late-August or September to evaluate the control strategy as well as to allow for developing a control strategy for the following year.



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Feet

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Sources:
Roads and Hydro: WDNR
Bathymetry: Onterra, 2015 - processed by Navico
Plant Survey: Onterra, 2017

Map Date: June 12, 2017
Filename: *Winslow_Oconto_EWM_June17.mxd*

Legend

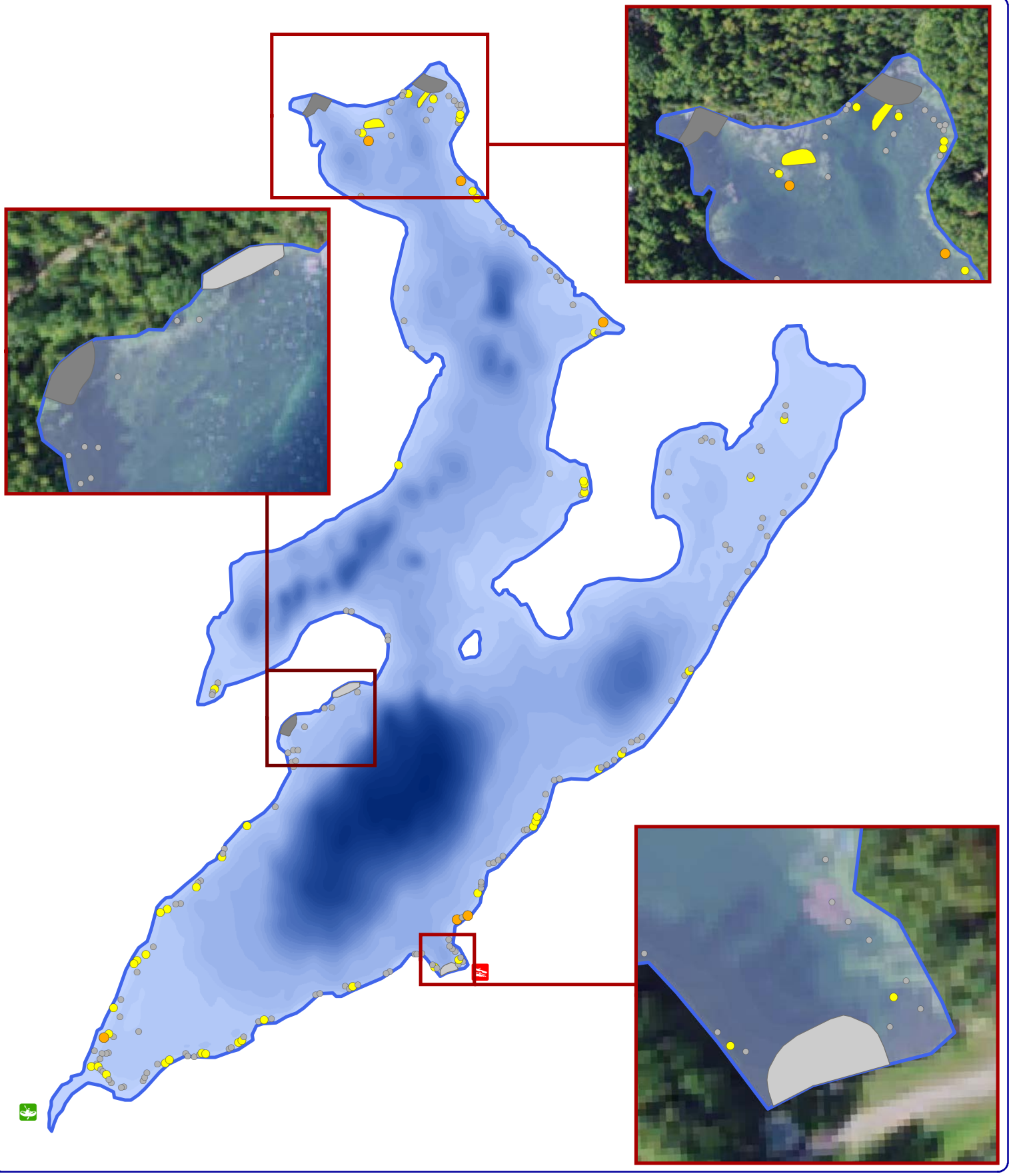
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting *(None)*
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony

Map 1

Winslow Lake

Oconto County, Wisconsin

2017 ESAIS HWM Survey Results



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Sources:
Roads and Hydro: WDNR
Orthophotography: NAIP, 2015
Plant Survey: Onterra, 2017
Map Date: October 9, 2017
Filename: *Winslow_Oconto_EWMPB_Summer17.mxd*

Project Location in Wisconsin

Legend

- Highly Scattered *(None)*
- Scattered
- Dominant
- Highly Dominant *(None)*
- Surface Matting *(None)*
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony

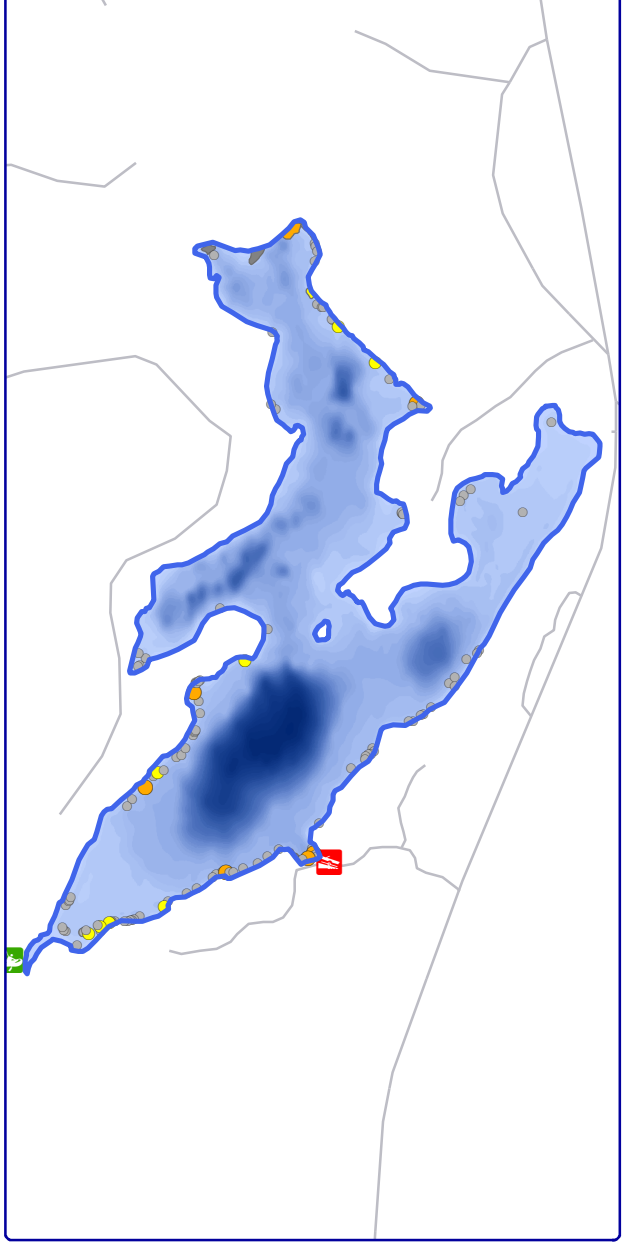
Map 2

Winslow Lake

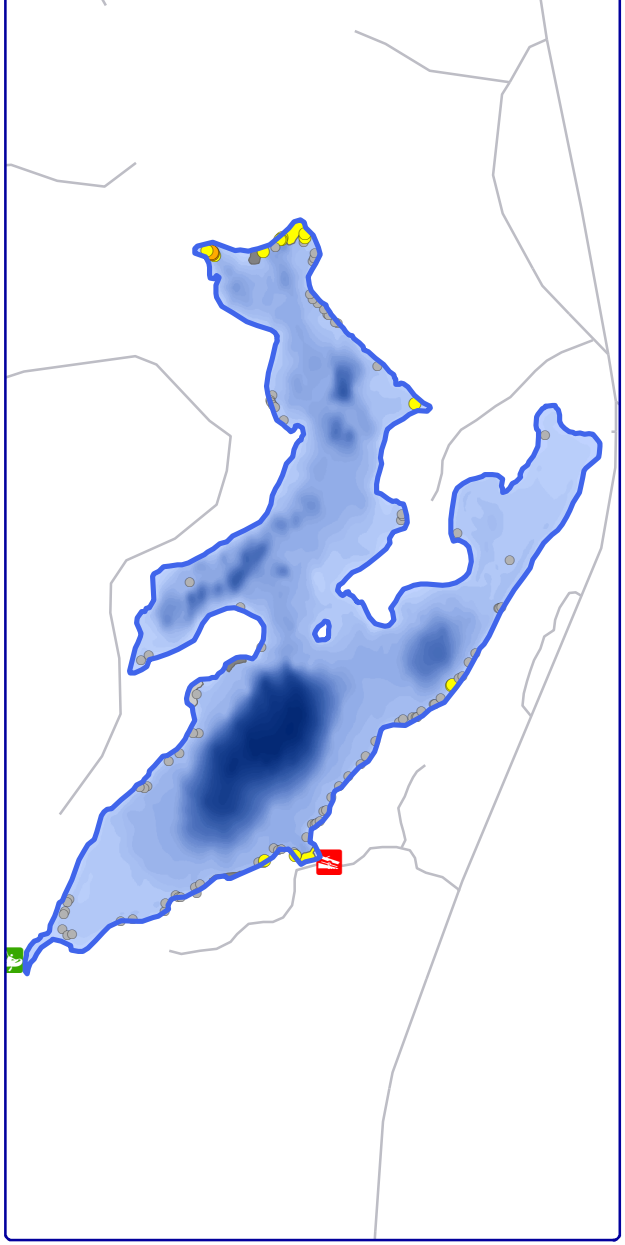
Oconto County, Wisconsin

September 2017
HWM Survey Results

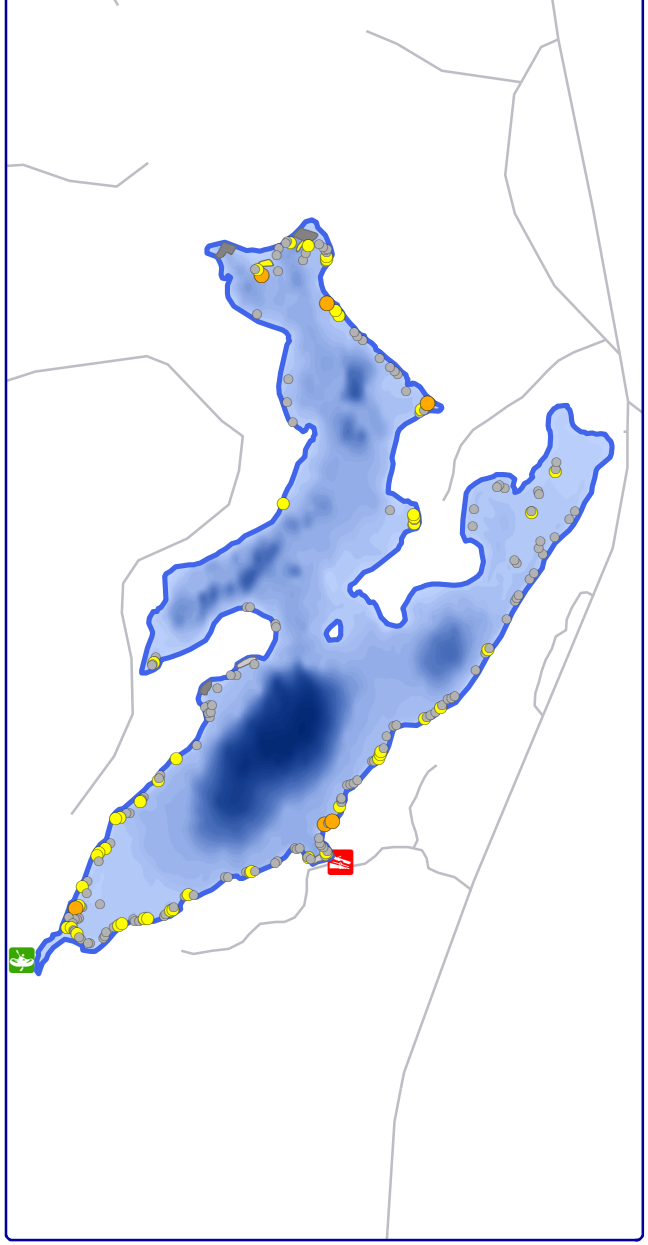
September 2015 HWM Results



September 2016 HWM Results



September 2017 HWM Results



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Sources:
Roads and Hydro: WDNR
Aquatic Plants: Onterra, 2015-2017
Map Date: January 9, 2018
File Name: Map3_Winslow_HWM_Progression_2015-2017.mxd

Project Location in Wisconsin

Legend

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting *(none found)*
- Single or Few Plants
- Clump of Plants
- Small Plant Colony

Map 3

Winslow Lake

Oconto County, Wisconsin

HWM Progression 2015-2017