INTRODUCTION

Lost Lake, Vilas County is a 544 acre lake with a maximum depth of 20 feet. During the 2013 growing season, a suspicious milfoil plant was confirmed by the Vilas County Land and Water Conservation Department to be Eurasian water milfoil (*Myriophyllum* spicatum, EWM). Onterra, LLC was contracted by the Lost Lake Protection and Rehabilitation District (LLPRD) to complete a focused EWM survey in October 2013 within the area of the lake where EWM had been located. Onterra ecologists located two colonized areas of EWM as well as numerous additional occurrences during this survey.

Photo 1. Lost Lake, Vilas County.

Based upon the 2013 EWM findings, a professional hand-harvesting strategy was proposed for EWM control in Lost Lake during 2014. With Onterra's assistance, the LLPRD successfully secured a Wisconsin Department of Natural Resources (WDNR) Aquatic Invasive Species (AIS) Early Detection and Response (EDR) Grant to fund the monitoring and implementation of the control strategy. The control activities conducted in 2014 were found to have had little impact on the EWM in the areas targeted by hand harvesting as the EWM population expanded. Professional hand-harvesting efforts continued in 2015 at a greater level of effort than 2014 and resulted in very limited control in the targeted areas. Another exotic invasive species, Curly-leaf pondweed (*Potamogeton crispus, CLP*) was located in Lost Lake during surveys conducted in 2014.

The LLPRD (Jim Ulett), Onterra (Tim Hoyman and Eddie Heath), and WDNR (Kevin Gauthier) held a teleconference in December 2015 where a strategy was devised to monitor the newly discovered EWM and CLP populations in 2016 in absence of active management to determine if further population increases may suggest herbicide treatment strategies are warranted, or if the population plateaus and active management is not needed. This strategy was conveyed in the 2015 AIS Monitoring & Control Strategy Assessment Report as well as the AIS-EDR grant. This report discusses the AIS monitoring efforts conducted in 2016 on Lost Lake.

WDNR 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. Because the state of Wisconsin's waters are managed for multiple uses (Statue 281.11), the WDNR wanted to understand if EWM populations would increase and cause either 1) ecological impacts to the lake and/or 2) reductions in ecosystem services (i.e. navigation, recreation, aesthetics, etc.) to lake users. As outlined in *The Science Behind the "So-Called" Super Weed* (Nault 2016), EWM population dynamics on lakes is not that simplistic.

Like other aquatic plants, EWM populations are dynamic and annual changes in EWM frequency of occurrence have been documented in many lakes, including those that are not being actively managed for EWM control (no herbicide treatment or hand-harvesting program). The data are most clear for unmanaged lakes in the Northern Lakes and Forests Ecoregion (Figure 1). Some lakes, such as Hancock Lake, maintained low EWM populations over the study averaging 2.3% between 2008 and 2015. At these low levels, there are likely no observable ecological impacts to the lake and are no reductions in ecosystem services to lake users. The EWM population of Hancock Lake has increased in recent years to 5.2% in 2015 and over 10% in 2016 (preliminary data not shown in Figure 1).

Eurasian water milfoil populations in other lakes, such as Bear Paw Lake and Little Bearskin Lake trended to almost 25% only to decline to approximately 5% by the end of the study period. There are many factors that could contribute to the decline in the EWM population of these lakes, including climactic conditions and water quality parameters. Little Bearskin is known to contain a robust population of milfoil weevils, and this native insect may be having an impact on the EWM population within the lake. Boot Lake is a eutrophic system with low water clarity (approx. 3-ft Secchi depth) due to naturally high phosphorus concentrations. It is hypothesized that water clarity conditions in some years may favor EWM growth whereas in other years it may keep the population suppressed. Extreme changes in EWM populations like those observed on Weber Lake have also been documented. The EWM population in 2010-2011 was approximately 20% before spiking above 50% in 2012. Then the population declined back to approximately 15% in 2014 and 2015.

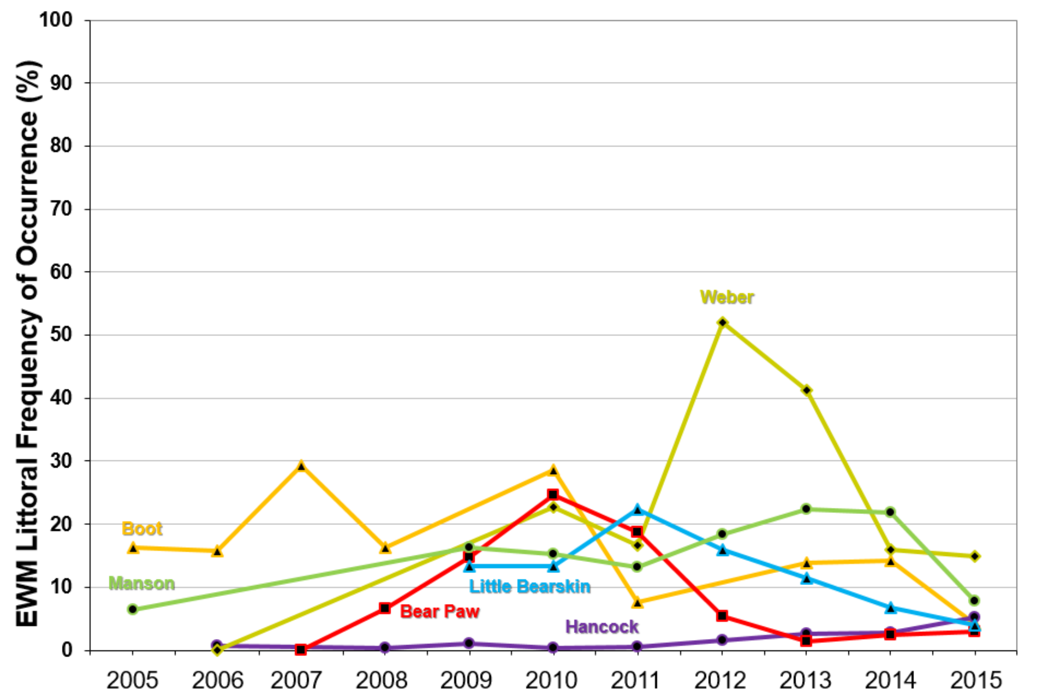


Figure 1. Littoral frequency of occurrence of EWM in the Northern Lakes and Forests Ecoregion without management. Data provided by and used with permission from the WDNR Bureau of Science Services.

The results of the study clearly indicate that EWM populations in unmanaged lakes can fluctuate greatly between years. Following initial infestation, EWM expansion was rapid on some lakes, but overall was variable and unpredictable (Nault 2016). On some lakes, the EWM populations reached a relatively stable equilibrium whereas other lakes had more moderate year-to-year variation. Some lake managers interpret these data to suggest that in some circumstances, it is not appropriate to manage the EWM population as in some years the population may become less. However, even a lowered EWM population of approximately 10% exceeds the comfort level of many riparians because it is potentially approaching a level than may be impactful to the function of the lake as well as not allowing the lake to be enjoyed by riparians as it had been historically.

CURLY-LEAF PONDWEED

Curly-leaf pondweed is a European exotic first discovered in Wisconsin in the early 1900's that has an unconventional lifecycle giving it a competitive advantage over our native plants. The plants begin growing almost immediately after, if not immediately before, ice-out and by early-summer they reach their peak growth. As they are growing, each plant produces numerous turions (asexual reproductive structures) which break away from the plant and settle to the bottom following the plant's senescence in early summer. The deposited turions lie dormant until autumn when they sprout to produce small winter foliage, and they remain in this state until spring foliage is produced. The advanced growth in spring gives the plant a significant head start over native vegetation. In certain lakes, CLP can become so abundant that it hampers recreational activities within the lake. In instances where large CLP populations are present, its mid-summer die-back can cause significant algal blooms spurred from the release of nutrients during the plants' decomposition. However, in some lakes, mostly in northern Wisconsin, CLP appears to integrate itself within the community without becoming a nuisance.

The CLP population was found to have dramatically increased since 2015 during the June 2016 ESAIS survey (Figure 1). Much of the CLP population in the western bay expanded to form large, continuous, and dense colonies in 2016. A total of 17.9 acres of colonized CLP was mapped during the June 2016 survey, all of which was described of as being of *dominant* or greater densities. Approximately 2.0 acres of the CLP was described as *surface matting*, the highest density rating used in the qualitative mapping methodology. An additional 6.7 acres of CLP was described as *highly dominant* during the 2016 survey. These highly visible, very dense CLP colonies completely dominate the aquatic plant population and can significantly inhibit navigation for boaters until the plant dies back in early July.

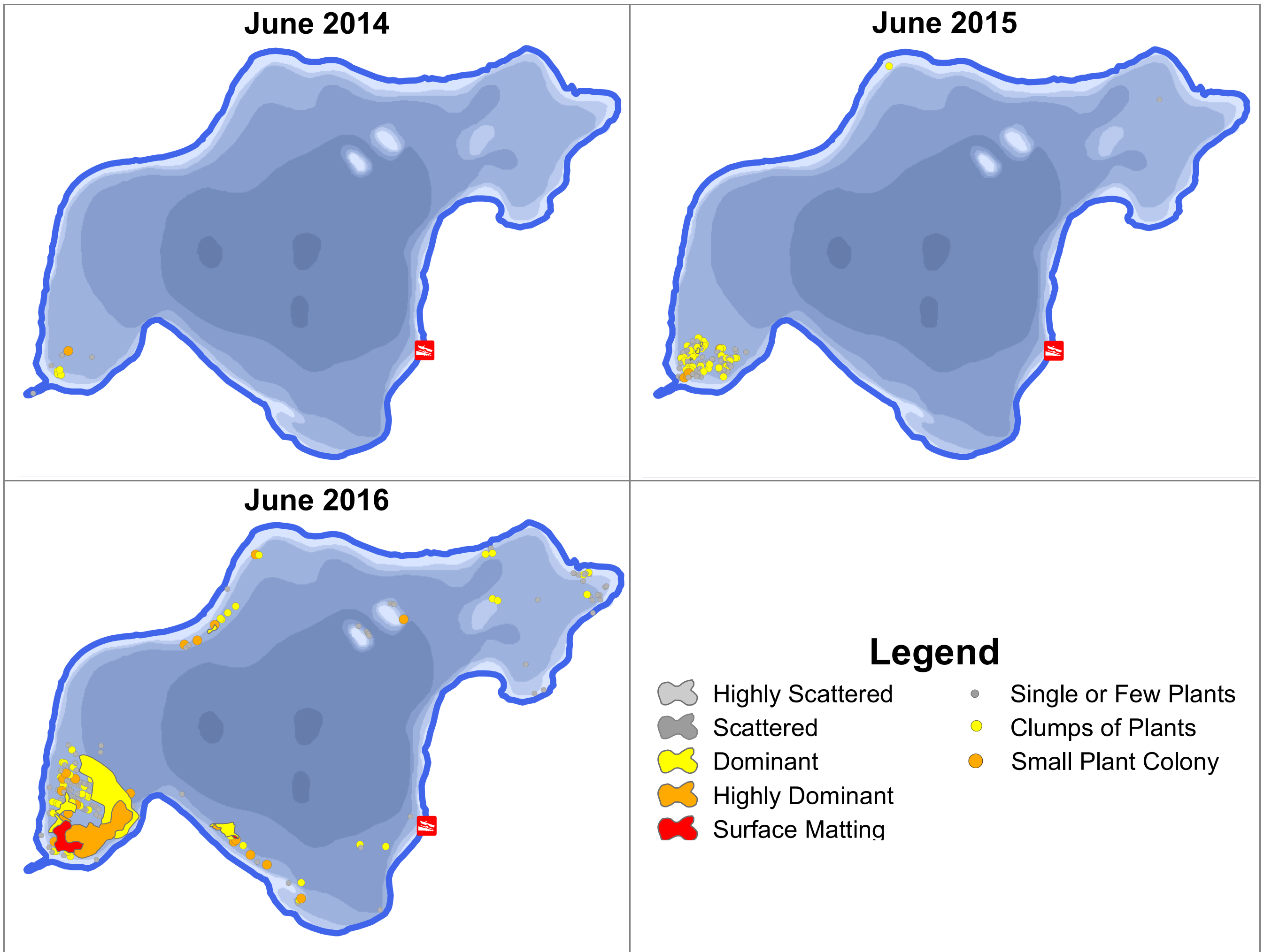


Figure 1. Curly-leaf Pondweed population progression on Lost Lake.

EURASIAN WATERMILFOIL

In late summer of each year, Onterra ecologists survey the entire littoral zone of Lost Lake to understand the EWM population at its peak growth stage for the year (peak-biomass). The largest concentration of EWM was found within the eastern bay of the lake similar as to in 2013-2015 surveys (Figure 2). The EWM population was found to have expanded since 2015 with many areas previously mapped with point-based methods now requiring delineation with area-based mapping (polygons). The majority of the colonized population of EWM was of a *highly scattered* density (28.4 acres). An additional 1.3 acres was of a *scattered* density and 1.8 acres were of a *dominant* density. Several *single or few plant* occurrences were marked in additional parts of the lake during the survey as well.

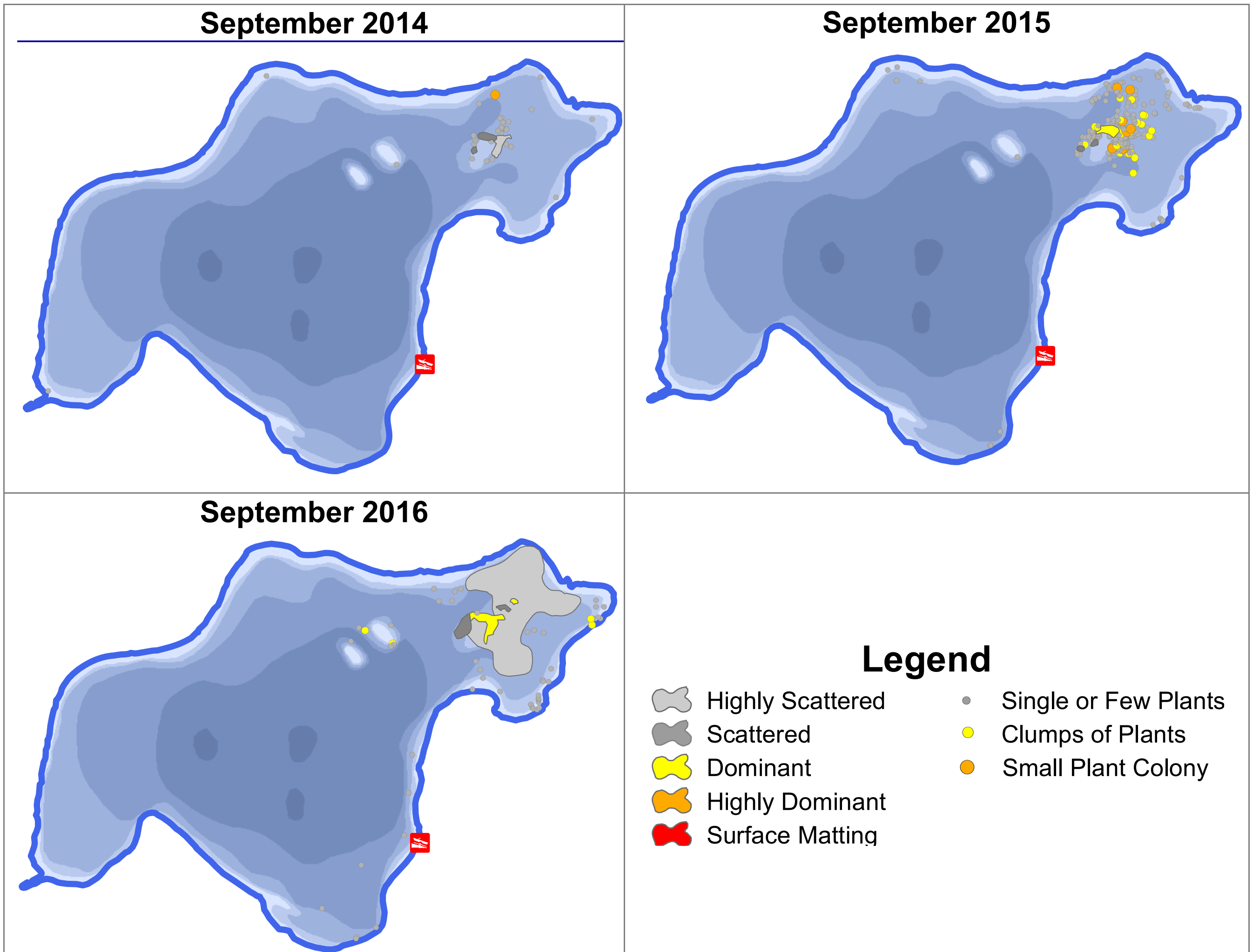


Figure 2. Eurasian Water Milfoil population progression on Lost Lake.

CONCLUSIONS & DISCUSSION

As discussed in the Introduction Section, the LLPRD's 2016 strategy was to monitor the EWM and CLP population within the lake to determine if the populations increased and active management would be warranted in 2017. During 2016, the EWM population was observed to increase but continues to be below levels that are likely not having a substantial impact on the overall ecosystem function nor is the population diminishing the ecosystem services the lake provides (i.e. navigability, recreation, aesthetics). The LLPRD has elected to continue monitoring the EWM population in the absence of active management. If the population continues to increase, they will give additional consideration to intervening with management.

The CLP population has increased greatly since first being detected during June 2014. The population level observed in 2016 may be threatening the function of the ecosystem and causing reductions in ecosystem services to lake users. Traditionally, CLP control consists of numerous annual herbicide treatments conducted a few weeks following ice-off. The treatment will kill each year's plants before they are able to produce reproductive turions (asexual seed-like structures). After multiple years of treatment, the turion supply in the sediment becomes exhausted and the CLP population decreases significantly. Normally a control strategy such as this includes 5 or more years of repetitive treatments to the same areas. Because CLP has only been present in Lost Lake for a few years, it is theorized that the turion base may be small and if a control program is initiated at this time, may not require as many successive treatments as a more established population would.

Until recently, many lake managers believed that mechanically harvesting the above ground CLP biomass early in the season, before turions are produced, would act in a similar manner to herbicides, such that the amount of CLP turion production in mechanically harvested areas would be significantly reduced. However, research conducted by John Skogerboe at the USACE Research and Development Center indicates that any management strategy that fails to kill the entire CLP plant (including rhizomes and root crowns) does not prevent new turion formation. The data indicate that stressed pants tend to produce more turions at internodes, and may be extremely numerous. Turion production has also been shown to occur on the rhizome itself, which would not be removed or killed during mechanical harvesting activities.

An early-season mechanical harvesting program may provide the benefit of removing CLP biomass to increase navigation and recreational activities during June and early July. However, these activities are typically only recommended for lakes that have established CLP populations and are not managing the lake for ecosystem restoration. As discussed above, the mechanical harvesting can lead to increase turion production and the harvesting activity can dislodge and spread turions around the lake.

The LLPRD presented information on the expanded CLP population and potential control options to attendees during its 2016 annual meeting. They voted in favor of increasing their tax levy to include sufficient funds to initiate a CLP control and monitoring strategy using herbicides during the spring of 2017. Map 1 outlies a strategy where a contiguous treatment in the western lobe of the lake would be targeted with liquid endothall at 2.0 ppm active ingredient (ai). This strategy would target approximately 94% of the colonized CLP located during the June 2016 mapping survey. This approach falls in line with current best management practices for spot treating CLP.

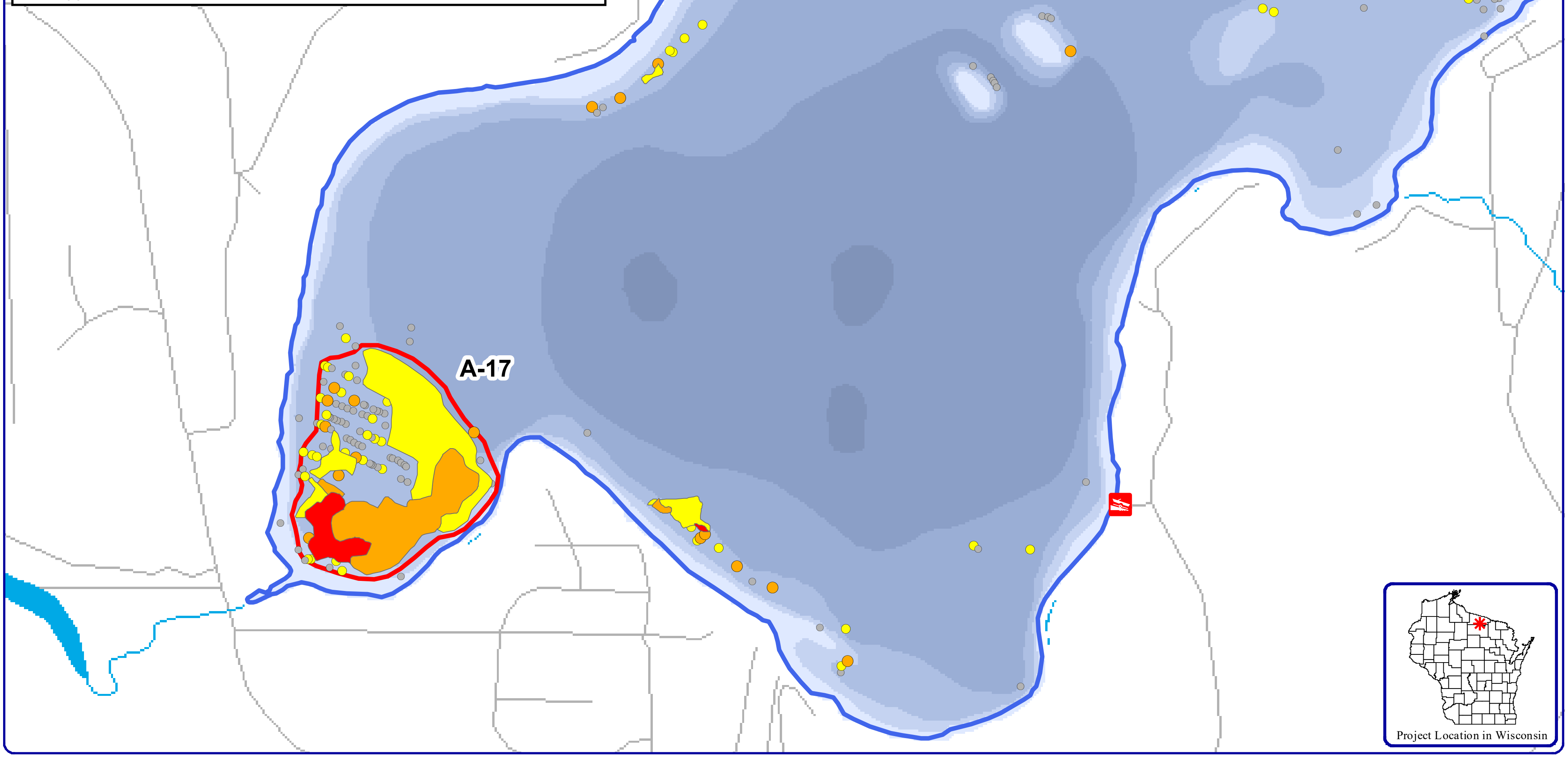
Monitoring AIS control programs typically includes quantitative and qualitative methods. Qualitative monitoring would be accomplished by comparing annual CLP mapping surveys consistent with Figure 1. Quantitative monitoring statistically compares point-intercept data over time in order to understand any changes is the aquatic plant population during a period of active management. To quantitatively understand CLP treatment efficacy, a sub-sample point-intercept survey would be conducted over the targeted area just prior to the treatment and during late-June following the treatment.

The LLPRD has recently been awarded a WDNR AIS Education, Prevention, and Planning Grant to update the district's Comprehensive Management Plan. As a part of this project, a lake-wide point-intercept survey would be conducted in 2017 and compared to past surveys to document changes in the aquatic plant community over time.

Preliminary 2017 CLP Herbicide Treatment

Site	Acres	Ave. Depth (feet)	Volume (ac-ft)	Application Area Dose: Endothall PPM ai	Application Area Dose: Aquathol K (gallons)
A-17	**29.5**	7.0	206.5	2.0	265.4

** 0.07 ppm ai lake-wide concentration when mixed*



N
W E
S
900
Feet

Legend

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clump of Plants
- Small Plant Colony
- Proposed 2017 CLP Treatment Area

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Sources:
Aquatic Plants: Onterra, 2016
Bathymetry: WDNR, 1964: digitized by Onterra

Map date: February 14, 2017
Filename: LostVilas_CLP_T2017_Preliminary.mxd

Map 1
Lost Lake
Vilas County, Wisconsin

June 2016 CLP Locations & Proposed 2017 Control Strategy v1