1.0 INTRODUCTION

Lost Lake, Vilas County, is a shallow (mixed) lowland drainage lake with a maximum depth of 24 feet and a surface area of 552 acres. This eutrophic lake has a relatively large watershed when compared to the size of the lake (20:1) and has a water residence time of approximately 6 months. Stella Lake and Found Lake both flow into Lost Lake with a water control structure (i.e. dam) on Lost Lake artificially maintaining a slightly higher water level (Figure 1.0-1). Lost Lake's outlet is through Lost Creek which meanders for several miles until reaching Big Saint Germain Lake.

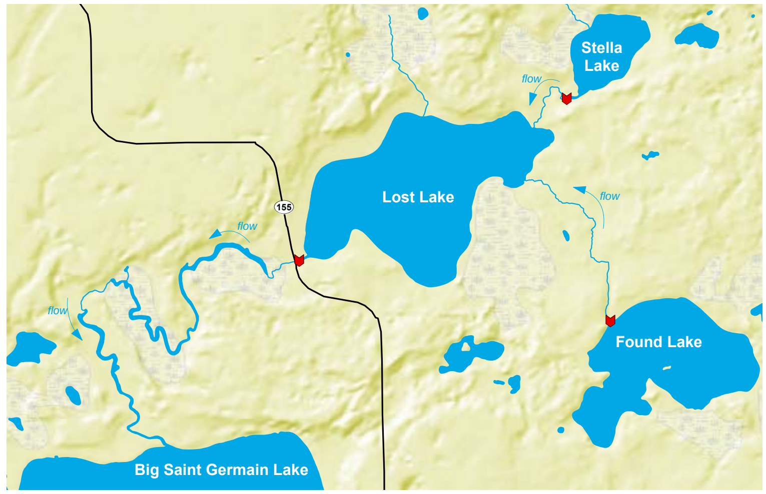


Figure 1.0-1. Lost Lake, Vilas County

Following the discovery of Eurasian watermilfoil (EWM) in 2013 and curly-leaf pondweed (CLP) in 2014, the Lost Lake Protection and Rehabilitation District (LLPRD) initiated an Aquatic Invasive Species (AIS) early detection and response framework with increased AIS population monitoring. Partial funding for the monitoring and management strategy (2013-2018) was received through two Wisconsin Department of Natural Resources (WDR) AIS-Early Detection and Response (EDR) grants. This report discusses the AIS management and monitoring efforts conducted in 2019 on Lost Lake which included an approximately 29.5-acre herbicide spot-treatment that targeted CLP for the third consecutive year.

The LLPRD has received an AIS-Established Population Control Grant to fund the continued monitoring and control strategy from 2019-2021. The monitoring strategy includes continued annual pretreatment monitoring, annual summer sub-set point-intercept surveys in the western basin of the lake, and annual volunteer-based herbicide concentration monitoring. A whole-lake point-intercept survey is planned for the final year of the project.

2.0 EURASIAN WATERMILFOIL (EWM)

Eurasian watermilfoil populations on Lost Lake were initially targeted through professional hand-harvesting activities (2013-2015). The hand-harvesting provided modest reductions in the areas where the hand-harvesting occurred, but the EWM population increases were greater than the amount of EWM that was being removed each year. Once the population exceeded a scale where these activities were thought to be applicable, the LLPRD opted to discontinue further active management until it understands if the EWM population will continue to increase or if the population will plateau at a level where the ecosystem function is not altered and navigation, recreation, and aesthetics are not impeded. EWM population monitoring in 2016-2018 showed that the EWM population continued to be present at low densities consisting mostly of *highly scattered* or *scattered* colonies (Map 1).

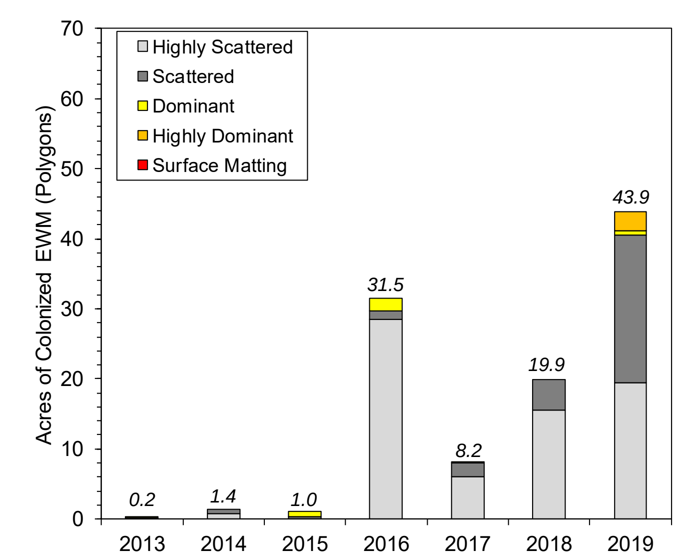


Figure 2.0-1. Acres of EWM colonies in Lost Lake from 2013-2019. Data from annual Onterra Late-Season EWM Mapping Surveys.

Some members of the LLPRD communicated that they believed the EWM population had expanded during 2019. Onterra ecologists completed a Late-Season EWM Mapping Survey on September 18, 2019. The survey results supported the LLPRD's notion that the population had expanded. A total of 43.9 acres of EWM were mapped in Lost Lake during the survey of which the majority consisted the relatively low-density ratings of either *highly scattered* (19.5 acres) or *scattered* (21.0 acres). An additional 0.6 acres were mapped as *dominant* density and 2.7 acres were designated as *highly dominant* in density (Figure 2.0-1).

The largest concentration of EWM in the lake was within the eastern bay where most of the bay contained colonized EWM. A particularly dense, *highly dominant*, colony surrounded a shallow submersed rocky area on the eastern side of the lake which corresponds to the approximate area where EWM was initially discovered in the lake (Map 2). A few other locations around Lost Lake were found to harbor colonized EWM that consisted of *highly scattered* or *scattered* densities (Map 2). Additional occurrences mapped as *single or few plants*, *clumps of plants*, or *small plant colonies* were also documented in many littoral areas of the lake.

The LLPRD has expressed concerns over the increasing EWM population and have begun to observe localized reductions in navigability where EWM has grown densest. The *Lost Lake Comprehensive Management Plan* includes an action to continue monitoring EWM and if colonies of dense (*dominant, highly dominant*, or *surface matting* are documented, the development of an EWM management goal may be considered. The LLPRD will work with lake managers and the WDNR to develop an EWM management goal if continued monitoring shows EWM to be forming more areas that consist of dense colonies that impact the use of the lake. The EWM population will be monitored in 2020 through the completion of a Late-Season EWM Mapping Survey.

3.0 CURLY-LEAF PONDWEED (CLP)

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 rapidly growing almost immediately after, if not 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 July (Photo 3.0-1). The deposited turions lie dormant until autumn when a portion of them sprout to produce small winter foliage, and they remain in this state until spring foliage is produced. The portion of turions that do not sprout can remain dormant for at least 5 years (likely longer) and still sprout (Johnson et al. 2012).

Photo 3.0-1. Curly-leaf pondweed turion. From Lost Lake, 2015.

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 (James et al. 2002). However, in some lakes, mostly in northern Wisconsin, CLP appears to integrate itself within the community without becoming a nuisance or having a measurable impact to the ecological function of the lake. Acknowledging that possibility for Lost Lake, the LLPRD did not reactively conduct active management on the CLP population in 2014-2016, rather monitored the population dynamics.

The CLP population in Lost Lake was found to have dramatically increased from 2014 to 2016. Much of the CLP population in the western bay expanded to form large, continuous, and dense colonies in 2016 (Figure 3.0-1). 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* (yellow polygon) or greater densities. Approximately 2.0 acres of the CLP was described as *surface matting* (red polygon), the highest density rating used in the qualitative mapping methodology. An additional 6.7 acres of CLP was described as *highly dominant* (orange polygon) during the 2016 survey. These highly visible, very dense CLP colonies dominate the aquatic plant population and can significantly inhibit navigation for boaters until the plant dies back in early summer. For reasons not completely

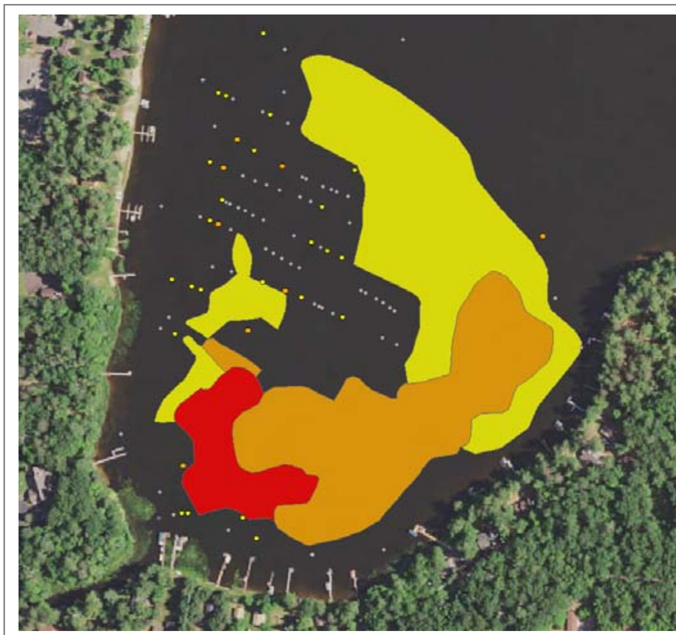


Figure 3.0-1. 2016 CLP Population from western basin of Lost Lake.

known, the CLP population on Lost Lake has been documented to persist much later in the growing season than other waterbodies.

3.1 CLP Management Strategy Development

The theoretical goal of CLP management is to kill the plants each year before they are able to produce and deposit new turions. Not all of the turions produced in one year sprout new plants the following year; many lie dormant in the sediment to sprout in subsequent years. This results in a sediment turion bank being developed. A control strategy for an established CLP population includes multiple consecutive years of treatments of the same area to deplete the existing turion bank within the sediment without replacement of turions.

During the late-fall/winter of 2016-17, there were a number of correspondences between the district and Onterra discussing the possibility of conducting an herbicide control strategy during the spring of 2017. Factors such as environmentally toxicity of the treatment including likely native plant impacts, the need for multiple subsequent annual treatments, and likely regulatory opposition where weighed heavily. Because CLP had only been present in Lost Lake for a few years, there was speculation that the turion base may be small and if a control program is initiated at that time, may not require as many successive treatments as a more established population would. Following these discussions, the LLPRD board of directors supported pursuing an herbicide spot treatment targeting the largest and densest population of CLP during the spring of 2017. The preliminary strategy was outlined within the *2016 AIS Monitoring & Control Strategy Assessment Report* originally distributed in mid-February 2017.

The permit was approved on May 17, 2017 and the herbicide treatment occurred on May 24, 2017. Monitoring results of the 2017 herbicide treatment are included within the *Lost Lake 2017 AIS Monitoring and Control Strategy Assessment Report* (Jan18). The report indicated that the treatment appeared to have effectively controlled a single years' worth of growth prior to turion formation within the targeted area. The report also investigated reductions in the native plant community on Lost Lake over time and possible association to the 2017 herbicide efforts.

The LLPRD board of directors voted unanimously to conduct another endothall spot treatment in the western bay of the lake during the spring of 2018 with the same monitoring strategy implemented in 2017. Following a period of review by WDNR, the treatment took place on June 21, 2018. The *Lost Lake 2018 AIS Monitoring and Control Strategy Assessment Report* (Feb19) discussed the results of the 2018 treatment and associated monitoring. The 2018 report also discussed the lake-wide aquatic plant community through the completion of a whole-lake point-intercept survey as it related to past surveys with the same methodology. The report offered a discussion regarding the decrease in aquatic plants lake-wide over the past number of years in Lost Lake and explored factors that may be contributing to the decline.

3.2 2019 Pretreatment Confirmation and Refinement Survey

On May 15, 2019, Onterra ecologists conducted the Spring Pre-treatment Confirmation and Refinement Survey on Lost Lake. A temperature profile indicated the that water temperatures were between 48-59°F throughout the water column. A secchi disk reading of 4.6 feet was recorded during the survey and the crew noted the water appeared brownish in color. Native plant growth was minimal with low amounts of common waterweed present in the site. The majority of the CLP population was not visible from the viewpoint of the boat deck so the survey crew deployed a submersible camera to investigate the site. Through the aid of the submersible camera, actively growing CLP was confirmed throughout the proposed application area with most plants being approximately 1-3 feet in height (Photo 3.2-1). Minimal native vegetation was observed during the submersible camera viewing.

Photo 3.2-1. Curly-leaf pondweed observed during a May 15, 2019 survey on Lost Lake. Photo by Onterra.

Quantitative data collected annually immediately before the treatment takes place allows for a determination if the CLP population is being reduced in the area over time. To assess the CLP population, a sub-sample point-intercept survey is conducted within the herbicide application area by sampling 101 locations at a resolution of 35 meters (Figure 3.2-1). These data are not used to understand the efficacy of a single treatment.

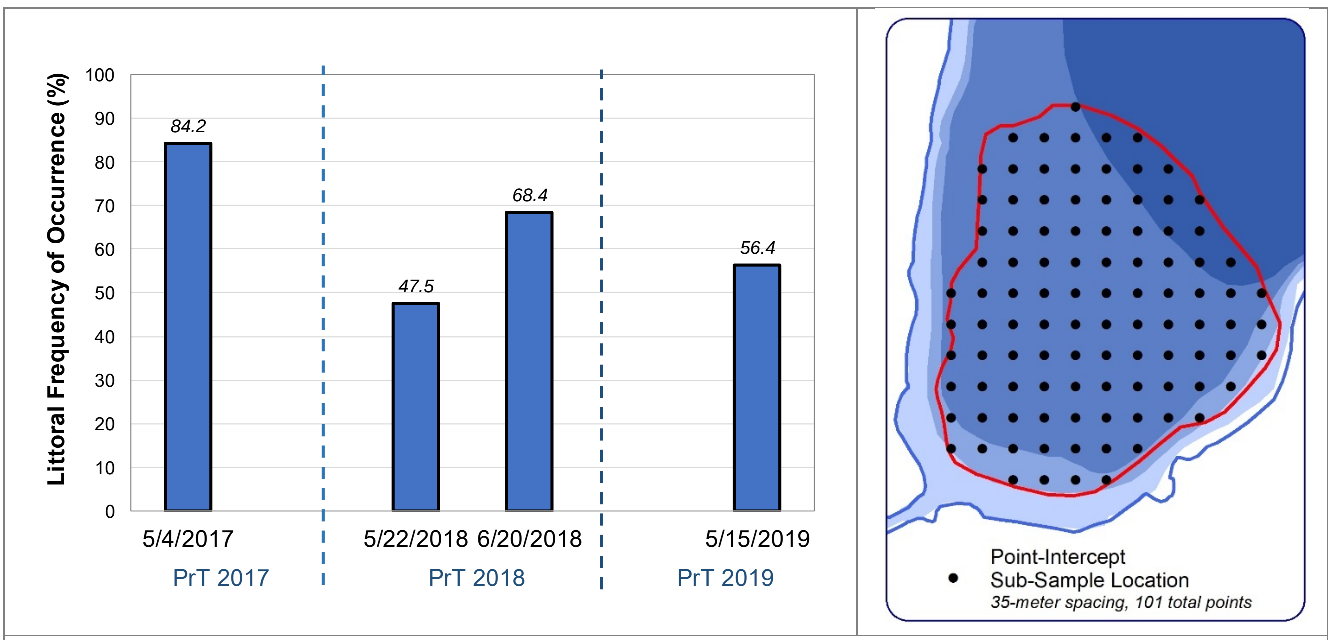


Figure 3.2-1. Pretreatment CLP LFOO in the 2017-2019 sub-sampling survey. (N=101). Blue lines indicate endothall treatments.

The crew conducted the sub-sample point-intercept survey of the proposed treatment area and located CLP on approximately 56.4% of sample locations (Figure 3.2-1). The pre-treatment occurrence of CLP has decreased each year since the spring of 2017 when the occurrence was 84.2%, suggesting that fewer viable CLP turions may be present as the multi-year control program progresses.

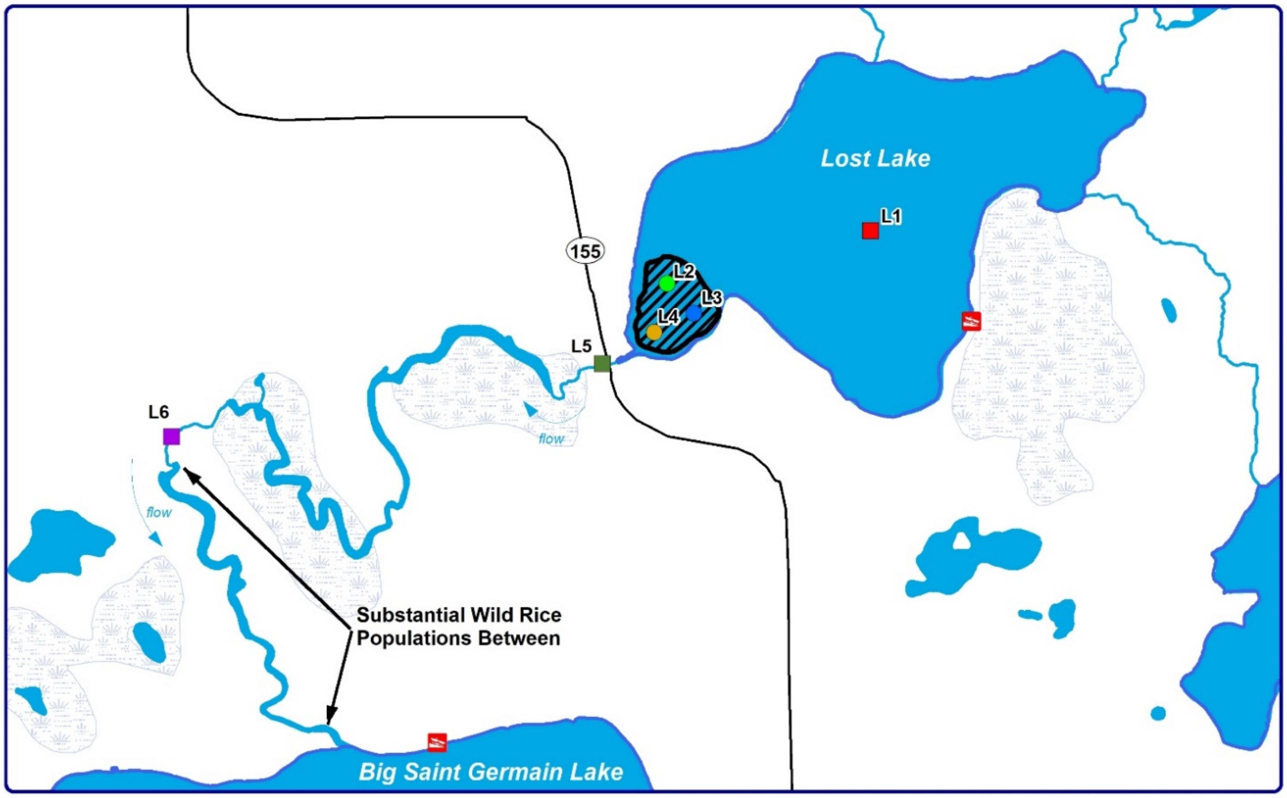
Based on water temperatures and the stage of CLP/native plant growth observed during the survey, Onterra advised the district that the treatment should occur as soon as the permit is finalized by the WDNR and the applicator could be mobilized. The final herbicide treatment included the application of liquid endothall over 29.5 acres of Lost Lake and was completed on May 23, 2019. An effort was made to alter the dam operations during and immediately after the herbicide treatment in attempt to keep the herbicide from being flushed downstream before it could impact the CLP as well as reduce potential downstream impacts of the herbicide on vulnerable growth stages of wild rice. The flow out of Lost Lake was reduced as far as legally allowed for approximately two days after treatment. High water levels in Lost Lake brought forth by rainfall resulted in the dam being partially opened on the evening of May 25 (2 DAT), and opened further on May 27 (4 DAT).

3.3 2019 Post Treatment Survey Results

Herbicide Concentration Data

An herbicide concentration monitoring plan was developed jointly by Onterra and the WDNR. LLPRD volunteers were given equipment and instruction by Onterra on how to collect and preserve water samples from Lost Lake that would be analyzed by the Wisconsin State Laboratory of Hygiene for concentrations of endothall. Some modifications were made between the 2017 and 2018 monitoring plans in an effort to balance costs along with obtaining sufficient data to gain further understanding of the dissipation and degradation rates. For the 2018 monitoring plan, the sampling intervals were extended out to 14 days after the treatment, additional samples were collected from the center of the lake and downstream sampling sites, and the number of sampling sites located within the direct application area was reduced from three sites to two. The 2019 plan design was the same as 2018, with the exception of the addition of a sampling interval from the center of the lake on 1 Day After Treatment. Water samples were collected with a 6-foot integrated sampler at two locations in the treatment area and the deep hole location in the center of the lake (outside of the application area). Samples were collected manually at two locations downstream of Lost Lake including near the outlet and further downstream in Lost Creek. The sampling interval matrix and sampling site details are displayed on Figure 3.3-1. Appendix A includes the 2019 Herbicide Concentration Monitoring Plan.

Endothall is an aquatic herbicide that is applied as either a dipotassium salt or an amine salt. These active ingredients break down following application to endothall acid, the form that acts as an herbicide (Netherland 2009). The 2017 and 2018 endothall treatments of CLP on Lost Lake use the dipotassium salt at a concentration of 2.0 ppm active ingredient (ai). When broken down into the acid, 2.0 ppm ai equates to 1.42 ppm acid equivalent (ae). The WI State Laboratory of Hygiene is able to test water samples for endothall using an ELISA (enzyme-linked immunosorbent assay) method and reports the results as acid equivalent. After low flows contributed to higher concentrations being yielded in 2018 vs 2017, a lower herbicide concentration was applied in 2019 (1.065 ppm ae vs 1.42 ppm ae).



Lost Lake Herbicide Sample Sites				
Site	**Station ID**	**Latitude**	**Longitude**	**Sample Depth**
L1 - Deep Hole	643081	45.96495	-89.482789	Integrated Sampler (0-6 ft)
L2 - Application Area	10048321	45.962808	-89.494945	Integrated Sampler (0-6 ft)
L4 - Application Area	10048323	45.960792	-89.495732	Integrated Sampler (0-6 ft)
L5- Outlet	10048324	45.959511	-89.498846	Manual
L6 - Lost Creek	10009240	45.956574	-89.524549	Manual

Interval	L1	L2	L4	L5	L6
2 HAT		X	X	X	X
4 HAT		X	X	X	X
8 HAT		X	X	X	X
1 DAT	X	X	X	X	X
3 DAT	X	X	X	X	X
5 DAT	X	X	X	X	X
7 DAT	X	X	X	X	X
14 DAT	X	X	X	X	X

X = sample to be collected (37 total samples)
HAT = Hours After Treatment
DAT = Days After Treatment

Figure 3.3-1. Lost Lake herbicide concentration monitoring locations from the 2017-2019 endothall treatments. General location of wild rice population provided by GLIFWC.

<u>Concentrations within the application area (L2, L3, L4):</u> The herbicide concentration data from Lost Lake indicate that the concentration in the treatment area was below the target (1.065 ppm ae), in the initial samples collected from within the application area in the hours immediately after the treatment. Concentrations within the application area fell below 0.1 ppm ae between the 1 DAT and 3 DAT sampling intervals. Minimal endothall was detected in the application area from 3 DAT to the 7 DAT sampling interval and were concentrations were below detection limits by 14 DAT. The concentrations observed in the application area in 2019 were lower than 2018, and similar to concentrations observed in 2017 (Figure 7).

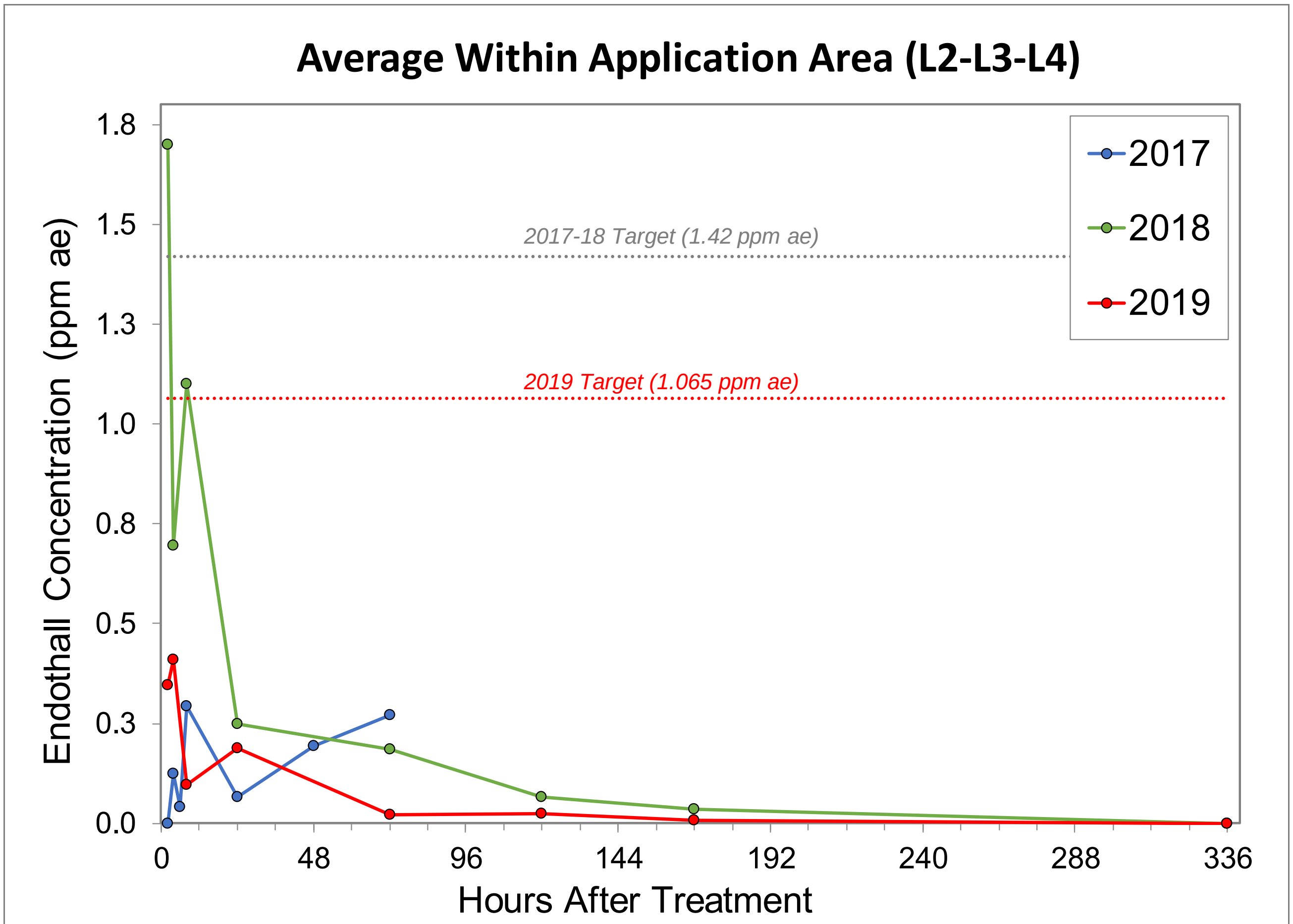


Figure 3.3-2. Average endothall concentrations from samples collected within the application area of the 2017-2019 endothall treatments in Lost Lake.

Concentrations within the adjacent outlet (L5): Minimal endothall was present at 2 and 4 HAT samples collected from the L5 sampling location on the downstream side of the dam in Lost Creek in each year (Figure 3.3-3). The 2018 concentrations were higher than those measured in 2017, but generally follow the same concentration curve. Detectable levels of endothall were present through 7 DAT in 2018 and 2019 and no herbicide was detected on 14 DAT at the outlet sampling location in 2018 or 2019 (L5).

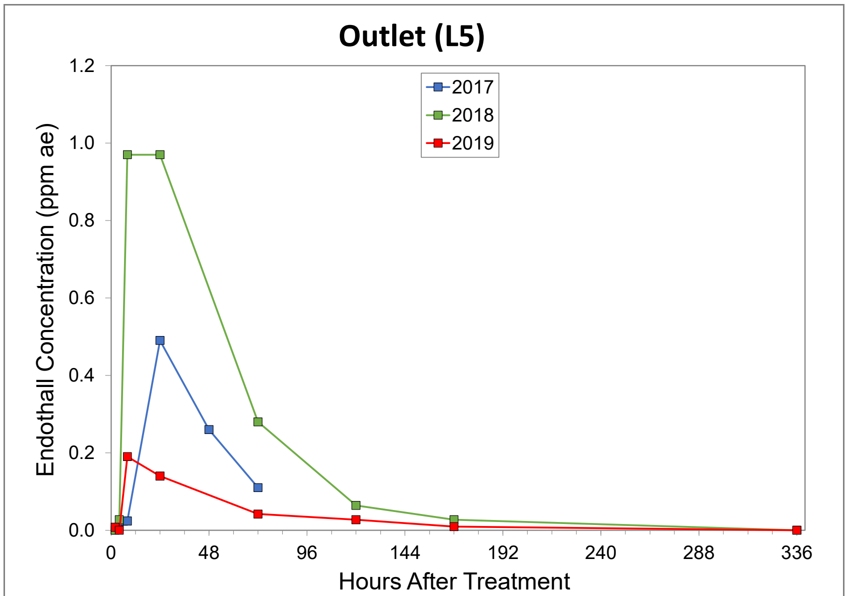


Figure 3.3-3. Lost Lake outlet herbicide concentration monitoring results from the 2017-2019 endothall treatments.

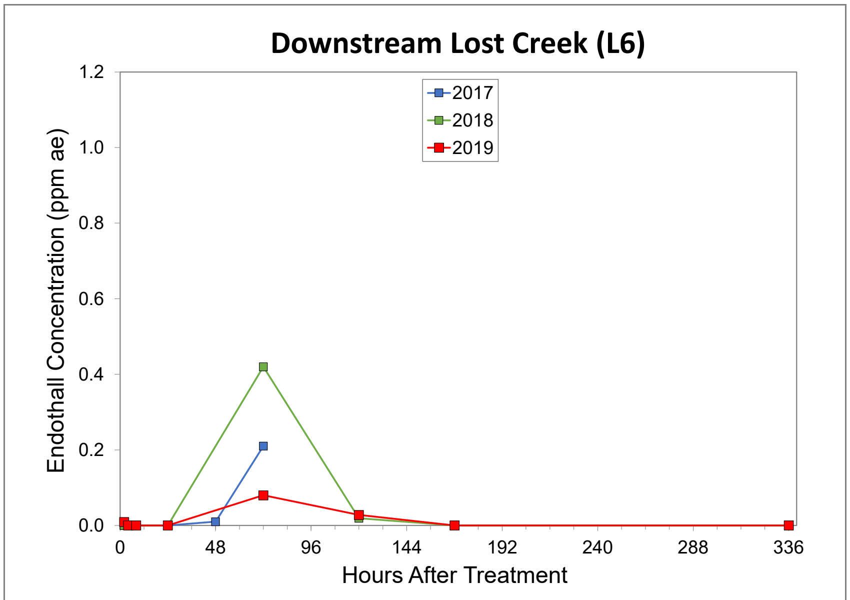


Figure 3.3-4. Downstream Lost Creek herbicide concentration monitoring results from the 2017-2019 endothall treatments.

<u>Downstream concentrations at the start of the wild rice populations (L6):</u> The samples that were collected from the L6 downstream sampling location in Lost Creek showed endothall was not detected in the first 24 hours after treatment. A sample collected 3 days after treatment showed low-level herbicide concentrations of (0.42 ppm ae) and by the time of the next collection at 5 DAT, the concentration had declined to just 0.019 ppm ae (Figure 3.3-4). Endothall was not detected in samples collected on 7 or 14 DAT in Lost Creek. The downstream concentrations in 2019 were lower than 2017 and 2018. It is interesting to note that the "pulse" of herbicide during all three years appears to be at 3 DAT (72 HAT).

The endothall concentrations that were documented in Lost Creek are lower than what the published literature documents as having impacts to wild rice (Nelson et al. 2003). The laboratory research has documented reduced wild rice seedling biomass at the lowest endothall concentration it tested (sustained 0.71 ppm ae for 72 hours), which is approximately 40% higher concentration and a likely longer exposure time as documented in this area in 2018. Young and mature wild rice growth stages did not have reduced biomass at the lowest tested concentration (0.71 ppm ae). While it depends on the specific weather conditions of a given year, early-season herbicide treatments that occur in early-May are most likely to have exposure to recently germinated wild rice (seedlings). The 2017 and 2019 treatments were completed in Late-May (May 23 & May 24), and the 2018 treatment was conducted in late-June (June 21), potentially all when wild rice plants have progressed past the seedling growth stage and are therefore less vulnerable to the impacts from endothall.

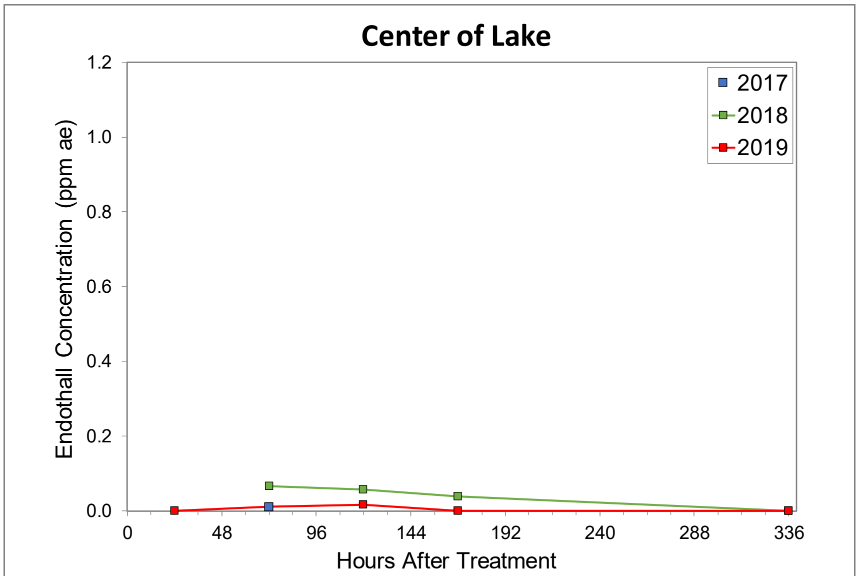


Figure 3.3-5. Center of the lake herbicide concentration monitoring results from the 2017-2019 endothall treatments in Lost Lake.

<u>Concentrations in the center of the lake (L1):</u> Only a single sample was collected from the center of the lake location in 2017 corresponding to 3 DAT. Based on published literature, this corresponds with when a lake may reach a lake-wide equilibrium concentration. Based upon feedback from WDNR, an earlier sampling event (24 HAT) was added to the plan in 2019.

The 2019 monitoring showed endothall was below detection limit at 1 DAT. By 3 DAT, the concentration was 0.011 ppm ae and was 0.018 ppm ae on 5 DAT. Samples collected at 7 DAT and 14 DAT were below detection limits. Overall, the concentrations at the center of the lake were slightly lower than was documented in 2018 where concentrations of 0.039-0.066 were documented on sampling intervals between 3 DAT and 7 DAT (Figure 8).

For whole-lake CLP treatments the manufacturers of endothall (UPL) recommend target concentration of recommend whole-lake target concentrations of 0.53 ppm ae (0.75 ppm ai) to 0.71 ppm ae (1.0 ppm ai). Based on the endothall concentrations observed in the center of the lake, the impacts of the spot treatment are anticipated to be confined to the approximate area of the application area.

<u>Efficacy (CLP Control)</u>

In a typical year, the herbicide treatment would occur in early- to mid-May and an Early-Season AIS Survey would map the CLP during late-June when it is expected to be at its peak growth stage. This allows four to six weeks between the treatment and the mapping survey, sufficient time for the effects of the herbicide to be realized. If CLP remains present in the application area 4-6 weeks after treatment, it may be assumed that the treatment was not successful. Because of the timing of the die-off of this species (CLP is starting to die-off around now on some systems) and having sufficient time passed since the time of the treatment (usually 4 or more weeks is needed for plants to fully die), it is difficult to understand how effective an individual treatment is.

The 2019 mapping survey was completed on June 13, 2019, which corresponds to three weeks after the herbicide treatment. During the survey, no CLP was visible in the treated area through visual observations on the survey boat so the crew deployed a submersible camera to inspect the treatment area. Submersible camera surveillance showed several relatively short-statured CLP plants in the treated area. The CLP appeared to be in poor condition and were presumed to be injured or in the process of dying. Aside from the treatment area, very little CLP was located in other parts of Lost Lake with a few relatively small *highly scattered* or *scattered* density colonies and a few isolated *single or few plants*

(Map 3). It is unclear if the rest of the system isn't good habitat for this species, or if CLP simply hasn't spread there yet.

Selectivity (native plant impacts)

Because many native aquatic plants are not actively growing at the time of the spring pre-treatment survey, a separate point intercept dataset is used to assess the native aquatic plant community in response to the herbicide treatments. Whole-lake point intercept surveys were conducted on Lost Lake in 2007, 2010, 2014, 2017 and 2018. A subset of these data comprised of the 40 points with a resolution of 75 meters in the western bay that is within and around the herbicide application area will be compared (Figure 3.3-6). In 2019, the sub-set (n=40) of the whole-lake point-intercept survey was completed and will be included in the analysis discussed in this report.

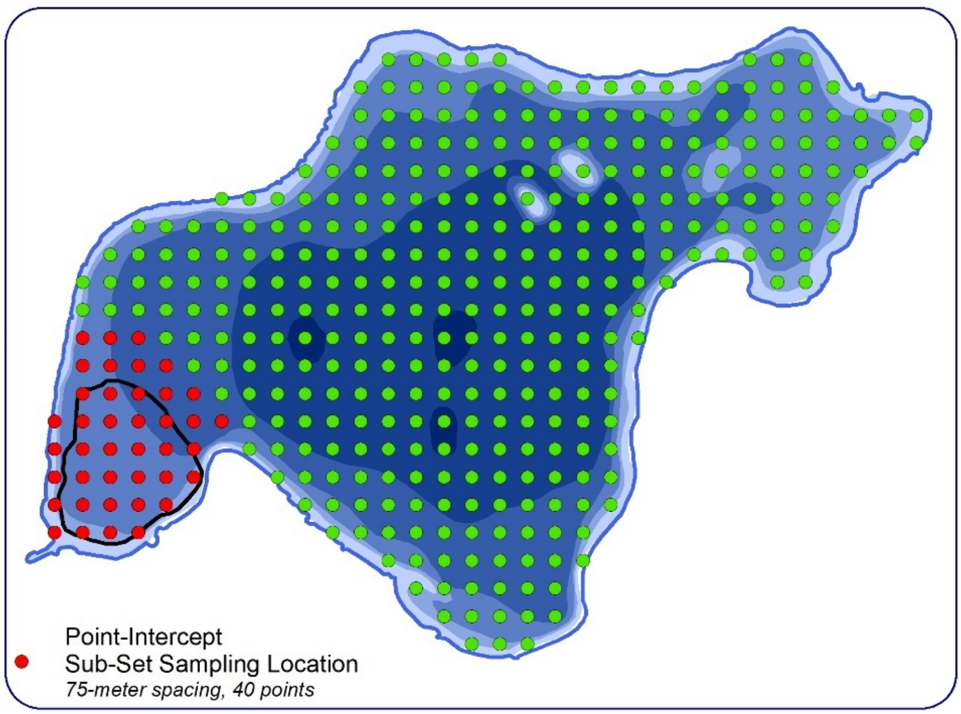


Figure 3.3-6. Lost Lake quantitative monitoring plan for the 2017 -2019 herbicide treatments.

Aquatic plant communities are dynamic, and the abundance of certain species can fluctuate from year to year depending on climatic conditions, herbivory, competition, water levels, and disease among other factors, and fluctuations in the abundance of species are to be expected over time. Herbicide treatments, can also impact non-target native plant abundance. Analysis of the Lost Lake aquatic plant community is provided within *Lost Lake Comprehensive Management Plan* (Final Sept19) as well as the 2017 and 2018 annual *Lost Lake AIS Monitoring and Control Strategy Assessment Reports*. These data show a reduced aquatic plant abundance within the lake. Large-scale reductions in aquatic plants are often associated within changes in water clarity within a lake. Lost Lake's water clarity can vary significantly from year to year, with some annual growing season Secchi disk readings averaging 9 or more feet while other years, like 2017, averaging 4.4 feet. The water clarity of Lost Lake is largely driven by freefloating algae but also impacted by dissolved humic substances and organic acids which give the lake a light tea color in some years (30 SU in 2017).

The maximum depth of aquatic plants found from the whole-lake point-intercept surveys has reduced by four feet during the most recent point-intercept survey completed in 2018 (Figure 3.3-7). Little vegetation was observed greater than 8 feet deep in 2017 and 2018. Some of the greatest abundance of aquatic plants during 2007, 2010, and 2014 was found in waters of 8 to 14 feet (Figure 3.3-8). A whole-lake point-intercept survey was not completed in 2019 and the next survey is scheduled to occur in 2021.

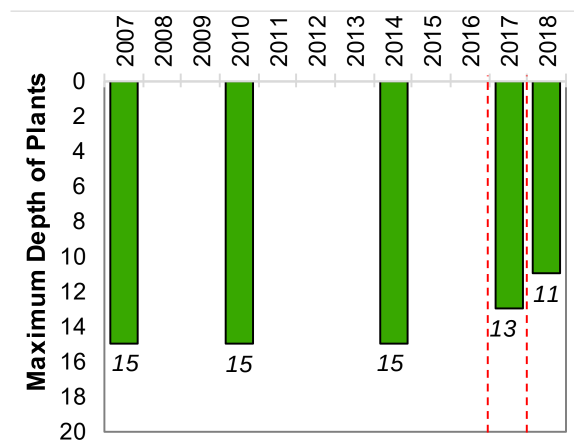


Figure 3.3-7. Maximum depth of plants from point-intercept surveys. Red dashed lines indicate western basin herbicide spot treatment.

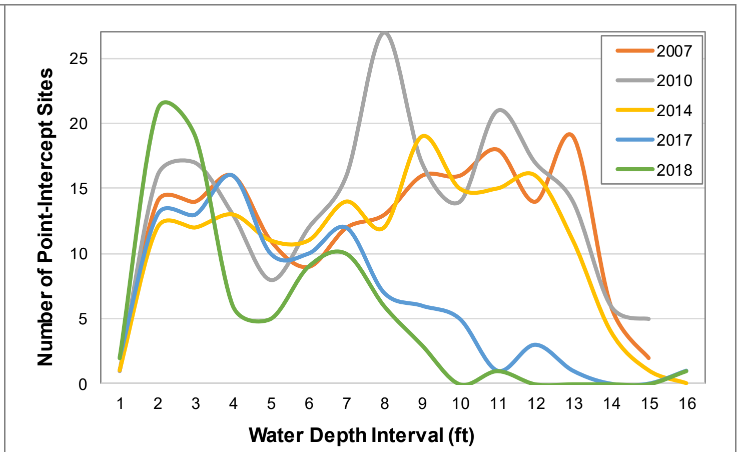


Figure 3.3-8. Depth distribution of aquatic plants from point-intercept surveys.

The following text and associated figures reflect the aquatic plant frequencies from the sub-set point-intercept survey (n=40) from surveys completed in 2007, 2010, 2014, and 2017-2019. Based on subset data from previous point-intercept surveys, the five most abundant plant species within the western bay were flat-stem pondweed, coontail, common waterweed, northern watermilfoil, and fern-leaf pondweed. Onterra's experience is that flat-stem pondweed, northern watermilfoil, and fern-leaf pondweed are particularly vulnerable to early-season endothall treatments whereas coontail is more resilient and common waterweed is unimpacted or has even shown to have population increases. Appendix B contains the full matrix of point-intercept data results.

Northern watermilfoil populations decreased from a littoral frequency of occurrence (LFOO) of 47.5% in 2010 to 15.8% in 2014 in absence of management. Northern watermilfoil has not been observed within the treatment area in 2017-2019 (Figure 3.3-7).

Flat-stem pondweed was present at 15.0% of the sampling locations within the treatment area in 2007 and 82.5% in 2020. The population declined to 0% in 2014 prior to the beginning of the herbicide treatment program. Flat-stem pondweed has not been located on the point-intercept survey in 2017-2019.

White-stem pondweed and fern-leaf pondweed populations exhibit a similar pattern in littoral frequency of occurrence since 2007. Both species have declined to 0% in recent years.

Coontail was prevalent in the survey area in surveys completed between 2007 (85% LFOO), 2010 (70% LFOO) and 2014 (65.8% LFOO). The occurrence of coontail was reduced between the 2014 and 2017 surveys to 10.3% and declined further in 2018 to 0%. In the 2019 survey, coontail exhibited a 2.5% occurrence.

Common waterweed has been shown to metabolize endothall much quicker than other species (particularly pondweeds) and not translocate the herbicide making it tolerant of endothall treatments (Keckemet and Nelson 1968). This species showed a statistically valid decrease in occurrence from 60% in 2010 to just 2.6% in 2014 (Figure 3.3-7). The occurrence of common waterweed has been steady in recent years between 12.5-15.0%.

Slender naiad was not located in the 2007 survey but was found at 7.5% in 2010 and 5.3% in 2014 (Figure 3.3-7). The occurrence of slender naiad has been variable in recent years showing a statistically valid decrease in occurrence between 2017-2019 and a valid increase between 2018-2019. The littoral frequency of occurrence of slender naiad in 2019 (22.5%) is higher than any previous survey dating back to 2007.

Wild celery is typically not impacted by most early-season herbicide treatments as this species emerges later in the year after the herbicide has dissipated/degraded. The occurrence of wild celery declined from 20% in 2010 to 0% in 2014, and has been present in low frequencies (2.5%-5.1%) in surveys between 2017-2019.

The large-leaf pondweed population exhibited a declining trend from 2007 to 2014 and decreased further to 0% by 2017 (Figure 3.3-7). The occurrence of large-leaf pondweed has remained at 0% in monitoring conducted in 2018 and 2019. Only one sampling point contained large-leaf pondweed in 2014 before the treatment and no sampling points contained large-leaf pondweed after the treatment in 2017 or 2018.

Clasping-leaf pondweed exhibited a littoral frequency of occurrence of between 2.5% and 10.5% in surveys between 2007-2014. No occurrences of clasping-leaf pondweed have been documented on subsequent surveys between 2017 and 2019 (Figure 3.3-7).

Small pondweed, slender pondweed, and stiff pondweed have all been identified from Lost Lake. These morphologically similar looking species are sometimes referred to as thin-leaved pondweeds. Analysis of these data requires grouping or “lumping” of the species. No sampling locations contained these species in 2007, however the population of thin-leaved pondweeds increased to 12.5% in 2010 and 31.6% in 2014 (Figure 3.3-7). Thin-leaved pondweeds have not been physically encountered on the survey rake in the sub-set point-intercept surveys in 2017, 2018 or 2019.

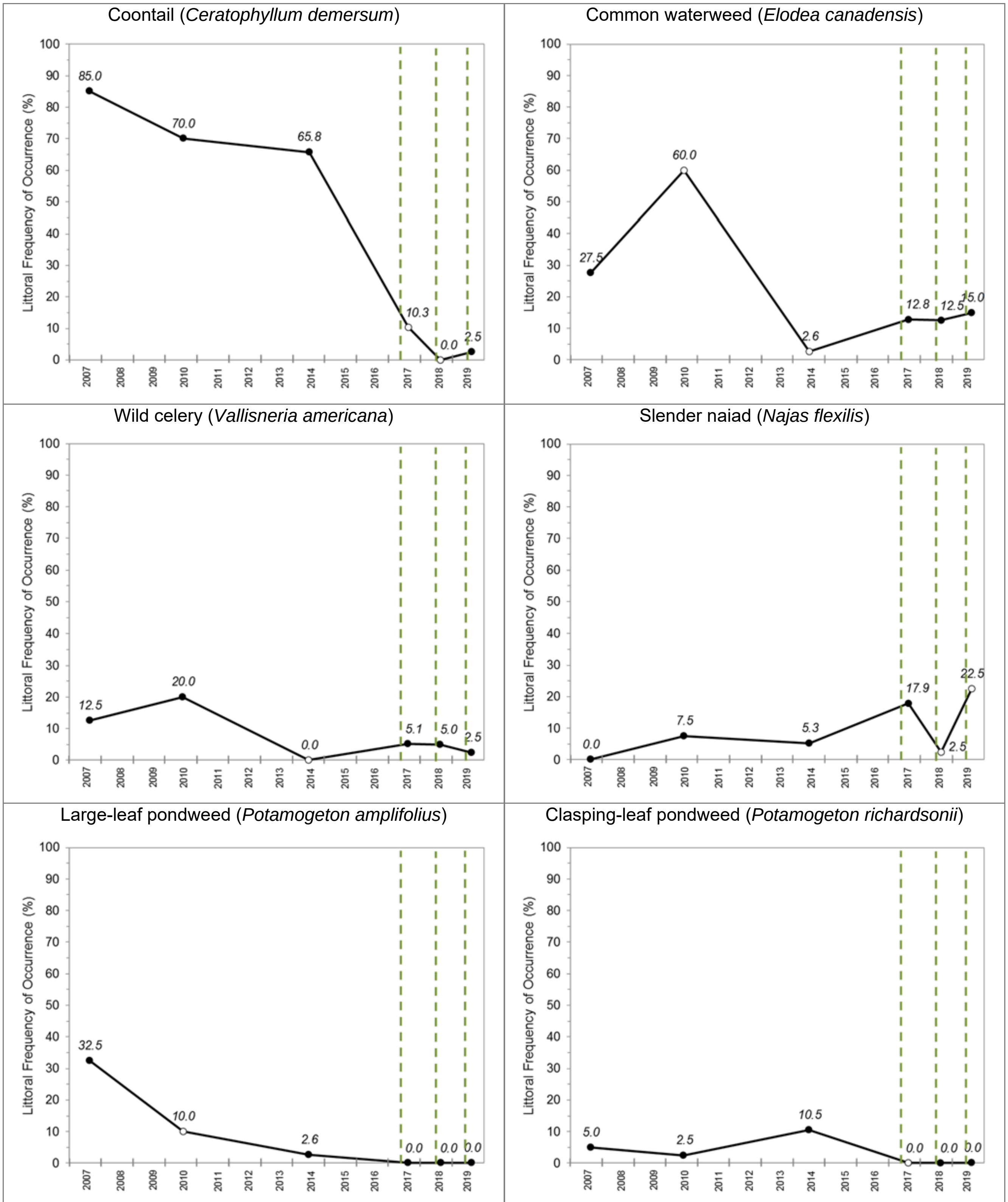


Figure 3.3-7. Littoral frequency of occurrence of select native aquatic plant species from the western basin of Lost Lake (n=40). Green dashed lines represent western basin spot herbicide treatments. Open circle represents statistically valid change in occurrence compared to previous survey.

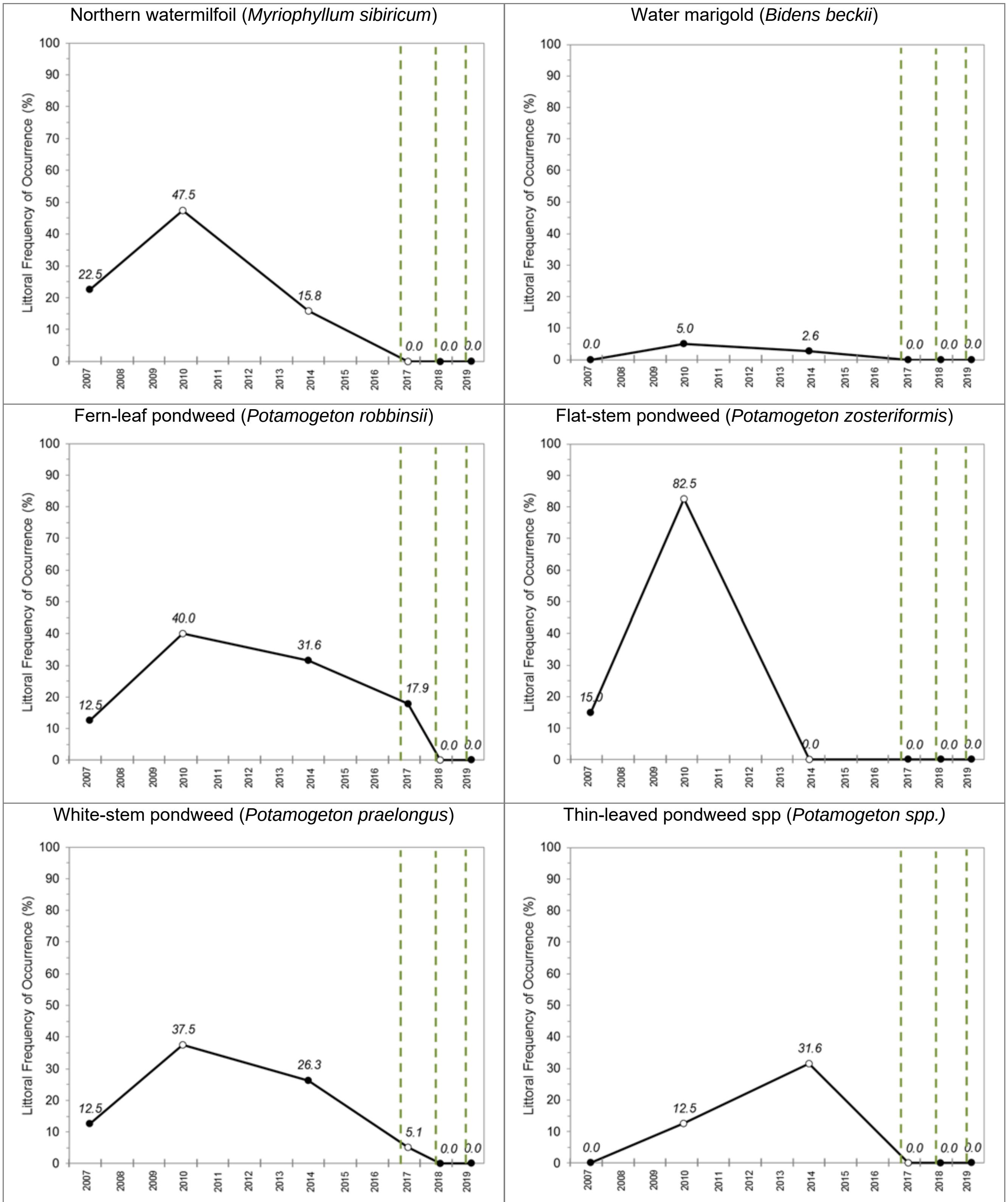


Figure 3.3-7-continued. Littoral frequency of occurrence of select native aquatic plant species from the western basin of Lost Lake (n=40). Green dashed lines represent western basin spot herbicide treatments. Open circle represents statistically valid change in occurrence compared to previous survey.

4.0 CONCLUSIONS & DISCUSSION

The 2019 Late-Season EWM Mapping Survey showed that EWM has expanded in Lost Lake. Some areas of *highly dominant* density EWM were documented during the survey, however much of the EWM population consisted of lower density occurrences that are likely not causing reductions in lake services including navigation, aesthetics, or ecological function. If continued monitoring of the EWM population demonstrates an increase in the amount of dominant, highly dominant, or surface matting colonies, the LLPRD will explore the possibility of enacting an active management strategy targeting EWM.

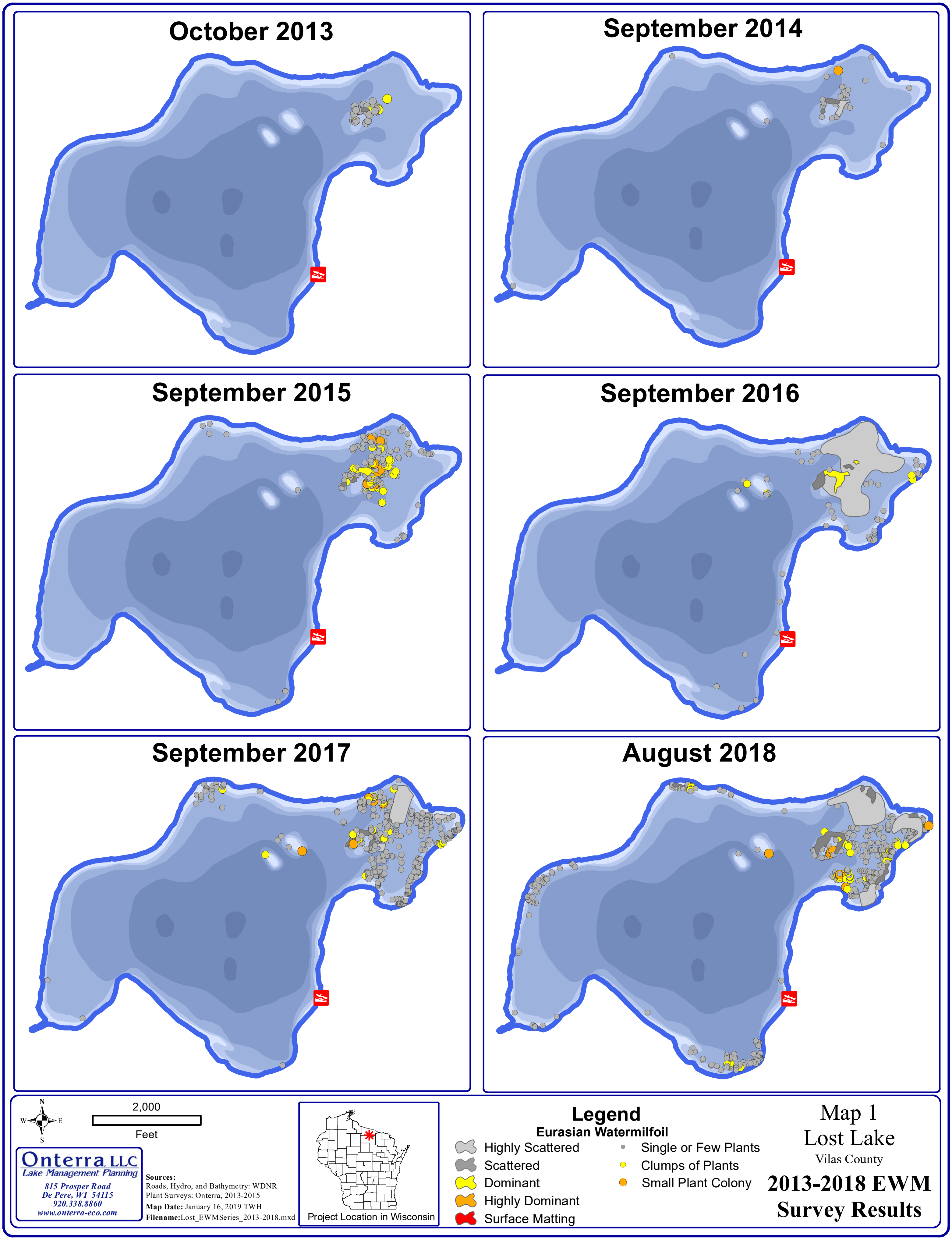
The coordination and implementation of the 2019 CLP management strategy was completed as planned for Lost Lake with collaboration from several project partners including the LLPRD, WDNR, and Onterra. Volunteer efforts provided by the LLPRD were instrumental in the completion of the pre-treatment planning and post-treatment monitoring associated with the treatment.

In the *Lost Lake Comprehensive Management Plan* (Sept2019), the LLPRD outlined a strategy to manage the early population of CLP with herbicide spot treatment. The LLPRD's strategy anticipates targeting the same location through at least 2020. Onterra ecologists plan to conduct a spring Pre-treatment Confirmation and Refinement Survey in spring 2020 to assess the growth stage of the CLP, measure water temperatures, and to conduct the sub point-intercept survey within the proposed application area (n=101). As outlined within the Plan, if the pretreatment sub-sample survey contains less CLP than 30% in 2020, consideration for postponement of the herbicide strategy would be given by the LLPRD. The LLPRD believes that this threshold for management guidance attempts to balance tolerance of CLP at lower levels/densities while continuing to manage for an overall reduced CLP population within lake. Further, this would guide herbicide management when the financial costs and collateral impacts of the treatment are commensurate with the level of CLP population reduction achieved. The LLPRD has applied for a permit with WDNR to carry forward this management action pending the results of the pretreatment survey. The proposed application area for 2020 includes the same 29.5 acres as in past treatments (Map 4). The proposed application rate for the 2020 treatment is the same rate as was applied in 2017-2018 at 2.0 ppm ai (1.42 ae).

The application would ideally occur before water temperatures greatly exceed 60°F, as endothall uptake rates have been shown to be higher at these water temperatures (Dr. Cody Gray, personal comm.). This timing also corresponds to the period before viable turion formation is likely to occur on CLP, which is important for the overall goal of the management strategy (i.e. control CLP before turions are produced). Conducting herbicide treatments earlier in the growing season are also thought to be more protective of the native plant community. A condition of the permit would likely include completing the application after the Lac du Flambeau Band of Lake Superior Chippewa Indians has finished their spring open-water spear harvest and when downstream wild rice populations are anticipated to have advanced past the growth stage that is most sensitive to endothall treatment. The impacts of precipitation events prior to and during the treatment will continue to be monitored, particularly as longer residence time may justify a decrease in application rate down to 1.5 ppm ai.as occurred in 2019. The LLPRD will coordinate with the WDNR, Onterra, and the contracted herbicide applicator to ensure the proper timing for the proposed 2020 treatment.

4.1 2020 Treatment Monitoring Plan

The proposed 2020 CLP treatment will be monitored through the same activities that accompanied the previous treatments. An ESAIS survey will occur in June 2020 to map the CLP population around the lake and to make observations of the CLP in the treated area. Native aquatic plants will be monitored in the treated area through a replication of the sub-set point-intercept survey as described in section 3.2 of this report. Herbicide concentration monitoring will occur in association with the proposed 2020 treatment and will mirror the design of previous monitoring. Onterra will work with the WDNR in determining the final design of the herbicide concentration monitoring plan. The post-treatment monitoring would again be conducted by trained volunteers from the LLPRD. Onterra will provide any necessary sampling equipment and supplies to the LLPRD volunteers.



October 2013
September 2014
September 2015
September 2016
September 2017
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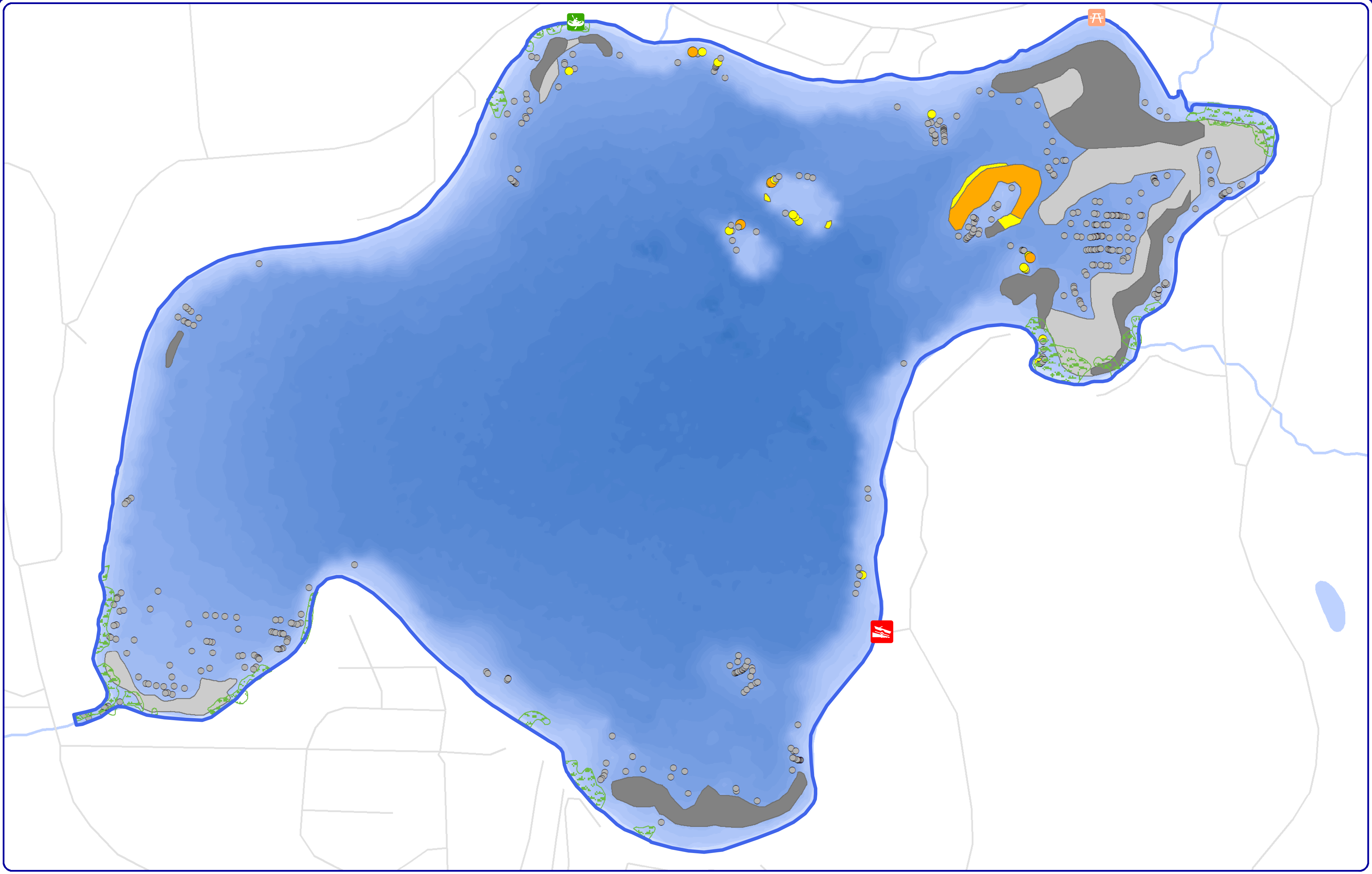
Feet
Onterra LLC
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com
Sources:
Roads, Hydro, and Bathymetry: WDNR
Plant Surveys: Onterra, 2013-2015
Map Date: January 16, 2019 TWH
Filename:Lost_EWMSeries_2013-2018.mxd
Project Location in Wisconsin
Legend
Eurasian Watermilfoil
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony
Map 1
Lost Lake
Vilas County
2013-2018 EWM
Survey Results



880

Feet

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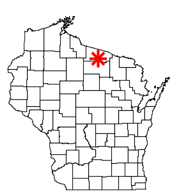
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Aquatic Plants: Onterra, 2019
Bathymetry: Onterra, 2017
Map date: September 26, 2019 - EJH
Filename: LostVilas_EWM_PB_Aug18.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
- Floating-leaf and/or Emergent Plant Colony

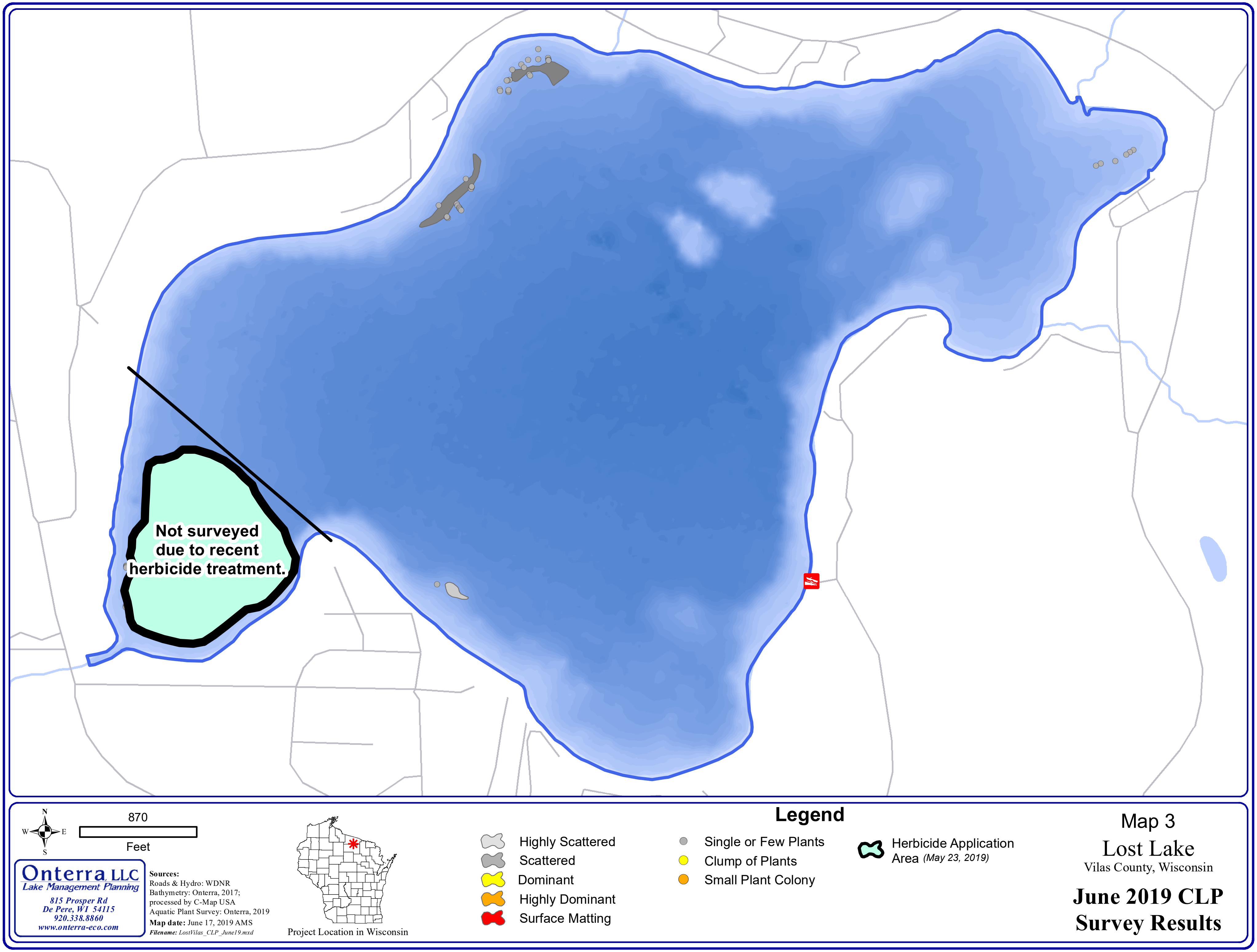
Map 2

Lost Lake

Vilas County, Wisconsin

September 2019

EWM Survey Results



Not surveyed due to recent herbicide treatment.
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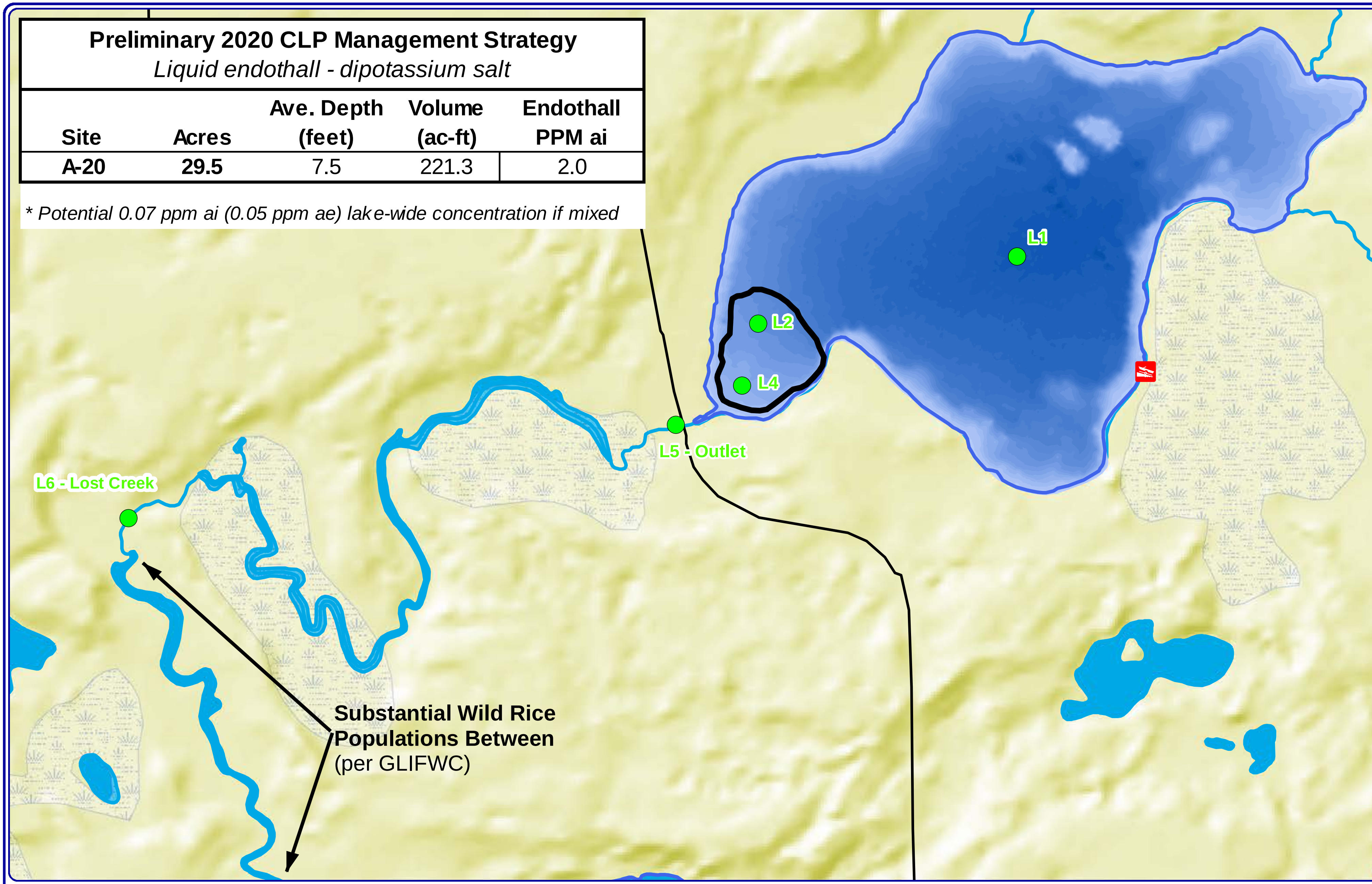
Feet
Onterra LLC
Lake Management Planning
815 Prosper Rd
De Pere, WI 54115
920.338.8860
www.onterra-eco.com
Sources:
Roads & Hydro: WDNR
Bathymetry: Onterra, 2017;
processed by C-Map USA
Aquatic Plant Survey: Onterra, 2019
Map date: June 17, 2019 AMS
Filename: LostVilas_CLP_June19.mxd
Project Location in Wisconsin
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clump of Plants
Small Plant Colony
Herbicide Application Area (May 23, 2019)
Map 3
Lost Lake
Vilas County, Wisconsin
June 2019 CLP
Survey Results

Preliminary 2020 CLP Management Strategy

Liquid endothall - dipotassium salt

Site	Acres	Ave. Depth (feet)	Volume (ac-ft)	Endothall PPM ai
A-20	**29.5**	7.5	221.3	2.0

** Potential 0.07 ppm ai (0.05 ppm ae) lake-wide concentration if mixed*



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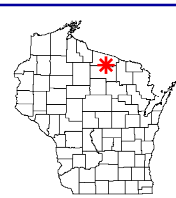
920.338.8860
www.onterra-eco.com

Sources:

Aquatic Plants: Onterra, 2016
Bathymetry: Onterra, 2017
Map date: January 8, 2019 EJH



Project Location in Wisconsin

Legend

- Herbicide Concentration Monitoring Site
- Preliminary 2020 CLP Treatment Area

Map 4

Lost Lake

Vilas County, Wisconsin

Preliminary 2020 CLP Management Strategy

A

APPENDIX A

Lost Lake 2019 Herbicide Concentration Monitoring Plan

Lost Lake, Vilas County (WBIC: 1593400)
Herbicide Sample Plan, 2019
Onterra, LLC

Lost Lake, Vilas County is a 538-acre drainage lake and has a maximum depth of 20 ft. Liquid endothall is proposed to be applied to 29.5 acres of the lake in spring 2019 to control curly-leaf pondweed. Herbicide concentration sampling will be conducted in order to monitor the herbicide concentrations in the hours and days following the application.

Water samples will need to be collected at the sites and depths listed below. Data are in decimal degrees and the datum is WGS84. A map of the herbicide sample site locations is attached.

Lost Lake Herbicide Sample Sites				
Site	**Station ID**	**Latitude**	**Longitude**	**Sample Depth**
L1 - Deep Hole	643081	45.96495	-89.482789	Integrated Sampler (0-6 ft)
L2 - Application Area	10048321	45.962808	-89.494945	Integrated Sampler (0-6 ft)
L4 - Application Area	10048323	45.960792	-89.495732	Integrated Sampler (0-6 ft)
L5- Outlet	10048324	45.959511	-89.498846	Manual
L6 - Lost Creek	10009240	45.956574	-89.524549	Manual

Samples will need to be collected at different time intervals (Hours After Treatment – HAT or Days After Treatment - DAT) throughout the project and are listed below. If a sample cannot be collected at the interval listed below, please collect the sample as soon as reasonably possible and record the change.

Interval	L1	L2	L4	L5	L6
2 HAT		X	X	X	X
4 HAT		X	X	X	X
8 HAT		X	X	X	X
1 DAT	X	X	X	X	X
3 DAT	X	X	X	X	X
5 DAT	X	X	X	X	X
7 DAT	X	X	X	X	X
14 DAT	X	X	X	X	X

X = sample to be collected (37 total samples)
HAT = Hours After Treatment
DAT = Days After Treatment

All water samples will be collected using an integrated sampler (Photo 1). A video tutorial demonstrating the proper use of an integrated sampler device is available on Onterra's YouTube web page. It is important to rinse the sampling device and the custom mixing bottle with the water from each sampling site upon arrival at the site.

Water is collected by pushing the integrated sampler straight down to an approximate depth of six feet; or in water shallower than six feet, down to approximately one foot above the bottom sediment. The sampler is brought to the surface and emptied into a customized mixing bottle by pushing open the stop valve at the end of the integrated sampler. The mixing bottle should be given a brief stir to mix the contents, and then emptied from the mixing bottle into the appropriately labeled final sampling bottle. Once in the final sampling bottle, the water sample must be preserved by adding 3-4 drops of sulfuric acid with an eye dropper.

Onterra will provide all of the necessary supplies to complete the sampling and provide training to the volunteer(s) collecting the samples. Onterra has a supply of GPS units, temperature probes, and integrated sampler devices available to loan out for the duration of the sampling upon request. All other materials including pre-labeled sampling bottles, a customized mixing bottle, vials of sulfuric acid, eye droppers, datasheets, and a shipping container will be provided.

It is important to use a separate data sheet for each day that is monitored. Fill out one data sheet for each sample interval and fill in the highlighted boxes. Store the preserved samples in a refrigerator within a dark, enclosed container. When all of the sample intervals are completed, please ship all of the samples and the data sheets to the Wisconsin State Lab of Hygiene (WSLH) within the insulated shipping box. Please review the attached *Herbicide Sample Handling Instructions* for specific shipping instructions.

If you have any questions, please call or email one of the contacts listed below.

Project specifics, logistics and sampling methods	
Todd Hanke **Onterra, LLC** **thanke@onterra-eco.com** **Cell Phone (920) 360-7233** **Office Phone (920) 338-8860**	**Eddie Heath** **Onterra, LLC** **eheath@onterra-eco.com** **Cell Phone (920) 360-1851** **Office Phone (920) 338-8860**
WDNR Support	
Michelle Nault **WI DNR** **Michelle.Nault@wisconsin.gov** **Office (608) 513-4587**	
Wisconsin State Lab of Hygiene	
Robel Kebede **WI State Lab of Hygiene** **Organic Chemistry Dept.** **Robel.Kebede@slh.wisc.edu** **Office (608) 224-6271**	**Jenna Smith** **WI State Lab of Hygiene** **Organic Chemistry Dept.** **Jenna.Smith@slh.wisc.edu**

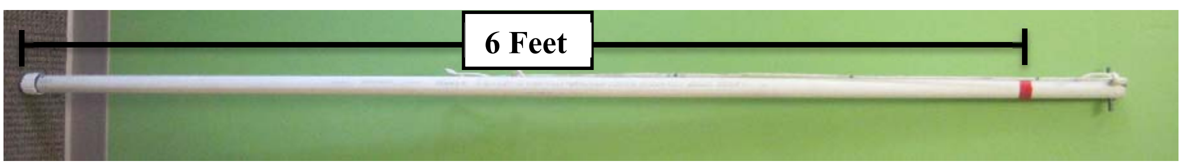


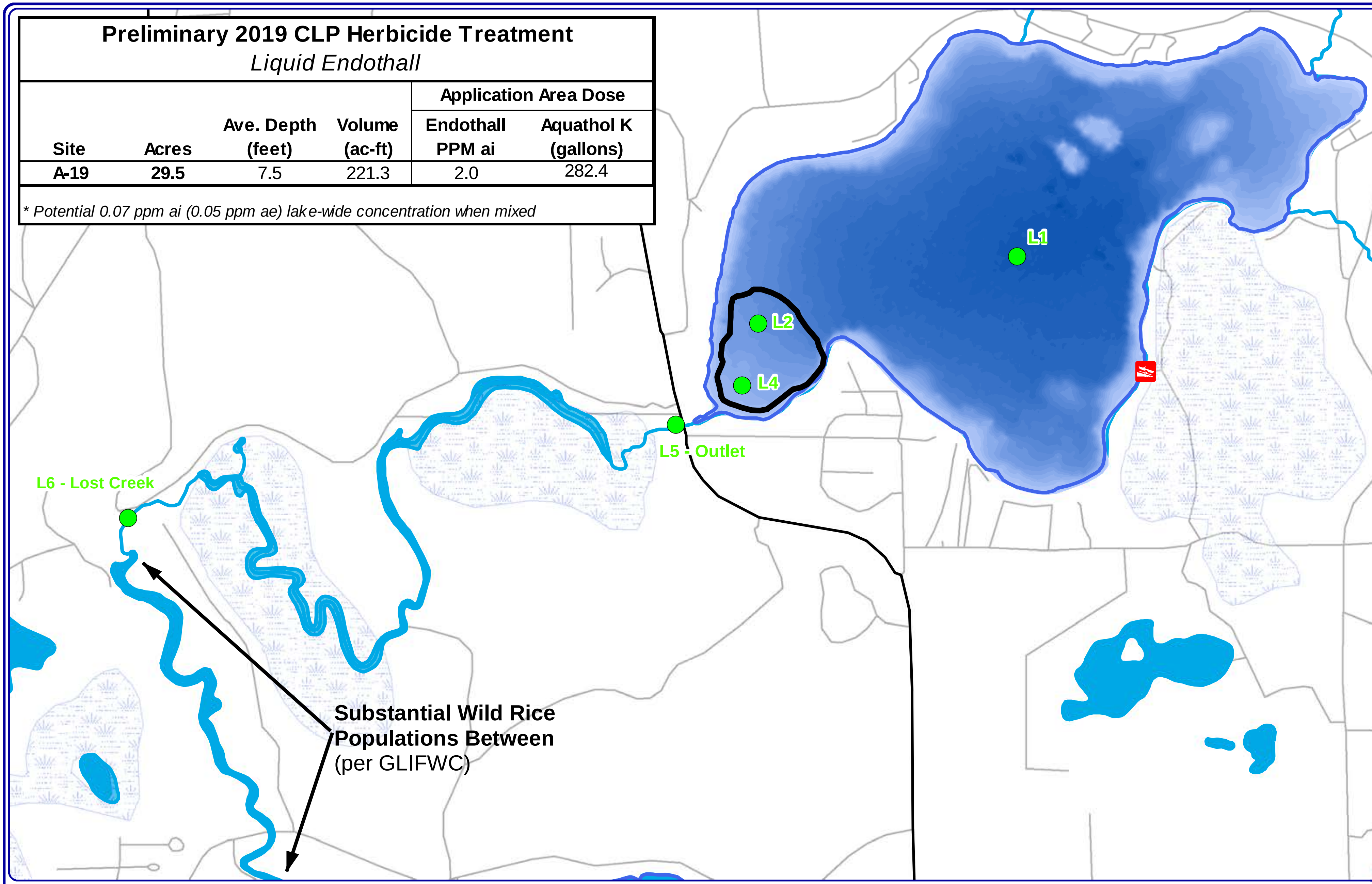
Photo 1. Six-Foot Integrated Sampler (top) & custom transfer bottle (Bottom).

Preliminary 2019 CLP Herbicide Treatment

Liquid Endothall

Site	Acres	Ave. Depth (feet)	Volume (ac-ft)	Application Area Dose: Endothall PPM ai	Application Area Dose: Aquathol K (gallons)
A-19	**29.5**	7.5	221.3	2.0	282.4

** Potential 0.07 ppm ai (0.05 ppm ae) lake-wide concentration when mixed*



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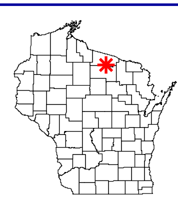
815 Prosper Rd
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:

Aquatic Plants: Onterra, 2016
Bathymetry: Onterra, 2017
Map date: January 8, 2019 EJH



Project Location in Wisconsin

Legend

Herbicide Concentration Monitoring Site

Preliminary 2019 CLP Treatment Area

Lost Lake
Vilas County, Wisconsin

Preliminary 2019 CLP Management Strategy

Lost Lake, Vilas County Herbicide Sampling Data Sheets, 2019

Account number:	351123
DNR User ID:	GAUTHK

Sample Matrix:	Surface Water (SU)
Project:	Grant Number: ACEI22919

WBIC:	**1593400**

Collector Name:	
Phone Number:	

Test Requested:	Endothall herbicide
Sample Interval:	

Site	Station ID	Sample Depth	Date	Time (24:00)	Water Temp in C (3 foot depth)	Wind Direction and Speed
L1 - Deep Hole	643081	Integrated (0-6 ft)				
L2 - Application Area	10048321	Integrated (0-6 ft)				
L4 - Application Area	10048323	Integrated (0-6 ft)				
L5 - Outlet	10048324	Manual				
L6 - Lost Creek	10009240	Manual				

Convert Fahrenheit to Celsius

T(°C) = (T(°F) - 32) × 5/9

Degree F	Degree C	Degree F	Degree C	Degree F	Degree C	Degree F	Degree C
50	10.0	60	15.6	70	21.1	80	26.7
51	10.6	61	16.1	71	21.7	81	27.2
52	11.1	62	16.7	72	22.2	82	27.8
53	11.7	63	17.2	73	22.8	83	28.3
54	12.2	64	17.8	74	23.3	84	28.9
55	12.8	65	18.3	75	23.9	85	29.4
56	13.3	66	18.9	76	24.4		
57	13.9	67	19.4	77	25.0		
58	14.4	68	20.0	78	25.6		
59	15.0	69	20.6	79	26.1		

Herbicide Sample Handling Instructions

1. Using permanent marker (one should be provided in kit), write the following information on the sample label and bottle lid:

   Sampling Site
   Sample Interval
   Date
   Time

2. IMPORTANT: As soon as possible after the sampling event (i.e. - within a few hours), acidify the sample in the sample bottle by adding 3 to 4 drops of sulfuric acid solution provided (vials of acid and droppers are included in kit). Failure to preserve samples will cause potential low bias in sample results due to microbial degradation of the herbicides. Please review the Material Safety Data Sheet (MSDS) accompanying the acid vials for safety precautions. The acid vials and droppers are meant to be saved and used more than once during the project – use the zip bag provided to store these items, but use best judgment to prevent acid exposure.

3. Store the samples refrigerated until ready to ship to the laboratory. There will be additional Ziploc bags provided for each day of sampling. (All samples from each day of sampling should be bagged together inside the cooler). Note that the samples can be shipped at room temperature as long as they are received at the lab within 24 hours.

4. When shipping samples to the laboratory, line the Styrofoam shipper with the large clear plastic bag provided. Ensure samples are tightly capped and place sample bottles in the plastic bag lined shipper. Once samples are added, close the large plastic bag and secure with the enclosed zip tie. Place sample submission forms in a zip bag and place on top of the samples. Affix Styrofoam lid and close/ seal box with packing tape.

5. Flip the card affixed to the outside of the shipper to show the WI State Lab shipping information

6. Ship the samples by overnight courier (Speedy, UPS, FedEx). Ideally, please notify the lab by phone or email when samples are shipped:

WI State Lab of Hygiene
EHD Organic Chemistry Dept.
2601 Agriculture Dr.
Madison, WI 53718
Office: (608) 224-6271
Fax: (608) 224-7166

B

APPENDIX B

Littoral Frequency of Occurrence of Aquatic Plants within a sub-set of the point-intercept survey of Lost Lake (n=40).

APPENDIX B

Littoral Frequency of Occurrence of Aquatic Plants within a sub-set of the point-intercept survey of Lost Lake (n=40).

	Scientific Name	Common Name	LFOO (%) 2007	2010	2014	2017	2018	2019
Dicots	*Myriophyllum spicatum*	Eurasian w atermilfoil	0.0	0.0	0.0	0.0	0.0	2.5
	Ceratophyllum demersum	Coontail	85.0	70.0	65.8	10.3	0.0	2.5
	Myriophyllum sibiricum	Northern w atermilfoil	22.5	47.5	15.8	0.0	0.0	0.0
	Bidens beckii	Water marigold	0.0	5.0	2.6	0.0	0.0	0.0
	Nuphar variegata	Spatterdock	2.5	2.5	0.0	0.0	0.0	0.0
Non-dicots	*Potamogeton crispus*	Curly-leaf pondw eed	0.0	0.0	0.0	17.9	5.0	10.0
	Elodea canadensis	Common w aterw eed	27.5	60.0	2.6	12.8	12.5	15.0
	Potamogeton robbinsii	Fern-leaf pondw eed	12.5	40.0	31.6	17.9	0.0	0.0
	Potamogeton zosteriformis	Flat-stem pondw eed	15.0	82.5	0.0	0.0	0.0	0.0
	Potamogeton praelongus	White-stem pondw eed	12.5	37.5	26.3	5.1	0.0	0.0
	Najas flexilis	Slender naiad	0.0	7.5	5.3	17.9	2.5	22.5
	Vallisneria americana	Wild celery	12.5	20.0	0.0	5.1	5.0	2.5
	Potamogeton amplifolius	Large-leaf pondw eed	32.5	10.0	2.6	0.0	0.0	0.0
	Potamogeton pusillus, P. berchtoldii, & P. stricifolius	Thin-leaved pondw eed spp.	0.0	12.5	31.6	0.0	0.0	0.0
	Chara spp.	Muskgrasses	5.0	0.0	0.0	0.0	15.0	2.5
	Potamogeton pusillus	Small pondw eed	0.0	2.5	21.1	0.0	0.0	0.0
	Potamogeton berchtoldii	Slender pondw eed	0.0	0.0	23.7	0.0	0.0	0.0
	Potamogeton richardsonii	Clasping-leaf pondw eed	5.0	2.5	10.5	0.0	0.0	0.0
	Isoetes spp.	Quillw ort spp.	0.0	0.0	0.0	2.6	2.5	5.0
	Filamentous algae	Filamentous algae	2.5	0.0	13.2	0.0	0.0	0.0
	Nitella spp.	Stonew orts	0.0	2.5	0.0	0.0	0.0	5.0
	Eleocharis acicularis	Needle spikerush	2.5	0.0	0.0	2.6	2.5	2.5
	Sagittaria sp. (rosette)	Arrow head sp. (rosette)	0.0	2.5	0.0	5.1	2.5	0.0
	Potamogeton strictifolius	Stiff pondw eed	0.0	10.0	0.0	0.0	0.0	0.0
	Elodea nuttallii	Slender w aterw eed	0.0	0.0	0.0	0.0	0.0	2.5
	Schoenoplectus tabernaemontani	Softstem bulrush	0.0	2.5	0.0	0.0	0.0	0.0
	Schoenoplectus acutus	Hardstem bulrush	0.0	0.0	0.0	0.0	2.5	0.0
	Potamogeton foliosus	Leafy pondw eed	2.5	0.0	0.0	0.0	0.0	0.0
	Pontederia cordata	Pickerelw eed	0.0	2.5	0.0	0.0	0.0	0.0
	Juncus pelocarpus	Brow n-fruited rush	0.0	2.5	0.0	0.0	0.0	0.0