1.0 INTRODUCTION

Berry Lake, Menominee and Oconto Counties, is a seepage lake with a maximum depth of approximately 23 feet. This mesotrophic lake has a relatively small watershed when compared to the size of the lake. Four exotic plant species, pale-yellow iris, reed canary grass, common reed, and Eurasian watermilfoil are known to exist in Berry Lake. The primary citizen-based organization leading management activities on Berry Lake is the Berry Lake Property Owners Association (BLPOA).

Like many other seepage lakes in Wisconsin, Berry Lake experiences more dramatic fluctuations in water levels through time when compared to lakes that receive surface water inflow (drainage lakes). In the spring of 2013, the US Geological Survey (USGS) installed a continuous water level monitoring station on Berry Lake and it has been recording daily water levels almost continuously since July of 2013. Figure 1.0-1 displays the daily gage height from Berry Lake from July 3, 2013 to November 25, 2019. Water levels have trended higher in the years since the gage was placed with water levels approximately four feet higher in late 2019 compared to 2013. Record rainfall in many parts of Wisconsin in 2019 contributed to the relatively rapid increase in water depth in Berry Lake during the year.

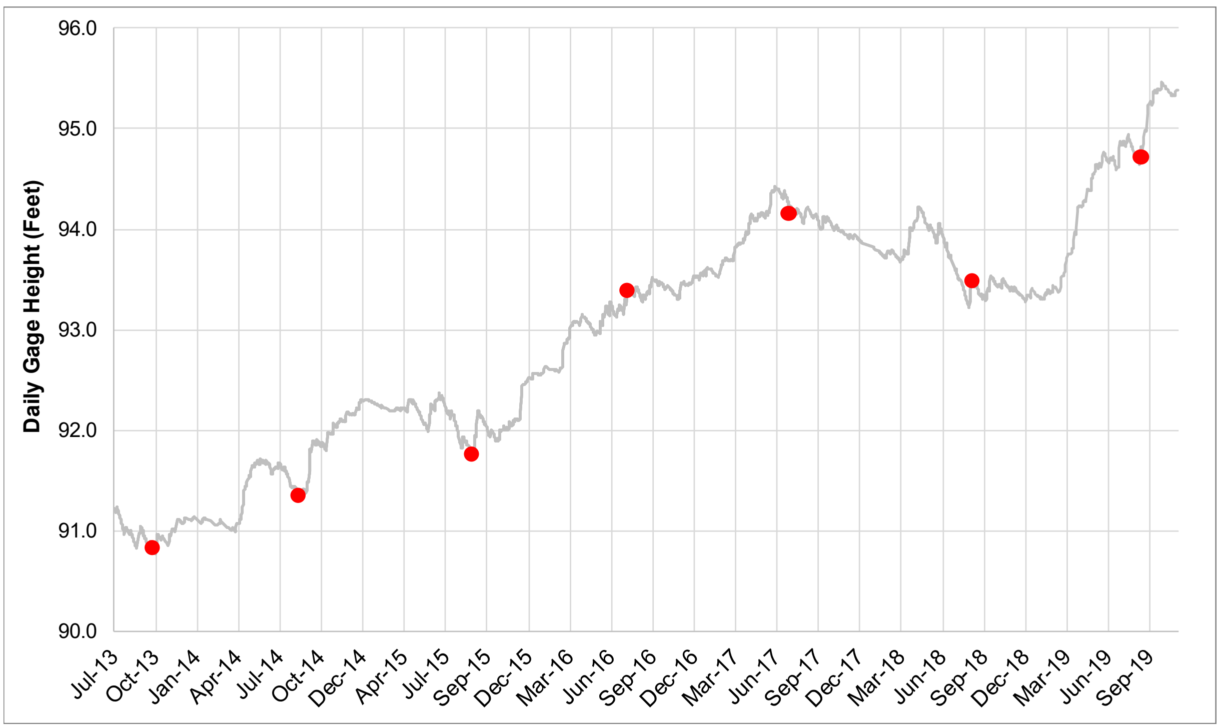


Figure 1.0-1. Berry Lake water levels from July 2013 through November 2019. Created using data obtained from the USGS Berry Lake water level monitoring station (USGS 2019). Red dots indicate timing of annual late-summer surveys.

1.1 Invasive Watermilfoil Management

Eurasian water milfoil (*Myriophyllum spicatum*; EWM) was first discovered in Berry Lake in 2007. Numerous control efforts have targeted the EWM population within Berry Lake since discovery, including volunteer-based hand-harvesting efforts, spot herbicide treatments (2007, 2008, 2010, 2011), and a large-scale eastern basin 2,4-D treatment in 2012.

Due to distinct features of the EWM's morphology, WDNR staff suspected that at least a portion of the EWM in Berry Lake may be a hybrid, a genetic cross between EWM and the indigenous northern water milfoil (*Myriophyllum sibiricum*). Plant samples were sent to the Annis Water Resources Institute at Grand Valley State University in Michigan for DNA analysis in 2010. The results confirmed that the milfoil sent in were a hybrid strain (HWM). Unless specifically indicated, this report will use "HWM" when discussing the invasive watermilfoil (EWM and HWM) population of Berry Lake.

Properly implemented whole-lake 2,4-D herbicide treatments can be highly effective on pure-strain EWM populations, with minimal EWM being detected for a year or two following the treatment. Following the same herbicide use pattern, lakes that contained an HWM component of their invasive watermilfoil population, as does Berry Lake, were reduced the year following treatment to a lesser degree than similar pure EWM populations. In almost all lakes with HWM populations, rebound took less time and the rebounded populations were at much higher frequencies than EWM populations.

With the uncertainty of long-term control from a large-scale 2,4-D treatment, the BLPOA investigated alternative herbicide strategies (e.g. fluridone, combination 2,4-D/endothall, triclopyr) that have been adopted for HWM populations. Following discussions between Onterra and the BLPOA during the fall/winter of 2017-2018, the BLPOA elected to move forward with a large scale 2,4-D treatment of the lake during the spring of 2018. The decision was based off the desire to balance invasive watermilfoil control, native plant selectivity, and overall cost of implementation. That being said, concerns over a higher invasive watermilfoil recovery potential exist following a 2,4-D treatment compared with other options explored.

1.2 2018 Whole-Lake 2,4-D Summary

The final control strategy included the application of liquid 2,4-D over 36.8 acres of the lake in order to achieve a target lake-wide concentration of 0.350 ppm ae. A strategy targeting an even higher lake-wide concentration (0.375 ppm ae) was considered, but the potential of having a long 2,4-D degradation pattern in the moderately-low nutrient seepage lake resulted in the slightly more conservative dosing strategy. The strategy accounted for limited potential water exchange between basins of the lake by configuring their concentrations independently.

During the *year of treatment* (2018) and *year after treatment* (2019), post treatment assessments would be made through replication of point-intercept surveys, acoustic bio-volume modeling, and HWM mapping assessments. The BLPOA understand that HWM population rebound is inevitable at some point following a whole-lake treatment. Depending on the results of the 2019 (*year after treatment*) surveys, the BLPOA would revisit their long-term invasive milfoil control strategy based upon the lessons learned during this period, which may include 1) strategically targeted management with small-scale management with hand-harvesting or short-exposure spot herbicide treatments, or 2) postponing active management until a replicate large-scale treatment is warranted.

Because the 2018 treatment on Berry Lake was anticipated to have whole-lake affects, the whole-lake point-intercept method as described by the WDNR Bureau of Science Services (PUB-SS-1068 2010) is used to complete a quantitative evaluation of the occurrences of non-native and native aquatic plant species. To monitor the treatment's efficacy, a whole-lake point-intercept survey was conducted in 2017 (*year prior to treatment*), 2018 (*year of treatment*), and 2019 (*year following treatment*). The success criteria of a whole-lake treatment would be a 70% reduction in HWM littoral frequency of occurrence comparing point-intercept surveys from the *year prior to the treatment* (2017) to the *year after the treatment* (2019).

Qualitative monitoring has been conducted annually through HWM mapping surveys on Berry Lake 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 are applied to locations that were considered as *small plant colonies* (<40 feet in diameter), *clumps of plants*, or *single or few plants*. These data are helpful to guide follow-up Integrated Pest Management (IPM) activities such as hand-harvesting or herbicide spot treatment.

Aquatic plant monitoring surveys conducted in 2018 indicate that the whole-lake 2,4-D treatment led to a high level of HWM control during the year-of-treatment. Herbicide concentration monitoring showed 2,4-D concentrations were approximately at the targeted level and had a half-life slightly above the median of other whole-lake 2,4-D treatments conducted in Wisconsin. Some amount of invasive watermilfoil survivorship was documented, particularly in the deeper portions of the eastern basin of the lake.

1.3 2019 HWM Management & Monitoring Strategy

Many lake groups initiate a large-scale herbicide strategy with the intention of implementing smaller-scale control measures (e.g. herbicide spot treatments, hand-removal) when HWM begins rebounding. This approach has shown promise on some lakes. However, the HWM population rebounds on some lakes in a lake-wide fashion that does not lend well to these methods.

No herbicide treatments were recommended to occur in Berry Lake in 2019 to allow for a more complete understanding of the efficacy of the 2018 whole-lake treatment and to allow time for any native plant species that may have been impacted to recover. Based on the HWM population that was mapped in the late-summer 2018 survey, the most appropriate HWM management strategy for Berry Lake in 2019 was a coordinated hand-harvesting effort that uses professional harvesting efforts, volunteer removal efforts, or some combination of each. This report will focus on the planning, control, and monitoring activities that took place in 2019 on Berry Lake.

2.0 2019 AQUATIC PLANT MONITORING RESULTS

2.1. Early Season AIS Survey (ESAIS)

A set of HWM mapping surveys were used within this project to coordinate and monitor the hand-harvesting efforts (Figure 2.1-1). The first monitoring event on Berry Lake in 2019 was the Early Season Aquatic Invasive Species Survey (ESAIS). This late-spring/early-summer survey provides an early look at the lake, helps understand HWM expansion since the previous survey, and is used to guide the final hand-harvesting management to occur on the system during the summer months. The final 2019 hand-harvesting strategy was determined following the 2019 ESAIS survey. After the hand-harvesting is complete, a Late-Summer HWM Mapping Survey was conducted to map the lake-wide HWM population and evaluate the effectiveness of the harvesting control program. The hand-removal program would be considered successful if the density of HWM within the targeted areas was found to have decreased from the ESAIS Survey to the Late-Summer Peak-Biomass Survey.

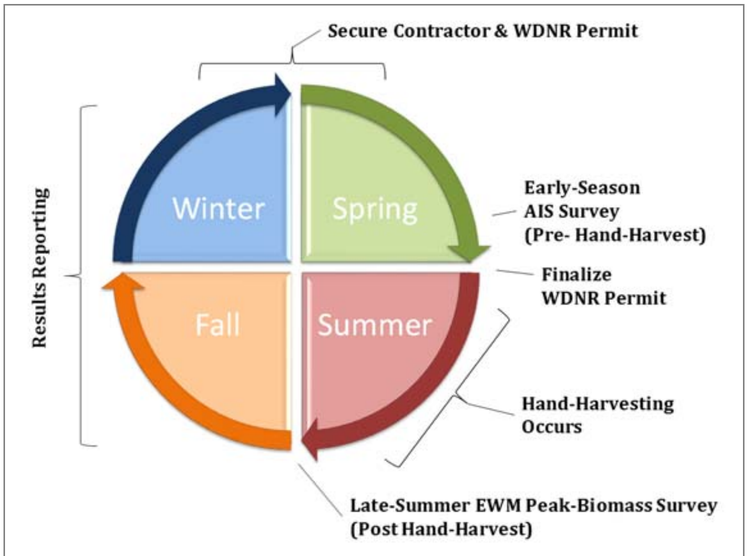


Figure 2.1-1. Hand-harvesting project timeline diagram.

Onterra field crews completed the Early Season AIS survey on Berry Lake on May 30, 2019. Crews noted favorable conditions for the survey with mostly sunny skies, light winds, and air temperatures in the 70's (°F). The majority of the HWM was mapped visually, however the survey was supplemented with the use of a submersible camera in several other areas of the lake. The submersible camera was deployed in sites that have previously harbored colonized areas of HWM, and revealed colonies of very short 2-3 foot tall HWM plants in a few locations. These plants were not visible from the surface and were often in 9 feet or deeper waters. Map 1 displays the results of the ESAIS survey on Berry Lake as well as the finalized hand-harvesting strategy. Site A-19 was adjusted slightly larger to include the areas mapped during the survey and site B-19 was removed from the preliminary strategy as no HWM was located at that location. With the addition of sites C, D, & E-19, the total acreage for the final harvesting sites was increased from 7.0 to 10.0 acres.

The hand harvesting strategy was prioritized to focus harvesting efforts at site D-19, and E-19 in the western basin. If sufficient time allows, harvesting efforts in C-19 would follow. Site A-19 at 7.3 acres, was believed to be beyond the size for which hand-harvesting was an appropriate control technique and was given low priority for hand-harvesting efforts. Onterra provided the spatial data from the ESAIS survey in the form of a GPS compatible basemap to the professional hand harvesting firm.

2.2 Professional Hand-Harvesting Activities

The BLPOA contracted with Aquatic Plant Management, LLC (APM) in 2019 to provide professional hand-harvesting services of HWM. AIS removal specialists from APM completed DASH services over five days between June 17 and July 2, 2019, harvesting approximately 253.5 cubic feet of HWM from Berry Lake (Table 2.2-1, Photo 2.2-1). The largest amount of harvest was from site E-19 in which 147 cubic feet of HWM was removed. Divers noted that much of the HWM consisted of relatively short plants and that HWM was auto-fragmenting at all sites. No harvesting efforts took place within site A-19 (Not shown on Table 2.2-1). Modest amounts of native plant by-catch consisting of pondweed species were reported by APM. A summary report of the DASH activities completed in 2019 authored by APM, LLC is included as Appendix A.

Photo 2.2-1. AIS removal specialists from Aquatic Plant Management, LLC work to harvest HWM from Berry Lake. (Photo provided by BLPOA)

Site	Time under water (hours)	AIS removed (ft^3)
C-19	7.32	68.5
D-19	9.33	38
E-19	12.51	147
Total	29.16	253.5

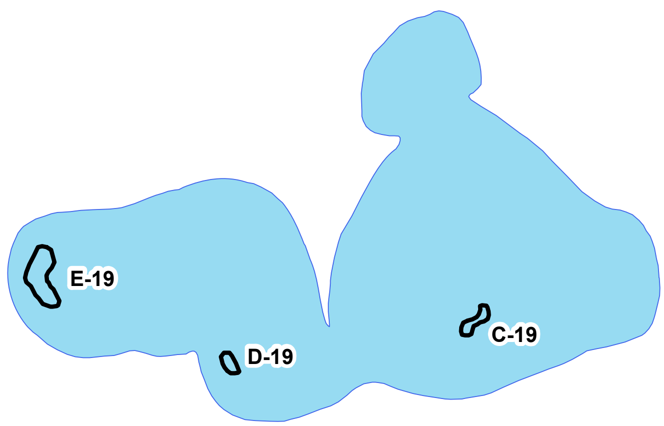


Table 2.2-1. Professional DASH Summary from 2019 HWM Removal Efforts in Berry Lake.

2.3 Late-Summer HWM Mapping Survey

The Late-Summer HWM Mapping Survey is a meander-based survey conducted when the plant is at its peak growth stage, allowing for a true assessment of the amount of this exotic within the lake. All HWM encountered were mapped with a sub-meter GPS using either points or polygons. Large colonies over 40 ft in diameter were mapped using polygons, while *small colonies*, *clumps of plants*, and *single plants* would be mapped using points. Colonies marked with polygons were attributed a density rating using a 5-tiered density scale from *highly scattered* to *surface matting*. Late-summer HWM mapping surveys have been conducted annually on Berry Lake since 2012.

On August 28, 2019, Onterra ecologists conducted the Late-Summer HWM Peak-Biomass Survey on Berry Lake. The purpose of the survey was to evaluate the lake-wide HWM population such that comparisons could be made to before the 2018 whole-lake treatment as well as allow for assessments for the specific sites that were included in the 2019 professional hand harvesting control strategy. The survey results are also used to develop a preliminary management and monitoring strategy for the following year. The results of the survey are displayed on Map 2.

During the survey, the field crew observed numerous floating HWM fragments as well as entire uprooted plants especially along the shorelines of many parts of the lake. Many of the fragments were observed to have advantageous roots protruding from them. The crew supplemented the visual survey with the aid of a submersible camera in select areas of the lake where colonies of HWM have historically been found in past surveys. The survey found the HWM population to have increased since the May 2019 survey with the majority of the newly identified occurrences being located in shallower waters near the shore. The largest contiguous colony of HWM that was mapped during the survey was located in the eastern basin surrounding a pocket of deeper water. This particular area has historically harbored some of the largest and most dense colonies of HWM in Berry Lake. This colony included a range of different density ratings including a few areas that were described as *dominant* or *highly dominant* in the late-summer survey. Numerous occurrences consisting of single plants, clumps or plants or small plant colonies were also mapped in various locations around the littoral areas of the lake (Map 2).

Professional DASH Site Assessments

The sites that were targeted for professional harvesting are highlighted in Figures 2.3-1 and 2.3-2 where one frame shows the pre-harvesting HWM population mapped in May 2019 and another frame show the post-harvesting HWM population mapped in late-August 2019. It should be noted that the late-summer survey occurred approximately seven weeks after the completion of the professional DASH efforts. This allows for sufficient time for HWM rebound in these areas from root crowns that were not completely removed.

Site C-19 The main target of the hand harvesting strategy in site C-19 was a *dominant* colony as well as two *small plant colonies* that were identified during the May 2019 survey. Harvesting efforts in the site totaled 7.3 hours and resulted in the harvest of 68.5 cubic feet of HWM. The 2019 Late-Summer HWM Mapping Survey indicated a *scattered* HWM colony within, and extending outside of, the permitted harvesting area. The survey results indicate a reduction in density from *dominant* to *scattered*; however, the overall size of the HWM colony expanded between the two surveys.

Site D-19 Site D-19 surrounded a *dominant* density HWM colony that was mapped during the May 2019 survey. Professional harvesting efforts yielded a harvest of 38 cubic feet of HWM over 9.33 hours of diver time. The 2019 Late-Summer HWM Mapping Survey indicated a reduction in density from *dominant* to *highly scattered* between the two surveys as well as a slight reduction in size.

Site E-19 Site E-19 targeted an area of colonized HWM consisting of *highly scattered*, *scattered*, and *dominant* densities that was mapped during the May 2019 survey on the far western end of the lake. Professional DASH efforts in the site yielded a harvest of 147 cubic feet of HWM over 12.51 hours of diver time. The 2019 Late-Summer HWM Mapping Survey indicated that an HWM colony remained present in approximately the same footprint as the previous survey, however the previous *dominant* density portion of the site appears to have been reduced to a lower density.

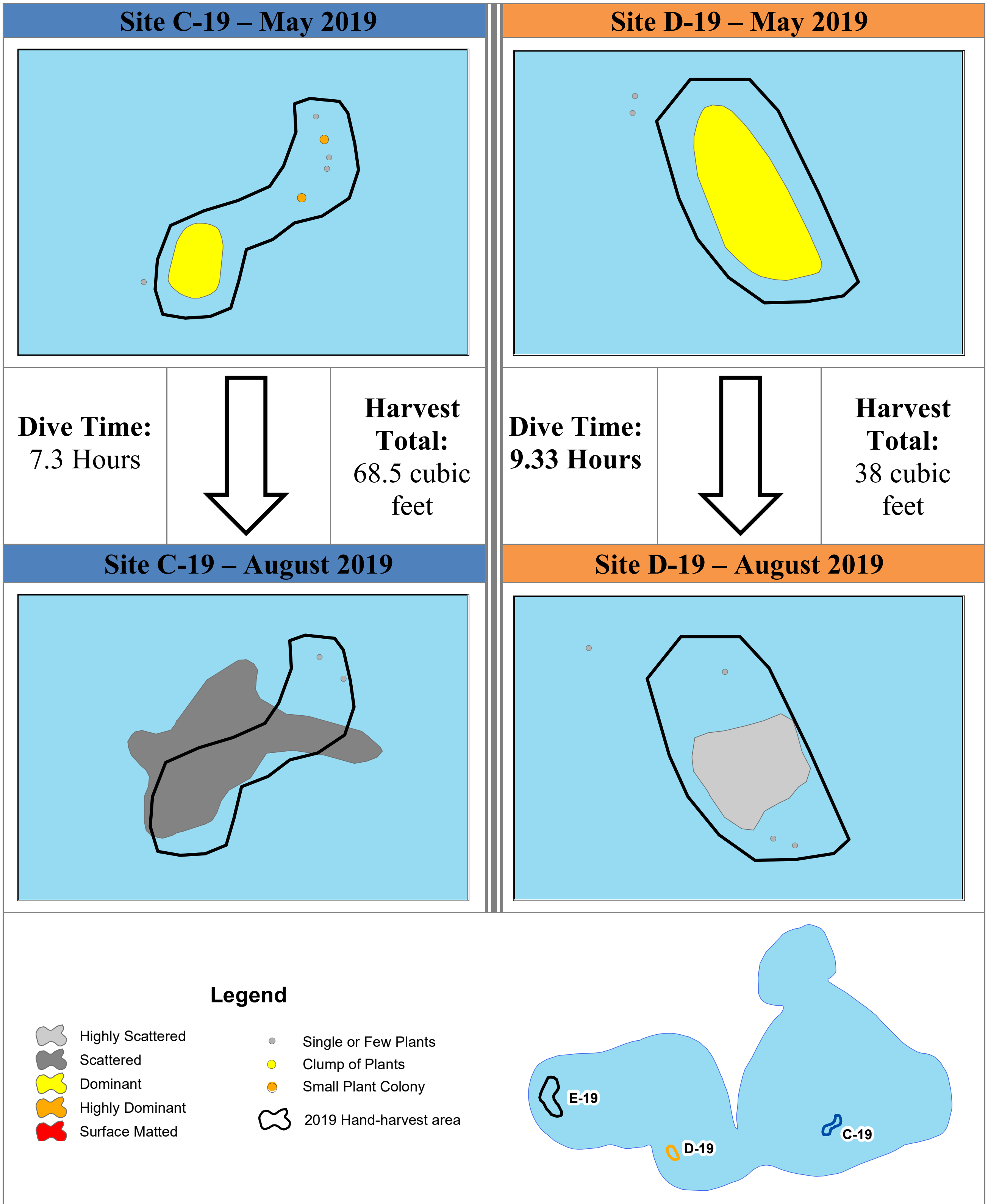


Figure 2.3-1. HWM results from before (May 2019) and after (August 2019) professional DASH efforts at sites C-19 & D-19 in Berry Lake.

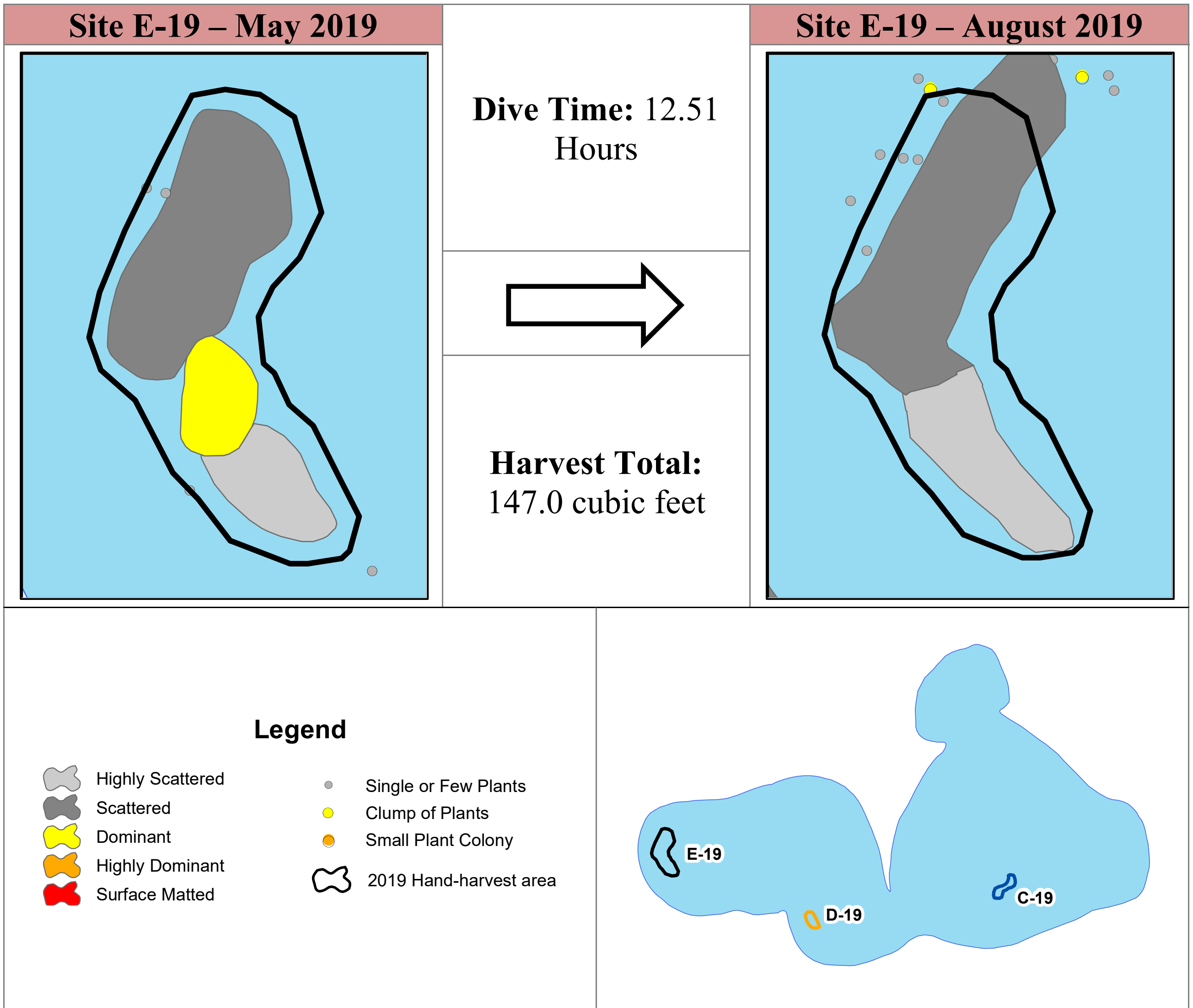


Figure 2.3-2. HWM results from before (May 2019) and after (August 2019) professional DASH efforts at site E-19 in Berry Lake.

2.4 Point-Intercept Survey

A point-intercept aquatic plant survey was first conducted on Berry Lake in 2007 as part of the US Environmental Protection Agency National Lake Assessment Program. Additional surveys were conducted by the WDNR in 2008-2015 as part of the EWM Long-Term Trends Monitoring Dataset and continued in 2016-2019 by Onterra as part of a WDNR grant-funded AIS control and monitoring project.

These data show that the HWM population of Berry Lake continued to increase following detection until a spring 2012 large-scale 2,4-D treatment in the eastern basin reduced the population to 2.1% (Figure 2.4-1, right frame). The HWM population rebounded in the following years only to decline in 2015 in the absence of any management actions taking place. While it cannot be confirmed, the increasing water levels may be influencing the HWM population as well as the populations of other aquatic plant species within the lake.

The HWM population increased to the highest level since monitoring began at 25.3% in 2017 (Figure 2.4-1, left frame), with almost 30% of littoral sampling locations in the eastern basin and 19% in the western basin containing HWM (Figure 2.4-1, right frame). Following the 2018 whole-lake 2,4-D treatment, the lake-wide littoral frequency of occurrence of HWM was reduced to 2.2%, representing a 92% reduction since 2017. Separating the data by basin, the littoral frequency of occurrence of HWM was reduced to 0% (100% decline) in the western basin, whereas the occurrence was reduced to 3.8% (87% decline) in the eastern basin (Figure 2.4-1 right frame). Continued monitoring during 2019 indicated that the lake-wide HWM littoral frequency of occurrence increased to 5.5%.

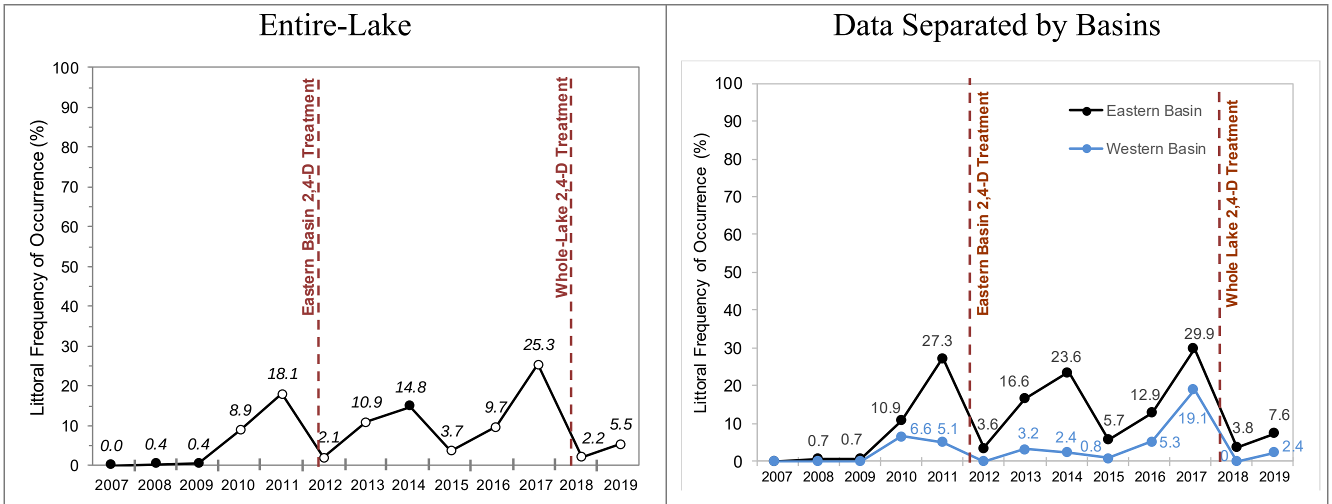


Figure 2.4-1. Berry Lake HWM littoral frequency of occurrence from 2007-2019. Open circles on left figure represent a statistically valid change from previous survey. .

Understanding the HWM occurrence in the *year of treatment* (2018) is important, however, the 2019 littoral frequency of occurrence is used to determine if the large-scale treatment meets the quantitative success criterion of a 70% decline from the *year prior to treatment* (2017) to *one-year after treatment* (2019). Table 2.4-1 shows that the 2018 whole-lake treatment strategy exceeded the pre-determined quantitative success criteria with a 78.3% decrease in littoral frequency of occurrence from the *year prior to treatment* to *one-year-after-treatment*.

Table 2.4-1. Berry Lake quantitative success criteria evaluation of the 2018 whole-lake 2,4-D treatment. Percent reductions shown in brackets.

Comparsion		Berry	
Year Prior to Treatment (2017)	-91.3%	25.3	**-78.3%**
Year of Treatment (2018)		2.2	
Year after Treatment (2019)		5.5	

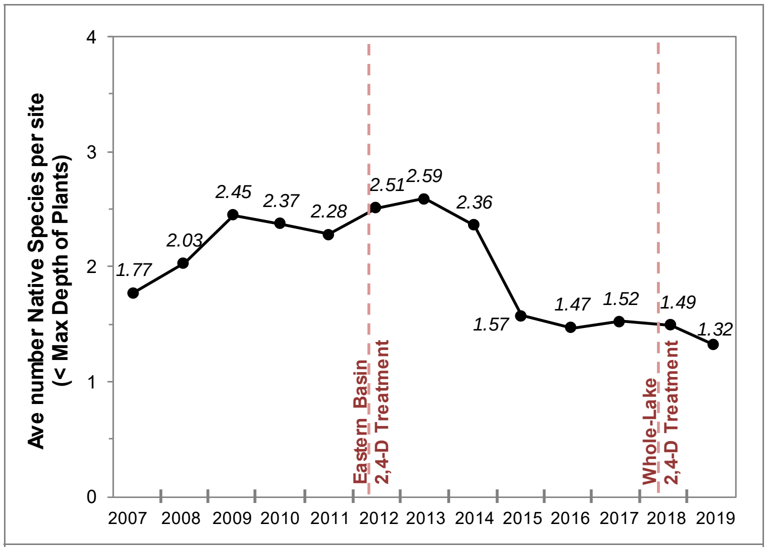


Figure 2.4-2. Average number of native aquatic plant species per littoral sampling site (2007-2019) in Berry Lake.

Figure 2.4-2 investigates the average number of native plant species at each point-intercept sampling location. These data show a reduction in this metric between 2014 to 2015 when no chemical treatment or hand-harvesting occurred. Rising water levels in Berry Lake around the same time frame are thought to be a factor that may influence the native plant populations. Since 2015, the average number of native species per site has remained fairly steady. Following the whole-lake herbicide treatment in spring 2018, the average number of native species remained approximately the same as the previous few years. The 2019 survey found 1.32 native plants per sampling site which is slightly lower than 2018, and is lower than any other year since monitoring began in 2007.

Based upon the point-intercept surveys conducted between 2007-2019, Figure 2.4-3 shows mean littoral frequency of occurrence of each species (square black symbol), the population range (extent bars), and the 2019 littoral frequency of occurrence (red circle). The 2019 frequency of occurrence of several of the non-dicot species are lower than the mean values and towards the lower end of the population range.

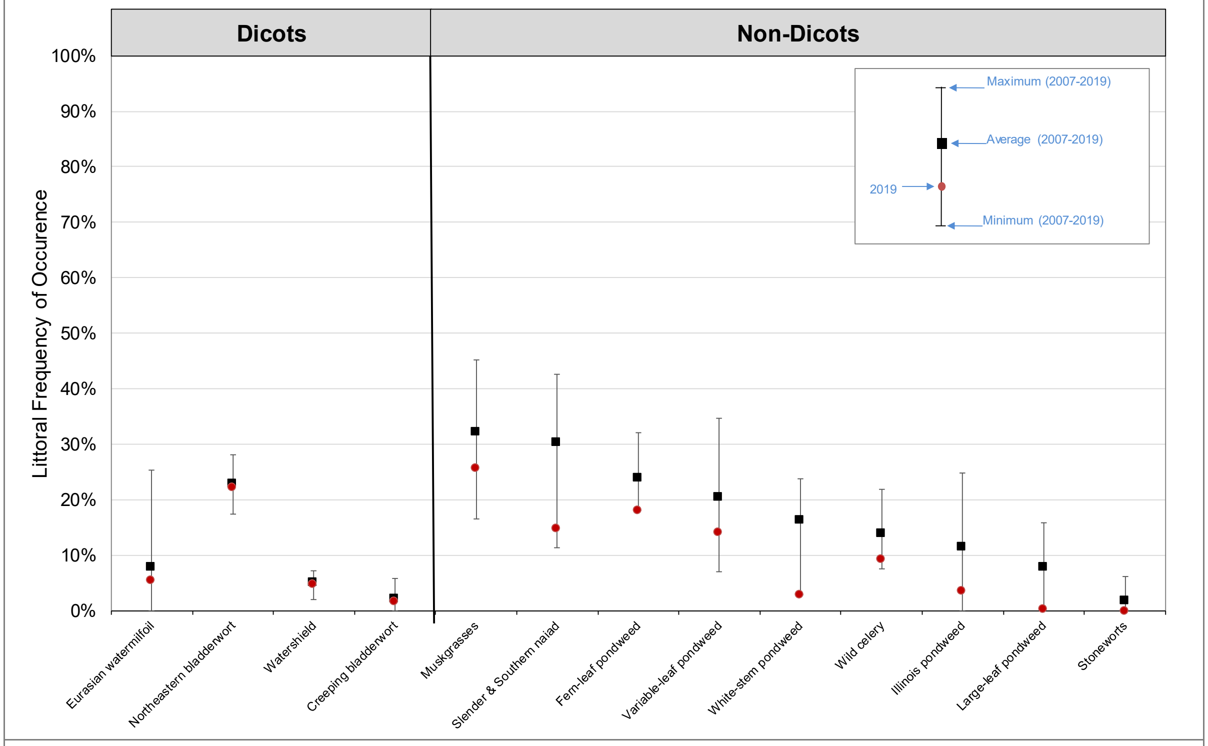


Figure 2.4-3. Historic average aquatic plant frequencies (2007-2019) in Berry Lake. Square symbol represents mean frequency of occurrence, error bars represent range of annual frequencies, red circle symbol represents 2019 frequency of occurrence. Only species with a mean frequency of occurrence ≥2% are shown.

Figures 2.4-4 - 2.4-6 further investigate the littoral frequency of occurrence of specific aquatic plant species in Berry lake from 2007-2019. Only species that exhibited at least a 2% littoral frequency of occurrence in at least one survey are displayed. A full matrix of all species through a chi-square analysis is included as Appendix B.

Important Note:
Littoral frequency of occurrence (LFOO) is used to describe how often each species occurred in the point-intercept survey sampling points that are within the maximum depth of plant growth (littoral zone), and is displayed as a percentage.

Figure 2.4-4 displays the littoral frequency of occurrence of native dicot aquatic plant species in Berry lake from 2007-2019. No native dicot species showed a statistically valid change in occurrence between the 2018 and 2019 surveys. Northern watermilfoil has not been detected on the point-intercept survey since 2013. Northern water milfoil has been known to be susceptible to early-season 2,4-D use patterns, but the recorded population may be further confounded by the field identification limitations of this species and HWM.

Figure 2.4-5 displays the littoral occurrence of native species that exhibited a statistically valid decrease in occurrence between the 2017 and 2018 surveys in Berry Lake which corresponds to the timing of the most recent whole-lake herbicide treatment. Three species, white-stem pondweed (-76.4%), large-leaf pondweed (-69.5%) and the collective occurrences of slender and southern naiad (-45.7%) exhibited statistically valid declines in littoral frequency of occurrence between 2017 and 2018. Continued monitoring in 2019 indicates that the occurrence of large-leaf pondweed and white-stem pondweed decreased slightly compared to 2018, however the difference was not statistically valid. There was a modest increase in the collective population of slender and southern naiads from 2018-2019.

Figure 2.4-6 displays the littoral occurrence of additional native species commonly located in point intercept surveys in Berry Lake. These data shows variability in native plant species from year to year as environmental variables and active aquatic plant management activities influence the populations. Some species such as wild celery and fern-leaf pondweed have been relatively stable over the period of monitoring, whereas others species such as Illinois pondweed and variable-leaf pondweed have been highly variable from year to year with many statistically valid changes in occurrence between surveys.

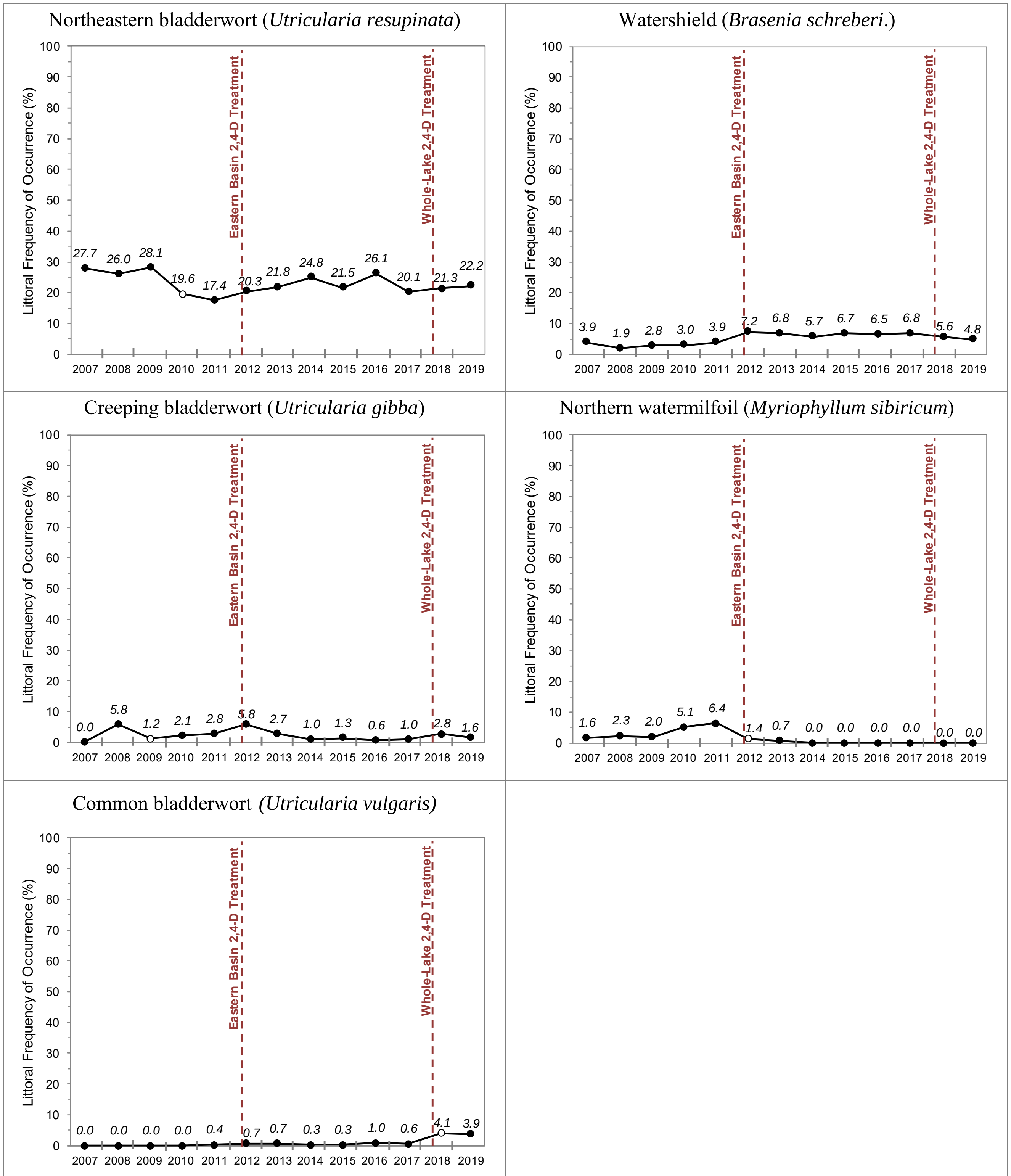


Figure 2.4-4. Littoral occurrence of native dicot species in Berry Lake from 2007-2019. Open circle represents a statistically valid change in occurrence from previous survey (Chi-square α = 0.05). Red-dashed lines indicate whole-lake herbicide treatments.

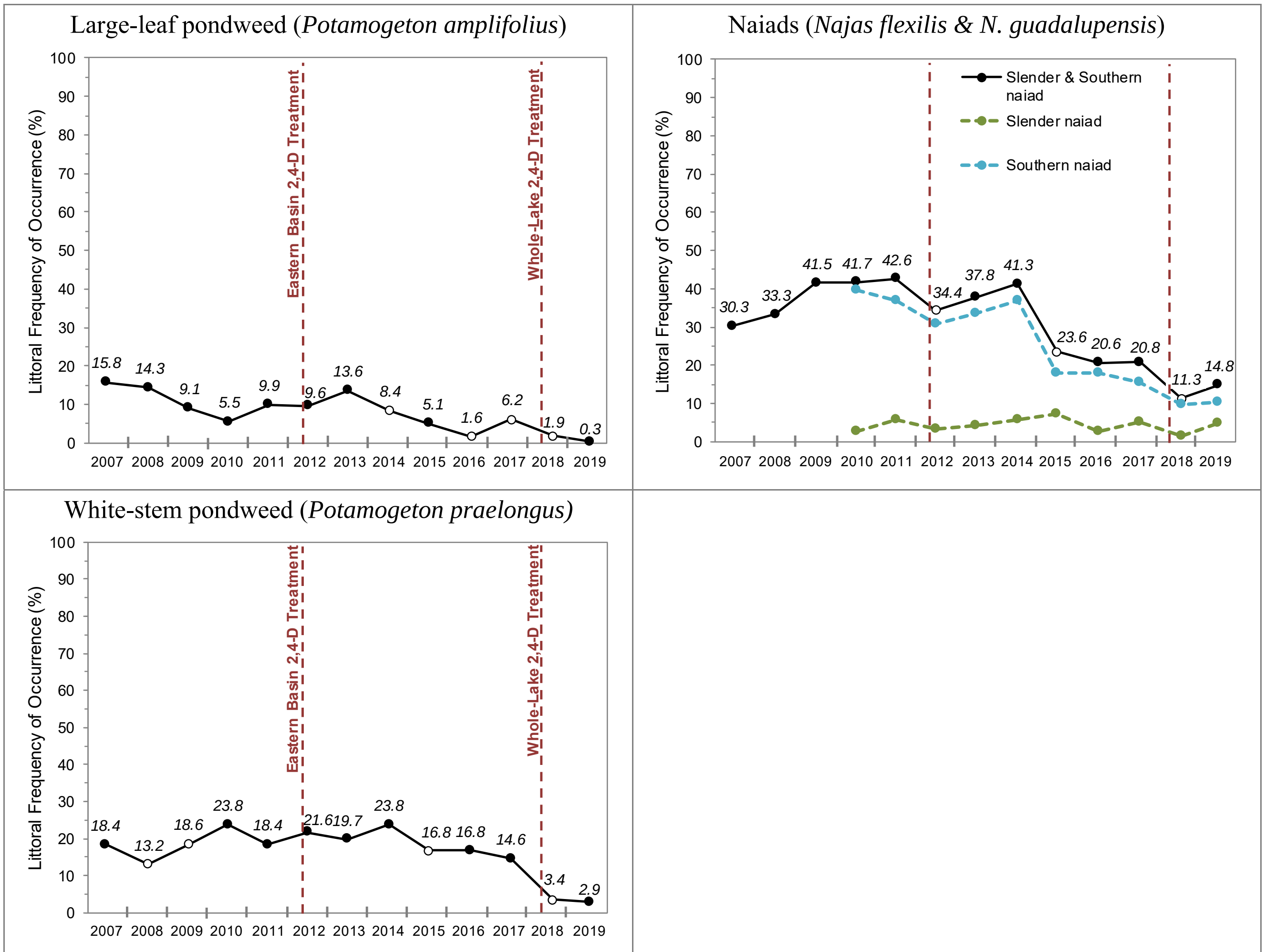


Figure 2.4-5. Littoral occurrence of native species that exhibited a statistically valid decrease in occurrence between 2017-2018 in Berry Lake. Open circle represents a statistically valid change in occurrence from previous survey (Chi-square α = 0.05).

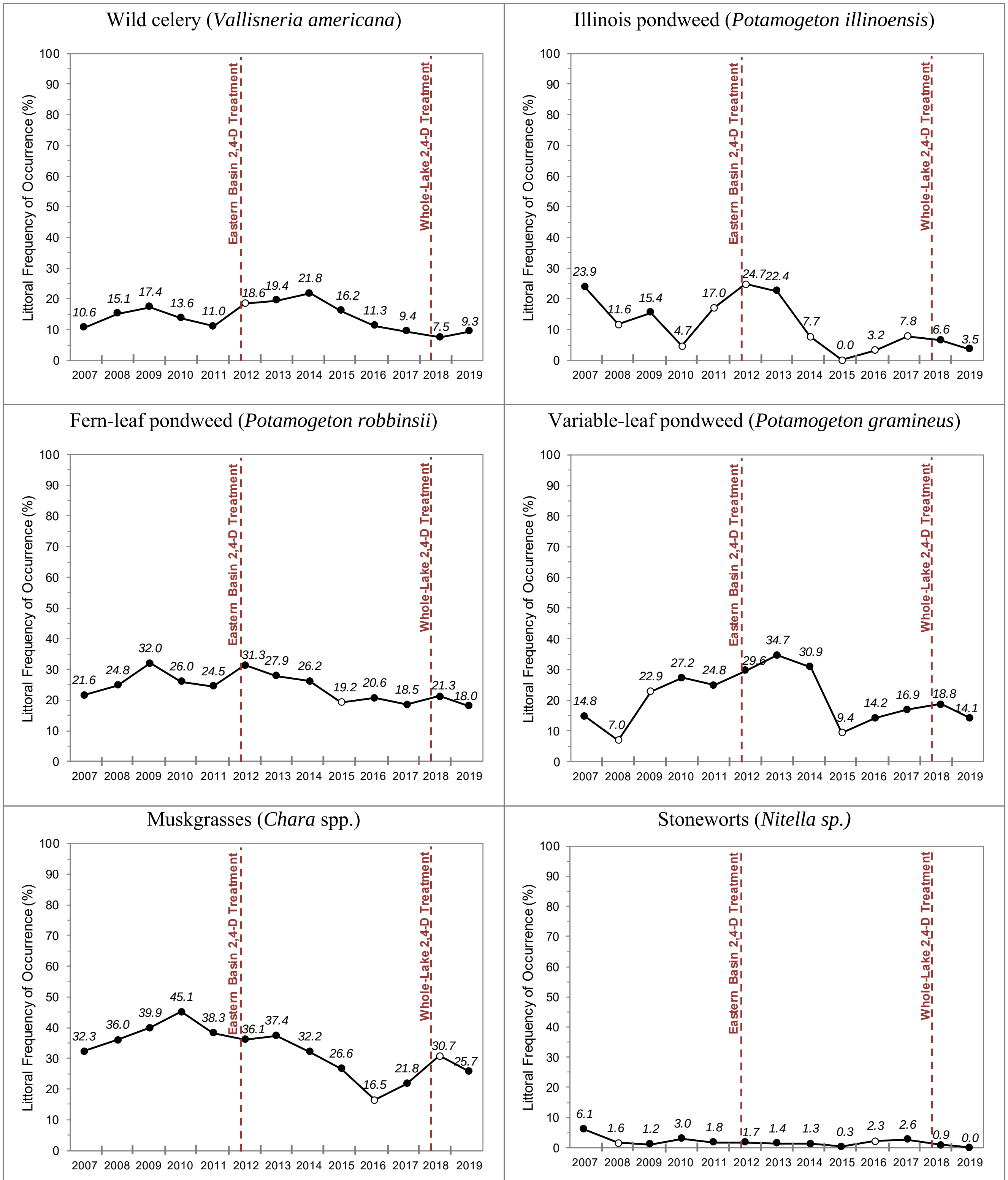


Figure 2.4-6. Littoral occurrence of native species commonly found in Berry Lake from 2007-2019. Open circle represents a statistically valid change in occurrence from previous survey (Chi-square α = 0.05).

Milfoil Genetic Analysis Study

A cooperative research project between WDNR and Grand Valley State University (transitioned to Montana State University) collected invasive milfoil samples from Berry Lake as part of each year's point-intercept survey. The goal was to determine the relative composition of EWM and HWM within the lake, and potentially even understand the strains (aka genotype) of the populations. As discussed within past annual reports, the study results indicate that both pure strain EWM and hybrid watermilfoil populations exist in the lake. In recent years, the lab has performed an ITS rapid assay analysis which allowed for distinctions between milfoil species (EWM, HWM, northern watermilfoil, etc). Advanced DNA analysis through microsatellite data allows for identifying specific genotypes of a species of milfoil.

During the 2019 point-intercept survey, Onterra staff collected meristems of invasive milfoil plants at each sampling location in which milfoil was recorded on the survey rake. The samples were preserved in accordance with the *WDNR Procedures and Policies for Milfoil Genetic Identification – Watermilfoil Drying Protocol* and ultimately shipped to Montana State University for genetic analysis.

The lab results in 2019 found that Berry Lake has two genotypes, one EWM strain and one HWM strain. Map 3 displays the invasive milfoil DNA results for the samples that have been collected and analyzed from 2014-2019 in Berry Lake. The data do not appear to show that the large-scale herbicide treatments have resulted in a shift in the populations favoring either EWM or HWM. Three of the samples from 2019 were identified as HWM, whereas 14 samples tested as EWM (Map 3).

Interestingly, similar DNA data has been collected on several nearby lakes and the results show the same HWM genotype present in Berry Lake has also been confirmed in neighboring Moshawquit Lake, as well as Loon Lake, and Washington Lake in Shawano County. The EWM genotype confirmed in Berry Lake has also been confirmed in four other Wisconsin Lakes including Moshawquit Lake.

2.5 Acoustic Surveys

Onterra ecologists have also conducted annual acoustic-based surveys to measure the bio-volume of aquatic plants throughout the lake. The survey is measuring the percentage of the water column occupied by aquatic plants. As illustrated on Figure 2.5-1, areas where aquatic plants occupy most or the entire water column are indicated in red, while areas of little to no aquatic plant growth are displayed in blue. The bio-volume data indicate that much of Berry Lake contains aquatic plant growth.

Aquatic plant biovolumes were higher in 2017 than in 2018 (Figure 2.5-1). The survey does not differentiate aquatic plant species, but the denser biovolumes located in 2017 generally correspond with the locations of HWM mapped during 2017. The 2018 post treatment biovolume is almost exclusively from native plants. In some whole-lake treatments, the native plant community is greatly reduced during the year of treatment. While some reductions in native plant were documented (white-stem pondweed, large-leaf pondweed, naiad species), the overall native plant biomass appears only modestly reduced. Aquatic plant biomass from a replication of the acoustic survey during the late-summer of 2019 is displayed on the bottom frame of Figure 2.5-1. The 2019 survey indicates an increased biomass compared to 2018 in some areas of the lake, particularly in the eastern basin as well as in several near shore locations. The increase in biomass between 2018-2019 can be partly contributed to the increasing HWM population during the same time period.

The acoustic surveys also collect data pertaining to water depths and substrate hardness. These aspects may have utility in comparing the lake water volume over a time period of increasing water levels.

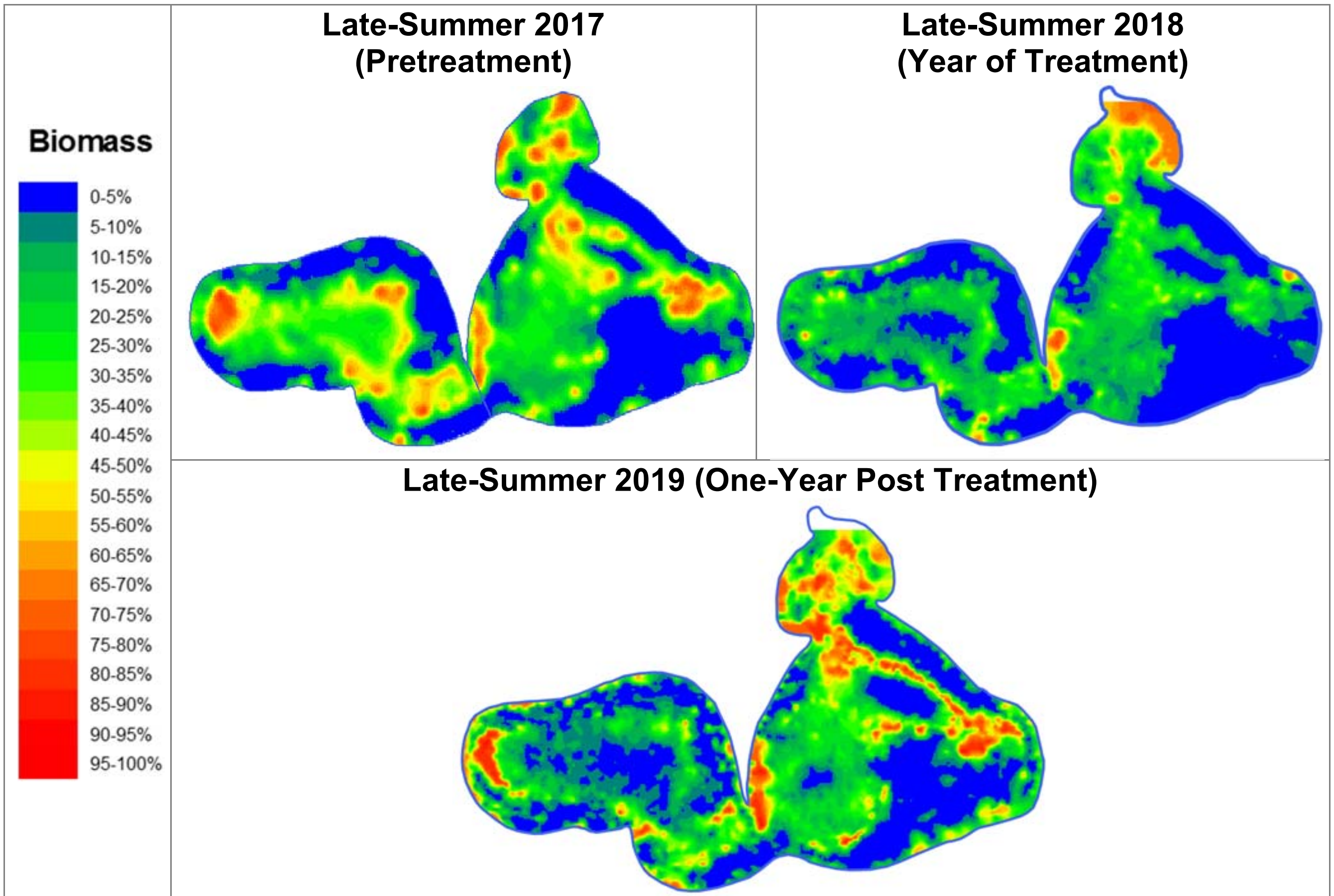


Figure 2.5-1. Bio-acoustic survey results from Late-Summer 2017-2019 on Berry Lake.

2.6 Common Reed (Phragmites)

During a 2014 survey, Onterra ecologists documented the presence of another non-native species found in Wisconsin; common reed. Common reed (*Phragmites australis* subsp. *australis*) is a tall, perennial grass that was introduced to the United States from Europe. A native strain (*P. australis* subsp. *americanus*) of this species also exists in Wisconsin and the plant material collected from Berry Lake in 2014 was sent to the UWSP herbarium where it was later confirmed to be of the non-native variety. This species can form towering, dense colonies that overtake native vegetation and replace it with a monoculture that provides inadequate sources of food and habitat for wildlife.

Because this species has the capacity to displace the valuable wetland plants along the exposed shorelines, it was recommended that these plants be removed by cutting and bagging the seed heads and applying herbicide to the cut ends. Common reed control has been most effective utilizing a foliar application of an enzyme-specific herbicide (imazapyr or glyphosate) applied to the plants during the late summer as the plants are actively transporting sugars and nutrients from their leaves to their rhizomes in preparation for over wintering. This will ensure translocation of the herbicide to the rhizomes where the entire plant can be controlled. A permit issued by the WDNR is required to place herbicide on plants that are located within the water.

Photo 2.6-1. Common Reed (Phragmites australis) observed growing in Berry Lake during a 2018 survey. (Photo by Onterra, LLC)

The BLPOA partnered with the WDNR through a program conducted under a Great Lake Research Initiative (GLRI) grant to help control common reed populations along the Lake Michigan shoreline, which includes Oconto County. Onterra conducted a survey of the giant reed locations during the summer of 2016 and forwarded the information to the WDNR. Following the appropriate notifications and obtaining landowner permissions, common reed control actions, were implemented by a licensed applicator at forty-five sites on Berry Lake in 2016. No Phragmites control efforts were completed in 2017; however, the population was monitored through a late-summer mapping survey that found three locations in the lake. indicating that past control efforts coupled with rising water levels may have contributed to the decline in this species. The common reed population was monitored again in the late-summer of 2018 when Onterra crews mapped all locations during an August visit (Photo 2.6-1).

During an August visit to Berry Lake in 2019, Onterra staff continued to monitor the common reed population in Berry Lake. The results of the mapping survey are indicated on Figure 2.6-1 where one colonized area of plants described as 'scattered' in density was located in the same general location as previous surveys as well as two additional occurrences consisting of a clump of plants or a single or few plants. The crew observed the common reed population to be almost entirely submerged, with some plants just poking above the waters' surface.

Common reed control activities in recent years are not evaluated or determined within the scope of this project, however control efforts may have occurred during 2018 and 2019. Representatives from the BLPOA may be able to provide further information regarding common reed control efforts in Berry Lake.

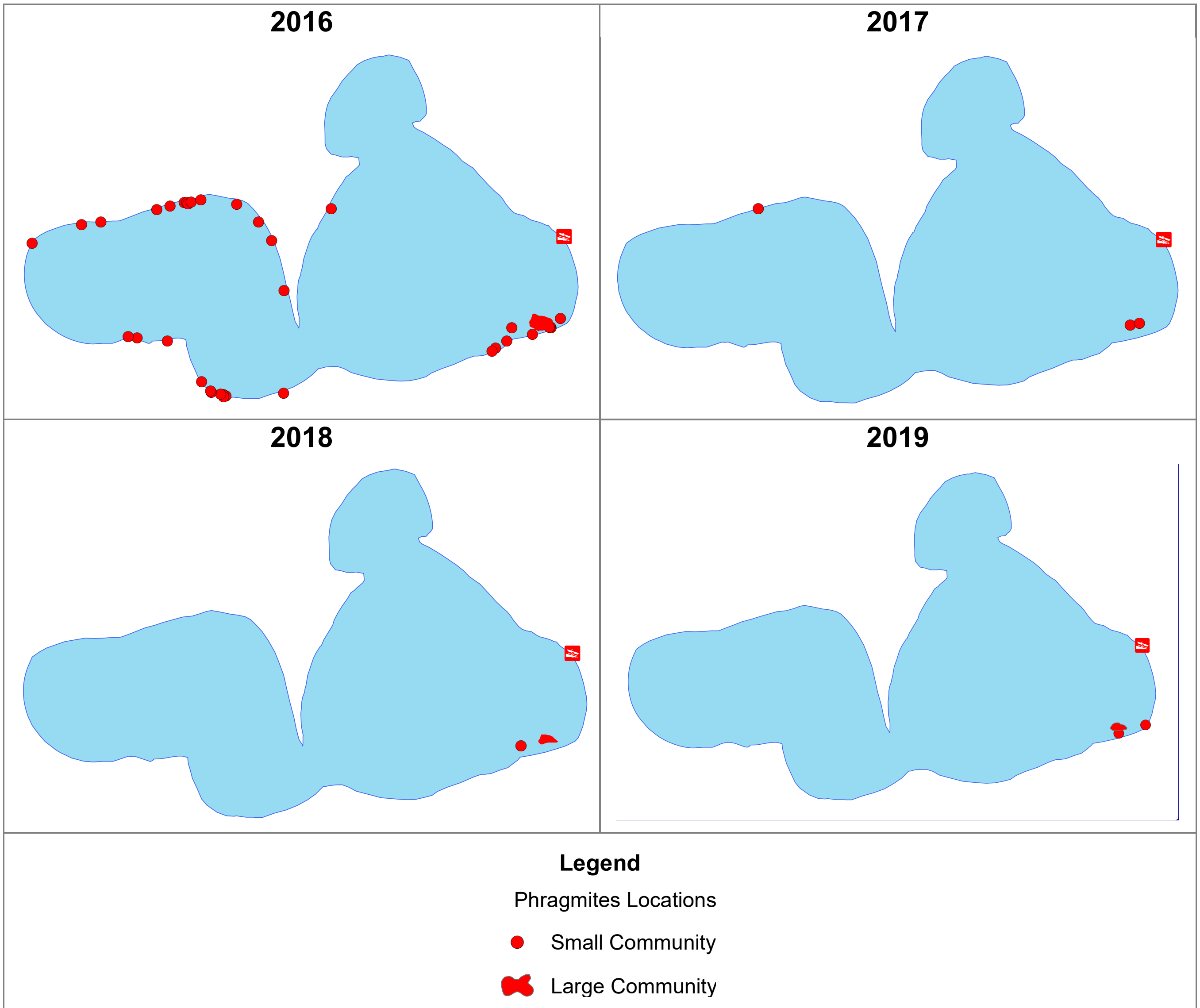


Figure 2.6-1. Berry Lake 2016-2019 Non-native Common Reed (Phragmites australis) Population. Data from Onterra 2016-2019 surveys.

3.0 CONCLUSIONS & DISCUSSION

In 2019, multiple aquatic plant surveys were completed in order to effectively monitor the plant populations during a period of active HWM management. Native aquatic plant species have exhibited some variability in occurrence over the course of time as these species are influenced by both environmental factors such as increasing water levels, and by active HWM management (herbicide treatment and hand harvesting). The 2019 point-intercept survey showed that the 2018 whole-lake 2,4-D treatment exceeded the quantitative success criteria with an HWM reduction of greater than 70% between the year before treatment and the year after treatment.

The monitoring associated with the professional DASH HWM control strategy in 2019 showed promising results where harvesting efforts resulted in reductions in the density of HWM in the targeted areas. The 2019 DASH strategy met lake managers' expectations for the sites where efforts took place in that the HWM population in the targeted areas were maintained at relatively low densities that likely impart little or no negative ecological or sociological impacts to the lake.

Water levels continued to increase in Berry Lake in 2019 with levels now approximately four feet deeper than just six years ago. The impact that the water level increase may have on the aquatic plant populations in Berry Lake are difficult to determine. It is speculated that the increase in water depth has made some areas of Berry Lake too deep for some species to persist. Over time, aquatic plant species will shift their location towards areas more suitable for them. In the short-term, this natural disturbance can decrease the standard metrics used for evaluating an aquatic plant community. As water levels stabilize, native plant populations may increase to a new stable state. Overall, some species likely struggle to adapt, while other species may thrive.

The 2019 Late-Summer HWM Mapping Survey indicated that the population has increased somewhat compared to the late-summer of 2018 although the population remains lower than in 2017 before the whole-lake 2,4-D treatment took place.

The BLPOA obtained an extension to their current AIS-EPC grant which will allow funding to carry out a coordinated IPM strategy during 2020 that utilizes herbicide treatment and hand harvesting HWM management techniques. The project will also include a replication of the whole-lake point-intercept survey and continued monitoring of the common reed population through the completion of a mapping survey.

3.1 Proposed 2020 HWM Management Strategy

The HWM population has shown signs of re-establishment since the 2018 whole-lake 2,4-D treatment in some parts of Berry Lake where the HWM footprint has historically been located. The BLPOA began an Integrated Pest Management (IPM) HWM management strategy in 2019 through the coordinated DASH program with the goal of inhibiting the HWM populations' rebound or re-establishment in the lake and in an effort to prolong the gains that were made following the whole-lake treatment. The BLPOA wishes to continue to manage the HWM population in Berry Lake in an attempt to keep the managed HWM population at a lower level where ecological and sociological impacts are mitigated.

Herbicide Spot-Treatment

One area of HWM in the eastern basin of Berry Lake has grown in size and density since the whole-lake treatment to a level in which a hand harvesting or DASH based control strategy is likely not scale appropriate. Spot herbicide treatments are challenging in practice in lakes where it is difficult to achieve herbicide contact exposure times that are long enough to kill the targeted plants. Further research has shown that HWM is often less impacted by certain herbicide use patterns than pure-strain EWM. The BLPOA explored options for an herbicide spot-treatment targeting this area in 2020 and has solicited bids on three potential treatment designs. At the time of this writing, the BLPOA is pursuing the option of using a relatively new herbicide called ProcellaCOR™ (florpyrauxifen-benzyl) that has shown some promise in other spot treatments in Wisconsin Lakes. Map 4 displays a proposed 10.0-acre ProcellaCOR herbicide treatment strategy that targets the largest and densest known area of HWM in Berry Lake at a dosing rate of 4.0 Prescription Dose Units (PDU) per acre-foot. The manufacturer of ProcellaCOR, SePRO, offers a multi-year warranty on ProcellaCOR treatments that meet certain conditions. Based on the proposed treatment design for Berry Lake, it is expected that the warranty would be applicable. The

BLPOA should work with their applicator to confirm the warranty conditions associated with the proposed treatment.

This herbicide is specifically designed to control invasive milfoil populations. ProcellaCOR™ is in a new class of synthetic auxin mimic herbicides (arylpicolinates) with short concentration and exposure time (CET) requirements compared to other systemic herbicides. Uptake rates of ProcellaCOR™ into EWM were two times greater than reported for triclopyr (Haug 2018, Vassios et al. 2017). ProcellaCOR™ is primarily degraded by photolysis (light exposure), with some microbial degradation. The herbicide is relatively short-lived in the environment, with half-lives of 4-6 days in aerobic environments and 2 days in anerobic environments (WSDE 2017). The product has a high affinity for binding to organic materials (i.e. high KOC).

Netherland and Richardson (2016) and Richardson et al. (2016) indicated control of select non-native plant species with the active ingredient in ProcellaCOR™, including invasive watermilfoils (EWM and HWM) at low application rates compared with other registered spot treatment herbicides. The majority of native plants tested to date also suggest greater tolerance to this mode of action. Water lilies, pickerelweed, arrowheads, and native watermilfoils have shown sensitivity to ProcellaCOR™. Coontail may also be impacted at higher application rates. Because this is a new herbicide, data available from field trials is relatively limited.

The use of any aquatic herbicide poses environmental risks to non-target plants and aquatic organisms. The EPA Ecological Risk Assessment places the risk to non-target wildlife into the "no risk concern" category and the impacts to bees, birds, reptiles, amphibians, and mammals in the "practically non-toxic" category. The EPA has also indicated that there are no risks of concern to human health. There are no restrictions on swimming, drinking, fish consumption, or turf irrigation. However, there would be an approximate 1-day waiting period of the proposed application for shoreland irrigation due to concerns of herbicidal impacts. The WDNR's Chemical fact sheet for florpyrauxifen-benzyl are included as Appendix C.

Pending the submission and subsequent acceptance of the WDNR permit to complete a spot-treatment in 2020, Onterra would complete a Pre-Treatment Confirmation and Refinement Survey in spring 2020 in order to evaluate the growth stage of the HWM plants and to finalize the dosing strategy for the proposed treatment.

Herbicide Treatment Monitoring Strategy

The BLPOA would accompany the herbicide treatment with post treatment herbicide concentration samples to couple with a post treatment Late-Season EWM Mapping Survey and a whole-lake point-intercept survey to evaluate the efficacy and selectivity of the treatment. The following paragraphs elaborate on this monitoring strategy.

Onterra would work with the WDNR to develop an herbicide concentration monitoring sampling plan in association with the 2020 early-season herbicide treatment. The plan would include volunteer collection of water samples at a number of locations and time intervals following the treatment. Samples would be shipped to the appropriate laboratory for analysis.

As a qualitative monitoring evaluation, a 2020 Late-Season HWM Mapping Survey would be compared to the pretreatment 2019 Late-Summer EWM Mapping Survey. The treatment would be considered successful in meeting the HWM control goals if the post-treatment survey indicates little to no HWM present in the targeted areas during the year of treatment. Further, reductions in HWM in the targeted areas would be expected to last into 2021.

Quantitative analysis of the native and HWM populations will include comparing the results of the 2019 whole-lake point-intercept survey to a replication of the survey planned for 2020. The point-intercept data would be evaluated on a lake-wide scale as well as specifically from points located in the eastern basin to evaluate any detectable changes in the aquatic plant community during the year-of-treatment.

Hand-Harvesting

Many of the known HWM locations in Berry Lake other than the site being considered for herbicide treatment may be considered for a hand-harvesting-based control effort. This management technique has utility in areas of the lake where herbicide treatment is not feasible, but where HWM suppression is still desired. It is believed that a reasonable level of targeted hand harvesting efforts could serve to inhibit the expansion of the population in select areas of Berry Lake and potentially delay the need for future herbicide management.

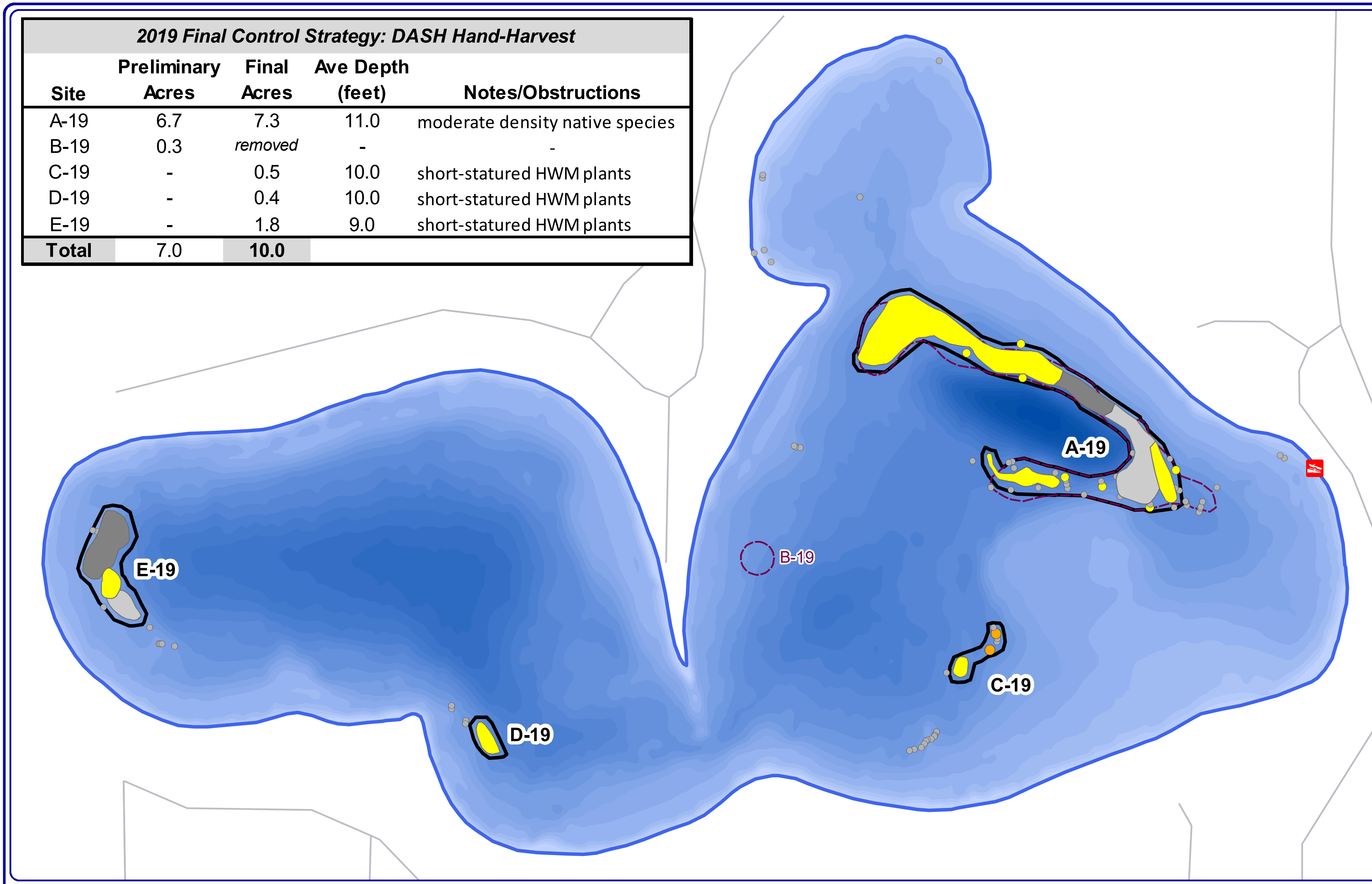
Map 5 offers a preliminary hand harvesting/DASH strategy that prioritizes the largest known remaining colonized areas of HWM in the western basin of the lake. Two sites, totaling 2.78 acres are included in the preliminary DASH strategy and are in approximately the same location as 2019 DASH work sites. It is expected that two days of DASH efforts in 2020 may be sufficient to target the sites included in the preliminary strategy. Depending on the progress of the harvesting operations during the first day, considerations should be made to split the harvesting efforts into two visits that are four or more weeks apart. This will allow for sufficient time to pass such that any HWM that was incompletely removed or has re-established in the sites can be targeted during the follow-up visit.

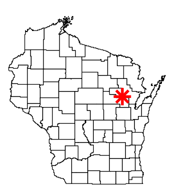
Map 5 may be used to acquire the conditional permit required for DASH from the WDNR. The DASH permit would be conditional pending the results of a spring survey in 2020 from which the final DASH strategy would be determined. Onterra crews would make observations of the HWM population in Berry Lake and the proposed DASH sites during a Spring Pre-Treatment Confirmation and Refinement Survey. The spring survey results will be valuable in re-evaluating the practicality of conducting hand harvesting management in Berry Lake as well as determining a prioritization scheme for any efforts that may take place.

Volunteer led HWM harvesting in Berry Lake can make localized impacts in areas where efforts take place, particularly in shallow waters around riparian property shorelines. No permits are required for an interested BLPOA volunteer to harvest HWM by hand from Berry Lake. The 2019 Late-Summer HWM Mapping Survey indicated several relatively new locations around Berry Lake's shoreline where HWM had taken hold in shallow waters. Many of these locations were amongst shrubs and other terrestrial vegetation that had become submerged with the rising water levels. These particular areas may be well suited for a volunteer harvesting effort as they would be difficult or impossible for DASH.

Any hand harvesting activities that take place in 2020 would be evaluated through comparing the mapping surveys from before and after the harvesting efforts. The strategy would meet control expectations if the population is approximately maintained at current levels or reduced in density in the targeted areas by the time of a 2020 Late-Summer HWM Mapping Survey.

2019 Final Control Strategy: DASH Hand-Harvest				
Site	Preliminary Acres	Final Acres	Ave Depth (feet)	Notes/Obstructions
A-19	6.7	7.3	11.0	moderate density native species
B-19	0.3	*removed*	-	-
C-19	-	0.5	10.0	short-statured HWM plants
D-19	-	0.4	10.0	short-statured HWM plants
E-19	-	1.8	9.0	short-statured HWM plants
Total	7.0	**10.0**		





Legend

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2019 Final Hand-harvest area
- 2019 Preliminary Hand-harvest area

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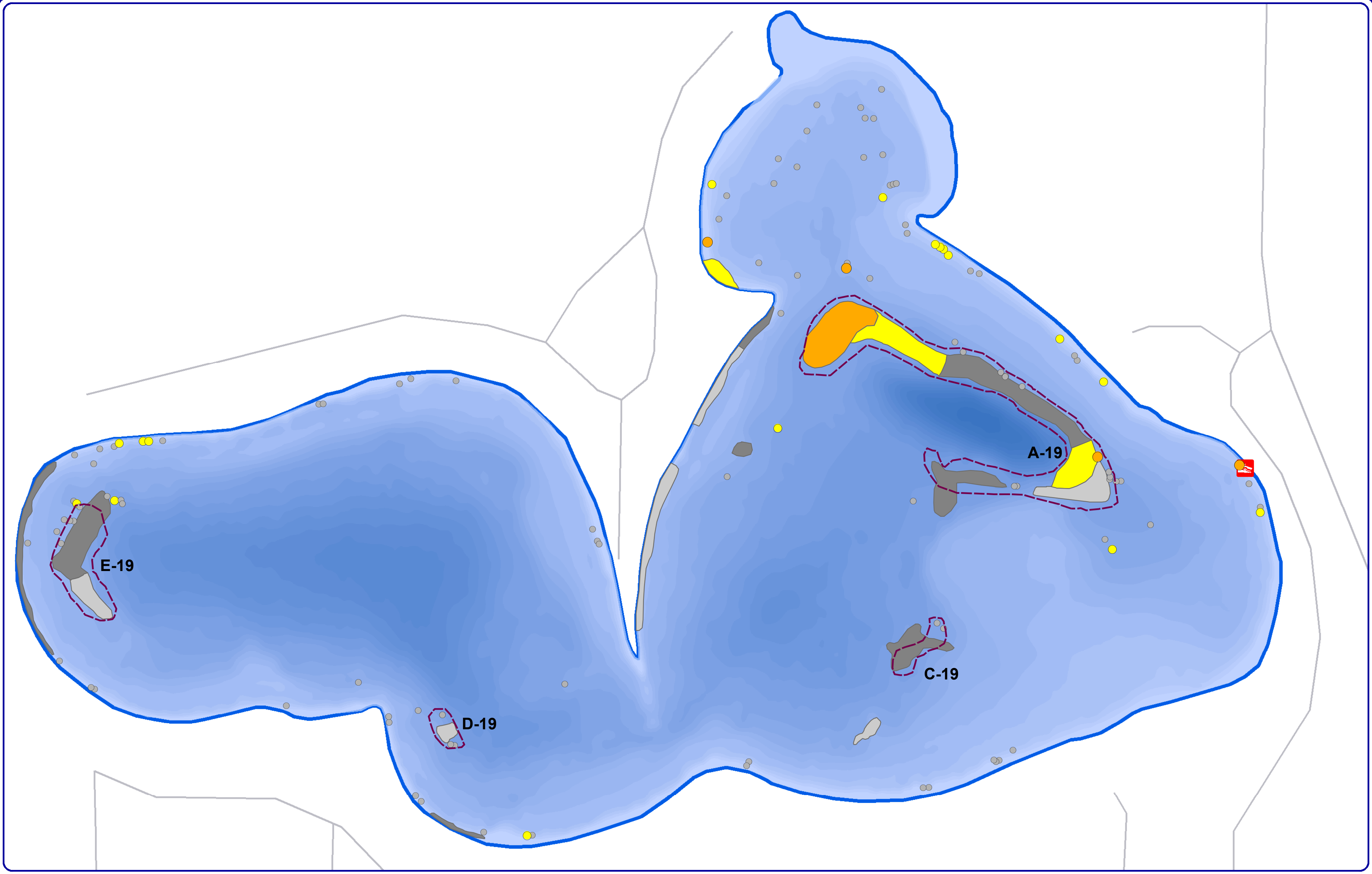
Sources:
Roads and Hydro: WDNR
Bathymetry: Onterra, 2017
Aquatic Plants: Onterra, 2019
Orthophotography: NAIP, 2017
Map Date: June 4, 2019 TWH
Filename: Berry_HWM_May19_HH_Perm.mxd

Map 1

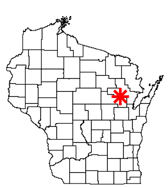
Berry Lake

Oconto County, Wisconsin

May 2019 HWM Survey Results & Final Hand-Harvesting Strategy



550
Feet



Project Location in Wisconsin

Legend

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2019 Final Hand-harvest area

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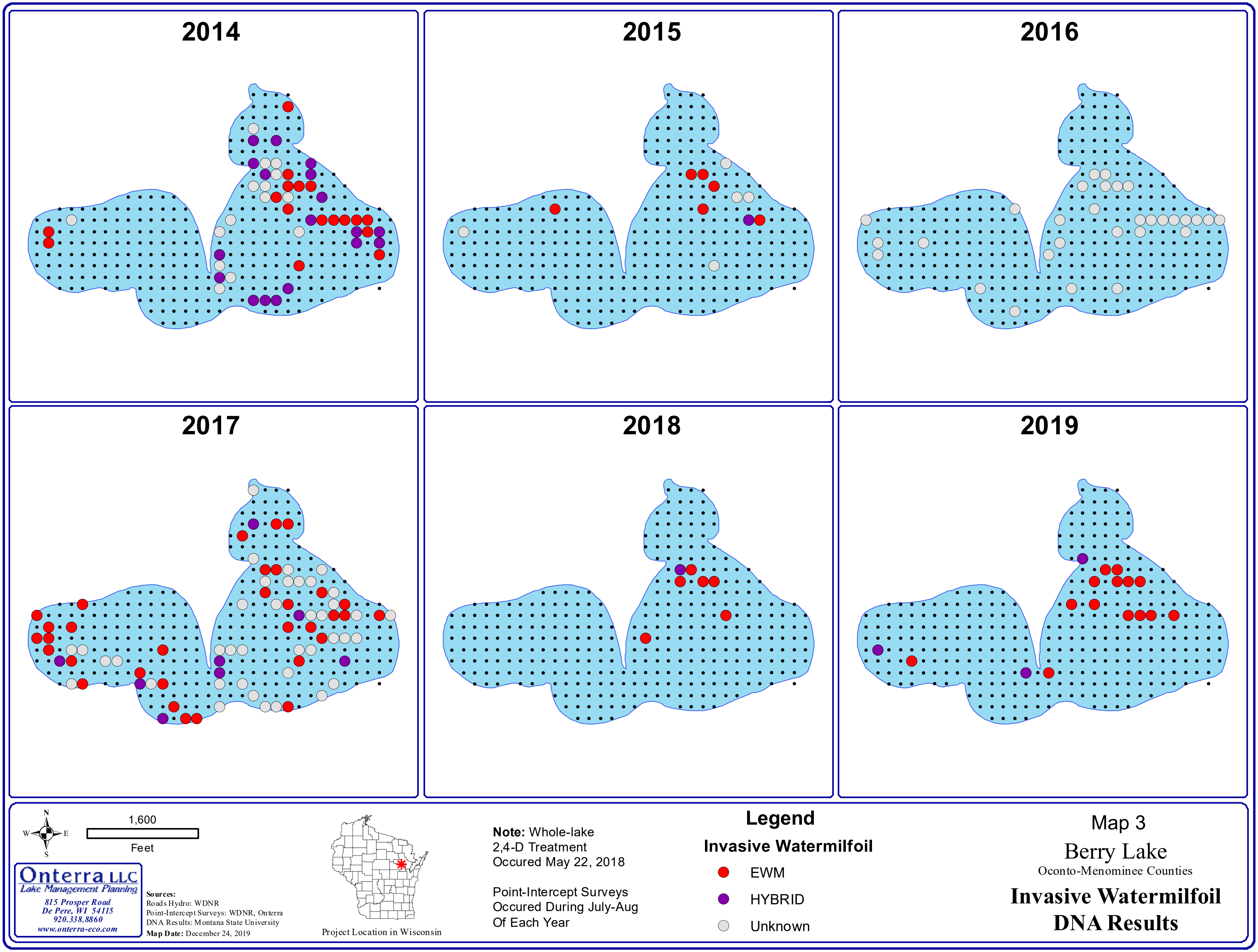
Sources:
Roads and Hydro: WDNR
Bathymetry: Onterra, 2017
Aquatic Plants: Onterra, 2019
Orthophtography: NAIP, 2017r
Map Date: September 19, 2019 - EJH

Map 2
Berry Lake
Oconto County, Wisconsin
Late-Summer 2019 EWM/HWM Survey Results


2014
2015
2016
2017
2018
2019
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E
S
1,600
Feet
Onterra LLC
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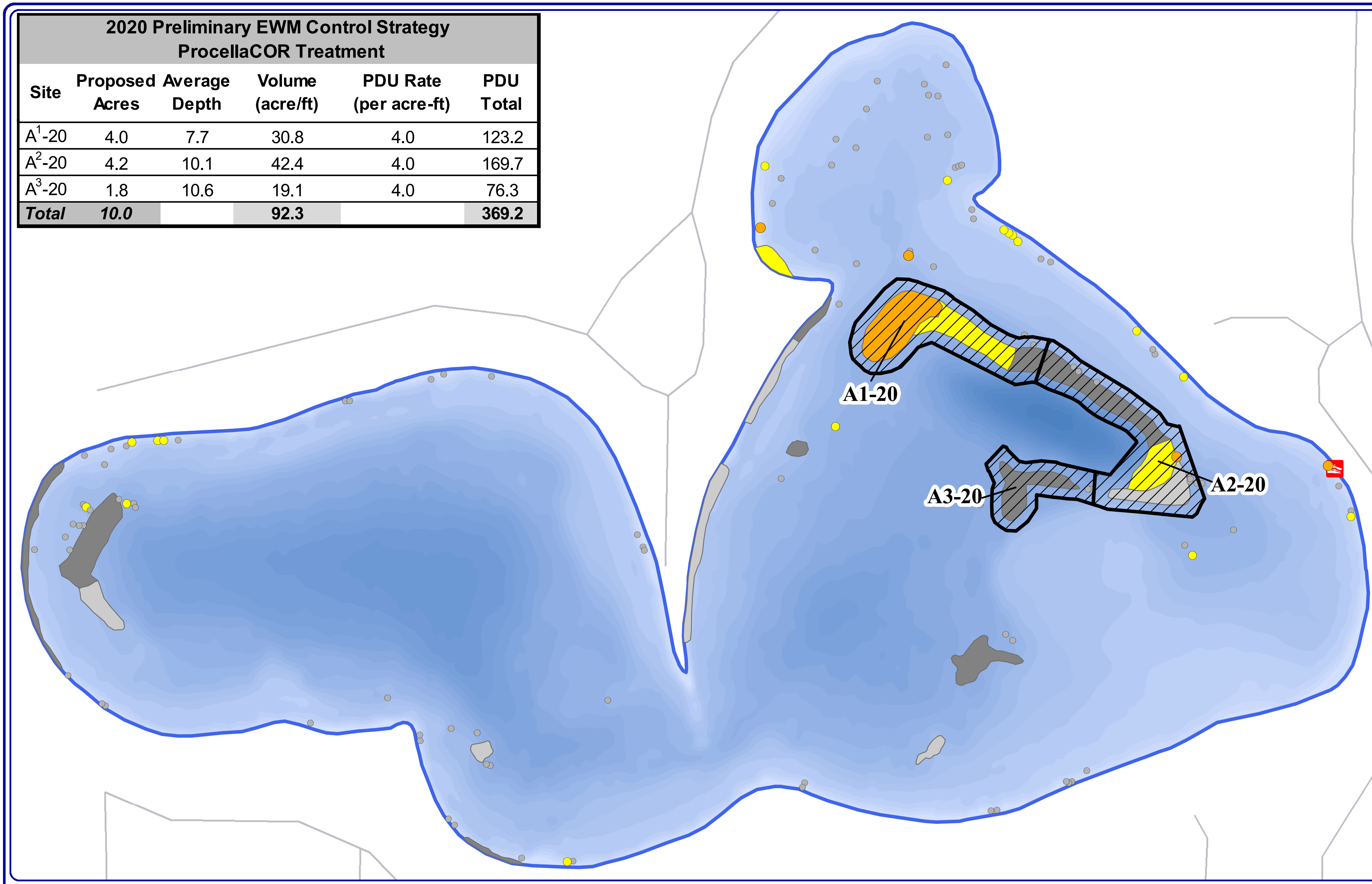
Sources:
Roads Hydro: WDNR
Point-Intercept Surveys: WDNR, Onterra
DNA Results: Montana State University
Map Date: December 24, 2019
Project Location in Wisconsin
Note: Whole-lake
2,4-D Treatment
Occured May 22, 2018
Point-Intercept Surveys
Occured During July-Aug
Of Each Year
Legend
Invasive Watermilfoil
EWM
HYBRID
Unknown
Map 3
Berry Lake
Oconto-Menominee Counties
Invasive Watermilfoil
DNA Results

2020 Preliminary EWM Control Strategy ProcellaCOR Treatment					
Site	Proposed Acres	Average Depth	Volume (acre/ft)	PDU Rate (per acre-ft)	PDU Total
A1-20	4.0	7.7	30.8	4.0	123.2
A2-20	4.2	10.1	42.4	4.0	169.7
A3-20	1.8	10.6	19.1	4.0	76.3
Total	***10.0***		**92.3**		**369.2**



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S

525
Feet

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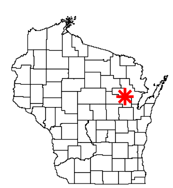
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: Onterra, 2017
Aquatic Plants: Onterra, 2019

Map Date: January 2, 2020 - TWH



Project Location in Wisconsin

Legend

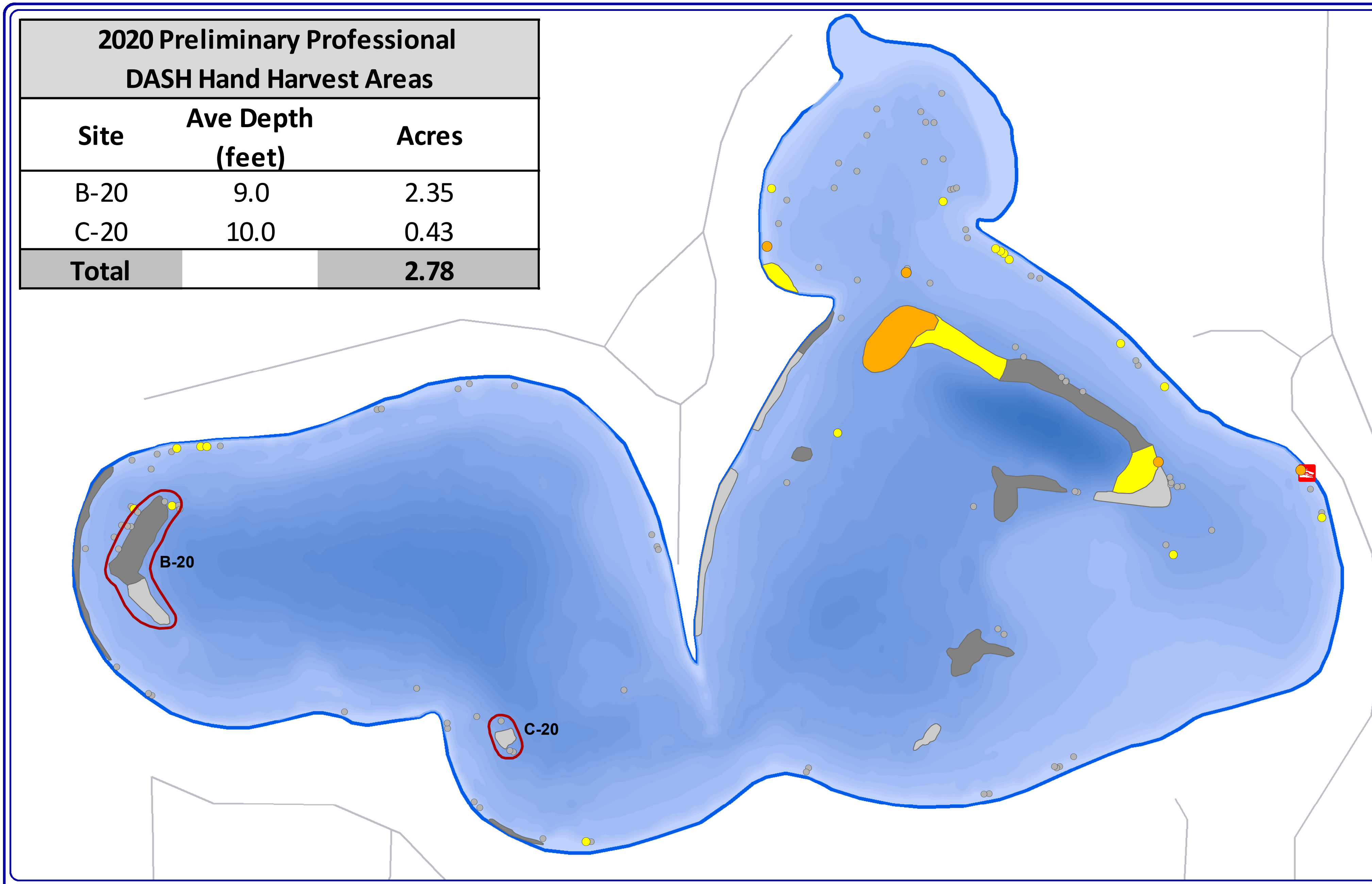
August 28, 2019 EWM Survey

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- Proposed 2020 Spot Herbicide Treament Area

Map 4
Berry Lake
Oconto County, Wisconsin

Proposed 2020 Herbicide Treatment Strategy

2020 Preliminary Professional DASH Hand Harvest Areas		
Site	**Ave Depth (feet)**	**Acres**
B-20	9.0	2.35
C-20	10.0	0.43
Total		**2.78**



N W E S

550

Feet

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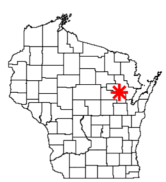
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: Onterra, 2017
Aquatic Plants: Onterra, 2019

Map Date: December 4, 2019 AMS



Project Location in Wisconsin

Legend

August 2019 EWM Survey Results

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2020 Preliminary Hand-Harvest Site

Map 5
Berry Lake
Oconto County, Wisconsin

Proposed 2020 HWM Hand-Harvesting Strategy

A

APPENDIX A

2019 EWM Hand-Harvesting Report – Aquatic Plant Management, LLC

Aquatic Plant Management LLC

Berry Lake HWM Treatment Report 2019

PO Box 1134 Minocqua, WI 54548

Berry Lake HWM Treatment Summary 2019

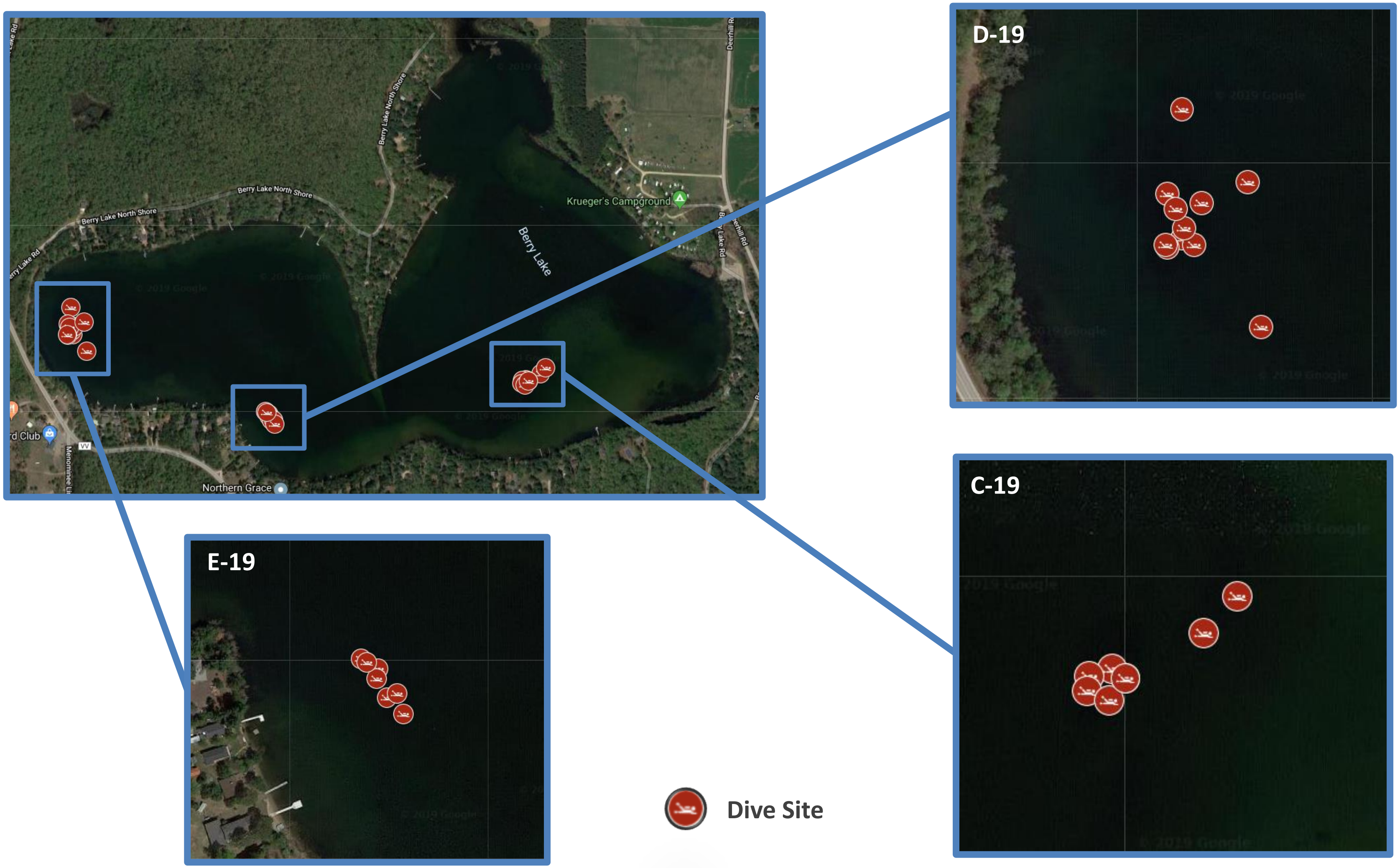
Summary: On June 17th , 18th and 19th and July 1st and 2nd Aquatic Plant Management LLC (APM) conducted Diver Assisted Suction Harvesting (DASH) of Hybrid Eurasian Watermilfoil (HWM) on Berry Lake in Oconto County, WI. Utilizing GPS coordinates provided by Onterra LLC, the dive team initially focused their efforts on the dominant colony within site D-19 on June 17th and the first part of the day on June 18th. Subsequently on the 18th, the dive team shifted briefly to site E-19 before ending the day at site C-19. On June 19th the team started at C-19, then moved to site E-19. Upon the team's return on July 1st and 2nd, they focused nearly all of their efforts on site E-19, with the exception of one final cleanup dive at site D-19. The dive team noted that at all sites the plants were auto-fragmenting. In total, the dive team was able to remove 253.5 cubic feet of HWM from the lake.

Conditions:

- 6/17/19: Weather was sunny with an air temperature of 75 degrees; water temperature was 72 degrees with an 10.5 foot clarity reading from the Secchi disk
- 6/18/19: Weather was cloudy with an air temperature of 67 degrees; water temperature was 72 degrees with an 10.5 foot clarity reading from the Secchi disk
- 6/19/19: Weather was partly cloudy with an air temperature of 73 degrees; water temperature was 72 degrees with an 10.5 foot clarity reading from the Secchi disk
- 7/1/19: Weather was partly cloudy with an air temperature of 79 degrees; water temperature was 77 degrees with an 11.0 foot clarity reading from the Secchi disk
- 7/2/19: Weather was sunny with an air temperature of 85 degrees; water temperature was 77 degrees with an 10.5 foot clarity reading from the Secchi disk

Recommendations: The HWM on Berry Lake consisted of relatively short plants over multiple different dive locations, however DASH was an effective method to target the denser areas of plants that were prioritized by the Berry Lake Property Owners Association. The Berry Lake Property Owners Association should continue to closely monitor the HWM growth over the course of the summer in order to determine if any new or regrowth occurs in the targeted areas.

Map of Berry Lake Dive Sites



Detailed Diving Activities

Date	Dive Location	Latitude	Longitude	Time Under-water	AIS CF Removed	AIS Density	Avg Water Depth	Native By-Catch (CF)	Native Species	Native Density	Substrate Type
6/17/19	D-19	44.88702	-88.48340	2	6.5	Medium	7.5	1.00	Pondweeds	Medium	Organic
6/17/19	D-19	44.88697	-88.48328	1.5	8.5	High	7.5	0.50	Pondweeds	Low	Organic
6/17/19	D-19	44.88692	-88.48329	1.5	7.5	High	8	<0.5	Pondweeds	Low	Organic
6/17/19	D-19	44.88683	-88.48322	2	7.5	High	9	<0.5	Pondweeds	Low	Organic
6/18/19	D-19	44.88685	-88.48315	1.67	5.5	High	9	<0.5	Pondweeds	Low	Organic
6/18/19	D-19	44.88675	-88.48311	0.33	1.5	Low	9	<0.5	Pondweeds	Low	Organic
6/18/19	E-19	44.888646	-88.48912	1.17	1.5	Low	8	<0.5	Pondweeds	Medium	Organic
6/18/19	C-19	44.8878	-88.47529	0.58	9.0	High	7.5	0.50	Pondweeds	Medium	Organic
6/18/19	C-19	44.88765	-88.47565	2.08	25.0	High	8.5	1.00	Pondweeds	Medium	Organic
6/18/19	C-19	44.88768	-88.47571	0.33	6.5	High	8.5	<0.5	Pondweeds	Medium	Organic
6/19/19	C-19	44.88766	-88.47582	1.17	18.0	Medium	9.5	<0.5	Pondweeds	Medium	Organic
6/19/19	C-19	44.88761	-88.47583	1	6.0	Medium	9.5	<0.5	Pondweeds	Medium	Organic
6/19/19	C-19	44.88758	-88.47573	1.08	2.5	Low	9	<0.5	Pondweeds	Medium	Organic
6/19/19	C-19	44.88765	-88.47565	1.08	1.5	Low	9.5	<0.5	Pondweeds	Medium	Organic
6/19/19	E-19	44.88862	-88.48905	0.83	6.5	Medium	7	<0.5	Pondweeds	Medium	Organic
6/19/19	E-19	44.88869	-88.48911	2.25	37.0	High	7	0.50	Pondweeds	Medium	Organic
7/1/19	E-19	44.88879	-88.48901	2.00	31.0	Medium	10	<0.5	Pondweeds	Medium	Organic
7/1/19	E-19	44.88918	-88.48912	0.75	7.5	Medium	13	<0.5	Pondweeds	Medium	Organic
7/1/19	E-19	44.88883	-88.48921	0.67	8.0	Medium	13	<0.5	Pondweeds	Medium	Organic
7/1/19	E-19	44.88877	-88.48916	1.00	15.5	Medium	13	<0.5	Pondweeds	Medium	Organic
7/2/19	E-19	44.88861	-88.48921	0.92	7.5	Low	11	<0.5	Pondweeds	High	Organic
7/2/19	E-19	44.88862	-88.48922	0.58	3.0	Low	11	<0.5	Pondweeds	High	Organic
7/2/19	D-19	44.88700	-88.48336	0.33	1.0	Low	9	<0.5	Pondweeds	High	Organic
7/2/19	E-19	44.88792	-88.47513	0.42	1.0	Low	10	<0.5	Pondweeds	High	Organic
7/2/19	E-19	44.88828	-88.48866	1.25	15.5	Low	10.5	<0.5	Pondweeds	High	Organic
7/2/19	E-19	44.88888	-88.48874	0.67	13.0	Low	10.5	0.50	Pondweeds	High	Organic
Total				**29.16**	**253.5**						

B

APPENDIX B

Point-Intercept Aquatic Macrophyte Survey Results (2007-2019)

APPENDIX B

Chi-Square Analysis of Point-Intercept Surveys completed in Berry Lake from 2007-2019.

		LFOO (%)													2018-2019	
Scientific Name	Common Name	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	% Change	Direction
Myriophyllum spicatum	Eurasian watermilfoil	0.0	0.4	0.4	8.9	18.1	2.1	10.9	14.8	3.7	9.7	25.3	2.2	5.5	149.1	▲
Utricularia resupinata	Northeastern bladderwort	27.7	26.0	28.1	19.6	17.4	20.3	21.8	24.8	21.5	26.1	20.1	21.3	22.2	4.1	△
Brasenia schreberi	Watershield	3.9	1.9	2.8	3.0	3.9	7.2	6.8	5.7	6.7	6.5	6.8	5.6	4.8	-14.5	▽
Utricularia gibba	Creeping bladderwort	0.0	5.8	1.2	2.1	2.8	5.8	2.7	1.0	1.3	0.6	1.0	2.8	1.6	-43.0	▽
Myriophyllum sibiricum	Northern watermilfoil	1.6	2.3	2.0	5.1	6.4	1.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0		-
Utricularia vulgaris	Common bladderwort	0.0	0.0	0.0	0.0	0.4	0.7	0.7	0.3	0.3	1.0	0.6	4.1	3.9	-5.3	▽
Nymphaea odorata	White water lily	0.6	0.4	0.0	0.0	1.1	1.0	1.7	1.7	1.3	0.0	0.3	0.9	1.9	105.1	△
Myriophyllum tenellum	Dwarf watermilfoil	0.6	0.4	1.2	0.4	0.4	1.0	1.0	0.3	1.3	0.3	1.0	2.2	1.3	-41.4	▽
Utricularia intermedia	Flat-leaf bladderwort	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.7	0.3	0.3	1.6	1.6	2.6	△
Utricularia geminiscapa	Twin-stemmed bladderwort	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	1.9	0.6	-65.8	▽
Utricularia minor	Small bladderwort	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6		△
Nuphar variegata	Spatterdock	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.3	0.0	0.0	0.0	0.0		-
Ceratophyllum demersum	Coontail	0.0	0.0	0.0	0.4	0.0	0.0	0.3	0.0	0.3	0.0	0.0	0.0	0.0		-
Bidens beckii	Water marigold	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0		-
Chara spp.	Muskgrasses	32.3	36.0	39.9	45.1	38.3	36.1	37.4	32.2	26.6	16.5	21.8	30.7	25.7	-16.3	▽
Najas flexilis & N. guadalupensis	Slender & southern naiad	30.3	33.3	41.5	41.7	42.6	34.4	37.8	41.3	23.6	20.6	20.8	11.3	14.8	31.1	△
Potamogeton robbinsii	Fern-leaf pondweed	21.6	24.8	32.0	26.0	24.5	31.3	27.9	26.2	19.2	20.6	18.5	21.3	18.0	-15.5	▽
Potamogeton gramineus	Variable-leaf pondweed	14.8	7.0	22.9	27.2	24.8	29.6	34.7	30.9	9.4	14.2	16.9	18.8	14.1	-24.8	▽
Najas guadalupensis	Southern naiad	0.0	0.0	0.0	39.6	36.9	30.9	33.7	36.9	17.8	18.1	15.6	9.7	10.3	5.9	△
Potamogeton praelongus	White-stem pondweed	18.4	13.2	18.6	23.8	18.4	21.6	19.7	23.8	16.8	16.8	14.6	3.4	2.9	-16.1	▽
Vallisneria americana	Wild celery	10.6	15.1	17.4	13.6	11.0	18.6	19.4	21.8	16.2	11.3	9.4	7.5	9.3	23.9	△
Potamogeton illinoensis	Illinois pondweed	23.9	11.6	15.4	4.7	17.0	24.7	22.4	7.7	0.0	3.2	7.8	6.6	3.5	-46.3	▽
Najas flexilis	Slender naiad	30.3	33.3	41.5	2.6	5.7	3.4	4.1	5.7	7.4	2.6	5.2	1.6	4.8	207.7	▲
Potamogeton amplifolius	Large-leaf pondweed	15.8	14.3	9.1	5.5	9.9	9.6	13.6	8.4	5.1	1.6	6.2	1.9	0.3	-82.9	▽
Nitella spp.	Stoneworts	6.1	1.6	1.2	3.0	1.8	1.7	1.4	1.3	0.3	2.3	2.6	0.9	0.0	-100.0	▽
Eleocharis acicularis	Needle spikerush	0.0	0.4	0.0	1.3	2.1	0.7	1.4	0.0	0.3	0.3	0.0	4.1	1.3	-68.4	▼
Stuckenia pectinata	Sago pondweed	1.0	1.9	2.0	1.3	0.4	2.1	2.7	0.3	0.7	0.3	0.0	0.0	0.0		-
Potamogeton pusillus	Small pondweed	0.0	0.0	2.0	3.4	1.1	0.3	1.7	1.3	0.0	0.6	0.3	0.0	0.6		△
Schoenoplectus pungens	Three-square rush	0.0	0.0	0.0	0.0	1.4	0.3	1.4	2.3	0.0	0.0	1.0	0.0	0.3		△
Freshwater sponge	Freshwater sponge	0.0	0.0	2.8	0.4	0.4	0.0	0.0	0.0	0.7	0.0	0.0	0.6	0.6	2.6	△
Potamogeton richardsonii	Freshwater sponge	0.0	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	-100.0	▽
Elodea canadensis	Common waterweed	0.6	1.2	2.0	0.4	0.4	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.0	-100.0	▽
Schoenoplectus acutus	Hardstem bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.6	1.0	53.9	△
Juncus pelocarpus	Brown-fruited rush	0.3	0.0	0.8	0.9	0.4	0.0	0.3	0.7	0.0	0.3	0.0	0.0	0.0		-
Elodea nuttallii	Slender waterweed	0.0	0.0	0.0	3.4	0.0	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0		-
Filamentous algae	Filamentous algae	0.0	0.0	0.4	0.4	0.0	0.3	0.0	0.0	0.3	0.0	0.0	1.6	0.0	-100.0	▼
Potamogeton strictifolius	Stiff pondweed	0.6	0.0	0.0	0.4	0.7	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0		-
Potamogeton natans	Floating-leaf pondweed	0.0	0.0	0.4	0.0	0.0	0.0	0.3	0.0	0.0	0.6	0.0	0.0	0.3		△
Eleocharis palustris	Creeping spikerush	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.3	-48.7	▽
Potamogeton zosteriformis	Flat-stem pondweed	0.3	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0		-
Fissidens spp. & Fontinalis spp.	Aquatic Moss	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.9	0.0	-100.0	▽
Schoenoplectus tabernaemontani	Softstem bulrush	0.0	0.0	0.0	0.0	0.4	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0		-
Eriocaulon aquaticum	Pipewort	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.3	0.0	0.0		-
Sagittaria sp. (rosette)	Arrowhead sp. (rosette)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0		-
Pontederia cordata	Pickerelweed	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0	-100.0	▽
Persicaria amphibia	Water smartweed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3		△
Typha spp.	Cattail spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0		-
Potamogeton X scoliophyllus	Large-leaf X Illinois pondweed	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		-
Lemna minor	Lesser duckweed	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		-

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

C

APPENDIX C

WDNR Chemical Fact Sheets

- **Florpyrauxifen-benzyl (ProcellaCOR™)**

July 2018

Florpyrauxifen-benzyl Chemical Fact Sheet

Formulations

Florpyrauxifen-benzyl was registered with the EPA for aquatic use in 2017. The active ingredient is 2-pyridinecarboxylic acid, 4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxyphenyl)-5-fluoro-, phenyl methyl ester. The current Wisconsin-registered formulation is a liquid (ProcellaCOR™ EC) solely manufactured by SePRO Corporation.

Aquatic Use and Considerations

Florpyrauxifen-benzyl is a systemic herbicide that is taken up by aquatic plants. The herbicide is a member of a new class of synthetic auxins, the arylpicolinates, that differ in binding affinity compared to other currently registered synthetic auxins. The herbicide mimics the plant growth hormone auxin that causes excessive elongation of plant cells that ultimately kills the plant. Susceptible plants will show a mixture of atypical growth (larger, twisted leaves, stem elongation) and fragility of leaf and shoot tissue. Initial symptoms will be displayed within hours to a few days after treatment with plant death and decomposition occurring over 2 – 3 weeks. Florpyrauxifen-benzyl should be applied to plants that are actively growing; mature plants may require a higher concentration of herbicide and a longer contact time compared to smaller, less established plants.

Florpyrauxifen-benzyl has relatively short contact exposure time (CET) requirements (12 – 24 hours typically). The short CET may be advantageous for localized treatments of submersed aquatic plants, however, the target species efficacy compared to the size of the treatment area is not yet known.

In Wisconsin, florpyrauxifen-benzyl may be used to treat the invasive Eurasian watermilfoil (*Myriophyllum spicatum*) and hybrid Eurasian watermilfoil (*M. spicatum* X *M. sibiricum*). Other invasive species such as floating hearts (*Nymphoides* spp.) are also susceptible. In other parts of the country, it is used as a selective, systemic mode of action for spot and partial treatment of the invasive plant hydrilla (*Hydrilla verticillata*). Desirable native species that may also be negatively affected include waterlily species (*Nymphaea* spp. and *Nuphar* spp.), pickerelweed (*Pontederia cordata*), and arrowhead (*Sagittaria* spp.).

It is important to note that repeated use of herbicides with the same mode of action can lead to herbicide-resistant plants, even in aquatic plants. Certain hybrid Eurasian watermilfoil genotypes have been documented to have reduced sensitivity to aquatic herbicides. In order to reduce the risk of developing resistant genotypes, avoid using the same type of herbicides year after year, and utilize effective, integrated pest management strategies as part of any long-term control program.

Post-Treatment Water Use Restrictions

There are no restrictions on swimming, eating fish from treated waterbodies, or using water for drinking water. There is no restriction on irrigation of turf. Before treated water can be used for non-agricultural irrigation besides turf (such as shoreline property use including irrigation of residential landscape plants and homeowner gardens, golf course irrigation, and non-residential property irrigation around business or industrial properties), follow precautionary waiting periods based on rate and scale of application, or monitor herbicide concentrations until below 2 ppb. For agricultural crop irrigation, use analytical monitoring to confirm dissipation before irrigating. The latest approved herbicide product label should be referenced relative to irrigation requirements.

Herbicide Degradation, Persistence and Trace Contaminants

Florpyrauxifen-benzyl is broken down quickly in the water by light (i.e., photolysis) and is also subject to microbial breakdown and hydrolysis. It has a half-life (the time it takes for half of the active ingredient to degrade) ranging from 1 – 6 days. Shallow clear-water lakes will lead to faster degradation than turbid, shaded, or deep lakes.

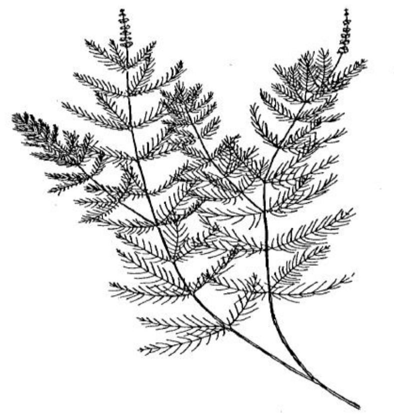
Florpyrauxifen-benzyl breaks down into five major degradation products. These materials are generally more persistent in water than the active herbicide (up to 3 week half-lives) but four of these are minor metabolites detected at less than 5% of applied active ingredient. EPA concluded no hazard concern for metabolites and/or degradates of florpyrauxifen-benzyl that may be found in drinking water, plants, and livestock.

Florpyrauxifen-benzyl binds tightly with surface sediments, so leaching into groundwater is unlikely. Degradation products are more mobile, but aquatic field dissipation studies showed minimal detection of these products in surface sediments.

Impacts on Fish and Other Aquatic Organisms

Toxicity tests conducted with rainbow trout, fathead minnow, water fleas (*Daphnia* sp.), amphipods (*Gammarus* sp.), and snails (*Lymnaea* sp.) indicate that florpyrauxifen-benzyl is not toxic for these species. EPA concluded florpyrauxifen-benzyl has no risk concerns for non-target wildlife and is considered "practically non-toxic" to bees, birds, reptiles, amphibians, and mammals.

Florpyrauxifen-benzyl does not bioaccumulate in fish or freshwater clams due to rapid metabolism and chemical depuration.



Human Health

EPA has identified no risks of concern to human health since no adverse acute or chronic effects, including a lack of carcinogenicity or mutagenicity, were observed in the submitted toxicological studies for florpyrauxifen-benzyl regardless of the route of exposure. EPA concluded with reasonable certainty that drinking water exposures to florpyrauxifen-benzyl do not pose a significant human health risk.

For Additional Information

Environmental Protection Agency Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
608-266-2621
http://dnr.wi.gov/lakes/plants/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

Washington State Department of Ecology. 2017.
https://fortress.wa.gov/ecy/publications/documents/1710020.pdf