1.0 INTRODUCTION

Berry Lake, Menominee and Oconto Counties, is a seepage lake with a maximum depth of approximately 29 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 (*Phragmites*), and Eurasian watermilfoil are known to exist in and along the shorelines 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 December 8, 2020. Water levels have trended higher in the years since the gauge was placed with water levels approximately five feet higher in late summer 2020 compared to 2013. Record rainfall in many parts of Wisconsin in 2019 and 2020 contributed to the relatively rapid increase in water depth in Berry Lake in recent years.

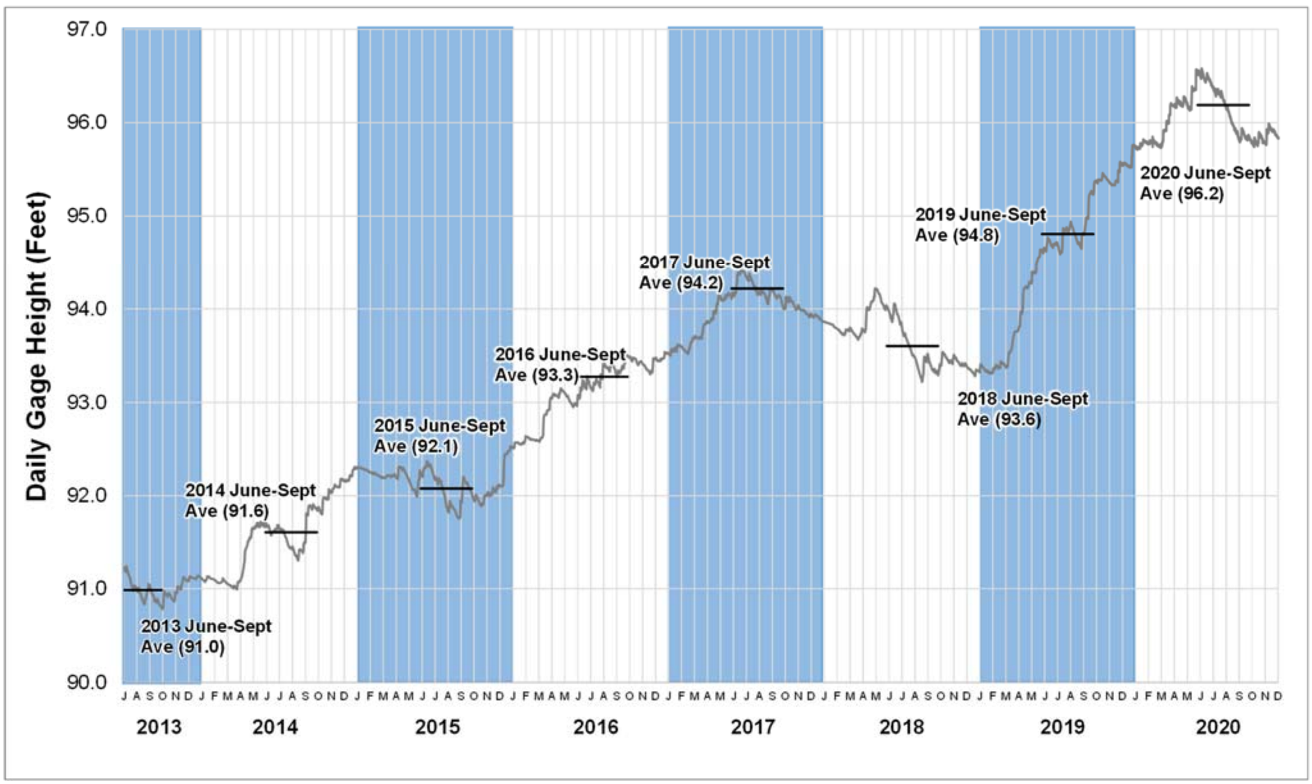


Figure 1.0-1. Berry Lake water levels from July 2013 through December 2020. Created using data obtained from the USGS Berry Lake water level monitoring station (USGS 2020).

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.

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.

After unexpectedly decreasing in 2015, the HWM population trended higher in Berry Lake in 2016 and 2017 prompting the BLPOA to plan for and implement a whole lake 2,4-D treatment in early-summer 2018. Monitoring associated with the 2018 treatment indicated that the post-treatment herbicide concentrations were near the target concentration of 0.350 ppm in each basin and were near or above 0.250 ppm ae through at least four weeks after treatment. A detailed description of the planning, analysis, and efficacy of the 2018 whole-lake treatment was reported on within each years' respective annual reports.

The HWM population showed signs of rebound 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 a coordinated professional hand harvesting program. This included the use of Diver Assisted Suction Harvesting (DASH), with the goal of inhibiting the HWM populations' rebound or re-establishment in the lake and to prolong the gains that were made following the whole-lake treatment. The 2019 professional hand harvesting strategy resulted in density reductions within the targeted area; however, these results were not as favorable as some BLPOA members would have liked considering the costs.

1.2 2020 HWM Management & Monitoring Strategy

The BLPOA obtained an extension to their current AIS-EPC grant (ACEI-162-15) which allowed for funding to carry out a coordinated IPM strategy during 2020 that utilizes either herbicide treatment or professional hand harvesting HWM management techniques. One area of HWM in the eastern basin of Berry Lake had 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 solicited bids on three potential treatment designs. The BLPOA ultimately chose to pursue the option of using a relatively new herbicide called ProcellaCOR™ (florpyrauxifen-benzyl from SePRO) that has shown some promise in other spot treatments in Wisconsin Lakes. Because this is a new herbicide, data available from field trials is relatively limited.

The efficacy of the 2020 herbicide treatment would be evaluated through qualitative and quantitative methods following treatment. Additionally, herbicide concentration monitoring would be conducted in the hours and days following the herbicide treatment during which trained volunteers from the BLPOA would collect and ship samples to a laboratory for analysis. This report details the monitoring associated with the 2020 ProcellaCOR™ treatment in Berry Lake.

1.3 Pre-Treatment Confirmation and Refinement Survey

Onterra ecologists completed the pre-treatment confirmation and refinement survey on May 29, 2020. The purpose of the visit was to verify application area extents and inspect the condition of the HWM colonies targeted for treatment through the use of a combination of surface surveys, rake tows, and submersible video monitoring. Parameters such as plant growth stage, water temperature, and water depth were investigated to confirm the final treatment strategy.

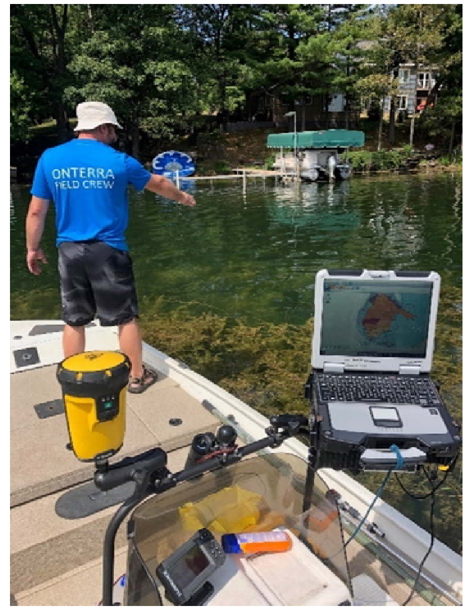
Photo 1.3-1. EWM observed during a May 29, 2020 pre-treatment survey on Berry Lake, Oconto County. Photo by Onterra, LLC

During the survey, actively growing EWM characterized by green growth was confirmed within the proposed treatment site. An underwater camera transect was completed through the targeted area which can be viewed on Onterra's YouTube webpage (Click Here). Surface water temperatures in the treatment area was 70°F. Water levels were higher than normal during the visit with much of the boat landing parking lot under water. The average depth of the treatment area was confirmed with a marked pole during the survey as well as through analyzing data from a USGS gauge station on the lake. Map 1 reflects the final treatment strategy using ProcellaCOR™ with an application rate of 4.0 product dosing units (PDU's) over one split treatment site totaling 10.0 acres. The herbicide application was completed on June 12, 2020 by Aquatic Biologists, Inc. The applicator noted very little wind at the time of the application with a surface water temperature of 68°F. A representative from SePRO accompanied the applicator during the application.

2.0 2020 AQUATIC PLANT MONITORING RESULTS

It is important to note that two types of surveys are discussed in the subsequent materials: 1) point-intercept surveys and 2) HWM mapping surveys. The point-intercept survey provides a standardized way to gain quantitative information about a lake's aquatic plant population through visiting predetermined locations and using a rake sampler to identify all the plants at each location. The survey methodology allows comparisons to be made over time, as well as between lakes. It is common to see a particularly plant species, such as HWM, very near the sampling location but not yield it on the rake sampler. Particularly in low-density colonies such as those designated by Onterra as *highly scattered* and *scattered*, large gaps between EWM plants may exist resulting in EWM not being present at a particularly pre-determined point-intercept sampling location in that area.

While the point-intercept survey is a valuable tool to understand the overall plant population of a lake, it does not offer a full account (census) of where a particular species exists in the lake. During the HWM mapping survey, the entire littoral area of the lake is surveyed through visual observations from the boat (Photography 2.0-1). Field crews supplemented the visual survey by deploying a submersible camera along with periodically doing rake tows. The HWM population is mapped using sub-meter GPS technology by using either 1) point-based or 2) area-based methodologies. Large colonies >40 feet in diameter are mapped using polygons (areas) and are qualitatively attributed a density rating based upon a five-tiered scale from *highly scattered* to *surface matting*. Point-based techniques were applied to AIS locations that were considered as *small plant colonies* (<40 feet in diameter), *clumps of plants*, or *single or few plants*.



Photograph 2.0-1. EWM mapping survey on Big Hills Lake, Waushara County. Photo credit Onterra.

Overall, each survey has its strengths and weaknesses, which is why both are utilized in different ways as part of this project. For reference, both the point-intercept survey and EWM mapping surveys occurred in 2020 on Berry Lake and are shown on Map 3.

2.1 Quantitative Monitoring: Whole-lake 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 2016-2020 by Onterra as part of a WDNR grant-funded AIS control and monitoring project.

For the purpose of assessing the 2020 herbicide treatment, this report will focus on the eastern basin sub-set of the whole lake point intercept data (Figure 2.2-2). Comparisons will be made between the 2019 (pre-treatment) and 2020 (post treatment) eastern basin point-intercept surveys. The 2020 whole-lake point-intercept survey was conducted on July 24, approximately six weeks after the herbicide treatment. Appendix B displays the 2020 whole-lake point-intercept survey littoral frequency of occurrence data as well as a Chi-square analysis of the 2007-2020 whole-lake surveys.

Figure 2.1-1 displays the littoral frequency of occurrence of aquatic plant species located in the eastern basin of Berry Lake during the 2019 and 2020 point-intercept surveys. The littoral frequency of occurrence of HWM exhibited a statistically valid 100% decrease in from 2019-2020 and was not located at any of the 195 sampling locations in 2020. Creeping bladderwort (*Utricularia gibba*) was the only native aquatic plant species to show a statistically valid decrease in occurrence between the two surveys. Creeping bladderwort is a very small, free-floating species that is susceptible to wind driven water movement and is most common in shallow waters, often amongst floating-leaf plant communities. All remaining native species in the survey area were statistically unchanged in occurrence between the two surveys with the exception of southern naiad (*Najas guadalupensis*) and Illinois pondweed (*Potamogeton illinoensis*) which exhibited a statistically valid increase in occurrence (Figure 2.1-1).

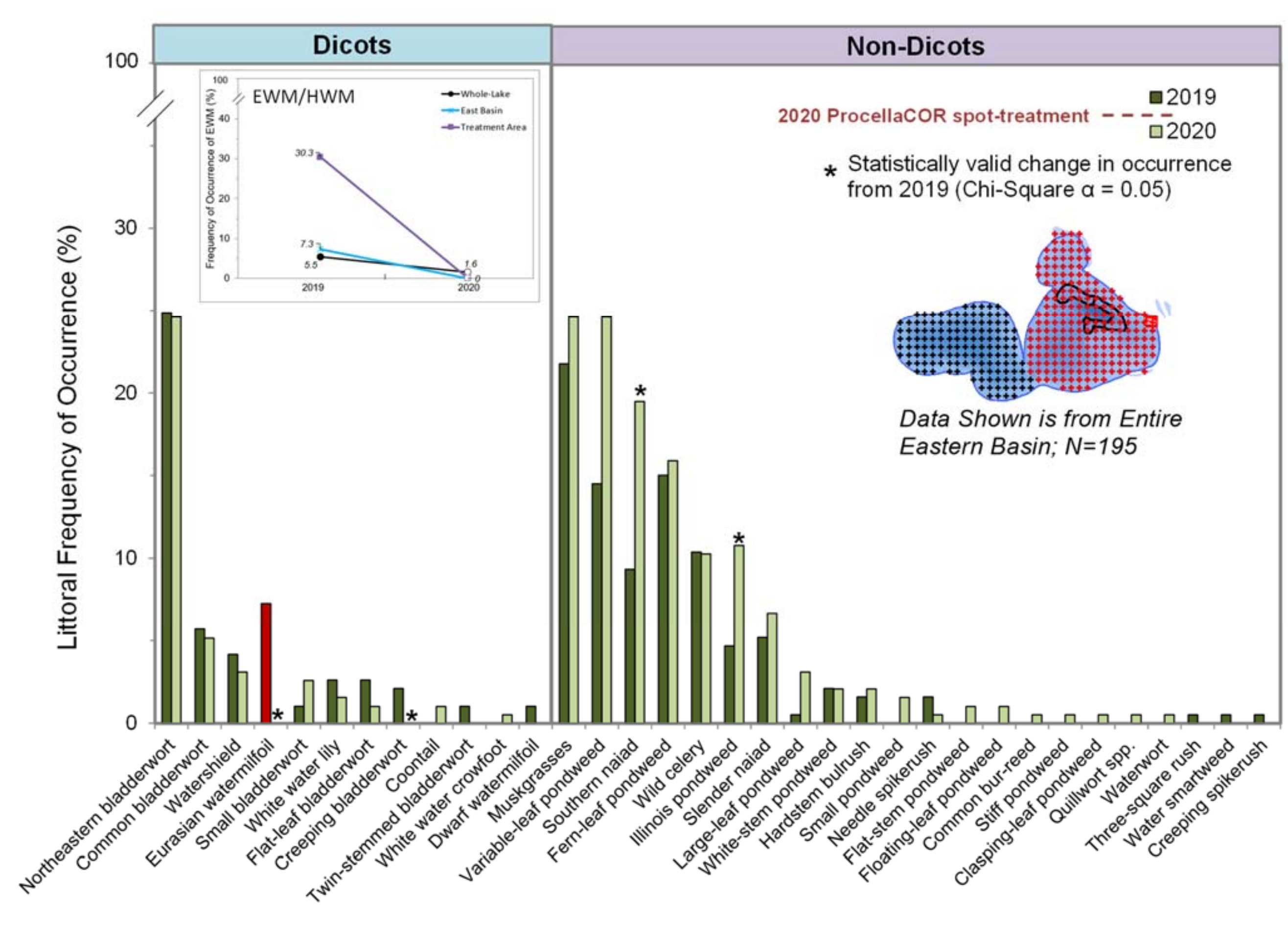
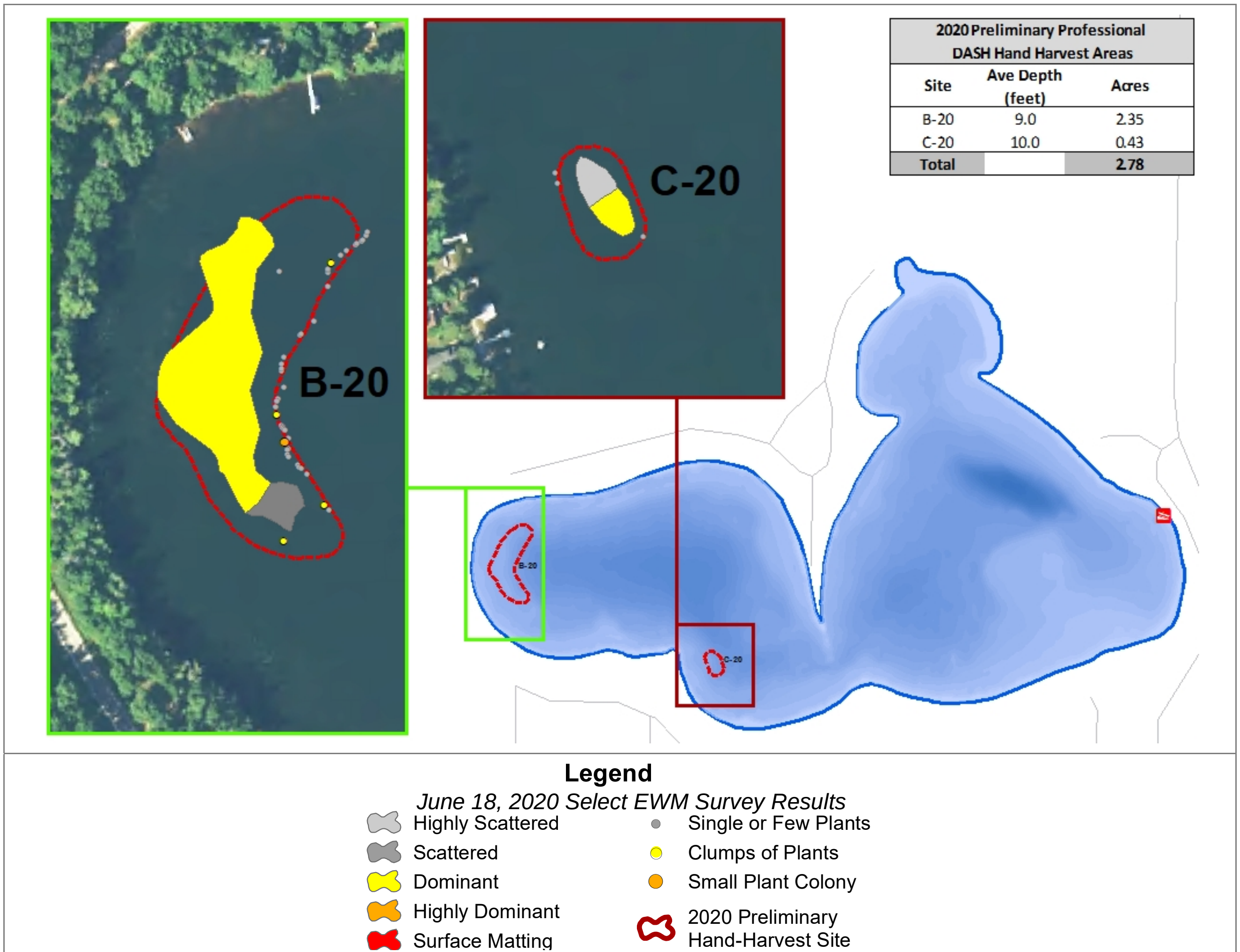


Figure 2.1-1. Eastern basin littoral frequency of occurrence of aquatic plants from a 2019 (Pre-Treatment) & 2020 (Post-Treatment) point-intercept survey in Berry Lake. Asterisk represents statistically valid change from 2019 to 2020 (Chi-Square α = 0.05).

2.2. Qualitative Monitoring: EWM Mapping Surveys

Focused Early Season AIS Survey (ESAIS)

Onterra field crews completed a focused Early Season AIS survey on Berry Lake on June 18, 2020. The purpose of this survey was solely for the purpose of evaluating two sites identified in 2019 that were under consideration for targeting during 2020 with a coordinated professional hand harvesting control strategy. The extent of the surveyed area was limited to just two sites in the western basin of the lake. The survey crew documented a large contiguous *dominant* density HWM colony in the preliminary harvest site B-20 and a smaller *highly scattered* and *dominant* colony within site C-20 (Figure 2.2-1). The BLPOA considered these survey results and in consultation with Onterra and a professional hand harvesting contractor, ultimately chose not to conduct any professional hand harvesting efforts in 2020.



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

Figure 2.2-1. Berry Lake June 2020 Focused HWM Mapping Survey Results (Survey extents limited to B-20 & C-20.).

Late-Summer HWM Mapping Survey

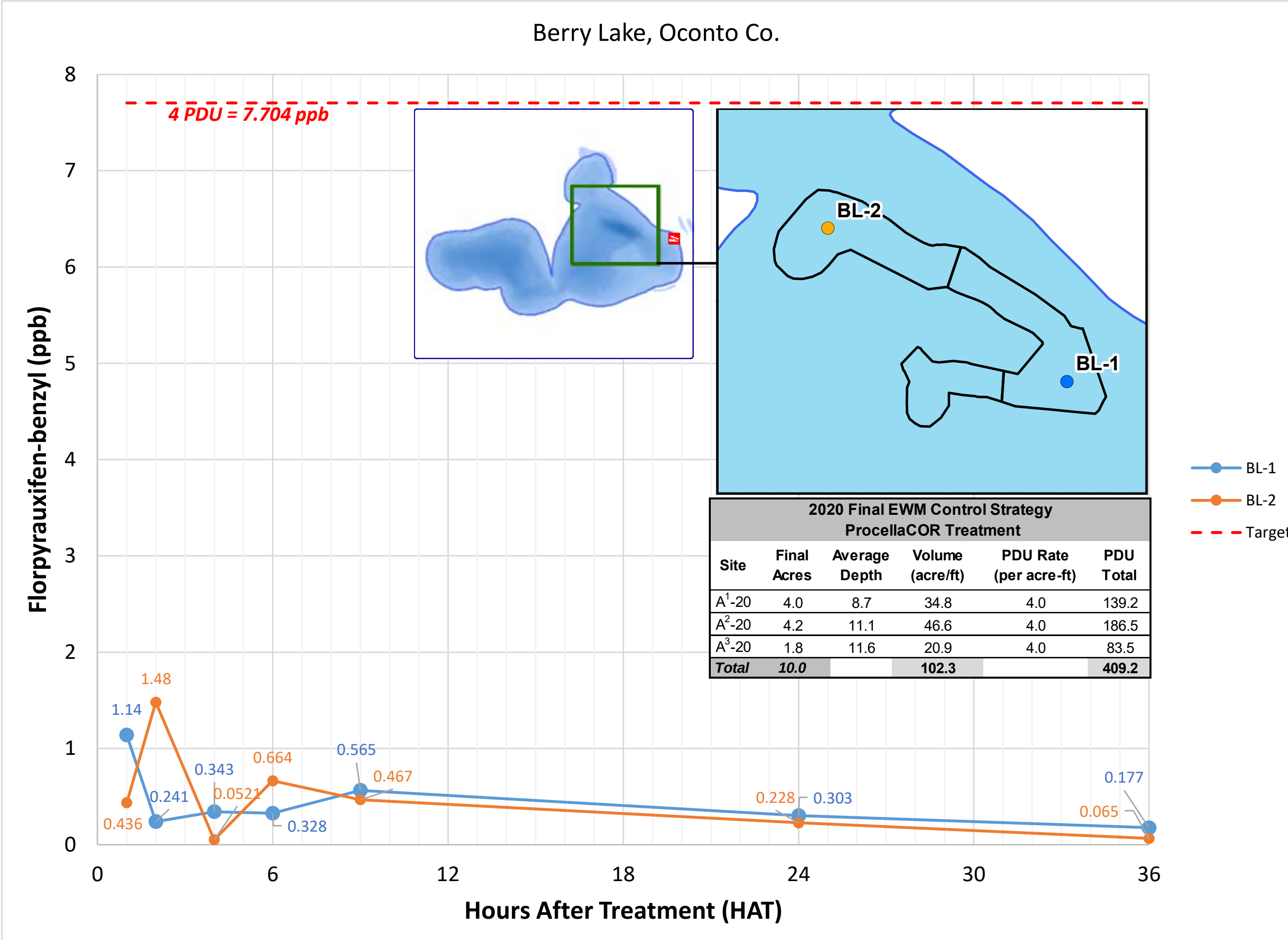
The Late-Summer HWM Mapping Survey is a meander-based survey conducted when the plant is at its peak growth stage, allowing for a true assessment of the amount of this exotic within the lake. All HWM encountered were mapped with a sub-meter GPS using either points or polygons. Large colonies over 40 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. The 2019 Late-Summer Mapping Survey represents the pre-treatment HWM population prior to the 2020 herbicide treatment. The 2019 survey found 8.6 acres of colonized HWM in Berry Lake of which the largest and densest concentration of plants was within the eastern basin (Map 2, top frame).

Onterra ecologists conducted the Late-Summer HWM Mapping Survey on Berry Lake on August 18, 2020, corresponding to approximately eight weeks after the herbicide treatment. The results of the survey are displayed on the bottom frame of Map 2. The survey crew put extra focus within the 2020 herbicide treatment area and supplemented the visual meander survey with the use of a submersible camera. The crew located just one single HWM plant in the entirety of the eastern basin of Berry Lake, and no HWM was located in the vicinity of the herbicide treatment (Map 2, bottom frame). A modest HWM population, was located in the western basin and included a *scattered* colony on the far west end of the lake, and a few narrow strips of plants growing near shore in shallow waters of the west basin (Map 2, bottom frame). The HWM population in the western basin was of a similar overall footprint between 2019 and 2020.

2.3 Herbicide Concentration Monitoring

The herbicide concentration monitoring plan associated with the treatment was developed by Onterra and the WDNR, with the intent of gaining sufficient data to aid in understanding the concentrations of florpyrauxifen-benzyl that were achieved in the treatment area in the hours and days after treatment. Samples were collected from two sites within the herbicide application area at seven time intervals after treatment. Samples were collected by volunteer members of the BLPOA and upon completion of the sampling, were shipped to EPL Bio Analytical Services in Niantic, Illinois for analysis. This lab was identified by the WDNR as being able to detect the florpyrauxifen-benzyl at lower levels than the herbicide manufacturer's facility – 1 part per billion (ppb). A copy of the herbicide concentration monitoring plan is included as Appendix A.

Figure 2.3-1 displays the results of the post-treatment herbicide concentration monitoring. The application rate is converted to parts per billion of florpyrauxifen-benzyl and is displayed as a dashed red line on the graph. The measured concentrations of herbicide were consistently well below the application rate of 7.704 ppb. The concentrations were somewhat variable between the two monitoring sites in the first six hours after treatment and from 9 HAT to 36 HAT were measured at nearly the same concentrations between sites (Figure 2.3-1). Low, but detectable amounts of herbicide were detected in the last sampling interval collected 36 HAT.



2020 Final EWM Control Strategy ProcellaCOR Treatment					
Site	Final Acres	Average Depth	Volume (acre/ft)	PDU Rate (per acre-ft)	PDU Total
A^1-20	4.0	8.7	34.8	4.0	139.2
A^2-20	4.2	11.1	46.6	4.0	186.5
A^3-20	1.8	11.6	20.9	4.0	83.5
Total	*10.0*		102.3		409.2

Figure 2.3-1. Herbicide concentration monitoring results following a 2020 florpyrauxifen-benzyl (ProcellaCOR™) treatment in Berry Lake. .

2.4 Common Reed (Phragmites)

Photo 2.4-1. Common Reed (Phragmites australis) observed growing in Berry Lake during a 2014 survey. (Photo by Onterra, LLC)

During a 2014 survey, Onterra ecologists documented the presence of another non-native species found in Wisconsin; common reed (Photo 2.4-1). 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.

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 has conducted surveys of the giant reed locations from approximately 2014 to current, forwarding these data on the WDNR to implement coordinated herbicide management. Common reed treatments have not occurred since 2016.

Figure 2.4-1 displays the common reed population that was mapped by Onterra staff during an August 18, 2020 visit to Berry Lake. One highly scattered colony was located during the survey in the same approximate location as it has been found in recent years south of the public boat landing. This colony was nearly completely submerged under the water's surface and measures approximately 150' x 90' or 0.22 acres (Photo 2.4-2). No other occurrences of common reed were observed during the course of the survey.

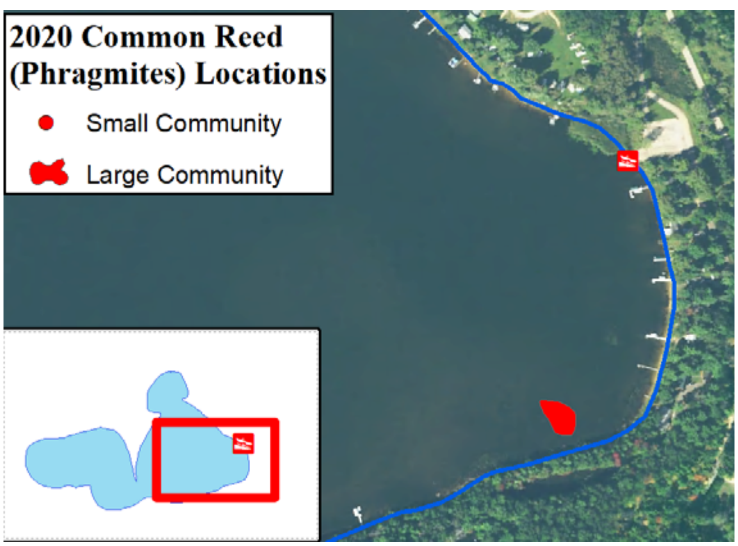


Figure 2.4-1. Berry Lake 2020 Non-native Common Reed (Phragmites australis) Population. Data from Onterra August 18, 2020 survey.

Photo 2.4-2. Common Reed (Phragmites australis) observed growing in Berry Lake during 2020 survey. (Photo by Onterra, LLC)

The rising water levels in Berry Lake in recent years may be causing the common reed to struggle to thrive, however the plants observed in 2020 appeared to be actively growing despite being largely submerged.

3.0 CONCLUSIONS & DISCUSSION

The 2020 herbicide treatment site shows promising results during the *year of treatment* with reductions in HWM demonstrated through comparative mapping surveys and point-intercept sub-sampling surveys. No significant impacts to the native plant community were detected in the post-treatment point-intercept survey. A replication of the mapping survey and eastern basin point-intercept survey will be considered for 2021 and would allow for an understanding of the longer-term efficacy of the treatment as well as an assessment of the native plant community's population dynamics one year after treatment.

The herbicide concentration data collected after treatment is somewhat difficult to interpret in a traditional sense in terms of a concentration exposure time necessary to achieve HWM control. In the 2020 treatment in Berry Lake, measured florpyrauxifen-benzyl concentrations were all less than 1.5 ppb and were well below the application rate of 7.7 ppb in every sampling interval, and yet a high level of HWM control was observed. Compared to several other projects that Onterra monitored in 2020 that also conducted post-treatment ProcellaCOR™ concentration monitoring, the measured amount of active ingredient in Berry Lake during the earliest sampling intervals (1 HAT, 2 HAT) were amongst the lowest in any project, likely because of the exposed nature of this treatment site.

The impacts of dispersion of ProcellaCOR™ in lakes after treatment is a topic for further study. In nearly every one of the ProcellaCOR™ treatments that Onterra monitored in 2020, EWM reductions were observed beyond the targeted area with the eastern basin of Berry Lake being amongst these examples. Weak-acid herbicides, like those used in the past on Berry Lake (i.e. 2,4-D), are known to quickly dissipate from the application area. When these herbicides dissipate out of the treatment site, the concentrations and exposure times in these adjacent areas are typically insufficient to cause any meaningful impacts. Because ProcellaCOR™ can produce plant impacts at such low concentrations, the effects of herbicide dissipation and drift may be more meaningful with this chemistry. ProcellaCOR™ has a high binding affinity with organic materials and therefore was not thought to move off site as much as other herbicides.

Calculations indicate that if the herbicide mixed within the entire volume of water within Berry Lake, a lake-wide concentration of approximately 0.38 ppb could be achieved. If mixing were limited to the volume solely within the eastern basin, a concentration of approximately 0.67 ppb would be achieved. Lake managers continue to collect data in furthering the understanding of what concentration constitutes a spot-treatment versus whole-lake or whole-basin treatment with this chemistry. Onterra believes that the 2020 ProcellaCOR™ treatment in Berry Lake functioned as an entire eastern basin treatment. Future research will likely include conducting herbicide concentration monitoring outside of the application areas to understand the dissipation of the product and concentrations in adjacent areas.

While conducting the whole-lake point-intercept survey on July 24, 2020, the survey crews encountered HWM in the western basin exhibiting obvious signs of stress in the form of fused leaflets and deformed growth (Photo 3.0-1). It is suspected that these characteristics were caused by exposure to ProcellaCOR™ that dissipated beyond the application area at a level that injured the plants rather than at levels sufficient to cause plant mortality. Onterra encountered similar apparently injured milfoil in several other lakes in 2020 in a similar treatment scenario in that the injured plants were well outside of the targeted area of the lake. It is unknown whether the HWM reductions observed in the eastern basin of Berry Lake in 2020 will be sustained through the 2021 growing season. The possibility exists that some HWM in Berry Lake may have been injured by the 2020 herbicide treatment, but root crowns may have survived and could rebound with new growth during 2021.

Photo 3.0-1. EWM observed during a July 24, 2020 survey on Berry Lake, Oconto County. Photo by Onterra, LLC

Environmental factors naturally influence aquatic plant populations as well and it is not known to what extent this played a role in the HWM population in Berry Lake. It is suspected that the herbicide treatment was the largest driver in the reductions of HWM in the lake, however environmental factors such as increased water levels in 2020 may have also contributed.

3.1 2021 HWM Management & Monitoring Strategy Development

The BLPOA intends to continue to monitor HWM in Berry Lake through the completion of a 2021 Late-Summer HWM Mapping Survey. This survey will be used to evaluate the year-after-treatment HWM population following the 2020 spot treatment and would drive discussions pertaining to developing an HWM monitoring and management strategy for 2022. A replication of the whole-lake point-intercept survey in 2021 would be beneficial in monitoring the HWM and native aquatic plant population’s dynamics during a period of active management confounded by increasing water levels in Berry Lake. The WDNR may have a research interest in completing a point-intercept survey in 2021.

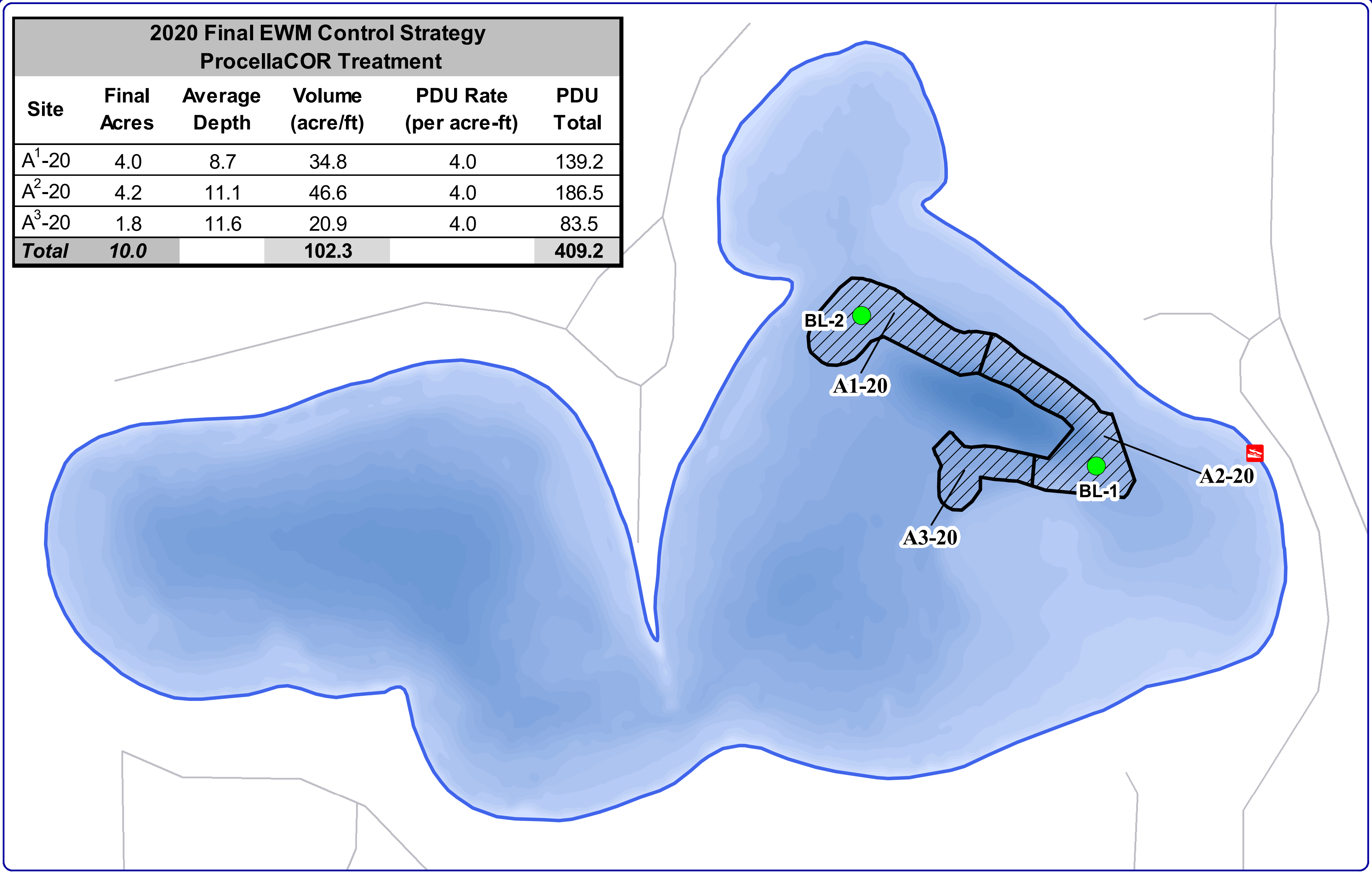
Having experience in managing HWM in recent years, the BLPOA has developed an increasingly clear understanding of the capabilities and limitations in implementing a coordinated hand harvesting strategy as a tool to manage HWM in Berry Lake. The HWM population identified in Berry Lake in the Late-Summer 2020 HWM Mapping survey is relatively modest and characterized by mostly point-based occurrences or a few relatively small and low-density colonies. The largest contiguous colony in the lake is a *scattered* colony on the far end of the western basin that approaching two acres in size, is considered too small and of insufficient density to warrant the use of aquatic herbicides, and yet may be too large to manage with a hand harvesting strategy in a cost-effective manner. This site was targeted in 2019 with 12.5 hours of professional DASH efforts yielding 147 cubic feet of HWM, however, the post-harvesting assessment showed little to no discernable change in the population indicating seasonal HWM suppression rather than extended control. If the BLPOA elects to target this site with a professional hand harvesting strategy in the future, they can consider the results of the 2019 hand harvesting efforts in understanding the effort and costs required to manage the site with this technique.

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 2020 Late-Summer HWM Mapping Survey indicated several 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.

The BLPOA has been in communications with Onterra and WDNR regarding future grant application possibilities. At this time, the BLPOA will consider the results of the 2021 Late-Summer HWM Mapping Survey to determine whether or not to apply for a WDNR AIS Control Grant in fall 2021 that would seek funds to implement a control strategy that would potentially target the HWM in the western basin of the lake with herbicide treatment in 2022. The WDNR has conveyed that since the BLPOA has been regularly monitoring the lake and providing annual reports documenting their control and monitoring activities, that the group is eligible to apply for a WDNR Control Grant in 2021.

The BLPOA is also investigating applying for a WDNR Planning Grant in 2022 that would result in an updated Management Plan for Berry Lake. Berry Lake's last management plan was finalized in 2015 and having an updated plan (five years old or less) will allow the BLPOA to ensure eligibility for future AIS Control Grants. The WDNR recommends that the BLPOA implement other previous plan recommendations such as shoreline or watershed restoration activities in order to compete well with other Planning Grant applicants. The BLPOA will investigate these topics during 2021 including the WDNR's Healthy Lakes & Rivers grant program.

2020 Final EWM Control Strategy ProcellaCOR Treatment					
Site	Final Acres	Average Depth	Volume (acre/ft)	PDU Rate (per acre-ft)	PDU Total
A[1]-20	4.0	8.7	34.8	4.0	139.2
A[2]-20	4.2	11.1	46.6	4.0	186.5
A[3]-20	1.8	11.6	20.9	4.0	83.5
Total	***10.0***		**102.3**		**409.2**



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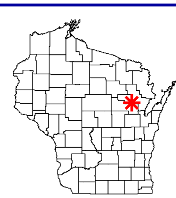
Onterra LLC
Lake Management Planning
815 Prosper Rd
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: Onterra, 2015
Map Date: June 2, 2020 - EJH



Project Location in Wisconsin

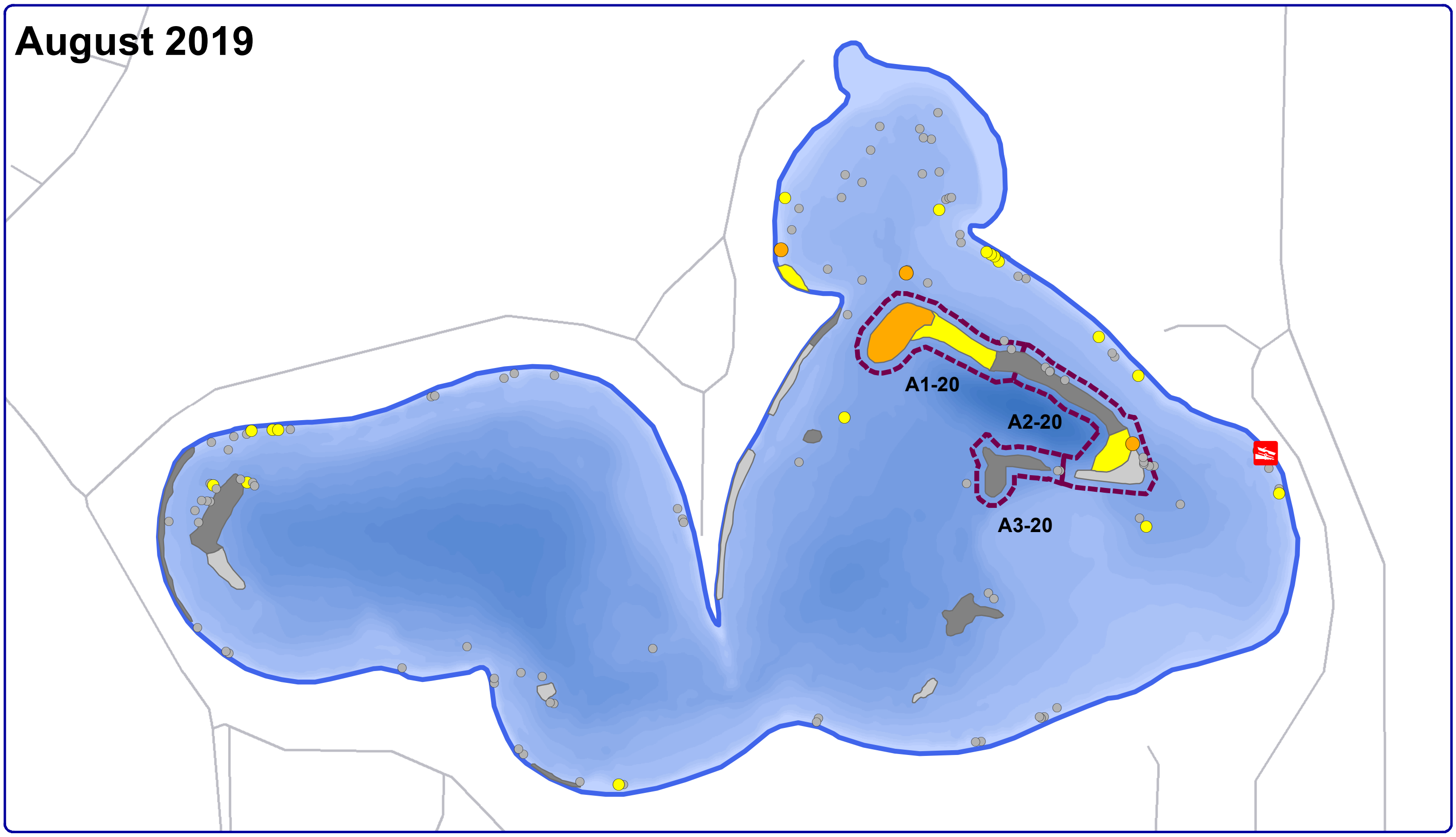
Legend

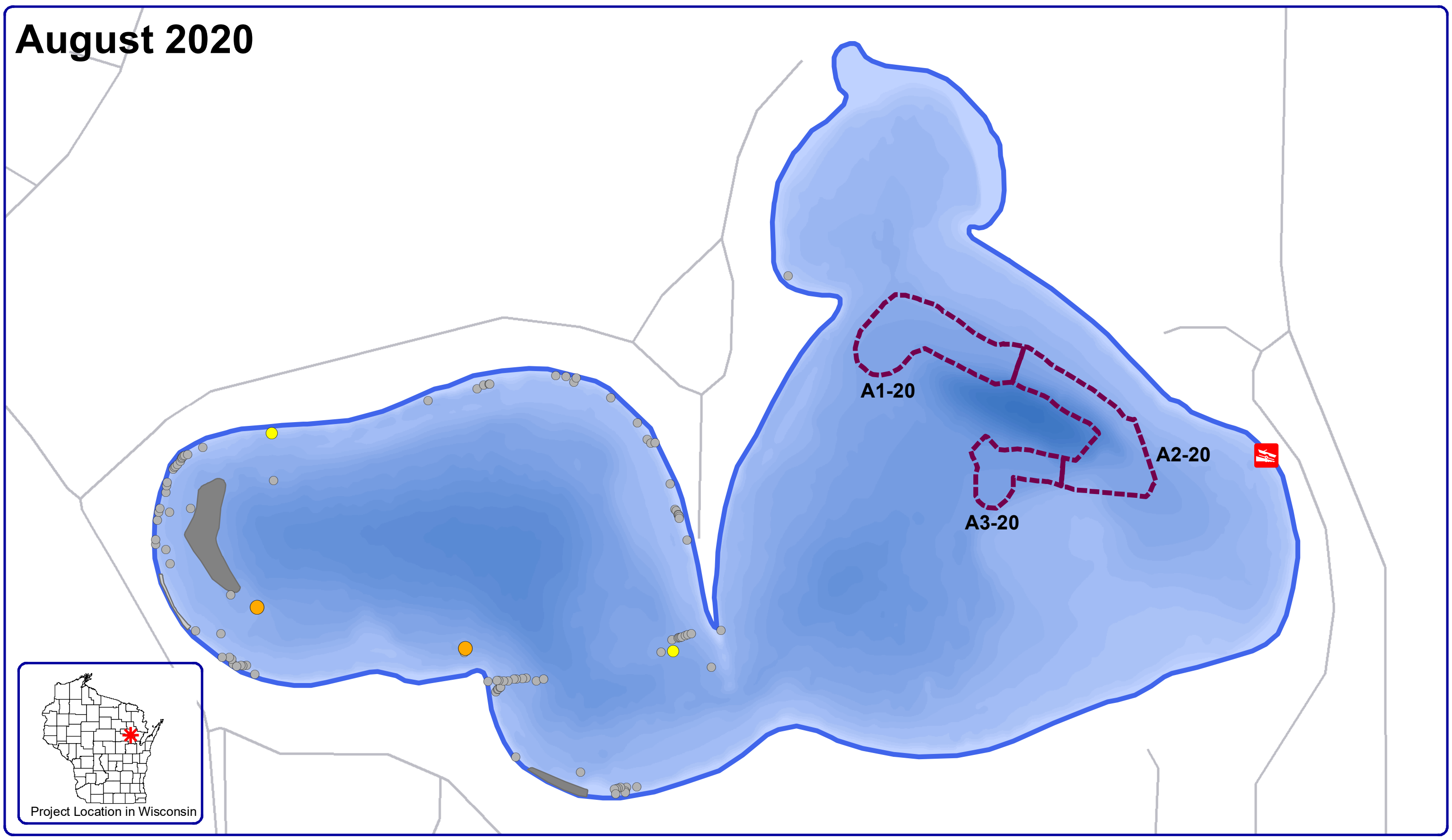
Herbicide Application Area

Herbicide Concentration Monitoring Site

Map 1
Berry Lake
Oconto County, Wisconsin

Final 2020 HWM Control Strategy





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Feet

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920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: Onterra, 2017
Aquatic Plants: Onterra, 2019 & 2020

Map Date: December 8, 2020 AMS

Legend

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2020 Herbicide Treatment Site

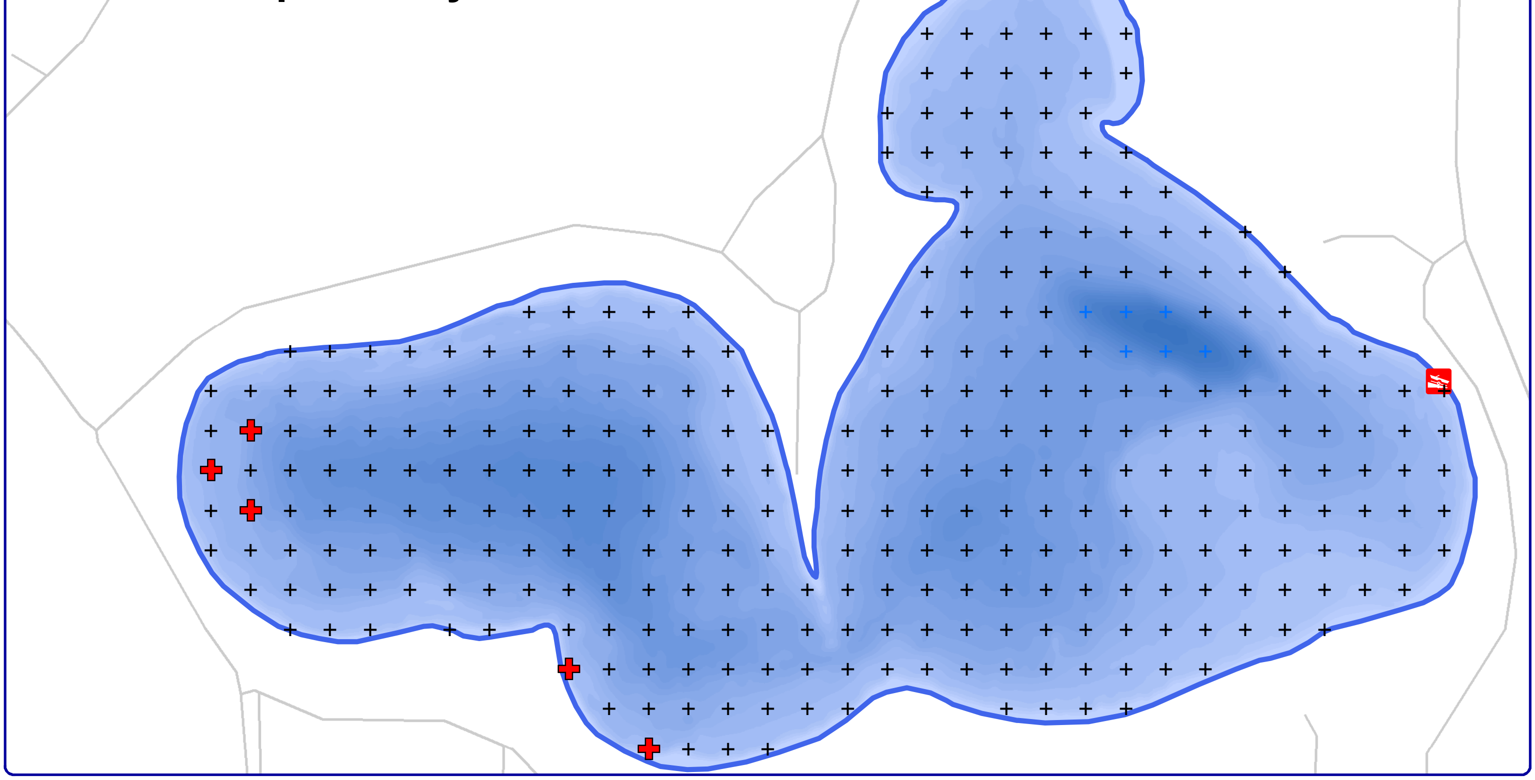
Map 2

Berry Lake

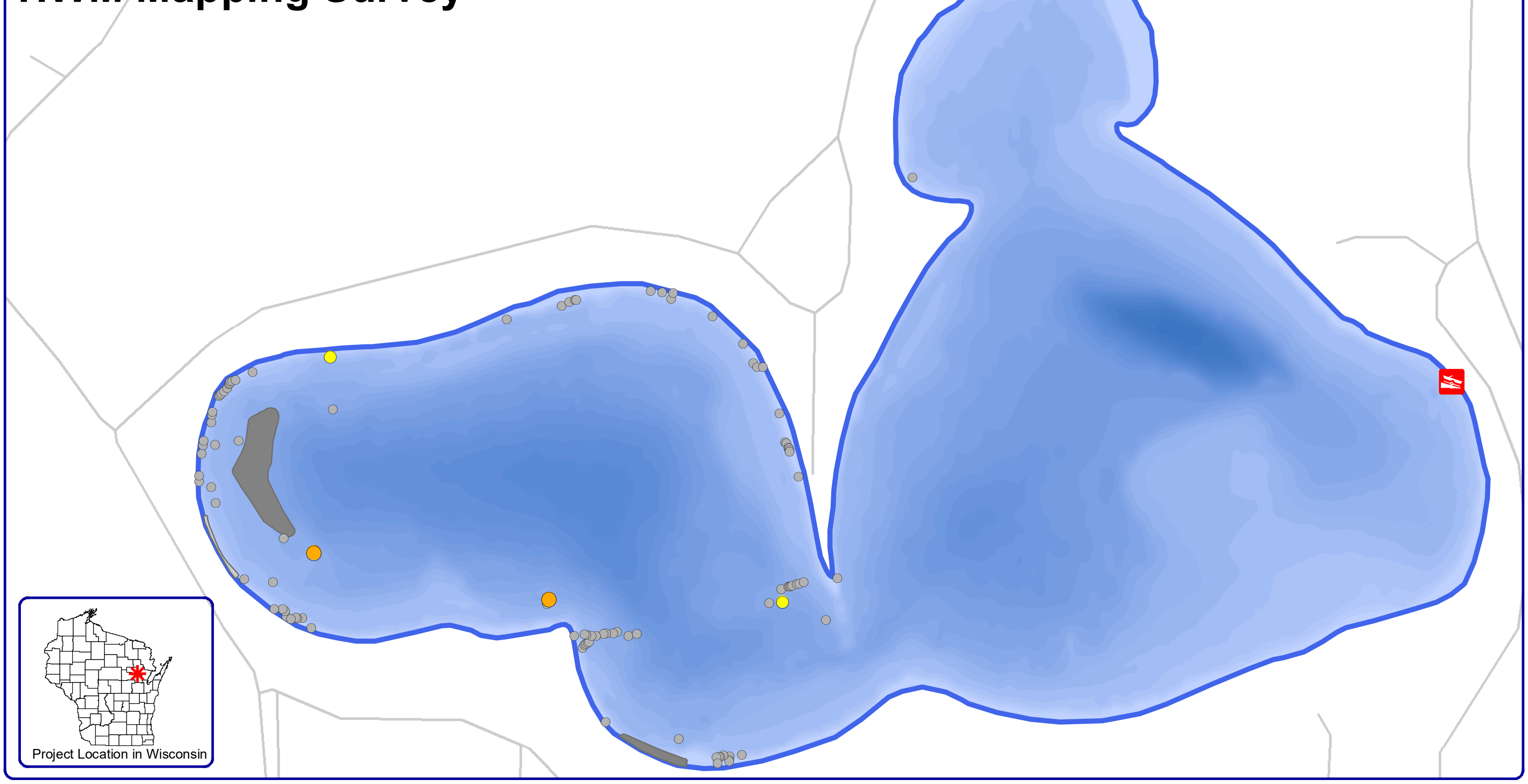
Oconto County, Wisconsin

2019-2020 Late-Season HWM Survey Results

Summer 2020
Point-Intercept Survey: HWM



Summer 2020
HWM Mapping Survey



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Legend

Top Frame

- \+ > Max Depth of Plant Growth
- \+ No HWM, Within Littoral Zone
- HWM Present

Bottom Frame

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clump of Plants
- Small Plant Colony

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Sources:
Roads and Hydro: WDNR
Bathymetry: Onterra, 2017
Aquatic Plants: Onterra, 2020

Map Date: December 30, 2020 EJH

Map 3

Berry Lake
Oconto County, Wisconsin

**2020 Compare:
HWM Mapping
vs PI Survey**

A

APPENDIX A

Berry Lake 2020 Herbicide Concentration Monitoring Plan

Berry Lake, Oconto County (WBIC: 418300)
2020 Herbicide Sample Plan
Onterra, LLC

Berry Lake, Oconto County is an approximately 209-acre seepage lake and has a mean depth of 8 feet and a maximum depth of 27 feet. Florpyrauxifen-benzyl (commercially as ProcellaCOR™) is proposed to be applied to 10.0 acres of the lake in spring 2020 to control Hybrid/Eurasian watermilfoil. Herbicide concentration sampling will be conducted in order to monitor the herbicide concentrations in the hours immediately 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.

Berry Lake Herbicide Sample Sites				
Site	**Station ID**	**Latitude**	**Longitude**	**Sample Depth**
BL1	10053775	44.889633	-88.472753	Integrated (0-6 feet)
BL2	10053776	44.891454	-88.476598	Integrated (0-6 feet)

Please note that a single sample is to be collected before the treatment as a 'control' for the lab analysis. Please collect the pre-treatment sample from site BL1 at a time that is most convenient for the volunteer but as close to the treatment date as possible. Samples will need to be collected at seven post-treatment time intervals (Hours After Treatment – HAT) 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 (HAT)	BL1	BL2
Pre-Treatment	X	
1 HAT	X	X
2 HAT	X	X
4 HAT	X	X
6 HAT	X	X
9 HAT	X	X
24 HAT	X	X
36 HAT	X	X
Total Samples: 15		

All water samples will be collected using an integrated sampler (Photo 1). A video tutorial demonstrating the proper sample collection methodology is available on Onterra's YouTube web page: https://www.youtube.com/channel/UCHj5OSdj1axlA9NYuXRXybw.

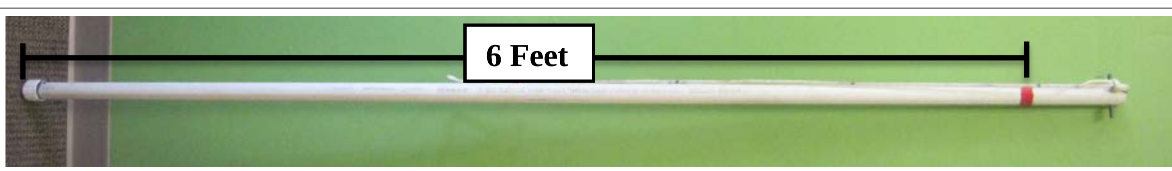

Photo 1. Integrated sampling device.

It is important to rinse the integrated sampler 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 a 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 (Photo 2). Water from the custom mixing bottle should be used to triple rinse the clear glass bottle. After the clear glass bottle is triple rinsed, it is to be filled for a fourth time with the water from the custom mixing bottle and then carefully poured into the brown glass bottle which has a preservative solution already inside (Photo 3). The sticker on the brown glass bottle must be appropriately labeled with the site label and time interval for which the sample was collected (Example: BL1, 1 HAT). The final sample (in the brown bottle) as well as the emptied clear glass bottle should be carefully placed within the provided bubble wrapped pouch to protect from accidental breakage.

	
Photo 2. Emptying the water sample from the integrated sampler device into the custom mixing bottle.	**Photo 3. Clear glass mixing bottle and final brown glass bottle.**

While the samples are being collected, they should be kept cold and out of direct sunlight by keeping them in a small cooler on the boat. Samples should be kept refrigerated until shipping.

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 sampling bottles with labels, a customized mixing bottle and necessary paperwork will be provided.

Fill out one Chain of Custody data sheet for each sample interval and fill in the highlighted fields including the following:

Sampler: (Volunteer Name)
Number of samples to be analyzed: (number of samples being sent in with the form)
Client Sample ID: (example: BL1, BL2)
Date sample collected
Shipped by: (name and date/time samples were shipped)

The samples should be shipped by overnight currier along with the Chain of Custody data sheets to:

EPL Bio Analytical Services
9095 W. Harristown Blvd.
Niantic, IL 62551

Samples should not be shipped on loose ice. Ice packs or frozen water bottles (contained in a zip bag) may be shipped with the samples to keep them cool. Samples should not be shipped on a Friday, but rather refrigerated and shipped on the following Monday.

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

Project specifics, logistics and sampling methods	
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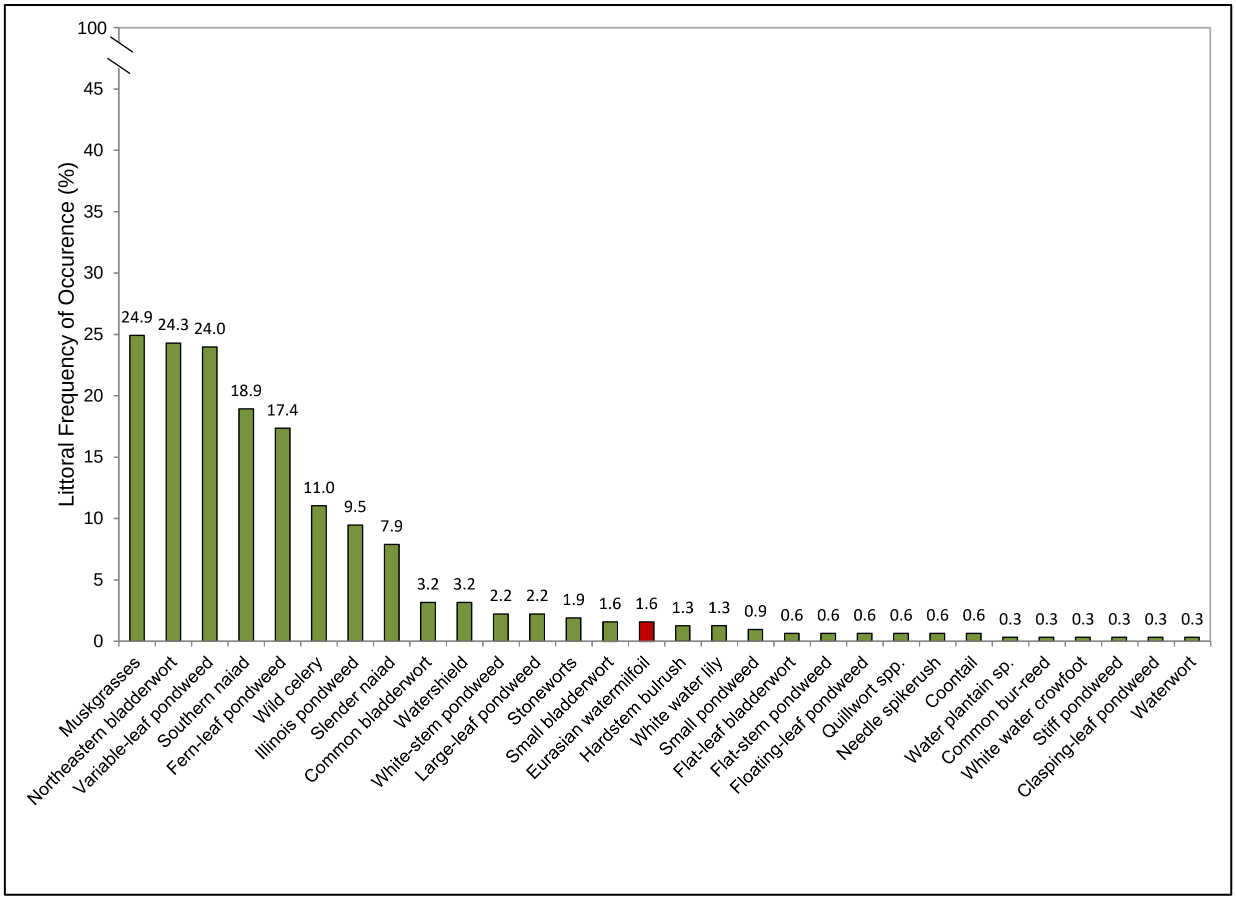
SePro (ProcellaCOR manufacturer)	
Michael Hiatt **SePro Aquatic Specialist** **michaelh@sepro.com**	

B

APPENDIX B

Littoral Frequency of Occurrence of Aquatic Plants from a 2020 Whole-Lake Point-Intercept Survey in Berry Lake.

Littoral Frequency of Occurrence of aquatic plants from a 2020 whole-lake point-intercept survey in Berry Lake.



Chi Square analysis of aquatic plants from whole-lake point-intercept surveys from 2007-2020 in Berry Lake.

Group	Scientific Name	Common Name	LFOO (%) 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2019-2020 % Change	2019-2020 Direction
Dicots	*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	24.3	9.5	▲
	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	1.6	-71.1	▼
	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	3.2	-34.6	▼
	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	0.0	-100.0	▼
	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	3.2	-18.2	▼
	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	0.0		-
	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	1.3	-34.6	▼
	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	0.0	-100.0	▼
	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	0.6	-60.8	▼
	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	1.6	145.3	▲
	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	0.0	-100.0	▼
	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	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	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	0.0		-
	Ranunculus aquatilis	White water crowfoot	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3		▲
Non-dicots	*Chara & Nitella*	Charophytes	33.5	37.6	41.1	47.2	39.0	37.1	38.8	33.2	26.9	18.4	24.4	30.9	25.7	26.2	1.8	▲
	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	30.6	25.7	24.9	-3.1	▼
	Najas flexilis & N. guadalupensis	Slender & Southern naiads	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	25.2	70.6	▲
	Potamogeton gramineus & P. illinoensi	Variable-leaf & Illinois pondweeds	33.5	16.7	33.2	30.2	36.2	40.2	44.6	35.2	9.4	17.1	23.4	24.1	17.7	29.7	67.7	▲
	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	17.4	-3.6	▼
	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	24.0	69.5	▲
	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	18.9	84.0	▲
	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	2.2	-23.7	▼
	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	11.0	18.4	▲
	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	9.5	167.6	▲
	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	7.9	63.5	▲
	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	2.2	586.8	▲
	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	1.9		▲
	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	0.6	-50.9	▼
	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	0.9	47.2	▲
	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	0.0		-
	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	0.0	-100.0	▼
	Potamogeton richardsonii	Clasping-leaf pondweed	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	0.3		▲
	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	1.3	30.8	▲
	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	0.0		-
	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	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	0.0		-
	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	0.3		▲
	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	0.6	96.2	▲
	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	0.6		▲
	Isoetes spp.	Quillwort spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.6		▲
	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	0.0		-
	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	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	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	0.0		-
	Alisma spp.	Water plantain sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3		▲
	Sparganium eurycarpum	Common bur-reed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3		▲
	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	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	0.0		-
	Elatine minima	Waterwort	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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	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	0.0		-
	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	0.0	-100.0	▼
	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	0.0		-
	Eleocharis robbinsii	Robbins' spikerush	0.0	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		-

▲ or ▼ = Change Statistically Valid (Chi-square; α = 0.05)

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