Minocqua-Kawaguesaga Lakes

Oneida County, Wisconsin

2021 EWM Management & Monitoring Report

March 2022

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Funded by: Minocqua Kawaguesaga Lakes Protection Association
Wisconsin Dept. of Natural Resources (ACEI-237-20, ACEI-1249-21, ACEI-1250-21)

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1.0 INTRODUCTION

Minocqua (1,339 acres) and Kawaguesaga (700 acres) Lakes are drainage lakes in Oneida County (Figure 1.0-1). Over 1,100 waterfront parcels exist on these two lakes, paying taxes on approximately 400 million dollars of property. The primary citizen-based organization leading management activities on Minocqua and Kawaguesaga Lakes is the Minocqua Kawaguesaga Lakes Protection Association (MKLPA).

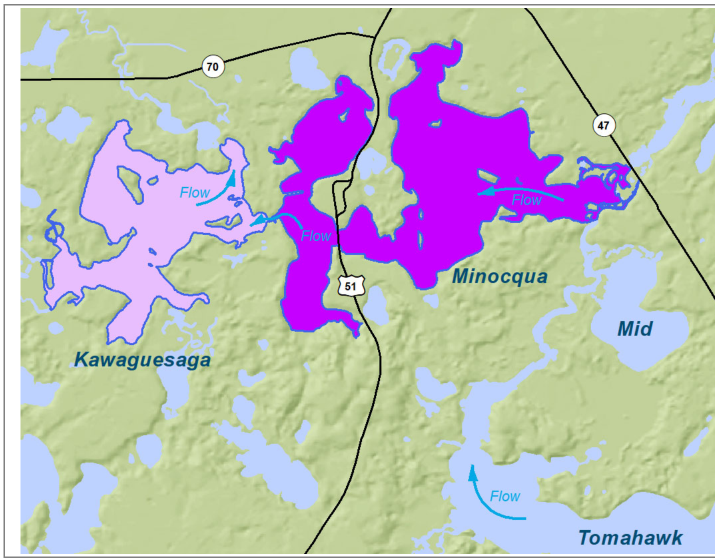

Figure 1.0-1. Minocqua and Kawaguesaga Lakes, Oneida County

1.1 Historic EWM Management & Planning

Eurasian watermilfoil (EWM) was first documented in the early 2000s. The MKLPA targeted EWM populations during 2005-2015 with 2,4-D spot treatments, considered the best management practice of the time. Herbicide spot treatments with 2,4-D generally lead to short term EWM population reductions, with reductions largely being limited to a single season. This type of strategy can be analogous to the "whack-a-mole" arcade game; where areas are targeted, rebound, and then are targeted again on an every-other year basis. The repeated need for exposing the same areas of the system to herbicides as is required when engaged in an annual 2,4-D spot treatment program has gone out of favor with some lake managers due to concerns over the non-target impacts that can accompany this type of strategy. In recent years, lake managers have sought actions that achieve multiyear EWM population suppression, such as whole-lake/basin treatments or spot treatments with chemistries theorized to require shorter exposure times. The EWM population reductions are more commensurate with the financial costs and risks of the treatment.

The MKLPA attempted a biological control activity towards EWM in 2008 by augmenting the native weevil populations that preferentially feed on EWM plants. Recent research from the University of Wisconsin – Trout Lake Station on milfoil weevils has indicated that background populations of these native weevils in most lakes is quite high, with stocking efforts likely having an insignificant impact on fostering a population sufficient to impact EWM on most systems. Due to the lack of success of weevil stocking on this system, the program was discontinued.

Following a 3-year (2014-2017) hand-harvesting program and cessation of herbicide management (ACEI-154-14), EWM populations in some areas of the chain increased to levels that impeded recreation and navigation. One area of each lake was targeted in 2019 with florpyrauxifen-benzyl (ProcellaCOR™ EC) spot treatments, a new herbicide that was first approved for use in Wisconsin in 2019. The 2019 herbicide program targeted areas with high conformance with the best characteristics for positive treatment outcomes, targeting EWM populations in contained bays with minimal herbicide dissipation potential (Map 1).

After meeting management goals in 2019, the 2020 herbicide treatment program targeted additional sites, some of which contain parameters difficult to achieve multi-year control, such as narrow EWM bands in exposed locations (Map 1). A robust hand-harvesting (includes DASH) program also occurred in 2020, aimed at preserving the gains in EWM reductions made by the previous season's herbicide treatment as well as reducing EWM in scale-appropriate situations. Prior to the start of the 2020 growing season, the MKLPA was able to secure a WDNR AIS-Established Population Control Grant (ACEI-237-20) to help fund the 2020 control and monitoring project. As outlined in the *2020 EWM Monitoring & Management Report* (March 2021), the 2020 control program exceeded lake mangers expectations with large EWM population reductions occurring and minimal collateral native plant impacts outside of a few sensitive species during the *year of treatment*. This report contains the *year after treatment* monitoring components that were conducted in 2021 as part of ACEI-237-20.

Large strides in understanding the field operations of ProcellaCOR™ treatments occurred in 2020, including from data collected on Minocqua and Kawaguesaga Lakes. For almost every ProcellaCOR™ treatment at Onterra monitored in Wisconsin to date, EWM impacts were observed extending outside of the application area and into an area of perceived impact (AOPI). On Minocqua and Kawaguesaga Lakes, this resulted in large EWM population reductions throughout the basin, sub-basin, or bay in which the herbicide treatments occurred within. Subsequent investigations determined the theoretical basin-wide herbicide concentration that likely was achieved to assist in driving strategies and expectations for 2021 and beyond.

2.0 2021 EWM CONTROL & MONITORING STRATEGY

The MKLPA developed the 2021 herbicide strategy that targeted EWM populations at the two ends of the system: the southwestern bays of Kawaguesaga Lake (Map 2) and upstream Stacks Bay (Map 3). These areas contain the highest density EWM populations in the system. The MKLPA, WDNR (lakes and fisheries programs), and Onterra discussed the 2021 strategy over the course of several teleconferences and follow-up email correspondences during the late-winter of 2022. Advanced calculations of potential basin-wide herbicide concentrations were made to help drive the 2021 herbicide treatment strategy and expectations. The final herbicide control strategy targeted 17.2 acres of the densest EWM in these two areas of the lake with the expectation that basin-wide impacts would occur.

The MKPA also directed follow-up hand-harvesting in all 2019 and 2020 herbicide treatment areas as part of their Integrated Pest Management (IPM) strategy aimed to preserve the gains made over the past two years. Hand-harvesting was also directed to previously dense areas that saw EWM reduction in 2020 potentially as a result of herbicide dissipation. The MKLPA was been awarded a set of WDNR AIS Established Population Control (EPC) Grants to assist with funding cost share for most of the 2021 management and monitoring activities (ACEI-1249-21, ACEI-1250-21).

2.1 2021 Pretreatment Confirmation and Refinement Survey

The Pretreatment Confirmation & Refinement Survey was conducted on June 14-15, 2021. This meander-based survey investigated for colonial expansion, reduced occurrence, growth stage of the EWM (and native plants), application area specifies (e.g. average depth and extents), and other aspects that would change treatment plan. The EWM in the treatment area contained active growth with a high amount of biomass. Healthy native plant growth was noted during the survey, including wild celery which starts growing a little later in the season compared to many other native species. Where present, the flowering rush growth was also quite advanced. Surface water temperatures were approximately 75°F at all sites. A set of underwater camera transects were completed through the targeted areas which can be viewed on Onterra's YouTube webpage: https://youtu.be/U-RiEv6caXo

Based upon the pretreatment survey, no modifications were made to the Minocqua Lake treatment of O-21. The average depths of the Kawaguesaga Lake treatments of P-21 and R-21 were increased based upon the pretreatment survey; and no changes to Q-21 were recommended. The field crew also delivered the herbicide concentration monitoring supplies to volunteers from the MKLPA during the visit. The herbicide application was completed on June 22, 2021 by Schmidt's Aquatic, LLC. The applicator noted light winds (0-3 mph) and a surface water temperature of 68°F at the time of the treatment.

2.2 2021 Professional Hand-Harvesting Actions

The MKLPA contracted with Aquatic Plant Management, LLC (APM) in 2021 to provide professional hand-harvesting services. The MKLPA EWM Committee created a site prioritization methodology that considered EWM density from the 2020 Late Season EWM Mapping Survey, traffic patterns, and distance from herbicide management sites. Through a total of 171 dives on 34 sites around Minocqua and Kawaguesaga Lakes, over 650 cubic feet of EWM were removed by APM in 2021 (Map 4). Details of hand-harvesting effort and amount of EWM removed on a site-by-site basis can be accessed on the MKLPA's interactive map and can be found in Appendix A.

Table 2.2-1. 2021 Hand-harvest summary

	Number of Sites	Number of Dives	Underwater Time (hours)	EWM Removed (cubic ft)
Traditional HH	31.0	123	112.5	343.0
DASH	3.0	48	74.2	309.5
	34.0	**171**	**186.7**	**652.5**

HH = Hand-Harvesting, DASH = Diver Assisted Suction Harvesting

3.0 2021 MONITORING RESULTS

It is important to note that two types of surveys are discussed in the subsequent materials: 1) point-intercept surveys and 2) EWM 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 EWM, 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 particular pre-determined point-intercept sampling location in that area.

The point-intercept survey can be applied at various scales. The point-intercept survey is most often applied at the whole-lake scale. The whole-lake point-intercept survey was last conducted on Minocqua and Kawaguesaga Lakes in 2017 and is planned to occur again in 2022. If a smaller area is being studied, a modified and finer-scale point-intercept sampling grid may be needed to produce a sufficient number of sampling points for comparison purposes. This sub-sample point-intercept survey methodology is often applied over management areas such as herbicide application sites. This type of sampling is used within this project on all treatment sites. Specifically, the locations used within this report to evaluate the 2020 and 2021 treatment sites are displayed on Map 1.

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 EWM mapping survey, the entire littoral area of the system is surveyed through visual observations from the boat (Photo 3.0-1). Field crews supplement the visual survey by deploying a submersible camera along with periodically doing rake tows. The EWM 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*. The 2021 Late-Season EWM Mapping Survey data are shown on Maps 4-11.

Photo 3.0-1. EWM mapping survey. Photo credit Onterra.

In an effort to increase the flow of information between lake stakeholders and project planners, the MKLPA added an interactive web map application to their website, allowing users to see each year's late-season EWM mapping survey and management areas as they relate to their property or favorite recreation and fishing spots. Various layers can be turned on and off, and some layers can be selected and a pop-up window will provide additional information. This platform allows a better understanding of the EWM population dynamics and management strategies over time. To directly access this interactive map:

https://www.arcgis.com/apps/View/index.html?appid=2d571b0ab1304deebb816ed72e5cc4f6

Overall, each survey has its strengths and weaknesses, which is why both are utilized in different ways as part of this project.

3.1 Qualitative Monitoring: Late-Summer EWM Mapping Surveys

For must lake users, investigating the EWM population before and after a treatment is best understood by comparting data from EWM mappings surveys. During this project, EWM mapping surveys occur annually during the latter part of the growing season when EWM has likely reached its peak growth stage for the year. The Late-Season EWM Mapping Survey from the year preceding the treatment is comparted to the *year of treatment* survey occurring a few months after the treatment, as well as the year *after treatment* survey which allows for the understanding if the reductions were maintained or if rapid rebound occurred.

The following figures will display the EWM mapping data from before and after the treatments. For spring 2020 treatment sites, the 2019 *pre-treatment* mapping data will be compared to the 2021 *year after treatment* mapping data (Figures 3.1-1 to 3.1-3). For the spring 2021 treatment sites, the 2020 *pre-treatment* mapping data will be compared to the 2021 *year of treatment* mapping data (Figures 3.1-4 to 3.1-5). These data can also be accessed through the MKLPA's interactive web map.

As outlined in the *2020 EWM Monitoring & Management Report* (March 2021), the 2020 control program exceeded lake mangers expectations with no EWM being observed from the bow of the survey boat within any of the 2020 treated sites. EWM reductions were also observed in areas adjacent to many of the treatment sites, as the herbicide dissipated out of the application areas and reached an equilibrium concentration with the basin containing the treatment sites. Back-calculations indicate that if florpyrauxifen-benzyl mixed evenly through the epilimnion of these basins, it was at levels sufficient to impact EWM populations throughout these areas, explaining why EWM reductions were observed in non-treated parts of this basin.

The 2021 Late-Season EWM Mapping Survey indicated that almost no EWM was observed rebounding within these application sites, with some EWM being noted rebounding in adjacent un-treated areas (Figures 3.1-1 to 3.1-3). It is also important to note that a great deal of hand-harvesting occurred in these areas during 2021 to maintain the lowered EWM populations.

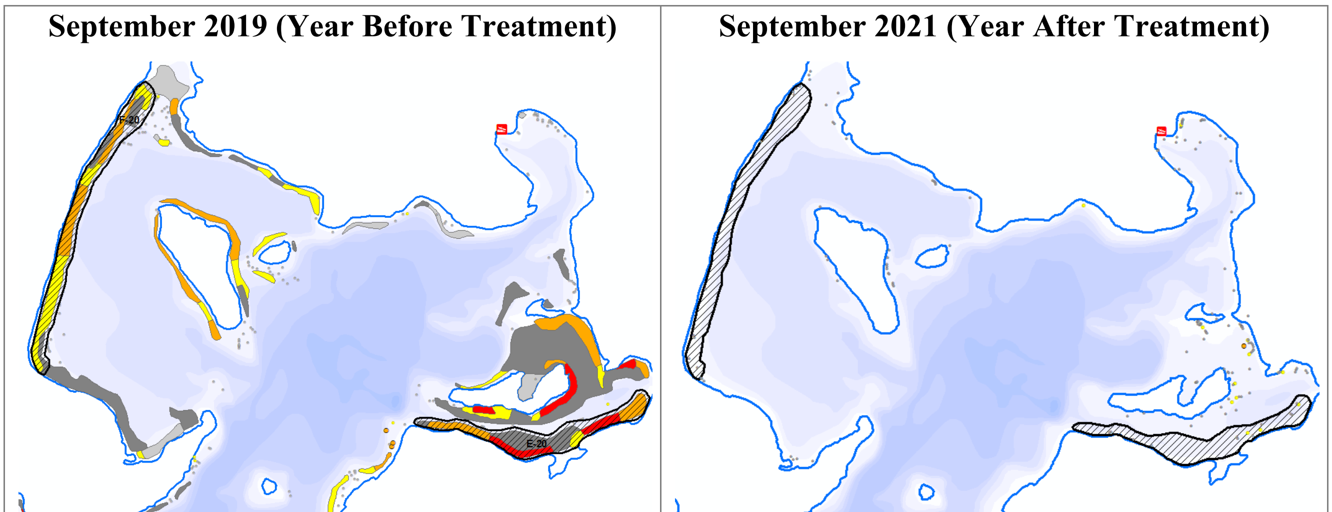

Figure 3.1-1. Northern Kawaguesaga Lake EWM Mapping Survey Results from Before (2019) and the Summer After (2021) ProcellaCOR™ herbicide treatment. For legend, reference Map 4.

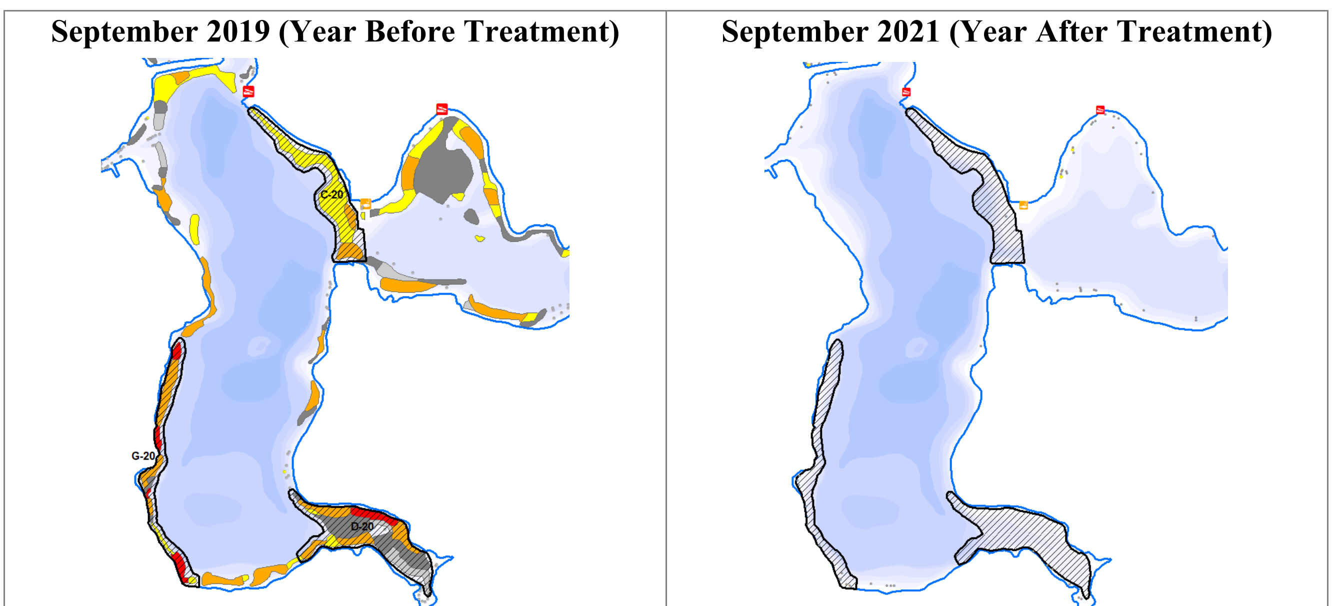

Figure 3.1-2. Western basin of Minocqua Lake EWM Mapping Survey Results from Before (2019) and the Summer After (2021) ProcellaCOR™ herbicide treatment. For legend, reference Map 4.

September 2019 (Year Before Treatment)	September 2021 (Year After Treatment)

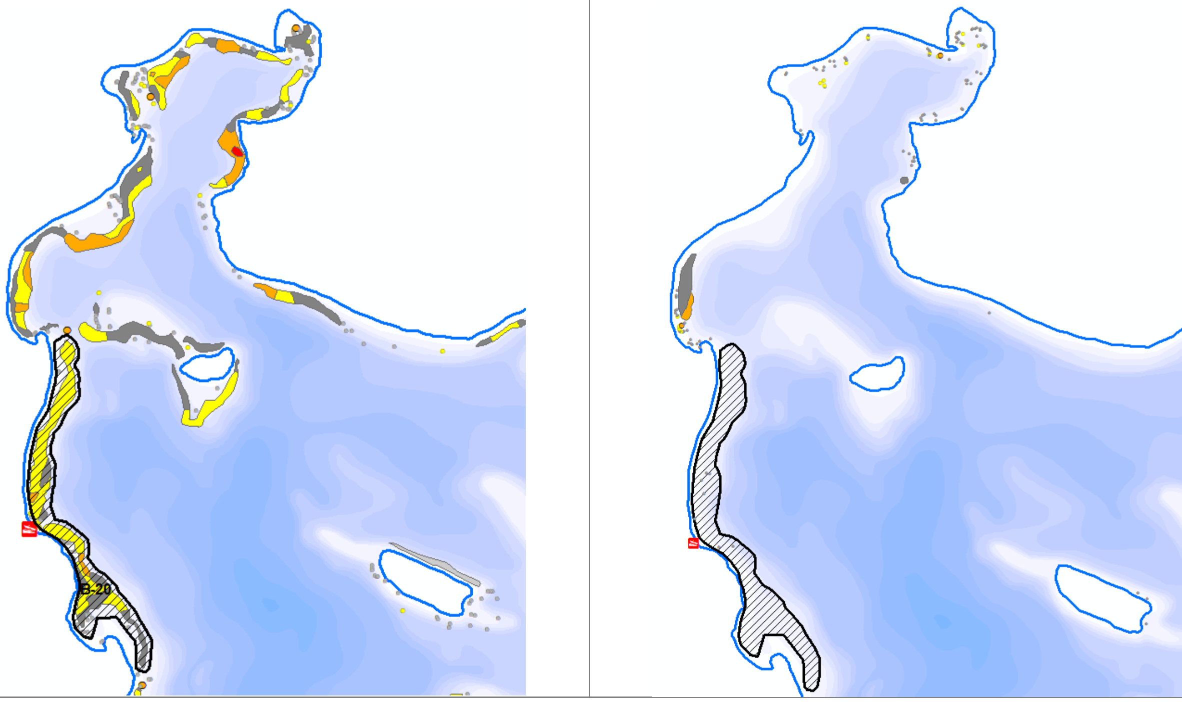

Figure 3.1-3. Huber Bay, Minocqua Lake EWM Mapping Survey Results from Before (2019) and the Summer After (2021) ProcellaCOR™ herbicide treatment. For legend, reference Map 4.

The 6.9-acre treatment site in Stack's Bay was designed with the expectation that EWM impacts would likely occur throughout most of that Area of Potential Impact (Map 4). The 2021 Late-Season EWM Mapping Survey data, collected approximately four months after treatment indicate that the treatment largely performed as designed (Figure 3.1-4). The *highly dominant* EWM colony within the application area was completely removed, with adjacent colonies also being greatly reduced. EWM reductions were minimal within the southern bay (by the Country Club Golf Course) east of hunter's point, likely as natural water flow out of this bay into the lake limited herbicide from moving into that bay.

September 2020 (Year Before Treatment)	September 2021 (Year of Treatment)

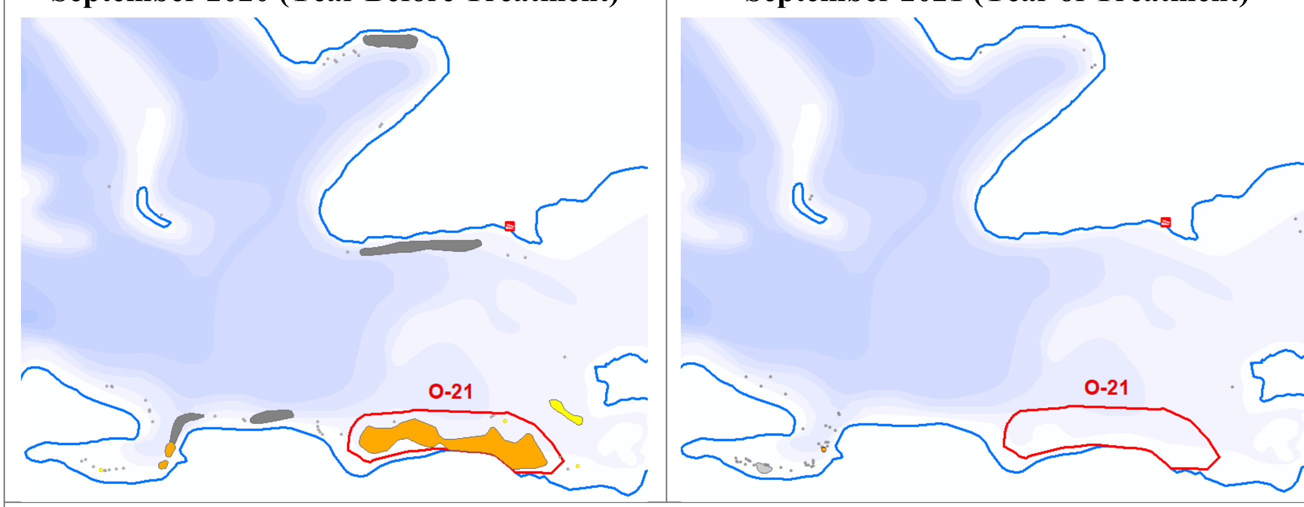

Figure 3.1-4. Stacks Bay, Minocqua Lake EWM Mapping Survey Results from Before (2020) and the Summer of (2021) ProcellaCOR™ herbicide treatment. For legend, reference Map 4.

The southern part of Kawaguesaga Lake, south of Beer Can Island, contained some of the highest density colonies from the system during the 2020 Late-Season EWM Mapping Survey (Figure 3.1-5). No EWM was located within any of the three herbicide application areas, with very little EWM being located within the western and southern bays.

Adjacent colonies were also being greatly reduced including occurrences located between application areas Q-21 and R-21. A lesser degree of EWM reductions occurred in a small bay northeast of application area P-21 where waters likely did not mix with adjacent areas enough to result in an herbicide concentration sufficient to kill the target plants.

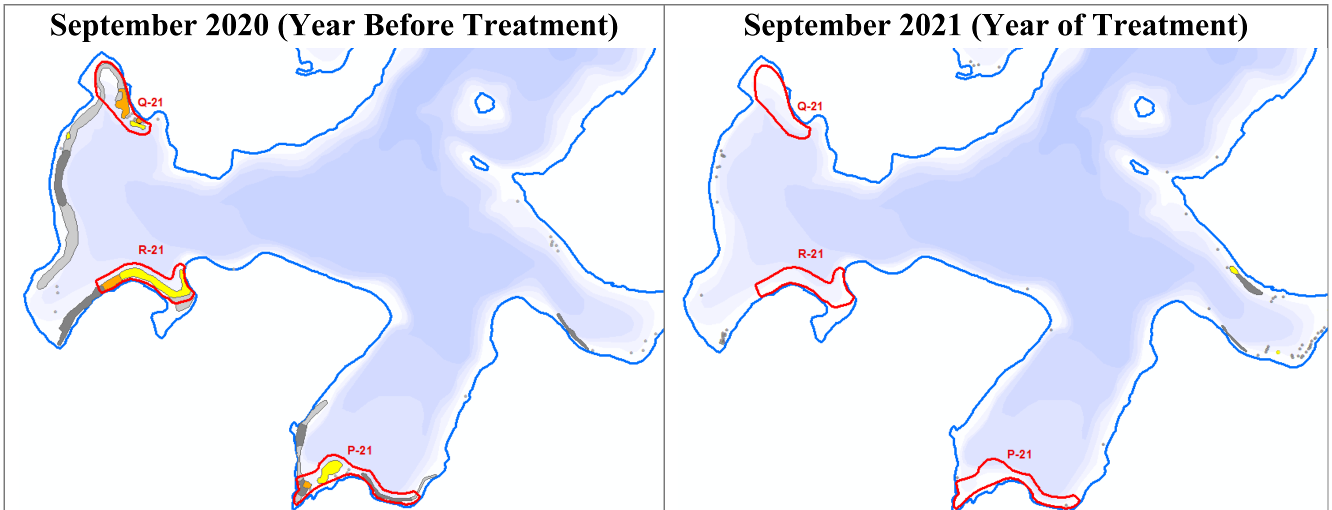

Figure 3.1-5. Southern Kawaguesaga Lake EWM Mapping Survey Results from Before (2020) and the Summer of (2021) ProcellaCOR™ herbicide treatment. For legend, reference Map 4.

A large manual removal effort took place in 2021, incorporating both traditional hand-harvesting and Diver Assisted Suction Harvesting (DASH). Map 4 shows where all the hand-harvesting, including DASH, took place in 2021 with color coding based upon the amount of underwater time spent in each site. Most of these efforts were aimed at rebounding EWM from prior treatments. Therefore, there is not as concise pre- hand-harvesting EWM mapping data as many of these areas were largely void of EWM mapped during the late-summer of 2020.

Figures 3.1-6 and 3.1-7 highlight two areas that were targeted for manual removal of EWM in 2021 because colonized EWM was documented during the 2020 Late-Summer EWM Mapping Survey. The largest amount of effort took place in PG-23, with almost 60 hour of underwater time taking place. The *dominant* colony mapped in the late-summer of 2020 was reduced to only *single or few plants* being located during the late-summer 2021 mapping survey (Figure 3.1-6). A similar reduction was observed in PG-5 after almost 25 hours of dive time (Figure 3.1-7)

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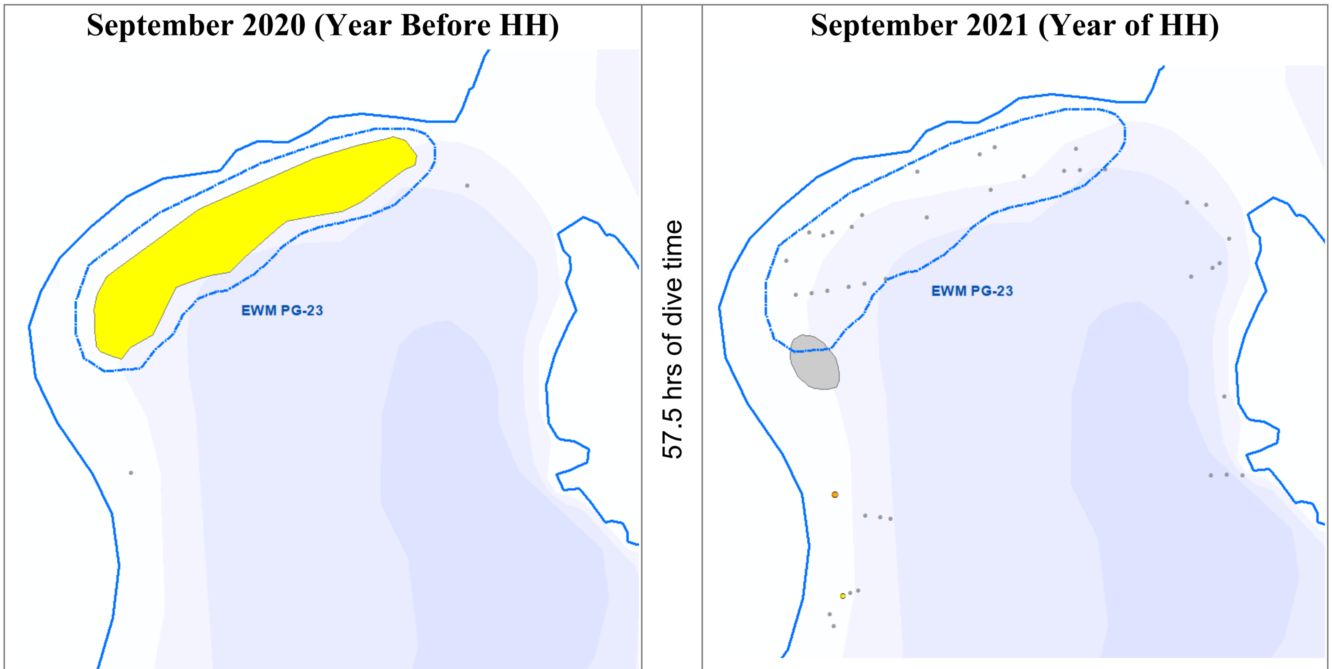


Figure 3.1-6. Western shore of Minocqua Lake EWM Mapping Survey Results from Before (2020) and after (2021) the 2021 hand-harvesting program. For legend, reference Map 4.

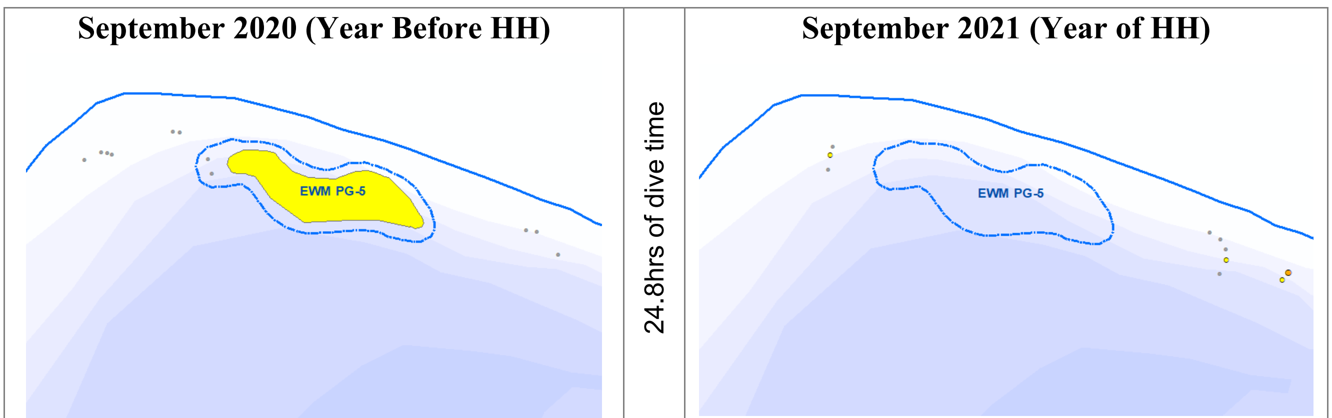


Figure 3.1-7. North Huber Bay of Minocqua Lake EWM Mapping Survey Results from Before (2020) and after (2021) the 2021 hand-harvesting program. For legend, reference Map 4.

3.2 Quantitative Monitoring: Sub-sample point-intercept Survey

A quantitative monitoring study was designed for this project which included the collection of sub-sample point-intercept survey data *prior to treatment* and compared to post treatment assessments during the *year of treatment* and the *year after treatment.* These surveys allowed a numeric understanding of the native and non-native aquatic plant population within the areas targeted with herbicide treatment. While sub-sample data collected during the *year of treatment* is important for understanding the initial results of the herbicide treatment, the data collected during the *year after treatment* allow un understanding if the impacts were sufficient that rebound did no occur and the treatment caused plant mortality.

When comparing aquatic plant populations over time, it is best to compare similar time periods from year to year. For treatment sites B-20, C-20, and D-20, *pretreatment* data was collected during the late-summer in 2019 and is compared to data collected during the late-summer of 2020 (*year of treatment)* and 2021 (*year after treatment*) (Table 3.2-1). Often in practice, the locations of a spring herbicide treatment are not developed until after the time period to collect the late-summer pretreatment data has passed. In these instances, the early-season herbicide treatment may be delayed from roughly early-June to mid-June. This slight delay in implementation allows the pretreatment sub-sample point-intercept survey to take place after many native plants have emerged from winter dormancy. However, it is believed that some species such as wild celery begin to grow a bit later in the growing season and are under-represented in the June survey.

Table 3.2-1. Quantitative monitoring plan. Application areas and sub-PI locations shown on Map 3.

Site	Lake	N	Treatment Date	Pre	Post Treatment Year of	Post Treatment Year After
A-20*	Minoc	64	N/A	7/13/2019	9/15/2020	9/8/2021
B-20	Minoc	76	6/15/2020	7/13/2019	9/15/2020	9/8/2021
C-20	Minoc	75	6/15/2020	8/11/2019	9/15/2020	9/8/2021
D-20	Minoc	95	6/15/2020	7/14/2019	9/15/2020	9/8/2021
E-20	Kawa	83	6/30/2020	6/24/2020	9/15/2020	9/8/2021
F-20	Kawa	96	6/30/2020	6/24/2020	9/15/2020	9/8/2021
G-20	Minoc	46	6/30/2020	6/24/2020	9/15/2020	9/8/2021
O-21	Minoc	68	6/22/2021	6/14/2021	9/8/2021	*To occur in 2022*
P-21	Kawa	38	6/22/2021	6/14/2021	9/8/2021	*To occur in 2022*
Q-21	Kawa	33	6/22/2021	6/14/2021	9/8/2021	*To occur in 2022*
R-21	Kawa	34	6/22/2021	6/14/2021	9/8/2021	*To occur in 2022*

** = untreated reference site*

Figures 3.2-1 through 3.2-6 will examine site-specific changes in select aquatic plant species. Appendix B includes a full analysis of the point-intercept sub-sample survey results on a site-by-site basis. These figures investigate sites treated in 2020 and 2021, with the naming convention of each site including the year treated following the dash (for example: B-20 was treated in 2020). The *year after treatment* data has not yet been collected for the 2021 treatment sites.

Eurasian watermilfoil was the most abundant plant within these sites prior to treatment and was reduced to zero during the *year after treatment* (Figure 3.2-1). EWM was detected in three of the six 2020 treatment sites during the *year after treatment*, but continue to be at near-zero levels.

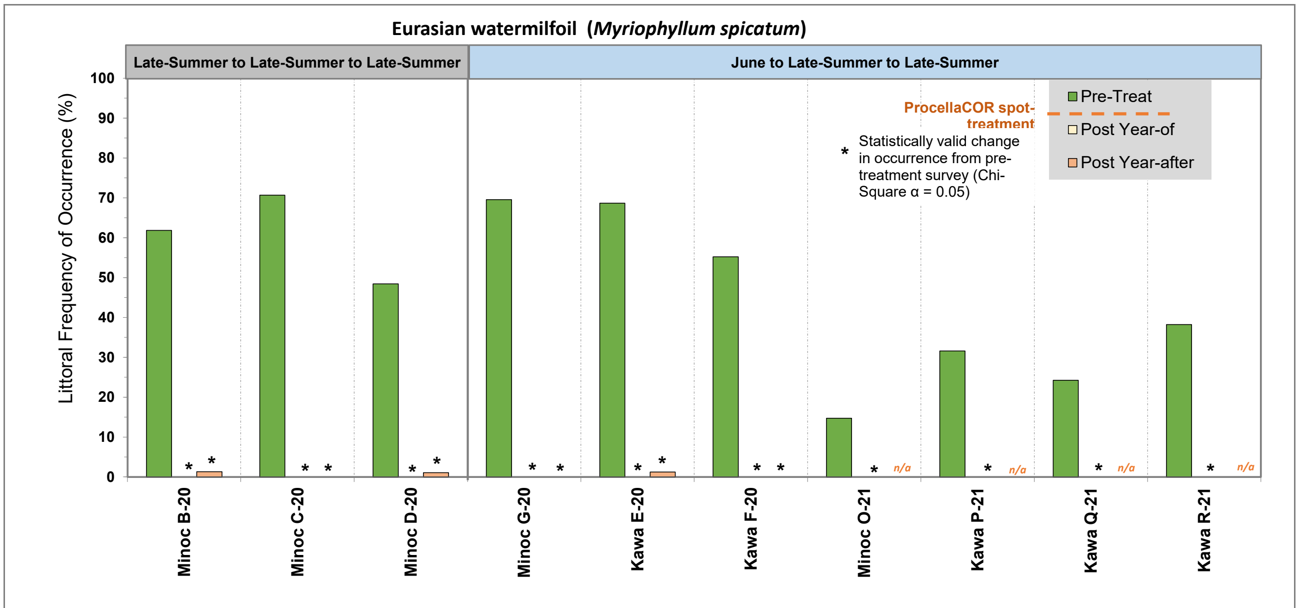
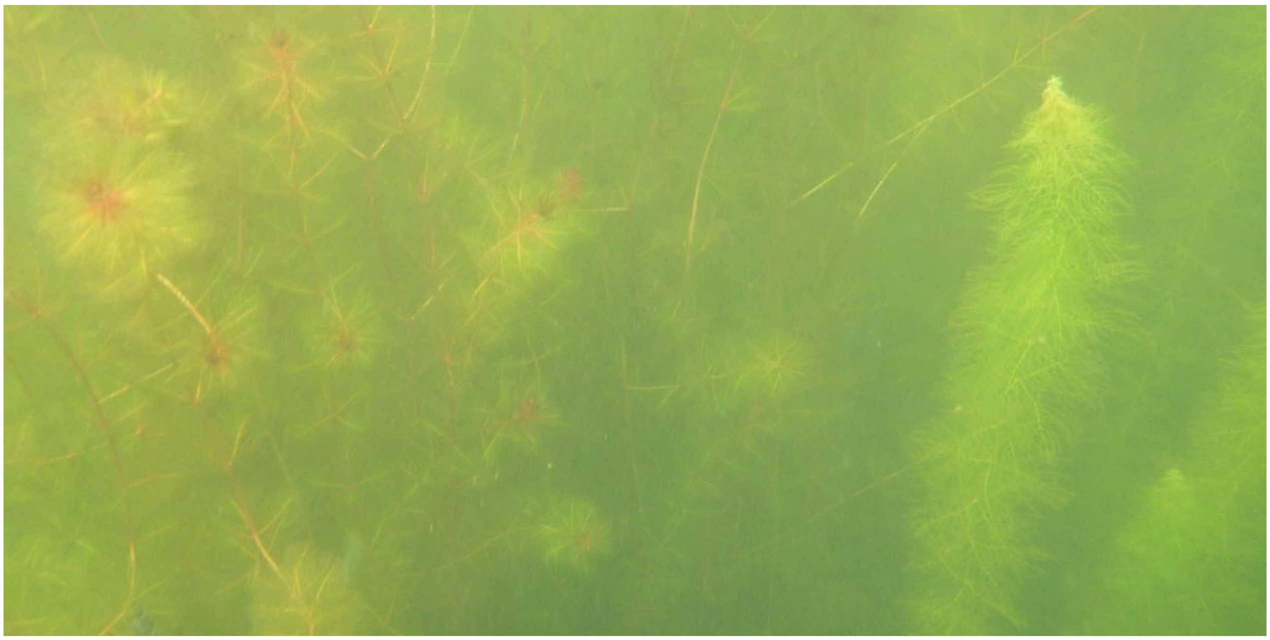


Figure 3.2-1. Frequency of occurrence of Eurasian watermilfoil within 2020-2021 treatment sites.

Northern watermilfoil is closely related to EWM, even being able to cross pollinate and form hybrid varieties. Northern watermilfoil is often growing alongside EWM and is also sensitive to this form of herbicide treatments (Photo 3.2-1). In all treatment sites except P-21, northern watermilfoil populations were reduced to zero during the *year after treatment* (Figure 3.2-2). Northern watermilfoil populations continue to be zero or near-zero within all sites that have progressed to the *year after treatment.*



Photograph 3.2-1. Eurasian watermilfoil (left) and northern watermilfoil (*right*). Photo credit Onterra.

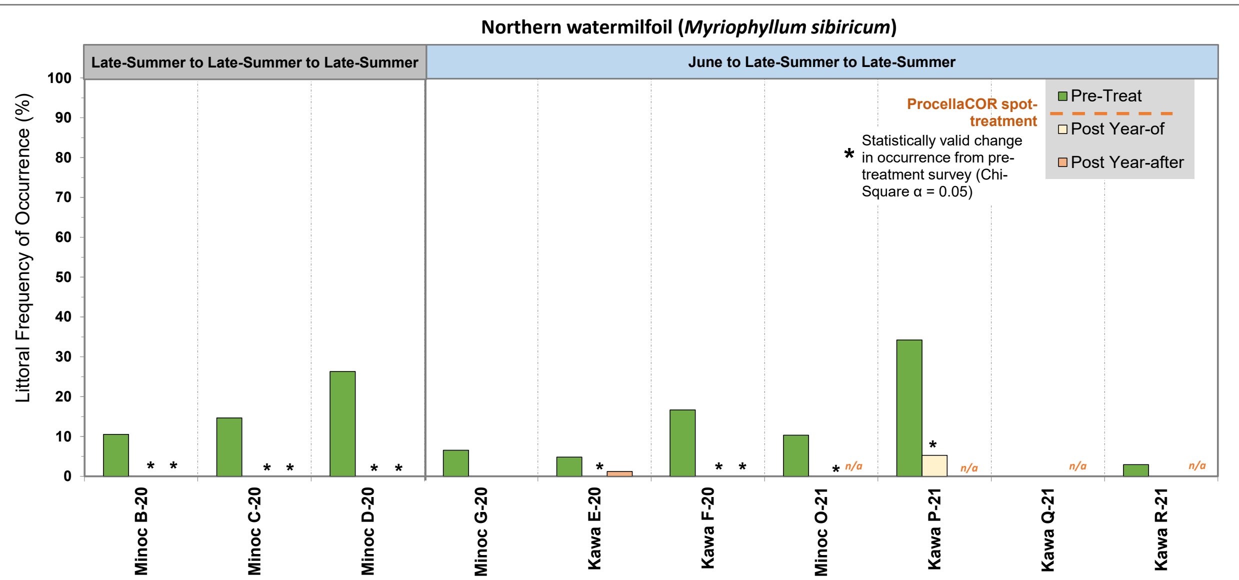
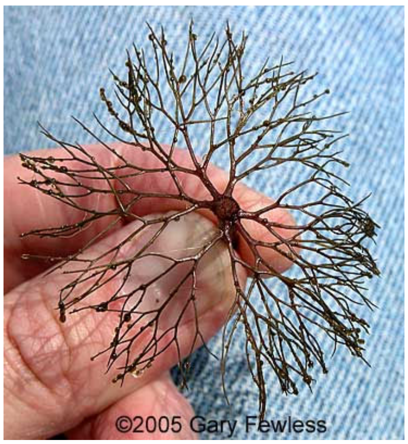


Figure 3.2-2. Frequency of occurrence of northern watermilfoil within 2020-2021 treatment sites.

Onterra's experience monitoring over three dozen ProcellaCOR™ treatments within the state during 2019-2021 indicates that EWM/HWM control has been high with almost no HWM being located during the summer post treatment surveys. Within these treatments, native plant impacts have been almost exclusive contained to sensitive dicot species such as northern watermilfoil, water marigold, and coontail. The subsequent discussion will investigate the herbicide response of some of the most common aquatic plant species in Minocqua and Kawaguesaga Lakes (Photo 3.2-2)

Water marigold (*Bidens beckii*)	Coontail (*Ceratophyllum demersum*)	Common waterweed (*Elodea canadensis*)
		
Fern pondweed (*Potamogeton robbinsii*)	Clasping-leaf pondweed (*Potamogeton richardsonii*)	Wild celery (*Vallisneria americana*)
		

Photograph 3.2-2. Select native plants from Minocqua and Kawaguesaga Lakes Photo credit Onterra unless otherwise indicated.

Water marigold is a broad-leaved (dicot) species that has shown sensitivity to many herbicides that have activity on EWM. This species has a bushy appearance often on a single stem, resembling a watermilfoil species. Prior to treatment, water marigold (*Bidens beckii*) was found in low abundance in most of the treatment sites. This species was only found in one post treatment survey (Figure 3.2-3).

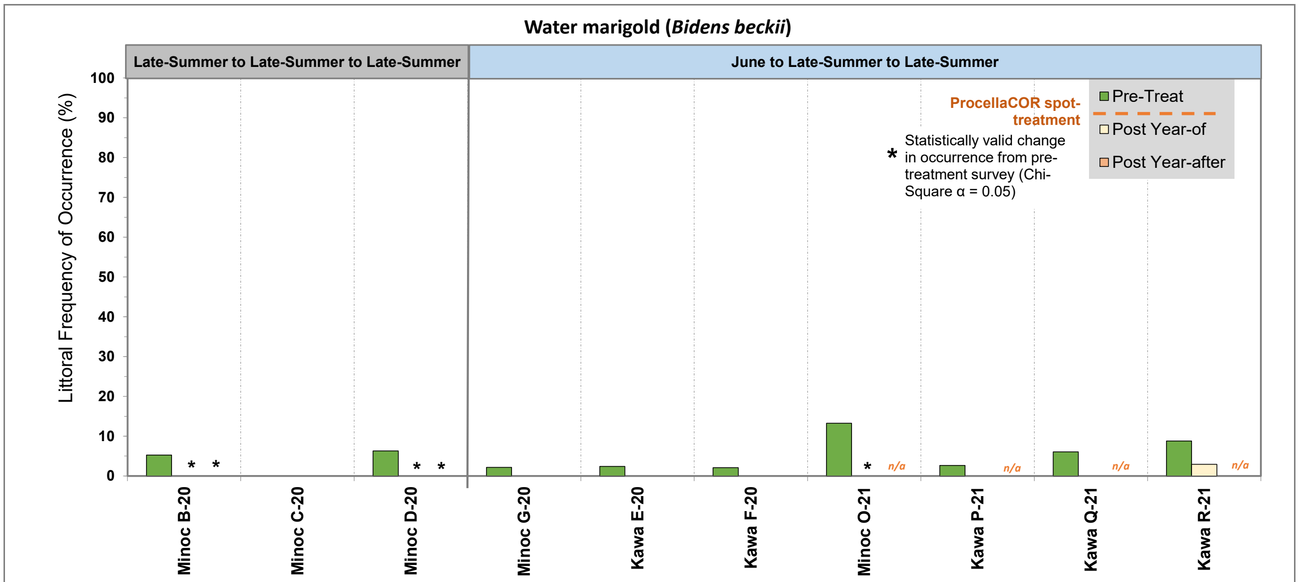


Figure 3.2-3. Frequency of occurrence of northern watermilfoil within 2020-2021 treatment sites.

Coontail is another dicot species shown to have sensitivity to ProcellaCOR™ treatments. Unlike most of the submersed plants found in Wisconsin, coontail does not produce true roots and is often found growing entangled amongst other aquatic plants or matted at the surface. Coontail populations were reduced in most of the treatment sites during the *year of treatment* (Figure 3.2-4). Populations of this species continued to decline in all of the 2020 treatment sites during the *year after treatment*.

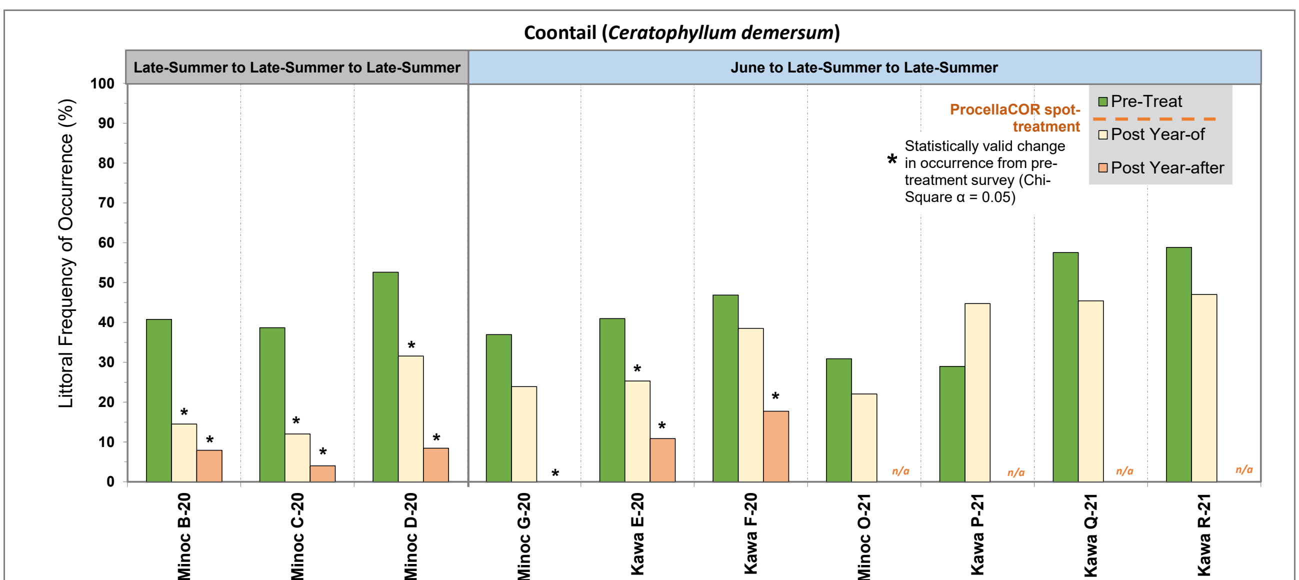


Figure 3.2-4. Frequency of occurrence of coontail within 2020-2021 treatment sites.

Like coontail, common waterweed does not contain true roots and obtains the majority of its nutrients directly from the water. While common waterweed can be found growing in many of Wisconsin's waterbodies, excessive growth of common waterweed is often observed in waterbodies with higher nutrients. It can tolerate the low light conditions found in eutrophic systems better than many other aquatic plant species. For these reasons, common waterweed has competitive advantages over other aquatic plant species that favor its growth in productive systems. When looking at the data that contains a late-summer pretreatment survey, common waterweed populations dipped during the *year of treatment*, but recovered at least to pretreatment levels during the *year after treatment* (Figure 3.2-5). Common waterweed populations within the remainder of the treatment sites remained the same or increased following treatment.

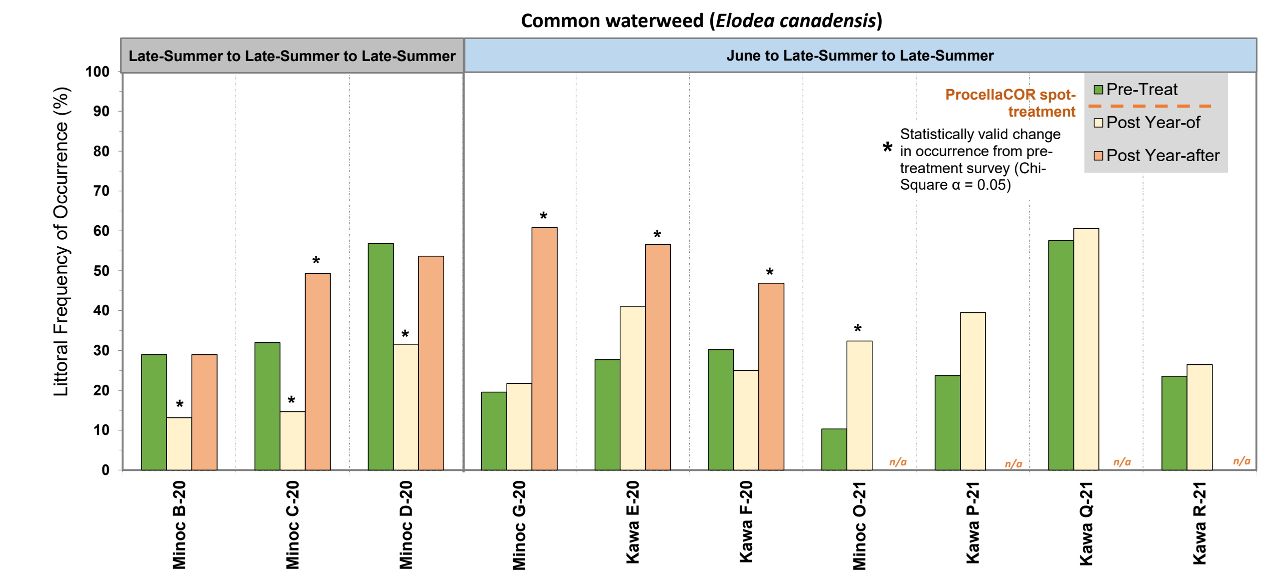


Figure 3.2-5. Frequency of occurrence of common waterweed within 2020-2021 treatment sites.

Many native pondweed species are present from the Minocqua-Kawaguesaga system. Fern pondweed and clasping-leaf pondweed were the most abundant pondweeds within the 2020 and 2021 herbicide treatment sites. Fern pondweed is generally found growing in thick beds over soft substrates where it stabilizes bottom sediments and provides a dense network of structural habitat for aquatic wildlife. Fern pondweed populations were largely unimpacted by the herbicide treatment program (Figure 3.2-6).

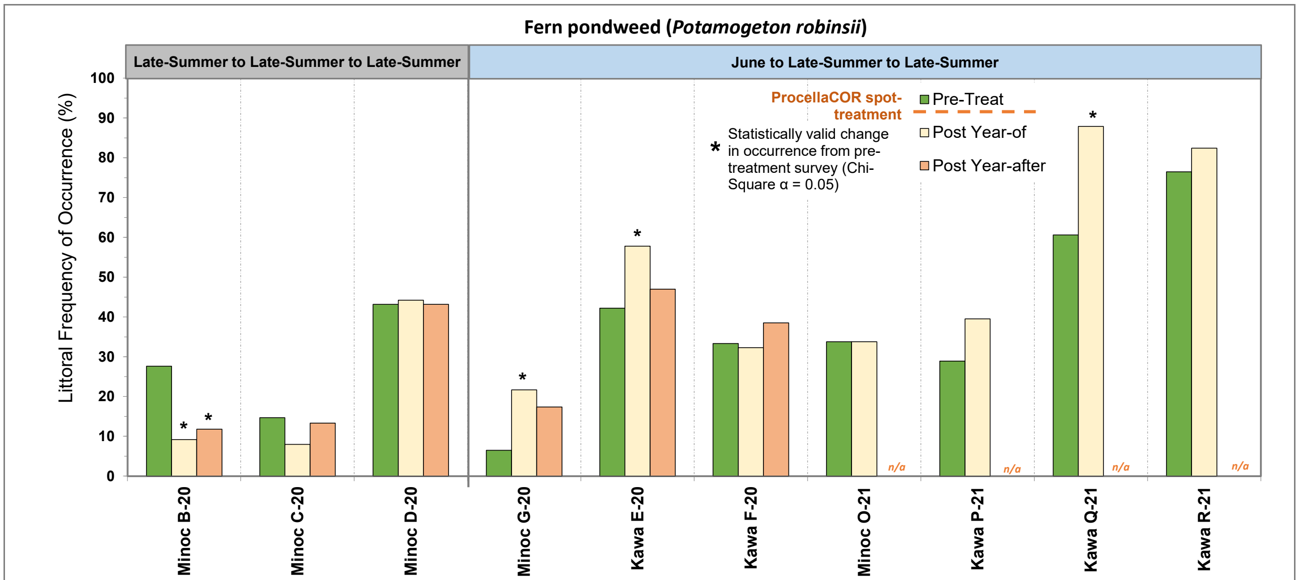


Figure 3.2-6. Frequency of occurrence of fern pondweed within 2020-2021 treatment sites.

Clasping-leaf pondweed grows tall in the water column and provides excellent habitat for aquatic life throughout the growing season. Clasping-leaf pondweed populations increased in most of the sites following treatment, especially when the *pretreatment* survey was conducted during mid-June during the year of treatment (Figure 3.2-7). This suggests that the population increases could potentially be from continued population expansion between the time of the June and late-summer post treatment survey as opposed to some kind of competitive release as plants compete in a site newly devoid of EWM after the herbicide treatment.

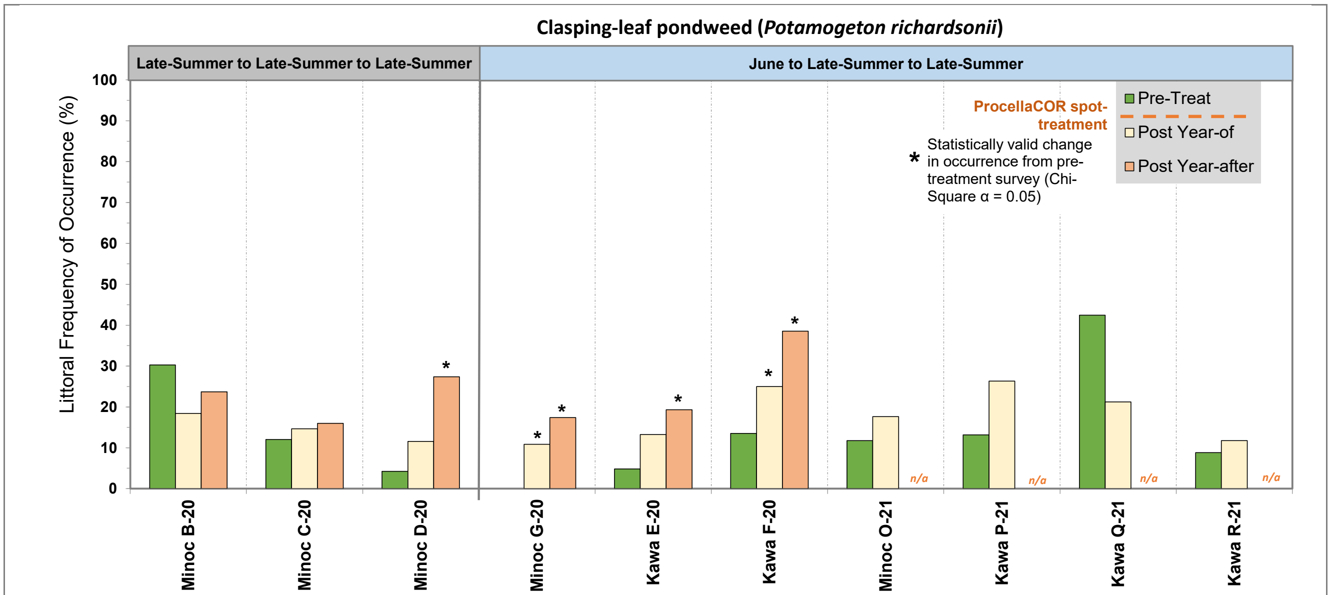


Figure 3.2-7. Frequency of occurrence of clasping-leaf pondweed within 2020-2021 treatment sites.

Wild celery, or tape grass, produces long linear leaves which originate from a basal rosette. Later in summer, numerous seeds are produced which serve as an important source of food for migratory waterfowl and other wildlife. The plant's extensive network of rhizomes stabilizes bottom sediments. Wild celery emerges a little later than many native plant species and perhaps is dormant during the herbicide treatment and thus less susceptible to impacts from this herbicide. Wild celery populations also increased following many of the herbicide treatments and continued to increase during many of the *year after treatment* survey (Figure 3.2-8).

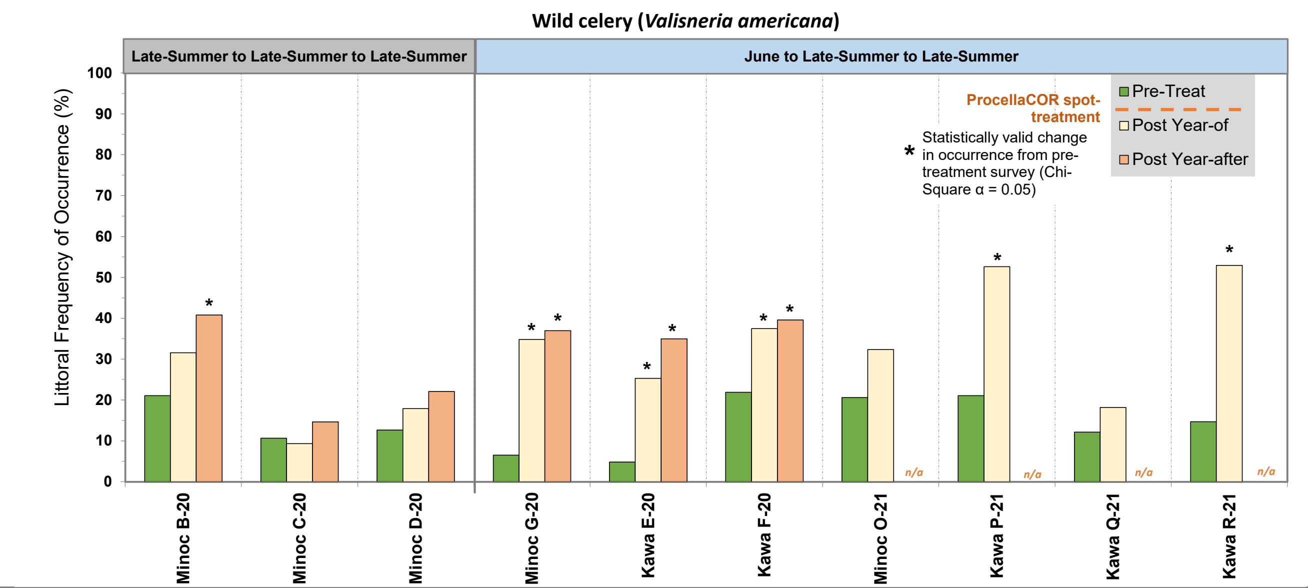


Figure 3.2-8. Frequency of occurrence of wild celery within 2020-2021 treatment sites.

3.3 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 and in the Areas of Potential Impact (AOPI) in the hours and days after treatment. Samples were collected by volunteer members of the MKLPA 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 C

Figure 3.3-1 and Figure 3.3-2 display the results of the post treatment herbicide concentration monitoring. The data are shown in parts per billion of florpyrauxifen-benzyl acid equivalent (ae), which one product dosing unit (PDU) equals a little under 2 ppb (1.926)

Weak-acid herbicides, like those used in the past on the Minocqua Chain (i.e. 2,4-D), are known to quickly dissipate from the application area. When these herbicides dissipate out of the treatment site and reach an equilibrium within a bay or basin of a system (AOPI), the concentrations and exposure times are typically insufficient to cause any meaningful impacts. Because ProcellaCOR™ can produce plant impacts at lower concentrations relative to the application rate, lake managers are mindful of the concentration potential within an AOPI. For the 2022 treatments on Kawaguesaga Lake, several AOPI scenarios were considered including the small bays which the sites were contained (grey and black shaded areas on inset map), as well as the southern part of the lake south of the islands (green hatched area on inset map) (Figure 3.3-1). The overall strategy considered the potential bay-wide concentrations with purposeful targets between 0.2-0.3 ppb ae.

Sites Q-21 and R-21 were contained within the western bay, with a predicted potential AOPI concentration of 0.31 ppb (grey dashed line). The measured concentrations at K4 reached 0.25 ppb at 48 HAT, falling close but slightly less than predictions. The concentrations at K5 within the southern bay that contained P-21 was around 0.22-0.23 ppb at 9-24 HAT, consistent with the predicted target of 0.22 ppb (black dashed line) in this bay. When the herbicide from all three of these treatment sites mixed within the bay south of roughly Beer Can Island (green hatched area on inset map), the measured concentrations met expectations (green dashed line). Unlike the concentrations achieved in the small bays (black and grey shaded areas on inset map), it is unclear if this lower concentration would be sufficient to cause EWM impacts throughout this AOPI. It is interesting to note that the average concentrations from within the application areas shown in the red dashed data line, is relatively similar to the AOPI concentrations. This suggests that aside from the initially high concentrations at the time of application, which are extremely difficult to capture during sampling, the concentrations within the sites were the same as the concentrations within the entire AOPI.

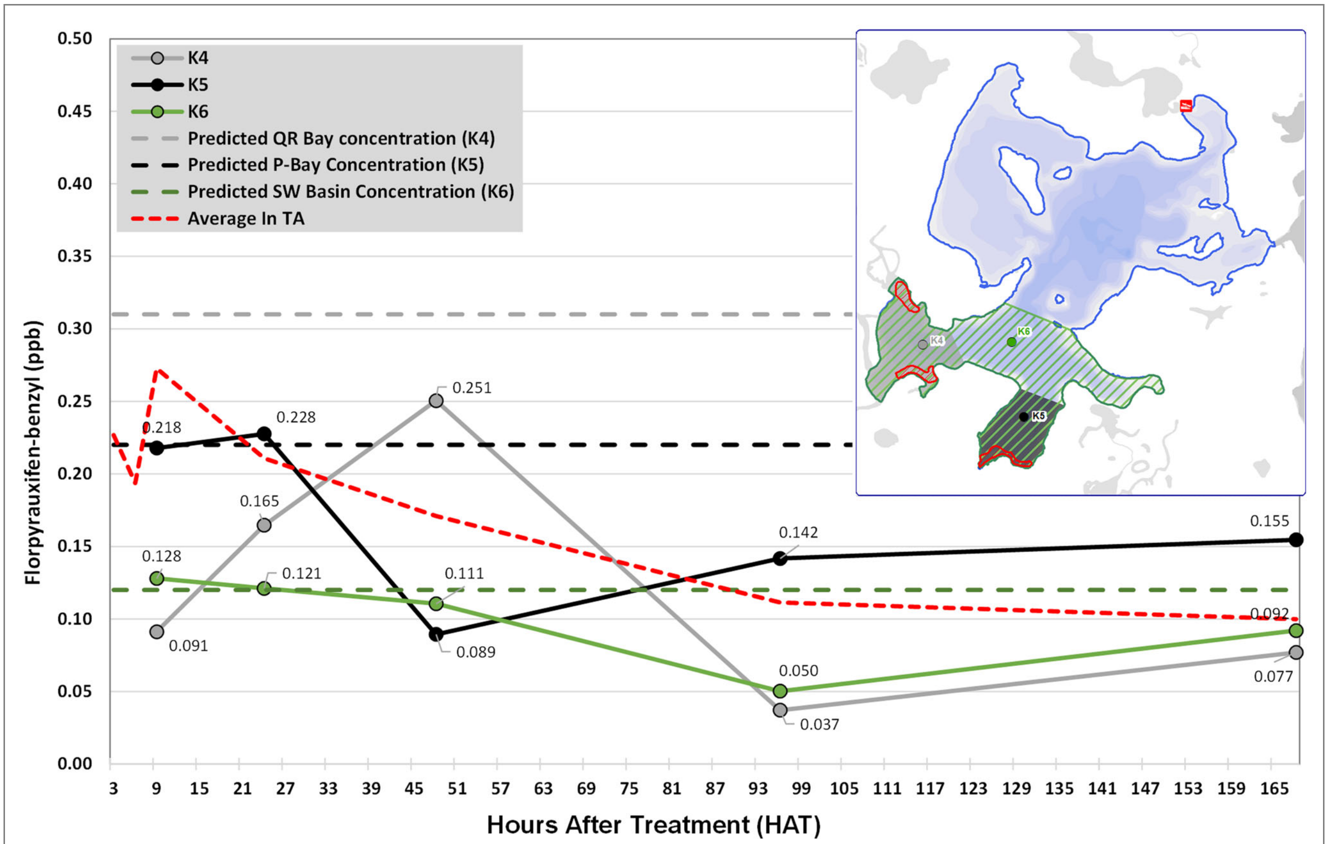


Figure 3.3-1. Herbicide concentration monitoring results following a 2021 florpyrauxifen-benzyl (ProcellaCOR™) treatment in Kawaguesaga Lake. .

For the Minocqua treatment of O-21, the target concentration was 4 PDU/acre-ft or 7.7 ppb ae. Herbicide concentrations at 3 hours after treatment (HAT) were found to be well below application rate targets, which is typical for this type of spot treatment. M1 was slightly more protected and had higher concentrations (Figure 3.3-2). Concentrations at 48hrs within the application area was slightly greater than the concentration at the untreated M3 location. The concentration at this location likely represents the mixed concentration within Stack's Bay. The potential predicted concentration within Stack's Bay was 0.21 ppb, but concentrations did not come close to these levels likely as this area is not confined by a narrow constriction and has constant water flow. Herbicide concentrations were below detection limits at M4 in the larger basin of Minocqua Lake at all sampling intervals.

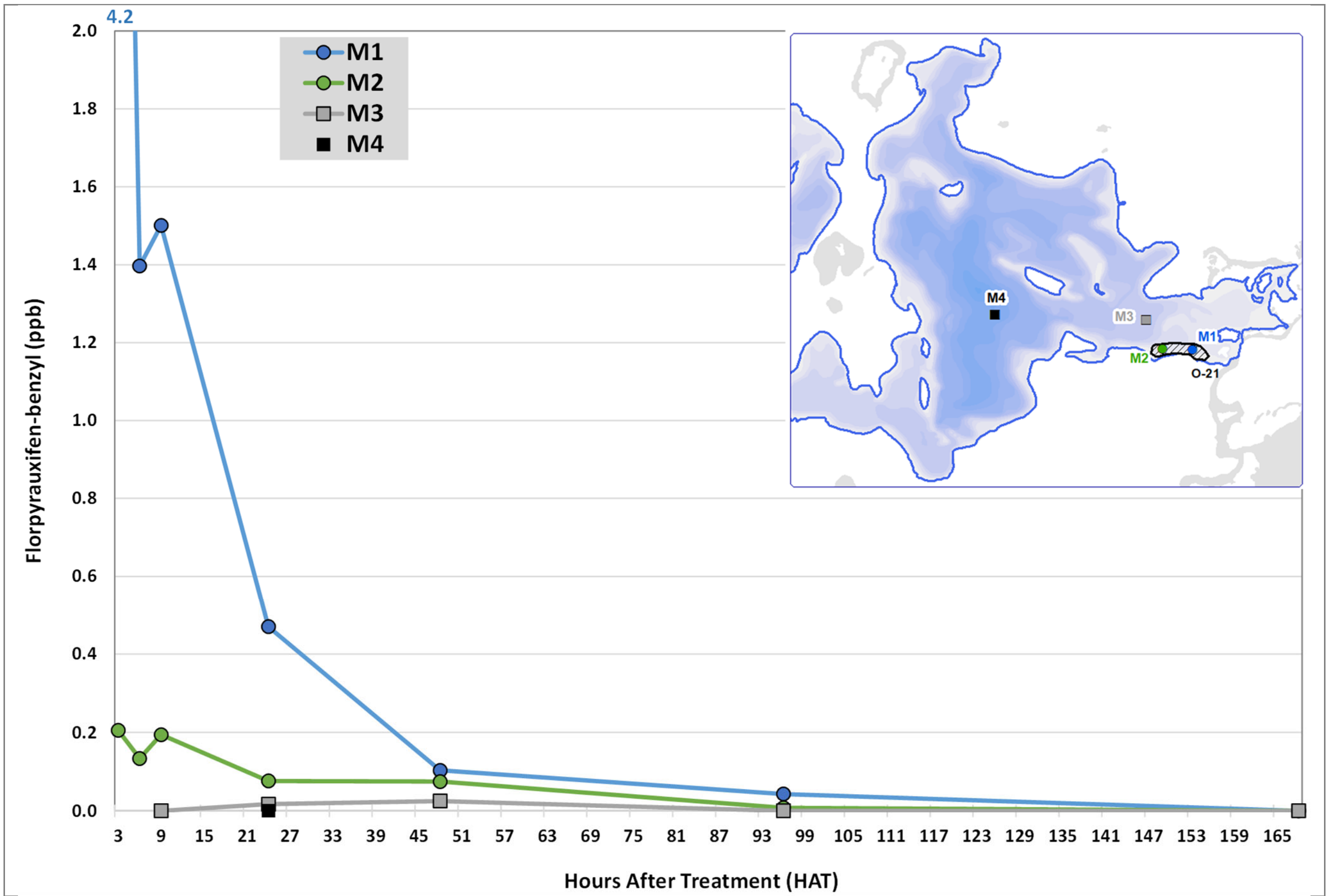


Figure 3.3-2. Herbicide concentration monitoring results following a 2021 florpyrauxifen-benzyl (ProcellaCOR™) treatment in Kawaguesaga Lake. .

3.0 CONCLUSIONS & DISCUSSION

The coordination and implementation of the 2020 and 2021 EWM management strategies were completed as planned for the Minocqua-Kawaguesaga Lakes System with collaboration from several project partners including the MKLPA, WDNR, Aquatic Plant Management, Schmidt's Aquatic, SePRO, and Onterra. Volunteer efforts provided by the MKLPA were instrumental in the completion of the post treatment herbicide concentration monitoring associated with the herbicide treatments.

Monitoring of the 2020 herbicide treatment sites confirmed EWM reductions were sustained during the *year after treatment*, demonstrating that these target plants were likely killed by the treatment. The 2021 herbicide treatments show promising results during the *year of treatment* with reductions in EWM demonstrated through comparative mapping surveys and point-intercept sub-sampling surveys. Continued monitoring of the 2021 treatments in 2022 will assist in understanding if success expectations were achieved.

Divers spent over 185 hours underwater in 2021 removing EWM, with the majority of time spent targeting EWM rebounding from previous herbicide treatment efforts. The MKLPA continues to be committed to their Integrated Pest Management (IPM) Plan, using manual removal efforts to preserve the gains made by herbicide treatment.

The overall impacts to the native plant populations appear to be confined primarily to northern watermilfoil and other sensitive broad-leaved (dicot species) such as water marigold and to a lesser extent, coontail. Some native aquatic plants are currently at similar levels to pretreatment and others are greater than pretreatment. A replication of the mapping survey and sub-sample point-intercept survey is proposed for 2022 and will allow for an understanding of the longer-term efficacy of the 2021 treatments as well as an assessment of the native plant communities population dynamics and recovery one year after treatment.

The impacts of ProcellaCOR™ dissipation and degradation in lakes after treatment continues to be investigated. Data collected on Minocqua and Kawaguesaga Lakes in 2020-2021 have been extremely valuable for scientists and lake managers as they strive for effective treatments with predictable selectivity towards native plants. This report highlights some of the data used for lake management purposes; with additional levels of data emerging from these investigations such as the concentrations of ProcellaCOR™ break-down products.

3.1 2021 EWM Monitoring & Management Strategy Development

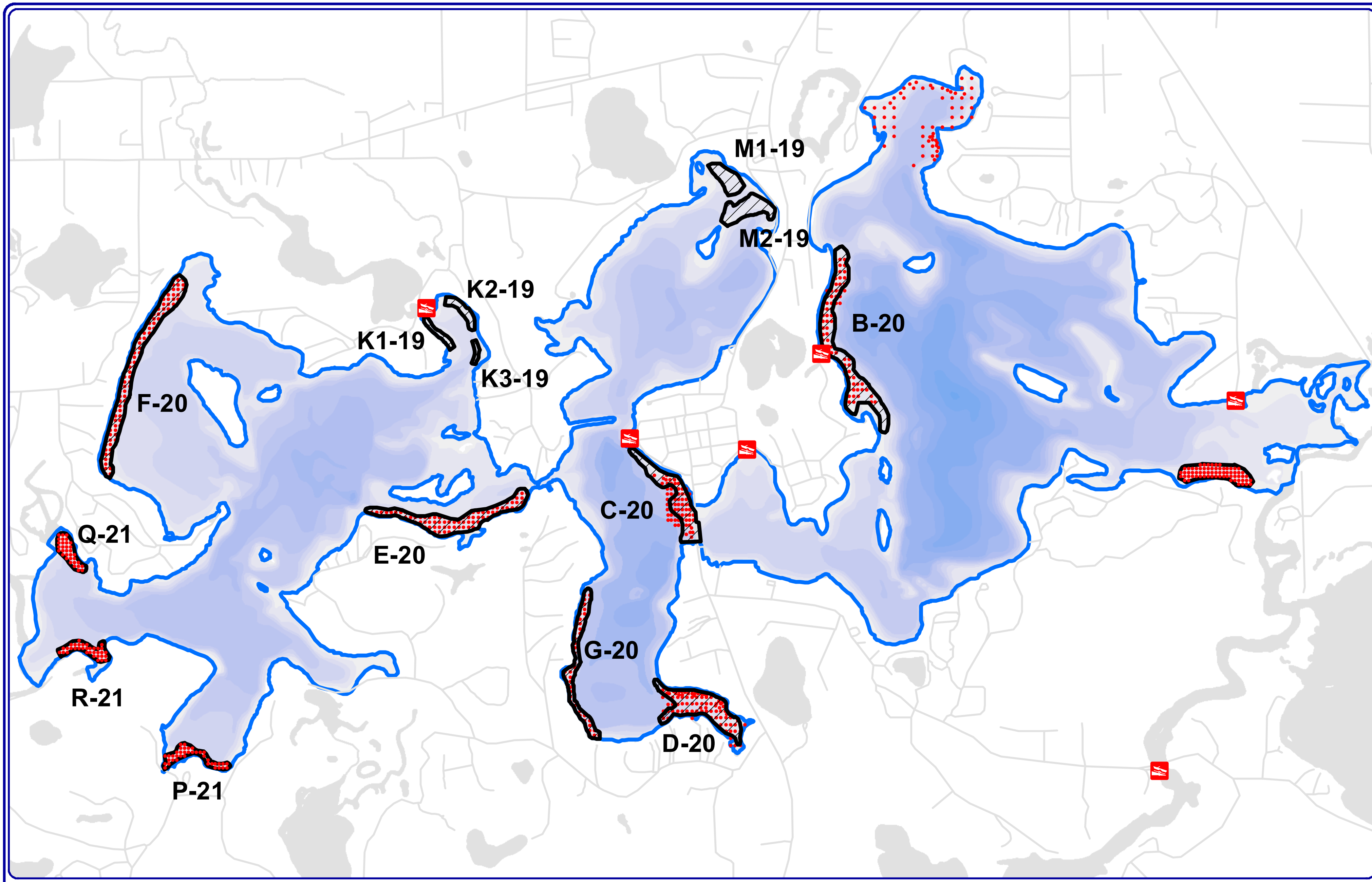
The MKLPA intends to maintain an aggressive approach to EWM management over the upcoming years following an adaptive management framework. With minimal acreage on the system containing colonized EWM, no herbicide treatments are being considered for 2022. The MKLPA, working with Onterra and Aquatic Plant Management, has developed a prioritized hand-harvesting strategy that considers the following locations in this order:

- 2019-2021 herbicide treatment areas
- EWM mapped as polygons during the 2021 Late-Season EWM Mapping Survey
- EWM mapped as *small plant colonies* during the 2021 Late-Season EWM Mapping Survey
- Rebounding EWM that is high-density and in areas of high boat traffic
- Rebounding EWM that is low-density and in areas of low boat traffic

The manual removal strategy will apply both traditional hand-harvesting and DASH techniques in situations that lend themselves best to each technique. Areas targeted with DASH efforts require WNDR permitting aspects. The overall goal of the hand-harvesting program is to keep EWM below levels that warrant herbicide treatment. Colonized areas of EWM are anticipated to be reduced to EWM only mapped with point-based techniques when comparing annual late-summer EWM mapping surveys. Areas containing only point-based EWM occurrences would be deemed successful if no or very little EWM is found after hand-harvesting takes place.

The term *Best Management Practice (BMP)* is often used in environmental management fields to represent the management option that is currently supported by that latest science and policy. When used in an action plan, the term can be thought of as a placeholder with anticipation of having an evolving definition over time. Best Management Practices for aquatic plant management change rapidly, as new information about effectiveness, non-target impacts, and risk assessment emerges. To be eligible to apply for grants that provide cost share for AIS control and monitoring, “a current plan has a completion date of no more than five years prior to submittal of the recommendation for approval. The department may determine that a longer lifespan is appropriate for a given management plan if the applicant can demonstrate it has been actively implemented and updated during its lifespan.

The MKLPA successfully applied for a series of WDNR grant funds to update their Aquatic Plant Management Plan as it relates to EWM during 2022-2023. This will allow the association to incorporate lessons learned since the previous plan was approved by the WDNR in January 2017. Main components of the project include whole-lake point-intercept aquatic plant surveys on Minocqua and Kawaguesaga Lakes, which were last conducted on the system in 2017. The association will also be soliciting riparian perceptions through a stakeholder survey. Following the 2022 field season, the association will hold a series of strategic planning committee meetings to revisit EWM management goals and association actions employed to reach their goals.



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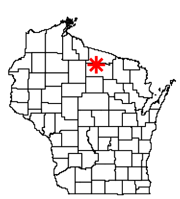


Project Location in Wisconsin

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

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR,1972 -digitized by Onterra
Orthophoto: NAIP, 2017
Aquatic Plants: Onterra, 2019
Map Date: June 5, 2020

Legend

2019-2021 Herbicide Application Area

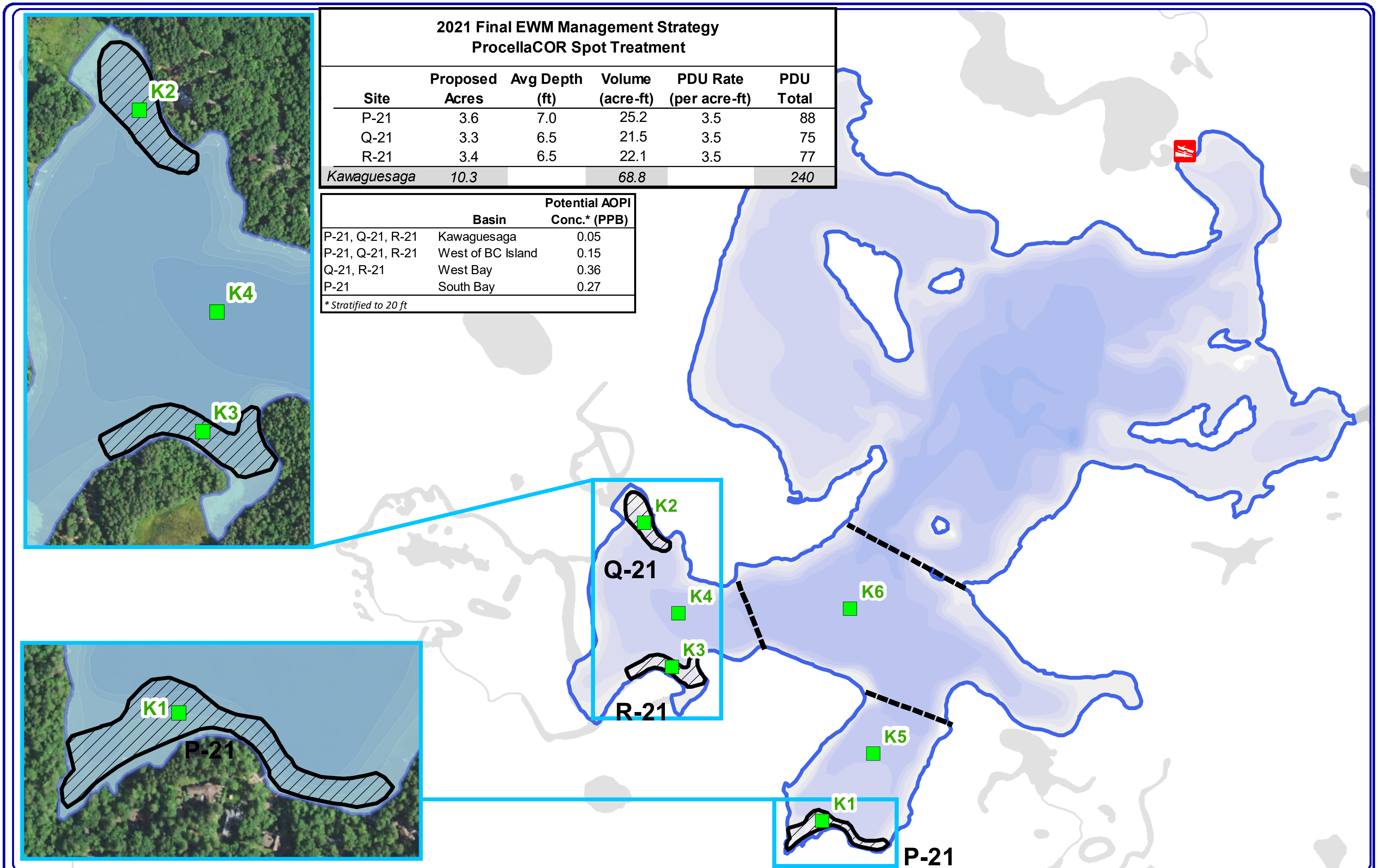
2020-2021 Sub-Sample Point-Intercept Location

Map 1

Minocqua Lake

Oneida, Wisconsin

2019-2021 Final EWM Treatment Areas



2021 Final EWM Management Strategy
ProcellaCOR Spot Treatment

Site	Proposed Acres	Avg Depth (ft)	Volume (acre-ft)	PDU Rate (per acre-ft)	PDU Total
P-21	3.6	7.0	25.2	3.5	88
Q-21	3.3	6.5	21.5	3.5	75
R-21	3.4	6.5	22.1	3.5	77
Kawaguesaga	*10.3*		*68.8*		*240*

	Basin	Potential AOPI Conc.* (PPB)
P-21, Q-21, R-21	Kawaguesaga	0.05
P-21, Q-21, R-21	West of BC Island	0.15
Q-21, R-21	West Bay	0.36
P-21	South Bay	0.27

** Stratified to 20 ft*

Legend

Final Herbicide Application Area

Herbicide Concentration Monitoring Location

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Lake Management Planning
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Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR,1972 -digitized by Onterra
Orthophoto: NAIP, 2020
Aquatic Plants: Onterra, 2020
Map Date: June 16, 2021 - EJH

Map 2
Kawaguesaga Lake
Oneida, Wisconsin

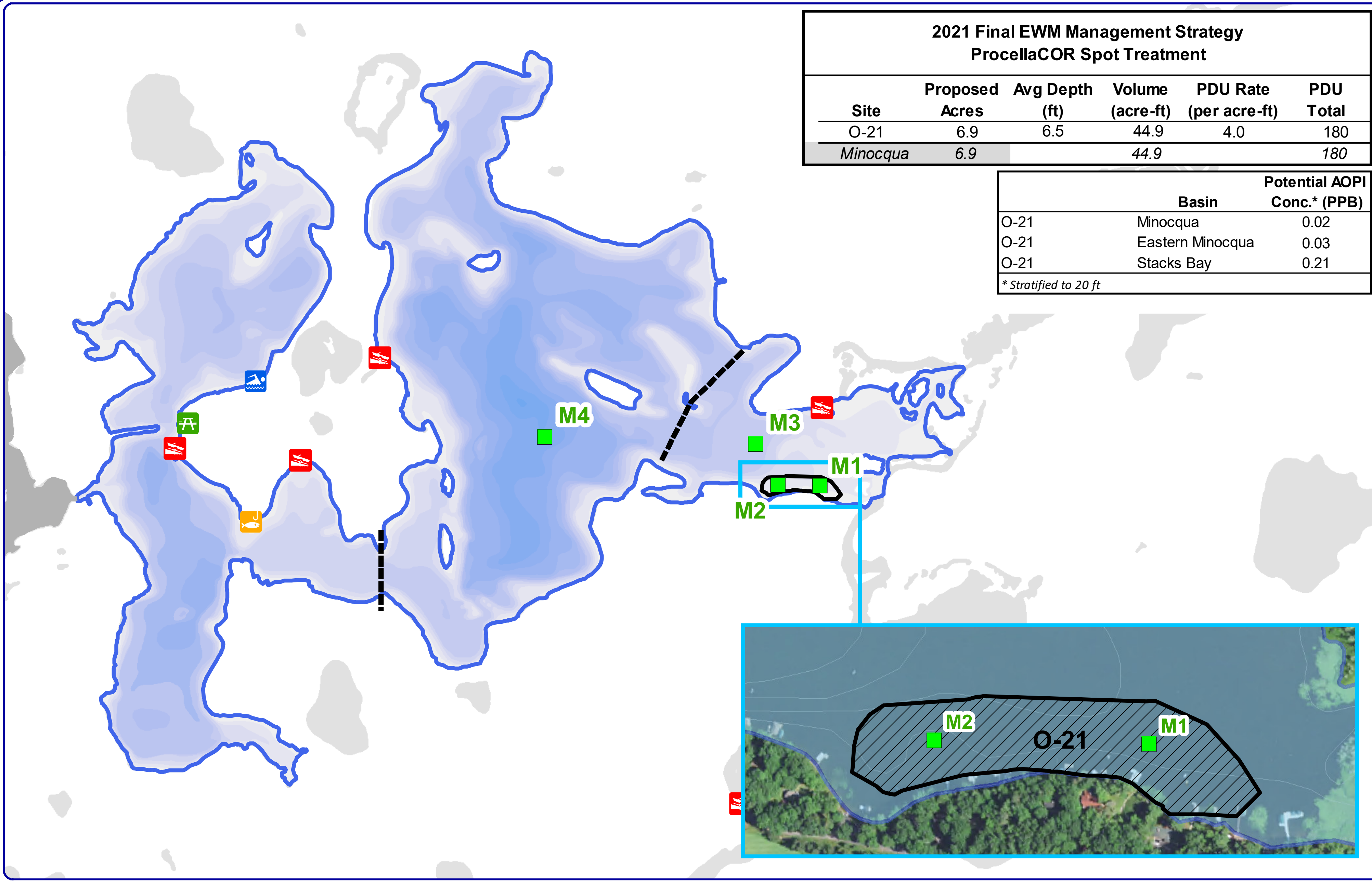
2021 Final EWM Treatment Strategy

2021 Final EWM Management Strategy
ProcellaCOR Spot Treatment

Site	Proposed Acres	Avg Depth (ft)	Volume (acre-ft)	PDU Rate (per acre-ft)	PDU Total
O-21	6.9	6.5	44.9	4.0	180
Minocqua	*6.9*		*44.9*		*180*

	Basin	Potential AOPI Conc.* (PPB)
O-21	Minocqua	0.02
O-21	Eastern Minocqua	0.03
O-21	Stacks Bay	0.21

** Stratified to 20 ft*



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Feet

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Lake Management Planning
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De Pere, WI 54115
920.338.8860
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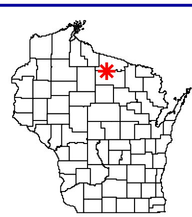
Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR,1972 -digitized by Onterra
Orthophoto: NAIP, 2020
Aquatic Plants: Onterra, 2020
Map Date: June 16, 2021 - EJH



Project Location in Wisconsin

Legend

Final Herbicide Application Area

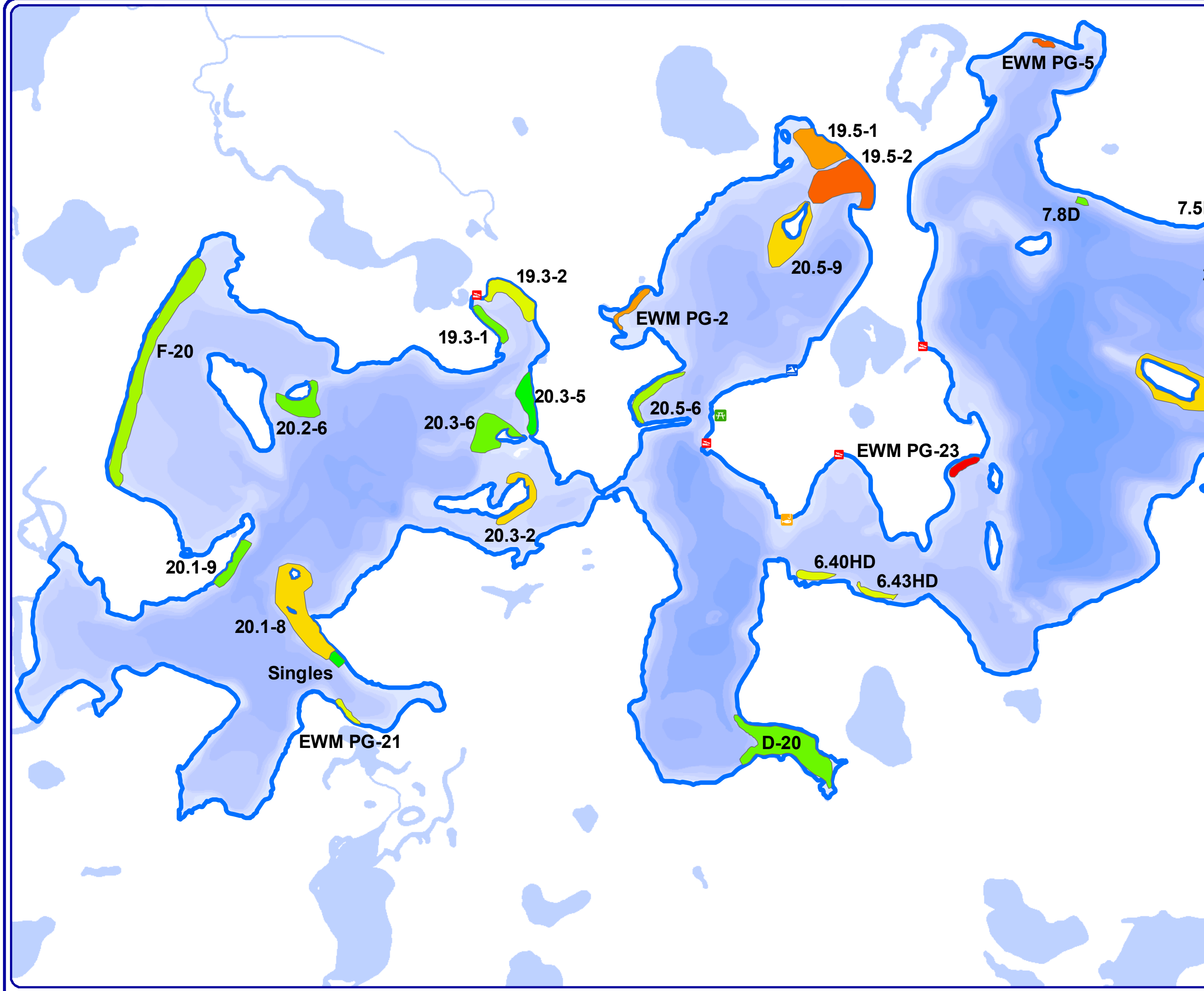
Herbicide Concentration Monitoring Location

Map 3

Minocqua Lake

Oneida, Wisconsin

2021 Final EWM Treatment Strategy



Dive Location	Underwater Dive Time (hrs)	AIS Removed (cubic ft)
19.3-1	0.66	2.5
19.3-2	3.34	4.0
19.5-1	8.93	23.0
19.5-2	24.40	103.0
20.1-8	4.24	7.5
20.1-9	0.50	1.0
20.2-6	0.50	0.5
20.3-2	4.99	21.0
20.3-5	0.16	1.0
20.3-6	0.34	1.0
20.5-6	0.91	3.0
20.5-9	6.18	14.0
20.7-6	1.41	2.0
20.8-2	5.67	38.0
6.40HD	2.66	3.0
6.43HD	2.33	4.0
7.2D	1.00	6.0
7.3D	3.25	9.5
7.5D	1.42	3.0
7.8D	0.50	1.0
8.1D	3.00	5.0
8.2HD	0.42	0.5
8.3D	1.33	3.0
8.5D	6.00	12.0
8.7HD	3.75	7.5
D-20	0.42	1.5
F-20	1.07	3.5
PG-2	11.50	23.5
PG-21	2.08	0.5
PG-23	57.48	283.0
PG-5	24.76	60.5
Singles east of 20.1-8	1.42	4.0
Total	**186.62**	**652.5**

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2,250

Feet

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Lake Management Planning
815 Prospect Road
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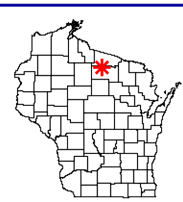
Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR,1972
- digitized by Onterra
Aquatic Plants: Onterra, 2021
HH: APM, 2021
Map Date: March 21, 2022



Project Location in Wisconsin

Legend

Hand-Removal Time (hours)

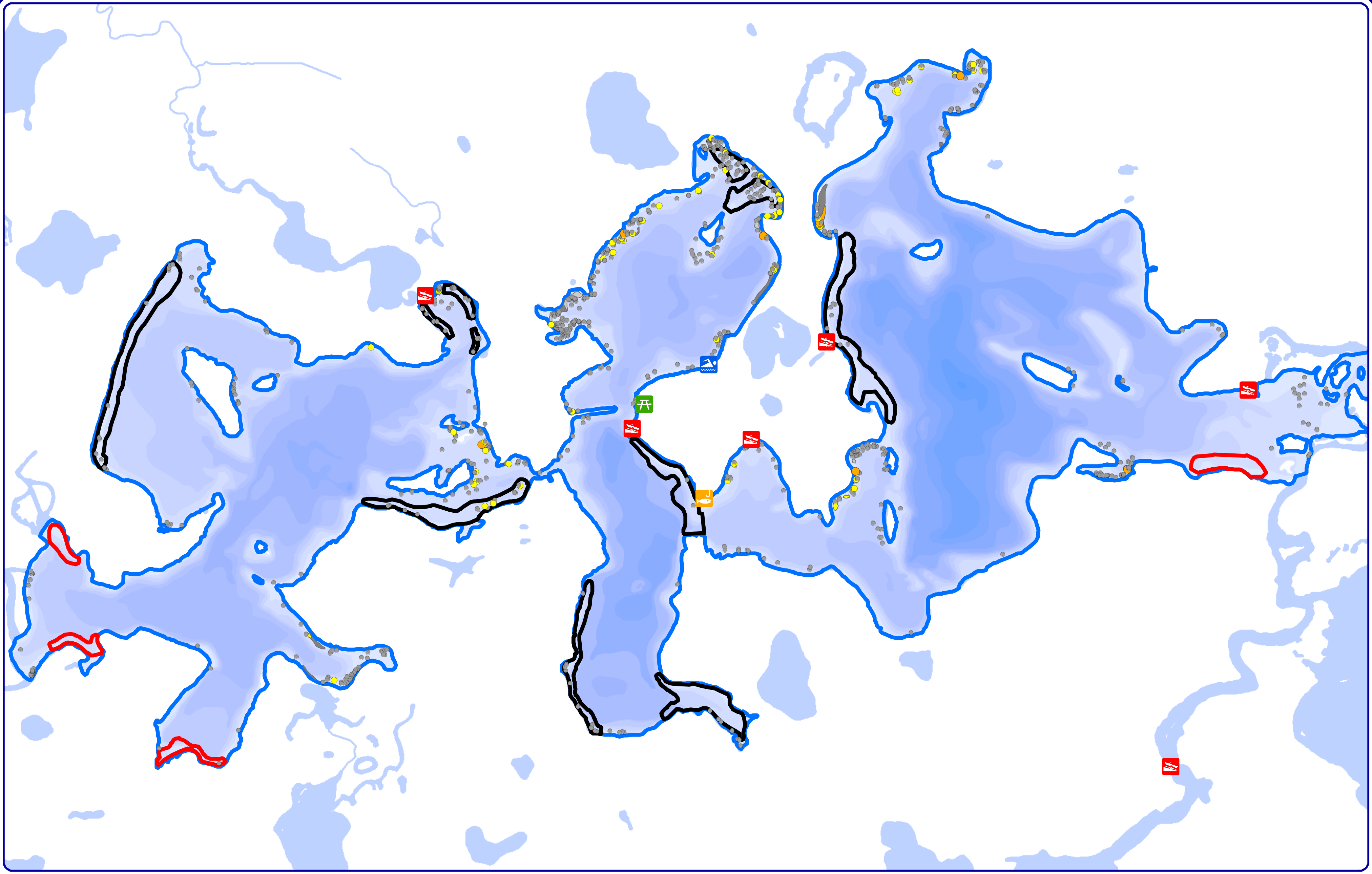
0 | 0.2 | 0.7 | 1.4 | 3.8 | 6.2 | 11.5 | 24.8 | 57.5

Map 4

Minocqua & Kawaguesaga

Oneida, Wisconsin

2021 Final EWM Hand-Harvest Areas



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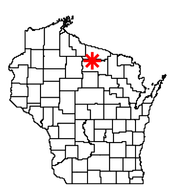
Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR,1972 -digitized by Onterra
Aquatic Plants: Onterra, 2021
Map Date: September 30, 2021 - EJH



Project Location in Wisconsin

Legend

EWM Survey Results (September 8,9,16, 2021)

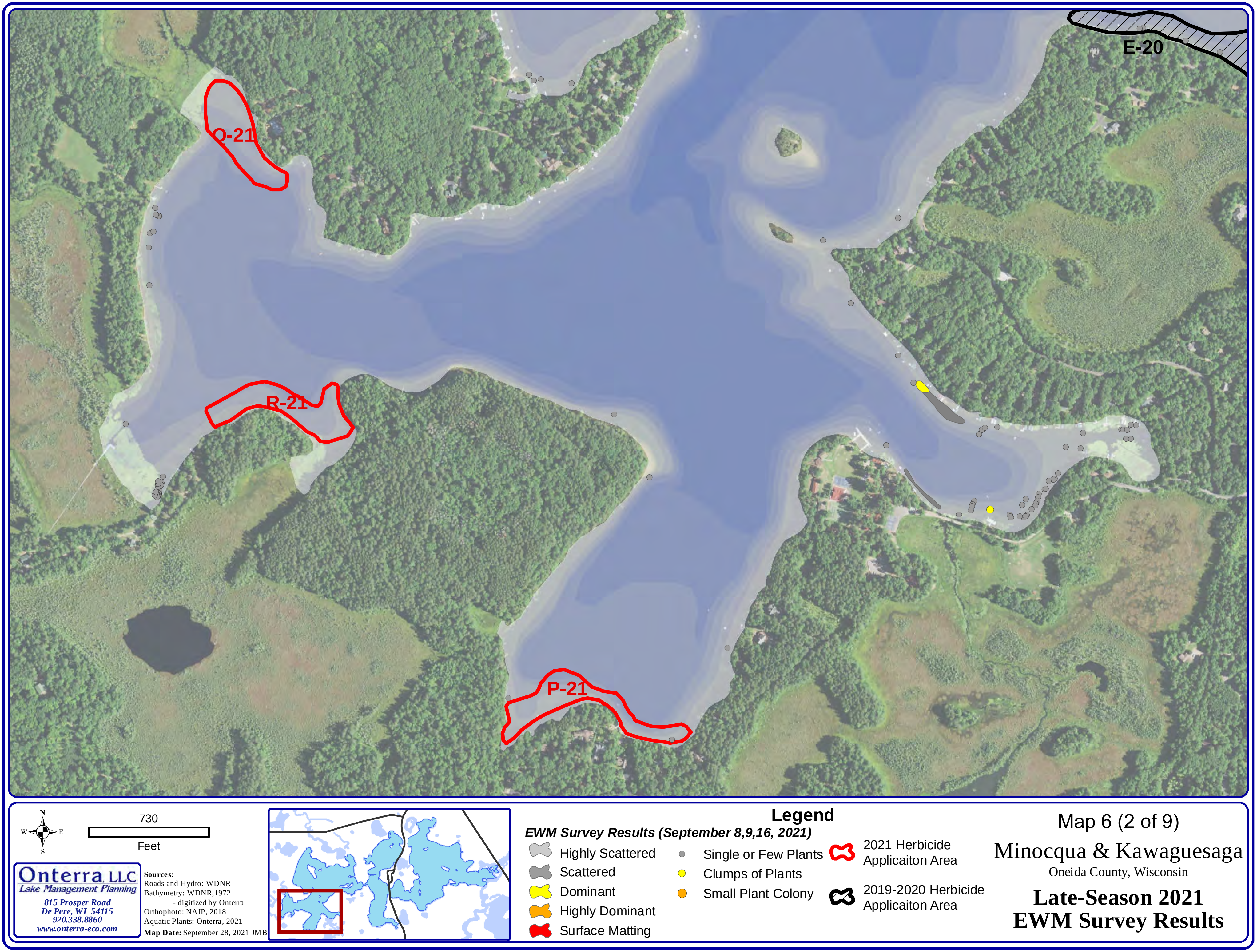
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2021 Herbicide Applicaiton Area
- 2019-2020 Herbicide Applicaiton Area

Map 5 (1 of 9)

Minocqua & Kawaguesaga

Oneida, Wisconsin

September 2021
EWM Survey Results



E-20
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P-21
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Onterra, LLC
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
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Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, 1972
- digitized by Onterra
Orthophoto: NAIP, 2018
Aquatic Plants: Onterra, 2021
Map Date: September 28, 2021 JMB
Legend
EWM Survey Results (September 8,9,16, 2021)
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony
2021 Herbicide Applicaiton Area
2019-2020 Herbicide Applicaiton Area
Map 6 (2 of 9)
Minocqua & Kawaguesaga
Oneida County, Wisconsin
Late-Season 2021
EWM Survey Results

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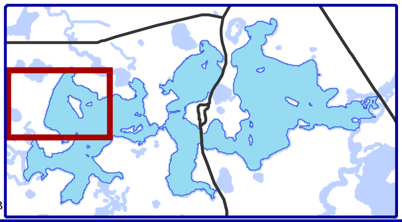
Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR,1972
- digitized by Onterra
Orthophoto: NAIP, 2018
Aquatic Plants: Onterra, 2021
Map Date: September 28, 2021 JMB



Legend

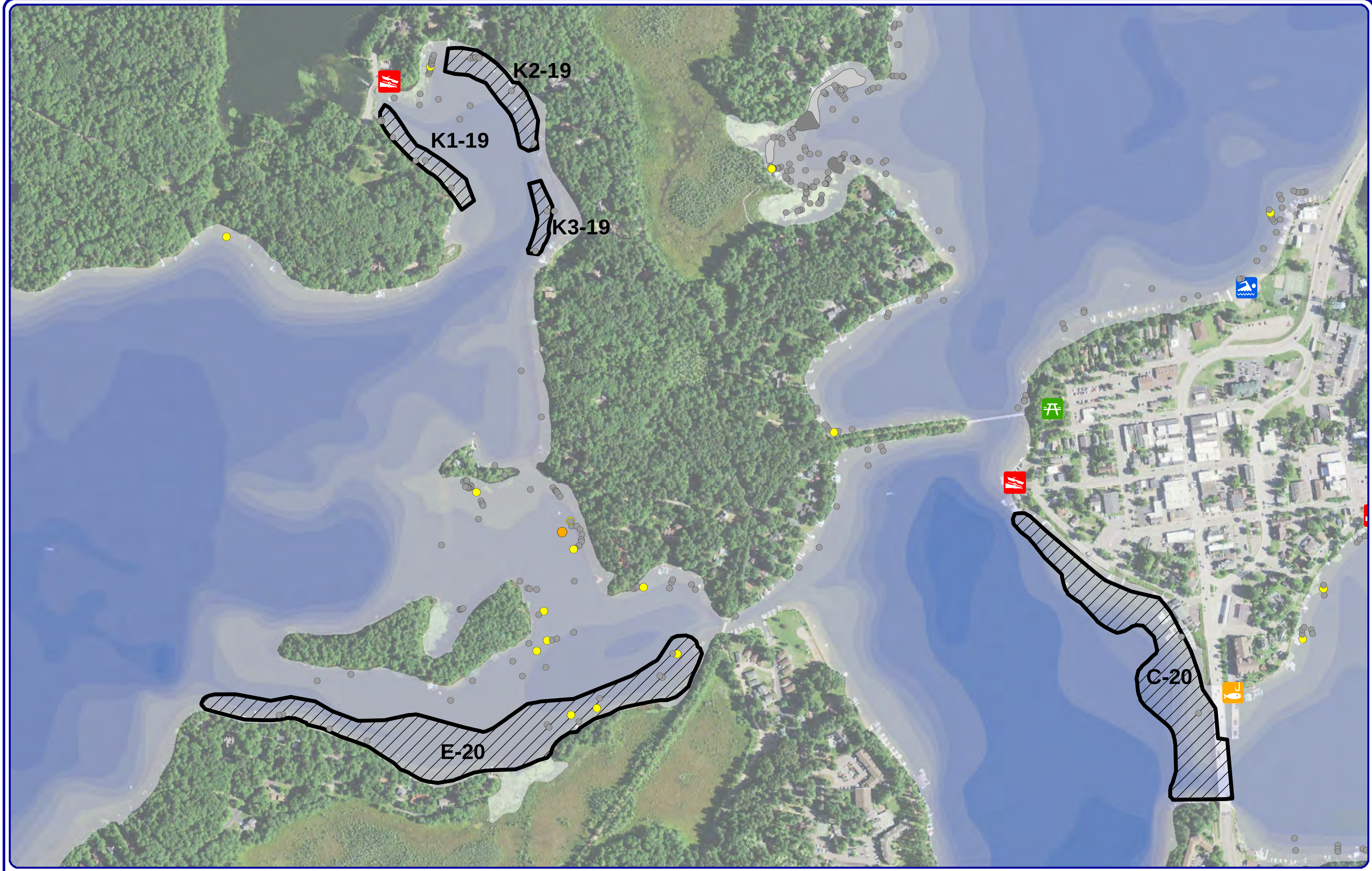
EWM Survey Results (September 8,9,16, 2021)

Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony
2021 Herbicide Applicaiton Area
2019-2020 Herbicide Applicaiton Area

Map 7 (3 of 9)

Minocqua & Kawaguesaga
Oneida County, Wisconsin

Late-Season 2021
EWM Survey Results



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Feet

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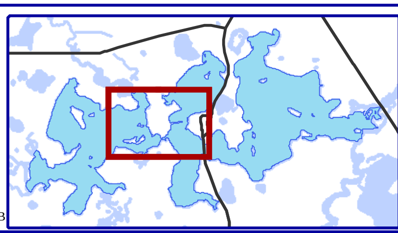
Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR,1972
- digitized by Onterra
Orthophoto: NAIP, 2018
Aquatic Plants: Onterra, 2021
Map Date: September 28, 2021 JMB



Legend

EWM Survey Results (September 8,9,16, 2021)

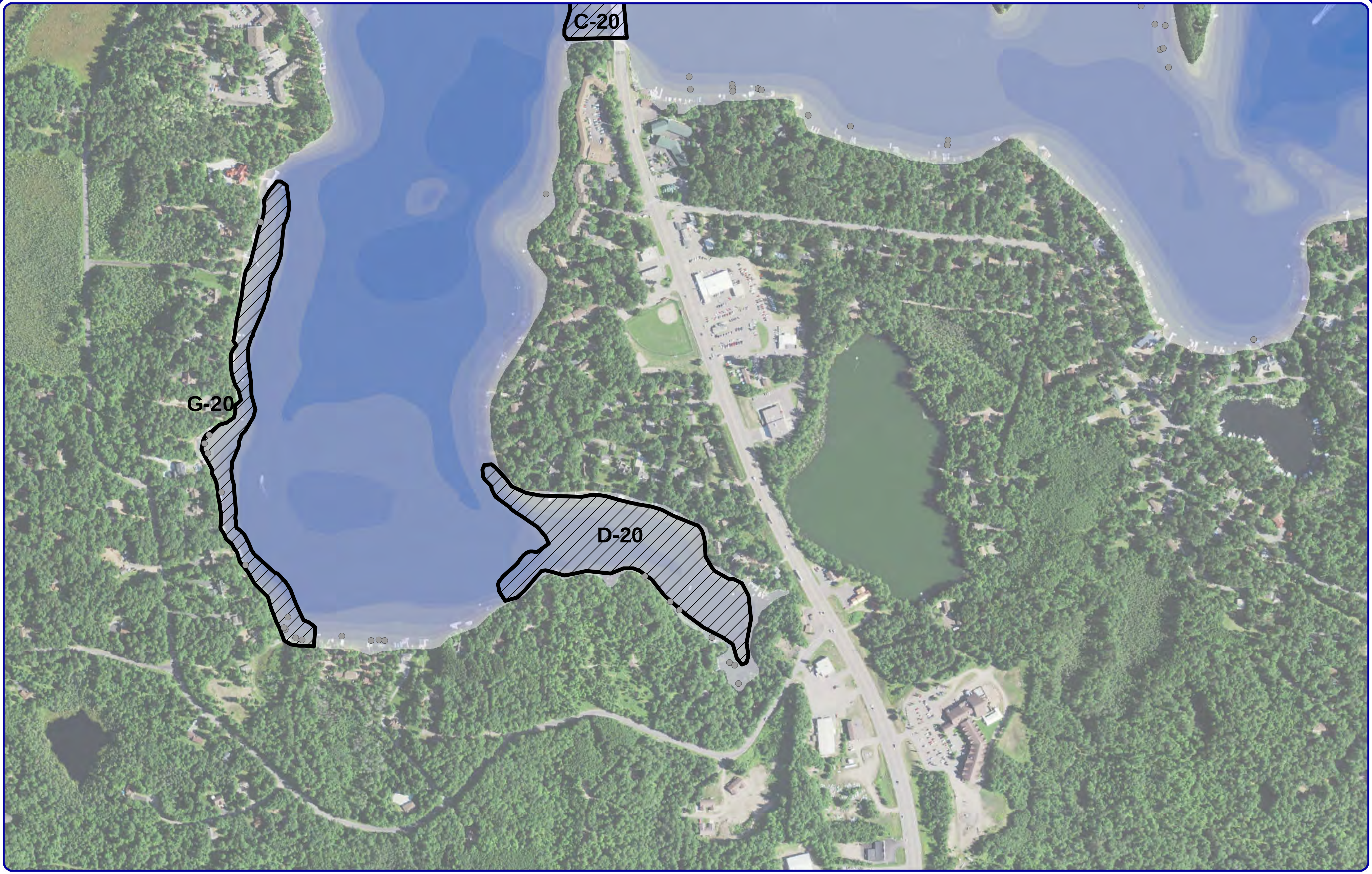
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2021 Herbicide Applicaiton Area
- 2019-2020 Herbicide Applicaiton Area

Map 8 (4 of 9)

Minocqua & Kawaguesaga

Oneida County, Wisconsin

Late-Season 2021 EWM Survey Results



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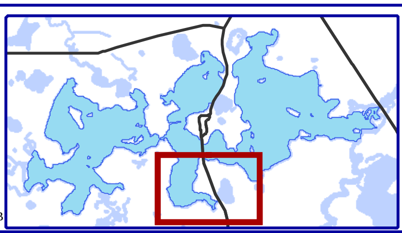
Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR,1972
- digitized by Onterra
Orthophoto: NAIP, 2018
Aquatic Plants: Onterra, 2021
Map Date: September 28, 2021 JMB



Legend

EWM Survey Results (September 8,9,16, 2021)

Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony
2021 Herbicide Applicaiton Area
2019-2020 Herbicide Applicaiton Area

Map 9 (5 of 9)

Minocqua & Kawaguesaga

Oneida County, Wisconsin

Late-Season 2021 EWM Survey Results

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920.338.8860
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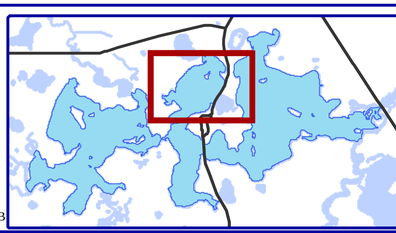
Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR,1972
- digitized by Onterra
Orthophoto: NAIP, 2018
Aquatic Plants: Onterra, 2021
Map Date: September 28, 2021 JMB



Legend

EWM Survey Results (September 8,9,16, 2021)

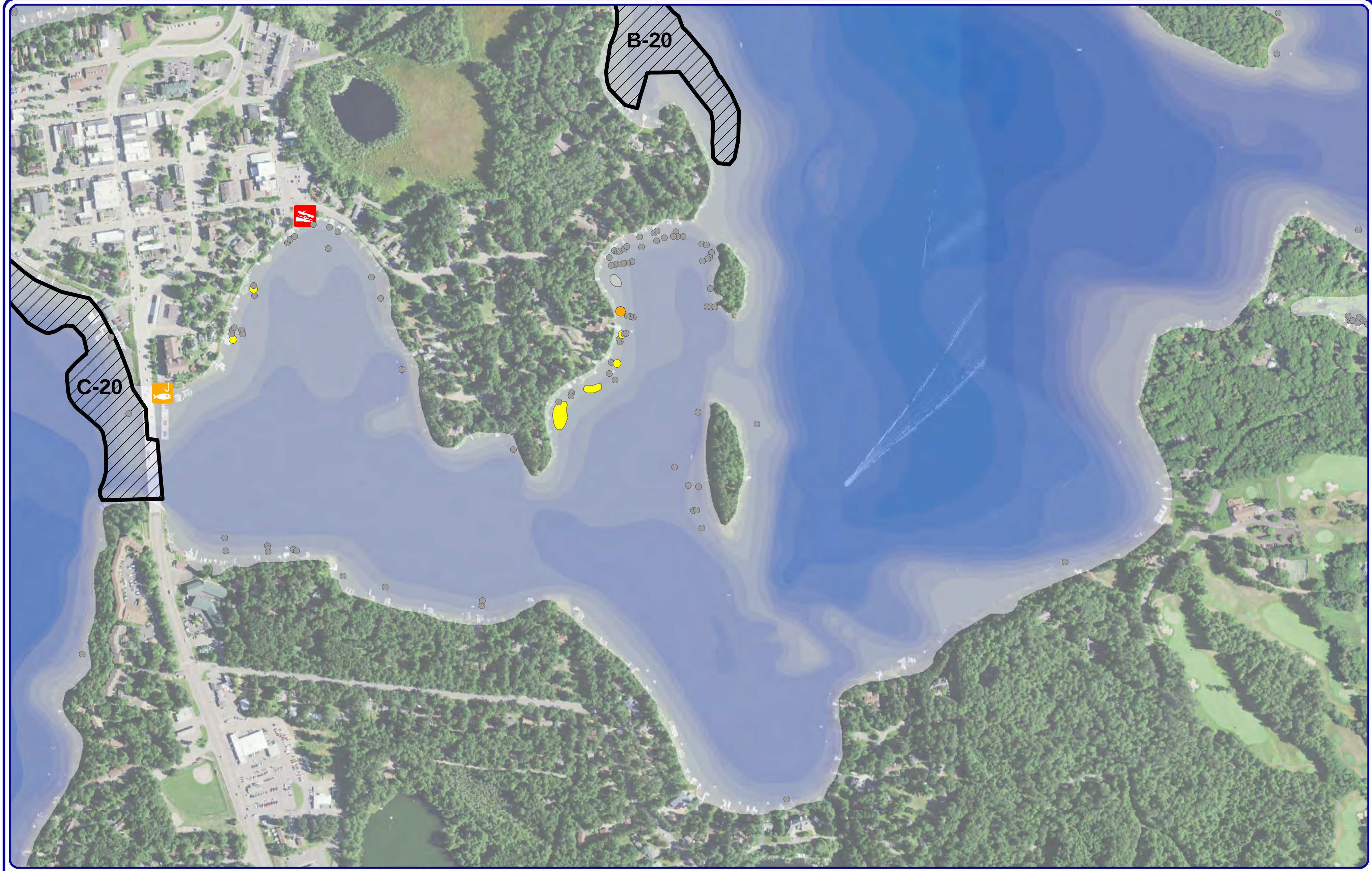
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony
2021 Herbicide Applicaiton Area
2019-2020 Herbicide Applicaiton Area

Map 10 (6 of 9)

Minocqua & Kawaguesaga

Oneida County, Wisconsin

Late-Season 2021
EWM Survey Results



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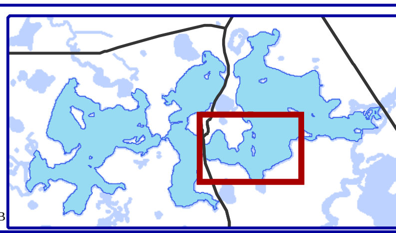

Legend

EWM Survey Results (September 8,9,16, 2021)

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2021 Herbicide Applicaiton Area
- 2019-2020 Herbicide Applicaiton Area

Map 11 (7 of 9)

Minocqua & Kawaguesaga

Oneida County, Wisconsin

Late-Season 2021 EWM Survey Results

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Lake Management Planning
815 Prosper Road
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920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR,1972
- digitized by Onterra
Orthophoto: NAIP, 2018
Aquatic Plants: Onterra, 2021
Map Date: September 28, 2021 JMB

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Feet

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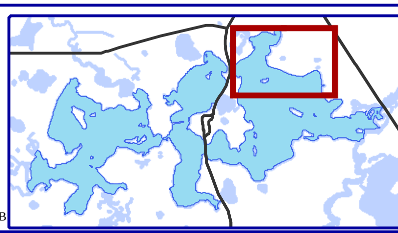
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR,1972
- digitized by Onterra
Orthophoto: NAIP, 2018
Aquatic Plants: Onterra, 2021
Map Date: September 28, 2021 JMB



Legend

EWM Survey Results (September 8,9,16, 2021)

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2021 Herbicide Applicaiton Area
- 2019-2020 Herbicide Applicaiton Area

Map 12 (8 of 9)

Minocqua & Kawaguesaga

Oneida County, Wisconsin

Late-Season 2021
EWM Survey Results

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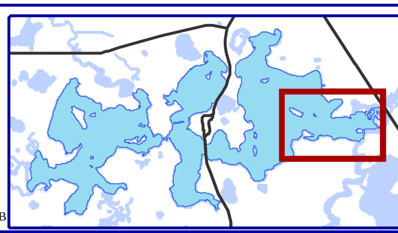
Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR,1972
- digitized by Onterra
Orthophoto: NAIP, 2018
Aquatic Plants: Onterra, 2021
Map Date: September 28, 2021 JMB



Legend

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Map 13 (9 of 9)

Minocqua & Kawaguesaga

Oneida County, Wisconsin

Late-Season 2021 EWM Survey Results