1.0 INTRODUCTION

The Unified Lower Eagle River Chain of Lakes Commission (ULERCLC) has been the successful recipient of several Wisconsin Department of Natural Resources (WDNR) Aquatic Invasive Species (AIS) Control Grants since 2007 to assist with monitoring and managing the Eurasian watermilfoil (*Myriophyllum spicatum*; EWM) population in the Eagle River Chain of Lakes (Figure 1). This report specifically discusses the monitoring and control activities conducted during 2019. The chain-wide results will be presented first, followed by results from each lake individually. Additional information regarding the management and monitoring actions completed from 2008-2018 can be found in their respective annual reports.

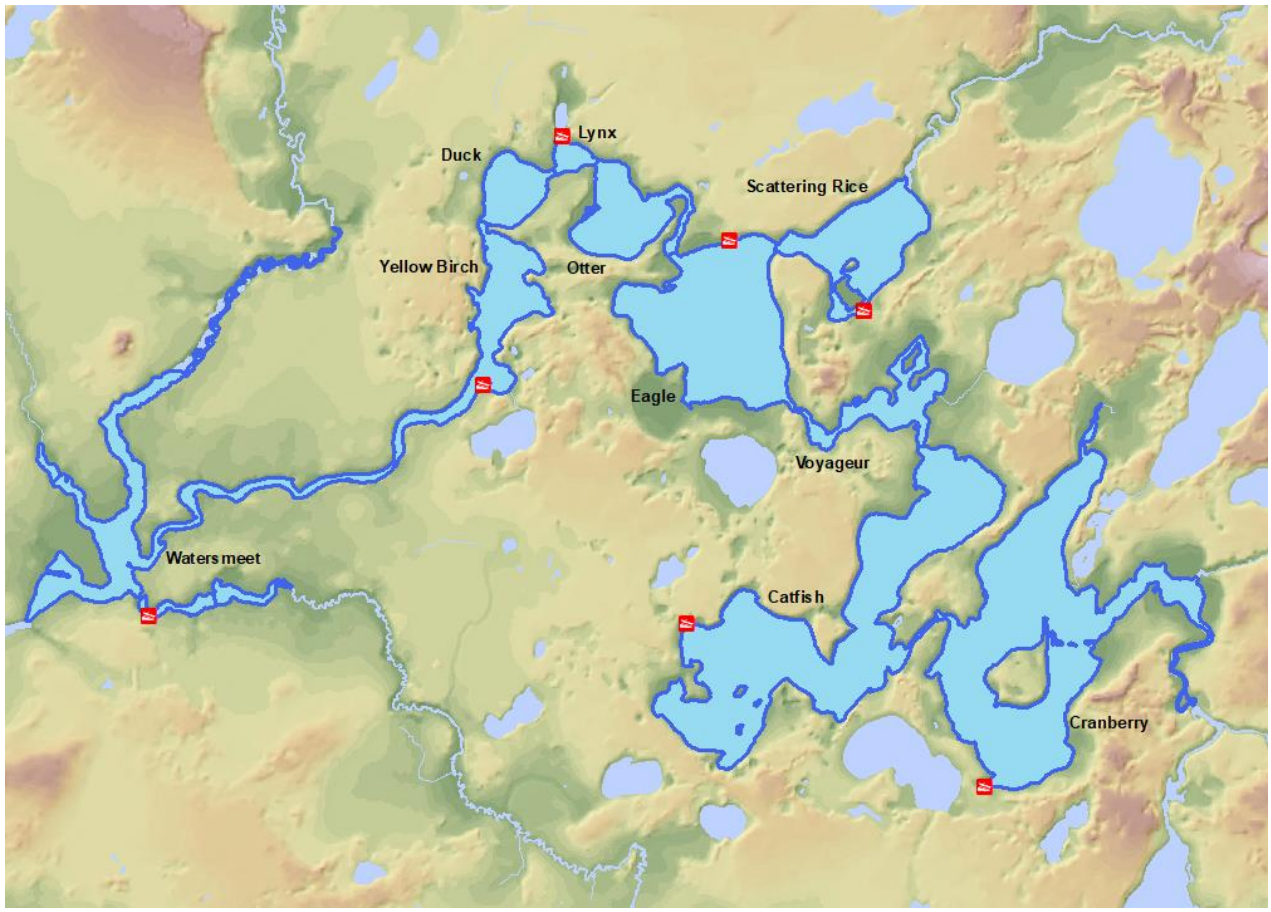


Figure 1. Lower Eagle River Chain of Lakes, Vilas-Oneida Counties.

2.0 2019 CHAIN-WIDE EWM CONTROL STRATEGY RESULTS

Onterra ecologists have conducted annual Late-Season EWM Mapping Surveys on the Eagle River Chain of Lakes since 2005. An objective of this survey is to understand the peak growth (peak-biomass) of the EWM population in the system at a fine enough scale to direct and assess management actions. An approach that utilizes a combination of volunteer- and professional-based surveys ensures the entire littoral area of the chain is assessed through visual observations from the boat (Photo 1). Onterra field crews ultimately map all discovered EWM populations using sub-meter GPS technology by using either 1) point-based or 2) area-based methodologies (i.e. colonized EWM). Large colonies >40 feet in diameter are mapped using polygons (areas) and were qualitatively attributed a density rating based upon a five-tiered scale from *highly scattered* to *surface matting*. Point-based techniques were applied to AIS locations that were considered as *small plant colonies* (<40 feet in diameter), *clumps of plants*, or *single or few plants*.

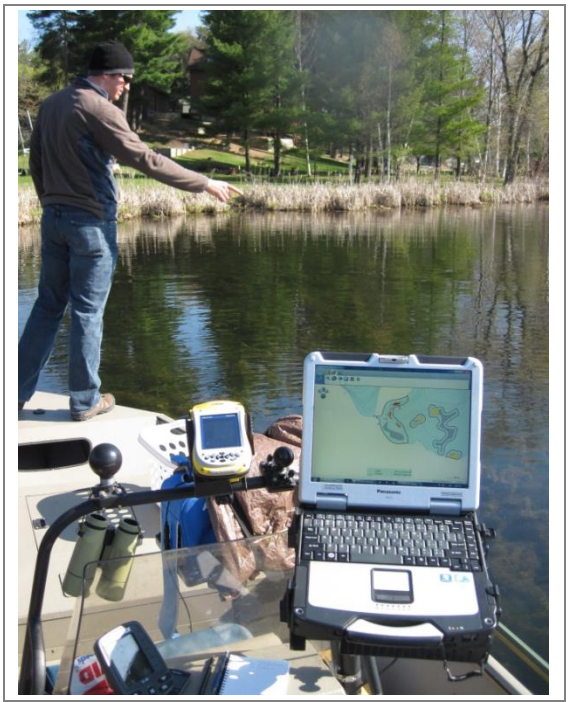


Photo 1. EWM mapping survey on Cloverleaf Lakes, Shawano County. Photo credit Onterra.

Figure 2 shows the acreage of colonized EWM as well as the distribution of each density rating. Please note that this figure only represents the acreage of mapped EWM polygons, not EWM mapped with point-based methodologies (*single or few plants, clumps of plants*, or s*mall plant colonies*). Over this same timeframe, the ULERCLC has coordinated active management of EWM.

From 2007 to 2010, an aggressive herbicide treatment program occurred consisting of strategically targeted herbicide spot treatments and a few whole-lake or whole-basin herbicide treatments. A more directed herbicide spot treatment strategy occurred from 2011 to 2015, where additional lessons were learned in invasive watermilfoil management. During this timeframe, the ULERCLC was an active participant in a Cooperative Research and Development Agreement (CRADA) between the WDNR and U.S. Army Corps of Engineers Research and Development Center that coupled field-collected herbicide concentration data with professional monitoring to understand efficacy, selectivity, and longevity of chemical control strategies.

During this project, the ULERCLC found that some of the herbicide treatments during this time period were not as effective as previous control strategies. Ongoing studies stemming from this project indicate that in small spot treatments, the herbicide dissipates too rapidly to cause EWM mortality if traditional weak-acid auxin systemic herbicides like 2,4-D are used. Even in some cases where larger treatment areas can be constructed, their narrow shape or exposed location within a lake may result in insufficient herbicide concentrations and exposure times for long-term control. With this knowledge, more effective herbicide spot treatment strategies were implemented in the latter years of this phase of management. In 2015, the EWM population of the Eagle River Chain of Lakes was arguably at its lowest levels in over a decade, with just over 12 acres of colonized EWM being documented chain-wide (Figure 2).

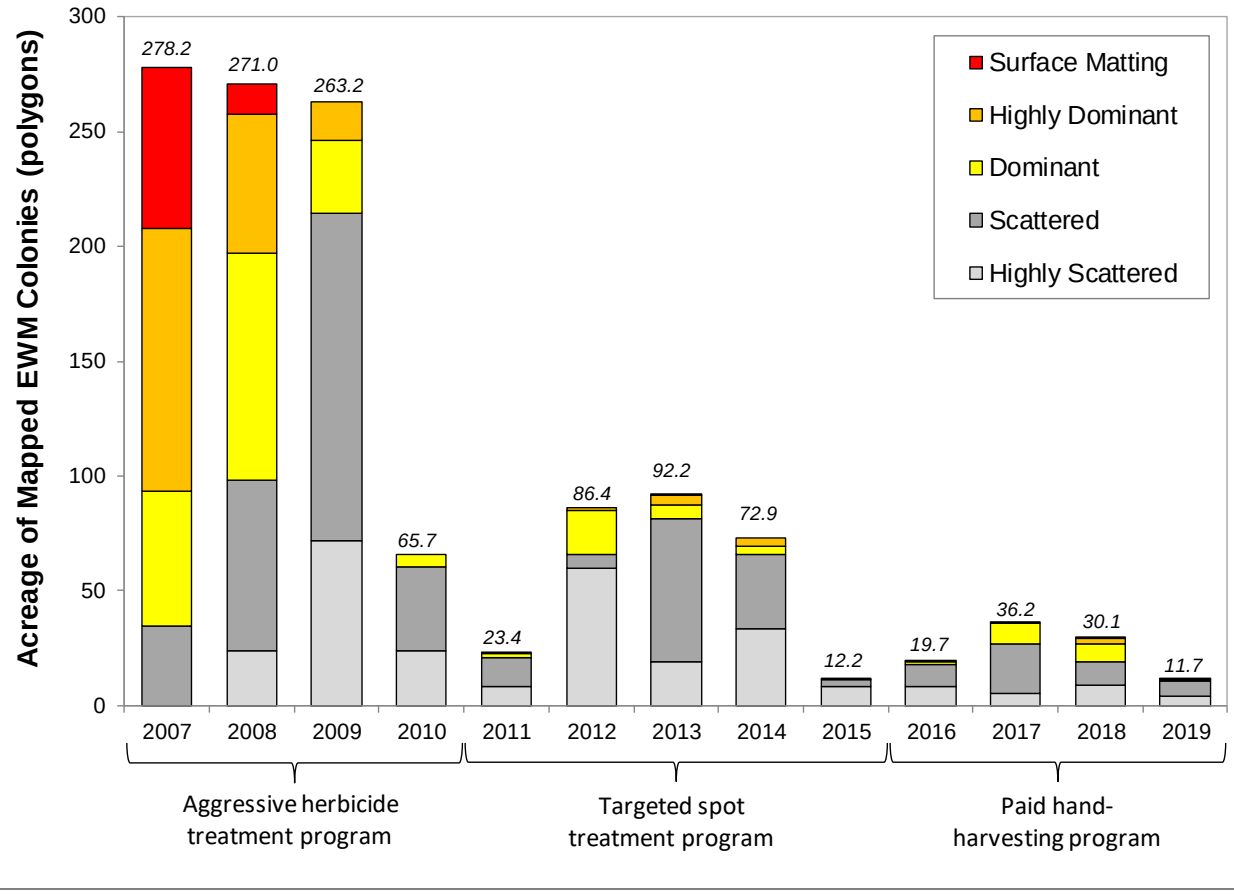


Figure 2. Chain-wide acreage of mapped EWM colonies on the Lower Eagle River Chain of Lakes from 2007-2019.

Since 2010, average chain-wide summer water clarity has declined by over 1 foot to an average of 4.4 feet (Figure 3). To investigate the reduction in water clarity within the chain since 2010, annual precipitation data were obtained from a station at the Eagle River wastewater treatment facility located on West Division Street. Correlation analysis between precipitation data and average summer Secchi disk depth revealed that total growing season precipitation (April-September) had the strongest negative correlation with average summer Secchi disk depth (r = -0.54). This means that as precipitation increases, water clarity decreases. The increase in precipitation may have resulted in increased phosphorus loading to the chain, increasing algal production and reducing water clarity. The increased precipitation may have also increased the amount of dissolved humic substances within the chain, increasing the stained appearance and decreasing water clarity.

It is clear that the management program reduced the EWM population within the Eagle River Chain. But it is also important to note the role of the reduced water clarity in the system this past decade. When EWM is targeted with an herbicide treatment, and they also have the added environmental stress of low water clarity, it's more difficult for the plants to rebound. The darker water has likely helped the treatments be more effective and last longer. Said another way, if the chain had clearer water during the years of treatment, the results may not have been as positive. It will be important for the ULERCLC to understand this reality and be prepared when water clarity returns.

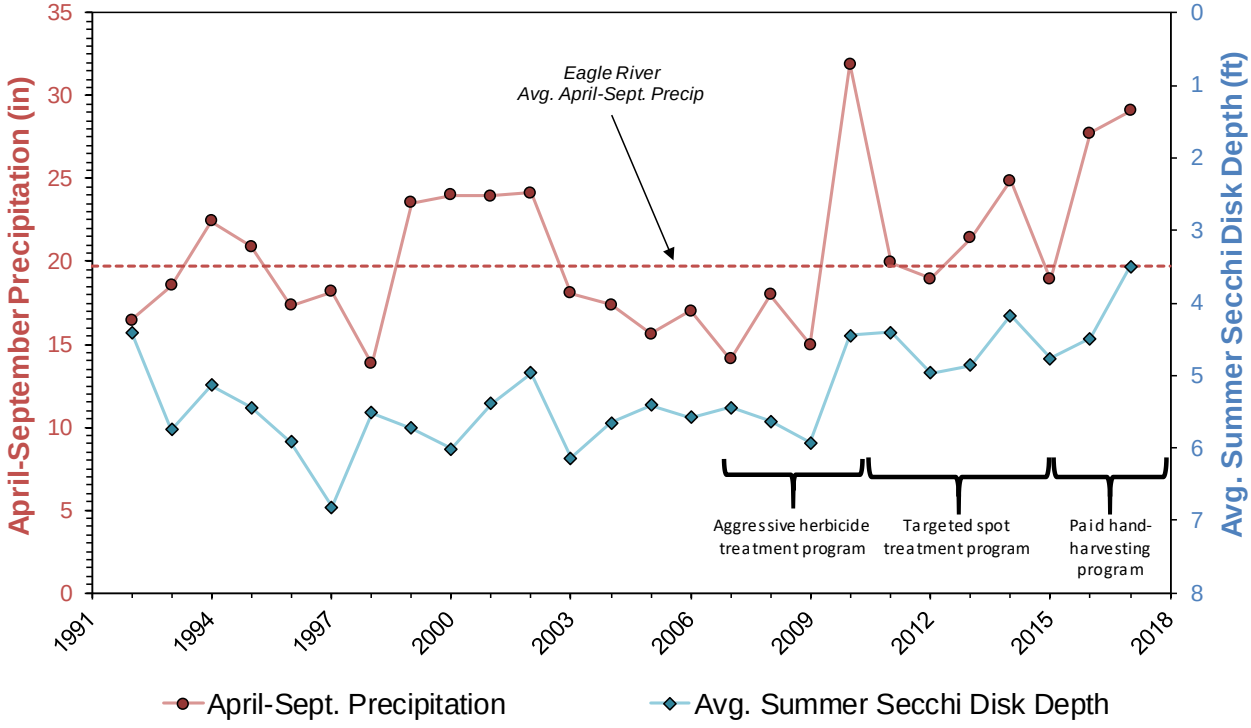


Figure 3. Eagle River total growing season (April-Sept.) precipitation and Lower Eagle River Chain of Lakes average summer (June-August) Secchi disk depth from 1992-2017. Precipitation data obtained through Midwestern Regional Climate Center data portal from Eagle River station (ID 472314).

In approximately 2015, the ULERCLC developed a working treatment strategy where consideration for herbicide application would be given to areas of EWM if they met a specific threshold (i.e. trigger). This evolved benchmark is currently understood as:

> colonized (polygons) areas of EWM, with preference to areas of *dominant* or greater densities, that have a size/shape/location where management is anticipated to be effective

Based upon this established herbicide treatment strategy, no areas of EWM in the Lower Eagle River Chain of Lakes have met this threshold since 2015 and no treatments have occurred since.

The areas of EWM that exist within the chain were too small to be effectively controlled using herbicide spot treatment techniques. These areas are also below levels that are believed to cause measurable ecological impacts to the system and below levels that cause impediments to navigation or recreation by lake users. It was important to the ULERCLC to not abandon management completely and simply wait for EWM populations to reach levels that are again applicable for herbicide control. The ULERCLC enacted a strategy that balanced a level of EWM population tolerance while targeting other locations with experimental hand-harvesting approaches.

A series of EWM mapping surveys were used to coordinate and monitor the hand-harvesting efforts (Figure 4). A preliminary hand harvesting strategy is developed over the fall/winter based on the results of the previous year's Late-Summer EWM Mapping Survey. In late-spring/early summer, an Early Season Aquatic Invasive Species Survey (ESAIS) is completed from which the hand-harvesting strategy was finalized. After the professional hand-harvesting activities were completed, Onterra completes the Late-Summer EWM Mapping Survey, the results of which serve as a post-harvesting assessment of the hand-removal efforts. The hand-removal program would be considered successful if the EWM population within the targeted areas was found to have been reduced and inhibited from expanding between the year before and year after Late-Summer EWM Mapping Surveys.

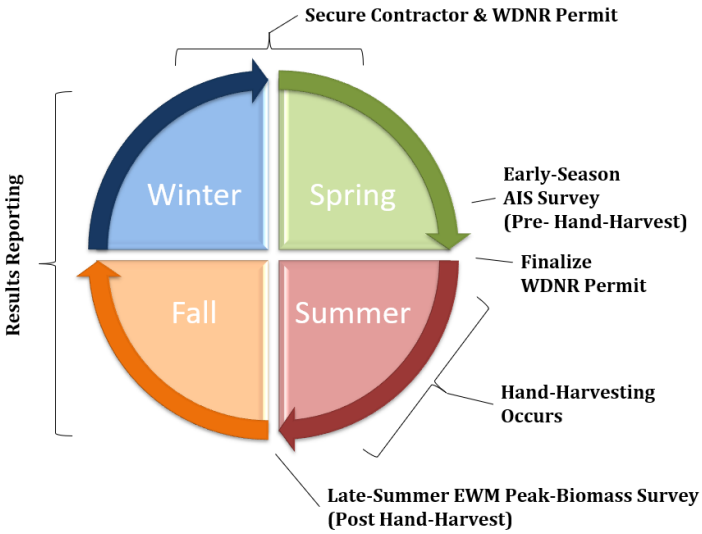


Figure 4. Hand-harvesting project timeline diagram.

In 2016, experimental traditional hand-harvesting was implemented by professionals in Voyageur Lake in an effort to control small, low-density colonies of EWM. This initial hand-removal effort in 2016 was largely successful, and this effort was expanded in 2017 to include traditional hand-harvesting in areas of Voyageur and Watersmeet Lakes, as well as hand-harvesting utilizing diver-assisted suction harvesting (DASH) in two areas of Scattering Rice Lake.

Diver Assisted Suction Harvest (DASH) is a form of hand-removal which involves divers removing target plants (i.e. EWM) and feeding them into a suctioned hose for delivery to the deck of the harvesting vessel. They do not simply vacuum the area to remove the plants as that would result in the removal of sediment and non-target native plants which would be considered suction dredging (requires elaborate permitting). The DASH system is thought to be more efficient than manual removal alone as the diver does not have to go to the surface to deliver the pulled plants to someone on a boat. The DASH system also is theorized to cause less fragmentation, as the plants are immediately transported to the surface using the vacuum technology.

In 2018, DASH was again utilized in Scattering Rice, Watersmeet, and Yellow Birch Lakes. Based upon the results observed in 2017 and 2018, a preliminary DASH strategy was designed over the winter of 2018/2019 for areas of Scattering Rice, Watersmeet, and Yellow Birch Lakes for 2019. During the 2019 Early-Season AIS Survey (ESAIS), the extents of EWM within the proposed hand-harvesting areas were refined and a final hand-harvesting strategy was derived. Onterra provided the hand-harvesting firm with the spatial data from the ESAIS Survey to coordinate the removal efforts. As is discussed specifically within the Yellow Birch, Scattering Rice, and Watersmeet Lakes' individual results sections, the hand-harvesting actions occurred on five separate days between July-September.

Overall, 2019 saw a decrease in colonized (polygon-mapped) EWM acreage on a chain-wide basis and actually had the lowest amount of EWM mapped since the AIS project began in 2007 (Figure 2).

While EWM population reductions were observed within the targeted hand-harvesting sites, some other areas of the chain that were not actively managed also observed EWM population reductions. It has been acknowledged that the conditions of the Eagle River Chain of Lakes, particularly low water clarity, may be more of a driver of the AIS population trajectory in some years than management efforts themselves. The 2019 survey results appear to further support this theory.

Like in past years, the majority of the EWM acreage mapped in 2019 (85%) was located in Cranberry and Watersmeet Lakes (Figure 5). The EWM within these lakes is largely located in channelized areas where water flow is higher. Past herbicide treatments conducted in these areas revealed it is difficult to achieve the needed concentration and exposure time to achieve EWM mortality. While the 2015 herbicide treatment in the Cranberry Channel achieved control beyond one year, assessments in 2017 and 2018 revealed EWM rebound within this area. The 2019 EWM Peak-Biomass survey compared to 2018 showed significantly decreased EWM in both density and acreage.

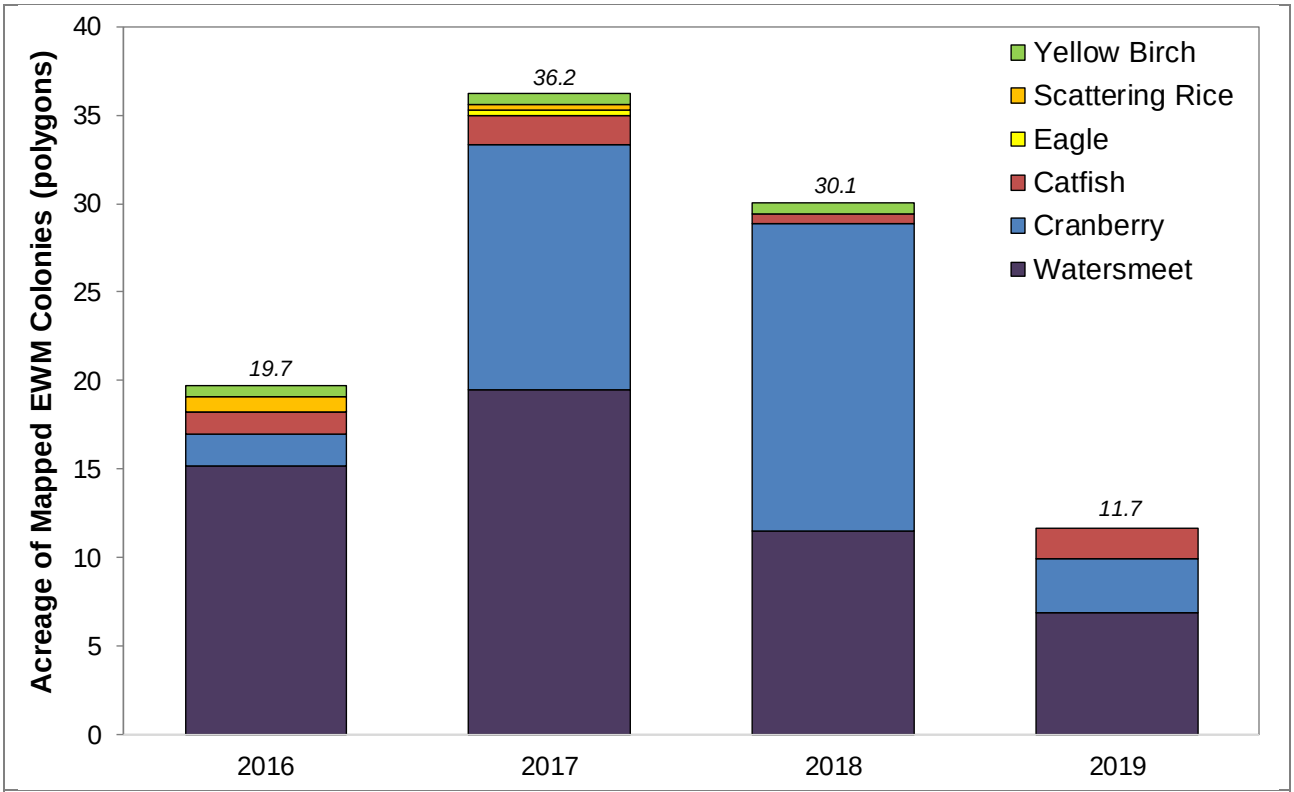


Figure 5. Distribution of acreage of mapped EWM colonies by lake in 2016-2019 (hand-harvesting years).

3.0 2020 PRELIMINARY CHAIN-WIDE EWM CONTROL STRATEGY

The EWM population of the Eagle River Chain of Lakes continues to mostly consist of locations mapped with point-based methods or mapped with low-density colonies. Higher density EWM populations were documented in Catfish Lake, the upstream channel leading into Cranberry Lake, and in river portions of Watersmeet Lake. These higher density colonies were very small areas, totaling less than 1 acre collectively across the three lakes. The high flows in the Wisconsin River make reaching EWM control goals unlikely unless alternative herbicides that may be more effective in short exposure situations are implemented. At the current size and density of the EWM populations

within Watersmeet Lake, moving forward with these more experimental strategies are not being considered.

The 2015 upstream Cranberry channel-wide 2,4-D treatment resulted in a reduced EWM population which has not reached pre-treatment EWM acreage since. It is important to note that an advanced understanding of water flows took place during that treatment, including manipulation of the upstream dam at Burnt Rollways to additionally slow water exchange. In some years, water flows caused by precipitation and snowmelt in the watershed may compromise the ability for a similarly effective treatment to take place.

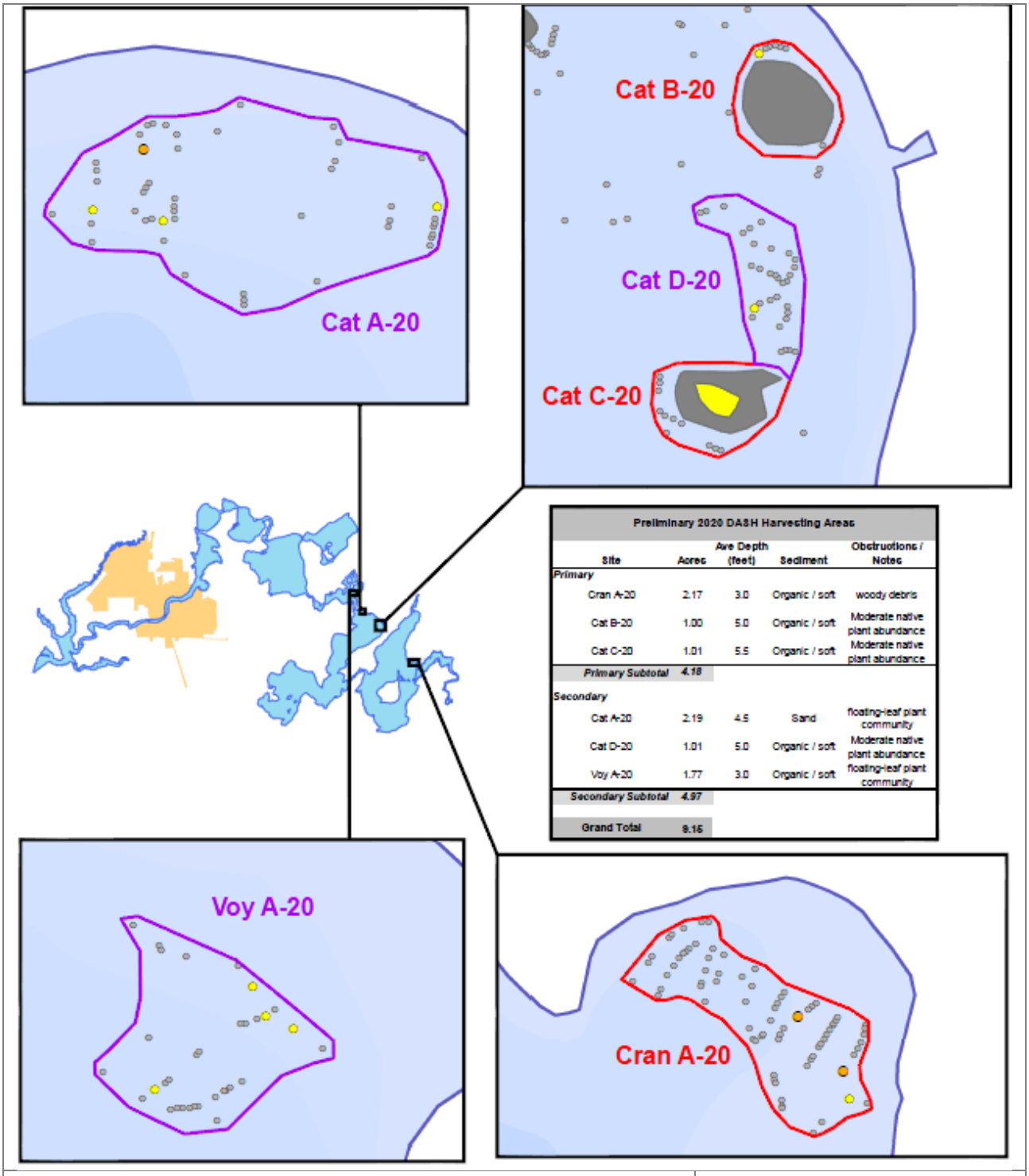
Based upon the 2018 Late-Season EWM Mapping Survey, the EWM population within the upstream Cranberry Channel exceeded the trigger for conducting the appropriate pretreatment data for potential treatment during the spring of 2019. This initiated the collection of sub-sample point-intercept aquatic vegetation over this area to serve as a pretreatment dataset. Following a period of review, the ULERCLC elected not to pursue an herbicide control program in 2019 on this area. While of greater population size and density than the trigger, the EWM population did not increase in density over 2018 and was at a level and location that the ULERCLC believed was not impacting recreation or navigation.

The ULERCLC may consider herbicides that require short exposure times (diquat, florpyrauxifen-benzyl [ProcellaCOR®], etc.) or herbicide combinations (diquat/endothall, 2,4-D/endothall, etc.) for future treatment of this area to increase the longevity of success. Again in 2019, the ULERCLC implemented the collection of pretreatment sub-sample point-intercept survey data in this location to be aligned for potential herbicide treatment if that option was pursued. Since the 2019 EWM Peak-Biomass survey showed a reduced EWM population within the Cranberry Lake channel, herbicide treatment will not be utilized in 2020.

No other areas of EWM within the chain met or exceeded the threshold developed for implementing herbicide control actions. Based on the results of the 2019 professional hand-harvesting program, the ULERCLC would like to maintain the positive strides gained through the continuation of professional EWM hand-harvesting efforts during the 2020 growing season.

A preliminary hand-harvesting EWM control strategy for 2020 includes primary and secondary sites in Cranberry, Catfish, and Voyageur Lakes (Figure 6, Map 2). Based upon the results of the 2020 Early-Season AIS Survey, areas could potentially be added, omitted, or revised. Onterra will provide the hand-harvesting firm with the spatial data from the early-July survey to aid the removal efforts. Following the hand removal efforts, a Late-Season EWM Peak Biomass Survey will qualitatively assess the hand harvesting efforts.

With Onterra's assistance, the ULERCLC applied for a WDNR Established Population Control (EPC) Grant to assist with funding 1) a 3-year EWM monitoring and hand-harvesting project and 2) completion of chain-wide point-intercept surveys in 2020 as outlined within the ERCLA's *Comprehensive Management Plan*.



Preliminary 2020 DASH Harvesting Areas

Site	Acres	Ave Depth (feet)	Sediment	Obstructions / Notes
Primary				
Cran A-20	2.17	3.0	Organic / soft	woody debris
Cat B-20	1.00	5.0	Organic / soft	Moderate native plant abundance
Cat C-20	1.01	5.5	Organic / soft	Moderate native plant abundance
Primary Subtotal	*4.18*			
Secondary				
Cat A-20	2.19	4.5	Sand	floating-leaf plant community
Cat D-20	1.01	5.0	Organic / soft	Moderate native plant abundance
Voy A-20	1.77	3.0	Organic / soft	floating-leaf plant community
Secondary Subtotal	*4.97*			
Grand Total	9.15			

Figure 6. Preliminary 2020 hand-harvesting strategy.

4.0 INDIVIDUAL LAKE SECTIONS

The remainder of this report will focus on 2019 EWM monitoring and control strategy assessments (if applicable) on a lake-by-lake basis. Some of the text may seem redundant if one reads each lake section. However, this is intentional to ensure the information is portrayed to those who only read the chain-wide sections and their individual lake-specific section.

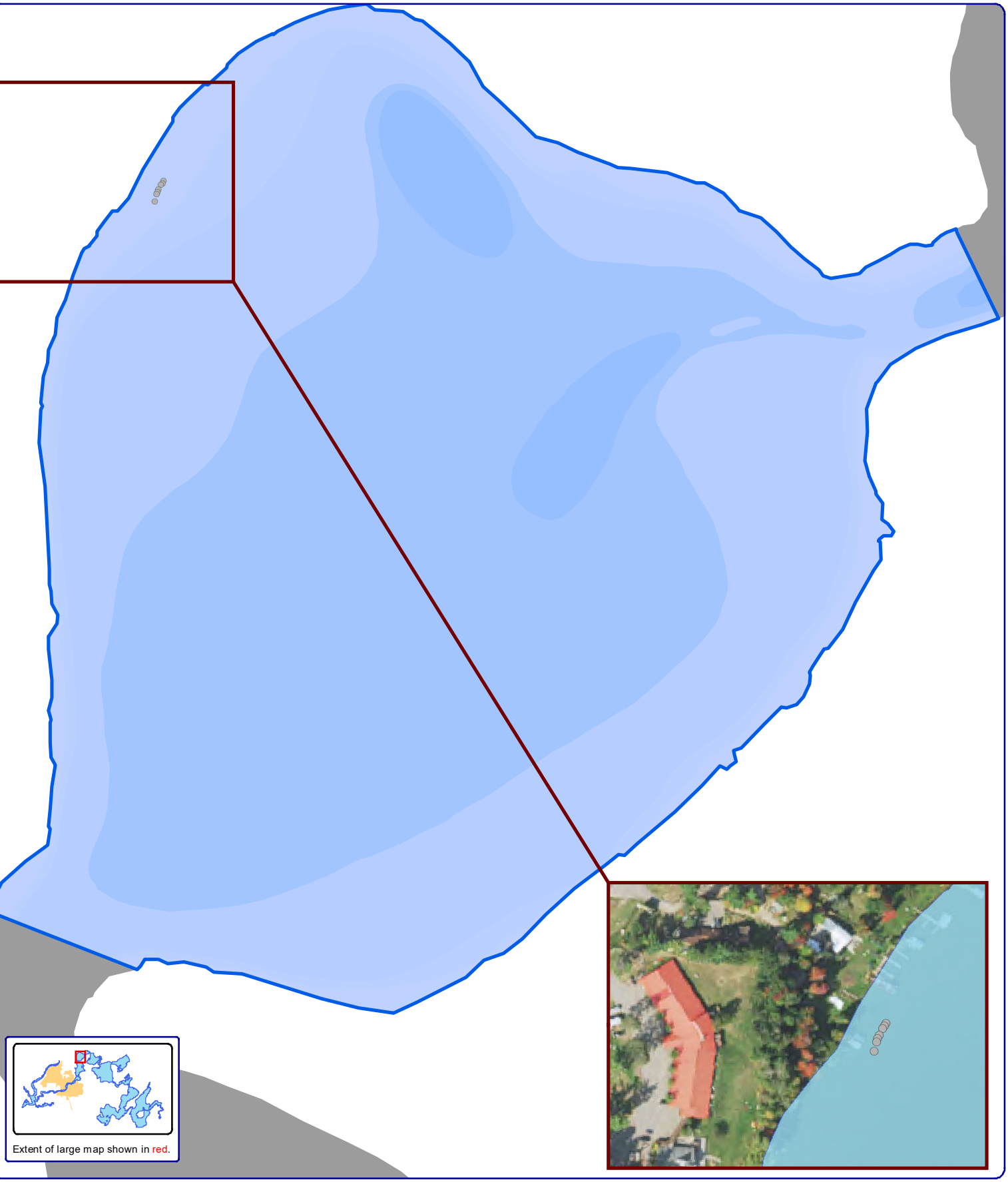
4.8 Duck Lake Summary and Conclusions

During the surveys completed in 2018 in Duck Lake, only point-based occurrences of EWM were located. Given the small EWM population, no control strategies were implemented in Duck Lake in 2019. As has occurred in past years, the EWM population in Duck Lake was mapped professionally during Onterra's 2019 Early-Season AIS (ESAIS) and Late-Season EWM Peak-Biomass (EWMPB) surveys. During the ESAIS survey, the entire littoral zone of the Lower Eagle River Chain of Lakes was searched for EWM by Onterra field staff. Completion of an ESAIS survey presents numerous advantages. Typically, the water is clearer during the early summer allowing for more effective viewing of submersed plants. While not at their peak growth stage (peak biomass), EWM plants are higher in the water column than most native plants during this time of year which increases the chances that even low-density and isolated EWM occurrences would be located.

The results from the ESAIS survey were loaded onto specific ULERCLC GPS units, and trained volunteers were tasked with searching and mapping EWM in areas where Onterra did not locate it during the ESAIS survey. Prior to the Late-Season EWM Peak-Biomass Survey, the volunteer mapping data were provided to Onterra. During the Late-Season EWM Peak-Biomass Survey, Onterra ecologists revisited and refined areas of EWM mapped during the Early-Season AIS Survey as well as any areas marked by volunteers.

Only point-based data was collected in Duck Lake during the 2019 ESAIS Survey, comprised of two *small plant colonies*, four *clumps of plants*, and several *single or few plant* occurrences. This was a slight increase from what was mapped during the 2018 EWMPB survey. These occurrences were in shallow water close to the shoreline. The results of Onterra's ESAIS Survey were loaded onto specific ULERCLC GPS units and trained volunteers were challenged to locate additional EWM occurrences within the chain during the remainder of the summer. The volunteer data were provided to Onterra prior to the late-summer 2019 EWM surveys and integrated into the onboard GPS-enabled computer system.

During the Late-Season EWM Peak-Biomass Survey, the EWM mapped was less than what was located during the ESAIS Survey and consisted of seven *single or few* plant occurrences all clustered in one small area close to the northwest shoreline (Duck Lake – Map 1). Given the small EWM population observed in 2019, no EWM control actions are proposed for 2020 in Duck Lake.



Extent of large map shown in red.

N
W E
S

400
Feet

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Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, Onterra digitized
Aquatic Plants: Onterra, 2019
Map Date: October 24, 2019 HAL
Filename: *Duck_EWM_PB_Sept19.mxd*

Legend

2019 EWMPB Survey (September 2019)

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

Duck Lake

Vilas County, Wisconsin

2019 EWM Peak-Biomass Survey Results