INTRODUCTION


Photo 1. Lake Metonga, Forest County, Wisconsin. Taken from north boat landing.

Lake Metonga, Forest County, is a 1,991-acre drainage lake with a maximum depth of 79 feet and a mean depth of 25 feet (Photo 1). Outlet Creek, Lake Metonga's outlet, leads to the Swamp Creek which flows through Rice Lake on its way to the Wolf River. First officially documented within the system in 1994, Eurasian water milfoil (*Myriophyllum spicatum;* EWM) has been actively managed by the Lake Metonga Association (LMA) to reduce its population and density through chemical applications and biological control introductions since 1998.

In 2015, the LMA was successful in obtaining a Wisconsin Department of Natural Resources (WDNR) Aquatic Invasive Species (AIS)-Established Population Control (EPC) Grant to cover monitoring and control costs for 2015 and 2016. Following alterations to the original project scope, control and monitoring activities conducted in 2017 were included within the grant-funded project. This report discusses the monitoring and control activities conducted during 2017. This document will serve as the final deliverable for the AIS-EPC Grant (ACEI-160-15).

Historic Milfoil Management

Spot treatments are a type of control strategy where the herbicide is applied to a specific area (treatment site) such that when it dilutes from that area, its concentrations are insufficient to cause significant affects outside of that area. Spot treatments typically rely on a short exposure time (often hours) to cause mortality. As a part of the ongoing EWM management project, the LMA has been educated on the difference between spot-treatments and large-scale (whole-lake or basin-wide) treatments. Ongoing studies are indicating that in small spot treatments (working definition is less than 5 acres) the herbicide dissipates too rapidly to cause EWM mortality if systemic herbicides like 2,4-D are used (Nault et al. 2015). 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. Ongoing field trials are assessing the efficacy (EWM control) and selectivity (collateral native plant impacts) of herbicides that may be effective with shorter contact and exposure time (CET) requirements such as diquat or herbicide combinations (diquat/endothall, 2,4-D/endothall, etc.).

Since 2007, varying herbicides and herbicide application strategies have been employed on Lake Metonga in an attempt to control EWM. While short-term control was observed in many of the spot treatment sites over the years, EWM population rebound was observed occurring as soon as one year after treatment. This *seasonal control* did not meet lake managers' expectations and number of different herbicide treatment strategies have been attempted since 2007 in an effort to provide longer-term control (Figure 1).

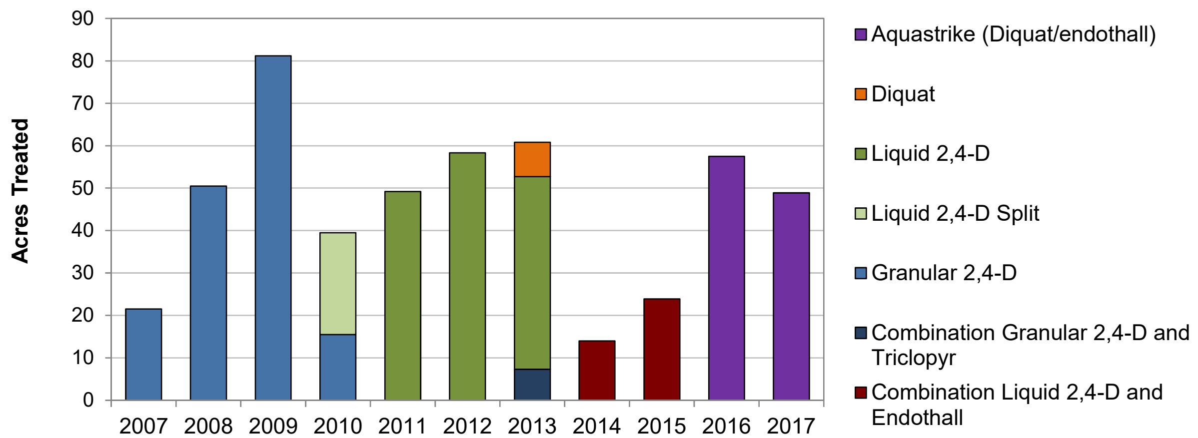


Figure 1. Lake Metonga treatment history.

A set of unsuccessful trial treatments occurred in 2013, followed by a lapse of funding in 2014 when a WDNR AIS-EPC Grant application was unsuccessful. Without state assistance, the LMA funded another trial treatment in 2014 using a combination of liquid 2,4-D and endothall. This treatment met short-term control goals and for the first time, lake managers believe that longer-term control may be observed from this treatment.

A subsequent AIS-EPC Grant Application was awarded; however, its original scope was modified by the WDNR. The project originally included conducting an expanded control strategy in 2015 with liquid 2,4-D/endothall but was paired down to only consist of areas near the two main public access locations. The 2015 combined 2,4-D/endothall herbicide treatment on Lake Metonga fell short of meeting expectations and the trial area from 2014 had completely rebounded by the end of 2015.

Nuisance Control and Containment Strategy

Many of the past herbicide control strategies used on Lake Metonga have been seasonally effective at best. While some treatments have proven slightly more effective over others, the rate of success has not been greater than the increase of the EWM population lake-wide. The results of a tracer-dye study conducted in 2015 indicated that target herbicide concentrations and exposure times (CET) were not met for the 2015 strategy. The herbicide movement offsite may have been impacted by winds that increased following the treatment. However, it is suspected that even in absence of the wind-induced water exchange, the CET required to achieve EWM control from this herbicide combination may be longer than can be achieved on exposed parts of Lake Metonga where natural sub-surface water movement is high.

Numerous meetings, teleconferences, and email exchanges occurred between the LMA, Onterra, the WDNR Lakes Coordinator, the WDNR Fisheries Manager, and the Sokaogon Chippewa Community's fisheries biologist during the winter of 2015-2016. All entities understand the difficulty of conducting successful active management on Lake Metonga. In the interim, a *Nuisance Control and Containment Strategy* was devised. This involved targeting approximately 60 acres near the lake's public access and high-use areas with an herbicide that required a short

CET. Ultimately, a strategy involving the combination application of diquat and endothall was approved. The WDNR agreed to allow a portion of this acreage to be applicable to the LMA's current AIS-Established Population Control Grant, in an effort to minimize EWM near the boat landings and the potential risk of EWM from Lake Metonga being taken out of the lake and spread to other lakes from transient boating activity (i.e. containment).

The EWM population in all locations targeted in 2016 showed reductions. Except for site C-16, all sites contained at least a modest amount of EWM present following the treatment. There were reliable anecdotal reports of reduced EWM populations in these areas for the majority of the summer before they rebounded late in the year; allowing recreation and navigation activity to occur in these areas. The reduction of the EWM population in these areas may have also resulted in lessened chance of EWM being transported out of the lake by transient lake users. Based on these two findings, the goal of the 2016 *Nuisance Control and Containment Strategy* had arguably been met. However, it is clear that the EWM populations of almost all sites except C-16 rebounded to near pretreatment levels by the end of the summer and only resulted in a single season of control. Similar to when mechanical harvesting is used to improve navigation and recreation to specific areas, the strategy needs to be repeated each year, as little to no impacts past a single season occur.

With remaining funds from the existing AIS-Grant (ACEI-160-15), the LMA decided to continue the *Nuisance Control and Containment Strategy* for 2017. With the lack of longer-term control being documented in 2016 and the native plant reductions observed within the treatment sites, Onterra did not recommend expansion of the program past strategic high use areas (e.g. swimming beaches, boat landings) until a control strategy with a higher degree of probably for control has been determined.

2017 AIS CONTROL AND MONITORING

Pretreatment Confirmation and Refinement Survey

On May 10, 2017, Onterra staff visited Lake Metonga to complete the Spring Pretreatment Confirmation and Refinement Survey. A temperature and dissolved oxygen profile indicated the water temperatures ranged from 13.9°C (57.0°F) near the surface to 8.8°C (47.8°F) at deeper depths. During this survey, the proposed herbicide application areas were assessed to ensure EWM was actively growing within these areas and that their boundaries as determined in 2016 were still appropriate. As a result of this survey, no modifications to the proposed treatment area extents were made and the average depths of each site were confirmed. Based on water temperatures and the stage of EWM/native plant growth, it was recommended the treatment occur as soon as the permit was been finalized and the applicator could be mobilized. It was recommended the treatment occur when winds were as low as possible to minimize wind driven water movement. Onterra supplied an anemometer to the LMA to record wind speed data at the time of the application.

The 2017 final herbicide treatment strategy on Lake Metonga was executed on June 1 and June 2, 2017 by Schmidt's Aquatics (Map 1). The applicator reported a water temperature of approximately 56-57°F and light winds of 0 to 4 mph at the time of application. Anemometer recordings were taken within each treatment site during the application. These data are displayed in Table 1 below.

Table 1. Wind speed and direction recorded during the 2017 herbicide application. Data recorded by Schmidt's Aquatics with a Kestrel 1000 anemometer.

Site	Wind speed (mph)	Wind Direction
A-17	3.4	South
E-17	1.3	Northwest
D-17	2.9	South
B-17	2.1	Southwest-Northwest

Wind speed and direction data were also obtained from nearby weather stations (Figure 2). These data indicate that winds were predominantly out of the west/southwest at the time of the application, ranging in speed from 0 to 5 mph during herbicide application. Winds remained southwesterly and relatively light for at least seven hours after the treatment.

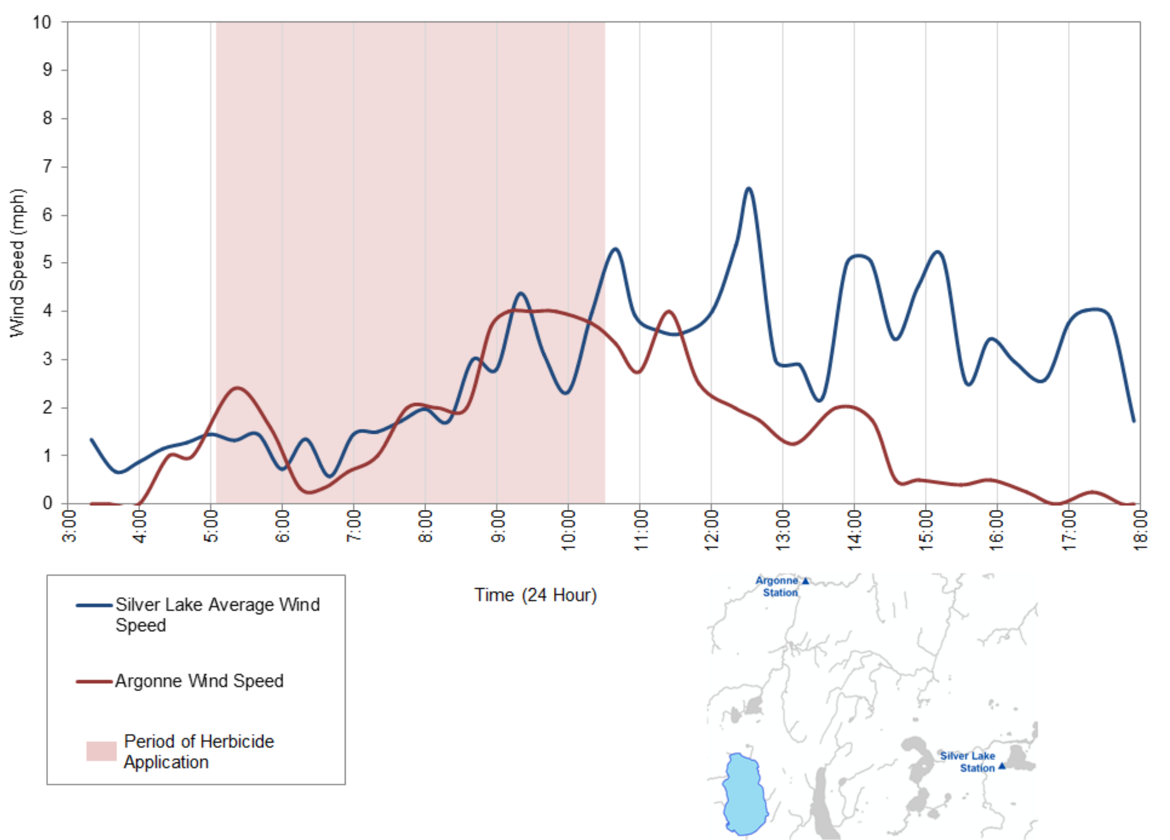


Figure 2. Wind speed surrounding 2017 herbicide treatment. Created using data obtained from Weather Underground Argonne and Silver Lake stations.

2017 HERBICIDE TREATMENT RESULTS

Quantitative Aquatic Plant Monitoring (Point-Intercept Sub-Sample Data)

Sites A-17, B-17, D-17 and E-17 were treated in both 2016 and 2017, whereas site C-16 was not included in the 2017 control strategy. An analysis of the aquatic plant populations within the sites that were treated in both years is included below. On Lake Metonga, quantitative data were collected at 197 locations during the late-summer of 2015, 2016 and 2017 (Figures 3 and 4). Within the analysis, the data were combined for the sites in close proximity to one another (A-17, D-17 & E-17) whereas site B-17 is analyzed independently.

In 2015, the areas near the north landing (sites A-17, B-17, D-17, and E-17, Figure 3) contained EWM at almost 80% of the sub-sample point-intercept locations, and the area near the south landing (B1-7, Figure 4) contained EWM at over 90% of sub-sampling locations. The EWM population near the north landing was reduced to approximately 20% following the 2016 treatment and further reduced to 9% following the 2017 treatment (Figure 3). EWM near the south landing was reduced to approximately 55% in 2016 and then to 0% in 2017 (Figure 4).

Near the northern landing in 2015, only three native aquatic plant species were located within the dense EWM colonies (Figure 3). Wild celery populations were more resilient to the herbicide treatments than coontail and common waterweed, which both species were not located during the 2017 survey.

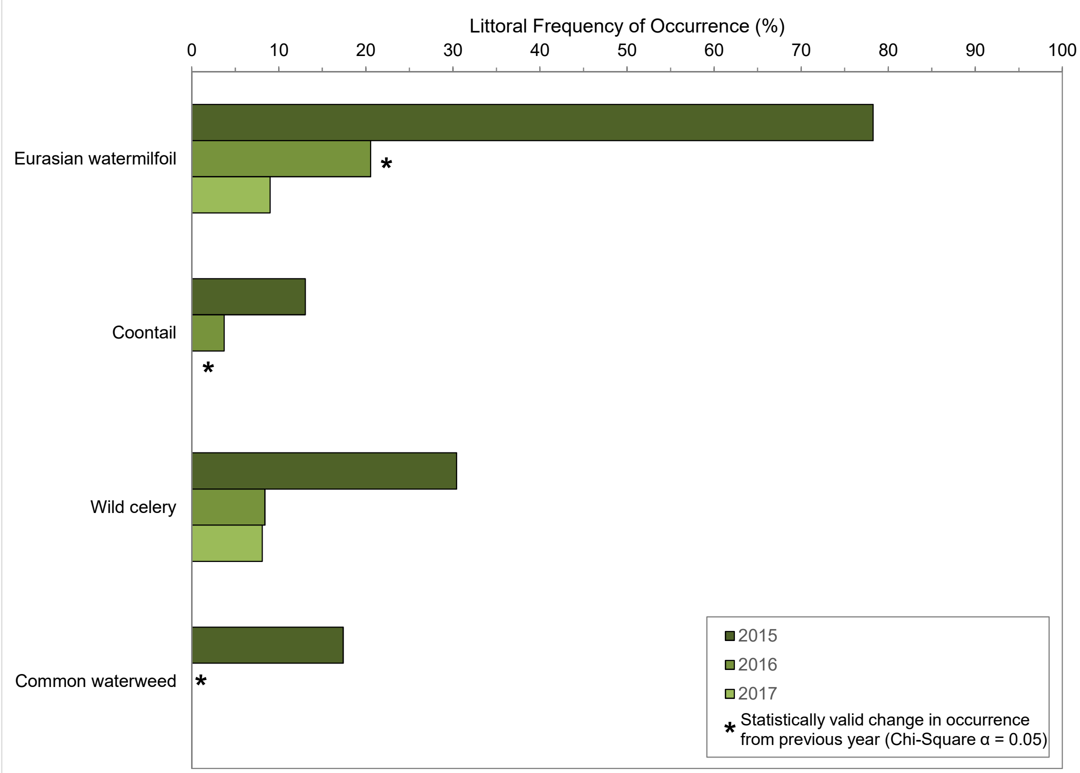


Figure 3. Littoral Frequency of Occurrence within sub-sample point-intercept surveys conducted at sites A-17, D-17 & E-17 from 2015-2017 (near north landing).

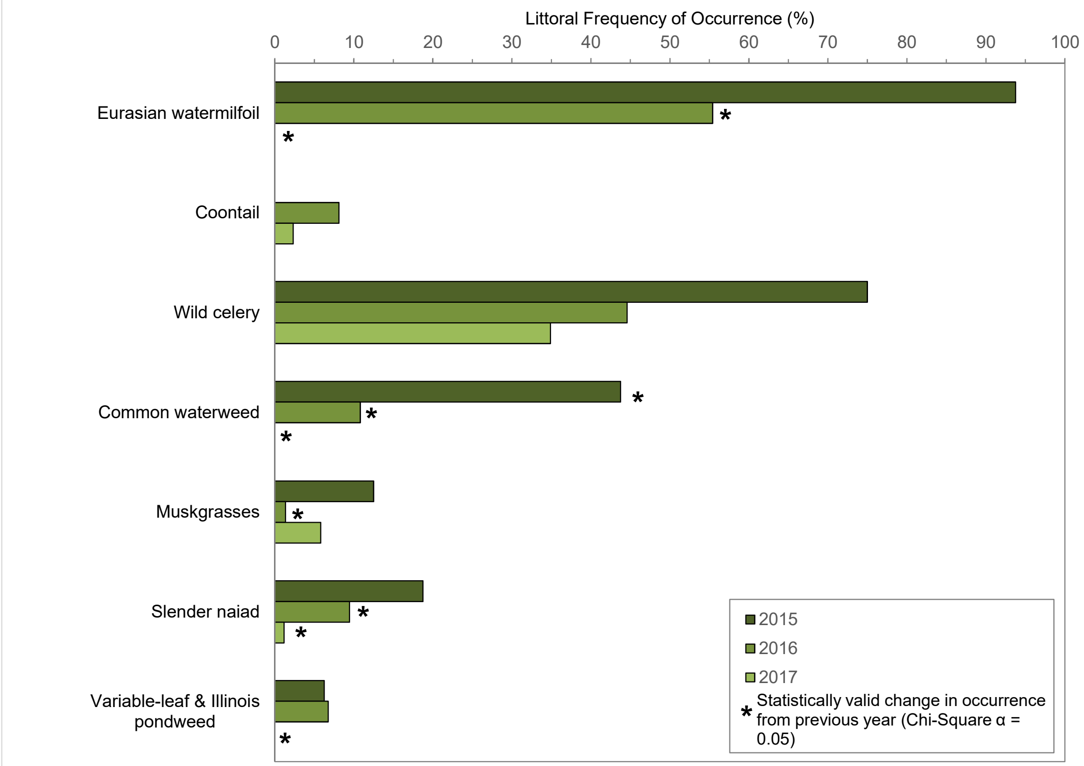


Figure 4. Littoral Frequency of Occurrence of Aquatic Plants within from sub-Point-Intercept surveys conducted at site B-17 from 2015-2017.

Six native plant species were found coexisting within the dense EWM colony near the southern landing in 2015 (Figure 4). Following the treatment, reductions in all aquatic plants were noted with wild celery populations being more resilient within this treatment area as well.

Qualitative Aquatic Plant Monitoring (EWM Mapping)

Using sub-meter GPS technology, EWM locations were mapped the year prior to treatment (2016) in late-summer when EWM is at or near its peak growth, and in the late summer immediately following the treatment (2017). The EWM population was mapped by using either 1) point-based or 2) area-based methodologies. Large colonies >40 feet in diameter are mapped using polygons (areas) and were qualitatively attributed a density rating based upon a five-tiered scale from *Highly Scattered* to *Surface Matting*. Point-based techniques were applied to EWM locations that were considered as *Small Plant Colonies* (<40 feet in diameter), *Clumps of Plants*, or *Single or Few Plants*). Comparisons of the survey mapping results are used to qualitatively evaluate the 2017 herbicide treatment on Lake Metonga.

Onterra ecologists completed the late summer EWM peak-biomass survey on Lake Metonga on September 20-21, 2017 to qualitatively assess the 2017 treatment strategy and to map EWM at its peak growth (biomass) stage of the growing season. Field crews noted favorable conditions during the survey with partial sun and low winds. A Secchi disk measurement of 20 feet was recorded during the survey indicating high water clarity.

Figure 5 displays the acreage of EWM colonies mapped in Lake Metonga from 2007 through 2017. Please note that Figure 6 represent the acreage of mapped EWM polygons, not EWM mapped with point-based methodologies (*Single or Few Plants, Clumps of Plants,* or *Small Plant Colonies*). Taken out of context, this figure can be misleading as large changes in EWM colonial acreage may be the results of differences in EWM populations fluctuating from point-based data to areas best delineated with polygons.

Colonized EWM acreage increased to the highest levels in 2015, with over 234 acres of colonized EWM documented during a late-summer 2015 survey. A reduction in EWM acreage from 2015 to 2016 was documented, largely attributed to the decline in colonized EWM within the Nuisance Control and Containment treatment areas (Map 2).

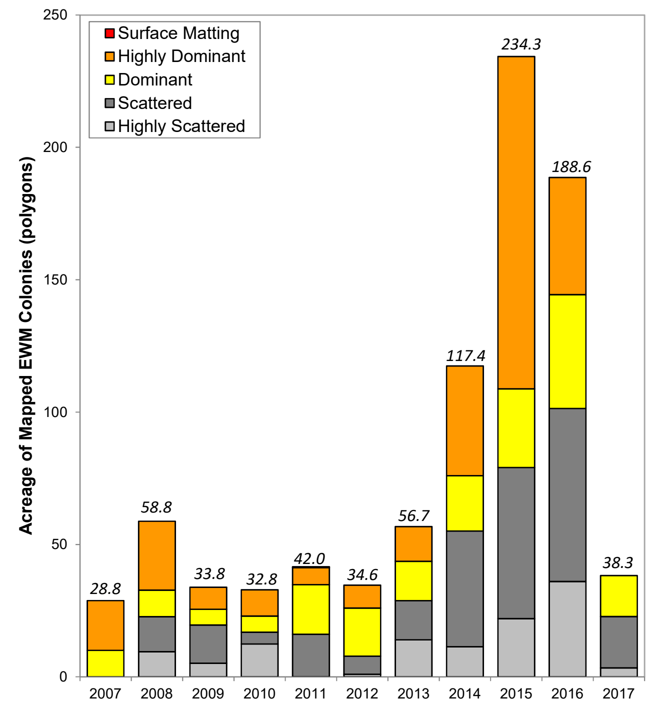


Figure 5. Acreage of mapped EWM colonies on Lake Metonga from 2007-2017.

A very large decrease in colonized EWM acreage was observed between 2016 and 2017 (Figure 5). While the largest EWM population declines were observed within the treatment areas, large declines in other parts of the lake were also noted that are unrelated to the treatment program. While it may seem clear that the reductions in the 2017 treatment areas were a result of the herbicide control strategy, the fact that large EWM reductions were observed in areas outside of the treatment area confound this interpretation. From the WDNR Long-Term EWM Trends Monitoring Research Project, EWM population fluctuations, and even reductions, have been documented on lakes that have not undergone active management.

WDNR Long-Term EWM Trends Monitoring Research Project

Starting in 2005, WDNR Science Services began conducting annual point-intercept aquatic plant surveys on a set of lakes to understand how EWM populations vary over time. This was in response to commonly held beliefs of the time that once EWM becomes established in a lake, its population would continue to increase over time. As outlined in *The Science Behind the "So-Called" Super Weed* (Nault 2016), EWM population dynamics on lakes are not that simplistic.

Like other aquatic plants, EWM populations are dynamic and annual changes in EWM frequency of occurrence have been documented in many lakes, including those that are not being actively managed for EWM control (no herbicide treatment or hand-harvesting program). The data are most clear for unmanaged lakes in the Northern Lakes and Forests Ecoregion (Figure 6). The upper frame of Figure 6 shows the EWM littoral frequency of occurrence for these unmanaged systems by year, and the lower frame shows the same data based on the number years the survey was conducted following the year of initial detection of EWM listed on the WDNR website.

During this study, six of the originally selected "unmanaged lakes" were moved into the "managed" category as the EWM populations were targeted for control by the local lake organization. For comparison, the EWM littoral frequency of occurrence in Lake Metonga was 7.6% in 2005 and 2.1% in 2013.

Some lakes, such as Hancock Lake, maintained low EWM populations over the study averaging a littoral occurrence of 2.3% between 2008 and 2015. At these low levels, there are likely no observable ecological impacts to the lake and are no reductions in ecosystem services to lake users. The EWM population of Hancock Lake has increased in recent years to almost 32% in 2017, which corresponds to 11 years after its initial detection.

Eurasian watermilfoil populations in other lakes, such as Bear Paw Lake and Little Bearskin Lake trended to almost 25% only three years following initial detection. The EWM population of Bear Paw Lake declined to below 2% by six years after detection and has increased to approximately 6% in 2017 (10 years after initial detection). The EWM population on Little Bearskin Lake followed a similar trend, but the magnitude of the decline was less and was just below 10% in 2017 (9 years after initial detection).

Boot Lake is a eutrophic system with low water clarity (approx. 3-ft Secchi depth) due to naturally-high phosphorus concentrations. It is hypothesized that water clarity conditions in some years may favor EWM growth whereas changes in these conditions may keep the population suppressed in other years. Since 2011, the EWM population of Boot Lake has stabilized around 10%, corresponding to 11-17 years following initial detection.

Rapid and large fluctuations in the occurrence of EWM like those observed on Weber Lake have also been documented. The EWM population in 2010-2011 was approximately 20% before rapidly increasing above 50% in 2012, corresponding with six years after being initially detected in the lake. Then the population declined to under 10% for two years before rebounding to approximately 17% in 2017.

The results of the study clearly indicate that EWM populations in unmanaged lakes can fluctuate greatly between years. Following initial infestation, EWM expansion was rapid on some lakes, but overall was variable and unpredictable (Nault 2016). On some lakes, the EWM populations reached a relatively stable equilibrium whereas other lakes had more moderate year-to-year variation. Regional climatic factors also seem to be a driver in EWM populations, as many EWM populations declined in 2015 even though the lakes were at vastly different points in time following initial detection within the lake.

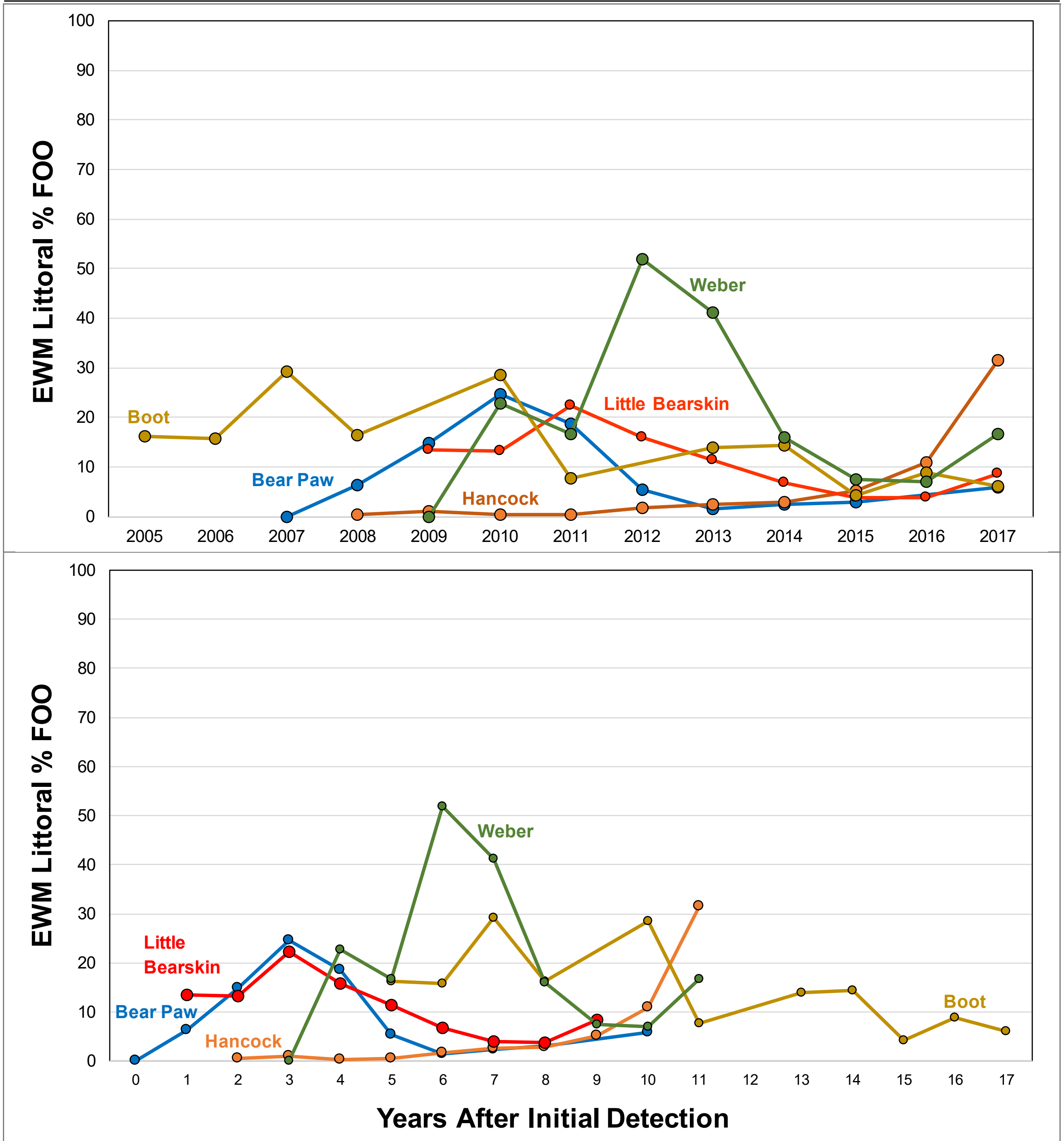


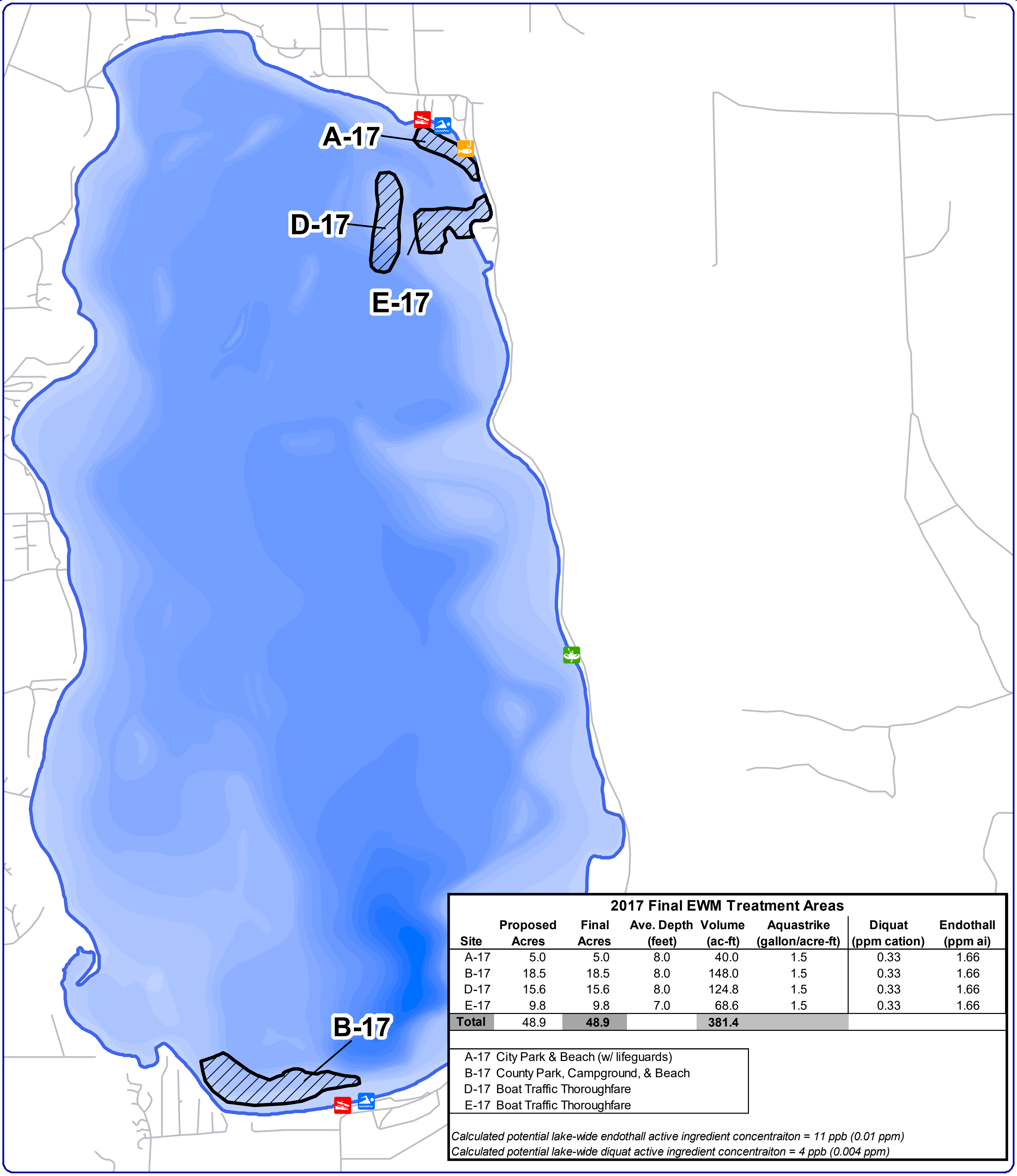
Figure 6. Littoral frequency of occurrence of EWM in the Northern Lakes and Forests Ecoregion without management. Data provided by and used with permission from the WDNR Bureau of Science Services.

CONCLUSIONS

Then 2016 *Nuisance Control and Containment Strategy* resulted in seasonally-reduced EWM populations. This strategy was replicated near the two public landings again in 2017 but with additional attention being made to conduct the treatment when wind conditions were low. This would retain the herbicide within the application areas longer to improve the impacts from the treatment. The 2017 treatment strategy was implemented at low wind conditions and the data show a higher level of EWM control than the 2016 strategy. As anticipated, relatively large impacts to the native plant community were again observed within these targeted areas.

Lake-wide EWM population declines were also observed in 2017 that cannot be directly attributed to the spot treatments that occurred near the two landings. It is believed that these reductions are largely attributed to natural population dynamics driven by environmental factors. It is unclear if the factors that reduced the lake-wide EWM population also had an impact on the lake-wide native plant community.

It is recommended that the LMA forgo the *Nuisance Control and Containment Strategy* in 2018 in favor of monitoring the aquatic plant community through continued late-summer EWM mapping surveys and a whole-lake point-intercept survey. These and other surveys are to be conducted on Lake Metonga in 2018 as the LMA starts a project to update their *Comprehensive Management Plan*. The LMA was awarded an AIS-Education, Prevention, & Planning Grant from the WDNR that will provide cost assistance for this roughly two-year project. The management planning process will result in the creation of a long-term strategy to address all matters of concern, not just the presence of EWM. It would include assessments of the water quality, watershed, shoreline condition, fisheries, native aquatic plant communities, and stakeholder perceptions on the lake. An important component of this process will allow the LMA to objectively review their ongoing AIS management activities, outline appropriate thresholds of when specific control strategies warrant implementation, and establish measurable success criteria standards to monitor future control strategies.



2017 Final EWM Treatment Areas

Site	Proposed Acres	Final Acres	Ave. Depth (feet)	Volume (ac-ft)	Aquastrike (gallon/acre-ft)	Diquat (ppm cation)	Endothall (ppm ai)
A-17	5.0	5.0	8.0	40.0	1.5	0.33	1.66
B-17	18.5	18.5	8.0	148.0	1.5	0.33	1.66
D-17	15.6	15.6	8.0	124.8	1.5	0.33	1.66
E-17	9.8	9.8	7.0	68.6	1.5	0.33	1.66
Total	48.9	48.9		381.4			

A-17	City Park & Beach (w/ lifeguards)
B-17	County Park, Campground, & Beach
D-17	Boat Traffic Thoroughfare
E-17	Boat Traffic Thoroughfare

Calculated potential lake-wide endothall active ingredient concentraiton = 11 ppb (0.01 ppm)
Calculated potential lake-wide diquat active ingredient concentraiton = 4 ppb (0.004 ppm)

N E S W

1,750
Feet

Onterra, LLC
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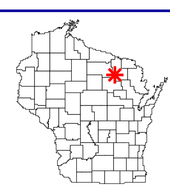
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: WDNR, digitized by Onterra
Aquatic Plant Survey: Onterra, 2016
Map Date: May 11, 2017



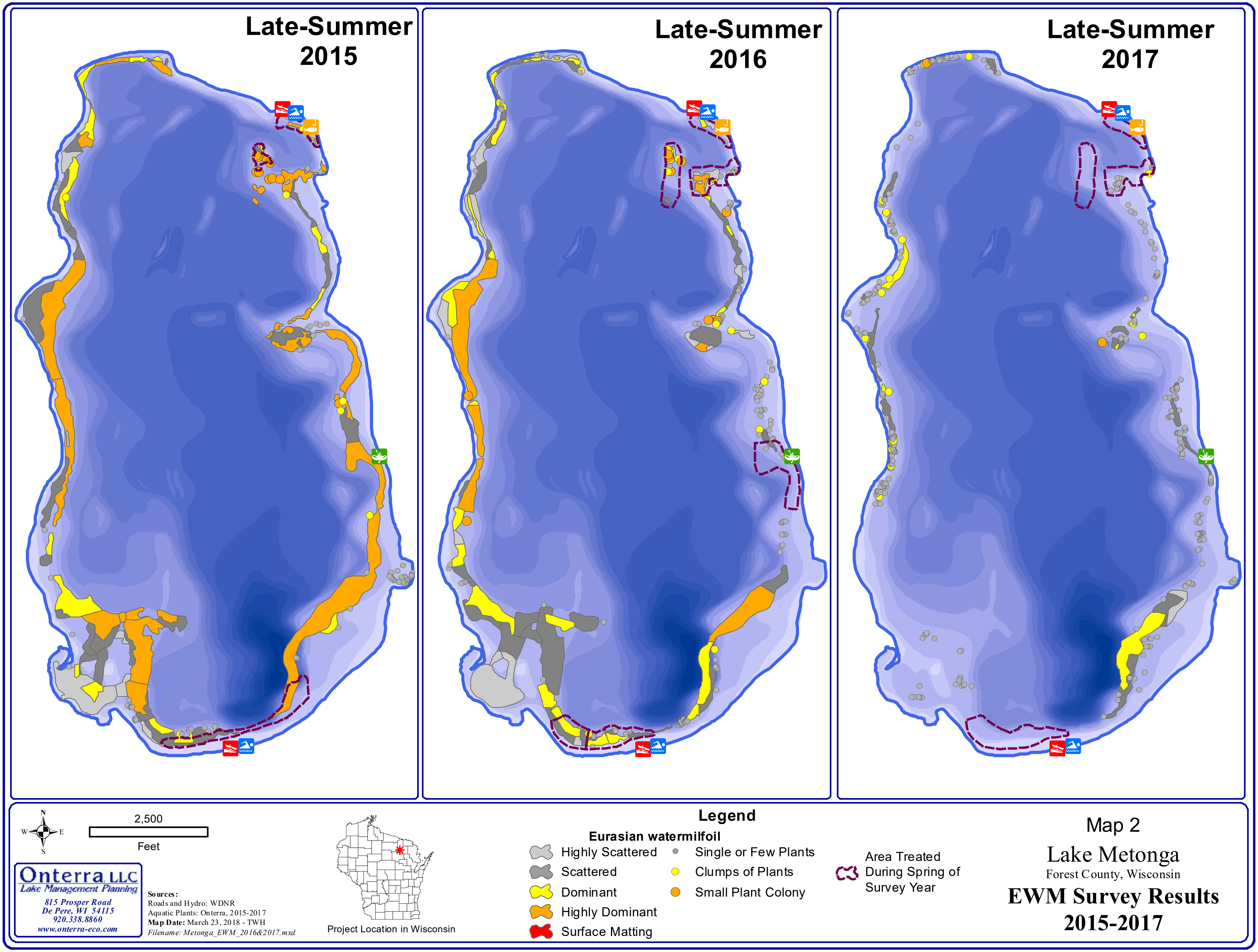
Project Location in Wisconsin

Legend

Final EWM Treatment Site

Map 1
Lake Metonga
Forest County, Wisconsin

2017 Final EWM Control Strategy



Late-Summer 2015
Late-Summer 2016
Late-Summer 2017
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W
E
S
2,500
Feet
Onterra LLC
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www.onterra-eco.com
Sources:
Roads and Hydro: WDNR
Aquatic Plants: Onterra, 2015-2017
Map Date: March 23, 2018 - TWH
Filename: Metonga_EWM_2016&2017.mxd
Project Location in Wisconsin
Legend
Eurasian watermilfoil
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony
Area Treated During Spring of Survey Year
Map 2
Lake Metonga
Forest County, Wisconsin
EWM Survey Results
2015-2017