INTRODUCTION

English Lake, Manitowoc County, is a 51-acre seepage lake with a maximum depth of 86 feet. Eurasian water milfoil (*Myriophyllum spicatum*; EWM) was first discovered in the lake in 2009 by members of the English Lake Protection and Rehabilitation District (ELPRD). That year, Onterra, LLC was contracted to complete a survey for EWM and discovered a dense infestation of the plant throughout the majority (13 acres) of the lake's narrow littoral area. This lead to the formulation of a whole-lake 2,4-D treatment plan that was implemented during the spring of 2010.

Whole-lake treatments are those where the herbicide may be applied to specific sites, but the goal of the strategy is for the herbicide to reach a target concentration when it equally distributes throughout the entire volume of the lake (or lake basin, or within the epilimnion of the lake or lake basin). The application rate of whole-lake treatments is dictated by the volume of water in which the herbicide will reach equilibrium with. Because exposure time is so much greater, effective herbicide concentrations for whole-lake treatments are significantly less than required for spot treatments. In most instances, the initial concentrations are maintained for 5-7 days after treatment (DAT) before observable herbicide degradation occurs. For this reason, the average 1-7 DAT concentration is often used by lake managers as predictor of EWM efficacy and associated native plant impacts (Figure 1). Typical whole-lake treatment EWM strategies target whole-lake concentrations between 0.250 and 0.400 ppm acid equivalent (ae), as this balances "acceptable" short-term impacts to the native plant community with a high level of control of EWM. Concentrations below 0.25 ppm ae have provided short-term EWM control, but a relatively quick population recovery. In lakes that have achieved average 1-7 DAT concentrations above 0.4 ppm ae, 90-100% EWM control was observed. However, this was coupled in most instances with high level of native plant damage, some of which has not recovered 3-4 years following the treatment.

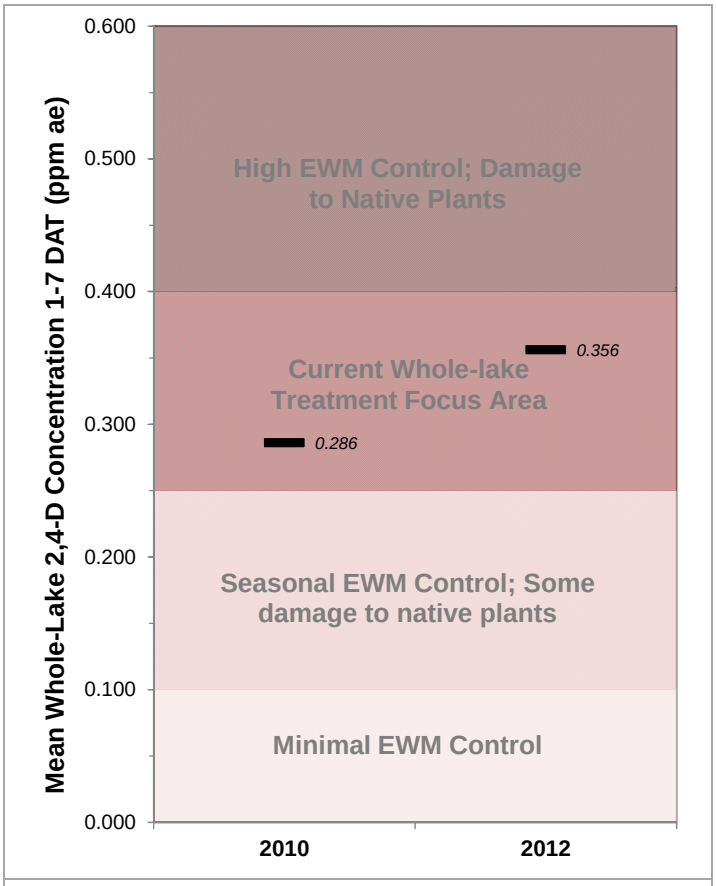


Figure 1. Observed 1-7 DAT (Days after Treatment) 2,4-D concentrations on English Lake. Categories provided from Nault et al, 2012.

The whole-lake 2,4-D treatment conducted on English Lake in 2010 achieved an average 1-7 DAT lake-wide 2,4-D concentrations of approximately 0.3 ppm ae (Figure 1); a concentration and exposure time proven successful when used on other lakes. While initially the treatment appeared effective, the EWM rebounded to almost pretreatment levels by the end of the year of treatment.

Due to distinct features of the EWM's morphology, Onterra field staff suspected that the EWM in English Lake may be a hybrid, a cross between EWM and the indigenous northern water milfoil

(*Myriophyllum sibiricum*). Subsequent plant material were collected in 2011 and sent by Onterra to the Annis Water Resources Institute at Grand Valley State University in Michigan for DNA analysis. Their results confirmed that the milfoil present in English Lake is a hybrid between EWM and the native northern water milfoil. The concept of heterosis, or hybrid vigor, is important in regards to hybrid water milfoil management on English. The root of this concept is that hybrid individuals typically have improved function compared to their pure-strain parents. Hybrid water-milfoil typically has thicker stems, is a prolific flowerer, and grows much faster than pure-strain EWM (LaRue et al. 2012). These conditions likely contribute to this plant being particularly less susceptible to biological (Enviroscience personal comm.) and chemical control strategies (Glomski and Netherland 2010, Poovey et al. 2007). Data gathered from whole-lake 2,4-D treatments in Wisconsin from 2009-2014 suggest that treatments on lakes with populations of HWM were not as successful when compared to lakes with pure-strain EWM. In other words, it appears that some strains of HWM, but not all, are more tolerant of 2,4-D treatments than pure-strain EWM.

Also in 2011, Onterra ecologists collected approximately 600 live strands of HWM from English Lake and sent to SePRO for herbicide challenge testing. Their study indicated that the HWM plants tested from English Lake were less responsive to auxin herbicides (2,4-D and triclopyr) than a pure EWM reference strain (SePRO unpublished data).

With this new information, another whole-lake low-concentration 2,4-D treatment strategy was developed for 2012 that included a higher target concentration of approximately 0.350 ppm ae. Herbicide monitoring of the 2012 treatment indicated the herbicide may not have evenly distributed throughout the lake, but the concentrations that were measured (1-7 DAT average of 0.356 ppm ae) should have been sufficient to cause significant HWM control (Figure 1). While HWM littoral occurrence was reduced by 21%, this level of control failed to meet expectations given the concentration and exposure time of 2,4-D measured within the lake.

While it was understood that eradication of HWM from English Lake was highly unlikely, those involved, including the district, WDNR, USACE, Onterra, and the applicator, were expecting a higher level of HWM control from the 2012 whole-lake treatment. Because the 2012 treatment did not meet expectations, a strategy involving a combination of 2,4-D and endothall was developed for 2013. The manufacturer of the brand name of endothall (Aquathol K by United Phosphorus, Inc.) agreed to donate the endothall for the trial treatment, recommending that the epilimnetic concentration of endothall be approximately 0.750 ppm ai (0.532 ppm ae) and the epilimnetic target concentration of 2,4-D be 0.250 ppm ae.

The 2013 whole-lake 2,4-D and endothall treatment on English Lake was effective at controlling the HWM population on a lake-wide level during 2013, as no HWM was observed during the year of treatment. Aquatic plant monitoring surveys conducted in June 2014 detected some rebound in HWM plants. The ELPRD solicited the services of Aquatic Plant Management LLC (APM) to conduct manual removal of HWM during the summer of 2014 resulting in 42 diver hours of hand harvesting. Surveys conducted in August 2014 showed HWM continued to rebound and re-establish in the lake since the June survey. A control strategy utilizing professional hand harvesting at a greater amount of effort was proposed for 2015.

A set of HWM mapping surveys were used within this project to coordinate and qualitatively monitor the hand-harvesting efforts. The first monitoring event on English Lake in 2015 was the Early Season Aquatic Invasive Species Survey (ESAIS). This late-spring/early-summer survey provides an early look at the lake to help guide the hand-harvesting management to occur on the system. Following the

hand-harvesting, Onterra ecologists completed the Late-Summer HWM Peak-Biomass Survey, the results of which serve as a post-treatment assessment of the hand-harvesting. The hand-removal program would be considered successful if the density of HWM within the hand-removal areas was found to have decreased from the ESAIS Survey to the Late-Summer Peak-Biomass Survey.

EARLY SEASON AIS SURVEY

Onterra conducted an ESAIS survey on June 1, 2015 to map CLP at its peak biomass and to locate areas of HWM, of which the data would be provided to hand harvesters. These populations were 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 AIS locations that were considered as *Small Plant Colonies* (<40 feet in diameter), *Clumps of Plants*, or *Single or Few Plants*.

As Figure 2 illustrates, the CLP population consists of only occurrences mapped using point-based methods and that no large colonized populations are present in the lake. The CLP population within English Lakes remains small and continues to be relatively stable without significant expansion or spreading being evident over the past number of years.

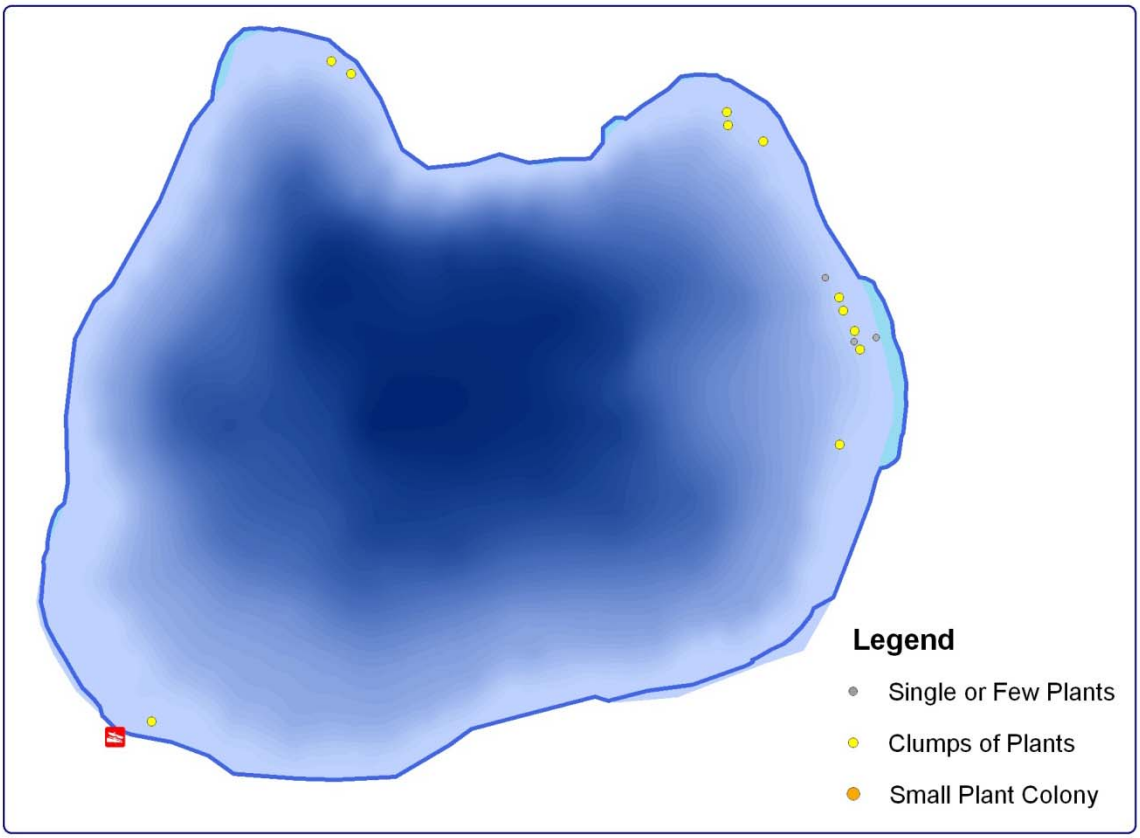


Figure 2. English Lake CLP Population June 2015.

During the June 2015 survey, HWM occurrences were mapped and the results of this survey were provided to the professional hand-harvesting firms to target these occurrences during the summer growing season.

HAND-HARVESTING MANAGEMENT ACTIONS

The ELPRD contracted with Aquatic Plant Management, LLC and Eco Waterway Services to conduct professional hand-harvesting of HWM in 2015. Utilizing traditional diving methods, Aquatic Plant Management conducted hand-harvesting activities on June 24-25, 2015. During these events, divers spent a combined total of 48.64 hours actively hand-harvesting HWM within English Lake removing approximately 375 gallons of HWM (Table 1). Requiring a mechanical harvesting permit from the WDNR, Eco Waterway Services utilizes a Diver Assisted Suction Harvester (DASH) which involves a scuba diver feeding HWM plants through a suction hose that delivers and filters the plants to a boat on the surface. Eco Waterway conducted harvesting activities on July 27-29, removing approximately 5043 pounds of HWM over the course of 25 diver hours (Table1). Details of the professional hand harvesting activities as reported by APM and Eco Waterway are included as an appendix to this report.

Table 1. English Lake, 2015 professional hand-harvesting activities

Aquatic Plant Management (APM)

Site	Dive Time (Minutes)	EWM Removed (gallons)
C-15	150	75
D-15	275	185
E-15	175	115
Total	**600**	**375**

Eco Waterway Services

Site	DASH Time (Hours)	EWM Removed (pounds)
A-15	22	4573
B-15	0	0
E-15	3	470
Totals	**25**	**5043**

LATE-SUMMER HYBRID EURASIAN WATER MILFOIL PEAK BIO-MASS SURVEY

The Late-Summer HWM Peak-Biomass Survey was conducted on August 11, 2015 to qualitatively assess the hand harvesting efforts as well as to understand the peak growth (peak-biomass) of the HWM population throughout the lake.

Figure 3 displays the qualitative results of the areas in which hand harvesting was undertaken in 2015. Sites C, D and E were initially recommended for control from divers associated with APM. Site E-15 was given first priority due to its location nearer to the public boat launch. APM reported unfavorable conditions for removal within the site including thick algal growth, limited visibilities, plants lying down near the bottom sediment and very soft and silty substrates (Appendix A). APM reported removing 115 gallons over the course of 175 diving minutes (2 hours 55 minutes) within the site. Additional removal efforts were undertaken within site E-15 during the late July visit to the lake by Eco Waterway. Although not in an area initially permitted for DASH removal, a small amount of time was dedicated in the area in which docking and off-loading activities were focused in an effort to minimize HWM spread and fragmentation. Three hours of dive time resulted in an additional 470 pounds of HWM removed from the site. During the August 2015 survey, HWM within site E-15 was found to have increased considerably since June with much of the site containing colonized HWM ranging from *scattered* to *highly dominant* densities (Figure 3). Considering the observations made by divers from APM within the site, the HWM densities were likely under-represented in the early June ESAIS survey in which plants lying down near the surface may not have been fully documented. The

combined removal efforts within site E-15 were not able to overcome the rate of HWM growth and control expectations were not met for the site.

Within site D-15, APM reported removing 185 gallons of HWM from 275 minutes (4 hours 35 minutes) of diving time. Following the August survey, HWM was found to have expanded within the site from a *scattered* colony and several point-based occurrences in June, to a denser and larger colony composed of densities ranging from *scattered* to *surface matting* plants (Figure 3). Success criterion were not met within site D-15. Two hours and thirty minutes of dive time were dedicated to Site C-15 by APM resulting in 75 gallons of HWM removed. Following the August 2015 survey, HWM within the site was reduced one level of density throughout most of the site with the exception a smaller *dominant* colony remaining within the site following the hand harvesting (Figure 3). The majority of HWM acreage was reduced by one density level within site C-15 meeting the predetermined success criteria of 75 % acreage reduced by at least one density level.

Eco Waterways spent the majority of their diving efforts within site A-15 having removed 4,573 pounds of HWM over the course of 22 diving hours. A qualitative assessment within the site shows the northern portion of the site was reduced in density by one rating from *dominant* in June to s*cattered* in August (Figure 3). The rest of the site saw either no change in density or an increase in density. Qualitative success criteria were marginally met for site A-15. Due to time constraints, no removal efforts were conducted in site B-15. In the absence of any control efforts, HWM expanded in density significantly within Site B-15 compared to previous surveys (Figure 3).

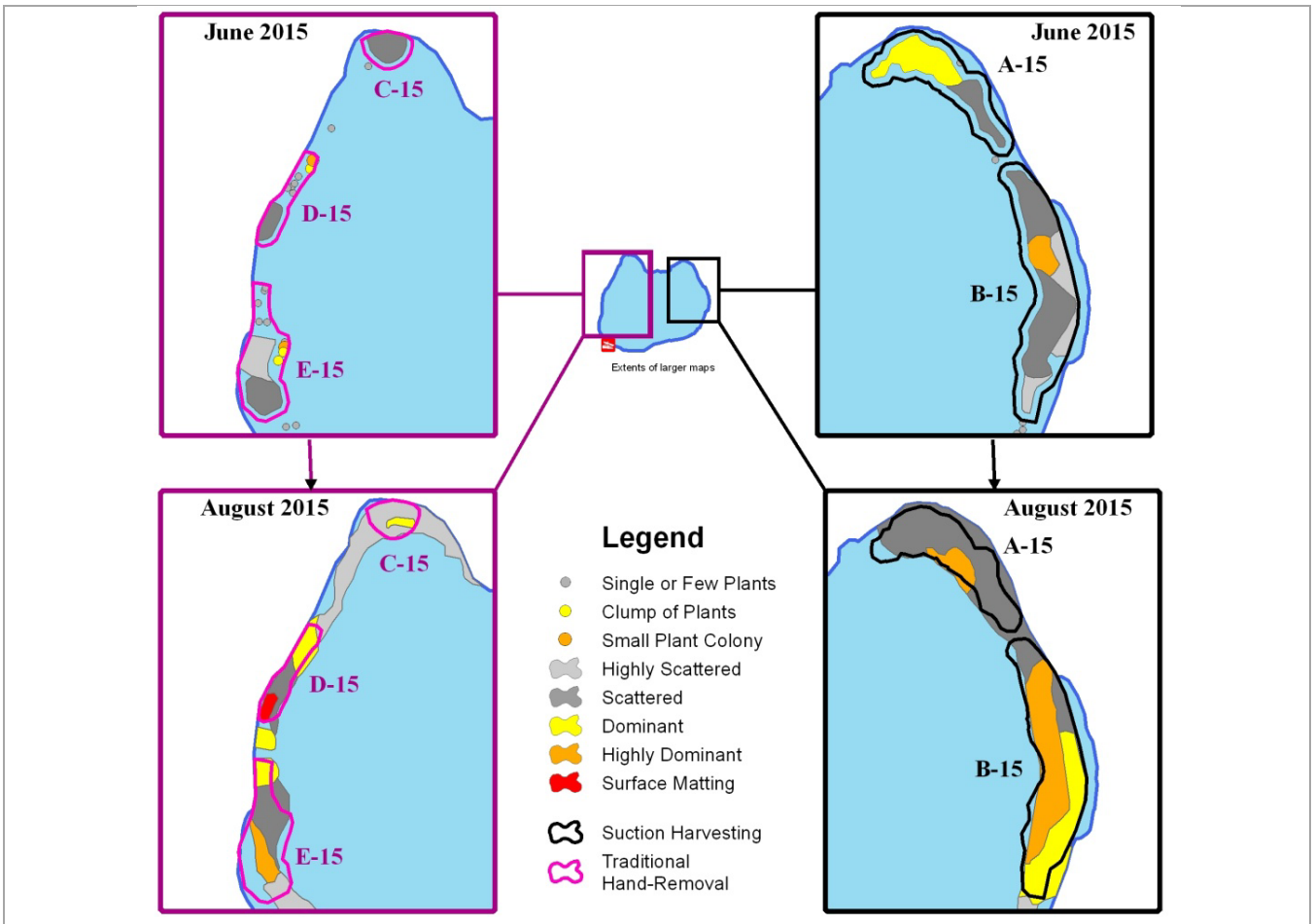


Figure 3. June 2015 Pre- and August 2015 Post-Hand Harvesting results on English Lake.

AQUATIC PLANT SURVEY RESULTS

Hybrid water milfoil Response

Because whole-lake treatments were conducted on Englsih Lake in 2010, 2012 and 2013, the whole-lake point-intercept method, as described by the WDNR Bureau of Science Services (Hauxwell et al. 2010), was used to complete quantitative evaluations of the occurrences of HWM and native aquatic plant species within the lake. Point-intercept surveys have been conducted in 2006 by the WDNR and annually on English Lake since 2010 by Onterra staff. During the August 2015 point-intercept survey, HWM was sampled on 29 of the 77 littoral sampling locations, yielding a littoral frequency of occurrence of 37.7% (Figure 3). This indicates the HWM population showed a significant increase in population over the levels from 2013-2014 following the reductions observed after the whole lake herbicide treatment in spring 2013. The 37.7% littoral frequency of HWM is similar to the 36.1% recorded in 2012 prior to the 2013 whole-lake herbicide treatment.

During the August 2015 HWM Peak-Biomass Survey, Onterra mapped 7.0 acres of HWM in English Lake compared to 0.1 acres in 2014 and 0 acres in 2013. The levels of HWM observed in 2015 are significantly higher than the previous two years however are somewhat below pre-treatment levels observed in 2012 in which HWM colonies covered 10.8 acres of the lake. Of the 7 acres of HWM mapped in 2015, 2.3 acres are considered *dominant*, *highly dominant* or *surface matting* in density.

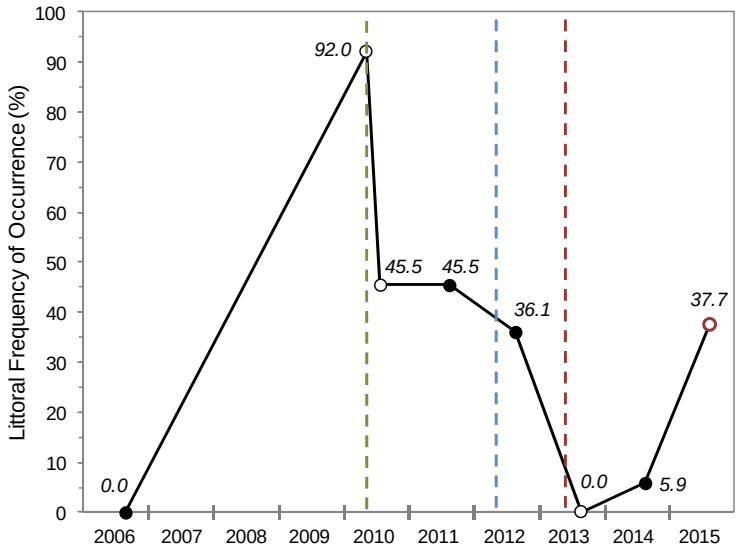


Figure 3. HWM littoral frequency of occurrence in English Lake from 2006 and 2010-2015. Created using data from WDNR 2006 and Onterra 2010-2015 point-intercept surveys. Open circle represents statistically valid change from previous survey. Dashed lines indicate whole-lake herbicide treatments.

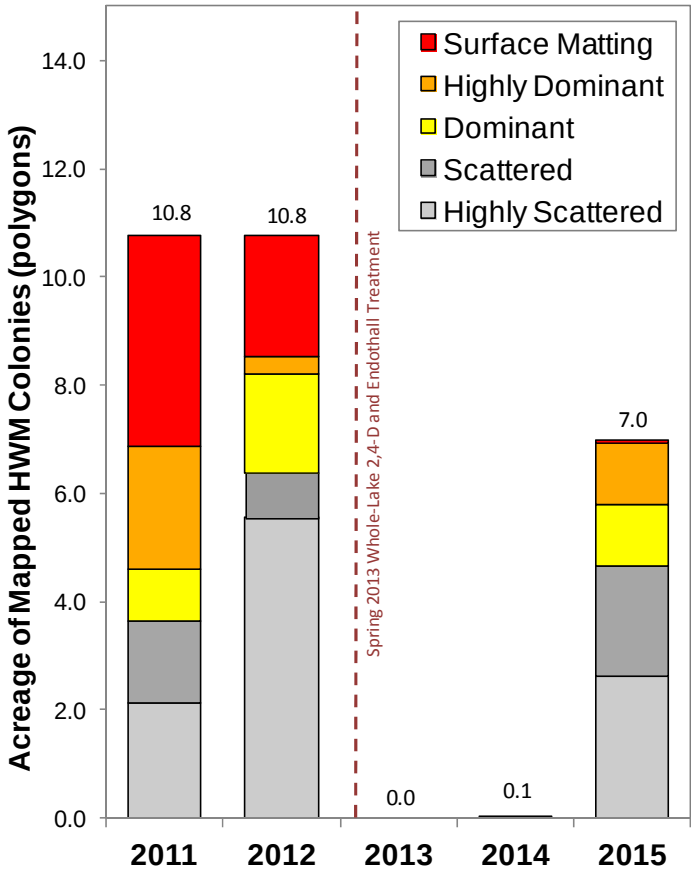


Figure 4. Acreage of HWM colonies mapped in English Lake from 2011-2015. Data collected from Onterra August HWM Peak Biomass Surveys 2011-2015.

Individual Aquatic Plant Species Response

The objective of any herbicide treatment strategy is to maximize target species (HWM) mortality while minimizing impacts to valuable native aquatic plant species. However, adverse impacts to some native aquatic plant species are predictable following whole-lake herbicide treatment strategies. Two native aquatic plants exhibited statistically valid changes in their occurrence during the summer following the 2013 treatment. The monocot slender naiad exhibited a statistically valid reduction in occurrence of 82%, while the macroalgae muskgrasses exhibited a statistically valid increase in occurrence of 108%.

The littoral frequencies of native aquatic plant species available from the seven (2006, 2010-2015) summer point-intercept survey are shown in Figures 5 & 6. Three plant species exhibited a significant decrease in littoral frequency from 2014 to 2015 while one native species saw a significant increase. Muskgrasses was reduced by 70.3%, slender naiad by 63.9% and small pondweed saw a 100% reduction from 2014 to 2015. In addition to hybrid water milfoil (540% increase), coontail also saw a significant increase of 80.6% from 2014 to 2015. Coontail is a largely unrooted plant that entangles itself on vegetation and other structure (rocks, wood, etc). It is hypothesized that with the increase in structure provided by HWM, populations have increased above levels observed in 2013 and 2014. The population decreases exhibited by the muskgrasses, slender naiad and small pondweed may be a result of inter-annual variation, although it is possible these changes are a result of the hand-harvesting operations.

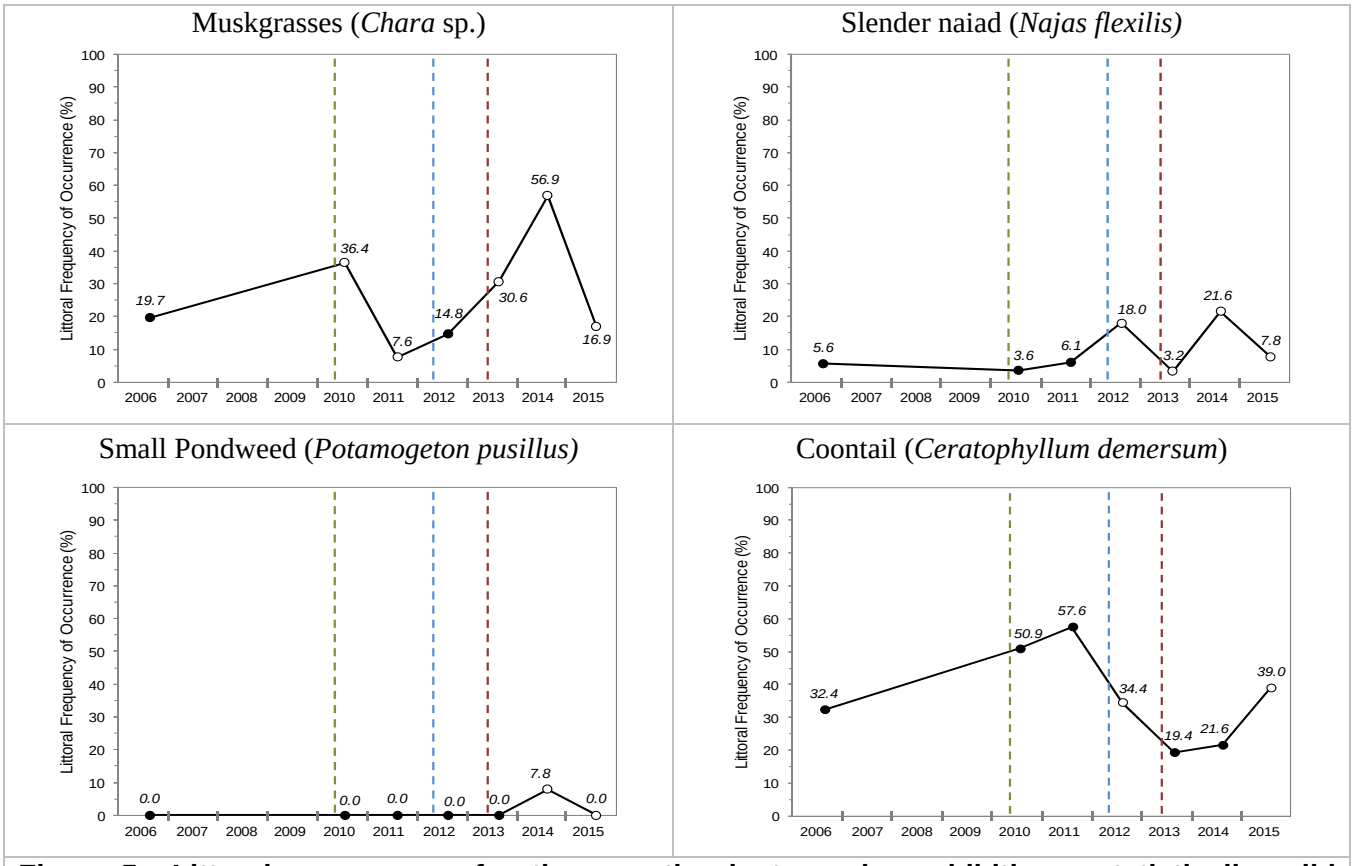


Figure 5. Littoral occurrence of native aquatic plant species exhibiting a statistically valid change in population from 2014 to 2015 within English Lake. Created using data from WDNR 2006 and Onterra 2010-2015 point-intercept surveys. Open circle represents statistically valid change from previous survey.

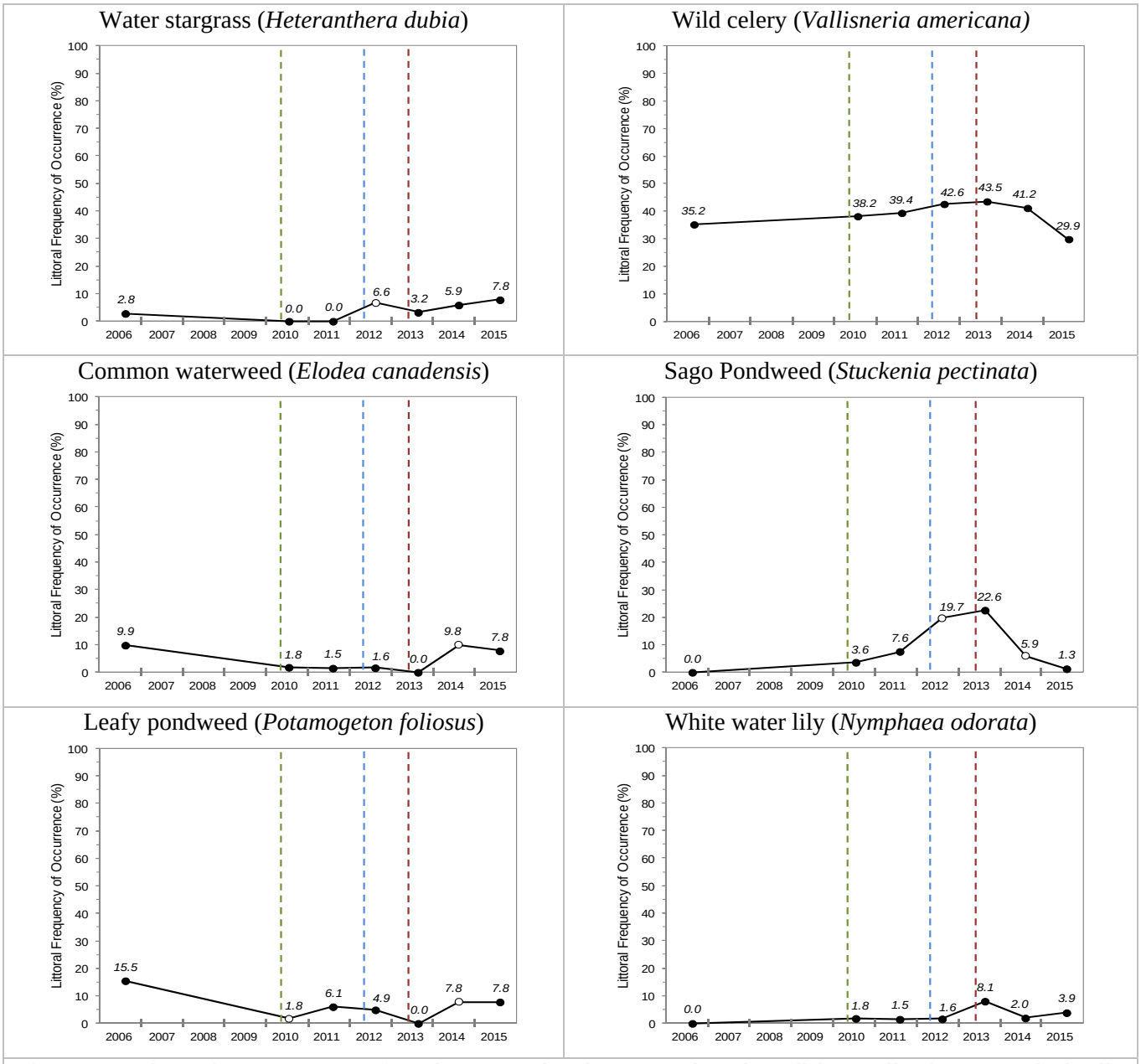


Figure 6. Littoral occurrence of native aquatic plant species that did not display a statistically valid change in occurrence from 2014-2015 within English Lake. Created using data from WDNR 2006 and Onterra 2010-2015 point-intercept surveys. Open circle represents statistically valid change from previous survey.

The overall abundance of native plants was observed to be less in 2013 compared to 2010-2012. Figure 7 shows a semi-quantitative analysis of the abundance of aquatic plants through looking at total rake fullness ratings (i.e. how full of plants is the sampling rake at each location). During 2013, there were no locations that had the highest rake fullness rating and only a few locations that had more than the lowest rake fullness rating. The data indicate that the abundance of vegetation in 2014 was approximately as high as in 2010, when much of the biomass of the lake was comprised of the non-native HWM. With only 5.9% of sampling locations containing HWM in 2014, most of the plant abundance can be attributed to native plants. Overall plant abundance in 2015 was slightly lower than in 2014 and similar to levels observed in 2011-2012. The 37.7% of sampling locations containing

HWM in 2015 is very similar to plant abundances in 2012 prior to the last whole-lake herbicide treatment

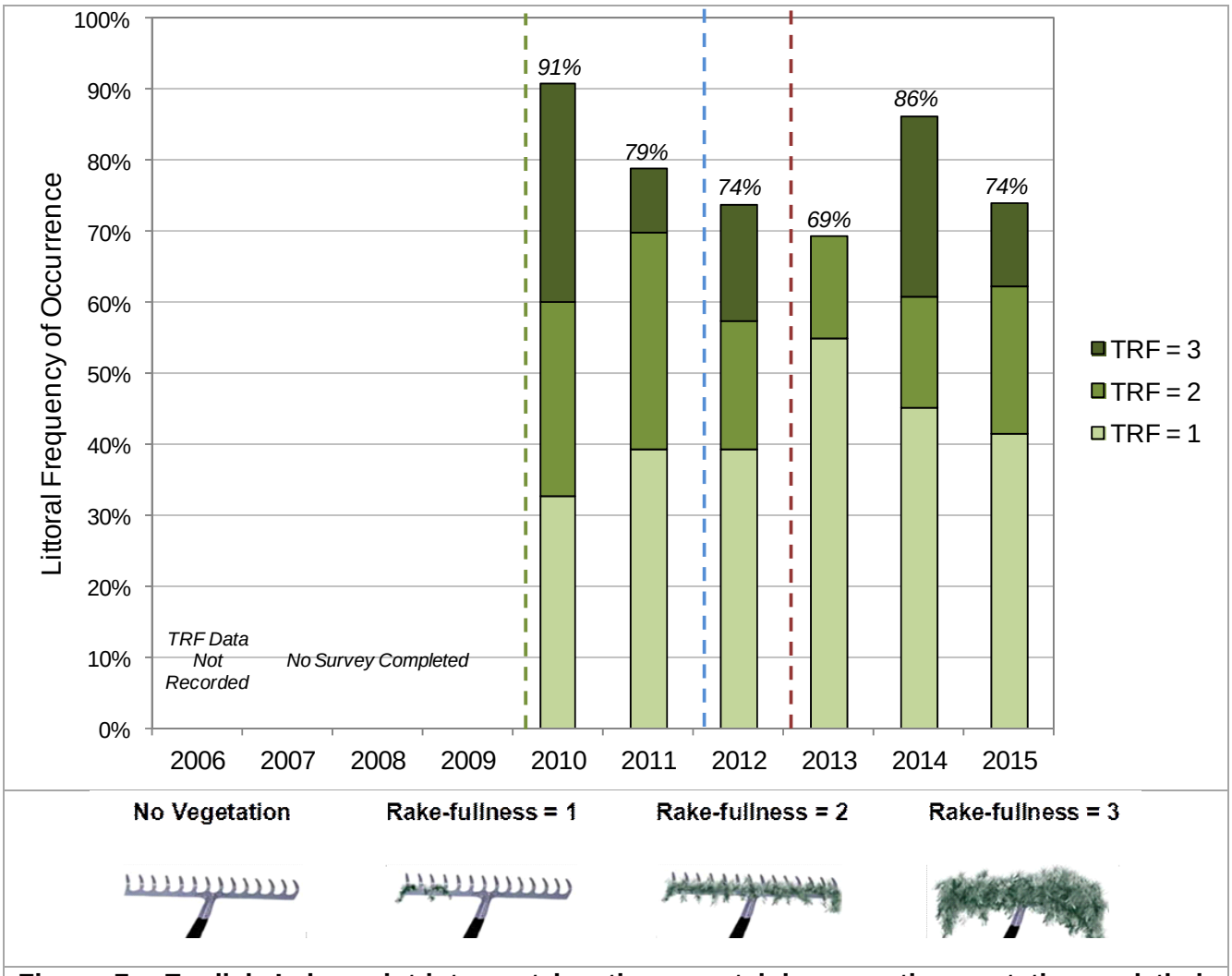


Figure 7. English Lake point-intercept locations containing aquatic vegetation and their respective total rake fullness rating. Created using data from WDNR 2006 and Onterra 2010-2015 point-intercept surveys.

CONCLUSIONS AND DISCUSSION

While the ELPRD and lake managers would liked there to have been no HWM rebound/regrowth following the aggressive whole-lake scale combination 2,4-D and endothall treatment, surveys conducted in 2015 indicate HWM to be showing strong signs of recovery in the third summer following treatment. Professional hand removal efforts conducted over the past two years have been shown to provide some limited control in the targeted areas but have not kept pace with the expanding HWM population in the lake (Map 1). During the late-summer of 2013, a few months following the spring treatment, 2-3 native plants displayed some reductions and the overall biomass of aquatic plants within the lake was lessened. The 2014 and 2015 data show that these reductions were short-lived and the native aquatic plant population of English Lake is arguably better than it has been since the introduction of EWM/HWM into the lake.

If active management of HWM is to occur on English Lake in the near future, several options should be considered. One option brought forth by the ELPRD was potentially conducting a spot treatment to target some of the densest colonized HWM located in 2015, likely using herbicides that require short exposure times, such as diquat or herbicide combinations (diquat/endothall, 2,4-D/endothall, etc). Supplementing the spot treatment control scenario, professional hand harvesting services could again be considered for controlling HWM in other areas of the lake. This strategy will likely provide localized control and relief from the nuisance conditions associated with dense HWM populations. However, it is unclear if this method will provide sustained, population-level control.

Conducting another whole-lake herbicide treatment is another avenue that English Lake may investigate moving forward. A few alternative treatment strategies that are less commonly used in Wisconsin have been employed on a number of lakes, including English Lake. These strategies are explored below as well as their potential applicability in the near future. Please note that the herbicide application costs discussed below should only be used as a general guide.

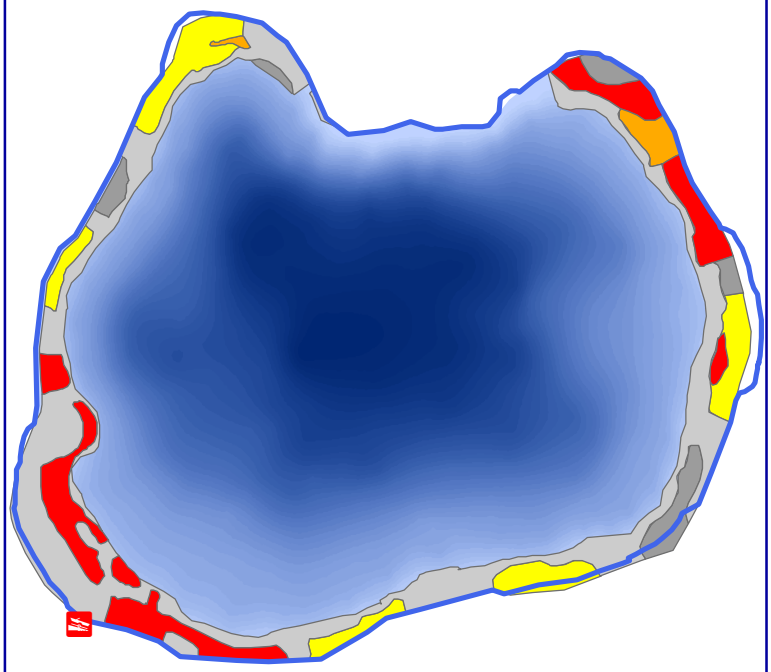
1. Auxin and Endothall Combination – 2,4-D & Endothall: An additive, potentially synergistic advantage occurs when combining 2,4-D and endothall. The simultaneous exposure to endothall and 2,4-D has been shown to provide increased control of EWM in outdoor growth chamber studies (Madsen et. al 2010). Promising results of HWM control and selectivity towards native plants were observed when this strategy was implemented on English Lake in 2013. However, rapid HWM rebound was observed on English Lake to approximately pretreatment levels in as short as two years after treatment. It has been suggested that the HWM that has been observed rebounding in these instances may be a result of germination from a seed (or turion) bank in the sediment, which would be an outcome regardless of the herbicide initially used to achieve control. Others suggest that this herbicide use pattern acts too quickly on the plant and fails to kill the entire plant (i.e. the roots) which results in population rebound during the year after treatment. General estimations for conducting a combination whole-lake 2,4-D/endothall treatment targeting approximately 0.25 ppm ae and 0.75 ppm ai, respectively are roughly $24,000.

2. Slow Acting Enzyme Inhibitor Herbicide – Fluridone. Fluridone is a systematic herbicide that disrupts photosynthetic pathways (carotenoid synthesis inhibitor). Because the herbicide degrades via photolysis (some microbial degradation may also occur) and requires long exposure times (>60 days) to cause mortality to HWM, adding additional herbicide ("bump treatment") a few weeks following the initial application may be required based upon herbicide concentration monitoring results. While more economical to implement, this herbicide it is often critiqued because of its perceived reduced selectivity towards native aquatic plants (WDNR 2012). However, results from more recently executed treatments (i.e. 2013 Frog Lake, Florence County, WI) have shown excellent control (no HWM located to date) and almost complete native plant rebound by two years after the treatment.

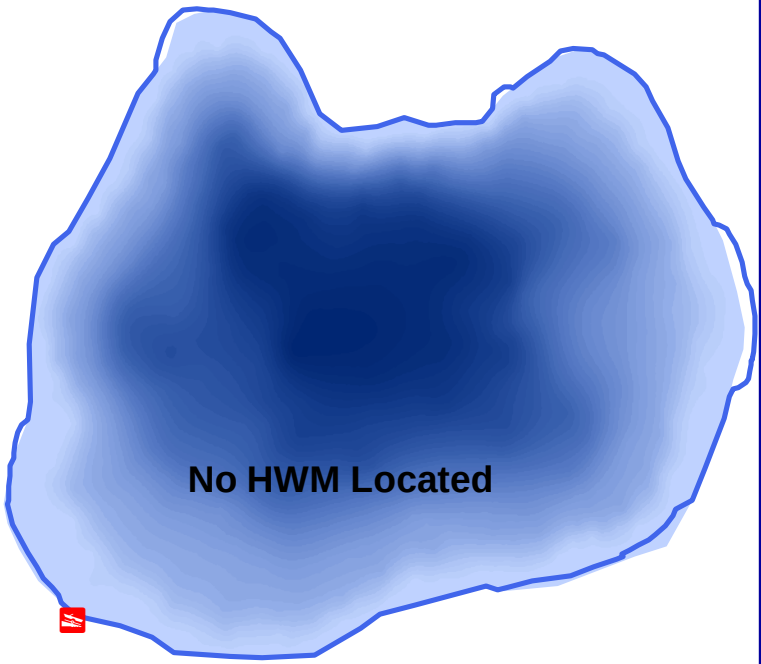
    a. More commonly used in other Midwestern states (esp. Michigan), a common fluridone use pattern involves applying liquid fluridone to achieve a lake-wide concentration of 6 parts per billion (ppb) and following up with an additional "booster" or "bump" treatment approximately three weeks following the first application. The goal of the bump treatment would be to bring the lake-wide concentration of fluridone within the lake back up to 6.0 ppb (referred to as 6-bump-6). General estimations for conducting a whole-lake liquid fluridone treatment targeting 6 ppb (with a single additional bump treatment) are $13,000.

b. Emerging use patterns of fluridone, particularly in a pelletized formulation with slightly later start times, appear to demonstrate some increased selectivity towards native plants. While liquid fluridone treatments result in a high initial concentration that taper off over time as the herbicide degrades, pelletized fluridone treatments gradually reach peak concentrations and result in a lower, sustained lake-wide herbicide concentration. This strategy would target 4 ppb for the initial treatment; but because herbicide comes off the pellet slowly, in-lake concentrations should only be 2-3 ppb. For initial planning purposes, potentially two follow-up bump treatments of 2 ppb each may be required. General estimations for conducting a whole-lake pelletized fluridone treatment targeting 4 ppb (with two additional bump treatments) are $14,000. It is important to note that on some lakes, the bump treatments may be reduced or eliminated based upon the measured fluridone concentrations of the lake prior to initiating the bump treatment. Along with the project cost savings, this also adds protection to keeping the fluridone concentrations within the target range.

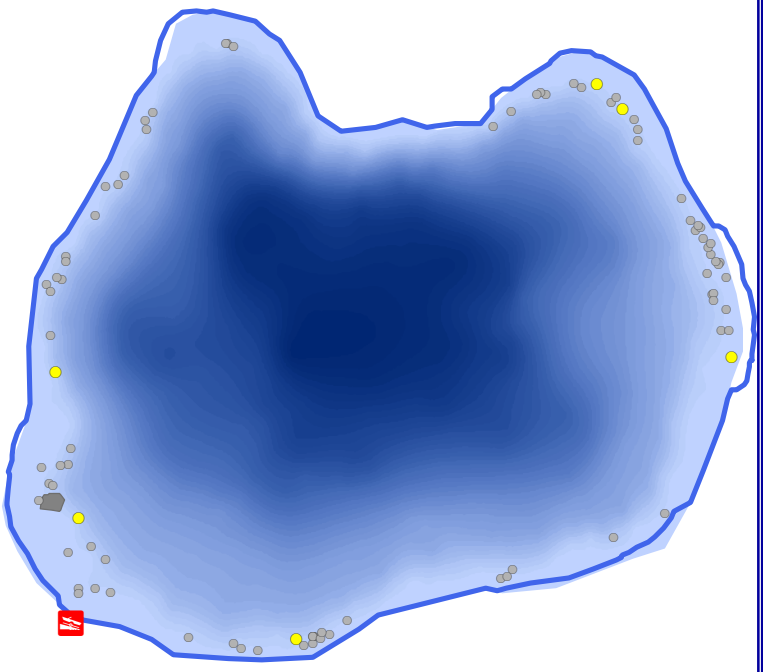
At this time, Onterra's recommendation would be for the ELPRD to re-evaluate its control goals for English Lake. If the goals are to tolerate HWM within the lake, it may be appropriate to continue conducting hand-harvesting efforts potentially in combination with limited herbicide spot treatments. If the control goal is to impact the HWM population lake-wide, another whole-lake herbicide treatment is likely warranted. Whole-lake treatments have financial costs, as well as can have potential secondary impacts to the lake. Therefore, whole-lake treatments are often postponed until the HWM population exceeds a certain threshold in order to balance these factors. Another whole-lake treatment may be warranted as soon as the spring of 2017. Postponing large-scale management past 2016 will allow more information to be available regarding other whole-lake 2,4-D/endothall and pelletized fluridone treatments conducted in Wisconsin during 2015 and 2016. Postponing large-scale efforts until 2017 may also allow the ELPRD to investigate additional funding strategies (i.e. support by district members for increased dues, WDNR AIS-EPC grant funds).



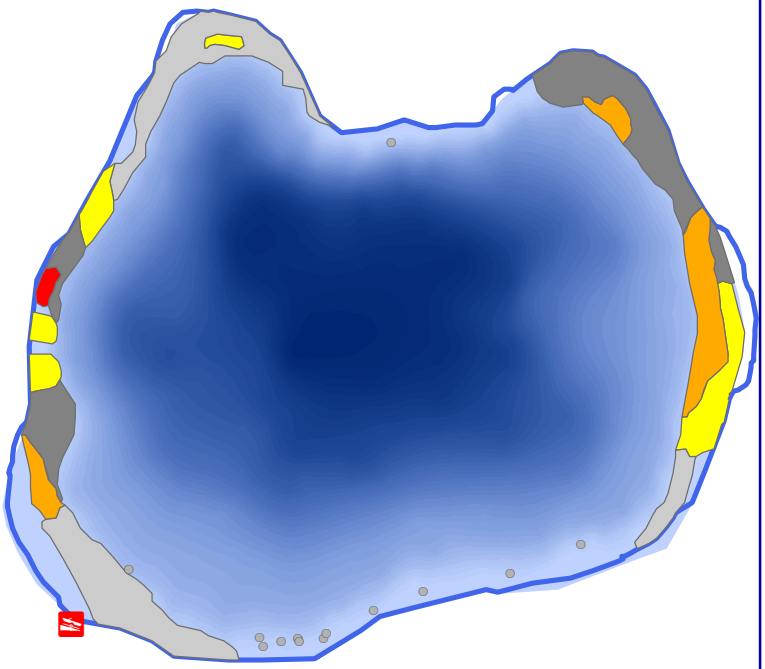
August 2012
(Year Before Treatment)



August 2013
(Year of Treatment)



August 2014
(Year After Treatment)



August 2015
(2 Years After Treatment)

N
W E
S

500
Feet

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

Sources:
Aquatic Plant Survey: Onterra, 2012-2015
Bathymetry: Onterra 2012

Map Date: December 21, 2015

Project Location in Wisconsin

Legend

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

Map 1
English Lake
Manitowoc County, Wisconsin

2012-2015 Hybrid Water Milfoil Distribution

Aquatic Plant Management LLC

English Lake EWM Removal Report
Summer 2015

1696 Silver Beach Drive Lac du Flambeau, WI 54538

English Lake EWM Removal Summary 2015

Summary: On June 24th and 25th, 2015 Aquatic Plant Management LLC (APM) conducted hand removal services of Eurasian Water Milfoil (EWM) on English Lake. Four experienced divers spent a combined total of 48.64 hours on the water and were able to successfully remove approximately **375 gallons** of EWM from the lake.

Dive Conditions: Conditions on June 24th and 25th were excellent with good initial water clarity and light winds. We began at site E-15 as requested, but due to thick algal growth on the EWM and a very silty substrate, we were forced to move on to D-15 before completion as visibility was quickly reduced to less than a foot. Most of the EWM we encountered was heavily saturated with algal growth which caused it to lie flat along the bottom, concealing it until we reached down into the sediment. Some plants were standing tall in the water column, but the vast majority of the EWM was overlapping at the bottom, with 4-5 foot plants rising up only 4 or 5 inches, with silt and algae obscuring them from the surface. Some of the areas mapped as highly scattered were actually fairly dense beds, but were concealed until the silt was disturbed.

Recommendations: The identified sites are manageable, however, and with a continued annual hand-harvesting effort, can be kept in check. At site C-15 the potential for regrowth is low, but E-15 and D-15 had several areas of obscured EWM that should be monitored and targeted for hand-harvesting in 2016.

Detailed Summary of Diving Activities – 6/24/15

Date	Dive Location	Latitude	Longitude	Time Underwater (Min)	Estimated EWM Removed (Gallons)	EWM Density Rating	Comments
6/24/2015	E-15	44.04478	87.7887	45	30	5	Substrate consisted of thick muck covered by a light layer of silt. Most EWM was located in 3-5 feet of water.
6/24/2015	E-15	44.04491	87.78841	40	35	5	Substrate consisted of thick muck covered by a light layer of silt. Most EWM was located in 3-5 feet of water.
6/24/2015	D-15	44.04633	87.78812	60	45	6	Substrate consisted of thick muck covered by a light layer of silt. Most EWM was located in 4-6 feet of water. Most plants were laying down against the bottom and weaved over top of one another, making removal difficult.
6/24/2015	D-15	44.04654	87.78797	50	40	6	Substrate consisted of thick muck covered by a light layer of silt. Most EWM was located in 4-6 feet of water. Most plants were laying down against the bottom and weaved over top of one another, making removal difficult.
6/24/2015	E-15	44.04456	87.7886	90	50	6	Substrate consisted of thick muck covered by a light layer of silt. Most EWM was located in 3-5 feet of water.

EWM Density Rating	0	1	2	3	4	5	6	7	8	9	10
Plants per 5 Square Yards	0	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20

Detailed Summary of Diving Activities – 6/25/15

Date	Dive Location	Latitude	Longitude	Time Underwater (Min)	Estimated EWM Removed (Gallons)	EWM Density Rating	Comments
6/25/2015	D-15	44.04605	87.78857	45	40	5	Substrate consisted of thick muck covered by a light layer of silt. Most EWM was located in 4-6 feet of water. Most plants were laying down against the bottom and weaved over top of one another, making removal difficult.
6/25/2015	D-15	44.04642	87.78819	60	35	5	Substrate consisted of thick muck covered by a light layer of silt. Most EWM was located in 4-6 feet of water. Most plants were laying down against the bottom and weaved over top of one another, making removal difficult.
6/25/2015	C-15	44.04771	87.78713	60	30	6	Substrate consisted of thick muck covered by a light layer of silt. Most EWM was located in 3-4 feet of water. EWM was spaced further apart than D-15, allowing for easier removal.
6/25/2015	C-15	44.04771	87.78699	90	45	6	Substrate consisted of thick muck covered by a light layer of silt. Most EWM was located in 3-4 feet of water. EWM was spaced further apart than D-15, allowing for easier removal.
6/25/2015	D-15	44.04627	87.78827	60	25	4	Substrate consisted of thick muck covered by a light layer of silt. Most EWM was located in 4-6 feet of water. Most plants were laying down against the bottom and weaved over top of one another, making removal difficult.

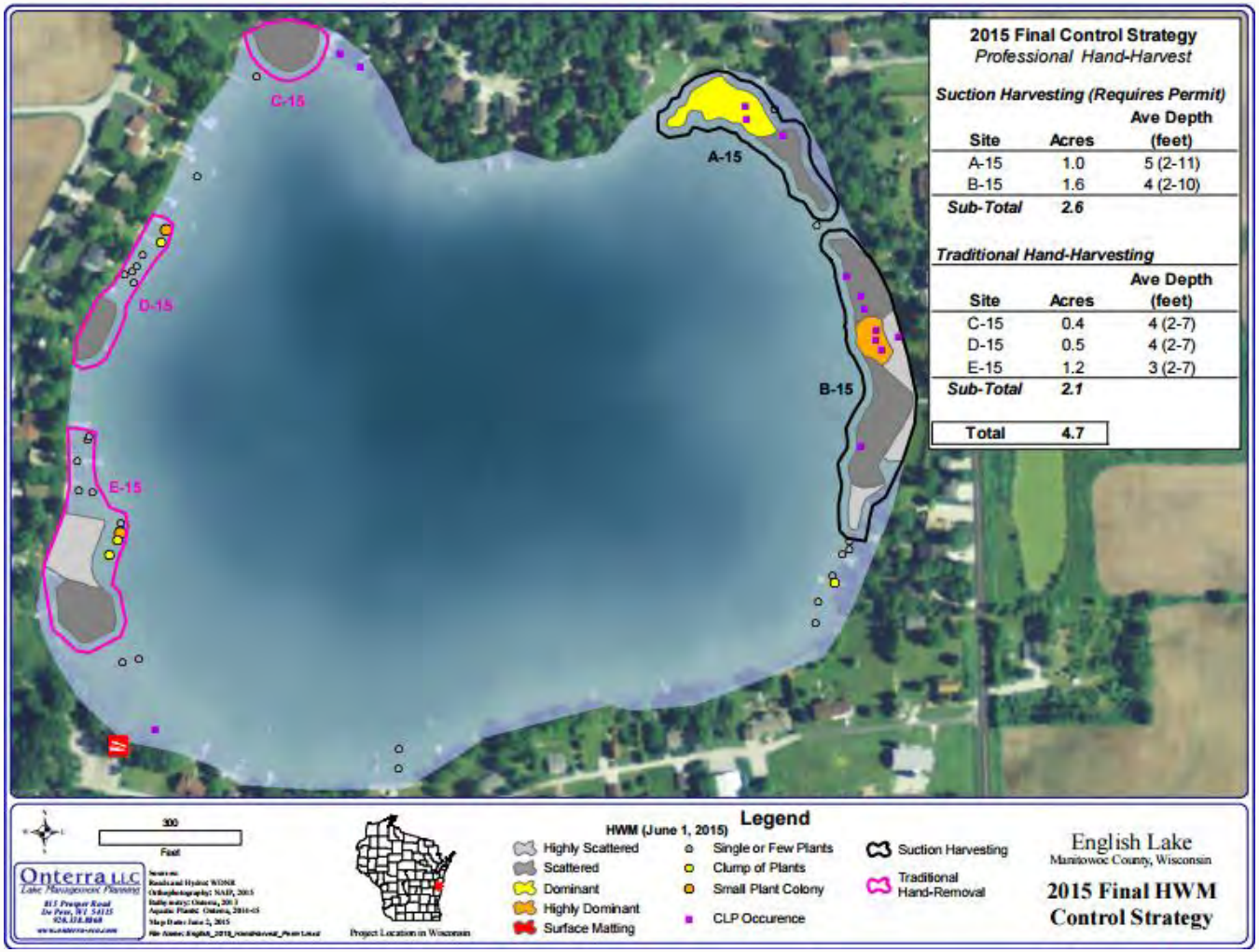
EWM Density Rating	0	1	2	3	4	5	6	7	8	9	10
Plants per 5 Square Yards	0	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20

EWM Pictures

EWM Pictures

EWM Pictures

Map Created by Onterra LLC



English Lake /Onterra Project		Non Diver hrs	Weed Disposal	Divers hrs Billable	Bag Count	LBS	CY	% non milfoil	decimal %*	lbs milfoil*	lbs non milfoil*
Date	**Notes**										
7/27/215	Travel Day/Set up/A-15 Harvesting; Started at far SE corner of Section A-15. Move to far NW area where more dominant plants were by early evening.	4.0	0.50	7.75	22	880	22	8%	0.08	809.6	70.4
7/28/2015	Site A-15 Harvesting- NW dominant area		0.50	8.50	60	2400	60	2%	0.02	2352	48
7/28/2015	Site E-15 by our boat dock dominant area			3.00	12	480	12	2%	0.02	470.4	9.6
7/29/2015	Site A-15 Harvesting- NW dominant area		1.00	5.75	36	1440	36	2%	0.02	1411.2	28.8
	Additional Weed Disposal		1.00								
7/29/2015	Travel/Take down	4.0									
	Boat Cleaning	1.5									
	Project Total	**9.50**	**3.00**	**25.00**	**130**	**5200**	**130**			**5043.2**	**156.8**

*Denotes Fields Modified by Onterra, LLC

ENGLISH LAKE PROTECTION
and
REHABILITATION DISTRICT

FINAL REPORT: AQUATIC INVASIVE SPECIES
GRANT # ACEI-117-12

In the summer of 2011 lake residents noticed Eurasian Water Milfoil (EWM) growing in English Lake. The Lake District Chair was very pro-active and immediately contacted Onterra, LLC to study the invasive species and the District applied and received a DNR grant. The District's goal was to control the species.

To achieve the District's goal the following took place:

A. Onterra, LLC staff mapped with GPS the (EWM) colonies and removed over 600 samples to study.

B. Upon completion of the study, ecologists recommended chemically treating the lake. Staff from Clean Lakes treated the lake in the spring of 2012. Unfortunately, the chemical treatment did not work on the EWM.

C. In the summer of 2013 Onterra staff again mapped the colonies and samples were taken to be studied and analyzed. It was found that the lake's EWM was a hybrid variety and thus would need a different chemical compound to treat the invasive species.

D. Spring of 2014 Clean Lakes staff applied an experimental chemical to the lake and the amount of EWM in the lake was reduced.

E. Spring of 2015 some colonies of the invasive EWM were still present in the Lake. It was decided not to apply another chemical treatment to the lake, but to have divers hand harvest the EWM colonies. At this time Aquatic Plant Management LLC staff removed 375 gallons of EWM.

F. Lake residents volunteer involvement during Aquatic Invasive Species Control Grant.

1. 339 hours at public boat landing inspecting boats for EWM.

2012	122 hours
2013	107 "
2014	60 "
2015	50 "

During the grant period volunteer monitors observed that many boats entering the lake were repeat users of this lake and had been inspected and educated on the importance of boat cleaning for invasive species.

2. A team of volunteers monitored the lake for invasive species throughout the grant period. During that time 67 hours of monitoring was completed.

3. At least 7 people attended training sessions on Citizen Lake Monitoring of Invasive Species presented by Tom Ward of Manitowoc County Lakes Association. At the public boat landing Tom Ward did a training session on Clean Boats Clean Waters for a 12 lake residents and future monitors. Lake District Chair did additional annual training during the grant period for CBCW and CLMN for 8 additional residents.

4. During the grant period 139 hours of hand pulling invasive species was completed by residents pulling EWM around their piers and shoreline as well as volunteers hand pulling at other areas on the lake.

5. During the grant period several complete lake chemical treatments were done to the lake to remove EWM. Monitors were needed for pre and post testing of the lake for temperature and sampling of chemical residue remaining from the treatments. Monitoring consisted of a pontoon boat driver, someone to take the samples and another person to record the sampling results. Together the volunteers logged 184 hours of work during the grant period.

6. A boat cleaning inspection station at the public boat landing was constructed in the first year of the grant. This was the first boat cleaning station in Manitowoc County. Manitowoc County Lakes Association and Manitowoc County parks and planning staff assisted in the contraction and installation of the station. Because of the success of this cleaning station coupled with requests from many boaters many more stations were installed at other Manitowoc County Lake boat landings. Volunteers spent 108 hours of maintaining the cleaning station, i.e. supplying bleach water several times a week as well replacing any broken or missing equipment.

All aspects of the grant have been completed, but efforts have not eliminated the EWM from the Lake. The Lake District will continue working with the DNR and Onterra staff to devise means and methods to control EWM in English Lake. Property owners will continue inspecting boats at the public landing for invasive species along with keeping cleaners and equipment at the landing for boaters to use. Our goals are to inform boaters about the EWM problem and to encourage better boat cleaning practices on our lake, as well as other lakes, to avoid the spread of invasive species.