1.0 INTRODUCTION

The Unified Lower Eagle River Chain of Lakes Commission (ULERCLC) successfully applied for a Wisconsin Department of Natural Resources (WDNR) Aquatic Invasive Species (AIS) Control Grant in August of 2013 to complete the sixth phase of a project aimed at reducing and keeping down the Eagle River Chain's Eurasian water milfoil (EWM, *Myriophyllum spicatum*) population. This report discusses the seventh year of treatment under this grant-funded AIS control and prevention project. The chain-wide results will be presented first followed by results from each lake individually. Additional information regarding the treatments completed in 2008-2012 can be found in their respective reports. A separate report (completed in 2013) describes complete native aquatic vegetation inventories from whole-lake point-intercept surveys that were conducted on all ten lakes within the Eagle River Chain in 2012. Additionally, the report compares the 2012 aquatic plant inventories with similar assessments that were carried out in 2006 as part of a chain-wide lake management planning project.

1.1 Herbicide Control of Aquatic Invasive Plants

As a part of the current project, strategic and spatially targeted herbicide treatments have been conducted on the Eagle River Chain since 2008 in an effort to control EWM. Herbicides that target submersed plant species are directly applied to the water, either as a liquid or an encapsulated granular formulation. Factors such as water depth, water flow, treatment area size, and plant density work to dilute herbicide concentration within aquatic systems. Understanding concentration-exposure times is an important consideration for aquatic herbicides. Successful control of the target plant is achieved when it is exposed to a lethal concentration of the herbicide for a specific duration of time. Much information on this issue has been gathered in recent years, largely as a result of a joint research project between the WDNR and US Army Corps of Engineers (USACE). Based on their preliminary findings, lake managers have adopted two main treatment strategies: 1) whole-lake treatments, and 2) spot treatments.

Whole-lake treatments are those where the herbicide is applied to specific sites, but when the herbicide reaches equilibrium within the entire volume of water (of the lake, lake basin, or within the epilimnion of the lake or lake basin); it is at a concentration that is sufficient to cause mortality to the target plant within that entire lake or basin. The application rate of whole-lake treatments is dictated by the volume of water in which the herbicide will reach equilibrium with. The target herbicide concentration for EWM treatments is typically between 0.275 and 0.400 parts per million (ppm) acid equivalent (ae) when exposed to the target plants for 7-14 days or longer. However, these same rates have been shown to impact some native plant species, particularly dicot species, some thin-leaved pondweeds, and naiad species. This strategy was implemented with success in 2010 on Scattering Rice Lake and only small area and low density EWM occurrences have been noted from this waterbody since the 2010 treatment.

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 effects outside of that area. This is the strategy that has historically and is currently being implemented on areas of EWM within the Eagle River Chain of Lakes. Spot treatments typically rely on a short exposure time (often hours) to cause mortality and therefore are applied at a much higher herbicide concentration than whole-lake treatments.

Herbicide application rates for spot treatment are formulated volumetrically, typically targeting 2,4-D at 3.0-4.0 ppm ae. This means that sufficient 2,4-D is applied within the *Application Area* such that if it mixed evenly with the *Treatment Volume*, it would equal 3.0-4.0 ppm ae. This standard method for determining spot treatment use rates is not without flaw, as no physical barrier keeps the herbicide within the *Treatment Volume* and herbicide dissipates horizontally out of the area before reaching equilibrium (Figure 1). While lake managers may propose that a particular volumetric dose be used, such as 3-4.0 ppm ae, it is understood that actually achieving 3-4.0 ppm ae within the water column is not likely due to dissipation and other factors.

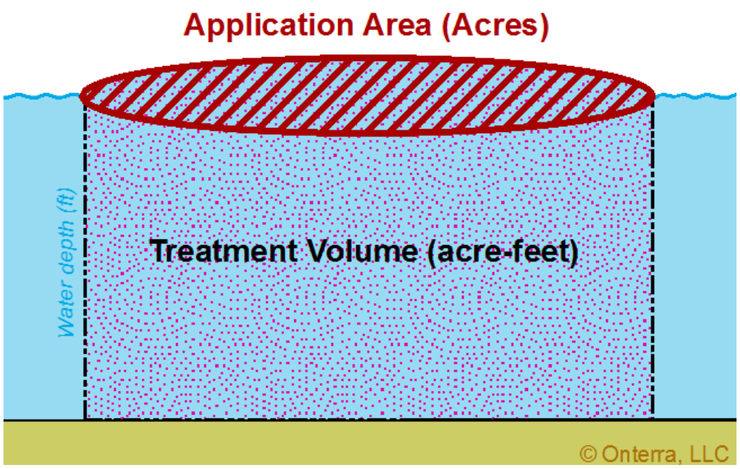


Figure 1. Herbicide Spot Treatment diagram.

Granular 2,4-D, which is typically used in spot-treatment scenarios, was chosen for the majority of treatment sites within the Eagle River Chain of Lakes. Ongoing research clearly indicates that the herbicide concentrations and exposure times of large (> 5 acres each) treatment sites are higher and longer than for small sites. Research also indicates that higher herbicide concentrations and exposure times are observed in protected parts of a lake compared with open and exposed parts of the lake.

Ongoing research is currently not able to demonstrate that granular herbicides maintain higher herbicide concentrations over liquid herbicides in spot treatment scenarios, and may actually be showing the opposite. With granular herbicides it is theorized that some of the 2,4-D granules sink into or bind with the sediment, not allowing a portion of the product to be included in herbicide measurements within the water column. Preliminary data indicate that surprisingly high 2,4-D concentrations exist near the sediment-water interface (porewater) in association with granular treatments. Some herbicide applicators and industry professionals have observed what has been interpreted as successful granular treatments in instances where measured herbicide concentrations within the water column would have suggested otherwise. In these cases, it has been theorized that the higher porewater 2,4-D concentrations have been the mechanism that caused the successful treatment. However, it is not known if there is a mode of action for the EWM plants to uptake the herbicide at this location within the water column, away from the foliage which is suspected as being the primary uptake location. Ongoing research is occurring on this topic, but preliminary and unpublished results suggests that when auxin herbicides (2,4-D and triclopyr) are applied directly to the roots of EWM in growth chambers, effective control is not achieved.

2.0 EAGLE RIVER CHAIN PRE-TREATMENT STUDIES

Table 1. Eagle River Chain 2013 EWM Treatment Acreage.

Lake	Proposed Acres	Final Acres
Catfish	4.5	6.4
Cranberry	34.3	34.3
Duck	0.0	0.0
Eagle	0.7	0.7
Lynx	0.0	0.0
Otter	0.0	0.0
Scattering Rice	1.6	1.6
Voyageur	1.2	1.2
Watersmeet	62.0	50.3
Yellow Birch	11.9	11.8
All Waterbodies	**116.2**	**106.3**

Following the 2012 peak-biomass survey, conditional treatment permit maps were created proposing 116.2 total acres of treatment on Cranberry, Catfish, Eagle, Yellow Birch, and Watersmeet Lakes (Table 1). It was determined that Duck, Lynx, and Otter Lakes did not hold sufficient populations of EWM to warrant treatment. On May 22 and 23, 2013, Onterra staff visited the Eagle River Chain to survey the proposed treatment areas and refine their boundaries as appropriate, primarily through the use of a submersible video camera. As a result of the spring pre-treatment survey, the treatment strategy was decreased to 106.3 acres in total for the seven lakes slotted for treatment (Table 1). Two sites in Catfish Lake were added to the treatment strategy and slight modifications were made to two sites within Yellow Birch Lake. Following the submission of the conditional treatment permit in early April 2012 and a subsequent multi-agency review by the WDNR and Great Lakes Indian Fish and Wildlife Commission (GLIFWC), the treatment of EWM within certain parts of Watersmeet Lake was suspended due to concerns regarding the proximity of wild rice populations. Based on laboratory and outdoor growth chamber research, wild rice has been shown to be vulnerable to early season herbicide treatments (Nelson et al 2003; Madsen et al. 2008).

Wild rice is an emergent aquatic grass that grows in shallow water of lakes and slow-moving rivers. Wild rice has cultural significance to the Chippewa Tribal Communities as well as being an important component of their diets. In addition, wild rice has great ecological importance as a valuable wildlife food source, provider of wildlife habitat, soil stabilizer, and it uptakes nutrients. Discussion of wild rice, particularly as it pertains to EWM management, is discussed within the Watersmeet Lake section of this report.

In 2010, both liquid and granular 2,4-D formulations were applied to EWM on the Eagle River Chain. Liquid 2,4-D (amine) was used in a large-scale treatment on Scattering Rice Lake while granular 2,4-D (ester) was applied to smaller treatment areas throughout the rest of the chain. Both strategies were shown to be successful at reducing the density and occurrence of EWM. The strategy employed in 2013 involved spot-treatments on colonized EWM within six Eagle River Chain lakes, utilizing the granular form of 2,4-D (amine), and large-scale treatments on Watersmeet Lake, Cranberry Lake and Yellow Birch Lake utilizing the liquid form of 2,4-D (amine).

While past successes were yielded using Navigate® (ester), the re-registration of this herbicide now accompanies a 1-day swimming restriction. Primarily for that reason, the ULERCLC decided that Sculpin G® (amine) would be the 2,4-D product used for the 2012 and 2013 spot treatments. Between May 31 and June 3, 2013, treatment sites were applied with either granular form 2,4-D Sculpin G® or liquid 2,4-D Navigate® (DMA 4 IVMI) by Schmidt's Aquatic Plant Control at a rate to achieve target concentrations of 3.0 to 3.5 ppm ae. The applicator reported wind conditions ranging from calm to 10 mph and water temperatures at the surface ranging from 57°F – 64.9°F.

3.0 2013 TREATMENT MONITORING

The goal of herbicide treatments is to maximize target species (EWM) mortality while minimizing impacts to valuable native aquatic plant species. Monitoring herbicide treatments and defining their success incorporates both quantitative and qualitative methods. As the name suggests, quantitative monitoring involves comparing number data (or quantities) such as plant frequency of occurrence before and after the control strategy is implemented. Qualitative monitoring is completed by comparing visual data such as EWM colony density ratings before and after the treatments.

3.1 Quantitative Monitoring

EWM treatment quantitative evaluation methodologies follow WDNR protocols in which point-intercept data are collected within treatment areas before and after the treatment. On the Eagle River Chain of Lakes, data of this type was collected at 229 point-intercept sub-sample locations during the summer of 2013 (Figure 2).

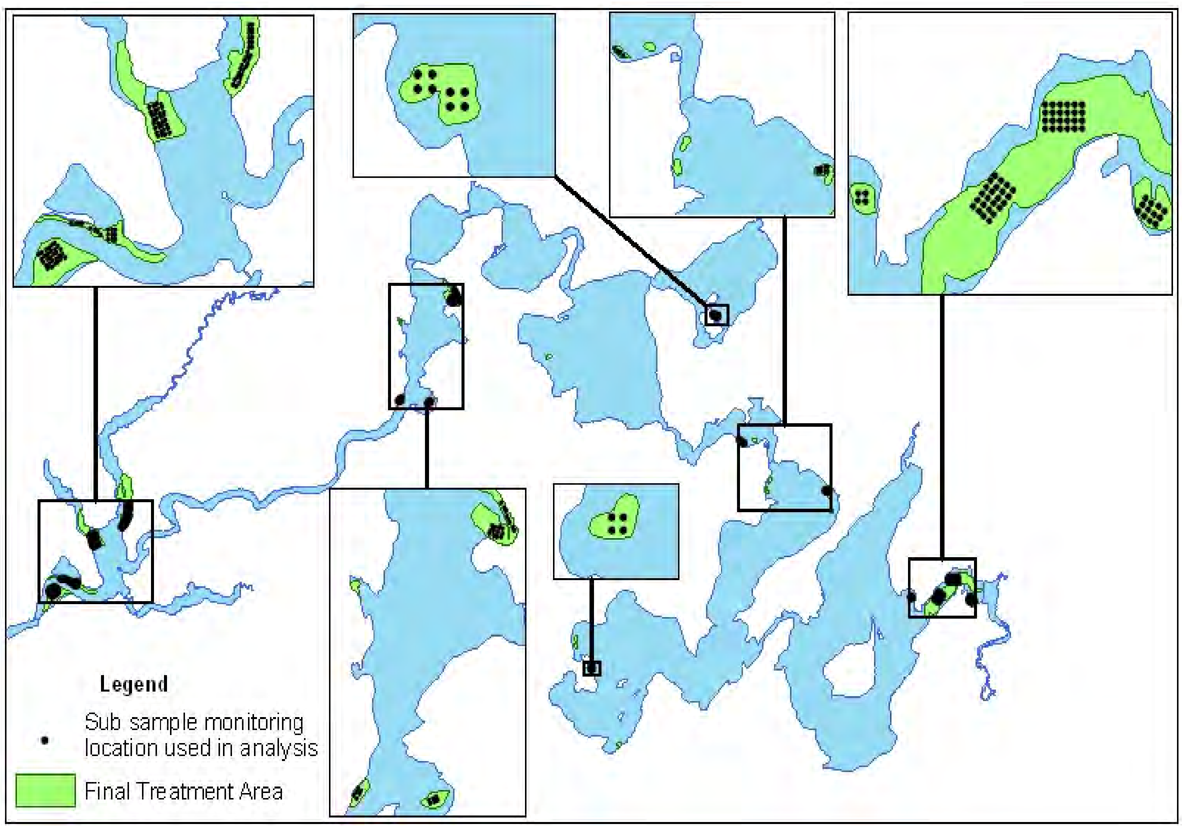


Figure 2. 2013 Quantitative monitoring plan for the Eagle River Chain of Lakes

The most comparative sub-sample data are those collected both the summer before (2012) and the summer immediately following the herbicide treatment (2013). On the Eagle River Chain of Lakes, all 229 point-intercept sub-sample locations fell into this category (Figure 2). At these sampling locations, EWM and native aquatic plant species presence and rake-fullness (on a scale of 0 to 3) were documented along with water depth and substrate type. Specifically, these surveys aim to determine if significant differences in frequencies of occurrence and density of EWM and native species occur following the herbicide application.

Quantitatively, a specific treatment site is deemed to be successful if the EWM frequency following the treatments exhibits a statistically valid reduction by at least 50%. Evaluation of treatment-wide effectiveness follows the same criteria based upon pooled sub-sample data from all of the treatment sites. Further, a noticeable decrease in rake-fullness ratings within the fullness categories of 2 and 3 should be observed. Preferably, there would be no rake tows exhibiting a fullness of 2 or 3 during the post treatment surveys.

Although it is never the intent of the treatments to impact native species, it is important to remember that in spot treatment scenarios, these non-target impacts can only be considered in the context of the areas treated and not on a lake-wide basis. In other words, the impact of the treatments on a non-target species in the treatment areas cannot be extrapolated to the entire population of that plant within the lake, unless the plant species is only found in locations where the herbicide applications took place. While product labeling indicates that 2,4-D is selective towards broad-leaf (dicot) species at the concentration and exposure times used during the 2013 treatment on the Eagle River Chain of Lakes, emerging research from the WDNR and USACE state that some narrow-leaf (monocot) species are also impacted by this herbicide.

3.2 Qualitative Monitoring

Spatial data reflecting EWM locations were collected using a sub-meter Global Positioning System (GPS) during the late summers of 2012 and 2013, when this plant is assumed to be at its peak-biomass or growth stage. Comparisons of these surveys are used to qualitatively evaluate the 2013 herbicide treatment on the Eagle River Chain. Qualitatively, a successful treatment on a particular site would include a reduction of EWM density as demonstrated by a decrease in density rating (e.g. *highly dominant* to *dominant*). In terms of a treatment as a whole (lake-wide), at least 75% of the acreage treated that year would decrease by one level of density as described above for an individual site.

3.3 Herbicide Concentration Monitoring

In conjunction with the WDNR and US Army Corps of Engineers (USACE), herbicide concentrations were monitored within and outside of select 2013 treatment areas in an effort to understand the herbicides movement and dissolution throughout the system. This information is collected to help determine if concentration levels and exposure times were met within treatment areas, and can thus be related to the efficacy of the herbicide treatment. ULERLC volunteers were trained to collect herbicide concentration samples following protocols developed by the USACE. Water samples were collected at various locations and time-periods following the treatment. Preserved samples were sent to the USACE laboratory for analysis. Results of the herbicide concentration study are available in Appendix A and Appendix B. The results of the herbicide concentration monitoring will be discussed within the individual lake section as appropriate.

4.0 2013 CHAIN-WIDE TREATMENT SUMMARY AND CONCLUSIONS

Post treatment surveys were completed on the Eagle River Chain by Onterra on September 4 and 5, 2013. Over the course of annual treatments from 2007 to 2013, EWM colonial acreage has been qualitatively reduced by 67% from 278.2 acres in 2007 to 92.2 acres in 2013. EWM density also decreased markedly over this period, from EWM mainly comprised of dominant, highly dominant, and surface matted areas in 2007 to scattered and highly scattered areas in 2013 (Figure 3).

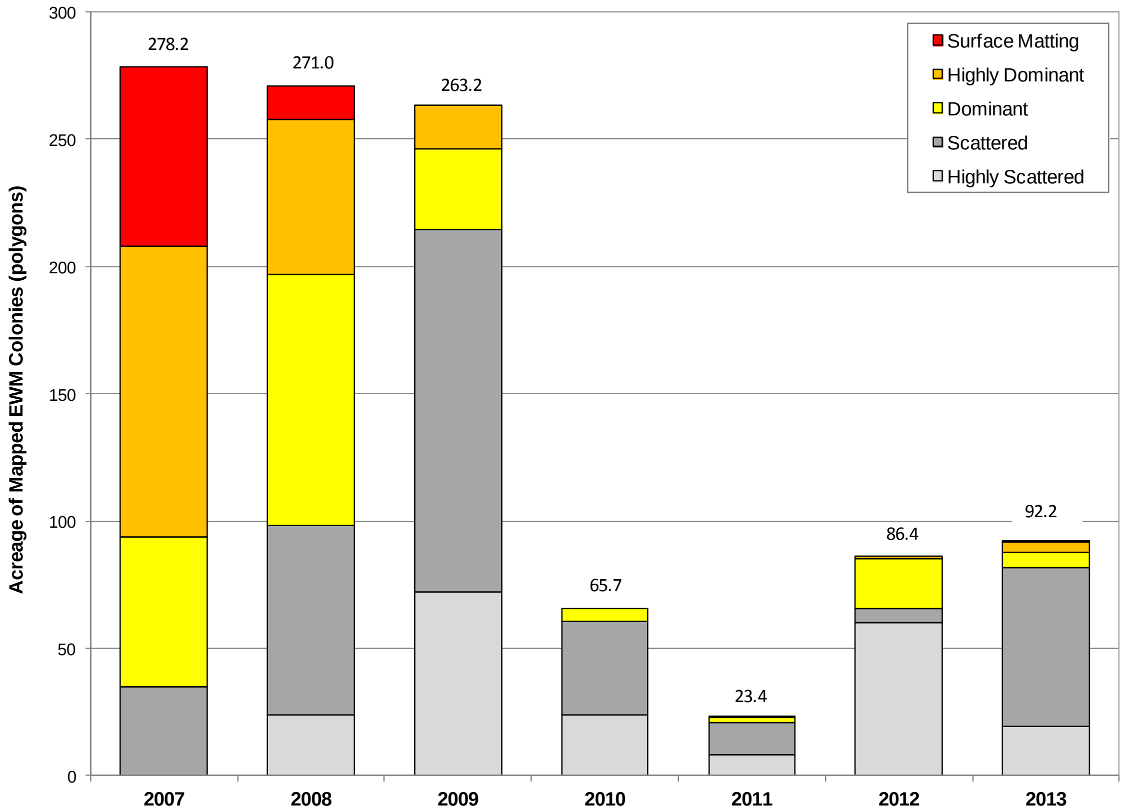


Figure 3. Acreage of mapped EWM colonies on the Eagle River Chain of Lakes from 2007-2013.

Chain-wide, approximately 52% of the EWM acreage treated in 2013 was reduced by at least one density rating, falling short of the qualitative success criteria (75% reduction). Figure 3 shows that EWM acreage increased from 86.4 to 92.2 acres from 2012 to 2013. This increase in EWM acreage in 2013 was not evenly spread across the chain as Figure 4 illustrates. Most of the increase in EWM in 2013 within the Eagle River Chain was located in Cranberry Lake and Watersmeet, while the EWM acreage within the other eight lakes was reduced slightly from 2012-2013.

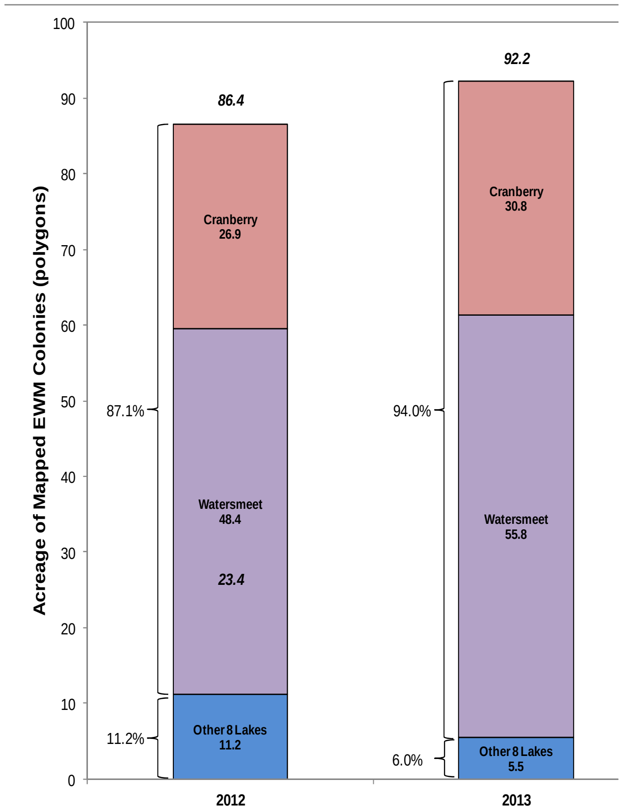


Figure 4. Acreage of mapped EWM colonies on the Eagle River Chain of Lakes, 2012 and 2013.

Of the 92.2 acres of EWM mapped chain-wide in 2013, approximately 94% are located within Cranberry Lake and Watersmeet (Figure 4). The EWM located in Cranberry Lake and Watersmeet in 2013 largely consist of EWM populations observed in 2012 that were marginally or ineffectively controlled in 2013. The EWM in both of these lakes resides in areas with higher water exchange rates, making it more difficult to attain adequate herbicide concentration-exposure times to cause significant EWM mortality.

During the summer of 2012, 93 (40.6%) of the 229 point-intercept locations within the 2013 treatment areas contained EWM compared to 54 (23.6% of 229 sample locations) in 2013, representing a statistically valid decrease in occurrence of 41.9%, and not meeting the chain-wide quantitative success criteria (50% reduction in occurrence) (Figure 5). However, as will be discussed in the individual lake sections, most of the EWM occurrences post treatment were within Cranberry Lake and Watersmeet. Of the 54 point-intercept locations that contained EWM post treatment during the summer of 2013, 52 (96.3%) of them were located in either Cranberry Lake or Watersmeet.

Individually, none of the lakes sampled showed an increase in EWM occurrence in 2013. Catfish and Cranberry Lakes experienced decreases in EWM frequency of occurrence; however, these values were not statistically valid. Scattering Rice Lake showed no change in frequency of occurrence between 2012 and 2013. Yellow Birch Lake (100% reduction) and Watersmeet (40.8% reduction) showed a statistically valid decrease in frequency of occurrence between 2012 and 2013 (Figure 5).

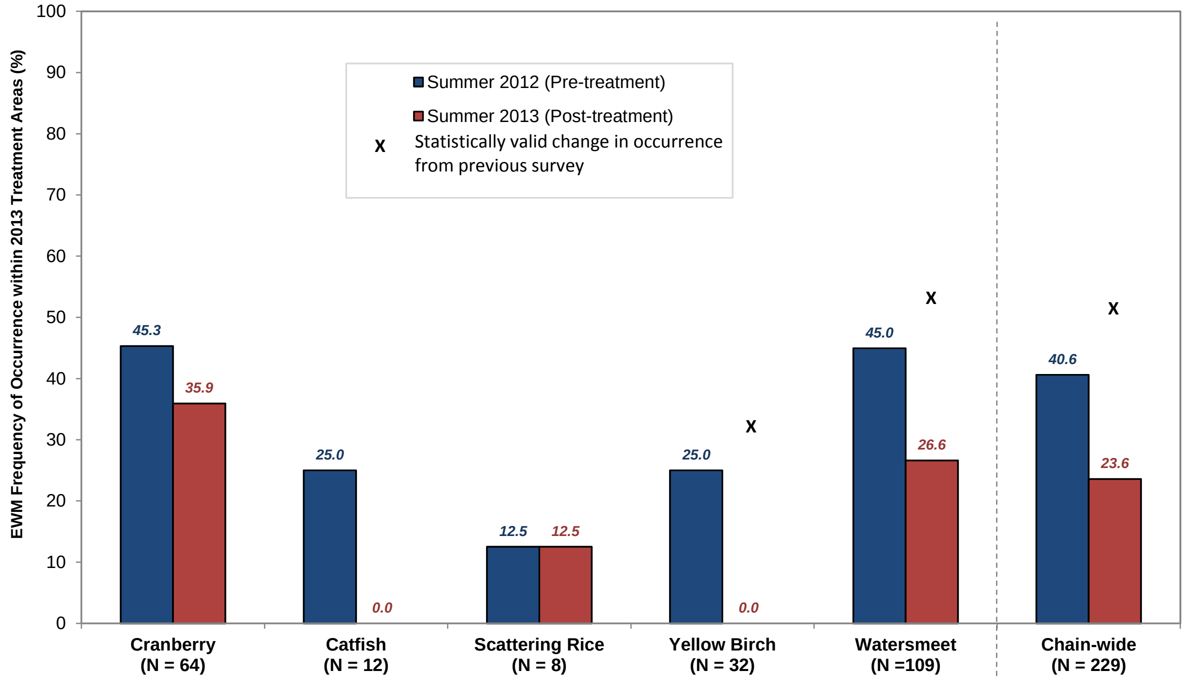


Figure 5. Eagle River Chain EWM percent occurrence in point-intercept locations, 2012 and 2013. No treatments occurred on Duck, Otter and Lynx Lakes in 2013.

A rake-fullness rating of 0-3 was used to determine the abundance of EWM at each of the 229 point-intercept locations. Figure 6 displays the chain-wide proportions of EWM rake-fullness ratings from the pre- and post-treatment surveys. Rake tows resulting in no incidence of EWM increased from 59% in 2012 to 76% in 2013, while the number of rake fullness ratings of 1 and 2 decreased between these two surveys. A small increase from one occurrence to four occurrences of the top level rake fullness rating was observed from 2012 to 2013 resulting in a 1% increase.

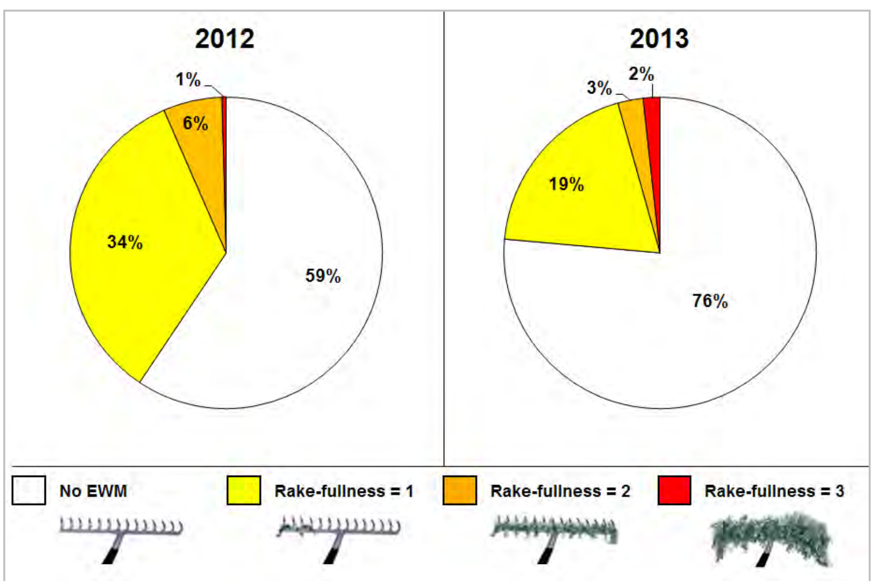


Figure 6. Eagle River Chain chain-wide proportions of EWM rake-fullness ratings. Data is derived from 229 pre-treatment (2012) and post-treatment (2013) point-intercept sub-sampling locations within 2013 treatment areas.

Data concerning native aquatic plant species were also collected at the same point-intercept locations during the summers of 2012 and 2013. Table 2 shows that within the 2013 treatment areas, no native species exhibited statistically valid reductions in occurrence following the 2013 treatment, and three native species saw statistically valid increases in occurrence. Like EWM, native dicot species are particularly susceptible to 2,4-D herbicide applications; however, no dicot species exhibited statistically valid reductions in occurrence following the 2013 treatment (Table 2). Efforts are taken to minimize impacts to these species by applying herbicides early in the spring before these plants are actively growing.

Table 2. Statistical comparison of native aquatic plant frequency within 2013 treatment areas from 2012 pre- and 2013 post-treatment surveys on the Eagle River Chain. Only species with greater than 5.0% frequency of occurrence in at least one of the two surveys are applicable for analysis.

	Scientific Name	Common Name	2012 FOO (%)	2013 FOO (%)	Percent Change	Direction	Chi-square Analysis	
							Statistically Valid	p-value
Dicots	*Myriophyllum spicatum*	Eurasian water milfoil	40.6	23.6	-41.9	▼	Yes	0.000
Dicots	*Ceratophyllum demersum*	Coontail	27.5	45.0	63.5	▲	Yes	0.000
Dicots	*Utricularia vulgaris*	Common bladderwort	0.4	4.8	1000.0	▲	Yes	0.003
Dicots	*Nymphaea odorata*	White water lily	2.2	5.7	160.0	▲	No	0.054
Non-dicots	*Potamogeton robbinsii*	Fern pondweed	17.5	29.7	70.0	▲	Yes	0.002
Non-dicots	*Elodea canadensis*	Common waterweed	60.7	58.5	-3.6	▼	No	0.634
Non-dicots	*Vallisneria americana*	Wild celery	22.3	22.7	2.0	▲	No	0.911
Non-dicots	*Potamogeton zosteriformis*	Flat-stem pondweed	11.8	11.4	-3.7	▼	No	0.884
Non-dicots	*Potamogeton pusillus*	Small pondweed	5.7	7.4	30.8	▲	No	0.450
Non-dicots	*Potamogeton richardsonii*	Clasping-leaf pondweed	5.2	6.1	16.7	▲	No	0.686
Non-dicots	*Potamogeton amplifolius*	Large-leaf pondweed	3.9	5.7	44.4	▲	No	0.382

2012 & 2013 N = 229
FOO = Frequency of Occurrence
▲ or ▼ = Change Statistically Valid (Chi-square; α = 0.05)
▲ or ▼ = Change Not Statistically Valid (Chi-square; α = 0.05)

As discussed earlier, the changes in native species' occurrences from pre- and post-treatment can only be considered in the context of the areas treated and not extrapolated to a lake-wide basis. To determine if the annual herbicide treatments are impacting native plant species on lake-wide levels, whole-lake point-intercept surveys would need to be conducted on each lake within the chain. These studies were completed in 2006 by Northern Environmental, Inc. and were replicated again in 2012 by Onterra, LLC. Analyses describing any changes in the aquatic plant community of the Eagle River Chain are discussed thoroughly within a separate report that was completed in 2013.

As outlined within the *Eagle River Chain of Lakes AIS Control & Prevention Project Aquatic Plant Community Reassessment (March 2013)*, the goal of the 2012 point-intercept surveys on the Lower Eagle River Chain of Lakes were intended to fulfill two main objectives:

1) Determine if the multi-year EWM control project has had detectable adverse impacts to the chain's native aquatic plant community at the lake-wide level.
2) Determine if the multi-year EWM control project has been successful at reducing the chain's EWM population.

According to the analysis and discussion within that report, the goals were fulfilled and have led to an understanding of the present state of the Lower Eagle River Chain of Lakes' native aquatic plant community and EWM population. The data presented indicate that there has been a substantial reduction in the chain's EWM population, and the native aquatic plant community of the Lower Eagle River Chain of Lakes is of exceptional quality, and if anything, is of higher quality at present than in 2005/2006. However, these data indicate that the declines observed in the chain-wide spatterdock, flat-stem pondweed, and large-leaf pondweed populations may be a result of the ongoing EWM control project.

As a part of a phased project being currently implemented, the Eagle River Chain of Lakes Association (ERCLA) will be updating each lake's management plan to reflect the success and limitations learned during this multi-year project. Along with establishing new thresholds (triggers) of when specific herbicide treatment strategies warrant implementation, the lake management planning process would also include a holistic understanding of the Eagle River Chain of Lakes ecosystem involving assessments of the water quality, watershed, shoreline condition, floating-leaf and emergent plant communities, and stakeholder perceptions.

5.0 2014 CHAIN-WIDE TREATMENT STRATEGY

While the acreage of EWM increased within the Eagle River Chain in 2013, as discussed earlier, much of this increase was within Cranberry Lake and Watersmeet. Overall, the 2013 treatment on the Eagle River Chain was partially successful, with 52% of the acreage treated being reduced in density by at least one density rating. Qualitatively, EWM met success criteria within treatment areas in four of the seven lakes (Catfish, Eagle, Voyageur and Yellow Birch Lakes). Quantitatively, EWM was reduced in two of six lakes (Watersmeet and Yellow Birch), while the other lakes either did not meet the quantitative success criteria or did not have a statistically valid change.

The increase of EWM within Cranberry and Watersmeet Lakes includes EWM populations that were not targeted for treatment in 2013 and expansion of areas that were treated in 2013 that were met with limited success. These two lakes hold EWM populations in locations with similar morphology; narrow, corridor-like channels that have greater flow than the open spacious areas of lakes such as Eagle, Scattering Rice, Otter, etc. Thus, dilution of herbicide occurs at a faster rate than in areas where less flow exists. This problem is exacerbated when small treatment areas are targeted.

For 2014, the preliminary treatment strategy includes targeting approximately 31 acres of EWM within the Eagle River Chain with herbicide control strategies (Table 3). While additional discussions between members of the ULERCLC workgroup and Onterra will occur, the following thresholds (triggers) were established that will dictate which EWM colonies would be targeted for control in 2014:

- Colonized EWM consisting of *Scattered* density or higher.
- Based upon past studies on the Eagle River Chain and on other lakes within Wisconsin, areas targeted of *Scattered* density must have a high likelihood of success. EWM colonies that are determined to be *Dominant* or higher were targeted in all instances.
- Designed treatment sites attempted to exceed 1.0 acre in size and no treatments were designed when at least a 0.5-acre treatment could not logistically be constructed.

The majority of this acreage is attributed to Watersmeet within Table 3; however, no EWM is being targeted within Watersmeet proper. Two areas within the Eagle River upstream of Watersmeet and one area within the Wisconsin River downstream of Watersmeet Lake are proposed to be targeted for control. Similarly, areas within the Eagle River upstream of Cranberry will also not be targeted for control in 2014. These areas are largely consisted of low density EWM colonies where a high likelihood of success is not anticipated. Continued investigation of achieving control in these areas will occur during 2014, possibly resulting in these areas being targeted in 2015.

Table 3. Proposed 2014 EWM treatment acreage for the Eagle River Chain.

Lake	Proposed Acres
Cranberry	2.6
Catfish	0.8
Voyageur	0.0
Eagle	1.0
Scattering Rice	3.1
Otter	0.8
Lynx	0.0
Duck	2.7
Yellow Birch	3.5
Watersmeet	16.5
All Waterbodies	**31.0**

On much of the Eagle River Chain of Lakes, the EWM population has reached a point at which some of the herbicide application areas are too small to consistently predict if they will cause EWM mortality. As indicated earlier, it is extremely difficult in micro-treatment scenarios to keep a sufficient herbicide concentration exposed to the target plants long enough to be effective. For that reason, almost all proposed treatment areas include an expanded buffer (40 feet) as well as the maximum granular 2,4-D application rate of 4.00 ppm ae.

As mentioned in previous reports, one of the greatest successes of the Eagle River Chain control program is the commitment by volunteers. Some volunteers aid in coordination of the project, some provide data to the professional ecologists relating to EWM occurrences, some conduct EWM hand-removal, and others work to educate other stakeholders on the importance of aquatic invasive species and the Eagle River Chain system. Continued volunteer commitment will be needed for long-term success to continue.

6.0 INDIVIDUAL LAKE SECTIONS

The remainder of this repot will focus on 2013 treatment results and proposed 2014 treatment strategies on a lake-by-lake basis.

6.1 Cranberry Lake Summary and Conclusions

Approximately 34.3 acres of EWM were treated in Cranberry Lake in 2013 with granular and liquid 2,4-D at 3.0 ppm ae (Map Cran 1). Following treatment with granular 2,4-D (Sculpin G®), Cran A-13 experienced an expansion of colonized EWM and no change in density indicating little or no control following treatment. Sites B-13 and C-13 being in an area of higher flow, were treated with liquid 2,4-D and were met with minimal control of EWM following treatment. Site C-13 expanded in size and density while site B-13 saw a small increase in area as well as some areas of higher density EWM within the site (Map Cran 2). In the summer of 2012, 45.3% of the 64 point-intercept locations within the 2013 treatment areas contained EWM compared to 35.9% in 2013 (Table 4). Despite this decrease, statistical analysis shows that this change is not valid at the predetermined confidence level ($\alpha = 0.05$).

Data concerning native aquatic plant species within the 2013 treatment areas indicate that no native species exhibited a statistically valid reduction in occurrence following the treatment (Table 4). One native, non-dicot species (fern pondweed) saw a statistically valid increase in occurrence following treatment. As discussed earlier, the declines observed to native species within the treatment areas cannot be extrapolated to the entire lake-wide population.

Table 4. Statistical comparison of aquatic plant frequency data within 2013 treatment areas on Cranberry Lake from 2012 pre- and 2013 post-treatment surveys. Only species with greater than 5.0% frequency of occurrence in at least one of the two surveys are applicable for analysis.

	Scientific Name	Common Name	2012 FOO (%)	2013 FOO (%)	Percent Change	Direction	Chi-square Analysis: Statistically Valid	Chi-square Analysis: p-value
Dicots	*Myriophyllum spicatum*	Eurasian water milfoil	45.3	35.9	-20.7	▼ (grey)	No	0.280
Dicots	*Ceratophyllum demersum*	Coontail	26.6	34.4	29.4	▲ (grey)	No	0.337
Dicots	*Myriophyllum sibiricum*	Northern water milfoil	6.3	7.8	25.0	▲ (grey)	No	0.730
Dicots	*Nymphaea odorata*	White water lily	6.3	4.7	-25.0	▼ (grey)	No	0.697
Dicots	*Brasenia schreberi*	Watershield	4.7	7.8	66.7	▲ (grey)	No	0.465
Dicots	*Utricularia vulgaris*	Common bladderwort	1.6	6.3	300.0	▲ (grey)	No	0.171
Non-dicots	*Potamogeton robbinsii*	Fern pondweed	25.0	50.0	100.0	▲	Yes	0.003
Non-dicots	*Elodea canadensis*	Common waterweed	84.4	93.8	11.1	▲ (grey)	No	0.089
Non-dicots	*Vallisneria americana*	Wild celery	17.2	10.9	-36.4	▼ (grey)	No	0.309
Non-dicots	*Sparganium fluctuans*	Floating-leaf bur-reed	9.4	3.1	-66.7	▼ (grey)	No	0.144
Non-dicots	*Potamogeton amplifolius*	Large-leaf pondweed	4.7	9.4	100.0	▲ (grey)	No	0.300

2012 & 2013 N = 64
FOO = Frequency of Occurrence
▲ or ▼ = Change Statistically Valid (Chi-square; $\alpha = 0.05$)
▲ or ▼ (grey) = Change Not Statistically Valid (Chi-square; $\alpha = 0.05$)

A rake-fullness rating of 0-3 was used to determine the abundance of EWM at each of the 64 point-intercept locations. Figure 7 displays the proportions of EWM rake-fullness ratings from the pre- and post-treatment surveys on Cranberry Lake. Rake tows resulting in no incidence of EWM increased from 55% in 2012 to 64% in 2013, while the number of rake fullness ratings of 1 and 2 decreased between these two surveys. An increase of the top level rake fullness rating (TRF=3) was observed from 2012 to 2013.

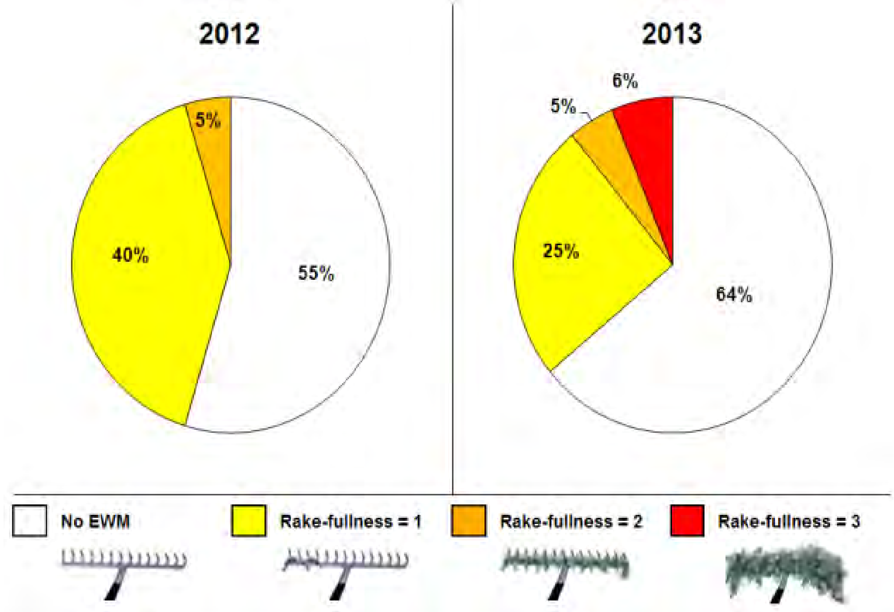


Fig 7. Cranberry Lake proportions of EWM rake-fullness ratings. Data is derived from 64 pre-treatment (2012) and post-treatment (2013) point-intercept sub-sampling locations within 2013 treatment areas.

Overall, the 2013 treatment on Cranberry Lake was unsuccessful. As discussed within the chain-wide portion of this report, difficulties in controlling small EWM colonies within channelized, high flow regions of the lake were encountered in 2013. The total proposed treatment acreage for Cranberry Lake in 2014 is 2.6 acres (Map Cran 2). The majority of this acreage is targeting EWM within and nearby to the unsuccessful A-13 treatment area. This site is believed to be somewhat more sheltered from the higher flow and with an increase in application rate to 4.00 ppm ae may have greater success in controlling EWM in 2014. The Eagle River Channel that leads from the Three Lakes Chain of Lakes is not currently being proposed for treatment following the unsuccessful treatment in 2013. An elaborate flow monitoring project is currently being developed for Cranberry Lake that may guide future active management strategies within Cranberry Lake.

It is important to note that much of the data that has been collected by the WDNR, US Army Corps of Engineers, Onterra, and other lake management consultants regarding spot treatments (like the preliminary treatment strategy shown on the attached map) has not been able to detect significant differences in herbicide concentration nor exposure times in using either liquid or granular herbicides. Because liquid herbicides are significantly less expensive than granular herbicides, some lake groups decide to use liquid herbicides in larger spot-treatment scenarios. That being said, Onterra has typically supported the use of granular herbicides in spot treatment scenarios where precision application is important, such as Cran A-14 (Map Cran 2). A discussion regarding the use of granular herbicide products is contained within the Herbicide Control of Aquatic Invasive Plants Sections (1.1)

Herbicide concentration monitoring occurred on Cranberry Lake at the locations displayed on Figure 8. The results of the herbicide concentration study are available in Appendix A.

Water samples were collected from each sampling site at time intervals of approximately 1, 2, 4, 6, 8, 24, 48, 72, and 120 hours after treatment (HAT) using an integrated sampler. The samples were fixed (preserved) with acid and shipped to the U.S. Army Engineer Research and Development Center (USAERDC) where the herbicide analysis is completed.

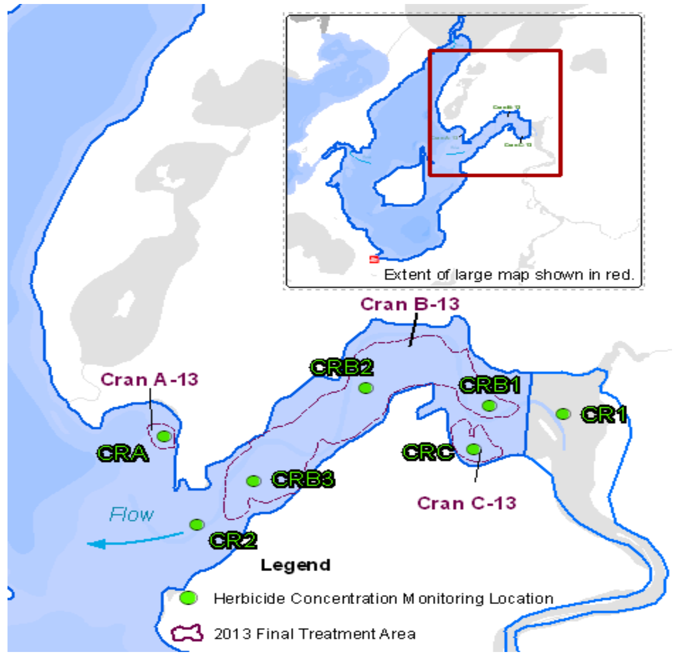


Figure 8. Herbicide concentration monitoring locations on Cranberry Lake.

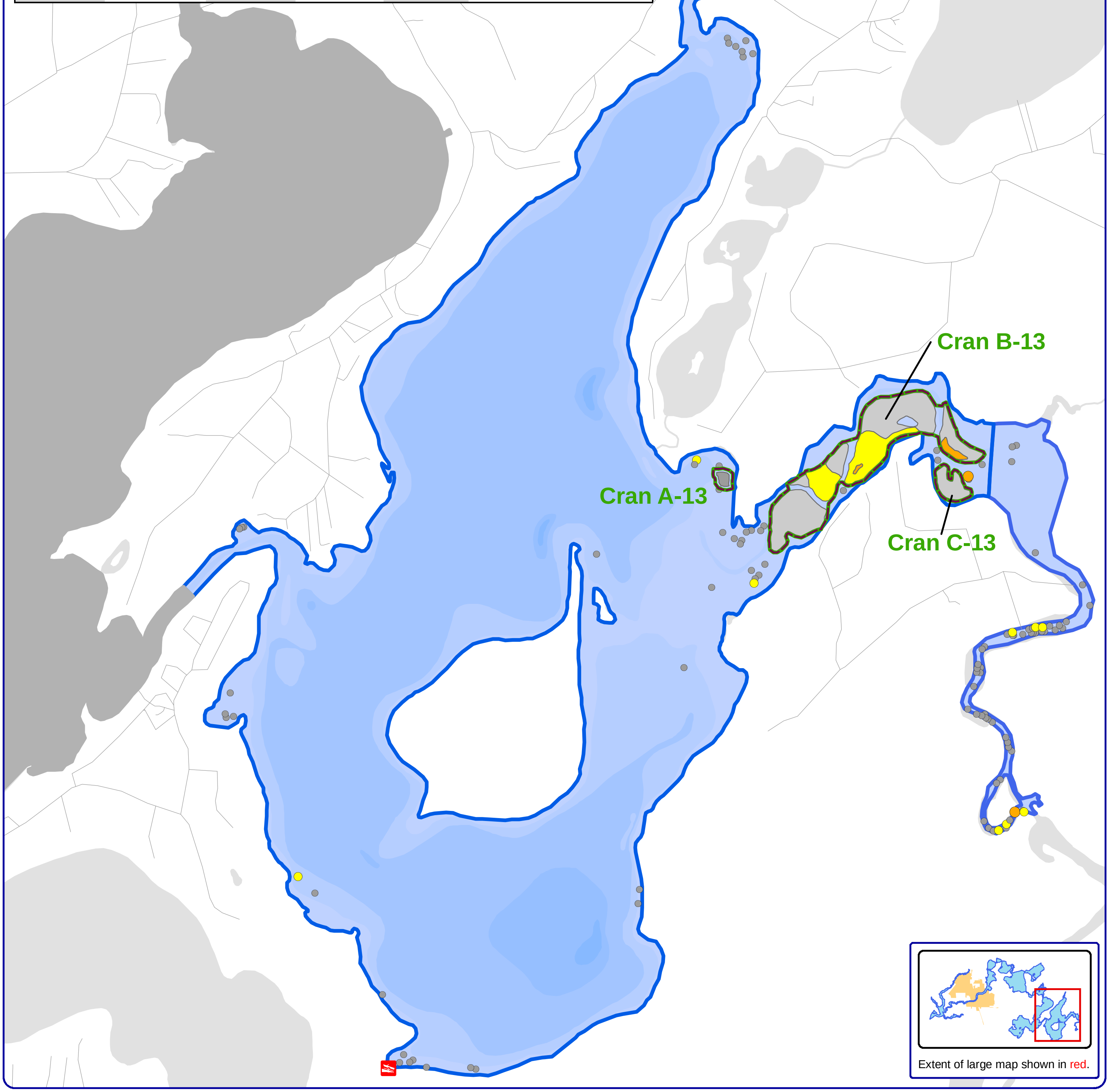
Treatment sites Cran A-13 and Cran C-13 were both relatively small spot treatments in protected bays outside of the main impacts of the channelized flow in adjacent areas. Both sites were treated within 2,4-D at 3.0 ppm ae; one with a liquid product and one with a granular product. As shown within Figure 4 of Appendix A, the herbicide concentrations spiked at approximately 0.8 ppm ae (800 ug/L) within the granular 2,4-D site (Cran A-13) and 1.6 ppm ae (1,600 ug/L) within the liquid 2,4-D site (Cran C-13) around 4-8 hours. However, the herbicide dissipated quickly from these areas and successful control EWM control was not observed within either site.

Within the Eagle River inlet channel to Cranberry Lake, the EWM within Cran B-13 was targeted with liquid 2,4-D at 3.0 ppm ae. This site historically contained large and dense colonies of EWM until targeted with granular 2,4-D in 2010 at 2.6 ppm ae (150 lbs/acre with average depth of 4 feet). Low density EWM rebounded/recolonized within this area and was targeted in 2013 at a similar dose as applied in 2010, but with a much more economically priced liquid 2,4-D product.

A total of four sampling sites can be used to understand the herbicide concentrations in association with the 2013 treatment of Cran B-13 and are listed from upstream to downstream: CR1 >> CRB1 >> CRB2 >> CR2. Sampling site CR1 was located upstream of Cran B-13 and barely detectable 2,4-D levels were registered within this area. CRB1 was located within the most upstream part of Cran B-13 and registered around 0.1 ppm ae (100 ug/L) in one sampling event, and barely detectable levels in all other sampling events (Figure 5 of Appendix A). Sampling site GRB2 was in the center of Cran B-13 and observed high amounts of herbicide within the first few sampling events, but was undetectable by 8 HAT. Sampling Sites CRB3 (downstream part of Cran B-13) and CR2 (just downstream of Cran B-13) observed similar herbicide concentrations as CRB2, but the impacts of the upstream 2,4-D inputs could be observed in 4 HAT and 6 HAT as small "bumps" in herbicide concentrations. Low concentrations of herbicide were detected within these two sites at 8 HAT with complete dissipation within all sites by 24 HAT.

2013 Final EWM Treatment Areas

Site	Proposed Acres	Final Acres	Ave. Depth	Volume (ac-ft)	2,4-D Product	2,4-D PPM ae
Cran A-13	1.1	1.1	3.0	3.3	Granular	3.00
Cran B-13	30.6	30.6	3.5	107.1	Liquid	3.00
Cran C-13	2.6	2.6	5.0	13.0	Liquid	3.00
Total	**34.3**	**34.3**		**123.4**		



N E S W

1,600

Feet

2012 EWM Survey (August 2012)

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2013 Conditional Treatment Area
- 2013 Final Treatment Area

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

Sources:
Roads and Hydro: WDNR
Aquatic Plants: Onterra, 2012-2013
Map Date: December 20, 2013
Filename: *Cran1_EWM_2012PB_T2013.mxd*

Cran 1

Cranberry Lake

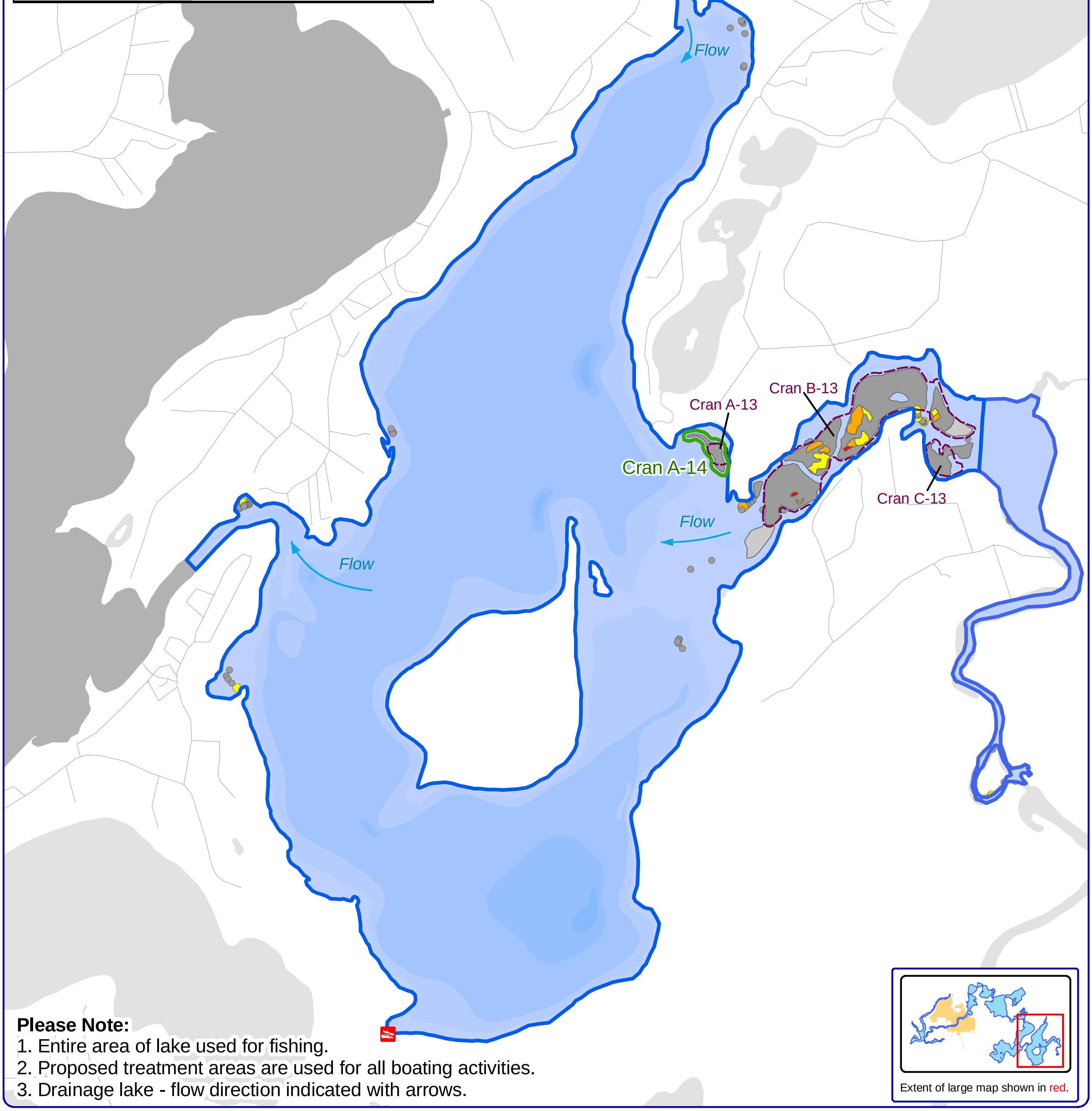
Vilas County, Wisconsin

2012 EWM Locations & 2013 Treatment Areas

2014 Proposed EWM Treatment Areas

Granular 2,4-D

Site	Proposed Acres	Ave. Depth (feet)	Volume (ac-ft)	2,4-D PPM ae
Cran A-14	2.6	3.0	7.8	4.00
Total	**2.6**		**7.8**	



Please Note:
1. Entire area of lake used for fishing.
2. Proposed treatment areas are used for all boating activities.
3. Drainage lake - flow direction indicated with arrows.

N W E S

1,600

Feet

2013 EWM Survey (September 2013)

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2013 Final Treatment Area
- 2014 Proposed Treatment Area

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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
Aquatic Plants: Onterra, 2012-2013
Map Date: January 2, 2014
Filename: *Cran2_EWM_T2014_Cond1.mxd*

Cran 2
Cranberry Lake
Vilas County, Wisconsin

2013 EWM Locations & 2014 Proposed Treatment Areas v.1

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