Eurasian water-milfoil (*Myriophyllum spicatum*) Pre/Post Herbicide Surveys, Meandering Littoral Zone Surveys, and Rake Removal Red Lake (WBIC: 2492100) Douglas County, Wisconsin

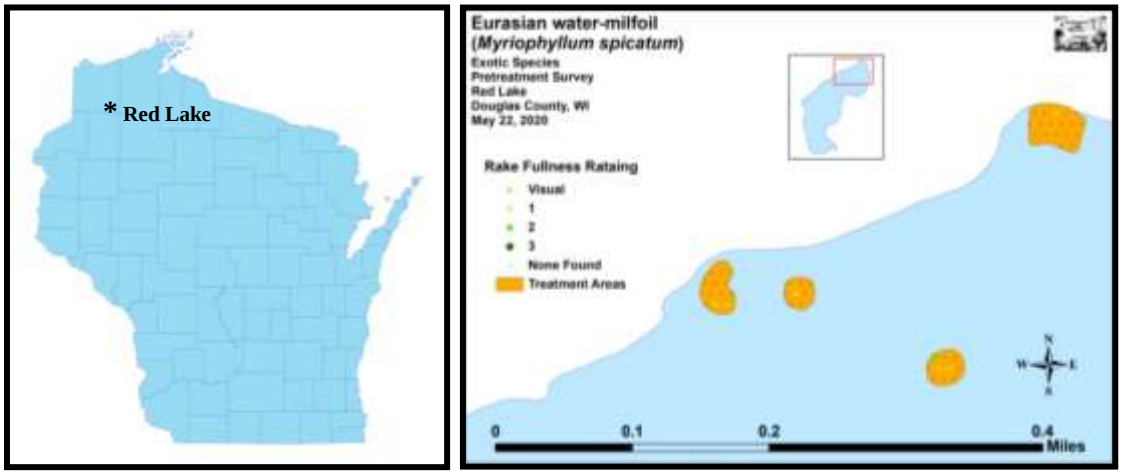
Red Lake 2020 treatment areas

Slime covered pretreatment EWM 5/22/20

Rake removed EWM 8/30/20

Project Initiated by:

The Red Lake Association, Lake Education and Planning Services, LLC and the Wisconsin Department of Natural Resources (Grant #AIRR25720)



2020 Pretreatment EWM Density and Distribution

Surveys Conducted by and Report Prepared by:

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May 22, July 3, and August 30, 2020

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INTRODUCTION:

Red Lake (WBIC 2492100) is a 253 acre stratified seepage lake located in the Town of Wascott in south-central/southeastern Douglas County (T43N R11W S21, 28, 29, 32). It reaches a maximum depth of 37ft in the deep hole on the south end of the central basin and has an average depth of 11ft (WDNR 2020). The lake is mesotrophic in nature, and water clarity is good with Secchi readings averaging 11.1ft from 1993-2020 (WDNR 2020). This clarity produced a littoral zone that extended to at least 20ft in 2020. The shoreline is dominated by sand with most areas transitioning to sandy muck at depths beyond 10ft. The lake's only nutrient-rich organic muck occurs in areas adjacent to the tamarack bogs near the small bay in the far southeast corner and on the north and south ends of the northeast bay (Holt et al. 1973) (Figure 1).

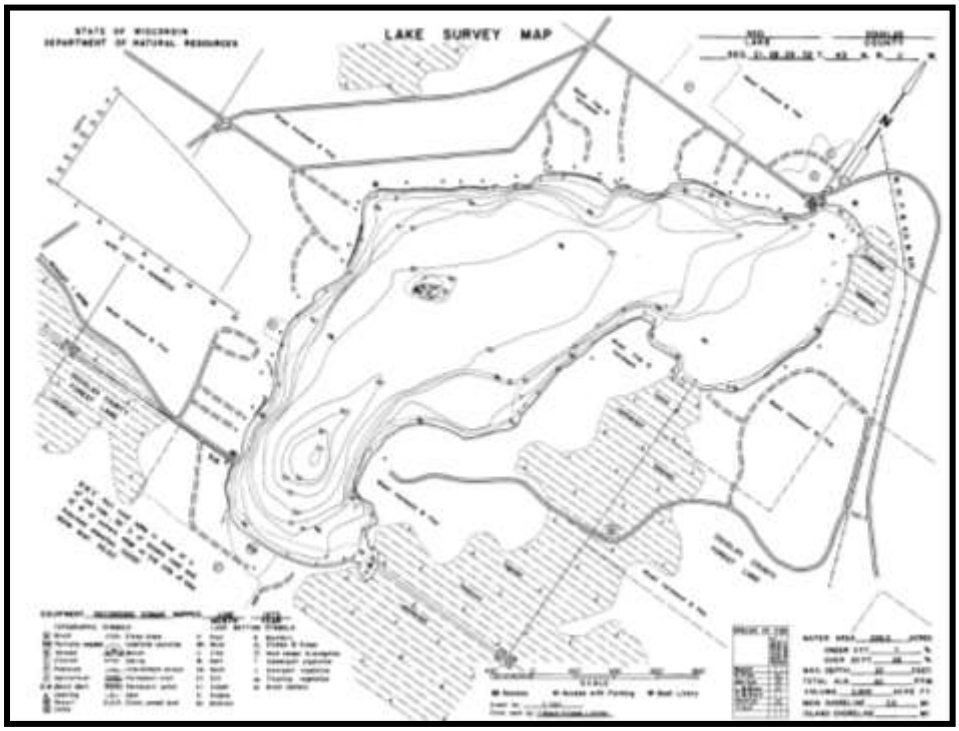


Figure 1: Red Lake Bathymetric Map

BACKGROUND AND STUDY RATIONALE:

On July 25, 2013, at the request of the Red Lake Association (RLA) and the Wisconsin Department of Natural Resources (WDNR), we conducted the original warm-water point-intercept survey of all aquatic plants in Red Lake. This extensive study established base-line data on the richness, diversity, abundance, and distribution of the lake's aquatic macrophyte populations. At that time, we found no evidence of Eurasian water-milfoil (*Myriophyllum spicatum*) (EWM), an invasive exotic aquatic plant, anywhere in the lake.

Unfortunately, in July 2016, biologists from the Great Lakes Indian Fish & Wildlife Commission (GLIFWC) found a few EWM plants near the public boat landing on the lake's southwest side and near the Red Lake Resort in the northeast bay. A follow-up survey by the WDNR also located plants in these areas, and our lakewide EWM bed mapping survey on October 2, 2016 found ten separate beds totaling 1.18 acres.

The RLA's WDNR approved Aquatic Plant Management Plan has outlined manual removal by both volunteers and professionals as well as limited herbicide applications to control the infestation; and these small scale treatments have occurred annually since 2017. Following 2019 bed mapping surveys by Lake Education and Planning Services, LLC (LEAPS – D. Blumer), the RLA decided to treat four beds totaling 1.93 acres (0.70% of the lake's total surface area) in 2020. Although pre and posttreatment surveys have not been conducted in the past due to the small size of the treatments and limited budgets, because ProcellaCor (a relatively new herbicide that specifically targets milfoil) was used, pre and posttreatment surveys were required. We were also asked to search the lake for surviving EWM in July and August, and, if possible, remove any EWM found. This report is the summary analysis of these four field surveys.

METHODS:

Pre/Post Herbicide Survey:

LEAPS provided treatment area shapefiles, and we generated pre/post survey points based on the size and shape of the proposed treatment areas. The 50 point sampling grid at 12.5m resolution approximated to just over 25 pts/acre – well above the minimum of 4 pts/acre required by WDNR protocol for pre/post treatment surveys (Appendix I).

These points were uploaded to a handheld mapping GPS (Garmin 76CSx) and located on the lake. At each point, we recorded the depth and bottom substrate and used a rake to sample an approximately 2.5ft section of the bottom. EWM was assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2), and we also recorded visual sightings of EWM within six feet of the sample point. Because visual sightings are not calculated into the pre/post statistical formulas, we only assigned a rake fullness value for non-EWM plants. A cumulative rake fullness value was also noted.

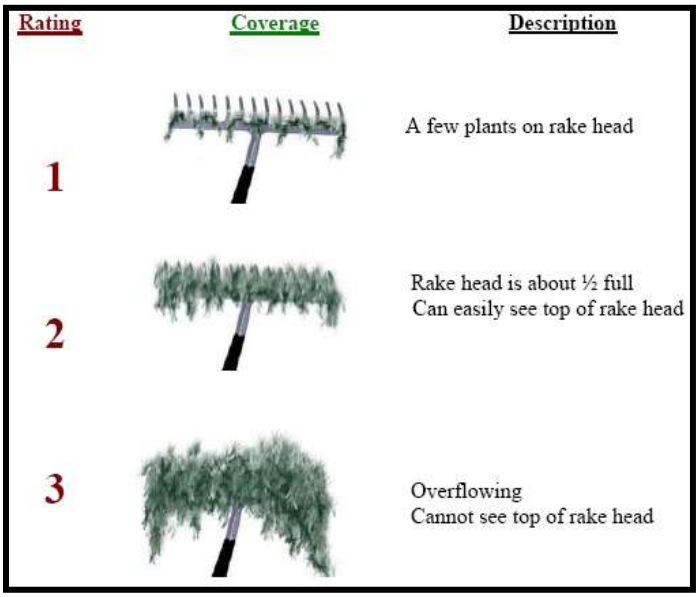


Figure 2: Rake Fullness Ratings

We entered all data collected into the standard WDNR APM spreadsheet (Appendix II). Data was analyzed using the linked statistical summary sheet and the WDNR pre/post analysis worksheet (UWEX 2010). For pre/post differences of individual plant species as well as count data, we used the Chi-square analysis on the WDNR pre/post survey worksheet. For comparing averages (mean species/point and mean rake fullness/point), we used t-tests. Differences were determined to be significant at $p<0.05$, moderately significant at $p<0.01$ and highly significant at $p<0.001$.

EWM Littoral Zone Rake Removal and Bed Mapping Surveys:

During the July and August surveys, we searched the lake's visible littoral zone for Eurasian water-milfoil. When found, we used a telescopic rake to remove EWM plants by their roots and logged the location with a GPS waypoint. We also took extra care to gather any fragments that broke off of the plants. If we found a "bed" where we estimated that EWM made up >50% of the plants and was generally continuous with clearly defined borders; we motored around the perimeter of the area, took GPS coordinates at regular intervals, documented the rake range and depth range of plants, and estimated the average rake fullness rating and depth of EWM within the bed. Using the WDNR's Forestry Tool's Extension to ArcGIS 9.3.1, we used these coordinates to generate bed shapefiles and determine the acreage to the nearest hundredth of an acre.

RESULTS AND DISCUSSION:

Finalization of Treatment Areas:

The four proposed treatment areas covered 1.93 acres (0.70% of the lake's surface area) (Figure 3) (Appendix I). Because the May 22nd pretreatment survey found Eurasian water-milfoil was present in each area, the RLA decided to go ahead with the treatment as originally planned.

Treatment occurred on June 2nd with Northern Aquatic Services (Dale Dressel - Dresser, WI) applying ProcellaCor at a rate of 5-8 pdu/acre ft. (66.56 total pdus – at 3.17 fl. oz./pdu) (Table 1). At the time of treatment, the reported water temperature was 68°F and the air temperature was 70°F. Wind speeds were clocked at 2-4mph out of the west.

Table 1: Spring EWM Treatment Summary
Red Lake, Douglas County
June 2, 2020

Bed Number	Final Treatment Area (acres)	Chemical, Rate, and Total Volume
9	0.39	ProcellaCor – 8pdu – 0.55gal.
11	0.76	ProcellaCor – 5pdu – 0.28gal.
12	0.49	ProcellaCor – 6pdu – 0.40gal.
13	0.29	ProcellaCor – 8pdu – 0.41gal.
Total	**1.93**	**ProcellaCor – 5-8pdu– 1.64gal.**

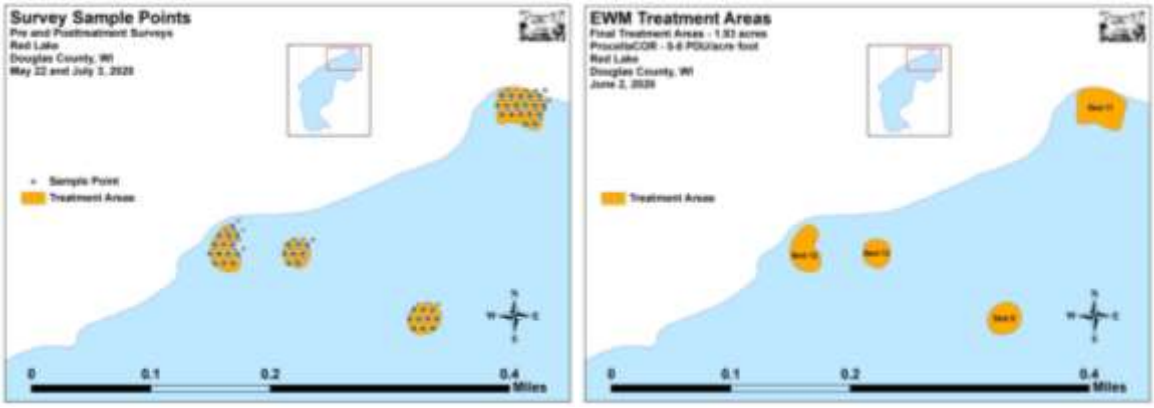


Figure 3: Pre/Post Survey Points and EWM Treatment Areas

EWM Pre/Post Herbicide Survey:

All survey points occurred in areas between 1.0ft and 10.0ft of water. Within the beds, plants grew at a mean and median depth of 5.1ft and 5.0ft respectively during the pretreatment survey before declining slightly to 5.0ft and 4.5ft posttreatment (Table 2). Nearshore, plants were established over pure sand, but this transitioned to a nutrient-poor sandy muck at most depths over 5.0ft (Figure 4) (Appendix III).

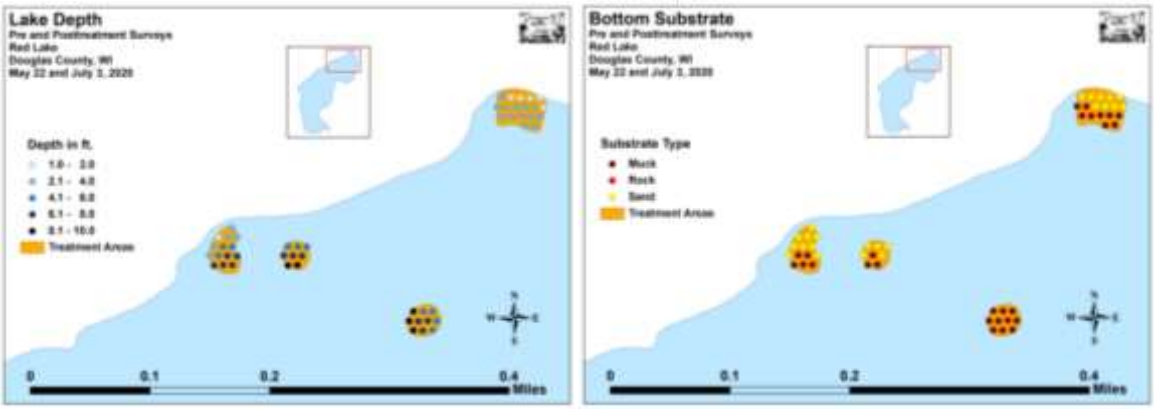


Figure 4: Treatment Area Depths and Bottom Substrate

Table 2: Pre/Posttreatment Surveys Summary Statistics
Red Lake, Douglas County
May 22 and July 3, 2020

Summary Statistics:	Pre	Post
Total number of points sampled	50	50
Total number of sites with vegetation	50	50
Total number of sites shallower than the maximum depth of plants	50	50
Freq. of occur. at sites shallower than max. depth of plants (in percent)	100	100
Simpson Diversity Index	0.85	0.90
Mean Coefficient of Conservatism	6.8	7.0
Floristic Quality Index	27.0	31.9
Maximum depth of plants (ft)	10.0	10.0
Mean depth of plants (ft)	5.1	5.0
Median depth of plants (ft)	5.0	4.5
Average number of all species per site (shallower than max depth)	2.58	2.82
Average number of all species per site (veg. sites only)	2.58	2.82
Average number of native species per site (shallower than max depth)	2.56	2.82
Average number of native species per site (sites with native veg. only)	2.56	2.82
Species Richness	17	21
Mean Rake Fullness (veg. sites only)	2.18	2.14

The entire treatment area fell within the littoral zone, and plants were present at all points during both the pre and posttreatment surveys (Figure 5) (Appendix IV). Total richness increased from 17 species pretreatment to 21 species posttreatment; and the Simpson's Diversity Index also rose from a high pretreatment value of 0.85 to an exceptionally high 0.90 posttreatment. The Floristic Quality Index (another measure of native plant community health) also increased from 27.0 pretreatment to 31.9 posttreatment.

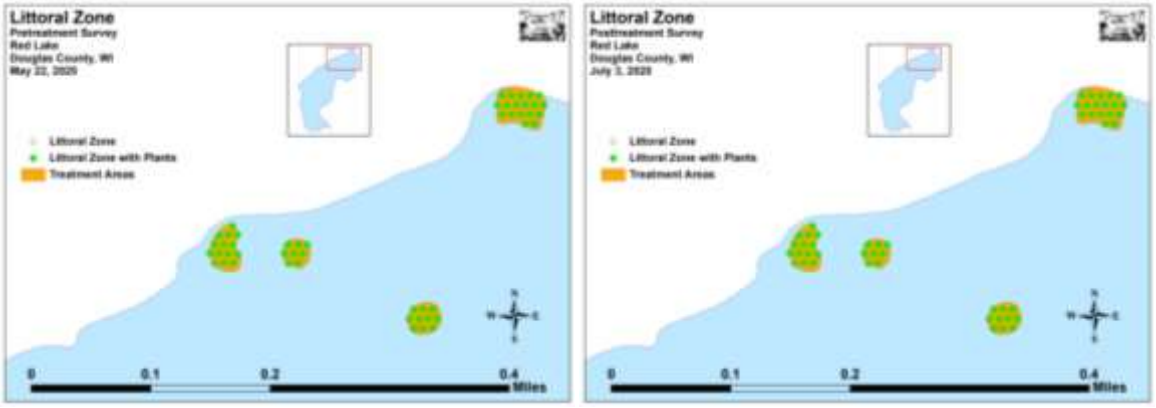


Figure 5: Pre/Posttreatment Littoral Zone

Mean native species richness at points with native vegetation demonstrated a non-significant increase (p=0.13) from 2.56 species/point pretreatment to 2.82/point posttreatment (Figure 6). Total mean rake fullness was almost unchanged from a moderate 2.18 pretreatment to 2.14 posttreatment (Figure 7) (Appendix IV).

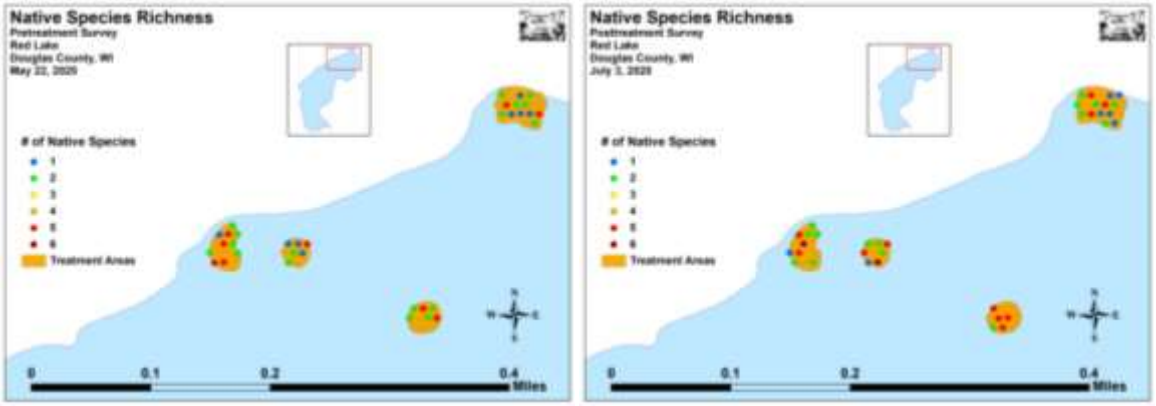


Figure 6: Pre/Posttreatment Native Species Richness

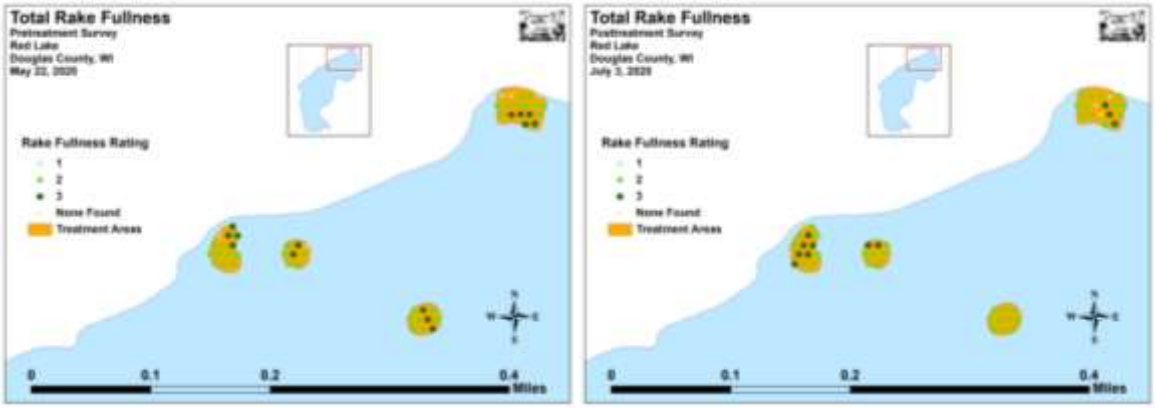


Figure 7: Pre/Posttreatment Total Rake Fullness

We found Eurasian water-milfoil occurred in scattered clusters within the treatment area. During the pretreatment survey, it was present in the rake at a single point (rake fullness of 2), and we also recorded it as a visual at six points (Figure 8) (Appendix V). Posttreatment, we saw no evidence of EWM anywhere in the treatment areas. Due to the **small number of pretreatment detections, only the decline in visual sightings was significant (*p*=0.01)** (Figure 9).

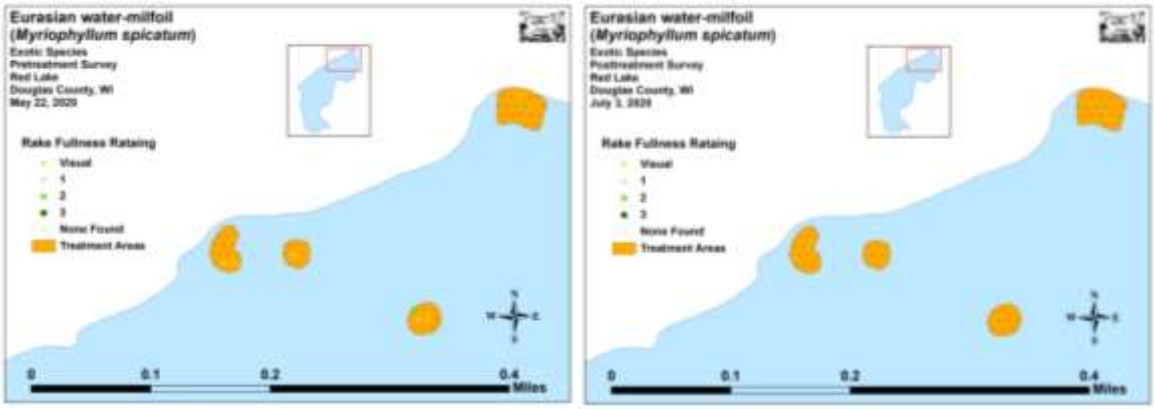
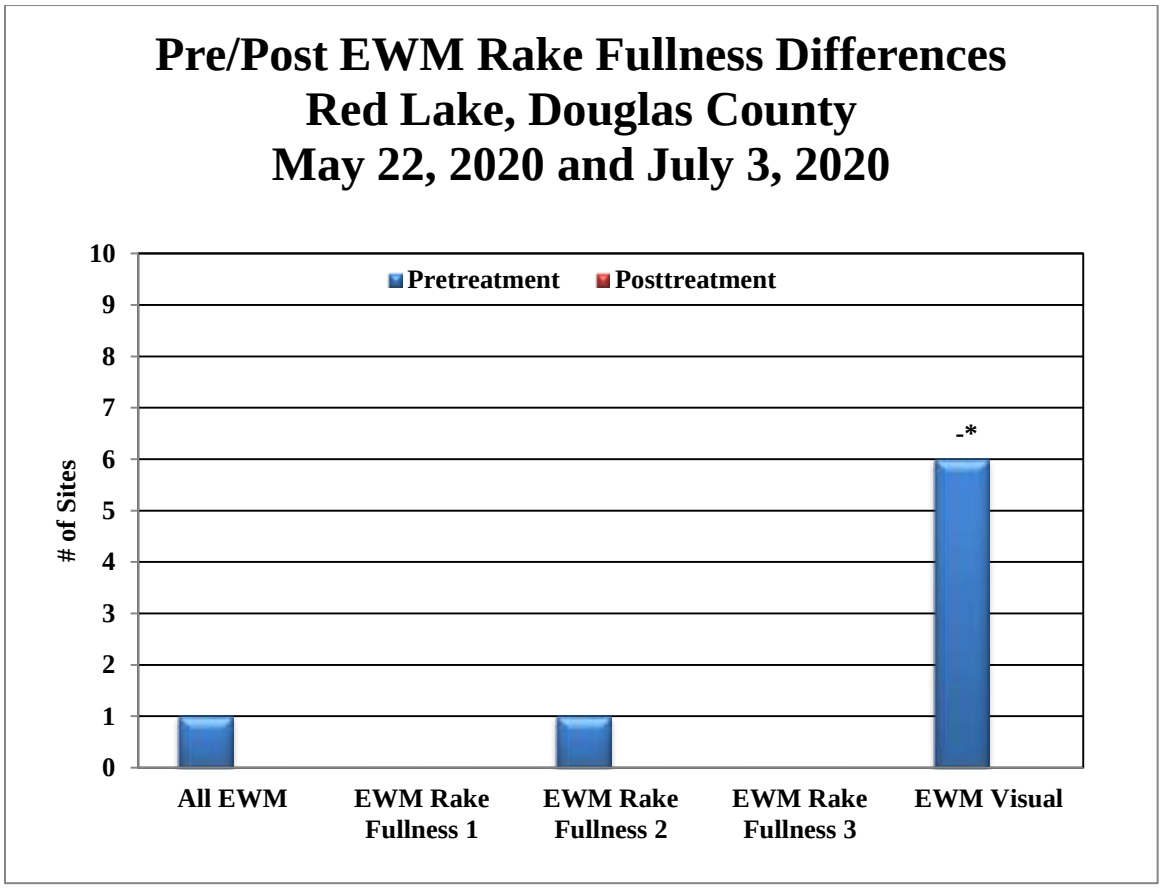


Figure 8: Pre/Posttreatment EWM Density and Distribution



Significant differences = * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Figure 9: Changes in EWM Rake Fullness

Fern pondweed (*Potamogeton robbinsii*) was the most widely distributed native species in both the pretreatment and posttreatment surveys (Figure 10) (Tables 3 and 4). Posttreatment, it declined in both distribution (28 sites pretreatment/23 sites posttreatment) and density (mean rake fullness of 1.82 pretreatment/1.61 posttreatment), but neither was significant (p=0.32/p=0.13).

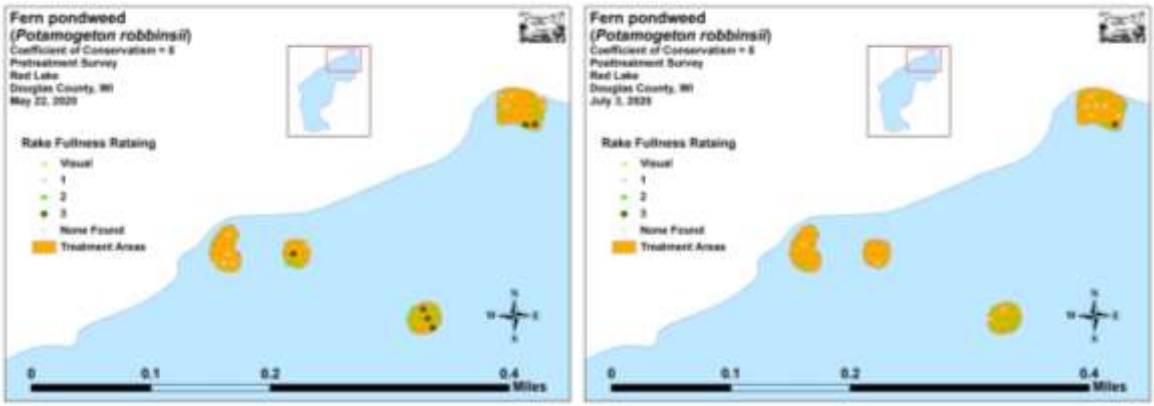


Figure 10: Pre/Posttreatment Fern Pondweed Density and Distribution

Large-leaf pondweed (*Potamogeton amplifolius*) was the second most common species pretreatment and tied for the most common posttreatment. In May, it was present at 26 sites with a mean rake fullness of 1.42 (Figure 11). Similar to Fern pondweed, it also saw non-significant declines (p=0.55/p=0.20) in distribution and density to 23 sites with a mean rake of 1.39 posttreatment.

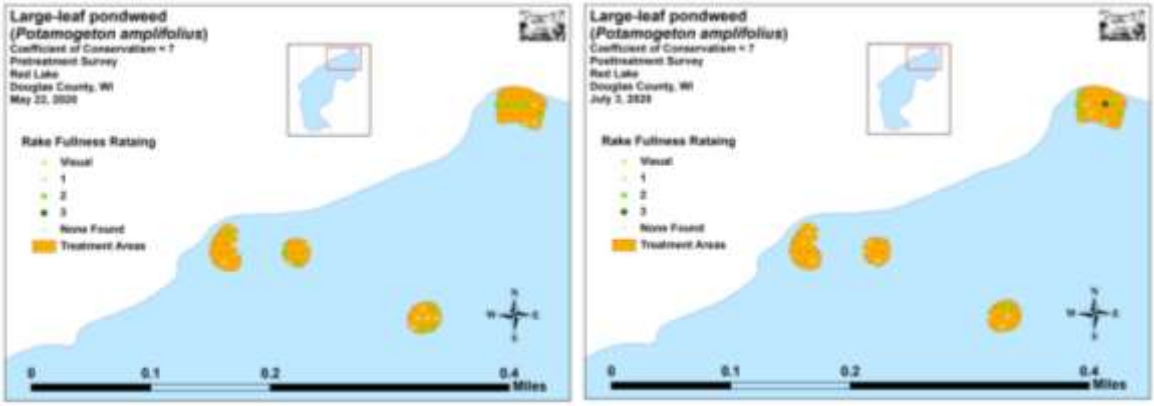


Figure 11: Pre/Posttreatment Large-leaf Pondweed Density and Distribution

Table 3: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Pretreatment Survey - Red Lake, Douglas County
May 22, 2020

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sites
Potamogeton robbinsii	Fern pondweed	28	21.71	56.00	56.00	1.82	0
Potamogeton amplifolius	Large-leaf pondweed	26	20.16	52.00	52.00	1.42	0
Chara sp.	Muskgrass	24	18.60	48.00	48.00	2.00	0
Elodea canadensis	Common waterweed	17	13.18	34.00	34.00	1.29	0
Heteranthera dubia	Water star-grass	8	6.20	16.00	16.00	1.50	0
Myriophyllum sibiricum	Northern water-milfoil	5	3.88	10.00	10.00	1.40	0
Bidens beckii	Water marigold	3	2.33	6.00	6.00	1.33	0
Eleocharis acicularis	Needle spikerush	3	2.33	6.00	6.00	1.00	0
Myriophyllum tenellum	Dwarf water-milfoil	3	2.33	6.00	6.00	1.67	0
Potamogeton praelongus	White-stem pondweed	3	2.33	6.00	6.00	1.00	0
Potamogeton pusillus	Small pondweed	3	2.33	6.00	6.00	1.00	0
Ceratophyllum demersum	Coontail	1	0.78	2.00	2.00	1.00	0
Myriophyllum alterniflorum	Alternate-flowered water-milfoil	1	0.78	2.00	2.00	1.00	0
Myriophyllum spicatum	Eurasian water milfoil	1	0.78	2.00	2.00	2.00	6
Polygonum amphibium	Water smartweed	1	0.78	2.00	2.00	1.00	0
Potamogeton gramineus	Variable pondweed	1	0.78	2.00	2.00	1.00	0
Sparganium emersum	Short-stemmed bur-reed	1	0.78	2.00	2.00	1.00	0
	Filamentous algae	1	*	2.00	2.00	1.00	0

* Excluded from relative frequency analysis

Table 4: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Posttreatment Survey - Red Lake, Douglas County
July 3, 2020

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sites
Potamogeton amplifolius	Large-leaf pondweed	23	16.31	46.00	46.00	1.39	0
Potamogeton robbinsii	Fern pondweed	23	16.31	46.00	46.00	1.61	0
Chara sp.	Muskgrass	21	14.89	42.00	42.00	2.00	0
Elodea canadensis	Common waterweed	11	7.80	22.00	22.00	1.36	0
Potamogeton pusillus	Small pondweed	10	7.09	20.00	20.00	1.40	0
Potamogeton praelongus	White-stem pondweed	9	6.38	18.00	18.00	1.33	0
Heteranthera dubia	Water star-grass	6	4.26	12.00	12.00	2.17	0
Potamogeton zosteriformis	Flat-stem pondweed	6	4.26	12.00	12.00	1.00	0
Vallisneria americana	Wild celery	6	4.26	12.00	12.00	1.17	0
Potamogeton gramineus	Variable pondweed	5	3.55	10.00	10.00	1.00	0
Bidens beckii	Water marigold	4	2.84	8.00	8.00	1.25	0
Potamogeton friesii	Fries' pondweed	4	2.84	8.00	8.00	1.50	0
Eleocharis acicularis	Needle spikerush	2	1.42	4.00	4.00	2.00	0
Myriophyllum sibiricum	Northern water-milfoil	2	1.42	4.00	4.00	1.00	0
Myriophyllum tenellum	Dwarf water-milfoil	2	1.42	4.00	4.00	1.00	0
Polygonum amphibium	Water smartweed	2	1.42	4.00	4.00	1.50	0
Eriocaulon aquaticum	Pipewort	1	0.71	2.00	2.00	1.00	0
Juncus pelocarpus f. submersus	Brown-fruited rush	1	0.71	2.00	2.00	2.00	0
Lobelia dortmanna	Water lobelia	1	0.71	2.00	2.00	1.00	0
Najas flexilis	Slender naiad	1	0.71	2.00	2.00	1.00	0
Potamogeton illinoensis	Illinois pondweed	1	0.71	2.00	2.00	1.00	0

Muskgrass (*Chara* sp.) was the third most common species in the pretreatment survey (24 sites/mean rake 2.00). We documented a non-significant decline (p=0.55) in distribution to 21 sites posttreatment, but it remained the third most common species in the community. Its density was also unchanged (Figure 12).

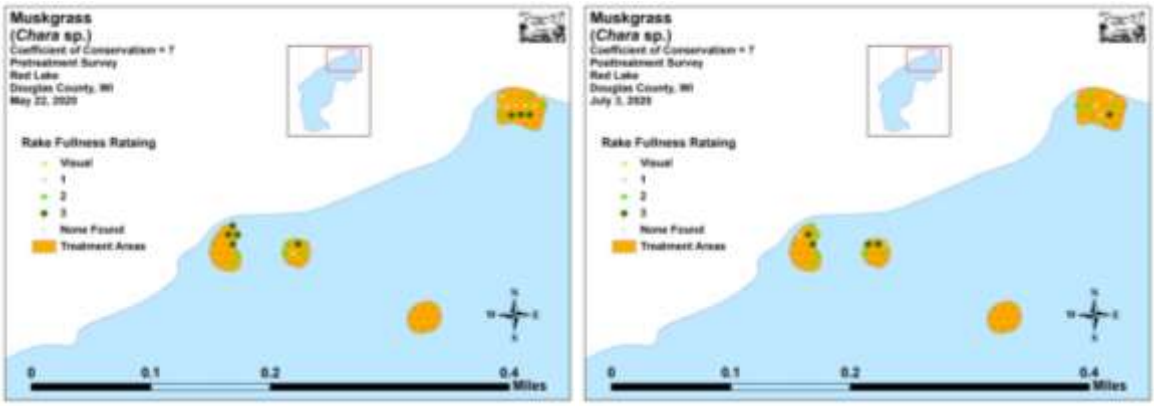


Figure 12: Pre/Posttreatment Muskgrass Density and Distribution

Common waterweed (*Elodea canadensis*) was the fourth most widely distributed species in both surveys (17 sites pretreatment/11 sites posttreatment) (Figure 13). Neither the decline in distribution nor its increase in mean rake fullness from 1.29 pretreatment to 1.36 posttreatment were significant (p=0.56/p=0.36).

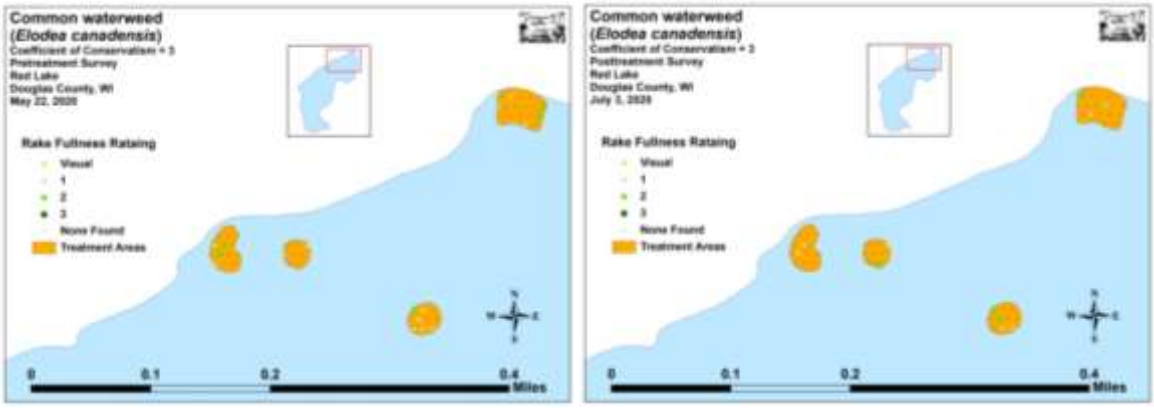
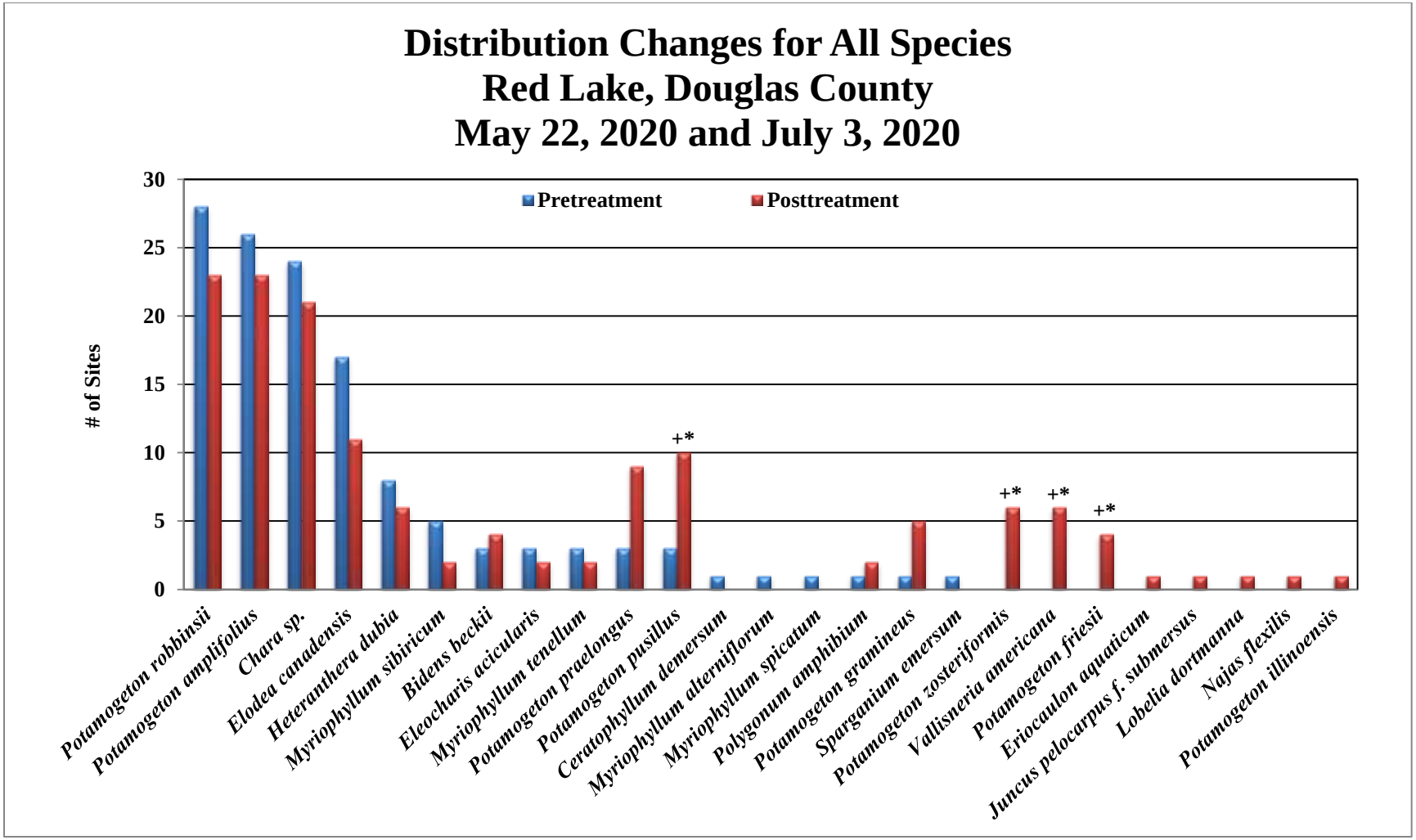


Figure 13: Pre/Posttreatment Common Waterweed Density and Distribution

No species showed significant declines in distribution posttreatment, but Small pondweed (*Potamogeton pusillus*), Flat-stem pondweed (*Potamogeton zosteriformis*), Wild celery (*Vallisneria americana*), and Fries' pondweed (*Potamogeton friesii*) all demonstrated significant increases in distribution (Figure 14) (Maps for all native species from the pre and posttreatment surveys can be found in Appendixes VI and VII).



Significant differences = * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Figure 14: Pre/Posttreatment Macrophyte Changes

July EWM Littoral Zone Rake Removal and Bed Mapping Survey:

On July 3rd, we surveyed transects covering 15.1km (9.4 miles) spending extra time in the treatment areas and along the south shoreline where we have found scattered plants but not beds in past surveys (Figure 15). We had mostly sunny skies and calm conditions which allowed us to see down 7-8ft into the water column. We did **NOT** find any evidence of Eurasian water-milfoil within or around the treatment area during this initial survey, and raking at the core of the treatment areas didn't produce any surviving plants either. However, we did find and rake remove a total of ten plants – seven in a cluster in the south bay and three plants along the sharp drop-offs of the western shoreline.

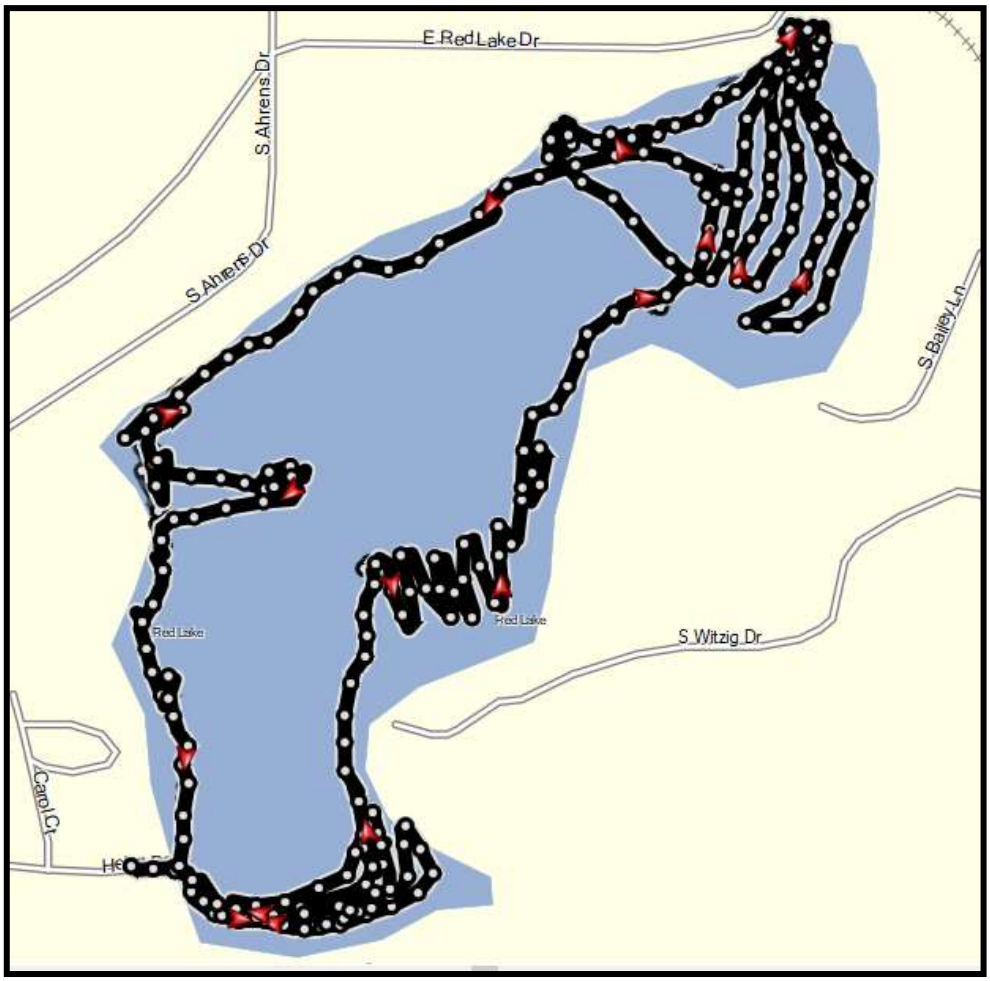


Figure 15: Early July 2020 Littoral Zone EWM Survey Transects

August EWM Littoral Zone Rake Removal and Bed Mapping Survey:

On August 30th we had ideal conditions with bright overhead sun and calm winds. This allowed us to see down almost 9ft into the water column. An expanded search of 22.1km (13.7 miles) (Figure 16) through all former beds and treatment areas found and removed 22 total plants – one along the western shoreline and 21 in the south bay. In addition to several plants found near the south bay cluster we first noticed in July, we also located a large canopied multi-stemmed plant in 10ft of water that may have been the source for the many new "sprouts" in the area. Encouragingly, we saw no plants or floating fragments anywhere else in the lake, and additional raking in the 2020 treatment areas failed to turn up any surviving plants.

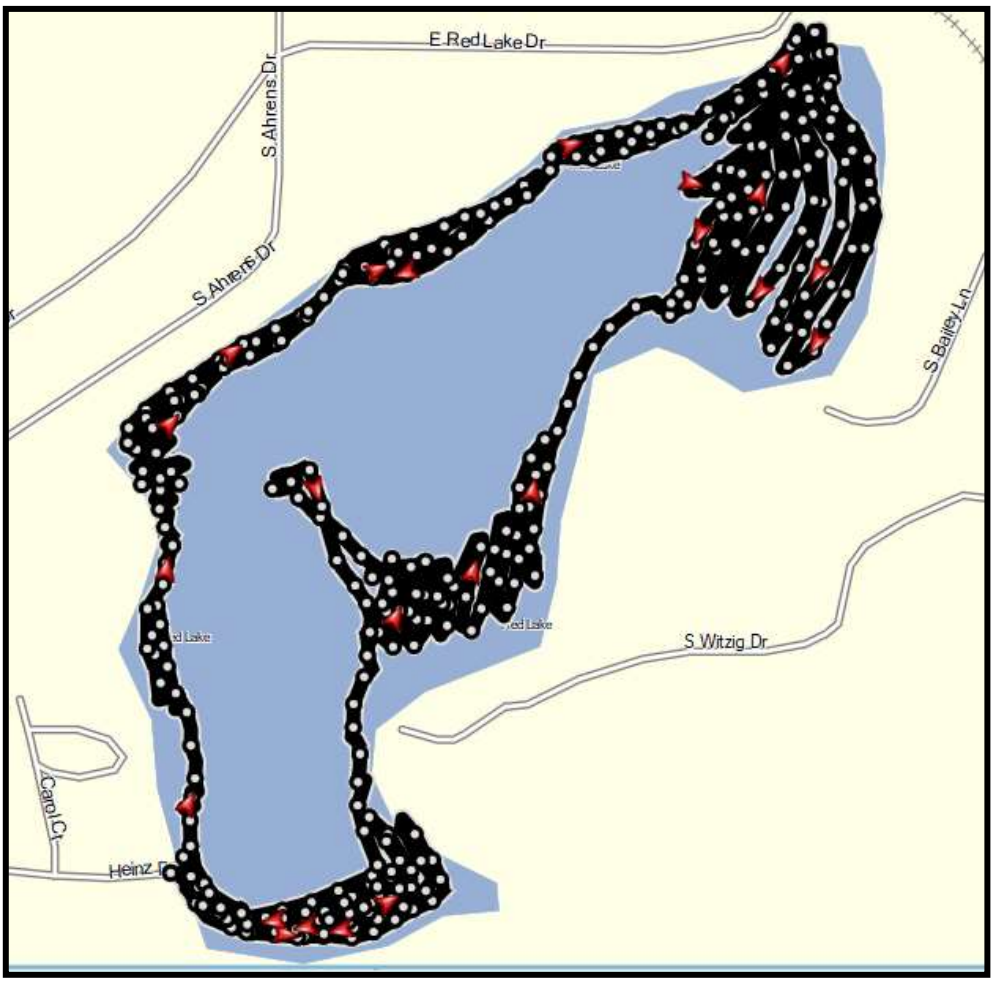


Figure 16: Late August 2020 Littoral Zone EWM Survey Transects

Although none of the areas found in 2020 were truly dense beds, drawing polygons with a small buffer around the four spots with the 32 plants that we rake removed produced a total area of 0.63 acres (approximately 0.25% of the lake's surface area) (Figure 17) (Appendix VIII). This was a decline of 1.30 acres (-67.36%) from the 1.93 acres mapped in 2019 (estimation based on treatment areas) (Table 5).

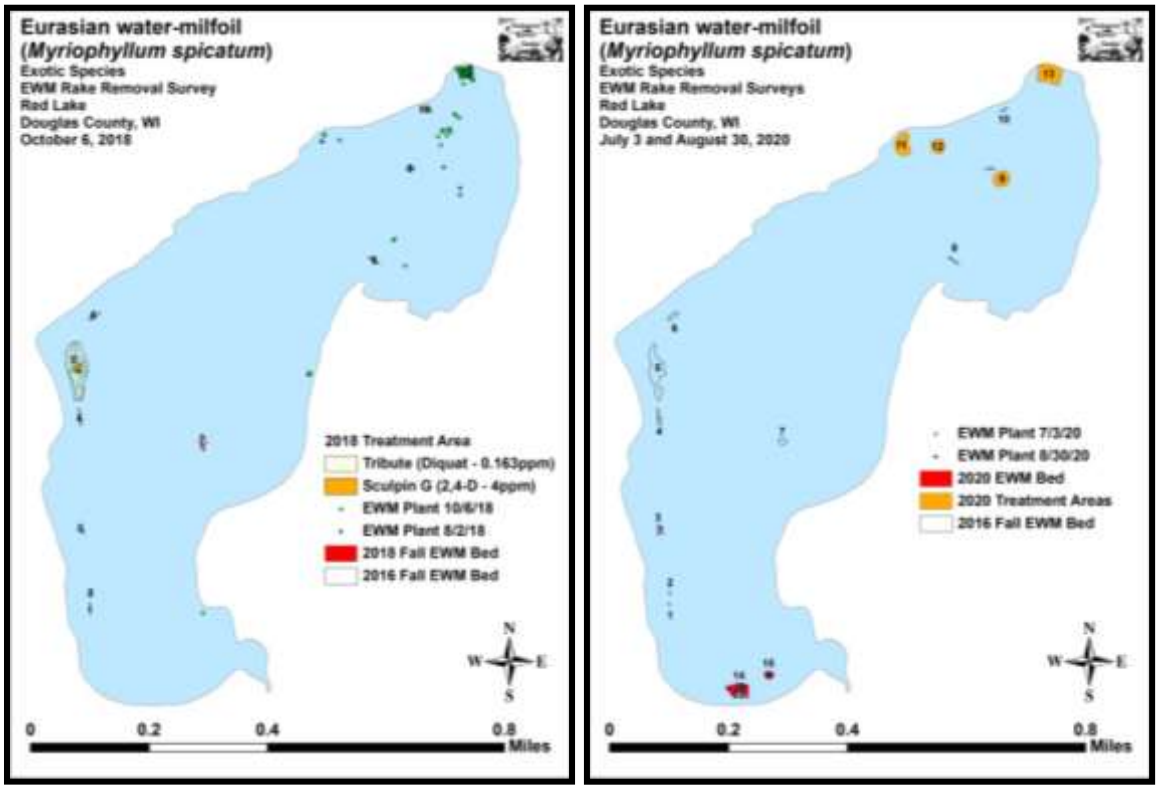


Figure 17: 2018 October and 2020 August EWM Bed Maps

Table 5: Eurasian Water-milfoil Bed Summary
Red Lake, Douglas County
August 30, 2020

Bed Number	2020 Area in Acres	2019** Area in Acres	2018 Area in Acres	2017 Area in Acres	2016 Area in Acres	Change in Acreage	Rake Range and Mean Rake Fullness	Field Notes
1	0	0	0	0	<0.01	0	0	No EWM seen.
2	0	0	0	0	<0.01	0	0	No EWM seen.
3	0.03	0	0	0	0.06	0.03	<<<1-1; <1	2 plants raked out
4	<0.01	0	0	0	0.06	<0.01	<<<1-1; <1	2 plants raked out
5	0	0	0.01	0.09	0.83	0	0	No EWM seen.
6	0	0	0	0	0.07	0	0	No EWM seen.
7	0	0	0.04	0	0.07	0	0	No EWM seen.
8	0	0	0	0	0.03	0	0	No EWM seen.
9	0	0.39	0	0	0.03	-0.39	0	No EWM seen.
10	0	0	0	0	0.03	0	0	No EWM seen.
11	0	0.76	0	0	0	-0.76	0	No EWM seen.
12	0	0.49	0	0	0	-0.49	0	No EWM seen.
13	0	0.29	0	0	0	-0.29	0	No EWM seen.
14	0.49	0	0	0	0	0.49	<<1-2; 1	23 plants raked out.
15	0.11	0	0	0	0	0.11	<<1-3; 1	5 plants raked out.
Total	**0.63**	**1.93**	**0.05**	**0.09**	**1.18**	**-1.30**		

**Treatment areas were used as an estimate

Descriptions of Past and Present EWM Beds:

Beds 1 and 2 – Despite extensive searching in the 8-11ft bathy ring during the 2017, 2018, and 2020 surveys, we were unable to relocate these narrow micro-beds that we found growing along the western shoreline in 2016. For whatever reason, at this point, it seems unlikely there are surviving plants in this area.

Beds 3 and 4 – The presence of only a few isolated individuals in these areas since they were first mapped in 2016 may mean that they provide EWM only marginal habitat. If volunteers are available, a SCUBA survey along the 9ft bathy ring on the western shoreline could potentially be used to determine if more plants are present and what their state of health is.

Beds 5-13 – Despite extensive searching and rake sampling, we didn't locate any surviving plants in any of the areas that have been treated repeatedly since 2016. We also didn't see any floating fragments anywhere along the north shoreline or in the northeast bay.

Bed 14 – After completing a rake removal of seven plants in this area in July where we felt we got everything cleaned up, we were disappointed to find 16 additional plants here in late August. The bed is in line with a dock, and it may be that these early plants were prop clipped as most of the plants we found in August were in deeper water than those removed in July. It may also be that they simply hadn't grown enough to be seen at the earlier date.

Bed 15 – We unfortunately missed the large multi-stemmed plant at the core of this area in July. Although we removed it in August, there were already additional satellite plants around it, and the parent plant was actively fragmenting. Because of this, we believe it's likely there will be additional plants found in this area in 2021.

CONSIDERATIONS FOR MANAGEMENT:

Future Active Management:

Eurasian water-milfoil continues to occupy only a small percentage of the lake's surface area, but it is widely-established making eradication an unrealistic expectation. With this in mind, continuing to work to control its spread in the most cost effective manner possible, while simultaneously minimizing its impact on the lake's aquatic ecosystem will likely continue to be important goals for the lake association moving forward.

ProcellaCor is expensive relative to other herbicide options, but it has produced impressive results in apparently eliminating EWM from areas where it has been used on Red Lake. Because even "spot" treatment areas of <0.50 acre have resulted in complete control, it may be worth considering a small treatment in the south bay beds in 2021. On the western shoreline, the extremely limited number of plants found likely doesn't justify treatment – at least with the information currently available. If SCUBA volunteers are available, searching this area for more EWM and conducting manual removal if plants are few in number might be a better option for control.

Locating Newly Established EWM:

Annual surveys by professionals to locate and, if possible, rake remove Eurasian water-milfoil may be desired in the future to quickly identify and manage newly established beds. Residents on the lake can assist with these efforts by watching the area around their docks for newly established EWM beds. Residents should know that Red Lake has a significant amount of the very similar looking Northern water-milfoil (NWM) – a valuable native plant that provides important fish habitat (Figure 18). NWM is widely distributed throughout the lake's rooted littoral zone, but does best over sandy and organic muck often just inshore from EWM in 6-8ft of water. Despite its superficial resemblance to EWM, NWM can be told apart by its leaflets numbering <24 that are usually held rigidly at 90 degree angles off the stem when out of water. Conversely, EWM normally has >26 leaflets that fall limp against the stem when out of water. EWM also tends to have a bright red growth tip on the top of the plant whereas NWM has a bright lime green growth tip. NWM on Red Lake is often mixed with other plants, is seldom bed-forming, and rarely canopies on the surface; whereas EWM is often found in nearly monotypic beds that exclude most native species, and it frequently canopies even in deep water. In the fall, NWM also forms over wintering turions on the tips of shoots whereas EWM has none. These turions of densely packed leaflets are readily visible on most plants after September 15 (Figure 19).

If residents find a plant or bed of plants that looks suspicious, they are encouraged to promptly contact us (saintcroixdfly@gmail.com and/or 715-338-7502) with a picture, specimen, description of, and/or preferably GPS coordinates. These locations could then be added to the existing map for management consideration and help keep small beds from becoming large ones. To assist with this effort, annually presenting all residents on the lake with "WANTED" posters that show the differences between native Northern water-milfoil and exotic Eurasian water-milfoil along with our contact information is another idea for the RLA to consider. Even if it's only in an email, a reminder at the start of the growing season in June could help us, or others, eliminate plants early in the growing season before they spread.

Eurasian water-milfoil

Northern water-milfoil

Figure 18: EWM and Northern Water-milfoil Identification (Berg 2007)

Figure 19: Limp Nature of EWM Leaflets along Stem – Stiff Nature of NWM Leaflets along Stem and Overwintering Turions

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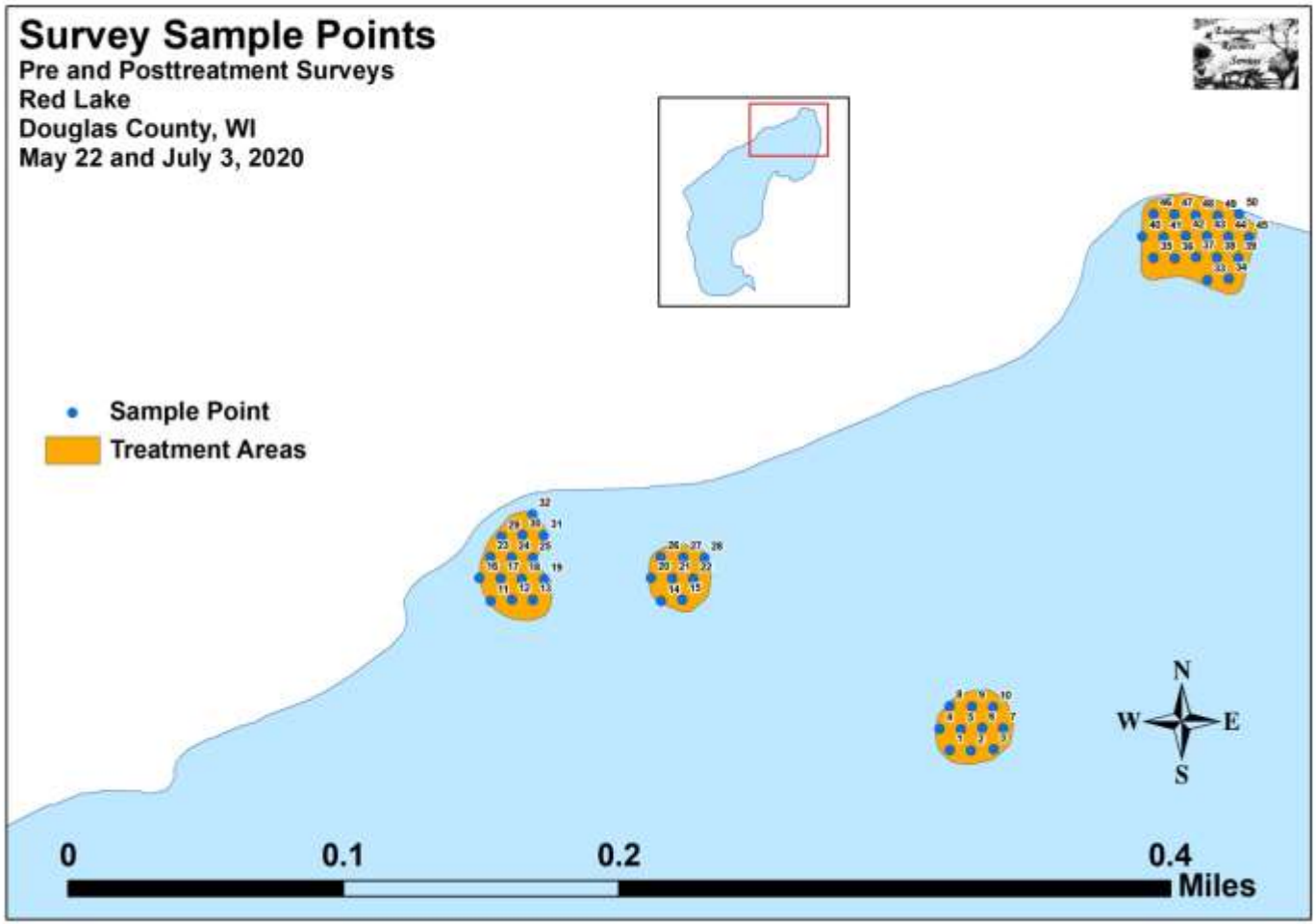
UWEX Lakes Program. [online]. 2010. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/ecology/aquaticplants/default.aspx (2020 June).

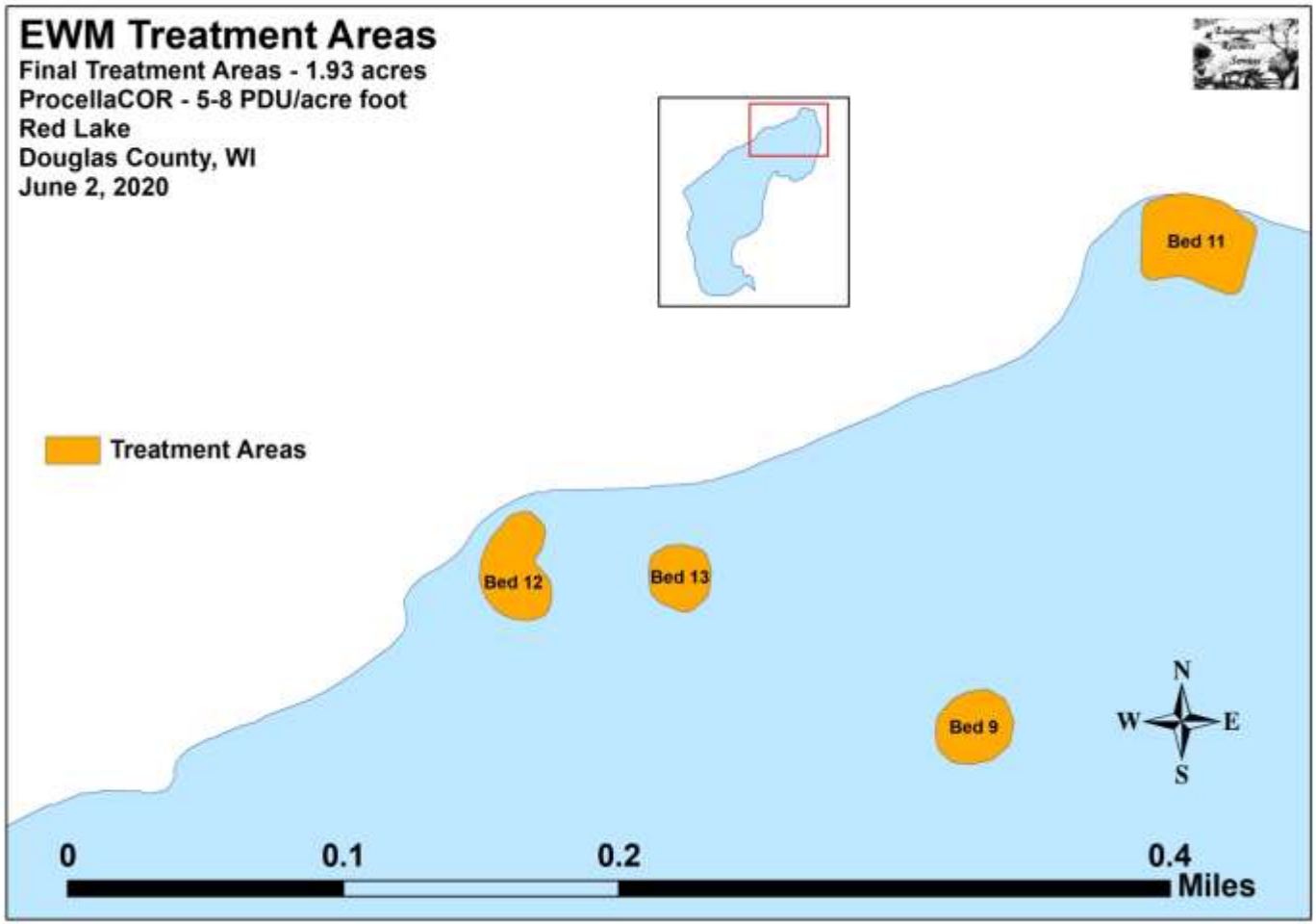
UWEX Lakes Program. [online]. 2010. Pre/Post Herbicide Comparison. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Documents/ecology/Aquatic%20Plants/Appendix-D.pdf (2020 June).

WDNR. [online]. 2020. Wisconsin Lake Citizen Monitoring Data for Red Lake – Douglas County. Available from http://dnr.wi.gov/lakes/waterquality/Station.aspx?id=163383 (2020 September).

WDNR. [online]. 2020. Wisconsin Lakes Information – Red Lake – Douglas County. http://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2492100 (2020 September).

Appendix I: EWM Pre/Post Survey Sample Points and Treatment Areas

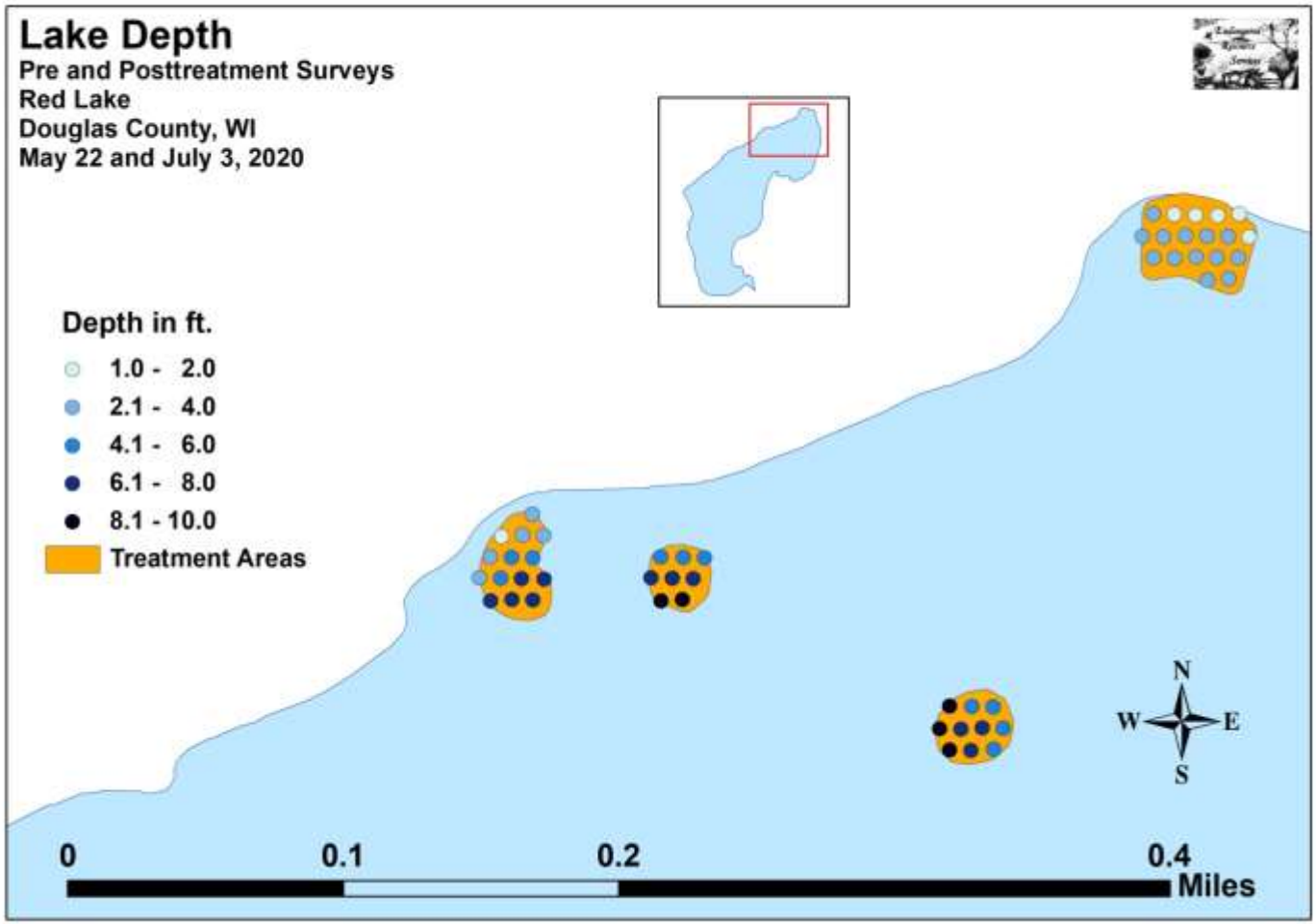

Survey Sample Points
Pre and Posttreatment Surveys
Red Lake
Douglas County, WI
May 22 and July 3, 2020
Sample Point
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

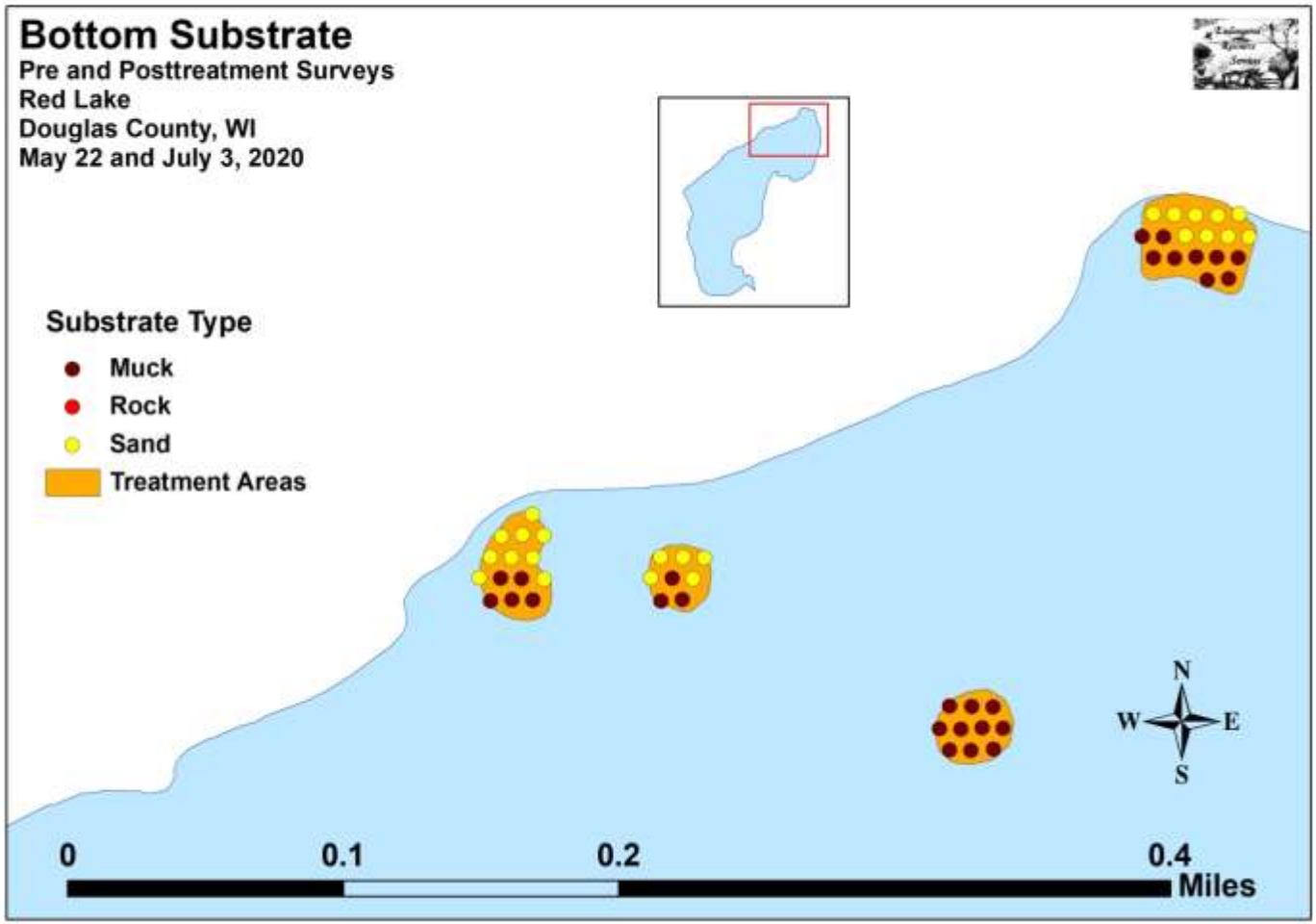

EWM Treatment Areas
Final Treatment Areas - 1.93 acres
ProcellaCOR - 5-8 PDU/acre foot
Red Lake
Douglas County, WI
June 2, 2020
Treatment Areas
Bed 11
Bed 12
Bed 13
Bed 9
N
W
E
S
0
0.1
0.2
0.4
Miles

Appendix II: Vegetative Survey Datasheet

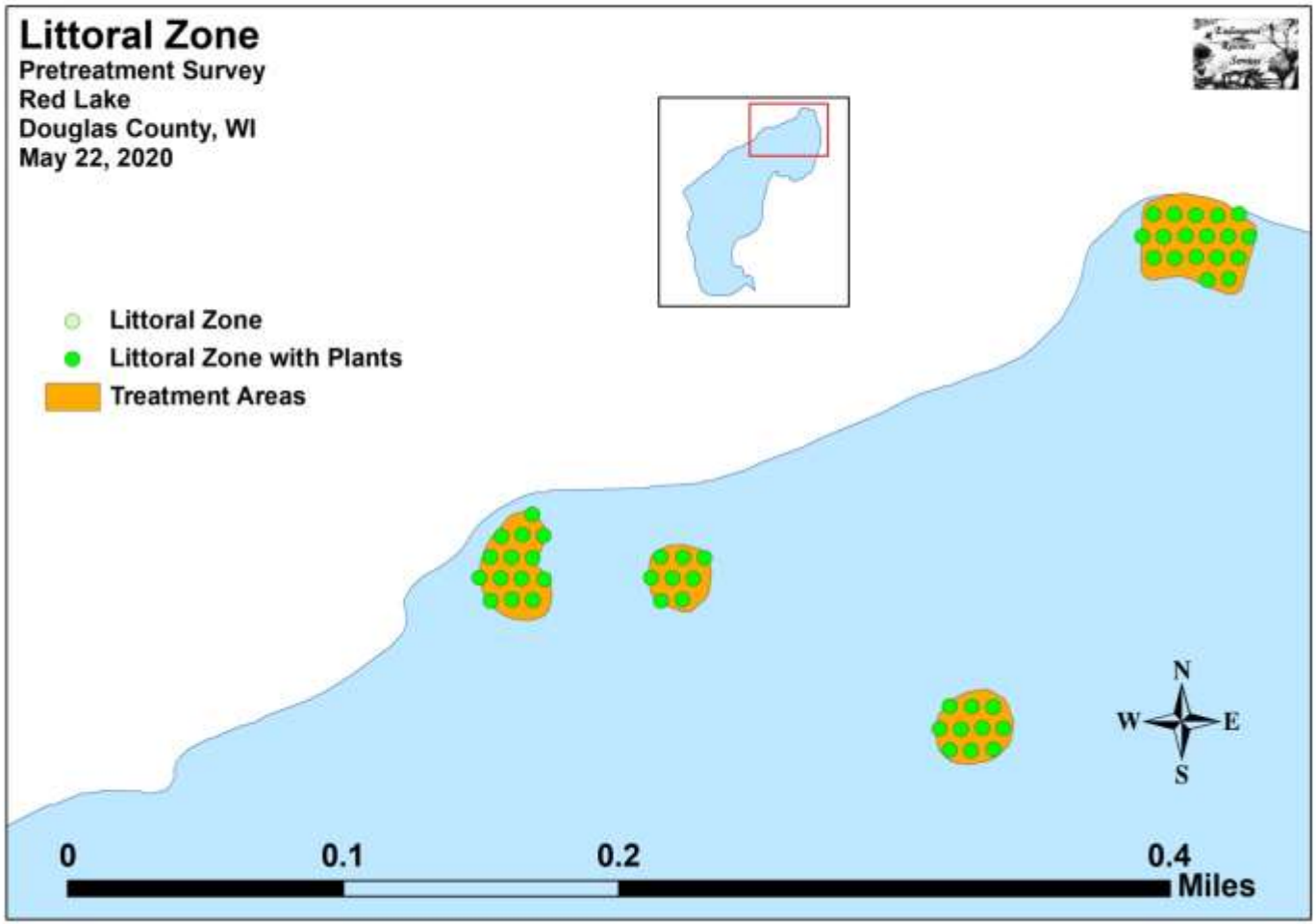
Observers for this lake: names and hours worked by each:																										
Lake:									WBIC									County						Date:	
Site #	Depth (ft)	Muck (M), Sand (S), Rock (R)	Rake pole (P) or rake rope (R)	Total Rake Fullness	EWM	EWM	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									

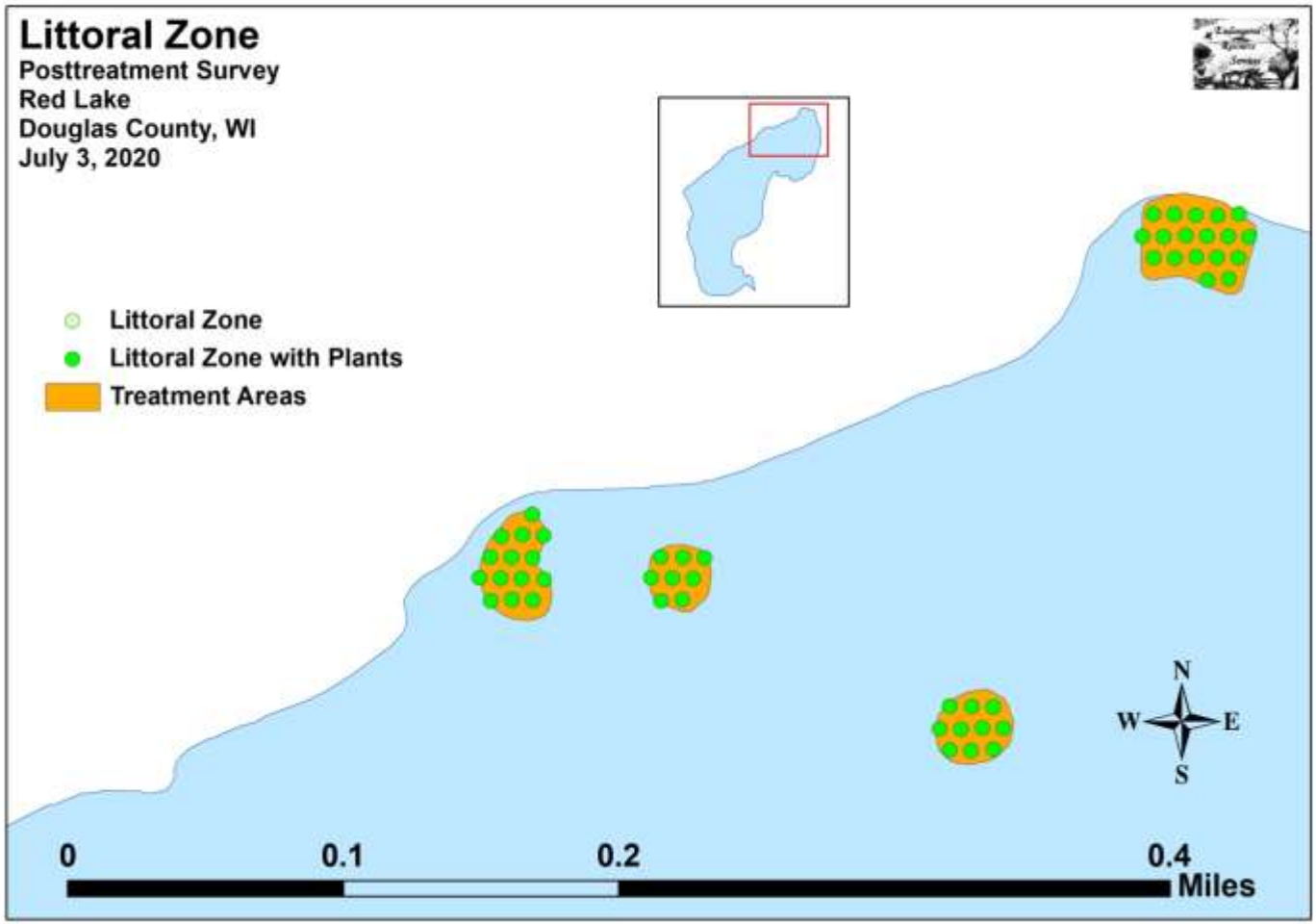
Appendix III: Pre/Post Habitat Variables

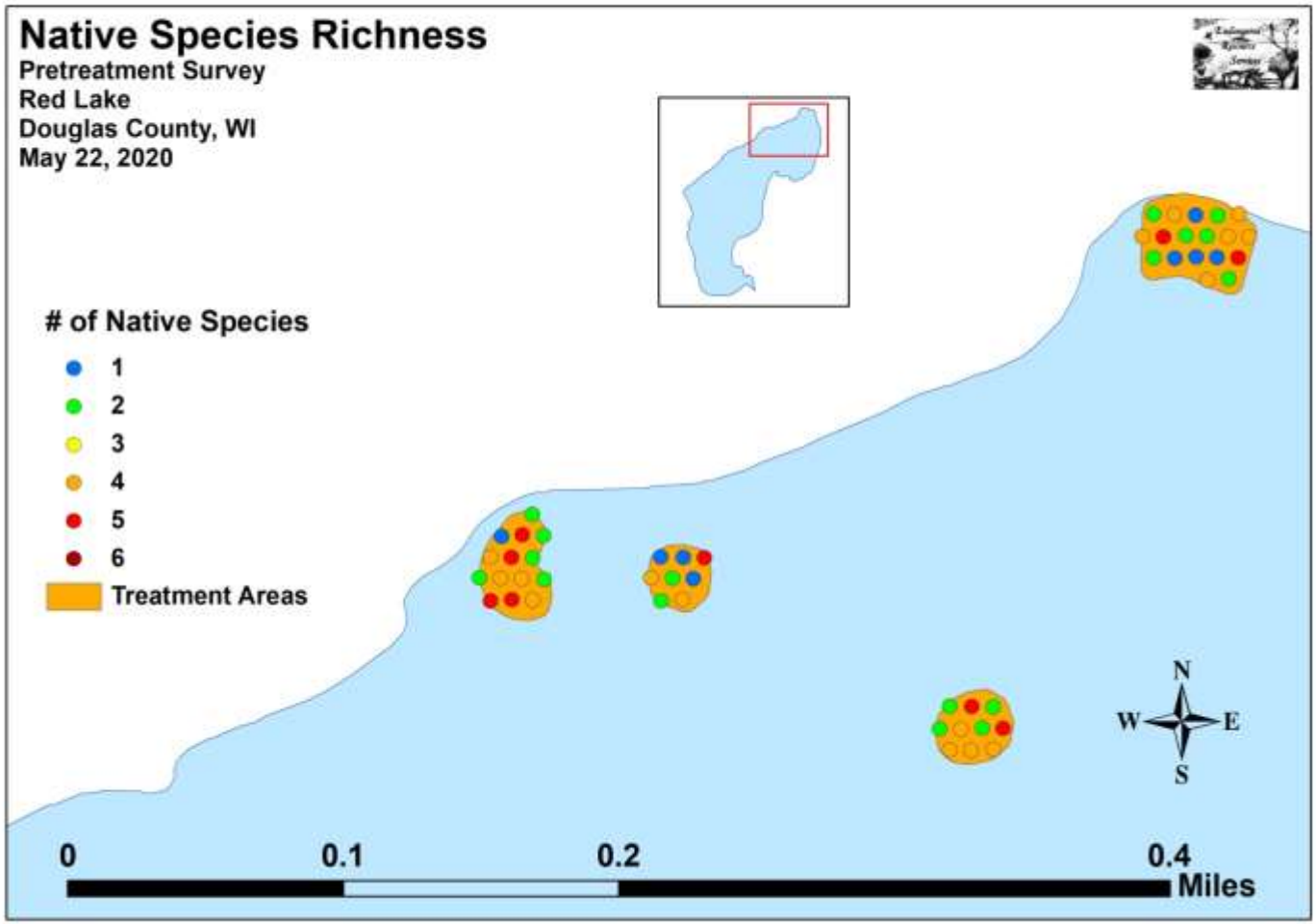

Lake Depth
Pre and Posttreatment Surveys
Red Lake
Douglas County, WI
May 22 and July 3, 2020
Depth in ft.
1.0 - 2.0
2.1 - 4.0
4.1 - 6.0
6.1 - 8.0
8.1 - 10.0
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

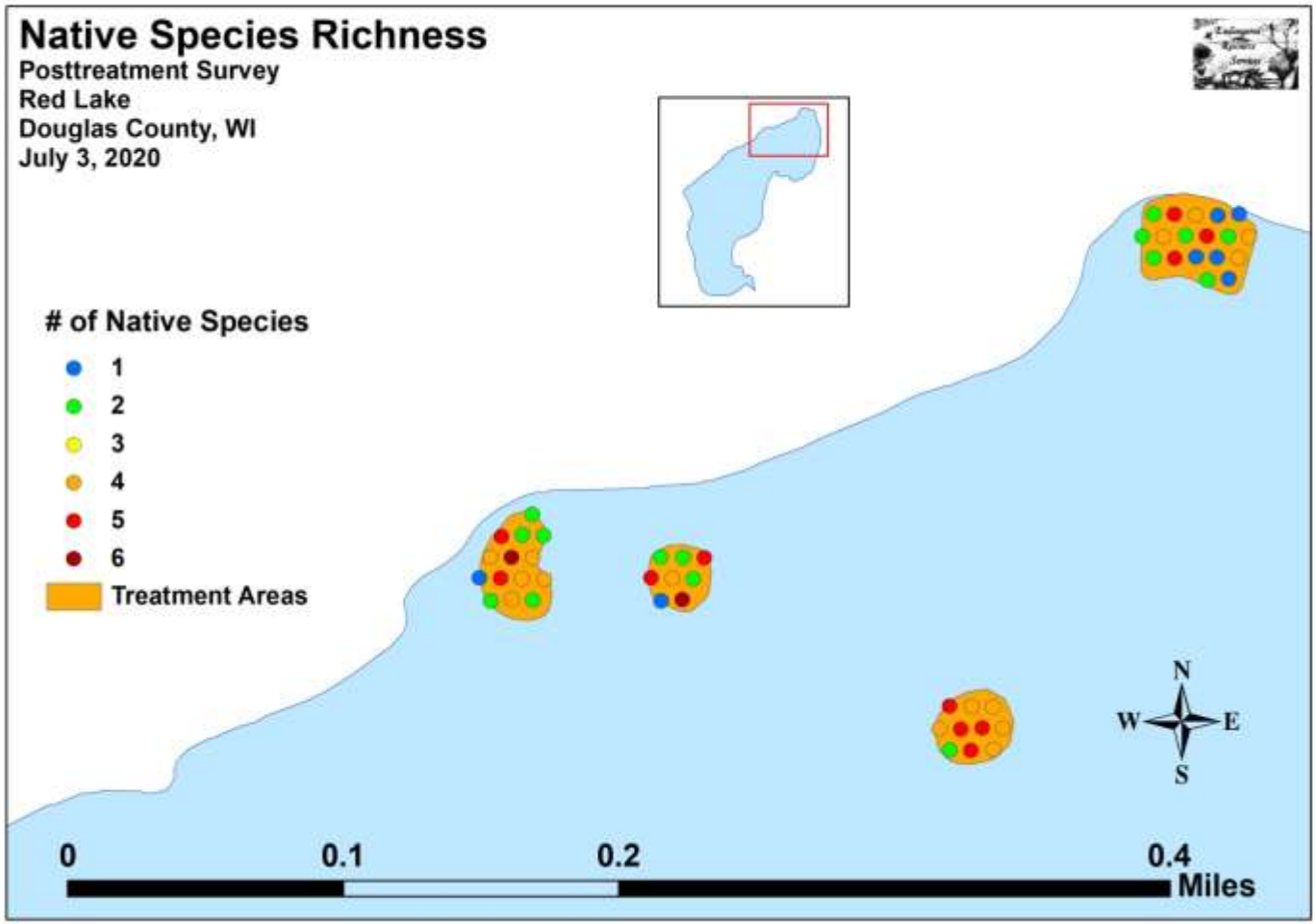

Bottom Substrate
Pre and Posttreatment Surveys
Red Lake
Douglas County, WI
May 22 and July 3, 2020
Substrate Type
Muck
Rock
Sand
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

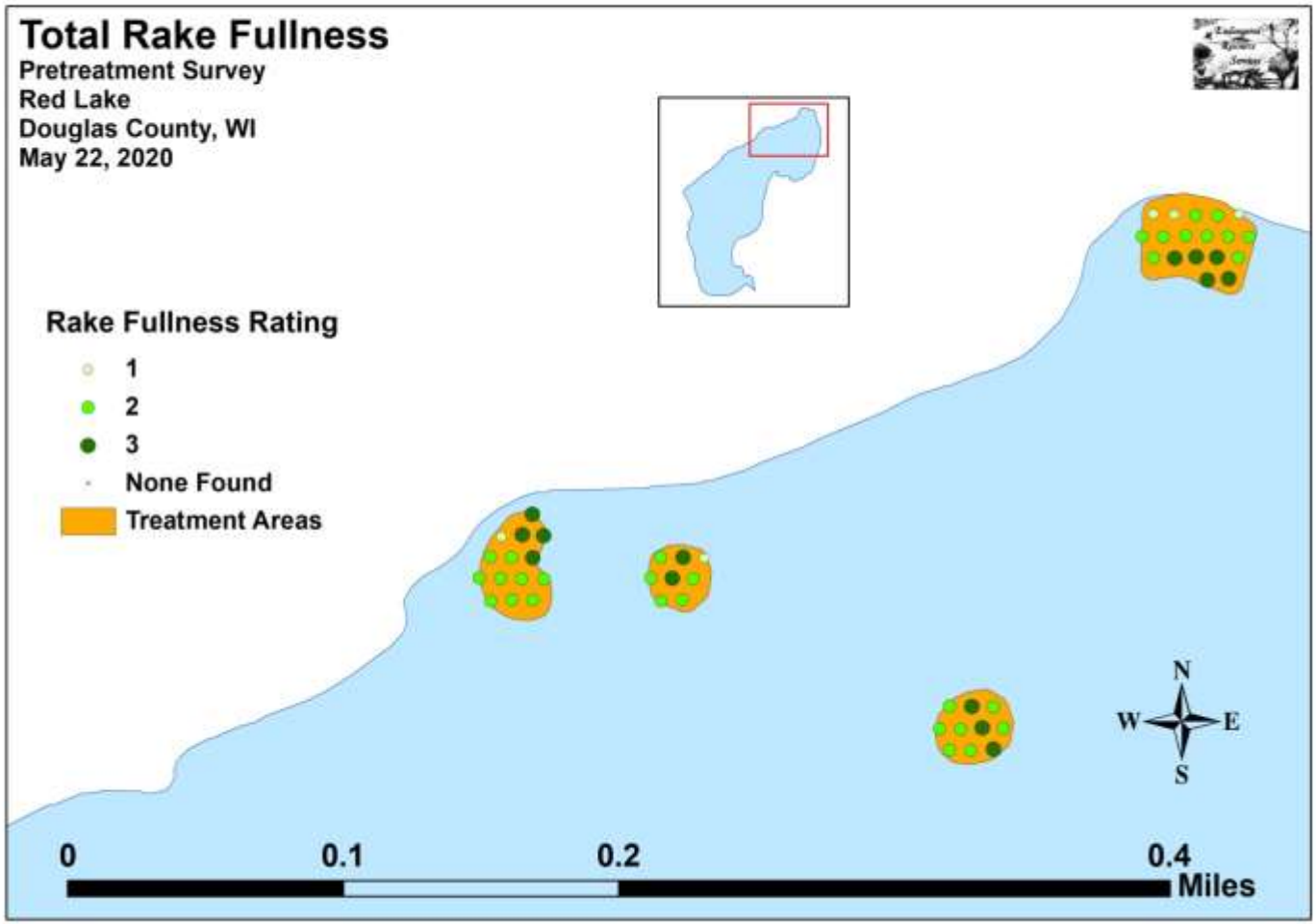
Appendix IV: Pre/Post Littoral Zone, Native Species Richness and Total Rake Fullness

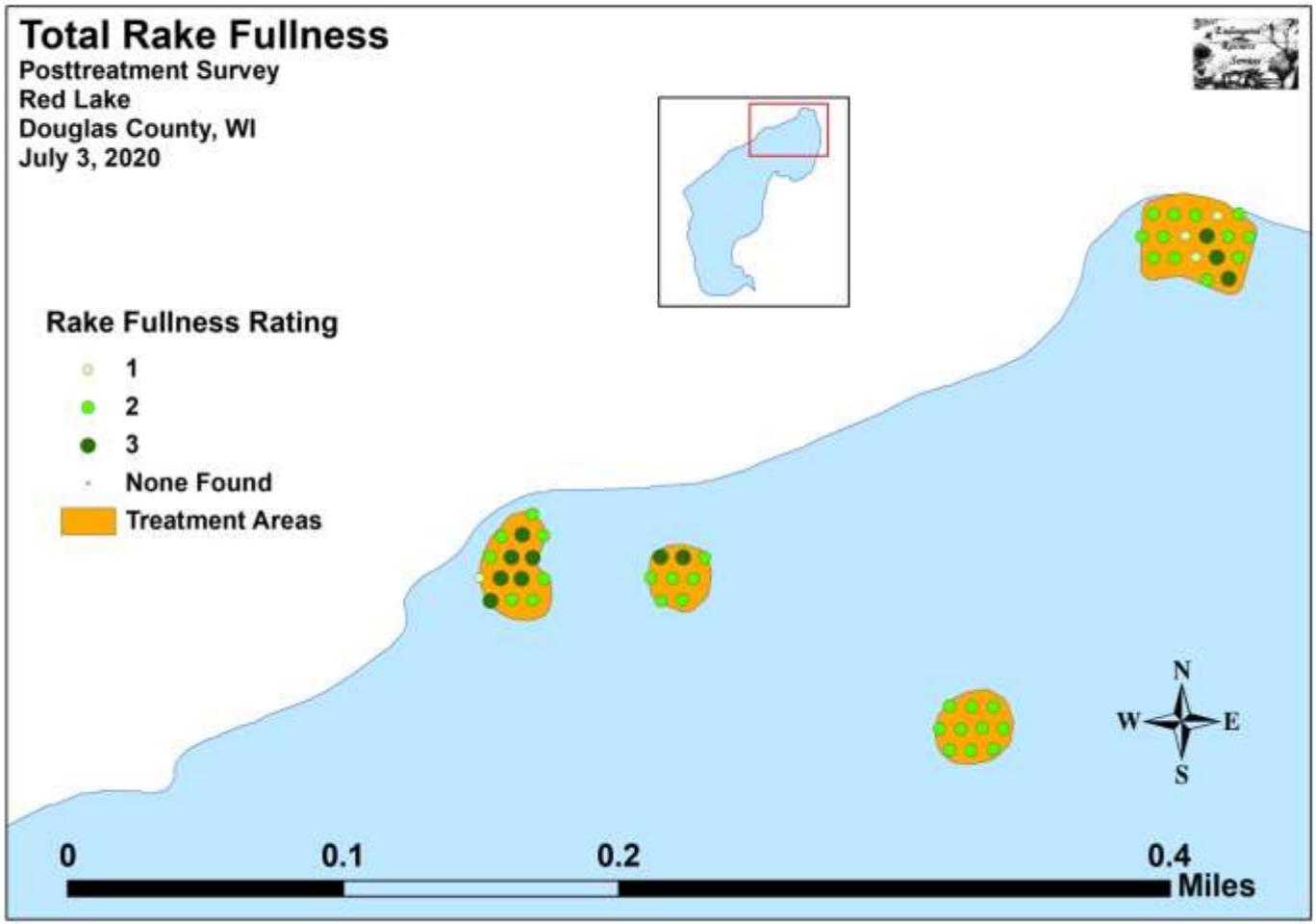

Littoral Zone
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Littoral Zone
Littoral Zone with Plants
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles


Littoral Zone
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Littoral Zone
Littoral Zone with Plants
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

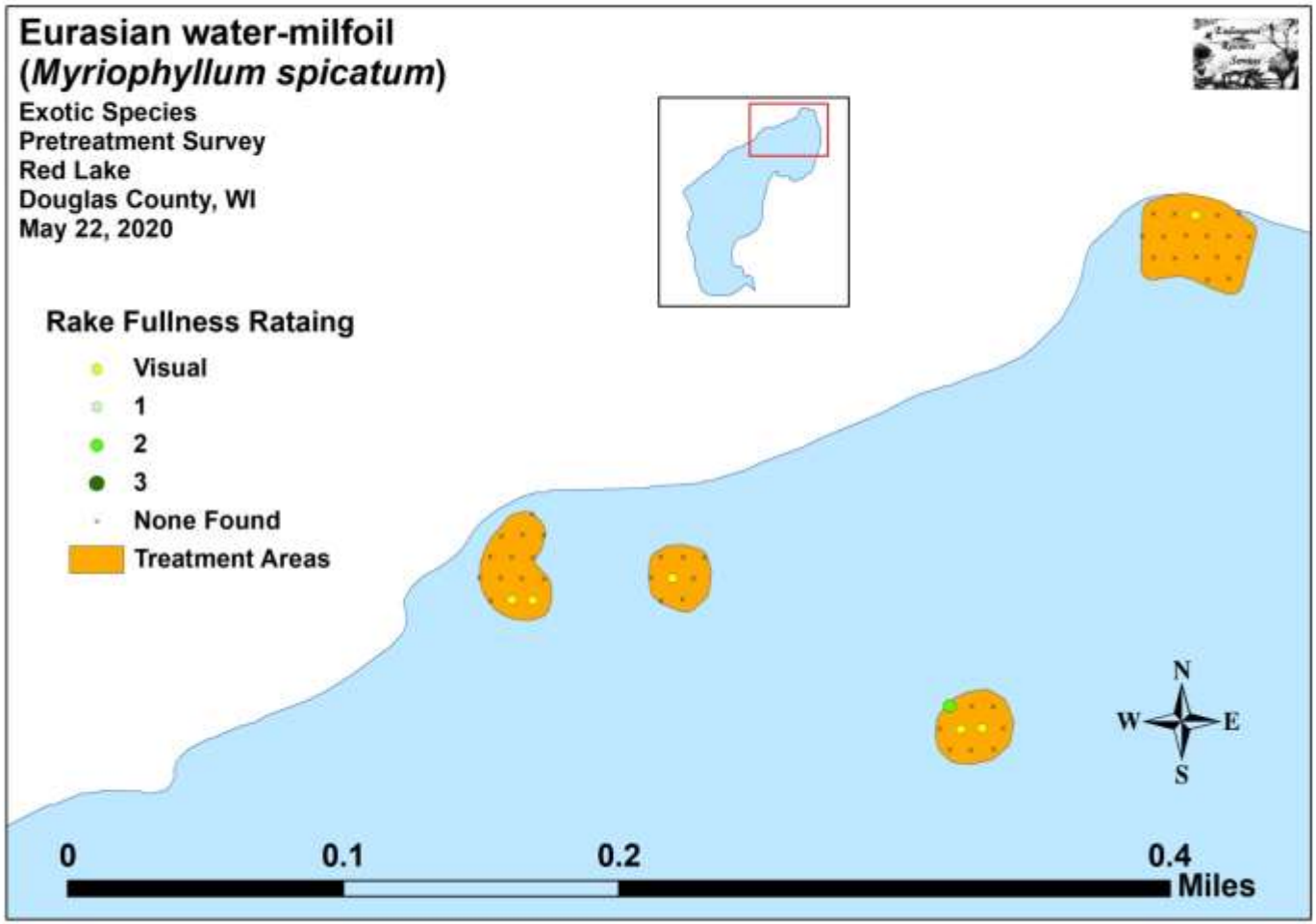

Native Species Richness
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
# of Native Species
1
2
3
4
5
6
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

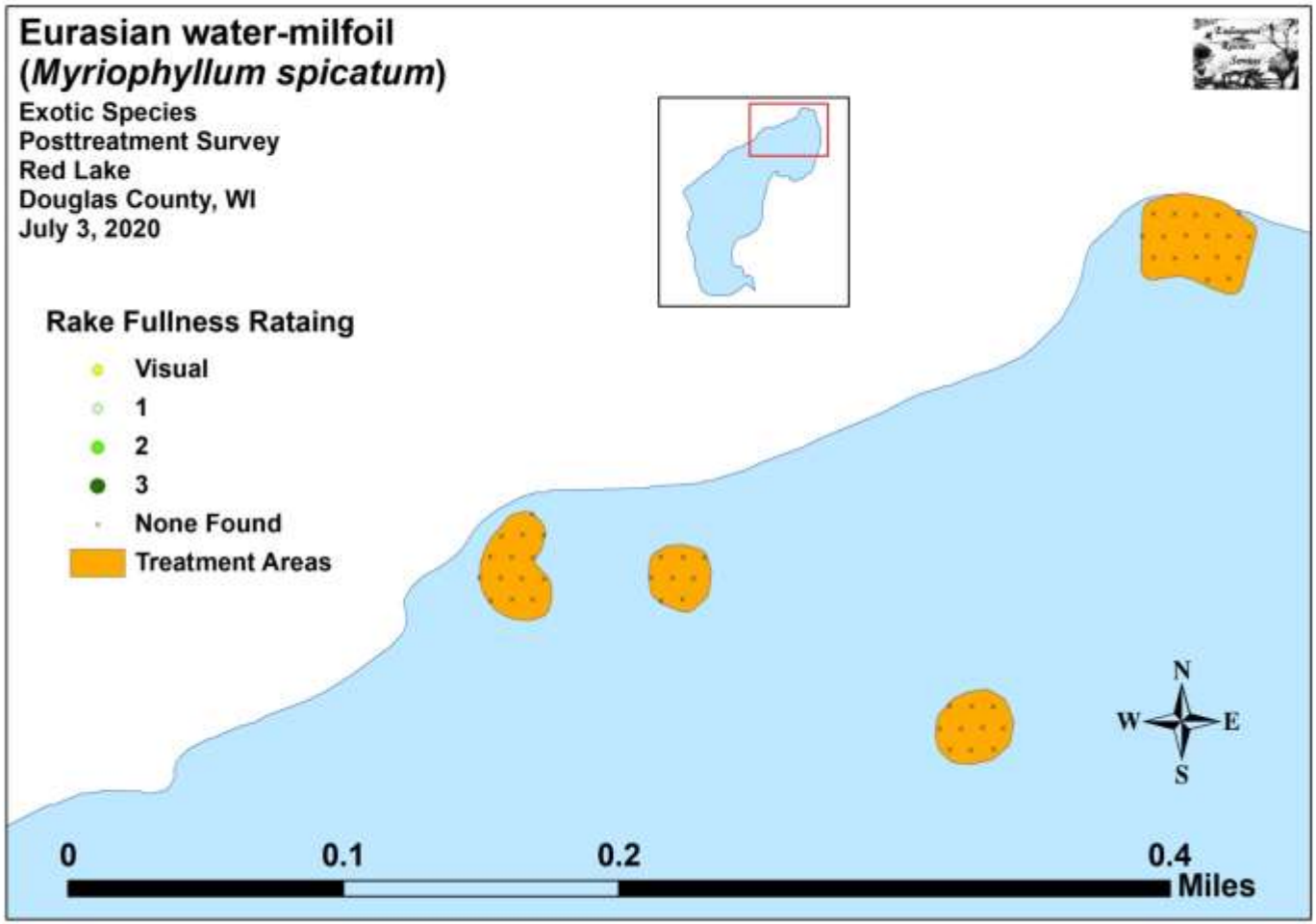

Native Species Richness
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
# of Native Species
1
2
3
4
5
6
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles


Total Rake Fullness
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rating
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

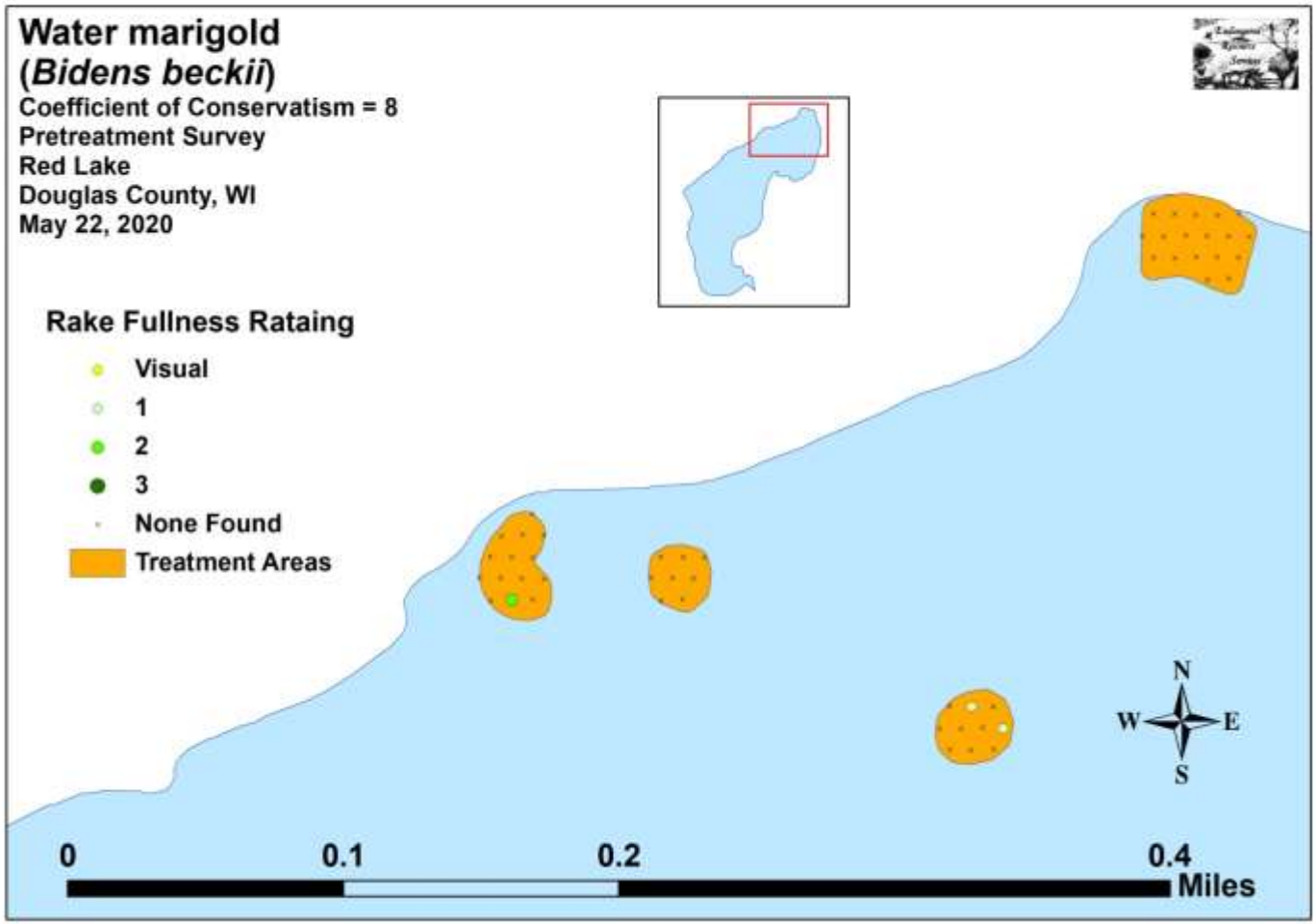

Total Rake Fullness
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rating
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

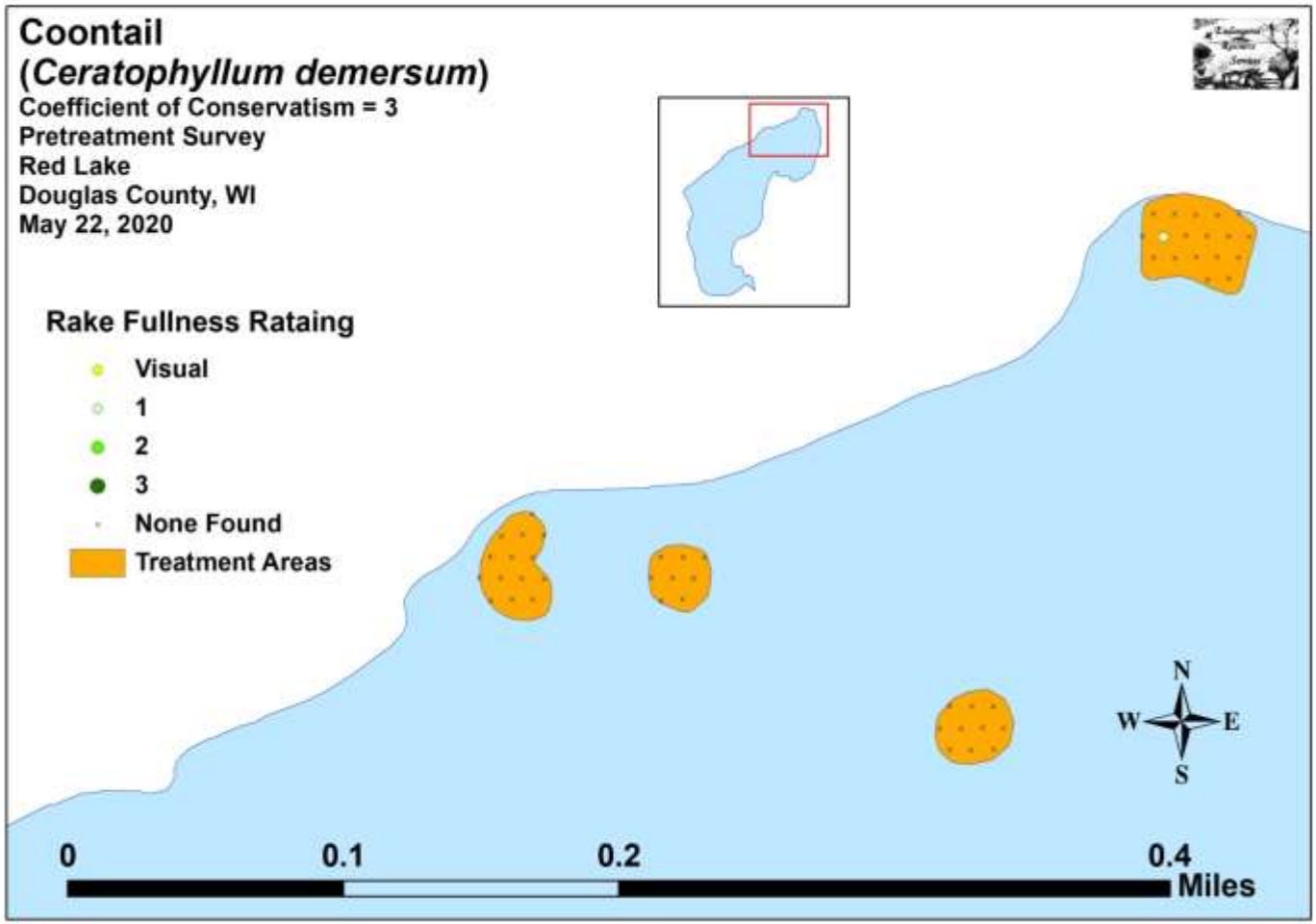
Appendix V: EWM Pre/Posttreatment Density and Distribution

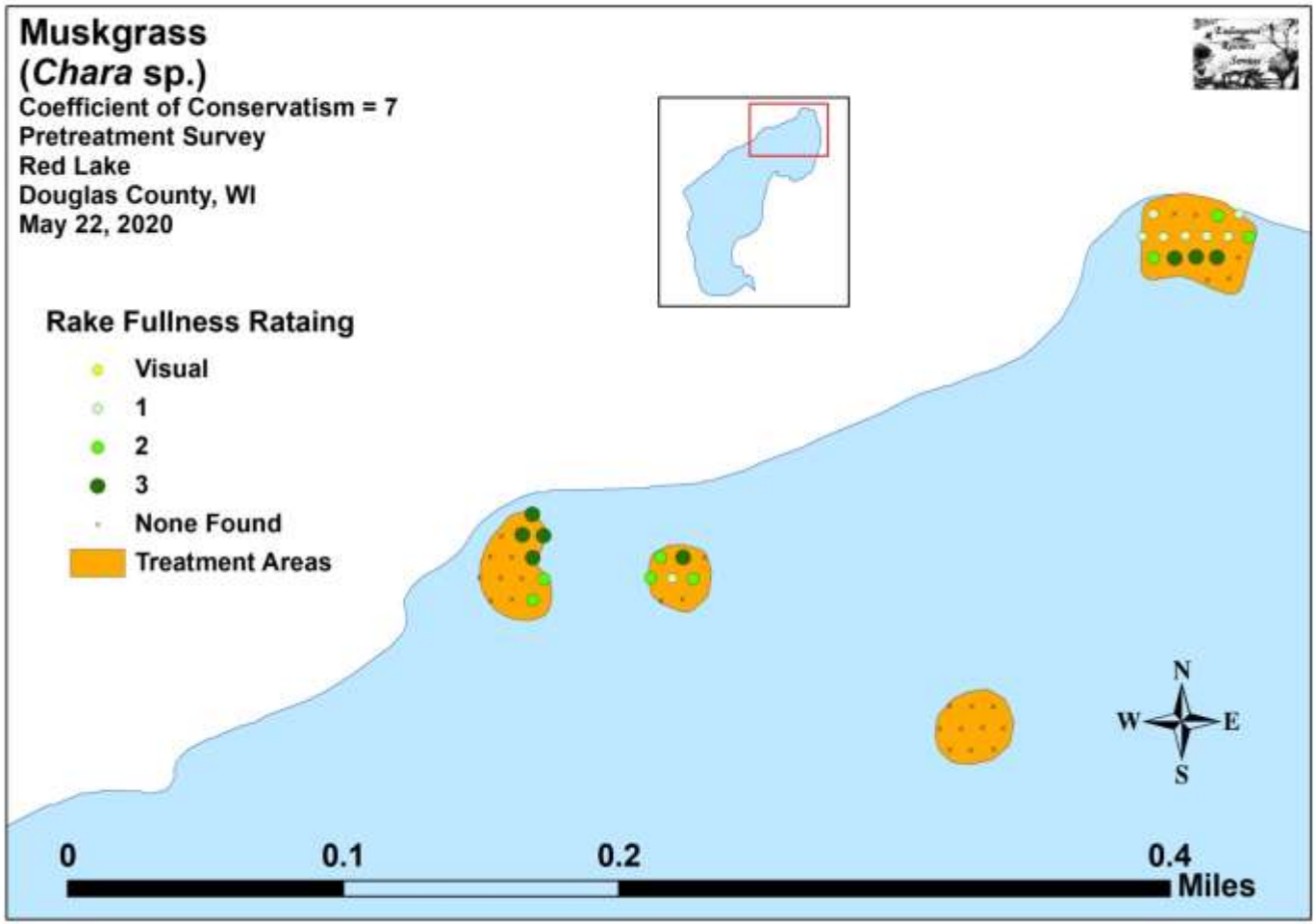

Eurasian water-milfoil
(Myriophyllum spicatum)
Exotic Species
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

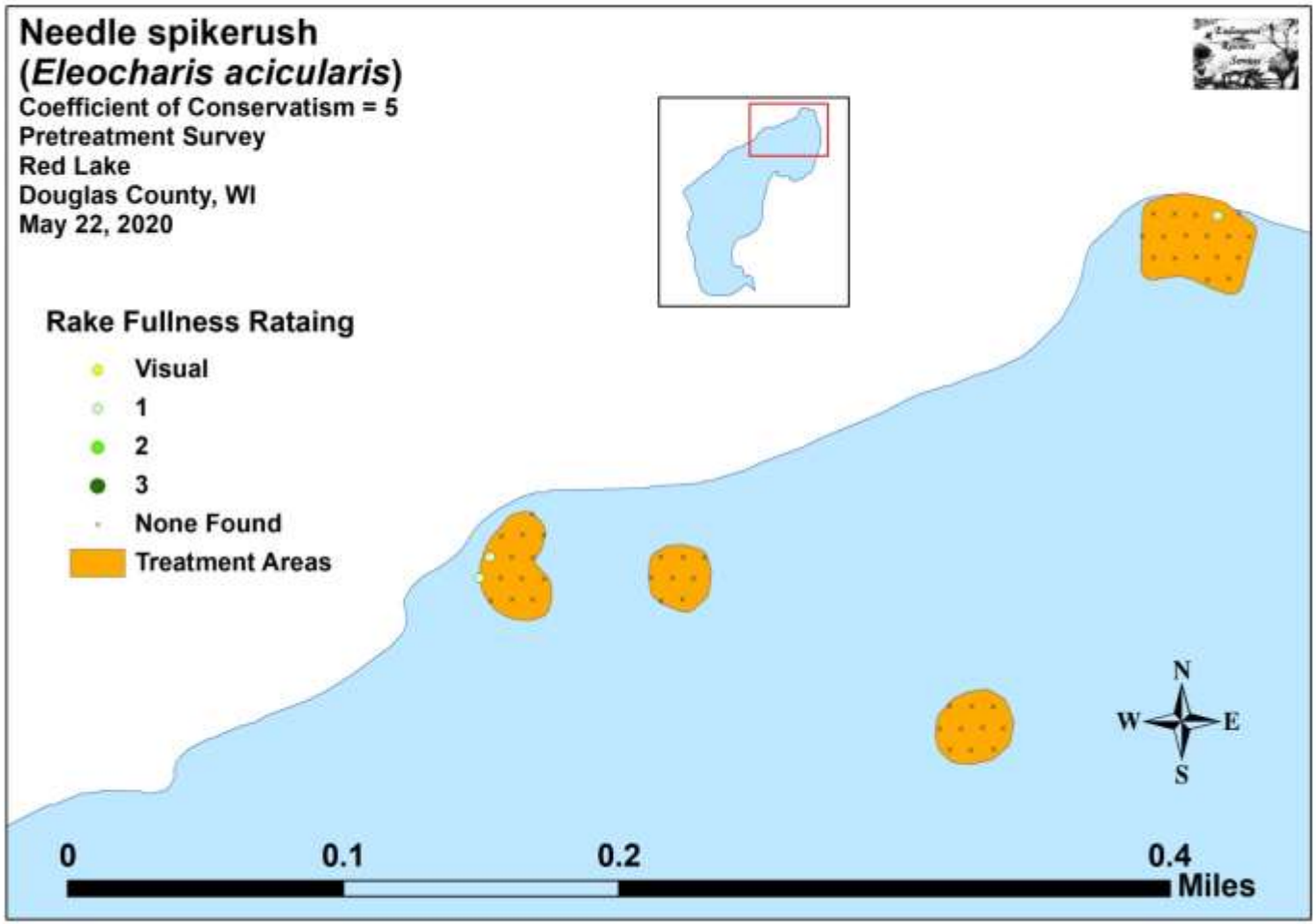

Eurasian water-milfoil
(Myriophyllum spicatum)
Exotic Species
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

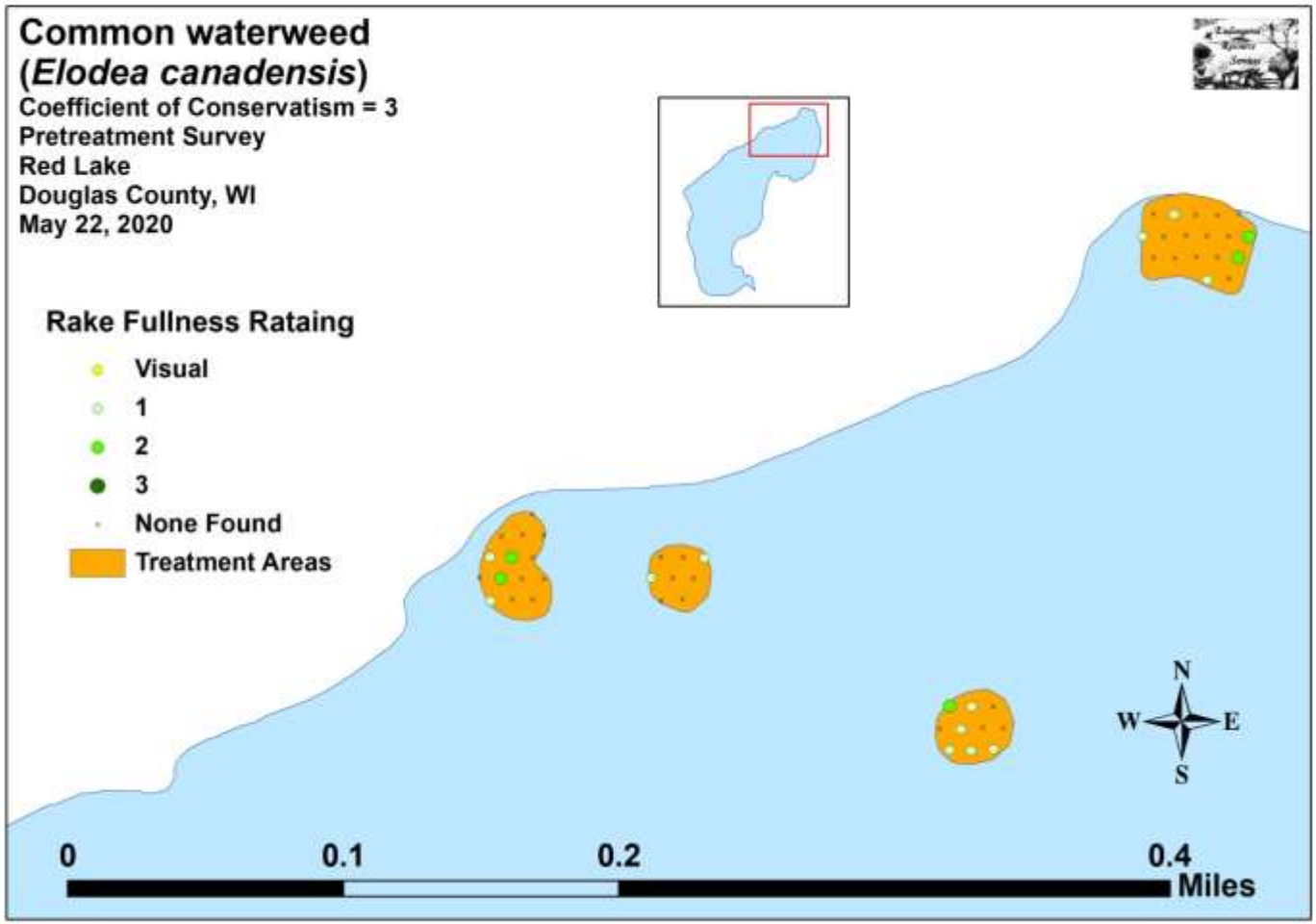
Appendix VI: Pretreatment Native Species Density and Distribution

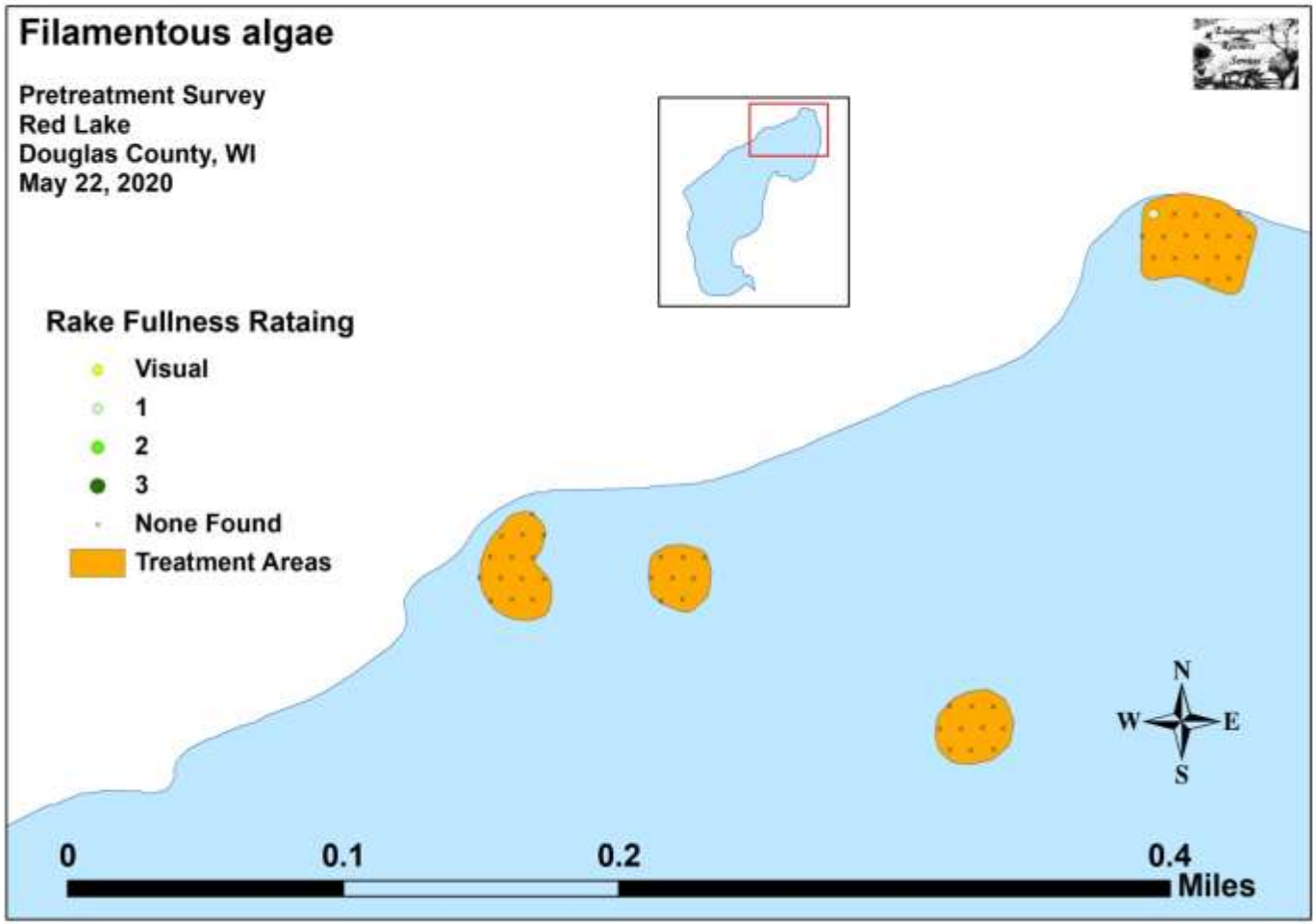

Water marigold
(Bidens beckii)
Coefficient of Conservatism = 8
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

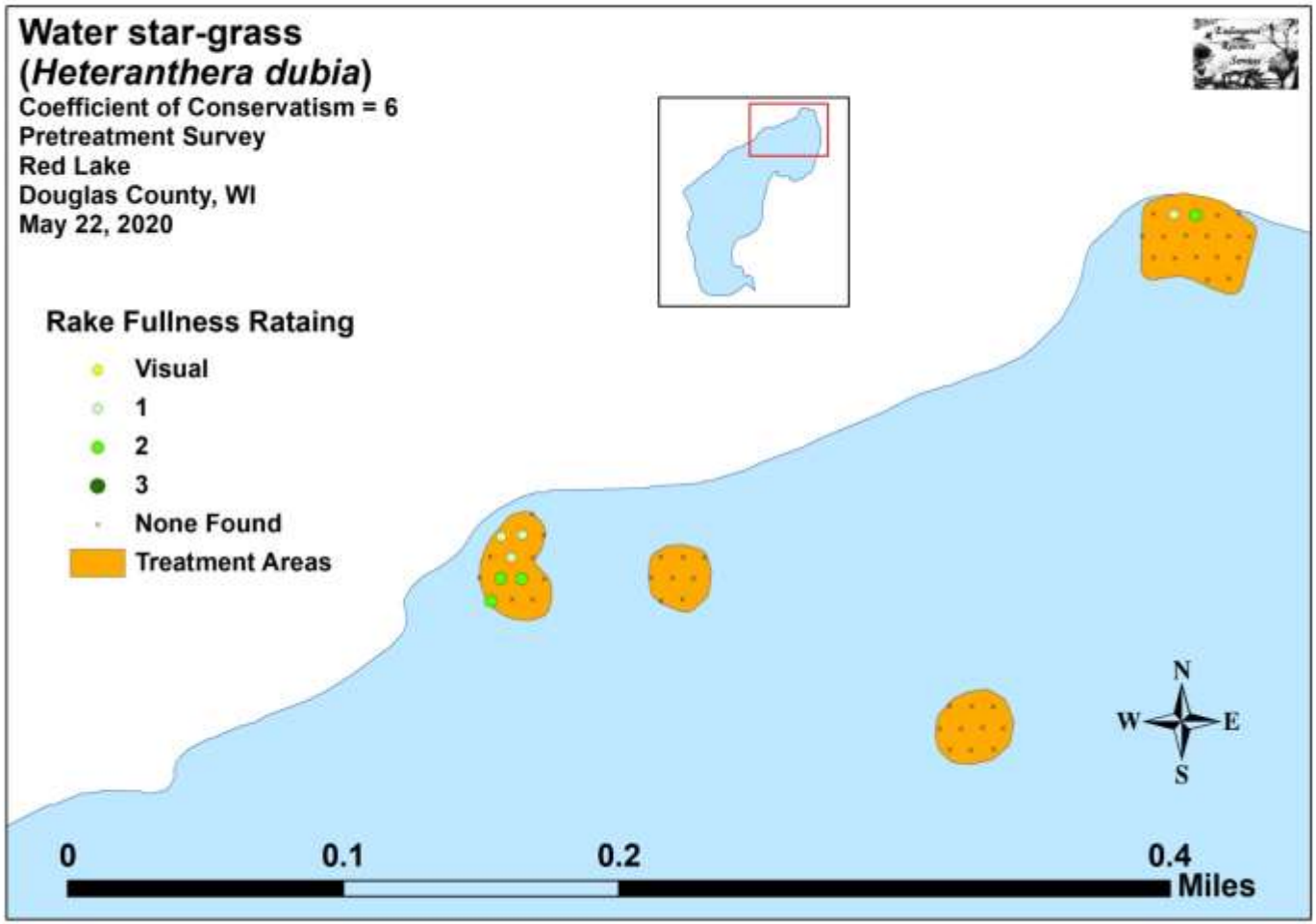

Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

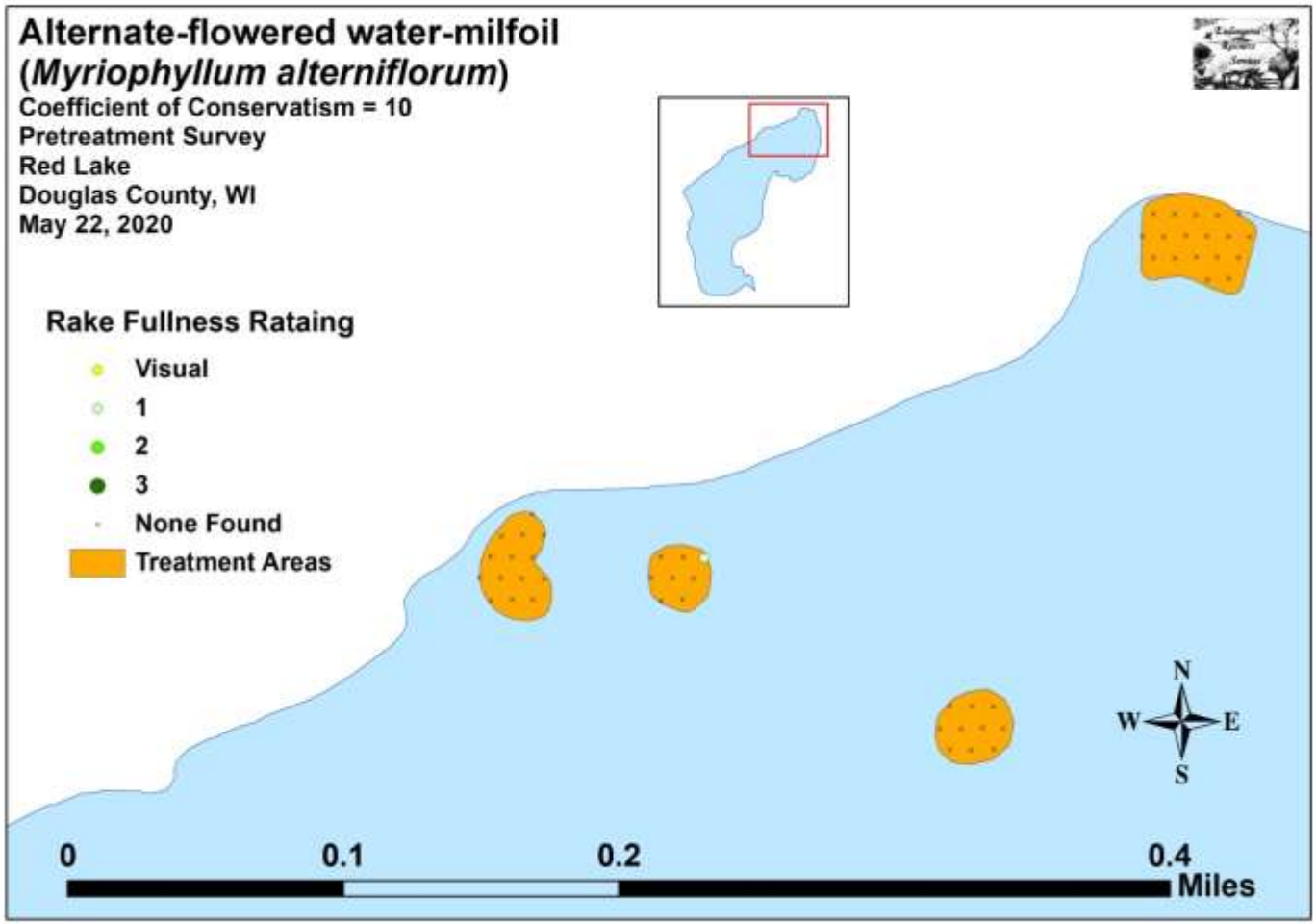

Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

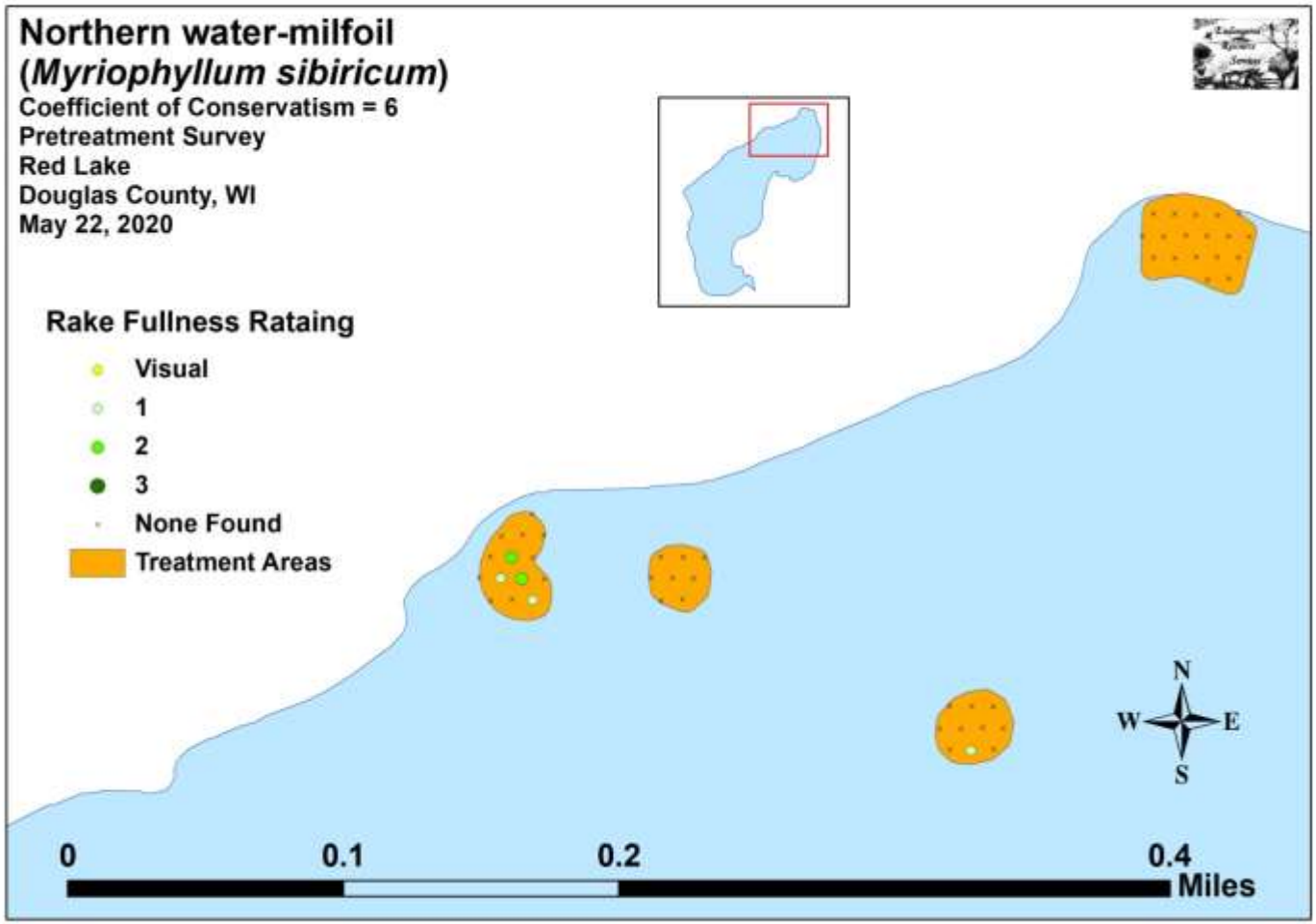

Needle spikerush
(Eleocharis acicularis)
Coefficient of Conservatism = 5
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

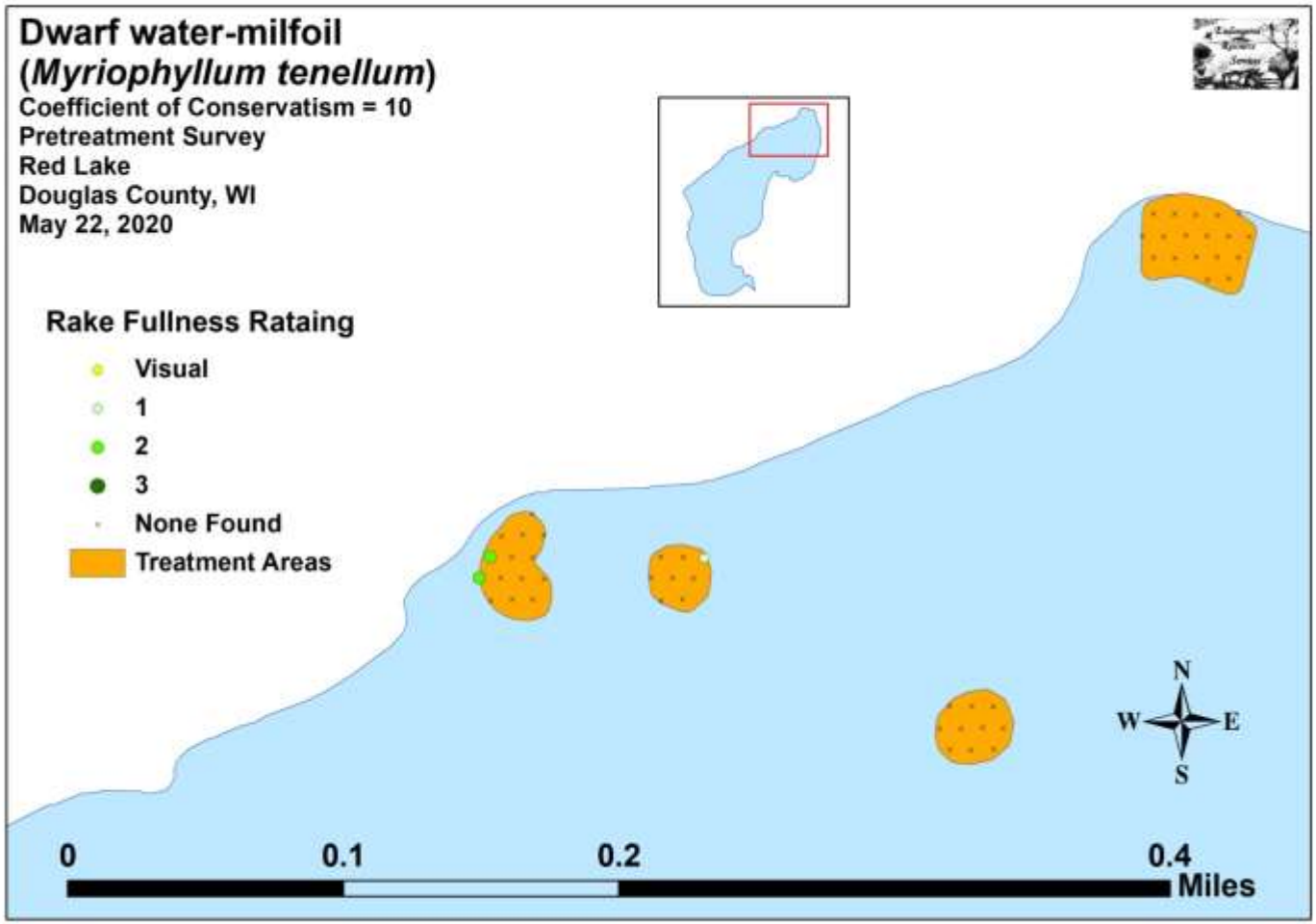

Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

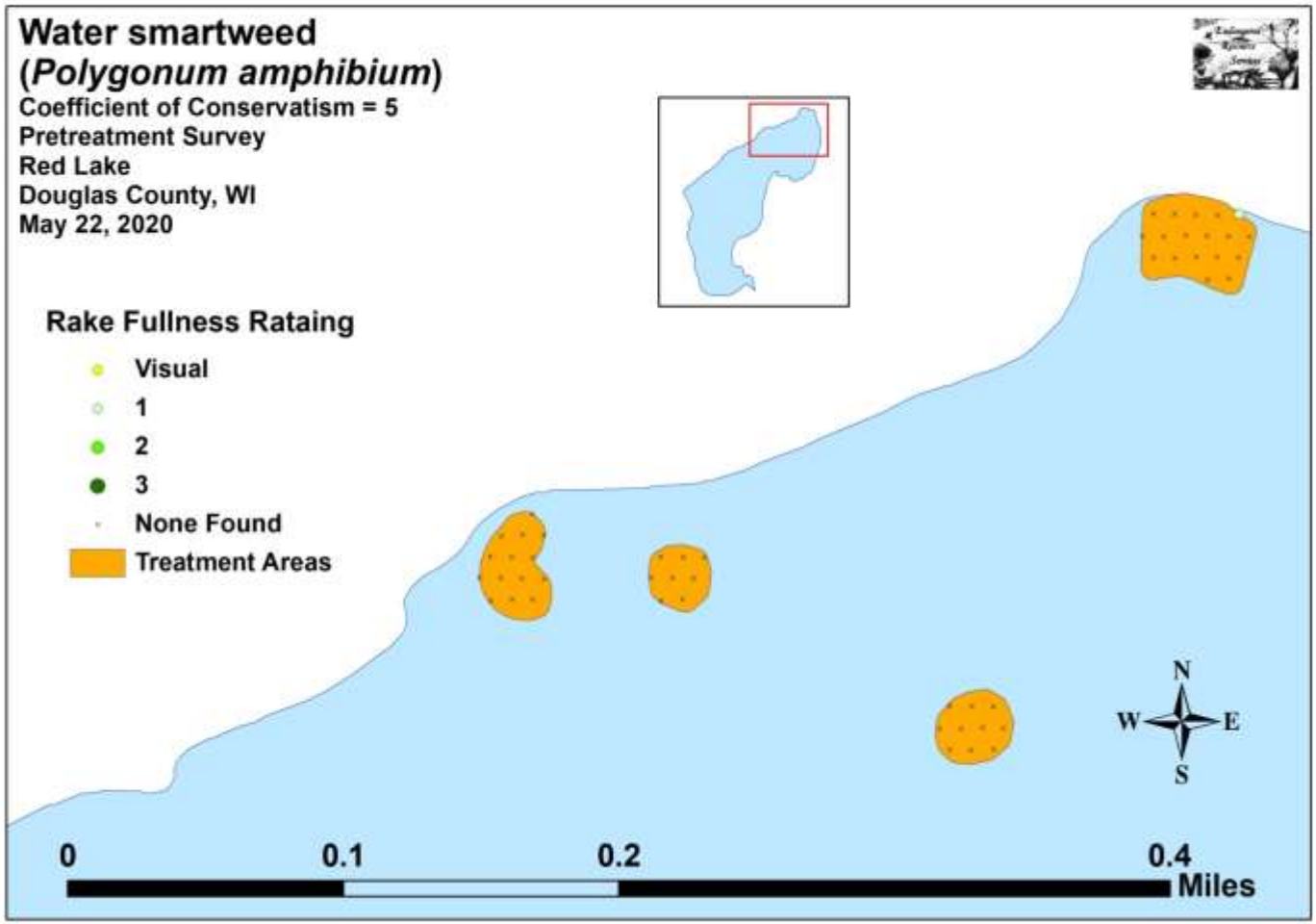

Filamentous algae
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

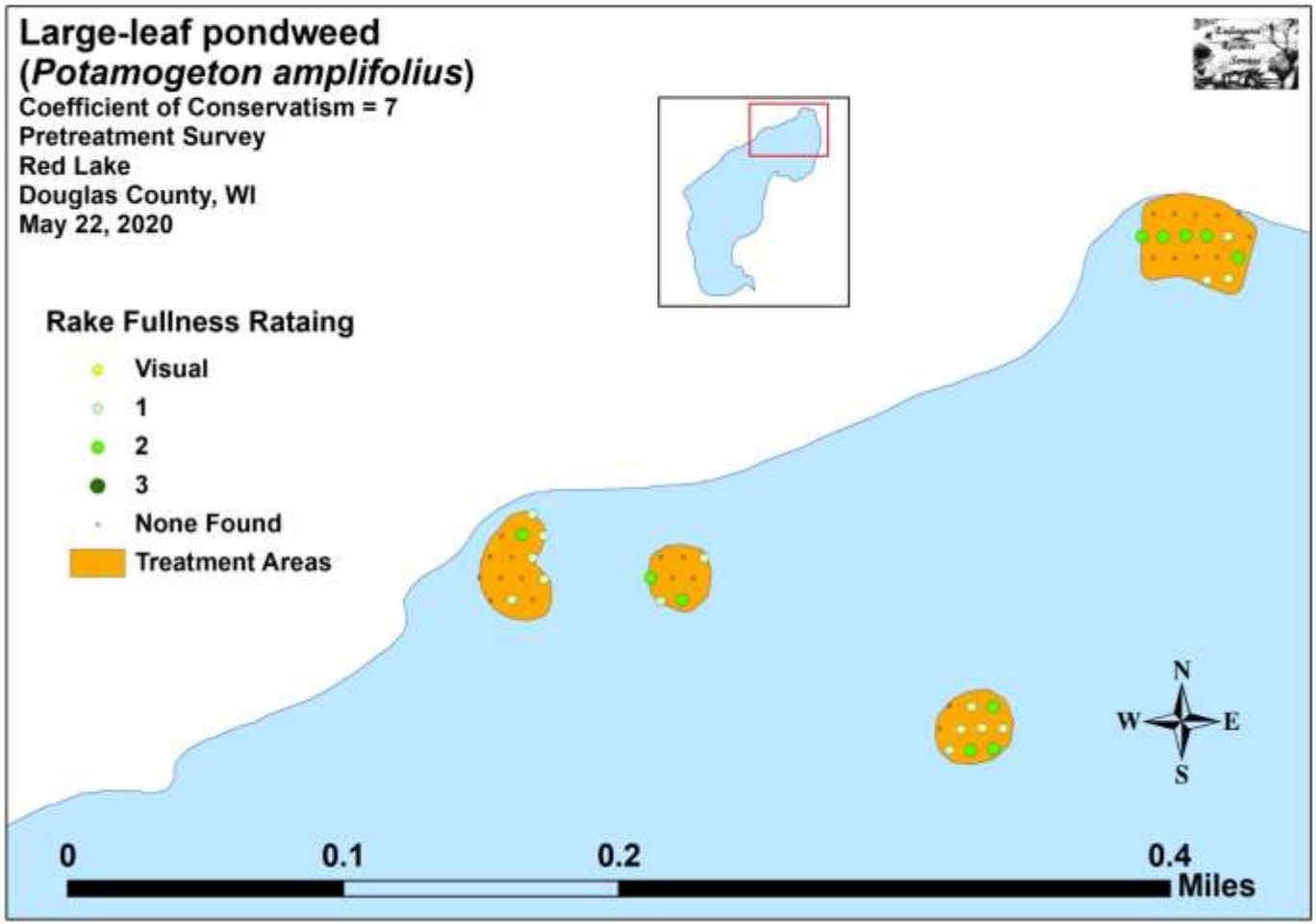

Water star-grass
(Heteranthera dubia)
Coefficient of Conservatism = 6
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

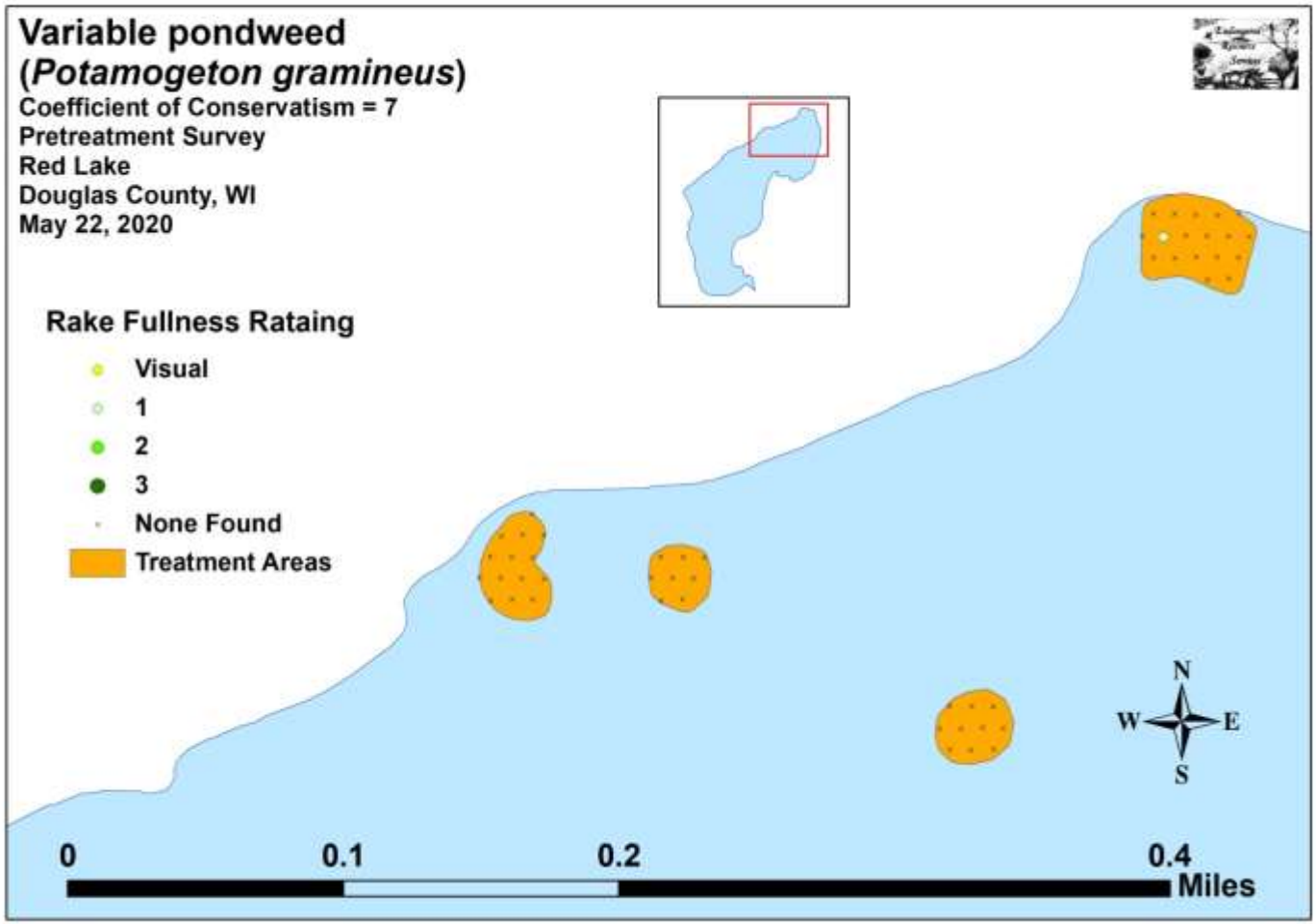

Alternate-flowered water-milfoil
(Myriophyllum alterniflorum)
Coefficient of Conservatism = 10
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

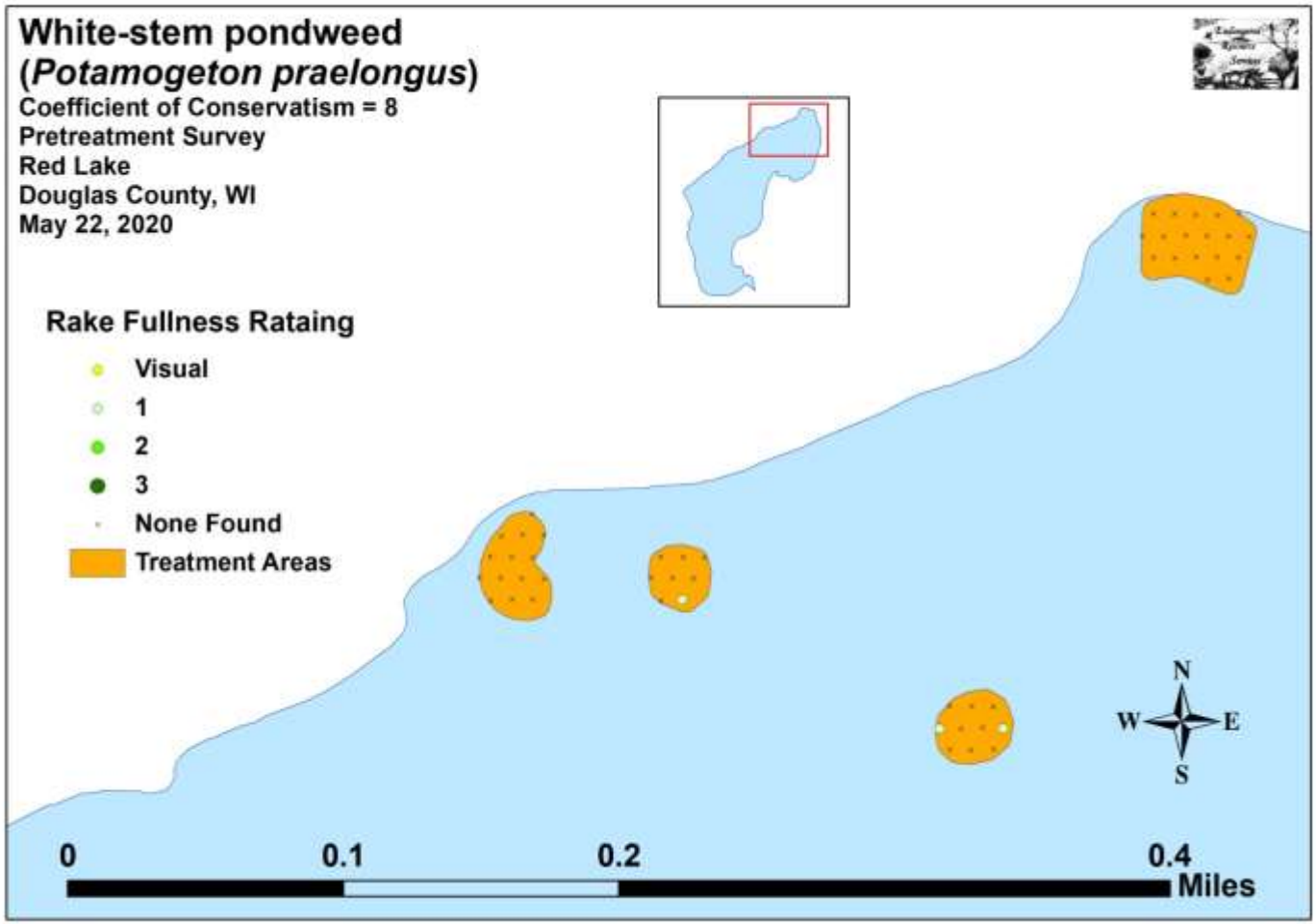

Northern water-milfoil
(Myriophyllum sibiricum)
Coefficient of Conservatism = 6
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

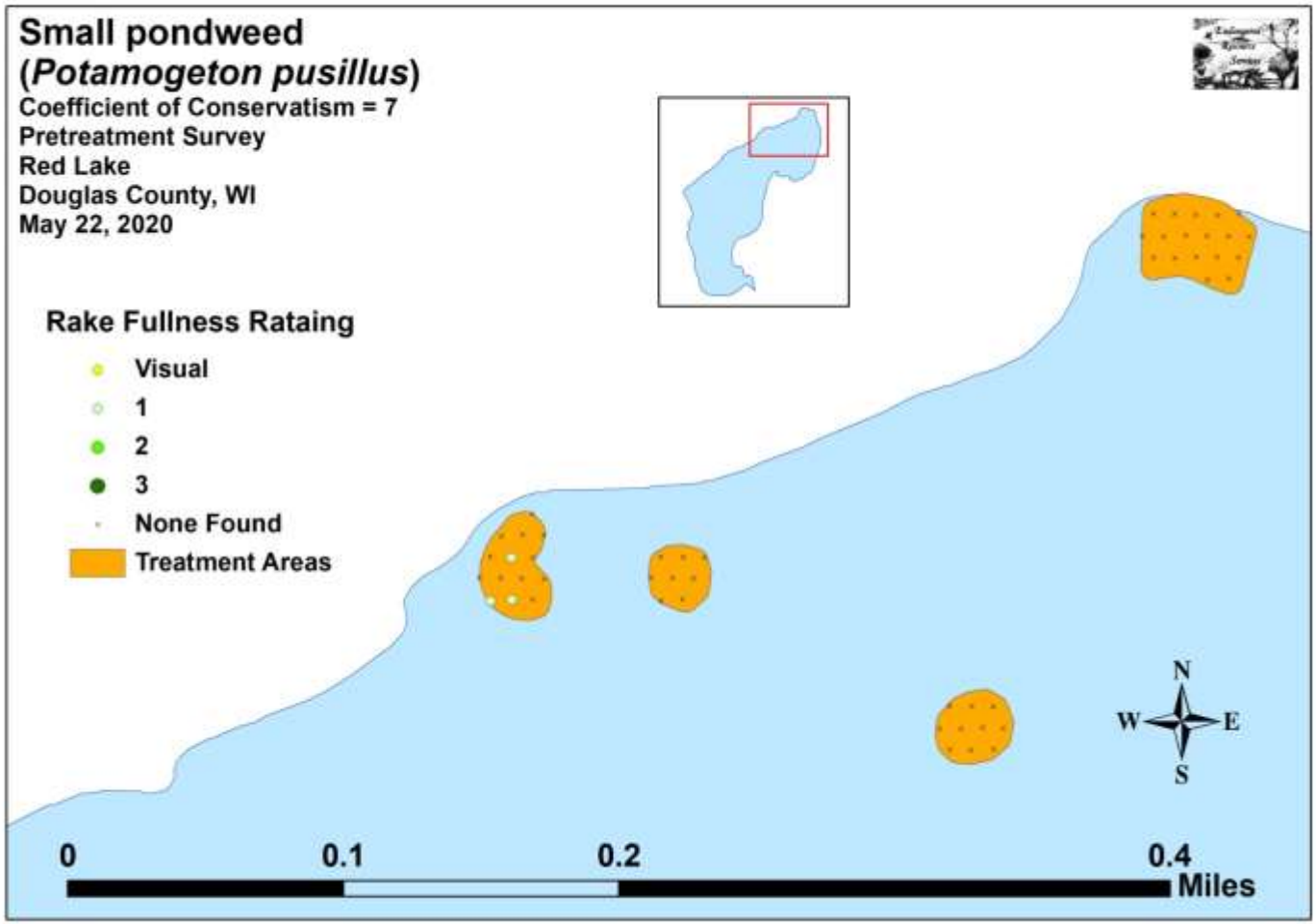

Dwarf water-milfoil
(Myriophyllum tenellum)
Coefficient of Conservatism = 10
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

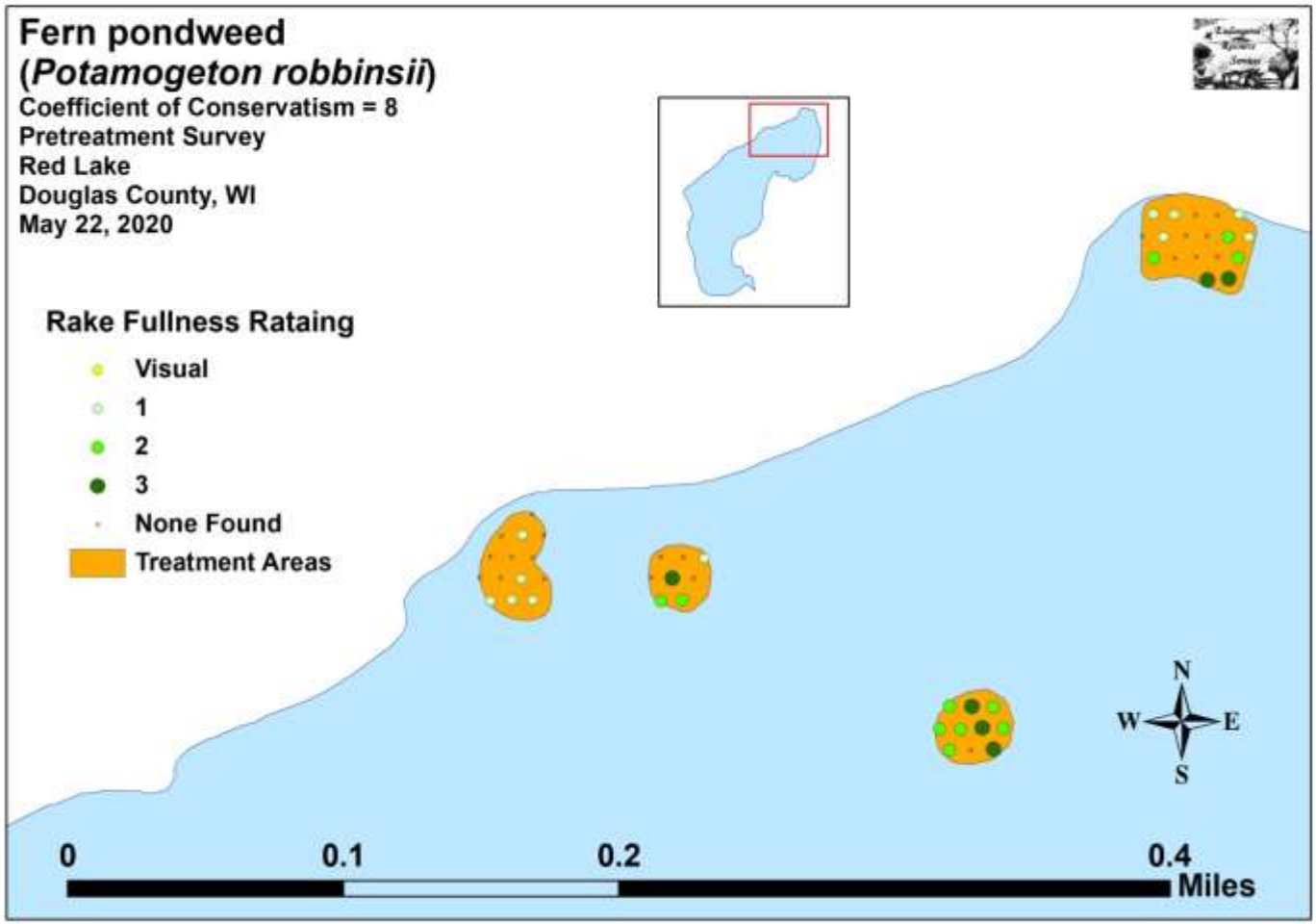

Water smartweed
(Polygonum amphibium)
Coefficient of Conservatism = 5
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

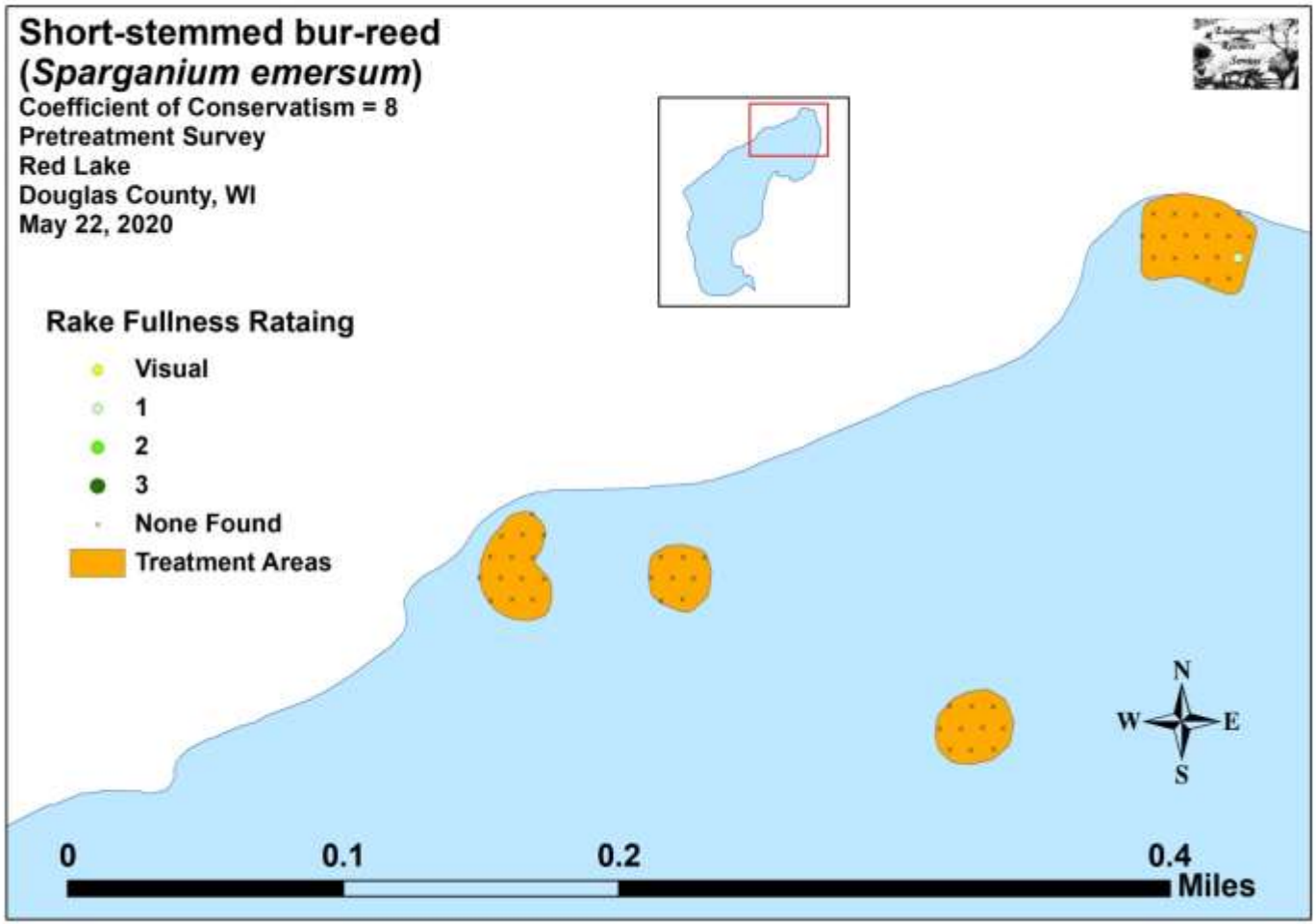

Large-leaf pondweed
(Potamogeton amplifolius)
Coefficient of Conservatism = 7
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles


Variable pondweed
(Potamogeton gramineus)
Coefficient of Conservatism = 7
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

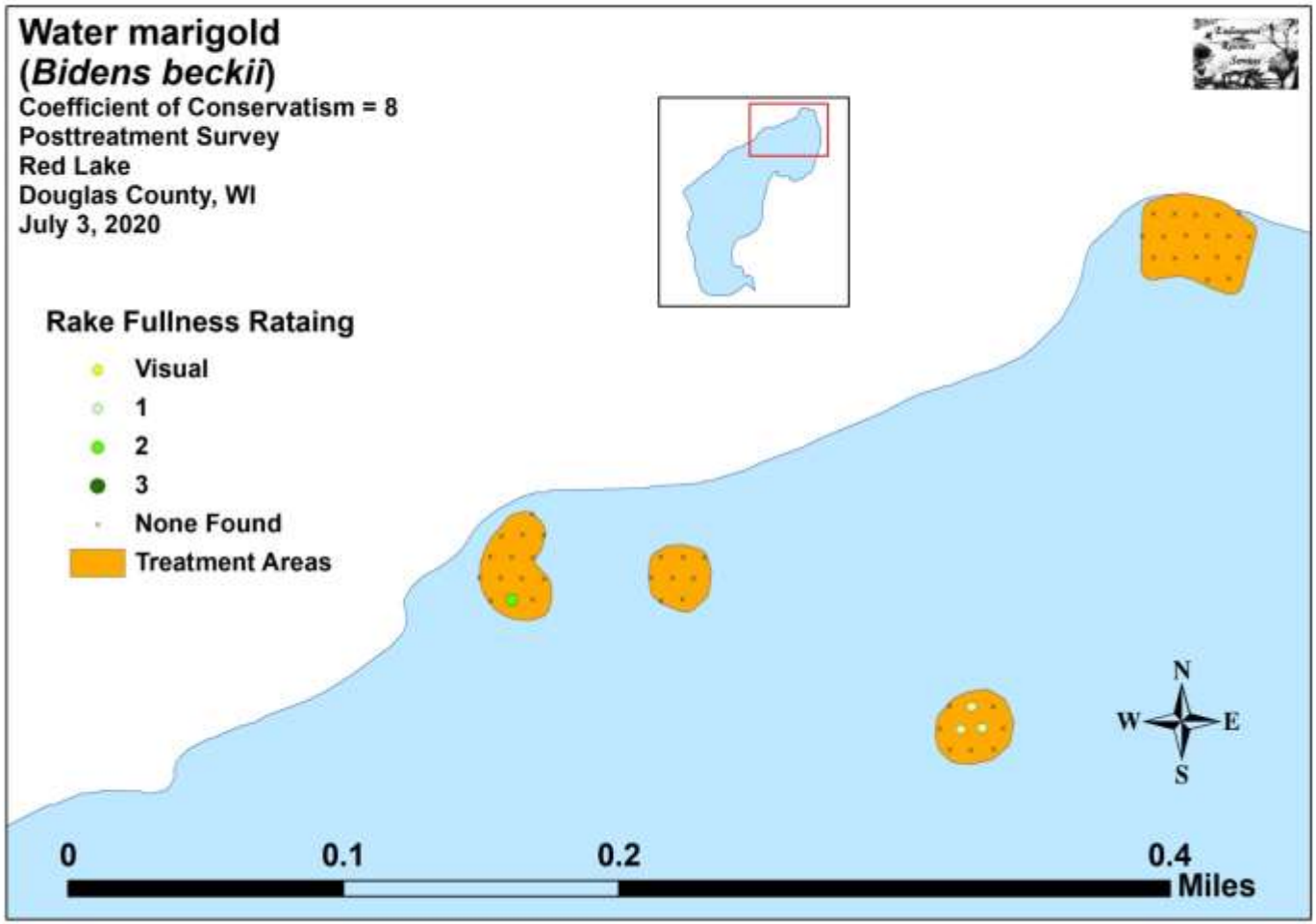

White-stem pondweed
(Potamogeton praelongus)
Coefficient of Conservatism = 8
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

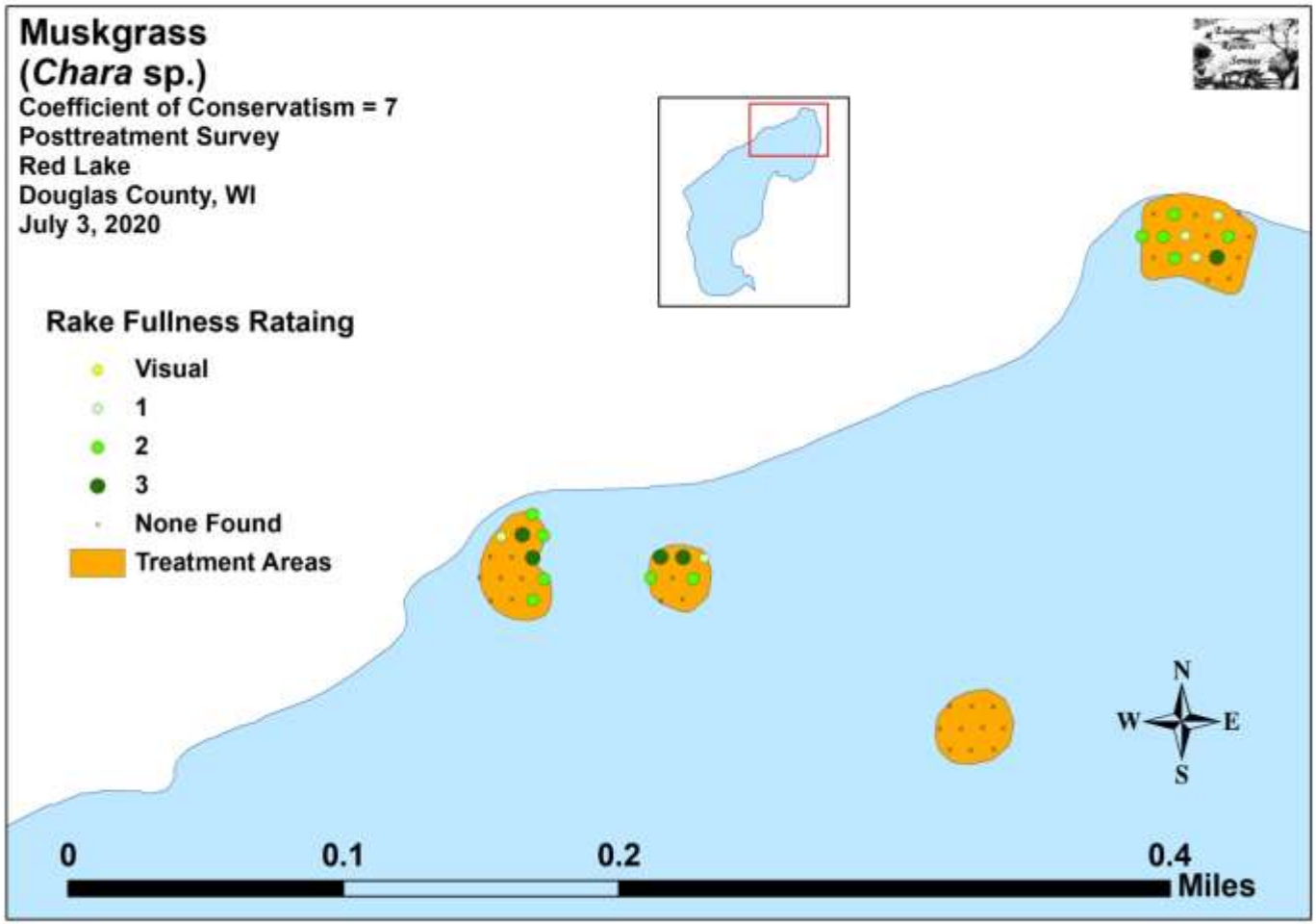

Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

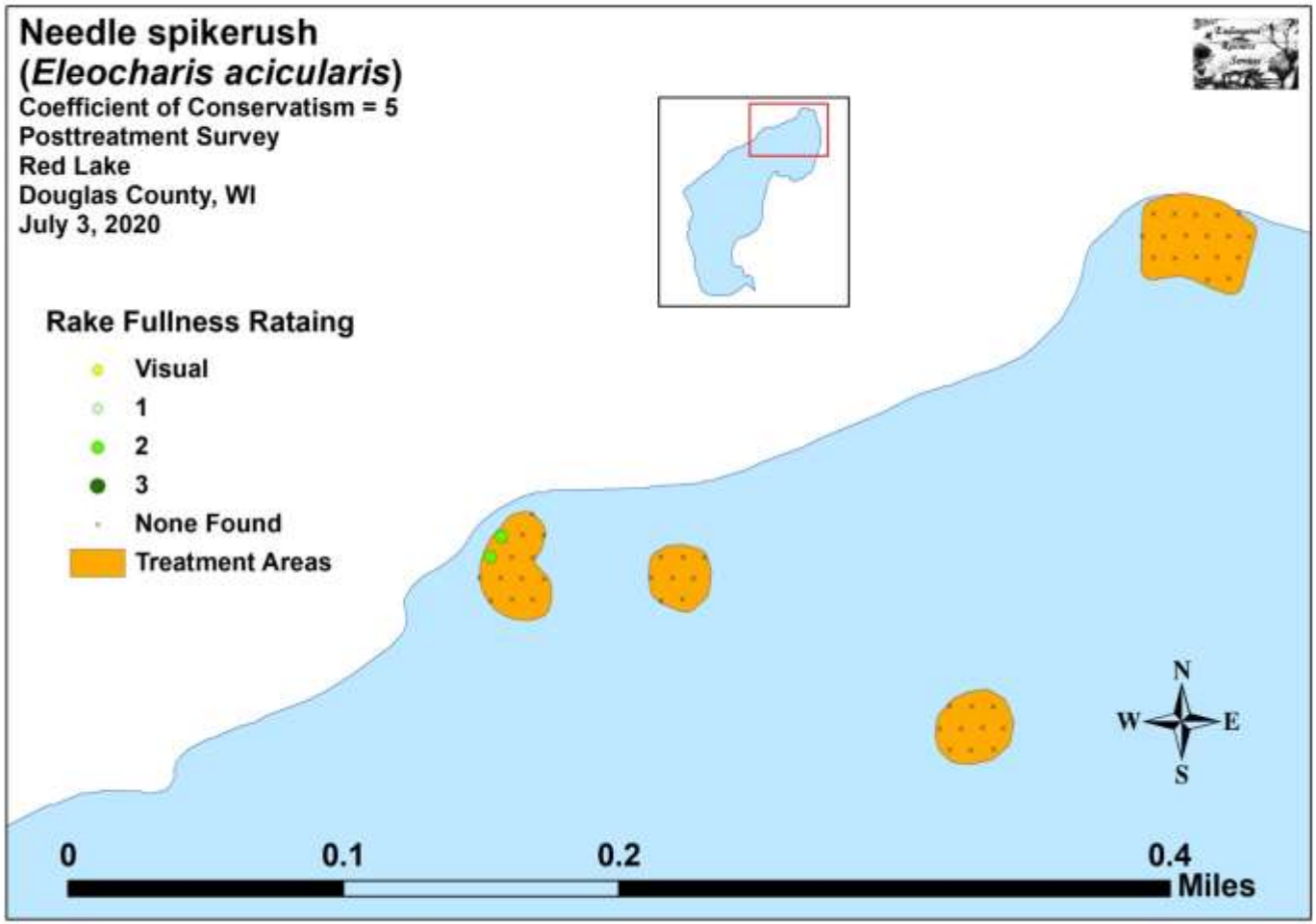

Fern pondweed
(Potamogeton robbinsii)
Coefficient of Conservatism = 8
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

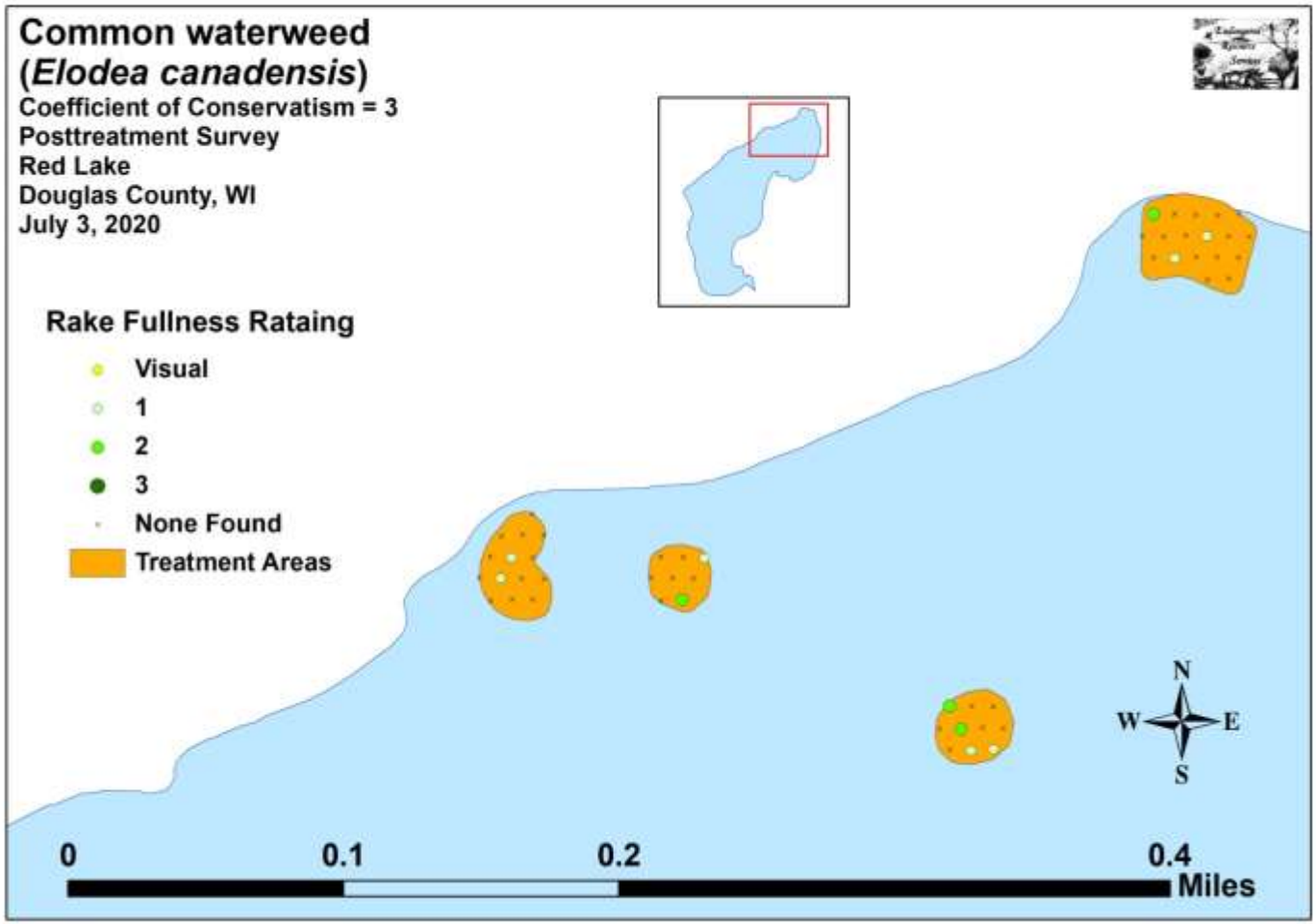

Short-stemmed bur-reed
(Sparganium emersum)
Coefficient of Conservatism = 8
Pretreatment Survey
Red Lake
Douglas County, WI
May 22, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

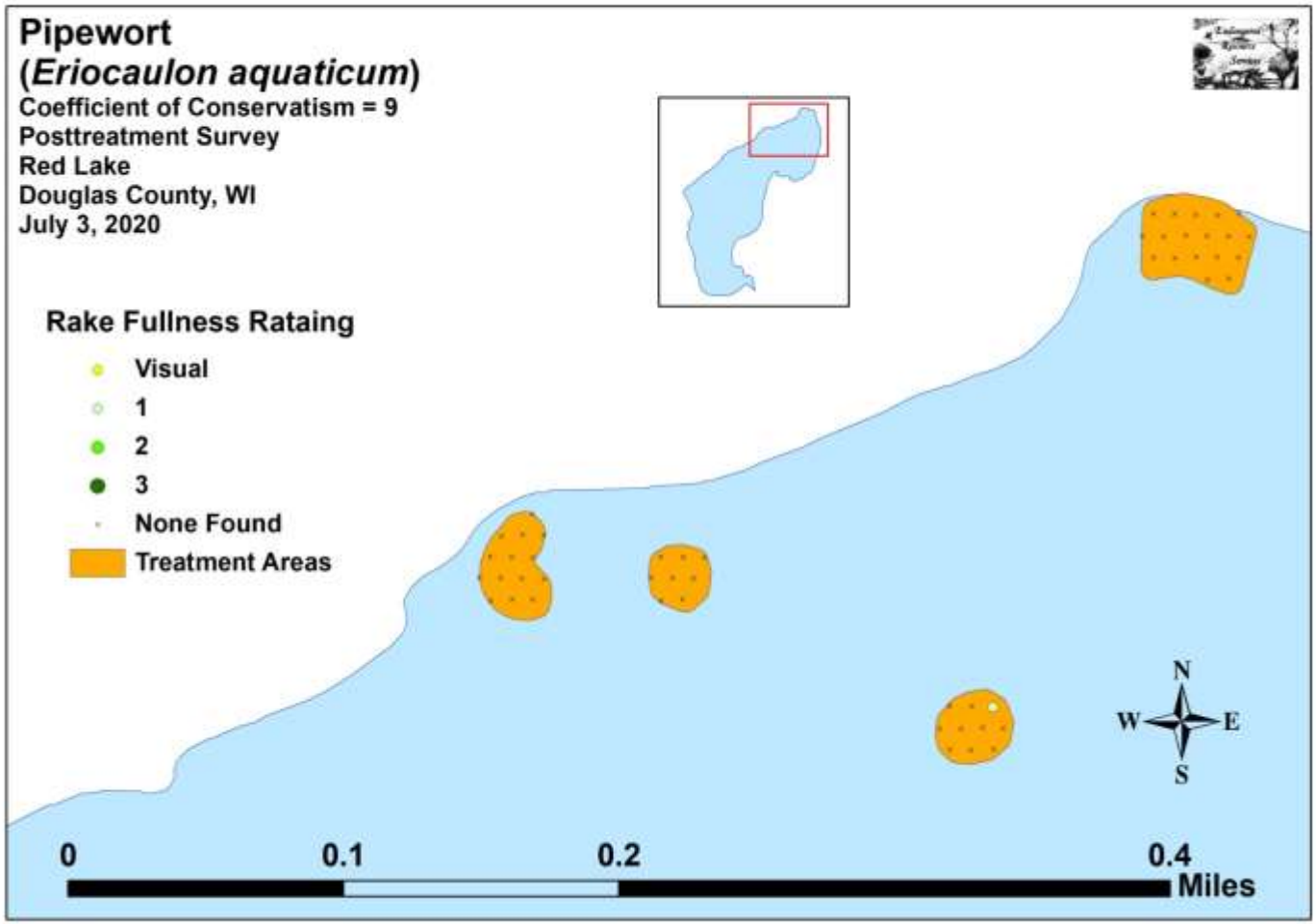
Appendix VII: Posttreatment Native Species Density and Distribution

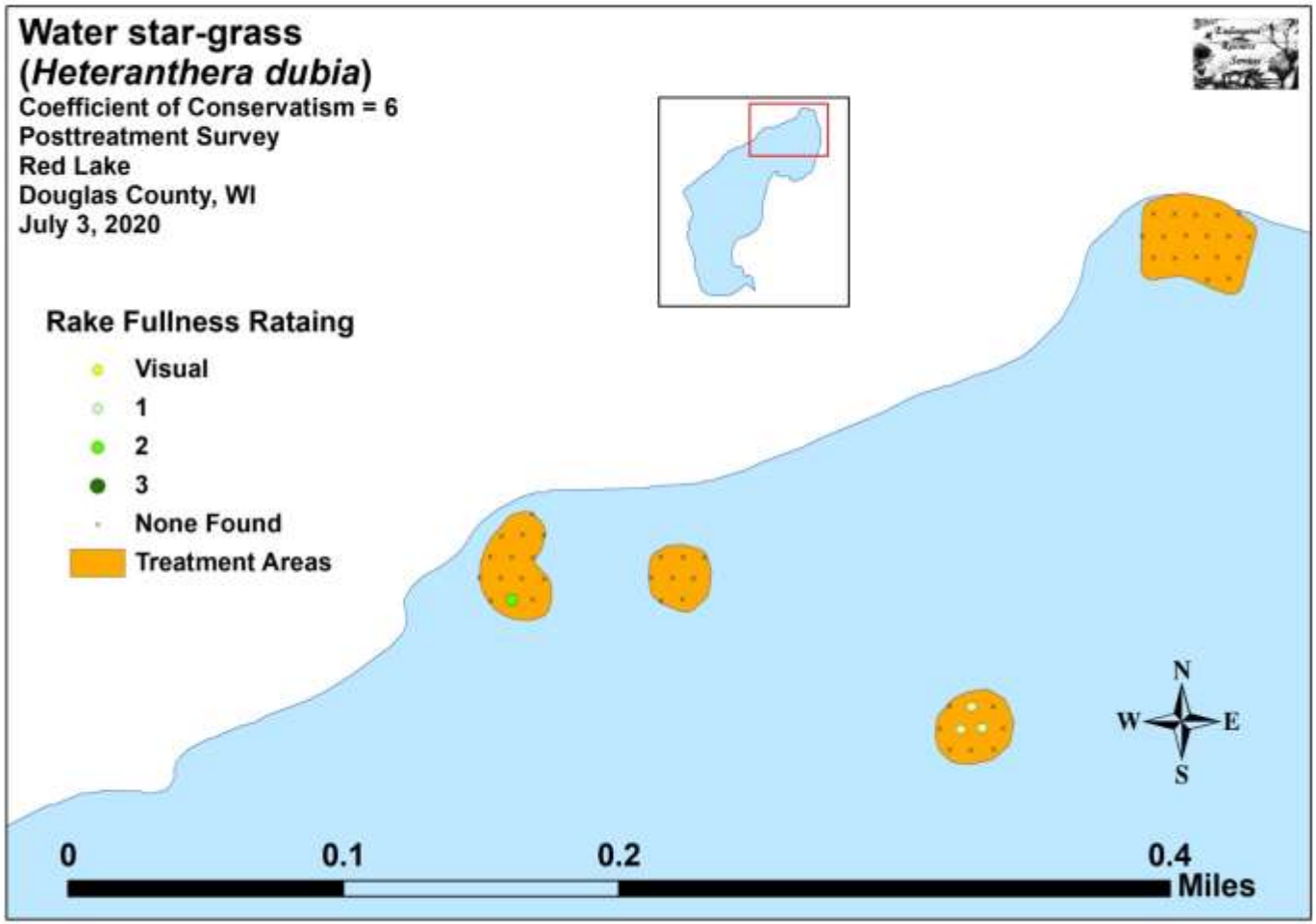

Water marigold
(Bidens beckii)
Coefficient of Conservatism = 8
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

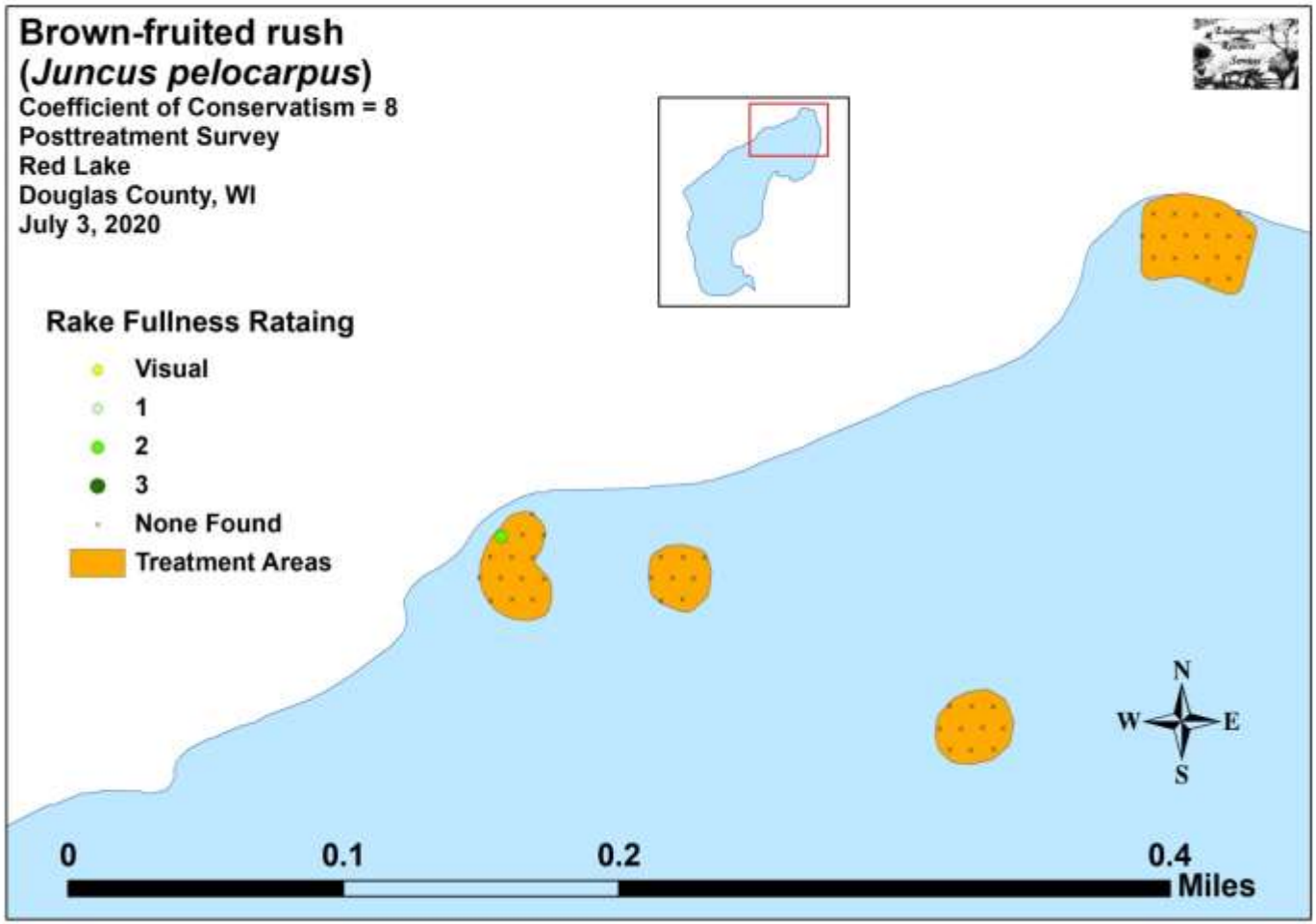

Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles


Needle spikerush
(Eleocharis acicularis)
Coefficient of Conservatism = 5
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles


Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles


Pipewort
(Eriocaulon aquaticum)
Coefficient of Conservatism = 9
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles


Water star-grass
(Heteranthera dubia)
Coefficient of Conservatism = 6
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles


Brown-fruited rush
(Juncus pelocarpus)
Coefficient of Conservatism = 8
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
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S
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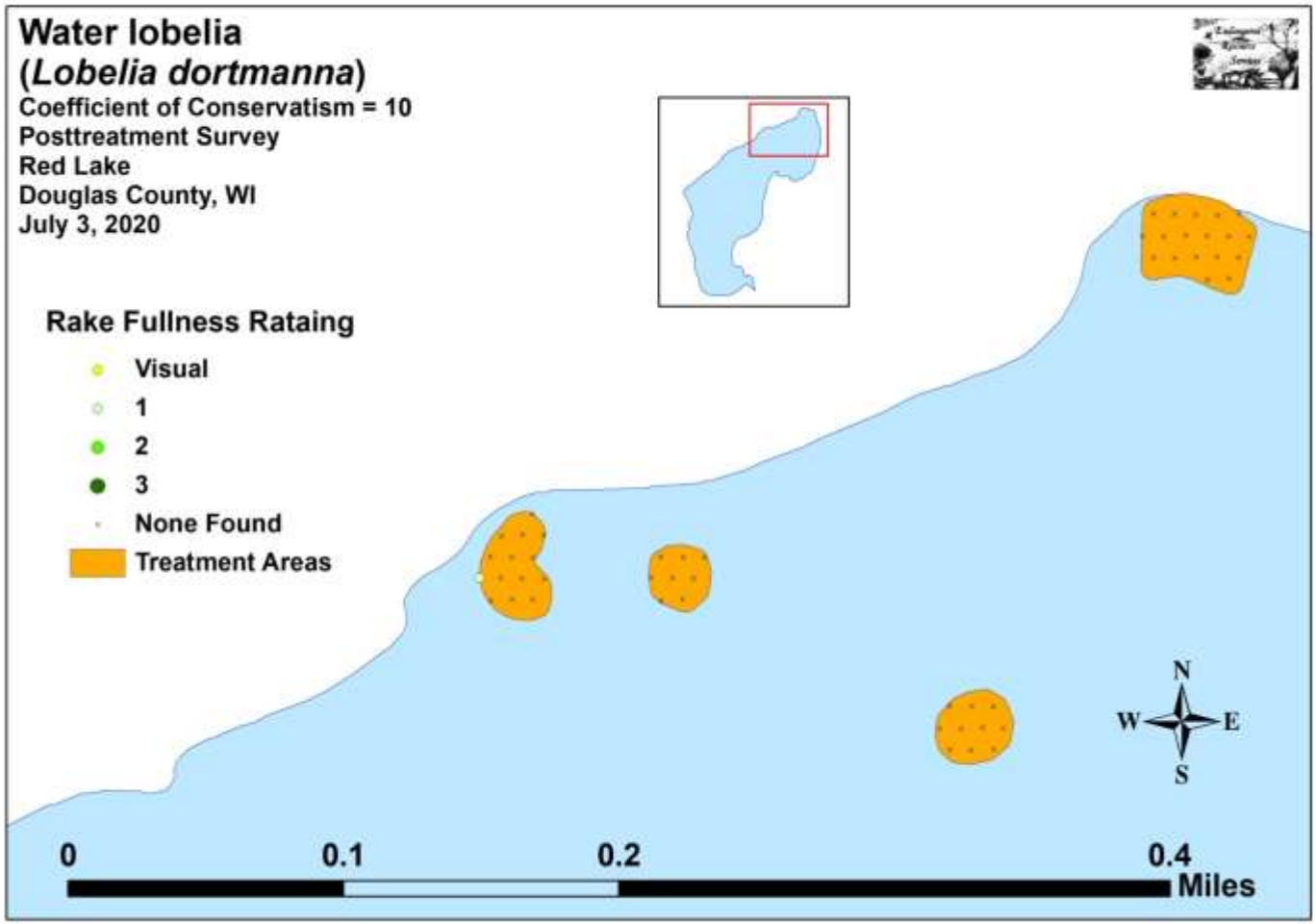
0.1
0.2
0.4
Miles


Water lobelia
(Lobelia dortmanna)
Coefficient of Conservatism = 10
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
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S
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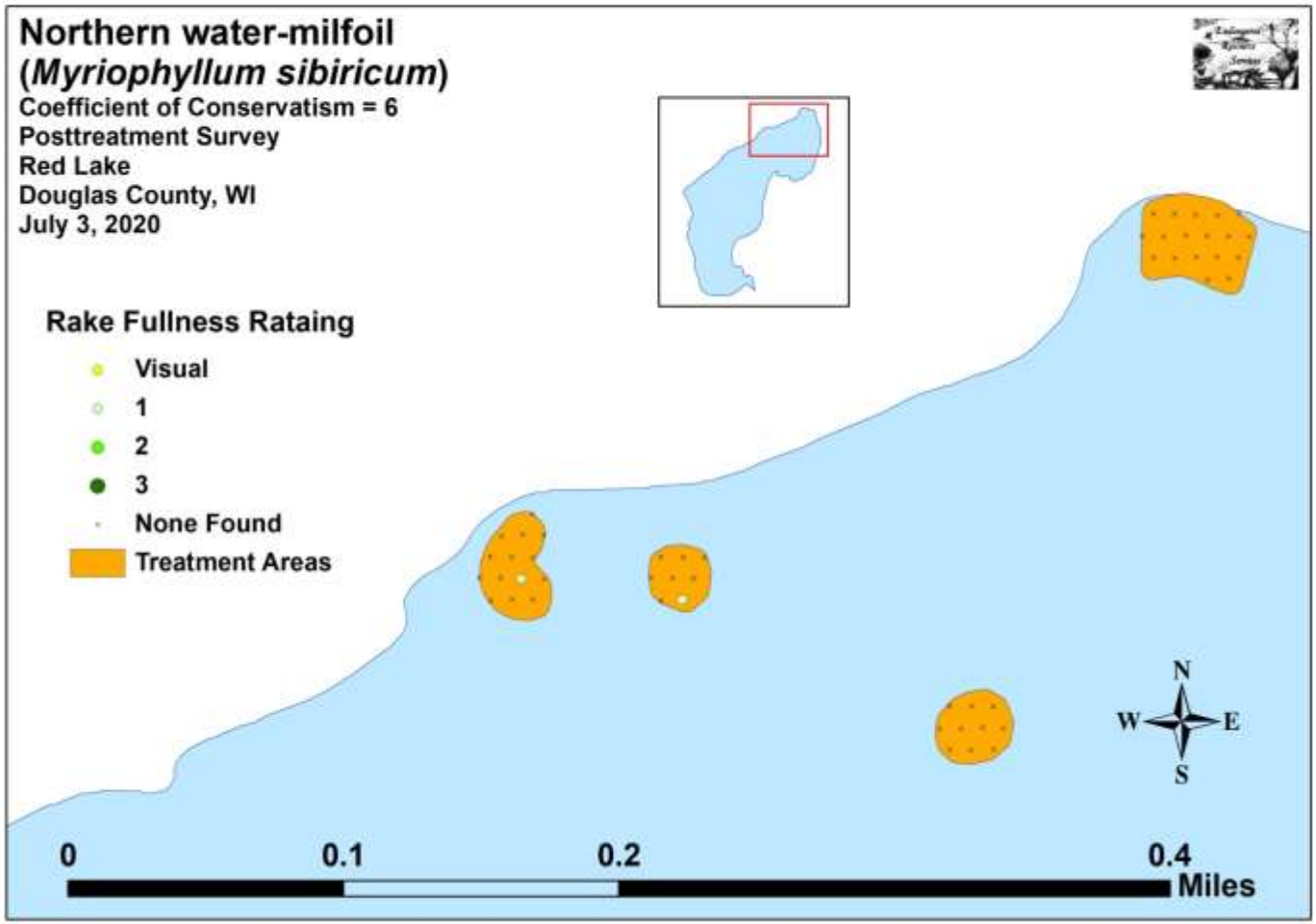
0.1
0.2
0.4
Miles


Northern water-milfoil
(Myriophyllum sibiricum)
Coefficient of Conservatism = 6
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
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W
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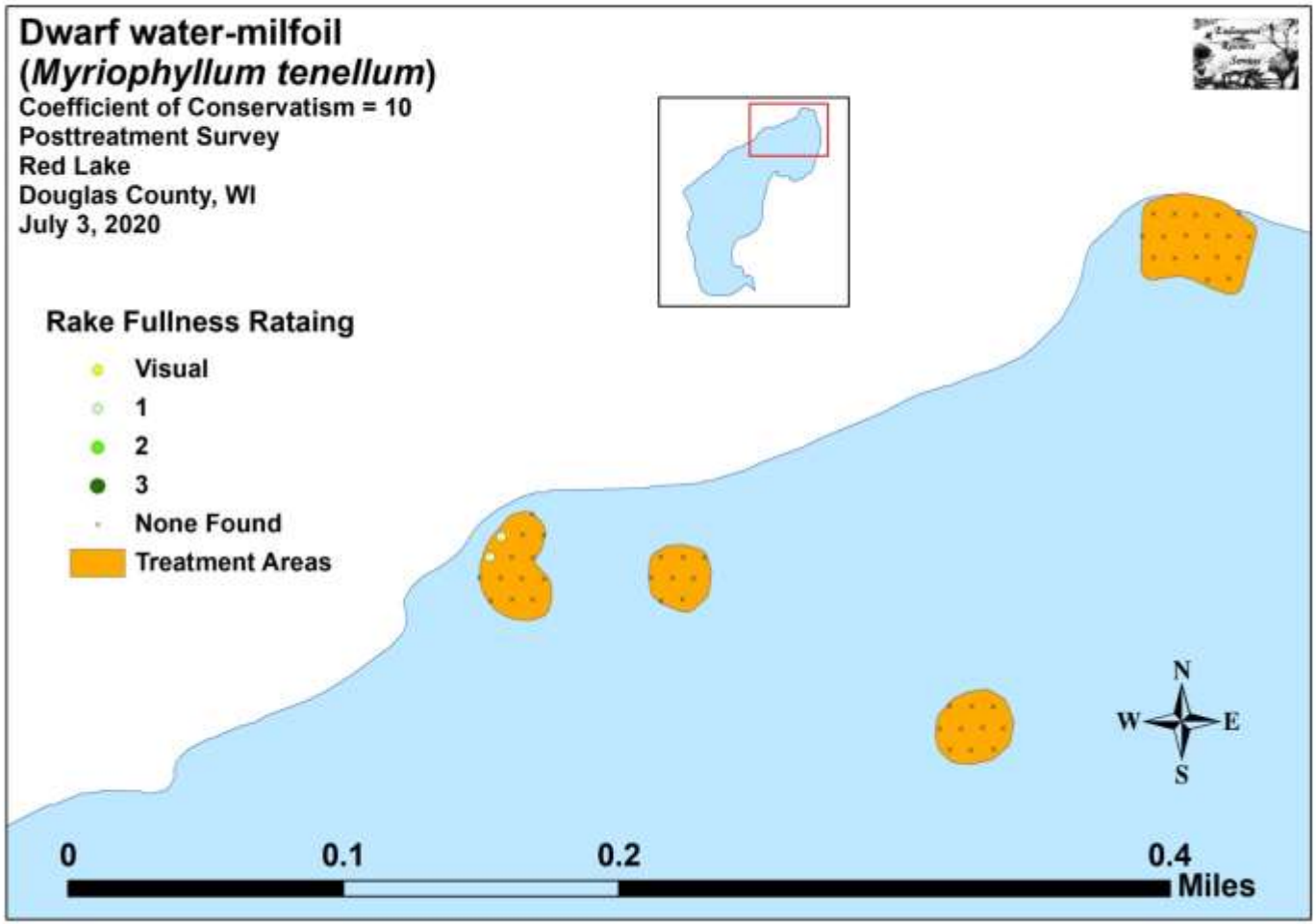
0.1
0.2
0.4
Miles


Dwarf water-milfoil
(Myriophyllum tenellum)
Coefficient of Conservatism = 10
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
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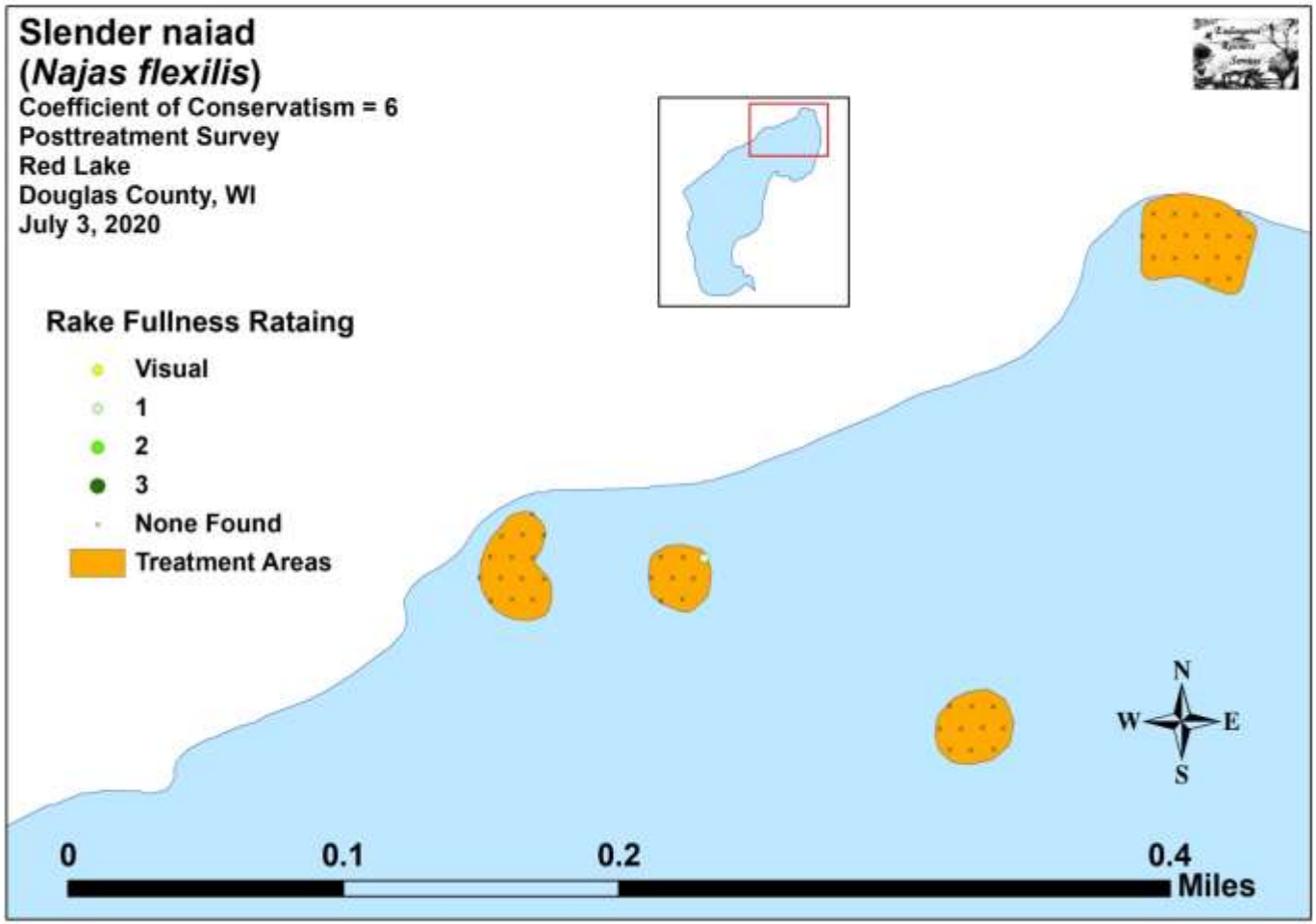
0.1
0.2
0.4
Miles


Slender naiad
(Najas flexilis)
Coefficient of Conservatism = 6
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
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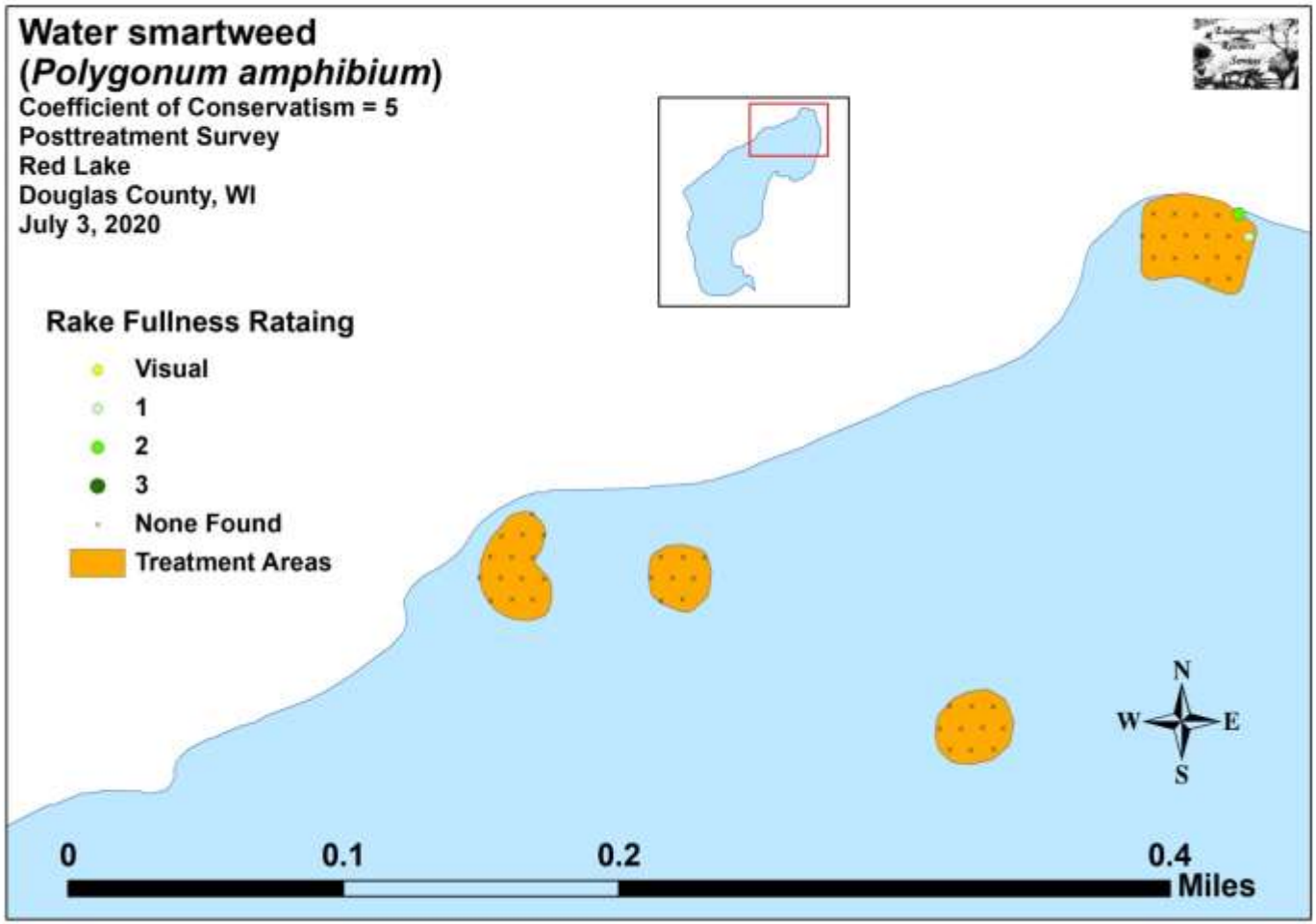
0.1
0.2
0.4
Miles


Water smartweed
(Polygonum amphibium)
Coefficient of Conservatism = 5
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
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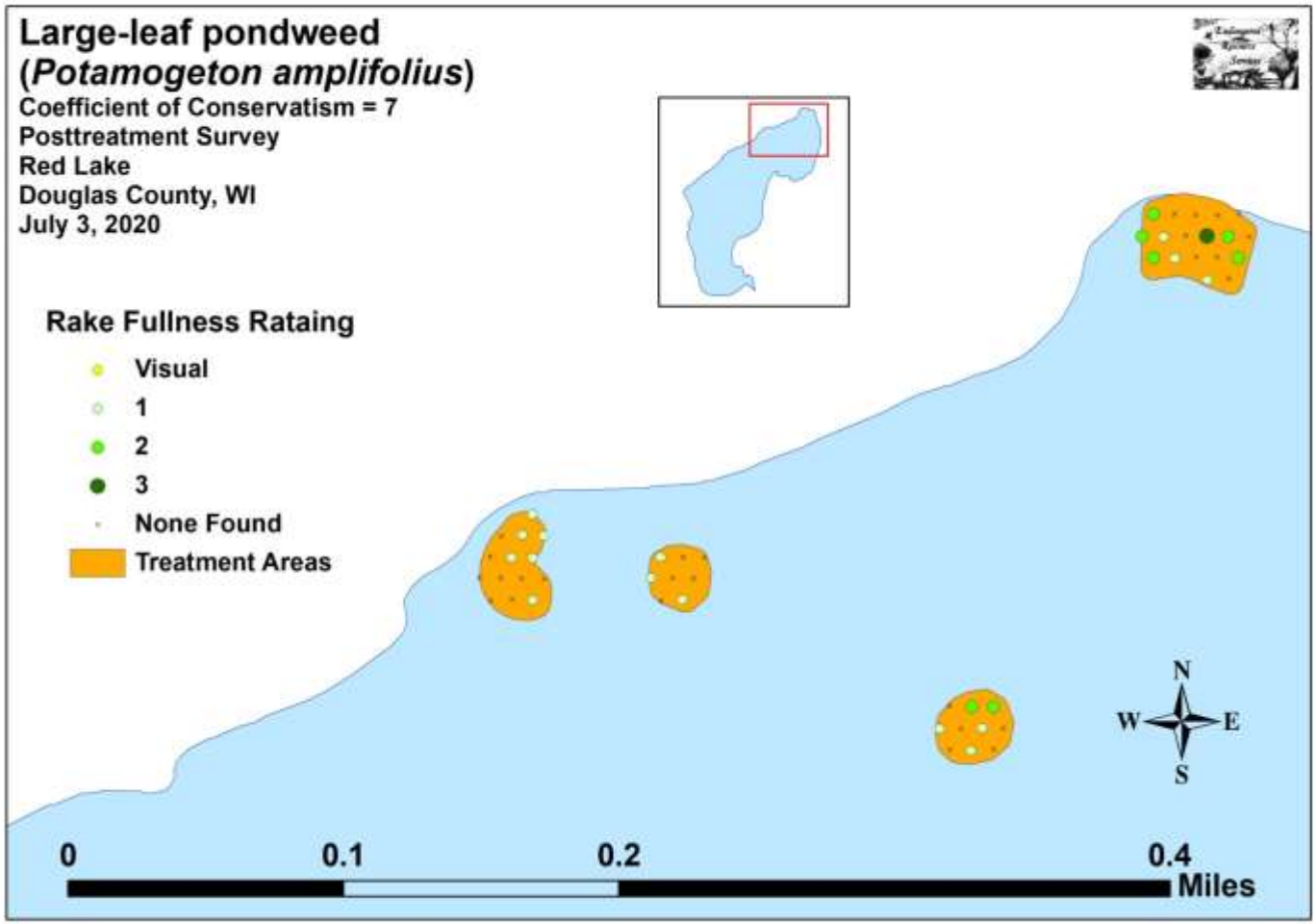
Miles


Large-leaf pondweed
(Potamogeton amplifolius)
Coefficient of Conservatism = 7
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
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0.1
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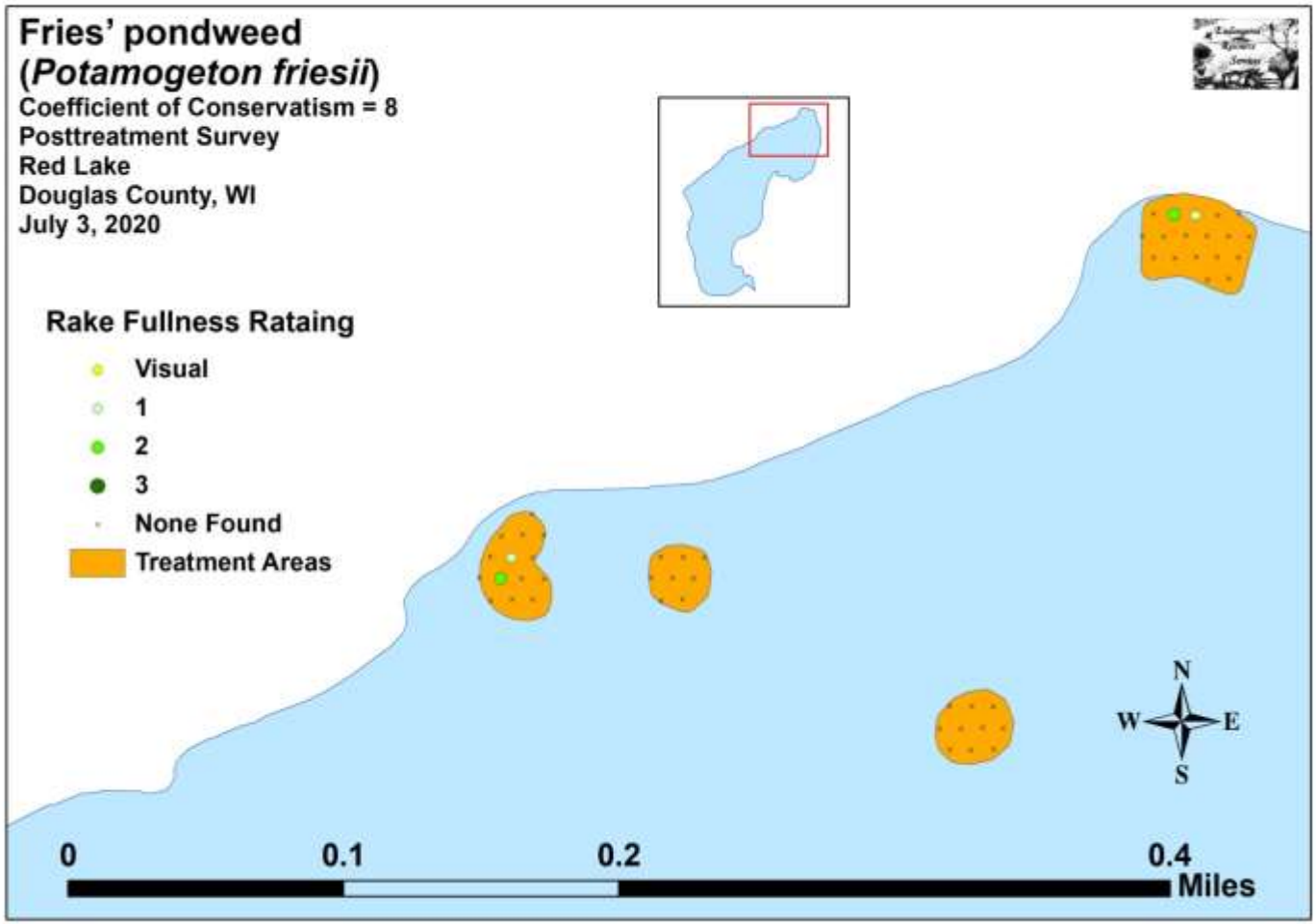
0.4
Miles


Fries' pondweed
(Potamogeton friesii)
Coefficient of Conservatism = 8
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
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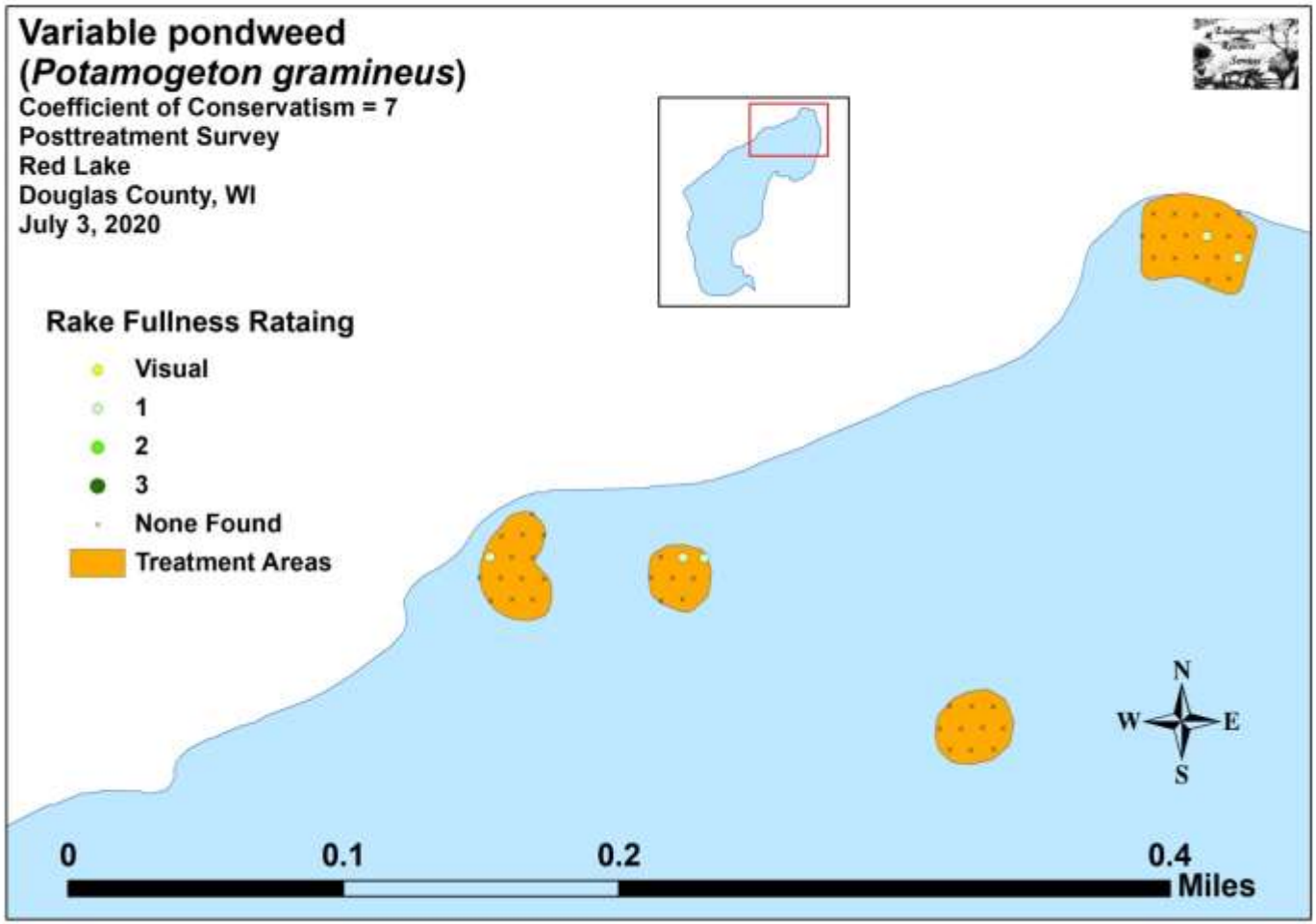
0.1
0.2
0.4
Miles


Variable pondweed
(Potamogeton gramineus)
Coefficient of Conservatism = 7
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
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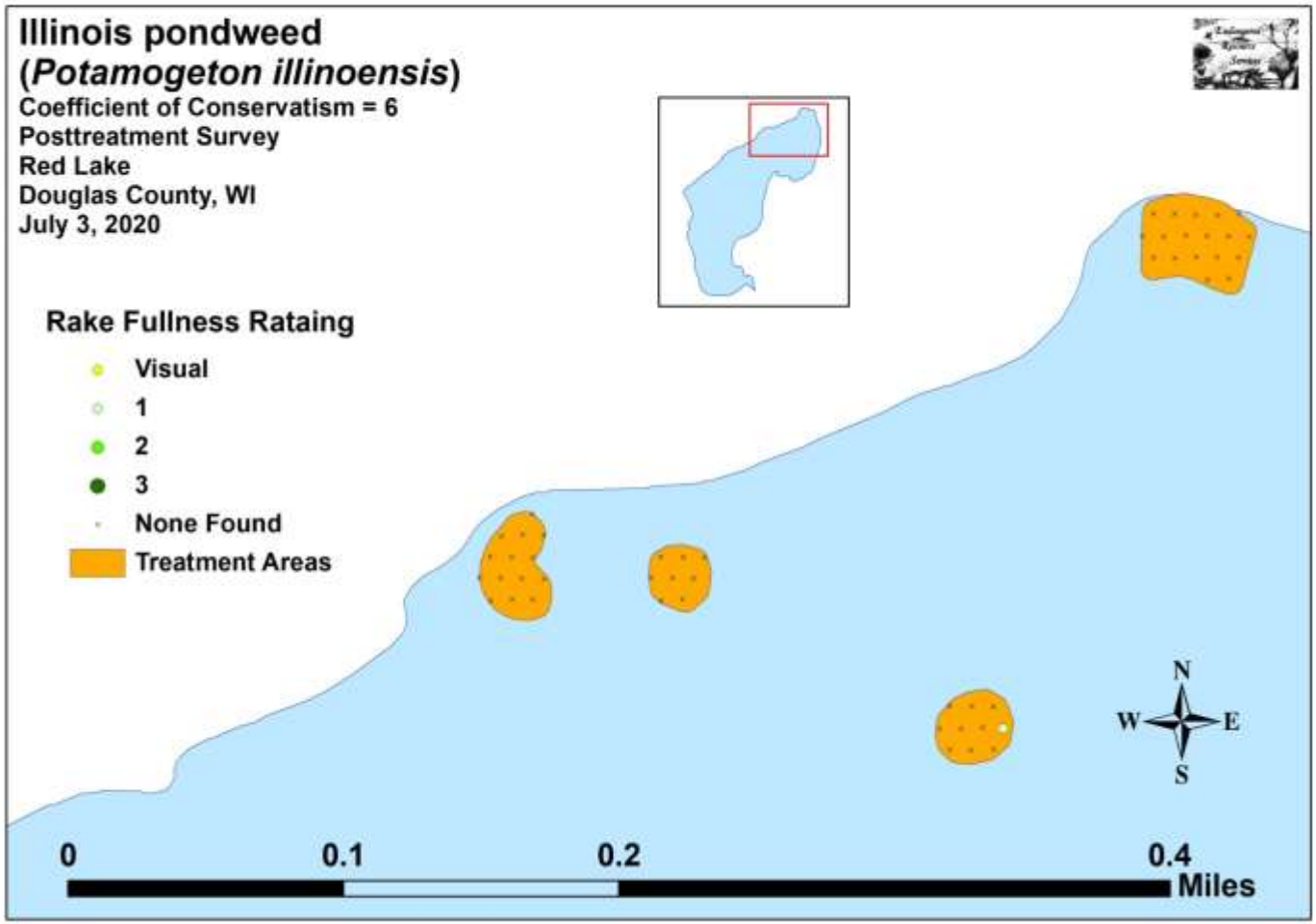
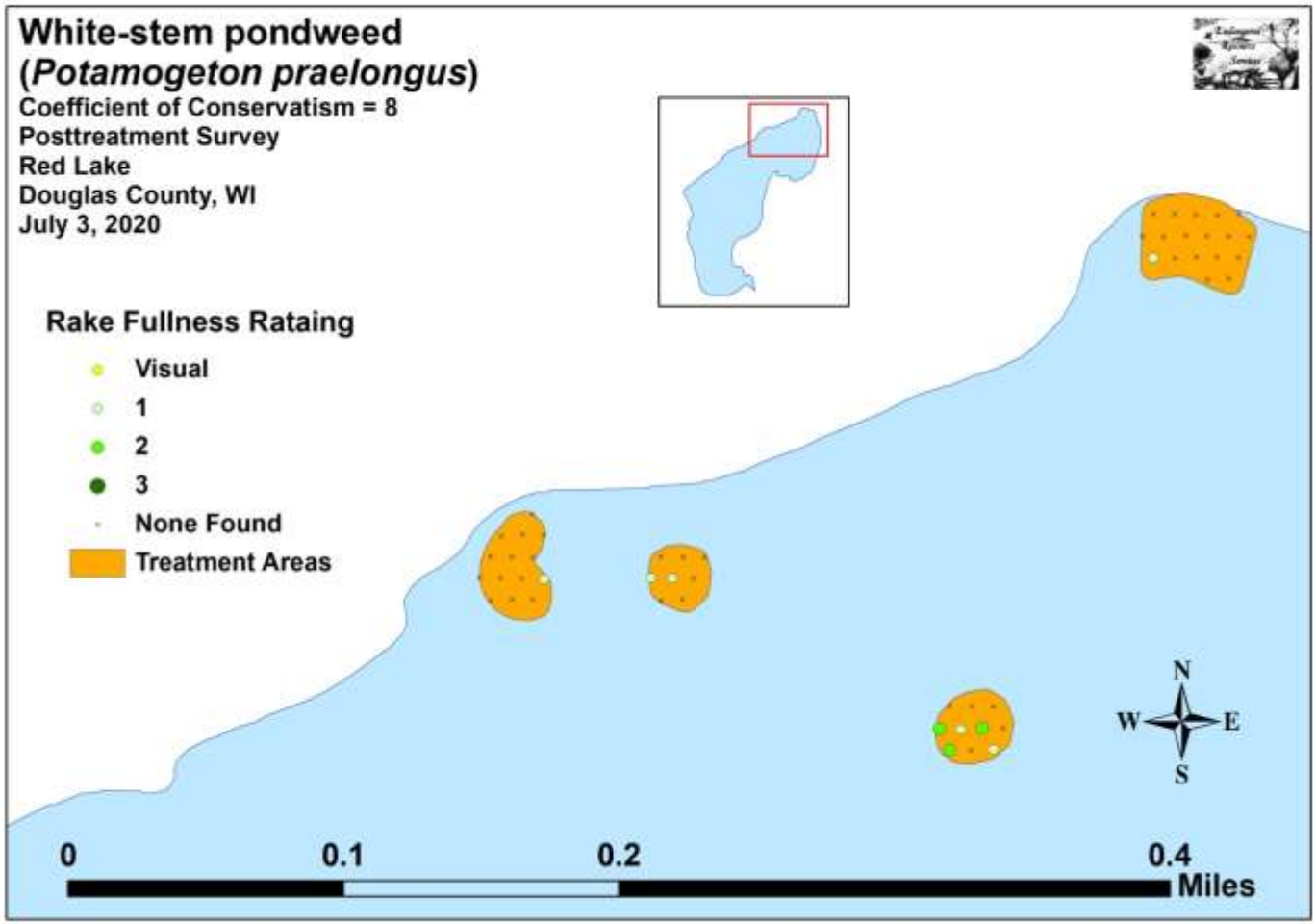
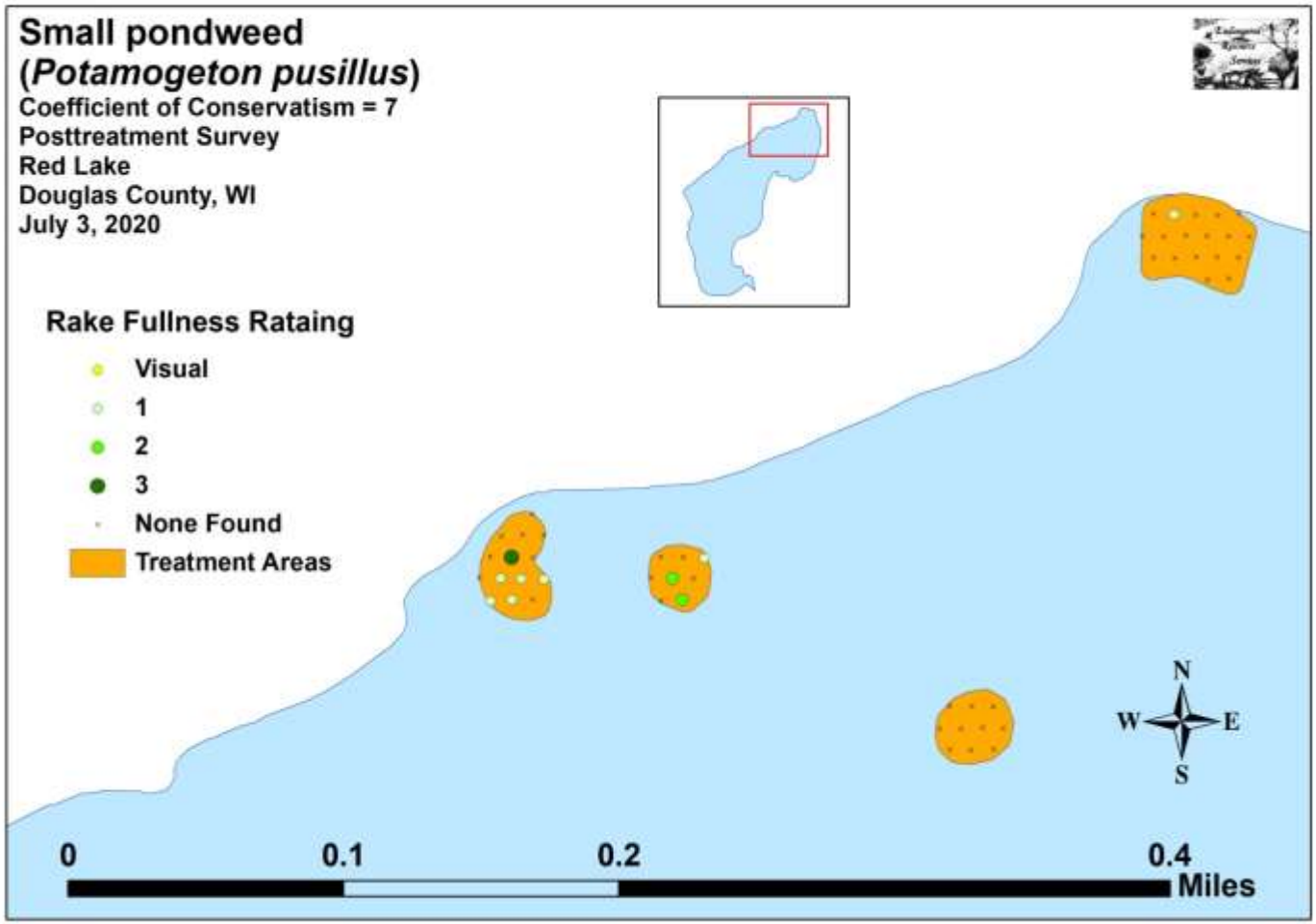
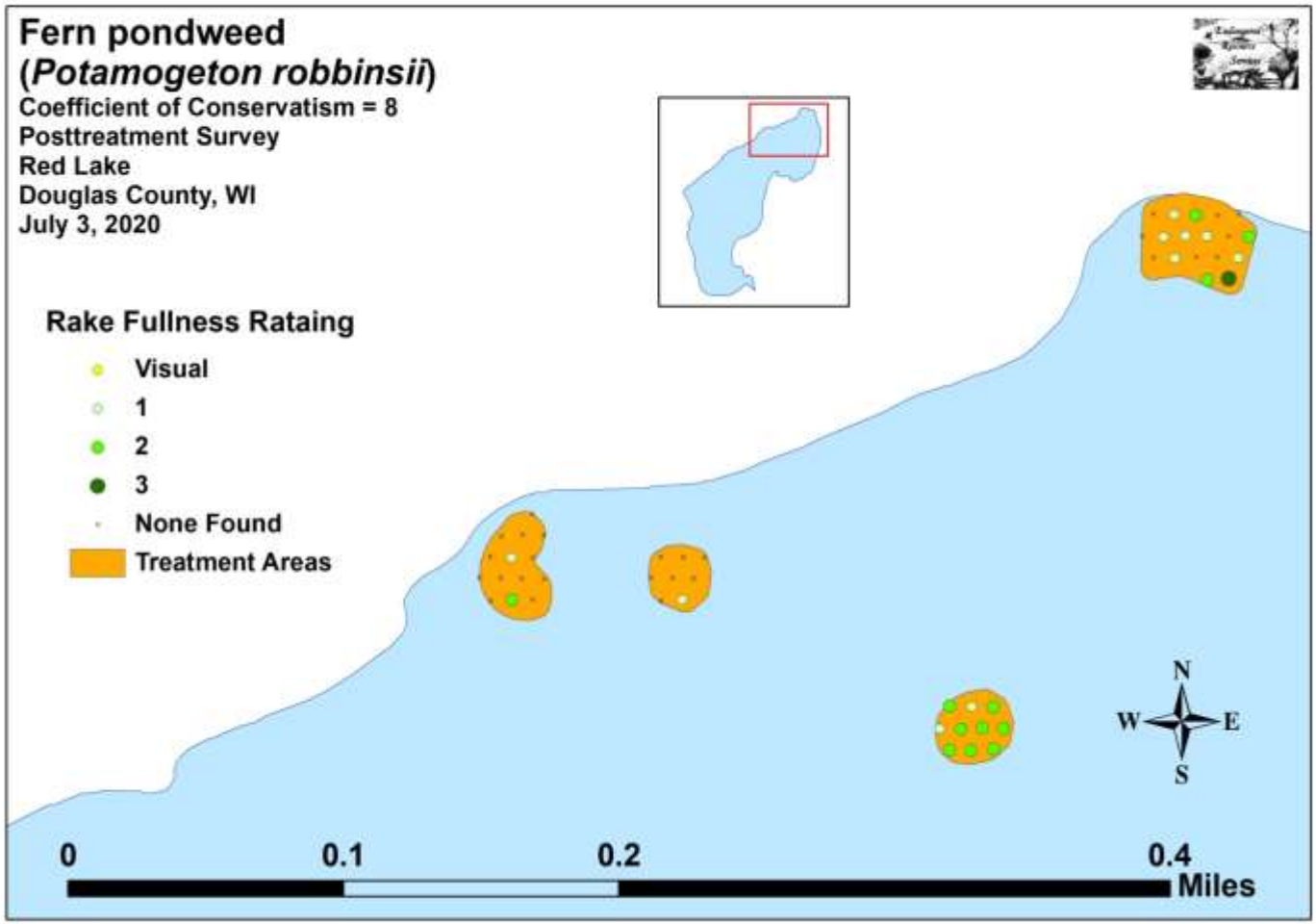
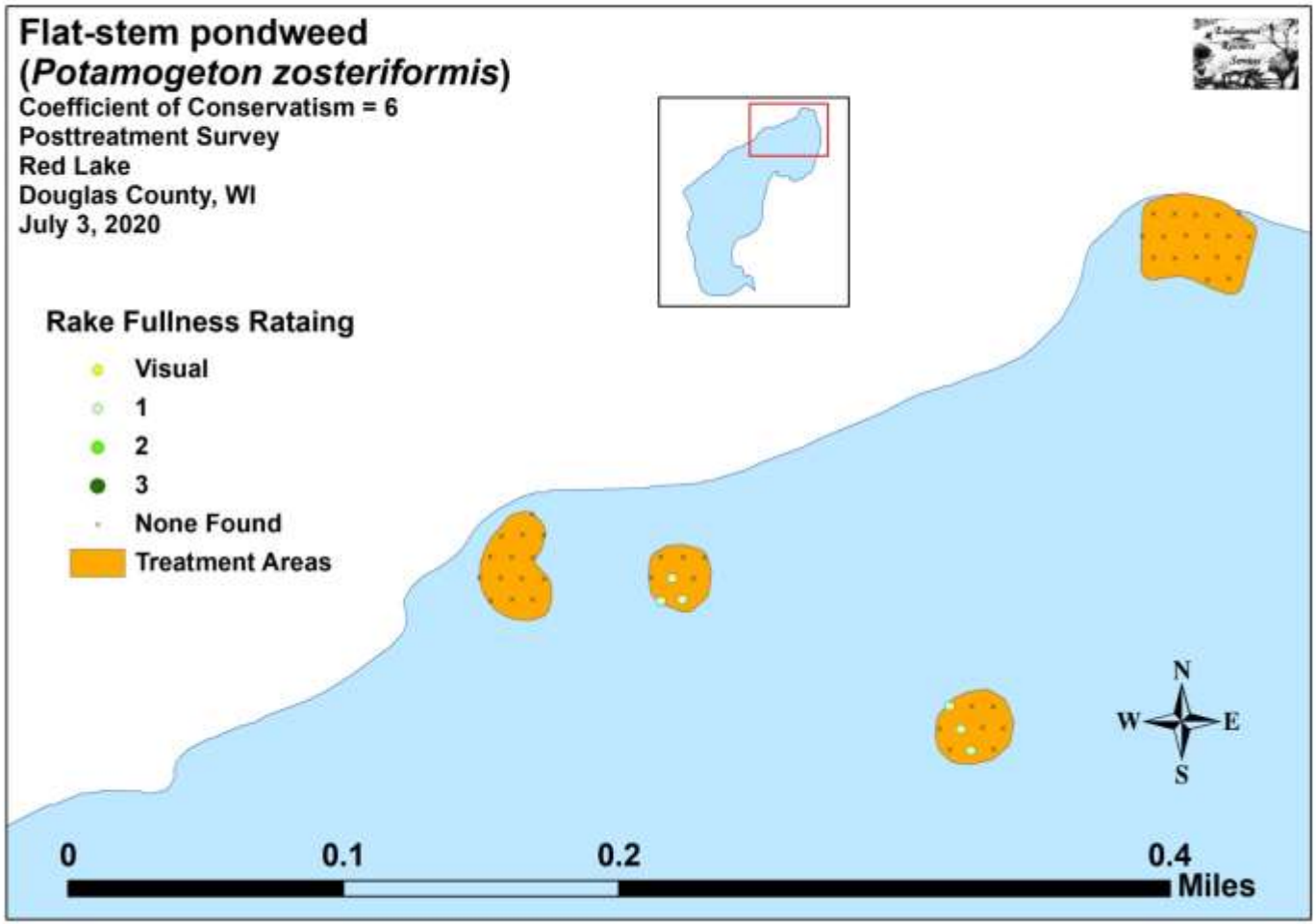
0.1
0.2
0.4
Miles

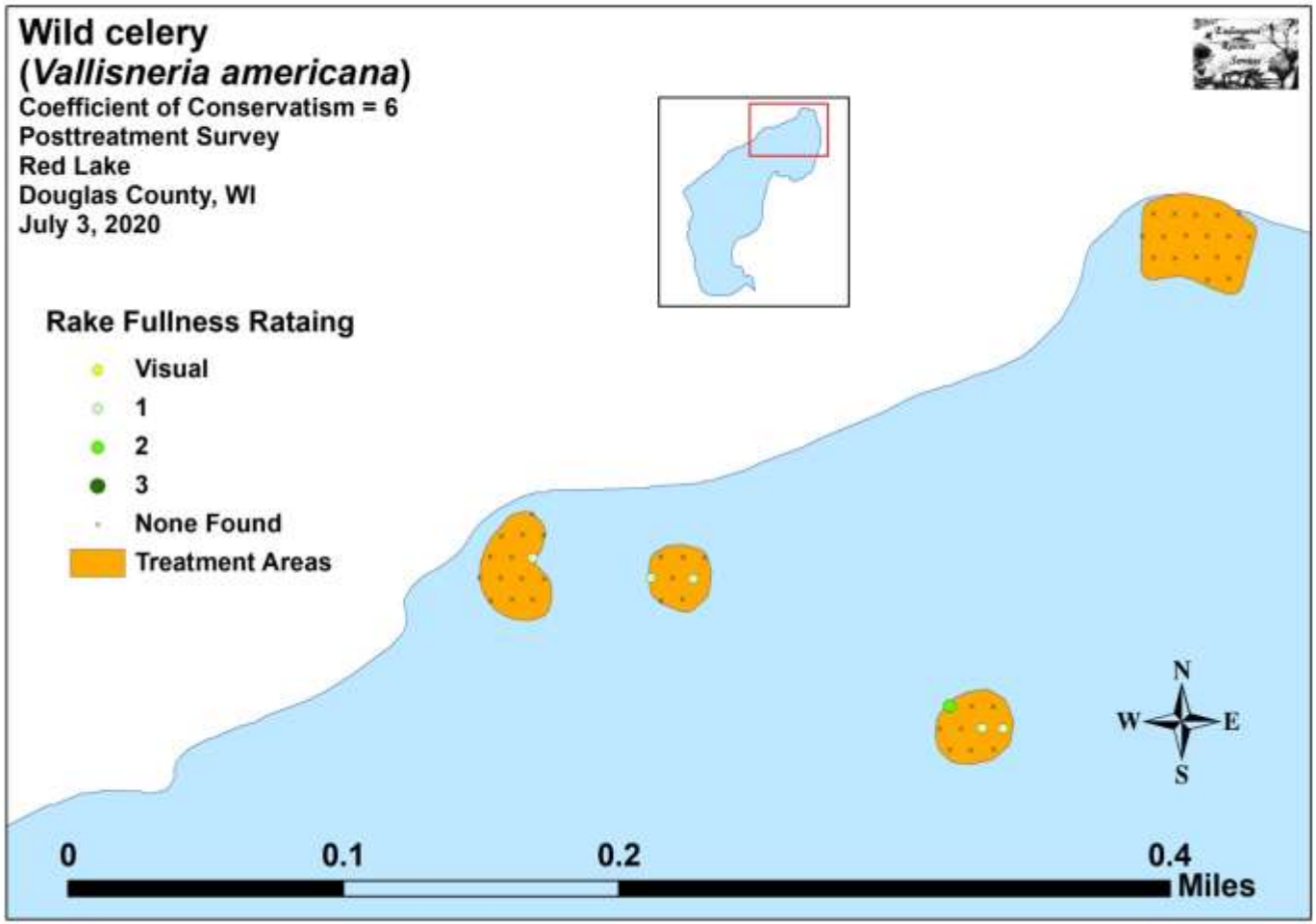

Illinois pondweed
(Potamogeton illinoensis)
Coefficient of Conservatism = 6
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles


White-stem pondweed
(Potamogeton praelongus)
Coefficient of Conservatism = 8
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

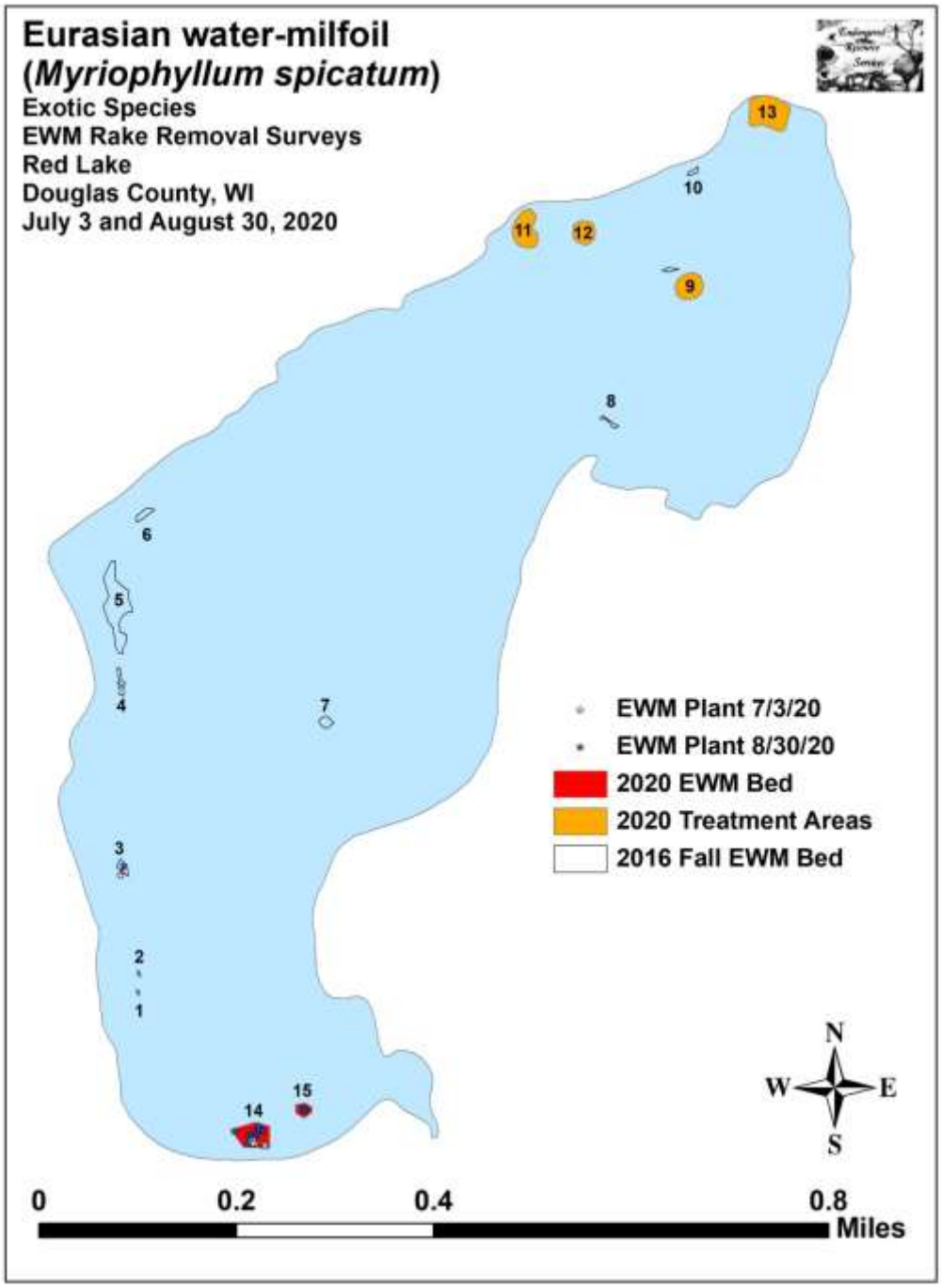

Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles


Fern pondweed
(Potamogeton robbinsii)
Coefficient of Conservatism = 8
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles


Flat-stem pondweed
(Potamogeton zosteriformis)
Coefficient of Conservatism = 6
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles


Wild celery
(Vallisneria americana)
Coefficient of Conservatism = 6
Posttreatment Survey
Red Lake
Douglas County, WI
July 3, 2020
Rake Fullness Rataing
Visual
1
2
3
None Found
Treatment Areas
N
W
E
S
0
0.1
0.2
0.4
Miles

Appendix VIII: 2020 EWM Rake Removal and Bed Map


Eurasian water-milfoil
(Myriophyllum spicatum)
Exotic Species
EWM Rake Removal Surveys
Red Lake
Douglas County, WI
July 3 and August 30, 2020
EWM Plant 7/3/20
EWM Plant 8/30/20
2020 EWM Bed
2020 Treatment Areas
2016 Fall EWM Bed
N
W
E
S
0
0.2
0.4
0.8
Miles