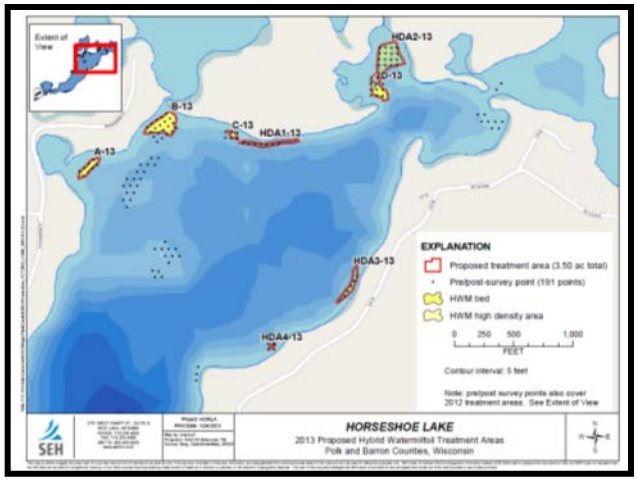
Hybrid Eurasian X Northern water milfoil (*Myriophyllum spicatum* X *Myriophyllum sibiricum*) Pre/Posttreatment and Fall Bed Mapping Surveys

Horseshoe Lake - WBIC: 2630100

Polk/Barron County, Wisconsin

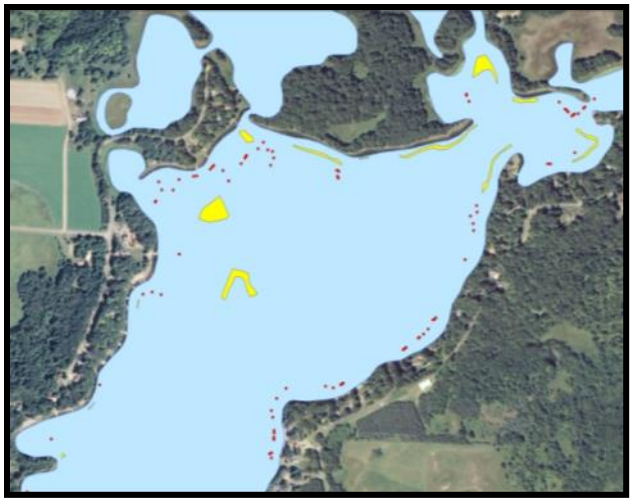
Hybrid Water Milfoil (C. Nackerud)



Spring 2013 HWM Treatment Areas

Project Initiated by:

Horseshoe Lake Improvement Association, Short Elliott Hendrickson Inc., and the Wisconsin Department of Natural Resources



2013 Fall HWM Plants (Red) and High Density Areas (Yellow)

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June 10-11, July 24, and October 6, 13, 2013

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INTRODUCTION:

Horseshoe Lake (WBIC 2630100) is a 398 acre mesotrophic stratified seepage lake located on the border of Polk and Barron Counties in northwest Wisconsin in the Towns of Beaver/Almena (T34N R14W S06 SW SW). The lake reaches a maximum depth of 57ft in the central basin and has an average depth of approximately 25ft under normal water conditions. The bottom is predominately sand and rock on the margins of the central basin before transitioning to nutrient poor sandy muck with increased depth. Brown organic muck bottoms are more common in the lake's sheltered bays on the northeast end (Holt et al. 1968). Water clarity is fair to good with mean summer Secchi readings averaging approximately 8ft from 1995-2013 (WDNR 2013).

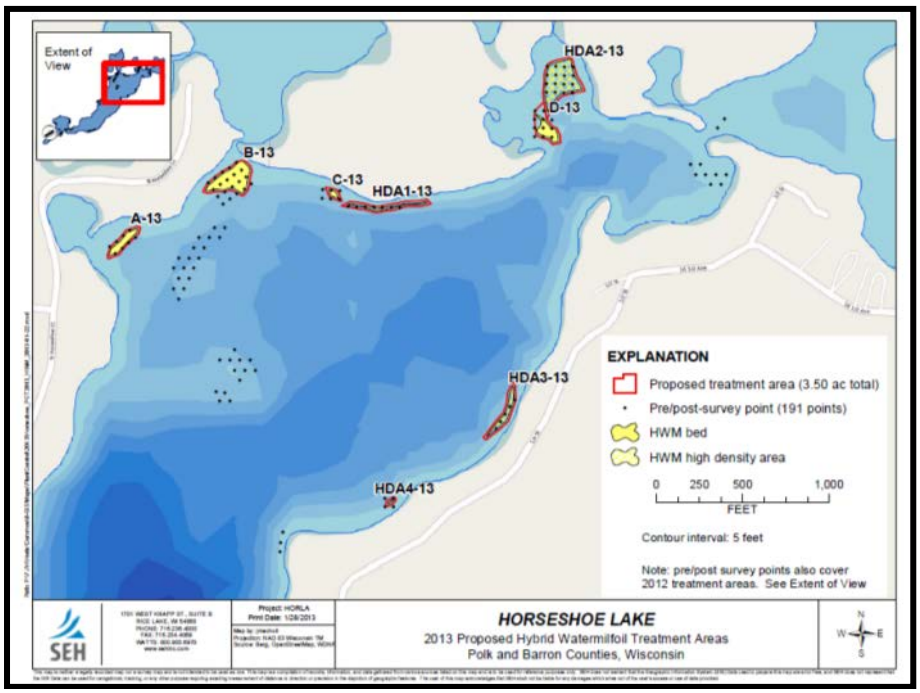


Figure 1: 2013 HWM Treatment Areas

In 2006, the Wisconsin Department of Natural Resources identified the presence of Hybrid water milfoil (HWM) – a cross between Northern and Eurasian water milfoils (*Myriophyllum sibiricum* X *Myriophyllum spicatum*) in the lake, and the Horseshoe Lake Improvement Association (HLIA) has been actively managing to control this invasive exotic species since 2008. Following the 2012 fall HWM bed mapping survey, the HLIA, under the direction of Short Elliott Hendrickson Inc. (SEH), decided to chemically treat eight areas totaled 3.5 acres or 0.9% of the lake's surface area (Figure 1).

On June 10-11th, we conducted a pretreatment survey to gather baseline data from the scheduled treatment areas and to allow SEH biologists to finalize treatment plans. Following the June 17th herbicide application, we conducted a July 24th posttreatment survey to evaluate the effectiveness of the treatment. We also conducted an October 6th and 13th HWM bed mapping survey to determine where HWM control might be considered in 2014. This report is the summary analysis of these three field surveys.

METHODS:

Pre/Post Herbicide Survey:

SEH biologists created pre/post survey points based on the size and shape of the proposed treatment areas with additional "exploratory" survey points scattered throughout the lake in areas that have supported HWM beds in the past. Of the 191 points they generated, approximately 64 fell within the eight treatment areas. This was well over the 4-10 pts/acre required by WDNR protocol (Appendix I).

During the surveys, we located each point using a handheld mapping GPS unit (Garmin 76CSx) and used a rake to sample an approximately 2.5ft section of the bottom. All plants on the rake were assigned a rake fullness value of 1-3 as an estimation of abundance, and a total rake fullness for all species was also recorded (Figure 2). Visual sightings of HWM and Curly-leaf pondweed (*Potamogeton crispus*), another exotic invasive species, were noted if they occurred within 6ft of the point. In addition to plant data, we recorded the lake depth using a hand held sonar (Vexilar LPS-1) and the bottom substrate (bottom type) when we could see it or reliably determine it with the rake.

We entered all data collected into the standard WDNR APM spreadsheet (Appendix II). These data were then analyzed using the linked statistical summary sheet and the WDNR pre/post analysis worksheet (UWEX 2010). Pre/post treatment differences were determined to be significant at $p < .05$, moderately significant at $p < .01$, and highly significant at $p < .005$.

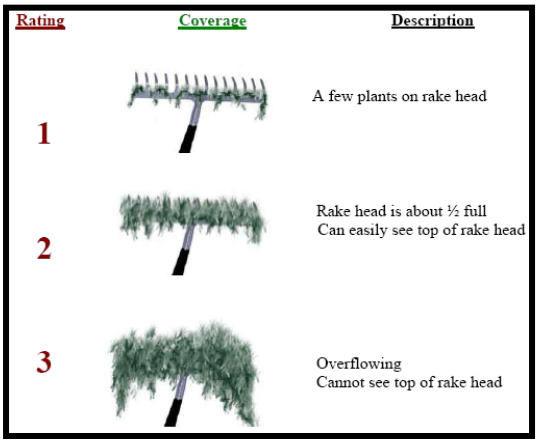


Figure 2: Rake Fullness Ratings

Fall Eurasian Water Milfoil Bed Mapping:

On October 6th and 13th, we searched the entire visible littoral zone of the lake and mapped all known beds of HWM. A "bed" was determined to be any area where we visually estimated that HWM made up >50% of the area's plants and was generally continuous with clearly defined borders. After we located a bed, we motored around the perimeter of the area, took GPS coordinates at regular intervals, and estimated the average rake fullness rating of HWM 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. We also GPS marked additional individual HWM plants that occurred outside of the beds.

RESULTS AND DISCUSSION:

Finalization of Treatment Areas:

Initial expectations were to treat 8 areas totaling 3.5 acres with granular 2, 4-D (Navigate) at a rate of 3-4ppm depending on the size of the bed (Table 1). The 191 point pretreatment survey found that HWM was patchy in distribution but still occurred in all areas. Because of this, it was decided to maintain these areas as initially proposed. The final treatment was conducted by Northern Aquatics Services on June 17th (Figure 3) (Appendix I).

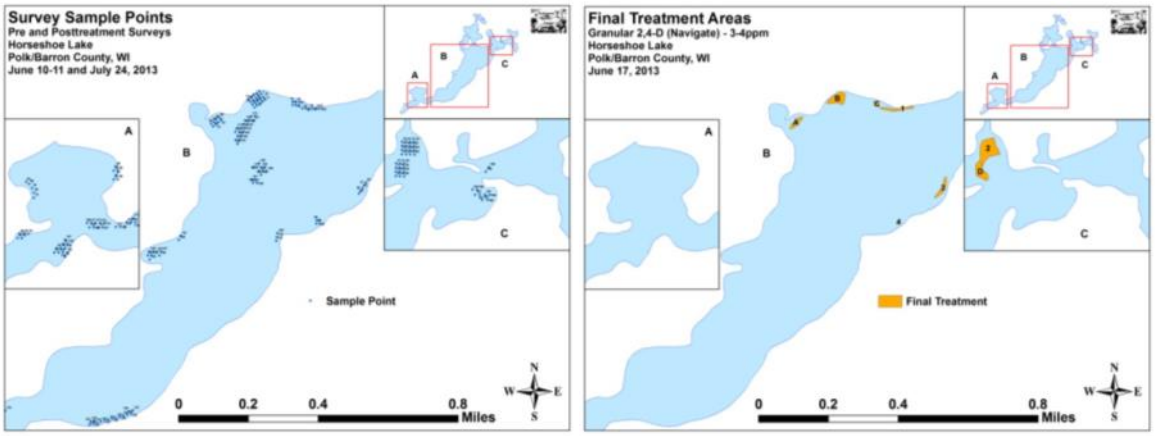


Figure 3: 2013 Survey Sample Points and Treatment Areas

Table 1: Spring HWM Treatment Summary
Horseshoe Lake – June 17, 2013

Bed/HDA Number	Proposed Acreage	Final Acreage	Difference +/-
HDA 1	0.38	0.38	0.00
HDA 2	1.05	1.05	0.00
HDA 3	0.38	0.38	0.00
HDA 4	0.05	0.05	0.00
Bed A	0.31	0.31	0.00
Bed B	0.78	0.78	0.00
Bed C	0.10	0.10	0.00
Bed D	0.45	0.45	0.00
Total Acres	**3.50**	**3.50**	**0.00**

HWM Pre/Post Herbicide Survey:

The littoral zone extended to at least 12.0ft during both the pre and posttreatment surveys. Mean and median depths for all plants were 6.1ft and 6.0ft respectively during the pretreatment survey before declining slightly to 5.8ft and 6.0ft in the posttreatment survey (Table 2). We found Hybrid water milfoil scattered throughout the littoral zone in 2-11ft of water with most plants growing over organic or sandy muck (Figure 4) (Appendix III).

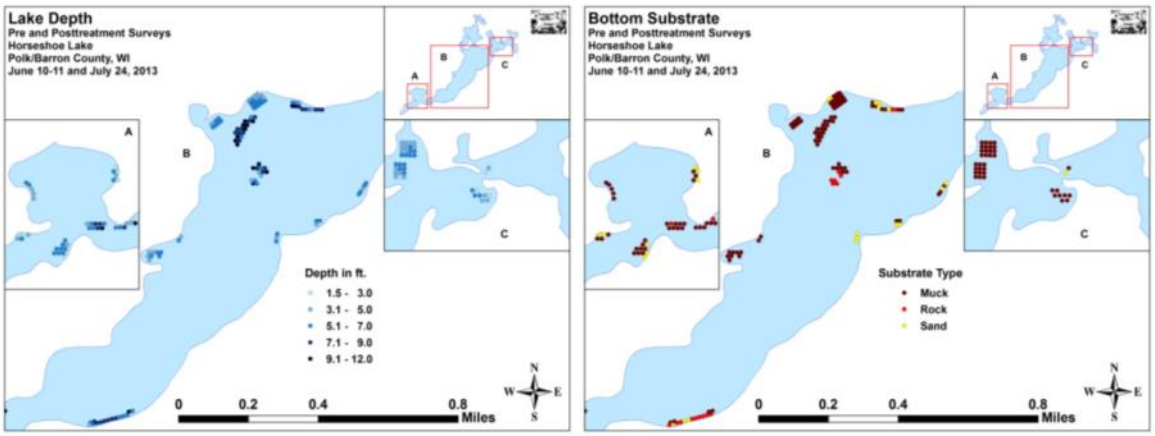


Figure 4: Lake Depths and Bottom Substrate

Table 2: Pre/Post Survey Summary Statistics
Horseshoe Lake, Polk/Barron Counties
June 10-11 and July 24, 2013

Summary Statistics:	Pre	Post
Total number of points sampled	191	191
Total number of sites with vegetation	182	189
Total number of sites shallower than the maximum depth of plants	191	191
Frequency of occurrence at sites shallower than maximum depth of plants	95.3	99.0
Simpson Diversity Index	0.70	0.86
Floristic Quality Index	26.3	33.1
Maximum depth of plants (ft)	12.0	12.0
Mean depth of plants (ft)	6.1	5.8
Median depth of plants (ft)	6.0	6.0
Average number of all species per site (shallower than max depth)	1.56	2.37
Average number of all species per site (veg. sites only)	1.64	2.40
Average number of native species per site (shallower than max depth)	1.48	2.36
Average number of native species per site (veg. sites only)	1.56	2.39
Species richness	18	25
Mean rake fullness (veg. sites only)	2.06	2.01

Initial diversity within the beds was moderate with a Simpson Diversity Index of 0.70. This value increased sharply to 0.86 posttreatment. The Floristic Quality Index of native plants also increased from 26.3 to 33.1. Mean native species richness at sites with vegetation was 1.56/site pretreatment, and this also increased significantly to 2.39/site posttreatment (Figure 5). Total rake fullness was nearly unchanged with a moderate 2.06 pretreatment and 2.01 posttreatment (Figure 6) (Appendix IV).

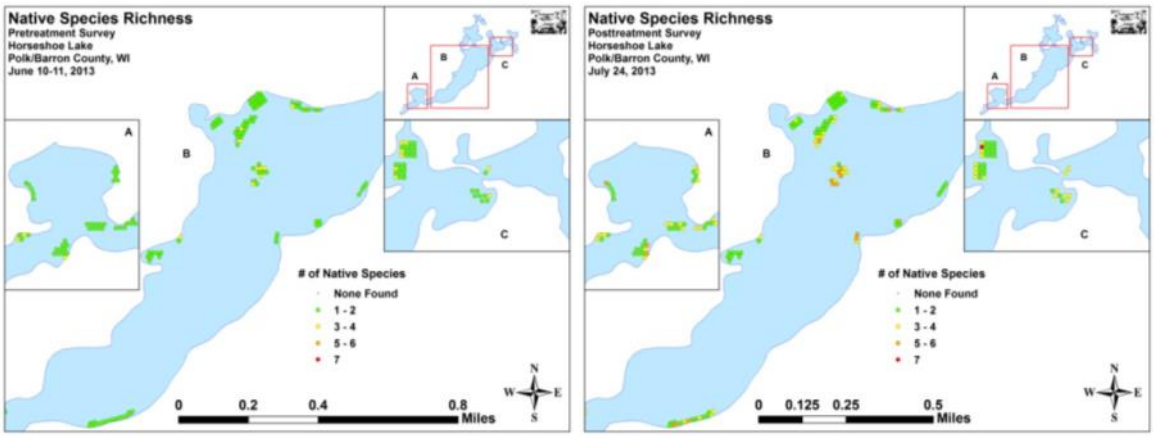


Figure 5: Pre/Post Native Species Richness

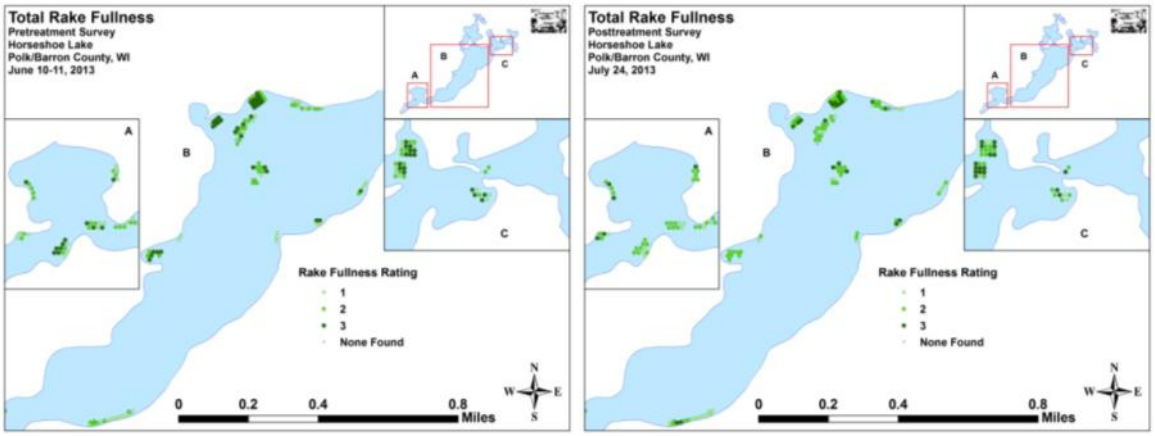


Figure 6: Pre/Post Total Rake Fullness

We found HWM at 14 sites during the pretreatment survey. Of these, two rated a 3, two were a 2, and the other seven had a rake fullness rating of 1 for an average rake fullness of 1.43. We also recorded HWM as a visual at 21 additional points. During the posttreatment survey, we found HWM at two sites with each rating a 1. HWM was also recorded as a visual at four additional sites (Figure 7) (Appendix V). This decrease in total HWM was moderately significant, and the decrease in rake fullness 1 was also significant (Figure 8).

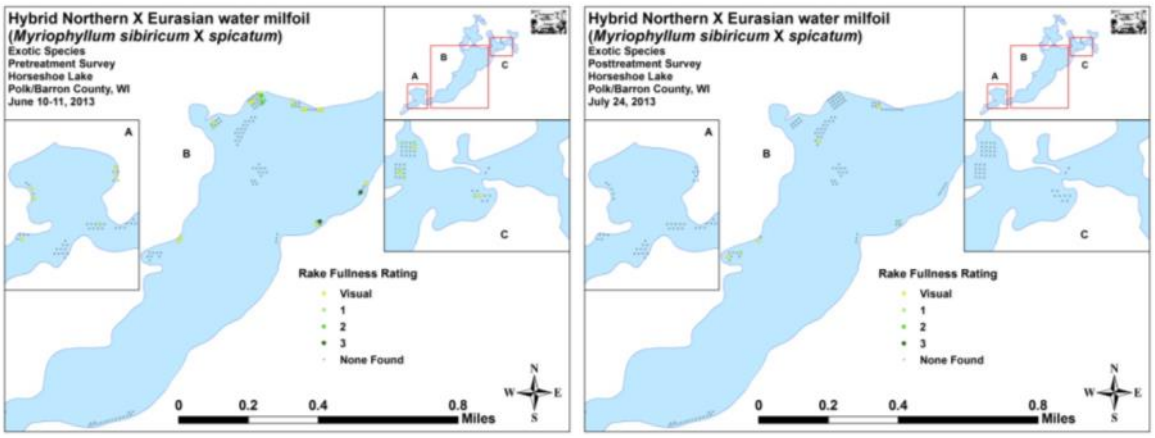
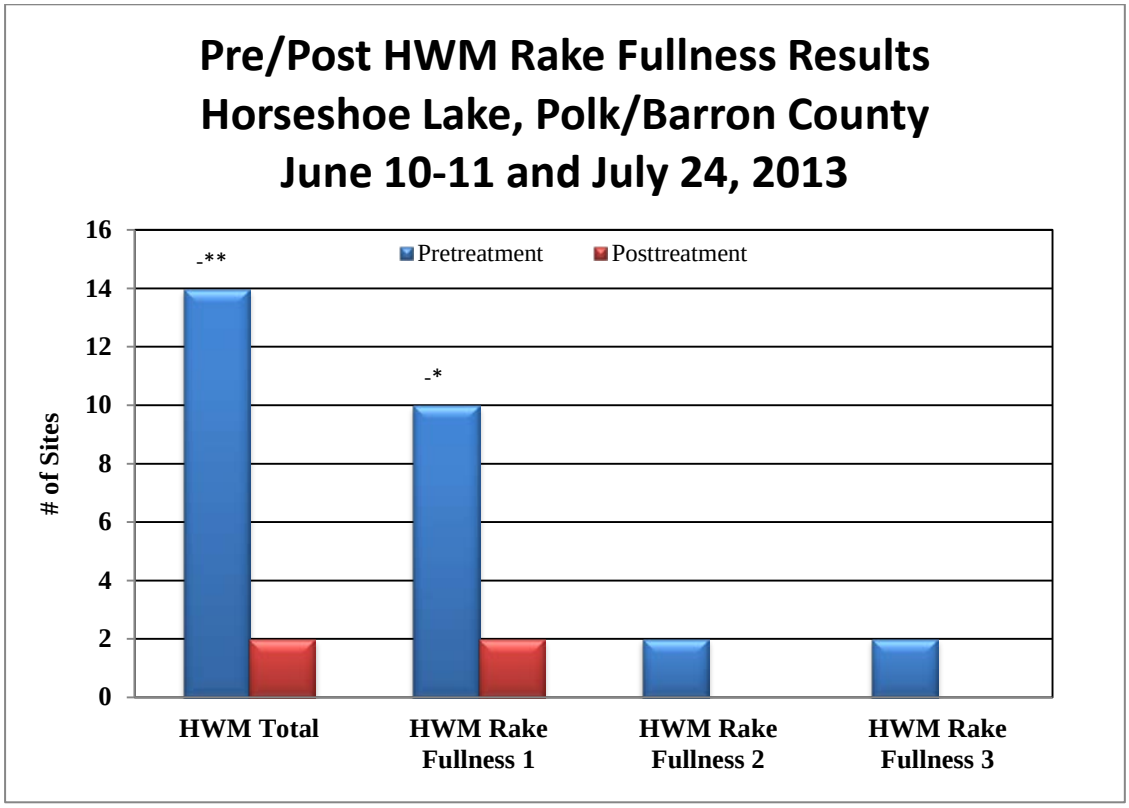


Figure 7: Pre/Post HWM Density and Distribution



Significant differences = * p <. 05, ** p <. 01, *** p <. 005

Figure 8: Pre/Post Changes in HWM Rake Fullness

We found Curly-leaf pondweed at just two sites during the pretreatment survey with one having a rake fullness rating of a two, and the other a 1. During the posttreatment survey, we didn't find CLP at any point (Figure 9) (Appendix V).

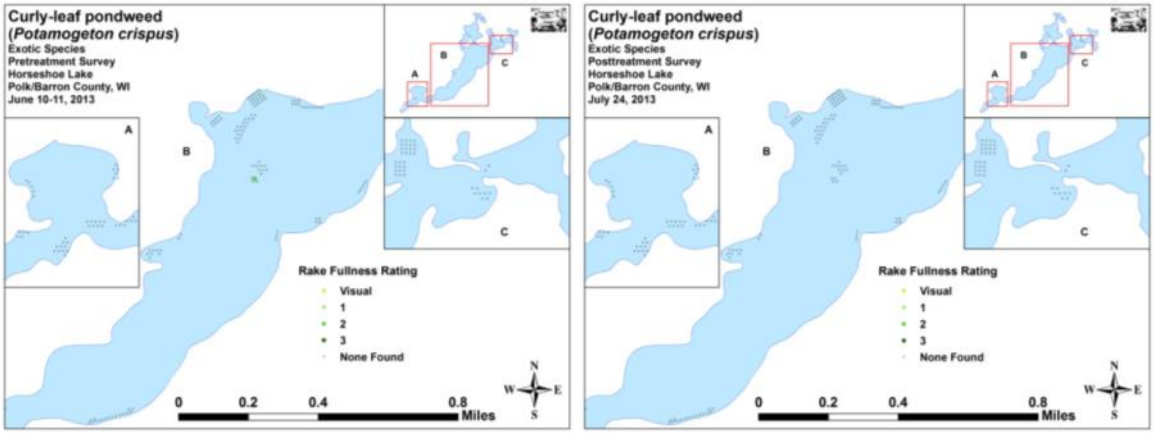


Figure 9: Pre/Post CLP Density and Distribution

Fern pondweed (*Potamogeton robbinsii*) and Common waterweed (*Elodea canadensis*) were the two most common native species in both the pre and posttreatment surveys, and neither showed a significant change posttreatment (Figures 10 and 11) (Tables 3 and 4). In fact, no species other than HWM showed a significant decline posttreatment (Figure 12). Vasey's pondweed (*Potamogeton vaseyi*), Clasping-leaf pondweed (*Potamogeton richardsonii*), Wild celery (*Vallisneria americana*), Northern naiad (*Najas gracillima*), and Spiral-fruited pondweed (*Potamogeton spirillus*) all showed highly significant increases posttreatment; Small pondweed (*Potamogeton pusillus*), and Watershield (*Brasenia schreberi*), showed moderately significant increases; and Slender naiad (*Najas flexilis*), Waterwort (*Elatine minima*), and Water star-grass (*Heteranthera dubia*) all showed significant increases. Many of these species tend to be late growing or germinate from seeds, and these increases are likely simply due to normal expansion over the growing season (Maps for all native species from the pre and posttreatment surveys are available in Appendixes VI and VII).

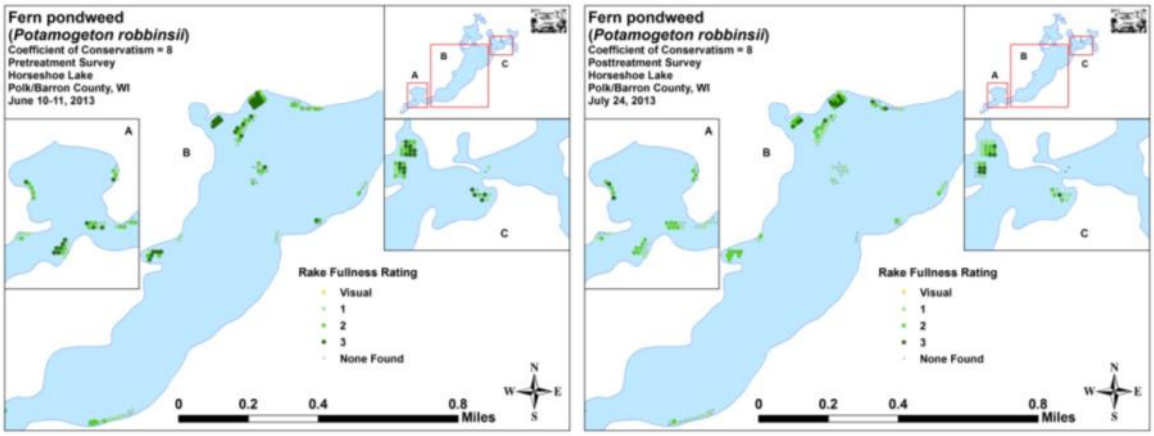


Figure 10: Pre/Post Fern Pondweed Density and Distribution

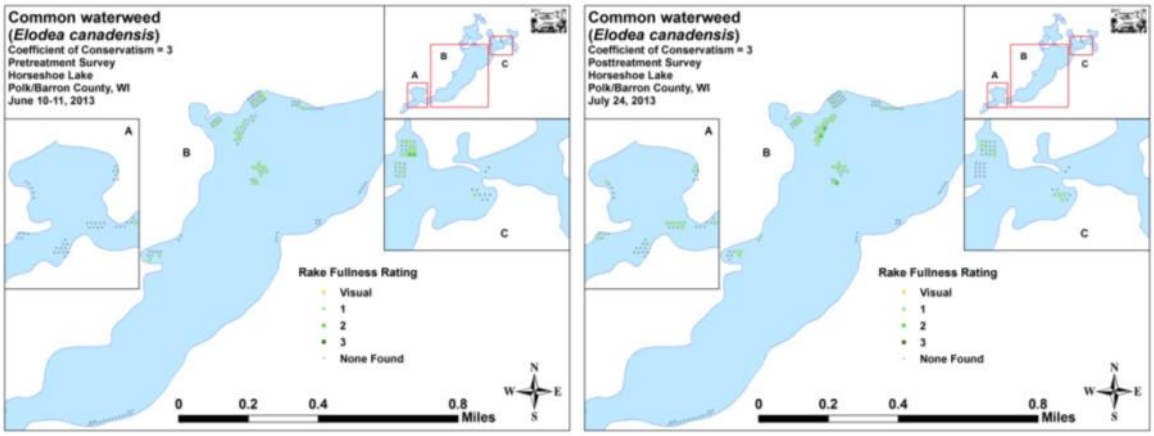
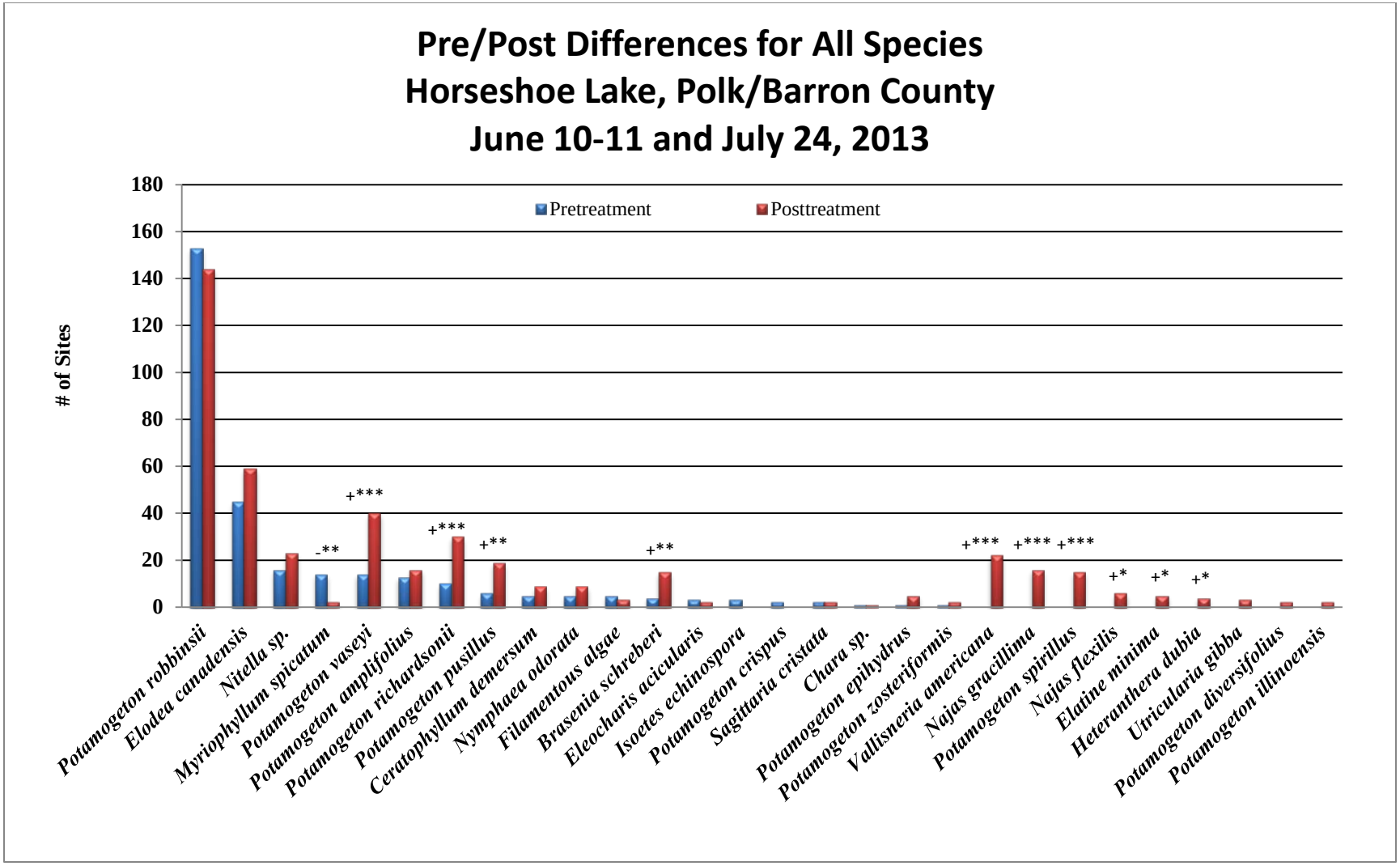


Figure 11: Pre/Post Common waterweed Density and Distribution



Significant differences = * p <. 05, ** p <. 01, *** p <. 005

Figure 12: Pre/Post Macrophyte Changes

Table 3: Frequencies and Mean Rake Sample of Aquatic Macrophytes Pretreatment Survey Horseshoe Lake, Polk/Barron Counties June 10-11, 2013

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sites
Potamogeton robbinsii	Fern pondweed	153	51.34	84.07	80.10	2.13	0
Elodea canadensis	Common waterweed	45	15.10	24.73	23.56	1.04	0
Nitella sp.	Nitella	16	5.37	8.79	8.38	1.63	0
Myriophyllum spicatum X *sibiricum*	Hybrid water milfoil	14	4.70	7.69	7.33	1.43	21
Potamogeton vaseyi	Vasey's pondweed	14	4.70	7.69	7.33	1.14	0
Potamogeton amplifolius	Large-leaf pondweed	13	4.36	7.14	6.81	1.31	0
Potamogeton richardsonii	Clasping-leaf pondweed	10	3.36	5.49	5.24	1.00	0
Potamogeton pusillus	Small pondweed	6	2.01	3.30	3.14	1.33	0
Ceratophyllum demersum	Coontail	5	1.68	2.75	2.62	1.00	0
Nymphaea odorata	White water lily	5	1.68	2.75	2.62	1.00	0
	Filamentous algae	5	*	2.75	2.62	1.20	0
Brasenia schreberi	Watershield	4	1.34	2.20	2.09	1.25	0
Eleocharis acicularis	Needle spikerush	3	1.01	1.65	1.57	1.00	0
Isoetes echinospora	Spiny spored-quillwort	3	1.01	1.65	1.57	1.00	0
Potamogeton crispus	Curly-leaf pondweed	2	0.67	1.10	1.05	1.50	0
Sagittaria cristata	Crested arrowhead	2	0.67	1.10	1.05	1.00	0
Chara sp.	Muskgrass	1	0.34	0.55	0.52	1.00	0
Potamogeton epihydrus	Ribbon-leaf pondweed	1	0.34	0.55	0.52	1.00	0
Potamogeton zosteriformis	Flat-stem pondweed	1	0.34	0.55	0.52	1.00	0

* Excluded from the Relative Frequency Calculation

Table 4: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Posttreatment Survey Horseshoe Lake, Polk/Barron Counties
July 24, 2013

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sites
Potamogeton robbinsii	Fern pondweed	144	31.79	76.19	75.39	1.75	0
Elodea canadensis	Common waterweed	59	13.02	31.22	30.89	1.05	0
Potamogeton vaseyi	Vasey's pondweed	40	8.83	21.16	20.94	1.63	0
Potamogeton richardsonii	Clasping-leaf pondweed	30	6.62	15.87	15.71	1.17	0
Nitella sp.	Nitella	23	5.08	12.17	12.04	1.65	0
Vallisneria americana	Wild celery	22	4.86	11.64	11.52	1.23	0
Potamogeton pusillus	Small pondweed	19	4.19	10.05	9.95	1.11	0
Najas gracillima	Northern naiad	16	3.53	8.47	8.38	1.31	0
Potamogeton amplifolius	Large-leaf pondweed	16	3.53	8.47	8.38	1.13	0
Brasenia schreberi	Watershield	15	3.31	7.94	7.85	2.47	0
Potamogeton spirillus	Spiral-fruited pondweed	15	3.31	7.94	7.85	1.07	0
Ceratophyllum demersum	Coontail	9	1.99	4.76	4.71	1.00	0
Nymphaea odorata	White water lily	9	1.99	4.76	4.71	1.56	0
Najas flexilis	Slender naiad	6	1.32	3.17	3.14	1.17	0
Elatine minima	Waterwort	5	1.10	2.65	2.62	1.00	0
Potamogeton epihydrus	Ribbon-leaf pondweed	5	1.10	2.65	2.62	1.20	0
Heteranthera dubia	Water star-grass	4	0.88	2.12	2.09	1.00	0
Utricularia gibba	Creeping bladderwort	3	0.66	1.59	1.57	1.00	0
	Filamentous algae	3	*	1.59	1.57	1.00	0
Eleocharis acicularis	Needle spikerush	2	0.44	1.06	1.05	1.00	0
Myriophyllum spicatum X *sibiricum*	Hybrid water milfoil	2	0.44	1.06	1.05	1.00	4
Potamogeton diversifolius	Water-thread pondweed	2	0.44	1.06	1.05	1.00	0

* Excluded from the Relative Frequency Calculation

Table 4 (cont'): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Posttreatment Survey Horseshoe Lake, Polk/Barron Counties
July 24, 2013

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sites
Potamogeton illinoensis	Illinois pondweed	2	0.44	1.06	1.05	1.00	0
Potamogeton zosteriformis	Flat-stem pondweed	2	0.44	1.06	1.05	1.00	0
Sagittaria cristata	Crested arrowhead	2	0.44	1.06	1.05	1.00	0
Chara sp.	Muskgrass	1	0.22	0.53	0.52	2.00	0

Fall Hybrid Water Milfoil Bed Mapping Survey:

On October 6th and 13th, we surveyed the visible littoral zone on Horseshoe Lake to identify any Hybrid water milfoil beds or high HWM density areas that deserve consideration for control in 2014. Water clarity was approximately six feet making it possible to see at least the tops of HWM plants throughout the lake's entire littoral zone.

During the survey, we didn't find any true beds. However, HWM, which was almost undetectable in the lake during the August 2013 full lake point intercept survey, had become considerably more widespread. We mapped 13 high HWM density areas that totaled 2.54 acres and marked an additional 167 HWM plants outside of these areas (Figure 13) (Table 5) (Appendix VIII).

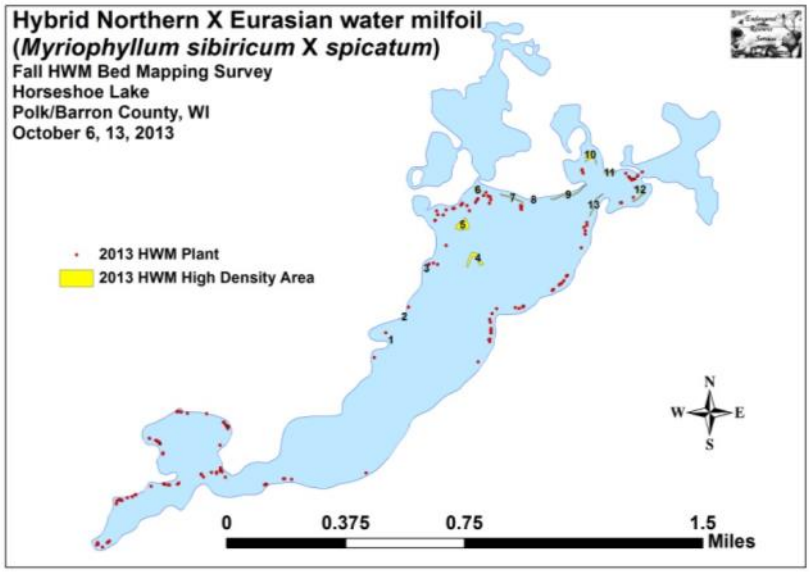


Figure 13: Fall 2013 HWM High Density Areas

Table 5: Fall Hybrid Water Milfoil High Density Areas Horseshoe Lake, Polk/Barron Counties - October 6, 13, 2013

HDA	Area (Acres)	Mean Rake Fullness	Field Notes
1	0.01	<1-2; mostly 1	Scattered canopied HWM in 4-6ft of water.
2	0.01	<1-1; mostly <1	Low density narrow ribbon of canopied HWM in 4-6ft of water.
3	0.01	<1-1; mostly <1	Low density narrow ribbon of canopied HWM in 4-6ft of water.
4	0.48	<<1-1; mostly <1	Extremely low density, but 10's of plants at or near canopy.
5	0.65	<1-1; mostly <1	Scattered near canopied towers in water 7-9ft deep.
6	0.13	<1-2; mostly 1	Scattered small clusters in water <4ft deep.
7	0.15	<1-1; mostly <1	Ribbon of few 10's of plants in water 6-8ft deep.
8	0.01	<1-1; mostly <1	Ribbon of approximately 150 plants in 6-8ft of water.
9	0.26	<<1-1; mostly <1	Ribbon of few 10's of plants in water 6-8ft deep.
10	0.39	<<1-1; mostly <1	Scattered new sprouts in water 3-6ft throughout the bay.
11	0.11	<<1-1; mostly <1	Ribbon of few 10's of plants in water 6-8ft deep.
12	0.17	<<1-1; mostly <1	Widely scattered plants in 4-6ft.
13	0.15	<<1-1; mostly <1	Ribbon of few 10's of plants in water 6-10ft deep.
Total Acres	**2.54**		

Descriptions of Current and Former HWM Beds/High Density Areas:

West End of the Lake - Although the west end formerly had numerous beds with thousands of plants, continued diver hand removal (Craig Nackerud pers. comm.), and rake removal during our surveys appears to be largely keeping the infestation in this area in check. During the fall survey, we found no beds or high density areas, and we marked a total of only 75 individual plants (Figure 14).

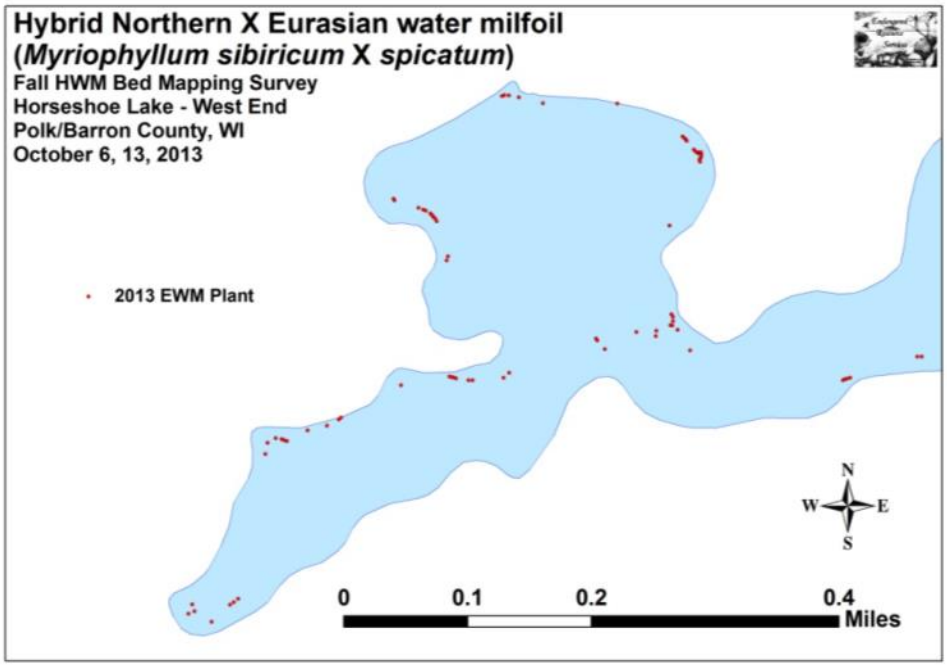


Figure 14: Fall 2013 HWM – West End

East End of the Lake – Although we found no true beds and even calling some areas "High Density" was a bit of a stretch, there was a definite uptick in both plant density and distribution in the eastern bays. In total, plants numbered in the 100's not 1,000's, but the widespread nature of these plants will potentially make control difficult in 2014.

HDA 1 – We found several clusters of HWM with multiple stems that were canopied on the rock point in 4-6ft of water.

HDAs 2 and 3– HWM was present in a narrow ribbon along the shoreline that was <10ft wide. Plants occurred at very low densities and were mixed among beds of Clasping-leaf pondweed (*Potamogeton richardsonii*).

HDA 4 – The area around the rock island again has 10's (not 100's) of HWM plant on the edge of the drop off from 6-10ft of water.

HDA 5 – This area north/northwest of the rock island continues to be an area of continued reestablishment as patches of near canopied HWM was scattered in 7-9ft of water. The total area contained a few 10's of plants.

HDA 6 – HWM was present in shallow water <4ft deep near the entrance to “Mud Lake”. Most plants in this area appeared to be recent sprouts as they were generally single stemmed and only 1-2ft tall/not yet canopied.

HDAs 7-9, 11, and 13 – These narrow beds followed the bathymetric ring in 6-10ft of water around the northwest end of the lake. HWM plants numbered in the 10’s in each bed, but were regularly encountered throughout in a more or less continuous band just a few feet wide along the areas’ sharp drop-offs into deeper water.

HDA 10 – HWM was present in shallow water 4-6ft deep. We noted most plants were in the far northeast corner of the bay where fragments were likely deposited by the prevailing winds.

HDA 12 – This bay barely deserved to be called a high density area as it was more a scattering of 30-40 individual plants. However, we decided to map it as we didn’t see anything here in August.

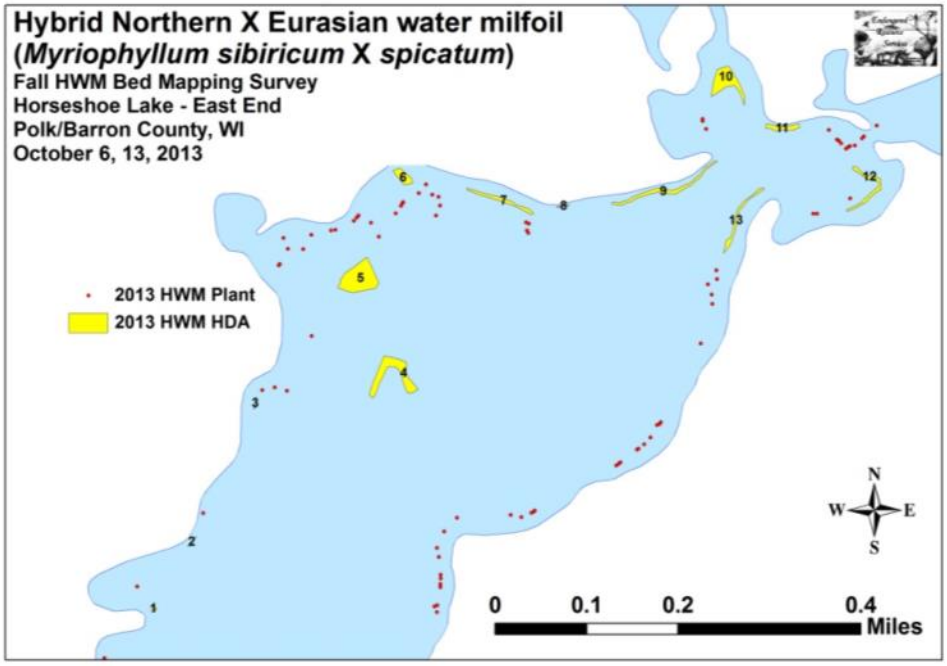


Figure 15: Fall 2013 HWM – East End

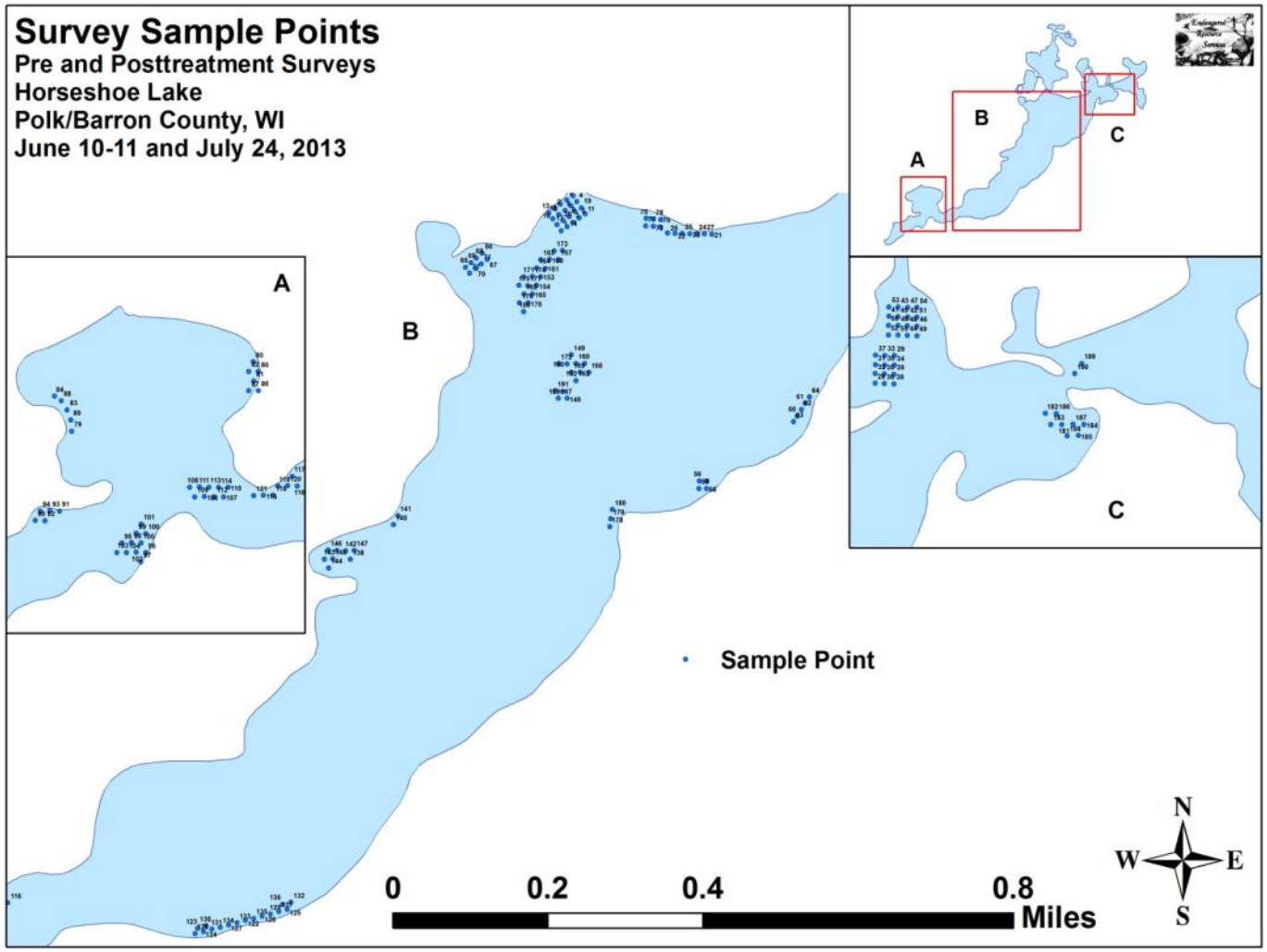
LITERATURE CITED

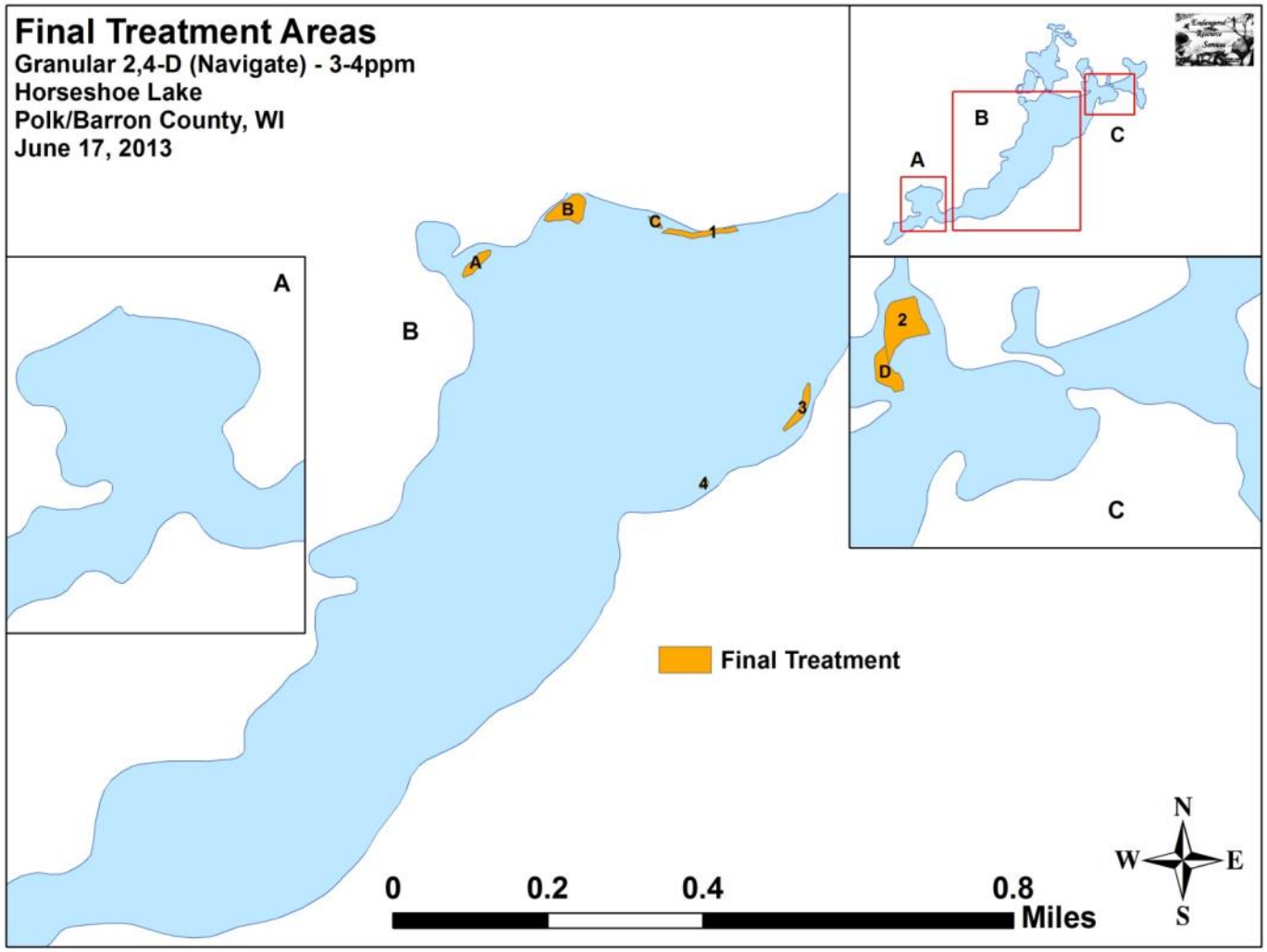
Holt, C., S. Busch, C., R. Kerr, and S. Johannes. [online]. 1968. Horseshoe Lake Map. Available from http://dnr.wi.gov/lakes/maps/DNR/2630100a.pdf (2013, November).

UWEX Lakes Program. [online]. 2010. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr/uwexlakes/ecology/APMguide.asp (2013, November).

WDNR. [online]. 2013. Horseshoe Lake - Citizen Lake Water Quality Monitoring Database. Available from http://dnr.wi.gov/lakes/waterquality/Station.aspx?id=493139 (2013, November).

Appendix I: Survey Sample Points and HWM Treatment Areas

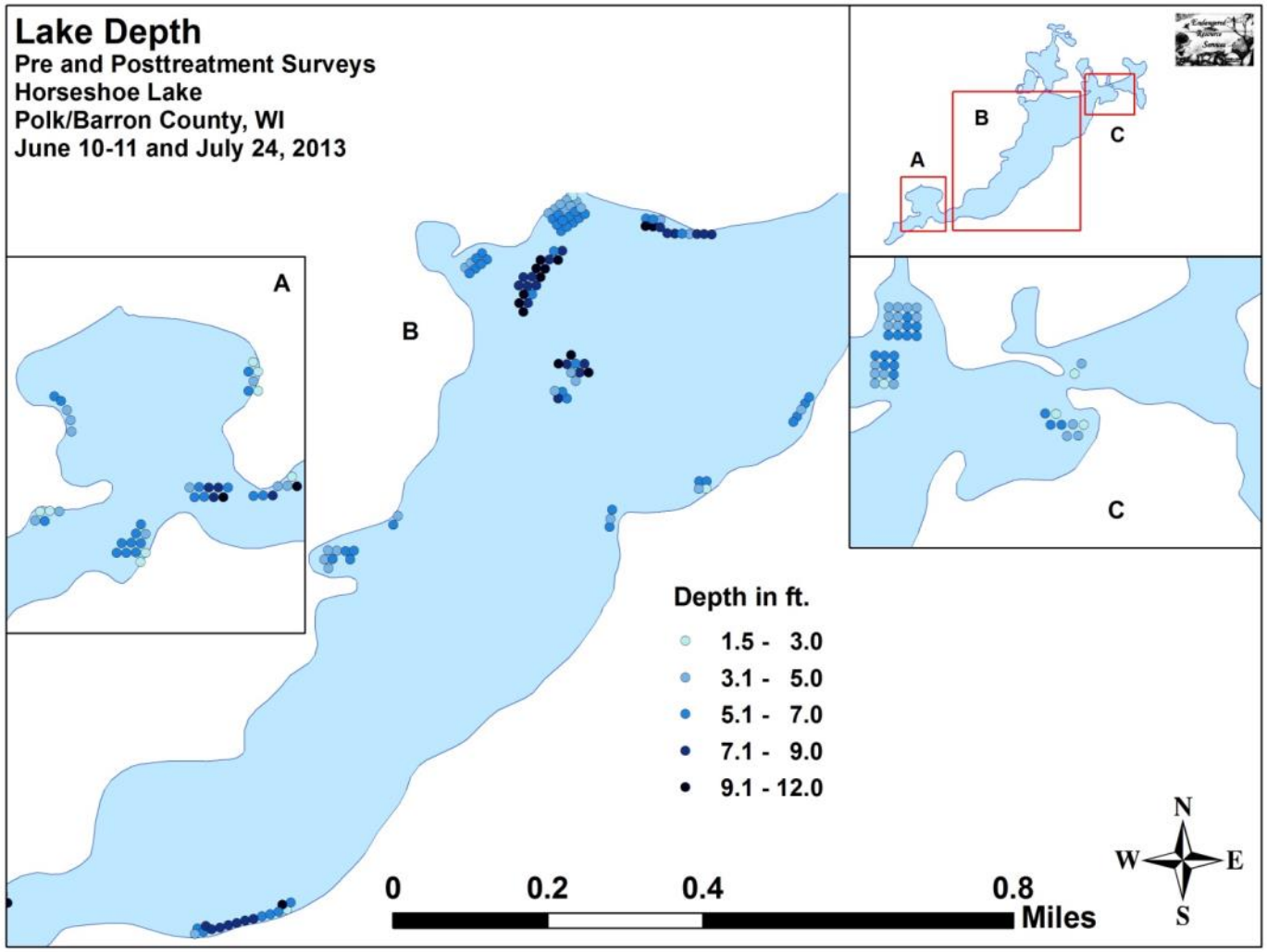

Survey Sample Points
Pre and Posttreatment Surveys
Horseshoe Lake
Polk/Barron County, WI
June 10-11 and July 24, 2013
A
B
C
Sample Point
0
0.2
0.4
0.8
Miles
N
W
E
S

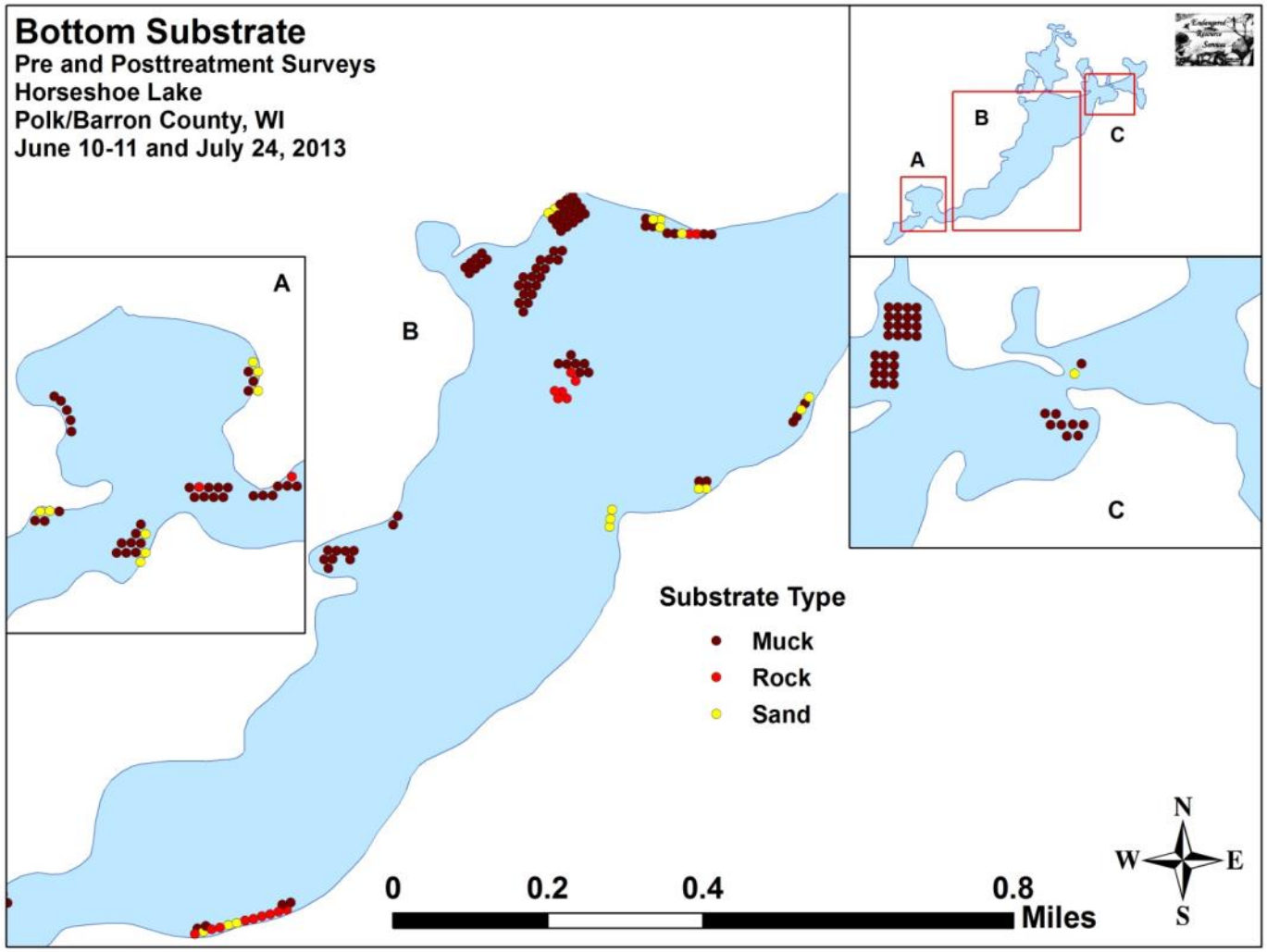

Final Treatment Areas
Granular 2,4-D (Navigate) - 3-4ppm
Horseshoe Lake
Polk/Barron County, WI
June 17, 2013
A
B
C
1
2
3
4
D
Final Treatment
0
0.2
0.4
0.8
Miles
N
W
E
S

Appendix II: Vegetative Survey Data Sheet

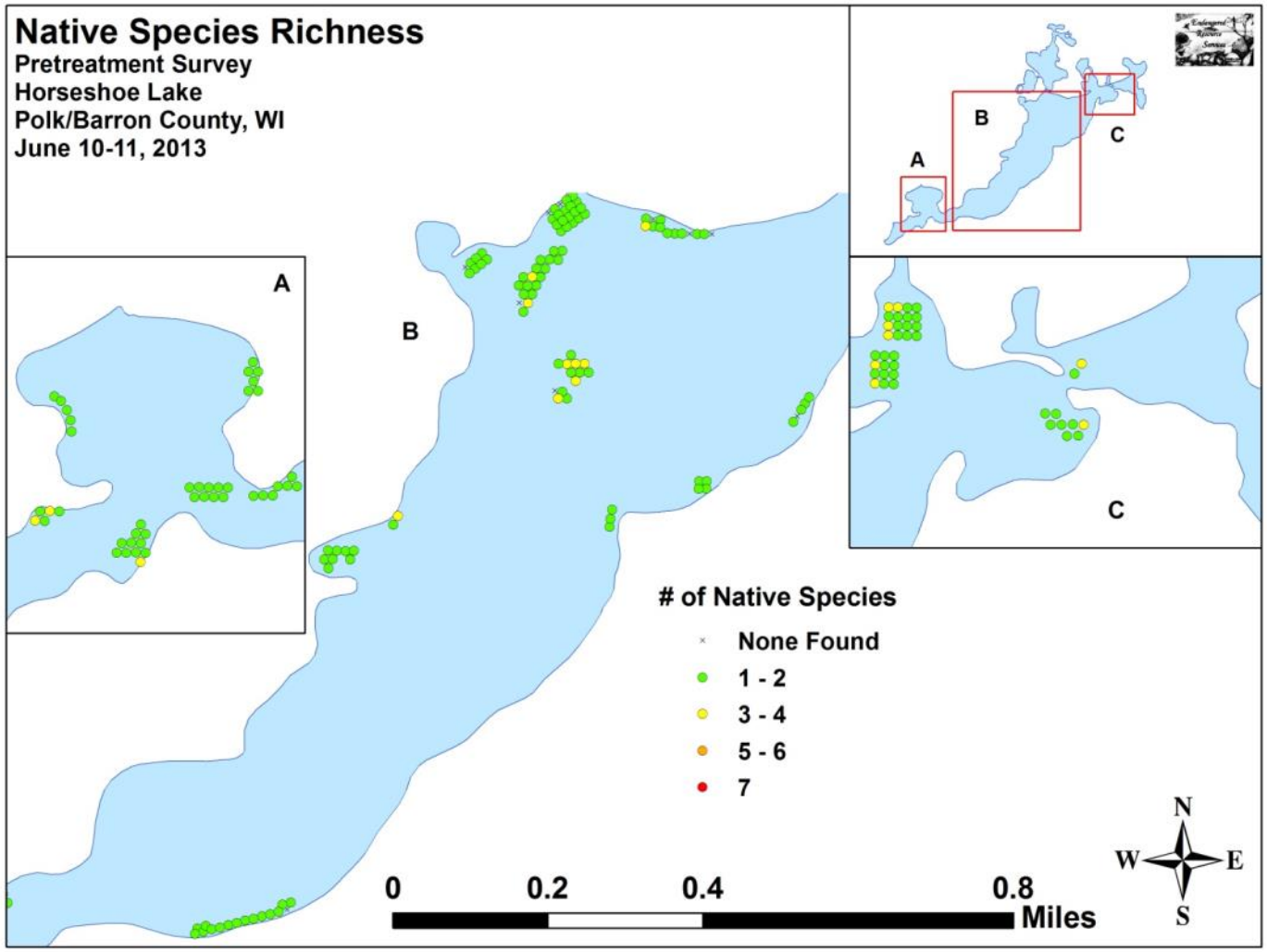
Observers for this lake: names and hours worked by each:																										
Lake:									**WBIC**									**County**						**Date:**	
Site #	**Depth (ft)**	**Muck (M), Sand (S), Rock (R)**	**Rake pole (P) or rake rope (R)**	**Total Rake Fullness**	**HWM**	**CLP**	**1**	**2**	**3**	**4**	**5**	**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																									

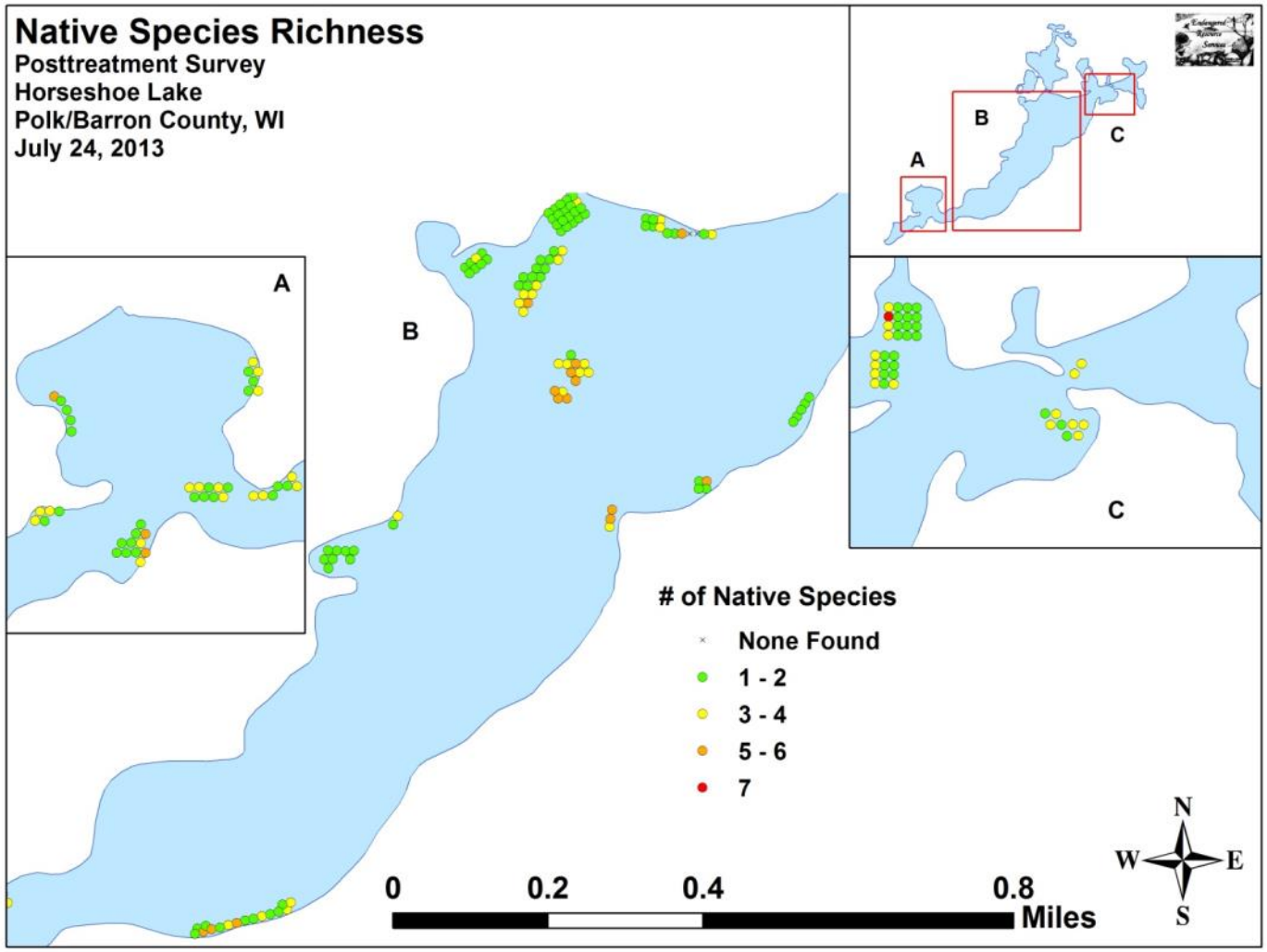
Appendix III: Pre/Post Habitat Variable Maps

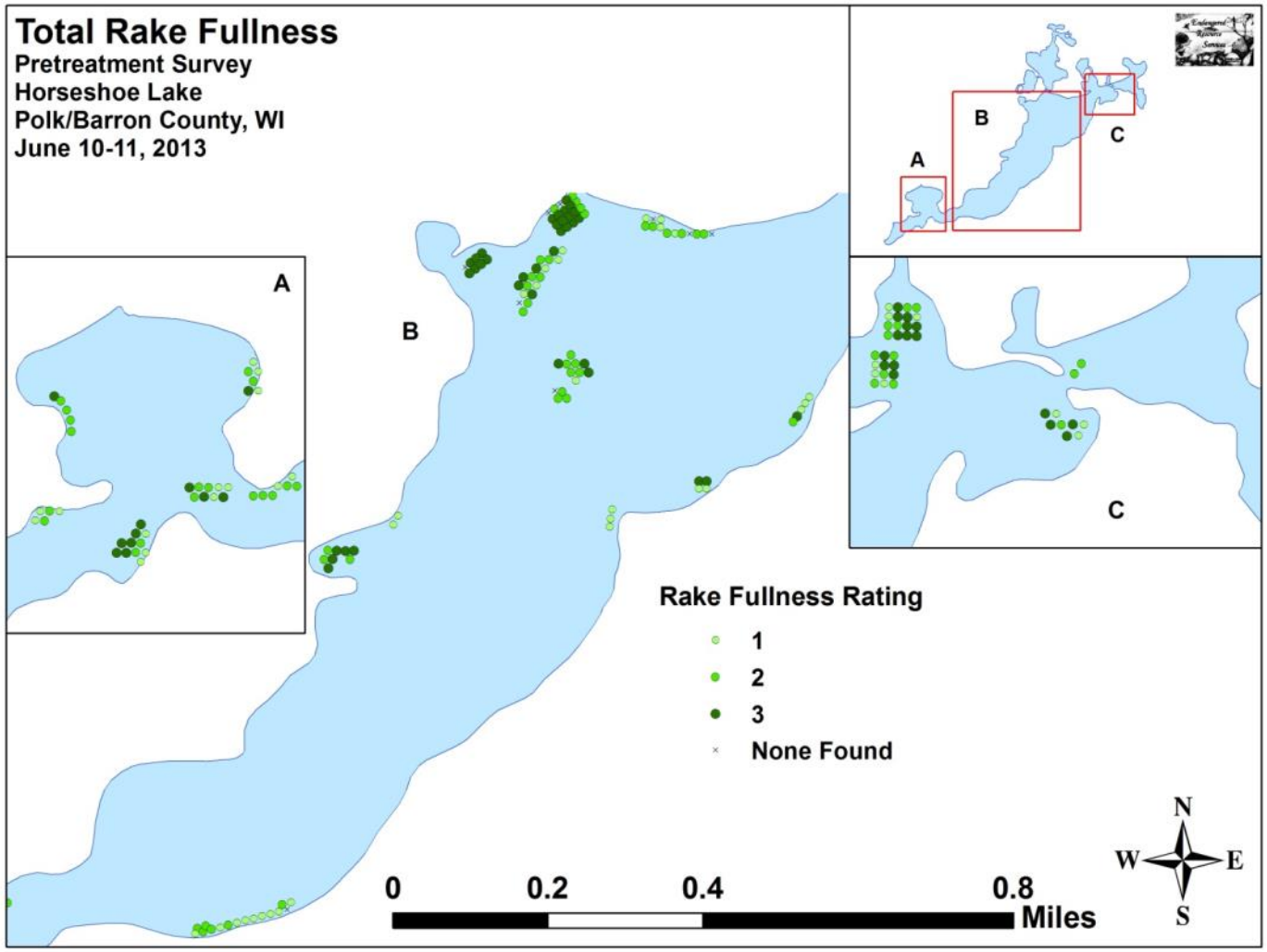

Lake Depth
Pre and Posttreatment Surveys
Horseshoe Lake
Polk/Barron County, WI
June 10-11 and July 24, 2013
A
B
C
Depth in ft.
1.5 - 3.0
3.1 - 5.0
5.1 - 7.0
7.1 - 9.0
9.1 - 12.0
0
0.2
0.4
0.8
Miles
N
W
E
S

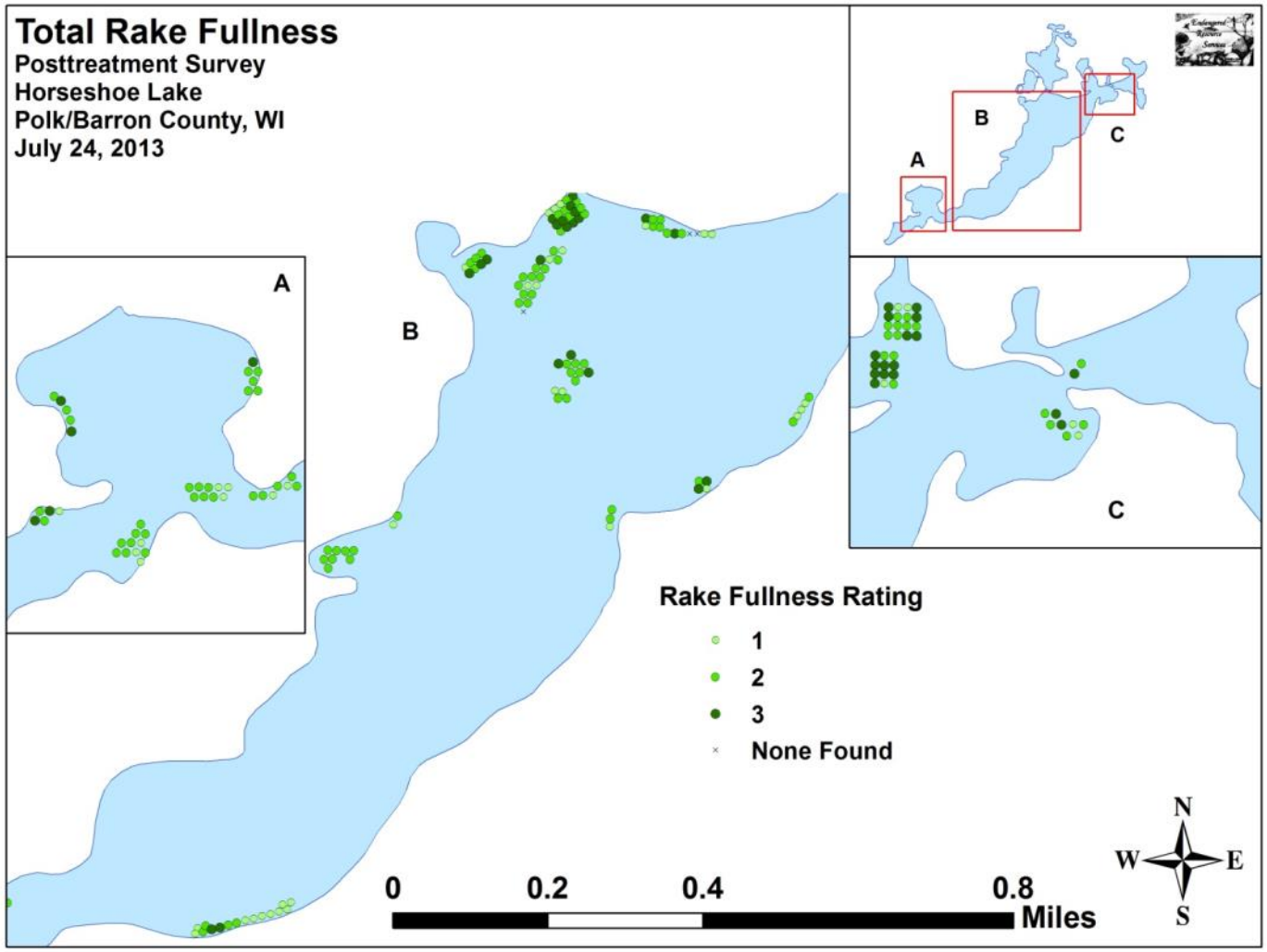

Bottom Substrate
Pre and Posttreatment Surveys
Horseshoe Lake
Polk/Barron County, WI
June 10-11 and July 24, 2013
A
B
C
Substrate Type
Muck
Rock
Sand
0
0.2
0.4
0.8
Miles
N
W
E
S

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

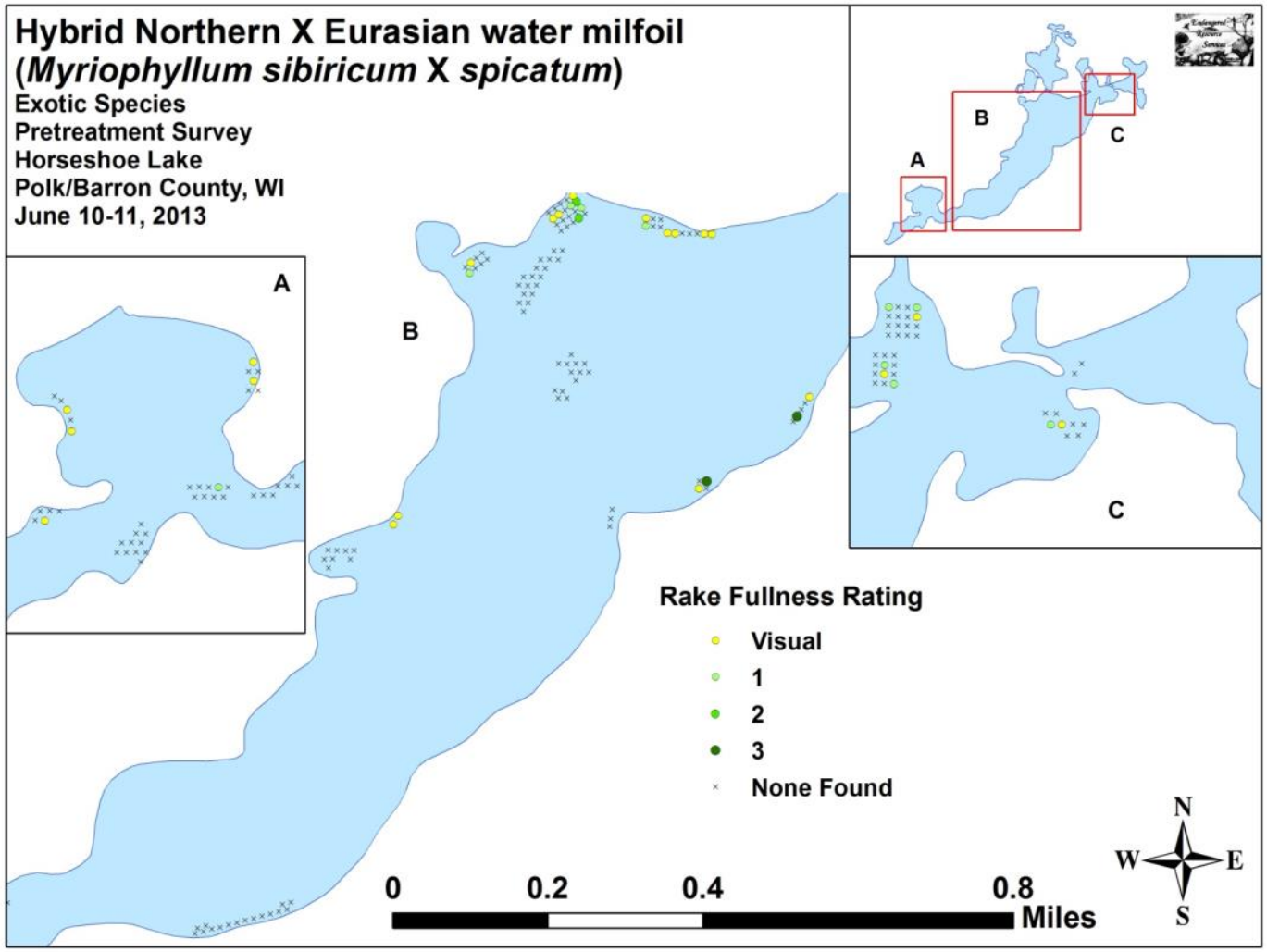

Native Species Richness
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
# of Native Species
None Found
1 - 2
3 - 4
5 - 6
7
0
0.2
0.4
0.8
Miles
N
W
E
S

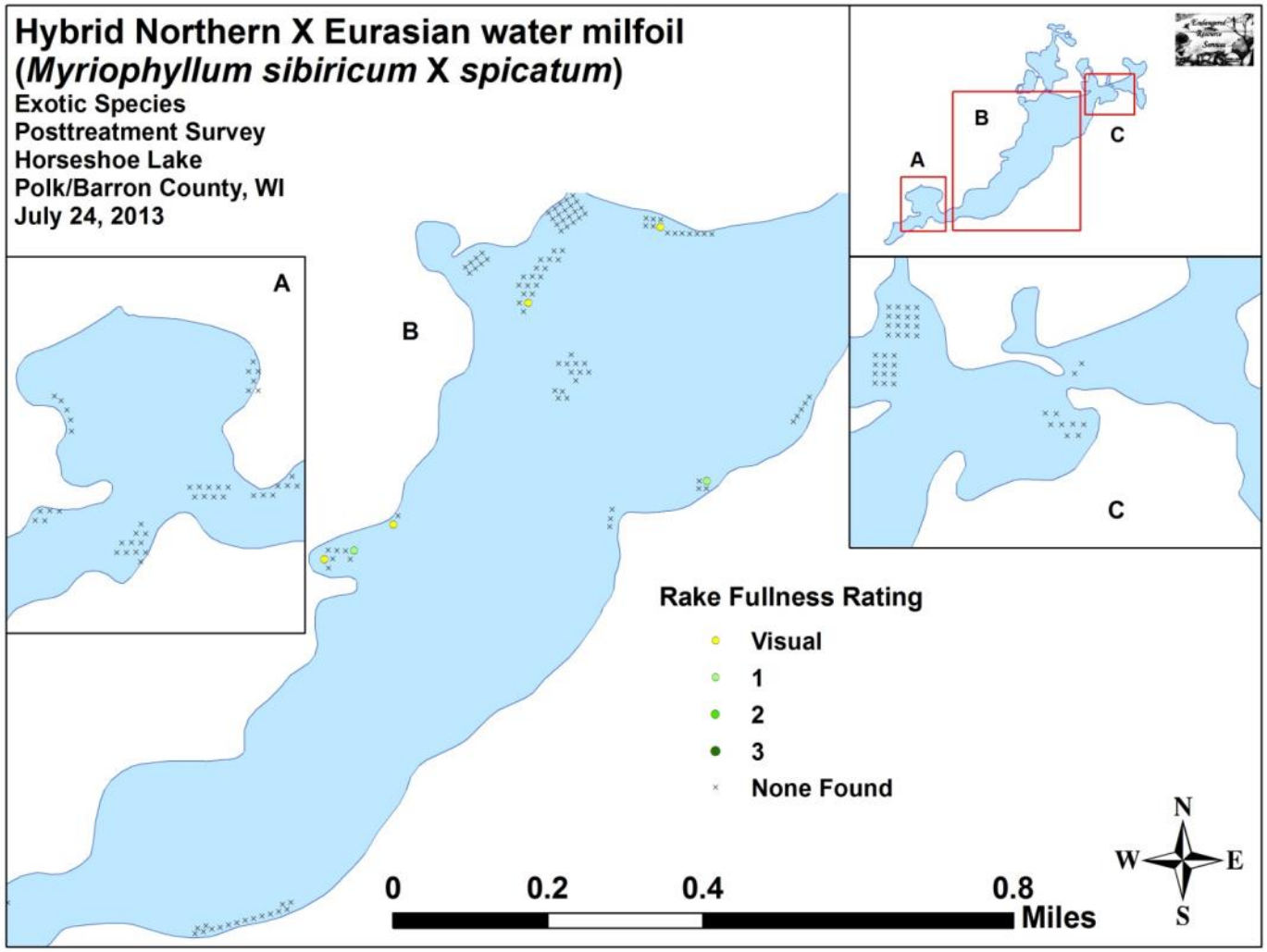

Native Species Richness
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
# of Native Species
None Found
1 - 2
3 - 4
5 - 6
7
0
0.2
0.4
0.8
Miles
N
W
E
S

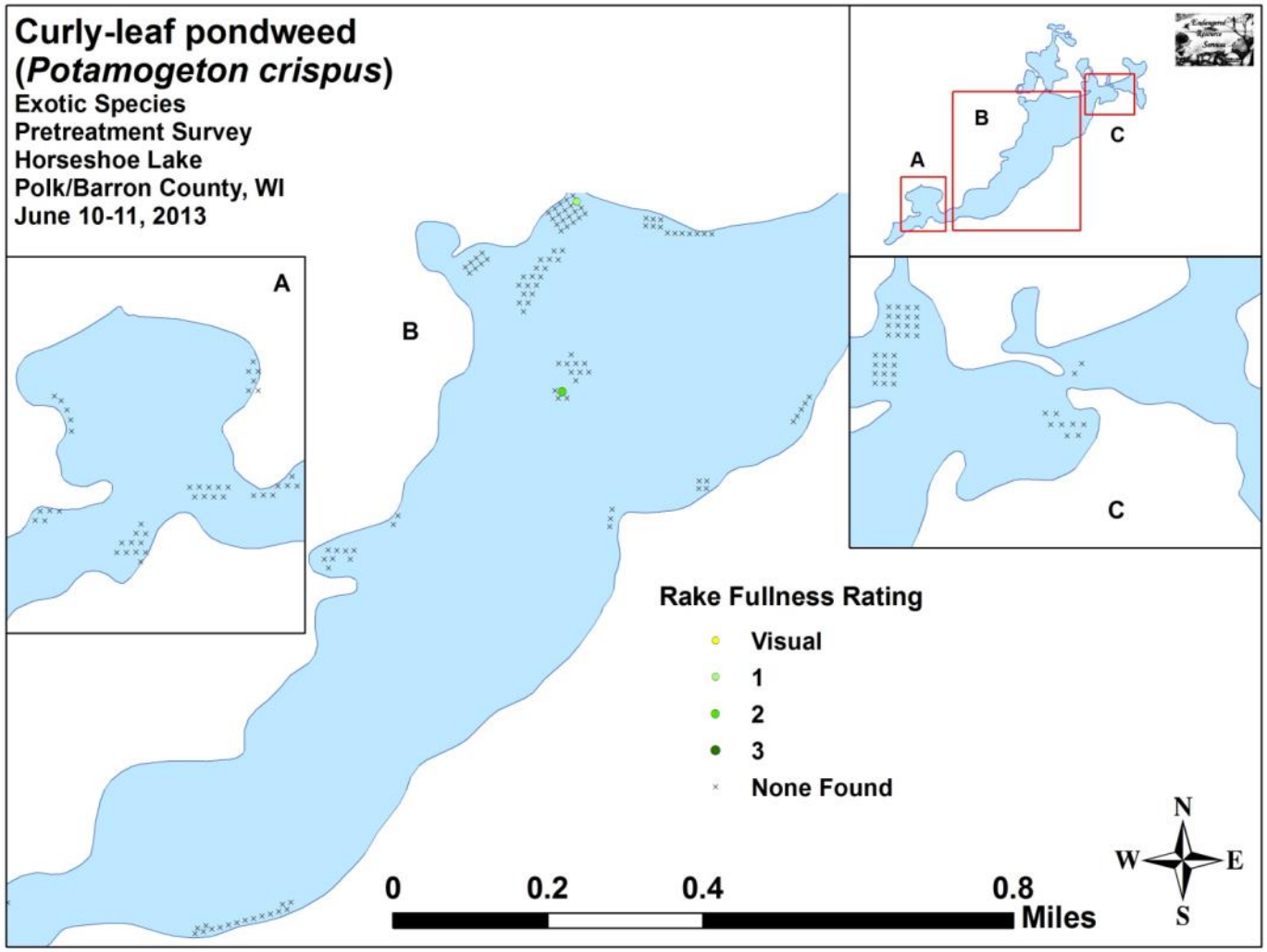

Total Rake Fullness
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

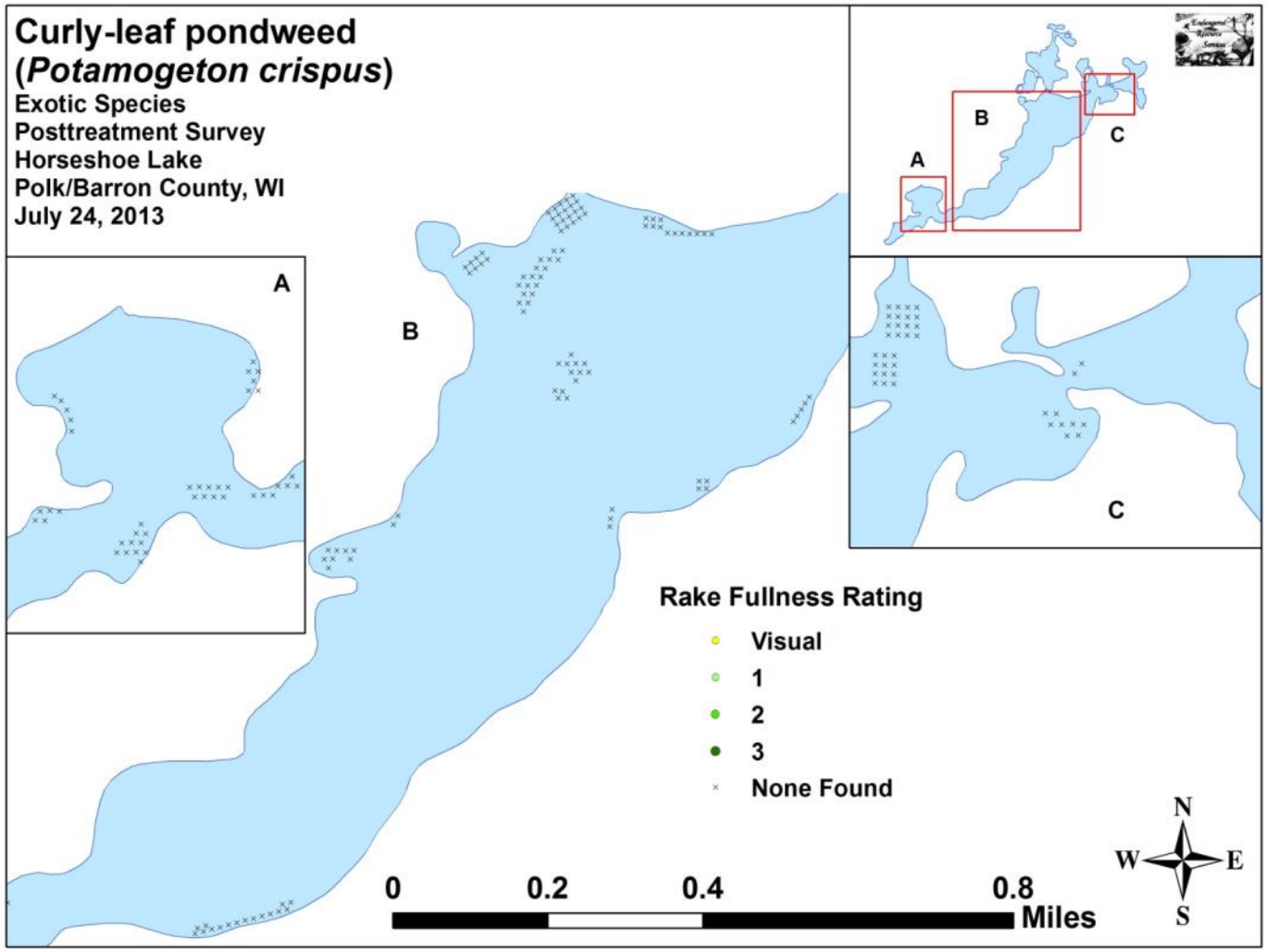

Total Rake Fullness
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

Appendix V: HWM and CLP Pre/Post Density and Distribution

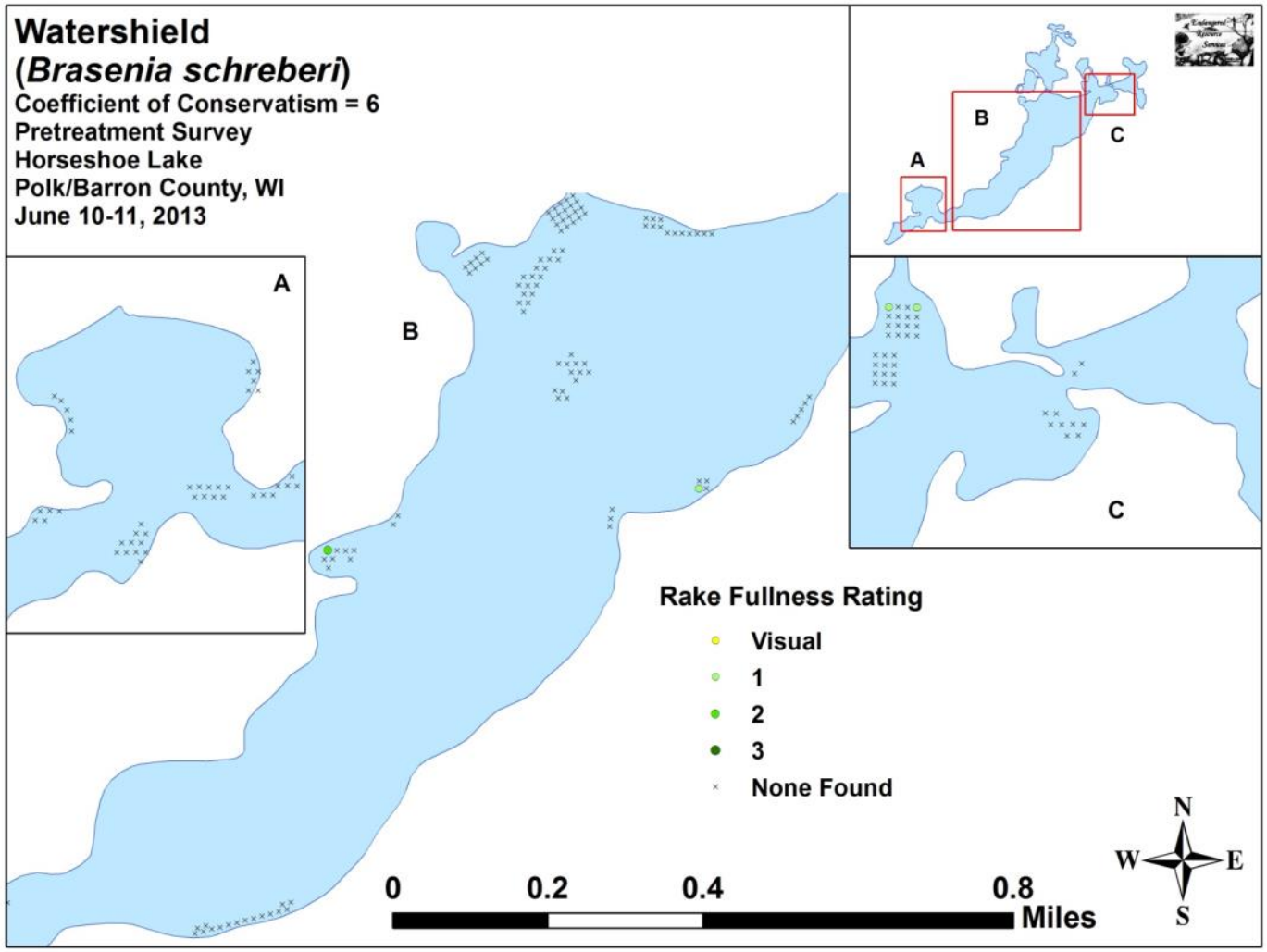

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibiricum X spicatum)
Exotic Species
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

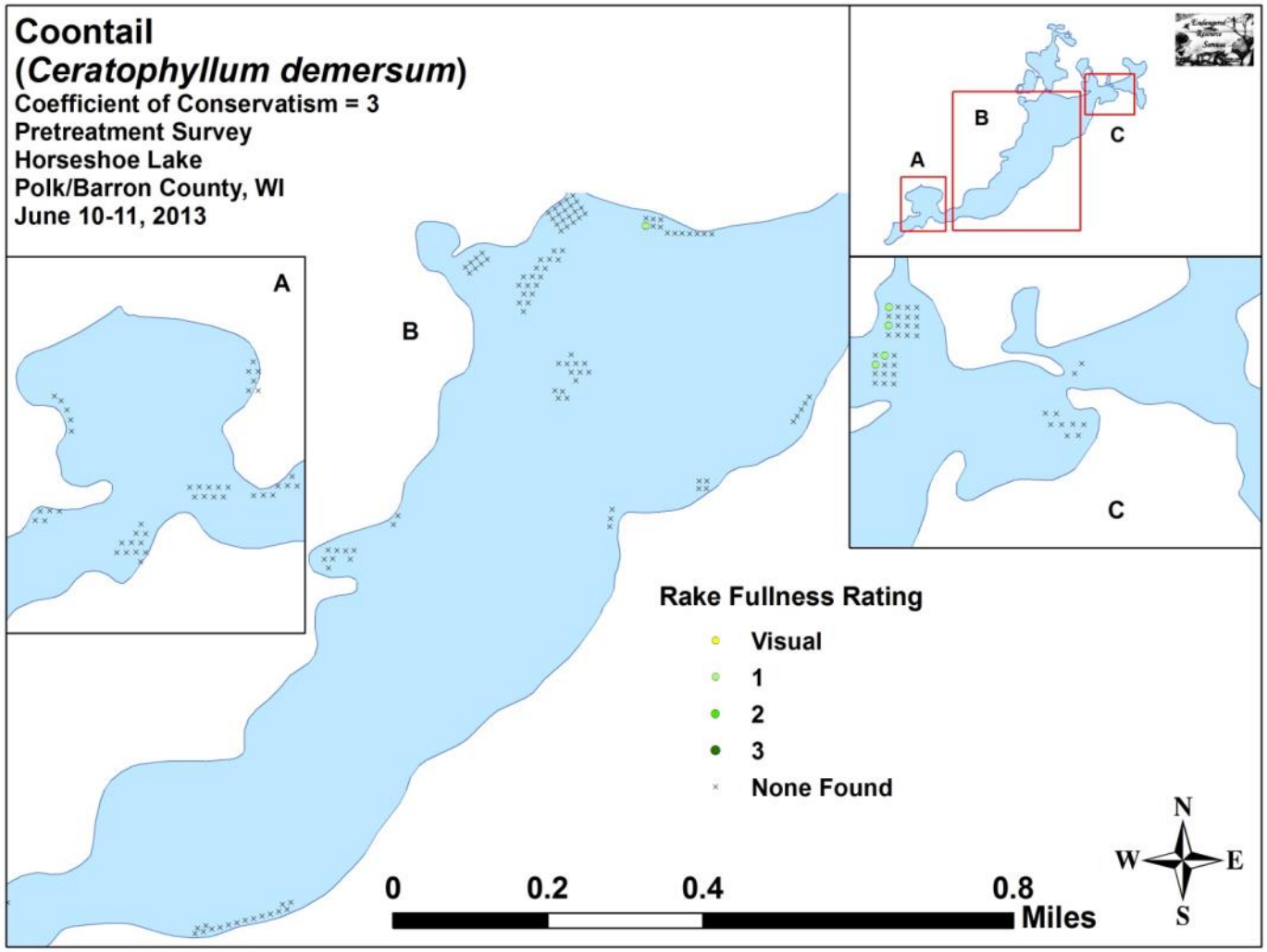

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibiricum X spicatum)
Exotic Species
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

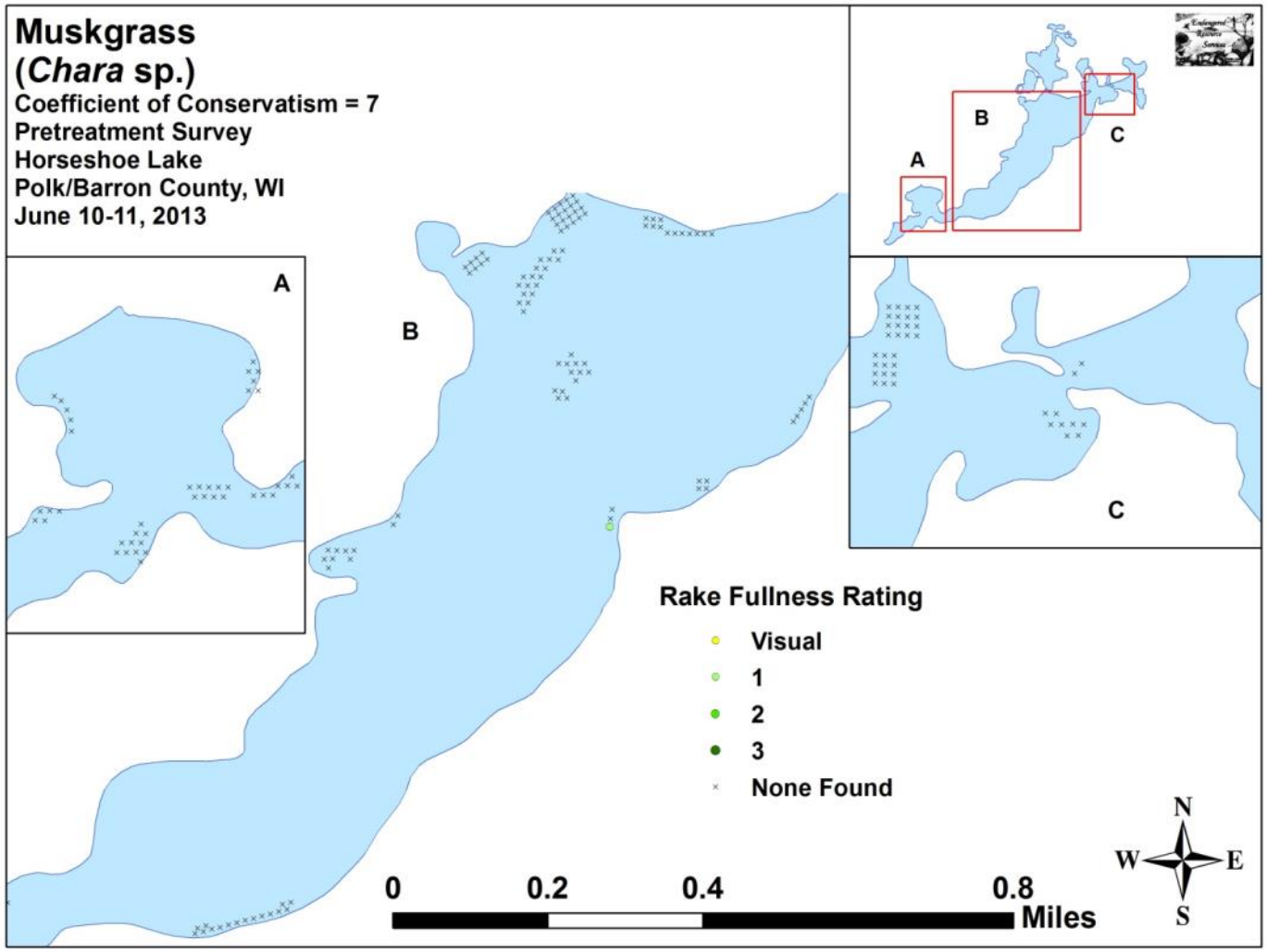

Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

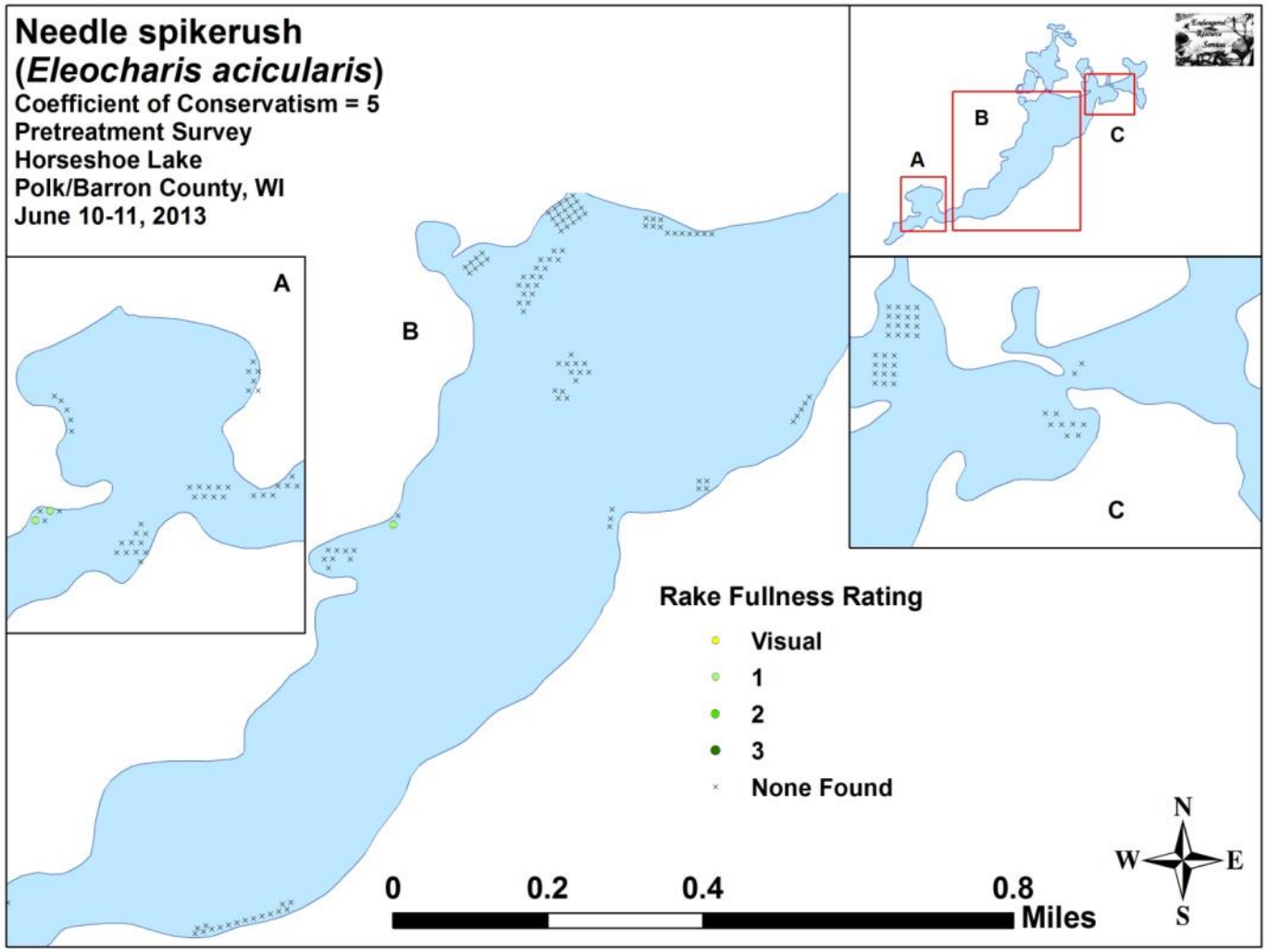

Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

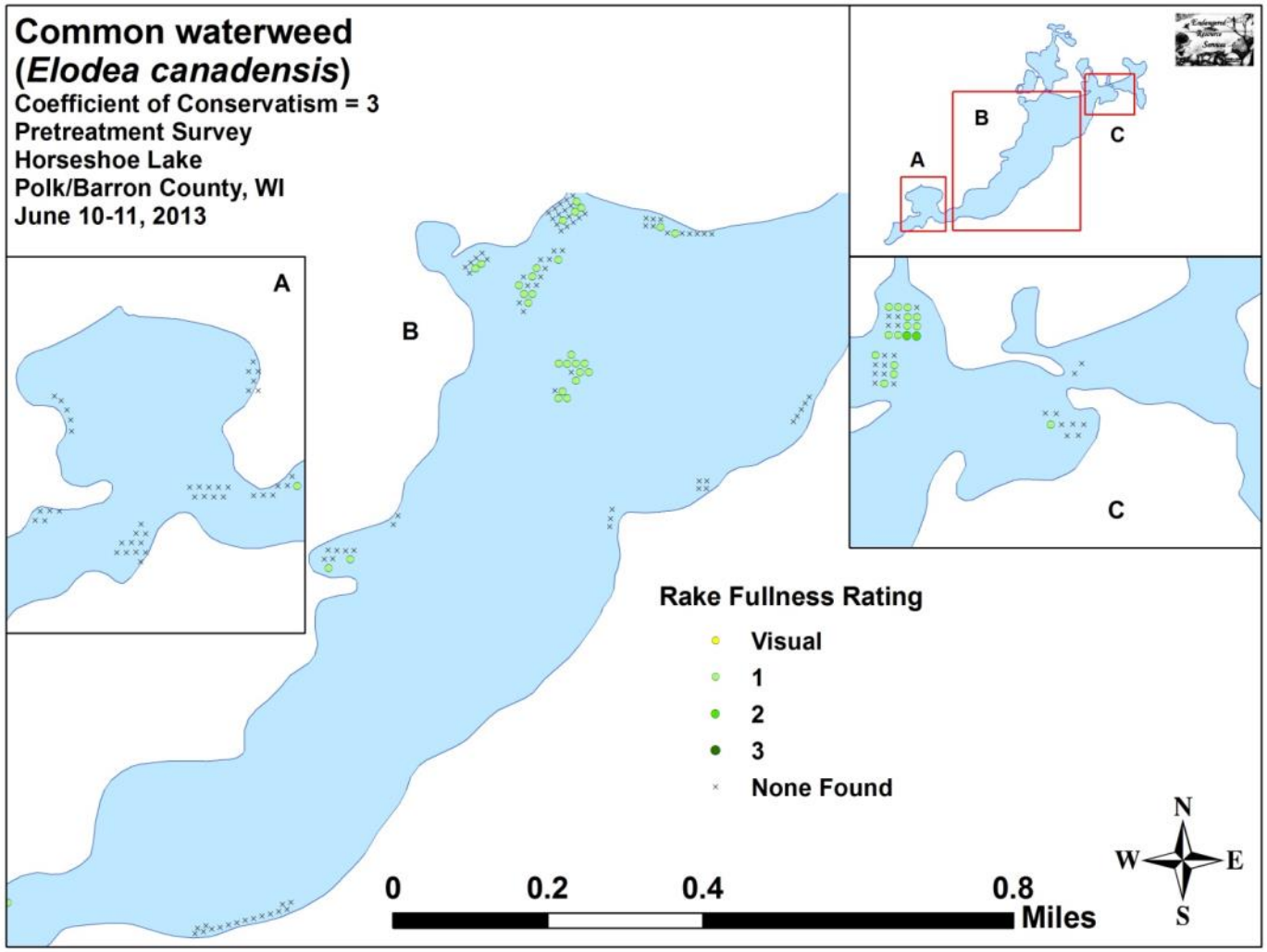
Appendix VI: Pretreatment Native Species Density and Distribution

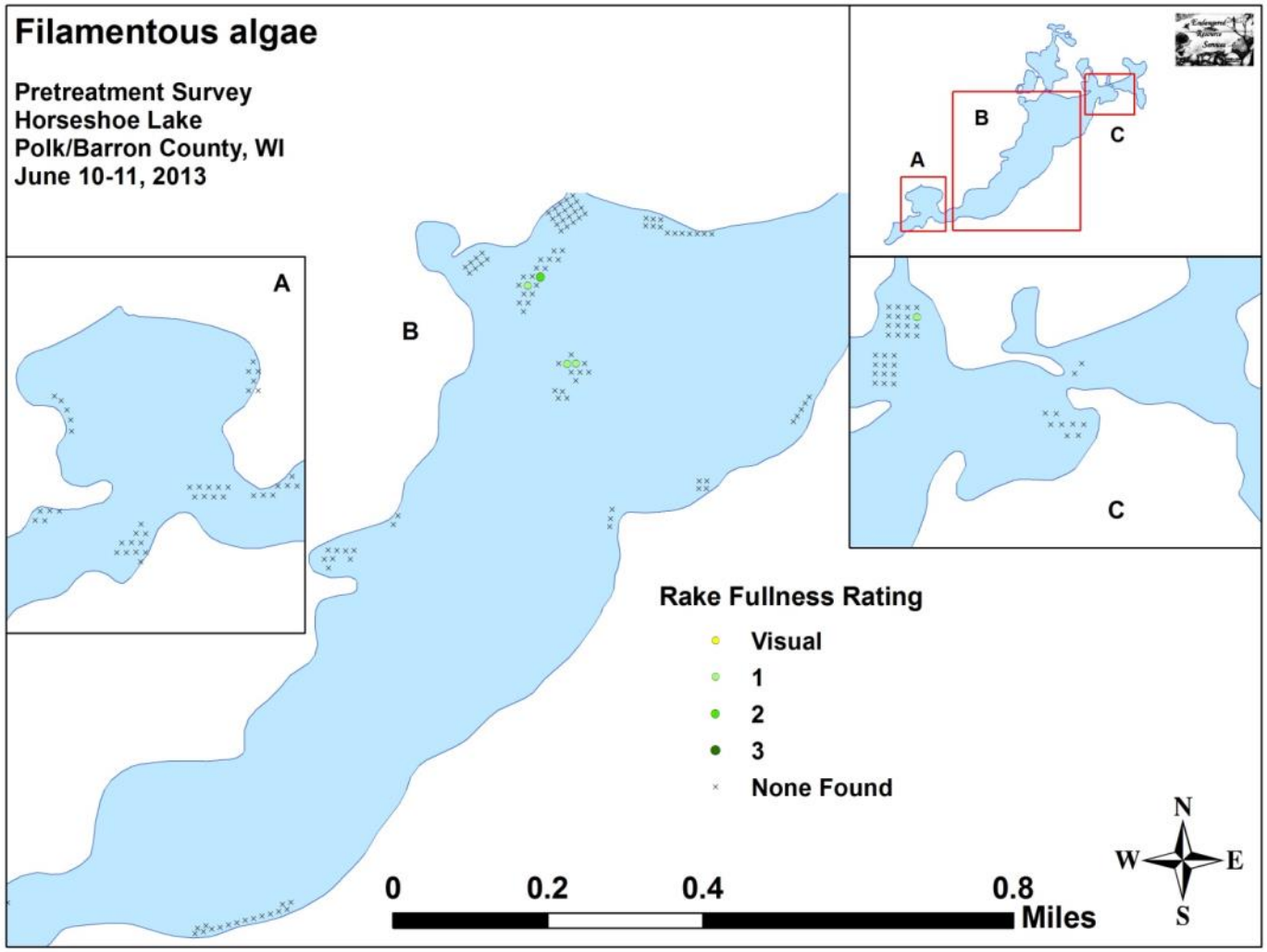

Watershield
(Brasenia schreberi)
Coefficient of Conservatism = 6
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

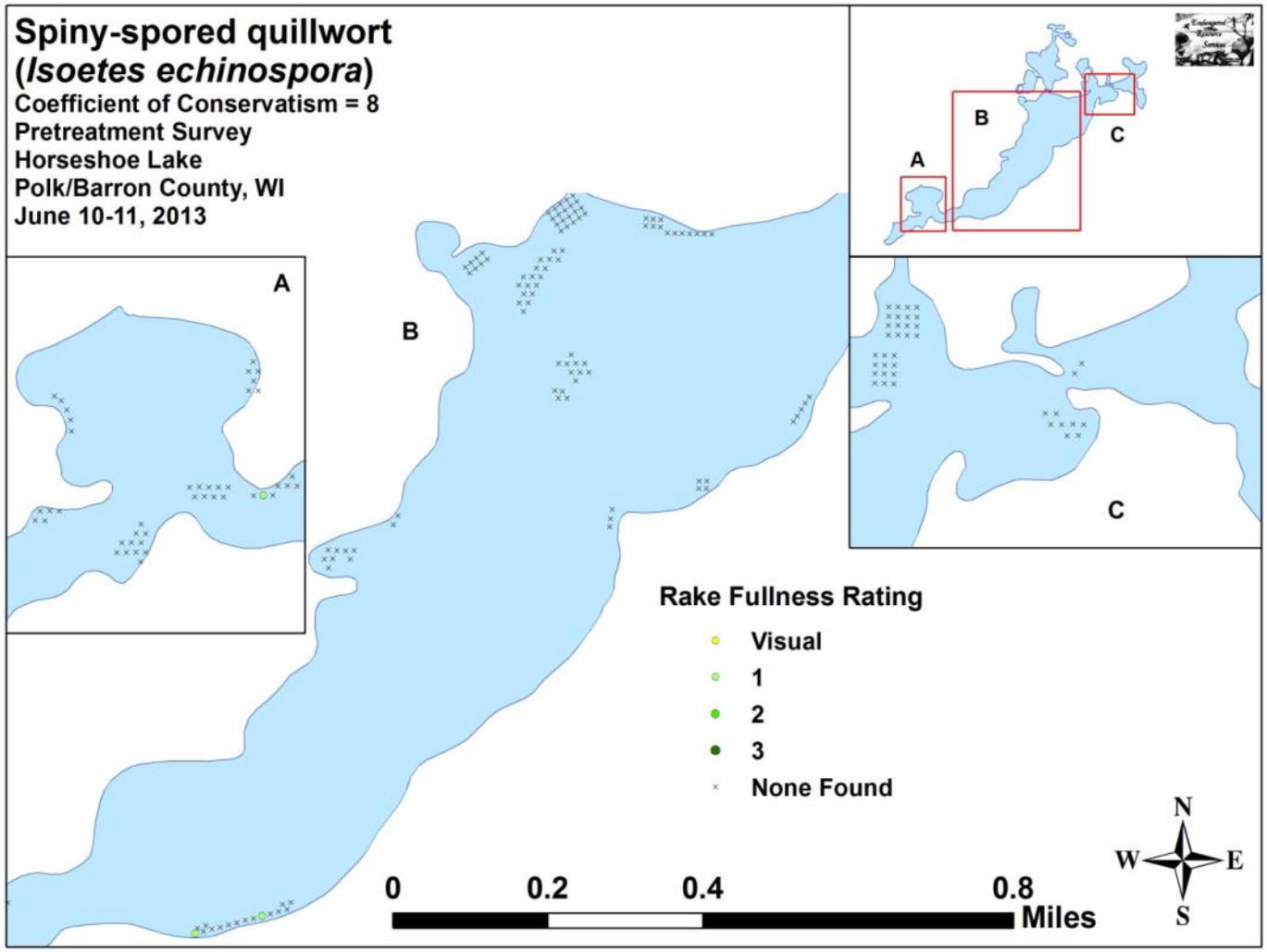

Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

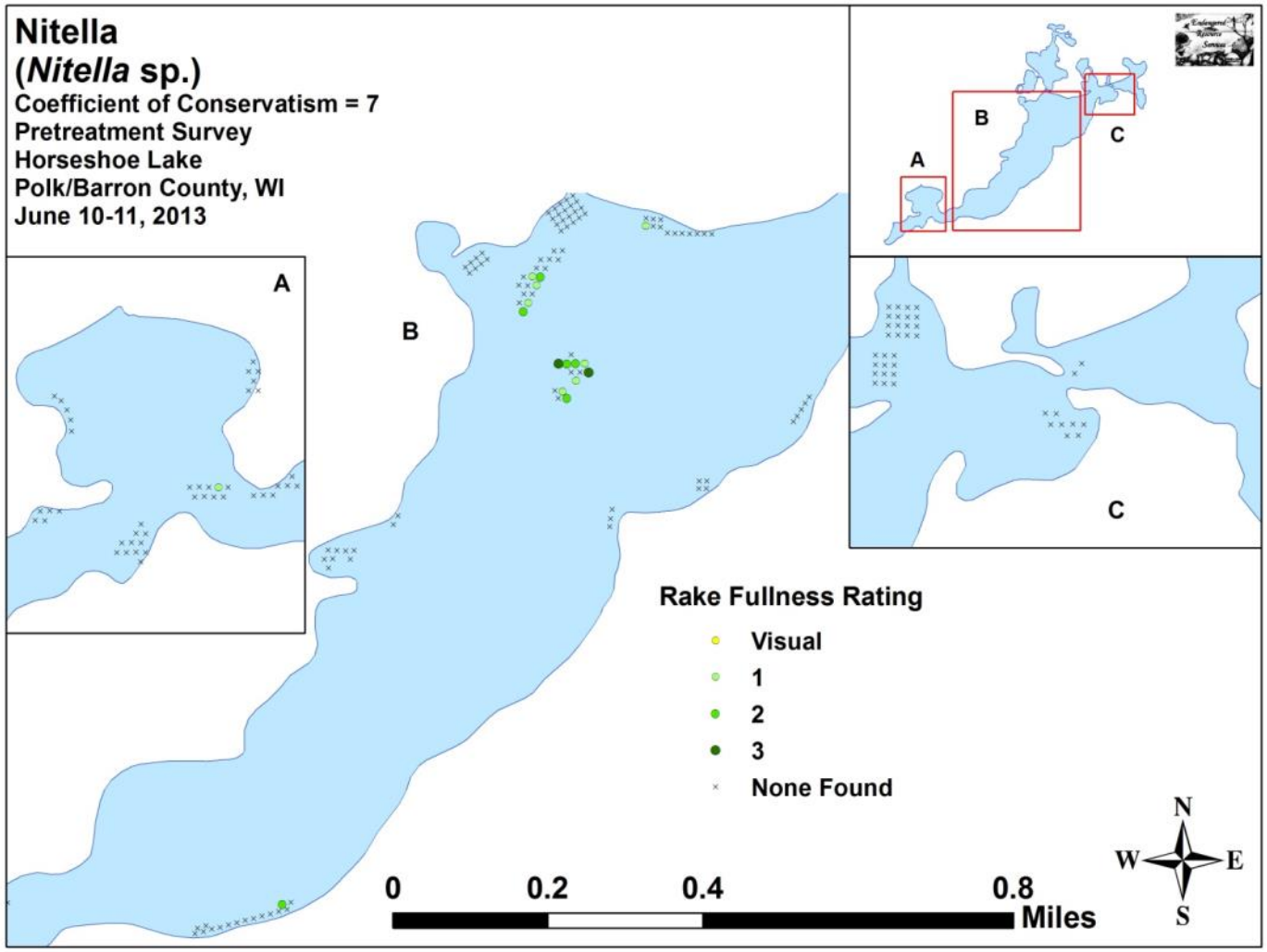

Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

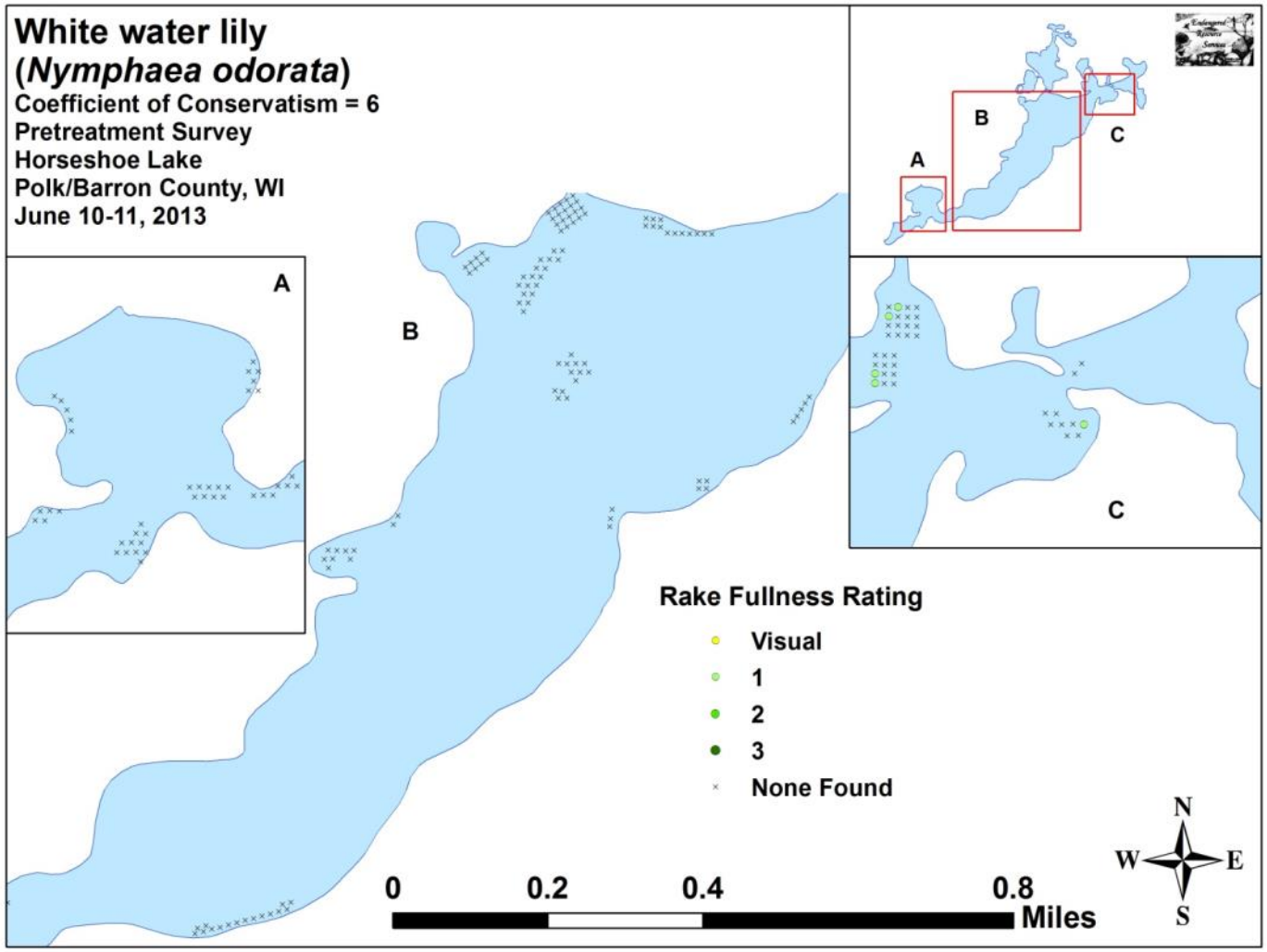

Needle spikerush
(Eleocharis acicularis)
Coefficient of Conservatism = 5
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

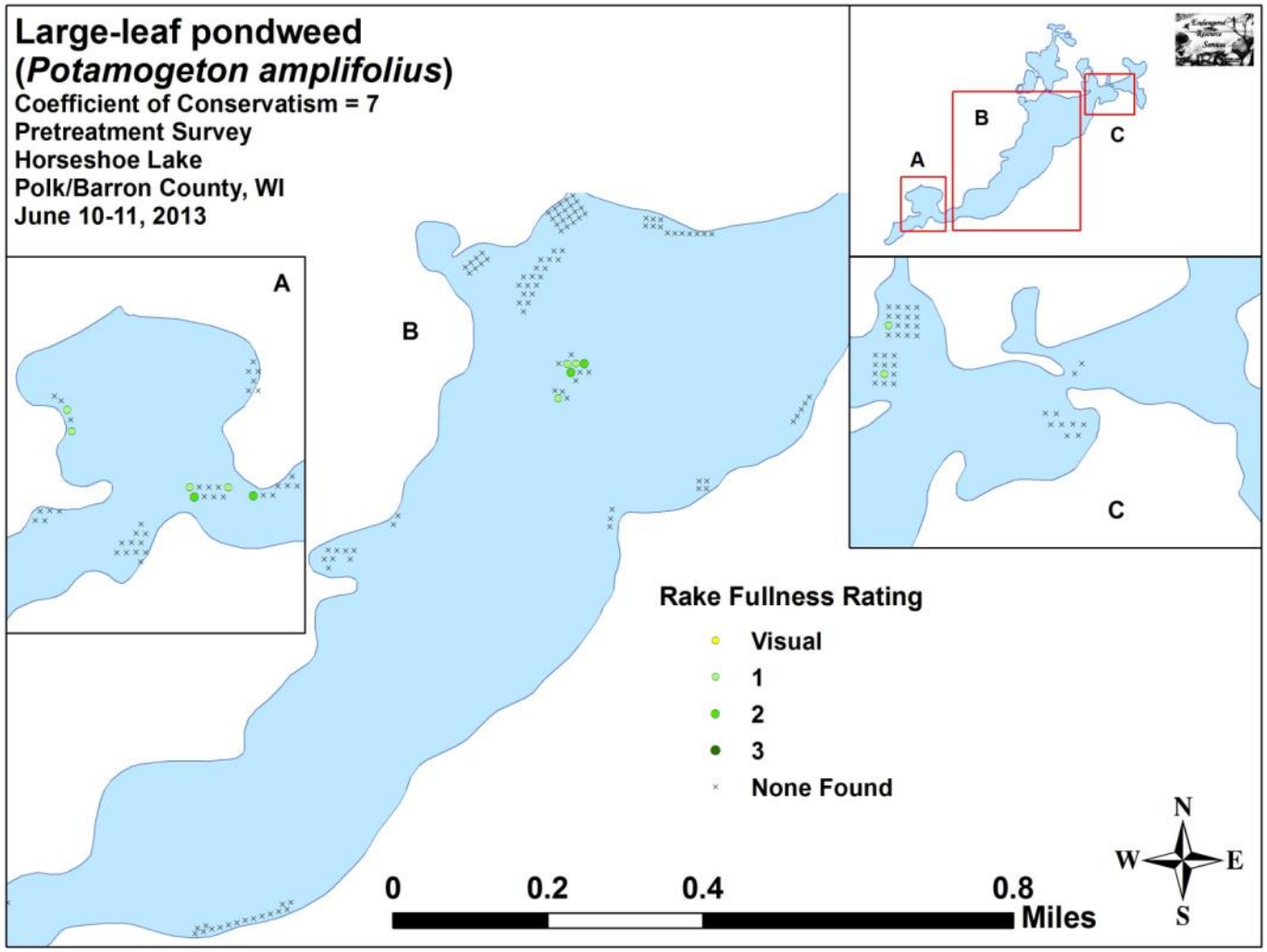

Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

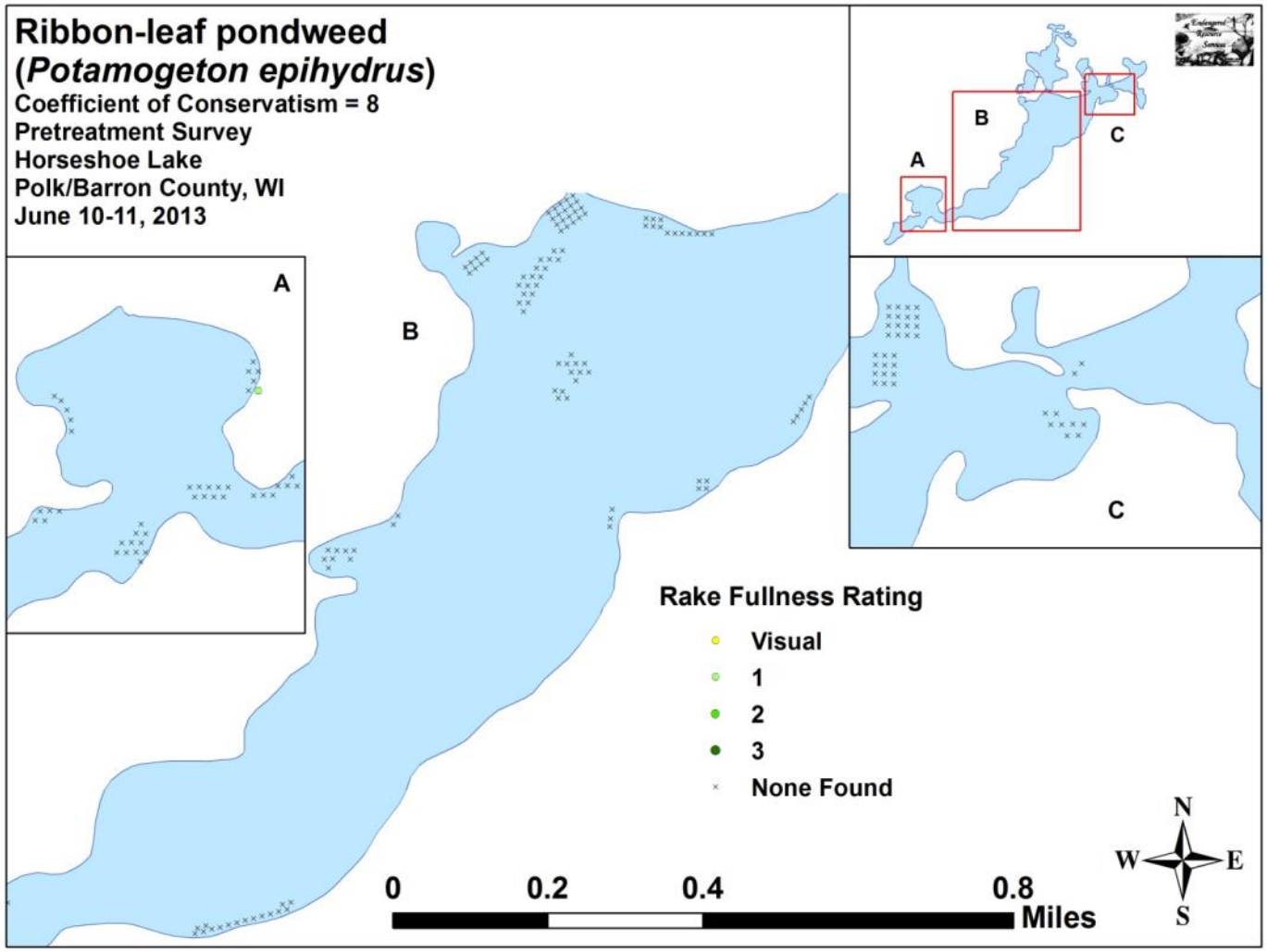

Filamentous algae
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

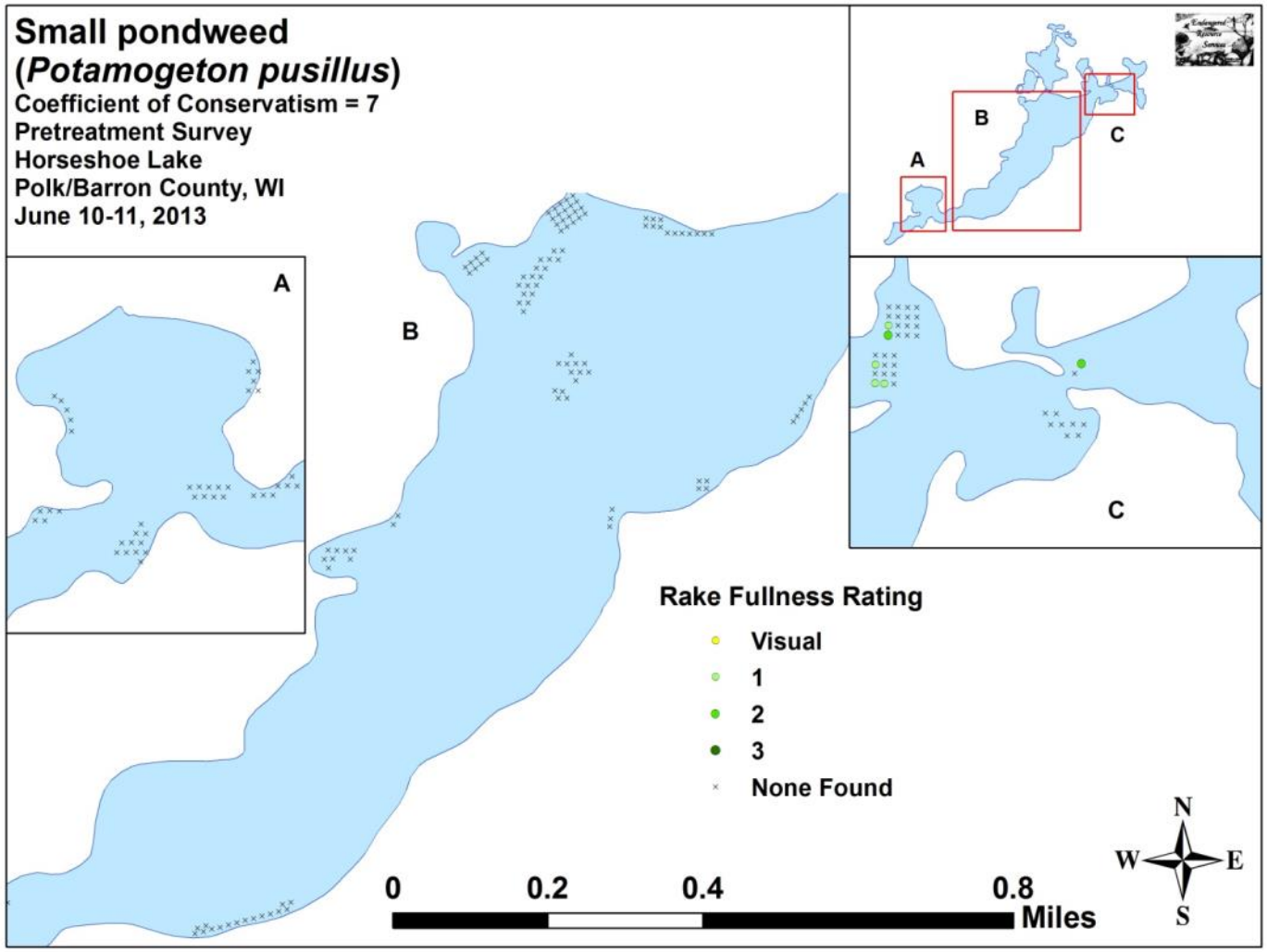

Spiny-spored quillwort
(Isoetes echinospora)
Coefficient of Conservatism = 8
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

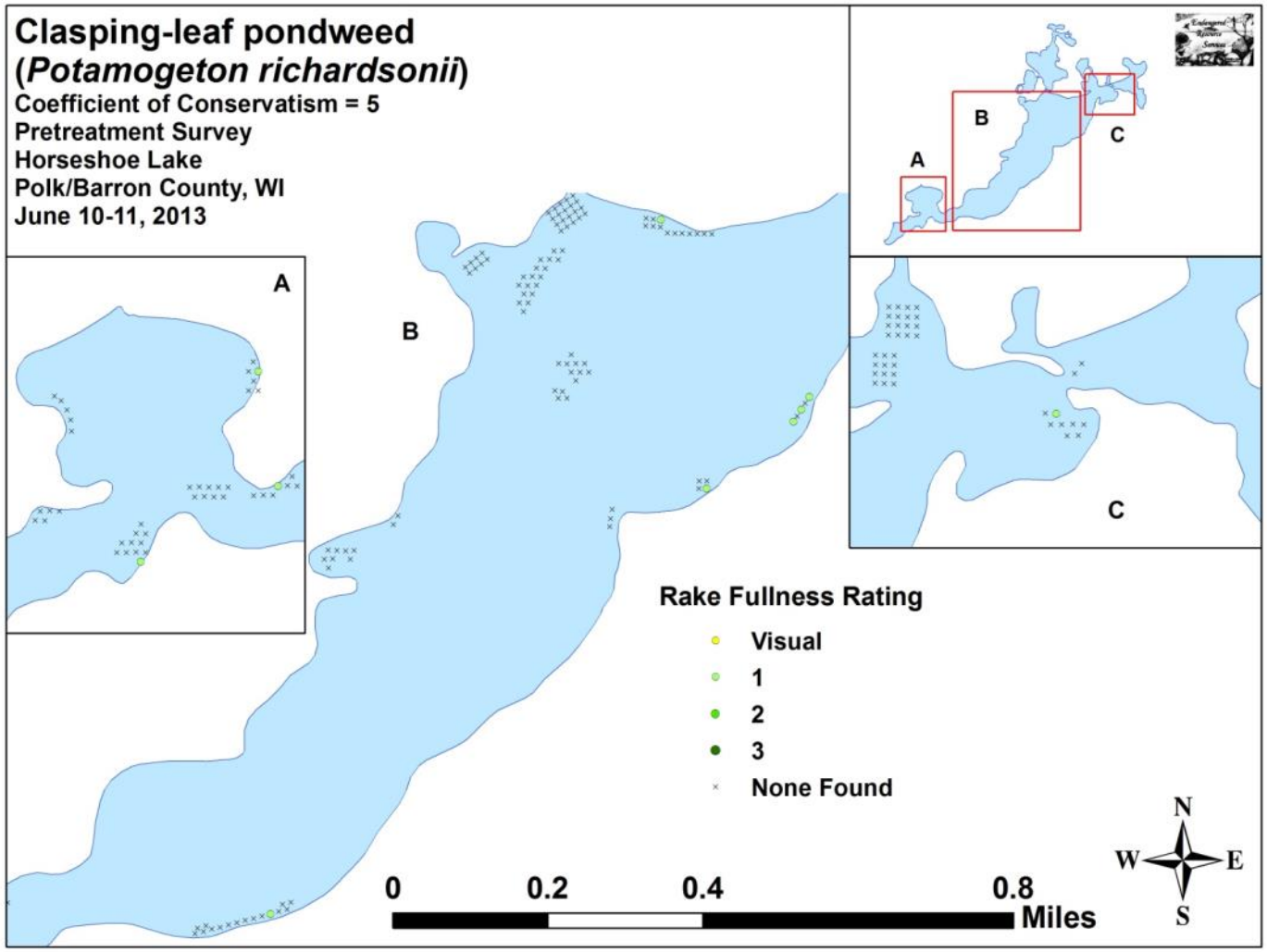

Nitella
(Nitella sp.)
Coefficient of Conservatism = 7
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

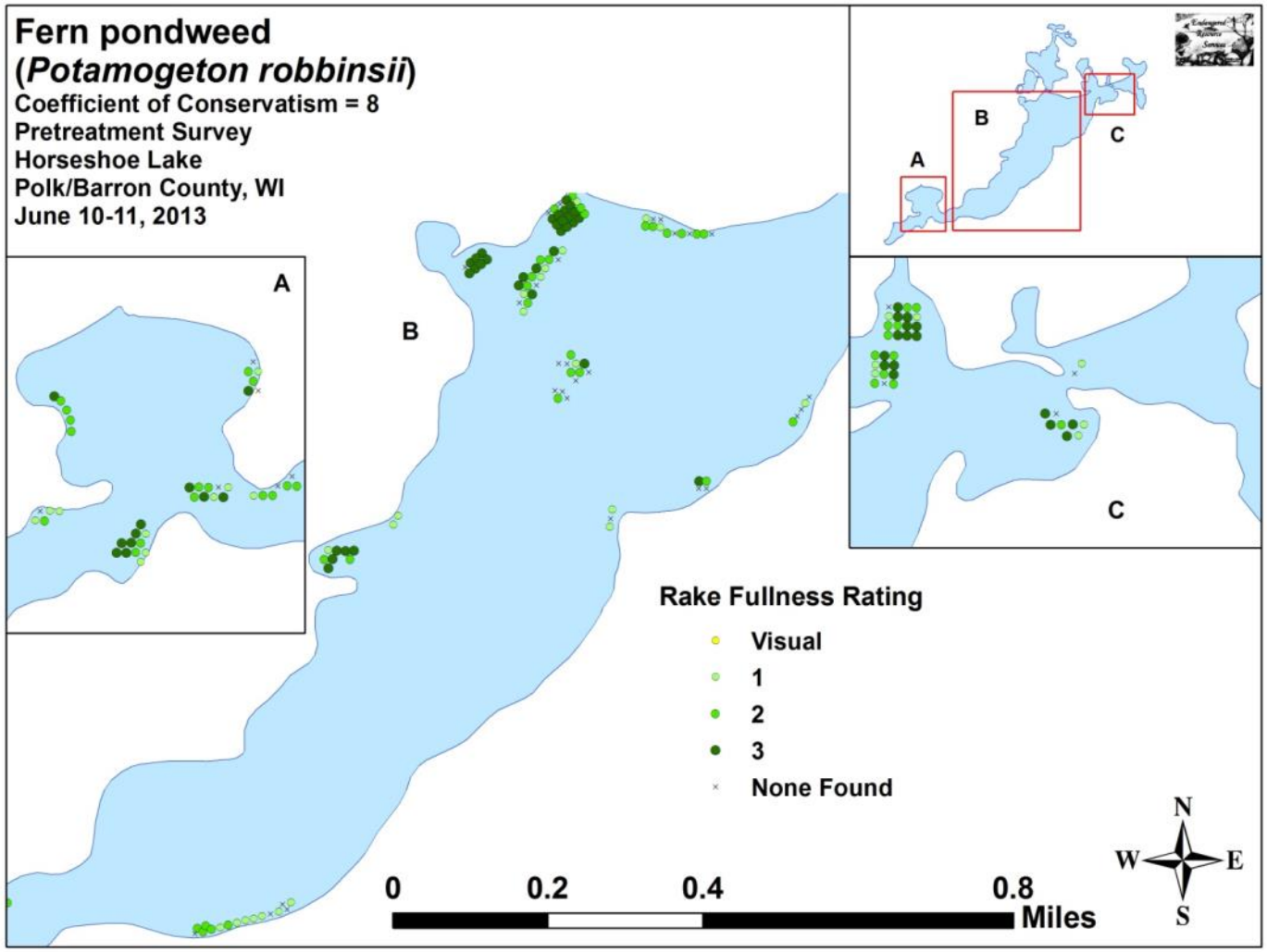

White water lily
(Nymphaea odorata)
Coefficient of Conservatism = 6
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

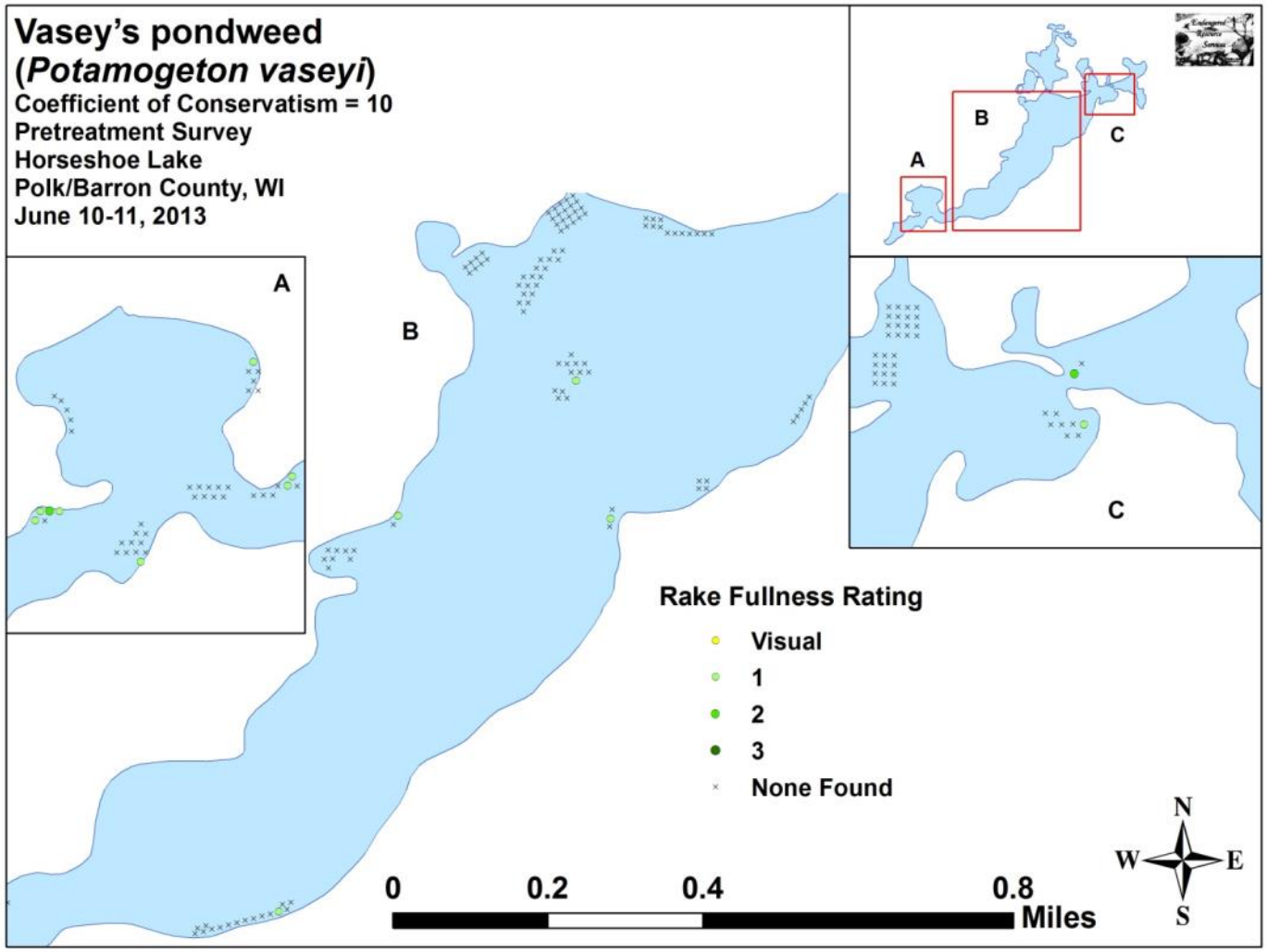

Large-leaf pondweed
(Potamogeton amplifolius)
Coefficient of Conservatism = 7
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

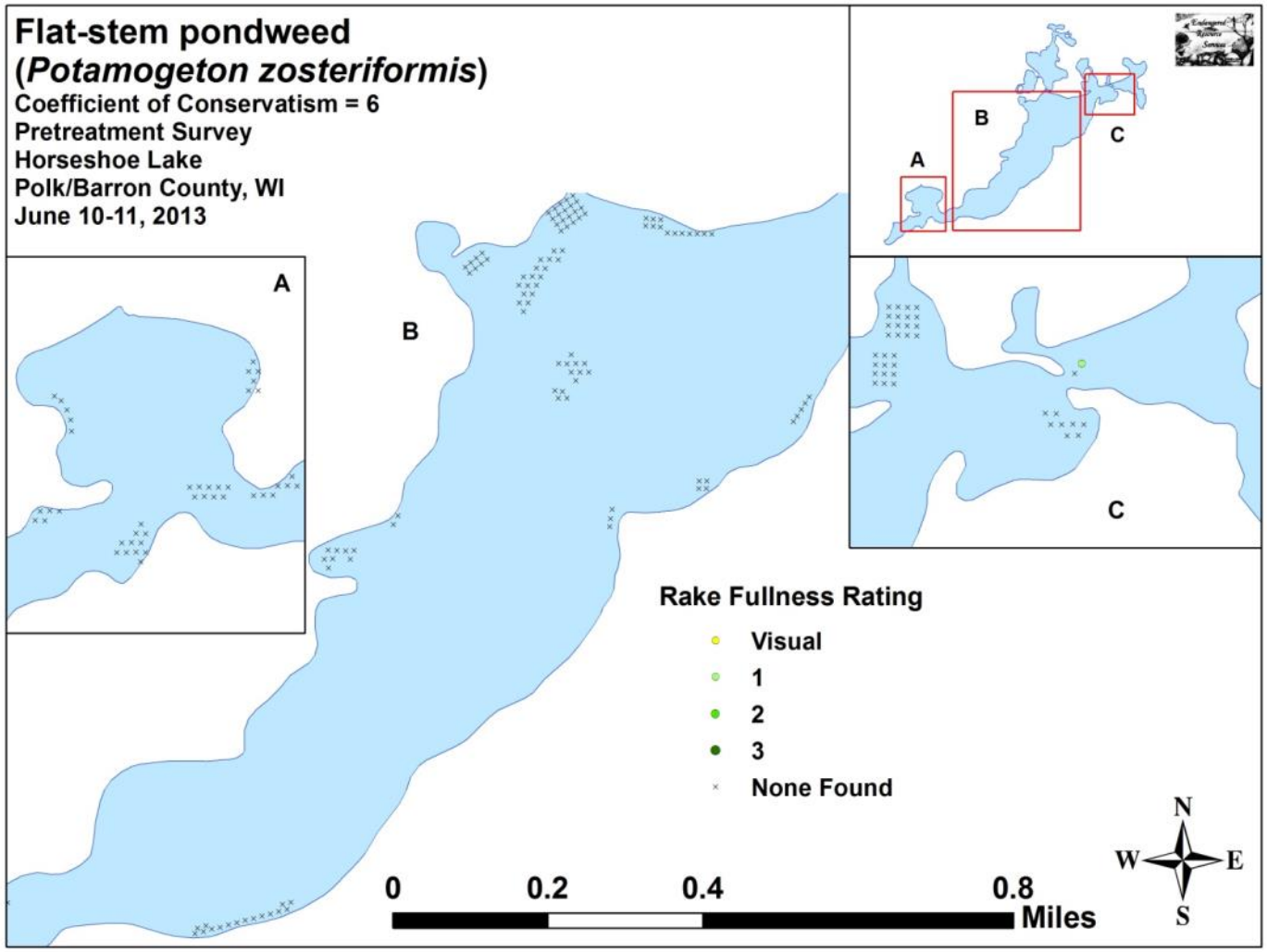

Ribbon-leaf pondweed
(Potamogeton epihydrus)
Coefficient of Conservatism = 8
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

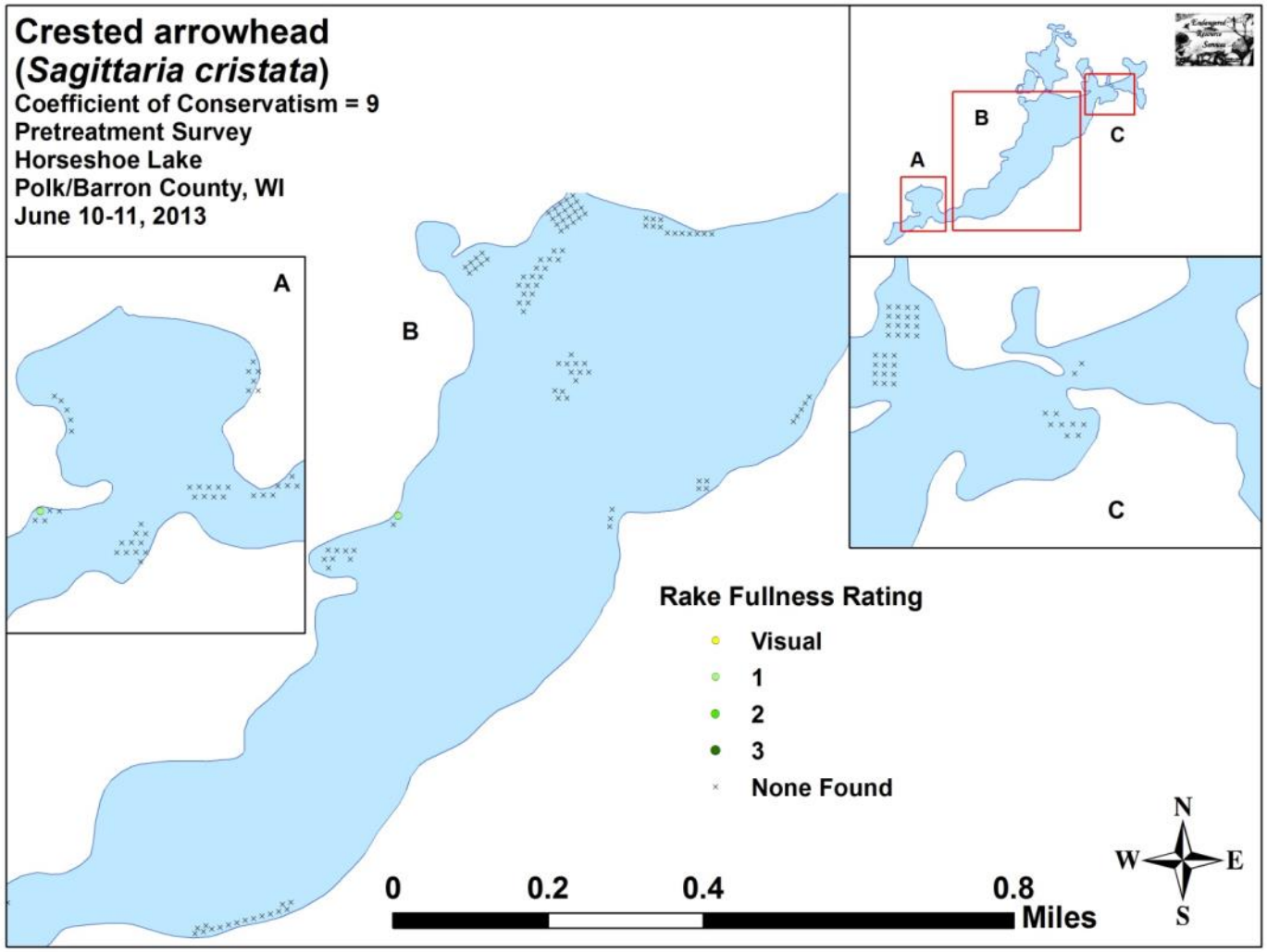

Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S


Clasping-leaf pondweed
(Potamogeton richardsonii)
Coefficient of Conservatism = 5
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

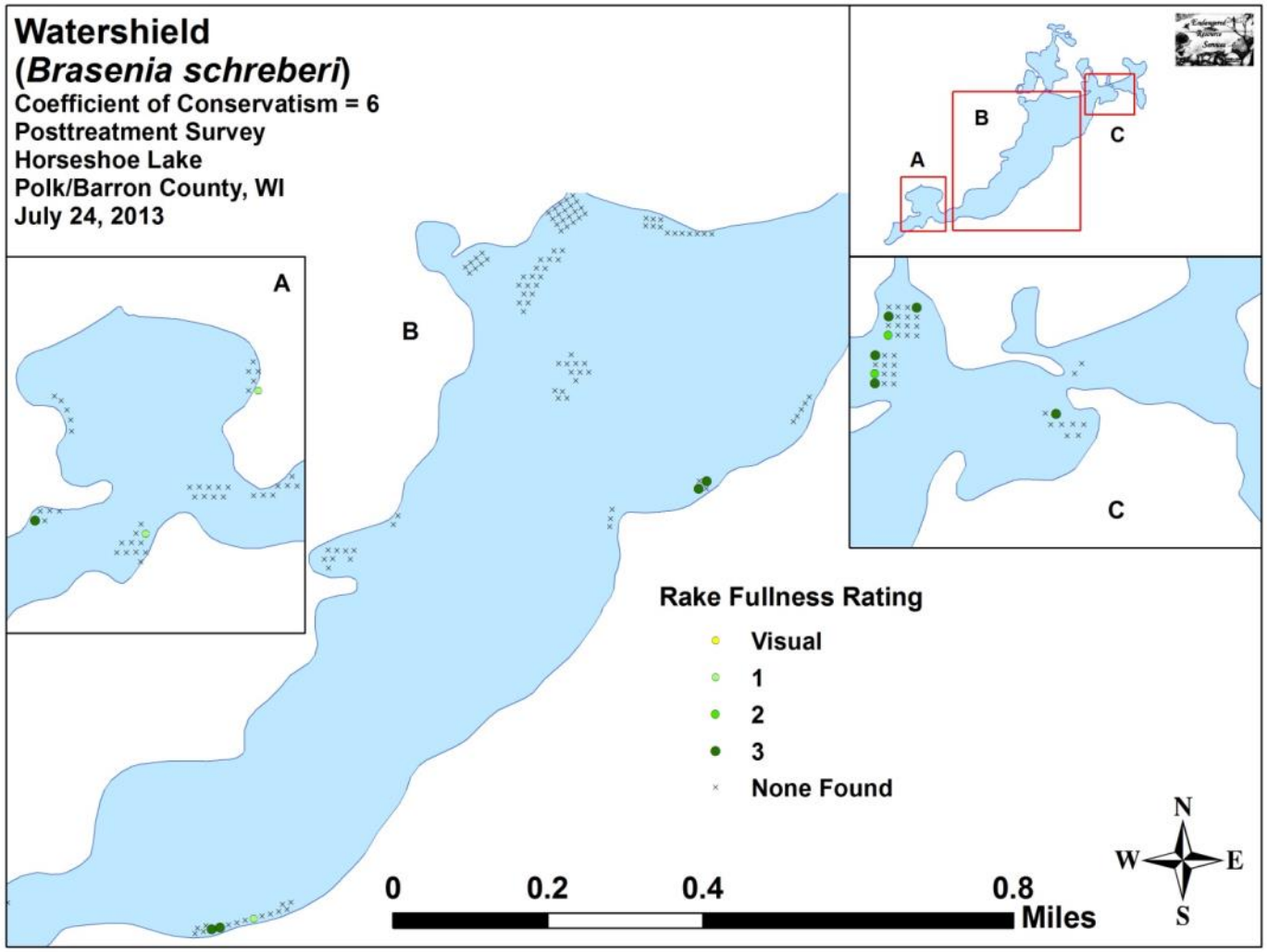

Fern pondweed
(Potamogeton robbinsii)
Coefficient of Conservatism = 8
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

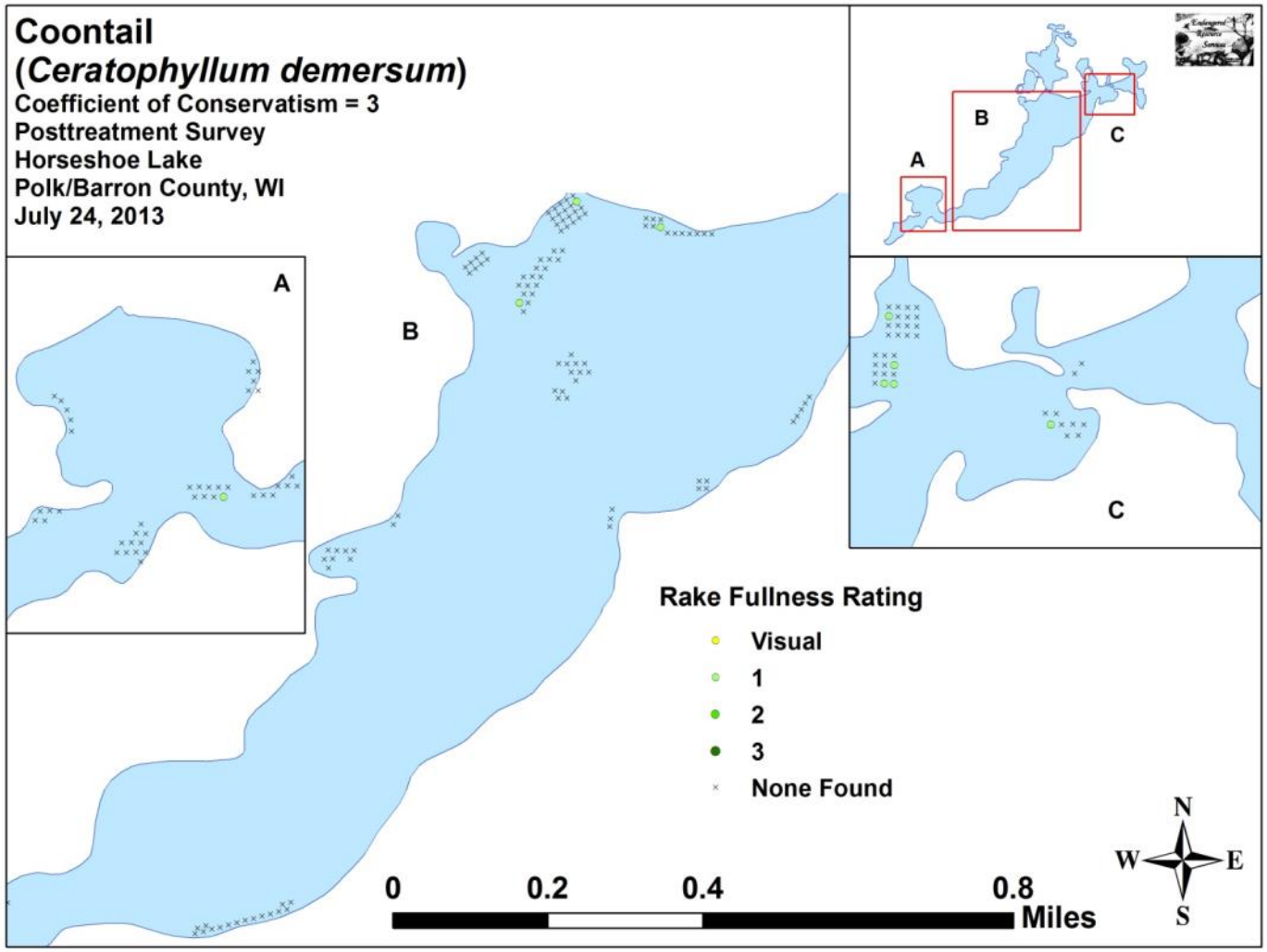

Vasey's pondweed
(Potamogeton vaseyi)
Coefficient of Conservatism = 10
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

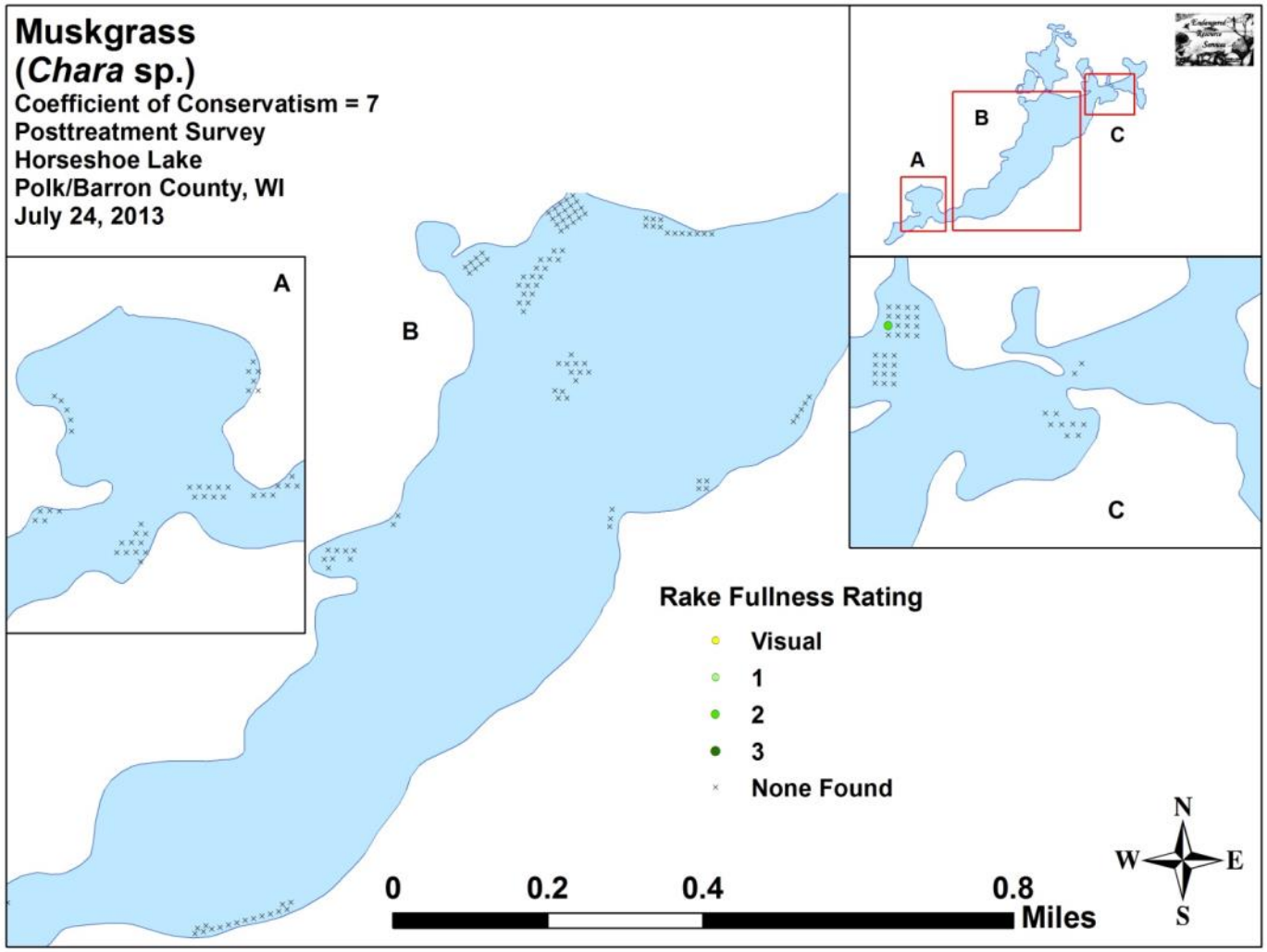

Flat-stem pondweed
(Potamogeton zosteriformis)
Coefficient of Conservatism = 6
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

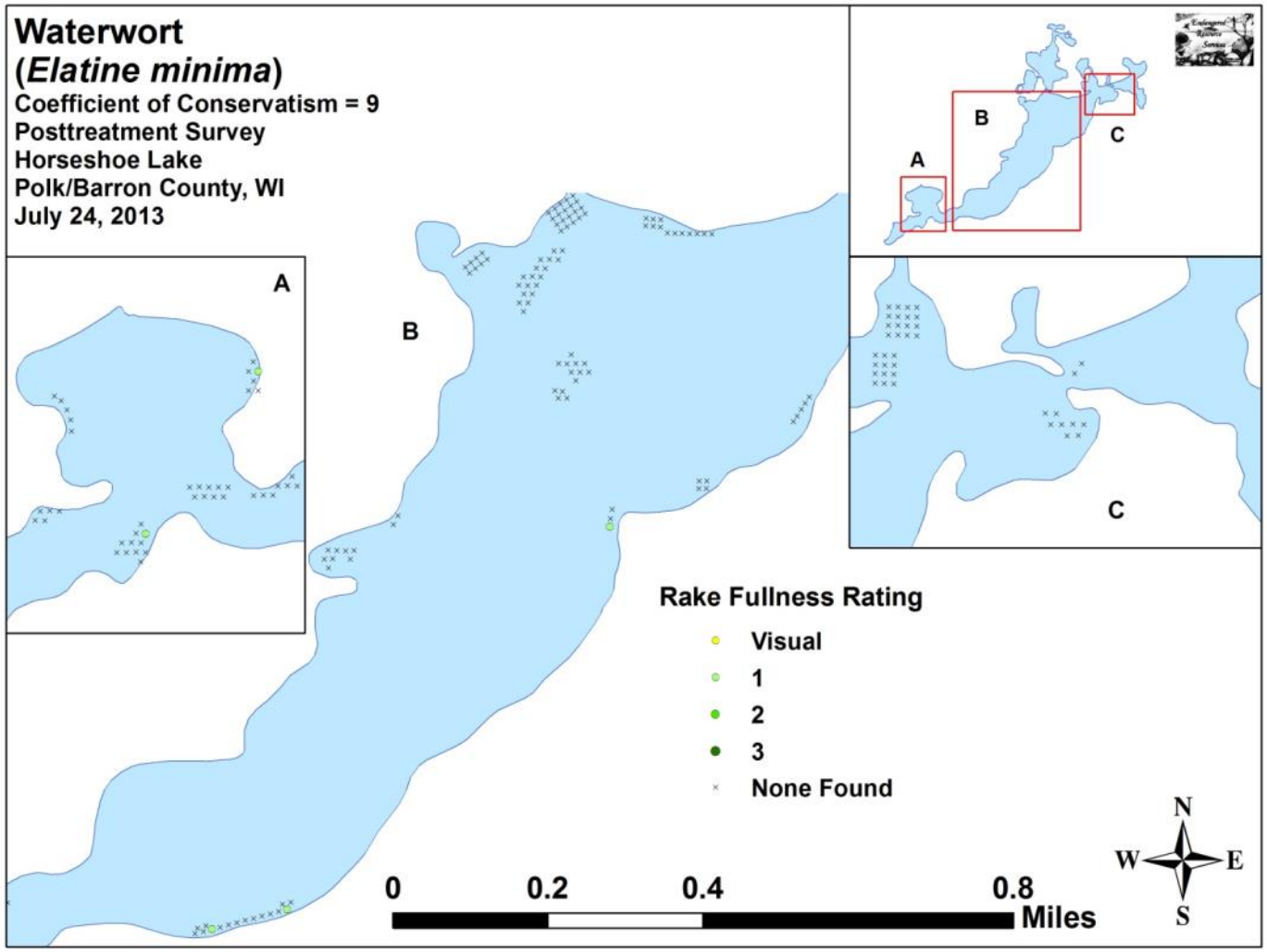

Crested arrowhead
(Sagittaria cristata)
Coefficient of Conservatism = 9
Pretreatment Survey
Horseshoe Lake
Polk/Barron County, WI
June 10-11, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

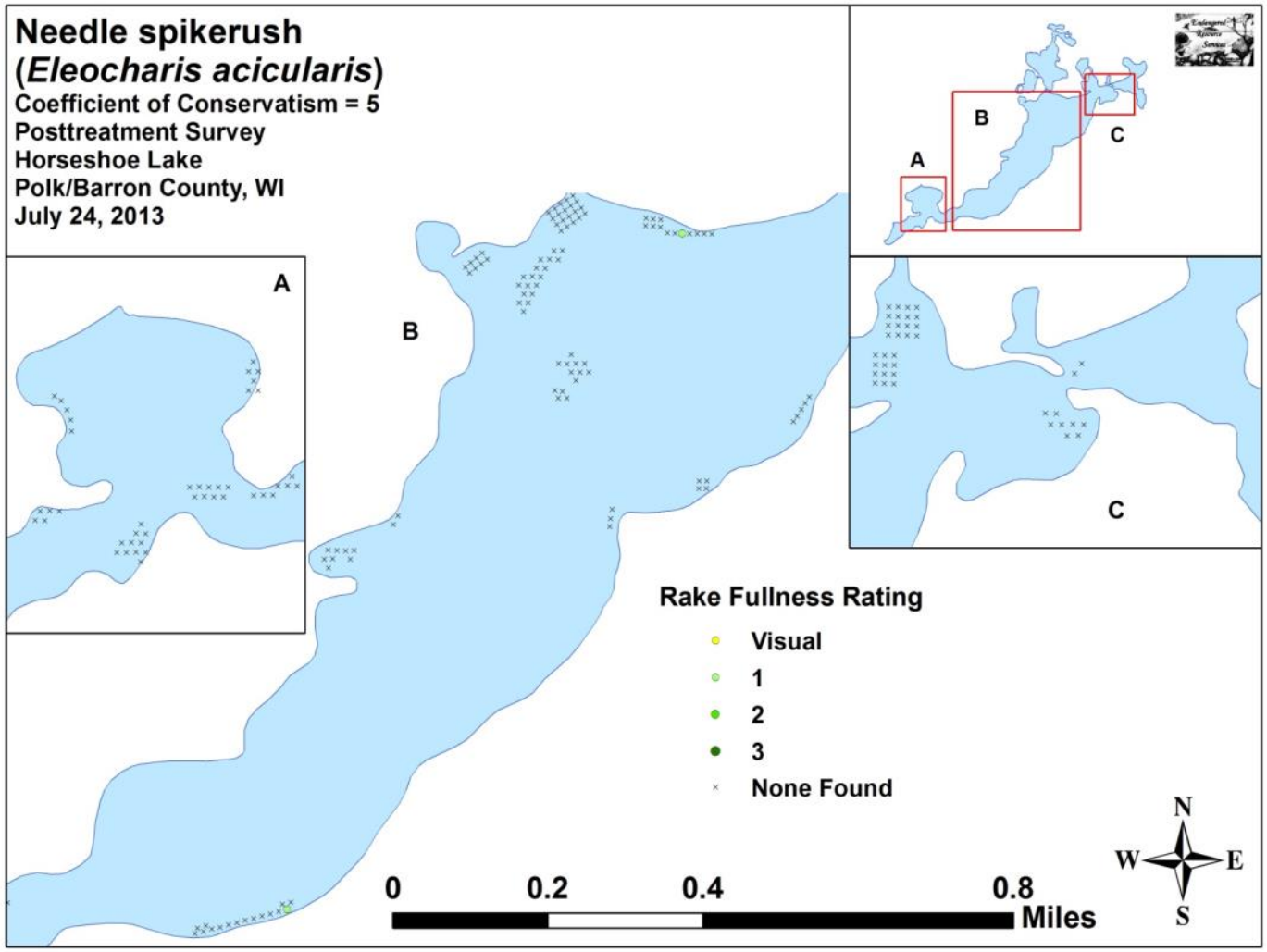
Appendix VII: Posttreatment Native Species Density and Distribution

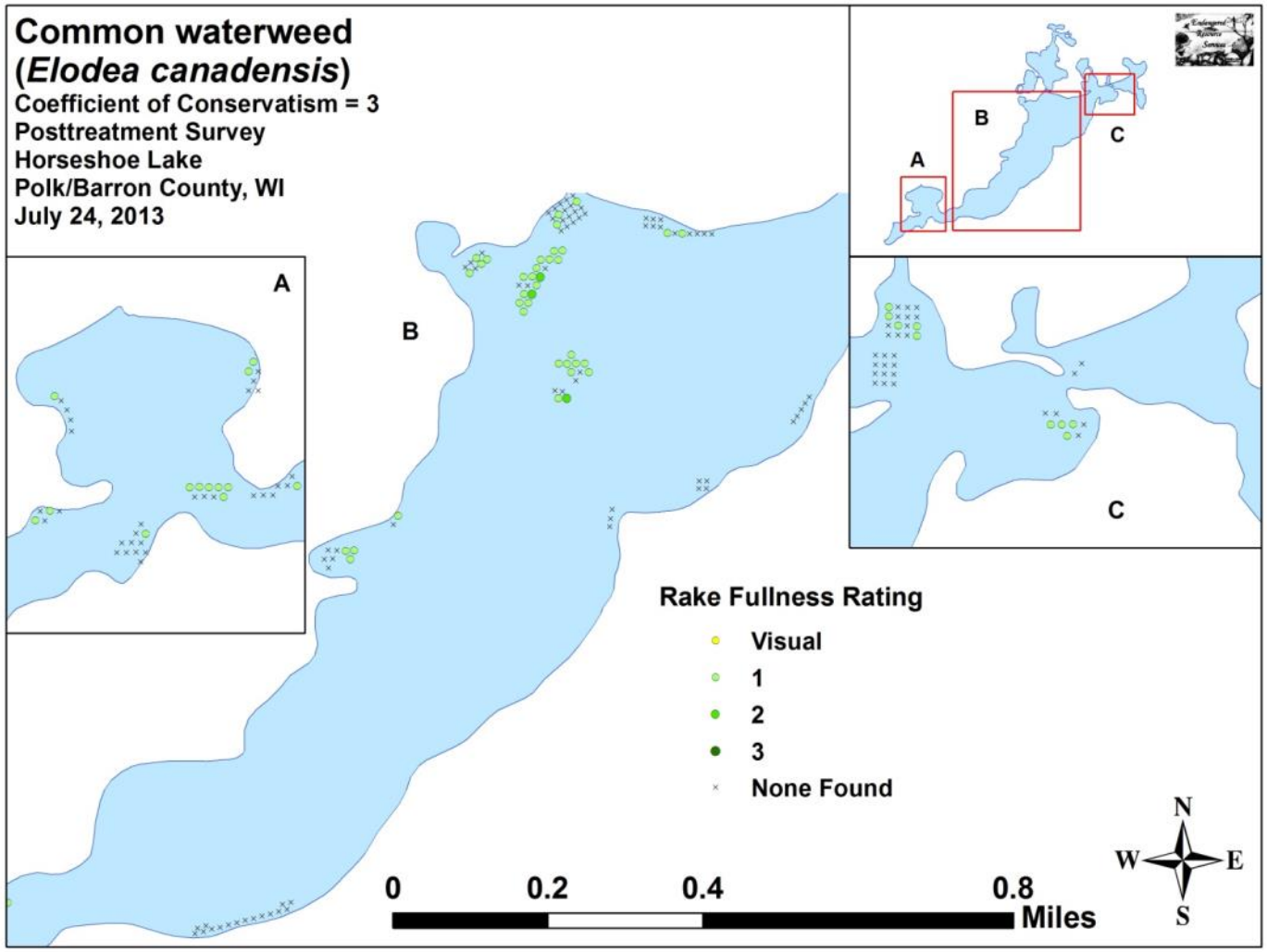

Watershield
(Brasenia schreberi)
Coefficient of Conservatism = 6
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

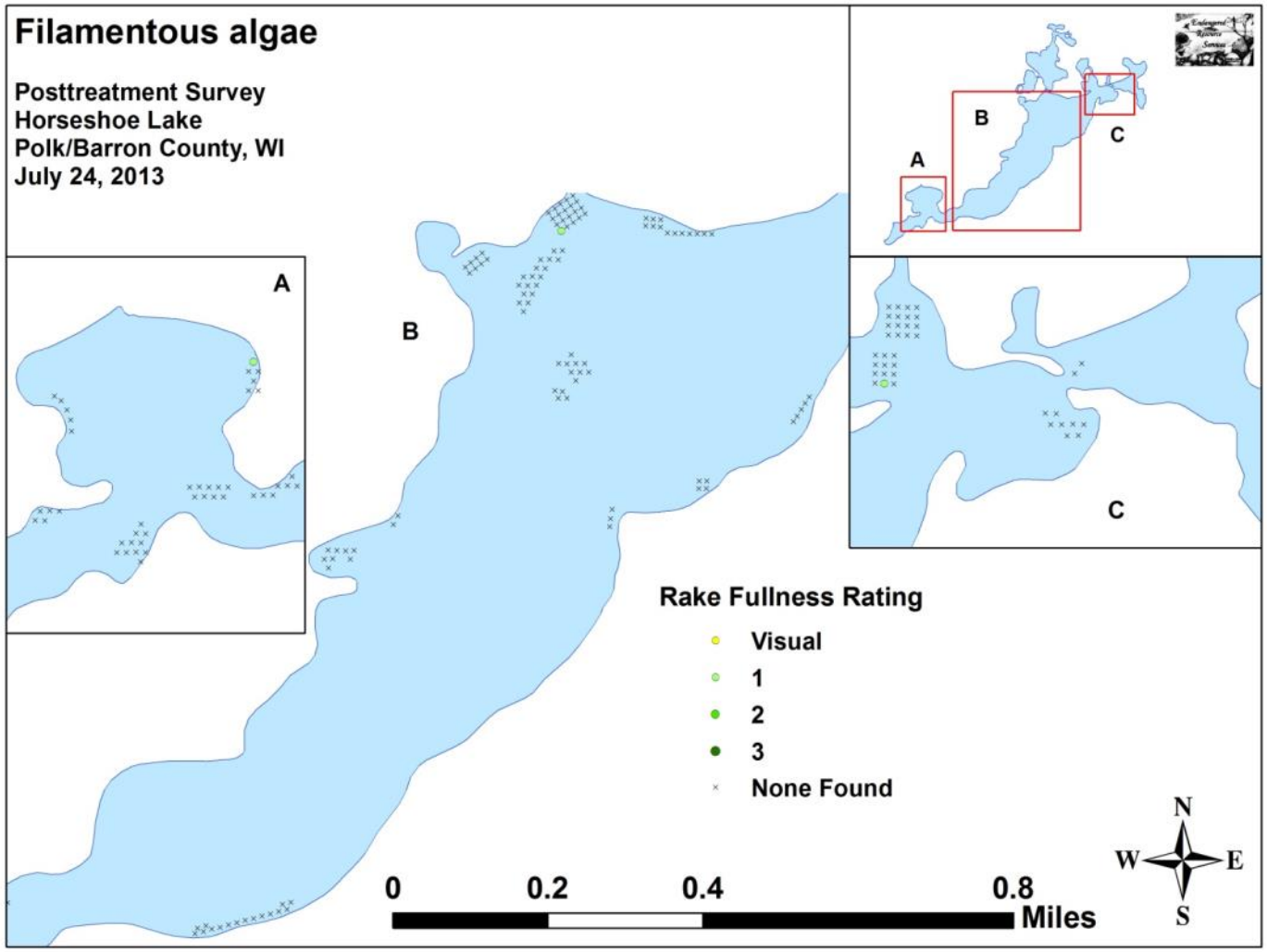

Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

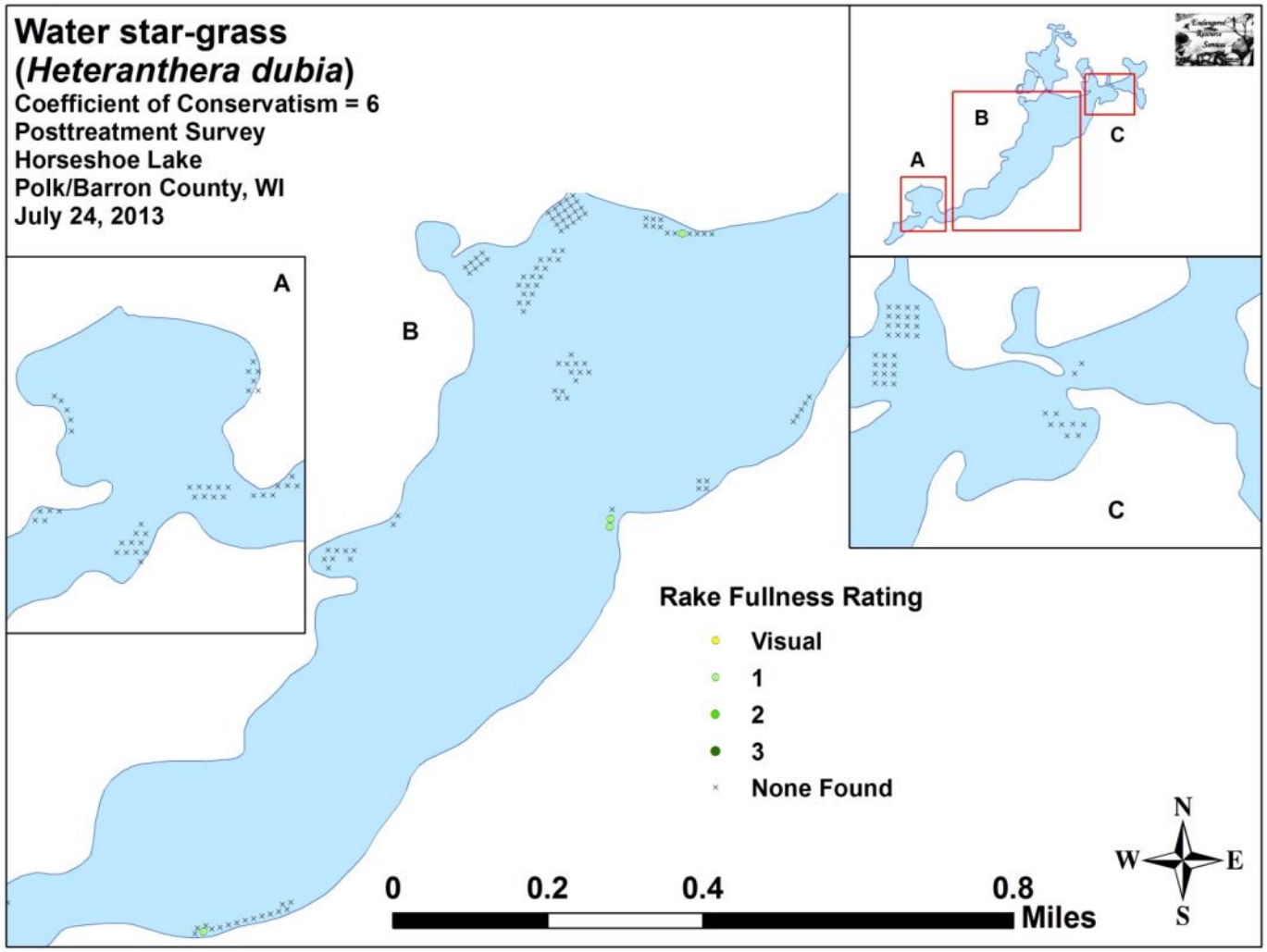

Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

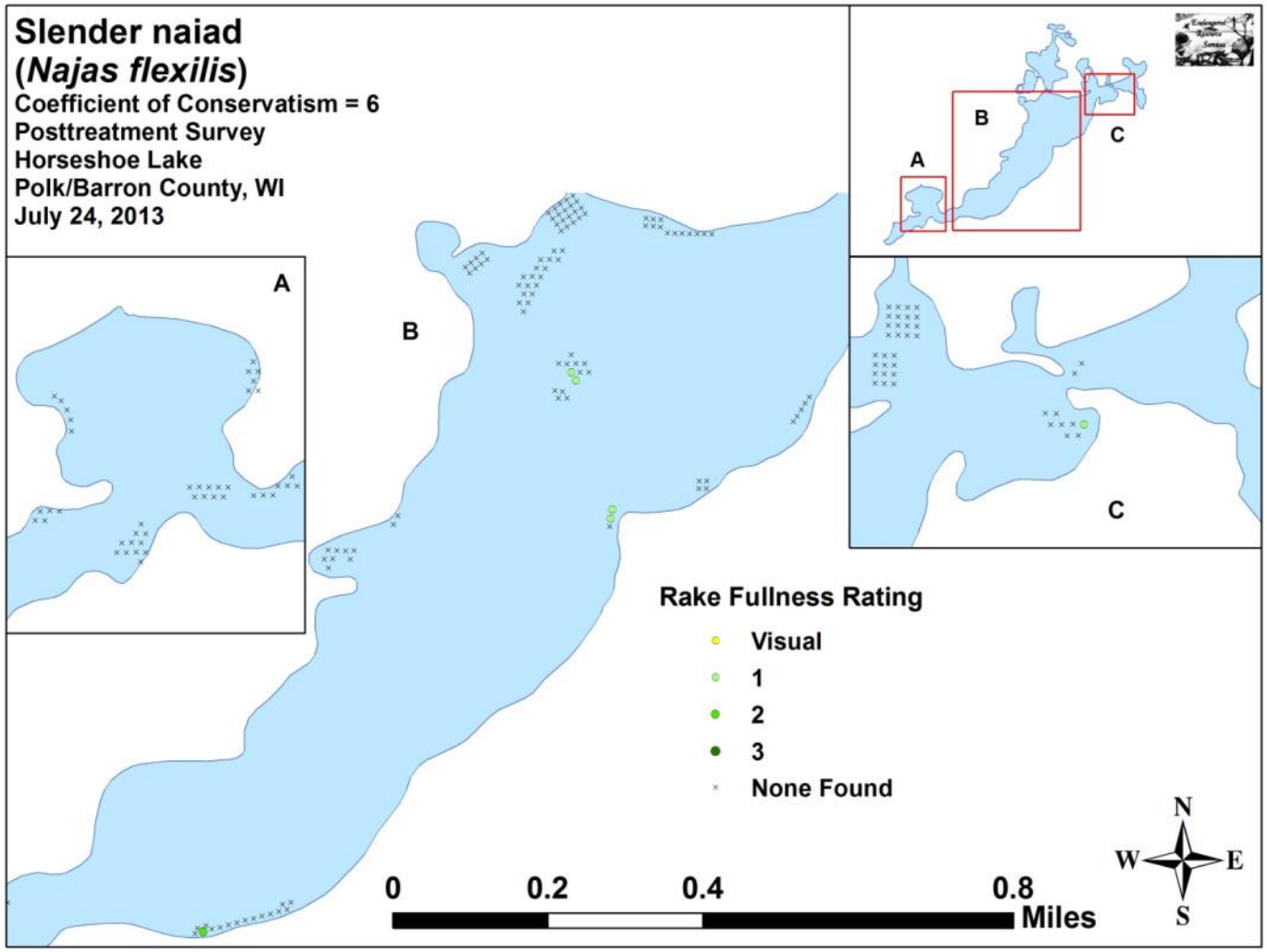

Waterwort
(Elatine minima)
Coefficient of Conservatism = 9
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

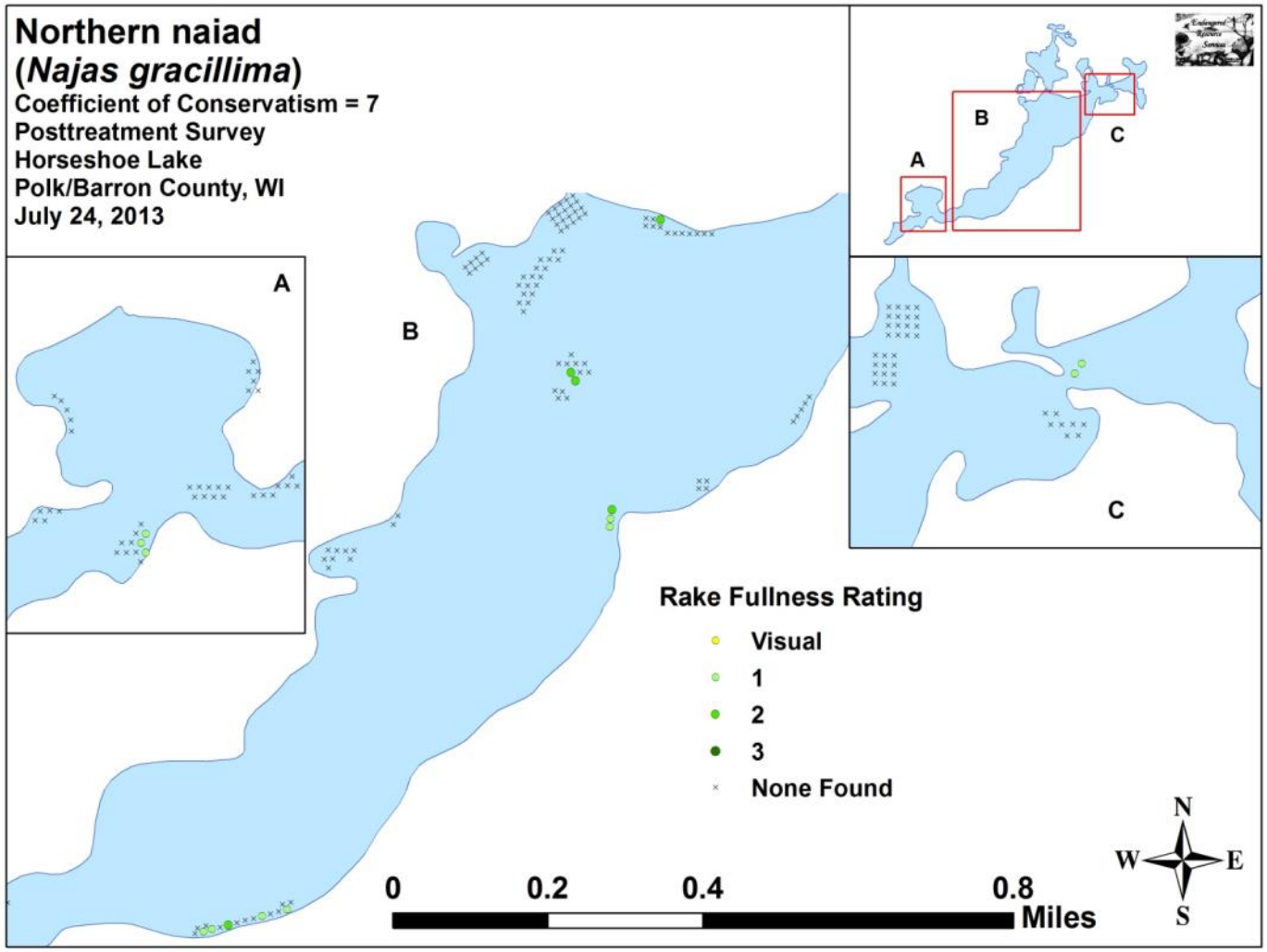

Needle spikerush
(Eleocharis acicularis)
Coefficient of Conservatism = 5
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

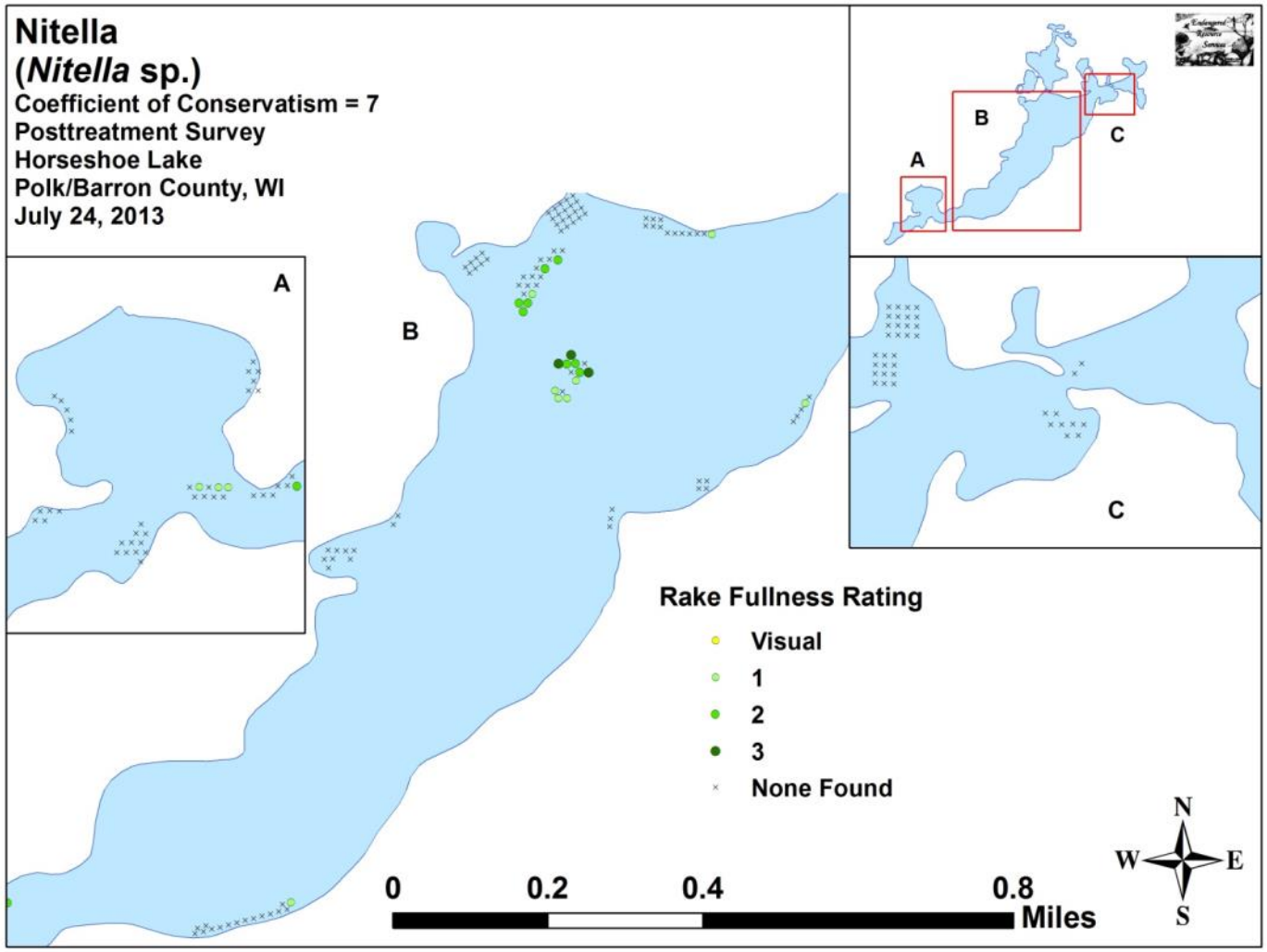

Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

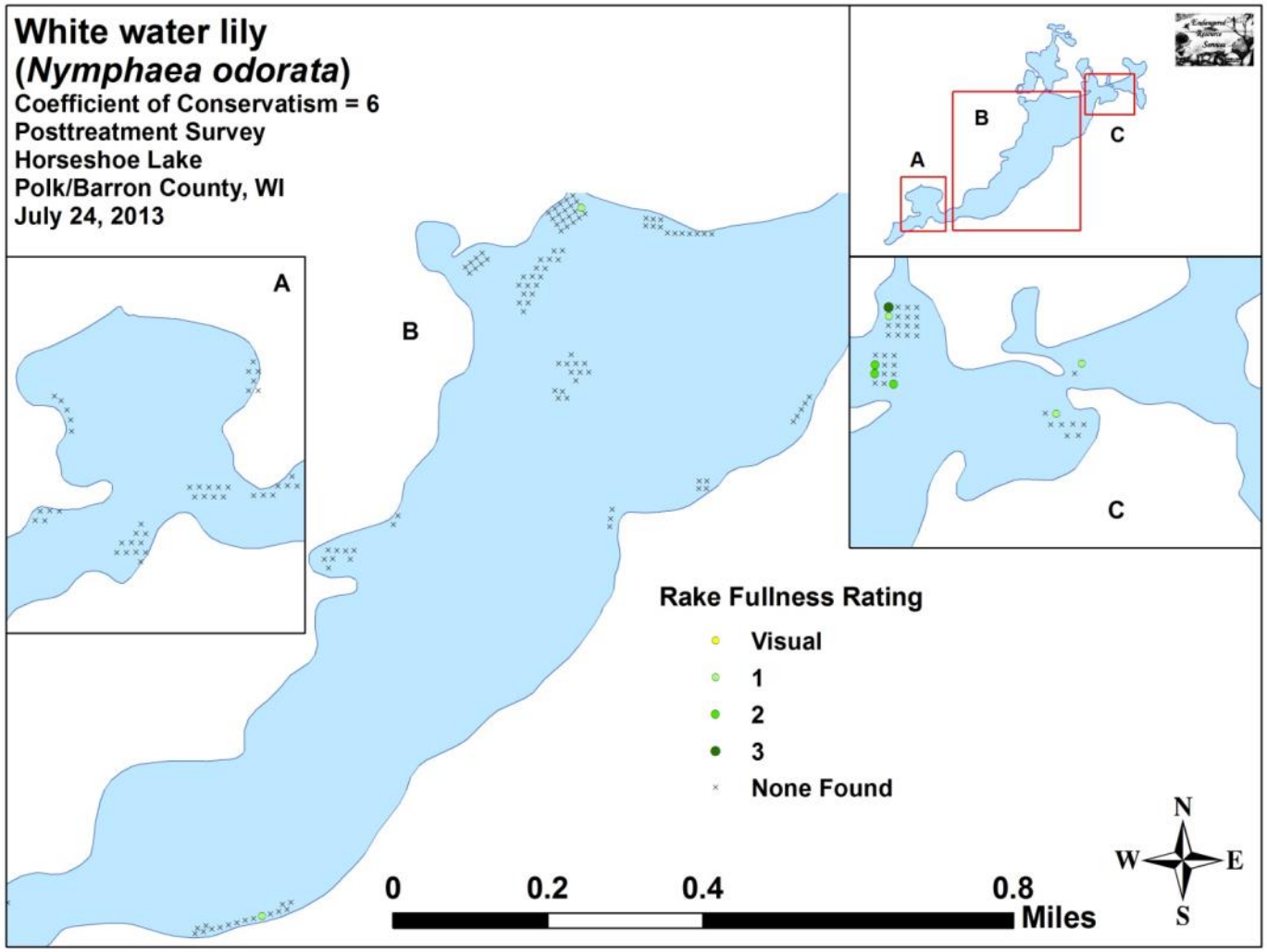

Filamentous algae
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

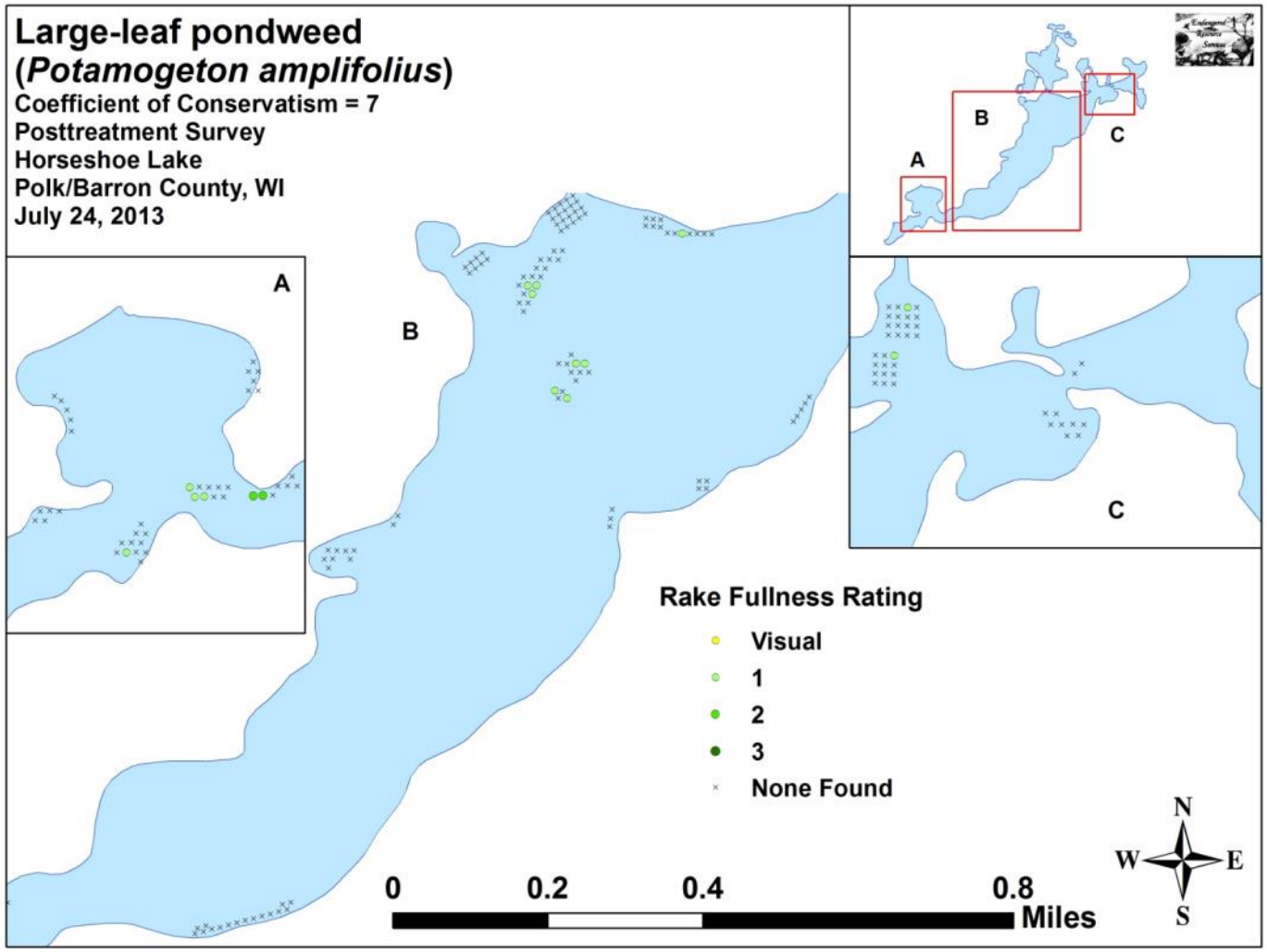

Water star-grass
(Heteranthera dubia)
Coefficient of Conservatism = 6
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

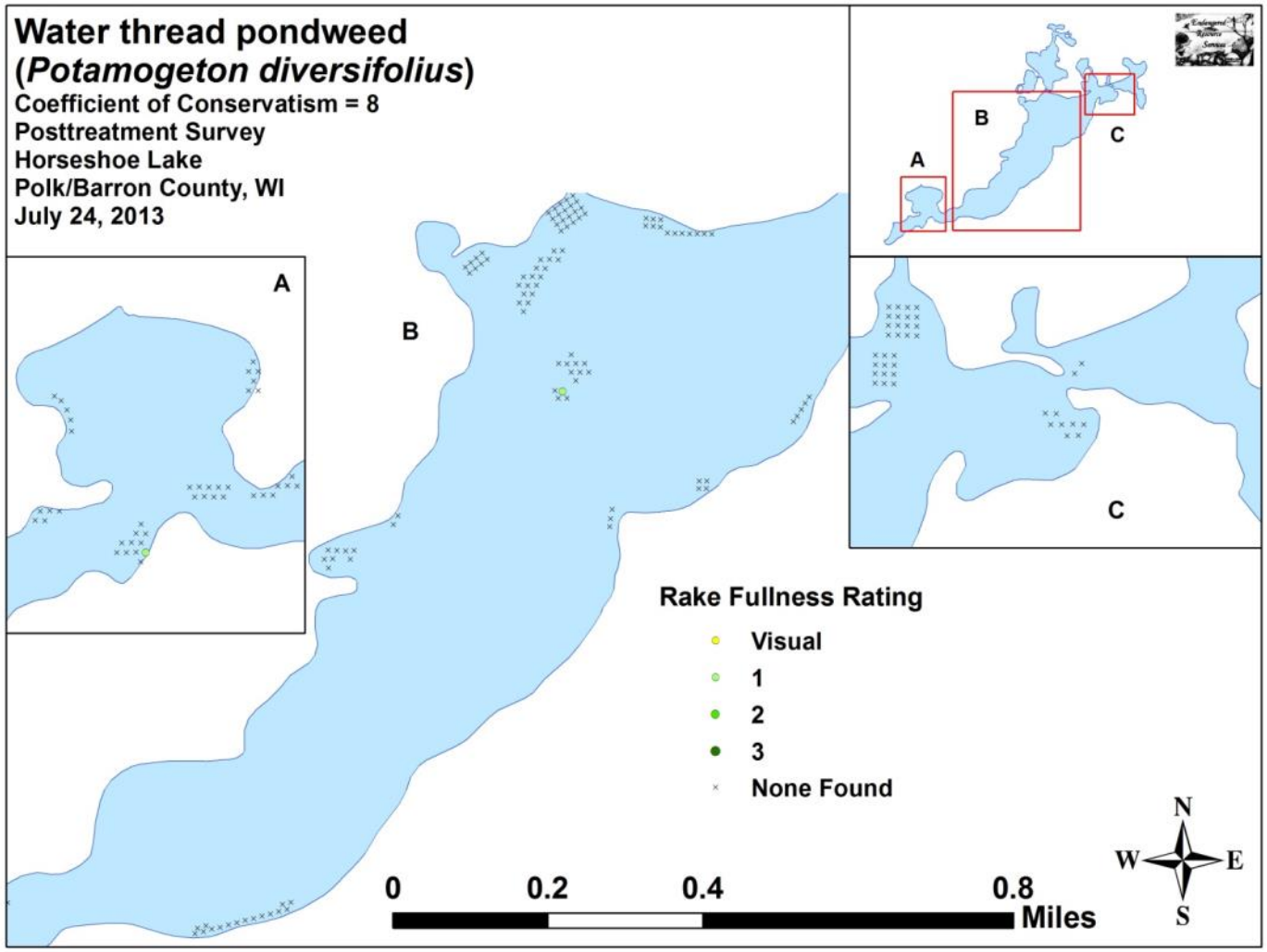

Slender naiad
(Najas flexilis)
Coefficient of Conservatism = 6
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

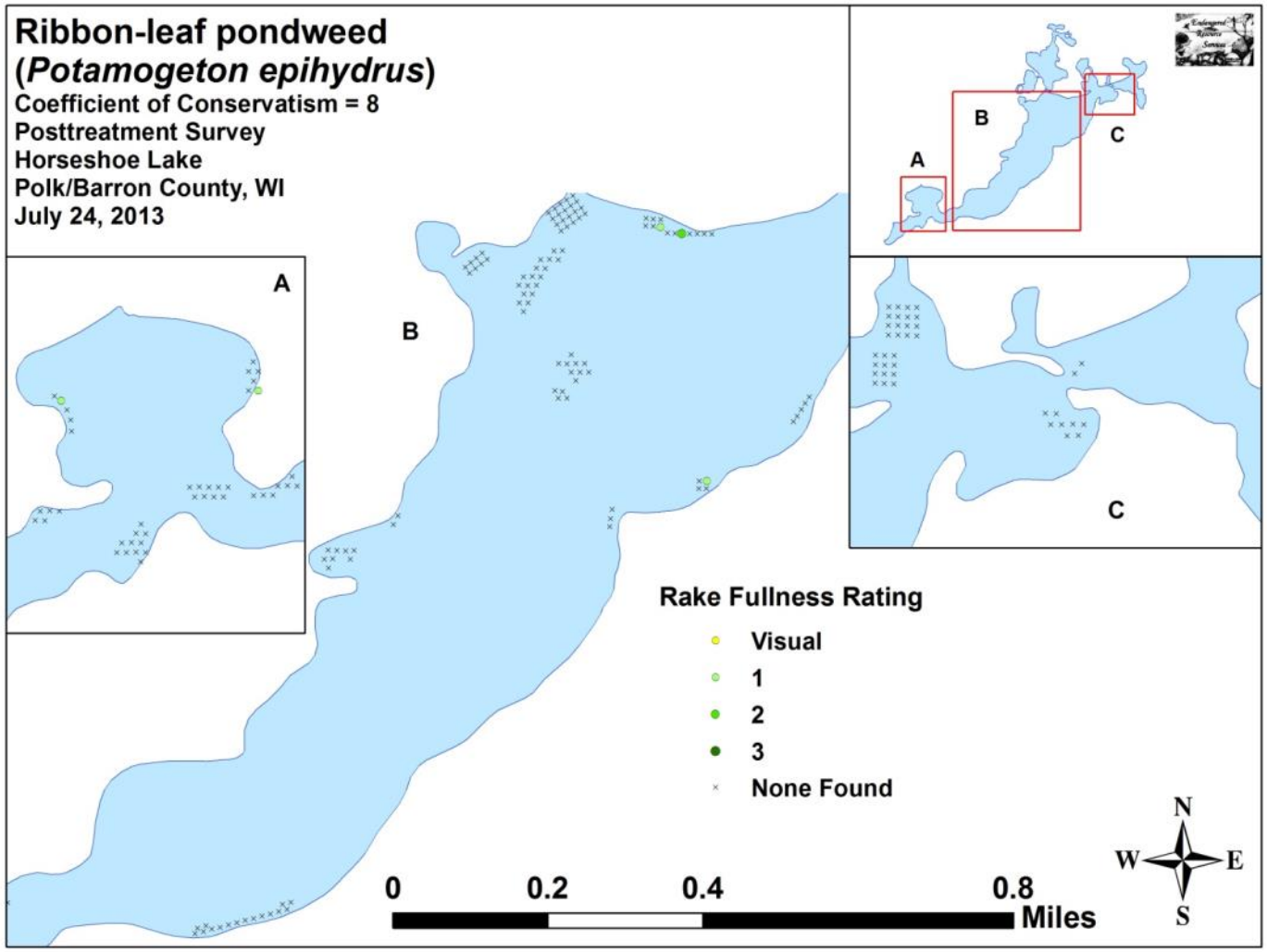

Northern naiad
(Najas gracillima)
Coefficient of Conservatism = 7
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

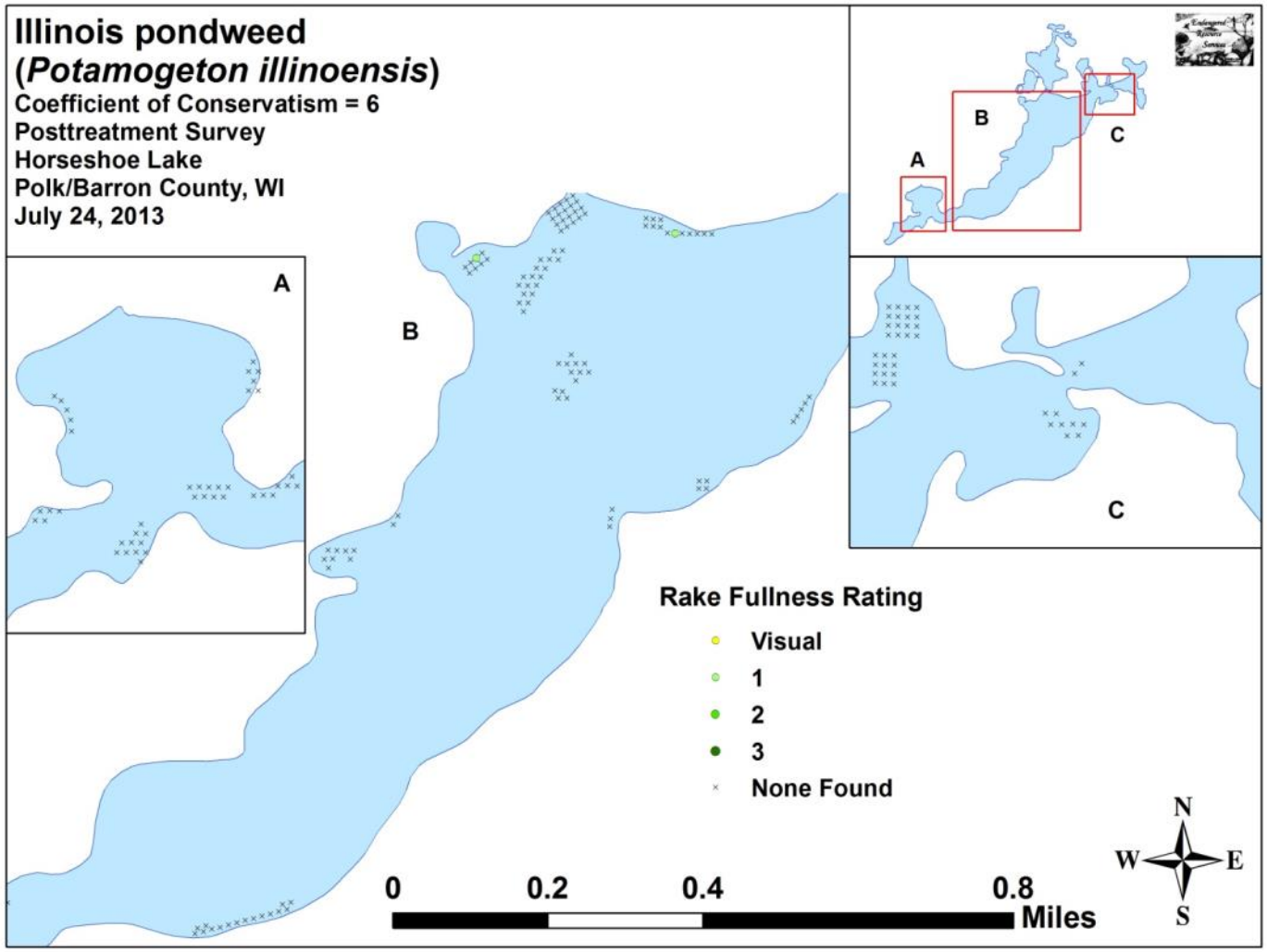

Nitella
(*Nitella* sp.)
Coefficient of Conservatism = 7
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

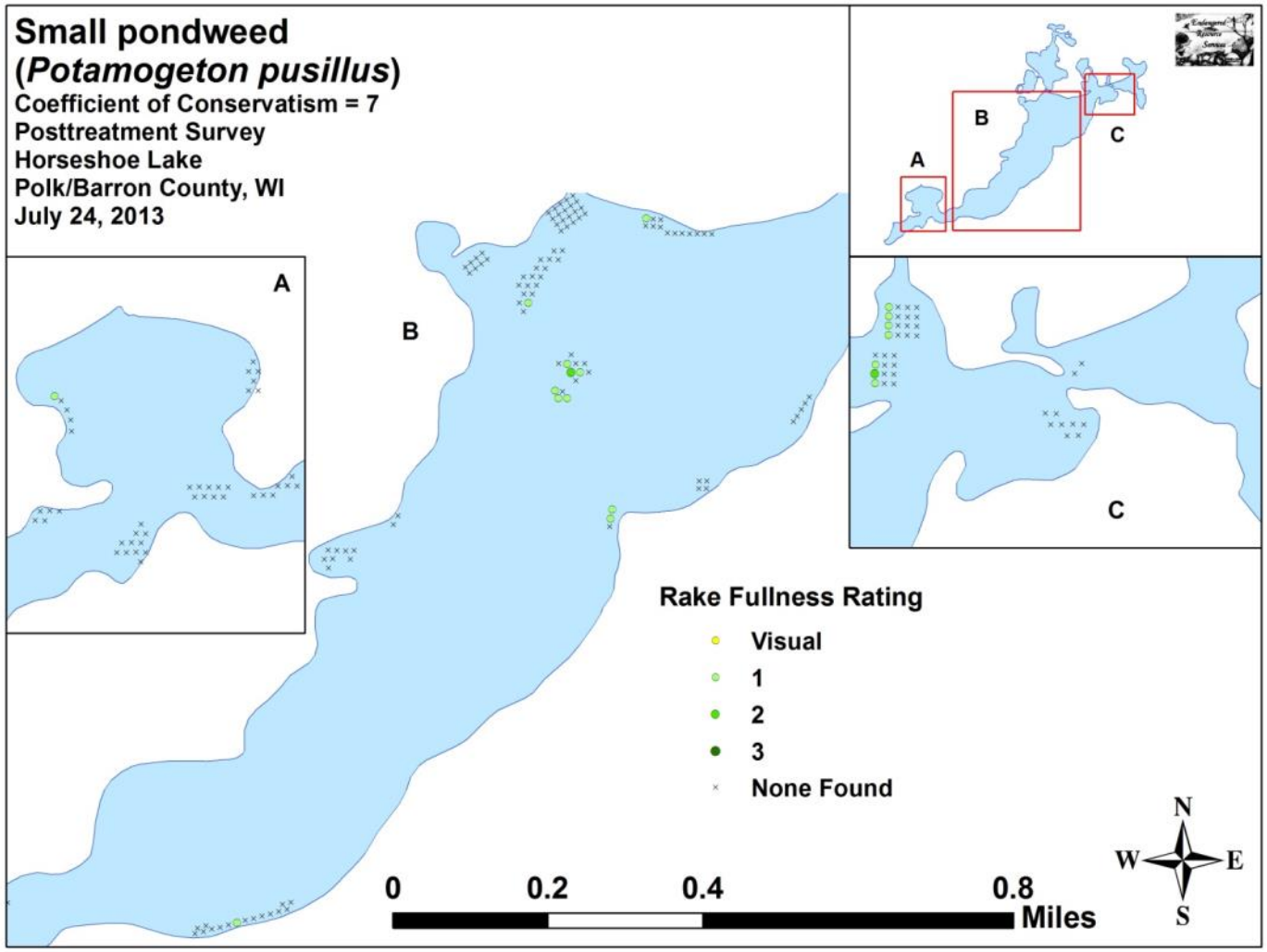

White water lily
(Nymphaea odorata)
Coefficient of Conservatism = 6
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

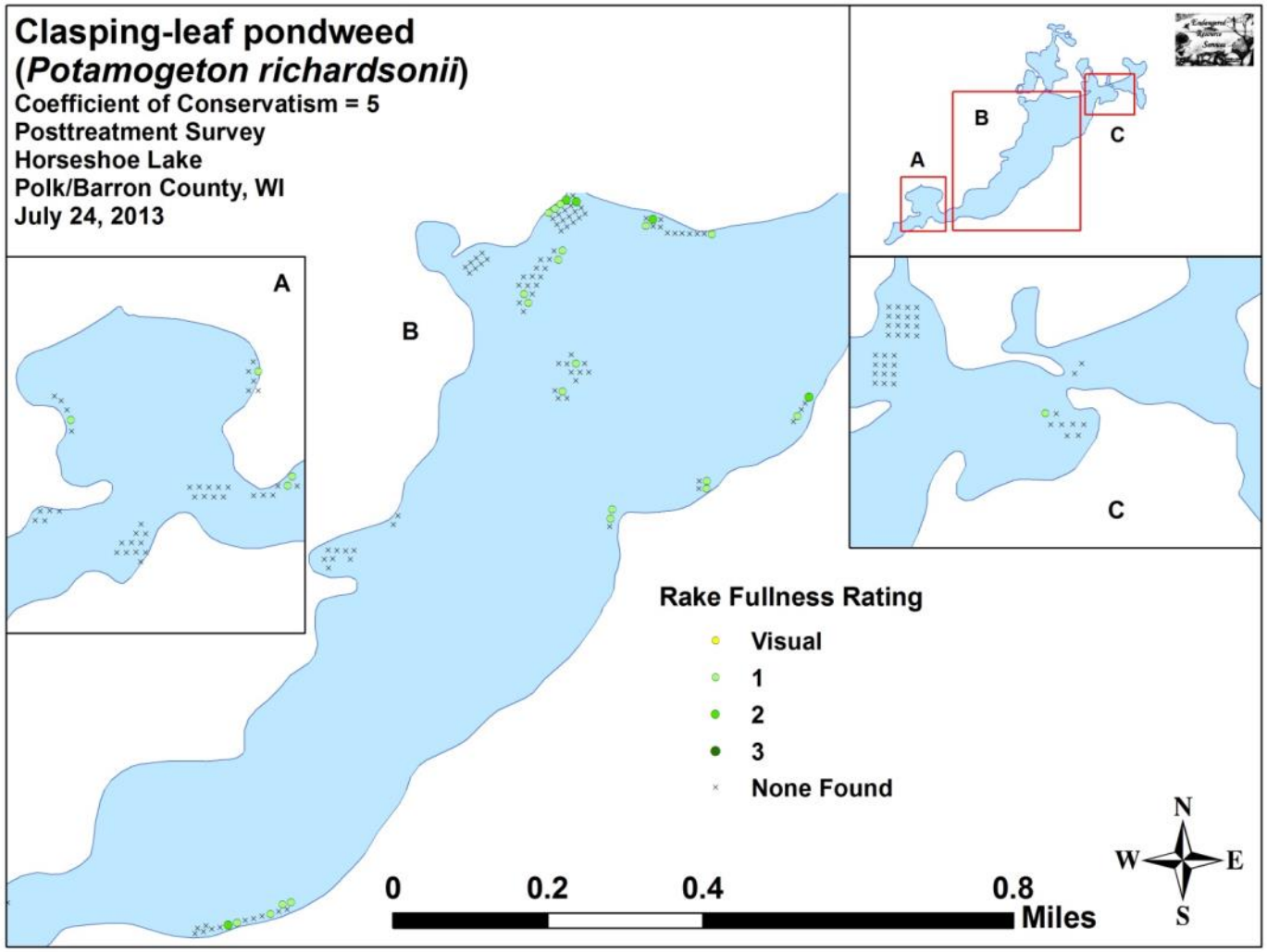

Large-leaf pondweed
(Potamogeton amplifolius)
Coefficient of Conservatism = 7
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

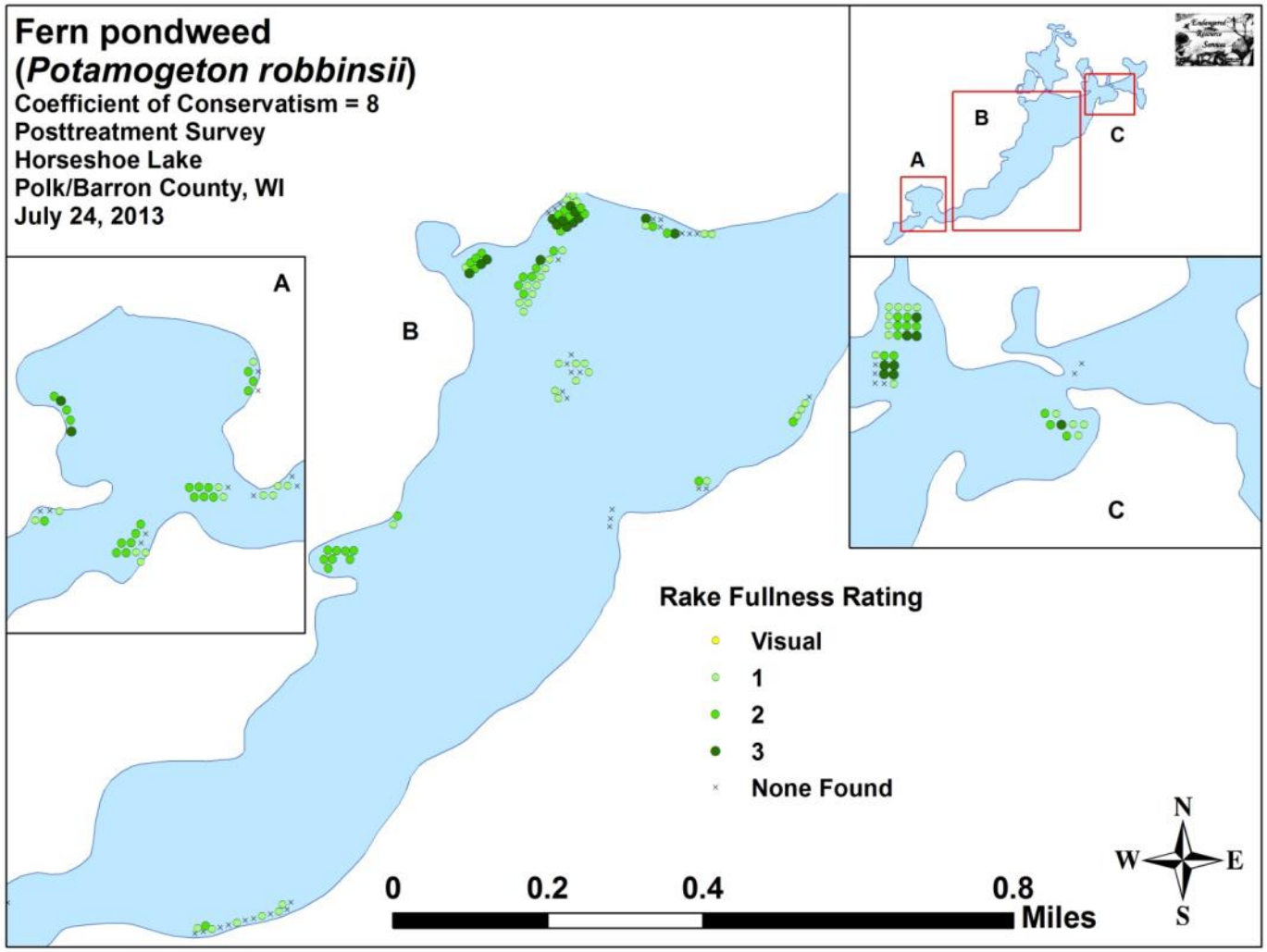

Water thread pondweed
(Potamogeton diversifolius)
Coefficient of Conservatism = 8
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

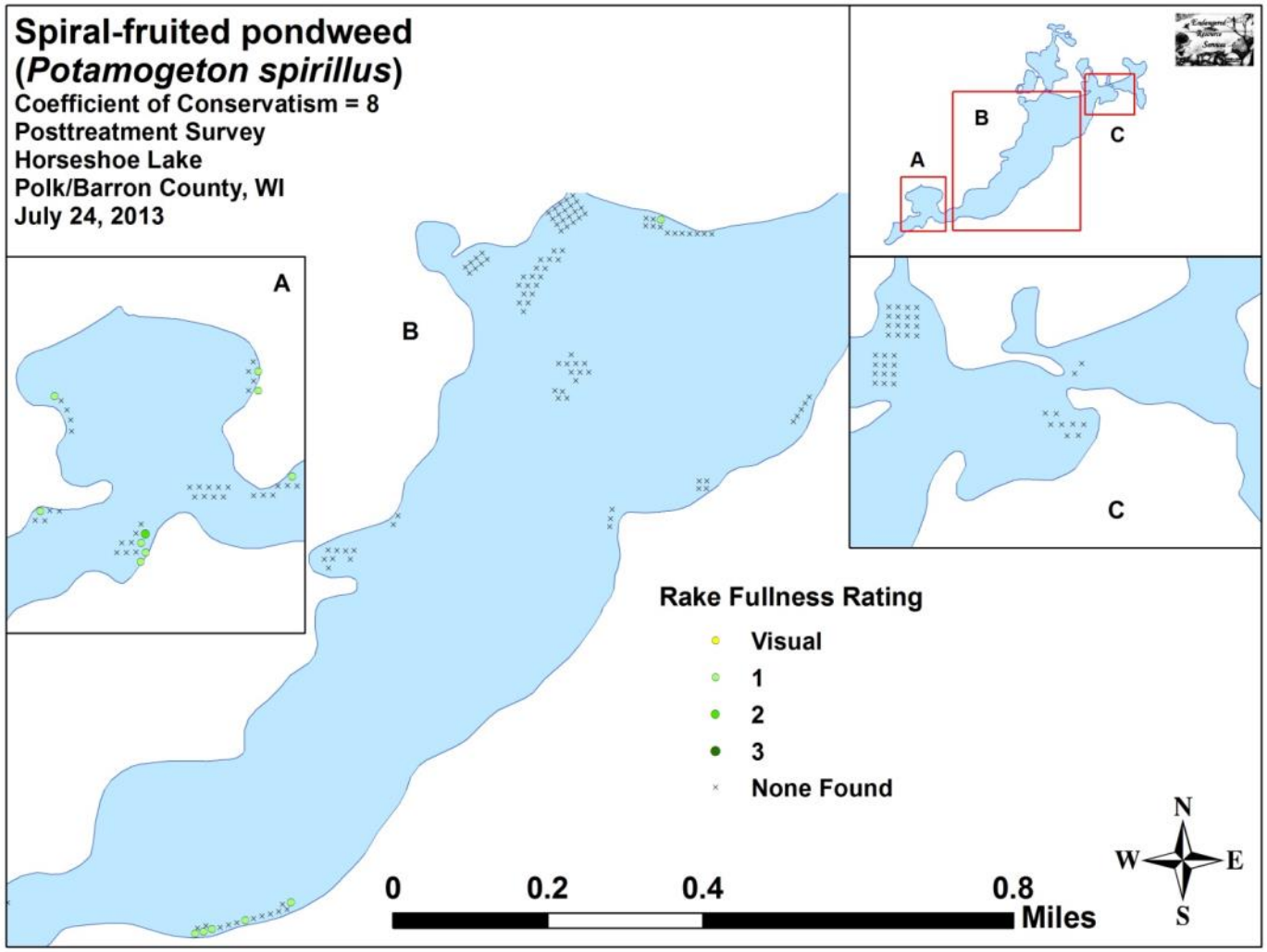

Ribbon-leaf pondweed
(Potamogeton epihydrus)
Coefficient of Conservatism = 8
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

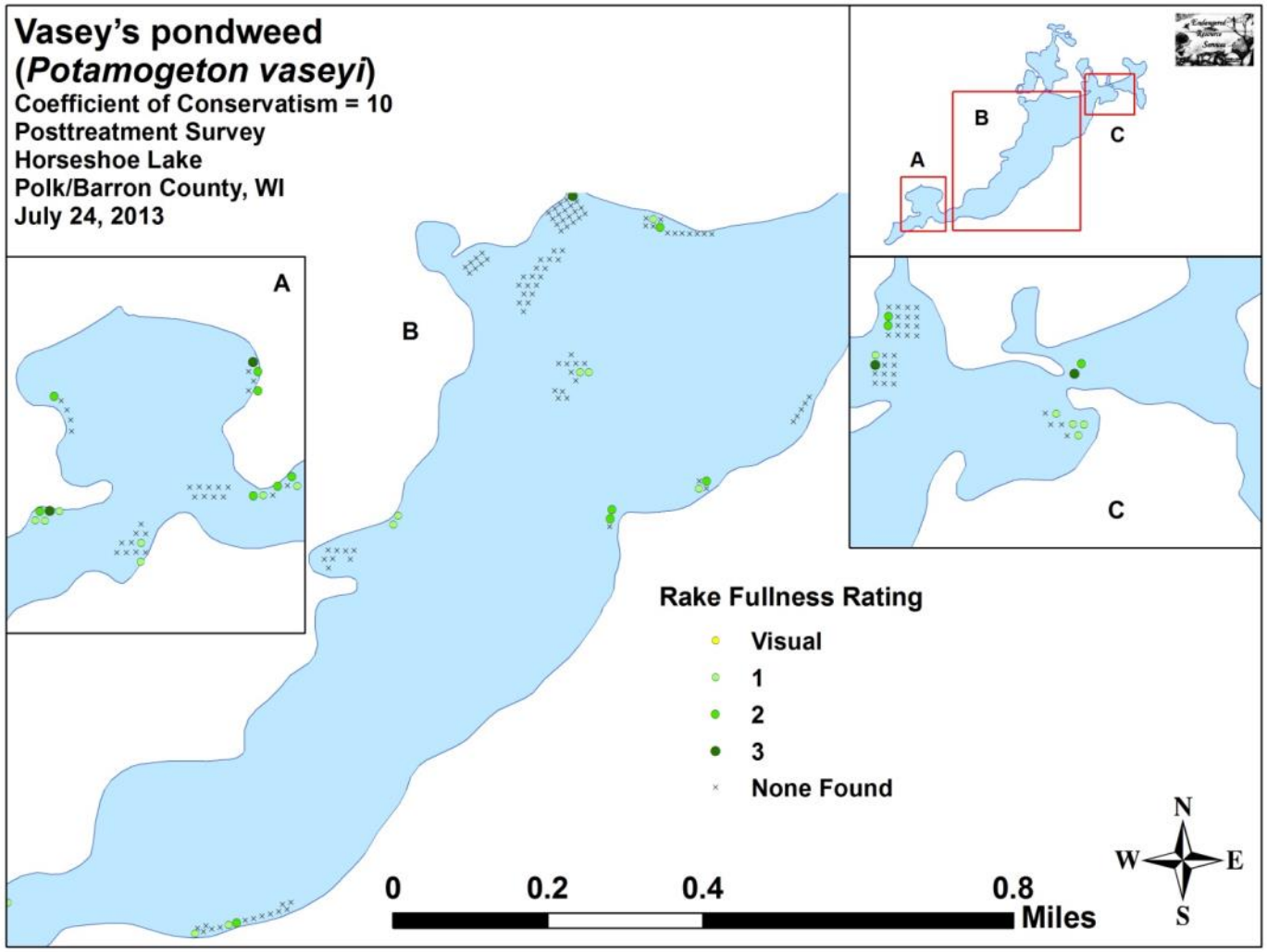

Illinois pondweed
(Potamogeton illinoensis)
Coefficient of Conservatism = 6
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

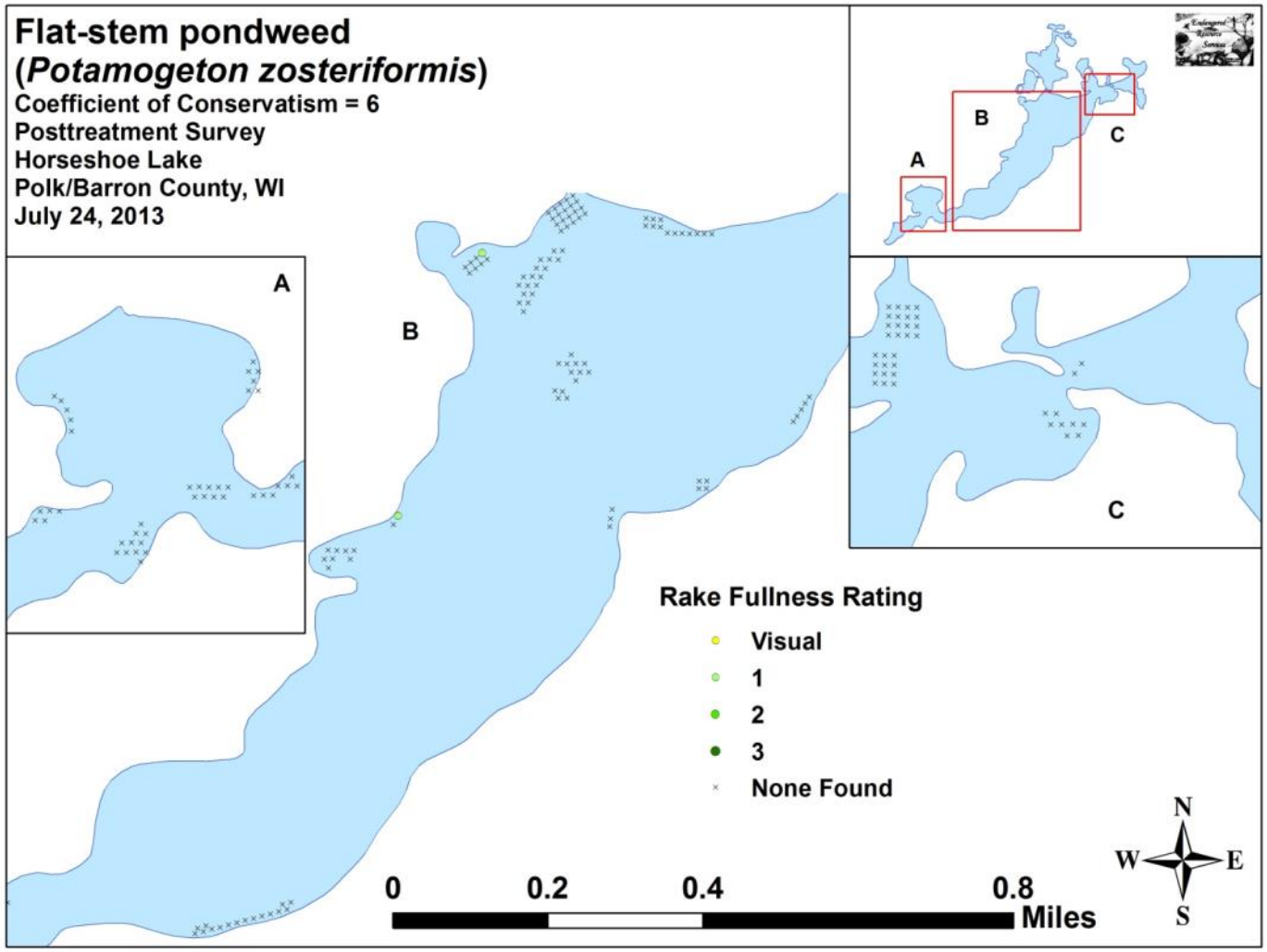

Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

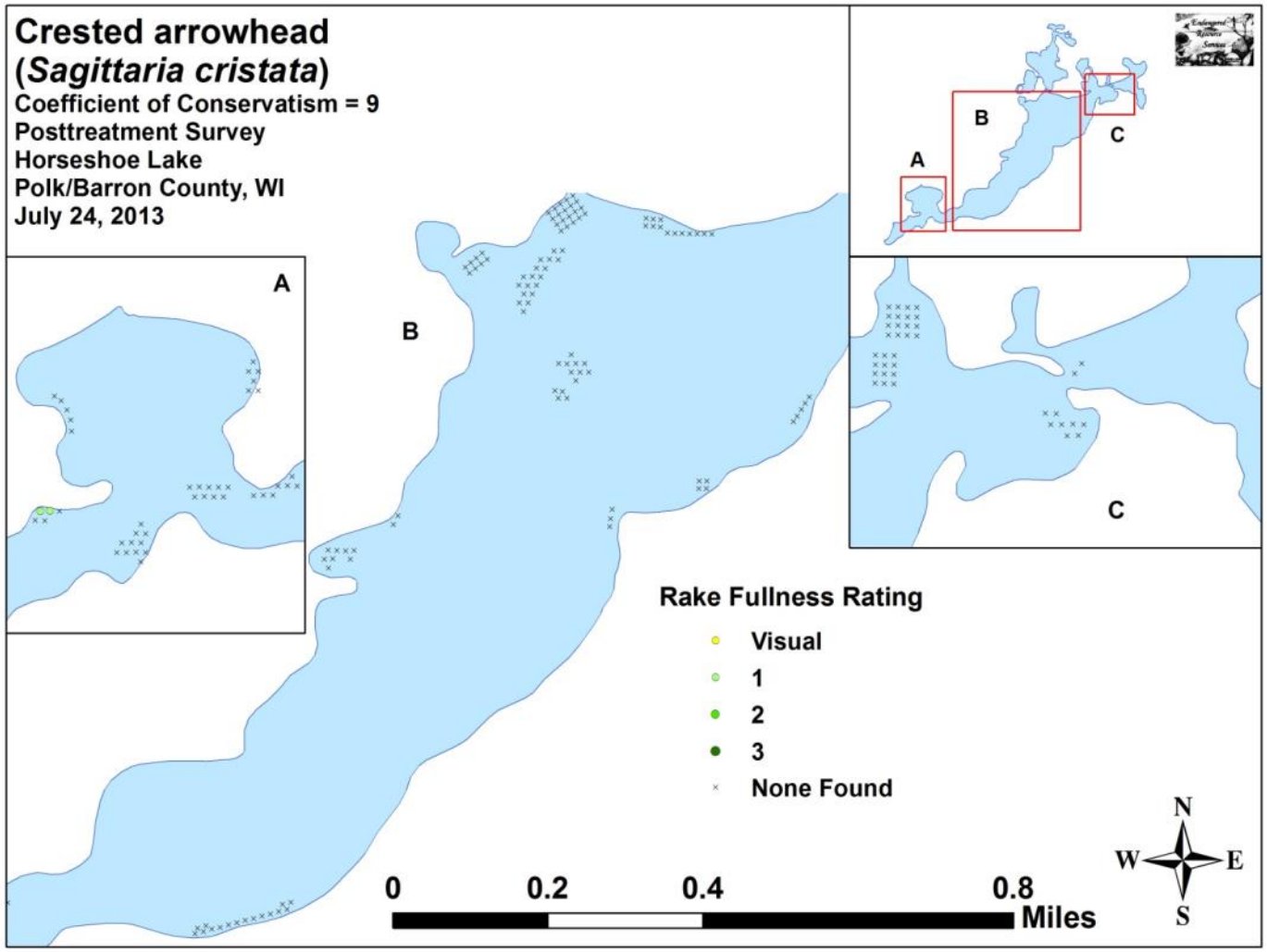

Clasping-leaf pondweed
(Potamogeton richardsonii)
Coefficient of Conservatism = 5
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

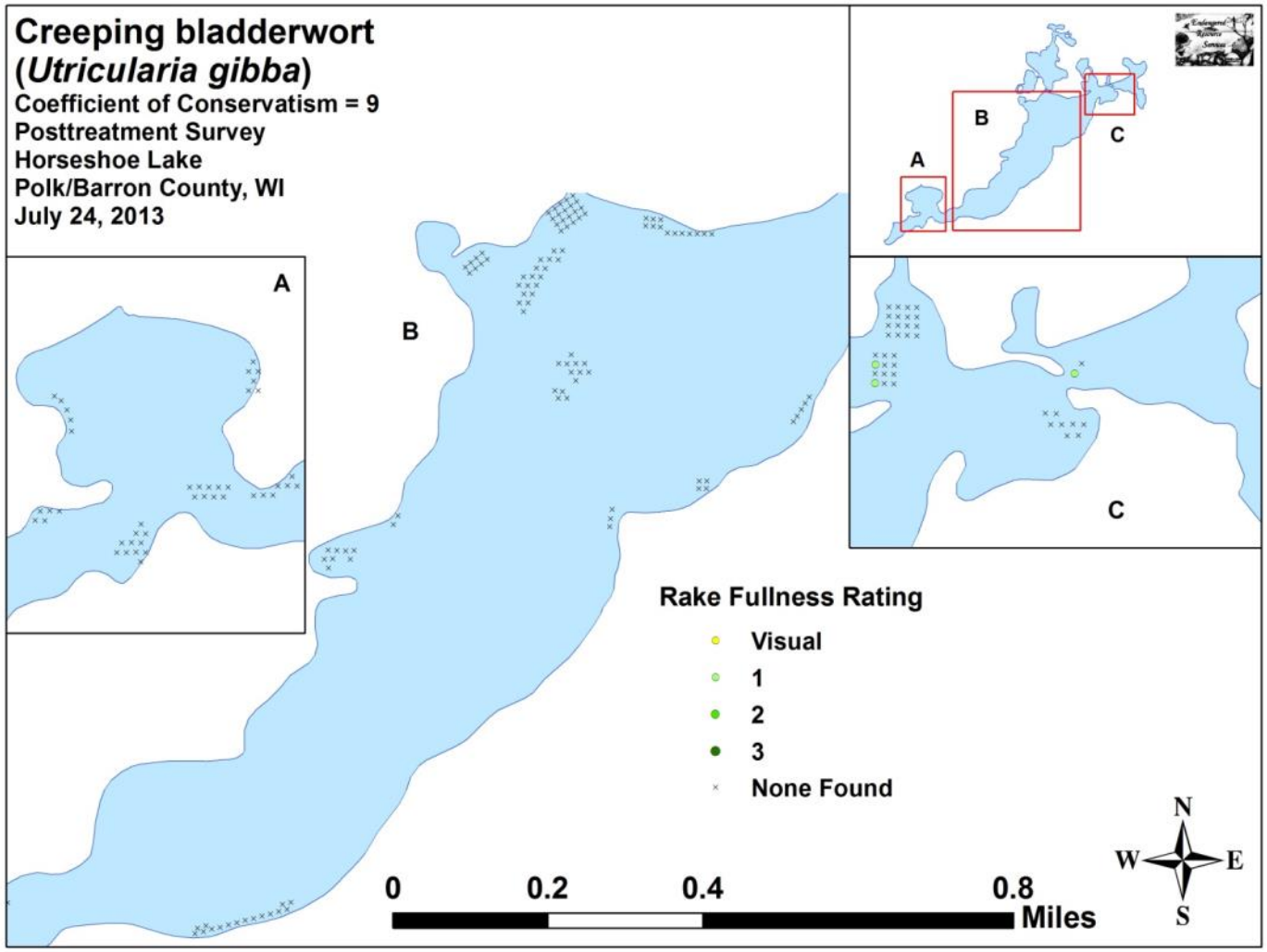

Fern pondweed
(Potamogeton robbinsii)
Coefficient of Conservatism = 8
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

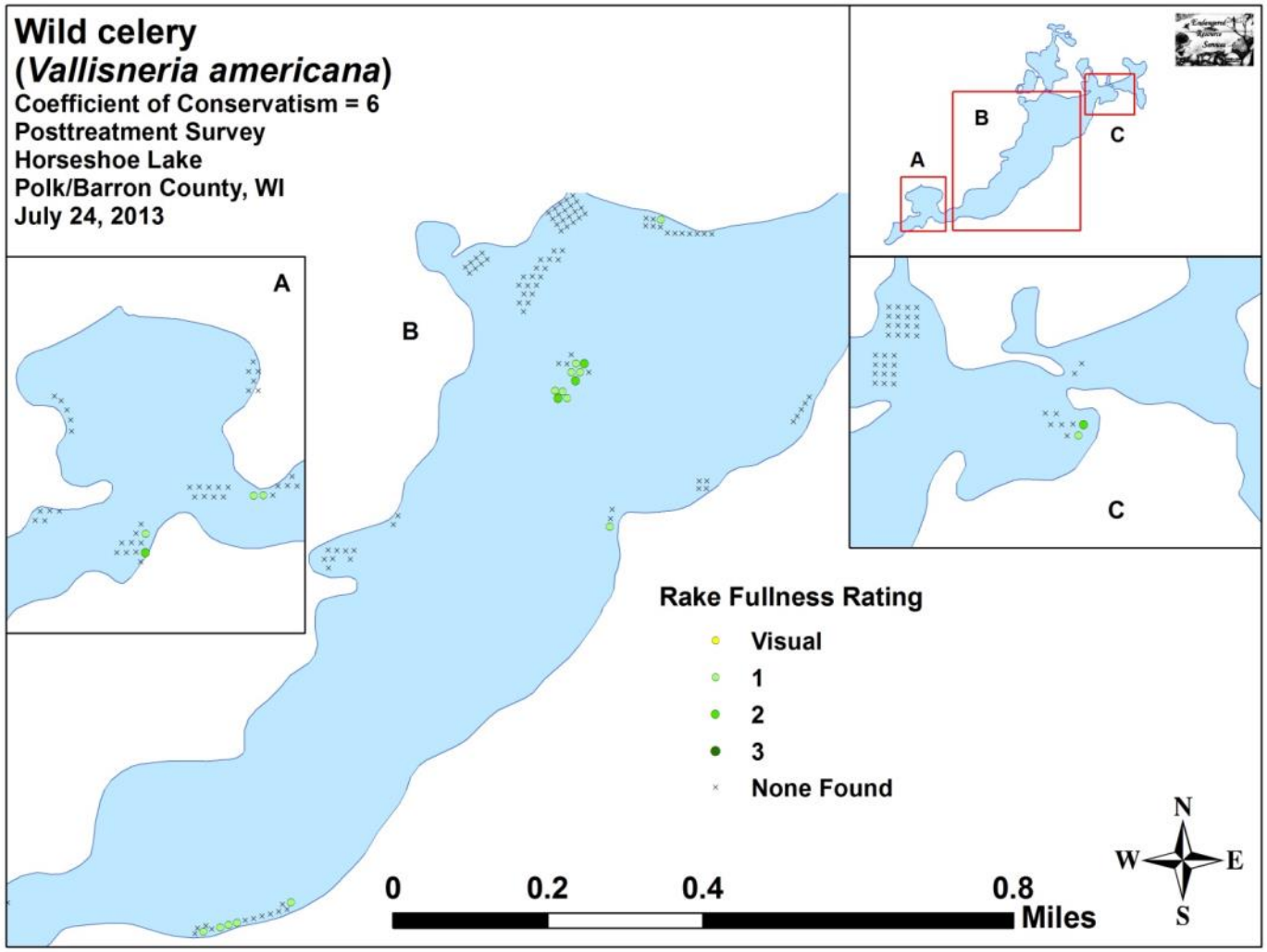

Spiral-fruited pondweed
(Potamogeton spirillus)
Coefficient of Conservatism = 8
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S


Vasey's pondweed
(Potamogeton vaseyi)
Coefficient of Conservatism = 10
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

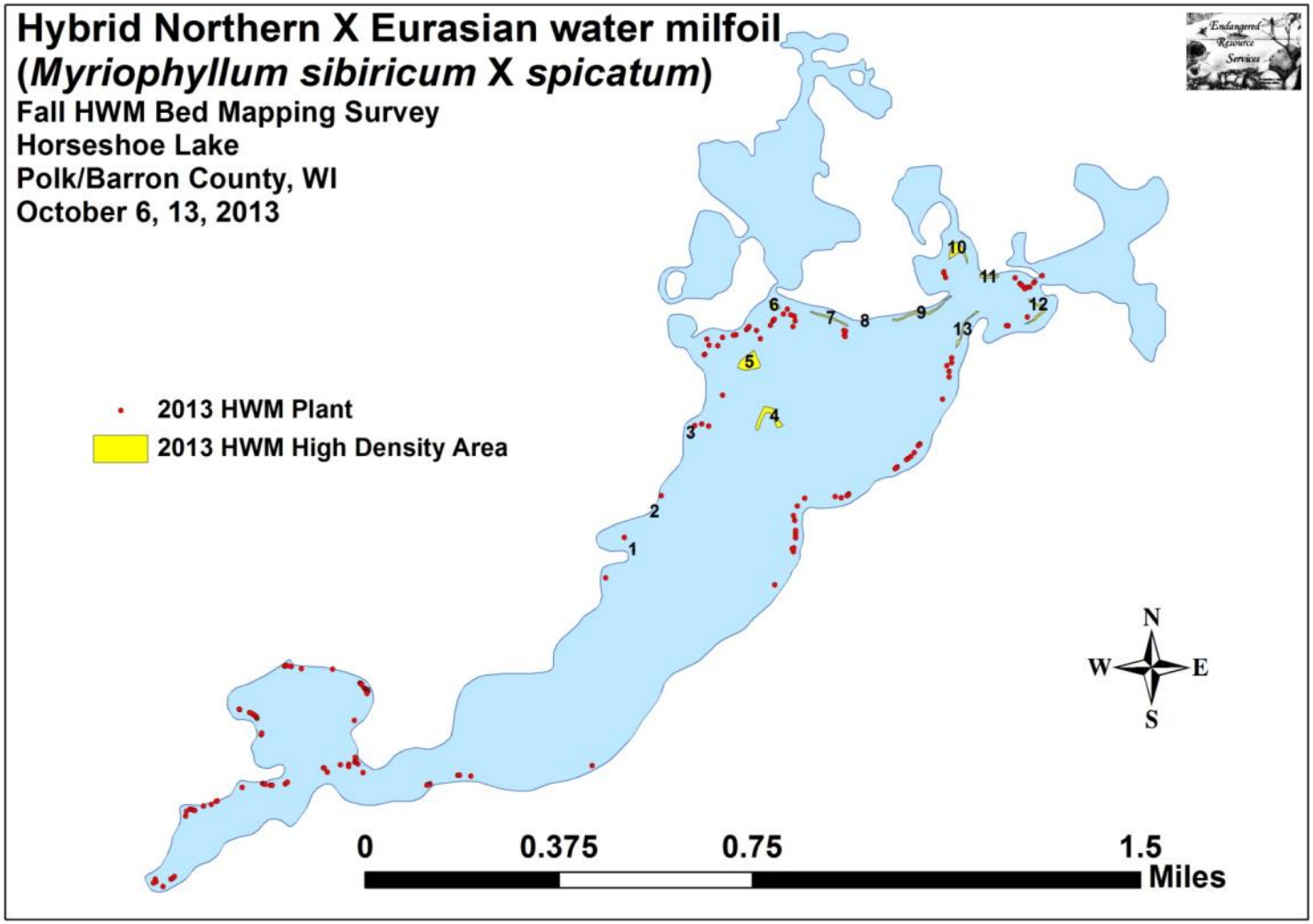

Flat-stem pondweed
(Potamogeton zosteriformis)
Coefficient of Conservatism = 6
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

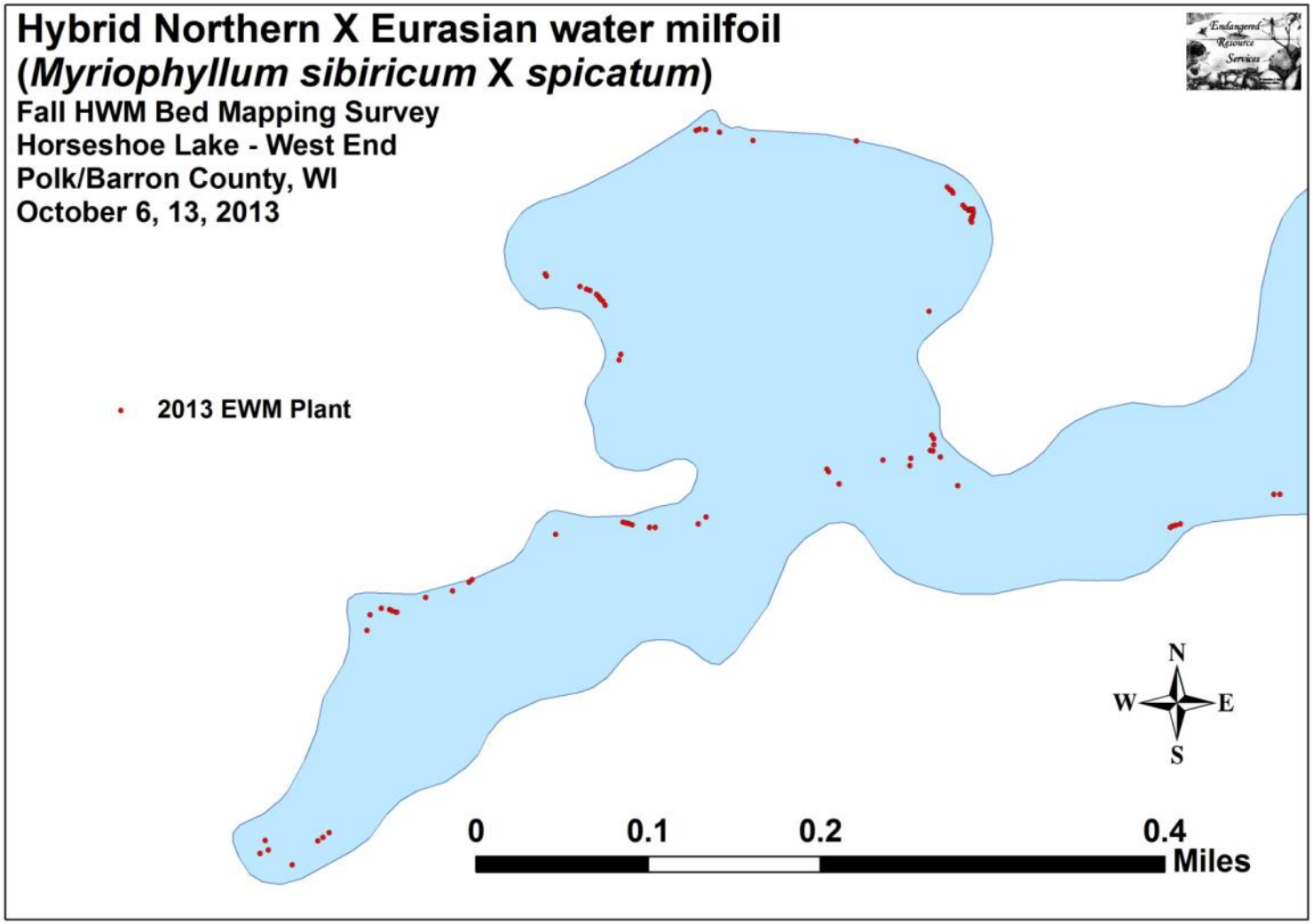

Crested arrowhead
(Sagittaria cristata)
Coefficient of Conservatism = 9
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

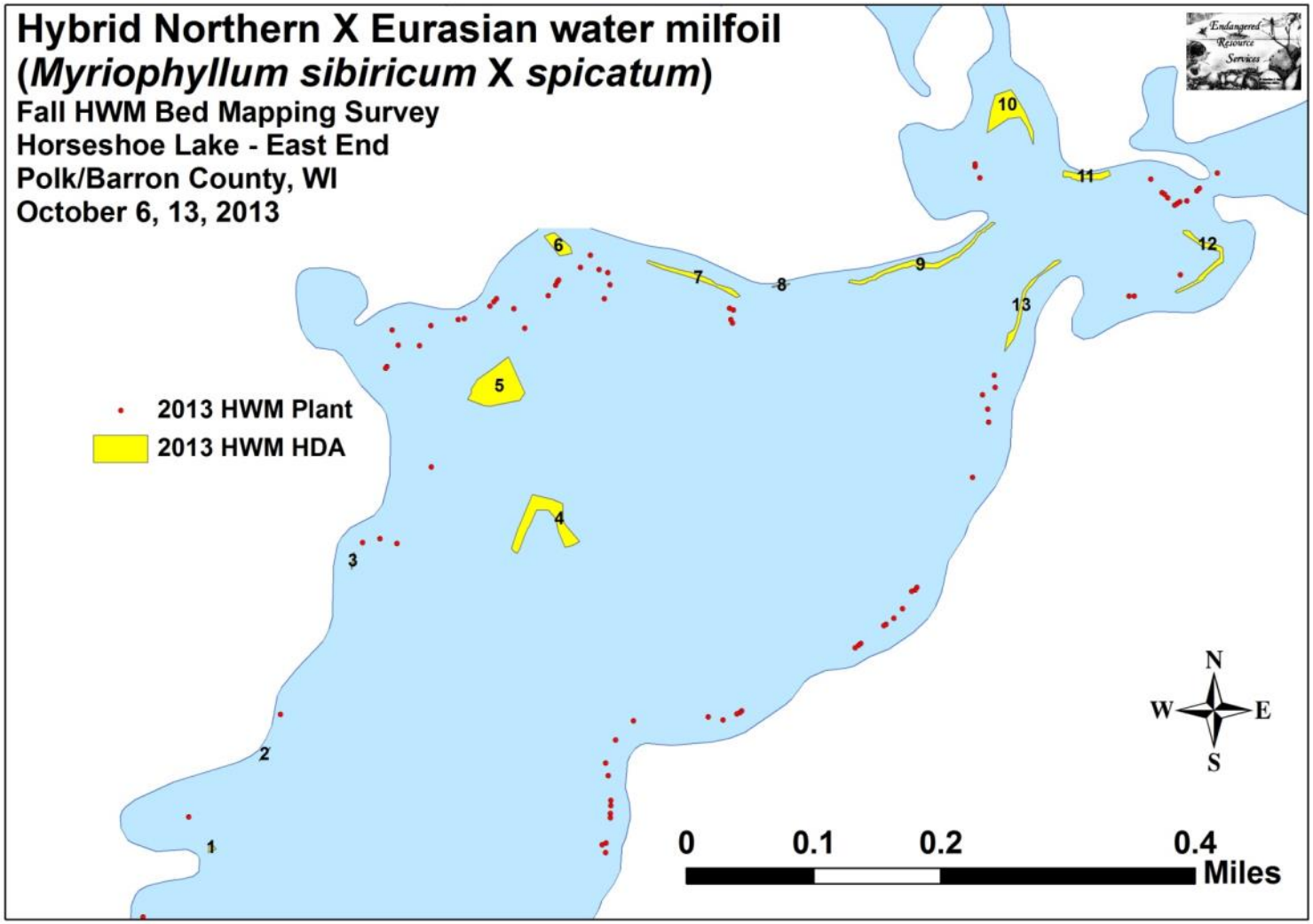

Creeping bladderwort
(Utricularia gibba)
Coefficient of Conservatism = 9
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Wild celery
(Vallisneria americana)
Coefficient of Conservatism = 6
Posttreatment Survey
Horseshoe Lake
Polk/Barron County, WI
July 24, 2013
A
B
C
Rake Fullness Rating
Visual
1
2
3
None Found
0
0.2
0.4
0.8
Miles
N
W
E
S

Appendix VIII: Horseshoe Lake Fall 2013 HWM Survey Maps


Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibiricum X spicatum)
Fall HWM Bed Mapping Survey
Horseshoe Lake
Polk/Barron County, WI
October 6, 13, 2013
Endangered Resource Services
2013 HWM Plant
2013 HWM High Density Area
1
2
3
4
5
6
7
8
9
10
11
12
13
N
W
E
S
0
0.375
0.75
1.5
Miles


Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibiricum X spicatum)
Fall HWM Bed Mapping Survey
Horseshoe Lake - West End
Polk/Barron County, WI
October 6, 13, 2013
Endangered Resource Services
2013 EWM Plant
N
W
E
S
0
0.1
0.2
0.4
Miles


Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibiricum X spicatum)
Fall HWM Bed Mapping Survey
Horseshoe Lake - East End
Polk/Barron County, WI
October 6, 13, 2013
Endangered Resource Services
2013 HWM Plant
2013 HWM HDA
1
2
3
4
5
6
7
8
9
10
11
12
13
N
W
E
S
0
0.1
0.2
0.4
Miles