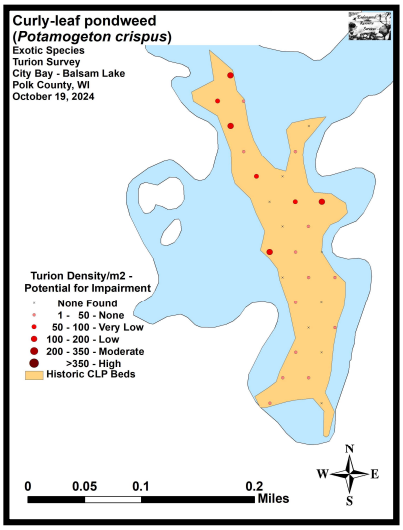
Curly-leaf Pondweed (*Potamogeton crispus*)
Fall Turion Survey
City Bay - Balsam Lake – WBIC: 2620600
Polk County, Wisconsin

Germinating turions (Berg 2022)



2024 fall turion density – City Bay

Project Initiated by:
Balsam Lake Protection and Rehabilitation District and the
Wisconsin Department of Natural Resources – Grant ACEI21218


Sieve with turions (Berg 2013)

Survey Conducted by and Report Prepared by:
Endangered Resource Services, LLC
Matthew S. Berg, Research Biologist
St. Croix Falls, Wisconsin
October 19, 2024

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INTRODUCTION:

Balsam Lake (WBIC 2620600) is a 2,054-acre stratified drainage lake in central Polk County, Wisconsin in the Towns of Balsam Lake, Milltown, Georgetown, and Apple River (T34N R17W) (Figure 1). It reaches a maximum depth of 37ft north of Cedar Island in the western basin and has an average depth of 20ft (Hopke et al. 1964). The lake is mesotrophic bordering on eutrophic in nature, and water clarity is fair with summer Secchi readings over the last 10 years averaging 3.4ft in East Balsam, 5.9ft in Little Balsam, and 10.8ft in the deep hole north of Cedar Island (WDNR 2024). The lake's bottom substrate is variable with organic muck in most bays, and rock/sand in the Big and Little Narrows and around the lake's many islands.

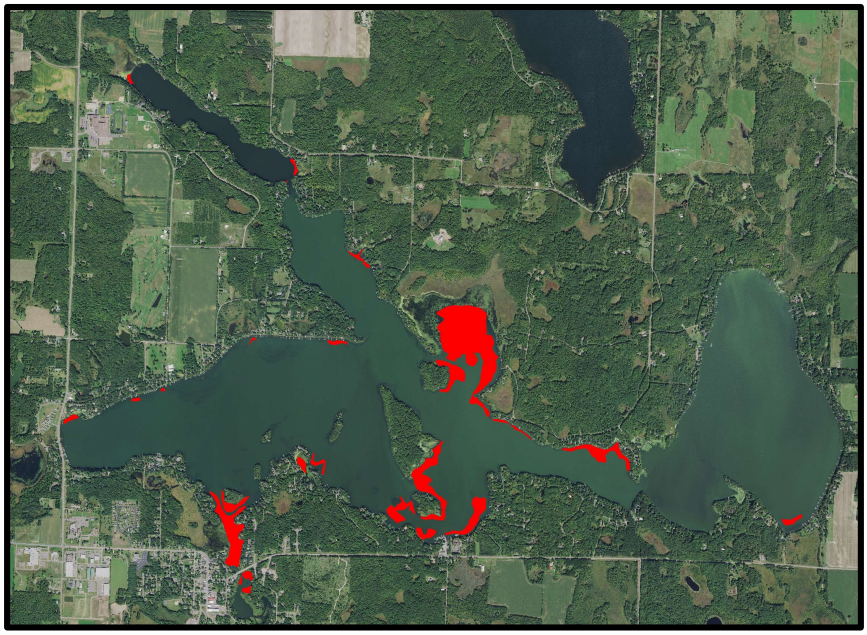


Figure 1: Balsam Lake with 2024 CLP Beds

BACKGROUND AND STUDY RATIONALE:

Curly-leaf pondweed (*Potamogeton crispus*) (CLP) is an invasive exotic plant that is common to abundant in parts of Balsam Lake. In their 2010 and 2015 Wisconsin Department of Natural Resources (WDNR) approved Aquatic Plant Management Plans (APMP), the Balsam Lake Protection and Rehabilitation District's (BLPRD) identified a) reducing overall lake coverage of CLP to <20 acres and b) relieving navigation impairment caused by canopied CLP beds as management goals (Clemens 2010, Clemens 2015). As part of their continuing efforts to meet these goals, the BLPRD is actively engaged in both herbicide treatments and mechanical harvesting. Although levels of CLP and native plants before and after herbicide use have been carefully studied, the long-term impacts of harvesting on the lake's vegetation have not been quantified. Because of this, in 2021, the BLPRD and Harmoney Environmental (HE) requested we initiate annual preharvest sub point-intercept surveys of all plant species and fall CLP turion surveys in City Bay north of the CTH I bridge/south of First Island within areas historically dominated by CLP. This report is the summary analysis of our October 19, 2024 turion survey.

CLP LIFE HISTORY AND STUDY OBJECTIVES:

Although Curly-leaf pondweed occasionally reproduces by seed, the vast majority of plants resprout from stiff overwintering buds called turions that are normally produced in number by the plants prior to their late June/early July senescence (Figure 2). After the pinecone-like turions germinate in late fall or early winter, plants continue to grow slowly under the ice. Following ice out, growth accelerates, and plants rapidly canopy allowing them a competitive advantage over slower growing native species (Capers 2005).

Figure 2: Germinating CLP Turion

Research suggests approximately 50% of turions germinate in a growing season while the rest remain dormant until the following growing season when another 50% will germinate (Johnson 2012). Depending on the level of turions at a given location and knowing that latent turions may be able to survive for over 5 years in the sediment, it may take several years of control to exhaust the "turion bank" (R. Newman – U of M unpublished data).

Following the 2024 summer growing season, we conducted a fall turion survey. The goals of the study were to determine the level of remaining CLP turions within City Bay's historic high-density CLP areas; and, if there were any present, to predict whether their numbers suggested there would likely be enough to cause navigation issues in 2025. This report is the summary analysis of that survey conducted on October 19, 2024.

METHODS:

Ponar Dredge Turion Survey:

Starting with the spring 2020 survey that outlined a 9.81-acre Curly-leaf pondweed bed in City Bay, we used Hawth's Analysis Tools Extension to ArcGIS 9.3.1 to generate regular points at the rate of just over three points/acre within the historic bed. This produced a 30-point sampling grid which was used during each of our surveys to allow for direct comparisons (Figure 3) (Appendix I). For ease in determining the total impact of the current harvesting program, we also left the 2021 – 2023 narratives in the results section of this report.

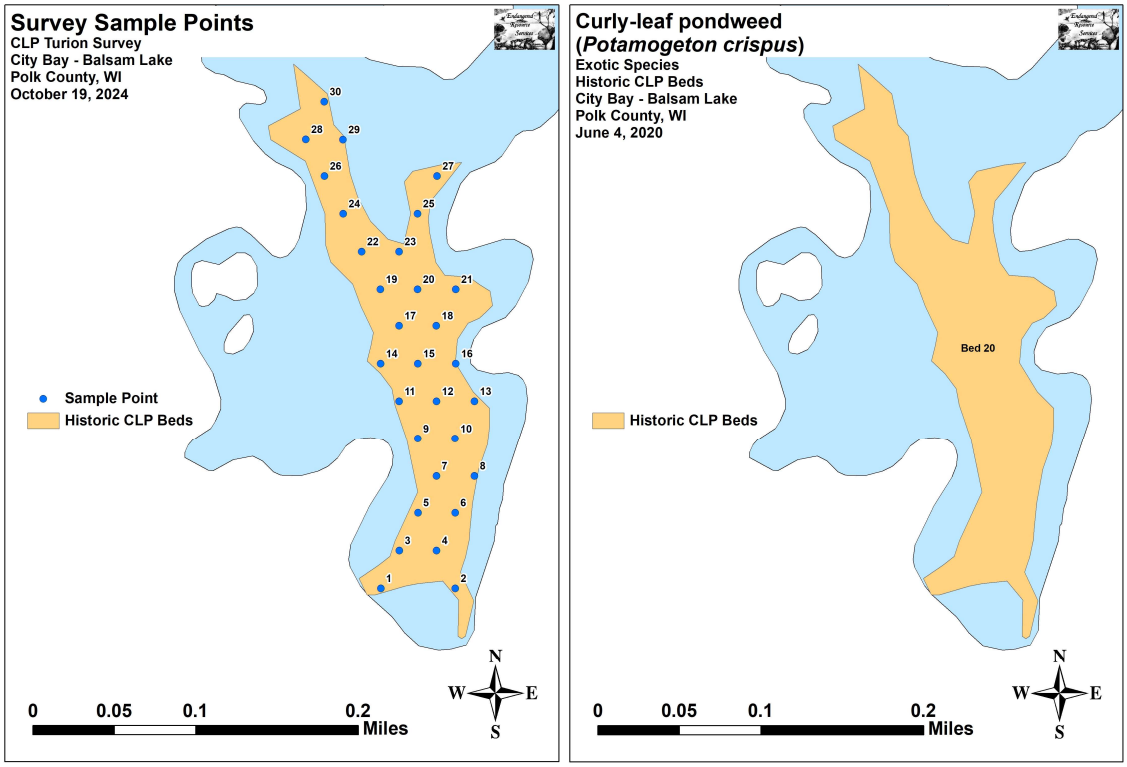


Figure 3: Turion Survey Sample Points in Historic CLP Beds

During the surveys, we located each point with a handheld mapping GPS unit (Garmin 76CSx) and used a Petite Ponar dredge with a 0.0232m^2 (36in^2) sample area to take a bottom sediment grab from each side of the boat at each location. These samples were then rinsed in a fine sieve to separate out the sediment (Figure 4). Samples with high numbers of turions or significant amounts of detritus were bagged for later analysis; at which time we discarded all rotten turions, tallied all live turions, and multiplied the combined total live turions from the two samples by 21.53 to estimate turions/m^2 at each location. This value gives an idea of how many CLP plants will germinate in an area during the following growing season.

Figure 4: Ponar Grab and Turion Sieving

DATA ANALYSIS:

We entered all data collected into an Excel spreadsheet and used standard formulas in the data analysis tool pack to calculate the following:

Total number of points sampled: This value is the total number of points on the lake within the study area. We took two Ponar samples at each sample point.

Total number of live turions: This value includes all live turions found at all sites within a study area.

Total number of points with live turions: This number includes all survey sites that had at least one turion in **either** of the Ponar samples taken at the site.

Frequency of occurrence: The frequency of turions is generally reported as a percentage of occurrences at all sample points. The value is used to extrapolate coverage within the study area. For example, if 20% of all sample sites have turions, it suggests that 20% of the study area will have at least some Curly-leaf pondweed coverage the following year.

Points at or above nuisance level: This value gives the number of survey sites within the study area that were above the predicted nuisance threshold (Figure 5). Research suggests that when the turion density is at or above 200/m^2, the following year's CLP growth has the potential to at least moderately impair navigation (Johnson 2012).

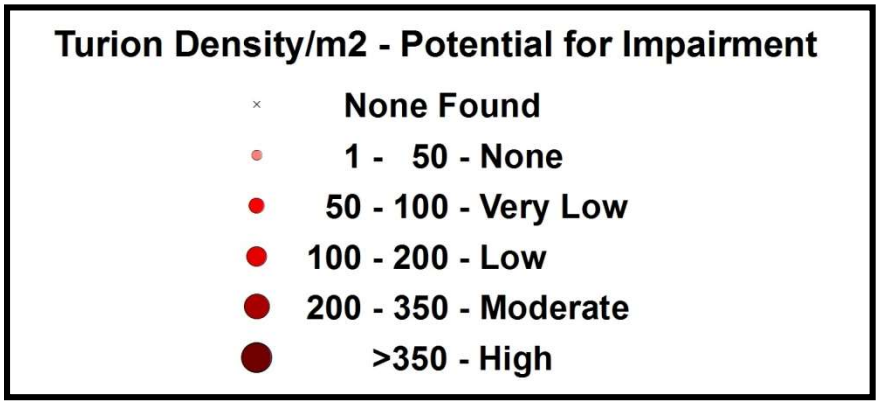


Figure 5: Predicted Navigation Impairment Based on Turion Density

Percent nuisance level: The percentage of nuisance points divided by the total number of survey points can be extrapolated to determine what percent of the study area has the potential to have at least moderate navigation impairment during the next growing season.

Mean turions/m^2: This value is the average number of turions/m^2 when pooling the data from all survey sites regardless of whether or not they had turions present.

Standard deviation of turions/m^2: This value tells us how far apart the data is from the mean. A low standard deviation suggests most points have a turion density that was similar to the mean, while a high value suggests there was greater variability in turion density within the sample area.

Year-over-Year Significant Differences:
Data from the 2021-2024 surveys were compared using paired t-tests as we returned to the same sites during each survey. Year-over-year differences were determined to be significant at $p<0.05$, moderately significant at $p<0.01$, and highly significant at $p<0.001$ (Tables 1-3).

RESULTS AND DISCUSSION:
2021 Fall Ponar Dredge CLP Turion Survey:
The November 20, 2021 survey found 37 live CLP turions at 14 of 30 survey sites (46.67% coverage) (Figure 6) (Appendix II). Of these, only one point (3.00%) suggested CLP growth in 2022 had the potential to exceed the nuisance threshold with densities >200 turions/m^2 (Table 1), and just five points (16.67%) were predicted to cause any impairment at all.

The overall mean turion density was 26.55 turions/m^2. This value suggested that the average point wasn't likely to cause any impairment. Turion densities were, however, somewhat variable with the standard deviation value of 45.82 being almost twice the mean.

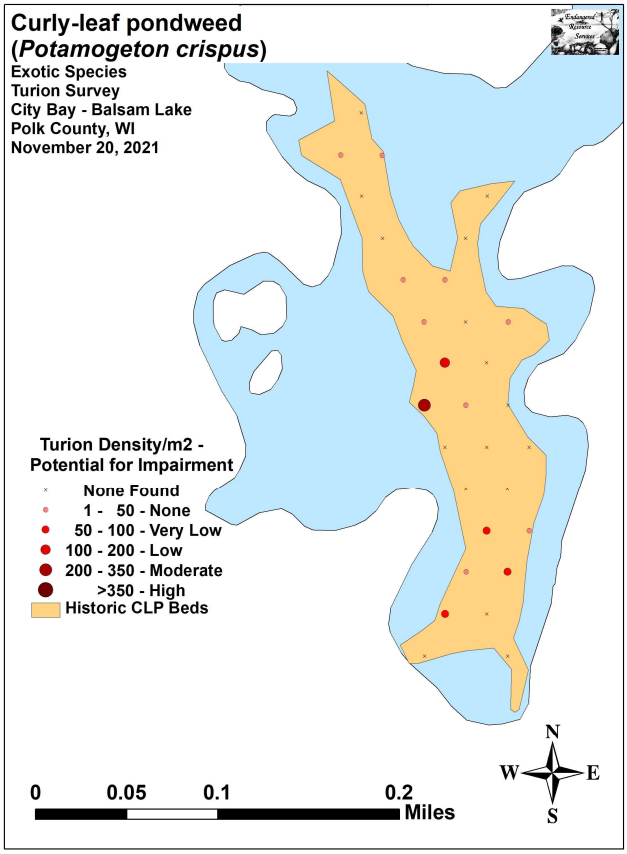


Figure 6: 2021 Fall CLP Turion Survey Density and Distribution

2022 Fall Ponar Dredge CLP Turion Survey:

During the October 18, 2022 survey, we found 50 live CLP turions at 18 of 30 points (60.00% coverage) (Figure 7) (Appendix II). This was an increase in distribution of 28.57% from the 14 points with 37 live turions in 2021 (Table 1). No points suggested there would be "nuisance level" CLP in 2023, but nine points (30.00%) were likely to have some impairment. This was an 80.00% increase from 2022 when just five points were predicted to cause any impairment.

We calculated the overall mean density within the study area at 35.88 turions/m^2 with a standard deviation of 45.35 turions/m^2. This was a non-significant increase (p=0.11) from 2021 when we found a mean of 26.55 turions/m^2 with a standard deviation of 45.82 turions/m^2. Visual analysis of the 2021 and 2022 maps suggested most points with predicted impairment occurred along the western edge of the bed adjacent to uninhabited areas of Idlewild Bay. Mean turion densities continued to be variable with the standard deviation being greater than the mean.

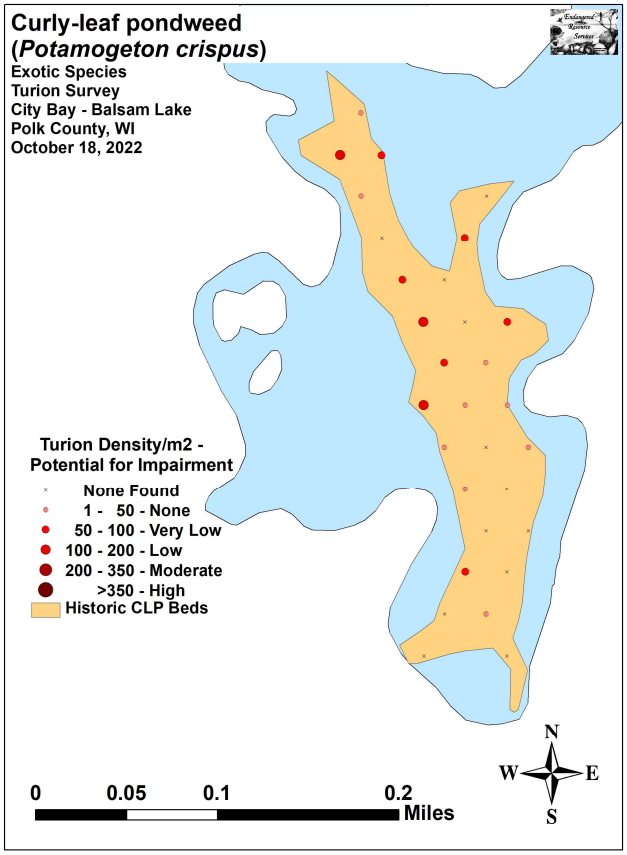


Figure 7: 2022 Fall CLP Turion Survey Density and Distribution

Table 1: CLP Turion Surveys - Summary Statistics
City Bay - Balsam Lake - Polk County, Wisconsin
November 20, 2021 and October 18, 2022

	2021	2022
Summary Statistics:	Total	Total
Total number of points sampled	30	30
Total live turions	37	50
Total number of points with live turions	14	18
Frequency of occurrence (in percent)	46.67	60.00
Points at or above nuisance level (+200/m^2)	1	0
% Nuisance level	3.33	0.00
Maximum turions/m^2	215	172
Mean turions/m^2	26.55	35.88
Standard deviation/m^2	45.82	45.35
Standard error of the paired difference		0.34
Degrees of freedom		29
t-statistic		1.26
p - value		0.11

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

2023 Fall Ponar Dredge CLP Turion Survey:

Our October 14, 2023 survey found 54 live CLP turions at 19 of 30 points (63.33% coverage) (Figure 8) (Appendix II). This was an increase in distribution of 5.56% from the 18 points with 50 live turions in 2022 (Table 2). A single point (3.33%) suggested there would likely be "nuisance level" CLP in 2024, but eight points (26.67%) were likely to have some impairment. This was an 11.11% decrease from 2023 when nine points were predicted to cause any impairment.

We calculated the overall mean density within the study area at 38.75 turions/m^2 with a standard deviation of 51.94 turions/m^2. This was a non-significant increase (p=0.37) from 2022 when we found a mean of 35.88 turions/m^2 with a standard deviation of 45.35 turions/m^2. Visual analysis of the 2023 map showed most points with predicted impairment occurred in side bays and in the northern lobes of the study area. Mean turion densities continued to be variable with the standard deviation being greater than the mean. This suggests CLP coverage in 2024 will continue to be patchy.

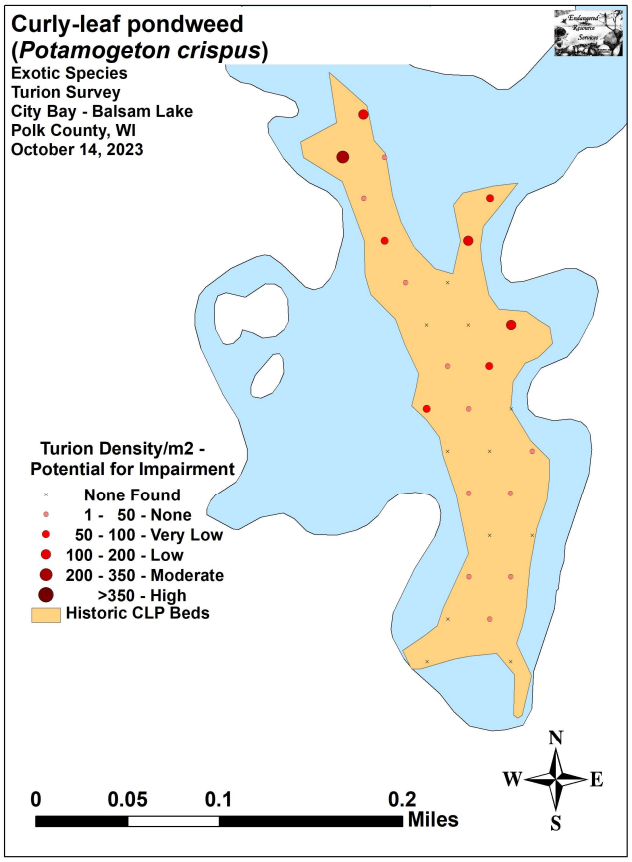


Figure 8: 2023 Fall CLP Turion Survey Density and Distribution

Table 2: CLP Turion Surveys - Summary Statistics
City Bay - Balsam Lake - Polk County, Wisconsin
October 18, 2022 and October 14, 2023

	2022	2023
Summary Statistics:	Total	Total
Total number of points sampled	30	30
Total live turions	50	54
Total number of points with live turions	18	19
Frequency of occurrence (in percent)	60.00	63.33
Points at or above nuisance level (+200/m^2)	0	1
% Nuisance level	0.00	3.33
Maximum turions/m^2	172	237
Mean turions/m^2	35.88	38.75
Standard deviation/m^2	45.35	51.94
Standard error of the paired difference		0.39
Degrees of freedom		29
t-statistic		0.35
p - value		0.37

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

2024 Fall Ponar Dredge CLP Turion Survey:

On October 19, 2024, we found 56 live CLP turions at 20 of 30 points (66.67% coverage) (Figure 9) (Appendix II). This was almost identical to the 19 points (63.33% coverage) with 54 live turions found in 2023 (Table 3). No points suggested there would likely be "nuisance level" CLP in 2025, but seven points (23.33%) were likely to have some impairment. This was a 12.50% decrease from 2023 when eight points were predicted to cause any impairment.

The overall mean density was 40.19 turions/m^2 with a standard deviation of 46.87 turions/m^2. This was a non-significant increase (p=0.44) when compared to 2023 when we found a mean of 38.75 turions/m^2 with a standard deviation of 51.94 turions/m^2. Visual analysis of the 2024 map showed most points with predicted impairment occurred in side bays and in the northwest lobe. Mean turion densities continued to be variable with the standard deviation being greater than the mean. This suggests CLP coverage in 2025 will again be variable.

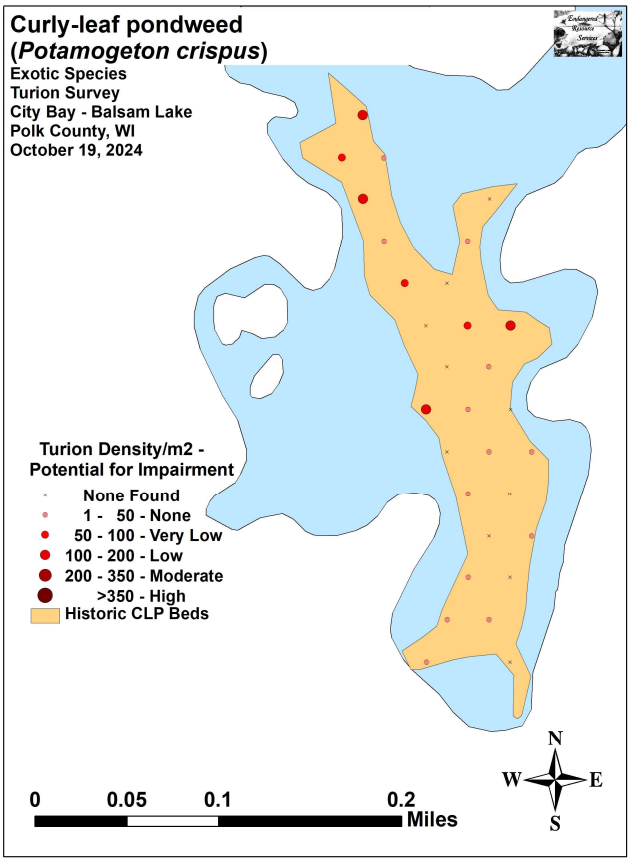


Figure 9: 2024 Fall CLP Turion Survey Density and Distribution

Table 3: CLP Turion Surveys - Summary Statistics
City Bay - Balsam Lake - Polk County, Wisconsin
October 14, 2023 and October 19, 2024

	2023	2024
Summary Statistics:	Total	Total
Total number of points sampled	30	30
Total live turions	54	56
Total number of points with live turions	19	20
Frequency of occurrence (in percent)	63.33	66.67
Points at or above nuisance level (+200/m^2)	1	0
% Nuisance level	3.33	0.00
Maximum turions/m^2	237	172
Mean turions/m^2	38.75	40.19
Standard deviation/m^2	51.94	46.87
Standard error of the paired difference		0.45
Degrees of freedom		29
t-statistic		0.15
p - value		0.44

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

LITERATURE CITED

Capers, R.S., G.J. Bugbee, R. Selsky and J.C. White. 2005. A guide to invasive aquatic plants in Connecticut. Conn. Agric. Exp. Sta. Bull. 997.

Clemens, C. [online]. 2010. Aquatic Plant Management Plan - Balsam Lake Polk County, WI. Sponsored by Balsam Lake Protection and Rehabilitation District - Prepared by Harmony Environmental – October 2010. Available from http://www.blprd.com/docs/BalsamLakeAPMfinal101810.pdf (2024, October).

Clemens, C. [online]. 2015. Aquatic Plant Management Plan - Balsam Lake Polk County, WI. Sponsored by Balsam Lake Protection and Rehabilitation District - Prepared by Harmony Environmental – September 2015. Available from http://www.blprd.com/docs/BalsamLakeAPM2015FINAL.pdf (2024, October).

Hopke, R., E. Nelson, and E. Eaton [online]. 1964. Balsam Lake Maps. Available from https://apps.dnr.wi.gov/doclink/lakes_maps/2620600a.pdf (2024, October).

Johnson, J.A., A.R. Jones & R.M. Newman (2012): Evaluation of lakewide, early season herbicide treatments for controlling invasive curly-leaf pondweed (*Potamogeton crispus*) in Minnesota lakes, Lake and Reservoir Management, 28:4, 346-363

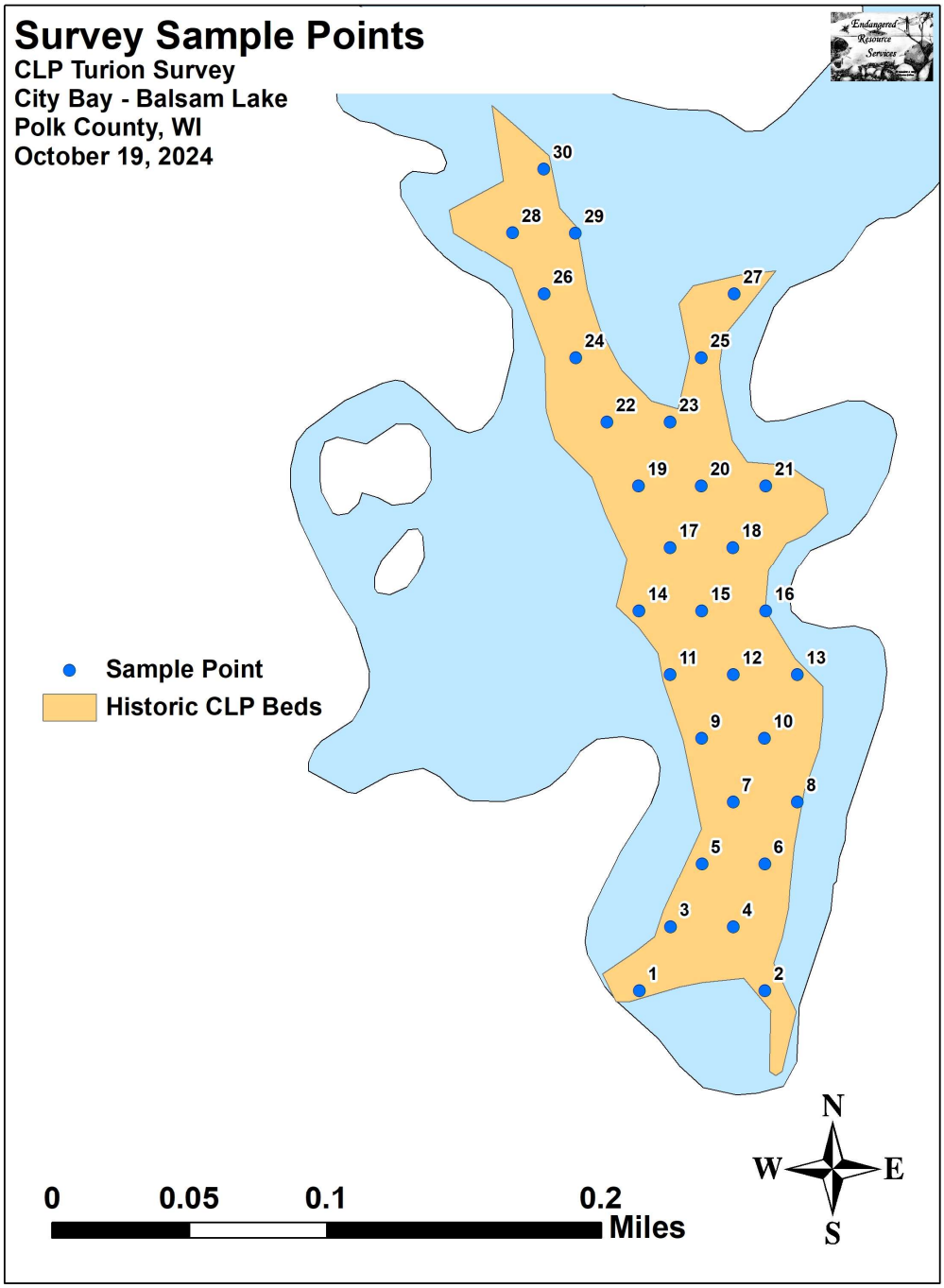
UWEX Lakes Program. [online]. 2010. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/ecology/aquaticplants/default.aspx (2024, October).

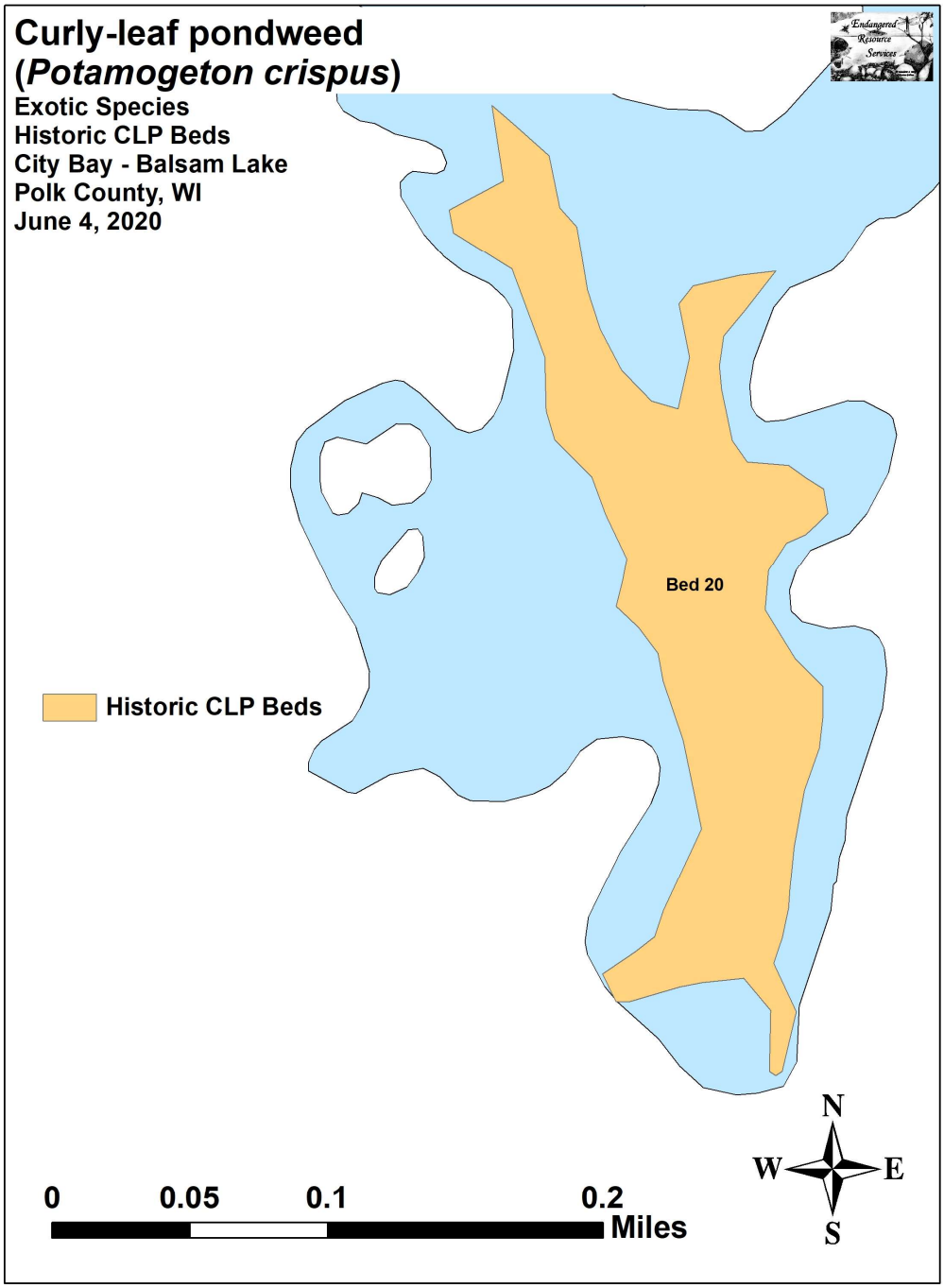
UWEX Lakes Program. [online]. 2010. Pre/Post Herbicide Comparison. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Documents/ecology/Aquatic%20Plants/Appendix-D.pdf (2024, October).

WDNR. [online]. 2024. Balsam Lake Citizen Monitoring Water Quality Database. Available from https://apps.dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2620600&page=waterquality (2024, October).

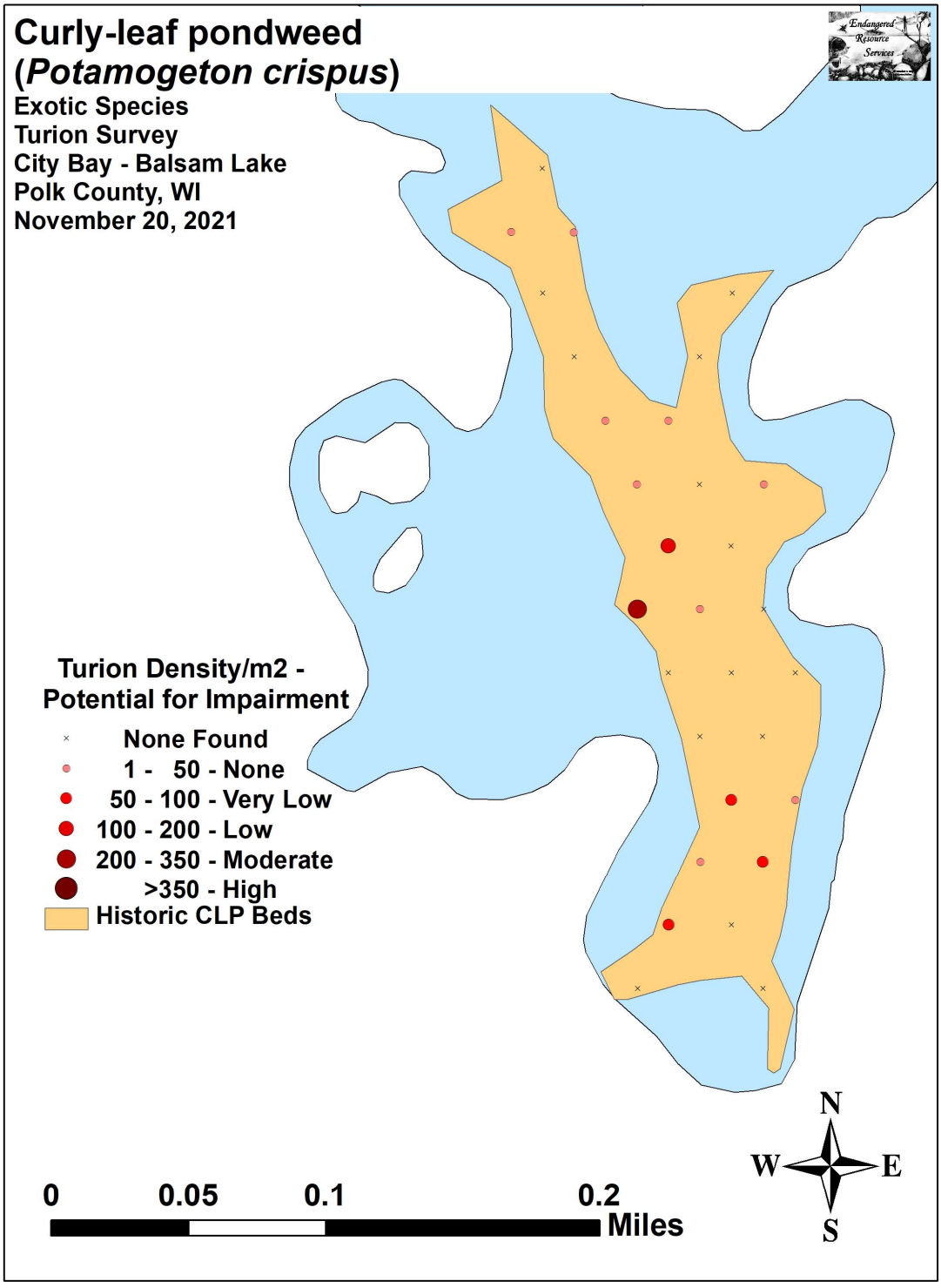
WDNR. [online]. 2024. Wisconsin Lakes Information – Balsam Lake – Polk County. https://apps.dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2620600 (2024, October).

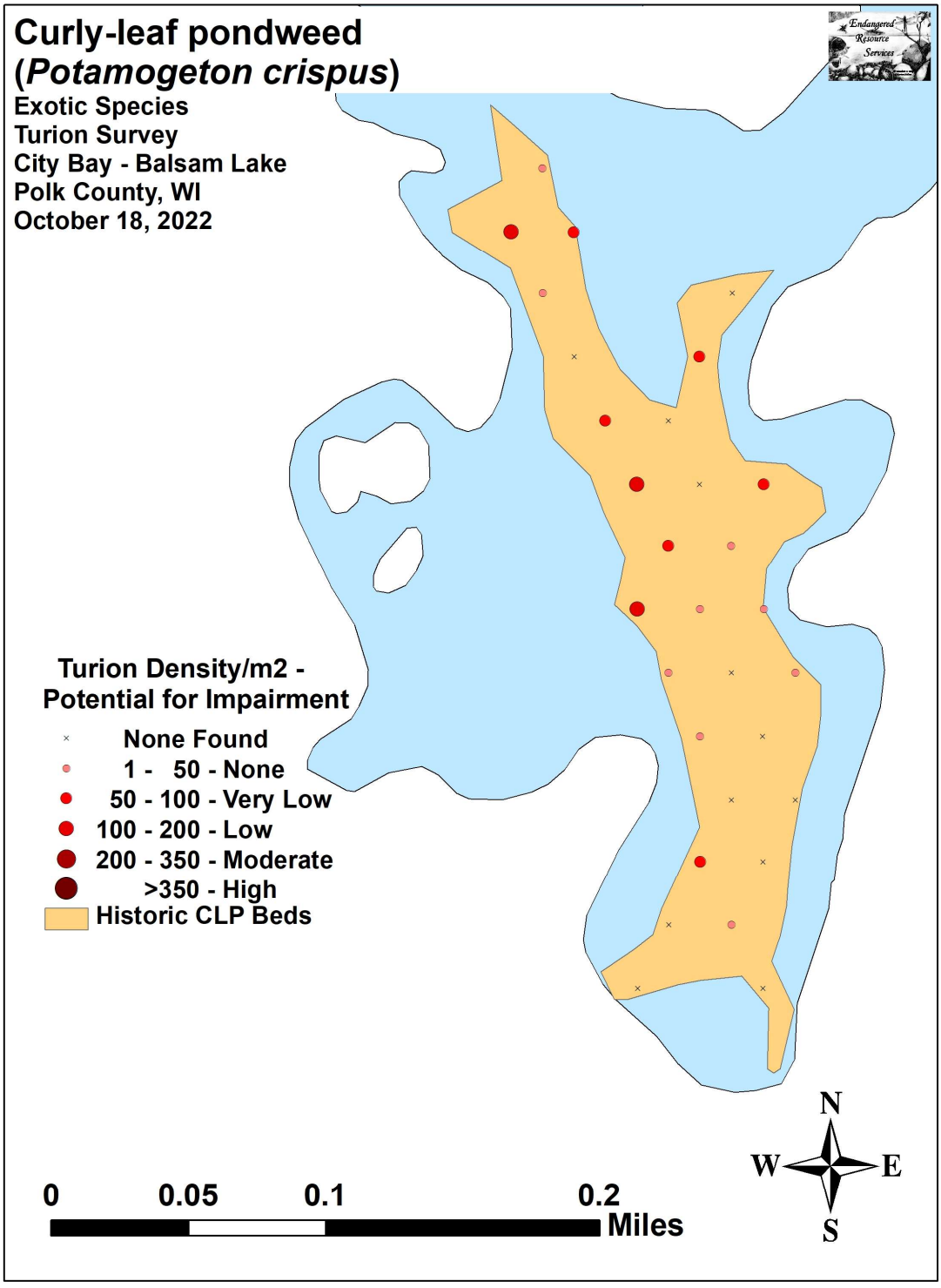
Appendix I: Survey Sample Points and Historic CLP Beds


Survey Sample Points
CLP Turion Survey
City Bay - Balsam Lake
Polk County, WI
October 19, 2024
Endangered Resource Services
30
28
29
26
27
24
25
22
23
19
20
21
17
18
14
15
16
11
12
13
9
10
7
8
5
6
3
4
1
2
Sample Point
Historic CLP Beds
0
0.05
0.1
0.2
Miles
N
W
E
S


Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
Historic CLP Beds
City Bay - Balsam Lake
Polk County, WI
June 4, 2020
Endangered Resource Services
Bed 20
Historic CLP Beds
N
W
E
S
0
0.05
0.1
0.2
Miles

Appendix II: 2021, 2022, 2023, and 2024 Fall Curly-leaf Pondweed Turion Density & Distribution Maps


Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
Turion Survey
City Bay - Balsam Lake
Polk County, WI
November 20, 2021
Endangered Resource Services
Turion Density/m2 -
Potential for Impairment
None Found
1 - 50 - None
50 - 100 - Very Low
100 - 200 - Low
200 - 350 - Moderate
>350 - High
Historic CLP Beds
0
0.05
0.1
0.2
Miles
N
W
E
S


Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
Turion Survey
City Bay - Balsam Lake
Polk County, WI
October 18, 2022
Endangered Resource Services
Turion Density/m2 -
Potential for Impairment
None Found
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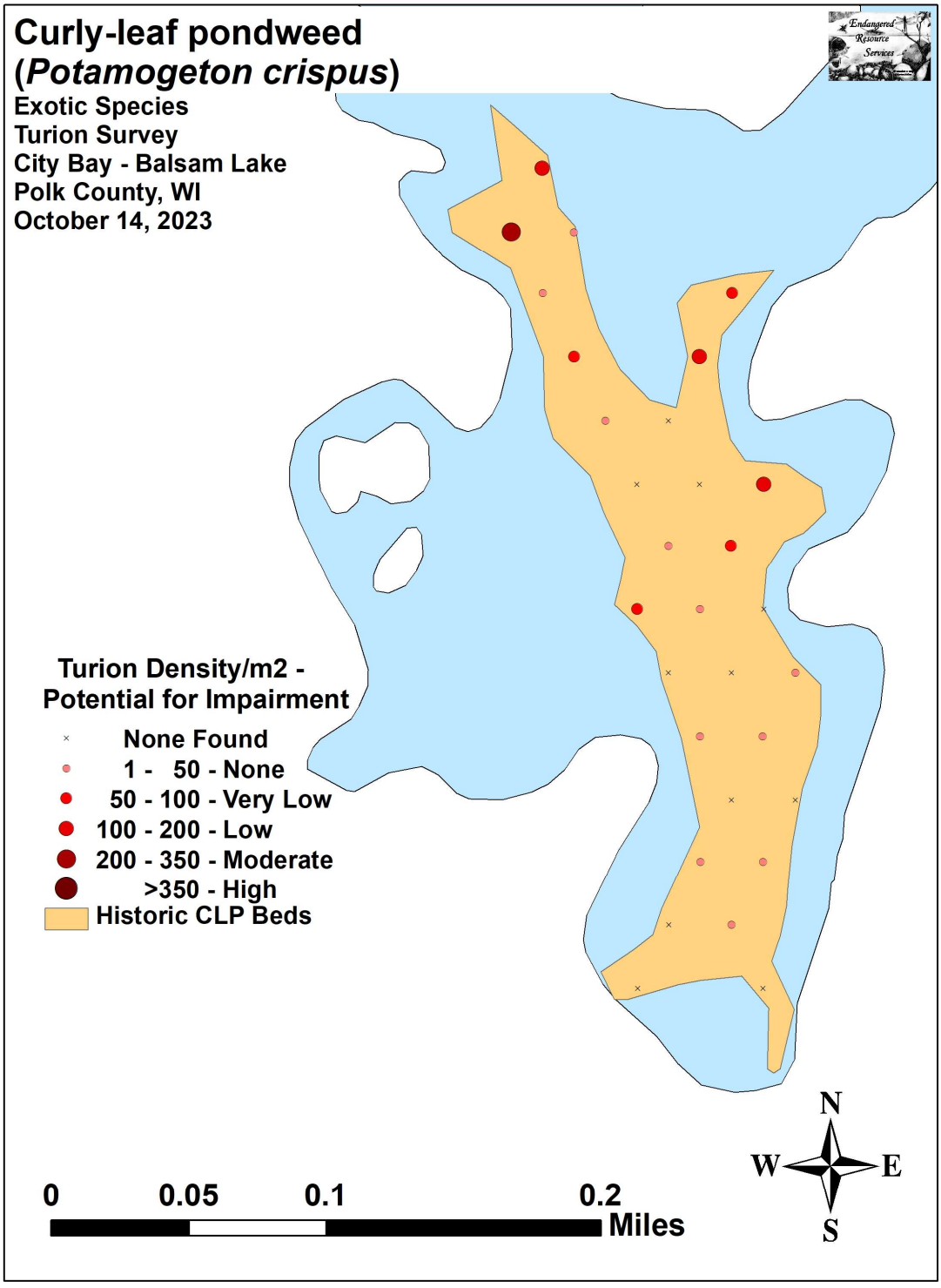
100 - 200 - Low
200 - 350 - Moderate
>350 - High
Historic CLP Beds
N
W
E
S
0
0.05
0.1
0.2
Miles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(Potamogeton crispus)
Exotic Species
Turion Survey
City Bay - Balsam Lake
Polk County, WI
October 14, 2023
Endangered Resource Services
Turion Density/m2 -
Potential for Impairment
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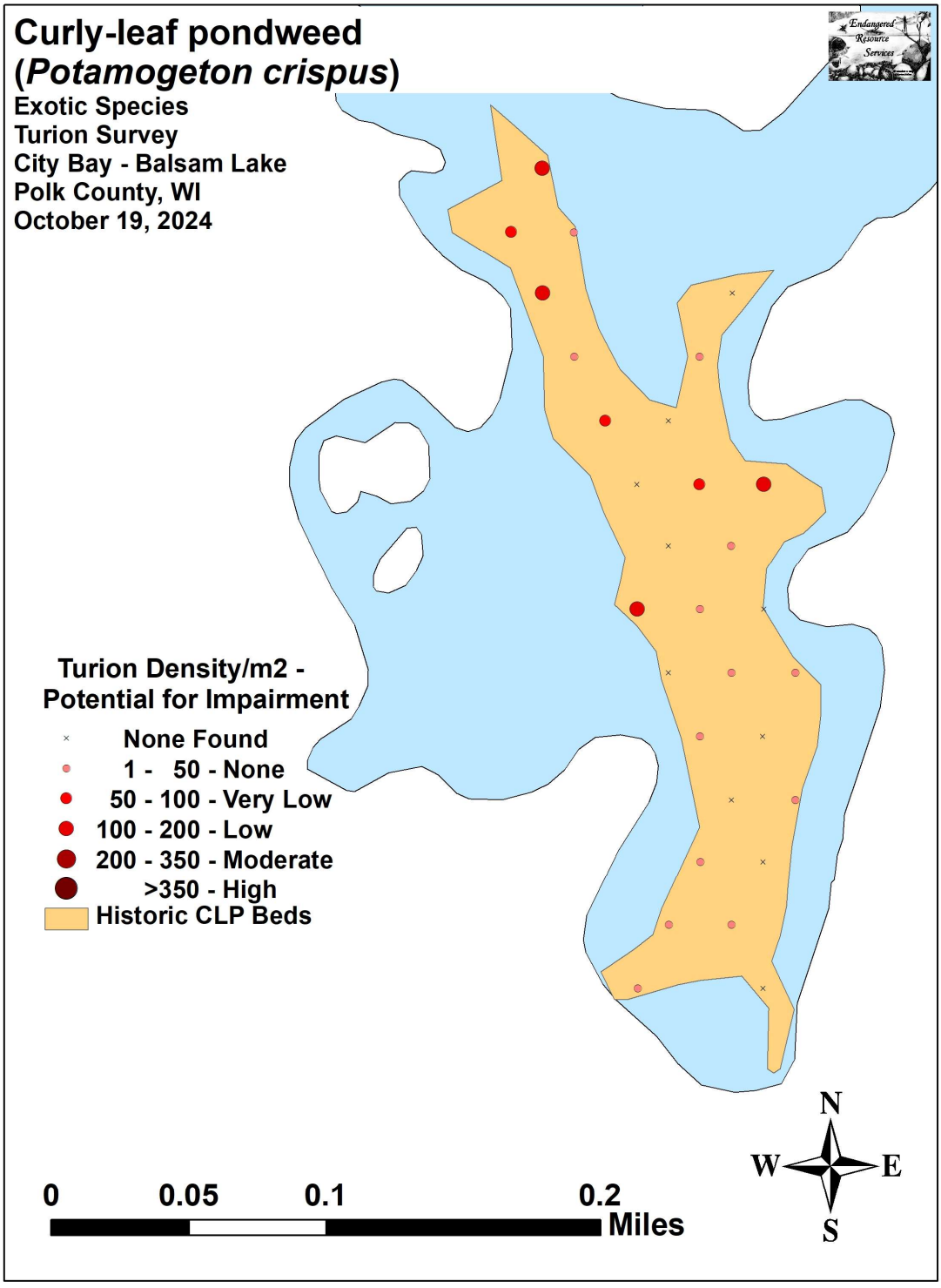
100 - 200 - Low
200 - 350 - Moderate
>350 - High
Historic CLP Beds
N
W
E
S
0
0.05
0.1
0.2
Miles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(Potamogeton crispus)
Exotic Species
Turion Survey
City Bay - Balsam Lake
Polk County, WI
October 19, 2024
Endangered Resource Services
Turion Density/m2 -
Potential for Impairment
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50 - 100 - Very Low
100 - 200 - Low
200 - 350 - Moderate
>350 - High
Historic CLP Beds
0
0.05
0.1
0.2
Miles
N
W
E
S