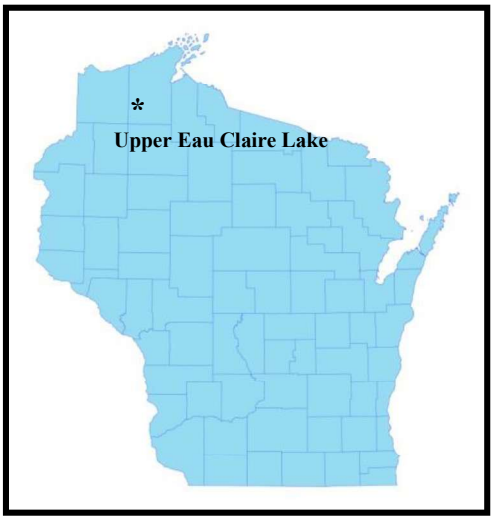
Curly-leaf pondweed (*Potamogeton crispus*) Bed Mapping Survey
Upper Eau Claire Lake – WBIC: 2742700
Bayfield County, Wisconsin

Curly-leaf pondweed bed in Upper Eau Claire Lake's southwest bay - 6/14/24

Upper Eau Claire Lake aerial photo with 2024 CLP beds.

Project Initiated by:

The Town of Barnes – Aquatic Invasive Species Committee,
Lake Education and Planning Services, LLC, and the
Wisconsin Department of Natural Resources (Grant ACEI24521)



Curly-leaf pondweed in the outlet bay narrows in Upper Eau Claire Lake's – 6 14 24

Survey Conducted by and Report Prepared by:

Endangered Resource Services, LLC
Matthew S. Berg, Research Biologist
St. Croix Falls, Wisconsin
June 14, 2024

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INTRODUCTION:

Upper Eau Claire Lake (WBIC 2742700) is a 1,024-acre stratified drainage lake located in southwestern Bayfield County, Wisconsin in the Town of Barnes (T44N R9W S2-3, 9-11, and 15-16). It reaches a maximum depth of 92ft in the hole due west of Three-in-One Island and has an average depth of approximately 29ft (Figure 1). The lake is oligotrophic in nature with summer Secchi readings over the last ten years averaging 18.4ft (WDNR 2024). This very good clarity produced a littoral zone that reached over 20ft in 2024. The bottom substrate is predominately sand and sandy muck, although areas of gravel are located throughout the lake – especially around exposed points and on shallow flats and sunken islands (Eaton et al 1974).

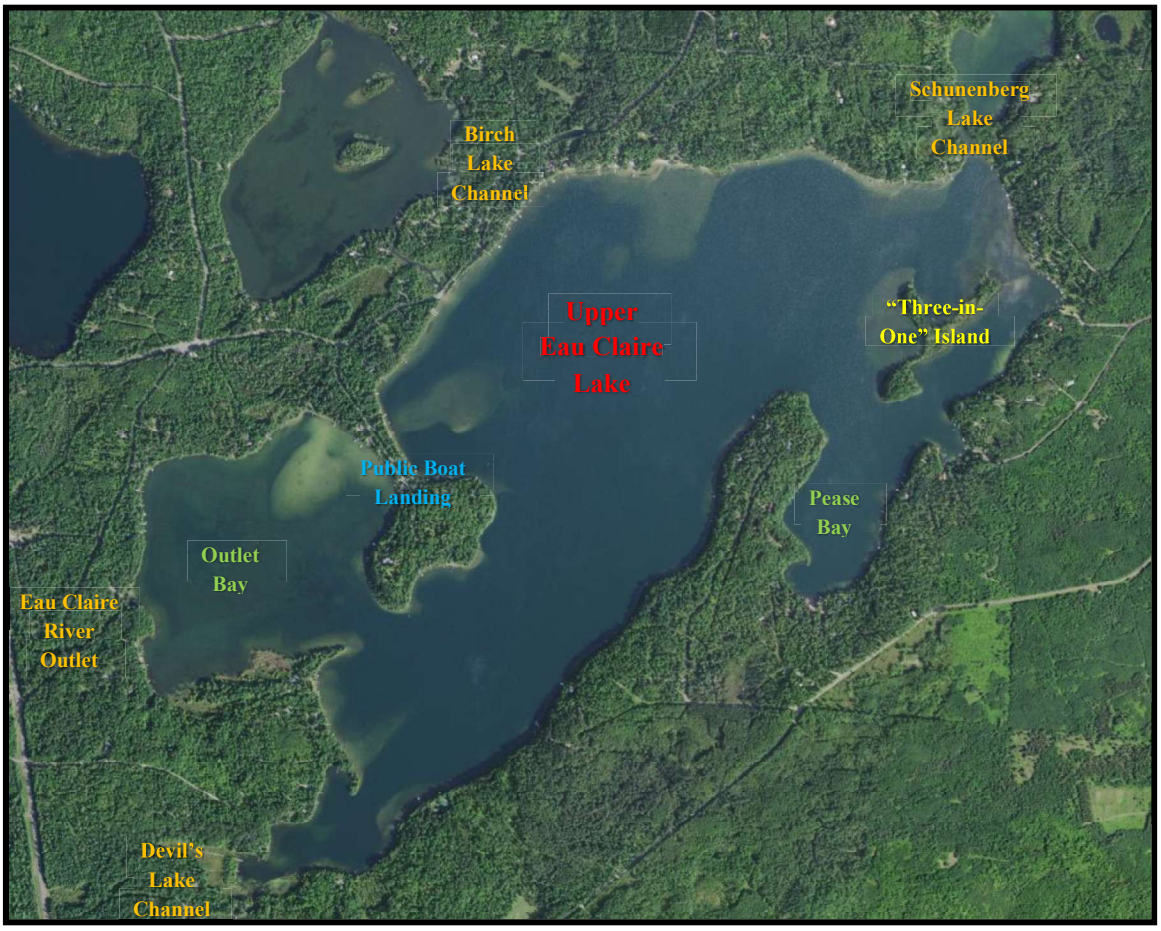

Figure 1: Upper Eau Claire Lake Aerial Photo

BACKGROUND AND STUDY RATIONALE:

In 2005, concern over the spread of Eurasian water-milfoil (*Myriophyllum spicatum*) (EWM) into nearby Tomahawk and Sand Bar Lakes prompted members of the Town of Barnes Aquatic Invasive Species Committee (then the Eurasian water-milfoil Committee) and the Eau Claire Lakes Area Property Owners Association (ECLAPOA) to authorize an initial point-intercept survey to look for exotic plant species in the lakes. This survey did **not** find EWM, Curly-leaf pondweed (*Potamogeton crispus*) (CLP), or any other exotic species in either Upper or Middle Eau Claire Lakes (Kudlas et al. – pers. comm.).

Along with the original 2005 point-intercept survey, the TOB/ECLAPOA initiated a Clean Boats/Clean Waters monitoring program at the lakes' landings, and trained volunteers as shoreline spotters to look for exotic invasive species. These spotters ultimately discovered CLP in Pease Bay on Upper Eau Claire Lake and in the south bays of Middle Eau Claire Lake during the summer of 2012. In an effort to determine how to deal with the newly found infestation, the TOB applied for and received a rapid response grant that authorized three plant surveys on each lake in 2013: May CLP point-intercept surveys, June CLP bed mapping surveys with a SCUBA habitat assessment, and late July warm-water point-intercept macrophyte surveys.

As these surveys found only small amounts of CLP that were generally minor components within expansive beds of beneficial habitat-forming native vegetation, it was decided to limit control of CLP to manual removal by volunteers. However, when a follow-up CLP bed mapping survey in 2015 found expanding numbers of small beds on both lakes, it was determined that suction harvesting using the "Barnes Aquatic Invasive Species Sucker" or BAISS would be employed to increase capacity. BAISS harvesting continued from 2015-2022 with occasional CLP bed mapping surveys used to guide harvesting and assess the efficacy of the program. Following the uptick in acreage we documented in 2021, we were again asked to conduct bed mapping surveys to assess the effectiveness of early-season BAISS removal and to look for new areas with CLP in 2022, 2023, and 2024. This report is the summary analysis of our June 14, 2024 survey.

METHODS:

Curly-leaf Pondweed Bed Mapping Survey:

During the bed mapping survey, we searched the lake's visible littoral zone. By definition, a "bed" was determined to be any area where we visually estimated that CLP made up >50% of the area's plants, was generally continuous with clearly defined borders, and was canopied, or close enough to being canopied that it would likely interfere with boat traffic. After we located a bed, we motored around the perimeter of the area taking GPS coordinates at regular intervals. We also estimated the rake density range and mean rake fullness of the bed (Figure 2), the maximum depth of the bed, whether it was canopied, and the impact it was likely to have on navigation (**none –** easily avoidable with a natural channel around or narrow enough to motor through/**minor –** one prop clear to get through or access open water/**moderate –** several prop clears needed to navigate through/**severe –** multiple prop clears and difficult to impossible to row through). These data were then mapped using ArcMap 9.3.1, and we used the WDNR's Forestry Tools Extension to determine the acreage of each bed to the nearest hundredth of an acre (Tables 1 and 2).

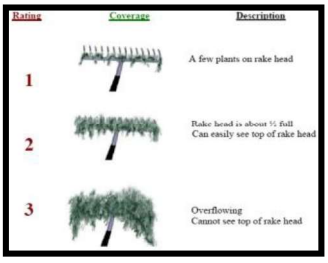

Figure 2: Rake Fullness Ratings (UWEX 2010)

RESULTS:

Summary of Past Curly-leaf Pondweed Bed Mapping Surveys:

During our original 2013 survey, we mapped eight small beds totaling 0.11 acre (0.01% of the lake's 1,024 acres) in the channel/bays east of Three-in-One Island (Figure 3) and in Pease Bay (Figure 4) (Appendix I). The biggest was 0.03 acre (Beds 3 and 5) and the smallest was little more than a few 10's of plants covering <0.001 acre (Bed 8) (Table 1).

The 2015 survey found four beds that totaled 0.17 acre with the biggest (Bed 4) covering 0.11 acre and the smallest (7B) encompassing <0.01 acre (Table 1). Collectively, this was an increase of 0.06 acre from the 2013 survey; however, this amount was within the error range of the GPS. Each of these beds was canopied, had a low mean rake fullness of 1, and a rake range that varied from 1-2 (low to moderate). Although canopied, because these beds were so small, they were easily avoided, and it seemed unlikely that they would cause even minor navigation impairment.

East of Three-in-One Island, we noted that three of the beds we mapped in 2013 (Beds 1, 2, and 5) had completely disappeared after volunteers pulled plants in these areas during the 2014 growing season. We also saw no evidence of CLP in the deep-water areas bordering Pease Bay where we mapped Beds 6 and 8 in 2013. At these locations, it may be that CLP, which was never dense, just didn't canopy or even get close enough to the surface that we could see it. It may also be that localized conditions prevented turions from germinating in 2015.

Our 2020 survey found two "beds" totaling 0.04 acre – a 0.13-acre decline (-76.47%) from 2015 (Table 1). Bed 3A east of Three-in-One Island consisted of about 30 total plants most of which we were able to rake remove. Bed 5A also contained only about 20-30 plants, but they were in a tight cluster and covered a much smaller area. We were also able to rake remove most of them although some turions broke off as the plants were beginning to senesce. Other than a few floating plants that had broken free from the bottom, we saw no evidence of CLP anywhere else in the lake. Following the survey, we were informed that the BAISS boat had already been on the lake, and that may explain the sharp decline relative to the 2015 survey.

In 2021, we mapped seven areas totaling 0.69 acre. This was a 0.65-acre increase (+1,605%) compared to 2020, but still represented only 0.07% of the lake's total surface area (Table 1). The biggest was 0.37 acre (Bed 5B) while the smallest (Beds 5 and 5D) covered <0.01 acre. All three beds occurred in a nearly continuous low to moderate density line running down the channel east of Three-in-One Island in water from 5-13ft deep (Figure 3). In Pease Bay, the only CLP seen was a new bed (5AA) in the northeast side bay (Figure 4). Unfortunately, for the first time ever, we also found a small but very dense deepwater bed (Bed 9) in the lake's far southwest bay (Figure 5). Even with the 2021 increase in acreage, none of the lake's CLP beds were likely to cause more than moderate impairment, and even that was questionable as most beds were easily avoided.

Despite the late ice out in 2022, we were informed that the BAISS team intended to start harvesting on Upper Eau Claire on May 31st (B. Clements – pers. comm). This meant that our survey would again serve as a postharvest assessment that would be used to guide management in 2023. Because of the late start to the growing season, we waited until the end of June to complete our survey to give CLP the maximum amount of time to grown and top out.

On June 28th, we located five beds covering 0.67 acre (0.07% of the lake's surface area). This was a decline of 0.02 acre compared to 2021 (-2.90%) (Table 1). In the bay northeast of Three-in-One Island, we found only scattered plants in the area formerly covered by Bed 3A. Elsewhere in the bay, we saw only a few handfuls of plants. The biggest beds (5B and 5C) were nearly continuous in the channel directly east of the islands. Although they were both moderately dense and combined to cover 0.41 acre, neither was canopied and, because of this, they likely weren't causing more than a minor impairment (Figure 3). In Pease Bay, we again saw no evidence of CLP outside of Bed 5AA in the northeast side bay. Although still only 0.24 acre, this area showed noticeable expansion compared to 2021. This may indicate that there wasn't time to harvest plants from this bay (Figure 4). Despite raking throughout the area where we delineated Bed 9 in the lake's southwest bay during our 2021 survey, we found no evidence of CLP here in 2022 (Figure 5).

Ice out in 2023 was again late, but, following a rapid warm-up, lake temperatures shot into the 60's in only a few weeks. Presumably because of this, we found Curly-leaf pondweed on most lakes was stunted in growth, and we noted plants were falling over and dying earlier than usual on several other lakes we work on further south. Because of this, we decided to survey earlier than we had in 2022. On June 20, 2023, we searched 25.5km (15.8 miles). We had mostly sunny skies and calm conditions that allowed us to see down in the water column approximately 8-10ft.

Ultimately, we located six beds covering 0.97 acre (0.09% of the lake's surface area). This was an increase of 0.30 acre compared to 2022 (+44.78%) (Table 1). In the bay northeast of Three-in-One Island, we found only scattered plants in the area formerly covered by Bed 3A. Elsewhere in the bay, we saw only a few handfuls of plants many of which we rake removed including all of Bed 4A. The biggest bed was again 5B (0.74 acre) which occurred directly east of the islands. Although it was again moderately dense, because it was subcanopy, it wasn't likely causing more than a minor impairment to navigation (Figure 3). In Pease Bay, we again saw no evidence of CLP outside of Bed 5AA in the northeast side bay where we found the BAISS crew hard at work and making significant progress as the bed was already much smaller than in 2022 (Figure 4). Had they already finished on the lake, our final total might also have been lower and more reflective of the actual year-over-year change. Elsewhere on the lake, we saw no evidence of CLP, and raking in the area formerly covered by Bed 9 in the lake's southwest bay again failed to produce any surviving plants (Figure 5).

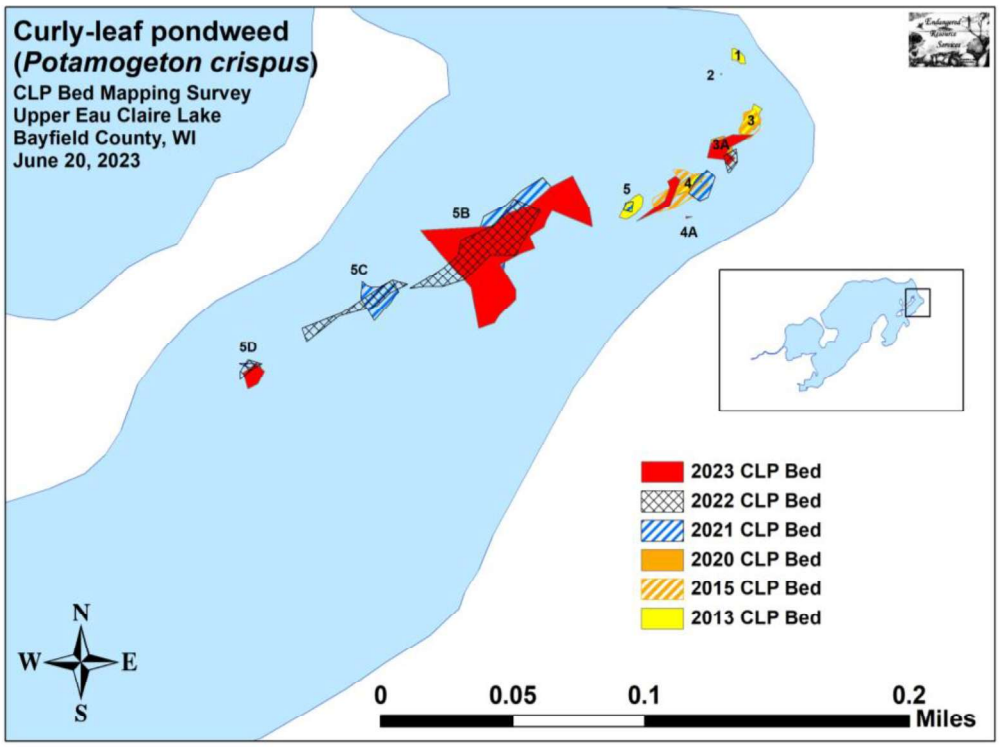

Figure 3: Upper Eau Claire Lake Curly-leaf Pondweed Beds – East of Three-in-One Island – 2013, 2015, 2020, 2021, 2022, and 2023

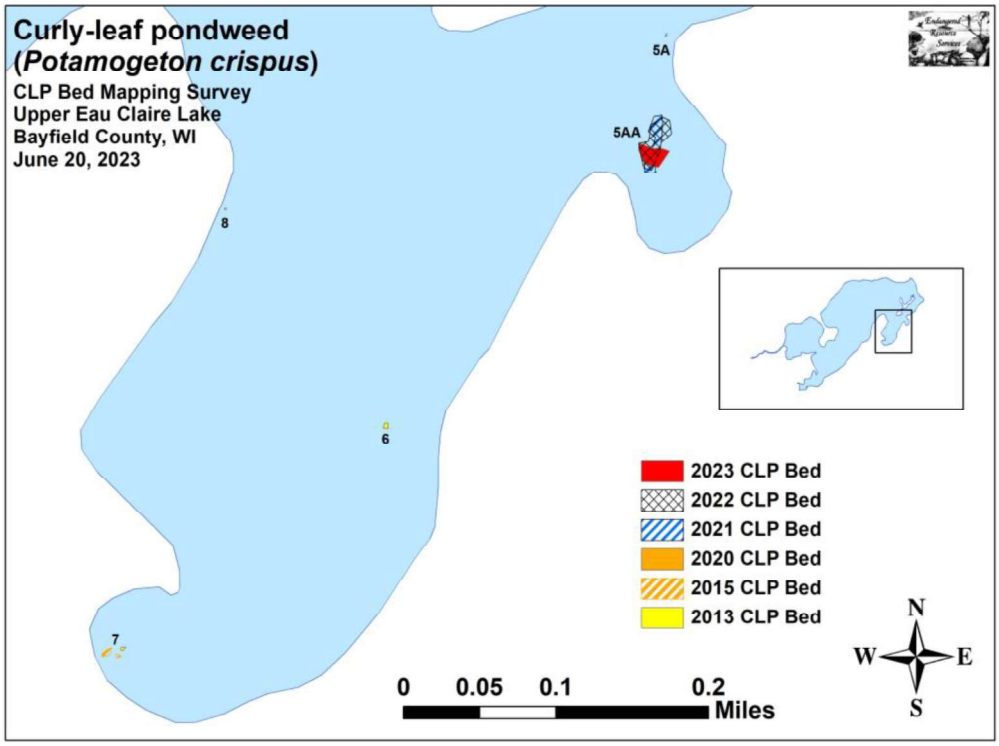

Figure 4: Upper Eau Claire Lake Curly-leaf Pondweed Beds – Pease Bay – 2013, 2015, 2020, 2021, 2022, and 2023

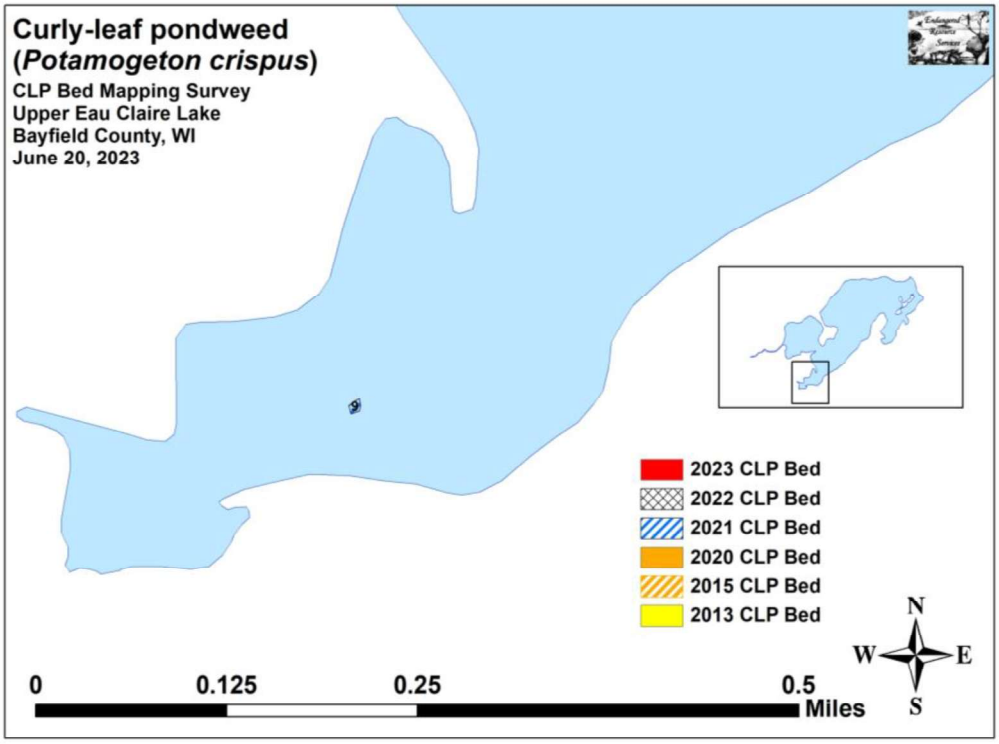

Figure 5: Upper Eau Claire Lake Curly-leaf Pondweed Beds – Southwest Bay – 2013, 2015, 2020, 2021, 2022, and 2023

Table 1: Historical Curly-leaf Pondweed Bed Summary
Upper Eau Claire Lake – Bayfield County, Wisconsin
2013-2024

Bed Number	2024 Acreage	2023 Acreage	2022 Acreage	2021 Acreage	2020 Acreage	2015 Acreage	2013 Acreage
1	0.14	0	0	0	0	0	0.01
1A	0.04	0	0	0	0	0	0
2	0	0	0	0	0	0	<<<0.01
3	0	0.05	0	0	0	0.04	0.03
3A	0	0	0.02	0	0.04	0	0
4 and 4A	0	0.03	0	0.04	0	0.11	0.02
5	0	0	0	0.01	0	0	0.03
5A	0	0	0	0	<0.01	0	0
5AA	0.39	0.12	0.24	0.15	0	0	0
5B	3.71	0.74	0.32	0.37	0	0	0
5C	Merged	0	0.09	0.08	0	0	0
5D	Merged	0.03	0.01	0.01	0	0	0
5E	0.01	0	0	0	0	0	0
6	0.01	0	0	0	0	0	<0.01
7 (A and B)	0	0	0	0	0	0.02	<<0.01
8	0	0	0	0	0	0	<<<0.01
9	0.01	0	0	0.03	0	0	0
10	<0.01	0	0	0	0	0	0
11	<0.01	0	0	0	0	0	0
12	<0.01	0	0	0	0	0	0
13	0.37	0	0	0	0	0	0
14	1.53	0	0	0	0	0	0
15	<0.01	0	0	0	0	0	0
Total Acres	**6.21**	**0.97**	**0.67**	**0.69**	**0.04**	**0.17**	**0.11**

Summary of 2024 Curly-leaf Pondweed Bed Mapping Survey:

The winter of 2023-24 was one of the shortest and warmest on record with little snowfall and late ice-on/early ice-off. This was followed by a prolonged cool spring that appeared to favor Curly-leaf pondweed growth as we found record levels and densities on the majority of lakes we surveyed. Because of this, we expected to see a significant uptick on Upper Eau Claire Lake as well. On June 14, 2024, we searched 32.9km (20.4 miles) of transects throughout the lake's visible littoral zone paying careful attention to all areas that were previously found to have CLP (Figure 6). We had sunny skies and mostly calm conditions that allowed us to see down in the water column approximately 9-10ft.

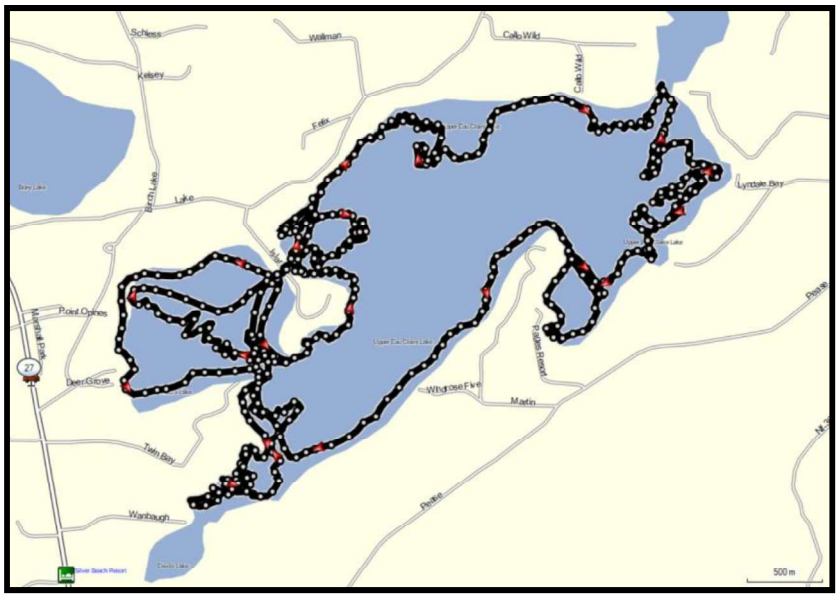

Figure 6: June 14, 2024 Littoral Zone CLP Survey Transects

We were disappointed but not surprised to locate 13 beds covering 6.21 acres (0.61% of the lake's surface area) (Table 1). This was a 5.24-acre increase (+540.21%) compared to 2023 (Table 2). The largest was Bed 5B (3.71 acres) which had merged with Beds 5C and 5D and covered much of the western half of the channel east Three-in-One Island. In the west-central bay, Beds 13 and 14 also covered a combined 1.90 acres. Both of these areas greatly exceeded the previous totals from our past surveys of the entire lake.

Table 2: Curly-leaf Pondweed Bed Summary
Upper Eau Claire Lake – Bayfield County, Wisconsin
June 20, 2023 and June 14, 2024

Bed Number	2024 Acreage	2023 Acreage	2023-24 Change in Area	Depth Range and Mean Depth	Est. Range and Mean Rake-full	Canopied	Navigation Impairment	2024 Field Notes
1	0.14	0	0.14	5-6; 5	<<<1-2; <1	Yes	None	Residual plants?
1A	0.04	0	0.04	7-10; 9	<<<1-2; 1	No	None	Bed on edge of drop-off.
2	0	0	0	-	-	-	None	No CLP plants seen.
3	0	0	0	-	-	-	None	No CLP plants seen.
3A	0	0.05	-0.05	3-5; 4	<<<1	Yes	None	Handful of plants.
4 and 4A	0	0.03	-0.03	4-6; 5	<<<1	Yes	None	Handful of plants.
5	0	0	0	-	-	-	None	No CLP plants seen.
5A	0	0	0	-	-	-	None	No CLP plants seen.
5AA	0.39	0.12	0.27	6-12; 10	<<<1-3; 2	Yes	Moderate	Patchy on edges.
5B	3.71	0.74	1.97	7-13; 10	<<<1-3; 2	Yes	Moderate	Prop-clipped throughout.
5C	Merged	0	-	7-13; 10	<<<1-3; 2	Yes	Moderate	Merged with 5B.
5D	Merged	0.03	-	7-13; 10	<<<1-3; 2	Yes	Moderate	Merged with 5B.
5E	0.01	0	0.01	9-11; 10	1-3; 2	No	None	Subcanopy microbed.
6	0.01	0	0.01	7-10; 9	<<<1-2; 1	No	None	Mixed w/ native pondweeds.
7 (A and B)	0	0	0	-	-	-	None	No CLP plants seen.
8	0	0	0	-	-	-	None	No CLP plants seen.
9	0.01	0	0.01	10-12; 12	1-3; 3	No	None	Dense isolated microbed.
10	<0.01	0	<0.01	10-12; 11	2-3; 3	Near	None	Dense isolated microbed.
11	<0.01	0	<0.01	10-12; 11	2-3; 3	Near	None	Dense isolated microbed.
12	<0.01	0	<0.01	6-7; 7	2-3; 3	Near	None	Dense isolated microbed.
13	0.37	0	0.37	6-11; 10	<<<1-2; 1	No	None	Low-density open bed.
14	1.53	0	1.53	8-13; 10	<1-3; 2	No	None	Most plants far subcanopy.
15	<0.01	0	<0.01	9-10; 10	2-3; 3	Near	None	Dense isolated microbed.
Total Acres	**6.21**	**0.97**	**+5.24**					

Descriptions of Past and Present Curly-leaf Pondweed Beds:

Bed 1A – This newly discovered low-density bed occurred on the drop-off northwest of Three-in-one Island. It was subcanopy and appeared unlikely to interfere with navigation (Figure 7) (Appendix I).

Beds 1 and 2 – The mapped area was more of a high-density area than a true bed. It may be that harvesting had already occurred in this area prior to our survey.

Beds 3, 3A, 4, 4A, 5, and 5A – We saw only a few handfuls of scattered CLP plants in a few of these former microbeds.

Beds 5B, 5C, and 5D – These beds had merged to form a super bed east of Three-in-one Island. About half of the bed was canopied, and there were prop-clipped plants and prop-trials throughout the channel as, although residents appeared to be avoiding it, we watched jet-skiers and boaters initially go right through the bed before veering out of it. Because it was the worst area on the lake, it is likely the highest priority for future management.

Bed 5E – This subcanopy microbed was located off to the side of the main navigation channel. Because of this, it is likely a low priority for management.

Bed 5AA – Although this bed occurred directly in the middle of the navigation channel leading out of this highly developed bay, residents appeared to be making a concerted effort to avoid it. Despite this, it is still likely a high priority for future management.

Bed 6 – For the first time in years, we found a small, subcanopy, deepwater CLP bed on the east shoreline of Pease Bay. Although not a navigation impairment, its isolation might make it a management priority (Figure 8).

Beds 7 and 8 – We saw no evidence of CLP anywhere else in Pease Bay.

Bed 9 – In the lake's southwest bay, we found Bed 9 had reformed. It was almost uniformly dense, but, because it was subcanopy and small, it was unlikely to impair navigation. Due to its isolated nature, it may, however, still be a management priority to prevent further spread on this end of the lake (Figure 9).

Beds 10, 11, and 12 – For the first time, we found CLP growing in the main navigation channel area of the outlet bay. Similar to Bed 9, these small dense microbeds may be a management priority to prevent further spread in this part of the lake (Figure 10).

Beds 13, 14, and 15 - Although we have found and rake removed individual plants in the west-central bay before, 2024 was the first time we have ever found true beds (Figure 10). CLP was often somewhat patchy, well below the surface, and unlikely to cause any navigation impairment. That said, its presence here is frustrating as it opens up another significant area for management consideration.

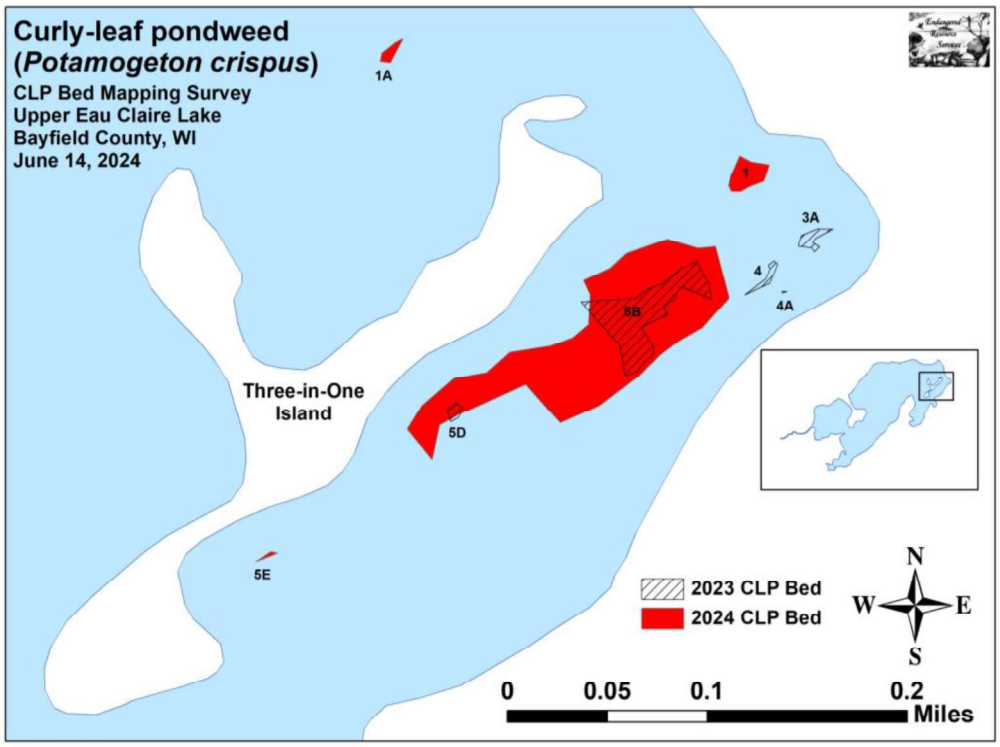

Figure 7: Upper Eau Claire Lake Curly-leaf Pondweed Beds – East of Three-in-One Island – 2024

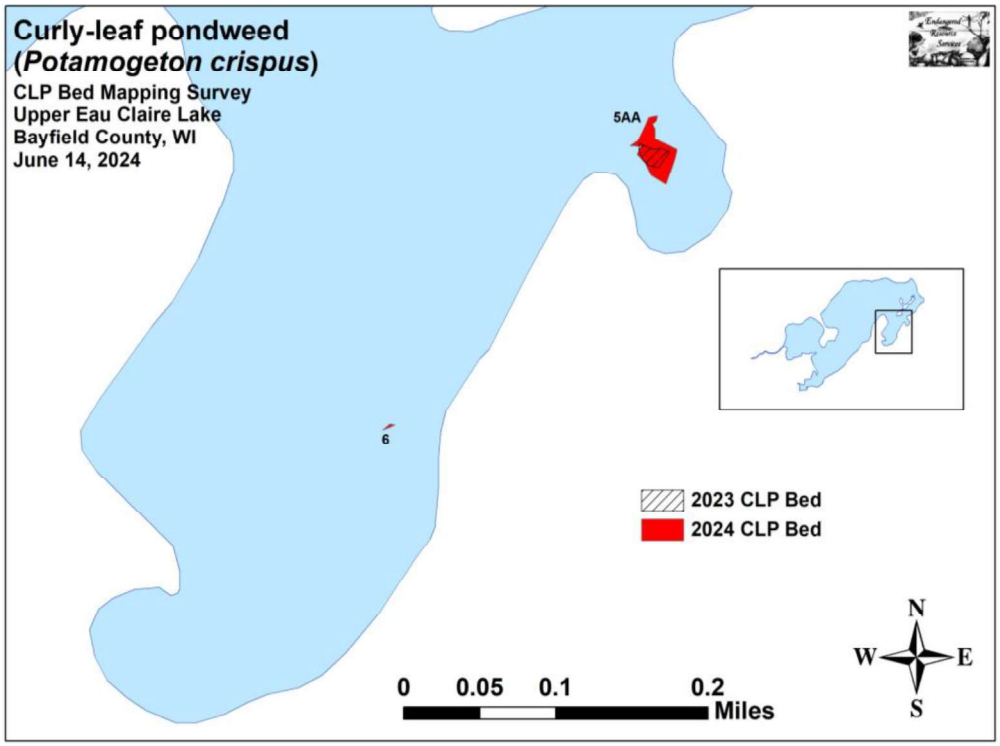

Figure 8: Upper Eau Claire Lake Curly-leaf Pondweed Beds – Pease Bay – 2024

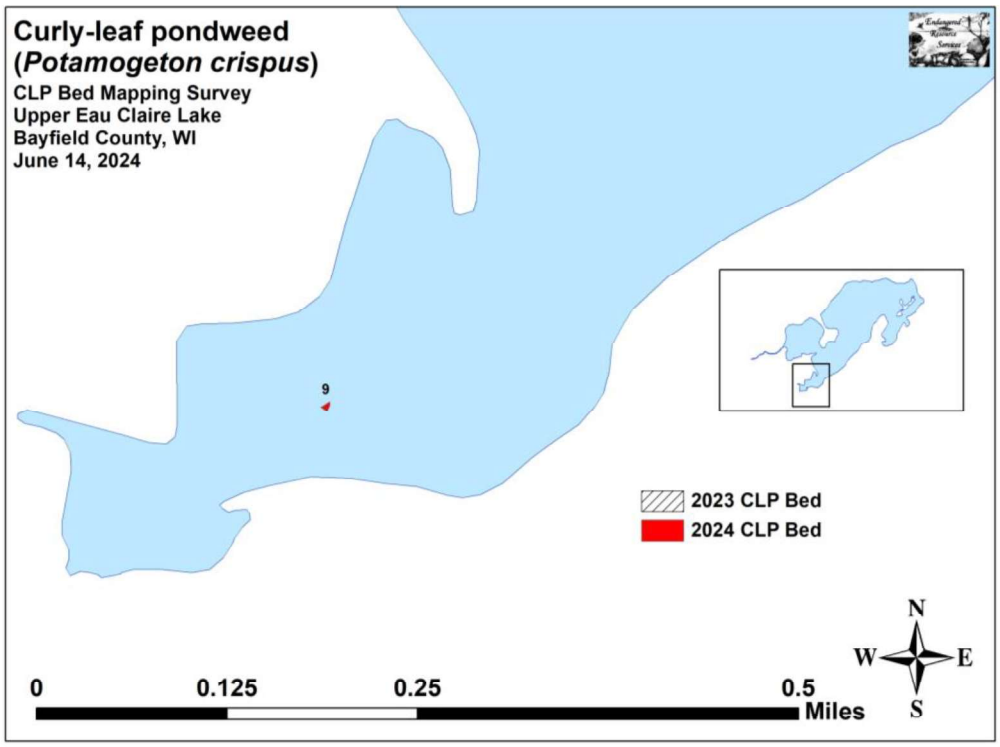

Figure 9: Upper Eau Claire Lake Curly-leaf Pondweed Beds – Southwest Bay – 2024

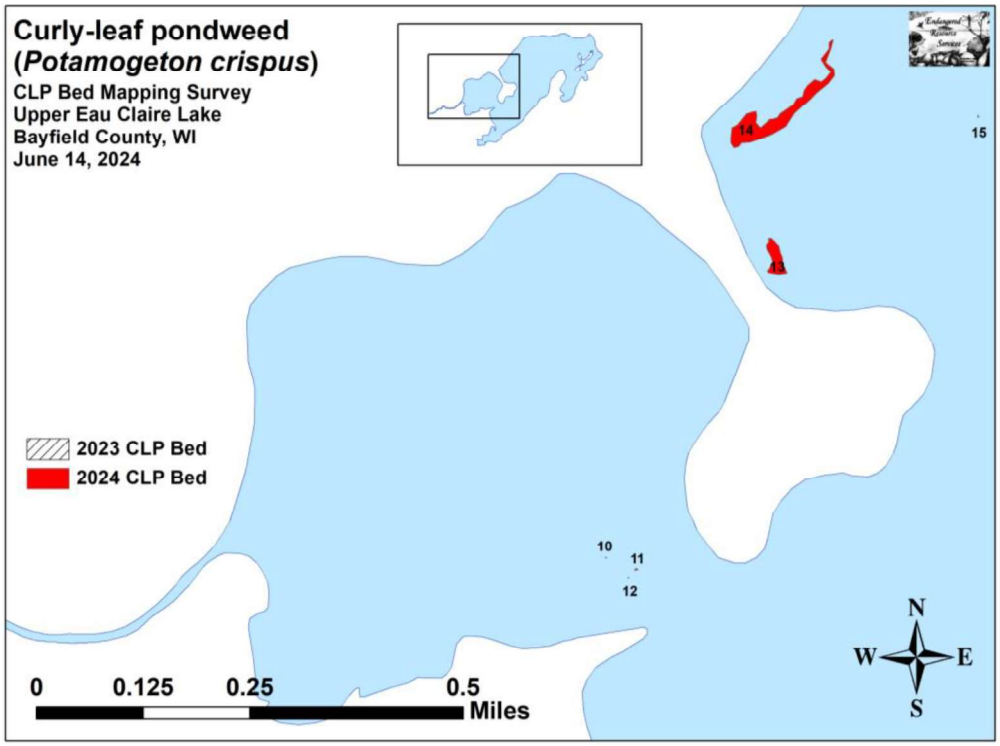

Figure 10: Upper Eau Claire Lake Curly-leaf Pondweed Beds – West-central and Outlet Bays – 2024

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

Although Curly-leaf pondweed currently covers a low percentage of Upper Eau Claire Lake's surface area, the significant uptick in acreage we documented in 2024 likely meant the "BAISS" harvesting program was not able to remove the majority of CLP plants. This also likely meant that CLP was causing at least a minor, and, in some areas, a moderate impairment for watercraft trying to navigate through the beds with these uprooted plants further spreading turions.

Upper Eau Claire Lake continues to have a rich and diverse native plant community, and suction harvesting is likely the most environmentally friendly method of controlling Curly-leaf pondweed as it targets the CLP while leaving native plants in place. If suction harvesting is discontinued in the future or if it isn't possible to get to all of the CLP beds in the time available and the TOB considers chemical control, we strongly encourage a measured approach that is closely evaluated. CLP is an opportunistic species that can rapidly exploit disturbed areas. As herbicides eliminate native vegetation as well as the target species, it is possible that CLP could rapidly reestablish in the treatment areas and ultimately become worse rather than better in the years following treatment – an outcome we have seen in many other systems over the years.

Regardless of what, if any, future active management occurs on the lake, we remind lakeshore residents that they can help minimize CLP's opportunities to spread by maintaining the lake's native plants. To accomplish this, residents should refrain from removing rooted plants from the lake unless absolutely necessary as these barren patches of substrate not only release nutrients into the water column but also give CLP a place to establish where it has a competitive advantage. Avoiding motor start-ups in water <5ft deep would also help limit CLP's spread by not clipping or uprooting vegetation. This would also work to keep nutrients out of the water column as the lake's soft sediments are easily stirred up by prop wash.

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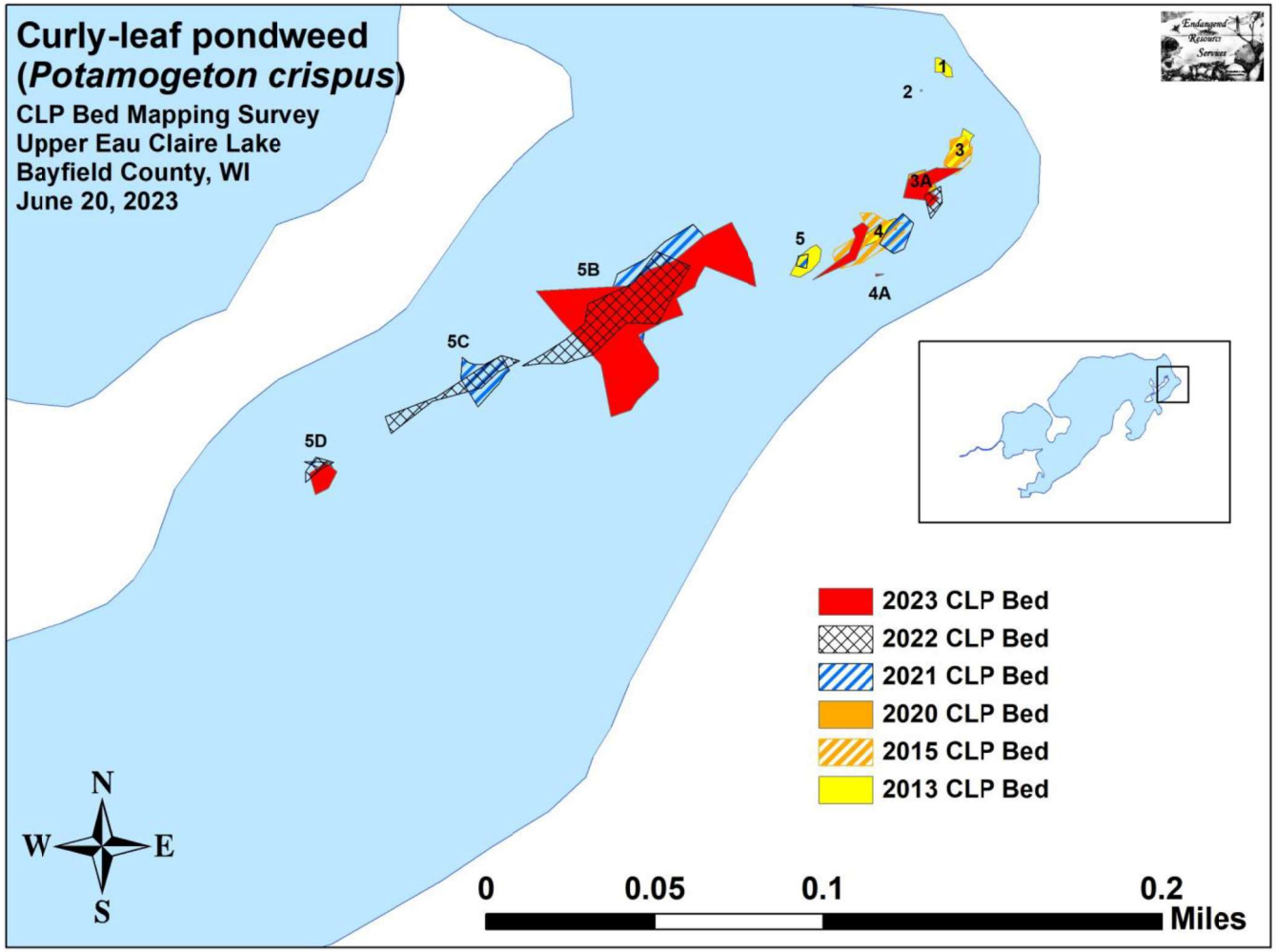
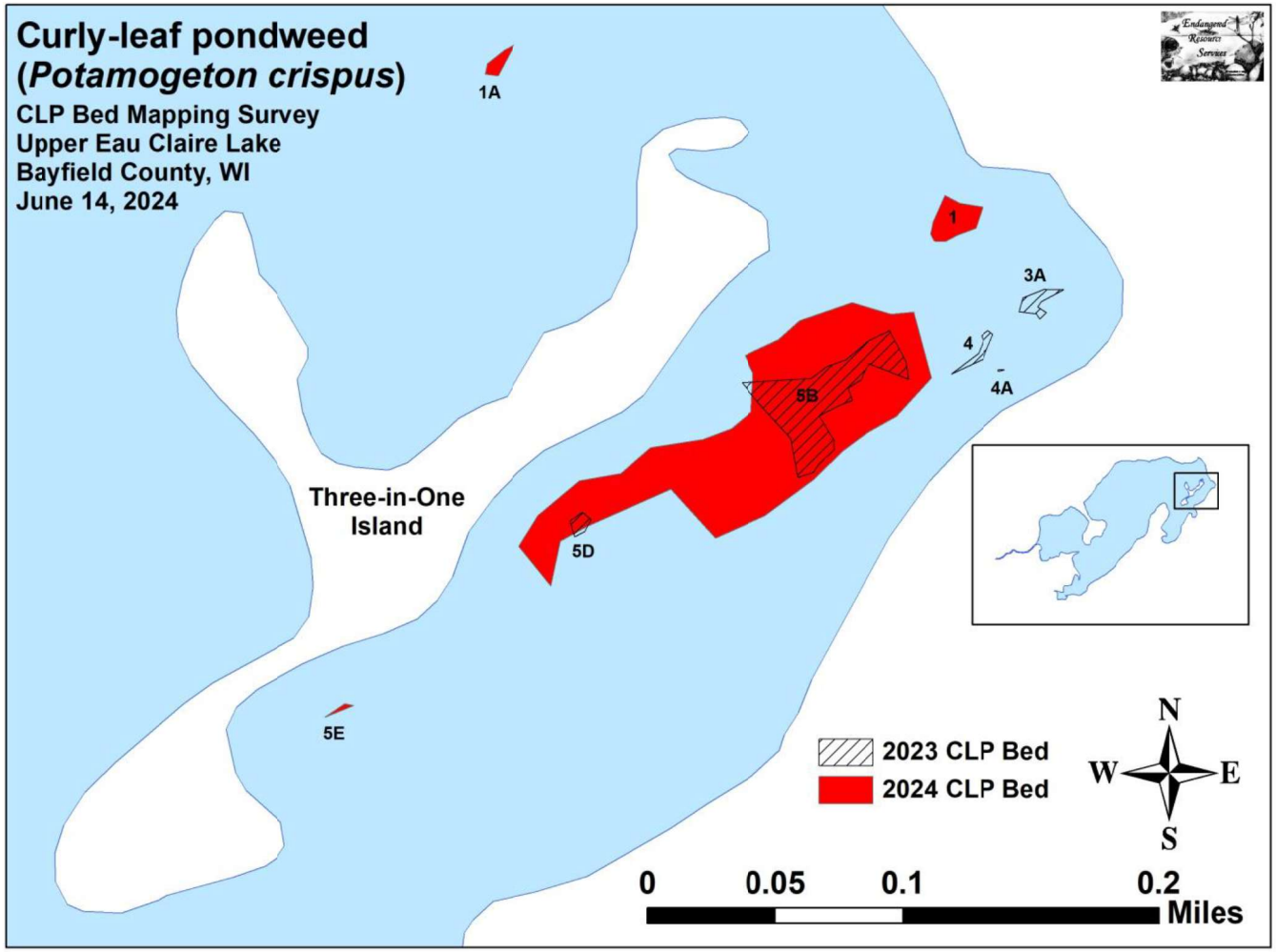
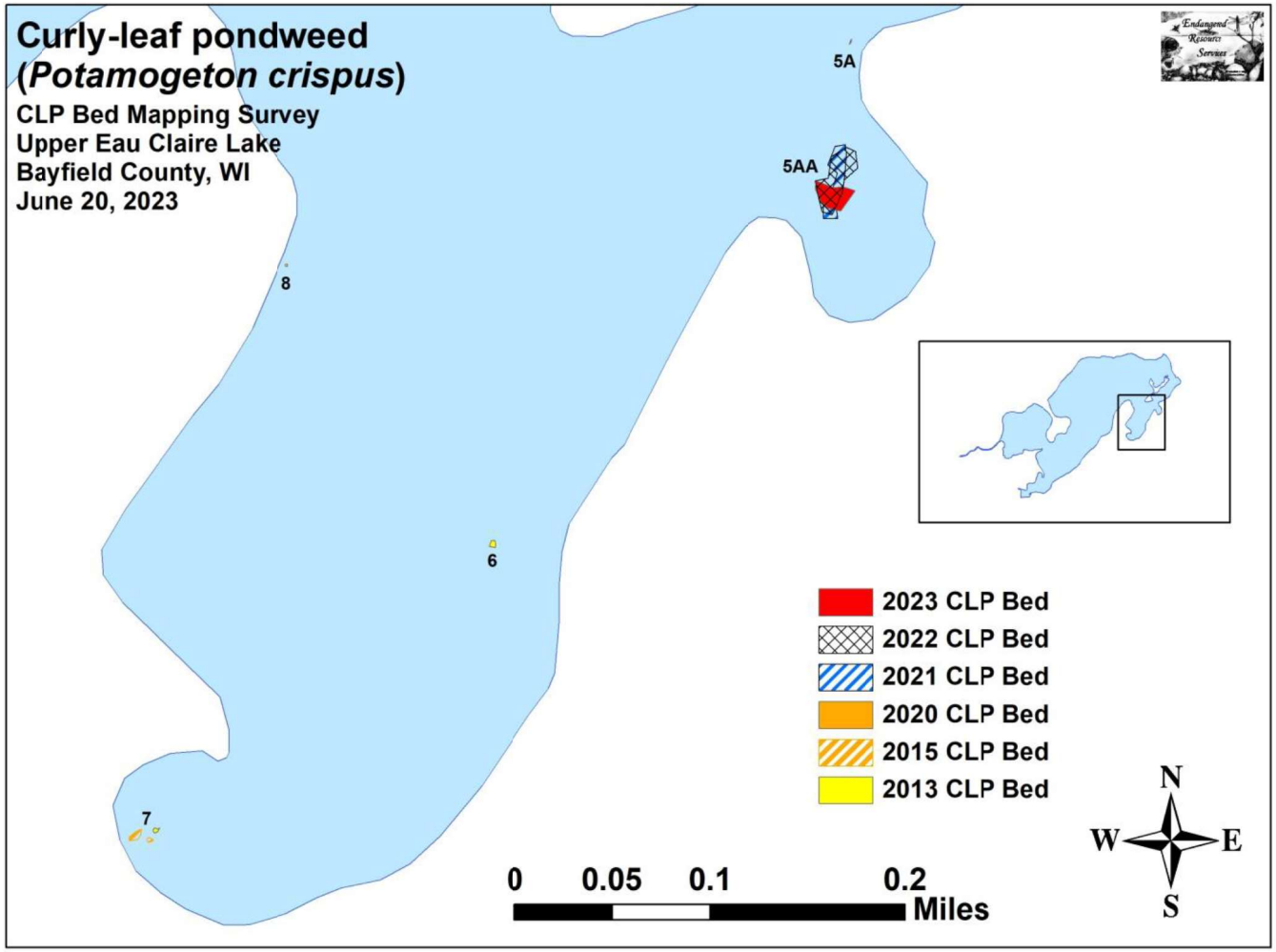
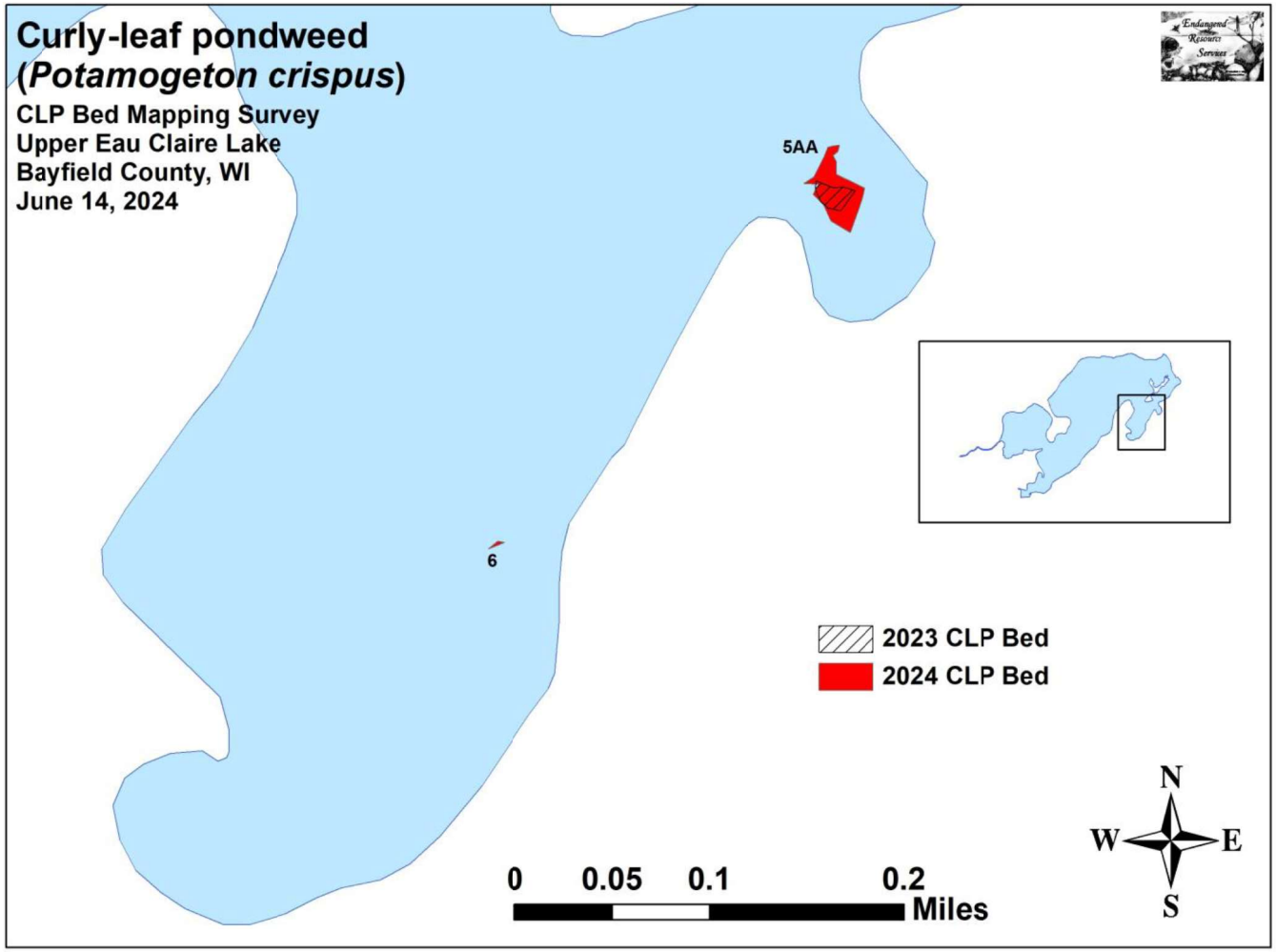
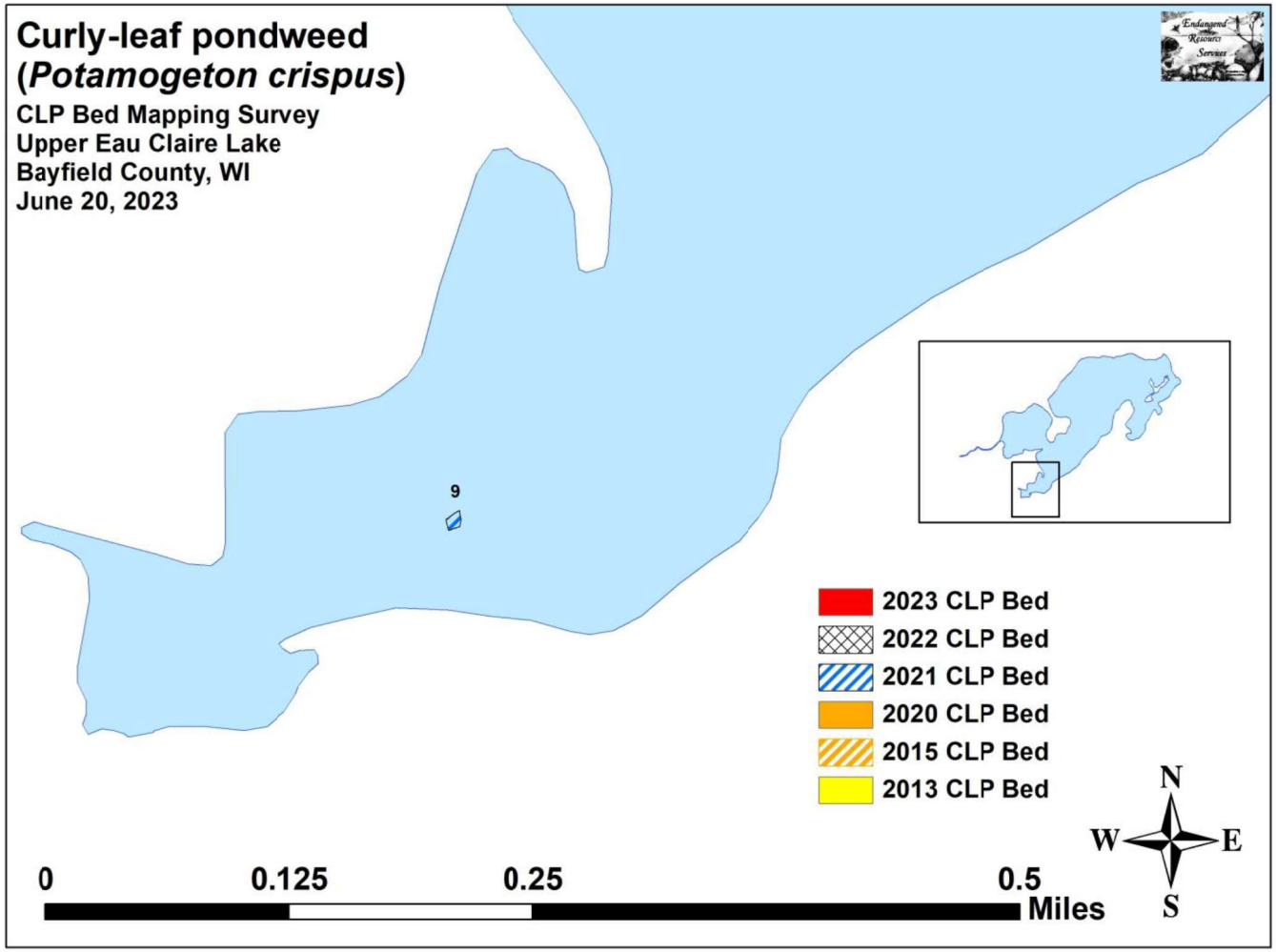
Appendix I: 2013, 2015, 2020-2024 June Curly-leaf Pondweed Bed Maps

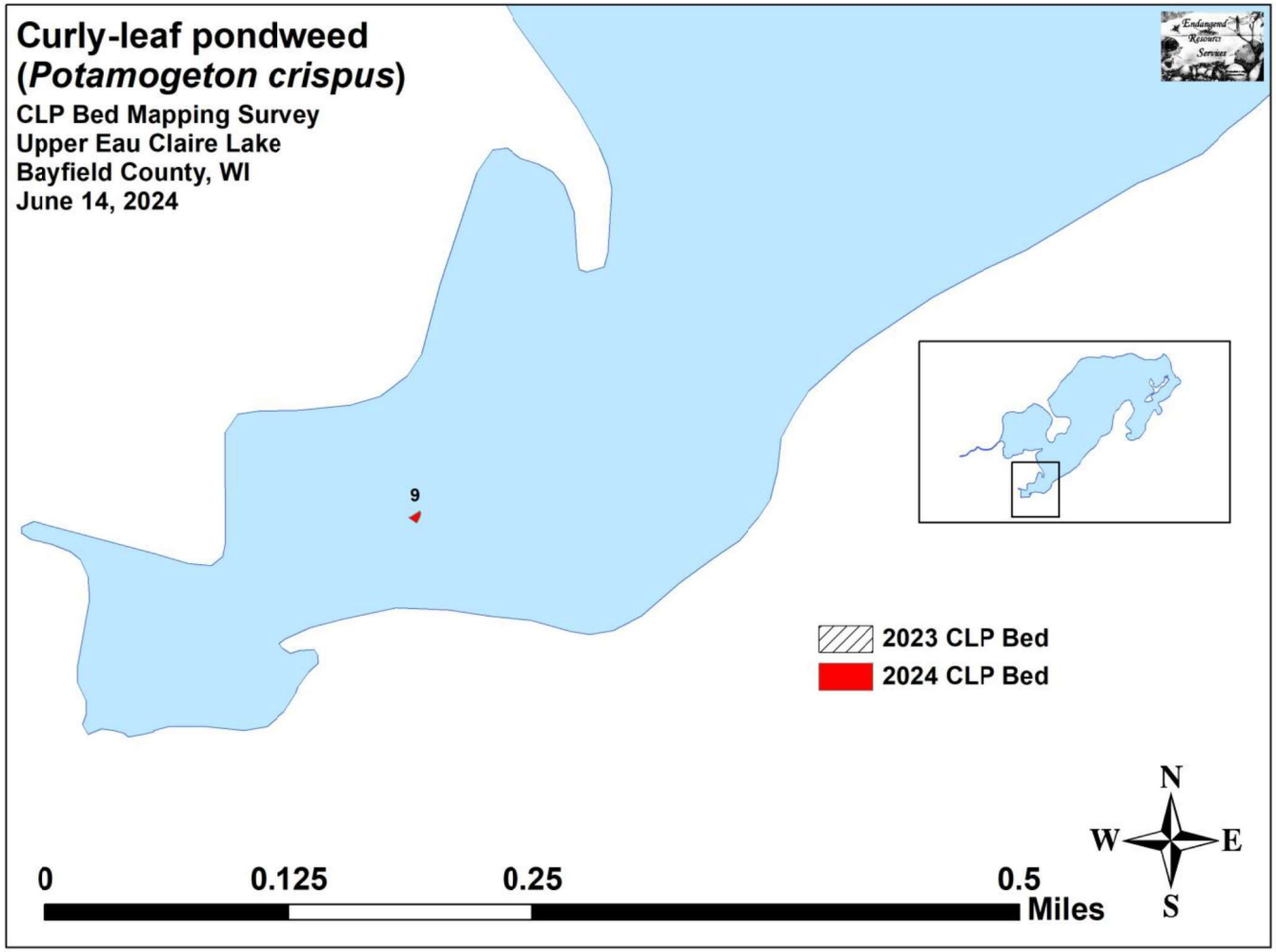

Curly-leaf pondweed
(Potamogeton crispus)
CLP Bed Mapping Survey
Upper Eau Claire Lake
Bayfield County, WI
June 20, 2023
1
2
3
3A
4
4A
5
5B
5C
5D
2023 CLP Bed
2022 CLP Bed
2021 CLP Bed
2020 CLP Bed
2015 CLP Bed
2013 CLP Bed
N
W
E
S
0
0.05
0.1
0.2
Miles

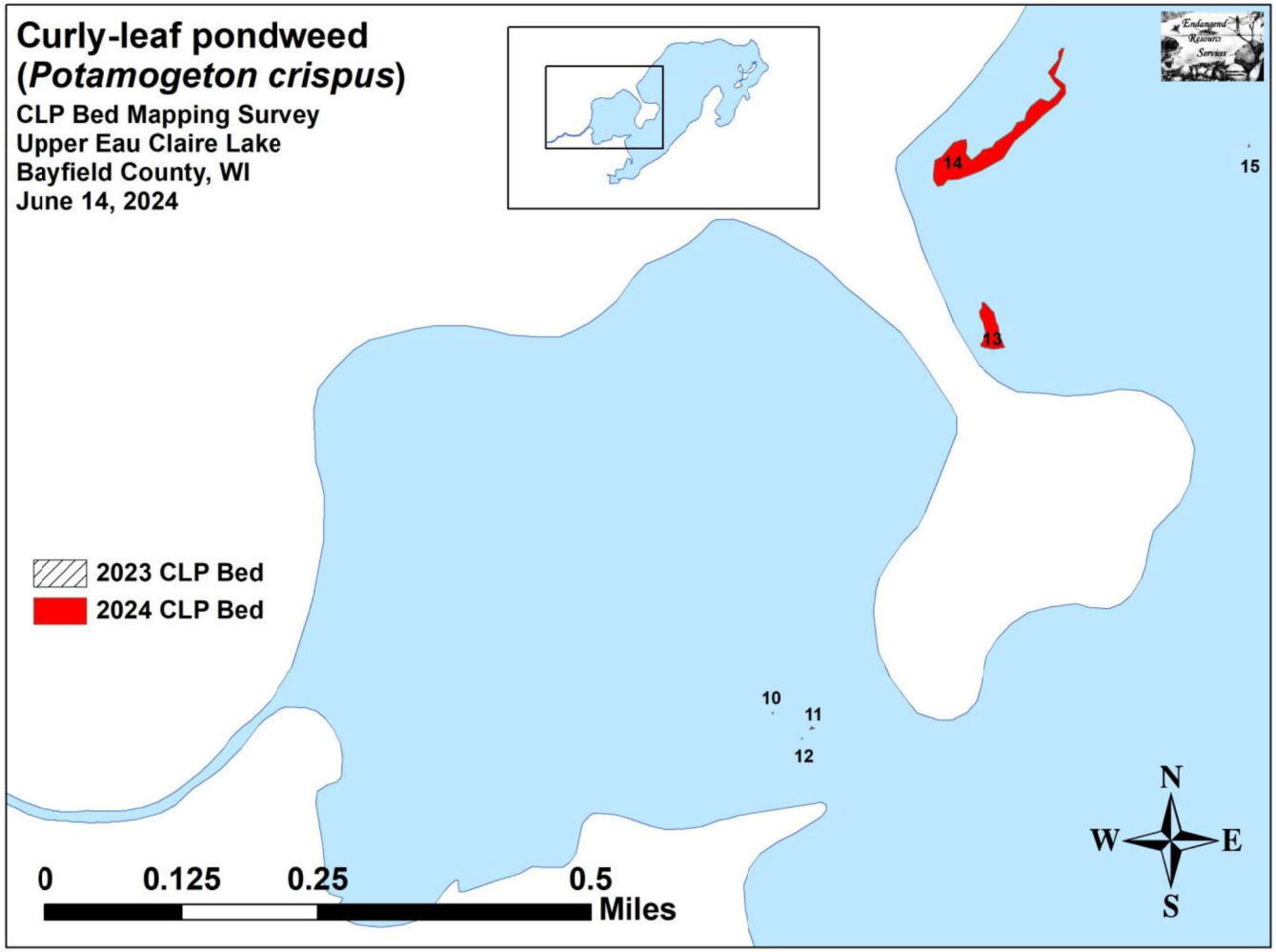

Curly-leaf pondweed
(Potamogeton crispus)
CLP Bed Mapping Survey
Upper Eau Claire Lake
Bayfield County, WI
June 14, 2024
1A
1
3A
4
4A
5B
5D
5E
Three-in-One
Island
2023 CLP Bed
2024 CLP Bed
N
W
E
S
0
0.05
0.1
0.2
Miles


Curly-leaf pondweed
(Potamogeton crispus)
CLP Bed Mapping Survey
Upper Eau Claire Lake
Bayfield County, WI
June 20, 2023
5A
5AA
8
6
7
2023 CLP Bed
2022 CLP Bed
2021 CLP Bed
2020 CLP Bed
2015 CLP Bed
2013 CLP Bed
0 0.05 0.1 0.2
Miles
N
W
E
S


Curly-leaf pondweed
(Potamogeton crispus)
CLP Bed Mapping Survey
Upper Eau Claire Lake
Bayfield County, WI
June 14, 2024
5AA
6
2023 CLP Bed
2024 CLP Bed
N
W
E
S
0
0.05
0.1
0.2
Miles


Curly-leaf pondweed
(Potamogeton crispus)
CLP Bed Mapping Survey
Upper Eau Claire Lake
Bayfield County, WI
June 20, 2023
9
2023 CLP Bed
2022 CLP Bed
2021 CLP Bed
2020 CLP Bed
2015 CLP Bed
2013 CLP Bed
N
W
E
S
0
0.125
0.25
0.5
Miles


Curly-leaf pondweed
(Potamogeton crispus)
CLP Bed Mapping Survey
Upper Eau Claire Lake
Bayfield County, WI
June 14, 2024
9
2023 CLP Bed
2024 CLP Bed
N
W
E
S
0
0.125
0.25
0.5
Miles


Curly-leaf pondweed
(Potamogeton crispus)
CLP Bed Mapping Survey
Upper Eau Claire Lake
Bayfield County, WI
June 14, 2024
2023 CLP Bed
2024 CLP Bed
14
15
13
10
11
12
0
0.125
0.25
0.5
Miles
N
W
E
S