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UPPER EAUCLAIRE LAKE, BAYFIELD COUNTY

2024-2028 Aquatic Plant Management Plan
WDNR WBIC: 2742700

Prepared by: Dave Blumer, Lake Educator
August 2023

Town of Barnes – Addendum 1

Distribution List

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1.0 Lake Characteristics

Upper Eau Claire Lake (UECL) is a 996-acre drainage lake located in southwestern Bayfield County in the Town of Barnes, at the headwaters of a series of interconnected lakes known as the Eau Claire Lakes Chain. It has clear water with a maximum depth of 92 feet and average of 29 feet. Primary nearshore substrates are comprised of sand, gravel and muck. Upper Eau Claire Lake is classified as a complex two-story lake meaning it supports a warm and cold water fishery. It has three inlets (Smith Lake, Birch Lake and Devils Lake) and one outlet (Eau Claire River). Most of the shoreline is privately owned except for one public boat landing and an island in the northeast portion of the lake (Figure 1).

Figure 1: Upper Eau Claire Lake aerial photo and location map

Depth soundings taken at Upper Eau Claire Lake's 1,139 survey points revealed the outlet bay is a shallow 5-10ft flat that slopes gently to the river channel. The main lake is dominated by a steep-sided 60ft+ trench running southwest to northeast with two separate deep holes that bottom out at 70ft+ in the south and 90ft+ in the north. The 30ft+ bay northwest of this trench contains several bars, flats, and sunken islands that top out at less than 10ft. Around Three-in-One Island, shallow flats extend to the north and west while the east side drops off sharply into a narrow 30ft+ groove that dominates Pease Bay (Figure 2).

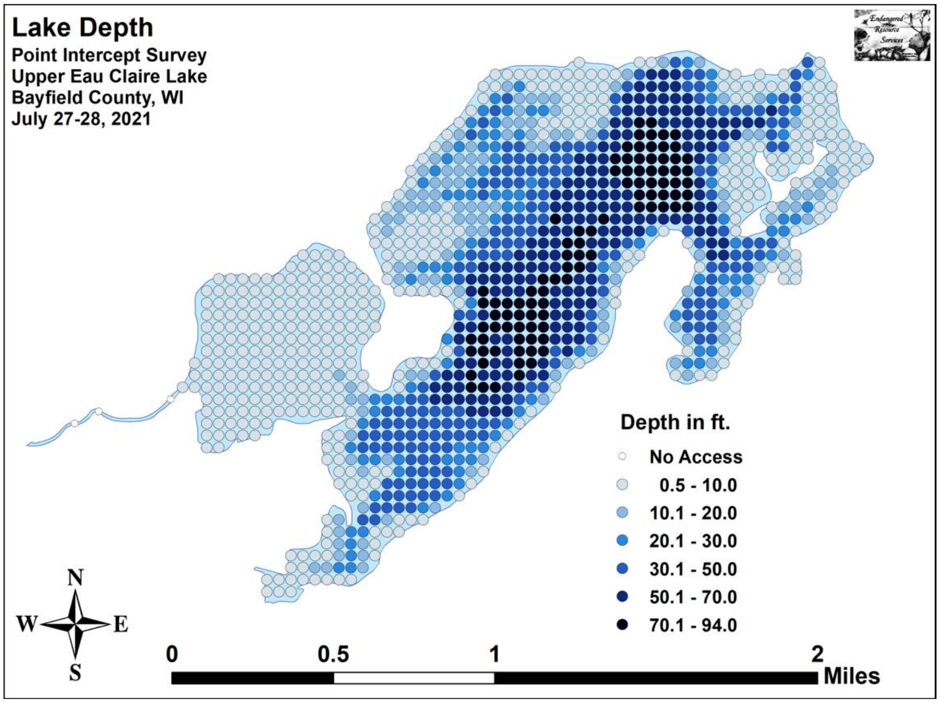


Figure 2: 2021 lake depth

Sand and rock dominate the majority of the nearshore lake bottom as well as around Three-in-One Island, the flats and bars in the northwest bay, and the northeast end of the outlet bay (Figure 3). In the lake's bays and the channel east of Three-in-One Island, these sandy areas quickly transition to a nutrient-poor sandy muck at most depths over 7ft. In the outlet bay, this muck was a thick marl, while in the bog bay near the channel to Devil's Lake, it was a thick organic muck. Of the 618 points where the substrate could be determined, the bottom was categorized as 54.9% pure sand, 29.9% sandy, marl, and organic muck, and the remaining 15.2% rock.

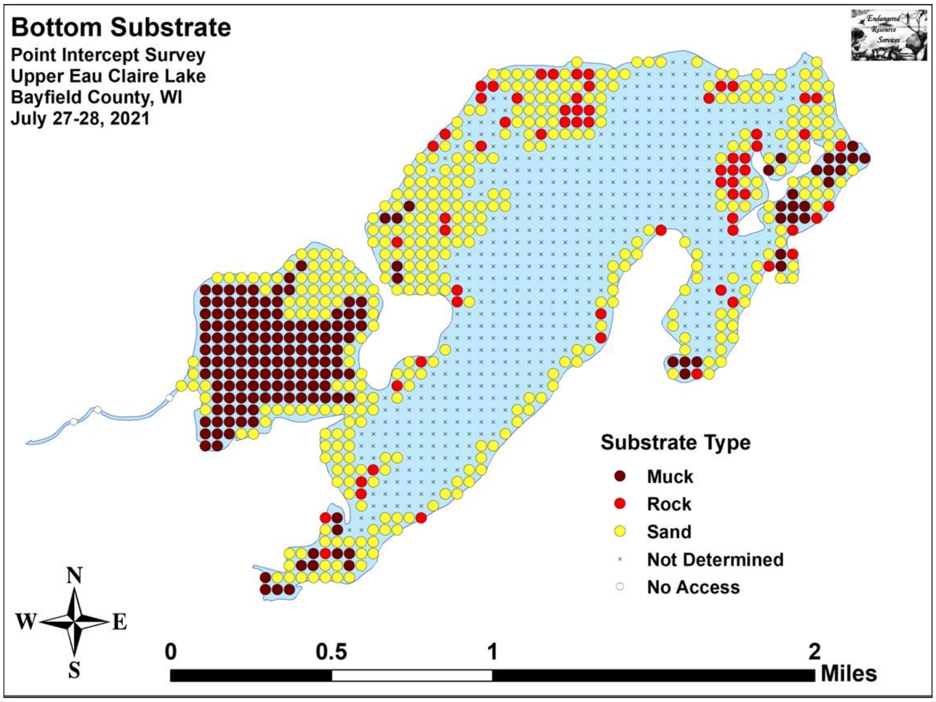


Figure 3: 2021 lake substrate

2.0 Water Quality Data

The Citizen Lake Monitoring Network[1] (CLMN) is a water quality monitoring partnership between the WDNR, the Wisconsin Lakes Partnership, and over a 1,000 citizen volunteers statewide. The goals of the CLMN are to collect high quality data, to educate and empower volunteers, and to share this data and knowledge. Volunteers measure water clarity using the Secchi disk, as an indicator of water quality (based on clarity). They also comment on other parameters including lake level, water color, murkiness, and how they perceive the lake on any given monitoring date using a 1 to 5 scale with 1 being "great, fantastic" and 5 being "really bad". Volunteers may also collect chemistry data; collect temperature and dissolved oxygen data; and monitor for the first appearance of aquatic invasive species near boat landings, other access points, or along the shoreline. Volunteers on UECL have been collecting CLMN water quality data since the CLMN program started in 1986. They have not missed any year of Secchi disk data between 1986 and 2022.

Water quality appears to decline slightly moving downstream in this chain. UECL shows signs of oligotrophic characteristics while the Middle Eau Claire Lake (MECL) and Lower Eau Claire Lake (LECL) show signs of increasing levels of fertility. Due to signs of deterioration in water quality, the Upper and Lower Lakes have been regularly monitored since 1986 through the WDNR's long term lake water quality monitoring program. Middle Eau Claire Lake has been monitored by a self-help volunteer program since 1988.

2.1 Secchi Readings of Water Clarity

From 1986 to 2022 the average annual Secchi disk reading of water clarity was about 17.4ft. The deepest Secchi disk reading of 39.5ft was taken in late May 2020. The worst or lowest Secchi disk reading of 7.9ft was taken in early May 1992. Breaking that down a little further, the average annual Secchi disk reading of water clarity from about 1990 to 2002 was around 15.2ft. From 2003 to 2011 it was much better at around 19.2ft. For a short period of time between 2012 and 2014 the average dropped to around 14.2ft, but from 2015 to 2022 it jumped back up to around 19.6ft. The average annual Secchi disk reading of water clarity has been at its best over the last five to six years (Figure 4).

Over the last 36 years, the average annual Secchi disk reading of water clarity was mostly between 15 and 20 feet. Six times during that time span, the average annual water clarity was less than 15ft. And, also six times during that time span, the average annual water clarity was greater than 20ft. Overall, it appears that water clarity in UECL has been trending deeper or better, particularly over the last 8 years or so (Figure 4).

[1] For more information about the CLMN go to: https://dnr.wisconsin.gov/topic/lakes/clmn

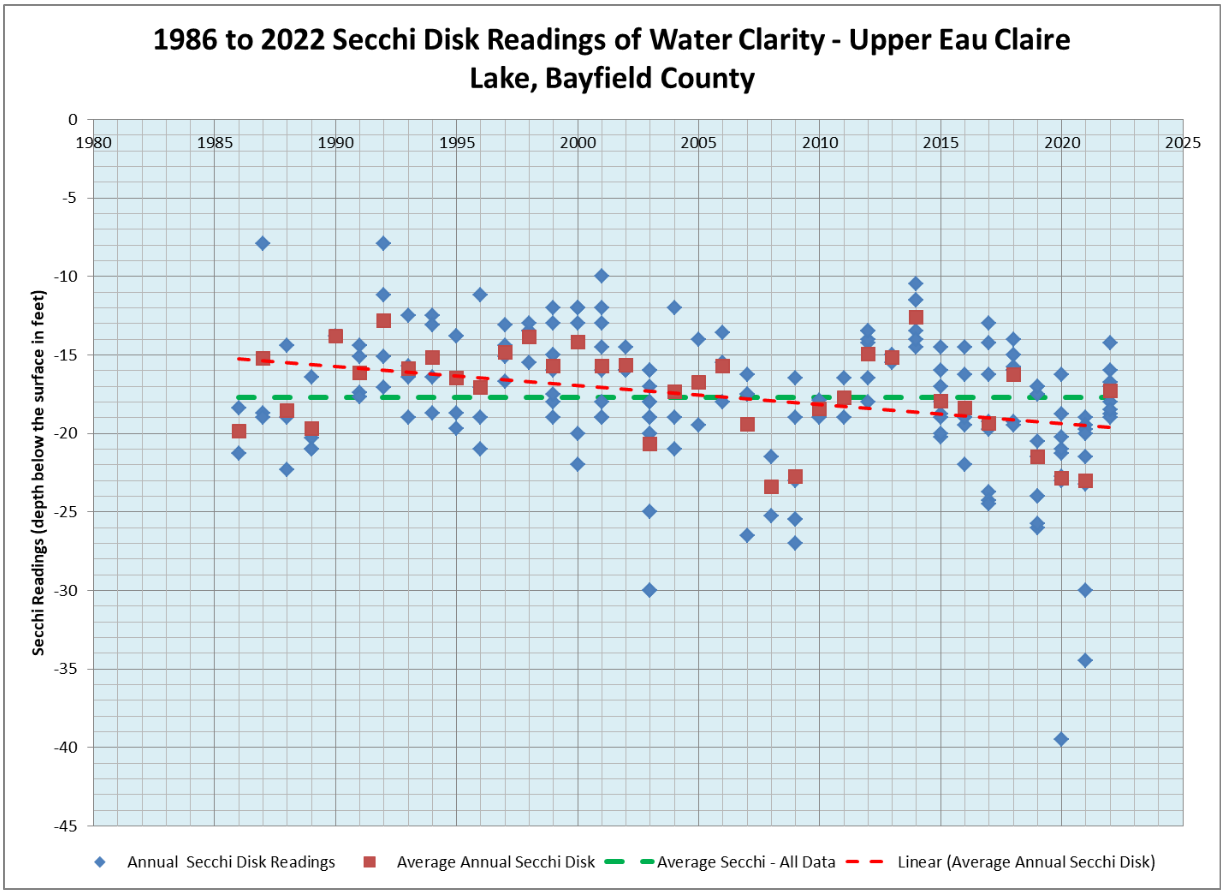


Figure 4: 1986 – 2022 Secchi depth readings, average annual readings, and trend line

Water clarity during the open water season in UECL follows a "not so common pattern". In many lakes across the state, April water clarity may be somewhat reduced by ice out and turnover and runoff into the lake during snowmelt. May and June present the best water clarity. Water clarity begins to worsen in July, with August and September being the worst due to warmer water and abundant phosphorus supporting the growth of algae. By October, water clarity begins to improve again as the water cools down again and algae die and sink to the bottom of the lake (Figure 5 - left).

This is not the pattern that presents itself in UECL. In UECL, water clarity is at its worst in the spring and again in the fall likely tied closely to spring and fall turnover, when water temperature is the same from the surface to the bottom of the lake. At this time, water density is also the same causing the entire water column to mix up. From late May through September, the deeper water in UECL keeps water temperatures cooler, the lake stratifies, and there is not as much phosphorus available to growth algae so the result is clear water through most of the summer (Figure 5 – right).

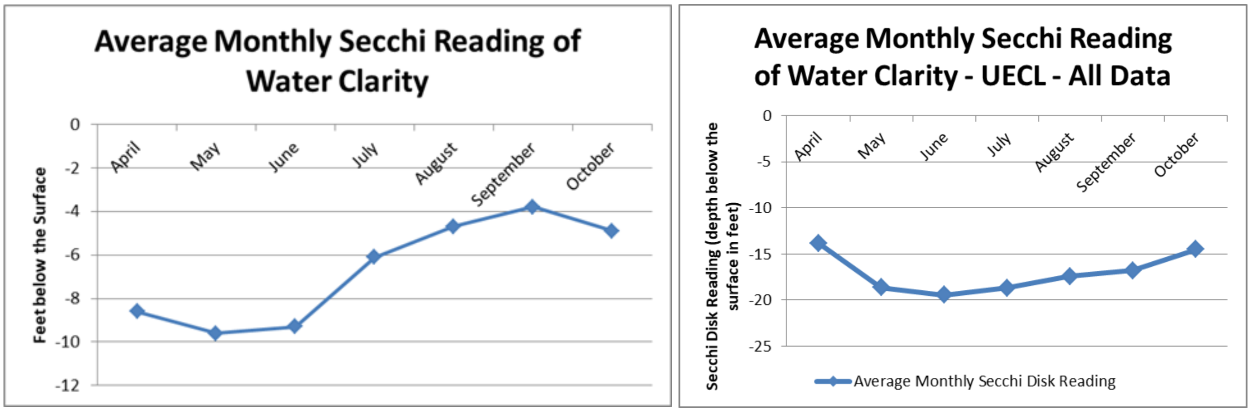


Figure 5: Average monthly Secchi depth readings of water clarity – common pattern (left); and Upper Eau Claire Lake (right)

2.2 Water Chemistry – TP and Chla

The “expanded” water quality monitoring level of the CLMN includes volunteers collecting Total Phosphorus (TP) and Chlorophyll-a (Chla) data along with Secchi disk readings of water clarity. Since 1988, when UECL’s involvement in the CLMN water quality monitoring program began, TP and Chla data has been collected during most of those years with a gap between 1998 and 2001. Phosphorus is the main nutrient needed for both aquatic plant and algae growth in a lake. CLMN protocol for TP monitoring involves collecting water samples four times during the open water season to determine the amount of phosphorus in the water. In most of those years, at least two surface water samples were collected each season. Any year with one or zero samples collected are not included in this analysis. Figure 6 reflects all of the TP data that can be confirmed to have been collected within 6-ft of the surface of the lake, the average annual TP for each year included, and the average TP across several years of data collection (1989-1997, 2002-2012, and 2013-2022). In the early 1990’s TP levels were generally lower than they are now. During the early 2000’s, it appears TP levels were much higher, although annual readings were fairly sporadic, before leveling out more in the late 20-teens and early 2020’s.

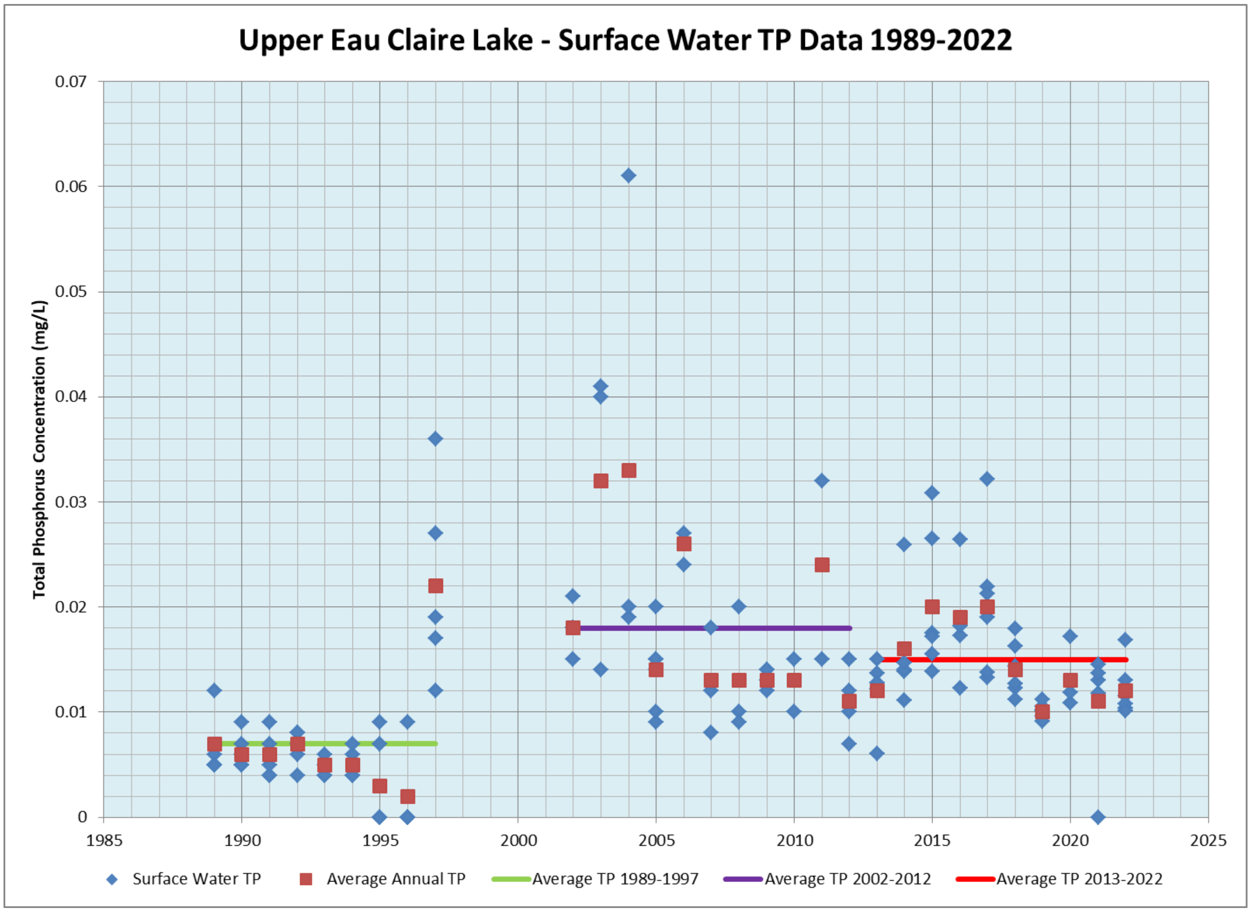


Figure 6: Average annual TP concentrations plus trend line

Chlorophyll-a monitoring involves collecting water samples three times during the open water season. Chla is the pigment that makes all plants green. In a lake, Chla is used as a measurement of the amount of algae that is in the water. Chla data has been collected on UECL since 1989 with a gap between 1998 and 2002. In a couple of years during that time frame, only one water sample for analysis of Chla was collected. These years have been removed from the data analysis. Chla data shows a trend of lessening amounts of algae in the lake water, particularly in the last 10 years or so (Figure 7). This trend holds up well with the trend of greater water clarity in the late 20teens and early 2020's. The amount of algae in the water is one of the main things that impacts water clarity. The more algae that there is, the greener the water gets, and the less deep the Secchi reading is. Less algae generally mean a better water clarity reading.

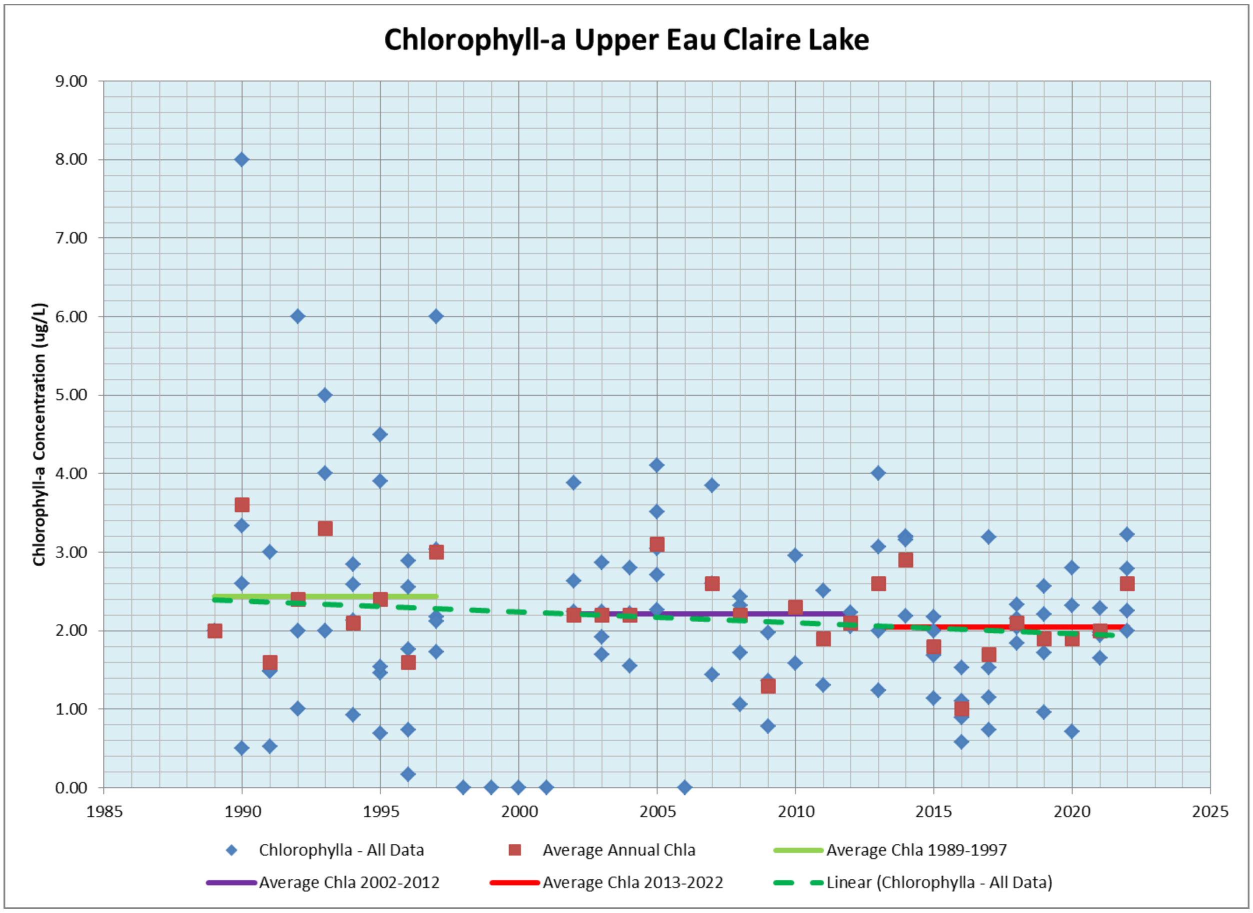


Figure 7: Chla concentrations w/average annual, trend line, and averages over certain time blocks

2.1 Temperature and Dissolved Oxygen

Temperature and dissolved oxygen are important factors that influence aquatic organisms and nutrient availability in lakes. As temperature increases during the summer in deeper lakes, the colder water sinks to the bottom and the lake develops three distinct layers as shown in Figure 8. This process, called stratification, prevents mixing between the layers due to density differences which limits the transport of nutrients and dissolved oxygen between the upper and lower layers. In most lakes in Wisconsin that undergo stratification, the whole lake mixes in the spring and fall when the water temperature is between 53 and 66°F, a process called overturn. Overturn begins when the surface water temperatures become colder and therefore denser causing that water to sink or fall through the water column. Below about 39°F, water becomes less dense and begins to rise through the water column. Water at the freezing point is the least dense which is why ice floats and warmer water is near the bottom (called inverse stratification) throughout the winter.

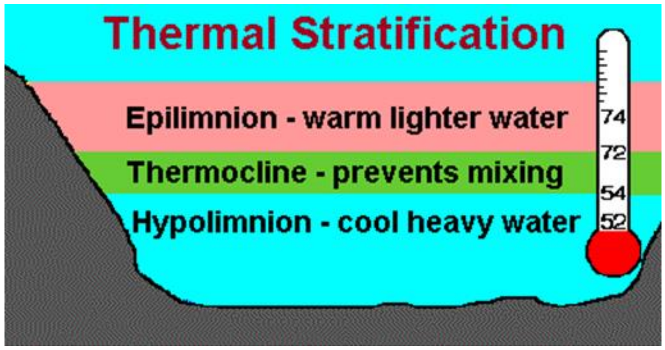


Figure 8: Summer thermal stratification

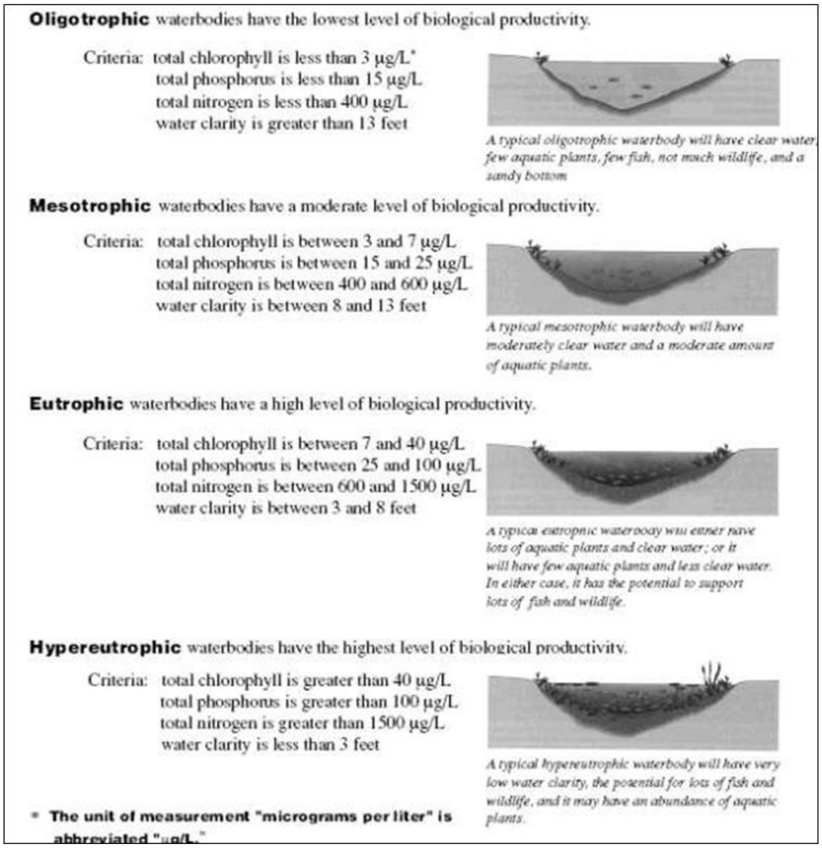
When a lake stratifies, dissolved oxygen (DO) levels in the bottom or hypolimnion portion of the lake may drop dramatically or disappear altogether. When this happens, nutrients normally trapped in the sediment can be released back into the water increasing the phosphorus available to grow more algae, degrading water quality further. If a deep lake stratifies and DO levels do not drop dramatically, that lake may support a two-story fishery – both cold water fish like cisco, trout and whitefish, and warm water fish like bass and walleye (see Section 3.1.1).

Temperature and DO monitoring in the entire water column of UECL is part of the data that is collected annually. According to WDNR SWIMS data between 2017 and 2022, UECL is stratified from about the end of June through the middle of September. The thermocline sets up in the 60-70ft range in July and then drops a little in August to 50-60ft, and then to 40-50ft in September. DO concentrations adequate to support a cold-water fishery hover around 50ft in July, dropping to around 35ft in August and September.

The results of this data analysis corroborate what was observed in the first paragraph of Section 2.0. "Water quality appears to decline slightly moving downstream in this chain. UECL shows signs of oligotrophic characteristics while the Middle Eau Claire Lake (MECL) and Lower Eau Claire Lake (LECL) show signs of increasing levels of fertility." Hence there is a slight decline in water quality as a whole from Upper to Middle to Lower Eau Claire lakes.

2.2 Trophic State Index – Lake Productivity

Water clarity (based on Secchi disk readings), total phosphorus, and chlorophyll-a are parameters that can be used to determine the productivity or trophic status of a lake. The Carlson trophic state index (TSI) is a frequently used biomass-related index. The trophic state of a lake is defined as the total weight of living biological material (or biomass) in a lake at a specific location and time. Eutrophication is the movement of a lake's trophic state in the direction of more plant biomass. Eutrophic lakes tend to have abundant aquatic plant growth, high nutrient concentrations, and low water clarity due to algae blooms (Figure 9). Oligotrophic lakes, on the other end of the spectrum, have high water clarity, are nutrient poor and have little plant and algae growth (Figure 9). Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms (Figure 9). Based on actual data (Secchi depth in feet and TP and Chla in ug/L), Figure 9 can be used to determine the productivity of a given lake. Secchi, TP, and Chla concentrations all put UECL in the oligotrophic range.



Oligotrophic waterbodies have the lowest level of biological productivity.

Criteria: total chlorophyll is less than 3 µg/L*
total phosphorus is less than 15 µg/L
total nitrogen is less than 400 µg/L
water clarity is greater than 13 feet

A typical oligotrophic waterbody will have clear water, few aquatic plants, few fish, not much wildlife, and a sandy bottom

Mesotrophic waterbodies have a moderate level of biological productivity.

Criteria: total chlorophyll is between 3 and 7 µg/L
total phosphorus is between 15 and 25 µg/L
total nitrogen is between 400 and 600 µg/L
water clarity is between 8 and 13 feet

A typical mesotrophic waterbody will have moderately clear water and a moderate amount of aquatic plants.

Eutrophic waterbodies have a high level of biological productivity.

Criteria: total chlorophyll is between 7 and 40 µg/L
total phosphorus is between 25 and 100 µg/L
total nitrogen is between 600 and 1500 µg/L
water clarity is between 3 and 8 feet

A typical eutrophic waterbody will either have lots of aquatic plants and clear water; or it will have few aquatic plants and less clear water. In either case, it has the potential to support lots of fish and wildlife.

Hypereutrophic waterbodies have the highest level of biological productivity.

Criteria: total chlorophyll is greater than 40 µg/L
total phosphorus is greater than 100 µg/L
total nitrogen is greater than 1500 µg/L
water clarity is less than 3 feet

A typical hypereutrophic waterbody will have very low water clarity, the potential for lots of fish and wildlife, and it may have an abundance of aquatic plants.

* **The unit of measurement "micrograms per liter" is abbreviated "µg/L."**

Figure 9: Trophic states in lakes

The TSI scale runs from “0” to “100”. Generally, TSI values from 0-40 are considered oligotrophic, 40-50 are mesotrophic, 50-70 are eutrophic, and anything above 70 is considered hypereutrophic (Table 1).

Table 1: TSI Scale (Cedar Corporation, 2006)

Table 3-4: Trophic State Index (TSI)

TSI Value	Water Quality Attributes	Fisheries, Recreation or Example Lakes
<30	**Oligotrophic:** Clear water, oxygen through the year in the hypolimnion. Water supply may be suitable unfiltered.	Salmonid fisheries dominate.
30-40	Hypolimnia of shallower lakes may become anoxic during the summer.	Salmonid fisheries in deep lakes only. Example: Lake Superior (WDNR)
40-50	**Mesotrophic:** Water moderately clear but increasing probability of anoxia in hypolimnion during summer. Possible iron, manganese, taste and odor problems may worsen in water supply. Water turbidity requires filtration.	Walleye may predominate and hypolimnetic anoxia results in loss of salimonoids.
50-60	**Eutrophic:** Lower boundary of classic eutrophy. Decreased transparency, anoxic hypolimnion during the summer, macrophyte problems evident, warm water fisheries dominant.	Bass may dominate.
60-70	Dominance of blue-green algae, algal scums probable, extensive macrophyte problems. Possible episodes of severe taste and odor from water supply. Anoxic hypolimnion, water-water fisheries.	Nuisance macrophytes, algal scums and low transparency may discourage swimming and boating.
70-80	**Hypereutrophic:** Light limited productivity, dense algal blooms and macrophyte beds.	Lake Menomin & Tainter Lake, Dunn County, WI (WDNR).
>80	Algal scums, few macrophytes, summer fishery kills.	Dominant rough fish.

The measurements of all three parameters (Secchi - feet, TP & Chla - µg/L) can be converted to values that fit in the TSI range of 0 to 100. By doing so, all three can be compared together to establish trends (Figure 10). The dark blue area of Figure 10 is considered oligotrophic; the light blue mesotrophic; and the green eutrophic. For UECL, the annual average summer Secchi disk readings (black dots) all fall in the oligotrophic area. Chla values (green squares) fall in both the oligotrophic and mesotrophic area. TP values fall mostly in the mesotrophic area with a few from the mid-2000s falling in the eutrophic range.

TSI data can be used for more than just visualizing trends. Over time, several familiar patterns emerge from the data. Carlson and Havens (2005) discussed the patterns that frequently emerge when looking at long-term trend data and TSI values. From 1989 to 1995, TSI values for Secchi, TP, and Chla for the most part are the same or similar (Figure 10). This pattern suggests that the amount of available phosphorus limits algae biomass and light attenuation is dominated by the presence of algae. From 2002 to 2022, the pattern changes, now TSI vales for Secchi and Chla are similar, but TSI values for TP are much higher (Figure 10). This pattern suggests that some other factor than the amount of TP (zooplankton grazing on algae, available nitrogen, something else?) limits algae biomass. From a water quality perspective, if water quality in UECL was deteriorating, than reducing phosphorus inputs into the lake would likely not help solve the problem because there is already plenty of excess phosphorus that is not being used to grow algae (Carlson & Havens, 2005).

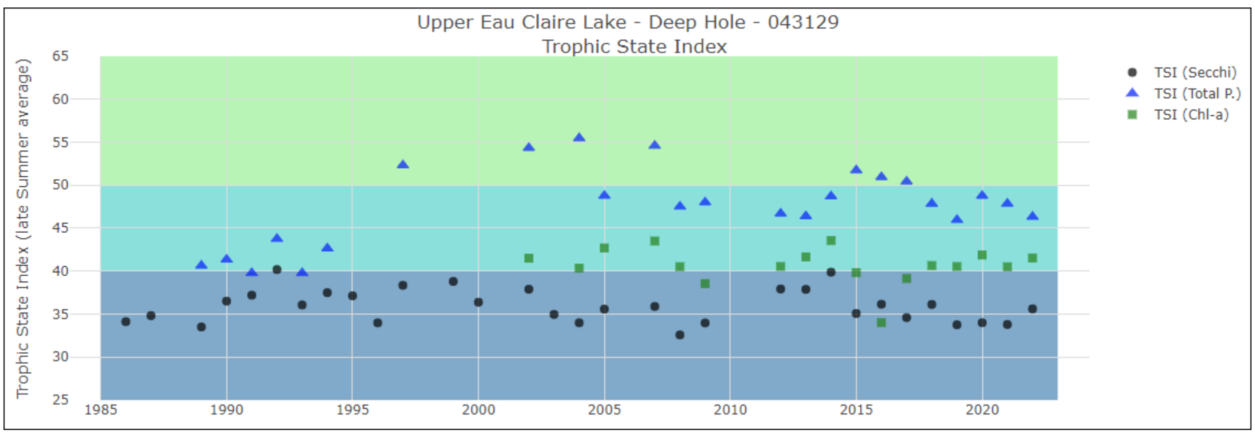


Figure 10: Yearly TSI values for Chla, Secchi (water clarity), and TP (CLMN)

3.0 Fisheries and Wildlife

As previously mentioned, UECL is considered an outstanding resource water by the WDNR. It is also listed as a Priority Navigable Water (PNW) for musky and walleye. Much of the data included in this section is from a comprehensive fishery survey completed by the WDNR on UECL from 2017-2018. The purpose of the survey was to obtain a walleye and muskellunge population estimate, assess gamefish and panfish populations and characterize sport and tribal use of the fishery (Klein, 2020).

3.1 Fisheries

UECL is home to variety of fish species including walleye, muskellunge, northern pike, largemouth bass, smallmouth bass, bluegill, pumpkinseed, rock bass, black crappie, yellow perch, white sucker, yellow bullhead, common shiner, spot-tail shiner, golden shiner, bluntnose minnow, tadpole madtom, and cisco. Management of UECL by the WDNR has included fishery surveys, stocking, regulation changes and habitat improvements. Surveys targeting walleye following standard treaty assessment protocol occurred in 1993, 2004, 2011 and 2017. Early surveys in 1948 and 1950 reported the presence of walleye, northern pike, largemouth and smallmouth bass, bluegill, black crappie, rock bass, bullheads and suckers. Other surveys in 1961 and 1969 indicated similar results, along with the presence of muskellunge.

In 1983, the first comprehensive fish survey was completed reporting the presence of the other species previously listed and included a walleye population estimate and cisco assessment. Since 1983, the Great Lakes Indian Fish & Wildlife Commission (GLIFWC) has conducted two walleye population estimates (1991 and 1999) and walleye recruitment surveys, and the WDNR has conducted bass/panfish, walleye recruitment and comprehensive surveys.

Stocking efforts in UECL have focused on walleye and muskellunge. From the late 1930's to 1950's, a myriad of species were stocked including: largemouth bass, bluegill, black crappie, walleye and muskellunge. Since 1982, only walleye, muskellunge and rainbow trout have been stocked (Table 2), however rainbow trout stocking was discontinued due to poor survival and return to creel. Walleye and muskellunge stocking efforts have continued and are currently being stocked semi-annually (Klein, 2020).

Fish management recommendations from the 2017-18 comprehensive fisheries survey include, 1) Re-evaluate current walleye stocking practices after next comprehensive survey but retain current walleye regulations, 2) Continue current muskellunge stocking practices and retain current regulations, 3) Retain current northern pike regulations, 4) Retain current largemouth and smallmouth bass regulations, 5) Retain current panfish regulations, 6) Gather input on angler desires for specific fisheries, 7) Manage 3 existing Aquatic Invasive Species (AIS), prevent new introductions of AIS, and protect/enhance shoreline habitat and water quality (Klein, 2020).

Table 2: WDNR stocking of musky, walleye, and rainbow trout

Stocking Year	Stocked Waterbody Name	Species	Age Class	Number Fish Stocked	Avg Fish Length(IN)
2022	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	LARGE FINGERLING	440	11.9
2021	UPPER EAU CLAIRE LAKE	WALLEYE	LARGE FINGERLING	10244	6.1
2019	UPPER EAU CLAIRE LAKE	WALLEYE	LARGE FINGERLING	10244	6.5
2018	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	LARGE FINGERLING	548	11.8
2017	UPPER EAU CLAIRE LAKE	WALLEYE	LARGE FINGERLING	10240	6.45
2016	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	LARGE FINGERLING	298	11.8
2015	UPPER EAU CLAIRE LAKE	WALLEYE	LARGE FINGERLING	10244	7.5
2014	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	LARGE FINGERLING	498	11.4
2013	UPPER EAU CLAIRE LAKE	WALLEYE	LARGE FINGERLING	9898	6.5
2012	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	LARGE FINGERLING	496	13.3
2010	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	LARGE FINGERLING	374	12.4
2008	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	LARGE FINGERLING	496	10.9
2006	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	LARGE FINGERLING	274	11.4
2004	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	LARGE FINGERLING	498	10.7
2002	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	LARGE FINGERLING	498	10.6
2000	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	LARGE FINGERLING	1000	11.1
1999	UPPER EAU CLAIRE LAKE	WALLEYE	SMALL FINGERLING	49800	1.5
1998	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	LARGE FINGERLING	900	12.5
1997	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	LARGE FINGERLING	500	12.1
1997	UPPER EAU CLAIRE LAKE	WALLEYE	SMALL FINGERLING	49800	1.8
1996	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	FINGERLING	1000	11.3
1995	UPPER EAU CLAIRE LAKE	WALLEYE	FINGERLING	49900	2.4
1993	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	FINGERLING	1000	11
1992	UPPER EAU CLAIRE LAKE	WALLEYE	FINGERLING	10350	3.6
1992	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	FINGERLING	1000	10
1991	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	FINGERLING	1000	11
1991	UPPER EAU CLAIRE LAKE	WALLEYE	FINGERLING	25000	3
1991	UPPER EAU CLAIRE LAKE	RAINBOW TROUT	YEARLING	3000	9
1989	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	FINGERLING	1000	9
1988	UPPER EAU CLAIRE LAKE	WALLEYE	FINGERLING	50318	3
1988	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	FINGERLING	1942	10
1988	UPPER EAU CLAIRE LAKE	RAINBOW TROUT	YEARLING	6432	9
1987	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	FINGERLING	1500	9
1985	UPPER EAU CLAIRE LAKE	RAINBOW TROUT	YEARLING	3000	10
1985	UPPER EAU CLAIRE LAKE	RAINBOW TROUT	ADULT	33	16
1984	UPPER EAU CLAIRE LAKE	MUSKELLUNGE	FINGERLING	1000	11
1982	UPPER EAU CLAIRE LAKE	WALLEYE	FRY	2000000	

3.1.1 Two-Story Fishery

UECL is considered a “two-story” fishery by the WDNR. A two-story fishery is a lake capable of supporting warm-water species like bass and northern pike in its warm, “top story”, while at the same time, capable of supporting cold-water species like cisco or whitefish in its deeper, colder, well-oxygenated “lower story”. In Wisconsin there are only about 200 of these lakes. Recent WDNR documentation (Minahan, 2017) suggests that cisco need DO levels >6.0mg/L and water temperatures <73°F to survive in a lake. The survival of cold water fish species like cisco depends on conditions in and below the thermocline that allow them to move up in the water column as oxygen levels in the bottom of the lake decline, while at the same time staying in cold enough water to keep them alive (Figure 11).

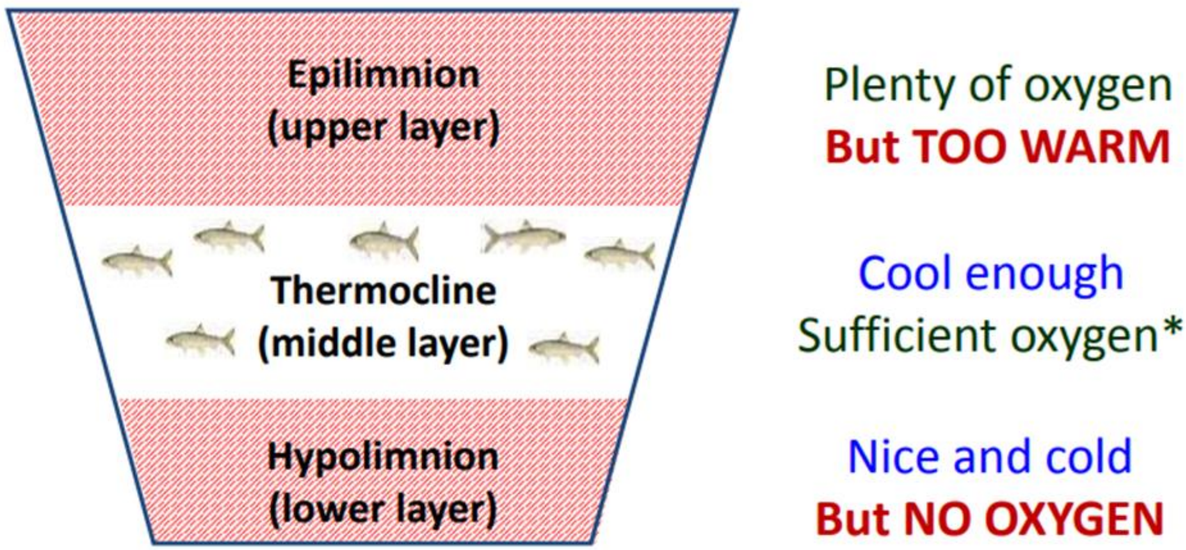


Figure 11: Lake stratification zones necessary to support a two-story fishery (Minahan, 2017)

Cold-water habitat in lakes is by its very nature fragile and imperiled. As organic matter dies and sinks, its decay uses up oxygen in deeper water. The amount of decay and the rate of oxygen loss depend upon how fertile the lake is. Imagine a first floor (lower story) where the floor and ceiling squeeze together for three or four months. Then a "normal" September brings surface cooling. Cisco and whitefish squeezed by low oxygen in the first floor now have an open stairway to the second floor (top story) because surface waters are now cool enough to meet their survival needs. If, however, summer hangs on well into September, a full month of squeeze is added and the proverbial stairs are blocked. The basement is plenty cold, but devoid of oxygen most of the time during the summer. The lower story can become devoid of oxygen as well, and if at the same time, the surface waters remain too warm, there is no escape. Under these conditions, the cold water fishery suffers. Longer summers and warmer temperatures brought on by climate change lead to even greater loss of oxygen in the "basement" and "first floor".

3.2 Critical Habitat

Every body of water has areas of aquatic vegetation that offers critical or unique fish and wildlife habitat. Such areas can be identified by the WDNR and identified as Sensitive Areas (critical habitat) per Ch. NR 107. A sensitive areas survey was completed on UECL by the WDNR in 2013 Smith et al. (2013). Figure 12 shows the critical habitat areas in UECL identified by the WDNR in 2013. Aquatic habitat areas provide the basic needs (e.g. habitat, food, nesting areas) for waterfowl, fish, and wildlife. Tables 3 and 4 provide greater detail about each of the critical habitat areas identified on the lake. Disturbance to these areas should generally be avoided or minimized and chemical treatment is generally not allowed. Areas of rock and cobble substrate with little or no fine sediment are considered high quality walleye spawning habitat. No dredging, structures, or deposits should occur in these sensitive areas. Further details for each sensitive area can be found in the UECL Critical Habitat Designation Report Smith et al. (2013).

Figure 12: Upper Eau Claire Lake Critical Habitat Map

Table 3: Upper Eau Claire Lake Critical Habitat Polygon Justifications

Critical Habitat Polygon ID	Acres	Justification	Justification	Justification	Justification	Justification	Classification
UEC1	5.6	3	6	11	-	-	Sensitive Area
UEC2	21.2	8	4	2	11	10	Sensitive Area
UEC3	5.8	4	-	-	-	-	Sensitive Area
UEC4	2.2	6	-	-	-	-	Sensitive Area
UEC5	0.4	4	-	-	-	-	Sensitive Area
UEC6	3.5	4	7	-	-	-	Sensitive Area
UEC7	20.4	6	3	-	-	-	Sensitive Area
UEC8	1.1	7	8	-	-	-	Public Rights Feature
UEC9	10.4	2	-	-	-	-	Sensitive Area
UEC10	14.5	3	6	-	-	-	Sensitive Area
UEC11	24.7	8	-	-	-	-	Public Rights Feature
UEC12	2.0	2	-	-	-	-	Sensitive Area
UEC13	1.8	7	8	-	-	-	Public Rights Feature
UEC14	4.4	2	3	-	-	-	Sensitive Area
UEC15	4.7	4	-	-	-	-	Sensitive Area
UEC16	0.9	4	-	-	-	-	Sensitive Area
UEC17	0.7	4	-	-	-	-	Sensitive Area
UEC18	1.1	4	-	-	-	-	Sensitive Area
UEC19	9.2	4	-	-	-	-	Sensitive Area
UEC20	2.4	8	-	-	-	-	Public Rights Feature
UEC21	8.4	2	-	-	-	-	Sensitive Area
UEC22	0.4	4	-	-	-	-	Sensitive Area

Table 4: Critical Habitat Justification Descriptions

Justifications	Justification Feature	Classification
1	Bio-diverse Submerged Aquatic Vegetation (SAV)	Sensitive Area
2	SAV Important to Fish and Wildlife Habitat	Sensitive Area
3	Emergent and Floating Leaf Vegetation	Sensitive Area
4	Rush Beds	Sensitive Area
5	Wild Rice Bed	Sensitive Area
6	Extensive Riparian Wetland	Sensitive Area
7	Woody Habitat	Public Rights Feature
8	Spawning Substrate	Public Rights Feature
9	Water Quality (springs, etc)	Public Rights Feature
10	Natural Scenic Beauty	Public Rights Feature
11	Navigational Thoroughfare	Public Rights Feature

3.2.1 Natural Heritage Inventory

The Natural Heritage Inventory (NHI) database contains recent and historic observations of rare species and plant communities. Each species has a state status including Special Concern (SC), Threatened (THR) or Endangered (END). On the county level (Bayfield County), there are well over 100 communities, birds, plants, insects, fish, mammals, mussels, reptiles, and amphibians included in the NHI list. On a township level, the township and range that UECL is in lists only three – a lake community, a fish species (Least Darter), and the Bald Eagle.

Three invasive species have been officially verified within UECL: curly-leaf pondweed, Chinese mystery snails, and Rusty crayfish. Purple loosestrife and yellow iris may also be present.

4.0 Aquatic Plant Surveys

While there is always some natural variation from year to year in the makeup of the aquatic plant community in a lake, human changes to a lake, including intensive management of an invasive species like CLP, may have a more obvious impact to aquatic plants. Under active management, it is recommended by the WDNR that whole-lake, point-intercept, aquatic plant surveys be completed at least every five years. There have been three such surveys completed in UECL. The first was completed in 2005 by Citizen Scientists, and although the data is interesting it has a lot of issues. The second was completed in 2013 a year after CLP had been identified in the lake for the first time. The 2013 survey was completed by Endangered Resource Services (ERS). The third survey was completed again by ERS in 2021. Only the changes between 2013 and 2021 are covered in this APM Plan.

4.1 2013 and 2021 Early Season, Whole-lake, CLP Point-intercept Surveys

Information in the next several sections related to plant survey work completed in the lake, is taken in part from reports written by ERS (Berg M. , 2021).

Using a standard formula that takes into account the shoreline shape and distance, islands, water clarity, depth, and total acreage, Jennifer Hauxwell (WDNR) generated the original 1,139-point sampling grid for Upper Eau Claire Lake that has been used for each survey since 2005. Using this grid, a density survey where CLP was sampled for at each point in and adjacent to the lake's littoral zone was completed in both 2013 and 2021. Each survey point was located using a handheld mapping GPS unit (Garmin 76CSx) and used a rake to sample an approximately 2.5ft section of the bottom. When found, CLP was assigned a rake fullness value of 1-3 as an estimation of abundance. Visual sightings of CLP within six feet of the sample point were also noted.

Following the establishment of the June 2021 littoral zone at approximately 20.5ft of water, survey results showed CLP was present in the rake at ten sample points with two additional visual sightings. This extrapolated to 0.9% of the entire lake and 1.7% of the 574-point littoral zone having at least some CLP present. Of these, two rated a rake fullness value of 3, three were a 2, and the remaining five were a 1 for a combined mean rake fullness of 1.70. The five points with a rake fullness of a 2 or a 3 suggested 0.4% of the entire lake and 0.9% of the spring littoral zone had a significant infestation (Figure 14).

In 2013, CLP was present in the rake at five sample points which approximated to 0.4% of the entire lake. Of these, a rake fullness value of 2 at two points, and a value of 1 at the remaining three points for a mean rake fullness of 1.40 was recorded. This extrapolated to 0.2% of the lake having a significant infestation (rake fullness of 2 or 3). CLP was not recorded as a visual at any additional points, and, other than a single leaf fragment raked up on the flat projecting from the north shore, no CLP plants were found anywhere outside of Pease Bay and the channel east of the island (Figure 13).

Comparing the 2013 and 2021 early-season surveys found increases in all categories of CLP growth (Figure 14); however, none of these changes were significant. This may mean the non-significant increase in coverage and the non-significant increase in density were simply due to the later date of the 2021 survey, changes in season growing conditions, or a combination of the two. It could also mean that CLP is expanding on the lake, but that the suction harvesting program is slowing this expansion.

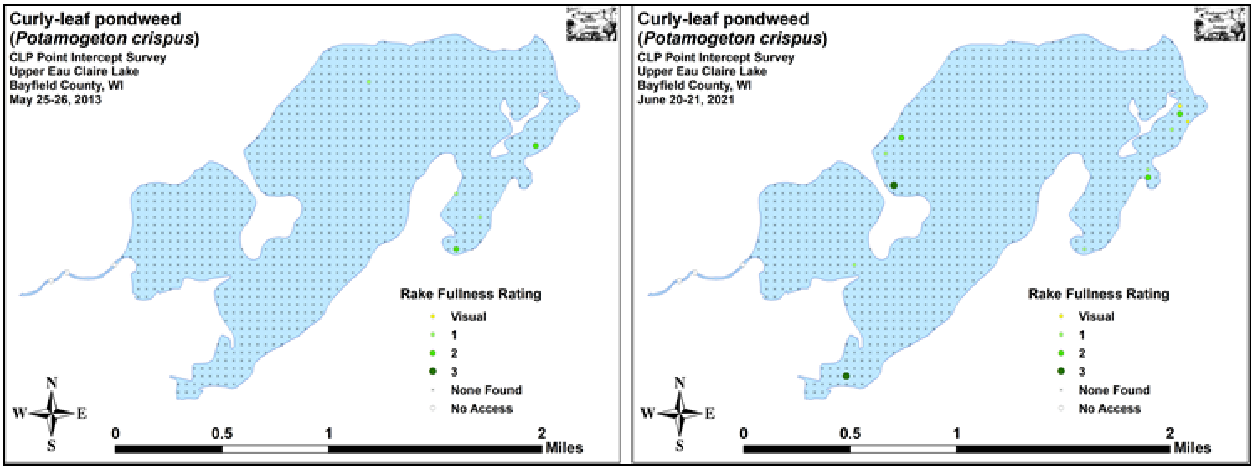


Figure 13: 2013 and 2021 spring CLP density and distribution

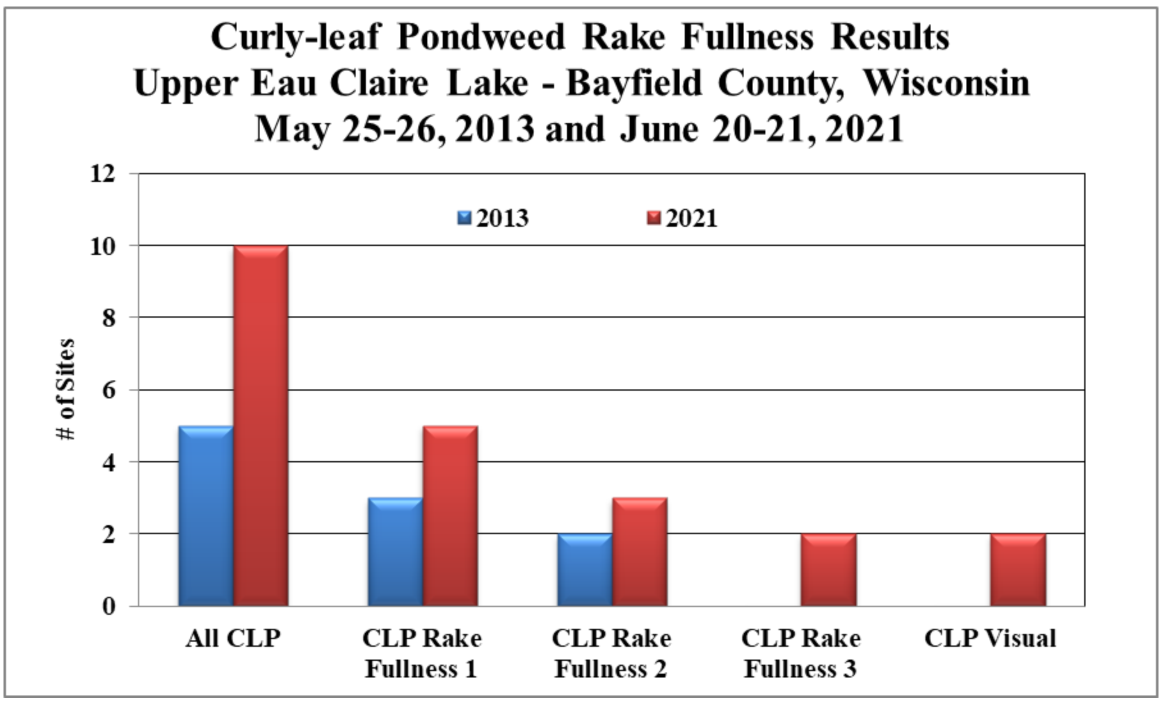


Figure 14: 2013 and 2021 changes in early-season CLP rake fullness

4.2 2013 through 2022 CLP Bed Mapping

During a bed mapping survey, the lake's entire visible littoral zone is searched. By definition, a "bed" is determined to be any area where CLP was visually estimated to make up >50% of the area's plants, is generally continuous with clearly defined borders, and is canopied, or close enough to being canopied that it would likely interfere with boat traffic. After a bed is located, GPS coordinates are taken at regular intervals while motoring around the perimeter of the area. The GPS points are used to create maps with the acreage of each area. The rake density range and mean rake fullness of each area or bed mapped is also estimated. 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) is also recorded.

During the original 2013 survey, 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 15) and in Pease Bay were mapped (Figure 16). 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 5).

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 5). 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, it was noted that three of the beds mapped in 2013 (Beds 1, 2, and 5) had completely disappeared after volunteers pulled plants in these areas during the 2014 growing season. There was also no evidence of CLP in the deep-water areas bordering Pease Bay where Beds 6 and 8 were mapped 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.

The 2020 survey found two "beds" totaling 0.04 acre – a 0.13-acre decline (-76.5%) from 2015 (Table 5). Bed 3A east of Three-in-One Island consisted of about 30 total plants most of which were rake removed by the surveyor. Bed 5A also contained only about 20-30 plants, but they were in a tight cluster and covered a much smaller area. The surveyor was 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, no evidence of CLP was seen anywhere else in the lake. The surveyor found out later, that the BAISS boat had already been on the lake, and that may explain the sharp decline relative to the 2015 survey.

In 2021, seven areas totaling 0.69 acre were mapped. This was a 0.65-acre increase compared to 2020, but still represented only 0.07% of the lake's total surface area (Table 5). 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 15). In Pease Bay, the only CLP seen was a new bed (5AA) in the northeast side bay (Figure 16). Unfortunately, for the first time ever, a small but very dense, deep water bed (Bed 9) was found in the lake's far southwest bay (Figure 18).

Despite the late ice out in 2022, the aquatic plant surveyor was informed that the BAISS team intended to start harvesting on UECL on May 31st (B. Clements – pers. comm). This meant that the 2022 bed mapping survey would again serve as a post-harvest assessment that would be used to guide management in 2023. Because of the late start to the growing season, the survey was not completed until the end of June to give CLP the maximum amount of time to grown and top out. On June 28th, five beds covering 0.67 acre (0.01% of the lake's surface area) were located. This was a decline of 0.02 acre compared to 2021 (-2.90%) (Table 5). In the bay northeast of Three-in-One Island, only scattered plants in the area formerly covered by Bed 3A were found. Elsewhere in the bay, only a few handfuls of plants were found. 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 were canopied and weren't likely causing more than a minor impairment (Figure 15). In Pease Bay, again there was 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 16). Despite raking throughout the area where we delineated Bed 9 in the lake's southwest bay had been delineated during the 2021 survey, no evidence of CLP was found in 2022 (Figure 17).

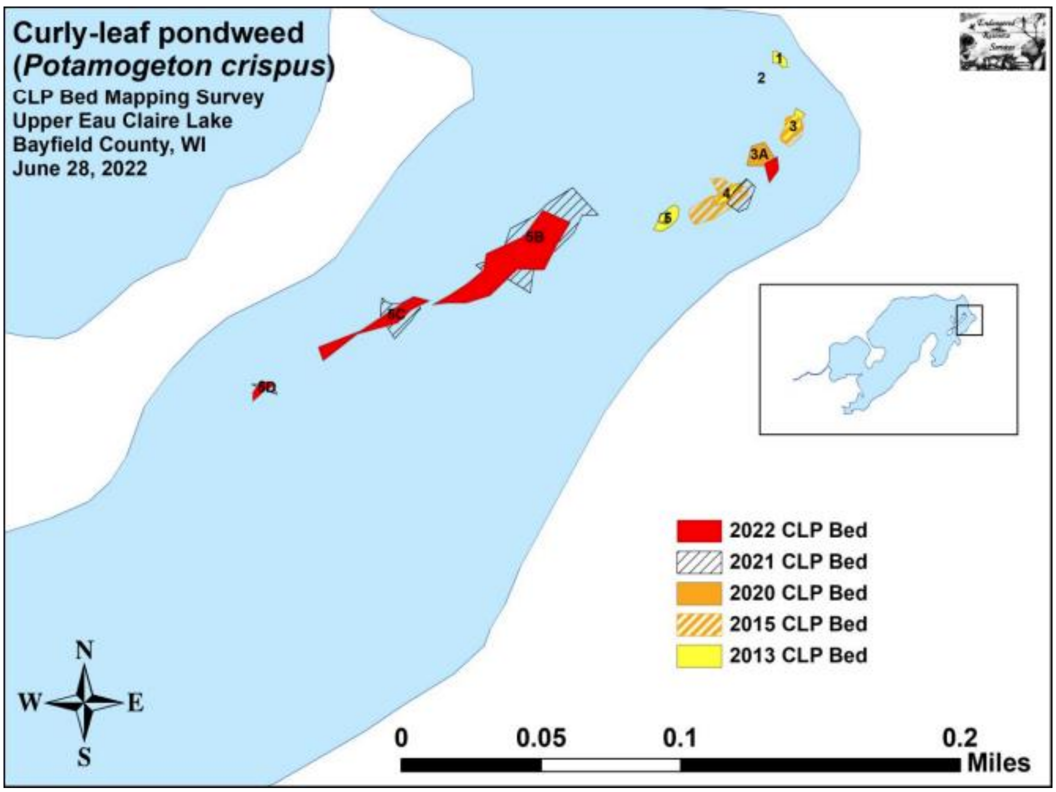


Figure 15: CLP beds – east of Three-in-One Island – 2013, 2015, 2020, 2021, and 2022

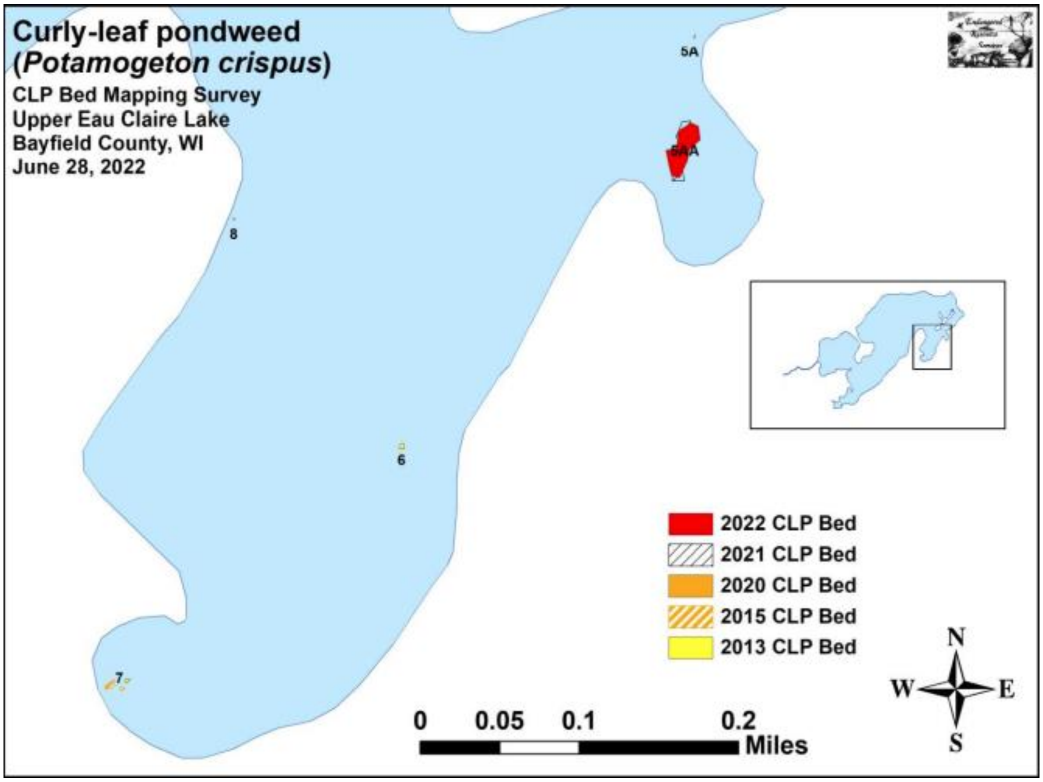


Figure 16: CLP beds – Pease Bay – 2013, 2015, 2020, 2021, and 2022

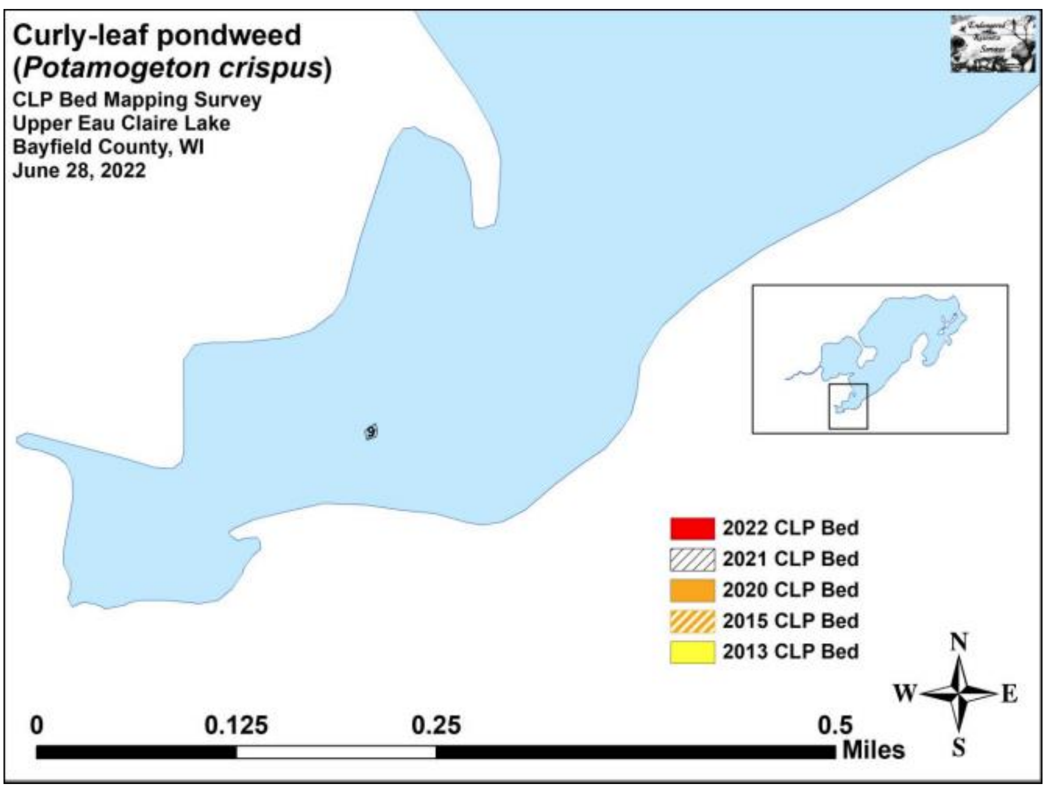


Figure 17: CLP beds – Southwest Bay – 2013, 2015, 2020, 2021, and 2022

Table 5: Curly-leaf Pondweed Bed Summary Upper Eau Claire Lake 2013-2022

Bed Number	2022 Acreage	2021 Acreage	2020 Acreage	2015 Acreage	2013 Acreage
1	0	0	0	0	0.01
2	0	0	0	0	<<<0.01
3	0	0	0	0.04	0.03
3A	0.02	0	0.04	0	0
4	0	0.04	0	0.11	0.02
5	0	0.01	0	0	0.03
5A	0	0	<0.01	0	0
5AA	0.24	0.15	0	0	0
5B	0.32	0.37	0	0	0
5C	0.09	0.08	0	0	0
5D	0.01	0.01	0	0	0
6	0	0	0	0	<0.01
7 (A and B)	0	0	0	0.02	<<0.01
8	0	0	0	0	<<<0.01
9	0	0.03	0	0	0
Total Acres	**0.67**	**0.69**	**0.04**	**0.17**	**0.11**

4.3 2013 and 2021 Warm-water Whole-lake, Point-intercept Aquatic Plant Survey

During the July 2021 survey, aquatic plants were found at 437 sites (38.3% of the bottom and 76.1% of the 20.5ft littoral zone) (Figure 18). This was a non-significant decline from 2013 when plants were present at 506 sites (44.4% of the entire lake bottom and in 83.5% of the then 23.5ft littoral zone). Plant growth in 2021 was strongly skewed to deep water as the mean depth of 7.3ft was much greater than the median depth of 6.0ft. This mean was identical to 2013, but the median was up sharply from 5.0ft that was found during the original survey.

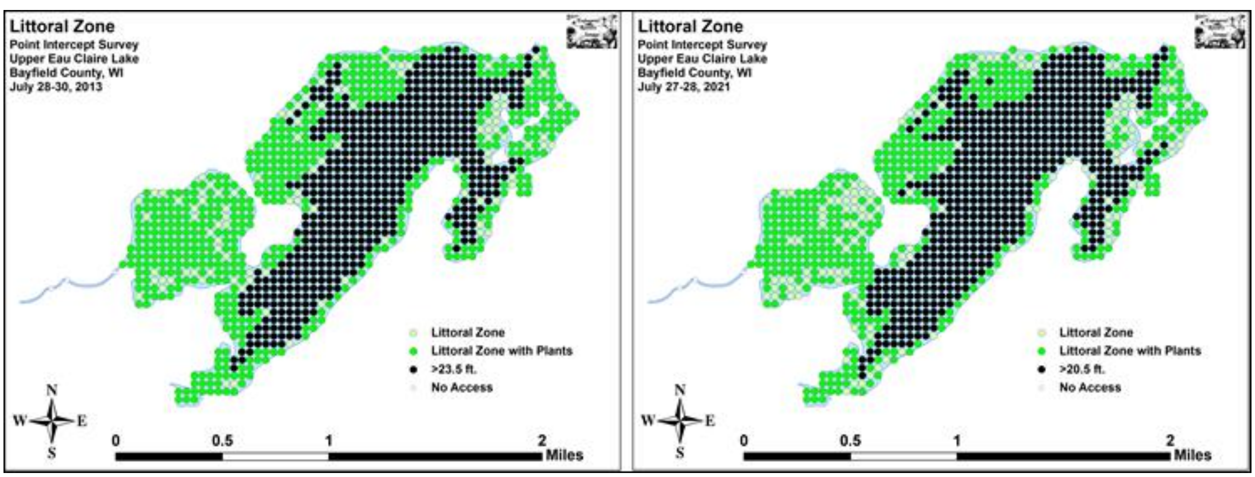


Figure 18: 2013 and 2021 littoral zone

Plant diversity was exceptionally high in 2021 with a Simpson Index value of 0.93 – up slightly from 0.92 in 2013. Total species richness was also high with 58 species found in and immediately adjacent to the lake in 2021 – up from 57 in 2013. From 2013 to 2021, mean native species richness at sites with native vegetation saw a non- significant increase from 2.56species/site in 2013 to 2.69 species/site in 2021. Visual analysis of the map showed few changes in localized richness (Figure 19).

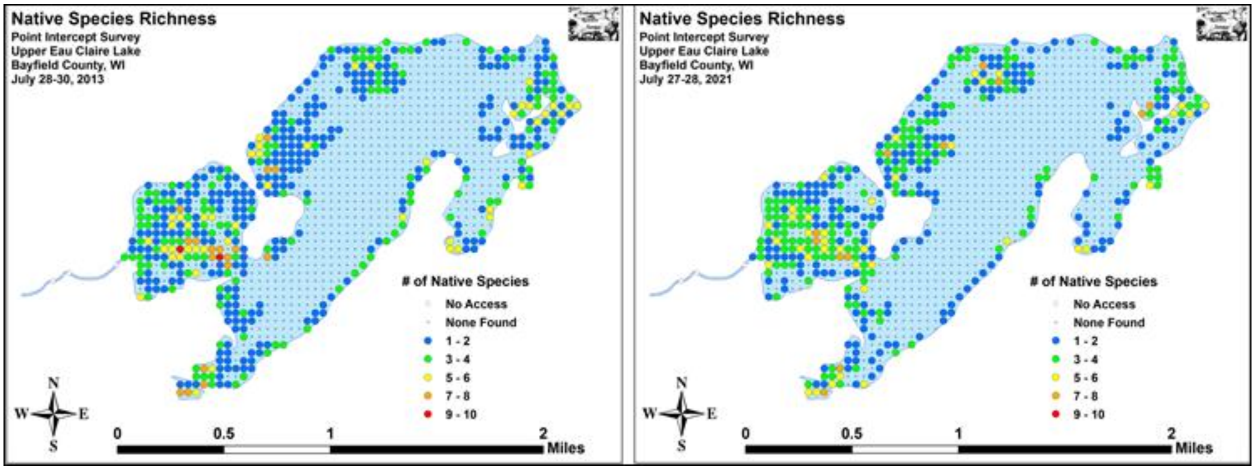


Figure 19: 2013 and 2021 native species richness

Total rake fullness underwent a highly significant increase from a low/moderate 1.43 in 2013 to a moderate 1.69 in 2021. Visual analysis of the maps showed these increases were lakewide (Figure 20).

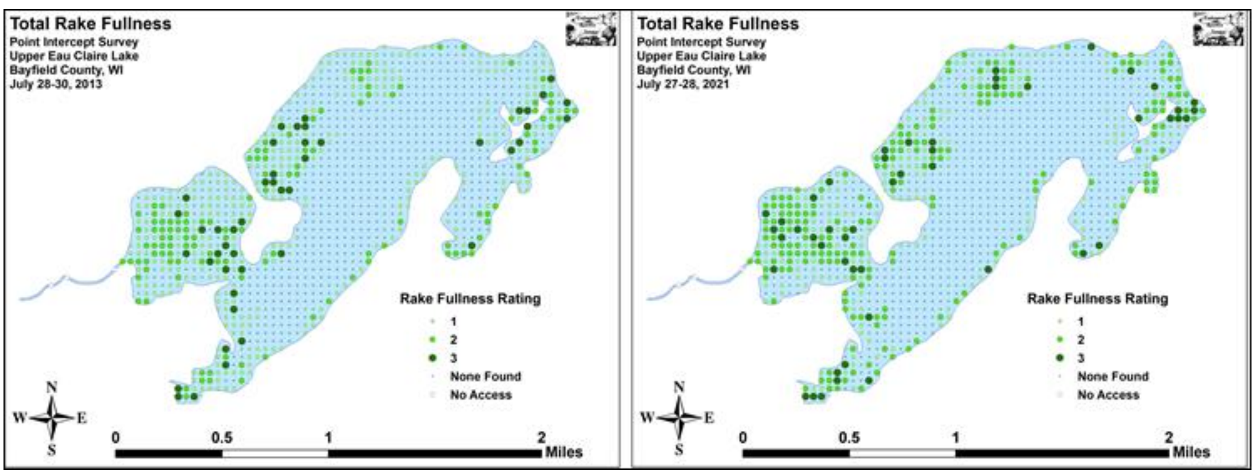


Figure 20: 2013 and 2021 total rake fullness

Survey statistics from each of the 2013 and 2021 PI surveys that were completed on UECL are included in Table 6.

Table 6: 2013 and 2021 aquatic plant PI survey statistics

Summary Statistics: Upper Eau Claire Lake	2013	2021
Total number of points sampled	1,139	1,139
Total number of sites with vegetation	506	437
Total number of sites shallower than the max. depth of plants	606	574
Freq. of occurrence at sites shallower than max. depth of plants	83.5	76.1
Simpson Diversity Index	0.92	0.93
Maximum depth of plants (ft)	23.5	20.5
Mean depth of plants (ft)	7.3	7.3
Median depth of plants (ft)	5.0	6.0
Number of sites sampled using rake on Rope (R)	98	98
Number of sites sampled using rake on Pole (P)	520	520
Average # of all species per site (shallower than max depth)	2.14	2.05
Average # of all species per site (veg. sites only)	2.56	2.69
Average # of native species per site (shallower than max depth)	2.14	2.04
Average # of native species per site (veg. sites only)	2.56	2.69
Species richness	41	41
Species richness (including visuals)	46	43
Species richness (including visuals and boat survey)	57	58
Mean rake fullness (veg. sites only)	1.43	1.69

4.3.1 Comparison of Floristic Quality Indexes in 2013 and 2021:

The FQI index measures the impact of human development on a lake's aquatic plants. The 124 species in the index are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and they often exploit these changes to the point where they may crowd out other species. Statistically speaking, the higher the index value, the healthier the lake's aquatic plant community is assumed to be. Nichols (1999) identified four eco-regions in Wisconsin: Northern Lakes and Forests, North Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. He recommended making comparisons of lakes within ecoregions to determine the target lake's relative diversity and health. Upper Eau Claire Lake is in the Northern Lakes and Forests Ecoregion.

Aquatic plant species are only included in calculating the FQI if they are identified on a rake. Visuals or plants identified during the boat survey are not included in the index and are excluded from FQI analysis. The 2013 point-intercept survey identified a total of 39 native index plants in the rake. They produced a mean Coefficient of Conservatism of 7.0 and a Floristic Quality Index of 43.7. Eight of the species identified were given Cs of 9 or 10 (three species had a C of 10) (Table 7).

Table 7: 2013 FQI calculations – Upper Eau Claire Lake

Species	Common Name	C
Bidens beckii	Water marigold	8
Brasenia schreberi	Watershield	6
Ceratophyllum demersum	Coontail	3
Chara sp.	Muskgrass	7
Elatine minima	Waterwort	9
Eleocharis acicularis	Needle spikerush	5
Eleocharis palustris	Creeping spikerush	6
Elodea canadensis	Common waterweed	3
Eriocaulon aquaticum	Pipewort	9
Heteranthera dubia	Water star-grass	6
Isoetes echinospora	Spiny-spored quillwort	8
Juncus pelocarpus	Brown-fruited rush	8
Myriophyllum sibiricum	Northern water-milfoil	6
Myriophyllum tenellum	Dwarf water-milfoil	10
Najas flexilis	Slender naiad	6
Najas guadalupensis	Southern naiad	8
Nitella sp.	Nitella	7
Nymphaea odorata	White water lily	6
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton friesii	Fries' pondweed	8
Potamogeton gramineus	Variable pondweed	7
Potamogeton illinoensis	Illinois pondweed	6
Potamogeton natans	Floating-leaf pondweed	5
Potamogeton praelongus	White-stem pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton robbinsii	Fern pondweed	8
Potamogeton strictifolius	Stiff pondweed	8
Potamogeton zosteriformis	Flat-stem pondweed	6
Ranunculus aquatilis	White water crowfoot	8
Ranunculus flammula	Creeping spearwort	9
Sagittaria cristata	Crested arrowhead	9
Schoenoplectus acutus	Hardstem bulrush	6
Schoenoplectus subterminalis	Water bulrush	9
Sparganium fluctuans	Floating-leaf bur-reed	10
Stuckenia pectinata	Sago pondweed	3
Utricularia minor	Small bladderwort	10
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6
N		39
mean C		7.0
FQI		43.7

The 2021 point-intercept survey found 38 native index plants in the rake. They produced a mean Coefficient of Conservatism of 6.9 and a Floristic Quality Index of 42.5. Nichols (1999) reported an average mean C for the Northern Lakes and Forest Region of 6.7 putting Upper Eau Claire Lake slightly above average for this part of the state. The FQI was, however, more than double the median FQI of 24.3 for the Northern Lakes and Forest Region. Seven exceptionally high-value index plants of note included Waterwort (C = 9), Pipewort (C = 9), Dwarf water-milfoil (C = 10), Creeping spearwort (C = 9), Crested arrowhead (C = 9), Water bulrush (C = 9), and Floating-leaf bur-reed (C = 10) (Table 8). These values were just slightly lower than in 2013.

Table 8: 2021 FQI calculations – Upper Eau Claire Lake

Species	Common Name	C
Bidens beckii	Water marigold	8
Brasenia schreberi	Watershield	6
Ceratophyllum demersum	Coontail	3
Chara sp.	Muskgrass	7
Elatine minima	Waterwort	9
Eleocharis acicularis	Needle spikerush	5
Eleocharis palustris	Creeping spikerush	6
Elodea canadensis	Common waterweed	3
Eriocaulon aquaticum	Pipewort	9
Heteranthera dubia	Water star-grass	6
Isoetes echinospora	Spiny-spored quillwort	8
Juncus pelocarpus f. submersus	Brown-fruited rush	8
Myriophyllum sibiricum	Northern water-milfoil	6
Myriophyllum tenellum	Dwarf water-milfoil	10
Najas flexilis	Slender naiad	6
Najas guadalupensis	Southern naiad	8
Nitella sp.	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton friesii	Fries' pondweed	8
Potamogeton gramineus	Variable pondweed	7
Potamogeton illinoensis	Illinois pondweed	6
Potamogeton natans	Floating-leaf pondweed	5
Potamogeton praelongus	White-stem pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton robbinsii	Fern pondweed	8
Potamogeton strictifolius	Stiff pondweed	8
Potamogeton zosteriformis	Flat-stem pondweed	6
Ranunculus aquatilis	White water crowfoot	8
Ranunculus flammula	Creeping spearwort	9
Sagittaria cristata	Crested arrowhead	9
Schoenoplectus acutus	Hardstem bulrush	6
Schoenoplectus subterminalis	Water bulrush	9
Sparganium fluctuans	Floating-leaf bur-reed	10
Stuckenia pectinata	Sago pondweed	3
Vallisneria americana	Wild celery	6
N		38
mean C		6.9
FQI		42.5

4.3.2 Changes in Native Aquatic Plant Species – 2013 to 2021

The 2013 survey identified Muskgrass, Slender naiad, Variable pondweed, and Clasping-leaf pondweed as the most common species (Figure 21). They were found at 45.65%, 39.13%, 19.17%, and 15.81% of sites with vegetation and encompassed 46.80% of the total relative frequency. Needle spikerush (4.79%), Nitella (4.40%), Fern pondweed (4.40%), and Wild celery (4.02%) were the only other species with relative frequencies over 4.00%.

The 2021 survey documented Muskgrass, Slender naiad, Variable pondweed, and Southern naiad as the most common species (Figures 21 and 22). They were found at 42.11%, 30.89%, 23.57%, and 19.45% of sites with vegetation and encompassed 43.15% of the total relative frequency. Fern pondweed (7.23%), Northern water-milfoil (7.06%), Clasping-leaf pondweed (5.53%), Common waterweed (5.19), Flat-stem pondweed (4.68), and Wild celery (4.60%) also had relative frequencies over 4.00%.

Figure 21: 2013 most common plant species (muskgrass, Slender naiad, Variable pondweed, and Clasping-leaf pondweed) (ERS)

Figure 22: Southern naiad (ERS)

Figure 23 reflects all of the changes in aquatic plants from 2013 to 2022. From 2013 to 2021, twelve species experienced significant changes in distribution (Figure 24). Slender naiad and Nitella suffered highly significant declines; Needle spikerush underwent a moderately significant decline; and Muskgrass, Stiff pondweed, and White-stem pondweed all saw significant declines. Conversely, Northern water-milfoil, Southern naiad, and filamentous algae enjoyed highly significant increases; Fern pondweed experienced a moderately significant increase; and Common waterweed and Curly-leaf pondweed saw significant increases.

None of these changes are likely the result of the CLP management using the BAISS boat that has occurred in the lake since 2013. Upper Eau Claire Lake is home to a healthy native plant community that is dominated by many high-value species that are sensitive to human disturbance.

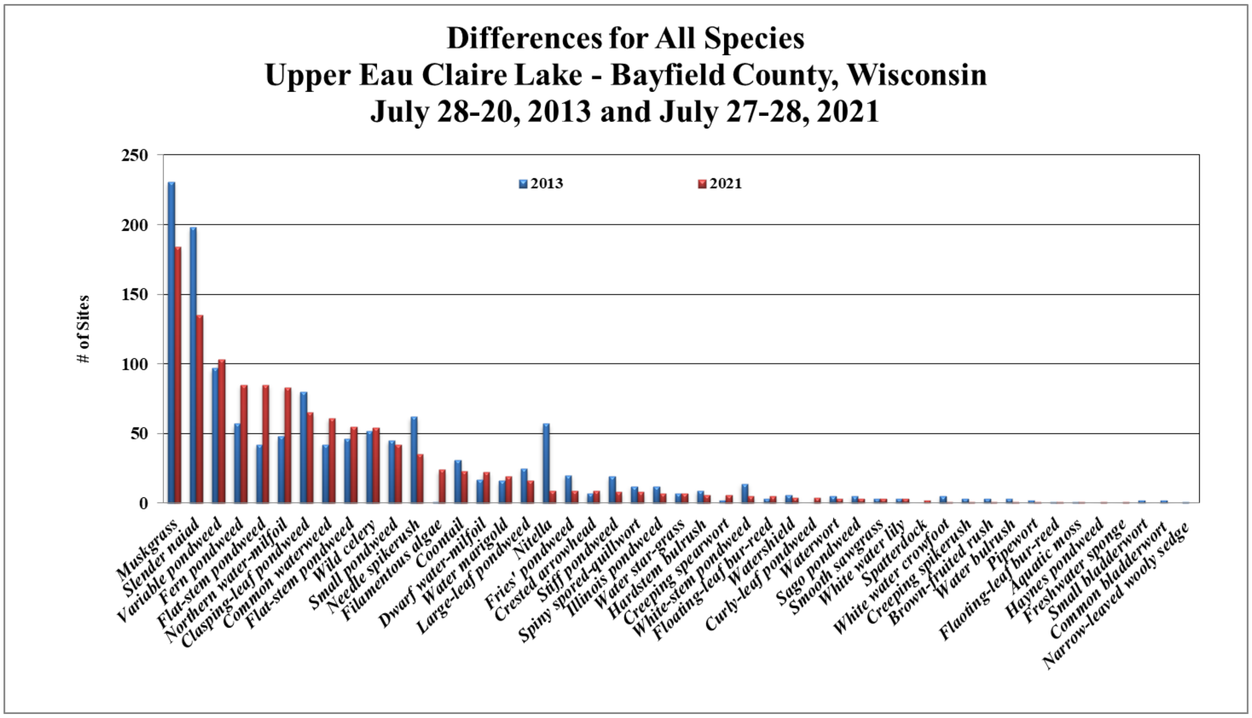


Figure 23: 2013 to 2021 differences for all aquatic plant species (ERS)

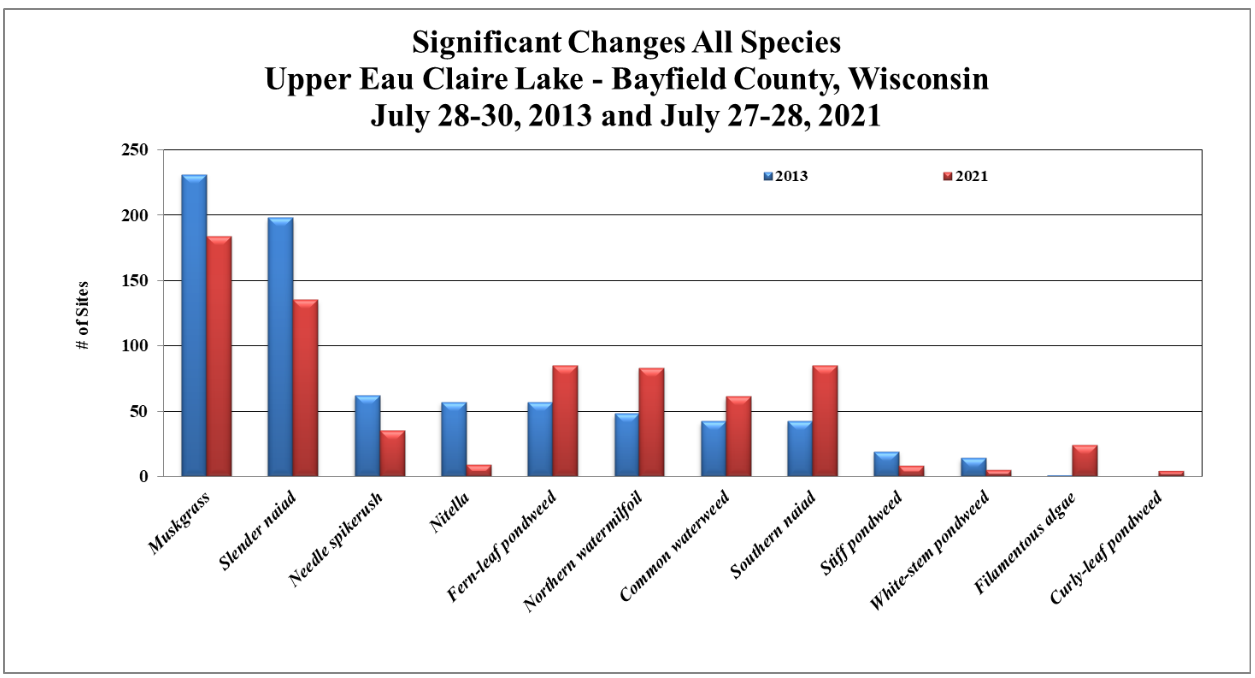


Figure 24: 2013 to 2021 significant differences in aquatic plant species (ERS)

4.4 Other Aquatic Invasive Species in Upper Eau Claire Lake

No evidence of EWM was found in UECL during any of the surveys that have been completed through 2022. However, in addition to CLP, a stand of Hybrid cattail growing in the bay northeast of Three-in-One Island was identified (Figure 25). Native to southern but not northern Wisconsin, Narrow-leaved cattail and its hybrids with Broad-leaved cattail are becoming increasingly common in Bayfield County where they also tend to be invasive. Besides having narrower leaves, the exotics can be told from our native cattails by having a relatively narrower and longer “hotdog-shaped” tan female cattail flower, whereas our native species tends to produce a fatter and shorter “bratwurst-shaped” dark chocolate colored female flower. Narrow-leaved cattail and its hybrids also have a male flower that is separated from the female flower by a thin green stem while the native Broad-leaved cattail has its male and female flowers connected.

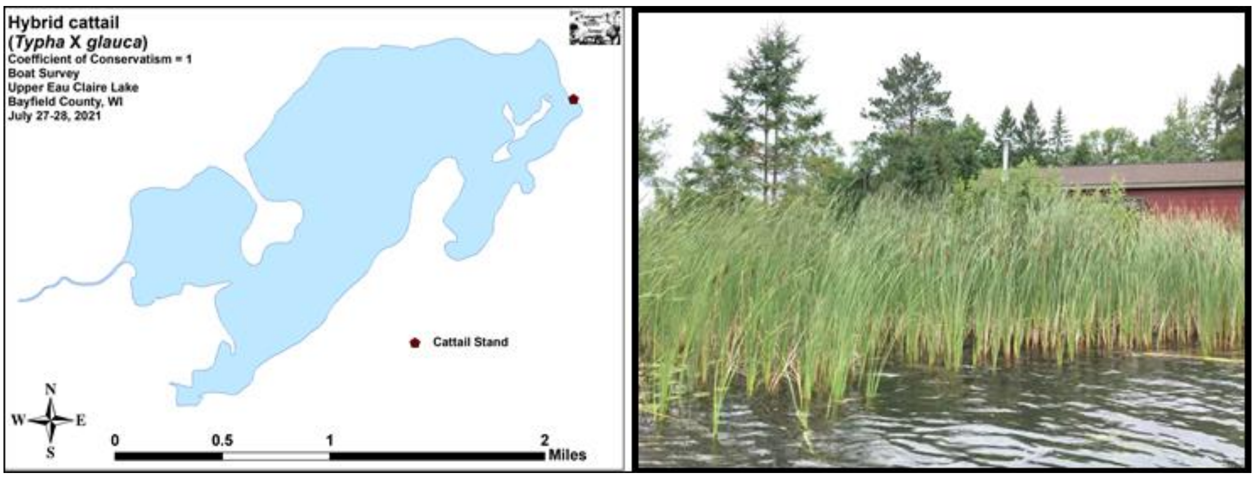


Figure 25: 2021 hybrid cattail distribution and stand in Northeast Bay

4.5 Wild Rice

Wild rice is an aquatic grass which grows in shallow water in lakes and slow flowing streams. This grass produces a seed which is a nutritious source of food for wildlife and people. The seed matures in August and September with the ripe seed dropping into the sediment, unless harvested by wildlife or people. It is a highly protected and valued natural resource in Wisconsin. Only Wisconsin residents may harvest wild rice in the state. According to the WDNR Surface Water Data Viewer, UECL is not wild rice water.

5.0 2014-2023 Curly-leaf Pondweed Management

Management of CLP in Upper Eau Claire Lake began in 2014. From 2014 to 2016 only physical removal by volunteers was completed. In 2015, the Town of Barnes began the discussion of building a DASH (diver-assisted suction harvest) boat for use to remove CLP in the Eau Claire Lakes and EWM in Sand Bar and Tomahawk Lakes. The Barnes AIS Sucker (BAISS) boat was completed in 2016 and used for the first time in 2017. DASH involves scuba divers who swim along the bottom of the lake with a hydraulic suction tube and when an offending plant is found, it is dislodged by the diver and fed into the suction tube. Hydraulic suction brings the removed plant to the surface of the lake and deposits into a bag or bin on the boat (Figure 23).

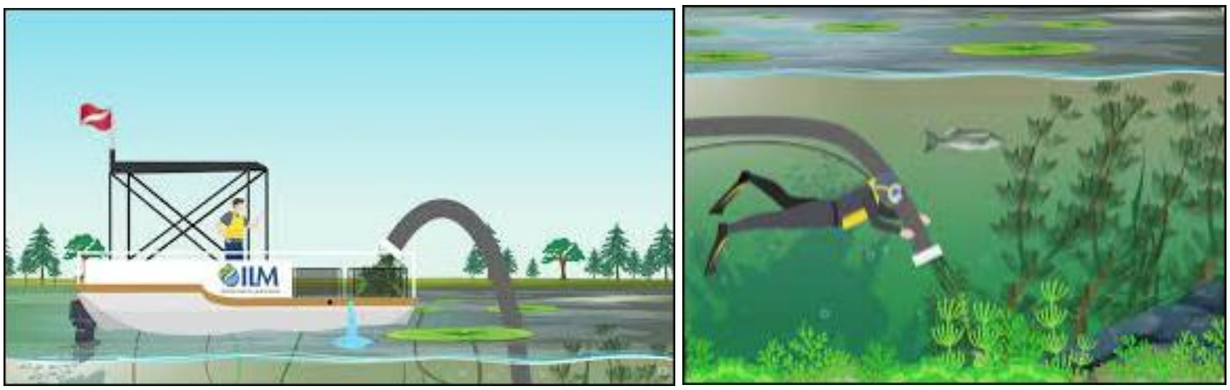


Figure 26: DASH boat and underwater operation (ILM Environments)
https://www.youtube.com/watch?v=YQmLMKzc1UM

While physical removal by volunteers continues in the lake to the current time, the BAISS boat and DASH is the main management action. No herbicide use has been proposed or implemented. Table 7 reflects the results of those management actions based on data mined from the Town of Barnes AIS Committee Minutes since 2014, and some of the volunteers involved in the process. In the Table, the term "bags" refers to the mesh bag or onion bag that is used to catch the aquatic vegetation that is removed from the bottom of the lake and fed into the suction tube (Figure 24).

When operating the BAISS boat having a volunteer driver, at least two volunteers to serves as deck hands assisting the divers and at least two paid divers is necessary. Hundreds of hours of volunteer and paid time have been expended by the Town of Barnes since 2017 operating the BAISS boat on Lower, Middle, and Upper Eau Claire Lakes.

CLP mapping of the lakes is a necessary pre-management action as it helps to minimize time wasted traveling around the lakes looking for CLP while on the BAISS boat. Hundreds of additional volunteers hours and paid consultant time has been expended doing mapping from 2014-2023.

In 2020, CLP was found in Shunenberg Lake and physically removed by volunteers. It was rediscovered in 2023.

Table 9: 2014-2023 CLP management actions in Lower, Middle, and Upper Eau Claire Lakes

2014 to 2023 Physical and DASH Removal of Curly-leaf Pondweed from Lower, Middle, and Upper Eau Claire Lakes										
Lake	2014		2015		2016		2017		2018	
	Method	Result	Method	Result	Method	Result	Method	Result	Method	Result
Lower	NA		NA		NA		NA		NA	
Middle	Physical	NR	Physical	NR	Physical	NR	DASH	48cuft	DASH	none
	Diver (ERS)	NR			Diver	NR				
Upper	Physical	NR	Physical	BR	Physical	NR	DASH	NR	DASH	NR
Lake	2019		2020		2021		2022		2023	
	Method	Result	Method	Result	Method	Result	Method	Result	Method	Result
Lower	NA		NA		NA		DASH	2 bags	DASH	?
Middle	DASH	none	DASH	10 bags	DASH	46.5 bags	DASH	25.5 bags	DASH	?
Upper	DASH	2 bags/day	DASH	21 bags	DASH	35.5 bags	DASH	57.25 bags	DASH	?
NA - Not Applicable		NR - No Report								

Figure 27: Onion bags full of AIS removed by DASH (not from the Town of Barnes)

6.0 Management Discussion

In a Technical Review of the literature available discussing CLP, two WDNR researchers identified the following potential lake impacts as it relates to CLP (Mikulyuk & Nault, 2009).

Economic Impact

Monotypic stands of P. crispus can be quite a nuisance, presenting significant navigational difficulties to recreational users. P. crispus can also stimulate algal blooms which can decrease the aesthetic value of a waterbody. These factors have a significant impact on the recreational and real estate value of a waterbody, and may also have an impact on the tourism industry. Impacts are greatest in the species' introduced range, where it is considered a noxious weed.

Social Impact

P. crispus can be a substantial nuisance to recreational users by impeding navigation and tangling fishing line. This species can also reduce swimming access and stimulate unsightly, possibly toxic algal blooms. Its environmental effects can decrease the aesthetic value of a waterbody as well as affect property values and tourism.

Impact on Crops and Other Plants

Given this species' tendency to grow in monocultures with high productivity, it has been reported to cause decreases in biodiversity by outcompeting native plants. However, it should be noted that the impact of this species on the native plant community is disputed, with some authors concluding that the fact that the plant acts like a winter annual removes it from negatively impacting native species. In its native range it can be productive, but is not generally reported as a nuisance.

Impact on Habitat

Massive stands of P. crispus substantially alter a waterbody's internal loading, and can also reduce the fetch of a lake, sometimes inducing stratification in normally unstratified systems. In a comparative study that evaluated four related macrophyte species, P. crispus produced the highest shoot growth rate and biomass. It can grow in dense monotypic stands and affect habitat structure, which may have impacts on commercially and recreationally sought after fish species. P. crispus has been reported to decrease the amount of light reaching the sediment surface. However, the plant may have positive effects in extremely degraded systems. One study reports that planting of P. crispus in enclosures improved water transparency, decreased electric conductivity, increased pH, and was shown to have an inhibitory effect on green algae.

Impact on Biodiversity

Several sources report that P. crispus has a negative effect on macrophyte biodiversity and often outcompetes native plants. P. crispus is found at sites where P. ogdenii, a critically impaired species, exists. P. crispus likely competes with P. ogdenii and may be having a significant impact on it. In studies conducted in its native range of Poland, the variety of fungus species reported growing on dead fragments of P. crispus was greater in relation to other plant species.

6.1 CLP in Upper Eau Claire Lake

During the 2021 and 2022 bed mapping surveys, CLP was primarily located in three areas of UECL: east of Three-in-One Island, Pease Bay, and lake's far southwest bay. Within these three areas, the amount of CLP covered about 2/3 of an acre total. The aquatic plant surveyor had this to say about the amount of CLP that was found.

"Curly-leaf pondweed continues to play only a minor role in the Upper Eau Claire Lake ecosystem, and, even when present, it is seldom dense enough to cause even minor navigation impairment."

Currently, the "BAISS" harvesting program appears to be keeping the CLP population in check while simultaneously having minimal impact on the lake's rich and diverse native plant community. As long as running the harvester remains a viable management option, it will likely continue to be the most environmentally friendly method of controlling CLP. In the future, if suction harvesting is discontinued or if isn't possible to get to all of the CLP beds with the time available and the Town of Barnes and/or the Friends of the Eau Claire Lakes considers chemical control, it is strongly encouraged that a measured approach that is closely evaluated is taken.

6.2 CLP Management

A scenario-based approach to CLP management is recommended over the next five years. A scenario-based approach means that any amount of CLP may be managed in the lake; however, the management actions implemented will be dictated by the conditions that exist in the lake at any given time. Not all CLP needs to be removed from the lake, but efforts should be made to keep it from gaining more purchase in the lake. To do this, a combination of manual/physical removal, DASH, and chemical control methods are recommended for UECL. As such, the following monitoring and control activities have been outlined:

1) CLP will be monitored by volunteers and resource professionals every year.
    a. Pre-management surveys will be completed annually as soon as CLP begins to make an appearance in an effort to judge the severity of seasonal growth.
    b. Early summer CLP bedmapping will be completed annually in early to mid-June in an effort to track its expansion or decline.
2) Areas of CLP with sparse, isolated plants can and should be hand pulled or raked by volunteers in shallow water (≈ 5 feet) around docks and along shorelines.
    a. Can be completed at any time during the CLP growing season
    b. Does not require a WDNR permit.
3) Snorkel, rake, and/or scuba diver removal of CLP can and should take place in areas with isolated plants, small clumps, or small beds of plants where practical and if resources are available.
    a. Would likely be completed by the Friends of the Eau Claire Lakes and supported by the Town of Barnes
    b. Can be completed at any time during the CLP growing season
    c. Does not require a WDNR permit.
4) Diver-assisted Suction Harvest or DASH will likely be the most used management action in UECL. It has been and will continue to be used in place of or in combination with snorkel, rake, and/or scuba diver removal of CLP allowing larger areas of CLP to be managed without the use of herbicides.

    a. Would likely be completed by the Friends of the Eau Claire Lakes and supported by the Town of Barnes
    b. Can be completed at any time prior to when turions are set
    c. DASH requires a WDNR Mechanical Harvesting permit.
5) Application of aquatic herbicides can be used in any area under the following guidelines
    a. The Town of Barnes or Friends of the Eau Claire Lakes can show that other management methods have been tried and did not work.
    b. Conditions exist that are likely to make other management alternatives less effective
        i. Bed size and density of CLP in the area
        ii. Location of the area in relation to lake access and usability
        iii. Bottom substrate, water depth, and/or clarity are prohibitive
        iv. Limited or unavailable access to diver, or DASH services
        v. Limited financial resources
        vi. Less than a majority constituent support for a proposed management action.
    c. One-time herbicide application
        i. Proposed chemical treatment areas are at least 5.0 acres in size.
        ii. Liquid endothall (Aquathol K) is used at 1-3 ppm
        iii. Single or combined area treatments >10.0 acres will be considered large-scale
            1. Pre (prior year) and post (year of and/or year after) treatment aquatic plant surveys should be considered.
            2. Herbicide concentration testing should be considered
        iv. Single or combined area treatments >51.0 acres will be considered whole-lake
            1. Whole-lake herbicide concentration should be calculated based on the proposed application rate.
            2. Pre (prior year) and post (year of and/or year after) treatment aquatic plant surveys should be considered.
            3. Herbicide concentration testing should be considered
        v. Requires a WDNR Chemical Application permit
        vi. Herbicides must be applied by a licensed Applicator

Many of the management actions outlined for CLP would also be effective for the management of Eurasian watermilfoil should it be found in UECL over the next five years. A different herbicide would be used; likely ProcellaCOR or a liquid 2,4D-based herbicide. Annual management decisions for CLP (or EWM) will always be based on the level of infestation, current understanding of management alternatives, resources available, what is acceptable to the constituency, and what the WDNR will approve.

6.3 Management of Other AIS

At the present time, CLP is the only AIS plant that is actively managed in UECL. That said, other AIS plants including but not limited to Eurasian watermilfoil, purple loosestrife, yellow iris should be monitored for on a regular basis and management actions taken when found. EWM would be managed similarly to CLP. Purple loosestrife could be physically removed, managed with aquatic herbicides, or in large areas, biological control beetles could be reared and released. Yellow iris would likely be managed with physical removal.

The lake should also be actively monitored for zebra mussels and spiny waterflea.

For more information about these and other AIS review the more inclusive Aquatic Plant Management Plan for the Towns of Barnes, Gordon, and Highland in Bayfield and Douglas Counties of which this document is an addendum.

7.0 Aquatic Plant Management Goals

This Aquatic Plant Management Plan establishes the following goals for aquatic plant management in Upper Eau Claire Lake:

1) **CLP Management.** Maintain CLP at low levels through environmentally responsible management methods that will minimize the potential for negative impacts to the lake and native plant community in the future.

2) **AIS Education and Awareness.** Continue to educate property owners and lake users on aquatic invasive species through public outreach and education programs to help contain existing AIS in and around the lake and new AIS that could get introduced to the lake.

3) **Research and Monitoring.** Develop a better understanding of the lake and the factors affecting lake water quality through continued and expanded monitoring efforts.

4) **Adaptive Management.** Follow an adaptive management approach that measures and analyzes the effectiveness of control activities and modifies the management plan as necessary to meet goals and objectives.

7.1 Goal 1. CLP Management

The main goal of this APM Plan for UECL is to keep CLP from increasing its distribution and density in the lake. While the presence of CLP in the lake is not necessarily an indicator that the health of the lake and its aquatic plant community is deteriorating, in many lakes CLP can cause the following issues identified by the WDNR[2]:

- It can become dominant and invasive due to its tolerance for low light and low water temperatures.
- It may out compete other underwater plants and become dominant, which causes problems due to the formation of dense mats that interfere with recreational activities.
- It also causes an increase in phosphorus concentrations, causing an increase in algae blooms and a pile-up of dying plants along the shore.

At the present time, CLP is doing none of these things in UECL. The goal is preventative management to keep it from doing so for as long as possible.

7.1.1 CLP Survey Work

Management of CLP will be updated regularly based on pre-management surveys and annual bed mapping surveys completed by either trained volunteers or resource professionals. Pre-management surveys should be completed as soon after ice out as possible to begin getting a perspective on how the given growing season will impact the amount of CLP in the lake. WDNR permitting either needs to wait to be completed until some perspective is gained from these surveys, or have the possibility of managing more CLP then expected built into it. This is easy with a mechanical harvesting permit, more difficult with a chemical application permit. Once pre-management surveys are completed management plans should be reviewed and modified if necessary. Annual CLP bed mapping surveys, completed at the

[2] https://dnr.wisconsin.gov/topic/Invasives/fact/CurlyLeafPondweed.html

height of CLP growth, will be used to quantify the extent of CLP in the lake in any given year. Generally speaking, greater amounts of CLP during a bed mapping survey will lead to more extensive management plans the following year.

Once these surveys are completed discussion pertaining to next season management will begin. Should it be determined that the application of aquatic herbicides will come into play in the following year, additional pre-treatment surveys of aquatic plants may be completed to document the present of native plants. Post-treatment surveys may be included in the year of treatment and/or in the year after treatment. Pre and post treatment surveys are not required by the WDNR unless the chemically treated areas cover 10 or more acres.

7.1.2 Herbicide Concentration Testing

At least in the first year covered in this APM Plan where aquatic herbicides are used in UECL it is highly recommended that herbicide concentration testing be done. Herbicide concentration testing helps determine if the amount of herbicide applied reached the expected concentrations, how fast it dissipates, and if it is transported to other parts of the lake that were not intended for treatment. If a chemical treatment is not very effective, concentration testing can help determine why.

7.2 Goal 2. AIS Education and Awareness

Aquatic invasive species can be transported via a number of vectors, but most invasions are associated with human activity. Maintaining signs and continuing watercraft inspection at the public boat landing should be done to educate lake users about what they can do to prevent the spread of AIS.

Early detection and rapid response efforts increase the likelihood that a new aquatic invasive species will be addressed successfully while the population is still localized and levels are not beyond that which can be contained and eradicated. Once an aquatic invasive species becomes widely established in a lake, complete eradication becomes extremely difficult, so attempting to partially mitigate negative impacts becomes the goal. The costs of early detection and rapid response efforts are typically far less than those of long-term invasive species management programs needed when an AIS becomes established.

It is recommended that the Town of Barnes and Friends of the Eau Claire Lakes continue to implement a proactive and consistent AIS monitoring program. At least three times during the open water season, trained volunteers should patrol the shoreline and littoral zone looking for EWM and other species like purple loosestrife, Japanese knotweed, giant reed grass, and zebra mussels. Free support for this kind of monitoring program is provided as part of the UW-Extension Lakes/WDNR CLMN AIS Monitoring Program. Any monitoring data collected should be recorded annually and submitted to the WDNR SWIMS database.

Providing education, outreach opportunities, and materials to the lake community will improve general knowledge and likely increase participation in lake protection and restoration activities. It is further recommended that the Town of Barnes and Friends of the Eau Claire Lakes continue to cultivate an awareness of the problems associated with AIS and enough community knowledge about certain species to aid in detection, planning, and implementation of management alternatives within their lake community. It is also recommended that the Town of Barnes and Friends of the Eau Claire Lakes continue to strive to foster greater understanding and appreciation of the entire aquatic ecosystem including the important role plants, animals, and people play in that system.

Understanding how their activities impact the aquatic plants and water quality of the lakes is crucial in fostering a responsible community of lakeshore property owners. To accomplish this, the Town of Barnes and Friends of the Eau Claire Lakes should distribute, or redistribute informational materials and provide educational opportunities on aquatic invasive species and other factors that affect the lakes. At least one annual activity (picnic at the lake, public workshop, guest speakers, etc.) should be sponsored and promoted by the Town of Barnes and Friends of the Eau Claire Lakes that is focused on AIS. Results of water quality monitoring should be shared with the lake community at the annual meeting, or another event, to promote a greater understanding of the lake ecosystem and potentially increase participation in planning and management.

7.3 Goal 3. Research and Monitoring

Long-term data can be used to identify the factors leading to changes in water quality. Such factors include aquatic plant management activities, changes in the watershed land use, and the response of the lakes to environmental changes. The CLMN Water Quality Monitoring Program supports volunteer water quality monitors across the state following a clearly defined schedule. UECL has been a part of this program for many years and should continue its involvement.

The intensity/success of water quality monitoring efforts should be evaluated at least every three years. The background information and trends provided by these data are invaluable for current and future lake and aquatic plant management planning.

To monitor any changes in the plant community, it is recommended that whole-lake point intercept aquatic plant surveys be completed at three to five-year intervals. This will allow managers to adjust the APM Plan as needed in response to how the plant community changes as a result of management and natural factors. The next whole-lake point-intercept survey should be planned for 2026 with an update of this plan completed in 2027.

The Town of Barnes and Friends of the Eau Claire Lakes should continue to support efforts to improve/restore native shoreland around the lake that lead to healthier habitat and less polluted runoff from properties immediately adjacent to the lake. These efforts should continue and can be supported by the Wisconsin Healthy Lakes and Rivers Initiative. In addition, the Town of Barnes and Friends of the Eau Claire Lakes should continue to work with the Bayfield County Soil and Water Conservation Department to address runoff concerns in the greater watershed.

7.4 Goal 4. Adaptive Management

This APM Plan is a working document guiding management actions on UECL for the next five years. This plan will follow a scenario-based, adaptive management approach by adjusting actions as the results of management and data obtained deem fit following IPM strategy. This plan is therefore a living document, progressively evolving and improving to meet environmental, social, and economic goals, to increase scientific knowledge, and to foster good relations among stakeholders. Annual and end of project assessment reports are necessary to monitor progress and justify changes to the management strategy, with or without state grant funding. Project reporting will meet the requirements of all stakeholders, gain proper approval, allow for timely reimbursement of expenses, and provide the appropriate data for continued management success. Success will be measured by the efficiency and ease in which these actions are completed.

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