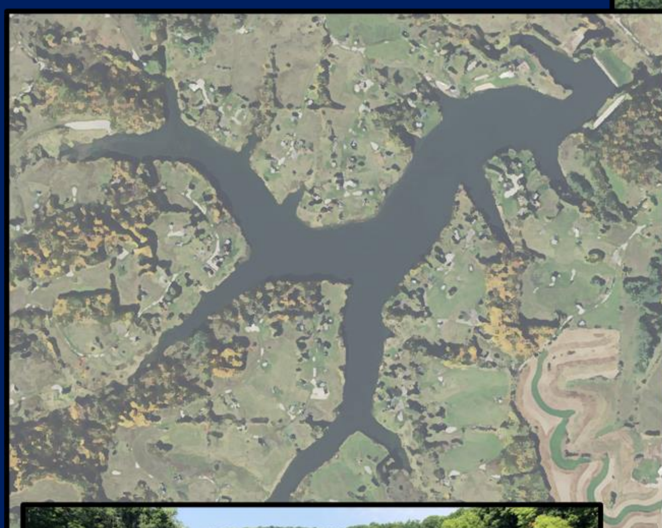
Aquatic Plant & Hybrid Watermilfoil Surveys
for
Dutch Hollow Lake
Sauk County, Wisconsin
August & September 2023



Project initiated & funded by the Friends of Dutch Hollow Lake
Also funded by Sauk County

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Survey assistance from AEM Aquatic Consulting

Photos from Cover Page:
1. Right photo illustrates a full rake of HWM from a depth of 16 feet (sample point #78) in western Dutch Hollow Lake. 2. Bottom photo illustrates the condition of Woodland Bay in August 2023 after ProcellaCOR treatment in June. There was no HWM visible from the lake surface in 2023 (native sago pondweed is visible in the photo) whereas the area was abundant with HWM growing to the surface in 2022.

BACKGROUND & INTRODUCTION

The Friends of Dutch Hollow Lake (FDHL) partnered with Aquatic Plant and Habitat Services LLC (APHS) and AEM Aquatic Consulting to complete a whole-lake aquatic plant point-intercept (PI) survey August 10-11, 2023 and Eurasian & hybrid watermilfoil (EWM & HWM) bed and pre-treatment PI surveys September 13, 2023. The surveys are intended to track the native aquatic plant community and track the success of EWM & HWM control efforts. There was a 10-acre herbicide treatment using florpyrauxifen-benzyl (ProcellaCOR) in Woodland Bay on June 5, 2023. Figure 1 summarizes other recent management activities, notable changes that the FDHL has made in management strategy based on available data, and plans for management in 2024. This document is intended to provide a summary of results from the 2023 point-intercept survey, comparisons to previous surveys, and results of the 2023 EWM & HWM surveys.

Figure 1 – Management of Hybrid & Eurasian Watermilfoil 2013-2023

EWM & sub-PI surveys are added to provide more information for management decisions (2018)

Integrated management used to help control EWM: DASH | Benthic Barriers (2019)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024 Plans
Surveys	PI		PI	PI	PI	PI, EWM, sub-PI	PI, EWM, sub-PI	PI, EWM	PI, EWM	PI, HWM, sub-PI	PI, HWM, sub-PI	PI, HWM, sub-PI
DASH							10 Days	5 Days		7 Days	8 Days	5 Days
Manual (hired)											4 Days	5 Days
Herbicide >10 ac	Whole lake 2,4-D	Whole lake 2,4-D			Whole lake 2,4-D				Whole lake 2,4-D			
Herbicide <10 ac			8 acres 2,4-D				10 acres 2,4-D			1.77 acres PCOR	10 acres PCOR	2 acres PCOR
Other							Benthic barrier (beach)	Benthic barrier (beach)	Milfoil genetic analysis			

Graphic created by Aquatic Plant & Habitat Services LLC

Whole-lake herbicide treatments less frequent to decrease impacts to native plant species (2017)

Genetic analysis confirms hybrid watermilfoil (HWM) to be dominant (2021)

Shift from 2,4-D to ProcellaCOR (2022)

RESULTS

PI Survey Results

A total of 428 predetermined survey points were sampled in Dutch Hollow Lake (436 points total, but 8 were not accessible). Points deeper than 28 feet were not sampled but depth was recorded. The maximum depth recorded was 39 feet. A total of 28 species of aquatic plants were found (filamentous algae not counted), three of which were documented as part of the boat survey (> 6 feet from any survey point) and three of which were visual only (<6 ft from sample point but not on sample rake).

Figure 2 – Total Rake Fullness Map

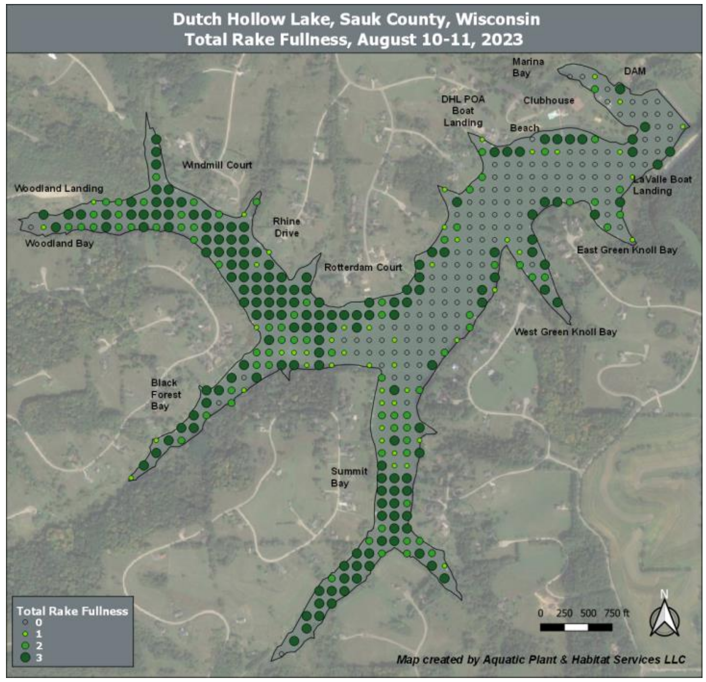


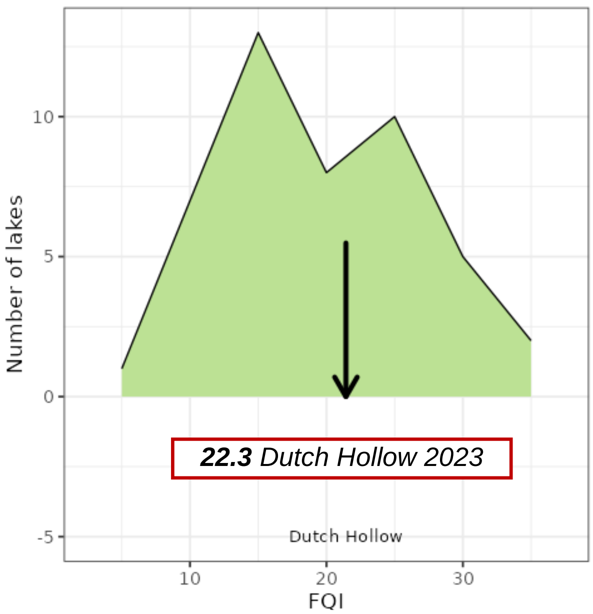
Table 1 – Summary Statistics Results 2011-2023

#	Summary Statistic		4.5-Acre herbicide 2,4-D & Endothall May 23, 2011	Sept 12 2011	Whole-lake herbicide 2,4-D May 22, 2013	Aug 29 2013	Whole-lake herbicide 2,4-D June 5, 2014	8-Acre herbicide 2,4-D, Endothall, Diquat May 11&15, 2015	Aug 27 2015	Aug 28 2016	Whole-lake herbicide June 12, 2017	Aug 19 2017	Aug 11 2018	10-Acre herbicide 2,4-D, Woodland Bay June 10, 2019	Aug 17 2019	Aug 10 2020	Whole-lake herbicide 2,4-D June 21, 2021	Aug 9 2021	1.8-Acre herbicide ProcellaCOR, June 14, 2022	Aug 14 2022	10-Acre herbicide ProcellaCOR, June 5, 2023	Aug 10, 2023
1	Total # of sites visited			367		358			429	436		435	430		436	430		430		432		428
2	Total # of sites with vegetation			240		289			264	312		230	240		241	302		298		292		292
3	Max. depth of plants (feet)			23.0		27.0			21.5	28.5		28.0	26.0		22.0	28.0		27.0		27.0		28.0
4	Total # of sites shallower than max. depth of plants			277		340			289	350		310	309		275	351		332		339		343
5	Frequency of occurrence (FOO) at sites shallower than max. depth of plants. AKA Littoral frequency			87%		85%			91%	89%		75%	78%		88%	86%		90%		86%		85%
6	Average # of species per site	a) Shallower than max. depth		2.42		2.24			2.19	2.75		1.91	2.61		2.69	2.51		2.48		2.56		2.61
		b) Vegetated sites only		2.80		2.64			2.40	3.09		2.57	3.35		3.07	2.91		2.76		2.97		3.06
		c) Native shallower than max. depth		2.27		2.14			2.09	2.35		1.85	2.39		2.41	2.09		2.10		1.89		1.96
		d) Native species at vegetated sites only		2.63		2.52			2.30	2.68		2.50	3.08		2.79	2.09		2.39		2.25		2.34
7	Species Richness	a) Total # species on rake at all sites		19		15			15	22		16	18		19	22		20		18		22
		b) Including visuals		19		18			15	22		17	19		20	22		21		21		25
8	Simpson's Diversity Index			0.89		0.85			0.88	0.90		0.86	0.89		0.90	0.89		0.87		0.85		0.86
9	Mean Coefficient of Conservatism			5.6		5.6			5.7	5.6		5.6	5.6		5.6	5.7		5.6		4.9		5.1
10	Floristic Quality Index			22.5		20.2			21.4	24.5		21.1	22.5		23.3	22.8		23.3		18.8		22.3
	Eurasian Watermilfoil Littoral Frequency of Occurrence			15%		9%			10%	39%		4%	20%		27%	41%		38%		66%		64%

Floristic Quality

The Floristic Quality Index (FQI) only factors species raked at survey points, meaning visual species were not included. Macroalgae are lumped into their genus (*Chara* and *Nitella*) and not counted as individual species. Therefore, 19 species were included in the calculation. The overall floristic quality of Dutch Hollow Lake was 22.3, classifying the aquatic plant community as "high quality" according to the FQI rubric from the WDNR Aquatic Plant Explorer[1] (Figure 3). The average C value for species included in the FQI calculation was 5.1, suggesting the aquatic plant community has moderate tolerance to human perturbations and some species with specific needs.

Figure 3 - FQI Scores for Southern Reservoir Lakes



FQI	Description	
0-19	Low quality	
20-35	High Quality	***22.3** Dutch Hollow 2023*
35-50	Very High Quality	
> 50	Extremely rare and important	

Mean C	Description	
0-3	Common, high tolerance	
4-6	Specific needs, moderate tolerance	***5.1** Dutch Hollow 2023*
7-8	Narrow range, minor tolerance	
9-10	Very narrow range, low tolerance	

Graph & rubric copied from WDNR Aquatic Plant Explorer tool 12/19/23

Individual Plant Species Results

Native Species

There were 22 aquatic plant species found on the sampling rake throughout Dutch Hollow Lake. Eurasian / hybrid watermilfoil (hereafter HWM) was the most commonly found plant in the lake with occurrence at 196 sites (Table 2). The next most common plant was flat-stem pondweed at 144 sites (Map in Appendix A). Third most common species was forked duckweed at 141 sites (Map in Appendix A). The total relative frequency of these three plants combined is 55% meaning these three species combined contribute to 55% of all plant observations and suggests a somewhat homogeneous plant community.

[1] https://dnr-wisconsin.shinyapps.io/AquaticPlantExplorer/

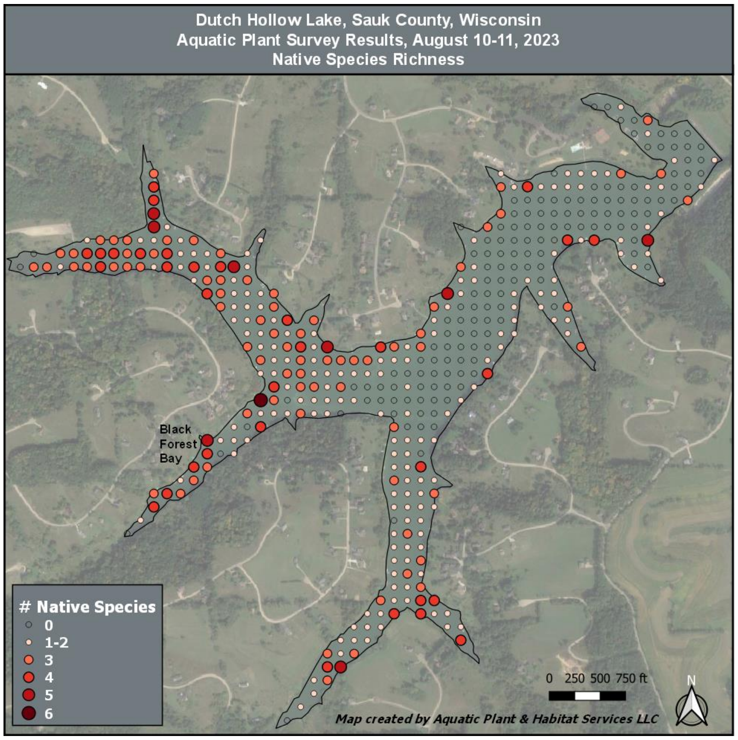
Table 2 – Individual Plant Species Results, 2023

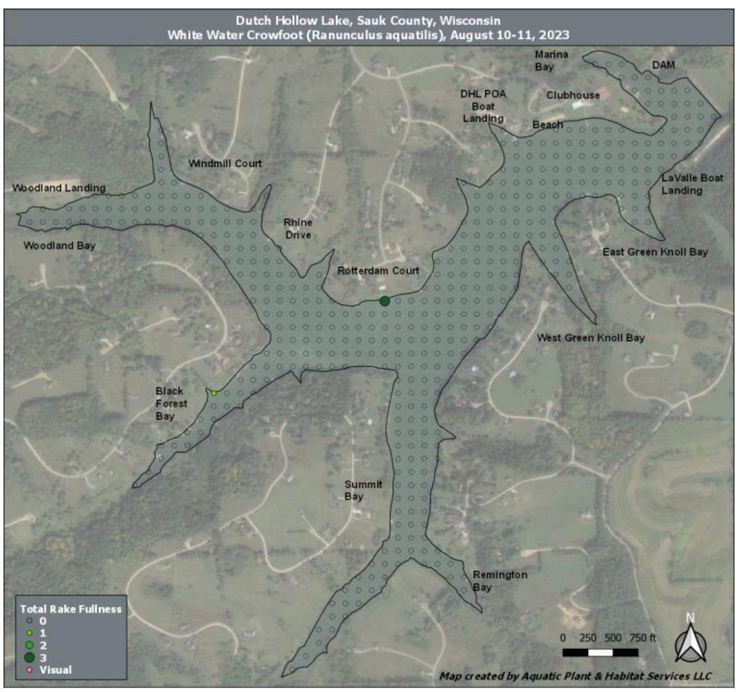
Common Name	Scientific Name	FOO in Veg. Areas	Littoral Frequency	Relative Frequency	# Sites	Avg. Rake Fullness	# Visual
Eurasian / Hybrid watermilfoil	*Myriophyllum spicatum*	75.68	64.43	24.7	221	1.79	8
	Myriophyllum spicatum x sibiricum	Milfoil genetic analysis in 2021 found Hybrid to be dominant					
Flat-stem pondweed	*Potamogeton zosteriformis*	49.48	41.98	16.59	144	1.63	0
Forked duckweed	*Lemna trisulca*	48.45	41.11	16.24	141	1.09	0
Globular stonewort	*Chara globularis*	28.87	24.49	9.68	84	1.85	0
Filamentous algae		28.87	24.49	-	84	1.17	3
Wild celery	*Vallisneria americana*	27.49	23.32	9.22	80	1.68	1
Common waterweed	*Elodea canadensis*	21.65	18.37	7.26	63	1.14	0
Coontail	*Ceratophyllum demersum*	19.24	16.33	6.45	56	1.11	1
Sago pondweed	*Stuckenia pectinata*	14.78	12.54	4.95	43	1.26	1
Common stonewort	*Chara contraria*	4.81	4.08	1.61	14	1.86	0
Water star-grass	*Heteranthera dubia*	4.47	3.79	1.50	13	1.08	0
Long-leaf pondweed	*Potamogeton nodosus*	2.74	2.33	0.90	8	1.88	8
Slender naiad	*Najas flexilis*	1.72	1.46	0.58	5	1.00	0
Slender Nitella	*Nitella flexilis*	1.72	1.46	0.58	5	1.00	0
Large-leaf pondweed	*Potamogeton amplifolius*	1.37	1.17	0.46	4	1.25	0
Large duckweed	*Spirodela polyrrhiza*	1.03	0.87	0.35	3	1.00	0
Small duckweed	*Lemna minor*	0.69	0.58	0.23	2	1.00	0
Fries' pondweed	*Potamogeton friesii*	0.69	0.58	0.23	2	1.00	0
White water crowfoot	*Ranunculus aquatilis*	0.69	0.58	0.23	2	2.00	0
Curly-leaf pondweed	*Potamogeton crispus*	0.34	0.29	0.12	1	1.00	0
Needle spikerush	*Eleocharis acicularis*	0.34	0.29	0.12	1	1.00	0
Small pondweed	*Potamogeton pusillus*	0.34	0.29	0.12	1	1.00	0
Horned pondweed	*Zannichellia palustris*	0.34	0.29	0.12	1	1.00	0
Reed canary grass	*Phalaris arundinacea*	0.00	0.00	0.00	0	0.00	1
Common arrowhead	*Sagittaria latifolia*	0.00	0.00	0.00	0	0.00	1
Softstem bulrush	*Schoenoplectus tabernaemontani*	0.00	0.00	0.00	0	0.00	1
Sweet flag	*Acorus calamus*	*	*	*	*	*	*
Broad-leaf cattail	*Typha latifolia*	*	*	*	*	*	*
Purple loosestrife	*Lythrum salicaria*	*	*	*	*	*	*
**Species in the lake but greater than 6 feet from any sample point.*		*Non-native aquatic invasive species*					

Native Species Richness & White Water Crowfoot

Native species richness ranged from one to six species at a site. The highest native species richness for a single sample point with 6 species was near-shore at the mouth of Black Forest Bay. For the first time, whitewater crowfoot (*Ranunculus aquatilis*) was detected during surveys in 2023. Arthur Watkinson from WDNR first noted the species in June 2023 in Black Forest and Summit Bays. In August 2023 it was found at one sample points in Black Forest Bay and another near Rotterdam Court (Figure 4). It was also observed between sample points near Rotterdam Court but not officially documented. Future surveys should plant to document white water crowfoot locations between sample points as well.

Figure 4 - Native Species Richness & Whitewater Crowfoot Maps

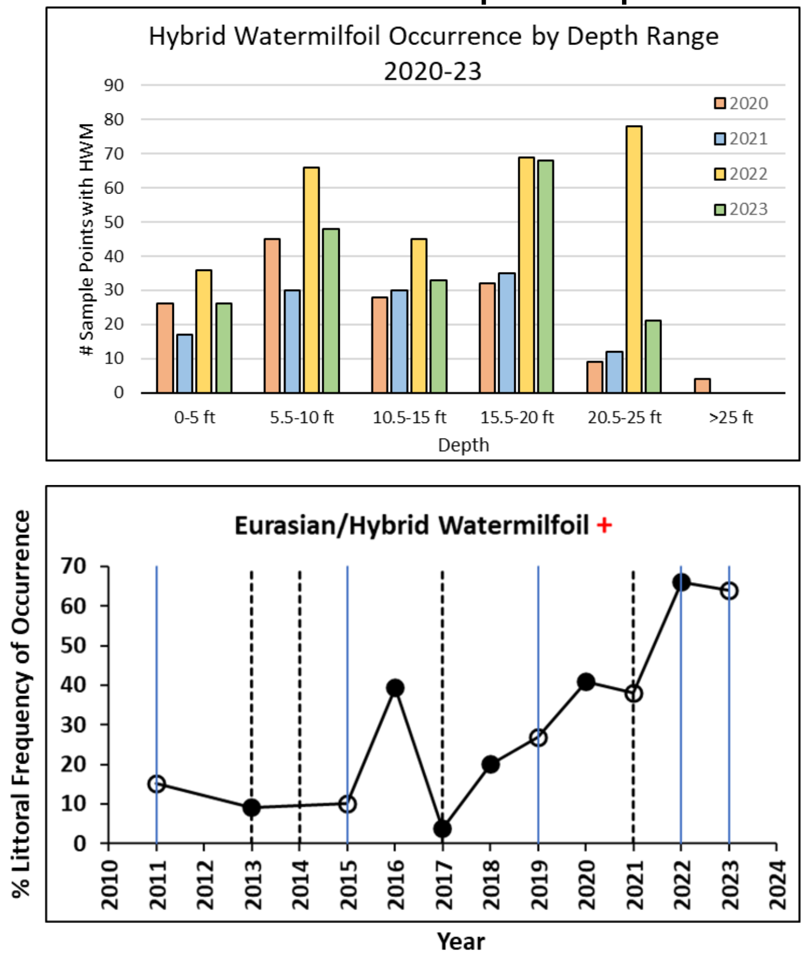




Hybrid Watermilfoil Whole-Lake Point-Intercept Results

Eurasian or hybrid water-milfoil (hereafter HWM) was found at 196 survey points and a visual observation at another 7 points. The frequency of occurrence at littoral sites was 64%, which is the second highest frequency since surveys began in 2011 (highest was 66% in 2022). The decrease in HWM in 2023 compared to 2022 is not statistically significant according to chi-square analysis. The increase in HWM in 2023 compared to 2011 (the first year of survey) is statistically significant. The EWM was found at sample points ranging from 2ft deep to 25 feet deep. In 2023 the depth range with the highest HWM occurrence was 15.5-20 feet compared to 2022 when greatest HWM occurrence was between 20.5-25 feet (Figure 5). Although 2022 and 2023 reflect the highest HWM frequencies, it is important to note that many sites with HWM were deeper than 15 feet and not causing navigation impairment at these locations.

Figure 5 – Depth Ranges of HWM Occurrence Over Time & HWM Chi-square Graph



Hybrid Water Milfoil Bed Results

Twenty-three (23) HWM beds were delineated with a total area of 20 acres (Figure 6 & Table 3). However, the majority of the HWM was scattered or highly scattered with only 1.12 acres of HWM classified as dominant and none highly dominant. By comparison, there were 38 acres of HWM in 2022, 30 of which was classified as dominant or highly dominant. Although the acreage of HWM may seem high at 20 acres in 2023, it is important to note that the HWM density of most areas is low and not causing impairment.

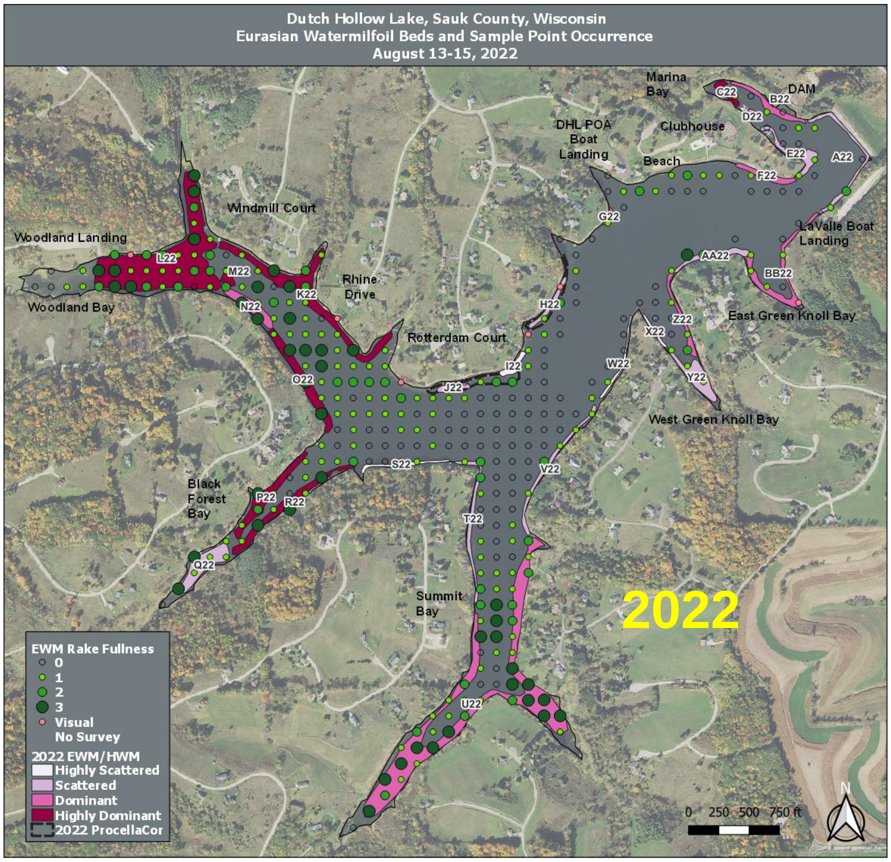
Table 3 – HWM Bed Acreages 2018-2023

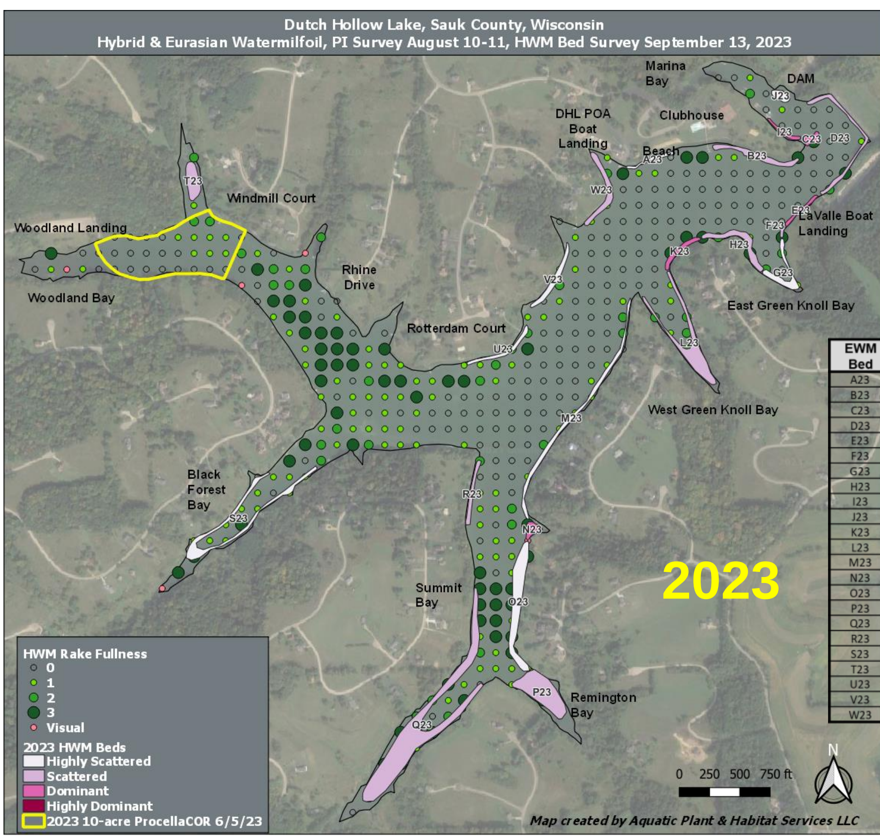
	2018	2019	2020	2021	2022	2023
EWM herbicide acres (June)	0.00	9.96	0.00	166.00	1.77	9.90
EWM DASH days (July)	0	10	5	0	7	8
EWM bed acres (August)	18.25	20.05	25.55	5.62	38.45	20.18

2018-2021 dominant or highly dominant acreage mapped (doesn't include acreage of scattered or highly scattered HWM)

2022-2023 includes all HWM densities (highly scattered, scattered, dominant, and highly dominant).
Dominant or highly dominant HWM in 2022 was 30.39 acres.
Dominant HWM in 2023 was only 1.12 acres and there were no beds of highly dominant HWM.

See page 10 for explanation of graph





EWM Bed	Area (ac)	Avg. Depth (ft)	EWM Height	EWM Density
A23	0.21	5	Near	Highly Scattered
B23	0.68	10	Below	Scattered
C23	0.2	8	Below	Dominant
D23	0.72		Near	Scattered
E23	0.18		At	Dominant
F23	0.06		At	Scattered
G23	0.58		At	Highly Scattered
H23	0.73	5	Near	Scattered
I23	0.18	5	At	Dominant
J23	0.22	6	Near	Highly Scattered
K23	0.31	5	At	Dominant
L23	1.61	5-10	Below-At	Scattered
M23	1.25	5-11	Below	Highly Scattered
N23	0.25	5-10	Near	Dominant
O23	1.82	5-10	Below-At	Highly Scattered
P23	1.86	5-12	Below-At	Scattered
Q23	5.23	5-10	Below-At	Scattered
R23	0.37	5-10	Below-At	Scattered
S23	1.47	5-10	Below-At	Highly Scattered
T23	0.65	6	Near	Scattered
U23	0.38	2-6	At	Highly Scattered
V23	0.53	2-6	At	Highly Scattered
W23	0.69	3-8	At	Scattered

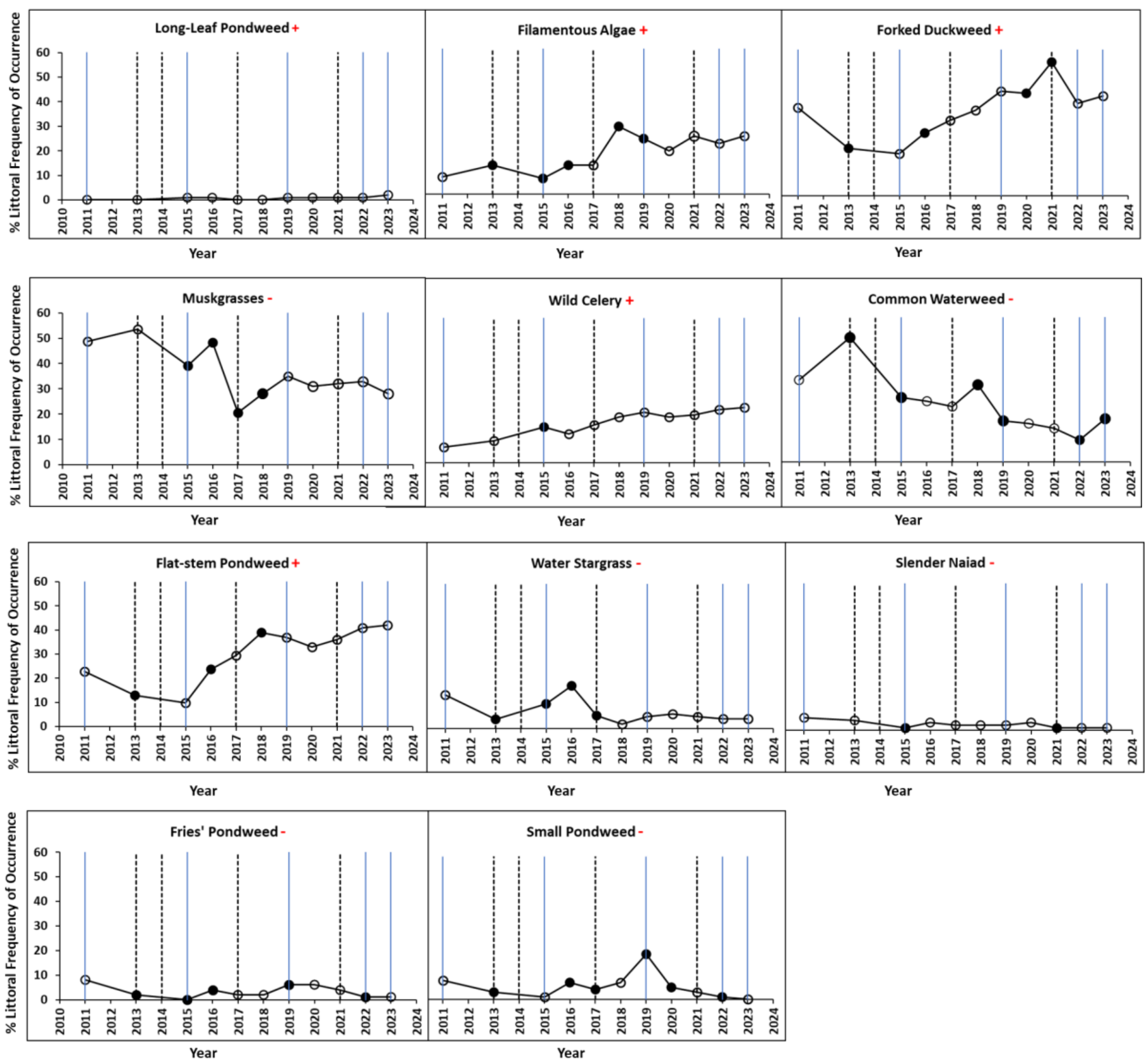
TOTAL 20.18 Acres

Aquatic Plant Species Changes 2011 - 2023

In Figure 7 the percent littoral frequency (explained in Figure 14) is on the y-axis and each year a plant survey was completed is on the x-axis. Only species with a statically significant change (using Chi-squared tests) in comparing 2011 & 2023 or 2022 & 2023 are displayed. The chi-square graph of HWM results is in Figure 5. The dashed vertical lines represent years when whole-lake herbicide treatments were done. The solid, faint, blue line represent herbicide treatments <10 acres. Open circles represent **no** statistically significant change compared to the previous year, solid circles represent a statistically significant change. Statistically significant changes between the first year of surveying (2011) and 2023 data are represented by **+** or **–** adjacent to plant names.

The results of 2011 vs 2023 reveal a statistically significant (SS) increase in wild celery, filamentous algae, forked duckweed, hybrid watermilfoil (Figure 5), flat-stem pondweed, and long-leaf pondweed while there was a decrease in six native species (common waterweed, muskgrasses, water star-grass, slender naiad, small pondweed, and Fries' pondweed). The only statistically significant change in 2023 compared to 2022 is an increase in common waterweed (Figure 5 & Figure 7).

Figure 7 – Chi-square Graphs 2011-2023



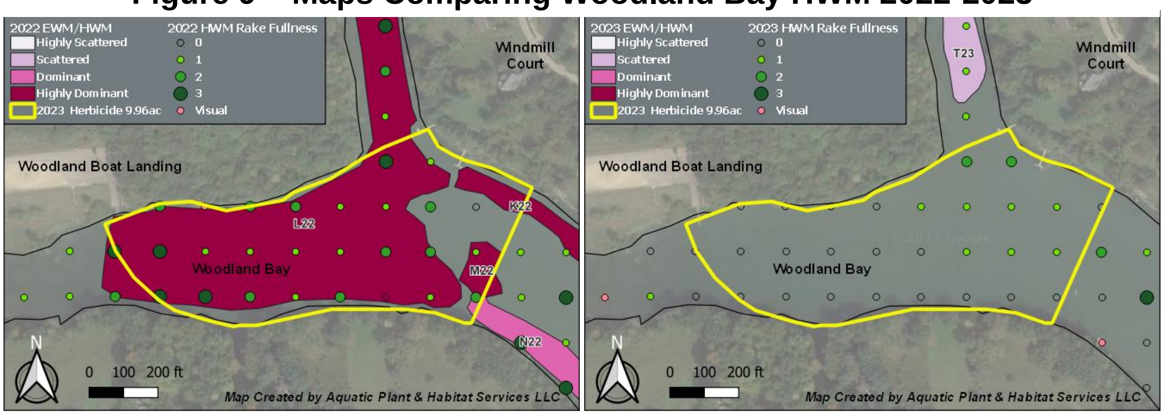
Herbicide Treatment Results 2023

Marine Biochemists used subsurface injection techniques to apply florpyrauxifen-benzyl (ProcellaCOR, PCOR) on June 5th, 2023 with the following details:

- Woodland Bay, illustrated in Figure 10.
- 9.96 acres treated, average depth 7.2 feet = 71.7 ac-ft
- Amount applied 285 PDU (prescription dose unit)
- Application concentration 4 PDC/acre-foot
- Although the treatment occurred in an area less than 10 acres, Chapter NR107.04(3) classified this treatment to be "large scale" because it "exceeds 10% of the area of the water body that is 10 feet or less in depth".
- 285 PDU / 1892 ac-ft = 0.15 PDU per ac-ft. OR 0.29 ppb target concentration (assuming 15ft thermocline on June 5, 2023, whereas the 18ft thermocline on June 21, 2021 was at 18 ft deep and 2135 ac-ft).

There were 25 sample points with HWM in 2022 and 9 sample points with HWM in 2023, which was a statistically significant reduction according to chi-square analysis. There were also highly dominant beds of HWM mapped in 2022 that were gone from the treatment area in 2023.

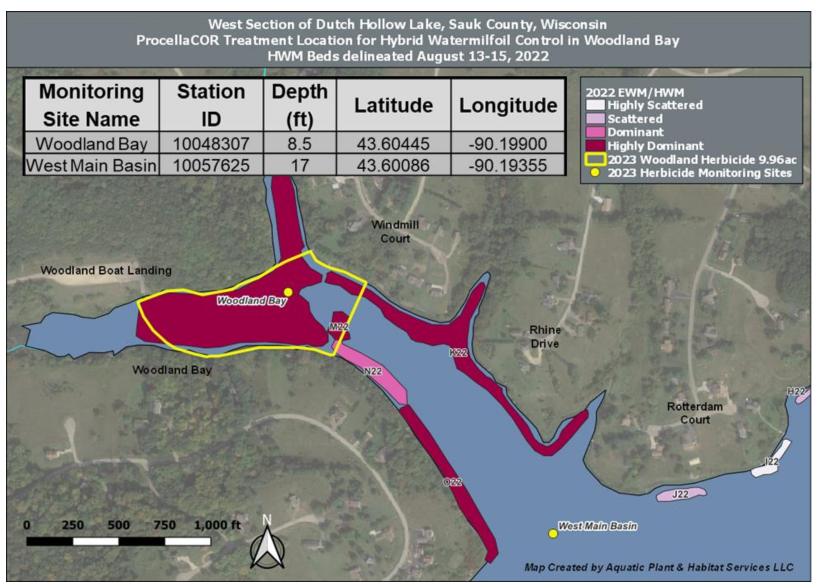
Figure 9 – Maps Comparing Woodland Bay HWM 2022-2023



Herbicide Monitoring

Water flows into Woodland Bay from Dutch Hollow Creek and toward the dam to the east. Two sample sites were established for herbicide monitoring, including one station in Woodland Bay and one station in the west main basin (Figure 10). Samples were collected by volunteers 3, 6, 9, 24, 48, and 96 hours after treatment or "HAT" (Figure 10). Samples were preserved and mailed to EPL Bio Analytic for ProcellaCOR concentration analysis.

Figure 10 – Herbicide Treatment Monitoring & Treatment Locations

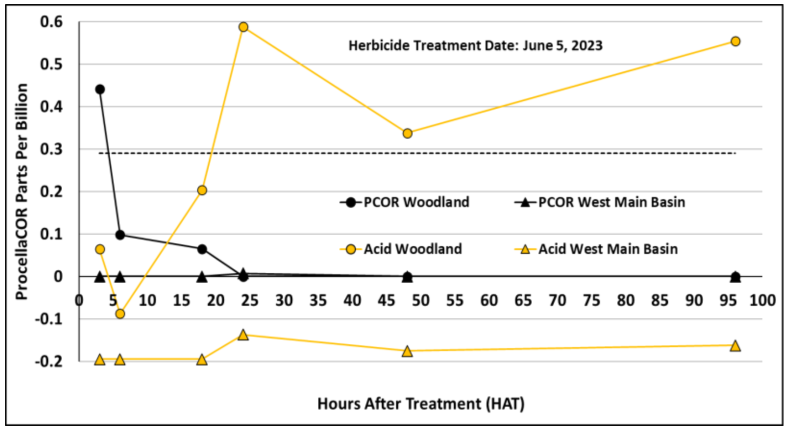


Monitoring Site Name	Station ID	Depth (ft)	Latitude	Longitude
Woodland Bay	10048307	8.5	43.60445	-90.19900
West Main Basin	10057625	17	43.60086	-90.19355

Herbicide Monitoring Results

The target lake-wide concentration was 0.29 parts per billion (ppb, 285 PDU / 1892 ac-ft = 0.15 PDU per ac-ft. OR 0.29 ppb). This concentration was reached in Woodland Bay for 3 hours after treatment (HAT) and then dropped below that level 6 HAT and beyond. The West Main Basin monitoring site had no detectable ProcellaCOR except for 0.01 ppb 24 hours after treatment. Even with these low PCOR values, the treatment was effective in controlling HWM in Dutch Hollow Lake in 2023.

Figure 11 – Herbicide Monitoring Graph



DASH Locations & Results

DASH was done for 8 days at various locations illustrated in Figure 12. Photos were taken of some locations before (July 10th) and after (September 13th) DASH occurred. Pictured below are two areas where DASH was successful in reducing localized HWM. Other areas were successful as well, but photos did not capture due to glare or the lake surface was not calm enough for successfully documenting the HWM levels below surface.

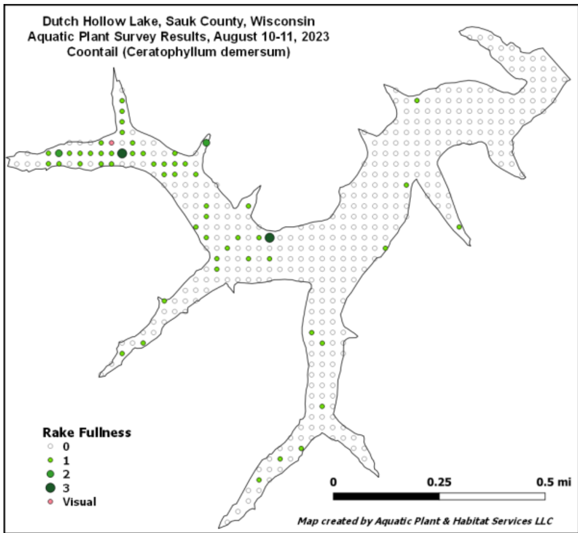
Figure 12 – DASH Locations & Photos of Successful EWM Reduction

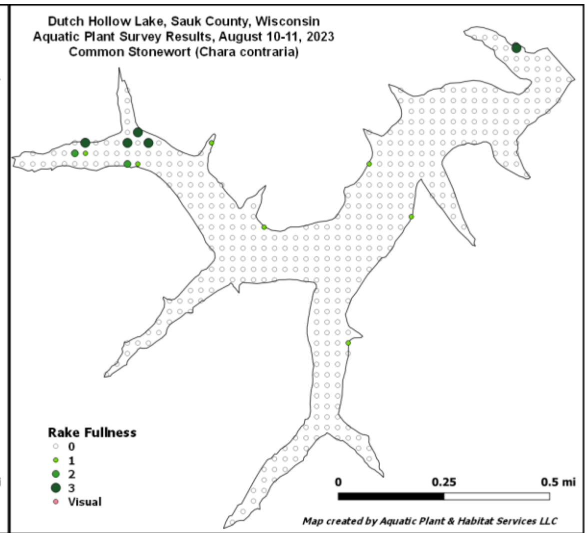
2024 MANAGEMENT LIST

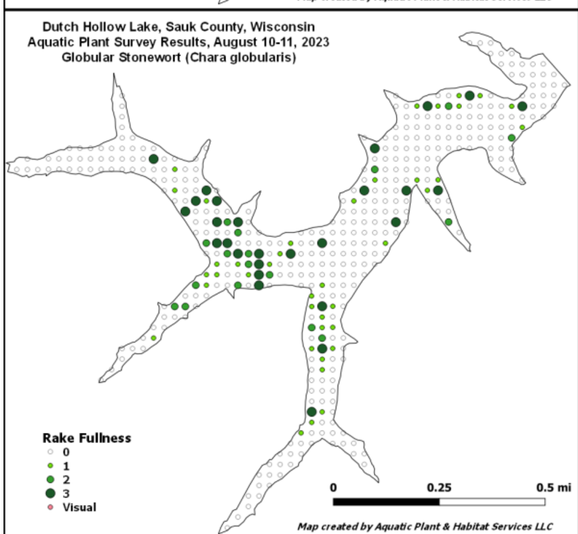
Tasks that were included in the WDNR Surface Water Grant Application in November 2023 are noted with an asterisk (*).

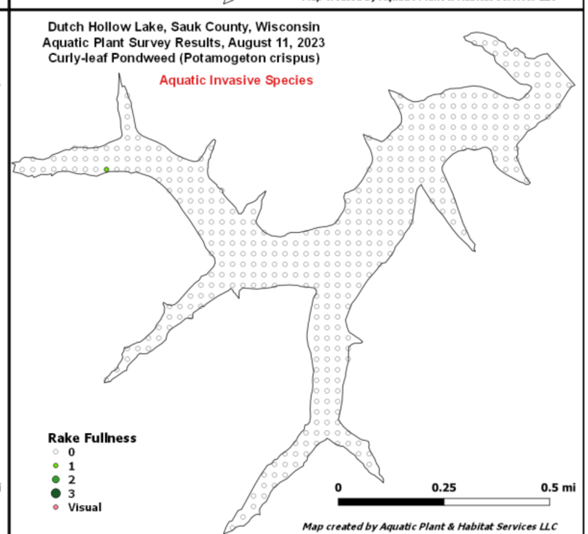
- Implement Clean Boats Clean Waters watercraft inspection program at both boat landings, summer 2024*
- ProcellaCOR treatment in Remington Bay, May or June 2024*
- Herbicide monitoring at 1 location 3, 6, 9 and 24 hours after treatment* (PCOR wasn't detectable or very low 24 HAT), May or June 2024*
- Manual removal of HWM from Woodland Bay, June or July 2024*
- DASH of HWM from high-use locations to reduce beneficial use impairment, July 2024
- Whole-lake aquatic plant point-intercept survey, August 2024*
- Track occurrence of white water crowfoot between sample points while conducting PI survey, August 2024*
- Post-treatment sub point-intercept survey of Remington Bay if treated, September 2024*
- HWM bed survey, September 2024*
- HWM pre-treatment survey of locations to be treated in 2025, September 2024*
- Final Report from 2024 findings, January 2025*

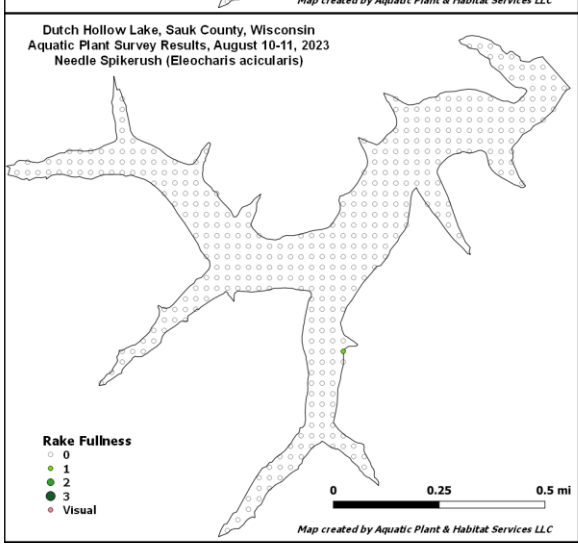
APPENDIX A – AQUATIC PLANT SURVEY MAPS

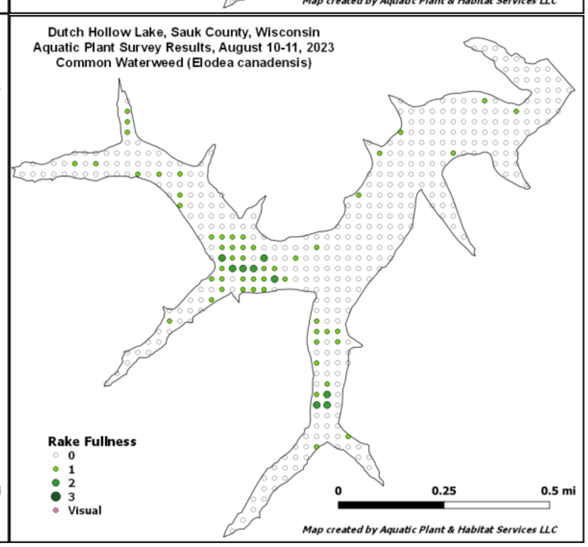


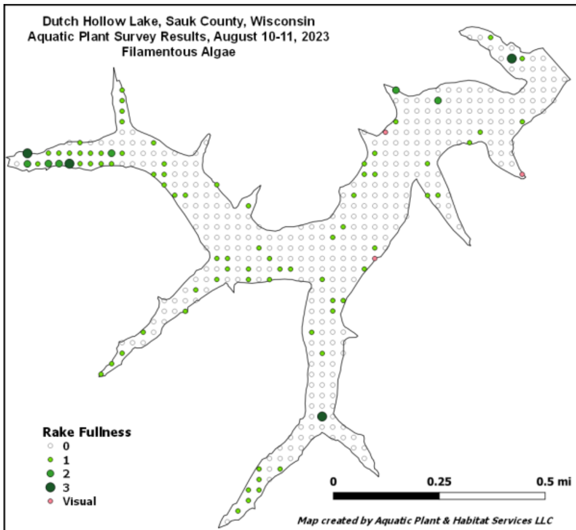


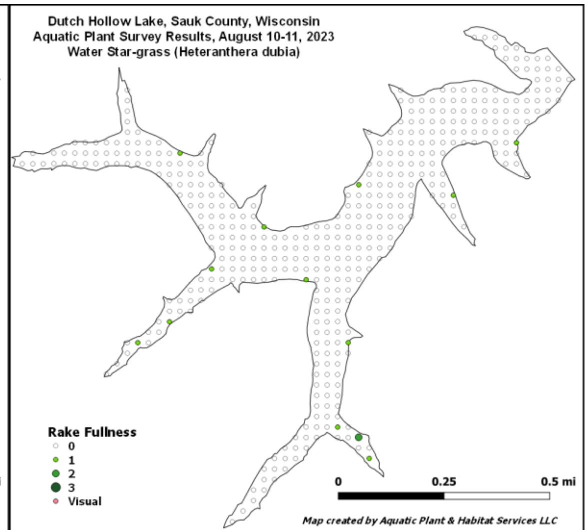


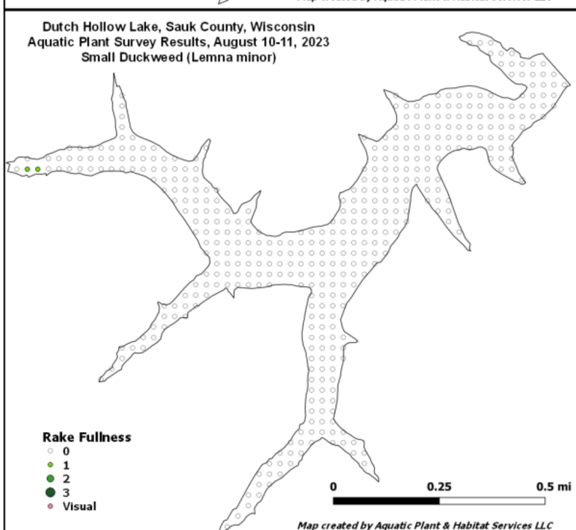


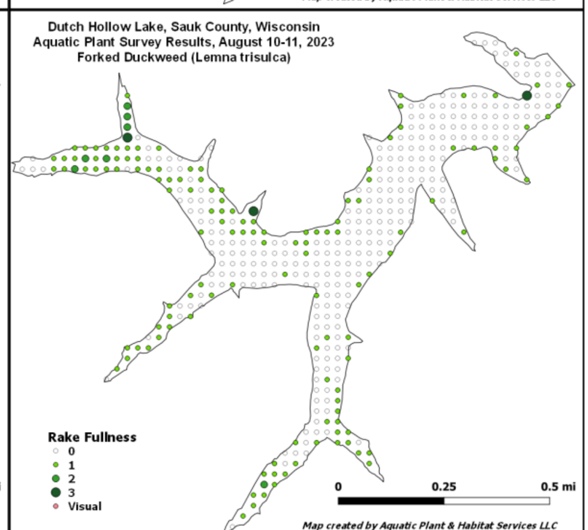


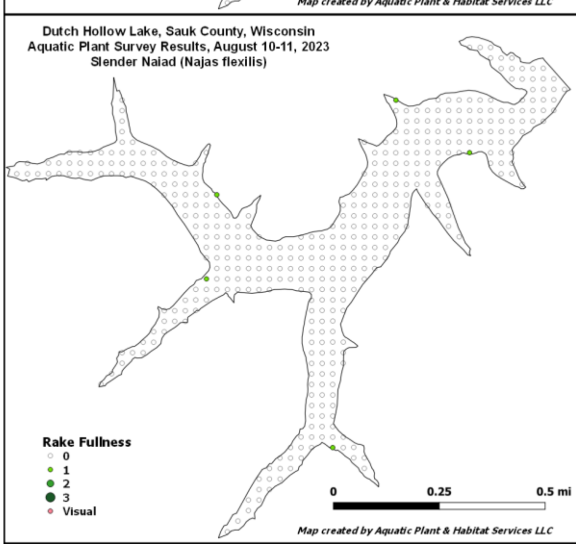


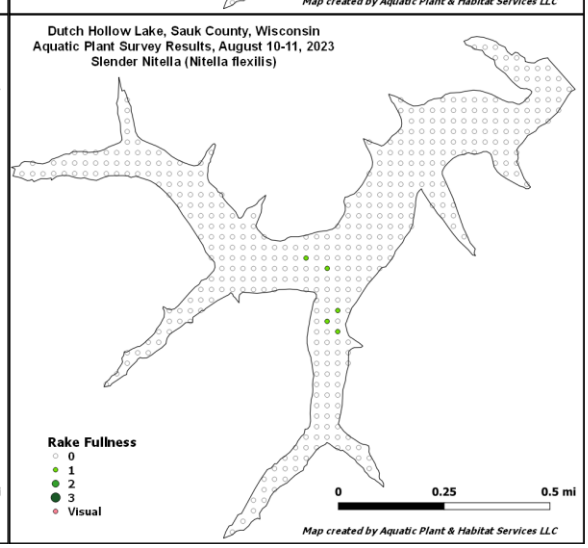

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Filamentous Algae
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

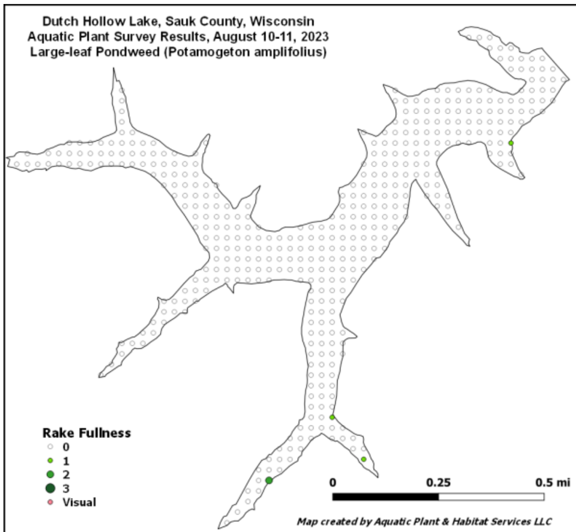

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Water Star-grass (Heteranthera dubia)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

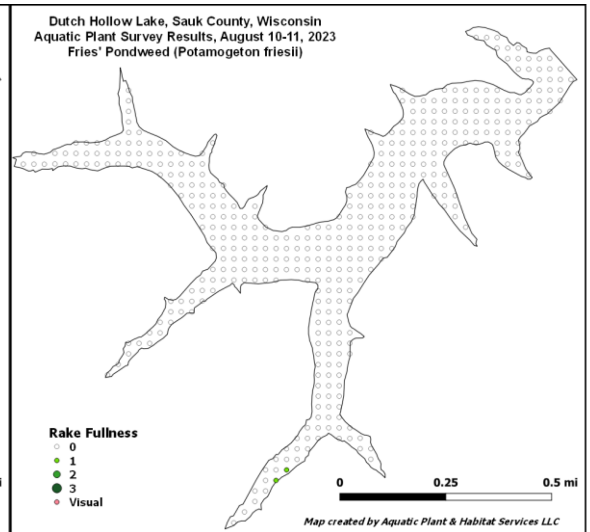

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Small Duckweed (Lemna minor)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

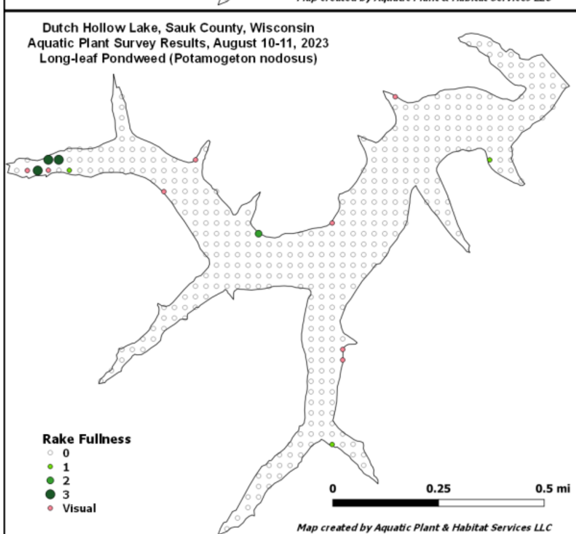

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Forked Duckweed (Lemna trisulca)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

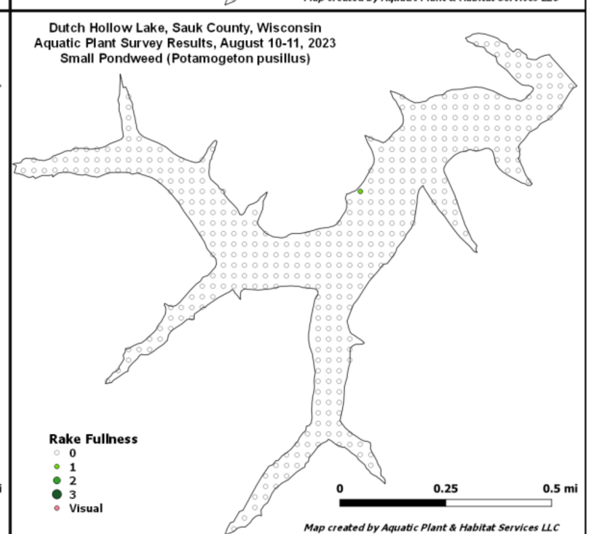

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Slender Naiad (Najas flexilis)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

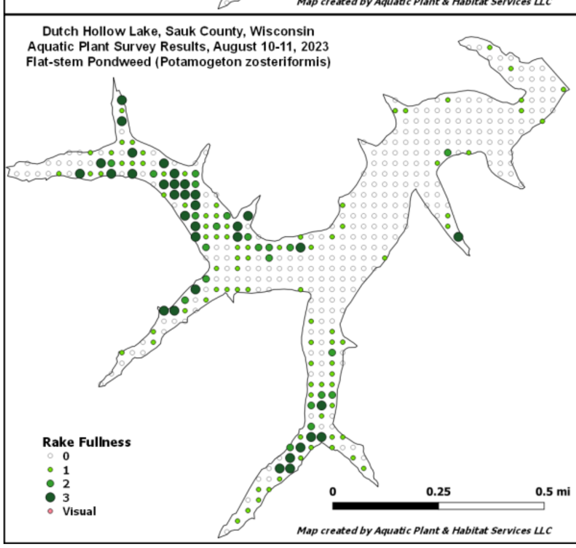

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Slender Nitella (Nitella flexilis)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

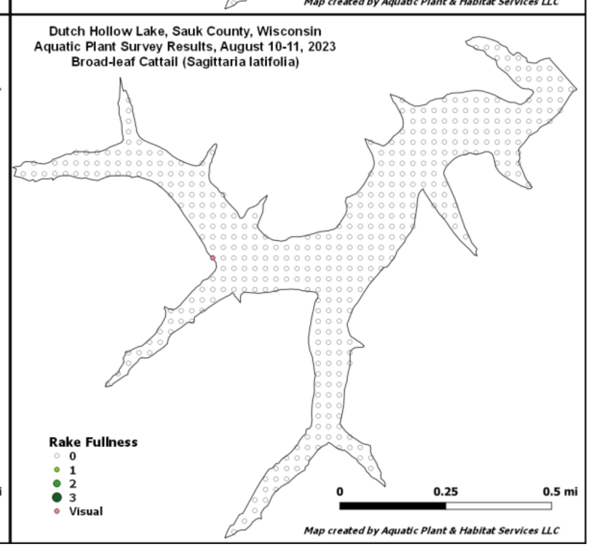

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Large-leaf Pondweed (Potamogeton amplifolius)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

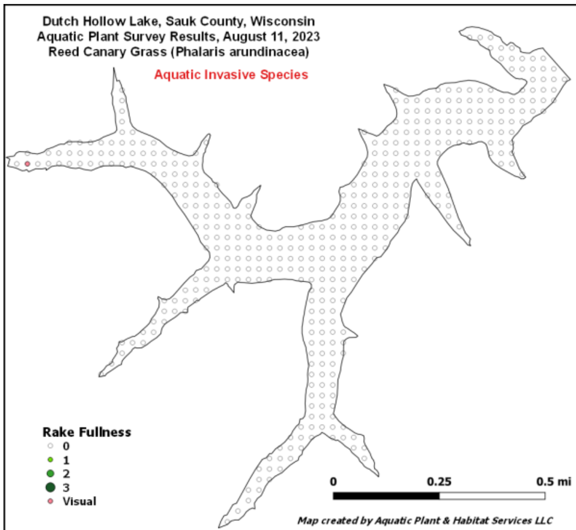

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Fries' Pondweed (Potamogeton friesii)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

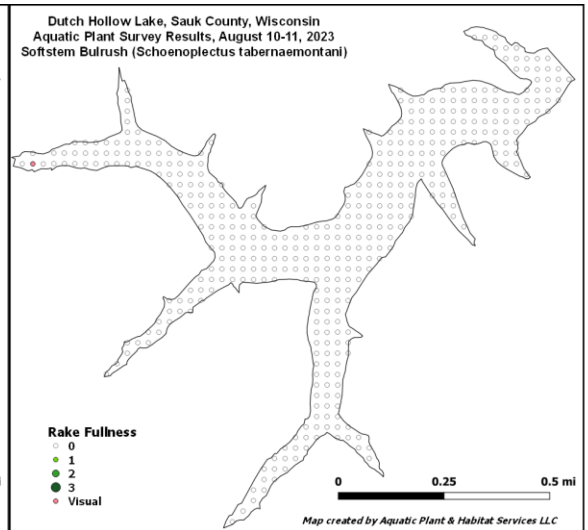

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Long-leaf Pondweed (Potamogeton nodosus)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

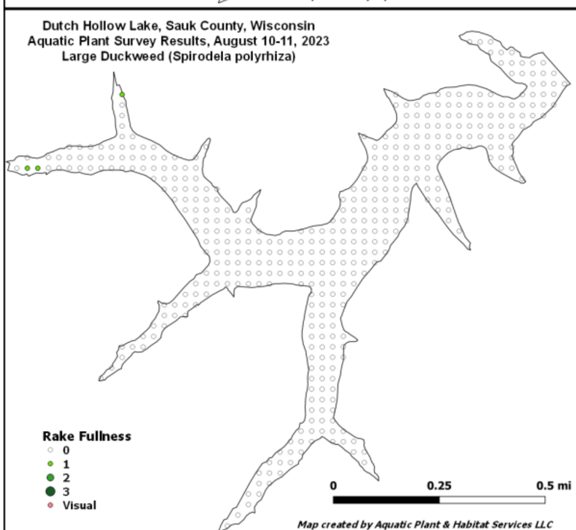

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Small Pondweed (Potamogeton pusillus)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

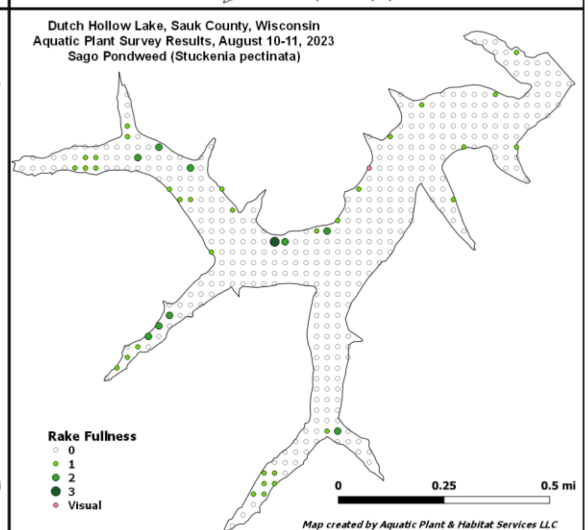

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Flat-stem Pondweed (Potamogeton zosteriformis)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

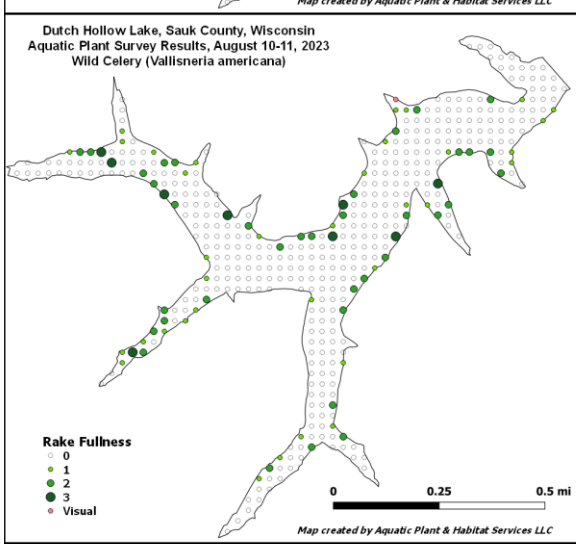

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Broad-leaf Cattail (Sagittaria latifolia)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

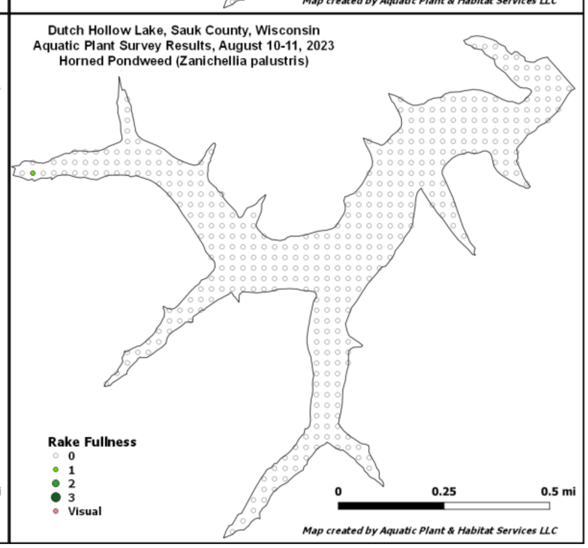

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 11, 2023
Reed Canary Grass (Phalaris arundinacea)
Aquatic Invasive Species
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC


Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Softstem Bulrush (Schoenoplectus tabernaemontani)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC


Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Large Duckweed (Spirodela polyrhiza)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC


Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Sago Pondweed (Stuckenia pectinata)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC


Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Wild Celery (Vallisneria americana)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

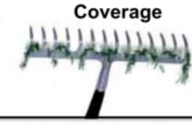
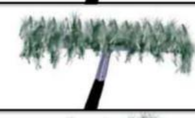

Dutch Hollow Lake, Sauk County, Wisconsin
Aquatic Plant Survey Results, August 10-11, 2023
Horned Pondweed (Zanichellia palustris)
Rake Fullness
0
1
2
3
Visual
0
0.25
0.5 mi
Map created by Aquatic Plant & Habitat Services LLC

APPENDIX B - METHODS

Field Methods for Point-Intercept Plant Survey

Field methods followed the standardized protocol developed by the Wisconsin Department of Natural Resources (WDNR) in Hauxwell et. al[2]. The survey coordinates were uploaded to a hand held device to allow navigation to each survey point on the lake. A double-sided rake head on a telescopic pole was used to sample each point ≤15 feet deep for aquatic plants, depth, and dominant sediment type (muck, rock, or sand). Sonar was used to gauge depth at points that were greater than 15 feet deep and a weighted double-sided rake attached to a rope was used to sample aquatic plants >15 feet deep. The rake fullness rating for total coverage of plants on the rake and a separate rake fullness rating for each species present were recorded (Figure 2). Aquatic plants found within 6 feet of the sample point but not found on the rake were counted as visual observations. Occurrence of species greater than 6 feet from any survey point were recorded to note their presence as part of a boat survey, but were not counted in statistical calculations.

Figure 13 - Rake Fullness Rating Illustration

Rating	Coverage	Description
1		Few plants
2		Plants cover length of the rake but not tines
3		Rake completely covered, tines not visible

Field Methods for EWM Survey

Field methods followed the WDNR Aquatic Plant Treatment Evaluation Protocol. Boundaries of HWM beds were visually determined from a boat and mapped while navigating along the bed perimeter. Each HWM bed was assigned a letter identifier followed by the year (e.g., A21). Beds were then classified as highly scattered, scattered, dominant, or highly dominant HWM.

Figure 14

Summary Statistics Explanations

	Statistic	Explanation
1	Total number of sites visited	The total number of sites sampled, which is not necessarily equal to the number of survey points because some sites may not be accessible.
2	Total number of sites with vegetation	Number of sites where at least one plant was found on the rake (does not include moss, sponges, filamentous algae, or liverworts).
3	Maximum depth of plants	Depth of deepest site where at least one plant was found on the rake (does not include moss, sponges, filamentous algae, or liverworts).
4	Total number of sites shallower than maximum depth of plants	Number of sites where depth was less than or equal to the maximum depth where at least one plant was found on the rake.
5	Frequency of occurrence at sites shallower than maximum depth of plants	Total number of sites with vegetation (2) / Total number of sites shallower than maximum depth of plants (4).
6	Average number of species per site (split into four subcategories)	a) Shallower than maximum depth – the average number of species found per site at sites less than or equal to the maximum depth where at least one plant was found on the rake (4).
		b) Vegetated sites only – the average number of species found per site at sites where at least one plant was found on the rake (2).
		c) Native species shallower than maximum depth – Same explanation as 6(a), non-native species excluded from average.
		d) Native species at vegetated sites only – Same explanation as 6(b), non-native species excluded from average.
7	Species Richness (split into two subcategories)	a) Total number of species found on the rake at all sites (does not include moss, sponges, filamentous algae, or liverworts
		b) Including visuals – Same explanation as 7(a) and including visual observations within 6 feet of the sample sight
8	Simpson Diversity Index	Estimates the heterogeneity of a community by calculating the probability that two individuals randomly selected from the data set will be different species. The index ranges from 0-1, and the closer the value is to one, the more diverse the community. Visual observations (within 6 feet of sample point) are not included in calculation of index.
9	Coefficient of Conservatism (C)	This is not a statistical calculation, but rather a value assigned to each plant species based on how sensitive that species is to disturbance. C values range from 1 to 10 with higher values assigned to species that are more sensitive to disturbance (Nichols, 1999).
10	Floristic Quality Index	How similar the aquatic plant community is to one that is undisturbed (Nichols, 1999). This index only factors species raked at survey points and does not include non-native species. The FQI is calculated using coefficient of conservatism values (9).

2 Hauxwell, J., S. Knight, K. Wagner, A. Mikulyuk, M. Nault, M. Porzky and S. Chase. 2010. Recommended baseline monitoring of aquatic plants in Wisconsin: sampling design, field and laboratory procedures, data entry and analysis, and applications. Wisconsin Department of Natural Resources Bureau of Science Services, PUB-SS-1068 2010. Madison, Wisconsin. 46pp.

Data Analysis Methods for Point-Intercept Plant Survey

Survey data were used to calculate statistics including Simpson Diversity Index, species richness, Floristic Quality Index, frequencies, rake fullness and number of visual sightings among other summary statistics. Species that were recorded as visuals (i.e., within 6 feet of a survey point but not sampled with the rake) were not included in Simpson Diversity Index and FQI calculations. Also, filamentous algae data was not used in any statistical calculations.

Summary Statistics

Summary statistics provide a general overview of the plant community and can be used to track the plant community in Dutch Hollow Lake over time or compare to other lakes in the region or state. Floristic Quality Index is a metric based on Coefficient of Conservatism (C) for each aquatic plant species ranging from 0 to 10. The C value estimates the likelihood of that plant species occurring in an environment that is relatively unaltered from pre-settlement conditions. As human disturbance increases, species with a lower C value occur more frequently while more sensitive species with a higher C value occur less frequently. To calculate floristic quality, the mean C value of all species found in the lake is multiplied by the square root of the total number of plant species in the lake. Only plants found on the rake are included in the calculations. Overall, the FQI metric helps us understand how close the aquatic plant community is to one of undisturbed conditions. A higher FQI value assumes a healthier aquatic plant community. Floristic quality values can be compared on a statewide value and within one of the four ecoregional-lake types. Dutch Hollow Lake falls within the “Driftless” ecoregional-lake type.

Individual Species Statistics

Individual species statistics assess the plant species composition in Dutch Hollow Lake and allow for comparisons of the plant community within the lake (Table 1). Relative frequency values are particularly helpful because they consider the number of times a particular species is found divided by the total number of times vegetation occurred. Frequency of occurrence at sites shallower than the maximum rooting depth, or littoral frequency, is a helpful metric in comparing plant occurrence among different survey years.

Chi-Squared Tests

Chi-squared tests were completed to assess the efficacy of past herbicide treatments and impacts to native aquatic plant species. Chi-squared tests help determine whether there is a significant difference between two years by comparing the number of sites a particular plant species was found those two years. The alpha, or Type I, error rate was set at 0.05, meaning there is a 5% chance of claiming there is a significant change when no real change has occurred.

Map Development

Aquatic plant survey data were uploaded to an open source geographic information systems (GIS) program known as QGIS[3]. Some maps created using QGIS are part of the Results Section while the remainder are compiled in Appendix B.

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[3] QGIS Development Team, 2024. QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.