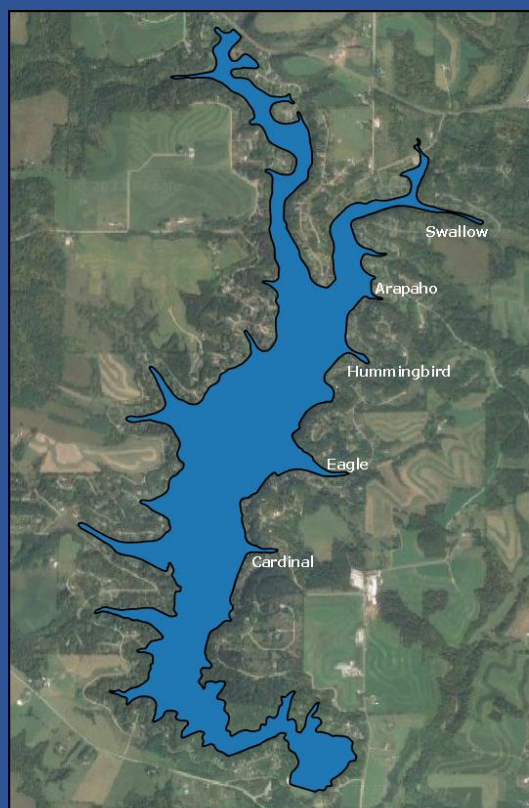
2023

Aquatic Plant Survey Report

Lake Redstone Bays

Sauk County, Wisconsin

Cardinal, North Chickadee, Chippewa, Mourning Dove, Oriole, & Swallow



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ABSTRACT

Aquatic plant surveys of six bays in Lake Redstone, Sauk County Wisconsin, were completed in 2023 as an ongoing effort to gauge Eurasian watermilfoil (*Myriophyllum spicatum,* EWM) occurrence where control activities may be needed. Cardinal, Chippewa, Mourning Dove, Oriole, and Swallow Bays were surveyed August 9th, 2023. North Chickadee Bay was surveyed September 12th. Each bay has its own management history with varied status in monitoring for EWM. Although some bays had been treated with herbicide in past years to control EWM, no bays were treated with herbicide 2019 through 2023 and dredging of all the bays surveyed took place in 2019. The surveys employed methods from Hauxwell (2010), but with a higher resolution survey grid than would be used on a whole-lake scale. EWM was the most commonly occurring species in all bays except for Swallow Bay in 2023. EWM increased significantly in 2023 compared to the most recent previous survey in Cardinal, Oriole, and Swallow Bays. There was a slight increase in EWM in Mourning Dove Bay. Littoral frequency of plants overall (combined native and non-native) was higher in Cardinal, Oriole, and Swallow Bays and slightly lower in Mourning Dove Bay. Comparisons to previous surveys were not possible for Chippewa Bay being its first survey and for North Chickadee Bay because only half of the bay was requested for survey. Average littoral frequencies of all bays surveyed from 2014 through 2022 suggested there was a steady decline in aquatic plants overall. Aquatic plants in the 2023 surveys were higher than previous years. When comparing ***native*** plant occurrence in 2023 to the previous survey, there were five instances of statistically significant (SS) increases, which is encouraging. When comparing ***native*** plant occurrence in 2023 to the ***first*** survey to data collected, there were nine instances of SS declines in native species and two instances of SS increases in native species. These data suggest the littoral frequency of native aquatic plants are on the rise at present, but still lower than the first surveys for Cardinal, Oriole, Mourning Dove, and Swallow Bays. Bay-wide surveys of ***all bays*** suggests there is no consistent trend in EWM occurrence between 2014 and 2023, but there appears to be an increase in EWM in the last 5 years. EWM samples were collected at 17 locations for milfoil weevil analysis. Weevils were detected at 3 locations. **Management Recommendations are as follows;** 1) Protect native aquatic plants. Control nuisance native vegetation with hand-pulling or raking, where permitted. 2) Continue water quality & AIS monitoring. 3) Conduct aquatic plant surveys of bays in 2024 as needed for management of EWM. 4) Use herbicide treatment criteria in Table 5 to help determine whether herbicide treatment is appropriate in 2024. Herbicide treatment is not recommended for Cardinal, North Chickadee, Mourning Dove, Oriole, or Swallow Bays. Herbicide treatment could be considered in Chippewa Bay. 5) Protect overwintering shoreline habitat for weevils.

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INTRODUCTION

Recent Management History

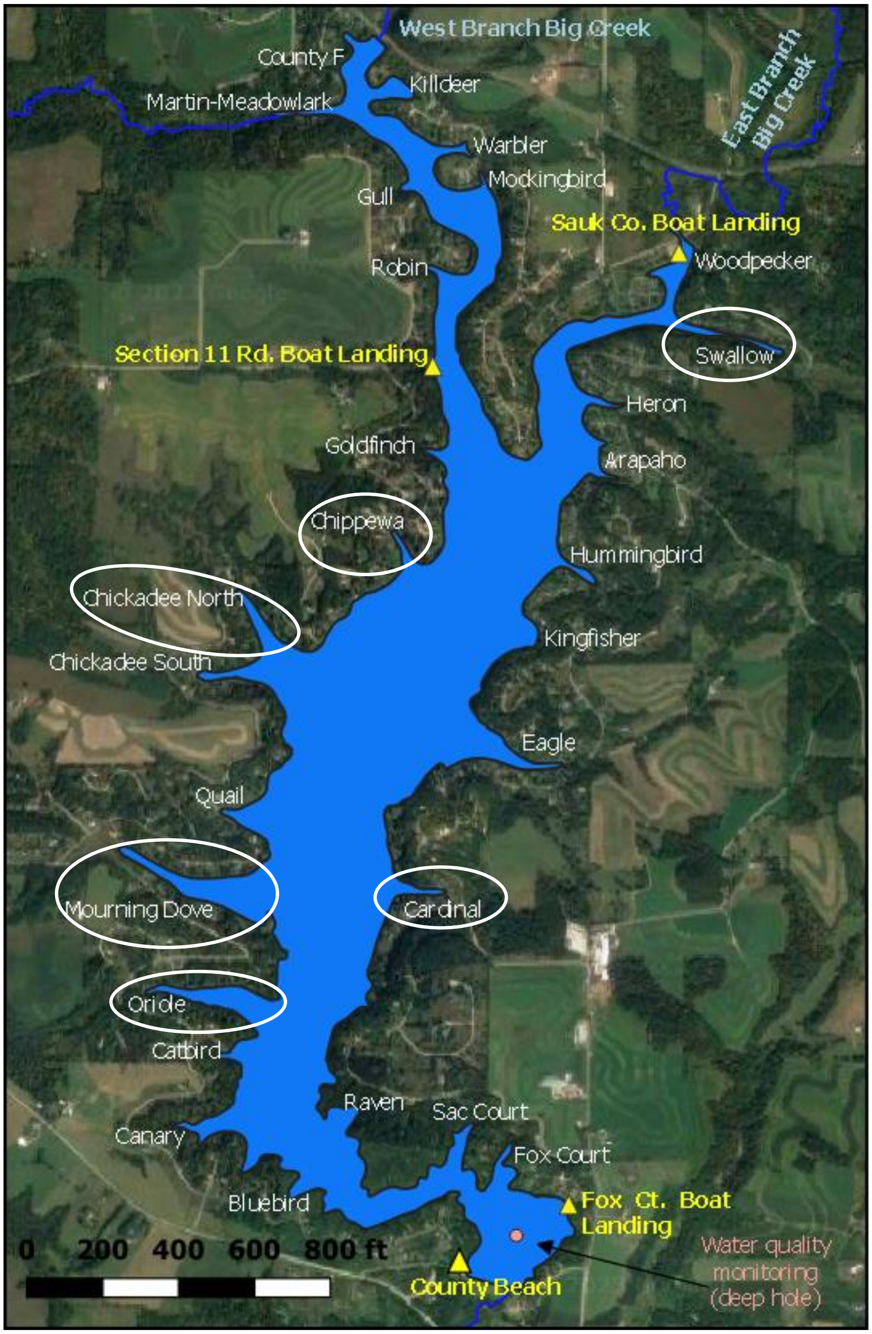
The Lake Redstone Protection District (LRPD) partnered with Aquatic Plant and Habitat Services to complete aquatic plant surveys of 6 bays in 2023 and continue statistical tracking of EWM occurrence where control activities may be needed. Dredging occurred in Lake Redstone from July through December of 2019 to remove sediment from 27 locations, protect lake property values, maintain and improve the lake, and aim to improve water quality[1]. In June 2021, Aquatic Plant Management LLC (APM) was hired for three days to manually remove EWM from 2 locations in Arapaho Bay and several areas near the mouth of Hummingbird Bay. In June 2022, APM LLC was hired for 4 days to use diver assisted suction harvesting targeting dense colonies near the Section 11 boat landing and Chippewa Bay. Water clarity was a significant issue for divers during manual removal and DASH, which lead to unsatisfactory results. As a result, LRPD is not pursuing the use of DASH or hired manual removal in the near future. No herbicide treatment occurred in any bays in 2019 through 2023.

Study Site

Lake Redstone (WBIC 1280400) is located in the Town of La Valle in northwestern Sauk County, Wisconsin. The lake is an impoundment of West and East Branches of Big Creek, although other intermittent streams also flow into the lake. Waters flow over a top draw dam at the southern end directly into Big Creek for a short stretch before flowing into the Baraboo River. Lake Redstone was created in the 1960's with the intent of creating >1500 lots for development. The lake's surface area is 635 acres, maximum depth is 36.5 feet, mean depth is 14 feet, and the shoreline length is 17.5 miles. The lake is considered an Area of Special Natural Resource Interest due to the presence of certain plant or animal species or unique ecological communities identified in the WDNR Natural Heritage Inventory. Lake Redstone is classified as a eutrophic system based on data collected since 1979 with low water clarity (Secchi depth of 2-3 feet since 2009). Bays circled in Figure 1 indicate those surveyed in 2023.

[1] https://www.lakeredstonepd.org/dredging-meeting-minutes. June 2018 Dredging Informational Meeting PowerPoint Presentation.

Figure 1 – Lake Redstone Map of Bays



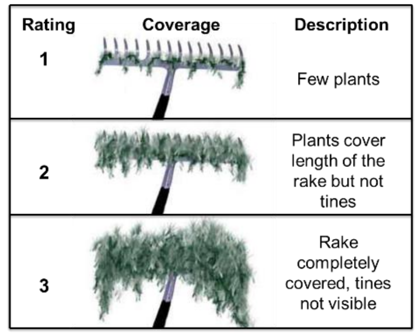
GOALS AND OBJECTIVES

GOAL: Survey aquatic plants in select bays in order to guide management decisions, specifically related to EWM management.

OBJECTIVES:

1. Complete a survey of all aquatic plants in 6 bays at pre-determined survey points.
2. Analyze data and create maps of plant distribution, sediment type, and depth.
3. Compare results of the previous surveys using Chi-squared tests to identify statistically significant changes in native and invasive plant species since 2014.

Figure 2 – Rake Fullness Illustration



METHODS

Field Methods

Field methods followed the standardized protocol developed by the Wisconsin Department of Natural Resources (WDNR) in Hauxwell et. al (2010)[2] and surveys were completed August 9th, 2023 for all bays except North Chickadee which was completed September 12th. All plant survey dates completed by APHS LLC are in List 1. Point-intercept maps were previously generated for Cardinal (71 pts), North Chickadee (62 pts), Chippewa (32 pts), Mourning Dove (123), Oriole (104 pts), and Swallow (72 pts) resulting in 464 sample points. The survey coordinates were uploaded to a Garmin device, allowing navigation to each survey point in the bays. Points that were deeper than 12 feet were not surveyed based on previous findings that maximum rooting depth of any bay-wide survey since 2015 was 11 feet (Table 4). A double-sided rake head on a telescopic pole was used to sample each point for aquatic plants, depth, and dominant sediment type. 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). Any survey points that were inaccessible were recorded as such and no sample was taken. Aquatic plants found within 6 feet of the sample point but not found on the rake were counted as visual observations.

List 1 – Aquatic Plant Survey Dates 2014-23

- Aug. 11, 2014
- July 17-18, 2015
- Aug. 17-18, 2016
- Sept. 8-9, 2017
- Aug. 24-25, 2018
- July 17, Aug. 3-4, 2019
- Aug. 11-13, 2020
- Aug. 12, 2021
- Aug. 11, 2022
- Aug. 9, 2023 (9/12 for one bay)

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[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

Summary Statistics

Summary statistics provide a general overview of the plant community in each bay and can be used to make comparisons among the bays and within the same bay over time. However, ***these statistics should not be used to compare to other lakes where a whole-lake survey has been done***. Explanations of summary statistics are in Table 2. Floristic Quality Index (FQI, Nichols 1999[3], Table 1) incorporates aquatic plant species associated with lake communities and native to Wisconsin by using the Coefficient of Conservatism (C) ranging from 0 to 10. The C value estimates the likelihood of a 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. A higher FQI value assumes a healthier aquatic plant community. The ***FQI values for each bay or even mean values of all bays cannot be compared to other lakes in the driftless region because the bays are not representative of a whole-lake survey***.

Individual Species Statistics

Individual species statistics assess the plant species composition in the 6 bays and allow for comparisons of the plant community within the bays (Table 1).

Chi-squared tests

A chi-squared test of plant occurrence was done for all bays. The statistical test helps determine whether there is a significant difference between two data sets by comparing the number of sites a particular plant species was found in two different 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. Chi-squared tests compared differences in plant occurrence from the most recent prior survey to 2023. The tests also compared differences from the first year of the bay being surveyed to 2023.

Table 1 – Individual Species Statistics Explanations

Individual Statistic	Explanation
Average Rake Fullness	Mean rake fullness rating ranging from 1 to 3. See Rake Fullness Illustration.
Number of sites where a species was found	The total number of survey points where a particular species was found on the rake.
Number of visual sightings	The total number of times a particular species was visually observed within 6 feet of a sampling point, but not collected on the rake.
Frequency of Occurrence FOO (split into two subcategories)	a) Among vegetated sites only – The number of sites at which a particular species is found on the rake divided by the total number of vegetated sites (Table 2, #2).
	b) Among sites shallower than the maximum depth of plants – The number of sites at which a particular species is found on the rake divided by the total number of sites less than or equal to the maximum depth of plants (Table 2, #4). Also known as **littoral frequency.**
Relative frequency (%)	This value represents the degree to which a particular species contributes to the total of all observations. The sum of all relative frequencies is 100%.

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[3] Nichols, S.A. 1999. Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications. Journal of Lake and Reservoir Management. 15(2):133-141.

Table 2 – 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).

RESULTS

The results for all 6 bays are summarized in Table 3 & Table 4. Table 3 lists individual species found in each bay in 2023 and corresponding statistics for each species. Table 4 lists summary plant statistics for each bay in 2023 and previous years. Results are further explained in this section.

Table 3 - Plant Species Results, 2023 Bays

Bay Name	Common Name	Scientific Name	Frequency of Occurrence at Veg. Sites (%)	Littoral Frequency (%)	Relative Frequency (%)	# Sites	Average Rake Fullness	# Visual
Swallow	White water lily	*Nymphaea odorata*	78.38	47.54	38.16	29	1.69	23
	Coontail	*Ceratophyllum demersum*	48.65	29.51	23.68	18	1.17	3
	Eurasian water milfoil	*Myriophyllum spicatum*	43.24	26.23	21.05	16	1.31	17
	Small duckweed	*Lemna minor*	27.03	16.39	13.16	10	1.00	9
	Filamentous algae		18.92	11.48	-	7	1.00	3
	Slender waterweed	*Elodea nuttallii*	5.41	3.28	2.63	2	1.00	0
	Small pondweed	*Potamogeton pusillus*	2.70	1.64	1.32	1	1.00	0
	Curly-leaf pondweed	*Potamogeton crispus*	0.00	0.00	0.00	0	0.00	1
Mourning Dove	Eurasian water milfoil	*Myriophyllum spicatum*	81.25	23.01	55.30	26	1.31	4
	Coontail	*Ceratophyllum demersum*	25.00	7.08	17.00	8	1.13	1
	White water lily	*Nymphaea odorata*	12.50	3.54	8.50	4	1.25	5
	Sago pondweed	*Stuckenia pectinata*	12.50	3.54	8.50	4	1.00	1
	Slender naiad	*Najas flexilis*	9.38	2.65	6.40	3	1.00	0
	Wild celery	*Vallisneria americana*	6.25	1.77	4.30	2	1.50	0
Cardinal	Eurasian water milfoil	*Myriophyllum spicatum*	87.88	50.00	50.00	29	1.34	1
	Coontail	*Ceratophyllum demersum*	30.30	17.24	17.24	10	1.20	0
	Sago pondweed	*Stuckenia pectinata*	21.21	12.07	12.07	7	1.00	0
	Small pondweed	*Potamogeton pusillus*	12.12	6.90	6.90	4	1.00	1
	Wild celery	*Vallisneria americana*	12.12	6.90	6.90	4	1.00	1
	Slender naiad	*Najas flexilis*	9.09	5.17	5.17	3	1.00	0
	Filamentous algae		9.09	5.17	-	3	1.00	1
	Water star-grass	*Heteranthera dubia*	3.03	1.72	1.72	1	1.00	0
	Curly-leaf pondweed	*Potamogeton crispus*	0.00	0.00	0.00	0	0.00	1
Chick-adee (North)	Eurasian water milfoil	*Myriophyllum spicatum*	100.00	26.09	92.31	12	1.25	4
	White water lily	*Nymphaea odorata*	8.33	2.17	7.69	1	2.00	1
	Filamentous algae		0.00	0.00	-	0	0.00	1
	Coontail	*Ceratophyllum demersum*	0.00	0.00	0.00	0	0.00	1
Oriole	Eurasian water milfoil	*Myriophyllum spicatum*	93.75	53.57	60	15	1.6	0
	Small pondweed	*Potamogeton pusillus*	37.50	21.43	24	6	1	0
	Coontail	*Ceratophyllum demersum*	18.75	10.71	12	3	1	0
	Sago pondweed	*Stuckenia pectinata*	6.25	3.57	4	1	1	0
	Filamentous algae		6.25	3.57	-	1	1	0
Chippewa	Eurasian water milfoil	*Myriophyllum spicatum*	90.00	58.06	75.00	18	1.44	5
	White water lily	*Nymphaea odorata*	10.00	6.45	8.33	2	2.00	0
	Sago pondweed	*Stuckenia pectinata*	10.00	6.45	8.33	2	1.00	1
	Coontail	*Ceratophyllum demersum*	5.00	3.23	4.17	1	1.00	0
	Wild celery	*Vallisneria americana*	5.00	3.23	4.17	1	1.00	0
	Filamentous algae		5.00	3.23	-	1	1.00	0

Table 4 – Summary Plant Statistics for Bays Surveyed in 2023

Bay & Year		1	2	3	4	5	6 Average # of species per site				7 Species Richness		8	
		Total # sites visited	Total # sites w/ vegetation	Max. depth of plants	Total # sites shallower than max. depth of plants	Littoral frequency (%)	a) Shallower than max. depth	b) Vegetated sites only	c) Native shallower than max. depth	d) Native at veg. sites only	a) Total # species on rake at all sites	b) Including visuals	Simpson's Diversity Index	Littoral frequency of EWM (%)
Swallow	**2014**	70	43	4	64	67.2	1.36	2.02	0.83	1.56	7	7	0.69	52
	2015	71	37	5	71	52.1	0.72	1.38	0.69	1.32	8	10	0.66	**1**
	2016	72	44	4	65	67.7	1.23	1.82	1.09	1.65	7	7	0.70	9
	2017	72	40	4	66	60.6	1.30	2.15	0.98	1.76	8	8	0.78	29
	2018	72	29	4	58	50.0	0.71	1.41	0.71	1.41	5	7	0.56	**0**
	2019	71	23	4	62	37.1	0.37	1.00	0.37	1.00	1	3	0	0
	2020	**71**	**14**	**5**	**57**	**24.6**	**0.32**	**1.29**	**0.26**	**1.15**	**5**	**6**	**0.46**	**4**
	2022	69	20	5	52	38.5	0.58	1.50	0.46	1.26	4	5	0.60	12
	2023	69	37	5	61	60.7	1.25	2.05	0.98	1.71	6	7	0.74	26
Mourning Dove	**2016**	122	59	7.5	89	66.3	1.04	1.58	0.88	1.39	9	10	0.68	17
	2017	122	56	6.5	78	71.8	1.19	1.66	0.88	1.28	8	9	0.62	31
	2018	122	36	6	75	48.0	0.84	1.75	0.81	1.69	8	8	0.72	**3**
	2020	**122**	**26**	**7.5**	**87**	**29.9**	**0.47**	**1.58**	**0.25**	**1.22**	**5**	**8**	**0.68**	**22**
	2021	120	27	8	90	30.0	0.49	1.63	0.28	1.47	8	9	0.74	20
	2023	114	32	10	113	28.3	0.42	1.47	0.19	1.40	6	6	0.64	23
Cardinal	**2015**	67	33	7	46	71.7	1.15	1.61	0.85	1.39	7	8	0.74	30
	2016	65	39	6	45	86.7	1.73	2.00	1.42	1.83	9	11	0.83	**31**
	2017	66	35	7	46	76.1	1.61	2.11	1.11	1.65	8	9	0.76	50
	2018	61	39	11	60	65.0	1.10	1.69	0.90	1.54	10	11	0.75	**20**
	2019	59	29	9	53	54.72	0.70	1.28	0.55	1.16	5	7	0.71	15
	2020	**62**	**26**	**7**	**45**	**57.8**	**1.09**	**1.88**	**0.78**	**1.52**	**8**	**8**	**0.79**	**31**
	2021	63	18	6*	39	46.2	0.77	1.67	0.46	1.20	6	6	0.76	28
	2022	68	22	5.5	39	56	0.82	1.45	0.46	1.29	8	10	0.78	33
	2023	67	33	11	58	56.9	1.00	1.76	0.50	1.45	7	8	0.69	50
Chickadee (North only)	**2023**	61	12	6	46	26.1	0.28	1.08	0.02	1.00	2	3	0.14	26
Oriole	**2015**	68	26	9	48	54.17	0.90	1.65	0.63	1.36	5	5	0.70	27
	2016	62	28	7	44	63.6	0.91	1.43	0.77	1.26	6	6	0.69	**14**
	2017	56	22	9.5	46	47.8	0.76	1.59	0.52	1.09	5	6	0.57	24
	2018	56	13	6	32	40.6	0.56	1.38	0.50	1.23	5	6	0.62	6
	2019	60	8	5	27	29.6	0.37	1.25	0.33	1.13	4	5	0.48	4
	2020	**60**	**16**	**7**	**38**	**43.2**	**0.59**	**1.38**	**0.22**	**1.00**	**3**	**5**	**0.52**	**38**
	2021	55	6	6	28	21.4	0.36	1.67	0.14	1.33	4	5	0.58	21
	2023	52	16	5.5	28	57.1	0.89	1.56	0.36	1.25	4	4	0.57	54
Chippewa	**2023**	31	20	6	31	64.5	0.77	1.20	0.19	1.00	5	5	0.42	58

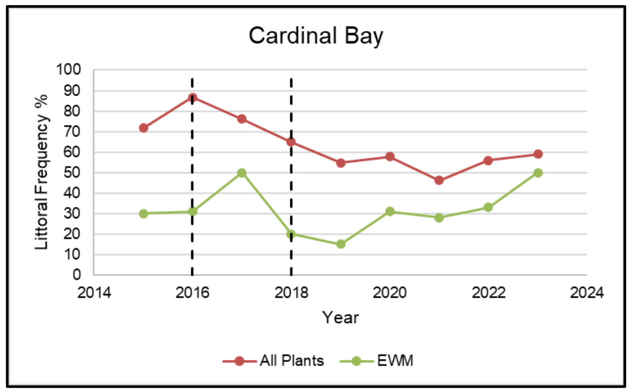
EWM with adventitious roots was found at 12 feet but was likely not rooted at that depth. Furthermore, the next deepest sample point of plant occurrence was 6 feet deep.* ***Herbicide treatment occurred during the years listed in red text. The results of these herbicide treatment years is considered post-treatment.*

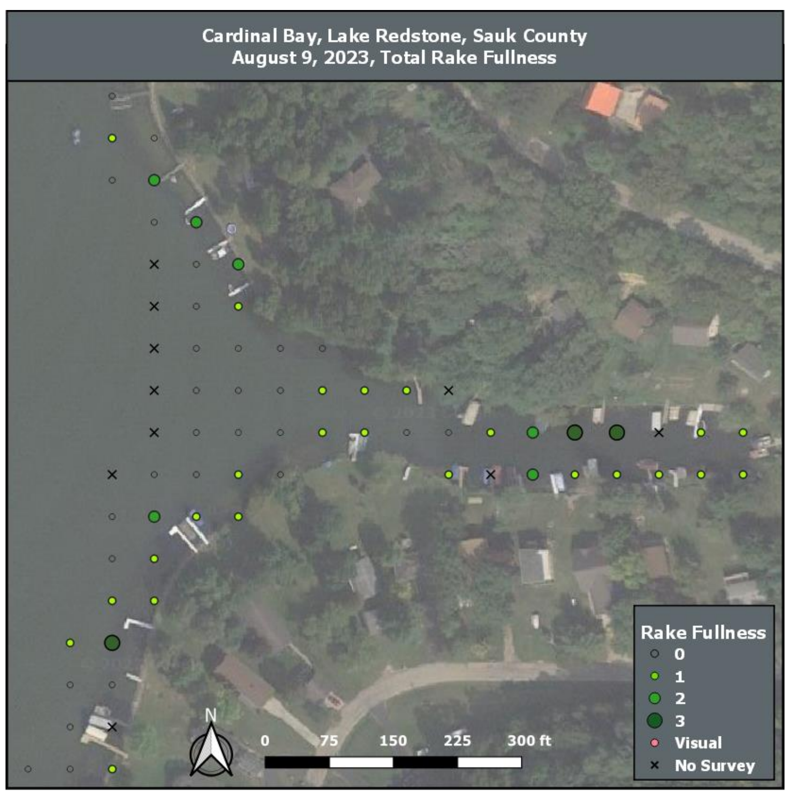
Results in BOLD text with blue shading are post-dredging (dredging occurred after the 2019 surveys).

Cardinal Bay 2023

- Max rooting depth = 11ft
- Total # sites shallower than 11ft = 58
- Total # sites with vegetation = 33
- 33/58 = 57% Littoral frequency all plants
- Most common plant was EWM at 29 sites
- Chi-squared tests revealed no statistically significant changes in native plant species between 2022 and 2023. There was a statistically significant decrease in coontail, slender waterweed, and filamentous algae when comparing 2015 data to 2023 (see graphs in Appendix F).
- Cardinal Bay is NOT designated as a critical habitat area

Bay & Year		1 Total # sites visited	2 Total # sites w/ vegetation	3 Max. depth of plants	4 Total # sites shallower than max. depth of plants	5 Littoral frequency (%)	7 Species Richness a) Total # species on rake at all sites	 b) Including visuals	Littoral frequency of EWM (%)
Cardinal	2015	67	33	7	46	71.7	7	8	30
	2016	65	39	6	45	86.7	9	11	31
	2017	66	35	7	46	76.1	8	9	50
	2018	61	39	11	60	65.0	10	11	20
	2019	59	29	9	53	54.72	5	7	15
	2020	**62**	**26**	**7**	**45**	**57.8**	**8**	**8**	**31**
	2021	63	18	6*	39	46.2	6	6	28
	2022	68	22	5.5	39	56	8	10	33
	2023	67	33	11	58	56.9	7	8	50

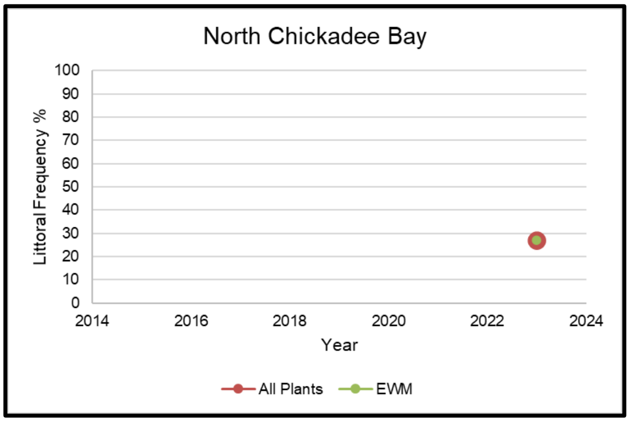




North Chickadee Bay 2023

- Max rooting depth = 6ft
- Total # sites shallower than 6ft = 46
- Total # sites with vegetation = 12
- 12/46 = 26% Littoral frequency all plants
- Most common plant was EWM at 12 sites
- No Chi-square tests were done because only the northern portion of the bay was requested for survey.
- All of Chickadee Bay is designated as a critical habitat area

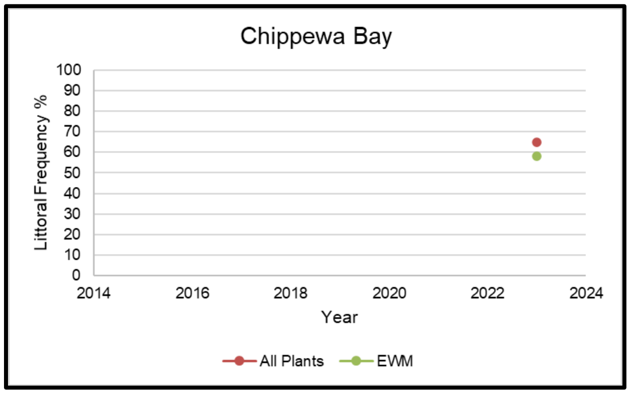
Bay & Year		1 Total # sites visited	2 Total # sites w/ vegetation	3 Max. depth of plants	4 Total # sites shallower than max. depth of plants	5 Littoral frequency (%)	7 Species Richness a) Total # species on rake at all sites	b) Including visuals	Littoral frequency of EWM (%)
Chickadee (North only)	2023	61	12	6	46	26.1	2	3	26

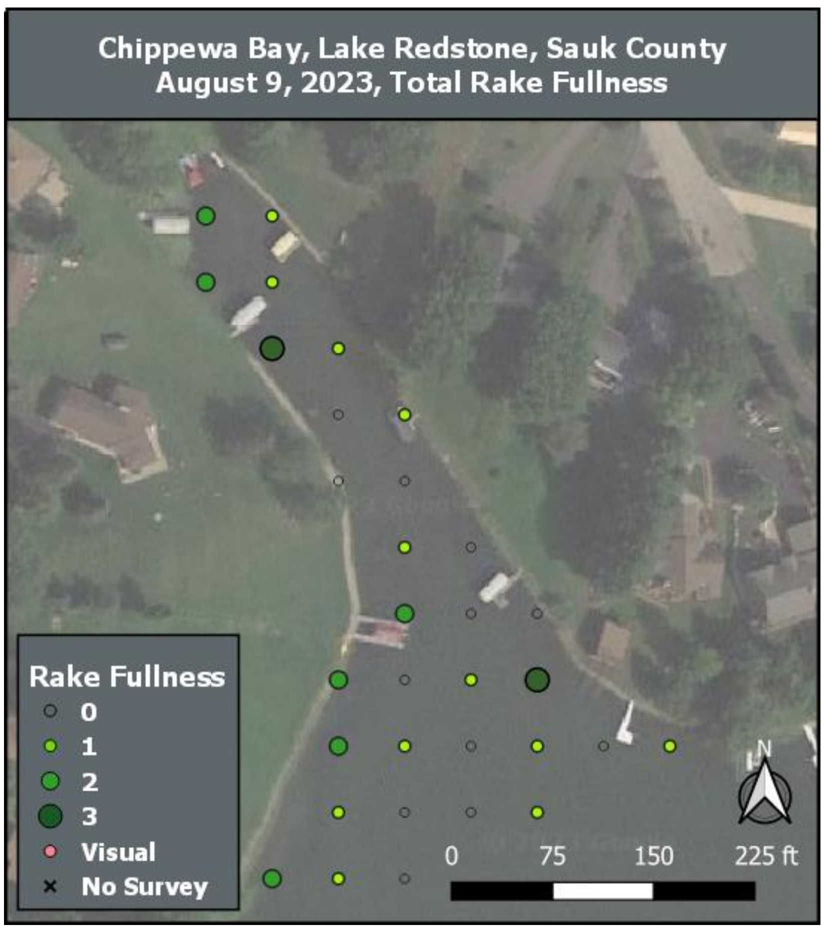


Chippewa Bay 2023

- Max rooting depth = 6ft
- Total # sites shallower than 6ft = 31
- Total # sites with vegetation = 20
- 20/31 = 65% Littoral frequency all plants
- Most common plant was EWM at 18 sites
- No Chi-square test was done because this was the first year surveying Chippewa Bay
- Chippewa Bay is NOT designated as a critical habitat area

Bay & Year		1 Total # sites visited	2 Total # sites w/ vegetation	3 Max. depth of plants	4 Total # sites shallower than max. depth of plants	5 Littoral frequency (%)	7 Species Richness a) Total # species on rake at all sites	b) Including visuals	Littoral frequency of EWM (%)
Chippewa	**2023**	31	20	6	31	64.5	5	5	58

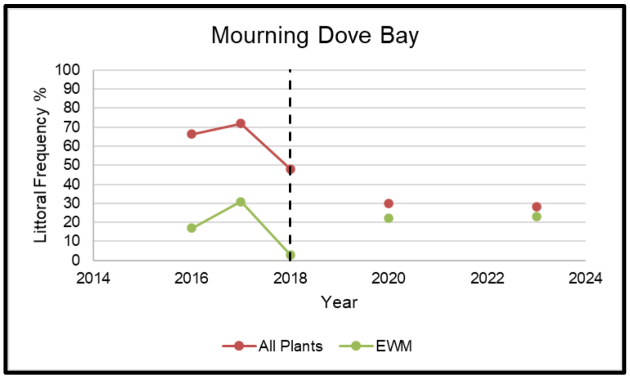


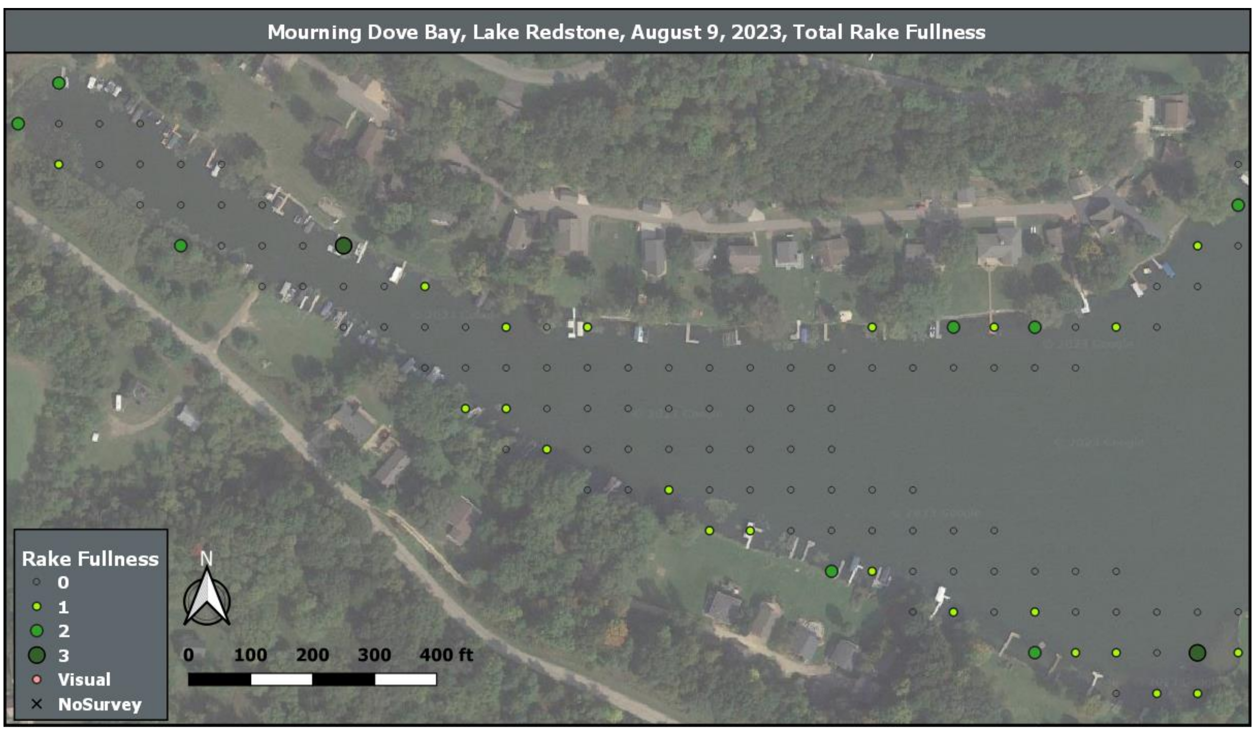


Mourning Dove Bay 2023

- Max rooting depth = 10ft
- Total # sites shallower than 10ft = 113
- Total # sites with vegetation = 32
- 32/113 = 28% Littoral frequency all plants
- Most common plant was EWM at 26 sites
- Chi-squared tests revealed a statistically significant increase in white water lily in 2023 compared to 2021. There was a statistically significant decrease in white water lily, coontail, small pondweed, and filamentous algae in 2023 compared to 2016 (see graphs in Appendix F).
- Mourning Dove Bay is designated as a critical habitat area.

Bay & Year		1 Total # sites visited	2 Total # sites w/ vegetation	3 Max. depth of plants	4 Total # sites shallower than max. depth of plants	5 Littoral frequency (%)	7 Species Richness a) Total # species on rake at all sites	b) Including visuals	Littoral frequency of EWM (%)
Mourning Dove	**2016**	122	59	7.5	89	66.3	9	10	17
	2017	122	56	6.5	78	71.8	8	9	31
	2018	122	36	6	75	48.0	8	8	**3**
	2020	**122**	**26**	**7.5**	**87**	**29.9**	**5**	**8**	**22**
	2023	114	32	10	113	28.3	6	6	23

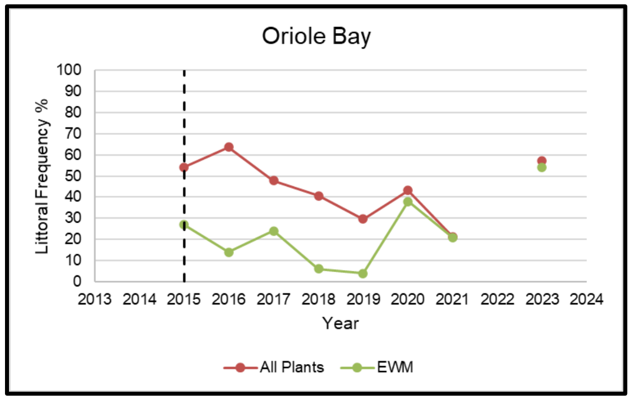


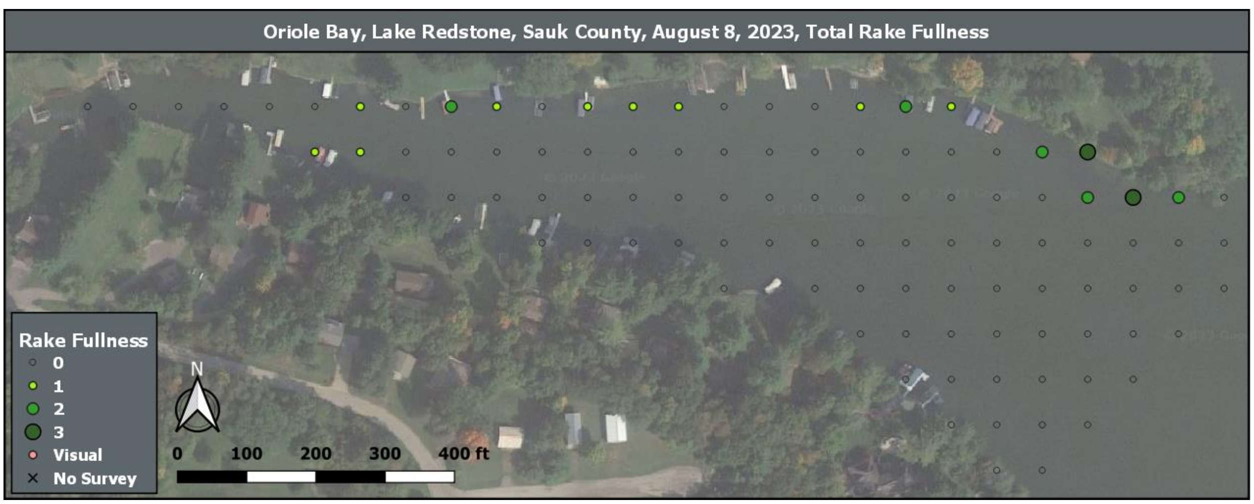


Oriole Bay 2023

- Max rooting depth = 5.5ft
- Total # sites shallower than 5.5ft = 28
- Total # sites with vegetation = 16
- 16/28 = 57% Littoral frequency all plants
- Most common plant was EWM at 15 sites
- Chi-squared tests revealed a statistically significant increase in small pondweed between 2021 and 2023. There was a significant decrease in coontail and slender waterweed in 2023 when compared to 2015 (see graphs in Appendix F).
- Oriole Bay is designated as a critical habitat area.

Bay & Year		1 Total # sites visited	2 Total # sites w/ vegetation	3 Max. depth of plants	4 Total # sites shallower than max. depth of plants	5 Littoral frequency (%)	7 Species Richness a) Total # species on rake at all sites	b) Including visuals	Littoral frequency of EWM (%)
Oriole	**2015**	68	26	9	48	54.17	5	5	27
	2016	62	28	7	44	63.6	6	6	**14**
	2017	56	22	9.5	46	47.8	5	6	24
	2018	56	13	6	32	40.6	5	6	6
	2019	60	8	5	27	29.6	4	5	4
	2020	**60**	**16**	**7**	**38**	**43.2**	**3**	**5**	**38**
	2021	55	6	6	28	21.4	4	5	21
	2023	52	16	5.5	28	57.1	4	4	54

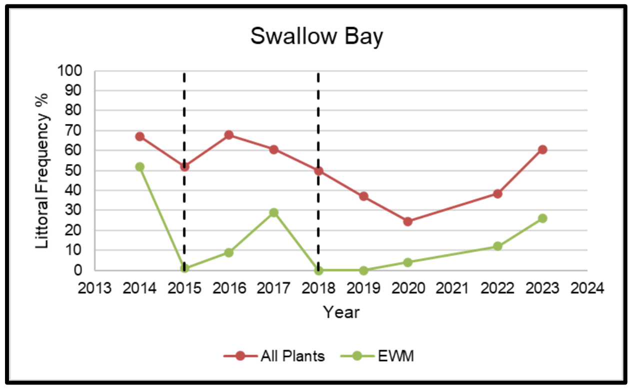


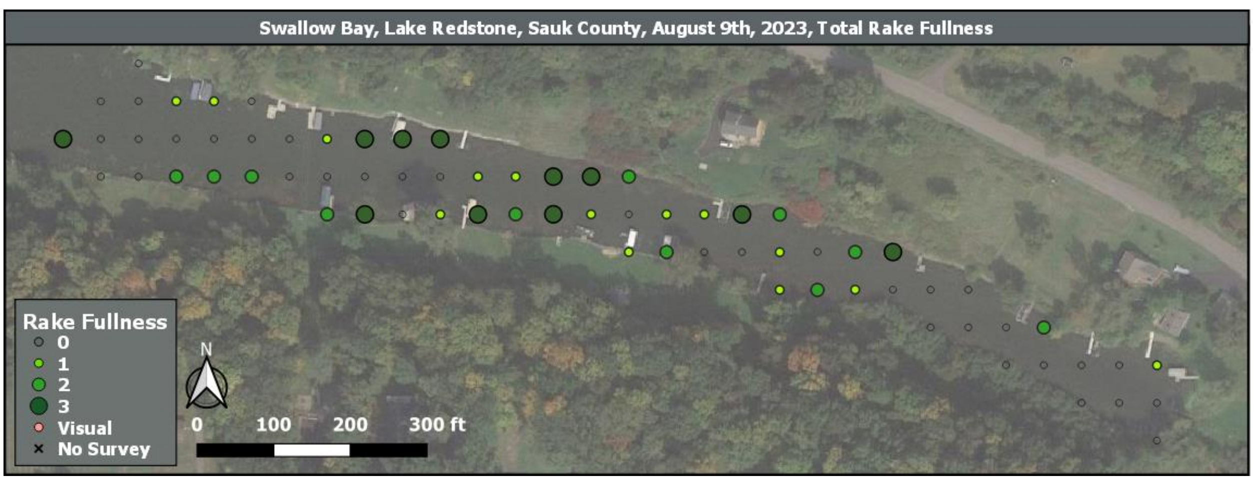


Swallow Bay 2023

- Max rooting depth = 5ft
- Total # sites shallower than 5ft = 61
- Total # sites with vegetation = 37
- 37/61 = 61% Littoral frequency all plants
- Most common plant was white water lily at 29 sites
- Chi-squared tests revealed a statistically significant increase in small duckweed, white water lily, and coontail in 2023 compared to 2022. When comparing 2023 to 2014, there was a significant increase in small duckweed and white water lily while there was a significant decrease in large duckweed and coontail (see graphs in Appendix F).
- Swallow Bay is designated as a critical habitat area.

Bay & Year		1 Total # sites visited	2 Total # sites w/ vegetation	3 Max. depth of plants	4 Total # sites shallower than max. depth of plants	5 Littoral frequency (%)	7 Species Richness a) Total # species on rake at all sites	 b) Including visuals	Littoral frequency of EWM (%)
Swallow	2014	70	43	4	64	67.2	7	7	52
	2015	71	37	5	71	52.1	8	10	1
	2016	72	44	4	65	67.7	7	7	9
	2017	72	40	4	66	60.6	8	8	29
	2018	72	29	4	58	50.0	5	7	0
	2019	71	23	4	62	37.1	1	3	0
	2020	**71**	**14**	**5**	**57**	**24.6**	**5**	**6**	**4**
	2022	69	20	5	52	38.5	4	5	12
	2023	69	37	5	61	60.7	6	7	26

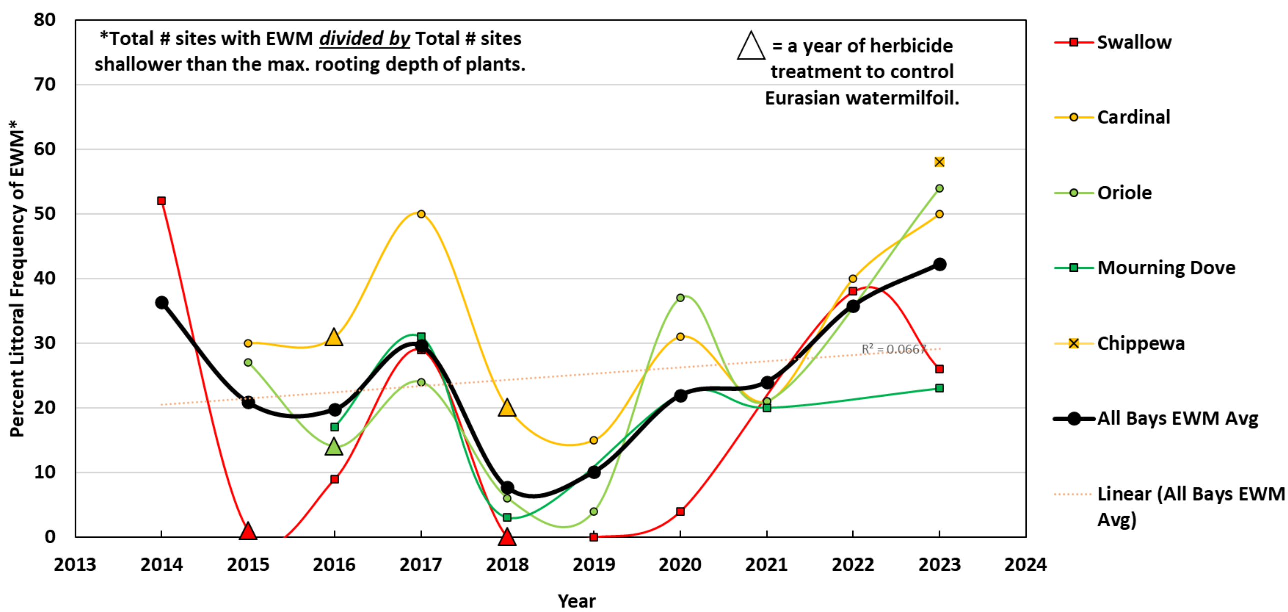




Eurasian Watermilfoil Results & Management History

Eurasian watermilfoil (EWM) was found in all 6 bays and was the most commonly occurring plant species in 5 bays. Figure 3 illustrates EWM littoral frequency in five of the bays surveyed in 2023 (North Chickadee is not included because only half the bay was requested for survey and therefore not comparable to past surveys of full Chickadee Bay). ***In summary, the increase in Mourning Dove Bay was very small and not significant. The increase in Swallow, Cardinal, and Oriole Bays in 2023 compared to the previous survey was statistically significant.*** A linear trendline of the average littoral frequency among all bays illustrates a weak R^2 of 0.07, which suggests there is no clear trend on EWM occurrence between 2014 and 2023, but there appears to be an increase in EWM in the last 5 years.

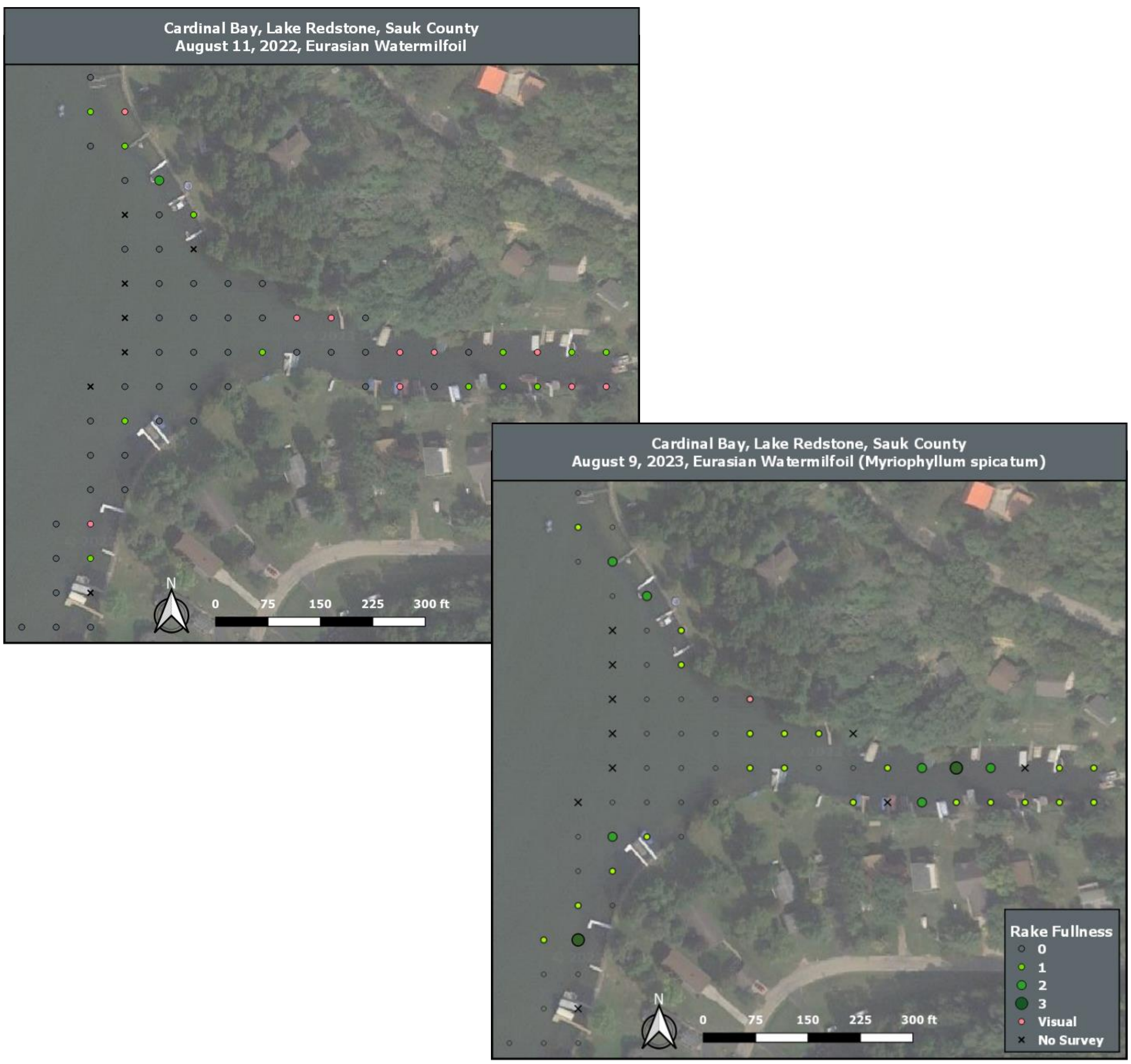
Figure 3 – Eurasian Watermilfoil Littoral Frequency Graph



Cardinal Bay EWM 2023

- EWM was the most common plant with occurrence at 29 sites (another 1 visual).
- Herbicide was applied in Cardinal Bay in 2016 and 2018.
- A small sample of EWM was found at an 11-ft deep sample point in 2023. Although it's possible the sample was growing in 11 feet of water, it is also possible the EWM was free-floating. This is noted because all other plants in Cardinal Bay were found at 7ft or shallower.
- Navigation impairment caused by EWM was not observed in 2023. There was a clear channel down the middle of Cardinal Bay allowing for navigation. The near shore areas between docks had greater EWM occurrence and density, likely causing nuisance for near-shore areas.
- A chi-squared test of EWM revealed a statistically significant increase in EWM between 2015 and 2023 and between 2022 and 2023 (see graph Appendix F).

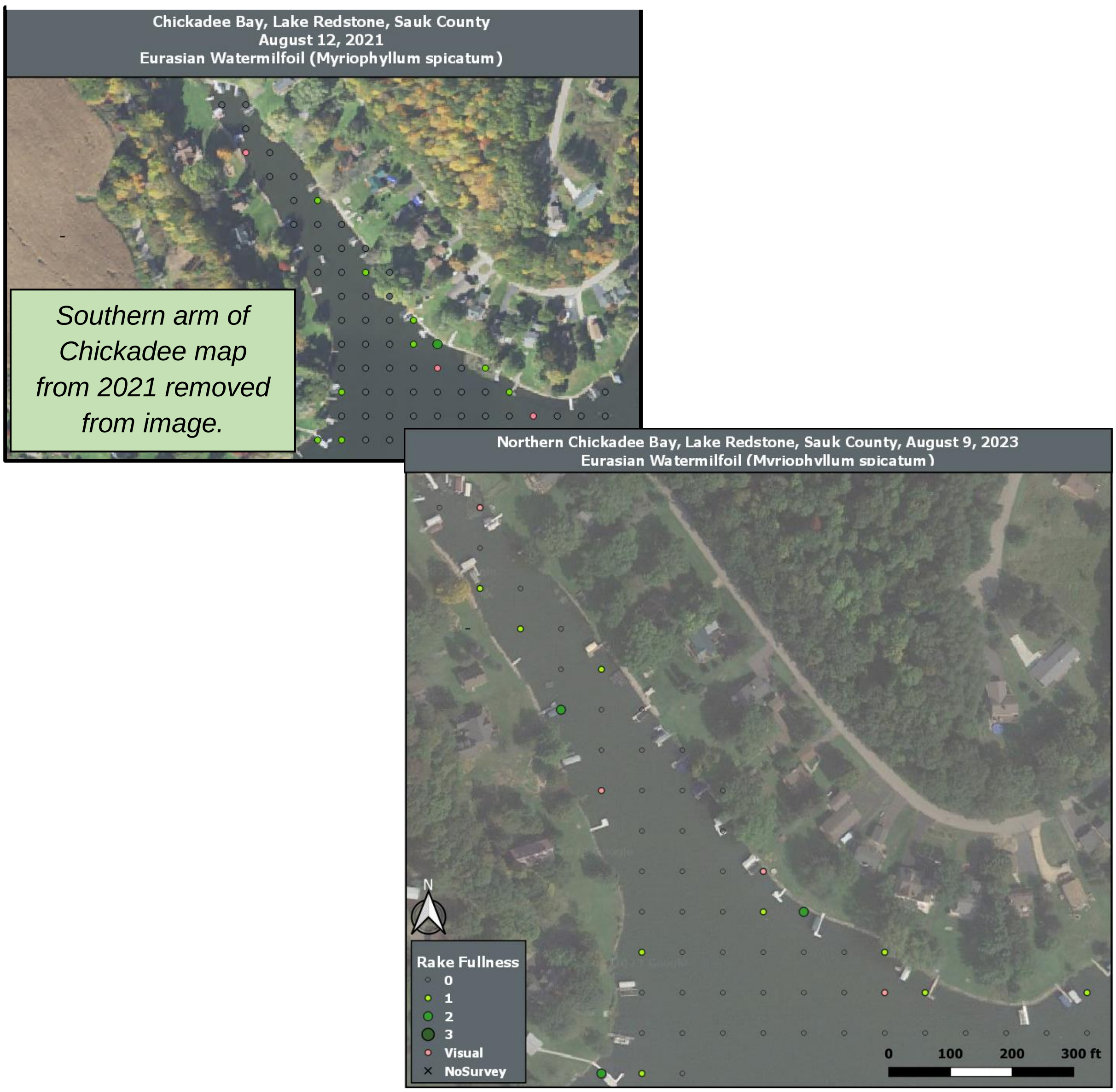
Figure 4 - Cardinal Bay Eurasian Watermilfoil Maps 2022 & 2023



North Chickadee Bay EWM 2023

- EWM was the most common species at 12 sites (another 4 visual).
- Herbicide treatment was conducted in the southern arm of Chickadee Bay in 2016. The northern arm has not been treated using herbicide.
- No chi-square for North Chickadee was completed due to only half of the bay being surveyed in 2023.
- Navigation impairment caused by EWM was not observed in 2023.

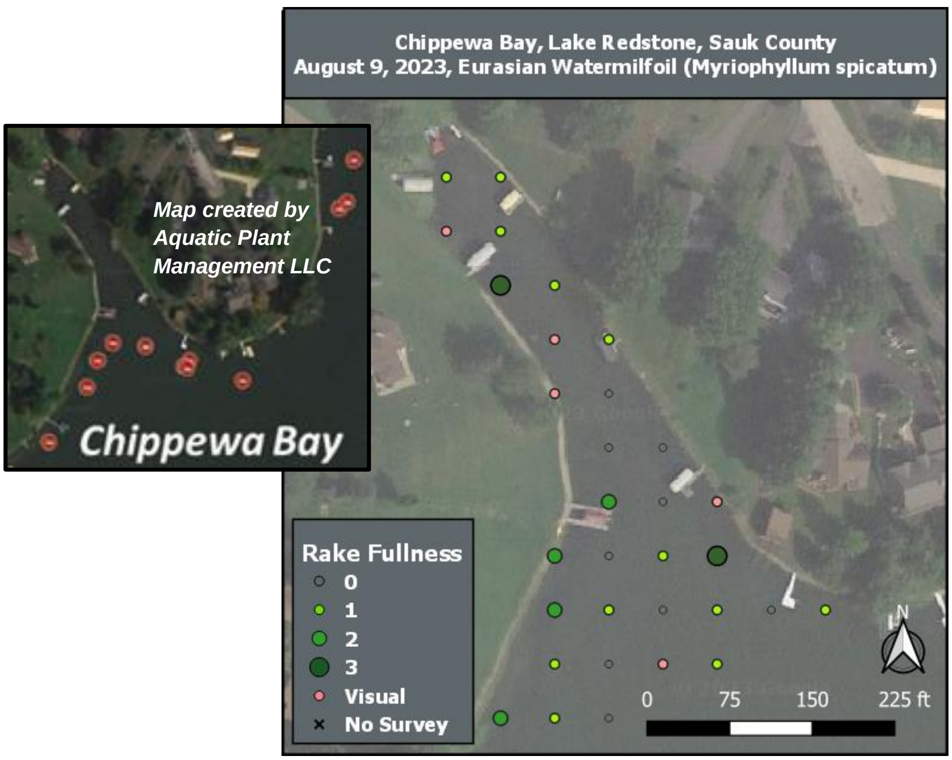
Figure 5 – North Chickadee Bay Eurasian Watermilfoil Maps 2021 & 2023



Chippewa Bay EWM 2023

- EWM was the most common species at 18 survey points (another 5 visual).
- No herbicide treatment has been conducted in Chippewa Bay.
- Diver assisted suction harvest (DASH) was used to control EWM at several locations in and near Chippewa Bay in June 2022. Water clarity was a significant issue for divers, leading to unsatisfactory results. As a result, LRPD is not pursuing the use of DASH in the near future.
- Being the first year of survey for Chippewa Bay, no chi-square test was done.
- Some navigation impairment caused by EWM was observed in 2023.

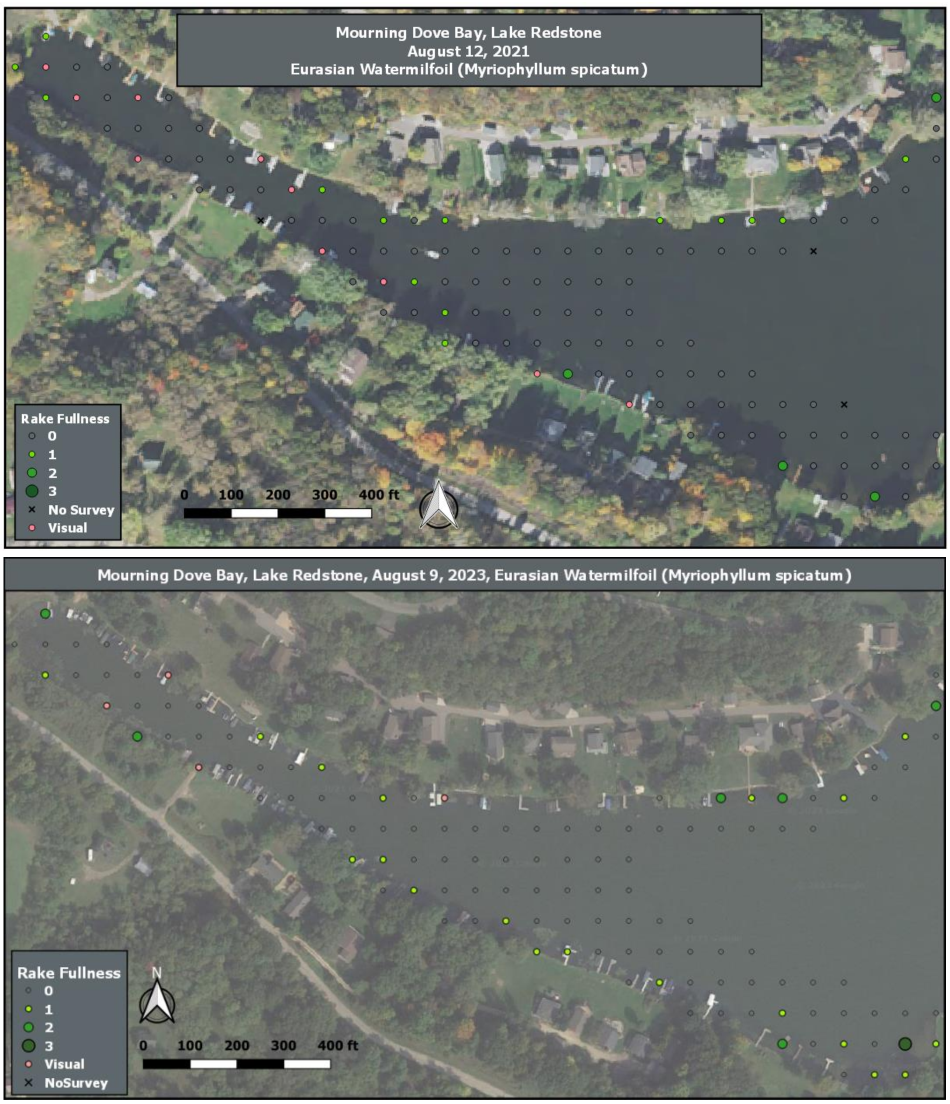
Figure 6 – Chippewa Bay Eurasian Watermilfoil Map 2023 & DASH Map 2022



Mourning Dove Bay EWM 2023

- EWM was the most common species at 26 survey points (another 4 visual).
- Herbicide was applied in Mourning Dove Bay in 2018.
- A small EWM plant was found at 10 feet deep and may have been growing there. It is also possible the EWM was free-floating. All other plants in Mourning Dove were 7ft or shallower.
- Navigation impairment caused by EWM was not observed in 2023.
- A chi-squared test revealed a statistically significant increase in EWM between 2016 and 2023. There was an increase 2021 vs 2023, but not significant (See graph in Appendix F)

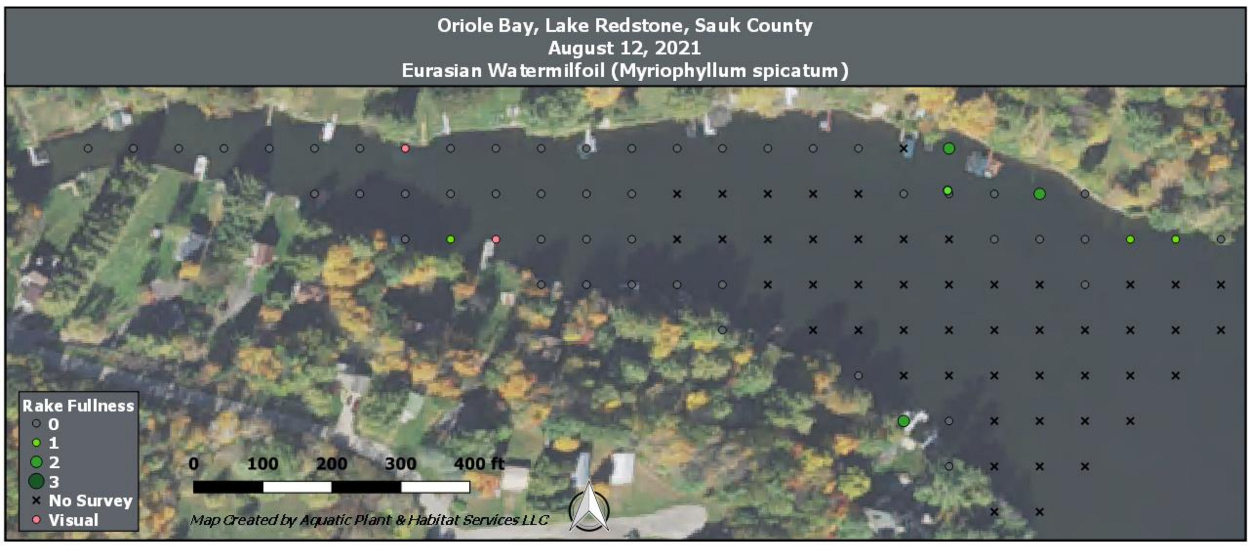
Figure 7 – Mourning Dove Bay Eurasian Watermilfoil Maps 2021 & 2023

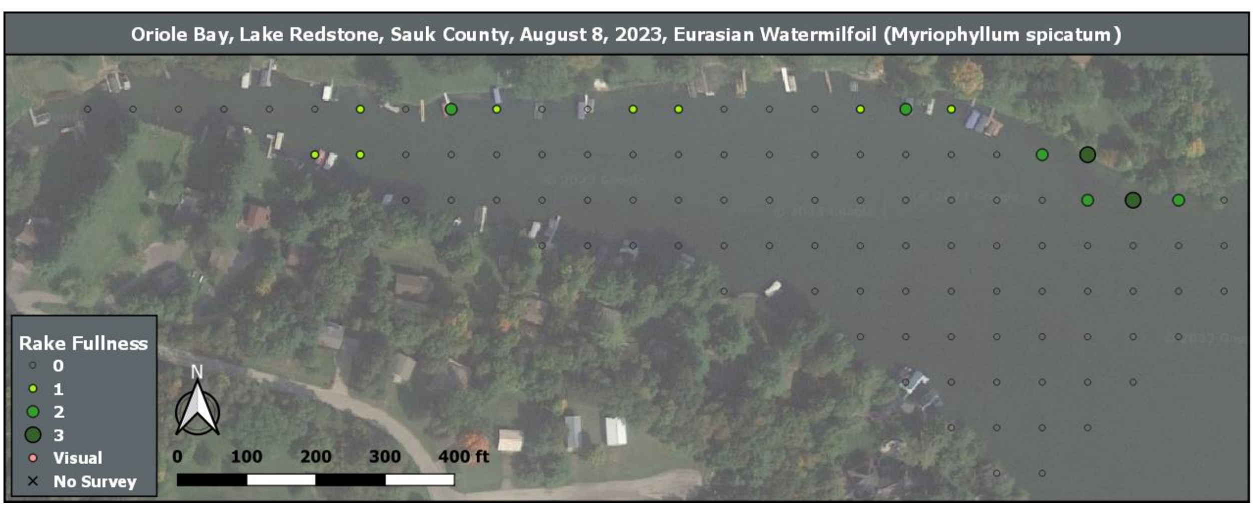


Oriole Bay EWM 2023

- EWM was the most common species at 15 survey points (0 visual).
- Herbicide was applied in Oriole Bay in 2016.
- A chi-squared test of EWM revealed an increase in EWM between 2015 and 2023 but it was not statistically significant. There was a statistically significant increase in EWM between 2021 and 2023 (See graph in Appendix F).
- Navigation impairment caused by EWM was not observed in 2023.

Figure 8 – Oriole Bay Eurasian Watermilfoil Maps 2021 & 2023





Swallow Bay EWM 2023

- EWM was found at 16 sites (another 17 visual), third most common plant species in 2023 (White water lily and coontail were more common than EWM).
- Herbicide treatment was done in 2015 & 2018 to control EWM.
- A chi-squared test of EWM data revealed a statistically significant decrease when comparing data from 2014 to 2023. There was a statistically significant increase in EWM between 2022 and 2023 (See graph in Appendix F).
- Navigation impairment caused by EWM was not observed in 2023. There was a clear channel down the middle of Swallow Bay allowing for navigation.

Figure 9 – Swallow Bay Eurasian Watermilfoil Maps 2022 & 2023

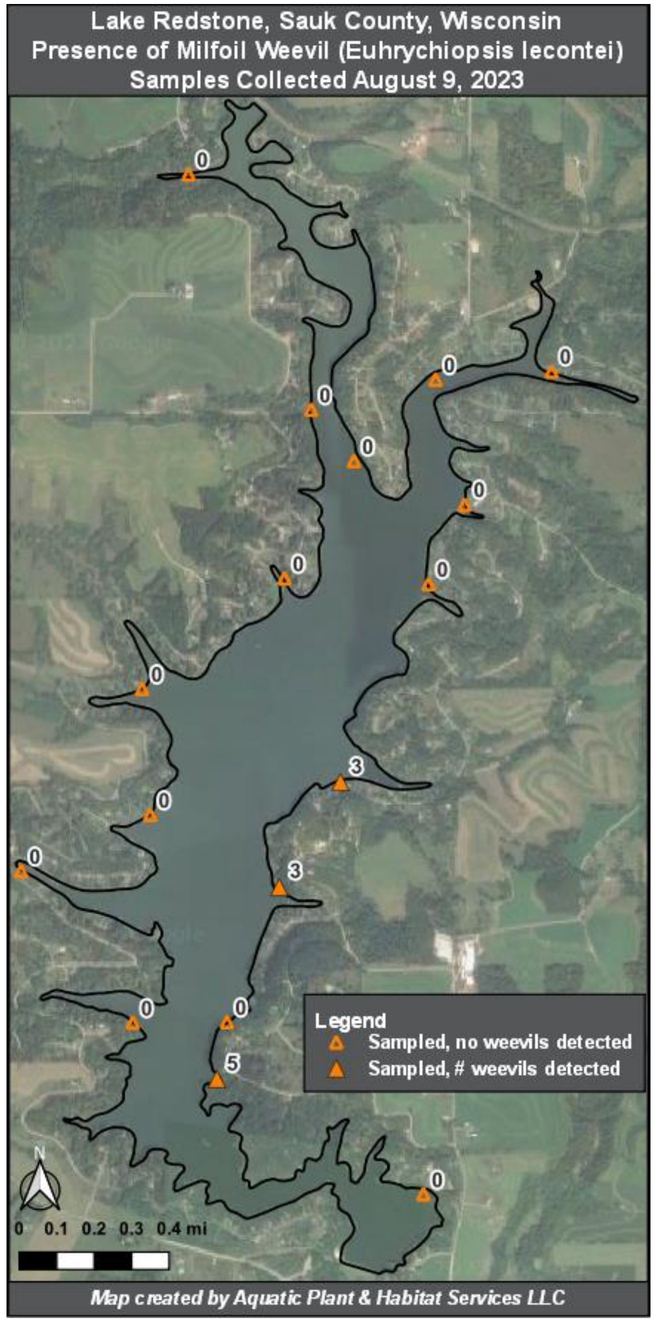
Weevil Results

On August 9, 2023, seventeen (17) EWM samples were collected from locations identified in Figure 10, preserved in alcohol, and analyzed for milfoil weevils (*Euhrychiopsis lecontei*) by Amy Thorstenson. EWM was analyzed for egg, larvae, pupae, and adult life stages and were **detected in Eagle Bay, Cardinal Bay, and very small "bay" north of Raven Bay.** A detailed spreadsheet of results is in Appedix G. The following findings were provided by Amy Thorstenson.

- Redstone avg = 0.31 weevils per stem.
- Statewide avg = 0.65 weevils per stem.
- Biocontrol has been documented as low as 0.25 weevils per stem, but densities closer to 1.0 weevils per stem seems necessary for some lakes.
- This population in Redstone appears to be very localized. This seems pretty typical with low-density populations.

The weevil survey fulfills Aquatic Plant Management Plan Goal 2, Obj. 2a. Protecting overwintering shoreline habitat for weevils is recommended as an additional tool that is no-cost and lasting for controlling EWM. Weevils will not eliminate all EWM but rather help keep its growth "in check."

Figure 10 – Map of Milfoil Weevil Results, 2023



DISCUSSION

Aquatic Plants are Necessary for Healthy Lakes

Aquatic plants serve important functions in lake systems. They provide structural habitat for small invertebrates that are an important food source for juvenile game fish and adult panfish. Plants also provide structural habitat for juvenile and small fish to hide from predators and vice versa as larger predators may lurk in the shadows of plants in wait of forage. Aquatic plants also provide foraging and/or hiding structure for reptiles, amphibians, and waterfowl. The shorelines of lakes are buffered from wave action when aquatic plants absorb some of the wave energy. Aquatic plants are important consumers of nutrients that would otherwise be available for nuisance algal growth. For these reasons, native aquatic plants should be protected in lakes and a healthy aquatic plant community should be promoted.

There are times when native aquatic plants grow to nuisance levels that hinder the aforementioned functions and also negatively impact recreation. An overabundance of vegetation can cause oxygen depletion in the water as plants decompose, thereby reducing the oxygen available to fish and other aquatic organisms.

Changes in Native Plant Occurrence

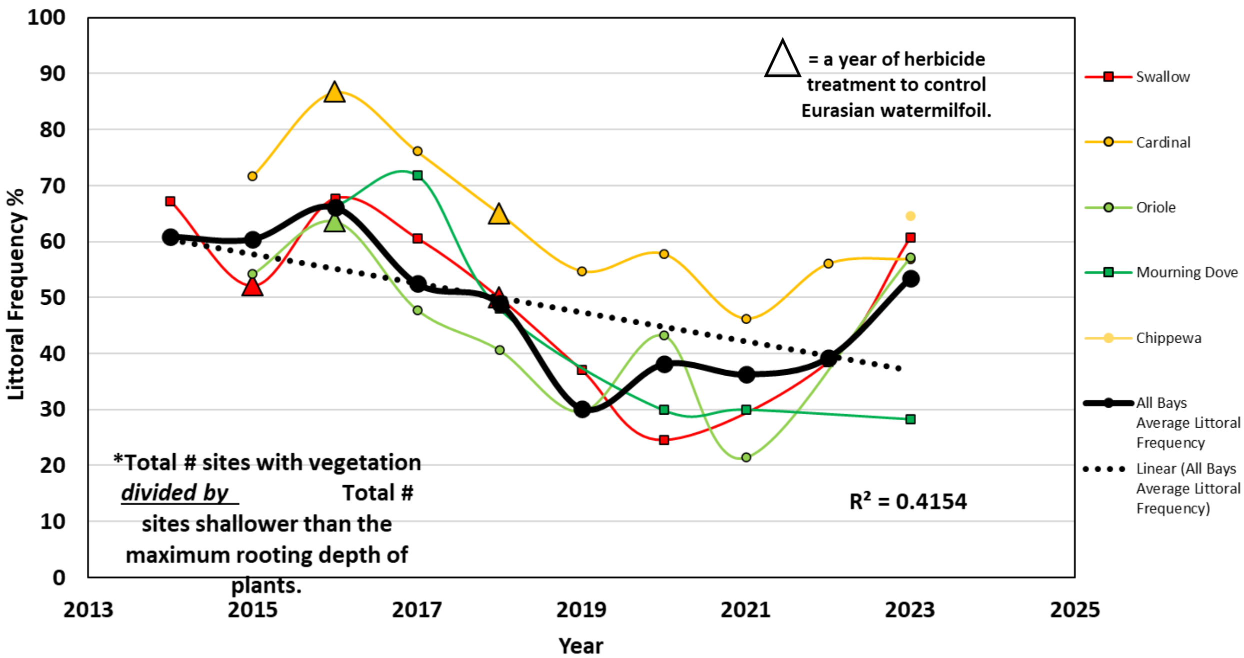
Chi-square tests were done for Swallow, Oriole, Mourning Dove, and Cardinal Bays. When comparing 2023 native species occurrence with that of most recent previous surveys, there were no statistically significant (SS) declines in native plant species and there were actually five instances of SS increases[4]. When comparing 2023 native species occurrence with the first year surveyed for the four bays there were 9 statistically significant (SS) declines in native plant species, 2 SS declines in filamentous algae, and 2 increases in native plants.[5] There was a declining trend in native and non-native aquatic plant occurrence from 2014 through 2022. The results from 2023, however, reveal an increase in aquatic plant occurrence in 5 out of 6 bays surveyed, resulting in a higher average frequency this year. This combined with the 5 instances of significant native plant increases in 2023 is encouraging and perhaps an indication that native aquatic plants are on the rise. The continued decline in filamentous algae can be considered good. As discussed in the updated Aquatic Plant Management Plan in 2023, the continued work by the LRPD to decrease nutrient input (especially phosphorus) and promote shoreland protection to decrease surface water runoff is expected to increase water clarity in the years to come. Increased water clarity is expected to allow more plants to grow and at greater depths with is better for overall lake ecology.

[4] Coontail, small duckweed, and white water lily in Swallow Bay, white water lily in Mourning Dove Bay, and small pondweed in Oriole Bay.
[5] Coontail in all 4 bays, large duckweed in Swallow Bay, white water lily and small pondweed in Mourning Dove Bay, and slender waterweed in Cardinal and Oriole Bays,

Reduced Plant Occurrence (Native & Non-native Species)

The graph in Figure 11 charts a function of the total number of sites where plants (native & non-native) *do* occur vs. the total number of sites where plants *could* occur (AKA littoral frequency) thereby factoring in water clarity because it only includes points that are equal to or shallower than the maximum depth of aquatic plants. In theory, if water clarity declines so do the number of points shallower than the maximum depth of plants. The bays that were surveyed since 2014 were selected each year based on perceived high aquatic plant abundance, particularly EWM, and therefore the bays are all thought to be representative of bays with overall high plant occurrence in Lake Redstone. Figure 11 illustrates littoral frequency for the bays surveyed in 2023 (not including North Chickadee because only half the bay was requested for survey) as well as the average littoral frequency for ***all bays*** surveyed since 2014. A linear trendline[6] of the average littoral frequency among all bays[7] suggests the littoral frequency of aquatic plants (combined native and non-native) was on a downward trend from 2014 through 2022 with an R^2 value of 0.72.[8] Surveys in 2023 weakened the R^2 value down to 0.42, suggesting aquatic plants could be on the rise. Figure 11 illustrates that the average aquatic plant occurrence in 2023 was higher compared to the last 6 years.

Figure 11 – Littoral Plant Frequency Graph



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[6] A **linear trendline** is a best-fit straight line that is used with simple **linear** data sets. Data is **linear** if the pattern in its data points resembles a line. A **linear trendline** usually shows that something is increasing or decreasing at a steady rate.

[7] All bays surveyed includes all those surveyed in a given year except for County F Bay in 2019 & 2020 (see 2020 report for more information).

[8] **R-squared** value measures the **trendline** reliability - the nearer $\mathbf{R}^2$ is to 1, the better the **trendline** fits the data. The $\mathbf{R}^2$ value in 2022 was much stronger at 0.72.

Using Criteria to Prioritize EWM Control

The Aquatic Plant Management Plan that was finalized in May 2023 included Table 5 to help guide management decisions. Under the “Size & Location” criteria, a trigger frequency of 36% is mentioned and is based on the littoral frequencies of EWM the year before they were treated with herbicide 2014-2018. Bays surveyed in 2023 with EWM littoral frequency greater than 36% are listed below.

Table 5 – Herbicide Treatment Criteria

Criteria for Prioritizing Eurasian Watermilfoil Control					
SIZE & LOCATION	DENSITY	TRAFFIC	IMPAIRMENT	HABITAT	SURVEY DATA
•Is the area in a sheltered bay or exposed shoreline? •If exposed, is the EWM bed >0.5 ac? •If sheltered, is the EWM frequency at least 36%?	•Is EWM the dominant species? •Is EWM rake fullness >2 on average?	•Is the EWM in an area of high boat traffic? •Is the EWM causing obstruction to navigation for more than a single riparian landowner?	•Is this area causing beneficial use impairment? (aquatic plants prevent activities such as angling, boating, swimming, or other navigation /recreation)	•Is EWM the dominant species to the detriment of native plant species? •Would the proposed treatment have limited impact on native plants?	•Has a pre-treatment survey been completed using standardized methods to document location, size, density, and height?

HOW TO USE THESE CRITERIA – Answer the 6 questions for a particular bed of EWM. If the answer is “yes” for most questions (ideally 4 or more), then that bed of EWM may be considered high priority for control actions. For beds of EWM with fewer “yes” answers, control actions can still be considered but perhaps that area is not the highest priority. This graphic is meant to help the LRPD prioritize if control actions should take place in any given year. Areas that do not receive attention in a given year may be considered higher priority the following year depending on conditions. Any herbicide permit application is subject to conditions in NR107, with particular attention to NR107.05 and NR107.08.

Graphic & criteria developed by Aquatic Plant & Habitat Services LLC

Cardinal Bay EWM occurrence was 50% with nuisance growth observed in the narrow portion of the bay extending from the shoreline out to the end of many docks (approximately 6.5 feet deep) but the center of the bay was clear for navigation. EWM is the dominant species but the average rake fullness was only 1.34. Traffic in the narrows of Cardinal Bay is likely dominated by the 12-15 residents and would be better known by LRPD members. The second-most common aquatic plant was coontail, which is a native species that would be impacted by 2,4-D or ProcellaCOR herbicides. **Cardinal Bay fulfills parts of 5 criteria in** Table 5, **therefore herbicide treatment could be considered in the narrows of Cardinal Bay, although it is not necessarily recommended due to the high occurrence of native coontail. Furthermore, milfoil weevils were detected at the mouth of Cardinal Bay in 2023 and reducing the weevil’s food source (EWM) will negatively impact their populations in and near Cardinal Bay.** The nearshore areas of Cardinal Bay outside the narrows have some localized high density EWM that would be best targeted with manual removal. Cardinal Bay is not designated as critical habitat (see APMP pg. 26).

Oriole Bay EWM occurrence was 54% with only localized navigation impairment observed in a few locations. EWM is the dominant species but the average rake fullness was only 1.60. Traffic in Oriole Bay is better known by LRPD members. The third-most common aquatic plant was coontail, which is a native species that would be impacted by 2,4-D or ProcellaCOR. **Oriole Bay fulfills parts of 3-4 criteria in** Table 5, **therefore herbicide treatment is not recommended.** Oriole Bay is designated as a sensitive area (see APMP pg. 26).

Chippewa Bay EWM occurrence was 58% with some navigation impairment observed throughout the small bay. EWM is the dominant species but the average rake fullness was only 1.44. Traffic in is likely dominated by the residents and would be better known by LRPD members. The second-most common aquatic plant was white water lily at only 2 sample sites (EWM was 18 sites), which is a native species that would be impacted by 2,4-D and possibly ProcellaCOR. Due to the low occurrence of white water lily and coontail in Chippewa Bay, herbicide treatment would be minimally impactful to those plant populations on a broad scale. **Chippewa Bay fulfills parts of 6 criteria in** Table 5, **therefore herbicide treatment could be considered for this location in 2024.** Chippewa Bay is not designated as critical habitat (see APMP pg. 26).

Gizzard Shad

The most recent comprehensive fishery surveys in Lake Redstone in 2022-2023 found gizzard shad (*Dorosoma cepedianum)* to be a highly abundant nuisance species. Gizzard shad are planktivores, which means they strain minute organic food sources such as zooplankton and phytoplankton (free-floating algae) with their gill rakers. High consumption and subsequent decreased abundance of zooplankton by gizzard shad can contribute to higher biomass of phytoplankton, or algae because there are fewer zooplankton to consume the phytoplankton. Gizzard shad also feed on organic detritus found in sediments when preferred food (plankton) is in low abundance. This feeding behavior can resuspend nutrients, in a sense, because the organic detritus becomes more biologically available when gizzard shad excrete the detritus in more biologically useable form. In this way the nutrients can help fuel algae growth. These complex food web interactions are further explained in Schaus et al. 2002[9].

There was no research found that would to suggest gizzard shad would have a significant negative impact on aquatic plant roots due to their feeding habits on detritus. Although this could occur on a small scale, it seems more likely that gizzard shad impact aquatic plants by contributing to nutrient availability for algal growth followed by decreased water clarity and ultimately limited plant growth.

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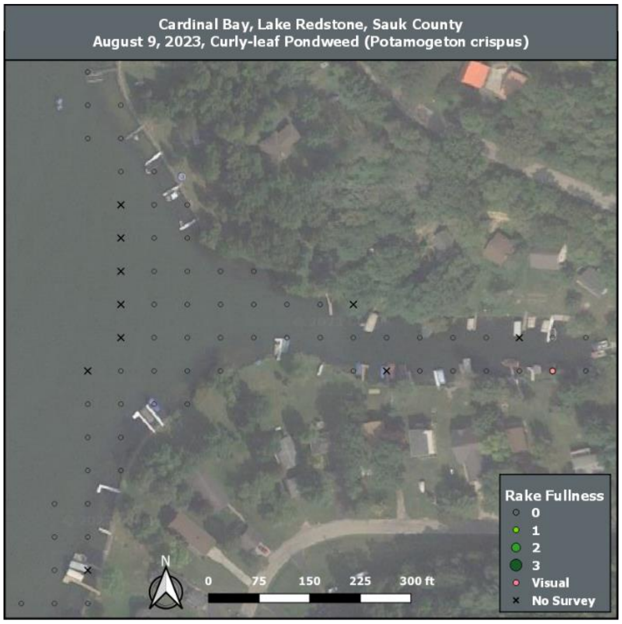
[9] Schaus M. H., M.J. Vanni, & T.E. Wissing. 2002. Biomass-Dependent Diet Shifts in Omnivorous Gizzard Shad: Implications for Growth, Food Web, and Ecosystem Effects. Transactions of the American Fisheries Society 131:40-54.

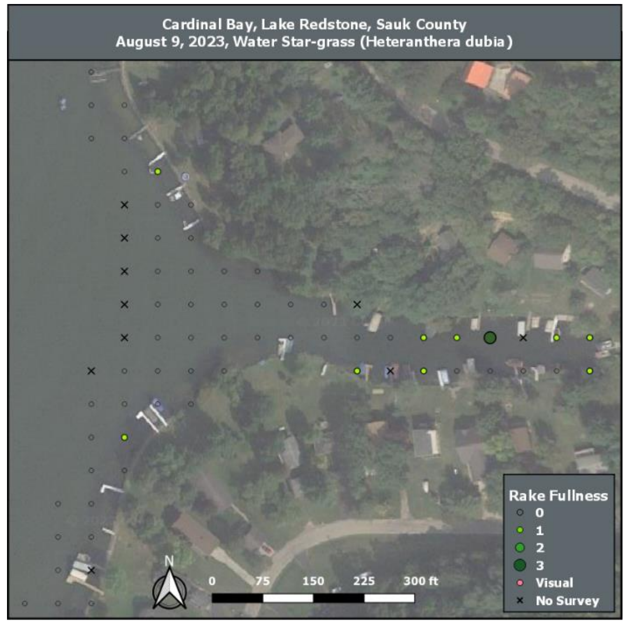
General Management Recommendations

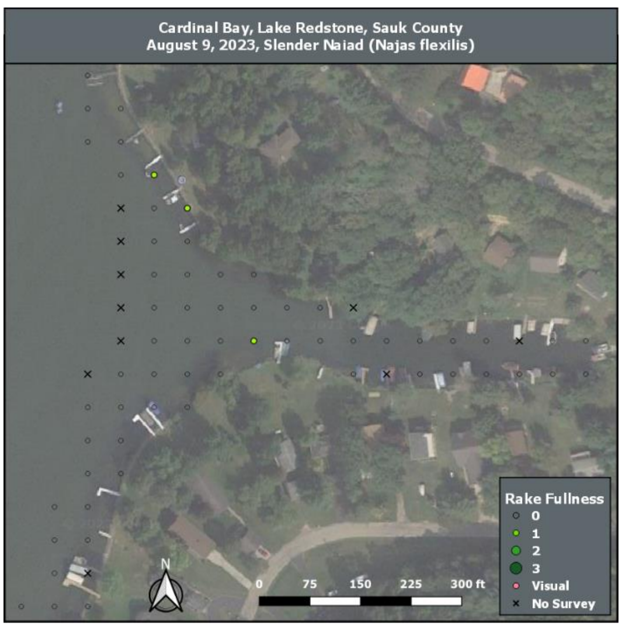
Table 6 General Management Recommendations

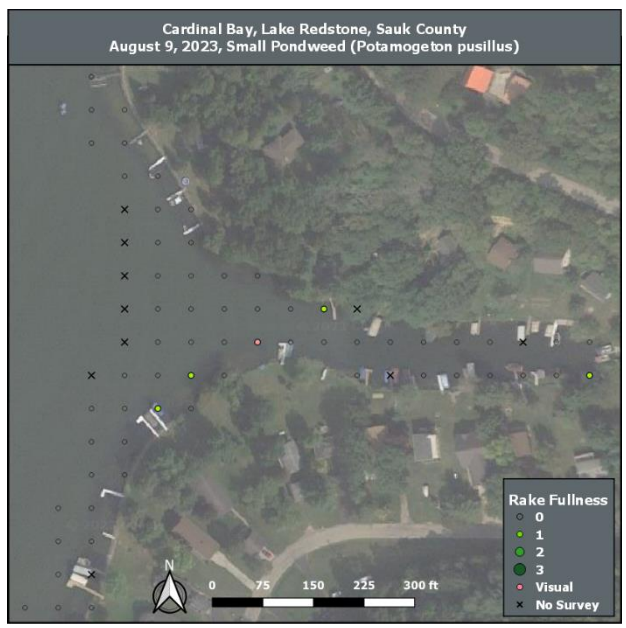
1. **All native aquatic plants should be protected**, especially due to the declining trend in plant occurrence 2014-2022. Hand removal of nuisance aquatic plants, even native plants, is permitted by Chapter NR 109 but the removal cannot occur in a designated sensitive area (identified in the updated APMP and includes Chickadee, Oriole, Mourning Dove, and Swallow Bays) without a permit, is limited to a single area no more than 30 feet wide measured along shore, and must not harm the overall aquatic plant community.
2. **Volunteer water monitoring and early detection of aquatic invasive species** is an important component of lake management. Continued water monitoring and AIS surveying is recommended.
3. **Conduct aquatic plant surveys** of bays in 2024 as needed. Cardinal, Oriole, and Chippewa Bays are recommended due to their relatively high EWM occurrence in 2023.
4. **Utilize herbicide treatment criteria in Table 5** to determine whether herbicide treatment should occur. Based on criteria, Oriole and Cardinal Bays are not recommended while Chippewa Bay could be considered.
5. **Protect overwintering shoreline habitat for weevils** as an additional tool that is no-cost and lasting for controlling EWM. Weevils will not eliminate all EWM but rather help keep its growth “in check.”

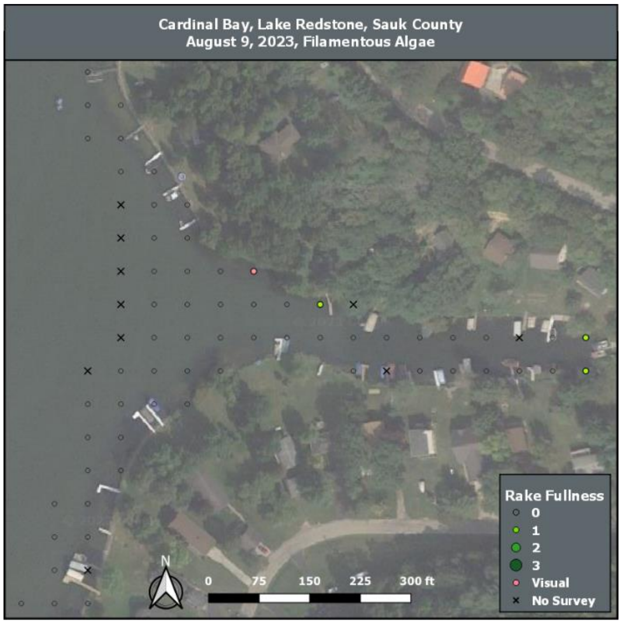
APPENDIX A – CARDINAL BAY MAPS

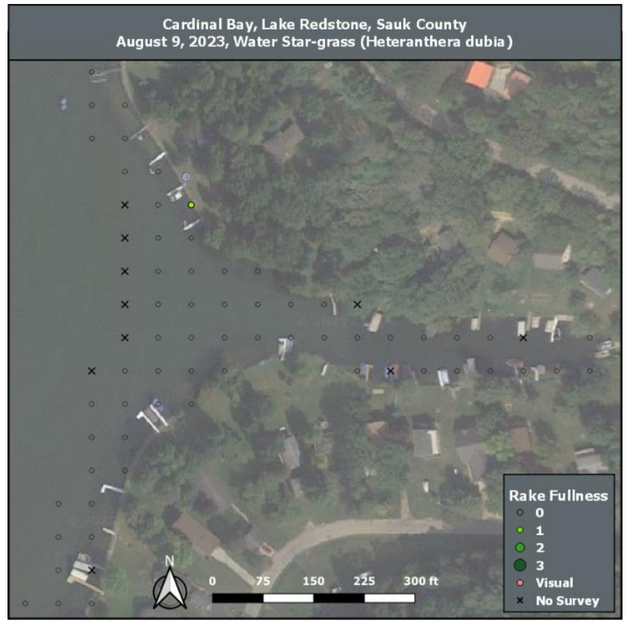


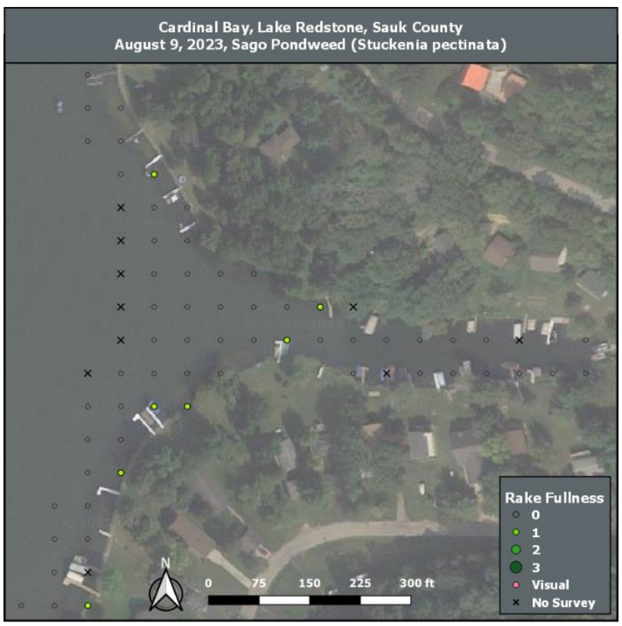


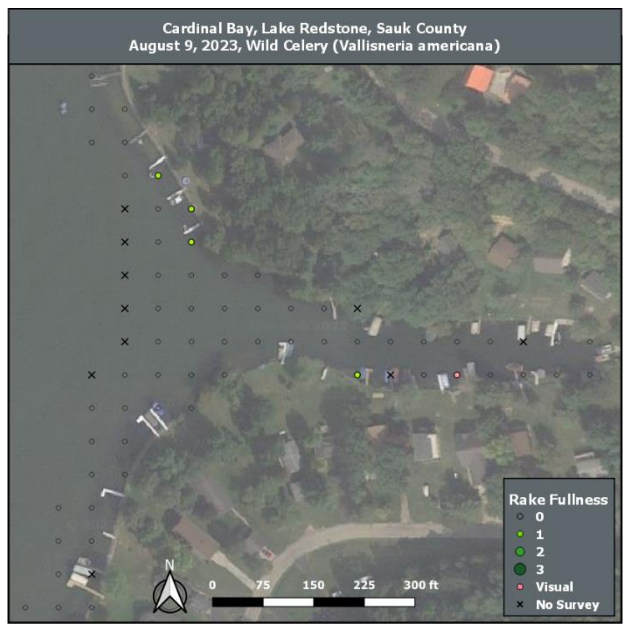




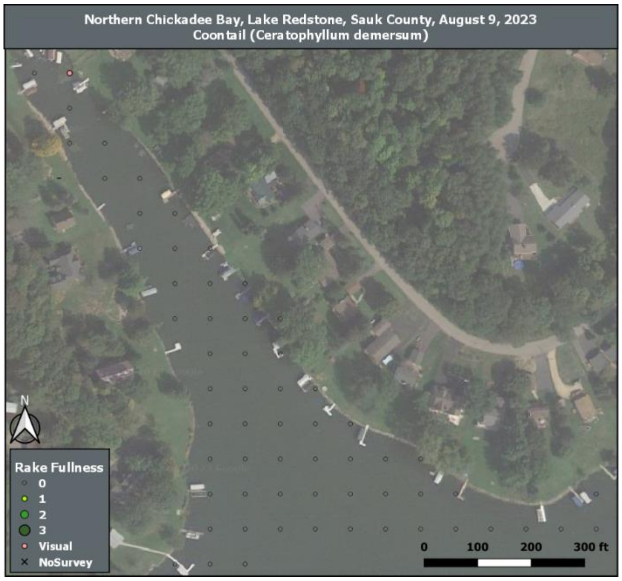

Cardinal Bay, Lake Redstone, Sauk County
August 9, 2023, Filamentous Algae
Rake Fullness
0
1
2
3
Visual
No Survey
N
0 75 150 225 300 ft

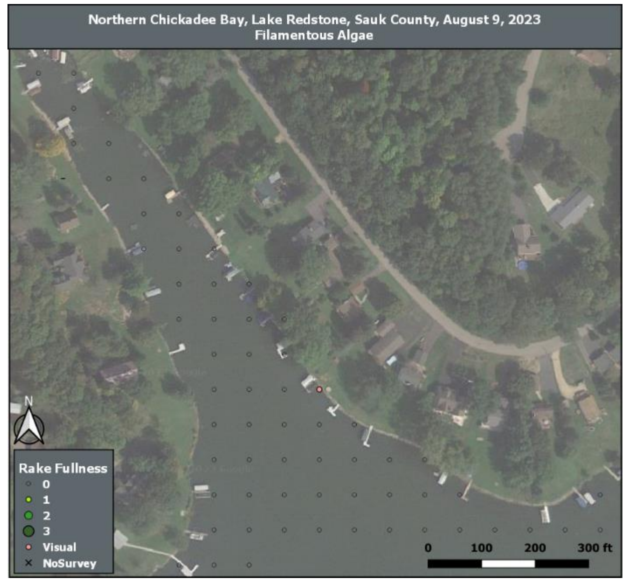

Cardinal Bay, Lake Redstone, Sauk County
August 9, 2023, Water Star-grass (Heteranthera dubia)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0 75 150 225 300 ft

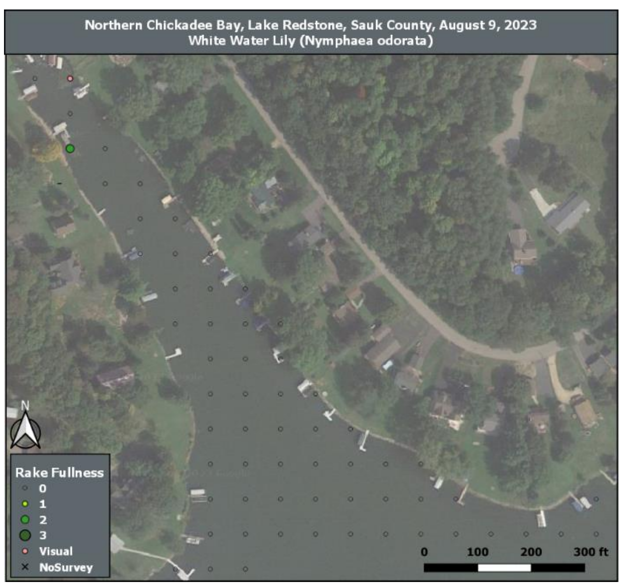

Cardinal Bay, Lake Redstone, Sauk County
August 9, 2023, Sago Pondweed (Stuckenia pectinata)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0 75 150 225 300 ft


Cardinal Bay, Lake Redstone, Sauk County
August 9, 2023, Wild Celery (Vallisneria americana)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0 75 150 225 300 ft

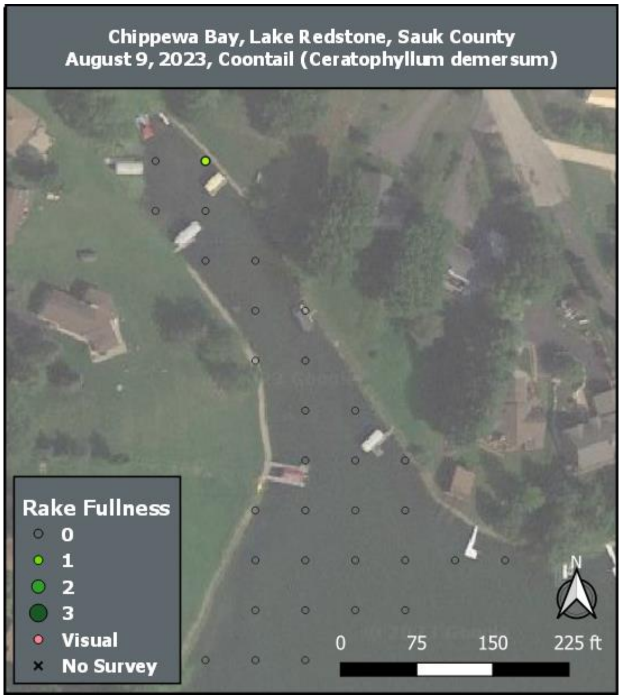
APPENDIX B – NORTH CHICKADEE BAY MAPS

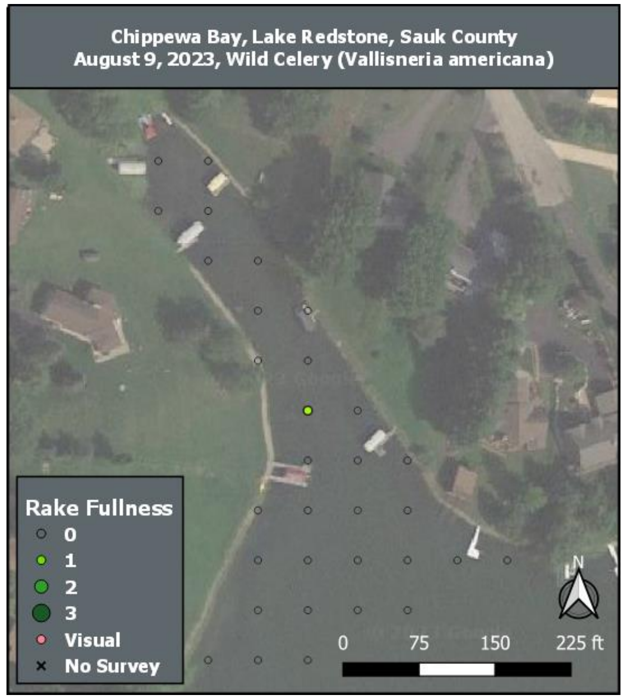


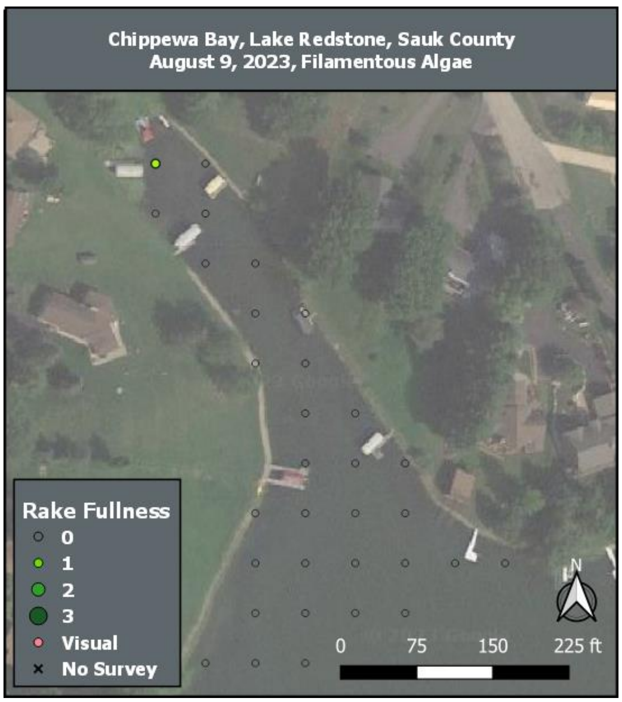


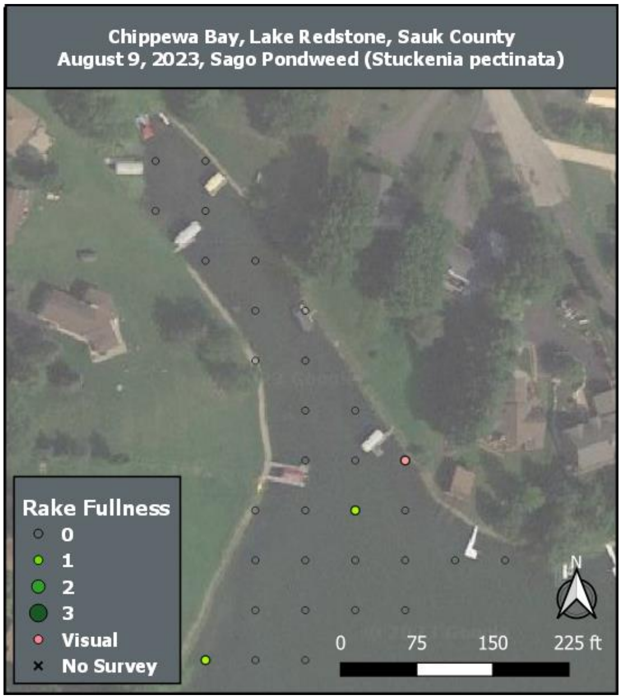


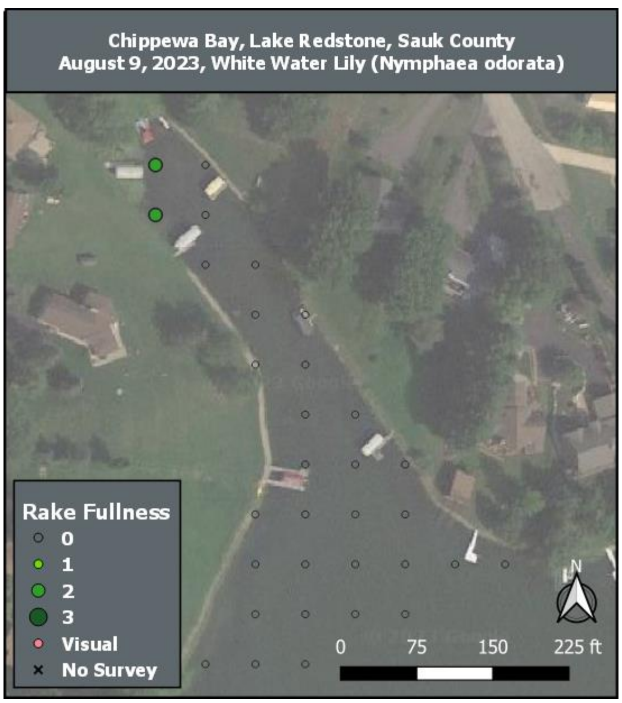
APPENDIX C – CHIPPEWA BAY MAPS



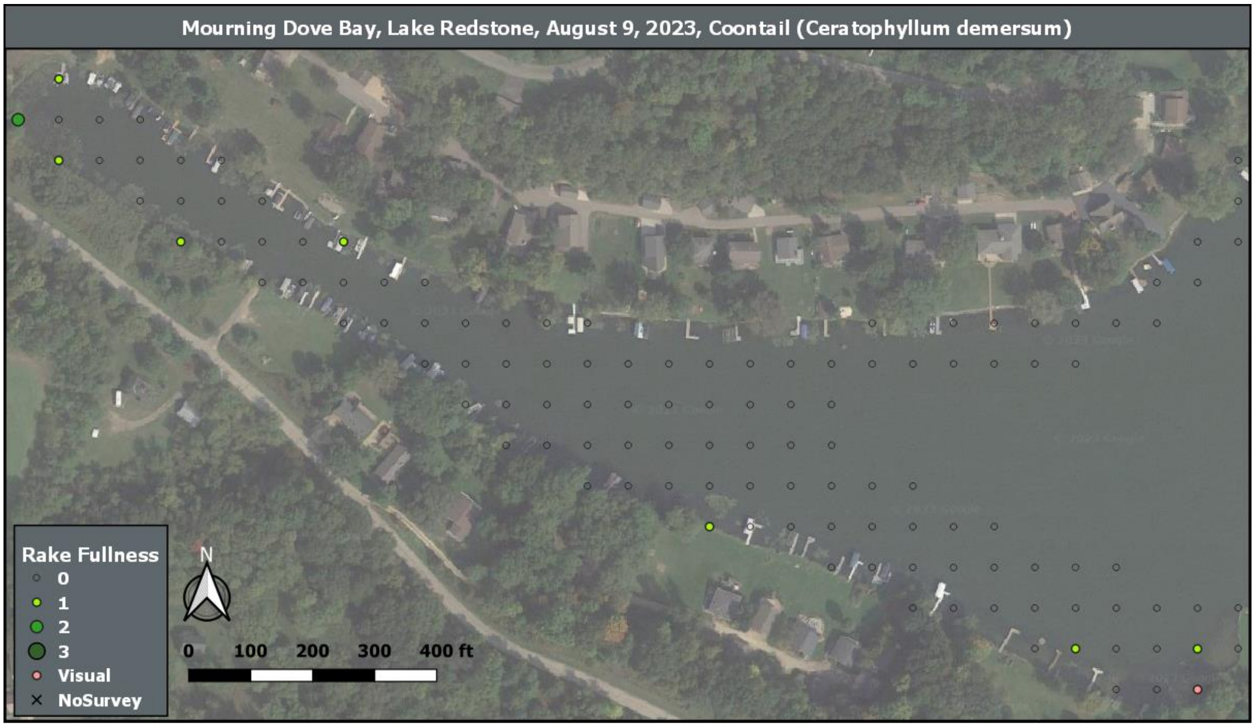


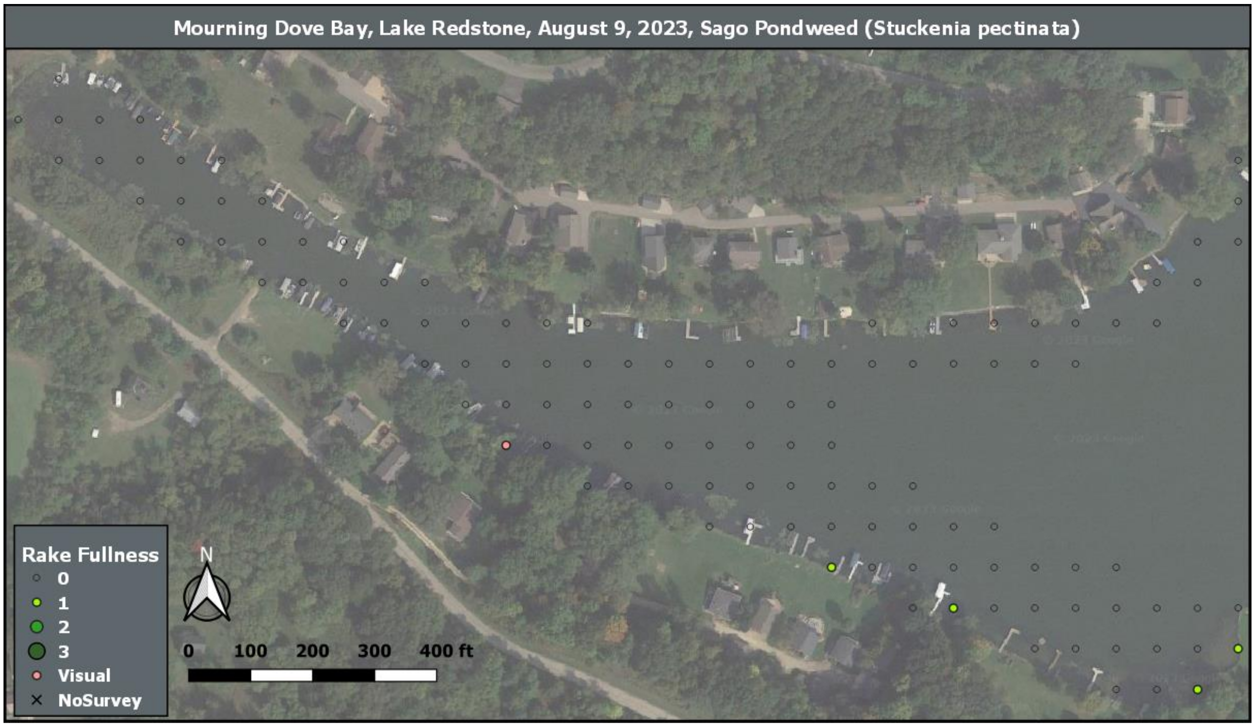


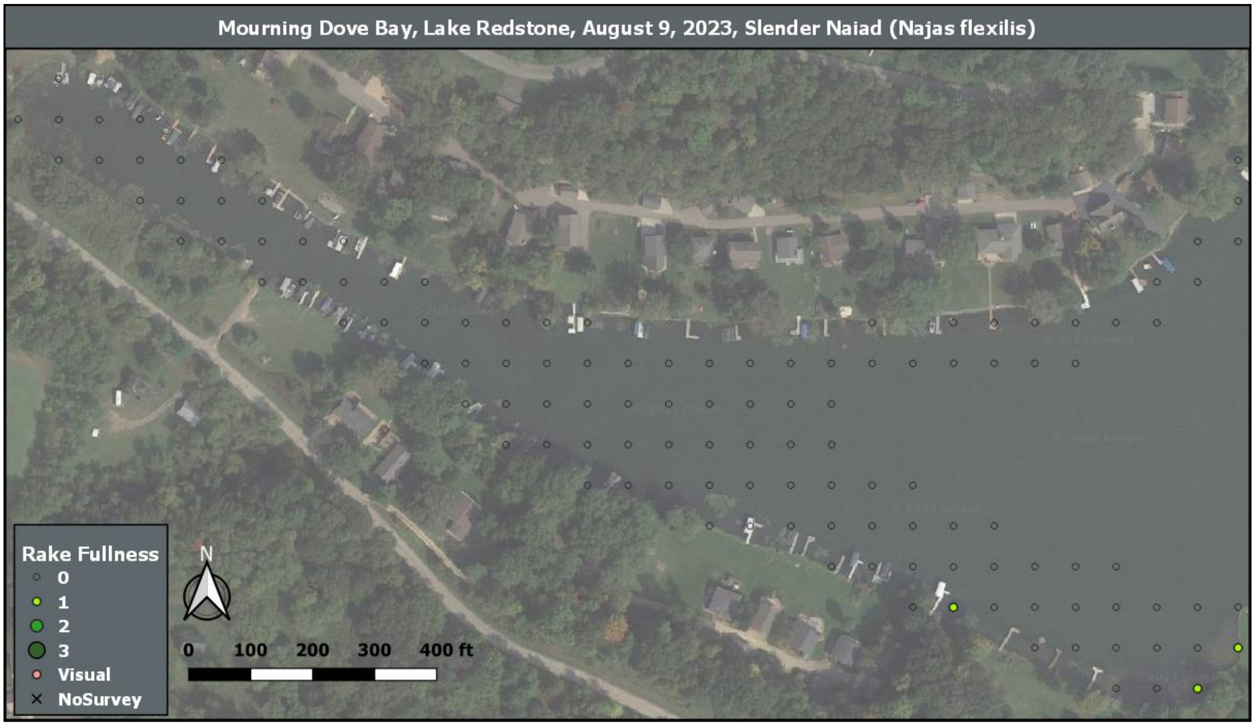

Chippewa Bay, Lake Redstone, Sauk County
August 9, 2023, Sago Pondweed (Stuckenia pectinata)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
75
150
225 ft

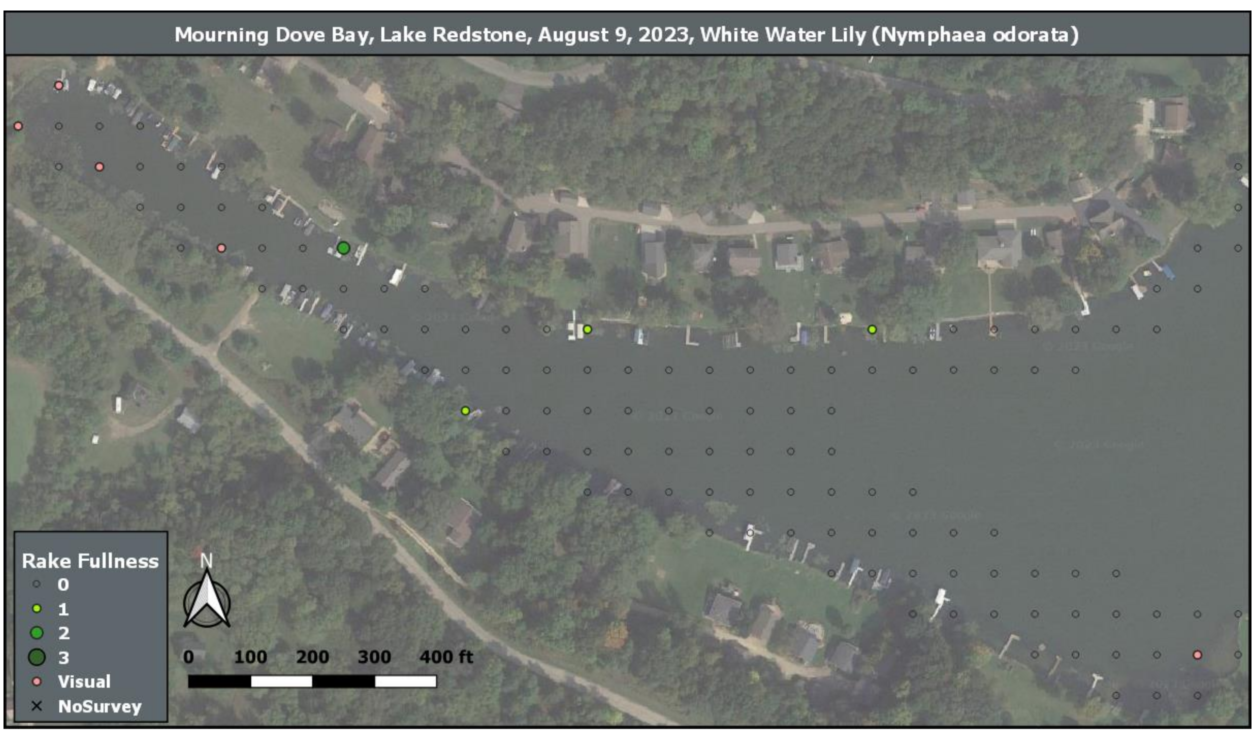

Chippewa Bay, Lake Redstone, Sauk County
August 9, 2023, White Water Lily (Nymphaea odorata)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
75
150
225 ft

APPENDIX D – MOURNING DOVE BAY MAPS

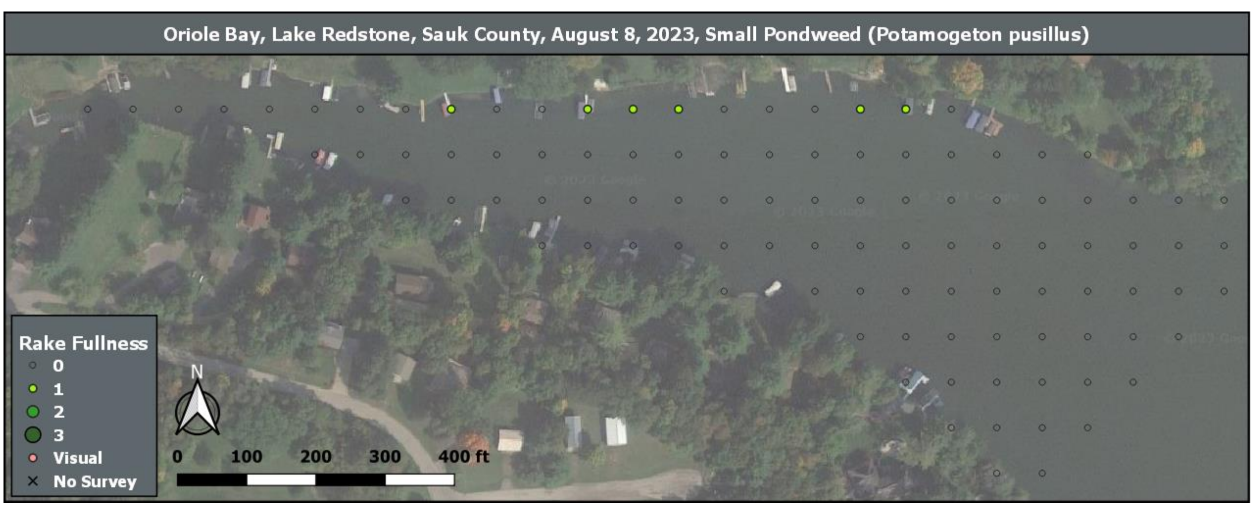





Mourning Dove Bay, Lake Redstone, August 9, 2023, Slender Naiad (Najas flexilis)
Rake Fullness
0
1
2
3
Visual
NoSurvey
N
0 100 200 300 400 ft

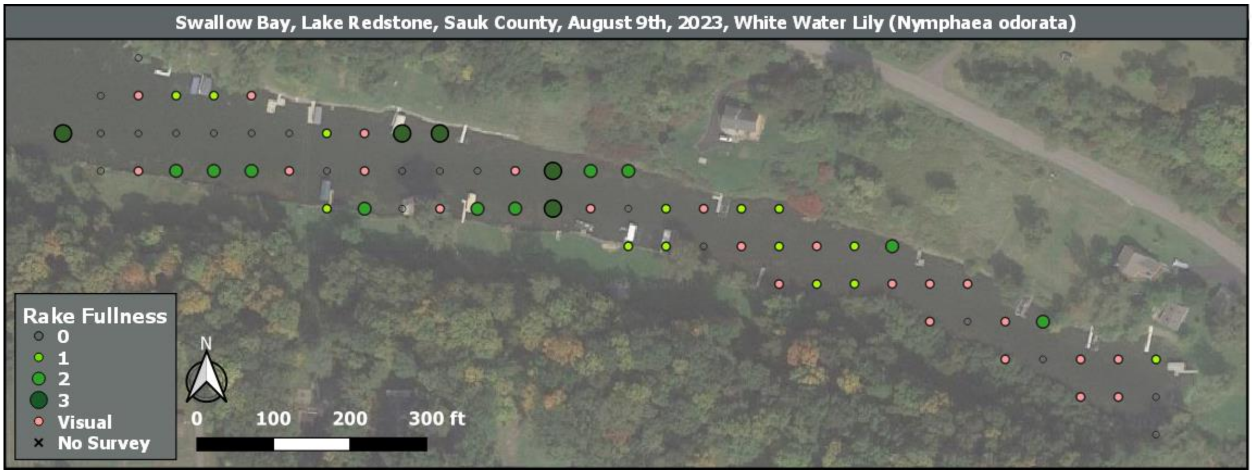

Mourning Dove Bay, Lake Redstone, August 9, 2023, White Water Lily (Nymphaea odorata)
Rake Fullness
0
1
2
3
Visual
NoSurvey
N
0 100 200 300 400 ft

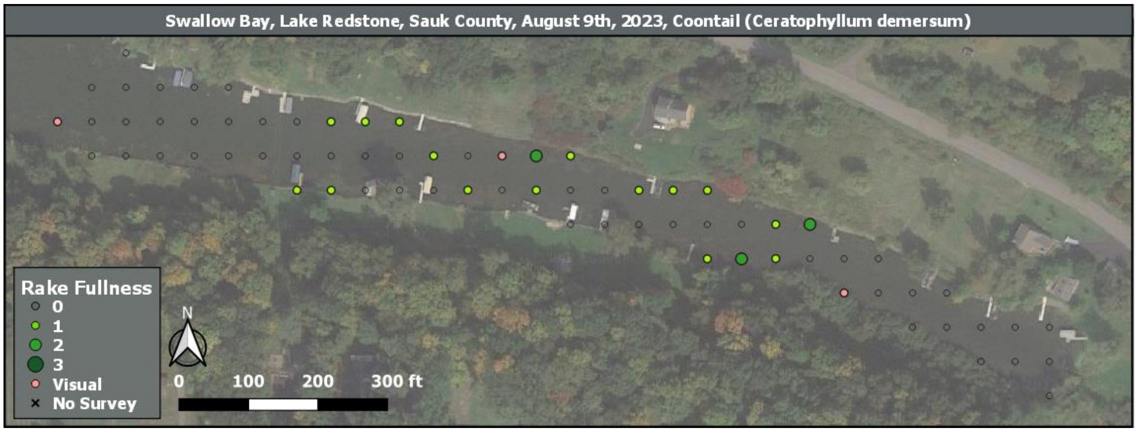
APPENDIX E – ORIOLE BAY MAPS

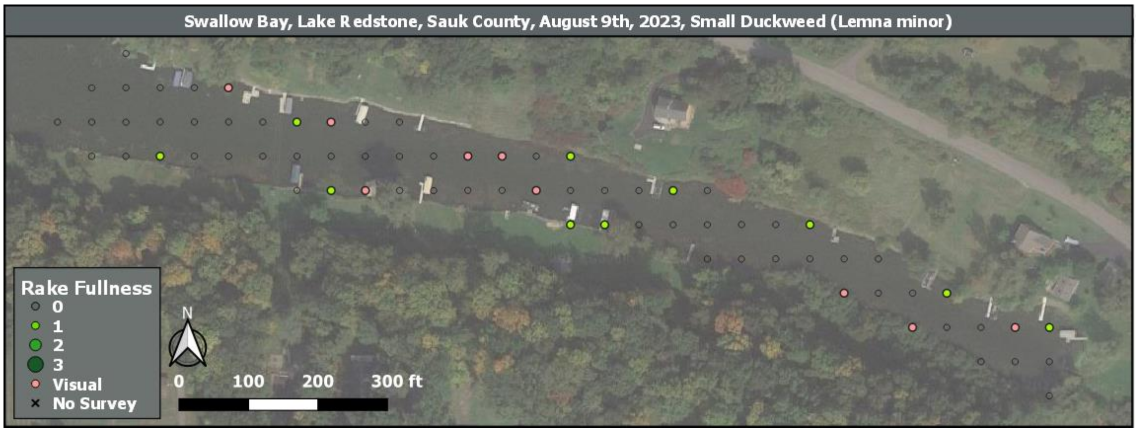



Oriole Bay, Lake Redstone, Sauk County, August 8, 2023, Sago Pondweed (Stuckenia pectinata)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
100
200
300
400 ft

APPENDIX F – SWALLOW BAY MAPS




Swallow Bay, Lake Redstone, Sauk County, August 9th, 2023, Coontail (Ceratophyllum demersum)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
100
200
300 ft

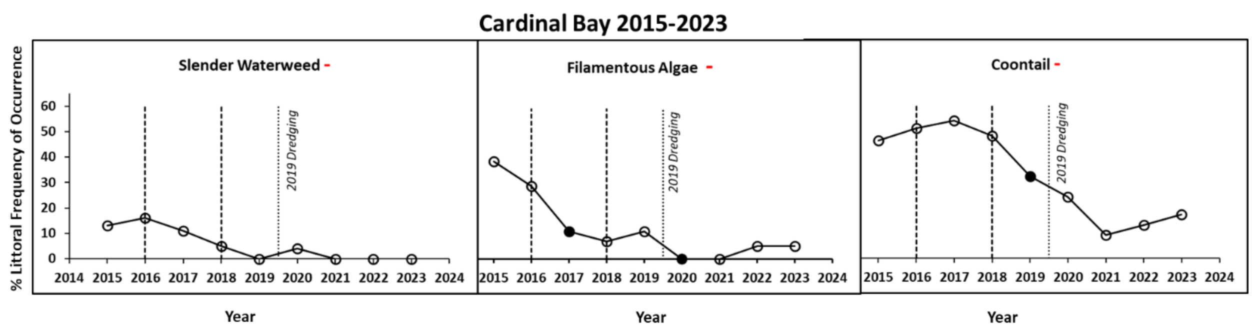

Swallow Bay, Lake Redstone, Sauk County, August 9th, 2023, Small Duckweed (Lemna minor)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
100
200
300 ft

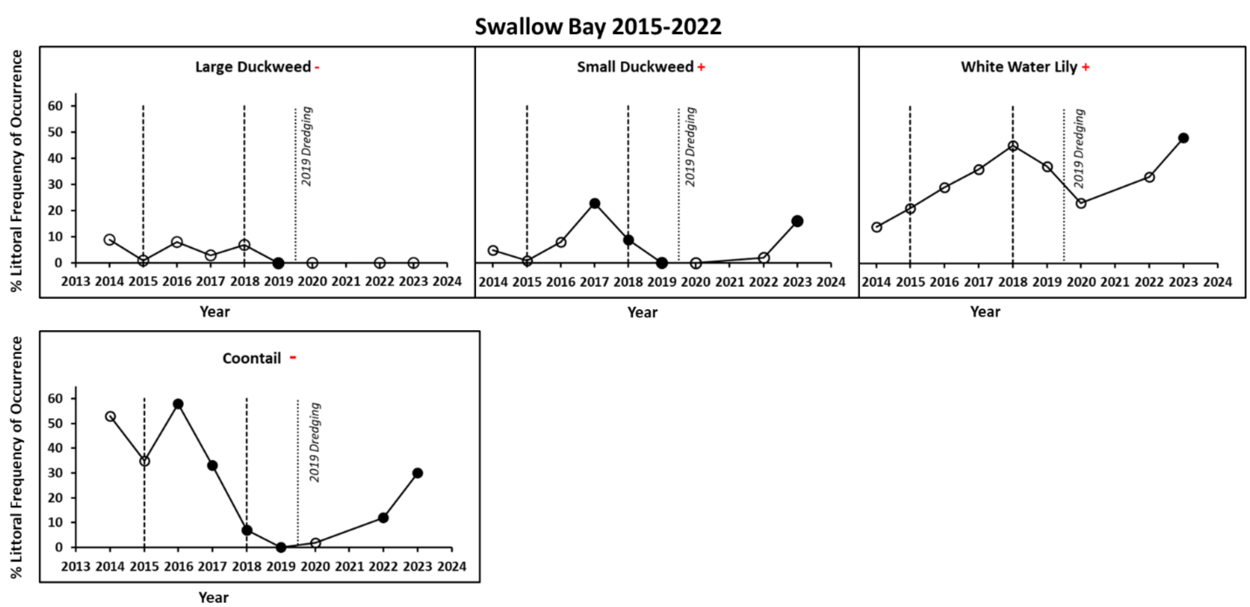

Swallow Bay, Lake Redstone, Sauk County, August 9th, 2023, Slender Waterweed (Elodea nuttallii)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
100
200
300 ft


Swallow Bay, Lake Redstone, Sauk County, August 9th, 2023, Curly-leaf Pondweed (Potamogeton Crispus)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
100
200
300 ft

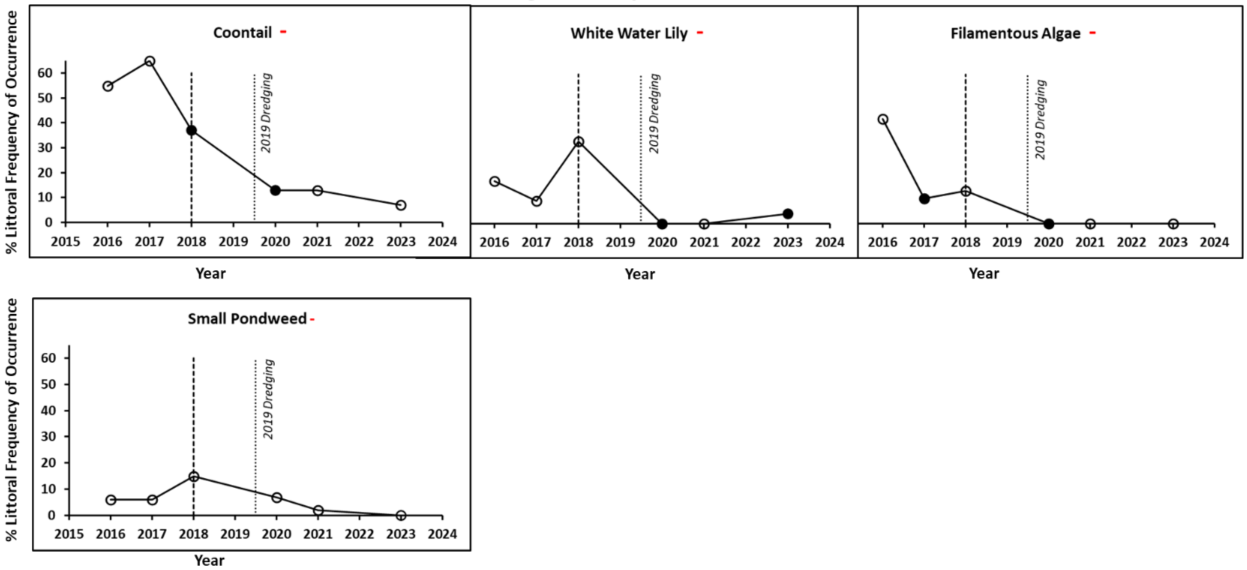
APPENDIX F – CHI-SQUARED TEST GRAPHS

Percent littoral frequency (# sites plants found at points shallower than maximum rooting depth divided by the number of site shallower than max depth of plants) 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) for most recent year vs 2023 or the first year vs 2023 are displayed. The dashed vertical lines represent years when herbicide treatments were done with the exception of the dashed line in 2019 that represents dredging as labeled. Open circles represent ***no*** statistically significant change compared to previous year, solid circles represent a statistically significant change compared to previous year. Statistically significant changes between the first year of surveying and 2023 data are represented by **+** or **–** adjacent to plant names.

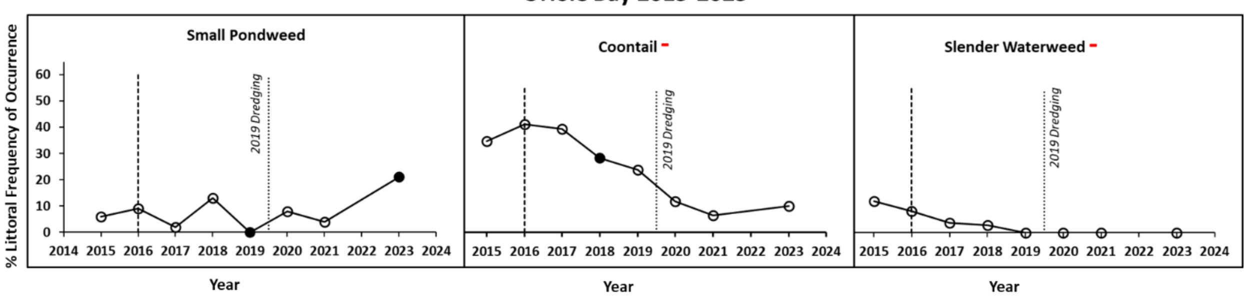




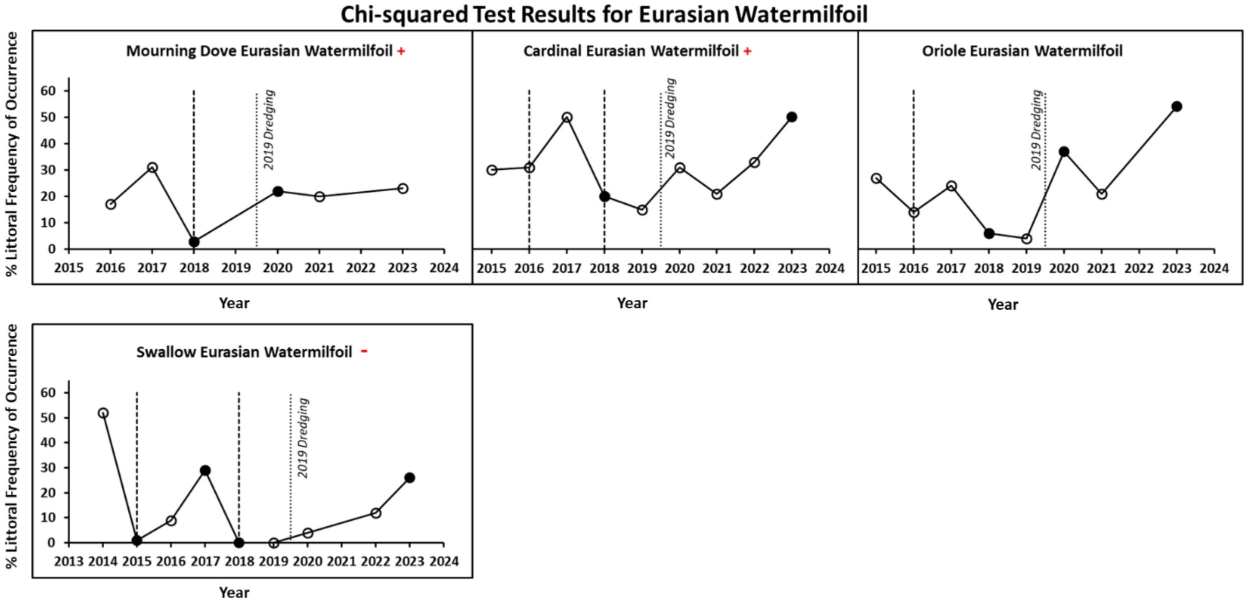
Mourning Dove Bay 2016-2023



Oriole Bay 2015-2023



Chi-squared Test Results for Eurasian Watermilfoil



APPENDIX G – MILFOIL WEEVILS SPREADSHEET OF RESULTS

Weevil analysis and results spreadsheet provided by Amy Thorstenson.

Waterbody: **Redstone Lk, Sauk for Aquatic Plant & Habitat Services, LLC (Sara Hatlili)**
Sample Date: 8/9/2023

Ave. # weevils per stem: **0.31**

Lab Date	Bed No.	Point #	Stem #	Length (in)	Algae/Marl Covered (1=yes, 0=no)	# Broken Tips	# Apical Tips	Weevil Damage? dmg meris. present	pinholes present	tunnels present	pupation chambers present	# Eggs	# Larvae	# Pupae	# Adults	Comments
11/10/23	Eagle Bay	89	1	22	0	2	3	0	0	0	0	0	0	0	0	Dmg meristems and tunnels from Tricoptera larvae. V good look-alikes.
			2	23	0	1	3	1	0	1	0	0	3	0	0	" "
12/3/23	Humming bird Bay	1	1	24	0	0	5	0	0	0	0	0	0	0	0	Lots of trichoptera tunnels! Very good look-alikes
			2	24	0	0	6	0	0	0	0	0	0	0	0	" "
12/3/23		724	1	24	0	1	6	0	0	0	0	0	0	0	0	Lots of caddisfly tunnels! Pen rubbed off. Don't know what bay.
			2	24	0	0	9	0	0	0	0	0	0	0	0	" "
12/3/23	East Bay	347	1	20	0	1	3	0	0	0	0	0	0	0	0	
			2	20	0	0	5	0	0	0	0	0	0	0	0	
12/3/23		10	1	24	0	0	9	1	0	1	0	1	2	0	0	
			2	22	0	0	5	0	0	0	0	0	0	0	0	
12/5/23		305	1	24	0	0	1	0	0	0	0	3	0	0	0	NE shore
			2	24	0	0	5	0	0	0	0	2	0	0	0	" "
12/5/23		11	1	24	0	0	1	0	0	0	0	0	0	0	0	
			2	24	0	0	4	0	0	0	0	0	0	0	0	
12/5/23	Chippewa Bay	8	1	21	1	0	4	0	0	0	0	0	0	0	0	Algae!
			2	22	1	0	2	0	0	0	0	0	0	0	0	" "
12/5/23	Chickadee		1	22	0	0	2	0	0	0	0	0	0	0	0	
			2	24	0	0	4	0	0	0	0	0	0	0	0	
12/5/23	Fox Ct Boat	910	1	21	0	0	3	0	0	0	0	0	0	0	0	Gritty w/ minerals
			2	24	0	0	6	0	0	0	0	0	0	0	0	" "
12/6/23	Mourning Dove	6	1	24	0	0	1	0	0	0	0	0	0	0	0	Some algae, but bad and not filamentous.
			2	24	0	0	1	0	0	0	0	0	0	0	0	" "
12/6/2023	Swallow Bay	6	1	24	0	0	7	0	0	0	0	0	0	0	0	
			2	24	0	0	4	0	0	0	0	0	0	0	0	
12/6/23	Oriole Bay	93	1	24	0	0	2	0	0	0	0	0	0	0	0	Crusty w/ minerals
			2	24	0	0	3	0	0	0	0	0	0	0	0	" "
12/6/23	Arapaho Bay	near 38	1	24	0	0	1	0	0	0	0	0	0	0	0	
			2	24	0	0	3	0	0	0	0	0	0	0	0	
12/6/23	Martin-Meadowlark		1	21	1	0	2	0	0	0	0	0	0	0	0	
			2	18	1	0	4	0	0	0	0	0	0	0	0	
12/6/23		915	1	24	1	2	3	0	0	0	0	0	0	0	0	
			2	24	1	0	1	0	0	0	0	0	0	0	0	
12/6/23	Cty F Boat Landing		1	24	1	1	2	0	0	0	0	0	0	0	0	Thickly covered w/ algae. Gross.
			2	22	1	1	3	0	0	0	0	0	0	0	0	" "
12/6/23	Sec 11 Boat Landing		1	24	0	0	4	0	0	0	0	0	0	0	0	Some algae but tips pretty clear.
			2	20	0	0	2	0	0	0	0	0	0	0	0	" "
		Totals =	36	826	8	9	129	2	0	2	0	6	5	0	0	
		Averages per stem =		22.9	22%	0.250	3.6	6%	0%	6%	0%	0.17	0.14	0.00	0.00	

Total weevils (all life stages) 11

% Of Stems With Weevil Damage (#/total stems) = **6%**

Ave Weevils Per Stem (8/69) = **0.31**

Survey Notes:

WEEVIL PRESENCE CONFIRMED: Milfoil Weevils (*Euhrychiopsis lecontei*)
Whole-lake Average = 0.31 weevils per stem
Statewide ave = 0.65 weevils per stem.
Biocontrol has been documented as low as 0.25 weevils per stem, but densities closer to 1.0 weevils per stem seems necessary for some lakes.
This population in Redstone appears to be very **localized** (pt 89, pt 10, pt 305). This seems pretty typical with low-density populations.