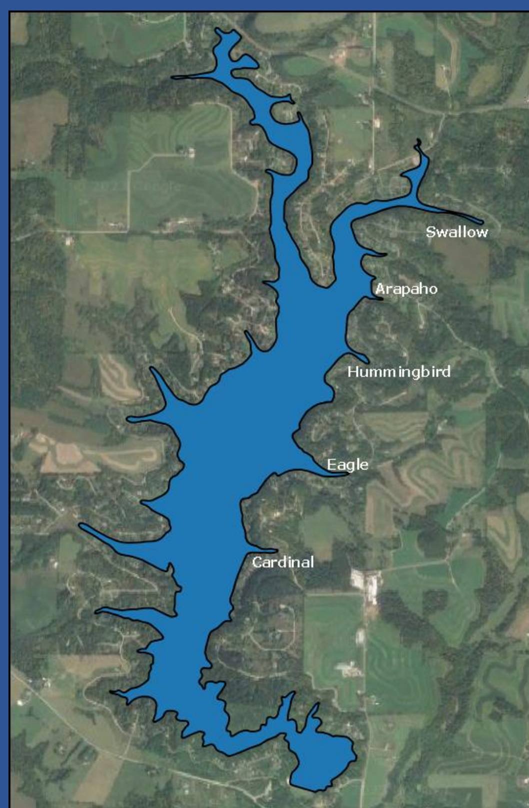
2022

Aquatic Plant Survey Report Lake Redstone Bays

Sauk County, Wisconsin

Arapaho, Cardinal, Eagle, Hummingbird, & Swallow



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ABSTRACT

Aquatic plant surveys of five bays in Lake Redstone, Sauk County Wisconsin, were completed in 2022 as an ongoing effort to gauge Eurasian watermilfoil (*Myriophyllum spicatum,* EWM) occurrence where control activities may be needed. Arapaho, Cardinal, Hummingbird, Eagle, and Swallow Bays were surveyed August 11th, 2022. 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 in 2019, 2020, 2021, nor 2022 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 2022. EWM increased in 2022 compared to the previous survey in all bays except Arapaho Bay, but the increases were not statistically significant. Littoral frequency of plants overall (combined native and non-native) was slightly higher in Cardinal, Eagle, Hummingbird, and Swallow but lower in Arapaho when compared to the previous survey. Average littoral frequencies of all bays surveyed since 2014 suggests aquatic plants are declining overall. When comparing ***native*** plant occurrence in 2022 to the previous survey, there was one instance of a statistically significant (SS) increase. When comparing ***native*** plant occurrence in 2022 to the ***first*** survey to data collected, there were 7 instances of SS declines in native species. These data suggest the littoral frequency of native aquatic plants is on a downward trend since 2014. Bay-wide surveys of ***all bays*** since 2014 (not just those surveyed in 2022) suggests EWM fluctuates each year with no obvious trend at this time.

Management Recommendations are as follows; 1) Protect native aquatic plants. 2) Control nuisance native vegetation with hand-pulling or raking, where permitted. 3) Continue water quality & AIS monitoring. 4) Conduct aquatic plant surveys of bays in 2023 as needed for management of EWM. Cardinal Bay is recommended for survey in 2023.

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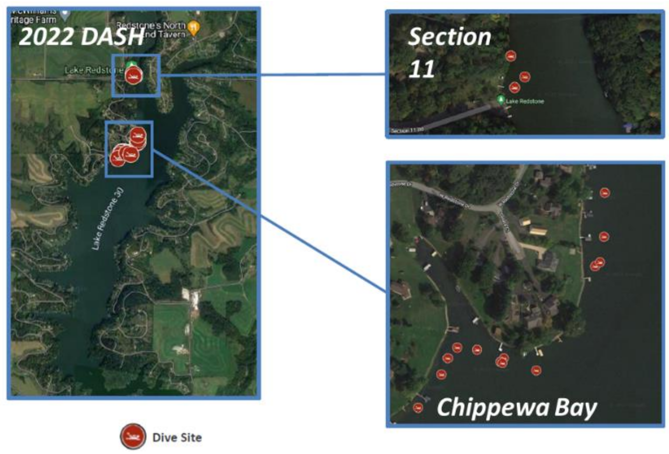
INTRODUCTION

Recent Management History

The Lake Redstone Protection District (LRPD) partnered with Aquatic Plant and Habitat Services to complete aquatic plant surveys of 5 bays in 2022 to continue statistical tracking of EWM occurrence where control activities may be needed. A whole-lake survey of aquatic plants was also completed in 2022, the results of which are presented in an updated Aquatic Plant Management Plan for Lake Redstone. 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 manual removal in the near future. No herbicide treatment occurred in any bays in 2019, 2020, 2021, or 2022.

Figure 1 – DASH Locations 2022

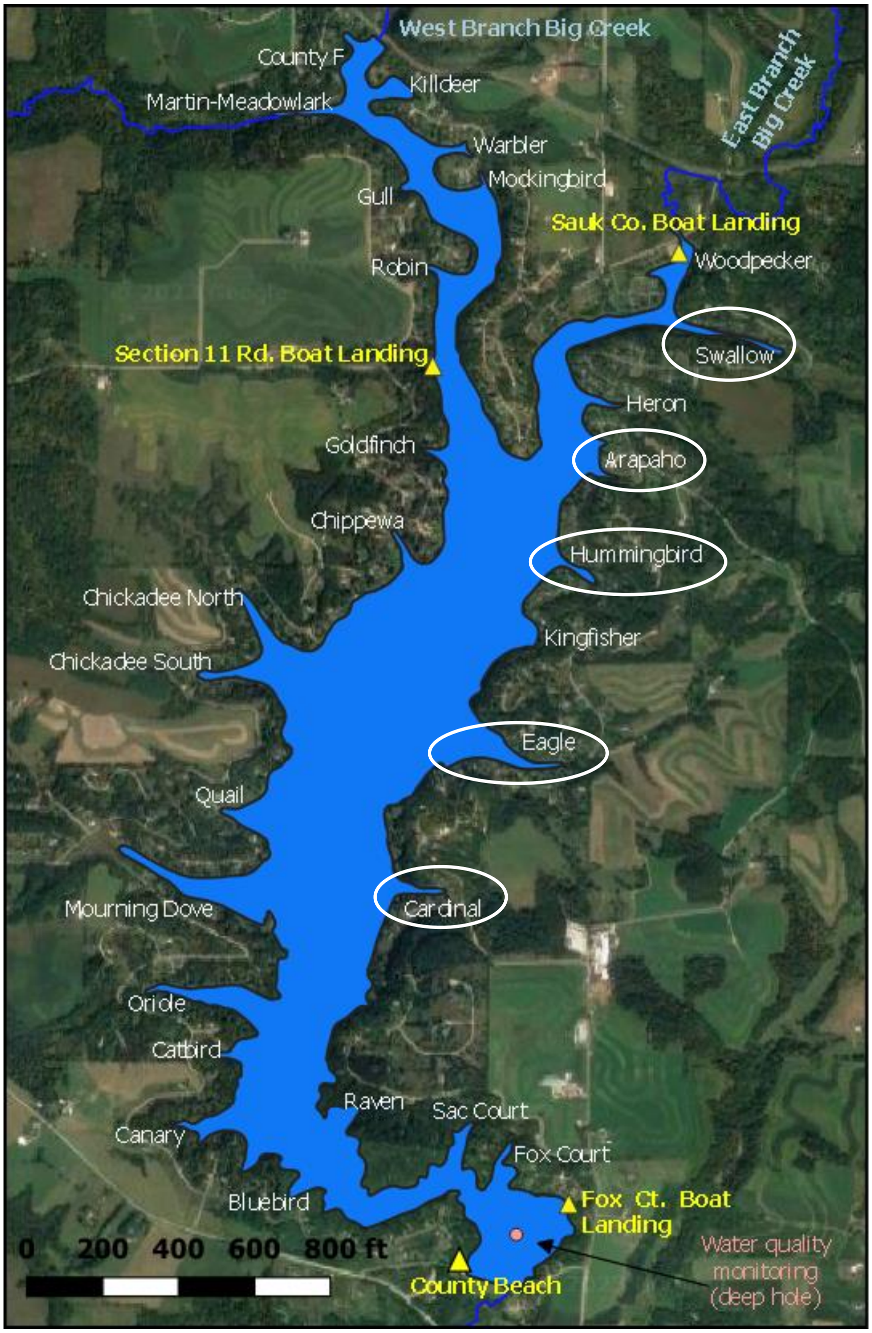


Study Site

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 creating in the 1960's with the intent of created >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 2 indicate those surveyed in 2022.

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

Figure 2 – 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 5 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 3 – Rake Fullness Illustration

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

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 11th, 2022. All plant survey dates completed by APHS LLC are in List 1. Point-intercept maps were previously generated for Arapaho (55 pts), Cardinal (71 pts), Eagle (115 pts), Hummingbird (65 pts), and Swallow (72 pts) resulting in 378 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), with the exception of Cardinal Bay in 2021 (see Cardinal EWM). The average maximum rooting depth is 5.5 feet among all years of all bays that were surveyed since 2014. 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 3). 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 2014-22

- 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

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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, ***<u>these statistics should not be used to compare to other lakes where a whole-lake survey has been done</u>***. 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 ***<u>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</u>***.

Individual Species Statistics

Individual species statistics assess the plant species composition in the 5 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 2021 to 2022. The tests also compared differences from the first year of the bay being surveyed to 2022.

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%.

[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 5 bays are summarized in Tables 3 through 5. Table 3 lists individual species found in each bay in 2022 and corresponding statistics for each species. Table 4 & Table 5 list summary plant statistics for each bay in 2022 and previous years. Results are further described later in this section.

Table 3 - Plant Species Results, 2022 Bays

Bay Name	Common Name	Scientific Name	Frequency of Occurrence at Veg. Sites (%)	Littoral Frequency (%)	Relative Frequency (%)	# Sites	Average Rake Fullness	# Visual
Arapaho	Eurasian watermilfoil	*Myriophyllum spicatum*	75.00	19.35	50.00	6	1.17	7
	Small pondweed	*Potamogeton pusillus*	25.00	6.45	16.67	2	1.00	1
	Sago pondweed	*Stuckenia pectinata*	25.00	6.45	16.67	2	1.00	1
	Slender naiad	*Najas flexilis*	12.50	3.23	8.33	1	1.00	0
	White water lily	*Nymphaea odorata*	12.50	3.23	8.33	1	2.00	6
	Filamentous algae		12.50	3.23	-	1	1.00	1
	Curly-leaf pondweed	*Potamogeton crispus*	-	-	-	-	-	1
	Arrowhead	*Sagittaria sp.*	-	-	-	-	-	1
Cardinal	Eurasian watermilfoil	*Myriophyllum spicatum*	59.09	33.33	40.63	13	1.08	10
	Coontail	*Ceratophyllum demersum*	22.73	12.82	15.63	5	1.00	1
	Slender naiad	*Najas flexilis*	13.64	7.69	9.38	3	1.00	2
	Sago pondweed	*Stuckenia pectinata*	13.64	7.69	9.38	3	1.00	0
	Wild celery	*Vallisneria americana*	13.64	7.69	9.38	3	1.00	2
	Small pondweed	*Potamogeton pusillus*	18.18	10.26	12.50	4	1.00	0
	Filamentous algae		9.09	5.13	-	2	1.00	2
	Curly-leaf pondweed	*Potamogeton crispus*	4.55	2.56	3.13	1	3.00	0
	Water star-grass	*Heteranthera dubia*	-	-	-	-	-	1
	Small duckweed	*Lemna minor*	-	-	-	-	-	1
Eagle	Eurasian watermilfoil	*Myriophyllum spicatum*	52.94	21.43	39.13	9	1.22	17
	Small pondweed	*Potamogeton pusillus*	29.41	11.90	21.74	5	1.00	2
	Coontail	*Ceratophyllum demersum*	17.65	7.14	13.04	3	1.00	0
	Wild celery	*Vallisneria americana*	11.76	4.76	8.70	2	1.00	1
	Horned pondweed	*Zanichellia palustris*	11.76	4.76	8.70	2	1.00	0
	Filamentous algae		11.76	4.76	-	2	1.00	1
	White water lily	*Nymphaea odorata*	5.88	2.38	4.35	1	1.00	5
	Sago pondweed	*Stuckenia pectinata*	5.88	2.38	4.35	1	1.00	5
	Water star-grass	*Heteranthera dubia*	-	-	-	-	-	1
Hummingbird	Eurasian watermilfoil	*Myriophyllum spicatum*	70.59	23.53	44.44	12	1.33	7
	Coontail	*Ceratophyllum demersum*	29.41	9.80	18.52	5	1.00	3
	Sago pondweed	*Stuckenia pectinata*	23.53	7.84	14.81	4	1.00	0
	Small pondweed	*Potamogeton pusillus*	17.65	5.88	11.11	3	1.00	1
	Slender waterweed	*Elodea nuttallii*	5.88	1.96	3.70	1	1.00	0
	Slender naiad	*Najas flexilis*	5.88	1.96	3.70	1	1.00	0
	Wild celery	*Vallisneria americana*	5.88	1.96	3.70	1	1.00	1
	Water star-grass	*Heteranthera dubia*	-	-	-	-	-	1
	White water lily	*Nymphaea odorata*	-	-	-	-	-	7
	Floating-leaf pondweed	*Potamogeton natans*	-	-	-	-	-	2
	Filamentous algae		-	-	-	-	-	3
Swallow	White water lily	*Nymphaea odorata*	85.00	32.69	56.67	17	1.47	25
	Eurasian watermilfoil	*Myriophyllum spicatum*	30.00	11.54	20.00	6	1.17	15
	Coontail	*Ceratophyllum demersum*	30.00	11.54	20.00	6	1.50	7
	Filamentous algae		10.00	3.85	-	2	1.00	5
	Small duckweed	*Lemna minor*	5.00	1.92	3.33	1	1.00	21
	Sago pondweed	*Stuckenia pectinata*	-	-	-	-	-	1

Table 4 – Summary Plant Statistics for All Bays 2014 - 2022

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 (%)	6 Average # of species per site: a) Shallower than max. depth	b) Vegetated sites only	c) Native shallower than max. depth	d) Native at veg. sites only	7 Species Richness: a) Total # species on rake at all sites	b) Including visuals	8 Simpson's Diversity Index	Littoral frequency of EWM (%)
Martin-Meadowlark	2014	52	45	4	52	86.5	2.25	2.6	1.81	2.41	7	9	0.8	42
	2015	54	30	3	50	60.0	1.12	1.87	1.12	1.87	7	8	0.75	0
	2016	54	50	4	54	92.6	2.63	2.84	2.41	2.83	8	9	0.83	22
	2017	55	37	3	48	77.1	1.54	2.00	1.31	1.80	6	6	0.79	23
	2018	56	35	3	53	66.0	1.11	1.69	1.04	1.72	7	7	0.72	6
	2019	51	10	3	49	20.4	0.27	1.30	0.22	1.22	3	4	0.62	0
	2020	**54**	**8**	**4**	**33**	**24.2**	**0.33**	**1.38**	**0.33**	**1.38**	**6**	**6**	**0.76**	**0**
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
Woodpecker	2016	83	22	4.5	77	28.6	0.77	2.68	0.68	2.36	7	8	0.82	9
	2017	85	15	4	70	21.4	0.39	1.80	0.29	1.43	4	4	0.68	10
	2018	84	14	3.5	45	31.1	0.62	2.00	0.58	1.86	5	7	0.71	4
	2019	86	10	4	79	12.7	0.14	1.10	0.13	1.11	3	6	0.31	1
	2020	**88**	**1**	**3**	**10**	**10.0**	**0.10**	**1.00**	**0.10**	**1.00**	**1**	**1**	**0.00**	**0**
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**
Eagle	2014	105	16	6.5	55	29.1	0.56	1.94	0.38	1.40	7	7	0.76	15
	2017	100	14	5	40	35.0	0.58	1.64	0.28	1.10	4	7	0.57	30
	2018	98	15	5	42	35.7	0.50	1.40	0.45	1.46	6	8	0.79	5
	2019	94	12	5	36	33.3	0.39	1.17	0.25	1.13	5	7	0.76	14
	2020	**97**	**13**	**5.5**	**46**	**28.3**	**0.43**	**1.62**	**0.28**	**1.63**	**6**	**7**	**0.75**	**17**
	2022	101	17	5.5	42	40.5	0.55	1.35	0.33	1.27	8	9	0.78	21
Killdeer	2017	62	5	3	10	50.0	1.00	2.00	0.60	2.00	4	4	0.72	40
	2019	61	4	4.5	32	12.5	0.16	1.25	0.16	1.25	2	2	0.48	0
	2020	**62**	**2**	**2**	**5**	**40.0**	**0.40**	**1.00**	**0.40**	**1.00**	**1**	**4**	**0.00**	**0**
Quail	2017	75	23	8.5	67	34.3	0.64	1.87	0.42	1.27	5	6	0.67	22
	2019	73	13	5	33	39.4	0.67	1.69	0.42	1.17	6	7	0.74	21
	2020	76	32	6	50	64.0	1.14	1.78	0.66	1.32	6	7	0.70	48
County F	2019	69	4	3.5	12	33.3	0.50	1.50	0.42	1.25	4	5	0.67	0
	2020	**72**	**2**	**2.5**	**6**	**33.3**	**0.33**	**1.00**	**0.33**	**1.00**	**1**	**2**	**0.00**	**0**

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).

Table 5 - Summary Plant Statistics for All Bays 2014 – 2022, Cont.

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 (%)
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
Chickadee (North & South)	2015	119	14	4.5	32	43.8	0.78	1.79	0.44	1.56	6	7	0.69	34
	2019	120	13	5	50	26.0	0.32	1.23	0.12	1.00	4	6	0.61	18
	2020	**119**	**46**	**6.5**	**83**	**55.4**	**0.78**	**1.41**	**0.23**	**1.19**	**5**	**5**	**0.45**	**55**
	2021	119	17	6.5	77	22.1	0.27	1.47	0.12	1.50	6	6	0.64	17
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
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
Hummingbird	2016	59	34	6	59	57.6	0.93	1.62	0.58	1.21	7	9	0.66	36
	2017	63	32	6	63	50.8	0.81	1.59	0.52	1.27	7	8	0.65	29
	2018	60	31	5.5	56	55.4	1.00	1.81	0.75	1.56	8	9	0.78	25
	2019	55	19	5	51	37.3	0.47	1.26	0.24	1.00	4	5	0.60	24
	2020	**55**	**25**	**7**	**55**	**45.5**	**0.64**	**1.40**	**0.24**	**1.08**	**5**	**7**	**0.55**	**40**
	2021	64	22	7	64	34.4	0.59	1.73	0.39	1.39	8	9	0.79	20
	2022	55	17	6	51	33.3	0.53	1.59	0.29	1.25	7	10	0.73	24
Arapaho**	2015	55	17	4	21	81.0	0.95	1.18	0.57	1.20	6	6	0.73	33
	2019	54	13	8	45	28.9	0.49	1.69	0.22	1.43	6	6	0.68	24
	2020	**55**	**10**	**6**	**29**	**34.5**	**0.52**	**1.50**	**0.21**	**2.00**	**5**	**5**	**0.60**	**31**
	2021	55	7	4	11	63.6	0.73	1.14	0.27	1.00	4	5	0.56	45
	2022	55	8	6	31	25.8	0.39	1.50	0.19	2.00	5	7	0.68	19

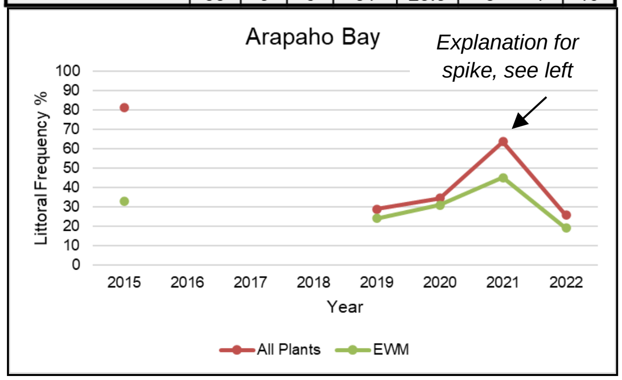
EWM with adventitious roots was found at 12 feet but was likely not rooted at that depth. Furthermore, the next deepest sample point of plant occurrence was 6 feet deep. **Arapaho Bay was also surveyed in 2015, but was labeled "Tanager Bay".* ***Herbicide treatment occurred during the years listed in red text. The results of these herbicide treatment years is considered post-treatment.*

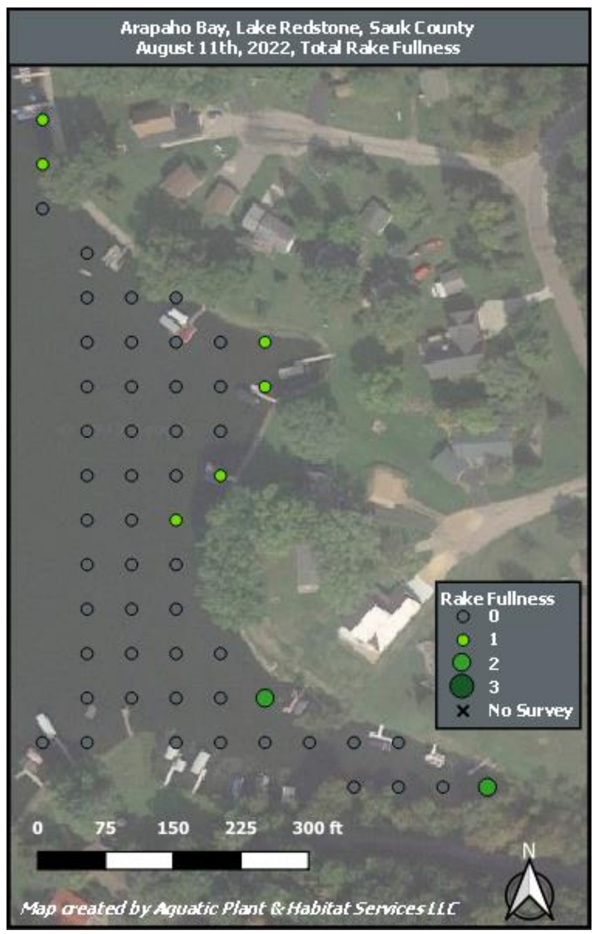
Results in BOLD text with blue shading are post-dredging (dredging occurred after the 2019 surveys).

Arapaho Bay

Bay & Year		1	2	3	4	5	7 Species Richness		
		Total # sites visited	Total # sites w/ vegetation	Max. depth of plants	Total # sites shallower than max. depth of plants	Littoral frequency (%)	a) Total # species on rake at all sites	b) Including visuals	Littoral frequency of EWM (%)
Arapaho	**2015**	55	17	4	21	81.0	6	6	33
	2019	54	13	8	45	28.9	6	6	24
	2020	**55**	**10**	**6**	**29**	**34.5**	**5**	**5**	**31**
	2021	55	7	4	11	63.6	4	5	45
	2022	55	8	6	31	25.8	5	7	19

- Max rooting depth = 6ft
- Total # sites shallower than 6ft = 31
- Total # sites with vegetation = 8
- 8/31 = 25.8% Littoral frequency all plants
- Most common plant was EWM at 6 sites
- 2019 maximum rooting depth of 8 feet occurred with coontail found at one sample point with the next deepest rooting depth of 5 feet. Coontail lacks true roots and therefore can occur "free-floating". Thus, the 8ft max rooting depth is likely an anomaly.
- 2021 spike in littoral frequency was likely due to low max depth of plants (4ft), yielding only 11 sites that were "shallower than the max rooting depth". The number of sites with vegetation (7) was a high numerator compared to a low denominator of 11. 7/11 = high littoral frequency of 63.6%
- Chi-squared tests revealed no statistically significant (SS) changes in the aquatic plant community when comparing 2021 to 2022 but there was a significant decrease in one native species (coontail) when comparing 2015 to 2022 (Appendix F).

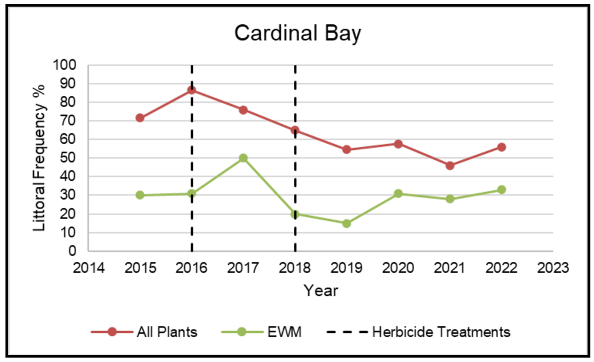


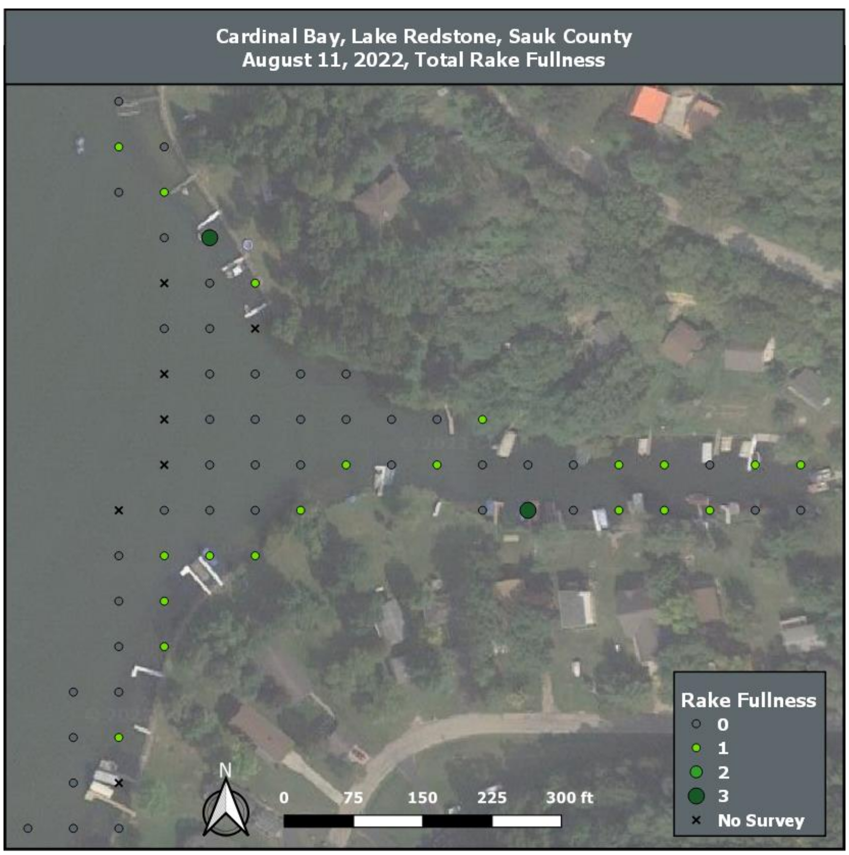


Cardinal Bay

- Max rooting depth = 5.5ft
- Total # sites shallower than 5.5ft = 39
- Total # sites with vegetation = 22
- 22/39 = 56.4% Littoral frequency all plants
- Most common plant was EWM at 13 sites
- Chi-squared tests revealed no statistically significant (SS) changes in the aquatic plant community when comparing 2021 to 2022, and SS decrease in filamentous algae, coontail, and slender waterweed when comparing 2015 to 2022 (Appendix F).

Bay & Year		1	2	3	4	5	7 Species Richness		
		Total # sites visited	Total # sites w/ vegetation	Max. depth of plants	Total # sites shallower than max. depth of plants	Littoral frequency (%)	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

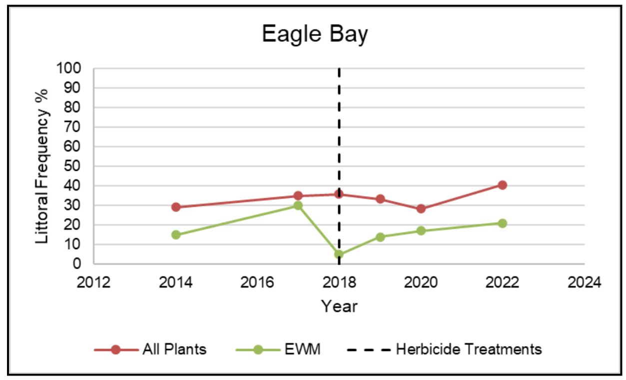


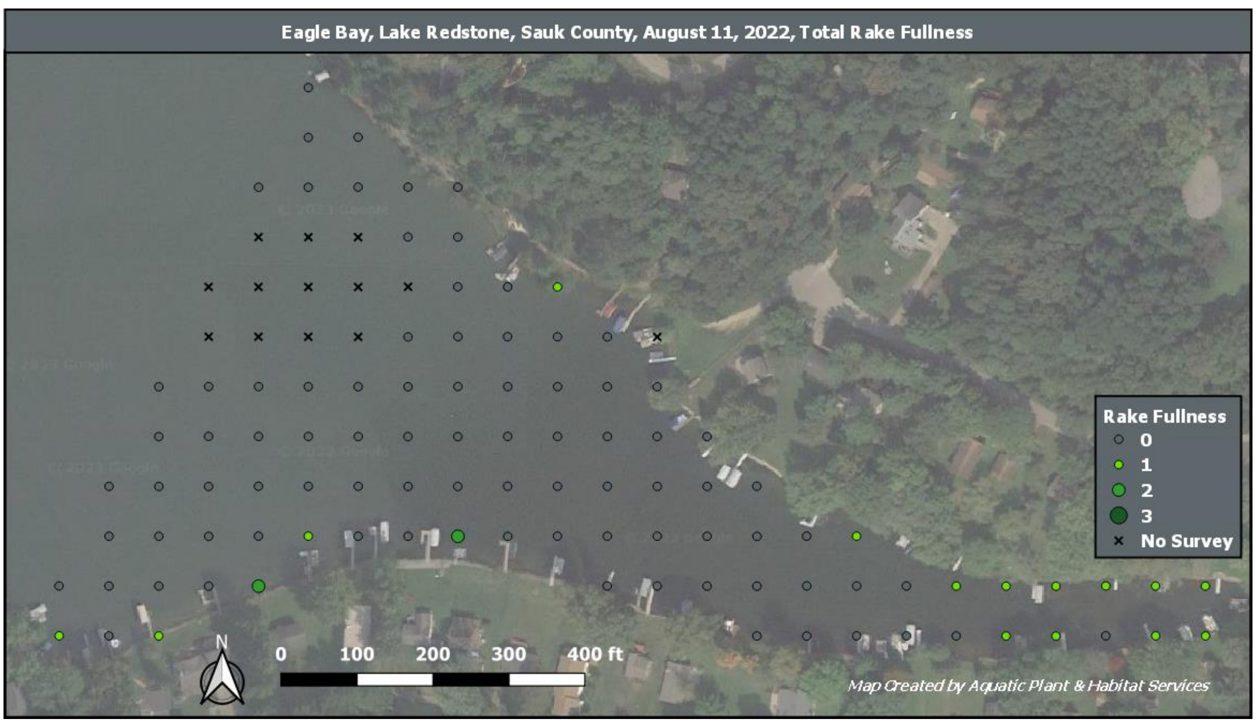


Eagle Bay

- Max rooting depth = 5.5ft
- Total # sites shallower than 5.5ft = 42
- Total # sites with vegetation = 17
- 17/42 = 40.5% Littoral frequency all plants
- Most common plant was EWM at 9 sites
- Chi-squared tests revealed no statistically significant (SS) changes in the aquatic plant community when comparing 2020 to 2022, and SS decrease in coontail when comparing 2014 to 2022 (Appendix F).

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	7 Species Richness b) Including visuals	Littoral frequency of EWM (%)
Eagle	2014	105	16	6.5	55	29.1	7	7	15
	2017	100	14	5	40	35.0	4	7	30
	2018	98	15	5	42	35.7	6	8	5
	2019	94	12	5	36	33.3	5	7	14
	2020	**97**	**13**	**5.5**	**46**	**28.3**	**6**	**7**	**17**
	2022	101	17	5.5	42	40.5	8	9	21

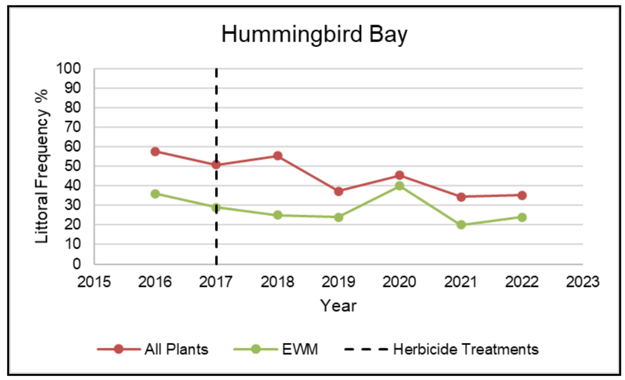




Hummingbird Bay

- Max rooting depth = 6ft
- Total # sites shallower than 6ft = 51
- Total # sites with vegetation = 17
- 18/51 = 35.3% Littoral frequency all plants
- Most common plant was EWM at 12 sites
- Chi-squared tests revealed no statistically significant (SS) changes in the aquatic plant community when comparing 2021 to 2022, and SS decrease in filamentous algae and coontail when comparing 2016 to 2022 (Appendix F).

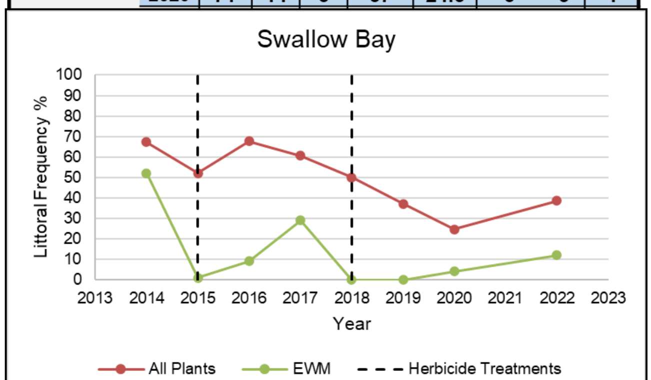
Bay & Year		1 Total # sites visited	2 Total # sites w/ vegetation	3 Max. depth of plants	4 Total # sites shallower than max. depth of plants	5 Littoral frequency (%)	7 Species Richness a) Total # species on rake at all sites	7 Species Richness b) Including visuals	Littoral frequency of EWM (%)
Hummingbird	2016	59	34	6	59	57.6	7	9	36
	2017	63	32	6	63	50.8	7	8	29
	2018	60	31	5.5	56	55.4	8	9	25
	2019	55	19	5	51	37.3	4	5	24
	2020	**55**	**25**	**7**	**55**	**45.5**	**5**	**7**	**40**
	2021	64	22	7	64	34.4	8	9	20
	2022	55	17	6	51	33.3	7	10	24

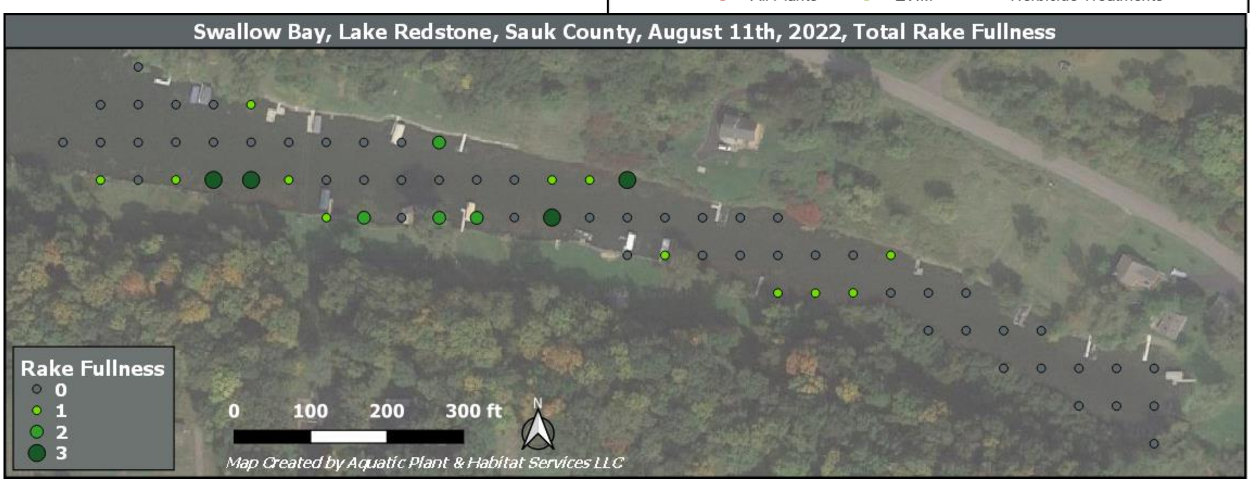


Swallow Bay

- Max rooting depth = 5ft
- Total # sites shallower than 5ft = 52
- Total # sites with vegetation = 20
- 20/52 = 38.5% Littoral frequency all plants
- Most common plant was white water lily at 17 sites
- Chi-squared tests revealed one statistically significant (SS) increase in the coontail when comparing 2020 to 2022, and SS decrease in filamentous algae, coontail, large duckweed, and EWM when comparing 2015 to 2022 (Appendix F)

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**



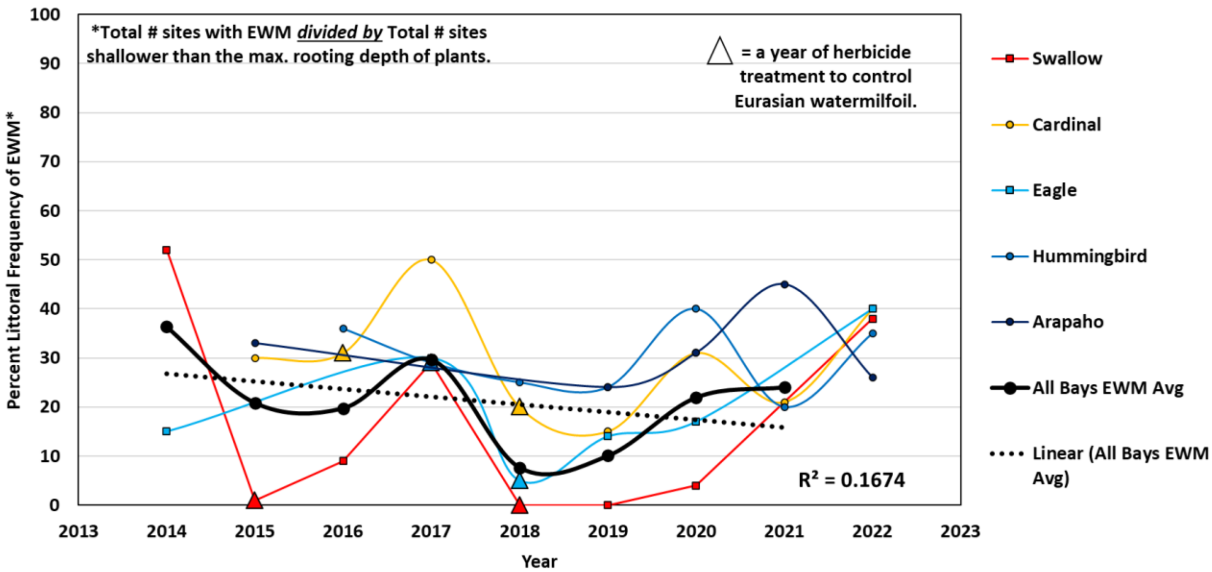


Eurasian Watermilfoil & Management History

Eurasian watermilfoil (EWM) was found in all 5 bays and was the most commonly occurring plant species in 4 bays as well. Figure 4 illustrates EWM littoral frequency in the five bays surveyed in 2022. ***In summary, four bays had increased occurrence of EWM in 2022 compared to 2021, although none of the increases were statistically significant.*** A linear trendline of the average littoral frequency among all bays illustrates a weak R^2 of 0.17, which suggests there is no clear trend on EWM occurrence between 2014 and 2022.

There were no statistically significant changes in EWM when comparing 2022 to the most recent previous survey. When comparing EWM in 2022 to the first survey year for each bay, Swallow Bay was the only location of a statistically significant decrease. There was no herbicide treatment of any bays between 2019 through 2022. Each bay has its own management history and an assessment of EWM in each bay is included in this section.

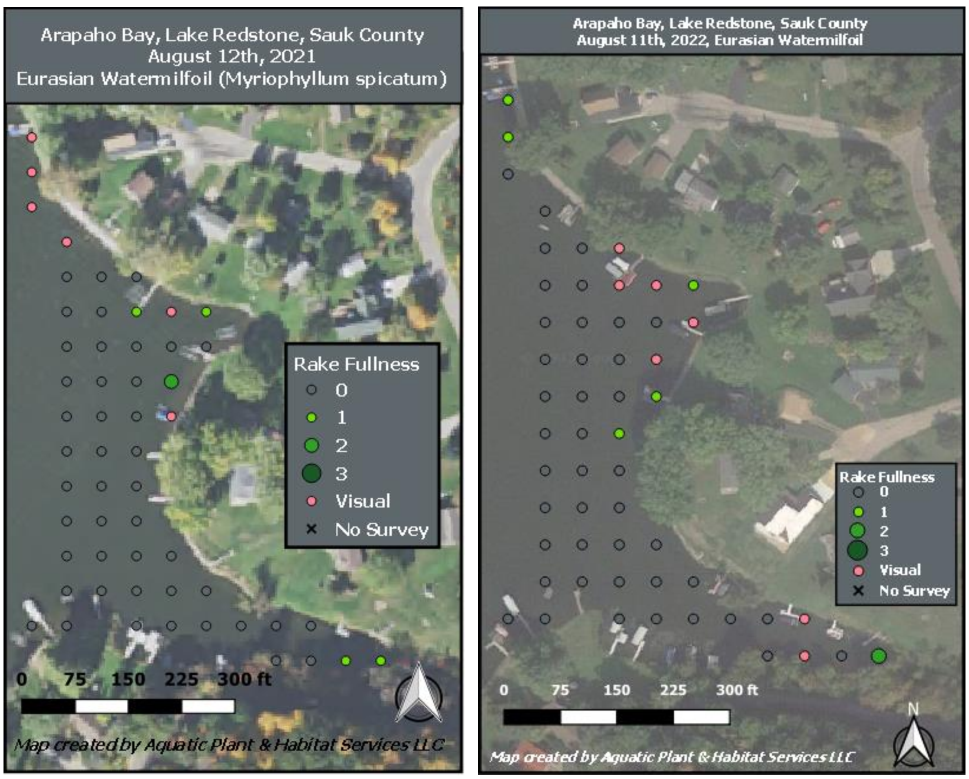
Figure 4 – Eurasian Watermilfoil Littoral Frequency Graph



Arapaho Bay EWM

- EWM most common at 6 sites (another 7 visual)
- No herbicide treatment has occurred in Arapaho Bay
- Manually remove EWM in 2021
- A chi-squared test of EWM revealed no significant change in EWM between 2015 and 2022 nor between 2021 and 2022.

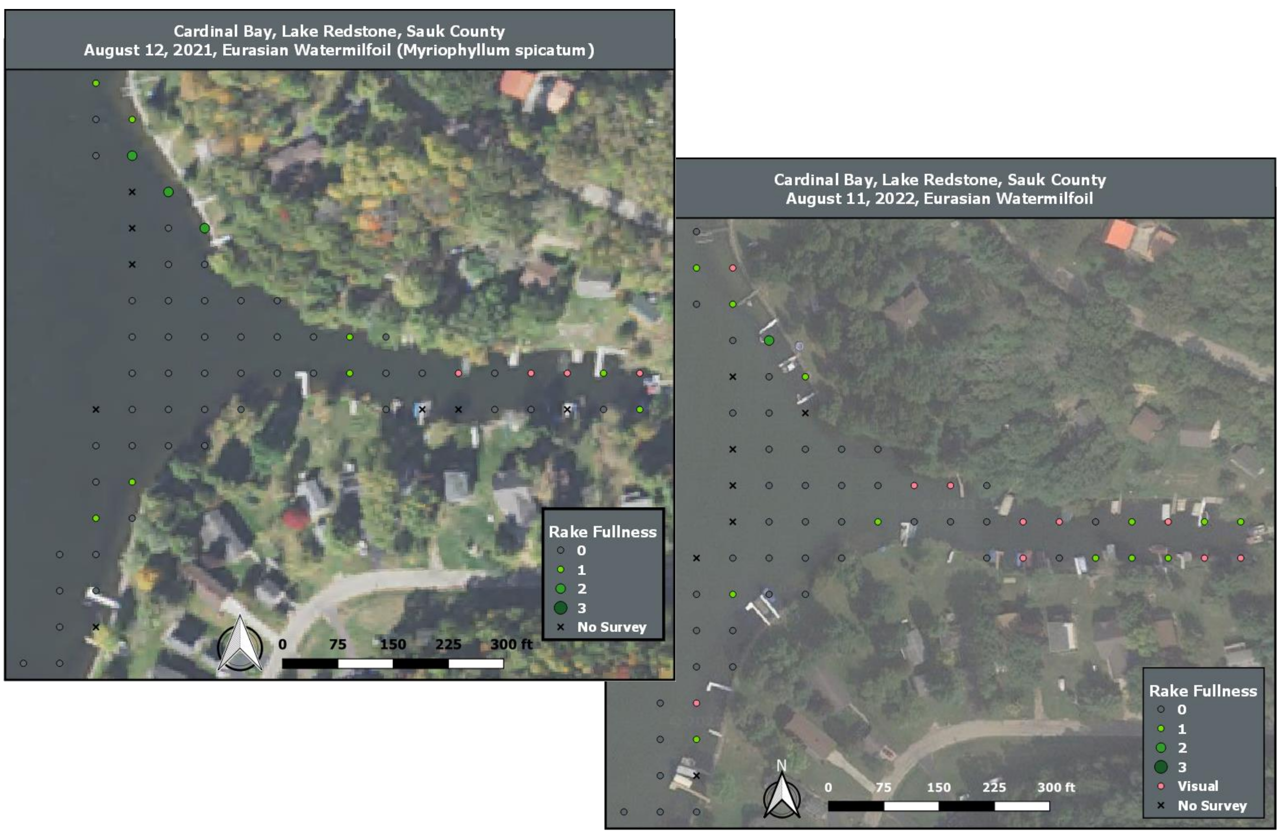
Figure 5 – Arapaho Bay Eurasian Watermilfoil Maps 2022-2023



Cardinal Bay EWM

- EWM was the most common plant with occurrence at 13 sites (another 10 visual).
- Herbicide was applied in Cardinal Bay in 2016 and 2018.
- A chi-squared test of EWM revealed no significant change in EWM between 2015 and 2022 nor between 2021 and 2022.
- EWM was found at a 12-ft deep sample point in 2021, but the EWM was growing adventitious roots and was likely free-floating and not rooted on site.

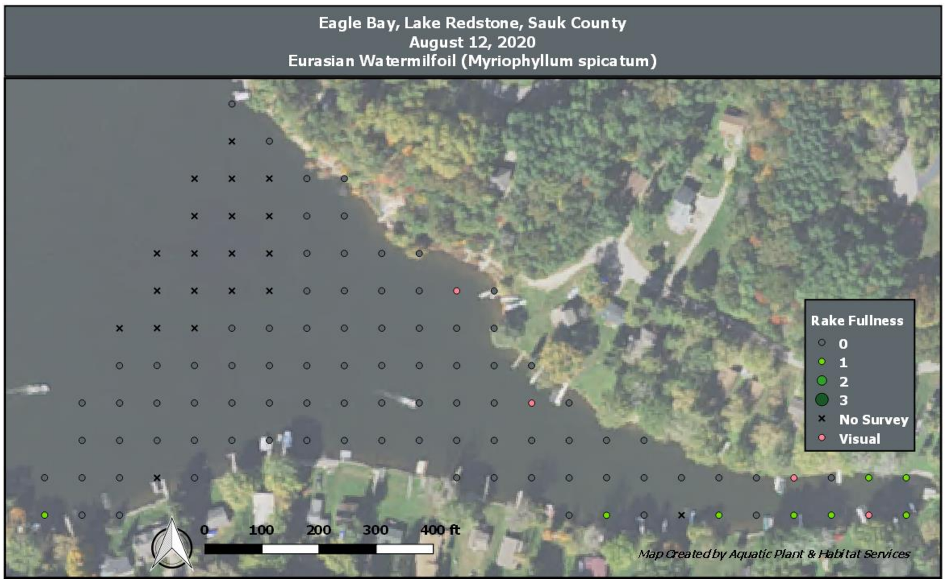
Figure 6 - Cardinal Bay Eurasian Watermilfoil Maps 2021-2022

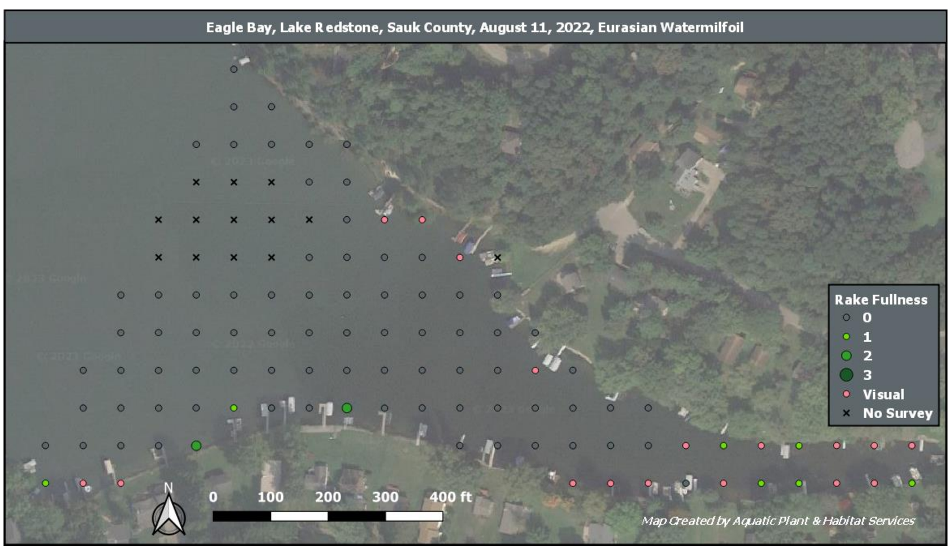


Eagle Bay EWM

- EWM was the most common species at 9 sites (another 17 visual).
- Herbicide treatment was conducted Eagle Bay in 2018.
- A chi-squared test of EWM revealed no significant change in EWM between 2014 and 2022 nor between 2020 and 2022.

Figure 7 – Eagle Bay Eurasian Watermilfoil Maps 2020 &2022

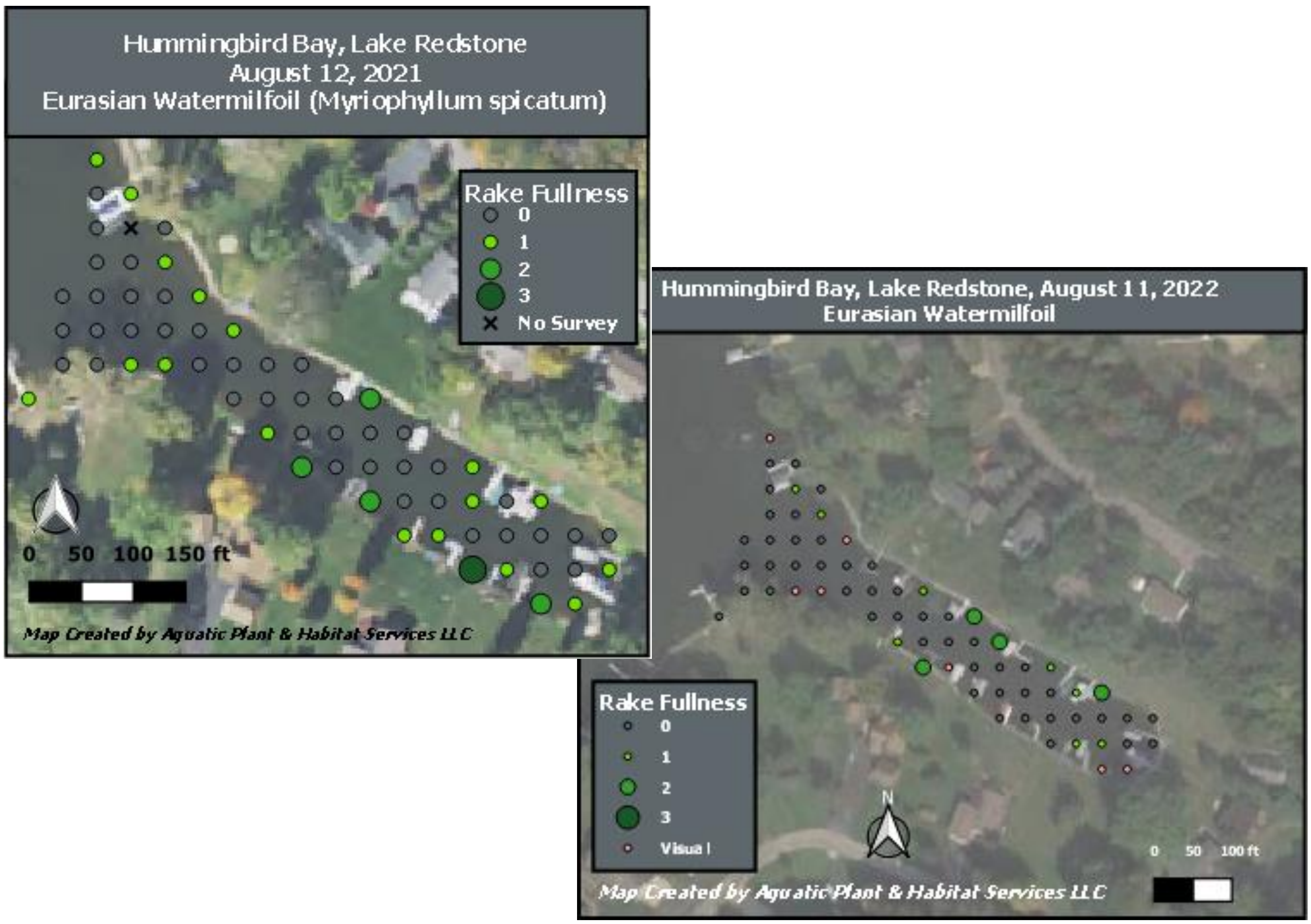




Hummingbird Bay EWM

- EWM was the most common species at 12 survey points (another 7 visual).
- Herbicide treatment was conducted in Hummingbird Bay in spring 2017.
- A chi-squared test of EWM revealed no significant change in EWM between 2016 and 2022 nor between 2021 and 2022.

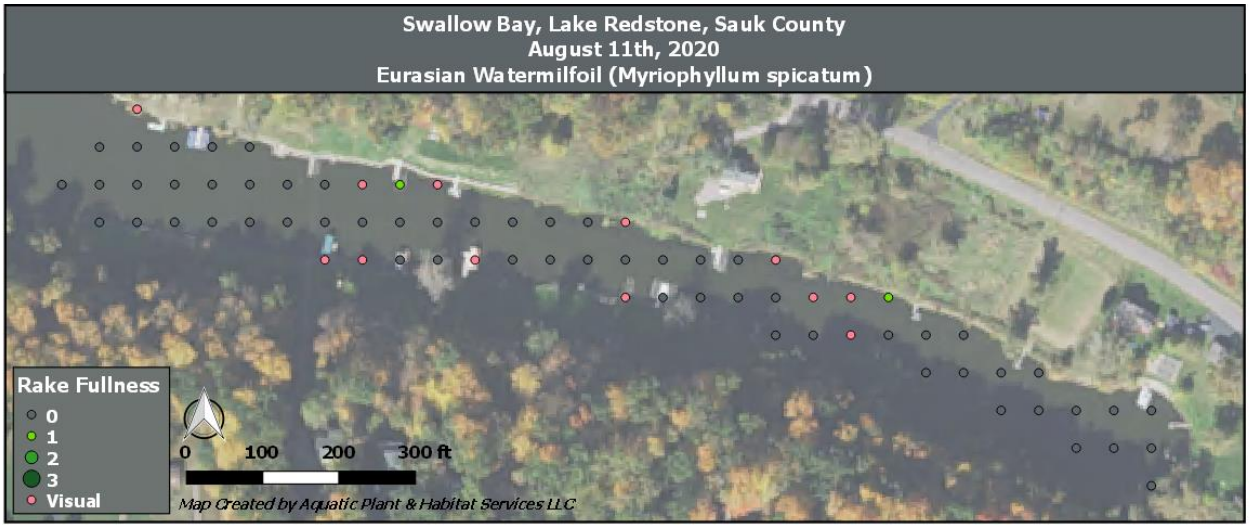
Figure 8 – Hummingbird Bay Eurasian Watermilfoil Maps 2021-2022

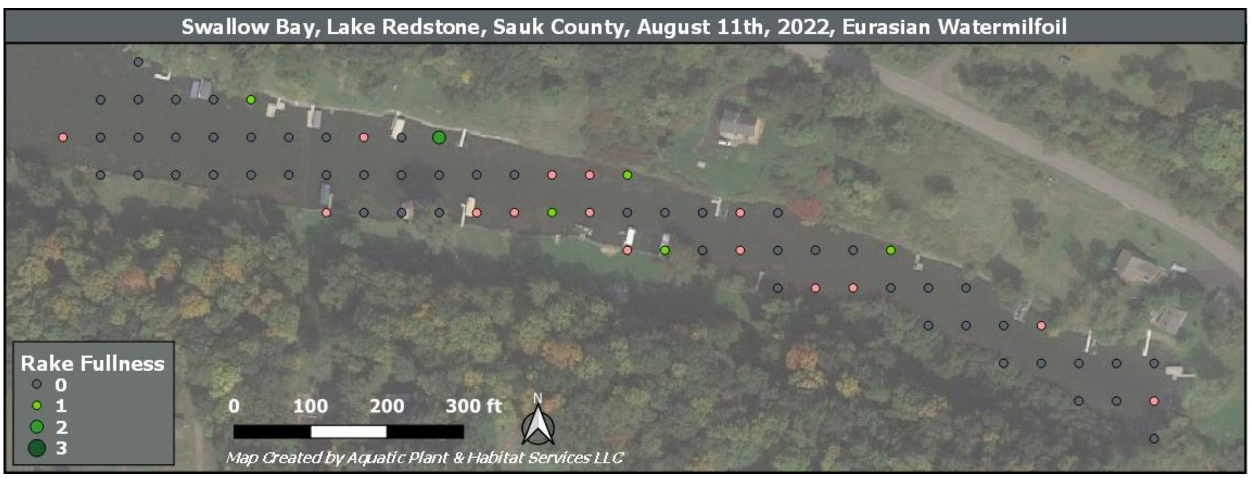


Swallow Bay EWM

- EWM was found at 6 sites (another 15 visual), second most common plant species in 2022.
- 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 2022 but no significant difference between 2020 and 2022.

Figure 9 – Swallow Bay Eurasian Watermilfoil Maps 2020 & 2022





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

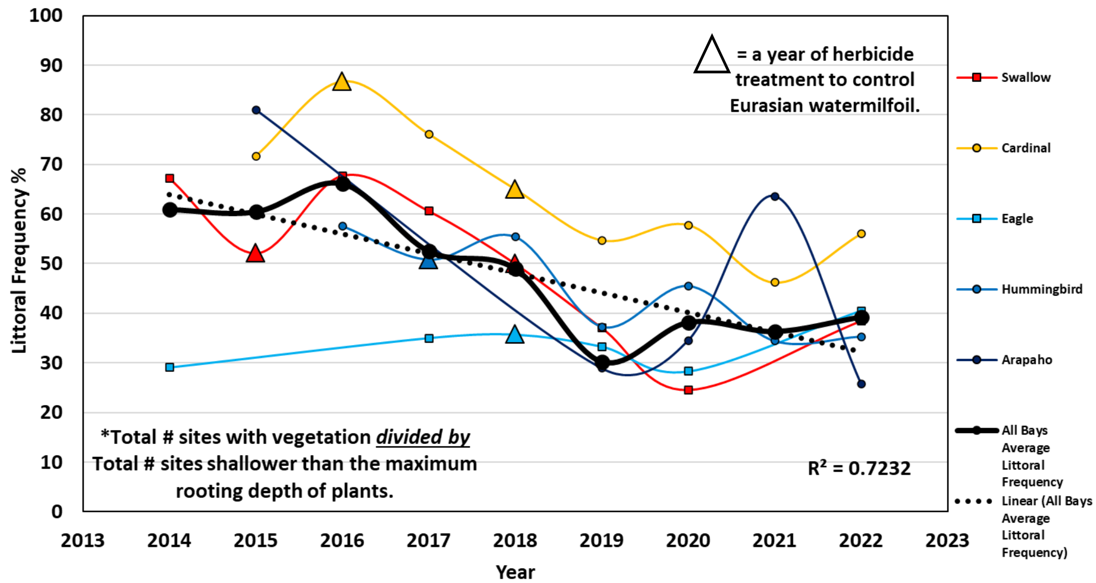
When comparing 2022 native species occurrence with that of 2021, there were no statistically significant (SS) declines in native plant species and there was actually one SS increase in native coontail in Swallow Bay. When comparing 2022 native species occurrence with the first year surveyed for each of the bays there were 7 statistically significant (SS) declines in native plant species and 3 SS declines in filamentous algae.[4] Based on these results, it seems as though there continues to be an overall decline in native plant occurrence and filamentous algae in the bays that are being studied. The continued decline in filamentous algae can be considered good news but the decline in native plant occurrence is a negative trend. 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. Increased water clarity is expected to allow more plants to grow and at greater depths with is better for overall lake ecology.

[4]Coontail SS decrease in all 5 bays, slender waterweed SS decrease in 1 bay, and large duckweed SS decrease in 1 bay.

Reduced Plant Occurrence (Native & Non-native Species)

The graph in Figure 10 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. Figure 10 illustrates littoral frequency for the 5 bays surveyed in 2022 as well as the average littoral frequency for *all bays* surveyed since 2014. A linear trendline[5] of the average littoral frequency among all bays[6] suggests the littoral frequency of aquatic plants (combined native and non-native) has been on a downward trend from 2014 through 2022 with an R^2 value of 0.72.[7]

Figure 10 – Littoral Plant Frequency Graph



[5] 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.

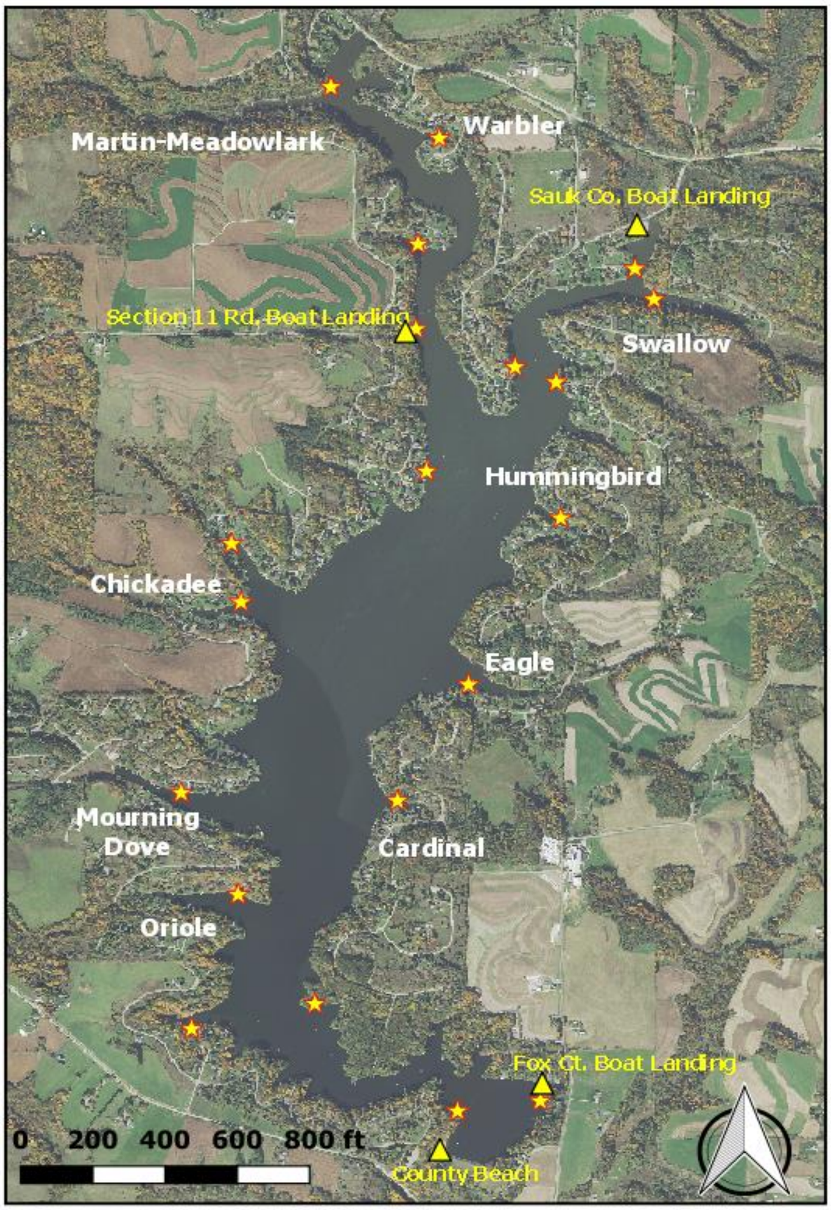
[6] All bays surveyed includes all those surveyed in a given year except for County F Bay in 2019 & 2020 (see 2020 report for more information).

[7] **R-squared** value measures the **trendline** reliability - the nearer R^2 is to 1, the better the **trendline** fits the data. The R^2 value in 2021 was stronger at 0.77.

Results of 2021 EWM Sampling for Genetic Analysis

Samples were collected for DNA genetic analysis to detect whether hybrid watermilfoil (Eurasian X northern watermilfoil) is present. Twenty samples were collected in 2021 and sent to Dr. Ryan Thum's laboratory at Montana State University. There was no evidence of hybrid watermilfoil found. Dr. Thum shared the following, "*Dominated by a widespread EWM that we see throughout the Great Lakes and beyond. This strain appears to be sensitive to 2,4-D and fluridone, based on laboratory assays. However, this strain is a strong/fast grower, which we hypothesize might translate to quick rebound from 2,4-D spot treatments."* Although HWM is not found in Lake Redstone, it is confirmed in nearby Dutch Hollow Lake and could spread through boat traffic.

Figure 11 – 2021 Locations of EWM Sampling for Genetic Analysis



Using Trigger Frequencies to Consider Herbicide Treatment

The following idea was presented in the 2017 report for Lake Redstone to help decide where herbicide treatment should occur, if at all. One possible management strategy is to identify a littoral frequency of EWM that triggers ***consideration*** for herbicide treatment the following spring. Table 6 lists the littoral frequencies of EWM the year before they were treated with herbicide[8]. If we take an average pre-treatment littoral frequency of EWM for all bays that had herbicide treatment (not including Woodpecker), the result is approximately 36%. Although the trigger frequency may be helpful in deciding whether herbicide treatment should occur, it is not intended to serve as the only factor for decision making. No bays surveyed in 2022 had a frequency higher than 36% but Cardinal Bay EWM frequency was close at 33%. Therefore, Cardinal Bay should be surveyed in 2023 to gauge EWM occurrence and determine whether control actions are needed.

Table 6 – Past EWM Frequencies before Herbicide Treatment

Bay & Year		Littoral frequency of EWM	Average littoral frequency of EWM
Martin-Meadowlark	**2014**	42	**36**
Swallow	**2014**	52	
	2017	29	
Cardinal	**2015**	30	
	2017	50	
Chickadee*	**2015**	34	
Oriole	**2015**	27	
Eagle	**2017**	30	
Hummingbird	**2016**	36	
Mourning Dove	**2017**	31	

**The entire bay was surveyed in 2015 but only the southern arm of the bay was treated with herbicide in 2016.*

[8] Woodpecker Bay had low EWM littoral frequency of only 9% in 2016 but only the northern section of the bay was treated in 2017 and is not included in the table.

General Management Recommendations

Similar to previous years' recommendations, all native aquatic plants should be protected, especially due to the declining trend in plant occurrence. 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 Sefton & Graham 2009[9]) 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.

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.

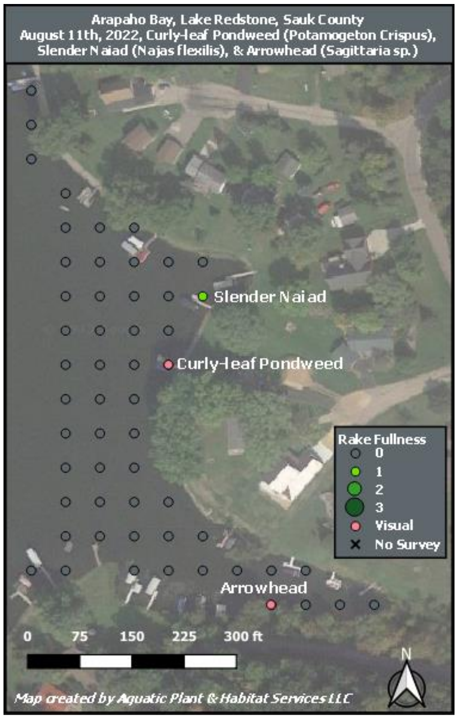
The overall trend based on chi-square analyses (Appendix F) and Figure 10 suggest native aquatic plant growth is declining in surveyed bays since 2014 while EWM occurrence fluctuates. Continued plant surveys in bays are recommended where needed with specific recommendation to survey Cardinal Bay in 2023.

Table 8 - Management Recommendations Summary

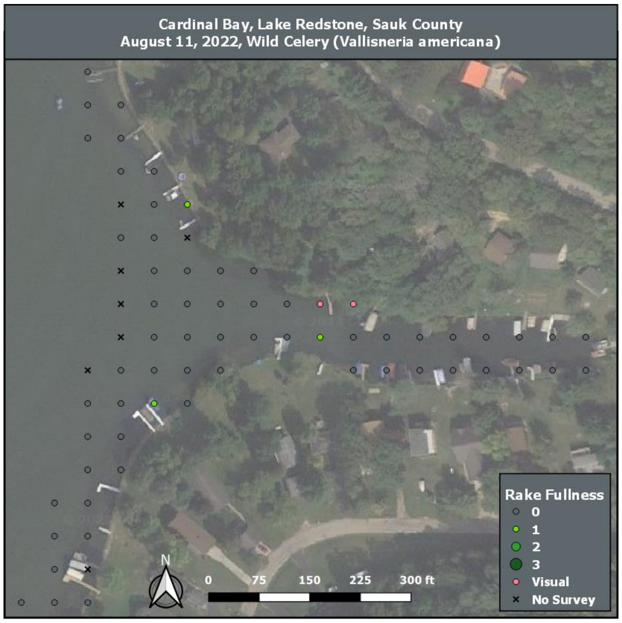
1. Protect native aquatic plants as they provide important structural habitat and contribute to a healthy lake system.
2. If necessary, shore land owners can hand pull or rake nuisance native vegetation in a <30-foot-wide area that is contiguous and parallel to shore. Designated sensitive areas require a permit. This should be done on very limited basis as native aquatic plants appear to be declining in surveyed bays since 2014.
3. Continue volunteer water quality and AIS monitoring.
4. Conduct aquatic plant surveys of bays in 2023 as needed, Cardinal Bay for sure.

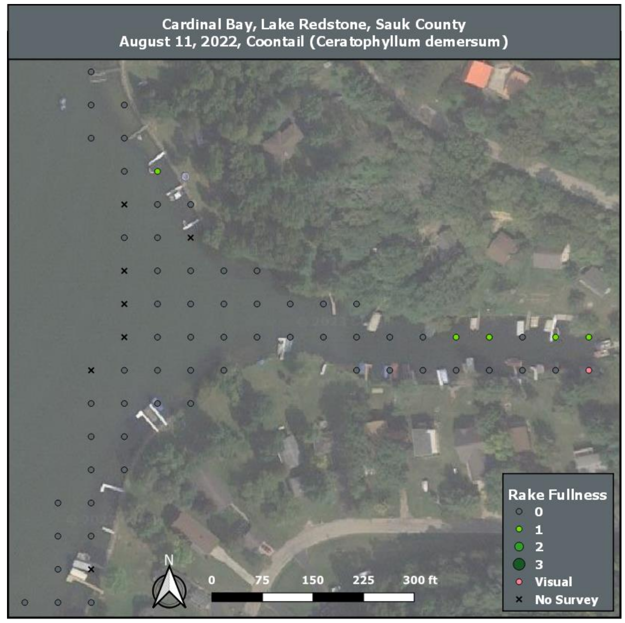
[9] Sefton, D. and S. Graham. 2009. Designation of Critical Habitat, Lake Redstone, Sauk County, Wisconsin. Wisconsin Department of Natural Resources. 29 Oct. 2016 http://dnr.wi.gov/lakes/criticalhabitat/Project.aspx?project=22761946.

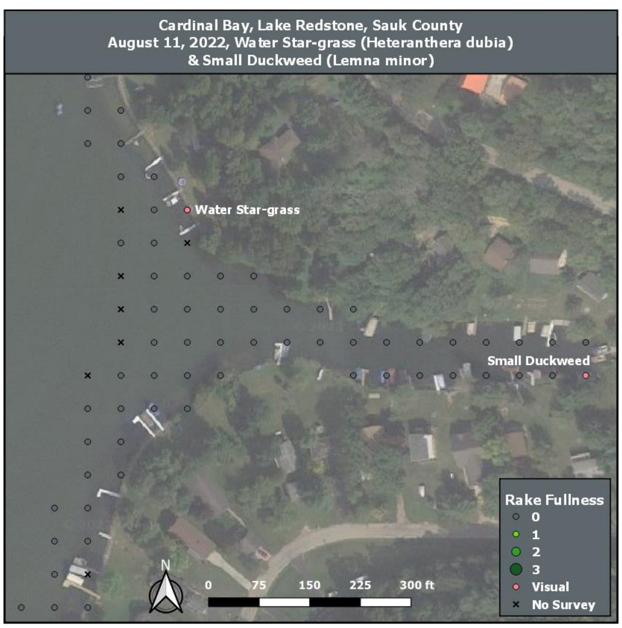
APPENDIX A – ARAPAHO BAY MAPS

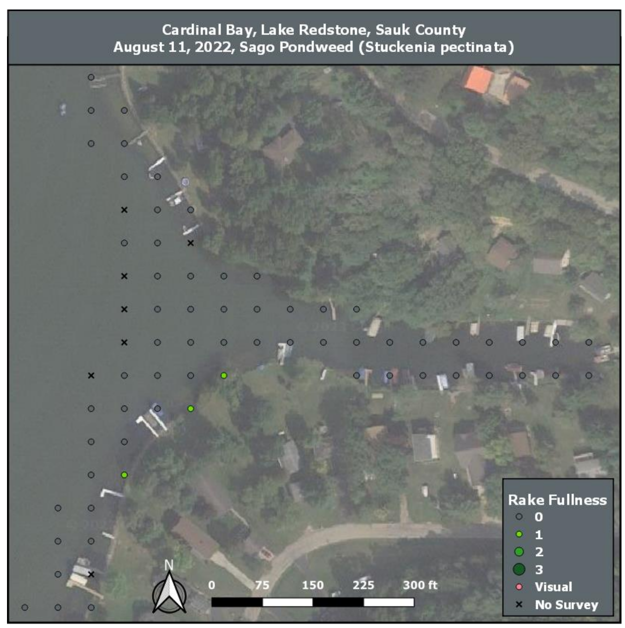


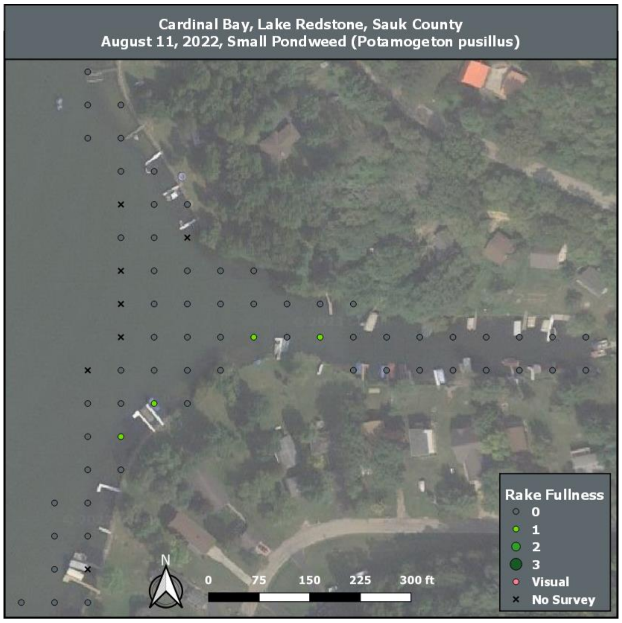
APPENDIX B – CARDINAL BAY MAPS

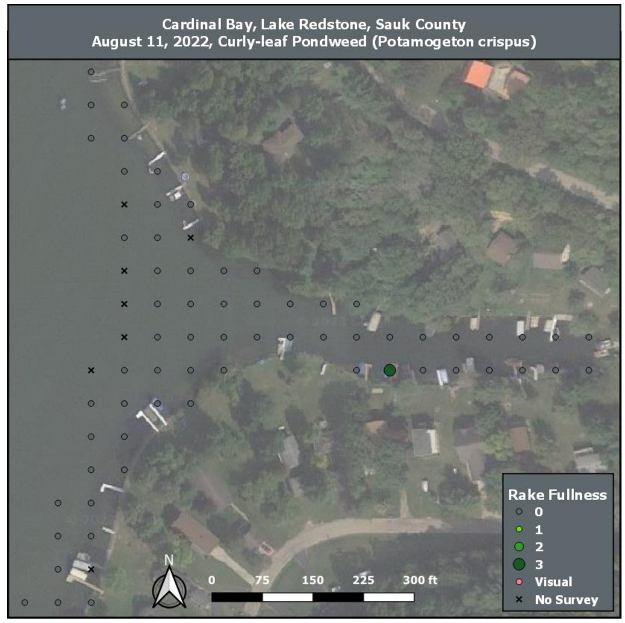


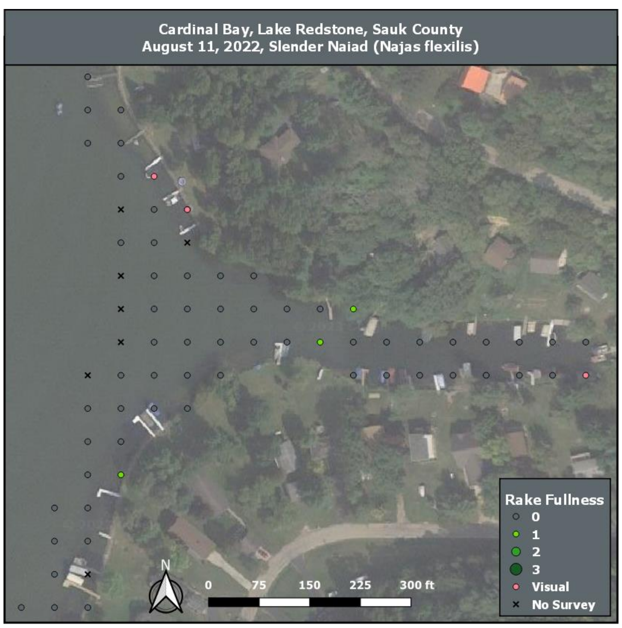


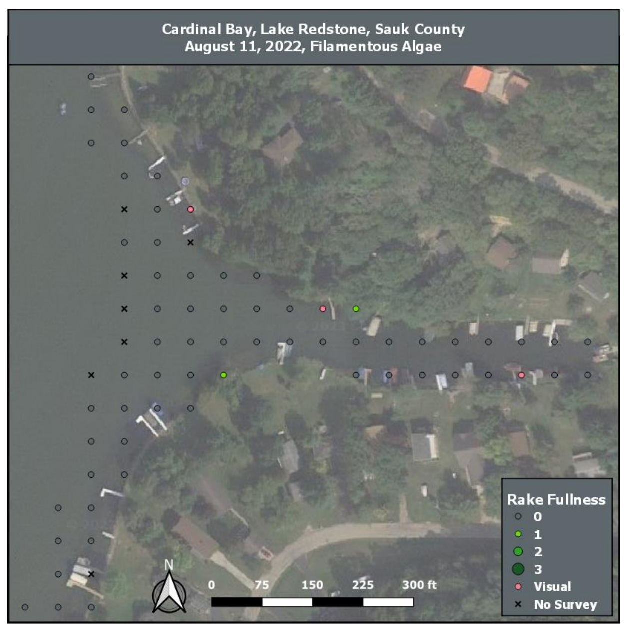




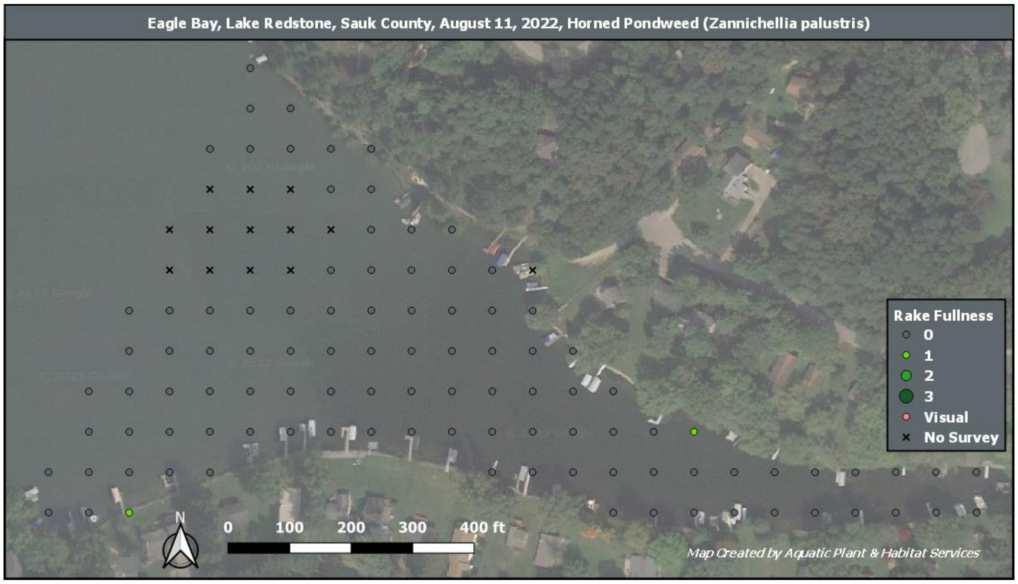

Cardinal Bay, Lake Redstone, Sauk County
August 11, 2022, Small Pondweed (Potamogeton pusillus)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
75
150
225
300 ft

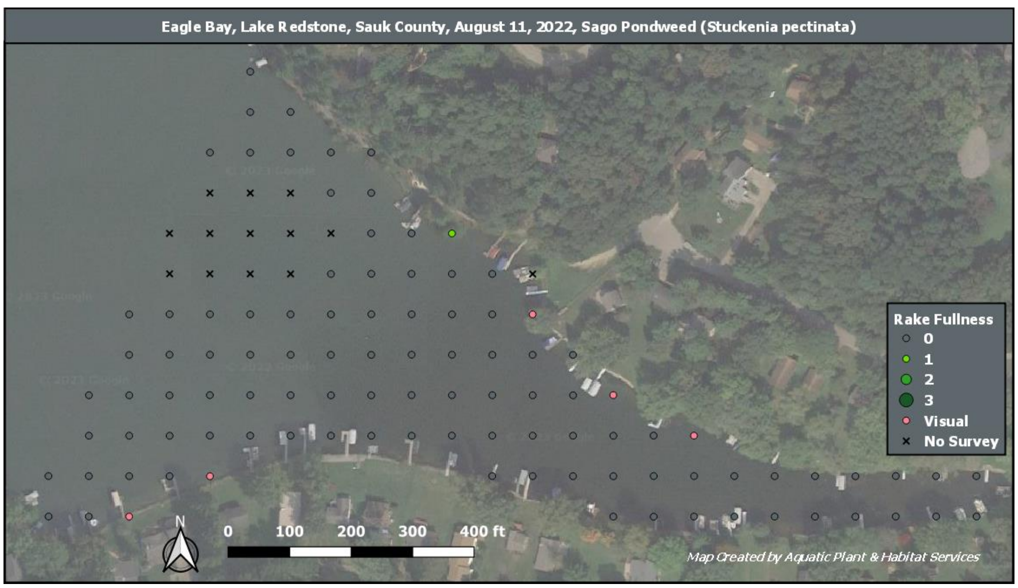

Cardinal Bay, Lake Redstone, Sauk County
August 11, 2022, Curly-leaf Pondweed (Potamogeton crispus)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
75
150
225
300 ft

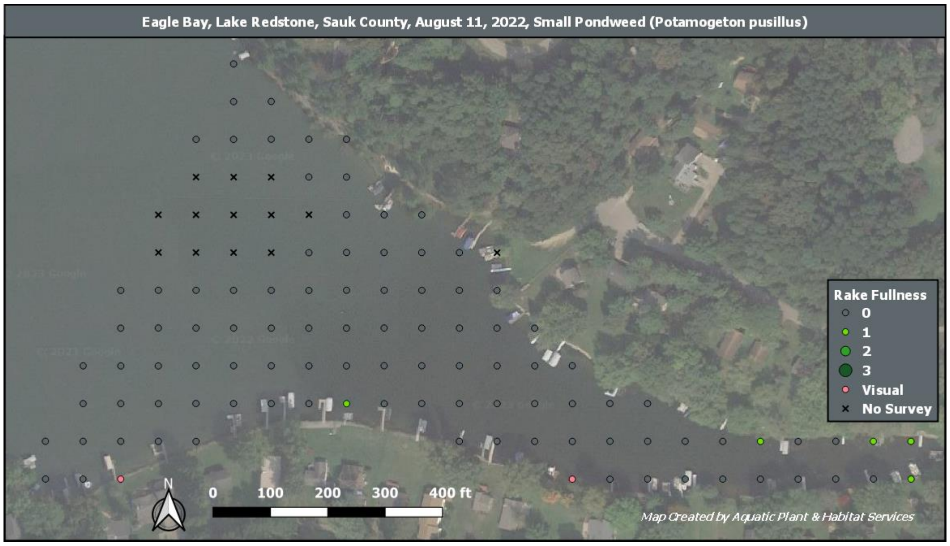

Cardinal Bay, Lake Redstone, Sauk County
August 11, 2022, Slender Naiad (Najas flexilis)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
75
150
225
300 ft


Cardinal Bay, Lake Redstone, Sauk County
August 11, 2022, Filamentous Algae
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
75
150
225
300 ft

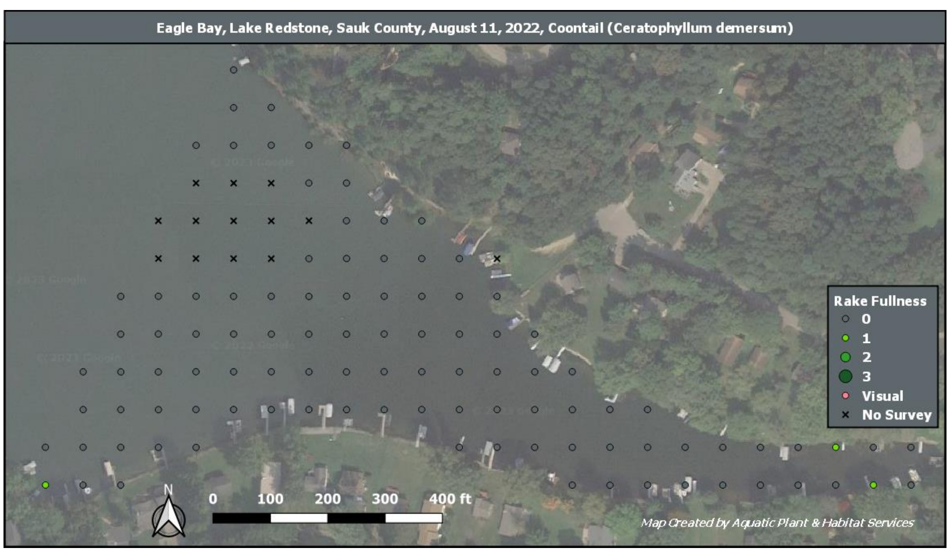
APPENDIX C – EAGLE BAY MAPS

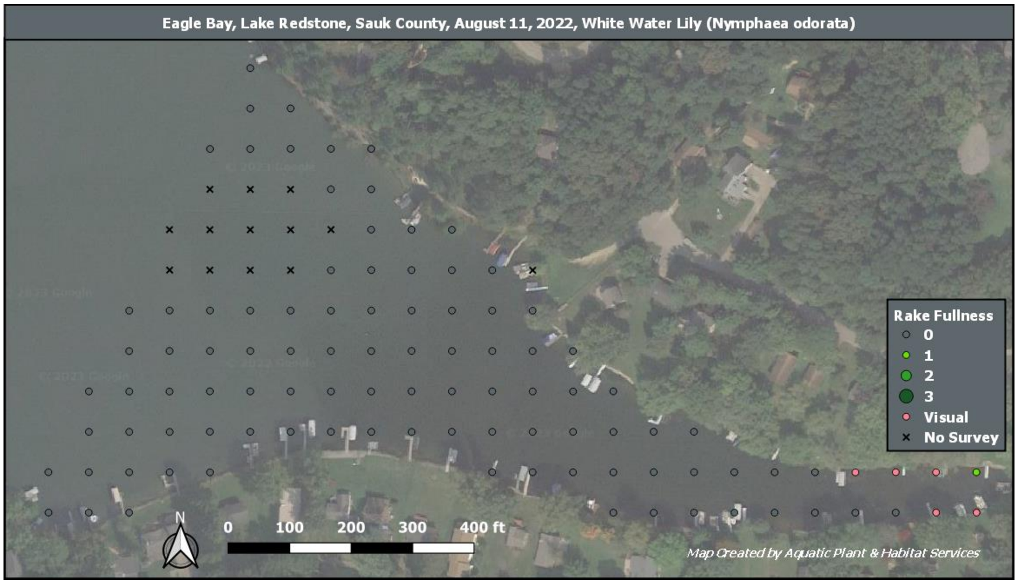




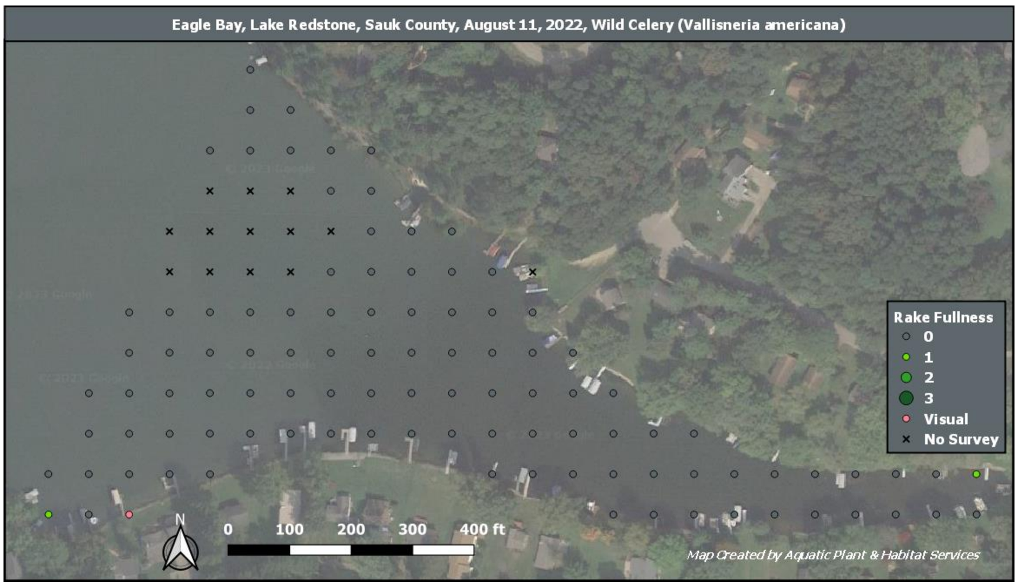

Eagle Bay, Lake Redstone, Sauk County, August 11, 2022, Small Pondweed (Potamogeton pusillus)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
100
200
300
400 ft
Map Created by Aquatic Plant & Habitat Services


Eagle Bay, Lake Redstone, Sauk County, August 11, 2022, Water Star-grass (Heteranthera dubia) & Filamentous Algae
Filamentous Algae
Water Star-grass
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
100
200
300
400 ft
Map Created by Aquatic Plant & Habitat Services


Eagle Bay, Lake Redstone, Sauk County, August 11, 2022, Coontail (Ceratophyllum demersum)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
100
200
300
400 ft
Map Created by Aquatic Plant & Habitat Services



Eagle Bay, Lake Redstone, Sauk County, August 11, 2022, White Water Lily (Nymphaea odorata)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
100
200
300
400 ft
Map Created by Aquatic Plant & Habitat Services



Eagle Bay, Lake Redstone, Sauk County, August 11, 2022, Wild Celery (Vallisneria americana)
Rake Fullness
0
1
2
3
Visual
No Survey
N
0
100
200
300
400 ft
Map Created by Aquatic Plant & Habitat Services

APPENDIX D – HUMMINGBIRD BAY MAPS

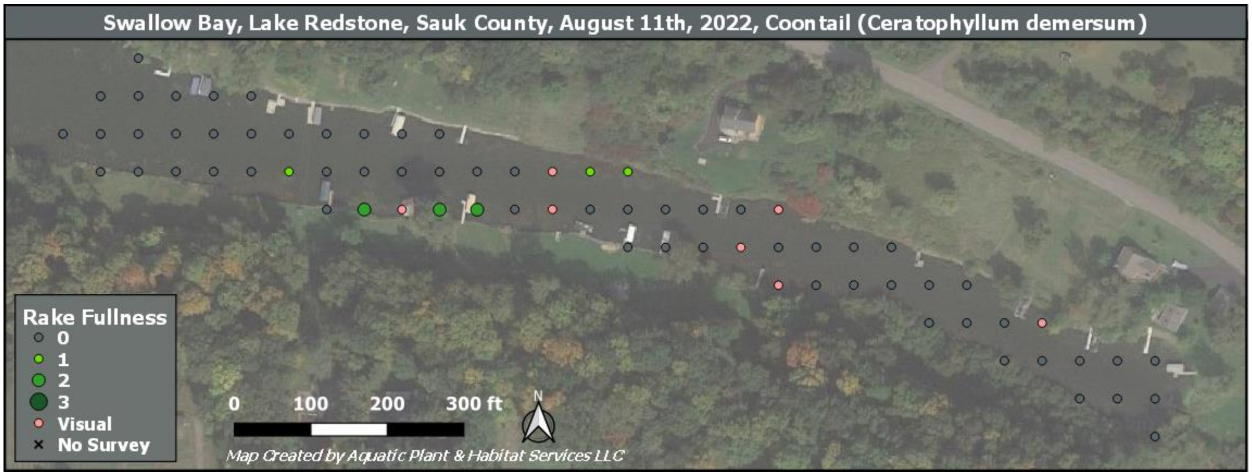

Hummingbird Bay, Lake Redstone, August 11, 2022
Small Pondweed (Potamogeton pusillus)
Rake Fullness
0
1
2
3
Visual
N
0 50 100 ft
Map Created by Aquatic Plant & Habitat Services LLC

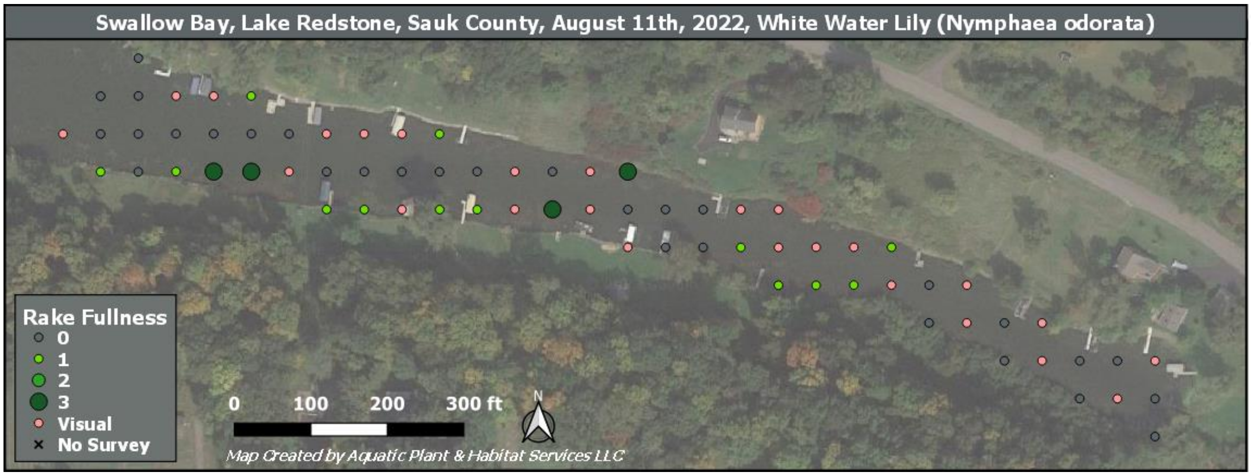

Hummingbird Bay, Lake Redstone, August 11, 2022
Floating-leaf Pondweed (Potamogeton natans)
Rake Fullness
0
1
2
3
Visual
N
0 50 100 ft
Map Created by Aquatic Plant & Habitat Services LLC


Hummingbird Bay, Lake Redstone, August 11, 2022
Wild Celery (Vallisneria americana)
Rake Fullness
0
1
2
3
Visual
N
0 50 100 ft
Map Created by Aquatic Plant & Habitat Services LLC


Hummingbird Bay, Lake Redstone, August 11, 2022
White Water Lily (Nymphaea odorata)
Rake Fullness
0
1
2
3
Visual
N
0 50 100 ft
Map Created by Aquatic Plant & Habitat Services LLC

APPENDIX E – SWALLOW BAY MAPS

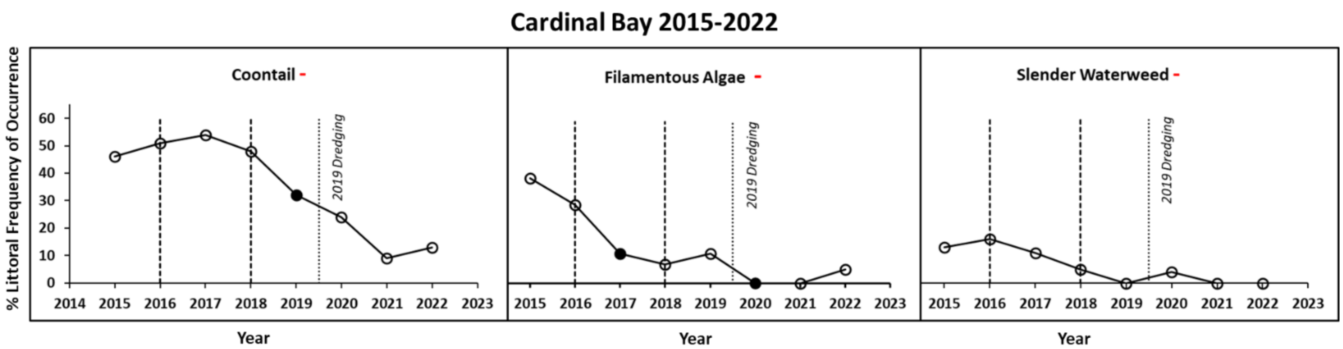


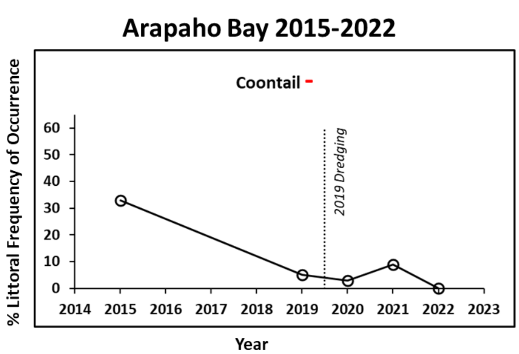

Swallow Bay, Lake Redstone, Sauk County, August 11th, 2022, White Water Lily (Nymphaea odorata)
Rake Fullness
0
1
2
3
Visual
No Survey
0 100 200 300 ft
N
Map Created by Aquatic Plant & Habitat Services LLC

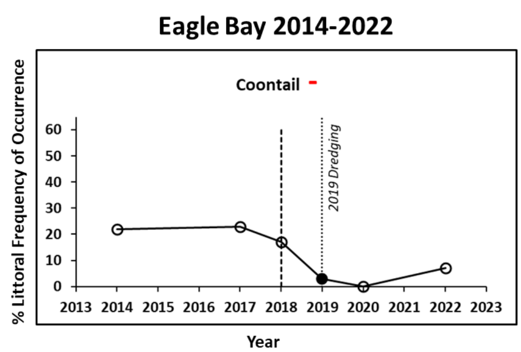

Swallow Bay, Lake Redstone, Sauk County, August 11th, 2022, Small Duckweed (Lemna minor)
Rake Fullness
0
1
2
3
Visual
No Survey
0 100 200 300 ft
N
Map Created by Aquatic Plant & Habitat Services LLC

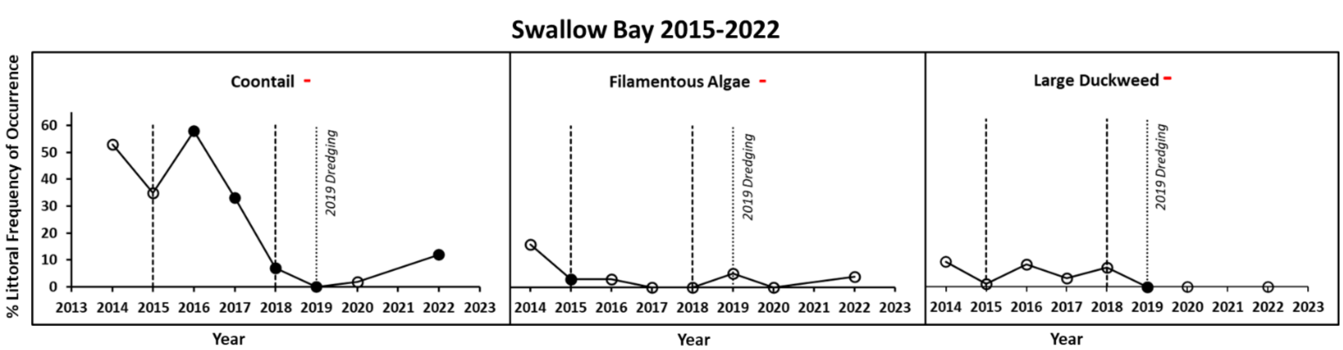
APPENDIX F – CHI-SQUARED TEST GRAPHS

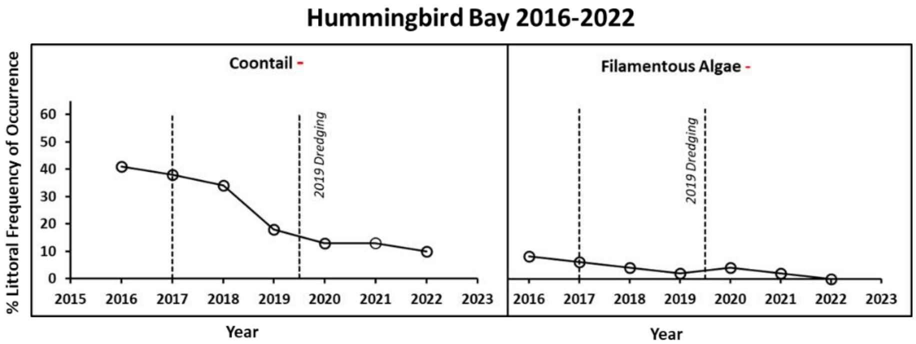
Percent littoral frequency (# sites plants found at points shallower than maximum rooting depth divided by the number of site shallower than max depth of plants) is on the y-axis and each year a plant survey was completed is on the x-axis. Only species with a statically significant change (using Chi-squared tests) for most recent year vs 2022 or the first year vs 2022 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 2022 data are represented by **+** or **–** adjacent to plant names.

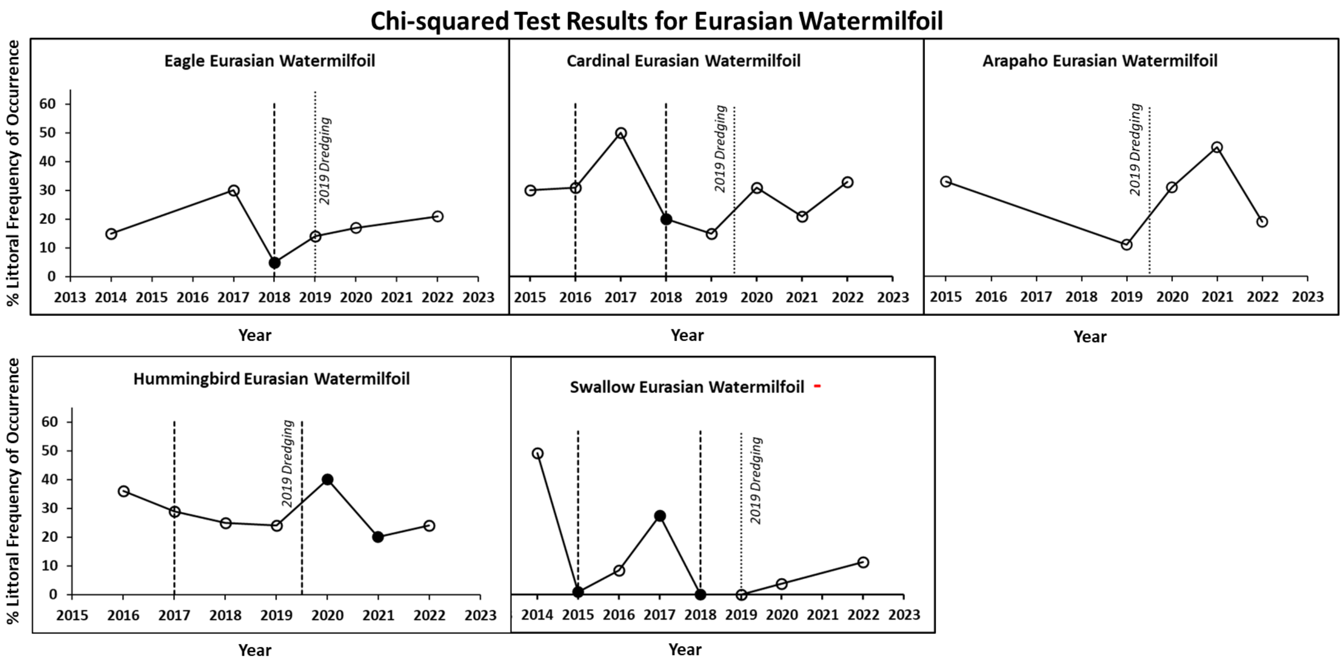









Hummingbird Bay 2016-2022
Coontail -
Filamentous Algae -
2019 Dredging
2019 Dredging
% Littoral Frequency of Occurrence
Year
Year


Chi-squared Test Results for Eurasian Watermilfoil
Eagle Eurasian Watermilfoil
Cardinal Eurasian Watermilfoil
Arapaho Eurasian Watermilfoil
Hummingbird Eurasian Watermilfoil
Swallow Eurasian Watermilfoil -
2019 Dredging
% Littoral Frequency of Occurrence
Year