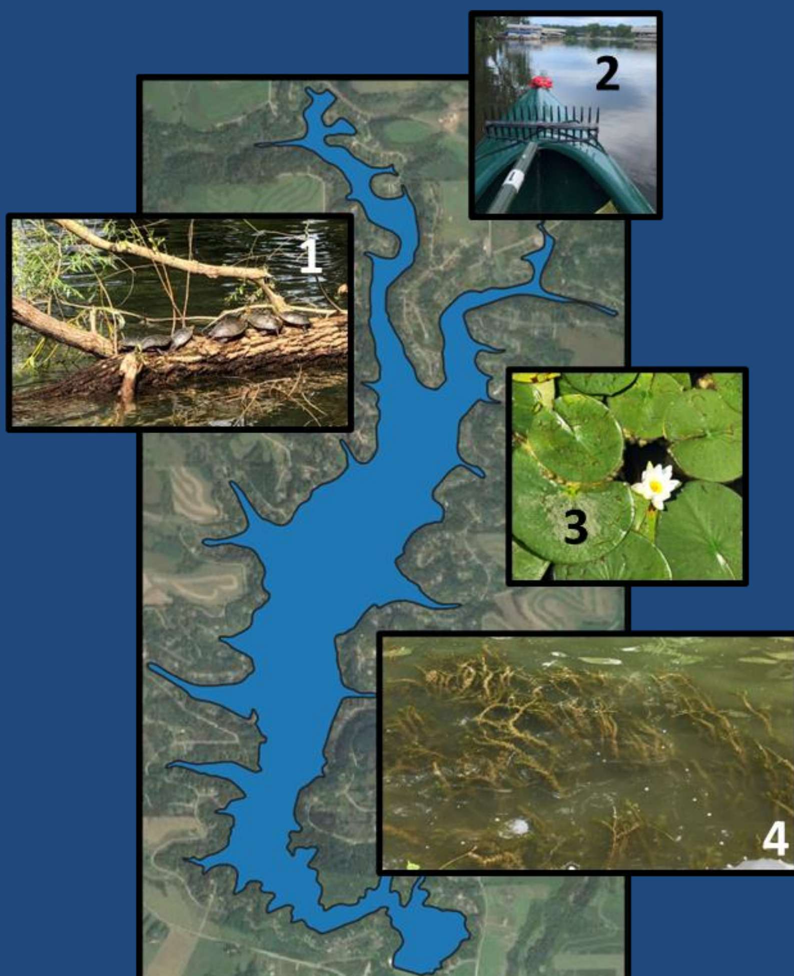
Aquatic Plant Management Plan

for

Lake Redstone
Sauk County, Wisconsin

2023-2028

Plan approved May 25th, 2023



Prepared for the Lake Redstone Protection District

Funded in part by WDNR Aquatic Invasive Species Planning Grant AEPP64522

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Field survey assistance provided by AEM Consulting

Photos from Cover Page: 1) Painted turtles basking in the sun on a fallen tree in Cardinal Bay. 2) Kayaks are sometimes used to conduct the sub-PI surveys in far reaches of bays. This photo was taken in Arapaho Bay in 2022 during a calm morning of surveying. 3) White water lily is one of the few native species found in Lake Redstone. The water lilies offer important structure and cover for aquatic animals, including fish. 4) Eurasian watermilfoil in Lake Redstone is found growing in less than 7 feet of water and near shore. In shallow areas around docks, it can grow to the surface as illustrated in this photo.

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Executive Summary

Lake Redstone is located in the Town of La Valle in northwestern Sauk County, Wisconsin. The lake is 635 acres in surface area with a maximum depth of 36.5 feet. The lake was created in the 1960's with dam construction on Big Creek.

The most recent aquatic plant survey of Lake Redstone in 2022 revealed very low plant occurrence of native AND non-native plant species with a shallow maximum rooting depth of only 6.5 feet. Although plant occurrence in previous plant surveys (2005 and 2012) was also low, there appears to be an ongoing decline in aquatic plants overall. Low water clarity is likely a major contributing factor, although previous herbicide treatments in the lake may have also contributed to a decline in plants overall. The Lake Redstone Protection District (LRPD) is taking meaningful strides towards improved water quality with their 9-Key Element Plan that was finalized in 2022.

Eurasian water-milfoil (EWM) and curly-leaf pondweed (CLP) were documented in Lake Redstone in 1989. Genetic analysis of 20 EWM samples from various locations in the lake found no evidence of hybrid watermilfoil in 2021. Since the last aquatic plant management plan in 2013, there has been herbicide treatment to control EWM in select sheltered bays each year from 2013 through 2018. An extensive dredging effort in most bays in 2019 and overall decline in aquatic plants has resulted in no herbicide treatment since 2018. Manual removal was used in 2021 and Diver Assisted Suction Harvest (DASH) in 2022 to control EWM in localized areas but limited water clarity hampered efforts for manual removal and DASH to have meaningful impact.

This updated management plan provides background information about Lake Redstone, identifies the issues and need for management, reviews past management activities, and presents management options. A public input meeting in September 2022 and follow-up planning meeting in November were vital in collecting public input and providing information to partners and the public. All these components were considered in honing the goals and objectives developed in this management plan. The outcome is a strategy that includes the following goals that are detailed on pages 42-46:

Goal 1 – Protect native aquatic plants, organisms, and associated native mammal and fish populations.
Goal 2 – Monitor and manage Eurasian watermilfoil to maintain occurrence that aligns with beneficial use of Lake Redstone.
Goal 3 – Prevent the introduction of new aquatic invasive species.
Goal 4 - Provide educational opportunities pertaining to aquatic plants, aquatic invasive species, and manual removal techniques.

1.0 Lake Redstone Background

1.1 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 (Figure 2). Lake Redstone was created 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.

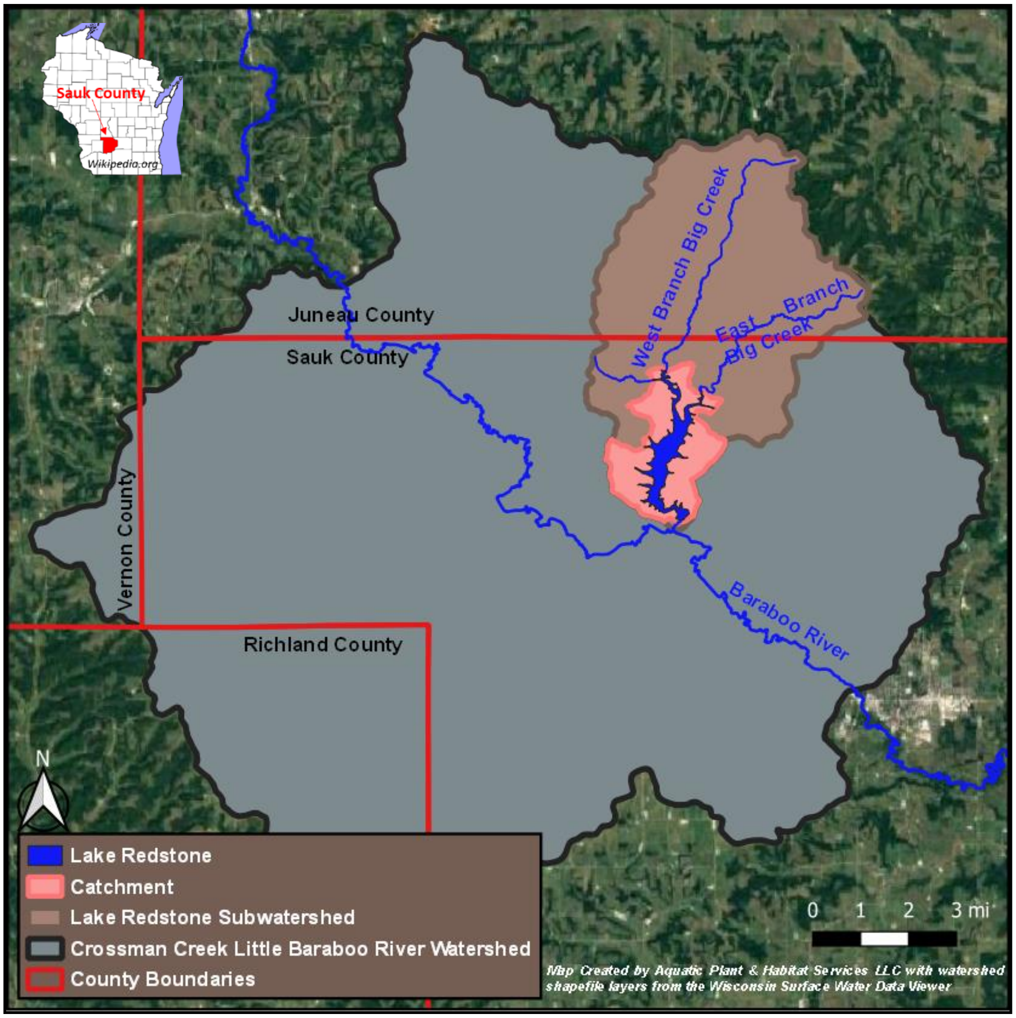
Figure 1 - Lake Redstone Study Site

1.2 Watershed, Shore Lands, and Water Quality Implications

1.2.1 Watershed

Lake Redstone is situated within the Crossman Creek & Little Baraboo River Watershed, which includes the gray, brown, and pink areas in Figure 2. Within the Crossman Creek & Little Baraboo River Watershed is the Lake Redstone Sub-watershed, which is shown as the brown and pink areas illustrated in Figure 2. The direct catchment Lake Redstone includes only the pink area in Figure 2.

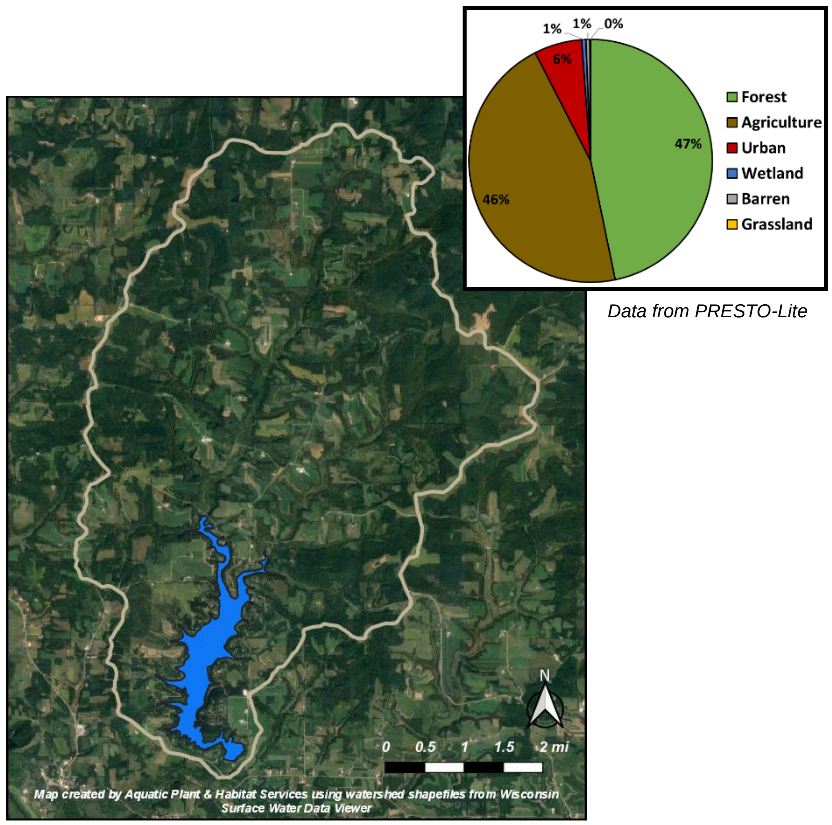
Figure 2 – Lake Redstone Watershed Map



1.2.2 Lake Redstone Sub-Watershed

The Lake Redstone sub-watershed is illustrated in Figure 3 along with land use data retrieved from the PRESTO-Lite Watershed Delineation tool in the Wisconsin Surface Water Data Viewer. The area is 17,862 acres (27.91 square miles). The land cover is 47% forested, 46% agriculture, 6% developed, 1% each wetland and barren, and <1% grassland.

Figure 3 – Map of Lake Redstone Catchment & Land Use Chart



Data from PRESTO-Lite

1.3 Water Quality Implications

The water quality of a lake, stream, or river is directly impacted by its watershed, including land that is directly adjacent to a lake. When waterfront land changes from forest-covered to a house, driveway, deck, garage, septic systems, lawns and sandy beaches, the water quality will be directly affected. It is the cumulative land cover change of many waterfront properties that leads to a decline in water quality.

Riparian land owners are the last line of defense in protecting water quality from the impacts of human development.

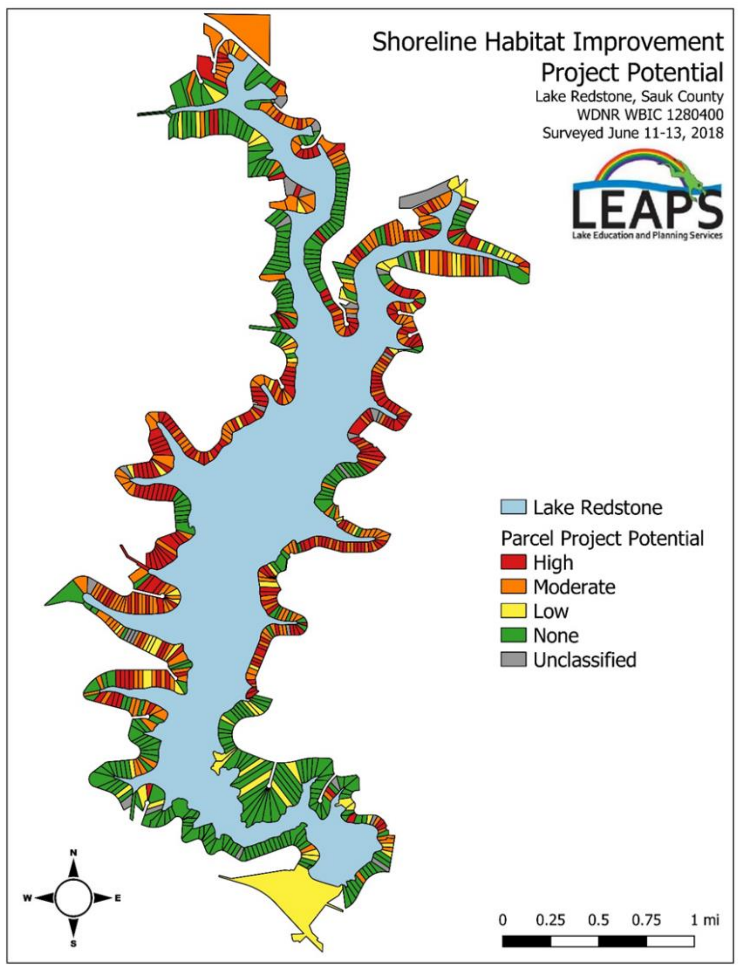
For example, the amount of phosphorus (P) entering a lake increases as land use changes from forested to residential (Panuska & Lillie 1995, Jeffrey 1985). A developed site with a lawn will allow more runoff volume carrying P and nitrogen than a forested site (Graczyk et al 2003). P is generally the key nutrient that leads to algae and nuisance aquatic plant growth. P sources include human waste (failing septic systems), animal waste (farm runoff), soil erosion, detergents, and lawn fertilizers (Shaw et al. 2004). Detergents and lawn fertilizer are presumed less of an issue with recent laws. Developed sites have more impervious surface that does not allow precipitation to infiltrate into the soils. This precipitation becomes surface water runoff at warmer temp. than at non-developed sites (Galli 1988). The warmer water that flows into the lake can lead to increased lake water temp., and as water temps. increase the amount of dissolved oxygen it can "hold" decreases.

The combined impacts of increased water temperatures, lower dissolved oxygen, and higher phosphorus can all result from shoreland development.

1.4 Lake Redstone Shoreline Assessment 2018

A shoreline assessment of Lake Redstone was completed June 11-13, 2018 by Lake Education and Planning Services LLC. Surveyors used WDNR protocols cruised along shore and estimated percent cover of shrub/herbaceous plants, tree canopy, impervious surfaces, and lawn at each of the 784 parcels among other information about the shoreline. Based on the percent cover of these variables, a point system was developed in order to rank each parcel based on whether the property was high, moderate, or low priority or no concern for shoreland improvement. Of the 784 parcels 214 were high priority, 209 moderate priority, 69 low priority, and 292 were no concern. Based on these findings, the Lake Redstone Protection District hosted Shoreline Improvement Workshops in 2021 and 2022 and is promoting Healthy Lakes Practices for interested property owners.

Figure 4 - Shoreline Assessment Map of Results, 2018



1.5 Healthy Lakes Practices

Healthy Lakes & Rivers is a collaborative effort among shoreland property owners, businesses, and the Wisconsin Lakes Partnership (WDNR, UWEX, & Wisconsin Lakes) to promote and install relatively simple and inexpensive best practices benefiting habitat and water quality. There are 5 “best practices” that improve habitat and water quality on shoreland property including native plantings, rain gardens, water diversions, rock infiltration, and “fish sticks” (i.e.tree drops to serve as habitat). Grant funding is available to pay for up to $1000 toward each practice with a cost share of 75% coming from the state and 25% covered by the sponsor. Grants must be sponsored by the Lake Redstone Protection District or other eligible sponsor (i.e., individual property owners do not qualify to apply on their own).

Sauk County Land Resources and Environment Department may also provide cost share funding limited to 50% of the project cost up to $2,500. Eligible projects reduce sediment loads in Sauk County and may include vegetated buffers, bioengineering with natural fiber products (e.g. natural fiber rolls and logs, blocks, and mats), wave-reducing natural timbers, and rock riprap with bioengineering techniques (e.g. rock riprap with native plantings, geotextile bags, geogrid lifts, and synthetic engineered matting). More information is available at https://www.co.sauk.wi.us/landconservation/lake-programs

Figure 5 – Healthy Lakes Practices

Photos from healthylakeswi.com provide examples of some best practices

1.6 Trophic State & Water Quality

Trophic state and water quality are often used interchangeably and while related, they are not the same. Trophic state describes the biological condition of a lake based on measurable and objective criteria. Water quality is a subjective descriptor of lake condition based on the observer's use of the lake. For example, clear-water lakes are often described as having "good" or "excellent" water quality, which may be true for swimmers or SCUBA divers. The same ultra-clear lake may have low productivity and thus a limited fishery leading to an "average" water quality classification by an angler.

Water clarity, total phosphorus, and chlorophyll-*a* are objective and measurable criteria used to determine the trophic state of a lake. The Carlson Trophic State Index (TSI) is frequently used to determine biomass in aquatic systems. Eutrophication is the movement of a lake's trophic state in the direction of more plant biomass. Eutrophic lakes tend to have abundant aquatic plant growth, high nutrient concentrations, and low water clarity due to algae blooms. Oligotrophic lakes, on the other end of the spectrum, are nutrient poor and have little plant and algae growth. Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms (Red ovals in Figure 6 represent Lake Redstone ranges).

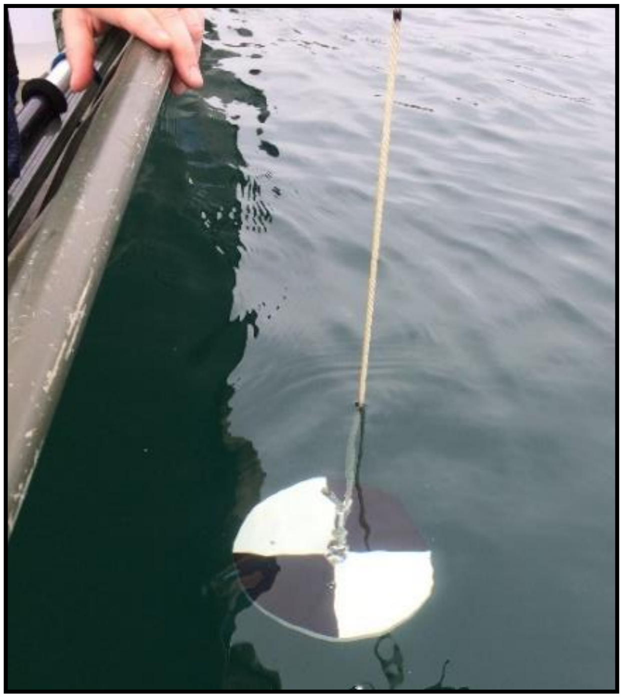
Figure 6 – Trophic State Gradient adapted from Simpson & Carlson (1996)

TSI	Chlorophyll-a (ug/L)	Secchi Depth (ft)	Total Phosphorus (ug/L)	Attributes	Fisheries & Recreation
<30	<0.95	>26	<6	Oligotrophic: Clear water, oxygen throughout the year in the hypolimnion	Salmonid fisheries dominate
30-40	0.95 - 2.6	13 - 26	6 - 12	Oligotrophic: Hypolimnia of shallower lakes may become anoxic	Salmonid fisheries in deep lakes only
40-50	2.6 - 7.3	6.5 - 13	12 - 24	Mesotrophic: Water moderately clear; increasing probability of hypolimnetic anoxia during summer	Hypolimnetic anoxia results in loss of salmonids. Walleye may predominate
50-60	7.3 - 20	3 – 6.5	24 - 48	Eutrophic: Anoxic hypolimnia, macrophyte problems possible	Warm-water fisheries only. Bass may dominate.
60-70	20 - 56	1.5 - 3	48 - 96	Eutrophic: Blue-green algae dominate, algal scums and macrophyte problems	Nuisance macrophytes, algal scums, and low transparency may discourage swimming and boating.
70-80	56 - 155	0.75 – 1.5	96 - 192	Hypereutrophic: (light limited productivity). Dense algae and macrophytes	Rough fish dominate; summer fish kills possible
>80	>155	<0.75	192 - 384	Algal scums, few macrophytes	

1.6.1 Water Clarity

The depth to which light can penetrate, or water clarity, is a factor that limits aquatic plant growth. Water clarity is measured by lowering a black and white Secchi disk (8 inches diameter) in the water and recording the depth of disappearance. The disk is then lowered further and slowly raised until it reappears. The Secchi depth is the mid-point between the depth of disappearance and the depth of reappearance. Because light penetration is usually associated with nutrient levels and algae growth, a lake is considered eutrophic when Secchi depths are less than 6.5 feet. Secchi depths vary throughout the year, with shallower readings in summer when algae concentrations increase, thus limiting light penetration. Conversely, deeper readings occur in spring and late fall when algae growth is lower. Volunteers on Lake Redstone have monitored Secchi depth consistently since 1986 at the Water Quality Monitoring Station illustrated in Figure 1. The average summer (July & August) Secchi depth since 1986 is 3 feet, which classifies Lake Redstone as a **EUTROPHIC** system from a water clarity standpoint (Figure 6, Figure 8).

Figure 7 – Secchi Disk



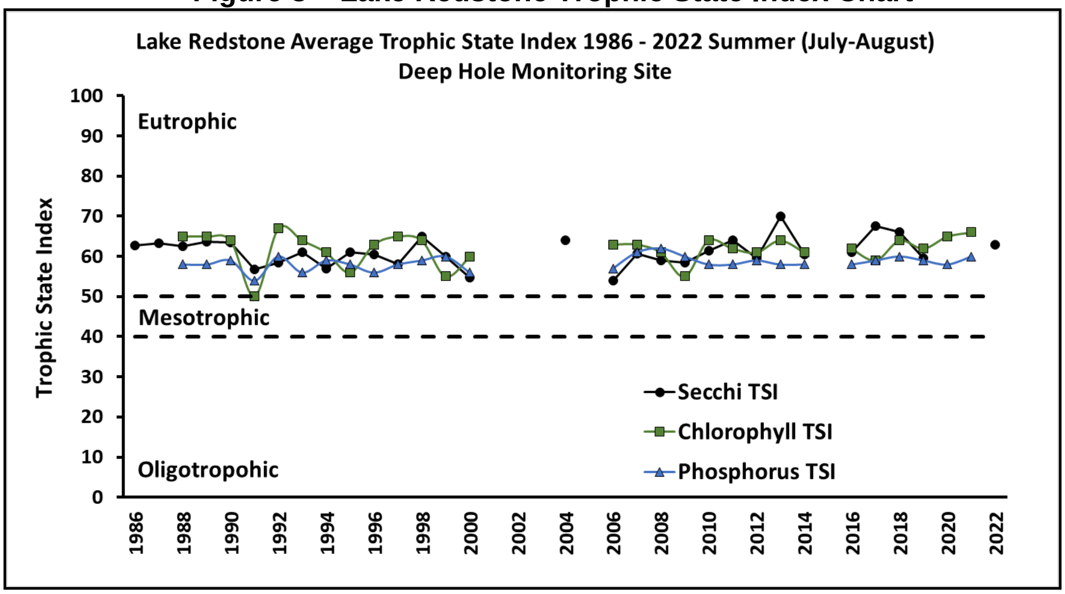
1.6.2 Phosphorus & Land Use Conservation Practices

Phosphorus is an important nutrient for plant growth and is commonly the limiting nutrient for plant production in Wisconsin lakes. As a limiting factor, adding small quantities of phosphorus to a lake can lead to dramatic increases in plant and algae growth. Total phosphorus was monitored consistently in Lake Redstone since 1988 using water samples from the surface (0-6 feet) at the Water Quality Monitoring Station illustrated in Figure 1. The average summer (July & August) total phosphorus TSI since 1988 is 58, therefore classifying Lake Redstone as a **EURTROPHIC** system from a nutrient standpoint (Figure 8). The recently developed 9-Key Element Plan for Lake Redstone goes into much greater depth on phosphorus loading and steps toward phosphorus load reduction.

1.6.3 Chlorophyll-a

Chlorophyll-*a* is the green pigment found in plants and algae. The concentration of chlorophyll-*a* is used as a measure of the algal population in a lake. For trophic state classification, preference is given to the chlorophyll-*a* trophic state index (TSI_{CHL}) because it is the most accurate at predicting algal biomass. The equations for calculating TSI are based on Carlson & Simpson (1996). Chlorophyll-*a* has been monitored consistently in Lake Redstone since 1988 using water samples from the surface (0-6 feet) at the Water Quality Monitoring Station illustrated in Figure 1. The average summer (July & August) TSI_{CHL} since 1988 is 62, therefore classifying Lake Redstone as a **EUTROPHIC** system from an algal biomass standpoint (Figure 8).

Figure 8 – Lake Redstone Trophic State Index Chart



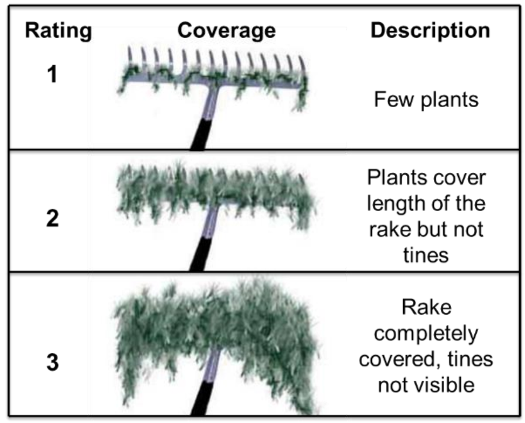
1.7 Aquatic Plants

1.7.1 2022 Survey Methods

Whole-lake Point-Intercept Survey

A whole-lake point-intercept aquatic plant survey of Lake Redstone was completed in 2005 by the WDNR, 2012 by Ecological Integrity Services LLC, and August 9-10th 2022 by Aquatic Plant & Habitat Services LLC. Survey assistance in 2022 was provided by AEM Consulting LLC. The plant survey followed a statewide standard protocol developed by Hauxwell et al. (2010) with predetermined survey points, of which there were 966 in Lake Redstone. Sample points were spaced 50 meters apart. Points that were deeper than 12 feet were not surveyed based on previous survey findings that maximum rooting depth since 2015 was 11 feet[1]. This left 502 sample points that were sampled using a double-sided rake head on a telescopic pole. Rake fullness was determined using guidelines in Figure 9. A map of the survey grid can be found in Appendix A.

Figure 9 – Total Rake Fullness Illustration



Pre-Post Sub Point-Intercept Survey

Lake Redstone Protection District has sponsored the survey of select bays each year depending on EWM occurrence and management history. If a bay was being considered for herbicide treatment, that bay was surveyed using a grid of sample points that are spaced 15 or 20 meters apart, which provided a pre-treatment assessment of that bay. If herbicide treatment occurred, the bay was surveyed after treatment to provide a post-treatment assessment. The same rake sampling methods from the whole-lake point-intercept survey were used. A report of findings was compiled each year with the exception of 2022, during which there were five bays surveyed based on their EWM occurrence (Arapaho, Eagle, Swallow, Cardinal, and Hummingbird). Results of the bay-wide surveys in 2022 are summarized in this management plan.

Map Development

Aquatic plant survey data were uploaded to an open-source geographic information systems (GIS) program known as QGIS[2] for map creation.

1.7.2 2022 Whole-lake Point-intercept Survey Results

The maximum rooting depth of plants was 6.5 feet and there were 151 sample points shallower than the maximum rooting depth. Of those sites, 25 (17%) had vegetation present (Table 1, Figure 10). Diversity was low with only 8 species found on the rake (not including filamentous algae), another 2 species within 6ft of

[1] Bay-wide surveys, or sub point-intercept surveys, have been completed in various bays in Lake Redstone since 2014.
[2] QGIS Development Team, 2022. QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.

survey points but not on the rake (considered "visual"). The Simpson Diversity Index was 0.77. The Floristic Quality Index was 13.4, which is lower than the average value for other lakes in the same ecoregion and statewide. Overall, the aquatic plant community of Lake Redstone is extremely sparse with low species richness.

Eurasian watermilfoil, small pondweed, wild celery and sago pondweed were the 3 most common species found in 2022 with littoral frequencies of 9%, 5%, and 3% (wild celery & sago pondweed), respectively (Table 2). Together, they accounted for 83% of the total relative frequency, which further indicates that Lake Redstone supports a highly homogeneous plant community. Maps of individual species are in Appendix B.

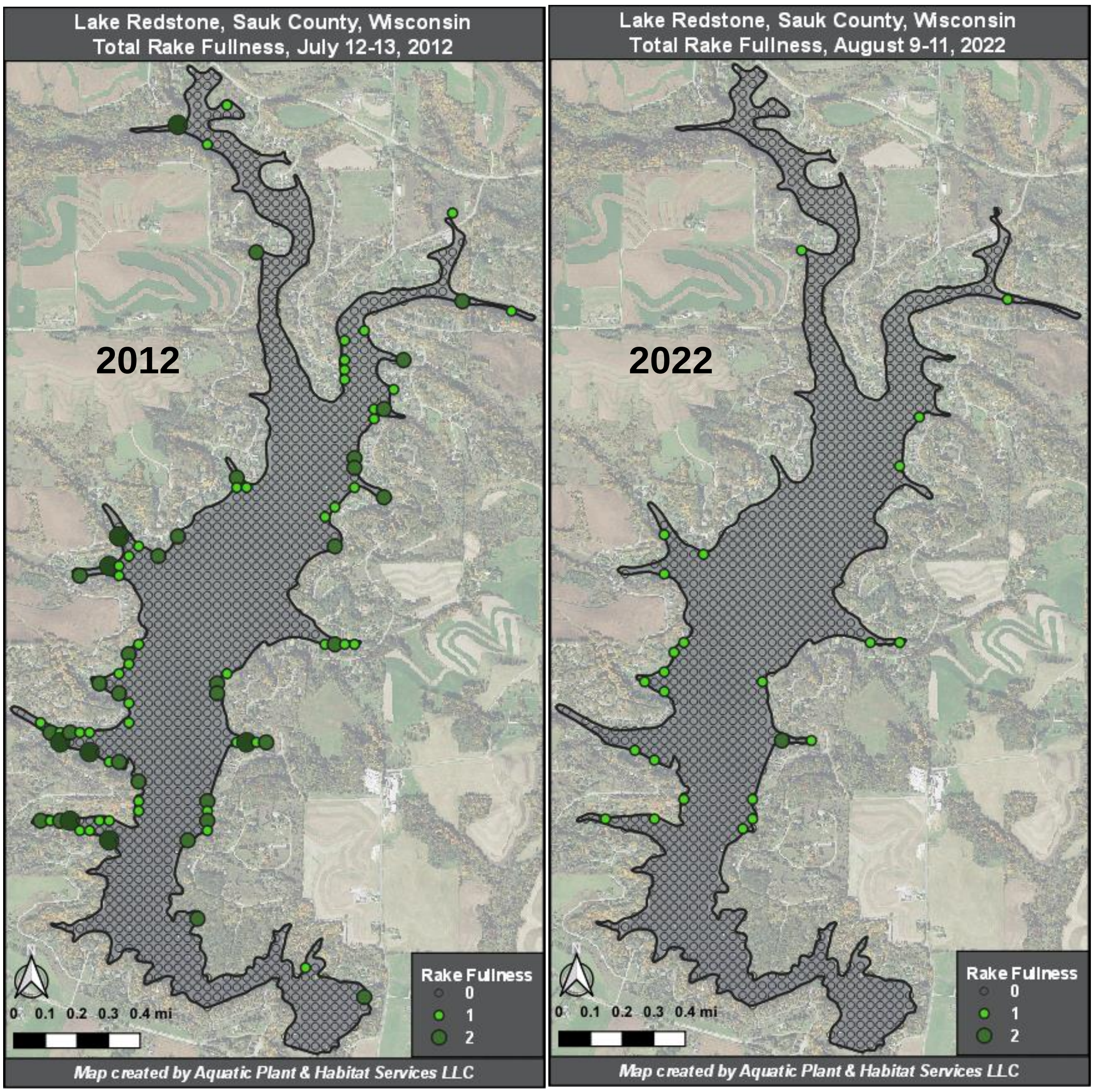
Table 1 – Aquatic Plant Survey Results for Lake Redstone 2005, 2012 & 2022

Summary Statistic			Aug 2005	July 2012	Aug 2022
1	Total # of sites visited		290	966	966
2	Total # of sites with vegetation		75	85	25
3	Max. depth of plants (feet)		12	10	6.5
4	Total # of sites shallower than max. depth of plants		255	337	151
5	Frequency of occurrence at sites shallower than max. depth of plants (Littoral FOO)		29.41	25.22	16.56
6	Average # of species per site	a) Shallower than max. depth	0.49	0.44	0.23
		b) Vegetated sites only	1.65	1.74	1.40
		c) Native shallower than max. depth	0.46	0.26	0.14
		d) Native species at vegetated sites only	1.57	1.40	1.40
7	Species Richness	a) Total # species on rake at all sites	8	10	8
		b) Including visuals	11	14	10
8	Simpson's Diversity Index		0.75	0.75	0.77
9	Mean Coefficient of Conservatism		3.71	5.13	4.75
10	Floristic Quality Index		9.8	14.5	13.4
11	Eurasian Watermilfoil Littoral Frequency of Occurrence		3.1	17.8	9.3
12	Curly-leaf Pondweed Littoral Frequency of Occurrence		0.0	0.30	0.0
2005 – Survey completed by Wisconsin Department of Natural Resources 2012 – Survey completed by Endangered Resource Services LLC 2022 – Survey completed by Aquatic Plant & Habitat Services LLC					

Table 2 – Aquatic Plant Species in Lake Redstone, 2022

Common Name	Scientific Name	FOO in Veg. Areas	Littoral Frequency	Relative Frequency	# Sites	Avg. Rake Fullness	# Visual
Eurasian water milfoil	*Myriophyllum spicatum*	56.00	9.27	40.00	14	1.00	21
Small pondweed	*Potamogeton pusillus*	28.00	4.64	20.00	7	1.14	2
Sago pondweed	*Stuckenia pectinata*	16.00	2.65	11.43	4	1.00	1
Wild celery	*Vallisneria americana*	16.00	2.65	11.43	4	1.00	2
Coontail	*Ceratophyllum demersum*	8.00	1.32	5.71	2	1.00	1
Slender naiad	*Najas flexilis*	8.00	1.32	5.71	2	1.00	0
White water lily	*Nymphaea odorata*	4.00	0.66	2.86	1	1.00	14
Horned pondweed	*Zannichellia palustris*	4.00	0.66	2.86	1	1.00	0
Filamentous algae		4.00	0.66	-	1	1.00	1
Curly-leaf pondweed	*Potamogeton crispus*	0	0	0	0	0	1
Small duckweed	*Lemna minor*	0	0	0	0	0	8
Aquatic Invasive Species							

Figure 10 – Lake Redstone Total Rake Fullness 2012 & 2022



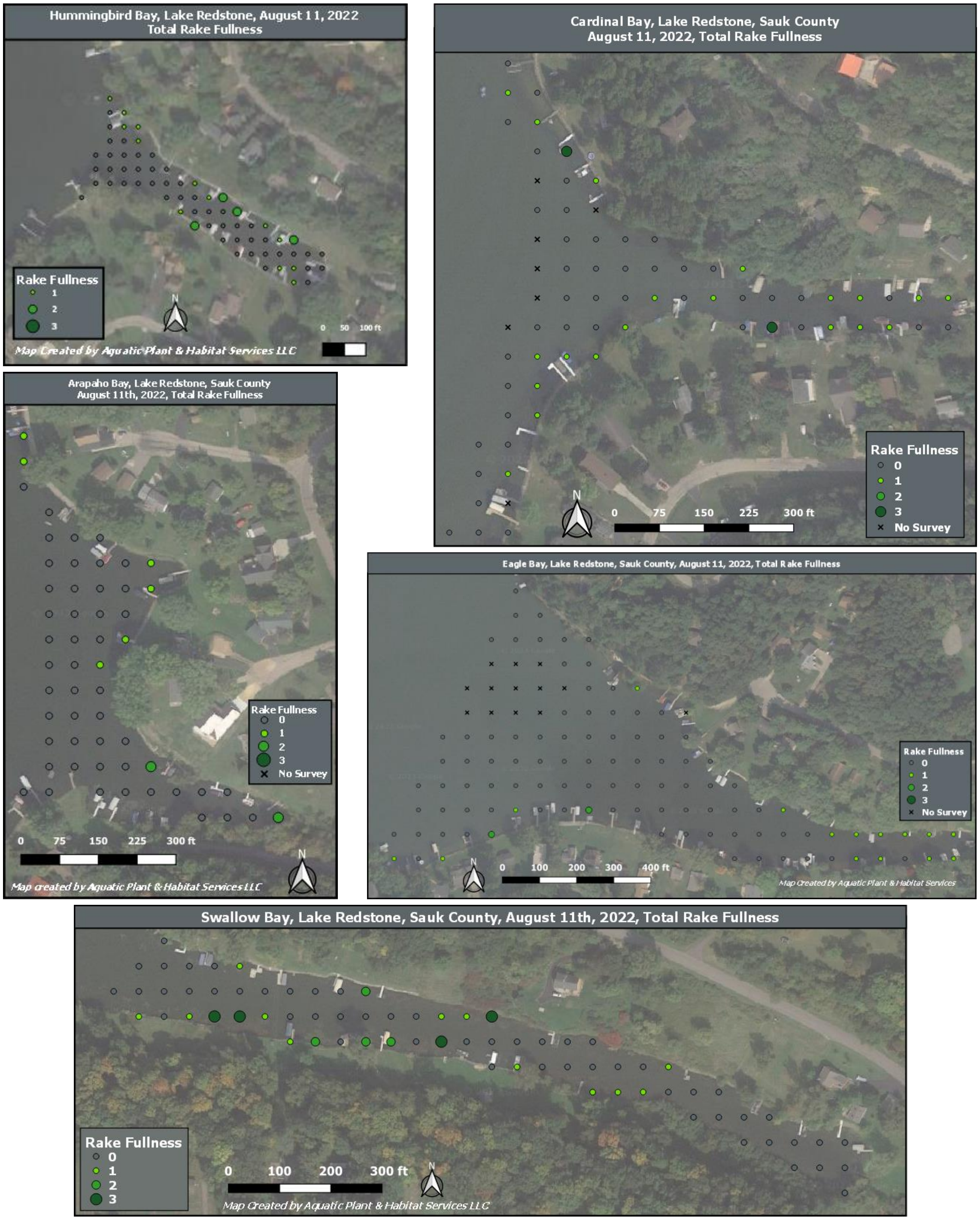
1.7.3 2022 Sub Point-Intercept Survey

On August 11th, 2022 there were 5 bays surveyed using a grid of sample points that were 15-20 meters apart (the whole-lake point-intercept survey sample points were spaced 50 meters apart). EWM was the most commonly occurring species in 4 of the bays (Table 3). The littoral frequency of aquatic plants in general (native and non-native) was 26% in Arapaho, 56% in Cardinal, 41% in Eagle, 35% in Hummingbird, and 39% in Swallow. These bay-wide surveys have higher aquatic plant occurrence than the whole-lake survey, which is expected since plants are generally more abundant in bays.

Table 3 – Aquatic Plant Species, Sub Point-Intercept Surveys 2022

Bay Name	Common Name	Scientific Name	Frequency of Occurrence at Veg. Sites (%)	Littoral Frequency (%)	Relative Frequency (%)	# Sites	Average Rake Fullness	# Visual
Arapaho*	Eurasian water milfoil	*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 water milfoil	*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 water milfoil	*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 water milfoil	*Myriophyllum spicatum*	66.67	23.53	44.44	12	1.33	7
	Coontail	*Ceratophyllum demersum*	27.78	9.80	18.52	5	1.00	3
	Sago pondweed	*Stuckenia pectinata*	22.22	7.84	14.81	4	1.00	0
	Small pondweed	*Potamogeton pusillus*	16.67	5.88	11.11	3	1.00	1
	Slender waterweed	*Elodea nuttallii*	5.56	1.96	3.70	1	1.00	0
	Slender naiad	*Najas flexilis*	5.56	1.96	3.70	1	1.00	0
	Wild celery	*Vallisneria americana*	5.56	1.96	3.70	1	1.00	1
	Water star-grass	*Heteranthera dubia*	-	-	-	-	-	1
	White water lily	*Nymphaea odorata*	-	-	-	-	-	7
	Filamentous algae		-	-	-	-	-	3
Swallow	White water lily	*Nymphaea odorata*	85.00	32.69	56.67	17	1.47	25
	Eurasian water milfoil	*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

Figure 11 – Sub Point-Intercept Survey Maps of 5 Bays, 2022

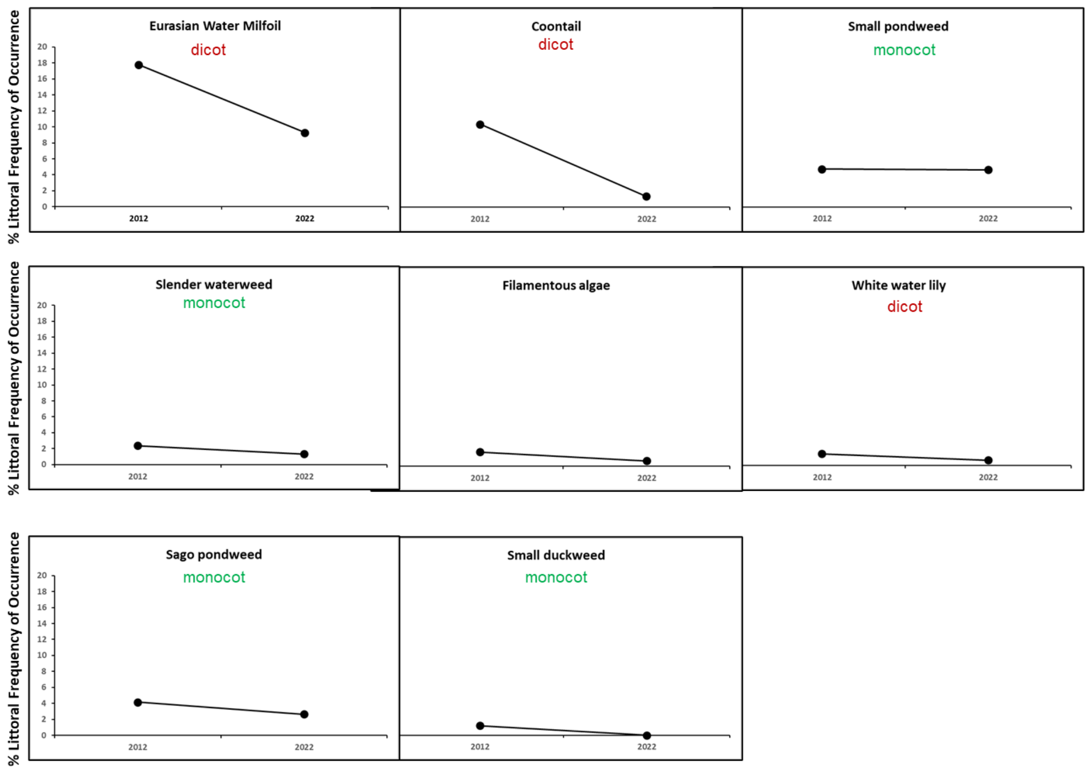


		Arapaho	Cardinal	Eagle	Hummingbird	Swallow
Total # of sites visited		55	68	101	55	69
Total # of sites with vegetation		8	22	17	18	20
Max. depth of plants (feet)		6	5.5	5.5	6	5
Total # of sites shallower than max. depth of plants		31	39	42	51	52
Frequency of occurrence at sites shallower than max. depth of plants (Littoral FOO)		26%	56%	40%	35%	38%
Species Richness	a) Total # species on rake at all sites	5	7	7	7	4
	b) Including visuals	7	9	8	10	5
Eurasian Watermilfoil Littoral Frequency of Occurrence		19%	33%	21%	24%	12%

1.7.4 Aquatic Plant Species Changes 20012-2022

The results of 2012 vs 2022 chi-square analysis reveal a statistically significant (SS) decrease in six native species including coontail, small pondweed, sago pondweed, slender waterweed, white water lily, and small duckweed (Figure 12). There was also a statistically significant decrease in EWM and filamentous algae. In Figure 12 the percent littoral frequency is on the y-axis and each year a plant survey was completed is on the x-axis. Only species with a statically significant change (using Chi-squared tests) in comparing 2012 vs. 2022 are displayed.

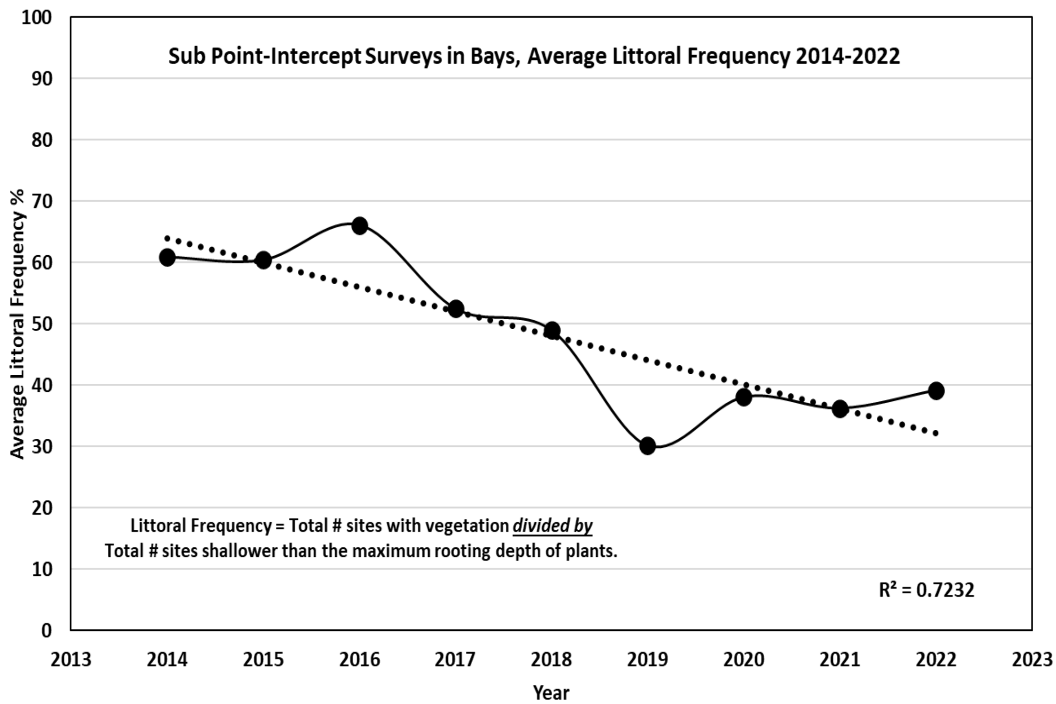
Figure 12 - Percent Littoral Frequency & Aquatic Plant Changes 2012 & 2022



1.7.5 Aquatic Plant Decline

The decrease in aquatic plant occurrence 2012-2022 (Figure 10), the statistically significant decrease in 6 native species (Figure 12), and the overall decrease in average littoral frequency of aquatic plants in bay-wide surveys (Figure 13) suggest there is an overall decline in aquatic plants in Lake Redstone since 2012. Figure 13 is the combination of surveys in many bays since 2014. The list of bays surveyed each year varied as did the number of bays surveyed. With the exception of 2019-2020 when bays were surveyed to gauge the impact of dredging, bays selected for survey were generally those with a high occurrence of EWM and plants in general reportedly causing impairment. Thus, averaging the littoral frequency of all bays in a given year is a reasonable approach for assessing overall aquatic plant occurrence over time. A summary of results for the bay-wide surveys (sub point-intercept surveys) is in Appendix C.

Figure 13 – Average Littoral Frequency 2014-2022



1.8 Fishery

The following is copied from an article by Nathan Nye, WDNR Senior Fisheries Biologist. This article was included in the annual spring newsletter[3].

<u>2022 Surveys & Dates</u>

*"The DNR fisheries crew from Poynette began a comprehensive fishery survey of Lake Redstone in the spring of 2022, the first since 2010-2011. This type of survey is normally completed every 10 years, but the COVID pandemic and some other time-sensitive survey work set the survey back a couple years. The survey included two spring netting surveys, two spring electrofishing surveys, and a fall electrofishing survey. The first netting survey started at ice out and ran from April 5-April 23. This survey targeted **walleyes** which were marked with fin clips for a population estimate. This survey also captured thousands of **panfish** and over 150 **muskies** which were marked with small internal tags (PIT tags) for a population estimate. The first electrofishing survey occurred on April 25 and targeted **walleyes**; this was the recapture event for the population estimate. The second netting survey ran from May 2-May 6 and targeted **muskies**, although **muskies** were mostly done spawning by that time and the **musky** catch was low. The survey did yield a lot of great **crappie** data, however. The second electrofishing survey occurred on the nights of May 16 and May 23, and targeted **bass** and **panfish**. The fall electrofishing survey occurred on October 11, targeting juvenile **walleyes**. The final piece of the survey will come in spring 2023 when another netting survey will again target **muskies**; this serves as the recapture effort for the **musky** population* monocot *estimate. What did we find? Overall, 17,439 fish representing **22 species and hybrids** were collected. Nearly 90% were collected during the two spring netting periods."*

<u>Bluegills, Crappies, & Yellow Perch</u>

***"Bluegills** were the most abundant species collected at 63% of the total catch. Size structure wasn't great with relatively few fish over 8 inches, and only one fish over 9 inches collected. The data suggest that poor size structure is due to limited growth potential and not overharvest. **Bluegill** growth lags behind the area average and most of the **bluegills** over 8 inches that were sampled were at least 10 years old with a maximum age of 12. These were older ages than we see in most area lakes which typically top out around age 8 or 9. For reference, the statewide average for **bluegill** growth is 8 inches by age 8, and in most area lakes **bluegills** reach 8 inches by age 6 or 7. Large **bluegills** in Lake Redstone are very old fish and even at advanced ages they don't show the potential to grow much past 8.5 inches. **Crappies** were abundant, with **white crappies** slightly more numerous than **black crappies**. Size structure for both species was good with the proportion of fish over 10 inches comparing favorably against other area lakes. Lake Redstone appears to have the best top-end size potential for **black crappies**; it is the only lake in Columbia and Sauk counties where **crappies** over 15 inches have been observed in a survey since 2010. The largest **crappie** recorded in the 2022 survey was a 17.4-inch whopper! **White Crappies** averaged 10 inches at age 4, while **black crappies** averaged over 10 inches by age 6. Both **crappie** species likely utilize **gizzard shad** as a significant part of their diet which is one of the things that allows them to reach such large sizes. **Yellow perch** were present,*

[3] https://www.lakeredstonepd.org/newsletters

*and abundance was similar to 2010 and about average compared to other area lakes. Size structure was just below the middle of the pack compared to other area lakes, although admittedly **yellow perch** populations in most small lakes in southern Wisconsin aren't too impressive in terms of the size of fish they produce. **Yellow perch** growth was on par with area and state averages."*

Walleye

*"Looking back, the **walleye** population in 2010 was excellent, with an estimated 4.4 adult **walleyes** ≥ 15 inches per acre. At that time, the population was well above the desired goal of 2 adults/acre in stocked fishery and the average of 1.7 adults/acre in stocked lakes in Wisconsin. However, the 2022 population estimate was much lower at 0.75 adults/acre. The 2010 population was produced almost entirely through the stocking of small fingerling fish, although the stocking rates and frequency were above recommended levels as part of an experimental study. Since 2010, stocking returned to recommended levels. Fall electrofishing surveys in 2017 and 2021 (years when DNR stocked small fingerlings) found that survival of stocked fish from spring to fall was not what it used to be, and we expected this decline in survival to be reflected in fewer adult fish in the lake, which the 2022 survey proved to be true. The two most abundant year classes of fish in 2022 were age 2 and age 4, representing years when large fingerlings were purchased from a private producer for stocking by the Lake Redstone Fishing Club. The writing is on the wall, and DNR will be switching to stocking large fingerling **walleyes** moving forward. Better survival of the large fingerlings to adulthood should increase adult abundance remarkably over the next several years. **Walleye** growth was slightly better than area and state averages, with fish reaching legal harvest size by age 4 on average. **Walleyes** in Lake Redstone have the potential to exceed 28 inches in length, and fish of that size observed in 2022 were females that were age 10 or older."*

Muskellunge

***"Muskies** are stocked in Lake Redstone every other year at the rate of one large fingerling (~12 inches) per acre in the fall, and the population is entirely sustained through stocking. The **musky** population in 2010-2011 was 0.33 fish ≥ 30 inches per acre (200 fish), and this was right where it should be when managing for a trophy fishery. After the 2010-2011 survey, the minimum length limit for musky in Lake Redstone was raised from 40 inches to 50 inches to support the trophy management strategy. The spring 2022 survey saw 159 unique muskies sampled, most of them during the first netting period in April. Musky spawning activity appeared to peak in mid-April when water temperatures were in the low 40s and this was true in 2010 as well. This differs from the norm in that the fish appear to spawn at water temperatures that are 10 degrees colder than they do in many other waterbodies. The reason for this is unclear, and netting efforts for the recapture survey in 2023 will focus on the period immediately following ice out. Data collected in 2022 indicated that **musky** size structure has improved in Lake Redstone under the 50-inch minimum length limit. The average length of **muskies** in 2022 was 39.2 inches, nearly 4 inches longer than 2010. The largest fish sampled was a 48.4-inch female, nearly 2 inches longer than the largest fish in 2010. Proportions of the population larger than 38, 40, and 42 inches were all higher in 2022 compared to 2010, and the proportion of 45-inch fish was the same. We anticipate the population will be similar numbers-wise to 2010 once the final* *part of the survey is completed in 2023. Age and growth analysis for muskies will be completed late this winter."*

Bass

"Largemouth *and* ***smallmouth bass*** *were also collected, and abundance of both species was in the middle of the pack compared to other area lakes. Most* ***bass*** *were collected by electrofishing.* ***Largemouth bass*** *up to 19.5 inches were sampled, and population size structure based on size-specific electrofishing catch rates was again in the middle of the pack compared to other area lakes.* ***Smallmouth bass*** *up to 17.4 inches were collected and like* ***largemouth bass****, population size structure was middle of the road compared to other area lakes with* ***smallmouth bass*** *populations."*

Summary of Results

"Overall, Lake Redstone's fish populations are robust and healthy*.* ***Walleye*** *abundance will improve following adjustments to the stocking program.* ***Musky*** *abundance appears to be right where it should be, and no adjustments to stocking are needed. Abundance of other species is right where it should be compared to other area lakes, as well as lakes across the state like Lake Redstone (small to medium-sized impoundments of small streams). Fish growth is good in most cases except for* ***bluegill*** *which just don't have the high-end growth potential that they do in some lakes.* ***Gizzard shad*** *and other abundant prey fish help fuel good growth of predator species, but competition with* ***gizzard shad*** *my hinder growth of* ***bluegills****. Good public access, healthy fish populations, and a picturesque setting make Lake Redstone a great place to go fishing in southwestern Wisconsin."*

1.9 Wildlife

The Wisconsin Natural Heritage Inventory (NHI) lists species and natural communities that are known or suspected to be rare in Wisconsin. The species are legally designated as endangered or threatened or they may be listed in an advisory capacity of special concern. The NHI lists species according to township and range, which includes T13N R03E for Lake Redstone. There are four NHI species in the Lake Redstone area (Table 4).

Table 4 – Rare Plant & Animal Species

Common Name	Scientific Name	State Status
Bell's Vireo	Vireo bellii	Threatened
Muskroot	Adoxa moschatellina	Threatened
Red-shouldered Hawk	Buteo lineatus	Threatened
Rock Clubmoss	Huperzia porophila	Special Concern

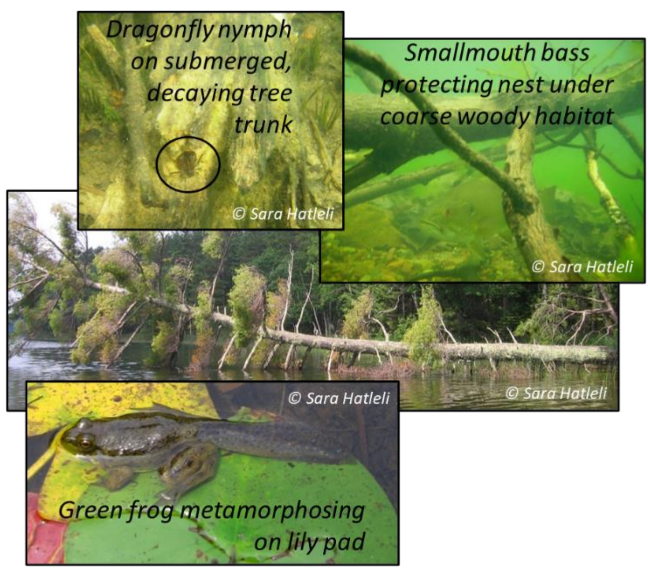
Information retrieved dnrx.wisconsin.gov/nhiportal/public/data/township Feb 27, 2023

1.9.1 Wildlife Habitat

There are many ways that lakeshore residents can improve wildlife habitat. Leaving trees, shrubs, and vegetation is one way to protect existing habitat because the zone within 100 feet of the lakeshore and into the shallows of the lake is a critical area for mammals, birds, reptiles, amphibians, and fish. If a lakeshore has already been cleared and developed then simple habitat restoration could include selection of areas that will not be mowed. Planting native plants and landscaping in a way that is aesthetically pleasing also supplies habitat for wildlife.

Near shore vegetation in the lake creates habitat for frogs, turtles, furbearers, and waterfowl. Minimal clearing in this area will maintain critical habitat for these animals and important areas for fish spawning and development. Fallen trees along the lakeshore also provide structural habitat for wildlife and fish. Examples are illustrated in Figure 14. There are grant programs that promote placement of trees back in the water, but it is much easier to leave trees where they fall naturally whenever possible.

Figure 14 – Near Shore Habitat Photos



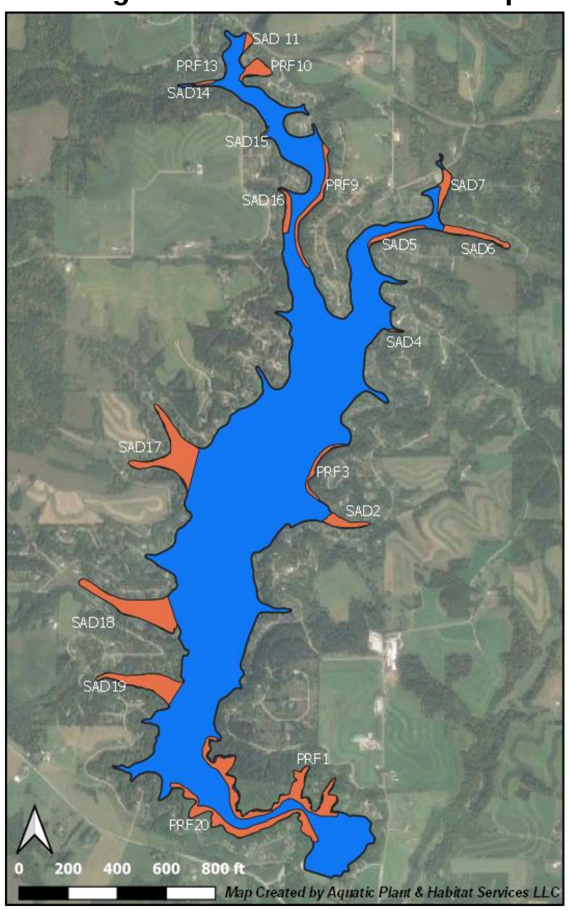
1.9.2 Critical Habitat

Every waterbody contains critical habitat, which are areas most important to the overall health of aquatic plants and animals. There are 20 such locations in Lake Redstone that were designated by the WDNR (Sefton & Graham, 2009). Two areas are not mapped in Figure 15 because they are separated from the main lake area by a bridge or culvert. The remaining 18 areas were designated as “sensitive areas” or “public rights features”.

Public Rights Features (PRF) provide fish and wildlife habitat, water quality protection, or that have reaches of shore that are predominately natural in appearance or that screen man-made or artificial features, and are not necessarily dependent on the presence of aquatic vegetation. For example, these areas may include mature forest or cliff faces, natural streambed features such as riffles or pools, or areas of lake or streambed where fish nests are visible.

Sensitive Area Designations (SAD) are a type of PRF defined specifically for stands of aquatic vegetation that provide critical or unique fish and wildlife habitat, including seasonal or life stage requirements, or offer water quality or erosion control benefits to the area. All aquatic plant management activities in Lake Redstone undergo careful review to ensure adverse impacts to lake ecology are avoided.

Figure 15 – Critical Habitat Map



2.0 Aquatic Invasive Species

2.1 Aquatic Invasive Species in Lake Redstone

Aquatic invasive species (AIS) are defined by their tendency to out-compete native species thereby threatening the diversity and balance of plants and animals that are native to a particular system. The aquatic invasive plant of greatest concern in Lake Redstone is Eurasian watermilfoil. The only other non-native plant species found during the 2022 aquatic plant surveys were curly-leaf pondweed (*Potamogeton crispus*) and purple loosestrife (*Lythrum salicaria*). Ornamental water lily (*Nymphaea sp.*) and yellow iris are also documented on the WDNR webpage for Lake Redstone but were not observed in 2022. The four latter species do not pose a serious threat to the lake ecosystem or recreation at the time.

2.2 Eurasian Watermilfoil in Lake Redstone

A survey of EWM beds completed by Cason & Associates in 2022 found 19 acres of dense or moderately dense EWM, which is 3% of the lake surface (Figure 17). Much of this was concentrated in the middle third of the lake and mainly along "open" shoreline (i.e., not in sheltered bays). Eurasian watermilfoil was the most commonly occurring aquatic plant in Lake Redstone in 2022 but was only found at 14 sample points (Figure 16). EWM was significantly lower in 2022 compared to 2012 (Figure 12). Although reduction in EWM is generally considered a positive change, it is noteworthy that EWM provides some habitat in a lake with very little aquatic plant structure. EWM, along with native plant species, uses phosphorus that would otherwise be available for nuisance / harmful algae.

Figure 16 – EWM Occurrence Maps 2012 & 2022

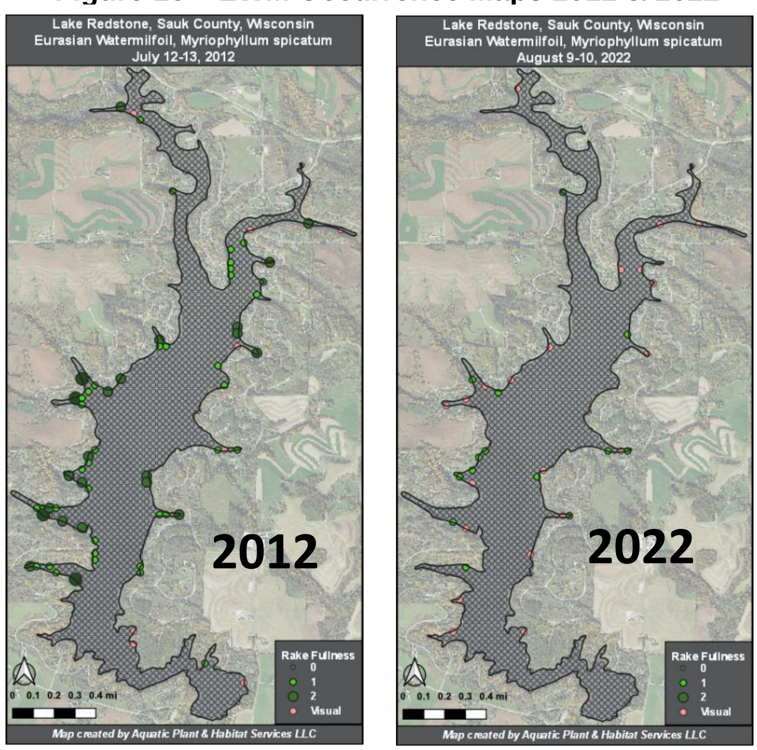
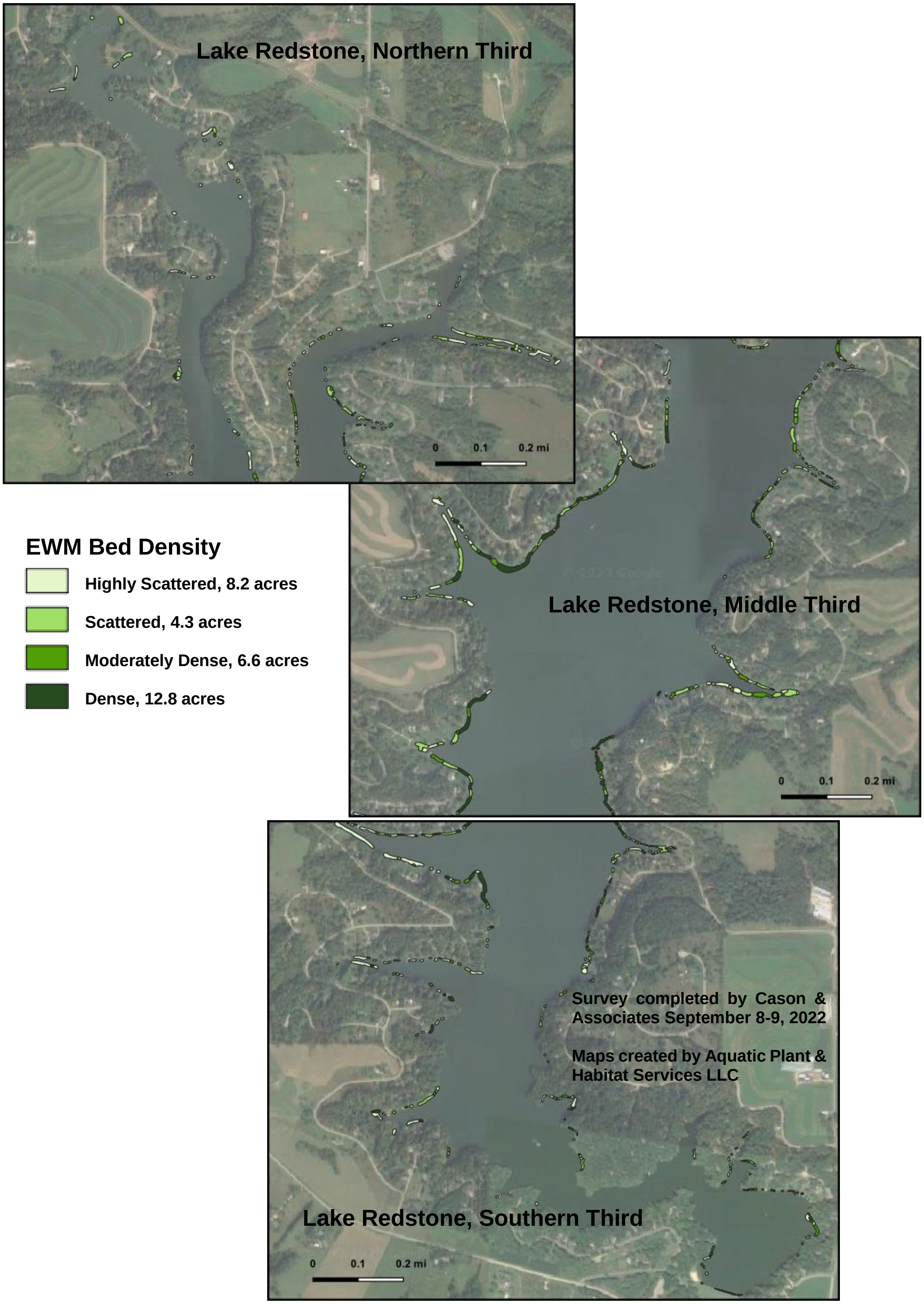


Figure 17 – EWM Bed Survey Maps, 2022



2.3 Aquatic Invasive Species NEAR Lake Redstone

The invasive species of greatest concern for introduction into Lake Redstone are stony starwort (*Nitellopsis obtusa*) and zebra mussels. These are not the only nearby invasive species. However, steps taken to prevent the introduction of starry stonewort and zebra mussels will help prevent the introduction of other invasive plants and animals. Starry stonewort looks like an aquatic plant but it is actually a type of macro algae. It can outcompete other vegetation and forms monotypic stands that may reduce fish spawning habitat. The nearest waterbodies with verified starry stonewort are Lake Emery and Kilby Lake located approximately 30-35 miles northeast of Lake Redstone and near Montello (Marquette County). The nearest waterbodies with verified zebra mussels are Castle Rock Lake, Delton Lake, and Lake Wisconsin. A single zebra mussel was found in nearby Dutch Hollow Lake in 2022 but continued monitoring is needed to know whether there is an established population. The proximity of these lakes with invasive species is relevant because boats leaving a lake with AIS can introduce the plants or animals into other lakes if proper prevention steps are not taken (see section 3.0 on AIS prevention).

Figure 18 – Nearest Lakes with Starry Stonewort & Zebra Mussels

2.4 Public Input & Planning

2.4.1 Lake User Survey

LRPD conducted a survey of households in the district in summer 2022. There were 212 respondents, which is about 25% of the households in the district. There were 17 questions that focused on water quality, aquatic plants, and shoreline buffers and a full description of results is on the LRPD website[4]. There were 4 questions directly related to aquatic plants, the results of which are summarized here:

- Most respondents (50%) said that aquatic plant presence ***somewhat*** impacts their enjoyment of the lake while 20% said ***a lot*** and about 30% said ***not at all***.
- Most respondents (60%) said that they are ***very concerned*** or ***concerned*** about aquatic plant growth in front of their property.
- Most respondents (84%) either ***strongly support*** use of DNR approved chemicals or ***support in some instances***. There were 1.5% who ***strongly oppose*** use of chemicals.
- Just under half of respondents would be ***interested*** in attending a workshop about manually harvesting Eurasian watermilfoil.

2.4.2 Public Meeting

Figure 19 – Lake Redstone Public Input Meeting

A public meeting was held September 22nd, 2022 at the LaValle Town Hall to present information and gather public input regarding aquatic plant management in Lake Redstone. A notice of the meeting was published in the Reedsburg Independent September 15th. The input was used in developing goals for this management plan. There were fourteen people in attendance including the facilitator (Sara Hatleli, Aquatic Plant & Habitat Services LLC), Sauk County Watershed Coordinator (Mitchell McCarthy), and WDNR Lakes Coordinator (Arthur Watkinson). During the meeting, information was shared on the 2022 aquatic plant survey results, comparisons to the 2012 aquatic plant survey, Eurasian watermilfoil (EWM) occurrence, water quality issues, aquatic plant management alternatives for the lake, and Sauk County Cost Share Funding Program. A worksheet was provided during the meeting for participants to track the feasibility of management options. The most feasible options discussed were

[4] https://www.lakeredstonepd.org/survey-2022

localized manual removal, future chemical treatment, and ongoing nutrient control. Participants were also given the opportunity to provide verbal input, which was recorded by a volunteer from the Lake Redstone Protection District. A complete summary of written and verbal comments is found in Appendix D.

2.4.3 APMP Review and Comment

A draft of this management plan was available to the LRPD Aquatic Plant Committee on March 14th through March 20th. Minor changes were made and more explanation was included regarding biological control using weevils. Also, information from the 2022 fish survey was included using a newsletter article written by the WDNR Fisheries Biologist.

A second draft of the plan was sent to the WDNR and Sauk County for another round of review on March 21st. Recommended changed included the addition of shoreland cost-share opportunities through Sauk County (Section 1.5) and the addition of "obstruction to navigation" as additional criterion for herbicide treatment (Goal 2). As a result of this recommendation, Table 7 was developed and added to Goal 2 to help LRPD determine whether herbicide treatment is a good control option for a particular location.

The third draft was made available to the general public for review and comment from April 6th through April 27th, 2023. A public notice was placed in the Reedsburg Independent and on the LRPD website on April 6th, 2023. The following question was the only feedback received during this period: Are there beneficial native plants that could be planted in a cost effective manner? Answer: Unfortunately, there is not a way to plant submersed plants in a cost effective manner. Better water clarity is first needed in Lake Redstone so that sunlight can penetrate into greater depths and aquatic plants can grow deeper than they currently are (we aren't finding plants deeper than 7 feet). In theory, once the water clarity improves, there should be greater submersed aquatic plant growth, including Eurasian watermilfoil (EWM). Even so, the possibility of increased EWM occurrence is, at present, less of an ecological concern than the low water clarity conditions of Lake Redstone.

Adoption by the Lake Redstone Protection District

The plan was sent to LRPD on May 1, 2023 for adoption. The APMP was unanimously adopted with no changes required at the regularly scheduled May 2nd LRPD meeting.

Approval by the WDNR

The APMP was provided to the WDNR on May 1, 2023 with the request for official approval. The plan was officially approved by the WDNR on May 25th with no changes required (approval letter in Appendix F).

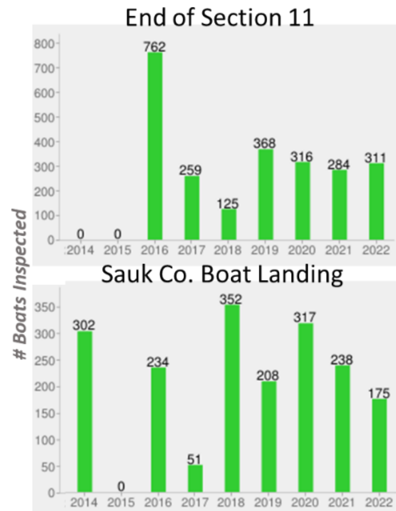
3.0 AIS Prevention & Monitoring

3.1 Clean Boats Clean Waters

Watercraft inspection through the Clean Boats Clean Waters Program has been active since 2014 at the Sauk County boat landing and since 2016 at the boat landing at the end of Section 11 Road. There were 175 and 311 boats inspected, respectively, in 2022 During watercraft inspections, boaters are asked to:

- **Inspect** boat, trailer and equipment
- **Remove** all attached plants or animals
- **Drain** all water from boats, motors, livewells and other equipment
- **Never** move live fish away from a waterbody
- **Dispose** of unwanted bait in the trash
- **Buy** minnows from a Wisconsin bait dealer, and use leftover minnows only if using them on that same waterbody.

Figure 20 – Lake Redstone Watercraft Inspections



Every year, the Clean Boats Clean Waters Program promotes the **Drain Campaign**, which is a set of education materials, outreach events and media designed to help anglers remember to drain their livewells and buckets before leaving the landing. The campaign recommends ice as a safe and legal alternative to keep fish fresh during transport. The **Landing Blitz** is a statewide effort every fourth-of-July weekend to remind boaters to stop the spread of aquatic invasive species. Fourth-of-July is Wisconsin's busiest boating holiday.

3.2 Internet Landing Installed Device Sensor (I-LIDS)

Even when a watercraft inspector is not present, boat launching activities can be recorded by a motion-activated camera and reviewed by paid interns, volunteers, or other workers in order to detect whether a boat was launched with aquatic plants attached to a trailer, which is illegal in Wisconsin. Boaters are more likely to comply with watercraft inspection requirements when the I-LIDS system is in place (Figure 21). This device is not currently installed at any public boat landing in Lake Redstone. The device is solar powered and requires Verizon 4G data service onsite. Cost of device, materials, and installation is approximately $16,000 and annual cost of operation of approximately $2,500. Grant funding is available to help pay for initial costs, but not annual costs.[5]

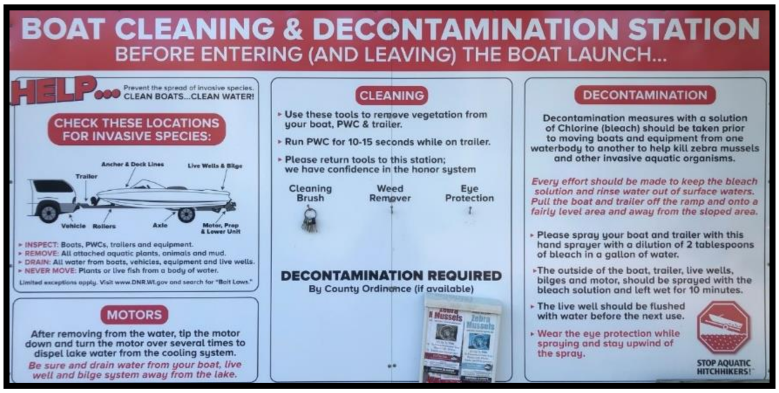
Figure 21 – I-LIDS Photo

[5] Surface Water Grant Applicant Guide 2022, page 130.

3.3 Decontamination Station

A decontamination station is another option for boaters when watercraft inspectors are not present. The sign includes instructions for watercraft inspection and using a mild bleach and water solution to spray on the boat, trailer, and equipment (Figure 22). There are currently no decontamination stations established at Lake Redstone boat landings.

Figure 22 –Decontamination Station Sign



3.4 Boater's Advisory Signage

There are many different signage options intended to capture boaters' attention and increase compliance with watercraft inspection steps. Figure 23 illustrates one such sign where there have been heightened efforts to prevent zebra mussels from spreading to other lakes in the area.

Figure 23 – Zebra Mussel Advisory Sign

4.0 Past Aquatic Plant Management

4.1 Management Plans

An aquatic plant management plan was approved for implementation in January 2015. Pages 11-14 of the 2015 APMP describe the history of herbicide treatment in Lake Redstone beginning in 1980 and are copied in Appendix E. The evolution of herbicide treatment in Lake Redstone is described, which has led to the current approach of focusing herbicide treatments in sheltered bays in order to achieve greater efficacy of EWM control. This section highlights aquatic plant management activities occurring from 2015 through 2022.

4.2 Aquatic Plant Surveys

Whole-lake point-intercept aquatic plant surveys using statewide standardized methods from Hauxwell et al (2010) have been completed in 2005, 2012, and 2022. Sub-point-intercept surveys of certain bays have been done since 2013. Bays with higher EWM occurrence and impairment have been targeted for surveys in a given year in order to provide pre-post treatment data to gauge herbicide treatment efficacy.

4.3 EWM Control 2015-2022

Herbicides were used to control EWM in Lake Redstone 2015 through 2018 (Table 5). No herbicide was used 2019 through 2022. With the exception of 2015, recent herbicide treatments have occurred in sheltered bays.

Table 5 – Herbicide Treatment History 2015-2022

Herbicide Treatment History, 2015 to 2022						
Year	Date	Applicator	Locations	Area (acres)	Herbicide Amount, Brand, Active Ingredient(s) & Applied Concentration	Aquatic Plant Survey
2015	May 12	Cason & Associates	Martin-Meadowlark & Swallow Bays	7.8	21.6 gal DMA 4 IVM at 1.5 ppm	July 18
	July 7		25 properties	0.7	1.6 gal Reward, conc. not listed	None
	July 23		NA	NA	2.25 gal Tribune, conc. not listed	NA
2016	May 29		Cardinal, Oriole & South Chickadee Bays	11.8	92.7 gal DMA 4 IVM, 2 ppm 26 gal Tribune, 0.245 ppm	Aug. 17
2017	May 8		Hummingbird Bay & northern-most Woodpecker Bay	1.76	6.6 gal DMA 4 IVM, 2 ppm 0.47 gal Tribune, 1.5 gal/acre	Sept. 8
2018	May 14		Cardinal, Eagle, Mourning Dove, & Swallow Bays	17.17	2.6 gal Tribune, 0.311 gal/acre-foot 140 gal Shredder Amine4, 2.5-3 ppm	Aug. 24
2019-2022, No herbicide treatment						

4.3.1 EWM Frequencies as Triggers for Herbicide Treatment

EWM littoral frequencies can help decide where herbicide treatment should occur, if at all. Table 6 lists the littoral frequencies of EWM the year before they were treated with herbicide. 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. The average pre-treatment littoral frequency of EWM for bays controlled with herbicide (not including Woodpecker) is approximately 36%. Therefore, if EWM frequency for a sub PI survey in a bay is over 36%, herbicide treatment may be a reasonable control option.

Table 6 – Pre-treatment EWM Frequency

Bay & Year		Littoral frequency of EWM (pre-treatment)	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.*

4.3.2 2019 Dredging

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[6]. Thirteen bays were surveyed before and after dredging to gauge the impact on aquatic plants. All 13 bays had higher or the same EWM occurrence in 2020 when compared to 2019[7]. The increase in EWM was statistically significant in 5 of those bays. This was unexpected because the act of dredging removes sediment and along with it come roots and seeds. However, EWM and non-native/invasive species in general thrive in disturbed environments and the dredging may have opened a niche for EWM to recolonize more quickly than native species. Also, root balls not fully removed and/or fragments of EWM readily grew in the dredged areas. Regrowth from seed is not a likely primary mechanism of recovery for EWM, although the possibility of some EWM seed germination isn't ruled out.

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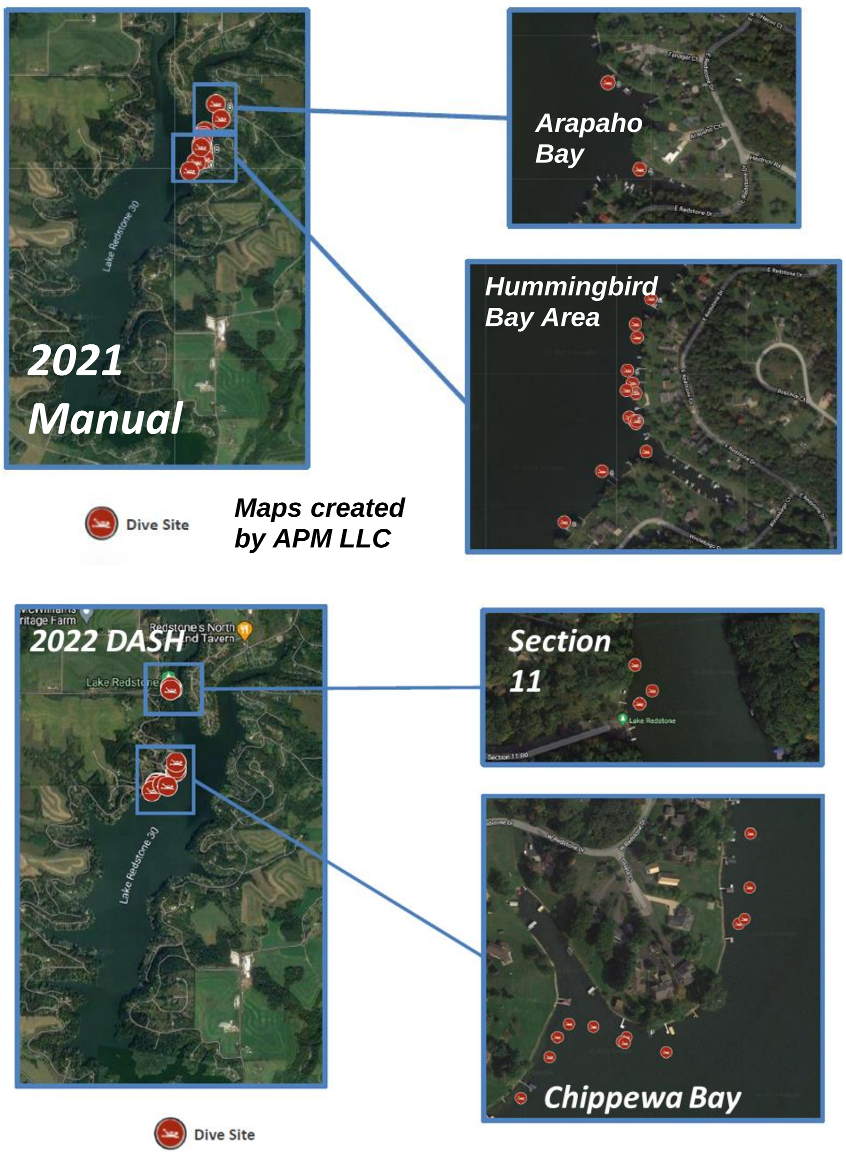
[6] https://www.lakeredstonepd.org/dredging-meeting-minutes. June 2018 Dredging Informational Meeting PowerPoint Presentation.

[7] Mourning Dove Bay was not surveyed in 2019 because dredging was already underway in July. Data from 2020 is compared to 2018 for Mourning Dove Bay. Woodpecker Bay had essentially the same EWM occurrence in 2020 at 0% compared to 1% in 2019.

4.3.3 2021-2022 Manual Removal & Diver Assisted Suction Harvest (DASH)

In June 2021, Aquatic Plan 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. Again in June 2022 APM was hired for four days to use DASH for EWM removal near the Section 11 boat landing and near Chippewa Bay. LRPD representatives at the planning meetings in September and November 2022 shared reluctance to use LRPD funds for hiring DASH and manual removal workers again due to the high cost and limited area that can be covered.

Figure 24 – EWM Manual Removal & DASH Locations



5.0 Plant Management Options

The best way to manage aquatic plants will be different for each lake and depends on the plant community, the species that require control, whether AIS are present, the level of human use of the system, and various other background information previously presented in this management plan. Aquatic plant management rules can be found in Wisconsin Administrative Codes, Chapters NR107 (chemical), NR109 (manual/mechanical), NR40 (invasive species) and Chapter 30/31 (waterways). Many management activities require a permit.

There are five broad categories for aquatic plant management:

- **No active management,** which means nothing is done to control plant growth, but a strong monitoring and education component may be included.
- **Manual & mechanical removal of plants**, which includes hand pulling, raking, using plant harvesters, and diver assisted suction harvest.
- **Chemical treatment**, which is the use of herbicide to kill aquatic plants.
- **Physical habitat alteration,** which means plants are reduced by altering variables that affect growth such as sediment, light availability, or depth.
- **Biological control**, which includes the use of living organisms, such as insects, to control plant growth.

The benefits and limitations of each of these broad groups is described. All actions are accompanied by risks and potential impact to non-target aspects of a lake, but the benefits must outweigh those risks and potential detriments.

5.1 Feasibility Factors

In order for a control method to be appropriate, it must be feasible from a biological, social, and financial perspective. ***Biological feasibility*** infers the control action will not cause significant harm to other aspects of lake ecology. ***Socially feasible*** actions are those that have support from project partners and in this case include LRPD, WDNR, and Sauk County. Social feasibility also infers that control actions meet regulatory requirements and will be formally permitted by regulatory agencies. ***Financial feasibility*** simply implies that any control action is affordable for the LRPD and partners providing cost share.

5.2 No Active Management

Sometimes the best course of management is to take no immediate action. There are many benefits including the lack of disturbance to desirable native species and the lake system, there is no financial cost (aside from possibly survey costs), there are no unintended consequences of chemical treatment, and no permit is required. Disadvantages to this approach include the potential for AIS infestations to grow. This approach often includes a strong monitoring and educational component. ***A "No Active Management" approach is feasible for Lake Redstone in the short term due to the low occurrence of EWM lake-wide and in bay wide surveys. If this approach is taken, however, it should be accompanied by a strong monitoring and education component.***

5.3 Manual & Mechanical Control

Manual and mechanical control includes pulling plants by hand or by using harvesting machines or devices. Permits are required for some activities and there are a variety of options under this type of control. Mechanical control is regulated under Chapter NR 109[8].

5.3.1 Manual Plant Removal

Figure 25 – Manual Removal Photo

Shore land property owners are allowed to manually remove a 30-foot wide section of native aquatic plants parallel to their shoreline without a permit. This can only occur in a single area and there must be piers, boatlifts, swim rafts, or other recreational or other water use equipment within that 30-foot zone. This method can only be employed where other plant control methods are not being used. Regulations require that the native plant community is not harmed during manual removal of AIS. Benefits of include little overall damage to the lake and plant community, the removal can be highly selective, and can be very effective in in small clusters of EWM. On the other hand, this method can be very labor intensive. ***Manual removal in Lake Redstone is feasible for small-scale control around docks, boat lifts, and other water use equipment. Manual removal is also feasible to complement herbicide treatment one year later. Permits are required for manual removal in critical habitat areas (***Figure 15***).***

5.3.2 Diver Assisted Suction Harvest (DASH)

Figure 26 – DASH Photo

This form of mechanical removal involves the use of suction tubes connected to pumps mounted on a barge or pontoon. The suction tubes reach to the bottom of the lake and SCUBA divers manually uproot plants (often EWM) to be sucked through the tubes, up to the barge, and strained. DASH is also selective toward EWM thereby protecting native and low frequency species and can be highly effective. DASH is labor intensive and costly at $2,500-$3,000 per day and speed of removal depends on density, EWM height, and the number of different locations. ***Continuing DASH to control EWM is feasible in small infestation sites, perhaps to be hired independently by lakeshore property owners. DASH is also feasible to complement herbicide treatment one year later, which is often a good integrated approach.***

[8] Chapter NR 109 https://docs.legis.wisconsin.gov/code/admin_code/nr/100/109.pdf.

5.3.3 Mechanical Harvest

This method includes "mowing" of aquatic plants down to depths of 5 feet and then collecting the plants and removing them from the lake. Mechanical harvesters are required to operate in depths of 3 feet or greater in order to minimize sediment disturbance in shallow areas. This technique is most appropriate for lake systems with large-scale or whole-lake aquatic plant issues. ***Mechanical harvest is not a feasible option for Lake Redstone due to the low aquatic plant occurrence and near-shore location of EWM beds.***

Figure 27 – Mechanical Harvester Photos

5.4 Chemical Control

Figure 28 – Chemical Treatment Photo

This method entails partnering with a certified herbicide applicator that will follow label guidelines and restrictions. There are herbicides intended to target specific plant species. For EWM control, an herbicide generally known as 2,4-D is often used because it is supposed to be selective to broadleaf plants such as milfoils. More recently, ProcellaCOR is being used and studied in Wisconsin to better understand its efficacy and impacts to native plants, if any. If the native plants are reduced by repeated chemical control, there is more area for invasive species to grow. Also, if the duration of EWM control only lasts for one or two growing seasons, one should weigh the financial costs combined with impacts to native plants versus the relatively short-lived control.

The feasibility of chemical control of EWM in Lake Redstone depends on several factors such as the location of treatment and whether any native species are at risk. The use of 2,4-D in bays since 2015 has been largely successful, however the low occurrence of aquatic plants lake-wide suggests extra caution is needed when considering herbicide treatment to avoid unintended decline of native plants.

5.5 Physical Habitat Alteration

Various physical habitat alterations exist and most are not appropriate for consideration Lake Redstone. Many of these alterations require a Chapter 30 permit.

5.5.1 Bottom Barriers

Bottom barriers prevent light from reaching aquatic plants, but kill all plants, and some allow for gas accumulation under the barrier and subsequent dislodging, they can impact fish spawning and food sources, and an anaerobic environment below the barrier could cause nutrient release from the sediment. ***Bottom barriers are appropriate for public swimming areas but not recommended in front of private properties.***

5.5.2 Drawdown

This control technique involves the lowering of water levels in fall and exposing sediments to freezing and drying, which results in plant death before allowing the lake to refill the following spring and summer. Although a dam is located at the south end of the lake, drawdown is not a favorable option for biological, economic, and social reasons. The biological reasons have to do with drawdown efficacy in controlling EWM and the potential impacts to the fishery. A successful drawdown would require lowering water levels at least 5 feet and would also require a cold and relatively dry winter to allow adequate freezing of the exposed sediments. If the winter is too mild or if there is too much snow insulating the sediments, EWM control would likely be compromised (WSDE, 2017). A drawdown would result in lower lake levels for fall, winter, spring and likely the entire summer, which would significantly impact recreation. For these reasons, ***drawdown is not recommended as a control technique at this time.***

5.5.3 Non-point Source Nutrient Control

No permit is required for this type of nutrient management, which reduces the runoff of nutrients from the watershed. As a result, fewer nutrients enter the lake and are therefore not available for plant growth. This approach is beneficial because it attempts to correct the source of a nutrient problem and not just treat the symptoms. Controlling non-point source pollution is always a good idea. Efforts are underway through Lake Redstone's 9-Key Element Plan.

5.6 Biological Control

5.6.1 Insects

Figure 29 – Milfoil Weevil

A native insect commonly known as the milfoil weevil (*Euhrychiopsis lecontei*) is a biological control agent for EWM. The native weevils lay eggs in the tips of milfoil plants. When the larvae hatch, they feed on the tips of the stem and burrow into the stem. Furthermore, adult weevils feed on leaves of milfoil plants. The weevils are native to Wisconsin and normally feed on northern water-milfoil (*Myriophyllum sibiricum*) but have demonstrated preference for EWM, even when native milfoil species are present (Solarz & Newman, 2001). Jester et al. (2000) conducted a study of Wisconsin lakes and found that most lakes containing EWM also contained weevils. It is not known whether native populations of weevils already exist in Lake Redstone. Stocking weevils has been done on other lakes, but whether they effectively control EWM depends on the ability for the weevil to survive in the introduced lake. They require natural shorelines for overwintering and seem to survive best in shallow milfoil beds (Jester, 2000). Furthermore, predation can be a major limiting factor in weevil survival, especially when high populations of sunfish (*Lepomis sp.,* including bluegill) are present (Ward & Newman, 2006). Havel et al. (2017) found lakes with a history of herbicide treatment had lower weevil densities compared to their similar but untreated counterpart lakes.

If biological control were to be pursued, the first step would be to determine whether the native weevils are already naturally present and in what densities.

6.0 Management Strategy 2023-2027

6.1 Goal 1 – Protect native aquatic plants, organisms, and associated native mammal and fish populations.

Objective 1a: Minimize the manual removal of native plants for navigation and recreation.

- Property owners can remove aquatic plants with restrictions under Wisconsin Administrative Code, Chapter NR109 (see Section 5.3.1). Manual removal is not allowed in areas designated as critical habitat (Figure 15) without a permit.
- If property owners remove the plants manually (not mechanically or chemically), this should only be done at a minimal level to meet the goal of protecting native plant species. This message will be shared at education sessions listed in Goal 3 and posted on the LRPD website.
- Incorporate the importance of native species protection into education sessions and outreach materials (LRPD website, newsletters, and social media).

Objective 1b: Inform shore land property owners about permit(s) for manual removal of Eurasian watermilfoil in critical habitat areas.

- Manual removal of EWM does not require a permit unless it is done in critical habitat areas illustrated in Figure 15.
- Lake Redstone shore land property owners may apply for a permit to remove EWM manually in areas designated as critical habitat. LRPD will serve as a supporting body to these district members by providing information on the LRPD website and at educational sessions listed in Goal 4.

Implementation of Goal #1 - Protect native aquatic plants, organisms, and associated native mammal and fish populations.								
Goals, Objectives, and Action Items		Entities Involved	2023	2024	2025	2026	2027	Surface Water Grant Eligible
1a	**Minimize the manual removal of native plants for navigation and recreation.**							Yes
	Share this goals and rules about manual removal at educational sessions (Goal 4), LRPD website, and newsletters.	LRPD	X	X	X	X	X	
1b	**Inform shore land property owners about permit(s) for manual removal of Eurasian watermilfoil in critical habitat areas.**							Yes
	Post this information on the LRPD website, newsletters, social media, etc..	LRPD	X	X	X	X	x	

LRPD = Lake Redstone Protection District

6.2 Goal 2 – Objective 2a: Use integrated pest management to control EWM where impairment occurs.

- Use Table 7 in deciding whether herbicide treatment is a suitable option.
- ProcellaCOR has never been used in Lake Redstone and although it may be an option for future treatments, extra caution is recommended due to its impact to coontail[9] and the low occurrence of all aquatic plants on a lake-wide scale.
- Consider deploying herbicide enclosure / limno-curtains for 24 hours at herbicide treatments along shore that are adjacent to open water (i.e., not in sheltered bays).
- Encourage landowners to manually remove EWM around docks as needed, but not allowed in sensitive areas without a permit (See Obj 1a).
- Conduct a weevil presence survey to determine whether the native weevil that feeds on milfoil species is present. If native EWM weevils are detected, protecting their overwintering shoreline habitat would be recommended as an additional tool that is no-cost and lasting for controlling EWM. An educational component would help explain that weevils would likely not eliminate all EWM but rather help keep its growth "in check." If weevils are not detected, stocking could be considered.

Table 7 – 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

Objective 2b: Continue sub-point-intercept surveys of herbicide treatment locations before and after treatment to track success of control efforts.

- LRPD will identify locations where sub-PI surveys should occur based on summer observations and reports of impairment. Sub-PI surveys can occur in bays and along exposed shoreline beds of EWM targeted for herbicide treatment. This activity is dependent on EWM occurrence.
- Pre-treatment surveys will occur in late summer or early fall the year prior to herbicide treatment.
- Post-treatment surveys will occur in late summer or early fall the same year as herbicide treatment.

[9] Coontail is a native aquatic plant that can sometimes grow to nuisance levels or even cause navigation obstruction. Due to the low occurrence of aquatic plants in Lake Redstone, the protection of all species, including coontail, is recommended for the duration of this management plan unless conditions dramatically change.

Objective 2c. Continue late summer / early fall EWM bed surveys to track EWM acreage, density, and location.

- Surveys will occur lake-wide in late summer or early fall each year. Results will be used to prioritize EWM control efforts and track EWM acreage.

Objective 2d. Conduct a whole-lake PI survey in 2027.

- Follow standardized methodology and compare results to 2005, 2012, & 2022.

<table>
<tr><th colspan="9">Implementation of Goal #2 - Monitor and manage Eurasian watermilfoil to maintain occurrence that aligns with beneficial use of Lake Redstone.</th></tr>
<tr><th colspan="2">Goals, Objectives, and Action Items</th><th>Entities Involved</th><th>2023</th><th>2024</th><th>2025</th><th>2026</th><th>2027</th><th>Surface Water Grant Eligible</th></tr>
<tr><td>2a</td><td colspan="7">Use integrated pest management to control EWM where impairment occurs.</td><td rowspan="5">Some herbicide treatment is eligible for grants, herbicide enclosure and weevil survey are eligible.</td></tr>
<tr><td></td><td>Use trigger frequencies of 36%-42% for herbicide treatment in bays.</td><td>RP, LRPD, WDNR</td><td colspan="5">Years when herbicide treatment is used.</td></tr>
<tr><td></td><td>Consider herbicide enclosure when herbicide treatment occurs along “open” shore area(s).</td><td>RP, LRPD, WDNR</td><td colspan="5">Years when herbicide treatment is used along “open” shore areas.</td></tr>
<tr><td></td><td>Encourage manual removal of EWM around docks but not in sensitive areas.</td><td>LRPD</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td></td><td>Milfoil weevil survey.</td><td>LRPD, RP</td><td colspan="5">Any year, one-time activity</td></tr>
<tr><td>2b</td><td colspan="7">Continue sub-point-intercept surveys of herbicide treatment locations before and after treatment to track success of control efforts.</td><td rowspan="4">Yes</td></tr>
<tr><td></td><td>LRPD identify locations of sub-PI surveys.</td><td>LRPD</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td></td><td>Conduct pre-treatment surveys as needed.</td><td>RP</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td></td><td>Conduct post-treatment surveys as needed.</td><td>RP</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2c</td><td colspan="7">Continue late summer / early fall EWM bed surveys to track EWM acreage, density, and location.</td><td rowspan="2">Yes</td></tr>
<tr><td></td><td>Annual surveys in late summer/early fall.</td><td>RP</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>2d</td><td colspan="7">Conduct a whole-lake PI survey in 2027.</td><td rowspan="2">Yes</td></tr>
<tr><td></td><td>Use standardized methodology.</td><td>RP</td><td></td><td></td><td></td><td></td><td>X</td></tr>
</table>

LRPD = Lake Redstone Protection District. RP = Resource Professional. WDNR = Wisconsin Department of Natural Resources

6.3 Goal 3 – Prevent the introduction of new aquatic invasive species.

Objective 3a. Continue watercraft inspections (see Section 3.1).

- Apply for grant funding each year to fund watercraft inspections.
- Continue watercraft inspections 2023-2027.
- Participate in the Drain Campaign in early summer each year.
- Participate in the Landing Blitz on weekend(s) of Independence Day each year.

Objective 3b: Work with Sauk County and Town of LaValle to consider decontamination station(s) if zebra mussel population in Dutch Hollow Lake is confirmed and reproducing (see Section 2.3).

Objective 3c: Work with Sauk County and Town of LaValle to explore installation of I-LIDS monitoring device at boat landing(s).

- LRPD I-LIDS material and grant options.
- If I-LIDS are supported by LRPD, all criteria are met in accordance with grant requirements, and the township(s) support installation, apply for AIS Prevention grant. Installation cost is grant eligible when an active watercraft inspection program is in place.

Objective 3d: If a new aquatic invasive species is confirmed, apply for early detection and response grant.

- If zebra mussels are confirmed, an early detection and response grant may help with funding for containment activities.

Implementation of Goal #3 - Prevent the introduction of new aquatic invasive species.								
	Goals, Objectives, and Action Items	Entities Involved	2023	2024	2025	2026	2027	Surface Water Grant Eligible
3a	**Continue watercraft inspections.**							Yes
	Apply for grant & continue inspections.	LRPD	X	X	X	X	X	
	Participate in the Drain Campaign each year.	LRPD	X	X	X	X	X	
	Participate in the Landing Blitz each year.	LRPD	X	X	X	X	X	
3b	**Consider decon. station(s) if ZM population in Dutch Hollow is confirmed and reproducing.**	LRPD, CO, WDNR, Town of LaValle	Timing dependent upon zebra mussel occurrence or absences and grant funding.					Yes
3c	**Work with Sauk County & Town of LaValle to explore installation of I-LIDS monitoring device at boat landings.**							The cost of device are grant eligible when an active watercraft inspection program is in place.
	If supported by LRPD, criteria are met, town & CO are supportive, apply for AIS Prevention grant.	LRPD, CO, WDNR, Town of LaValle	Timing dependent upon various details.					
3d	**If new AIS is confirmed, apply for early detection and response grant.**	LRPD, RP	Timing is based on new AIS detection.					Costs related to grant application services are not eligible

LRPD = Lake Redstone Protection District. CO = Sauk County. RP = Resource Professional. WDNR = Wisconsin Department of Natural Resources.

6.4 Goal 4 - Provide educational opportunities pertaining to aquatic plants, aquatic invasive species, and manual removal techniques.

Objective 4a: Organize two educational sessions that focus on AIS identification and prevention.

- During the summer months of 2023 through 2027, LRPD will sponsor at least two educational sessions that focus on AIS identification, preventing the introduction of starry stonewort and zebra mussels, native plant identification, manual removal, and goals of the management plan. Other possible topics include nutrients, water clarity, and aquatic plants.
- Emphasize the decline in plant occurrence overall and importance of protecting native species in the lake.
- Work with WDNR and/or private consultant to provide instruction.
- Include educational events in grant applications submitted in 2023-2026.
- Connect with the Friends of Dutch Hollow Lake to explore potential for offering educational sessions jointly.

Implementation of Goal #4 - Provide educational opportunities pertaining to aquatic plants, aquatic invasive species, and manual removal techniques.								
Goals, Objectives, and Action Items		Entities Involved	2023	2024	2025	2026	2027	Surface Water Grant Eligible
4a	**Organize two educational sessions that focus on AIS identification and prevention.**							Yes (costs related to grant application services are not eligible)
	Sponsor at least two educational events.	LRPD, RP	At least twice in 5 year period					
	Include in grant applications.	LRPD, RP	Include in grant applications					

LRPD = Lake Redstone Protection District. RP = Resource Professional.

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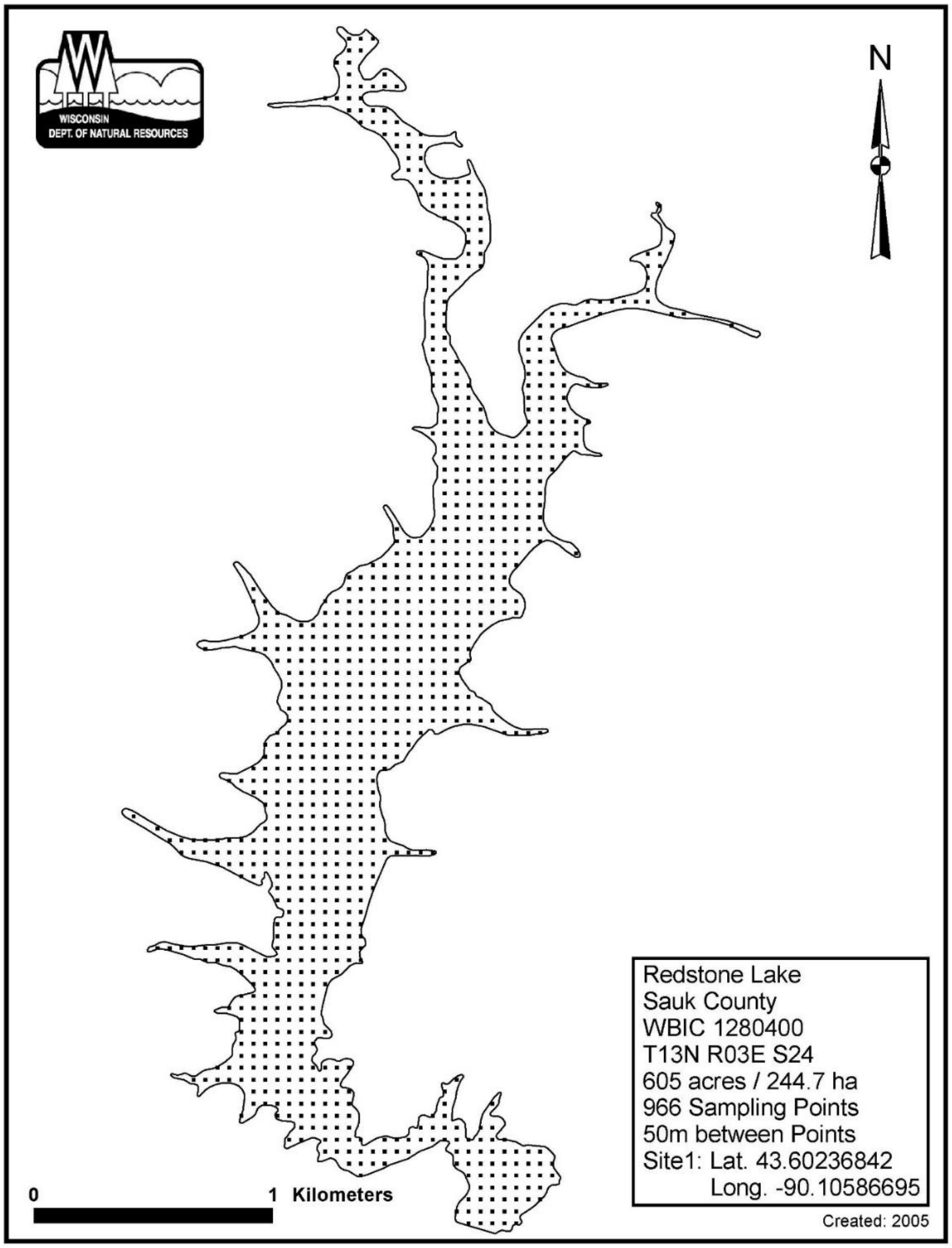
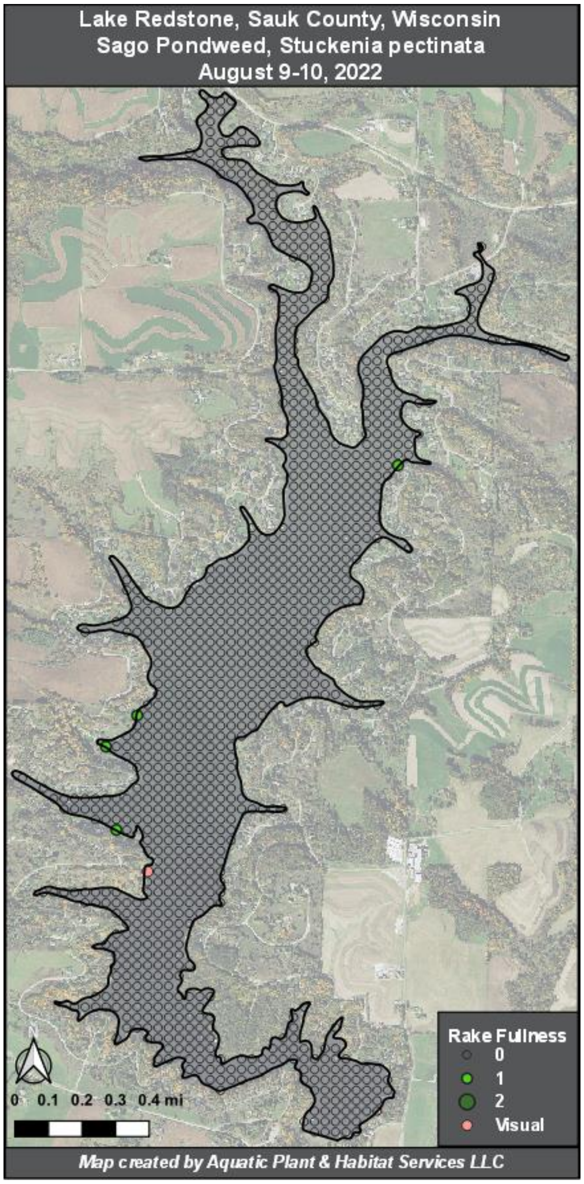
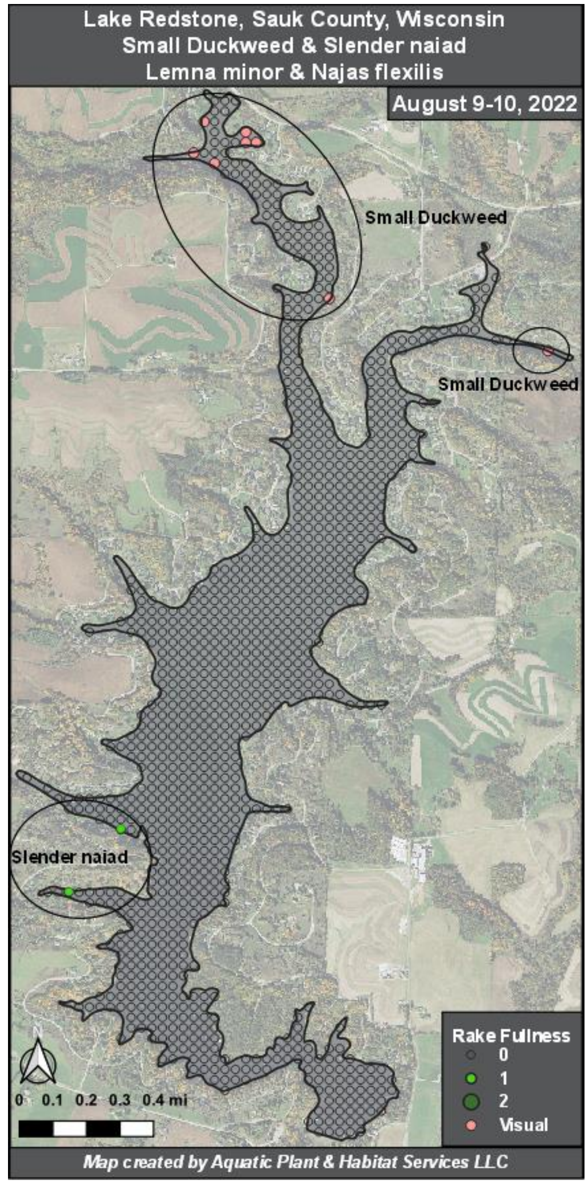
8.0 Appendix

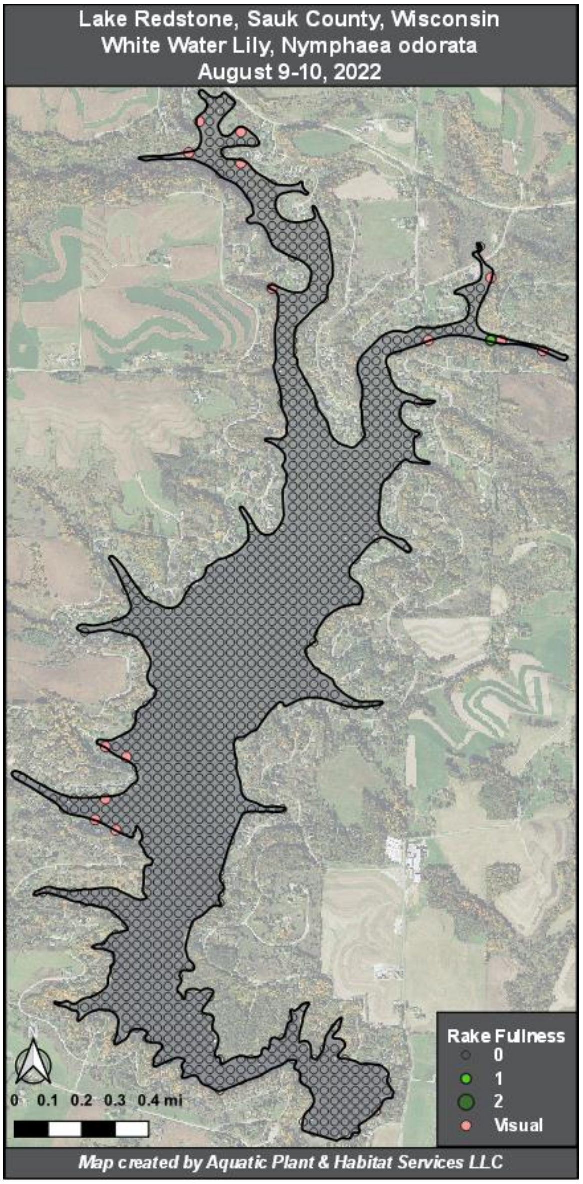
8.1 Appendix A – Lake Redstone Aquatic Plant Survey Grid

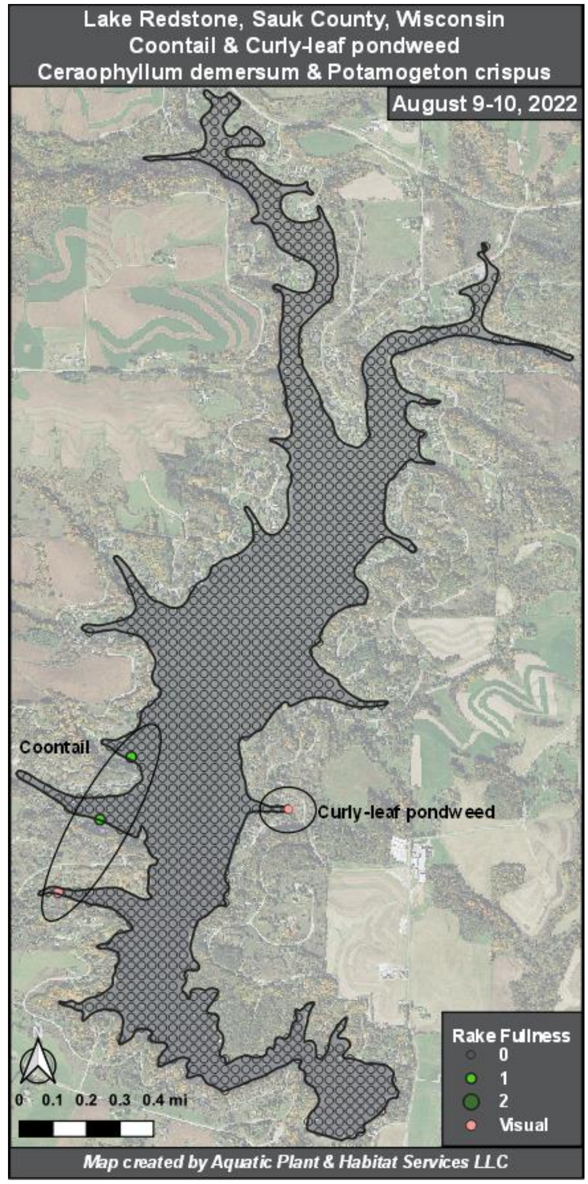


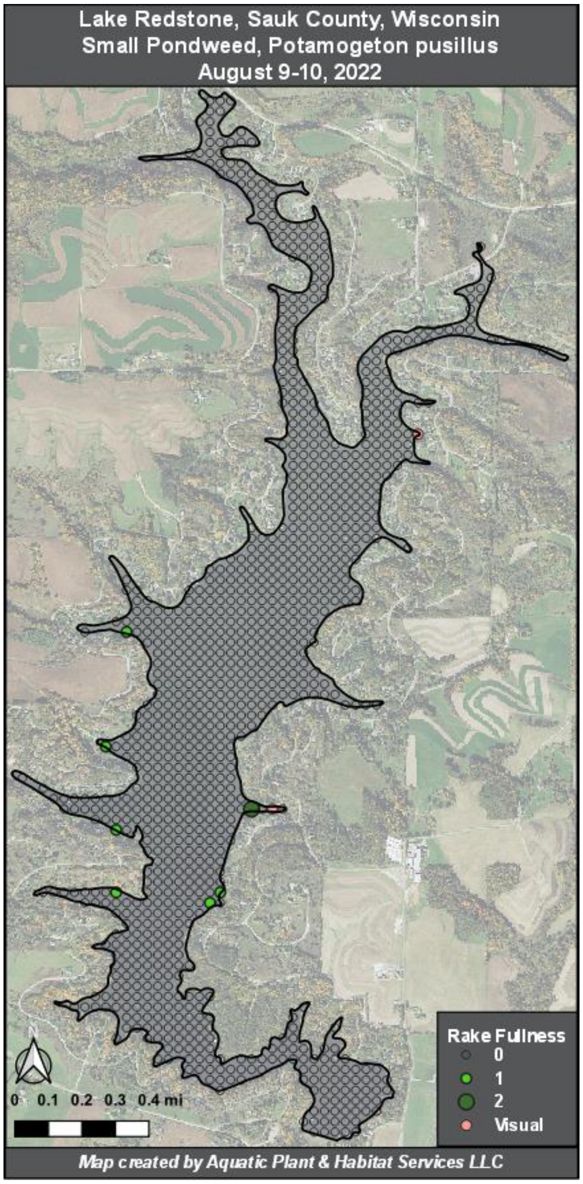
8.2 Appendix B – Lake Redstone Aquatic Plant Species Maps

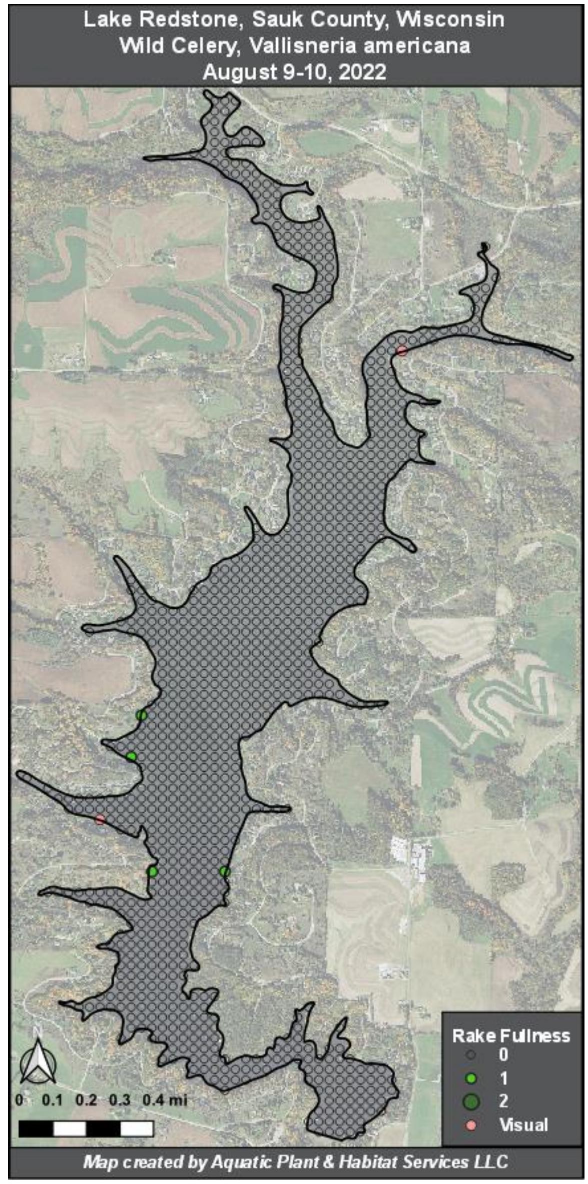


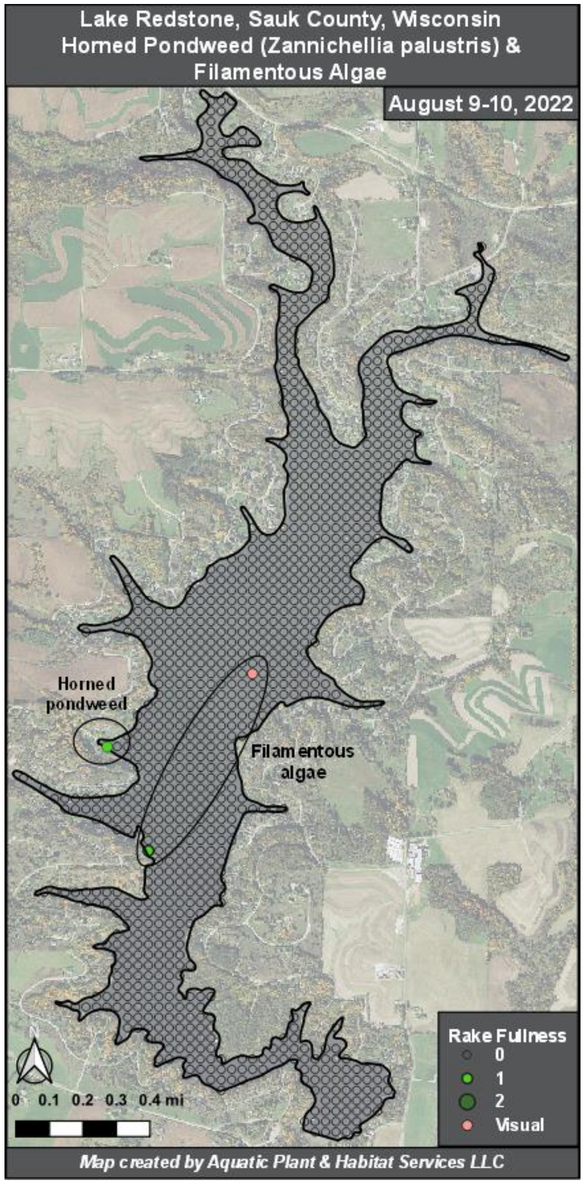



Lake Redstone, Sauk County, Wisconsin
White Water Lily, Nymphaea odorata
August 9-10, 2022
Rake Fullness
0
1
2
Visual
0 0.1 0.2 0.3 0.4 mi
Map created by Aquatic Plant & Habitat Services LLC


Lake Redstone, Sauk County, Wisconsin
Coontail & Curly-leaf pondweed
Ceraophyllum demersum & Potamogeton crispus
August 9-10, 2022
Coontail
Curly-leaf pondweed
Rake Fullness
0
1
2
Visual
0 0.1 0.2 0.3 0.4 mi
Map created by Aquatic Plant & Habitat Services LLC


Lake Redstone, Sauk County, Wisconsin
Small Pondweed, Potamogeton pusillus
August 9-10, 2022
Rake Fullness
0
1
2
Visual
0 0.1 0.2 0.3 0.4 mi
Map created by Aquatic Plant & Habitat Services LLC


Lake Redstone, Sauk County, Wisconsin
Wild Celery, Vallisneria americana
August 9-10, 2022
Rake Fullness
0
1
2
Visual
0 0.1 0.2 0.3 0.4 mi
Map created by Aquatic Plant & Habitat Services LLC



Lake Redstone, Sauk County, Wisconsin
Horned Pondweed (Zannichellia palustris) &
Filamentous Algae
August 9-10, 2022
Horned pondweed
Filamentous algae
Rake Fullness
0
1
2
Visual
0 0.1 0.2 0.3 0.4 mi
Map created by Aquatic Plant & Habitat Services LLC

8.3 Appendix C – SubPI Survey Results for Bays Surveyed 2015-2022

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	18	6	51	35.3	0.53	1.50	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).

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).

8.4 Appendix D – Public Input from Meeting September 22, 2022

Written Comments / Emails

1. I would like to see a drawdown by opening the lake bottom drain valve. Since the lake stratifies by temperature, o2 levels, and phosphorous. Allowing the opening of the large bottom valve (during times when the lake is high after heavy rains) would remove phosphorous from the lake bottom. This needs much discussion from our board and the water quality committee.
2. Have LRPD statements emphasize aquatic plant "control" (management), improved water clarity, and water quality improvement (vs. saying "weed removal" or similar).
3. Could a local company be hired or formed for timely, on-demand manual removal of EWM on riparian property? If properly trained and permitted, this could take some of the immediate concerns and complaints off of the LRPD so that the active management can focus on water quality and sediment control vs. plant treatments.

Verbal Comments / questions

How did 2022 plant survey compare to before dredging? Response: 8 plants in the lake showed a significant decrease in numbers from 2012 to 2022. Water clarity appears to be a factor driving the low plant occurrence. However, water clarity alone cannot be attributed to the decrease in plant occurrence since 2012 because we do not see a downward trend in water clarity that coincides with decreased plant occurrence. The water clarity is about the same as it was in 2012.
With a couple of years after dredging, is the plant growth increasing? Sara's response was: No, there is a downward trend in total overall plants.

EWM has some positives. By looking only to kill EWM could have detrimental effects on native plants.

Were surveys completed at the same time of year in 2012 and 2022? Per Sara the protocols require surveys to be done the same time of year, in July/August. They were performed within protocol requirements. Curly Leaf Pondweed dies off in early July and may be underrepresented in data. CLP has not caused issues in Lake Redstone and therefore an early-season CLP survey has not been done.

In 2012 EWM was in 60 locations. Now it is in 14 sites. There is a general downward trend of EWM in bays.

From an aesthetic view, even moderate density of EWM is still bad, as opposed to just causing navigational impairment.

When considering EWM treatment, DNR rule NR109 does not take aesthetics into account.

In previously treated bays, the EWM average presence that triggered EWM treatment was 36%

DASH (diver assisted removal) was on Lake Redstone for 4 days to remove EWM in 2022 but was not successful.

Under NR109, a permit is required for property owners wishing to employ DASH themselves. Can clear a 30-foot area without a permit if this is not in a sensitive area. Permitting takes about 15 days and is good through the year.

In the past, the Protection District was not successful in applying for property owners permits for EWM removal. There was not much interest.

Water clarity affects the success of DASH removal.

High phosphorus causes less clarity. Our recent social survey showed that residents wanted both lower phosphorus levels and higher water quality. Our water quality is about a 4 rating, but some people think differently.

There are grant opportunities for lake groups to obtain assistance for lake improvement.

Chemical treatment for EWM is not currently biologically feasible because EWM occurrence is low.

Are there any options for lake shoreline treatment of EWM? You can curtain off areas for treatment. Chemicals such as 2,4-D have been used. ProcellaCOR is a new herbicide being evaluated and can be explored. Limno-Curtains are a big job. The LRPD can explore options.

Alum treatment and other options are also available. For controlling internal phosphorus loads. This is an expensive option, and you must first address internal loading for phosphorus and decrease that which is being brought into the lake. We must determine how much phosphorus is due to internal loading, reduce external phosphorus loading before we can consider other methods.

Residents must apply for Sauk County projects by November 4, 2022. Sauk County (Mitchell McCarthy) does free consultations. Projects applications are ranked against other applicants. Mitch then does designs and overseas approved projects. These projects are designed to reduce erosion and runoff.

8.5 Appendix E – History of Herbicide Treatment in Lake Redstone

The following is copied from the 2015 APMP pages 11-14

Active Aquatic Plant Management

Aquatic plant management in Lake Redstone has been on-going since the early 1980's when the use of aquatic herbicides was first employed. In the years between the 1980s and 2002, algae and EWM were chemically treated in small localized populations by LRPD volunteers who had obtained Category 5 commercial applicator certification. During this time frame, algae was the dominant plant species in the lake and most treatments were to provide relief from nuisance algae blooms, not from excessive plant growth.

Around 2000, larger aquatic plants began dominating the lake. These larger aquatic plants were better for the lake and recreation began to improve, because large plant beds are localized problems while green water caused by algae blooms is lake wide. By 2002, the level of nuisance aquatic vegetation (EWM and certain native plants) in Lake Redstone reached a point where professional applicator services were required. Since the early 2000s, plant management permits applied for by the LRPD have included 25-33 acres of possible treatment. Chemical treatments have mostly been completed mid-summer in front of developed properties only. An applicator would be chosen by the LRPD at the beginning of the season, and then would patrol the littoral zone of Lake Redstone and under certain guidelines apply some combination of Navigate (granular 2,4-D, a systemic herbicide), Aquathol K (liquid endothall, a contact herbicide), Cutrine Ultra (a copper-based algaecide) and Reward (liquid diquat, a contact herbicide) at least once during the growing season with the management goal of controlling EWM and other nuisance level aquatic plants, duckweed, and algae. Often the applicator would be accompanied on the lake by LRPD and WDNR representatives. Although annual permit applications were for up to 33 acres, this level of management was very rarely, if ever reached over the last ten years. From 2005 to 2008, the WDNR completed a Critical Habitat Survey on Lake Redstone (5). After that survey was completed and presented to the LRPD by the WDNR in 2009, the following permit conditions were placed on chemical management actions in the lake.

- Mid-summer aquatic plant management is only to be implemented for the purpose of
- providing property owner relief from Eurasian watermilfoil growth and limited native
- aquatic plant growth.
- Summer treatments allowed primarily in high use areas in front of developed lots only and no more than 50-ft of shoreline can be treated in front of any one property, and then only if there is a need.
- In "sensitive areas" designated by the WDNR, 50-ft treatments will be approved only when the majority of offensive plants are EWM. If native plants comprise some or most of the plant population in a high use area and there is a navigational need, treatment may be allowed, but only up to 25-ft along the shoreline.
- If only native plants are present and navigation is not impeded, no treatment will be
- allowed.
- Because of the ecological value of water lilies, no treatment will be allowed within beds of lily pads. Lily pads are one of a few native plants that can survive and prosper when other native plants may struggle. They are not as affected by poor water clarity and competition with EWM, and provide excellent habitat for fish and other aquatic life.

7.3 2011 Chemical Management

In 2011, a permit was applied for by the LRPD for up to 33 acres of chemical management. In the absence of more quantifiable point-intercept aquatic plant survey data, bed-mapping survey work completed on June 1 by Cason and Associates was used to determine areas of nuisance level EWM growth. This type of survey is completed by visually inspecting the shoreline where aquatic plants grow and estimating the size of the EWM area and the density of the EWM growth in the area. GPS points are taken to help identify the border of the bed during off-lake mapping, and a rake toss may be done to help determine density. The presence of native plants is documented visually. This type of plant survey can be useful in planning and implementing EWM management, but is not quantifiable or truly repeatable and should only be considered anecdotal. Aquatic plant surveys conducted by Cason and Associates on Lake Redstone prior to 2015 were conducted in this manner so are not wholly quantifiable. Management of nuisance level EWM growth areas totaling 5.2 acres occurred on July 28. Generally an earlier treatment is better. Navigate® (granular 2,4-D) was used at a rate of 150 lbs/ac. A total of 775 lbs of Navigate® was used for the entire 2011 treatment. When aquatic herbicides are used for management of EWM, early spring treatments when water temperatures are between 10 and 15°C (50-60°F) are generally considered better for several reasons: 1) target species selectivity is better as many native aquatic plant species are still dormant and not actively growing; 2) the density of target plants is less reducing the amount of plant tissue to be killed by the herbicide and left in the system to decay; and 3) lake use conflicts are reduced as fewer people are using the lakes at this time. On August 16, Cason and Associates completed post-treatment survey work. During this survey it was noted that many of the areas of nuisance EWM that were treated on July 28 had greatly reduced levels of EWM, or had no EWM growing at all. No documentation on the impact of the treatment to native plants was made. It was also noted, that areas with less than nuisance level EWM that were not treated in July were at nuisance levels at the time of the August 16th survey (6). A fall survey was not completed.

7.4 2012 Chemical Management

On May 5, 2012 a survey of the aquatic plants in Lake Redstone was completed by Cason and Associates to determine the distribution of EWM and CLP. Only two locations of CLP were found, but the EWM appeared to have expanded beyond what was noted in the August 2011 survey (6). Chemical treatments targeting nuisance level EWM took place on June 21, 2012. In absence of an approved APM Plan, a single-property treatment size was set by the WDNR. If EWM made up the majority of the nuisance aquatic plant growth, 50-ft of the shoreline could be treated per property. If native plants made up some or most of the nuisance aquatic plant growth, then only 25-ft of the shoreline per property could be treated. The maximum label rate of Navigate® (200 lbs/ac) was applied at each property with nuisance EWM provided the area was not within a designated sensitive area identified in 2008. A total of 53 properties comprising only 1.87 acres were treated under the supervision of WDNR staff and LRPD members. When the June treatment was completed it was expected that additional management would occur later in the year. However, due to a possible risk of fishkill brought on by excessive heat and extreme drought conditions through the summer and fall of 2012, no additional chemical management was approved by the WDNR.

7.4.1 2012 Fall EWM Bed Mapping

Cason and Associates completed a fall bed mapping survey of Lake Redstone on September 17. Based on the 2012 fall bed mapping results from Cason and Associates, 39 acres of dense growth EWM were identified with an additional 17 acres of scattered EWM.

7.5 2013 Chemical Management

With the development of a new APM Plan underway, and some preliminary data that suggested a new approach to EWM management might be beneficial for the lake, changes in the existing management strategy were proposed and eventually agreed upon by the LRPD and the WDNR.

7.5.1 Large-scale, Early-season, Low Dose Chemical Treatment

Based on fall 2012 EWM mapping completed by Cason & Associates and the results of the 2012 PI survey, and after discussions between the LRPD, SEH, and the WDNR; large-scale, early-season, low dose chemical management was added to the 2013 treatment plan. On May 13, 16.26 acres, the entire area of Mourning Dove Bay (Figure 1), was treated using 160.9 gallons of herbicide (liquid 2,4-D). The goal was to apply enough herbicide to the entire volume of water within the selected bay to reach a target concentration of 2 parts per million (ppm). Only 4.5 acres of EWM was actually present in the bay. The advantages and disadvantages of this management approach are listed below.

Advantages

- Limits damage to native plants that aren't actively growing at that time
- Reduces conflicts with swimming, fishing and irrigation
- Completes treatment when EWM is small, but is actively growing, reducing the biomass that will decay
- Provides for longer contact times at concentrations known to kill EWM
- May provide long-term (more than just one season) relief from EWM growth.
- Restrictions on treatments in Sensitive Areas are eased

Disadvantages

- If target concentration within the bay is too high, or if contact time is longer than expected, greater damage could be done to native plants
- More expensive than completing small-scale spot treatments

With the aid of the WDNR, LRPD volunteers and a private contractor (Clearwater Consulting, LLC) chemical concentration monitoring to determine herbicide contact time with the target plants and the amount of time for the chemical to dissipate took place immediately following the treatment and for several hours and days after treatment. Pre and post treatment aquatic plant survey work in the treatment area was also completed, using the more quantitative point-intercept survey method. This data was collected to provide three things: 1) More accurate information to base recommendations for future aquatic plant management; 2) data on how much herbicide is needed to achieve desired results; and 3) data on herbicide dissipation rates in the treated area and in non-treated areas adjacent to treated area.

8.6 Appendix F – WDNR Approval Letter for APMP

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
3911 Fish Hatchery Road
Fitchburg WI 53711-5397

Tony Evers, Governor
Adam N. Payne, Secretary
Telephone 608-266-2621
Toll Free 1-888-936-7463
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May 25, 2023

Lake Redstone Protection District
PO Box 313
La Valle, WI 53491

Subject: Approval of Aquatic Plant Management Plan – Lake Redstone

Dear Lake Redstone Protection District:

This letter is to serve as notice that the Department of Natural Resources (Department) has reviewed and approved your document entitled "Aquatic Plant Management Plan for Lake Redstone." This plan was written by Aquatic Plant and Habitat Services LLC and the plan is dated May 2023. The final version of the plan was received by the Department on May 1st, 2023.

Management activities identified in the plan are eligible for Surface Water Grants funding under Administrative Code NR 193 subject to the eligibility requirements of that program.

The Department hereby approves the 2023 Aquatic Plant Management Plan for Lake Redstone for use as the guidance document for aquatic plant management and associated activities on Lake Redstone. This approval is not an endorsement of the plant management activities that may occur under the appropriate permits.

Sincerely,

Arthur Watkinson
Regional Lakes Coordinator

Cc: Michael Sorge, DNR NR Basin Supervisor (e-mail)
Nathan Nye, DNR Fisheries Biologist (e-mail
Gina Keenan, DNR Grant Specialist (e-mail)