A Summary of Findings from LakeScan™
Guided Surveys and Analysis of:

Cedar Lake North

Alcona and Iosco Counties

2024 DATA AND ANALYSIS SUMMARY REPORT WITH MANAGEMENT RECOMMENDATIONS

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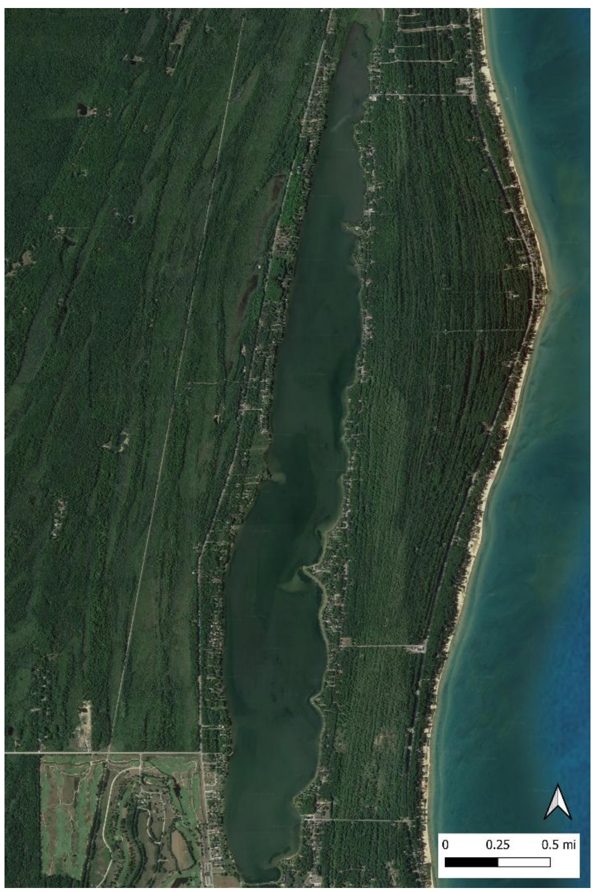

Executive Summary

Kieser & Associates, LLC (K&A) conducted vegetation monitoring on Cedar Lake North (Alcona and Iosco Counties, MI) during the summer of 2024 using LakeScan™ assessment methods. The purpose of these efforts was to assess aquatic vegetation during the summer recreational season in the context of nuisance conditions and management needs/outcomes. LakeScan™ methods combine detailed field data collection with mapping capabilities and whole-lake analyses based on established scientific metrics to score various lake conditions. This approach allows lake managers to readily and consistently identify successful lake management activities, highlight potential issues requiring intervention, and gather critical planning information necessary to improve the ecological and recreational conditions of the lake.

To summarize the overall findings on the lake in 2024, assessed LakeScan™ metrics were averaged across the early and late-season vegetation surveys, revealing that Cedar Lake North met the optimal management goals for all metrics in 2024 (Table ES-1). These findings illustrate improving trends from the conditions observed in 2023, which fell short of the management goals for the Shannon biodiversity index and recreational nuisance presence. These findings additionally indicate that the lake is improving in both species and structural diversity and that nuisance conditions are declining. The high Shannon morphology and biodiversity scores show that the species in the lake are both diverse in type and structure, contributing to greater habitat suitability for aquatic organisms. The consistently high average Floristic Quality Index suggests a high distribution of desirable native plant species and a low distribution of undesirable invasive species. The Algal Bloom Risk rating for Cedar Lake North is "low" reflecting the small proportion of agricultural and urban land use draining to the lake.

Table ES-1 – Summary of lake analysis metrics.

LakeScan™ Metric	2024 Average	Management Goal
Species Richness	20	n/a
Shannon Biodiversity Index	10.2	> 8.8
Shannon Morphology Index	9.0	> 6.3
Floristic Quality Index	26.7	> 20
Recreational Nuisance Presence	7%	< 10%
Algal Bloom Risk	Low	Low

The Cedar Lake North early-season LakeScan™ survey was conducted on Monday, July 1, 2024. The most common native species observed during the survey were *Chara* (*Chara sp.*), broadleaf pondweed (*Potamogeton amplifolius)*, Richardson's pondweed *(Potamogeton richardsonii),* and common bladderwort (*Utricularia vulgaris L.*). Broadleaf pondweed and Richardson's pondweed were observed at moderate densities around the lake, typically not dense enough to cause any nuisance concerns, except in AROS 370-375, 384, 385, 398, 321, and 341-342, which had broadleaf pondweed growing to the surface.

The aquatic invasive species observed during the early-season survey were hybrid Eurasian watermilfoil (*Myriophyllum spicatum x sibiricum*), *Phragmites* (*Phragmites australis*), and purple loosestrife (*Lythrum salicaria L.*). Distribution of these species was minimal, with Eurasian watermilfoil found in single stand-alone clusters in AROS 342, 343, and 350, *Phragmites* only observed at AROS 361, and purple loosestrife at AROS 340, 351, and 352.

The late-season LakeScan™ survey was conducted on Wednesday, August 7, 2024. The most common native species observed during the survey were, broadleaf pondweed, Richardson's pondweed, and rushes (*Juncus sp.*). In some shoreline AROS locations (321, 338, 347, 348, 371, 373, and 398), tall native pondweeds were growing to the surface which could have caused some minor recreational nuisance conditions, but the patches of pondweeds appeared to be less dense and continuous than what was observed during the early-season survey. The majority of dense native vegetation growth was noted in the excavated trenches (#500 AROS).

The aquatic invasive species observed during the 2024 late-season survey were hybrid Eurasian watermilfoil, *Phragmites*, and purple loosestrife. Eurasian watermilfoil was found in clusters in AROS 357, 358, 368, 567, 577, and 582. The emergent invasive species *Phragmites* and purple loosestrife were found in small clusters along the shoreline, with *Phragmites* at AROS 360, 361, and 364 and purple loosestrife across much of the shoreline.

Over the last five years, variable-leaf watermilfoil (*Myriophyllum heterophyllum)* and hybrid Eurasian watermilfoil coverage on Cedar Lake North have exhibited declining trends (Figure ES-1). Coverage of variable-leaf watermilfoil has decreased by 6% since 2020, remaining consistently under 10% coverage over the last five years (Figure ES-1). Although variable-leaf watermilfoil coverage has declined over the last five years, coverage did increase by roughly 0.4% in the last year, which while minor, might indicate a slight rebound of the species. Eurasian watermilfoil coverage has remained consistently under 1% over the past five years (Figure ES-1). While Eurasian watermilfoil coverages have remained minor across multiple years, the species did increase in coverage by 0.2% in the last year, indicating the possibility of a slight rebound of the species, which was not found during either survey in 2023. Despite slight increases in Eurasian watermilfoil and variable-leaf watermilfoil coverages in the last year, the coverage of these species remains minor and trends are decreasing, indicating that management activities are successfully controlling nuisance watermilfoil populations on a multi-year basis. If milfoil coverage continues to increase in future surveys, alternative management options may need to be explored.

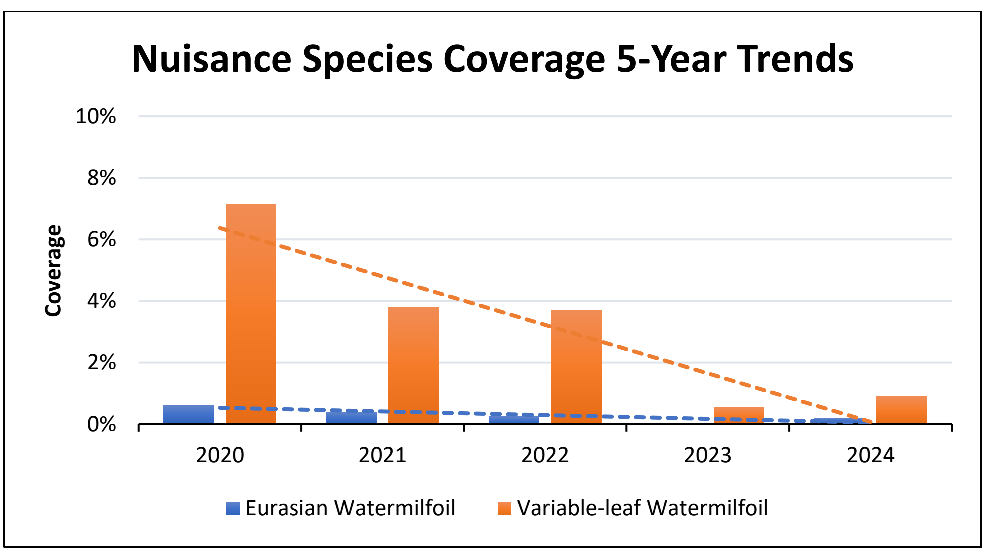

Figure ES-1 – Nuisance species coverage 5-year trends.

Based on 2024 findings, K&A recommends the following management considerations for 2025:

- **Continued management of Eurasian and Variable-leaf watermilfoil.**
    - Watermilfoil coverages have trended downward over the last five years with coverage in 2024 being less than 2%. Thus, current management interventions appear to be effective at suppressing growth and reducing the cumulative coverage of nuisance watermilfoil presence. Despite low coverages in 2024, both species displayed slight increases in coverages over the past year, indicating the possibility of species rebound. Therefore, it is recommended that the Cedar Lake Improvement Board continues exploring management options similar to the ones implemented in 2024 for treating nuisance watermilfoil conditions in the following years.
- **Continued ProcellaCOR applications to treat Eurasian watermilfoil in the northern trenches of Cedar Lake North**.
    - Recent ProcellaCOR applications in Cedar Lake North appear to have been an effective strategy for the management of nuisance hybrid Eurasian watermilfoil. Applications should continue through 2025 to determine if ProcellaCOR continues to be an effective means to control hybrid Eurasian watermilfoil. If coverage trends continue to increase, a re-evaluation of the current treatment regimen may be warranted.
- **Continued monitoring of the coverage and nuisance conditions of variable-leaf watermilfoil.**
    - The treatments in 2020 targeting nuisance variable-leaf watermilfoil were projected to have lasting effects for up to three years. Based on 2021 - 2024 LakeScan™ surveys, the 2020 treatments appear to have continually suppressed nuisance conditions, although the species did have a slight uptick in coverage from 2023 to 2024. It will be important to closely monitor the treatment areas to see if treatment results persist into 2025.
- **Continued monitoring of coverage and nuisance conditions of emergent invasive species.**
    - It will be crucial to monitor and document *Phragmites* coverage in Cedar Lake North following the treatment on September 18, 2024. Close monitoring will reveal the effectiveness of the treatment and inform if follow-up treatments are warranted. An additional on-the-ground survey of the treated areas might be pursued by the lake board to achieve reliable and accurate monitoring data on *Phragmites* populations.
    - Given the increasing shoreline distribution of purple loosestrife, it is recommended that the lake board consider the use of biocontrols over a few seasonal applications to manage the spread of the species. K&A has seen effective, self-sustaining populations of *Galerucella* beetles forage exclusively on purple loosestrife after three years of beetle releases.
- **Monitoring the coverage and nuisance conditions of native pondweed production.**
    - Nuisance pondweed production in Cedar Lake North has been increasing. Pondweeds resembling broad leaf pondweed and Richardson's pondweed may be aggressive hybrids that are increasing in cumulative cover. The Department of the Environment, Great Lakes, and Energy (EGLE) does not permit treatment of pondweeds in many of the nuisance areas in Cedar Lake North. Mechanical harvesting is not regulated in Michigan and can be used as an effective management strategy for nuisance pondweeds where navigation is impaired. This approach should be considered for use if there is a substantial increase in the nuisance production of hybrid native pondweeds.

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1.0. Introduction

Inland lakes are complex systems, and managing them for both ecological health and recreational enjoyment involves balancing goals that are sometimes at odds with one another. Successful lake management requires an understanding of the current ecological and recreational conditions of a lake, as well as how those conditions change over time. The LakeScan™ program combines a detailed data collection methodology with mapping capabilities and whole-lake analysis metrics backed by scientific literature. This analysis allows lake managers to identify successful lake management activities, as well as highlight potential issues requiring intervention. Appropriately targeted aquatic plant suppression can minimize weedy and nuisance species while allowing beneficial species to flourish at ecologically balanced levels supporting healthy lake conditions. This kind of adaptive management system provides a scientifically sound and consistent methodology to better manage lake ecological and recreational conditions.

The LakeScan™ analysis involves collecting data over two vegetation surveys during the critical summer recreational season. These surveys are based on a system where the lake is first divided into biological tiers (Table 1) and then further subdivided into Aquatic Resource Observation Sites (AROS; Figure 1). For each survey, field personnel record the density, distribution, and position in the water column of each aquatic plant species in each AROS, as well as noting any nuisance conditions. Dissolved oxygen profiles, temperature profiles, and Secchi depth are additionally recorded. Other water quality sampling can be included with surveys when requested.

Aquatic plant communities change over the course of a year, so the surveys are split into early and late-season observations. Early-season surveys are scheduled with the goal of taking place within 10 days of early-summer treatments to best observe treatment-targeted and non-targeted vegetation. Late-season surveys are scheduled to occur roughly two months after the early season survey. However, this scheduling is subject to weather and times of increased boat activity.

Table 1 – Biological Tier Descriptions.

Tier*	Description
2	Emergent Wetland
3	Near Shore
4	Off Shore
5	Off Shore, Drop-Off
6	Canals
7	Around Islands and Sandbars
9	Off Shore Island Drop-Off

*Tiers 1 and 8 are reserved for future use.

Figure 1 - Map of Aquatic Resource Observation Sites (AROS).

2.0. Lake and Watershed Characteristics

Location

Counties: Alcona and Iosco

Townships: Greenbush and Oscoda

Township/Range/Section(s): T25N and T24N, R9E Sections: 15, 22, 27, 34, and 3

GPS Coordinates: 44.528853, -83.331903

Morphometry

Total Area: 830 acres

Shoreline Length: 47,339 feet

Maximum Depth: 10 feet

Administrative Management

Management Authority: Cedar Lake Improvement Board

Years in LakeScan™ Program: 2003 to present

2.1. Algal Bloom Risk Level

K&A calculates an algal bloom risk level for each LakeScan™ lake based on the characteristics of its watershed. Agricultural and urban land uses contribute more phosphorus to receiving waters than grasslands or forested land uses; phosphorus being the limiting nutrient that drives algal blooms. Lakes with watersheds that have high proportions of land in agricultural and urban land uses are more likely to be at risk of algal blooms. Not all algal blooms contain cyanobacteria and their associated toxins (Harmful Algal Blooms or HABs). It is important to note that the risk factor reported here is based on a limited watershed analysis. Lakes at high risk of algal blooms should consider more in-depth studies that can identify possible watershed or in-lake improvements to mitigate the risk of HABs.

The algal bloom risk for Cedar Lake South is: **Low**

This risk is a reflection of the summary of watershed land-use composition for Cedar Lake North, which has minor inputs from urban and agricultural sources.

3.0. Dissolved Oxygen and Temperature Profiles

Secchi depth, dissolved oxygen and temperature data were collected during each vegetation survey. Secchi disk transparency is the depth at which a Secchi disk (a flat white or black and white platter, approximately 20 centimeters in diameter) suspended into a lake disappears from the investigator's sight. In general, the greater depth at which the Secchi disk can be viewed, the lower the productivity of the water body. Secchi depth readings of greater than 15 feet can be indicative of low productivity or oligotrophic conditions.[1] Some variation in Secchi disk reporting may be a result of cloud cover, time of day, recent rain events, and recreational lake usage. Dissolved oxygen levels and temperature were measured by K&A using a YSI ProSolo dissolved oxygen meter, calibrated prior to use.

A sufficient supply of dissolved oxygen (DO) in lake water is necessary for most forms of desirable aquatic life. Colder waters contain more dissolved oxygen than warmer waters. In highly productive lakes, oxygen depletion can occur in deeper, unmixed bottom waters during warmer summer months. This decrease in oxygen is due in part to dead algae and other organic matter, such as leaves, grass and plant debris settling to the bottom of the lake and getting consumed, along with oxygen, by organisms in the sediment. DO depletion is most often observed in lake bottom waters during periods of temperature stratification in warmer summer months and, to a lesser degree, under winter ice cover conditions. Shallow lakes, like Cedar Lake, may not experience stratification and would not be expected to have as notable of oxygen depletion in the lake bottom waters compared to deeper bodies of water.

Secchi disk clarity on Cedar Lake North decreased from 9ft (clear to bottom) to 8.1ft between the early and late season surveys. This decrease in water clarity could likely be attributed to a slight increase in lake productivity later in the growing season and/or an increase in turbidity caused by sediment disturbance from swimming, boating, and other recreational activities increasing throughout the summer. The DO and temperature profiles remained consistent across the two surveys with no notable stratification, to be expected due to the shallow depths of the lake (Figures 2 and 3).

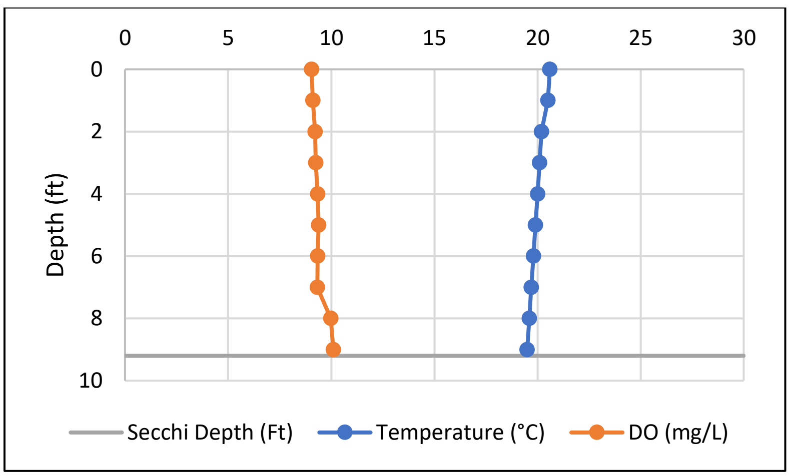

Figure 2 – Early-season survey (7/1/2024) dissolved oxygen and temperature profiles with Secchi depth, taken near AROS 521.

[1]US Geological Survey. 2012. "Water Quality Characteristics of Michigan's Inland Lakes, 2001-10." Scientific Investigations Report 2011–5233. Available online at: https://pubs.usgs.gov/sir/2011/5233/.

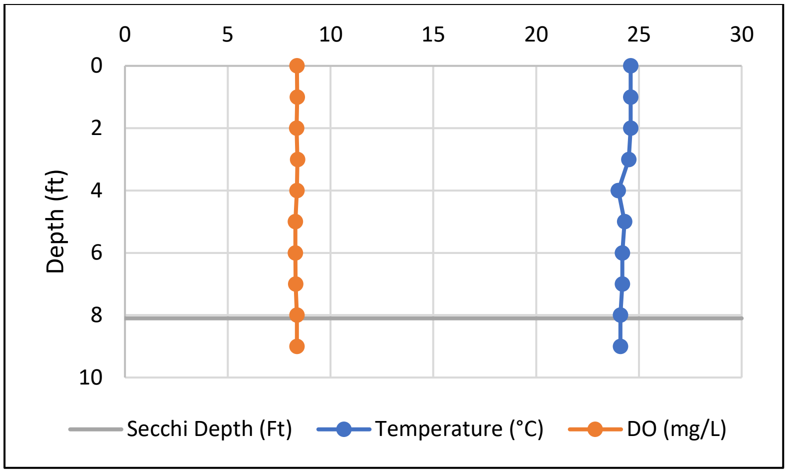

Figure 3 – Late-season survey (8/7/2024) dissolved oxygen and temperature profiles with Secchi depth, taken near AROS 521.

4.0. Aquatic Vegetation

4.1. Early-Season Survey

The Cedar Lake North early-season LakeScan™ survey was conducted on Monday, July 1, 2024. The weather throughout the survey was sunny with temperatures near 72°F and gentle northwestern winds around 3-5 mph. Visibility in the water column was great with a Secchi Disk reading of 9 feet, clear to the bottom. The survey occurred 13 days after the herbicide treatment on Tuesday, June 18, 2024.

A visual depiction of the data on all combined species observed in Cedar Lake North during the early-season survey is displayed using three-dimensional density, which reflects a combination of vegetation density, distribution and height observations for all species observed during the survey (Figure 4). Color-coding is provided for each AROS to spatially depict observed vegetation data. The colors range in a gradient from dark blue which depicts no vegetation observed, to yellow depicting medium density and distribution, to red which depicts high density and distribution of vegetation within the AROS.

The most common native species observed during the survey were *Chara*, broadleaf pondweed, Richardson's pondweed, and common bladderwort. *Chara* was the most commonly observed species and was found at moderate to high densities throughout a majority of observation areas. Broadleaf pondweed and Richardson's pondweed were observed at moderate densities around the lake, often flowering, but typically not dense enough to cause any nuisance concerns. In some shoreline AROS locations (370-375, 384, 385, 398, 321, and 341-342) tall broadleaf pondweed was growing to the surface which were noted as causing nuisance conditions. Variable-leaf watermilfoil was not observed throughout most of the survey, but was common throughout the shallow northern bay of the lake (Figure 5).

The only submerged aquatic invasive species observed in Cedar Lake North during the 2024 early-season survey was hybrid Eurasian watermilfoil. Eurasian watermilfoil was found in single stand-alone clusters in AROS 342, 343, and 350 and did not appear to be very hardy and was expected to drop from the water column on its own (Figure 6). Additionally, the emergent invasive species *Phragmites* and purple loosestrife were found along the shoreline, with *Phragmites* only at AROS 361, and purple loosestrife at AROS 340, 351, and 352, neither causing management concerns at the time of the survey (Figures 7 and 8).

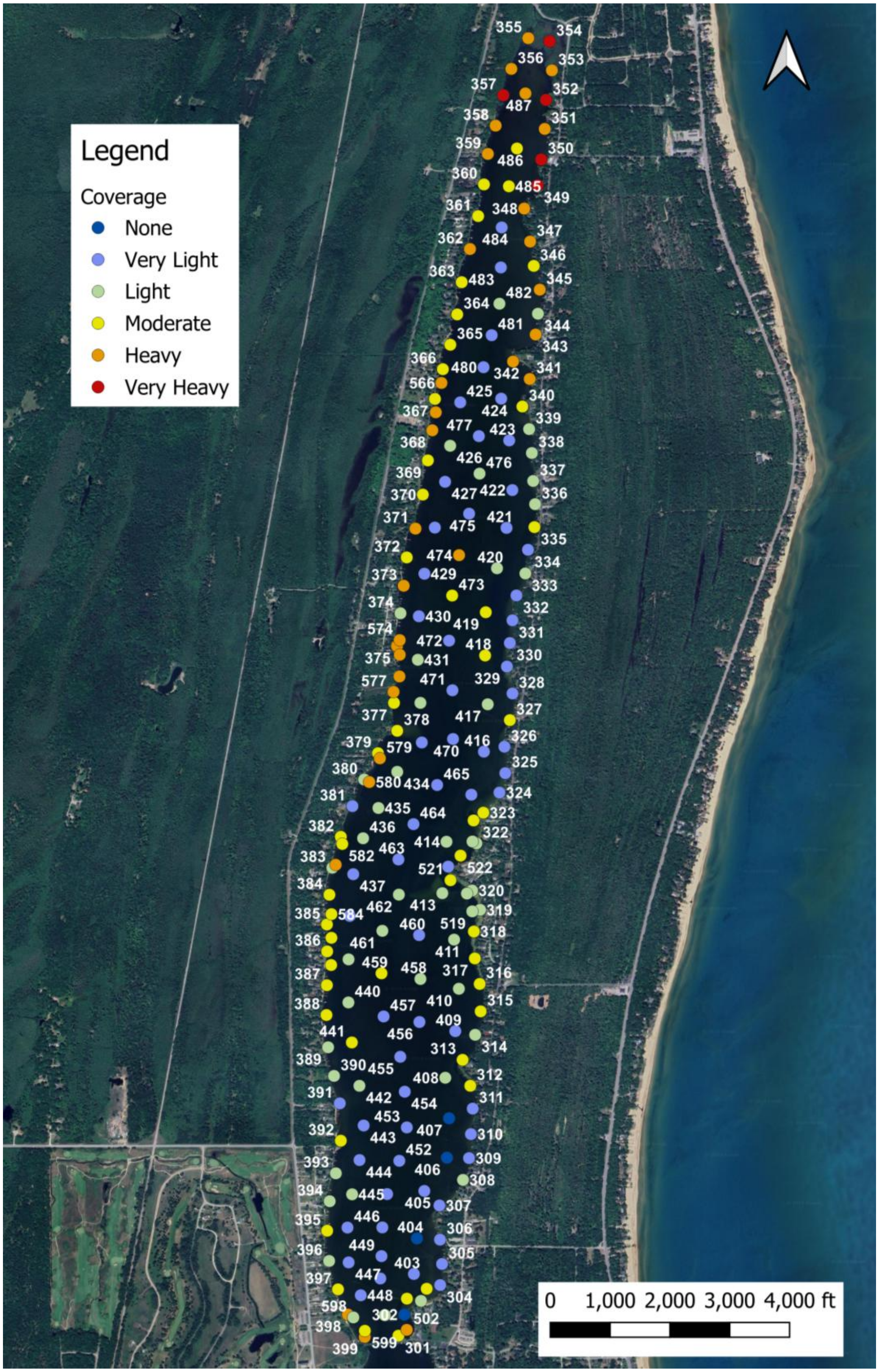

Figure 4 – Early-season survey (7/1/2024) vegetation 3D Density (a function of observed vegetation coverage, and height of all vegetation species).

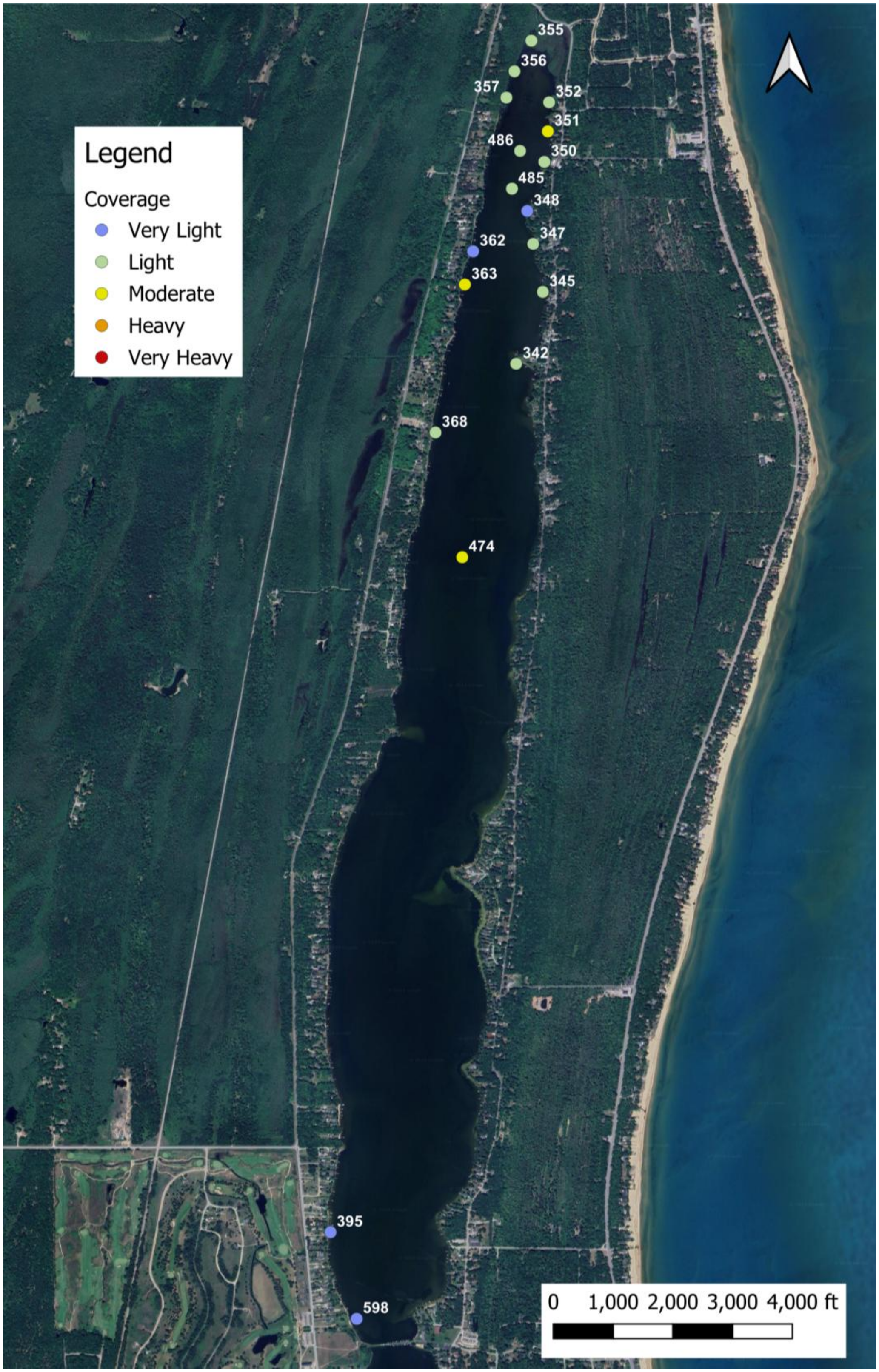

Figure 5 – Early-season (7/1/2024) Variable-leaf watermilfoil coverage (a combination of the LakeScan™ density and distribution observations).

Figure 6 – Early-season (7/1/2024) Eurasian watermilfoil coverage.

Figure 7 – Early-season (7/1/2024) Phragmites coverage.

Figure 8 – Early-season (7/1/2024) purple loosestrife coverage.

4.2. Late-Season Survey

The Cedar Lake North late-season LakeScan™ survey was conducted on Wednesday, August 7, 2024. The weather throughout the survey was sunny with temperatures around 77°F and southeastern winds around 8-12 mph. Visibility in the water column was good with a Secchi Disk reading of 8.1 feet.

A visual depiction of the data on all combined species observed in Cedar Lake North during the late-season survey is displayed using three-dimensional density (Figure 9). The most common native species observed during the survey were *Chara*, broadleaf pondweed, Richardson's pondweed, and rushes. In some shoreline AROS locations (321, 338, 347, 348, 371, 373, and 398) tall native pondweeds were growing to the surface which could cause some minor recreational nuisance conditions. Vegetation growth was the densest in the excavated trenches (#500 AROS) which were typically dominated by *Chara*, wild celery (*Vallisneria americana Michaux),* broadleaf pondweed, and Richardson's pondweed. Similar to conditions observed in the early-season survey, variable-leaf watermilfoil was not commonly observed during the survey, but was found at light coverages in the shallow northern bay of the lake (Figure 10).

The only submerged aquatic invasive species observed in Cedar Lake North during the 2024 late-season survey was hybrid Eurasian watermilfoil. Eurasian watermilfoil was found in clusters in AROS 357, 358, 368, 567, 577, and 582 (Figure 11). The milfoil that was spotted in AROS 342, 343, and 350 in the early-season survey was not observed at the time of the late-season survey. The emergent invasive species *Phragmites* and purple loosestrife were found along the shoreline, with *Phragmites* at AROS 360, 361, and 364. Purple loosestrife was flowering during the time of the survey making it more conspicuous. It was spotted in stand-alone pockets across much of the shoreline (Figure 12). Purple loosestrife was the densest and widely distributed in AROS 340, 352, 358, 360, 368, 376, 380, and 392 (Figure 13).

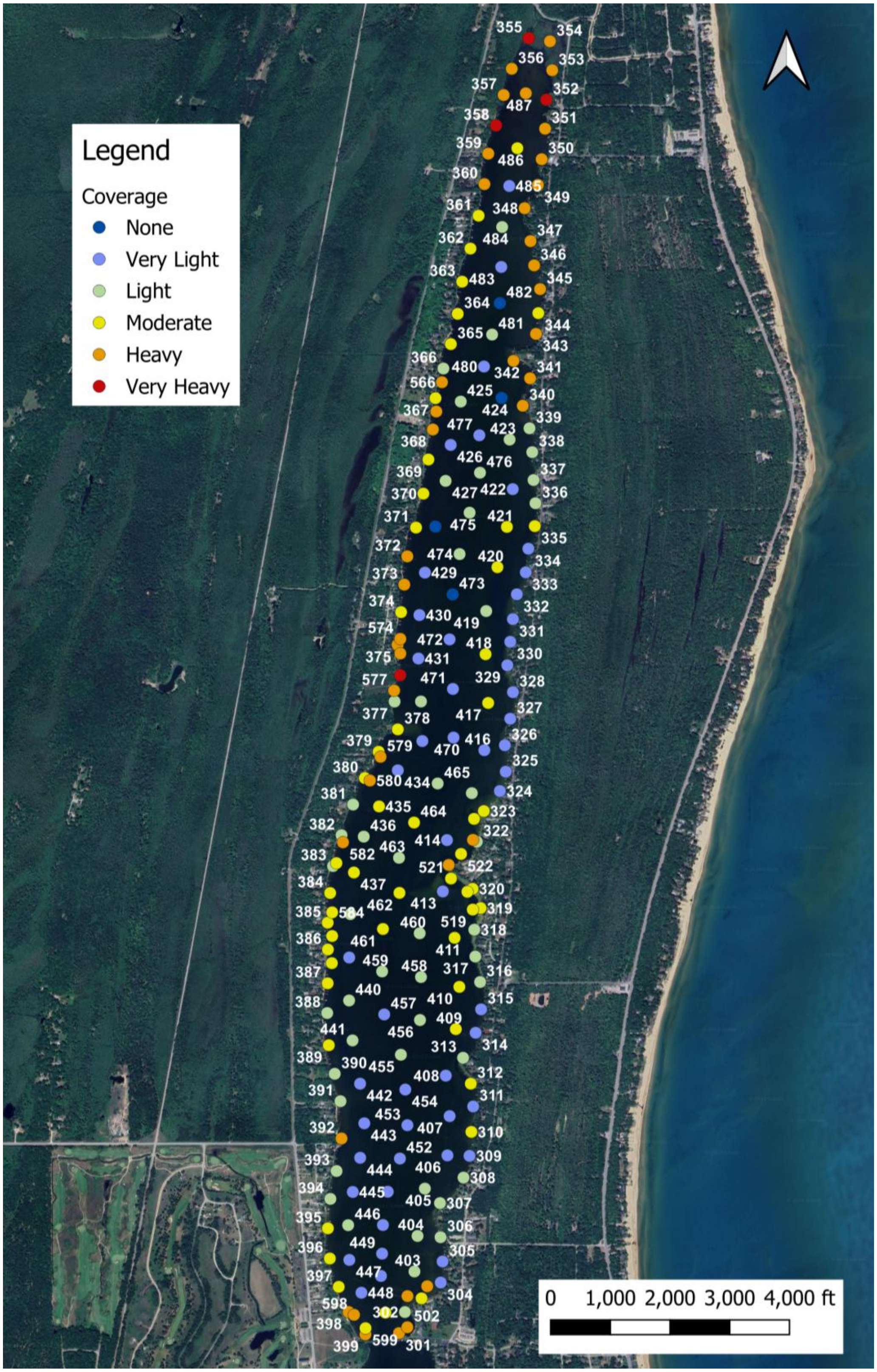

Figure 9 – Late-season survey (8/7/2024) vegetation 3D Density (a function of observed vegetation coverage, and height of all vegetation species).

Figure 10 – Late-season (8/7/2024) Variable-leaf Watermilfoil coverage (a combination of the LakeScan™ density and distribution observations).

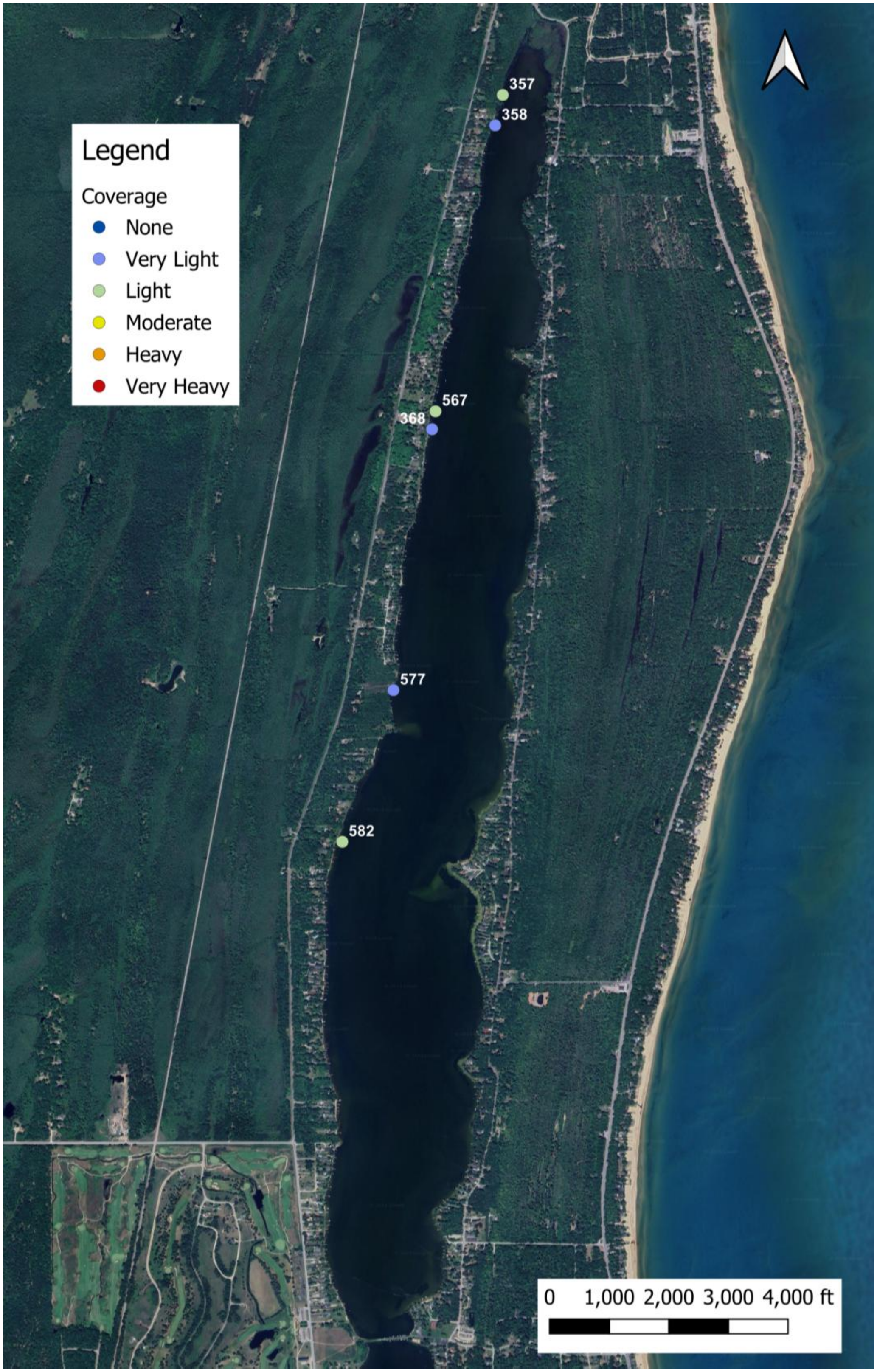

Figure 11 – Late-season (8/7/2024) Eurasian watermilfoil coverage.

Figure 12 – Late-season (8/7/2024) Phragmites coverage.

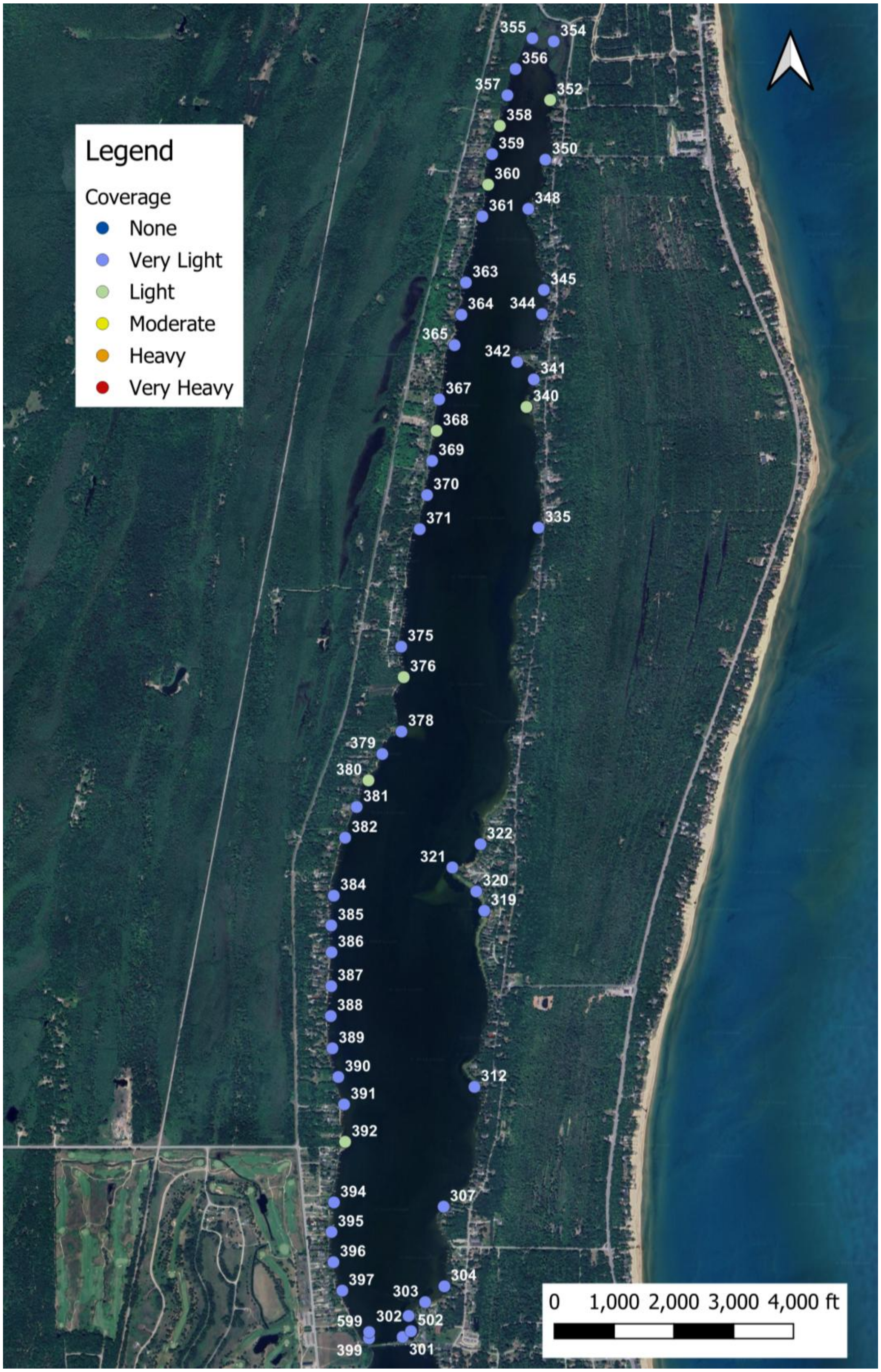

Figure 13 – Late-season (8/7/2024) purple loosestrife coverage.

4.3. Summary Observations for Early and Late-Season Surveys

All aquatic plant species observed during the 2024 vegetation surveys were paired with their associated C-value and recorded for frequency, coverage, and dominance (Table 2). The Coefficient of Conservation, or C-Value, is a qualitative value ranging from 0 to 10 that is assigned to each species representing the estimated probability that it is likely to occur in an environment. A C-value of 0, is given to plants that may be found almost anywhere, while a C-value of 10 is applied to plants that are almost always restricted to high-quality natural areas.[2] 'Frequency' represents the percentage of survey sites (AROS) where a given species was found. ‘Coverage’ represents the lake bottom spatial cover observed for each species, represented as a percentage of available area. 'Dominance' represents the degree to which a species is more numerous than its competitors.

Table 2- Aquatic Plant Species Observed in 2024.

Common Name	C Value	Frequency		Coverage		Dominance	
		Early '24	Late '24	Early '24	Late '24	Early '24	Late '24
Eurasian Watermilfoil Hybrid	0	1.5%	3.0%	0.1%	0.3%	0.2%	0.5%
Green/Variable Watermilfoil	6	8.9%	4.0%	1.2%	0.6%	2.1%	1.0%
Common Bladderwort	6	34.2%	14.4%	2.3%	1.0%	4.1%	1.8%
Elodea	3	9.9%	0.0%	2.2%	0.0%	3.9%	0.0%
Naiad	6	15.8%	20.8%	1.9%	3.9%	3.5%	7.1%
Chara	7	97.5%	83.2%	18.7%	16.9%	33.3%	30.8%
Flat Stem Pondweed	5	1.0%	0.5%	0.1%	0.1%	0.2%	0.2%
Purple Loosestrife	0	2.5%	29.7%	0.2%	2.2%	0.3%	4.0%
Swamp Loosestrife	7	2.5%	0.0%	0.2%	0.0%	0.3%	0.0%
Richardsons Pondweed	5	37.6%	39.1%	6.7%	7.3%	12.0%	13.3%
Broadleaf Pondweed	6	62.4%	55.4%	7.0%	6.5%	12.4%	11.9%
Hybrid Pondweed	5	25.7%	25.2%	2.9%	2.9%	5.1%	5.3%
Sago Pondweed	3	6.4%	3.0%	1.2%	0.4%	2.1%	0.8%
Thin Leaf Pondweed	4	2.0%	3.5%	0.4%	0.4%	0.7%	0.8%
Wild Celery	7	26.2%	24.8%	3.0%	3.2%	5.3%	5.9%
Rush	8	24.8%	29.2%	2.3%	2.5%	4.1%	4.6%
Waterlily	6	11.9%	16.8%	1.8%	2.6%	3.2%	4.7%
Spadderdock	7	12.4%	16.3%	2.0%	2.2%	3.6%	4.1%
Arrow Arum	6	5.9%	5.0%	1.1%	0.6%	1.9%	1.2%
Cattail	1	7.4%	8.4%	0.9%	1.1%	1.6%	1.9%
Phragmites	0	0.5%	1.5%	0.0%	0.1%	0.1%	20.0%

[2] Michigan Department of Natural Resources Wildlife Division. (n.d.). Floristic Quality Assessment with Wetland Categories and Examples of Computer Applications for the State of Michigan.

4.4. LakeScan™ Metrics

Six important metrics for defining lake conditions are included in the LakeScan™ analyses, where early and late-season scores are averaged for a yearly score and compared against a management goal for each metric (Table 3). Management goals are based on median Michigan lake values (Shannon Biodiversity Index and Shannon Morphology Index), scientific literature (Floristic Quality Index), and professional judgement (Recreational Nuisance Presence and Algal Bloom Risk). Green shading in Table 3 highlights scores meeting management goals, while yellow and red highlights represent scores needing improvement, with red scores being further away from the optimal management goals potentially requiring a higher level of management attention. Descriptions of each of the six metrics are detailed below:

- **Species Richness** – the number of aquatic plant species present in the lake. More species are generally indicative of a healthier ecosystem, but not all species are desirable.
- **Shannon Biodiversity Index** – a measure of aquatic plant species diversity and distribution evenness, indicative of the stability and diversity of the plant community. Also known as the Shannon Expected Number of Species.[3]
- **Shannon Morphology Index** – a measure of aquatic plant morphology type diversity and distribution evenness, indicative of fish and macroinvertebrate habitat quality. This is calculated using morphology types instead of species.
- **Floristic Quality Index**[4] – a measure of the distribution of desirable aquatic plants. This index is used by Midwestern states for aquatic habitats, with higher scores indicative of increased biodiversity and a positive ratio of desirable versus undesirable aquatic plant species.
- **Recreational Nuisance Presence** – the percentage of survey sites that identified aquatic plants inhibiting recreational activities.
- **Algal Bloom Risk** – a calculated algal bloom risk level based on the characteristics of the lake watershed. Lakes with watersheds that have high proportions of land in agricultural and urban land uses are more likely to be at risk of algal blooms because these land uses contribute more phosphorus to receiving waters than grasslands or forests.

Table 3 – 2024 LakeScan™ Metric Results.

LakeScan™ Metric	Score Range	2024 Early Season	2024 Late Season	2024 Average	Management Goal
Species Richness	5 - 30	21	19	20	n/a
Shannon Biodiversity Index	1 -15	10.2	10.1	10.2	> 8.8
Shannon Morphology Index	1 - 10	9.1	8.8	9.0	> 6.3
Floristic Quality Index	1 - 40	27.6	25.7	26.7	> 20
Recreational Nuisance Presence	0 - 100%	9%	5%	7%	< 10%
Algal Bloom Risk	Low-High	n/a	n/a	Low	Low

*n/a = not applicable

[3] Hill, M. O. (1973). Diversity and evenness: a unifying notation and its consequences. *Ecology*, 54(2), 427-432.
[4] Nichols, S. A. (1999). Floristic quality assessment of Wisconsin lake plant communities with example applications. *Lake and Reservoir Management*, 15(2), 133-141.

The assessed LakeScan™ metrics for both the early and late-season surveys on Cedar Lake North met all management goals in 2024. These metrics also had very limited variability between the two surveys, indicating a high level of lake stability throughout 2024. Compared to 2023, which fell short of the management goals for the Shannon biodiversity index and recreational nuisance presence, the survey metrics from 2024 show improving trends. These findings indicate that the lake is improving in both species and structural diversity and that nuisance conditions are declining.

The high Shannon morphology and biodiversity indices indicate that the species in the lake are both diverse in type and structure, contributing to greater habitat suitability for aquatic organisms. The consistently high average Floristic Quality Index suggests a high distribution of desirable, native plant species and a low distribution of undesirable invasive species.

Over the past five years, the Floristic Quality Index on Cedar Lake North has exhibited a positive trend, indicating an increase in desirable, native plants and a decrease in undesirable, invasive aquatic species (Figure 14). Cedar Lake North Lake has met the FQI management score of 20 for the past the last five years, displaying a high level of floristic quality that is maintained from year-to-year by the current management regimen.

Figure 14 – Floristic Quality Index 5-Year Trend.

Despite Eurasian watermilfoil and variable-leaf watermilfoil coverage increasing slightly from 2023, the coverage of both species has generally declined over the past five years (Figure 15). Variable-leaf watermilfoil coverage on Cedar Lake North has decreased by 6% since 2020 and has remained consistently under 10% coverage throughout the last five years. Although variable-leaf watermilfoil coverage has generally declined over the last five years, coverage did increase by roughly 0.4% in 2024, which while minor, might indicate a rebound of the species. Eurasian watermilfoil coverage has remained consistently under 1% over the past five years. The species did increase in coverage by 0.2% in the last year, indicating a potential of a slight rebound of the species, which was not found during either of the 2023 surveys. Despite slight increases in Eurasian watermilfoil and variable leaf-watermilfoil coverages in the last year, the overall coverage of these species remains minor, indicating that management activities are successfully controlling nuisance watermilfoil populations.

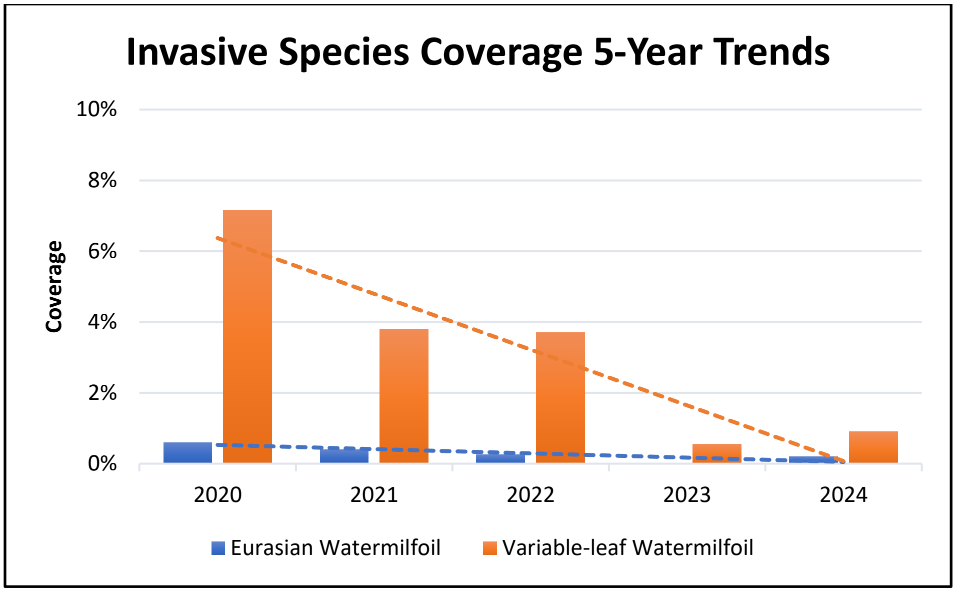

Figure 15 – Nuisance Species Coverage 5-Year Trends.

5.0. Lake Management

There are several species that typically become a nuisance in Michigan's inland lakes, these species are usually targeted for selective control to prevent them from becoming an aesthetic or recreational nuisance and to protect desirable plants that are part of healthy lake ecosystems. More information on common nuisance species in Michigan and their associated management options can be found in Appendix A. Treatment maps and data displaying acreage, herbicides, and targeted species for Cedar Lake North in 2024 can be found in Appendix B (note that the chemical tables provided in the ANC report are not split by North and South lakes).

A total of two chemical herbicide treatments were conducted by Solitude Lake Management on Cedar Lake North in 2024. The first chemical herbicide treatment took place on Tuesday, June 18, 2024, 13 days prior to the early-season survey. Solitude reported that the treatment targeted roughly 13.25 acres using treatment applications that target hybrid Eurasian watermilfoil, curly-leaf pondweed, starry stonewort (*Nitellopsis obtusa*), and algae using Tribune, Cutrine Plus, ProcellaCOR, and Hydrothol 191. The treatment areas were primarily relegated to the excavated trenches on the western edge of the lake; Hydrothol 191 was only used in the northern-most trench.

It is important to note that the "species targeted" descriptors provided by Solitude and included in Appendix B Figure B3 include curly-leaf pondweed and starry stonewort as treated species for the June 18th treatment despite neither of the species being noted in the lake for over a decade. Future species treated references provided by the applicator should be made consistent with pre-season survey findings and mutually-agreed upon target species, for accuracy in reporting. Where new invasive species are suspected by the applicator, immediate notification to K&A should otherwise be made and treatments recommendations discussed.

The second and final chemical herbicide treatment occurred on September 18, 2024, targeting roughly 1.25 acres of *Phragmites* and 4.5 acres of hybrid Eurasian watermilfoil. The treatment regimen targeted species using Tribune, Cutrine plus, Habitat, Aquaneat, and Cygnet plus.

During the early-season survey, which occurred 13 days after the first herbicide treatment, Eurasian watermilfoil was found at 0.1% coverage and grew slightly to 0.3% by the late-season. Both coverages of Eurasian watermilfoil were higher in 2024 than what was observed in 2023 which had 0% coverage across both surveys. However, this species has still maintained low and manageable levels of coverage at less than 1%, indicating a general multi-year success of herbicide treatments on managing the spread of hybrid Eurasian watermilfoil in Cedar Lake North (Figure 16).

Variable-leaf watermilfoil had higher coverages than the Eurasian watermilfoil with 1.2% coverage in the early season and 0.6% in the late season. The slight decline of the species from the early to late-season surveys and the relatively low overall coverages of less than 2%, further demonstrates the effectiveness and long-term success of the treatment regimen for variable-leaf watermilfoil.

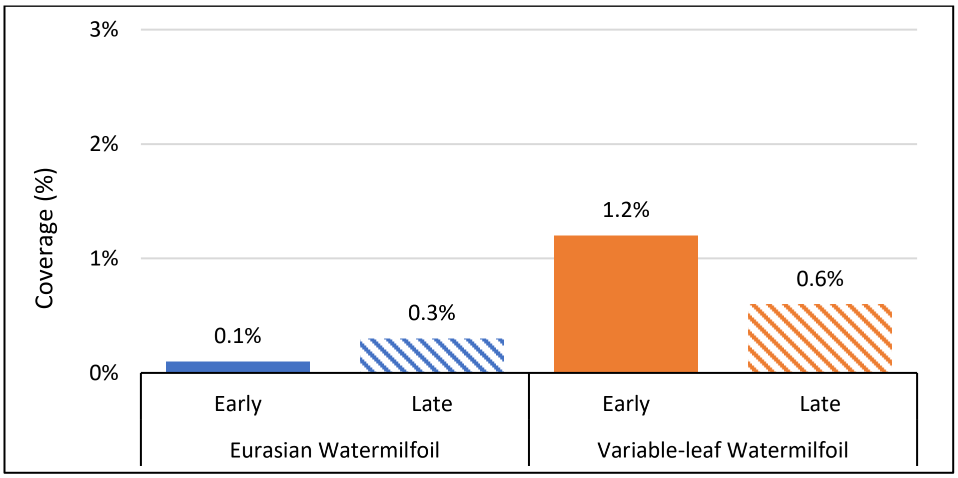

Figure 16 – Changes in coverage across both surveys for targeted species.

5.1. Management Recommendations

Watermilfoil coverages have trended downward over the last five years with coverage in 2024 being less than 2%. Thus, current management interventions appear to be effective at suppressing growth and reducing the cumulative coverage of nuisance watermilfoil presence. Despite low coverages in 2024, both species displayed slight increases in coverages over the past year, indicating the possibility of species rebound. Therefore, it is recommended that the Cedar Lake Improvement Board continues exploring management options similar to the ones implemented in 2024 for treating nuisance watermilfoil conditions in the following years.

Recent ProcellaCOR applications in Cedar Lake North appear to have been an effective strategy for the management of nuisance hybrid Eurasian watermilfoil. Applications should continue through 2025 to determine if ProcellaCOR continues to be an effective means to control hybrid Eurasian watermilfoil. If coverage trends continue to increase, a re-evaluation of the current treatment regimen may be warranted.

The treatments in 2020 targeting nuisance variable-leaf watermilfoil were projected to have lasting effects for up to three years. Based on 2021-2024 LakeScan™ surveys, the 2020 treatments appear to have continually suppressed nuisance conditions, although the species did have a slight uptick in coverage from 2023-2024. It will be important to closely monitor the treatment areas to see if treatment results persist into 2025.

It will be crucial to monitor and document *Phragmites* coverage in Cedar Lake North following the treatment on September 18, 2024. Close monitoring will reveal the effectiveness of the treatment and inform if follow-up treatments are warranted. An additional on-the-ground survey of the treated areas might be pursued by the CLIB to achieve reliable and accurate monitoring data on *Phragmites* populations.

Given the increasing shoreline distribution of purple loosestrife, it is recommended that the lake board consider the use of biocontrols over a few seasonal applications to manage the spread of the species. K&A has seen effective, self-sustaining populations of *Galerucella* beetles forage exclusively on purple loosestrife after three years of beetle releases.

Nuisance pondweed production in Cedar Lake North has been increasing. Pondweeds resembling broad leaf pondweed and Richardson's pondweed may be aggressive hybrids that are increasing in cumulative cover in the lake. The Department of the Environment, Great Lakes, and Energy (EGLE) does not permit treatment of pondweeds in many of the nuisance areas in Cedar Lake North. Mechanical harvesting is not regulated in Michigan and can be used as an effective management strategy for nuisance pondweeds. This approach should be considered for use in 2025 if there is a substantial increase in the nuisance production of hybrid native pondweeds.

6.0. Appendices

6.1. Appendix A: Information About Nuisance and Aquatic Invasive Species

Algal Blooms

Blue green algae blooms are becoming increasingly common in Michigan. Blooms can appear as though green latex paint has been spilled on the water, or resemble an oil slick in enclosed bays or along leeward shores. Blue green algae blooms are usually temporal events and may disappear as rapidly as they appear. Blue green algae blooms are becoming more common for a variety of reasons; however, the spread and impact of zebra mussels has been closely associated with blooms of blue green algae.

Figure A1 - Example blue green algae images from the 2019 LakeScan™ field crew.

Blue green algae are really a form of bacteria known as cyanobacteria. They are becoming an important issue for lake managers, riparian property owners and lake users because studies have revealed that substances made and released into the water by some of these nuisance algae can be toxic or carcinogenic. They are known to have negative impacts on aquatic ecosystems and can potentially poison and sicken pets, livestock, and wildlife. Blue green algae can have both direct and indirect negative impacts on fisheries. Persons can be exposed to the phytotoxins by ingestion or dermal absorption (through the skin). They can also be exposed to toxins by inhalation of aerosols created by overhead irrigation, strong winds, and boating activity.

Approximately one half of blue green algae blooms contain phytotoxins, and this is determined through lab testing. It is recommended that persons not swim in waters where blue green algae blooms are conspicuously present. Specifically, persons should avoid contact with water where blooms appear as though green latex paint has been spilled on the water, or where the water in enclosed bays appears to be covered by an "oil slick". Pets should be prevented from drinking from tainted water. Since blue green algae toxins can enter the human body through the lungs as aerosols, it is suggested that water containing obvious blue green algae blooms not be used for irrigation in areas where persons may be exposed to it.

Blue green algae are not very good competitors with other, more desirable forms of algae. They typically bloom and become a nuisance when resources are limiting or when biotic conditions reach certain extremes. Some of the reasons that blue green algae can bloom and become noxious are listed below:

TP and TN: The total phosphorus (TP) concentration in a water resource is usually positively correlated with the production of suspended algae (but not rooted plants, i.e. seaweed). Very small amounts of phosphorus may result in large algae blooms. If the ratio of total nitrogen (TN) to total phosphorus is low (<20), suspended algae production may become nitrogen limited and noxious blue green algae may dominate a system because they are able to "fix" their own nitrogen from atmospheric sources. Other common and desirable algae are not able to do this.

Biotic Factors: Zebra mussels and zooplankton (microscopic, free-floating animals) are filter feeding organisms that strain algae and other substances out of the lake water for food. Studies have shown that filter-feeding organisms often reject blue green algae and feed selectively on more desirable algae. Over time, and given enough filter feeding organisms, a lake will experience a net loss in "good" algae and a gain in "bad" blue green algae as the "good" algae are consumed and the "bad" algae are rejected back into the water column. This is one of the most disturbing factors associated with the invasion and proliferation of zebra mussels. Lakes that are full of zebra mussels may not support the production of "good" algae and experience a partial collapse of the system of "good" algae that are necessary to support the fishery.

Eurasian Watermilfoil and Hybrids:

Background: Anecdotal evidence suggests that hybrid milfoil has been found in Michigan inland lakes for a long time (since the late 1980's). University of Connecticut professor Dr. Don Les was the first to determine that there were indeed, Eurasian watermilfoil and northern watermilfoil hybrids in Michigan based on samples sent to his Connecticut lab by Dr. Douglas Pullman, Aquest Corp. in 2003. Experience has proven that it is usually not possible to determine whether the milfoil observed is either Eurasian or hybrid genotype. However, because they play such similar roles in lake ecology, they are simply "lumped together" and referred to collectively as Eurasian watermilfoil. Eurasian watermilfoil is a very common nuisance in many Michigan inland lakes.

Management: Lake disturbance, such as weed control, unusual weather, and heavy lake use can destabilize the lake ecosystem and encourage the sudden nuisance bloom of weeds, like Eurasian watermilfoil. Eurasian watermilfoil is an ever-present threat to the stable biological diversity of the lake ecosystem. Species selective, systemic herbicide combinations have been used to suppress the nuisance production of Eurasian watermilfoil and support the production of a more desirable flora. However, it is becoming much more resistant to herbicidal treatment and herbicide resistant Eurasian watermilfoil and hybrid watermilfoil has been observed in many lakes throughout the Midwest.[5,6] Continued chemical applications can select for herbicide resistant plants, resulting in hybrid watermilfoil.[7] Some research suggests this resistance can be defeated with the use of microbiological system treatments. Milfoil community genetics are dynamic and careful monitoring is needed to adapt to the expected changes in

[5] Berger, S. T., Netherland, M. D., & MacDonald, G. E. (2015). Laboratory documentation of multiple-herbicide tolerance to fluridone, norflurazon, and topramazone in a hybrid watermilfoil (*Myriophyllum spicatum× M. sibiricum)* population. Weed Science, 63(1), 235-241.

[6] Netherland, M. D., & Willey, L. (2017). Mesocosm evaluation of three herbicides on Eurasian watermilfoil (*Myriophyllum spicatum*) and hybrid watermilfoil (*Myriophyllum spicatum x Myriophyllum sibiricum*): Developing a predictive assay. J. Aquat. Plant Manage, 55, 39-41.

[7] Netherland and Willey, 2017

the dominance of distinct milfoil genotypes. Some of these genotypes may be more herbicide resistant than others and treatment strategies must be adjusted to remain effective in different parts of the lake.

Figure A2 - Example Eurasian Watermilfoil and Hybrids images from the 2019 LakeScan™ field crew.

Starry Stonewort

Background: Starry stonewort, a macroalgae native to northern Eurasia, invaded North American inland lakes after becoming established in the St. Lawrence Seaway/Great Lakes system. Though not positively identified in a Michigan inland lake until 2006, by Aquest Corporation in Lobdell Lake, Genesee County, starry stonewort has likely been present in Michigan's inland lakes since the late 1990's. Since then, this invasive species has spread throughout Michigan. Able to spread by both fragmentation and asexual reproduction, starry stonewort has thrived in Michigan's high-quality oligotrophic and mesotrophic lakes, particularly those with marl sediments. Once established, this opportunistic species will bloom and crash and impose a very significant and deleterious impact on many ecosystem functions. Bloom and crash events are unpredictable and can happen at any time of the year. In some years starry stonewort can become a horrendous nuisance while it can be inconspicuous in others. It can comingle with other similar species and be very difficult to find when it is not blooming.

Management: Starry stonewort is capable of growing to extreme nuisance levels and can significantly impact important ecosystem functions. This species is difficult to control due to its asexual reproductive structures (bulbils) which embed in lake sediments.[8] While many strategies have been employed to manage starry stonewort, no single strategy has emerged as a panacea for controlling infestations.

Diver-assisted suction harvesting (DASH) or diver-assisted hand-pulling of small starry stonewort infestations could reduce populations over time.[9] While these methods can be effective and have high specificity, they are expensive, labor-intensive strategies that require long-term commitment.[10] These strategies may not be viable for large-scale infestations, however, due to their labor-intensive nature

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[8] Glisson, W. J., Wagner, C. K., McComas, S. R., Farnum, K., Verhoeven, M. R., Muthukrishnan, R., & Larkin, D. J. (2018). Response of the invasive alga starry stonewort (*Nitellopsis obtusa*) to control efforts in a Minnesota lake. Lake and Reservoir Management, 34(3), 283-295.

[9] Glisson et al., 2018.

[10] Larkin, D.J., Monfils, A.K., Boissezon, A., Sleithd, R.S., Skawinski, P.M., Welling, C.H., Cahill, B.C., and Karold, K.G. 2018. Biology, ecology, and management of starry stonewort (*Nitellopsis obtusa*; Characeae): A Red-listed Eurasian green alga invasive in North America. https://doi.org/10.1016/j.aquabot.2018.04.003

and their potential for increasing distribution of the target plant species through fragmentation during removal.

Starry stonewort chemical treatments using copper-, diquat-, flumioxazin, and endothall-based algaecides have produced mixed results and long-term management has yet to be achieved using chemical biocides alone.[11] While starry stonewort is susceptible to most selective algaecides, the dense mats of vegetation are very difficult to penetrate and provide reasonable biocide exposure. Consequently, multiple algaecide applications may be required to “whittle down” dense starry stonewort growth if the mats reach sufficient height.

Figure A3 - Example starry stonewort images from the 2019 LakeScan™ field crew.

Curly Leaf Pondweed

Background: Curly leaf pondweed is one of the world’s most widespread aquatic plant species. Although it is found worldwide, curly-leaf pondweed is native to only Eurasia. The earliest verifiable records of the plant are from Pennsylvania in the 1840s, and has been found in Michigan since 1910. Curly leaf pondweed is currently found in inland lakes of 34 counties in Michigan, distributed both in the upper and lower peninsulas. [12] Scientific literature suggests that curly leaf pondweed is an aggressively growing species that often expands to nuisance levels when native plants are damaged.

Curly leaf pondweed can create problems such as recreational nuisances, ecological nuisances (by outcompeting native species and reducing light availability to other plants), and degraded fish spawning habitat. Curly leaf pondweed is easily detectable in early spring as it will be one of the few plants readily growing and the first submersed plant to reach the surface. This gives it a competitive advantage and can grow 4 to 5 feet tall before other plants begin germinating from the bottom sediments. As water temperatures rise in late June and early July, curly-leaf pondweed stems begin to die, break down, and can be completely gone by mid-July.[13]

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[11] Pokrzywinski, K. L., Getsinger, K. D., Steckart, B., & Midwood, J. D. (2020). Aligning research and management priorities for *Nitellopsis obtusa* (starry stonewort).

[12] MDEQ. (2018). “State of Michigan’s Status and Strategy for Curly-leafed Pondweed (*Potamogeton crispus L.*).” Accessed online: <https://www.michigan.gov/documents/invasives/egle-ais-potamogeton-crispus_708948_7.pdf>.

[13] Hart, Steven, M. Klepinger, H. Wandell, D. Garling, L. Wolfson. (2000). “Integrated Pest Management for Nuisance Exotics in Michigan Inland Lakes.” Accessed online: <https://www.michigan.gov/documents/invasives/egle-great-lakes-aquatics-IPM-manual_708904_7.pdf>.

Management: Like other invasive species, curly-leaf pondweed is difficult to control once established and is considered widespread in Michigan. Therefore, prevention of new populations in uninfected waters is the most economical management approach. Several herbicides have been shown to be effective at long-term control of curly-leaf pondweed, but eradication is difficult after establishment. Bottom barriers have shown effectiveness at combating curly-leaf pondweed in small areas, and mechanical harvesting of curly-leaf pondweed can be effective if timed and managed correctly.[14]

The most viable ways to control curly-leaf pondweed is through chemical and physical means after developing an integrated pest management plan. Early infestations may best be controlled by manual removal, diver-assisted suction harvesting (DASH), or benthic barrier use during spring before turions are produced. Aquatic herbicides including endothall, diquat, and flumioxazin are the most effective for general applications. Aquatic herbicides including flumioxazin and imazamox are effective for specific types of application and in specific environments. Chemical treatments are a part of a long-term integrated management plan as the turions are viable for at least 5 years and only diquat, fluridone, and some hormone treatments have shown a reduction of turion development in the laboratory.[15]

Figure A4 - Example curly leaf pondweed image from the 2021 LakeScan™ field crew.

[14] MDEQ, 2018.

[15] MDEQ, 2018.

6.2. Appendix B: Herbicide Applicator Data and Maps

Date of treatment (one per section): 6/18/2024

Name of person applying chemical: Michael Rohlman

Name of Company or NA if not applicable: Solitude Lake Management

Effectiveness: ■ Good (70-100%) ☐ Fair (50-69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

Chemical Brand Used	EPA Registration Number	Method of Application	Application Rate (10 lbs./acre, etc.)	Treatment Area Size: (Acres)	Average Depth (Feet)	Total Amount (4 gallons, 10 lbs., etc.)	For Control of: (Plant and/or Algae names)
Tribune	100-1390	Surface Spray/Sub Surface Injection	1 gal/acre	7.5	3	7.5 gal	Eurasion Water Milfoil/Curlyleaf Pondweed
Cutrine Plus	67690-93	Surface Spray/Sub Surface Injection	.33 gal/acre-foot	7.5	3	7.5 gal	Macro-algaeStarry Stonewort
Hydrothol 191	70506-175	Surface Spray/Sub Surface Injection	1.33 pint/acre-foot	4.5	3	2.25 gal	Macro-algaeStarry Stonewort
Procellacor EC	67690-80	Surface Spray/Sub Surface Injection	25.6 fl oz/acre-foot	10.25	6	1574 oz	Eurasion Water Milfoil
Tribune	100-1390	Surface Spray/Sub Surface Injection	1 gal/acre	10.25	6	10.25 gal	Eurasion Water Milfoil/Curlyleaf Pondweed
Cutrine Plus	67690-93	Surface Spray/Sub Surface Injection	.17 gal/acre-foot	8.75	6	8.75 gal	Algae
Aquathol K	70506-176	Surface Spray/Sub Surface Injection	1 gal/acre	3	3	3 gal	Curly-leaf Pondweed

Figure B1 – Solitude Lake Management Aquatic Nuisance Control (ANC) treatment report for Cedar Lake, Alcona and Iosco counties, on June 18, 2024.

Date of treatment (one per section): 9/18/2024

Name of person applying chemical: Michael Rohlman

Name of Company or NA if not applicable: Solitude Lake Management

Effectiveness: ■ Good (70-100%) ☐ Fair (50-69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

Chemical Brand Used	EPA Registration Number	Method of Application	Application Rate (10 lbs./acre, etc.)	Treatment Area Size: (Acres)	Average Depth (Feet)	Total Amount (4 gallons, 10 lbs., etc.)	For Control of: (Plant and/or Algae names)
Tribune	100-1390	Surface Spray	2 gal/acre	4.5	3	9 gal	Eurasion Water Milfoil
Cutrine Plus	67690-93	Surface Spray	.33 gal/acre-foot	4.5	3	4.5 gal	Algae
Habitat	241-426-67690	Foliage Spray	2 pint/acre-foot	1.25	1	2.5 pint	Phragmites
Aquaneat	228-365	Foliage Spray	2 pint/acre-foot	1.25	1	2.5 pint	Phragmites
Cygnet Plus	N/A	Foliage Spray	.5 pint/acre-foot	1.25	1	.625 pint	Phragmites

Figure B2 – Solitude Lake Management Aquatic Nuisance Control (ANC) treatment report for Cedar Lake, Alcona and Iosco counties, on September 18, 2024.

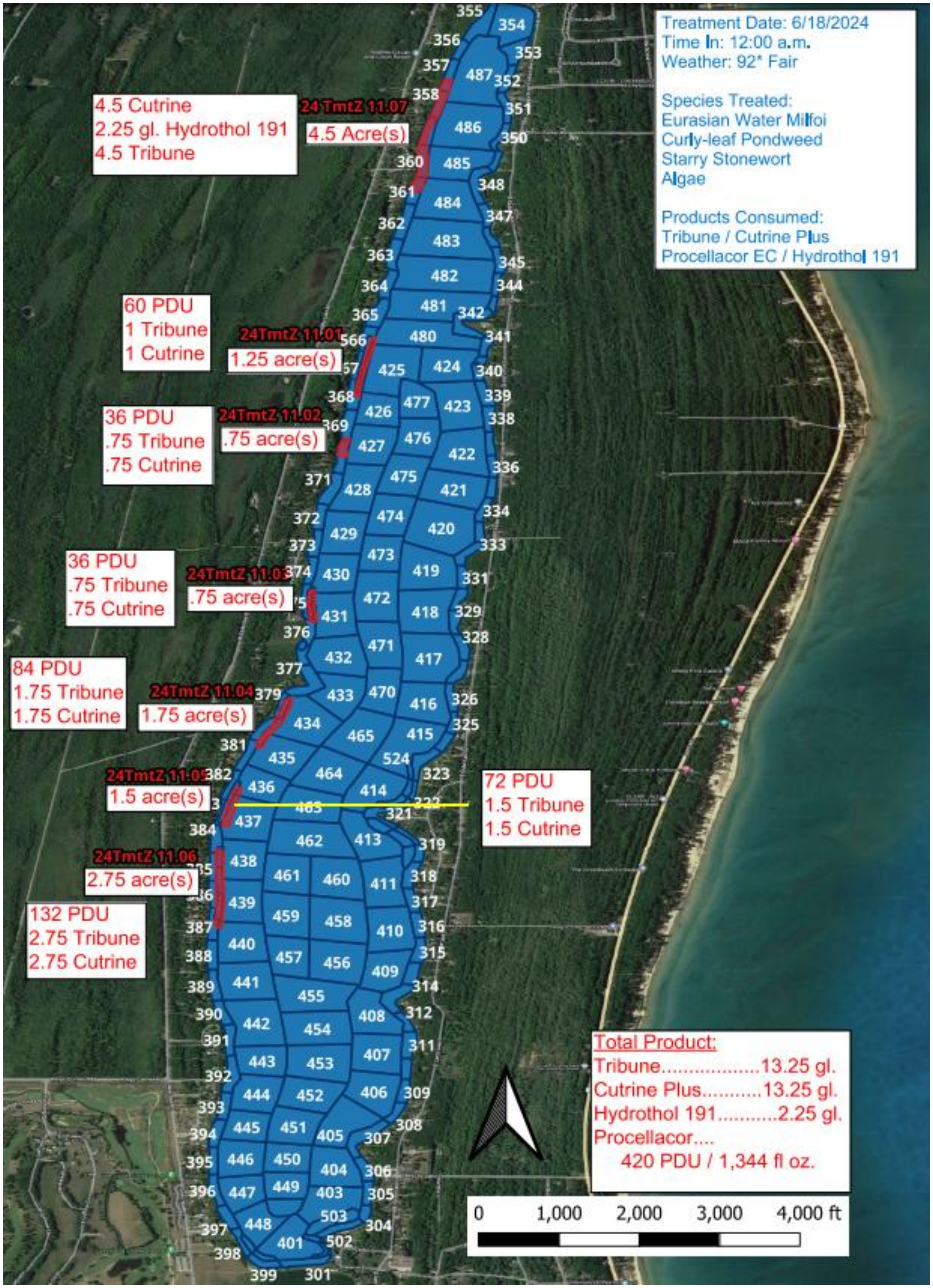

Figure B3 – Solitude Lake Management treatment map for Cedar Lake, Alcona and Iosco counties, on June 18, 2024.

Treatment Date: 9/18/2024
Time In: 12:00 P.M.
Weather: 78* Fair

Species Treated:
Eurasian Water Milfoil
Phragmites

Products Consumed:
Tribune
Cutrine Plus
Habitat
Aqua-neat
Cygnet Plus

Figure B4 – Solitude Lake Management treatment map for Cedar Lake, Alcona and Iosco counties, on September 18, 2024.