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Geneva Lake
2022 Aquatic Plant Survey Report

Prepared for:
Geneva Lake Environmental Agency

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INTRODUCTION / SUMMARY

The Geneva Lake Environmental Agency (GLEA) is a group formed to protect and enhance the waters of Geneva Lake for all current and future users. Wisconsin Lake & Pond Resource, LLC (WLPR) was contracted by the GLEA to provide an aquatic plant survey and a report summarizing results and historical comparisons for the Lake. WLPR furnished all labor, materials, tools and equipment necessary to perform all operations.

Geneva Lake is a 5,262-acre lake in south central Walworth County. The lake is a deep, natural spring-fed lake with a maximum depth of 140-ft, mean depth of 61-ft, and 20.2 miles of shoreline. Seven aquatic invasive species (AIS) are confirmed to be present in the Lake. For purposes of this report a focus will be on vegetative AIS found, including; curly-leaf pondweed (*Potamogeton crispus* - CLP), Eurasian water-milfoil (*Myriophyllum spicatum* - EWM), and starry stonewort (*Nitellopsis obtusa*). During recent surveys, the submersed AIS have been found at low levels not requiring direct management across the lake.

Geneva Lake is the largest lake in southern Wisconsin with a long history as a popular tourist destination. The lake is not only locally important to many year-round residents but also significantly important to Wisconsin. Its proximity to larger metropolitan areas of Milwaukee, Madison, and Chicago, support a wide array of heavy recreational use year-round. Increasing lakeshore development, introduction of aquatic invasive species (AIS), watershed impact to water quality, and high recreational use have been causes for concern to protect the lake for continued use while also maintaining and improving existing quality.

To achieve this, multiple interest groups led by the GLEA have collaborated to manage the resources to ensure their use for future generations. Lake management activities have been broad and encompass many actions. There have been multipole whole-lake aquatic plant surveys completed in recent history. An aquatic plant survey provides a whole-lake baseline of presence and abundance of individual species. This allows for documenting AIS, assessing current lake health, and comparing changes over time by evaluating management actions.

Aquatic plant surveys are typically completed as part of a broader project to create a management plan for a lake. Collected data can be used for implementation within a specific aquatic plant management portion of the overall Geneva Lake management plan. To gauge current conditions and assist future management, a whole-lake point-intercept aquatic plant survey was again completed in July, 2022 by Wisconsin Lake & Pond Resource.

Aquatic Plants

Aquatic plants are vital to the health of a water body. Unfortunately, they are often negatively referred to as "weeds". The misconceptions this type of attitude brings must be overcome in order to properly manage a lake ecosystem. Rooted aquatic plants are extremely important for the well-being of a lake community and possess many positive attributes. Despite their importance, they sometimes grow to nuisance levels that hamper recreational activities and are common in degraded ecosystems. The introduction of aquatic invasive species, such as Eurasian water-milfoil, often can

increase nuisance conditions, particularly when they successfully out-compete native vegetation and occupy large portions of a lake.

To assess the state of the current plant communities, a full point-intercept survey was completed by Wisconsin Lake & Pond Resource, LLC (WLPR) in July 27-29, 2022 for Geneva Lake. For areas of historical starry stonewort growth, sub-set point intercept surveys were also completed to more accurately document the presence of this invasive species on August 2, 2022. All surveys followed Wisconsin Department of Natural Resources (WDNR) survey protocol and included sampling pre-determined locations to document the following at each site:

- Individual species present and their density
- Water depth
- Bottom substrate

In total, 2,685 individual locations were created to be sampled and spaced on a 90-meter (295-feet) grid for Geneva Lake proper (Figure 1). The sub-set surveys focused on areas of known and expected starry stonewort growth in the southeastern portion of the lake, including in Trinke Lagoon and the main basin of Geneva Lake. Two separate, sub-set grids were used to sample for starry stonewort only in these locations. The main-basin had a grid of 216 points spaced 45-meters (148-feet) apart while Trinke Lagoon had a grid of 36 points spaced 15-meters (49-feet) apart (Figure 6).

For all locations, latitude and longitude coordinates and sample identifications were assigned to each intercept point. Geographic coordinates were uploaded into a global positioning system (GPS) receiver. The GPS unit was then used to navigate to intercept points. At each intercept point, plants were collected by either tossing a specialized rake on a rope in depths 15' or greater or by using a specialized rake on a pole in depths less than 15' by dragging the rake along the bottom sediments. All collected plants were identified to the lowest practicable taxonomic level (e.g., typically genus or species) and recorded on field data sheets. Visual observations of aquatic plants were also recorded. Water depth and, when detectable, sediment types at each intercept point were also recorded on field data sheets. Data collected at each point in 2022 was then entered into a WDNR spreadsheet, which outputs various aquatic plant community indexes and data, allowing for a comparison to past data to monitor changes over time. Information on methods and all referenced tables, figures or charts is included in Appendices A-D.

To compare the plant community within Geneva Lake to similar lakes in Wisconsin, the Floristic Quality Index (FQI) can be used. FQI provides the ability to compare aquatic plant communities based on species presence. This value varies throughout Wisconsin, ranging from 3.0 to 44.6 with a statewide average of 22.2. To achieve this, each plant species, except for AIS, is assigned a coefficient of conservatism value (C value). A plant's C value relates to a plant species' ability to tolerate disturbance. Low C values (0-3) indicate that a species is very tolerant of disturbance, while high C values (7-10) indicate species with a low tolerance of disturbance. Intermediate C values (4-6) indicate plant species that can tolerate moderate disturbance.

The whole-lake plant survey performed in 2022 will allow for continued tracking of changes over time within the Lake. Additionally, collected data will create a comparison of the Lake to other lakes with similar environmental conditions within a delineated area, called an ecoregion.

Geneva Lake is located in the southern portion of the Southeastern Till Plains ecoregion. Lakes within the Southeastern Till Plains are typically natural lakes that, due to higher population density in this area of the State, have developed shoreline. Increased development around the lake and overall use of these lakes leads to more disturbance from an undisturbed, natural condition, which leads to lower plant community metrics like FQI and coefficient of conservatism.

2022 Whole-Lake Point-Intercept Survey

The entire aquatic plant community was surveyed on July 27-29, 2022 by WLPR and repeated sampling at the same sample points from past surveys. The photic zone, depth to which sunlight reaches the bottom allowing plants to grow, was found to a depth of 27-ft. Due to the Lake's great depth many points were beyond the maximum depth of plant growth and not directly sampled. In total, 795 were directly sampled (Figure 1). The amount of photic zone vegetated continued to be high, with 75.7% of points within it vegetated. Native species richness exhibited continued good diversity per sample point with an average of 1.67 native species per site within the photic zone. Total density per location was occasionally high with an average total rake fullness of 1.40 (Figure 2). Distribution of aquatic plant species was again excellent throughout the lake, as exhibited by a Simpson Diversity Index (SDI) of 0.90. An SDI value closer to 1.0 indicates a healthier, more evenly spread plant community. Table 1 below summarizes the overall aquatic plant community statistics along with past results.

Table 1: Aquatic Plant Community Statistics. Geneva Lake, Walworth Co., Wisconsin.

	2015	2019	2020	2022
Number of sites sampled	784	994	1268	795
Number of sites with vegetation	652	607	628	566
Number of sites shallower than maximum depth of plants	732	770	860	748
Frequency of occurrence at sites less than max depth of plants (%)	89.07	78.83	73.02	75.67
Simpson Diversity Index	0.91	0.9	0.9	0.9
Maximum Depth of Plants (Feet)	41.6	32	37	27
Taxonomic Richness (Number Taxa - includes visuals)	31	29	28	30
Average Number of Species per Site (within photic zone)	2.42	2.02	1.74	1.8
Average Number of Species per Site (sites with vegetation)	2.75	2.56	2.38	2.38
Average Number of Native Species per Site (within photic zone)	2.16	1.75	1.55	1.67
Average Number of Native Species per Site (sites with vegetation)	2.47	2.26	2.13	2.21
Floristic Quality Index	37.14	31.00	31.03	32.16
Average Coefficient of Conservatism	6.90	6.20	6.33	6.31

Table 2 in Appendix B includes the abundance statistics for each species from each survey completed from 2015-2022. The following charts displays frequency of occurrence for all species sampled over in 2022 and then all species sampled from 2015-2022.

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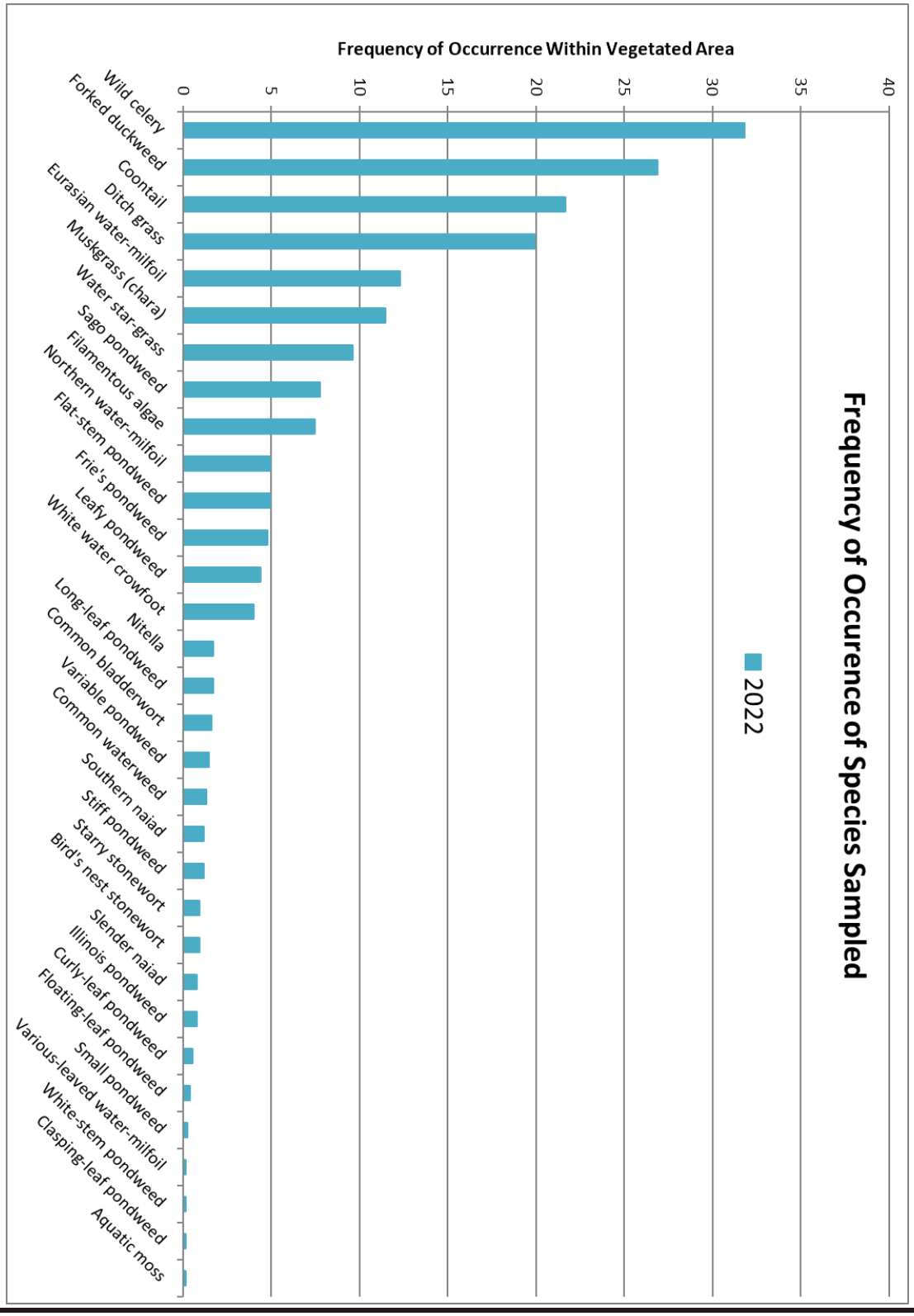

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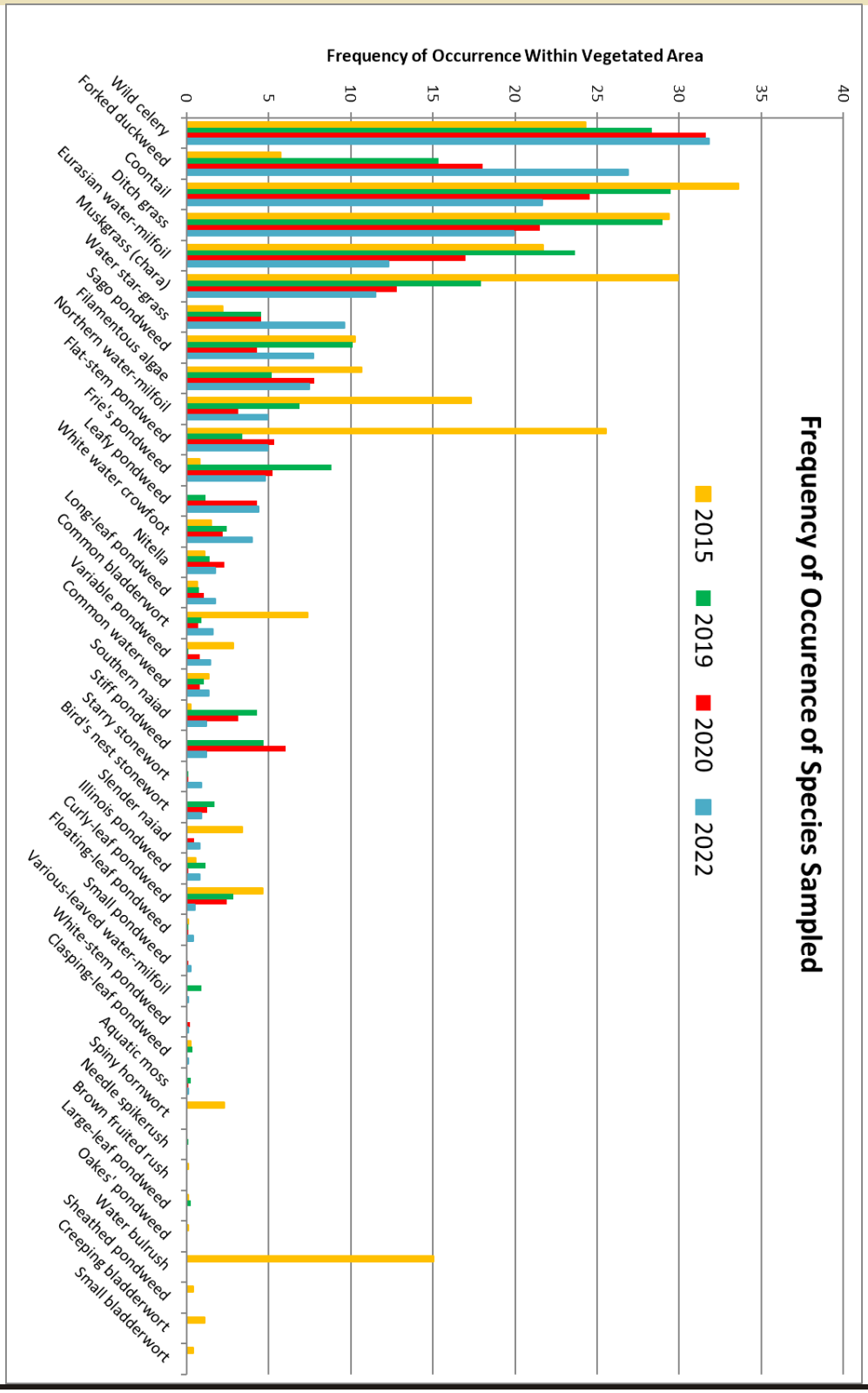

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Species sampled in the Lakes were present in three categories: submersed true plant species which root on the lake bottom and remain below the water's surface (ex. coontail – *Ceratophyllum demersum*), submersed, plant-like algae species that have root-like structures and remain below the water's surface (ex. Muskgrass – *Chara sp.*), and free-floating species which are not rooted to the lake bottom and freely float on the surface (ex. forked ducked – *Lemna trisulca*).

The most abundant aquatic plant identified during the 2022 aquatic plant survey was wild celery (*Vallisneria american*). It exhibited an 31.8% frequency of occurrence at photic zone locations (percent of intercept points at which plants can grow) and 42% of all points with vegetation. Density of wild celery was moderate with an average rake fullness of 1.02. Wild celery has routinely been one of, if not the most, common plants sampled in Geneva Lake. Populations of wild celery were noted throughout the lake, primarily from depths of 2-10-ft, and often mixed in with other species.

Forked duckweed was the next most abundant species, occurring at 26.9% of photic zone sample points. Forked duckweed is a free-floating, rootless plant and starts growing in mats along the lake bottom. Unlike most plants, forked duckweed does not root and can drift around the lake, causing dense areas to shift throughout the year. On occasion, large mats of forked duckweed can drift into shoreline areas and become a nuisance on Geneva Lake. Forked duckweed has even caused issues clogging the lake's outflow and requiring mechanical removal to alleviate conditions. Populations of forked duckweed have increased between each survey completed.

The third most abundant was coontail (*Ceratophyllum demersum* Coontail is one of the most common aquatic plant species across Wisconsin and can grow to dense, nuisance causing levels. Unlike most plants, coontail does not root and can drift around the lake, causing dense areas to shift throughout the year. Coontail is green throughout much of the year and offers good habitat for fish under ice cover when many other species have died back. During the 2022 survey it was found at 21.7% of photic zone sample sites.

Floristic Quality Index

To compare changes in the plant community over time within Geneva Lake and to similar lakes in Wisconsin, the floristic quality index (FQI) can be used. FQI provides the ability to compare aquatic plant communities based on species presence. This value varies throughout Wisconsin, ranging from 3.0 to 44.6, with a statewide average of 22.2. To achieve this, each plant species, except for AIS, is assigned a coefficient of conservatism value (C value). A plant's C value relates to a plant species' ability to tolerate disturbance. Low C values (0-3) indicate that a species is very tolerant of disturbance, while high C values (7-10) indicate species with a low tolerance of disturbance and are typically found in systems of higher water quality. Intermediate C values (4-6) indicate plant species that can tolerate moderate disturbance. The calculated FQI for Geneva Lake from the 2022 plant survey is 32.16 with an average C value of 6.31 (Table 3 – Appendix B).

Not only does this track changes over time within the lake, but allows for comparison of the Lake to lakes with similar environmental conditions within a delineated area, called an eco-region, to be

compared. Geneva Lake is located within the Southeastern Till Plains Lakes eco-region. Lakes within this region are typically natural lakes created by glaciation.

Geneva Lake is found near the western border of the southern portion of the ecoregion within the Kettle Moraines sub-region. Typical lakes within this area are primarily seepage lakes that formed in low areas between the ridges of deposits created by glaciation. Land use varies within the region from primarily forest to agricultural watersheds to areas of dense residential development. Nearly all the lakes within this eco-region have at least moderate development along the shoreline and many stretches of densely developed shoreline.

Lakes within this eco-region have increased development around the shoreline and increased overall use. Both conditions lead to more disturbances from an expected natural condition, which leads to lower plant community metrics like FQI and coefficient of conservatism. Both of these are below the average for all Wisconsin lakes due to this.

Even after years of intense recreational use, AIS impacts, and shoreline development, Geneva Lake displays a very high quality and diverse plant community for the eco-region. Its average C value (6.31), FQI (32.16), and total species (30) are all above the upper quartile of the eco-region. All values compare favorable and are in line with past results, showing a continued stable aquatic plant community (Table 4).

Table 4: FQI and Average Coefficient of Geneva Lake Compared to Wisconsin & Southeastern Till Plains Eco-region

	Avg. Coefficient of Conservatism			Floristic Quality			Number of Species		
Quartile*	Lower	Mean	Upper	Lower	Mean	Upper	Lower	Mean	Upper
Wisconsin Lakes	5.5	6	6.9	16.9	22.2	27.5	8	13	20
Southeastern Till Plains	5.2	5.6	5.8	17	20.9	24.4	10	14	19
2022	6.31			32.16			30		
2020	6.33			31.03			28		
2019	6.2			31			29		
2015	6.9			37.14			31		

Native Aquatic Plant Species Changes

To assess changes between 2022 and past surveys, statistical analysis was completed using a Chi-square test with a 5% Type-I error rate. This error rate is standard in ecological studies and equals that there is a 5% chance of claiming statistically significant change when no real change occurred. Only those species that display a p-value of 0.05 or lower changed significantly population-wise between years. To calculate these values, the total number of sample locations each species was found at is compared between years. Table 5 displays statistical changes, if any, for each species sampled.

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Table 5: Statistical Significance of Species between Sampling Events, Geneva Lake, Walworth Co., WI

Species	2022 vs 2020			2022 vs 2019			2022 vs 2015		
	P-value	Significance	+ / -	P-value	Significance	+ / -	P-value	Significance	+ / -
Eurasian water-milfoil	0.008427734	**	↓	9.37283E-09	***	↓	1.37196E-06	***	↓
Curly-leaf pondweed	0.00204765	**	↓	0.000489309	***	↓	5.78811E-07	***	↓
Starry stonewort	0.019818207	*	↑	0.030138897	*	↑	0.008702808	**	↑
Coontail	0.17276508	n.s.	↓	0.000482365	***	↓	2.70085E-07	***	↓
Spiny hornwort	---	---	---	---	---	---	2.76422E-05	***	↓
Muskgrass (chara)	0.429109298	n.s.	↓	0.000417831	***	↓	1.96283E-18	***	↓
Needle spikerush	---	---	---	0.324164734	n.s.	↓	---	---	---
Common waterweed	0.306459537	n.s.	↑	0.591864428	n.s.	↑	0.961174091	n.s.	-
Water star-grass	5.90512E-05	***	↑	0.000110648	***	↑	1.43765E-09	***	↑
Brown fruited rush	---	---	---	---	---	---	0.31191518	n.s.	↓
Forked duckweed	2.02007E-05	***	↑	3.37616E-08	***	↑	5.14679E-28	***	↑
Various-leaved water-milfoil	0.283455372	n.s.	↑	0.03697398	*	↓	0.322378778	n.s.	↑
Northern water-milfoil	0.064489753	n.s.	↑	0.110200068	n.s.	↓	2.95827E-14	***	↓
Slender naiad	0.391190692	n.s.	↑	0.012767957	*	↑	0.000448362	***	↓
Southern naiad	0.008848676	**	↓	0.000251494	***	↓	0.037287783	*	↑
Nitella	0.40712275	n.s.	↓	0.629001461	n.s.	↑	0.294142065	n.s.	↑
Large-leaf pondweed	---	---	---	0.163081215	n.s.	↓	0.31191518	n.s.	↓
Leafy pondweed	0.914572787	n.s.	↑	0.000117514	***	↑	9.07192E-09	***	↑
Frie's pondweed	0.70110064	n.s.	↓	0.00194572	**	↓	3.73862E-06	***	↑
Variable pondweed	0.211907407	n.s.	↑	0.003188625	**	↑	0.06443921	n.s.	↓
Illinois pondweed	0.037188065	*	↑	0.470221577	n.s.	↓	0.548282792	n.s.	↑
Floating-leaf pondweed	0.252830923	n.s.	↑	0.302797814	n.s.	↑	0.327204377	n.s.	↑
Long-leaf pondweed	0.2338333	n.s.	↑	0.092995533	n.s.	↑	0.064147883	n.s.	↑
Oakes' pondweed	---	---	---	---	---	---	0.31191518	n.s.	↓
White-stem pondweed	0.646773225	n.s.	↓	0.310137448	n.s.	↑	0.322378778	n.s.	↑
Small pondweed	0.483712797	n.s.	↑	0.151057474	n.s.	↑	0.161527466	n.s.	↑
Clasping-leaf pondweed	0.283455372	n.s.	↑	0.330852344	n.s.	↓	0.550697633	n.s.	↓
Stiff pondweed	3.96192E-07	***	↓	6.67268E-05	***	↓	0.002912684	**	↑
Flat-stem pondweed	0.716088297	n.s.	↓	0.125223415	n.s.	↑	2.05858E-28	***	↓
White water crowfoot	0.03606545	*	↑	0.088994096	n.s.	↑	0.003290114	**	↑
Ditch grass	0.432543275	n.s.	↓	4.23149E-05	***	↓	2.4266E-05	***	↓
Water bulrush	---	---	---	---	---	---	3.07739E-28	***	↓
Sago pondweed	0.003409882	**	↑	0.105140709	n.s.	↓	0.093751349	n.s.	↓
Sheathed pondweed	---	---	---	---	---	---	0.079661203	n.s.	↓
Creeping bladderwort	---	---	---	---	---	---	0.004144737	**	↓
Small bladderwort	---	---	---	---	---	---	0.079661203	n.s.	↓
Common bladderwort	0.084787813	n.s.	↑	0.2232145	n.s.	↑	7.47807E-08	***	↓
Wild celery	0.934823001	n.s.	↑	0.136247567	n.s.	↑	0.00132913	**	↑
Aquatic moss	0.921294123	n.s.	↑	0.580364308	n.s.	↓	0.322378778	n.s.	↑
Filamentous algae	0.819007968	n.s.	↓	0.066635874	n.s.	↑	0.033651901	*	↓
Bird's nest stonewort	0.514052768	n.s.	↓	0.198632455	n.s.	↓	0.008702808	**	↑

* - somewhat significant change, ** - moderatly significant change, *** - very significant change

n.s. - Change not significant

--- - Species was not sampled in both comparison years

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The 2022 survey was completed following past procedures to further assess the aquatic plant and plan for future management. In comparing 2022 to historic data, multiple species saw statistical increase or decrease over time. Most recently, four species saw a significant decrease in abundance between 2022 and 2020; Eurasian water-milfoil, curly-leaf pondweed, southern naiad, and stiff pondweed. Conversely, six species were noted to have a statical increase; starry stonewort, water star-grass, forked duckweed, Illinois pondweed, white water crowfoot, and sago pondweed.

Overall, the native aquatic plant community of Geneva Lake remained from 2020 and earlier and remains in excellent condition as found during the 2022 survey. The native community has continued to remain healthy as noted by high FQI, average coefficient of conservancy, species diversity, and SDI. A historically diverse native plant community is vital for lake health and helps naturally protect again non-native species. An aquatic plant community is dynamic and will see changes in species from year to year under natural conditions and reductions or increases of species between surveys is not an immediate cause for concern.

Aquatic Invasive Species

Currently, three AIS of concern are found in Geneva Lake; Eurasian water-milfoil, curly-leaf pondweed, and starry stonewort. Though non-native, both EWM and CLP have been historically found at low, background levels and not required active, directed management. Often these plans are found mixed in with native species with little to no areas of monotypic growth. The 2022 survey showed this trend to continue. Though EWM was the fifth most common species found at 12.3% of photic zone points, it was found only at low density and coverage. In total, EWM was found at 98 sites spread throughout the lake and with an average rake fullness of 1.02 (Figure 3).

Curly-leaf pondweed has a unique life cycle among aquatic plants. It begins growing under ice cover, has its highest density in late spring, then dies back naturally in early summer. Due to this, populations of CLP are often under-sampled during whole-lake surveys, which are timed to gather data on native species. Curly-leaf pondweed was found only at 4 sites (Figure 4). Though limited CLP was found, it may be present in higher amounts during spring in Geneva Lake. However, based on past experience and current data, CLP populations are not at levels to require active management and often blend in with native plant communities.

Starry stonewort is a newly-identified AIS in Geneva Lake. Since it was first identified in 2018 it has continued to spread in abundance. Populations of starry stonewort continue to be found only in the southeastern portion of the lake. Within the whole-lake survey grid, starry stonewort was found at seven sample locations, or 0.94% of photic zone points, and with an average rake fullness of 1.57 (Figure 5).

2022 Sub-set Point-Intercept Survey Results – Starry Stonewort

To better delineate starry stonewort populations, two sub-set sampling grids were sampled during the 2022 surveys on August. These grids were eastablished in areas with known populations of starry stonewort and used grids with tighter spacing of sampling points. Sampling locations included Trinke Lagoon and an approximately 105-acre area of the southeastern portion of the Lake. Only the presence of starry stonewort and its rake fullnes were recorded. Raw results are included in Appendix D.

Starry stonewort was first found in the Trinke Lagoon in fall of 2018. Since then, populations within the lagoon have grown dense enough to impact navigation and require active management. Control has ranged from dredging to targeted chemical applications. Though both have temporarily reduced nuisance levels, they have not resulted in a reduced population. The 2022 sub-set survey identified starry stonewort at 24 of 36 survey locations (67%) with an average rake fullness of 1.67 (Figure 6). Many areas were noted to have growth of starry stonewort at or just below the surface of the lagoon.

Within the main lake, starry stonewort was found at only one sample location in 2020. Growth of starry stonewort has expanded since this survey. Starry stonewort was found at seven whole-lake survey grid locations and 22 of 216 sub-set locations (10.2%) with an average rake fullness of 1.13. Populations of starry stonewort within the main lake were found in a narrow band of locations and typically following depth contours of 10-14-ft. Maximum depth of starry stonewort growth was noted at 14.5-ft in the sub-set survey and 17.5-ft in the whole-lake grid (Figures 5 & 6)

Conclusion

As a whole, the aquatic plant community of Geneva Lake was found at high diversity and relative quality. The 2022 survey findings echo those identified in past surveys and show a continued dynamic and healthy aquatic plant community. Though three AIS were found, EWM and CLP were at low, non-nuisance levels when found. Starry stonewort was found to be low-growing in deep water (10-17ft) within the main lake and did not present a nuisance at the time of survey. However, within Trinke Lagoon populations of starry stonewort were noted to be dense and often at or near the surface. The presence and spread of existing AIS and introduction of new AIS should be continually monitored.

Management of aquatic plants can take many facets, depending on each lake's unique condition and desire by the community. To be successful, management options must be accepted by its users while not causing undue harm or impact to the lake itself. A diverse and healthy aquatic plant community is a great asset for the lake and helps protect against aquatic invasive species. The size of the Geneva Lake can make meaningful large-scale management of AIS difficult. To prevent this, multi-faceted small-scale management is necessary and currently ongoing.

Current DNR recommendations for control of AIS include the use of an integrated pest management approach, or IPM. Use of IPM includes changing methods of control, including but not limited to: varying herbicide active ingredients, mechanical harvesting, hand or suction harvesting, and

no-action. The spread of EWM and CLP within Geneva Lake as recorded in 2022 is found primarily in scattered, low-density populations throughout the lake. These populations are too small and spread out to be require management or be feasibly controlled.

Starry stonewort continues to expand through the Lake and is likely to do so. However, many locations within the main lake basin were low growing, low density, and found in deeper water. Starry stonewort at these locations does not present a nuisance to lake use. However, in Trinke Lagoon starry stonewort was found to be significantly denser and can impact lake health and use of the Lagoon. Past actions for starry stonewort have not reduced it's spread, but have reduced seasonal nuisance. Should control continue it is recommended primarily for the densest areas to reduce nuisance conditions.

Finally, though of high quality and diversity, native plant species can still grow very dense within the Lake and cause navigational nuisance requiring management. Notably in 2022, large rafts of forked duckweed washed up, clogged the outflow, and required mechanical removal. Direct control of native plant species is not recommended for much of the lake and should focus only on select nuisance conditions, such as those created by forked duckweed.

It is our recommendation to continue to conduct management in select areas for navigational relief while monitoring populations of AIS throughout the lake. A few management items are as follows:

- **Boat landing monitoring** – Geneva Lake is a popular, heavily recreated lake with multipole public and private launches. Boat access site monitoring is a primary action to prevent the introduction of new AIS into the Lake or transport of current AIS out of the Lake.
- **Starry Stonewort** – reduction of nuisance-causing populations in protected, shallow water areas such as Trinke Lagoon. Potential actions may include;
    - Mechanical harvesting
    - Diver Assisted Suction Harvesting (DASH)
    - Chemical control
    - Hand pulling
- **Eurasian water-milfoil and curly-leaf pondweed** – seasonal monitoring only. Current populations do not require large-scale targeted control. Small, near-shore populations may be hand-pulled to lakeshore residents without a permit.
- **Nuisance causing native populations** – small-scale removal of nuisance causing plants may be warranted to temporarily alleviate conditions.
    - Mechanical harvesting
    - DASH
    - Chemical control
    - Hand pulling

Recommended management may require WNDR permitting, primarily mechanical harvesting, DASH, and chemical control. Appropriate planning with affected parties should be completed during any management within the Lake. Wisconsin Lake & Pond Resource appreciates working for the GLEA this past season and furthering the understanding and management of Geneva Lake.

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Appendix A

Supporting Aquatic Plant Survey Methods and Documentation

The point intercept method was used to evaluate the existing emergent, submergent, floating-leaf, and free-floating aquatic plants. If a species was not collected at a specific point, the space on the datasheet was left blank. For the survey, the data for each sample point was entered into the WDNR "Worksheets" (i.e., a data-processing spreadsheet) to calculate the following statistics:

- **Total number of sites visited:** number of sites where the boat stopped, even if too deep to have plants
- **Total number of sites with vegetation:** number of sites where at least one plant was found
- **Total number of sites shallower than maximum depth of plants:** number of sites where the depth was less than or equal to the maximum depth where plants were found.
- **Frequency of occurrence within vegetated areas (%):** number of times a species was seen in a vegetated area divided by the total number of vegetated sites
- **Frequency of occurrence at sites shallower than maximum depth of plants:** number of times a species was seen divided by the total number of sites shallower than maximum depth of plants
- **Relative taxonomic frequency of occurrence**: the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected, divided by the sum of all species' occurrences
- **Simpson Diversity Index (SDI):** an estimator of community heterogeneity (diversity). SDI is based on relative frequency and thus is not sensitive to whether all sampled sites (including non-vegetated sites) are included. The closer the SDI is to 1, the more diverse the community.
- **Maximum depth of plants (ft):** the depth of the deepest site sampled at which vegetation was present
- **Average number of species per site**: calculated for sites shallower than max depth and vegetated sites only using both all species present and native species only
- **Species richness:** total number of species collected. Does not include visual sightings
- **Species richness (including visuals):** total number of species collected including visual sightings

Floristic Quality Index (FQI) (This method uses a predetermined Coefficient of Conservatism (C), that has been assigned to each native plant species in Wisconsin, based on that species' tolerance for disturbance. Non-native plants are not assigned conservatism coefficients. The aggregate conservatism of all the plants inhabiting a site determines its floristic quality. The mean C value for a given lake is the arithmetic mean of the coefficients of all native vascular plant species occurring on the entire site, without regard to dominance or frequency. The FQI value is the mean C times the square root of the total number of native species. This formula combines the conservatism of the species present, with a measure of the native species richness of the site.

FQI and C values listed for Wisconsin and associated eco-regions as found in:

Nichols, Stanley A. 1999. *Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications.* Journal of lake and Reservoir Management 15(2) 133-141.

Appendix B

Tables

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Phone: (920) 872-2032
Fax: (920) 872-2036

Table 2: Frequency of Occurrence of Aquatic Plant Species by Year, Geneva Lake, Walworth Co., WI.

Species	Frequency of Occurrence Within Photic Zone			
	2015	2019	2020	2022
Eurasian water-milfoil	**21.72**	**23.64**	**16.98**	**12.30**
Curly-leaf pondweed	**4.64**	**2.86**	**2.44**	**0.53**
Starry stonewort	**---**	**0.13**	**0.12**	**0.94**
Coontail	33.61	29.48	24.53	21.66
Spiny hornwort	2.32	---	---	---
Muskgrass (chara)	29.92	17.92	12.79	11.50
Needle spikerush	---	0.13	---	---
Common waterweed	1.37	1.04	0.81	1.34
Water star-grass	2.19	4.55	4.53	9.63
Brown fruited rush	0.14	---	---	---
Forked duckweed	5.74	15.32	18.02	26.87
Various-leaved water-milfoil	---	0.91	---	0.13
Northern water-milfoil	17.35	6.88	3.14	4.95
Slender naiad	3.42	---	0.47	0.80
Southern naiad	0.27	4.29	3.14	1.20
Nitella	1.09	1.43	2.33	1.74
Large-leaf pondweed	0.14	0.26	---	---
Leafy pondweed	---	1.17	4.30	4.41
Frie's pondweed	0.82	8.83	5.23	4.81
Variable pondweed	2.87	0.13	0.81	1.47
Illinois pondweed	0.55	1.17	0.12	0.80
Floating-leaf pondweed	0.14	0.13	0.12	0.40
Long-leaf pondweed	0.68	0.78	1.05	1.74
Oakes' pondweed	0.14	---	---	---
White-stem pondweed	---	---	0.23	0.13
Small pondweed	---	---	0.12	0.27
Clasping-leaf pondweed	0.27	0.39	---	0.13
Stiff pondweed	---	4.68	6.05	1.20
Flat-stem pondweed	25.55	3.38	5.35	4.95
White water crowfoot	1.50	2.47	2.21	4.01
Ditch grass	29.37	28.96	21.51	19.92
Water bulrush	15.03	---	---	---
Sago pondweed	10.25	10.13	4.30	7.75
Sheathed pondweed	0.41	---	---	---
Creeping bladderwort	1.09	---	---	---
Small bladderwort	0.41	---	---	---
Common bladderwort	7.38	0.91	0.70	1.60
Wild celery	24.32	28.31	31.63	31.82
Aquatic moss	---	0.26	0.12	0.13
Filamentous algae	10.66	5.19	7.79	7.49
Bird's nest stonewort	---	1.69	1.28	0.94

* - recorded as visual only

--- - species not sampled

Table 3: FQI Breakdown by species for Geneva Lake, Walworth Co., WI.

	Coefficient of Conservatism			
Common Name	**2015**	**2019**	**2020**	**2022**
Coontail	3	3	3	3
Spiny hornwort	10	---	---	---
Muskgrass (chara)	7	7	7	7
Needle spikerush	---	5	---	---
Common waterweed	3	3	3	3
Water star-grass	6	6	6	6
Brown fruited rush	8	---	---	---
Forked duckweed	6	6	6	6
Various-leaved water-milfoil	---	7	---	7
Northern water-milfoil	6	6	6	6
Slender naiad	6	---	6	6
Southern naiad	8	8	8	8
Nitella	7	7	7	7
Large-leaf pondweed	7	7	---	---
Leafy pondweed	---	6	6	6
Frie's pondweed	8	8	8	8
Variable pondweed	7	7	7	7
Illinois pondweed	6	6	6	6
Floating-leaf pondweed	5	5	5	5
Long-leaf pondweed	7	7	7	7
Oakes' pondweed	10	---	---	---
White-stem pondweed	---	---	8	8
Small pondweed	---	---	7	7
Clasping-leaf pondweed	5	5	---	5
Stiff pondweed	---	8	8	8
Flat-stem pondweed	6	6	6	6
White water crowfoot	8	8	8	8
Ditch grass	8	8	8	8
Water bulrush	9	---	---	---
Sago pondweed	3	3	3	3
Sheathed pondweed	9	---	---	---
Creeping bladderwort	9	---	---	---
Small bladderwort	10	---	---	---
Common bladderwort	7	7	7	7
Wild celery	6	6	6	6
Total Species	29	25	24	26
Mean C	6.90	6.20	6.33	6.31
Floristic Quality Index (FQI)	**37.14**	**31.00**	**31.03**	**32.16**

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Appendix C

Figures

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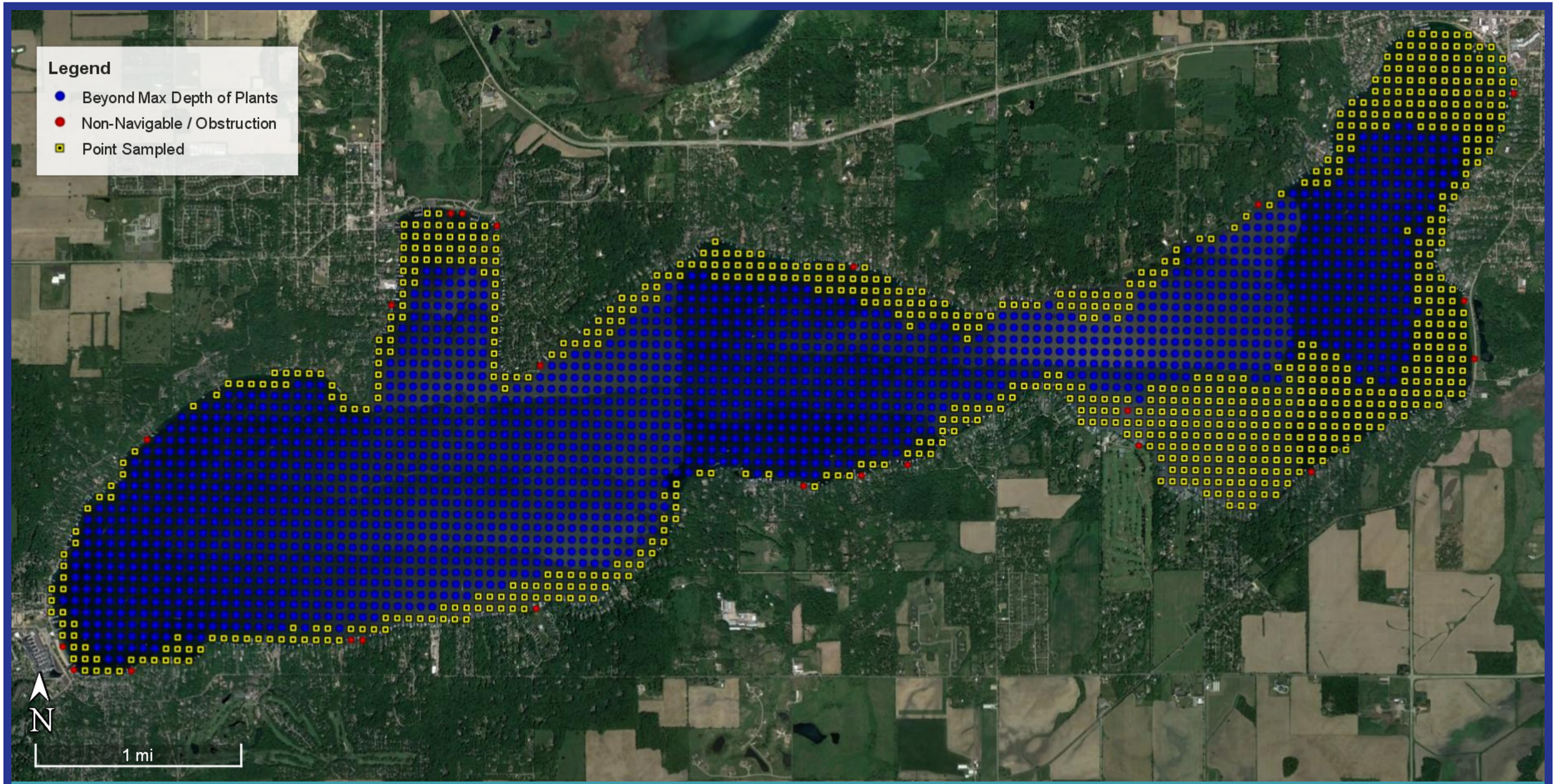

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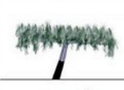
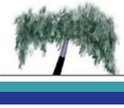
Legend

- GPS Sample Locaitons
- Rake Density - 1
- Rake Density - 2
- Rake Density - 3
- Rake Density - Visual Only

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

2022 Aquatic Plant Survey

Point Intercept Survey Sample Locations

Geneva Lake
Walworth County

Figure 1
Surveyed: 07/27-29/2022

N

1 mi

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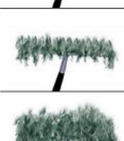
Legend

- GPS Sample Locaitons
- Rake Density - 1
- Rake Density - 2
- Rake Density - 3
- Rake Density - Visual Only

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

2022 Aquatic Plant Survey

Total Rake Fullness

Geneva Lake
Walworth County

Figure 2
Surveyed: 07/27-29/2022

N

1 mi

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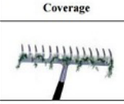
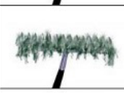
Legend

- GPS Sample Locaitons
- Rake Density - 1
- Rake Density - 2
- Rake Density - 3
- Rake Density - Visual Only

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

2022 Aquatic Plant Survey

Eurasian Water-milfoil

Myriophyllum spicatum

Geneva Lake
Walworth County

Figure 3
Surveyed: 07/27-29/2022

N

1 mi

Wisconsin Lake & Pond Resource LLC

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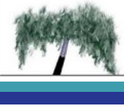
Legend

- GPS Sample Locaitons
- Rake Density - 1
- Rake Density - 2
- Rake Density - 3
- Rake Density - Visual Only

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

2022 Aquatic Plant Survey

Curly-leaf Pondweed

Potamogeton crispus

Geneva Lake
Walworth County

Figure 4
Surveyed: 07/27-29/2022

N

1 mi

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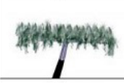
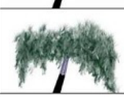
Legend

- GPS Sample Locaitons
- Rake Density - 1
- Rake Density - 2
- Rake Density - 3
- Rake Density - Visual Only

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

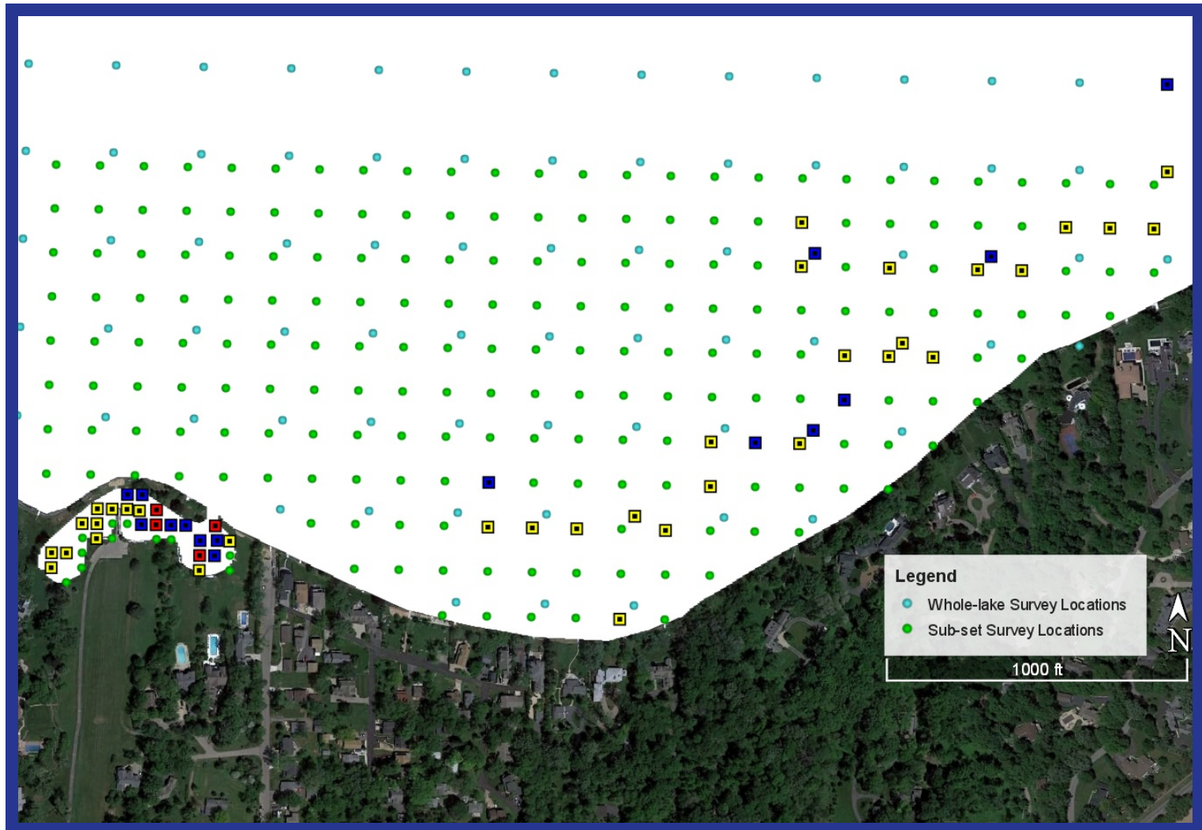
2022 Aquatic Plant Survey - Whole Lake

Starry Stonewort

Nitellopsis obtusa

Geneva Lake
Walworth County

Figure 5
Surveyed: 07/27-29/2022



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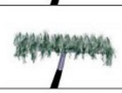
Legend
- GPS Sample Locaitons
- Rake Density - 1
- Rake Density - 2
- Rake Density - 3
- Rake Density - Visual Only

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

2022 Aquatic Plant Survey - Sub-set Survey

Starry Stonewort

Nitellopsis obtusa

Geneva Lake
Walworth County

Figure 6
Whole-lake Survey: 07/27-29/2022
Sub-set Survey: 08/02/2022

Appendix D

Raw Aquatic Plant Survey Data Sheets

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	B	C	D	E	Q	S	AC	AI	AS	AZ	BA	BD	BF	BI	BZ	CA	CB	CD	CE	CF	CI	CK	CL	CO	CQ	CR	CU	DR	ED	EE	EL	EN	EQ	ER	ES	ET	EU
1	**STATS**	Total vegetation	Myriophyllum spicatum, Eurasian water milfoil	Potamogeton crispus Curly-leaf pondweed	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Elodea canadensis, Common waterweed	Heteranthera dubia, Water star-grass	Lemna trisulca, Forked duckweed	Myriophyllum heterophyllum, Various-leaved watermilfoil	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Najas guadalupensis, Southern naiad	Nitella sp., Nitella	Potamogeton foliosus, Leafy pondweed	Potamogeton friesii, Fries' pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton natans, Floating-leaf pondweed	Potamogeton nodosus, Long-leaf pondweed	Potamogeton praelongus, White-stem pondweed	Potamogeton pusillus, Small pondweed	Potamogeton richardsonii, Clasping-leaf pondweed	Potamogeton strictifolius, Stiff pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Ranunculus aquatilis, White water crowfoot	Ruppia cirrhosa, Ditch grass	Stuckenia pectinata, Sago pondweed	Utricularia vulgaris, Common bladderwort	Vallisneria americana, Wild celery	Aquatic moss	Filamentous algae	Nitellopsis obtusa, Starry Stonewort	Tolypella intricata , Bird's nest stonewort	spp	sp4	sp5
2	Lake Geneva																																				
3	Walworth																																				
4																																					
5	07/27/22 - 07/29/22																																				
6	**INDIVIDUAL SPECIES STATS:**																																				
7	**Frequency of occurrence within vegetated areas (%)**		16.25	0.71	28.62	15.19	1.77	12.72	35.51	0.18	6.54	1.06	1.59	2.30	5.83	6.36	1.94	1.06	0.53	2.30	0.18	0.35	0.18	1.59	6.54	5.30	26.33	10.25	2.12	42.05	0.18	9.89	1.24	1.24			
8	**Frequency of occurrence at sites shallower than maximum depth of plants**		12.30	0.53	21.66	11.50	1.34	9.63	26.87	0.13	4.95	0.80	1.20	1.74	4.41	4.81	1.47	0.80	0.40	1.74	0.13	0.27	0.13	1.20	4.95	4.01	19.92	7.75	1.60	31.82	0.13	7.49	0.94	0.94			
9	**Relative Frequency (%)**		6.8	0.3	12.0	6.4	0.7	5.3	14.9	0.1	2.7	0.4	0.7	1.0	2.5	2.7	0.8	0.4	0.2	1.0	0.1	0.1	0.1	0.7	2.7	2.2	11.1	4.3	0.9	17.7			0.5	0.5			
10	Relative Frequency (squared)	0.10	0.00	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.03			0.00	0.00			
11	**Number of sites where species found**		92	4	162	86	10	72	201	1	37	6	9	13	33	36	11	6	3	13	1	2	1	9	37	30	149	58	12	238	1	56	7	7			
12	**Average Rake Fullness**	1.37	1.08	1.00	1.20	1.09	1.00	1.22	1.04	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.05	1.13	1.15	1.07	1.08	1.02	1.00	1.00	1.57	1.00			
13	**#visual sightings**																																				
14	**present (visual or collected)**		present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present			
15																																					
16	**SUMMARY STATS:**																																				
17	**Total number of sites visited**	**795**																																			
18	**Total number of sites with vegetation**	**566**																																			
19	**Total number of sites shallower than maximum depth of plants**	**748**																																			
20	**Frequency of occurrence at sites shallower than maximum depth of plants**	**75.67**																																			
21	**Simpson Diversity Index**	**0.90**																																			
22	**Maximum depth of plants (ft)****	**27.00**																																			
23	**Number of sites sampled using rake on Rope (R)**	**292**																																			
24	**Number of sites sampled using rake on Pole (P)**	**501**																																			
25	**Average number of all species per site (shallower than max depth)**	**1.80**																																			
26	**Average number of all species per site (veg. sites only)**	**2.38**																																			
27	**Average number of native species per site (shallower than max depth)**	**1.67**																																			
28	**Average number of native species per site (veg. sites only)**	**2.21**																																			
29	**Species Richness**	**30**																																			
30	**Species Richness (including visuals)**	**30**																																			
31																																					
32	****SEE "MAX DEPTH GRAPH" WORKSHEET TO CONFIRM**																																				

	B	C	EQ	EZ	FA	FB	FC
1	**STATS**	Total vegetation	sp1 - Nitellopsis obtusa, Starry Stonewort				
2	Lake Geneva - subset PI for starry only						
3	Walworth						
4							
5	08/02/22						
6	**INDIVIDUAL SPECIES STATS:**						
7	**Frequency of occurrence within vegetated areas (%)**		100.00				
8	**Frequency of occurrence at sites shallower than maximum depth of plants**		20.44				
9	**Relative Frequency (%)**		100.0				
10	Relative Frequency (squared)	1.00	1.00				
11	**Number of sites where species found**		46				
12	**Average Rake Fullness**	#DIV/0!	1.41				
13	**#visual sightings**						
14	**present (visual or collected)**		present				
15							
16	**SUMMARY STATS:**						
17	**Total number of sites visited**	**236**					
18	**Total number of sites with vegetation**	**46**					
19	**Total number of sites shallower than maximum depth of plants**	**225**					
20	**Frequency of occurrence at sites shallower than maximum depth of plants**	**20.44**					
21	**Simpson Diversity Index**	**0.00**					
22	**Maximum depth of plants (ft)****	**14.50**					
23	**Number of sites sampled using rake on Rope (R)**	**0**					
24	**Number of sites sampled using rake on Pole (P)**	**236**					
25	**Average number of all species per site (shallower than max depth)**	**0.20**					
26	**Average number of all species per site (veg. sites only)**	**1.00**					
27	**Average number of native species per site (shallower than max depth)**	**0.20**					
28	**Average number of native species per site (veg. sites only)**	**1.00**					
29	**Species Richness**	**1**					
30	**Species Richness (including visuals)**	**1**					
31							
32	****SEE "MAX DEPTH GRAPH" WORKSHEET TO CONFIRM**						