memo

Project Name |	2022 Aquatic Plant Management Services	**Date** |	1/4/2022
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	–Karen Kill, District Administrator		
From / Contact info |	Jimmy Marty, Chris Long, Joe Pallardy - EOR		
Regarding |	South School Section Lake and Goggins Lake Point Intercept Survey		

Background

Point-intercept aquatic plant surveys of South School Section Lake (SSSL) and Goggins Lake were completed on August 26, 2022. The point-intercept method is considered the standard protocol by MNDNR for sampling macrophytes (aquatic plants) because it offers a methodology that is quantitative (e.g., frequency of occurrence), repeatable (can be used to track trends in aquatic plant communities over time), and georeferenced (can be used to compare plant communities within different areas of a lake). Point spacing of 50-meters was used for the survey and totaled 130 sampling points on South School Section Lake and 75 sampling points on Goggins Lake. At each point, a vegetation sampling rake was used to collect plants and assign a species density rating of 1 (sparse), 2 (common), or 3 (abundant). From this data, a Floristic Quality Index (FQI) was calculated that measures the diversity and health of the aquatic plant community.

The FQI calculation is based on both the quantity of species observed (species richness) as well as the quality of each individual species. Aquatic plants in Minnesota have been assigned a coefficient of conservatism value (c-value) ranging from 0 to 10. The c-value of all aquatic plants sampled from a lake is used to determine the FQI for a given lake. Species with a c-value of 0 include non-native species such as curly-leaf pondweed (*Potamogeton crispus*) that are indicative of a highly disturbed environment. In comparison, the native species Oakes pondweed (*Potamogeton oakesainus*) has a c-value of 10 because this species is extremely rare and only found in undisturbed, pristine waterbodies.

The average FQI score for Minnesota Lakes in the North Central Hardwood Forest (NCHF) ecoregion is 23.7±8 with a median of 22.5 (Radomski and Perleberg, 2012). A study of 41 Minnesota lakes surveyed across the state, as part of the EPA's National Lakes Assessment Project, yielded a maximum FQI score of 30. In 2016, the MNDNR developed a robust geodatabase of aquatic plant surveys and associated FQI scores from more than 3,600 lakes across the state. FQI scores ranged from 0 to 49 with a median of 25.1±9.

Survey Results

Floristic Quality Index (FQI) Comparison

The FQI scores for SSSL and Goggins Lake were similar: 15.6 and 15.5 respectively, which is below the median FQI score for assessed lakes in the DNR geodatabase (Table 3 and Table 4).

South School Section Lake

Sampling points located in the littoral zone of SSSL (87 of 130 total points) contained an average of 1.5 species per sample site. In total, 12 aquatic or emergent species were observed in SSSL. Coontail (*Ceratophyllum demersum*), Canada waterweed (*Elodea canadensis*), and Eurasian watermilfoil (*Myriophyllum spicatum*) were by far the most encountered species, with white water lily (*Nymphaea odorata*) the next most common species. All other species had less than 10% frequency of occurrence.

Goggins Lake

Goggins Lake, which was 100% littoral (less than 15 feet deep), displayed a slightly better distribution of species. Although only 11 aquatic or emergent species were observed in Goggins, it contained an average of 1.8 species per sample site. Despite the near ubiquity of coontail (91% of points), fern leaf pondweed was widely encountered (40% of points). Four (4) other species had a frequency of occurrence (FOO) greater than 10%, including flat-stemmed pondweed (*Potamogeton zosteriformis*), Canada waterweed, and Eurasian watermilfoil. Notably, a single, immature individual of a floating-leaved pondweed (*Potamogeton* spp.) was observed that resembled several state-listed species, but sufficient features were not present to make a species identification.

Invasive Species

The plant community in both lakes was generally dominated by native species, although two invasive species were observed during the surveys: Eurasian watermilfoil and curly-leaf pondweed (*Potamogeton crispus*).

Eurasian Watermilfoil

Eurasian watermilfoil (EWM) was observed at 44% of the sample points in SSSL and 12.2% of sample points in Goggins Lake. Eurasian watermilfoil was generally observed growing in patches with tall prominent stalks intermixed with native species. Heavy growth was observed on SSSL in the northern portion of the lake, and it is widely distributed throughout the entire shoreline (Photograph 1). EWM density on Goggins Lake is low and more sparsely distributed throughout the lake.

Curly-leaf pondweed

Very little curly-leaf pondweed (CLP) was observed during the surveys. CLP dies back in mid-summer and peak growth was not captured by this survey. CLP was found at only 1 sample point of 130 on SSSL (0.8% of points). On Goggins, a single turion (a wintering bud that becomes detached and remains dormant at the bottom of the water) was recovered during the survey, but no live plants were observed. During a focused meander survey conducted in May 2022, CLP was observed at 2.7% of sample points on SSSL and it was not found at all on Goggins Lake.

Comparison to Past Point-Intercept Surveys

Point-intercept surveys were conducted at both SSSL and Goggins Lakes in 2014. A comparison of survey results shows a slight improvement in both the number of native species recorded and the overall quality of the aquatic plant community as demonstrated by a slight increase in FQI scores (Table 1 and Table 2). However, Eurasian watermilfoil (EWM) was observed at 44% of sampling locations in SSSL and 12% of sampling locations in Goggins Lake. EWM was not found in either lake during the 2014 survey. A comparison of species detected is provided in Appendix B.

Table 1. South School Section Lake 2014 vs. 2022 P.I. Survey Comparison.

Metric	2014	2022
Total # of Native Plants	9	10
% of Sites with Aquatic Plants	67%	72%
FQI Score	12.9	15.6
Max Depth of Growth (ft)	N/A	17
% of sites w/ EWM	0	44%
Average growing season water level (ft)[1]	964.29	967.88

[1]Based on available water level data from DNR Lakefinder. Datum: NGVD 29 (ft)

Table 2. Goggins Lake 2014 vs. 2022 P.I. Survey Comparison.

Metric	2014	2022
Total # of Native Plants	11	9
% of Sites with Aquatic Plants	39%	75%
FQI Score	13.3	15.5
Max Depth of Growth (ft)	N/A	14
% of sites w/ EWM	0	12.2%
Average growing season water level (ft)[1]	961.70	967.42

[1]Based on available water level data from DNR Lakefinder. Datum: NGVD 29 (ft)

Conclusions and Assessment of Curly-Leaf Pondweed Treatments

The FQI scores from both lakes indicate that the floristic quality of the plant communities increased since last surveys in 2014. The reason for the improvements is not immediately clear and could be due to several factors and their interactions such as water level fluctuations, water quality, aquatic plant management, or simply natural variability. Additionally, though FQI scores improved, the invasive EWM was observed at both SSSL and Goggins for the first time, with relatively high frequency of occurrence (44% of sites) at SSSL.

Water levels at both lakes have fluctuated over this time, with average water levels being deeper in 2022 by just under 3 feet at Goggins and over 6 feet at SSSL compared to 2014 (Table 1 and Table 2). Both lakes exceeded highs of 970 feet in 2019-2021, over 3 feet higher than average levels in 2022. Water level increases could have shifted the littoral zone (area of aquatic plant growth). For example, newly inundated areas represent a new opportunity for aquatic plant growth, while areas with

deeper water become limiting due to less light penetration. A potential mechanism for increased plant abundance and FQI scores driven by water level changes would be when newly inundated areas host unique species while existing vegetation in deeper areas persists at decreased density. Another mechanism driven by fluctuations could be wet-drying cycles that stimulate the aquatic seed bank and provide suitable conditions for germination.

Water quality could also factor into the slightly increased FQI scores. Water clarity is a primary driver of aquatic plant growth and diversity. Based on the 2021 BCWD water monitoring summary, statistically significant improving trends for water quality parameters have been recorded at Goggins Lake, while no statistically significant trends are present for SSSL. Improving water clarity while also increasing water depth could lead to expansion of the littoral zone where newly inundated areas provide new habitat while deeper areas of the lake also become habitat due to increasing clarity. This may have occurred at Goggins, where water clarity has both improved and lake levels have increased since 2014.

Finally, aquatic plant management conducted by BCWD at SSSL and Goggins could have contributed to slightly increased FQI scores. Chemical treatments for CLP were conducted at SSSL in 2017 and 2021 and at Goggins in 2021. In general, CLP does not compete directly with native vegetation and is more limited by environmental factors like good water clarity (that allows native plants to compete), deep winter snow cover (that limits light availability beneath the ice), spring water temperatures, or deeper water levels (that shift the littoral zone toward areas not yet colonized by CLP). That said, management may have limited CLP and reduced establishment in newly inundated areas, creating more open niches for native vegetation and thereby improved FQI scores. At the very least, the improved FQI scores suggest that management has not harmed the native plant community.

EWM was documented at both SSSL and Goggins for the first time, with relatively high frequency of occurrence at SSSL (44% of sites). It is not known when EWM colonized the lakes between 2014 and 2022. High density and frequency of EWM was concentrated along the shoreline in many areas that were likely above the lake elevation in 2014. Higher water levels may have facilitated EWM colonization before native plants (or CLP) could establish in newly inundated areas. Unlike CLP, EWM competes directly with native vegetation and aggressive growth forms mats that shade out competitors (Photograph 1). Continued expansion of EWM could negatively impact FQI scores in the future.

Recommendation: While every lake and lake user is different, most experts agree that CLP treatments, which almost exclusively involve the use of contact herbicides, are not warranted unless CLP occupies 15% or more of the littoral zone due to the potential for damage to non-target species. Intermittent treatments of CLP conducted over the past 5 years have helped to keep CLP below this threshold. The efficacy of these treatments has likely been aided by above average lake levels which likely reduced the area in which CLP could germinate or sprout from turions in deeper areas while expanding the littoral zone into shallower areas where little or no CLP seed/turion bank existed.

EOR recommends spring CLP surveys every three years, which likely will be sufficient to identify problematic CLP growth greater than 15% or more of the littoral zone that warrants treatment. Additionally, research shows that long-term CLP control is best achieved via improvements to water

clarity. Continued watershed or in-lake practices to improve and maintain clarity will likely be the most cost-effective means of CLP management at SSSL and Goggins and should be prioritized as part of a comprehensive AIS management strategy. Improved clarity also supports native vegetation and could increase FQI scores.

Further, given that the quality of the aquatic plant community appears to be at least stable and possibly increasing, EOR is not recommending treatments to target EWM. However, the increase in the abundance of EWM should be monitored via early summer point-intercept aquatic plant surveys conducted every three years (e.g., 2025). If the frequency of EWM continues to increase to the detriment of the native plant community, EOR would likely recommend that BCWD explore herbicide treatments using ProcellaCOR. EOR has had outstanding success with ProcellaCOR treatments on lakes in Wisconsin and Minnesota both in terms of control of the target species (EWM) and avoidance of impacts to the native plant community. Progress towards achieving control of these target species is subject to change based on feedback from lake users and methods of control.

Photograph 1. Surface matting of EWM at SSSL.

Mapping

The distribution for each individual species with a frequency of occurrence ≥ 10% is mapped within Appendix A.

Table 3. South School Section Lake species list and frequency of occurrence.

Common Name	Scientific Name	C-Value	Frequency of Occurrence
Coontail	*Ceratophyllum demersum*	2	63.8%
Muskgrass/stonewort	*Chara* cf. *globularis*	7	0.8%
Needle spikerush	*Eleocharis acicularis*	4	1.5%
Canada waterweed	*Elodea canadensis*	4	35.4%
Northern watermilfoil	*Myriophyllum sibiricum*	7	0.8%
Eurasian watermilfoil	*Myriophyllum spicatum*	0	44.6%
White water lily	*Nymphaea odorata*	6	10.8%
Water smartweed	*Persicaria amphibium*	4	6.2%
Curly-leaf pondweed	*Potamogeton crispus*	0	0.8%
White-stem pondweed	*Potamogeton praelongus*	7	0.8%
Small pondweed	*Potamogeton pusillus*	7	1.5%
Flat-stemmed pondweed	*Potamogeton zosteriformis*	6	1.5%
Summary Table			
FQI = C*√S	**Average C-Value**	4.5	
C= Mean coefficient of conservatism value	**Number of species**	12	
S= Number of species in sample	**FQI**	**15.6**	

Table 4. Goggins Lake species list and frequency of occurrence.

Common Name	Scientific Name	C-Value	Frequency of Occurrence
Coontail	*Ceratophyllum demersum*	2	91.5%
Canada waterweed	*Elodea canadensis*	4	12.2%
Eurasian watermilfoil	*Myriophyllum spicatum*	0	12.2%
Water smartweed	*Persicaria amphibium*	4	4.9%
Curly-leaf pondweed (turion)	*Potamogeton crispus*	0	1.2%
Small pondweed	*Potamogeton pusillus*	7	2.4%
Fern-leaf pondweed	*Potamogeton robbinsii*	8	40.2%
Unknown floating-leaved pondweed	*Potamogeton sp.*	7	1.2%
Flat-stemmed pondweed	*Potamogeton zosteriformis*	6	12.2%
Unknown arrowhead	*Sagittaria* sp.	7	1.2%
River bulrush	*Schoenoplectus fluviatilis*	4	2.4%
Summary Table			
FQI = C*√S	**Average C-Value**	4.9	
C= Mean coefficient of conservatism value	**Number of species**	10	
S= Number of species in sample	**FQI**	**15.5**	

Appendix A

South School Section Lake and Goggins Lake Aquatic Plant Species Distribution

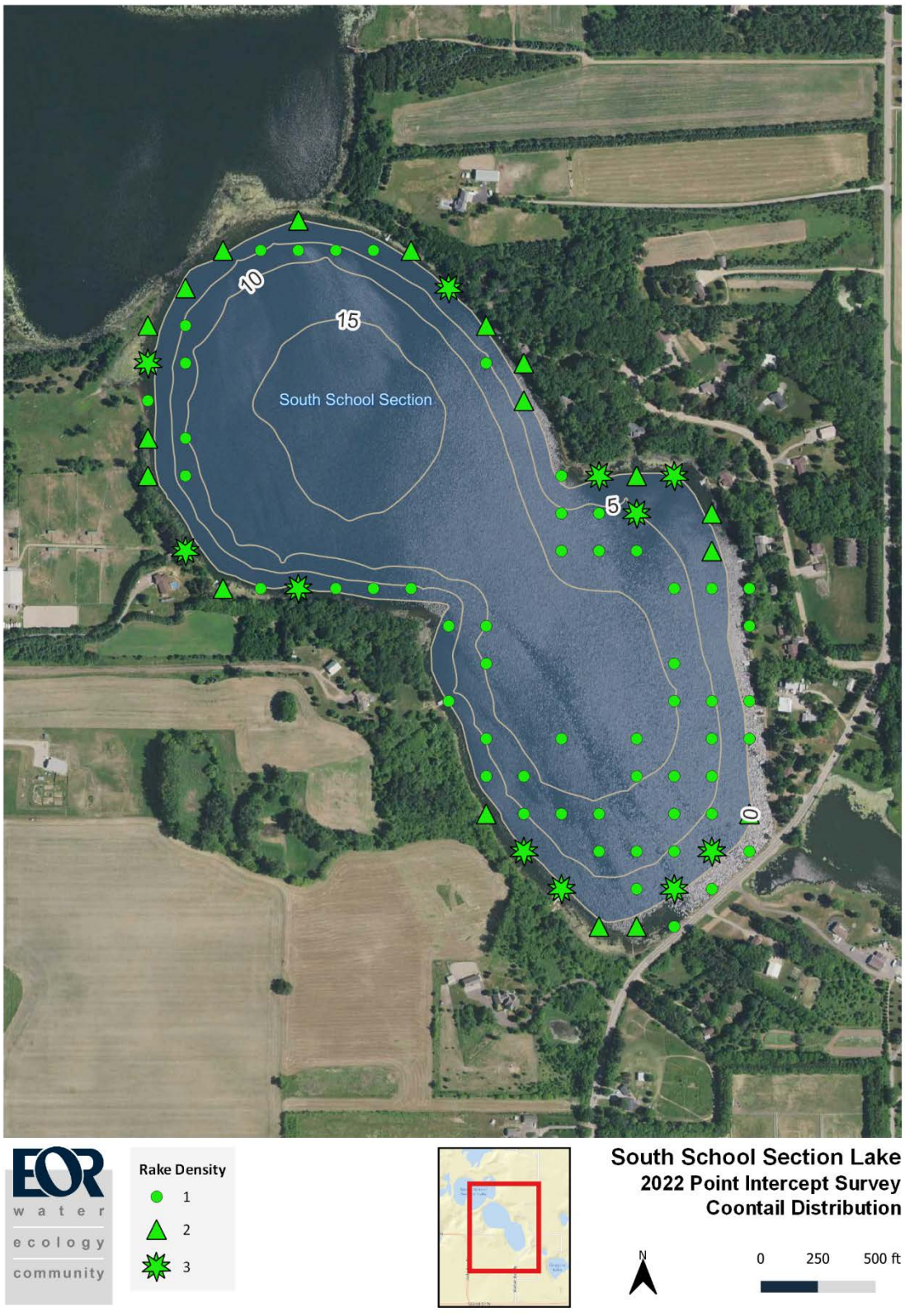

Figure 1. South School Section Lake coontail distribution – August 2022.

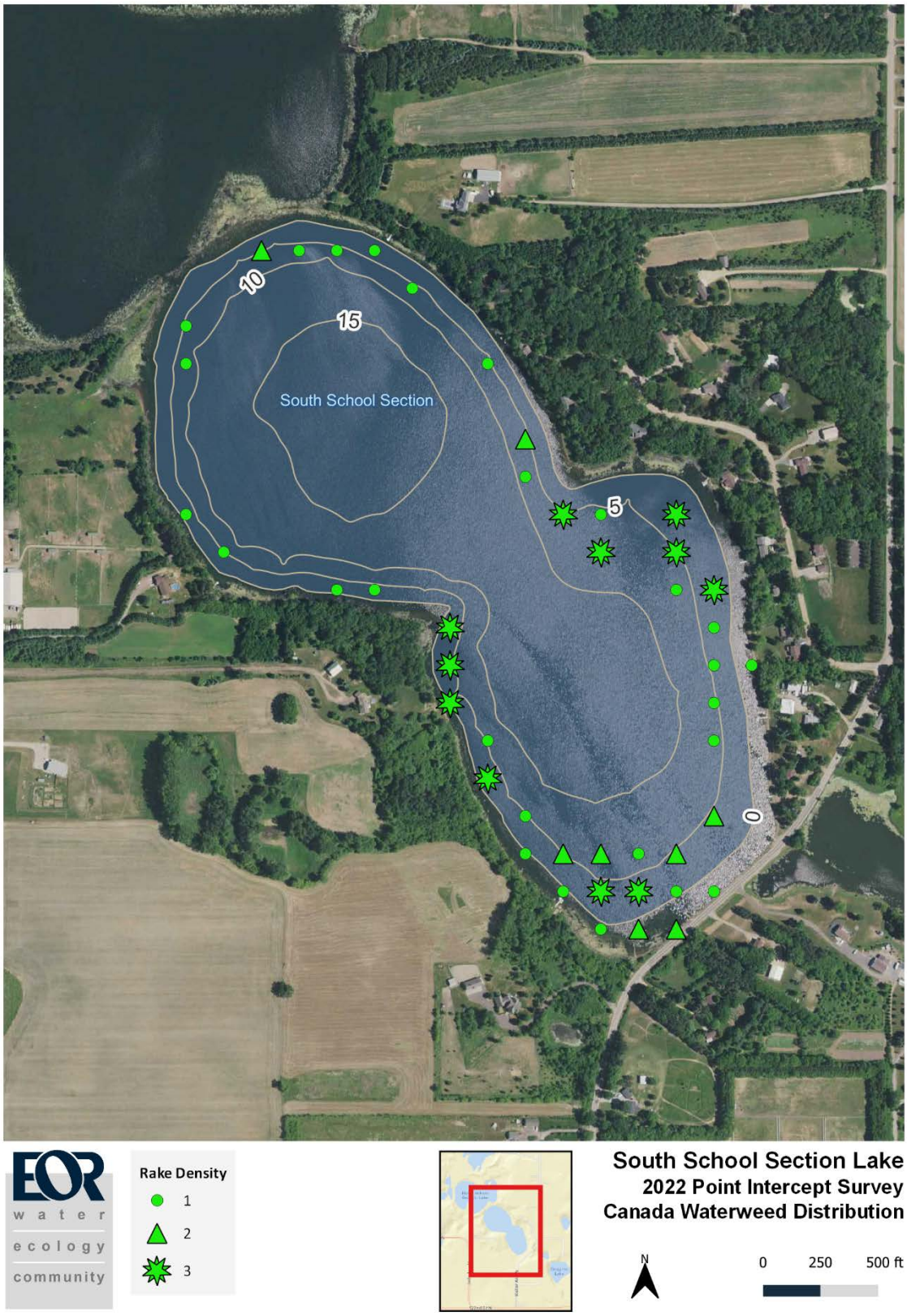

Figure 2. South School Section Lake Canada waterweed distribution– August 2022.

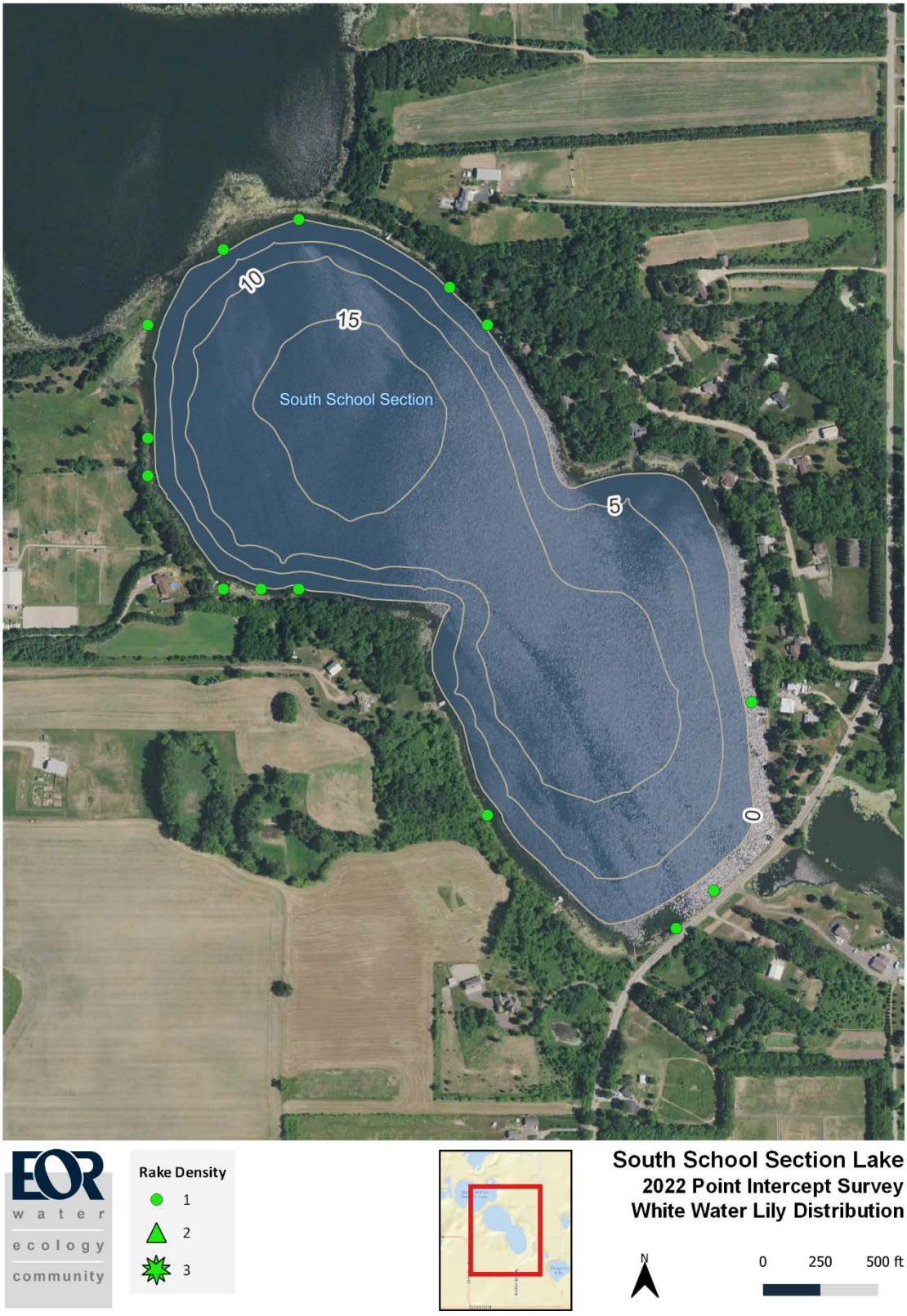

Figure 3. South School Section Lake white water lily distribution – August 2022.

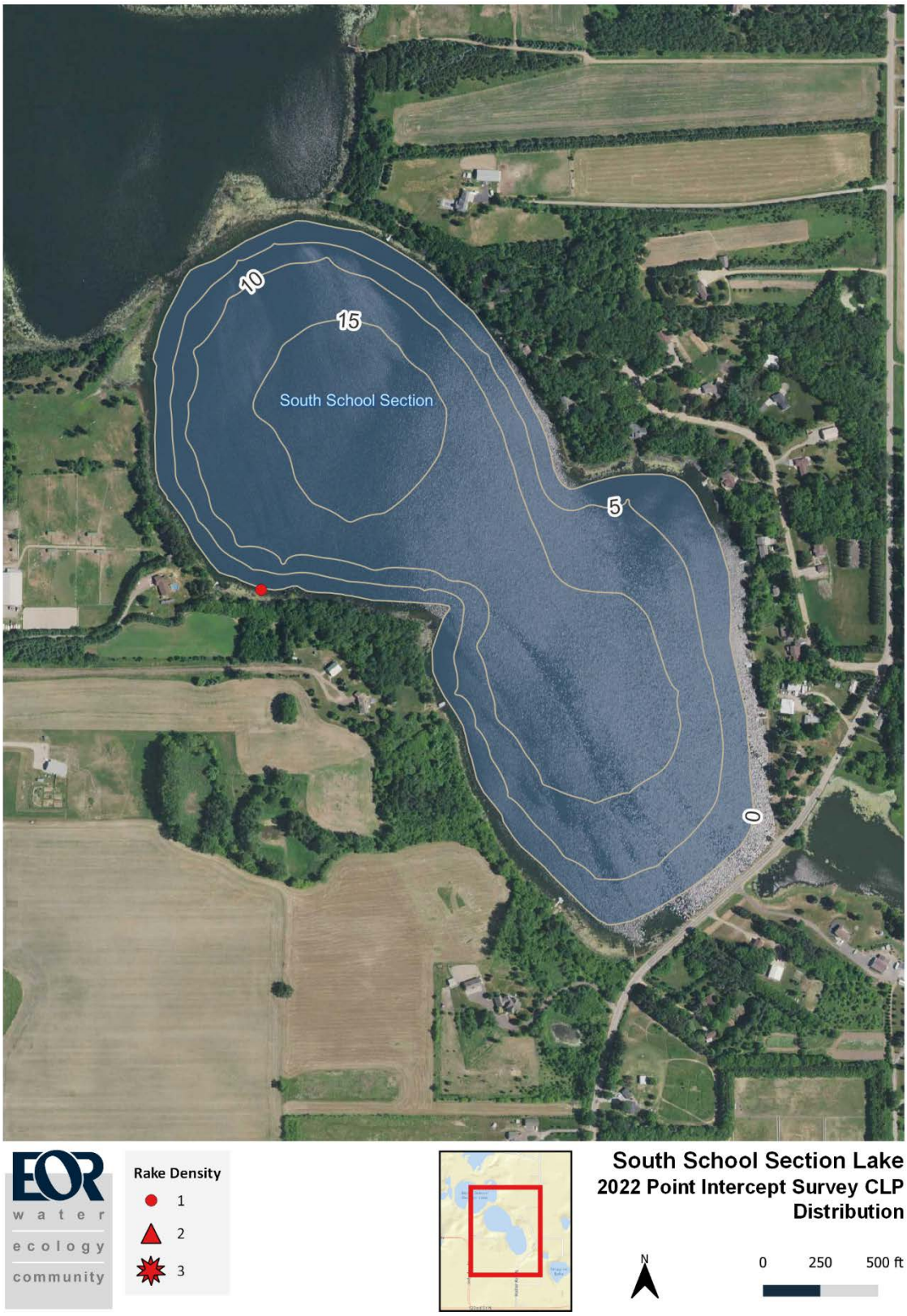

Figure 4. South School Section Lake curly-leaf pondweed distribution – August 2022.

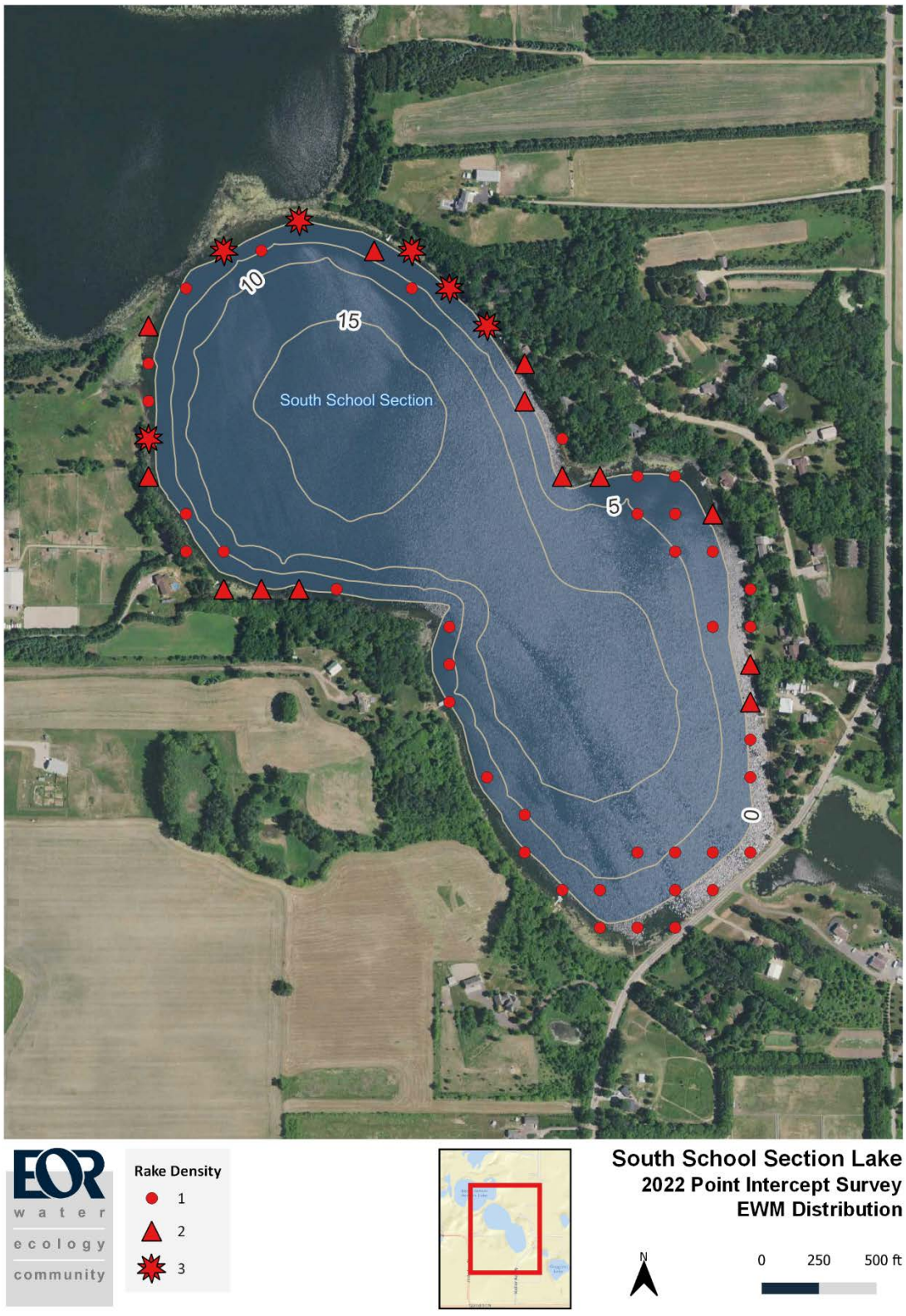

Figure 5. South School Section Lake Eurasian watermilfoil distribution – August 2022.

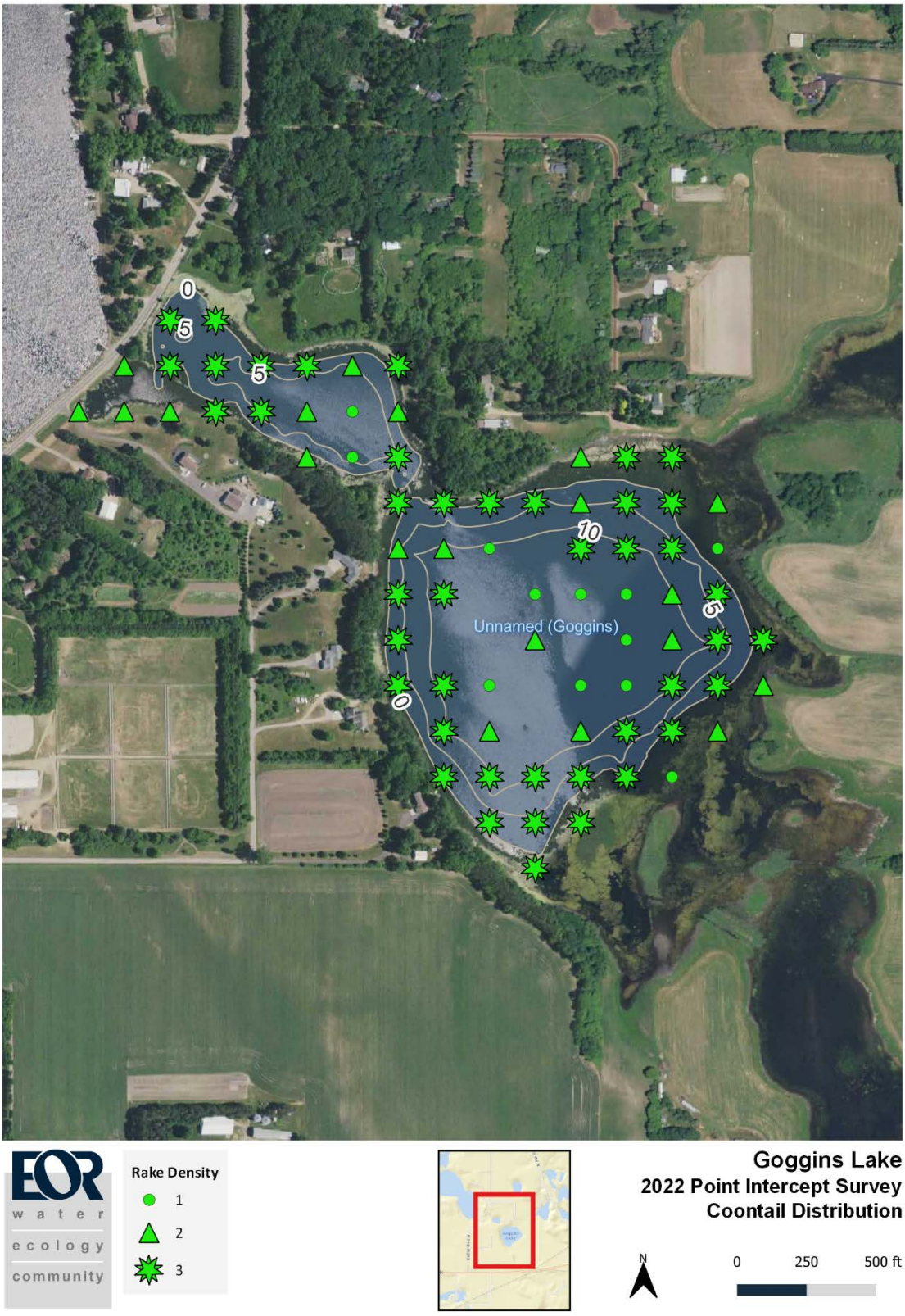

Figure 6. Goggins Lake coontail distribution – August 2022.

Figure 7. Goggins Lake Canada waterweed distribution – August 2022.

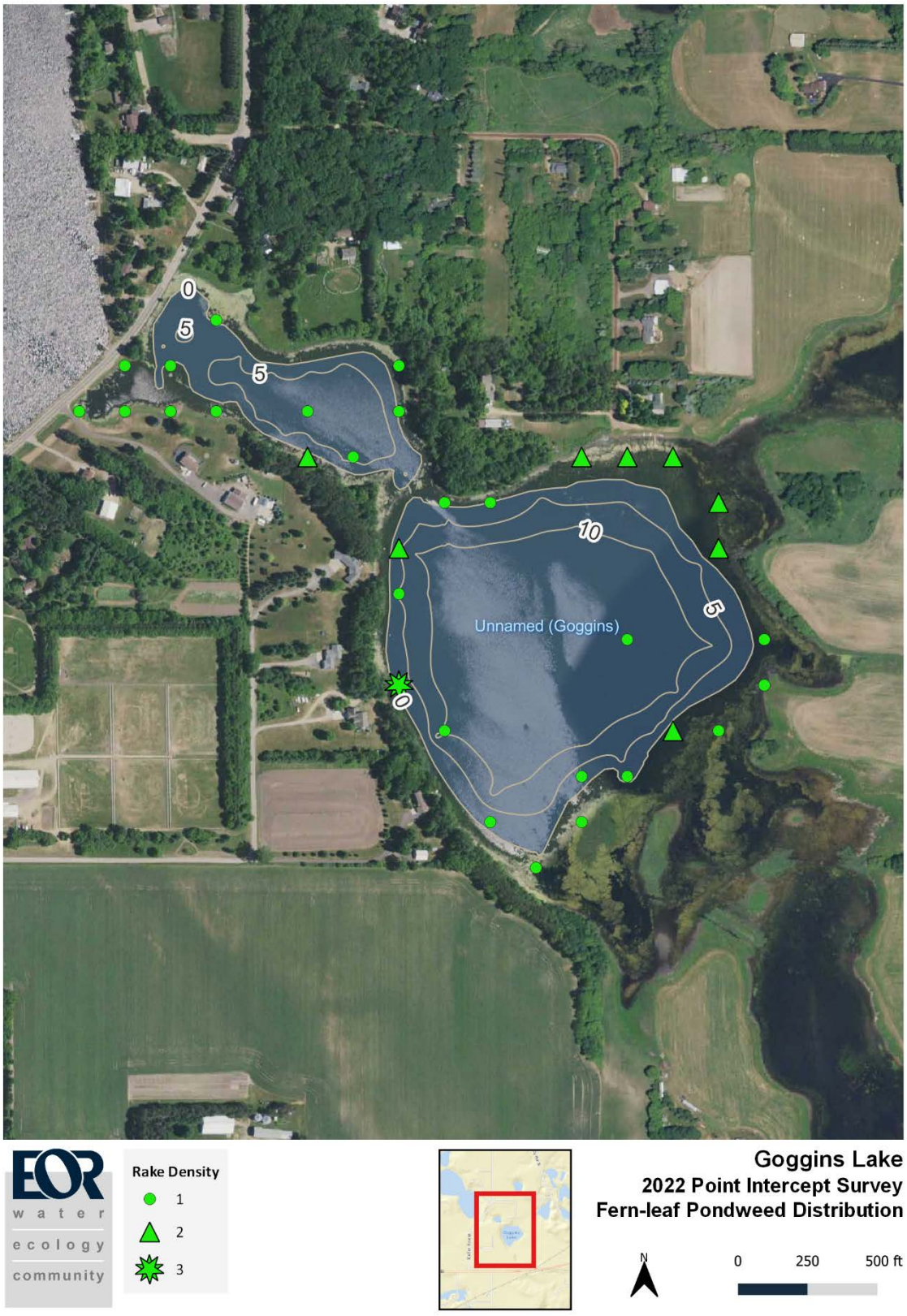

Figure 8. Goggins Lake fern-leaf pondweed distribution – August 2022.

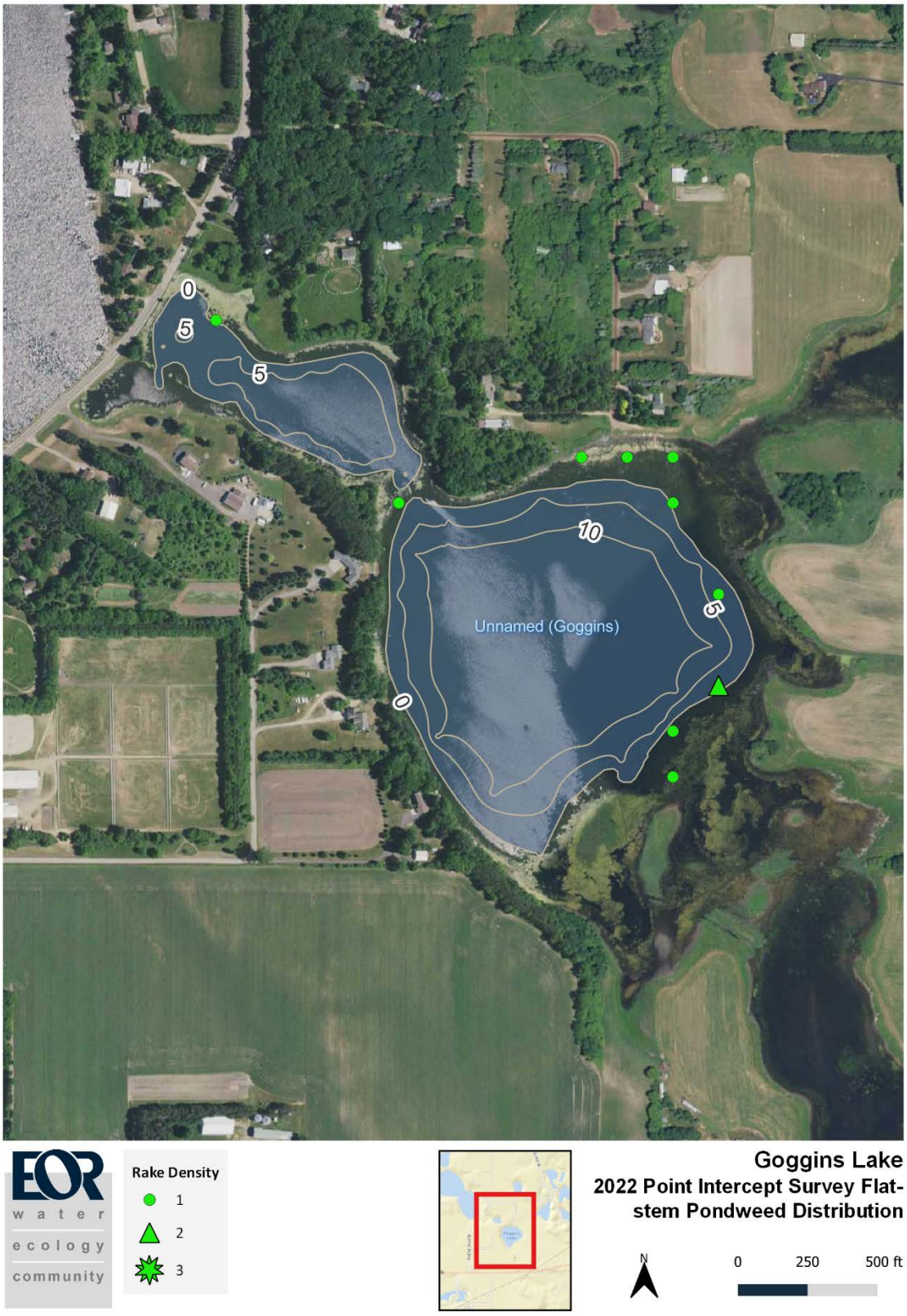

Figure 9. Goggins Lake flat-stem pondweed distribution – August 2022.

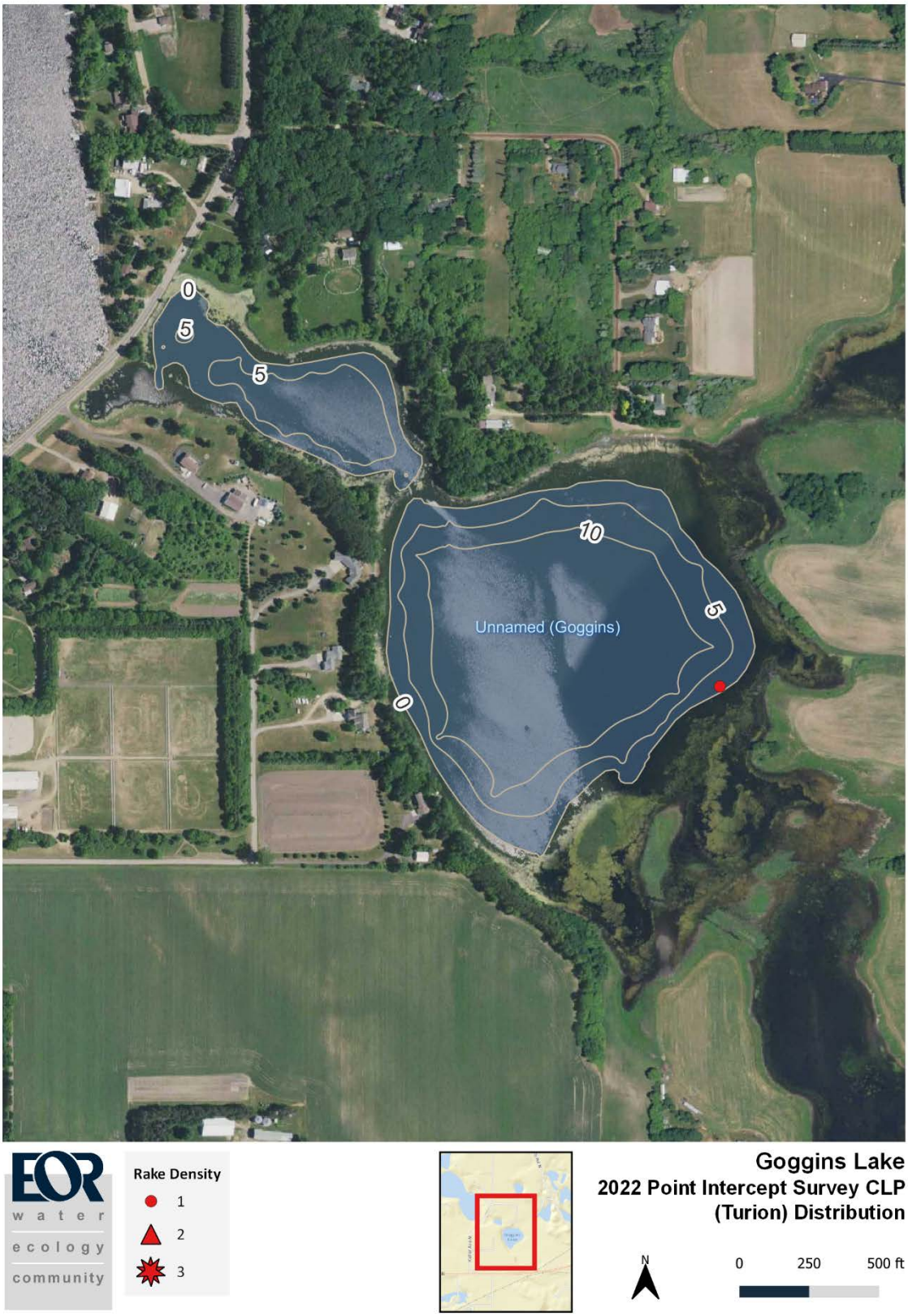

Figure 10. Goggins Lake CLP (turion) distribution – August 2022.

Figure 11. Goggins Lake EWM distribution – August 2022.

Appendix B

Historical Macrophyte Data

Table 5. Historical Aquatic Plant Survey Results

Lake Name		Goggins		South School Section (2014)		South School Section (2017)*	
Scientific Name	Common Name	Avg. Density	% of Sites	Avg. Density	% of Sites	Avg. Density	% of Sites
Elodea canadensis	Canada waterweed	2.4	22%				60%
Brasenia schreberi	Watershield			1	2%		
Ceratophyllum demersum	Coontail	1.4	27%	1.97	41%		45%
Lemna Minor	Lesser Duckweed	1	10%				
Najas guadalupensis	Southern waternymph			1.7	13%		
Nitella spp.	Stonewort (algae)	1	1%	1.3	21%		
Nuphar lutea	Yellow pond lily						
Nymphaea odorata	American white waterlily	1	1%	1.2	3%		
Potamogeton crispus	Curlyleaf pondweed			1.3	55%		48%
Potamogeton foliosus	Leafy pondweed			1.2	3%		
Potamogeton natans	Floating-leaf pondweed	1	1%				
Potamogeton pectinatus	Sago pondweed	1.2	18%	1	4%		
Potamogeton robbinsii	Robbins' pondweed						
Potamogeton spp.	Unidentified pondweed			1	1%		
Potamogeton zosteriformis	Flatstem pondweed	1	1%	1.5	19%		
Typha spp.	Cattail/possible hybrid	1.5	1%	1.2	6%		
Utricularia macrorhiza	Common Bladderwort	1	3%				
Vallisneria americana	Wild celery	1	1%				

* The 2017 survey was conducted early in the growing season with an emphasis on delineating the extent of CLP growth. Many native species had not