DIAMOND LAKE, HENNEPIN COUNTY: 2019 AQUATIC VEGETATION REPORT

Report by the Invasive Species Program – Division of Ecological and Water Resources

Minnesota Department of Natural Resources

Lake: Diamond (DOW# 27012500)

Lake Surface Area: 405 acres

Littoral Area: 405 acres

County: Hennepin

Survey Type: Point-intercept

Date of Survey (most recent): July 8, 2019

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2019 Summary:

The most recent aquatic vegetation point-intercept survey of Diamond Lake (DOW #27012500) was completed on July 8, 2019. Submersed plants were identified out to a maximum depth of 2.1 meters (5.5 feet). Within the littoral zone [zone in lake from the 0-15 foot depth range (0-4.5 meters)], 34% of sampled points contained native submersed taxa. The average number of native submersed taxa per sample point was 0.6. Eleven native submersed plant species were observed during the 2019 survey. For the first time in 2019, whole lake fluridone was applied to Diamond Lake targeting curly-leaf pondweed in early spring and these treatments will require future evaluations.

Summary Table. Summary of aquatic submersed plants in Diamond Lake, Hennepin County, Minnesota (DOW# 27012500) as indicated by results of Point-Intercept surveys. Values were calculated from littoral depth range (0-15 feet).

YEAR	Treatment Date	CLP* Acres Treated	PI Survey Date	Max Depth of Growth in feet [95%]†	% Points w/ Native Submersed Taxa	Mean Native Submersed Taxa/ Point	# Submersed Taxa	AVG Secchi Depth [m]
2011	**NA**	0	**JUN 30**	6.9	69	1.5	6	1.7
	NA	0	**SEPT 09**	6.9	82	1.3	5	
2012	**NA**	0	**MAY 18**	6.7	62	1.2	4	1.2
	NA	0	**AUG 31**	6.4	79	1.3	6	
2018	**MAY**	60	**JUN 28**	6.9	50	0.8	6	0.8
			SEPT 4	4.6	26	0.4	3	
2019	**MAY**	405	**MAY 30**	7.0	36	0.5	6	1.3
			JUL 8	5.5	34	0.6	12	

*CLP is short for Curly-leaf pondweed

†95th percentile calculated based on all vegetated sampling points

Taxa refers to groups of submersed aquatic plant species or genera

AVG- average Secchi depth (water clarity measurement) from May-September

Lake Description:

Diamond Lake is a 419-acre lake located near Rogers, Minnesota. The lake contains one invasive aquatic plant, curly-leaf pondweed (*Potamogeton crispus*, abbreviated as CLP). The maximum depth of water is 2.4 meters (8 feet). Approximately 97% of the lake is littoral. Diamond Lake has a long history of water quality impairments possibly due to land use, rough fish and an abundance of CLP. Three Rivers Parks District (TRPD) plans to reduce rough fish populations through drawdowns or barriers and has continued to make water quality a priority in Diamond Lake. For more information on Diamond Lake water quality see: https://cf.pca.state.mn.us/water/watershedweb/wdip/waterunit.cfm?wid=27-0125-00.

Table 1-Secchi Averages. Average Secchi disk observations in meters for Diamond Lake (DOW# 27012500). Data gathered from Three Rivers Park District.

YEAR	MAY	JUNE	JULY	AUG	SEPT	Secchi Depth Average [May-Sept]
2011	2.1	2.0	2.2	1.1	0.5	1.7
2012	2.2	1.3	0.6	0.8	1.5	1.2
2013	1.8	1.4	0.4	0.3	0.5	0.9
2014	1.3	2.5	2.3	1.2	2.1	1.9
2015	2.1	1.9	1.8	1.3	1.3	1.7
2016	2.4	1.7	0.6	0.6	0.4	1.1
2017	1.6	1.0	1.0	0.5	0.6	0.9
2018	1.5	0.9	0.7	0.5	0.3	0.8
2019	2.0	2.2	1.2	0.6	0.4	1.3

Management History:

Invasive plant treatments have been organized by the Diamond Lake Improvement Association (see below ***Table 2-Invasive Plant Management Summary*** for a recent history of herbicide treatments). Since 2013, endothall has been used to treat CLP at the 15% littoral (60.5 acres). A variance to treat more than 15% of the littoral area was granted in 2019 to allow for whole lake control of CLP using fluridone. Low dose fluridone was applied to approximately 405 acres shortly after ice out. Fluridone is generally applied early in the growing season and subsequent applications may be necessary to maintain concentrations and exposures to control CLP (4-5 ppb, up to 30 days). Evaluations of fluridone treatments will be needed through 2021 to determine the efficacy on CLP management and also potential affects to the native plant community. Future survey efforts will include spring and summer point intercept surveys, herbicide concentration monitoring and post-treatment delineations for CLP.

Table 2-Invasive Plant Management Summary. Characteristics and history of herbicide treatment for Diamond Lake (DOW# 27012500, Total acres: 419, Littoral acres: 405, 15% Littoral acres: 60.75).

Date	Treatment [W,P,N]	Target Species	Total Acres Treated	Herbicide	Licensed Commercial Applicator
2013	P	CLP	60.5	Endothall	Clarke Aquatic Services
2014	P	CLP	60.5	Endothall	Lake Restoration Inc.
2015	P	CLP	60.5	Endothall	Lake Restoration Inc.
2016	P	CLP	60.5	Endothall	Lake Restoration Inc.
May 2017	P	CLP	60.5	Endothall	Lake Restoration Inc.
May 2018	P	CLP	60	Endothall & Diquat	Lake Restoration Inc.
May 2019*	W	CLP	405	Fluridone (Sonar AS)	PLM Lake and Land Mgmt Corp

Treatment: W (whole lake), P (partial lake), N (no treatment)

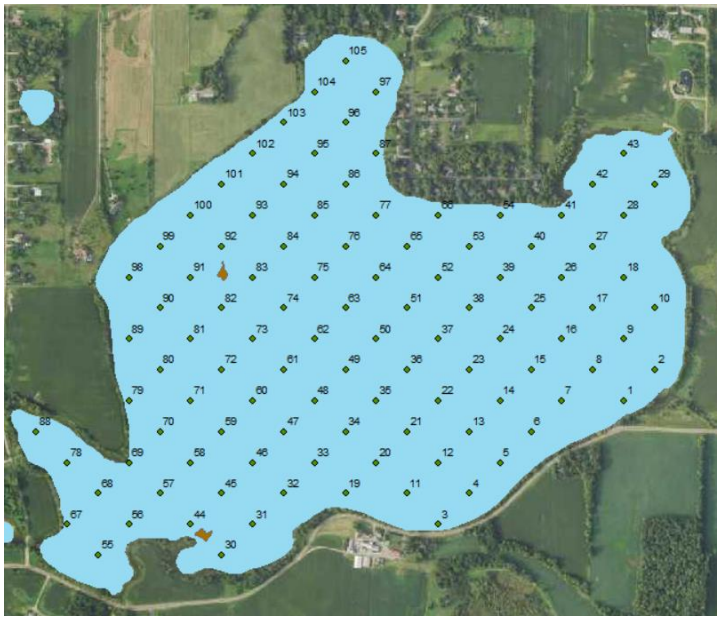
CLP is an abbreviation for curly-leaf pondweed

* LVMP year

Survey Objectives:

Point-intercept surveys were used to assess the distribution of aquatic plants in Diamond Lake. The primary purpose for this type of survey is to 1) develop baseline knowledge of the current plant community in a lake, and over time, 2) compare year to year plant variation (in plant presence and spatial location). Moreover, this survey will help the DNR and our partners monitor native plant communities and evaluate possible responses to invasive aquatic plant management efforts. It is important to note that distributions of aquatic plants may vary from year to year due to effects such as differences in weather, as well as the effects from plant and water quality management.

Survey Methods:



We used a point intercept survey method developed by John Madsen in "Aquatic Plant Control Technical Note MI-02, 1999". Survey points were placed approximately 122 meters apart using a Geographic Information System (GIS), allowing for placement of 105 points. Plant samples were collected by throwing and dragging a double-sided rake along the lake bottom at each point for approximately 3 meters. Plant samples were assessed on the boat to determine plant species and rake fullness was used as a surrogate for density (scale of zero [no plants] to 3 [dense plants] was used in 2019 (MnDNR survey) and a zero to 5 scale in 2011, 2012 and 2018 (Three Rivers Park survey years). Frequencies of occurrence percentages (i.e. how often a plant species was found in the lake) were calculated based on the littoral zone (the portion of the lake that is less than 15 feet in depth).

Survey Observations:

Maximum depth of rooted vegetation ranged between 1.4 and 2.1 meters (4.5-7 feet) from spring 2011 to summer 2019 (see ***Table 3a and b-Point Intercept Metrics*** for historical point-intercept survey calculations). Native plant diversity and frequency ranges from 0.4-1.5 mean submersed native taxa/point and 26-82% native FOO respectively.

Eleven native submersed plants were observed during the 2019 summer survey which occurred on July 8th. The most abundant native plants included coontail, Canadian waterweed and sago pondweed and most recently horned pondweed (***Table 4b- Plant Frequency Occurrence)***. Less common plant species observed include leafy pondweed, small pondweed, water stargrass and flat-stem pondweed. The first observation of horned pondweed was documented during the 2019 survey (**Photo 3**). Monitoring of aquatic plants will continue through 2021 in Diamond Lake.

In early spring 2019, CLP was found throughout the lake and observed at 74% frequency of occurrence (FOO, **Photo 1**). Historically, CLP has been observed as high as 92% FOO in 2011. The timing of spring surveys vary in relation to treatment timing and it is likely the 2018 survey occurred post-treatment and CLP had already died off. Minimal impacts to native plants were observed post fluridone treatment, although coontail did show signs of degradation (**Photo 2**).

Photo 1 Curly-leaf pondweed growing in surface matting abundance during the spring 2019 survey on Diamond Lake, Hennepin County.

Photo 2 Coontail during the summer 2019 point intercept survey showing signs of fluridone effects.

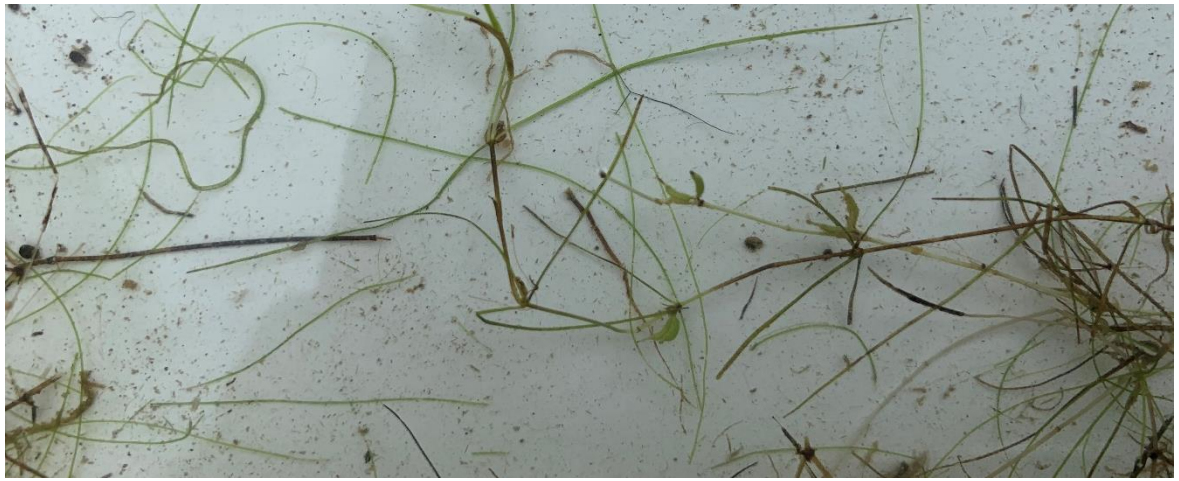


Photo 3 Horned pondweed found in several locations throughout the lake during the summer 2019 survey

Photo 4 Filamentous algae was found in high densities and was present at most sampling locations in the summer 2019 survey

Table 3a- Point Intercept Metrics. Summary of spring point intercepts metrics for Diamond Lake, Hennepin County (DOW# 27012500). Shaded values were calculated from littoral depth range.

Survey Metrics	JUN 30 2011	MAY 18 2012	JUN 28 2018	MAY 30 2019
Treated (Y/N)	N	N	Y	Y
Surveyor	3RPD	3RPD	3RPD	MN DNR
Total # Points Sampled	104	105	105	104
Max Depth of Growth (95%)	6.9	6.7	6.9	7
# Point in Max Depth Range	98	100	95	97
# Points in Littoral (0-15 feet)	104	105	105	104
% Points w/ Submersed Native Taxa	69	62	50	36
Mean Submersed Native Taxa/ Point	1.48	1.18	0.8	0.53
# Submersed Native Taxa	5	3	5	5
# Submersed Non-Native Taxa	1	1	1	1

Table 3b- Point Intercept Metrics. Summary of summer point intercepts metrics for Diamond Lake, Hennepin County (DOW# 27012500). Shaded values were calculated from littoral depth range.

Survey Metrics	SEPT 9 2011	AUG 31 2012	SEPT 4 2018	JUL 8 2019
Treated (Y/N)	N	N	Y	Y
Surveyor	3RPD	3RPD	3RPD	MN DNR
Total # Points Sampled	105	106	105	105
Max Depth of Growth (95%)	6.9	6.4	4.6	5.5
# Point in Max Depth Range	96	92	39	57
# Points in Littoral (0-15 feet)	105	106	105	105
% Points w/ Submersed Native Taxa	82	79	26	34
Mean Submersed Native Taxa/ Point	1.3	1.3	0.4	0.6
# Submersed Native Taxa	4	5	3	11
# Submersed Non-Native Taxa	1	1	1	1

Table 4a- Plant Frequency Occurrence. Historic percent frequency of occurrence for submersed vegetation within the littoral zone (0-15 feet) in spring. Diamond Lake, Hennepin County (DOW# 27012500).

Taxonomic Name **SUBMERSED PLANTS**	Common Name	JUN 30 2011	MAY 18 2012	JUN 28 2018	MAY 30 2019
*Potamogeton crispus**	Curly-leaf pondweed*	92	89	11**	74
Ceratophyllum demersum	Coontail	44	47	24	23
Elodea canadensis	Canadian waterweed	7	32	9	16
Potamogeton pusillus	Small pondweed	30	0	0	0
Stuckenia pectinata	Sago pondweed	7	0	4	4
Zannichelia palustris	Horned pondweed	1	0	0	8
Floating, Free-floating & Emergent plants observed: *Lemna trisulca* (Forked duckweed), *Nymphaea odorata* (White waterlily), *Spirodela polyrhiza* (Great Duckweed)					
Less common (< 5% frequency) submersed vegetation observed: *Nitella spp.*in 2011, *Potamogeton foliosus* (Leafy pondweed) in 2012 and 2018, *Najas flexilis* (Bushy Pondweed) in 2018, *Potamogeton zosteriformis* (Flat-stem pondweed) in 2019					

* denotes invasive aquatic plant

** survey timing was after the endothall treatment thus reductions in CLP

Table 4b- Plant Frequency Occurrence. Historic percent frequency of occurrence for submersed vegetation within the littoral zone (0-15 feet) in summer. Diamond Lake, Hennepin County (DOW# 27012500).

Taxonomic Name	Common Name	SEPT 9 2011	AUG 31 2012	SEPT 4 2018	JUL 8 2019
SUBMERSED PLANTS					
*Potamogeton crispus**	Curly-leaf pondweed*	2	4	0	14
Ceratophyllum demersum	Coontail	50	58	18	29
Elodea canadensis	Canadian waterweed	2	67	18	7
Stuckenia pectinata	Sago pondweed	1	3	1	9
Zannichellia palustris	Horned pondweed	0	0	0	8
Floating, Free-floating & Emergent plants observed: Nymphaea odorata (White waterlily), *Lemna trisulca* (Forked duckweed), Spirodela polyrhiza (Great Duckweed), Columbian watermeal (*Wolffia columbiana*)					
Less common (< 5% frequency) submersed vegetation observed: *Potamogeton foliosus* (Leafy pondweed) in 2011 and 2019, *Potamogeton pusillus* (Small pondweed) in 2012, *Chara spp*, *Heteranthera dubia* (Water stargrass), *Nitella spp*, *Potamogeton zosteriformis* (Flatstem pondweed), *Utricularia gibba* (Creeping bladderwort), *Utricularia minor* (Lesser bladderwort) in 2019					

* denotes invasive aquatic plant

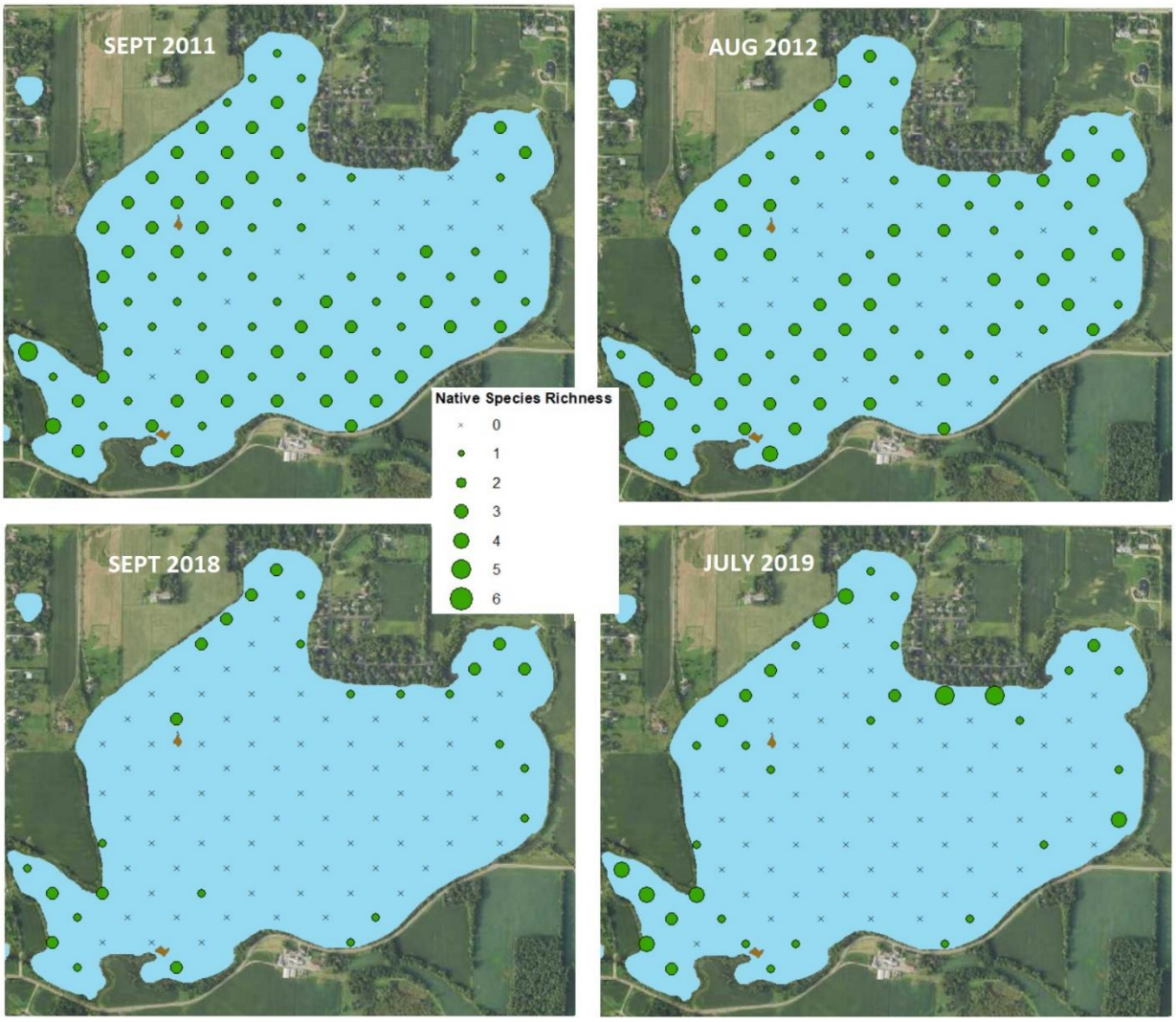


Figure 1. Spatial distribution and species richness (# of native submersed taxa per sample point). Dates correspond to month of point intercept survey. 2011, 2012 and 2018 surveys were conducted by Three Rivers Park District while the 2019 was conducted by the Minnesota Department of Natural Resources. Diamond Lake, Hennepin County (DOW # 27012500).

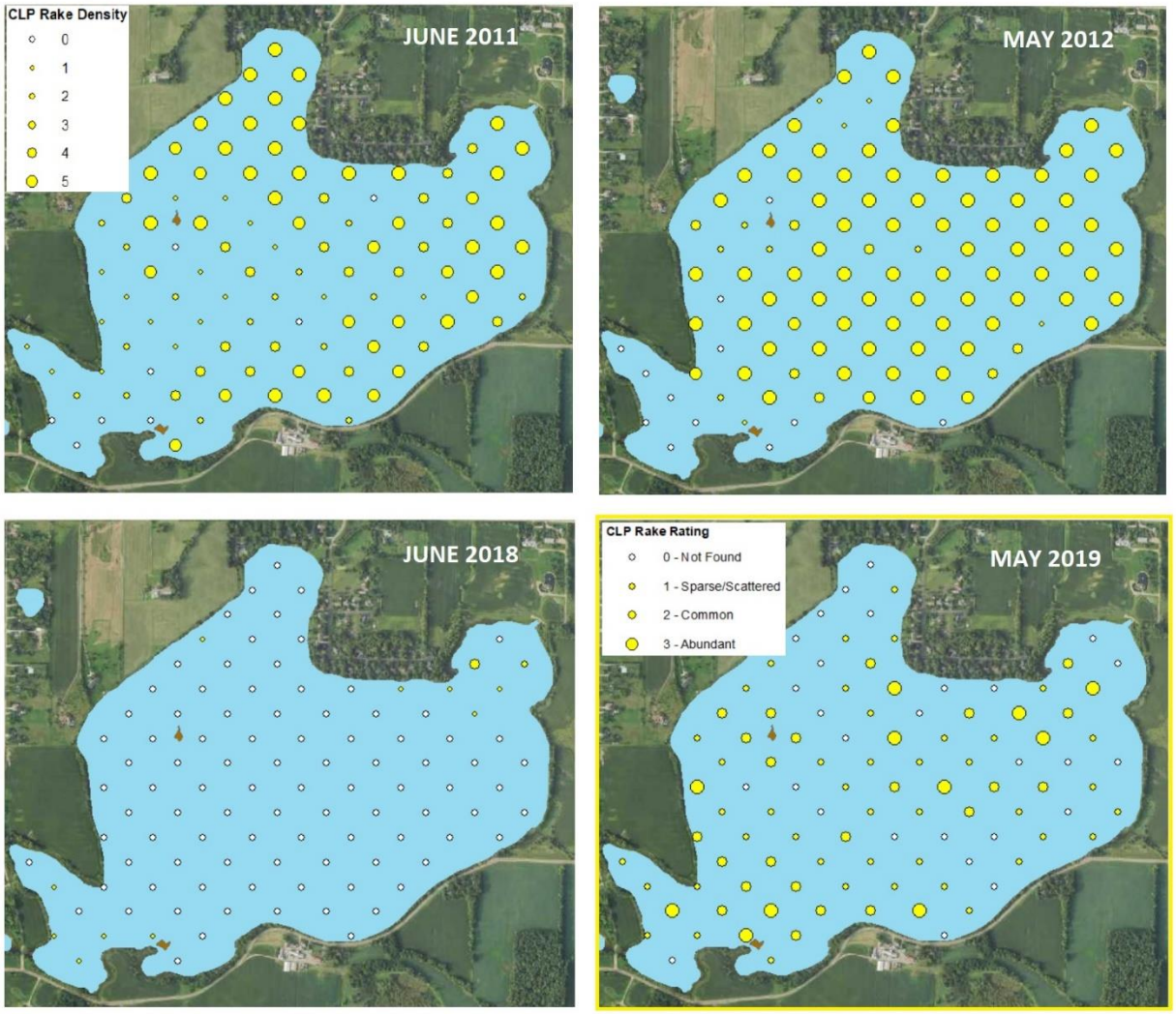


Figure 2. Spatial distribution and rake density per sample point of Curly-leaf pondweed. Dates correspond to month of point intercept survey. 2011, 2012 and 2018 surveys were conducted by Three Rivers Park District while the 2019 was done by the Minnesota Department of Natural Resources. Dot densities for the 2011, 2012 and 2018 surveys were on a scale from 0 (none found)-5(abundant) while the 2019 survey was based on the MnDNR designated scale of 0(none found)-3(abundant). Diamond Lake, Hennepin County (DOW # 27012500).