DEPARTMENT OF NATURAL RESOURCES

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
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November 8, 2018

Rice County Board of Commissioners
320 3rd St. NW #4
Faribault, MN 55021

Re: DNR Advisory Report on the Formation of the Circle Lake Improvement District in Rice County

Dear Commissioners:

I am writing to inform you that the Minnesota Department of Natural Resources has reviewed the petition submitted to create the Circle Lake Improvement District (SLID) and prepared this Advisory Report in accordance with Minnesota Rules, part 6115.0970, subp. 5. We conclude that:

- we approve of the proposed boundary for the Circle Lake LID for the purpose of aquatic plant management, in-lake water quality projects, and shoreline projects; and
- we recommend that the LID proposers work with the MPCA, Cannon River Watershed Partnership, and Rice County Soil and Water Conservation District (SWCD) on integrating its activities with the overall goals of the Cannon River TMDL and on collaborating with the partners on larger watershed projects as is feasible.

Goals of the Proposed Lake Improvement District

The overall goal of the Circle Lake LID is to improve water quality sufficient to allow removal of Circle Lake from MPCA's Impaired Waters List for nutrients. To attain that goal, the LID will engage in the following projects:

- Remove carp
- Control nuisance aquatic vegetation and aquatic invasive species (AIS), including curlyleaf pondweed (*Potamogeton crispus*, CLP) and Eurasian Watermilfoil (*Myriophyllum spicatum*, EWM)
- Promote and protect native aquatic vegetation
- Plant native vegetation along the lakeshore and in runoff areas
- Control erosion around Circle Lake and in the upstream watershed
- Pursue various watershed improvement projects
- Monitor water quality
- Address other water quality issues that arise in the future

The Circle Lake Association has investigated and implemented these projects to varying degrees in the past, but has been limited by financial constraints. The LID is being proposed to provide a more stable financial and organizational structure to better manage and implement these projects.

Background Information on Circle Lake

1. Circle Lake (Lake ID Number 66002700) is classified as Recreational Development (RD). In Rice County, RD lakes have structure setbacks of 75 and 100 feet above the Ordinary High Water Level (OWHL) for sewered and unsewered properties, respectively.
2. Circle Lake has an area of approximately 838 acres, all of which is considered to be littoral (15 feet deep or less per M.R. part 6280.0100, sub 9). Generally, the littoral zone is the part of a lake where rooted aquatic plants can grow, though the maximum depth at which plants can grow depends on water clarity and so varies from lake to lake and even from year to year within the same lake. Circle Lake's maximum depth is 14 feet.
3. The immediate catchment has an area of approximately 2846 acres, and the total upstream watershed has an area of approximately 21,414 acres. These yield land:lake ratios of approximately 3.4:1 for the direct catchment and 25:1 for the total watershed.
4. There are three islands on Circle Lake, one of which is designated as a MN DNR Aquatic Management Area[1].
5. Two shoreland restoration projects, funded by Rice County grants, are under way or have been completed on the southern shore of the lake[2].
6. Circle Lake is at the southern edge of the North Central Hardwood Forests ecoregion.
7. Agriculture dominates land cover in the upstream watershed. Pasture and grazing land cover about 29% and row crops 33% of the watershed area. Forest, almost entirely deciduous, covers approximately 14%. An additional 5% of the watershed is developed in some other fashion (residential or commercial properties and developed open space, for example)[3]. In addition, there are 91 active and 26 inactive feedlots in the watershed[4]. This level of development exceeds the 25% threshold for disturbance beyond which water quality tends to decline.
8. Circle Lake and several nearby water bodies are considered to be impaired for mercury, nutrients, or both. Circle Lake is considered an impaired water for mercury and nutrients; the Minnesota Pollution Control Agency (MPCA) has issued a consumption advisory for fish caught in the lake, and it is listed as impaired for aquatic recreation due to high concentrations of phosphorus. Two other lakes in Circle's upstream watershed are also considered impaired: Fox Lake (DOW Lake Number 66002900), immediately upstream from Circle Lake, is listed as impaired for phosphorus, and Mazaska Lake (DOW Lake Number 66003900), upstream of Fox Lake, is impaired for phosphorus and mercury. Finally, Wolf Creek, which flows from Circle Lake to the Cannon River, is considered impaired for aquatic life and aquatic recreation use due to Total Suspended Solids (TSS) and high concentrations of *Escherichia coli*[5].

1: State Administered Lands-DNR Management Units, Fisheries
2: MN DNR Fisheries, Shoreland Habitat Restoration Sites
3: National Land Cover Database 2011- U.S. Geological Survey
4: Feedlots in Minnesota-MPCA (2016)
5: Cannon River Watershed TMDL

9. Circle Lake is in the Wolf Creek watershed, a subwatershed of the Cannon River. MPCA conducted a Total Maximum Daily Load (TMDL) study for the Cannon River watershed. Findings from this study will be used in part to develop the Cannon River Watershed Restoration and Protection Strategies (WRAPS) Report. More information on this can be found at https://www.pca.state.mn.us/water/watersheds/cannon-river.
10. Circle Lake is considered to be hypereutrophic. In 2010, the mean TP was > 300 µg/L , mean chl-*a* was 129 µg/L , and mean Secchi depth was 0.4 m; threshold values for North Central Hardwood Forest Shallow Lakes are <60 µg/L TP, <20 µg/L chl-*a*, and >1.0 m Secchi depth[6].
11. Circle Lake is infested with two aquatic invasive plants, Eurasian watermilfoil and curlyleaf pondweed.
12. MN DNR maintains a concrete boat ramp on the northern shore of the lake. A public fishing pier is to the right of the ramp.
13. A concrete weir at Circle Lake's outlet maintains the lake's elevation at 1004.6 feet MSL, NGVD 29 datum[7].
14. The proposed LID will include all properties with direct or deeded lake access.
15. The proposed method of the Lake Improvement District formation is by citizen petition.

Issue Analysis

Carp Control

Common carp (*Cyprinus carpio*) can have a negative effect on water quality through their feeding behaviors. Carp root around in the bottom sediments while feeding, causing suspension of fine particulates in the water column; uncovering, uprooting, and damaging aquatic vegetation; and releasing phosphorus from sediments into the water column. These activities increase turbidity and phosphorus concentrations, and decrease vegetation.

To reduce these impacts, the lake association has been engaging in carp control projects, including removal, migration prevention, and promotion of predation. Carp have been removed from the lake since 2010. In 2013, bluegill (*Lepomis macrochirus*) were stocked in adjacent wetlands to promote predation on carp eggs and fry. In 2012 and 2013, a fish barrier was deployed in Wolf Creek to prevent carp from migrating from the creek into the lake. The proposed LID would take over and continue these projects.

Evidence from fish surveys suggests that carp control is having an effect on the carp population: MN DNR fish surveys indicate that carp numbers have dropped since their peak in 2007, from a mean of 51.8/trap net in 2007 to 1.3/trap net in 2017[8]. MN DNR encourages the LID to continue these efforts, and suggests that the LID consult with MN DNR Fisheries to evaluate whether re-installing the carp barriers would be helpful.

6: Circle Lake Improvement District Summary Report
7: Todd Piepho, personal communication

Aquatic Invasive Plants Management

Circle Lake has two invasive plant species: curly-leaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*). Curly-leaf pondweed has been present in the lake for several decades, but Eurasian watermilfoil was first found floating in the channel between Circle Lake and Fox Lake in 2010. Further searches confirmed the presence of rooted Eurasian watermilfoil at a small number of isolated points on the south shore of Circle Lake, near where Wolf Creek flows into Circle Lake. Fox Lake, which is upstream of Circle Lake, has had documented Eurasian watermilfoil since 2009, and a 2016 MN DNR point intercept survey showed that the plant was present in that lake at approximately 40% of the surveyed points in the littoral zone. However, in Circle Lake, Eurasian watermilfoil presence has remained low. The 2015 point intercept survey found that Eurasian watermilfoil was present at only 3% of the surveyed points. As of 2018, MN DNR searches have continued to find only low densities of Eurasian watermilfoil at isolated, shallow locations in the lake.

Invasive aquatic plant management in Circle Lake has focused on curly-leaf pondweed, using either an endothall herbicide or mechanical harvesting. Only partial-lake treatments have taken place. Densities of curly-leaf pondweed have fluctuated greatly over the past 15 years. In the early 2000s, curly-leaf pondweed was abundant, but from 2007 to 2014, there was not sufficient curly-leaf to warrant any control. The most recent treatment was mechanical control of 15 acres of curly-leaf pondweed in 2018, organized by the Circle Lake Association. Although Eurasian watermilfoil is present in Circle Lake, it has not been a management target due to its consistently very low levels in the lake. Prior to any treatments, the lake has been surveyed by the MN DNR to determine the permitted treatment area.

There have been three full lake point intercept surveys of aquatic vegetation in Circle Lake, conducted by the MN DNR Invasive Species program in June 2010, July 2014, and June 2015. In 2015, MN DNR surveys found plants in a range of water depth from two to 10 feet. However, it was rare to find rooted plants deeper than seven feet. 23% of the surveyed points had submersed native vegetation, but this increased to 47% when points that also had curly-leaf pondweed were included. In total, six submersed species, one floating-leaf species, and one emergent plant species were observed during the survey. Curly-leaf pondweed was the most commonly occurring plant, at 44% of all surveyed points. The dominant native plant species in the 2015 survey were coontail (*Ceratophyllum demersum*), sago pondweed (*Stuckenia pectinata*), and filamentous algae. *Elodea* (Canada waterweed) was also present, but only at 1% of the sampled points. Duckweed (*Leman* sp.) was the only floating-leaf plant observed during the survey. Cattails (*Typha* sp.) were the only emergent plant, and were present in multiple beds around the edges of the lake, especially along the northwest shoreline near the public access.

Circle Lake has historically had periods of abundant submerged vegetation alternating with low levels of vegetation, but species diversity has generally been low, and the dominant plant species have remained consistent across all years. In all sampled years, the average number of native species per point has consistently been below one species per sampling point. *Chara* sp. (muskgrass) was observed at one sampling point in 2010, but has not been detected at surveys since then. However, it is possible that Chara is still present in the lake at very low levels. The maximum depth of observed rooted vegetation was similar between 2014 and 2015, and was shallower (six feet) in 2010.

CLP and EWM abundance is not very high at the moment, but that may be due to the fact that vegetation growth in general is currently suppressed due to the lake's turbidity. If water clarity increases, aquatic vegetation growth will probably increase significantly as well, since the entire lake is shallow enough to theoretically support plant growth. Considering that CLP is the dominant submersed plant in the lake, it is reasonable to suspect that an increase in water clarity will result in greatly increased growth of CLP. The DNR therefore considers it proactive to continue to manage current CLP patches, as well as EWM patches. In addition, CLP has unique life history patterns (emergence and growth early in the spring, followed by midsummer senescence) that must be taken into account when treatments and monitoring surveys are conducted. Any AIS management should be accompanied by regular lake vegetation surveys, and with the guidance of MN DNR's Aquatic Invasive Species Program. The LID should contact the local Aquatic Invasive Species specialist Allison Gamble (507-362-8786; Allison.Gamble@state.mn.us) for further guidance on AIS management.

The petition does not discuss monitoring, cleaning stations, or educational efforts at the public access site on the lake, but such efforts are a key component in managing and limiting the spread of AIS, and MN DNR encourages the LID to adopt such activities as part of its AIS management strategy. Rice County and the DNR Watercraft Inspection Program can provide additional guidance to the LID or the lake association on AIS monitoring and prevention of additional AIS infestations in Circle Lake. The local contact for the DNR's Watercraft Inspection Program, Travis Kinsell (320-234-2550 x247, travis.kinsell@state.mn.us), can provide guidance on establishing and staffing cleaning stations at these sites.

MN DNR cautions the proposers that AIS growth is currently fairly sparse, probably due to the high turbidity in the water. If water quality improves and clarity increases, it will probably spark increased vegetation growth, including CLP and EWM. If this occurs, the LID should remember that this may be a consequence of increased water quality and not necessarily negative. The LID should therefore continue to work very closely with the MN DNR Aquatic Invasive Species Program to ensure that any AIS management remains in balance with overall water quality improvement goals.

Native Vegetation Management

The LID proposes to promote native aquatic vegetation and plant native vegetation along the lakeshore and in direct runoff areas. This is an appropriate goal and MN DNR supports it. Native vegetation provides habitat for wildlife and vegetation buffers along the shoreline reduce erosion and runoff into the lake. MN DNR also suggests planting native wetland and aquatic vegetation. Currently, there is very little aquatic vegetation in the lake, and even less native aquatic vegetation. If the LID is successful in its water quality goals, plant growth will expand throughout most or all of the basin as water clarity increases. Promoting native aquatic vegetation will decrease the amount of bare substrate available for CLP and EWM colonization.

Water Quality

Circle Lake is hypereutrophic, with elevated total phosphorus and chlorophyll *a* concentrations and low water transparency. Mean summertime TP is > 300 µg/L , mean chl-*a* is >100 µg/L , and mean Secchi depth is < 0.5 m. Threshold values for lakes similar to Circle Lake in the same ecoregion (North Central

Hardwood Forest Shallow Lakes) are considerably less: <60 µg/L TP, <20 µg/L chl-*a*, and >1.0 m Secchi depth. Circle Lake must attain these water quality thresholds to be removed from MPCA's Impaired Waters List for nutrients.

Much of Circle Lake's phosphorus comes from input from its watershed. Circle Lake is in a watershed with a relatively large watershed:lake ratio, and the dominant land use in the watershed is agriculture; these characteristics increase the lake's vulnerability to pollution from the watershed. Circle Lake is in the Wolf Creek subwatershed of the Cannon River watershed, which is itself considered impaired and for which a Watershed Restoration and Protection Strategy (WRAPS) has been developed. Circle Lake receives eutrophic inputs from two watercourses, Wolf Creek and a tributary to County Ditch 32, and in turn it acts as a source for phosphorus for Wolf Creek when it outlets the lake. Because these phosphorus sources are largely outside the boundaries of the proposed LID, it will be challenging for the LID to remediate them; nevertheless, reducing phosphorus inputs from the watershed is the most effective way to help Circle Lake with its eutrophication problems. To achieve this goal, MN DNR strongly encourages the LID to pursue any erosion control, landscaping and ecosystem restoration projects within the boundary of the LID, and to pursue partnerships and collaborations with private property owners, Rice County, the Rice County SWCD, BWSR, and the MPCA to indirectly influence those sources of phosphorus outside the LID's boundaries. The 2011 Circle Lake Management Plan lists several recommendations for projects, along with potential contributors, contractors, and funding sources, for consideration. MN DNR suggests that the LID consult with MPCA, Rice County SWCD, and the Cannon River Watershed Partnership to determine which projects would provide the greatest return on investment, and for coordination to make the LID a more effective partner in reducing nutrient loading from the larger watershed.

The LID proposal and 2011 lake management plan list several water quality enhancement projects that the LID may pursue, although very few specifics are given about them. In-lake, riparian, and near riparian projects listed that could be pursued by the LID directly because they would be carried out within the LID's boundaries include: erosion control; wetland restoration; shoreland protection; and planting of native vegetation. The DNR encourages pursuit of all of these projects since each can play a role in improving Circle Lake's water quality:

> The boundaries of the proposed LID include some portion of the two watercourses that enter Circle Lake as well as about 2000 feet of Wolf Creek after it leaves Circle Lake. These areas are excellent locations for the LID to carry out some of its proposed bank stabilization and erosion control projects. These would also be promising locations for the LID to consider creating wetlands for sediment and nutrient retention, thus reducing phosphorus and sediment inputs into the lake.
>
> Planting native vegetation in the Shore Impact Zone (SIZ), in swales and other runoff areas, and in the nearshore water will trap sediment and reduce nutrient- and sediment-laden runoff from lawns and increase wildlife habitat. Emergent wetland vegetation will also remove nutrients from the water.
>
> Stabilizing and restoring eroded shoreline will reduce sedimentation and runoff into the lake and prevent further erosion.

MN DNR also suggests that the LID undertake a survey to determine whether any septic systems on the lake are noncompliant and, if so, bring them into compliance. Noncompliant septic systems can be a significant contributor of nutrients to the lake.

The LID should consult with the MPCA, BWSR, and Rice County SWCD for guidance in how to implement these projects.

In addition to input from the watershed, Circle Lake also has a large degree of internal phosphorus loading from resuspension. This is promoted by carp bioturbation and winds re-suspending bottom sediments. The LID will continue the lake association's carp removal program as discussed above. The LID is also considering adding alum or iron to the water, which will bind phosphate ions and make them unavailable. This may be helpful, and the MN DNR encourages the LID to work with the MPCA on exploring the feasibility of this treatment method. However, MN DNR also suggests that the LID prioritize doing what it can to decrease external phosphorus inputs into the system first, before it attempts to reduce internal loading.

The LID proposal does not include a discussion on water quality monitoring, but monitoring results are included in the 2011 lake management plan, so it is evident that monitoring is being carried out. The LID should continue monthly monitoring of nutrients and transparency throughout the growing season. Monitoring should be conducted at both inlets to the lake; in the lake itself; and at the outlet at Wolf Creek. MN DNR suggests that the LID also monitor for total suspended solids (TSS) and dissolved oxygen (DO). DO readings should be taken twice a day, near dawn and dusk, to monitor diurnal variation. MN DNR suggests that the LID coordinate with MPCA on water quality monitoring, since MPCA already monitors water quality in much of the Cannon River watershed. Also, there is no mention of a plan to calculate a phosphorus budget for the lake. A phosphorus budget will help the LID identify the major sources of phosphorus to the lake and thereby allow the LID to prioritize projects better. MN DNR suggests that the LID explore this topic with MPCA; this information may already be available through MPCA's Cannon River Watershed studies.

The high mercury concentrations in fish tissue in Circle Lake is being addressed with the Statewide Mercury TMDL.

Recommendations/Conclusions

Proposed LID Boundaries

The boundaries of the proposed LID include only properties with direct or deeded access to Circle Lake. MR Part 6115.0920 subpart 5 requires that the boundaries include all lands and waters within the direct drainage basin of the lake (shown on the attached map). However, this rule also allows the County Board or City Council to create a boundary less than the entire drainage basin with written Commissioner approval if the boundary selected includes a sufficient amount of the lake's watershed to develop and implement feasible solutions to the problems the LID intends to address. Restriction of the district's boundary to these properties is sufficient to address the in-lake and shoreline water quality and vegetation

management activities for which the LID is being proposed. Therefore, in accordance with these rules, the DNR approves the proposed boundaries identified in the resolution.

Advisory Comments & Recommendations

Circle Lake has a serious eutrophication problem. The proponents of the LID appear to be aware of the complexity and magnitude of their problem, and are including in the proposal both projects that the LID can carry out directly, within its boundaries, and projects outside the LID's boundaries that will require coordination and cooperation with other parties, including: the Rice County SWCD, Cannon River Watershed Partnership, MN DNR, Circle Lakes Association, other area lake associations, and the MPCA. MN DNR is pleased that the LID proposers recognize and acknowledge the importance of working with these other groups, because it is unlikely that a problem of the nature and magnitude of Circle Lake's nutrient problem can be solved solely through in-lake and shoreline projects.

Thank you for consideration of these comments. Please contact Kathy Metzker, DNR Land Use Hydrologist at 651-259-5694, if you have any questions. If approved, please provide the name and address of the primary contact of the Board of Directors for the LID and remind the LID of its obligation to provide DNR notice of annual meetings and copies of annual reports per MS § 103B.571.

Sincerely,
DIVISION OF ECOLOGICAL AND WATER RESOURCES

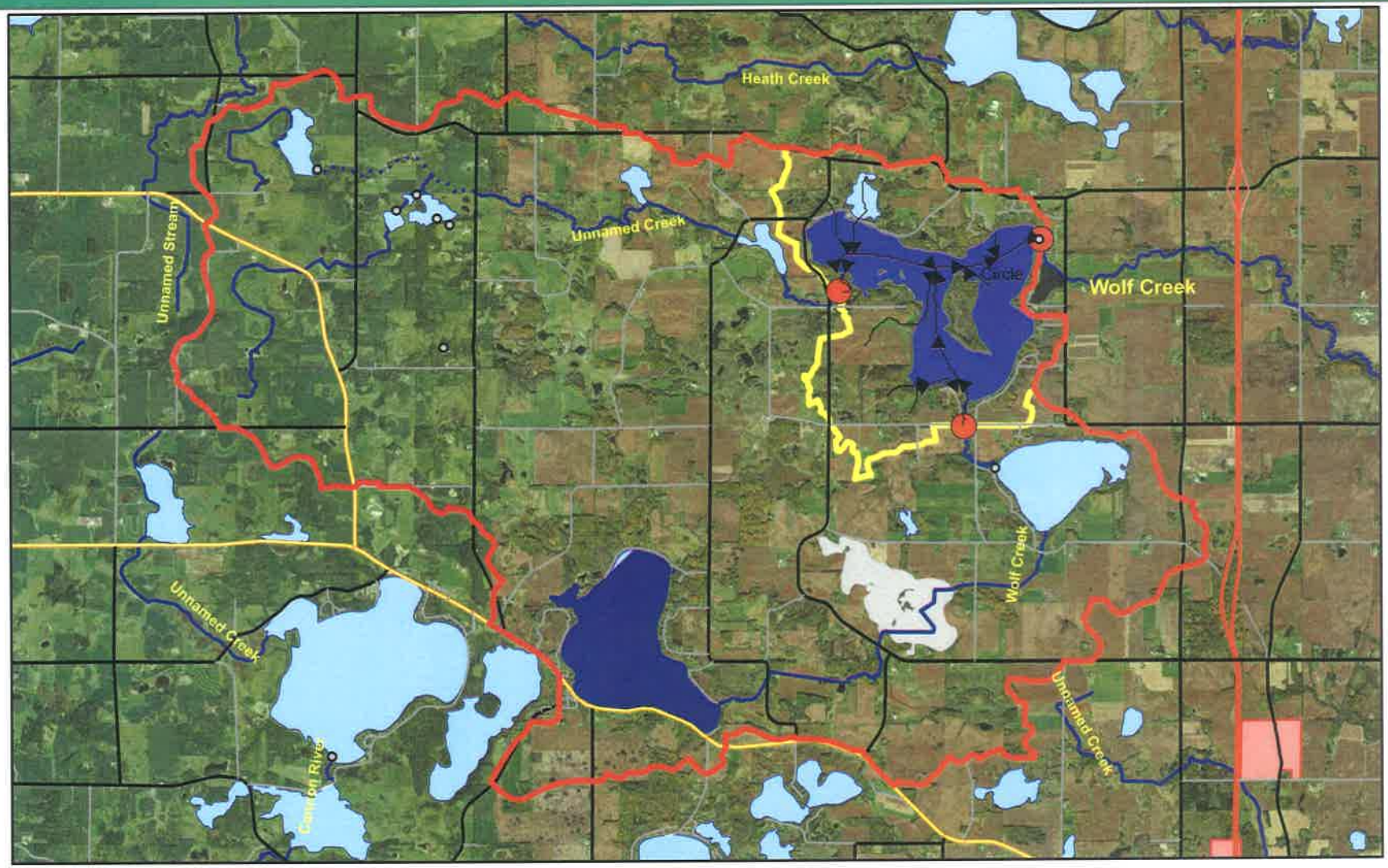
Julie Ekman

Julie Ekman
Manager, Conservation Assistance and Regulations (CAR) Section

Attachments

c: Jennifer Shillcox, Land Use Programs Supervisor
Todd Piepho, Area Hydrologist (Rice County)
Allison Gamble, DNR Aquatic Invasive Species Specialist
Daniel Petrik, Land Use Specialist
Katherine Logan, Southeast Watershed Unit- MPCA
Craig Soupir, DNR Fisheries Supervisor-Waterville
Mark Origer, Circle Lake Improvement District
Sara Folsted, Rice County Auditor

Circle Lake Watershed



The watershed data presented here are part of the National Watershed Boundary Dataset (WBD).
A Hydrologic Unit (HU) is the smallest division in the nested, hierarchical watershed classification system of the WBD.
Electronic data for use in a GIS (Geographic Information System) can be downloaded from the DNR Data Deli:
http://deli.dnr.state.mn.us/

- Water Flow
- Circle Catchment
- Upstream Watershed
- Circle Lake
- Catchment Pour Points

Watershed	Area	
	Acres	Square Miles
Circle Lake DOW Lake No. 66002700	638	1.3
Direct Catchment Watershed Wolf Creek	2846	4.45
Total Upstream Contributing Watershed	21,414	33.46

DEPARTMENT OF NATURAL RESOURCES

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CIRCLE LAKE, RICE COUNTY:

2015 AQUATIC VEGETATION REPORT

Report by the Invasive Species Program

Division of Ecological and Water Resources

Minnesota Department of Natural Resources

Lake: Circle (DOW#66002700)
Lake Surface Area: 838 acres
Littoral Area: 838 acres
County: Rice County
Survey Type: Point-intercept
Date of Survey (most recent): May 27, June 2, 2015
Observer[s]: Allison Gamble (MnDNR), Martin Evans (MnDNR), April Londo (MnDNR)
Report updated: October 11, 2018
Author[s]: Allison Gamble
Email: allison.gamble@state.mn.us
Phone: 507.362.8786

2015 Summary

The most recent aquatic vegetation point intercept survey of Circle Lake (DOW # 66002700) took place on May 27 and June 2, 2015. Plants were present throughout the lake to a depth of 10 feet. All of the points were within the littoral zone (zone in lake from the 0-15 foot depth range), and 23% of the points had native submersed taxa. When non-native species were included, 47% of the surveyed points in the littoral zone contained submersed taxa. The average number of native submersed taxa per sample point was 0.3. Two invasive species were observed: curly-leaf pondweed and Eurasian watermilfoil. In total, six submersed taxa, one floating-leaf taxa, and one emergent taxa were observed during the 2015 survey.

Lake Description

Circle Lake is an 838 acre lake located six miles northwest of Faribault, in Rice County, MN. The lake has two invasive plant species: curly-leaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*). Curly-leaf pondweed has been present in the lake for several decades, but Eurasian watermilfoil was first found floating in the channel between Circle Lake and Fox Lake in 2010. Further searches confirmed the presence of rooted Eurasian watermilfoil at a small number of isolated points on the south shore of Circle Lake, near where Wolf Creek flows in to Circle Lake. Fox Lake, which is upstream of Circle Lake, has had documented Eurasian watermilfoil since 2009, and a 2016 point intercept survey showed that the plant was present at approximately 40% of the surveyed points in the littoral zone in Fox Lake. However, in Circle Lake, Eurasian watermilfoil presence has remained low. The 2015 point intercept survey found that Eurasian watermilfoil was present at 3% of the surveyed points.

The maximum depth of water in Circle Lake is 14 feet, so the entire lake is classified as littoral (areas of water depth between zero to 15 feet, where aquatic plants are most likely to grow). The lake has historically had periods of abundant submerged vegetation alternating with low levels of vegetation, but species diversity has generally been low. Water clarity during the summer has generally been low, ranging between 0.5 to one foot, although only limited sampling data exist. According to surveys from the Minnesota Pollution Control Agency, Circle Lake is classified as a nutrient-rich lake, based on its Trophic State Index (TSI) of 74. For more information concerning water quality see: Circle Lake Water Quality

Management History

Invasive aquatic plant management in Circle Lake has focused on curly-leaf pondweed, using either an endothall herbicide or mechanical harvesting. Only partial-lake treatments have taken place. Densities of curly-leaf pondweed have fluctuated greatly over the past 15 years. In the early 2000s, curly-leaf pondweed was abundant, but from 2007 to 2014, there was not sufficient curly-leaf to warrant any control. The most recent treatment was done in 2018, organized by the Circle Lake Association (see ***Figure 1*** for treatment locations and ***Table 1*** for a history of invasive plant treatments treatments). Although Eurasian watermilfoil is present in Circle Lake, it has not been a management target due to its consistently very low levels in the

lake. Prior to any treatments, the lake has been surveyed by the MN DNR to determine the permitted treatment area. Generally, treatments are appropriate when there is dense Eurasian watermilfoil or curly-leaf pondweed and few to no native plants mixed in with the invasive species.

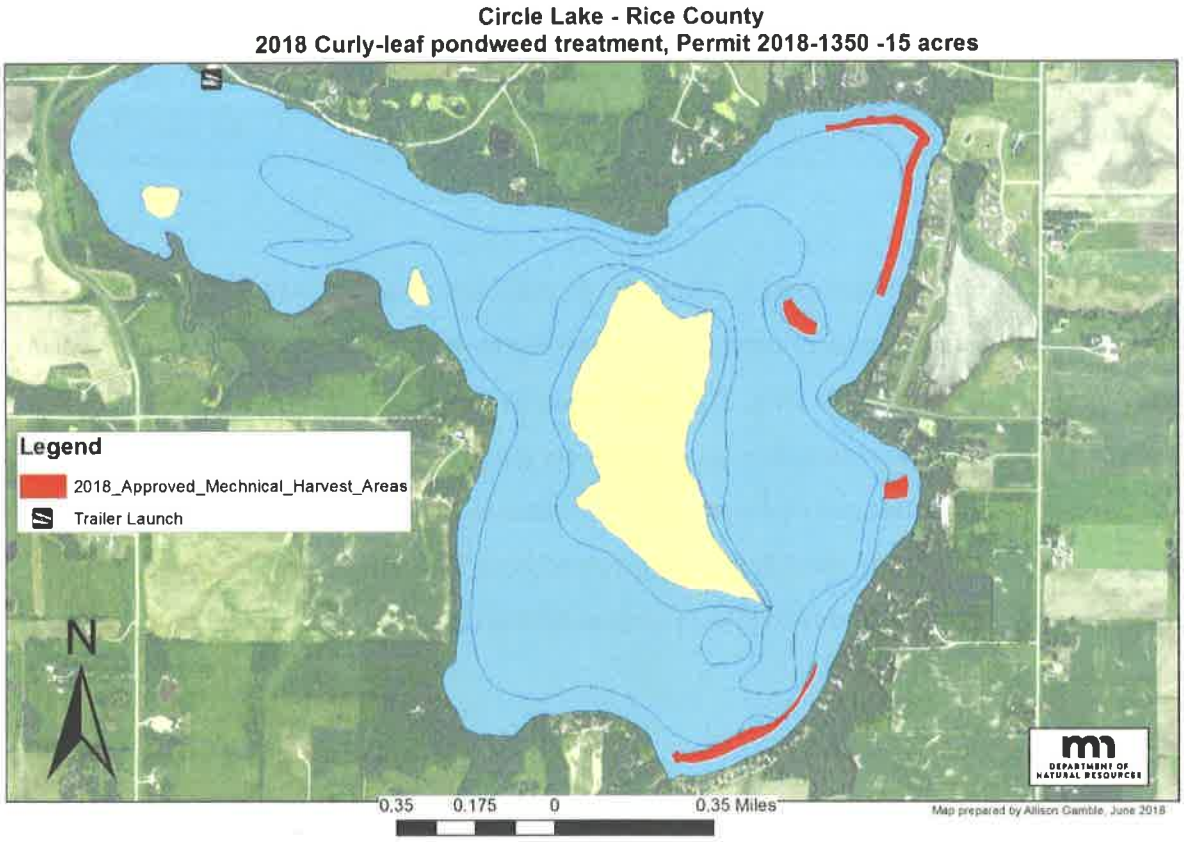

Figure 1 – 2018 Treatment Areas. 2018 permitted areas for mechanical harvest of 15 acres of curly-leaf pondweed in Circle Lake, Rice County (DOW# 66002700).

Table 1-Invasive Plant Management Summary. Characteristics and history of partial lake invasive plant treatments for Circle Lake, Rice County (DOW# 66002700, Total acres: 838, Littoral acres: 838, 15% of Littoral acres: 125.6). CLP is an abbreviation for curly-leaf pondweed. No treatments occurred from 2007 to 2014, due to low levels of CLP.

Date	Target Species	Total Acres Treated	Herbicide	Licensed Commercial Applicator
MAY/JUNE 2002	CLP	42	Mechanical harvest	N/A -Lake association
MAY/JUNE 2003	CLP	42	Mechanical harvest	N/A -Lake association
MAY/JUNE 2004	CLP	42	Mechanical harvest	N/A -Lake association
MAY/JUNE 2005	CLP	30	Mechanical harvest	N/A -Lake association
JUNE 2006	CLP	1.5	Mechanical harvest	N/A -Lake association

Date	Target Species	Total Acres Treated	Herbicide	Licensed Commercial Applicator
MAY 2015	CLP	9.15	Endothall	Lakescapes, LLC
MAY 2016	CLP	15	Mechanical harvest	No treatment due to contractor issues
MAY 2017	CLP	15.1	Mechanical harvest	J&N Weed Harvesting
JUNE 2018	CLP	15	Mechanical harvest	J&N Weed Harvesting

Survey Objectives

Point-intercept surveys were used to assess the distribution of aquatic plants in Circle 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 to monitor native plant communities and evaluate possible responses to invasive aquatic plant management via herbicide control. 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 management efforts.

Survey Methods

We used a point intercept survey method developed by Madsen (1999; Point intercept survey method protocols). Sampling points were placed 150-175 meters apart using a Geographic Information System. This spacing allowed for placement of 106-185 points. The 2010 survey used 175 m spacing (106 points), while the 2014 and 2015 surveys used 150 m spacing (185 points). Plant samples were collected by throwing and dragging a double-sided rake along the lake bottom at each point. Frequencies of occurrence percentages (i.e., how often a plant species was sampled in the lake) were calculated based on the littoral zone.

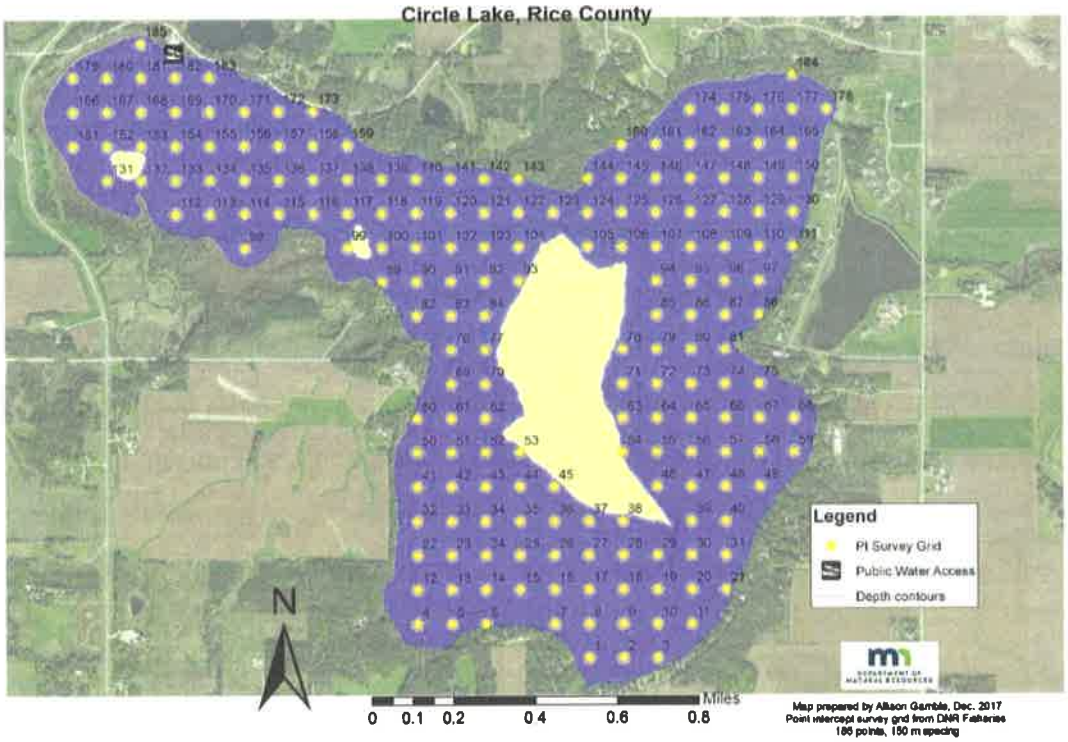

Figure 2 – Point Intercept Survey Grid. Point intercept survey grid for Circle Lake, Rice County (DOW# 66002700). 185 points were surveyed in 2014 and in 2015.

Survey Observations

In 2015, we found plants in Circle Lake in a range of water depth from two to 10 feet (see ***Table 2*** for point-intercept survey calculations). However, it was rare to find rooted plants deeper than seven feet. 23% of the surveyed points had submersed native vegetation, but this increased to 47% when points that also had curly-leaf pondweed were included. In total, we found six submersed species, one floating-leaf species, and one emergent plant species during the survey (***Table 3***). Curly-leaf pondweed was the most commonly occurring plant, at 44% of all surveyed points (***Figure 3***). The dominant native plant species in the 2015 survey were coontail, sago pondweed, and filamentous algae (***Figure 4***). *Elodea* (Canada waterweed) was also present, but only at 1% of the sampled points. Duckweed was the only floating-leaf plant observed during the survey, at 1% of the sampled points. Cattails were the only emergent plant, and were present in multiple beds around the edges of the lake, especially along the northwest shoreline near the public access.

Comparison to previous years

Circle Lake has historically had periods of abundant submerged vegetation alternating with low levels of vegetation, but species diversity has generally been low. Two previous MN DNR aquatic plant surveys have taken place, one in June 2010 and one in July 2014. The dominant plant species have generally remained consistent across all years, although filamentous algae was highest in 2015 (***Table 3, Figure 3***). Native plant diversity was highest in 2010, but the average number of native species per point has consistently been below one species per sampling point. *Chara* (muskgrass) was observed at one sampling point in 2010, but has not been detected at surveys since then. However, it is possible that *Chara* is still present in the lake at very low levels. The maximum depth of observed rooted vegetation was similar between 2014 and 2015, and was shallower in 2010.

Eurasian watermilfoil was documented at an isolated location in Circle Lake in fall 2010, but was not found at any of the points sampled during that year's point intercept survey. Eurasian watermilfoil has remained present in the lake, but only at very low densities. Eurasian watermilfoil was found at only one of the sampling points during the 2014 survey, and at five of the points in 2015. As of 2018, MN DNR searches have continued to find only low densities of Eurasian watermilfoil at isolated, shallow locations in the lake.

Table 2- Point Intercept Metrics. Summary of point intercepts metrics for Circle Lake, Rice County (DOW# 66002700). Shaded values were calculated from littoral depth range (0-15 feet).

	JUNE 2010	JULY 2014	MAY/JUNE 2015
Treated (Y/N)	N	N	Y
Surveyor	MN DNR	MN DNR	MN DNR
Depth Range of Rooted Veg	2-6 ft	1-8 ft	2-10 ft
Total # Points Sampled	103	185	185
Max Depth of Growth (95%)	5 ft	6 ft	8 ft
# Point in Max Depth Range	36	71	99
# Points in Littoral (0-15 feet)	103	185	185
% Points w/ Submersed Native Plants	7%	22%	23%
% Points w/ Submersed Plants	20%	25%	47%
Mean Submersed Native Taxa/ Point	0.1	0.3	0.3
# Submersed Native Taxa	5	4	4
# Submersed Non-Native Taxa	1	2	2

Table 3- Plant Frequency Occurrence. Percent frequency of occurrence for observed plant species in Circle Lake, Rice County (DOW# 66002700).

Taxonomic Name	Common Name	JUNE 2010	JULY 2014	MAY/JUNE 2015
SUBMERSED NON-NATIVE				
Myriophyllum spicatum	Eurasian watermilfoil	0	1	3
Potamogeton crispus	Curly-leaf pondweed	20	15	44
SUBMERSED NATIVE				
Algae	Filamentous algae	1	9	15
Ceratophyllum demersum	Coontail	4	14	8
***Chara* sp.**	Muskgrass	1	0	0
Elodea canadensis	Canadian waterweed	3	1	1
Stuckenia pectinata	Sago pondweed	2	6	7
FLOATING LEAF				
***Lemna* sp.**	Duckweed	0	1	1

***Typha* (cattail) sp. was present in all years. *Lemna minor* (small duckweed) was observed in 2010, but not at any of the sampling points.**

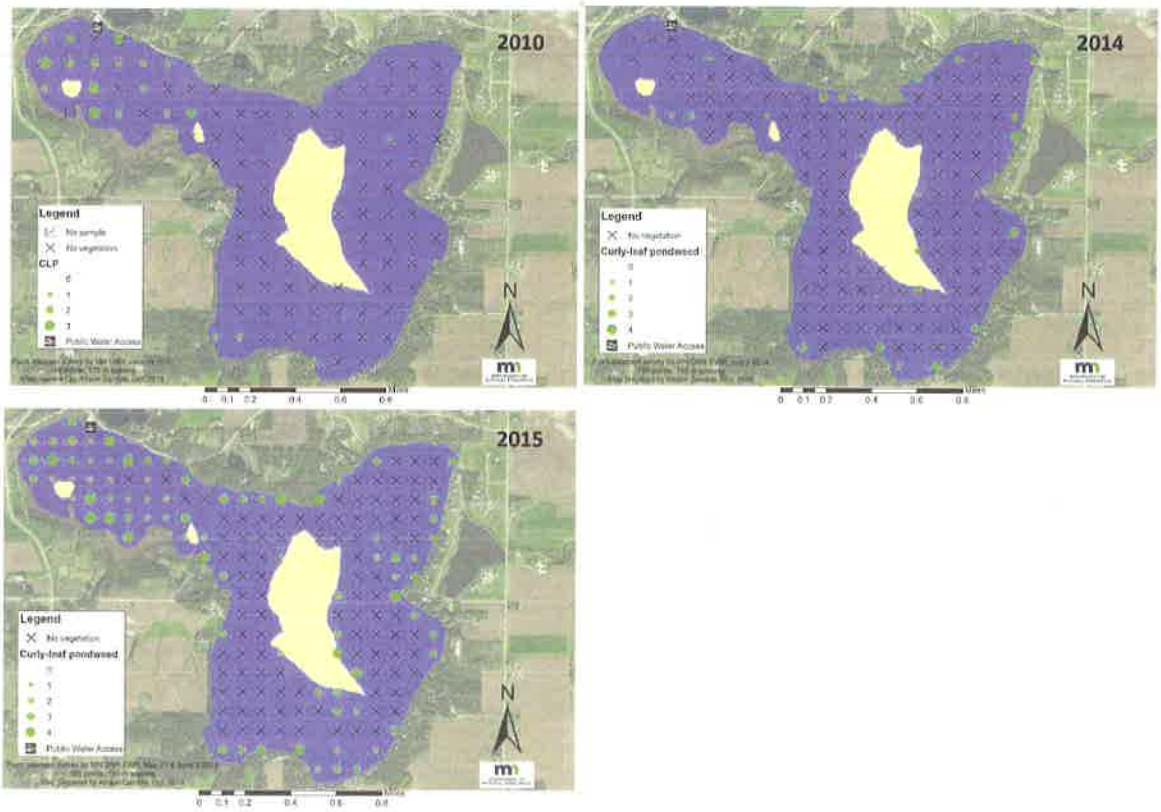

Figure 3 – Curly-leaf Pondweed Distribution 2010-2015. Curly-leaf pondweed distribution maps from the 2010 (upper left), 2014 (upper right), and 2015 (lower left) point intercept surveys in Circle Lake, Rice County (DOW# 66002700). Plant densities ranged from 0 to 4 at each point, with a 4 indicating dense plant presence and a 0 indicating nothing was found. Xs indicate that no plants of any species were found at a point.

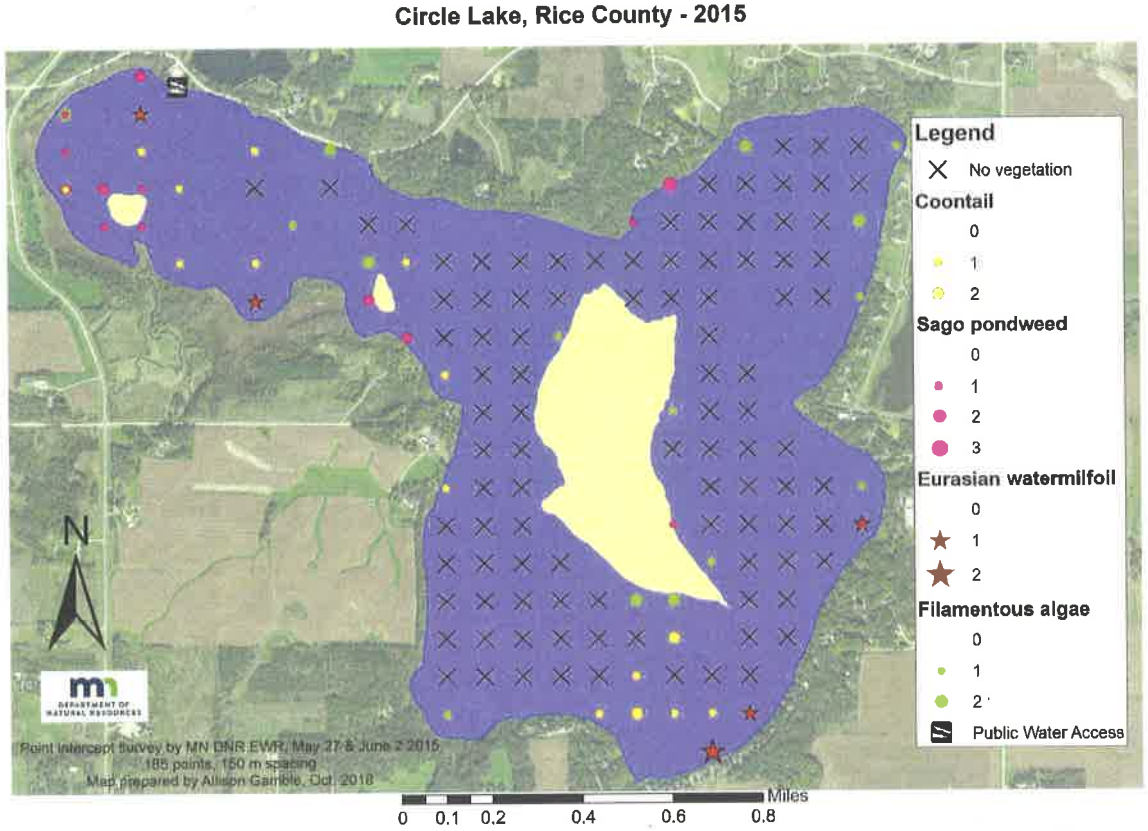

Figure 4 – 2015 Native Plants & Eurasian Watermilfoil Distribution. Native plants (coontail, sago pondweed, and filamentous algae) and Eurasian watermilfoil distributions from the 2015 point intercept survey in Circle Lake, Rice County (DOW# 66002700). Plant densities ranged from 0 to 4 at each point, with a 4 indicating dense plant presence and a 0 indicating nothing was found. Xs indicate that no plants of any species were found at a point.