

# **Seasonal Changes in Aquatic Vegetation within Five Sibley County Lakes**



## **A Final Vegetation Distribution Report Submitted to the Sibley County Soil and Water Conservation District**

**Samuel A. Schmid and Ryan M. Wersal, Ph.D.**

Department of Biological Sciences  
Minnesota State University, Mankato

Aquatic Weed Science Lab

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## Background

In the prairie pothole region, shallow lakes are an essential resource that hold a lot of economic and ecological value. Plants are food and habitat for all other organisms and aquatic macrophytes are a very important piece of the shallow lake system. Invasive macrophytes, however, can be incredible detrimental to lake systems. When invasive plants dominate the communities of natural lakes, they alter the structure and function of the lake. These detrimental effects can vary spatially and temporally depending on the species and system at hand. With the threat of aquatic invasive plants, it is important to survey for and monitor these species in order to document their colonization and spread; and ultimately manage them as soon as possible to mitigate the economic and ecological costs.

Shallow lakes are very important to the economy and environment in Sibley County. The lakes are used for recreation, wildlife habitat, water quality improvement, and flood reduction. However, to date, there is no record of any quantitative assessments of the macrophyte communities in any of the Sibley County lakes. The objectives of this project are to 1) to survey five of Sibley County's high-profile lakes (High Island Lake, Titlow Lake, Schilling Lake, Silver Lake, and Clear Lake) to provide a comprehensive assessment of the abundance and distribution of aquatic macrophytes and 2) assess how the plant community changes over the growing season.

## Methods

The aquatic plant communities of High Island Lake, Titlow Lake, Schilling Lake, Silver Lake, and Clear Lake were assessed early in the growing season (May 23<sup>rd</sup> – June 28<sup>th</sup>) and then again late in the season (August 31<sup>st</sup> – September 23<sup>rd</sup>). The surveys were conducted using the point-intercept method that consisted of surveying points within each lake that were set on a 150-meter grid (Madsen and Wersal 2018). A total of 766 points were sampled across all five lakes (High Island Lake – 249, Titlow Lake – 163, Schilling Lake – 145, Silver Lake – 119, Clear Lake – 90) during both spring and fall surveys, though High Island Lake was not surveyed late season because it was dewatered during that time. At each point, the presence of macrophytes was sampled using a plant rake and water depth determined using hydroacoustic equipment. Spatial data were recorded using the FarmWorks Site Mate Software on a Trimble Yuma 2 tablet PC. The software was used to display the survey grid for navigation as well as to collect geospatial data. Data were collected using a database template and pick lists specifically constructed for this project. Secchi disk measurements were also measured at each lake to assess water clarity.

For each species, presence was averaged over all sampled points for a given lake to determine the frequency of occurrence. The differences in species composition between the early season and the late season were statistically analyzed using McNemar's chi square test (Stokes et al. 2000, Wersal et al. 2006). The mean species richness was determined by taking the average of all the different species at each point. These values were analyzed between the early and late season using Wilcoxon signed rank test (Madsen et al. 2015). Voucher specimens were collected for every species that occurred and total species lists for the early season surveys were constructed for each lake.

## Results and Discussion

### High Island Lake

Surveyed on June 1<sup>st</sup> and June 3<sup>rd</sup>

Secchi: 149 cm

Average depth: 1.67 m

High Island Lake was the largest lake sampled and had the greatest water clarity. This lake had the highest mean species richness of aquatic macrophytes during the early season survey (Table 1). High Island Lake had the greatest species richness in the early season and the dominance of sago pondweed is typical of shallow lakes in this region (Figure 1) (Case & Madsen 2004; Wersal et al. 2006). There were isolated patches of coontail (*Ceratophyllum demersum*), which seemed to be unique to this lake. There was no curly pondweed (*Potamogeton crispus*) observed in this lake. The lack of curlyleaf pondweed in High Island Lake is surprising given its proximity to Schilling Lake, which was heavily infested with curlyleaf pondweed. The shoreline of the lake was dominated by cattail (*Typha* spp.) in large patches, but there were also instances of river club-rush (*Bolboschoenus fluviatilis*) and softstem bulrush (*Schoenoplectus tabernaemontani*). Between the early season and late season surveys, High Island Lake was dewatered, so a late season survey was not conducted.

Monitoring should continue in order to detect or prevent non-native species infestations, such as curlyleaf pondweed. Early detection and rapid response will help mitigate the cost of managing aquatic invasive species and increase management success (Simberloff 2003; Madsen & Wersal 2017).

Table 1. The sample frequencies of all macrophyte species observed in High Island Lake, Sibley Co., MN, during the early season (n=249) survey. Mean species richness is the average richness per survey point. *Bolboschoenus fluviatilis*, *Nymphaea odorata*, and *Phragmites australis* were observed, but not sampled.

Species	Common name	Sample frequency (%)
<i>Ceratophyllum demersum</i>	coontail	2.00
<i>Lemna minor</i>	lesser duckweed	2.80
<i>Lemna trisulca</i>	star duckweed	0.80
<i>Schoenoplectus tabernaemontani</i>	softstem bulrush	0.40
<i>Stuckenia pectinata</i>	sago pondweed	49.00
<i>Typha</i> spp.	cattail	4.80
<i>Wolffia columbiana</i>	Columbian watermeal	0.80
Mean species richness		0.62

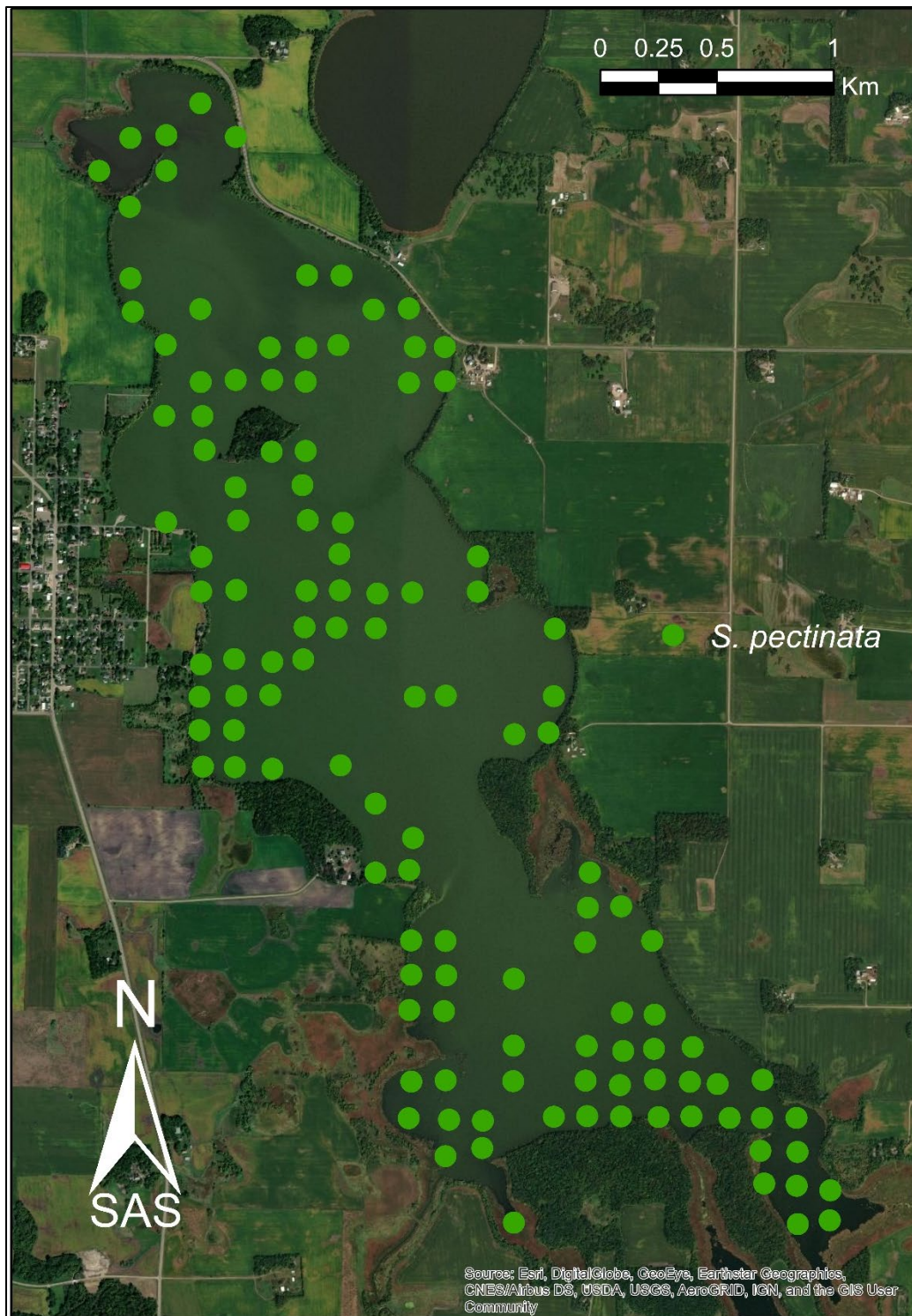


Figure 1. A map of the distribution of sago pondweed (*Stuckenia pectinata*) in High Island Lake, Sibley Co., MN, during the early season surveys.

## Titlow Lake

Surveyed dates:

- Early season – May 28<sup>th</sup> and 31<sup>st</sup>
- Late season – September 7<sup>th</sup>

Secchi: 22 cm

Average depth: 1.52 m

Titlow Lake was the shallowest lake that was surveyed and had one of the lowest water clarities. Additionally, this lake had one of the lowest mean species richness; however, the mean species richness rose significantly later in the growing season (Table 2). Sago pondweed was the most dominant submerged plant and there was a significant decline in its frequency from the early season to the late season (Table 2) (Figure 2). On the north side of Titlow Lake, the shoreline was dominated by cattail. The southern shoreline consisted primarily of residences and had little emergent vegetation. Although the difference of species frequency between the early and late season was statistically significant, the structure of the lake did not appear to change much throughout the growing season. Additionally, the vegetation composition in Titlow Lake primarily consisted of lesser duckweed, cattail, and sago pondweed; and these species have very little niche overlap, due to their different growth forms and therefore there is little competition between them (Schuyler 1984; Wetzel 2001).

Table 2. The sample frequencies of all macrophyte species observed in Titlow Lake, Sibley Co., MN, during the early season and late season surveys. Mean species richness is the average richness per survey point. *Carex spp.* was observed, but not sampled in the early season and late season surveys. *Phragmites australis* was observed, but not sampled in the late season survey.

Species	Common name	Sample frequency (%)		p-value (n=160)
		Early season	Late season	
<i>Lemna minor</i>	lesser duckweed	0.62	3.09	0.103 <sup>1</sup>
<i>Phragmites australis</i>	common reed	0.60		
<i>Stuckenia pectinata</i>	sago pondweed	25.31	14.81	0.013 <sup>1</sup>
<i>Typha spp.</i>	cattail	0.62	1.23	0.564 <sup>1</sup>
Mean species richness		0.16	0.30	0.017 <sup>2</sup>

<sup>1</sup>Calculated using McNemar's chi square test

<sup>2</sup>Calculated using Wilcoxon signed rank test

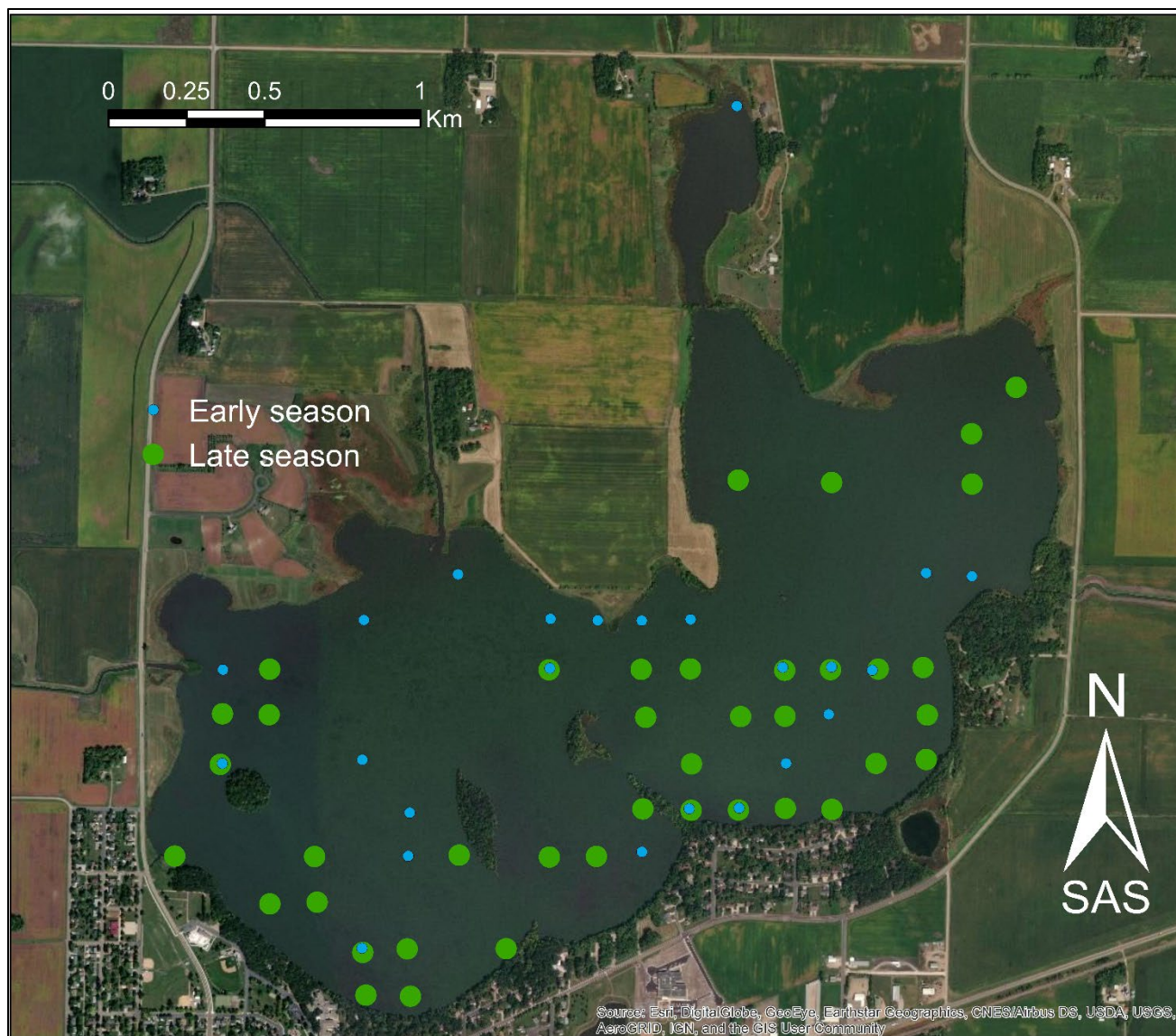


Figure 2. A map of the distribution of sago pondweed (*Stuckenia pectinata*) in Titlow Lake, Sibley Co., MN, during the early season and late season surveys.

## Schilling Lake

Survey dates:

- Early season – May 23<sup>rd</sup> and 24<sup>th</sup>
- Late season – October 31<sup>st</sup>

Secchi: 86 cm

Average depth: 1.67 m

Schilling Lake experienced the greatest vegetation community shift from early to late season out of all lakes surveyed (Table 3). The shift was driven by the heavy infestation of curlyleaf pondweed and its atypical life history. Curlyleaf pondweed had the highest early season frequency of occurrence at 44.44%; however, there was a significant reduction in the frequency of curlyleaf pondweed during the late season survey (13.89%) (Table 3) (Figure 3). The inverse was observed for sago pondweed. The frequency of sago pondweed was low in the early season (6.25%) and increased significantly later in the growing season to 63.89% (Table 3) (Figure 4).

Since the atypical life cycle of curlyleaf pondweed causes it to reach peak biomass in the spring and die off in the early summer, there was a dramatic reduction in curlyleaf pondweed sample frequency from early season to late season (Bolduan et al. 1994). This major reduction in curlyleaf pondweed frequency, was also observed in tandem with a dramatic increase in the frequency of sago pondweed. This shift in the dominant individual suggests that the dying back of curlyleaf pondweed exhibits a competitive release on sago pondweed, however, information on macrophyte competitive interaction seems to be lacking (Nichols & Shaw 1986). Other macrophytes were observed later in the season including muskgrass (*Chara spp.*), coontail, and slender naiad (Table 3). The shoreline of Schilling Lake primarily consisted of cattail with scarce instances of sedges (*Carex spp.*) during both survey times.

Table 3. The sample frequencies of all observed macrophyte species in Schilling Lake, Sibley Co., MN, during the early season and late season surveys. Mean species richness is the average richness per survey point. *Lemna trisulca* was observed, but not sampled in the early season survey. *Phragmites australis* was observed, but not sampled in the late season survey.

Species	Common name	Sample frequency (%)		p-value (n=144)
		Early season	Late season	
<i>Carex spp.</i>	true sedge	2.78	2.78	1.000 <sup>1</sup>
<i>Ceratophyllum demersum</i>	coontail		0.04	
<i>Chara spp.</i>	muskgrass		0.69	
<i>Lemna minor</i>	lesser duckweed	2.08	9.72	0.005 <sup>1</sup>
<i>Lemna trisulca</i>	star duckweed		0.69	
<i>Najas flexilis</i>	slender naiad		3.47	
<i>Phragmites australis</i>	common reed	0.69		
<i>Potamogeton crispus</i>	curly pondweed	44.44	13.89	<0.001 <sup>1</sup>
<i>Spirodela polyrhiza</i>	greater duckweed		2.78	
<i>Stuckenia pectinata</i>	sago pondweed	6.25	63.89	<0.001 <sup>1</sup>
<i>Typha spp.</i>	cattail	15.28	5.56	0.006 <sup>1</sup>
<i>Wolffia columbiana</i>	Columbian watermeal		1.39	
Native mean species richness		0.27	0.95	<0.001 <sup>2</sup>
Non-native mean species richness		0.44	0.14	<0.001 <sup>2</sup>
Total mean species richness		0.72	1.09	0.006 <sup>2</sup>

<sup>1</sup>Calculated using McNemar's chi square test

<sup>2</sup>Calculated using Wilcoxon signed rank test

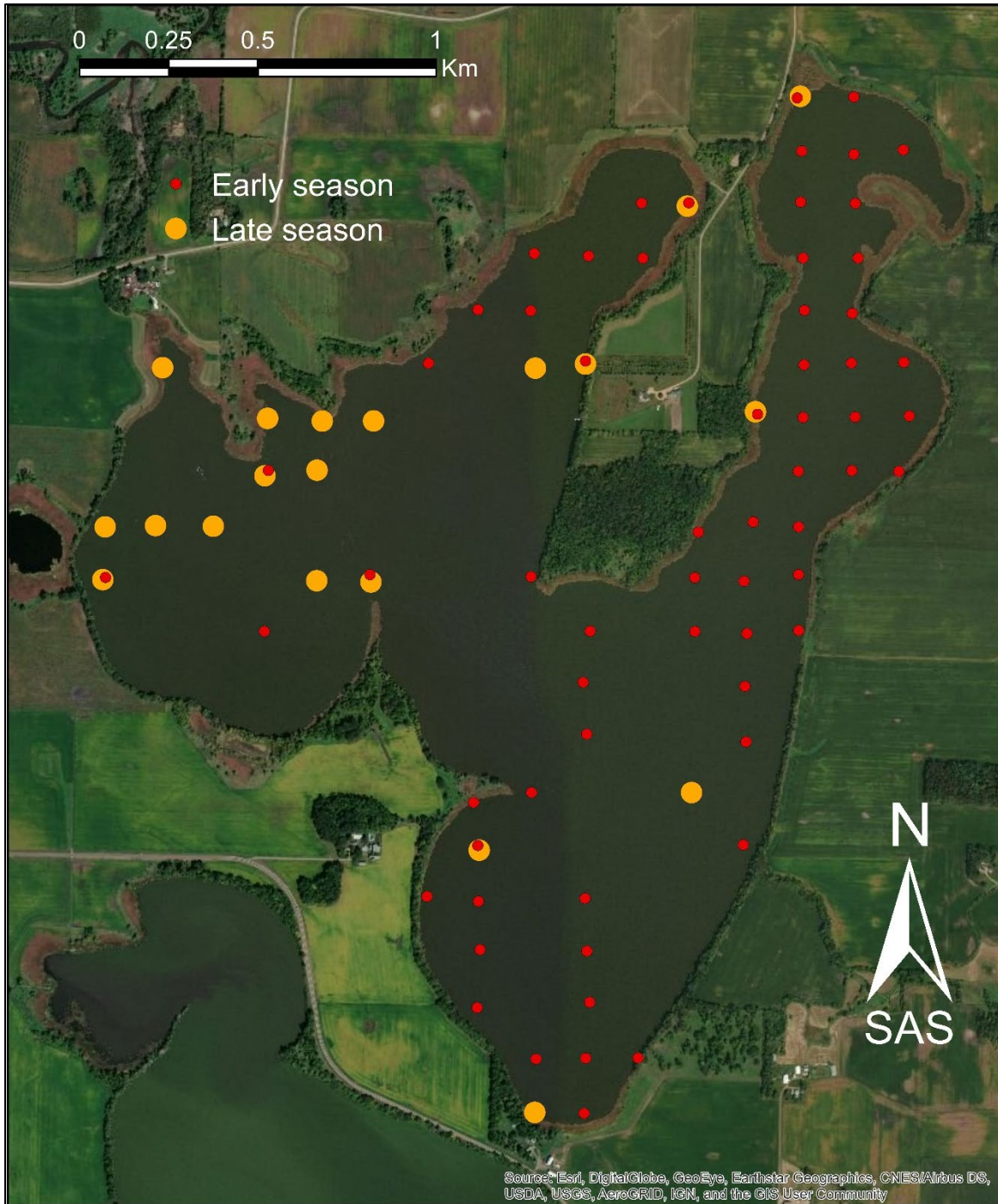


Figure 3. A map of the distribution of curly pondweed (*Potamogeton crispus*) in Schilling Lake, Sibley Co., MN, during the early season and late season surveys.

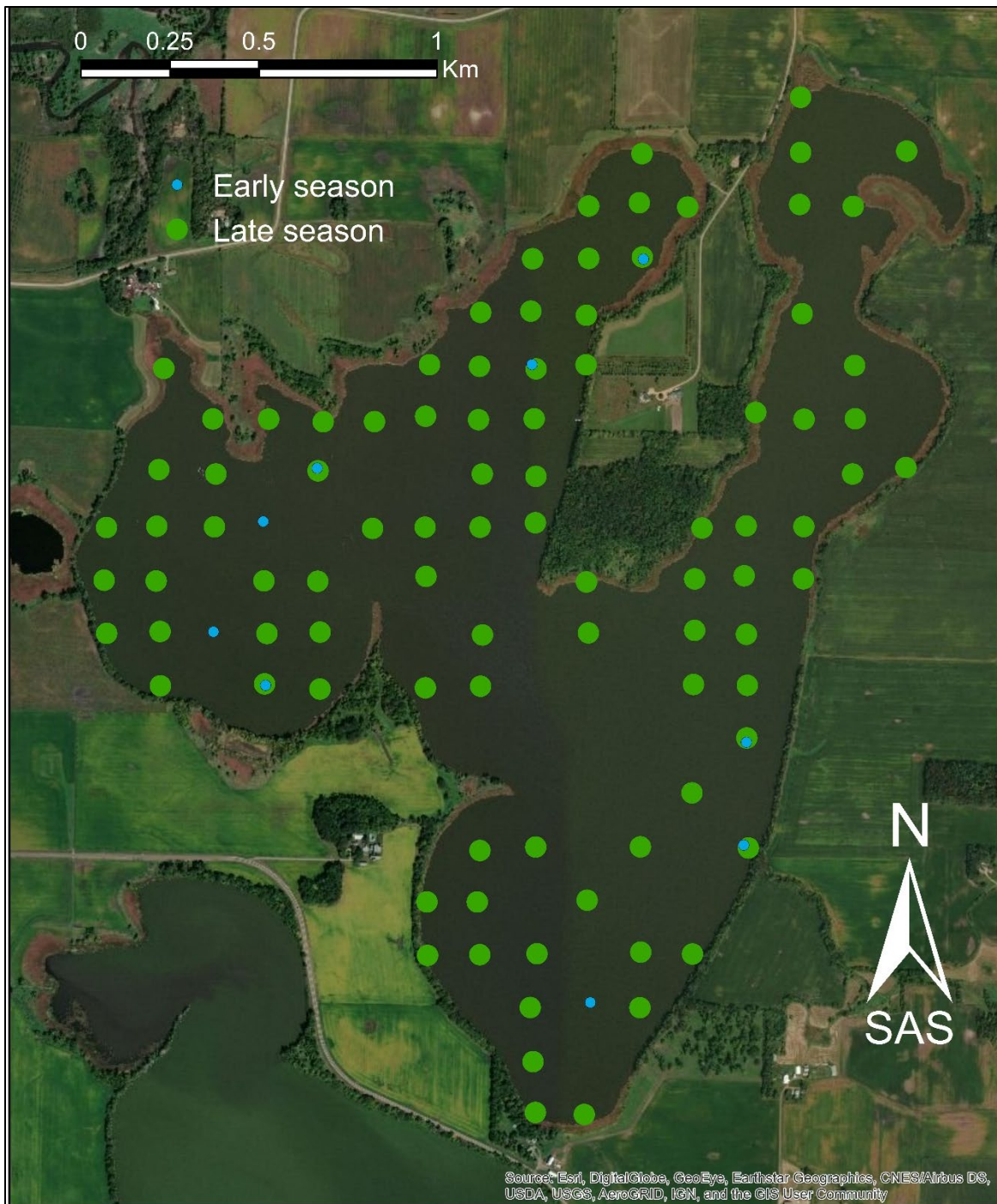


Figure 4. A map of the distribution of sago pondweed (*Stuckenia pectinata*) in Schilling Lake, Sibley Co., MN, during the early season and late season surveys.

## Silver Lake

Survey dates:

- Early season – June 25<sup>th</sup>
- Late season – September 22<sup>nd</sup>

Secchi: 10 cm

Average depth: 1.65 m

Silver Lake had the highest turbidity of all lakes surveyed. This was primarily driven by a dense algal bloom that persisted through the entirety of the 2019 growing season. During the late season surveys, there were no submersed macrophytes sampled in Silver Lake (Table 4). The dominant macrophytes in Silver Lake were white waterlily and cattail in both the early season and the late season (Table 4). For both species there was no significant change in abundance or distribution from the early season to late season (Table 4) (Figure 5). On the shoreline, there were also instances of sedges and broadleaf arrowhead in addition to the dense cattail (Table 4).

The macrophyte community of Silver Lake consisted primarily of emergent and floating-leaf macrophytes. There were little to no submersed macrophytes in Silver Lake. This lack of submersed plants is likely caused by the dense algal bloom, as submersed plants have been shown to decline in lakes that experience algal blooms (Bakker et al. 2010). Conversely, floating-leaf macrophytes are often found in highly turbid lakes as the floating leaves are not limited by light availability

Table 4. The sample frequencies of all observed macrophyte species in Silver Lake, Sibley Co., MN, during the early season and late season surveys. Mean species richness is the average richness per survey point. *Schoenoplectus acutus* was observed, but not sampled during the early season and late season surveys. *Carex hystericina*, and *Phragmites australis* were observed, but not sampled during the early season survey. *Carex spp.* was observed, but not sampled during the late season survey.

Species	Common name	Sample frequency (%)		p-value (n=116)
		Early season	Late season	
<i>Carex spp.</i>	true sedge	1.68		
<i>Lemna minor</i>	lesser duckweed	2.52	5.04	0.317 <sup>1</sup>
<i>Nymphaea odorata</i>	white waterlily	10.08	9.24	0.835 <sup>1</sup>
<i>Phragmites australis</i>	common reed		0.84	
<i>Sagittaria latifolia</i>	broadleaf arrowhead	0.84	0.84	1.000 <sup>1</sup>
<i>Stuckenia pectinata</i>	sago pondweed	8.40		
<i>Typha spp.</i>	cattail	6.72	4.20	0.405 <sup>1</sup>
Mean species richness		0.30	0.20	0.427 <sup>2</sup>

<sup>1</sup>Calculated using McNemar's chi square test

<sup>2</sup>Calculated using Wilcoxon signed rank test



Figure 5. A map of the distribution of white waterlily in Silver Lake, Sibley Co., MN, during the early season and late season surveys.

## Clear Lake

Survey date:

- Early season – June 28<sup>th</sup>
- Late season – September 23<sup>rd</sup>

Secchi: 29 cm

Average depth: 2.29 m

Clear lake was the deepest lake surveyed and also had low clarity. These two factors combined contributed to the low species richness through reduced light availability for plant growth. Additionally, there was an algal bloom during the late season survey which further exacerbated light attenuation in the water column. Sago pondweed was the dominant submersed plant sampled in this lake (Table 5). Curlyleaf pondweed was also observed, but not sampled, in the early season survey near the northwest boat landing. Curlyleaf pondweed was not included in the early season survey data because it was found between sample points. A second attempt was made to find the curlyleaf pondweed after the initial survey, but it has already senesced and living tissue could not be found. During the late season survey, curlyleaf pondweed was not observed. The majority of the shoreline of Clear Lake immediately transitioned to forest. The southwest arm of the lake was surrounded by cattail marsh and was where most of the emergent vegetation richness was aside from a few isolated patches of cattail.

Since curlyleaf pondweed was observed in Clear Lake during the early season survey, it is important to monitor its distribution, if it overwinters. Efforts to document the extent of the curlyleaf pondweed infestation should commence immediately in the spring of the following growing season. During this time, the curlyleaf biomass will be the greatest, and the most accurate distribution will be observed (Bolduan et al. 1994). Detection efforts should be directed near the northwest boat landing, where curly leaf pondweed was initially observed.

Table 5. The sample frequencies of all observed macrophyte species in Silver Lake, Sibley Co., MN, during the early season and late season surveys. Mean species richness is the average richness per survey point. *Typha spp.* was observed but not sampled during the early season and late season surveys. *Potamogeton crispus* was observed, but not sampled during the early season survey.

Species	Common name	Sample frequency (%)		p-value (n=90)
		Early season	Late season	
<i>Lemna minor</i>	lesser duckweed		1.11	
<i>Stuckenia pectinata</i>	sago pondweed	7.78		
Mean species richness		0.08	0.01	0.064 <sup>1</sup>

<sup>1</sup>Calculated using Wilcoxon signed rank test

## Literature Cited

- Bolduan BR, Van Eeckhout GC, Quade HW, Gannon JE. 1994. *Potamogeton crispus* – The Other Invader. *Lake Reserv Manag.* 10:113–125.
- Case ML, Madsen JD. 2004. Factors Limiting the Growth of *Stuckenia pectinata* (Sago Pondweed) in Heron Lake, Minnesota. *J Freshw Ecol.* 19:1:17–23.
- Engel S, Nichols SA. 1994. Aquatic Macrophyte Growth in a Turbid Windswept Lake. *J Freshw Ecol.* 9:97–109.
- Madsen JD, Wersal RM, Woolf TE. 2015. Operational control of Eurasian watermilfoil and impacts to the native submersed aquatic macrophyte community in Lake Pend Oreille, Idaho. *Invas. Plant Sci. Manage.* 8:219–232.
- Madsen JD, Wersal RM. 2017. A review of aquatic plant monitoring and assessment methods. *J Aquat Plant Manag.* 55:1–12.
- Madsen JD, Wersal RM. 2018. Proper survey methods for research of aquatic plant ecology and management. *J Aquat Plant Manag.* 56:90–96.
- Nichols SA, Shaw BH. 1986. Ecological life histories of the three aquatic nuisance plants, *Myriophyllum spicatum*, *Potamogeton crispus* and *Elodea canadensis*. *Hydrobiologia.* 131:3–21.
- Schuyler AE. 1984. Classification of Life Forms and Growth Forms of Aquatic Macrophytes. *Bartonia* 50:8–11.
- Simberloff D. 2003. How Much Information on Population Biology Is Needed to Manage Introduced Species? *Conserv Biol.* 17:83–92.
- Stokes ME, Davis CS, Koch GG. 2000. Categorical Data Analysis Using the SASH System. 2nd edn. Cary, NC: SAS Institute. 648 p
- Wersal R, Madsen J, McMillan B, Gerard P. 2006. Environmental factors affecting biomass and distribution of *Stuckenia pectinata* in the Heron Lake System, Minnesota, USA. *Wetlands.* 26:313–321.
- Wetzel RG. 2001. *Limnology Lake and River Ecosystems*. San Diego, CA, USA: Academic Press.