Minnesota Dept. of Natural Resources
Division of Fish and Wildlife
Section of Fisheries

Vegetation survey of North Center Lake (13-0032), Chisago County, Minnesota

Summer 2011

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Area Fisheries Supervisor Date

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Introduction

North Center Lake is a 725 acre lake located adjacent to the towns of Lindstrom and Center City, Minnesota, in the Sunrise River-Upper St. Croix River watershed. The lake has a maximum depth of 46 feet. 84% of the lake's surface area has a depth of less than 15 feet. The watershed of North Center Lake is relatively small compared to the lake's surface area (3:1 ratio) (Figure 2, Table 1). Land uses in the watershed include pasture/hayfield, deciduous forest, and developed land. The shoreline is highly developed, with 270 homes (22.3 homes/mile). North Center is a eutrophic lake and is currently classified as "impaired" under the Clean Water Act.

The Chisago chain of lakes, which also includes Chisago (13-0012), South Lindstrom (13-0028), North Lindstrom (13-0035), and South Center (13-0027), has a history of extreme water level fluctuations. In 2010 water levels were at 40 year lows; water levels rebounded by approximately two feet in the spring of 2011 but were still three feet below ordinary high water levels.

Historical information on aquatic vegetation in North Center Lake can be found in Fisheries lake surveys dating back to 1942. Various surveys list vegetation growing down to approximately 12 feet. However, methods were not standardized until the 1995 survey, so quantitative comparisons are not possible with earlier data. Point intercept vegetation surveys, as described by Madsen (1999) and the Minnesota Department of Natural Resources (2008), are becoming the standard for vegetation sampling in Minnesota lakes.

Eurasian watermilfoil (*Myriophyllum spicatum*), considered to be an invasive species, was first documented in North Center Lake in the spring of 2008. Eurasian watermilfoil can hybridize with native northern watermilfoil (Myriophyllum sibiricum), producing a plant with characteristics intermediate between the two species (Moody and Les 2002). Annual vegetation surveys on South Center Lake from 2008-2010 documented a rapid increase in the abundance of hybrid milfoil, and an overall increase in late summer plant cover since the discovery of Eurasian watermilfoil in the lake system (MN DNR 2011).

Curlyleaf pondweed, also considered to be an invasive species, has been present in North Center Lake since 1969 or earlier. Curlyleaf pondweed reaches its peak abundance in early summer, often forming extensive thick surface mats. When curlyleaf pondweed senesces in mid summer, nutrients are released than can contribute to algae blooms and decreased water clarity. However, studies on Minnesota lakes have shown that lakewide control of curlyleaf pondweed does not by itself result in increased water clarity or reduced phosphorus levels (MN DNR Invasive Species Program 2011).

Permits for nuisance control of aquatic vegetation have been issued annually on North Center Lake by the DNR Aquatic Plant Management program, which is administered by the Section of Fisheries. An average of eleven total acres of nearshore waters have been treated with herbicides each year over the last 20 years on North Center Lake (Figure 3). This amounts to slightly less than 2% of the lake's littoral area. Lakeshore owners are allowed to remove up to a 50 x 50 area of submerged vegetation by hand without a permit. Illegal use of herbicides may also occur, therefore the total area of vegetation removed each year is likely higher than permit totals indicate.

The goal of this survey was to document and characterize the aquatic vegetation community in North Center Lake.

Methods

A point intercept vegetation survey was conducted on several dates between June 13-20, 2011, using methodology described by Madsen (1999) and the Minnesota Department of Natural Resources (2008). Sample points were generated using ArcView GIS software to provide a density of approximately 0.7 points per acre in the portion of the lake with a depth of 15 feet or less (Figure 4). A Garmin GPSMap 298 GPS unit with color depth finder was used to navigate a boat to each sample point. Vegetation was observed on one side of the boat in an area approximately one meter square. A double headed garden rake was tossed once at each point to sample vegetation that could not be visually identified from the boat. Depth was measured with a stadia rod. The depth finder graph was used to determine the presence or absence of vegetation in deeper water.

Data was entered in the field on a laptop computer using the DNR Fisheries Lake Survey application.

Results and discussion

A total of 506 points were sampled, with depths ranging from 0.7-17.2 feet Figure 4). 476 points (94 percent) had rooted aquatic vegetation. Plants were found growing down to a depth of 12.1 feet; recent vegetation transect surveys done in 1995 and 2005 found vegetation at maximum depths of 9 and 5.5 feet, respectively. Seven species of submerged vegetation were recorded, with five species of floating leaf and ten species of emergent vegetation (Table 3).

Hybrid watermilfoil was the most abundant species, occurring at 71 percent of sample points (Table 3, figure 5). Eurasian and northern watermilfoil were also recorded in this survey. The main criteria for identification of hybrid watermilfoil included having approximately 12 leaflet pairs on leaves, and having larger, more rigid leaves with longer gaps between leaflet pairs than classic Eurasian watermilfoil (Figure 6). However, considerable field experience and familiarity with all three forms of milfoil is necessary to make these distinctions, particularly between northern and hybrid watermilfoil. It is suspected that the prevalence of northern watermilfoil may be overestimated in surveys when these two forms are present (Ray Valley, pers. comm.) Recent low water levels could have been a factor in the rapid colonization by hybrid watermilfoil; areas of lake bottom that were normally beyond the plant growth zone were in more shallow water, and there was no competition from rooted vegetation in these areas. Smith and Barko (1990) noted that periods of drought and low water levels provide ideal conditions for the expansion of Eurasian watermilfoil.

Curlyleaf pondweed was nearly as widespread as hybrid watermilfoil (Figure 7). Monitoring on nearby South Center Lake has shown a trend of reduced curlyleaf pondweed frequency of occurrence from 2008-2011 (MN DNR SLICE program, unpublished data). Heavy winter snow cover was suggested as a reason for the decline, although competition from hybrid watermilfoil could be a factor.

The only native submerged aquatic vegetation species besides northern watermilfoil that occurred at over 1% of sample points was coontail (common hornwort). This species is considered tolerant of impaired water quality.

The relative health of a lake ecosystem can be assessed using measurements of plant or animal communities. A plant-based index of biotic integrity (IBI) was recently developed for Minnesota lakes (Beck et al. 2010). This index derives a numerical score from various aspects of point intercept survey data including maximum depth of plant growth, relative frequency of sensitive and tolerant species, and other factors (Table 3). Scores are on a scale of 0-100, with higher numbers indicating better condition of the plant community. The IBI score for North Center Lake, 43, was lower than the mean score (52.6) of the 97 lakes throughout Minnesota that were used to develop the plant IBI. More widespread use of the plant-based IBI will be required before detailed comparisons can be made.

Emergent vegetation was common in points with depths of less than 3 feet (Figure 8, Table 3). The abundance of emergent vegetation was probably due to rising water levels inundating areas that had been exposed for several years. Emergent vegetation provides important habitat for wildlife, fish and invertebrates, as well as providing protection from shoreline erosion (Radomski and Goeman 2001). The regeneration of emergent vegetation stands on North Center Lake should provide long term ecological benefits to the lake. However, heavy boating activity and landscaping practices above the high water level can be detrimental to emergent vegetation stands. Lakeshore property owners are encouraged to use natural landscaping practices and minimize disturbance to aquatic vegetation. During low water levels, any disturbance to exposed lake bed such as tilling or raking is considered excavation and is subject to state laws governing lake bed alterations and plant removal.

The extensive surface growth of hybrid watermilfoil on North Center Lake will likely raise questions about treatment options. Once Eurasian or hybrid watermilfoil is established in a lake, eradication has not proven to be a realistic goal. Whole-lake treatments to reduce the abundance of milfoil have been studied by the DNR (Invasive Species Program 2011). These treatments, usually done with the herbicide fluridone, have produced mixed results. In eutrophic lakes dominated by one or two invasive species, whole lake treatments that target these species can lead to large declines in total plant abundance and water clarity (Valley et al. 2004). From a lake ecosystem standpoint, abundant vegetation is more desirable than little or no vegetation. In addition, there is little evidence that introductions of Eurasian watermilfoil or curlyleaf pondweed will lead to dramatic declines in fisheries (Valley et al. 2004). A less risky option for management of hybrid watermilfoil and/or curlyleaf pondweed would be to selectively treat areas where heavy plant growth is hindering reasonable recreational use of the lake.

It is likely that hybrid milfoil abundance will decline over time whether or not control efforts take place. In many lakes where Eurasian watermilfoil infestations have been studied, milfoil quickly dominates the plant community but begins to decline in 5-10 years (Smith and Barko 1990). As water levels rise back to normal on North Center Lake, large areas where hybrid milfoil is currently growing may be too deep to support plant growth. Implementation of practices to reduce nutrient loading, as a result of the Total Maximum Daily Load (TMDL) study, may help to restore a more diverse native plant community in North Center Lake.

References

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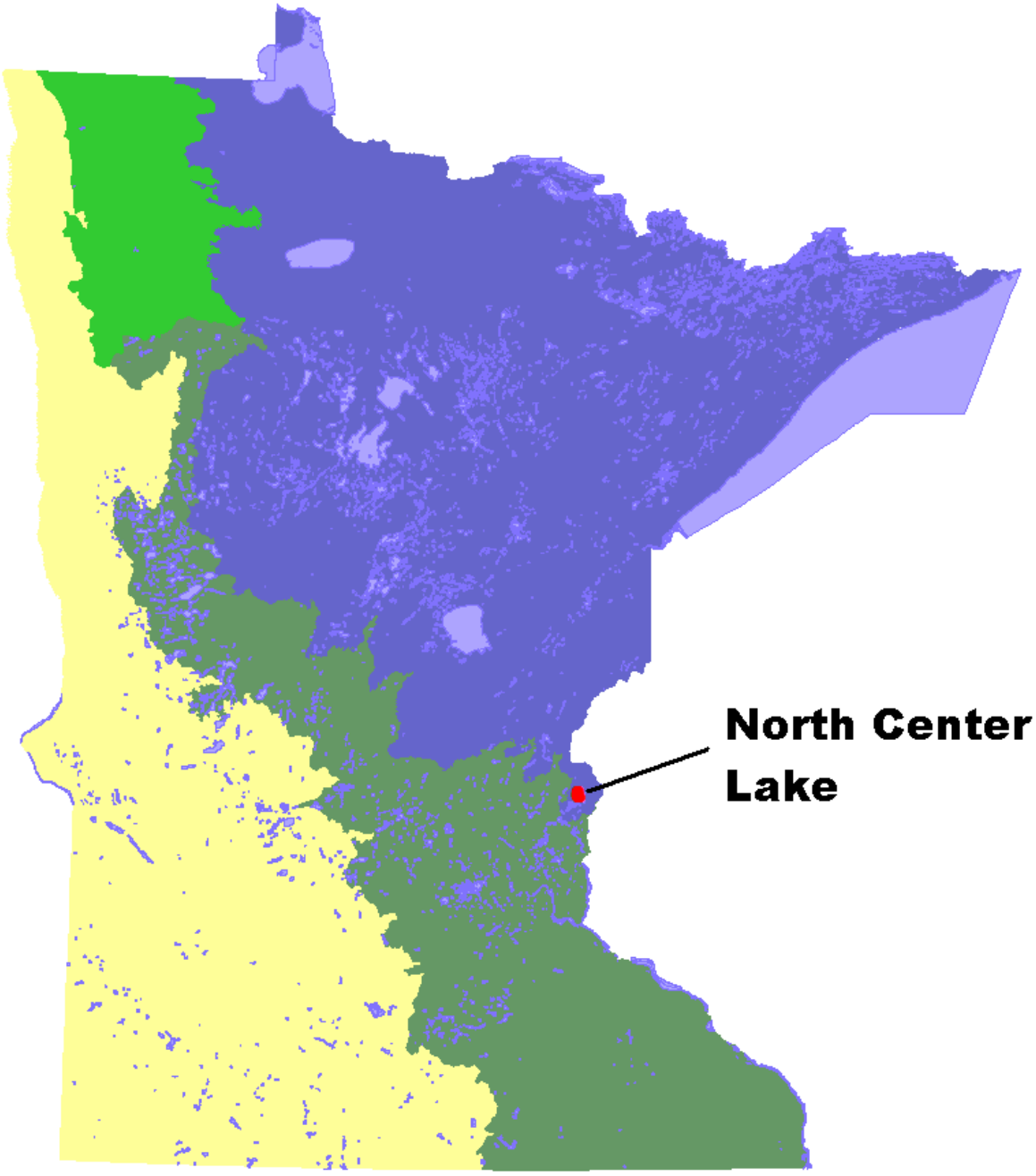

Figure 1. Location of North Center Lake, Chisago County, Minnesota.

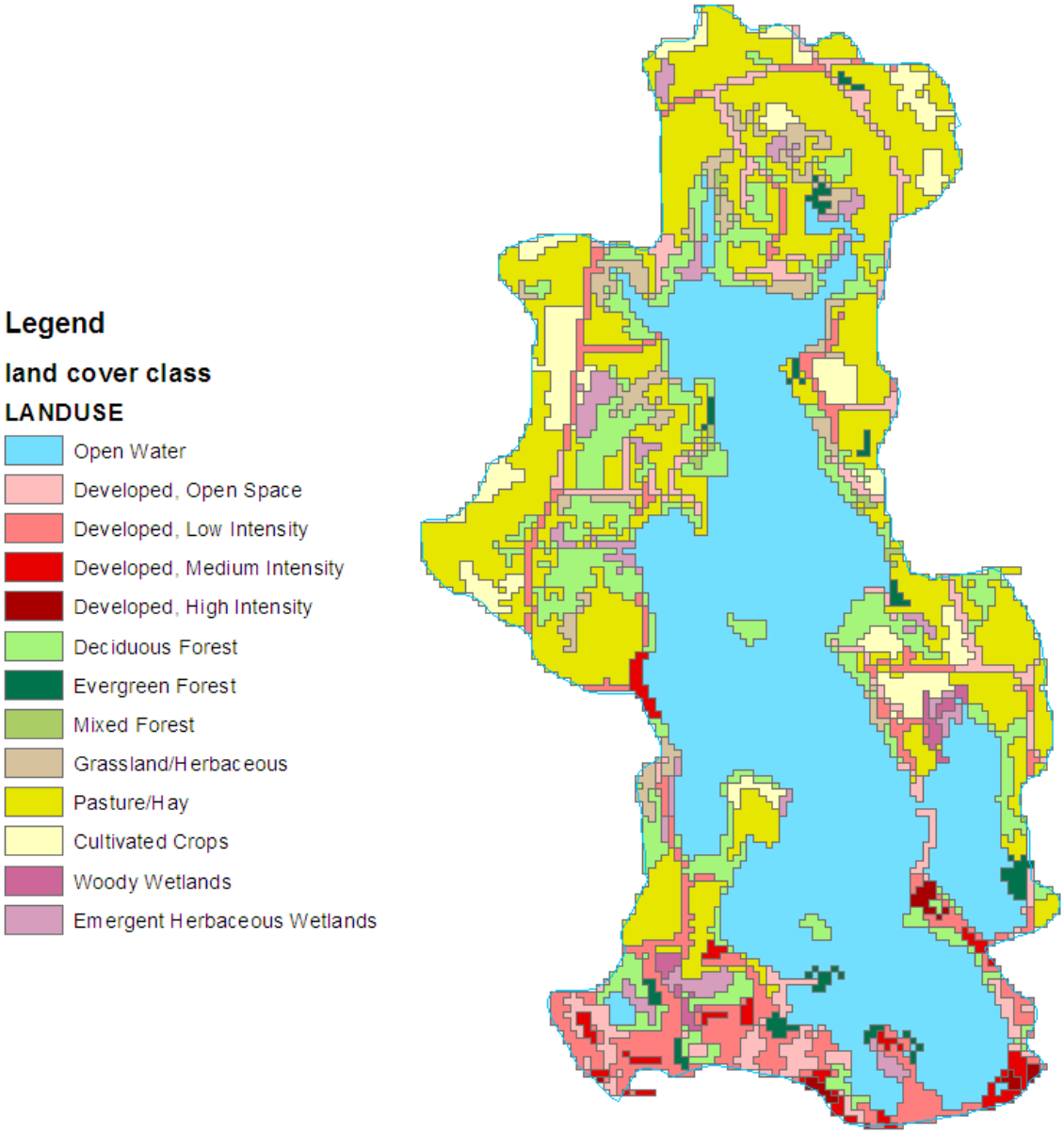

Figure 2. Land cover types in the North Center Lake watershed

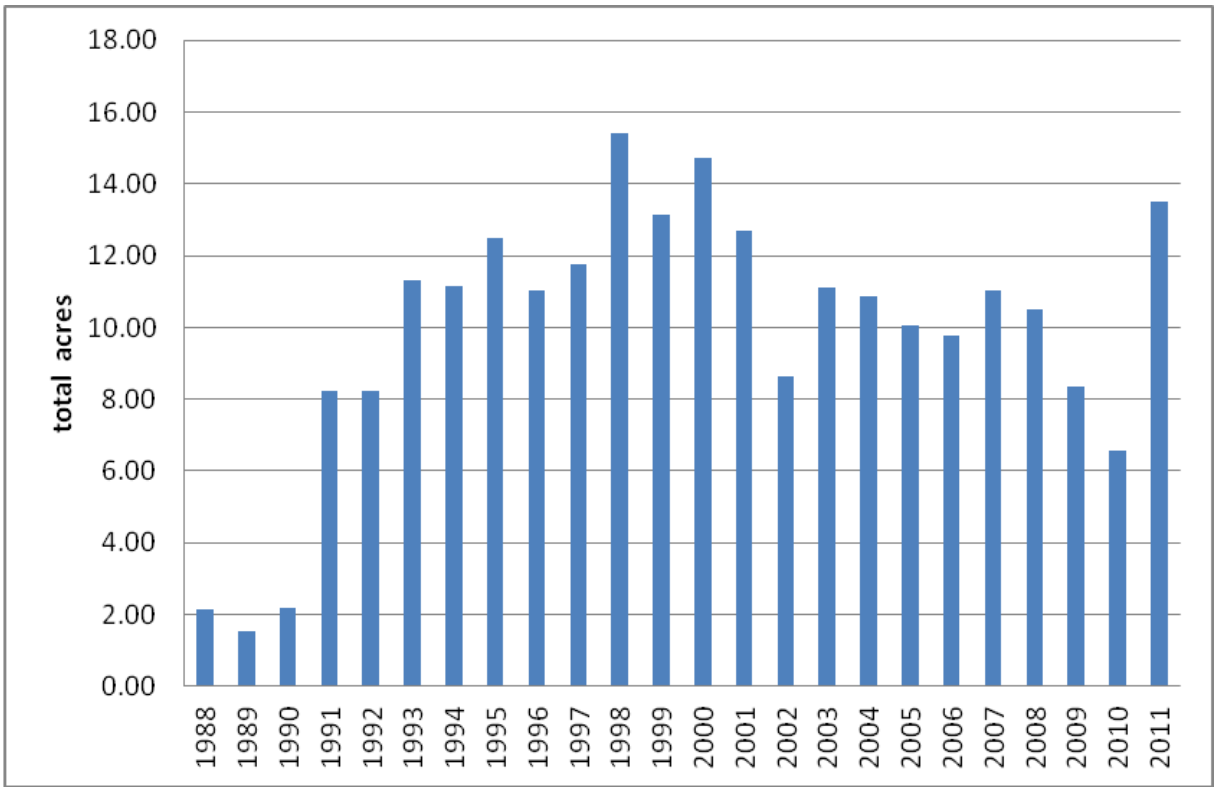

Figure 3. Total area permitted for chemical control of aquatic vegetation in North Center Lake, 1988-2011.

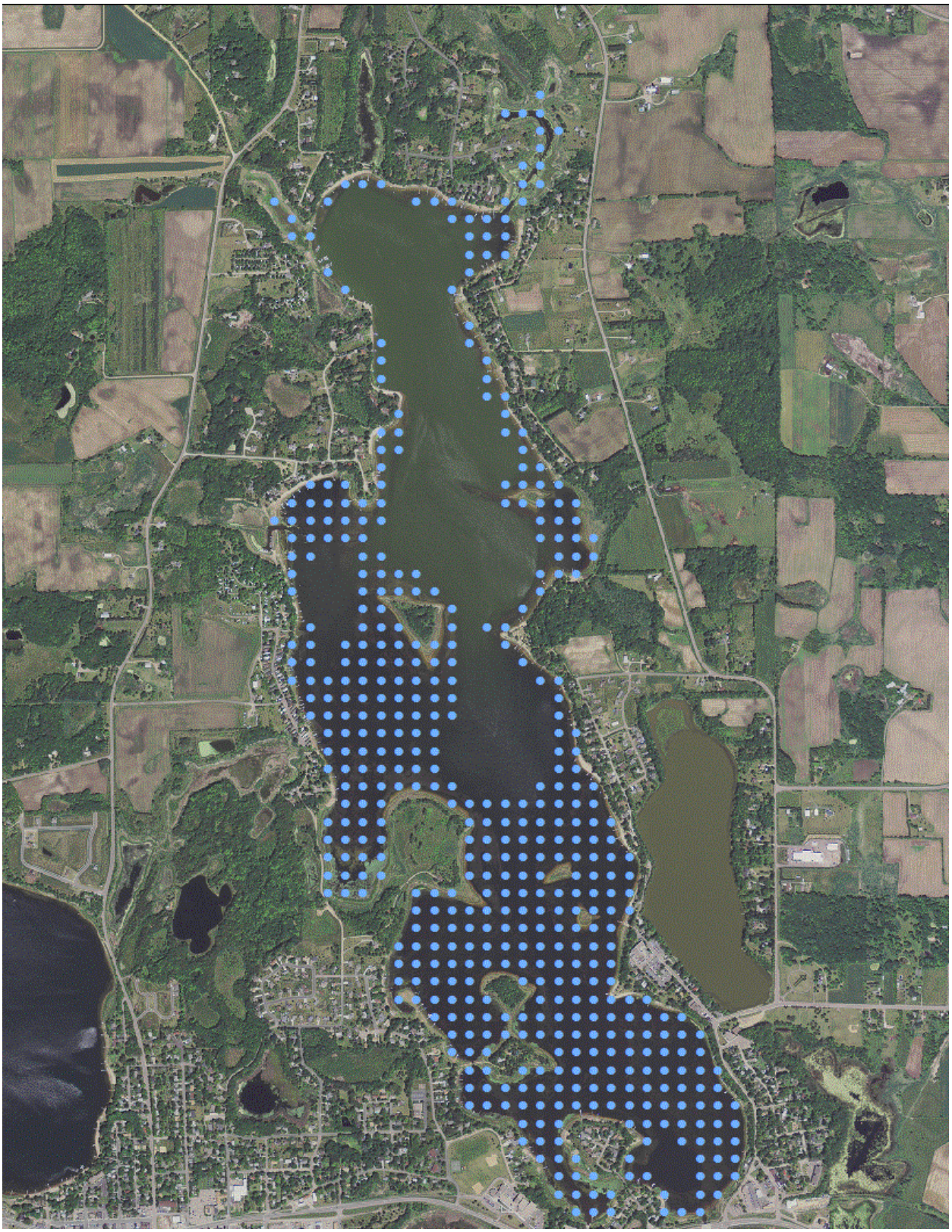

Figure 4. Grid of points that were sampled during the vegetation survey on North Center Lake. (2010 aerial photo)

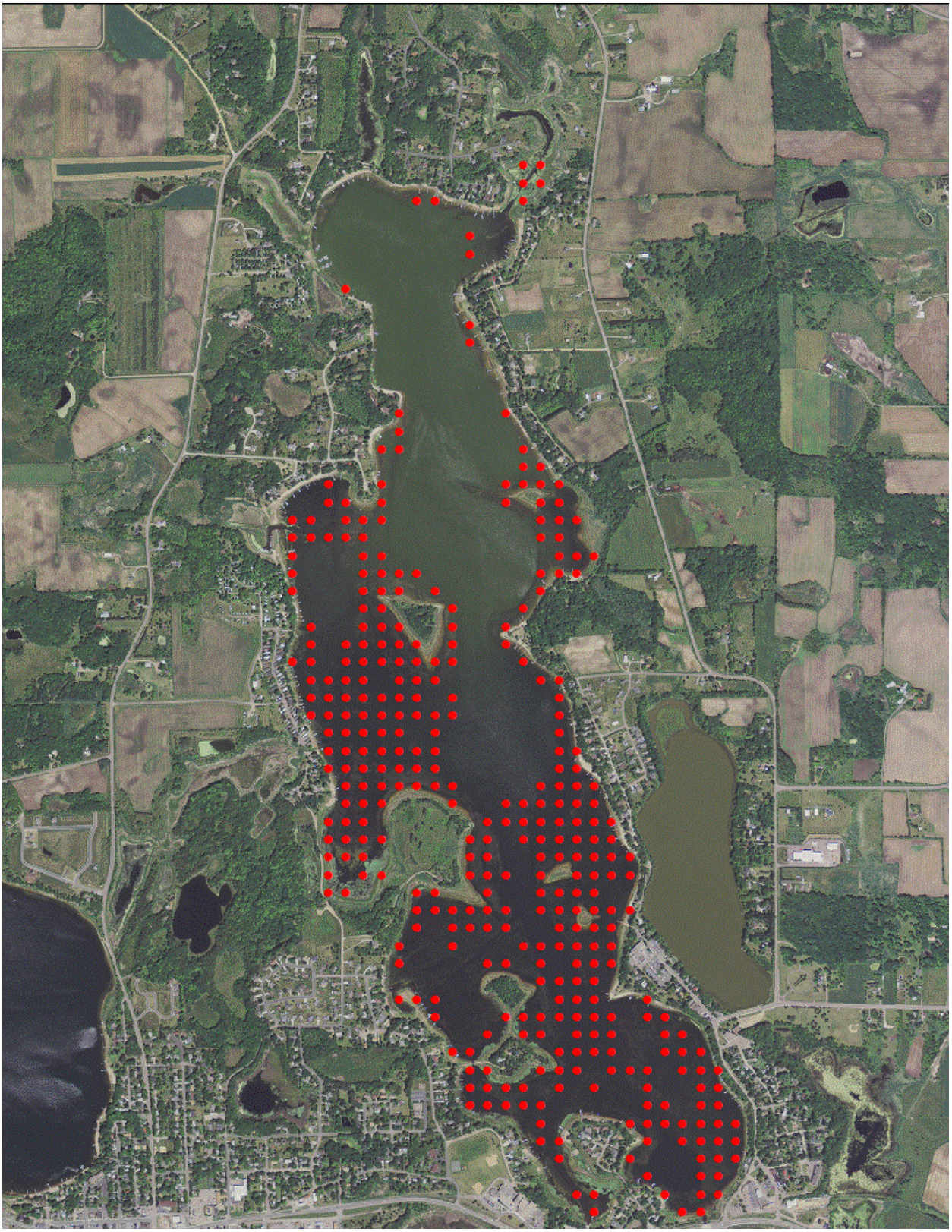

Figure 5. Points where hybrid milfoil was sampled in 2011.

Figure 6. Hybrid watermilfoil (top photo) compared with Eurasian watermilfoil (bottom photo)

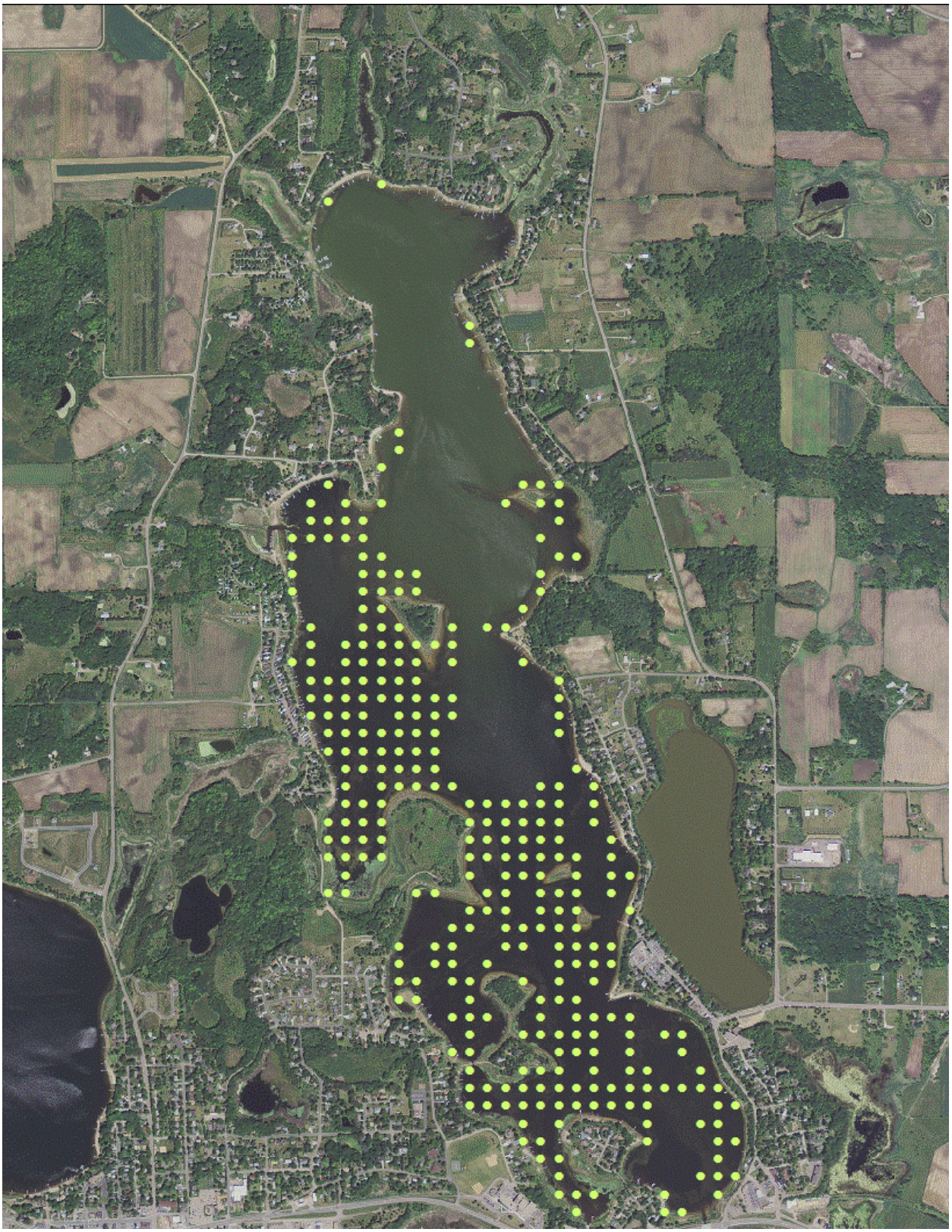

Figure 7. Points where curlyleaf pondweed was sampled in 2011.

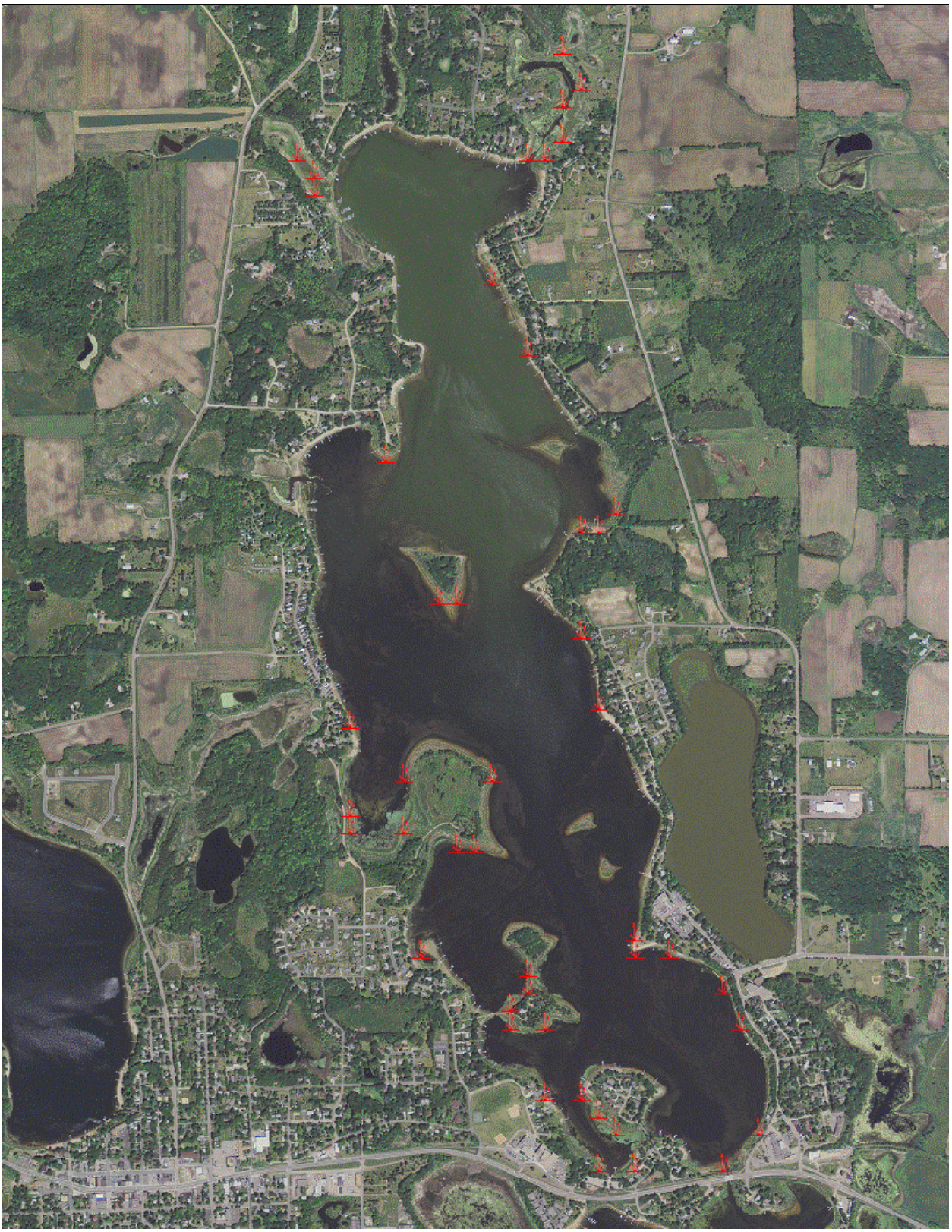

Figure 8. Shoreline points (<3 feet depth) where emergent vegetation was present in 2011.

Table 1. Land cover types within the North Center Lake watershed. From National Land Cover Database, 2006.

Land cover type	Area, acres	Percentage of watershed
Open water	835.29	38.6
Pasture/hay	562.17	26.0
Deciduous forest	222.95	10.3
Developed, low intensity	142.43	6.6
Cultivated crops	107.39	5.0
Developed, open space	103.47	4.8
Grassland/herbaceous	62.66	2.9
Emergent herbaceous wetlands	51.54	2.4
Developed, medium intensity	26.89	1.2
Evergreen forest	22.87	1.1
Woody wetlands	11.55	0.5
Developed, high intensity	8.21	0.4
Mixed forest	6.43	0.3
Total area, acres	2163.85	

Table 2. List of aquatic plant species that have been recorded in North Center Lake

Common name	Scientific name	Survey years
Emergent species (11 total)		
Broad leaved arrowhead	*Sagittaria latifolia*	D, E, F, G, I
Cattail	*Typha sp.*	A, B, C, D, E, F, G, I
Giant burreed	*Sparganium eurycarpum*	F, G, I
Hardstem bulrush	*Schoenoplectus acutus*	B, C, D, E, F, G, I
River bulrush	*Scirpus fluviatilis*	I
Rushes	*Juncus sp.*	F
Sedge	*Carex or Cyperaceae*	F, G, I
Sessile-fruited arrowhead (stiff wapato)	*Sagittaria rigida*	E
Softstem bulrush	*Schoenoplectus tabernaemontanii*	B, C, D, F, I
Spikerush	*Eleocharis palustris*	I
Water arum	*Calla palustris*	E
Water smartweed	*Polygonum amphibium*	D, E, F, G
Wild rice	*Zizania palustris*	I
Wool grass	*Scirpus cyperinus*	F
Submerged and floating leaf species (24 total)		
Bushy pondweed	*Najas flexilis*	F, G
Canada waterweed	*Elodea canadensis*	A, B, C, F, G, I
Claspingleaf pondweed	*Potamogeton Richardsonii*	C, D, E, F, G
Coontail	*Ceratophyllum demersum*	A, D, E, F, G, I
Curlyleaf pondweed	*Potamogeton crispus*	C, D, E, G, I
Eurasian watermilfoil	*Myriophyllum spicatum*	H, I
Filamentous algae		F, G
Flatstem pondweed	*Potamogeton zosteriformis*	A, E, F, G, I
Floatingleaf burreed	*Sparganium fluctuans*	I
Floatingleaf pondweed	*Potamogeton natans*	C, D
Greater duckweed	*Spirodela polyrhiza*	D, E, F
Hybrid watermilfoil	*Myriophyllum sp.*	I
Largeleaf pondweed	*Potamogeton amplifolius*	A, C
Leafy pondweed	*Potamogeton foliosus*	F, G
Lesser duckweed	*Lemna minor*	D, F, G, I
Mud plantain (water stargrass)	*Zosterella dubia*	A
Northern watermilfoil	*Myriophyllum sibiricum (exalbescens)*	A, D, E, F, G, I
Pondweed (unspecified)	*Potamogeton sp.*	B
Robbins' pondweed	*Potamogeton Robbinsii*	G
Sago pondweed	*Stuckenia pectinata*	D, E
Stonewort	*Nitella sp.*	A
Water meal	*Wolffia sp.*	F, I
Water shield	*Brasenia schreberi*	A
White waterlily	*Nymphaea tuberosa*	A, B, C, D, E, F, G, I
Whitestem pondweed	*Potamogeton praelongus*	A
Wild celery	*Vallisneria americana*	B, C, F
Yellow waterlily	*Nuphar variegatum*	A, B, C, D, E, F, G, I

A) 1942 Fisheries lake survey; B) 1956 Fisheries lake survey; C) 1969 Fisheries lake survey; D) 1976 Fisheries lake survey; E) 1985 Fisheries lake survey; F) 1995 Fisheries lake survey; G) 2005 Fisheries lake survey; H) 2008 DNR Invasive Species Program investigation; I) 2011 Fisheries vegetation point intercept survey

Table 3. Aquatic plants found in North Center Lake during the 2011 survey

type	Common name	Scientific name	Frequency (%)
submerged	hybrid watermilfoil	*Myriophyllum sp.*	71.4
	curlyleaf pondweed	*Potamogeton crispus*	64.2
	coontail	*Ceratophyllum demersum*	39.0
	northern watermilfoil	*Myriophyllum sibiricum*	13.4
	Eurasian watermilfoil	*Myriophyllum spicatum*	2.4
	Canada waterweed	*Elodea canadensis*	0.6
	flatstem pondweed	*Potamogeton zosteriformis*	0.2
floating leaf	lesser duckweed	*Lemna minor*	5.4
	white waterlily	*Nymphaea sp.*	5.4
	yellow waterlily	*Nuphar variegatum*	1.6
	water meal	*Wolffia sp.*	1.0
	floatingleaf burreed	*Sparganium fluctuans*	0.2
emergent	cattail	*Typha sp.*	5.0
	spikerush	*Eleocharis palustris*	3.0
	giant burreed	*Sparganium eurycarpum*	3.0
	grasses		2.8
	softstem bulrush	*Schoenoplectus tabernaemontanii*	2.2
	river bulrush	*Scirpus fluviatilis*	1.0
	broad leaved arrowhead	*Sagittaria latifolia*	0.8
	sedge	*Carex sp.*	0.4
	hardstem bulrush	*Schoenoplectus acutus*	0.4
	wild rice	*Zizania palustris*	0.2
	all emergents		9.1
	emergents < 3 ft depth		82.6

average species diversity at points = 2.3 (range = 0-8)
maximum depth of plant growth = 12.1 feet

Table 4. Plant-based Index of Biotic Integrity (IBI) metrics and scores for North Center Lake, 2011.

Metric	Raw score	Scaled score
Maximum depth of plant growth (ft), 95% occurrence	11.2	5.74
Percentage of littoral vegetated	0.949686	9.5
Number of species with frequency occurrence >10%	4	3.28
Relative frequency of submersed species	0.855098	4.26
Relative frequency of sensitive species	0.000894	0.04
Relative frequency of tolerant species	0.813953	1.37
Number of native taxa	19	5.88
	IBI score (0-100)	42.96