
Aquatic Vegetation of George Lake

July and September, 2013

George Lake, ID# 02-0091-00

Anoka County, Minnesota

Bulrush stands along the shoreline of George Lake, July, 2013.



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SUMMARY

Aquatic and shore vegetation surveys of George Lake (02-0091-00), Anoka County, Minnesota, were conducted in July and September of 2013. Three lake habitat zones were assessed: the shore, the nearshore, and the in-lake plant communities. Surveys included characterization of shore habitat and near-shore plant communities at 27 sites, delineation of all emergent and floating-leaf plant stands, and quantitative assessments of submerged plant communities at 258 sample stations within the shore to 15 feet depth.

The majority (67%) of George Lake shore sites were classified as developed. On a scale of 0 to 100, the mean lakewide shore habitat score was 50.5, indicating that about half of the shore habitat has been lost. Most developed sites had few or no remaining trees, shrubs and/or natural ground cover compared to undeveloped sites where these plants were present along the entire shore frontage.

Aquatic plants were evenly distributed around the perimeter of George Lake and 67% of all in-lake sample sites contained vegetation. Forty-one aquatic plant taxa were found including 10 emergent, four floating-leaved, three free-floating and 24 submerged taxa.

Emergent and floating-leaved plants occurred in shallow water (0-5 feet deep) and occupied 27 acres, or 11%, of that depth zone. Approximately 12 acres of bulrush (*Schoenoplectus* sp.), 10 acres of arrowhead (*Sagittaria* sp.) and 4.5 acres of cattails (*Typha* sp.) were delineated. Non-native plants found along shore included Kentucky bluegrass (*Poa pratensis*), reed canary grass (*Phalaris* sp.), and purple loosestrife (*Lythrum salicaria*).

Submerged plants were found to a maximum depth of 14 feet but were most frequent in depths from shore to 10 feet, where 79% of the sites contained at least one submerged taxon. Within the shore to 15 feet zone, the most common submerged plants were native: muskgrass (*Chara* sp.) (32% occurrence), coontail (*Ceratophyllum demersum*) (20%), naiads (*Najas flexilis* and *N. guadalupensis*) (18%), and Robbin's pondweed (*Potamogeton robbinsii*) (12%). Two non-native aquatic plant species; curly-leaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*) were found growing in the lake but they occurred in less than 11% of sites.

Near shore sites contained highest diversity and sites of high richness (6 or more taxa per site) often occurred in depths less than 10 feet and included sites where emergent, floating-leaf and submerged plants co-occurred. All of the plant taxa found in the lake occurred in this shallow zone and 71% were only found in this depth zone.

The abundance and diversity of submerged plants, and the stands of emergent and floating-leaf plants help maintain high water clarity and provide critical habitat for fish and wildlife in this lake.

INTRODUCTION

LAKE LOCATION AND CHARACTERISTICS

George Lake is located in the Eastern Broad-leaf Forest Province of central Minnesota, south of the town of St. Francis in Anoka County ([Map 1](#)). This region of the state is characterized by broad areas of mixed hardwood forests, and conifer bogs and swamps with numerous glacial lakes. The lake lies within the southern half of the Rum River Watershed. There are no inlets to George Lake and it outflows from the southeast where an unnamed stream flows into County Ditch 19 ([Map 1](#)). County Ditch 19 then flows west and connects with the Rum River.

With a surface area of 488 acres, George Lake is the 9th largest lake in Anoka County and the 12th largest lake in the watershed. The lake has a round outline and three miles of shoreline. Most of the shoreline is developed with residential homes. Parts of the north shore are undeveloped where the City of St. Francis manages a park with a swim beach and the State of Minnesota maintains a public access ([Map 2](#)).

George Lake has a maximum depth of 32 feet but about 80% of the lake is 15 feet or less in depth ([Map 2](#)). The lake is a hard water lake and is characterized as mesotrophic, based on phosphorus (nutrients), chlorophyll-a (algae concentration) and Secchi depth (transparency). The 2001 to 2013 mean summer water clarity was six feet (MPCA 2014). Based on Secchi disk measurements alone, aquatic plants have the potential to reach depths of about 15 feet in the lake. Other factors that may influence the depth of plant growth include substrate, wind fetch and the types of plants present.

HISTORICAL AQUATIC PLANT COMMUNITY

Eight previous aquatic plant surveys of George Lake were conducted between 1925 and 2007 (MNDNR Lake files). These surveys varied in methods; the earliest surveys focused on the commonly occurring in-lake plants while the 2007 survey included a detailed listing of any plant taxa encountered by an experienced botanist. The areas of the lake surveyed and the surveyor's botanical experience influence the number and types of plants detected in each survey. Data from these surveys were compiled and compared to recent data collected in 2013.

2013 SURVEY OBJECTIVES

The 2013 surveys assessed three habitat zones of George Lake: shore, the near-shore area, and the lakewide plant community. Specific objectives included:

1. Estimate the remaining shore habitat on a scale of 0 to 100.
2. Describe the types and general distribution of plants in the lake.
3. Describe and map the emergent and floating-leaf plant stands.
4. Estimate the abundance of aquatic plants by estimating the frequency of occurrence of all plants and each taxon within the vegetated zone.

METHODS

In 2013, four different methods were used to survey the different plant and habitat zones of George Lake.

SHORE HABITAT ASSESSMENT

The shore habitat of George Lake was assessed using the “Score the Shore” method (MNDNR 2015). Survey sites were established every 200 meters along the shoreline and corresponded to the nearshore aquatic plant survey sites ([Map 3](#)). Surveys were conducted on June 6 by boat and at each site; surveyors visually assessed 100 feet of shoreline. Habitat features were assessed in the Shoreland, Shoreline and Aquatic zones and included tree cover, shrub cover, natural ground cover, overhanging vegetation, and woody habitat. Disturbance to habitat was assessed by noting the presence of artificial openings in aquatic plant stands and the presence of human structures such as docks. Sites with a high percentage of tree, shrub and natural ground cover and with little or no human disturbance receive higher scores than sites where vegetation has been removed.

MAPPING FLOATING-LEAF AND EMERGENT VEGETATION STANDS

Mapping focused on emergent and floating-leaf plant stands that were at least 0.01 acres, or about 400 square feet, in size (generally larger than the surface area covered by a pontoon boat). Field surveys were conducted September 12, 2013. Surveyors motored or waded around the perimeter of each stand and recorded a track with a handheld Global Positioning System (GPS) unit. Field data were uploaded to a computer and a Geographic Information System (GIS) software program was used to estimate acreage. Plant stands were classified by the dominant taxa (Table 1).

Class	Dominant Taxa
Rushes	Bulrush (<i>Schoenoplectus</i>) or Spikerush (<i>Eleocharis</i>)
Rushes and other	Bulrush (<i>Schoenoplectus</i>) or Spikerush (<i>Eleocharis</i>) and other common taxa
Waterlilies	White waterlily (<i>Nymphaea</i>) or Yellow waterlily (<i>Nuphar</i>)
Waterlilies and other	White waterlily (<i>Nymphaea</i>) or Yellow waterlily (<i>Nuphar</i>) and other common taxa
Cattail	<i>Typha</i> spp.
Other emergent	Ex. arrowhead (<i>Sagittaria</i>), common reed grass (<i>Phragmites</i>)

2013 LAKEWIDE VEGETATION SURVEY (POINT INTERCEPT)

A lakewide vegetation survey was conducted on July 11, 15-17, 2013 using a point-intercept survey method (Madsen 1999, MNDNR 2015). Survey waypoints were created using a geographic information system (GIS) computer program and downloaded into a handheld geographic positioning system (GPS unit). Sampling was stratified by water depth and an effort was made to sample 50 to 100 sites in each stratum (Table 2). Survey points were placed in a grid pattern and point spacing varied between strata. In the 0 to 5 feet stratum, points were spaced 80 meters apart; in deeper strata points were spaced 65 meters (213 feet) ([Map 3](#)). The depth contours from the 1956 survey were used to determine approximate depth strata

locations; the water depth at any given site may have been different than what is shown on that historical map.

The survey was conducted by boat and a GPS unit was used to navigate to each sample point. One side of the boat was designated as the sampling area. At each site, water depth was recorded in one-foot increments using a measured stick in water depths less than seven feet and an electronic depth finder in deeper water.

Preliminary sampling detected no vegetation in water depths greater than 15 feet. Surveyors attempted to sample all sites in water depths less than 16 feet for a total of 258 samples in that zone (Table 2). Surveyors did not sample sites that occurred within the City swim beach or an area of the lake that had recently posted as no entry following an herbicide application for Eurasian watermilfoil ([Map 5](#)).

Table 2. Survey effort by depth

Water depth (feet)	Number of survey sites
0 to 5	92
6 to 10	114
11 to 15	52
Total	258
16-20	7

SUBSTRATE SAMPLING

At each sample site where water depths were seven feet and less, surveyors described the bottom substrate using standard substrate classes (Table 3). Surveyors evaluated substrate by tapping a pole into the lake bottom; soft substrate could usually be brought to the surface on the pole or sampling rake for evaluation. If this method was not feasible, substrate was evaluated by visual observation of the lake bottom. If more than one substrate type was found, surveyors recorded the most common type. Surveyors attempted to record a substrate description around the entire perimeter of the lake. If a sample site occurred near shore but in water depths greater than seven feet, surveyors collected depth and vegetation data and then motored into shallower water and recorded the substrate type adjacent to the actual survey point; this information was used for mapping purposes.

Table 3. Substrate classes

muck	decomposed organic material
marl	calcareous material
silt	fine material with little grittiness
sand	diameter < 1/8 inch
gravel	diameter 1/8 - 3 inches
rubble	diameter 3 - 10 inches
boulder	diameter > 10 inches

PLANT SAMPLING

Surveyors recorded all plant taxa found at each sample site (approximately a one square meter sample site at the pre-designated side of the boat). A double-headed, weighted garden rake, attached to a rope was used to survey vegetation not visible from the water surface (Photo 1). Any additional plant taxa found outside of sample sites were recorded as “present” in the lake but these data were not used in frequency of occurrence calculations. Plant identification followed Crow and Hellquist (2000) and Flora of North America (1993+) and nomenclature followed MnTaxa (2013). Frequency of occurrence was calculated for the entire vegetated zone (0-15 feet) and data were also separated into five feet increment

Photo 1. Survey rake.



depth zones for analysis (Table 1). Frequency estimates were also calculated for individual taxa and selected groups of plants.

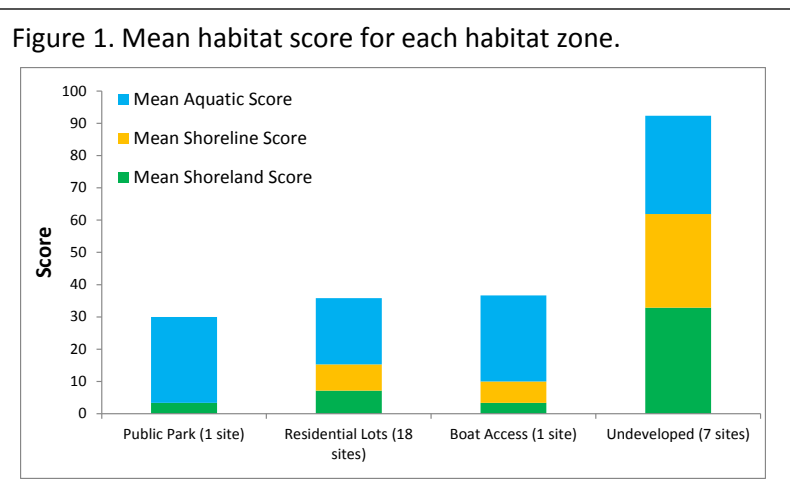
2013 NEAR-SHORE PLANT COMMUNITY ASSESSMENTS (PLOTS)

Because the point intercept method may under sample near-shore plant zone, additional surveys were conducted at the shore-water interface (or near-shore) zone of George Lake. Survey waypoints were created using a GIS computer program. Sample sites were spaced 200 meters apart along the shoreline for a total of 27 sites ([Map 3](#)). At each site, surveyors sampled a plot area measuring approximately 5 meters along the shore and extending 5 meters lakeward. Surveyors waded through the plot and recorded all plant taxa observed; view tubes were used to aid in visual observation of plants. Water depth at the center of the plot was recorded and substrate was described using classes in Table 3.

RESULTS AND DISCUSSION

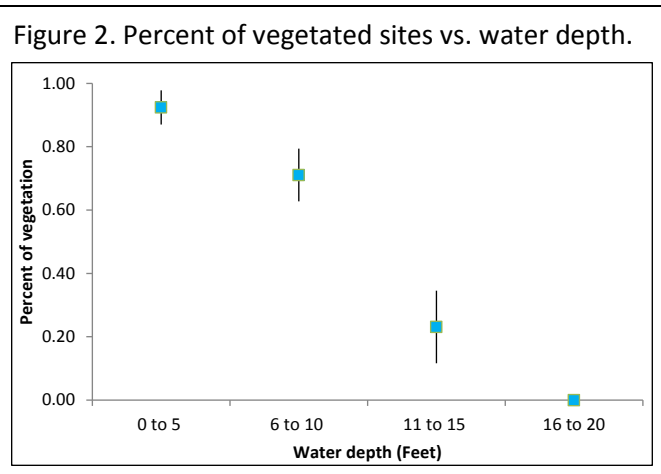
SHORE HABITAT

Shore habitat was assessed at 27 sites. The majority of the sites (67%) were classified as developed with residential homes, seven were undeveloped, one was developed as the City Park, and one was developed as the public boat launch. The mean habitat score (on a scale of 0 to 100) was 50.3. Developed sites had a mean score of 35.6 and undeveloped sites had a mean score of 92.4. Sites that scored low received few habitat points in the Shoreline and Shoreland Zones (Figure 1) because they had few or no remaining trees, shrubs and/or natural ground cover compared to undeveloped sites where these plants were present along the entire shore frontage.



IN-LAKE HABITAT

The shallow water (0-7 feet) substrates of George Lake were primarily sand ([Map 4](#)).



Vegetation occurred in 67% of all sampled sites, 69% of the Point-Intercept (rake toss) sample sites and in 64% of the nearshore plots ([Map 5](#)). Aquatic Plants were evenly distributed around the perimeter of the lake and were found to a depth of 14 feet. In the 0 to 15 feet depth zone, 69% of the survey sites contained vegetation but the 0 to 5 feet depth zone contained the most plants with 92% of sites vegetated (Figure 2). Plant occurrence declined with increasing water depth and in depths of 11 to 15 feet, 23% of the sites were vegetated.

AQUATIC PLANT DIVERSITY

A total of 41 aquatic and wetland plants were observed in George Lake in 2013 including 10 emergent, four floating-leaved, 24 submerged, three free-floating ([Table 4](#)). Five of these taxa (water plantain (*Alisma* sp.), river bulrush (*Bolboschoenus fluviatile*), three-square bulrush (*Schoenoplectus pungens*), floating-leaf pondweed (*Potamogeton natans*) and stonewort (*Nitella* sp.) were recorded for the first time during the 2013 survey. Two species, pipewort (*Eriocaulon aquaticum*) and ribbon-leaf pondweed (*Potamogeton epihydrus*) that had been reported in previous surveys were not located in 2013; these species are most often found in soft-water lakes of northern Minnesota and though reported in earlier surveys, they were never documented by voucher specimens.

The majority of aquatic plants observed in George Lake in 2013 were native with the exception of the submerged plants curly-leaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*). Non-native terrestrial and wetland plants were present along the shore and included Kentucky bluegrass (*Poa pratensis*), reed canary grass (*Phalaris* sp.) and purple loosestrife (*Lythrum salicaria*).

The highest number of plant taxa was found in shallow water, in depths less than 11 feet. All of the taxa found in the lake were present within this shallow zone and 29 were only found in this area. The number of plant taxa from rake toss sites found at each sample site ranged from 0 to 15 with a mean of 2 taxa per site. Sites of high richness (6 or more taxa per site) often occurred in depths less than 10 feet and included sites of where emergent, floating-leaf and submerged plants co-occurred ([Map 7](#)).

FLOATING AND EMERGENT PLANTS

Emergent and floating-leaf plants were restricted to shallow water of George Lake and within the 0 to 5 feet depth zone, they occupied 27 acres ([Map 6](#)). Emergent plant stands were present at 67% of the shore sites and artificial channels had been created in 38% of the plant stands.

Rushes (*Schoenoplectus* spp., *Eleocharis palustris*, *Schoenoplectus pungens*) occupied about 12 acres and were found on sandy sites in water depths from shore to five feet. Rushes are emergent, perennial plants that are rooted in the lake bottom with narrow stems that may extend several feet above the water. In addition to providing valuable fish and wildlife habitat, the extensive root network of these plants help to stabilize sandy shorelines. In shallow water, they may spread by underground rhizomes but these plants are particularly susceptible to destruction by direct cutting by human, motorboat activity and excess herbivory. Restoration of rush stands can be very difficult, making established stands particularly unique and valuable.

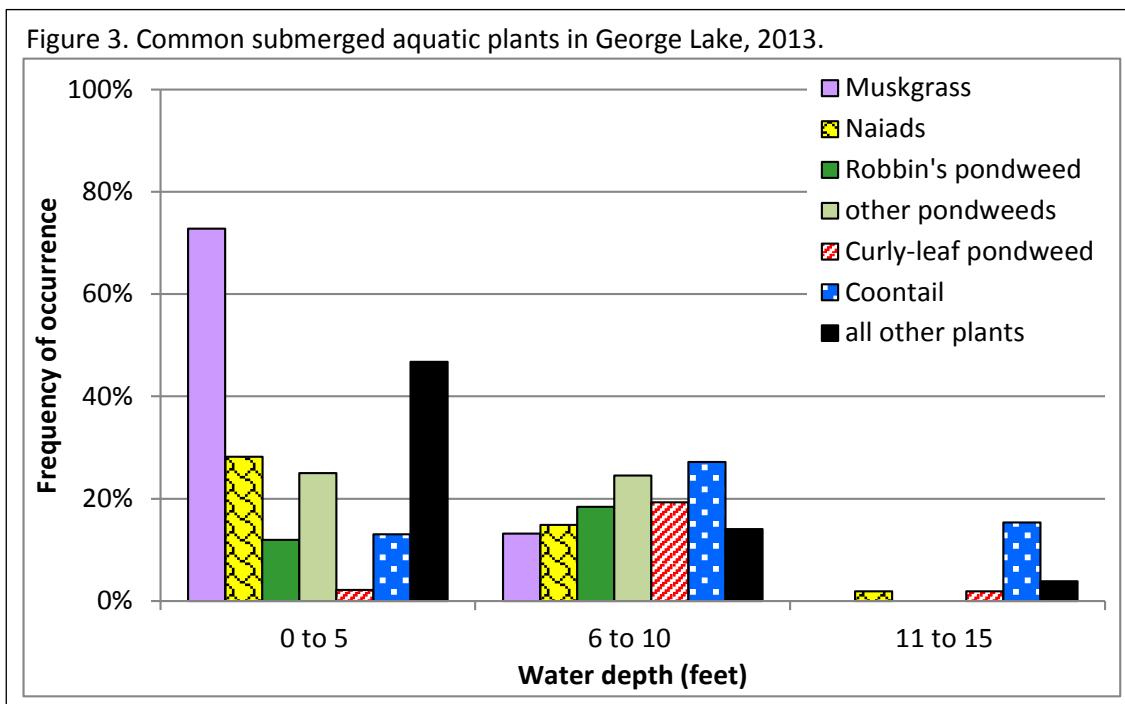
About 10 acres of arrowhead (*Sagittaria* sp.) were mapped. Arrowhead is an emergent plant that emerges above the water and can grow up to a few feet tall. The leaves look like an arrow and can vary from very narrow to broader leaves. The flower stem has whorls of short-stalked male flowers on the upper end and longer stalked female flowers below. The flowers have three-rounded white petals. Arrowhead is a good source of food for waterfowl and birds (Borman et al. 2001).

Cattails (*Typha* sp.) were found in 4.5 acres and were common on the north, east and west shorelines. Cattails (*Typha* sp.) are emergent plants that can grow as high as 10 feet and are found in shallow water up to 4 feet deep. Cattail leaves are flat, long and about one inch wide. It has a green cigar shaped flower that can turn brown and fuzzy in the fall. It helps stabilize shorelines and protects them from wave erosion.

A small area (0.13 acres) of floating-leaf plants were mapped and the dominant taxa were [white waterlily](#) (*Nymphaea odorata*), and [yellow waterlily](#) (*Nuphar variegata*). Other floating-leaf plants included watershield (*Brasenia schreberi*) and floating-leaf pondweed (*Potamogeton natans*). The floating leaves of waterlilies provide shade and shelter for fish, frogs and invertebrates. The showy flowers produce seeds that are eaten by waterfowl and the rhizome are a food source for muskrats and deer (Borman et al. 2001).

SUBMERGED PLANTS OF GEORGE LAKE

Lakewide, submerged plants were the most common type of vegetation and were found in 57% of all sites sampled, 63% of all of the Point-Intercept (rake toss) sample sites and in 52% of the nearshore plots. The most frequently occurring taxa were muskgrass (*Chara* sp) (32% occurrence in 0-15ft zone), naiads (*Najas* spp.) (18%), coontail (*Ceratophyllum demersum*) (19%), Robbin’s pondweed (*Potamogeton robbinsii*) (12%) and curly-leaf pondweed (10%). All other taxa occurred in less than 10% of the sample sites. Each plant taxa varied in frequency within each depth zone (Figure 3).



Muskgrass (*Chara* sp.) was the most frequent plant found in the 0 to 5 feet Zone of George Lake, where it occurred in 73% of the sites (Figure 3). It also occurred in the 6 to 10 feet zone but were found in less than 20% of those sites and was not detected in depths greater than 7 feet. This freshwater macroalgae is common in many hard water Minnesota lakes. It has a brittle texture and is named for its characteristic “musky” odor. Because muskgrass does not form true stems, it is a low-growing plant, often found entirely beneath the water surface where it may form low “carpets” on the lake bottom (Photo 6). Muskgrass is adapted to variety of substrates, can withstand heavier wave action than can rooted plants, and is often the first plant to colonize open areas of lake bottom where it can act as a sediment stabilizer. Stands of muskgrass can provide important fish spawning and nesting habitat.

Photo 6. Muskgrass



Naiads [Bushy pondweed (*Najas flexilis*; [Photo 7](#)) and southern naiad (*Najas guadalupensis*)] were also frequent in the 0 to 5 feet zone, occurring in 28% of the sites. In depths greater than 10 feet they were found in only 2% of the sites. Naiads are native submerged plants that often grow low in the water column and form inconspicuous flowers. The two species look very similar, but bushy pondweed is unusual because it is one of the few annual submerged species in Minnesota and must re-establish every year from seed. It prefers hard substrates and is not tolerant of turbidity (Nichols 1999). Southern naiad may overwinter as a perennial plant or sprout from seed. The seeds and foliage of both plants are an important duck food and the foliage provides good fish cover

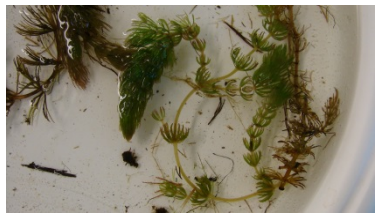
Photo 7. Naiads



©2002, Gary Fewless
Photo by Gary Fewless (UW Green bay)

Coontail (*Ceratophyllum demersum*) was one of six taxa that occurred in all of the vegetated zones and was found to a depth of 14 feet. It was most frequent in the 6 to 10 feet zone where it occurred in 27% of the sites and it was the most frequent species in the 11 to 15 feet zone. Coontail is the most common submerged plant in Minnesota. It grows entirely submerged and its roots are only loosely anchored to the lake bottom. It is adapted to a broad range of lake conditions and is tolerant of higher turbidity and can grow in muck substrates (Nichols 1999). Coontail is perennial and can over winter as a green plant under the ice and then begins new growth early in the spring, spreading primarily by stem fragmentation. The finely divided leaves of this plant (Photo 8) provide a home for insects valuable as fish food.

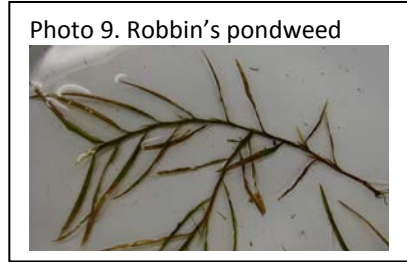
Photo 8. Coontail



Pondweeds (*Potamogeton* spp. and *Stuckenia* spp.) were most frequent in the 6 to 10 feet zone. These plants are primarily submerged, perennial plants that are anchored to the lake bottom by underground rhizomes. Depending on water clarity and depth, pondweeds may reach the water surface and may produce flowers that extend above the water. Pondweed seeds and tubers are an important source of waterfowl food (Fassett 1957) and the foliage of

pondweeds is food for a variety of marsh birds, shore birds and wildlife and provides shelter, shade and spawning sites for a range of fish species (Borman et al. 2001).

Robbin's pondweed (*Potamogeton robbinsii*) (Photo 9) was the most common native pondweed in George Lake and occurred to a depth of nine feet. This perennial plant forms leaves that grow entirely beneath the water surface and often lies flat on the lake bottom. It may form flowers that extend above the water surface.



Other native pondweeds each occurred in less than 8% of the sample sites and included white-stem pondweed, variable pondweed, large-leaf pondweed, and flat-stem pondweed (Table 4).

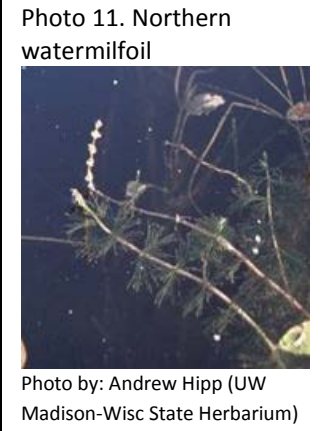
Curly-leaf pondweed (*Potamogeton crispus*) occurred in 10% of the sample sites and had a maximum growth in the 6 to 10 feet zone. This submerged plant has been present in Minnesota since at least 1910 (Moyle and Hotchkiss 1945) and is now considered naturalized, occurring in more than 750 Minnesota lakes (Invasive Species Program 2015). It was first documented in George Lake in the 1950's.

Like many submerged plants, curly-leaf pondweed (Photo 10) is perennial but it has a unique life cycle that may provide a competitive advantage over native species. This plant is actually dormant during late summer and begins new growth in early fall. Winter foliage is produced and continues to grow under ice (Wehrmeister and Stuckey 1978). Curly-leaf reaches its maximum growth in May and June, when water temperatures are still too low for most native plant growth. In late spring and early summer, curly-leaf plants form structures called "turions" which are hardened stem tips that break off and fall to the substrate. Turions remain dormant through the summer and germinate into new plants in early fall (Catling and Dobson 1985).



The foliage of curly-leaf pondweed does provide some fish and wildlife habitat, but it may also create problems in some lakes, or in areas of some lakes. During its peak growth in spring, curly-leaf may reach the water surface at certain depths and create dense mats, creating potential problems for recreational lake users.

Watermilfoils present in George Lake included Northern watermilfoil (*Myriophyllum sibiricum*), leafless watermilfoil (*Myriophyllum tenellum*) and the non-native, Eurasian watermilfoil (*Myriophyllum spicatum*). Native species were the most common type of watermilfoil's found in George Lake. Leafless watermilfoil is a unique species that is restricted to shallow, sandy sites that are close to shore. In George Lake it was only found to three feet. Leafless is a unique plant that is not common in central Minnesota lakes. These are submerged rooted perennial plants with finely dissected, "feather-shaped" leaves. There are several native species of watermilfoils in Minnesota and these plants are not tolerant of



turbidity (Nichols 1999) and grow best in clear water lakes. Particularly in depths less than 10 feet, watermilfoils may reach the water surface and their flower stalk will extend above the water surface (Photo 11). They spread primarily by stem fragments and over-winter by hardy rootstalks and winter buds.

Eurasian was first found in George Lake in 1998.

In some areas of some lakes, Eurasian watermilfoil can form thick stands and crowd out native plants. For information on how to distinguish the non-native, Eurasian watermilfoil from the native northern watermilfoil, click here: [identification](#).

2013 NEARSHORE PLANT COMMUNITIES

In the 25 near-shore sample plots, the mean water depth was 0.8 feet. The number of plant taxa present in each plot ranged from 0 to 11 with a mean of 3 taxa per site. The most frequently occurring plants in the nearshore plots included plants that were also common in the lakewide survey: naiads (32%), muskgrass (24%), coontail (16%), and curly-leaf pondweed (8%) plus several submerged species that were only common in the shallow water zone: bladderwort (*Utricularia vulgaris*) (12%), needlegrass (*Eleocharis acicularis*) (8%), and leafless watermilfoil (8%). Emergent and floating-leaf plants that were frequent in the nearshore plots were cattails (32%), three-square bulrush (12%), bulrush (8%) and white waterlily (8%).

AQUATIC PLANT COMMUNITY DYNAMICS

The shoreline habitat of George Lake has been greatly altered by humans. The undeveloped lake lots provide examples of how some of these sites may be at least partially restored by increasing trees, shrubs and/or natural ground cover. Humans can also impact aquatic plant communities directly by destroying vegetation with herbicide or by mechanical means. The results of these control activities can be difficult to predict and should be conducted with caution to reduce potential negative impacts to non-target species. Motorboat activity in vegetated areas can be particularly harmful for taxa such as bulrush. Shoreline and watershed development can also indirectly influence aquatic plant growth if it results in changes to the overall water quality and clarity. For information on the laws pertaining to aquatic plant management: [MNDNR APM Program](#).

The in-lake aquatic plant community of George Lake provides a diversity of native plant communities that provide critical fish and wildlife habitat and other lake benefits. (Click here for more information on: [value of aquatic plants](#)). The types and amounts of aquatic plants are influenced by a variety of factors including water clarity, water chemistry, depth, substrate type and wave activity. Within lake differences in these physical features as well as different levels of human activity can result in different types and amounts of vegetation.

The 2013 survey provides a snapshot of the George Lake plant communities and there may be a year to year difference in amounts and types of plants present in the lake. The annual abundance, distribution and composition of aquatic plant communities may change annually due to environmental factors and the specific phenology of each plant species. Monitoring change in the aquatic plant community can be helpful in determining whether changes in the lake water quality are occurring and for estimating the quality of vegetation habitat available

for fish and wildlife communities. The quantitative data collected in 2013 can be used to monitor finer-scale changes that may occur, such as an increase in a particular species, loss of species, or changes in the depths at which individual species occur.

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TABLE 4: HISTORICAL AND CURRENT PLANTS OF GEORGE LAKE

Emergent plants

Common Name	Scientific Name	1925	1955	1963	1973	1983	1993	2003	2007	2013	2013 NS
Water plantain	<i>Alisma</i> sp.									P	
River bulrush	<i>Bolboschoenus fluviatile</i>									P	--
Sedge	<i>Carex</i> sp.			P		O				--	--
Spikerush	<i>Eleocharis palustris</i>				X		X		X	1	--
Horsetail	<i>Equisetum fluviatilis</i>					R				--	--
Purple loosestrife (I)	<i>Lythrum salicaria</i>									P	
Common reed	<i>Phragmites australis</i>		O	P	R				X	P	--
Broad-leaf arrowhead	<i>Sagittaria latifolia</i>		*C	*P	*X		*X			P	4
Stiff wapato	<i>Sagittaria rigida</i>					R				<1	4
Bulrush	<i>Schoenoplectus</i> sp.		A	O		A	X	X	X	2	8
Three-square bulrush	<i>Schoenoplectus pungens</i>	X								1	12
Narrow-leaf cattail	<i>Typha angustifolia</i>				O	A					
Broad-leaf cattail	<i>Typha latifolia</i>		O	R	R	O				1	32
Total		1	3	5	4	6	3	1	2	10	5

Floating-leaved plants

Common Name	Scientific Name	1925	1955	1963	1973	1983	1993	2003	2007	2013	2013 NS
Watershield	<i>Brasenia schreberi</i>			P	R			X	X	<1	--
White waterlily	<i>Nymphaea odorata</i>			P	O	O		X	X	<1	8
Yellow waterlily	<i>Nuphar variegata</i>					R				P	--
Floating-leaf smartweed	<i>Persicaria amphibia</i>						X			--	--
Floating-leaf pondweed	<i>Potamogeton natans</i>									P	--
Total		0	0	2	2	2	1	2	2	4	1

Aquatic Vegetation of George Lake, Anoka County, 2013

Submerged plants

	Common Name	Scientific Name	1925	1955	1963	1973	1983	1993	2003	2007	2013 lake wide	2013 NS	
Macro Algae	Muskgrass	<i>Chara sp.</i>	X	C	X			X	X		32	24	
	Stonewort	<i>Nitella sp.</i>									3	4	
Monocots	Canada waterweed	<i>Elodea canadensis</i>						X	X	X	5	4	
	Needlerush	<i>Eleocharis acicularis</i>		C	*X			X		X	4	8	
	Pipewort	<i>Eriocaulon aquaticum</i>							?		--	--	
	Water star-grass	<i>Heteranthera dubia</i>					C			X	P	--	
	Bushy pondweed	<i>Najas flexilis</i>	X		X	O		X	X	X	18	32	
	Southern naiad	<i>Najas guadalupensis</i>								X			
	Large-leaf pondweed	<i>Potamogeton amplifolius</i>		A	A	A	C	X	X	X	3	--	
	Curly-leaf pondweed (I)	<i>Potamogeton crispus</i>		A	A	O		X	X	X	10	8	
	Ribbon-leaf pondweed	<i>Potamogeton epihydrus</i>				?					--	--	
	Fries pondweed	<i>Potamogeton friesii</i>								X		--	
	Small pondweed	<i>Potamogeton pusillus</i>								X		--	
	Leafy pondweed	<i>Potamogeton foliosus</i>					X	A	X	X		--	
	Straight-leaved pondweed	<i>Potamogeton strictifolius</i>								X		--	
	Variable pondweed	<i>Potamogeton gramineus</i>							X	X	X	2	--
	Illinois pondweed	<i>Potamogeton illinoensis</i>	X							X	X	1	--
	White-stem pondweed	<i>Potamogeton praelongus</i>		A	A	A			X	X	X	7	4
	Clasping leaf pondweed	<i>Potamogeton richardsonii</i>	X		X	A	C		X	X	X	1	4
	Robbin's pondweed	<i>Potamogeton robbinsii</i>							X	X	X	12	--
	Flat-stem pondweed	<i>Potamogeton zosteriformis</i>						C	X	X	X	3	--
	Sago pondweed	<i>Stuckenia pectinata</i>			C	A			X	X	X	<1	4
Wild celery	<i>Vallisneria americana</i>	X						X	X	X	5	4	

Aquatic Vegetation of George Lake, Anoka County, 2013

	Common Name	Scientific Name	1925	1955	1963	1973	1983	1993	2003	2007	2013 lake wide	2013 NS
Dicots	Water marigold	<i>Bidens beckii</i>						X	X	X	3	--
	Coontail	<i>Ceratophyllum demersum</i>	X	A	A	C	O	X	X	X	20	16
	Northern watermilfoil	<i>Myriophyllum sibiricum</i>	X		X	X	O	X	X	X	1	8
	Eurasian watermilfoil (I)	<i>Myriophyllum spicatum</i>							X	X	4	--
	Leaf-less watermilfoil	<i>Myriophyllum tenellum</i>							X	X	5	8
	White water buttercup	<i>Ranunculus aquatilis</i>					R	X	X		<1	--
	Greater bladderwort	<i>Utricularia vulgaris</i>			*X	*C	O	X		X	<1	12
Total			7	6	11	11	9	19	21	25	24	4

Free-floating plants

Common Name	Scientific Name	1925	1955	1963	1973	1983	1993	2003	2007	2013	2013 NS
Star duckweed	<i>Lemna trisulca</i>								X	<1	8
Greater duckweed	<i>Spirodela polyhriza</i>						X		X	<1	4
Lesser duckweed	<i>Lemna</i> sp.				X	R				<1	4
Total		0	0	0	1	1	1	0	2	3	3

A = abundant, C = common, O = occasional, R = rare, sparse, X = present (abundance not described)

* - plant only identified to genus level

I = introduced

1925 (July 1925) - Neil Hotchkiss, USDA

1955 – Department of Conservation

1963 (June 21) – Earl Huber and Roger Schwartz – MNDNR Division of Game and Fish

1973 (July 5-11) – Richard Trombley – MNDNR Division of Game and Fish

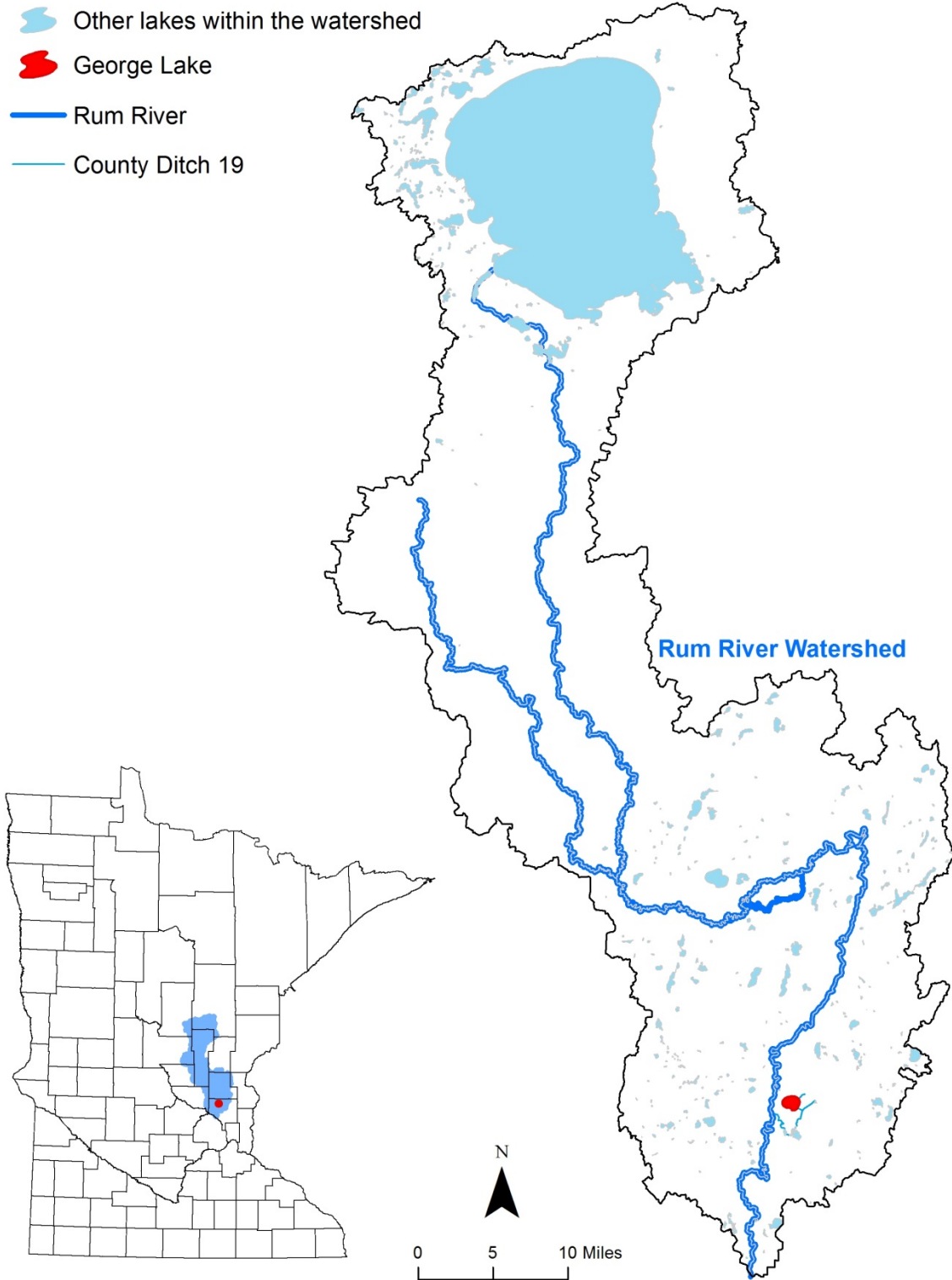
1983 (June 22) – Lee Sundmark – MNDNR Division of Fish and Wildlife

1993 (June 21) – MNDNR Division of Fish and Wildlife

2003 (June 9) – MNDNR Division of Fish and Wildlife

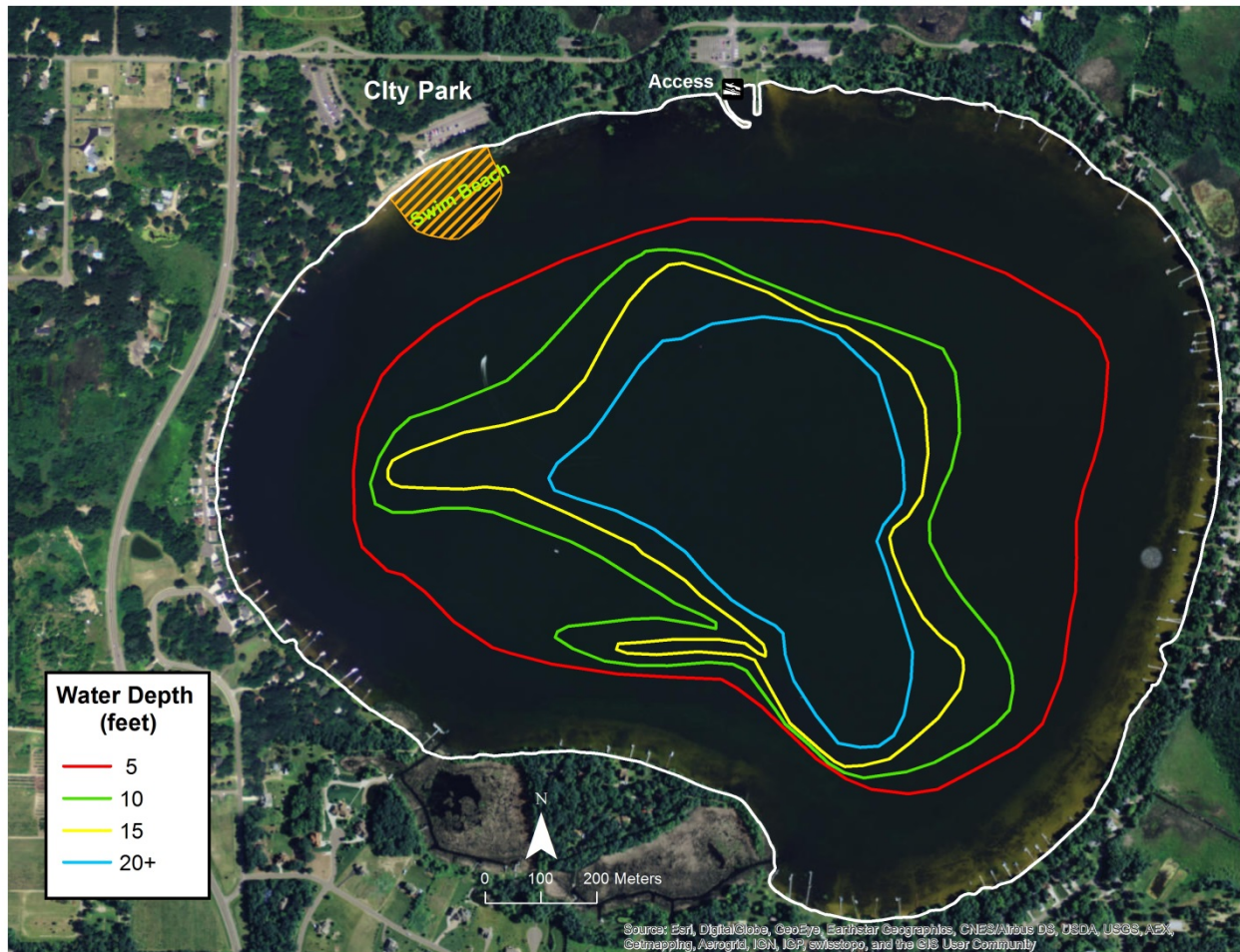
2007 (July 9) – Karen Myhre - MNDNR Division of Ecological and Water Resources – Minnesota Biological Survey

MAP 1. GEORGE LAKE WITHIN THE RUM RIVER WATERSHED

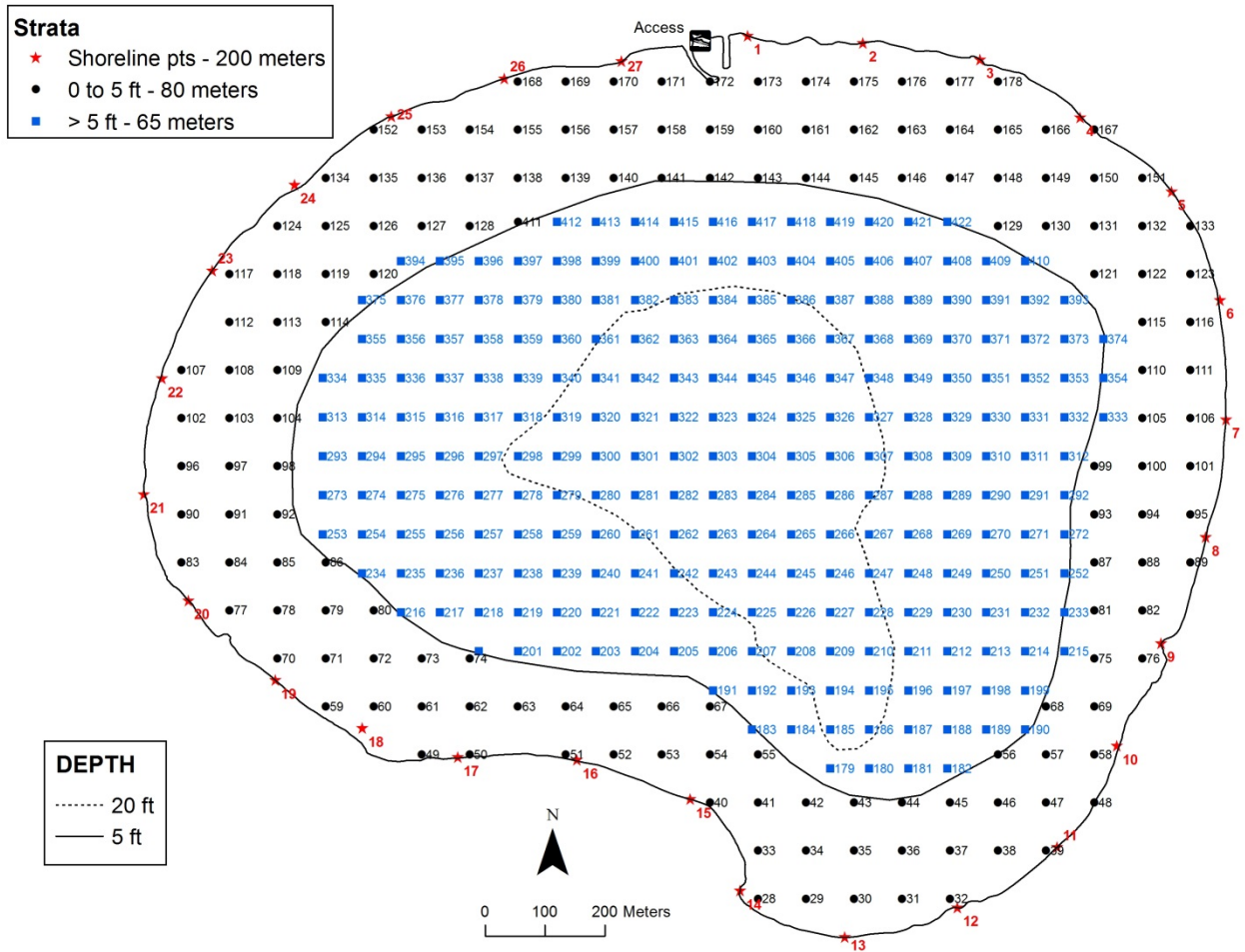


MAP 2. DEPTH CONTOURS OF GEORGE LAKE

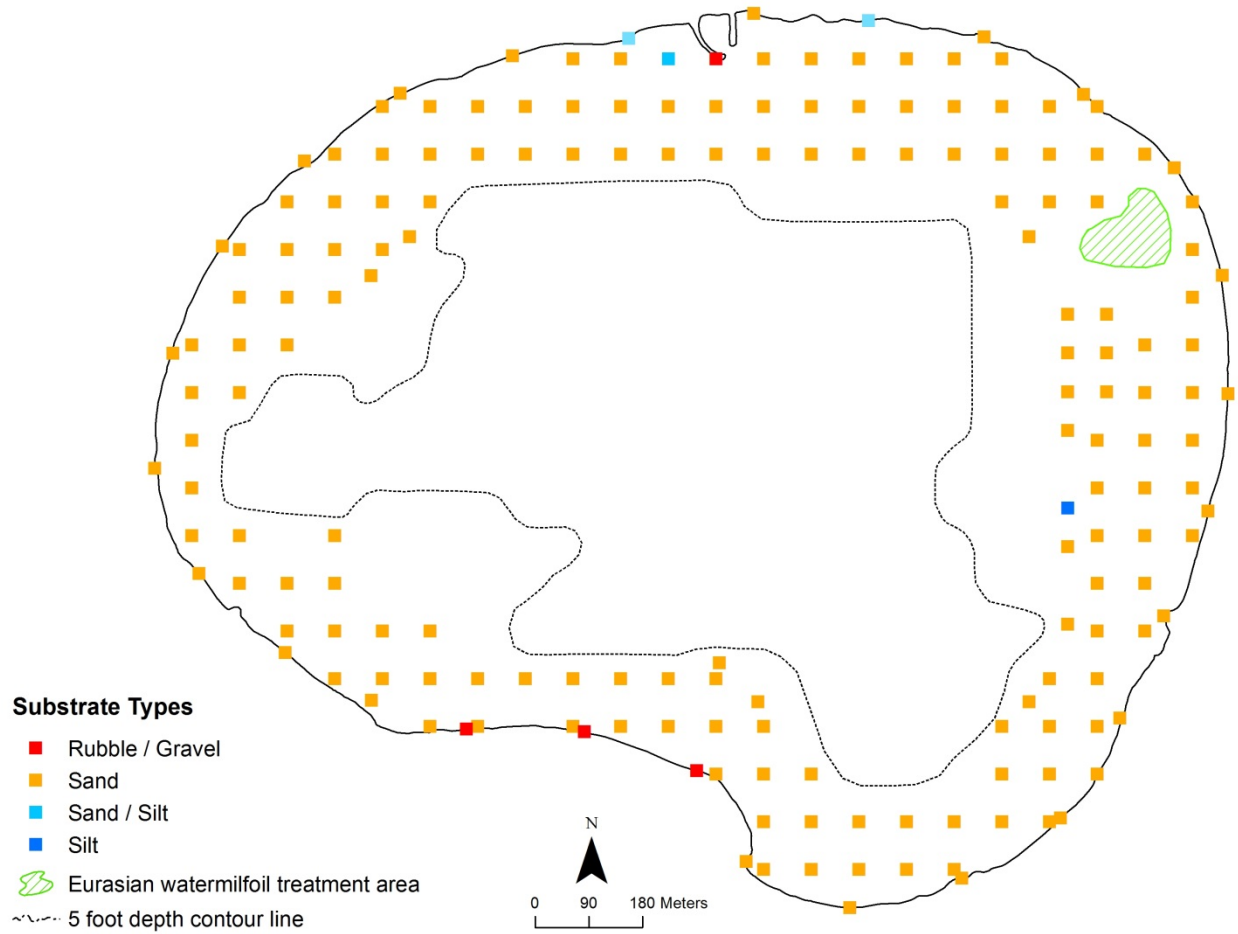
*Depth contours based on 1956 Survey



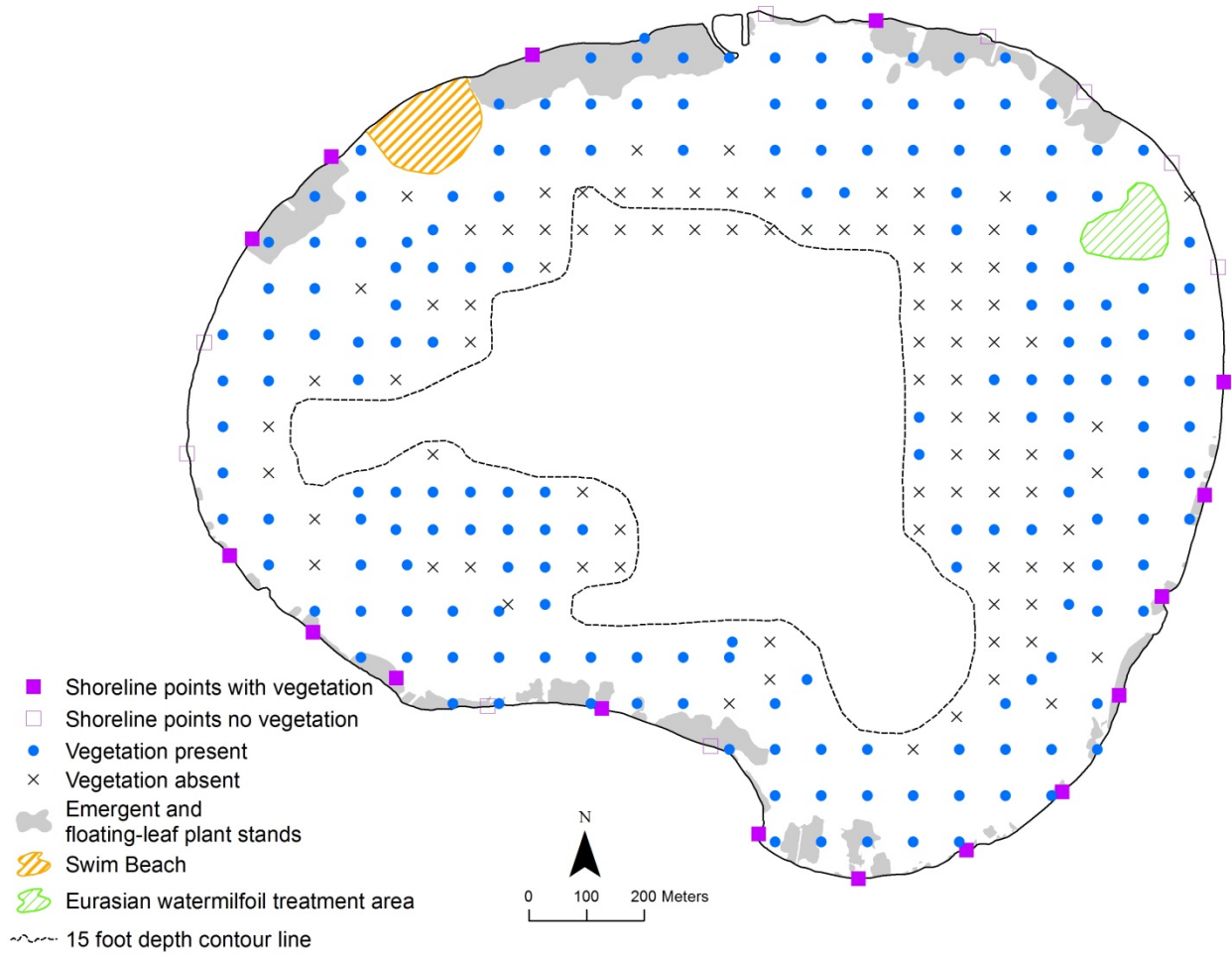
MAP 3. 2013 VEGETATION SURVEY SITES.



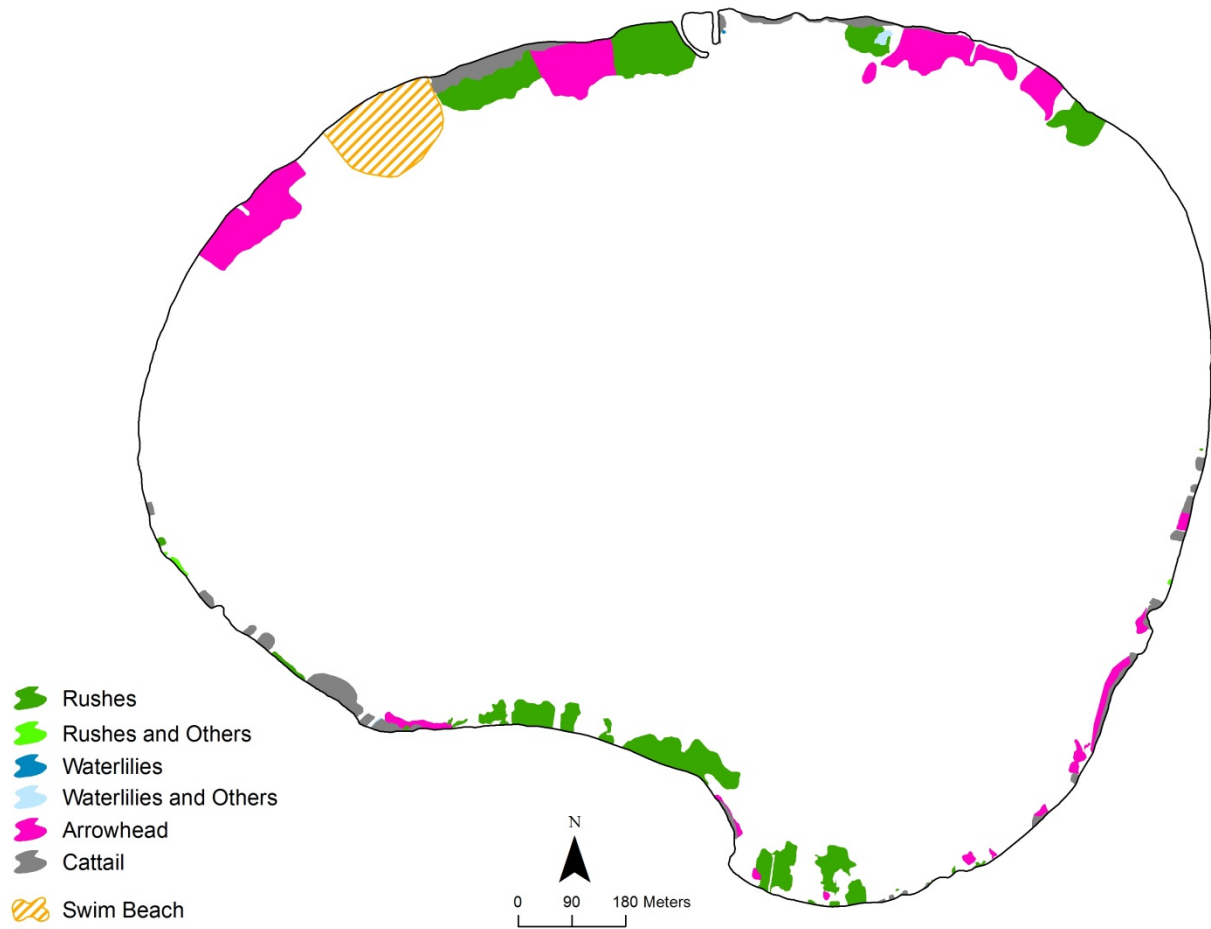
MAP 4. NEAR-SHORE SUBSTRATES OF GEORGE LAKE, 2013.



MAP 5. GEORGE LAKE SAMPLE SITES WITH AQUATIC VEGETATION, 2013.



MAP 6. EMERGENT AND FLOATING-LEAF PLANT STANDS, GEORGE LAKE, 2013.



MAP 7. NUMBER OF TAXA PER SAMPLE SITE, GEORGE LAKE, 2013.

