



DARRIN
Fresh Water Institute

Lake George, New York
Adirondack Field Station at Bolton Landing

**Aquatic Vegetation of Canada Lake, West Lake
and Green Lake, Town of Caroga, New York**

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Background.

Quantitative aquatic plant surveys were undertaken for Canada Lake, West Lake and Green Lake in the Town of Caroga, New York, in July 2013. The assessment included a survey of existing aquatic plant communities and the extent of rare, threatened or endangered species (Young 2010). The Point-Intercept Rake Toss method recommended by the US Army Corps of Engineers and required by NYS DEC for Tier III Lakes was employed. The survey consisted of collection of: a) herbarium specimens throughout both lakes for compilation of species lists, b) frequency data for points distributed throughout the lakes, and c) relative abundance data for each species collected in all three lakes.

Methods

Survey Sites

Canada Lake is the largest of a group of three lakes located in Fulton County in the Town of Caroga, New York (Figure 1). Elevations within the watershed for these lakes range from 1550

Figure 1. Aerial photograph of Canada Lakes chain, Fulton County, NY.



feet at the surface of the lakes to in excess of 2200 feet above sea level. Canada Lake and West Lake have a combined surface area of 128 acres and a watershed of 26, 816 acres. Mikol and Polsinelli (1985) report a maximum depth of 150 feet and a mean depth of 70 feet (Figure 2). Located on the western margin of Canada Lake is the only outlet which ultimately drains to the Mohawk River. One additional lake, Green Lake (Figure 3), has a navigable surface connection with Canada Lake passing under County Route 10. Green Lake has a surface area of 45 acres and a watershed area of 1572 acres. Adirondack Lake Survey Corporation (1987) reports a

maximum depth of 52 feet for Green Lake. No invasive (i.e. non-native) aquatic plant species have been reported for any of the three lakes. Canada Lake is part of the Citizens State Lake Assessment Program (CSLAP) and is ranked as oligotrophic (low productivity) to mesotrophic (moderate productivity). Secchi disk transparency is reported to be 4.8 m (CSLAP 2012).

Canada Lake

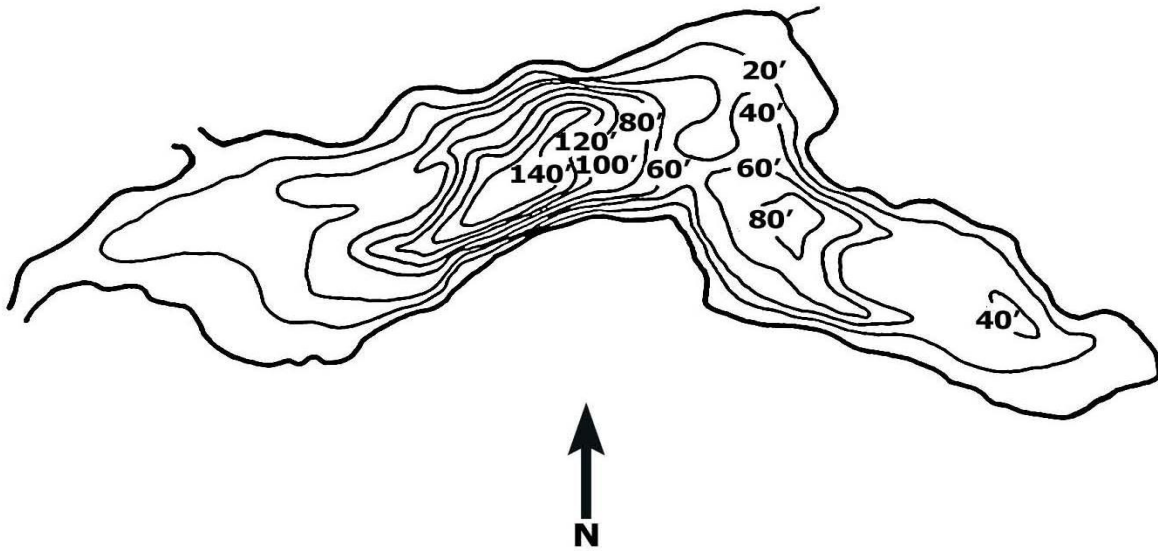
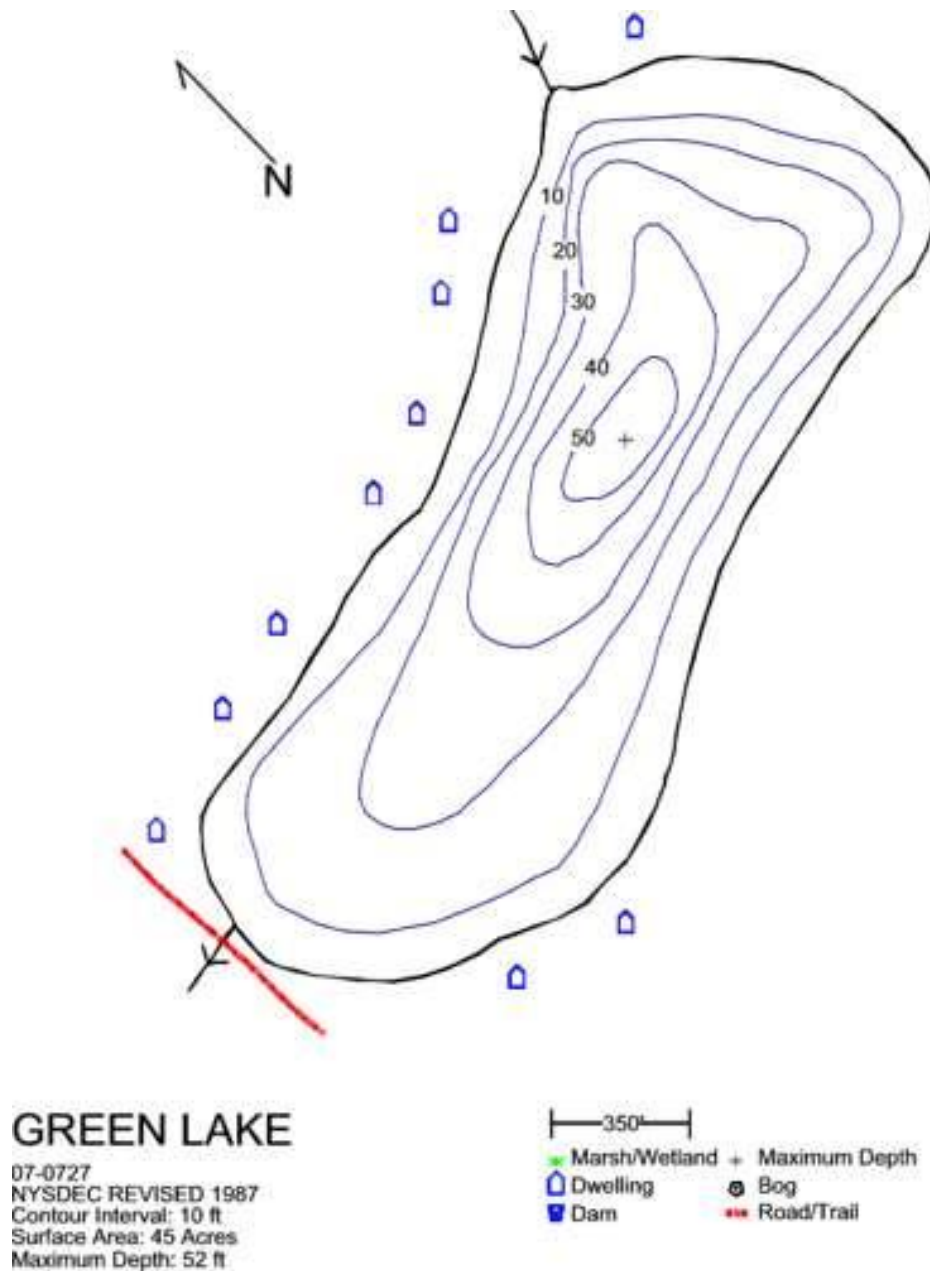


Figure 2. Bathymetric (depth) map of Canada Lake (Mikol and Polsinelli 1985).

Muenschler (1934) wrote that: "For the purposes of this report Canada Lake, West Lake (P718), and Lily Lake (P716) will be considered as one lake. This body of water has an area of 710 acres about 400 acres of which is over 40 ft. deep. The maximum depth is 144 ft. The chemical conditions in Canada Lake proper are excellent while the bottom samples from the West Lake and Lily Lake portions contain no oxygen. The lack of oxygen is due to the decomposition of the sawdust with which the bottom of these two lakes is covered." In 1934, the Canada Lake group supported a diverse native plant community with 19 submersed species, 4 rooted floating-leaved species and 7 native emergent species reported.

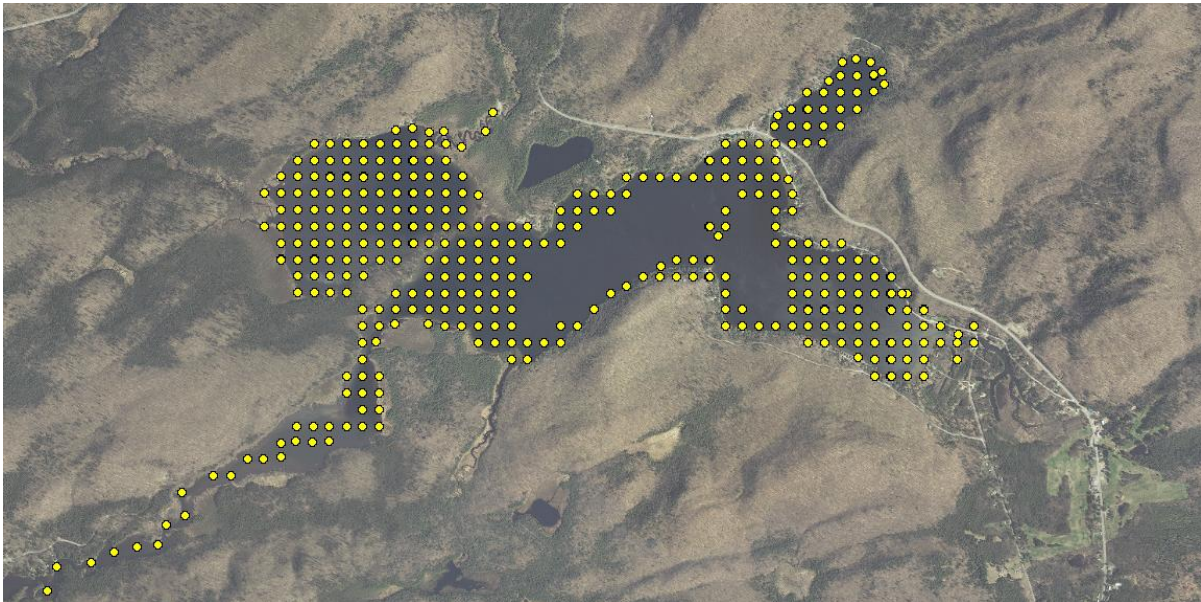
Figure 3. Bathymetric (depth) map of Green Lake (ALSC 1987).



Species List and Herbarium Specimens. As the lakes were surveyed, the occurrence of each aquatic plant species observed in the lake was recorded and adequate herbarium specimens were collected. The herbarium specimens were returned to the Darrin Fresh Water Institute, where they were pressed, dried, and mounted (Hellquist 1993). A number of species which were collected as reference specimens for each lake were not found in line intercept or wetland transect surveys.

Point Intercept Surveys. The frequency and distribution of aquatic plant species in each waterbody were evaluated using a point intercept method (Madsen 1999). At each grid point intersection, all species located at that point were recorded, as well as water depth. Water depth was determined with a weighted sounding lead and fiberglass tape measure (Keson, Warrensville, IL). Species were located by a visual inspection of the point and by deploying a rake to the bottom, and examining the plants retrieved. A total of 136 points were selected for Canada Lake, 65 points for West Lake, and 36 points for Green Lake, all based on a 100 m grid. A global positioning system (GPS) was used to navigate to each point. Surveys were conducted on July 29th and 30th of 2013. Data presented in the summary are on a whole-lake basis, and have not been adjusted for the littoral zone only. Locations for survey points were determined using MapInfo Software (MapInfo Corp., Troy, NY). A differential global positioning system (DGPS) was used to navigate to each point for the survey observation.

Figure 4. Map of Canada Lake, West Lake and Green Lake with point intercept survey locations for 2013.



Results and Discussion

In July of 2013, the aquatic plant community of Canada Lake included eighteen submersed species, four floating-leaved species, and six emergent species. Both West Lake and Green Lake supported similar plant populations with no invasive species reported for any of the lakes. In West Lake, twenty-one submersed species, four floating-leaved species, and six emergent species were recorded. Green Lake supported eleven submersed species, three floating-leaved species, and four emergent species. Species richness for all three lakes was quite high, with a number of species occurring in more than 5% of survey points. Rushes (*Scirpus sp.*) were the most widespread rooted plant for all three lakes, found in 54, 49 and 45% of survey points for Canada, West and Green Lakes, respectively. A number of native species were also commonly observed. A list of species observed for the three lakes is provided in Table 1.

**Table 1. Species lists for Canada Lake, West Lake and Green Pond.
Results for 1932 are from Meunscher 1934.**

<i>Species</i>	Common Name	1932	Canada	West	Green
<i>Brasenia schreberi</i> J.F. Gmel	Watershield	fl	fl	fl	fl
<i>Callitriche sp</i>	water starwort	s	s	s	
<i>Chara/Nitella sp.</i>	muskgrass, chara	s	s	s	s
<i>Dulichium arundinaceum</i> (L.) Britt.	three-way sedge	e	e	e	
<i>Eleocharis acicularis</i> (L.) Roemer & Schultes	needle spike-rush	e	e	e	e
<i>Eriocaulon septangulare</i> With.	Pipewort	s	s	s	s
<i>Fontinalis sp.</i>	Moss		s	s	s
<i>Isoetes echinospora</i> Dur.	Quillwort	s	s	s	s
<i>Isoetes lacustris</i> L.	large-spored quillwort		s	s	s
<i>Juncus pelocarpus</i> Mey.	Rush	s	s	s	
<i>Lobelia dortmanna</i> L.	water lobelia	s		s	s
<i>Myriophyllum humile</i> L.	Watermilfoil			s	
<i>Myriophyllum tenellum</i> L.	leafless watermilfoil	s	s	s	
<i>Najas flexilis</i> (Willd.) Rostk. & Schmidt.	bushy pondweed	s	s	s	
<i>Nuphar variegata</i> Engelm. ex Durand	yellow pondlily	fl	fl	fl	fl
<i>Nymphaea odorata</i> Ait.	white pondlily	fl	fl	fl	fl
<i>Nymphoides cordatum</i> (Ell.) Fern.	floating heart	fl	fl	fl	
<i>Pontederia cordata</i> L.	Pickerelweed	e	e	e	
<i>Potamogeton amplifolius</i> Tuckerm.	largeleaf pondweed			s	

<i>Species</i>	Common Name	1932	Canada	West	Green
<i>Potamogeton bicupulatus</i> Fern.	Pondweed	s	s	s	s
<i>Potamogeton epihydrus</i> Raf.	ribbon-leaf pondweed	s	s	s	s
<i>Potamogeton gramineus</i> L.	variable-leaf pondweed	s	s	s	
<i>Potamogeton natans</i> L.	floating-leaf pondweed		s	s	
<i>Ranunculus reptans</i> L.	creeping spearwort	s			s
<i>Sagittaria graminea</i> Michx.	Arrowhead	s	s	s	
<i>Scirpus sp.</i>	Rush	e	e	e	e
<i>Sparganium angustifolium</i> Michx.	Burreed	e	e	e	e
<i>Sparganium sp.</i>	Burreed	e	e	e	e
<i>Stuckenia pectinata</i> L.	sago pondweed		s	s	
<i>Typha sp.</i>	Cattail	e	e	e	e
<i>Utricularia gibba</i>	Bladderwort	s	s	e	
<i>Utricularia intermedia</i> Hayne	Bladderwort	s	s	s	
<i>Utricularia purpurea</i>	Bladderwort	s	s	s	S
<i>Utricularia resupinata</i> B.D. Greene	Bladderwort	s	s	s	S
<i>Utricularia vulgaris</i> L.	giant bladderwort	s	s	s	
<i>Vallisneria americana</i> L.	wild celery	s	s	s	S

S=submersed

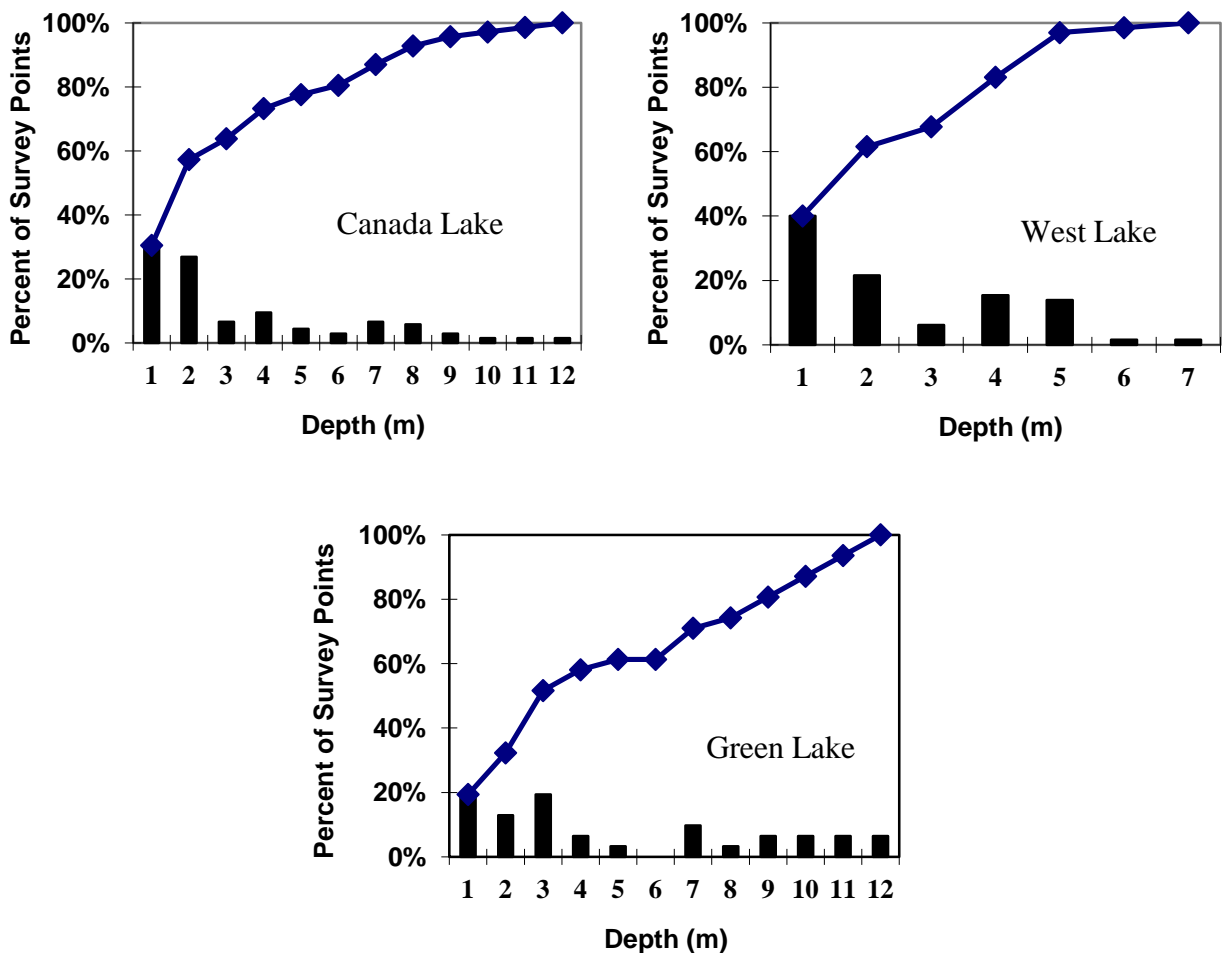
e=emergent

fl=floating leaved

Maximum Depth of Colonization

Maximum depth of rooted aquatic plant growth was similar for the three lakes, with the littoral zone extending to a depth of approximately 6 meters for West, Canada and Green Lakes. Depth distribution of sampling points (Figure 5) was uniform for all three lakes. Moss, *Fontinalis sp.*, was reported for a single sample in a depth of 8.6 m in Green Lake and 7.9 meters in Canada Lake. This species is known to be able to survive in low light conditions.

Figure 5. Depth Distribution of Sampling Points in 1 meter depth classes.



Species Lists

Maps of the distribution of aquatic plant species for all lakes are included in Appendix A, Figures A1 – A14. Frequency of occurrence results are presented in Table 2. For all three lakes, spikerush (*Scirpus spp.*) was the most common native species, 54%, 49% and 44% of survey points, respectively for Canada Lake, West Lake and Green Lake. Common native species for Canada Lake included *Sparganium angustifolium* (26% percent of survey points), *Utricularia*

purpurea (18%), *Nymphaea odorata* (10%), *Potamogeton epihydrus* (10%), *Vallisneria americana* (7%), *Najas flexilis* (7%), *Utricularia resupinata* (6%), and *Nymphoides cordata* (6%). Common native species for West Lake included *Utricularia purpurea* (31%), *Nymphoides cordata* (26%), *Sparganium angustifolium* (23%), *Utricularia vulgaris* (17%), *Vallisneria americana* (15%), *Najas flexilis* (15%), *Nymphaea odorata* (11%), *Utricularia intermedia* (8%), *Chara/Nitella* (8%), and *Potamogeton epihydrus* (6%).

Table 2. Percent frequency of occurrence data.

Species	Common Name	Percent Frequency		
		Canada	West	Green
<i>Brasenia schreberi</i>	Watershield	2.9%		
<i>Chara/Nitella</i>	Muskgrass	2.9%	7.7%	8.7%
<i>Eleocharis acicularis</i>	spikerush	2.9%	1.5%	
<i>Eriocaulon septangulare</i>	Pipewort	2.9%		17.4%
<i>Fontinalis sp.</i>	Moss	2.9%		13.0%
<i>Isoetes echinospora</i>	Quillwort	2.9%		4.3%
<i>Lobelia dortmanna</i>	Water lobelia			8.7%
<i>Myriophyllum humile</i>	Milfoil		1.5%	
<i>Myriophyllum tenellum</i>	Leafless milfoil	0.7%		
<i>Najas flexilis</i>	Bushy pondweed	6.6%	15.4%	
<i>Nuphar variegata</i>	Yellow pondlily	3.7%	6.2%	8.7%
<i>Nymphaea odorata</i>	White pondlily	10.3%	10.8%	8.7%
<i>Nymphoides cordata</i>	Floating heart	5.9%	26.2%	
<i>Pontederia cordata</i>	Pickerelweed	3.7%	1.5%	
<i>Potamogeton amplifolius</i>	Large-leaf pondweed		4.6%	
<i>Potamogeton epihydrus</i>	Ribbon-leaf pondweed	9.6%	6.2%	8.7%
<i>Potamogeton gramineus</i>	Variable-leaf pondweed	0.7%	1.5%	
<i>Potamogeton natans</i>	Floating-leaf pondweed	3.7%	6.2%	
<i>Ranunculus reptans</i>	Creeping spearwort			4.3%
<i>Sagittaria graminea</i>	Arrowhead	3.7%	6.2%	
<i>Scirpus sp.</i>	Spikerush	54.4%	49.2%	43.5%
<i>Sparganium angustifolium</i>	Burreed	25.7%	23.1%	8.7%
<i>Potamogeton bicupulatus</i>	Pondweed	1.5%	4.6%	
<i>Utricularia gibba</i>	Bladderwort	0.7%		
<i>Utricularia intermedia</i>	Bladderwort	0.7%	7.7%	
<i>Utricularia purpurea</i>	Purple bladderwort	18.4%	30.8%	26.1%
<i>Utricularia resupinata</i>	Bladderwort	5.9%		4.3%
<i>Utricularia vulgaris</i>	Giant bladderwort	2.9%	16.9%	
<i>Vallisneria americana</i>	Wild celery	7.4%	15.4%	

For Green Lake, the most common native species were *Utricularia purpurea* (26%), *Eriocaulon septangulare* (17%), *Fontinalis* sp. (13%), *Chara/Nitella* (9%), *Lobelia dortmanna* (9%), *Nymphaea odorata* (9%), *Nuphar variegata* (9%), *Potamogeton epihydrus* (9%), and *Sparganium angustifolium* (9%).

A total of 25 species were recorded in open lake surveys of Canada Lake. West Lake produced 20 species and 13 were recorded in Green Lake in 2013. The total number of aquatic plant species for the 3 lakes, including those observed for the lake but not captured by the point intercept survey technique, was 30, 33 and 19 for Canada Lake, West Lake and Green Lake, respectively. Of the 30 species reported in 1932, all were still present in at least one of the three lakes (Muenscher 1934).

Seventy-three percent of whole lake sampling points were vegetated by at least one native plant species, 83% of survey points with depths less than 6 m and 97% of survey points less than 2 meters depth yielded native aquatic plants in 2013 (Figure 6). The expected relationship of greater frequency of occurrence of aquatic plants with shallower water depth is consistent with other regional lakes. For survey points within the littoral zone, water depth less than 6 m, results similar to whole lake surveys are reported for West Lake, where nearly all survey points were at depths of less than 6 meters. All three lakes had a greater frequency of occurrence of plants in the surveys points from less than 2 meters, representing the shallow end of the littoral zone.

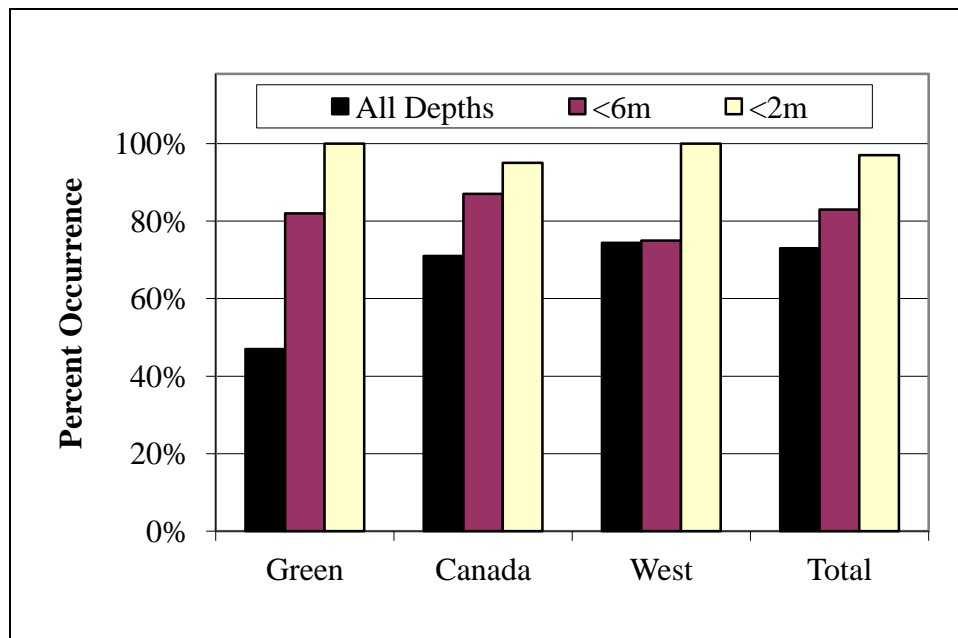


Figure 6. Frequency of occurrence summaries.

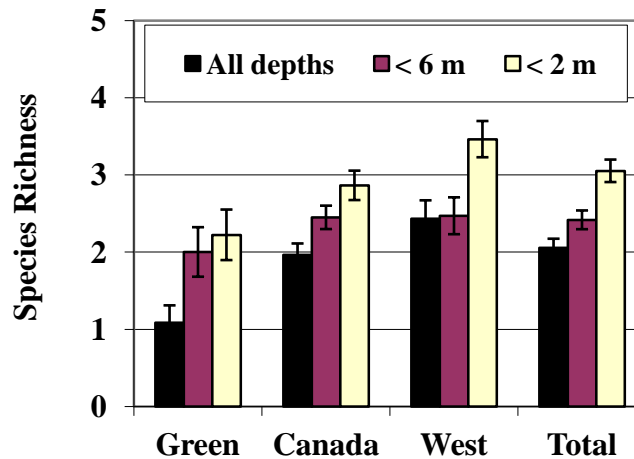
Species richness results are presented in Table 3 and Figure 7. Whole lake species richness ranged from 1.09 species per sample point in Green Lake to 2.43 species per sample point in West Lake. Species richness values within this range are typical for low to moderate productivity lakes in the Adirondack region of New York State.

Table 3. Species richness comparison between depths for the open-lake survey.

Water Depth Class	Summary Statistic	August Surveys			
		Green	Canada	West	Total
Whole Lake (all depths)	Mean	1.09	1.97	2.43	2.06
	N	36	146	65	247
	Std. Error	0.22	0.14	0.24	0.11
Points with depths <6m	Mean	2	2.45	2.47	2.42
	N	17	116	64	197
	Std. Error	0.32	0.15	0.24	0.12
Points with depths <2m	Mean	2.22	2.86	3.46	3.05
	N	8	73	39	120
	Std. Error	0.33	0.19	0.23	0.15

For survey points exclusively within the littoral zone (depths less than 6 meters), species richness was similar between the three lakes at between 2 and 2.5 species per survey point. From the shallow margin of the littoral zone, depths less than 2 meters, species richness was substantially greater in West Lake. As expected, species richness in the littoral zone and its shallow fringe was higher than whole lake species richness.

Figure 7. Species richness summaries. Error bars are standard error.



Summary

Quantitative aquatic plant surveys were undertaken for the Canada Lakes (Canada Lake, West Lake and Green Lake) in the Town of Caroga, New York, in July of 2013. Surveys were conducted to obtain aquatic plant density and distribution data for the three lakes, with a focus on the discovery of invasive species. Aquatic plant surveys were designed to be comparable to other regional aquatic plant surveys conducted by the US Army Corps of Engineers and the Darrin Fresh Water Institute over the last 2 decades. The frequency and distribution of aquatic plant species in each waterbody were evaluated using a point intercept method based on a differential global positioning system of grid points. To address concerns with potential impacts on wetland communities, peripheral wetland areas were included at each lake to characterize the wetland plant communities present.

The aquatic plant community of the Canada Lakes included twenty two submersed species, four floating-leaved species, and six emergent species. All of the species reported are native to our region, with no exotic or invasive species encountered. The total number of aquatic species for the 3 lakes was 30, 33 and 19 for Canada Lake, West Lake and Green Lake, respectively. This number of species greatly exceeds the 15 species typically reported for moderately productive lakes in New York and indicates good water quality and a variety of habitat types. None of the species reported are found on New York's rare plant status lists (Young 2008). Comparing the species list to a 1932 survey by Muenscher (1934), all of the species reported in 1932 are still present in at least one of the three lakes surveyed. These results suggest a highly stable lake system.

Species richness was quite high, with a large number of species occurring in more than 5% of survey points. Seventy-three percent of whole lake sampling points were vegetated by at least one native plant species and 97% of survey points with depths less than 2 meters yielded native aquatic plants. The littoral zone or zone of rooted aquatic plants extended to approximately 6 meters in all lakes, with a moss (*Fontinalis* sp.) observed to 8 meters in Canada and Green Lake. Native species richness in the littoral zone was 2.41 species per sample similar to many low to moderate productivity lakes in the Adirondack region of New York. In all three lakes, rushes (*Scirpus*) were the most common native species (44% to 54% of survey points) followed by purple bladderwort (*Utricularia purpurea*). Floating heart (*Nymphoides*) was abundant in West Lake, while burreed (*Sparganium*) filled that position in Canada Lake and pipewort (*Eriocaulon*) was common in Green Lake. A number of native species were commonly observed in all three lakes. Common native species for Canada Lake included purple bladderwort (32% of survey points), burreed (26%), white pond lily (10%), ribbon-leaf pondweed (10%), duck celery (7%), water naiad (7%), and floating heart (6%). For West Lake, common native species included purple bladderwort (38%), floating heart (26%), burreed (23%), giant bladderwort (17%), duck celery (15%), water naiad (15%), white water lily (11%), and muskgrass (8%). Common native species for Green Lake included purple bladderwort (26% of survey points), pipewort (17%), moss (13%), white pond lily (9%), yellow pond lily (9%), ribbon-leaf pondweed (9%), and burreed (9%).

The aquatic plant community of the Canada Lakes included twenty two submersed species, four floating-leaved species, and six emergent species. All of the species reported are native to our

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Appendix A

Canada Lakes Aquatic Plant Distribution Maps

