Aquatic plant population assessments as part of a program to eradicate Eurasian watermilfoil from selected sites in Lake George, New York

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Background

In 2005, the FUND for Lake George secured a grant from NYS under the Milfoil Eradication Program to support management of Eurasian watermilfoil (*Myriophyllum spicatum* L.) in Lake George. The project was designed to eliminate three major beds of Eurasian watermilfoil (EWM). The sites were located in Dunham's Bay, Van Warmer Bay (Elizabeth Island Channel) and Sunset Bay, and represented critical areas where removal was beneficial to significant portions of the lake. The eradication program had three components: 1) assessment of the distribution and density of all plants including rare, threatened and endangered species both prior to and post eradication, 2) eradication of dense growth of EWM via installation of benthic barrier and 3) eradication of scattered and moderate density growth of EWM via hand harvesting at each location peripheral to benthic barrier installation. Program administration was provided by the FUND for Lake George, physical aquatic plant management was provided by Lycott Environmental Services under the direction of the Lake George Park Commission (LGPC) and aquatic plant assessment was provided by the Darrin Fresh Water Institute. The current report focuses on the Darrin Fresh Water Institute aquatic plant assessment component.

Methods

Site Description.

Lake George is part of the St. Lawrence River drainage. Situated at the southeastern margin of the Adirondack Park, the majority of the lake is within Warren County, with portions of its watershed in Washington and Essex Counties. The drainage basin covers approximately 238 square miles, with one fifth of the watershed (43 square miles) occupied by the lake itself. The majority of the Lake George watershed is forested with recent estimates ranging from 89% to 93%. Developed areas account for a very limited proportion of the basin area, 3% to 5%, limited largely to a thin strip along the southern and western shores of the lake. Lake George is best described as an oligotrophic, soft water, circum-neutral lake. Classified as Class AA(special), Lake George serves as a primary water supply for the Village of Lake George, and a secondary supply for Bolton Landing and Ticonderoga.

Morphometric characteristics of Lake George and its drainage basin	
Length	32 miles
Max Width	2.1 miles
Average Width	1.3 miles
Area	42.5 square miles
Average Depth	69.7 feet
Maximum Depth	196 feet
Elevation	320 feet
Drainage Basin	
Area	238.4 square miles
Maximum Elevation	2646 feet

The aquatic plant community of the lake includes 59 species exclusive of wetland vegetation (Ogden et al., 1976) with 7 of these species on the New York State Rare Plant List or associated Watch List (Young, 2007). This high species richness is indicative of the diversity of habitat types and excellent water quality. The littoral or zone of aquatic plant growth extends to water depths of 12 m, and includes approximately 15% of the lake surface. Several exotic aquatic plant species are or have been present in Lake George.

These include Curly-leaf Pondweed (*Potamogeton crispus*), Water chestnut (*Trapa natans*) and Eurasian watermilfoil (*Myriophyllum spicatum*). Of utmost concern is the rapid proliferation of Eurasian watermilfoil (EWM) since its invasion in the early 1980's. Dense EWM growth in Lake George has been demonstrated to: 1) significantly reduce habitat complexity by eliminating native plant species including those considered rare, threatened and endangered, 2) increase resuspension of nutrients from lake bottom sediments affecting water quality, 3) reduce species richness in the macroinvertebrate community, 4) interfere with fish spawning, and 5) degrade access for contact recreation, boating and fishing. The fisheries of Lake George are managed by the NYS Department of Environmental Conservation as a two story fishery, with annual stocking of land locked salmon and periodic stocking of lake trout. Recreation is a principle activity with numerous public and private access points. With over 15,000 registered boats on LG and dozens of public and private boat launch facilities, a severe threat exists for transport of aquatic nuisance species (ANS).

Over a dozen areas dominated by EWM exist in LG toward which little or no management effort has been directed. Three of these areas were determined to represent significant environmental and recreational impacts in terms of their location near important wetlands and intensely used recreational areas. Dunham Bay (19), Elizabeth Island Channel (152) and Sunset Bay (6) were selected as high priority EWM removal sites. An eradication program was developed based on three components: 1) assessment of the distribution and density of EWM and all native plants including rare, threatened or endangered (RTE) species both prior to and post eradication, 2) eradication of dense growth of EWM via installation of benthic barrier and 3) eradication of scattered and moderate density growth of EWM via hand harvesting at each location peripheral to benthic barrier installation. Assessment will include point and line-intercept plant distribution and density data collections and GPS mapping of dense growth of EWM. Distribution of native and exotic species will be assessed and mapped providing logistic support to pre-plan benthic barrier installation and evaluation to maximize effectiveness of the EWM eradication efforts while minimizing impacts to non-target species. Surveys will provide the basis for evaluation of impacts to both target and non-target species.

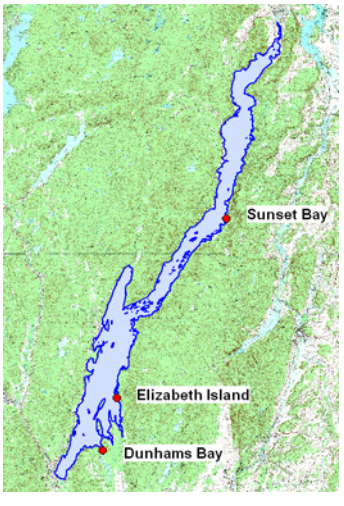


Figure 1. Location of EWM management sites.

Dunham Bay (19). EWM growth was first reported in Dunhams Bay in 1985, when a small area of dense growth (bed) was discovered in water depths of 4 to 5 meters. In 1986, the LGPC installed benthic barrier to control this dense bed of EWM, however scattered EWM growth of low to moderate density occurred from the former bed site towards the wetland, and in shallow water throughout the inner bay. Scattered growth of EWM has been removed periodically via hand harvesting, however additional dense growth of EWM has developed in areas adjacent to the original barrier placement. The condition of the original barrier is largely unknown, because it is buried in 8 inches of silt and in large part decomposed, however EWM is currently colonizing sediments on top of the original barrier. A moderate

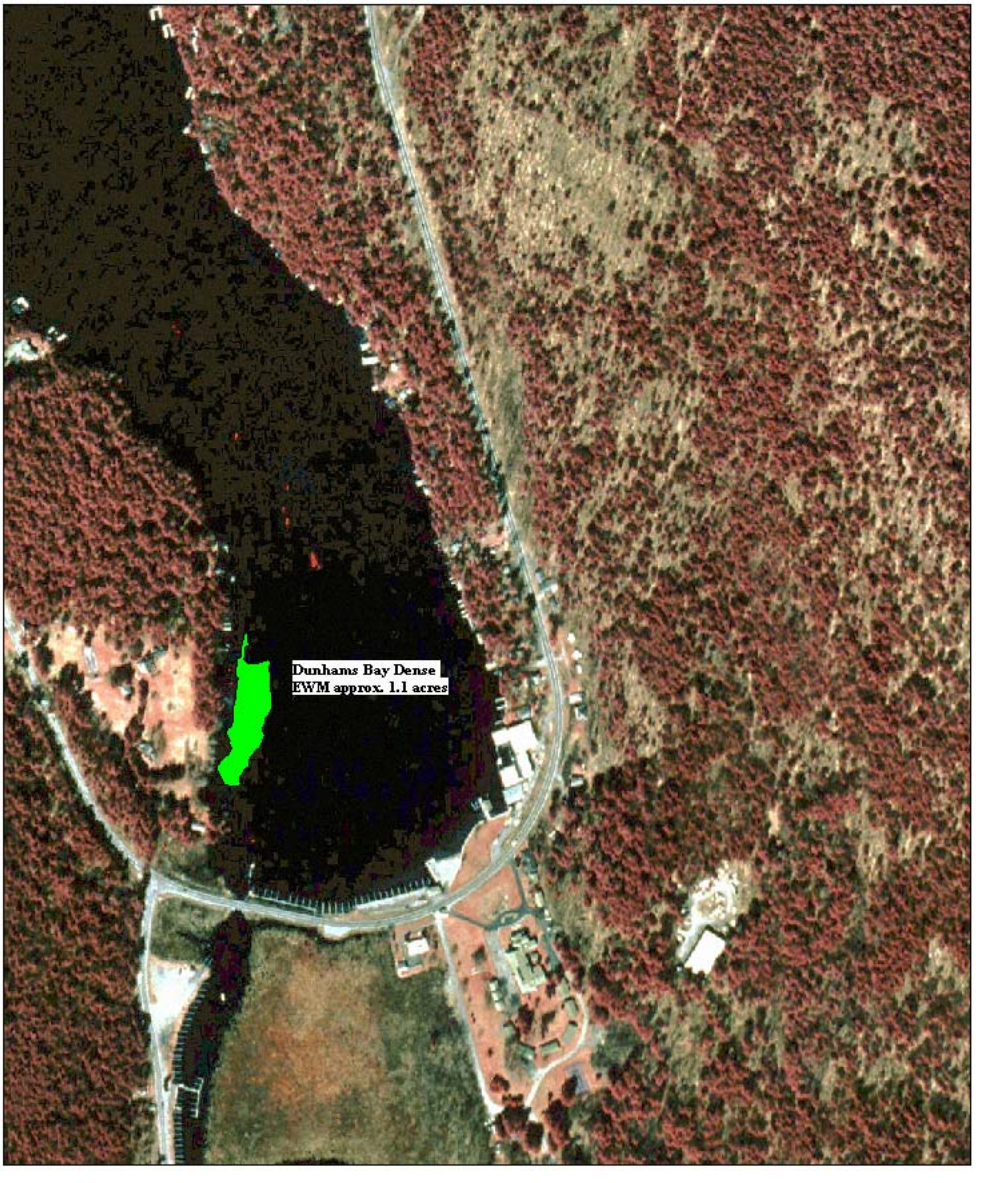


Figure 2. Map of Dunhams Bay with EWM dense growth (bed) delineated.

sized area (0.5 acres) of dense EWM growth has developed adjacent to the matted area on the eastern side, just inside the reduced speed zone. Moderate density growth of milfoil is found to the west of the barrier material, with sediment buildup on the barrier supporting EWM growth. This site is adjacent to a marina and an in-lake wetland, Dunham's Bay Wetland, that transport significant sediment into the bay in part from marinas that lie within the wetland. Boat traffic from the numerous marinas in this bay and its associated wetland is extremely heavy. This site is a major source of fragmented EWM plants that act to colonize the southern end of the lake. EWM fragmentation and transport into the Dunham's Bay Creek threatens

this fragile wetland. The most recent survey of this location in 2003, documented the presence of 27 native plant species, none of which are RTE.

Sunset Bay (6). The moderate density area surrounding a small bed of EWM reported in 1989 has increased in density and merged with an adjacent area of dense EWM growth. A portion of the dense EWM growth in this area was covered with barrier in 1992 and 1993. The remainder of this small bay contains scattered EWM plants. EWM occurs from 1 - 4 meters depth with very dense EWM growth in 2 - 3 meters depth. Substantial

Figure 3. Map of Sunset Bay with EWM dense growth (bed) delineated.

accumulations of silt are found on top of the existing benthic barrier. EWM continues to spread southward along the shore. Dense EWM growth covers approximately 0.75 acres. This site served as a "control" locations for a proposed pilot herbicide application program, denied by the APA in 2003. As such, control efforts were suspended from 1996 through 2003. Proposed EWM eradication techniques included installation of 0.75 acres of benthic barrier and hand-harvesting of scattered EWM plants within the remainder of the bay (approx. 8 acres). A survey of this location in 2005 documented the presence of 22 native plant species, one of which (*Myriophyllum alterniflorum*) is on the NYS Rare Plant List.

Particular care was taken to train divers to recognize this species and benthic barrier will not be installed where it is present.

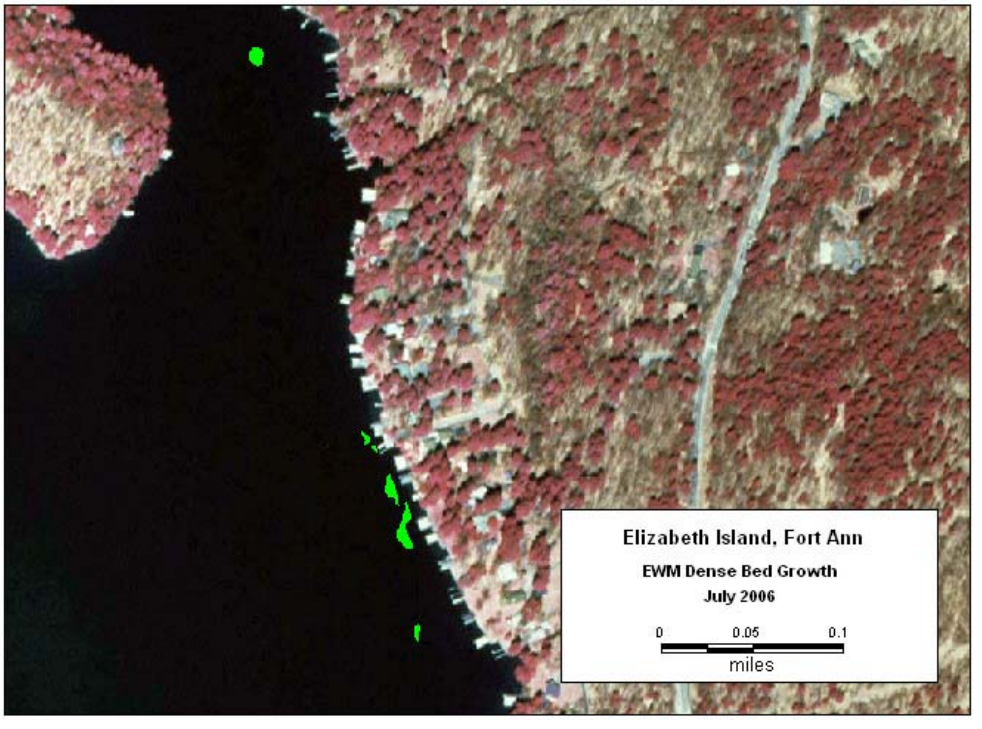


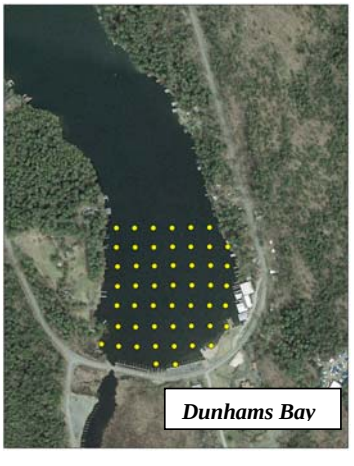
Figure 4. Map of Elizabeth Island Channel with EWM dense growth (bed) delineated.

Elizabeth Island Channel (152). A new dense bed of EWM was reported in 2005 in the bay east of Elizabeth Island. The area of dense growth occurs along the mainland side of the channel. Extensive use of this channel by boaters has the potential to spread EWM fragments into Warner Bay and its associated wetland, one of the largest high quality wetlands in the LG basin. The location and recreational activities associated with this location dictate a rapid response. Rapid response also allows for a minimum of barrier material to be used and limits impacts to non-target species. Approximately 0.2 acres of benthic barrier, with follow-up hand harvesting was proposed to eradicate EWM growth in this area. A survey of this location in 2003 documented the presence of 24 native plant species, one of which (*Megalodonta beckii*) is on the NYS Watch List. Particular care will be taken to train divers to recognize this species and benthic barrier will not be installed where it is present.

Species List and Herbarium Specimens. As the treatment locations were surveyed, the occurrence of any unknown aquatic plant species observed was recorded and adequate herbarium specimens were collected. The herbarium specimens were returned to the Darrin Fresh Water Institute, where they were identified, pressed, dried, and mounted (Hellquist 1993). The Darrin Fresh Water Institute maintains an extensive herbarium collection for the 59 species of submersed plants reported for Lake George.

Perimeter Mapping of Dense EWM Growth. In the current mapping effort, the perimeter of dense growth of EWM was located by skin and/or SCUBA divers and GPS coordinates recorded at intervals around the perimeter of dense growth. Boat mounted GPS units were employed as a check of the hand-held units. Instrumentation used to develop EWM dense growth area maps for Lake George included a Garmin GPSmap 168, WAAS corrected GPS data collection system with integrated depth recording and a Garmin GPS III Plus, hand held DGPS data collection system. Dimensions of EWM dense growth area were prepared by compiling numerous discrete location/depth points at the margins of the dense growth areas. After all data points were recorded on the GPS datalogging systems, the information was downloaded to Garmin MapSource software. The coordinates were then exported into MapInfo Professional™ version 7.8 (MapInfo Corp., Troy, NY) GIS software, for area estimation and graphic representation.

EWM often grows in dense, nearly mono-specific stands, produces a canopy and eliminates native species via shading. These dense growth areas have been termed "beds" and defined as areas where EWM growth covers more than 50% of the lake bottom. In the Lake George Aquatic Plant Management Program administered by the Lake George Park Commission, benthic barrier has been the method of choice for controlling dense EWM growth, both from a cost and efficacy standpoint. Benthic barrier installation can be streamlined by maximizing shore-based preparation of the barrier and associated lake bottom attachment materials prior to installation. Completing barrier installation at a location within a single season or at most two seasons has been demonstrated to minimize collateral EWM invasions and site maintenance. Accurate mapping of 'bed" density growth of EWM aids the planning and preparation stages for benthic barrier placement.



Point Intercept. The frequency and diversity of aquatic plant species 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. Species were located by deploying a rake to the bottom, and examining the plants retrieved. A total of 50 points were selected for Dunhams Bay, 40 points for Elizabeth Island Channel, and 30 points for Sunset Bay based on a 100 m grid. A differential global positioning system (DGPS) was used to navigate to each point for the survey observation. Point intercept plant frequencies were surveyed in July 2006 for all locations and in September of 2006 at the sites where benthic barrier installation had occurred. End of season surveys were completed in September of 2007 at the Sunset Bay site.

Line Transects. Macrophyte communities at each treatment site were also surveyed by a line intercept (transect) method employed extensively by DFWI and others to provide data comparable to historical surveys. Transect percent cover characterizes aquatic plant communities by density (percent cover), diversity (species richness) and dominance (relative percent cover). Transects were placed perpendicular to the shoreline and consisted of a polyethylene rope 100 meters in length, with marks every meter to indicate stop or

observation points. At each observation point on the transect, a 0.1 m^2 quadrat is used to quantify percent cover by species, utilizing the Daubenmire scale (Daubenmire 1959, 1968). Relative percent cover is recorded for each species observed within the quadrat. Physical characteristics including depth, sediment type, and obstructions are also recorded for each quadrat. One transect, to the limit of the littoral zone (lake bottom area with rooted aquatic plants present), or 100 meters was completed for each location. Line intercept plant frequencies and percent cover were surveyed in July for all locations and in September of 2006 at the sites where treatments occurred. End of season surveys were completed in September of 2007 at the Sunset Bay site.

Water Quality Assessment. Aquatic plant management can have a significant effect on water quality both directly through the use of herbicides and related products and indirectly by the release of nutrients from decomposing plant materials. Hose integrated surface water samples and on-site measurements were obtained from all sites on a monthly basis. The chemical analyses and the samples for which they were conducted are listed below. All analyses were conducted at the Darrin Fresh Water Institute laboratory in Bolton Landing, NY.

Chemical analyses conducted for the water quality program.

Analysis	Samples	Analysis	Samples
pH	all	Silica	all
Specific Conductance	all	Sodium	all
Total Nitrogen	all	Calcium	all
Total Phosphorus	all	Chloride	all
Total Soluble Phosphorus	all	Sulfate	all
Soluble Reactive Phosphorus	all	Chlorophyll *a*	all
Nitrate	all	Magnesium	all
Ammonia	all	Alkalinity	selected samples

Plant Management

Benthic barrier installation was completed in July and August of 2006 by Lycott Environmental Services at two (Dunhams Bay and Elizabeth Island Channel) of the three sites proposed for treatment (see Figures 1, 2 & 3). A total of 1.25 acres of benthic barrier was installed at these two sites to complete initial management efforts. Hand harvesting of scattered EWM plants to complete management efforts was also initiated at the Elizabeth Island channel site. The third site, Sunset Bay, was scheduled for management via benthic barrier in 2007, however the consultant for the LGPC reported a decline in abundance of Eurasian watermilfoil at this site, concluding that the density of growth was insufficient for benthic barrier placement. No management was conducted at this site in 2007.

Site descriptions and aquatic plant management history provided by Lycott Environmental Services (King & Lyman, 2006* and *King, 2007)

Dunham's Bay (M-19). The inner bay has had Eurasian watermilfoil growth to 4 meters of depth. Scattered plants of low to moderate density occurred from the former bed site towards the wetland, and in shallow water throughout the inner bay. This is one location in which the LGPC installed benthic barrier in 1986 over a dense bed of milfoil. The slope is uniformly gentle, with a bottom of predominantly silty material. Water clarity is reduced by the wetland drainage. Boat traffic is moderately heavy at this site. A moderate sized bed has developed adjacent to the matted area on the eastern side, just inside the reduced speed zone. Scattered growth of Eurasian watermilfoil to the northwest of the bridge has been removed annually via hand harvesting. Moderate density growth of milfoil is found to the west of the barrier material, with sediment buildup on the barrier supporting a number of milfoil plants as well. In 2005, 38 panels were installed to cover ca. half of the bed. In 2006, between July 31 and August 15, 127 panels of barrier were installed. In 2007, an additional 73 panels were installed and 978 plants removed by hand pulling.

Sunset Bay (M-6). The moderate density area surrounding the small bed of milfoil reported in 1989 has increased in density and merged with the small milfoil bed. A majority of this area was covered with benthic barrier in 1992 and 1993. The remainder of this small bay contains scattered plants. A small patch of scattered plants to the north of the principal milfoil area has increased to moderate density. The slope is gradual, with a silty bottom. Eurasian watermilfoil was found from 1 to 4 meters water depth with very dense milfoil growth in 2 to 3 meters depth. Substantial accumulations of silt on top of benthic barrier were observed annually from 1998 through 2006. Eurasian watermilfoil continues to spread southward along the shore, mixed with a native pondweed, *Potamogeton amplifolius*. In 2007, this location was inspected and characterized as a relatively small 'bed' and then lots of milfoil scattered throughout natives.

S.E. Elizabeth Island Channel. **(M-152)** Confirmed by Lycott in 2006, this site is actually several isolated patches of milfoil extending from near site M-135 north ca. 0.25 miles toward Elizabeth Island Channel. In 2006, between July 10 and August 17, all of the patches were covered with a total of 31 panels and 1453 plants were hand pulled. Primarily

rocky bottom. In 2007, more patches of growth were found and 2,396 plants were hand pulled.

Aquatic Plant Survey Results

A total of 45 species of aquatic plants were encountered in the surveys of the 3 locations in Lake George (Table 1). The aquatic plant community of Dunhams Bay included twenty-four submersed species, two floating-leaved species, one floating species and four emergent species. At the Elizabeth Island Channel site, thirty submersed species, one floating-leaved species and one emergent species were reported. In Sunset Bay, twenty-six submersed species and one emergent species were observed. .*Myriophyllum spicatum* was the only exotic species reported. These results exceed those from other regional lakes, where whole lake species richness in moderately productive, low elevation lakes in New York State is reported to average 15 species (Taggett et al. 1990). The exceptional water quality, large littoral zone and diversity of habitat types are generally accepted as the reasons for the large number of aquatic plant species present in Lake George.

One of the species encountered was on the New York Rare Plant List (Young, 2007), *Myriophyllum alterniflorum*, and two species were on the Watch List: *Megalodonta (Bidens) beckii* and *Isoetes lacustris*. *Myriophyllum alterniflorum* was reported for both the Elizabeth Island and Sunset Bay sites in limited numbers, pre-treatment, but was absent post-treatment at both locations. This species typically grows on sandy sediments in shallow water (less than 2 meters) throughout the Lake George basin. Its absence post-treatment should not be interpreted as a treatment effect since it was absent from both a managed (Elizabeth Island Channel) and a control (Sunset Bay) site. *Megalodonta (Bidens) beckii* was reported for all 3 locations while *Isoetes lacustris* was only reported from Elizabeth Island Channel. Frequency of occurrence for both species on the watch list either increased or remained unchanged within the relative error of the surveys. Both of these species are common members of the Lake George aquatic plant community.

Perimeter Mapping of Dense EWM Growth. Prior to management efforts in 2006, perimeter mapping of dense growth areas of EWM was completed. The pretreatment location and areal coverage of EWM is presented in Figure 2 for Dunhams Bay, Figure 3 for Sunset Bay and Figure 4 for Elizabeth Island Channel. A pretreatment total of 1.93 acres of dense EWM growth was reported for the three locations (Table 2). The largest area was in Dunhams Bay (1.1 acres), followed by Sunset Bay (0.53 acres) and Elizabeth Island Channel (0.30 acres). Following installation of 1.02 acres of benthic barrier at Dunhams Bay in 2006, surveys reported a total of 0.14 acres of dense EWM growth remaining (Figure 5). In 2007, an additional 0.59 acres of benthic barrier were installed in Dunhams Bay to complete management. At the Elizabeth Island channel site, 0.25 acres of benthic barrier were installed in 2006. Post-treatment surveys failed to find any dense EWM growth remaining at the Elizabeth Island Channel site. At Sunset Bay, 0.53 acres of dense EWM growth were reported in 2006. In 2007, prior to any treatment occurring, EWM density in Sunset Bay was reported to be less than 50% of bottom coverage. This is the permit criteria for benthic barrier use, so no benthic barrier was installed at this location.

Table 1. Species list for Lake George Treatment Sites.

Species	Common Name	Dunhams Bay	Elizabeth Island	Sunset Bay
Brasenia schreberi J.F. Gmel	Water shield	X		
Ceratophyllum demersum L.	coontail	X		
Chara sp.	muskgrass, chara	X	X	X
Elatine minima (Nutt.) Fisch. & C.A. Mey.	small waterwort	X	X	X
Eleocharis acicularis (L.) Roemer & Schultes	needle spike-rush	X	X	X
Elodea canadensis Michx.	elodea	X	X	X
Eriocaulon septangulare With.	pipewort		X	X
Isoetes echinospora Dur.	quillwort	X	X	
Isoetes lacustris L.	large spore quillwort		X	
Juncus pelocarpus Mey.	rush			X
Lobelia dortmanna L.	water lobelia		X	
Megalodonta (Bidens) beckii Torr.	water marigold	X	X	X
Myriophyllum alterniflorum **DC.**			X	X
Myriophyllum sibiricum Kom.	northern watermilfoil	X		
Myriophyllum spicatum L.	Eurasian watermilfoil	X	X	X
Myriophyllum tenellum Bigel.	leafless milfoil	X	X	X
Najas flexilis (Willd.) Rostk. & Schmidt.	bushy pondweed	X	X	X
Najas guadalupensis (Spreng.) Magnus	southern naiad		X	X
Nuphar advena (Ait.) Ait. f.	yellow pondlily		X	
Nymphaea odorata Ait.	white waterlily	X		
Pontederia cordata L.	pickerelweed	X		X
Potamogeton amplifolius Tuckerm.	largeleaf pondweed	X	X	X
Potamogeton epihydrus Raf.	ribbon-leaf pondweed		X	
Potamogeton foliosus Raf.	leafy pondweed			X
Potamogeton gramineus L.	variable-leaf pondweed	X	X	X
Potamogeton perfoliatus L	clasping-leaf pondweed	X	X	X
Potamogeton praelongus Wulfen	white-stem pondweed	X	X	X
Potamogeton pusillus L.	small pondweed	X	X	X
Potamogeton richardsonii (Ar. Benn.) Rydb.	Richardsons' pondweed		X	
Potamogeton robbinsii Oakes	Robbins' pondweed	X	X	X
Potamogeton spirillus Tuckerm.	narrow leaf pondweed	X	X	X
Potamogeton vaseyii Robbins	narrow leaf pondweed			X
Potamogeton zosteriformis Fern.	flat-stem pondweed		X	X
Ranunculus longirostris Godron	white watercrowfoot	X	X	X
Ranunculus reptans L.	creeping spearwort	X		
Sagittaria cuneata Sheldon (S. arifolia)	arumleaf arrowhead		X	
Sagittaria graminea Michx.	grassy arrowhead	X	X	
Scirpus sp.	bulrush	X		
Sparganium sp.	burreed	X	X	
Sphagnum sp.	sphagnum	X		
Utricularia resupinata B.D. Greene	bladderwort		X	
Utricularia vulgaris L.	great bladderwort	X		X
Vallisneria americana L.	wild celery	X	X	X
Zosterella (Heteranthera) dubia Jacq.	water stargrass	X	X	X
Typha sp.	cattail	X		

Shaded species are on the NYS Rare Plant Lists or Watch Lists (Young, 2007).

Table 2. Estimated area of dense EWM growth at the proposed treatment sites. Area in acres.

Site Name	Site Code	Pre-treatment	Post-treatment
Sunset Bay	6	0.53	No bed density
Dunhams Bay	19	1.10	0.14
Elizabeth Island	152	0.30	No EWM observed
TOTAL		**1.93**	**0.14**

Figure 5. Map of Dunhams Bay, post-treatment, with EWM dense growth (bed) delineated.

Point Intercept Species Frequency. Species richness at all locations was quite high, with a large number of species occurring in more than 5% of survey points (Table 3). Maps of the distribution of select species is provided in Appendices A through C. In Dunhams Bay, duck celery, *Vallisneria americana* was the most common species (39% of survey points) both pre and post-treatment. Eurasian watermilfoil frequency of occurrence remained stable in Dunhams Bay (11% of survey points pre-treatment and 13% post-treatment). The extensive distribution of EWM in Dunhams Bay at densities below that deemed appropriate

for benthic barrier dictates intensive hand harvesting efforts in future years. Some additional dense EWM growth also remained to be managed by benthic barrier in 2007. Other common native species for Dunhams Bay prior to benthic barrier installation included *Potamogeton robbinsii* (30% of survey points), *P. praelongus* (22%), *Sphagnum* (13%), *Elodea canadensis* (11%), *P. zosteriformis* (9%), *P. gramineus* (7%), and *Ranunculus longirostris* (7%). Comparable results were observed post-treatment in Dunhams Bay, with native species including *Vallisneria americana* (39% of survey points), *Potamogeton robbinsii* (26%), *P. praelongus* (26%), *Sphagnum* (17%), *Elodea canadensis* (15%), *P. gramineus* (4%), and *Ranunculus longirostris* (2%).

Table 3. Point intercept aquatic plant percent frequency by species for pre-treatment and post-treatment surveys.

Species	**Dunham**		**Elizabeth**		**Sunset**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Ceratophyllum demersum	6.5%	2.2%				
Chara sp.		2.2%	30.0%	2.5%	35.7%	21.4%
Eleocharis acicularis			7.5%	17.5%	10.7%	7.1%
Elodea canadensis.	10.9%	15.2%	7.5%	2.5%	33.9%	21.4%
Elatine minima			2.5%	2.5%		
Eriocaulon septangulare			2.5%	2.5%	10.7%	8.9%
Isoetes echinospora	2.2%	2.2%	2.5%			
Isoetes lacustris			7.5%	7.5%		
Juncus pelocarpus			5.0%		7.1%	3.6%
Megalodonta beckii (Bidens beckii)	2.2%	2.2%	10.0%	20.0%	7.1%	5.4%
Myriophyllum alterniflorum			5.0%		3.6%	
Myriophyllum spicatum	10.9%	13.0%	5.0%		10.7%	10.7%
Myriophyllum tenellum			2.5%	5.0%	3.6%	1.8%
Najas flexilis	4.3%		22.5%	2.5%	17.9%	5.4%
Najas guadalupensis			7.5%	2.5%	7.1%	7.1%
Nuphar advena			10.0%			
Nymphaea odorata			2.5%			
Potamogeton amplifolius	2.2%	4.3%	25.0%	25.0%	10.7%	7.1%
Potamogeton epihydrus		2.2%	2.5%			
Potamogeton foliosus			17.5%			
Potamogeton friesii			5.0%			
Potamogeton gramineus	6.5%	4.3%	27.5%	25.0%	14.3%	8.9%
Potamogeton perfoliatus	2.2%		22.5%	7.5%	8.9%	7.1%
Potamogeton praelongus	21.7%	26.1%	10.0%	10.0%		1.8%
Potamogeton pusillus	2.2%		7.5%		3.6%	3.6%
Potamogeton robbinsii	30.4%	26.1%	37.5%	22.5%	30.4%	26.8%
Potamogeton vaseyii			2.5%	7.5%		
Potamogeton zosteriformis	8.7%		5.0%		17.9%	28.6%
Ranunculus longirostris	6.5%	2.2%	5.0%			
Ranunculus reptans			2.5%	2.5%	3.6%	1.8%

Species	Dunham		Elizabeth		Sunset	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Sphagnum	13.0%	17.4%				
Utricularia vulgaris			2.5%			1.8%
Vallisneria americana	39.1%	39.1%	22.5%	47.5%	57.1%	35.7%
Zosterella dubia (Heteranthera dubia)	2.2%	2.2%	2.5%		5.4%	8.9%

For Elizabeth Island Channel, Robbins pondweed, *Potamogeton robbinsii* was the most common species (38% of survey points) pre-treatment but declined to fourth post-treatment (22.5% of survey points). EWM frequency of occurrence declined from 5% pre-treatment to absent post-treatment. Other common native species prior to benthic barrier installation at the Elizabeth Island site included *Potamogeton gramineus* (28%), *P. amplifolius* (25%), *P. perfoliatus* (23%), *V. americana* (23%), *Najas flexilis* (23%), *N. guadalupensis* (18%), *P. foliosus* (18%) and *P. praelongus* (10%). Comparable results were observed post-treatment for Elizabeth Island, where common native species included *V. americana* (48%), *P. robbinsii* (23%), *P. gramineus* (25%), *P. amplifolius* (25%), *P. praelongus* (10%), *P. perfoliatus* (8%), *Najas flexilis* (3%), and *N. guadalupensis* (3%). The decline in the naiads is a normal seasonal phenomena resulting from early fall senescence in this genera.

In Sunset Bay, duck celery, *Vallisneria americana* was the most common species in both 2006 (57% of survey points) and 2007 (36% of survey points). Other common native species for Sunset Bay in 2006 included *Elodea canadensis* (34% of survey points), *Potamogeton robbinsii* (30%), *Najas flexilis* (18%), *P. zosteriformis* (18%), *P. gramineus* (14%), *P. amplifolius* (11%), *Eleocharis acicularis* (11%) and *Eriocaulon septangulare* (11%). Eurasian watermilfoil frequency of occurrence remained stable in Sunset Bay (11% of survey points in both years). In 2007, Sunset Bay plant distribution was comparable to 2006 and included *Vallisneria americana* (36% of survey points), *Potamogeton zosteriformis* (29%), *Potamogeton robbinsii* (27%), *Elodea canadensis* (21%), *Eriocaulon septangulare* (9%), *P. gramineus* (9%), *P. amplifolius* (7%), *Eleocharis acicularis* (7%) and *Najas flexilis* (5%). Sunset Bay can be considered a control plot since no plant management occurred at this location.

Between seventy and eighty-eight percent of lake sampling points were vegetated by at least one native plant species (Figure 6), with native species clearly dominating at all locations. Total plant frequency of occurrence remained stable in both the managed and unmanaged sites. Eurasian watermilfoil was present in 3% to 11% of survey points pretreatment, and 0% to 13% of survey points post-treatment. Native species frequency remained relatively stable between pretreatment and post-treatment surveys at from 72 to 88% of survey points. Eurasian watermilfoil frequency of occurrence declined rapidly between pretreatment and post-treatment surveys at Elizabeth Island Channel, with no EWM reported post-treatment. Frequency of occurrence of EWM increased between pre- and post-treatment surveys at Dunhams Bay. At the Sunset Bay site, which received no treatment, EWM frequency of occurrence remained stable at 11% of survey points pre- and post-treatment. Both benthic barrier and hand pulling were employed at the Elizabeth Island Channel site while only benthic barrier was employed at Dunhams Bay in 2006. As expected, the combination of these two physical control techniques is more effective at eradicating EWM than benthic barrier alone.

Figure 6. Point intercept aquatic plant percent frequency by species for pre-treatment and post-treatment surveys.

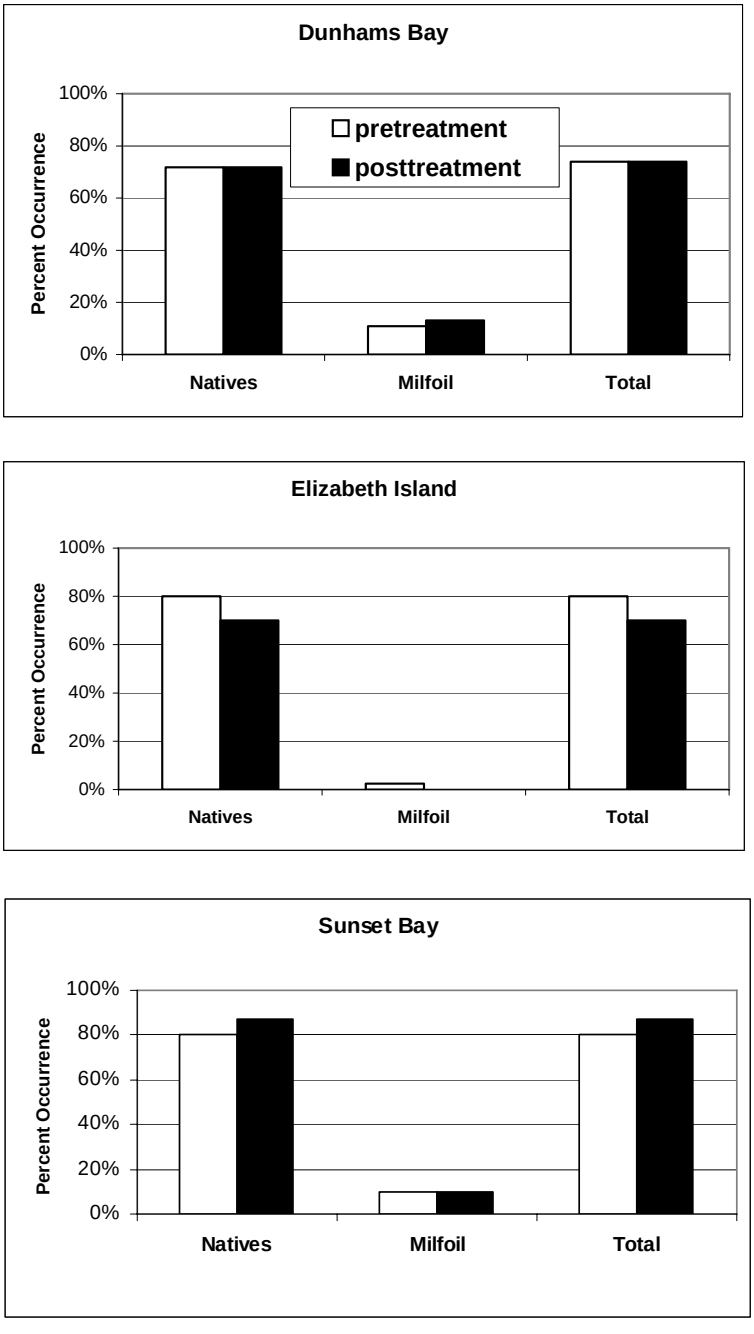


Table 4. Species richness comparison between all sites and surveys.

Plant Grouping	Summary Statistic	Dunhams Bay		Elizabeth Island		Sunset Bay	
		pretreat	posttreat	pretreat	posttreat	pretreat	posttreat
Native species	Mean	1.61	1.48	2.3	2.13	2.93	2.05
	N	100	100	100	100	100	100
	Std. Error	0.21	0.22	0.32	0.37	0.24	0.23
Exotic species	Mean	0.11	0.13	0.03	0	0.11	0.11
	N	100	100	100	100	100	100
	Std. Error	0.05	0.05	0.03	0	0.04	0.04
All species	Mean	1.72	1.61	2.33	2.13	3.04	2.16
	N	100	100	100	100	100	100
	Std. Error	0.21	0.24	0.33	0.37	0.26	0.25

Species richness results for all survey sites are presented in Table 4. Native plant species richness between sites was variable at 1.5 to 2.9 species per survey point (Figure 7). Differences between pretreatment and post-treatment were greatest at the untreated site, Sunset Bay, highlighting the heterogeneous nature of aquatic plant populations. Species richness for all survey sites and all species averaged 2.19 species per sample. The Dunhams Bay site had the fewest species per sample both pretreatment (1.61 ± 0.21) and post-treatment (1.48 ± 0.22). Two factors may account for the limited species richness in Dunhams Bay. In addition to supporting the largest area of dense EWM growth (1.1 acres) prior to benthic barrier installation, Dunhams Bay had approximately 0.3 acres of benthic barrier installed in 2005. An additional acre of benthic barrier material was installed in Dunhams Bay in 2006 between the pretreatment and post-treatment surveys.

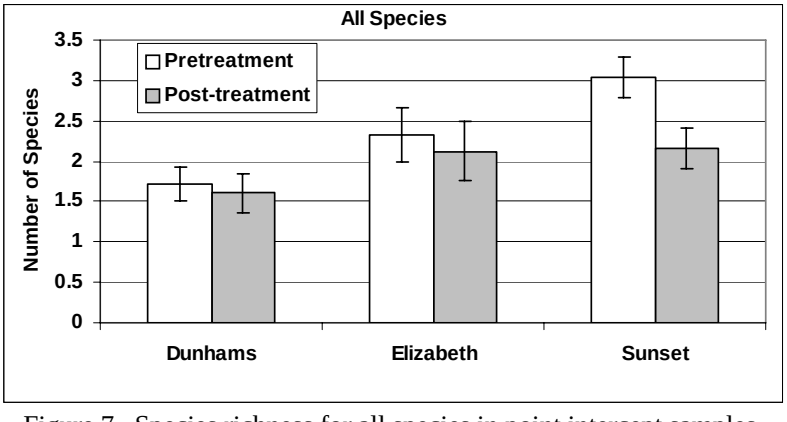


Figure 7. Species richness for all species in point intercept samples. Error bars are standard error of the mean.

Line Intercept Transects. Line intercept results differed from point intercept, although many individual species were represented in both (Tables 3 & 5). In Dunhams Bay, the most common species pre-treatment were *Vallisneria americana* (82%), *Potamogeton robbinsii* (46%), *Myriophyllum spicatum* (38%), *P. praelongus* (31%), *Elodea canadensis* (17%), *Najas flexilis* (15%), and *Isoetes echinospora* (11%). Post-treatment, Dunhams Bay was dominated by *Vallisneria americana* (28%), *Potamogeton robbinsii* (47%), *P. gramineus* (12%), *Myriophyllum spicatum* (10%), *P. praelongus* (19%), *Elodea canadensis*

(13%), *Najas flexilis* (14%), and *Isoetes echinospora* (2%). The line intercept transect in Dunhams Bay was sited through the area managed with benthic barrier, accounting for the decline in EWM frequency of occurrence following benthic barrier installation. In the Elizabeth Island Channel area, the most common species pre-treatment were *Chara sp.*

Table 5. Aquatic plant percent frequency by species for the line intercept transects.

	Dunham		**Elizabeth**		**Sunset**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Ceratophyllum demersum	4.0	3.0				
Chara sp.	2.0	5.0	46.0	23.0	16.0	48.0
Elatine minima	2.0	2.0		10.0	1.0	
Eleocharis acicularis	1.0	3.0			17.0	
Elodea canadensis.	17.0	13.0	8.0		42.0	69.0
Eriocaulon septangulare				6.0		
Isoetes echinospora	11.0	2.0	3.0			
Isoetes lacustris			26.0	35.0		
Juncus pelocarpus					7.0	
Lobelia dortmanna				1.0		
Megalodonta beckii (Bidens beckii)	6.0	7.0			2.0	
Myriophyllum sibiricum	1.0					
Myriophyllum spicatum	38.0	10.0	13.0		27.0	43.0
Myriophyllum tenellum				17.0	13.0	
Najas flexilis	15.0	7.0	6.0	26.0	34.0	1.0
Najas guadalupensis			2.0	5.0		
Potamogeton amplifolius						3.0
Potamogeton foliosus					3.0	
Potamogeton gramineus	3.0	6.0	4.0	13.0	6.0	15.0
Potamogeton perfoliatus	5.0	3.0		5.0	10.0	35.0
Potamogeton praelongus	31.0	19.0				
Potamogeton pusillus	1.0	1.0	1.0	5.0	10.0	4.0
Potamogeton robbinsii	46.0	47.0	1.0	21.0	16.0	15.0
Potamogeton spirillus	3.0	3.0	1.0		13.0	
Potamogeton vaseyii					19.0	
Potamogeton zosteriformis	5.0	4.0			11.0	19.0
Ranunculus longirostris	6.0	4.0			6.0	
Ranunculus reptans		2.0	1.0			
Sagittaria graminea	2.0					
Utricularia resupinata				2.0		
Utricularia vulgaris	5.0	2.0				
Vallisneria americana	82.0	28.0	6.0	50.0	60.0	72.0
Zosterella dubia (Heteranthera dubia)	5.0	5.0			26.0	27.0

(46%), *Myriophyllum spicatum* (13%), *Isoetes lacustris* (11%), *Elodea canadensis* (8%), *Vallisneria americana* (6%), and *Najas flexilis* (6%). Post-treatment, the most common species in the Elizabeth Island area were *Vallisneria americana* (50%), *Isoetes lacustris* (35%), *Najas flexilis* (26%), *Potamogeton robbinsii* (21%), *Myriophyllum tenellum* (17%), and *Chara sp.* (16%). EWM was absent from the Elizabeth Island transect post-treatment. In Sunset Bay, the most common species in 2006 were *Vallisneria americana* (60%), *Elodea canadensis* (42%), *Najas flexilis* (34%), *Myriophyllum spicatum* (27%), *Zosterella dubia* (26%), *P. vaseyii* (19%), *Eleocharis acicularis* (17%) and *Potamogeton robbinsii* (16%). In 2007, Sunset Bay was dominated by *Vallisneria americana* (72%), *Elodea canadensis* (69%), *P. perfoliatus* (35%), *Myriophyllum spicatum* (27%), *Zosterella dubia* (27%), *P. zosteriformis* (19%), *Potamogeton robbinsii* (15%), and *P. gramineus* (15%).

The number of species per transect in Dunhams Bay ranged from 21 pretreatment to 20 post-treatment. At Elizabeth Island, 13 species were reported pretreatment and 14 species post-treatment. In Sunset Bay, 20 species were recorded per transect in 2006 and 12 species in 2007. Species present have been variable between surveys, with a total of 22 species recorded between survey for Dunhams Bay, 19 species for Elizabeth Island and 21 species for Sunset Bay. Differences have generally been in the less common species, less than 2% frequency of occurrence.

Table 6. Species richness comparison between all sites and surveys for the line intercept surveys.

Plant Grouping	Summary Statistic	Dunhams Bay		Elizabeth Island		Sunset Bay	
		pretreatment	posttreatment	pretreatment	posttreatment	pretreatment	posttreatment
Native species	Mean	2.53	1.66	1.04	2.2	3.12	3.08
	N	100	100	100	100	100	100
	Std. Error	0.11	0.04	0.06	0.09	0.13	0.19
Exotic species	Mean	0.38	0.1	0.13	0	0.27	0.43
	N	100	100	100	100	100	100
	Std. Error	0.05	0.03	0.04	0	0.04	0.05
All species	Mean	2.91	1.76	1.17	1.97	3.39	3.51
	N	100	100	100	100	100	100
	Std. Error	0.09	0.17	0.06	0.09	0.13	0.21

Species richness results for line intercept surveys at all survey sites are presented in Table 6. Species richness between sites was variable at 1.2 to 3.5 species per survey point (Figure 8). Differences between pretreatment and post-treatment were greatest at the Dunhams Bay site, largely due to the transect passing directly through the area covered with benthic barrier. Species richness for all survey sites and all species averaged 2.24 ± 0.061 (SE) species per sample, a result comparable to results for the point intercept survey (2.19 ± 0.21). The Elizabeth Island Channel site had the fewest species per sample pretreatment (1.17 ± 0.06), however Dunhams Bay had the lowest richness post-treatment (1.76 ± 0.17). Species richness for Sunset Bay remained largely unchanged between pre and post-treatment line intercept surveys.

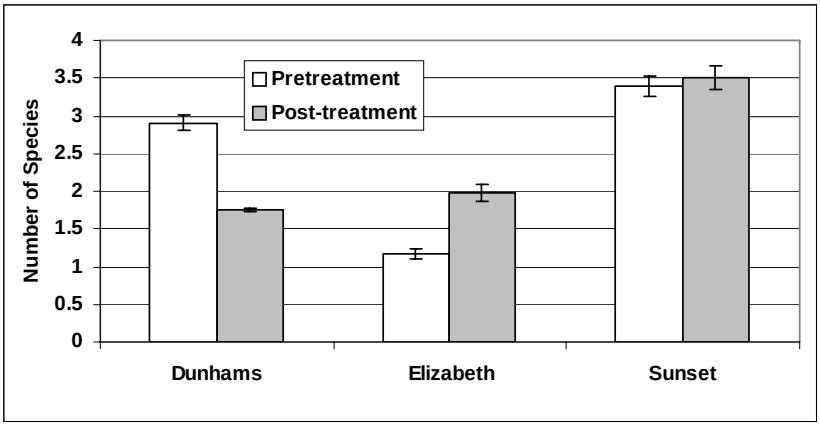


Figure 8. Species richness for all species in the line intercept survey. Error bars are standard error of the mean.

While frequency of occurrence provides measures of distribution and community composition, percent bottom coverage indicates the dominance of certain species within a population. Percent bottom cover estimates from the line intercept transects are provided in Table 7. For Dunhams Bay, the dominant species pretreatment were *Potamogeton robbinsii* (17% bottom coverage), *Vallisneria americana* (17%), *Myriophyllum spicatum* (12%), *P. praelongus* (7%), *Isoetes echinospora* (4%), and *Elodea canadensis* (3%). Post-treatment, *Myriophyllum spicatum* declined to 1% of bottom covered, while the other dominant species were substantially less variable. For the Elizabeth Island Channel area, the most common species pre-treatment were *Chara sp.* (38% bottom coverage), *Isoetes lacustris* (22%), *Myriophyllum spicatum* (3%), and *Elodea canadensis* (1%). Post-treatment, the most common species in the Elizabeth Island Channel area were *Isoetes lacustris* (16%), *Vallisneria americana* (8%), and *Chara sp.* (6%). *Myriophyllum spicatum* was absent. For Sunset Bay, the dominant species pretreatment were *Vallisneria americana* (13% bottom coverage), *Myriophyllum spicatum* (8%), *Elodea canadensis* (7%), *Najas flexilis* (7%), *Zosterella dubia* (4%), and *Eleocharis acicularis* (4%). Post-treatment, *Myriophyllum spicatum* increased to 11% of bottom covered, while the other dominant species were substantially more variable. *Elodea canadensis* and *Chara* sp. more than doubled their bottom coverage while *Najas flexilis* declined sharply to less than 1% cover. As mentioned previously, *Najas flexilis* is an annual which completes its life cycle by August and then dies back. Post-treatment surveys in September thus find only limited numbers of this species.

Table 7. Aquatic plant mean percent cover by species for the line intercept transects.

	Dunham		Elizabeth		Sunset	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Ceratophyllum demersum	0.6	0.5				
Chara sp.	0.3	0.8	38.1	6.3	3.1	9.0
Elatine minima	0.1	0.1		0.5	0.0	
Eleocharis acicularis	0.2	0.3			3.8	
Elodea canadensis.	2.6	1.8	1.4		7.3	16.4
Eriocaulon septangulare				1.6		
Isoetes echinospora	4.0	0.2	0.5			
Isoetes lacustris			22.1	16.0		
Juncus pelocarpus					1.3	
Lobelia dortmanna				0.2		
Megalodonta beckii (Bidens beckii)	0.9	1.1			0.3	
Myriophyllum sibiricum	0.2					
Myriophyllum spicatum	12.4	1.4	2.6		8.0	10.9
Myriophyllum tenellum				2.3	2.5	
Najas flexilis	2.3	1.1	0.4	4.1	7.4	0.2
Najas guadalupensis			0.3	0.8		
Potamogeton amplifolius						0.5
Potamogeton foliosus					0.3	
Potamogeton gramineus	0.5	0.9	0.6	1.8	1.1	2.3
Potamogeton perfoliatus	0.8	0.5		0.8	1.5	6.2
Potamogeton praelongus	6.7	4.7				
Potamogeton pusillus	0.2	0.2	0.2	0.8	1.0	0.6
Potamogeton robbinsii	17.1	17.1	0.2	4.1	2.4	2.3
Potamogeton spirillus	0.5	0.3	0.0		0.8	
Potamogeton vaseyii					1.6	
Potamogeton zosteriformis	0.8	0.6			1.7	2.9
Ranunculus longirostris	0.9	0.6			1.1	
Ranunculus reptans		0.3	0.1	0.2		
Sagittaria graminea	0.3					
Utricularia resupinata				0.3		
Utricularia vulgaris	0.8	0.3				
Vallisneria americana	16.8	7.7	0.9	8.4	13.3	10.1
Zosterella dubia (Heteranthera dubia)	0.8	0.8			4.2	6.3

Water Chemistry Effects

Monthly hose integrated water samples were collected from June through September at the three treatment locations. All management activities occurred between the July and August sample collection dates. The results for all chemical analyses are presented in Appendix D. Phosphorus is known to be the limiting nutrient in Lake George, meaning that it is an

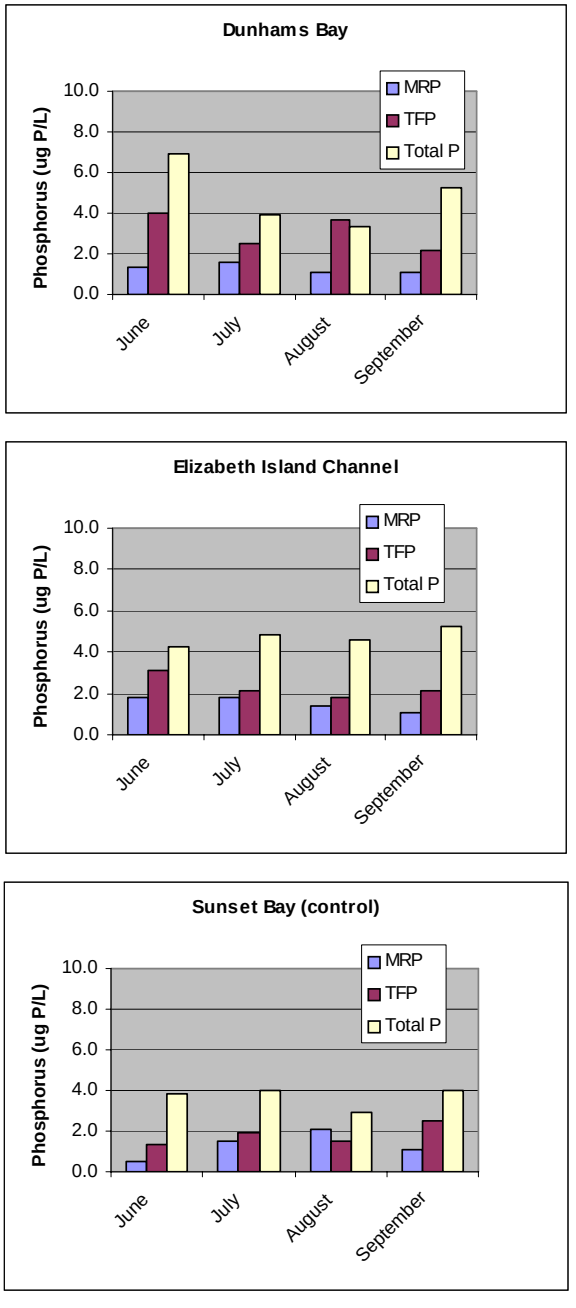


Figure 9. Phosphorus concentrations in the water column prior to, during and after benthic barrier installation at Dunhams Bay and Elizabeth Island Channel. MRP is the most biologically available form of phosphorus, TFP is total soluble phosphorus and TP is total phosphorus.

essential requirement for growth and productivity in the lake ecosystem, and is the least available of any of the necessary nutrients (Figure 9). Phosphorus was measured as three different forms: total phosphorus (TP), total soluble phosphorus (TFP), and reactive or orthophosphorus (MRP). TP is exactly as the name implies; measuring all forms of phosphorus in the water column at the time of sampling. TFP is a measure of all forms of phosphorus dissolved in the water column, and MRP is the amount of phosphorus in the water column that is most readily available for consumption by the phytoplankton.

Typically, Lake George has two times of peak TP levels, once in the spring and once in the fall. The spring peak is due to the rapid influx of nutrients, including P, from snowmelt and runoff throughout the basin. This rapid influx of nutrients outpaces the biological uptake and removal of phosphorus by sedimentation from the upper waters. Throughout the summer months TP levels decline due to the sedimentation of organisms that have taken up the P, and its removal from the water column via uptake by rooted aquatic plants. The fall overturn brings P into the surface waters from deeper strata. The soluble P becomes available for the primary producers (algae) in the photosynthetic zone (surface waters) and can often cause phytoplankton blooms in the fall. In 2006 however, severe storms and subsequent runoff events occurred in June, which may have been the cause of elevated levels of phosphorus observed in June in Dunhams Bay. The lake-wide epilimnetic mean TP concentration was 4.6 $\pm$ 1.1 μg P/l, with a south basin mean value of 4.9 $\pm$ 1.1 μg P/l and a north basin mean value of 4.3 $\pm$ 1.0 μg P/l (Eichler et al., 2007). Historically, higher values are seen in the southern basin (Dunhams Bay and Elizabeth Island Channel). Similar results are seen for average TP values in the near-shore waters. Shallow embayments frequently display elevated levels of P, particularly those receiving wetland inputs such as Dunhams Bay. The most likely source of phosphorus to this site under normal conditions is organic phosphorus containing material from the adjacent wetland system. Waters released from the wetland often cause the water in Dunhams Bay to take on a brown color as a result of dissolved organic compounds. This is a common occurrence in freshwater wetland systems.

Chlorophyll levels reflect the amount of algal biomass or standing crop in the water column. Chlorophyll levels are directly related to nutrient levels, primarily phosphorus in the case of Lake George. The pattern of chlorophyll closely follows the changing availability of the major nutrients needed for algal growth, namely phosphorus and nitrogen, where the spring and fall of the year show greater concentrations of chlorophyll than the summer. Rapid nutrient inputs from spring rains and snowmelt create a situation ideal for phytoplankton growth, allowing their populations to expand. As the rates of nutrient utilization and incorporation into biomass outpace inputs to the lake, populations die off and sink into the deeper waters, carrying with them the nutrients absorbed. The Lake George epilimnetic average for chlorophyll was 1.9 $\pm$ 0.8 (SD) μg/l in 2006.

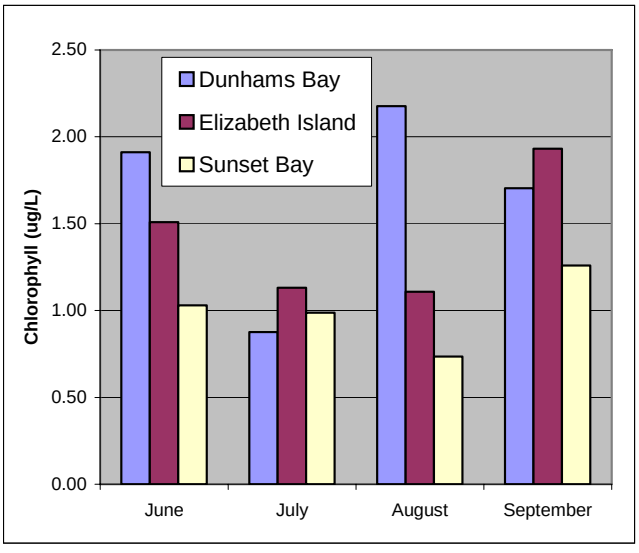


Figure 10. Chlorophyll concentrations in the water column prior to, during and after benthic barrier installation at Dunhams Bay and Elizabeth Island Channel.

The shallow waters do not behave in as predictable a manner. Being relatively close to a major source of nutrients to the lake at the shoreline, phytoplankton populations can fluctuate quickly as nutrients become available. The Dunhams Bay site is a good example of this (Figure 10) as chlorophyll concentrations fluctuate widely throughout the summer. Dunhams Bay experienced maximum chlorophyll levels in June and August before returning to lower levels in September. The June peak may be due to the heavy volumes of rain in June of 2006, which probably caused a rapid influx of nutrients into the bay from the adjacent wetland. All chlorophyll levels reported still remain well within oligotrophic ranges characteristic of Lake George. Chlorophyll levels in the north basin site (Sunset Bay) remained fairly stable across the sampling season.

Summary

In 2005, the FUND for Lake George secured a grant from NYS under the Milfoil Eradication Program to support management of Eurasian watermilfoil (*Myriophyllum spicatum* L.) in Lake George. The project was designed to eliminate three major beds of Eurasian watermilfoil (EWM). The sites were located in Dunham's Bay, Van Warmer Bay (Elizabeth Island Channel) and Sunset Bay, and represented critical areas where removal was beneficial to significant portions of the lake. The eradication program had three components: 1) assessment of the distribution and density of all plants including rare, threatened and endangered species both prior to and post eradication, 2) eradication of dense growth of EWM via installation of benthic barrier and 3) eradication of scattered and moderate density growth of EWM via hand harvesting at each location peripheral to benthic barrier installation. Program administration was conducted by the FUND for Lake George, physical aquatic plant management was provided by Lycott Environmental Services under the direction of the Lake George Park Commission and aquatic plant assessment was the responsibility of the Darrin Fresh Water Institute.

The current report focuses on the Darrin Fresh Water Institute aquatic plant assessment component. Aquatic plant assessment included point and line-intercept plant distribution and density data collections and GPS mapping of dense growth of EWM. Distribution of native and exotic species was assessed and mapped to provide logistic support to pre-plan benthic barrier installation and to maximize effectiveness of the EWM eradication efforts while minimizing impacts to non-target species. Surveys provided the basis for evaluation of impacts to both target and non-target species. Quantitative aquatic plant surveys were completed in 2006 for Dunhams Bay, Elizabeth Island Channel and Sunset Bay to obtain pre-treatment data prior to benthic barrier installations to control Eurasian watermilfoil (*Myriophyllum spicatum* L.). Pre-treatment surveys in 2006 reported dense growth of EWM covering nearly 2 acres at the 3 sites proposed for management. Management activities in 2006 and 2007 included installation of 1.9 acres of benthic barrier and hand harvesting at two of the three locations. Aquatic plant communities were quantified pretreatment and post-treatment by both point intercept and line intercept methodologies. The project deliverables included: a) aquatic plant identification at all three locations for compilation of species lists, b) maps of dense growth of Eurasian watermilfoil for each treatment location, c) point intercept frequency of occurrence data for all plant species for points distributed throughout each of the treatment sites, and d) line-intercept transect data for all plant species for each treatment site. For the two locations where benthic barrier was installed in 2006, results indicate that management was complete at one site (Elizabeth Island Channel) but additional benthic barrier installation was necessary to complete management at the other location (Dunhams Bay) in 2007. Native aquatic plant populations were similar pre and post-treatment, suggesting little impact from management activities. No management occurred at the third site (Sunset Bay), due to the changing abundance and distribution of Eurasian watermilfoil at that location.

A total of 45 species of aquatic plants were encountered at the 3 locations in Lake George. The aquatic plant community of Dunhams Bay included twenty-four submersed species, two floating-leaved species, one floating species and four emergent species. At the Elizabeth Island site, thirty submersed species, one floating-leaved species and one emergent species were reported. In Sunset Bay, twenty-six submersed species and one

emergent species were observed. .*Myriophyllum spicatum* was the only exotic species reported. One of the species encountered was on the New York Rare Plant List (Young, 2007), *Myriophyllum alterniflorum*, and two species were on the Watch List: *Megalodonta (Bidens) beckii* and *Isoetes lacustris*. *Myriophyllum alterniflorum* was reported for both the Elizabeth Island and Sunset Bay sites in limited numbers, pre-treatment, but was absent post-treatment at both locations. This species typically grows on sandy sediments in shallow water (less than 2 meters) throughout the Lake George basin. Its absence post-treatment should not be interpreted as a treatment effect since it was absent from both a managed (Elizabeth Island Channel) and a control (Sunset Bay) site. *Megalodonta (Bidens) beckii* was reported for all 3 locations while *Isoetes lacustris* was only reported from Elizabeth Island Channel. Frequency of occurrence for both species on the watch list either increased or remained unchanged within the relative error of the surveys. Both of these species are common members of the Lake George aquatic plant community.

Between seventy and eighty-eight percent of lake sampling points were vegetated by at least one native plant species, with native species clearly dominating at all locations. Eurasian watermilfoil was present in 3% to 11% of survey points pretreatment, and 0% to 13% of survey points post-treatment. Native species frequency remained relatively stable between pretreatment and post-treatment surveys at from 72 to 88% of survey points. Eurasian watermilfoil frequency of occurrence declined rapidly between pretreatment and post-treatment surveys at Elizabeth Island Channel, with no EWM reported post-treatment. Frequency of occurrence of EWM increased from 11% pre-treatment to 13% post-treatment at Dunhams Bay, however lake bottom percent cover declined from 12% pre-treatment to 1% post-treatment. At the Sunset Bay site, which received no treatment, EWM frequency of occurrence remained stable at 11% of survey points pre- and post-treatment. Total plant frequency of occurrence remained stable in both the managed and unmanaged sites. Both benthic barrier and hand pulling were employed at the Elizabeth Island Channel site while only benthic barrier was employed at Dunhams Bay. The combination of these two physical control techniques proved more effective at eradicating EWM than benthic barrier alone.

Native plant species richness between sites was variable at 1.5 to 2.9 species per survey point. Differences between pretreatment and post-treatment were greatest at the untreated site, Sunset Bay, highlighting the heterogeneous nature of aquatic plant populations. Species richness for all survey sites and all species averaged 2.19 species per sample. The Dunhams Bay site had the fewest species per sample both pretreatment (1.61 ± 0.21) and post-treatment (1.48 ± 0.22). Two factors may account for the limited species richness in Dunhams Bay. In addition to supporting the largest area of dense EWM growth (1.1 acres) prior to benthic barrier installation, Dunhams Bay had approximately 0.3 acres of benthic barrier installed in 2005. An additional acre of benthic barrier material was installed in Dunhams Bay in 2006 between the pretreatment and post-treatment surveys.

Dense EWM growth has been demonstrated to: 1) significantly reduce habitat complexity by eliminating native plant species including those considered RTE, 2) increase nutrient release from lake bottom sediments and impact water quality, 3) reduce species richness in the macroinvertebrate community, 4) interfere with fish spawning, 5) degrade and impair access for contact recreation, boating and fishing and 6) disrupt wetland function and structure. Impacts from management on native species can be minimized by selected

eradication methods. In Lake George, physical control techniques were chosen for their selectivity, including benthic barrier installation and hand harvesting. Hand harvesting provides a highly selective control technique with minimal impacts to non-target species. Diver training in species recognition by experts in aquatic plant identification further assures the selectivity of this method. Benthic bottom barriers provide 100% control of aquatic plant growth in areas where they are installed. The lack of selectivity of benthic barriers is minimized by limiting their use to areas where invasive aquatic species clearly dominate the plant community (>50% bottom cover). EWM growth has been demonstrated to have a greater impact on native plant populations than physical control activities; with few native species able to survive beneath a canopy of EWM. During the matting period, the short-term loss of a small number of native plant and animal species is expected, however native species reestablish when mats are removed. More importantly, benthic mats mitigate the long-term impacts EWM has on the entire food chain when used as a rapid response technique for eradicating pioneering colonies of EWM. Matting to clear high-use areas provides immediate recreational benefits to beaches, boat launches, and dock areas.

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