Darrin Fresh Water Institute

AT LAKE GEORGE

AN AQUATIC PLANT SURVEY OF FOREST LAKE & LAKE ALLURE WARREN COUNTY, NEW YORK

Prepared for

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EXECUTIVE SUMMARY

In 2000, an Aquatic Plant Survey of Forest Lake and Lake Allure was commissioned by the Northwoods Association. This survey was conducted by the Darrin Fresh Water Institute on October 5, 2000. The focus of the survey and current report are the status of aquatic plants in Forest Lake and Lake Allure, and management options for the future.

Findings

1. A total of 25 submersed plant species were observed in Forest Lake and Lake Allure in 2000. Of these species, the dominant plants were Robbins Pondweed, Broadleaf Pondweed, Variable Pondweed, Waterweed, Spikerush, Duck Celery, Pondweed and White Water Lily (*Potamogeton robbinsii, Potamogeton amplifolius, Potamogeton gramineus, Elodea canadensis, Eleocharis acicularis, Vallisneria americana, Potamogeton epihydrus* and *Nymphaea odorata*). This high diversity suggests a healthy aquatic plant population at the present time.

2. Aquatic plant growth was found from the waters edge to water depths of 3.5 meters (12 feet) in Forest Lake and 2.5 meters (8 feet) in Lake Allure. These depth distributions represent the entire areas of both lakes.

3. None of the aquatic plant species found in either Forest Lake or Lake Allure are on the New York State Rare or Threatened Species List.

Recommendations

1. The Northwoods Association should consider formation of an aquatic plant management committee, if one does not exist. This committee should review recommendations contained in this report and oversee aquatic plant management efforts, as necessary.

2. Very limited plant growth is observed in Lake Allure, thus no plant management is necessary. Aquatic plant growth in Forest Lake is extensive, with surface growth and canopy formation present for a number of species. Plant growth at its' current levels interferes with recreational use of Forest Lake.

3. Drawdown, as it is currently used, is the least expensive aquatic plant management option. Survey results suggest that aquatic plant populations are healthy at the current time, even after a number of years of annual drawdowns

4. The presence of Eurasian watermilfoil in one of the downstream lakes (Lake Luzerne) in this chain, makes prevention imperative. The Northwoods Association should post all boat access areas both on Forest Lake and Lake Allure and the inlet and outlet areas, with posters identifying Eurasian watermilfoil and urging all boaters to clean their boats prior to launching and upon retrieval. This will help prevent the introduction of exotic species to Forest Lake and Lake Allure.

Introduction

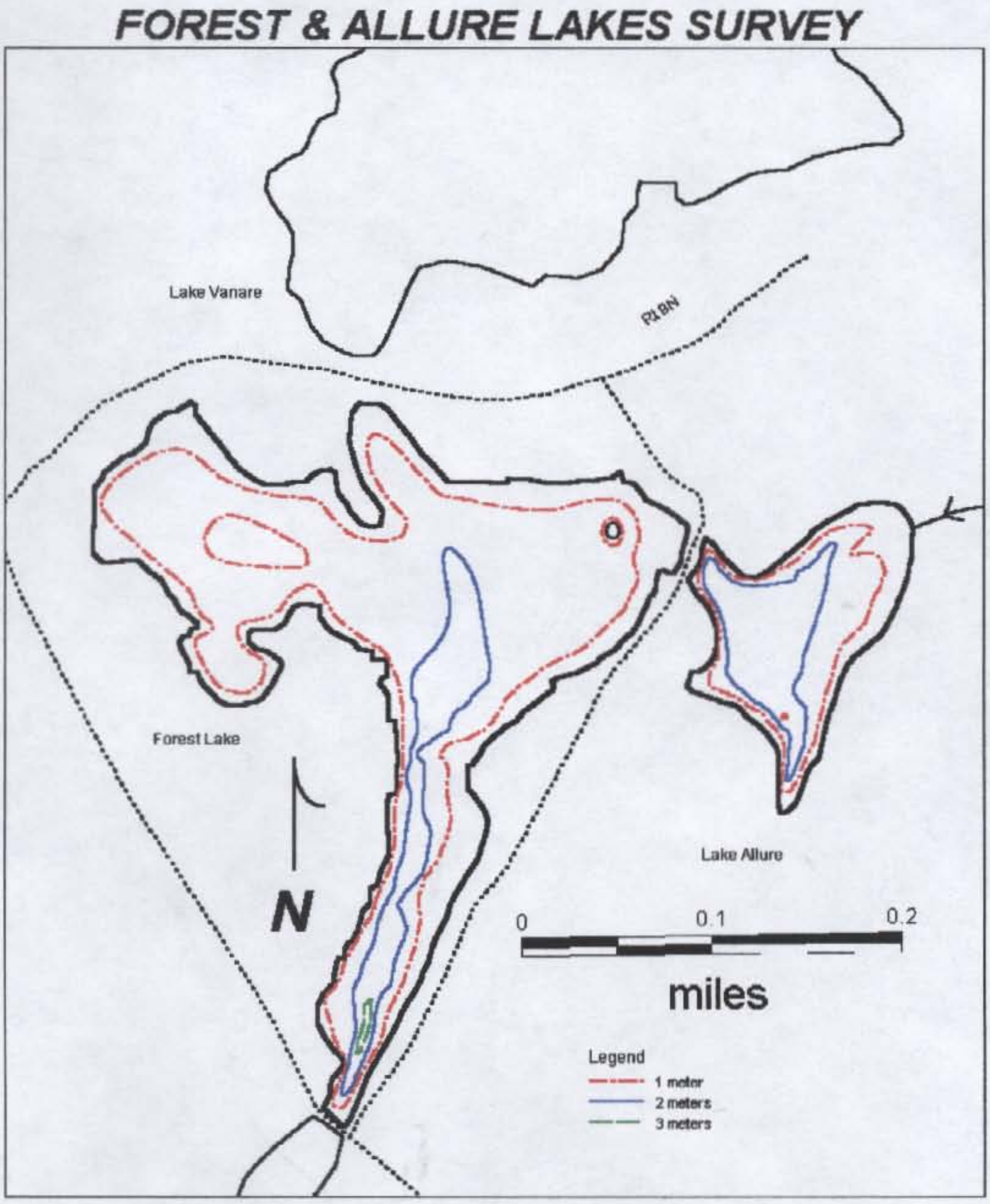
In August of 2000, an Aquatic Plant Survey of Forest Lake and Lake Allure was commissioned by the Northwoods Association. The survey was designed to provide information necessary to meet the requirements for an Aquatic Plant Management Permit from the Adirondack Park Agency. The current and proposed management programs are based on lake level drawdown. An annual lake level drawdown of approximately 2 feet had been conducted for many years on both Lake Allure and Forest Lake. In 1993, with the building of new outlet structures, Forest Lake could be drawn down approximately 7 feet, and Lake Allure approximately 4 feet below typical summer levels. Full drawdowns were employed in 1993 through 1996, with lake levels lowered in mid-October and left down until April. In 1997, the Northwoods Association initiated a permit application with the Adirondack Park Agency. One of the requirements of the permitting process was a survey of the existing plant populations in Forest Lake and Lake Allure.

The survey was conducted by the Darrin Fresh Water Institute as part of a Watershed Management Plan being developed in conjunction with the Warren County Soil and Water Conservation Service. The survey was completed on October 5, 2000. The focus of the survey and current report are to document the status of aquatic plant populations in Forest Lake and Lake Allure, review the existing aquatic plant management program and provide management options for the future. A bathymetric (depth) map of Forest Lake and Lake Allure was also completed in conjunction with the aquatic plant survey.

Background

Forest Lake and Lake Allure are situated in the Town of Luzerne, Warren County, New York. Surface elevation of Forest Lake is 705 feet above mean sea level. The lakes have surface areas of 26.2 and 6.4 acres, respectively, and shoreline lengths of 1.5 & 0.5 miles. The watershed area for the two lakes combined is 1051 acres, excluding upstream lakes such as Lake Vanare (J. Lieberum, pers. comm.). Maximum depth was approximately 3.5 meters (12 feet) in Forest Lake and 2.8 meters (9 feet) in Lake Allure on October 5, 2000; the time of the current survey. Forest Lake and Lake Allure are part of a chain of lakes, including Vanare, Fourth, Third, Second and Luzerne, with their ultimate drainage to the Hudson River in Hadley.

Figure 1. Bathymetric map of Forest Lake and Lake Allure. Contours are 1 meter.



Assessment Methods

The location of scattered and dense native plant populations for the entire lake were recorded by divers trained in plant identification. To quantify the aquatic plant populations present in the lake, transects were located evenly around the lake. At each transect, all aquatic plant species and their relative abundance were recorded at one meter depth intervals using the following abundance classes: abundant (greater than 50%

bottom cover), common (25 to 50% cover), present (15 to 25% cover), occasional (5 to 15% cover) and rare (less than 5% cover). This data provides both average depth distribution of plants, and an estimate of the relative abundance of all species in the lake.

In order to characterize the aquatic plant community of Forest Lake and Lake Allure, six sites were selected for transects (Figure 2 and Table 1). Sites were chosen to provide samples representative of the lake as a whole. Selection criteria included: water depth, degree of shoreline development, density of aquatic weed growth, and proximity to inlets and outlets.

Table 1. Diver survey transect site locations and physical characteristics.

Site Number	Site Name	Sediment Type	Bottom Slope
Forest 1	Association Beach	Sand to silt	moderate
Forest 2	Southwest Shore	Sand to silt	gradual
Forest 3	Vanare Inlet	Sand to soft silt	gradual
Forest 4	West Cove	Silt and peat	flat
Allure 1	Inlet	Sand to silt	gradual
Allure 2	South Cove	Sand to silt	gradual

Instrumentation used to develop bathymetric maps included a Trimble TDC1 Asset Surveyor™ GIS/DGPS data collection system (Trimble Navigation Ltd, Sunnyvale, CA), an Eagle™ SupraPro I.D. acoustic depth sounder (Lowrance, Tulsa, OK).

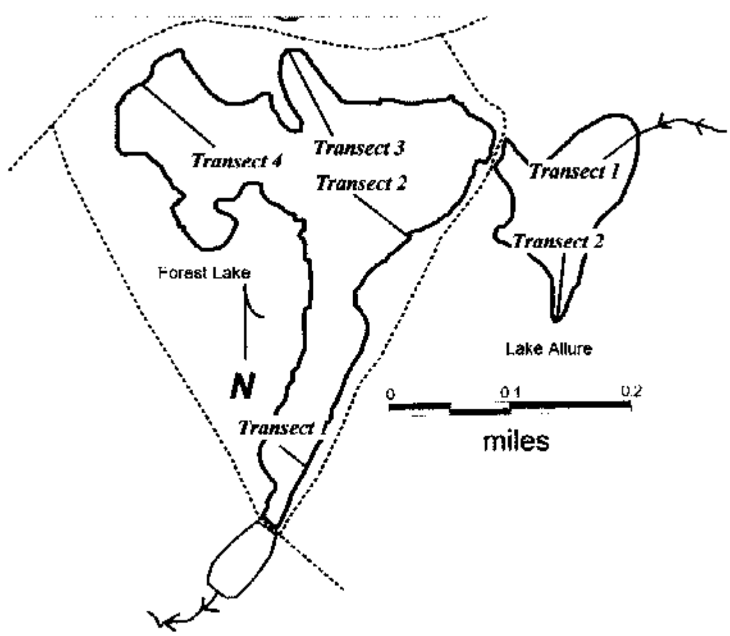
The Trimble navigation system was programmed to utilize a minimum of five satellites at any given time, thus reducing the Position Dilution of Precision (PDOP) Mask to less than 6, a standard set to achieve horizontal accuracy better than 50 centimeters (cm). PDOP is a measure of the satellite geometry in the sky, and indicates accuracy with which the Global Positioning System (GPS) positions are recorded. The Signal-To-Noise Ratio (SNR) Mask was also set to 6. This is a measure of the background noise that can interfere with signals from the satellites. The TDC1 Asset Surveyor was also configured for an Elevation Mask of 15°, a setting to ensure that only data from satellites 15° or more above the horizon is recorded. If data from satellites less than 15° above the horizon is incorporated, accuracy in the GPS is compromised. The occupation period for 50 cm horizontal accuracy was set to a one-second occupation time to allow for proper positioning data.

In order for positioning data to be available for use without post processing, differential correction (DGPS) was incorporated. To achieve improved accuracy for this real-time data, the Trimble system was programmed to receive signals from a remote base station (in addition to the minimum of five satellites). Connection to the remote base station allows the Trimble system to compute positioning data from satellite links and correct the information to provide a highly accurate location. If connection to this remote link is lost, the Trimble system stops logging data from the satellites thus ensuring exclusion of inaccurate data. Data almanacs were downloaded daily to determine the times of day when greatest precision (largest number of satellites) were available.

The Eagle™ acoustic depth sounder was calibrated for various depths using a weighted fiberglass tape (Keson, Warrenville, IL), where measurement of the tape was recorded simultaneously with measurements from the Eagle™ depth sounder. Correction factors were applied to the depth sounder measurements.

Depth contours were prepared by compiling numerous discrete location/depth points. After all data points were recorded on the Trimble datalogging system, the information was downloaded to Trimble Pathfinder Office™ version 2.10 software. The coordinates were then exported into MapInfo Professional™ version 5.5 (MapInfo Corp., Troy, NY), for contour generation and graphic representation.

Figure 2. Transect location and number for Forest Lake & Lake Allure.



Aquatic Plants

A list of all submersed and floating-leafed aquatic plant species observed in Forest Lake and Lake Allure is given in Table 2. A total of 25 species were observed between the two lakes, 24 species in Forest Lake and 10 species in Lake Allure. Of these species, one is a macroscopic alga, or charophyte (*Chara/Nitella*), two were emergent species (*Scirpus* and *Typha*), three were pad-forming species (*Brasenia, Nuphar,* and *Nymphaea)* and the remaining 19 are submersed. Given the small size of Forest Lake and Lake Allure, the number of species observed indicates excellent diversity, typical of low-elevation Northeastern lakes (Madsen et al. 1989). For instance, Lake George has 47 submersed species (RFWI et al., 1988) and 28 were observed in Lake Luzerne (Eichler and Madsen, 1990; Eichler et al., 1998). The composition of the species list for Forest Lake and Lake Allure are similar to that of other nearby lakes. For instance, all of the species observed in Forest Lake and Lake Allure have been noted for other regional lakes (Madsen et al., 1989). A list of all transect survey data is included as Appendix III.

Table 2. Aquatic plant species list for Forest Lake and Lake Allure.

Species	Common Name	Lake		Abundance
		Allure	Forest	
Brasenia schreberi	Water Shield		X	Present
Chara/Nitella	Muskgrass	X	X	Rare
Elatine minima	Little Elatine	X	X	Rare
Eleocharis sp.	Spike Rush	X	X	Rare
Elodea canadensis	Waterweed		X	Present
Isoetes echinospora	Quillwort	X		Rare
Najas flexilis	Water Naiad		X	Rare
Nuphar luteum	Yellow Pond Lily	X	X	Dominant
Nymphaea odorata	White Pond Lily		X	Dominant
Polygonum sp.	Smartweed		X	Rare
Potamogeton alpinus	Pondweed		X	Rare
Potamogeton amplifolius	Broad-leaf Pondweed	X	X	Dominant
Potamogeton epihydrus	Leafy Pondweed	X	X	Present
Potamogeton gramineus	Variable Pondweed		X	Dominant
Potamogeton pusillus	Pondweed	X	X	Present
Potamogeton robbinsii	Robbins Pondweed		X	Dominant
Potamogeton spirillus	Pondweed	X	X	Rare
Potamogeton vaseyi	Vasey's Pondweed		X	Rare
Utricularia minor	Bladderwort		X	Present
Utricularia intermedia	Bladderwort		X	Present
Utricularia vulgaris	Giant Bladderwort		X	Rare
Scirpus subterminalis	Bulrush		X	Rare
Sparganium sp.	Bur-reed	X	X	Rare
Typha sp.	Cattail		X	Rare
Vallisneria americana	Duck Celery		X	Present

One important factor to account for during the permitting process for any aquatic plant management program is the occurrence and abundance of rare plant species that might be affected by a given management technique. None of the plant species observed in either Forest Lake or Lake Allure are on the New York State Rare Plant list (Mitchell, 1986; Clemants, 1989; Young, 1999).

Aquatic plant survey data for all transects is included as Appendix I. For Forest Lake, transect one was located near the outlet, adjacent to the Association Beach on the east side of the lake (see Figure 2). In the shallow zone (0-1 m), species diversity was high (13 species) with waterweed (*Elodea canadensis*), spike rush (*Eleocharis* sp.) and pondweeds represented. From 1 to 2 meters, Variable Pondweed (*Potamogeton gramineus)* shared dominance with waterweed. Beyond 2 meters depth, Robbins Pondweed (*Potamogeton robbinsii*) dominated the plant community, forming a low growing carpet over the lake bottom. Moderate growth of Broadleaf Pondweed (*Potamogeton amplifolius*) was also observed in this area.

The sandy shoreline at transect 2 sloped gradually to the edge of the lake. Robbins Pondweed dominated at all water depths. In shallower zones (0-1 meters), spike rush shared dominance. Beyond a depth of 1 meter, Variable Pondweed was common.

A gradually sloped site with sand near shore (0 - 1 meter depth) changing to sand and silt in deeper water was examined at Transect 3. Dominant species from 0 to 1 meters included *Potamogeton robbinsii, Vallisneria americana* and *Utricularia minor*. Robbins Pondweed dominated at 1 to 2 meters. The pad forming water lilies and water shield were also common.

Transect 4 was a flat sloped site, with silty sediments and peat dominant. In the shallow zone, less than 1 meter, the dominant species were Robbins and Broadleaf Pondweed. Beyond a depth of 1 meter the plant community was very diverse, but still dominated by Robbins Pondweed.

For Lake Allure, transect one was located near the inlet (see Figure 2). In the shallow zone (0-1 m), species diversity was low (5 species), with spike rush (*Eleocharis* sp.) and pondweeds represented. From 1 to 2 meters, Pondweeds (*Potamogeton epihydrus* and *P. spirillus)* were the only species observed.

Transect 2 in Lake Allure was located in the southern bay. Sandy sediments dominated and the bottom slope was gradual. Species diversity was extremely limited with only seven species present, and none of the species exceeding 5% bottom cover.

The depth distribution and cumulative percent cover, listed in alphabetical order, for all aquatic plants in Forest Lake and Lake Allure is shown in Table 3. These species are ranked in order of abundance in Table 4. The majority of species occur between the waters edge and 2 meters. The littoral zone or area where rooted plants can grow included all areas of both lakes.

The depth distribution of the ten most common species is displayed in Figure 3. From this graph, the most typical dominants for each depth interval can be summarized. The dominant species for all depths in Forest Lake was *Potamogeton robbinsii*. The littoral or zone of aquatic plant growth extended from the waters' edge to the maximum depth of the lake (3.5 meters). Aquatic plant growth was extensive, with both canopy and understory species represented. Other typical species in shallow waters (0 - 1 m) included *Potamogeton amplifolius* and *P. gramineus*. In deeper waters (1 - 2 meters depth*), Elodea canadensis* and the water lilies *(Nuphar* and *Nymphaea)* joined *P. amplifolius* and *P. gramineus* as common species. In water depths of 2-3 meters, *Potamogeton amplifolius* and *P. pusillus* were also common.

In Lake Allure, the aquatic plant population was quite limited, with a total of 10 species present and percent cover rarely exceeding 10% of the lake bottom. Small littoral zone size, coarse sediments and extensive shading by shoreline vegetation severely restrict the aquatic plant species present in Lake Allure.

Table 3. Cumulative Percent Cover for All Species and All Depth Intervals

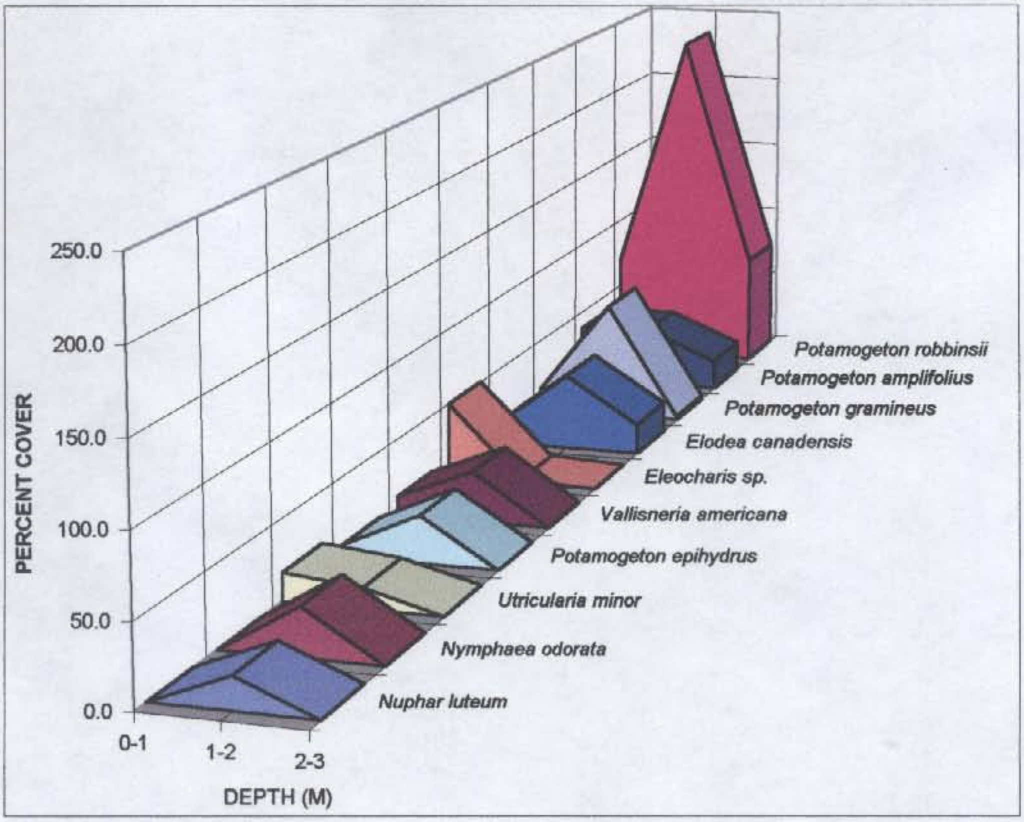
Forest Lake		Depth Interval (m)		Total
Species	0-1	1-2	2-3	
Brasenia schreberi	0	12.5	0	12.5
Elatine minima	10.0	0	0	10.0
Eleocharis sp.	50.0	2.5	0	52.5
Elodea canadensis	12.5	50.0	20.0	82.5
Najas flexilis	2.5	2.5	2.5	7.5
Nuphar luteum	0	20.0	0	20.0
Nymphaea odorata	0	30.0	0	30.0
Polygonum sp.	2.5	0	0	2.5
Potamogeton amplifolius	37.5	40.0	20.0	97.5
Potamogeton epihydrus	7.5	30.0	0	37.5
Potamogeton gramineus	15.0	77.5	2.5	95.0
Potamogeton pusillus	2.5	0	0	2.5
Potamogeton robbinsii	70.0	235.0	75.0	380.0
Potamogeton spirillus	5.0	2.5	0	7.5
Potamogeton vaseyii	10.0	0	0	10.0
Scirpus subterminalis	0	20.0	0	20.0
Sparganium sp.	2.5	0	0	2.5
Utricularia intermedia	5.0	12.5	0	17.5
Utricularia minor	17.5	12.5	0	30.0
Utricularia vulgaris	2.5	5.0	0	7.5
Vallisneria americana	12.5	32.5	0	45.0
Total	***265***	***585***	***120***	***970***

Lake Allure				
Chara sp.	2.5	10.0	0	12.5
Elatine minima	2.5	0	0	2.5
Eleocharis sp.	2.5	0	0	2.5
Isoetes echinospora	2.5	2.5	0	5.0
Nuphar luteum	0	2.5	0	2.5
Potamogeton amplifolius	5.0	0	0	5.0
Potamogeton epihydrus	2.5	5.0	0	7.5
Potamogeton pusillus	2.5	0	0	2.5
Potamogeton spirillus	5.0	2.5	0	7.5
Sparganium	2.5	0	0	2.5
Total	***27.5***	***22.5***	***0***	***50***

Table 4. Cumulative Percent Cover for All Species and All Depth Intervals Listed In Order of Abundance.

Forest Lake		Depth Interval (m)		Total
Species	0-1	1-2	2-3	
Potamogeton robbinsii	70.0	235.0	75.0	380.0
Potamogeton amplifolius	37.5	40.0	20.0	97.5
Potamogeton gramineus	15.0	77.5	2.5	95.0
Elodea canadensis	12.5	50.0	20.0	82.5
Eleocharis sp.	50.0	2.5		52.5
Vallisneria americana	12.5	32.5		45.0
Potamogeton epihydrus	7.5	30.0		37.5
Nymphaea odorata		30.0		30.0
Utricularia minor	17.5	12.5		30.0
Nuphar luteum		20.0		20.0
Scirpus subterminalis		20.0		20.0
Utricularia intermedia	5.0	12.5		17.5
Brasenia schreberi		12.5		12.5
Elatine minima	10.0			10.0
Potamogeton vaseyii	10.0			10.0
Najas flexilis	2.5	2.5	2.5	7.5
Potamogeton spirillus	5.0	2.5		7.5
Utricularia vulgaris	2.5	5.0		7.5
Polygonum sp.	2.5			2.5
Potamogeton pusillus	2.5			2.5
Sparganium sp.	2.5			2.5
Lake Allure				
Chara sp.	2.5	10.0		12.5
Potamogeton epihydrus	2.5	5.0		7.5
Potamogeton spirillus	5.0	2.5		7.5
Isoetes echinospora	2.5	2.5		5.0
Potamogeton amplifolius	5.0			5.0
Elatine minima	2.5			2.5
Eleocharis sp.	2.5			2.5
Nuphar luteum		2.5		2.5
Potamogeton pusillus	2.5			2.5
Sparganium	2.5			2.5

Figure 2. Depth distribution of the aquatic plant species in Forest Lake.



Aquatic Plant Populations in Forest Lake and Lake Allure

At the current time, Forest Lake supports a healthy, diverse, native aquatic plant population. The majority of the littoral zone is covered by aquatic plants, even in the shallow water zone exposed by annual drawdowns. In the 0 to 1 meter depth interval, approximately 90% of the lake bottom is covered by plants. In deeper waters, percent cover exceeds 100%, due to the presence of a canopy of tall plants, with understory species beneath them.

Annual winter lake level drawdowns, from 1993 through 1996, have not produced an impoverished flora. This may be due to the presence of numerous aquatic plant species which are tolerant of dehydration. This resistance is common among annuals or species which grow from seed each year (e.g. Naiads and selected Pondweeds). Seeds are durable, and frequently unaffected by freezing or desiccation. Species with sub-sediment runners, rhizomes or tubers, are also tolerant of freezing and desiccation (e.g. *Vallisneria*, some Pondweeds and water lilies). Many of the species present in Forest Lake fall into these two categories.

Lake Allure supports only a limited number of aquatic plant species at low densities. Lake bottom conditions including sand and gravel sediments, coupled with limited light availability due to the forested nature of the watershed may account for limited plant populations. Drawdown may also partially account for the limited number and density of aquatic plant species.

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Appendix I. Water Quality Management Options

Water quality management is generally keyed to maintenance or improvement of an accustomed use rather than what is best for a lake from a purely environmental standpoint. In the case of Forest Lake and Lake Allure, maintenance for recreational uses such as swimming, sailing and fishing is the desired goal. The principal threat to these uses at present is excessive growth of aquatic plants and algae in Forest Lake.

Forest Lake has relatively high productivity in terms of rooted aquatic plants, a condition which is undesirable in light of the desired use of the lake. Productivity of both suspended algae and rooted aquatic plants is tied to the availability of nutrients or fertilizers in the lake water and sediments.

Maintenance or reduction in the density of aquatic plants and algae, from a water quality standpoint, revolves around reduction of the amount of nutrients present in or added to the lake. A management plan to reduce nutrient concentrations draining into the lake from the shoreline areas should include the following basic components.

EDUCATION
PREVENTION
IMPLEMENTATION OF CONTROLS
MONITORING AND EVALUATION

Education. In order to develop support for lake management, area residents need to understand the need for and the justification of activities relative to water quality management. They need to understand how their actions may affect the use of the lake and how they can get assistance to remedy any real or perceived problems. Education can provide understanding and enlist support for programs to improve water quality. In order to assist your association in developing an educational program for your members, a number of regional organizations exist, including:

- New York State Department of Environmental Conservation
- Warren County Cooperative Extension Service (4-H)
- Warren County Soil and Water Conservation District
- Area Universities and Colleges
- Lake Luzerne Planning and Zoning Department

These agencies will provide speakers and technical assistance in developing and implementing water quality protection and management plans.

Prevention. The protection of water quality will start with prevention of excess nutrients from entering the lake. Nutrients enter the lake in three ways; directly with precipitation, through runoff of waters from the lake's watershed and via resuspension from the sediments of the lake. Little can be done to reduce the amount of nutrients falling directly on the lake as precipitation, at least on the local level. Substantial reductions in the nutrients carried by runoff waters can be accomplished by local residents at the grass roots level. Reduction of nutrients coming into the water column of the lake via resuspension from the sediments will generally require in-lake control.

Reductions of the amount of impermeable surfaces adjacent to the lake (paved roads and driveways, sidewalks, etc.) will slow the flow of rainwater to the lake by forcing it to percolate through soils prior to entering the lake. Soils act as a natural filter removing much of the nitrogen and phosphorus compounds before the water reaches the lake. Eliminating stormwater drains emptying directly into the lake is also helpful. The drains may be redirected to small graveled areas for slow dispersal of the water. Sediment traps can be installed in roadside drainage ditches to capture the larger grained sediments and debris before it enters the lake.

Sewage from failing or improperly located septic systems can be a major source of nutrients to a lake. In a properly maintained and located septic system, solid material is allowed to settle in the septic tank where microorganisms can decompose it into water-soluble material. The water-soluble components (leachate) are allowed to pass into lateral drainage fields where the liquid slowly percolates into adjacent soils. In the soil, chemical reactions and bacteria remove the nitrogen and phosphorus compounds from the water and convert it to insoluble material, cellular material and gaseous material. Thus, in a properly operating system nitrogen and phosphorus are removed or reduced before the water finally percolates back to the lake. In a system which is not operating properly, insufficient time is available for complete removal of nitrogen and phosphorus compounds before the leachate reaches the lake.

Eroding soils carry considerable amounts of nutrients into the lake. Soils generally contain much greater amounts of nitrogen and phosphorus compounds than lake-water. If soils are stabilized by good vegetation cover, only small amounts of nutrients are washed into the lake. If large areas of timber are logged or if roads and developments are improperly designed, large-scale erosion of soils frequently results. Soil erosion may be controlled in several ways by: 1) maintaining or planting effective ground cover vegetation (e.g. Crown Vetch) in erosion prone areas, 2) restricting the amount of acreage that may be logged at any one time and the time of year when logging operations occur, 3) providing guidelines on road construction within the area and methods that contractors use to develop property, and 4) maintenance of a vegetated area along the shoreline. Considerable amounts of soils are deposited in the lake by streams and drainage ditches. Some of the soils may be kept out of the lake by minimum adjustments to the stream bed to reduce the water velocity in the stream prior to entry into the lake. Reduced water velocity in the stream will cause the bulk of the suspended soils to be deposited in the low velocity area and with occasional clean-out this area can be maintained fairly easily. Your local Soil Conservation Service representative can provide valuable assistance in determining the extent of erosion problems and suggesting methods for soil conservation.

The runoff of fertilizers applied to lawns and gardens can frequently add nitrogen and phosphorus to a lake. There are a number of "common sense" methods for reducing the inputs from these sources. Don't fertilize early in the spring or at other times when soils are saturated from a recent rainstorm. Try to apply small amounts of fertilizer more frequently (i.e. twice per year add one-half the amount usually applied once per year). Don't locate vegetable gardens or other gardens that you plan to fertilize heavily close to the lake. Don't fertilize immediately before a rainstorm is forecast.

Implementation of Controls. A number of control techniques are available, however each has advantages and disadvantages. Control of nutrient inputs from the terrestrial part of the lake basin has been discussed in the previous section. In-lake controls are frequently costly, large scale projects requiring permits from state and local agencies. Considering the good water quality, in-lake controls for nutrient reduction are not warranted at present.

Monitoring and Evaluation. Monitoring of runoff areas by your association is desirable. In addition to the plant survey presented in this report association members in conjunction with their water quality committee can make certain observations and measurements that will prove useful in observing any long-term trends in water quality. Membership in the Citizens Statewide Lake Assessment Program (CSLAP) sponsored by the New York State Department of Environmental Conservation and the NYS Federation of Lake Associations (NYS FOLA) can also provide volunteer assisted water quality monitoring a very little cost. On a three to five year basis, more complete chemical assays and observations of the lake are advisable. These analyses will act as a "report card" to determine how successful control techniques have been. Collection of samples can be done by lake association members and then analyzed by consulting laboratories or with the assistance of state agencies (CSLAP). Aquatic plant assessments similar to that contained in this report can be contracted for. Water quality is representative of not only the chemical condition of the lake water but also the plant and animal communities present. Understanding how these components interact is critical for effective lake management.

Appendix II. Management of Aquatic Plants in Forest Lake and Lake Allure

Although lake residents all want immediate action, the first step in addressing aquatic plant growth problems in Forest Lake is to develop a long-term aquatic plant management plan as a component of an overall lake management plan. A long-term plan is needed, since it is unlikely (if not impossible) that nuisance, or weedy aquatic plant growth can be eradicated from the lake. Even if elimination were to be accomplished, continued vigilance would be necessary to prevent any future re-introductions.

Some specific components to address in any aquatic plant management plan are:

Education
Prevention
Implementation of Controls
Evaluation and Monitoring

Education. Education of lake-users and homeowners is imperative to develop support for management efforts, and to gather volunteers to assist with the program. Homeowners and lake-users must have a basic understanding of nuisance aquatic plants and how to prevent further introductions and spread. One fact is becoming clear, in these times of limited funding opportunities, the only way to protect your lake is to join forces and do it as a lake association. In addition to educational materials, surveys also provide insights into the issues and priorities of the lake-users. Periodic surveys of property owners and recreational users can define the needs of any management program. The surveys also indicate the level of support or resistance for management efforts; information which is critical to the permitting process for management efforts.

Prevention. Once control has been successful, efforts must be made to prevent introduction of non-native aquatic plants, and slow the growth of aquatic vegetation in general. Prevention efforts might include education, non-point pollution control, erosion management and encouraging the introduction and growth of beneficial native plants.

Evaluation and Implementation of Controls. A wide variety of control techniques are available, none of which provides a perfect solution. All techniques have advantages and drawbacks. Each location with nuisance aquatic vegetation must be assessed individually, and a control technique selected that will work under those conditions.

The vegetation management committee must study the control options and decide on a suitable group of control techniques. Do not rely solely on consultants to decide for you. One important consideration generally neglected is that these techniques will have to be approved through a permitting process, so select techniques that will be acceptable to the permit administrator. The permits for aquatic plant control within the Adirondack Park are administered by the Adirondack Park Agency, outside the park the NYS Department of Environmental Conservation is the permit administrator.

Aquatic plant management options fall into 4 major groups:

Physical - lake level drawdown, hand harvesting or benthic barrier

Mechanical - harvesters, dredges and rakes

Chemical - herbicides

Biological - pathogens, herbivores and parasites

Of these four categories, only biological, physical and chemical means offer the possibility of long-term reductions in aquatic plant growth for Forest Lake. There are currently two viable biological control options: 1) grass carp, a plant eating fish, is approved in New York State and 2) herbivorous insects which include beetles and aquatic moth larvae (caterpillar). Grass carp may not be particularly suitable for Forest Lake since they are completely non-selective in their feeding habits, consuming all types of vegetation. Control structures to keep the grass carp from leaving the lake are also necessary. Grass carp may also produce turbidity problems related to resuspension of bottom sediments when feeding. Herbivorous insects are experimental at the current time, but appear to have potential for long-term control of certain aquatic plant species. Since all aquatic plant growth in Forest Lake is by native species, biological control is unlikely to provide a consistent benefit.

Mechanical controls, while they may be useful in a long-term maintenance program, do not generally eliminate the target plant species from a given area, but simply reduce its abundance to allow recreational use. While raking and harvesting (cutting) can provide some relief for lakeside residents, longer-term control is generally desired. Mechanical harvesting can also have a side effect of spreading plant fragments during the process of cutting. These fragments may start new populations or increase the density of existing populations. Given the limited concern for nuisance plant growth in Forest Lake, mechanical cutting is probably not warranted. Manual cutting and removal may fit into an integrated aquatic plant management program.

Lake level drawdown, a physical control technique, lowers lake water levels in the winter in order to freeze the plants. Water levels are drawn down in the Fall of the year and allowed to remain low until early Spring. The combination of dehydration, freezing and thawing has proven effective at limiting the abundance of certain plant species. The presence of a lake outlet structure on both Forest Lake, will allow a lake level reduction of from 4 to 7 feet. This level change should be more than adequate to reduce plant growth in the shallow portion, less than 2 meters depth, of the lake basin. This technique has had success on nuisance plant growth in several area lakes, including Forest Lake, Saratoga Lake and Galway Lake. From 1993 through 1996, annual winter drawdowns of Forest Lake were conducted.

Benthic barriers, fabric stretched over the lake bottom to smother plants, also have been successful for aquatic plant control. Benthic barriers typically cost from $15,000 to $25,000 per acre, installed. Significant cost savings can be achieved by the use of non-typical barrier materials such as belt press cloths, sand and others in place of commercially available benthic barrier materials. Benthic barriers are only recommended for small areas of dense growth of nuisance plants, primarily due to environmental considerations due to their totally non-selective nature for aquatic plant control. Cost also becomes a factor when large areas are to be managed by this technique.

The availability of a suction harvester from East Caroga Lake, or possibly Lake George, makes this a viable plant management option. Suction harvesting is essentially an automated hand harvesting procedure. Divers scoop up plants, including roots, and feed them into a suction hose. The hose transports the plants and their associated sediments to a mesh basket at the surface, where the sediments are allowed to wash out and settle to the lake bottom. This form of management is labor intensive, but has the advantage of being very selective for the removal of nuisance species with little impact to other plant species present. Costs for this technique are on the same order as benthic barrier per unit area.

Chemical or herbicide application offers a possible alternative for aquatic plant control in Forest Lake. The limited extent of nuisance growth in Forest Lake, however, probably excludes herbicides from consideration. While herbicide application is often inexpensive on a per acre basis, when compared to physical plant controls, the time and costs associated with acquiring a permit for herbicide application frequently make this technique more costly. There are a number of herbicides on the market which are used for aquatic plant management. The most commonly used and/or recommended include Aqua-Kleen (2,4-D) and Sonar (fluridone). New York State requires that these chemical herbicides be applied by a licensed applicator. The lake association may wish to contact an applicator and get cost estimates on various applications. The information contained in this survey should allow for fairly specific price quotations. All herbicides contain label restrictions for applications rates, proximity to drinking water intakes, contact restrictions for swimming, and toxicity for species other than those targeted. The applicator should be able to provide this type of information. Contacting several applicators in order to get the best price and possibly differing points of view is recommended.

Management Option	Cost per Acre	Limitations
Lake Level Drawdown	$0	non-selective, limited to depth of outlet structure
Hand Harvesting	$30,000	limited to low density growth labor intensive
Suction Harvesting	$20,000	limited to moderate density growth labor intensive
Benthic Barrier	$20,000	non-selective labor intensive
Herbicide	$2000	public perception moderate selectivity
Grass Carp	$400 - $500	non-selective, turbidity
Insects	$400 - $500	some selectivity experimental

Monitoring and Evaluation. These two activities are similar in execution, but somewhat distinct in purpose. The vegetation committee should coordinate a lay monitoring program of lake-users to observe lake areas for the presence and spread of exotic species (e.g. Eurasian watermilfoil) in the lake. In addition, these individuals might help in posting boat launches and even inspecting boats and interviewing owners about the potential threats posed by exotic species.

Monitoring the lake would include consistent visual inspections of areas of the lake, using snorkeling or SCUBA, for the presence and spread of nuisance aquatic plants. Currently the Citizens Statewide Lake Assessment Program (CSLAP) collects information on the aquatic plants in a number of New York State lakes. Coordination with the efforts of this program should be encouraged. These monitoring activities should be part of an overall lake monitoring program.

Evaluation activities are designed to examine specific control programs and techniques, as well as assessing the rate of nuisance plant regrowth or recolonization and the need for repeated control at a given location. This may be done by lay monitors, or contracted with consultants.

An ongoing effort in prevention, education, evaluation and monitoring will greatly facilitate gathering information and making decisions on future management directions.

Appendix III. Aquatic Plant Survey Results for Forest Lake and Lake Allure.

APPENDIX I. Survey Results

Forest Lake Aquatic Plant Survey Date: 10/5/00

Site: T-1 Assn Beach

Species	Depth Interval (m)		
	0-1	1-2	2-3
Eleocharis sp.	10.0		
Elodea canadensis	10.0	37.5	20.0
Najas flexilis	2.5	2.5	2.5
Nymphaea odorata		10.0	
Potamogeton amplifolius		10.0	20.0
Potamogeton epihydrus	2.5		
Potamogeton gramineus	2.5	37.5	2.5
Potamogeton pusillus	2.5		
Potamogeton robbinsii	2.5	10.0	75.0
Potamogeton spirillus	2.5		
Potamogeton vaseyii	10.0		
Sparganium sp.	2.5		
Utricularia intermedia	2.5		
Utricularia minor	2.5		
Vallisneria americana	2.5	2.5	

Site: T-2

Species	Depth Interval (m)		
	0-1	1-2	2-3
Eleocharis sp.	37.5		
Elodea canadensis	2.5	2.5	
Elatine like	10.0		
Potamogeton amplifolius		10.0	
Potamogeton epihydrus	2.5	10.0	
Potamogeton gramineus		37.5	
Potamogeton robbinsii	10.0	75.0	
Polygonum sp.	2.5		
Utricularia intermedia	2.5	10.0	
Utricularia minor	2.5		
Utricularia vulgaris	2.5	2.5	

Site: T-3

Species	Depth Interval (m)		
	0-1	1-2	2-3
Brasenia schreberi		10.0	
Eleocharis sp.	2.5	2.5	
Elodea canadensis		10.0	
Nuphar luteum		10.0	
Nymphaea odorata		10.0	
Potamogeton amplifolius		10.0	
Potamogeton epihydrus		10.0	
Potamogeton gramineus	2.5	2.5	
Potamogeton robbinsii	20.0	75.0	
Potamogeton spirillus	2.5		
Scirpus subterminalis		10.0	
Utricularia intermedia		2.5	
Utricularia minor	10.0	10.0	
Utricularia vulgaris		2.5	
Vallisneria americana	10.0	20.0	

Site: T-4

Species	Depth Interval (m)		
	0-1	1-2	2-3
Brasenia schreberi		2.5	
Nuphar luteum		10.0	
Nymphaea odorata		10.0	
Potamogeton amplifolius	37.5	10.0	
Potamogeton epihydrus	2.5	10.0	
Potamogeton gramineus	10.0		
Potamogeton robbinsii	37.5	75.0	
Potamogeton spirillus		2.5	
Scirpus subterminalis		10.0	
Utricularia minor	2.5	2.5	
Vallisneria americana		10.0	

Lake Allure Aquatic Plant Survey

Site: T-1

Species	Depth Interval (m) 0-1	1-2
Chara sp.	2.5	10.0
Eleocharis sp.	2.5	
Potamogeton amplifolius	2.5	
Potamogeton epihydrus	2.5	2.5
Potamogeton spirillus	2.5	2.5
Sparganium	2.5	

Site: T-2

Species	Depth Interval (m) 0-1	1-2
Chara sp.		
Elatine minima	2.5	
Potamogeton amplifolius	2.5	
Potamogeton epihydrus		2.5
Potamogeton spirillus	2.5	
Potamogeton pusillus	2.5	
Isoetes echinospora	2.5	2.5
Nuphar luteum		2.5