INDIAN BROOK RESERVOIR

2011 Aquatic Vegetation Surveys Report and Long-Term Aquatic Vegetation Management Plan

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INTRODUCTION

Indian Brook Reservoir is a valuable freshwater resource for the Town of Essex, VT. Eurasian watermilfoil (*Myriophyllum spicatum*) was discovered in the pond in 1999. The Vermont Department of Environmental Conservation (DEC) was alerted of its presence and performed an aquatic plant survey in 1999 to document the extent of milfoil growth. DEC repeated their survey effort in 2000 and reported a considerable expansion of the milfoil infestation. Aquatic Control Technology was contracted to complete an in depth aquatic plant survey and develop a long-term management plan for the town in 2001. An estimated 22 acres of the 50-acre water body supported varying density milfoil growth in 2001. Following the development of a long-term management plan a permit for herbicide application was filed in the fall of 2001. During the State's permit review in subsequent years, another survey was conducted by the State and the milfoil population had crashed. As a result of this fortuitous crash in the milfoil population, herbicide treatment was no longer required and the Town withdrew its permit application. In the last several years the Eurasian watermilfoil has recovered and it is again beginning to impair recreational use of Indian Brook Reservoir.

In 2011 the Town of Essex funded an additional survey in order to update the information on the Eurasian milfoil infestation in the reservoir. Survey findings would then be used to evaluate Eurasian watermilfoil management alternatives and to update the long-term aquatic vegetation management plan. Results from the survey conducted on September 21, 2011 and management recommendations are presented within this report.

LAKE CHARACTERISICS

Mophology

Indian Brook Reservoir occupies a surface area of approximately 50 acres was measured off of the current digital copy of the USGS topographical quadrangle using a GIS computer program. The pond has rough dimensions of 3,250 feet by 1000 feet, with the long axis having a north to south configuration. Inlet streams empty into the northern end of the pond, while the dam and outlet stream are found at its southernmost point. The watershed drainage area lies primarily to the north of the pond. The total watershed area was estimated in 2001 at 680 acres, which results in a drainage basin to lake basin ratio of 14:1. The majority of the pond shoreline remains heavily wooded, with the exception of small clearings for car top boat access and swimming along the southeast shoreline. Smaller access points are found along the remainder of the shoreline. The pond bank is mostly lined with large rocks and boulders.

Shoreline and Lake Uses

Indian Brook Reservoir is located in the Town of Essex, Chittenden County, Vermont. The pond, its immediate shoreline and most of its watershed are owned by the Town and managed as the Indian Brook Conservation Area. Numerous walking and hiking trails are found throughout the property, there are also picnic and camping areas adjacent to the pond. The pond itself is enjoyed for passive recreational activities. A formal Town swim area is located at the south end of the pond near the dam. Non-motorized boating, fishing and swimming are also encouraged.

SURVEY METHODS

In order to facilitate the most direct comparison with the data collected in 2001, the 58 sample points established in 2001 were again visited in 2011 (Figure 1).

In 2001 the data point locations were estimated on a map during the survey. Prior to the 2011 survey, the original data points were digitized over the vertices of the 2001 transect survey using ArcView software. Data points were navigated to in field in a Jon boat using a GPS unit. At each data point water depth was recorded using a high-resolution depth finder (Lowrance LC X15mt). The estimated total percent cover and the percent composition of each species were also recorded. The species compositions was estimated utilizing two rake tosses with a throw rake, an underwater AquaVu camera system and visual inspection from the surface.

In addition to the percent composition of species a biomass index was assigned based the average height of the plants in the vicinity of the sample point.

0 no plants
1 growth along bottom
2 growth halfway through water column
3 growth within 1-2 feet of surface
4 growth matted to the surface

SURVEY RESULTS AND DISCUSSION

Bathymetric Measurements

The depth range of the sampled data points ranged from 1.0 to 25.0 feet. Distribution of the data points by depth was biased towards deeper sampling points. This is attributable to the bathymetric contours of Indian Brook Reservoir rather than any deliberate bias. This bias was more pronounced in 2011 than in 2001. The difference is likely due in part to error in the original data point locations during the 2001 survey that were navigated to without the use of GPS technology.

Table 1: Depth Distribution of Sampled Data Points

Depth Range (feet)	# of Data Points 2001	# of Data Points 2011
Less than or equal to 5	4	5
Greater than 5 and less than or equal to 10	15	8
Greater than 10 and less than or equal to 15	16	12
Greater than 15	22	33
Total	57	58

Aquatic Plant Species Distribution

Twelve aquatic plant species were observed during the 2011 survey. The following table shows the frequency of occurrence of species at the specific data point locations for use in comparative analysis (Table 3).

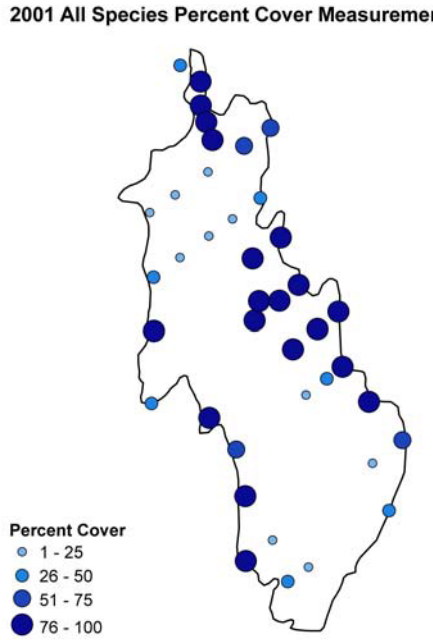
Table 2: Aquatic Plant Species and Frequency of Occurrence

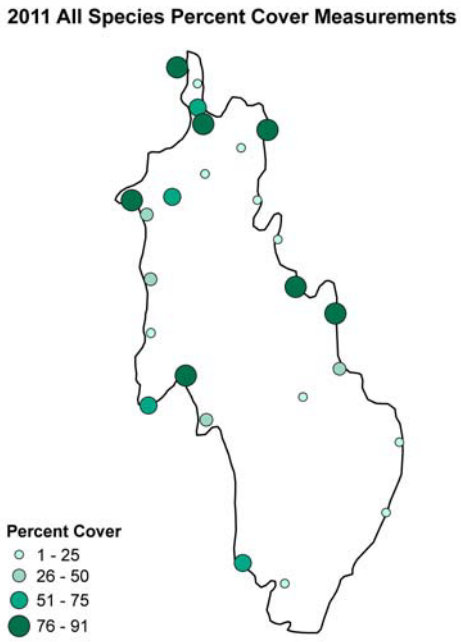
Species	Common Name	Abbreviation (used in field data)	Number of Occurrences	Frequency of Occurrence
Myriophyllum spicatum	Eurasian watermilfoil	Ms	20	36%
Najas flexilis	Naiad	Nf	11	20%
Potamogeton zosteriformis	Flat-stem Pondweed	Pz	5	9%
Potamogeton amplifolius	Large-leaf Pondweed	Pa	4	7%
Ceratophyllum demersum	Coontail	Cd	3	5%
Fontinalis sp.	Aquatic moss	Am	1	2%
Potamogeton epihydrus	Ribbon-leaf Pondweed	Pe	1	2%
Potamogeton foliosus	Leafy Pondweed	Pf	1	2%
Sagittaria sp.	Arrow-head	Sp2	1	2%
Sparganium sp.	Burreed	Spar	1	2%
Utricularia sp.	Bladderwort	U	1	2%
Vallisneria americana	Tapegrass	Val	1	2%

Myriophyllum spicatum was the most frequently encountered species during the survey. It was documented at 36% of the data points. Other common species observed included *Najas flexilis* (20%), *Potamogeton amplifolius* (7%), *Potamogeton zosteriformis* (9%) and *Ceratophyllum demersum* (5%). In the places where Elodea was dominant in 2001, the dominance had shifted to a combination of Eurasian watermilfoil and Naiad. Submersed species dominated the plant community over the majority of the littoral zone. No floating species were observed during the survey. Very few emergent plant species were encountered at the data point locations; however, there were a few established beds of emergent species along the shoreline. *Sparganium sp.* was dominant within these emergent beds. Lesser amount of *Typha sp.* and *Sagittaria sp.* were also observed in the beds.

Maps depicting the distribution of each species documented during the survey are provided in Appendix B. The greatest plant diversity was observed in the shallower water depths, as is often the case.

Cumulative vegetation percent cover was recorded at each data point and is depicted below. In 2011 most plant growth was generally found in water depths less than 15 feet. The higher percent cover values observed in 2001 and in 2011 are likely due to a number of factors inclusive of differences in water clarity (11.5 feet in 2001 and 5.75 feet in 2011), errors in estimation of data point locations in 2001 in addition to actual differences in species coverage at the data points. Some of the loss of clarity in 2011 may have been due to a high influx of storm water following Tropical Storm Irene.





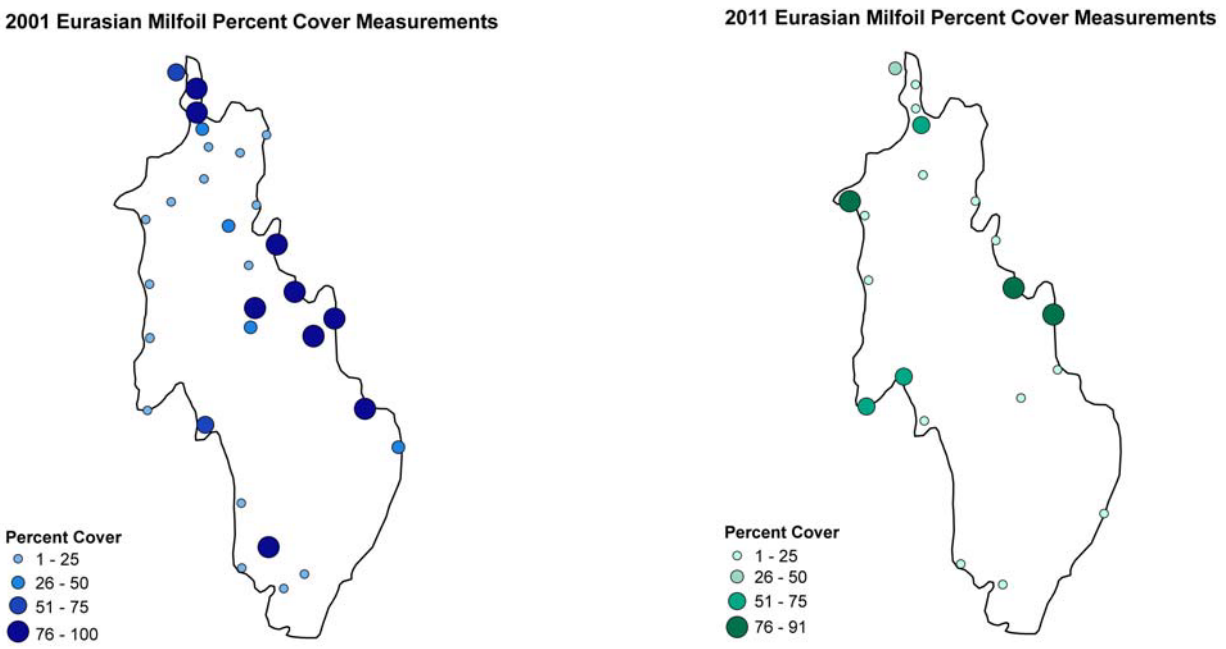
The species richness (average number of species recorded) for all sampled points was 1.4 species per data point in 2001 and 0.9 species per data point in 2011. While it does appear that there was a decline in species richness in some locations, some of the variance may again be due to errors in data point locations in 2001. Species richness values were higher in shallower water and showed a typical reduction in deeper water sample points in both 2001 and 2011.

Table 3: Species Richness

Data Point Depth Range (feet)	Species Richness 2001	Species Richness 2011
Less than or equal to 5	3.5	2
Greater than 5 and less than or equal to 10	2.4	3.2
Greater than 10 and less than or equal to 15	1.875	2.1
Greater than 15	0.27	0.2
Overall Average	1.4	0.9

Eurasian Watermilfoil Distribution

Documenting the extent of the Eurasian watermilfoil infestation was the principal objective of this data point survey. The following maps depict varying milfoil distributions in 2001 and 2011. As observed with overall percent, on average values for Eurasian milfoil percent cover were lower in 2011 as compared to 2001 values.



Eurasian watermilfoil density and distribution is approaching similar densities to those observed in 2001. The majority of the littoral zone of Indian Brook Reservoir supported varying density growth of Eurasian watermilfoil. Areas of moderate to dense milfoil were observed along much of the shoreline. While the distribution of milfoil appeared to only moderately impact non-motorized boating activity, it was observed as dense near many of the shorelines access points, hindering swimming and negatively impacting the aesthetic quality of the Reservoir. During our survey we were approached by several concerned patrons asking what management was planned for milfoil control.

EVALUATION OF EURASIAN WATERMILFOIL MANAGEMENT OPTIONS

Due to the fact that Eurasian watermilfoil density and distribution are again approaching levels observed in 2001, we feel it is time to again consider management of the plant before expansion further hinders recreation. The following section discusses several aquatic plant management options. Each strategy is discussed in reference to the situation facing Indian Brook Reservoir, spelling out both advantages and disadvantages of the particular technique. Those techniques that are not appropriate for Indian Brook Reservoir are quickly discounted. Non-chemical controls are discussed first, followed by an in-depth look at chemical treatment options.

Hand-Pulling, Suction Harvesting and Benthic Barriers

Hand-pulling, suction harvesting (diver assisted suction harvesting) and benthic barrier installations are generally used to control small localized patches of dense plant growth. Hand-pulling and suction harvesting can also be useful in controlling widely scattered aquatic growth. The limitations of these control measures often restricts their application to newly discovered, pioneer infestations or as follow-up to a larger scale management strategy such as chemical treatment or drawdown. It is

usually ineffective and often counter-productive to apply these strategies to large-scale control efforts.

Table 4: Comparison of Manual Eurasian Watermilfoil Control Techniques[1]

Approach	Typical Application	Advantages	*Limitations*
Hand-Pulling	Widely scattered plants <500 stems per acre	• Highly selective • Can utilize trained volunteers in some cases	• Impractical for large areas with milfoil coverage greater than ~1-5%. • Reduced visibility from poor water clarity or suspended sediments from a mucky bottom
Suction Harvesting	Small scattered to moderate infestations (< 1 acre in size)	• More efficient than hand pulling for higher plant densities	• Equipment difficult to relocate • Additional staff required • Increased turbidity • Very high cost
Benthic Barriers	Small dense patches (< 0.25 acres)	• Quick control for small areas • Prevents reinfestation • Barriers can be reused	• Non-selective, kills all plants and may impact macroinvertebrates and other non-target organisms • Barriers require routine maintenance • High cost per acre

Given the density and distribution of EWM in Indian Brook Reservoir none of these manual techniques are recommended at this time. Larger scale management techniques are required to achieve a significant reduction in Eurasian watermilfoil abundance. However, all three of these techniques will likely prove useful in future years as part of a long-term and integrated Eurasian watermilfoil management plan.

Mechanical Removal

Several different approaches have been used to mechanically remove aquatic vegetation in other waterbodies. The most commonly employed strategies in the northeast include dredging, harvesting and hydro-raking. Other mechanical techniques like rotovating/rototilling have been used on a limited basis elsewhere across the country with anecdotal if any demonstrated project experience in New England.

Mechanical control of Eurasian watermilfoil is generally not recommended in waterbodies where Eurasian watermilfoil is not already distributed throughout a majority of the littoral zone or where the infrastructure to install a fragment barrier over the outlet does not exist. Unavoidable plant fragmentation resulting from mechanical harvesting or hydro-raking will likely lead to an increase in EWM density and distribution within Indian Brook Reservoir and allow for downstream spread. There is also considerable qualitative evidence that suggests repetitive mechanical harvesting stimulates increases in Eurasian watermilfoil abundance. Dredging the reservoir beyond the photic beyond the photic zone (>15 feet) is impractical from a cost-effective perspective and would drastically alter existing wildlife habitat.

Drawdown

Lowering water levels during the winter months to expose aquatic plants to freezing and desiccation (drying) is a commonly used management approach in northern climates. It can be a relatively low or no-cost management strategy. The dam structure at Indian Brook Reservoir is likely suitable to facilitate drawdown provided that the low-level valves are functional. The major complication at Indian Brook Reservoir is that milfoil was observed at depths in excess of 14 feet. Lowering the pond enough to expose all of the milfoil is not expected to leave enough water volume to preserve fish and other aquatic organisms once the lake is lowered. There may also be deleterious impacts to the native plant community

[1] Resource: Commonwealth of Massachusetts Executive Office of Environmental Affairs. Practical Guide to Lake Management in Massachusetts (2004) pp 102-103.

including the emergent or wetland plant community around the pond shoreline. That said, a limited winter drawdown (< 3 ft) may be useful in future years as part of an integrated milfoil management strategy.

Biological Controls

The introduction of herbivorous insects and fish is often considered to be a natural and potentially long-term management strategy to control excessive aquatic vegetation. Sterile or triploid grass carp (*Ctenopharyngidon idella*) that consume aquatic plants are regularly used as a management strategy. They reportedly do not show a feeding preference for Eurasian watermilfoil and are therefore not recommended for use in Indian Brook Reservoir. Non-selective vegetation removal on a large scale would have serious impacts on fish habitat and the overall lake ecology.

Several Eurasian watermilfoil infested lakes in the northeast have attempted weevil stocking programs. Some significant Eurasian watermilfoil reductions attributed to weevil herbivory have been reported, but this does not appear to be the norm. Weevil density must be high, several individuals per plant, to cause the stems to collapse. Aside from the anticipated oscillations in a predator-prey relationship other factors that may limit weevil populations include insufficient shoreline cover for overwintering weevils and fish predation. Robert Johnson of the Cornell University Research Ponds presented paper at two conferences (2006 NEAPMS and 2006 NYS FOLA) that discussed their research with *E. lecontei*. They have concluded that while stocking *E. lecontei* at high densities can, in some cases, cause reductions of Eurasian watermilfoil, the process is not yet perfected to be considered a viable control strategy. Supplemental introductions (stockings) of *E. lecontei* has largely yielded disappointing Eurasian watermilfoil control. VT DEC has shared similar sentiments in their findings sections in recently issued aquatic herbicide permits.

Herbicide Treatment

The use of chemicals to control nuisance aquatic plant and algae growth is probably the most widely used and recommended management strategy for lakes with submersed aquatic plant infestations that are beyond effective control with the previously mentioned manual techniques (hand-pulling, suction harvesting or bottom barriers). Registered herbicides must meet strict federal guidelines and demonstrate that there is not an "unreasonable risk" to humans and the environment when applied in accordance with their product label. According to Madsen (Madsen 2000), "currently no product can be labeled for aquatic use if it poses more than a one in a million chance of causing significant damage to human health, the environment, or wildlife resources. In addition, it may not show evidence of biomagnification, bioavailability or persistence in the environment".

Herbicides are generally described as having either "contact action", meaning that only the actively growing portions of the plants that the chemical comes into contact with are controlled; or "systemic action", where the herbicide is internally translocated throughout the plant effectively killing the stem, foliage and root structures. Systemic herbicides are usually preferred for control of perennial nuisance weeds like Eurasian watermilfoil, due to the fact that multiple-year plant control can be achieved. This reduces the frequency of amount of chemicals that are applied.

When properly used, aquatic herbicides are capable of providing area and, to some extent, species selective plant control, often with less temporary disturbance than comparative mechanical or other non-chemical techniques. Species-selective control is also desired when targeting non-native and invasive species like Eurasian watermilfoil. Although challenging, treatment programs can be tailored to limit impacts to non-target native species to some extent through treatment timing, treatment location, use of different herbicide formulations, and manipulation of the herbicide concentration or dose rate.

Triclopyr – Results of the triclopyr herbicide treatments performed at several Vermont lakes over the past several years has demonstrated that triclopyr can provide effective and highly-selective milfoil control, even when used for partial-lake or shoreline treatments.

Triclopyr (trade name: Renovate 3 or Renovate OTF) is an auxin-mimic systemic herbicide that targets dicot or broad-leafed plants. Renovate OTF is a granular formulation of Triclopyr which allows for the added advantage of maintaining the concentrations of the herbicide in the hypolimnion of the lake where the plants are actively growing. This allows for reduced dose use and reduced cost, when compared to the liquid formulation, Renovate 3.

Triclopyr is translocated throughout the entire plant killing the stem, foliage and roots. It only requires a short contact time (1-3 days) with targeted plants, and is effective for partial lake treatments. Both the liquid (Renovate 3) and granular (Renovate OTF) formulations have been used effectively in VT lakes since 2006. Dosing is based on the volume of water being treated and the configuration of the treatment area.

Considering its highly selective nature and efficacy in exposed shoreline treatments triclopyr is the best suited herbicide for treatment of the milfoil infestation currently found in Indian Brook Reservoir.

Fluridone – Fluridone (Sonar) is another systemic herbicide that could be considered for use at Indian Brook Reservoir. Fluridone was proposed for treatment in the permit application that was filed in the winter of 2001. Fluridone has demonstrated the ability to provide fairly selective control of Eurasian watermilfoil at low doses and its systemic action typically yields multiple years of effective control. Fluridone also has a favorable toxicology profile with regulators and the general public. It is even labeled for use directly in potable (drinking) water reservoirs at low doses (<20 ppb) with no restrictions on using the treated lake water for drinking or domestic purposes. Eurasian watermilfoil is susceptible to low dose (5-10 ppb) concentrations of fluridone. Provided that adequate contact time can be maintained for 90 days or longer, the systemic action of fluridone typically provides multiple years of control of Eurasian watermilfoil. The high solubility of fluridone makes it difficult to achieve effective control with spot or shoreline applications, even when using the slow-release pellet formulations (One, PR, Q and SRP).

Given that Eurasian milfoil distributed in spot locations along much of the shoreline of Indian Brook Reservoir and is therefore exposed to high levels of dilution, spot treatment is likely not possible. Whole-lake Sonar treatment is not as cost-effective as spot treatment with triclopyr herbicide and it may have more adverse impact on non-target, native species.

Contact Herbicides – Contact-acting herbicides like diquat (Reward), endothall (Aquathol K), flumioxazin (Clipper) and copper based herbicides are not recommended for Indian Brook Reservoir. These products only kill the actively growing shoots and foliage and do not penetrate into the root structures. As a result, control is usually seasonal at best. They are also usually more broad-spectrum, impacting desirable native plants in addition to milfoil. These characteristics make it unlikely that contact-acting herbicides could be permitted for use in Vermont public water bodies.

Water Use Restriction Comparison

Table 5 summarizes the water use restrictions that are likely to be imposed following treatment with the herbicides described above. Vermont regulations extend the water use restriction periods beyond what is required in the EPA label in many cases and the most restrictive time periods are listed.

Table 5: Water Use Restrictions for Aquatic Herbicides Approved for use in VT in Recent Years.

Herbicide	Swimming Restrictions	Domestic Use Restrictions	Irrigation Restrictions	Livestock Watering Restrictions	Fishing Restrictions	Potable Water Restrictions
Sonar (Fluridone)	None	None	30+ days following last application	14-30+ days	none	1/4 mile from intake
Renovate (Triclopyr)	None	Until concentration is <75ppb	120 days (or when conc. < 1 ppb by assay)	None	None	300-2600 feet from intake depends on acerage treated (label)

Impacts of Herbicides on Target and Non-Target Plants

Predicting potential impacts to non-target species will be paramount to obtaining successful permit approval for the use of herbicides for large scale treatment work at Indian Brook Reservoir. Anticipated response of all documented plant species in Indian Brook Reservoir to the various herbicides is summarized in Table 8.

Table 6: Anticipated Response of Plants in Indian Brook Reservoir to Sonar and Renovate[2]

Species	Common Name	Renovate (Triclopyr)	Sonar (Fluridone)
Myriophyllum spicatum	Eurasian milfoil	S	S
Najas flexilis	Naiad	T	S
Potamogeton amplifolius	Large-leaf Pondweed	T	I
Potamogeton epihydrus	Ribbon-leaf Pondweed	T	I
Potamogeton foliosus	Leafy Pondweed	T	I
Potamogeton zosteriformis	Flat-stem Pondweed	T	I
Sparganium sp.	Burreed	T	T
Ceratophyllum demersum	Coontail	S/I	S/I
Vallisneria americana	Tapegrass	I/T	S/I
Sagittaria sp.	Arrow-head	T	T
Fontinalis sp.	Aquatic moss	T	T
Utricularia sp.	Bladderwort	T	S/I
Key: Susceptible – S; Intermediate –I **;** Tolerant – T; Unknown –U			

Permit Requirements

[2] Susceptibility ratings based on manufacturer literature, Massachusetts GEIR (2004), and treatment experience of Aquatic Control Technology Inc.

Chemical treatments to lakes and ponds in Vermont must be approved through the Aquatic Nuisance Control Permit Program that is administered by the Department of Environmental Conservation (DEC). Permits can be issued when DEC can make the following findings:

1. There is no reasonable non-chemical alternative available;
2. There is acceptable risk to the non-target environment;
3. There is negligible risk to public health
4. A long-range management plan has been developed which incorporates a schedule of pesticide minimization; and
5. There is a public benefit to be achieved from the application of the pesticide, or in the case of a pond located entirely on a landowner's property, no undue adverse effect upon the public good.

Preparation of an integrated management program that incorporates non-chemical control techniques for follow-up management has been needed to secure permit approval in recent years. This will undoubtedly be required if a chemical treatment program is pursued at Indian Brook Reservoir.

Starting in the fall of 2011 aquatic treatments are now subject to a National Pollutant Discharge Elimination System (NPDES) permit that will be administered by the State of Vermont.

AQUATIC VEGETATION MANAGEMENT RECOMMENDATIONS

Managing invasive species like Eurasian watermilfoil requires a commitment to ongoing maintenance as eradication is rarely, if ever, achieved for established infestations, such as the infestation present at Indian Brook Reservoir. At the time of the 2011 survey there were an estimated 16 acres of moderate to dense Eurasian watermilfoil growth in the reservoir. The beds were matted to the surface in many locations or were visible within one foot of the surface. In many locations, the Eurasian watermilfoil densities were undoubtedly interfering with water-based recreational pursuits.

Management Objectives

Formulating realistic and attainable management objectives is a critical first step when developing an integrated, long-term aquatic vegetation management program. Since eradication is not attainable, efforts should be focused on developing a sustainable management program. The following management objectives or principals should be incorporated into a long term aquatic vegetation management program for Indian Brook Reservoir. The challenge will be to develop a program that adequately addresses all of these stated needs.

1. Target control of the dense Eurasian watermilfoil growth
2. Prevent the establishment of other non-native and potentially invasive species
3. Preserve a diverse native plant assemblage for fish and wildlife habitat
4. Avoid any adverse impacts on water quality
5. Improve recreation for the multiple user groups, including: fishing, non-motorized boating and swimming.

Integrated Program Elements

The current Eurasian watermilfoil infestation in Indian Brook Reservoir is too extensive to be effectively managed with hand-pulling, suction harvesting benthic barrier installations and/or limited winter drawdown. However, these techniques are still effective and widely used to control small or scattered milfoil infestations. It will be necessary to incorporate these non-chemical techniques into an integrated program for Indian Brook Reservoir; not only to secure permit approval, but to maximize the duration of control of chemical treatments. Even when systemic herbicides are used, complete control of all the targeted plant growth rarely occurs. Usually a single application cannot sufficiently deplete the starch reserves in the roots of multi-year old Eurasian watermilfoil growth with well established root structures. There may also be regeneration by seed, which has yet to be fully documented. Re-growth seen after treatment, however, tends to occur throughout previously infested areas. Utilizing non-chemical strategies to control low-density re-growth following treatment will continue to stress the Eurasian watermilfoil population and reduce the frequency and scope of follow-up herbicide applications.

Based on the distribution of milfoil primarily along exposed shorelines in Indian Brook Reservoir, we believe that an initial treatment with triclopyr herbicide would be the preferred management option. Triclopyr has proven to be more effective than fluridone for partial lake treatments where dilution would hinder concentration-exposure-time. Working under a 5-year Integrated Management Plan, it would be expected that two or possibly three herbicide applications may be required over a 5-year period.

Herbicide Treatment Protocol

The recommended triclopyr herbicide treatment program should seek permit approval to treat portions of the reservoir where milfoil cover is too abundant to be cost-effectively managed using suction harvesting or hand-pulling. Both Renovate 3 (liquid) and Renovate OTF (granular) should be considered for use depending on the location and configuration of the targeted treatment area. For 2012, treatment would likely focus on approximately 16 acres of the reservoir.

An annual treatment program is expected follow the timeline and protocol below:

- ♦ August/September — Comprehensive Late Season Survey
- ♦ November — Submission of Annual Report that identifies preliminary plans for upcoming year
- ♦ December — Project review and meeting with DEC
- ♦ May — Early season survey to develop Final Treatment Map; Submit map and specific treatment plans to DEC for review and approval; Perform required pre-treatment notification
- ♦ Late-May/June — Schedule and perform herbicide treatment
- ♦ July-September — Surveys/inspections

Based on the recent treatment experiences with triclopyr herbicide at other Vermont lakes, the following treatment protocol is recommended:

1. Delay treatment until there is more active milfoil growth to improve herbicide uptake. Additional milfoil biomass is expected to provide more stem/leaf surface area for herbicide uptake and may help limit dilution caused by water movement. Treatments will likely be scheduled between late May and late June
2. The application rate (dose) will be determined by the size and configuration of the treatment area and the formulation of Renovate being applied. Allow for treatment using the maximum application rate of 2.5 ppm as listed on the product labels, to facilitate effective treatment of narrow, shoreline beds of milfoil and small (<5 contiguous acres) treatment areas. The concentration and formulation to be applied would be specified in a specific treatment plan that would be submitted to DEC with the proposed treatment map following the early season survey.

Herbicide	**Renovate 3** Liquid formulation EPA Reg. No.: 62719-37-67690 Active Ingredient: triclopyr (3,5,6-trchloro-2-pyridinyloxyacetic acid, triethylamine salt) 44.4%	**Renovate OTF** Flake formulation EPA Reg. No.: 67690-42 Active Ingredient: triclopyr (3,5,6-trchloro-2-pyridinyloxyacetic acid, triethylamine salt) 14.0%
Application Rate	0.75 – 1.5 ppm Amount to be applied would be calculated based on the targeted water volume being treated; Lower rates would be used for treatment of entire basins (i.e. Lily Pond) or large contiguous areas.	2.0 – 2.5 ppm Amount to be applied would be calculated based on the bottom four feet or on the targeted water volume being treated; Higher rates will be needed to target narrow, shoreline beds or smaller (<5 acre) patches
Treatment Timing	Between late May and late June Delay treatment until there is more active milfoil growth to improve herbicide uptake. Additional milfoil biomass is expected to provide more surface area for herbicide uptake and may help limit dilution caused by water movement.	Between late May and late June Delay treatment until there is more active milfoil growth to improve herbicide uptake. Additional milfoil biomass is expected to provide more surface area for herbicide uptake and may help limit dilution caused by water movement.
Method of Application	The concentrated liquid formulation will be injected subsurface through weighted hoses using a boat-mounted pumping system. A DGPS system with sub-meter accuracy will be used to provide real-time navigation and to insure that the herbicide is evenly applied throughout the designated treatment area.	The solid (flake) formulation will be evenly applied using the eductor/boom spray system used in 2008 or calibrated cyclone spreader mounted on the bow of a boat. A DGPS system with sub-meter accuracy will be used to provide real-time navigation and to insure that the herbicide is evenly applied throughout the designated treatment area.

Non-Chemical Program Elements

Non-chemical controls will need to be incorporated as part of a 5-year integrated milfoil management program. Techniques that should be used include:

- Suction harvesting
- SCUBA Diver hand-pulling
- Snorkel hand-pulling (volunteer)
- Limited drawdown
- Volunteer monitoring
- Boat launch inspections
- Education

Applicable non-chemical control techniques should be utilized when and where appropriate. Non-chemical controls will need to be evaluated annually to determine which are most appropriate

FIVE-YEAR MILFOIL MANAGEMENT PROGRAM BUDGET ESTIMATES

Project cost estimates for the Five-Year Milfoil Management Program being recommended at Indian Brook Reservoir is provided in the following table. Please note these are estimates based on recent management experiences at other Vermont lakes.

Estimated Program Costs – 2011 dollars	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Year	2012	2013	2014	2015	2016
Renovate Herbicide Treatment Program	$20,000	$0	$10,000	$0	$0
Suction Harvesting / Hand-Pulling	$0	$5000	$2500	$3000	$3000
Permitting / Notifications	$2500	$500	$2500	$500	$500
Monitoring / Reporting	$5000	$3000	$3000	$2500	$2500
Education (newsletter, etc.)	pending	pending	pending	pending	pending
In-Kind	pending	pending	pending	pending	pending
TOTALS	$27,500±	$8,500±	$18,000±	$6,000±	$6,000±

ATTACHMENT A

Additional Figures

Indian Brook Reservoir

Essex, VT
Transect Survey Point Locations

FIGURE:	SURVEY DATE:	MAP DATE:
1	09/19/11	11/08/11

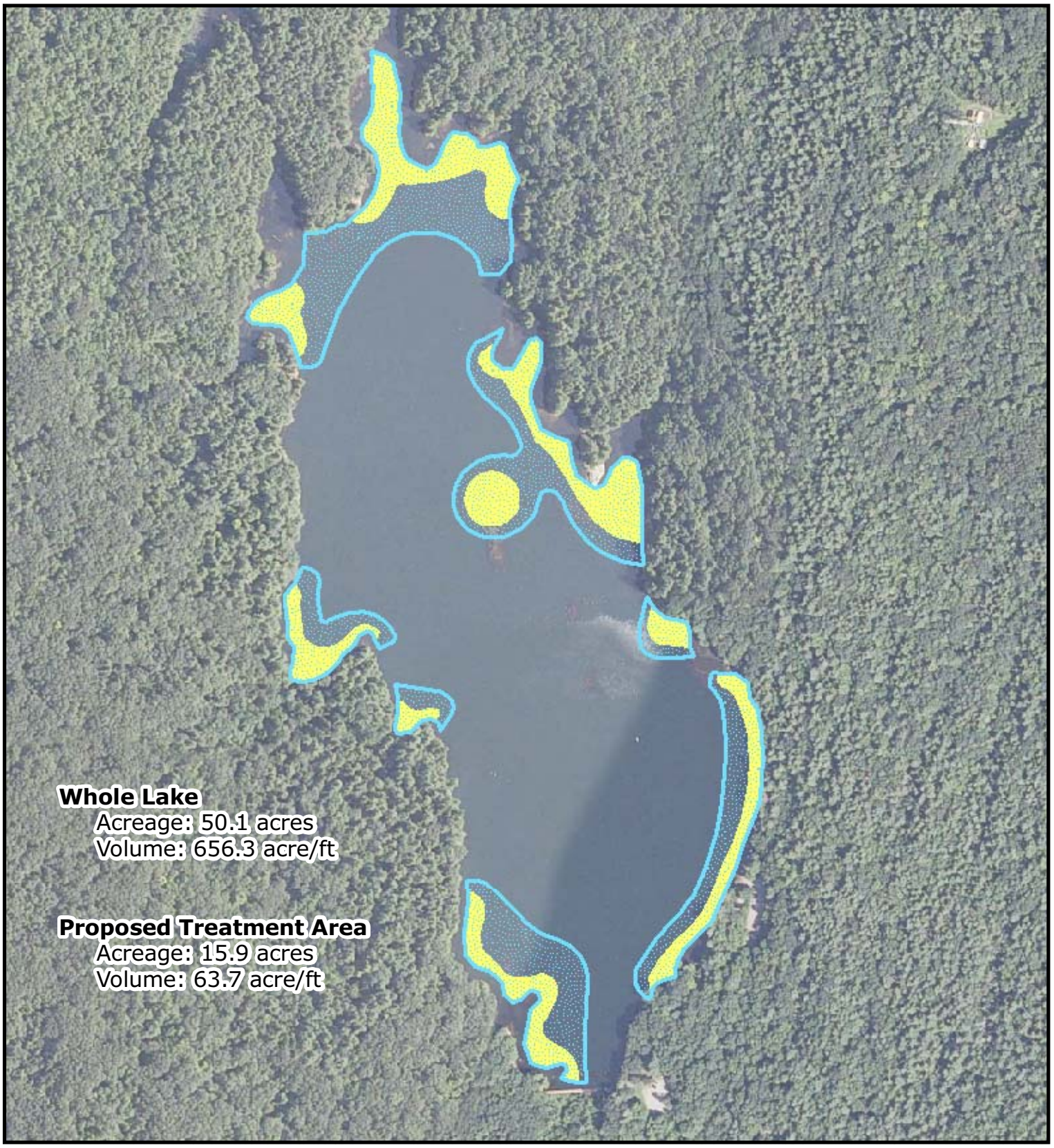
Legend:

Survey Points

N
W E
S

0 220 440
Feet

AQUATIC CONTROL TECHNOLOGY, INC.
11 JOHN ROAD
SUTTON, MASSACHUSETTS 01590
PHONE: (508) 865-1000
FAX: (508) 865-1220
WEB: WWW.AQUATICCONTROLTECH.COM



Indian Brook Reservoir

Essex Junction, VT
2012 Proposed Milfoil Treatment Areas

FIGURE:	SURVEY DATE:	MAP DATE:
2	9/19/11	10/27/11

Legend:

- Proposed Treatment Areas
- Milfoil Infestations

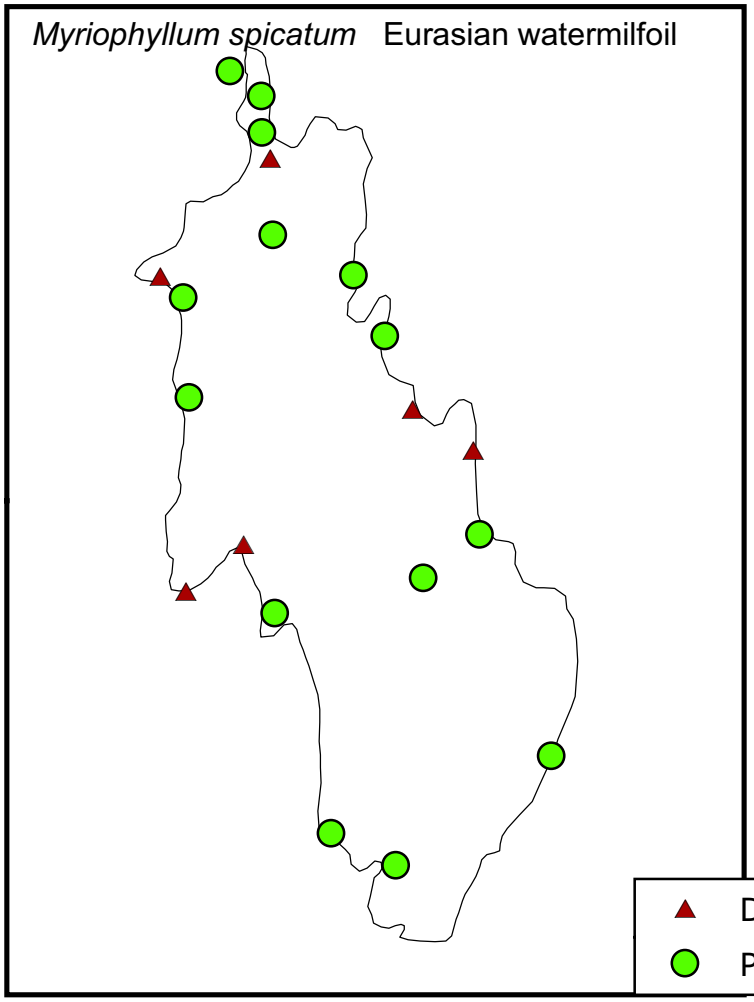
0 200 400 Feet

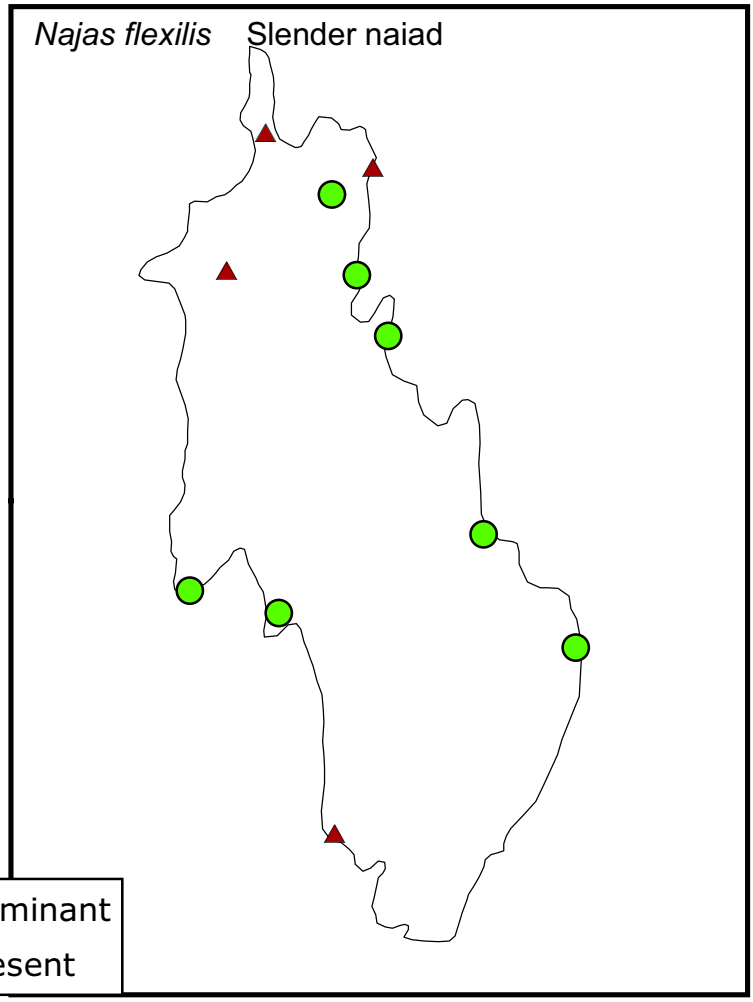
N W E S

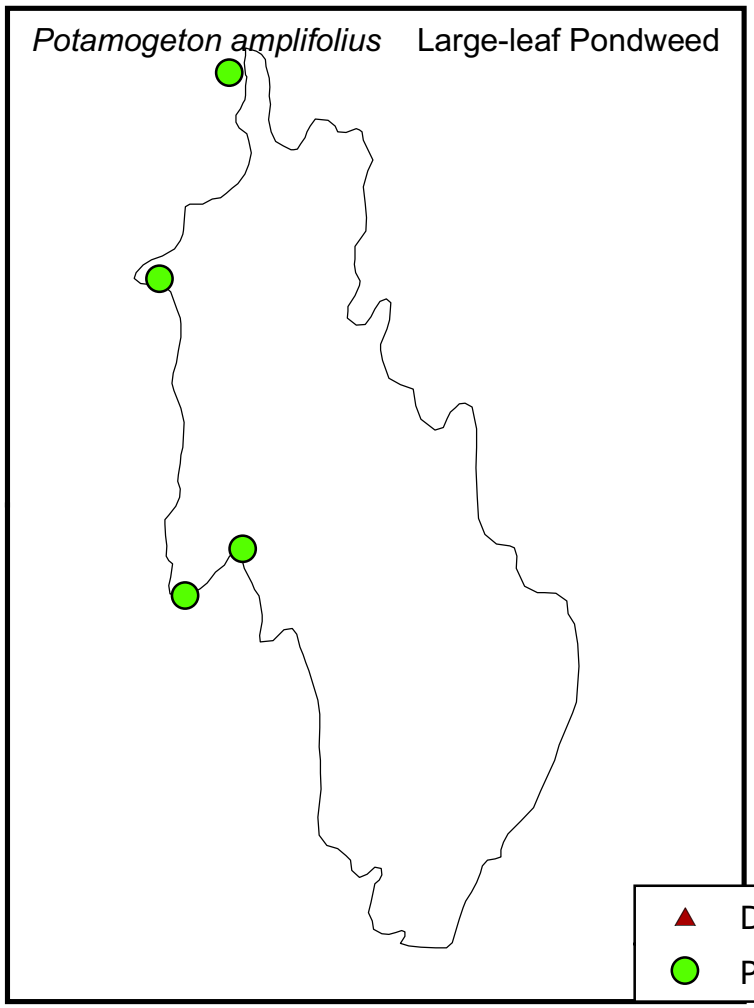
AQUATIC CONTROL TECHNOLOGY, INC.
11 JOHN ROAD
SUTTON, MASSACHUSETTS 01590
PHONE: (508) 865-1000
FAX: (508) 865-1220
WEB: WWW.AQUATICCONTROLTECH.COM

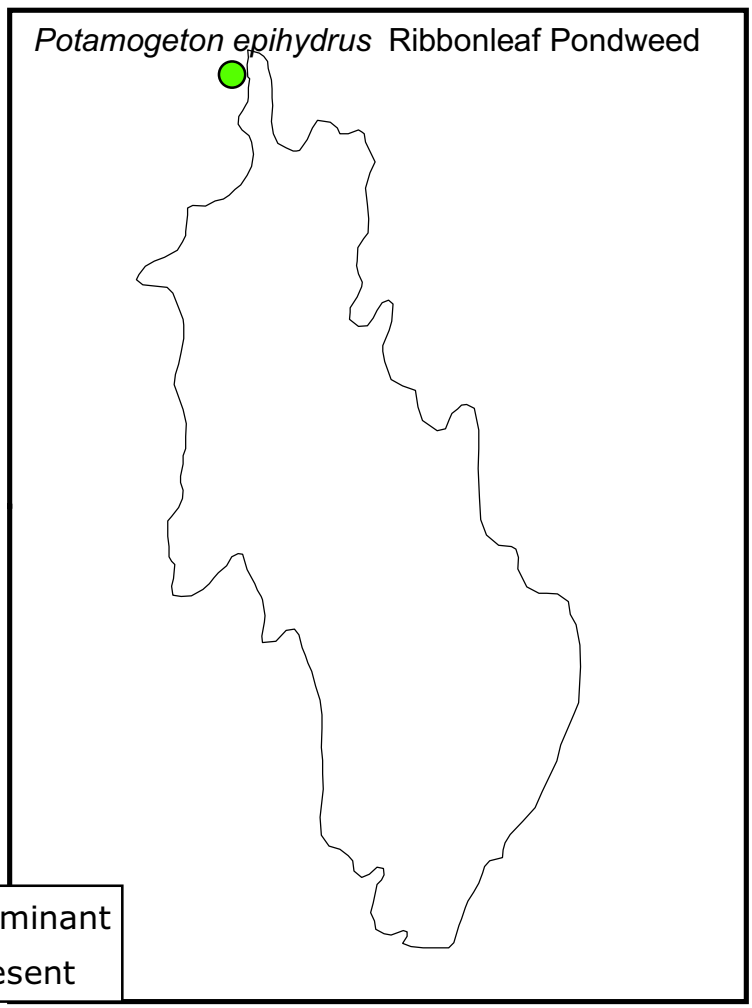
ATTACHMENT B

Indian Brook Reservoir aquatic plant distribution maps 2011

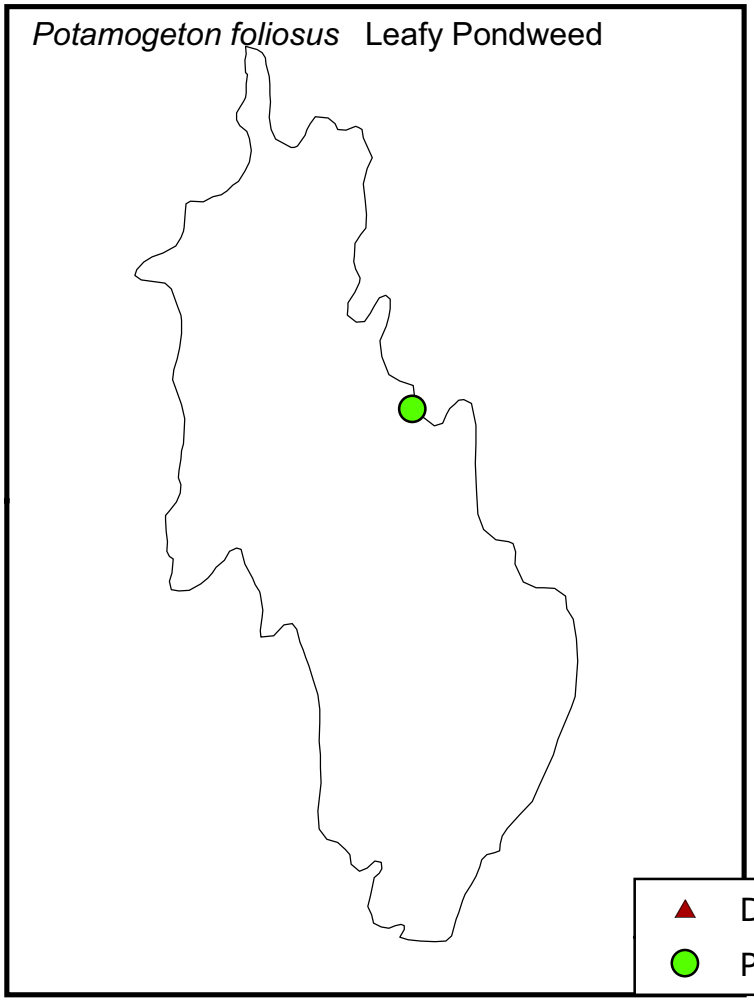


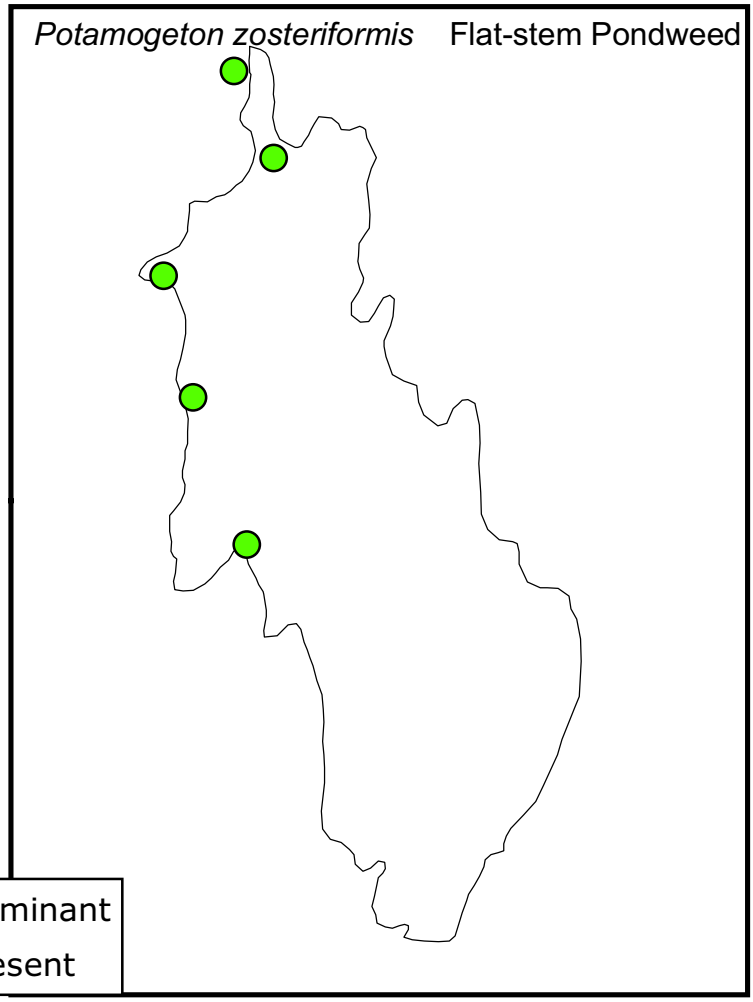


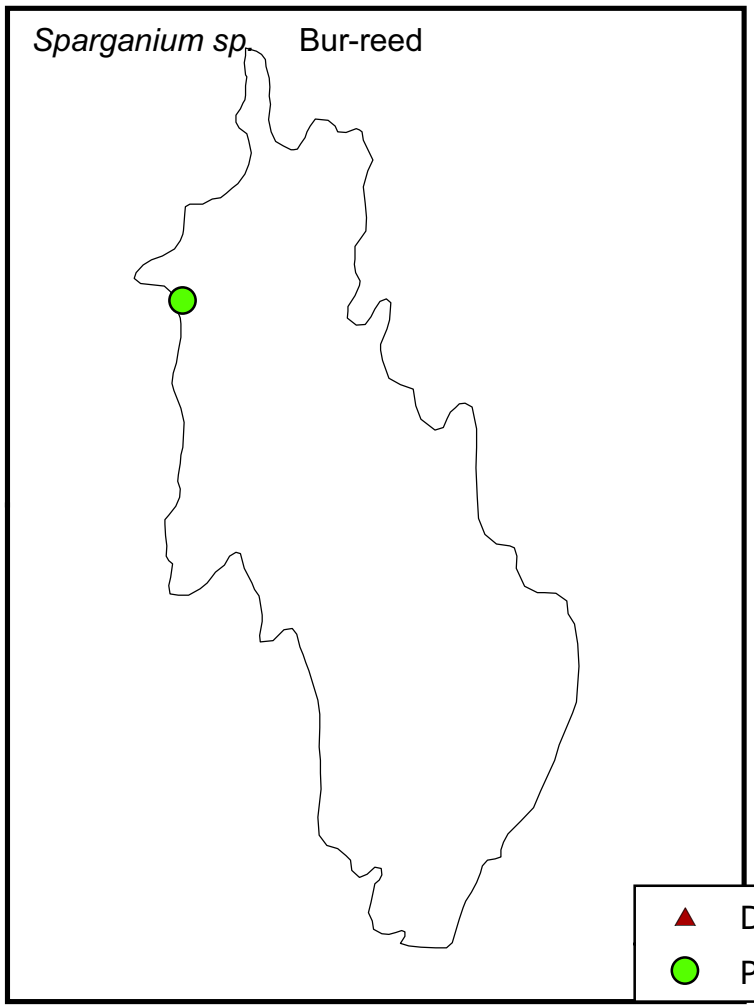


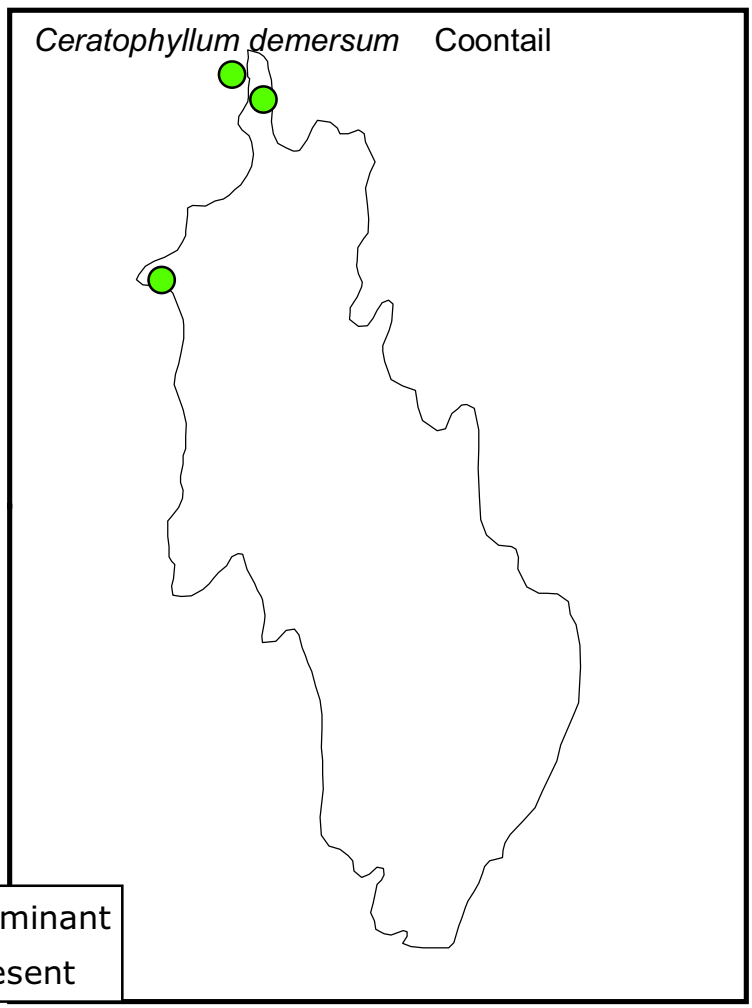


Dominant
Present

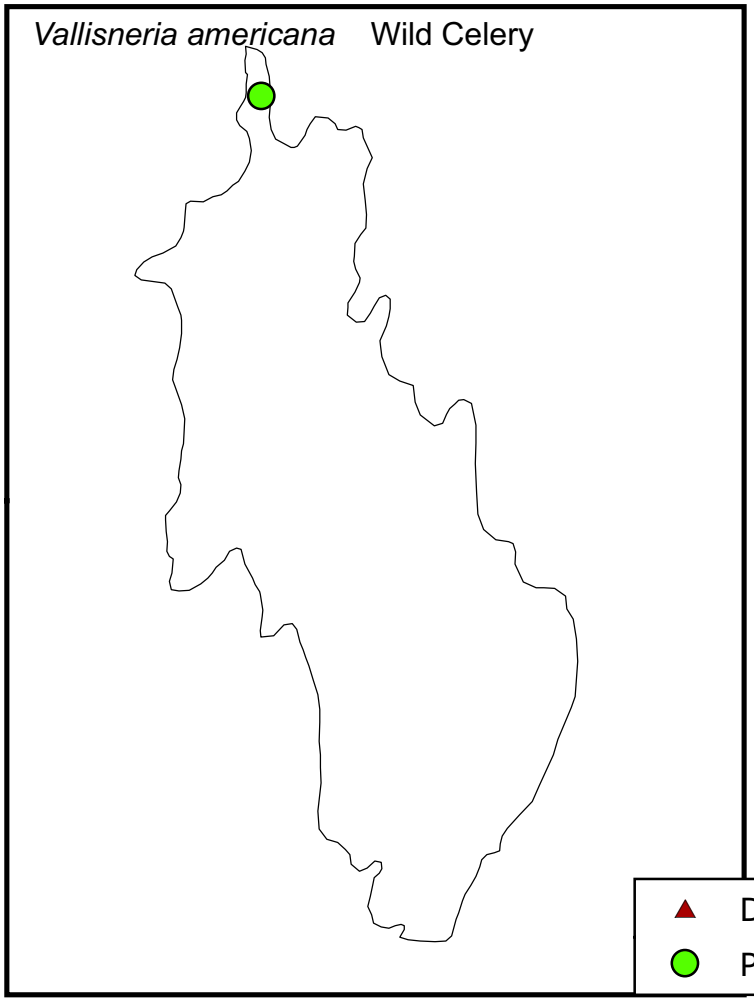


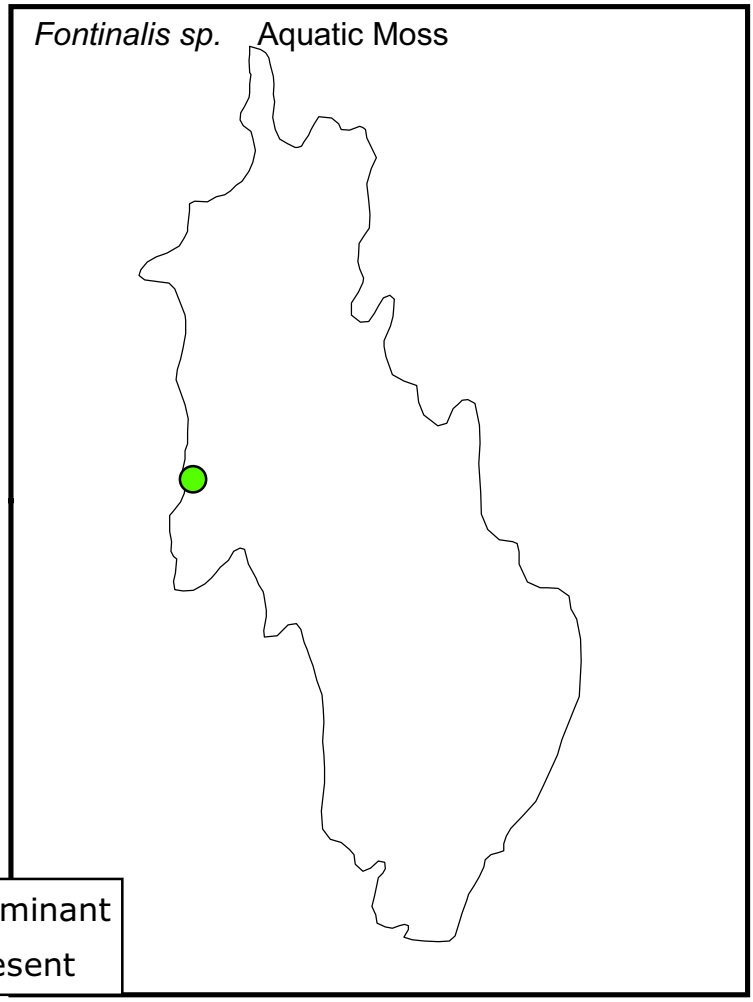


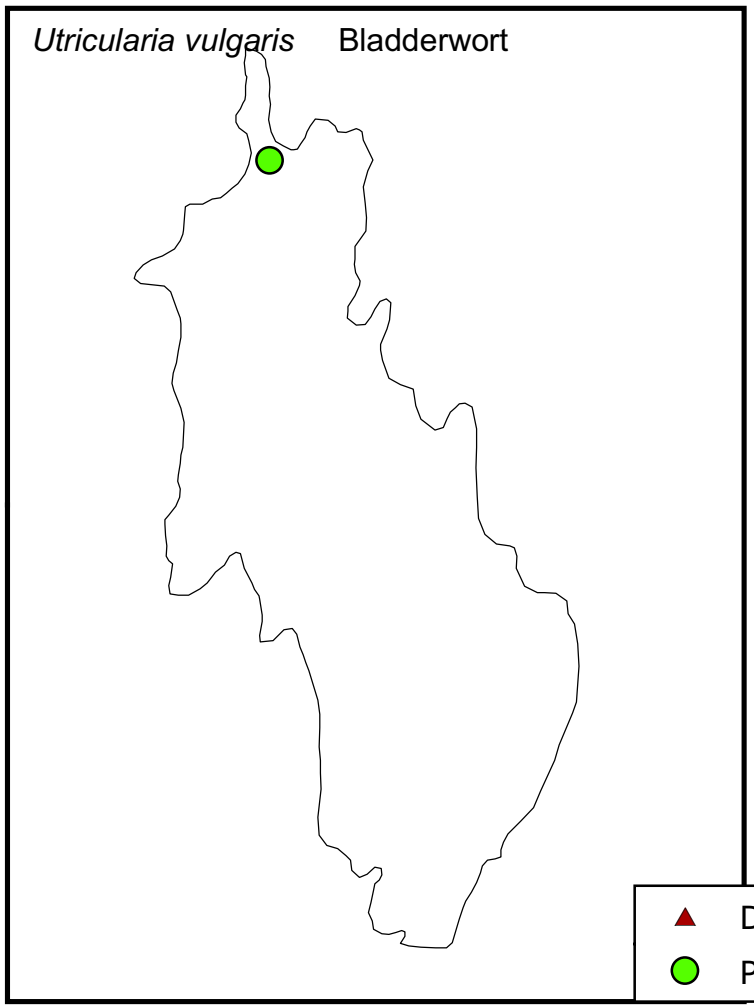


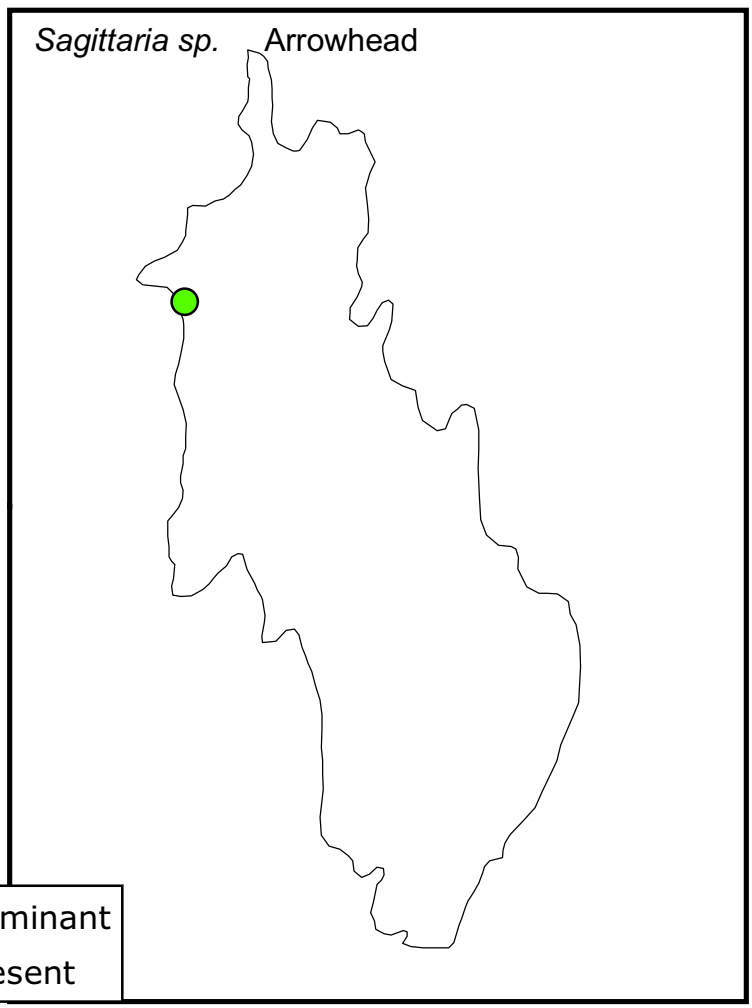


Dominant
Present









Dominant
Present

ATTACHMENT C

Field data from 2011 Point-Intercept Survey

Point Number	Water Depth (Ft)	Sediment Type	Overall Cover (%)	Ms Cover (%)	Biomass Index	Species Composition (%)											
						Myriophyllum spicatum	Najas flexilis	Potamogeton amplifolius	Potamogeton epihydrus	Potamogeton foliosus	Potamogeton zosteriformis	Sparganium sp.	Ceratophyllum demersum	Vallisneria americana	Sagittaria sp.	Fontinalis sp.	Utricularia sp.
1A	2	MSG	80	40	2	40		15	5		10		5				
1B	7.5	S	20	10	1	10							5	5			
1C	4.5	SG	60	10	1	10	50										
1D	7	M	85	70	2	70					5						10
1E	14				0												
2A	12.5	M	85		1		85										
2B	16	M	5		1		5										
2C	16.5	MS	5	5	1	5											
2D	14.5		75		1		75										
2E	1	RS	50	15	1	20						20			10		
2F	5	SG	100	20	3	80		10			5		5				
3A	12.5	R	5	2	2	2	3										
3B	19				0												
3C	18.5				0												
3D	18.5				0												
3E	4.5	RSG	40	20	3	20					20						
4A	13.5	R	5		0											5	
4B	21				0												
4C	21				0												
4D	21				0												
4E	19.5				0												
4F	12	MS	20	5	1	5	15										
5A	5.5	MS	75	55	4	55	10	10									
5B	7	M	100	70	3	70		20			10						
5C	22				0												
5D	19				0												
5E	17				0												
5F	14.5				0												
5G	10.5		90	80	2	80				10							
6A	7	M/Silt	85	85	1	85											
6B	13				0												
6C	21				0												
6D	19.5				0												
6E	20				0												
6F	7	RS	40	10	2	10	30										
7A	6	RS			0												
7B	20.5				0												
7C	18.5				0												
7D	17	Silt/Muck	1	1	2	1											
7E	14				0												
7F	16		50	10	1	10	40										
8A	15.5	M			0												
8B	23.5				0												
8C	24				0												
8D	25				0												
8E	23.5				0												
8F	10.5	RS			0												
9A	9.5		75	10	2	10	65										
9B	20.5				0												
9C	24.5				0												
9D	24				0												
9E	24				0												
9F	14.5		5	1	1		5										
10A	15.5		5	5	1	5											
10B	21				0												
10C	25				0												
10D	24.5				0												
10E	16		5	5	2	5											

ATTACHMENT D

Representative Photos of the 2011 Point-Intercept Survey

Indian Brook Reservoir – Essex, VT

Photographs taken on: 9/21/11

Dense Eurasian water milfoil matted to the surface.

Small bed of emergent species, where bur-reed is dominant

Dominant plant species. From left to right: Eurasian milfoil, large-leaf pondweed, naiad, flat-stem pondweed and ribbon-leaf pondweed

Lower water clarity was observed in 2011 when compared to 2001