2009 Foster's Pond Aquatic Vegetation Survey and Water Quality Monitoring Report

October 15, 2009



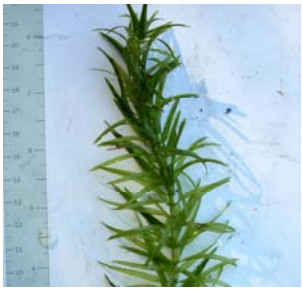

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TABLE OF CONTENTS

SECTION 1: INTRODUCTION

Geosyntec Consultants (Geosyntec) was contracted by the Foster's Pond Corporation (FPC) to conduct an aquatic vegetation survey and water quality monitoring at Foster's Pond in Andover, MA during the summer of 2009. The purpose of the survey was to:

1. Provide an update on the composition and distribution of the Foster's Pond macrophyte community, allowing the FPC to track changes in the Pond's plant community in response to recent herbicide applications and associated re-growth of non-native species such as Fanwort (*Cabomba caroliniana*);

2. Provide updated water chemistry data to aide in the assessment of general water quality and pond trophic status.

Foster's Pond (Andover, MA)

SECTION 2: AQUATIC VEGETATION SURVEY

2.1 Methodology

On August 27, 2009, Geosyntec conducted a macrophyte survey of Foster's Pond. Plant species were identified at 50 sampling locations (see Figure 1), based (with minor modifications) on the sampling stations established by the 2008 aquatic vegetation survey conducted by Aquatic Control Technology (ACT). Plants were identified by visual inspection and by using an aquatic vegetation grappling hook to sample submerged vegetation. At each station, the dominant plant(s) were recorded, as well as estimates of plant growth density and biomass. As categorized in Table 1, plant density is an estimate of aerial coverage when looking down to the lake bottom from the water surface. Biomass estimates the amount of plant matter within the water column. For example, a sampling station with dense growth of low-growing plants may have a high density estimate but a relatively low plant biomass estimate. A station with dense growth of a long, ropey plant like Fanwort, with stems reaching the water surface, would have both high plant density and high biomass estimates.

In addition to recording information from the 50 sampling stations, a running documentation of plant growth densities was estimated throughout the lakewide survey based on field observations.

2.2 Vegetation Survey Results

General Notes:

- Overall, 33 species of macrophytes were documented in Foster's Pond during the 2009 survey, compared to 23 species in 2008. A list of the species observed is provided below in Table 2.

- As shown below in Table 1, the species richness index for Foster's Pond increased from1.7 in 2008 to 5.5 in 2009. The species richness index is the average number of species observed at the vegetation sampling stations. This significant increase in species richness is likely partially explained by reestablishment of species following the 2005 whole-lake herbicide application and spot treatments conducted in 2007. Some of the observed differences between the 2008 and 2009 vegetation survey data may also be due to differences in the sampling methodologies used by Geosyntec (2009 survey) and Aquatic Control Technology, Inc. (2008 survey). It should also be noted that 8 of the species identified during the survey were observed at only one sampling station, and that over half of the species were observed at 5 stations (10%) or fewer.

- As shown in Table 1, estimated total plant cover increased from 15.9% in 2008 to 34.2% in 2009. This increase likely reflects both the reestablishment of plants following recent herbicide treatments and differences in sampling methodologies used by Geosyntec and ACT.

- A listing of plant species present at each of the 50 sampling stations is provided in Table 3, including information on vegetation density, plant biomass, and dominant plants at each station.

Table 1: Aquatic Vegetation Data Summary

Year	Estimated % Total Plant Cover	Estimated % Fanwort Cover	Biomass Index	Species Richness Index
2004	78.9	54.5	2.9	3.6
2005	25.5	0.1	1.4	1.7
2008	15.9	0.9	1.6	1.7
2009	34.2	6.1	1.6	5.5

Invasive/Non-native Species:


Fanwort

- **Fanwort** (*Cabomba caroliniana*) was observed at just over half of the sampling stations (27 stations, 54%) and was a dominant plant at 9 stations. Overall, Fanwort was one of the most well distributed and dominant submerged plants in Foster's Pond. In 2008, Fanwort was observed at only 4 stations. The average density of Fanwort growth for all sampling stations increased from 0.9% in 2008 to 6.1% in 2009. Fanwort was generally most dense near the shallow channel leading to Outlet Cove. Fanwort was observed growing in very small quantities (<5% density) at two-thirds of the sampling stations where it was observed.


European Naiad

- **Spiny Naiad** (*Najas minor*, also known as European Naiad) was found at 3 stations in the western portion of the Main Pond and in the channel leading to Outlet Cove. Growth of this plant was quite dense in some portions of the channel. Spiny Naiad was not observed during previous vegetation surveys conducted by ACT in 2004, 2005 and 2008. This invasive plant has the potential to grow densely in shallow areas and can create monoculture stands that outcompete native species. Future monitoring efforts should carefully track the spread of this plant.


Brazilian Elodea

- **Brazilian Elodea** (*Egeria densa*) was found in small quantities at two sampling stations in the Glenwood Road Basin. Based on communications with the staff of the Massachusetts Natural Heritage and Endangered Species Program (NHESP), this may be the only known occurrence of Brazilian Elodea in Essex County. As such, funding for future control efforts may be available from the NHESP.

Native Species:


White Water Lily

- **White Water Lily** *(Nymphaea odorata)* was the most well-distributed and dominant plant in Foster's Pond during the 2009 survey. This floating-leaf plant was found at 35 sampling stations (70%) and was a dominant plant at 13 stations.


Common Bladderwort

- **Bladderwort species,** including Common Bladderwort (*Utricularia vulgaris*) and Little Floating Bladderwort (*Utricularia radiata*) were found throughout the Pond (34 stations, 68%). The bladderwort species were reported collectively because of the difficulty in confirming species identification at several sites due to specimens lacking flowers or other key identifying attributes. Bladderworts are carnivorous plants that trap and digest zooplankton (microscopic animals) in clusters of "bladders" for which they are named.


Ribbonleaf Pondweed

- **Ribbonleaf Pondweed** (*Potamogeton epihydrus*) was the most abundant native submerged species in the Pond. This plant was observed at just

under half of the sampling stations (23 stations) and was a dominant plant at 6 stations. This plant was observed at 10 stations in 2008.

Lesser Duckweed

- **Lesser Duckweed (***Lemna minor***)** was observed in relatively small quantities at 17 stations (34%) scattered throughout Foster's Pond. These tiny plants, which float feely on the water surface, were not dominant at any of the sampling locations. This plant was not reported to be present during the 2004, 2005 or 2008 vegetation surveys.

Pickerelweed

- **Pickerelweed** (*Pontederia cordata*) was the most commonly observed emergent species in the pond. This plant, which was found at 15 stations scattered throughout the pond perimeter, has an arrowhead shaped emergent leaf and showy purple flower.

- Other native species that were observed at 20% or more of the sampling stations included Coontail (*Ceratophyllum demersum*), Water Purslane (*Ludwigia palustris*), and Watershield (*Brasenia schreberi*).

Coontail

Water Purslane

Watershield

Table 2: Aquatic Plant Species List, 2004-2009[1]

Type	Scientific Name	Common Name	2004[1]	2005[1]	2008[1]	2009
Submersed Species	*Bidens beckii*	Water Marigold	X			
	Cabomba caroliniana	Fanwort	X	X	X	X
	Callitriche palustris	Water Starwort				X
	Ceratophyllum demersum	Coontail	X	X	X	X
	Chara vulgaris	Musk Grass				X
	Chlorophyta	Filamentous algae	X	X	X	X
	Egeria densa	Brazilian Elodea		X	X	X
	Elodea canadensis	Waterweed				X
	Hypericum boreale	Northern St. John's Wort				X
	Isoetes sp.	Quillwort		X	X	X
	Ludwigia palustris	Water Purslane				X
	Musci	Water Moss		X	X	X
	Myriophyllum humile	Lowly Milfoil		X	X	X
	Najas flexilis	Bushy Pondweed		X	X	X
	Najas minor	Spiny Naiad				X
	Nitella sp.	Stonewort		X	X	X
	Potamogeton amplifolius	Largeleaf Pondweed	X			
	Potamogeton epihydrus	Ribbonleaf Pondweed	X		X	X
	Potamogeton gramineus	Variable Pondweed	X			X
	Potamogeton natans	Floating Leaf Pondweed			X	X
	Potamogeton perfoliatus	Clasping-leaf Pondweed	X			
	Sagittaria sp.	Arrowhead			X	X
	Utricularia spp.	Bladderwort	X	X	X	X
	Vallisneria americana	Wild Celery	X			X
Floating Leaf Species	*Brasenia schreberi*	Watershield	X		X	X
	Lemna minor	Lesser Duckweed				X
	Nuphar variegatum	Yellow Water Lily		X	X	X
	Nymphaea odorata	White Water Lily	X	X	X	X
	Spirodela polyrhiza	Big Duckweed				X
Emergent Species	*Decodon verticillatus*	Water Willow	X	X	X	X
	Eleocharis sp.	Spike Rush				X
	Eriocaulon sp.[2]	Pipewort[2]	X	X	X	
	Lythrum salicaria	Purple Loosestrife	X	X	X	X
	Peltandra virginica	Arrow Arum				X
	Pontederia cordata	Pickerelweed	X	X	X	X
	Scirpus sp.	Rushes	X	X	X	
	Sparganium sp.	Bur-Reed	X		X	X
	Typha latifolia	Cattail	X	X	X	X

Notes:

1. 2004, 2005 and 2008 data from ACT 2008 Aquatic Plant Survey report (November 24, 2008);
2. *Eriocaulon sp.* (Pipewort) was identified by the common name of Spike Rush in the 2008 ACT report. Spike Rush is typically the common name given to *Eleocharis sp.,* which was observed by Geosyntec during the 2009 survey. No *Eriocaulon* species were observed during the 2009 survey.

Table 3: Aquatic Vegetation Survey Tally Sheet

Geosyntec consultants

Location: Fosters Pond
Date: 8/27/09 **Surveyed by: Robert Hartzel**

● species present at monitoring station **●** species dominant at monitoring station

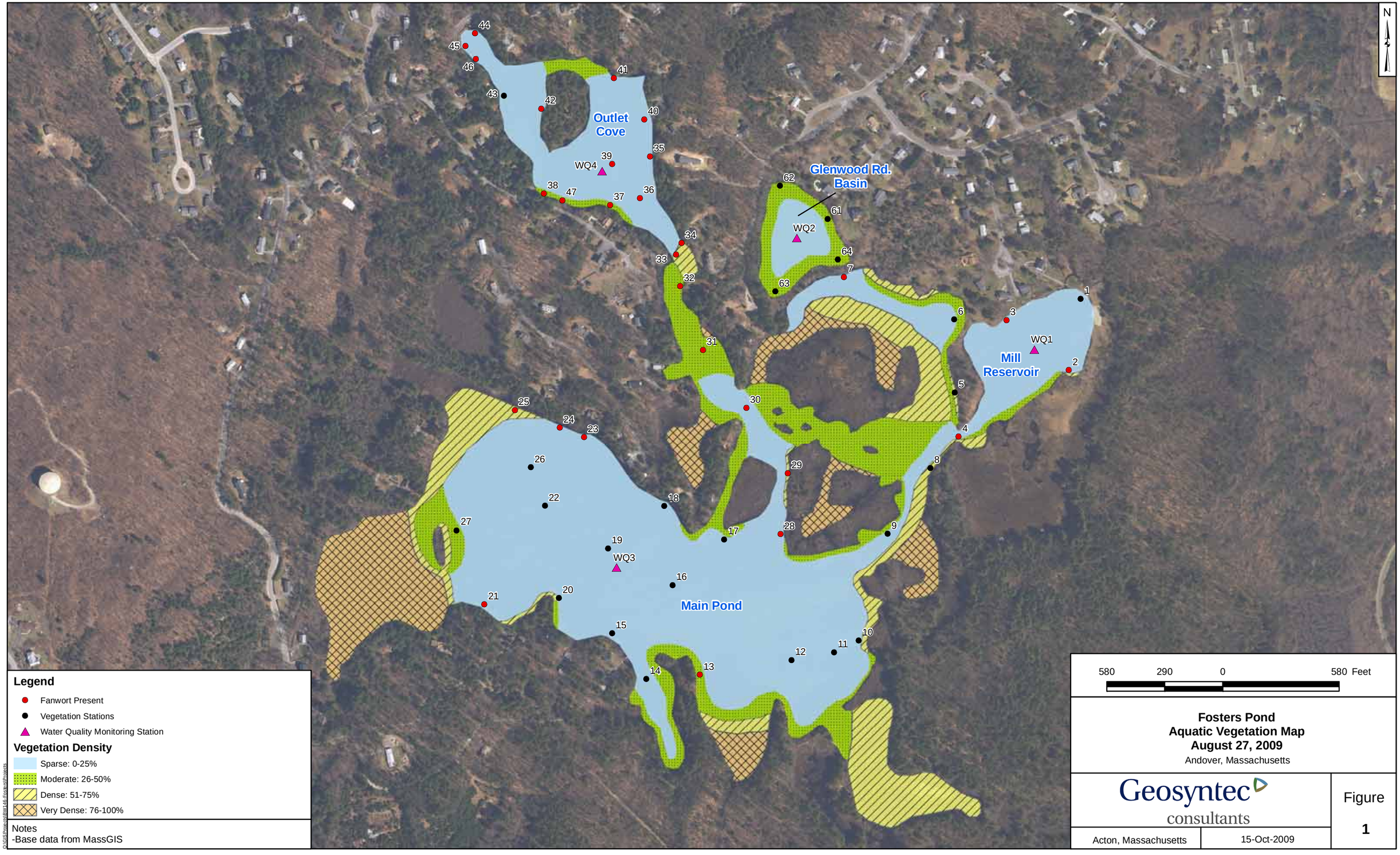
Monitoring Locations

Plant Species	# stations present	# stations dominant	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
White Water Lily (*Nymphaea odorata*)	35	13	●	**●**	●	●	●		●	**●**	**●**	**●**			**●**	●	**●**		**●**			**●**	●				●
Bladderwort (*Utricularia spp*.)	34	5		●	●	●	●	●	●	●	●	●							●				**●**		●	●	
Fanwort (*Cabomba caroliniana*); **Non-native**	27	9		●	●	**●**			**●**						●								●		●	●	●
Ribbonleaf Pondweed (*Potamogeton epihydrus*)	23	6	●	●	●	●																				●	●
Lesser Duckweed (*Lemna minor*)	17	0	●	●	●							●				●	●		●			●					
Pickerelweed (*Pontederia cordata*)	15	1		●		●	**●**		●	●									●								
Watershield (*Brasenia schreberi*)	12	0							●		●											●					
Water Purslane (*Ludwigia palustris*)	11	0							●													●	●				
Coontail (*Ceratophyllum demersum*)	10	1													●				●	●					●	●	●
Water Willow (*Decodon verticillatus*)	8	0					●			●	●	●															
Musk Grass (*Chara vulgaris*)	7	4					●								**●**								●			**●**	
Yellow Water Lily (*Nuphar spp.*)	7	0					●								●												
Lowly Milfoil (*Myriophyllum humile)*	7	1																									
Water Starwort (*Callitriche palustris*)	7	0	●		●																						
Water Moss (*Musci*)	6	0																		●			●				
Spike Rush (*Eleocharis sp.*)	5	0					●		●																		
Purple Loosestrife (*Lythrum salicaria*)	4	0		●																						●	
Bushy Pondweed (*Najas flexilis*)	3	1							●	**●**																	
Spiny Naiad (*Najas minor*); **Non-native**	3	1																								**●**	
Cattail (*Typha latifolia*)	3	0	●	●			●																				
Bur-Reed (Sparganium spp.)	3	0																									
Arrow Arum (*Peltandra virginica*)	3	0																									
Brazilian Elodea (*Egeria densa*); **Non-native**	2	0																									
Big Duckweed (*Spirodela polyrhiza*)	2	0										●										●					
Stonewort (*Nitella sp*.)	1	0																									
Variable Pondweed (*Potamogeton gramineus*)	1	0																									
Quillwort (*Isoetes sp*.)	1	0			●																						
Waterweed (*Elodea canadensis*)	1	0																									
Wild Celery (*Vallisneria americana*)	1	0																									
Arrowhead (*Sagittaria sp.*)	1	0	●																								
Northern St. John's Wort (*Hypericum boreale*)	1	0																									
Floating Leaf Pondweed (*Potamogeton natans*)	1	0																									
Filamentous algae (*Chlorophyta*)	12	0									●	●			●	●	●										
Plant Density Rating			1	3	1	3	4	1*	3	2	1	4	0	0	3	1	1	0	3	1*	0	3	1	0	3	3	3
Plant Biomass Rating			1	3	1	2	4	1*	3	2	1	3	0	0	3	1	1	0	2	1*	0	3	1	0	3	3	3
Estimated Total Plant Density %			10	60	5	60	85	<5	70	50	10	80	0	0	70	5	10	0	65	<5	0	70	10	0	70	70	60
Estimated Fanwort Cover %			0	<5	<5	30	0	<5	50	<5	0	0	0	0	<5	0	0	0	0	0	0	0	<5	0	<5	<5	<5
# species present			6	8	7	5	8	1	8	5	5	6	0	0	6	3	3	0	5	2	0	5	6	0	3	7	4

Plant Species	26	27	28	29	30	31	32	33, 34	35	36	37	38	39	40	41	42	43	44	45	46	47	G1	G2	G3	G4
White Water Lily (*Nymphaea odorata*)		**●**	**●**	●	●	●		●	●	●	●			●	●	●	●		●		●	●	**●**		**●**
Bladderwort (*Utricularia spp*.)		●	●	●	●	●	**●**	●		●	●	**●**	●	●	●	**●**	●		●		●	**●**	●	●	●
Fanwort (*Cabomba caroliniana*); **Non-native**			●	**●**	**●**	**●**	●	●	●	●	●	**●**	**●**	●	●	**●**		●	●	**●**	●				
Ribbonleaf Pondweed (*Potamogeton epihydrus*)			●		●	●	**●**	**●**	●	**●**	**●**				●	●	●		●		**●**	●	●	●	**●**
Lesser Duckweed (*Lemna minor*)		●	●	●							●	●					●		●	●	●				
Pickerelweed (*Pontederia cordata*)				●							●	●					●		●	●		●	●		●
Watershield (*Brasenia schreberi*)				●	●				●	●	●	●				●	●		●						
Water Purslane (*Ludwigia palustris*)								●	●			●		●		●	●		●	●					
Coontail (*Ceratophyllum demersum*)			**●**	●	●	●																			
Water Willow (*Decodon verticillatus*)				●				●						●	●										
Musk Grass (*Chara vulgaris*)			●	**●**	**●**																				
Yellow Water Lily (*Nuphar spp.*)										●		●			●			●			●				
Lowly Milfoil (*Myriophyllum humile)*												●					●	●	●				**●**	●	●
Water Starwort (*Callitriche palustris*)									●			●				●	●			●					
Water Moss (*Musci*)									●	●	●					●									
Spike Rush (*Eleocharis sp.*)																						●	●		●
Purple Loosestrife (*Lythrum salicaria*)																							●		●
Bushy Pondweed (*Najas flexilis*)																	●								
Spiny Naiad (*Najas minor*); **Non-native**							●	●																	
Cattail (*Typha latifolia*)																									
Bur-Reed (Sparganium spp.)												●									●				●
Arrow Arum (*Peltandra virginica*)												●		●						●					
Brazilian Elodea (*Egeria densa*); **Non-native**																								●	●
Big Duckweed (*Spirodela polyrhiza*)																									
Stonewort (*Nitella sp*.)																		●							
Variable Pondweed (*Potamogeton gramineus*)																	●								
Quillwort (*Isoetes sp*.)																									
Waterweed (*Elodea canadensis*)																●									
Wild Celery (*Vallisneria americana*)																			●						
Arrowhead (*Sagittaria sp.*)																									
Northern St. John's Wort (*Hypericum boreale*)																									●
Floating Leaf Pondweed (*Potamogeton natans*)																			●						
Filamentous algae (*Chlorophyta*)			●	●				●	●					●	●	●									
Plant Density Rating	0	3	3	4	2	4	2	2	1	1	1	2	1	1	1	1	1	1	1	1	2	2	3	3	3
Plant Biomass Rating	0	2	2	3	2	4	2	2	1	1	1	2	1	1	1	1	1	1	1	1	2	2	3	2	2
Estimated Total Plant Density %	0	60	60	80	50	85	40	40	10	20	20	35	15	5	20	10	15	5	10	10	35	30	70	60	60
Estimated Fanwort Cover %	0	0	<5	40	20	70	10	5	<5	<5	<5	10	15	<5	<5	5	0	<5	<5	5	<5	0	0	0	0
# species present	0	3	8	10	7	5	4	8	8	7	8	11	2	7	7	10	11	4	11	6	7	5	7	4	10

Key to Density and Biomass Ratings

Rating	Density	Biomass
0	Absent: 0%	Macrophytes absent
1*	Trace: 0-5% density	Trace plant growth, macrophytes virtually absent
1	Sparse: 5-25% density	Scattered plant growth; or primarily at lake bottom
2	Moderate: 26-50% density	Plants generally protruding into less than half of water column
3	Dense: 51-75% density	Substantial growth through majority of water column
4	Very Dense: 76-100% density	Abundant growth throughout water column to surface


N
Outlet Cove
Glenwood Rd. Basin
Mill Reservoir
Main Pond
WQ1
WQ2
WQ3
WQ4
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41
42
43
44
45
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62
63
64
61
Legend
Fanwort Present
Vegetation Stations
Water Quality Monitoring Station
Vegetation Density
Sparse: 0-25%
Moderate: 26-50%
Dense: 51-75%
Very Dense: 76-100%
Notes
-Base data from MassGIS
580 290 0 580 Feet
Fosters Pond
Aquatic Vegetation Map
August 27, 2009
Andover, Massachusetts
Geosyntec consultants
Acton, Massachusetts
15-Oct-2009
Figure
1

SECTION 3: WATER QUALITY MONITORING

On August 27, 2009, Geosyntec conducted water quality monitoring at Foster's Pond to provide updated baseline data on overall pond conditions. Geosyntec collected surface grab water samples at each of the four water quality monitoring sites shown on Figure 1 (Mill Reservoir, Glenwood Road Basin, Main Pond, and Outlet Cove). The sampling locations were selected based on the sites sampled by ACT in 2008. Sampling was conducted at each site for each of the following parameters:

- pH
- Alkalinity
- Total Phosphorous
- True Color
- Apparent Color
- Total Coliform
- Fecal Coliform
- Turbidity (*in-situ*)
- Secchi Disk transparency (*in-situ*)

With the exception of the parameters analyzed in-situ as noted above, all samples were analyzed at AMRO Environmental Laboratory in Merrimack, NH. Turbidity was analyzed in-situ with a LaMotte 2020 turbidity meter. The monitoring results are provided below in Table 4.

Table 4: Water Quality Data, August 27, 2009

Parameter (units)	**Mill Reservoir (WQ1)**	**Glenwood Rd. Basin (WQ2)**	**Main Pond (WQ3)**	**Outlet Cove (WQ4)**
pH (standard units)	7.1	7.1	6.9	6.9
Alkalinity (CACO3/L)	28	13	20	23
Total Phosphorus (mg/L)	0.027	0.012	0.046	0.035
True Color (color units)	55	10	45	55
Apparent Color (CU)	50	10	40	50
Total Coliform (colonies/100ml)	34	10	<2	8
Fecal Coliform (colonies/100ml)	14	<2	<2	18
Turbidity (NTU)	3	1	4	4
Secchi Disk (feet)	5.9	8.3	4.5	4.0

The 2009 water quality sampling results were generally quite similar to the 2008 results, as summarized below:

- **pH:** pH is a measure of acidity based on the presence of hydrogen ions. A pH of 7.0 is neutral. Values below 7.0 indicate acidic waters and values above 7.0 indicate basic waters. Most fish cannot tolerate a pH below 4 or above 11, and their growth and health is affected by long-term exposure to a pH less than 6.0 and over 9.5. All pH values reported for Fosters Pond were near neutral.

- **Alkalinity:** Alkalinity is the measure of a pond's natural ability to resist changes in pH by "buffering" or neutralizing acids. Alkalinity is primarily determined by the presence of naturally available

bicarbonate, carbonate, and hydroxide ions. The alkalinity values ranged from 13 to 28 CACO3/L, indicating moderate buffering capacity and results similar to 2008 (15 to 32 CACO3/L).

- **Total phosphorus** (TP) is a measure of all organic and inorganic phosphorus forms present in the water. In freshwater lakes, phosphorus is usually the most important nutrient determining the growth of algae and aquatic plants. Because phosphorus is typically relatively less abundant than nitrogen, it is considered the "limiting nutrient" for biological productivity. In-lake TP concentrations greater than 0.025 mg/l are considered an indicator of eutrophic (nutrient-rich) conditions. The TP results were higher than observed in 2008, with all sites except for Glenwood Road Basin exceeding the 0.025 mg/l benchmark.

- **Apparent Color/ True Color:** Apparent color is the color of the whole water sample, and consists of color from both dissolved and suspended components. True color is measured after filtering the water sample to remove all suspended material. The apparent color values were similar to the 2008 results, ranging from 10 CU (color units) at Glenwood Road Basin to 50 CU at both the Outlet Cove and Mill Reservoir. However, the true color values slightly exceeded the apparent color values at all sites except for Glenwood Road Basin, and were higher than reported in 2008. This indicates a greater proportion of color imparted from dissolved material (e.g. tannins) than suspended material (e.g. suspended sediment, algae) as compared to 2008.

- **Total and Fecal Coliform Bacteria:** Total and fecal coliform bacteria are "indicator organisms" which indicate the presence of fecal matter from mammals and potential pathogenic organisms in the water. The sampling results ranged and from 34 to >2 colonies/100ml for total coliform and from 18 to >2 colonies/100ml for fecal coliform. These levels are quite low, consistent with typical background measurements from wildlife.

  If the FPC plans to conduct future monitoring for bacteria indicator organisms, Geosyntec recommends that sampling for either Escherichia Coli (E. Coli) or Enterococci will provide a more reliable data related to potential pathogenic organisms in the pond. In 2001, the Massachusetts bathing beach regulations at 105 CMR 445.031 (B)(1) adopted these indicator organisms for sampling required at public swimming beaches. These regulations state:

  - No single E. Coli sample shall exceed 235 colonies per 100 ml and the geometric mean of the most recent five E. Coli samples within the same bathing season shall not exceed 126 colonies per 100 ml.

  - No single Enterococci sample shall exceed 61 colonies per 100 ml. and the geometric mean of the most recent five (5) Enterococci samples within the same bathing season shall not exceed 33 colonies per 100 ml.

- **Turbidity** is a measurement of the degree to which light traveling through water is scattered by suspended organic and inorganic particles. The scattering of light increases with a greater suspended load. Turbidity is commonly measured in Nephelometric Turbidity Units (NTU). For recreational use of water bodies (swimming, etc), the general standard for turbidity is 5 NTU or less. Turbidity measurements at Foster's Pond ranged from 1 to 4 NTU, similar to the 2008 results that ranged from 0.7 to 5.2.

- The **Secchi disk** is a weighted black and white disk that is lowered into the water by a calibrated chain until it is no longer visible. This method provides a measure of water clarity (light penetration) within the water column, which is primarily a function of algal productivity, water color, and turbidity

caused by suspended particulate matter. Water clarity affects the growth of rooted aquatic plants by determining the depth to which sunlight can penetrate to the lake sediments. Secchi disk measurements below 6 feet generally indicate eutrophic conditions. Secchi disk measurements at Foster's Pond ranged from 4.0 feet at the Outlet Cove to 8.3 feet at Glenwood Road basin, similar to the 2008 results.

SECTION 4: CONCLUSIONS / MANAGEMENT RECOMMENDATIONS

When compared to 2008 conditions, the 2009 vegetation survey documented a considerable increase in both overall plant abundance and the diversity of species observed within Foster's Pond. The most notable findings of the survey with regard to plant management are the significant reestablishment of invasive Fanwort throughout the Pond, the new infestation of Spiny Naiad, and the continued presence of Brazilian Elodea in the Glenwood Road Basin. Specific recommendations related to these species are as follows:

Fanwort Control: Fanwort was present at over half of the sampling stations and was distributed throughout the pond, compared to 2008 when Fanwort was observed at less than 10% of the sampling stations. Although Fanwort was growing in very low densities at most (67%) of the sampling stations, this plant has the potential to rapidly colonize areas with dense monoculture beds that can impede recreational pond uses and outcompete native species. The speed and degree of potential Fanwort infestation will vary for every pond depending on factors such as water chemistry, sediment characteristics, water clarity, macrophyte species composition, and plant management history. However, recent history clearly indicates that the conditions in Foster's Pond are well suited for dense growth of Fanwort over much of the pond's littoral zone (area of rooted plant growth). As such, the widespread nuisance Fanwort growth that characterized Foster's Pond prior to the 2005 Sonar herbicide treatment appears likely to recur over the next several years if additional herbicide applications are not conducted.

In general, control of Fanwort and other invasive species discussed below should attempt to balance the goals of (1) maintaining recreational use of the pond and (2) maintaining a diverse and healthy pond ecosystem. Excessive plant growth (whether native or non-native) can clearly have a negative impact on pond recreational uses, and non-native species can impact aquatic habitat by reducing species diversity and habitat types.

It is also important to consider the relationship between macrophyte abundance and algal abundance. Reduced water clarity, which appears to be primarily due to algal abundance, has been documented at Foster's Pond over the past several years. In general, lakes with extremely limited macrophyte communities tend to have higher phytoplankton (microscopic plant algae) abundance and more frequent occurrences of nuisance algal blooms. This condition can occur as a response to whole-lake macrophyte control efforts, such as the 2005 herbicide treatment at Foster's Pond. Many studies have shown that shallow ponds commonly exist in one of two alternative stable states: either a clear-water, macrophyte-dominated state or a turbid-water, phytoplankton-dominated state. Turbidity generally increases with increasing nutrient concentration, primarily due to increased algal abundance. However, biotic interactions related to the abundance of submersed macrophytes, fish and zooplankton also have a very strong influence in determining overall algal abundance and availability of nutrients in the water column. As such, herbicide treatments in Foster's Pond which rapidly reduce the macrophyte community and alter other biota which are supported by these plants may exacerbate the conditions which have resulted in poor water clarity and high algal abundance in recent years.

When considering the factors discussed above, Geosyntec recommends the continued use of Sonar on an as-needed basis for the control of Fanwort in Foster's Pond. It is encouraging that the whole-lake Sonar

treatment in 2005 (and follow-up 2007 spot treatment) has yielded such a high degree of Fanwort control over a four-year period. Given that Fanwort was either absent or growing in very low densities (<5%) at a vast majority (78%) of the sampling stations, Geosyntec recommends that a summer 2010 whole-lake Sonar treatment is not warranted at this time. Given the wide distribution of Fanwort around the lake, spot treatments are not recommended at this time. The FPC should plan to monitor the growth of Fanwort and develop an updated plant management strategy on at least an annual basis.

Spiny Naiad Control: Given the relatively limited extent (3 stations) of Spiny Naiad observed in Foster's Pond, spot treatment with the contact herbicide Reward (Diquat) is recommended. Future monitoring efforts should carefully track the future growth and spread of Spiny Naiad in Foster's Pond.

Brazilian Elodea Control: As stated above, the Brazilian Elodea infestation documented in the Glenwood Road Basin may be the only known occurrence of Brazilian Elodea in Essex County. As such, funding for future control efforts may be available from the NHESP. For more information on obtaining funds for treatment and other technical support, the FPC may contact Bryan Connolly, State Botanist for the NHESP Program, at 508-389-6344 or bryan.a.connolly@state.ma.us.