Water quality and species diversity survey of Thayer Farm ponds, summer 2006

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INTRODUCTION

Obtained through donation in 2000, the Thayer Farm located in Springfield consists of about 100 acres of active farmland surrounded by 164 acres of woodland and 1.6 acres of lakefront property (Gifford 2003, Meehan 2003). Scattered throughout the farm property are eleven man-made ponds (Figure 1). Originally the ponds had been habitually wet areas unable to be farmed; once dug out, they were traditionally used as bait ponds. Many of the ponds lie in close proximity to each other. Ponds 1 and 2 are connected by a small stream and ponds 3 – 8 (collectively called the "chain ponds") can connect in times of high water (Meehan 2003). The purpose of this study was to begin and continue water quality monitoring of the Thayer Farm ponds as well as to establish baseline information with respect to fish, plant and zooplankton species presence and diversity and to catalogue the ponds' physical characteristics such as depth at center, surface area and approximate volume. An analogous, though more abbreviated, water quality study was conducted in the summer of 2002 (Meehan 2003).

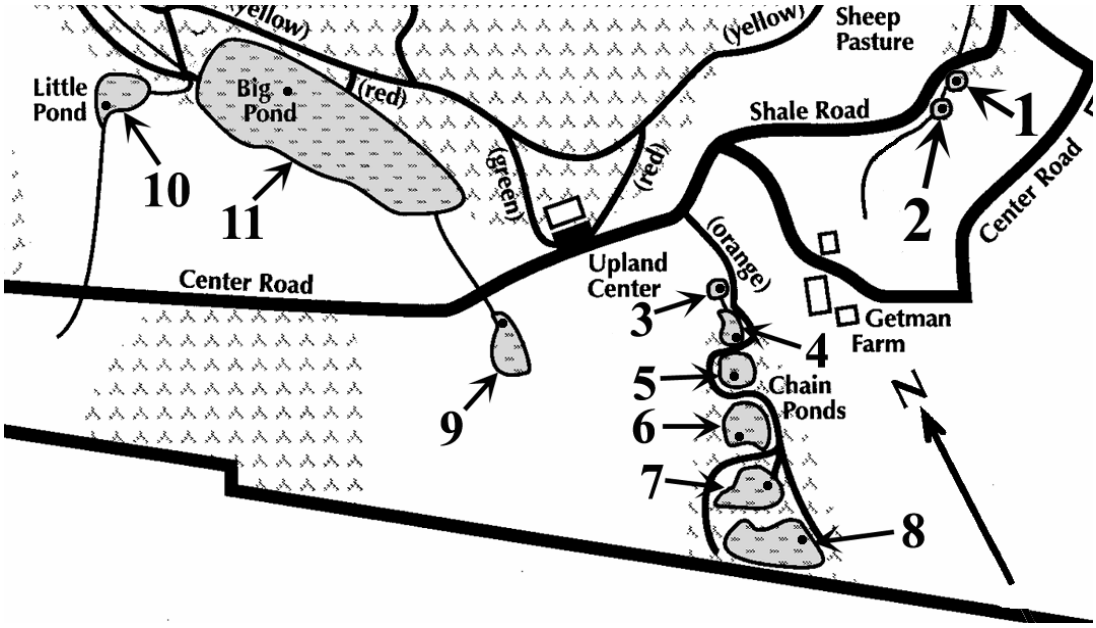

Figure 1. Map of the Thayer Farm indicating pond designations and locations with black dots identifying water quality sampling locations surveyed over summer 2006 (from Meehan 2003).

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METHODS

Water quality

Water samples from all eleven of the Thayer Farm ponds were collected over a two-day window beginning on 20 June 2006. The water samples were analyzed for total phosphorus, total nitrogen, nitrite+nitrate and ammonia. The aforementioned tests were preformed once using the Lachat QuickChem FIA+® water autoanalyzer. Table 1 shows a summary of methodologies used to conduct the above tests. A Hydrolab Scout II®, (Hydrolab Corp. 1993) calibrated according to the manufacturer's instructions preceding its employment, was used to determine parameters such as conductivity (mmho/cm), dissolved oxygen concentration (mg/l), pH and temperature (degrees Celsius) at each site. Hydrolab testing in ponds 1-10 was done from a few meters off shore. The Hydrolab testing was conducted twice in each pond over a three week period, beginning on 20 June 2006. In pond 11 Hydrolab testing was done from a boat at 1m intervals starting at the surface and ending just above the bottom (this was the only pond having a maximum depth greater than 1.7m). All test sites are indicated in Figure 1.

Parameter	Preservation	Method	Reference
Total Phosphorus-P	H_2SO_4 to pH<2	Persulfate digestion followed by single reagent ascorbic acid	Liao and Marten, 2001.
Total Nitrogen-N	H_2SO_4 to pH<2	Cadmium reduction method following peroxodisulfate digestion	Pritzlaff, 2003; Ebina et. al 1983.
Nitrite+Nitrate-N	H_2SO_4 to pH<2	Cadmium reduction	Pritzlaff, 2003.
Ammonia-N	H_2SO_4 to pH<2	Phenolate	Liao 2001.

Table 1. Summary of laboratory methodologies used on Thayer ponds nutrient data calculations, summer 2006.

Physical Characteristics

Pond depths were taken from a canoe using a hand held depth-meter. Measurements were taken at three points in transect along the length of each pond for oblong ponds such as ponds 8, 9 and 11. For all other ponds only a center depth measurement was taken. The surface area of the ponds was found using aerial photos with a known scale and a Tamaya Planix 5,6 planimeter, used according to the instruction manual (Tamaya Technics Inc). Surface area and depth measurements were used to calculate approximate volume of the ponds. For the sake of calculating volume, it assumed that each pond was conical in shape. The formula used was volume= surface area x ⅓ maximum depth.

Zooplankton

Zooplankton sampling sites for all ponds were the same as the water quality sampling sites (see Figure 1); samples were taken in the same two-day window, beginning on 20 June 2006. An approximate volume of 5 liters of surface water was concentrated to a volume less than 100mL using a 63µm meshed plankton filter. The samples were put in a sample bottle and kept cool until preserved in 70% ethanol. Each preserved sample was further concentrated to a final volume of 100 ml, giving a final concentration factor of 50x. Three separate 1ml sub-samples were viewed on a Sedgwick rafter cell under a research grade compound microscope with digital imaging capabilities. Any zooplankton found was identified and measured.

Species Presence and Diversity: Fish

The ponds varied in character to the extent that no single protocol could reasonable survey the fish communities. Therefore, three methods of collection were employed, including the use of minnow traps, seining and electrofishing. Five minnow traps were placed in ponds 1-10. Traps were placed in ponds 6-10 on 19 June 2006 and removed 27 June, while traps were placed in ponds 1-5 on 27 June 2006 and removed on 5 July. Traps were baited with bread and crackers and placed in the sites where water quality was evaluated.

Seining was performed on 15 June 2006 and on 14 July 2006 in pond 11. On each day, two locations were seined: off the southwest shore and off the northwest shore. The technique used mimics that of the 2005 Moe Pond study (Dresser 2006). Fish were collected using a 200ft haul seine deployed with a john boat. Lengths (mm) of all fish collected were recorded and scale samples and stomach contents were taken from fish larger than 150 mm. Using a microprojector the annual rings on the scales were counted to determine age of the specimen. A standard gastric lavage was used to dispel the stomach contents into sample bags (Foster 1977). Stomach contents were preserved in 70% ethanol and identified using Perckarsky et. al. (1990).

Seining was also done on 26 July 2006 in ponds 2, 9 and 10. A 25ft shore seine was used to collect fish. Species and number collected was recorded; lengths and stomach contents were not collected because all fish collected were less than 150mm.

Electrofishing was preformed with a Smith-Root backpack unit along the shoreline of ponds 1 and 3-8, in areas that were accessible and depth permitted. Times the ponds were fished ranged from 176 seconds to 350 seconds. Stunned fish were collected using hand-held scap nets and transferred to a five gallon bucket. Note of species and number collected was recorded; lengths and stomach contents were not collected because all fish collected were less than 150mm. Standard electrofishing procedures as outlined by Murphy (1996) were used.

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Species Presence and Diversity: Aquatic Vegetation

The qualitative collection of plants was done in all ponds except pond 9, which was devoid of any visible plant life, on 21 June 2006. Two methods were used in determining species presence and diversity in the Thayer Farm ponds. In ponds 1-8 hand harvesting was done. In ponds 10 and 11 a plant rake was used. Plant samples collected were placed in plastic bags, brought back to the Field Station and identified. Specimens were mounted and curated.

RESULTS AND DISCUSSION

Limnology/ Water Quality

All summer mean nutrient and physical water quality data from the eleven ponds in 2006 are shown in Table 2. That table also shows comparative physical water quality data from the Thayer ponds averaged over summer 2002. Ponds 3 and 4 were not tested in 2002 due to low water levels (Meehan 2003).

Pond 10 exhibited the highest average surface water temperature at 23.84°C, while pond 2 exhibited the lowest average surface temperature at 19.4°C (Table 2). The temperature readings collected by Meehan in 2002 were consistently higher than the 2006 figures, varying up to 8.57°C from the 2006 data.

Dissolved oxygen (DO) values colleted in 2003 were quite dissimilar from the values collected in 2006 (Table 2). The DO values collected from both years ranged of between 1.82mg/l and 14.39mg/l, with the 2002 values differing +/- 6.57mg/l from the 2006 values. Recorded values from both years for pH and conductivity were similar (Table 2), varying +/- 1.54 and +/- 0.120mmho/cm, respectively (Meehan 2003). In 2006, average dissolved oxygen was highest in pond 11 (11.27 mg/l) and lowest in pond 5 (3.12mg/l). Pond 3 had the lowest average conductivity and pH levels (.012mmho/cm and 6.225); Pond 10 had the highest average conductivity reading at .272mmho/cm, and pond 11 had the highest average pH of 8.22.

The levels of total phosphorus (TP) were generally higher in 2003 compared to 2006 with the exception of ponds 1, 7 and 10 (Table 2). Total phosphorus level ranged from 11.7µg P/L in pond 11 to 120µg P/L in pond 1.

The nitrite+nitrate levels were also higher in 2003 compared to those collected in 2006 (Meehan 2003) (Table 2). In 2006, ammonia and nitrite+nitrate readings were below detectable levels (< 0.02 mg N/L) (Table 2). Given that ammonia and nitrite+nitrate were below detection in all instances, and total nitrogen (TN) (which is comprised of ammonia, nitrite+nitrate and organic nitrogen) was measurable, (ranging between 0.057mg N/L and 0.268mg N/L), virtually all nitrogen present in the Thayer ponds would have been bound in organic form, such as algae or other dissolved organic materials. Based upon the TN: TP ratio in algal biomass of 7 – 10 established by

Vallentyne (1974), algal production in bodies of water with ratios greater than 10 should be expected to be limited by phosphorus; likewise, algal production in waters with ratios less than 7 are expected to be nitrogen limited. Because soluble nitrogen is lacking in the Thayer ponds, and the TN: TP ratios for all the ponds except for ponds 9 and 11 were less than 7 (Table 3) it appears that nitrogen, rather than phosphorus, is limiting algal production. The TN: TP ratios in ponds 9 and 11 fall within the 7 -10 range and therefore could potentially be limited by either nitrogen or phosphorus.

Pond #	Date	Temp. (℃)	Diss. Oxygen (mg/l)	Cond. (mmho/cm)	pH	Total Nitrogen (mg N/L)	Ammonia (mg N/L)	Total Phosphorus (µg P/L)	Nitrite + Nitrate (mg N/L)
1	2006	19.40	8.40	0.156	7.87	0.199	BD	120	BD
2		18.02	10.71	0.243	7.87	0.125	BD	38.7	BD
3		23.79	7.22	0.124	6.23	0.195	BD	116	BD
4		20.67	4.89	0.135	6.63	0.175	BD	84.2	BD
5		20.24	3.12	0.137	6.61	0.216	BD	80.6	BD
6		20.94	4.45	0.130	7.11	0.268	BD	163	BD
7		22.56	8.89	0.150	7.22	0.194	BD	63.1	BD
8		22.12	6.61	0.217	7.26	0.163	BD	31	BD
9		22.68	8.02	0.220	7.85	0.127	BD	16.8	BD
10		23.85	8.14	0.273	7.70	0.057	BD	15.2	BD
11 (0m)		23.71	11.27	0.205	8.22	0.098	BD	11.7	BD
11 (1m)		21.18	14.39	0.258	7.82	Data not taken			
11 (2m)		18.06	9.04	0.258	7.44	Data not taken			
11 (2.5m)		17.10	6.39	0.265	7.24	Data not taken			
1	2002	22.60	1.82	0.276	7.19			76	0.04
2		24.75	6.86	0.230	7.69			136	0.03
3		Data not taken							
4		Data not taken							
5		28.81	8.83	0.131	7.83			88	0.04
6		23.96	2.85	0.111	7.30			180	0.04
7		28.60	11.12	0.074	9.36			30	0.03
8		28.13	7.92	0.172	8.80			66	0.02
9		28.59	9.35	0.245	8.09			63	0.08
10		26.80	8.10	0.159	7.90			15	0.02
11		27.07	6.56	0.334	7.72			19	0.02

Table 2. Average physical water properties (i.e. conductivity, dissolved oxygen concentration, pH and temperature) and nutrient data (i.e. total phosphorus, total nitrogen, nitrite+nitrate and ammonia) of Thayer ponds, summer 2006; pond numbers correspond to pond labels shown in Figure1. BD = below detection (< 0.02mg N/L).

Site	Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6	Pond 7	Pond 8	Pond 9	Pond 10	Pond 11 0m
TN:TP	1.66	3.23	1.68	2.08	2.68	1.64	3.07	5.26	7.56	3.72	8.40

Table 3. The calculated TN: TP ratios (mg N/L: µg P/L) of the Thayer ponds, as indicated in Figure 1, for the summer 2006.

Morphological Characteristics

Table 4 shows the depths, surface areas and estimated volumes of the Thayer ponds. A dash (—) indicates a measurement was not applicable and therefore not taken. The greatest center depth found in the ponds was 2.9 meters in pond 11. The shallowest recorded center depth was 0.9 meters in pond 8. Possible interference of submerged matter and/or plants may have created some discrepancies between measured and actual depths. Due to the shallow nature and locations of the Thayer ponds the likelihood of fluctuations in depths, surface areas and volumes is relatively high. The surface areas of the ponds are shown in Table 4, measured in both hectares and acres. Values for volume are approximated. The smooth sloped nature of the pond bottoms, the center depth typically being the maximum depth, and the mean depth was approximately one-third maximum depth were the grounds for the assumption that pond were conical in shape. The failure to take any irregularities in bottom surface into account when calculating volumes make any recorded figures inexact and disputable. Estimated pond volumes are shown in Table 4.

Pond	Center (m)	West bank (m)	East bank (m)	North bank (m)	South bank (m)	Surface area (ha)	Surface area (ac)	Volume (m^3)
Pond 1	0.6	—	—	—	—	0.03	0.08	61
Pond 2	1.1	—	—	—	—	0.03	0.07	111
Pond 3	1.0	—	—	—	—	0.03	0.08	99
Pond 4	1.1	—	—	—	—	0.03	0.06	91
Pond 5	1.4	—	—	—	—	0.05	0.12	223
Pond 6	1.5	—	—	—	—	0.08	0.21	419
Pond 7	1.5	—	—	—	—	0.08	0.21	404
Pond 8	0.9	1.0	1.3	—	—	0.12	0.31	515
Pond 9	1.1	—	—	1.0	1.1	0.24	0.58	886
Pond 10	1.6	—	—	—	—	0.03	0.07	154
Pond 11	2.9	4.6	0.7	—	—	1.49	3.66	22846

Table 4. Depths, surface areas and approx. volumes of Thayer ponds, summer 2006; pond numbers correspond to pond labels shown in Figure1.

Zooplankton

On average, zooplankton densities were 66 individuals/l in the Thayer ponds, the most commonly found being nauplii (larval copepods). Figure 2 shows the quantity per liter by type of zooplankton found in each pond. The largest diversity of zooplankton was found in ponds 1 and 5 in which three different zooplankter types were found. Pond 6 had the highest total number of zooplankton per liter (207/l), and pond 10 had none. The average lengths of the zooplankton collected is shown in Table 5.

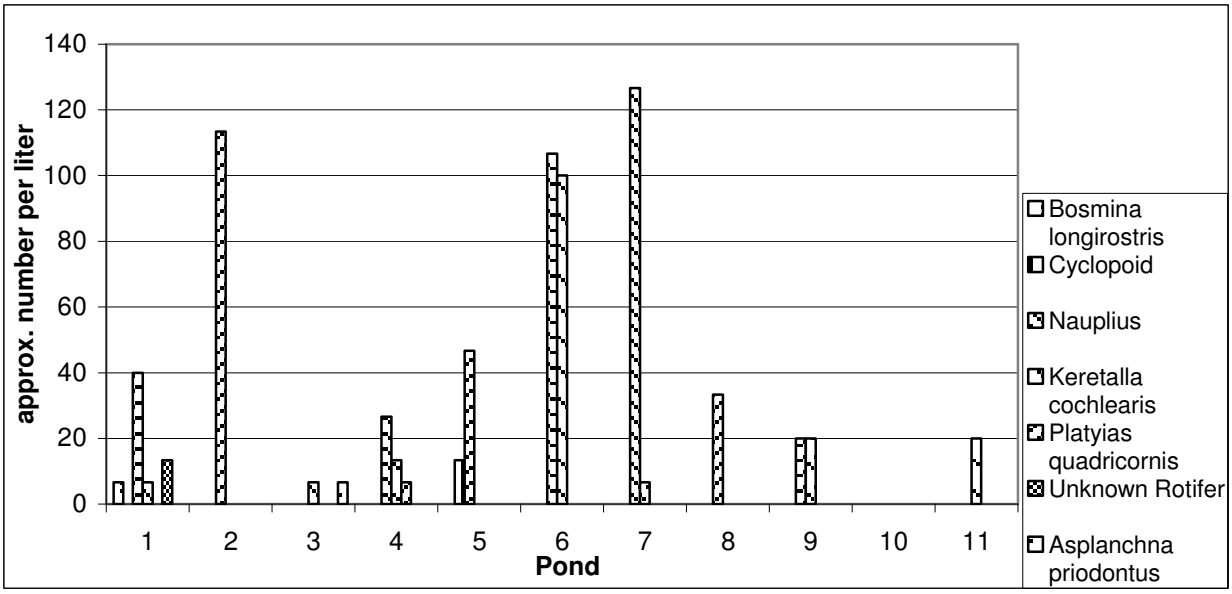

Figure 2. Approximate number per liter of common zooplankton in Thayer ponds, collected on 20 and 21 June 2006; pond numbers correspond to pond labels shown in Figure 1.

Species	Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6	Pond 7	Pond 8	Pond 9	Pond 10	Pond 11	Average length (µm)
Cladocera												
Bosmina longirostris	—	228	—	—	—	—	—	—	—	—	—	228
Copepoda												
Cyclopoid	—	—	—	—	343	—	—	—	—	—	—	343
Nauplius	133	141	—	130	84	117	151	111	185	—	—	132
Rotifera												
Keretalla cochlearis	172	—	160	126	—	94	96	—	81	—	83	116
Platyias quadricornis	—	—	—	218	—	—	—	—	—	—	—	218
Unknown Rotifer	67	—	—	—	—	—	—	—	—	—	—	67
Asplanchna priodontus	—	—	119	—	—	—	—	—	—	—	—	119

Table 5. Average measured lengths of zooplankton collected on 20 and 21 June 2006 from Thayer ponds; pond numbers correspond to pond labels shown in Figure1.

Fish Presence and Diversity

The numbers and type of fish caught in each pond via minnow traps is shown in Figure 3. The category 'Lepomis' includes both blue gill (*Lepomis macrochirus*) and pumpkinseed (*Lepomis gibbosus*), many of which couldn't be distinguished because they were too young. Also found in the minnow traps were golden shiners (*Notemigonus crysoleucas*), fathead minnows (*Pimephales promelas*) and yellow perch (*Perca flavescens*). In ponds 2, 7 and 10 no fish were found in the minnow traps. Aside from fish, several other aquatic organisms were caught in the minnow traps. Commonly found in the minnow traps were rusty crayfish (*Orconectes rusticus*), and various types and life stages of amphibians.

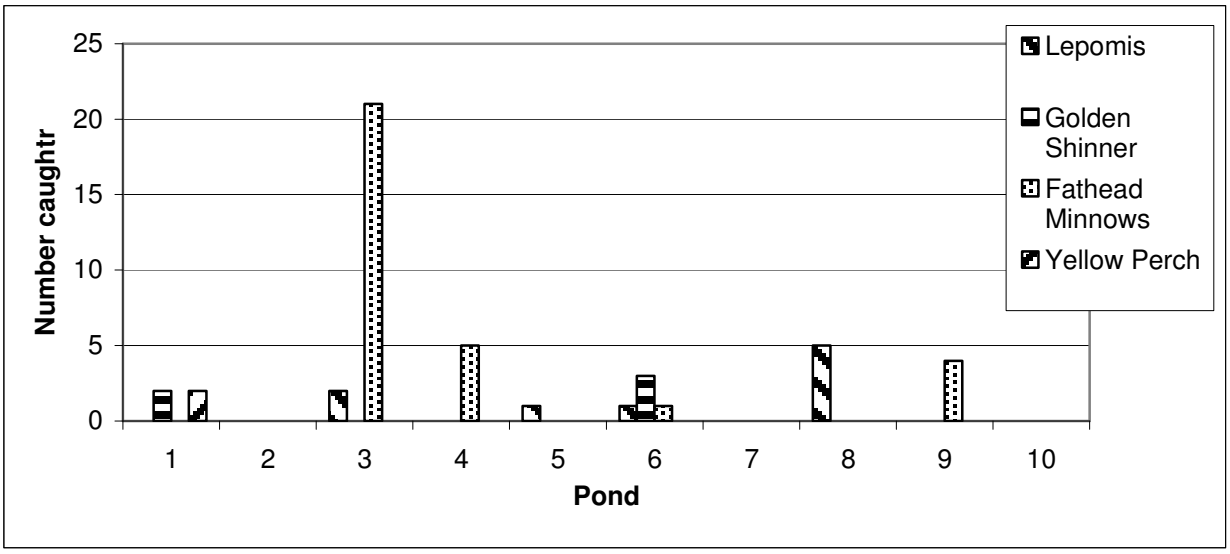

Figure 3. Fish caught in the Thayer ponds using minnow traps set on 19 June 2006 for ponds 6-10 and on 27 June 2006 in ponds 1-5; pond numbers correspond to pond labels shown in Figure 1.

The relationship between length and age for fish seined from pond 11, the only pond having a balanced community of both forage and game fish, is shown in Figure 4. For all fish species collected, there was a positive correlation between length and age, (see trend line for large mouth bass (*Micropterous dolomieui*) on Figure 4, for example). Overall, pumpkinseeds were the most frequently documented fish, with 47 collected during the three seines. The next most commonly documented fish were large mouth bass, with32 collected, followed by 17 young of the year 'Lepomis', 9 redbreasts (*Lepomis auritus*), 4 yellow perch and 1 golden shiner. The data collected from seining ponds in 2, 9 and 10, as well as electrofishing ponds 1 and 3-8, are shown in Table 6. 'YOY' indicates young of the year, or fish that were too young to distinguish species.

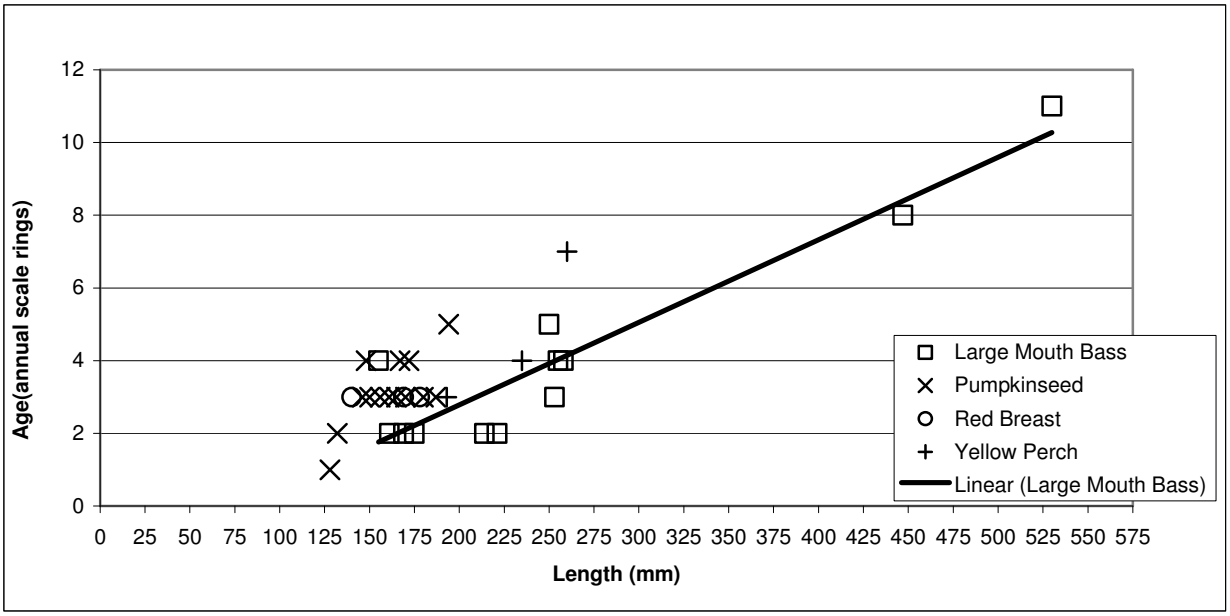

Figure 4. Measured length in millimeters vs. age calculated through annual scale rings of fish seined from Thayer pond 11 on 15 June 2006; pond numbers correspond to pond labels shown in Figure1.

Pond	Method	Time	Fathead Minnow	Golden Shinner	Pumpkinseed	Lepomis (yoy)
pond 1	Electorfishing	250	0	0	7	0
pond 2	Shore sein	n/a	0	127	0	0
pond 3	Electorfishing	350	3	1	0	0
pond 4	Electorfishing	350	41	0	0	0
pond 5	Electorfishing	182	2	5	1	1
pond 6	Electorfishing	176	0	0	2	0
pond 7	Electorfishing	350	0	1	5	0
pond 8	Electorfishing	350	0	0	8	0
pond 9	Shore sein	n/a	221	23	145	0
pond 10	Shore sein	n/a	2	0	0	0

Table 6. Methods used, times electrofished and fish collected, from 26 July 2006 seining and electrofishing of Thayer ponds 1- 10; pond numbers correspond to pond labels shown in Figure1.

Figure 5 shows the stomach contents collected from the fish on the 15 June 2006 seining of pond 11. Most commonly found was diptera, with 190 aquatic and 16 terrestrial life stages found (including both aquatic and terrestrial life stages). Stomach contents were collected from 14 pumpkinseeds, 12 large mouth bass, 4 red breasts, 3 yellow perch and 1 golden shiner.

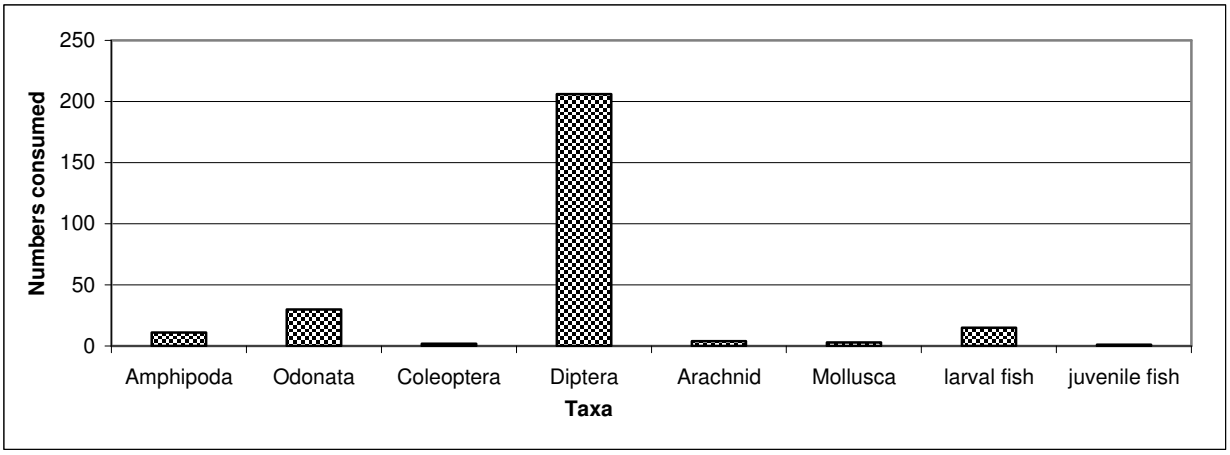

Figure 5. Collective fish stomach contents from 14 pumpkinseeds, 12 large mouth bass, 4 red breasts, 3 yellow perch and 1 golden shiner collected in the 15 June 2006 seining of Thayer pond 11.

Plant Presence and Diversity

Overall 16 different plant species were found in the Thayer ponds. Table 7 shows the plants present in the ponds; an "x" indicated plant presence. Not including pond 9, which had no visible plant life, each pond contained at least 2 different plant species. Pond 11 had the largest diversity,containing 7 different species of plants. Most commonly found throughout the ponds was *Veronica* sp. (needs verification)

Chara vulgaris											x
Eleocharis sp.							x				
Elodea canadensis											x
Juncus spp.		x									
Lemna minor			x	x		x					
Nymphaea odorata											x
Potamogeton pectinatus			x	x				x			
Potemogeton crispus	x										
Potemogeton natans											x
Potemogeton oblongus								x		x	
Potemogeton zosteriformis					x	x					x
Sagittaria spp.							x	x			
Utricularia vulgaris											x
Vallisneria americana											x
Veronica sp. (needs verification)			x		x		x	x		x	

Table 7. Plant presence and diversity in Thayer ponds, summer 2006; pond numbers correspond to pond labels shown in Figure1.

CONCLUSION

The work conducted was designed to serve as a preliminary survey of the Thayer ponds physical and chemical water quality as well as an aquatic vegetation and fish presence and diversity survey. Aimed at being the grounds for detecting drastic changes in any of the above mentioned parameters, such as the introduction of a foreign species, and its effect on the state of the pond, no viable and all inclusive conclusions can be made with out future research and analysis.

REFERENCES

Dresser, K. 2006. Continued monitoring of the dynamics of Moe Pond after the introduction of smallmouth bass (*Micropterous salmoides*) and largemouth bass (*Micropterous dolomieui*). *In* 38th Annual Report (2005). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta.

Ebina, J., T. Tsutsui, and T. Shirai.1983. Simultaneous determination of total nitrogen and total phosphorus in water using peroxodisulfate oxidation. Water Res. 17(12): 1721-1726.

Foster, J.R. 1977. Pulsed gastric lavage: An efficient method of removing the stomach contents of live fish. The progressive fish culturist 39:4.

Gifford, K. A. 2003. Thayer Farm Master Plan, 2003. Rensselaer, NY.

Hydrolab Corporation, 1993. Scout 2 operating manual. Hydrolab Corp. Austin, TX.

Liao, N. 2001. Determination of ammonia by flowinjection analysis. QuikChem® Method 10-107-06-1-J. Lachat Instruments. Loveland, Colorado.

Liao, N. and S. Marten, 2001. Determination of total phosphorus by flow injection analysis colorimetry (acid persulfate digestion method).QuikChem® Method 10-115-01-1-F. Lachat Instruments. Loveland, Colorado.

Meehan, H. 2003. Physiochemical Survey of Thayer Farm Ponds. *In* 35th Annual Report (2002). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta.

Murphy, B.R. and D.W. Willis. 1996. Fisheries techniques, 2nd edition. American Fisheries Society. Bethesda, MD.

Peckarsky, B.L., P.R. Fraissinet, M.A. Penton and D.J. Conklin, Jr. 1990. Freshwater Macroinvertebrates of Northeastern North America. Cornell University Press. Ithaca, NY.

Pritzlaff, D. 2003. Determination of nitrate/nitrite in surface and wastewaters by flow injection analysis. QuikChem® Method 10-107-04-1-C. Lachat Instruments. Loveland, Colorado.

Somerville, T., and Albright, M.F. 2006. A survey of Otsego Lake's zooplankton community, summer 2005. *In* 38th Annual Report (2005). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta.

Tamaya Technics Inc. Digital planimeter Planix 5,6 instruction manual. Tamaya Technics Inc. Tokyo, Japan.

Vallentyne, J.R. 1974. The algal bowl. Can. Fish. Mar. Serv. Misc. Publ. 22.