Continued observations of Moe Pond after the unauthorized stocking of smallmouth and largemouth bass

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INTRODUCTION

Moe Pond (Figure 1) is located in Otsego County, New York and is a part of the Biological Field Station's Upper Site. This property, including a northern hardwood and coniferous forest, is owned by SUNY Oneonta and is used for research and other educational purposes. The pond is an artificial impoundment, constructed in 1939, and is a contributor of the Otsego Lake watershed (Albright et al. in press). Moe Pond has a maximum depth of 3.8 meters, a mean depth of 1.8 meters and a surface area of 15.6 ha (Sohacki 1972).

Initial limnological descriptions of the pond were recorded in 1971. Transparencies were reduced to < 0.5 m during the summer due to chronic blooms of blue-green algae and it was noted that vascular plants were nonexistent (Albright et al. in press). A more intensive survey was performed in 1994-1995 that provided a detailed assessment of the ecological characteristics in and around the pond, including limnological analyses and population estimates of fishes (McCoy et al. 2000). The fish community at this time was composed only of brown bullhead (*Ictalurus nebulosus*) and golden shiner (*Notemigonus crysolucas*). It was hypothesized that the abundance of golden shiner, a planktivorous fish, was responsible for the lack of large zooplankton which in turn allowed for high algal densities (McCoy et al. 2000). It was suggested that if predators of golden shiner were introduced, the zooplankton would proliferate and algal grazing would increase, thereby increasing transparencies. In the spring of 1999, it was discovered that unauthorized predator fish, both largemouth bass (*Micropterous salmoides*) and smallmouth bass (*M. dolomieui*) had been stocked (Wilson et al. 1999).

This study is a continuation and a comparison of those previously done to evaluate the changes that can be ascribed to the addition of game fish. Possible management plans were also evaluated in order to determine if the pond could become more ecologically balanced. The fish community was analyzed, as were the zooplankton and benthic communities, algal densities (estimated by chlorophyll *a* determinations) and water quality parameters.

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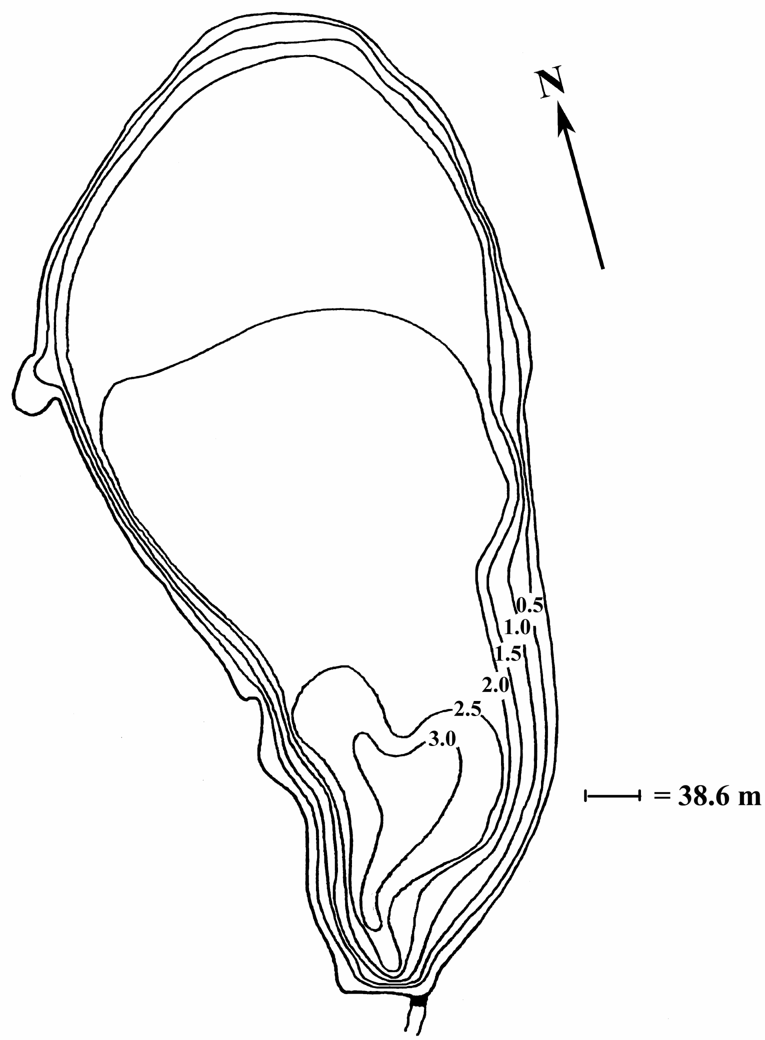

Figure 1. Basin morphometry of Moe Pond, Otsego County, NY. Contours in meters (modified from Sohacki, 1972).

METHODS

All sampling occurred weekly from 2 June to 28 July 2003. A Hydrolab Reporter®, calibrated prior to operation following the manufacturer's instructions (Hydrolab Corp. 1995), was used to determine the temperature (˚C), conductivity (µS/cm), pH and dissolved oxygen (mg/l) at 1m intervals from the surface to the bottom. It was attempted to acquire these readings at the deepest point of the pond (Fig. 1), but because a depth finder was not used, the data were taken from the deepest point the researchers located. A Secchi disk was also used to determine water clarity.

Samples of water were retrieved at 1 meter depth using a Van Dorn collection bottle. This water was analyzed for nitrite+nitrate-N using the cadmium reduction method (APHA 1987), total phosphorous using persulfate digestion followed by the single reagent ascorbic acid technique (APHA 1987), and chlorides by titration with mercuric nitrate (APHA 1987). Chlorophyll *a* was also examined at 1 meter depth. The water sample was brought back to the lab in an opaque bottle and was then passed through Whatman GF/A glass filters. The filters were then cut into small pieces and added to a grinding tube with buffered acetone and Chlorophyll *a* was extracted using a pestle grinder on an electric drill. After being completely ground up, the volume was taken to 10 ml with buffered acetone and centrifuged. Chlorophyll *a* concentrations were then determined fluorometrically using methods described by Welshmeyer (1994).

The zooplankton community was analyzed weekly at 1 meter depth using a Van Dorn sampling bottle. In order to obtain a good representation of the population, 2 to 3 liters of water was processed. The water sample was brought back to the lab and concentrated through a 63 µm mesh filter and preserved with ethanol. The final volume of the concentrated sample was recorded so that the population density could be later determined. In order to identify and quantify the zooplankton community, 1ml sub-samples were transferred to a sedgewick-rafter cell and the organisms were identified according to Pennak (1989). The zooplankton were individually measured in micrometers using an optic micrometer. Typically 3 sub-samples were analyzed.

A semi-quantitave analysis of the invertebrate community was conducted on one occasion. On 9 June 2003 invertebrates were collected on both the south and north ends by dragging a triangle net along the bottom and through overhanging vegetation and emptying the contents into a plastic pan. The invertebrates were removed and preserved in 70% ethanol. The species were identified and a list was compiled of the invertebrates found.

In previous years, fish were collected using a 200' haul seine at the south end of the pond and their populations estimated by areal extrapolation (i.e. Tibbits 2001). However, in 2002 and 2003 the aquatic macrophyte *Elodea canandensis* was too dense to render this method possible. Instead, in those years, fish densities were evaluated by using a Smith Root™ electro-fishing boat. The intent was to use Peterson's mark-recapture method (Bailey 1951), though in both years inadequate numbers of marked fish were collected to allow for reasonable population estimates. Additional electrofishing had been planned during both years, but was not accomplished due to equipment unavailability. However, insight into fish abundances was possible by compassion to catch rates (fish/hour) of other New York lakes having bass (Olson et al. 2000).

The pond was fished on two occasions, after sunset on 30 and 31 July 2003. After the fish were netted onto the boat, they were measured, identified, fin clipped and released. Also, thirty large mouth bass were brought back to the lab in a cooler in order to analyze their stomach contents. They were later thawed out, dissected and their contents were emptied into glass jars for later identification using Smith (2001). A percent composition for each species found inside the fish was determined (Bowen 1983).

RESULTS AND DISCUSSION

Results of the water quality parameters collected in Moe Pond over the summer are given in Table 1. There was an overall water temperature increase throughout the summer. Near bottom concentrations were occasionally depressed, at times dropping below 1.0 mg/l. On most of the dates sampled, Secchi readings were not obtainable because the disk was visible on the pond's bottom. Transparency was lowest at the end of July, which was correlated with the highest chlorophyll *a* concentrations encountered (see Table 2).

Date	Depth (m)	Temp (ºC)	Cond (mS/cm)	pH	DO (mg/L)	SD (m)
6/2/2003	0	16.1	N/A	N/A	8.98	>2.9
	1	15.7	N/A	N/A	8.99	
	2	15.5	N/A	N/A	9.06	
6/9/2003	0	18.43	0.0502	7.02	8.85	>2.9
	1	18.43	0.0504	7.11	9.03	
	2	17.38	0.052	7.73	7.44	
	2.5	16.33	0.0623	7.83	2.98	
6/16/2003	0	19.67	0.0443	8.34	9.39	3.2
	1	19.54	0.0443	8.2	9.28	
	2	19.21	0.0456	7.85	8.54	
	2.5	18.9	0.0474	7.7	8.57	
6/23/2003	0	19.56	0.0499	8.36	8.85	>2.1
	1	18.93	0.0499	8.52	8.93	
	2	18.62	0.0499	8.58	8.85	
	2.3	18.18	0.0514	7.77	4.77	
7/1/2003	0	23.27	0.0522	9.08	9.73	>2
	1	23.01	0.0518	9.05	9.52	
	2	22.3	0.0527	8.18	9.39	
	2.3	20.29	0.0522	6.85	4.09	
7/8/2003	N/A	N/A	N/A	N/A	N/A	>2.5
7/14/2003	0	23.61	0.052	8.27	8.14	2.4
	1	22.53	0.051	8.31	7.96	
	2	21.91	0.0554	7.78	2.63	
7/21/2003	0	22.59	N/A	7.88	8.07	>1.5
	1	22.57	N/A	7.88	7.64	
	2	20.36	N/A	6.6	0.67	
	2.3	19.29	N/A	6.58	0.23	
7/28/2003	0	23.6	0.0521	7.65	7.81	1.5
	1	23.04	0.0513	7.61	7.57	
	2	19.44	0.0514	6.6	0.76	

Table 1. Water quality monitored in Moe Pond over summer 2003 (Cond = conductivity, DO = dissolved oxygen, and SD = Secchi depth reading).

The concentrations of total phosphorous, nitrates, chlorides and chlorophyll *a* of the pond are given in Table 3. Past **i**nformation on nutrient levels in Moe Pond have been sparse, although total phosphorous levels in the past two summers have been significantly lower than the values collected in 1994 ($p<.05$). In 1994 the average concentration was 37 ug/l while in 2003 the average was 29 ug/l. Conversely, nitrate+nitrate-N, which was below detection throughout the summer of 1994, averaged 0.11 mg/l during this study (somehwat lower then in 2002). Chlorophyll *a* concentrations have decreased steadily between 1994 and 2003. In 1994 the values were between 32-43 ug/l and averaged 37.1 ug/l. In 2000, 2001, 2002 the concentrations averaged 26.5, 20.4, 12.0 ug/l, respectively. This summer the average concentration was 9.8 ug/l.

Date	T..Phos. (*u*g/l)	Nitrates (mg/l)	Chloride (mg/l)	Chlorophyll a (ppb)
6/2/2003			1.0	4.82
6/9/2003	24	0.09	2.0	1.55
6/16/2003	25	0.14	2.0	3.39
6/23/2003	24	0.20	1.5	10.58
7/1/2003	40	0.11	1.8	6.10
7/8/2003	29	0.10	0.5	14.90
7/14/2003	30	0.04		14.80
7/21/2003	30			21.98

Table 2. Water chemistry of Moe Pond, summer 2003. Samples taken at 1 m depth.

A synopsis of zooplankton collected over the summer, as well as the mean length of each taxa on each date, is given in Table 3. While the overall densities of crustacean plankton was lower than in 2001 or 2002, the community was well represented by large-bodied *Daphnia* on each date (averaging 114/l at 565 *u*m).

A list of benthic invertebrate species by taxa was compiled as indicated in Tables 4 (north end) and 5 (south end). The species of invertebrates present in a pond can often reflect characteristics of the pond. For example, the abundance of odonates and trichopterans (noted in 2002) in Moe Pond may be the result of higher abundance of vascular plants in the pond in recent years. It is also important to study the invertebrate population two or more times over the summer, although only one collection was made this summer, because of the variability of the life cycles of the different species. Many of these organisms likely are important food sources for fish in the pond.

Fish electroshocking on 30 July yielded 1 smallmouth bass, 317 largemouth bass, 2 golden shiner and 196 brown bullheads. On 31 July, 0 smallmouth bass, 338 largemouth bass, 2 golden shiner and 188 brown bullhead were collected from three sites. Of those, only 27 of the largemouth bass had been clipped and none of the smallmouth bass or golden shiners had been clipped. Therefore, population estimates using the Peterson equation were not attempted.

	2-Jun	
	per liter	**mean length (*u*m)**
Cladoceran		
Bosmina longirostris	60	288
Daphnia pulex	87	665
Copepods		
Cylopoid spp.	7	540
Calanoid spp.	13	625
Nauplii.	13	253
Rotifers		
Gastropus stylifer	0	0
Kellicotia longispina	13	168
Keratella cochlearis	307	91
Keratella quadrata	7	200
Polyartha vulgaris	460	100

9-Jun	
per liter	**mean length (*u*m)**
85	409
233	714
21	650
11	650
297	178
11	225
0	
159	102
11	180
11	100

	16-Jun	
	per liter	**mean length (*u*m)**
Cladoceran		
Bosmina longirostris	57	233
Daphnia pulex	91	692
Copepods		
Cylopoid spp.	0	
Calanoid spp.	11	625
Nauplii.	102	182
Rotifers		
Gastropus stylifer	0	
Kellicotia longispina	0	
Keratella cochlearis	102	107
Keratella quadrata	23	83
Polyartha vulgaris	102	136

23-Jun	
per liter	**mean length (*u*m)**
104	294
74	686
15	500
0	
74	197
0	
0	
133	91
15	210
104	109

	1-Jul	
	per liter	**mean length (*u*m)**
Cladoceran		
Bosmina longirostris	107	319
Daphnia pulex	200	551
Copepods		
Cylopoid spp.	67	468
Calanoid spp.	80	684
Nauplii.	160	170
Rotifers		
Gastropus stylifer	0	
Kellicotia longispina	0	
Keratella cochlearis	27	115
Keratella quadrata	0	
Polyartha vulgaris	107	96

8-Jul	
per liter	**mean length (*u*m)**
80	310
107	461
27	838
93	669
147	172
0	
0	
93	90
0	
107	104

Table 3. Summary of zooplankton densities and mean length collected over summer 2003.

	14-Jul	
	per liter	**mean length (*u*m)**
Cladoceran		
Bosmina longirostris	97	259
Daphnia pulex	73	487
Copepods		
Cylopoid spp.	121	577
Calanoid spp.	16	560
Nauplii.	113	192
Rotifers		
Gastropus stylifer	32	138
Kellicotia longispina	0	
Keratella cochlearis	169	90
Keratella quadrata	16	130
Polyartha vulgaris	65	103

21-Jul	
per liter	**mean length (*u*m)**
97	259
73	487
121	577
16	560
113	192
32	138
0	
169	90
16	130
65	103

	28-Jul	
	per liter	**mean length (*u*m)**
Cladoceran		
Bosmina longirostris	25	281
Daphnia pulex	88	344
Copepods		
Cylopoid spp.	50	407
Calanoid spp.	38	680
Nauplii.	25	181
Rotifers		
Gastropus stylifer	0	
Kellicotia longispina	0	
Keratella cochlearis	6	70
Keratella quadrata	6	160
Polyartha vulgaris	6	110

Table 3 (cont.). Summary of zooplankton densities and mean length collected over summer 2003.

Phylum	Class	Order	Family	Genus	Species
Arthropoda	Crustacea	Amphipoda	Talitridae	*Hyalella*	*azteca*
Arthropoda	Hydrachnida	Acriformes			
Arthropoda	Insecta	Diptera	Chironomidae		
Arthropoda	Insecta	Ephemeroptera	Caenidae	*Caenis*	
Arthropoda	Insecta	Hemiptera	Mesoveliidae	*Mesovelia*	
Arthropoda	Insecta	Odonata	Coenagrionidae	*Coenagrion*	
Arthropoda	Insecta	Odonata	Coenagrionidae	*Ischnura*	
Arthropoda	Insecta	Odonata	Coenagrionidae	*Telebasis*	
Arthropoda	Insecta	Trichoptera	Leptoceridae	*Oecetis*	
Mollusca	Gastropoda	Pulmonata	Physidae	*Physa*	*gyrina*
Mollusca	Gastropoda	Pulmonata	Physidae	*Physa*	*elliptica*
Mollusca	Gastropoda	Pulmonata	Planorbidae	*Gyralus*	*parvus*

Table 4. Taxonomic listing of benthic macro-invertebrates collected at the north end of Moe Pond on June 9, 2003.

Phylum	Class	Order	Family	Genus	Species
Arthropoda	Crustacea	Amphipoda	Talitridae	*Hyalella*	
Arthropoda	Hydrachnida	Acriformes			
Arthropoda	Insecta	Coleoptera	Haliplidae	*Peltodytes*	
Arthropoda	Insecta	Coleoptera	Dytisidae	*Haliplus*	
Arthropoda	Insecta	Diptera	Chironomidae		
Arthropoda	Insecta	Hemiptera	Mesoveliidae	*Mesovilia*	
Arthropoda	Insecta	Hemiptera	Pleidae	*Neoplea*	
Arthropoda	Insecta	Odonata	Libellulidae	*Sympetrum*	
Arthropoda	Insecta	Odonata	Macromiidae	*Macromia*	
Arthropoda	Insecta	Odonata	Coenagrionidae	*Coenagrion*	
Arthropoda	Insecta	Odonata	Coenagrionidae	*Ischnura*	
Arthropoda	Insecta	Trichoptera	Leptoceridae	*Oecetis*	
Mollusca	Gastropoda	Pulmonata	Physidae	*Physa*	*gyrina*
Mollusca	Gastropoda	Pulmonata	Planorbidae	*Menetus*	*dilatatus*

Table 5. Taxonomic listing of benthic macro-invertebrates collected at the south end of Moe Pond on June 9, 2003.

Table 6 provides population estimates for each species in 1995 and 1999-2001, including confidence intervals. Because of the low number of recaptured fish in 2002 and 2003, estimates using the Peterson equation have excessively high variances. However, the mean catch-per-hour of largemouth bass, at 318, implies that this species is abundant compared to other New York waterbodies having bass (Olson et al. 2000), while smallmouth bass and golden shiner densities have been in steady decline.

Year	Golden Shiner	Largemouth Bass	Smallmouth Bass
1994 (McCoy et al. 2000, 2000)	7,154: +12,701;-6,356	0	0
1999 (Wilson et al., 2000)	3,210 +/- 1,760	1,588 +/- 650	958 +/- 454
2000 (Tibbits, 2001)	381 +/- 296	2,536 +/- 1,177	945 +/- 296
2001 (Wojnar, 2002)	1,708 +/- 1693	3,724 +/- 3,447	504 +/- 473
2002 (Hamway, 2003)[a]	3	206	20
2003[a]	2	318	1

[a] mean catch·hr^{-1} during electrofishing survey

Table 6. Population estimates of golden shiner and largemouth bass and smallmouth bass in Moe Pond, 1994 and 1999-2001 determined by areal extrapolation of multiple haul seines, and catch per unit effort of electrofishing surveys in 2002 and 2003.

Diet analysis involved the examination of 29 largemouth bass stomachs. Table 7 summarizes the frequency of occurrence (FOO, as %) of the items encountered. All items were invertebrates, the most prevalent being dipterans and hymenopterans. This result was different in comparison to what was discovered in the past three summers (Hamway 2003) during which the diet of largemouth bass consisted predominately of young-of-the-year bass. Apparently, by 2000 golden shiner had already been reduced, likely due to previous predation by bass, so that they were not available as a food source. Essentially no recruitment by shiners has been documented since 1999. In this study, two nights of electrofishing the entire pond yielded only four golden shiner.

Species	FOO (%)
Amphipoda	1.9
Aranae	0.6
Coleoptera	5.1
Decapoda (Cambaridae)	1
Diptera	34.9
Ephemeroptera	9.9
Hemiptera	1.6
Hydrachnidea (Acariformes)	0.3
Hymenoptera	23.1
Micropterous	0.3
Odonata (Zygoptera)	18.3
Orthoptera	1
Trichoptera	1.9
N (stomachs)	29
Items Identifiable	312

Table 7. Frequency of occurrence (FOO) of food items collected from largemouth bass stomachs.

While vascular plants have never been quantified in Moe Pond, many anecdotal observations have been recorded. In 1971, Harman (1972) noted "…a paucity of aquatic macrophytes…as scattered individuals in a few restricted areas". In 1994, McCoy (2000) echoed that observation. By 2000, a slight increase in plants was noted (Tibbits 2001); by 2001 the increase was more obvious (Wojnar, 2002). In 2002, *Elodea Canadensis* practically covered the entire pond to depths of up to 2 meters and continued to do so in 2003. It was for this reason that fish were again surveyed by electrofishing rather than using a haul seine as had been done in the past. Plant densities precluded conventional seining.

CONCLUSION

Between 1971 and 1994, Moe Pond regularly experienced dense algal blooms, often dominated by blue-greens, throughout the summer. Rooted plants were virtually nonexistent. Brown bullhead and golden shiner were the only two species of fish present, both of which were stunted due to their high abundance (McCoy 2000). Zooplankton densities were low and dominated by rotifers.

Following the unauthorized introduction of largemouth and smallmouth bass by 1999, golden shiner populations declined sharply. Essentially no recruitment has been documented since that time. In 2003, only four golden shiner were collected, all large.

Consistent with last years results, algal densities (assessed by chlorophyll *a* concentrations) were lower in 2002 and 2003 than ever before recorded and Secchi transparencies the highest. Most days the Secchi disk was visible on the bottom of the pond. Rooted plants now dominate the autotrophic community. It is possible that the decline of golden shiners released crustacean zooplankton from planktivory, leading to an increase in algal grazing, and the resultant increased transparency stimulated the growth of rooted plants (Albright et al. in press). Changes in nutrient dynamics, also brought about by trophic modifications, may also have influenced these changes (Hamway 2003). Any effort to reduce macrophyte growth would likely return Moe Pond to an algal-dominated waterbody.

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