

Fifth annual report on the status of Moe Pond following the stocking of *Micropterus salmoides* and *M. dolomieu*

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ABSTRACT

Moe Pond is a 38.5 acre water body located within the Biological Field Station's upper site and is characteristically a eutrophic water body. Since the unauthorized introduction of game fish sometime in 1999, annual surveys of the pond's limnology as well as plant and animal communities have been conducted. A return to water conditions similar to the years prior to stocking was observed this year. After the stocking, the fish community continues to exhibit a trend towards reduced diversity, led by the loss of one of the ponds native fish, the golden shiner. The community of aquatic invertebrates continues to increase while a marked decline in the macrophyte community was observed after several years of steady growth.

INTRODUCTION

In 1967, what is now known as the Biological Field Station's Upper Site was obtained from the Leatherstocking Corporation by SUNY (Harman 1972). This land includes Moe Pond as well as its watershed, which is predominantly northern hemlock hardwood forest (Harman 1972). Since that time, Moe Pond has seen very little human impact due to its designation as a research site (McCoy 2000).

Damning of a natural wetland formed Moe Pond. It is a eutrophic water body with a surface area of 38.5 acres (15.6 ha), and an average depth of 1.8m (Albright et al. 2004). Observations and surveys on the property go back as far as 1972, with extensive research being conducted from 1994 to the present.

The most extensive survey of Moe Pond was conducted between the years of 1994 and 1995 by McCoy (2000) to gain an understanding of the limnology of Moe Pond as well as its general ecology. McCoy's work provided baseline data on the ponds physical and chemical characteristics, and made abundance estimates of brown bullhead (*Ictalurus nebulosis*) and golden shiner (*Notemigonus crysoleucas*), the only fish species present at that time. Annual comprehensive surveys of the pond's limnology, fish, invertebrate, and macrophyte communities commenced in 1999 (Wilson et al. 2000) in order to study the ecological effects of largemouth bass (*Micropterus salmoides*) and smallmouth bass (*M. dolomieu*), which had been introduced into Moe Pond through unauthorized stocking some time in 1999.

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As the abundance of largemouth bass increased, golden shiners and, later, smallmouth bass decreased. Zooplankton densities increased substantially, as did their mean size. Clarity increased as algal standing crops were reduced. While aquatic macrophytes were practically non-existent prior to 2000, *Elodea Canadensis* dominated the pond during the summers of 2002 and 2003 to that point that seining as a means of surveying the fishery was impossible. Albright et al. (2004) postulated that this exemplified trophic cascading; that is, bass reduced planktivorous shiners which allowed for an increased zooplankton community which, in turn, reduced algae through grazing. That would explain improved clarity, which favored macrophytic growth.

The objective of this study is to continue monitoring Moe Pond, in addition to assimilating previously collected data in an attempt to better understand the ecological shifts that have been occurring since the stocking of game fish. Understanding the cascading trophic dynamics will lend insight into the implications of fisheries management on the limnological character of similar water bodies.

METHODS

Limnology

Between the dates of 26 May to 12 July samples were taken weekly from Moe Pond at its deepest spot (3.8m; Figure 1) located using a depth finder then marked with a buoy (N 42° 50.153', W 075° 40.112'). Measurements of temperature (°C), conductivity ($\mu\text{S}/\text{cm}$), dissolved oxygen (mg/l) and pH were acquired with aid of a Hydrolab Reporter[®] which was calibrated prior to use (Hydrolab Corp. 1995). Readings were taken at the surface then at intervals of one meter to the bottom (~3m depth). Secchi readings were also taken to gauge water clarity.

Water samples for total phosphorus and nitrate+nitrite analysis were collected at a depth of 1m by using a Van Dorn collection bottle. Nitrate+nitrite-N was analyzed through the cadmium reduction method (APHA 1989). Total phosphorus was analyzed by persulfate digestion followed by the single reagent ascorbic acid technique (APHA 1989).

Chlorophyll *a* was also examined on a weekly basis at a depth of 1m. The sample was collected in a Van Dorn collection bottle then immediately placed in an opaque container and processed promptly upon return to the lab. A 100mL sample was passed through a Whatman GF/C filter, which was cut up into small pieces and placed in a buffered acetone. A grinder at the end of an electric drill extracted the chlorophyll. The concentrations of chlorophyll *a* was then determined using fluorometric techniques (Welschmeyer 1994).

On a weekly basis zooplankton populations in Moe Pond were also monitored. Samples were taken at 1m depth with a Van Dorn collection bottle. One liter was concentrated through a filter with a 63 μm mesh, and then preserved to about 70% with ethanol. Initial and final volumes were recorded and used to back calculate the

abundance of zooplankton per liter. Three one milliliter sub samples were viewed under a compound microscope with a sedgewich-rafter cell. Organisms were identified and measured in micrometers using an ocular micrometer.

Fish community Survey

A survey of the fish community was conducted on 14 and 15 June using a 200 foot shore-to-shore haul seine. Methods were similar to those employed in 2000 and 2001 (Tibbits 2001, Wojnar 2002), but differed from those used in 2002 and 2003 (Hamway 2003, 2004) in which an electrofishing boat was needed in order to evaluate fish abundances because submerged macrophytes were too dense for haul seining.

Three seines were conducted along the south shore of Moe Pond. Data collected on captured fish included length (mm) and weight (g), collected using a measuring board and a Denver Instruments XP-1500 scale. Scales from the fish were also taken from just in front of the dorsal fin and were examined with a microprojector for age analysis. Measurements from the annuli to individual age rings were back calculated to determine length at age (Murphy 1996).

Diets of predator fish measuring over 100mm were evaluated using gastric lavage. Stomach contents were preserved at the time of collection and later identified with the aid of Peckarsky (1990).

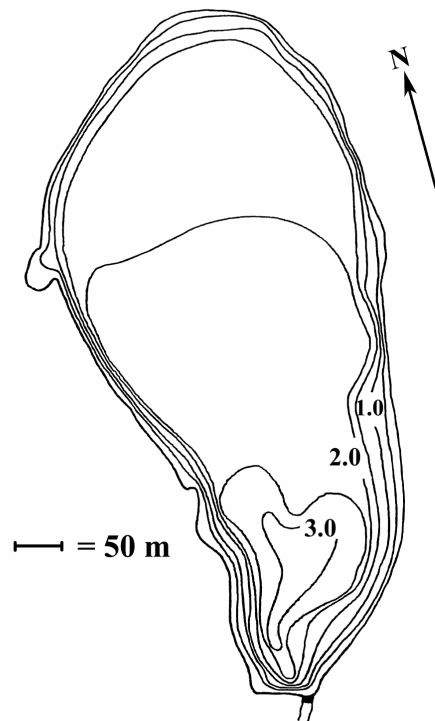


Figure 1. Bathymetry of Moe Pond, Otsego County, NY. Contours in meters (modified from Sohacki 1972).

An estimate of the number of fish in Moe Pond was acquired through the area extrapolation method. An assumption made during the calculations was that the average area within the ellipse of the haul seine equaled 300m². For each seine the number of fish caught per species was divided by the area seined to get the number of fish per m², then multiplied by the area of the pond, 155,800m². Populations were reported as the mean extrapolated number as well as +/- a 95% confidence number. Area extrapolation is not expected to accurately estimate population size, but since data have been collected in this manner for prior studies, it can be considered a proxy of abundance.

Invertebrate Community Survey

A semi-quantitative invertebrate survey was conducted on 30 June. Two sampling sites were used, one at the south end of the pond and one at the north end. Both sites were chosen for their similar characteristics, muddy bottom with emergent vegetation and rocks. At each site a 7m stretch of shoreline was sampled with a triangular collection net for 3 minutes, during which care was taken to ensure all rocks and emergent macrophytes were thoroughly scraped. Samples were preserved at the site of collection with ethanol and organisms were separated and identified according to Peckarsky (1990). Catch per unit effort (CPUE) was also calculated to provide a semi-quantitative value for each taxa.

Macrophyte Community Survey

The macrophyte survey of Moe Pond was conducted on 30 June, and consisted of circumnavigating the pond identifying, and collecting, both emergent and submerged vegetation. Specimens were brought back to the Biological Field Station for identification verification.

RESULTS AND DISCUSSION

Limnology

A summary of the limnological data collected on Moe Pond from 1972 to the present survey are provided in Table 1. Parameter values from this summer appear more similar to data gathered in 1994, 2000, and 2001 (during pre-smallmouth/largemouth bass establishment years when the community was dominated by golden shiners) rather than 2002 and 2003.

While the physical and chemical data collected during this survey seem to be similar to years before bass were established, zooplankton numbers are exhibiting a trend of continually increasing density (Table 2). Numbers of large crustacean zooplankton are increasing concurrent with the decline of the planktivorous golden shiners. Despite that increase, the chlorophyll *a* and Secchi readings resemble those years when zooplankton densities were low. This implies that the zooplankton are not effectively grazing algae enough to effect chlorophyll *a* and clarity. This is perhaps compounded by algal blooms which seem unusually strong this season, perhaps due lack of nutrient competition with macrophytes.

	1972 ^a	1994	2000	2001	2002	2003	2004
Secchi Depth (m)	NA	0.85 (0.1)	1.2 (0.2)	1.1 (0.1)	>2.2 ^c	>2.33 ^c	1.4 (0.2)
Total Phosphorus-P (u g/l)	40-70	36.7 (3.7)	NA	NA	26.4 (2.6)	29.1 (2.12)	42.5 (2.04)
Nitrite+Nitrate-N (mg/l)	NA	<0.05 ^b	NA	NA	0.14 (0.02)	0.11 (0.02)	0.10 (0.01)
Chlorophyll <i>a</i> (u g/l)	NA	37.1 (2.2)	26.5 (0.2)	20.4 (8.1)	12.0 (2.4)	9.76(2.49)	22.9 (4.4)
Alkalinity (mg/l as CaCO ₃)	26-37	18.0 (0.4)	NA	17.0 (0.2)	16.0 (0.5)	NA	NA
pH	6.8-10.2	7.93 (0.37)	8.63 (0.35)	8.66 (0.32)	9.08 (0.18)	6.84 (.44)	7.3 (0.07)

^a only ranges available

^b all samples below detection

^c Secchi disk visible on pond bottom 50% of samples

Table 1. Summer mean values (+/- standard error) for Secchi depth, total phosphorus, nitrite-nitrate, chlorophyll a, alkalinity and pH in Moe Pond (adapted from Albright et al. 2004).

Summer 2003		
Species	#/liter	mean length (µm)
Cladoceran		
<i>Bosmina longirostris</i>	79	295
<i>Daphnia pulex</i>	114	565
Copepods		
<i>Cylopoid sp.</i>	48	569
<i>Calanoid sp.</i>	31	632
<i>Nauplius sp.</i>	116	191
Rotifers		
<i>Gastropus stylifer</i>	8	167
<i>Kellicotia longispina</i>	1	168
<i>Keratella cochlearis</i>	130	94
<i>Keratella quadrata</i>	10	156
<i>Polyartha vulgaris</i>	114	107
Mean Total /L:	651	

Summer 2004		
Species	#/liter	mean length (µm)
Cladoceran		
<i>Bosmina longirostris</i>	225	323
<i>Daphnia pulex</i>	151	677
Copepods		
<i>Cylopoid sp.</i>	71	430
<i>Calanoid sp.</i>	22	559
<i>Nauplius sp.</i>	187	184
Rotifers		
<i>Asplanchna priodontus</i>	66	410
<i>Gastropus stylifer</i>	120	105
<i>Kellicotia longispina</i>	57	199
<i>Keratella cochlearis</i>	2367	95
<i>Polyartha vulgaris</i>	138	159
<i>Dicehocesa</i>	97	202
<i>Microeodon</i>	6	155
Mean Total/L:	3506	

Table 2. Mean numbers of zooplankton per liter, length (µm) and mean total per liter for summer 2003 (Hamway 2003) and from the current study.

Fish Community

The data attained from this year's fish community survey continued to follow trends that have been appearing in the data since the introduction of largemouth and smallmouth bass into Moe Pond (Table 3). This survey marked the first time that no golden shiners were found in Moe Pond which, considering last year's low capture numbers, imply that golden shiners are at vestigial levels. Smaller golden shiners are believed to have been used by the bass as forage fish (Tibbits 2001). The few shiners captured in recent years have been large; no evidence of recruitment has been documented since 2000.

Another previously documented fish species that failed to appear this year was smallmouth bass. The decline of this fish species has been documented since 2000, especially between the years of 2001 and 2003. Local extirpation of this species is most likely competition with large mouth bass, which are better suited for conditions present in Moe Pond (Tibbits 2001).

From collecting and analyzing the scales collected from largemouth bass captured, it is evident that Moe Pond remains a stunted fishery (Figure 2) just as Tibbits hypothesized in his 2000 survey, inferring the cause likely the lack of forage available in the pond. The mean length of bass captured during haul seining was 177 mm, with a mean weight of 117.9 grams. It was also determined that the average age of the fish was three years.

Year	Golden Shiner	Largemouth Bass	Smallmouth Bass
1994 (McCoy et al. 2000, 2000)	7,154: +12,701;-6,356	0.00	0.00
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 +/- 1,693	3,724 +/- 3,447	504 +/- 473
2002 (Hamway, 2003)*	3	206	20
2003 (Hamway, 2004)*	2	318	1
2004 (Current Survey)	0	6,924 +/- 2,912	0

Table 3. Fish population estimates 1994, 1999-2001, and 2004 calculated by extrapolation method, +/- 95% confidence interval. (*)denotes dates when electro fishing was necessary and numbers are presented in catch per hour of effort (adapted from Hamway 2003).

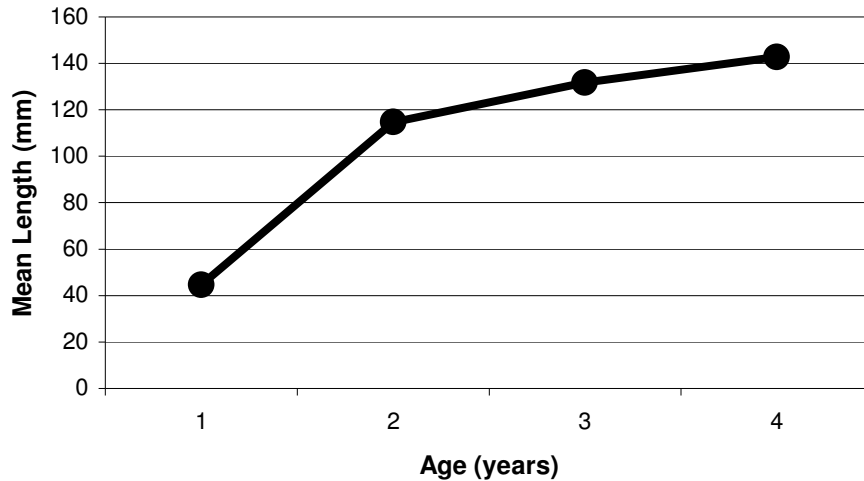


Figure 2. Largemouth bass length versus age growth curve for Moe Pond

Data collected on largemouth bass diet this year resembled those from other years in that there were large numbers of arthropods from the taxa Diptera and Odonata (Table 4). Unlike years previous, however, were large numbers of Daphnia occurring in about twelve percent of the stomachs. Also, since the Daphnia appear in only a few of the fish stomachs it seems that cladocerans are a food source that only a few fish have learned to exploit.

Taxa	Mean per stomach	% Occurrence Largemouth Bass
Bivalvia	0.19	12.50
Acariformes	0.31	12.50
Daphnia	155.94	12.50
Amphipoda	0.63	25.00
Diptera	7.25	68.75
Hymenoptera	0.06	6.25
Ephemeroptera	7.19	43.75
Lepidoptera	0.06	6.25
Odonata	2.06	62.50
Ictaluria nebulosus	0.06	6.25
Larval Fish	0.25	18.75

Table 4. Largemouth bass stomach contents arranged by mean number per stomach and percent occurrence.

Invertebrate Community Survey

More taxa of benthic invertebrates were found during this survey than had been found in previous years (Hamway 2003), and greater numbers were captured in the southern sampling site (Table 5), which can be attributed to a greater density of vegetation and a muddier substrate than found at the northern sampling site. Beetles, however, were far more abundant at the northern site.

Total numbers of invertebrates captured, as well as catch per unit effort readings (Table 6), appeared much higher than the last qualitative survey conducted in summer 2000 (Tibbitts 2001). A reason for this difference could be that prior to the summer 2000 there was very little macrophyte presence in Moe Pond. During the years from 2001 to 2003 (Wojnar 2002, Hamway 2003, Hamway 2004) Moe Pond became dominated by submerged macrophytes, affording more habitat to conceal invertebrates. It is surprising that the numbers of invertebrates continue to remain high after the apparent failure of the macrophyte cover this year. It may be informative to track the invertebrate populations throughout the summer season in future studies, with the goal to track population fluctuations due to introductions and rates of predation.

Southern End		Northern End	
Taxa	Number of Individuals	Taxa	Number of Individuals
Ephemeroptera (mayflies)	5	Ephemeroptera (mayflies)	4
Anisoptera (dragonflies)	12	Anisoptera (dragonflies)	3
Zygoptera (damsleflies)	18	Zygoptera (damsleflies)	3
Trichoptera (caddisflies)	5	Trichoptera (caddisflies)	1
Coleoptera (beetles)		Coleoptera (beetles)	125
Megaloptera (dobsonflies)	1	Megaloptera (dobsonflies)	1
Diptera (true flies)	54	Diptera (true flies)	5
Amphipoda (scuds)	373	Amphipoda (scuds)	90
Decapoda (crayfish)	1	Decapoda (crayfish)	
Acariformes (water mite)	7	Acariformes (water mite)	3
Planorbidae (rams horn snails)	88	Planorbidae (rams horn snails)	63
Valvatidae (valve snails)	116	Valvatidae (valve snails)	24
Sphaeriidae (finger nail clams)	63	Sphaeriidae (finger nail clams)	
Hirudinea (leeches)	12	Hirudinea (leeches)	3
Total Number Captured:	755	Total Number Captured:	325

Table 5. Invertebrate sampling for 29 June by sampling site and by number of individuals captured per taxa.

Sampling Site	Catch per unit Effort		Catch per unit effort
	Number of Individuals Caught	Effort (minutes netting)	
South Shore	755	3	252
North Shore	325	3	108

Table 6. Catch Per Unit Effort calculations for invertebrates captured at the northern and southern sampling sites.

Macrophyte Community Survey

The virtual absence of macrophytes compared to those present in 2002 and 2003 in Moe Pond was the most interesting observation made this year. A rudimentary qualitative survey of emergent and submerged macrophytes revealed some interesting data. Most notable was the decline of *Elodea canadensis*, which was still observed, but not nearly in the densities observed in recent years (Hamway 2003; 2004) when it reached the surface over approximately half the pond.

The emergent plants that were observed were in low densities. *Iris versicolor* (larger blue flag) and *Onoclea sensibilis* (sensitive fern) had both been mentioned in past text (McCoy 2000), so their presence in the eulittoral and littoral zones was expected. A surprising find was made in the littoral zone at the northern end of the pond where the old airfield meets the edge of the pond. *Isoetes sp.*, quillwort, was found in shallow water less than half a meter deep in a plot that measured roughly one by three meters. There was no evidence of sexual reproduction observed at that time, which made species identification impossible. The only other macrophyte present in the area was *Elodea canadensis*, of which some particularly unhealthy fragments had washed up on shore.

CONCLUSIONS

Through the summer of 2003, it seemed that the establishment of bass were effecting practically every aspect of Moe Pond's limnology. As shiners were reduced (presumably due to predation by bass), zooplankton abundance and mean size increased. Algal standing crops were reduced as transparency increased. The macrophyte community, which was virtually non-existent prior to the establishment of bass, had become dominated by dense beds of *Elodea canadensis* throughout the pond. It was suggested that the shift from algal to macrophytic dominance was due to trophic cascading from predation by bass (Albright et al. 2004). During 2004, largemouth bass continue to increase in abundance, golden shiners are practically non-existent, and zooplankton densities remain high. However, conditions in the pond have reverted to those similar to what had been documented prior to bass establishment, again being dominated by algal biomass with macrophytes at low densities. The causal mechanisms behind this shift are unknown.

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