The continuing evaluation of Moe Pond after the unauthorized stocking of smallmouth and largemouth bass

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INTRODUCTION

Moe Pond (Figure 1) is located on the Biological Field Stations Upper Site in Otsego County, New York, just outside of Cooperstown. The pond was named after Henry Allen Moe, a past member of the New York State Historical Association (Wilson et al., 1999). It is a man-made pond, created in 1939 with a surface area of 15.6 ha (39.5 ac), a mean depth of 1.8 m and a maximum depth of 3.8 m (Sohaki, 1972). The area is currently owned by SUNY Oneonta, which uses the property for educational and research purposes only.

In 1995, McCoy et al. (2000) provided a physical and chemical limnological summary as well as an ecological survey. His findings showed a fish community solely of brown bullhead (*Ictalurus nebulosus*) and golden shiners (*Notemigonus crysolucas*). They had believed that a large population of shiners was responsible for the decline in larger zooplankton, leading to a decrease in phytoplanktivory and lower Secchi readings as a result of greater algal blooms. It was suggested that addition of smallmouth bass (*Micropterous dolomeui*) and largemouth bass (*M. salmonoides*) might reduce shiner populations through predation, in turn resulting in a rebound of the zooplankton community. However, in 1999, preceding further assessment, a small population of smallmouth and largemouth bass were discovered in Moe Pond (Wilson et al., 1999). They had estimated the fish, of an unknown origin, were stocked at a length of 120mm, in the spring of 1999.

The purpose of this study was to further evaluate the fish community and limnological character of Moe Pond, and to give an overview of the plant and invertebrate communities. Particularly, fish populations and age analysis were studied. Recruitment and diet were also described in less detail. Zooplankton communities and algal densities (using chlorophyll *a* analysis) were also investigated. Brown bullhead were not considered in this survey.

MATERIALS AND METHODS

Limnological analyses were conducted on 13 June, 16 July and 8 August 2001 using a Hydrolab® Reporter and a Secchi disk. Water samples were taken using a 4 l Van Dorn sampler from a rowboat in 3 meters of water at a depth of one meter, near the south end of Moe Pond.

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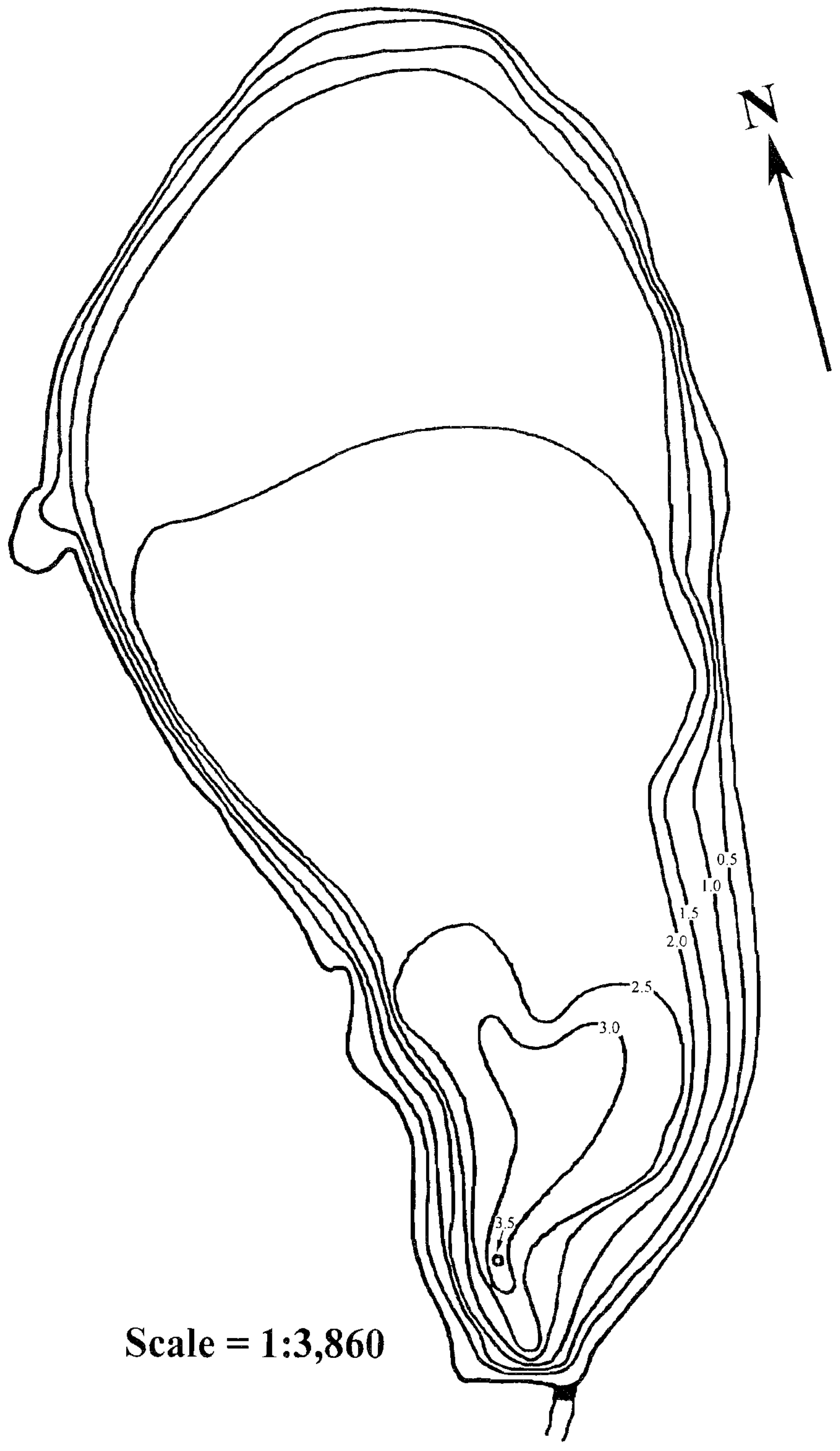


Figure 1. Basin morphometry of Moe Pond, Otsego County, NY. Contours in meters.

Dissolved oxygen, conductivity and pH were determined using a Hydrolab® Reporter which had been calibrated on the morning of each sample date following manufacturer's instructions (Hydrolab® Corp., 1995). Nitrate + nitrite was determined using the cadmium reduction method (APHA, 1989) and total phosphorous by single reagent absorbic acid technique following persulfate digestion (EPA, 1983).

A two-liter zooplankton sample was taken back to the lab, filtered through a 63um mesh, and preserved with Lugol's Iodine. Identification and total abundance of zooplankton was evaluated using a compound microscope according to Pennak (1989). A sedgewick rafter cell was used to examine three one-ml subsamples of the zooplankton concentrate. Chlorophyll *a* was concentrated by filtering 40 ml of water through a GF/A Whatman filter. After extraction, chlorophyll *a* concentrations were measured flurometrically using methods depicted by Welshmeyer (1994).

Invertebrate analysis was performed using triangle nets along the north and south shores of Moe Pond. Species identification and abundance were determined according to Pennak (1989) and were semi-quantitatively reported as catch per unit effort (CPUE).

Fish populations were evaluated from 18 June 2001 through 30 July 200. A 200' haul seine was used to capture fish near at the south end of the pond. Fish were weighed and measured using a HOMS 1000 scale and a measuring board. Scale samples were taken with a knife for aging purposes. Fish populations were determined by the areal extrapolation method described by Wilson et al. (1999). The area swept was assumed to be half an elipse, determined by Wilson et al. (1999) to be 310 m^2. For each date sampled, populations of each species were calculated as the product of the number caught times 155,800 m^2 (pond area) divided by 310 m^2. Populations were reported as the mean extrapolated number +/- the 95% confidence limit.

Fish community, including age structure, condition (K), and stomach analysis, was also evaluated. Stomach analysis was carried out using the pulsed gastric lavage method of extraction. Only bass stomachs were evaluated. Percent composition of each taxa retrieved was determined following methods used by Tibbits (2000). Length-at-age was used to determine different age groups and recruitment as describe by Murphy and Willis (1996). Age was determined with the use if a microprojector. Length-weight relationships were used to illustrate the condition of the bass and golden shiner populations. Length-frequency histograms were used to describe the rates of recruitment, growth and mortality of the age groups present.

RESULTS AND DISCUSSION

Limnological data are presented in Table 1. Dissolved oxygen levels decreased slightly throughout the summer, paralleling increasing temperature. An increase in chlorophyll *a* readings from June to July indicates a mid-summer algal bloom. Secchi readings only varied slightly, but were initially low in relationship to previous summers

(1.5 m on 28 June 2000). Fluctuations in pH may be due to the low levels of alkalinity, which in turn results in a low buffering capacity.

Table 1. Water quality parameters monitored in Moe Pond, 1 m depth.

Month	Chlorophyll *a* (ppb)	Secchi (m)	pH	Dissolved Oxygen (mg/l)	Cond. (mmho/cm)	Alkalinity (CaCO3) (mg/l)
13-28 June	10.5	1.25	8.4	9.66	0.0420	17.5
July	30.3	1.0	8.3	9.34	0.0484	16.5
Aug		1.0	9.3	8.35	0.0489	

Tibbits (2001) indicated macrophyte production was very low for Moe Pond in 2000. This year plant production was significantly higher. By July, *Elodea canadensis* dominated the deeper areas of Moe Pond and in August, the dominant species was *Potamogeton pectinatus,* which inhabited the shallows as well. Such a significant change in macrophyte production may be due to the decreasing number of golden shiners grazing upon the plants.

Zooplankton densities are presented in Table 2. Also included are data collected for similar dates in 2000, where available. Abundance for June was significantly lower than at a similar time last year. Mean zooplankton size increased from June to July but then decreased in the month of August. Cladocerans and copepods were largest in size, however the community was dominated by the smaller rotifers. This is significant to Moe Pond because smaller zooplankton are less efficient grazers, allowing for greater phytoplankton densities (Matthews, 1998). Furthermore, larger zooplankton are a more sufficient food source for larval fish and planktivores (Matthews, 1998), making Moe Pond less likely to be able to sustain a healthy forage population.

Table 2. Monthly zooplankton abundance per ml of concentrated sample and per liter.

06/28/2001	1	2	3	Total	Per Liter	06/28/2000
Bosmina longirosis	0	1	0	1	34	67
Daphnia pulex	0	0	0	0	-	33
Cyclops varicans	0	0	0	0	-	-
Senecella calanoides	0	0	2	2	68	50
Nauplii	0	0	0	0	-	83
Asplanchna priodontus	0	0	0	0	-	280
Filinia longiseta	0	0	0	0	-	-
Gastropus stylifer	0	0	0	0	-	50
Kellicotia longispina	0	0	0	0	-	-
Keratella cochlearis	3	3	2	8	273	100
Keratella quadrata	0	1	0	1	34	-
Polyartha vulgaris	3	3	0	6	205	-
Total	6	8	4	18	614	1,000

07/16/2001	1	2	3	Total	Per Liter	07/30/2000
Bosmina longirosis	0	2	1	3	215	1,260
Daphnia pulex	0	0	1	1	72	210
Cyclops varicans	1	1	1	3	215	-
Senecella calanoides	0	0	0	0	-	279
Nauplii	0	0	2	2	143	139
Asplanchna priodontus	0	0	0	0	-	-
Filinia longiseta	1	0	0	1	72	-
Gastropus stylifer	0	0	0	0	-	-
Kellicotia longispina	10	7	4	21	1505	-
Keratella cochlearis	1	1	1	3	215	-
Keratella quadrata	0	0	0	0	-	-
Polyartha vulgaris	0	0	1	1	72	420
Total	13	11	11	35	2,509	2,310

08/14/2001	1	2	3	Total	Per Liter
Bosmina longirosis	1	0	3	4	190
Daphnia pulex	0	3	1	4	190
Cyclops varicans	0	0	0	0	-
Senecella calanoides	0	0	0	0	-
Nauplii	1	0	1	2	95
Asplanchna priodontus	1	0	0	1	47
Filinia longiseta	0	0	0	0	-
Gastropus stylifer	0	3	0	3	143
Kellicotia longispina	0	1	2	3	143
Keratella cochlearis	3	10	5	18	855
Keratella quadrata	0	0	0	0	-
Polyartha vulgaris	0	3	1	4	190
Total	6	20	13	39	1,853

Catch per unit effort for invertebrate species (Table 3) was almost equal for both the north and south ends of the pond, as were the taxa encountered. All aquatic species were counted.

Table 3. Invertebrate population by total numbers and CPUE (per hr) organized by taxa and area of sampling.

14-Jun-01	**North End**		14-Jun-01	**South End**	
Taxa	**Number**	**CPUE (1hr)**	**Taxa**	**Number**	**CPUE (1hr)**
Coleoptera			Coleoptera		
-Psephenidae	0	0	-Psephenidae	1	1
-Dytiscidae	0	0	-Dytiscidae	1	1
-Halipus sp	12	12	-Halipus sp	3	3
Decapoda	1	1	Decapoda	3	3
Trichoptera	35	35	Trichoptera	3	3
Ephemeroptera	12	12	Ephemeroptera	6	6
Zygoptera	2	2	Zygoptera	1	1
Amphipoda	12	12	Amphipoda	19	19
Hirudinea	7	7	Hirudinea	4	4
Diptera			Diptera		
-Chironomidae	38	38	-Chironomidae	75	75
-Ceratopogonidae	0	0	-Ceratopogonidae	1	1
Gastropoda			Gastropoda		
-Planorbidae	19	19	-Planorbidae	13	13
Bivalvia			Bivalvia		
-Spheridae	1	1	-Spheridae	0	0
Hydracarina	0	0	Hydracarina	3	3
Oligochaeta	3	3	Oligochaeta	7	7
Megaloptera			Megaloptera		
-Sialidae	1	1	-Sialidae	0	0
Total	**143**	**143**	**Total**	**140**	**140**

Table 4 summarizes stomach analysis performed over the summer. Largemouth bass stomach contents consisted mainly of chironomid midges in June, but shifted to brown bullhead and largemouth bass in July. Smallmouth stomachs consisted primarily of ephemeropterans (mayflies) in June, though only two stomachs were evaluated this summer.

Table 4. Largemouth and smallmouth bass stomach analysis.

% Occurrence Largemouth Bass			% Occurrence Smallmouth Bass	
Taxa	**June**	**July**	**Taxa**	**June**
Zygoptera	13.6	0	Zygoptera	4.2
Decapoda	22.7	0	Decapoda	8.3
Diptera	13.6	0	Diptera	66
Chironomidae	36.3	0	Anisoptera	4.2
Hemiptera	9.09	0	Ephemeroptera	16.6
M. salmonoides	0	33		
Ictalurus nebulosus	0	33		
N (stomachs)	4	3	**N (stomachs)**	2
%Items Identifiable	100	66	**% Items Identifiable**	95

Figure 2 shows dominance by shiners between 170 and 175 mm. In 2000, most shiners were between 130 and 150 mm. Only one yoy (Young Of the Year) shiner was caught, indicating that recruitment is practically nonexistent. That is consistent with Figure 3, which shows that with that single exception, no shiner less than three years old has been collected in 2000-2001. Tibbits (2001) stated that macrophyte cover is important to golden shiner recruitment. With the increase in macrophyte production, there may be an increase in yoy golden shiner survival. Age-length analysis found golden shiners at 3-5 years of age, but at a much larger size than those found last year.

Figure 2. Golden shiner length vs. frequency of occurrence for Moe Pond.

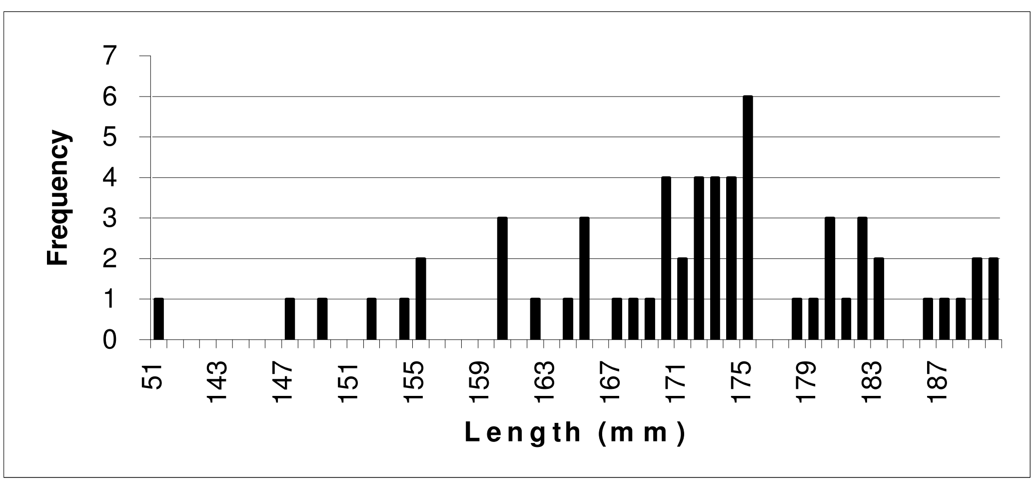
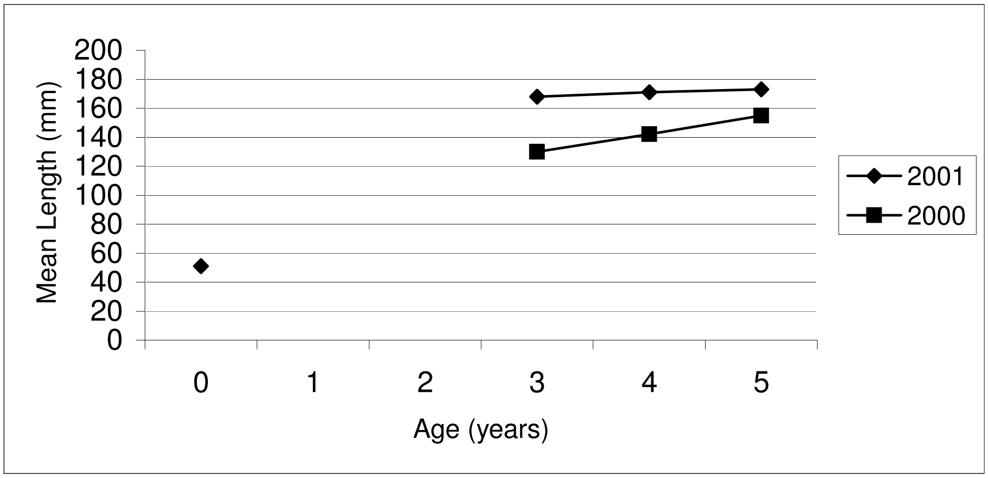
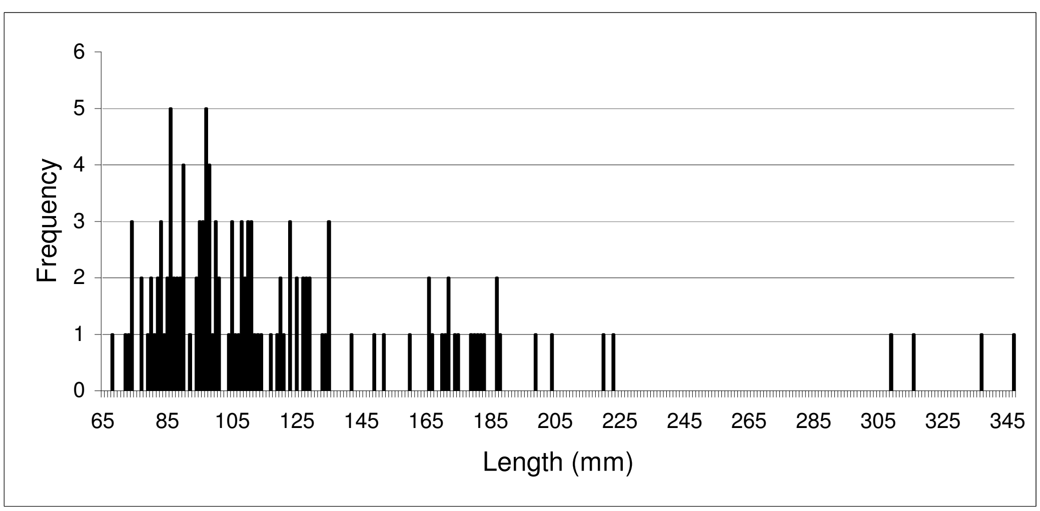


Figure 3. Golden shiner length at age growth curve for Moe Pond.



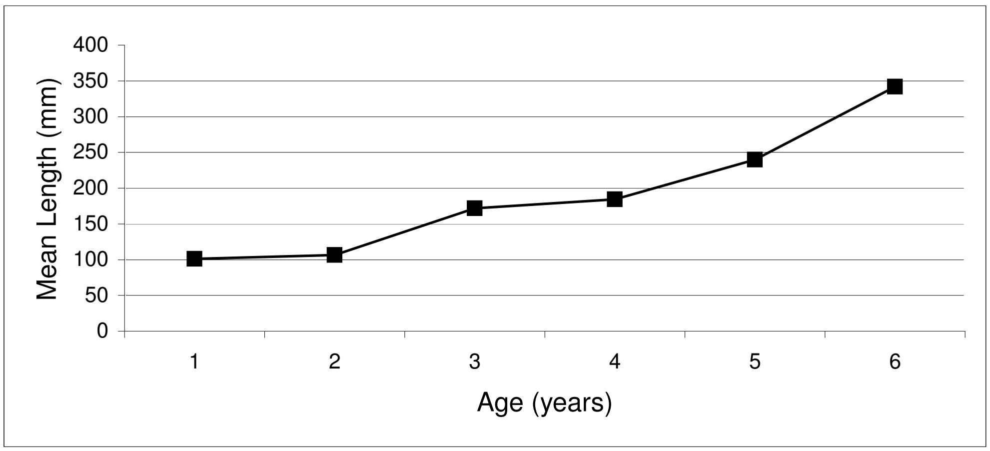
The largemouth bass population shows strong recruitment of fish, represented by those 1 and 2 years of age (Figure 4), which is sign of a healthy bass community (Kohler, 1993). Young of the year bass were abundant, but were not measured. The decrease in golden shiners has not had a significant effect on the survival of the largemouth bass population at this time. Without a significant food source, the bass population will probably result in a cycling of strong year classes and eventually a large number of stunted fish of the same size.

Figure 4. Largemouth bass length vs. frequency of occurrence for Moe Pond.



Growth for largemouth bass was initially fairly slow Figure 5). This may be an indication of an insignificant food supply of appropriate size for smaller bass. With a lack of significant nutritional sources, bass must expend more energy to find food, therefore reducing growth. However, as they exceed about 200 mm (in their fourth year), growth accelerates. Those fish, being few in number, are likely cannibalistic.

Figure 5. Largemouth bass age-length analysis for Moe Pond



Smallmouth bass length vs frequency of occurrence (Figure 6) shows little recruitment, though the small sample size makes conclusions difficult. Back – calculation was used to describe the length-at-age of smallmouth bass. The 3+ year olds are growing at a much slower rate than the 4+ year olds (Figure 7).

Figure 6. Smallmouth bass length vs. frequency of occurrence for Moe Pond.

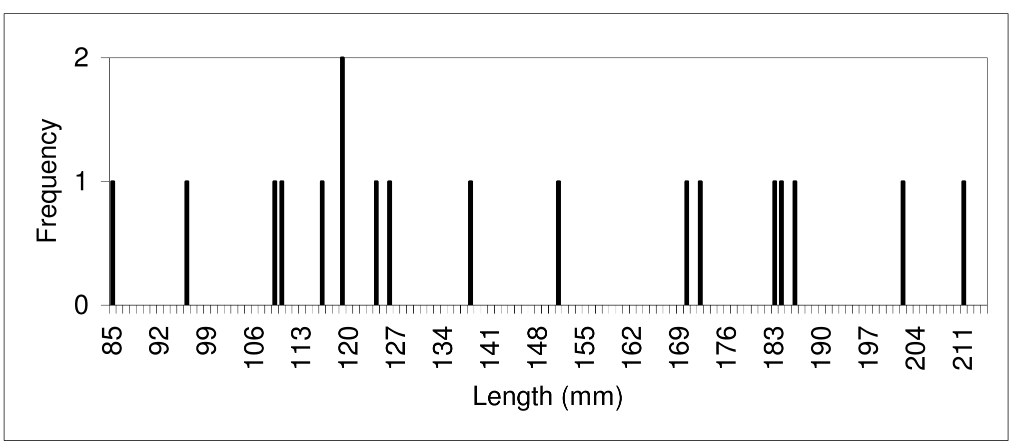
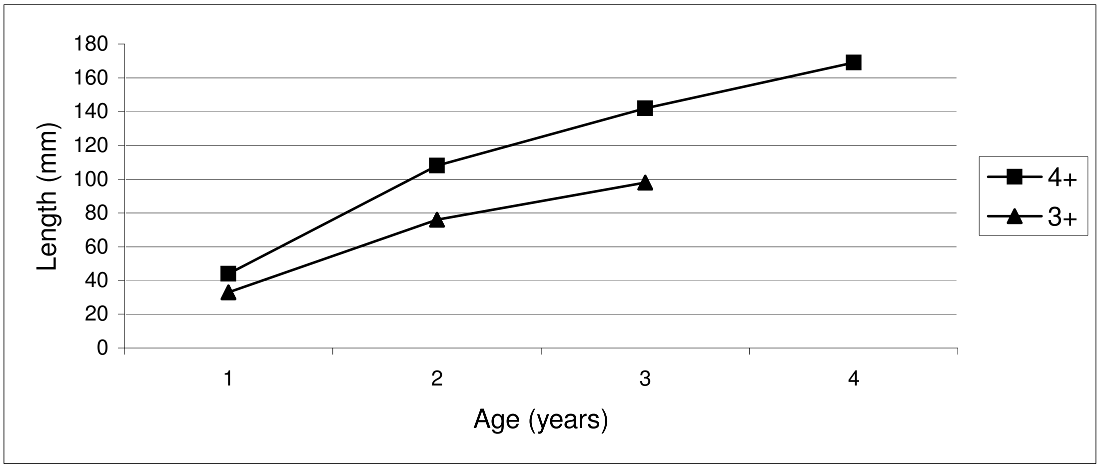


Figure 7: Smallmouth bass age-length analysis for Moe Pond.



CONCLUSIONS

Pond-wide population estimates, including ranges based upon the 96% confidence intervals, for golden shiner and smallmouth and largemouth bass are given in Table 5. IT seems as though smallmouth bass are declining while largemouths are becoming more abundant. Estimates for golden shiners are greater than they had been in 2000, though the absence of documented recruitment makes that unlikely and is rather a reflection of high confidence intervals for those data. Future work should attempt to increase netting effort in order to reduce confidence intervals in order to refine the ability to note subtle changes in fish populations.

Table 5. Population estimates in Moe Pond at a 95% confidence interval.

Year	**Golden Shiner**	**Largemouth Bass**	**Smallmouth Bass**
1995 (McCoy et al., 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
2000 (current study)	1,708 +/- 1693	3,724 +/- 3,447	504 +/- 473

To date, the changing fish community seemingly has had little impact on other trophic levels or on the physical character of the pond. One notable exception is the suggestion that rooted macrophytes, historically sparse in the pond, are increasing. Continued research will provide insight into whether trophic changes will develop over time, or whether the eutrophic nature of this waterbody may be such that top down management will not prove effective there.

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