# Continued monitoring of the Moe Pond ecosystem following the introduction of smallmouth and largemouth bass (*Micropterus dolomieu* and *M. salmoides*, respectively)

Kristen M. Finger[1]


## ABSTRACT

Moe Pond, at N42º43.00'W74º56.75', is a 38.6 acre warm water polymictic water body located in Cooperstown, Otsego County, New York (McCoy et al. 2000) and is owned by SUNY Oneonta Biological Field Station (Albright et al. 2004). Moe Pond was classified as eutrophic because it has high density of phytoplankton and low transparency (Albright et al. 2004). The presence of golden shiners (*Notemigonus crysoleucas*) was assumed to be the leading factor in curtailing the growth of the zooplankton community (McCoy et al. 2000). The low water clarity seemed to prevent the growth of macrophytes in the pond, which contributed to the paucity of habitat for benthic organisms, leading to decreased numbers. In 1999, smallmouth bass (*Micropterus dolomieui*) and largemouth bass (*M. salmoides*) were found in Moe Pond due to unauthorized introduction (Hamway 2003). The presence of these piscivorous fish led to the extripation of the golden shiners. The zooplankton population and mean size increased and the phytoplankton population decreased, and therefore water clarity increased. *Elodea canadensis* covered much of the pond in 2002 and 2003 (Albright et al. 2004). In 2004, golden shiners were not captured in the fish census and Daphnia were found in the bass stomachs for the first time. The bass seemed to have begun targeting zooplankton as prey after the elimination of golden shiners as a stable item. As zooplankton numbers declined, the pond's Secchi readings decreased to the first recorded conditions, prior to the introduction of bass, as the stunted bass population filled the niche previously occupied by the golden shiners during 2004-2005. In 2006-2007, a sharp decrease in total phosphorous and a sudden increase in Secchi disk readings were the only exceptions to this continuation of a trend noted in the previous years. In 2008, levels appeared similar to those noted in 1994, before the introduction of bass, with the exception of a slightly increased water clarity reading that was much less than the 2005-2006 years. The fish population is comprised solely of brown bullhead and largemouth bass. The zooplankton population increased slightly from last year's quantity while the average mean length decreased. The benthic community was evaluated.


## INTRODUCTION

Moe Pond (Figure 1) is a warm water polymictic water body located in Cooperstown, Otsego County, New York (McCoy et al. 2000) at N42º43.00'W74º56.75' (Albright et al. 2004). It has 38.6 acres of surface water in a 360 acre watershed that contains a mixed northern-hardwood and coniferous forest in a mesic site (McCoy et al. 2000) that drains to Otsego Lake, the headwaters of the Susquehanna River (Albright et al. 2004). It is now a Restricted Access Experimental Research Area so it can remain

---

[1] Biological Field Station intern, summer 2008. Present affiliation: SUNY Binghamton.

undisturbed for the purpose of continuous study. With a geological base of acid shale, it was expected that the pond has acidic, soft waters (McCoy et al. 2000). However, between 1966 and 1967, 50 metric tons (56 tons) of crushed limestone was added to the water. This was done so that the water would be more efficient to irrigate a golf course located downstream, but such use was discontinued in 1967, when it became part of the State University of New York College at Oneonta Biological Field Station's Upper Site property (Albright et al. 2004). According to a study preformed on Swedish lakes, liming would double the amount of zooplankton found in a previously acidic lake. The rotifer populations in particular would increase dramatically (Persson 2007). While data are not available prior to the liming of the pond, it is reasonable to assume that such an addition increased the available nutrients, leading to a state of eutrophy (McCoy et al. 2000).

Moe Pond is considered an atypically eutrophic body. It has algal blooms, increased nutrient content, low dissolved oxygen levels in the deepest areas of the pond, and an increased fish production. However, historically it has been devoid of rooted vegetation, which is normally a common characteristic in eutrophic water bodies. Moe Pond is located in an area that is in a northern hardwoods and conifers forest, where old fields and a conifer plantation existed, a beaver lodge, floating sphagnum mats (Albright, et al. 2004). There is a spillway located in the south east corner of the lake that feeds water downstream to the town of Cooperstown.

There were chronic blue-green algal blooms in 1970 to 1998, which reduced transparencies to <0.5m during the majority of the summer months. Vascular plants were practically nonexistent. The intensive biological survey conducted in 1994 determined that there were only two species of fish, the brown bullhead (*Ictalurus nebulosus*) and the golden shiner (*Notemigonus crysoleucas*). It was hypothesized that the abundance of golden shiner, a planktivorous fish, led to the dearth of large zooplankton that would have controlled the density of the algal blooms (Albright et al. 2004). McCoy et al. (2000) concluded that an introduction of a piscivorious fish would decrease the population of planktivorous fish, leading to a change in water conditions to a less eutrophic state.

Smallmouth bass (*Micropterus dolomieui*) and largemouth bass (*M. salmoides*) were found in Moe Pond in 1999 (Hamway 2003). Due to the remote access of the pond, it is assumed that the fish were carried to the pond in buckets, so the pond would have originally had a small population of both smallmouth and largemouth bass. Monitoring of the pond's conditions began, and the effects of instigating a top-down predator into the ecosystem have been and continue to be documented annually. Alterations of the ecosystem were noted by the changes undergone by the aquatic invertebrate, fish, macrophyte, and zooplankton communities. The continuing purpose of the survey is to continue the evaluation of trophic changes and their influences on the water quality instigated by the abrupt introduction of piscivorous and planktivorous bass into Moe Pond.

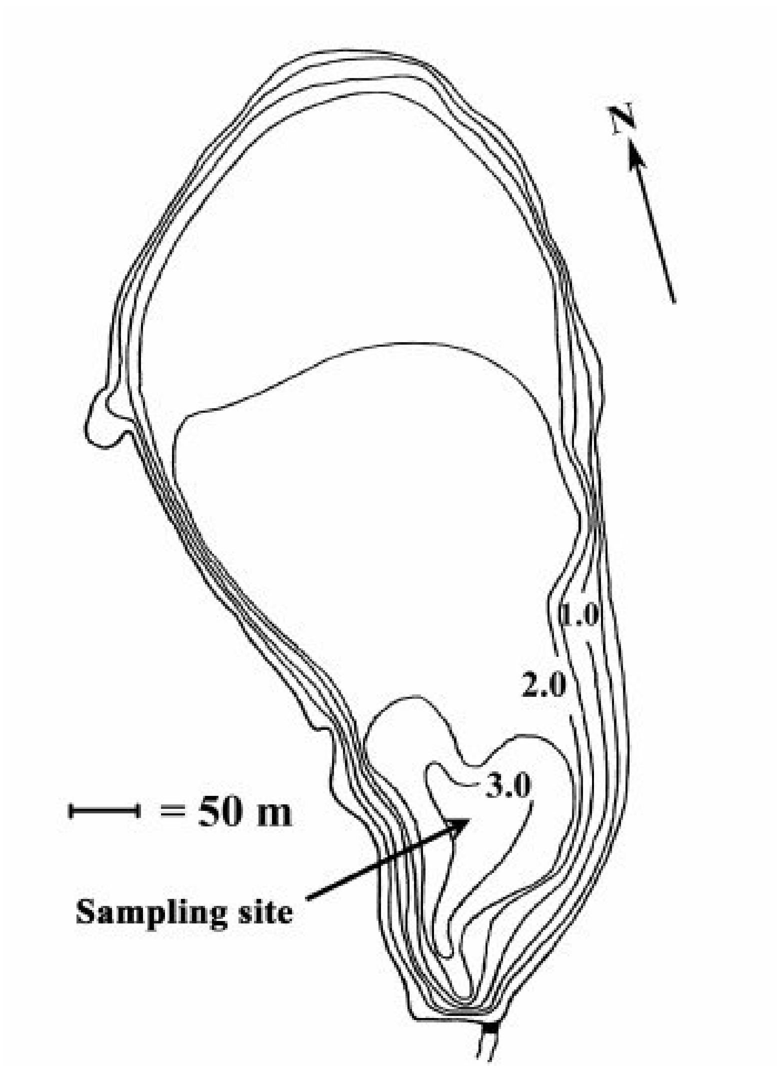


Figure 1. Map of Moe Pond, Otsego County, NY that indicates the sampling site. Contours in meters (modified from Sohacki 1973).

METHODS

**Limnology**

Moe Pond was surveyed on a weekly basis from 22 May to 22 July 2008. Data were collected at the deepest point in the pond, marked with a bouy, that had a maximum depth of 2.64m (Figure 1). A Eureka Manta, calibrated prior to use according to the manufacturer's instructions (Eureka 2005), was used to measure temperature (°C), conductivity (µS/cm), dissolved oxygen (mg/l), and pH. These readings were taken at the surface and every meter until the bottom of the pond was reached. Transparency was measured with a standard Secchi disk.

A Kemmerer sampler was used to collect 500mL samples at 1 meter depth to determine water chemistry and chlorophyll *a.* These water samples were used to measure total phosphorus (µg/L) via the ascorbic acid method following persulfate digestion (Liao and Marten 2001), total nitrogen (mg/l) through the cadmium reduction method (Pritzlaff 2003) following peroxodisculfate digestion (Ebina et al. 1983), ammonia (mg/L) using the phenolate method (Liao 2001), and nitrate+nitrite (mg/L) via the cadmium reduction method on undigested samples (Pritzlaff 2003). All of these variables were analyzed with a Lachat QuikChem FIA+® autoanalyzer.

Chloride values were determined using the mercuric nitrate method (APHA 1992). Calcium concentration was titrated with EDTA until full saturation occurred. Alkalinity analysis titrated the 100mL of sample water with 0.02 N HCl until a pH of 4.6 was reached (APHA 1992).

Chlorophyll *a* (ppb) was analyzed by running 50mL of the 1m water sample through a Whatman GF/C filter under subdued light. The filters were then blotted dry, cut into small pieces, and placed into test tubes with buffered acetone. A pestle on the end of an electric drill was used to grind each filter into a slurry to extract the chlorophyll. These mixtures were then centrifuged for ten minutes and their chlorophyll *a* concentrations were computed by a Turner fluorometric reader (Welschmeyer 1994).

**Zooplankton Community**

Zooplankton were analyzed weekly by using a Kemmerer sampler to gather water samples. The sample was concentrated through a 63 µm mesh plankton filter and brought back to the lab, where the volume was doubled with 70% ethanol to preserve it. Upon further filtration, one millimeter sub-samples were viewed in a Sedgwick-Rafter cell under a compound microscope until a minimum of one hundred zooplankton individuals were measured and identified according to Pennak (1989). The volume of filtered water and the final viewing sample were recorded and back-calculated in determine zooplankton per liter.

**Fish Community**

Using a 200ft haul seine, samples of the fish population in Moe Pond were taken on 28 May and 16 July 2008 using methods described by Nielsen (1983). A john boat was used to set the net in the southwest corner of the pond. Brown bullheads were released immediately back into the pond.

All bass over 100mm were gastric lavaged to evaluate stomach contents (Foster 1977). Fish stomach contents were analyzed afterwards to determine if selection occurred among the noted abundance of zooplankton and various other macro invertebrates. Items were identified according to Pecharsky et al. (1990).

Scale samples were taken from all remaining fish over 100 mm in length on 28 May 2008. Scales were removed from each fish directly below the lateral line and behind the pectoral fin. Each scale was later examined under a dissecting scope to determine the age of the fish by counting the annuli (Murphy and Willis 1996).

The mean number and percent occurrence of the stomach contents were calculated (Murphy and Willis 1996) and a population estimate for the largemouth bass in Moe Pond was determined through the area extrapolation method. The frequency of occurrence is the proportion of fish that contained a particular food type (Nielsen 1983).

To determine the amount of fish in the pond from the sample data it was estimated that the surface area of Moe Pond is 155,800 $m^2$ and the area covered by the haul seine is 300 $m^2$. While not intended to accurately estimate abundance, this approach is expected to provide insight into year-to-year changes. Since this method is unique to this research location, it is misleading to compare statistics generated from the data at Moe Pond to other sites that were analyzed using a different method.

**Invertebrate Community**

Benthic invertebrates were surveyed on 30 May 2008. Sampling was conducted at two sites with similar macrophyte cover and substrate composition, at the south and north ends of the pond. A 7m area along the shore was swept with three triangle nets for three minutes (Underwood 2007). The contents of the nets were then emptied into glass jars and returned to the lab for identification and quantified by taxa (Pecharsky et al. 1990).

**Macrophyte Community**

No formal survey occurred of the macrophyte community at Moe Pond, however, there was a noted abundance of *Elodea canadosis* as the summer progressed.

## RESULTS AND DISCUSSION

**Limnology**

Limnological data collected from 1972 to 2008 are presented in Table 1. Water quality improved through 2003, after the introduction of bass in 1999, as determined by a decrease in chlorophyll *a* concentrations and an increase in Secchi depth readings. There was a decrease in chlorophyll *a* levels in 2005 and 2006, but since then the level has only increased, leaving 2008 the highest year since the bass introduction. The chlorophyll *a* level can be due to the bass targetting the various zooplankton as prey, which would lead to an increase in the phytoplankton as there is less grazing to keep the population manageable by the decreasing population of zooplankton.

It appears that the calcium and chloride content has decreased but because the data is incomplete in regards to these values, further data collection is recommended before drawing conclusions about the amount of nutrient level in the pond decreasing, and allowing a more oligotrophic environment to occur.

| | 1972 | 1994 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Seechi Depth (m)** | NA | 0.85 (0.1) | 1.2 (0.2) | 1.1 (0.1) | >2.2 | >2.33 | 1.26 (0.13) | 1.26 (0.13) | 2.20 (0.15) | >2.62 (0.11) | 1.35 (0.20) |
| **Total phosphorus (µg/L)** | 40-70 | 36.7 (3.7) | NA | NA | 26.4 (2.6) | 29.05 (2.12) | 42.29 (2.04) | 56.64 (7.44) | 26.91 (5.49) | 20.5 (2.5) | 28.95 (3.99) |
| **Nitrate+nitrate (mg/L)** | NA | <0.05 | NA | NA | 0.14 (0.02) | 0.11 (0.02) | 0.10 (0.01) | 0.01 (0.006) | 0.01 (0.04) | <0.01 (NA) | 0.0027 (0.002) |
| **Chlorophyll a (ppb)** | NA | 37.1 (2.2) | 25.6 (0.20) | 20.4 (8.1) | 12.0 (2.4) | 9.76 (2.49) | 22.94 (4.4) | 17.03 (2.41) | 20.53 (19.4) | 23.63 (2.75) | 31.02 (3.94) |
| **Alkalinity (mg/L)** | 26-37 | 18.0 (0.4) | NA | 17.0 (0.2) | 16.0 (0.5) | NA | NA | NA | 2.1 (0.1) | 16.1 (0.35) | 19.0 (0.56) |
| **pH** | 6.8-10.2 | 7.93 (0.37) | 8.63 (0.35) | 8.66 (0.32) | 9.08 (0.18) | 6.84 (0.44) | 7.3 (0.07) | 7.66 (0.62) | 7.3 | 7.54 (0.07) | 7.39 (0.11) |
| **Calcium (mg/L)** | NA | NA | NA | NA | 10.45 (0.8) | NA | NA | NA | NA | NA | 1.02 (0.10) |
| **Chloride (mg/L)** | NA | NA | NA | NA | 1.06 (0.14) | 1.47 (0.23) | NA | NA | NA | NA | 0.54 (0.04) |

Table 1. Mean values (+/- standard error) of Secchi disk transparency, total phosphorus, nitrite+nitrate, chlorophyll *a*, alkalinity, pH, chlorides, and calcium levels in Moe Pond during the summers of 1972, 1994, and 2000-2008. Secchi transparency often exceeded water depth in 2002, 2003, and 2007. The 2007 and 2008 chlorophyll *a* value represents the mean derived from only two samples.

## Fish Community

Table 2 summarizes abundance estimates for fish in Moe Pond for 1994 and 1999-2008. The only fish species caught via haul seine in Moe Pond during the summer of 2008 was the largemouth bass and brown bullhead (which were not evaluated). No golden shiners have been collected since 2003, suggesting that the species has extirpated. Smallmouth bass were absent from the haul seines this summer, as they have been for the past two years. The steady decline of smallmouth bass can be attributed to interspecies competition with the largemouth bass, which are known predators.

The largemouth bass tended to cluster in age groups, with a noted majority of three year olds (Figure 2). Since the fish lengths are similar between the four and three year olds, stunted growth may occur annually. This is possibly due to the lack of larger prey available and to the strong intraspecies competition that is a result of the high densities of bass.

| Year | Golden shiner (*Notemigonus crysoleucas*) | Largemouth Bass (*Micropterus salmoides*) | Smallmouth Bass (*Micropterus dolomieu*) |
|---|---|---|---|
| 1994 (McCoy et al., 2000) | 7,154: +12,701;-6,356 | 0 | 0 |
| 1999 (Wilson et al., 2000) | 3,210+/-1760 | 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)[1] | 3 | 206 | 20 |
| 2003 (Hamway, 2004)[1] | 2 | 318 | 1 |
| 2004 (Lopata, 2005) | 0 | 6,924+/-2,912 | 0 |
| 2005 (Dresser, 2006) | 0 | 12,019+/-3,577 | 223+/-257 |
| 2006 (Reinicke & Walters, 2007) | 0 | 11,555.17+/- | 0 |
| 2007 (Underwood, 2008) | 0 | 13,373+/-249 | 0 |
| 2008 (current) | 0 | 46,740+/-13,220 | 0 |

Table 2. Estimates of golden shiner, largemouth bass, and smallmouth bass abundances (+/- standard error) in Moe Pond, based on numbers of individuals collected during the summers of 1994, 1999-2001, and 2004-2008.

[1] Indicates years in which electrofishing, measured in fish per hour, replaced seining due to excessive *Elodea* growth.

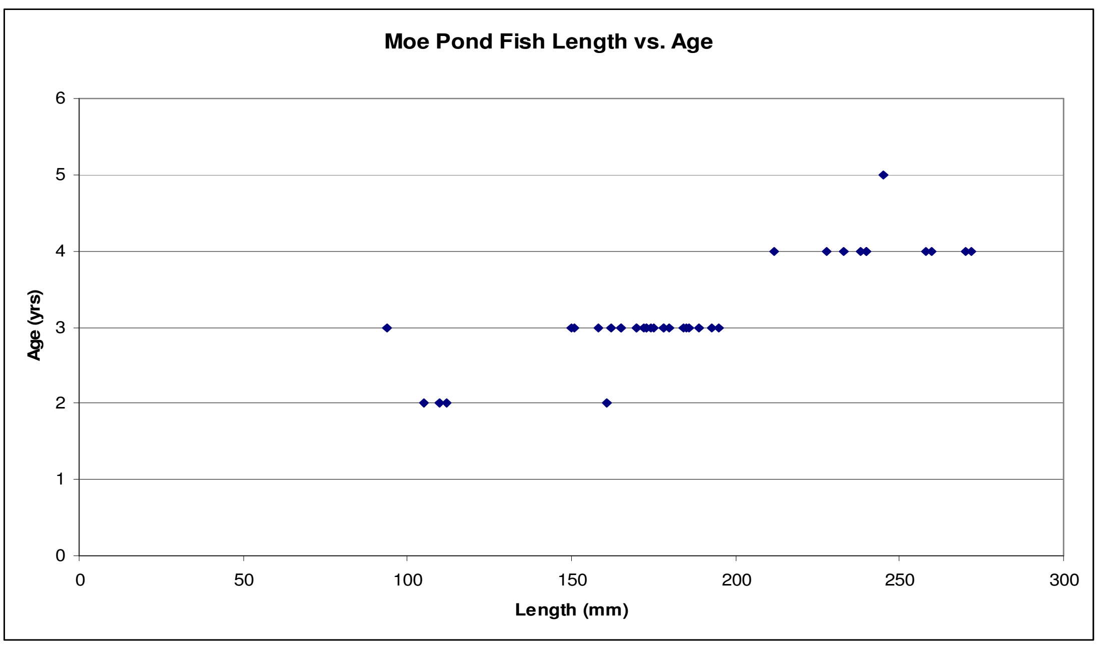


Figure 2. Length vs. Age for largemouth bass collected in Moe Pond on 28 May 2008.

Stomach contents of the largemouth bass continued in the trends of a large proportion of the diet consisting of *Daphnia,* Odonates, *Ictalurus nebulosus*, and Amphipods, in order of most to least abundant. Since *Daphnia* were only observed in the bass diet in 2004, their increase in importance has only become more apparent as the zooplankton begin to become a stable prey item for the bass. The increase in brown bullhead found in the stomachs may be a result of an increase in the brown bullhead population, but due to lack of data about that portion of the fish community, such speculation is specious.

| **Taxa** | **Mean Per Stomach** | **% Occurrence Largemouth Bass** |
|---|---|---|
| **Acariformes (Water Mites)** | 0.016 | 1.6 |
| **Amphipoda (Scuds)** | 2.54 | 18 |
| **Anura (Frog)** | 0.019 | 0.93 |
| **Chironomidae (Bloodworms)** | 0.032 | 2 |
| **Coleoptera (Beetles)** | 0.022 | 2.2 |
| **Daphnia** | 18.02 | 10 |
| **Decapoda (Crayfish)** | 0.019 | 0.93 |
| **Diptera (True Flies)** | 0.35 | 1.7 |
| **Epemeroptera (Mayflies)** | 0.27 | 12 |
| **Gastropoda (Snails)** | 0.02 | 1.6 |
| **Hemiptera (Water Striders)** | 0.15 | 0.79 |
| **Hirudinea (Leeches)** | 0.019 | 0.93 |
| ***Ictalurus nebulosus* (Brown Bullhead larva)** | 5.39 | 15 |
| **Lepidoptera (Catepillers)** | 0.037 | 1.9 |
| ***Micropterus sp.* (Bass)** | 0.0079 | 0.79 |
| **Odonata (Dragonflies and Damselflies)** | 7.41 | 41 |
| **Plecoptera (Stone Fly)** | 0.11 | 3.2 |
| **Sphaeriidae (Finger Nail Clams)** | 0.04 | 2.8 |
| **Trichoptera (Caddisflies)** | 0.0079 | 0.79 |
| **N (stomachs)** | 180 | 180 |

Table 3. Analysis of stomach contents of largemouth bass caught in summer 2008, determined by mean per stomach and frequency of occurrence.

### Zooplankton Community

Zooplankton densities in 2008 varied in relation to data gathered last summer but the mean total amount of zooplankton per liter has increased by slightly more than a factor of 1.5 (Table 4). Mean lengths of zooplankton species have fallen from recorded levels in summer 2007, however, with the exceptions of Nauplii copepods and *Keratella*, which only increased slightly. This could be a response to the planktivorous fish selecting for the larger zooplankton, leading to a smaller population surviving to reproduce. The smaller populations of various kinds of zooplankton would also allow for more diversity since there would not be a dominant zooplankton species.

| **Summer 2007** | | |
|---|---|---|
| | | |
| **Species** | **#/liter** | **mean length (µm)** |
| **Cladocera** | **31** | **-** |
| *Bosmina sp.* | 16 | 385 |
| *Daphnia sp.* | 15 | 1248 |
| **Copepoda** | **112** | **-** |
| *Cyclopoid sp.* | 19 | 628 |
| *Calanoid sp.* | 6 | 645 |
| *Nauplius larva* | 87 | 174 |
| **Rotifera** | **255** | **-** |
| *Asplanchna* sp. | 8 | 257 |
| *Gastropus* sp. | 11 | 201 |
| *Kellicottia sp.* | 16 | 120 |
| *Keratella sp.* | 201 | 107 |
| *Polyarthra sp.* | 20 | 150 |
| **Mean Total/L:** | **398** | **-** |

| **Summer 2008** | | |
|---|---|---|
| | | |
| **Species** | **#/liter** | **mean length (µm)** |
| **Cladocera** | **113** | **-** |
| *Bosmina sp.* | 59 | 317 |
| *Daphnia sp.* | 54 | 860 |
| **Copepoda** | **56** | **-** |
| *Cyclopoid sp.* | 5 | 306 |
| *Calanoid sp.* | 19 | 471 |
| *Nauplius larva* | 31 | 176 |
| **Rotifera** | **413** | **-** |
| *Asplanchna* sp. | 20 | 151 |
| *Gastropus* sp. | 0 | 0 |
| *Kellicottia sp.* | 0.4 | 15 |
| *Keratella sp.* | 313 | 111 |
| *Polyarthra sp.* | 79 | 95 |
| **Mean Total/L:** | **581** | **-** |

Table 4. Zooplankton densities and mean lengths during the summers of 2007 and 2008.

| **Moe Pond 5/22/08** | | |
|---|---|---|
| | | |
| **Species** | #/liter | mean length (µm) |
| **Cladocera** | **90** | - |
| *Bosmina sp.* | 60 | 376 |
| *Daphnia sp.* | 30 | 1474 |
| **Copepoda** | **70** | - |
| *Cyclopoid sp.* | 30 | 387 |
| *Calanoid sp.* | 0 | 0 |
| *Nauplius sp.* | 40 | 192 |
| **Rotifera** | **870** | - |
| *Asplanchna sp.* | 0 | 0 |
| *Kellicottia sp.* | 0 | 0 |
| *Keratella sp.* | 870 | 121 |
| *Polyarthra sp.* | 0 | 0 |
| **Mean Total/L:** | **1030** | - |

| **Moe Pond 5/28/08** | | |
|---|---|---|
| | | |
| **Species** | #/liter | mean length (µm) |
| **Cladocera** | **136** | - |
| *Bosmina sp.* | 59 | 321 |
| *Daphnia sp.* | 77 | 967 |
| **Copepoda** | **13** | - |
| *Cyclopoid sp.* | 5 | 1057 |
| *Calanoid sp.* | 3 | 486 |
| *Nauplius sp.* | 5 | 196 |
| **Rotifera** | **339** | - |
| *Asplanchna sp.* | 21 | 147 |
| *Kellicottia sp.* | 0 | 0 |
| *Keratella sp.* | 317 | 125 |
| *Polyarthra sp.* | 0 | 0 |
| **Mean Total/L:** | **403** | - |

Table 5. Weekly analysis of zooplankton samples with mean length and number per liter from Moe Pond in 2008.

| Moe Pond 6/2/08 | | |
|---|---|---|
| | | |
| **Species** | #/liter | mean length (µm) |
| **Cladocera** | **43** | - |
| *Bosmina sp.* | 43 | 304 |
| *Daphnia sp.* | 0 | 0 |
| **Copepoda** | **28** | - |
| *Cyclopoid sp.* | 0 | 0 |
| *Calanoid sp.* | 0 | 0 |
| *Nauplius sp.* | 28 | 141 |
| **Rotifera** | **445** | - |
| *Asplanchna sp.* | 48 | 126 |
| *Kellicottia sp.* | 0 | 0 |
| *Keratella sp.* | 957 | 118 |
| *Polyarthra sp.* | 0 | 0 |
| **Mean Total/L:** | **1076** | - |

| Moe Pond 6/10/08 | | |
|---|---|---|
| | | |
| **Species** | #/liter | mean length (µm) |
| **Cladocera** | **105** | - |
| *Bosmina sp.* | 101 | 302 |
| *Daphnia sp.* | 4 | 784 |
| **Copepoda** | **51** | - |
| *Cyclopoid sp.* | 0 | 0 |
| *Calanoid sp.* | 12 | 489 |
| *Nauplius sp.* | 39 | 152 |
| **Rotifera** | **233** | - |
| *Asplanchna sp.* | 4 | 236 |
| *Kellicottia sp.* | 0 | 0 |
| *Keratella sp.* | 221 | 113 |
| *Polyarthra sp.* | 8 | 129 |
| **Mean Total/L:** | **389** | - |

Table 5 cont. Weekly analysis of zooplankton samples with mean length and number per liter from Moe Pond in 2008.

| Moe Pond 6/16/08 | | |
|---|---|---|
| | | |
| **Species** | #/liter | mean length (µm) |
| **Cladoceran** | **89** | - |
| *Bosmina sp.* | 61 | 276 |
| *Daphnia sp.* | 28 | 632 |
| **Copepods** | **29** | - |
| *Cyclopoid sp.* | 6 | 436 |
| *Calanoid sp.* | 6 | 999 |
| *Nauplius sp.* | 17 | 163 |
| **Rotifers** | **220** | - |
| *Asplanchna sp.* | 0 | 0 |
| *Kellicottia sp.* | 0 | 0 |
| *Keratella sp.* | 165 | 117 |
| *Polyarthra sp.* | 55 | 192 |
| **Mean Total/L:** | **338** | - |

| Moe Pond 6/24/08 | | |
|---|---|---|
| | | |
| **Species** | #/liter | mean length (µm) |
| **Cladoceran** | **103** | - |
| *Bosmina sp.* | 43 | 262 |
| *Daphnia sp.* | 60 | 966 |
| **Copepods** | **30** | - |
| *Cyclopoid sp.* | 0 | 0 |
| *Calanoid sp.* | 17 | 493 |
| *Nauplius sp.* | 13 | 157 |
| **Rotifers** | **345** | - |
| *Asplanchna sp.* | 9 | 206 |
| *Kellicottia sp.* | 0 | 0 |
| *Keratella sp.* | 89 | 101 |
| *Polyarthra sp.* | 247 | 172 |
| **Mean Total/L:** | **478** | - |

Table 5 cont. Weekly analysis of zooplankton samples with mean length and number per liter from Moe Pond in 2008.

| Moe Pond 7/1/08 | | |
|---|---|---|
| | | |
| **Species** | #/liter | mean length (µm) |
| **Cladocera** | **115** | - |
| *Bosmina sp.* | 53 | 258 |
| *Daphnia sp.* | 62 | 1018 |
| **Copepoda** | **34** | - |
| *Cyclopoid sp.* | 0 | 0 |
| *Calanoid sp.* | 10 | 378 |
| *Nauplius sp.* | 24 | 167 |
| **Rotifera** | **352** | - |
| *Asplanchna sp.* | 1 | 88 |
| *Kellicottia sp.* | 0 | 0 |
| *Keratella sp.* | 58 | 97 |
| *Polyarthra sp.* | 293 | 117 |
| **Mean Total/L:** | **501** | - |

| Moe Pond 7/8/08 | | |
|---|---|---|
| | | |
| **Species** | #/liter | mean length (µm) |
| **Cladocera** | **137** | - |
| *Bosmina sp.* | 66 | 279 |
| *Daphnia sp.* | 71 | 1009 |
| **Copepoda** | **99** | - |
| *Cyclopoid sp.* | 0 | 0 |
| *Calanoid sp.* | 70 | 567 |
| *Nauplius sp.* | 29 | 229 |
| **Rotifera** | **272** | - |
| *Asplanchna sp.* | 54 | 114 |
| *Kellicottia sp.* | 4 | 152 |
| *Keratella sp.* | 169 | 100 |
| *Polyarthra sp.* | 45 | 121 |
| **Mean Total/L:** | **508** | - |

| Moe Pond 7/15/08 | | |
|---|---|---|
| | | |
| **Species** | #/liter | mean length (µm) |
| **Cladocera** | **141** | - |
| *Bosmina sp.* | 79 | 313 |
| *Daphnia sp.* | 62 | 936 |
| **Copepoda** | **142** | - |
| *Cyclopoid sp.* | 0 | 0 |
| *Calanoid sp.* | 51 | 614 |
| *Nauplius sp.* | 91 | 184 |
| **Rotifera** | **295** | - |
| *Asplanchna sp.* | 23 | 429 |
| *Kellicottia sp.* | 0 | 0 |
| *Keratella sp.* | 148 | 109 |
| *Polyarthra sp.* | 125 | 107 |
| **Mean Total/L:** | **579** | - |

| Moe Pond 7/22/08 | | |
|---|---|---|
| | | |
| **Species** | #/liter | mean length (µm) |
| **Cladocera** | **174.25** | - |
| *Bosmina sp.* | 21.25 | 473 |
| *Daphnia sp.* | 148.75 | 810 |
| **Copepoda** | **63.75** | |
| *Cyclopoid sp.* | 12.75 | 1180 |
| *Calanoid sp.* | 25.5 | 682 |
| *Nauplius sp.* | 25.5 | 176 |
| **Rotifera** | **195.5** | - |
| *Asplanchna sp.* | 38.25 | 164 |
| *Kellicottia sp.* | 0 | 0 |
| *Keratella sp.* | 140.25 | 127 |
| *Polyarthra sp.* | 17 | 113 |
| **Mean Total/L:** | **433.5** | - |

Table 5 cont. Weekly analysis of zooplankton samples with mean length and number per liter from Moe Pond in 2008.

## Invertebrate Community

The amount of benthic organisms collected at the north and south ends of Moe Pond were almost identical in number and have a similarity in the relative proportions of each taxa (Table 6). There is a large amount of Zygopterans, Coleopterans, and Amphipods as has been found in past years, while the amount of Physids (Pouch Snails) were nonexistent this year and last year were the second most abundant. The similarity in numbers between the north and south ends of the pond could be due to a similarity in aquatic conditions becoming more prevalent throughout the ecosystem. There is a large decrease in quantity from 2007's data, leading to the idea that last year was an atypical year for the invertebrate population.

| | Organisms Collected | |
|---|---|---|
| **Taxa** | **North End** | **South End** |
| Acariformes (Water Mites) | 3 | 9 |
| Amphipoda (Scuds) | 60 | 33 |
| Anisoptera (Dragonflies) | 9 | 10 |
| Coleoptera (Beetles) | 102 | 63 |
| Diptera (True Flies) | 15 | 34 |
| Ephemeroptera (Mayflies) | 8 | 6 |
| Hemiptera (True Bugs) | 0 | 0 |
| Hirudinea (Leeches) | 3 | 0 |
| Oligiocheta (Bloodworms) | 11 | 1 |
| Planorbidae (Rams Horn Snails) | 0 | 16 |
| Sphaeriidae (Finger Nail Clams) | 0 | 1 |
| Trichoptera (Caddisflies) | 11 | 8 |
| Valvatidae (Valve Snails) | 2 | 6 |
| Zygoptera (Damselflies) | 121 | 153 |
| ***Total Organisms*** | **345** | **340** |

Table 6. Count of invertebrates collected during benthic sampling of Moe Pond, summer 2008.

**Macrophyte Community**

No formal survey of Moe Pond's macrophyte community was undertaken in 2008, however, there was a noted abundance of *Elodea canadensis* on the south side of the pond.

CONCLUSION

There has been a large increase in the abundance of largemouth bass since they have been introduced in 1999, reaching a highest population of 46,740 ± 13,220 individuals in 2008. The number of *Daphnia* per liter began to decrease once zooplankton was first found in bass stomachs, starting in 2004, as an important part of the bass diet. The mean length of *Daphnia*, however, began to increase. In 2007, mean length was 1248µm, and the quantity of *Daphnia* found in 2008 doubled, even though the abundance levels are still lower than those found in 2001, when the evaluating *Daphnia* began. The low zooplankton densities would lead to an increase in phytoplankton, as measured by particularly high chlorophyll *a* readings in 2008.

REFERENCES


Albright, M.F., W.N. Harman, W.T. Tibbits, M.S. Gray, D.M. Warner, and R.J. Hamway. 2004. Biomanipulation: A classic example in a shallow eutrophic pond. Lake and Reserv. Manage, 20(4):263-269.

Bowen, S.H. 1996. Quantitative description of the diet. *In* Murphy, B. R., and D. W. Willis, ed. Fisheries Techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Cooke, G. Dennis, Eugene B. Welch, Spencer A. Peterson, and Peter R. Newroth. 1986, rev. ed. 1993. Restoration and Mangement of Lakes and Reservoirs, revised edition. Lewis Publishers, USA.

Eureka Environmental Engineering. 2005. Amphibian User's Guide. Eureka Manta™ Austin, Texas.

Everhart, W. Harry and William D. Youngs. 1981. Principles of Fishery Science, Second Edition. Cornell University Press, London, UK.

Foster, J. R. 1977. Pulsed gastric lavage: An efficient method of removing the stomach contents of life fish. Prog. Fish Culturists. 39(4): 166-169.

Hamway, Rebeeca J. 2002. Continued monitoring of Moe Pond after the unauthorized stocking of smallmouth and largemouth bass. *In* 36th Ann. Rept. (2002). SUNY Oneonta Biol. Fld. Sta., SUNY Oneonta: 66-80.

Hamway, Rebeeca J. 2003. Continued observations of Moe Pond after t unauthorized stocking of smallmouth and largemouth bass. *In* 37th Ann. Rept. (2003). SUNY Oneonta Biol. Fld. Stat., SUNY Oneonta: 110-120.

Greenberg, Arnold E., Lenore S. Clesceri, and Andrew D. Eaton, eds. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association, American Water Works Association, and Water Environment Federation. Washington, D.C.

Liao, N. 2001. Determination of ammonia by flow injection analysis. QuikChem® Method 10-115-01-1-F. 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 10-107-06-1-J. Lachat Instruments. Loveland, Colorado.

McCoy, C. Mead III, Charles P. Madenjian, Jean V. Adams, and William N. Harman. September 2001. The Fish Community of a Small Impoundment in Upstate New York. Journal of Freshwater Ecology, 16(3): 389-394.

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

Nielsen, Larry A. and David L. Johnson, ed. 1983. Fisheries Techniques. American Fisheries Society. Blacksburg, Virginia.

O'Sullivan, P. E. and C. S. Reynolds, ed. 2005. The Lakes Handbook: Lake Restoration and Rehabilitation, Volume 2. Blackwell Science Ltd, USA.

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

Pennak, R. W. 1989. Fresh-Water Invertebrates of the United States: Protozoa to Mollusca, 3rd edition. John Wiley and Sons, Inc. New York.

Persson, Gunnar. 2007. Zooplankton response to long-term liming: Comparison of 15 limed and 15 reference lakes in Sweden. Limnologica – Ecology and Management of Inland Waters, 38(1): 1-88.

Pritzlaff, D. 2007. Determination of nitrate/nitrite in surface and wastewaters by flow injection analysis. QuikChem® Method 10-107-04-1-C. Lachat Instruments. Loveland, Colorado.

Underwood, Emily S. 2007. Continued monitoring of the ecosystem dynamics Moe Pond following the introduction of largemouth bass *(Micropterus salmoides)* and smallmouth bass *(M. dolomieu)*. *In* 40th Ann. Rept. (2007). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta: 125-140.

Wetzel, Robert G. 2001. Limnology: Lake and River Ecosystems, Third Edition. Academic Press, a Harcourt Science and Technology Company; London, UK.

Wojnar, Kimberly Anne. 2001. The continuing evaluation of Moe Pond after the unauthorized stocking of smallmouth and largemouth bass. *In* 34th Ann. Rept. (2001). SUNY Oneonta Bio. Fld. Sta., SUNY Oneonta: 166-176.