

A survey of Otsego Lake zooplankton, summer 2002

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INTRODUCTION

Zooplankton play a vital role in a lake's ecosystem. They regulate algal densities through grazing and they serve as a food source for forage fish. Otsego Lake's zooplankton community changed drastically following the introduction of alewives (*Alosa pseudoharengus*) in 1986 (Harman et al., 2002). That planktivorous fish selectively consumes larger-bodied crustacean plankton and, in Otsego, resulted in a shift from a community dominated by larger crustacea to one dominated by smaller cladocera (i.e., *Bosmina* spp.) and rotifers. This change reduced grazing rates, correlated with declining transparencies and deep-water oxygen concentrations (Harman et al., 2002). Additionally, rotifers, aside from being a poor food item for planktivorous fish, regenerate more phosphorus per unit body mass than do crustacean plankton (Warner, 1999). The impacts of this trophic change are effectively similar to that caused by increased nutrient loading.

In order to utilize the forage base provided by the alewife, attempts are being made to re-establish walleye (*Stizostedion vitreum*) into Otsego Lake. Between 40,000 and 80,000 fish, primarily pond fingerlings, were added each in 2000, 2001 and 2002. Since that time, BFS research has attempted to evaluate any changes in the alewife population, as well as any resultant lake-wide changes (Cornwell, 2003). This report, a component of the above research, evaluates the nature of the zooplankton community of Otsego Lake. The expectation was that a declining alewife population would allow for a resurgence of larger bodied crustacean plankton. Concurrent with this work, survival rates of stocked walleye were evaluated (McDonnell and Cornwell, 2003), alewife populations were monitored acoustically (Warner and Cornwell, unpubl.), the littoral fish community was evaluated using trap netting (Wayman, 2003a) chlorophyll *a* concentrations were evaluated over the summer (Wayman, 2003b) and physical and chemical profiles were collected year round (Albright, 2003).

MATERIALS AND METHODS

Between 15 May and 18 July 02, zooplankton samples were collected from Otsego Lake using a vertical tow from 12 m to the surface at TR4C (Figure 1) on a bi-weekly basis. Samples were collected using a 0.5 m conical plankton net with 63 μ m mesh. A G.O. Environmental[®] flow meter was attached to the net in order to determine the volume of the sample filtered (e.g., net efficiency). In the lab samples were concentrated, if necessary, using a 63 μ m plankton cup and preserved in 70% ethanol. The final volume of concentrate was recorded and used with the amount of lake water filtered to determine the zooplankton density within the lake.

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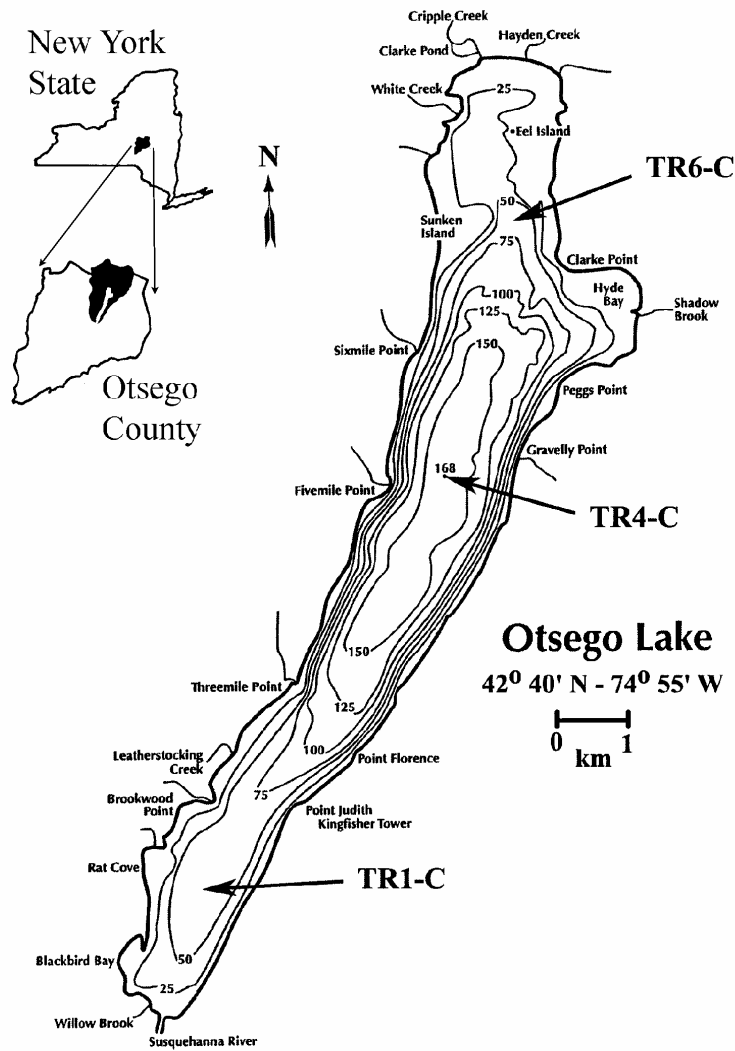


Figure 1. Map of Otsego Lake, NY, showing TR4-C, the sampling station.

From each concentrated sample, 1 ml sub-samples were transferred to a Sedgwick- Rafter cell using a Henson-Stiple pipette. All of the zooplankton within the 1 ml sub-sample were identified according to Smith (2001) and measured using a compound microscope fitted with an ocular micrometer. This was repeated three times for each sample collected.

After finding the average length and densities of rotifers, copepods, and cladocerans for each date, dry weight (Peters and Downing, 1984), filtering rate (Knoechel and Holtby, 1986), and phosphorus regeneration (Esjmont-Karabin, 1983) were derived using the average length. Table 1 provides the equations used.

Dry Weight	$D.W.=9.86*(Length\ in\ mm)^{2.1}$
Filtering Rate	$F.R.=11.695*(length\ in\ mm)^{2.48}$
Phosphorus Regeneration:	
Cladocera	$P.R.=.229*(Dry\ Weight\ in\ ug)^{-0.645}*e^{0.039*(Temp.\ in\ ^\circ C)}$
Copepods	$P.R.=.519*(Dry\ Weight\ in\ ug)^{-0.230}*e^{0.039*(Temp.\ in\ ^\circ C)}$
Rotifers	$P.R.=.0154*(Dry\ Weight\ in\ ug)^{-1.27}*e^{0.096*(Temp.\ in\ ^\circ C)}$

Table 1. Formulas used to derive zooplankton dry weight, filtering rates and phosphorus regeneration by cladocera, copepods and rotifers.

RESULTS AND DISCUSSION

Table 2 provides a summary of the data, including mean epilimnetic temperature, numbers of taxa per liter, average length, mean dry weight per individual and per liter, phosphorus regeneration rates per individual and per liter, filtering rates and the percent of the epilimnion per day. Figures 2-3 provide dry weight contributed by cladocerans, copepods and rotifers and the percent of the epilimnion each group filters per day on each date sampled, respectively. Table 3 compares several trophic indicators during a period prior to alewife establishment (1970-1988), during alewife dominance (1990-1999) and during a year of apparent alewife decline (2002).

The data collected in the summer of 2002 indicate that changes have occurred in the structure of Otsego Lake's zooplankton community. *Daphnia* spp., cladocera historically common but virtually absent since the establishment of alewives (Harman et al., 2002), comprised sixteen percent of cladocera this year. While *Daphnia* spp. are generally considered large-bodied, most encountered were <0.6 mm, so their presence did not lead to a larger mean crustacean body length. The mean grazing index was 9.9% of the epilimnion per day (Table 2), which is consistent with 1996, 1997, and 2000 (12.0%, 10.0% and 9.8% per day, respectively). In 1970, prior to the introduction of alewives, an average of 27.8% of the epilimnion was filtered per day (Harman et al., 2002).

Kerratella cochlearis dominated the rotifer population, as has historically been the case. This was particularly true on dates in August and September, when this was practically the only rotifer encountered. *Kellicotia longispina* also played a large role in contributing to this group earlier in the summer. By mid-June rotifer abundances decreased and cladocerans and copepods both had larger contributions to the biomass of the plankton community.

While rotifers were the most numerous zooplankton, their small size results in their having a relatively low impact on algal grazing. *Bosmina* spp. made up 84% of the cladoceran population observed throughout the summer. *Daphnia* spp. made up the balance of this group, and because they had a biomass 3 times that of *Bosmina*, they contributed largely to the dry weight of this group. Most *Daphnia* exhibited cyclomorphosis, an altered growth form caused by water temperature in which the

A	B	C	D	E	F	G	H	I	J
	Avg. Temp.	#/L	Avg length	mean	Dry wt	Phos. Regen. Rate	Phos. Regen.	Filtering Rates	% Epilimnion
	(deg. C)		(mm)	Dry Wt (ug)	(ug/l)	$\text{ugP}^*\text{mgdrywt}^{-1}*\text{ind}^*\text{h}^{-1}$	Rate (ug/l/day)	ml/ind/day	filtered/day
15-May	8.13								
Cladocera		11	0.250	0.536	5.78	0.822	0.114	0.376	0.41
Copepods		123	0.245	0.512	63.12	0.484	0.733	0.356	4.38
Rotifers		930	0.138	0.154	142.95	0.363	1.244	0.086	7.98
total		1064				211.85		2.092	
4-Jun									
Cladocera	12.27	13	0.264	0.602	7.99	0.941	0.181	0.431	0.57
Copepods		99	0.319	0.892	88.17	0.398	0.842	0.685	6.77
Rotifers		708	0.121	0.118	83.34	0.757	1.514	0.063	4.44
total		820				179.51		2.536	
20-Jun									
Cladocera		77	0.394	1.398	108.18	0.481	1.248	1.164	9.01
Copepods		122	0.244	0.508	62.05	0.354	0.528	0.352	4.30
Rotifers		432	0.110	0.096	41.43	0.302	0.300	0.049	2.12
total		631				211.65		2.076	
3-Jul									
Cladocera	18.5	91	0.338	1.010	91.88	1.066	2.350	0.793	7.22
Copepods		89	0.335	0.990	88.05	0.474	1.002	0.775	6.89
Rotifers		408	0.102	0.082	33.46	2.178	1.749	0.041	1.67
total		588				213.39		5.100	
18-Jul									
Cladocera	18.51	62	0.328	0.950	58.58	1.081	1.520	0.738	4.55
Copepods		119	0.209	0.367	43.66	0.899	0.942	0.240	2.86
Rotifers		241	0.135	0.148	35.62	1.034	0.884	0.082	1.98
total		422				137.86		3.345	
Excel® formula format for:		Copepods		$9.86*D^{2.1}$	$C*E$	$(0.229*E^{-0.645})*(EXP(0.039*B))$	$G*E*C^{24}/1000$	$11.695*D^{2.48}$	$C*I/10$
		Cladocera		"	"	$(0.519*E^{-0.23})*(EXP(0.039*B))$	"	"	"
		Rotifers		"	"	$(0.0154*E^{-1.27})*(EXP(0.096*B))$	"	"	"

Table 2: Summary of mean epilimnetic temperature, zooplankton densities and mean length per taxa, as well as derived values for mean weight per individual and per l, phosphorus regeneration per individual and per l, filtering rates per individual and the percent of the epilimnion filtered per day. The formulas used to derive these values in Excel® are also given in a format compatible with that software. The letters in the formulas refer to the column headers across the top of the sheet.

A	B	C	D	E	F	G	H	I	J
	Avg. Temp.	#/L	Avg length	mean	Dry wt	Phos. Regen. Rate	Phos. Regen.	Filtering Rates	% Epilimnion
1-Aug	(deg. C)		(mm)	Dry Wt (ug)	(ug/l)	ugP*mgdrywt ⁻¹ *ind*h ⁻¹	Rate (ug/l/day)	ml/ind/day	filtered/day
Cladocera	21.42	76	0.318	0.890	67.53	1.229	1.992	0.683	5.18
Copepods		101	0.263	0.597	60.28	0.736	1.065	0.427	4.31
Rotifers		186	0.113	0.102	18.86	2.196	0.994	0.053	0.98
total		362			146.68		4.051		10.47
15-Aug									
Cladocera	21.53	39	0.263	0.595	22.99	1.354	0.747	0.424	1.64
Copepods		72	0.232	0.459	33.00	0.877	0.694	0.312	2.25
Rotifers		108	0.105	0.087	9.34	2.711	0.608	0.044	0.47
total		218			65.33		2.049		4.36
28-Aug	21.24								
Cladocera		20	0.269	0.625	12.45	0.578	0.173	0.450	0.90
Copepods		70	0.285	0.705	49.14	0.287	0.338	0.519	3.62
Rotifers		22	0.109	0.094	2.10	0.309	0.016	0.048	0.11
total		112			63.69		0.527		4.62
13-Sep									
Cladocera	16.94	26	0.249	0.531	13.64	1.162	0.380	0.371	0.95
Copepods		102	0.229	0.448	45.69	0.744	0.816	0.304	3.10
Rotifers		117	0.111	0.097	11.31	1.523	0.413	0.050	0.58
total		245			70.64		1.610		4.63
Excel® formula format for:		Copepods		9.86*D ^{2.1}	C*E	(0.229*E ^{-0.645})*(EXP(0.039*B))	G*E*C*24/1000	11.695*D ^{2.48}	C*I*10
		Cladocera		"	"	(0.519*E ^{-0.23})*(EXP(0.039*B))	"	"	"
		Rotifers		"	"	(0.0154*E ^{-1.27})*(EXP(0.096*B))	"	"	"

Table 2(cont.): Summary of mean epilimnetic temperature, zooplankton densities and mean length per taxa, as well as derived values for mean weight per individual and per l, phosphorus regeneration per individual and per l, filtering rates per individual and the percent of the epilimnion filtered per day. The formulas used to derive these values in Excel® are also given in a format compatible with that software. The letters in the formulas refer to the column headers across the top of the sheet.

Daphnia develops (Smith, 2001). Copepods were dominated by *Diacyclops bicuspidatus*, although *Cyclops varicans* and *Senecella calanoides* were observed.

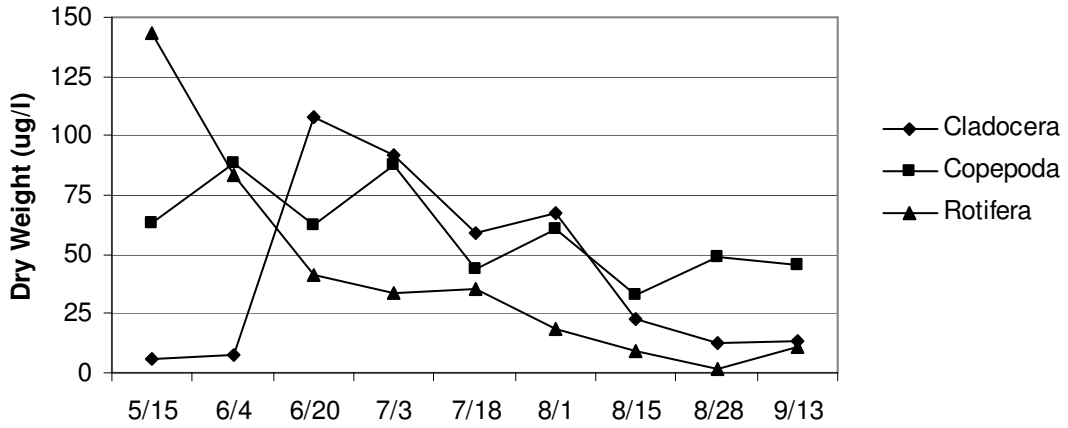


Figure 2. Dry weight (ug/l) contributed by cladocerans, copepods and rotifers on each sampling date, summer 2002.

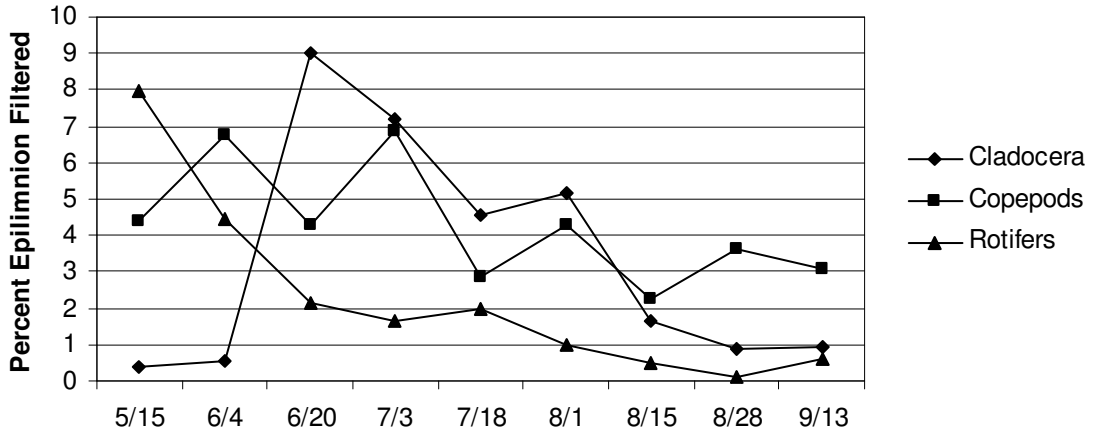


Figure 3. Percent of the epilimnion filtered per day by cladocerans, copepods and rotifers on each sampling date, summer 2002.

		1970-1988 (pre-alewife establishment)	1990-1999 (Alewife Dominance)	2002 (Alewife decline)
Common Crustacean Plankton	Cladocera	Daphnidae Bosminidae Leptodoridae	Bosminidae	Daphnidae Bosminidae
	Copepoda	Diaptomidae Senecellidae		Diaptomidae Senecellidae
Cladoceran size (mm)		0.80	0.33	0.30
Crustacean plankton biomass ($\mu\text{g}\cdot\text{l}^{-1}$)		500	100	145
Epilimnion filtered ($\%\cdot\text{day}^{-1}$)		27.8%	9.7%	9.9%
Chlorophyll <i>a</i> ($\mu\text{g}\cdot\text{l}^{-1}$)		2.4 (1.3)	6.4 (2.4)	3.5
Secchi depth (m)		5.1 (1.03)	3.3 (.46)	3.3
AHOD ($\text{mg}\cdot\text{cm}^{-2}\cdot\text{day}^{-1}$)		0.066 (0.021)	0.096 (1.3)	0.087
Lake trout (fish-net ⁻¹)		4.8	10.4	14.8

Table 3. Comparison of Otsego Lake's composition throughout the last 30 years (modified from Harman et al., 2002).

Prior to this survey, the alewife population seems to have declined based upon hydroacoustic surveys conducted in fall 2001 and spring 2002 (Warner and Cornwell, unpubl.). Also, spring electrofishing (Cornwell, 2002) and summertime trap netting (Wayman, 2003a) substantiate a significant decline in age 1+ alewives. While the cause of this decline is unknown, involved factors could be the cyclic nature of alewives (Smith, 1985), the fact that Otsego Lake did not freeze during the winter of 2001-2002, which led to colder-than-normal temperatures throughout the water column (Albright, 2003) and/or successful attempts to re-establish walleye in the lake. Though the mean crustacean biomass during the summer of 2002 was higher than the 1990s, when alewives were considered dominant, the percent of the epilimnion filtered per day has remained unchanged. Despite this, chlorophyll *a* concentrations have decreased, as has the rate of hypolimnetic oxygen depletion. Further evaluations of alewife abundance, the zooplankton community and water quality indicators should provide insight into the relationships between various trophic levels should the alewife remain depressed. Regardless of the cause of the observed situation, the ramification of alewife decline provides insight into what could be realized if this population could be managed in a controlled state.

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