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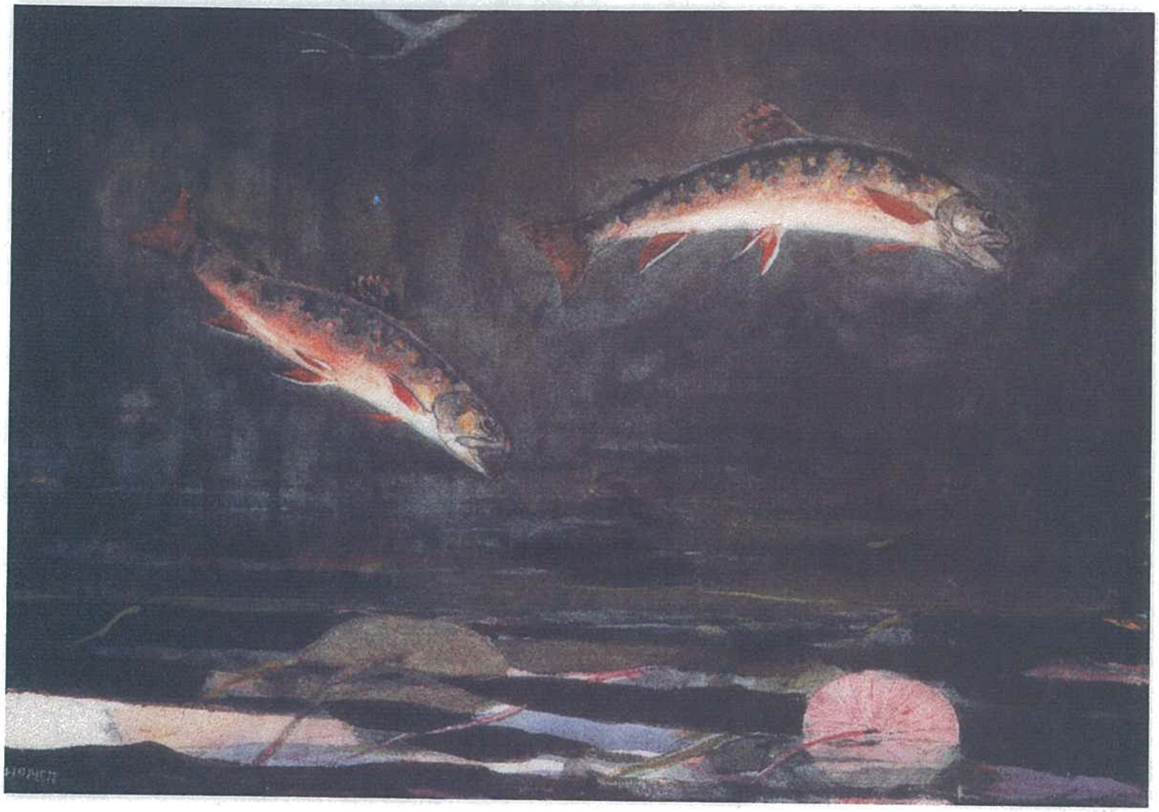

Winslow Homer, *Leaping Trout*, **1889**

Plant Harvesting and Zooplankton Dynamics in Muskrat Lake for 1997

Status Report
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Prepared for:
Pelican River Watershed District
Detroit Lakes, Minnesota

Prepared by:
Blue Water Science
St. Paul, Minnesota
(612) 690.9602

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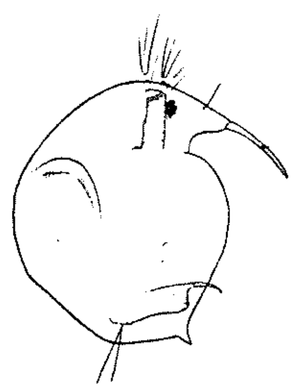
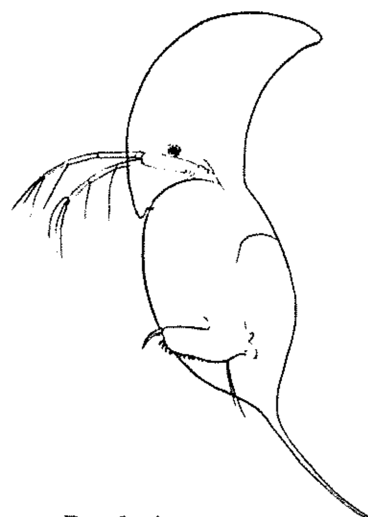
Summary

Zooplankton are small members of the crustacean family (lobster, shrimp, etc). A number of zooplankton species feed on algae, and if the feeding is intense enough, open water algae numbers can be reduced. In Muskrat Lake in 1997, an aquatic plant harvestor cut fish cruising lanes twice. The idea was to give gamefish better access to smaller preyfish. If preyfish numbers are reduced, there will be reduced predation pressure on zooplankton, and their numbers should increase. Approximately 123 truck loads of aquatic plants were removed from Muskrat Lake in the course of cutting fish cruising lanes (fisherman can use these to catch fish also).

The zooplankton community was monitored in Muskrat Lake this summer (1997) to evaluate the composition of the zooplankton population. The Muskrat Lake zooplankton community was found to be composed of small-sized zooplankton and at lower densities than zooplankton of Long Lake. Long Lake was used as a reference because it has the type of large-bodied zooplankton that are known to be good algal grazers. If the plant harvesting program results in zooplankton populations shifts in Muskrat Lake, we could see more large-bodied zooplankton next summer.



Bosmina
common in Muskrat Lake
These zooplankton are relatively small.



Daphnia retrocurva
common in Long Lake
These zooplankton are larger than Bosmina.

Introduction

Muskrat Lake is an important component in the improvement of Lake Sallie. Nearly all surface runoff going into Lake Sallie passes through Muskrat Lake. The intent is to manipulate Muskrat Lake to be a phosphorus sink rather than a phosphorus source. In turn, lower phosphorus loads would then be passed on to Lake Sallie.

In 1997, the first attempts were being implemented to enhance zooplankton biomass, which in turn would increase grazing on algae, possibly reducing water column phosphorus. We are using what Dr. Joe Shapiro has referred to as biomanipulation or the top down trophic cascade coined later by Dr. Carpenter.

In 1997, a mechanical harvester cut cruising lanes through the aquatic plant beds in Muskrat Lake on two occasions. Cruising lanes are intended to allow game fish (piscivores) access to forage fish (planktivores), and control their numbers. In turn, the reduced predation pressure by forage fish on their zooplankton prey should allow zooplankton numbers to increase. Higher zooplankton numbers means more grazing pressure on algae. By removing algae through grazing and subsequent sedimentation as zooplankton fecal pellets, phosphorus is removed from the water column of Muskrat Lake . Theoretically, less phosphorus is carried over into Lake Sallie.

In addition, the aquatic plants that are harvested are removed from Muskrat Lake. This will also remove some phosphorus from Muskrat Lake that could move into Lake Sallie with the aquatic plant die back.

Methods

We employed methods similar to what the MnDNR - Ecological Services (St. Paul) has used for zooplankton analysis in Long Lake.

Field Procedures:

Zooplankton were collected with an 80 μm mesh Wisconsin Plankton Net. Vertical tows were taken off the fishing pier, a shallow shoreline site. One vertical tow through the water column was taken. The net was lowered to 0.5 meter from the bottom and raised at 0.5 to 1 meter per second to the surface. The sample was rinsed from the bucket of the net into a plastic bottle and preserved with 100% Ethanol. The bottle was labeled with the lake name, site number, date, and tow length (in meters). Tows were taken three times in July and five times in August.

Lab Procedures:

The MnDNR Ecological Services - Biology Lab uses the following protocol to analyze lake zooplankton samples and the same protocol was used by Blue water Science. Sample volumes are adjusted to a known volume by filtering through 80 μm mesh netting and rinsing specimens into a graduated beaker. Water is added to the beaker to a volume that provides at least 150-200 organisms per 5 ml aliquot. The beaker is swirled in a figure-eight motion to ensure thorough mixing. A 5 ml aliquot is withdrawn from each sample using a bulb pipet and transferred to a counting wheel and zooplankton samples are counted and measured at 30X magnification under a dissecting microscope. Identification to species (or the lowest taxonomic group possible) is done with the use of a compound microscope. In addition to density estimates, estimates of biomass were calculated using length/weight regression coefficients calculated by the MnDNR-Ecological Services, on a Muskrat Lake sample from August 28, 1997. We assigned unit weights for the various zooplankton taxa for other sample dates.

Results - Aquatic Plant Harvesting

For the first time in a long time, a Pelican River Watershed District harvester was cutting plants in Muskrat Lake. Cruising lanes were cut twice, once in late July and again in late August. A summary of aquatic plants removed from Muskrat Lake is shown in Table 1.

Table 1. Loads of aquatic plants removed from Muskrat Lake. An average harvester load is about 3,000 pounds, wet weight.

Date	Number of Loads
07.23.97	9
07.27.97	12
07.25.97	12
07.29.97	16
07.30.97	12
07.31.97	7
08.22.97	12
08.25.97	4
08.26.97	12
08.27.97	9
08.28.97	9
08.29.97	9
totals loads	123

An average harvester load is about 3,000 pounds of wet material. Typical phosphorus concentration in the tissue of the wet material is about 0.01 percent phosphorus which is equivalent to three pounds per 3,000 pounds of wet plants. With 123 loads removed, about 370 pounds of phosphorus was removed by harvesting.

Results - Zooplankton

Zooplankton sampling began on July 11, 1997 about twelve days before harvesting started. Zooplankton densities are summarized in Table 2. Large daphnids and caloniods are the preferred zooplankton for maximum algae grazing potential. Very few big zooplankters were found in the water samples. Bosmina were the most numerous daphnids and cyclopoids were the most numerous copepods.

Table 2. Zooplankton summary table for Muskrat Lake. Results are shown in number per liter.

Date (1997)	Daphnids						Copepods				Rotifers
	Daphnia		Ceriodaphia	Bosmina	Chydorus	**Total Cladocerans**	Calanoids	Cyclopoids	Nauplii	**Total Copepods**	
	Big >1mm	Little <1mm									
7.11	1	1	0	23	0	25	1	10	3	14	0
7.16	1	3	0	31	0	35	1	16	5	22	12
7.25	1	2	0	6	0	9	1	5	9	15	6
8.1	0	1	0	3	0	4	1	6	11	18	10
8.8	1	2	0	4	0	7	1	5	7	13	5
8.15	0	5	0	9	1	15	1	2	3	6	1
8.22*	0	1	1	13	1	17	1	2	3	6	1
8.28**	1	0	3	17	2	23	0	9	10	19	

* Diaphanosoma was found at 1/liter
** Sample counted by the MnDNR

Illustrations of the Muskrat Lake zooplankton are shown on the next page (Figure 1) and photographs of Muskrat Lake zooplankton are shown after that in Figures 2, 3, and 4.

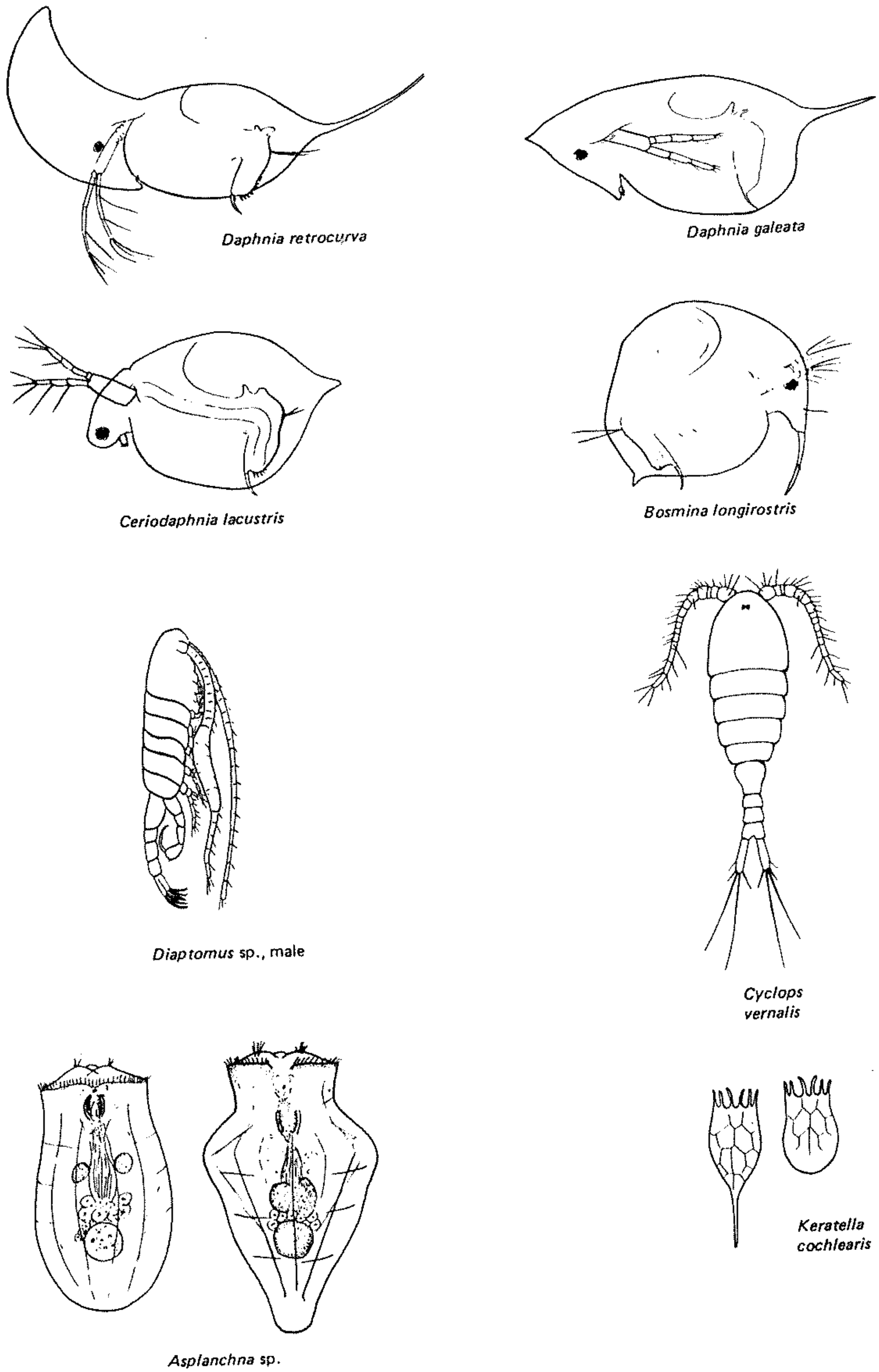


Figure 1. Representative zooplankton found in Long and Muskrat Lakes. The top two rows are cladocerans, the third row is copepods, and the bottom is rotifers.

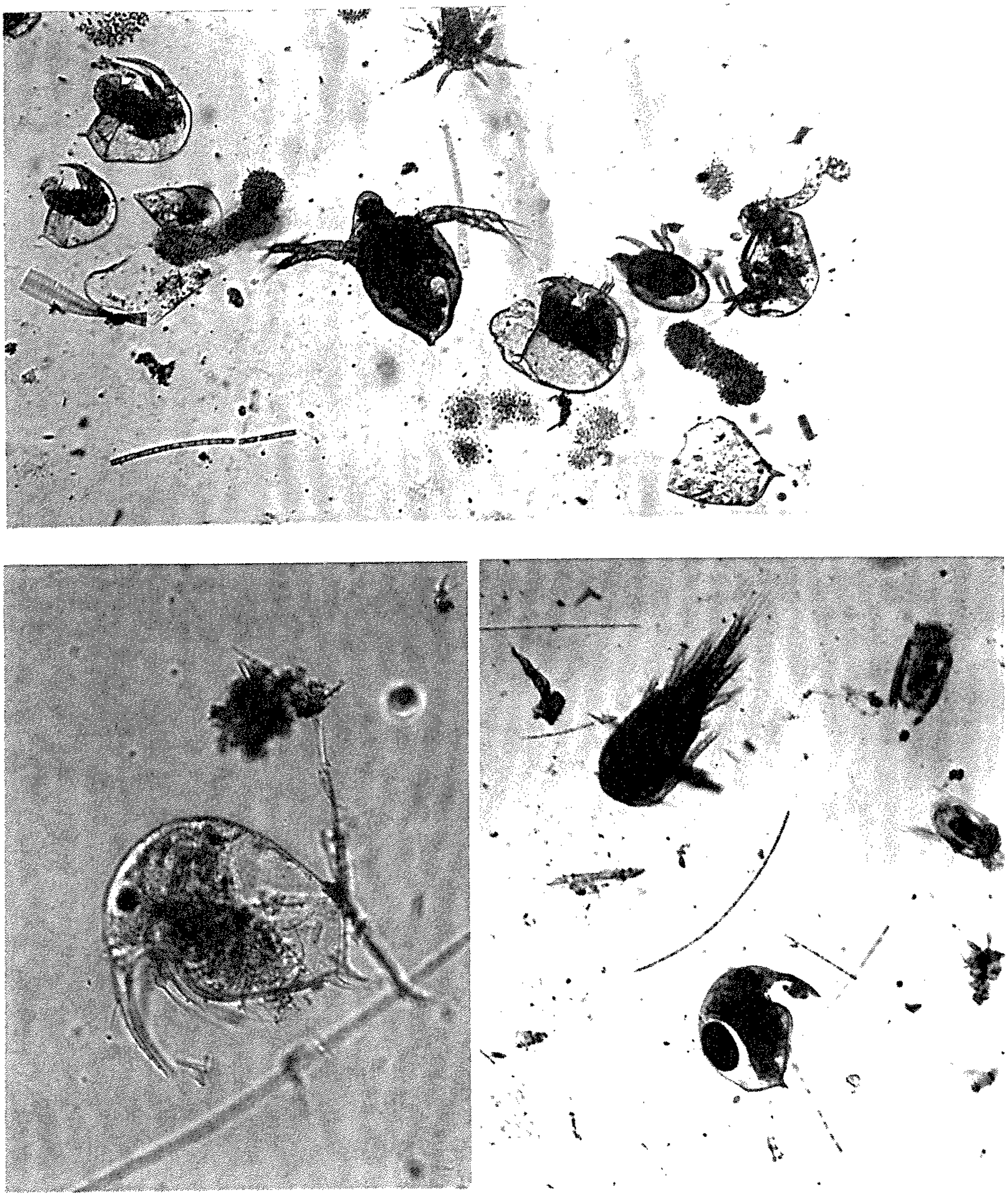


Figure 2. (Top) Muskrat Lake zooplankton: Bosmina on the left, Ceriodaphnia in the center and a nauplii at the top. (Bottom - left) Bosmina; (Bottom - right) Copepod on top and a Bosmina toward the bottom.

Figure 3. (Top) Muskrat Lake zooplankton: nauplii; (Bottom - left) Ceriodaphnia on top and a rotifer (Asplanchna sp) on the bottom; (Bottom - right) Ceriodaphnia on the left and a colonial green algae. Inside the Volvox mother colony are daughter colonies.

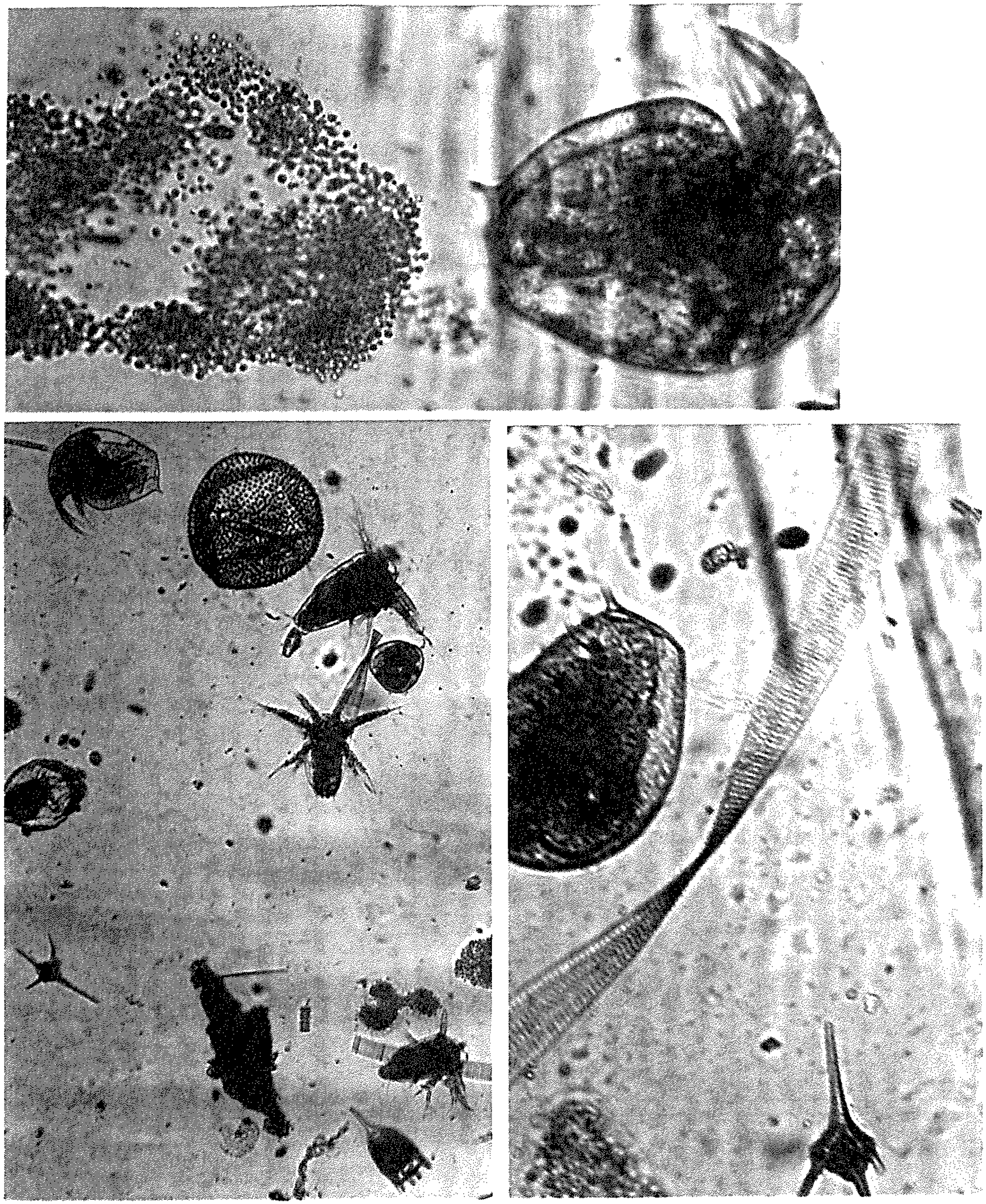


Figure 4. (Top) Colonial blue-green algae (Microcystis) on the left and a Bosmina on the right in Muskrat Lake. (Bottom - left) Bosmina at the top of the picture with a Volvox colony next to it. Nauplii, rotifers, Microcystis, and a dinoflagellate are also shown. (Bottom - right) A long strand of a filamentous diatom, Fragillaria, goes through the middle of the picture. A dinoflagellate is shown at the bottom.

Comparing Zooplankton of Muskrat Lake to Long Lake

Long Lake appears to have the type of zooplankton that could have an impact on algae densities. The large daphnids and calanoids are suppose to be effective grazers on algae. I have used Long Lake as a reference lake for zooplankton impacts on algae. When comparing the overall densities of zooplankton, Long Lake and Muskrat Lake are similar (Figures 5 and 6), although Long Lake may have slightly higher numbers, especially for cladocerans.

However, there appears to be a bigger difference in zooplankton biomass. Long Lake has greater biomass for cladocerans and copepods (Tables 3 and 4).

In a side by side comparison, Long Lake has two to three times more zooplankton biomass than Muskrat Lake (Table 5).

Muskrat lake zooplankton are less numerous and smaller in size than Long Lake zooplankton.

The goal of the harvesting action in Muskrat Lake is to increase the number and size of zooplankton to more efficiently graze algae. A zooplankton community like Long Lake (Figure 7) would produce better algal grazing than the current Muskrat zooplankton community.

Table 3. Zooplankton biomass for Muskrat Lake in July and August, 1997 in μg/l-dry weight. Dry weights were based on MnDNR determinations made on the 8.28 sample used for the other sample dates.

	μg/organisms	7.11	7.16	7.25	8.1	8.8	8.15	8.22	8.28
Cladocerans									
Big (>1mm)	12.00	12.0	12.0	12.0	0	12.0	0	0	0.2
Little (<1mm)	4.13	4.13	12.39	8.26	4.13	8.26	20.65	4.13	0
Ceriodaphnia	1.03	0	0	0	0	0	0	1.03	3.09
Bosmina	1.18	27.14	36.58	7.08	3.54	4.72	10.62	15.34	20.06
Chydorus	1.61	0	0	0	0	0	1.61	1.61	3.22
Total Cladocerans		43.27	60.97	27.34	7.67	24.98	32.88	22.11	38.37
Copepods									
Calanaids	5.00	5.0	5.0	5.0	5.0	5.0	5.0	5.0	0
Cyclopoids	1.00	10.0	16.0	5.0	6.0	5.0	2.0	2.0	9.0
Nauplii	0.27	0.81	1.35	2.43	2.97	1.89	0.81	0.81	2.70
Total Copepods		15.81	22.35	12.43	13.97	11.89	7.81	7.81	11.70
Total		59.08	83.32	39.77	21.54	46.87	40.69	29.99	50.07

Table 4. Long Lake zooplankton biomass (μg/l). Sites 201 and 202 are different sample locations in Long Lake.

Date (1997)	Cladocerans		Copepods		**Total**	
	201	202	201	202	**201**	**202**
6.26	31	6	23	20	**54**	**26**
7.09	86	6	108	92	**194**	**98**
7.21	102	43	126	51	**228**	**92**
8.06	147	93	156	149	**303**	**242**
8.21	119	32	86	27	**205**	**59**
8.28	--	28	--	86	--	**114**
9.18	10	--	54	--	**64**	--

Table 5. Comparing the combined zooplankton biomass (in μg/l) of copepods and daphnids between Long Lake and Muskrat Lake.

	Muskrat Lake one site (μg/l)	**Long Lake** average of two sites (μg/l)
June		
week 4	--	40
July		
week 2	59	146
3	83	160
4	40	-
August		
week 1	22	273
2	47	-
3	41	132
4	40	114
September		
week 2	-	64

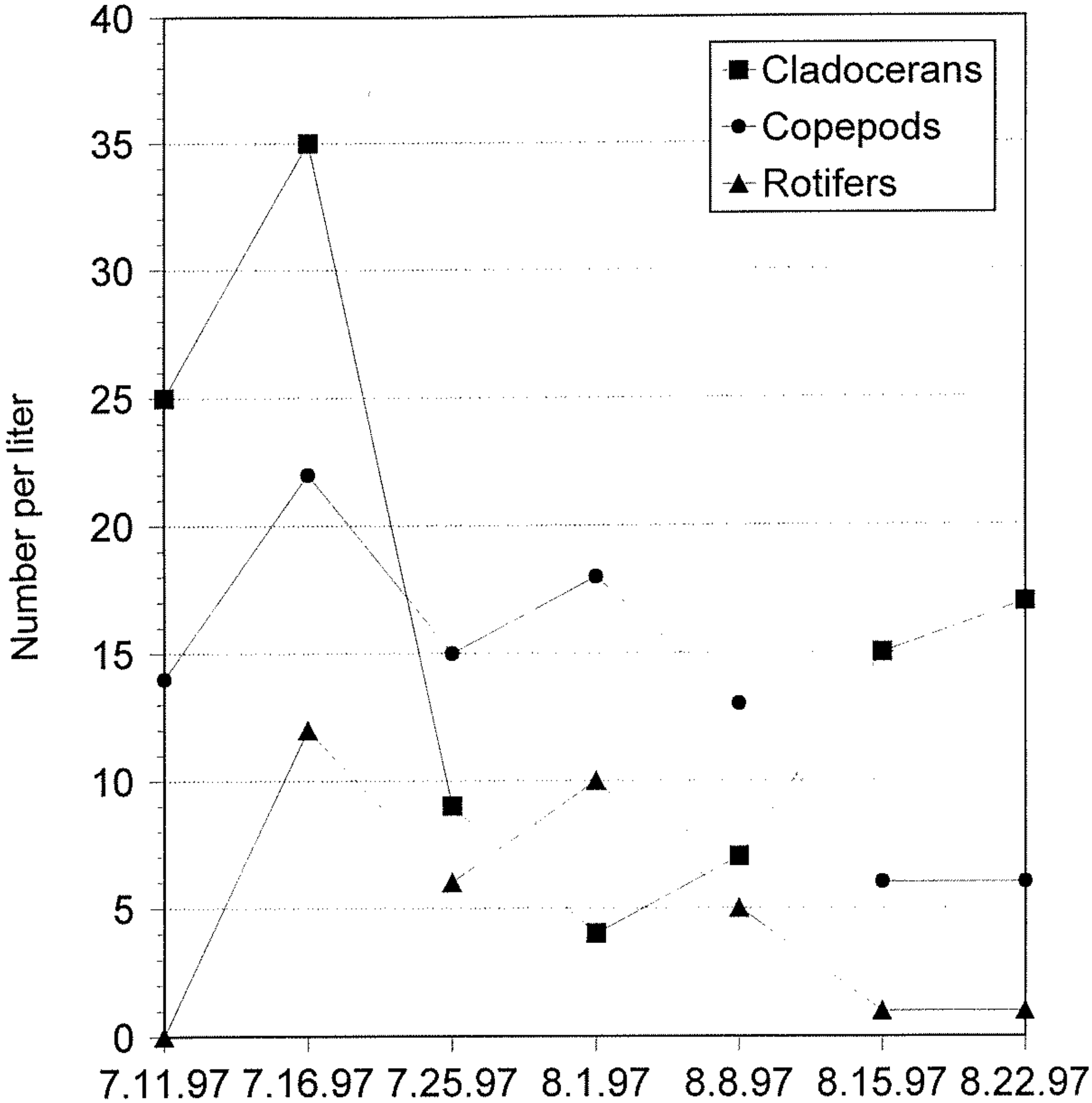
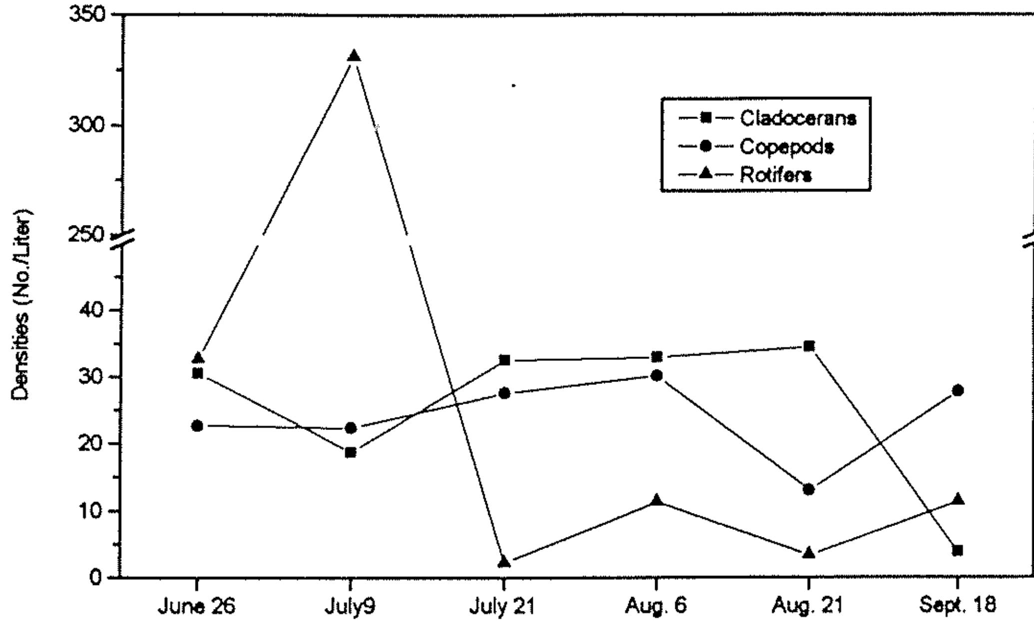


Figure 5. Number of cladocerans, copepods, and rotifers in number per liter for Muskrat Lake.

Site #201



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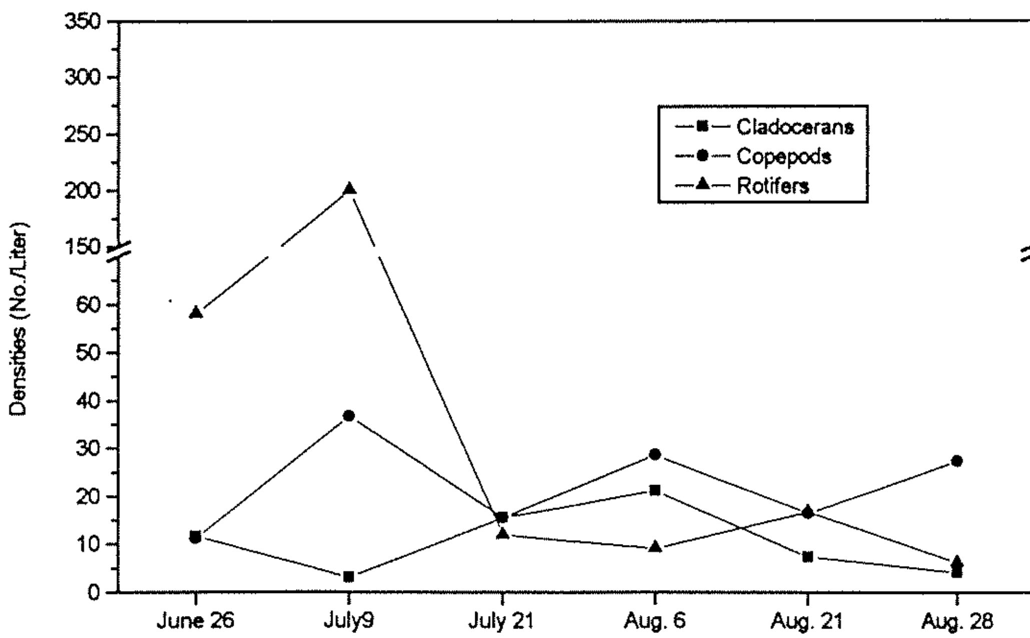

Figure 6. Number of cladocerans, copepods, and rotifers in number per liter for two sites in Long Lake.

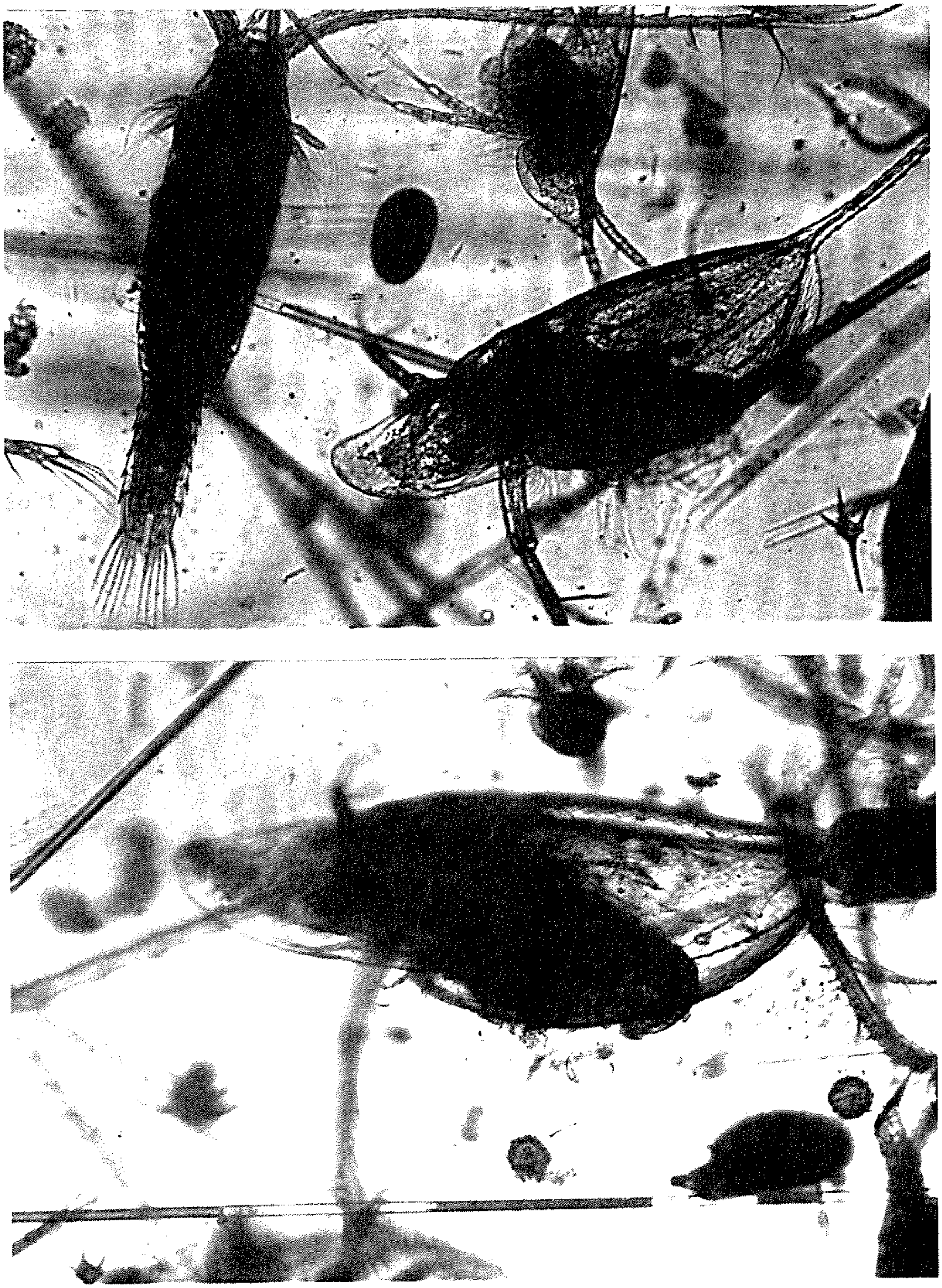

Figure 7. (Top) Large calanoid copepod on the left and a Daphnia on the right, are from Long Lake. (Bottom) Daphnia retrocurva over 1mm long were common in Long Lake in 1997.