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Thomas Hart Benton: *From My Mother's House (the Clammer)*, **1952**

Plant Harvesting and Zooplankton Dynamics in Muskrat Lake for 1998

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Prepared for:
Pelican River Watershed District
Detroit Lakes, Minnesota

Prepared by:
Steve McComas and
Jo Stuckert
Blue Water Science
St. Paul, Minnesota
(651) 690.9602

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Plant Harvesting and Zooplankton Dynamics in Muskrat Lake for 1998

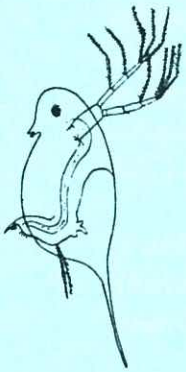
Summary

Aquatic Plant Harvesting

An estimated 146 tons (wet weight) of aquatic plant biomass was removed from Muskrat Lake in 1998. This represents a removal of an estimated 292 pounds of phosphorus or about 11% of the phosphorus loading to Muskrat Lake.

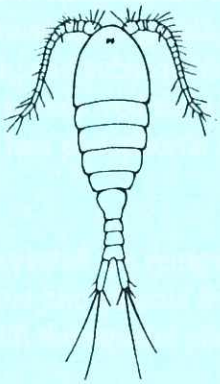
Zooplankton Densities and Biomass in Muskrat Lake

Zooplankton were collected in the middle of the lake and from the nearshore area. The overall density of zooplankton (#/liter) were similar, but the biomass (dry weight) was greater in the middle of the lake primarily because more cladocerans were present compared to copepods.



Cladocerans

Slow swimmers, are vulnerable to fish predation, but are very good grazers on algae. These are the preferred type of zooplankton for keeping the water clear.



Copepods

Fast swimmers, can avoid fish predation, but are not as good at grazing down algae.

Clarity and Phosphorus

Water clarity averaged 9.2 feet for June, July, and August in Muskrat Lake. The average phosphorus concentration in Muskrat Lake over this time was 59 ppb.

Phosphorus Export

Muskrat Lake appeared to export 334 pounds of phosphorus compared to what came in for 1998. This is down from 427 pounds of phosphorus exported in 1997. In 1996, Muskrat Lake retained 381 pounds of phosphorus.

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 and 1998, aquatic plant harvesting was conducted to indirectly 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 what Dr. Steve Carpenter has call the top down trophic cascade.

In 1998, a mechanical harvester cut cruising lanes through the aquatic plant beds in Muskrat Lake. Cruising lanes are intended to allow game fish (piscivores) access to forage fish (planktivores), to better control planktivore numbers. In turn, the reduced predation pressure by forage fish on their zooplankton prey should allow zooplankton numbers to increase. Higher zooplankton numbers mean 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.

Aquatic Plant Harvesting Methods

Pelican River Watershed District Harvester #1 was used to harvest aquatic plants in Muskrat Lake in July and August of 1998. The harvester can cut down to a depth of 5 feet below the water surface. The harvester cut plants for 10 days on Muskrat Lake.

Zooplankton Sampling 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-style Plankton Net. Near-shore tows were taken from the fishing pier, a shallow shoreline site. Vertical tows were taken from a boat through the water column in the middle of Muskrat Lake. The net was lowered to 0.5 meter from the bottom and raised at 0.5 to 1 meter per second to the surface. All tow samples were 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 feet). Tows were taken twice in May, three times in June, three times in July and three 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 Long Lake sample from the summer of 1998. We assigned unit weights for the various zooplankton taxa for other sample dates.

Results

Aquatic Plant Harvesting

For the second consecutive year, the Pelican River Watershed District conducted aquatic plant harvesting on Muskrat Lake. The District harvested for 10 days on Muskrat Lake and removed 97 loads for an estimated 146 tons (wet weight) of plants.

In 1997, an estimated 185 tons of aquatic plants were removed from Muskrat Lake. Statistics for aquatic plant removal and phosphorus removal are summarized in Table 1.

Table 1. Amounts of plant material and phosphorus removed by harvesting from Muskrat Lake in 1997 and 1998.

Year	Tons of Plants Removed	Phosphorus Concentration of Plant Tissue* (wet weight)	Pounds of Phosphorus Removed	Percent of Incoming P Load Removed by Harvesting**
1997	185	0.1%	370	10%
1998	146	0.1%	292	11%

* estimated from various literature values

** estimated from PRWD loading estimates (see page 8, this report)

The primary objective of harvesting has been to increase zooplankton biomass and grazing pressure on algae, and to indirectly reduce phosphorus loading to Lake Sallie. Zooplankton sampling results are shown in the next section.

Zooplankton Densities and Biomass in Muskrat Lake

Zooplankton sampling occurred in the nearshore area (off of the fishing pier) and in the middle of Muskrat Lake through the 1998 summer. Results of zooplankton density and biomass are shown in Tables 2 and 3 and Figure 1.

Table 2. Muskrat Lake zooplankton data for 1998 for zooplankton densities and biomass for nearshore and middle of the lake tows.

Middle of the Lake Tows

	ug/ organism	6.4.98		7.16.98		8.6.98		8.20.98	
		#/l	wt	#/l	wt	#/l	wt	#/l	wt
Daphnia - big	12.00	6	72	0	0	4	48	3	36
Daphnia - small	4.13	37	153	40	165	10	41	12	50
Diaphanosoma	2.5	0	0	0	0	0	0	1	3
Bosmina	1.18	4	5	0	0	11	13	3	4
Chydorus	1.61	1	2	0	0	1	2	0	0
CLADOCERANS SUBTOTAL		**48**	**232**	**40**	**165**	**22**	**104**	**19**	**93**
Calanoids	5.00	4	20	14	70	10	50	10	50
Cyclopoids	1.00	3	3	7	7	20	20	7	7
Nauplii	0.27	25	7	0	0	38	10	8	2
COPEPODS SUBTOTAL		**32**	**30**	**21**	**77**	**68**	**80**	**25**	**59**
Rotifers	--	3	--	0	--	11	--	3	--
Total Zoop Wt		--	**262**	--	**242**	--	**184**	--	**151**

Nearshore Tows

	ug/ org	5.98		5.22.98		6.8.98		6.16.98		7.1.98		7.16.98		7.30.98		8.12.98	
		#/l	wt	#/l	wt	#/l	wt	#/l	wt	#/l	wt	#/l	wt	#/l	wt	#/l	wt
Daphnia - big	12.0	0	0	1	12	1	12	0	0	0	0	0	0	0	0	0	0
Daphnia - small	4.13	6	25	1	4	5	21	27	112	2	8	9	37	3	12	1	4
Diaphanosoma	2.5	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bosmina	1.18	3	4	1	1	2	2	5	6	0.5	0.6	4	5	4	5	0	0
Chydorus	1.61	2	3	0	0	1	2	3	5	0.5	0.8	1	2	2	3	0	0
CLADOCERANS SUBTOTAL		**12**	**35**	**3**	**17**	**9**	**37**	**35**	**123**	**3**	**9**	**14**	**44**	**9**	**20**	**1**	**4**
Calanoids	5.00	2	10	1	5	9	45	0	0	7	35	6	30	3	15	0	0
Cyclopoids	1.00	15	15	1	1	9	9	24	24	9	9	12	12	19	19	1	1.0
Nauplii	0.27	3	0.9	12	3	25	7	40	11	7	2	47	13	29	8	5	1
COPEPODS SUBTOTAL		**20**	**26**	**14**	**9**	**43**	**61**	**64**	**35**	**23**	**46**	**65**	**55**	**51**	**42**	**6**	**2**
Rotifers	—	1	--	4	--	2	--	27	--	1	--	3	--	10	--	5	--
Total Zoop Wt		--	**61**	--	**26**	--	**98**	--	**158**	--	**55**	--	**99**	--	**62**	--	**6**

A monthly summary of zooplankton densities indicates that cladoceran numbers are higher in the middle of the lake compared to the nearshore area. In June and July overall zooplankton densities were similar (Table 3). However, zooplankton biomass was higher in the middle of Muskrat Lake over the summer. Cladoceran biomass was generally greater than copepod biomass.

Table 3. Comparison of zooplankton density (#/liter) for nearshore and middle of the lake tows in Muskrat Lake in 1998.

	Total Cladocerans		Total Copepods		Total Zooplankton	
	nearshore	middle	nearshore	middle	nearshore	middle
May	8	--	17	--	25 (n=2)	--
June	22	48	54	32	76 (n=2)	80 (n=1)
July	9	40	46	21	54 (n=3)	61 (n=1)
August	1	21	6	47	7 (n=1)	68 (n=2)

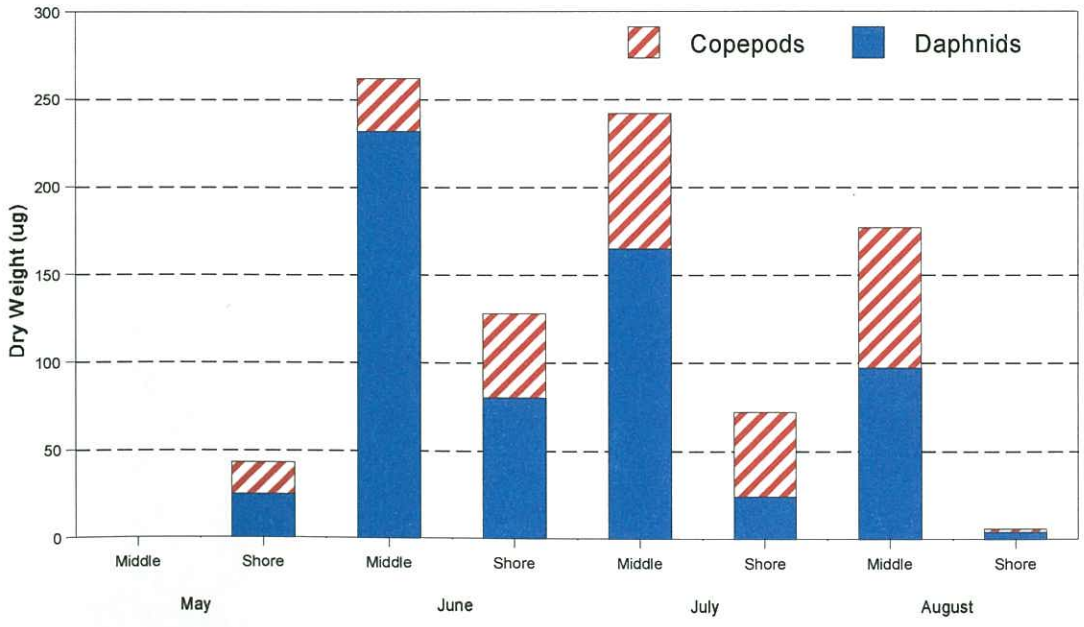


Figure 1. Comparison of zooplankton biomass for nearshore and middle of the lake tows in Muskrat Lake in 1998.

Comparisons between 1997 and 1998 zooplankton data are restricted to the near-shore areas as there were no mid-lake zooplankton tows in 1997. Based on July data for 1997 and 1998, zooplankton biomass was similar (Table 4).

Table 4. Comparison of zooplankton dry weights (ug/l) for nearshore zooplankton tows in 1997 and 1998.

	Total Cladocerans		Total Copepods		Total Zooplankton	
	1997	1998	1997	1998	1997	1998
May						
week 3	--	17	--	9	--	26
June						
week 2	--	37	--	61	--	98
week 3	--	123	--	35	--	158
July						
week 1	--	9	--	46	--	55
week 2	43	--	16	--	59	--
week 3	61	44	22	55	83	99
week 4	27	20	13	62	40	82
August						
week 1	33	--	26	--	69	--
week 2	33	4	8	2	41	6
week 3	22	--	8	--	30	--
week 4	38	--	12	--	50	--

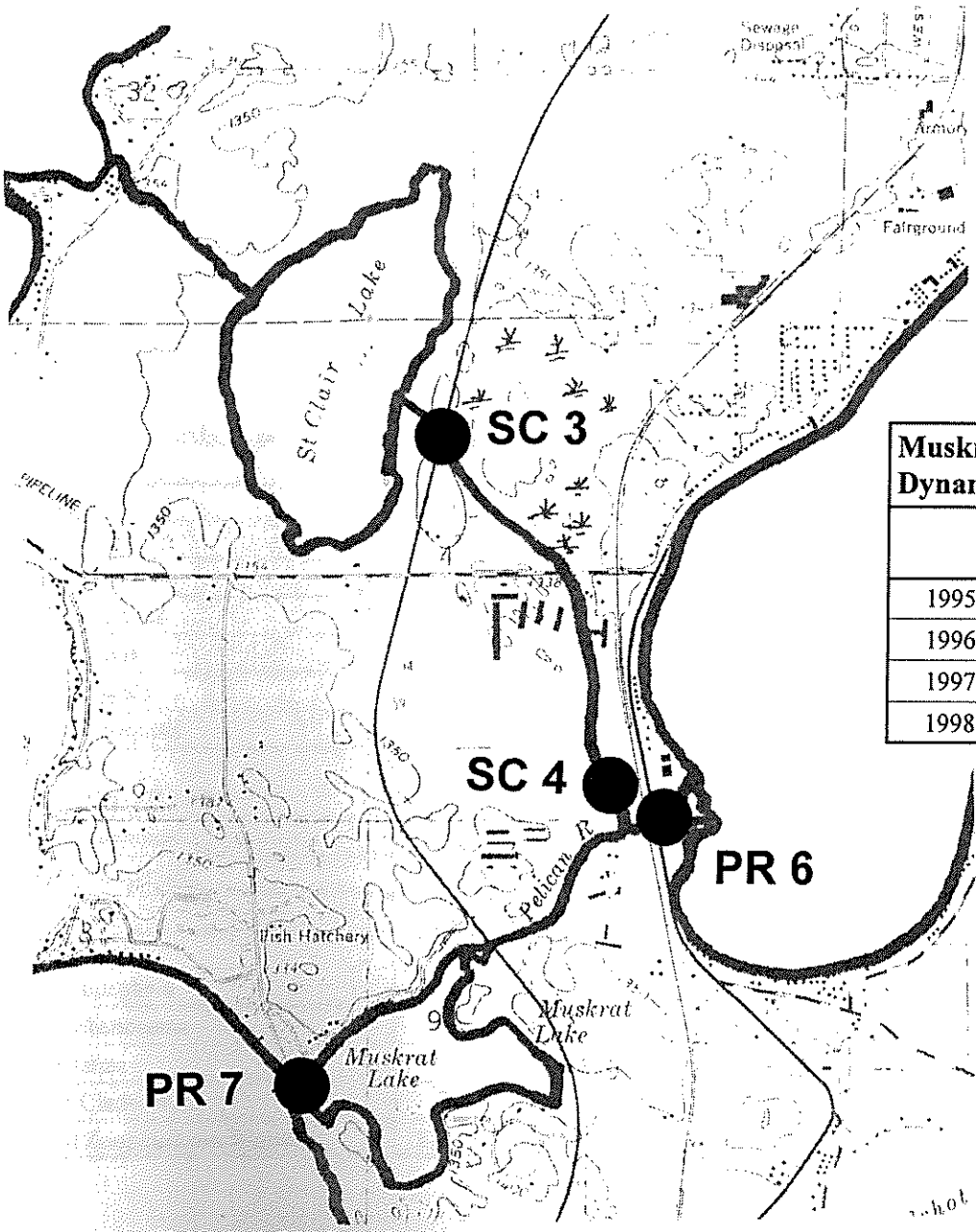
Muskrat Lake Water Quality and Phosphorus Export

Water quality in Muskrat Lake was fair to good in 1998. Secchi disc transparency averaged 9.2 feet for June, July, and August. Phosphorus averaged 59 ppb for the same time period (Table 5).

Phosphorus loading to Muskrat Lake from SC 4 and PR 6 was estimated at 2,610 pounds (Table 6). Phosphorus export from Muskrat Lake was estimated at 2,944 pounds. This represents a net phosphorus export from Muskrat Lake of 334 pounds and indicates Muskrat Lake may have been a net exporter of phosphorus in 1998.

Table 5. Muskrat Lake 1998 water chemistry data (site 201).

	6.4.98	6.25.98	7.16.98	8.6.98	8.20.98	Summer Average
Secchi disc (ft)	12	7	11	7	7	9.2
T.P. (ppb)	34	41	72	65	67	59
T.P. (ppb) (A.W. Lab)					20	--
O.P. (ppb) - top	10	12	32	41	20	25
O.P. (ppb) -bottom	14	25	42	40		34
Chl a (ppb) (A.W.Labs)	<1					--
Temp (C)	15.6	22.0	25.2	24.0	22.6	--
Depth (ft) where DO <2.0 mg/l	na		4	5	4	--



Muskrat Lake Phosphorus Dynamics: Source or Sink		
	Source (lbs)	Sink (lbs)
1995	55	
1996		381
1997	427	
1998	334	

Table 6. Phosphorus loading data for April - October. Loading is in pounds of phosphorus.

	SC 3 St. Clair Outlet to Ditch 14	SC 4 Ditch 14 Outlet	PR 6 PR Outlet from DL	SC 4 + PR 6	PR 7 (Muskrat Lake outlet) = PR inlet to Lake Sallie
1995	--	1,002	720	1,722	1,777
1996	567	1,511	884	2,395	2,014
1997	783	1,835	1,813	3,648	4,075
1998	669	1,242	1,368	2,610	2,944

Comparison of Long Lake and Muskrat Lake Zooplankton

A summary of zooplankton biomass for Long Lake in 1998 is shown in Table 7.

Table 7. Zooplankton biomass (ug/l) for Long Lake 1998.

	5.2	6.5	6.17	7.1	7.13	7.31	8.10	8.24
COPEPODS								
Nauplii	--	0.38	--	0.14	0.21	0.20	0.38	0.28
Copepodites	5.12	1.76	1.64	0.13	2.85	1.16	2.43	0.72
Calanoids	94.29	78.98	37.28	17.88	15.34	52.89	18.25	15.06
Cyclopoids	6.53	51.79	18.18	17.83	38.06	24.68	22.46	16.49
Total Copepods	105.94	132.91	57.10	35.98	56.47	78.92	43.52	32.54
CLADOCERANS								
Big Daphnids	2.90	2.97	19.00	43.44	30.94	24.15	8.08	1.59
Little Daphnids	4.33	6.94	28.70	21.48	8.51	16.35	3.87	6.71
D. pulex	—	--	0.69	1.83	--	--	--	--
Chydorus	0.19	--	--	--	--	--	--	--
Ceriodaphnia	--	—	0.13	--	--	--	--	0.13
Diaphanosoma	—	—	--	1.22	0.97	1.55	0.34	0.31
Bosmina	—	6.56	0.66	--	--	--	1.07	2.82
Total Cladocerans	7.43	16.48	49.17	67.97	40.42	42.04	13.36	11.57
Total Zooplankton Biomass	**113.37**	**149.38**	**106.27**	**103.95**	**96.89**	**120.97**	**56.88**	**44.11**

A comparison of Long Lake and Muskrat Lake zooplankton biomass is shown in Table 8. Muskrat Lake apparently had higher zooplankton biomass than Long Lake.

Table 8. Comparison of Long Lake and Muskrat Lake zooplankton biomass (from middle of the lake) in ug/l-dry weight.

	Cladocerans		Total Zooplankton	
	Long Lake	Muskrat Lake	Long Lake	Muskrat Lake
May	7	--	113	--
June	33	232	128	262
July	75	165	107	242
August	13	70	51	166