Biological Control of Eurasian Watermilfoil

Third Status Report for 2001-2004

BY

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1 December 2002

Deliverable A-3. Completion of 2002 sampling and experiments.
Due Date: 1 December 2002 $27,500

Content: A one to two page status report on progress during the 2002 field season will be submitted to the MnDNR. Preliminary analyses of summer 2002 samples will be presented, though not all samples will be processed. The report will include results of attempts to detect declines in milfoil, bi-weekly weevil surveys, weevil augmentations, population modeling, and assessment of plant communities. Progress, problems and qualitative observations will be reported for these efforts.

Introduction

Eurasian watermilfoil (*Myriophyllum spicatum* L.) is an exotic aquatic weed that often interferes with recreation (Smith and Barko 1990), inhibits water flow, impedes navigation, (Grace and Wetzel 1978) and will displace other aquatic macrophytes (Madsen et al. 1991). It was first reported in Minnesota in 1987 and now occurs in over 130 waterbodies in Minnesota (Exotics Species Programs 2002).

Recent work on the biological control of Eurasian watermilfoil has focused on the indigenous weevil *Euhrychiopsis lecontei* (Dietz) (= *Eubrychiopsis lecontei*). This work work suggests that *E. lecontei* is the most promising control agent (Creed and Sheldon 1995, Sheldon and Creed 1995, Creed 1998, Newman and Biesboer 2000). The weevil is native to Minnesota and Wisconsin (Newman and Maher 1995, Jester et al. 1997) and is highly specific to watermilfoils (Solarz and Newman 2001). Sheldon and O'Bryan (1996), Newman et al. (1996, 1997), Mazzie et al. (1999) and Newman et al. (2001) describe the life history and development times of the weevil. Additional review and management information can be found in Getsinger et al. (2002).

Although declines of milfoil in several lakes have been related to the occurrence of *E. lecontei* (Sheldon and Creed 1995, Lillie 1996, Newman and Biesboer 2000, Creed 1998), it is clear that at many sites in Minnesota, weevil densities do not get high enough to effect control (Newman et al. 1996, Newman et al. 1998, Newman and Biesboer 2000). Fish predation may be one factor limiting populations in some lakes (Sutter and Newman 1997, Newman and Biesboer 2000).

The aim of this project is to attempt to detect milfoil declines and assess milfoil weevil populations, identify and manipulate factors that may be limiting control agent densities and identify and manipulate factors that may limit the effectiveness of milfoil control agents (plant community response). This report summarizes our sample collection efforts in 2002 and presents preliminary results for a portion of these efforts. Complete methods (which follow those of Newman et al. 2002) and results from 2002 will be presented in our June 2003 progress report.

Acknowledgements

Numerous people assisted with this project, including: Chris Lemmon, Darren Ward, Shannon Bishop, Aaron Berger, Kerry Accola, Matthew Dowgwillo, Jon German, Jen German, Jordan Greenwood, Heather Hendrixson, Ruth Isakson, Todd Kittle, Chris Kolasinski, Luke Kramer, Nick Lehnertz, Seth Lengkeek, Jack Lund, William Tanberg and Kim Whorrall. Darren Ward and Shannon Bishop were instrumental in sample collection, sample processing and data tabulation for this report.

Summary of activities in 2002

Semi-permanent Transect Sites:

We sampled our regular transect sites in 5 lakes (Auburn, Cedar, Cenaiko, Otter and Smith's Bay) in 2002; all were sampled twice, in late-June or early-July and late-August or early September. Twenty to thirty samples were collected at each lake on each date. The samples have been processed for wet and dry mass, but invertebrates have not been sorted and the dry mass data have not been entered into the computer. These remaining data will be presented in our June 2003 report. Methods follow those of our May 2002 report.

There was a continued persistence of dense milfoil at Cedar Lake (Table 1) and numbers of species remained low (Table 2). Nonmilfoil biomass increased but was almost all coontail and milfoil composed 60-70% of total plant biomass (Table 3). Milfoil continued to increase at Lake Auburn where it once again became the dominant plant in the community. Native plant biomass decreased as did the total and mean number of species.

Table 1. Biomass ± 1SE (g wet/m^2) of Eurasian watermilfoil at the four sampling sites in 1994-2002. n = number of samples. Dry biomass (g/m^2 ± 1SE) is presented for 1995-2001.

Sampling Date	Auburn	n	Cedar	n	Otter	n	Smith's Bay	n
5/19-6/3/94	1474 ± 326	10	610 ± 289	18	2208 ± 332	21	1470 ± 320	14
7/1-7/11/94	1570 ± 297	16	1642 ± 523	18	1589 ± 231	27	3478 ± 399	16
8/12-8/19/94	1581 ± 224	15	601 ± 207	15	2626 ± 472	14	1886 ± 328	16
9/14-9/21/94	2205 ± 350	19	824 ± 188	24	2510 ± 557	9	1767 ± 386	14
6/07-6/27/95	1999 ± 324	30	2307 ± 631	23	3444 ± 336	27	1618 ± 289	25
dry	280 ± 43		245 ± 67		312 ± 33		158 ± 28	
7/31-8/15/95	2277 ± 417	19	1821 ± 797	10	2526 ± 385	15	1481 ± 245	25
dry	267 ± 46		172 ± 79		171 ± 29		149 ± 28	
9/18-9/29/95	5044 ± 752	17	479 ± 173	17	2629 ± 323	18	1281 ± 178	25
dry	551 ± 94		37 ± 13		194 ± 23		113 ± 15	
6/12-6/24/96	2959 ± 402	30	568 ± 200	30	21 ± 8	27	665 ± 144	25
dry	306 ± 40		59 ± 24		2 ± 1		46 ± 10	
7/30-8/9/96	3035 ± 619	27	665 ± 219	30	1 ± 1	27	1415 ± 256	25
dry	390 ± 82		62 ± 20		0 ± 0		176 ± 36	
9/12-9/19/96	3622 ± 469	30	574 ± 174	30	0 ± 0	27	1656 ± 393	25
dry	361 ± 49		50 ± 14		0 ± 0		156 ± 40	
6/27-7/17/97	2134 ± 321	30	1906 ± 341	28	24 ± 22	26	1880 ± 327	25
dry	294 ± 46		210 ± 40		3 ± 3		296 ± 55	
9/8-9/18/97	2786 ± 400	30	2646 ± 502	29	4 ± 4	27	1055 ± 170	25
dry	321 ± 49		271 ± 55		0 ± 0		100 ± 18	
6/8-6/18/98	1080 ± 168	30	1690 ± 360	31	79 ± 52	27	815 ± 164	25
dry	130 ± 18	30	213 ± 52	31	7 ± 4	27	105 ± 21	25
7/27-8/3/98	581 ± 133	30					2103 ± 475	25
dry	67 ± 16	30					286 ± 65	25
9/8-9/16/98	530 ± 76	30	3146 ± 514	29	181 ± 44	27	1487 ± 338	25
dry	48 ± 7	30	367 ± 63	29	15 ± 4	27	172 ± 40	25
6/15-6/22/99	202 ± 50	30	2238 ± 393	28	355 ± 113	27	1806 ± 289	25
dry	24 ± 7	30	252 ± 50	28	25 ± 8	27	155 ± 32	25
7/29-8/3/99					483 ± 101	27	1358 ± 289	25
dry					36 ± 8	27	189 ± 44	25
8/23-8/25/99	253 ± 83	30	1632 ± 237	30			1362 ± 320	25
dry	25 ± 9	30	105 ± 15	30			106 ± 26	25
6/6-6/23/00	1392 ± 263	30	2045 ± 321	29	2652 ± 340	27	981 ± 318	25
dry	208 ± 39	30	219 ± 38	29	331 ± 42	27	109 ± 37	25
7/11-7/19/00	783 ± 200	30			607 ± 82	27	501 ± 150	25
dry	115 ± 32	30			45 ± 7	27	77 ± 22	25
8/23-8/29/00	1007 ± 152	30	1988 ± 305	29	1098 ± 136	27	1474 ± 346	25
dry	91 ± 14	30	175 ± 28	29	90 ± 14	27	162 ± 40	25
6/18-6/25/01	1022 ± 199	30	1213 ± 267	29	116 ± 34	27	408 ± 107	25
dry	109 ± 21	30	108 ± 26	30	9 ± 3	27	31 ± 8	25
7/17/-7/30/01	1641 ± 279	30			138 ± 58	25	1211 ± 290	25
dry	232 ± 45	30			6 ± 3	27	168 ± 43	25
8/23-8/30/01	1549 ± 289	30	1798 ± 398	25	24 ± 11	27	1438 ± 381	25
dry	158 ± 33	30	145 ± 38	28	2 ± 1	27	160 ± 43	25
6/2-7/8/02	1886 ± 339	30	1955 ± 380	21	313 ± 89	29	1067 ± 245	25
8/8-9/6/02	1776 ± 273	30	1910 ± 294	32	205 ± 49	30	1746 ± 346	25

Milfoil remained suppressed at the shallowest stations in Smiths Bay (it was absent from many samples at the first two stations) but relatively high densities increased at the deepest stations. Overall, milfoil biomass increased to 1700 g/m/2 by September or 52% of plant biomass. Total and mean number of species remained high but decreased slightly from previous years. The major decline of milfoil persisted at Otter Lake but milfoil did increase to 25% of total plant biomass and 200-300 g/m2 (still 10% of peak biomass in previous years). Total and mean numbers of species remained very high at Otter Lake and native plant biomass remained at around 1100 g/m2.

Table 2. Mean number of species per sample (Spp/S) ± 1SE and non-milfoil biomass (B; g wet /m2) at the 4 sampling sites in 1994-2002. Number of samples is given in Table 1.

Sampling Date	Auburn		Cedar		Otter		Smith's Bay	
	Spp/S	B	Spp/S	B	Spp/S	B	Spp/S	B
5/19-6/3/94	3.80±0.47	670	1.33±0.28	75	4.76±0.19	600	3.29±0.22	1231
7/1-7/11/94	3.63±0.29	444	1.83±0.28	370	4.37±0.29	520	3.75±0.35	1604
8/12-8/19/94	3.00±0.28	647	1.53±0.26	282	5.57±0.39	1126	3.13±0.42	765
9/14-9/21/94	3.11±0.37	268	1.46±0.19	54	4.89±0.61	431	3.50±0.39	975
6/07-6/27/95	2.23±0.22	822	1.43±0.20	214	4.70±0.21	1065	3.64±0.30	877
7/31-8/15/95	3.37±0.26	1789	1.70±0.15	516	4.27±0.30	642	2.68±0.24	703
9/18-9/29/95	2.18±0.18	1058	1.41±0.17	337	2.44±0.34	135	2.80±0.20	856
6/12-6/24/96	2.93±0.24	1450	2.10±0.22	248	5.19±0.25	434	4.32±0.36	1159
7/30-8/9/96	2.78±0.31	1186	1.43±0.18	270	4.19±0.20	1171	3.88±0.41	1017
9/12-9/19/96	2.50±0.20	1166	1.57±0.16	307	3.93±0.28	1798	3.88±0.32	1531
6/27-7/17/97	2.97±0.14	1435	1.82±0.14	460	4.31±0.29	1516	4.16±0.39	1162
9/8-9/18/97	2.63±0.17	1500	1.59±0.09	235	4.81±0.26	3180	3.64±0.27	1863
6/8-6/18/98	2.43±0.18	1158	1.74±0.81	637	5.37±0.24	1835	5.32±0.43	1038
7/27-8/3/98	2.97±0.23	2197					5.00±0.44	1385
9/8-9/16/98	2.40±0.12	1258	1.62±0.12	296	4.74±0.39	1423	4.32±0.38	969
6/15-6/22/99	3.07±0.16	1806	1.86±0.13	326	4.52±0.31	825	4.60±0.37	810
7/29-8/3/99					5.33±0.30	720	3.72± 0.31	973
8/23-8/25/99	1.93±0.13	679	1.37±0.09	570			2.92± 0.33	534
6/6-6/23/00	3.17±0.19	1597	1.62±0.10	919	4.33±0.28	471	3.44±0.39	458
7/11-7/19/00	2.70±0.20	1090			4.59±0.24	595	4.48±0.45	949
8/23-8/29/00	2.30±0.12	852	1.62±0.10	354	4.33±0.21	778	4.00±0.36	979
6/18-6/25/01	2.77±0.21	971	1.52±0.11	495	4.44±0.23	628	4.00±0.35	663
7/17/-7/30/01	2.40±0.11	996			3.04±0.24	1189	3.96±0.32	1387
8/23-8/30/01	2.80±0.16	2314	1.80±0.08	1303	3.81±0.27	1293	3.60±0.28	1342
6/2-7/8/02	2.17±0.11	861	1.67±0.11	738	3.55±0.27	1124	3.28±0.26	858
8/8-9/6/02	2.30±0.14	398	1.53±0.12	709	4.53±0.25	1094	3.12±0.19	928

Water quality samples and sediment cores (9 per sampling period) were obtained during each sampling. Sediment cores were analyzed for extractable (exchangable) N in addition to pore water ammonium. Almost all of these data have been processed (including cores) but have not been entered into the computer and will be summarized in our June 2003 report.

Table 3. Percentages of total plant wet biomass that was Eurasian watermilfoil (±1SE) and total number of species (N) collected at each site. These are the average percentage found in the samples and are thus not equal to total mean milfoil biomass/plant biomass.

Sampling Date	Auburn	N	Cedar	N	Otter	N	Smith's Bay	N
5/19-6/3/94	65% ±10%	9	67% ±11%	4	80% ± 6%	9	64% ±10%	8
7/1-7/11/94	79% ± 6%	9	67% ± 9%	4	75% ± 5%	9	72% ± 6%	11
8/12-8/19/94	74% ± 6%	9	61% ±13%	3	75% ± 6%	11	81% ± 5%	11
9/14-9/21/94	91% ± 6%	9	87% ± 5%	4	83% ± 6%	11	71% ± 8%	9
6/07-6/27/95	72% ± 7%	7	82% ± 7%	3	79% ± 4%	9	61% ± 5%	10
7/31-8/15/95	58% ± 7%	7	58% ± 6%	2	80% ± 7%	9	63% ± 6%	11
9/18-9/29/95	81% ± 7%	5	38% ± 5%	2	95% ± 1%	6	63% ± 7%	10
6/12-6/24/96	70% ± 7%	7	57% ± 7%	5	7% ± 5%	9	33% ± 6%	10
7/30-8/9/96	56% ± 8%	7	59% ± 9%	5	0.1% ± 0.1%	10	56% ± 7%	11
9/12-9/19/96	69% ± 6%	8	73% ± 6%	4	0% ± 0%	9	49% ± 7%	10
6/27-7/17/97	53% ± 13%	10	82% ± 9%	3	1.2% ± 2.3%	12	54% ± 14%	12
9/8-9/18/97	60% ± 13%	8	88% ± 9%	2	0.2% ± 0.3%	13	40% ± 14%	11
6/8-6/18/98	42% ± 5%	11	79% ± 5%	4	4% ± 2%	15	37% ± 6%	15
7/27-8/3/98	24% ± 4%	12					49% ± 8%	16
9/8-9/16/98	34% ± 4%	7	82% ± 6%	4	20% ± 5%	13	50% ± 8%	13
6/15-6/22/99	14% ± 4%	7	82% ± 6%	3	30% ± 6%	13	61% ± 7%	12
7/29-8/3/99					40% ± 5%	14	53% ± 8%	13
8/23-8/25/99	36% ± 7%	6	85% ± 6%	2			61% ± 8%	12
6/6-6/23/00	43% ± 6%	9	75% ± 7%	5	81% ± 5%	12	49% ± 9%	13
7/11-7/19/00	37% ± 6%	9			53% ± 4%	15	40% ± 8%	15
8/23-8/29/00	55% ± 6%	6	77% ± 6%	3	63% ± 5%	9	50% ± 8%	13
6/18-6/25/01	52% ± 6%	10	77% ± 6%	2	20% ± 5%	15	35% ± 8%	14
7/17/-7/30/01	56% ± 6%	5			9% ± 4%	11	42% ± 7%	14
8/23-8/30/01	40% ± 6%	5	59% ± 8%	2	5% ± 3%	12	42% ± 8%	12
6/27/02	65% ± 6%	6	63% ± 9%	2	27% ± 5%	13	44% ± 8%	11
9/6/02	76% ± 5%	6	73% ± 7%	4	26% ± 5%	16	52% ± 8%	11

Cenaiko Lake

Milfoil biomass increased at Cenaiko Lake in 2002 compared to previous years (Table 4), but remained well below peak biomass (120 g/m^2 in 1996) and similar to the biomass reached in 1998 (44 g/m^2). Milfoil biomass did increase to almost 50% of total plant biomass in August 2002, the highest percentage since the decline in 1996. Native plant biomass in early summer was similar to previous years but declined considerably by late August and the mean and total number of species continued to decrease from previous years with only 5-6 total species being found on each sampling date. Poor water clarity associated with summers rains may have helped suppress the plant community and low densities of herbivores (see below) may be failing to control the milfoil. Results of fish surveys in 2002 are not completed but density of sunfish appears to be increasing from the low levels seen in the mid-1990s.

Table 4. Biomass (g dry/m2) of all plants (Total), Eurasian watermilfoil (MSP), the dominant plants (coontail (CRT), *Zosterella* (= *Heteranthera*) *dubia* (ZOS), *Potamogeton zosteriformis* (PZS), *Chara* (CHA) and *Potamogeton amplifolius* (PAM)), non-milfoil biomass (NAT), total (TN) and mean number of species (N Sp) and mean percentage of biomass that was Eurasian watermilfoil in Cenaiko Lake 1999-2002. N=17-27 samples per date. Dry biomass in 2002 was estimated based on 10% of wet biomass. In July and August 2001, *Potamogeton nodosus* was present at densities of 36 and 19 g dry/m^2 and in August 2002 at 50 g/m^2. In 2002 *P. pectinatus* was present at 2-3 g/m^2.

Date	Total	MSP	CRT	PZS	ZOS	CHA	PAM	TN	N Sp.	NAT	%MSP
6/24/99	53.7	1.3	32.2	0.2	3.0	0.5	12.3	11	1.9	52.4	7.9%
1 S.E.	17.0	0.9	12.0	0.2	2.5	0.4	10.7		0.2	17.1	5.2%
8/2/99	214.6	1.1	124.5	0.0	26.7	0.0	34.1	10	2.6	213.5	1.0%
1 S.E.	40.1	0.8	37.5	0.0	9.7	0.0	23.6		0.2	40.2	0.7%
8/26/99	55.0	0.0	30.2	0.1	5.0	0.0	6.7	5	1.5	55.0	0.0%
1 S.E.	20.1	0.0	20.1	0.1	3.4	0.0	4.4		0.1	20.1	0.0%
6/29/00	225.9	10.0	123.9	0.0	16.3	46.0	19.8	9	2.1	215.9	3.1%
1 SE	34.1	5.2	31.2	0.0	8.2	21.1	14.3		0.2	33.1	1.7%
7/20/00	146.8	3.7	86.4	0.0	19.5	14.5	18.3	8	2.4	143.2	8.4%
1 SE	23.6	2.2	22.5	0.0	10.1	9.4	11.8		0.3	24.1	5.1%
8/30/00	134.5	0.1	89.4	34.5	0.0	8.0	1.7	8	1.8	129.4	0.1%
1 SE	22.0	0.1	23.5	14.9	0.0	7.3	1.5		0.2	22.8	0.1%
6/26/01	25.5	2.8	17.2	0.6	0.0	0.0	0.6	7	1.4	22.7	3.5%
1 SE	8.5	2.8	7.9	0.3	0.0	0.0	0.6		0.4	8.0	3.3%
7/30/01	105.4	6.8	59.5	0.0	0.0	0.0	0.0	7	1.1	98.6	7.1%
1 SE	43.1	4.0	26.1	0.0	0.0	0.0	0.0		0.3	42.6	4.4%
8/27/01	133.6	0.0	98.8	1.0	0.0	0.0	8.8	6	1.0	133.6	4.0%
1 SE	29.6	0.0	27.3	0.5	0.0	0.0	6.4		0.1	29.6	4.0%
7/1/02	189.2	51.4	131.6	4.2	0.0	0.0	0.0	5	2.2	137.8	16.4%
1 SE	56.9	27.2	41.7	3.2	0.0	0.0	0.0		0.2	38.3	7.8%
8/27/02	83.6	50.7	24.2	0.3	0.0	0.0	0.0	6	1.8	33.0	49.2%
1 SE	17.9	18.9	11.8	0.2	0.0	0.0	0.0		0.2	11.9	11.7%

Weevil surveys

Biweekly weevil surveys were conducted in Lake Auburn, Cenaiko Lake, Otter Lake and Smiths Bay. For each survey, 5-8 stems (top 50 cm) of milfoil were collected at each of 15-18 stations every other week (at Cenaiko we often were unable to find milfoil at some stations). Weevils and lepidopterans were removed from the samples, which were scanned at 8X magnification, and weevils were enumerated by life stage. The results of these surveys are tabulated but have not been analyzed.

Weevil densities continued to decline at Cenaiko (< 0.21 per stem) from previous years although weevils were present throughout the summer (Table 5). *Acentria* and *Parapoynx* densities were also lower than previous years. DNR fisheries surveys in 2002 will reveal if sunfish densities have increased from 1998. Weevils returned to Lake Auburn in spring 2002 (they were not found after July in 2001) but were below detection in July. Densities increased from August through September, when a high density of adults was found during the last sampling period (0.27 adults per stem). It is not clear if this was due to an in situ population buildup or due to immigration from across the lake or from another lake, however, the presence of most life stages in both late August and late September suggests that the population may have developed in situ. It is unclear if the high final density will translate into a higher population in spring 2003. *Acentria* and *Parapoynx* were not detected at Lake Auburn. Weevil densities were high at Otter Lake through mid-July but decreased to moderate levels in August and September. *Acentria* and *Parapoynx* were present in spring and early summer but at lower levels than in 2001 and neither species was detected in August and September.

Table 5. Density of weevil life stages (per stem), total weevils per stem and density of the caterpillars *Acentria* (Acent) and *Parapoynx* (Parap) from the bi-weekly weevil surveys.

Lake	Date	Eggs	Larvae	Pupae	Adults	Total	Acent	Parap
Cenaiko								
	5/16/00	0.1952	0.0229	0.0000	0.0000	0.2181	0.2762	0.0000
	5/30/00	0.0397	0.0159	0.0069	0.0000	0.0625	0.1905	0.0000
	6/13/00	0.1190	0.0883	0.0488	0.0756	0.3318	0.1584	0.0000
	6/29/00	0.2476	0.0556	0.0397	0.0238	0.3667	0.0508	0.0000
	7/11/00	0.3214	0.0347	0.0208	0.1141	0.4911	0.1141	0.0000
	7/24/00	0.7393	0.0208	0.0069	0.1181	0.8851	0.0417	0.0000
	8/10/00	0.5417	0.0917	0.0000	0.0167	0.5667	0.0083	0.0000
	8/24/00	0.0822	0.0519	0.0065	0.0652	0.2058	0.0465	0.0000
	9/7/00	0.0278	0.0324	0.0379	0.0866	0.1847	0.1554	0.0000
	9/20/00	0.0000	0.0694	0.0000	0.0478	0.1173	0.0556	0.0000
	10/3/00	0.0000	0.0368	0.0000	0.0083	0.0451	0.0000	0.0000
	5/21/01	0.0833	0.0000	0.0000	0.0000	0.0833	0.8068	0.0000
	6/6/01	0.6893	0.0000	0.0000	0.1857	0.8750	0.1250	0.0000
	6/18/01	0.0500	0.0000	0.0000	0.0000	0.0500	0.0000	0.0000
	7/3/01	0.0343	0.0000	0.0000	0.0000	0.0343	0.0100	0.0000
	7/19/01	0.0000	0.1268	0.0000	0.0000	0.1268	0.0250	0.0000
	7/30/01	0.0000	0.0000	0.0000	0.0125	0.0125	0.0250	0.0000
	8/15/01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	8/27/01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	9/5/01	0.0104	0.0000	0.0000	0.0000	0.0104	0.0625	0.0000
	9/18/01	0.0000	0.0000	0.0000	0.0000	0.0000	0.1472	0.0000
	5/24/02	0.0000	0.0000	0.0000	0.0000	0.0000	0.0625	0.0000
	6/3/02	0.0208	0.0000	0.0000	0.0000	0.0208	0.0046	0.0139
	6/17/02	0.0000	0.0196	0.0000	0.0000	0.0196	0.0000	0.0000
	7/1/02	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	7/16/02	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	7/29/02	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	8/13/02	0.0000	0.0069	0.0000	0.0069	0.0139	0.0228	0.0000
	8/26/02	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	9/10/02	0.0000	0.0069	0.0000	0.0139	0.0208	0.0000	0.0000
Auburn								
	5/19/00	0.0267	0.0267	0.0000	0.0000	0.0533	0.0000	0.0000
	6/1/00	0.0000	0.0218	0.0000	0.0079	0.0298	0.0000	0.0000
	6/15/00	0.0139	0.0278	0.0000	0.0000	0.0417	0.0000	0.0000
	6/27/00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	7/10/00	0.0000	0.0000	0.0069	0.0347	0.0417	0.0000	0.0000
	7/25/00	0.1528	0.0000	0.0069	0.0556	0.2153	0.0000	0.0000
	8/9/00	0.0368	0.0515	0.0515	0.0294	0.1691	0.0000	0.0000
	8/28/00	0.0000	0.0000	0.0000	0.0074	0.0074	0.0000	0.0000
	9/12/00	0.0000	0.0208	0.0062	0.0123	0.0394	0.0000	0.0149
	9/28/00	0.0000	0.0000	0.0000	0.0139	0.0139	0.0000	0.0000
	5/10/01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	5/24/01	0.2562	0.0139	0.0000	0.0309	0.3009	0.0000	0.0000
	5/30/01	0.1847	0.0000	0.0000	0.0000	0.1847	0.0000	0.0000
	6/13/01	0.0069	0.0139	0.0139	0.0308	0.0655	0.0000	0.0000
	6/28/01	0.0278	0.0139	0.0000	0.0000	0.0417	0.0000	0.0000
	7/9/01	0.0278	0.1389	0.0139	0.0139	0.1944	0.0000	0.0000
	7/23/01	0.0000	0.0123	0.0270	0.0139	0.0532	0.0000	0.0000
	8/8/01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	8/20/01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	9/11/01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	9/27/01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 5. Continued.

Lake	Date	Eggs	Larvae	Pupae	Adults	Total	Acent	Parap
Auburn Continued								
	5/22/02	0.0185	0.0000	0.0000	0.0000	0.0185	0.0000	0.0000
	6/13/02	0.0074	0.0000	0.0000	0.0000	0.0074	0.0000	0.0000
	6/26/02	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	7/11/02	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	7/22/02	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	8/7/02	0.0000	0.0000	0.0000	0.0208	0.0208	0.0000	0.0000
	8/21/02	0.0185	0.0417	0.0024	0.0062	0.0688	0.0000	0.0000
	9/4/02	0.0000	0.0000	0.0000	0.0417	0.0417	0.0000	0.0000
	9/20/02	0.0000	0.0208	0.0417	0.2708	0.3333	0.0000	0.0069
Otter								
	6/5/00	0.1940	0.1321	0.0500	0.0821	0.4583	0.0250	0.0000
	6/22/00	0.1395	0.2027	0.0580	0.0804	0.4806	0.0268	0.0089
	7/5/00	0.0000	0.0403	0.0079	0.0079	0.0575	0.0000	0.0000
	7/18/00	0.0000	0.0074	0.0074	0.0000	0.0147	0.0000	0.0000
	8/2/00	0.0218	0.0000	0.0069	0.0218	0.0506	0.0069	0.0000
	8/16/00	0.0074	0.0147	0.0000	0.0000	0.0221	0.0000	0.0000
	8/29/00	0.0000	0.0441	0.0074	0.0515	0.1029	0.0000	0.0000
	9/13/00	0.0000	0.0394	0.0278	0.0231	0.0903	0.0000	0.0000
	9/26/00	0.0000	0.0069	0.0764	0.1042	0.1875	0.0000	0.0000
	5/21/01	0.3268	0.0000	0.0000	0.1250	0.4518	0.0000	0.0000
	6/4/01	0.2225	0.0000	0.0000	0.1789	0.4015	0.0417	0.0147
	6/21/01	0.5345	0.0407	0.0000	0.0663	0.6415	0.0074	0.0000
	7/5/01	0.4117	0.1354	0.0851	0.1634	0.7955	0.0202	0.0000
	7/16/01	0.1119	0.0000	0.0000	0.2608	0.3727	0.0000	0.0000
	8/1/01	0.1027	0.0469	0.0000	0.1007	0.2502	0.0000	0.0000
	8/13/01	0.1507	0.0306	0.0000	0.0512	0.2324	0.0000	0.0000
	8/28/01	0.0515	0.1922	0.0000	0.0221	0.2658	0.0074	0.0000
	9/5/01	0.1128	0.1553	0.0131	0.1063	0.3875	0.0378	0.0069
	9/17/01	0.0278	0.2750	0.0486	0.2935	0.6449	0.0069	0.1918
	10/2/01	0.0193	0.0432	0.0288	0.1211	0.2124	0.0455	0.0481
	5/21/02	0.0179	0.0000	0.0000	0.0625	0.0804	0.0238	0.0000
	6/2/02	0.5218	0.1862	0.0147	0.1183	0.8646	0.0000	0.0715
	6/17/02	0.0981	0.2302	0.0591	0.0757	0.4631	0.0083	0.0000
	7/3/02	0.1759	0.2037	0.0208	0.1319	0.5324	0.0000	0.0069
	7/16/02	0.1911	0.0000	0.0000	0.2444	0.4355	0.0000	0.0069
	7/29/02	0.0294	0.0296	0.0000	0.0795	0.1459	0.0000	0.0131
	8/13/02	0.0964	0.0182	0.0000	0.0339	0.1484	0.0000	0.0000
	8/26/02	0.0672	0.0389	0.0000	0.0546	0.1607	0.0000	0.0000
	9/9/02	0.0208	0.0069	0.0000	0.0208	0.0486	0.0000	0.0000

At Smith's Bay, weevils were abundant in June but densities decreased in July and stayed at low to moderate levels during the rest of the summer. As in previous years, *Parapoynx* was not detected and *Acentria* was found in very low abundance only on one date in June.

Table 5. Continued.

Lake	Date	Eggs	Larvae	Pupae	Adults	Total	Acent	Parap
Smith's								
	5/25/00	0.2867	0.0267	0.0000	0.0000	0.3133	0.0000	0.0000
	6/8/00	0.2095	0.1429	0.0095	0.0000	0.3619	0.0000	0.0000
	6/21/00	0.2519	0.0824	0.0429	0.0167	0.3938	0.0583	0.0000
	7/3/00	0.0810	0.0369	0.0000	0.0000	0.1179	0.0000	0.0000
	7/19/00	0.0167	0.0250	0.0111	0.0417	0.0944	0.0000	0.0000
	8/4/00	0.2604	0.0702	0.1339	0.0274	0.4919	0.0000	0.0000
	8/15/00	0.0472	0.0750	0.0074	0.0389	0.1685	0.0000	0.0000
	8/23/00	0.0919	0.1100	0.0726	0.0871	0.3361	0.0085	0.0000
	9/6/00	0.0250	0.0880	0.0000	0.0591	0.1721	0.0000	0.0000
	9/19/00	0.0000	0.0167	0.0000	0.0167	0.0333	0.0000	0.0000
	5/15/01	0.0000	0.0000	0.0000	0.0083	0.0083	0.0000	0.0000
	5/31/01	0.0241	0.0000	0.0000	0.0333	0.0574	0.0000	0.0000
	6/11/01	0.2287	0.0083	0.0000	0.0095	0.2466	0.0000	0.0000
	6/25/01	0.0222	0.0000	0.0000	0.0274	0.0496	0.0000	0.0000
	7/10/01	0.0000	0.0482	0.0240	0.0000	0.0722	0.0000	0.0000
	7/23/01	0.0000	0.0639	0.0307	0.0000	0.0946	0.0000	0.0000
	8/8/01	0.0250	0.1480	0.0194	0.0083	0.2008	0.0000	0.0000
	8/24/01	0.0148	0.0917	0.0083	0.0000	0.1148	0.0000	0.0000
	9/13/01	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	6/5/02	0.1790	0.0000	0.0000	0.0079	0.1870	0.0102	0.0000
	6/18/02	0.2113	0.1247	0.0000	0.0000	0.3360	0.0000	0.0000
	7/2/02	0.0676	0.0475	0.0079	0.0119	0.1349	0.0000	0.0000
	7/19/02	0.0111	0.0000	0.0083	0.0194	0.0389	0.0000	0.0000
	8/1/02	0.0167	0.0400	0.0000	0.0328	0.0894	0.0000	0.0000
	8/12/02	0.0000	0.0398	0.0000	0.0083	0.0481	0.0000	0.0000
	8/28/02	0.0083	0.0824	0.0000	0.0324	0.1231	0.0000	0.0000
	9/10/02	0.0000	0.0000	0.0000	0.0102	0.0102	0.0000	0.0000

Weevil Introduction/Manipulation:

To determine if open lake weevil augmentation might be successful we stocked weevils into two city lakes: Hiawatha (low sunfish density) and Harriet (high sunfish density). In each lake a stocked area and an adjacent control area were sampled for plant biomass (12 samples per treatment) and the stocked area was stocked with weevils (adults, associated meristems and any attached eggs and larvae, which were tied to individual plants). Biweekly weevil surveys were conducted (12 sample stations per treatment) and at the end of the summer, biomass was again determined. Harriet and Hiawatha each were stocked with 2000 adult weevils in mid-July. Biomass samples have been processed for wet and dry mass but dry mass and herbivore densities have not yet been determined.

Weevils were found at both lakes after stocking (pre-stocking weevil densities from biomass samples have not yet been determined). *Acentria* and *Parapoynx* were not present. Surprisingly, as many or more weevils were found in unstocked versus stocked areas (Table 6) and weevil densities were higher in Harriet (supposedly higher sunfish) than in Hiawatha. Milfoil and total plant biomass was lower in Hiawatha than Harriet (perhaps due to clarity) and milfoil was more dominant in Harriet (Table 7). Significant declines of milfoil were not noted in either lake, but milfoil increased more in the not-stocked plots compared to stocked plots. A complete statistical analysis has yet to be conducted so no conclusions regarding the effects of stocking can be made. This further analysis will be reported in our May 2003 report.

Table 6. Results of weevil surveys in stocked lakes Hiawatha and Harriet. Numbers are densities of weevil life stages (per stem), total weevils per stem and density (per stem) of the caterpillars *Acentria* (Acent) and *Parapoynx* (Parap).

Date	Treatment	Eggs	Larvae	Pupae	Adults	Total	*Acent*	*Parap*
Hiawatha								
7/30/02	stocked	0.000	0.000	0.000	0.013	0.013	0.009	0.000
7/30/02	notstocked	0.013	0.000	0.000	0.000	0.013	0.000	0.000
8/12/02	stocked	0.000	0.000	0.000	0.000	0.000	0.008	0.000
8/12/02	notstocked	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8/26/02	stocked	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8/26/02	notstocked	0.023	0.034	0.000	0.000	0.057	0.000	0.000
9/12/02	stocked	0.000	0.000	0.000	0.073	0.073	0.000	0.000
9/12/02	notstocked	0.000	0.000	0.000	0.072	0.072	0.000	0.000
Harriet								
7/24/02	stocked	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7/24/02	unstocked	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8/6/02	stocked	0.000	0.000	0.000	0.010	0.010	0.000	0.000
8/6/02	unstocked	0.104	0.000	0.000	0.000	0.104	0.000	0.000
8/19/02	stocked	0.031	0.000	0.021	0.014	0.066	0.000	0.000
8/19/02	unstocked	0.010	0.104	0.021	0.010	0.146	0.000	0.000
9/6/02	stocked	0.000	0.021	0.010	0.052	0.083	0.000	0.000
9/6/02	unstocked	0.063	0.000	0.000	0.045	0.107	0.000	0.000
9/17/02	stocked	0.000	0.021	0.000	0.021	0.042	0.000	0.000
9/17/02	unstocked	0.000	0.031	0.031	0.031	0.094	0.000	0.000

Table 7. Total plant biomass (g wet/m^2), milfoil biomass (MSP), non-milfoil biomass and percent milfoil before (July) and 7 weeks after stocking weevils in stocked and non-stocked plots at Hiawatha and Harriet.

Session	Date	Trt	Total Biomass	MSP	NonMSP	%MSP
Hiawatha	7/18/02	Stocked	104.3	49.8	54.5	41.1%
	7/18/02	Not Stocked	132.9	21.5	111.4	18.5%
	9/12/02	Stocked	52.5	44.9	7.6	58.0%
	9/12/02	Not Stocked	61.2	40.3	21.0	58.5%
Harriet	7/11/02	Stocked	246.3	235.9	9.4	90.4%
	7/11/02	Not Stocked	176.7	151.9	24.8	84.3%
	9/14/02	Stocked	321.1	288.7	30.4	91.8%
	9/14/02	Not Stocked	348.8	345.7	2.7	99.1%

Surveys of weevils and milfoil

Survey Sites:

We repeated broader scale (whole lake or bay) surveys in August at Lake Calhoun, Cedar Lake, Lake Harriet and Lake of the Isles. At each lake, plant community structure was determined with plant hook surveys along 12-15 transects, water quality was recorded and a set of biomass samples collected. Water quality and sediment cores were also collected. These samples have been processed but not yet entered or analyzed.

To attempt to detect additional declines and to determine if agent and perhaps milfoil

density may be related to fish density we also conducted weevil surveys on 6 new lakes and Cedar Lake in August. These lakes had DNR fish surveys conducted in 2001 or 2002 (results not yet available). A range of weevil densities was found; generally lakes with high fish densities had low weevil densities and lakes with high weevil densities had low sunfish densities (Table 8). We also conducted plant hook macrophyte surveys on these lakes but these data have not been entered or analyzed.

Table. 8. Results of mid-summer weevil surveys at lakes with a range of fish densities. Qualitative fish densities are indicated; quantitative results will be determined from yet to be published DNR fisheries surveys.

Lake	Fish Density	Eggs	Larvae	Pupae	Adults	Total
Bald Eagle	High	0	0	0	0.008	0.008
Cedar	High	0	0.005	0	0	0.005
Schultz	Mod-High	0	0	0	0.013	0.013
Independence	Mod	0	0	0	0.014	0.014
Centerville	Low	0.218	0.066	0.019	0.042	0.346
Peltier	Low	0.042	0	0	0	0.042
Vadnais	Low	0.169	0.013	0.025	0.113	0.319

Effects of plant community:

The plant manipulation plots established in Otter Lake and Lake Auburn in 2001 were resampled in 2002 and a new set of plots was established in Cedar Lake. Each manipulation consists of twenty plots; five replicates each of 4 treatments (remove all plants, remove no plants, remove milfoil, or remove native plants). Samples have been processed but data have not been entered into the computer or analyzed.

To assess effects of water clarity and alum treatments, we sampled Cedar and Harriet twice (July and August) and Isles and Calhoun once (July) for biomass, sediments and water quality; all four lakes were also surveyed with plant hook sampling for whole lake estimates in August. Cedar and Isles were treated with alum in 1997 and Calhoun was treated in 2000. We have not yet completed analysis of these samples.

In addition to the plant manipulations, we continued measuring exchangable nitrogen (KCl extraction) from all sediment cores in addition to pore water ammonium. These results should allow us to evaluate McComas's (1999) hypothesis that nuisance levels of milfoil should only appear in sediments with high total nitrogen (e.g., > 3 mgN/L) whereas native plants should dominate in lower nitrogen sediments. Most of these analyses have been completed, however, the data have not been entered or analyzed.

Summary:

The results presented above are very preliminary and major conclusions cannot yet be made. Summer 2002 presented good growing conditions for milfoil and milfoil biomass remained high at Cedar Lake where weevil density is very low. Milfoil also increased at Lake Auburn which had low summer densities of weevils; weevil densities increased in the fall but it is unclear if a higher density of weevils will develop in 2003. Milfoil remained controlled at the shallowest sites in Smith's Bay with moderate weevil densities but increased at deeper sites where weevil density is low or zero. Milfoil remained suppressed at Otter Lake although a late summer decrease in weevil density may be cause for concern. Finally, herbivore density was low at Cenaiko Lake and milfoil biomass increased. Results of fish surveys at Otter and Cenaiko should help indicate if fish may be limiting herbivore populations. A survey of 6 new lakes showed a range of weevil densities that appear related to sunfish density. Results of

weevil stocking or augmentation are unclear. There appeared to be movement of weevils between stocked and unstocked areas and factors other than fish predation might be important in these two lakes.

Additional conclusions and suggestions will be made in our May 2003 report when we have processed and analyzed all the data collected in 2002 and previous years.

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