Factors Influencing the Control of Eurasian Watermilfoil With Native Or Naturalized Insects

Fourth Status Report for 1999-2001

BY

Raymond M. Newman[1], David W. Ragsdale[2] & David D. Biesboer[3]
[1]Department of Fisheries & Wildlife
[2]Department of Entomology and
[3]Department of Plant Biology
University of Minnesota
St. Paul, MN 55108

TO

Chip Welling
Eurasian Watermilfoil Program
Ecological Services Section, Box 25
Minnesota Department of Natural Resources
500 Lafayette Rd.
St. Paul, MN 55155-4025

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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 occurred in over 120 Minnesota waterbodies by fall 2000 (Exotic Species Program 2001).

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 1993, 1995, Sheldon and Creed 1995, Newman et al. 1996, Sheldon 1997, Creed 1998). 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 1996, 2001). Sheldon and O’Bryan (1996), Newman et al. (1996, 1997a) and Mazzei et al. (1999) describe the life history and development times of the weevil. More recent information on the biology, distribution and control potential of the weevil is presented in the July 2000 issue of the Journal of Aquatic Plant Management (Madsen 2000).

Although declines of milfoil in several lakes have been related to the occurrence of *E. lecontei* (Sheldon and Creed 1995, Lillie 1996, 2000, 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 et al. 1999, 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 monitor a set of milfoil populations for potential declines, determine factors that may be limiting control agent densities and their effectiveness in the field, determine the effects of fish on weevil augmentations and determine if chronic effects such as sediment quality or competition with native plants is responsible for declines of milfoil associated with herbivores. This report summarizes our methods and collection efforts in 2000 and presents preliminary results of our research through 2000.

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Methods

Semi-permanent Transect Sites:

During the summers of 1993 and 1994, we initiated selection of semi-permanent sampling sites, which can be repeatedly sampled at fixed locations (Newman and Ragsdale 1995). The sites were Lake Auburn (Carver Co.; T116N; R24W; S10), Otter Lake (Anoka and Ramsey Co.; T30-31N; R22W; S3-4, S35-36), Cedar Lake (Hennepin Co.; T29N; R24W; S29) and Smith’s Bay of Lake Minnetonka (Hennepin Co.; T117N; R23W; S10,11). At each site, 5 transects, 30 m apart, were run from near shore (0.5 m depth) toward the plant limit. At Lake Auburn and Cedar Lake, the transects were extended to 50 m from the shoreward starting point, in approximately 2.5 m depth at Auburn and 5 m depth in Cedar. Semipermanent stations were marked along the transect at 10 m intervals with fluorescent floats that were attached to bricks and suspended 0.5-1m beneath the surface. At Otter Lake, the transects were extended 100 m from shore, in approximately 2 m depth. At Smith's Bay, transects were started 100 m from shore and run to 4.5 m depth, approximately 0.8 km from shore, with 5 sampling stations along each transect approximately geometrically spaced. Distances from shore determined from GPS data were: 100m, 200m, 370m, 585m and 805m. These stations were marked with floating milfoil buoys.

In summer 1996, we noticed a dense population of weevils at Cenaiko Lake (Anoka Co.; T31N; R24W; S26). We therefore sampled this lake in July and September as a new site to be regularly sampled. We ran 3 or 4 transects, west to east across the north end of the lake, with sampling stations every 30 m. This resulted in 25-32 samples on each date (21-30 with plants; deep stations were deleted from the analysis). At Lake Auburn transects were sampled at 10 m intervals (stations) , resulting in 6 samples per transect, or 30 samples. At Otter Lake samples were taken at each 20m sampling station, resulting in 5-6 samples per transect or 27 samples. At Cedar (30) and Smiths Bay (25), all stations were sampled, however, several stations in Cedar Lake were deeper than the plant limit (>7m) and these are excluded if no plants occurred there during the season. In 1997 sampling occurred twice: in late June to early July and in mid-September. In 1998, three lakes (Auburn, Cenaiko and Smith's Bay) were sampled thrice, in June, late-July or early August and in September. Otter and Cedar were sampled in June and September. Samples were alternately taken 2m from each side of each station on successive sampling dates to minimize sampling disturbance. In 1999, two lakes (Cenaiko, and Smith's Bay) were sampled thrice, in June, late-July or early August and in late August. Auburn and Cedar were sampled in June and late August and Otter was sampled in June and early August. In 2000, four lakes were sampled three times (Auburn, Cenaiko, Otter and Smith's Bay), in June, July and August and Cedar Lake was sampled twice, in June and August. Twenty-four to thirty samples were collected at each lake on each date.

At each sampling station, plant biomass and invertebrate samples were taken from 0.1 m^2 quadrats (all plant material was clipped at sediment interface and immediately placed in a sealable bag underwater). Sediment cores were also collected at shallow, medium and deep stations along 3 transects (transects 1, 3 and 5 at all but Cenaiko, where 1-3 were sampled) at each site.

A set of water column parameters were measured in the open water (>5.5m depth and >100 m from the bed) at each site on each sampling date. Secchi depth and surface conductivity were measured and a water sample (combined surface and Secchi depth sample) was collected for pH, alkalinity and chlorophyll a determination. A light (Photosynthetically active radiation = PAR, Li-Cor LI-189 with LI-192SA quantum sensor), temperature and oxygen (YSI 50B) profile was taken at 0.5 m depth increments from surface to bottom.

Alkalinity was determined by titration in the field. For chlorophyll, 500 ml of water were filtered through a 1.2 mm glass fiber filter, the filter was placed on dry ice and returned to the laboratory and frozen until analysis. Chlorophyll was extracted and measured spectrophotometrically (APHA 1989). Sediment cores were stored on ice and returned to the laboratory. Within 48 hr the top 15 cm of sediment was homogenized. A 5 ml sediment subsample was dried at 105 ˚C for 24-48 hrs and then weighed to obtain bulk density (g dry mass ml^{-1}). The dried sediment was then ashed at 550 ˚C for 4 hrs to obtain percent organic matter ([AFDM dry $mass^{-1}$] X 100). Pore water was extracted from the remaining sediment by centrifugation, acidified to < pH 2 and stored in the refrigerator. Within seven days, the NH_4 concentration was determined by selective electrode (APHA, 1989).

Biomass samples were rinsed of invertebrates and invertebrates were picked (endophytic and external on milfoil and from the wash water) from all samples; weevils and Lepidoptera were enumerated. Milfoil stems were counted and the average maximum stem length determined. Plants were separated, identified to species, spun for 15 sec in a salad spinner and wet mass was recorded. These samples were dried (105 ˚C for 48h) and weighed or frozen for later dry mass determination.

We sampled our regular transect sites in 5 lakes during 2000. In 2000, four lakes (Auburn, Cenaiko, Otter and Smith's Bay) were sampled three times, in June, mid-July and late August. Cedar was sampled in June and early August. We decided that the extra sampling intensity was required to track changes in milfoil and control agent densities over the summer. Twenty-four to thirty samples were collected at each lake on each date.

Because the relatively infrequent sampling of these sites (2 or 3 times per summer) does not provide very good resolution of weevil population dynamics, we initiated a biweekly weevil survey in Lake Auburn 1998 and in 1999 added Cenaiko and Smiths Bay to our weevil surveys. In 2000 we added Otter to our survey sites and we are now doing bi-weekly surveys at Auburn, Cenaiko, Otter and Smith's 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). At sites with lower densities of weevils we have been collecting 7 or 8 stems to increase our power to detect weevils. Weevils were removed from the samples, which were scanned at 8X magnification, and enumerated by life stage. Results were expressed as numbers per basal stem.

Weevils collected from the surveys in 1999 were examined for pathogens (Oien and Ragsdale 1993). Samples were put in PBS with azide and squashed. A 10 microliter sample of each squashed tissue was then placed on a slide with a coverslip and examined under a compound microscope in phase contrast. Infection was defined as protozoan, microsoridia, or saprophytic fungi present in individuals of each stage. Those results are presented in Newman et al. (*in review*), which was appended to our December 2000 report.

Survey Sites:

We conducted broader scale (whole lake or bay) surveys in August at 5 sites: Lake Calhoun Hennepin Co.; T28-29N; R24W; S4,5,32,33), Lake Harriet (Hennepin Co.; T28N; R24W; S8,9,16,17), Lake of the Isles (Hennepin Co.; T29N; R24W; S32,33) and Shady Island (Hennepin Co.; T117N; R23W; S26) and Grays Bay (Hennepin Co.; T117N; R22W; S8) in Lake Minnetonka. 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 was collected.

Localized sites in each of these lakes were sampled quantitatively for milfoil, invertebrates and site characteristics. At two of these sites (Gray's Bay and Shady Island), 3 transects were run perpendicular to shore and 3 stations, based on depth (e.g., 2, 3 and 4 m), were sampled along each transect in August. At Calhoun, Lake of the Isles and Harriet, 5 transects with 5 stations on each transect were sampled in June and August. At each station $0.1m^2$ quadrat samples were taken for plants and invertebrates. Sediment cores were sampled at the intermediate depth station along each transect. Open-water water quality samples were taken and processed in the same manner as the permanent transect sites. Samples were processed as above for plant mass by species, weevil abundance, and sediment characteristics. Weevil densities have not yet been enumerated for all of these samples.

At these waterbodies, we also conducted whole lake or bay surveys. The extent of surfaced (matted) or visible milfoil was mapped by navigating along the edge of the matted milfoil (contiguous milfoil that reaches the surface and blocks ability to see beneath the surface) around the lake or bay while continuously recording our position with a GPS unit (Trimble Pathfinder Basic Plus). If very little milfoil was matted, this was noted and the extent of visible (seen beneath the surface) milfoil was mapped. At most lakes we mapped visible milfoil because surface matting was not extensive around the entire lake. The extent of matted or visible milfoil coverage (and thus area of nuisance level) was determined by subtracting the area encompassed by the differentially corrected GPS coordinates (calculated by Pfinder program) from the lake and littoral (DNR 15 ft contour) surface areas. These results have not yet been mapped.

To quantitatively determine the extent of milfoil coverage, a set of 10-15 transects, perpendicular to shore, was located around the lake or bay in a stratified random manner (i.e., 1 transect located within each 1/10 of the lake shoreline circumference). Along each transect, observations were made from shore (0.5 m depth) to the plant limit at 5 to 6 stations, at 7.5, 15, 30, 60, or 90m intervals to the depth of the plant limit. At steeper transects the shorter intervals were used, at long and gently sloping transects, the longer intervals were used. Transects were laid with a measuring rope and marked with jugs attached to bricks; the shoreward and offshore positions were recorded with a GPS unit. At each observation point, visible milfoil (% coverage) and other plant occurrence was recorded, plant height determined and plant disk (depth at which a Secchi disk disappears; Crowell et al. 1994) was measured within a 1m^2 area around the marker jug. Depth was recorded by dropping a plant hook vertically; plant species found on the plant hook or the jug rope and brick were also recorded and milfoil was examined for weevils and given a weevil damage rating (0-5). These data provide an estimate of milfoil and other plant coverage and frequency of occurrence around the lake as well as a relative estimate of weevil damage or occurrence.

Semi-quantitative estimates of plant density and weevil abundance were determined along a stratified subset of 5 of the transects with modification of a grapple hook method of Jessen and Lound (1962; see Newman et al. 1994 for discussion of this approach). At each sampling point 3 or 4 grapple throws were collected and rated for plant occurrence (Jessen and Lound 1962); these data provide species occurrence and relative density estimates for each species. The milfoil collected on each throw was scanned for the presence of weevils and visually assigned a damage rating (0-5). Thus for these 5 transects, we have both visual estimates of plant occurrence and density as well as the semiquantitative plant hook estimates.

Weevil Introduction/Manipulation:

Our aim was to determine the effects of artificial introduction of weevils, *Euhrychiopsis lecontei*, on the density and condition of Eurasian watermilfoil and other macrophytes during a single growing season by introductions of weevils at replicated sites in fish exclosures and open areas. This should allow us to determine if fish predation may be limiting the success of prior introductions to open areas (see Newman et al. 1997b). To exclude fish, 3m X 3m cages were constructed with PVC pipe and fitted with 1/2" bar nylon mesh netting. The netting was attached to 1m high cross supports and was connected to cylinder floats that allowed the netting to extend to the surface from 1m to 2.25m maximum depth; the tops and bottoms of the cages were open. Ten cages were fitted with mesh on all four sides (complete enclosures) and 10 cages were fitted with two mesh panels that each covered 1.5 sides (i.e., a total of 3m or 1/4 of the cage was open); the open cages served as controls by permitting fish entry.

In July 1999 20 sites were located in milfoil beds in the NE bay of Cedar Lake in water ≤ 2.2m deep and marked with floats. The cages were placed over each float such that the float was in the center of each cage; the frames dropped straight to the bottom and the cylinder floats keep the mesh taut to the surface). Cage bottoms were pushed into the sediment and weighted with bricks. Two plant biomass samples (0.1m^2 quadrat samples) were collected from each cage prior to stocking. Cages were then fished to remove fish trapped within the cages. Cages (open or closed) and treatment (stocked or not stocked with weevils) were assigned to the sites in a stratified random block design. One hundred and fifty adult weevils (adults and the apical tips they were collected from, which contained some larvae and eggs), collected from Cenaiko Lake, were stocked into each cage designated to receive weevils (5 closed and 5 open cages). Care was taken to ensure that adults moved onto the live milfoil and the meristems were attached to milfoil plants to ensure that associated larvae and eggs also had access to the live plants. In August, the cages were resampled for biomass and weevils. In 1999 the cages were sampled for plants and weevils (2 samples per cage) in June and were stocked with 150 weevils in July; biomass was sampled again in late August. The samples within each cage (for pre and post stocking samples) were averaged and statistical analyses were performed treating each cage as a true replicate. The experiment was repeated in summer 2000. More effort was placed at removing fish and the weevils were collected from Smith's Bay of Lake Minnetonka.

At approximately biweekly intervals, cages were examined and counts of visible weevils (eggs, larvae, pupae and adults) were made by examining 100 to 150 stems during a 15 min period. Larval occurrence was estimated based on recent stem damage. Any fish observed in the closed cages were enumerated and angling and minnow traps were used to remove these fish. We were more successful at removing fish from cages in 2000 than in 1999 and this may have influenced the results. These experiments are being repeated again in 2001 and this year year stocking took place in early June before milfoil was near the surface. We expect more clear results in 2001 but have been hampered by high water levels.

Influence of milfoil genotype and rearing sediment on weevil performance:

Because previous work indicated that weevils perform better on different milfoil species (Newman et al. 1997a), other studies have shown that plant genotype and nutritional status can affect biocontrol agent performance (Newman et al. 1998), and because we have seen substantial variation in weevil densities amongst lakes, we conducted an experiment to determine the effects of milfoil genotype (lake source) and milfoil rearing sediment on weevil performance. This experiment, which was a modification of the one conducted in 1998 by Ramona Johnson (see Newman et al. 1999), was conducted by Joanna Watson. The results of this experiment were presented in our June 2000 report and are not repeated here.

Weevil development with temperature and initial modelling:

Previous research determined the number of degree days required for milfoil weevil development (Mazzei et al. 1999). Temperature monitoring in several lakes has since been used to assess potential for weevil population development and for additional modelling.

Degree days above 10 ˚C (DD) were determined for two lakes (Auburn and Smith's Bay) that were monitored with temperature data loggers (Optic StowAway, Onset Computer, Pocasset, MA) from April or May through October 1996, 1998, 1999 and 2000. Temperatures were recorded every 0.5 hr at 0.75m depth and the surface. These results were used to estimate number of generations and potential population growth at the field sites. Data logger failure and loss resulted in no data prior to June (Auburn) or July (Smith's Bay) in 1997 and no surface temperature at Auburn in 1999.

A stage structured model of weevil development with temperature was developed by grad student Darren Ward. The model is a stage structured model with plausible values for egg-adult survival (Newman et al., 1997; Mazzei et al., 1999), development time (Mazzei et al., 1999), and daily fecundity (Sheldon and O'Bryan 1996). Adult life span and the length of the pre-reproductive adult stage were estimated by finding the strongest correlations with observed relative population stage structure in field populations; it was set at values that correlated fairly well with field observations (from weevil surveys) for relative stage composition in Smith's Bay in 1999. The parameter estimates that provided the strongest correlations were: an average adult life expectancy of 125 DD, length of the pre-reproductive adult stage of 50 DD, and 0.9 female eggs/female/25 DD. At typical summer temperatures there are about 15 DD per day. An experiment was conducted in summer 2000 to determine the length of time required after eclosion and emergence from the milfoil stem for female weevils to begin laying eggs.

Results and Discussion

Semi-permanent transect sites:

Milfoil biomass in Cedar Lake remained high during 2000, similar to 1997-1999 (Table 1). Milfoil biomass at Lake Auburn increased from the lowest densities we have seen there (1999; Fig. 1) to around 1000 g wet/m^2 during 2000. Nevertheless, milfoil remained suppressed well below densities found from 1994-1997.

Milfoil in Smith's Bay was at the lowest densities found in many years during June and July (500 g/m^2 wet in July) but increased to a more moderate density of 1474 g wet/m^2 in August, similar to previous years (Fig. 1). The higher milfoil density was mainly due to a high densities at the deepest three stations (>1400 g wet/m^2); density at the two shallowest stations remained low even in August (6 and 450 g wet/m^2 at the shallowest and next station respectively). Milfoil increased sharply in June 2000 at Otter Lake to over 2650 g wet/m^2 (330 g dry/m^2). A combination of high weevil densities and possible herbicide treatment resulted in a significant decline in July (to 600 g wet/m^2) with a partial rebound in August (1100 g wet/m^2). The milfoil density was the highest seen since the catastrophic decline in 1996, but the mid-summer suppression of milfoil along with a summer-long increase in native plants (Table 2) and presence of weevils at the highest density we have seen in Otter offers some hope that the very high densities of 1994 and 1995 will not return. Changes in milfoil biomass at our sites (Fig. 1) are not due to regional changes; there was little concordance among the sites.

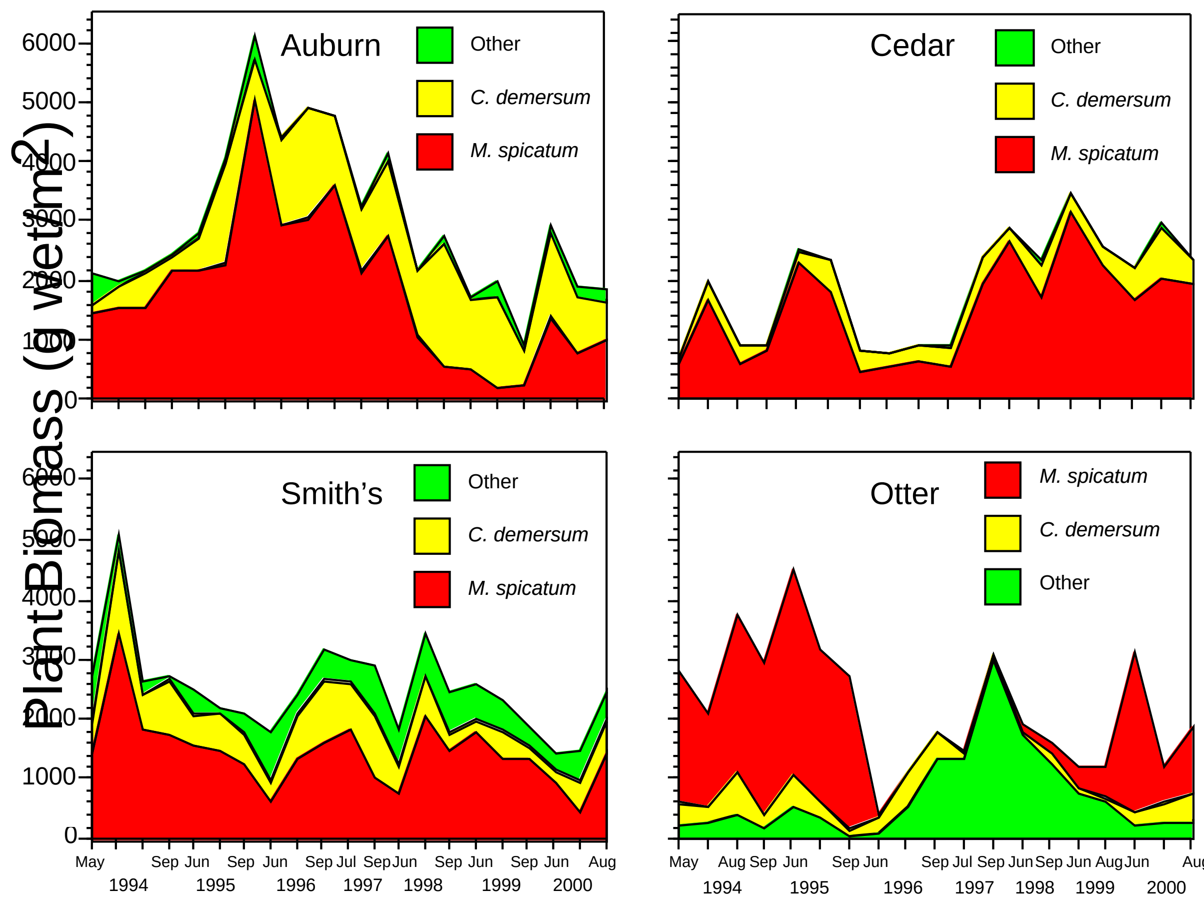


Fig. 1. Total plant biomass (Eurasian watermilfoil, coontail and other non-milfoil biomass; g wet/m^2) at the four permanent transect sites from May 1994 - August 2000.

The contribution of the non-milfoil plant community remained moderate at all sites except Cedar Lake (Table 2); Eurasian watermilfoil contributed ≤ 55% of the biomass at Auburn and ≤50% at Smith's Bay (Table 3). Although Eurasian watermilfoil rebounded at Otter Lake, to over 80% of biomass in June, it was subsequently suppressed and contributed 53 and 63% of biomass in July and August. Eurasian watermilfoil biomass remained high at Cedar Lake and contributed > 75% of the plant biomass there. Non-milfoil plant biomass declined over the summer at Lake Auburn (from 1600 to 850 g wet/m^2) and Cedar Lake (from 900 to 350 g wet/m^2) but increased at both Otter and Smith's Bay (Table 2). Dry biomass for all species is summarized in Appendix III.

Table 1. Biomass ± 1SE (g wet/m^2) of Eurasian watermilfoil at the four sampling sites in 1994-2000. n = number of samples. Dry biomass (g/m^2 ± 1SE) is presented for 1995-2000.

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

Table 2. Mean number of species per sample (Spp/S) ± 1SE and non-milfoil biomass (B; g wet /m^2) at the 4 sampling sites in 1994-2000. 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

Table 3. Percentages of total plant wet biomass that was Eurasian watermilfoil (±1SE) and 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

It should be noted that at the shallowest station at Smith's Bay, northern watermilfoil dominated Eurasian watermilfoil in June and July and Eurasian watermilfoil never exceeded 70 g wet/m^2 or 9% of plant mass at this station. The total number of species increased at Auburn from 1999 and remained relatively high at Otter and Smith's Bay (9-15 species), but remained low at Cedar (3-5 species) (Table 3). Similar trends were seen for numbers of species per sample with four or more per sample at Otter and Smith's Bay but only 1.6 per sample at Cedar Lake (Table 2).

Sediment bulk density and organic content at each of the lakes were similar to previous years (Table 4). Sediment pore water ammonium was lower at most lakes in 2000 compared to 1998-1999, and although it increased through the summer it did not reach the high values of 1998-1999. Water clarity and light penetration increased at Lake Auburn relative to 1998-1999. Water clarity during 2000 in Otter and Smith's Bay was similar to 1998-1999, while clarity in Cedar Lake remained at values more typical of the mid-1990's (1.6-3.0m) compared to the high clarity seen in 1998.

Table 4. Sediment characteristics (bulk density, percent organic matter, sediment pore water ammonium and water column characteristics in 1995-2000 at the four permanent transect sites. Sediment samples were collected from shallow, moderate and deep stations along transects 1, 3 and 5 (n=9). Secchi depth (SD), chlorophyll a (Chl-a; pooled surface and SD sample) and light and temperature profiles were taken in deep water > 100 m from the plant bed. Temperature is at 1m depth and 10% PAR depth is the depth at which light intensity was 10% of surface light (presented as the range which encompassed the 10% value). *Water quality data for Cedar in late July 1998 was collected for the weevil introductions and sediment was not analyzed.

Lake/Date	Bulk Dens. (g dm/ml)	NH_4 (mg/L)	% Organic	Chl-a (mg/m^3)	SD (m)	Temp (˚C 1m)	10% PAR Depth (m)	Plant Limit (m)
Auburn								
6/15/95	0.60	3.96	11.34	9.5	2.3	20.7	2.5-3.0	3.0
2se	0.15	0.91	3.73					
8/1/95	0.49	4.00	10.69	13.9	1.4	26.0	1.5-2.0	3.0
2se	0.18	1.24	4.39					
9/26/95	0.45	4.40	12.67	8.0	2.0	14.8	2.5	3.0
2se	0.13	1.96	4.05					
6/13/96	0.41	3.08	16.0	2.9	4.2	25.1	3	3.0
2se	0.11	1.66	8.6					
7/31/96	0.42	5.81	13.6	12.8	2.4	23.3	1-1.5	3.0
2se	0.17	1.52	4.7					
9/12/96	0.38	2.68	13.7	8.8	2.4	21.2	2.5-3.0	3.0
2se	0.14	0.95	4.3					
6/23/97	0.59	1.93	25.64	11.2	1.2	24.5	2.0	3.4
2se	0.22	0.56	16.79					
9/8/97	0.48	4.42	12.30	16.6	1.4	22.4	1.5-2.0	3.4
2se	0.14	1.46	3.27					
6/8/98	0.23	11.82	11.91	14.4	1.9	18.8	1.5-2.0	
2se	0.08	4.07	4.43					
7/28/98	0.45	20.09	9.52	41.2	0.7	25.7	0.5-1.0	
2se	0.27	3.68	4.25					
9/9/98	0.44	37.72	11.86	36.4	1.1	21.9	1.0-1.5	
2se	0.15	12.57	4.59					
6/22/99	0.50	2.79	13.62	9.4	1.8	22.4	2.0	
2SE	0.16	1.06	3.80					
8/23/99	0.44	10.98	11.64	11.0	1.5	23.1	1.0-1.5	
2SE	0.12	1.81	4.23					
6/19/00	0.51	2.36	11.14	5.9	2.1	20.4	2.5-3.0	
2se	0.14	0.51	4.00					
7/17/00	0.57	4.61	10.15	5.3	2.5	25.3	2.5-3.0	
2se	0.22	1.54	3.63					
8/28/00	0.53	7.75	11.78	5.3	2.3	24.3	3.0	
2se	0.14	1.58	3.93					

Table 4 Continued

Cedar								
6/28/95	0.62	3.90	13.73	10.2	4.5	24.0	4.5	4.0
2se	0.36	1.63	6.00					
8/3/95	0.45	7.27	16.41	16.3	1.2	26.7	1.0-1.5	3.1
2se	0.33	1.39	7.40					
9/28/95	0.43	6.06	21.56	27.5	0.8	14.8	1.0-1.5	3.1
2se	0.36	1.98	7.38					
6/18/96	0.57	3.78	13.3	1.1	5.5	24.6	3.5-4.0	6.5
2se	0.38	1.34	6.3					
8/1/96	0.42	3.86	19.0	4.5	1.9	23.8	2.5-3.0	3.1
2se	0.38	1.59	7.5					
9/16/96	0.41	5.12	18.5	5.3	2.8	20.1	2-2.5	3.1
2se	0.37	1.63	6.9					
7/8/97	0.54	3.97	12.89	9.6	2.5	21.0	3.0-4.0	6.0
2se	0.40	2.87	5.97					
9/11/97	0.42	5.69	15.76	0.8	3.7	22.0	3.0-3.5	6.4
2se	0.33	2.26	6.31					
6/18/98	0.31	4.01	18.35	2.1	4.7	22.6	4.5-5.0	
2se	0.30	1.99	5.27					
7/24/98*	N.A.	N.A.	N.A.	1.3	4.7	26.0	4.5-5.0	
9/16/98	0.29	34.77	18.68	6.9	2.6	23.4	2.5-3.0	
2se	0.30	18.72	4.78					
6/23/99	0.51	4.68	16.15	5.3	2.6	25.6	3.5	
2SE	0.36	1.68	8.79					
8/24/99	0.36	12.35	12.14	17.6	1.6	22.9	2.0-2.5	
2SE	0.34	3.87	3.37					
6/23/00	0.32	2.29	18.28	5.1	3.3	23.1	3.0-3.5	
2se	0.25	1.42	4.77					
8/8/00	0.52	4.15	16.89	4.3	1.6	25.9	3.5-4.0	
2se	0.40	3.91	8.43					
Otter								
6/26/95	0.42	3.27	20.26	5.6	3.0	30.0	3.5-4.0	4.0
2se	0.18	1.43	7.23					
8/10/95	0.39	4.66	24.44	12.5	2.5	24.7	1.5-2.0	4.0
2se	0.26	1.77	9.49					
9/30/95	0.38	2.76	25.07	3.7	1.1	14.5	1.0-1.5	4.0
2se	0.26	1.34	11.34					
6/20/96	0.47	4.86	23.5	8.5	1.9	21.1	1.5-2.0	3.5
2se	0.34	1.67	10.2					
8/6/96	0.27	3.54	27.5	4.8	2	26	2-2.5	4.0
2se	0.16	0.88	8.6					
9/17/96	0.33	3.77	24.9	8.0	1.5	17.9	1.5-2.0	4.0
2se	0.24	1.76	9.5					
7/2/97	0.33	1.89	26.42	9.9	1.3	21.1	2.0-2.5	3.5
2se	0.21	1.09	8.17					
9/15/97	0.29	5.88	27.47	4.8	2.1	21.0	2.0-2.5	3.5
2se	0.16	2.61	9.52					
6/10/98	0.18	10.51	24.24	2.9	2.6	17.8	4.5-5.0	
2se	0.11	3.55	8.54					
9/10/98	0.24	27.47	24.36	1.6	4.0	21.1	3.5-4.0	
2se	0.11	9.40	7.55					
6/21/99	0.24	3.37	27.31	15.5	2.7	24.5	2.5	
2SE	0.07	0.83	8.34					
7/29/99	0.22	9.58	25.37	13.4	2.1	26.4	2.0	
2SE	0.12	3.02	8.61					
7/11/00	0.47	2.69	21.36	6.9	2.5	26.7	1.5-2.0	
2se	0.32	1.63	9.13					
8/29/00	0.25	3.16	29.84	4.5	2.9	23.7	2.0-2.5	
2se	0.13	1.69	9.13					

Table 4 Continued

Smith’s								
6/29/95	0.59	5.18	11.81	4.0	3.9	23.7	5.0	5.0
2se	0.25	3.40	4.62					
8/16/95	0.28	4.06	12.86	7.5	2.1	24.9	3.5-4.0	5.0
2se	0.14	0.97	3.71					
9/18/95	0.31	4.25	12.50	10.7	2.1	14.7	2.5	5.0
2se	0.15	0.77	3.98					
6/24/96	0.36	1.13	13.9	3.7	3.7	20.6	3.5-4.0	5.0
2se	0.22	0.32	4.7					
8/8/96	0.37	2.61	17.6	1.3	3.4	24.4	4.5-5.0	5.0
2se	0.21	1.01	5.3					
9/19/96	0.32	2.43	19.1	3.2	3.5	20.1	3.0-3.5	5.0
2se	0.18	0.90	14.3					
7/15/97	0.34	2.44	9.29	1.6	3.5	22.2	4.5-5.0	5.0
2se	0.17	0.80	3.48					
9/18/97	0.31	2.94	14.10	5.3	2.4	20.9	2.5-3.0	5.0
2se	0.17	1.21	4.74					
6/15/98	0.35	3.35	11.50	1.6	3.6	21.0	4.0-4.5	
2se	0.19	1.98	4.22					
8/4/98	0.34	9.32	11.76	4.0	2.9	23.6	3.5-4.0	
2se	0.16	3.27	3.59					
9/15/98	0.30	26.00	13.55	4.3	2.7	22.5	3.0-3.5	
2se	0.14	5.87	3.40					
6/16/99	0.34	2.21	12.71	4.3	3.7	20.8	4.0	
2SE	0.18	0.40	4.08					
8/4/99	0.37	11.54	10.32	4.8	2.6	26.1	4.5-5	
2SE	0.22	8.83	3.84					
8/25/99	0.30	9.71	10.63	7.2	2.9	24.7	4.0	
2SE	0.16	3.24	3.52					
6/20/00	0.39	2.03	11.06	4.3	3.2	19.9	4.0-4.5	
2se	0.16	0.62	3.17					
7/18/00	0.38	4.00	9.91	4.5	1.9	24.3	4.5-5.0	
2se	0.20	1.13	4.71					
8/23/00	0.42	3.02	12.90	4.3	3.2	23.9	4.0	
2se	0.24	0.82	4.69					

Weevil densities from the plant biomass samples have now been computed for 1999 and 2000 (Table 5). Milfoil weevils disappeared from Lake Auburn in July 1998 and were not found during 1999 (see also bi-weekly weevil survey results). Milfoil weevils did reappear in 2000 at low but detectable levels throughout the summer (2 to 5/m^2), similar to 1995. *Acentria* and *Parapoynx* were found sporadically at low densities (Table 5). The milfoil weevil was also found in Cedar Lake at low densities, but these are the highest milfoil weevil densities seen at Cedar since 1994. Adult densities were very low (≤ 0.4/m^2). A few *Acentria* were also found and *Phytobius* was present on flowering milfoil in June of both years at low densities (1.8/m^2 in June 1999 and 0.1/m^2 in 2000), but not in September.

Milfoil weevil densities were low at Otter Lake in 1999, but increased in 2000 to the highest densities we have seen in this lake. Weevils were most abundant in June (24/m^2 or 0.15/stem) and persisted throughout the summer (6/m^2 or 0.08/stem in August). These densities were probably sufficient to suppress the milfoil in Otter Lake from the high density found in June (Table 1). *Acentria* and *Parapoynx* were found at low densities only in August 2000. Milfoil weevils were found at low densities in Smith’s Bay (0.8 to 6.4/m^2), however, most weevils are found at the first two sites < 300 from shore where densities are more than double the total for the entire bed. *Acentria* and *Parapoynx* were found sporadically at low densities (<2/m^2).

Table 5. Density (N/m^2 ± 2 SE and N per stem ± 2SE) of *Euhrychiopsis lecontei* larvae, pupae and adults, *Acentria ephemerella* and *Parapoynx* at the four permanent transect sites, 1994-2000. *Parapoynx* were not enumerated before 1996. A stem is a basal milfoil stem emerging from the sediment; estimates per stem do not include samples without milfoil and because caterpillars occurred often without milfoil, per stem estimates are not reported for them.

Lake Date	Weevil n	Larvae N/m^2	Pupae N/m^2	Adults N/m^2	Total *E.l.* N/m^2	*Acentria* N/m^2	*Parapoynx*
Auburn							
May-94	9	27.8 ±27.4	1.1± 2.2	6.7± 8.8	35.6± 36.5	1.1± 2.2	
per stem	9	0.134±0.103	0.002±0.004	0.018±0.020	0.154±0.106		
Jul-94	16	58.8± 21.1	12.5± 9.6	31.3± 14.0	102.5± 36.7	6.3± 7.7	
per stem	16	0.217±0.092	0.034±0.034	0.084±0.036	0.335±0.127		
Aug-94	15	8.7± 7.5	2.0± 2.9	3.3± 3.7	14.0± 9.5	0.7± 1.3	
	15	0.031±0.025	0.003±0.005	0.008±0.008	0.042±0.030		
Sep-94	18	1.7± 3.3	2.2± 2.6	7.8± 7.8	11.7± 11.8	3.9± 3.3	
	18	0.002±0.004	0.006±0.008	0.014±0.012	0.022±0.019		
Jun-95	30	6.0± 4.0	0.7± 0.9	1.0± 1.1	7.7± 2.7	0.3± 0.7	
	21	0.070±0.043	0.003±0.006	0.011±0.015	0.085±0.056		
Jul-95	15	2.0± 2.1	0.7± 1.3	5.3± 5.5	8.0± 3.8	0.0± 0.0	
	14	0.006±0.009	0.000±0.000	0.032±0.039	0.038±0.042		
Sep-95	16	2.5± 2.2	3.1± 3.5	3.8± 4.0	9.4± 3.4	1.3± 1.7	
	11	0.140±0.194	0.049±0.090	0.103±0.180	0.292±0.385		
Jun-96	30	31.0± 17.8	2.0± 2.0	0.0± 0.0	33.0± 19.5	0.3± 0.7	0.0± 0.0
	27	0.729±1.179	0.080±0.148	0.000±0.000	0.809±1.326		
Jul-96	25	9.2± 15.2	3.6± 2.6	12.8± 6.3	25.6± 17.9	1.6±1.5	0.8±1.1
	23	0.029±0.043	0.020±0.021	0.048±0.027	0.096±0.061		
Sep-96	30	6.7± 4.3	2.3± 1.6	3.0± 2.7	12.0± 6.5	0.7±0.9	5.7± 4.4
	29	0.048±0.053	0.007±0.005	0.011±0.010	0.065±0.055		
Jun-97	30	35.7±19.6	0.3±0.7	4.3±5.9	40.3±24.3	0.7±1.3	0.0±0.0
	27	0.201±0.126	0.001±0.003	0.022±0.027	0.224±0.144		
Sep-97	30	0.3±0.7	0.0±0.0	1.7±1.4	2.0±1.5	1.7±2.7	2.3±2.8
	29	0.001±0.001	0.000±0.000	0.007±0.007	0.008±0.008		
Jun-98	27	1.0±1.1	0.0±0.0	0.3±0.7	1.3±1.3	1.0±2.0	0.0±0.0
	27	0.005±0.005	0.000±0.000	0.001±0.003	0.006±0.006		
Jul-98	28	0.0±0.0	0.0±0.0	0.0±0.0	0.±0.0	0.7±1.0	0.0±0.0
	24	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Sep-98	30	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.3±0.7
	28	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Jun-99	27	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.3±0.7	0.0±0.0
	19	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Aug-99	27	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
	19	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Jun-00	26	0.8±1.1	0.0±0.0	1.5±1.4	2.3±2.0	0.0±0.0	0.0±0.0
	23	0.004±0.005	0.000±0.000	0.007±0.007	0.010±0.009		
Jul-00	28	1.6±2.5	0.4±0.8	3.6±3.6	5.4±5.5	0.0±0.0	0.0±0.0
	21	0.009±0.014	0.004±0.008	0.027±0.025	0.039±0.038		
Aug-00	28	1.1±2.1	0.0±0.0	2.1±2.4	3.2±4.4	0.0±0.0	2.1±3.1
	27	0.011±0.022	0.000±0.000	0.024±0.028	0.035±0.047		

Table 6. Continued.

Cedar

Date	Weevil n	Larvae N/m^2	Pupae N/m^2	Adults N/m^2	Total *E.l.* N/m^2	*Acentria* N/m^2	*Parapoynx*
May-94	11	5.5± 10.9	0.0± 0.0	0.9± 1.8	6.4± 10.9	0.0± 0.0	
per stem	0	–	–	–	–		
Jul-94	14	4.3± 8.6	1.4± 2.9	1.4± 2.9	7.1± 14.3	0.0± 0.0	
	0	–	–	–	–		
Aug-94	11	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	
Sep-94	17	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	
Jun-95	18	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	
Aug-95	10	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	
Sep-95	17	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	
Jun-96	29	0.3± 0.7	0.0± 0.0	0.0± 0.0	0.3± 0.7	0.0± 0.0	0.0±0.0
	25	0.010±0.020	0.000±0.000	0.000±0.000	0.010±0.020		
Aug-96	21	0.0± 0.0	0.5± 1.0	0.5± 1.0	1.0± 1.9	0.0± 0.0	0.0±0.0
	21	0.000±0.000	0.002±0.004	0.002±0.004	0.004±0.008		
Sep-96	23	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0±0.0
	24	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Jul-97	28	0.0±0.0	0.0±0.0	0.4±0.7	0.4±0.7	0.4±0.7	0.0±0.0
	28	0.000±0.000	0.000±0.000	0.002±0.003	0.002±0.003		
Sep-97	26	0.8±1.1	0.0±0.0	0.4±0.8	1.2±1.3	0.0±0.0	0.0±0.0
	26	0.012±0.016	0.000±0.000	0.002±0.003	0.013±0.019		
Jun-98	31	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
	30	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Sep-98	28	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.4±0.7	0.0±0.0
	24	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Jun-99	26	1.9±2.5	0.0±0.0	0.38±0.77	2.3±2.6	0.0±0.0	0.0±0.0
	24	0.011±0.013	0.000±0.000	0.003±0.006	0.013±0.013		
Aug-99	27	0.7±1.5	0.0±0.0	0.0±0.0	0.7±1.5	0.0±0.0	0.0±0.0
	26	0.002±0.004	0.000±0.000	0.000±0.000	0.002±0.004		
Jun-00	26	7.7±6.8	0.8±1.5	0.4±0.8	8.8±7.8	0.0±0.0	0.0±0.0
	25	0.035±0.031	0.003±0.005	0.001±0.002	0.039±0.034		
Aug-00	27	3.3±3.2	0.0±0.0	0.0±0.0	3.3±3.2	0.7±1.0	0.0±0.0
	25	0.023±0.023	0.000±0.000	0.000±0.000	0.023±0.023		

Table 6. Continued.

Otter

Date	Weevil n	Larvae N/m^2	Pupae N/m^2	Adults N/m^2	Total *E.l.* N/m^2	*Acentria* N/m^2	*Parapoynx*
May-94	20	12.5± 10.2	0.0± 0.0	0.0± 0.0	12.5± 10.2	0.5± 1.0	
per stem	20	0.047±0.038	0.000±0.000	0.000±0.000	0.047±0.038		
Jul-94	24	0.4± 0.9	0.0± 0.0	0.4± 0.9	0.8± 1.2	0.0± 0.0	
	24	0.001±0.002	0.000±0.000	0.001±0.003	0.002±0.003		
Aug-94	14	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	1.4± 2.9	
	14	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Sep-94	8	0.0± 0.0	1.3± 2.5	2.5± 3.3	3.8± 3.7	6.3± 5.3	
	7	0.000±0.000	0.003±0.007	0.013±0.022	0.016±0.021		
Jun-95	27	5.9± 5.1	2.6± 3.3	3.3± 3.4	11.9± 9.0	0.4± 0.7	
	26	0.033±0.030	0.021±0.034	0.022±0.020	0.076±0.071		
Aug-95	15	0.0± 0.0	0.0± 0.0	0.7± 1.3	0.7± 1.3	0.0± 0.0	
	1	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Sep-95	18	0.6± 1.1	0.0± 0.0	1.1± 2.2	1.7± 2.4	0.0± 0.0	
	1	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Jun-96	25	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.8± 1.6	0.8±1.6
	5	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Aug-96	26	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.8± 1.1	2.3± 2.0
	2	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Sep-96	27	0.0± 0.0	0.0± 0.0	0.0± 0.0	0.0± 0.0	4.4± 3.6	100.4±24.5
	0	–	–	–	–		
Jul-97	26	0.4±0.8	0.0±0.0	0.0±0.0	0.4±0.8	6.2± 3.9	20.8±20.5
	3	0.083±0.167	0.000±0.000	0.000±0.000	0.083±0.167		
Sep-97	27	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	1.5±1.8	30.0±13.8
	1	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Jun-98	27	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	1.1±1.6	0.4±0.7
	13	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Sep-98	27	4.1±4.3	0.0±0.0	1.9±3.0	5.9±5.1	0.0±0.0	4.4±5.4
	16	0.206±0.219	0.000±0.000	0.049±0.084	0.255±0.223		
Jun-99	22	1.4±2.0	0.0±0.0	0.0±0.0	1.4±2.0	0.0±0.0	0.0±0.0
	20	0.030±0.050	0.000±0.000	0.000±0.000	0.030±0.050		
Jul-99	26	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
	26	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Jun-00	27	14.4±14.8	4.8±4.3	4.8±3.9	24.1±20.4	0.0±0.0	0.4±0.7
	27	0.092±0.093	0.029±0.037	0.028±0.027	0.150±0.131		
Jul-00	27	1.1±1.6	0.0±0.0	0.7±1.5	1.9±3.0	0.0±0.0	0.0±0.0
	27	0.019±0.030	0.000±0.000	0.015±0.030	0.033±0.059		
Aug-00	27	4.1±4.8	0.0±0.0	1.5±1.4	5.6±5.7	1.9±1.5	3.3±2.4
	27	0.064±0.074	0.000±0.000	0.011±0.012	0.076±0.083		

Table 6. Continued.

Smith's Bay

Date	Weevil n	Larvae N/m^2	Pupae N/m^2	Adults N/m^2	Total *E.l.* N/m^2	*Acentria* N/m^2	*Parapoynx*
Jun-94	13	3.8± 5.3	0.0± 0.0	0.8± 1.5	4.6± 6.6	0.0± 0.0	
per stem	12	0.020±0.030	0.000±0.000	0.005±0.010	0.025±0.040		
Jul-94	11	12.3± 13.0	6.9± 8.0	1.5± 2.1	20.8± 20.9	0.8± 1.5	
	13	0.064±0.083	0.038±0.052	0.006±0.009	0.108±0.137		
Aug-94	16	18.0± 15.0	3.1± 4.0	1.9± 2.7	23.1± 20.2	0.6± 1.3	
	15	0.104±0.079	0.019±0.022	0.010±0.015	0.133±0.109		
Sep-94	14	0.0± 0.0	1.4± 2.9	2.1± 2.3	3.6± 4.5	0.0± 0.0	
	14	0.000±0.000	0.003±0.006	0.013±0.020	0.016±0.022		
Jun-95	25	0.4± 0.8	0.0± 0.0	0.8± 1.1	1.2± 1.3	0.0± 0.0	
	14	0.001±0.003	0.000±0.000	0.027±0.048	0.028±0.047		
Aug-95	25	4.0± 4.3	1.2± 1.8	0.4± 0.8	5.6± 5.3	0.0± 0.0	
	9	0.080±0.096	0.000±0.000	0.007±0.015	0.087±0.107		
Sep-95	25	0.8± 1.1	2.0± 3.3	0.8± 1.1	3.6± 5.0	0.0± 0.0	
	15	0.010±0.014	0.025±0.039	0.013±0.019	0.048±0.061		
Jun-96	25	4.8± 5.8	0.0± 0.0	0.0± 0.0	4.8± 5.8	5.2± 8.8	0.0± 0.0
	20	0.037±0.043	0.000±0.000	0.000±0.000	0.037±0.043		
Aug-96	25	12.4± 10.0	1.2± 1.8	2.0± 2.0	15.6± 10.5	0.0± 0.0	1.6± 2.5
	24	0.107±0.084	0.006±0.008	0.015±0.015	0.127±0.087		
Sep-96	25	1.2± 1.8	2.0± 2.0	2.8± 3.4	6.0± 5.3	0.8± 1.1	0.0± 0.0
	24	0.005±0.007	0.009±0.009	0.014±0.015	0.028±0.022		
Jul-97	25	5.2±4.3	0.4±0.8	4.0±3.7	9.6±6.9	0.0± 0.0	0.8±1.6
	21	0.049±0.053	0.003±0.005	0.043±0.049	0.094±0.094		
Sep-97	25	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.4±0.8	0.0± 0.0
	21	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Jun-98	25	7.2±7.2	0.4±0.8	0.0±0.0	7.6±7.6	1.2±1.8	0.0±0.0
	21	0.052±0.054	0.002±0.005	0.000±0.000	0.054±0.055		
Aug-98	25	1.2±1.8	0.0±0.0	0.8±1.1	2.0±2.0	0.0±0.0	0.0±0.0
	20	0.017±0.023	0.000±0.000	0.002±0.005	0.019±0.023		
Sep-98	25	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.4±0.8
	19	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
Jun-99	22	0.9±1.3	0.0±0.0	0.9±1.3	1.8±2.1	0.9±1.3	0.0±0.0
	22	0.047±0.091	0.000±0.000	0.047±0.091	0.094±0.182		
Aug-99	25	2.4±4.8	0.8±1.1	1.2±1.3	4.4±4.9	0.0±0.0	1.2±1.5
	21	0.000±0.000	0.002±0.003	0.014±0.024	0.017±0.024		
Aug-99	23	0.9±1.2	0.0±0.0	0.9±1.2	1.7±2.0	0.0±0.0	0.0±0.0
	22	0.005±0.007	0.000±0.000	0.007±0.010	0.012±0.015		
Jun-00	22	3.6±4.1	0.9±1.8	1.8±1.7	6.4±5.5	1.4±2.0	0.0±0.0
	20	0.027±0.035	0.007±0.014	0.008±0.009	0.042±0.042		
Jul-00	24	0.0±0.0	0.0±0.0	0.8±1.7	0.8±1.7	0.0±0.0	0.0±0.0
	19	0.000±0.000	0.000±0.000	0.009±0.018	0.009±0.018		
Aug-00	23	1.3±1.4	0.0±0.0	0.0±0.0	1.3±1.4	0.0±0.0	1.7±2.4
	21	0.009±0.010	0.000±0.000	0.000±0.000	0.009±0.010		

Cenaiko Lake

The suppression of milfoil biomass at Cenaiko Lake continued in 2000 (Table 5). Although milfoil biomass was higher in June 2000 (10 g dry/m^2) than any time in 1999, this density was well below values seen in 1996 and 1998 (Fig. 2) and by the end of the summer, milfoil biomass declined to 0.1 g dry/m^2, or 0.1% of total plant biomass. Native plant biomass was higher than in 1999 and more similar to previous years but the mean number of species was lower than other years with 8-9 total species being found on each sampling date. *Chara* became more common in 2000 than in 1999 when it became rare.

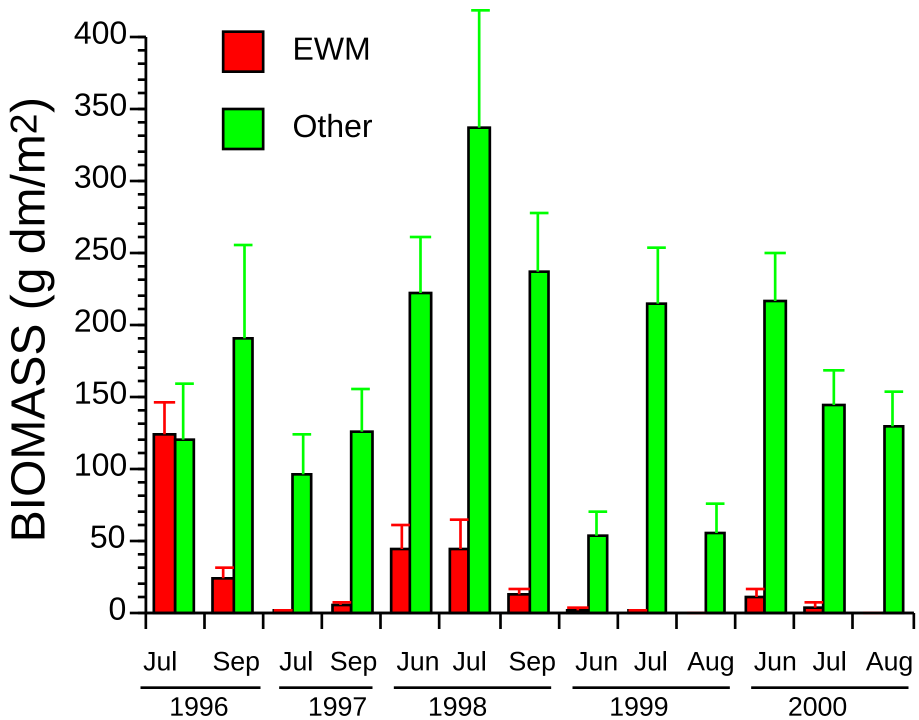


Fig. 2. Dry biomass of milfoil (EWM) and non-milfoil plants at Cenaiko Lake, 1996-2000. There was a significant decline of milfoil between July and September 1996 and July 1997 and a significant increase in native plants. Milfoil was present but not found in August 1999 samples. N > 20 samples on each date.

Table 5. Biomass (g dry/m^2) 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 1999-2000. N=22-26 samples per date.

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%

Weevil densities were below detection in our biomass samples during 1999 and 2000 (Table 6). Milfoil density was quite low in both years and on average less than 1 stem would be detected in a sample. Weevils were present in both years and maintained fairly high densities per stem as evidenced by the biweekly surveys that are presented later in the report (Fig. 4). *Acentria* density increased in 2000, reaching nearly 70/m^2 in June 2000. *Parapoynx* also reached detectible densities in 2000. Both species were found on a variety of native plants and were more likely to be found in samples with native plants and no milfoil (e.g., coontail, *Zosterella* and *Potamogetons*).

Table 6. Density (N/m^2 ± 2 SE and N per stem) of *Euhrychiopsis lecontei* (*E.l.*) larvae, pupae and adults, and *Acentria ephemerella* and *Parapoynx* sp. at Cenaiko Lake in 1996-2000. Densities per stem were only calculated for samples with Eurasian watermilfoil and because the caterpillars often occurred in samples with no milfoil their densities per stem were not calculated. A stem is a basal milfoil stem emerging from the sediment. .

Date	Weevil n	Larvae N/m^2	Pupae N/m^2	Adults N/m^2	Total *E.l.* N/m^2	*Acentria* N/m^2	*Parapoynx* N/m^2
7/22/96	29	48.6± 25.2	22.8± 10.8	31.7± 13.6	103.1± 41.9	18.3± 7.7	1.0± 1.5
per stem	26	0.923±1.292	0.337±0.458	0.381±0.280	1.640±1.972		
9/5/96	21	2.9± 2.4	1.0± 1.3	4.3± 4.3	8.1± 5.6	31.9± 20.2	0.0± 0.0
per stem	8	0.229±0.259	0.008±0.017	0.417±0.516	0.654±0.721		
7/16/97	26	1.5±1.8	0.0±0.0	0.0±0.0	1.5±1.8	8.8±5.8	0.0±0.0
per stem	3	0.389±0.401	0.000±0.000	0.000±0.000	0.389±0.401		
9/17/97	24	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	32.1±19.6	1.7±2.0
per stem	6	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
6/16/98	25	0.4±0.8	0.0±0.0	0.0±0.0	0.4±0.8	17.6±9.1	0.4±0.8
per stem	15	0.004±0.009	0.000±0.000	0.000±0.000	0.004±0.009		
7/29/98	25	0.0±0.0	0.0±0.0	0.8±1.6	0.8±1.6	1.6±1.5	0.4±0.8
per stem	12	0.000±0.000	0.000±0.000	0.019±0.037	0.019±0.037		
9/14/98	25	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	6.4±4.5	21.6±19.8
per stem	3	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
6/24/99	26	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	16.9±10.3	0.0±0.0
per stem	3	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
8/2/99	24	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	2.0±1.1	0.0±0.1
per stem	3	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
8/26/99	23	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	6.5±5.4	0.0±0.0
per stem	0	-	-	-	-		
06/29/00	22	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	69.1±43.2	0.0±0.0
per stem	6	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
07/20/00	22	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	32.0±16.1	3.0±5.0
per stem	7	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		
08/30/00	21	0.5±1.0	0.0±0.0	0.0±0.0	0.5±1.0	12.9±9.4	4.3±8.6
per stem	7	0.000±0.000	0.000±0.000	0.000±0.000	0.000±0.000		

Water clarity was lower than in previous years, however the poor clarity was due primarily to suspended sediment from rain events rather than high algal abundance (Table 7). Sediment bulk density remained high and organic matter low, and pore water ammonium levels remained similar to post milfoil decline levels. These pore water ammonium levels are as high as many of our other lakes sites and do not appear to be limiting.

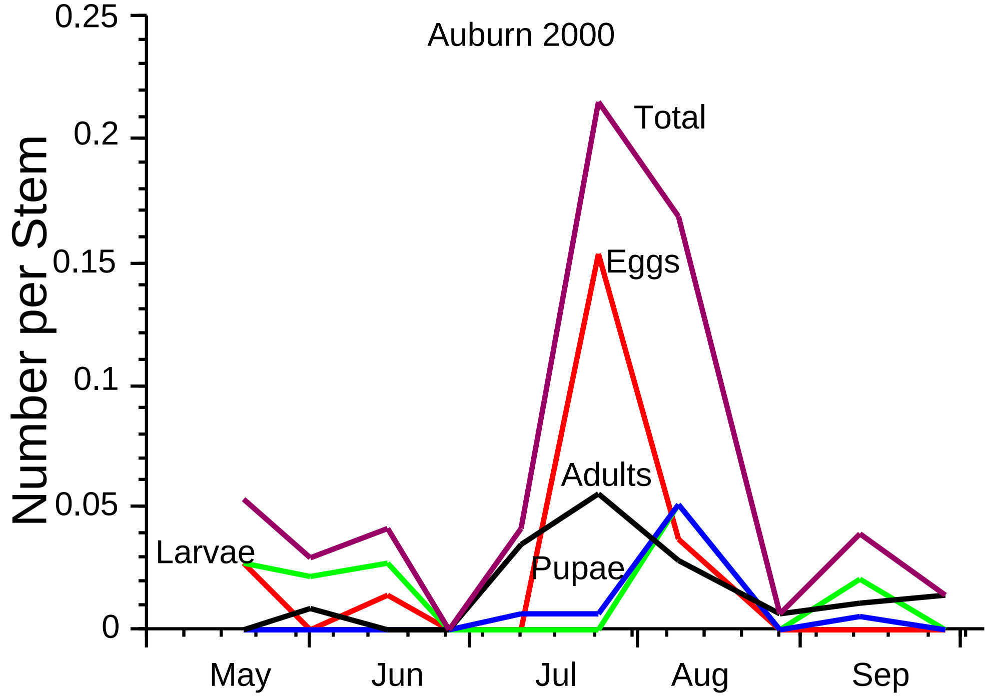
Table 7. Sediment characteristics (bulk density, percent organic matter, sediment pore water ammonium and water column characteristics in 1996-2000 at Cenaiko Lake. Sediment samples were collected from shallow, moderate and deep stations along transects 1, 2 and 3 (n=9).

Date	Bulk Dens. (g dm/ml)	NH_4 (mg/L)	% Organic	Chl-a (mg/m^3)	SD (m)	Temp (˚C 1m)	10% PAR Depth (m)	Plant Limit (m)
7/22/96	1.23	0.60	1.5%	1.34	5.0	25.4	4.5-5.0	3.4
2se	0.22	0.54	0.5%					
9/5/96	1.22	0.67	2.4%	5.61	4.0	25.7	5.0	3.4
2se	0.23	0.40	1.1%					
7/16/97	1.10	1.63	2.5%	4.54	2.3	27.6	3.5	3.0
2se	0.20	0.67	0.6%					
9/17/97	0.96	2.87	2.5%	1.60	2.3	21.3	2.0-2.5	3.0
2se	0.18	1.65	0.5%					
6/16/98	0.98	2.37	2.2%	2.41	3.8	23.7	5.5-6.0	3.4
2se	0.18	0.66	0.5%					
7/29/98	0.97	4.98	2.3%	2.41	4.4	25.9	4.5-5.0	3.4
2se	0.16	2.31	0.7%					
9/14/98	1.12	6.08	1.7%	3.21	3.0	23.8	3.5-4.0	3.2
2se	0.12	4.90	0.5%					
6/24/99	1.12	1.12	1.76%	1.3	2.7	24.3	3.5-4.0	
2SE	0.24	0.24	0.82%					
8/2/99	1.14	2.09	1.29%	3.5	2.7	27.4	3.0-3.5	
2SE	0.17	0.78	0.40%					
8/26/99	1.22	4.20	1.30%	2.1	3.1	24.3	3.0-3.5.0	
2SE	0.14	1.27	0.45%					
6/29/00	1.08	1.11	2.31%	2.14	2.3	23.5	3.5	
2se	0.27	0.73	0.41%					
7/20/00	1.13	4.09	3.01%	3.47	1.6	23.2	2.0-2.5	
2se	0.35	.	1.57%					
8/30/00	1.25	3.27	2.43%	2.94	1.4	23.1	4.5-5.0	
2se	0.26	2.41	0.70%					

Bi-weekly weevil surveys

The bi-weekly weevil surveys showed a reappearance of weevils in Lake Auburn (Fig. 3); weevils disappeared there in July 1998 (Newman et al. 1999) and no weevils were found in the 1999 surveys. Densities at Lake Auburn were low (generally fewer than 0.05 per stem for any stage) but all stages persisted throughout the summer. Weevils were also evident at Otter Lake, so surveys were initiated in early June 2000, when total densities exceeded 0.4 per stem (Fig. 3). The weevil population declined in July but increased through August and September with over 0.1

adults per stem at the end of the summer. Moderate weevil densities (total ≥ 0.5 per stem) persisted throughout the summer at both Smith's Bay and Cenaiko Lake (Figs. 4 and 5). Densities were generally higher at Cenaiko Lake than Smith's Bay and lower than in 1999, however, adult and pupal densities at both lakes were as high or higher than in 1999. Eggs were not found after early September at any of the sites. At least 3 generations are obvious in the stage frequencies.



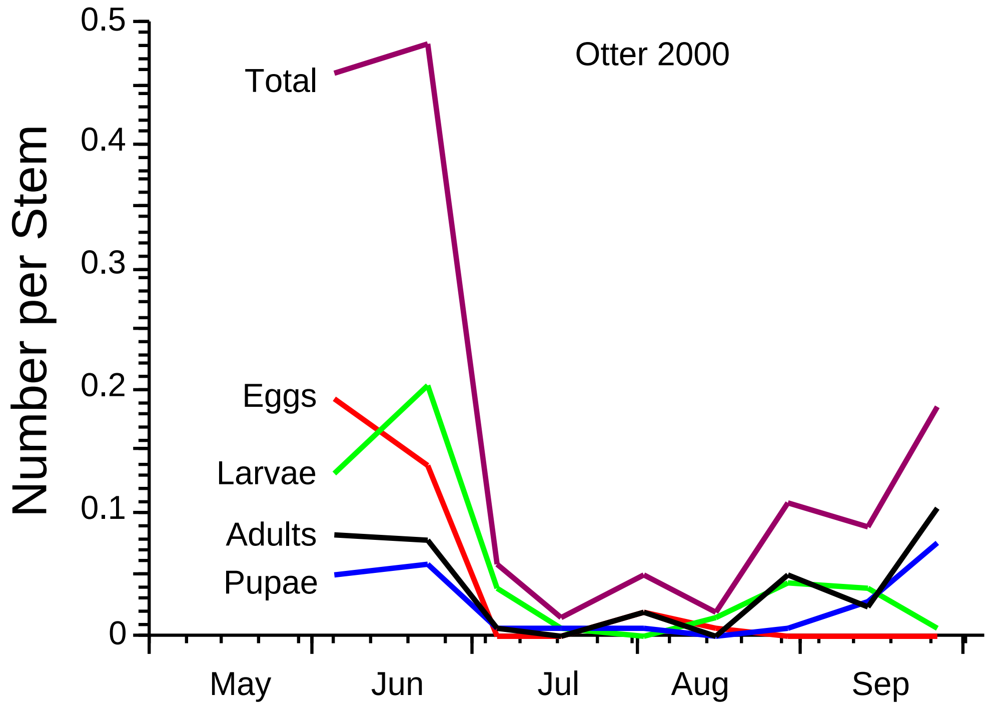
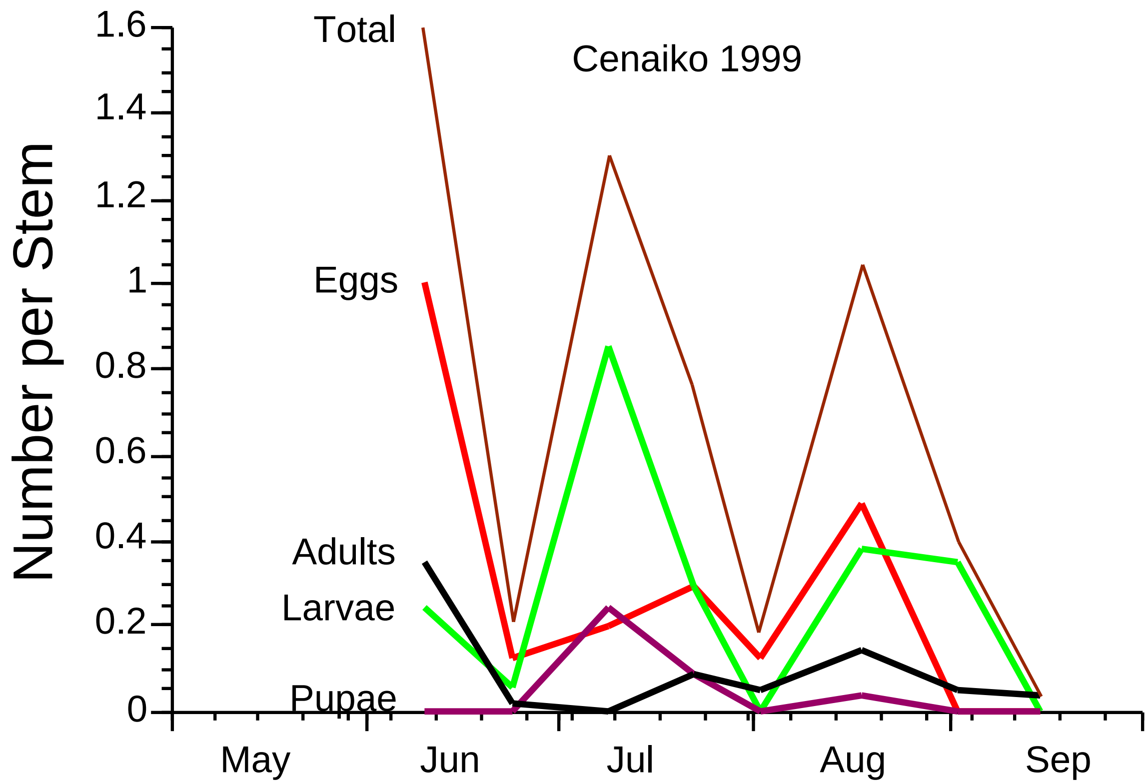


Fig. 3. Biweekly density (number per milfoil stem) of weevil life stages at Lake Auburn and Otter Lake in 2000.



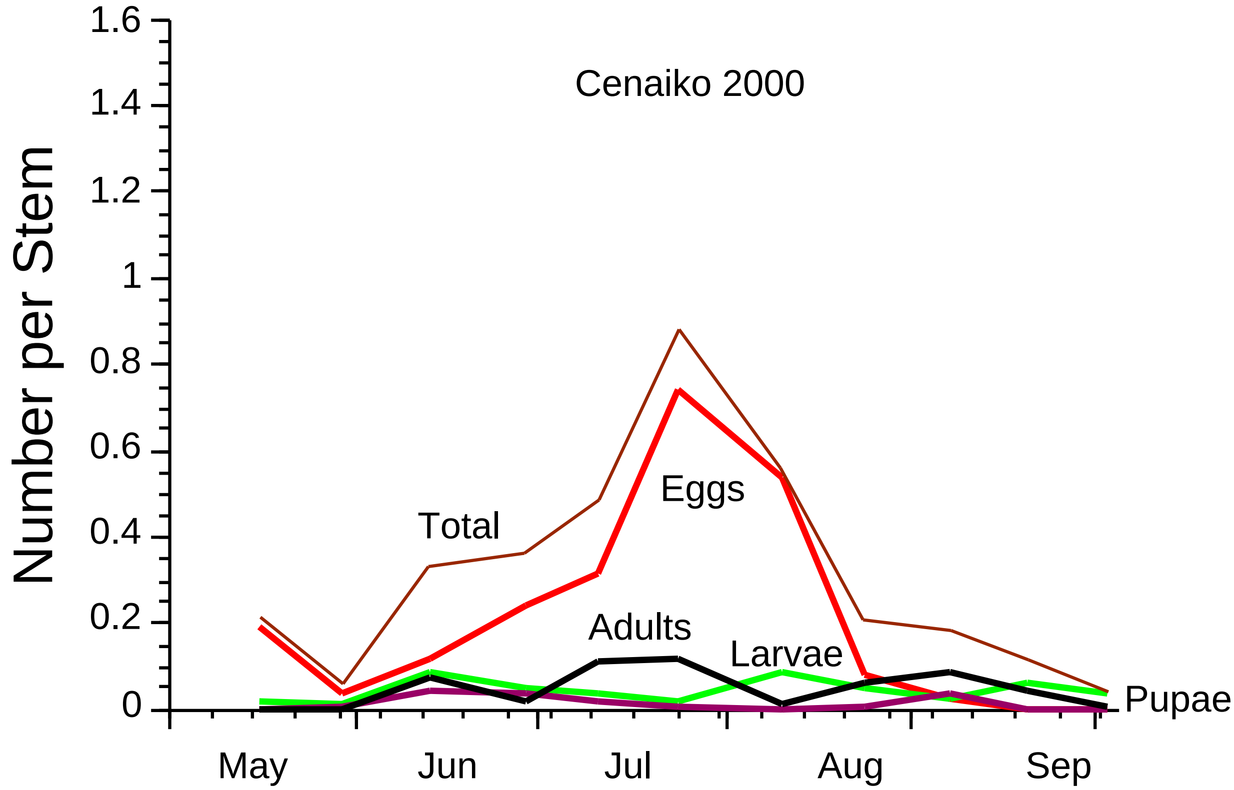


Fig. 4. Biweekly density (number per milfoil stem) of weevil life stages at Cenaiko Lake in 1999 and 2000.

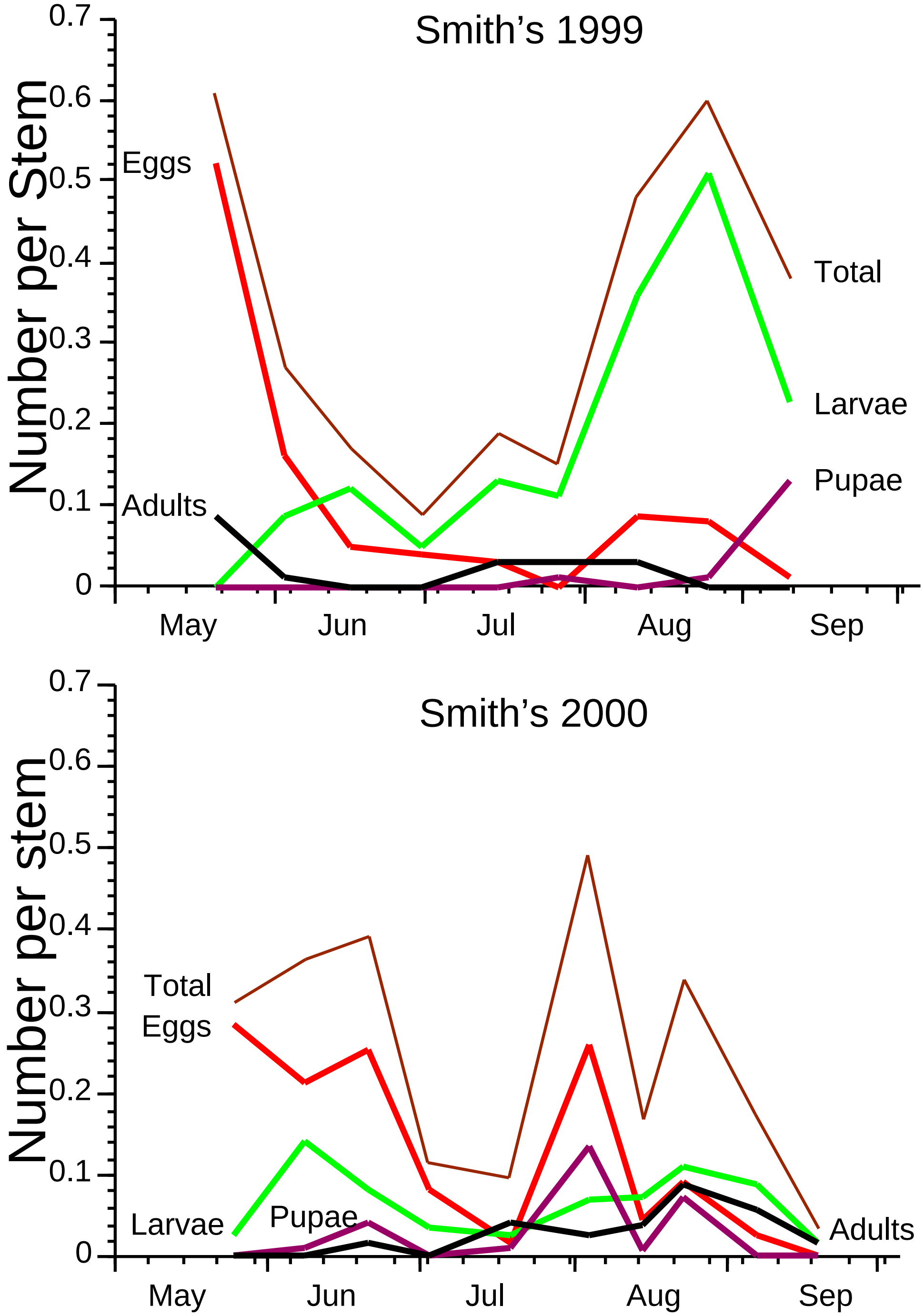


Fig. 5. Biweekly density (number per milfoil stem) of weevil life stages at Smith’s Bay in 1999 and 2000. Note that these surveys were conducted on the shallowest 3 stations ≤ 370 m from shore.

Survey sites:

Eurasian watermilfoil biomass increased at most sites relative to 1999; Eurasian watermilfoil composed from 33% (Gray’s Bay) to over 89% (Isles) of total plant biomass (Table 8) . Non-milfoil biomass also increased at Gray’s Bay and Shady Island but remained low at the other sites. Water clarity was similar to 1999 at three sites (Table 9) but increased substantially at Lake-of-the-Isles. The increased Secchi Depth (and lower chlorophyll) at Lake-of-the-Isles persisted through the summer and no doubt enabled the dense growth of milfoil, the highest we have recorded in that lake. Sediment ammonium levels were similar to 1999 and lower than in 1998.

Table 8. Total plant and milfoil biomass (g dry/m^2) and mean percent of plant biomass that was Eurasian watermilfoil at the three survey sites in summer 1995-2000. N ≥ 9 samples at all sites. Results for 2 additional sites sampled in 1999 and 2000 are also presented.

Lake	Date	Total Plant Biomass (g/m^2)	Milfoil Biomass (g/m^2)	% Milfoil (of biomass)	Secchi Depth (m)
Gray's Bay	8/30/95	209.4	194.0	94.0%	2.0
	SE	55.3	53.2	3.8%	
	9/4/96	309.0	49.5	30.9%	1.9
	SE	132.1	21.1	12.7%	
	8/15/97	323.7	99.7	37.3%	3.5
	SE	43.0	29.6	10.6%	
	8/25/98	420.0	294.3	58.5%	2.3
	SE	61.8	40.8	6.9%	
	8/12/99	270.0	117	27.2%	3.1
	SE	67.0	37	6.7%	
	7/27/00	359.6	103.2	33.0%	2.5
	1 SE	43.6	22.8	7.1%	
Shady Island	9/12/95	259.8	215.1	83.6%	1.8
	SE	42.8	37.3	4.8%	
	9/4/96	262.2	158.6	70.5%	2.3
	SE	45.5	30.6	10.8%	
	8/28/97	432.9	175.6	47.4%	2.4
	SE	45.8	47.5	12.5%	
	8/27/98	339.6	139.2	42.6%	1.9
	1 SE	59.4	57.7	15.2%	
	8/6/99	100.4	40.3	41.1%	2.2
	1SE	28.0	19.0	14.2%	
	8/2/00	383.3	201.0	54.6%	2.2
	1 SE	64.5	71.7	17.1%	
Lake of the Isles	9/14/95	62.5	58.3	90.1%	0.5
	SE	20.6	22.6	5.0%	
	8/30/96	199.7	169.2	74.6%	1.1
	SE	74.0	74.1	10.1%	
	8/14/97	31.9	9.9	22.4%	1.4
	SE	10.4	5.3	8.6%	
	8/31/98	28.2	14.0	36.9%	0.3
	1 SE	4.7	6.1	12.2%	
	8/16/99	51.8	49.3	88.3%	0.5
	1SE	14.8	14.5	4.4%	
	6/28/00	265.4	252.9	88.9%	2.3
	1 SE	45.6	46.9	3.7%	
	8/16/00	195.4	192.7	97.7%	2.2
	1 SE	17.6	17.8	1.1%	
Calhoun	9/16/99	41.6	8.1	10.8%	1.6
	1 SE	10.7	3.9	5.5%	
	6/26/00	22.7	10.8	38.3%	3.1
	1 SE	11.3	5.6	13.5%	
	8/18/00	12.5	10.9	56.5%	1.8
	1 SE	4.0	4.1	10.0%	
Harriet	9/23/99	180.2	168.3	87.9%	2.6
	1 SE	27.6	26.8	5.2%	
	6/30/00	332.1	215.0	61.5%	1.6
	1 SE	53.2	37.8	5.7%	
	8/22/00	106.0	90.7	78.0%	2.3
	1 SE	18.9	19.5	5.9%	

Table 9. Sediment characteristics (bulk density, percent organic matter, sediment pore water ammonium concentrations) and water column characteristics in 1995-2000 at the three survey sites. Three sediment samples from the intermediate depth were collected at each site.

Lake/Date	Bulk Dens. (g dm/ml)	NH_4 (mg/L)	% Organic	Chl-a (mg/m^3)	SD (m)	Temp (˚C 1m)	10% PAR Depth (m)	Plant Limit (m)
Grays Bay								
8/30/95	0.10	6.75	34.1	6.1	2.0	25.2	3.0-3.5	3.5
2se	0.04	3.39	4.3					
9/4/96	0.12	3.29	21.3	2.1	1.9	26.2	3.0-3.5	3.5
2se	0.04	1.82	1.0					
8/15/97	0.10	4.90	35.4	3.5	3.5	22.6	4.0-4.5	4.1
2se	0.05	3.19	4.9					
8/25/98	0.10	29.13	33.7	3.5	2.3	25.1	3.0-3.5	3.3
2se	0.02	7.08	6.7					
8/12/99	0.07	10.96	27.6	4.3	3.1	25.0	4.0	4.5
2se	0.01	6.24	3.9					
7/27/00	0.10	10.05	27.2	5.1	2.5	24.7	2.5-3.0	5.4
2se	0.03	0.86	6.1					
Shady Island								
9/12/95	0.14	3.74	23.9	8.8	1.8	21.0	2.0-2.5	4.5
2se	0.05	3.12	2.8					
9/4/96	0.42	1.44	10.1	7.5	2.3	25.1	3.0-3.5	3.5
2se	0.41	0.48	9.0					
8/28/97	0.09	4.49	27.2	2.4	2.4	23.9	3.0-3.5	4.7
2se	0.77	1.87	16.8					
8/27/98	0.69	10.93	10.8	5.9	1.9	24.6	3.0-3.5	4.4
2se	0.93	8.71	10.7					
8/6/99	0.20	6.64	14.3	5.6	2.2	25.8	3.0-3.5	4.4
2se	0.13	2.65	2.3					
8/4/00	0.23	0.67	15.8	4.5	2.2	25.3	2.5-3.0	4.9
2se	0.09	0.38	6.0					
Lake of the Isles								
9/14/95	1.45	5.21	1.8	57.4	0.5	20.3	0.5-1.0	0.5
2se	0.36	4.36	1.1					
8/30/96	0.28	9.30	10.0	6.9	1.1	24.6	1.5-2.0	2.0
2se	0.08	5.32	6.7					
8/13/97	0.71	8.48	16.2	26.2	1.4	22.5	1.0-1.5	3.7
2se	0.58	0.88	20.0					
8/31/98	0.25	29.33	23.9	54.3	0.3	24.3	0.5-1.0	3.3
2se	0.28	19.07	19.0					
8/16/99	0.15	0.54	24.2	83.7	0.5	22.5	0.5-1.0	3.0
2se	0.05	0.56	12.5					
6/28/00	0.72	0.57	41.1	8.8	2.3	22.9	1.5-2.0	
2se	0.87	0.23	13.3					
8/16/00	0.51	1.13	26.1	15.8	2.2	25.7	2.5-3.0	4.0
2se	0.39	1.09	12.8					

Milfoil biomass at Harriet was remained high and despite the lower water clarity relative to 1997 and 1998 (Table 10). Total plant biomass declined further from 1999 at Lake Calhoun to

100g wet/m^2 and milfoil remained at a very low density of 70 g/m^2. Eurasian watermilfoil composed about 50% of plant biomass in 2000, due to the decline of other plants rather than an increase in milfoil biomass. The cause of the overall decline in plant biomass at Calhoun is unknown, however, it does not appear to be due to poor water clarity (Table 10).

Table 10. Water column characteristics of two additional survey sites.

Lake/Date		Chl-a (mg/m^3)	SD (m)	Temp (˚C 1m)	10% PAR Depth (m)	Milfoil Limit (m)	Plant Limit (m)
Calhoun	9/24/97	7.2	3.1	18.9	2.5-3.0	4.7	4.7
	9/4/98	3.7	3.0	23.7	3.5-4.0	4.1	4.1
	9/21/99	17.1	1.6	18.5	2.0	2.6	3.8
	6/26/00	4.3	3.1	21.4	3.5-4.0		
	8/18/00	8.6	1.8	24.3	3.5-4.0	2.0	2.4
Harriet	10/9/97	4.5	> 5.4	17.3	3.0-3.5	5.2	5.2
	9/23/98	3.7	2.6	20.3	4.0-4.5	5.0	5.0
	9/24/99	7.5	2.6	17.5	3.5	4.0	4.0
	6/30/00	6.1	1.6	22.8	2.5-3.0		
	8/22/00	8.3	2.3	23.1	3.5-4.0	4.1	4.2

Plant coverage and occurrence (Table 11) showed trends similar to biomass.

Table 11. Estimates of plant coverage and occurrence for the whole-lake surveys (Calhoun, Cedar, Gray's, Harriet, Isles and Shady Island). Estimates of visual milfoil cover (% Vis MSP Cov), percent visual occurrence, occurrence on the drop hook and mean weevil damage rating (0-5) for the whole lake estimates were based on n = 66-82 stations at each lake. Jessen and Lound (1962) relative density ratings (0-5) were determined from a subset of 5-6 transects (n=24-29 stations). Relative density is the mean for all stations sampled. Total Eurasian watermilfoil coverage, % of littoral zone and % of lake area with milfoil were determined by GPS mapping based on the criteria indicated; these estimates have not yet been calculated for 1999 and 2000. Species abbreviations are given in Appendix I.

Cedar Lake		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating n = 26	
Date	n	Mean ± 1S.E.	Spp.	% Occ. ±1S.D.	Spp.	% Occ. ±1S.D.	Spp.	Density ± 2S.E.
9/27/99	75	50.1 ± 4.2%	MSP	78.7 ± 4.7%	MSP	90.7 ± 3.4%	MSP	3.96 ± 0.46
			NMP	13.3 ± 3.9%	CRT	25.3 ± 5.0%	CRT	1.50 ± 0.60
Eurasian Watermilfoil					NMP	6.7 ± 2.9%	NMP	0.12 ± 0.23
Total area							PRI	0.04 ± 0.08
% of Litt. Zone:							DRC	0.04 ± 0.08

Cedar Lake	n	Mean ± 1S.E.	Spp.	% Occ. ±1S.D.	Spp.	% Occ. ±1S.D.	Spp.	Density ± 2S.E.
8/9/00	72	44.3 ±4.7%	MSP	68.1 ± 5.5%	MSP	87.5 ± 3.9%	MSP	3.58 ± 0.61
			CRT	9.7 ± 3.5%	CRT	23.6 ± 5.0%	CRT	1.29 ± 0.53
Eurasian Watermilfoil			NMP	15.3 ± 4.2%	NAJ	1.4 ± 1.4%	NMP	0.38 ± 0.38
Total area			PAM	1.4 ± 1.4%	NMP	6.9 ± 3.0%	NAJ	0.08 ± 0.17
% of Litt. Zone:			PEC	1.4 ± 1.4%	PAM	1.4 ± 1.4%	CHA	0.04 ± 0.08
% Lake Area:					PCR	1.4 ± 1.4%		
Surface area Criteria:		Visible milfoil			CHA	1.4 ± 1.4%		
Weevil Damage Rating:								

Lake Calhoun		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating n = 29	
Date	n	Mean ± 1 S.E.	Spp.	% Occ. ± 1 S.D.	Spp.	% Occ. ± 1 S.D.	Spp.	Density ± 2S.E.
9/24/97	69	29.9 ± 3.3%	MSP	87.0 ± 4.1%	MSP	94.2 ± 2.8%	MSP	4.28 ± 0.43
			CRT	2.9 ± 2.0%	CRT	52.2 ± 6.0%	CRT	1.86 ± 0.58
Eurasian Watermilfoil:			NAJ	1.4 ± 1.4%	PRI	7.2 ± 3.1%	PRI	0.31 ± 0.33
Total Area:		71.9 ha.			PEC	3.0 ± 2.0%	NAJ	0.28 ± 0.28
% of Litt. Zone:		144.4 %					PEC	0.10 ± 0.12
% of Lake Area:		44.3 %					PCR	0.07 ± 0.10
Survey Criteria: Visible milfoil							CHA	0.03 ± 0.07
Weevil Damage rating 0.493±0.085							PZS	0.03 ± 0.07

Table 11 Continued

Lake Calhoun		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating	n = 27
Date	n	Mean ± 1SE	Spp.	% Occ. ± 1 SD	Spp.	% Occ. ± 1 SD	Spp.	Density ± 2SE
9/4/98	63	30.7 ± 4.4%	MSP	87.3 ± 4.2%	MSP	76.2 ± 5.4%	MSP	3.67 ± 0.49
			PEC	17.5 ± 4.8%	CRT	50.8 ± 6.3%	CRT	3.07 ± 0.53
Eurasian Watermilfoil			PRI	14.3 ± 4.4%	PEC	12.7 ± 4.2%	PCR	0.48 ± 0.38
Total Area: 22.3 ha.			CRT	11.1 ± 4.0%	PRI	3.2 ± 2.2%	PEC	0.48 ± 0.43
% of Litt. Zone: 44.8%			PCR	7.9 ± 3.1%	PZS	1.6 ± 1.6%	PRI	0.41 ± 0.36
% of Lake Area: 13.7%			NAJ	6.3 ± 3.1%			NAJ	0.33 ± 0.34
Survey Criteria: Visible milfoil			ELD	1.6 ± 1.6%			ELD	0.04 ± 0.07
Weevil Damage Rating: 0.698±0.133			HET	1.6 ± 1.6%			HET	0.04 ± 0.07

Lake Calhoun		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating	n = 25
Date	n	Mean ± 1SE	Spp.	% Occ. ± 1 SD	Spp.	% Occ. ± 1 SD	Spp.	Density ± 2SE.
9/16/99	74	45.0± 4.5%	MSP	87.3 ± 3.9%	MSP	76.2 ± 5.0%	MSP	1.84 ± 0.75
			PEC	17.5 ± 4.4%	CRT	50.8 ± 5.8%	CRT	3.32 ± 0.47
Eurasian Watermilfoil			PRI	14.3 ± 4.1%	PEC	12.7 ± 3.9%	PRI	0.20 ± 0.23
Total area			CRT	11.1 ± 3.7%	PRI	3.2 ± 2.0%		
% of Litt. Zone:			PCR	7.9 ± 3.1%	PZS	1.6 ± 1.5%		
% Lake Area:			NAJ	6.3 ± 2.8%				
Surface area Criteria: Visible milfoil			ELD	1.6 ± 1.5%				
Weevil Damage Rating:			HET	1.6 ± 1.5%				

Lake Calhoun		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook		Density Rating	n = 26
Date	n	Mean ±1S.E.	Spp.	% Occ. ±1S.D.	Spp.	% Occ. ±1S.D.	Spp.	Density ±2S.E.
8/17/00	73	6.8±2.0%	MSP	26.0 ± 5.1%	MSP	24.7 ± 5.0%	MSP	1.62 ± 0.70
			PEC	1.4 ± 1.4%	CRT	11.0 ± 3.7%	PEC	0.04 ± 0.08
Eurasian Watermilfoil			PRI	2.7 ± 1.9%	NAJ	2.7 ± 1.9%	PZS	0.12 ± 0.17
Total area			NAJ	1.4 ± 1.4%	PRI	2.7 ± 1.9%	CRT	2.00 ± 0.63
% of Litt. Zone:			CHA	1.4 ± 1.4%	PZS	1.4 ± 1.4%	ELD	0.04 ± 0.08
% Lake Area:							PCR	0.38 ± 0.35
Surface area Criteria: Visible milfoil							NAJ	0.31 ± 0.29
Weevil Damage Rating:							PRI	0.12 ± 0.17
							HET	0.08 ± 0.15
							CHA	0.42 ± 0.32
							VAL	0.04 ± 0.08
							ZPA	0.15 ± 0.31

Lake Harriet		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating	n = 29
Date	n	Mean ± 1 S.E.	Spp.	% Occ. ± 1 S.D.	Spp.	% Occ. ± 1 S.D.	Spp.	Density ± 2S.E.
10/9/97	72	52.2 ± 3.8%	MSP	87.5 ± 3.9%	MSP	86.1 ± 4.1%	MSP	4.41 ± 0.36
			CRT	8.3 ± 3.3%	CRT	40.3 ± 5.8%	CRT	2.21 ± 0.49
Eurasian Watermilfoil:			HET	1.4 ± 1.4%	PRI	1.4 ± 1.4%	PRI	0.17 ± 0.14
Total Area:		28.6 ha.	PRI	1.4 ± 1.4%	PZS	1.4 ± 1.4%	ELD	0.03 ± 0.07
% of Litt. Zone:		83.2%					NAJ	0.03 ± 0.07
% of Lake Area:		21.1%					PEC	0.03 0.07
Survey Criteria: Visible milfoil								
Weevil Damage rating 0.507±0.072								

Lake Harriet		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating	n = 27
Date	n	Mean ± 1SE	Spp.	% Occ. ± 1 SD	Spp.	% Occ. ± 1 SD	Spp.	Density ± 2SE
9/23/98	73	59.2 ± 4.2%	MSP	84.9 ± 4.2%	MSP	82. ± 4.5%	MSP	3.81 ± 0.68
			CRT	8.2 ± 3.2%	CRT	39.7 ± 5.7%	CRT	2.07 ± 0.55
Eurasian Watermilfoil			PRI	6.8 ± 3.0%	PRI	6.8 ± 3.0%	PRI	0.26 ± 0.31
Total Area: 23.1 ha.			NAJ	1.4 ± 1.4%	NAJ	5.7 ± 2.7%	PZS	0.19 ± 0.26
% of Litt. Zone: 67.2%			PZS	1.4 ± 1.4%	PEC	1.4 ± 1.4%	NAJ	0.15 ± 0.18
% of Lake Area: 17.1%					PZS	1.4 ± 1.4%	PEC	0.07 ± 0.10
Survey Criteria: Visible milfoil							HET	0.04 ± 0.07
Weevil Damage Rating: 0.493±0.088								

Table 11 Continued

Lake Harriet		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating	n = 29
Date	n	Mean ±1S.E.	Spp.	% Occ. ± 1S.D.	Spp. ±	% Occ. ±S.D.	Spp.	Density ±2S.E.
9/24/99	71	71.9 ±2.8%	MSP	79.2 ± 4.8%	MSP	93.1 ± 3.0%	MSP	3.86 ± 0.44
			CRT	11.1 ± 3.7%	CRT	59.7 ± 5.8%	PZS	0.03 ± 0.07
Eurasian Watermilfoil							CRT	3.14 ± 0.46
Total area								

Lake Harriet		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating	n = 25
Date	n	Mean ±1S.E.	Spp.	% Occ. ±1S.D.	Spp.	% Occ. ±1S.D.	Spp.	Density ±2S.E.
8/21/00	66	36.8 ±4.2%	MSP	71.2 ± 5.6%	MSP	74.2 ± 5.4%	MSP	3.56 ± 0.54
			CRT	24.2 ± 5.3%	CRT	62.1 ± 6.0%	PEC	0.12 ± 0.13
Eurasian Watermilfoil			NAJ	1.5 ± 1.5%	NAJ	1.5 ± 1.5%	PZS	0.08 ± 0.16
Total area			PZS	3.0 ± 2.1%	PZS	1.5 ± 1.5%	CRT	3.20 ± 0.60
% of Litt. Zone:			PEC	3.0 ± 2.1%			NAJ	0.12 ± 0.24
% Lake Area:							PRI	0.04 ± 0.08
Surface area Criteria:		Visible milfoil					CHA	0.04 ± 0.08

Lake of the Isles		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating	n = 25
Date	n	Mean ± 1 S.E.	Spp.	% Occ. ± 1 S.D.	Spp.	% Occ. ± 1 S.D.	Spp.	Density ± 2S.E.
8/13/97	72	15.4 ± 3.5%	MSP	31.9 ± 5.5%	MSP	59.7 ± 5.8%	CRT	2.48 ± 0.37
			CRT	26.4 ± 5.2%	CRT	62.5 ± 5.7%	MSP	1.84 ± 0.53
Eurasian Watermilfoil:			PZS	1.4 ± 1.4%	NAJ	2.8 ± 1.9%	PZS	0.04 ± 0.08
Total Area:		14.3 ha.			PZS	2.8 ± 1.9%		
% of Litt. Zone:		39.7%						
% of Lake Area:		32.4%						
Survey Criteria: Visible milfoil								

Lake of the Isles		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating	n = 26
Date	n	Mean ± 1SE	Spp.	% Occ. ± 1 SD	Spp.	% Occ. ± 1 SD	Spp.	Density ± 2SE
8/31/98	73	8.5 ± 2.0%	MSP	28.8 ± 5.3%	MSP	56.2 ± 5.8%	CRT	2.85 ± 0.60
			CRT	15.1 ± 4.2%	CRT	39.7 ± 5.7%	MSP	2.81 ± 0.69
Eurasian Watermilfoil					CHC	2.7 ± 1.9%	NAJ	0.08 ± 0.15
Total Area: 36.0 ha.					NAJ	2.7 ± 1.9%	CHC	0.04 ± 0.08
% of Litt. Zone: 100.0%					PEC	1.4 ± 1.4%	PCR	0.04 ± 0.08
% of Lake Area: 49.6%							PEC	0.04 ± 0.08
Survey Criteria: Visible milfoil								
Weevil Damage Rating: 1.411±0.320								

Lake of the Isles		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating	n = 26
Date	n	Mean ±1S.E.	Spp.	% Occ. ±1S.D.	Spp.	% Occ. ±1S.D.	Spp.	Density ± 2S.E.
8/17/99	72	21.2 ± 2.8%	MSP	22.2 ± 4.9%	MSP	72.2 ± 5.3%	MSP	3.69 ± 0.57
			CRT	1.4 ± 1.4%	CRT	40.3 ± 5.8%	PEC	0.04 ± 0.08
Eurasian Watermilfoil							CRT	2.88 ± 0.52
Total area							NAJ	0.04 ± 0.08
% of Litt. Zone:							CHA	0.04 ± 0.08

Lake of the Isles		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating	n = 26
Date	n	Mean ±1S.E.	Spp.	% Occ. ±1S.D.	Spp.	% Occ. ±1S.D.	Spp.	Density ± 2S.E.
8/14/00	82	50.7 ± 4.4%	MSP	82.2 ±14.2%	MSP	87.7 ±13.6%	MSP	3.73 ± 0.49
					CRT	24.7 ±14.8%	CRT	1.58 ± 0.58
Eurasian Watermilfoil							PCR	0.23 ± 0.26
Total area							NAJ	0.04 ± 0.08
% of Litt. Zone:							PRI	0.04 ± 0.08

Table 11 Continued

Gray’s Bay		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating n = 37	
Date	n	Mean ± 1 S.E.	Spp.	% Occ. ± 1 S.D.	Spp.	% Occ. ± 1 S.D.	Spp.	Density ± 2S.E.
8/15/97	97	17.6 ± 2.7%	MSP	54.1 ± 5.1%	MSP	49.0 ± 5.1%	MSP	1.92 ± 0.45
			CHA	1.0 ± 1.0%	CRT	42.9 ± 5.0%	NAJ	1.76 ± 0.41
Eurasian Watermilfoil			PAM	1.0 ± 1.0%	NAJ	38.8 ± 4.9%	CRT	1.59 ± 0.39
Total Area:		58.4 ha.	VAL	1.0 ± 1.0%	PRI	38.8 ± 4.9%	PRI	1.41 ± 0.43
% of Litt. Zone:		113.7%			PZS	25.5 ± 4.4%	PZS	0.92 ± 0.37
% of Lake Area:		82.5%			PEC	12.2 ± 3.3%	CHA	0.76 ± 0.41
Survey Criteria: Visible milfoil					PAM	11.2 ± 3.2%	PAM	0.46 ± 0.25
Weevil Damage rating 0.000±0.000					ELD	5.1 ± 2.2%	PEC	0.43 ± 0.24
					PFO	5.1 ± 2.2%	PFO	0.24 ± 0.18
					CHA	4.1 ± 2.0%	VAL	0.24 ± 0.20
					VAL	3.1 ± 1.7%	ELD	0.08 ± 0.09
					PCR	2.0 ± 1.4%	MSI	0.05 ± 0.08
							PCR	0.05 ± 0.08

Gray’s Bay	n	Mean ± 1SE	Spp.	% Occ. ± 1 SD	Spp.	% Occ. ± 1 SD	Spp.	Density ± 2SE
8/25/98	87	24.8 ± 3.3%	MSP	60.9 ± 5.2%	MSP	58.6 ± 5.3%	MSP	2.73 ± 0.60
			PRI	41.4 ± 5.3%	NAJ	55.1 ± 5.3%	NAJ	2.13 ± 0.63
Eurasian Watermilfoil			PAM	20.7 ± 4.3%	CRT	49.4 ± 5.4%	CRT	2.07 ± 0.57
Total Area: 14.2 ha.			VAL	19.5 ± 4.3%	PRI	37.9 ± 5.2%	PRI	1.97 ± 0.58
% of Litt. Zone: 27.6%			NAJ	18.4 ± 4.2%	PZS	16.1 ± 3.9%	PZS	1.03 ± 0.49
% of Lake Area: 20.0%			PEC	10.3 ± 3.3%	PAM	11.5 ± 3.4%	PAM	0.63 ± 0.44
Survey Criteria: Visible milfoil			PFO	5.7 ± 2.5%	VAL	11.5 ± 3.4%	VAL	0.63 ± 0.41
Weevil Damage Rating: 0.195±0.067			CRT	4.6 ± 2.2%	PFO	9.2 ± 3.1%	ELD	0.53 ± 0.30
			PNA	3.4 ± 2.0%	CHA	6.9 ± 2.7%	MSI	0.27 ± 0.32
			MGD	2.3 ± 1.6%	ELD	5.7 ± 2.5%	PEC	0.27 ± 0.16
			PZS	2.3 ± 1.6%	HET	5.7 ± 2.5%	PFO	0.27 ± 0.25
			HET	1.1 ± 1.1%	PEC	3.4 ±2.0%	CHA	0.23 ± 0.28
			NMP	1.1 ± 1.1%	ALG	1.1 ± 1.1%	HET	0.20 ± 0.15
			PCR	1.1 ± 1.1%	MGD	1.1 ± 1.1%	MGD	0.13 ± 0.19
			PNO	1.1 ± 1.1%	MSI	1.1 ± 1.1%	LTR	0.03 ± 0.07
			RAN	1.1 ± 1.1%	RAN	1.1 ± 1.1%	PCR	0.03 ± 0.07
							RAN	0.03 ± 0.07

Gray’s Bay		% Vis MSP Cov	% Occurrence (Visual)			% Occurrence (Drop Hook)			Density Rating n = 31		
Date	n	Mean ± 1SE	Spp.	% Occ. ± 1 SD		Spp.	% Occ. ± 1 SD		Spp.	Density ± 2SE	
8/11/99	87	44.8±3.5%	MSP	60.9	5.2%	MSP	58.6	5.3%	MSP	3.84	0.57
			PRI	41.4	5.3%	NAJ	55.2	5.4%	PEC	0.23	0.18
Eurasian Watermilfoil			PAM	20.7	4.3%	CRT	49.4	5.4%	PZS	0.97	0.52
Total area			VAL	19.5	4.3%	PRI	37.9	5.2%	CRT	1.77	0.50
% of Litt. Zone:			NAJ	18.4	4.2%	PZS	16.1	4.0%	ELD	0.74	0.44
% Lake Area:			PEC	10.3	3.3%	PAM	11.5	3.4%	NMP	0.03	0.06
Surface area Criteria:		Visible milfoil	PFO	5.7	2.5%	VAL	11.5	3.4%	NUP	0.10	0.19
Weevil Damage Rating:			CRT	4.6	2.2%	PFO	9.2	3.1%	PAM	0.19	0.27
			PNA	3.4	2.0%	CHA	6.9	2.7%	NAJ	1.32	0.54
			MGD	2.3	1.6%	ELD	5.7	2.5%	PRI	1.65	0.55
			PZS	2.3	1.6%	HET	5.7	2.5%	HET	0.03	0.06
			HET	1.1	1.1%	PEC	3.4	2.0%	MGD	0.03	0.06
			NMP	1.1	1.1%	ALG	1.1	1.1%	CHA	0.68	0.47
			PCR	1.1	1.1%	MGD	1.1	1.1%	VAL	0.58	0.36
			PNO	1.1	1.1%	MSI	1.1	1.1%	PNA	0.10	0.11
			RAN	1.1	1.1%	RAN	1.1	1.1%	AMP	0.13	0.15

Table 11 Continued

Gray's Bay		% Vis MSP Cov	% Occurrence (Visual)			% Occurrence (Drop Hook)			Density Rating	n = 26	
Date	n	Mean ± 1SE	Spp.	% Occ.	± 1 SD	Spp.	% Occ.	± 1 SD	Spp.	Density	± 2SE
7/25/00	77	29.2 ±3.7%	MSP	74.0	5.0%	MSP	63.6	5.5%	CRT	2.92	0.58
			PRO	18.2	4.4%	CRT	61.0	5.6%	MSP	2.69	0.52
Eurasian Watermilfoil			PAM	16.9	4.3%	NAJ	51.9	5.7%	NAJ	2.23	0.79
Total area			CRT	15.6	4.1%	PRI	40.3	5.6%	PRI	2.04	0.62
% of Litt. Zone:			PRI	14.3	4.0%	PZS	32.5	5.3%	ELD	1.85	0.57
% Lake Area:			NAJ	9.1	3.3%	ELD	26.0	5.0%	PZS	1.69	0.51
Surface area Criteria: Visible milfoil			PZS	9.1	3.3%	PRO	16.9	4.3%	PRO	0.92	0.52
Weevil Damage Rating:			ELD	7.8	3.1%	CHA	13.0	3.8%	VAL	0.81	0.44
			PEC	7.8	3.1%	PAM	11.7	3.7%	PAM	0.69	0.47
			VAL	6.5	2.8%	HET	10.4	3.5%	CHA	0.65	0.51
			CHA	3.9	2.2%	VAL	7.8	3.1%	MGD	0.46	0.40
			MGD	2.6	1.8%	MSI	2.6	1.8%	RAN	0.23	0.20
			RAN	2.6	1.8%	MGD	1.3	1.3%	HET	0.19	0.25
			HET	1.3	1.3%	PEC	1.3	1.3%	MSI	0.12	0.17
			MSI	1.3	1.3%	RAN	1.3	1.3%	PEC	0.08	0.11
			NMP	1.3	1.3%	UTV	1.3	1.3%	NMP	0.04	0.08
			PGR	1.3	1.3%				PGR	0.04	0.08
									UTV	0.04	0.08

Shady Island		% Vis MSP Cov	% Occurrence (Visual)		% Occurrence (Drop Hook)		Density Rating n = 15	
Date	n	Mean ± 1 S.E.	Spp.	% Occ. ± 1 S.D.	Spp.	% Occ. ± 1 S.D.	Spp.	Density ± 2S.E.
8/29/97	50	9.3 ± 2.9%	MSP	34.0 ± 6.7%	MSP	46.0 ± 7.0%	NAJ	2.13 ± 0.58
			NAJ	16.0 ± 5.2%	CRT	38.0 ± 6.9%	CRT	1.27 ± 0.66
Eurasian Watermilfoil:			VAL	10.0 ± 4.2%	NAJ	30.0 ± 6.5%	UTV	1.20 ± 0.68
Total Area: 8.6 ha.			UTV	6.0 ± 3.4%	CHA	22.0 ± 5.9%	PZS	1.13 ± 0.70
% ofLitt. Zone: 45.0%			PRI	4.0 ± 2.8%	PRI	22.0 ± 5.9%	VAL	1.13 ± 0.64
% ofLake Area: 45.0%			PZS	4.0 ± 2.8%	PZS	20.0 ± 5.7%	CHA	1.07 ± 0.60
Survey criteria: Visible milfoil					VAL	10.0 ± 4.2%	MSP	1.07 ± 0.63
Weevil Damage rating 0.000±0.000					ELD	8.0 ± 3.8%	PRI	0.93 ± 0.57
					UTV	6.0 ± 3.4%	ELD	0.53 ± 0.43
					PEC	4.0 ± 2.8%	PEC	0.40 ± 0.38
					PFO	4.0 ± 2.8%	PAM	0.27 ± 0.31
					ALG	2.0 ± 2.0%	PFO	0.27 ± 0.24
					BRA	2.0 ± 2.0%	MSI	0.07 ± 0.13
					PAM	2.0 ± 2.0%		

Date	n	Mean ± 1SE	Spp.	% Occ. ± 1 SD	Spp.	% Occ. ± 1 SD	Spp.	Density ± 2SE
8/27/98	64	26.3 ± 4.3%	MSP	67.2 ± 5.9%	MSP	59.4 ± 6.1%	MSP	3.38 ± 0.65
			VAL	21.9 ± 5.2%	NAJ	45.3 ± 6.2%	CRT	2.08 ± 0.67
Eurasian Watermilfoil			NAJ	17.2 ± 4.7%	CRT	40.6 ± 6.1%	NAJ	1.63 ± 0.67
Total Area: 17.0 ha.			PRI	14.1 ± 4.3%	PZS	26.6 ± 5.5%	CHA	1.13 ± 0.56
% of Litt. Zone: 89.5%			CRT	9.4 ± 3.6%	VAL	17.2 ± 4.7%	PRI	0.67 ± 0.48
% of Lake Area: 89.5%			PAM	9.4 ± 3.6%	CHA	15.6 ± 4.5%	VAL	0.63 ± 0.46
Survey Criteria: Visible milfoil			PZS	9.4 ± 3.6%	MGD	12.5 ± 4.1%	PZS	0.46 ± 0.34
Weevil Damage Rating: 1.250±0.194			CHA	7.8 ± 3.4%	PRI	12.5 ± 4.1%	ELD	0.29 ± 0.22
			MGD	7.8 ± 3.4%	HET	7.8 ± 3.4%	MGD	0.25 ± 0.28
			NMP	6.3 ± 3.0%	PAM	6.3 ± 3.0%	PAM	0.25 ± 0.22
			NUP	4.7 ± 2.6%	ELD	4.7 ± 2.6%	HET	0.21 ± 0.29
			PEC	4.7 ± 2.6%	NMP	3.1 ± 2.2%	NUP	0.17 ± 0.33
			PNA	4.7 ± 2.6%	NUP	3.1 ± 2.2%	PPR	0.08 ± 0.17
			ELD	3.1 ± 2.2%	PEC	3.1 ± 2.2%	UTV	0.08 ± 0.12
			HET	1.6 ± 1.6%	PNA	1.6 ± 1.6%	RAN	0.04 ± 0.08
			PCR	1.6 ± 1.6%	RAN	1.6 ± 1.6%		
			PNO	1.6 ± 1.6%				
			SCR	1.6 ± 1.6%				

Table 11 Continued

Shady Island		% Vis MSP Cov	% Occurrence (Visual)			% Occurrence (Drop Hook)			Density Rating		n = 23
Date	n	Mean ± 1SE	Spp.	% Occ.	± 1 SD	Spp.	% Occ.	± 1 SD	Spp.	Density	± 2SE
8/6/99	70	19.9 ±2.8%	MSP	67.2	5.6%	MSP	59.4	5.9%	MSP	2.96	0.75
			VAL	21.9	4.9%	NAJ	45.3	5.9%	PZS	1.13	0.58
Eurasian Watermilfoil			NAJ	17.2	4.5%	CRT	40.6	5.9%	CRT	2.39	0.70
Total area			PRI	14.1	4.2%	PZS	26.6	5.3%	ELD	0.13	0.14
% of Litt. Zone:			CRT	9.4	3.5%	VAL	17.2	4.5%	NMP	0.22	0.35
% Lake Area:			PAM	9.4	3.5%	CHA	15.6	4.3%	NUP	0.17	0.35
Surface area Criteria: Visible milfoil			PZS	9.4	3.5%	MGD	12.5	4.0%	PCR	0.17	0.20
Weevil Damage Rating:			CHA	7.8	3.2%	PRI	12.5	4.0%	PAM	0.30	0.43
			MGD	7.8	3.2%	HET	7.8	3.2%	NAJ	1.30	0.72
			NMP	6.3	2.9%	PAM	6.3	2.9%	PRI	0.35	0.27
			NUP	4.7	2.5%	ELD	4.7	2.5%	HET	0.22	0.18
			PEC	4.7	2.5%	NMP	3.1	2.1%	MGD	0.17	0.20
			PNA	4.7	2.5%	NUP	3.1	2.1%	CHA	0.70	0.44
			ELD	3.1	2.1%	PEC	3.1	2.1%	PGR	0.04	0.09
			HET	1.6	1.5%	PNA	1.6	1.5%	VAL	0.48	0.40
			PCR	1.6	1.5%	RAN	1.6	1.5%	JUN	0.04	0.09
			PNO	1.6	1.5%				UTV	0.17	0.20
			SCR	1.6	1.5%				PNA	0.09	0.17

Shady Island		% Vis MSP Cov	% Occurrence (Visual)			% Occurrence (Drop Hook)			Density Rating		n = 25
Date	n	Mean ± 1SE	Spp.	% Occ.	± 1 SD	Spp.	% Occ.	± 1 SD	Spp.	Density	± 2SE
7/31/00	73	25.4 ± 3.8%	MSP	68.5	5.4%	MSP	65.8	5.6%	MSP	3.16	0.71
			NAJ	27.4	5.2%	CRT	56.2	5.8%	CRT	2.32	0.66
Eurasian Watermilfoil			CRT	26.0	5.1%	NAJ	34.2	5.6%	NAJ	1.72	0.75
Total area			MGD	17.8	4.5%	PZS	30.1	5.4%	CHA	1.52	0.61
% of Litt. Zone:			PZS	16.4	4.3%	CHA	12.3	3.8%	PZS	1.16	0.56
% Lake Area:			CHA	15.1	4.2%	ELD	9.6	3.4%	MGD	0.72	0.48
Surface area Criteria: Visible milfoil			PAM	13.7	4.0%	MGD	8.2	3.2%	PRI	0.56	0.38
Weevil Damage Rating:			NMP	11.0	3.7%	VAL	6.8	3.0%	VAL	0.56	0.46
			VAL	11.0	3.7%	PRO	5.5	2.7%	ELD	0.40	0.28
			NUP	9.6	3.4%	HET	4.1	2.3%	PRO	0.32	0.44
			PEC	9.6	3.4%	NUP	4.1	2.3%	PAM	0.28	0.29
			PRO	9.6	3.4%	PEC	4.1	2.3%	PGR	0.16	0.19
			PRI	8.2	3.2%	PRI	4.1	2.3%	PNA	0.16	0.32
			ELD	6.8	3.0%	PAM	2.7	1.9%	PNO	0.12	0.24
			PGR	2.7	1.9%	NMP	1.4	1.4%	NUP	0.08	0.16
			PNA	2.7	1.9%	PGR	1.4	1.4%	UTR	0.08	0.16
			HET	1.4	1.4%	PNA	1.4	1.4%	PEC	0.04	0.08
			PNO	1.4	1.4%	PPR	1.4	1.4%	NMP	0.04	0.08
						UTV	1.4	1.4%	PCR	0.04	0.08
									HET	0.04	0.08
									RAN	0.04	0.08

Weevil Introduction/Manipulation:

Milfoil density at the 20 Cedar Lake plots in June 1999 (prior to weevil stocking) ranged from 3112± 909 g wet/m^2 to 3810± 664 g wet/m^2 (508 g dry/m^2) (Table 12); this was higher than these sites in 1998 and than our permanent transect sites in 1999. At the end of the experiment in late August, milfoil biomass declined to between 1512± 458 g wet/m^2 and 2551± 252 g wet/m^2. The mean number of species also declined.

Weevil stocking appeared less successful than in 1998. Initially, higher densities of weevils were found in stocked vs non-stocked cages during visual surveys, but later in the summer higher densities of weevils were found in closed compared to open cages (Table 13). Few significant differences in weevil density were found. By the last date there were significantly ($P > 0.1$) more total weevils, and more larvae and pupae per stem in the stocked cages but no effect of cage type.

There was no significant effect of cage or stocking on milfoil biomass (all $P > 0.1$); biomass generally decreased in all the cages after stocking. The failure to build substantially higher weevil densities in stocked cages and the relatively late stocking date may have prevented any effect on the watermilfoil. There was also no evidence of carryover effects from stocking in 1998. Fish invasion was a persistent problem and the experiment was conducted again in 2000.

Table 12. Wet and dry biomass (g/m^2 ± 1SE) of Eurasian watermilfoil (MSP) and non-milfoil plants, %Eurasian watermilfoil and mean number of species per sample for the 1999 cage experiment. The June sample was taken 3 weeks prior to stocking and the August sample was taken 8 weeks after initial stocking. Two samples per cage were taken in July and 3 samples per cage in August. N=5 replicate cages per treatment. Open cages allow fish entry, closed cages do not. A total of 150 adult weevils were stocked into each stocked cage.

Date	Cage Type	Stocked	MSP	NonMSP	%MSP	Mean No. spp.
6/3/99	Open	No	3810 ± 664	424 ± 195	89.9 ± 4.1%	2.30 ± 0.34
Dry			389 ±59	36 ± 17	91.3 ±4.2%	
6/3/99	Closed	No	3455 ±495	149 ± 76	95.5 ± 1.3%	2.00 ± 0.16
Dry			331 ± 37	8 ± 4	96.3 ± 0.9%	
6/3/99	Open	Yes	3112 ± 909	409 ± 187	81.8 ± 9.9%	2.50 ± 0.16
Dry			321 ± 88	36 ± 16	83.2 ± 9.6%	
6/3/99	Closed	Yes	3252 ± 430	350 ± 151	88.1 ± 7.0%	2.50 ± 0.22
Dry			346 ± 39	27 ± 10	90.1 ± 5.9%	
8/30/99	Open	No	2551 ± 252	363 ± 183	87.9 ± 5.8%	1.70 ± 0.20
Dry			175 ± 22	22 ± 12	89.3 ± 5.9%	
8/30/99	Closed	No	1512 ± 458	174 ± 173	92.5 ± 7.4%	1.30 ± 0.20
Dry			106 ± 33	13 ± 13	92.2 ± 7.8%	
8/30/99	Open	Yes	2241 ± 524	429 ± 311	82.8 ± 13.1%	1.80 ± 0.12
Dry			153 ± 45	25 ± 17	81.9 ± 13.8%	
8/30/99	Closed	Yes	2062 ± 250	319 ± 132	78.4 ± 10.0%	1.80 ± 0.20
Dry			140 ± 21	22 ± 9	78.6 ± 10.3%	

Weevil stocking in 2000 was more successful than in 1999. For some unknown reason, adult and larval weevils also turned up in non-stocked cages (casual observation suggested no weevils prior to stocking). Some dispersal among cages may have occurred, particularly into the closed cages (see also the 1999 experiment), however, the presence of detectable weevils at our transect sites in 1999 and 2000 (Table 6) suggests that caging may have protected already occurring weevils. Throughout the experiment there were more weevils found in the stocked and closed cages than in not-stocked and open cages (Fig. 6, Table 14). A repeated measures ANOVA indicated a significant effect of cage type and stocking on larval density and cage type on adult density (all $P \leq 0.03$). At the end of the experiment, ANOVA indicated a significant cage effect ($p < 0.05$) for larvae (more larvae in closed than in open cages) and a significant ($p < 0.05$) cage and stocking effect for adults (more adults in closed cages and in stocked cages). No interactions were significant. These results suggest that fish (open cages) were reducing the establishment and abundance of weevils.

Table 13. Visual counts (mean number per 100 stems and 1 SE) of weevils in stocked and unstocked cages (open and closed) at Cedar Lake in 1999. There were 5 reps of each treatment combination.

Date	Cage type	Stocked	Eggs	Larvae	Pupae	Adults	Total
7/23/99	Open	No	0.3	6.4	1.7	0.1	8.5
		1 SE	0.3	3.6	1.4	0.1	3.2
	Closed	No	0	3.9	1.1	0.7	5.6
		1 SE	0.0	2.4	0.5	0.3	2.5
	Open	Yes	1.2	5.1	2.3	0.8	9.3
		1 SE	0.5	1.5	1.6	0.5	3.6
	Closed	Yes	0.7	20.1	5.1	1.3	27.2
		1 SE	0.3	11.9	2.9	0.6	11.1
8/5/99	Open	No	0.8	8.3	4.0	0.8	13.9
		1 SE	0.6	4.5	3.7	0.4	8.2
	Closed	No	0.5	4.1	1.6	4.1	10.4
		1 SE	0.3	1.0	0.7	2.9	3.9
	Open	Yes	0.4	2.3	0.3	0.4	3.3
		1 SE	0.4	1.5	0.2	0.3	2.2
	Closed	Yes	2.8	8.5	1.9	2.0	15.2
		1 SE	2.5	4.2	1.6	0.9	7.5
8/17/99	Open	No	0.4	1.2	0.4	0.8	2.8
		1 SE	0.2	0.6	0.3	0.5	0.5
	Closed	No	0.3	8.7	0.8	0.5	10.3
		1 SE	0.2	3.8	0.2	0.4	4.0
	Open	Yes	0.7	1.2	0.8	0.5	3.2
		1 SE	0.3	0.6	0.5	0.5	0.9
	Closed	Yes	0.9	8.8	2.1	1.5	13.3
		1 SE	0.5	5.1	0.7	0.9	5.3

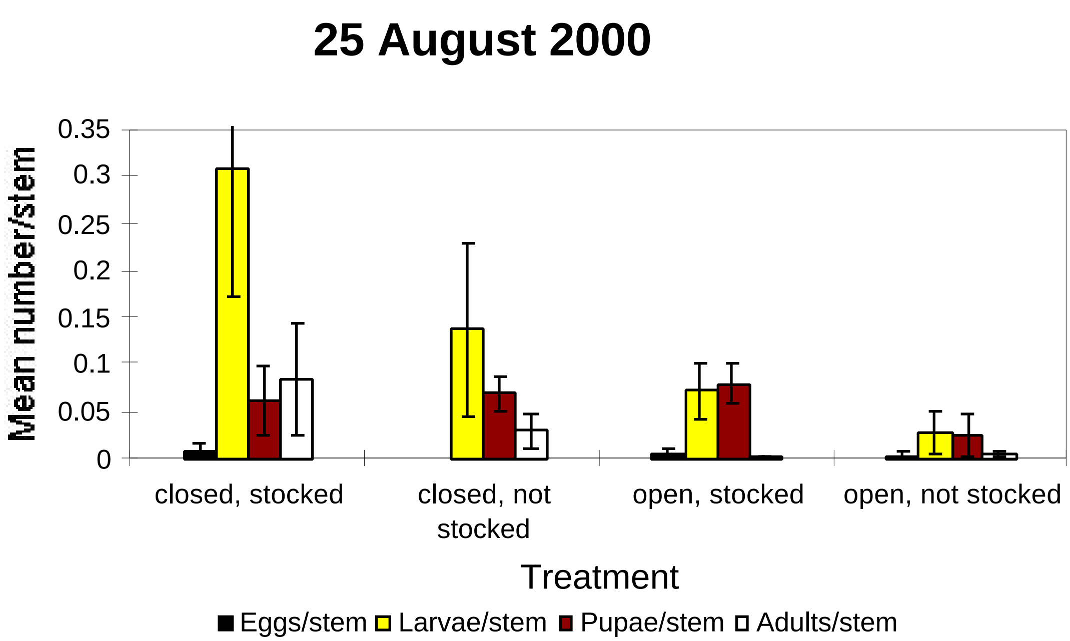


Fig. 6. Number of weevils per treatment (±2SE) at the end of the 2000 cage stocking experiment.

Table 14. Visual counts (mean number per 100 stems) of larvae, pupae and adult weevils in stocked and unstocked cages (open and closed) at Cedar Lake in 2000. There were 5 reps of each treatment combination. The first sample date was 1 week after stocking.

Date	Treatment	Larvae	Pupae	Adults
14-Jul-00	Closed Stocked	5.1	0.0	2.5
	Closed Not Stocked	2.3	0.1	2.9
	Open Stocked	3.2	0.0	1.4
	Open Not Stocked	0.0	0.0	1.2
26-Jul-00	Closed Stocked	18.6	1.5	2.6
	Closed Not Stocked	7.5	0.1	5.3
	Open Stocked	7.5	0.6	0.7
	Open Not Stocked	1.2	0.0	0.7
8-Aug-00	Closed Stocked	6.7	1.2	5.2
	Closed Not Stocked	7.6	1.0	1.7
	Open Stocked	8.7	0.5	4.3
	Open Not Stocked	3.9	0.3	0.3
25-Aug-00	Closed Stocked	30.8	6.2	8.5
	Closed Not Stocked	13.7	6.5	3.1
	Open Stocked	7.3	3.2	0.3
	Open Not Stocked	2.9	4.4	0.5

Table 15. Dry biomass (g/m^2 ± 1SE) of Eurasian watermilfoil (MSP) and non-milfoil plants, % Eurasian watermilfoil and mean number of species per sample for the 2000 cage experiment. The June sample was taken 3 weeks prior to stocking and the August sample was taken 8 weeks after initial stocking. Two samples per cage were taken in June and also in August. N=5 replicate cages per treatment. Open cages allow fish entry, closed cages do not. A total of 150 adult weevils were stocked into each stocked cage.

Date	Cage Type	Stocked	MSP	NonMSP	%MSP	Mean No. spp.
6/14/00	closed	stocked	353.3	25.2	87.8%	2.7
			101.3	11.5	6.5%	0.2
6/14/00	closed	not	425.9	46.9	86.9%	2.3
			84.6	20.2	7.9%	0.3
6/14/00	open	stocked	147.4	13.5	83.4%	2.1
			52.8	6.0	8.6%	0.4
6/14/00	open	not	369.2	42.2	78.4%	2.0
			100.6	26.2	13.3%	0.4
8/31/00	closed	stocked	186.1	37.4	84.0%	1.9
			45.7	30.0	9.9%	0.3
8/31/00	closed	not	255.3	112.9	71.3%	2.0
			66.9	54.5	14.5%	0.0
8/31/00	open	stocked	151.2	14.1	91.7%	1.7
			35.3	10.4	5.9%	0.2
8/31/00	open	not	302.9	28.0	89.4%	1.7
			69.2	16.1	5.7%	0.2

Milfoil biomass was somewhat lower in 2000 than in 1999 and generally declined over the season (Table 15). There was a significant effect of cage ($p = 0.062$) on the difference in milfoil biomass from the beginning to end of the experiment. Stocking and the stocking by cage interaction were not significant. Milfoil biomass decreased more in closed vs open cages, suggesting that excluding fish predation (and the subsequent increase in weevil density noted above) resulted in a decrease in milfoil. In addition, there was a negative relation ($p = 0.1$) between change in milfoil biomass and final larval density (Fig. 7), further suggesting a decrease in milfoil density with more weevils. For 2001 we are repeating these experiments and stocking was completed in early June, more than a month before previous years. The earlier stocking, before the milfoil was flowering, should enhance our ability to detect effects on milfoil.

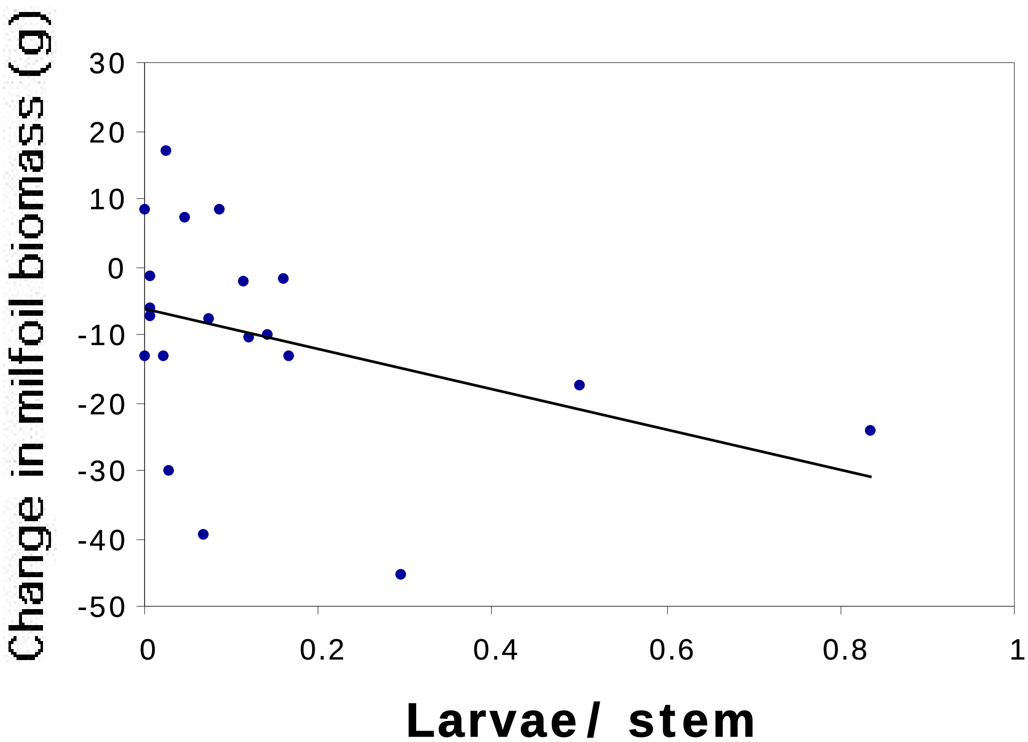


Figure 7. Change in milfoil dry biomass vs larval density at the end of the experiment.

Weevil modelling:

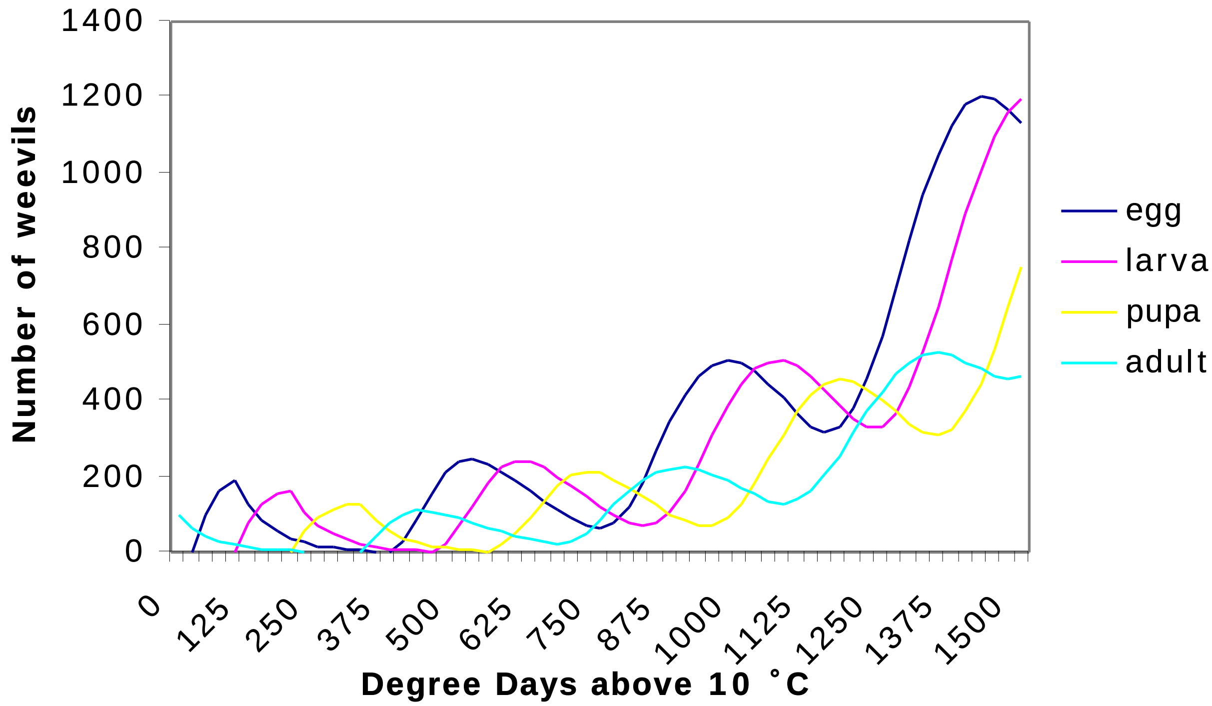
Thermisters at 0.75m depth in Lakes Auburn and Smith's Bay showed that in 1999 early-May minimum temperatures exceeded 10 ˚C in both lakes and by June temperatures averaged over 20 ˚C; temperature continued to increase to a peak of over 30 ˚C in early August and temperature declined rapidly in September from 25 to around 15 ˚C (Appendix II). Temperatures exceed 30 ˚C for several days in late July. To provide a conservative estimate of accumulated degree days, we only included data from mid-May to mid-September when mean daily temperatures were above 15 ˚C (and minima well above 10 ˚C). In both lakes more than 1700 degree days (dd >10 ˚C, the lower thermal threshold) were accumulated, indicating a potential for development of five generations (but see below). In 2000 similar patterns were seen but thermisters were not deployed until early May. Smith's Bay accumulated 1575 dd above 10 ˚C and Lake Auburn 1700 dd.

The stage structure model was parameterized to match proportions of each life stage observed over the summer at Smith's Bay. The parameter estimates that provided the strongest correlations were: an average adult life expectancy of 125 DD, length of the pre-reproductive adult stage of 50 DD, and 0.9 female eggs/female/25 DD. At typical summer temperatures (25 ˚C) there are about 15 DD per day. Based on these estimates the mean generation time calculated from the life table was 450 DD (about 30 days at typical mid-summer lake temperatures). Based on the model, weevil populations increase over the 1500 DD of summer (about the number generally accumulated before September 1st in our lakes). Even though reproduction is continuous, there are obvious peaks and valleys in the abundance of each stage (Fig. 8), however, all stages increase in abundance over the summer. Note that there are only three peaks in the adult population, corresponding to the estimated average generation time. However, 4 generations are possible with slightly more degree days. Thus although the maximum number of generations possible in a summer (from progeny of the first adults) is 4-6 (Newman et al. 1999) it is likely that only 3 or 4 average generations are produced each year (see also Creed and Sheldon 1995, Sheldon and O'Bryan 1996). The last (4th) peaks of eggs and larvae may not mature or eggs may not be laid as egg laying appears to decline in field populations after late August or early September.

Our experiment in 2000 suggest that a females require 1 week to 10 days after eclosion before they start laying eggs. Due to the high variability in our results we are repeating this experiment in 2001. It does suggest, however, that an additional week is required before egg laying starts and this will require an even longer female life span to maintain or increase populations.

The correlation between predicted and observed population stage structure was most sensitive to average adult life expectancy and relatively insensitive to the length of the pre-reproductive adult stage and the oviposition rate. However, weevil density predicted was sensitive to the length of the pre-reproductive adult stage and the oviposition rate, and high correlations could be obtained for the population stage structure at with unreasonable predictions for population density (negative values or unreasonably high).

It should be noted that the resulting model was calibrated based on population stage structure, not density, so density predictions should not be taken literally. However, manipulation of the model will provide insight into sensitive life stages and factors limiting weevil populations. For example, average adult reproductive longevity of 125 DD corresponds to about 8 days at typical summer temperatures and will result in a population increase; adult reproductive longevity of 75 DD (5 days) can also result in a population increase (Fig 8), however, further decreases in adult longevity will result in stable (50DD) or declining populations. An increase of adult longevity from 75DD to 150 DD resulted in an 8 fold increase in fall adult density, underscoring the potential importance of female longevity to mid- and late-summer weevil densities. Because egg laying may not start for 1 week to 10 days after eclosion a total adult life span of 12 to 15 days is required for a stable population.



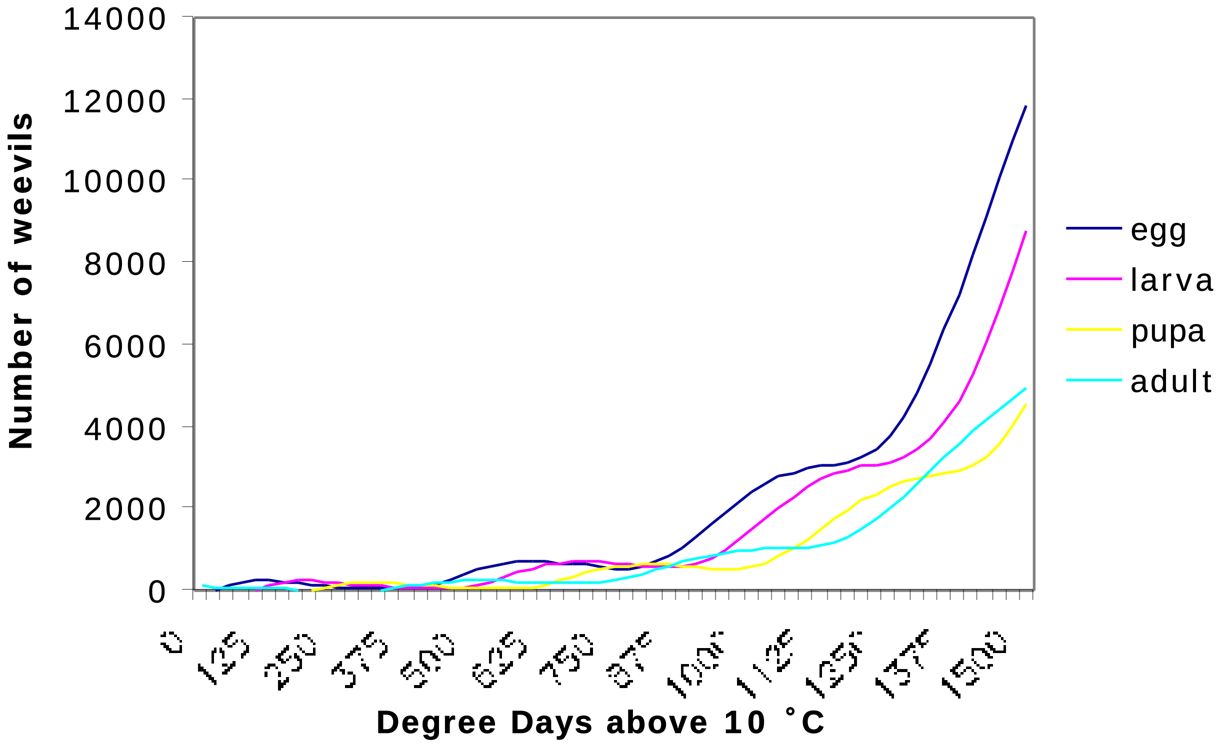


Figure 8. Predicted population density of egg, larvae, pupae and adults over a summer of 1500 degree days above 10 ˚C. Top: Based on average adult longevity of 75 DD (about 5 days). Bottom: Based on average adult longevity of 150 DD (about 10 days). Initial density of adults was 100 and hatch and pupal survival were 0.8, larval survival was 0.7 and egg laying was estimated at 0.9 female eggs/female/25 DD. Development times for each stage were estimated from temperature-development relationships given by Mazzei et al. (1999).

Summary

We have documented one decline that is clearly attributable to weevil stem mining (Newman and Biesboer 2000), and have evidence that milfoil weevils and their damage, at least in the shallower sites, at Lake Auburn, Smith's Bay and possibly Otter Lake, have reduced milfoil abundance. The decline at Cenaiko Lake has persisted; an increase in milfoil in early summer 1998 was met with high weevil populations and a subsequent decrease of milfoil. The decline persisted through the summer of 1999 with milfoil biomass remaining below 2g/m^2 (Newman and Biesboer, 2000) and a slight increase in June 2000 was similarly suppressed; milfoil was 0.1% of total plant biomass in August 2000. It is not certain what permits development of high weevil populations in Cenaiko Lake, however, low predation by sunfish appears to be a factor. All life stages persist throughout the summer and adult densities in September were as high as seen all summer. The fish exclusion results in Cedar Lake further suggest that fish may be limiting weevil populations. If predation by sunfish is shown to be an important limiting factor, it may be feasible to explore fisheries enhancements to the sunfish population and size structure through enhancement of predator populations or fishing regulations. It would be particularly fortuitous if enhancing sport fishing populations would aid in the biological control of Eurasian watermilfoil.

The longer and less dramatic suppression of Eurasian watermilfoil continued at Smith's Bay. The July milfoil biomass (500 g wet/m^2) was the lowest we have seen there since sampling began in the early 1990's. At the shallower sites milfoil remains suppressed and native plants dominate. Northern watermilfoil has returned to the shallowest stations. At deeper sites, with little evidence of weevil damage, Eurasian watermilfoil remains quite dense, but well beneath the surface. A key to success in both Cenaiko and Smith's Bay appears to be the summer-long persistence or increase in weevil density, particularly adults, which in the past, has not been maintained at the other lakes. In Cedar Lake, fair water clarity and the very low weevil densities resulted in a continued high density Eurasian watermilfoil that persisted through the summer. DNR fisheries surveys have consistently indicated a high density of bluegills at Cedar Lake (60-90 per trapnet) and the other lakes in the Minneapolis Chain-of-Lakes.

Milfoil increased greatly at Otter Lake in the spring of 2000, to a biomass similar to historic highs, but weevil populations increased and the milfoil declined and remained below 90 g dry/m^2. If weevil densities continue to increase in Otter Lake they may be able to suppress the plant. Climatic factors may have been generally favorable to weevils in 2000 because this is the highest density of weevils we have observed at Otter, however biweekly surveys in 2001 indicate an even higher density of weevils this spring. DNR Fisheries surveys in Otter in 1997 indicated a low density of bluegills (2.1 per trapnet).

The response of Lake Auburn remains puzzling. The early season decline of milfoil in 1998 was associated with relatively low weevil densities but much apparent damage (personal observation). However, for some reason the weevil population crashed and the poor light probably prevented regrowth of milfoil and other plants. Although no weevils were found in 1999 they returned in 2000 and although they did not reach high densities the population increased and persisted through the summer. Due to poor visibility it is difficult to tell if sunfish populations are high, however surveys conducted by Pothoven (1996) in Cedar and Auburn suggest similar high densities of sunfish in both lakes during 1993-1995, with sunfish increasing from 1993 to 1995. DNR Fisheries surveys reported 62 bluegill per trapnet in Auburn in 1995; this density increased to 110 per trapnet in 2000. In some ways, the recent milfoil decline is similar to that observed in 1993; weevil populations declined in 1995 and milfoil increased to record levels. It remains to be seen if the factors limiting weevil populations have been reduced and if milfoil will remain suppressed, at least below the high densities of the mid 1990s.

We will collate additional fisheries information to determine if there is any relationship between sunfish density and weevil densities. Unfortunately, the typical 5 or more years between fisheries surveys may not capture important changes in fish populations. For example, sunfish density in Cenaiko declined from 95 per trapnet in 1992 to 5 per trapnet in 1998.

It is possible that other herbivores in addition to the milfoil weevil are affecting milfoil

populations. Johnson et al. (1998, 2000) have shown milfoil declines in New York associated with high densities of *Acentria*. They suggest that in many lakes *Acentria* may be more important than the milfoil weevil and they also suggested competition between *Acentria* and *Euhrychiopsis*. *Acentria* and *Parapoynx* have been at low densities in all of our lakes with the exception of Cenaiko Lake and, in 1996-1997, Otter Lake (Table 6). The high densities in Otter Lake (20-100 per m^2) were noted the summer following the decline of milfoil when milfoil densities ranged from not detectable to <25 g wet/m^2. Most caterpillars were associated with plants other than Eurasian watermilfoil. Thus, the caterpillars may be assisting with milfoil suppression following a decline but we have little evidence that they are initiating declines. Furthermore, if fish predation is limiting weevil densities it likely would limit caterpillar densities. We do not have high caterpillar densities in our lakes that have few weevils and high sunfish densities. More analysis of these interactions is required.

Two conditions are needed for successful biological control of weeds: adequate agent densities and a negative response of the target to the control agent (Newman et al. 1998). At sites with persistent control of milfoil, the native plant community has expanded. It is also clear that at many of our sites weevil populations have not built to adequate densities, although weevil densities in 2000 appeared higher in all lakes, and these populations appear to have at least contained milfoil growth in all except Cedar during 2000. Cenaiko Lake provides a clear example of the potential for high weevil populations and subsequent effects on milfoil. Given the potential for population increase in the summer, and the lack of a strong correlation between in-lake and onshore densities, it does not appear that overwinter populations are the main limiting factor (Newman et al. *in review*) at least at Lake Auburn and Smith's Bay where detectible populations have been found in early summer each year. Fish exclusion experiments suggest that fish predation could be one important factor.

It is clear that we do not yet have adequate information to reliably predict if and when insects will cause declines in milfoil populations or if the declines will persist (Creed 2000). It is also clear that milfoil suppression can be obtained given adequate densities of weevils throughout the summer, and perhaps positive plant community response. On-going focused research should shed additional light on the factors that regulate weevil populations and their effects on plant communities. Once these factors have clearly been identified, management strategies, such as piscivore enhancement or water clarity improvements can be tested to determine their feasibility for enhancing the biological control of Eurasian watermilfoil.

Conclusions

- Declines in Eurasian watermilfoil biomass persisted through 2000 at Cenaiko Lake and native plants remain abundant. Milfoil increased dramatically in June 2000 at Otter Lake but was suppressed in July. In Smith's Bay, milfoil remained suppressed at the shallower sites with high non-milfoil biomass and high weevil densities, but remained dense at the deeper sites that show little evidence of weevil damage. Milfoil increased in spring 2000 at Lake Auburn from the very low densities of 1999, but remained at moderate levels through the summer. Milfoil density remained high at Cedar Lake and composed ≥75% of plant biomass.

- Bi-weekly weevil surveys showed that weevils had disappeared from Lake Auburn in July 1998 and were absent in 1999, but returned to the lake in 2000 and persisted throughout the summer. Weevil densities at Cenaiko and Smith's Bay were moderate and all stages persisted throughout summer 2000. Weevils were abundant at Otter Lake in 2000 and may have suppressed the high density of milfoil in early summer from increasing to historical levels. In general, weevil densities in 2000 appeared to be higher and more persistent in more lakes than in previous years.

- The fish exclusion experiment in Cedar lake provided some evidence that fish predation may limit weevil populations and that milfoil is depressed with increasing weevil densities.

- Weevil temperature-development models are useful for predicting trends and matching field observations. A stage based model suggests that 3 or 4 average generations are produced per year, that adult reproductive longevity of 50 to 125 degree days is required to sustain populations and that adult longevity is important to developing high weevil densities later in the summer.

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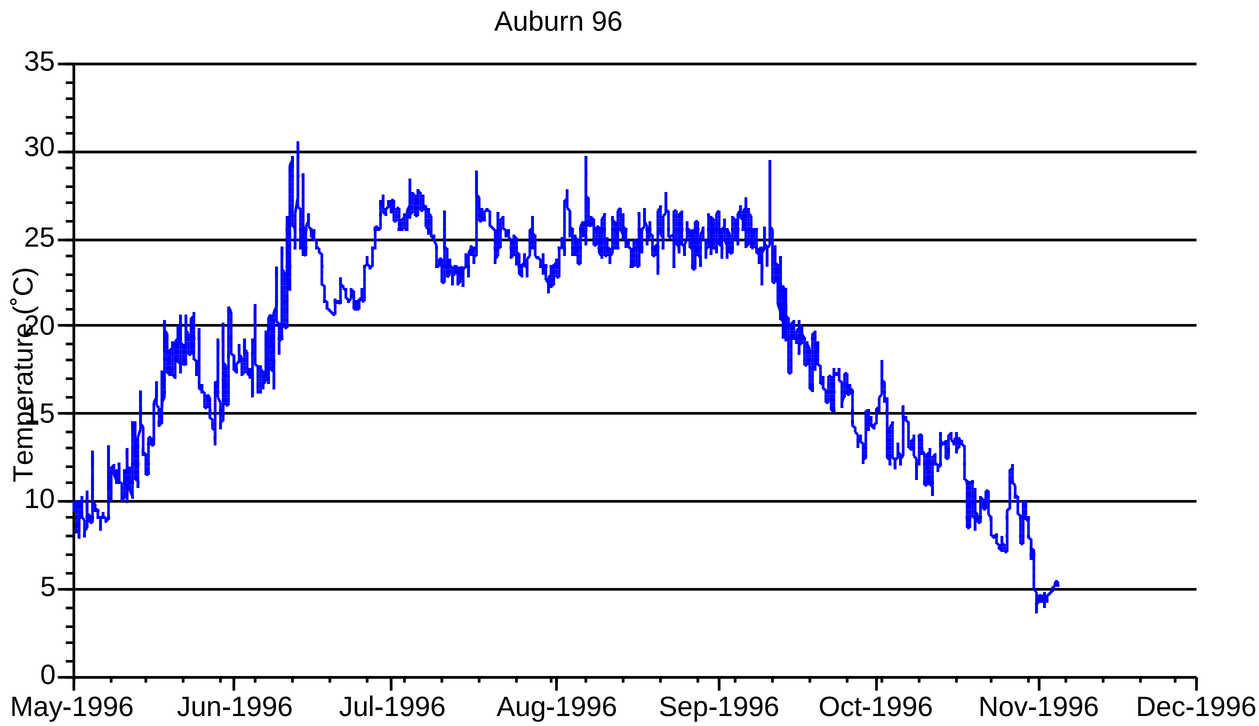
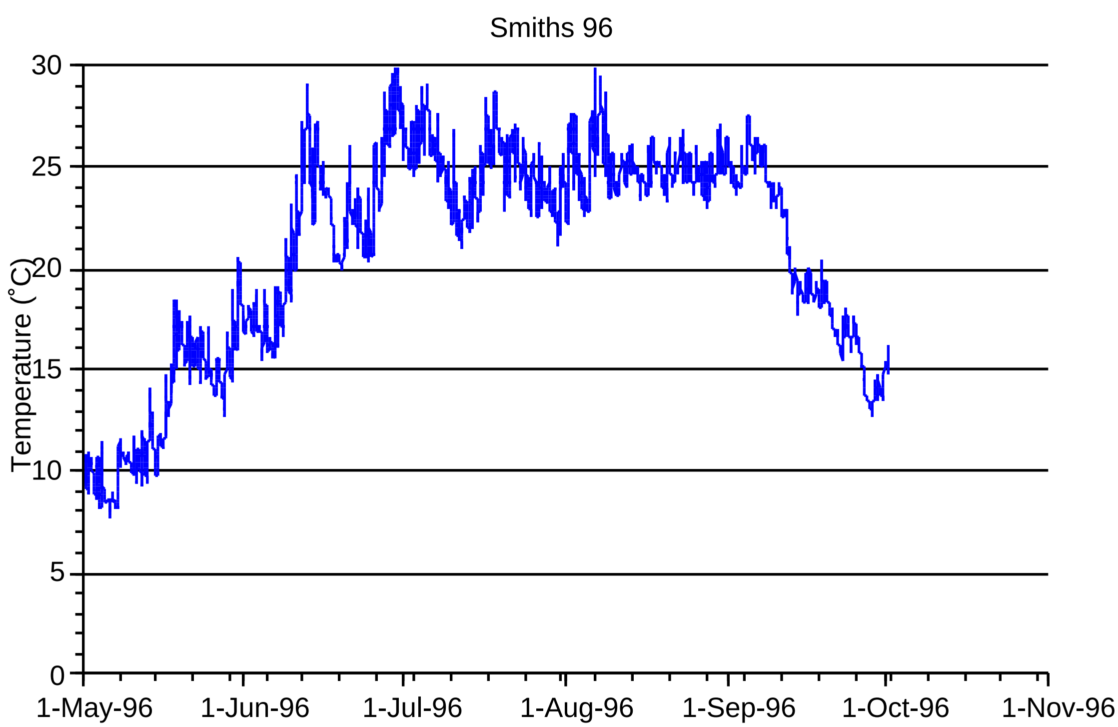
Appendix I. Abbreviations of plants collected from 1994 through 2000. Dry biomass for all species is reported in Appendix III.

Key to plant abbreviations used in this report.

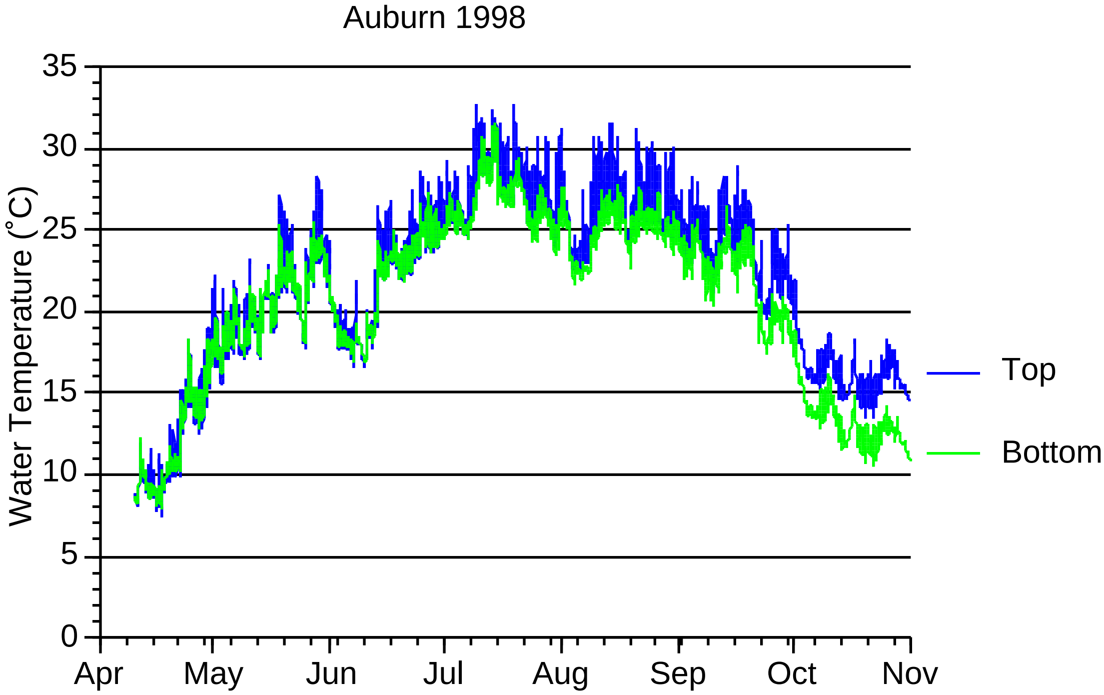
CHA	*Chara* spp. (muskgrass)
CRT	*Ceratophyllum demersum* (coontail)
ELD	*Elodea canadensis* (Canada waterweed)
HET	*Heteranthera dubia* (mud plantain) = *Zosterella dubia*
LMR	*Lemna minor* (lesser duckweed)
LTR	*Lemna trisulca* (star duckweed)
MGD	*Megalodonta beckii* (water marigold)
MSI	*Myriophyllum sibiricum* (northern watermilfoil)
MSP	*Myriophyllum spicatum* (Eurasian watermilfoil)
NAJ	*Najas* spp.
NMP	*Nymphaea* spp.
NUP	*Nuphar* spp.
PAM	*Potamogeton amplifolius* (largeleaf pondweed)
PBE	*Potamogeton berchtoldi* (Berchtolds' pondweed)
PCR	*Potamogeton crispus* (curled pondweed)
PDI	*Potamogeton diversifolius*
PEC	*Potamogeton pectinatus* (sage pondweed)
PFO	*Potamogeton foliosus* (leafy pondweed)
PGR	*Potamogeton gramineus* (variable pondweed)
PIL	*Potamogeton illinoensis* (Illinois pondweed)
PNA	*Potamogeton natans*(floating leaf pondweed)
PNO	*Potamogeton nodosus* (river pondweed)
PRI	*Potamogeton richardsonii* (claspingleaf pondweed)
PRO	*Potamogeton robbinsii* (Robins' pondweed)
PSP	*Potamogeton spirillus* (snailedseed pondweed)
PZS	*Potamogeton zosteriformis* (flatstem pondweed)
RAN	*Ranunculus* spp. (white water buttercup)
SPO	*Spirodela polyrhiza* (greater duckweed)
VAL	*Vallisneria americana* (wild celery)
UTV	*Utricularia vulgaris* (bladderwort)

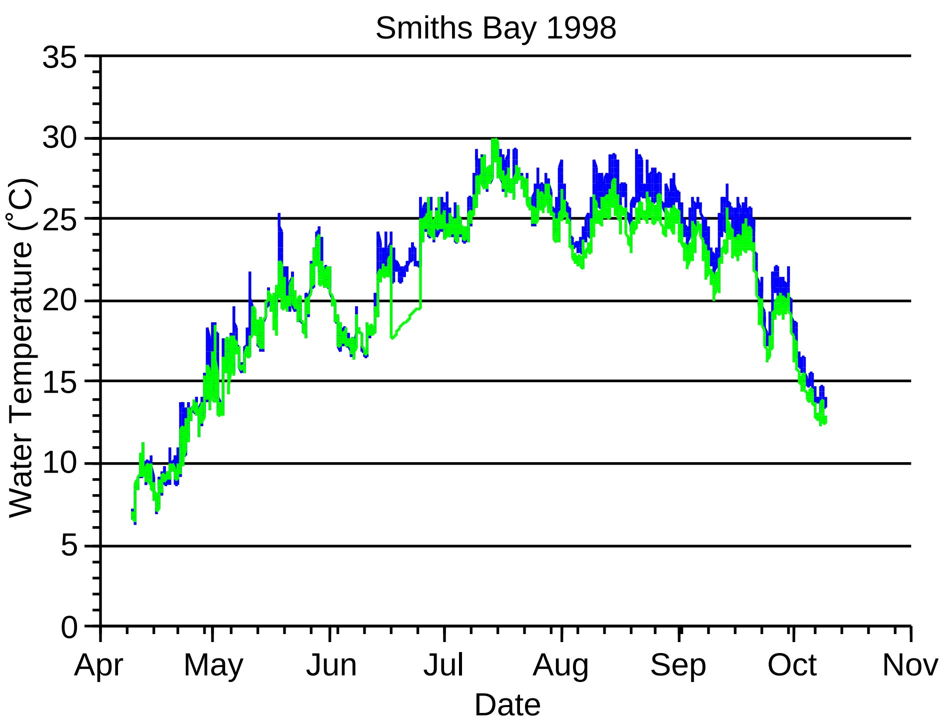
Appendix II. Temperature at 0.75m depth in Lake Auburn and Smith’s Bay 1996.



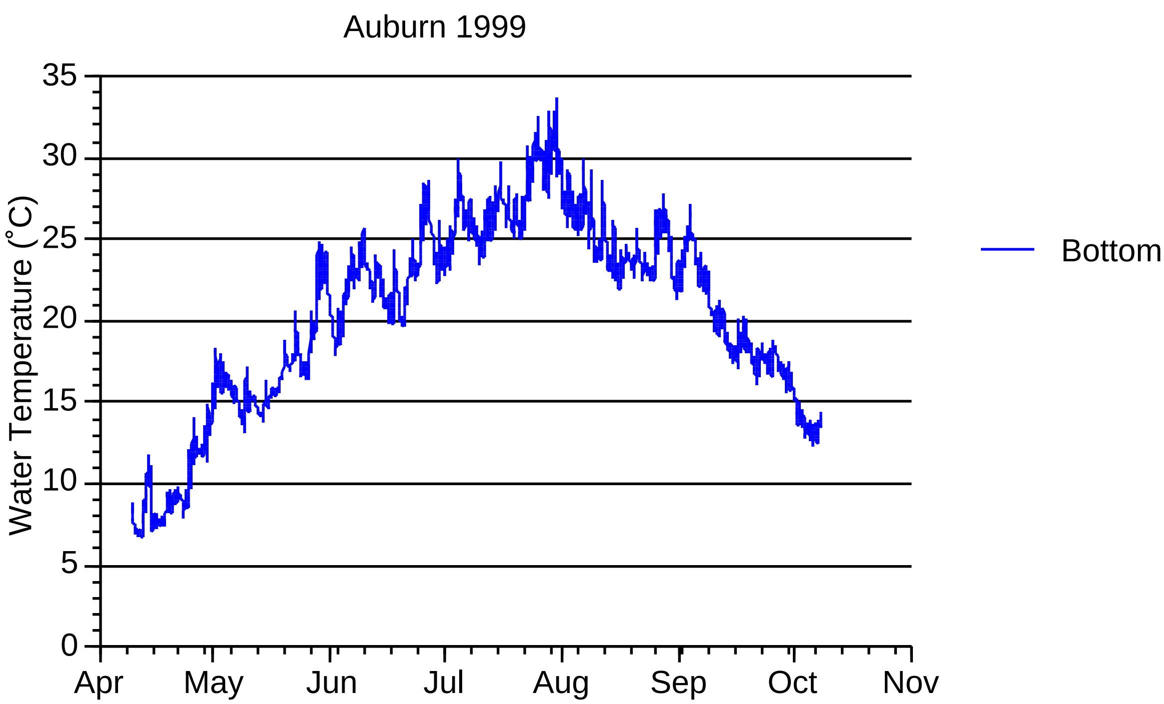


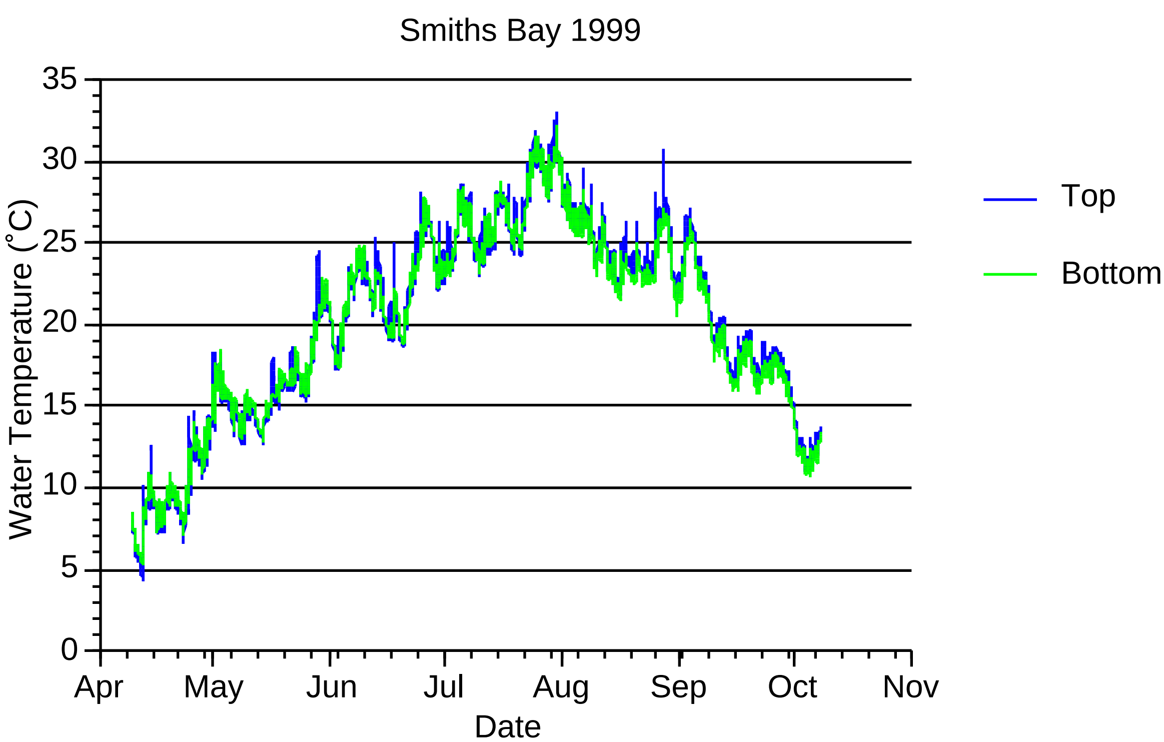
Appendix II continued. Temperature at 0.75m depth (bottom) and surface (top) in Lake Auburn and Smith's Bay 1998. Buoy damage (sinking) at Smith's Bay in the last two weeks of June resulted in a sharp decline in temperature; during this time, the top thermistor was at about 0.75m depth and the bottom thermistor was in the bottom sediments. The float was repaired at the end of June.



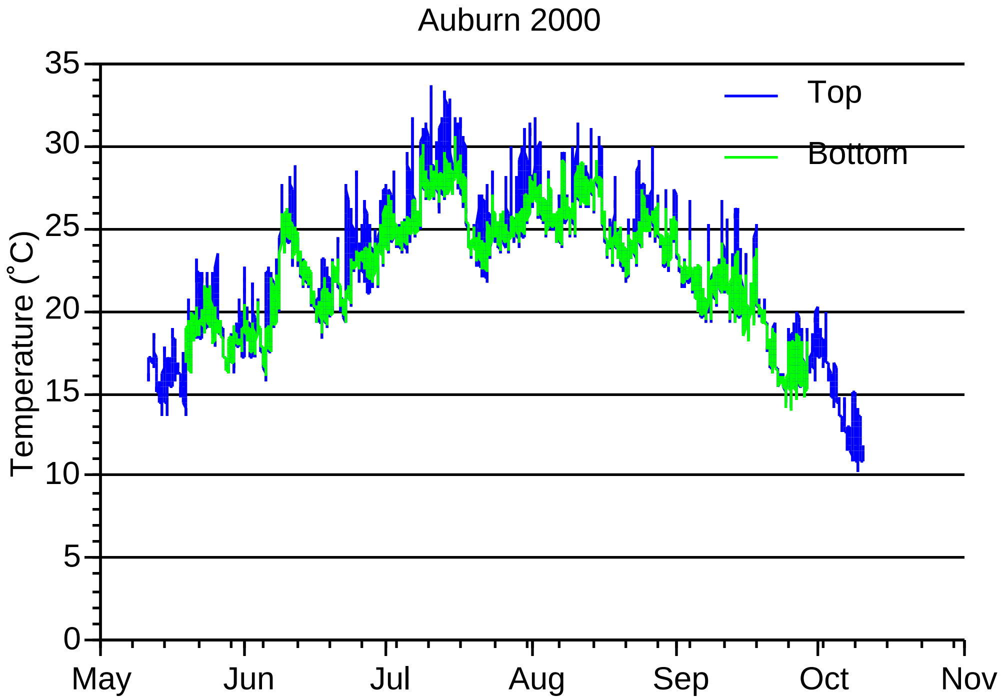


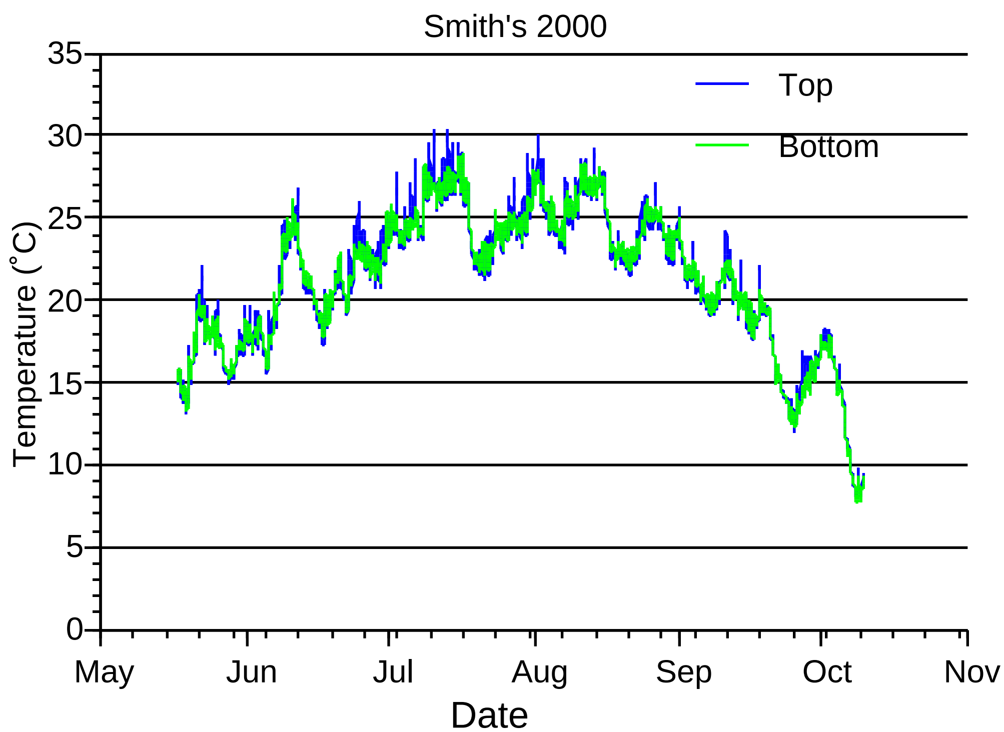
Appendix II continued. Temperature at 0.75m depth (bottom) in Lake Auburn and at surface (top) and 0.75m depth in Smith’s Bay 1999.





Appendix II continued. Temperature at 0.75m depth (bottom) and surface (top) in Lake Auburn and Smith's Bay 2000.





Dry biomass		g dry/m2																														
Auburn	Total	MSP	MSI	CRT	ELD	PZS	NAJ	PCR	HET	PEC	PRI	VAL	LTR	PDI	NMP	PRO	PIL	ALG	MGD	CHA	PAM	PGR	PFO	RAN	PSP	PBE	SPO	BRA	%MSP	nonMSP	%NatCRT	No. Spp.
6/7/95	344.1	279.6	0.0	58.6	4.6	1.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	82.0%	64.4	63.6%	2.2
1 S.E.	42.5	43.0	0.0	22.8	3.0	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7%	23.0	7.9%	0.2
7/31/95	421.2	267.0	0.0	141.0	2.9	7.4	0.7	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	62.6%	154.2	74.5%	3.4
1 S.E.	53.6	46.3	0.0	41.7	1.9	2.5	0.7	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8%	41.6	7.6%	0.3
9/26/95	648.1	550.9	0.0	61.2	33.6	0.2	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.6%	97.2	80.2%	2.2
1 S.E.	85.9	94.3	0.0	19.9	33.1	0.2	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2%	35.7	9.4%	0.2
6/12/96	431.4	306.0	0.0	123.2	0.8	0.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	72.4%	125.2	91.1%	2.9
1 S.E.	46.7	40.1	0.0	39.4	0.4	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.5%	39.8	4.6%	0.2
7/30/96	586.2	390.2	0.0	183.4	1.1	0.4	0.4	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.0%	201.0	89.9%	2.8
1 S.E.	85.3	82.2	0.0	40.8	0.5	0.2	0.4	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8%	43.2	5.5%	0.3
9/12/96	475.3	360.9	0.4	110.0	0.2	0.0	0.6	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	69.7%	112.6	87.2%	2.5
1 S.E.	49.6	49.4	0.4	24.0	0.1	0.0	0.5	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2%	24.1	5.6%	0.2
6/27/97	387.9	293.6	0.4	93.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	50.8	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	60.9%	94.4	96.8%	3.0
1 S.E.	47.0	45.7	0.4	16.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	12.4	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	6.8%	16.3	1.6%	0.1
9/8/97	464.0	320.5	2.6	127.6	0.2	0.2	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	12.0	0.0	0.0	12.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61.2%	143.5	91.6%	2.6
1 S.E.	49.3	48.5	2.5	22.4	0.2	0.1	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	7.8	0.0	0.0	6.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2%	23.9	3.9%	0.2
6/8/98	226.5	120.9	0.2	110.0	0.2	0.8	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	1.9	0.0	0.0	33.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.0%	109.6	97.0%	2.4
1 S.E.	20.1	18.2	0.2	17.1	0.2	0.5	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	1.9	0.0	0.0	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2%	17.0	2.1%	0.2
7/27/98	276.6	67.0	0.0	189.9	0.9	0.8	1.9	0.0	0.1	5.5	0.0	0.0	0.0	0.0	9.1	0.0	0.0	10.2	0.0	0.2	0.0	0.0	0.9	0.1	0.0	0.0	0.0	0.0	26.7%	209.6	89.3%	3.0
1 S.E.	34.2	15.5	0.0	34.7	0.6	0.5	1.4	0.0	0.1	3.3	0.0	0.0	0.0	0.0	5.7	0.0	0.0	4.6	0.0	0.2	0.0	0.0	0.9	0.1	0.0	0.0	0.0	0.0	4.9%	34.0	3.7%	0.2
9/8/98	163.1	47.7	1.3	108.7	0.0	0.0	1.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.0%	117.0	95.1%	2.4
1 S.E.	16.9	7.3	1.3	15.8	0.0	0.0	0.7	0.0	0.0	0.2	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1%	16.5	2.4%	0.1
6/22/99	198.8	23.8	0.0	125.6	0.0	0.3	0.0	4.4	1.1	0.3	0.0	0.0	0.0	0.0	14.0	0.0	0.0	29.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.6%	145.8	0.9	3.0
1 S.E.	25.9	7.2	0.0	22.4	0.0	0.2	0.0	2.2	0.8	0.2	0.0	0.0	0.0	0.0	8.8	0.0	0.0	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3%	22.2	0.0	0.2
8/23/99	88.1	25.2	0.0	55.6	0.0	0.2	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	36.3%	62.9	0.9	1.9
1 S.E.	19.4	8.6	0.0	16.5	0.0	0.2	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	6.8%	17.5	0.0	0.1
6/19/00	334	207.6	0.0	115.4	0.0	0.5	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	50.9%	125.8	43.0%	3.2
1 SE	38	39.0	0.0	20.2	0.0	0.3	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	6.3%	20.6	5.8%	0.2
7/17/00	222	115.5	3.3	95.5	0.0	0.1	0.0	0.2	0.0	0.0	0.00	0.0	0.0	0.0	1.4	0.0	0.0	5.5	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	42.0%	100.8	51.2%	2.7
1 SE	38	31.6	2.7	19.6	0.0	0.1	0.0	0.1	0.0	0.0	0.00	0.0	0.0	0.0	0.9	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	6.7%	20.0	6.8%	0.2
8/24/00	165	91.0	0.4	59.0	0.0	0.1	0.0	0.0	0.0	0.4	0.00	0.0	0.0	0.0	14.1	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.5%	74.3	37.5%	2.3
1 SE	17	14.2	0.4	11.3	0.0	0.1	0.0	0.0	0.0	0.4	0.00	0.0	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7%	12.4	5.8%	0.1
Cenaiko	Total	MSP	MSI	CRT	ELD	PZS	NAJ	PCR	HET	PEC	PRI	VAL	LTR	PDI	NMP	PRO	PIL	ALG	MGD	CHA	PAM	PNO	PFO	RAN	PSP	PBE	SPO	DRC	%MSP	nonMSP	%NatCRT	No. Spp.
7/22/96	242.9	122.9	0.0	95.5	0.0	0.0	0.2	0.8	0.3	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	20.7	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	63.0%	120.0	58.5%	2.5
1 S.E.	38.0	22.3	0.0	34.4	0.0	0.0	0.2	0.4	0.3	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	20.2	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	6.8%	38.0	8.4%	0.2
9/23/96	213.1	23.4	0.0	146.0	0.0	0.0	0.0	0.0	0.1	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.5	0.0	41.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.6%	189.8	74.1%	2.3
1 S.E.	63.9	6.9	0.0	56.0	0.0	0.0	0.0	0.0	0.1	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	39.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8%	64.8	9.3%	0.2
7/16/97	97.0	0.9	0.0	81.6	0.0	0.1	1.5	2.0	0.9	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	3.4	0.8	0.0	0.0	0.0	0.0	0.0	3.7%	96.1	63.8%	2.1
1 S.E.	27.5	0.7	0.0	28.2	0.0	0.1	1.5	0.7	0.5	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	2.8	0.7	0.0	0.0	0.0	0.0	0.0	2.8%	27.4	8.2%	0.2
9/17/97	130.0	4.7	0.0	86.1	0.0	0.0	0.2	1.6	12.5	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	12.2	5.1	0.0	0.0	0.0	0.0	0.0	0.0	6.5%	125.3	50.8%	2.2
1 S.E.	30.3	2.1	0.0	30.3	0.0	0.0	0.2	1.1	6.5	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	12.2	4.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6%	30.3	8.6%	0.2
6/16/98	265.3	44.2	0.0	164.5	0.1	0.0	11.7	13.4	12.7	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2	1.3	8.7	0.0	0.0	0.0	0.0	0.0	0.0	15.7%	221.1	56.6%	3.0
1 S.E.	40.0	16.2	0.0	40.2	0.1	0.0	10.2	9.6	7.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.4	1.3	8.7	0.0	0.0	0.0	0.0	0.0	0.0	5.0%	38.4	8.9%	0.2
7/29/98	390.5	44.4	0.0	199.6	0.0	0.0	5.7	0.0	36.9	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	64.8	32.8	1.4	0.0	0.0	0.0	0.0	0.0	0.0	13.9%	346.1	48.0%	2.9
1 S.E.	83.3	20.0	0.0	60.2	0.0	0.0	4.2	0.0	16.7	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	59.2	23.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	4.7%	82.0	8.9%	0.3
9/14/98	247.7	12.5	0.0	142.3	0.0	0.0	8.9	0.2	40.6	15.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	17.0	6.4	0.0	0.0	0.0	0.0	0.0	0.0	7.8%	235.2	47.8%	3.0
1 S.E.	41.4	4.7	0.0	43.0	0.0	0.0	6.6	0.1	13.8	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	14.4	6.4	0.0	0.0	0.0	0.0	0.0	0.0	3.0%	41.9	8.2%	0.2
6/24/99	53.7	1.3	0.0	32.2	0.0	0.2	0.8	1.8	3.0	0.8	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	12.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	7.9%	52.4	42.7%	1.9
1 S.E.	17.0	0.9	0.0	12.0	0.0	0.2	0.8	0.8	2.5	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	10.7	0.0	0.0	0.0	0.0	0.0	0.0	0.2	5.2%	17.1	8.6%	0.2
8/2/99	214.6	1.1	0.0	124.5	0.0	0.0	2.0	0.7	26.7	21.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.1	4.2	0.0	0.0	0.0	0.0	0.0	0.0	1.0%	213.5	54.5%	2.6
1 S.E.	40.1	0.8	0.0	37.5	0.0	0.0	1.2	0.5	9.7	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.6	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.7%	40.2	6.8%	0.2
8/26/99	55.0	0.0	0.0	30.2	0.0	0.1	0.0	0.0	5.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	55.0	37.4%	1.5
1 S.E.	20.1	0.0	0.0	20.1	0.0	0.1	0.0	0.0	3.4	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	20.1	8.8%	0.1
6/29/00	226	10.0	0.0	123.9	0.0	0.0	6.0	0.8	16.3	3.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.0	19.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1%	215.9	47.8%	2.1
1 SE	34	5.2	0.0	31.2	0.0	0.0	5.7	0.7	8.2	2.2	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.1	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7%	33.1	8.7%	0.2
7/20/00	147	3.7	0.0	86.4	0.0	0.0	0.7	0.0	19.5	3.7	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.5	18.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.4%	143.2	35.1%	2.4
1 SE	24	2.2	0.0	22.5	0.0	0.0	0.4	0.0	10.1	3.5	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4	11.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1%	24.1	9.2%	0.3
8/30/00	134	0.1	0.0	89.4	0.0	34.5	2.9	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	1.7	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.1%	129.4	53.1%	1.8
1 SE	22	0.1	0.0	23.5	0.0	14.9	2.9	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	1.5	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.1%	22.8	9.7%	0.2

Cedar	Total	MSP	MSI	CRT	ELD	PZS	NAJ	PCR	HET	PEC	PRI	VAL	LTR	PDI	NMP	PRO	PIL	ALG	MGD	CHA	PAM	PGR	PFO	RAN	PSP	PBE	SPO	UTV	%MSP	nonMSP	%NatCRT	No. Spp.
6/19/95	260.3	245.3	0.0	13.1	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	84.4%	19.2	65.2%	1.4
1 S.E.	68.8	67.0	0.0	4.5	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	7.0%	5.5	11.2%	0.2
8/2/95	203.3	172.3	0.0	31.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	67.8%	31.0	90.0%	1.7
1 S.E.	78.4	78.7	0.0	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	11.8%	9.6	10.0%	0.2
9/28/95	65.6	37.5	0.0	28.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	37.0%	31.9	100.0%	1.4
1 S.E.	18.3	13.2	0.0	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	10.2%	9.2	0.0%	0.2
6/18/96	76.8	58.5	0.0	15.8	0.0	0.1	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	55.6%	23.2	79.9%	2.1
1 S.E.	25.1	24.4	0.0	6.4	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	7.4%	8.1	7.2%	0.2
8/1/96	83.4	61.7	0.0	21.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	60.3%	32.0	83.3%	1.4
1 S.E.	23.3	19.6	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	8.1%	11.4	8.1%	0.2
9/16/96	80.7	50.3	2.7	27.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	68.1%	45.1	95.0%	1.6
1 S.E.	19.1	14.4	2.7	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	6.1%	12.1	5.0%	0.2
7/8/97	243.8	210.4	0.0	32.8	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.031	0.0	0.0	84.8%	34.1	64.2%	1.6
1 S.E.	45.0	39.9	0.0	8.6	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.031	0.0	0.0	4.1%	9.1	9.0%	0.2
9/11/97	292.9	270.9	0.0	22.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	88.1%	22.0	58.6%	1.4
1 S.E.	54.8	55.0	0.0	10.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	0.0	4.4%	10.9	9.3%	0.0
6/18/98	260.3	213.4	0.0	42.5	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	82.4%	46.9	82.9%	1.7
1 S.E.	54.8	51.5	0.0	17.7	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0%	17.6	8.1%	0.1
9/16/98	393.8	367.1	0.0	26.4	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	82.1%	26.7	93.0%	1.6
1 S.E.	63.7	63.4	0.0	8.6	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3%	8.5	5.2%	0.1
6/23/99	273.8	251.9	0.0	21.1	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	83.5%	21.9	89.0%	1.9
1 S.E.	49.5	50.2	0.0	8.1	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8%	8.0	6.1%	0.1
8/24/99	136.8	105.0	0.0	31.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.2%	30.5	100.0%	1.4
1 S.E.	21.5	15.2	0.0	19.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7%	19.8	0.0%	0.1
6/23/00	281	219.1	0.0	58.7	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.0%	62.2	20.6%	1.6
1 SE	35	37.5	0.0	21.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0%	21.4	6.5%	0.1
8/8/00	198	175.0	0.0	21.7	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.0%	22.6	21.8%	1.7
1 SE	26	28.0	0.0	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0%	6.1	6.5%	0.1
Otter	Total	MSP	MSI	CRT	ELD	PZS	NAJ	PCR	HET	PEC	PRI	VAL	LTR	PDI	NMP	PRO	PIL	ALG	MGD	CHA	PAM	PGR	PFO	RAN	PSP	PBE	SPO	UTV	%MSP	nonMSP	%NatCRT	No. Spp.
6/22/95	408.7	312.4	0.0	43.9	40.0	4.5	0.0	0.1	0.8	0.3	0.0	0.0	1.3	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.003	0.0	79.6%	96.4	62.1%	4.7
1 S.E.	36.1	33.1	0.0	9.2	28.9	1.1	0.0	0.1	0.3	0.3	0.0	0.0	0.2	0.0	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.003	0.0	4.5%	34.1	5.2%	0.2
8/9/95	212.1	171.0	0.0	17.0	20.0	2.1	0.0	0.0	0.7	0.5	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.000	0.0	80.8%	41.0	61.0%	4.3
1 S.E.	27.6	28.7	0.0	7.3	13.5	1.2	0.0	0.0	0.7	0.4	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.000	0.0	6.6%	15.3	8.8%	0.3
9/29/95	208.7	194.0	0.0	10.7	2.2	1.6	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	93.6%	14.7	42.7%	2.4
1 S.E.	25.3	23.5	0.0	3.3	1.6	1.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.0	1.4%	3.8	10.9%	0.3
6/19/96	34.4	1.6	0.0	21.4	6.2	2.9	0.0	0.0	0.3	0.4	0.0	0.0	0.5	0.0	1.1	0.0	0.0	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.9%	32.8	60.1%	5.2
1 S.E.	7.1	0.5	0.0	4.7	3.7	1.0	0.0	0.0	0.1	0.2	0.0	0.0	0.1	0.0	1.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6%	7.1	6.1%	0.3
8/6/96	121.2	0.1	0.0	56.9	7.8	44.0	0.0	0.0	3.1	7.3	0.6	0.0	0.5	0.0	0.0	0.0	0.0	4.1	0.0	0.4	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.1%	121.1	41.2%	4.2
1 S.E.	18.2	0.1	0.0	11.5	2.6	11.7	0.0	0.0	1.4	4.5	0.5	0.0	0.1	0.0	0.0	0.0	0.0	1.7	0.0	0.3	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.1%	18.1	4.7%	0.2
9/17/96	178.4	0.0	0.0	45.2	25.3	27.3	0.0	0.0	32.3	22.3	0.3	0.0	0.3	0.0	8.3	0.0	0.0	0.0	0.0	17.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	178.4	27.4%	3.9
1 S.E.	30.1	0.0	0.0	12.0	19.3	10.2	0.0	0.0	9.5	8.4	0.3	0.0	0.1	0.0	7.4	0.0	0.0	0.0	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	30.1	4.8%	0.3
7/2/97	186.7	2.6	0.0	5.7	15.7	74.1	0.0	0.1	0.0	1.6	6.6	0.1	0.1	0.0	2.5	0.0	0.0	11.1	0.9	76.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1%	184.0	5.5%	4.3
1 S.E.	27.6	2.6	0.0	2.0	4.6	20.3	0.0	0.1	0.0	1.6	6.2	0.1	0.0	0.0	2.5	0.0	0.0	2.7	0.9	25.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0%	27.5	1.9%	0.3
9/15/97	294.8	0.3	0.0	12.0	59.8	32.6	0.0	0.0	96.9	4.8	0.0	0.0	0.0	0.0	38.7	0.0	0.0	0.1	0.2	48.4	0.3	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.1%	294.5	4.8%	4.8
1 S.E.	34.3	0.3	0.0	5.6	19.0	9.0	0.0	0.0	15.8	2.0	0.0	0.0	0.0	0.0	24.6	0.0	0.0	0.1	0.2	15.8	0.3	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.1%	34.3	1.8%	0.3
6/10/98	189.4	6.7	0.1	11.2	78.2	27.5	0.0	0.6	28.0	1.0	0.2	0.0	0.3	0.0	1.8	0.0	0.0	1.0	0.0	30.4	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	4.0%	182.7	4.3%	5.4
1 S.E.	24.0	4.5	0.0	5.4	21.7	8.1	0.0	0.6	7.7	0.7	0.1	0.0	0.1	0.0	1.8	0.0	0.0	0.6	0.0	11.6	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	1.8%	24.0	1.8%	0.2
9/10/98	131.8	15.2	0.0	18.7	39.9	3.1	1.3	0.0	46.5	0.1	0.1	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.3	1.1	0.0	4.9	0.0	0.3	0.0	0.0	0.0	0.0	19.1%	116.6	10.7%	4.7
1 S.E.	24.2	3.5	0.0	7.2	19.0	1.0	1.2	0.0	11.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.3	1.0	0.0	4.8	0.0	0.1	0.0	0.0	0.0	0.0	4.7%	24.2	3.6%	0.4
6/18/99	71.0	24.7	0.2	3.1	12.1	4.9	0.0	0.3	8.0	0.1	6.3	0.0	0.1	0.0	4.5	0.0	0.0	0.1	0.0	0.0	3.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	30.4%	46.2	10.3%	4.5
1 S.E.	12.5	7.8	0.1	1.2	8.8	1.3	0.0	0.2	2.7	0.1	4.6	0.0	0.0	0.0	4.5	0.0	0.0	0.1	0.0	0.0	2.5	0.0	0.0	1.7	0.0	0.0	0.0	0.0	5.9%	10.5	4.5%	0.3
7/29/99	103.0	35.9	0.7	8.6	18.8	17.0	0.8	0.5	7.9	1.6	5.7	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	36.7%	67.1	17.7%	5.3
1 S.E.	14.5	8.1	0.4	2.3	9.8	4.9	0.6	0.4	2.4	0.9	5.6	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	4.9%	12.9	5.2%	0.3
6/6/00	375	331.4	0.1	20.8	12.9	4.6	0.0	0.1	0.0	0.0	1.2	0.0	0.1	0.0	1.5	0.0	0.0	0.5	0.1	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	83.1%	42.8	6.7%	4.3
1 SE	42	42.0	0.1	5.8	4.0	1.0	0.0	0.1	0.0	0.0	0.8	0.0	0.1	0.0	1.5	0.0	0.0	0.5	0.1	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	4.6%	7.6	1.9%	0.3
7/11/00	91	44.7	0.1	24.2	5.0	2.0	0.1	0.3	1.2	0.0	1.0	0.0	0.5	0.0	9.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	53.7%	46.1	20.8%	4.6
1 SE	14	6.6	0.1	6.6	1.5	0.7	0.1	0.2	0.4	0.0	0.9	0.0	0.4	0.0	6.3	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	4.5%	12.2	3.8%	0.2
8/29/00	153	90.0	0.0	46.1	4.8	4.7	0.0	0.0	0.0	1.3	0.8	0.0	0.1	0.0	4.7	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	62.6%	62.6	23.5%	4.3
1 SE	19	14.1	0.0	15.1	2.1	1.7	0.0	0.0	0.0	0.4	0.8	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8%	17.8	4.3%	0.2

Smiths	Total	MSP	MSI	CRT	ELD	PZS	NAJ	PCR	HET	PEC	PRI	VAL	LTR	AMP	NMP	PRO	PIL	ALG	MGD	CHA	PAM	PGR	PFO	RAN	PSP	PBE	SPO	UTV	%MSP	nonMSP	%NatCRT	No. Spp.
6/27/95	233.9	158.3	0.0	39.3	0.4	1.6	0.8	29.4	0.7	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.2	0.0	0.0	62.6%	75.6	43.9%	3.6
1 S.E.	33.2	28.0	0.0	9.1	0.3	1.0	0.8	6.9	0.6	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.2	0.0	0.0	4.8%	12.1	7.5%	0.3
8/15/95	214.3	148.6	0.0	58.1	0.2	2.1	0.0	0.5	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.2	1.7	0.0	0.0	0.0	62.5%	65.7	74.1%	2.7
1 S.E.	27.6	28.1	0.0	11.5	0.1	1.0	0.0	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.2	1.3	0.0	0.0	0.0	6.1%	10.9	8.0%	0.2
9/18/95	203.2	112.6	0.0	52.2	1.0	3.4	0.0	0.2	0.0	1.6	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	21.9	0.0	0.0	61.0%	90.6	63.9%	2.8
1 S.E.	27.2	15.0	0.0	14.0	0.9	1.5	0.0	0.2	0.0	0.9	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	20.0	0.0	0.0	6.3%	29.9	8.4%	0.2
6/24/96	122.3	46.2	0.0	20.5	0.3	3.7	0.7	42.0	2.7	0.9	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.03	36.5%	76.2	35.7%	4.3
1 S.E.	9.7	9.6	0.0	4.2	0.1	1.5	0.5	8.7	2.4	0.5	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.02	6.7%	10.7	6.5%	0.4
8/9/96	267.9	175.7	0.0	64.8	0.6	7.3	4.4	0.7	6.8	1.8	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	58.0%	92.2	56.8%	3.9
1 S.E.	38.0	36.3	0.0	21.1	0.3	1.8	4.3	0.5	3.7	1.2	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	6.7%	20.7	8.2%	0.4
9/19/96	337.3	155.8	3.6	128.6	2.0	6.0	0.0	0.0	24.2	4.5	8.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	44.0%	181.5	67.0%	3.9
1 S.E.	41.2	39.6	3.6	34.5	1.5	2.0	0.0	0.0	15.3	1.3	3.5	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	6.8%	35.3	7.5%	0.3
7/14/97	413.5	296.5	7.2	66.8	2.5	11.8	1.1	2.5	1.7	0.4	22.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.7	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.00	59.6%	117.0	56.6%	4.2
1 S.E.	59.3	55.4	7.0	13.9	1.4	3.9	0.8	1.1	1.1	0.2	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.6	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.00	7.2%	17.5	7.8%	0.4
9/18/97	300.9	100.2	4.8	121.0	5.1	10.6	0.0	9.7	26.5	1.3	18.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	38.0%	200.7	54.8%	3.6
1 S.E.	36.4	17.7	3.9	29.7	3.2	3.7	0.0	5.0	11.9	1.3	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	7.0%	32.4	8.0%	0.3
6/15/98	215.5	105.2	0.8	46.0	1.2	10.7	0.7	18.0	0.6	0.5	13.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	12.4	0.0	0.0	4.5	0.0	0.0	0.0	0.0	41.6%	110.3	40.9%	5.3
1 S.E.	21.6	20.7	0.5	10.4	0.7	2.5	0.6	6.2	0.5	0.4	5.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	5.6	0.0	0.0	2.0	0.0	0.0	0.0	0.0	6.6%	12.0	7.3%	0.4
8/3/98	437.2	286.1	1.8	56.9	3.4	15.4	4.9	0.0	9.3	13.2	18.6	0.0	0.0	0.0	0.0	0.5	0.0	0.0	10.1	1.2	12.6	0.0	0.0	3.0	0.0	0.0	0.0	0.0	51.3%	151.1	45.3%	5.0
1 S.E.	52.6	65.3	1.3	21.1	2.5	5.5	2.6	0.0	5.1	6.4	5.9	0.0	0.0	0.0	0.0	0.5	0.0	0.0	6.4	0.9	12.6	0.0	0.0	2.4	0.0	0.0	0.0	0.0	7.7%	27.9	8.2%	0.4
9/15/98	276.6	172.5	2.0	34.3	1.6	3.3	1.9	0.0	26.2	5.2	15.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	0.0	5.8	0.0	0.0	0.2	0.0	0.0	0.0	0.0	50.2%	104.2	47.4%	4.3
1 S.E.	36.1	40.2	1.8	10.9	1.1	1.5	1.0	0.0	11.1	3.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	5.8	0.0	0.0	0.1	0.0	0.0	0.0	0.0	8.3%	21.3	8.5%	0.4
6/16/99	220.4	154.5	0.2	14.8	1.2	10.6	0.7	12.5	1.1	0.0	18.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.7	0.0	1.9	0.0	0.0	0.0	0.0	51.6%	65.9	25.8%	4.6
1SE	30.4	31.5	0.2	3.9	1.1	3.8	0.6	2.9	0.5	0.0	9.3	0.0	0.0	1.7	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.5	0.0	1.8	0.0	0.0	0.0	0.0	8.4%	14.8	5.5%	0.4
8/3/99	280.5	188.6	1.6	38.6	0.4	19.4	6.3	0.0	1.7	0.1	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.6	0.0	5.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	55.8%	91.9	54.4%	3.7
1SE	38.9	44.3	1.2	10.1	0.3	10.0	4.1	0.0	1.0	0.1	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.6	0.0	5.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	8.4%	21.5	7.8%	0.3
8/25/99	148.6	106.1	0.3	14.0	0.1	10.9	0.2	0.8	0.0	1.3	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	1.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	60.4%	42.4	46.9%	2.9
1SE	23.7	25.7	0.2	4.8	0.1	5.1	0.2	0.8	0.0	1.1	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	1.5	0.0	0.0	0.4	0.0	0.0	0.0	0.0	7.8%	11.7	10.2%	0.3
6/20/00	154.8	109.5	2.8	16.6	0.5	6.2	0.6	1.8	0.0	0.8	8.4	0.0	0.0	0.0	0.0	0.0	1.1	0.0	2.9	0.0	2.3	0.0	0.0	1.5	0.0	0.0	0.0	0.0	49.2%	45.4	17.4%	3.4
1SE	35.1	36.6	1.8	7.6	0.3	1.9	0.5	0.7	0.0	0.5	4.3	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.7	0.0	2.3	0.0	0.0	1.4	0.0	0.0	0.0	0.0	9.0%	9.3	6.2%	0.4
7/19/00	161.3	76.9	1.1	40.6	2.4	16.5	10.1	0.2	2.0	0.9	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.7	0.3	0.0	0.0	0.1	0.0	0.0	0.0	0.5	44.9%	84.4	18.1%	4.5
1SE	25.7	22.4	0.6	17.0	1.5	8.6	5.3	0.1	1.6	0.8	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.5	0.3	0.0	0.0	0.1	0.0	0.0	0.0	0.5	8.7%	22.9	6.0%	0.4
8/23/00	250.3	162.1	0.0	50.5	0.2	11.9	10.6	0.0	0.1	3.1	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.0%	88.2	19.0%	3.9
1SE	45.1	40.0	0.0	17.2	0.1	4.1	8.8	0.0	0.1	1.7	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.1%	18.0	5.4%	0.4