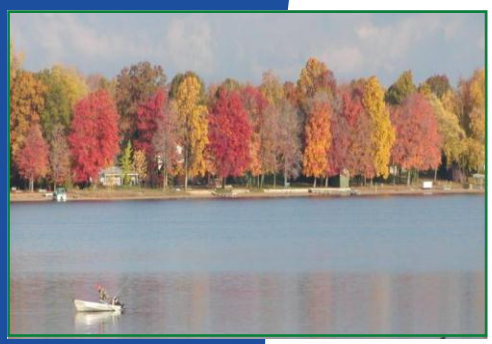
2013 Milfoil Solution® Progress Report at Big Cedar Lake

Prepared for:

The Big Cedar Lake Stewardship Association



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1.0 Introduction

The exotic-invasive aquatic plant, Eurasian watermilfoil (*Myriophyllum spicatum*, herein after referred to as milfoil) has become one of the most troublesome aquatic plants in North America. The ability to displace native species creating dense monotypic beds can limit recreational use, reduce biodiversity and cause detrimental changes to water quality. Although milfoil has been present in Ontario since the 1960s, this plant remains a nuisance throughout many waterways in which it has established itself and continues to infest new inland lakes. Within recent years, Big Cedar Lake in Peterborough County, Ontario has become infested with this invasive plant. To manage portions of this milfoil infestation, EnviroScience implemented the **Milfoil Solution®** process since 2011 using the milfoil weevil (*Euhrychiopsis lecontei)*.

The milfoil weevil is a native insect to North America that began to feed on this invasive plant when it was introduced. The milfoil weevil spends its entire life cycle on the plant through the growing season impacting milfoil in multiple ways. The most significant impacts are caused during their larval lifestage as they feed on the meristem, or growing tip of the plant, and burrow through the stem. This causes nutrient flow within the plant to be disrupted. Additionally, the stem loses buoyancy and collapses in the water column creating a cascading effect which pulls neighboring plants lower into the water column.

Stocking programs are typically approached over a 3-5 year program to cause significant declines in nuisance populations of milfoil throughout a lake. This year marked the third consecutive stocking season in Big Cedar Lake and consisted of stocking established and new sites as well as private contributions throughout the lake. This report outlines the progress of the program to date at Big Cedar Lake and provides recommendations for following seasons.

The table below outlines the Milfoil Solution® program for Big Cedar Lake, including site establishment and number of weevils stocked:

Year	Survey/Stocking Dates	Sites Established	Number of weevils
2011	Initial: 9, 11, 15 August Follow-up: 18 September	S1-S5, M1, M2 5 private stocking sites	30,000 (Lake Association) 23,000 (Private Stocking)
2012	Initial: July 1/17, 2012 Follow-up: August 27/28, 2012	S1-S5, S6 (formerly M1), M2 7 private stocking sites	35,000 (Lake Association) 27,000 (Private Stocking)
2013	Initial: June: 7,12,18, 31; July 8 Late season: August 23, 2013	S1-S6, M2 5 Private stocking sites	32,500 (Lake Association) 22,000 (Private Stocking) 12,500 (In Kind from ES)*

* To begin our lab culture, 6,250 adult weevils were collected from Big Cedar Lake from an area located away from established stocking sites. At the end of the culturing program, 12,500 weevil eggs and the remaining adults used in the culturing process were re-stocked. Sites 3-6 each received an additional 1250 weevil eggs (5000 weevils total). The remaining 7,500 weevils were stocked at the boat launch located south of S3 and the surrounding area to replace the weevils that were used in the culture. The number of adults stocked were not formally assessed and is estimated to be approximately 3,500 weevils. Adult weevils were stocked across Site 1, Site 4, Site 5 and the area surrounding Site 3. Adult weevils were not included in the total numbers for 2013.

2.0 Survey Methods

An initial survey is performed prior to weevil stocking at each site with a late-season survey conducted six to eight weeks later. These surveys provide us with the opportunity to compare and monitor changes in the aquatic plant community and the weevil populations between sites and seasons. These surveys are integral in monitoring changes that occur in both the augmented weevil population and the health of the milfoil over the course of the program in order to make informed management decisions. Qualitative observations in these surveys include the overall density and health of milfoil, identification of native plant species present, and the presence of weevils and weevil-induced damage. Quantitative measurements include milfoil density and weevil population density. Milfoil density is determined by randomly collecting stems throughout the milfoil bed using a 0.09 m^2quadrat. This sample is then converted to the number

of stems per square meter (stems/m^2). Weevil population density (number of weevils per stem) is determined through lab analysis of 30 stems sampled from three transect lines at each site.

3.0 2011-2012 Summary

Since our initial stocking date in Big Cedar Lake we have noticed several positive responses to milfoil weevil stocking including:

- Increases in milfoil weevil density and decrease in milfoil density across several sites.
- Relocation of S3 following the first season of stocking as a result of successful collapse of the milfoil.
- Heavy milfoil damage throughout several sites by late season.
- The return of overwintering weevils in high density.

4.0 2013 Surveys and Weevil Stocking

Stocking occurred at Big Cedar over several dates in the 2013 season and are outlined in the summaries below for each stocking site.

- **S1 –** 6,250 weevils were stocked at S1 on July 8th, 2013. Due to the lack of milfoil at the surface at the original S1 site, this site was moved to a southern point of the same bay where milfoil was more of a nuisance (see attached map of stocking sites). Milfoil at the original site was sparse to moderately dense and was 3m below the surface of the water. Milfoil density at the new S1 at the time of stocking moderately dense making up roughly 80% of the plant community. Weevils were observed in the larval and pupal lifestages and roughly 20% of the milfoil showed signs of larval damage. Weevil density prior to stocking was 0.23 weevils per stem and milfoil density consisted of 81.48 stems/m^2.

  During the late-season survey, milfoil density was slightly lower at S1 with 75.9 stems/m^2 and consisted of 75% of the plant community. Weevil density dramatically increased

over the summer and consisted of 1.70 weevils/stem during the late-season survey. Additionally, milfoil did not reach the surface by the end of the growing season.

- **S2 -** 6,250 weevils were stocked at S2 on June 28, 2013. The stocking location at S2 was moved 10m to the west of the original site due to the amount of damage noticed in the original location. Rather than stocking on heavily damaged stems, weevils were placed on healthy milfoil nearby. Milfoil made up 99% of the plant community at site 2 and consisted of a density of 155.56 stems/m2. Weevils were observed at the site in the larval form at the time of stocking and 60% of the plants showed weevil damage. Weevil density at the time of the initial survey was 1.77 weevils/stem. At the time of the initial survey, milfoil was down 0.9 m from the surface.

  During the late-season survey, milfoil density dramatically dropped to 51.85 stems/m^2 and was considered sparse. Weevil density was also observed to decline and consisted of 0.90 weevils/stem. Weevils were observed during the late-season survey in the adult, larval and pupal lifestages. Additionally, 30% of the milfoil population was at the surface.

- **S3** – In 2012 this site was moved due to a total collapse of the milfoil population following stocking in 2011. Similarly, the location of S3 had to be moved 80m south in 2013 due to the successful collapse of the milfoil community at the 2012 location. On June 18th, 5,000 weevils were stocked at the new location of S3. On June 31st, 1250 more weevils were stocked at S3 and an additional 7,500 weevils were stocked in the surrounding area between S3 and the boat launch to replace weevils collected to begin the culture. Milfoil density at the new stocking location was dense and consisted of 137.04 stems/m^2 and was consisted of 80% of the plant community. At the time of stocking, milfoil was 15cm below the surface of the water with 20% showing weevil damage. Weevils were observed in the adult and larval lifestages and weevil density consisted of 1.17 weevils/stem.

  During the late season survey, milfoil was not observed at the 2012 stocking site. Milfoil at the new stocking site in 2013 consisted of 80% of the plant community with a slightly lower milfoil density of 122.22 stems/m^2. Eight percent of the milfoil was topped out at

the surface with 40% showing signs of weevil damage. Weevils were observed in the adult, larval and pupal lifestages with a density of 1.20 weevils/stem.

- **S4** – 5,000 weevils were stocked at S4 on June 12, 2013 with an additional 1,250 weevils stocked on July 8, 2013. Milfoil at this site was healthy, dense and consisted of 80% of the plant community at the time of stocking. Weevils were observed at this site in the larval stage and 20% of the milfoil showed signs of weevil damage. Milfoil density at the time of the initial survey consisted of 155.56 stems/m^2; weevil density consisted of 0.37 weevils/stem.

  Milfoil density at S4 remained constant in comparison to the initial survey with 151.85 stems/m^2, however 60% of the stems showed signs of weevil damage and appeared to be brittle and weakened. Weevils were observed in the larval stage at the site. Weevil density increased to 1.07 weevils/stem by the time of the late-season survey.

- **S5** – S5 was moved from its original location in 2011 and 2012 due to the collapse of the milfoil population at the original site. The new S5 site was located 100 m to the east of the original site. On June 18, 2013, 5,000 weevils were stocked at the new location, an additional 1,250 weevils were stocked on July 8th, 2013. Milfoil at the time of stocking was moderate to dense and composed 80% of the plant community. Milfoil was healthy with a density of 137.04 stems/m^2. Weevils were observed in the larval form and 20% of the plants showed weevil damage. Weevil density at the time of the initial survey was 0.87 weevils/stem**.**

  Milfoil density at S5 remained constant by the late-season survey with 133.33 stems/m^2 and composed 70% of the plant community. Plants appeared to be relatively healthy with 40% showing signs of weevil damage. Weevil density slightly dropped by the late-season survey to 0.77 weevils/stem and weevils were observed in the larval stage.

- **S6** – S6 was stocked on June 7th, 2013 with 5,000 weevils with an additional 1,250 weevils stocked on July 8th, 2013. This site was originally a monitoring site in 2011 and was first stocked in 2012. Focus of stocking at this site was along the northeastern side of the stocking site due to the collapse of dense milfoil on the southwestern side of the

stocking site. The area stocked consisted of moderately dense milfoil that composed 80% of the plant population. At the time of stocking, milfoil was 15 cm below the surface of the water with a milfoil density of 122.22 stems/m^2. Thirty percent of the milfoil showed signs of weevil damage. Weevils were observed in the larval lifestage with a weevil density of 1.50 weevils/stem.

Milfoil density increased to 166.67 stems/m2 by the late season survey however appeared to be weakened and were 0.5m below the surface of the water. Forty percent of the milfoil at this site showed signs of weevil damage with weevils observed in the adult, egg and pupae form. Weevil density at the time of the late-season survey consisted of 1.37.

- **M2** –Monitoring site (M2) was set up as a site that has not received any weevil augmentation since the beginning of the program. This site was not surveyed early in the growing season due to the late emergence of the milfoil bed. During the late-season survey, milfoil composed 70% of the plant community with a density of 75.93 stems/m2. The milfoil was healthy and green at the site with 5% showing larval damage. Weevils were observed in the adult, egg and pupal stage. Weevil density at the time of the late season survey consisted of 1.17 weevils/stem.

Private Stocking Sites: A total of 22,000 weevils were stocked throughout five private stocking. These private stocking sites are not included in this report, however these sites showed strong presence of weevil presence with some showing major declines in milfoil density since 2012.

The following native aquatic plant species were identified throughout Big Cedar Lake: Canada waterweed (*Elodea canadensis*), common bladderwort (*Utricularia vulgaris*), coontail (*Ceratophyllum demersum*), curly-leafed pondweed (*Potamogeton crispus*), flat-stemmed pondweed (*P. zosteriformis*), large-leaf pondweed (*P. amplifolius*), northern watermilfoil (*M. sibiricum*), Richardson's pondweed (*P. richardsonii*), sago pondweed (*P. pectinatus*), slender naiad (*Najas flexilis*), small pondweed (*P. pusillus*), variegated pond lily (*Nuphar variegata*), water celery (*Vallisneria americana*), water marigold (*Megalodonta beckii*), water stargrass (*Zosterella dubia*), watersheild (*Brasenia schreberi*).

5.0 Discussion

Overall, the results of the 2013 surveys show continued positive response due to weevil stocking. These positive results include:

- Relocation of S1, S3 and S5 due to collapses of the milfoil plant communities.
- High weevil densities during initial and late-season surveys at all sites.
- Large decrease in milfoil density at S2 over the 2013 season.
- Major decrease in milfoil density at all sites in comparison to the milfoil density observed in 2012.
- Milfoil at most sites appeared to be brittle and bent over by the end of the 2013 season.

These positive responses outline the success of the program to date. Most interestingly, we have noticed total collapses of milfoil communities each season of the stocking program with the most collapses observed in 2013. Interestingly, areas that showed major collapse following the first winter after stocking have not shown a resurgence in milfoil populations. Rather, these sites consist of healthy native plant populations.

Additionally, stocking within several established sites have been shifted towards the outer perimeter of the original location. Focusing on nuisance populations within close proximity to original sites allows us build on weevil populations already present.

Milfoil density across all sites was observed to decline in comparison to the summer of 2012. The dry-hot summer observed in 2012 led to explosive milfoil growth throughout Big Cedar Lake and across the province. Conditions in the summer of 2013 were in contrast to 2012 with a late start to the growing season. Due to the slowed milfoil growth early in the season, stocking occurred on plants well below the surface of the water to severely limit the milfoil's ability to mat on the surface of the lake. This, in turn, helped weevil populations to reproduce since weevils lay their eggs on the growing tip (apical

meristems). Upon reaching the surface, milfoil beings to branch profusely and flower. Milfoil flowers are arranged on a spiked inflorescence that grows from the apical meristem of the plant, subsequently lowering the number of meristems upon which weevils can lay their eggs. The slower growing season in 2013 was complimentary to the stocking efforts of the program. This was especially helpful following a year of high milfoil growth.

As a biological control, the Milfoil Solution® process is most successful when introduction of the milfoil weevil occurs over multiple, successive growing seasons to ensure that the weevil population reaches high densities in the lake to maintain the milfoil to non-nuisance levels. Signs of milfoil suppression observed throughout Big Cedar Lake include:

- ✓ Reduction in density of the milfoil
- ✓ Maintenance of the stems below the lake surface at a non-nuisance level
- ✓ Open areas within the stocking sites

These results point towards positive progress of reducing milfoil density throughout the lake to non-nuisance levels. As milfoil density decreases, re-establishment of the native aquatic plant community occurs. Over the course of the program, areas of infestation transition into a more natural distribution of native plants, restoring a balanced lake ecology that supports a healthier fishery while improving recreational and aesthetic value. A total of 15 native aquatic plants were identified throughout the surveys in 2013, two more species than previously observed in 2012.

6.0 Recommendations

Based on the positive response during the first three years of stocking at Big Cedar Lake, it is our recommendation to continue stocking during the 2014 season. We would further recommend that you continue to stock weevils at the volume levels of last year ie: 32,500

weevils. With respect to where the weevils should be stocked in 2014, we would reserve that recommendation until the spring assessment is completed.

In addition to continuation of the Milfoil Solution® program, there are many practices that can contribute to the success of the stocking program and decrease the potential of increasing milfoil density such as:

- Limiting the amount of boat traffic in stocked sites and dense milfoil beds. Milfoil weevils typically reside in the upper 60cm of the plant, if heavy boat traffic occurs throughout the patch these plants can be damaged and impact the weevils ability to flourish. Driving through dense patches should also be limited since fragments of the plant can be dispersed throughout the lake capable of starting a new population.

- Providing a natural shoreline can increase weevil habitat for overwintering. In the fall months, weevils move to shore to overwinter in loose soils and leaf litter, leaving a 1-3m buffer adjacent to shore where grasses can grow and leaves can collect provides suitable habitat for weevils through these winter months.

- Milfoil stems that are floating in the water or washed up on shore can be collected and removed. If left alone, these fragments can move freely through the waterbody and can root to start a new plant. Once dried or composted, milfoil is often used as mulch in gardens and flower beds.

As part of a lake-wide strategy to manage Eurasian watermilfoil infesting Big Cedar Lake, it is key to recognize that suppressing this invasive species will be a gradual process that will require continued support from the Big Cedar Lake Stewardship Association. Thank you for choosing our natural program to manage Eurasian watermilfoil safely and sustainably.

Please contact EnviroScience/Milfoil Solution LLC. at (800) 940-4025, or e-mail at kborrowman@enviroscienceinc.com with questions regarding this report.

EnviroScience, Inc.
Lake Management Division

Table 1. Average Weevil Population Density (weevils/stem) in Big Cedar Lake

Site	Parameter measured	August 10, 2011	September 18, 2011	July 1 and 17, 2012	August 27, 2012	June 7,12,18, 31; July 8, 2013	August 23, 2013
S1	Total weevils	2.00	20.00	8.00	47.00	7.00	51.00
	Total stems	30.00	30.00	30.00	30.00	30.00	30.00
	Avg. weevils/stem	**0.07**	**0.67**	**0.27**	**1.57**	**0.23**	**1.70**
S2	Total weevils	2.00	10.00	8.00	33.00	53.00	27.00
	Total stems	30.00	20.00	29.00	30.00	30.00	30.00
	Avg. weevils/stem	**0.07**	**0.50**	**0.28**	**1.10**	**1.77**	**0.90**
S3	Total weevils	28.00	66.00	24.00	9.0	35.00	36.00
	Total stems	30.00	30.00	30.00	30.00	30.00	30.00
	Avg. weevils/stem	**0.93**	**2.20**	**0.80**	**0.30**	**1.17**	**1.20**
S4	Total weevils	23.00	8.00	30.00	16.00	11.00	32.00
	Total stems	30.00	30.00	30.00	30.00	30.00	30.00
	Avg. weevils/stem	**0.77**	**0.27**	**1.00**	**0.53**	**0.37**	**1.067**
S5	Total weevils	10.0	25.00	36.00	27.00	26.00	23.00
	Total stems	30.00	30.00	30.00	30.00	30.00	30.00
	Avg. weevils/stem	**0.33**	**0.83**	**1.20**	**0.90**	**0.88**	**0.77**
M1/S6	Total weevils	7.00	20.00	20.00	24.00	45.00	41.00
	Total stems	30.00	30.00	30.00	29.00	30.00	30.00
	Avg. weevils/stem	**0.23**	**0.67**	**0.67**	**0.83**	**1.50**	**1.37**
M2	Total weevils	2.00	29.00	19.00	30.00	--	35.00
	Total stems	30.00	30.00	26.00	30.00	--	30.00
	Avg. weevils/stem	**0.07**	**0.97**	**0.73**	**1.00**	--	**1.17**

Table 2. Average Density of EWM (stems/m^2) in Big Cedar Lake

Site	August 10, 2011	September 18, 2011	July 1 and 17, 2012	August 27, 2012	June 7,12,18, 31; July 8, 2013	August 23, 2013
S1	103.70	188.89	301.06	245.98	81.48	75.93
S2	88.89	211.11	192.86	334.68	155.56	51.85
S3	244.44	114.81	160.70	504.63	137.04	122.22
S4	25185	355.56	109.21	403.16	155.56	151.85
S5	470.37	692.59	238.68	439.53	137.04	133.33
M1/S6	466.67	159.26	149.92	409.87	122.22	166.67
M2	237.04	244.44	81.84	259.61	--	70.37

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Big Cedar Lake

Peterborough County, Ontario
2013 Stocking Sites

- 2013 Weevil Stocking Sites
- 2013 Private Stocking Sites
- 2011-2012 Weevil Stocking Sites
- 2011-2013 Monitoring Site

MILFOIL SOLUTION