2012 Progress Report of the Milfoil Solution® Program in

Hackert Lake

Prepared for:

Hackert Lake Improvement Board

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1.0 Introduction

Eurasian watermilfoil (*Myriophyllum spicatum*, hereafter referred to as milfoil) is an exotic aquatic species that tolerates a wide range of growing conditions and out-competes native vegetation. Monocultures of milfoil limit recreational use, reduce biodiversity, and can cause detrimental changes to water temperature and dissolved oxygen in severe infestations. Hackert Lake is a 125-acre lake in Mason County, Michigan severely infested with this invasive plant. To manage portions of this milfoil infestation, EnviroScience implemented the Milfoil Solution® process from 2005 to 2007 and from 2010 to 2012 using the milfoil weevil (*Euhrychiopsis lecontei*)(Table 1).

This weevil is native to North America and is a specialist herbivore of milfoil. It inhibits the plant in multiple ways, the most significant impacts caused by weevil larvae as they damage the meristem, or growing tip, and burrow through the stem. Nutrient flow in the plant is disrupted and the stem loses buoyancy and collapses in the water column. A cascading effect pulls neighboring plants lower into the water column and the rate of photosynthesis is significantly reduced in these stems.

Table 1. Weevil stocking at Hackert Lake, 2005-2007, 2010-2012.

Year	Sites Stocked	Number of Weevils
2005	S1, S2, S3	9,000
2006	S1, S2, S3	9,000
2007	S2, S4	9,000
2010	S2, S3, S5	12,000
2011	S3, S5, S2	9,000 10,000 extra*
2012	S3, S6	18,000

** 10,000 weevils were stocked on 7/20/11 at no charge due to excess production in the EnviroScience culturing laboratory.*

2.0 Survey Methods

An initial survey is performed prior to weevil stocking and a follow-up survey is conducted six to eight weeks later. 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 quadrat. This sample is then converted to the number of stems per square meter (stems/m^2). Weevil population density (the number of weevils per stem) is determined through microscope analysis of stems sampled along three transect lines at each site to identify various weevil life stages (egg, pupae, larvae, adult) and convert this to the average number of weevils per stem.

3.0 Previous Stocking and Survey Summary

Weevils were first stocked at Hackert Lake from 2005 to 2007. A total of 24,000 were stocked throughout four sites (S1-S4, see attached map) during this time frame. The indigenous weevil population initially recorded was undetected to very low, and after three seasons of stocking had increased at all sites to detectable densities. After three consecutive years of stocking, milfoil abundance decreased at the stocking sites and the number of beneficial native plant species identified had increased.

In 2010, weevil stocking resumed with a total of 12,000 at three sites (S2, S3, and S5). Two sites (S3 and S5) were stocked again in June of 2011. Due to excessive production in the culturing facility later in the season 10,000 extra weevils were stocked at S2 in late July for no extra charge. Survey sites exhibited a healthy weevil population with multiple adults seen as well as weevil damage.

4.0 2012 Stocking and Surveys

The 2012 survey of all sites and weevil stocking at two sites (S3 and S6) occurred on June 22 and 28. Quantitative data measuring weevil densities (Table 2) and milfoil densities (Table 3) were collected at each site and these parameters were recorded again during the follow-up survey on August 9.

- **S1 –** Milfoil at S1 was sparse to moderately dense and was dispersed with native species, composing 60% of the plant community. A weevil egg was initially found on analyzed samples and weevil-induced damage was observed during both surveys. Milfoil stem density remained consistent from June to August (56 to 49 stems/m^2).

- **S2 –** Milfoil at S2 composed 60% of the plant community. During the initial survey, two weevils were found on analyzed samples. At the time of the follow-up survey in August, milfoil at this site had grown past the surface of the water and formed a dense canopy. Stem density increased from 69 to 91 stems/m^2 from the initial to follow-up survey.

- **S3 –** Due to sparse milfoil on the west side of S3, 5,000 weevils were stocked at the east side where it composed 60% of the vegetation. Stem damage and a weevil were initially observed, and stem density increased slightly from June to August (67 to 81 stems/m^2).

- **S4 –** Milfoil at S4 was sparse to moderate and composed 50% of the plant community, growing lower than many sites despite the shallow site depth. Weevils and minimal stem damage was initially detected. Stem density decreased from 96 to 65 stems/m^2.

- **S5 –** This site was surveyed on June 28. Sparse to moderate milfoil composed 40% of the plant community and was growing primarily along the drop-off. No weevils were detected on samples but stem damage was observed within the site. Milfoil appeared unhealthy and there were not enough suitable plants on which to stock weevils. Stem density did not change significantly between sampling (63 and 65 stems/m^2).

- **S6 –** Located along the southeastern shore between S1 and S2, this new site was stocked with 13,000 weevils on June 28. Milfoil composed 50% of the area and was generally healthy. Weevils were initially observed. From June to August, stem density decreased from 52 to 43 stems/m^2.

- **M1 –** Samples were collected at the monitoring site where weevils have never been stocked to compare conditions throughout the lake. Milfoil at this site was overall healthy and exhibited very minimal damage. Weevils were initially recorded in June, and stem density increased slightly from 78 to 89 stems/m^2.

Nineteen aquatic plant species were identified in 2012 in addition to Eurasian watermilfoil (Table 4): Chara/Muskgrass (*Chara spp.*), Coontail (*Ceratophyllum demersum*), Clasping-leaf/Richards' pondweed (*Potamogeton richarsdonii*), Eelgrass/Wild Celery (*Vallisneria americana*), Elodea/Common Waterweed (*Elodea canadensis*), Illinois pondweed (*P. illinoensis*), Large-leaf pondweed (*P. amplifolius*), Northern watermilfoil (*Myriophyllum sibiricum*), Robbins'/Fern pondweed (*P. robbinsii*), Sago pondweed (*P. pectinatus*), Slender naiad (*Najas flexilis*), Small Pondweed (*P. pusillus*), Stargrass (*Zosterella dubia*), Thread-leaf pondweed (*P. filiformis*), Variable pondweed (*P. gramineus*), Variable-leaf watermilfoil (*Myriophyllum heterophyllum*), White water lily (*Nymphaea odorata*), Water marigold (*Bidens beckii*), White-stem pondweed (*P. praelongus*).

5.0 Discussion

Hackert Lake provides excellent habitat for both native and invasive plant growth, as evident by the number of individual species observed in recent surveys. In 2007, seven native species were identified throughout Hackert Lake with two to eight individual species being found at each site. In 2012, a total of nineteen species were identified and sites contained eight to fourteen individual species (Table 3). These native plants contribute to sediment stabilization, compete with milfoil for space, and provide habitat and cover for invertebrates and small fish. Selective management techniques can inhibit the growth of Eurasian watermilfoil with minimal negative impact to beneficial native species.

Stem density at most sites was lower than detected in previous survey years and was mixed with native species at many survey sites. Dense milfoil growth at S2 on the eastern side of the lake had formed a dense canopy at the surface, which is largely attributed to low precipitation and optimal growing conditions in 2012. While complete eradication of milfoil is not practical, signs of suppression include a reduction in stem density, maintenance of the stems below the surface at a non-nuisance level, and open areas within the stocking sites. Areas of infestation eventually transition into a more natural distribution of milfoil and native plants, restoring a balanced lake ecology that also improves recreational potential and aesthetic value.

The highest weevil densities at Hackert Lake are typically detected during the initial survey, with the exception being the 2005 late-season sample analysis. Although the weevil population detected in 2012 was low, it is important to note that this also corresponds to the lowest milfoil stem densities and these fluctuations reflect the predator-prey nature of this biological control process.

6.0 Recommendations

At this time, EnviroScience is contracted to perform a vegetation survey with a final follow up survey to conclude the overall program. However in addition to the continued monitoring, it is the recommendation of EnviroScience that weevils are stocked at S6 and other suitable areas of infestation in 2013. Dense milfoil growth at S2 may change next year with seasonal conditions, so it is also important to monitor this area to guide management

practices. Limiting the amount of boat traffic directly in dense milfoil beds will aid in mitigating the existing infestation by reducing fragmentation and new beds from occurring. Milfoil stems washed up on shore can also be collected and removed since these fragments can establish in additional areas.

Please contact EnviroScience at (800) 940-4025 or at slomske@enviroscienceinc.com with questions and comments regarding this report.

EnviroScience, Inc.
Lake Management Division

Table 2. Weevil population analysis (weevils/stem), 2010-2012.

Site	Parameter measured	6/2/05	10/5/05	6/28/07	6/4/10	8/11/10	6/9/11	8/24/11	6/22/12	8/14/12
S1	**Total weevils**	0	11	1	**	**	3	0	1	0
	Avg. weevils/stem	0.00	0.37	0.03			0.01	0.00	0.03	0.00
S2	**Total weevils**	0	8	0	8	0	6	1	2	0
	Avg. weevils/stem	0.00	0.27	0.00	0.27	0.00	0.21	0.03	0.07	0.00
S3	**Total weevils**	8	22	**	8	2	7	0	1	0
	Avg. weevils/stem	0.27	0.73		0.27	0.07	0.23	0.00	0.03	0.00
S4	**Total weevils**			0	**	**	2	0	13	0
	Avg. weevils/stem	**	**	0.00			0.07	0.00	0.43	0.00
S5	**Total weevils**			**	14	0	10	0	0.00	0
	Avg. weevils/stem	**	**		0.47	0.00	0.33	0.00	0.00	0.00
S6	**Total weevils**			**	**	**	**	**	0	0
	Avg. weevils/stem	**	**						0.00	0.00
M1	**Total weevils**	0	4	**	**	**	***	**	5	0
	Avg. weevils/stem	0.00	0.13						0.17	0.00

***Site not established or no data available*

Table 3. Average densities of Eurasian watermilfoil (stems/m^2), 2005, 2007, 2010-2012.

Site	2005	2007	2010	2011	2012
S1	255.00	70.00	**	122.4	51.8
S2	333.33	77.78	87.0	159.1	80.1
S3	311.00	**	100.0	125.7	74.1
S4	**	58.89	***	174.3	80.5
S5	**	**	107.4	112.95	63.9
S6	**	**	**	**	47.2
M1	**	**	**	**	83.3

***Site not established or no data available*

Table 4. Summary of Native Aquatic Plant Species in Hackert Lake, 2012.

Common Name	S1	S2	S3	S4	S5	S6	M1
Chara/Muskgrass	x	x	x	x	x	x	x
Clasping-leaf/Richards' Pondweed	x	x	x	x	x	x	x
Coontail			x				
Eel grass/Wild Celery	x	x	x	x	x	x	x
Elodea		x	x		x	x	x
Illinois Pondweed		x		x			x
Large-leaf pondweed	x	x	x	x	x	x	x
Northern watermilfoil		x	x				
Robbins/Fern pondweed	x	x	x	x	x	x	x
Sago pondweed	x	x	x	x	x	x	
Slender naiad	x	x	x		x	x	
Small pondweed	x	x	x	x		x	x
Stargrass	x	x	x				x
Thread leaf					x	x	
Variable pondweed	x				x	x	x
Variable-leaf watermilfoil		x					
Water marigold			x			x	
White-stem pondweed					x	x	
White water Lily		x				x	
Total Species by Site	10	14	13	8	11	14	10
Total Species Identified in Hackert Lake	19						

Hackert Lake
Mason County
Michigan

Stocking and Survey Sites

Monitoring Site

500 ft
200 m

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