Eurasian Watermilfoil Strategic Biological Control Program
2012 Progress Report

Prepared for:

Les Cheneaux Islands Watershed Council

Prepared by:

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1.0 Introduction

In 2011, EnviroScience was contracted by Les Cheneaux Islands Watershed Council to supply the Milfoil Solution® (formerly Middfoil®) program to various bays within Lake Huron as part of a Great Lakes Restoration Initiative Grant. This program is specific in that it uses a biological control agent, the milfoil weevil (*E. lecontei*), for an invasive, exotic aquatic plant, Eurasian watermilfoil (*M. spicatum*) (EWM). This program was implemented in June of 2007 stocking over 15,500 weevils in two areas of Cedarville Bay. An indigenous weevil population was discovered at the time of the stocking. Dramatic reduction of EWM was observed after augmenting to the natural weevil population.

This report summarizes the second year of the Milfoil Solution® program that began in late June of 2012, in which over 30,000 weevils were stocked among four areas. It includes qualitative and quantitative data for all the established sites within each bay. The table below outlines the program thus far, including site establishment and the number of weevils stocked by bay:

Bay	Year	Survey Dates	Sites Established	Number of Weevils
Cedarville Bay	2007	Initial: 6/21 Follow-up: 8/7	S1,S2, MonA	15,500
	2008	Follow-up: 8/6	Survey	0
	2009	Follow-up:8/11	Survey	0
	2011	Initial:8/5 Follow-up:9/12	S3, MonB	15,000
	2012	Initial: 6/27 Follow-up:8/30	Stocking/Survey	12,000
Sheppard's Bay	2011	Initial:8/5 Follow-up:9/12	S1, MonA	30,000
	2012	Initial: 6/27 Follow-up: 8/30	Stocking/Survey	14,000
Smith's Bay	2011	Initial:8/5 Follow-up:9/12	S1, MonA	10,000
	2012	Initial: 6/27 Follow-up: 8/30	Stocking/Survey	5,000

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. As part of the program, two basic types of quantitative and one type of qualitative data were collected at the time of the initial and follow-up surveys. The first of these involved collecting plants along three transect lines by swimming through the selected beds of Eurasian watermilfoil perpendicular to shore. The tops of two randomly selected plants were removed at five evenly

spaced intervals, for a total of ten plants along each line, and 30 stem samples per site. These plants were analyzed, using a microscope, for the presence of weevils and number of meristems.

Quantitative measurement for EWM density was determined by randomly tossing a 0.09 m^2 PVC quadrat and collecting all plants that fall within the square. The milfoil plants are counted and converted to number of plants per square meter (Table 2). Six replicates are made per site and an average calculated. These data will serve as an indicator of increases or decreases in EWM density in future survey years.

A qualitative survey of the overall plant community was accomplished by swimming through and around the bed of milfoil, looking at all suitable habitat for milfoil growth, noting the presence and density of native species. A comparison of overall native species to milfoil is made on a percentage scale. This sampling technique provides an indication of weevil impact on the EWM beds. We can compare the follow-up survey to the initial survey to determine if the native plants in the lake are becoming more abundant as the weevils damage the EWM stems as well from year to year.

3.0 Cedarville Bay

2012 Results

2007 Sites

S1

The milfoil was considered sparse making up 30% of the overall plant community in June. Elodea (*Elodea canadensis*) was the dominant species while chara (*Chara spp.*) was dense in shallower water hugging the large area of bulrush (*Scirpus spp*.) and cattails (*Typha spp*) (Figure 1). It was noted that the milfoil was starting to increase but was not comparable to the levels found in June of 2007. No plants were at the surface but rather three to nine inches below. Minimal larval damage to the plants was seen while in the field.

By late August, milfoil increased drastically comprising 80% while the remaining 20% was native species. Density data revealed that the bed more than doubled in size (Table 2). Sporadic patches were found close to shore while the density of the plants increased moving closer to the channel. Fifty percent of the milfoil was observed to be matted at the surface. Weevil life stages and damage indicative to weevils was observed on 10% of the plants and also found on the stems collected for lab analysis (Table 1).

Native species observed during the surveys included: chara, elodea, filiform pondweed (*Potamogeton filiformis*), northern watermilfoil (*Myriophyllum sibiricum*), ribbon-leaf pondweed (*Potamogeton epihydrus*), slender naiad (*Naiad flexilis)*, stonewort (*Nitella spp*.) and water marigold (*Bidens beckii*).

Figure 1. Cedarville Bay 2007-2012 Stocking and Monitoring Locations.

T

2007 Stocking and Monitoring Sites

2011/2012 Stocking Sites

2007/2012 Stocking Site

2011 Monitoring Site

1,600 800 0 1,600 Feet

400 200 0 400 Meters

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S2

The milfoil in this site was growing just below the surface of the water and was recorded as moderately dense. Sparse patches were found closer to shore and increased in the eastward direction to the channel. Five thousand weevil eggs and larvae were stocked among the dense plants outside the channel (Figure 1). No weevil life stages were found while swimming through the bed of plants or on the stems collected for analysis, minimal larvae damage was observed (Table 1).

The bed of milfoil at S2 is a continuation of S1; respectively, the milfoil density increased by the follow-up survey (Table 2). By the time of this survey, the milfoil had reached the surface with 80% of the plants flowering. Two weevil life stages were found on the collected stems while 15% weevil larvae damage to the plants was observed in the field.

Multiple native species were identified during the surveys including: chara, clasping-leaf pondweed (*Potamogeton richardsonii*), eel grass (*Valisneria americana*), elodea, filiform pondweed, flat-stem pondweed (*Potamogeton zosteriformis*), illinois pondweed (*Potamogeton illinoensis*), large-leaf pondweed (*Potamogeton amplifolius*), northern watermilfoil, robbins pondweed (*Potamogeton robinsii*), slender naiad, stonewort, variable pondweed (*Potamogeton gramineus*), water marigold and white-stem pondweed (*Potamogeton praelongus*).

MA

This was the densest site surveyed in Cedarville Bay in June. The vast area was considered moderate to dense. The plants were sparse to moderate on the western side of the bed (near marina) but became denser in the eastward direction. The plants were three to six inches below the surface. Minimal larvae damage to the plants was noted while in the field. No life stages were identified from either field observations or lab analysis (Table 1).

By August, the milfoil was observed to be matted closer to shore with more than 90% of the overall dense bed at the surface flowering. The visibility in the water was noted to be cloudy in this area. The stem density data revealed a slight reduction compared to June (Table 2). Although insignificant, no other density reduction was observed at any other sites only increases. Minimal larvae activity was observed on the plants while in the field with one life stage identified during lab analysis.

The same three native species were noted at both surveys; chara, eel grass, and stonewort.

2011 Sites

S3

The narrow bed located west of the navigation channel was considered moderate to dense in June but not as dense as seen in September the previous year. The milfoil was growing six inches to two feet below the water surface. Open areas were observed in the southern portion of the bed while becoming more dense swimming north. It was on this dense area that 7,000 weevil eggs and larvae were stocked. While no weevil life stages were found on the stems collected for lab analysis, damage indicative to larvae was observed to approximately 5% of the plants (Table 1).

The same density was observed in August as in June as evident from the density data. The plants were noted as healthy, growing anywhere from eighteen inches below the surface to the surface with only 5% of the plants within the bed flowering. Cloudy visibility noted at the monitoring site, MonA, was also detected in this area of the bay. The same weevil assessments made in June were observed again in August; no life stages from the stem analysis and 5% larval damage to the plants in the field.

The native plant community comprised 20% at each of the 2012 surveys which consisted of: chara, clasping-leaf pondweed, eel grass, elodea, large-leaf pondweed, northern watermilfoil, robbins pondweed and slender naiad.

MB

The moderately dense milfoil bed adjacent to the channel, south of S3, was growing one foot below the surface and comprised 75% of the overall plant community. No evidence of weevils were found in the field or on the stems collected for lab analysis.

The stem density increased by August but at an insignificant rate from 62.96 stems/m^2 to 81.48 stems/m^2. Although no weevil life stages were identified from the transect analysis, minimal larval damage was observed to 4% of the plants while in the field. The same cloudy visibility observed in the northern sites was apparent here.

The same native species identified at S3 were seen at this site with the addition of: flat-stem pondweed and white-stem pondweed.

Table 1. Summary Data from Site Transect Analysis of EWM 2011 and 2012 Initial and Follow-up Surveys of Cedarville Bay

Bay	Site	Parameter measured	Initial Survey 8/5/11	Follow-up Survey 9/12/11	Initial Survey 6/27/12	Follow-up Survey 8/30/12
Cedarville	S1	Total weevils Total stems **Avg. weevils/stem**	8.00 30.00 **0.27**	1.00 30.00 **0.03**	0.00 30.00 **0.00**	2.00 30.00 **0.67**
	S2	Total weevils Total stems **Avg. weevils/stem**	0.00 10.00 **0.00**	0.00 29.00 **0.00**	0.00 30.00 **0.00**	2.00 30.00 **0.67**
	S3	Total weevils Total stems **Avg. weevils/stem**	0.00 30.00 **0.00**	0.00 30.00 **0.00**	0.00 29.00 **0.00**	0.00 30.00 **0.00**

	MA	Total weevils Total stems **Avg. weevils/stem**	3.00 30.00 **0.10**	0.00 29.00 **0.00**	0.00 28.00 **0.00**	1.00 30.00 **0.03**
	MB	Total weevils Total stems **Avg. weevils/stem**	*	0.00 30.00 **0.00**	0.00 30.00 **0.00**	0.00 30.00 **0.00**

* = site not established

Table 2. Average Density of EWM (stems/m^2) in Cedarville Bay

Bay	Site	Initial Survey 8/5/11	Follow-up Survey 9/12/11	Initial Survey 6/27/12	Follow-up Survey 8/30/12
Cedarville	S1	51.9	<10	50	120.37
	S2	<10	<10	72.22	174.07
	S3	77.8	163.0	83.33	88.89
	MA	66.7	63.0	157.41	125.93
	MB	*	144.4	62.96	81.48

* = site not established

4.0 Sheppard's Bay

S1

The large, dense bed of milfoil had taken a different shape as last seen the previous season. The milfoil comprised of 80% of the overall plant community. Although the bed was large in size, the milfoil was one to three feet below the surface with a few open areas seen throughout. During the survey it was decided to stock the 14,000 weevil eggs and larvae north of the 2011 stocking area. The new area was within the same large bed, called the same name, and actually overlapped the old site (Figure 2). A total of 60 stems were collected from both areas for the transect analysis however no weevil life stages were identified. Field observations revealed larval damage to 5% of the stems.

The large area of milfoil seen in June had spread throughout the whole bay, tripling in size by the August survey. The total area was made up 99% of milfoil. The milfoil in the western side of the bed (close to MA) exhibited fused leaves, black tips and black flowering parts. This type of plant growth could be a result of herbicide drift or chemical burn. The majority of the milfoil was at the surface and flowering with 80% flowering occurring in the overall 2011 stocking area and 65% flowering in the 2012 area. Positively, stem analysis revealed multiple life stages on the 59 stems collected. This is the first time identifying life stages from the four surveys conducted over the last two years. No other evidence of weevils was observed in the field.

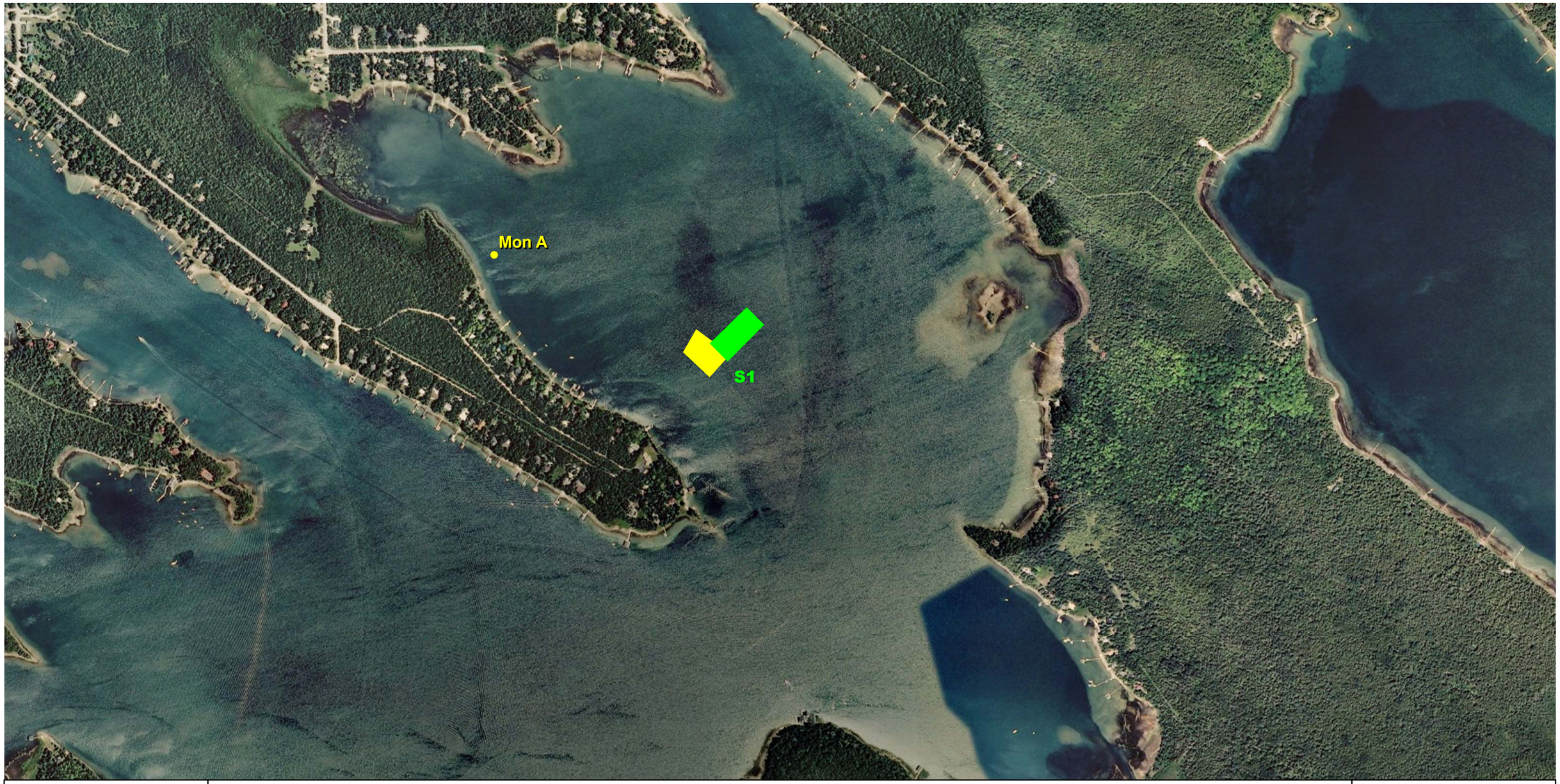

Figure 2. Sheppard's Bay 2011-2012 Stocking and Monitoring Locat

2011 Monitoring Location

2011 Stocking Location

2012 Stocking Location

1,600 800 0 1,600 Feet

400 200 0 400 Meters

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Native species observed during the surveys included: chara, clasping-leaf pondweed, eel grass, elodea, flat-stem pondweed, robbins pondweed, stonewort, water marigold and white-stem pondweed,.

MA

The milfoil was considered to be sparse to moderate in density and appeared unhealthy with fused leaves. This is a characteristic to herbicide drift. It is possible that a homeowner close to this site treated milfoil around their dock. Although no evidence of weevil activity was observed on the unhealthy stems in the field, three weevil life stages were identified on the stems brought back to the lab.

By August the milfoil more than doubled in density from 70.37 stems/m^2 to 183.33 stems/m^2 (Table 4). The stems were calcified with blackened tips. New growth with adventitious roots (another form of asexual propagation) was evident on the unhealthy stems. It was confirmed that homeowners treated with herbicides around their docks in the spring. As previously observed, weevils were not found on the stems in the field but were identified in the lab. The same native species observed in S1 were observed at MA in addition to illinois pondweed and variable pondweed.

Table 3. Summary Data from Site Transect Analysis of EWM 2011 and 2012 Initial and Follow-up Surveys of Sheppard's Bay

Bay	Site	Parameter measured	Initial Survey 8/5/11	Follow-up Survey 9/12/11	Initial Survey 6/27/12	Follow-up Survey 8/30/12
Sheppard's	S1	Total weevils Total stems **Avg. weevils/stem**	0.00 30.00 **0.00**	0.00 60.00 **0.00**	0.00 60.00 **0.00**	2.00 58.00 **0.07**
	MA	Total weevils Total stems **Avg. weevils/stem**	5.00 30.00 **0.17**	0.00 30.00 **0.00**	3.00 30.00 **0.10**	1.00 30.00 **0.03**

Table 4. Average Density of EWM (stems/m^2) in Sheppard's Bay

Bay	Site	Initial Survey 8/5/11	Follow-up Survey 9/12/11	Initial Survey 6/27/12	Follow-up Survey 8/30/12
Sheppard's	S1	74.1	211.1	105.56	195.30
	MA	37.0	31.5	70.37	183.33

5.0 Smith's Bay

S1

The highest amount of weevil activity (life stages and damage) was observed at this site. The milfoil throughout the bay was dense and observed to be extending into the channel in the northward direction towards the monitoring site, MA (Figure 3). Eighty percent of the plants were at the surface but not flowering. The remaining 20% plants, within the 2011 stocking location, were 3-6 inches below the surface. A total of 5,000 weevil eggs and larvae were stocked outside the bay, in the mouth of the channel. It was determined that a new site name was not necessary since this area was a continuation of S1. A total of 60 stems were collected, 30 from within the bay and 30 from the channel. Lab analysis revealed a population at .22 weevils per stem, the highest found during the June surveys (Table 1). More than 10% stem damage was observed while in the field. Another observation while in the field was the large amount of a specific macro-invertebrate, the water mite (*Hydrachnidae*). This species is a predator to zooplankton and insect larvae of stoneflies, caddisflies and beetles. Although the weevil larva spends most of its life cycle within the stem, the water mite could be a potential predator.

The bed of milfoil expanded exponentially by August. Milfoil was observed to be one large monoculture extended into Hassel Bay. The milfoil was at the surface and flowering with the exception of the plants in the stocking locations. Lab results revealed a reduction in the number of weevils per stem with a slight increase in the number of stems per square meter (Tables 5 and 6). Larval damage to the stems increased within the bay and mouth of the channel ranging from 15-25% of the total stems, up from 10% observed in June.

Native plant species observed during the surveys included: bulrush, chara, clasping-leaf pondweed, eel grass, elodea, filiform pondweed, large-leaf pondweed, northern watermilfoil and stonewort.

MA

Milfoil comprised 65% of the total plant community during the initial survey. Sporadic patches of milfoil one foot below the surface were observed mixed with native species and gradually increased in density in the southward direction towards site 1. Although minimal stem damage, 5%, caused by weevil larvae was observed, 13 life stages were identified on the stem analysis (Table 5).

No significant changes in milfoil density were measured in August (Table 6). However sporadic patches of milfoil were observed throughout the bay and it appeared that the area of infestation increased. No weevil life stages were found on the stems collected for lab analysis however, the same amount of stem damage was observed at the follow-up survey.

A healthy and diverse native community was seen throughout the area and consisted of: chara, clasping-leaf, coontail (*Ceratophyllum demersum*), eel grass, elodea, filiform pondweed, northern watermilfoil, robbins pondweed, slender naiad, stonewort, variable pondweed and water marigold.

Figure 3. Smith's Bay 2011-2012 Stocking and Monitoring Locations.

2011 Stocking and Monitoring Sites

2012 Stocking Site

1,600 800 0 1,600 Feet

400 200 0 400 Meters

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Table 5. Summary Data from Site Transect Analysis of EWM 2011 and 2012 Initial and Follow-up Surveys of Smith's Bay

Bay	Site	Parameter measured	Initial Survey 8/5/11	Follow-up Survey 9/12/11	Initial Survey 6/27/12	Follow-up Survey 8/30/12
Smith's	S1	Total weevils Total stems **Avg. weevils/stem**	5.00 30.00 **0.17**	2.00 30.00 **0.07**	13.00 60.00 **0.22**	1.00 60.00 **0.017**
	MA	Total weevils Total stems **Avg. weevils/stem**	*	0.00 30.00 **0.00**	13.00 29.00 **0.45**	0.00 30.00 **0.00**

* = site not established

Table 6. Average Density of EWM (stems/m^2) in Smith's Bay

Bay	Site	Initial Survey 8/5/11	Follow-up Survey 9/12/11	Initial Survey 6/27/12	Follow-up Survey 8/30/12
Smith's	S1	137.0	113.9	209.26	235.19
	MA	*	85.2	77.78	83.33

* = site not established

6.0 Discussion

Due to the mild winter and warmer than usual spring temperatures, milfoil doubled and grew to the surface in most lakes across the Midwest as far north as the Upper Peninsula of MI. Early onset growth can result in early flowering as observed in Sheppard's Bay. Surprisingly, the milfoil was growing inches below or just at the surface in a majority of the sites. This early season milfoil growth and flowering may have affected the overall effectiveness of the weevil population. This atypical season for strong milfoil growth may contribute to the absence of weevils during the survey and lab analysis. Moreover, the milfoil weevil utilizes the apical meristem (very top of the plant) for egg laying, once the larvae hatch and burrow down the stem, that particular stem can no longer flower. If the milfoil is starting to flower when the overwintered adults leave shore from hibernation, the only viable option for survival is to mate on the lateral meristems which will not be as effective. Additionally, these plants can flower multiple times throughout a growing season, which could potentially result in new milfoil growth. This is the first time EnviroScience biologists have witnessed this growing pattern this early, this extensive.

An aerial survey performed in late August, prior to the survey, showed the infestation of milfoil had increased throughout a large portion of the Les Cheneaux Chain of Islands. Milfoil density data revealed dramatic increases at sites 1 and 2 of Cedarvile Bay and S1 and MA of Sheppard's Bay. EnviroScience biologists were expecting higher density readings during the August survey at all the nine sites given the strong growing season exhibited across the Midwest. It should be mentioned that the increases in density observed in Cedarville Bay at sites 1 and 2 were found to be closer to the channel whereas the actual stocking area was considered sparse to moderate in density. It appeared the milfoil had re-seeded further out. Additionally, weevils were identified for the first time in Sheppard's Bay on the stems collected for lab analysis.

The discovery of the water mite existing within Smith's Bay at high numbers should not cause for alarm but is something to monitor in future years. Although no research has been done on the specific predation of weevil larvae, it is known that this insect does in fact feed on other macro-invertebrate larvae including beetles.

Density oscillations observed between weevils and milfoil are expected as milfoil has the potential to grow faster than the weevil population can reproduce. This year is a prime example of this occurrence. As the milfoil begins to decrease over time, so will the population of weevils until the two reach a state of equilibrium and sustain each other within the lake at low levels. It may take the population of weevils a season to "catch up" if the density of experiences a resurgence. In order to get a better handle of the increased milfoil, EnviroScience recommends an integrated management strategy is applied in 2013 using both weevils and aquatic herbicides. At this time, a final follow-up survey to the program is scheduled for 2013. In addition to active management, 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.

Should you have any questions or comments, please do not hesitate to contact EnviroScience at (800) 940-4025 or at cmarquette@enviroscienceinc.com.

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Milfoil Weevil Private Purchase Program for Lake Huron Residents within the Les Cheneaux Islands

Milfoil Solution®, offered exclusively by EnviroScience, utilizes a native weevil as the biological control agent for managing the exotic Eurasian watermilfoil (EWM) in an environmentally-friendly and sustainable manner. Fourteen years of experience enables EnviroScience's Lake Management Team to customize effective programs for lakes and ponds of all sizes.

In 2011, The Les Cheneaux Watershed Council began a two-year **Milfoil Solution®** program on several bays of the lake. The watershed council was scheduled to receive 30,000 milfoil weevils in June, 2012 for specific sites. However, given the warm conditions of the spring the milfoil proliferated and grew exponentially faster than the weevil population. The additional weevils were stocked in late June but their efforts were minuscule compared to the infestation. By late August, the situation worsened to unprecedented levels.

A number of lake-front property owners have expressed interest in stocking additional milfoil weevils along their shoreline through private or group purchases. Because these efforts will promote more rapid and effective lake-wide EWM control, EnviroScience is pleased to offer a special program for Lake Huron property owners that make it more affordable to stock larger numbers of weevils. This is important because the more weevils stocked, the faster the process works. The following table outlines the 2013 pricing structure. **Note**: the cost includes weevils and labor for stocking.

Weevil Units	No. of Weevils	Total
1	1,000	$1,000.00
2	2,000	$1,500.00
3	3,000	$2,250.00
4	4,000	$3,000.00
5	5,000	$3,750.00
6	6,000	$4,500.00

In order to support the efforts and investment already made by the watershed district, another alternative is to join forces with ***all*** the homeowners for a massive weevil stocking starting in 2013. EnviroScience is proposing to set up a culturing facility strictly for the Les Cheneaux Islands on Lake Huron. This option could be used in conjunction with other management techniques (ie. Herbicides) if managed carefully!

No. of Weevils	Unit Cost	Total
200,000	$750/unit	$150,000.00
300,000	$600/unit	$180,000.00
Labor and Expenses		$12,000.00

After the weevils have been stocked, ES biologists will return to assess every site stocked since the beginning of the program. Weevil culturing will begin in early June with weevil stocking throughout the month. Please contact Cortney Marquette, cmarquette@envirosciencienc.com or Rebecca McMenamin, rmcmenamin@envirosciencenceinc.com, for more information.

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