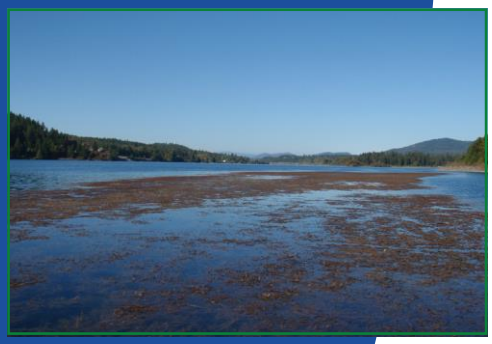
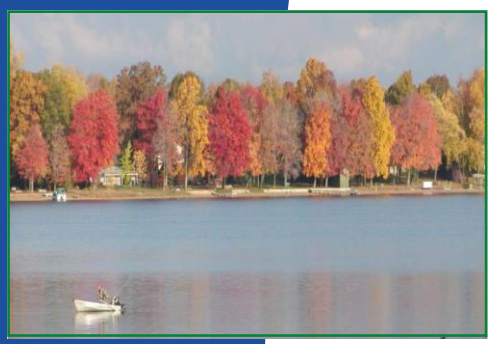
2015 Vegetation Survey and Weevil Population Survey at Les Cheneaux Islands, Lake Huron, Michigan

Prepared for:

The Les Cheneaux Watershed Council





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1.0 Introduction

At the request of the Les Cheneaux Watershed Council (LCWC), a vegetation survey was conducted throughout several bays and channels of the Les Cheneaux Chain of Islands (LCI) from August 24 to 26, 2015 (Table 1.0). The purpose of this survey was to compile an inventory of all aquatic vegetation species, identify locations of the Eurasian watermilfoil (EWM) infestation, and identify additional invasive/nuisance species to provide a baseline for future management practices. A milfoil weevil (*Euhrychiopsis lecontei*) population survey was also conducted in Cedarville, Sheppard's, and Smith's Bays to document the extent to which the weevils have controlled the EWM in the project areas per the requirements of the stocking contract.

2015 was the third year of EnviroScience performing a vegetation survey following the same methods outlined in the Michigan Department of Environmental Quality (MDEQ) and at similar times each summer to ensure consistent plant identification each survey year. The goal of this survey was to document the extent of the aquatic invasive species Eurasian watermilfoil (*Myriophyllum spicatum*, herein referred to as milfoil), as well as to document the diverse native plant community occurring in the bays and navigation channels throughout the Les Cheneaux Islands.

Table 1.0. Summary of 2015 Survey Areas

Survey Area	Vegetation Survey Type	# Survey Points	Length Between Transects or Points (ft)	2015 Survey Date
Cedarville Bay	AVAS	3	500	8/25/2015
Cedarville Bay*	PI	113	350	8/25 & 8/26/2015
East LaSalle Channel	AVAS	9	500	8/25/2015
Hessel Harbor	AVAS	1	500	8/24/2015
Hill's Channel	AVAS	1	1000	8/25/2015
Islington Channel	AVAS	23	250	8/25/2015
North LaSalle Channel	AVAS	4	550	8/25/2015
Sheppard's Bay	AVAS	11	500	8/24/2015
Sheppard's Bay*	PI	122	150, 350	8/24/2015
Smith's Bay	AVAS	6	550	8/24/2015

*AVAS = Aquatic Vegetation Assessment Site Survey, PI = Point Intercept Survey, *Weevil Population Survey 8/26/15*

2.0 Methods

Two vegetation survey methods were implemented throughout nine areas: an Aquatic Vegetation Assessment Site (AVAS) survey and a Point Intercept (PI) survey (Section 3). A follow-up survey to the Milfoil Solution® program to evaluate the milfoil weevil was conducted in Cedarville Bay, Sheppard's Bay, and Smith's Bay following protocols established by EnviroScience (Section 4).

2.1 Aquatic Vegetation Assessment Sites (AVAS) Survey Method

Qualitative Vegetation sampling was performed following Michigan DEQ methods contained in Standard Procedures for Surveying Aquatic Plants. This survey can be easily replicated to monitor changes throughout the plant community each year and is typically conducted in late summer when peak growth has occurred.

This method involves performing visual and rake tow surveys along evenly-divided sections of the littoral zone, or the area closest to shore where submersed and emergent aquatic vegetation is able to grow. The shoreline of each survey area/channel was divided into equal sections. In each survey section (i.e. aquatic vegetation assessment site [AVAS]), the presence and relative density of each aquatic plant species was determined and the information was recorded on the Standard Aquatic Vegetation Assessment Site Species Density Sheet. Species abundance was reported as cover codes A, B, C, and D to describe the approximate percent cumulative cover (%CC) of each plant within the map area as described in the following table. However, the cover code colors listed below are represented in the maps for Eurasian watermilfoil in each location; if there is no color there was no significant milfoil. Visual and rake surveys were performed at each site until no new species were encountered and the biologists conducting the survey were confident that adequate information had been obtained at each AVAS. Species of questionable identity were placed in a sample bag, appropriately labeled, and identified using taxonomic keys at the completion of the survey. The boundary of each AVAS was determined using differential GPS technology.

Cover Code and Map Color	Percent Cumulative Cover (%CC) Range
A	1-2%
B	3-20%
C	21-60%
D	61-100%

2.2 Point Intercept Survey Methods

A Point Intercept Survey (PI) was conducted in Cedarville Bay and Sheppard's Bay following methods outlined in Point Intercept and Line Intercept Methods for Aquatic Plant Management (Madsen, 1999). This survey method was chosen based on the relatively shallow depths and larger areas of both bays. A grid of evenly-spaced Point Intercepts was created using GPS technology and the surveyors navigated to each point along the grid. At each PI location, the presence and relative density of each aquatic plant species was determined by a single rake tow. Once the rake was retrieved from a point, each species found on the rake was identified and assigned a density code for rake cover similar to the AVAS method. Color codes on the resulting maps were also similar to the AVAS method described in Section 2.1 of this report.

2.3 Weevil Population Survey Methods

Survey methods developed by EnviroScience include qualitative and quantitative information to monitor changes occurring in both the weevil population and milfoil density over the course of time. Qualitative observations in these surveys included the general appearance and health of milfoil, identification of native plant species present, and the presence of weevils and weevil-induced damage. Quantitative measurements included milfoil density and weevil population density. Milfoil density was determined by using a 0.09 m^2 PVC quadrat, randomly tossing it throughout the milfoil bed, and counting the stems within the quadrat. This count was converted to the number of milfoil stems per square meter (stems/m^2). Weevil population density (the average number of weevils per stem) was determined through lab analysis of 30 stems collected randomly from each site.

3.0 Vegetation Survey (AVAS and PI)

A total of 34 aquatic vegetation species were observed throughout the Les Cheneaux Islands in 2015 (see Table 3.0). The following sections outline the results of the Point Intercept and AVAS surveys with tables organized to display each species from most abundant to least abundant. Where applicable, a second table is shown with native pondweeds (genus *Potamogeton*) grouped together to more accurately display their abundance relative to EWM and other native species.

Table 3.0 Aquatic Plant Species List 2015

Common Name	Scientific Name
Alternate watermilfoil	*Myriophyllum alterniflorum*
Bladderwort	*Utricularia macrohiza*
Blunt-leaf pondweed	*Potamogeton obtusifolius*
Bulrush/Sedge	*Scirpus sp.*
Cattail	*Typha latifolia*
Cattail (Narrow leaf)	*Typha angustifolia*
Chara	*Chara sp.*
Clasping-leaf pondweed	*Potamogeton richardsonii*
Coontail	*Ceratophyllum demersum*
Eelgrass	*Vallisneria americana*
Elodea	*Elodea canadensis*
Eurasian watermilfoil	*Myriophyllum spicatum*
Flatstem pondweed	*Potamogeton zosteriformis*
Floating-leaf pondweed	*Potamogeton natans*
Fries' pondweed	*Potamogeton friesii*
Illinois pondweed	*Potamogeton illinoensis*
Large-leaf pondweed	*Potamogeton amplifolius*
Marigold	*Bidens beckii*
Naiad/Bushy pondweed	*Najas flexilis*
Nitella	*Nitella sp.*
Northern watermilfoil	*Myriophyllum sibiricum*
Phragmites (native)	*Phragmites americanus*
Pickerelweed	*Pontederia cordata*
Purple loosestrife	*Lythrum salicaria*
Robbins'/Fern pondweed	*Potamogeton robbinsii*
Sheathed pondweed	*Stuckenia vaginata*
Spikerush	*Eleocharis acicularis*
Stiff pondweed	*Potamogeton strictifolius*
Thin-leaf pondweed	*Potamogeton pusillus*
Variable pondweed	*Potamogeton gramineus*
Water lobelia	*Lobelia dortmanna*
Water Stargrass	*Zosterella dubia*
Water-lily	*Nuphar sp.*
Whorled watermilfoil	*Myriophyllum verticillatum*

3.1. Cedarville Bay

To accommodate the large area in Cedarville Bay, both Point Intercept and AVAS survey methods were implemented. In addition, East Lasalle Channel and North LaSalle Channel have been combined in the Cedarville Bay AVAS survey results.

Point Intercept Survey

The point intercept survey was conducted at 113 points within Cedarville Bay (Figure 3.1.a. in Appendix A). In total, 19 species were observed in 2015 which was a decrease from 21 species in 2014 and 25 species in 2013.(Table 3.1.a). Milfoil was present at 28% of the sites (32 sites total) with varying densities, however the majority of which consisted of <3% cover. A majority of the milfoil rake tows contained densities from Category A (1-2%) while only five locations contained Category B (3-20%). Species with the highest occurrence across sites consisted of Naiad/Bushy pondweed (67%), Eelgrass (58% of sites) and Chara (50% of sites). The large group of native pondweeds appeared in 65% of point intercepts. The invasive species *Phragmites australis*, reed canary grass, and purple loosestrife observed at the Cedarville boat launch in 2013 were not present in the survey in 2015.

Table 3.1.a: Comparison of Species Occurrence at PI Sites in Cedarville Bay, 2013-2015

Species	2013 Percent of Points (146)	2014 Percent of Points (146)	2015 Percent of Points (113)
Naiad/Bushy pondweed	30	39	67
Eelgrass	52	66	58
Chara	59	53	50
Eurasian watermilfoil	**51**	**44**	**28**
Illinois pondweed	16	12	16
Nitella	19	14	15
Robbins'/Fern pondweed	25	20	10
Clasping-leaf pondweed	17	18	9
Elodea	28	15	9
Flatstem pondweed	6	1	9
Fries' pondweed	3	3	8
Variable pondweed	8	7	7
Large-leaf pondweed	12	14	4
Marigold	2	5	2
Coontail	3	2	<1
Thin-leaf pondweed	*	1	<1
Sheathed pondweed	*	*	<1
Whorled watermilfoil	*	*	<1
Cattail	*	*	<1

Northern watermilfoil	3	18	*
Stiff pondweed	<1	1	*
Alternate watermilfoil	<1	<1	*
Water lobelia	<1	<1	*
Blunt-leaf pondweed	3	*	*

**Species not observed*

Table 3.1.b: Occurrence of Species' Groups at PI Sites in Cedarville Bay, 2015

Species (grouped)	Total Occurrence	Percent of Points (113)
Naiad/Bushy pondweed	76	67
Macroalgae	75	66
Native Pondweeds	74	65
Eelgrass	66	58
Eurasian watermilfoil	**32**	**28**
Elodea	10	9
Marigold	2	2
Cattail	<1	<1
Coontail	<1	<1
Native watermilfoils	<1	<1

AVAS Survey

Three AVAS's were performed along the southeast portion of Cedarville Bay, while four surveys were performed in North LaSalle Channel and nine within East LaSalle Channel (Figure 3.1.b and 3.1.c in Appendix A). In total, 27 species were observed throughout this large section of LCI with Bulrush/Sedge as the dominant species covering 20.69% CC. Although Elodea was the most dominant species, the group of native pondweeds had a higher cumulative cover overall with 11.19% CC (see Table 3.1.d). EWM comprised 8.00% CC throughout the 16 transects (was previously 40.00%CC in 2013).

A single AVAS was also performed at Breezeswept Docks in the west end of Cedarville Bay which encompassed the docks and navigation channel in front of this property. This location contained twenty-four plant species making it the highest in species richness (number of species) in a single AVAS. Although milfoil was found in this area, a majority of the dense vegetation was native species such as Chara, Bladderwort, Eelgrass, and various pondweeds.

Table 3.1.c: Percent Cumulative Cover of Species Present in Cedarville Bay (including East LaSalle and North LaSalle channels) AVAS, 2105

Species	%CC
Bulrush/Sedge	20.69
Elodea	10.19
Naiad/Bushy pondweed	9.63
Robbins/Fern pondweed	8.25
Eurasian watermilfoil	**8.00**
Eelgrass	6.19
Cattail (Narrow Leaf)	5.00
Chara	3.63
Cattail	1.31
Thin-leaf pondweed	0.88
Illinois pondweed	0.69
Water-lily	0.69
Phragmites (native)	0.69
Nitella	0.50
Variable pondweed	0.50
Clasping-leaf pondweed	0.31
Flatstem pondweed	0.31
Fries' pondweed	0.31
Coontail	0.19
Large Leaf pondweed	0.19
Water lobelia	0.19
Water stargrass	0.19
Purple loosestrife	0.19
Whorled watermilfoil	0.13
Marigold	0.06
Stiff pondweed	0.06
Alternate watermilfoil	0.06

Table 3.1.d: Percent Cumulative Cover of Species' Groups in Cedarville Bay (including East LaSalle and North LaSalle channels) AVAS, 2015

Species (grouped)	%CC
Bulrush/Sedge	20.69
Native pondweeds	11.19
Elodea	10.19
Naiad/Bushy pondweed	9.63
Eurasian watermilfoil	**8.00**
Eelgrass	6.19
Cattail (Narrow Leaf)	5.00
Chara	4.13
Cattail	1.31
Water-lily	0.69
Phragmites (native)	0.69
Clasping-leaf pondweed	0.31
Coontail	0.19
Water lobelia	0.19

Water stargrass	0.19
Purple loosestrife	0.19
Native watermilfoils	0.19
Marigold	0.06

3.2 Hessel Harbor

AVAS Survey

One AVAS was performed at Hessel Harbor in 2015 with 6 species total observed. Chara was the dominant species at 40.00%CC. EWM was very sparse at only 1.00%CC (Figure 3.2.a in Appendix A; Table 3.2.a below). Additional native species each composed 1% of the cumulative cover (See Table 3.2.b).

Table 3.2.a: Percent Cumulative Cover of Species Present in Hessel Harbor AVAS, 2015

Species	CC%
Chara	40.00
Elodea	1.00
Eurasian watermilfoil	**1.00**
Fries' pondweed	1.00
Eelgrass	1.00
Naiad	1.00

3.3 Hill's Channel

Although a full AVAS was not performed at Hill's Channel in 2015, ES biologists noted that Cattails remain the dominant species from the tunnel under South Forest Lane to the southeast portion of this navigation channel.

3.4 Islington Channel

AVAS Survey

In total, 23 species were observed throughout Islington Channel (Table 3.4.a), an increase from 18 in 2014. Cumulative cover of EWM at Islington Channel decreased to 0.17% CC in three areas in 2015 (Figure 3.4.a). The majority of the plant community was comprised of the

macroalgae Chara and Nitella (17.65% CC), Bulrush/Sedge (13.00% CC), and Naiad/Bushy pondweed (9.65% CC).

Table 3.4.a: Percent Cumulative Cover of Species Present in Islington Channel AVAS, 2015

Species	%CC
Chara	17.39
Bulrush/Sedge	13.00
Naiad/Bushy pondweed	9.65
Eelgrass	5.39
Elodea	1.76
Cattail	0.87
Flat-stem pondweed	0.57
Variable pondweed	0.57
Clasping-leaf pondweed	0.48
Nitella	0.26
Fries' pondweed	0.22
Purple loosestrife	0.22
Eurasian watermilfoil	**0.17**
Marigold	0.17
Illinois pondweed	0.13
Robbins/Fern pondweed	0.13
Coontail	0.09
Large Leaf pondweed	0.09
Pickerelweed	0.04
Sheathed pondweed	0.04
Thin-leaf pondweed	0.04
Water stargrass	0.04
Water-lily	0.04

Table 3.4.b: Percent Cumulative Cover of Species Present in Islington Channel AVAS, 2015

Species (grouped)	%CC
Macroalgae	17.65
Bulrush/Sedge	13.04
Naiad/Bushy pondweed	9.65
Eelgrass	5.39
Native pondweeds	2.28
Elodea	1.76
Cattail	0.87
Purple loosestrife	0.22
Eurasian watermilfoil	**0.17**
Marigold	0.17
Coontail	0.09
Pickerelweed	0.04
Water stargrass	0.04
Water-lily	0.04

3.5 Sheppard's Bay

Point Intercept Survey

A point intercept survey was implemented at 122 points in Sheppard's Bay in 2015 (see Figure 3.1.a. in Appendix A). In total, 20 species were observed in 2015 which is consistent with previous survey years. Milfoil was present at 8% of the sites (9 total) with sparse densities, the majority of which consisted of <3% cover (see Table 3.5.a). This is a significant decrease from 48% in 2014 and 79% in 2013. Native pondweeds as a combined group were the most frequent (74% of sites) followed by Naiad/Bushy pondweed (70%).

Table 3.5.a: Comparison of Species Occurrence at PI Sites in Sheppard's Bay 2013-2015, 2105

Species	2013 Percent of Points (147)	2014 Percent of Points (147)	2015 Percent of Points (122)
Naiad/Bushy pondweed	41	48	70
Eelgrass	48	45	49
Chara	50	31	40
Clasping-leaf pondweed	24	30	19
Robbins'/Fern pondweed	7	9	18
Nitella	1	10	10
Eurasian watermilfoil	**79**	**48**	**8**
Variable pondweed	12	9	8
Fries' pondweed	<1	7	8
Illinois pondweed	7	14	7
Elodea	7	2	6
Large-leaf pondweed	*	4	5
Marigold	<1	3	4
Sheathed pondweed			4
Coontail	1	1	3
Bulrush/Sedge	3	*	3
Flatstem pondweed	5	*	3
Whorled watermilfoil	3	*	2
Spikerush			<1
Stiff pondweed	<1	1	*
Blunt-leaf pondweed	<1	<1	*
Floating-leaf pondweed	*	<1	*
Northern watermilfoil	*	<1	*

Yellow water-lily	*	<1	*
Cattail (Narrow leaf)	<1	*	*
Thin-leaf pondweed	1	*	2
Water Stargrass	3	*	*

**Species not found*

Table 3.5.b: Occurrence of Species' Groups at PI Sites at Sheppard's Bay, 2015

Species (grouped)	Total Occurrence	Percent of Points (120)
Native Pondweeds	89	74
Naiad/Bushy pondweed	84	70
Eelgrass	59	49
Chara	59	49
Eurasian watermilfoil	**9**	**8**
Elodea	7	6
Marigold	5	4
Coontail	3	3
Bullrush	3	3
Whorled watermilfoil	2	2
Spikerush	1	<1

AVAS Survey

Eleven AVAS's were surveyed at Sheppard's Bay and 13 species were observed throughout (Table 3.5.c) with the majority consisting of Naiad/Bushy pondweed (8.27% CC), Eelgrass (5.09% CC), and Native Pondweeds (3.99% CC)(see Figure 3.5.b in Appendix A and Table 3.5.d below). EWM accounted for 1.45%CC, a decrease from 2.64%CC in 2014.

Table 3.5.c: Percent Cumulative Cover of Species Present in Sheppard's Bay AVAS, 2015

Species	%CC
Naiad/Bushy pondweed	8.27
Eelgrass	5.09
Chara	2.55
Robbins/Fern pondweed	2.00
Eurasian watermilfoil	**1.45**
Clasping-leaf pondweed	1.27
Fries' pondweed	0.45
Marigold	0.45
Elodea	0.36
Nitella	0.36
Large Leaf pondweed	0.27
Variable pondweed	0.18
Illinois pondweed	0.09

Table 3.5.d: Percent Cumulative Cover of Species' Groups in Sheppard's Bay AVAS, 2015

Species (grouped)	%CC
Naiad/Bushy pondweed	8.27
Eelgrass	5.09
Native pondweeds	3.99
Chara	2.55
Eurasian watermilfoil	**1.45**
Marigold	0.45
Elodea	0.36
Nitella	0.36
Large Leaf pondweed	0.27

3.6 Smith's Bay

AVAS Survey

In total, 11 species were present at Smith's Bay (Table 3.6.a). EWM composed 7.00% of the cumulative cover across the six AVAS transects, occurring twice in AVAS Category A (1-2%) and once in Category C (21-60%). The dominant species present were Bulrush/Sedge, Naiad/Bushy pondweed, Chara, and Eelgrass rangin from 10.50 to 12.00%CC (Table 3.6.a). The group of native pondweeds totaled 2.67%CC (Table 3.6.b).

Table 3.6.a: Percent Cumulative Cover of Species Present in Smith's Bay AVAS, 2015

Species	CC%
Bulrush/Sedge	12.00
Naiad/Bushy pondweed	12.00
Chara	10.50
Eelgrass	10.50
Eurasian watermilfoil	**7.00**
Clasping-leaf pondweed	2.50
Fries' pondweed	2.33
Elodea	0.50
Large Leaf pondweed	0.17
Nitella	0.17
Water-lily	0.17

Table 3.6.b: Percent Cumulative Cover of Species' Groups in Smith's Bay AVAS, 2015

Species (grouped)	CC%
Bulrush	12.00
Naiad/Bushy pondweed	12.00
Chara	10.50
Eelgrass	10.50
Eurasian watermilfoil	**7.00**
Native Pondweeds	2.67
Fries' pondweed	2.33
Elodea	0.50
Nitella	0.17
Water-lily	0.17

4.0 Weevil Population Survey

The milfoil weevil is an insect native to North America that completes its entire life cycle on the milfoil plant (egg, larvae, pupae, and adult) and is capable of producing multiple generations in one growing season. Although these weevils are present throughout the United States, they often occur in naturally low populations unable to cause significant declines to dense milfoil beds in a short span of time. Since its widespread introduction, this invasive species of milfoil has become one of the most problematic plants in North American lakes. Rapid growth and reproduction by seed, stolon and fragment allows this plant to create dense, monotypic stands that displace native species. In turn, these dense beds can reduce biodiversity, cause detrimental changes to water quality and impact the aesthetics and recreational use of the water.

By stocking the weevils in high concentrations over several years as part of the Milfoil Solution® process, it is possible to weaken the milfoil infestation and allow for native plant growth. The most significant impacts occur during the larval life stage in which weevils feed on the meristem (growing tip) of the plant and burrow through the stem. This disrupts nutrient flow within the plant and causes the stem to lose buoyancy from air escaping through the damaged plant tissue causing the plant to collapse. This process also leaves the weakened plant susceptible to secondary infection. Once the weevil population reaches sufficient levels to cause wide-spread milfoil stem damage, stands become weakened and start to decrease in stem density (measured by stems/m^2). Although milfoil weevils are present throughout the northern U.S. states, they are often in populations unable to cause significant declines. Milfoil Solution® is employed to increase weevil populations to aid in reducing nuisance stands of milfoil. This form of biological control is based on a gradual process with significant declines to nuisance populations typically occurring over a multiple year program.

This Milfoil Solution® program (formerly Middfoil®) was first implemented in two locations within Cedarville Bay in 2007, stocking over 15,000 weevil eggs and larvae to an indigenous population (see Appendix B for weevil stocking location maps). A dramatic reduction of EWM was observed for multiple years after this initial augmentation. In 2011, EnviroScience was contracted by Les Cheneaux Islands Watershed Council to supply the Milfoil Solution® program to various bays within Lake Huron as part of a Great Lakes Restoration Initiative Grant. A total of 86,000 weevil eggs and larvae were stocked within four areas (Table 4.1) in 2011 and 2012. EnviroScience biologists returned to all weevil stocking sites throughout Cedarville Bay, Sheppard's Bay, and Smith's bay on August 26, 2015 to perform a final follow up survey. As outlined in the following sections, milfoil at these stocking and monitoring sites was either completely absent or found at extremely sparse densities in 2015.

Table 4.1 Milfoil Solution® at Cedarville, Sheppard's, and Smith's Bays.

Bay	Year	Survey Dates	Sites – established and/or stocked	Number of Weevils Stocked
Cedarville Bay	2007	Initial: 6/21 Follow-up: 8/7	S1,S2, MA	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, MB	15,000
	2012	Initial: 6/27 Follow-up:8/30	S2, S3	12,000
	2013	Follow-up: 8/6	Survey	0
	2014	Follow-up: 8/12	Survey	0
	2015	Follow-up: 8/26	Survey	0
Sheppard's Bay	2011	Initial:8/5 Follow-up:9/12	S1, MA	30,000
	2012	Initial: 6/27 Follow-up: 8/30	S1	14,000
	2013	Follow-up: 8/6	Survey	0
	2014	Follow-up: 8/12	Survey	0
	2015	Follow-up: 8/26	Survey	0
Smith's Bay	2011	Initial:8/5 Follow-up:9/12	S1, MA	10,000
	2012	Initial: 6/27 Follow-up: 8/30	S1	5,000
	2013	Follow-up: 8/6	Survey	0
	2014	Follow-up: 8/12	Survey	0
	2015	Follow-up: 8/26	Survey	0

4.1 Cedarville Bay

Eurasian watermilfoil was virtually absent from the weevil survey sites at Cedarville Bay in 2015 with the exception of monitoring site MA in which a total of seventeen stems were analyzed. Stems at this site were growing well below the surface in sparse distribution. No weevils were observed at this site, although damage indicative of weevil adults and larvae was found on

analyzed samples. Northern watermilfoil, a native species, was also observed at MA in addition to numerous low-growing native species found at the time of the vegetation survey. No milfoil was found during the S1 survey and one milfoil stem was found at S2. Due to these conditions, sites S3 and MB of Cedarville Bay were excluded from the weevil population survey.

Table 4.1.a Weevil Population Density in Cedarville Bay

Site	Parameter measured	6/22/07	8/7/07	8/6/08	8/11/09	8/5/11	9/12/11	6/27/12	8/30/12	8/6/13	8/12/14	8/26/15
S1	Total weevils Total stems **Avg. weevils/stem**	8.00 30.00 **0.27**	11.00 30.00 **0.37**	9.00 30.00 **0.30**	21.00 30.00 **0.70**	8.00 30.00 **0.27**	1.00 30.00 **0.03**	0.00 30.00 **0.00**	2.00 30.00 **0.67**	36.00 30.00 **1.20**	50.00 30.00 **1.67**	**
S2	Total weevils Total stems **Avg. weevils/stem**	16.00 30.00 **0.53**	7.00 30.00 **0.23**	0.00 28.00 **0.00**	11.00 30.00 **0.37**	0.00 10.00 **0.00**	0.00 29.00 **0.00**	0.00 30.00 **0.00**	2.00 30.00 **0.67**	25.00 30.00 **0.83**	13.00 30.00 **0.43**	**
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**	1.00 30.00 **0.03**	1.00 30.00 **0.03**	**
MA	Total weevils Total stems **Avg. weevils/stem**	2.00 30.00 **0.07**	9.00 30.00 **0.30**	1.00 28.00 **0.036**	8.00 30.00 **0.27**	3.00 30.00 **0.10**	0.00 29.00 **0.00**	0.00 28.00 **0.00**	1.00 30.00 **0.03**	16.00 30.00 **0.53**	2.00 27.00 **0.07**	0.00 17.00 **0.00**
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**	0.00 30.00 **0.00**	0.00 29.00 **0.00**	**

** = site not established, ** = EWM not present or occurring at density too low to survey*

Table 4.1.b Average Density of EWM (stems/m^2) in Cedarville Bay

Site	6/22/07	8/7/07	8/6/08	8/11/09	8/5/11	9/12/11	6/27/12	8/30/12	8/6/13	8/12/14	8/26/15
S1	244.44	211.11	11.11	25.89	51.9	<10	50	120.37	15.87	75.93	**
S2	300.00	166.67	40.00	0.00	<10	<10	72.22	174.07	20.37	22.22	**
S3	*	*	*	*	77.8	163.0	83.33	88.89	70.37	75.93	**
MA	155.55	270.00	133.33	74.11	66.7	63.0	157.41	125.93	38.89	12.96	**
MB	*	*	*	*	*	144.4	62.96	81.48	42.59	79.37	**

** = site not established*, *** = EWM not present or occurring at density too low to survey*

4.2 Sheppard's Bay

S1 – After numerous rake tows throughout the survey area and on GPS points from previous survey years, no Eurasian watermilfoil stems were observed at S1. Although decaying stems were found in 2014, ES biologists were unable to locate or sample milfoil at this site in Sheppard's Bay in 2015.

MA – Milfoil at this site comprised 15% of the plant community and was overall sparse with a density of only 1.85 stems/m^2 , a decrease from 35.19 stems/m^2 in 2014(Table 4.2.a). Stem samples exhibited weevil-induced damage from larval and adult stages, although no weevils were observed in the field or on samples.

Table 4.2.a Weevil Population Density in Sheppard's Bay

Site	Parameter measured	8/5/11	9/12/11	6/27/12	8/30/12	8/6/13	8/12/14	8/26/15
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**	0.00 30.00 **0.00**	**	**
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**	8.00 30.00 **0.27**	0.00 30.00 **0.00**	0.00 27.00 **0.00**

*** = EWM not present or occurring at density too low to survey*

Table 4.2.b Average Density of EWM (stems/m^2) in Sheppard's Bay

Site	8/5/11	9/12/11	6/27/12	8/30/12	8/6/13	8/12/14	8/26/15
S1	74.1	211.1	105.56	195.30	55.56	**	**
MA	37.0	31.5	70.37	183.33	64.81	35.19	1.85

***=EWM not present or occurring at density too low to survey*

4.3 Smith's Bay

S1 –Milfoil at S1 was sparse and made up 15% of the plant community and stem density was measured at 16.67 stems/m^2, a decrease from 33.33 in 2014 (Table 4.3.b). Adult weevils were observed at this site at the time of the survey as well as on analyzed stem samples which displayed extensive weevil damage. Weevil density was once again the highest at this site in 2015 with an average of 0.46 weevils/stem (Table 4.3.a).

MA – Milfoil at MA was also sparse and composed less than 10% of the plant community in this area. Measured stem density declined significantly from 14.81 stems/m^2 in 2014 to 7.41 stems/m^2 in 2015 (Table 4.3.a). No weevils were observed at this site, although damage indicative of weevil adults and larvae was identified on analyzed stem samples.

Table 4.3.a Weevil Population Density in Smith's Bay

Site	Parameter measured	8/5/11	9/12/11	6/27/12	8/30/12	8/6/13	8/12/14	8/26/15
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 **0.02**	6.00 30.00 **0.20**	12.00 30.00 **0.40**	13.00 28.00 **0.46**
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**	6.00 29.00 **0.21**	3.00 29.00 **0.10**	0.00 30.00 **0.00**

** = site not established, ** = EWM not present or occurring at density too low to survey*

Table 4.3.b Average Density of EWM (stems/m^2) in Smith's Bay

Site	8/5/11	9/12/11	6/27/12	8/30/12	8/6/13	8/12/14	8/26/15
S1	137.0	113.9	209.26	235.19	19.05	33.33	16.67
MA	*	85.2	77.78	83.33	64.81	14.81	7.41

** = site not established, ** = EWM not present or occurring at density too low to surve*

5.0 Discussion

5.1 Plant Survey

Eurasian watermilfoil decreased at all survey areas in total occurrence and density in 2015. When found, it was primarily rated as Category A (1-2% cover) and B (3-20% cover). Sheppard's Bay continues to display a collapse of dense EWM throughout the center navigation channel, a trend first noted in 2014 (Figure 3.1.a of Appendix A). This location once contained a dense monoculture of milfoil last observed in 2013 and during weevil population surveys prior to that year. Similarly, Cedarville Bay exhibited sparse milfoil in 2015 and zero instances of Category C (21-60%CC) or Category D (61-100%CC) density ratings found in previous years. Although not a monoculture, milfoil was found to be most dense in the west end of Cedarville Bay near the boat launch and around locations of boat traffic and docking locations.

Of the 33 plant species identified in 2015, thirty are beneficial native species. Several native submersed species identified in 2013 and 2014 were not in seen in 2015 but are likely still present and unaccounted for due to the nature of systematic sampling and the tendency of these species to be sparse and/or low growing. It appears that the native plant community is growing in a diverse, balanced distribution without an obvious or significant monoculture

occurring. A majority of survey areas were abundant in the macroalgae Chara and Nitella as well as Naiad/Bushy pondweed, Eelgrass, and native pondweed species in the genus *Potamogeton*. Species diversity is an important component of fish and invertebrate habitat as well as successful competition with submersed invasive plants such as EWM and Curly-leaf pondweed. Native aquatic vegetation provides cover, foraging and spawning habitat and is an essential part of a healthy aquatic food web. In addition, native aquatic plants can influence lake nutrient cycling, stabilize banks, and oxygenate the water column.

Three of the species found in 2015 are considered exotic or invasive (Narrow-leaf Cattail, Eurasian watermilfoil, and Purple loosestrife) and have the potential to grow at nuisance levels. The invasive emergent species *Phragmites australis* observed in previous survey years was not observed in 2015, likely due to the decrease in overall survey area. The similar-looking native species *Phragmites americanus* was observed in sparse density.

Although Curly-leaf pondweed was not found in 2015, this invasive species is very common throughout the Great Lakes Watershed and has become widespread across North American lakes. This pondweed is a cold tolerant species that has been known to actively grow in winter months. This species can be introduced by fragments or turions (winter bud) given off by the plant. Once established, curly-leaf pondweed grows quickly in the spring and mats at the surface of the water in the early growing season. This matting is typically followed by a mid-summer die-off, and in turn, can decrease oxygen levels due to decomposition. Continued monitoring for this species will be included in future vegetation surveys.

5.2 Weevil Survey

Although milfoil density was low in 2015, the weevil population still remains in Smith's Bay at S1. No weevils were found at Cedarville Bay or Sheppard's Bay since there was no significant habitat (milfoil) throughout those survey locations and stem densities (stems/m^2) at all weevil survey locations are at an all-time low compared to the initial 2007 and 2011 data.

Using a biological control such as the milfoil weevil can result in varying degrees of success between systems. Many factors play an important role including the size and density of the stocking area, shoreline habitat, initial health of the milfoil, amount of weevils stocked, and the degree of recreation occurring on the lake which can disrupt beds of milfoil. Goals of milfoil management using the weevil include: reduction of milfoil at the stocking locations, increase in

desirable native plant community and continuing to observe weevils throughout the existing milfoil beds.

It appears that the weevil population is successfully overwintering and returning to sparse milfoil habitat each spring based on long-term data from stem analysis. The weevil population will respond each year to changes in the plant community. As milfoil decreases, so too will the weevil population to adjust for decreased habitat. Should milfoil increase due to seasonal conditions (such as a mild winter or warmer summer) the weevil population will gradually catch up with plant growth and remain in the lake to varying degrees as long as there is milfoil present.

6.0 Recommendations

Of the three most recent vegetation surveys conducted, 2015 exhibited the lowest abundance of Eurasian watermilfoil. It is likely that a combination of several factors has caused the decrease of EWM throughout Les Cheneaux from 2013 to 2015, but determining the exact cause is difficult and prone to speculation in the absence of long-term data. Managing invasive species (as eradication is typically not possible) is a continuous process that will require the ongoing effort and support from the residents of the Les Cheneaux watershed. Milfoil can propagate from small fragments so it is recommended that boat operators avoid navigating directly through dense beds of aquatic vegetation in order to hinder the spread of unwanted invasive plants. Additionally, removing plant fragments from boats and trailers before and after launching will help this cause. In addition to noteworthy decreases in EWM, LCI continues to host an extremely diverse freshwater native plant community consisting of both emergent and submersed species. Ongoing management strategies should take into account the preservation of desirable and sensitive species as well as overall ecosystem health while focusing on the control of unique nuisance species on a case-by-case basis.

It is the recommendation of EnviroScience that an aquatic vegetation survey is conducted on an annual or biennial basis to monitor invasive plant growth and assist in management decisions. Invasive species of concern are primarily Eurasian watermilfoil, Purple loosestrife, non-native *Phragmites*, and Curly-leaf pondweed which have the potential to propagate to nuisance levels as is the case in numerous areas of the Great Lake and many smaller inland lakes. The vegetation survey should be performed towards the end of each summer (August to early

September). Although vegetation surveys can be conducted in spring and early summer, they will not accurately represent peak plant growth occurring later in the summer season.

Please contact EnviroScience at (800) 940-4025, or cmarquette@EnviroScienceInc.com with questions regarding this report.