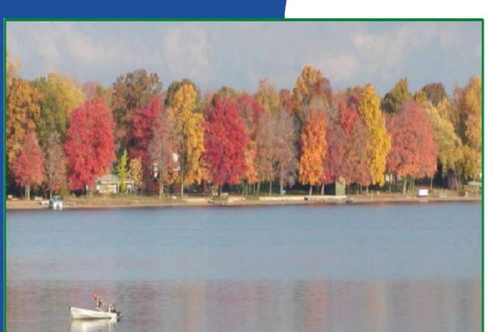
2013 Vegetation Survey and *Eurasian Watermilfoil Strategic Biological Control Program* at Les Cheneaux Islands, Lake Huron, Michigan

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 24 bays of the Les Cheneaux Chain of Islands (LCI) from July 31 to August 6, 2013 (Table 1.0, Figure 1.0). The purpose of this survey was to compile an inventory of all aquatic vegetation species, identify locations of Eurasian watermilfoil (*Myriophyllum spicatum*) (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 2013 requirements of the stocking contract.

Table 1.0. Summary of 2013 Survey Areas

Survey Area	Abbreviation	Vegetation Survey Type	# Survey Points	Length Between Points/Transects (ft)	2013 Survey Date
Cedarville Bay	CVB	AVAS	1	1000	8/5
Cedarville Bay*	CDB	PI	146	350	8/4-8/5
Coryell Bay	COR	AVAS	1	1000	8/4
Duck Bay	DB	AVAS	4	1000	8/2
Government Island	GVT	AVAS	4	1000	8/5
Hessel Bay	HB	AVAS	10	500	8/2
Hessel Harbor	HH	AVAS	9	500	8/2
Hill's Channel	HC	AVAS	6	1000	8/5
Islington Channel	IC	AVAS	26	250	8/3
Lakeside Landing	LSL	AVAS	2	1000	8/4
Mackinac Bay	MAC	AVAS	2	1000	8/3
Marquette Bay	MQT	AVAS	17	500	7/31
McKay Bay	MCK	AVAS	4	1000	8/4
Middle Entrance	ME	AVAS	3	500	8/2
Mismer Bay	MIS	AVAS	9	500	7/31
Moscoe Bay	MOS	AVAS	7	1000	8/4
Muskellunge Bay	MSK	AVAS	15	500	8/1-8/2, 8/5
Peck Bay	PB	AVAS	1	500	8/2
Scammon's Harbor	SH	AVAS	1	1000	8/5
Sheppard's Bay*	SHP	PI	147	150, 350	8/3-8/4
Smith's Bay*	SM	AVAS	9	500	8/1-8/2
Snow's Channel	SNO	AVAS	40	500	8/2-8/3
Urie Bay	UB	AVAS	3	1000	8/3
Voight Bay	VB	AVAS	3	1000	8/2
Wilderness Bay	WDS	AVAS	20	350	7/31

**Weevil Population Survey 8/6/13*

AVAS = Aquatic Vegetation Assessment Site Survey

PI = Point Intercept Survey

2.0 Methods

Two vegetation survey methods were implemented throughout twenty-four areas: an Aquatic Vegetation Assessment Site (AVAS) survey and a Point Intercept (PI) survey (Section 3). A final 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 Methods

Qualitative vegetation sampling was performed using the Michigan DEQ guidance contained in Standard Procedures for Surveying Aquatic Plants. Survey areas were selected based on input from the LCWC and EnviroScience biologists. The boundary of each AVAS was determined using differential GPS technology. Plant community data were collected through visual and rake tow surveys along evenly-spaced transects of the littoral zone. In each of these transect zones, the presence and relative density of each aquatic plant species were determined and the information was recorded on the Standard Aquatic Vegetation Assessment Site Species Density Sheet developed by the State of Michigan. 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 to estimate the density of each species encountered. Species of unknown identity were placed in a sample bag, appropriately labeled, and identified using taxonomic keys at the completion of the survey. The approximate percentage of cumulative cover (%CC) was reported as cover codes A, B, C, and D to describe the approximate coverage of each plant between each transect and within each AVAS. However, the cover code colors listed below are represented in the maps (App A, Figures 3.1-3.24) for Eurasian watermilfoil in each bay; if there is no color then simply there was no milfoil.

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 (CDB) and Sheppard's Bay (SHP) 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. As stated above, the density of EWM is represented in the maps for this particular survey. Species of questionable identity were identified at the completion of the survey.

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 43 species were identified in all survey areas (Table 3.1). EWM was identified to varying extent in 22 of the 24 survey areas. Milfoil distribution maps and plant species tables are shown in Appendix A. A vegetation guide of species identified in 2013 is located in Appendix B.

Table 3.1 Vegetation Species Summary

Common Name	Scientific Name
Alternate watermilfoil	*Myriophyllum alterniflorum*
Arrowhead	*Sagittaria spp.*
Bladderwort	*Utricularia macrorhiza*
Blunt pondweed	*Potamogeton obtusifolius*
Bulrush	*Scirpus spp.*
Bushy pondweed/Slender naiad	*Najas flexilis*
Buttercup/White water buttercup	*Ranunculus aquatilis*
Cattail	*Typha latifolia*
Cattail (Narrow-leaved)	*Typha angustifolia*
Chara	*Chara spp.*
Clasping Leaf pondweed	*Potamogeton richardsonii*
Coontail	*Ceratophyllum demersum*
Elodea	*Elodea canadensis*
Eelgrass	*Vallisneria americana*
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*
Water lobelia	*Lobelia dortmanna*
Mare's Tail	*Hippuris vulgaris*
Marigold	*Bidens beckii*
Nitella	*Nitella sp.*
Northern watermilfoil	*Myriophyllum sibiricum*
Phragmites	*Phragmites australis*

Pickerelweed	*Pontederia cordata*
Pipewort	*Eriocaulon aquaticum*
Purple loosestrife	*Lythrum salicaria*
Reed Canary Grass	*Phalaris spp.*
Robbins'/Fern pondweed	*Potamogeton robbinsii*
Sago pondweed	*Stuckenia pectinata*
Sedge	*Juncus spp.*
Spadderdock	*Nuphar variegata*
Spikerush	*Eleocharis acicularis*
Stiff pondweed	*Potamogeton strictifolius*
Thinleaf pondweed	*Potamogeton diversifolius*
Variable pondweed	*Potamogeton gramineus*
Water Stargrass	*Heteranthera dubia*
Whitestem pondweed	*Potamogeton praelongus*
White waterlily	*Nymphaea odorata*
Whorled watermilfoil	*Myriophyllum verticillatum*
Wild rice	*Zizania aquatica*

3.1. Cedarville Bay (CDB [PI] and CVB [AVAS])

Both survey methods were implemented in areas of Cedarville Bay to accommodate the large area. The point intercept survey was conducted at 146 points within Cedarville Bay (Figure 3.1a). Twenty-five species were identified in these points (App. A, Table 3.1). Milfoil was found in 51% of the points (73 of 146) at varying densities (Figure 3.1b). If there was no milfoil in the rake tow at a given point, no color code was assigned. Low growing native species found to occur in high abundance included Chara (59%), naiad (30%) and Robbins' pondweed (25%). Eelgrass was also relatively high at 52% occurrence. This native species is not often considered problematic, but in shallow areas it can grow to the surface and foul boat propellers. The native sedge (*Juncus spp.*) was observed on shore. Three invasive shoreline species were observed: Phragmites, reed canary grass, and purple loosestrife at the Cedarville boat launch.

A single AVAS along the southeast portion of Cedarville Bay, towards Government Bay, contained a total of 20 species (Figure 3.1c). EWM comprised 40% cumulative cover (CC) of the 1,000 foot long survey area. Chara, eelgrass, Robbins' pondweed and whorled watermilfoil each occurred at 10% CC while other species were sparse.

3.2 Coryell Bay (COR)

No EWM was found in the AVAS at Coryell Bay (Figure 3.2). Of the eight species identified, Chara and mare's tail were the most dominant.

3.3 Duck Bay (DB)

EWM comprised 13% CC in the AVAS survey at Duck Bay and was most dense on the east transect closest to Muskellunge Bay (Figure 3.3). Of the 15 total observed, other dominant species were bulrush, Chara, and naiad.

3.4 Government Island (GVT)
Three of four transects contained EWM with a density rating of C at Government Island (Figure 3.4). A total of 19 species were identified which included Phragmites and reed canary grass on shore.

3.5 Hessel Bay (HB)
Milfoil was found primarily at ratings of C and D and encompassed 53% of cumulative cover at Hessel Bay (Figure 3.5). A total of 16 species were identified which included Phragmites and reed canary grass on shore.

3.6 Hessel Harbor (HH)
EWM was most dense at the marina at Hessel Harbor, encompassing 17% AVAS cumulative cover (Figure 3.6). EWM was the only invasive of the 16 species found.

3.7 Hill's Channel (HC)
EWM totaled 16.83% cumulative cover at Hills' Channel and was most dense southeast of the South Forest Lane bridge. (Figure 3.7). EWM, Chara and cattail (including the invasive, Narrow-leaf cattail) were the most dominant of the 24 species in this area.

3.8 Islington Channel (IC)
EWM was distributed along both sides of Islington Channel at 27.81% CC, primarily at ratings of C (Figure 3.8). The eastern side of the channel contained the most dense transects. Bulrush was also prominent at this area and species richness was relatively high totaling 23 species.

3.9 Lakeside Landing (LSL)
No EWM was observed in two AVAS transects at Lakeside Landing (Figure 3.9). The 11 species observed occurred at sparse densities, including the native whorled watermilfoil.

3.10 Mackinac Bay (MAC)
EWM was not the dominant species at Mackinac Bay but was most abundant at a rating of B (3-20%) at the southwest entrance (Figure 3.10). Bulrush and large-leaf pondweed were the most abundant of the nine species identified.

3.11 McKay Bay (MCK)
Chara was the most dominant of the 15 species at McKay Bay. Native whorled watermilfoil comprised 5.25% CC of the AVAS while sparse EWM was found along the southwestern shore at 0.50% CC (Figure 3.11).

3.12 Middle Entrance (ME)
Chara was also dominant throughout Middle Entrance at 40% CC. Of the 12 species in this area, EWM was sparse at 0.67% CC (Figure 3.12).

3.13 Mismer Bay (MIS)
EWM was most dense along the eastern side of Mismer Bay but it was almost equally abundant to native milfoils (6.80% CC) (Figure 3.13). A total of 13 species were observed including invasive Phragmites on the shore.

3.14 Moscoe Bay (MOS)

Milfoil exhibiting unusual characteristics was discovered in Moscoe Bay, but genetic testing revealed it to be Northern watermilfoil. Native milfoils were most abundant in Moscoe Bay and sparse EWM was observed along the southern shore (Figure 3.14). A total of 20 species were observed including invasive Phragmites on the shore.

3.15 Marquette Bay (MQT)

EWM was sparse in Marquette Bay and was found at a density rating of B in the southeast corner (Figure 3.15). Of the 21 species in this bay, Chara and clasping-leaf pondweed were most abundant. Invasive Phragmites and reed canary grass were identified on shore.

3.16 Muskellunge Bay (MSK)

The densest EWM at Muskellunge Bay occurred in the northeast transects and comprised 15.47% CC (Figure 3.16). Of the 18 species identified, bulrush and Chara were most dominant. Invasive reed canary grass was observed on shore.

3.17 Peck Bay (PB)

Very sparse EWM was observed in Peck Bay (Figure 3.17). Chara was most dominant of the 11 species at 40% CC.

3.18 Scammon's Harbor (SH)

The five species identified at Scammon's Harbor were sparse and equally distributed. EWM was calculated at 1% CC (Figure 3.18).

3.19 Sheppard's Bay (SHP)

A Point Intercept survey at Sheppard's Bay was implemented at 147 grid points (Figure 3.19a). EWM was identified in 75% of the points (111 of 147) (Table 3.19). It was most dense near the center of both major basins (Figure 3.19b). The remaining 36 points or rake tows only contained native species. Twenty-two species were identified, including reed canary grass on shore. A sparse stand of purple loosestrife was observed along the northern shore (GPS point SHP 39). Additional species observed during the survey but not collected were: cattail, needle spikerush, and spatterdock for a total of 25 species.

3.20 Smith's Bay (SM)

Of the 21 species identified in Smith's Bay, EWM was most dominant at 41.11% CC (Figure 3.20). It was primarily recorded at densities of C and D, but further in to the bay it was sparse and distributed with dense eelgrass. A weevil population survey was conducted in the eastern end of this bay (Section 4.3). Invasive Phragmites and reed canary grass were seen on shore.

3.21 Snow's Channel (SNO)

EWM was the dominant species in Snow's Channel, being dense along the northeastern shore, composing 42% CC of the AVAS (Figure 3.21). A total of 23 species were found, including invasive reed canary grass and purple loosestrife on shore.

3.22 Urie Bay (UB)

Fifteen species were found at Urie Bay, of which bulrush and Chara were most dominant. EWM was sparse throughout the AVAS at 4% CC (Figure 3.22). No additional invasive species were recorded.

3.23 Voight Bay (VB)

Sparse EWM was observed near docks along the southwestern shore of Voight Bay (Figure 3.23). Seven species were identified in the survey area but vegetation was sparse overall. Invasive Phragmites was observed on shore but appeared unhealthy due to previous management.

3.24 Wilderness Bay (WDS)

Of the 19 species observed in Wilderness Bay, Chara was most dominant at 43.50% CC. EWM was most dense in the northeast corner and totaled 10.75% CC (Figure 3.24). Invasive Phragmites was also observed on shore.

4.0 Weevil Population Survey

Milfoil Solution® (formerly Middfoil®) utilizes a biocontrol agent, the milfoil weevil (*Euhrychiopsis lecontei*), for an invasive, exotic plant, Eurasian watermilfoil. This program was first implemented in two locations within Cedarville in 2007, stocking over 15,000 weevil eggs and larvae to an indigenous population. 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.

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, 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	S2, S3	12,000
	2013	Follow-up: 8/6	Survey	0
Sheppard's Bay	2011	Initial:8/5 Follow-up:9/12	S1, MonA	30,000
	2012	Initial: 6/27 Follow-up: 8/30	S1	14,000
	2013	Follow-up: 8/6	Survey	0
Smith's Bay	2011	Initial:8/5 Follow-up:9/12	S1, MonA	10,000
	2012	Initial: 6/27 Follow-up: 8/30	S1	5,000
	2013	Follow-up: 8/6	Survey	0

4.1 Cedarville Bay

2007 Sites

S1 and S2 – Milfoil in both of these areas has historically been sparse close to shore and denser toward the channel (App. C, Figure 4.1).The same was true in 2013 with more than 70% of the plant community consisting of native species. Milfoil in this area was sparse, unhealthy and heavily damaged by weevil larvae. Additionally, lab analysis of the collected stems revealed the highest weevil counts ever recorded from both of these sites in the six years of monitoring (Table 4.2). The milfoil density has lowered dramatically over the years since stocking of weevils began; this season being one of the lowest recorded (Table 4.3).

Native species recorded include: blunt-leaf pondweed, Chara, clasping-leaf pondweed, eelgrass, elodea, flatstem pondweed, Illinois pondweed, large-leaf pondweed, water marigold, naiad, Nitella, northern watermilfoil and whorled watermilfoil.

MA – Milfoil in this site, located along the northern shoreline of the bay, was moderately dense. However, the density data (in stems/m^2) was the lowest recorded. At the time of the survey, weevil adults and eggs were observed swimming through the stand of milfoil. Lab analysis revealed that 35% of the stems were damaged by larval tunneling. The milfoil was 4" below the water surface and covered in algae. Chara, eelgrass and Nitella were the only native species seen mixed in within the milfoil, making up 50% of the plant community.

A small area within this site was tested with the fungi pathogen (*Mycoleptodiscus terrestris*) by the LCWC. At the time of the survey, the stems within the area were in poor health and dying back.

2011 Sites

S3 - Since stocking weevils on the eastern side of the bay in 2011, no drastic changes have been observed as was the case along the western side (S1 and S2). Milfoil here was still considered dense but didn't appear as large in size as in previous seasons. Damage caused by boat propellers has been an ongoing occurrence and was still observed this season even though the plants were on average 7" to 1' below the surface. No weevil life stages or damage indicative of weevils was observed in the field, but lab analysis detected one life stage on a single collected stem. Eleven native species were identified mixed in with the milfoil at a low density (10%) and these included: Chara, clasping-leaf pondweed, eelgrass, elodea, flatstem pondweed, Illinois pondweed, large-leaf pondweed, marigold, naiad, Nitella and Robbins' pondweed.

MB – Although no weevil life stages were identified from stem analysis, weevil adults were observed while swimming through the narrow stand of milfoil in August. Another observation made was the existence of the Acentria moth (*Acentria ephemerella*) on a few stems of milfoil. While the caterpillar of the moth does eat milfoil, it's typically not found in densities high enough to cause significant damage. Milfoil compromised 60% of the overall plant community, was in poor health and exhibited missing apical meristems (tips of the plant) from possible prop damage. The same native species found in S3 were also found here in addition to Fries' pondweed. The stems density, on average, has changed little over the period of the program (Table 4.3).

Table 4.2. 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
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**
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**
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**
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**
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**

** = site not established*

Table 4.3. Average Density of EWM (stems/m²) 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
S1	244.44	211.11	11.11	25.89	51.9	<10	50	120.37	15.87
S2	300.00	166.67	40.00	0.00	<10	<10	72.22	174.07	20.37
S3	*	*	*	*	77.8	163.0	83.33	88.89	70.37
MA	155.55	270.00	133.33	74.11	66.7	63.0	157.41	125.93	38.89
MB	*	*	*	*	*	144.4	62.96	81.48	42.59

** = site not established*

4.2 Sheppard's Bay

S1 – At the end of the 2012 season, milfoil had expanded across the whole bay having an average stem density at 195.30 stems/m^2 (App. C, Figure 4.2). On August 6, 2013 the stand of milfoil was found to be considerably smaller in size and the density decreased considerably to 55.56 stems/m^2, the lowest density observed during the program (Table 4.5). The majority of the milfoil was 2'-3' below the water surface, and was below what would normally be considered nuisance levels. Illinois pondweed was at the surface flowering. No actual weevil life stages were identified on the stems from lab analysis but damage indicative of the weevil larvae were observed in the field and on a number of the lab-analyzed stems. Twenty percent of the native plant community included: Chara, clasping-leaf pondweed, eel grass, elodea, flatstem pondweed, Illinois pondweed, marigold, naiad, northern watermilfoil, Robbins' pondweed, variable pondweed and water stargrass.

MA – The density of the milfoil was less than that observed the prior year. However, the lowest density recorded was at the start of the program (Table 4.5). This year the plants were noted as being healthy and growing 6"-20" below the water surface. Weevil induced damage was observed in more than 45% of the plants. Additionally, multiple life stages were identified on the 30 stems collected for lab analysis (Table 4.4). The same native species observed in S1 were observed in the monitoring site but at a higher rate of 50% cover.

Table 4.4. 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
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**

Table 4.5. 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
S1	74.1	211.1	105.56	195.30	55.56
MA	37.0	31.5	70.37	183.33	64.81

4.3 Smith's Bay

S1 – Eelgrass was found to be the dominant species within this site. Milfoil declined dramatically to 19.05 stems/m^2 in 2013, compared to 235.19 stems/m^2 the previous year (Table 4.7). The little milfoil that remained was 4"-10" below the surface in this shallow bay (App. C, Figure 4.3). Other species observed include: Chara, elodea, naiad, Nitella, northern watermilfoil, thin-leaf pondweed and water stargrass. Although little larval damage was observed on the stems while in the field, life stages were identified from lab analysis (Table 4.6). Additionally, the water mite that was observed in abundance last season was not seen during the 2013 survey.

MA – As was noted last season, milfoil compromised 65% of the overall plant community. A slight decrease was measured in density, but this change was considered insignificant (Table 4.7). Contrary to last year when milfoil was topped out and flowering in August, milfoil was one foot below the surface, overall health declined and no flowering was observed. Obvious and prevalent weevil damage was seen during the survey; affecting approximately 20% of the plants. Most significantly, a diverse native community was found dispersed within the milfoil. These natives include: Chara, clasping-leaf pondweed, eelgrass, elodea, large-leaf pondweed, needle spikerush, northern watermilfoil, Robbins' pondweed and variable pondweed.

Table 4.6. 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
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**
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**

* = site not established

Table 4.7. 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
S1	137.0	113.9	209.26	235.19	19.05
MA	*	85.2	77.78	83.33	64.81

** = site not established*

5.0 Discussion

5.1 Plant Survey

The 2013 vegetation survey confirmed that the Les Cheneaux Islands contain a diverse aquatic plant community comprised of 38 desirable native species, as well as five problematic invasive species that warrant ongoing monitoring. Native species exhibiting special characteristics for the state of Michigan were: bladderwort (good water quality indicator), alternate watermilfoil which is found in only six Upper Peninsula (UP) counties, blunt-leaf pondweed (a northern Michigan species), water lobelia (found in UP lakes with low pH), mare's tail (does not occur in the lower half of Michigan's Lower Peninsula), water marigold (good water quality indicator), and pipewort (soft-water and acidic lakes). In addition to their special characteristics, these native species are often found in minimally disturbed, "pre-settlement" habitats (Michigan Flora Online, 2011).

Chara was a prolific native species found intermixed with the milfoil in Cedarville, Sheppard's and numerous other bays. This species is a macroalgae rather than a true plant and competes with milfoil for space, growing further below the surface than most invasive and native species (Figure 5.1). It also stabilizes sediments and is consumed by many species of ducks.

Figure 5.1 Shorter, dense Chara growing with taller, sparse milfoil.

Of the 43 species identified, five are considered invasive in the state of Michigan: Eurasian watermilfoil, Phragmites/common reed, purple loosestrife, narrow-leaved cattail, and reed canary grass.

EWM is successful in many aquatic plant communities because it out-competes desirable native vegetation and tends to form dense monocultures which may contain several hundred stems per square meter. This is primarily due to its fast growth rate and canopy-forming growth habit, which allows it to shade out more desirable native vegetation. EWM does well in a wide variety of sediment conditions, can tolerate low light, and low temperatures. Dense colonies of the plants and its ability to form thick floating mats interfere with all types of recreation, provide poor fish habitat, and may contribute to degraded water quality.

Much of the EWM throughout the study areas was found to be growing from 3 to 15 feet below the surface and sometimes deeper away from shore, such as in the center of Cedarville Channel. Although EWM was found in 22 of 24 bays, it wasn't always the dominant species (Appendix A). Although the native plant community is quite diverse in LCI, factors including the level of recreation, development, and natural connectivity of the area have contributed to dense assemblages of EWM in many of the bays and channels. The level of recreation and prop cuttings are the most probable cause of the spread of milfoil throughout the chain of islands. Based on EWM %CC and % Occurrence throughout the LCI, the areas of greatest concern are: Cedarville Bay, Government Island, Hessel Bay, Hessel Harbor (marina), Hill's Channel, Islington Channel, Muskellunge Bay, Sheppard's Bay, Smith's Bay, Snow's Channel, and Wilderness Bay. However, all bays containing EWM should be monitored annually as growing conditions change from year to year.

Suspected hybrid milfoil samples (Eurasian watermilfoil x Northern watermilfoil) were collected in Moscoe Bay because plants here exhibited unusual growth characteristics. Hybrid milfoils often exhibit aggressive growth patterns and reduced sensitivity to 2,4-D and Fluridone. Samples were sent to Dr. Ryan Thum of the Annis Water Resources Institute at Grand Valley State University, the geneticist identifying hybrid diversity and lineages throughout Michigan and the Midwest. Samples were ultimately determined to be native Northern watermilfoil despite the unusual characteristics.

Phragmites and reed canary grass were observed along the shoreline in almost every bay while purple loosestrife was only found in isolated areas of Snow's Channel, Sheppard's Bay, and at the boat launch in Cedarville Bay. Cattails (*Typha spp*.) were identified along the shoreline of 10 bays. There are many types of cattails, the most common species (*T. latifolia*) is native while narrow-leaved cattail (*T. angustifolia*) is exotic in North America. This species prefers salty soils or marshes and can become invasive. Positive identification is often difficult as the two species can hybridize to form *T. x glauca*. Narrow-leaved cattail was notably found dominating a section of Hill's Channel, south of the bridge. Dense stands were not located elsewhere, although it is possible that it is established within other bays further from the survey zones.

Native aquatic plant species provide essential habitat for fish and for organisms that provide food for both juvenile and adult fish. Fish also depend on these plants for cover to protect their young and as an area for predator avoidance. The plants also play an important role in nutrient cycling and in oxygenating the water column. As with most native species, these rooted aquatic plants seldom grow so dense that active management is required. When excessive growth by one or more species of plants (native or exotic) begins to form a monoculture and interfere with recreational use of the lake, the plants become "weeds" and require active management. As with a garden, management implies encouraging certain plants and controlling others. In general, aquatic plants are essential components of lake ecosystems. They, along with plankton, are the base of the food chain. Additionally, aquatic plants contribute to the beauty of the lake, stabilize banks, oxygenate water, protect fish, provide spawning habitat, and serve as food sources for waterfowl and wildlife.

Species richness is simply a count of species. In terms of the 'species richness' of the plant community in LCI, it is relatively **high**. Inland lakes (closed systems) within the state on average contain half the amount of plants found in LCI. However, the open system of the LCI on Lake Huron cannot be compared fairly to inland lakes as those systems have separate confounding issues such as water quality. For instance, a known lake in the southern part of the state less than 300 acres in size and surrounded by agriculture can't sustain a healthy plant community. Eurasian watermilfoil is problematic in this lake but the main issue lies with the internal and external loading of nutrients in the lake being Phosphorus limited, Nitrogen overloaded and having low dissolved oxygen throughout the growing season. As a result, only one other native plant species coexists with the milfoil. If you compared the species richness to another Great Lake such as Lake Erie, the difference in species richness is immeasurable. Given this diversity of species found in the LCI, it is reasonable to justify other communities within the food chain are also in abundance such as macro-invertebrates and the overall fisheries.

Management strategies should be designed to alter a specific component (EWM) while preserving the sensitive, more desirable species. Potentially impacting the 'producers' of the food web could have a cascading affect. The overall health of the ecosystem should be considered when making management decisions.

5.2 Weevil Survey

It was hoped at the start of the 2011 weevil pilot study that the weevils would gain control of the milfoil as quickly as was observed during the initial 2007 program. Unfortunately, grant constraints pushed the first stocking event to early August, much later than the preferred stocking time of early June to mid-July. By September, milfoil densities at two of the new sites (Cedarville, S3 and Sheppard's Bay, S1) had more than doubled over a five week period. Additionally, a very early spring and unusually warm temperatures during the first half of 2012 resulted in EWM flowering very early and heavily throughout the Midwest. Once milfoil flowers, it is generally unsuitable for egg laying by female weevils. As a result, dramatic declines in weevil populations were noted across the region during the summer. As evidenced by the weevil survey information contained in Section 4 above, this trend also held true for the Les Cheneaux Islands region.

More typical weather patterns returned in 2013, weevil populations rebounded and a more typical EWM-weevil relationship was observed, particularly in the original Cedarville sites (S1 and S2) and in the Smith's Bay stocking location. One of the largest changes noted was the decrease in density and size of milfoil bed in Sheppard's Bay, S1. Additionally, a more desirable native plant community continues to increase and thrive in all the project areas.

The presence of a healthy and diverse native plant community has been shown to be an important factor in maintaining long-term control of Eurasian watermilfoil. In project after project, we have observed that if the milfoil population can be decreased enough to allow for re-establishment of desirable native species, the natives are often able to out-compete EWM for light and space.

When working with a biocontrol such as the milfoil weevil, it is important to remember that the rate in which "control" is achieved can vary greatly from lake to lake. Many factors play an important role including the size of the lake, shoreline habitat, amount and health of the EWM, amount of weevils stocked, and how much recreation occurs on the lake. EnviroScience develops Milfoil Solution® programs for clients based on these factors. Most programs entail stocking weevils over multiple years (3-5) to gain effective control. Augmenting to the indigenous weevil population in Cedarville Bay in 2007 yielded abnormally quick results within one season. Although the same results were not achieved during the pilot study, positive attributes were still observed including: reduction of milfoil at the stocking locations, increase in desirable native plant community and finding weevils in various locations proving they are surviving, successfully overwintering and returning to the lake. Despite variation in weevil numbers and milfoil density, overall the Les Cheneaux Islands pilot weevil stocking program continues to make steady, positive progress given the two years of stocking. Further augmentation of the various sites, and potentially new areas, over the next several seasons could be expected to yield even greater results.

6.0 Recommendations

There are two major concerns for the Les Cheneaux Islands; decreasing water level due to activities in the St. Clair River and the continued spread of the noxious weed, Eurasian watermilfoil. EWM has been increasing and spreading rapidly throughout the Les Cheneaux Watershed for more than twenty years. An example of this rapid spread can be seen in a small stand of milfoil was found in Sheppard's Bay in 2008. This stand comprised of a relatively few acres increased dramatically over the next few years and by 2012, the LCWC estimated that EWM infested at least 14,000 total surface acres across the chain of islands (2012 Aerial Survey). The worsening infestation has become more evident with the decreasing water level over the last several years, and abnormal growing seasons like the one in 2012 contribute to optimal conditions for milfoil growth and resulting nuisance conditions. Prior to the LCWC designing and implementing an aquatic plant management program and best management practices (BMPs), it is suggested to perform a detailed survey to document plant distribution and abundance of emergent, floating-leaved and submersed species. Although the survey methods used in the 2013 plant survey are common practice in the state of Michigan, they are somewhat limited in that they do not calculate total acreage occupied by each species. With the underlying goal of this survey in mind, these methods did successfully in identify the primary locations of the EWM infestation and other species present. They were also the most accurate and practical methods to inventory the extensive aquatic plant community throughout the Les Cheneaux Islands given the scope and budget of the project.

For future years, annual or biannual vegetation surveys are recommended to monitor the spread of invasive species and plant community changes over time. In addition to monitoring the spread of existing exotic species in Les Cheneaux islands, these surveys provide an early warning system by detecting new exotic species. Several invasive species have the potential to grow in the LCI (Figure 6.0). Starry Stonewort (*Nitellopsis obtusa*) is a submersed algal species that is considered highly invasive in IN, NY, PA, and southern Michigan. This plant proliferates very rapidly and grows vertically within the water column forming dense mats in water depths up to 27 feet. This species is visually similar to Chara, but Chara typically grows closer to the substrate. If populations of what appear to be Chara are seen to expand dramatically and grow close to the water's surface, a sample should be collected and sent to a specialist for proper identification. Another invasive species common in the state is Curly-leaf pondweed (*Potamogeton crispus*) which occurs early in the growing season. Invasive Hydrilla (*Hydrilla verticillata*) has been identified in the Ohio River, Indiana and New York. A similar species, Brazilian Elodea (*Egeria densa*), has been found in southern Indiana and West Virginia. Early detection of Hydrilla and Brazilian Elodea is often difficult as they both resemble the commonly found native species elodea.

Figure 6.0. Starry Stonewort, Curly-leaf Pondweed, Hydrilla, and Brazilian Elodea (L to R)

A variety of methods are currently available for controlling nuisance aquatic plants, including Eurasian watermilfoil. These include physical, mechanical, chemical, and biological methods. All aquatic plant management techniques have positive and negative attributes. Selection of a method needs to be based on economic, environmental, technical, and sometimes regulatory constraints.

Harvesting: **Mechanical, Suction and Diver Assisted (Hand Pulling)**:

Mechanical harvesting produces immediate results in reducing plant biomass, but is generally not recommended for EWM management since it has the potential to spread EWM by fragmentation. Small fragments can re-colonize elsewhere, potentially promoting the long-term spread and persistent infestation. However, this method is useful for targeted control in areas of heavy boat traffic. This technique does require a permit from the MDEQ. To date, mechanical harvesting has been used with success to improve conditions such as navigation in selected areas of the lake. The harvester selected by LCWC collects all the milfoil fragments and disposes all of it on an upland location where they are composted and used as fertilizer. Private homeowners have contracted harvesting in front of boat houses and docks as well. Additionally, the void area (non-shaded) in Smith's Bay (Figure 3.20) was due to harvesting activities.

Suction harvesting and diver assisted harvesting employ underwater divers to hand select the milfoil and pull it out by the root crown. Suction harvesting requires the diver to send the plant matter through a large vacuum hose to a boat for removal. Diver assisted harvesting is typically classified as bagging the plant material underwater. Permits from MDEQ may be required for these activities. In any event, suction harvesting or diver assisted harvesting are unlikely to be feasible or cost effective over large areas.

Benthic Barriers

These are large mats (typically black in color) set on the lake bottom in early spring to inhibit plant growth. This technique is ideal for areas consumed by milfoil such as; swimming beaches, boat launches and boat docks. Durable material should be used (i.e. Geotextile fabric, pond liner) as a barrier and shouldn't stay in one area longer than 6-8 weeks; sediment can build up on top of mat creating new habitat for milfoil growth. It's important to keep in mind that gas may build up under the mat as a result of decaying plant material creating bubbles; maintenance may be required. It should be noted that barriers also shade out the beneficial native species as well.

EnviroScience biologists have observed the use of these mats in a few lakes with marginal success; it appears that the approximate time of placement is critical for success. For instance, a mat placed in mid-June can result in milfoil growing laterally under the barrier. Once removed six weeks later, the milfoil can rebound vertically back into the water column. Benthic barriers 10 by 20 feet in size have been used within a few areas of the chain of islands and have worked well. No permit is currently required by the state at this time. This management technique could be a feasible option on a per homeowner basis. This is not suited for areas on a large scale.

Dredging

Dredging involves a machine or vessel that excavates and removes sediment from the bottom of a water body. This method can be used to alleviate milfoil growth however, it is a very costly option and can potentially cause an influx of other problems. Unless performed to extreme depths, dredging also is not a long-term plant control method. However, the LCWC is currently experimenting with dredge/drag techniques in the previously dredged channels as a means to prevent milfoil re-establishment.

Chemical Herbicide

This management technique is the most commonly used when treating Eurasian watermilfoil. A state permit, issued by MDEQ, is required for the use of aquatic herbicides. There are two categories of aquatic herbicides; contact and systemic. Contact herbicides (i.e. Reward) damage the plant leaves and structure while systemic herbicides (i.e. Sonar, Triclopyr and 2,4-D) are taken up in the root structure and actually kills the entire plant. Systemic herbicides will impact native dicot species essential for a lake ecosystem. Sonar is often a 'whole-lake' treatment and MDEQ often requires one full season of water quality sampling prior to treatment. Triclopyr and 2,4-D are used more in a spot treatment basis. However, there is a restriction by the state of the use of 2,4-D in the vicinity of drinking water wells. There are more than 100 water intakes identified within the chain of islands for the use of potable water. Additionally, the use of herbicides could potentially impact the low growing plant community observed throughout the islands. Disturbance to that community can open up areas for colonization by other invasive species or for more available milfoil habitat.

Herbicides have been applied at private residences near boathouses and docks to alleviate dense milfoil growth. However, wide range use of herbicides throughout the LCI will be very expensive and will have to be repeated indefinitely. High priority areas such as marinas would be well suited for herbicide treatment.

Biological Control Agents

Using the predator-prey relationship found in nature, biological control organisms are used for nuisance plant management by artificially increasing one organism to gain control of the other. Two organisms have been used in the Les Cheneaux Islands, the milfoil weevil, (*Euhrychiopsis lecontei*) and a pathogenic fungi (*Mycoleptodiscus terrestris)*.

Milfoil Weevil

The milfoil weevil (*Euhrychiopsis* lecontei) (predator) is a specialist herbivore of Eurasian watermilfoil (prey) and is native to North America. It damages the plant in multiple ways, the most significant impact caused by the weevil larva as it damages the apical meristem, or growing tip, and burrows through the stem eating vital vascular tissue. Nutrient flow within the plant is disrupted and the stem loses buoyancy and eventually collapses in the water column. No permit is required by the state of Michigan. Naturally occurring populations of the weevil have been augmented (as discussed in Section 4) in multiple bays of the LCI.

It should be noted that the use of herbicides has an indirect impact on the milfoil weevil by depleting their food source. However, any copper based products such as algaecides does directly affect the lifecycle of numerous invertebrates including the weevil.

This management technique is completely environmentally safe and offers longer, sustainable milfoil control. A positive attribute of this technique is that this native insect already exists throughout LCI; increasing the population to sufficient numbers would significantly reduce the density of the milfoil. A potential negative to this approach is that it takes longer to accomplish and the rate of control may vary based on seasonal factors. One additional positive aspect is that this technique can be integrated with other management techniques if applied properly.

Pathogenic Fungi

Pathogenic fungi cause disease in organisms by manipulating the molecular makeup of the plant. An experiment using pathogens (*Mycoleptodiscus terrestris*) on the milfoil was set up this season by the LCWC to evaluate the impact in a relatively small area. During the weevil follow-up survey, EnviroScience biologists noted stems to be dying back in the area the pathogen was applied.

Depending on the cost, this technique may be feasible for a large scale treatment. Additional testing is planned for 2014.

Preventive Management

A total of five invasive macrophyte species have been identified within LCI requiring further rmonitoring or active management. Other potential macrophyte species, listed above, pose a major threat to the waterways of Les Cheneaux. Hydrilla, for instance, is much more invasive and problematic than the current underlying issue, Eurasian watermilfoil. This species, if introduced, could be a tremendous detriment to ecosystem of LCI.

A cardinal rule to follow: **prevention** is far less expensive than management. In other words, the management plan should also include preventative measurements to reduce further introductions of invasives into the LCI. Boat wash stations installed at boat launches are a great preventative tool. Boats are the leading cause of invasive introductions, traveling from one infested waterbody to the next, carrying potential hitchikers all around. Washing boats and trailers prior to entering the water could reduce future issues.

Integrated Aquatic Plant Management

Aquatic ecosystems are multi-dimensional systems, affected by a wide variety of factors that are not well understood. An integrated approach to aquatic plant management involves a combination of targeted management techniques to obtain cost-effective and long term results. This is the recommended approach for the Les Cheneaux Islands, as each bay should be treated as individual water bodies with varying degrees of issues. A certain technique used in one bay may not be appropriate for another. The role and importance of maintaining a healthy native plant community has been mentioned repeatedly in this report. Minimal disturbance of the native vegetation is also crucial for the rebounding fisheries. Heavy use of mechanical harvesting or herbicides could have negative impacts on the fishery.

Aquatic plants are a critical component of the LCI ecosystem. Native species compete with milfoil for space, contribute to sediment stabilization, and provide habitat for invertebrates and small fish. Studies suggest that for many lakes, optimal habitat conditions for game fish begin to deteriorate when aquatic vegetation coverage falls below approximately 10% or exceeds 60% coverage. (Valley et. al., 2004). In 2013, LCI is currently within this range throughout every bay. Controlling invasive species (as eradication is typically not possible in a large and open system) is a gradual process that will require ongoing effort and support from the residents of the Les Cheneaux Islands.

An integrated program recommended by EnviroScience includes:

- Harvesting areas to create lanes for navigation
- Bottom barriers around docks
- Spot treat with herbicides in Hessel Bay and Cedarville Bay Marinas
- Implement boat wash stations at each boat launch as a preventive measurement
- Continued dredge/drag technique in dredged channels
- Continued testing areas with the fungi pathogen (*Mycoleptodiscus terrestris*)
- Continued evaluation of the weevil program after another full season (early August, 2014) and consideration of additional weevil stocking in additional areas.

Regardless of the ultimate management techniques used, continued monitoring of both the weevils and the aquatic plant community is critical to evaluate program effectiveness and to track overall changes in the aquatic vegetation community.

7.0 Literature Cited

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