Use of an aquatic weevil, *Euhrychiopsis lecontei,* as a biological control agent against Eurasian watermilfoil (*Myriophyllum spicatum*) in Michigan's Les Cheneaux Islands.

A study sponsored by the
Les Cheneaux Watershed Council

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Summary.
An aquatic weevil (*Euhrychiopsis lecontei*) was used for biological control of the highly invasive Eurasian watermilfoil (*Myriophyllum spicatum*) in Cedarville Bay, a shallow, protected harbor of the Les Cheneaux Islands located in northern Lake Huron. The density and vigor of Eurasian watermilfoil (EWM) was quantified for two years following the introduction of *E. lecontei* in 2007. Program success criteria included reduction of EWM density and re-growth of native macrophytes. Fourteen months following *E.lecontei* introduction, a decrease of eighty-five to ninety-five percent in EWM growth was observed at both test sites. Native macrophytes began to grow in voids where they could not previously compete against the invasive EWM. Presence of a native *E. lecontei* population was a probable factor in successful EWM control in this project. Primary goals of the Les Cheneaux Watershed Council have been achieved by the use of *E. lecontei* to control EWM growth in Cedarville Bay: EWM presence has been significantly reduced, native macrophytes are again present and recreational boaters can now transit portions of the bay that were minimally navigable prior to this study. The Council will continue to monitor EWM growth and re-growth of macrophyte species in the project test areas.

Introduction.
During the summer of 2007 aquatic weevils (*Euhrychiopsis lecontei*) were planted at two test sites in Cedarville Bay to determine their ability to control Eurasian watermilfoil (*Myriophyllum spicatum*). The weevils used are native to temperate waters and have been shown to preferentially feed on the invasive Eurasian watermilfoil *vs.* a native macrophyte, Northern watermilfoil (*Myriophyllum sibiricum*) Aquatic weevils have been commercially produced by EnviroScience Inc., Stow, Ohio, for fifteen years and dozens of successful milfoil control programs have been conducted in lakes across the country, including several Michigan lakes. Biological control of milfoil growth is part of an integrated aquatic weed management approach implemented by the Les Cheneaux Watershed Council to improve the ecology and economy of Cedarville Bay and in the Les Cheneaux area in general.

Background.
Results from the 2007 introducing *E. lecontei* in Cedarville Bay to combat EWM were favorable (Smith, 2008). Weevil totals increased at both test sites, the number of weevils recovered from sampled plants increased and the number of meristems (growing tips) per EWM plant decreased; indicating successful feeding and infestation by the weevils. All of these variables suggest that the commercially-produced weevils acclimated to the local conditions and food source.

Indigenous weevils were found in the test areas during the pre-plant survey conducted by EnviroScience (ESI) staff. Subsequent enumeration by the ESI staff showed that native weevils outnumbered the commercial weevils by a factor of five at one test site and a factor of twenty-five at the other site (Smith, 2008) Accurate values for native weevils could not be made for the untreated control site because the area actually monitored during the pre-introduction survey was not accurately measured.

Methods.

Based on background data provided by the Les Cheneaux Watershed Council (LCWC) staff from EnviroScience, Inc. (ESI) planted approximately 15,000 weevils in Cedarville Bay during June, 2007 (Fig.1).Thirteen thousand weevils were planted at Site-1 and two thousand weevils were planted at Site-2. A third, distant site in the same bay was used as an untreated control (UTC) site (Sloan, 2009). Site-1 was located in 3-4 ft of water about ten meters east of the Boat School channel. Site-2 was in 2-4 ft of water ca forty meters east of dock cribs at the old Shoberg resort. The UTC was also in 2-4 ft of water on the northeast side of Cedarville Bay and about six-tenths of a mile from Site-1, the closer of the two test sites. The UTC marker was placed approximately fifty meters offshore between Markey's and Waterlawn Cottages. Each test site was about three acres in area. GPS coordinates were taken for all three sites.

Site-1	N 45^{o} 59.541'	W 084^{o} 21.517'
Site-2	N 45^{o} 59.346'	W 084^{o} 21.289'
UTC	N 45^{o} 59.727'	W 084^{o} 21.389'

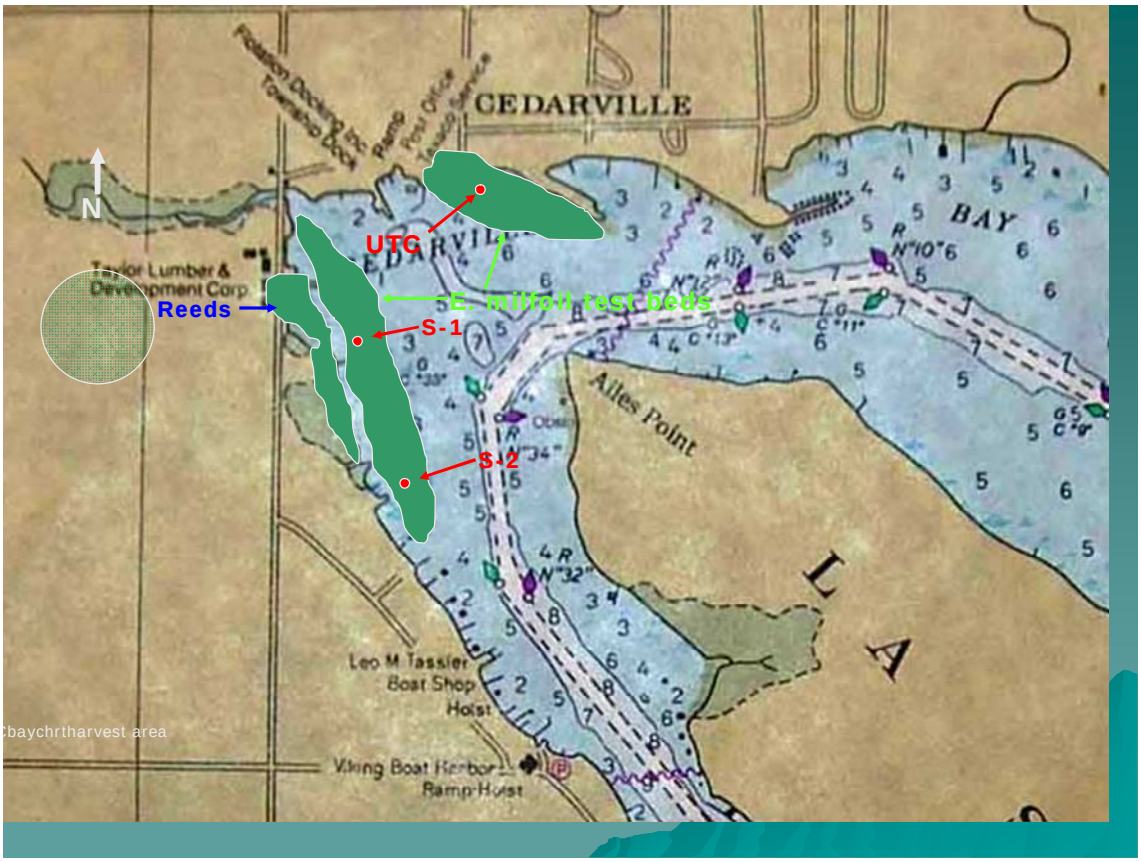


Fig. 1. Relative position of Eurasian watermilfoil beds monitored during Cedarville Bay weevil study: 2007 – 2009.

A survey was conducted at each site to identify native macrophyte species present prior to planting weevils from ESI. EWM plant and stem densities were estimated by sampling a specific number of specimens based on a statistical model. Thirty stems collected from each site were taken to the ESI laboratories to determine the presence of native weevils.

Abbreviations used herein:

ESI: EnviroScience, Inc.
S-1: Test site-1
S-2: Test site-2
UTC: Untreated control site
EWM: Eurasian watermilfoil
LCWC: Les Cheneaux Watershed Council.

Results and Discussion.

Data collected during this three year study are shown in Tables 1 and 2. EnviroScience, Inc. holds the raw data on file. Parameters monitored during each survey included: total weevils per 30 stems ; total stems; average number weevils per stem and meristems per stem. Meristems are the actively growing tips of EWM plants, and the preferred weevil feeding area (Table 1). The most important measure of project success for the Les Cheneaux Watershed Council was the impact of weevils on EWM plant density (Table 2).

Fourteen months post weevil introduction only five percent of the initial EWM density was observed at Site 1. After twenty-six months the EWM density remained low at about ten percent of that initially observed. Site-2 pattern was similar in that less than fifteen percent of the initial EWM crop was present at fourteen months and after twenty-six months less than five percent of the EWM density recorded at the beginning of the study was observed.

EWM density decreased at the untreated control (UTC) site as well but not as dramatically as the treated sites. After fourteen months EWM was eighty-five percent of the initial density and it was about fifty percent of initial density after twenty-six months.

Table 1. Summary Data from Cedarville Bay Site Transect Surveys of Eurasian Watermilfoil for 2007 through 2009. <weevils 2010>

Site	Parameter measured	Pre-Plant (b,c)	2 mo observ	14 mo observ	26 mo observ
		Jun 2007	Aug 2007	Aug 2008	Aug 2009
S-1	Total weevils	8.00	11.00	9.00	21.00
	Total stems	30.00	30.00	30.00	30.00
	Avg Weevils/stem	0.27	0.37	0.30	0.70
	Avg meristems/stem	3.25	2.17	1.20	1.13
S-2	Total weevils	16.00	7.00	0.00	11.00
	Total stems	30.00	30.00	28.00	30.00
	Avg Weevils/stem	0.53	0.23	0.00	0.37
	Avg meristems/stem	2.00	1.97	0.14	1.43
UTC (a)	Total weevils	2.00	9.00	1.00	8.00
	Total stems	30.00	30.00	28.00	30.00
	Avg Weevils/stem	0.07	0.30	0.04	0.27
	Avg meristems/stem	2.87	1.43	0.75	2.63

LEGEND:
(a) UTC: untreated control area
(b) Values for weevil/30 stems during preplant survey indicate native weevil population.
(c) 30 stems were examined for each quantification except for Site-2 and UTC at 14 months where, due to reduced EWM presence, only 28 stems were collected after taking the specified number of sampling attempts.

Table 2. Average density of Eurasian watermilfoil collected during Cedarville Bay surveys from 2007 through 2009. Density reported as stems / m^2. <weevils2 2010>

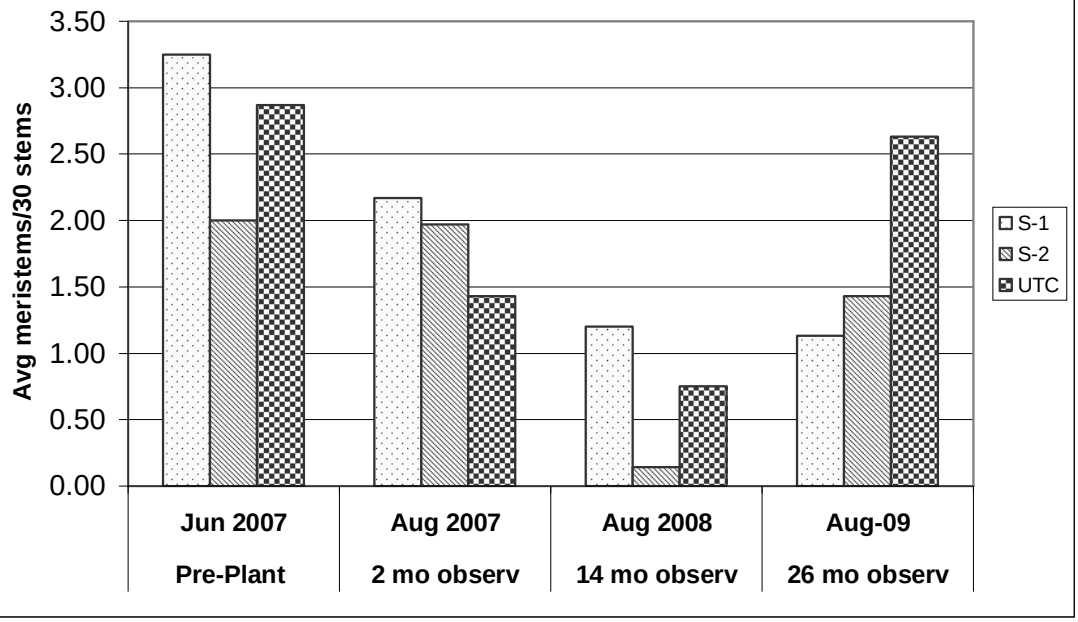
Site	Pre-Plant	2 mo observ	14 mo observ	26 mo observ
	Jun 2007	Aug 2007	Aug 2008	Aug 2009
S-1	244.4	211.1	11.1	25.9
S-2	300.0	166.7	40.0	0.0
UTC (a)	155.6	270.0	133.3	74.1

Legend:
(a) UTC: untreated control site.

A measure of weevil impact on EWM vigor was to observe the change in number of meristems per plant stem. Increased weevil feeding was reflected by fewer meristems on each stem. Fig. 2 shows a decrease in meristem values relative to the time of weevil introduction. Only the UTC showed significant meristem growth twenty-six months post weevil introduction. Based on these data the EWM was considered controlled by *E. lecontei* when the meristem/stem ratio became 1.5 or less.

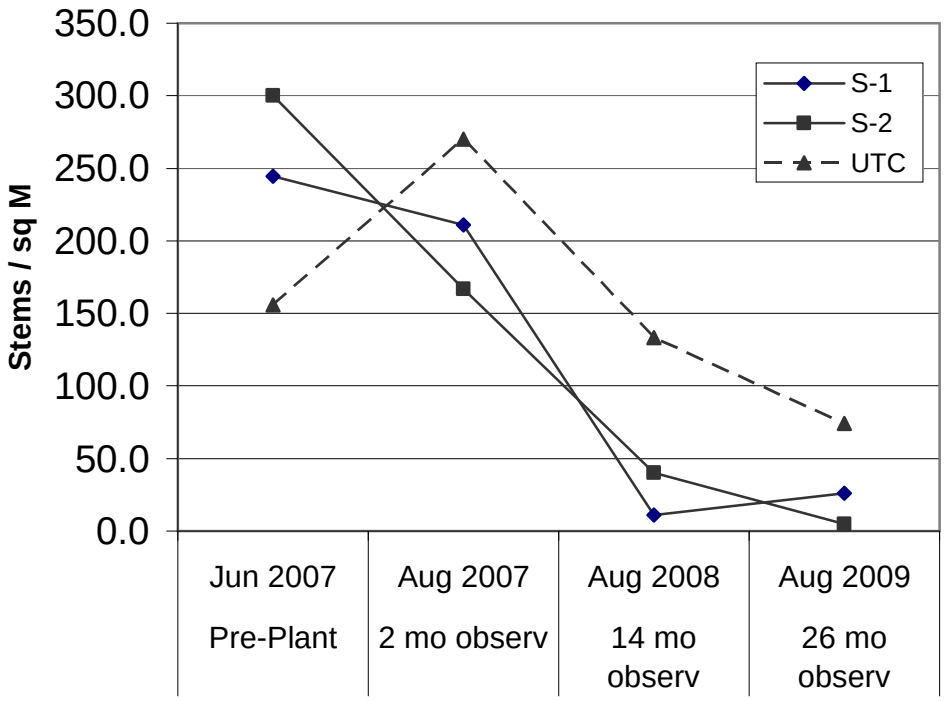
Native macrophytes that grew into the milfoil void included Elodea (*Elodea canadensis*), Northern watermilfoil (*Myriophyllum sibiricum*), Eel grass (*Vallisneria americana*), Claspy leaf pondweed (*Potamogeton richardsonii*) and the alga, *Chara* spp. Other native macrophytes inhabiting Cedarville Bay include Large leaf pondweed (*Potamogeton amplifolious*) and Coontail (*Ceratophyllum demersum*) (Sloan, 2009).

Fig. 2. Weevil impact on EWM as measured by meristem frequency. <weevils 2010 p2>



The dramatic effect of *E. lecontei* on EWM density in Cedarville Bay as displayed in Table 2 is reinforced in Fig. 3. Reduced EWM density was observed at test sites after only eight weeks during the year of weevil introduction. Similarly, both test sites exhibited impressive reductions in EWM density after fourteen months with continued control through 26 months.

Fig. 3. Average EWM density during Cedarville Bay Weevil Project. Weevil impact reported as number of EWM stems/M^2.



Also seen in Fig. 3 is a slow decline in EWM density at the UTC site after fourteen and twenty-six months. It is possible that the commercially-produced weevils had migrated to the UTC area after this length of time. It is also possible that native weevils that were discovered prior to introduction of ESI weevils had an impact on EWM at the UTC site.

The contribution of native weevils in the overall EWM control project is not known. During the two seasons prior to introducing ESI weevils the EWM growth had increased to densities such that recreational boaters had difficulty transiting much of Cedarville Bay from late June until late September. It is probable that native weevil populations were building in response to the increased food source during the same period. Given the significant numbers recorded for native weevils during the pre-introduction survey, it is highly likely that the native weevil population in Cedarville Bay might have had the impact against EWM documented in this study without the use of ESI weevils. At this stage one cannot say. The fortunate point is, however, it appears that *E. lecontei* had a significant role as a biological control agent in reducing EWM growth in Cedarville Bay test areas from 2007 through 2009.

Conclusion.
Primary goals of the Les Cheneaux Watershed Council have been achieved by the use of *E. lecontei* to control EWM growth in Cedarville Bay: EWM presence has been significantly reduced, native macrophytes are again present and recreational boaters can now transit portions of the bay that were minimally navigable prior to this study.

Acknowledgment. Appreciation is expressed to supporters of this project, to include: Les Cheneaux Islands Association, Les Cheneaux Community Foundation, Council members and dozens of individual contributors.

Citations.
Sloan, J. 2009. Les Cheneaux Island Watershed Council MiddFoil Program Summary. EnviroScience, Inc.

Smith, R.A. 2008. Status report on the impact of planting aquatic weevils, *Euhrychiopsis lecontei* (Deitz) in Cedarville Bay to combat Eurasian watermilfoil *(Myriophyllum spicatum*) during the summer of 2007.