# We Energies
# Eurasian Water Milfoil -
# 2009 Management Plan Summary

In 2007, We Energies began implementation of a long-term management program for studying the effectiveness of various control methods and implementation of these methods. An experimental project utilizing manual, chemical, and biological controls was conducted in 2007. Manual (hand pulling) controls were found to be ineffective, while chemical controls were found to be relatively effective after a single treatment. Biological controls were implemented on three reservoirs: Brule, Lower Paint, and Twin Falls. Positive trends were immediately observed in both Lower Paint and in Brule. These included a sharp drop in the cover of Eurasian water milfoil, an increase in native diversity and cover, and evidence of successfully reproducing native milfoil weevils (*Euhrychiopsis lecontei)*. While conducting the weevil release, indigenous populations of the native weevils were observed at both Brule and Lower Paint. Conversely, no weevils were observed in or around the release site at Twin Falls pre or post-release, which occurred in Badwater Lake.

Cowboy Lake in the Kingsford Reservoir exhibited similar characteristics to Badwater Lake during both the 2006 and 2007 seasons. Both water bodies contained the largest extent of Eurasian water milfoil growth as well as the highest densities. Based on the apparent lack of weevils in Badwater Lake, we suspected that one of two factors could be playing a role in why Eurasian water milfoil is growing at such high distribution and densities in these two lakes. We suspected that either significant predation was occurring or weevil reproduction was oppressed by the presence of a hybrid milfoil strain.

The results from 2007 led to the development of a multi-faceted management program. Implementation began in 2008 and was continued in 2009. With the discovery of indigenous weevil populations at two reservoirs and the apparent lack of weevils at Twin Falls, the 2008 and 2009 activities have been focused on evaluating the extent to which indigenous populations are present in the system. We've also studied how other factors could be affecting the weevil reproduction potential. Work over the past two season has focused on the following objectives:

- characterizing the indigenous weevil population throughout the system (2008-09)
- determining whether successful weevil reproduction could occur on known hybrid strains of Eurasian water milfoil (2008)
- evaluating the extent to which weevil predation is occurring: in Twin Falls (i.e. Badwater Lake) and Kingsford (i.e. Cowboy Lake) both 2008-09; Big Quinnesec Falls (2009)
- collect baseline water quality measurements at sample locations in all reservoirs (2008-09)
- supplementing indigenous weevil populations with additional weevils, and evaluate the resulting affects (2007-09)

Indigenous weevil populations were found in each of the nine reservoirs studied in 2008. The nine reservoirs were selected as they are the only ones with Eurasian water milfoil present. Half of the reservoirs were resampled in 2009, with the other half scheduled in 2010. Correlations are beginning to develop between weevil populations and increasing/decreasing trends in Eurasian water milfoil spatial distribution and density. Weevil populations varied from one reservoir to another, with the highest populations generally occurring in reservoirs with either fewer stands of milfoil or the lowest average densities. Where Eurasian water milfoil is on an increasing trend, weevil populations declined between 2008 and 2009, and vice versa.

Attached is a summary report from EnviroScience, Inc. describing the methods and summarizing the results from the weevil population surveys conducted in 2008-2009, the fish predation study, and the weevil release work.

We Energies is currently developing the management program to be carried out in 2010. Facets of this plan include the following items:

- Replication of plan methods implemented in 2008 and 2009 to continue developing an understanding of indigenous populations, predation on these populations, and the affects indigenous populations are having,
- Conducting additional supplemental weevil releases,
- Monitoring of the affects of prior weevil releases, and
- Cooperating with an independent study being run by the Dickinson County Conservation District. The objective of this study is to evaluate Eurasian water milfoil and hybrid forms through a genetic analysis.

# 2009 Progress Report of Milfoil Biological Control Research for the Menominee River

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## INTRODUCTION

In 2008, EnviroScience was contracted to further investigate the milfoil weevil (*Euhrychiopsis lecontei*) and its potential to control Eurasian watermilfoil (*Myriophllum spicatum*) (EWM) within the Menominee River watershed. As a continuation of that study for 2009; weevils were stocked in three reservoirs, four reservoirs were evaluated for the weevil distribution and sunfish were collected from three reservoirs for a study of predation on weevils.

## 1.0 WEEVIL DISTRIBUTION METHODS

During the second week of July 2009, four reservoirs were surveyed for the second year in a row to evaluate the weevil population density. Those four reservoirs were: Big Quinessec, Kingsford, Peavy Falls, and Michigamme Falls. To be consistent, stems of EWM were collected along the same transects taken in 2008. This was achieved by collecting pairs of plants along a transect line placed perpendicular to shore by swimming through selected beds of EWM. The tops of two randomly selected plants were removed at five evenly spaced intervals, for a total of ten plants along each line. Plants were assessed the following day after collection to search for all weevil life stages.

Water quality measurements were taken at each transect, measuring pH, temperature, dissolved oxygen (DO), and conductivity using a YSI 556 MPS multi-parameter water quality monitoring device. All measurements were taken at the surface.

## 1.1 WEEVIL DISTRIBUTION RESULTS

### 1.1.1 Big Quinnesec Reservoir

In 2008, 69 stems were collected from sparse milfoil along seven transects. On July 6, 2009, EnviroScience biologists went back to the same transect locations and collected a total of 60 stems (Figure 1-1). Northern watermilfoil had replaced the Eurasian watermilfoil in the area of transect 2 (T2). Weevils were found on stems from each


**Figure 1-1. WE Energies Big Quinnesec Hydro Project. 2009 Weevil Distribution Survey.**

Survey Transect

EWM_point (WE Energies)

EWM_poly (WE Energies)

500 250 0 500 Meters

1,500 750 0 1,500 Feet

N

2006 NAIP imagery courtesy of USDA. 2009 vegetation points and polygons appear as provided by WE Energies.

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transect surveyed; the highest density found was from T5 and T7. From the assessment of the 60 stems, a total of 61 life stages were found which is down from last year's 171 life stages (Table 1-1). Another finding is the increase in Dissolved Oxygen and Conductivity at each location from 2008 to 2009.

**Table 1-1** 2008 (Gray) and 2009 (White) Stem Analysis and Water Quality Data at Each Transect in Big Quinnesec Reservoir

| | Water Quality | | | | Stem Counts | | | Weevil Count | |
|---|---|---|---|---|---|---|---|---|---|
| Transect | Cond | Temp | pH | DO | Stems | Meristems | Ave. Meristem/ Stem | Total Weevils | Weevils/ Stem |
| 1 | 0.162 | 22.78 | 8.31 | 7.54 | 10 | 25 | 2.5 | 14 | 1.4 |
| 1 | 0.205 | 22.96 | 8.25 | 9.56 | 10 | 8 | 0.80 | 10 | 1.00 |
| 2 | 0.161 | 23.25 | 8.09 | 8.33 | 9 | 26 | 2.89 | 23 | 2.56 |
| 2 | 0.196 | 22.97 | 8.37 | 9.69 | - | - | - | - | - |
| 3 | 0.162 | 23.14 | 8.06 | 7.86 | 10 | 23 | 2.3 | 30 | 3.0 |
| 3 | 0.205 | 23.68 | 8.78 | 11.90 | 10 | 14 | 1.40 | 4 | 0.40 |
| 4 | 0.159 | 22.50 | 8.14 | 7.53 | 10 | 30 | 3.0 | 49 | 4.9 |
| 4 | 0.191 | 23.08 | 8.38 | 9.12 | 10 | 23 | 2.30 | 10 | 1.00 |
| 5 | 0.162 | 22.86 | 8.04 | 7.58 | 10 | 18 | 1.8 | 11 | 1.1 |
| 5 | 0.205 | 23.00 | 8.29 | 9.16 | 10 | 22 | 2.20 | 15 | 1.50 |
| 6 | 0.164 | 23.32 | 8.14 | 8.7 | 10 | 23 | 2.3 | 17 | 1.7 |
| 6 | 0.208 | 23.45 | 8.41 | 9.20 | 10 | 15 | 1.50 | 7 | 0.70 |
| 7 | 0.163 | 23.33 | 8.12 | 9.11 | 10 | 28 | 2.8 | 27 | 2.7 |
| 7 | 0.187 | 23.56 | 8.41 | 10.7 | 10 | 15 | 1.50 | 15 | 1.50 |
| | | | | **2008 TOTAL** | **69** | **173** | **2.51** | **171** | **2.48** |
| | | | | **2009 TOTAL** | **60** | **97** | **1.62** | **61** | **1.02** |

## 1.1.2 Kingsford Reservoir

On July 8, 2009, the survey team collected 150 stems of EWM along the same 15 transect locations developed in 2008 (Figure 1-2). Lab analysis revealed no weevil life stages on the stems collected from transects 13 and 14, located in Cowboy Lake. The overall population of the weevils in each area decreased, with the exception of T6 (Table 1-2). The total weevils/stem for Kingsford Reservoir was 0.41for a total of 62 life stages. The surface temperature was four to six degrees cooler in 2009 than in 2008.

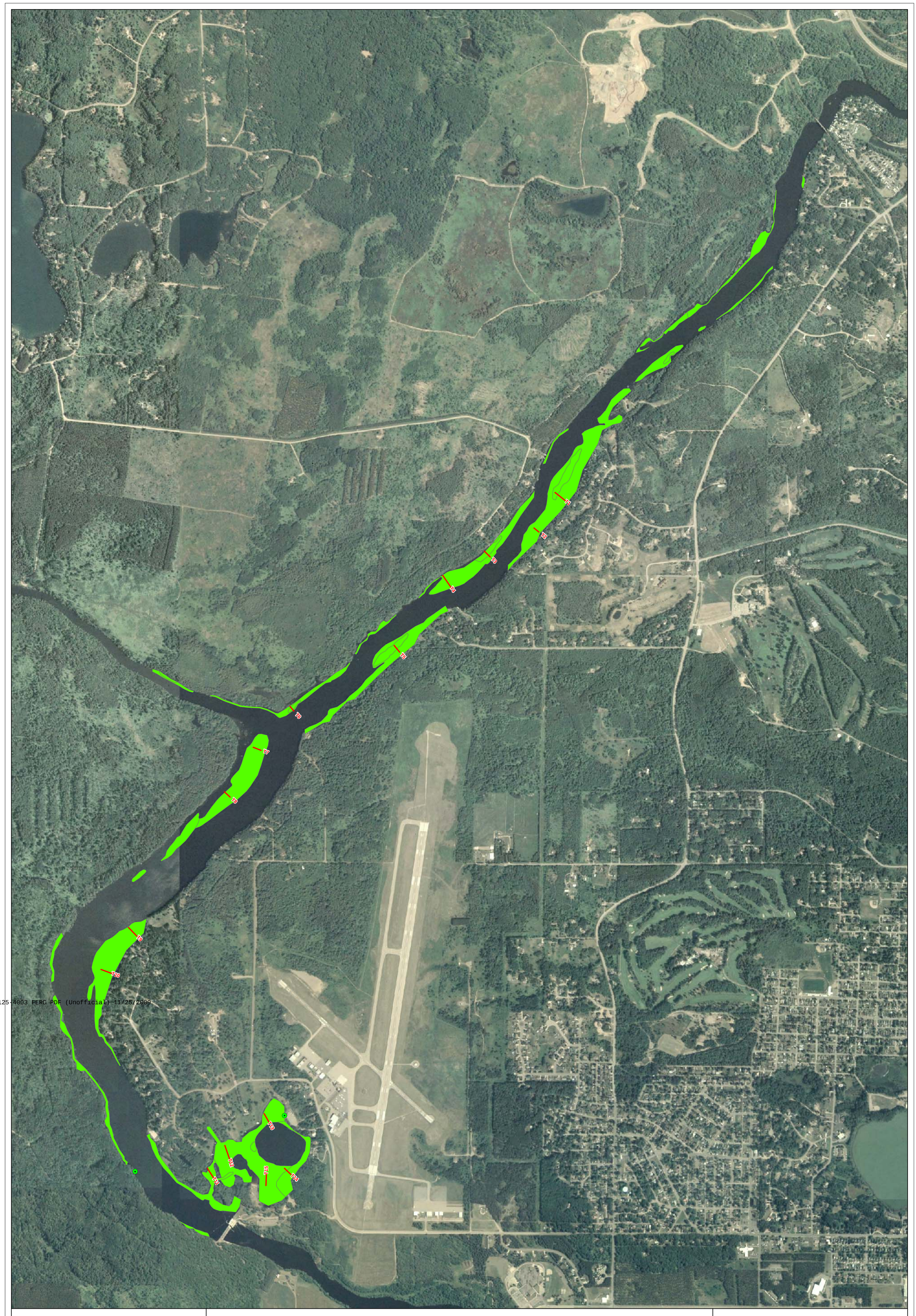


**Figure 1-2. WE Energies Kingsford Hydro Project. 2009 Weevil Distribution Survey.**

Survey Transect

EWM_point (WE Energies)

EWM_poly (WE Energies)

500 250 0 500 Meters

1,500 750 0 1,500 Feet

N

2006 NAIP imagery courtesy of USDA. 2009 vegetation points and polygons appear as provided by WE Energies.

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**Table 1-2** 2008 (Gray) and 2009 (White) Stem Analysis and Water Quality Data at Each Transect in Kingsford Reservoir

| | Water Quality | | | | Stem Counts | | | Weevil Count | |
|---|---|---|---|---|---|---|---|---|---|
| Transect | Cond | Temp | pH | DO | Stems | Meristems | Ave. Meristem/ Stem | Total Weevils | Weevils/ Stem |
| 1 | 0.165 | 25.61 | 8.24 | 7.6 | 10 | 25 | 2.5 | 48 | 4.8 |
| 1 | 0.192 | 21.94 | 8.49 | 9.36 | 10 | 7 | 0.70 | 2 | 0.20 |
| 2 | 0.161 | 24.4 | 7.9 | 7.44 | 10 | 30 | 3.0 | 51 | 5.1 |
| 2 | 0.188 | 21.36 | 8.32 | 9.07 | 10 | 7 | 0.70 | 2 | 0.20 |
| 3 | 0.165 | 25.66 | 7.99 | 7.16 | 10 | 21 | 2.1 | 29 | 2.9 |
| 3 | 0.177 | 21.36 | 8.21 | 8.92 | 10 | 6 | 0.60 | 2 | 0.20 |
| 4 | 0.165 | 25.54 | 7.92 | 7.4 | 10 | 26 | 2.6 | 26 | 2.6 |
| 4 | 0.191 | 21.49 | 8.24 | 8.97 | 10 | 6 | 0.60 | 1 | 0.10 |
| 5 | 0.164 | 25.37 | 8.09 | 9.43 | 9 | 15 | 1.67 | 24 | 2.67 |
| 5 | 0.192 | 21.44 | 8.27 | 8.87 | 10 | 25 | 2.50 | 11 | 1.10 |
| 6 | 0.169 | 25.02 | 7.81 | 12.6 | 10 | 19 | 1.9 | 29 | 2.9 |
| 6 | 0.193 | 21.99 | 8.27 | 9.29 | 10 | 23 | 2.30 | 24 | 2.40 |
| 7 | 0.192 | 30.15 | 8.38 | 9.65 | 10 | 22 | 2.2 | 26 | 2.4 |
| 7 | 0.195 | 22.28 | 8.30 | 9.15 | 10 | 26 | 2.60 | 3 | 0.30 |
| 8 | 0.172 | 27.01 | 8.35 | 9.83 | 10 | 18 | 1.8 | 6 | 0.6 |
| 8 | 0.196 | 21.80 | 8.25 | 9.00 | 10 | 16 | 1.60 | 4 | 0.40 |
| 9 | 0.186 | 28.19 | 8.19 | 8.58 | 10 | 15 | 1.5 | 36 | 3.6 |
| 9 | 0.196 | 21.63 | 8.19 | 8.89 | 10 | 22 | 2.20 | 2 | 0.20 |
| 10 | 0.175 | 28.62 | 8.17 | 8.5 | 9 | 14 | 1.56 | 17 | 1.89 |
| 10 | 0.203 | 22.84 | 8.46 | 9.67 | 10 | 23 | 2.30 | 2 | 0.20 |
| 11 | 0.174 | 29.52 | 8.69 | 8.92 | 10 | 15 | 1.5 | 16 | 1.6 |
| 11 | 0.196 | 22.88 | 8.50 | 9.62 | 10 | 13 | 1.30 | 4 | 0.40 |
| 12 | 0.17 | 28.34 | 8.75 | 9.03 | 10 | 22 | 2.2 | 0 | 0 |
| 12 | 0.188 | 22.91 | 8.81 | 9.73 | 10 | 18 | 1.80 | 3 | 0.30 |
| 13 | 0.171 | 28.25 | 8.73 | 9.17 | 10 | 19 | 1.9 | 11 | 1.1 |
| 13 | 0.189 | 23.07 | 8.79 | 8.76 | 10 | 5 | 0.50 | 0 | 0 |
| 14 | 0.166 | 27.13 | 8.85 | 9.51 | 9 | 18 | 2.0 | 3 | 0.3 |
| 14 | 0.187 | 22.27 | 8.80 | 10.01 | 10 | 2 | 0.20 | 0 | 0 |
| 15 | 0.172 | 28.94 | 8.83 | 9.35 | 10 | 14 | 1.4 | 3 | 0.3 |
| 15 | 0.184 | 22.38 | 8.82 | 10.19 | 10 | 17 | 1.70 | 2 | 0.20 |
| | | | | **2008 TOTAL** | **147** | **293** | **1.99** | **329** | **2.24** |
| | | | | **2009 TOTAL** | **150** | **216** | **1.44** | **62** | **0.41** |

### 1.1.3 Michigamme Falls Reservoir

Two hundred stems of EWM were collected along the 2008 transect locations on July 7, 2009, in Michigamme Falls Reservoir (Figure 1-3). For two consecutive years, weevil life stages have not been identified on the sparse milfoil in the western bay, T7. Additionally, weevils were not found along transect 9 (T9) in 2009. There was a dramatic decrease in the weevil counts in all of the other locations of the reservoir for a total population average of 0.27 weevils/stem (Table 1-3). No stems of EWM were available for collection along transect 17 (T17). For water quality data, Conductivity increased, Temperature decreased, pH stayed the same but the Dissolved Oxygen increased in 2009 (Table 1-3).

**Table 1-3** 2008 (Gray) and 2009 (White) Stem Analysis and Water Quality Data at Each Transect in Michigamme Falls Reservoir

| | Water Quality | | | | Stem Counts | | | Weevil Count | |
|---|---|---|---|---|---|---|---|---|---|
| Transect | Cond | Temp | pH | DO | Stems | Meristems | Ave. Meristem/ Stem | Total Weevils | Weevils/ Stem |
| 1 | 0.094 | 22.7 | 8.37 | 8.45 | 10 | 18 | 1.8 | 27 | 2.7 |
| 1 | 0.113 | 19.31 | 8.12 | 8.97 | 10 | 7 | 0.70 | 1 | 0.1 |
| 2 | 0.094 | 22.6 | 8.19 | 8.48 | 10 | 11 | 1.1 | 2 | 0.2 |
| 2 | 0.113 | 19.64 | 8.01 | 9.44 | 10 | 6 | 0.60 | 1 | 0.1 |
| 3 | 0.093 | 22.59 | 8.01 | 8.02 | 10 | 13 | 1.3 | 13 | 1.3 |
| 3 | 0.111 | 19.22 | 7.97 | 9.51 | 10 | 11 | 1.10 | 1 | 0.1 |
| 4 | 0.093 | 22.46 | 7.89 | 7.78 | 10 | 13 | 1.3 | 4 | 0.4 |
| 4 | 0.113 | 19.60 | 7.97 | 9.47 | 10 | 25 | 2.50 | 2 | 0.2 |
| 5 | 0.092 | 22.04 | 7.92 | 7.98 | 9 | 11 | 1.22 | 5 | 0.56 |
| 5 | 0.113 | 19.88 | 7.90 | 9.33 | 10 | 18 | 1.80 | 3 | 0.3 |
| 6 | 0.092 | 21.88 | 7.83 | 7.85 | 10 | 13 | 1.3 | 21 | 2.1 |
| 6 | 0.113 | 19.92 | 7.86 | 9.18 | 10 | 21 | 2.10 | 10 | 1.0 |
| 7 | 0.091 | 20.93 | 7.8 | 7.5 | 8 | 12 | 1.5 | 0 | 0 |
| 7 | 0.105 | 19.86 | 7.89 | 9.17 | 10 | 19 | 1.90 | 0 | 0 |
| 8 | 0.091 | 22.25 | 8.02 | 7.91 | 10 | 15 | 1.5 | 11 | 1.1 |
| 8 | 0.114 | 20.11 | 7.89 | 9.38 | 10 | 24 | 2.40 | 1 | 0.1 |
| 9 | 0.093 | 22.12 | 7.83 | 7.49 | 10 | 22 | 2.2 | 9 | 0.9 |
| 9 | 0.115 | 20.67 | 8.08 | 9.96 | 10 | 25 | 2.50 | 0 | 0 |
| 10 | 0.092 | 22 | 7.71 | 7.76 | 10 | 23 | 2.3 | 13 | 1.3 |
| 10 | 0.114 | 20.47 | 8.06 | 9.49 | 10 | 23 | 2.30 | 2 | 0.2 |
| 11 | 0.101 | 22.87 | 7.77 | 7.88 | 10 | 28 | 2.8 | 9 | 0.9 |

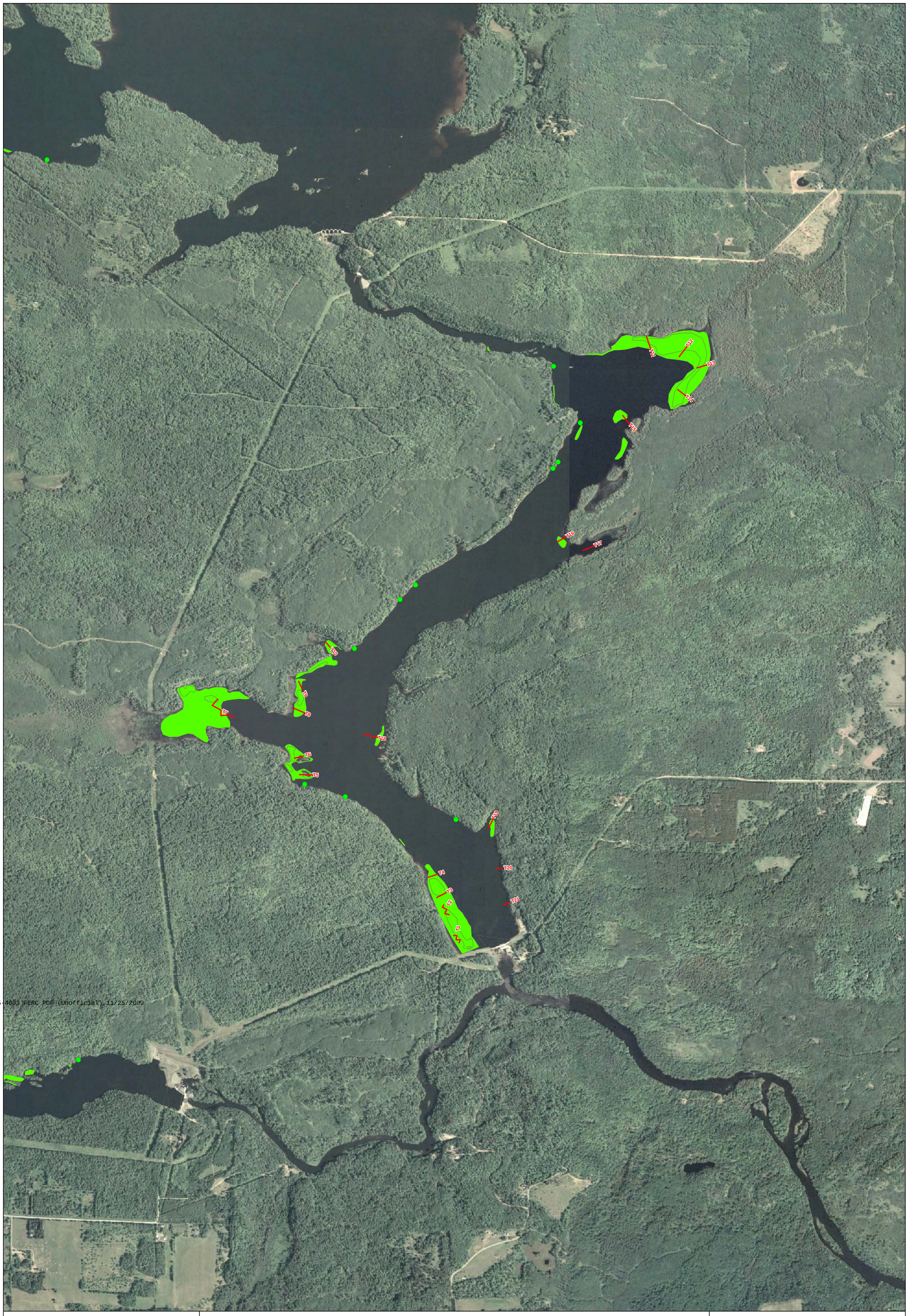




**Figure 1-3. WE Energies Michigamme Falls Hydro Project. 2009 Weevil Distribution Survey.**

Survey Transect

EWM_point (WE Energies)

EWM_poly (WE Energies)

500 250 0 500 Meters

1,500 750 0 1,500 Feet

N

2006 NAIP imagery courtesy of USDA. 2009 EWM points and polygons appear as provided by WE Energies.

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 11 | 0.114 | 20.00 | 7.92 | 9.11 | 10 | 27 | 2.70 | 3 | 0.3 |
| 12 | 0.103 | 22.7 | 8.37 | 8.45 | 10 | 18 | 1.8 | 27 | 2.7 |
| 12 | 0.116 | 19.60 | 7.93 | 9.05 | 10 | 22 | 2.20 | 9 | 0.9 |
| 13 | 0.107 | 22.1 | 7.87 | 8.23 | 10 | 15 | 1.5 | 40 | 4 |
| 13 | 0.122 | 20.13 | 7.97 | 9.65 | 10 | 11 | 1.10 | 1 | 0.1 |
| 14 | 0.096 | 22.75 | 7.91 | 8.28 | 10 | 19 | 1.9 | 22 | 2.2 |
| 14 | 0.116 | 20.60 | 7.99 | 9.46 | 10 | 7 | 0.70 | 1 | 0.1 |
| 15 | 0.094 | 22.61 | 7.88 | 7.92 | 10 | 23 | 2.3 | 21 | 2.1 |
| 15 | 0.113 | 20.14 | 7.60 | 9.54 | 10 | 5 | 0.50 | 1 | 0.1 |
| 16 | 0.095 | 22.99 | 7.97 | 8 | 9 | 10 | 1.11 | 12 | 1.33 |
| 16 | 0.113 | 20.29 | 7.93 | 9.44 | 10 | 7 | 0.70 | 1 | 0.1 |
| 17 | 0.095 | 23.11 | 7.88 | 7.79 | 10 | 26 | 2.6 | 17 | 1.7 |
| 17 | 0.113 | 20.99 | 8.99 | 9.27 | - | - | - | - | - |
| 18 | 0.093 | 22.27 | 7.7 | 7.8 | 10 | 27 | 2.7 | 37 | 3.7 |
| 18 | 0.115 | 20.46 | 7.98 | 9.59 | 10 | 17 | 1.70 | 9 | 0.9 |
| 19 | 0.094 | 23.47 | 7.8 | 8.07 | 10 | 22 | 2.2 | 15 | 1.5 |
| 19 | 0.114 | 19.95 | 7.86 | 9.26 | 10 | 16 | 1.60 | 4 | 0.4 |
| 20 | 0.094 | 22.96 | 7.8 | 8.12 | 10 | 25 | 2.5 | 25 | 2.5 |
| 20 | 0.116 | 20.80 | 7.96 | 9.42 | 10 | 10 | 1.00 | 1 | 0.1 |
| 21 | 0.093 | 22.79 | 7.77 | 7.92 | 5 | 6 | 1.2 | 11 | 2.2 |
| 21 | 0.117 | 21.03 | 8.02 | 9.53 | 10 | 17 | 1.70 | 3 | 0.3 |
| | | | | **TOTAL** | **199** | **378** | **1.89** | **326** | **1.63** |
| | | | | **TOTAL** | **200** | **318** | **1.59** | **54** | **0.27** |

## 1.1.4 Peavy Falls Reservoir

During the 2008 study, thirty transects, 296 stems, were sampled throughout Peavy Falls Reservoir finding a total of 656 weevil life stages (Table 1-4). At the start of the survey on July 6, 2009, it was obvious that the EWM was going to be difficult to find. Only two of the original thirty transect locations contained EWM for collection, T13 and T18. Additional stems were collected from four new locations (T31-T34) (Figure 1-4). Lab analysis found the highest population of weevils in one of the new locations, T31. Although the EWM was found to be sparser during the 2009 survey, the weevil population was still considerably high. On the 60 stems, 107 weevil life stages were found (Table 1-4). The conductivity and dissolved oxygen readings from the six locations were slightly higher than measured in 2008 while the temperature was slightly lower. The pH readings were similar to the 2008 measurements.

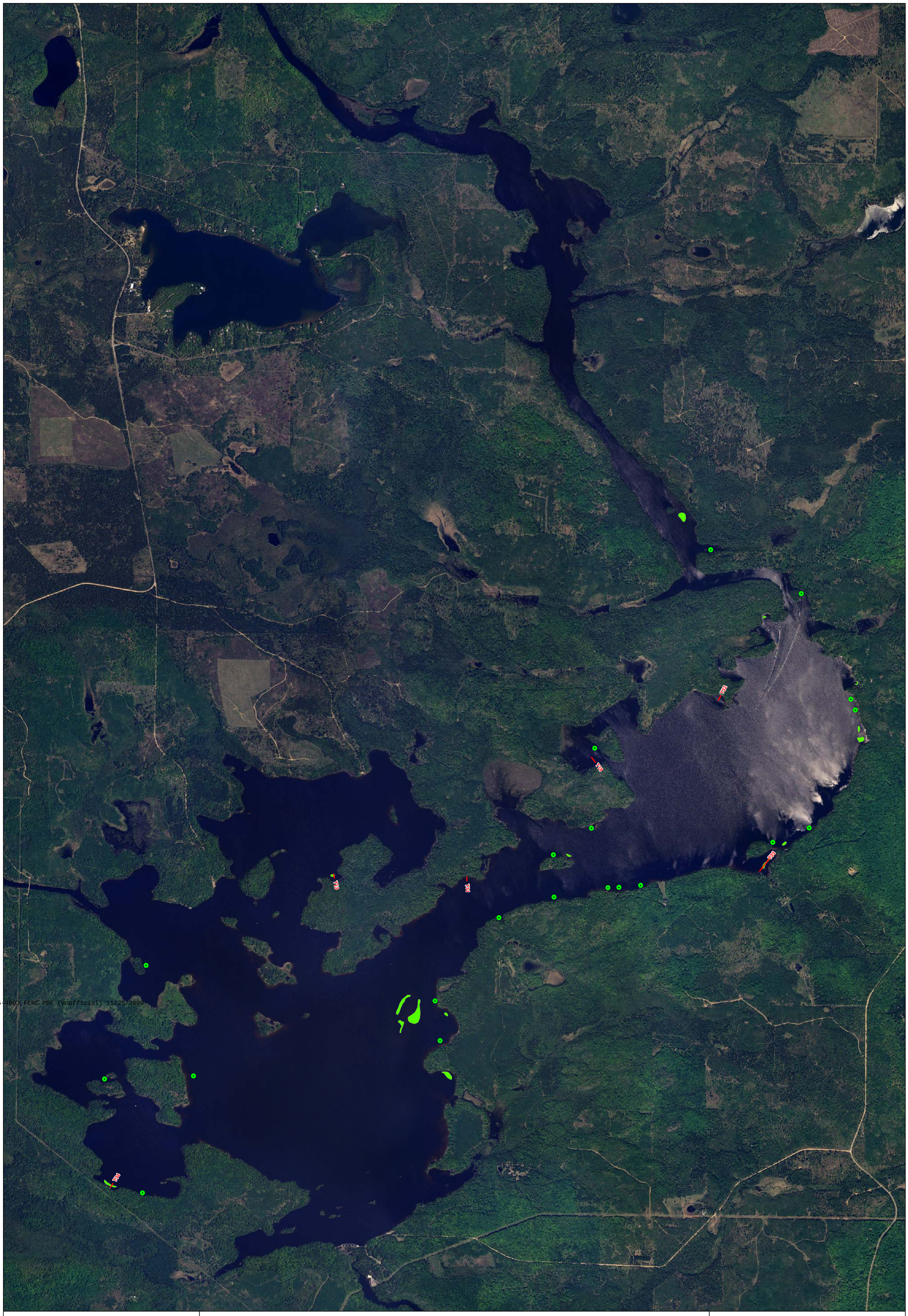


**Figure 1-4. WE Energies Peavy Falls Hydro Project. 2009 Weevil Distribution Survey.**

Survey Transect
EWM_point (WE Energies)
EWM_poly (WE Energies)

600 300 0 600 Meters

2,000 1,000 0 2,000 Feet

N

2005 NAIP imagery courtesy of USDA. 2009 EWM points and polygons appear as provided by WE Energies.

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**Table 1-4** 2008 (White) and 2009 (Gray) Stem Analysis and Water Quality Data at Each Transect in Peavy Falls Reservoir

| | Water Quality | | | | Stem Counts | | | Weevil Count | |
|---|---|---|---|---|---|---|---|---|---|
| Transect | Cond | Temp | pH | DO | Stems | Meristems | Ave. Meristem/ Stem | Total Weevils | Weevils/ Stem |
| 1 | 0.095 | 22.1 | 8.48 | 7.64 | 10 | 26 | 2.6 | 25 | 2.5 |
| 2 | 0.095 | 21.94 | 8.22 | 7.67 | 10 | 18 | 1.8 | 14 | 1.4 |
| 3 | 0.094 | 21.99 | 7.92 | 7.78 | 10 | 34 | 3.4 | 15 | 1.5 |
| 4 | 0.092 | 22.14 | 7.74 | 7.56 | 10 | 36 | 3.6 | 31 | 3.1 |
| 5 | 0.093 | 22.26 | 7.85 | 8.25 | 9 | 14 | 1.55 | 10 | 1.11 |
| 6 | 0.092 | 22.24 | 7.94 | 7.73 | 10 | 14 | 1.4 | 17 | 1.7 |
| 7 | 0.094 | 22.33 | 7.98 | 7.47 | 10 | 21 | 2.1 | 33 | 3.3 |
| 8 | 0.094 | 22.6 | 7.87 | 7.35 | 10 | 16 | 1.6 | 24 | 2.4 |
| 9 | 0.094 | 22.61 | 7.82 | 7.45 | 10 | 17 | 1.7 | 46 | 4.6 |
| 10 | 0.093 | 22.73 | 7.75 | 7.41 | 10 | 14 | 1.4 | 24 | 1.9 |
| 11 | 0.083 | 22.66 | 7.8 | 7.46 | 10 | 13 | 1.3 | 22 | 2.2 |
| 12 | 0.093 | 22.67 | 7.78 | 7.2 | 10 | 15 | 1.5 | 4 | 0.4 |
| 13 | 0.096 | 22.44 | 8.02 | 8.14 | 10 | 39 | 3.9 | 30 | 3 |
| 13 | 0.108 | 19.23 | 7.73 | 9.80 | 10 | 24 | 2.40 | 12 | 1.20 |
| 14 | 0.092 | 22.44 | 8.01 | 8.15 | 10 | 22 | 2.2 | 11 | 1.1 |
| 15 | 0.095 | 22.44 | 7.85 | 7.93 | 10 | 28 | 2.8 | 12 | 1.2 |
| 16 | 0.092 | 21.44 | 7.11 | 8.53 | 10 | 28 | 2.8 | 6 | 0.6 |
| 17 | 0.091 | 21.67 | 7.35 | 7.91 | 10 | 32 | 2.8 | 36 | 0.6 |
| 18 | 0.089 | 21.18 | 7.43 | 6.97 | 10 | 25 | 2.5 | 12 | 1.2 |
| 18 | 0.108 | 20.08 | 7.59 | 8.75 | 10 | 13 | 1.3 | 2 | 0.2 |
| 19 | 0.091 | 21.53 | 7.39 | 7.31 | 10 | 31 | 3.1 | 18 | 1.8 |
| 20 | 0.09 | 21.7 | 7.44 | 7.78 | 10 | 22 | 2.2 | 19 | 1.9 |
| 21 | 0.094 | 21.52 | 7.7 | 7.57 | 10 | 16 | 1.6 | 16 | 1.6 |
| 22 | 0.092 | 21.72 | 7.79 | 7.52 | 10 | 20 | 2.0 | 27 | 2.7 |
| 23 | 0.091 | 21.79 | 7.76 | 7.71 | 9 | 17 | 1.89 | 15 | 1.67 |
| 24 | 0.091 | 21.93 | 7.71 | 8.06 | 10 | 17 | 1.7 | 13 | 1.3 |
| 25 | 0.091 | 21.44 | 7.6 | 8.07 | 10 | 30 | 3.0 | 20 | 2 |
| 26 | 0.092 | 21.8 | 7.66 | 7.53 | 10 | 22 | 2.2 | 15 | 1.5 |
| 27 | 0.091 | 21.15 | 7.7 | 7.93 | 10 | 43 | 4.3 | 75 | 7.4 |
| 28 | 0.09 | 21.46 | 7.59 | 7.55 | 10 | 13 | 1.3 | 15 | 1.5 |
| 29 | 0.097 | 22.27 | 7.72 | 8.16 | 8 | 19 | 2.38 | 36 | 4.5 |
| 30 | 0.095 | 22.43 | 7.8 | 8.4 | 10 | 24 | 2.4 | 21 | 2.1 |
| 31 | 0.108 | 19.88 | 7.6 | 9.6 | 10 | 24 | 2.4 | 40 | 4.0 |
| 32 | 0.108 | 20.42 | 7.70 | 8.23 | 10 | 21 | 4.10 | 28 | 2.80 |
| 33 | 0.110 | 20.48 | 7.64 | 7.97 | 10 | 41 | 4.10 | 28 | 2.80 |
| 34 | 0.112 | 20.90 | 7.90 | 6.01 | 10 | 11 | 1.10 | 9 | 0.90 |

| | | | | | |
|---|---|---|---|---|---|
| **TOTAL** | **296** | **686** | **2.3** | **656** | **2.23** |
| **TOTAL** | **60** | **134** | **2.23** | **107** | **1.78** |

## 1.2 WEEVIL DISTRIBUTION DISCUSSION

A dramatic decrease in the weevil population was observed in Kingsford and Michigamme Reservoirs from 2008 to 2009. The population also decreased in the other two reservoirs, Peavy Falls and Big Quinnesec, but not as much. Although it decreased, the highest weevil population was still observed in Peavy Falls Reservoir. The weevil population was relatively high given the low density of EWM. This year it is possible to correlate the weevil population data with the EWM data collected by WE Energies. In 2009, WE Energies biologists found over seven acres of EWM in Peavy Falls Reservoir during their monitoring survey, which is down from 200 acres found in 2007. This natural decline is congruent with the weevil population. Contrary, WE Energies found an increase in EWM density in Kingsford and Michigamme Falls Reservoirs where EnviroScience found a decrease in weevil population. Density data of EWM for Michigamme Falls will be collected in 2010.

Water quality measurements were taken at each transect in all reservoirs. Parameters measured were dissolved oxygen (DO), temperature, pH, and conductivity. All measurements were lower at every site in Kingsford Reservoir from 2008 to 2009. Readings increased at every site within Big Quinnesec Reservoir, excluding temperature, which stayed the same. For Michigamme Falls, the temperature and DO decreased, conductivity increased, while the pH stayed the same. The pH and DO readings for Peavy Falls Reservoir were comparable to that recorded in 2008 while the temperature readings were lower and conductivity higher. These measurements serve as baseline data within each reservoir from year to year and may reveal some type of correlation between water chemistry and weevil densities in future years. A continuation of this study at every reservoir is suggested and will better illustrate the weevil population dynamics from year to year.

## 2.0 MIDDFOIL® PROGRAM

During the summer of 2007, a MiddFoil® program was started by stocking twenty-five units (1,000 weevils = 1 unit) of milfoil weevils in three reservoirs: Brule, Twin Falls, and Lower Paint. The discovery of an indigenous weevil population that year led to the start of a weevil distribution study in 2008. From that, it was decided to further implement the MiddFoil® program in Brule, Lower Paint and Cowboy Lake stocking eight units in each reservoir. No further implementations occurred in Badwater Lake (Twin Falls Reservoir) due to the lack of EWM found in 2008.

In 2007 and 2009, two basic types of quantitative data collection and one type of qualitative data collection were sampled at the time of the initial and follow-up surveys. The first of these involved collecting plants along three transect lines by swimming through the selected beds of Eurasian watermilfoil perpendicular to shore. The tops of two randomly selected plants were removed at five evenly spaced intervals, for a total of ten plants along each line, and 30 stem samples per site. These plants were analyzed, using a microscope, for the presence of weevils and number of meristems.

Where sufficient EWM stems were found, plant density was determined by collecting all EWM plants within a 0.09 $m^2$ PVC quadrat. These plants were counted and converted to number of plants per square meter. These data will serve as an indicator of increases or decreases in EWM density in future survey years.

A qualitative survey of the overall plant community was accomplished by swimming through and around the bed of milfoil noting the presence and density of native species. This sampling technique provides an indication of weevil impact on the EWM beds. We can compare the follow-up survey to the initial survey to determine if the native plants in the lake are becoming more abundant as the weevils damage the EWM stems.

## 2.1 MIDDFOIL® RESULTS

### 2.1.1 Brule Reservoir – S1B

*Initial survey*

On June 23, 2009, an EnviroScience field team conducted an initial survey at S1B (formerly called S1BR), the same stocking location from 2007 located where the Brule River meets the Menominee River (Figure 2-1). Qualitative measurements included visual analysis of the milfoil plants, presence of weevils and weevil-induced damage, and native plant species present in the areas. The overall density of EWM at S1B was moderate to dense, just below the surface, and damage from weevil larvae was seen on about 15% of the plants. The bed was noted to be larger in size than in 2007.

The EWM was the dominant plant and comprised about 65% of the aquatic plant community. Coontail (*Ceratophyllum demersum*) was the next dominant species within the bed. Other plant species found in lower densities included; common waterweed (*Elodea canadensis*), flat-stem pondweed (*Potamogeton zosterformis*), clasping-leaf pondweed (*Potamogeton richardsonii*), thinleaf pondweed (*Potamogeton capillaceus*), threadleaf pondweed (*Potamogeton filiformis*), ribbonleaf pondweed (*Potamogeton epihydrus*) and lilies (Nuphar spp.).

From the quantitative assessment, lab analysis revealed no weevil life stages on the stems collected from S1B (Table 2-1A). The EWM plants were counted and converted to number of plants per square meter (Table 2-1B). The density was recorded to be lower than it was at the start of the program in 2007.

Over 10,000 weevil eggs and larvae were stocked the following day on June 24. During the stocking event, the lateral meristems fragmented easily.

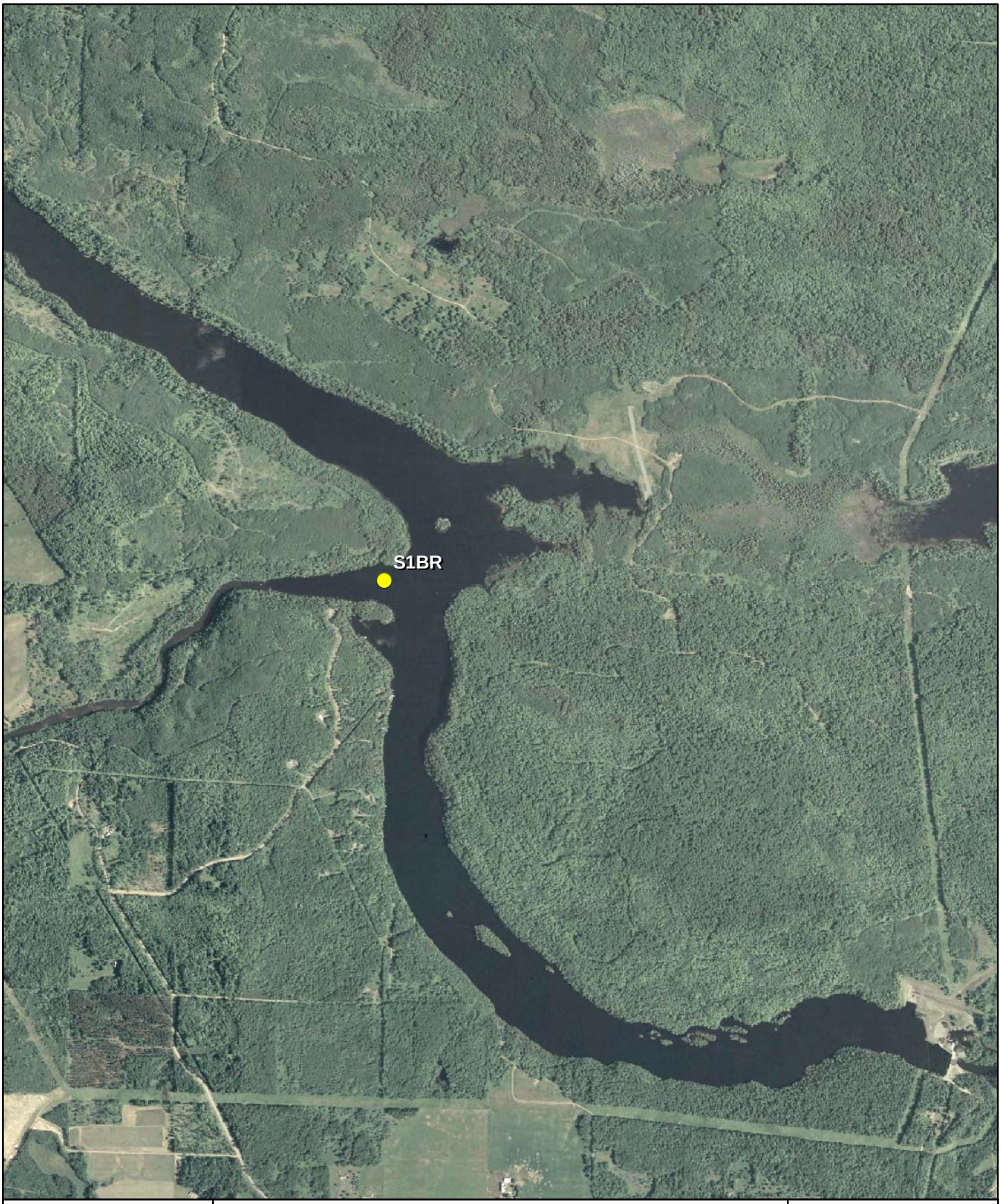


Figure 2-1. MiddFoil Stocking Location, Brule Hydro Project.

2007/2009 Stocking Location

300 150 0 300 Meters

1,000 500 0 1,000 Feet

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*Follow-up survey*

By the time of the follow-up survey, conducted on August 18, 2009, the overall EWM density was still considered moderate to dense with 50% at the surface and 70% flowering. Dense elodea and sago pondweed (*Potamogeton pectinatus*) made up an additional 20% of matted plant material within the bed. Other species noted were flat-stem pondweed and coontail.

Weevil adults, eggs, and larval damage to 20% of the plants were observed in the field. Multiple life stages were found on the stems brought back to the EnviroScience lab (Table 2-1A). The EWM density increased by the time of the follow-up survey but was still less than what was measured in 2007 follow-up survey (Table 2-1B).

**Table 2-1A Summary Data from Site Transect Analysis of EWM During 2007 and 2009 Initial and Follow-up Surveys of Brule Reservoir**

| Site # | Parameter Measured | Initial Survey (June 27, 2007) | Follow-up Survey (August 8, 2007) | Initial Survey (June 23, 2009) | Follow-up Survey (August 18, 2009) |
|---|---|---|---|---|---|
| **S1B** | Total weevils | 18.00 | 15.00 | 0.00 | 12.00 |
| | Total stems | 30.00 | 30.00 | 30.00 | 30.00 |
| | **Total weevils/stem** | **0.60** | **0.50** | **0.00** | **0.40** |
| | Average meristems/stem | 2.13 | 2.73 | 3.07 | 3.13 |

**Table 2-1B Density of Eurasian Watermilfoil Collected During 2007 and 2009 Initial and Follow-up Surveys of Brule Reservoir**

| Site | June 27, 2007 Density (stem /$m^2$) | August 8, 2007 Density (stem /$m^2$) | June 22, 2009 Density (stem /$m^2$) | August 18, 2009 Density (stem/$m^2$) |
|---|---|---|---|---|
| **S1B** | 88.89 | 177.78 | 51.11 | 93.33 |

### 2.1.2 Cowboy Lake – S1C

#### *Initial survey*

On June 23, 2009, a new stocking location was established, S1C, within Cowboy Lake located in the northwest corner before entering into the Menominee River (Figure 2-2). At the time of the survey the EWM was considered moderately dense with 20% at the surface and starting to flower. Weevil adults and larval damage was observed on 40% of the plants. However, lab analysis revealed no life stages on the stems collected (Table 2-2A).

The EWM was the dominant plant and comprised about 75% of the aquatic plant community. Other plant species found included; elodea, flat-stem pondweed, robbins pondweed (*Potamogeton robbinsii*), largeleaf pondweed (*Potamogeton amplifolius*), coontail, northern watermilfoil (*Myriophyllum spicatum*), thinleaf pondweed, eel grass (*Vallisneria americana*), and lilies.

Once the survey was completed, 8,000 weevil eggs and larvae were stocked within the area.

#### *Follow up survey*

By the time of the follow-up survey on August 18, the bed of EWM had increased compromising 80% of the plant community. The majority of the bed, 90%, was at the surface and flowering. While swimming around the bed of milfoil, biologists observed adult weevils and a few areas where the EWM was falling out of the water column caused by larvae damage. The same native plant species that were observed in the initial survey were found during the follow-up with the addition of water marigold (*Bidens beckii*). Lab analysis revealed an increase in both weevil life stages and density (Tables 2-2A, 2-2B).

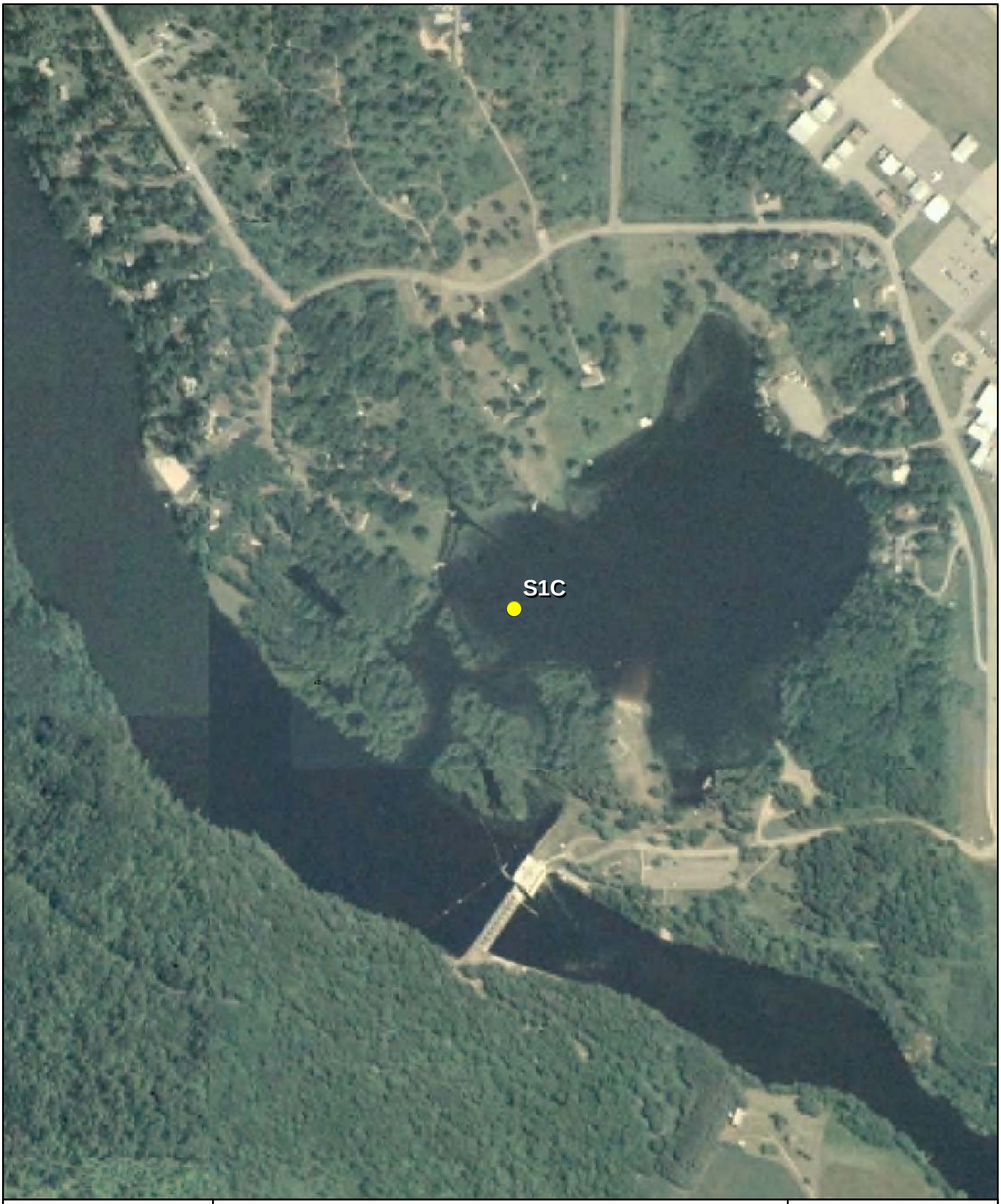


Figure 2-2. MiddFoil Stocking Locations, Cowboy Lake (Kingsford Hydro Project).

2009 Stocking Location

100 50 0 100 Meters

300 150 0 300 Feet

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**Table 2-2A Summary Data from Site Transect Analysis of EWM During 2009 Initial and Follow-up Surveys of Cowboy Lake**

| Site # | Parameter Measured | Initial Survey (June 23, 2009) | Follow-up Survey (August 18, 2009) |
|---|---|---|---|
| **S1** | Total weevils | 0.00 | 2.00 |
| | Total stems | 30.00 | 30.00 |
| | **Total weevils/stem** | **0.00** | **0.07** |
| | Average meristems/stem | 1.13 | 1.90 |

**Table 2-2B Density of Eurasian Watermilfoil Collected During 2009 Initial and Follow-up Surveys of Cowboy Lake**

| Site # | Species | Common Name | June 23, 2009 Density (stem /$m^2$) | August 18, 2009 Density (stem/$m^2$) |
|---|---|---|---|---|
| S1 | *Myriophyllum spicatum* | Eurasian watermilfoil | 50.00 | 88.89 |

## 2.1.3 Lower Paint Reservoir – S1LP, S2LP

### *Initial survey*

On June 22, 2009 two sites were surveyed, S1LP (formerly called S1BP) established in 2007 and S2LP established this summer. S1LP is located north of the hydro dam on the east side of the Lower Paint River while the new site is located farther upstream on the west side (Figure 2-3). At the time of the survey, the EWM was sparse to moderate in S1LP. The old 2007 stocking location was comprised of sporadic patches, however, 20-30 ft from shore the milfoil was dense. Farther out into the middle of the channel a very large, dense bed was discovered. Random stem samples were collected there. Thirty stems were collected from the sporadic patches for the initial survey for S1LP. Larval damage was seen on 30% of the plants.

The EWM at S2LP was considered moderately dense and compromised 40% of the overall plant community. The majority, 60%, of the milfoil was at the surface but only 30% was flowering. The milfoil was denser in the bay and became sparse and mixed


Figure 2-3. MiddFoil Stocking Locations, Lower Paint Hydro Project.

2007 Stocking Location
2009 Stocking Location

200 100 0 200 Meters
500 250 0 500 Feet

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with natives farther out in the river channel. Adult weevils and larval damage were seen on the plants in the lake.

The native plant community seen in both sites included: coontail, northern watermilfoil, flat-stem pondweed, largeleaf pondweed, eel grass, robbins pondweed, thin-leaf pondweed, elodea, bladderwort (*Utricualria vulgaris*), buttercup (*Ranunculus longirostris*), whorled watermilfoil (*Myriophyllum verticulatum*), watershield (*Brasenia shreberi*), sedges (*Carex* spp.) and lilies.

Quantitative analysis revealed weevil life stages from both sites (Table 2-3A) while the density was low (Table 2-3B). No weevil life stages were found on the random stems collected from the newly discovered bed.

### *Follow up survey*

Both sites were revisited on August 18, 2009, to conduct a follow-up survey. The milfoil in S1LP was still sparse but denser than what was observed in the June survey. Larval damage was seen on 30% of the stems. More stems were taken from the large bed in the middle of the river. Larval damage was observed on stems on the outside edges of the bed with minimal damage inside. The milfoil bed at S2LP had taken a different shape by the August survey; there was one small dense area with sparse, sporadic patches all throughout the bay. EnviroScience biologists still considered the area moderate. Weevil eggs, adults, and damage on 70% of the plants were seen in the field.

The same plant community was seen again in the August survey as in the June survey.

Lab results showed a decrease in weevils at S1LP with an increase at S2LP. There was a slight increase in the densities from both sites. Eighteen weevil life stages were found on thirty stems from the large bed in the middle of the river.

**Table 2-3A Summary Data from Site Transect Analysis of EWM During 2007 and 2009 Initial and Follow-up Surveys of Lower Paint Reservoir**

| Site # | Parameter Measured | Initial Survey (June 27, 2007) | Follow-up Survey (August 8, 2007) | Initial Survey (June 22, 2009) | Follow-up Survey (August 18, 2009) |
|---|---|---|---|---|---|
| **S1LP** | Total weevils | 77.00 | 25.00 | 45.00 | 8.00 |
| | Total stems | 30.00 | 30.00 | 30.00 | 30.00 |
| | **Total weevils/stem** | **2.57** | **0.67** | **1.50** | **0.27** |
| | Average meristems/stem | 1.37 | 2.47 | 2.80 | 2.10 |
| **S2LP** | Total weevils | n/a | n/a | 11.00 | 20.00 |
| | Total stems | n/a | n/a | 47.00 | 30.00 |
| | Total weevils/stem | n/a | n/a | **0.23** | **0.67** |
| | Average meristems/stem | n/a | n/a | 2.83 | 2.00 |

**Table 2-3B Density of Eurasian Watermilfoil Collected During 2007 and 2009 Initial and Follow-up Surveys of Lower Paint Reservoir**

| Site | June 27, 2007 Density (stem /$m^2$) | August 8, 2007 Density (stem /$m^2$) | June 22, 2009 Density (stem /$m^2$) | August 18, 2009 Density (stem/$m^2$) |
|---|---|---|---|---|
| **S1LP** | 55.56 | 72.22 | 22.22 | 41.67 |
| **S2LP** | n/a | n/a | 28.89 | 37.78 |

n/a = site not established

## 2.2 MIDDFOIL® DISCUSSION

The use of a biological control agent is to suppress the growth of the plant that it is feeding on, in this case Eurasian watermilfoil. Augmenting the natural population of weevils in Lower Paint Reservoir has achieved positive results. The 2007 stocking site (S1LP) continued to show a positive trend. There was a slight increase in the density of EWM in both sites by the time of the follow-up survey but nothing significant. Brule Reservoir and Cowboy Lake did not exhibit as good of results.

The stocking site in Brule was noted to be larger in size than observed in 2007; however the EWM density data was half the stems $m^2$ at the follow-up survey in 2009 than what

it was in 2007. Weevils were not found in the samples collected during the initial survey. It is likely that the weevils were present but the samples just simply did not capture any weevils. Positively, the population increased by the time of the follow-up survey close to what was observed in 2007.

Although no weevils were found on the stems collected for analysis during the initial survey in Cowboy Lake, three eggs were noted on the stems collected for the population study from the same area (T12) performed two weeks later.

## 3.0 Sunfish Predation Assessment Methods

EnviroScience conducted a sunfish survey to evaluate the impact of these fish on weevil populations. This was accomplished by analyzing the gut contents of fifty sunfish obtained by electrofishing. In 2008, fifty sunfish (*Lepomis macrochirus*, Bluegill, and *Lepomis gibbosus*, Pumpkinseed) were collected from Badwater Lake and Cowboy Lake. Gut analysis from the two lakes revealed higher predation was occurring in Cowboy Lake. It should also be mentioned that the milfoil density in Badwater Lake was considerably low during the 2008 season. In 2009, the same two lakes were evaluated with the addition of Big Quinnesec Reservoir. Fifty sunfish were collected from each water body using a Smith-Root® 5.0 electrofisher. The electrofisher uses pulsed-direct current from anodes mounted to a boom on the front of a 5.33 m (17'6") boat. Electrofishing was performed at night because of the tendency of fish to rise within four to six feet of the surface at night to feed. When shocked, the fish became temporarily stunned and floated to the surface where they were netted. Sampling zones were determined for the areas where weevils were located within the lake. Each sampling zone was approximately 500 m (1640.4 ft.) in length and all available habitats were sampled for approximately 2000 seconds, collecting representative size classes of only Lepomis spp. All specimens were immediately sorted and stored on ice for gut analysis at the EnviroScience laboratory.

The collected fish were identified, weighed, and length measured at the EnviroScience laboratory. Each fish was dissected and any internal anomalies were noted. The digestive tract of each fish was removed using scissors and scalpel, starting at the esophagus and ending at the anus. The contents of the esophagus, stomach (including pyloric caeca), and entire length of intestine was thoroughly investigated under a mounted Wild stereoscopic dissecting microscope. All contents were identified to lowest possible taxa, and all *E. lecontei* encountered (whole and body parts) were enumerated and preserved in 70% ethanol. Data sheets for gut analysis were completed and remaining fish portions were disposed.

## 3.1 Sunfish Predation Assessment Results

### 3.1.1 Cowboy Lake

Three sampling zones were electro fished in Cowboy Lake in 2009. The first of these was the northwest corner (population transect K12) collecting 20 fish, second was the northeast corner (population transect K13) collecting 10 fish, and the final zone was from the southwest corner near the boat launch (population transect 15) collecting 20 fish. A total of 50 sunfish (40 bluegill and 10 pumpkinseed) were collected for gut analysis. The mean length of these fish was 99.8 mm. Thirty-six adult weevils were found in three fish, (2 bluegill, 1 pumpkinseed) collected from the last sampling zone near the boat launch. No predation was found in the gut analysis from the fish collected from the northeast corner of the lake. Forty weevils of a different weevil (Family Curculionidae) species, (further referenced as non-milfoil weevils) were found in five fish, 4 bluegill and 1 pumpkinseed. This unknown species of weevil is larger in size and iridescent in color. The majority of these were found in fish collected from the northwest corner (K12). Snails, clams, chironomid larvae, zooplankton, amphipods, plant material, and other unidentified invertebrates were found in the gut contents. The nematode *Camallanus* sp., also noted last year, was found in the intestines of many fish. Additionally, another parasite “black spot” was found on the outside of eight fish caught from Cowboy Lake. Typically, parasites are indicators of poor water quality.

### 3.1.2 Badwater Lake

Three sampling zones were electro fished in Badwater Lake in 2009, collecting a total of 50 fish with a mean length of 120.74 mm. Twenty fish (fourteen bluegill and six pumpkinseed) were collected from the southern part of the lake (population transect TF23). This is the area where the predation was found in 2008. Four milfoil weevils were found within the stomach contents in addition to one non-milfoil weevil. A total of fifteen fish were collected from the other two sites; the 2007 herbicide treatment area and the other in the furthest northern section of the lake (population transect TF22). Two non-milfoil weevil species were found in 12 bluegill and three pumpkinseed in the first area mentioned. In the last area, one milfoil weevil and three non-milfoil weevils were found in the fourteen bluegill and one pumpkinseed stomach contents.
The analysis of the gut contents consisted of plant material, chironomid larvae, nymphs, isopods, amphipods, snails, unidentified invertebrates, and zooplankton.

### 3.1.3 Big Quinnesec Reservoir

Three sampling zones were electrofished in Big Quinnesec Reservoir collecting 33 bluegill and 17 pumpkinseed. The average mean of the 50 fish was 102.92mm. Twenty fish were collected from the furthest northern bay of the reservoir (population transects 1-3). Ten fish (six bluegill and four pumpkinseed) were collected along the eastern side of the reservoir (population transect 5). The last twenty fish were collected from a bay in the southeastern section of reservoir (population transect 7). The gut analysis revealed no milfoil weevils but 61 non-milfoil weevils. The gut analysis revealed the same contents seen in the other reservoirs.

## 3.2 SUNFISH PREDATION ASSESSMENT DISCUSSION

Based on the results of the gut analyses from 2009, weevil predation is higher in Cowboy Lake. This trend was also observed in 2008. One possible explanation for the higher predation was the food source appeared to be limited. However, this was not the case in 2009. The gut contents revealed the food source was comparable to that found in the other reservoirs. Interestingly, parasites were found in and on the fish only caught from Cowboy Lake. No predation was found to be occurring on the milfoil weevil

in Big Quinnesec Reservoir while limited weevil predation was found in Badwater Lake. Although not identified to species, multiple weevils of the Curculionidae family were found in the stomach contents of fish caught from the three reservoirs.

Document Content(s)